QUEENSLAND
Urban Utilities

ELECTRICAL SWITCHBOARD OPERATION AND MAINTENANCE MANUAL FOR

QUEENSLAND URBAN UTILITIES SEWAGE PUMPING STATION

## TSR02 - JESMOND ROAD

## Developed by:



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# ELECTRICAL SWITCHBOARD OPERATION AND MAINTENANCE MANUAL FOR QUEENSLAND URBAN UTILITIES SEWAGE PUMPING STATION TSR02 - JESMOND ROAD 

DOCUMENT CHANGE HISTORY

## Version History

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## 1 INTRODUCTION

These operating instructions cover the Sewage Pumping Station electrical equipment supplied by J \& P Richardson Industries Pty Ltd in 2014.

### 1.1 OPERATING INSTRUCTIONS

Normal operation of the pumping station is in the automatic mode with control by means of a Motorola RTU, which receives level signals from the Level Measurement System in the wet well.

Manual controls and Manual Emergency operation of the station is available by means of selector switches on the common control compartment of the switchboard.

## 2 DESCRIPTION OF OPERATION

### 2.1 MODE SELECTOR

The station can be operated either in Local-Remote (automatic) or manual emergency mode with selection being made by means of the mode selector switches mounted on common control section escutcheon of the switchboard. The selector switch designated for Manual Emergency Mode is made by means with the following mode selections OFF-ON.

### 2.2 MANUAL EMERGENCY CONTROL

Each pumping unit can be run in manual emergency control from the common control section by: -

1. Selecting the "ON" setting on the "MODE SELECTOR SWITCH" as described in Clause 2.1.
2. The Duty Pump will start.
3. After a time delay, the Standby Pump will start.
4. Return the selector switch back to "OFF".

## N.B. DO NOT LEAVE THE STATION IN MANUAL EMERGENCY CONTROL WHILE UNATTENDED

### 2.3 MANUAL CONTROL

For manual control of the station: -

1. Select the "MANUAL" position on the "MODE SELECTOR SWITCH" on the common control section escutcheon.
2. Starting and stopping of each pump is now controlled via the "START" and "STOP" push buttons located on the common control section escutcheon.
3. To return to Automatic Control, return the selector switch back to "REMOTE".

## N.B. DO NOT LEAVE THE STATION IN MANUAL CONTROL WHILE UNATTENDED

### 2.4 AUTOMATIC CONTROL

For automatic control of the station: -

1. The "MODE SELECTOR SWITCH" on the common control section should be in the "REMOTE" position.
2. The automatic starting and stopping of the pumps is controlled by signals from the Motorola RTU.

For NORMAL OPERATION, each of the pump selector switches should have "EMERGENCY PUMP OFF" mode selected.

In the REMOTE mode the selected Duty Pump unit will start automatically as pre-set by the level in the wet well. In the event of the duty pump not being capable of supplying enough flow to continue draining the wet well and the well level rises to a second pre-set level, then the Standby Pump unit will automatically start to provide additional pumping. The supplementary pump unit also takes over for the respective pump duty on the occurrence of the Duty Pump unit failing. Duty and Standby pump delegation is assigned via the RTU programming.

## 3 ELECTRICAL EQUIPMENT LIST

This list is to be used in conjunction with Sheet 16 of the electrical switchboard drawings (refer Section 5).

| ITEM | DESCRIPTION | SUPPLIER | MANUFACTURER | CATALOGUE NUMBER |
| :---: | :---: | :---: | :---: | :---: |
| 1 | METERING ISOLATOR | SOCOMEC | SOCOMEC | SLB 630 3P |
| 2 | BASIC TRANSFER SWITCH | SCHNEIDER | SCHNEIDER | NSX630M/ MICROLOGIC 2.3M |
| 3 | - TO SUIT MAIN SWITCHES Q2 \& Q3 | SCHNEIDER | SCHNEIDER | Q3 - c/w AUX CONTACTS |
| 4 | Q4 PUMP 1 CIRCUIT BREAKER | SCHNEIDER | SCHNEIDER | NSX250F/ MICROLOGIC 2.2M |
| 5 | Q5 PUMP 2 CIRCUIT BREAKER | SCHNEIDER | SCHNEIDER | NSX250F/ MICROLOGIC 2.2M |
| 6 | Q6 DRYWELL SUMP PUMP CIRCUIT BREAKER | SCHNEIDER | SCHNEIDER | NSX100N - MA12.5 |
| 7 | Q7 ESS SERVICES DB - MAINS SUPPLY - CIRCUIT BREAKER | SCHNEIDER | SCHNEIDER | NSX100N-TM40D |
| 8 | Q8 SUB-DISTRIBUTION BOARD CIRCUIT BREAKER | SCHNEIDER | SCHNEIDER | NSX100N - TM100D |
| 9 | Q9 EM. STORAGE DEWATERING PUMP CIRCUIT BREAKER | SCHNEIDER | SCHNEIDER | C60H-10A |
| 10 | Q10 STATION MAINS PHASE FAILURE CIRCUIT BREAKER | SCHNEIDER | SCHNEIDER | C60H 3P-6A |
| 11 | Q11 PUMP BUILDING 15A GPO CIRCUIT BREAKER | SCHNEIDER | SCHNEIDER | C60H RCBO Type AC 30mA 16A |
| 12 | Q12 RTU LAPTOP GPO CIRCUIT BREAKER | SCHNEIDER | SCHNEIDER | C60H RCBO Type AC 30mA 10A |
| 13 | Q13 DRY WELL LIGHTING CIRCUIT BREAKER | SCHNEIDER | SCHNEIDER | C60H RCBO Type AC 30mA 6A |
| 14 | Q14 DRY WELL VENT FAN CIRCUIT BREAKER | SCHNEIDER | SCHNEIDER | C60H RCBO Type AC 30mA 10A |
| 15 | Q15 GENERATOR AUXILLARY SUPPLY CIRCUIT BREAKER | SCHNEIDER | SCHNEIDER | C60H RCBO Type AC 30mA 10A |
| 16 | Q16 PUMP BUILDING EXTERNAL AREA LIGHTING CCT BKR | SCHNEIDER | SCHNEIDER | C60H RCBO Type AC 30mA 6A |
| 17 | Q17 SURGE FILTER CIRCUIT BREAKER | SCHNEIDER | SCHNEIDER | C60H 1P - 10A |
| 18 | Q18 EM PUMP CNTRL \& SURCHARGE IMMINENT CB | SCHNEIDER | SCHNEIDER | C60H 1P - 6A |
| 19 | Q19 SPARE CIRCUIT BREAKER | SCHNEIDER | SCHNEIDER | C60H 1P - 6A |
| 20 | Q20 PUMP BUILDING 3 PHASE OUTLET CIRCUIT BREAKER | SCHNEIDER | SCHNEIDER | C60H 3P - 20A |
| 21 | Q21 PUMP BUILDING INTERNAL LIGHTING CIRCUIT BREAKER | SCHNEIDER | SCHNEIDER | C60H RCBO Type AC 30mA 6A |
| 22 | Q22 PUMP BUILDING 10A GPO'S CIRCUIT BREAKER | SCHNEIDER | SCHNEIDER | C60H RCBO Type AC 30mA 10A |
| 23 | Q23 VALVE PIT SUMP PUMP POWER SUPPLY | SCHNEIDER | SCHNEIDER | C60H RCBO Type AC 30mA 10A |
| 24 | Q24 SPARE | SCHNEIDER | SCHNEIDER | C60H RCBO Type AC 30mA 10A |
| 25 | Q25 SPARE CIRCUIT BREAKER | SCHNEIDER | SCHNEIDER | C60H 3P-20A |
| 26 | Q26 GANTRY CRANE SUPPLY CIRCUIT BREAKER | SCHNEIDER | SCHNEIDER | C60H 3P - 20A |
| 27 | Q27 ODOUR CONTROL SUPPLY CIRCUIT BREAKER | SCHNEIDER | SCHNEIDER | C60H 3P - 20A |
| 28 | Q28 CHEMICAL DOSING SUPPLY CIRCUIT BREAKER | SCHNEIDER | SCHNEIDER | C60H 3P - 20A |
| 30 | Q30 RTU POWER SUPPLY CIRCUIT BREAKER | SCHNEIDER | SCHNEIDER | C60H 1P - 6A |

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| 31 | Q31 SURGE FILTER ALARM RELAY CIRCUIT BREAKER | SCHNEIDER | SCHNEIDER | C60H 1P - 4A |
| :---: | :---: | :---: | :---: | :---: |
| 32 | Q32 FLOWMETER 240VAC SUPPLY CIRCUIT BREAKER | SCHNEIDER | SCHNEIDER | C60H 1P - 4A |
| 33 | Q33 SPARE | SCHNEIDER | SCHNEIDER | C60H 1P - 4A |
| 35 | Q40 SWITCHROOM 3 PHASE OUTLET CIRCUIT BREAKER | SCHNEIDER | SCHNEIDER | C60H 3P - 20A |
| 36 | Q41 SWITCHROOM AIR CONDITIONER 1 CIRCUIT BREAKER | SCHNEIDER | SCHNEIDER | C60H 1P - 16A |
| 37 | Q42 SWITCHROOM AIR CONDITIONER 2 CIRCUIT BREAKER | SCHNEIDER | SCHNEIDER | C60H 1P - 16A |
| 38 | Q43 SWITCHROOM 10A GPO'S CIRCUIT BREAKER | SCHNEIDER | SCHNEIDER | C60H RCBO Type 30mA 10A |
| 39 | AUXILLIARIES CONTROL PLATE | SCHNEIDER | SCHNEIDER | ACP |
| 40 | INTERLOCKING \& TERMINAL BLOCK UNIT | SCHNEIDER | SCHNEIDER | IVE |
| 41 | AUTOMATIC TRANSFER SWITCH CONTROLLER | SCHNEIDER | SCHNEIDER | UV150 |
| 42 | PUMP 240VAC CONTROL CIRCUIT BREAKER | SCHNEIDER | SCHNEIDER | C60H 1P - 4A |
| 43 | 24VDC CONTROL CIRCUIT BREAKER | SCHNEIDER | SCHNEIDER | C60H 1P - 6A |
| 44 | BATTERY SHORT CCT PROTECTION CIRCUIT BREAKER | SCHNEIDER | SCHNEIDER | C60H 2P-10A |
| 45 | DISTRIBUTION BOARD CHASIS | SCHNEIDER | SCHNEIDER | MSC 18-48 POLE |
| 46 | EMERGENCY LIGHTING TEST KIT | NHP | NHP | CPELK1 |
| 47 | F1-2 - SURGE DIVERTER CIRCUIT FUSES | NHP | NHP | CPELK1 |
| 48 | SURGE DIVERTER | CRITECT | CRITECT | TDS1100-2SR-277 |
| 49 | SURGE FILTER ALARM RELAY - SFAR | CRITECT | CRITECT | DAR-275V |
| 50 | SURGE REDUCTION FILTER - SRF | CRITECT | CRITECT | TDF-10A-240V |
| 51 | ENERGEX PHASE FAILURE RELAY PFRE | SCHNEIDER | SCHNEIDER | RM17TG20 |
| 52 | STATION PHASE FAILURE RELAY - PFRS | SCHNEIDER | SCHNEIDER | RM17TG20 |
| 53 | GENERATOR PHASE FAILURE RELAY - PFRG | SCHNEIDER | SCHNEIDER | RM17TG20 |
| 54 | MAIN NEUTRAL \& EARTH LINKS | CLIPSAL | CLIPSAL | COPPER BAR |
| 55 | DIST. BD NEUTRAL LINK | CLIPSAL | CLIPSAL | BP165D48 |
| 56 | DIST. BD EARTH LINK | CLIPSAL | CLIPSAL | BP165D48 |
| 57 | SURGE DIVERTER NEUTRAL LINK | CLIPSAL | CLIPSAL | L5A |
| 58 | INSTRUMENT EARTH LINK | CLIPSAL | CLIPSAL | L13/25A |
| 59 | FILTERED SUPPLY NEUTRAL LINK | CLIPSAL | CLIPSAL | L7 |
| 61 | F4-9 - PHASE FAILURE - FAULT LIMITING FUSES | NHP | NHP | 6AMP |
| 62 | PUMP VARIABLE SPEED DRIVES \& SEMICONDUCTOR FUSES | DANFOSS | DANFOSS | Model \#: <br> FC202N11T4E5MH1TGC7xxSxxxxAN <br> BKCxxxxDx + Safe Stop |
| 63 | REMOTE KEYPAD MOUNTING KIT | DANFOSS | DANFOSS | 130B1107 |
| 64 | SPEED POTENTIONMETERS $1 \mathrm{k} \Omega 1 \mathrm{~W}$ <br> 1 Turn | NHP | NHP | D7P-POT3 |
| 65 | EMERGENCY PUMPING RELAY - K1 | IDEC | IDEC | RH2B-ULD-DC24V |
| 66 | VSD RUNNING RELAY - K2 | IDEC | IDEC | RH4B-ULD-DC24V |
| 67 | PUMP INTERLOCK RELAY - K3 | IDEC | IDEC | RH1B-ULD-DC24V |
| 68 | PUMP EM.STOP RELAY - K4 | IDEC | IDEC | RH4B-ULD-DC24V |


| 69 | PUMP CONTROL CCT POWER ON <br> RELAY - K5 | IDEC | IDEC | RH1B-ULD-DC24V |
| :--- | :--- | :--- | :--- | :--- |
| 70 | PUMP MOISTURE IN OIL RELAY - K7 |  <br> FUCHS | PEPPEL \& FUCHS | KFA6-ER-1.6 |
| 71 | PUMP MOISTURE IN STATOR RELAY <br> - K8 |  <br> FUCHS | PEPPEL \& FUCHS | KFA6-ER-1.6 |
| 72 | PUMP BEARING TEMPERATURE <br> RELAY - K9 | MOORE <br> INDUSTRIES | MOORE <br> INDUSTRIES | CPA/TPRG/2PRG/24VDC/DIN |
| 73 | PUMP RUN COMMAND RELAY - K20 | IDEC | IDEC | RH1B-ULD-DC24V |
| 74 | PUMP FAULT RESET RELAY - K21 | IDEC | IDEC | RH1B-ULD-DC24V |
| 75 | PUMP EMERGENCY MODE <br> INTERRUPT RELAY - K22 | IDEC | IDEC | R |


| 104 | GENERATOR FAULT RELAY- GFR | IDEC | IDEC | RH1B-ULD-24VDC |
| :--- | :--- | :--- | :--- | :--- |
| 105 | GENERATOR WARNING RELAY - <br> GWR | IDEC | IDEC | RH1B-ULD-24VDC |
| 106 | GENERATOR LOW FUEL RELAY - <br> GLFR | IDEC | IDEC | RH1B-ULD-24VDC |
| 107 | GENERATOR MEDIUM FUEL RELAY - <br> GMFR | IDEC | IDEC | RH1B-ULD-24VDC |
| 108 | GENERATOR RUNNING RELAY - GRR | IDEC | IDEC | RH1B-ULD-24VDC |
| 109 | GENERATOR CANOPY DOOR RELAY - <br> GDR | IDEC | IDEC | RH1B-ULD-24VDC |
| 110 | GENERATOR CB STATUS RELAY - <br> GCB | IDEC | IDEC | TAS |


| 149 | ETHERNET 8 PORT SWITCH | MOXA | MOXA | EDS-208 |
| :---: | :---: | :---: | :---: | :---: |
| 150 | GRAPHIC DISPLAY | REDLION | REDLION | G306A000 |
| 153 | CHEMICAL DOSING TRANSIENT BARRIER CD-TB1 | CRITEC | CRITEC | UTB-30SP |
| 157 | INTERNAL COAX CABLE | TRIO | TRIO | TRIO - SMAM/NM/TL23 |
| 158 | EXTERNAL COAX CABLE | RF <br> INDUSTRIES | RF INDUSTRIES | ANDREW - CNT400 |
| 159 | COAX PLUG | PULSE | PULSE | N-203HS |
| 160 | U CLAMPS | $\overline{\mathrm{RF}}$ <br> INDUSTRIES | RF INDUSTRIES | UNV |
| 164 | MINIATURE THERMAL CIRCUIT BREAKER | PHOENIX CONTACT | PHOENIX CONTACT | TCP 'x'A + UK6FSI/C |
| $\begin{aligned} & 164 . \\ & 1 \\ & \hline \end{aligned}$ | THROUGH TERMINALS | PHOENIX CONTACT | PHOENIX CONTACT | PT2.5 |
| $\begin{aligned} & 164 . \\ & 2 \\ & \hline \end{aligned}$ | DISCONNECT TERMINALS | PHOENIX CONTACT | PHOENIX CONTACT | PT2.5-MT |
| $\begin{aligned} & 164 . \\ & 3 \\ & \hline \end{aligned}$ | THROUGH TERMINALS | PHOENIX CONTACT | PHOENIX CONTACT | PT4 |
| $\begin{aligned} & 164 . \\ & 4 \end{aligned}$ | DUAL LEVEL TERMINALS | PHOENIX CONTACT | PHOENIX CONTACT | PTTB2.5 |
| $\begin{aligned} & 164 . \\ & 5 \\ & \hline \end{aligned}$ | GROUP MARKER CARRIER | PHOENIX CONTACT | PHOENIX CONTACT | UBE |
| $\begin{aligned} & 164 . \\ & 6 \end{aligned}$ | PLUG-IN BRIDGE | PHOENIX CONTACT | PHOENIX CONTACT | FBS |
| $\begin{aligned} & 164 . \\ & 7 \end{aligned}$ | TEST PLUG | PHOENIX CONTACT | PHOENIX CONTACT | PS-5 |
| $\begin{aligned} & 164 . \\ & 8 \\ & \hline \end{aligned}$ | COVER PROFILE (SHROUDING) + CARRIER PLATE | PHOENIX CONTACT | PHOENIX CONTACT | AP-2 + AP2-TU |
| 170 | LAPTOP GPO - TWIN 10A | CLIPSAL | CLIPSAL | $25+449 \mathrm{~A}+449 \mathrm{AP}$ |
| 179 | $\begin{aligned} & \text { 240VAC/24VDC FLOAT BATTERY } \\ & \text { CHARGER - BC1 } \end{aligned}$ | INNOVATIVE ENERGIES | INNOVATIVE ENERGIES | SR250K |
| 180 | ANCILLARY SUPPLY CHANGEOVER CONTACTOR - K50 | $\begin{aligned} & \text { SPRECHER \& } \\ & \text { SCHUH } \end{aligned}$ | $\begin{aligned} & \text { SPRECHER \& } \\ & \text { SCHUH } \end{aligned}$ | CA7 |
| 181 | LIGHTING ISOLATION CONTACTOR K51 | IDEC | IDEC | RH4B-ULD-DC24V |
| 182 | $\begin{aligned} & \text { Q50 ESS SERVICES DB - ANCILLARY } \\ & \text { SUPPLY - CCT BKR } \end{aligned}$ | SCHNEIDER | SCHNEIDER | NSX100N - TM40D |
| 183 | Q51 ESS SERVICES DB MAIN CIRCUIT BREAKER | SCHNEIDER | SCHNEIDER | C60H 1P - 32A |
| 184 | Q52 ANCILLARY BATTERY CHARGER CIRCUIT BREAKER | SCHNEIDER | SCHNEIDER | C60H 1P - 4A |
| 185 | Q53 SWITCHROOM VENTILATION FAN CCT BREAKER | SCHNEIDER | SCHNEIDER | C60H 1P - 6A |
| 186 | Q54 SWITCHROOM INTERNAL LIGHTING CCT BREAKER | SCHNEIDER | SCHNEIDER | C60H RCBO Type AC 30mA 6A |
| 187 | Q55 SWITCHROOM EXTERNAL LIGHTING CCT BREAKER | SCHNEIDER | SCHNEIDER | C60H RCBO Type AC 30mA 6A |
| 188 | Q56 SWITCHROOM EMERGENCY LIGHTING CCT BREAKER | SCHNEIDER | SCHNEIDER | C60H RCBO Type AC 30mA 6A |
| 189 | Q57 SPARE CIRCUIT BREAKER | SCHNEIDER | SCHNEIDER | C60H 1P - 4A |
| 190 | Q58 SPARE CIRCUIT BREAKER | SCHNEIDER | SCHNEIDER | C60H 1P - 4A |
| 191 | $\begin{aligned} & \text { Q59 ESS SERVICES - MAINS SUPPLY } \\ & \text { CONTROL CB } \end{aligned}$ | SCHNEIDER | SCHNEIDER | C60H 1P - 4A |
| 192 | Q60 ESS SERVICES - ANCILLARY SUPPLY CONTROL CB | SCHNEIDER | SCHNEIDER | C60H 1P - 4A |
| 193 | CORROSION INHIBITOR | CORTEC | CORTEC | VPCI-110 OR 111 |

## 4 TEST RESULTS

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disconnected，including the main power supply，generator power supplies and battery power supplies． The following visual inspections shall take place previous to energising the switchboard circuits．All power supplies shall be

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particular lock barrel type.



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Queensland Urban Utilities Electrical Inspector
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 the work complies with the requirements of AS／NZS 3000.



[^2]Owner：Alfonso Chavez
Date
Rev： 14

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Queensland Urban Utilities Electrical Inspector
Company Name J\＆PRichardson Industries
Company Electrical Licence No． 756
Owner：Alfonso Chavez
әןロ

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## әuren Kueduoo <br> J \＆P Richardson Industries

Contractor＇s Signature


## Company Electrical Licence No． 756

 가 ：＾әу
Date
．．．．．．．．．．．．．．．．．．．．．．．．．．．．．．．．．．．．
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Company Name J \＆P Richardson Industries
Contractor＇s Signature specified in the equipment schedule

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Contractor's Signature
Company Electrical Licence No. 756
Owner: Alfonso Chavez
Date

Note: Printed copies of this document should be verified for currency against the published electronic copy.




Company Name J \＆P Richardson Industries
Contractor＇s Signature


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Company Name J \& P Richardson Industries
Queensland Urban Utilities Electrical Inspector
Contractor's Signature


switchboard meets all operational requirements.
F. Live Power and Operational Tests
The following tests shall be m
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QueensIand Urban Utilities Electrical Inspector ........................................

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## Date

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Company Name J \& P Richardson Industries
Contractor's Signature

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G. Non-Conformances and Unauthorised Modifications




 ャレOZIZOに\＆L ：pazulad Doc Id：CA－17a

Company Name J \＆P Richardson Industries

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This section is to be completed only at the conclusion of the FAT：
CA17a－Factory Inspection Tests

## J. \& P. RICHARDSON INDUSTRIES PTY LTD

114 Campbell Avenue, WACOL QLD 4076
Ph: (07) 32712911 -Fax: (07) 32713623
E-mail: jpr@jpr.com.au

## SWITCHBOARD \& SHEETMETAL INSPECTION REPORT

| Customer Name: QUEENSLAND URBAN UTILITIES |  |  | Job No : M74000 / S74000 |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Item: TSR-02 TRANSPORTABLE SWITCHROOM VFD CABLING ENCLOSURE \& CABLING TIER |  |  | Drawing No:486/5/7-0396-000(AMEND. A) to 486/5/7-0396-070 |  |  |
| TASK | $\begin{gathered} \hline \text { PRODUCT } \\ \text { DETAIL } \\ \hline \end{gathered}$ | $\begin{gathered} \hline \text { INSPECTE } \\ \text { D BY } \\ \hline \end{gathered}$ | DATE | $\begin{gathered} \hline \text { PASS / } \\ \text { FAIL } \end{gathered}$ | CORRECTIVE ACTION REQUEST OR COMMENTS |
| Design | Documents | D.MC | 11/02/2014 | $\checkmark$ |  |
| Drafting | Documents | D.MC | 11/02/2014 | $\checkmark$ |  |
| Sheetmetal <br> (Refer F1018 for details) | Switchboard |  |  |  |  |
|  | Doors | $\cdots$ | $1 / 5$ |  |  |
|  | Cell/Panels |  |  |  |  |
| Painting |  |  |  |  |  |
| Process | Powder/Wet |  |  |  |  |
| Min DFT (40 STD) |  |  |  |  |  |
| Cure Test |  | 1 |  |  |  |
| Colour Exterior |  |  | $4 \mathrm{P} / \mathrm{P}$ | $p$ | 4 |
| Colour Internal |  | HV | $1075 / 14$ | $1$ | $1 / 6$ |
| Colour Panels |  |  |  |  |  |
| Cubicle Erection |  |  |  |  |  |
| Electrical Fitout <br> (In accordance with drawings) |  | CK |  |  |  |
|  |  |  |  |  |  |
| $\begin{array}{\|c} \text { Inspection \& Test } \\ \text { (Refer to F1019) } \\ \hline \end{array}$ |  | EEnter | 12/5/14 | Past |  |
|  |  | P.CRAM | 23-5 | p |  |
| Packing |  |  |  |  |  |
| Comments: |  |  |  |  |  |
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| NOTE: - Manufacture is not to proceed to the next process until the item has passed inspection |  |  |  |  |  |
| Affix Status Here: - |  |  |  |  |  |
| Yellow | Awaiting Inspection |  |  |  |  |
| Green | Inspection \& Test Passed |  |  |  |  |
| Red | Inspection \& Test Failed, Awaiting Rectification |  |  |  |  |

## J. \& P. RICHARDSON INDUSTRIES PTY. LTD.

## D 4076

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E-mail: jpr@jpr.com.au

## SWITCHBOARD / SHEETMETAL INSPECTION CHECKLIST



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## SWITCHBOARD / SHEETMETAL INSPECTION CHECKLIST

| CONSTRUCTION | QUALITY |  | COMPLIANCE WITH DRAWINGS |  | REMARKS OR ACTION |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | GOOD | POOR | YES | NO |  |
| 27. Mullion Welded to Divider |  |  |  | $\cdots$ |  |
| 28. Double Hinge Meter Panel Fitted |  |  | - | $\checkmark$ |  |
| 29. Plinth Fitted . |  |  | $r$ | . |  |
| 30. Wall Mount Brackets |  | - | / |  |  |
| 31. Light Switch Brackets |  |  |  | i |  |
| 32. Cowls |  |  | - |  | - |
| $\text { INSPECTED BY: } D \cdot C \cap A N E$ | DATE: 19-3-14 |  |  |  |  |

AFFIX STATUS HERE

Yellow
Green
Red

Awaiting Inspection Inspected/Tested Passed Inspected/Tested Awaiting Rectification

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## SWITCHBOARD / SHEETMETAL INSPECTION CHECKLIST


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Ph: (07) 32712911 - Fax: (07) 32713623
E-mail: Jpr@jpr.com.au
SWITCHBOARD / SHEETMETAL
INSPECTION CHECKLIST

| CONSTRUCTION | QUALITY |  | COMPLIANCE WITH DRAWINGS |  | REMARKS OR ACTION |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | GOOD | POOR | YES | NO |  |
| 27. Mullion Welded to Divider |  |  | - |  |  |
| 28. Double Hinge Meter Panel Fitted |  |  | . |  |  |
| 29. Plinth Fitted |  |  | $\Gamma$ |  |  |
| 30. Wall Mount Brackets |  | - |  |  | . |
| 31.: Light Switch Brackets |  |  |  |  |  |
| 32. Cowls |  |  | - |  | - |
| $\text { INSPECTED BY: } D \cdot C \_A N E:$ | DATE: $19-3-14$ |  |  |  |  |

AFFIX STATUS HERE Yellow Awaiting Inspection
Green Inspected/Tested Passed Red

ELECTRICAL INSTALLATION AND MAINTENANCE
-24 HOUR
BREAKDOWN SERVICE

- SWITCHBOARD DESIGN AND MANUFACTURE
- DATA \&

COMMUNICATIONS

- HIGH VOLTAGE INSTALLATIONS
- ELECTRICAL ENGINEERING, PLC \& PROCESS SOFTWARE DESIGN
- OVERHEAD

RETICULATION \& UNDERGROUND RETICULATION

- ROADWAY LIGHTING \& TRAFFIC SIGNALLING
- MUNICIPAL PUMPING INSTALLATIONS
- PUMPING EQUIPMENT MECHANICAL SERVICE \& REPAIRS
- SHEETMETAL FABRICATION


## BRANCHES

EAGLE FARM
PH: (07) 38683535
IPSWICH
PH: (07) 32811399
TOOWOOMBA
PH: (07) 46343800
GOLD COAST
PH: (07) 55916340
SUNSHINE COAST
PH: (07) 54765133
CHINCHILLA
PH: (07) 46627452
YATALA
PH: (07) 33861355


Q-Pulse Id:
FORM F 1025 - dial 19
dmck0136/slg
Job No: C74000
Email To: Andrew.Hanlon@urbanutilities.com.au
3 June 2014
Queensland Urban Utilities
Attention: Mr. Andrew Hanlon
Dear Sir,

## Certificate of Compliance

TSR02 Temporary Switchroom No. 2 (Jesmond Road)
Please be advised that the abovementioned switchboard and its containing equipment has been manufactured as per our offer and supplied drawings 57-0396-Set_B.

All applicable work was carried out to AS3000:2007 and has been tested in accordance with the prescribed procedure and that such work complies in every respect with the requirements of the electrical safety regulation 2002.

Thank you for your order, we trust that yourself and your team has been impressed by our commitment to QUU and we look forward to assisting you in the future.

Should you require any further information or clarification please do not hesitate in contacting the undersigned.

Yours faithfully,


Darren McKlaren
Technical Officer
Estimator
J \& P Richardson Industries Pty Ltd

## J. \& P. RICHARDSON INDUSTRIES PTY LTD

114 Campbell Avenue, WACOL QLD 4076
Ph: (07) 32712911 - Fax: (07) 32713623
E-mail: jpr@jpr.com.au

## SWITCHBOARD \& SHEETMETAL INSPECTION REPORT

| Customer Name: QUEENSLAND URBAN UTILITIES |  |  | Job No: M74000 / S74000 |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Item: TSR-02 TRANSPORTABLE SWITCHROOM MARSHALLING BOXES MB01 \& MB02 |  |  | Drawing No:486/5/7-0396-000(AMEND. A) to 486/5/7-0396-070 |  |  |
| TASK | $\begin{gathered} \hline \text { PRODUCT } \\ \text { DETAIL } \end{gathered}$ | $\begin{gathered} \text { INSPECTE } \\ \text { D BY } \\ \hline \end{gathered}$ | DATE | $\begin{gathered} \hline \text { PASS / } \\ \text { FAIL } \end{gathered}$ | CORRECTIVE ACTION REQUEST OR COMMENTS |
| Design | Documents | D.MC | 11/02/2014 | $\checkmark$ |  |
| Drafting | Documents | D.MC | 11/02/2014 | $\checkmark$ |  |
| Sheetmetal (Refer F1018 for details) | Switchboard |  | $10 / 2$ | $\bigcirc$ |  |
|  | Doors | , | 173 |  |  |
|  | Cell/Panels |  | 1 |  |  |
| Painting |  |  |  |  |  |
| Process | Powder / Wet |  |  |  |  |
|  |  |  |  |  |  |
| Cure Test |  | 7 |  |  |  |
| Colour Exterior |  |  |  | 0 | Hh |
| Colour Internal |  |  | 190314 |  | $7^{\prime}$ |
| Colour Panels |  |  |  |  |  |
| Cubicle Erection |  |  |  |  |  |
| Electrical Fitout <br> (In accordance with drawings) |  |  |  |  |  |
|  |  |  |  |  |  |
| Inspection \& Test (Refer to F1019) |  | EEnsor | 12/5/16 | Pass |  |
|  |  | D. CRANE | 23-5 | P |  |
| Packing |  |  |  |  |  |
| Comments: |  |  |  |  |  |
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| NOTE: - Manufacture is not to proceed to the next process until the item has passed inspection |  |  |  |  |  |
| Affix Status Here: - |  |  |  |  |  |
| Yellow | Awaiting Inspection |  |  |  |  |
| Green | Inspection \& Test Passed |  |  |  |  |
| Red | Inspection \& Test Failed, Awaiting Rectification |  |  |  |  |

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## SWITCHBOARD / SHEETMETAL INSPECTION CHECKLIST


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E-mail: jpr@jpr.com.au

## SWITCHBOARD / SHEETMETAL

 INSPECTION CHECKLIST| CONSTRUCTION | QUALITY |  | COMPLIANCE WITH DRAWINGS |  | REMARKS OR <br> ACTION |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | GOOD | POOR | YES | NO |  |
| 27. Mullion Welded to Divider |  |  |  |  |  |
| 28. Double Hinge Meter Panel Fitted |  |  | . | $\checkmark$ |  |
| 29. Plinth Fitted . |  |  |  |  |  |
| 30. Wall Mount Brackets |  | - |  |  |  |
| 31.) Light Switch Brackets |  |  |  | . |  |
| 32. Cowls |  |  | - |  |  |
| INSPECTED BY: D. CRAN:B | DATE: | 3- | 14 |  |  |

AFFIX STATUS HERE

Yellow Green Red

Awaiting Inspection
Inspected/Tested Passed
Inspected/Tested Awaiting Rectification

## J. \& P. RICHARDSON INDUSTRIES PTY. LTD.

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Ph: (07) 32712911 -Fax: (07) 32713623
E-mail: jpr@jpr.com.au

## SWITCHBOARD / SHEETMETAL INSPECTION CHECKLIST

| Client: QuU |  |  | JOB NO: $\$ 74000$ |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| PRODUCT DESCRIPTION: CONNECTION BO |  |  | DRAWING \& SCHEDULE NUMBERS$486 / 5 / 7-0396-065 \text { is }$ |  |  |
|  |  |  |  |  |  |
| CONSTRUCTION | QUALITY |  | COMPLIANCE WITH DRAWINGS |  | REMARKS OR ACTION |
|  | GOOD | POOR | YES | No |  |
| 1. Folds |  |  | $\checkmark$ |  |  |
| 2. Welds |  |  | $\checkmark$ |  |  |
| 3. Edges / File |  |  | $\checkmark$ |  |  |
| 4. Gauge |  |  | $\checkmark$ |  |  |
| 5. Material $\quad$, |  |  | $\checkmark$ | , |  |
| 6. Ventilation Openings / Filter Bracket |  | . |  | $\checkmark$ |  |
| 7. Water Ingress Test |  |  | $r$ |  |  |
| 8. Equipment Mounting Arrangement |  |  | $\checkmark$ |  |  |
| 9. Doors Stiffened |  |  |  | $\checkmark$ |  |
| 10. Escutcheons and Lexan Covers |  |  | $\checkmark$ |  |  |
| 11. Cable Saddles |  |  |  | $\checkmark$ |  |
| 12. Grinding - |  |  | $\checkmark$ |  |  |
| 13. Door Stays Fitted |  | . | $\checkmark$ |  |  |
| 14. Earth Studs |  |  | $\checkmark$ |  |  |
| 15. Rubber Retainer |  |  |  | $\checkmark$ |  |
| 16. Drawing Holder |  |  |  | $\checkmark$ |  |
| 17. Hat Sections |  |  |  | $\checkmark$ |  |
| 18. Locking Bars Fitted |  |  | $\checkmark$ |  |  |
| 19. External Crevice Welded and Ground |  |  | $\checkmark$ | . |  |
| 20. Legend Cards |  |  |  | $\checkmark$ |  |
| 21. General Conditions Satisfactory |  |  | $\checkmark$ |  |  |
| 22. Cabinet Clean |  |  | $\checkmark$ |  | - . |
| 23. Job Name and Number Marked on Board and Panels |  |  | / . |  | . $\quad \cdots$ |
| 24. Lap Top Tray |  |  |  | < |  |
| 25. Gland Plates Fitted |  |  | $\checkmark$ |  |  |
| 26. Sunshields Fitted |  | - |  | / |  |

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E-mail: jpr@jpr.com.au
SWITCHBOARD / SHEETMETAL INSPECTION CHECKLIST

| CONSTRUCTION |  | QUALITY |  | $\begin{array}{c}\text { COMPLIANCE } \\ \text { WITH DRAWINGS }\end{array}$ |  |
| :--- | :--- | :--- | :--- | :--- | :--- | \(\left.\begin{array}{c}REMARKS OR <br>

ACTION\end{array}\right]\)

AFFIX STATUS HERE

Yellow Green Red

Awaiting Inspection
Inspected/Tested Passed
Inspected/Tested Awaiting Rectification

## J. \& P. RICHARDSON INDUSTRIES PTY LTD

114 Campbell Avenue, WACOL QLD 4076
Ph: (07) 32712911 -Fax: (07) 32713623
E-mail: jpr@jpr.com.au

## SWITCHBOARD \& SHEETMETAL INSPECTION REPORT

| Customer Name: QUEENSLAND URBAN UTILITIES |  |  | Job No: M74000 / S74000 |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Item: TSR-02 TRANSPORTABLE SWITCHROOM RTU \& MAIN SWITCHBOARDS |  |  | Drawing No:486/5/7-0396-000(AMEND. A)to 486/5/7-0396-070 |  |  |
| TASK | PRODUCT DETAIL | $\begin{gathered} \text { INSPECTE } \\ \text { D BY } \\ \hline \end{gathered}$ | DATE | $\begin{gathered} \hline \text { PASS / } \\ \text { FAIL } \end{gathered}$ | CORRECTIVE ACTION <br> REQUEST OR COMMENTS |
| Design | Documents | D.MC | 11/02/2014 | $\checkmark$ |  |
| Drafting | Documents | D.MC | 11/02/2014 | $\checkmark$ |  |
| Sheetmetal <br> (Refer F1018 for details) | Switchboard |  | 012 | 1 |  |
|  | Doors |  | $1 / 3$ | $\square$ |  |
|  | Cell/Panels |  |  |  |  |
| Painting |  |  |  |  |  |
| Process | Powder/Wet |  |  |  |  |
| Min DFT ( 40 STD) |  |  |  |  |  |
| Cure Test |  |  |  |  |  |
| Colour Exterior |  | 10 | 9.015 | 0 |  |
| Colour Internal |  |  |  |  |  |
| Colour Panels |  |  |  |  |  |
| Cubicle Erection |  |  |  |  |  |
| Electrical Fitout <br> (In accordance with drawings) |  | CK |  |  |  |
|  |  |  |  |  |  |
| $\begin{array}{\|c} \text { Inspection \& Test } \\ \text { (Refer to F1019) } \\ \hline \end{array}$ |  | EEssor | $12 / 5 / 14$ | foss |  |
|  |  | JFOTEY | $22-5-14$ | Pass |  |
| Packing |  |  |  |  |  |
| Comments: |  |  |  |  |  |
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|  |  |  |  |  |  |
| NOTE: - Manufacture is not to proceed to the next process until the item has passed inspection |  |  |  |  |  |
| Affix Status Here: -  <br> Yellow Awaiting Inspection <br> Green Inspection \& Test Passed <br> Red Inspection \& Test Failed, Awaiting Rectification |  |  |  |  |  |
|  |  |  |  |  |  |
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|  |  |  |  |  |  |

## J. \& P. RICHARDSON INDUSTRIES PTY. LTD.

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E-mail: jpr@jpr.com.au

## SWITCHBOARD / SHEETMETAL INSPECTION CHECKLIST



## J. \& P. RICHARDSON INDUSTRIES PTY. LTD.

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## SWITCHBOARD / SHEETMETAL INSPECTION CHECKLIST

| CONSTRUCTION | QUALITY |  | COMPLIANCE WITH DRAWINGS |  | REMARKS OR ACTION |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | GOOD | POOR | YES | No |  |
| 27. Mullion Welded to Divider |  |  | $\checkmark$ |  |  |
| 28. Double Hinge Meter Panel Fitted |  |  | , | $\checkmark$ |  |
| 29. Plinth Fitted |  |  | $\checkmark$ |  |  |
| 30. Wall Mount Brackets |  |  | $\checkmark$ |  |  |
| 31. Light Switch Brackets |  |  |  | . |  |
| 32. Cowls |  |  |  | $\checkmark$ |  |
| InSPECTED BY: D.CRANB: | DATE: | G - | $-14$ |  |  |

## AFFIX STATUS HERE

Yellow Green Red

Awaiting Inspection Inspected/Tested Passed Inspected/Tested Awaiting Rectification

## J. \& P. RICHARDSON INDUSTRIES PT LTD

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## SWITCHBOARD ELECTRICAL INSPECTION \& TEST REPORT

Customer Name: Queensland Urban UTilities Project: TSR-O2 Temporary Switchboard Room \#2 (Jesmood Read) TRR Job No: M 14000 Item: Sewage Pumping Station Mobiles switch chard
Constructed by: CK, pen Tested by:

## 4

| rem check list: |
| :--- |
| Main Functional Units |



| comply with Drawings, Docu |  |
| :---: | :---: |
| Size |  |
| Size |  |
| Size |  |
| Setting |  |
| Size |  |
| Size |  |
| Rating |  |
| Rating |  |
| Rating |  |
| Rating |  |
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| Size |  |
| Size |  |
| Size |  |
| Size |  |
| Label |  |
| Rating |  |
| Size |  |
| Stamped |  |
| Correct |  |
| Size |  |
| Rating |  |


$\qquad$ Date: $12 / 5 / 14$ | Fuse Fittings |
| :--- |
| Circuit Breakers |
| Motor Protection C.B. | General Check List:



| Earth Leakage |
| :--- |
| Earth Leakage Test |


| Earth Leakage Test |  | Rated Current |  | Trip Current |  | Trip Time |  |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |

## Comments:

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E-mail: jpr@jpr.com.au

## SWITCHBOARD CONTINUTTY \& INSULATION TEST REPORT



## J. \& P. RICHARDSON INDUSTRIES PTY LTD

114 Campbell Avenue, WACOL QLD 4076
Ph: (07) 32712911 - Fax: (07) 32713623
E-mail: jpr@jpr.com.au
SWITCHBOARD CONTINUITY \& INSULATION TEST REPORT


SP160 Jesmond Road Indoofdopiny

## SWITCHBOARD ELECTRICAL INSPECTION \& TEST REPORT EARTH LEAKAGE TEST



## SWITCHBOARD ELECTRICAL INSPECTION \& TEST REPORT PRIMARY \& SECONDARY INJECTION TESTS



114 Campbell Avenue, WACOL QLD 4076
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Email: jpr@jpr.com.xu

SWITCHBOARD ELECTRICAL INSPECTION \& TEST REPORT
VFD \& SOFT STARTER SETUP


## J. \& P. RICHARDSON INDUSTRIES PTY. LTD.

114 Campbell Avenue, WACOL QLD 4076
Ph: (07) 32712911 - Fax: (07) 32713623
E-mail: jpr(ajpr.com.au ABN: 23001952325

## LV CIRCUIT TEST SHEET

CUSTOMER: QuU.
JOB NO: M74000
description: TSR-O2 TRANSORTABLE S/RROM
MCC/DISTRIBUTION BOARD NO: TSR-O2
Tested By: D.METRGGART. $\quad$ Date: 5/5/14 $\quad$ Certificate No: MOO224


## LIVE LOW VOLTAGE WORK

## TESTING SWITC̈ABOARDS AND CONXROL PANELS WITHN OUR MANURACTURING PREN.

APPROVED BY: Eric McCulloch (WHSO)
LOCATION: WACOL WORKSHOP DATE: 7.I.5.J. 14

understand and am fully aware of the requirements of this job safety analysis.

| ignatures: | $1 . E \notin Q$ | 4. | 4. | 5. |
| :--- | :--- | :--- | :--- | :--- | :--- |

## LIVE LOW YOLTAGE WORK

## TESTING SWITCABOARDS AND CONCROL PANELS WIXEIN OUR MANUEA CTURING PREM

APPROVED BY: Eric McCulloch (WHSO)
LOCATION: WACOL WORKSHOP DATE: ك.I.5.!!

understand and am fully aware of the requirements of this job safety analysis.

| ignatures: | 1. Elchad | 2. Cham | 3. | 4. | 5. |
| :---: | :---: | :---: | :---: | :---: | :---: |

## LIVE LOW YOLTAGE WORK

## TESTING SWITCABOARDS AND CONXROL PANELS WIXEUN OUR MANUEA CTURING PREN

APPROVED BY: Eric McCulloch (WHSO)
LOCATION: WACOL WORKSHOP DATE: 9.15 .1 .14

|  |  |  |
| :---: | :---: | :---: |
| - Authorisation from person charge | in $\|$PERSONAC PROTECTNYE <br> -Long cotton clothing <br> - <br> Insulating work gloves in test <br> Insulating mats / covers in test <br> Switchboard rescue kit in test <br> - | $\begin{aligned} & \text { MPMENX } \\ & \text { of YES } \\ & \text { of YES } \\ & \text { of YES } \\ & \text { \& YES } \end{aligned}$ |
| TASK <br> LIVE LOW YOLTAGE WORK <br> TESTING SWITCHBOARDS AND CONTROL PANELS WITHIN OUR MANUFACTURING PREMISES | - Isolation points identified and accessible <br> - Work area clear of obstructions <br> - Unauthorised access prevented to work area <br> - P.P.E. is fit for purpose <br> - Test equipment is fit for purpose <br> - Written authority to proceed has been obtained from a person in charge <br> - JPR authorisation to conduct live work is current <br> - Approved dedicated power supply only used for testing. <br> - Approved dedicated power supply in current test <br> (A) RCD protected outputs used at power supply <br> $>$ RCD protection checked daily prior to use <br> > Safety Observeris / is not required <br> (B) Non RCD protected outputs used at power supply <br> $>$ Supervisor consulted prior to use <br> > Safety Observer is in attendance |  |

understand and am fully aware of the requirements of this job safety analysis.

| ignatures: | $1 . \sum C L E m e r$ | 2 Lhang | 3. | 4. | 5. |
| :--- | :--- | :--- | :--- | :--- | :--- |

## LIVE LOW YOLTAGE WORK

TESTING SWIXCABOARDS AND CONXROL PANELS WITEON OUR MANUFA CTURING PREM

APPROVED BY: Eric McCulloch (WHSO)
LOCATION: WACOL WORKSHOP
DATE: 1.7 .5 .1 .14

understand and am fully aware of the requirements of this job safety analysis.

| ignatures: | $1 . E Q$ linoch | $2 . C$ Rue | 3. | 4. | 5. |
| :--- | :--- | :--- | :--- | :--- | :--- |

## APPROVED BY: Eric McCulloch (WHSO)

LOCATION: WACOL WORKSHOP DATE: 27.1.5...!!.4

| AUTHORISATIO |  |
| :---: | :---: |
| - JPR induction completed <br> - Authorisation from JPR person in con to perform live work <br> - Independent body employee Qualifications in accordance with requirements of Electrical Safety Ac $\qquad$ |  |
|  |  |
|  |  |
|  |  |
|  | (Signature) |
|  | JPR Person in Contro |

HAZARDS

- CONTACT WITH LIVE LOW VOLTAGE
- ELECTRIC SHOCK
- BURNS

MINIMUM PERSONAL PROTECTIVE EQUIPMENT

- Long cotton clothing
7 YES
YES
YES

Note:- Items 2,3,4 are to be supplied by the independent body and submitted to JPR for inspection prior to initial use
HAZARDS

- CONTACT WITH LIVE LOW
VOLTAGE
- ELECTRIC SHOCK
• BURNS


## CONTROL MEASURES

- Isolation points identified and accessible
- Work area clear of obstructions
- Unauthorised access prevented to work area Barriers and signage provided by independent body
- P.P.E. is fit for purpose and in test
- Test equipment is fit for purpose and in test
- Authority to proceed has been obtained from JPR person in control
- Independent body authorisation to conduct live work is current (documentation required to support evidence)
- Approved dedicated power supply only used for testing. (JPR supplied)
- Approved dedicated power supply in current test

OPTION
(A) RCD protected outputs used at power supply
$>$ RCD protection checked daily prior to use
$>$ Safety Observer is $/$ is not required (Competent safety observer supplied by independent body for duration of live work, documentation required to support evidence)

## OPTION

(B) Non RCD protected outputs used at power supply
$>$ JPR person in control prior to use
$>$ Safety Observer is in attendance (Competent safety observer supplied by independent body for duration of live work, documentation required to support evidence)

- YES
$\triangle$ YES
- YES

I understand and am fully aware of the requirements of this job safety analysis.
ALL INDEPENDENT BODY EMPLOYEES ON SITE PERFORMING LIVE WORK TO SIGN


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## SWITCHBOARD \& SHEETMETAL INSPECTION REPORT

| Customer Name: QUEENSLAND URBAN UTILITIES |  |  | Job No: M74000 / S74000 |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Item: TSR-02 TRANSPORTABLE SWITCHROOM |  |  | $\begin{aligned} & \text { Drawing No:486/5/7-0396-050(AMEND. A) } \\ & \text { to 486/5/7-0396-070 } \end{aligned}$ |  |  |
| TASK | $\begin{gathered} \hline \text { PRODUCT } \\ \text { DETAIL } \end{gathered}$ | $\begin{gathered} \text { INSPECTE } \\ \text { D BY } \end{gathered}$ | DATE | $\begin{gathered} \hline \text { PASS / } \\ \text { FAIL } \end{gathered}$ | CORRECTIVE ACTION REQUEST OR COMMENTS |
| Design | Documents | D.MC | 11/02/2014 | $\checkmark$ |  |
| Drafting | Documents | D.MC | 11/02/2014 | $\checkmark$ |  |
| Sheetmetal <br> (Refer F1018 for details) | Switchboard |  |  |  |  |
|  | Doors |  |  |  |  |
|  | Cell/Panels |  |  |  |  |
| Painting |  |  |  |  |  |
| Process | Powder/Wet | , |  |  |  |
| Min DFT (40 STD) |  |  |  |  |  |
| Cure Test |  |  |  |  |  |
| Colour Exterior |  |  |  |  |  |
| Colour Internal |  |  |  |  |  |
| Colour Panels |  |  |  |  |  |
| Cubicle Erection |  |  |  |  |  |
| Electrical Fitout <br> (In accordance with drawings) | CK |  |  |  |  |
|  |  |  |  |  |  |
| Inspection \& Test (Refer to F1019) |  | E Ensor | $12 / 5 / 14$ | lass |  |
|  |  | DCRANL | $23-5$ | $\beta$ |  |
| Packing |  |  |  |  |  |
| Comments: |  |  |  |  |  |
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|  |  |  |  |  |  |
| NOTE: - Manufacture is not to proceed to the next process until the item has passed inspection |  |  |  |  |  |

Affix Status Here: -

| Yellow | Awaiting Inspection |
| :--- | :--- |
| Green | Inspection \& Test Passed |
| Red | Inspection \& Test Failed, Awaiting Rectification |

5 "AS INSTALLED" RED PENNED DRAWINGS

## 6 SERVICE \& MAINTENANCE

This product is designed to operate under specific environmental, supply and load conditions. Should these conditions change, consult a licenced electrician or electrical engineer before operating this product.

These procedures are to be performed only by a licenced electrician as they may expose live equipment.
The Switchgear and Control gear Assembly is essentially maintenance free, however the following safety measures and routine maintenance is recommended.

Where fitted, ensure cabinet vents and filters are clear and clean.
During operation, ensure all doors and covers are secure and closed.
All faults are to be investigated and repaired by an appropriately licenced electrician.
All components to be operated in accordance with manufacturers data.
The protective devices within switchboards are designed to operate in the event of a short circuit or overload condition. In the event of these devices operating under such conditions the device or devices must be inspected and tested by a suitably trained person to ascertain its condition prior to reconnecting the protective device to the supply.

## Periodic checks should ensure

The switchboard is clean and free of any contaminants, which could reduce the insulation properties of the switchboard.
All entries are sealed to ensure no vermin can enter.
There is no evidence of overheating, arcing or moisture.
The earthing system is maintained and is adequate to allow correct operation of protective devices.
Insulation resistance is maintained to appropriate levels.
Check terminations for correct tension.
Test operation of protective devices.
Re-calibrate instrument loops as required.
Refer to AS-INSTALLED electrical drawings for details of protection equipment settings.
No special tools or equipment are required to perform routine maintenance.

7 ELECTRICAL EQUIPMENT TECHNICAL INFORMATION


## SLB Standard load-break switches <br> SIRCO 125 to 4000 A



SLB 125... 630

The SIRCO range of load-break switches offer compact solutions for switching from 125 A to 4000 A . Base mounting is standard.
The SIRCO range are a proven, reliable design that more than suit harsh Australian conditions.
The switches come complete with extended shaft and door mountable pistol grip handle.
Available in three and four pole versions with a large range of accessories to choose from.
Front operated surface mount
(Supplied with external handle and shaft)

| 125 A | AC 21400 V <br> (A) | AC 23400 V <br> (A) | $\begin{aligned} & \text { AC } 23400 \mathrm{~V} \\ & \text { (kW) } \end{aligned}$ | No. of poles ${ }^{1}$ ) | Cat. No. |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | 125 | 125 | 63 | 3 | SLB 125 3P |
|  |  |  |  | 4 | SLB 125 4P |
| 160 A | 160 | 160 | 80 | 3 | SLB 160 3P |
|  |  |  |  | 4 | SLB 160 4P |
| 200 A | 200 | 200 | 100 | 3 | SLB 200 3P |
|  |  |  |  | 4 | SLB 200 4P |
| 250 A | 250 | 250 | 132 | 3 | SLB 250 3P |
|  |  |  |  | 4 | SLB 250 4P |
| 315 A | 315 | 315 | 160 | 3 | SLB 315 3P |
|  |  |  |  | 4 | SLB 315 4P |
| 400 A | 400 | 400 | 220 | 3 | SLB 400 3P |
|  |  |  |  | 4 | SLB 400 4P |
| 500 A | 500 | 400 | 280 | 3 | SLB 500 3P |
|  |  |  |  | 4 | SLB 500 4P |
| 630 A | 630 | 500 | 280 | 3 | SLB 630 3P |
|  |  |  |  | 4 | - ${ }^{\text {SLB }} 630$ 4P |
| 800 A | 800 | 800 | 450 | 3 | SLB 800 3P |
|  |  |  |  | 4 | - SLB 800 4P |

Notes: ${ }^{1}$ ) 6 and 8 pole switches available on indent. Refer NHP.
i Available on indent only.


SLB 800... 3150

# Technical data and dimensions (mm) 

COMO M SLB 20 to 100 A

COMO M 20 to 40 A


COMO M 63 to 100 A


COMO M Selector handle door drilling


COMO M Pistol handle door drilling


# Technical data and dimensions (mm) <br> SIRCO SLB 125 to 2500 A 

## SIRCO 125 to 2500 A



| Rating | Overall dimensions |  | Terminal shrouds |  | Switch body |  |  |  |  |  |  |  |  | Switch mounting |  |  |  | Connection terminals |  |  |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| A |  | D |  | AD | $\begin{aligned} & \mathrm{F} \\ & 3 p \\ & \hline \end{aligned}$ | $\begin{aligned} & F \\ & 4 p \end{aligned}$ |  | H | $\begin{aligned} & \mathrm{J1} \\ & 3 \mathrm{p} \end{aligned}$ | $\begin{aligned} & \mathrm{J1} \\ & 4 \mathrm{p} \end{aligned}$ | J2 | K | BC |  | $\begin{aligned} & M \\ & 4 p \end{aligned}$ |  | R | T | U | U1 | V | W | $\begin{aligned} & \mathrm{X} 1 \\ & 3 p \\ & \hline \end{aligned}$ | $\begin{aligned} & \mathrm{X1} \\ & \text { 4p } \end{aligned}$ | X2 | Y | Z | AA | BA | CA |
| 125 | 120 | 124... 354 | 235 | 50 | 140 | 170 | 93 | 65 | 45 | 75 | 75 | 31.5 | 80 | 120 | 150 | 65 | 5.5 | 36 | 20 | 20.5 | 25 | 9 | 28 | 22 | 20 | 3.5 | 20.5 | 135 | 115 | 10 |
| 160 | 120 | 124... 354 | 235 | 50 | 140 | 170 | 93 | 65 | 45 | 75 | 75 | 31.5 | 80 | 120 | 150 | 65 | 5.5 | 36 | 20 | 20.5 | 25 | 9 | 28 | 22 | 20 | 3.5 | 20.5 | 135 | 115 | 10 |
| 200 | 130 | 135... 365 | 290 | 60 | 180 | 230 | 108 | 75 | 55 | 105 | 105 | 34 | 115 | 160 | 210 | 80 | 5.5 | 50 | 25 | 25.5 | 30 | 11 | 33 | 33 | 27 | 3.5 | 22.5 | 160 | 130 | 15 |
| 250 | 130 | 135... 365 | 290 | 60 | 180 | 230 | 108 | 75 | 55 | 105 | 105 | 34 | 115 | 160 | 210 | 80 | 5.5 | 50 | 25 | 25.5 | 30 | 11 | 33 | 33 | 27 | 3.5 | 22.5 | 160 | 130 | 15 |
| 315 | 165 | 167... 397 | 401 | 89 | 230 | 290 | 170 | 110 | 75 | 135 | 135 | 55 | 115 | 210 | 270 | 140 | 7 | 65 | 32 | 45.5 | 37.5 | 11 | 42.5 | 37.5 | 37.5 | 5 | 36 | 235 | 205 | 15 |
| 400 | 165 | 167... 397 | 401 | 89 | 230 | 290 | 170 | 110 | 75 | 135 | 135 | 55 | 115 | 210 | 270 | 140 | 7 | 65 | 32 | 45.5 | 37.5 | 11 | 42.5 | 37.5 | 37.5 | 5 | 36 | 235 | 205 | 15 |
| 500 | 165 | 167... 397 | 401 | 89 | 230 | 290 | 170 | 110 | 75 | 135 | 135 | 55 | 115 | 210 | 270 | 140 | 7 | 65 | 32 | 45.5 | 37.5 | 13 | 42.5 | 37.5 | 37.5 | 5 | 36 | 235 | 205 | 15 |
| 630 | 165 | 167... 397 | 400 | 89 | 230 | 290 | 170 | 110 | 75 | 135 | 135 | 55 | 115 | 210 | 270 | 140 | 7 | 65 | 45 | 45.5 | 50 | 13 | 42.5 | 37.5 | 37.5 | 5 | 36 | 260 | 220 | 20 |



Castell Drilling


| Rating | Switch body |  | Switch mounting |  | Connection terminals |  |  |  |  |  |  |  |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| A | F 3p | F 4p | M 3p | M 4p | T | U | V | Y | X1 | X2 | Z | AA |
| 800 | 280 | 360 | 255 | 335 | 80 | 50 | 60.5 | 7 | 47.5 | 47.5 | 46.5 | 321 |
| 1000 | 280 | 360 | 255 | 335 | 80 | 50 | 60.5 | 7 | 47.5 | 47.5 | 46.5 | 321 |
| 1250 | 372 | 492 | 347 | 467 | 120 | 90 | 44 | 8 | 53.5 | 53.5 | 47.5 | 288 |
| 1600 | 372 | 492 | 347 | 467 | 120 | 90 | 44 | 8 | 53.5 | 53.5 | 47.5 | 288 |
| 1800 | 372 | 492 | 347 | 467 | 120 | 90 | 44 | 8 | 53.5 | 53.5 | 47.5 | 288 |


Rating

| Rating <br> A | A 3p | Overall dimensions | A 4p | M 3p | Switch mounting |
| :--- | :--- | :--- | :--- | :--- | :--- |
| 2000 | 372 | 492 | 347 | M 4p |  |
| 2500 | 372 | 492 | 347 | 467 |  |

# Technical data and dimensions (mm) 

## SIRCO SLB 3150 to 4000 A

## SIRCO 3150 A



Castell Drilling


Switch mounting

| Rating <br> A | A 3p | Overall dimensions | A 4p | M 3p | Switch mounting |
| :--- | :--- | :--- | :--- | :--- | :--- |
| 3150 | 372 | 492 | 347 | 467 |  |

## SIRCO 4000 A


Castell Drilling


| Rating |  |  |  |  |  |
| :--- | :--- | :--- | :--- | :--- | :--- |
| A | Overall dimensions |  | Switch body |  | F 4p |

## SIRCO Connection terminals - 800 to 4000 A



800-1000 A


1250-1800 A


2000-2500 A


3150-4000 A

## Technical data and ratings chart

## SIRCO SLB 125 to 630 A

## Ratings to AS 3947－3 and IEC 60947－3



Note： $240 / 415 \mathrm{~V}$ ratings suitable for use on $230 / 400 \mathrm{~V}$ in accordance with AS $60038: 2000$.

# Compact NSX 

Moulded-case circuit breakers and switch-disconnectors
Measurement and communication
from 100 to 630 A

## Catalogue 2008




## Compact NSX Next-generation circuit breakers

Today, next-generation Compact NSX circuit breakers provide an intelligent outlook and set the standards of tomorrow. A power monitoring unit enhances their invariably impeccable protective functions. For the first time, users can monitor both energy and power, offering new performance in a remarkably compact device.

Compactness, discrimination and modularity - all of the features which defined the success of the Compact NS generation of circuit breakers combined with new functions for safe, easy monitoring and management of installations.

The new range of Compact NSX circuit breakers stands out from the crowd, thanks to its electronic intelligence. Through direct access to in-depth information, and networking via open protocols, Compact NSX lets operators optimise the management of their electrical installations.

Far more than a circuit breaker, Compact NSX is a measurement and communication tool ready to meet energy-efficiency needs through optimised energy consumption, increased energy availability, and improved installation management.


# Safety and performance 

Compactness, discrimination and modularity - new Compact NSX circuit breakers incorporate advanced monitoring and communication functions, from 40 amps up, combined with impeccable protection.


## Expert technology

A roto-active contact breaking principle provides each circuit breaker with very high breaking capacity in a very small device, remarkable fault current limitation performance, and endurance.
$>$ Compact NSX benefits from a patented double roto-active contact breaking concept, together with a reflex tripping system for ultimate breaking.
> Exceptional fault current limitation guarantees robust, reliable protection and, above all, reduces the causes of component aging, thus extending service life for installations.



## New breaking capacities

New performance levels for Compact NSX improve application targeting: > 25 kA - standard low short-circuit level applications, e.g., for service businesses,
> 36-50 kA - standard applications (industrial plants, buildings and hospitals),
> 70-100 kA - high performance at controlled cost,
> 150 kA - demanding applications (maritime).

## Enhanced protection for motors

Compact NSX meets the requirements of IEC 60947-4-1 standards for protection of motors:
> well adapted to motor-starting solutions up to 315 kW at 400 V , providing protection against short circuits, overloads, phase unbalance and loss,
> also enables set-up of additional protection systems for starting and braking with the motor running, reverse braking, jogging or reversing in complete safety,
> add a Schneider Electric contactor; Compact NSX complies with the requirements of so-called type 2 coordination.


## Reduced installation costs

Optimising installations allows for achieving up to 30 \% savings:
$>$ considerable savings at the time of installation, thanks to total discrimination with miniature circuit breakers,
> smaller devices, more economic switchboards mean best overall installation cost, without overcalibration.


The trip units are now true circuit breaker control systems.


With the integration of electronics, trip units have gained in speed and accuracy.


## Greater reliability and better

 discrimination allows more refined settings, especially for time delays.
## Monitoring and management

Compact NSX is a single device, which contains a monitoring unit to control energy consumption and power.


## Integrated monitoring

> The new Compact NSX range incorporates Micrologic electronic trip units in the circuit breaker, offering both:

- an accurate power monitoring unit,
- a highly reliable protective device.
> A Micrologic electronic tripping device combines next-generation sensors:
- an "iron" sensor for the power supply to the electronics,
- an "air" sensor (Rogowski coils) for measurement, guaranteeing high accuracy.
> These electronic systems are designed to withstand high temperatures $\left(105^{\circ} \mathrm{C}\right)$, ensuring reliability under severe operating conditions.
> The originality lies in how Compact NSX measures, processes and displays data, either directly on screen, on the switchboard front panel, or via a monitoring system.

-10 \%
Monitoring consumption can reduce energy costs by as much as $10 \%$.


## Accessibility of information...

To keep costs under control and ensure service continuity, relevant information must be available in real time:
> a kilowatt-hour meter helps optimise costs and their allocation,
> harmonic distortion rate shows the quality of electrical supply,
$>$ alarm notification secures operational control and maintenance planning,
> event logs and tables, activated continuously, ensure the installed equipment base operates correctly, so energy efficiency is maximized.

## ...for power monitoring

> Together with power monitoring software (e.g., PowerLogic), the Compact NSX Modbus communication interface provides operators with a parameter set and tools that make system monitoring very easy.
> Operators have real-time data to control energy availability, to monitor power supply quality, to optimise consumption of different applications or zones, reducing load peaks and continuously supplying priority loads, and to draw up maintenance schedules.
> A software utility (RSU) allows protection and alarm configuration, in addition to testing communications with all installed devices.


Logiciel de supervision PowerLogic ION-E


Measurement functions are controlled
by an additional microprocessor.

Protection functions are electronically managed independently of measurement functions.

An ASIC (Application-Specific Integrated Circuit) is common to all trip units, which boosts immunity to conducted or radiated interference and increases reliability.

## Simplicity

## Compact NSX takes the principles of easy installation and use -

 which made its predecessor so successful - to a higher level.

## Simple in design

Compact NSX is mounted and wired reusing the same measurements as Compact NS.

Cut-outs are the same whatever the type of handle. Engineering drawings are the same, so installation and connection layouts can be used on new projects, simplifying extensions or retrofits, and reducing maintenance costs.

Integration in help software, for parameter settings and switchboard installation, further eases design.



## Simple to install

> A Limited Torque Screw (LTS) system ensures proper installation of the tripping device, for added flexibility. It insures each screw is aligned correctly and tightened to the required torque. The LTS system thus avoids the need for a torque wrench.
> A transparent lead-sealable cover protects access to tripping device switches and prevents settings from being changed.
> The new electrical control adjustment also has a transparent lead- sealable cover to prevent it from being operated accidentally.
$>$ Compact NSX has an optional functional terminal shield that offers excellent protection against direct contact (IP40 on all sides, IP20 at cable entry points) and easy installation.
> All Compact NSX devices can be equipped with a communication function via a pre-wired connection with a Modbus interface module. When the Modbus address is declared, the Compact NSX device is integrated into the network.

## 65 \%

time savings in installation compared with a classic monitoring solution.
> There are four levels of functionalities:

- communication of device status: On/Off position, trip indication and fault-trip indication,
- communication of commands: open, close, and reset,
- communication of measurements: mainly I, U, f, P, E, and THD,
- communication of operating assistance data: settings, parameters, alarms, histograms and event tables, and maintenance indicators.
> The switchboard "plug \& play" display unit connects to the trip unit without any special settings or configuration. A cable fitted with an RJ45 connector allows for easy integration with communications networking.


## Simple to use

> Users customise time-stamped alarms for all parameters, assign them to indicator lights, choose display priorities, and configure time delay thresholds and modes.
$>$ Event logs and tables are continuouslyactivated. Providing a wealth of information, they enable users to ensure that the installed equipment base operates correctly, to optimize settings, and to maximise energy efficiency.
> Local and remote displays offer easy access to operators and provide the main electrical values: I, U, V, f, energy, power, total harmonic distortion, etc. The user-friendly switchboard display unit with intuitive navigation is more comfortable to read, and offers quick access to information.


Performance, yet unimposing. Compact NSX perfectly blends into its environment.


Attractively designed.
The front of Compact NSX circuit breakers has an attractive curved profile.
Measurements are easy to read on a backlit LCD display. Screen navigation is intuitive and settings are simplified by immediate readouts in amps.

# Service continuity 

Compact NSX makes discrimination its main advantage in minimising the impact of short circuits, ensuring service continuity for installations.


## Total discrimination

Thanks to its 30 years of experience, Schneider Electric, with Compact NSX, offers perfect mastery of discrimination for ever more reliable service continuity. Compact NSX circuit breakers strongly limit fault currents, occurring as the result of short-circuits, which reduces installation downtime and avoids overdimensioning cables.
When several circuit breakers are used in series, the downstream circuit breaker trips as close as possible to the fault, isolating only the circuit concerned. The upstream circuit breaker is not affected and allows the other circuits to remain operational.

## Service continuity

Adding an SDTAM module allows remote indication of motor overloads and actuation of a contactor, ensuring total service continuity: $>$ the SDTAM switches the contactor instead of tripping the circuit breaker,
> the module allows for machine restart directly from the contactor without having to operate circuit breakers.

## Preventive maintenance

Maintenance indicators provide information on the number of operations, level of wear on contacts and total load rates. This makes it far easier to monitor equipment ageing and optimise investments over time. Maintenance s now preventive, avoiding faults.


100 \%
service continuity


Direct access to maintenance indicators


## Schneider Electric expertise

Schneider Electric commits to reducing energy costs and $\mathrm{CO}_{2}$ emissions for its customers. It offers products, solutions and services that integrate with all levels of the energy value chain. Compact NSX is part and parcel of the Schneider Electric energy efficiency approach.


## Solutions for the future

With Compact NSX, Schneider Electric works through flexible solutions for commercial and industrial buildings, Schneider Electric commits to help customers gradually move towards an active approach to their energy efficiency. It helps get more return from investments and future design solutions.

## Energy performance contracts

An energy performance contract offers innovative service to modernise technical installations.

The objective is dramatically to reduce energy costs, whilst improving comfort and safety, all in an environmentally-responsible way.

## Environmentally responsible

Schneider Electric meets the expectations of its markets with products adapted to the practices of the 190 countries where it is present and strongly commits to respect the norms and directives of each of those countries.

- Compact NSX, like all the products in its $L V$ ranges, is a product designed to comply with all European directives for the environment. It has also received international certifications and approval from independent agencies.
- In compliance with ISO 14001 standards, all of its factories are non-polluting.
- Designed for easy disassembly and recycling at end of life, Compact NSX complies with environmental directives RoHS* and WEEE**.
yot 30 \%
savings in energy costs


## steps

$>$ Diagnosis
>Proposals
>Implementation
$>$ Follow-up

[^3]

## Functions and characteristics

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Compact NSX100 to 630 offers high performance and a wide range of interchangeable trip units to protect most applications. Electronic versions provide highly accurate protection with wide setting ranges and can integrate measurement, metering and communication functions. They can be combined with the FDM121 switchboard display unit to provide all the functions of a
Power Meter as well as operating assistance.


Compact NSX equipped with Micrologic 5 / 6 trip units offer type A (ammeter) or E (energy) metering functions as well as communication. Using Micrologic sensors and intelligence, Compact NSX provides access to measurements of all the main electrical parameters on the built-in screen, on a dedicated FDM121 display unit or via the communication system.

## Operating assistance - page A-22

Integration of measurement functions provides operators with operating assistance functions including alarms tripped by user-selected measurement values, time-stamped event tables and histories, and maintenance indicators.

## Switchboard display unit - page A-24

The main measurements can be read on the built-in screen of Micrologic 5 / 6 trip units.
They can also be displayed on the FDM121 switchboard display unit along with pop-up windows signalling the main alarms.

## Communication <br> page A-26

Compact NSX equipped with Micrologic 5 / 6 trip units provide communication capabilities. Simple RJ45 cords connect to a Modbus interface module.


Protection of distribution systems (AC 220/690 V) page A-14

## Compact NSX devices are equipped with MA or TM

 thermal-magnetic trip units or Micrologic 2 / 5 / 6 electronic trip units to provide protection against shortcircuits and overloads for:b distribution systems supplied by transformers
b distribution systems supplied by engine generator sets
b long cables in IT and TN systems.

They can be easily installed at all levels in distribution systems, from the main LV switchboard to the subdistribution boards and enclosures.
All Compact NSX devices can protect against insulation faults by adding a Vigi module or Vigirex relay.

## Protection of

motors
(AC 220/690 V) page A-36

The Compact NSX range includes a number of versions to protect motor applications:
b basic short-circuit protection with MA magnetic trip units or the electronic Micrologic 1-M version, combined with an external relay to provide thermal protection
b protection against overloads, short-circuits and phase unbalance or loss with Micrologic 2-M trip units
b more complete protection against overloads and short-circuits with additional motor-specific protection (phase unbalance, locked rotor, underload and long start) with Micrologic 6 E-M trip units. These versions also offer communication, metering and operating assistance.
The exceptional limiting capacity of Compact NSX circuit breakers automatically provides type-2 coordination with the motor starter, in compliance with standard IEC 60947-4-1.

## Protection of <br> special <br> applications <br> > page A-48

## Special applications:

The Compact NSX range offers a number of versions for special protection applications:
b service connection to public distribution systems

- page A-48
b generators $>$ page $A-50$
b industrial control panels $\boldsymbol{\square}$ page A-52
with:
$\checkmark$ compliance with international standards
IEC 60947-2 and UL 508 / CSA 22-2 N14
v compliance with US standard UL 489
$v$ installation in universal and functional enclosures.
b $16 \mathrm{~Hz} 2 / 3$ systems $>$ page A-53
b 400 Hz systems - page $\mathrm{A}-54$


## Control and

isolation using
switch-
disconnectors
page A-56

A switch-disconnector version of Compact NSX circuit breakers is available for circuit control and isolation. All add-on functions of Compact NSX circuit breakers may be combined with the basic switch-disconnector function, including:
b earth-leakage protection
b motor mechanism
b ammeter, etc.

For all these applications, circuit breakers in the Compact NSX range offer positive contact indication and are suitable for isolation in accordance with standards IEC 60947-1 and 2.

## Source changeover systems

page A-60

## To ensure a continuous supply of power, some

 electrical installations are connected to two power sources:b a normal source
b a replacement source to supply the installation when the normal source is not available.
A mechanical and/or electrical interlocking system between two circuit breakers or switch-disconnectors avoids all risk of parallel connection of the sources during switching.

## A source-changeover system can be:

b manual with mechanical device interlocking b remote controlled with mechanical and/or electrical device interlocking
b automatic by adding a controller to manage switching from one source to the other on the basis of external parameters.

For information on other switch-disconnector ranges, see the Interpact (offering positive contact indication and visible break) and Fupact (fusegear) catalogues.
atget 88 of 1302

# Introduction <br> General characteristics of the Compact NSX range 



Standardised characteristics indicated on the rating plate:
1 Type of device: frame size and breaking capacity class
2 Ui: rated insulation voltage.
3 Uimp: rated impulse withstand voltage.
4 Ics: service breaking capacity.
5 Icu: ultimate breaking capacity for various values of the rated operational voltage Ue
6 Ue:operational voltage.
7 Colour label indicating the breaking capacity class.
8 Circuit breaker-disconnector symbol.
9 Reference standard.
10 Main standards with which the device complies Note: when the circuit breaker is equipped with an extended rotary handle, the door must be opened to access the rating plate.

## Compliance with standards

Compact NSX circuit breakers and auxiliaries comply with the following: b international recommendations:
v IEC 60947-1: general rules
v IEC 60947-2: circuit breakers
v IEC 60947-3: switch-disconnectors
v IEC 60947-4: contactors and motor starters
v IEC 60947-5.1 and following: control circuit devices and switching elements; automatic control components
b European (EN 60947-1 and EN 60947-2) and corresponding national standards:
v France NF
v Germany VDE
v United Kingdom BS
v Australia AS
$v$ Italy CEI
b the specifications of the marine classification companies (Veritas, Lloyd's Register of Shipping, Det Norske Veritas, etc.), standard NF C 79-130 and recommendations issued by the CNOMO organisation for the protection of machine tools. For U.S. UL, Canadian CSA, Mexican NOM and Japanese JIS standards, please consult us.

## Pollution degree

Compact NSX circuit breakers are certified for operation in pollution-degree III environments as defined by IEC standards 60947-1 and 60664-1 (industrial environments).

## Climatic withstand

Compact NSX circuit breakers have successfully passed the tests defined by the following standards for extreme atmospheric conditions:
b IEC 60068-2-1: dry cold ( $-55^{\circ} \mathrm{C}$ )
b IEC $60068-2-2$ : dry heat $\left(+85^{\circ} \mathrm{C}\right)$
b IEC 60068-2-30: damp heat ( $95 \%$ relative humidity at $55^{\circ} \mathrm{C}$ )
b IEC 60068-2-52 severity level 2 : salt mist.

## Environment

Compact NSX respects the European environment directive EC/2002/95 concerning the restriction of hazardous substances (RoHS).
Product environment profiles (PEP) have been prepared, describing the environmental impact of every product throughout its life cycle, from production to the end of its service life.
All Compact NSX production sites have set up an environmental management system certified ISO 14001
Each factory monitors the impact of its production processes. Every effort is made to prevent pollution and to reduce consumption of natural resources.

## Ambient temperature

b Compact NSX circuit breakers may be used between $-25^{\circ} \mathrm{C}$ and $+70^{\circ} \mathrm{C}$. For temperatures higher than $40^{\circ} \mathrm{C}\left(65^{\circ} \mathrm{C}\right.$ for circuit breakers used to protect motor feeders), devices must be derated (pages B-8 and B-9).
b Circuit breakers should be put into service under normal ambient, operatingtemperature conditions. Exceptionally, the circuit breaker may be put into service when the ambient temperature is between $-35^{\circ} \mathrm{C}$ and $-25^{\circ} \mathrm{C}$.
b The permissible storage-temperature range for Compact NSX circuit breakers in the original packing is $-50^{\circ} \mathrm{C}{ }^{(1)}$ and $+85^{\circ} \mathrm{C}$.
(1) $-40^{\circ} \mathrm{C}$ for Micrologic control units with an LCD screen


## -

## Electromagnetic compatibility

Compact NSX devices are protected against:
b overvoltages caused by circuit switching (e.g. lighting circuits)
b overvoltages caused by atmospheric disturbances
b devices emitting radio waves such as mobile telephones, radios, walkie-talkies, radar, etc.
b electrostatic discharges produced by users.
Immunity levels for Compact NSX comply with the standards below. b IEC/EN 60947-2: Low-voltage switchgear and controlgear, part 2: Circuit breakers:
v Annex F: Immunity tests for circuit breakers with electronic protection
v Annex B: Immunity tests for residual current protection
b IEC/EN 61000-4-2: Electrostatic-discharge immunity tests
b IEC/EN 61000-4-3: Radiated, radio-frequency, electromagnetic-field immunity tests
b IEC/EN 61000-4-4: Electrical fast transient/burst immunity tests
b IEC/EN 61000-4-5: Surge immunity tests
b IEC/EN 61000-4-6: Immunity tests for conducted disturbances induced by radiofrequency fields
b CISPR 11: Limits and methods of measurement of electromagnetic disturbance characteristics of industrial, scientific and medical (ISM) radio-frequency equipment.

## Discrimination

Compact NSX reinforces the discrimination capabilities of the Compact NS range by applying the rapid calculation capacity of the Micrologic trip units.
Total discrimination is now possible between NSX100 and modular Multi 9 circuit breakers rated y 63 A (see page A-8).

## Suitable for isolation with positive contact indication

All Compact NSX circuit breakers are suitable for isolation as defined in IEC standard 60947-2:
b The isolation position corresponds to the O (OFF) position.
b The operating handle cannot indicate the OFF position unless the contacts are effectively open.
b Padlocks may not be installed unless the contacts are open Installation of a rotary handle or a motor mechanism does not alter the reliability of the position-indication system.
The isolation function is certified by tests guaranteeing:
b the mechanical reliability of the position-indication system
b the absence of leakage currents
b overvoltage withstand capacity between upstream and downstream connections. The tripped position does not insure isolation with positive contact indication. Only the OFF position guarantees isolation.

## Installation in class II switchboards

All Compact NSX circuit breakers are class II front face devices. They may be installed through the door of class II switchboards (as per IEC standards 61140 and 60664-1) without downgrading switchboard insulation. Installation requires no special operations, even when the circuit breaker is equipped with a rotary handle or a motor mechanism

## Degree of protection

The following indications are in accordance with standards IEC 60529 (IP degree of protection) and IEC 62262 (IK protection against external mechanical impacts).

## Bare circuit breaker with terminal shields

b With toggle: IP40, IK07.
b With standard direct rotary handle / VDE: IP40 IK07
Circuit breaker installed in a switchboard
b With toggle: IP40, IK07.
b With direct rotary handle:
v standard / VDE: IP40, IK07
v MCC: IP43 IK07
v CNOMO: IP54 IK08
b With extended rotary handle: IP56 IK08
b With motor mechanism: IP40 IK07.

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Functions and characteristics

## Introduction

Characteristics and performance of Compact NSX circuit breakers from 100 to 630 A


Compact NSX100/160/250.


Compact NSX400/630.
(1) OSN: Over Sized Neutral protection for neutrals carrying high currents (e.g. 3rd harmonics).
(2) ZSI: Zone Selective Interlocking using pilot wires.
(3) 2P circuit breaker in 3P case for $B$ and F types, only with thermal-magnetic trip unit.

| Common characteristics |  |  |  |
| :---: | :---: | :---: | :---: |
| Rated voltages |  |  |  |
| Insulation voltage (V) | Ui |  | 800 |
| Impulse withstand voltage (kV) | Uimp |  | 8 |
| Operational voltage (V) | Ue | AC $50 / 60 \mathrm{~Hz}$ | 690 |
| Suitability for isolation |  | IEC/EN 60947-2 | yes |
| Utilisation category |  |  | A |
| Pollution degree |  | IEC 60664-1 | 3 |



Characteristics as per Nema AB1

| Breaking capacity (kA rms) | AC 50/60 Hz 240 V |  |
| :--- | ---: | :--- |
|  | 480 V |  |
| 600 V |  |  |
| Characteristics as per UL 508 |  |  |
| Breaking capacity (kA rms) | AC $50 / 60 \mathrm{~Hz}$ | 240 V |
|  | 480 V |  |
|  | 600 V |  |

## Protection and measurements

| Short-circuit protection | Magnetic only |  |
| :---: | :---: | :---: |
| Overload / short-circuit protection | Thermal magnetic |  |
|  | Electronic |  |
|  | with neutral protection (Off-0.5-1-OSN) ${ }^{(1)}$ |  |
|  | with ground-fault protection |  |
|  | with zone selective interlocking (ZSI) ${ }^{(2)}$ |  |
| Display / I, U, f, P, E, THD measurements / interrupted-current measurement |  |  |
| Options | Power Meter display on door |  |
|  | Operating assistance |  |
|  | Counters |  |
|  | Histories and alarms |  |
|  | Metering Com |  |
|  | Device status/control Com |  |
| Earth-leakage protection | By Vigi module |  |
|  | By Vigirex relay |  |
| Installation / connections |  |  |
| Dimensions and weights |  |  |
| Dimensions (mm) | Fixed, front connections | 2/3P |
| W $\times \mathrm{H} \times \mathrm{D}$ |  | 4 P |
| Weight (kg) | Fixed, front connections | 2/3P |
|  |  | 4 P |
| Connections |  |  |
| Connection terminals | Pitch | With/without spreaders |
| Large Cu or Al cables | Cross-section | $\mathrm{mm}^{2}$ |


| Common characteristics |  |  |  |
| :--- | :--- | :--- | :--- |
| Control |  |  |  |
|  | Manual | With toggle | b |
|  | With direct or extended rotary handle | b |  |
|  | Electrical | With remote control | b |
|  |  | b |  |



With Micrologic electronic trip units, Compact NSX stands out from the crowd. Thanks to the new generation of sensors and its processing capability, protection is enhanced even further. It also provides measurements and operating information.

## Thermal-magnetic or electronic trip unit?

Thermal-magnetic trip units protect against overcurrents and short-circuits using tried and true techniques. But today, installation optimisation and energy efficiency have become decisive factors and electronic trip units offering more advanced protection functions combined with measurements are better suited to these needs. Micrologic electronic trip units combine reflex tripping and intelligent operation. Thanks to digital electronics, trip units have become faster as well as more accurate and reliable. Wide setting ranges make installation upgrades easier. Designed with processing capabilities, Micrologic trip units can provide measurement information and device operating assistance. With this information, users can avoid or deal more effectively with disturbances and can play a more active role in system operation. They can manage the installation, anticipate on events and plan any necessary servicing.

## Accurate measurements for complete protection

Compact NSX devices take advantage of the vast experience acquired since the launch of Masterpact NW circuit breakers equipped with Micrologic trip units. From 40 amperes on up to the short-circuit currents, they offer excellent measurement accuracy. This is made possible by a new generation of current transformers combining "iron-core" sensors for self-powered electronics and "aircore" sensors (Rogowski toroids) for measurements.
The protection functions are managed by an ASIC component that is independent of the measurement functions. This independence ensures immunity to conducted and radiated disturbances and a high level of reliability.

## Numerous security functions

## Torque-limiting screws

The screws secure the trip unit to the circuit breaker. When the correct tightening torque is reached, the screw heads break off. Optimum tightening avoids any risk of temperature rise. A torque wrench is no longer required.

## Easy and sure changing of trip units

All trip units are interchangeable, without wiring. A mechanical mismatch-protection system makes it impossible to mount a trip unit on a circuit breaker with a lower rating.

## "Ready" LED for a continuous self-test

The LED on the front of the electronic trip units indicates the result of the self-test runs continuously on the measurement system and the tripping release. As long as the green LED is flashing, the links between the CTs, the processing electronics and the Mitop release are operational. The circuit breaker is ready to protect. No need for a test kit. A minimum current of 15 to 50 A , depending on the device, is required for this indication function.
A patented dual adjustment system for protection functions.
Available on Micrologic 5 / 6, the system consists of:
b an adjustment using dials sets the maximum value
b an adjustment, made via the keypad or remotly, fine-tunes the setting. This setting may not exceed the first one. It can be read directly on the Micrologic screen, to within one ampere and a fraction of a second.

## Coordinated tripping systems

Compact NSX detects faults even faster and its tripping time is reduced. It protects the installation better and limits contact wear.


Because it directly actuates the mechanism, it precedes the trip unit by a few milliseconds.


Compact NSX100 with Micrologic for total discrimination with Multi 9 devices rated y 40 A or a C60. Better coordination between protection functions reduces the difference in ratings required for total discrimination.

## Unmatched discrimination

Discrimination
Compact NSX provides maximum continuity of service and savings through an unmatched level of discrimination:
b given the high accuracy of measurements, overload discrimination is ensured even between very close ratings
b for major faults, the fast processing of the Micrologic trip units means the upstream device can anticipate the reaction of the downstream device. The upstream breaker adjusts its tripping delay to provide discrimination b for very high faults, the energy of the arc dissipated by the short-circuit in the downstream breaker causes reflex tripping. The current seen by the upstream device is significantly limited. The energy is not sufficient to cause tripping, so discrimination is maintained whatever the short-circuit current.

For total discrimination over the entire range of possible faults, from the long-time pick-up Ir to the ultimate short-circuit current Icu, a ratio of 2.5 must be maintained between the ratings of the upstream and downstream devices.
This ratio is required to ensure selective reflex tripping for high short-circuits.

Understanding the names of Micrologic electronic trip units


## Examples

| Micrologic 1.3 | Instantaneous only | 400 or 630 A |  | Distribution |
| :--- | :--- | :--- | :--- | :--- |
| Micrologic 2.3 | LS 1 | 400 or 630 A |  | Distribution |
| Micrologic 5.2 A | LSI | 100,160 or 250 A | Ammeter | Distribution |
| Micrologic 6.3 E-M | LSIG | 400 or 630 A | Energy | Motor |

(1) $L S_{0}$ I protection is standard on Micrologic 2. To ensure discrimination, it offers short-time protection $S_{0}$ with a non-adjustable delay and instantaneous protection.

Compact NSX offers a range of trip units in
interchangeable cases, whether they are magnetic, thermal-magnetic or electronic. Versions 5 and 6 of the electronic trip unit offer communication and metering. Using Micrologic sensors and intelligence, Compact NSX supplies all the information required to manage the electrical installation and optimise energy use.

Compact NSX100/160/250


Compact NSX400/630


Type of protection and applications

| MA magnetic | TM-D thermal-magnetic |
| :--- | :--- |


b Distribution and motors

b Distribution
b Generators

Circuit breakers and trip units
 motors

TM-G Generators

1.3-M Distribution and motors

Settings and indications


Adjustment and
reading
Pick-up set in amps using dials
Non-adjustable time delay


Adjustment and reading
Pick-up set in amps using dials
Non-adjustable time delay


The capabilities of Micrologic $5 / 6$ A and $E$ trip units come into full play with the FDM121 switchboard display unit.
When the two are connected via a simple cord with RJ45 connectors, the combination offers full Power Meter capabilities and all the measurements required to monitor the electrical installation.


## Ammeter Micrologic (A)

## I measurements

## Current measurements

b Phase and neutral currents I1, I2, I3, IN
b Average current of the 3 phases lavg
b Highest current of the three phases Imax
b Ground-fault current Ig (Micrologic 6.2 / 6.3A)
b Maximeter/minimeter for I measurements

## Operating and maintenance assistance

Indications, alarms and histories
b Indication of fault types
b Alarms for high/low alarm thresholds linked to I measurements
b Trip, alarm and operating histories
b Time-stamped tables for settings and maximeters

## Maintenance indicators

b Operation, trip and alarm counters
b Operating hours counter
b Contact wear
b Load profile and thermal image

## Communication

b Modbus with add-on module



Functions and characteristics

## Protection of distribution systems <br> TM thermal-magnetic and MA magnetic trip units

TM thermal-magnetic and MA magnetic trip units can be used on Compact NSX100/160/250 circuit breakers with performance levels $B / F / H / N / S / L$
TM trip units are available in 2 versions:
b TM-D, for the protection of distribution cables b TM-G, with a low threshold, for the protection of generators or long cable lengths.
Vigi modules or Vigirex relays can be added to all the circuit breakers to provide external earth-leakage protection.

Note: All the trip units have a transparent lead-sealable cover that protects access to the adjustment dials.

## TM-D and TM-G thermal-magnetic trip units

| $\stackrel{\sim}{0}$ |  |  | TM 250 D $250 \mathrm{~A} / 40^{\circ} \mathrm{C}$ |  |
| :---: | :---: | :---: | :---: | :---: |

Circuit breakers equipped with thermal-magnetic trip units are used mainly in industrial and commercial electrical distribution applications: b TM-D, for protection of cables on distribution systems supplied by transformers b TM-G, with a low pick-up for generators (lower short-circuit currents than with transformers) and distribution systems with long cable lengths (fault currents limited by the impedance of the cable).

## Protection

$\qquad$

## Thermal protection (Ir)

Thermal overload protection based on a bimetal strip providing an inverse time curve $\mathrm{I}^{2} \mathrm{t}$, corresponding to a temperature rise limit. Above this limit, the deformation of the strip trips the circuit breaker operating mechanism.
This protection operates according to:
b Ir that can be adjusted in amps from 0.7 to 1 times the rating of the trip unit (16 A to
250 A), corresponding to settings from 11 to 250 A for the range of trip units
b a non-adjustable time delay, defined to ensure protection of the cables.

## Magnetic protection (Im)

Short-circuit protection with a fixed or adjustable pick-up Im that initiates instantaneous tripping if exceeded.
b TM-D: fixed pick-up, Im, for 16 to 160 A ratings and adjustable from 5 to $10 \times \ln$ for 200 and 250 A ratings
b fixed pick-up for 16 to 63 A ratings.
Protection against insulation faults
Two solutions are possible by adding:
b a Vigi module acting directly on the trip unit of the circuit breaker
b a Vigirex relay connected to an MN or MX voltage release.

## Protection versions

b 3-pole:
v 3P 3D: 3-pole frame (3P) with detection on all 3 poles (3D)
v 3P 2D: 3-pole frame (3P) with detection on 2 poles (2D).
b 4-pole:
v 4P 3D: 4-pole frame (4P) with detection on 3 poles (3D).
$v$ 4P 4D: 4-pole frame (4P) with detection on all 4 poles (same threshold for phases and neutral).

## MA magnetic trip units



In distribution applications, circuit breakers equipped with MA magnetic-only trip units are used for:
b short-circuit protection of secondary windings of LV/LV transformers with overload protection on the primary side.
b as an alternative to a switch-disconnector at the head of a switchboard in order to provide short-circuit protection.
Their main use is however for motor protection applications, in conjunction with a thermal relay and a contactor or motor starter (see "Motor protection", page A-36).

## Protection

$\qquad$


## Magnetic protection (Im)

Short-circuit protection with an adjustable pick-up Im that initiates instantaneous tripping if exceeded.
b $\operatorname{Im}=\ln \mathbf{x} \ldots$ set in amps on an adjustment dial covering the range 6 to $14 x \ln$ for 2.5 to 100 A ratings or 9 to $14 \operatorname{In}$ for 150 to 220 A ratings.

## Protection versions

b 3-pole (3P 3D): 3-pole frame (3P) with detection on all 3 poles (3D).
b 4-pole (4P 3D): 4-pole frame (4P) with detection on 3 poles (3D).

(1) For temperatures greater than $40^{\circ} \mathrm{C}$, the thermal protection characteristics are modified. See the temperature derating table.

Functions and characteristics

## Protection of distribution

 systemsMicrologic 2 and 1.3-M trip units

Micrologic 2 trip units can be used on Compact NSX100 to 630 circuit breakers with performance levels B/F/H/N/S/L.
They provide:
b standard protection of distribution cables
b indication of:
v overloads (via LEDs)
v overload tripping (via the SDx relay module). Circuit breakers equipped with Micrologic 1.3-M trip units, without thermal protection, are used in certain applications to replace switch-disconnectors at the head of switchboards. Micrologic 1.3-M trip units are dedicated to Compact NSX400/630 A circuit breakers.

Micrologic 2


Circuit breakers equipped with Micrologic 2 trip units can be used to protect distribution systems supplied by transformers. For generators and long cables, Micrologic 2-G trip units offer better suited low pick-up solutions (see page A-50).

## Protection



Settings are made using the adjustment dials with fine adjustment possibilities.
Overloads: Long time protection (Ir)
Inverse time protection against overloads with an adjustable current pick-up Ir set using a dial and a non-adjustable time delay tr.
Short-circuits: Short-time protection with fixed time delay (Isd)
Protection with an adjustable pick-up Isd. Tripping takes place after a very short delay used to allow discrimination with the downstream device.
Short-circuits: Non-adjustable instantaneous protection Instantaneous short-circuit protection with a fixed pick-up.

## Neutral protection

b On 3-pole circuit breakers, neutral protection is not possible.
b On four-pole circuit breakers, neutral protection may be set using a three-position switch:
v 4P 3D: neutral unprotected
$v 4 P 3 D+N / 2$ : neutral protection at half the value of the phase pick-up, i.e. $0.5 \times \mathrm{Ir}$
v 4P 4D: neutral fully protected at Ir.


Indications


Front indications
b Green "Ready" LED: flashes slowly when the circuit breaker is ready to trip in the event of a fault.
b Orange overload pre-alarm LED: steady on when I > 90 \% Ir
b Red overload LED: steady on when I > 105 \% Ir


Remote indications
An overload trip signal can be remoted by installing an SDx relay module inside the circuit breaker.
This module receives the signal from the Micrologic electronic trip unit via an optical link and makes it available on the terminal block. The signal is cleared when the circuit breaker is reclosed. For description, see page A-81.

Micrologic 1.3-M for magnetic protection only


Micrologic 1.3-M trip units provide magnetic protection only, using electronic technology. They are dedicated to 400/630 A 3-pole (3P 3D) circuit breakers or 4pole circuit breakers with detection on 3 poles (4P, 3D) and are used in certain applications to replace switch-disconnectors at the head of switchboards. They are especially used in 3-pole versions for motor protection, see page A-40.

Note: all the trip units have a transparent lead-sealable cover that protects access to the adjustment dials.

(1) If the trip units are used in high-temperature environments, the Micrologic setting must take into account the thermal limitations of the circuit breaker. See the temperature derating table.

Micrologic 1.3-M


Functions and characteristics

## Protection of distribution

systems
Micrologic 5 / 6 A or E trip units

Micrologic 5 / 6 A (Ammeter) or E (Energy) trip units can be used on Compact NSX100 to 630 circuit breakers with performance levels $B / F / H / N / S / L$. They all have a display unit.
They offer basic LSI protection (Micrologic 5) or LSI and ground-fault protection G (Micrologic 6).
They also offer measurement, alarm and communication functions.


Trip unit menus.


Display of interrupted current.


SDx remote indication relay module with its terminal block.

Note: all the trip units have a transparent lead-sealable cover that protects access to the adjustment dials.


## Protection

Settings can be adjusted in two ways, using the dials and/or the keypad . The keypad can be used to make fine adjustments in 1 A steps below the maximum value defined by the setting on the dial. Access to setting modifications via the keypad is protected by a locking function displayed on the screen and controlled by a microswitch $\boldsymbol{O}$. The lock is activated automatically if the keypad is not used for 5 minutes. Access to the microswitch is protected by a transparent lead-sealable cover. With the cover closed, it is still possible to display the various settings and measurements using the keypad.
Overloads: Long time protection (Ir)
Inverse time protection against overloads with an adjustable current pick-up Ir set using a dial or the keypad for fine adjustments. The time delay $t r$ is set using the keypad.
Short-circuits: Short-time protection (Isd)
Short-circuit protection with an adjustable pick-up Isd and adjustable time delay tsd, with the possibility of including a portion of an inverse time curve ( $I^{2 t}$ On).
Short-circuits: Instantaneous protection (li)
Instantaneous protection with adjustable pick-up li.
Additional ground fault protection (lg) on Micrologic 6
Residual type ground-fault protection with an adjustable pick-up Ig (with Off position) and adjustable time delay $\boldsymbol{t g}$. Possibility of including a portion of an inverse time curve ( $I^{2}$ t On).

## Neutral protection

b On 4-pole circuit breakers, this protection can be set via the keypad:
v Off: neutral unprotected
v 0.5: neutral protection at half the value of the phase pick-up, i.e. 0.5 x Ir v 1.0: neutral fully protected at Ir
v OSN: Oversized neutral protection at 1.6 times the value of the phase pick-up. Used when there is a high level of 3rd order harmonics (or orders that are multiples of 3) that accumulate in the neutral and create a high current. In this case, the device must be limited to $\mathrm{Ir}=0.63 \times \mathrm{In}$ for the maximum neutral protection setting of $1.6 \times \mathrm{Ir}$. b With 3-pole circuit breakers, the neutral can be protected by installing an external neutral sensor with the output (T1, T2) connected to the trip unit.

## Zone selective interlocking (ZSI)

A ZSI terminal block may be used to interconnect a number of Micrologic control units to provide zone selective interlocking for short-time (Isd) and ground-fault (Ig) protection, without a time delay. For Compact NSX 100 to 250, the ZSI function is available only in relation to the upstream circuit breaker (ZSI out).

Display of type of fault $\qquad$
On a fault trip, the type of fault (Ir, Isd, II, Ig), the phase concerned and the interrupted current are displayed. An external power supply is required.

Indications $\qquad$


Front indications

b Green "Ready" LED: flashes slowly when the circuit breaker is ready to trip in the event of a fault.
b Orange overload pre-alarm LED: steady on when I > $90 \%$ Ir
b Red overload LED: steady on when I > 105 \% Ir

## Remote indications

An SDx relay module installed inside the circuit breaker can be used to remote the following information:
b overload trip
b overload prealarm (Micrologic 5) or ground fault trip (Micrologic 6).
This module receives the signal from the Micrologic electronic trip unit via an optical link and makes it available on the terminal block. The signal is cleared when the circuit breaker is closed.
These outputs can be reprogrammed to be assigned to other types of tripping or alarm. The module is described in detail in the section dealing with accessories.

(1) If the trip units are used in high-temperature environments, the Micrologic setting must take into account the thermal limitations of the circuit breaker. See the temperature derating table.
(2) For 40 A rating, the neutral N/2 adjustment is not possible.

Functions and characteristics

## Power Meter functions

Electronic Micrologic 5 / 6 A or E

In addition to protection functions, Micrologic 5 / 6 trip units offer all the functions of Power Meter products as well as operating-assistance for the circuit breaker.
b display of settings
b measurement functions:
v Ammeter (A)
v Energy (E)
b alarms
b time-stamped histories and event tables
b maintenance indicator
b communication.


Micrologic built-in LCD display showing an energy measurement


FDM121 display: navigation.


Current.


Power.
Consumption.

Examples of measurement screens on the FDM121 display unit.

Micrologic A and E measurement functions are made possible by Micrologic intelligence and the accuracy of the sensors. They are handled by a microprocessor that operates independent of protection functions.

## Display



## Micrologic LCD

The user can display all the protection settings and the main measurements on the LCD screen of the trip unit.
b Micrologic A: instantaneous rms current measurements
b Micrologic E: voltage, frequency and power measurements and energy metering, in addition to the measurements offered by Micrologic A
To make the display available under all conditions and increase operating comfort, an external power supply is recommended for Micrologic A. It is indispensable to:
b display faults and interrupted current measurements
b use all the functions of Micrologic E (e.g. metering of low power and energy values)
b ensure operation of the communication system.
The external power supply can be shared by several devices. For description, see page A-32.

## FDM121 display unit

An FDM121 switchboard display unit can be connected to a Micrologic trip unit using a prefabricated cord to display all measurements on a screen. The result is a veritable $96 \times 96$ mm Power Meter.
In addition to the information displayed on the Micrologic LCD, the FDM121 screen shows demand, power quality and maximeter/minimeter values along with alarms, histories and maintenance indicators.
The FMD121 display unit requires a 24 V DC power supply. The Micrologic trip unit is supplied by the same power supply via the cord connecting it to the FDM121.

## PC screen

When the Micrologic, with or without an FDM121 switchboard display unit, is connected to a communication network, all information can be accessed via a PC.

## Measurements

$\qquad$


## Instantaneous rms measurements

The Micrologic A and E continuously display the RMS value of the highest current of the three phases and neutral (Imax). The navigation buttons $\rightarrow$ can be used to scroll through the main measurements.
In the event of a fault trip, the current interrupted is memorised.
The Micrologic A measures phase, neutral, ground fault currents.
The Micrologic E offers voltage, frequency and power measurements in addition to the measurements provided by Micrologic A
Maximeters / minimeters
Every instantaneous measurement provided by Micrologic A or E can be associated with a maximeter/minimeter. The maximeters for the highest current of the 3 phases and neutral, the demand current and power can be reset via the trip unit keypad, the FDM121 display unit or the communication system.

## Energy metering

The Micrologic E also measures the energy consumed since the last reset of the meter. The active energy meter can be reset via the keypad and the FDM121 display unit or the communication system.

## Demand and maximum demand values

Micrologic E also calculates demand current and power values. These calculations can be made using a block or sliding interval that can be set from 5 to 60 minutes in steps of 1 minute. The window can be synchronised with a signal sent via the communication system. Whatever the calculation method, the calculated values can be recovered on a PC via Modbus communication.
Ordinary spreadsheet software can be used to provide trend curves and forecasts based on this data. They will provide a basis for load shedding and reconnection operations used to adjust consumption to the subscribed power.

## Power quality

Micrologic E calculates power quality indicators taking into account the presence of harmonics up to the 15th order, including the total harmonic distortion (THD) of current and voltage.

(1) Absolute mode: E absolute $=$ E out + E in; Signed mode: $E$ signed $=E$ out $-E$ in.
(2) Available via the communication system only.

## Additional technical characteristics

## Measurement accuracy

Accuracies are those of the entire measurement system, including the sensors:
b Current: Class 1 as per IEC 61557-12
b Voltage: $0.5 \%$
b Power and energy: Class 2 as per IEC 61557-12
b Frequency: $0.1 \%$.


Micrologic built-in LCD display.


FDM121 display: navigation.


Overpower alarm.


Alarm pick-up and drop-out.

Examples of operating-assistance screens on the FDM121 display unit.

## Personalised alarms with time-stamping <br> Alarm types <br> The user can assign an alarm to all Micrologic A or E measurements or events: b up to 12 alarms can be used together: <br> $\checkmark$ two alarms are predefined and activated automatically: <br> - Micrologic 5: overload (Ir) <br> - Micrologic 6: overload (Ir) and ground fault (Ig) <br> v thresholds, priorities and time delays can be set for ten other alarms. <br> b the same measurement can be used for different alarms to precisely monitor certain values, e.g. the frequency or the voltage <br> b alarms can also be assigned to various states: phase lead/lag, four quadrants, phase sequence <br> b selection of display priorities, with pop-up possibility <br> b alarm time-stamping. <br> Alarm settings <br> Alarms cannot be set via the keypad or the FDM121 display unit. They are set via communication with the PC. Set-up includes the threshold, priority, activation delay before display and deactivation delay. It is also possible to reprogram the standard assignment for the two SDx relay outputs to user-selected alarms.

## Alarm reading

Remote alarm indications
b reading on FDM121 display unit or on PC via the communication system
b remote indications via SDx relay with two output contacts for alarms.

## Histories and event tables

$\qquad$


Micrologic $A$ and $E$ have histories and event tables that are always active.

## Three types of time-stamped histories

b Tripping due to overruns of Ir, Isd, li, Ig: last 17 trips
b Alarms: last 10 alarms
b Operating events: last 10 events
Each history record is stored with:
b indications in clear text in a number of user-selectable languages
b time-stamping: date and time of event
b status: pick-up / drop-out
Two types of time-stamped event tables
b Protection settings
b Minimeters / maximeters

## Display of alarms and tables

The time-stamped histories and event tables may be displayed on a PC via the communication system.

## Embedded memory

Micrologic A and E have a non-volatile memory that saves all data on alarms,
histories, event tables, counters and maintenance indicators even if power is lost.

## Maintenance indicators



Micrologic $A$ and $E$ have indicators for, among others, the number of operating cycles, contact wear and operating times (operating hours counter) of the Compact NSX circuit breaker.
It is possible to assign an alarm to the operating cycle counter to plan maintenance.
The various indicators can be used together with the trip histories to analyse the level of stresses the device has been subjected to.
The information provided by the indicators cannot be displayed on the Micrologic LCD. It is displayed on the PC via the communication system.

## Management of installed devices

Each circuit breaker equipped with a Micrologic 5 or 6 trip unit can be identified via the communication system:
b serial number
b firmware version
b hardware version
b device name assigned by the user.
This information together with the previously described indications provides a clear view of the state of the installed devices.

|  |
| :--- |

(1) The BSCM module (page A-27) is required for these functions.
(2) Available via the communication system only.

## Additional technical characteristics

## Contact wear

Each time Compact NSX opens, the Micrologic 5/ 6 trip unit measures the interrupted current and increments the contact-wear indicator as a function of the interrupted current, according to test results stored in memory. Breaking under normal load conditions results in a very slight increment. The indicator value may be read on the FDM121 display. It provides an estimation of contact wear calculated on the basis of the cumulative forces affecting the circuit breaker. When the indicator reaches $80 \%$, it is advised to replace the circuit breaker to ensure the availability of the protected equipment.

## Circuit breaker load profile

Micrologic 5 / 6 calculates the load profile of the circuit breaker protecting a load circuit. The profile indicates the percentage of the total operating time at four current levels (\% of breaker In):
b 0 to $49 \%$ In
b 50 to $79 \%$ In
b 80 to $89 \%$ In
b $u 90 \%$ In.
This information can be used to optimise use of the protected equipment or to plan ahead for extensions.

# Switchboard-display functions <br> Micrologic 5 / 6 A or E trip units 

Micrologic measurement capabilities come into full play with the FDM121 switchboard display. It connects to Compact NSX via a simple cord and displays Micrologic information. The result is a true integrated unit combining a circuit breaker and a Power Meter. Additional operating assistance functions can also be displayed.


FDM121 display.


Surface mount accessory.


Connection with FDM121 display unit.

## FDM121 switchboard display

The FDM121 is a switchboard display unit that can be integrated in the Compact NSX100 to 630 A system. It uses the sensors and processing capacity of the Micrologic trip unit. It is easy to use and requires no special software or settings. It is immediately operational when connected to the Compact NSX by a simple cord. The FDM121 is a large display, but requires very little depth. The anti-glare graphic screen is backlit for very easy reading even under poor ambient lighting and at sharp angles.

## Display of Micrologic measurements and alarms

The FDM121 is intended to display Micrologic 5 / 6 measurements, alarms and operating information. It cannot be used to modify the protection settings. Measurements may be easily accessed via a menu.
All user-defined alarms are automatically displayed. The display mode depends on the priority level selected during alarm set-up:
b high priority: a pop-up window displays the time-stamped description of the alarm and the orange LED flashes
b medium priority: the orange "Alarm" LED goes steady on
b low priority: no display on the screen.
All faults resulting in a trip automatically produce a high-priority alarm, without any special settings required.
In all cases, the alarm history is updated.
If power to the FDM121 fails, all information is stored in the Micrologic non-volatile memory. The data can be consulted via the communication system when power is restored.

## Status indications and remote control

When the circuit breaker is equipped with the BSCM module (page A-27), the FDM121 display can also be used to view circuit breaker status conditions:
b O/F: ON/OFF
b SD: trip indication
b SDE: Fault-trip indication (overload, short-circuit, ground fault)

## Main characteristics

b $96 \times 96 \times 30 \mathrm{~mm}$ screen requiring 10 mm behind the door (or 20 mm when the 24 volt power supply connector is used).
b White backlighting.
b Wide viewing angle: vertical $\pm 60^{\circ}$, horizontal $\pm 30^{\circ}$.
b High resolution: excellent reading of graphic symbols.
b Alarm LED: flashing orange for alarm pick-up, steady orange after operator reset if alarm condition persists.
b Operating temperature range $-10^{\circ} \mathrm{C}$ to $+55^{\circ} \mathrm{C}$.
b CE / UL marking.
b 24 V DC power supply, with tolerances $24 \mathrm{~V}-20 \%(19.2 \mathrm{~V})$ to $24 \mathrm{~V}+10 \%(26.4 \mathrm{~V})$. When the FDM121 is connected to the communication network, the 24 V is supplied by the communication system wiring system.
b Consumption 40 mA .

## Mounting

The FDM121 is easily installed in a switchboard.
b Standard door cut-out $92 \times 92 \mathrm{~mm}$.
b Attached using clips.
To avoid a cut-out in the door, an accessory is available for surface mounting by drilling only two 22 mm diameter holes.
The FDM121 degree of protection is IP54 in front. IP54 is maintained after switchboard mounting by using the supplied gasket during installation.

## Connection

The FDM121 is equipped with:
b a 24 V DC terminal block:
v plug-in type with 2 wire inputs per point for easy daisy-chaining
V power supply range of $24 \mathrm{~V}-20 \%(19.2 \mathrm{~V})$ to $24 \mathrm{~V}+10 \%(26.4 \mathrm{~V})$
b two RJ45 jacks.
The Micrologic connects to the internal communication terminal block on the Compact NSX via the pre-wired NSX cord. Connection to one of the RJ45 connectors on the FDM121 automatically establishes communication between the Micrologic and the FDM121 and supplies power to the Micrologic measurement functions.
When the second connector is not used, it must be fitted with a line terminator.


## Navigation

Five buttons are used for intuitive and fast navigation.
The "Context" button may be used to select the type of display (digital, bargraph, analogue).
The user can select the display language (Chinese, English, French, German, Italian, Portuguese, Spanish, etc.) Other languages can be downloaded.

## Screens

Main menu
When powered up, the FDM121 screen automatically displays the ON/OFF status of the device.


When not in use, the screen is not backlit. Backlighting can be activated by pressing one of the buttons. It goes off after 3 minutes.

## Fast access to essential information

b "Quick view" provides access to five screens that display a summary of essential operating information (I, U, f, P, E, THD, circuit breaker On / Off).

## Access to detailed information

b "Metering" can be used to display the measurement data (I, U-V, f, P, Q, S, E, THD, PF) with the corresponding min/max values.
b Alarms displays active alarms and the alarm history.
b Services provides access to the operation counters, energy and maximeter reset function, maintenance indicators, identification of modules connected to the internal bus and FDM121 internal settings (language, contrast, etc.)

## Compact NSX communication

Communications modules

All Compact NSX devices can be equipped with the communication function via a prewired connection system and a Modbus network interface.
The interface can be connected directly or via the FDM121 switchboard display unit. Four functional levels can be combined to adapt to all supervision requirements.

## Four functional levels

The Compact NSX can be integrated in a Modbus communication environment. Four functional levels can be used separately or combined.

## Communication of status indications

This level is compatible with all Compact NSX circuit breakers, whatever the trip unit, and with all switch-disconnectors. Using the BSCM module, the following information is accessible:
b ON/OFF position (O/F)
b trip indication (SD)
b fault-trip indication (SDE).

## Communication of commands

Also available on all circuit breakers and switch-disconnectors, this level (communicating remote control) can be used to:
b open
b close
b reset.
Communication of measurements with Micrologic 5/6 A or E
This level provides access to all available information:
b instantaneous and demand values
b maximeters/minimeters
b energy metering
b demand current and power
b power quality.
Communication of operating assistance with Micrologic 5/6 A or E
b protection and alarm settings
b time-stamped histories and event tables
b maintenance indicators.

Communication components and connections


## Modbus interface module

## Functions

This module, required for connection to the network, contains the Modbus address (1 to 99) declared by the user via the two dials in front. It automatically adapts (baud rate, parity) to the Modbus network in which it is installed.
It is equipped with a lock-out switch to enable or disable operations involving writing to Micrologic, i.e. reset, counter reset, setting modifications, device opening and closing commands, etc.
There is a built-in test function to check the connections of the Modbus interface module with the Micrologic and FDM121 display unit.


## Mounting

The module is mounted on a DIN rail. A number of modules may be clipped one next to the other. For this, a stacking accessory is available for fast clipconnection of both the Modbus link and the 24 V DC supply.
The Modbus interface module supplies 24 V DC to the corresponding Micrologic, FDM121 display and BSCM module. Module consumption is $60 \mathrm{~mA} / 24 \mathrm{~V}$ DC.


1 Five-point Modbus and 24 V DC connector
2 Two Modbus address dials (1 to 99)
3 Modbus traffic LED
4 Lock-out to disable writing to the NSX
5 Test LED
6 Test button
7 Two connectors for RJ45 cable


## BSCM module

## Functions

The optional BSCM Breaker Status \& Control Module is used to acquire device status indications and control the communicating remote-control function.
It includes a memory used to manage the maintenance indicators.

## Status indications

Indication of device status:
O/F, SD and SDE

## Maintenance indicators

The BSCM module manages the following indicators:
b mechanical operation counter
b electrical operation counter
b history of status indications. It is possible to assign an alarm to the operation counters.

## Controls

The module can be used to carry out communicating remote control operations: (open, close and reset) in different modes (manual, auto).

## Mounting

The BSCM module can be installed on all Compact NSX circuit breakers and switch-disconnectors. It simply clips into the auxiliary contact slots. It occupies the slots of one O/F contact and one SDE contact. The BSCM is supplied with 24 V DC power automatically via the NSX cord when the communication system is installed.


Functions and characteristics

## Compact NSX communication

 Networks and softwareCompact NSX uses the Modbus communication protocol, compatible with SMS PowerLogic supervision systems.
Two downloadable utilities facilitate implementation of communication functions.

## Modbus

Modbus is the most widely used communication protocol in industrial networks. It operates in masterslave mode. The devices (slaves) communicate one after the other with a gateway (master). Masterpact, Compact NSX, PowerLogic and Sepam products all operate with this protocol. A Modbus network is generally implemented on an LV or MV switchboard scale.
Depending on the data monitored and the desired refresh rate, a Modbus network connected to a gateway can serve 4 to 16 devices. For larger installations, a number of Modbus networks can be connected to an Ethernet network (TCP/IP/Modbus protocol) via their gateways.


## Micrologic utilities

b Two utilities, RSU and RCU, presented on the next page, are available to assist in starting up a communicating installation. Intended for Compact NSX and Masterpact, the software can be downloaded from the Schneider Electric internet site.
b The "Live update" function enables immediate updating to obtain the most recent upgrades. These easy-to-use utilities include starting assistance and online help. They are compatible with Microsoft Windows 2000, XP and Vista.


RSU configuration screen for a Micrologic 5.2.


RCU mini-supervision screen for current measurements.

## Gateway

The gateway has two functions:
b access to the company intranet (Ethernet) by converting Modbus frames to the TCP/IP/Modbus protocol
b optional web-page server for the information from the devices.
Examples include MPS100, EGX400 and EGX100.

## MPS100

b Plug and play device. It comes loaded with a webpage application for graphic display of currents and voltages and viewing of circuit-breaker status and power and energy values.
To use the application, simply declare the Modbus addresses of the connected slaves. Automatically recognised devices include all Masterpact and Compact NSX Micrologic trip units and the PM500/700/800 and PM9c power monitoring units. b Can be used for automatic alarm notification via a messaging server available on the site intranet or via mobile phones (e-mail converted into SMS).
b Can be used for logging of data that can be automatically sent as e-mail attachments, e.g. a weekly consumption report.


Web page.

Two utilities, RSU and RCU, are available to assist in starting up a communicating installation.
They can be downloaded from the Schneider Electric internet site and include a "Live update" function that enables immediate updating.


RSU: Micrologic Remote Setting Utility.

## RSU (Remote Setting Utility)

This utility is used to set the protection functions and alarms for each Masterpact and Compact NSX device.
After connection to the network and entry of the circuit-breaker Modbus address, the software automatically detects the type of trip unit installed.
There are two possible operating modes.
Off-line with the software disconnected from the communication network
For each selected circuit breaker, the user can do the following.

## Determine the protection settings

The settings are carried out on a screen that shows the front of the trip unit. The Micrologic setting dials, keypad and screen are simulated for easy use of all Micrologic setting functions.
Save and duplicate the protection settings
Each configuration created can be saved for subsequent device programming. It can also be duplicated and used as the basis for programming another circuit breaker.

## On-line with the software connected to the network

Similarly, for each selected circuit breaker, the user can do the following.

## Display the current settings

The software displays the trip unit and provides access to all settings.

## View the corresponding protection curves

A graphic curve module in the software displays the protection curve corresponding to the settings. It is possible to lay a second curve over the first for discrimination studies.

## Modify settings in a secure manner

b There are different levels of security:
v password: by default, it is the same for all devices, but can be differentiated for each device
v locking of the Modbus interface module which must be unlocked before the corresponding device can be set remotely
v maximum settings limited by the positions of the two dials on the trip unit.
These dials, set by the user, determine the maximum settings that can be made via the communication system.
b Settings are modified by:
v either direct, on-line setting of the protection settings on the screen
$v$ or by loading the settings prepared in off-line mode. This is possible only if the positions of the dials allow the new settings.
All manual settings made subsequently on the device have priority.

## Program alarms

b Up to 12 alarms can be linked to measurements or events.
b two alarms are predefined and activated automatically:
v Micrologic 5: overload (Ir)
v Micrologic 6: overload (lr) and ground fault (lg)
b thresholds, priorities and time delays can be set for 10 other alarms. They may be selected from a list of 91 alarms

## Set the outputs of the SDx relays

This is required when the user wants to change the standard configuration and assign different signals to the 2 outputs of the SDx relay.


RCU: Remote Control Utility for communication tests.

## RCU (Remote Control Utility)

The RCU utility can be used to test communication for all the devices connected to the Modbus network. It is designed for use with Compact NSX, Masterpact, Advantys OTB and Power Meter devices. It offers a number of functions.

## Mini supervisor

b Display of I, U, f, P, E and THD measurements for each device, via navigation b Display of ON/OFF status
Open and close commands for each device
A common or individual password must first be entered.

When all functions have been tested, this utility is replaced by the supervision software selected for the installation.

# Supervision software 

Schneider Electric electrical installation supervision, management and expert system software integrates Compact NSX identification modules.


Connection symbol for Compact NSX compatible modules.


PowerView software.


SMS software screen.

## Types of software

Masterpact and Compact NSX communication functions are designed to interface with software dedicated to electrical installations:
b switchboard supervision
b electrical installation supervision
b power system management: electrical engineering expert systems
b process control
b SCADA (Supervisory Control \& Data Acquisition), EMS (Enterprise Management System) or BMS (Building Management System) type software.

## Integration of Compact NSX

Compact NSX devices are integrated via Modbus interface modules connected via FDM121 display units or NSX cords.
For easy connection of the different modules, the prefabricated cables are identified by ULP (Universal Logic Plug) symbols. The connection points on compatible modules are marked in the same manner.

## Schneider Electric solutions

## Electrical switchboard supervision via MPS100 or EGX400 Web servers

A simple solution for customers who want to consult the main electrical parameters of switchboard devices without dedicated software.
Up to 16 switchboard devices are connected via Modbus interfaces to an MPS100 or EGX400 Ethernet gateway integrating the functions of a web page server. The embedded Web pages can be easily configured with just a few mouse clicks. The information they provide is updated in real time.
The Web pages can be consulted using a standard Web browser on a PC connected via Ethernet to the company Intranet or remotely via a modem. Automatic notification of alarms and threshold overruns is possible via e-mail or SMS (Short Message Service).

Electrical installation supervision via PowerView software
PowerLogic ${ }^{\circledR}$ PowerView software is ideally suited to the supervision needs of small system applications, monitoring up to 32 devices. Installed on a PC under Windows, it represents a cost-effective and easy-to-implement power-monitoring solution that offers:
b automatic detection of compatible devices
b real-time monitoring of data including power consumption
b a report generator with a number of pre-defined reports that can be exported to Excel
b cost allocation
b time-stamped data-logging possibilities
b Modbus serial and Modbus TCP/IP compatible communication.
SMS electrical engineering expert system software
PowerLogic ${ }^{\circledR}$ SMS is a family of web-enabled software products for high-end powermonitoring applications. It is designed for large power systems.
SMS products offer detailed analysis of electrical events, long-duration data logging and extensive, economical report-building capabilities (e.g. consumption monitoring and tariff management).
A wide variety of screens can be displayed in real time, including more than 50 tables, analogue meters, bargraphs, alarms logs with links to display waveforms and predefined reports on energy quality and service costs.

## Other software

Compact NSX devices can forward their measurement and operating information to special software integrating the electrical installation and other technical facilities:
b SCADA process control software: Vijeo CITECT
b BMS Building Management System software: Vista.
Please consult us.


External neutral current transformers.


External neutral voltage tap (cat. no. LV434208)


External 24 V DC power-supply module.

## External neutral current transformer (ENCT)

The external transformer is a sensor required for a three-pole circuit breaker in a system with a distributed neutral to measure the neutral current in order to: b protect the neutral conductor
b protect against insulation faults.
This current transformer can be connected to Micrologic 5 / 6 trip units. The transformer rating must be compatible with that of the circuit breaker.
Required current transformers for different circuit breaker models

| Type of circuit breaker | Rating | Catalogue <br> number |
| :--- | :--- | :--- |
| NSX100/160/250 | $\frac{25-100 \mathrm{~A}}{\text { LV429521 }}$ |  |
| NSX400/630 | $400-630 \mathrm{~A}$ | LV430563 |

## External neutral voltage tap (ENVT)

The neutral voltage transformer is required for Micrologic E power metering with a three-pole circuit breaker in a system with a distributed neutral. It is used to connect the neutral to the Micrologic trip unit to measure phase-to-neutral (Ph-N) voltages.

## External 24 V DC power-supply module

Use
An external 24 V DC power supply is required for installations with communication, whatever the type of trip unit.
On installations without communication, it is available as an option for Micrologic 5/6 in order to make it possible to:
b modify settings when the circuit breaker is open
b display measurements when the current flowing through the circuit breaker is low ( 15 to 50 A depending on the rating)
b maintain the display of the cause of tripping and interrupted current.

## Characteristics

A single external 24 V DC supply may be used for the entire switchboard.
The required characteristics are:
b output voltage: $24 \vee \mathrm{DC} \pm 5 \%$
b ripple: $\pm 1 \%$.
b overvoltage category: OVC IV - as per IEC 60947-1
External 24 V DC power-supply modules with an output current of 1 A are available:


An external 24 V DC power-supply module with an output current of 3 A is also available:



Configuration and maintenance module (cat. no. TRV00911).


Using the configuration and maintenance module.

## Test battery

This pocket battery connects to the Micrologic test connector. It powers up the Micrologic and the Ready LED. It supplies the screen and allows settings to be made via the keypad.

## Battery module

The battery module is a back-up supply for the external power-supply module. The input/output voltages are 24 V DC and it can supply power for approximately three hours (100 mA).

## 24 V DC power-supply terminal block

The 24 V DC power-supply terminal block can be installed only on Micrologic 5/6 trip units. It is required to power the trip unit when the trip unit is not connected to an FDM121 display unit or to the communication system. When used, it excludes connection of an NSX cord.

## NSX cord

b For voltage U y 480 V , available in 3 prefabricated lengths: $0.35 \mathrm{~m}, 1.3 \mathrm{~m}$ and 3 m . b For voltages $U>480 \mathrm{~V}$, a special 1.3 m cord with an insulation accessory is required.
b A set of cords with RJ45 connectors is available to adapt to different distances between devices.

## Maintenance case

The case includes:
b configuration and maintenance module
b power supply (110... 220 V AC / 50-60 Hz 24 V DC - 1 A)
b special cable for connection to the trip-unit test connector
b standard USB cable
b standard RJ45 cable
b user manual
b optional Bluetooth link (to PC).

## Configuration and maintenance module

Included in the maintenance kit, this module tests Micrologic operation and provides access to all parameters and settings. It connects to the Micrologic test connector and can operate in two modes.
b Stand-alone mode to:
$v$ supply the Micrologic and check operation via the Ready LED
v check mechanical operation of the circuit breaker (trip using pushbutton).
b PC mode, connected to a PC via USB or Bluetooth link. This mode provides access to protection settings, alarm settings and readings of all indicators. Using the associated RSU software utility, it is possible to store, in a dedicated file for each device, all the data that can transferred to another device.
This mode also offers operating-test functions:
$v$ check on trip time delay (trip curve)
v check on non-tripping time (discrimination)
$v$ check on ZSI (Zone Selective Interlocking) function
$v$ alarm simulation
$v$ display of setting curves
v display of currents
$v$ printing of test reports.

There are two ways to add earth-leakage protection to any three or four-pole Compact NSX100 to 630 circuit breaker equipped with a magnetic, thermal-magnetic or Micrologic 2, 5 or 6 trip unit:
b by adding a Vigi module to the circuit breaker to form a Vigicompact NSX
b by using a Vigirex relay and separate toroids.


Vigicompact NSX100 to 630.


Earth-leakage relay.


[^4]
## Circuit breaker with add-on Vigi module (Vigicompact NSX)

b For general characteristics of circuit breakers, see pages A-6 and A-7. b Add-on Vigi modules. Earth-leakage protection is achieved by installing a Vigi module (characteristics and selection criteria on next page) directly on the circuit breaker terminals It directly actuates the trip unit (magnetic, thermal-magnetic or Micrologic).

## Circuit breaker combined with a Vigirex relay

## Compact NSX circuit breaker + Vigirex relay

Vigirex relays may be used to add external earth-leakage protection to Compact NSX circuit breakers. The circuit breakers must be equipped with an MN or MX voltage release. The Vigirex relays add special tripping thresholds and time delays for earth-leakage protection.
Vigirex relays are very useful when faced with major installation constraints (circuit breaker already installed and connected, limited space available, etc.).

## Vigirex-relay characteristics

b Sensitivity adjustable from 30 mA to 250 mA and 9 time-delay settings ( 0 to 4.5 seconds).
b Closed toroids up to 630 A ( 30 to 300 mm in diameter), split toroids up to 250 A
( 46 to 110 mm in diameter) or rectangular sensors up to 630 A .
b $50 / 60 \mathrm{~Hz}, 400 \mathrm{~Hz}$ distribution systems.

## Options

b Trip indication by a fail-safe contact
b Pre-alarm contact and LED, etc.

## Compliance with standards

b IEC 60947-2, annex M
b IEC/EN 60755: general requirements for residual-current operated protective devices
b IEC/EN 61000-4-2 to 4-6: immunity tests
b CISPR11: radio-frequency radiated and conducted emission tests
b UL1053 and CSA22.2 No. 144 for RH10, RH21 and RH99 relays at supply voltages up to and including 220/240 V.


## Vigicompact NSX100 to 630 circuit breakers with earth-leakage protection

Addition of the Vigi module does not alter circuit-breaker characteristics:
b compliance with standards
b degree of protection, class II front-face insulation
b positive contact indication
b electrical characteristics
b trip-unit characteristics
b installation and connection modes
b indication, measurement and control auxiliaries
b installation and connection accessories.

\left.| Dimensions and weights |  |  | NSX100/160/250 |
| :--- | :--- | :--- | :--- |$\right)$ NSX400/630

## Vigi earth-leakage protection modules

Compliance with standards
b IEC 60947-2, annex B.
b Decree dated 14 November 1988 (for France).
b IEC 60755, class A, immunity to DC components up to 6 mA
b operation down to $-25^{\circ} \mathrm{C}$ as per VDE 664.

## Remote indications

Vigi modules may be equipped with an auxiliary contact (SDV) to remotely signal
 tripping due to an earth fault.

## Use of 4-pole Vigi module with a 3-pole Compact NSX

In a 3-phase installation with an uninterrupted neutral, an accessory makes it possible to use a 4-pole Vigi module with connection of the neutral cable.

## Power supply

Vigi modules are self-supplied internally by the distribution-system voltage and therefore do not require any external source. They continue to function even when supplied by only two phases.

## Vigi module selection



1 Sensitivity setting
2 Time-delay setting (for selective earth-leakage protection). 3 Lead-seal fixture for controlled access to settings.
4 Test button simulating an earth-fault for regular checks on the tripping function
5 Reset button (reset required after earth-fault tripping).
6 Rating plate
7 Housing for SDV auxiliary contact.

## Plug-in devices

The Vigi module can be installed on a plug-in base. Special accessories are required (see catalogue number chapter).

| Type | Vigi ME | Vigi MH | Vigi MB |
| :---: | :---: | :---: | :---: |
| Number of poles | 3, $4^{(1)}$ | 3, $4^{(1)}$ | $3,4{ }^{(1)}$ |
| NSX100 | b | b | - |
| NXS160 | b | b | - |
| NSX250 | - | b | - |
| NSX400 | - | - | b |
| NSX630 | - | - | b |
| Protection characteristics |  |  |  |
| Sensitivity | fixed | adjustable | adjustable |
| $1 \Delta n(A)$ | 0.3 | 0.03-0.3-1-3-10 | 0.3-1-3-10-30 |
| Time delay | fixed | adjustable | adjustable |
| Intentional delay (ms) | < 40 | 0-60 ${ }^{(2)}-150{ }^{(2)}-310^{(2)}$ | 0-60-150-310 |
| Max. break time (ms) | < 40 | < $40<140<300<800$ | < $40<140<300<800$ |
| Rated voltage VAC $50 / 60 \mathrm{~Hz}$ | 200... 440 | 200... 440-440... 550 | 200...440-440... 550 |

(1) Vigi 3P modules may also be used on 3P circuit breakers used for two-phase protection.
(2) If the sensitivity is set to 30 mA , there is no time delay, whatever the time-delay setting.

## Operating safety

The Vigi module is a user safety device. It must be tested at regular intervals (every 6 months) via test button.

## Motor protection

General information on motor feeders

The parameters to be considered for motor-feeder protection depend on:
b the application (type of machine driven, operating safety, frequency of operation, etc.)
$b$ the level of continuity of service required by the load or the application
b the applicable standards for the protection of life and property
The required electrical functions are:
b isolation
b switching, generally at high endurance levels b protection against overloads and short-circuits, adapted to the motor
b additional special protection.
A motor feeder must comply with the requirements of standard IEC 60947-4-1 concerning contactors and their protection:
b coordination of feeder components
b thermal-relay trip classes
b contactor utilisation categories
b coordination of insulation

## Motor-feeder function

A motor feeder comprises a set of devices for motor protection and control, as well as for protection of the feeder itself.

## Isolation

The purpose is to isolate the live conductors from the upstream distribution system to enable work by maintenance personnel on the motor feeder at no risk. This function is provided by a motor circuit breaker offering positive contact indication and lockout/ tagout possibilities.

## Switching

The purpose is to control the motor (ON / OFF), either manually, automatically or remotely, taking into account overloads upon start-up and the long service life required. This function is provided by a contactor. When the coil of the contactor's electromagnet is energised, the contactor closes and establishes, through the poles, the circuit between the upstream supply and the motor, via the circuit breaker.

## Basic protection

b Short-circuit protection
Detection and breaking, as quickly as possible, of high short-circuit currents to avoid damage to the installation. This function is provided by a magnetic or thermalmagnetic circuit breaker.
b Overload protection
Detection of overload currents and motor shutdown before temperature rise in the motor and conductors damages insulation. This function is provided by a thermalmagnetic circuit breaker or a separate thermal relay.

## Overloads: < 10 x ln

They are caused by:
b an electrical problem, related to an anomaly in the distribution system (e.g. phase failure,
voltage outside tolerances, etc.)
b a mechanical problem, related to a process malfunction (e.g. excessive torque) or damage to the motor (e.g. bearing vibrations).
These two causes will also result in excessively long starting times.
Impedant short-circuits: $10 \times$ In <l < $50 \times$ In
This type of short-circuit is generally due to deteriorated insulation of motor windings or damaged supply cables.
Short-circuits: I> 50 x In
This relatively rare type of fault may be caused by a connection error during maintenance
b Phase unbalance or phase loss protection
Phase unbalance or phase loss can cause temperature rise and braking torques that can lead to premature ageing of the motor. These effects are even greater during starting, therefore protection must be virtually immediate.

## Additional electronic protection

b Locked rotor
b Under-load
b Long starts and stalled rotor
b Insulation faults.

## Motor-feeder solutions

Standard IEC 60947 defines three types of device combinations for the protection of motor feeders.

## Three devices

b magnetic circuit breaker + contactor + thermal relay.

## Two devices

b thermal-magnetic circuit breaker + contactor.

## One device

b thermal-magnetic circuit breaker + contactor in an integrated solution (e.g.
Tesys U).

## Device coordination

The various components of a motor feeder must be coordinated. Standard IEC 60947-4-1 defines three types of coordination depending on the operating condition of the devices following a standardised short-circuit test.

## Type-1 coordination

b No danger to life or property.
b The contactor and/or the thermal relay may be damaged.
b Repair and replacement of parts may be required prior to further service.

## Type-2 coordination

b No danger to life or property.
b No damage or adjustments are allowed. The risk of contact welding is accepted as long as they can be easily separated.
b Isolation must be maintained after the incident, the motor feeder must be suitable for further use without repair or replacement of parts.
b A rapid inspection is sufficient before return to service.

## Total coordination

b No damage and no risk of contact welding is allowed for the devices making up the motor feeder. The motor feeder must be suitable for further use without repair or replacement of parts.
This level is provided by integrated 1-device solutions such as Tesys U .

## Contactor utilisation categories

For a given motor-feeder solution, the utilisation category determines the contactor withstand capacity in terms of frequency of operation and endurance. Selection, which depends on the operating conditions imposed by the application, may result in oversizing the contactor and circuit-breaker protection. Standard IEC 60947 defines the following contactor utilisation categories.
Contactor utilisation categories (AC current)

| Contactor utilisation <br> categories | Type of load | Control function | Typical applications |  |
| :--- | :--- | :--- | :--- | :--- |
| AC1 | Non-inductive $(\cos \varphi$ u 0.8$)$ | Energising | Heating, distribution |  |
| AC2 | Slip-ring motor $(\cos \varphi$ u 0.65) | Starting <br> Switching off motor during running <br> Counter-current braking <br> Inching | Wiring-drawing machine |  |
| AC3 | Squirrel-cage motor <br> $(\cos \varphi=0.45$ for $y 100 \mathrm{~A})$ <br> $(\cos \varphi=0.35$ for $>100 \mathrm{~A})$ | Starting <br> Switching off motor during running | Compressors, elevators, pumps, mixers, <br> escalators, fans, conveyer systems, air- <br> conditioning |  |
| AC4 |  | Starting <br> Switching off motor during running <br> Regenerative braking <br> Plugging <br> Inching | Printing machines, wire-drawing machines |  |

Utilisation category AC3-common coordination tables for circuit breakers and contactors
This category covers asynchronous squirrel-cage motors that are switched off during running, which is the most common situation ( $85 \%$ of cases). The contactor makes the starting current and switches off the rated current at a voltage approximately one sixth of the nominal value. The current is interrupted without difficulty.
The circuit breaker-contactor coordination tables for Compact NSX are for use with contactors in the AC3 utilisation category, in which case they ensure type-2 coordination.

## Utilisation category AC4 - possible oversizing

This category covers asynchronous squirrel-cage motors capable of operating under regenerative braking or inching (jogging) conditions
The contactor makes the starting current and can interrupt this current at a voltage that may be equal to that of the distribution system.
These difficult conditions make it necessary to oversize the contactor and, in general, the protective circuit breaker with respect to category AC3.

Functions
and characteristics

## Motor protection <br> Motor-feeder characteristics and solutions

The trip class determines the trip curve of the thermal protection device (inverse-time curve) for a motor feeder.
Standard IEC 60947-4-1 defines trip classes 5, 10, 20 and 30.
These classes are the maximum durations, in seconds, for motor starting with a starting current of 7.2 Ir , where Ir is the thermal setting indicated on the motor rating plate.

Example: In class 20, the motor must have finished starting within 20 seconds ( 6 to 20 s) for a starting current of 7.2 Ir .

## Standardised values in kW

| Rated operational power | Standardised values in kW currents le (A) for: |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
|  | 230 V | 400 V | 500 V | 690 V |
| kW | A | A | A | A |
| 0.06 | 0.35 | 0.32 | 0.16 | 0.12 |
| 0.09 | 0.52 | 0.3 | 0.24 | 0.17 |
| 0.12 | 0.7 | 0.44 | 0.32 | 0.23 |
| 0.18 | 1 | 0.6 | 0.48 | 0.35 |
| 0.25 | 1.5 | 0.85 | 0.68 | 0.49 |
| 0.37 | 1.9 | 1.1 | 0.88 | 0.64 |
| 0.55 | 2.6 | 1.5 | 1.2 | 0.87 |
| 0.75 | 3.3 | 1.9 | 1.5 | 1.1 |
| 1.1 | 4.7 | 2.7 | 2.2 | 1.6 |
| 1.5 | 6.3 | 3.6 | 2.9 | 2.1 |
| 2.2 | 8.5 | 4.9 | 3.9 | 2.8 |
| 3 | 11.3 | 6.5 | 5.2 | 3.8 |
| 4 | 15 | 8.5 | 6.8 | 4.9 |
| 5.5 | 20 | 11.5 | 9.2 | 6.7 |
| 7.5 | 27 | 15.5 | 12.4 | 8.9 |
| 11 | 38 | 22 | 17.6 | 12.8 |
| 15 | 51 | 29 | 23 | 17 |
| 18.5 | 61 | 35 | 28 | 21 |
| 22 | 72 | 41 | 33 | 24 |
| 30 | 96 | 55 | 44 | 32 |
| 37 | 115 | 66 | 53 | 39 |
| 45 | 140 | 80 | 64 | 47 |
| 55 | 169 | 97 | 78 | 57 |
| 75 | 230 | 132 | 106 | 77 |
| 90 | 278 | 160 | 128 | 93 |
| 110 | 340 | 195 | 156 | 113 |
| 132 | 400 | 230 | 184 | 134 |
| 160 | 487 | 280 | 224 | 162 |
| 200 | 609 | 350 | 280 | 203 |
| 250 | 748 | 430 | 344 | 250 |
| 315 | 940 | 540 | 432 | 313 |

## Trip class of a thermal-protection device

The motor feeder includes thermal protection that may be built into the circuit breaker. The protection must have a trip class suited to motor starting. Depending on the application, the motor starting time varies from a few seconds (no-load start) to a few dozen seconds (high-inertia load).
Standard IEC 60947-4-1 defines the trip classes below as a function of current setting Ir for thermal protection.
Trip class of thermal relays as a function of their Ir setting

| Class | $1.05 \mathrm{Ir} \mathrm{r}^{(1)}$ | 1.2 Ir ${ }^{(1)}$ | $1.5 \mathrm{lr}{ }^{(2)}$ | $7.21{ }^{(1)}$ |
| :---: | :---: | :---: | :---: | :---: |
| 5 | $\mathrm{t}>2 \mathrm{~h}$ | $t<2 h$ | $\mathrm{t}<2 \mathrm{mn}$ | $2 \mathrm{~s}<\mathrm{ty} 5 \mathrm{~s}$ |
| 10 | $t>2 \mathrm{~h}$ | $t<2 h$ | $\mathrm{t}<4 \mathrm{mn}$ | $4 \mathrm{~s}<\mathrm{ty} 10 \mathrm{~s}$ |
| 20 | $t>2 \mathrm{~h}$ | $t<2 h$ | $\mathrm{t}<8 \mathrm{mn}$ | $6 \mathrm{~s}<\mathrm{ty} 20 \mathrm{~s}$ |
| 30 | $\mathrm{t}>2 \mathrm{~h}$ | t<2h | $\mathrm{t}<12 \mathrm{mn}$ | $9 \mathrm{~s}<\mathrm{ty} 30 \mathrm{~s}$ |

(1) Time for a cold motor (motor off and cold).
(2) Time for warm motor (motor running under normal conditions).

## Currents of squirrel-cage motors at full rated load

Standardised values in HP

| Rated operational power | Indicative values of the rated operational currents le (A) for |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\begin{aligned} & 110- \\ & 120 \mathrm{~V} \end{aligned}$ | 200 V | 208 V | $\begin{aligned} & 220- \\ & 240 \mathrm{~V} \end{aligned}$ | $\begin{aligned} & 380- \\ & 415 \mathrm{~V} \end{aligned}$ | $\begin{aligned} & 440- \\ & 480 \mathrm{~V} \end{aligned}$ | $\begin{aligned} & 550- \\ & 600 \mathrm{~V} \end{aligned}$ |
| hp |  |  |  |  |  |  |  |
| 1/2 | 4.4 | 2.5 | 2.4 | 2.2 | 1.3 | 1.1 | 0.9 |
| 3/4 | 6.4 | 3.7 | 3.5 | 3.2 | 1.8 | 1.6 | 1.3 |
| 1 | 8.4 | 4.8 | 4.6 | 4.2 | 2.3 | 2.1 | 1.7 |
| 11/2 | 12 | 6.9 | 6.6 | 6 | 3.3 | 3 | 2.4 |
| 2 | 13.6 | 7.8 | 7.5 | 6.8 | 4.3 | 3.4 | 2.7 |
| 3 | 19.2 | 11 | 10.6 | 9.6 | 6.1 | 4.8 | 3.9 |
| 5 | 30.4 | 17.5 | 16.7 | 15.2 | 9.7 | 7.6 | 6.1 |
| $71 / 2$ | 44 | 25.3 | 24.2 | 22 | 14 | 11 | 9 |
| 10 | 56 | 32.2 | 30.8 | 28 | 18 | 14 | 11 |
| 15 | 84 | 48.3 | 46.2 | 42 | 27 | 21 | 17 |
| 20 | 108 | 62.1 | 59.4 | 54 | 34 | 27 | 22 |
| 25 | 136 | 78.2 | 74.8 | 68 | 44 | 34 | 27 |
| 30 | 160 | 92 | 88 | 80 | 51 | 40 | 32 |
| 40 | 208 | 120 | 114 | 104 | 66 | 52 | 41 |
| 50 | 260 | 150 | 143 | 130 | 83 | 65 | 52 |
| 60 | - | 177 | 169 | 154 | 103 | 77 | 62 |
| 75 | - | 221 | 211 | 192 | 128 | 96 | 77 |
| 100 | - | 285 | 273 | 248 | 165 | 124 | 99 |
| 125 | - | 359 | 343 | 312 | 208 | 156 | 125 |
| 150 | - | 414 | 396 | 360 | 240 | 180 | 144 |
| 200 | - | 552 | 528 | 480 | 320 | 240 | 192 |
| 250 | - | - | - | 604 | 403 | 302 | 242 |
| 300 | - | - | - | 722 | 482 | 361 | 289 |

Note: $1 \mathrm{hp}=0.7457 \mathrm{~kW}$.

## Asynchronous-motor starting parameters

The main parameters of direct on-line starting of three-phase asynchronous motors ( $90 \%$ of all applications) are listed below.
b Ir: rated current
This is the current drawn by the motor at full rated load (e.g. approximately 100 Arms for 55 kW at 400 V ).
b Id: starting current
This is the current drawn by the motor during starting, on average 7.2 In for a duration td of 5 to 30 seconds depending on the application (e.g. 720 Arms for 10 seconds). These values determine the trip class and any additional "long-start" protection devices that may be needed.
b I"d: peak starting current
This is the subtransient current during the first two half-waves when the system is energised, on the average 14 In for 10 to 15 ms (e.g. 1840 A peak).

The protection settings must effectively protect the motor, notably via a suitable thermal-relay trip class, but let the peak starting current through.

Typical motor-starting curve

## Compact NSX motor-feeder solutions

Compact NSX motor circuit breakers are designed for motor-feeder solutions using:
b three devices, including an MA or 1.3-M magneticonly trip unit
b two devices including a TM-D or 2-M thermal-
magnetic trip unit.
They are designed for use with contactors in the AC3 utilisation category ( $80 \%$ of all cases) and they ensure type-2 coordination with the contactor.
For the AC4 utilisation category, the difficult conditions generally make it necessary to oversize the protection circuit breaker with respect to the AC3 category.

## Compact NSX motor-protection range

Compact NSX trip units can be used to create motor-feeder solutions comprising two or three devices. The protection devices are designed for continuous duty at $65^{\circ} \mathrm{C}$.

## Three-device solutions

b 1 NSX circuit breaker with an MA or Micrologic 1.3-M trip unit
b 1 contactor
b 1 thermal relay.

## Two-device solutions

b 1 Compact NSX circuit breaker
v with a Micrologic 2.2-M or 2.3-M electronic trip unit
$\vee$ with a Micrologic 6 E-M electronic trip unit. This version offers additional protection and Power Meter functions.
b 1 contactor.


MA magnetic trip units are used in 3-device motorfeeder solutions. They can be mounted on all Compact NSX100/160/250 circuit breakers with performance levels B/F/H/N/S/L.
They provide short-circuit protection for motors up to 110 kW at 400 V .

Micrologic 1.3-M trip units are used in 3-device motorfeeder solutions on Compact NSX400/630 circuit breakers with performance levels $B / F / H / N / S / L$.
They provide short-circuit protection for motors up to 250 kW at 400 V .
They also provide the benefits of electronic technology: b accurate settings
b tests
b "Ready" LED.

## MA magnetic trip units


Circuit breakers with an MA trip unit are combined with a thermal relay and a contactor or a starter.

## Protection



## Magnetic protection (Im)

Short-circuit protection with an adjustable pick-up Im that initiates instantaneous tripping if exceeded.
b $\operatorname{Im}=\ln x \ldots$ is set on an adjustment dial in multiples of the rating:
$v 6$ to $14 x \ln$ (2.5 to 100 A ratings)
v 9 to $14 \times \ln$ ( 150 to 200 A ratings)
Protection version
b 3-pole (3P 3D): 3-pole frame (3P) equipped with detection on all 3 poles (3D).

## Micrologic 1.3-M trip units



Circuit breakers with a Micrologic 1.3-M trip unit are combined with a thermal relay and a contactor.

## Protection <br> $\qquad$ <br> Settings are made using a dial. <br> Short-circuits: Short-time protection (Isd) <br> Protection with an adjustable pick-up Isd. There is a very short delay to let through motor starting currents. <br> b Isd is set in amperes from 5 to $13 \times \mathrm{ln}$, as follows: <br> v from 1600 to 4160 A for the 320 A rating. <br> $v$ from 2500 to 6500 A for the 500 A rating. <br> Short-circuits: Non-adjustable instantaneous protection (Ii) <br> Instantaneous protection with non-adjustable pick-up li. <br> Protection version

b 3-pole (3P 3D): 3-pole frame (3P) equipped with detection on all 3 poles (3D).

## Indications



Front indications
b Green "Ready" LED: flashes slowly when the circuit breaker is ready to trip in the event of a fault.


Micrologic 1.3-M

(1) Motor standards require operation at $65^{\circ} \mathrm{C}$. Circuit-breaker ratings are derated to take this requirement into account.

Micrologic 2-M trip units provide built-in thermal and magnetic protection. They are used in 2-device motorfeeder solutions on Compact NSX100 to 630 circuit breakers with performance levels B/F/H/N/S/L.
They provide protection for motors up to 315 kW at 400 V against:
b short-circuits
b overloads with selection of a trip class (5, 10 or 20) b phase unbalance.


SDTAM remote indication relay module with its terminal block.


Circuit breakers with a Micrologic 2.2 / 2.3-M trip unit include protection similar to an inverse-time thermal relay. They are combined with a contactor.

## Protection

Settings are made using a dial.


Overloads (or thermal protection): Long-time protection and trip class (Ir) Inverse-time thermal protection against overloads with adjustable pick-up Ir. Settings are made in amperes. The tripping curve for the long-time protection, which indicates the time delay $t r$ before tripping, is defined by the selected trip class.

## Trip class (class)

The class is selected as a function of the normal motor starting time.
b Class 5: starting time less than 5 s
b Class 10: starting time less than 10 s
b Class 20: starting time less than 20 s
For a given class, it is necessary to check that all motor-feeder components are sized to carry the 7.2 Ir starting current without excessive temperature rise during the time corresponding to the class.

## Short-circuits: Short-time protection (Isd)

Protection with an adjustable pick-up Isd. There is a very short delay to let through motor starting currents.
Short-circuits: Non-adjustable instantaneous protection (li) Instantaneous protection with non-adjustable pick-up li.

## Phase unbalance or phase loss (lunbal) (受)

This function opens the circuit breaker if a phase unbalance occurs:
b that is greater than the $30 \%$ fixed pick-up lunbal
b following the non-adjustable time delay tunbal equal to:
v 0.7 s during starting
$v 4 \mathrm{~s}$ during normal operation.
Phase loss is an extreme case of phase unbalance and leads to tripping under the same conditions.

## Indications

## Front indications

b Green "Ready" LED: flashes slowly when the circuit breaker is ready to trip in the event of a fault.
b Red alarm LED for motor operation: goes ON when the thermal image of the rotor and stator is greater than $95 \%$ of the permissible temperature rise.

## Remote indications via SDTAM module

Compact NSX devices with a Micrologic 2 can be equipped with an SDTAM module dedicated to motor applications for:
b a contact to indicate circuit-breaker overload
b a contact to open the contactor. In the event of a phase unbalance or overload, this output is activated 400 ms before circuit-breaker tripping to open the contactor and avoid circuit breaker tripping.
This module takes the place of the MN/MX coils and an OF contact.

(1) Motor standards require operation at $65^{\circ} \mathrm{C}$. Circuit-breaker ratings are derated to take this requirement into account.
(2) The unbalance measurement takes into account the most unbalanced phase with respect to the average current.


Unbalance of phase currents and voltages


## Additional technical characteristics

## Phase unbalance

An unbalance in three-phase systems occurs when the three voltages are not equal in amplitude and/or not displaced $120^{\circ}$ with respect to each other. It is generally due to single-phase loads that are incorrectly distributed throughout the system and unbalance the voltages between the phases.
These unbalances create negative current components that cause braking torques and temperature rise in asynchronous machines, thus leading to premature ageing.

## Phase loss

Phase loss is a special case of phase unbalance.
b During normal operation, it produces the effects mentioned above and tripping must occur after four seconds.
b During starting, the absence of a phase may cause motor reversing, i.e. it is the load that determines the direction of rotation. This requires virtually immediate tripping ( 0.7 seconds). Starting time in compliance with the class (Micrologic 2-M)
For normal motor starting, Micrologic 2-M checks the conditions below with respect to the thermal-protection (long-time) pick-up Ir:
b current > $10 \%$ x Ir (motor-off limit)
b overrun of 1.5 x Ir threshold, then return below this threshold before the end of a 10 s time delay.
If either of these conditions is not met, the thermal protection trips the device after a maximum time equal to that of the selected class.
Pick-up Ir must have been set to the current indicated on the motor rating plate.
Long starts (Micrologic 6 E-M)
When this function is not activated, the starting conditions are those indicated above.
When it is activated, this protection supplements thermal protection (class).
A long start causes tripping and is characterised by:
b current > $10 \%$ x $\operatorname{Ir}$ (motor-off limit) with:
b either overrun of the long-time pick-up (1 to $8 \times \operatorname{lr}$ ) without return below the pick-up before the end of the long-time time delay ( 1 to 200 s)
b or no overrun of the long-time pick-up (1 to $8 \times \mathrm{Ir}$ ) before the end of the long-time time delay ( 1 to 200 s).
Pick-up Ir must have been set to the current indicated on the motor rating plate.
This protection should be coordinated with the selected class.

Motor protection
Micrologic 6 E-M electronic trip units

Micrologic 6.E-M is used in 2-device motor-feeder solutions.
It provides the same protection as Micrologic 2-M: b short-circuits
b overloads with selection of the same trip classes (5,
10 or 20), plus trip class 30 for starting of machines with high inertia.
In addition, it offers specific motor-protection functions that can be set via the keypad.


SDTAM remote indication relay module with its terminal block.

Note: all the trip units have a transparent lead-sealable cover that protects access to the adjustment dials.


## Protection

The protection functions are identical to those of Micrologic 2-M and can be fineadjusted via the keypad $\boldsymbol{\square}$.
Access to setting modifications via the keypad is protected by a locking function that is controlled by a microswitch 0 . The lock is activated automatically if the keypad is not used for 5 minutes. Access to the microswitch is protected by a transparent lead-sealable cover. It is possible to scroll through settings and measurements with the cover closed.
Overloads (or thermal), class and short-circuits
The long-time, short-time and instantaneous functions are identical to those of Micrologic 2-M.
In addition, there is trip class 30 for long-time protection and a setting for self-cooled or fan-cooled motors (\%).

## Ground-fault protection (Ig)

Residual type ground-fault protection with an adjustable pick-up Ig (with Off position) and adjustable time delay $\boldsymbol{t g}$.
Phase unbalance or phase loss (lunbal)
This function opens the circuit breaker if a phase unbalance occurs:
b that is greater than the lunbal pick-up that can be fine-adjusted from 10 to $40 \%$ (30 \% by default)
b following the tunbal time delay that is:
v 0.7 s during starting
v adjustable from 1 to 10 seconds ( 4 seconds by default) during normal operation. Phase loss is an extreme case of phase unbalance and leads to tripping under the same conditions.

## Locked rotor (Ijam)

This function detects locking of the motor shaft caused by the load.
During motor starting (see page A-43), the function is disabled.
During normal operation, it causes tripping:
b above the ljam pick-up that can be fine-adjusted from 1 to 8 xlr
b in conjunction with the tjam time delay that can be adjusted from 1 to 30 seconds.

## Under-load (lund)

This function detects motor no-load operation due to insufficient load (e.g. a drained pump). It detects phase undercurrent.
During motor starting (see page A-43), the function is always enabled.
During normal operation, it causes tripping:
b below the lund pick-up that can be fine-adjusted from 0.3 to $0.9 \times \mathrm{lr}$
b in conjunction with the tund time delay that can be adjusted from 1 to 200
seconds.
Long starts (llong)
This protection supplements thermal protection (class).
It is used to better adjust protection to the starting parameters.
It detects abnormal motor starting, i.e. when the starting current remains too high or too low with respect to a pick-up value and a time delay.
It causes tripping:
b in relation with a llong pick-up that can be fine-adjusted from 1 to 8 x Ir
b in conjunction with the tlong time delay that can be adjusted from 1 to 200
seconds.
(see "long starts" page A-43)

## Display of type of fault

$\qquad$
On a fault trip, the type of fault (Ir, Isd, II, Ig, lunbal, Ijam), the phase concerned and the interrupted current are displayed.

## Indications



Front indications
b Green "Ready" LED: flashes slowly when the circuit breaker is ready to trip in the event of a fault.
b Red alarm LED for motor operation: goes ON when the thermal image of the rotor or stator is greater than $95 \%$ of the permissible temperature rise.
Remote indications via SDTAM or SDx module
See description on page A-42 for SDTAM and page A-81 for SDx.

(1) Motor standards require operation at $65^{\circ} \mathrm{C}$. Circuit-breaker ratings are derated to take this requirement into account.
(2) The unbalance measurement takes into account the most unbalanced phase with respect to the average current.

Motor protection
Micrologic 6 E-M electronic trip units (cont.)

Micrologic 6 E-M provides Power Meter functions with energy metering. With the FDM121 display unit, all metering data and operating indicators are available on the switchboard front panel. This version also displays the thermal image of the motor.


Thermal-image alarm.


PC screen with motor thermal image and value monitoring.

## Power Meter functions

The built-in Power Meter functions of the Micrologic 6 E-M are the same as those for the Micrologic 6-E presented in the section on distribution (see page A-20). When used exclusively in the three-phase version, neutral measurements are excluded.

## Operating-assistance functions

The operating-assistance functions of the Micrologic 6 E-M are the same as those for the Micrologic 6-E presented in the section on distribution (see page A-22).

## Special functions for motor feeders

Additional operating functions specifically for motor feeders are available.

## Phase sequence

The order in which the phases L1, L2, L3 are connected determines the direction of motor rotation. If two phases are inverted, the direction is reversed.
Information on the direction of rotation is provided. It can be linked to an alarm to detect an inversion in the direction following servicing on the supply under deenergised conditions and disable restarting.

## Thermal image of the rotor and stator

Micrologic 6 E-M offers a thermal-image function.
Taking into account the Ir setting and the class, an algorithm simulates rotor and stator temperature rise. It includes the slow temperature rise of the stator and its metal mass. Also included is the faster temperature rise of the copper rotor. The thermal protection function trips the circuit breaker when the calculated thermal image reaches $100 \%$ of the permissible temperature rise.
The communication indicates the thermal-image value as a percentage of the permissible temperature rise. One or more alarms may be assigned to selected thresholds. A red LED on the front signals when the value exceeds $95 \%$. An SDx module with two outputs programmed for thermal-image values can be used to implement other alarm functions.

(1) Absolute mode: $E$ absolute $=$ E out + E in; Signed mode: $E$ signed $=E$ out $-E$ in.
(2) Available via communication system.
(3) The BSCM module (page A-27) is required for these functions.

Micrologic $A B$ trip units are used in public distribution systems to limit the current supplied according to the consumer's contract. They are available in 100, 160, 240 and 400 A ratings and are supplied with a lead-seal device to protect the settings.


INV switch-disconnector with visible break.


Compact NSX with Micrologic 2-AB.


Compact NSX circuit breakers equipped with Micrologic AB trip units are installed as incoming devices for consumer installations connected to the public LV distribution system.
With respect to the utility, they have two functions.
b Consumption is limited to the contractual power level. If the limit is exceeded, a fast thermal-protection function trips the device at the head of the consumer's installation without the utility having to intervene.
b Total discrimination is ensured with the upstream fuses on the public distribution system in the event of a fault, overload or short-circuit in the consumer's installation, protecting the utility line.
In addition, they provide the consumer with:
b protection for the installation as a whole, with the possibility of adding a Vigi earthleakage protection module
b the possibility of downstream discrimination.
This type of Compact NSX is often used in conjunction with an Interpact INV switchdisconnector located outside the consumer's building and providing the visible-break function.
This means the operator can directly see, through a transparent cover, the physical separation of the main contacts. The Interpact INV range is also suitable for isolation with positive contact indication.
This means utility operators can work on the service-connection unit after isolating it from the upstream line.

## Protection

Settings are made using the adjustment dials with fine-adjustment possibilities and a lead-seal fixture.

## Overloads: Long-time protection (Ir)

Inverse-time thermal protection against overloads with an adjustable current pick-up Ir and a very short, non-adjustable time delay $\mathbf{t r}$ ( 15 seconds for $\mathbf{1 . 5} \mathbf{x} \mathbf{~ I r}$ ).
Short-circuits: Short-time protection (Isd) with fixed time delay
Short-circuit protection with an adjustable pick-up Isd. The short-time pick-up values are high enough to avoid nuisance tripping in the event of transient current spikes.
Short-circuits: Non-adjustable instantaneous protection
Instantaneous short-circuit protection with a fixed pick-up.

## Neutral protection

Available on four-pole circuit breakers only. Neutral protection may be set using a three-position switch:
b 4P 3D: neutral unprotected
b 4P 3D $+N / 2$ : neutral protection at half the value of the phase pick-up, i.e. $0.5 \times \mathrm{Ir}$
b 4P 4D: neutral fully protected at Ir.
Indications


Front indications

b Green "Ready" LED: flashes slowly when the circuit breaker is ready to trip in the event of a fault.
b Orange overload pre-alarm LED: steady on when I > $90 \%$ Ir
b Red overload LED: steady on when I > 105 \% Ir

## Remote indications

An SDx relay module installed inside the circuit breaker can be used to remote the overload-trip signal. This module receives the signal from the Micrologic electronic trip unit via an optical link and makes it available on the terminal block. The signal is cleared when the circuit breaker is closed.
The module is described in detail in the section dealing with accessories page A-81.

SDx remote indication relay module with its terminal block.

(1) If the trip units are used in high-temperature environments, the Micrologic setting must take into account the thermal limitations of the circuit breaker. See the temperature derating table.


Consumer connection diagram.

## Technical details

Advantages of the AB trip unit
b Controls the power drawn with respect to contractual power levels. If the contractual level is overrun, the circuit breaker opens and the consumer is not billed excess costs.
b If a short-circuit occurs, the circuit breaker opens and the upstream HRC fuses on utility lines are not affected. No expensive utility servicing is billed to the consumer.

Special applications
Generator protection with Micrologic 2.2-G

Micrologic G trip units are used for the protection of systems supplied by generators or comprising long cable lengths. They can be mounted on all Compact NSX100/160/250 circuit breakers.
With extensive setting possibilities, Micrologic 5 offers the same functions from 100 to 630 A .
A thermal-magnetic trip unit is also available for the NSX100 to 250 (see page A-15).


SDx remote indication relay module with its terminal block.


Circuit breakers equipped with Micrologic G trip units protect systems supplied by generators (lower short-circuit currents than with transformers) and distribution systems with long cable lengths (fault currents limited by the impedance of the cable).

## Protection

Settings are made using the adjustment dials with fine adjustment possibilities

## Overloads: Long-time protection (Ir)

Inverse-time thermal protection against overloads with an adjustable current pick-up Ir and a very short, non-adjustable time delay $\mathbf{t r}$ ( 15 seconds for 1.5 x Ir).

## Short-circuits: Short-time protection (Isd) with fixed time delay

Short-circuit protection with an adjustable pick-up Isd, delayed 200 ms, in compliance with the requirements of marine classification companies.
Short-circuits: Non-adjustable instantaneous protection (Ii) Instantaneous short-circuit protection with a fixed pick-up required for generator protection.

## Neutral protection

b On 3-pole circuit breakers, neutral protection is not possible.
b On four-pole circuit breakers, neutral protection may be set using a three-position switch:
v 4P 3D: neutral unprotected
$v 4 P 3 D+N / 2$ : neutral protection at half the value of the phase pick-up, i.e. $0.5 \times \mathrm{lr}$
$\checkmark$ 4P 4D: neutral fully protected at Ir.

## Indications



Front indications

|  |  |
| :---: | :---: |

b Green "Ready" LED: flashes slowly when the circuit breaker is ready to trip in the event of a fault.
b Orange overload pre-alarm LED: steady on when I > 90 \% Ir
b Red overload LED: steady on when I > 105 \% Ir

## Remote indications

An SDx relay module installed inside the circuit breaker can be used to remote the overload-trip signal.
This module receives the signal from the Micrologic electronic trip unit via an optical link and makes it available on the terminal block. The signal is cleared when the circuit breaker is closed.
The module is described in detail in the section dealing with accessories.

(1) If the trip units are used in high-temperature environments, the Micrologic setting must take into account the thermal limitations of the circuit breaker. See the temperature derating table.

Compact NSX circuit breakers are also used in industrial control panels.
They serve as an incoming devices or can be combined with contactors to protect motor feeders:
b compliance with worldwide standards including IEC
60947-2 and UL 508 / CSA 22-2 no. 14
boverload and short-circuit protection
b isolation with positive contact indication, making it possible to service machines safely by isolating them from all power sources
b installation in universal and functional type enclosures
b NA switch-disconnector version.


## Industrial control panels

Compact NSX circuit breakers equipped for public distribution or motor protection functions as described in the previous pages can be used in industrial control panels. The accessories for the Compact NSX range are suitable for the special needs of these switchboards.

## Auxiliaries

All auxiliaries can be added to the circuit breaker by the user:
b padlocking devices (in the OFF position)
b rotary handle
b status-indication auxiliary contacts (ON, OFF and tripped)
b shunt ( $M X$ ) or undervoltage (MN) releases
b early-make or early-break contacts.

## Rotary handle

Direct or extended versions for mounting up to 600 mm behind the front:
b black front with black handle
b yellow front with red handle (for machine tools or emergency off as per IEC 204 / VDE 0013).
All rotary handles can be padlocked in the OFF position. Optional door interlock, recommended for MCC panels (motor control centres).
When the device is equipped with an extended rotary handle, a control accessory mounted on the shaft makes it possible to operate the device with the door open. The device can be padlocked in the OFF position in compliance with UL508.

## Early-make or early-break contacts

These contacts can be used respectively to supply an MN undervoltage release before the circuit breaker closes or to open the contactor control circuit before the circuit breaker opens.

## Special functions

b Indication of thermal overloads with the SDx module.
b Early opening of the contactor for overload faults with the SDTAM module.
b Links with PLCs via the communication system.
b Measurement of all electrical parameters with Micrologic A and E.
b Programmable alarms with Micrologic 5 and 6.

## Installation in enclosures

Compact circuit breakers can be installed in a metal enclosure together with other devices (contactors, motor-protection circuit breakers, LEDs, etc.) (see page A-90).

## Compliance with North American industrial control equipment standards

Compact NSX devices have received UL508 / CSA 22-2 no. 14 approval for industrial control equipment of the "Manual Motor Controller", "Across the Line Starter", "General Use" and "Disconnecting Means" types.
Type NA devices are switch-disconnectors that must always be protected upstream.
UL508 approval

| Circuit breakers | Trip units | Approvals |
| :--- | :--- | :--- |
| Compact NSX100 to 630 <br> F/N/H | TMD, Micrologic 2,5 and 6 | General Use |
|  |  | Motor Disconnecting Means |
|  | NA, MA, Micrologic 1.3 M, 2.2 M, | Manual Motor Controller <br> 2cross the Line Starter |
|  | 2.3 M, Micrologic 6.2 E-M and <br> $6.3 \mathrm{E}-\mathrm{M}$ | Motor Disconnecting Means |


| V AC ratings |  | 115 | 230 | 460 | 575 |
| :---: | :---: | :---: | :---: | :---: | :---: |
| TMD <br> Micrologic 2, 5 and 6 | NA, MA Micrologic $1.3 \mathrm{M}, \mathbf{2 . 2} \mathrm{M}$, 2.3 M Micrologic 6.2 E-M and 6.3 E-M |  |  |  |  |
| 25 | 25 | 3 | 7.5 | 15 | 20 |
| 50 | 50 | 7.5 | 15 | 30 | 40 |
| 100 | 100 | 15 | 30 | 75 | 100 |
| 160 | 150 | 25 | 50 | 100 | 150 |
| $\underline{250}$ | 220 | 40 | 75 | 150 | 200 |
| 400 | 320 | - | 125 | 250 | 300 |
| 550 | 500 | - | 150 | 350 | 500 |

The deratings indicated on pages $B-8$ and $B-9$ apply to TMD, Micrologic 2,5 and 6 trip units, rated at $40^{\circ} \mathrm{C}$.

## 16 Hz 2/3 network protection Micrologic 5 A-Z trip unit

Compact NSX circuit breakers may be used on 16 Hz 2/3 systems with special thermal-magnetic and electronic (Micrologic 5 A-Z) trip units.

Phase and isolated neutral interrupted-250/500 V
$B$ and $F$ (3P 2D version) $\quad N$ and $H$ (3P 3D version)


Remark. For an operating voltage > 250 V, the installation

## $16 \mathrm{~Hz} 2 / 3$ networks

Single-phase distribution networks with a frequency of $16 \mathrm{~Hz} 2 / 3$ are used for railroad applications in certain European countries.
Breaking capacity for $16 \mathrm{~Hz} 2 / 3$ at $250 / 500 \mathrm{~V}$
Compact NSX circuit breakers of the 3P 2D or the 3P 3D type protect $16 \mathrm{~Hz} 2 / 3$ networks at 250 V or 500 V .
They can be equipped with either:
b a TM-D thermal-magnetic trip unit for Compact NSX100 to 250
b or an electronic Micrologic 5.2 A-Z trip unit for Compact NSX100 to 250 or a 5.3 A-Z for Compact NSX400/630.
The possible breaking-capacity performance levels are B, F,N and H as indicated below.
Breaking capacity Icu

| Operating voltage |  | TMD and Micrologic 5 A-Z trip units |  |  |  |
| :--- | :--- | :--- | :--- | :--- | :--- |
|  | Performance | B | F | N | H |
| $250 \mathrm{~V} / 500 \mathrm{~V}$ | Icu (kA) | 25 | 36 | 50 | 70 |

## Protection

TM-D thermal-magnetic trip units


## Micrologic 5 A-Z trip units



Micrologic 5.2 A-Z and 5.3 A-Z are dedicated to $16 \mathrm{~Hz} 2 / 3$ networks. They use a suitable sampling frequency. The protection settings are identical to those of Micrologic 5 A (see page A-19). They also offer a current-measurement function for this specific frequency.
Trip-unit selection


## Wiring for NSX100 to 630 A

2 poles in series - Earthed neutral - 250 / 500 V



Compact NSX circuit breakers may be used on 400 Hz systems.

## 400 Hz distribution systems

The main 400 Hz applications are in aeronautics and certain military ships. Modern aircraft have three-phase $115 / 200 \mathrm{~V} 400 \mathrm{~Hz}$ networks.

## Impact on protective devices

Due to the higher frequency, circuit breakers are subjected to additional temperature rise for identical current levels, resulting from higher losses caused by Foucault currents and an increase in the skin effect (reduction in the useful CSA of conductors). To remain within the rated temperature-rise limits of devices, current derating is required.
The power levels of 400 Hz applications rarely exceed a few hundred kW with relatively low short-circuit currents, generally not exceeding four times the rated current.
The standard Compact NSX and Masterpact NT/NW ranges are suitable for 400 Hz applications if derating coefficients are applied to the protection settings. See the derating table below.

Breaking capacity of Compact NSX circuit breakers in $400 \mathrm{~Hz}, 440$ V systems

| Circuit breaker | Breaking capacity lcu |
| :--- | :--- |
| NSX100 | 10 kA |
| NSX160 | 10 kA |
| NSX250 | 10 kA |
| NSX400 | 10 kA |
| NSX630 | 10 kA |

## Trip units equipped with thermal-magnetic protection

The 400 Hz current settings are obtained by multiplying the 50 Hz values by the following adaptation coefficient:
b K1 for thermal trip units
b K2 for magnetic trip units.
These coefficients are independent of the trip-unit setting.
Thermal trip units
The current settings are lower at 400 Hz than at $50 \mathrm{~Hz}(\mathrm{~K} 1<1)$.

## Magnetic trip units

The current settings are conversely higher at 400 Hz than at $50 \mathrm{~Hz}(\mathrm{~K} 2>1)$.
Consequently, when the trip units are adjustable, they must be set to the minimum value.
Adaptation coefficients for thermal-magnetic trip units

| Circuit breaker | Trip unit | $\begin{aligned} & \ln (A) \\ & 50 \mathrm{~Hz} \end{aligned}$ | Thermal at $40^{\circ} \mathrm{C}$ |  | $\operatorname{lm}_{50 \mathrm{~Hz}}(\mathrm{~A})$ | Magnetic |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | K1 | 400 Hz |  | K2 | 400 Hz |
| NSX100 | TM16G | 16 | 0.95 | 15 | 63 | 1.6 | 100 |
|  | TM25G | 25 | 0.95 | 24 | 80 | 1.6 | 130 |
|  | TM40G | 40 | 0.95 | 38 | 80 | 1.6 | 130 |
|  | TM63G | 63 | 0.95 | 60 | 125 | 1.6 | 200 |
| NSX100 | TM16D | 16 | 0.95 | 15 | 240 | 1.6 | 300 |
|  | TM25D | 25 | 0.95 | 24 | 300 | 1.6 | 480 |
|  | TM40D | 40 | 0.95 | 38 | 500 | 1.6 | 800 |
|  | TM63D | 63 | 0.95 | 60 | 500 | 1.6 | 800 |
|  | TM80D | 80 | 0.9 | 72 | 650 | 1.6 | 900 |
|  | TM100D | 100 | 0.9 | 90 | 800 | 1.6 | 900 |
| NSX250 | TM100D | 100 | 0.9 | 90 | 800 | 1.6 | 900 |
|  | TM160D | 160 | 0.9 | 144 | 1250 | 1.6 | 2000 |
|  | TM200D | 200 | 0.9 | 180 | 1000 to 2000 | 1.6 | $\begin{aligned} & 1600 \text { to } \\ & 3200 \end{aligned}$ |
|  | TM250D | 250 | 0.9 | 225 | 1250 to 2500 | 1.6 | $\begin{aligned} & 2000 \text { to } \\ & 4000 \end{aligned}$ |

## Example

NSX100 equipped with a TM16G with 50 Hz settings $\mathrm{Ir}=16 \mathrm{~A}$ and $\mathrm{Im}=63 \mathrm{~A}$.
400 Hz settings $\mathrm{lr}=16 \times 0.95=15 \mathrm{~A}$ and $\mathrm{Im}=63 \mathrm{~A} \times 1.6=100 \mathrm{~A}$.

# Protection of 400 H systems (cont.) 



Micrologic 5 E trip unit.


MX or MN voltage release.


SDx remote indication relay module with its terminal block.

## Protection(cont.)

## Micrologic electronic trip units

Micrologic 2.2, 2.3 or 5.2, 5.3 with A or E measurement functions are suitable for 400 Hz . The use of electronics offers the advantage of greater operating stability when the frequency varies. However the units are still subject to temperature rise caused by the frequency.
The practical consequences are:
b limit settings: see the Ir derating table below
b the long-time, short-time and instantaneous pick-ups are not modified (see pages A-17 or A-19)
b the accuracy of the displayed measurements is 2 \% (class II).
Thermal derating: maximum Ir setting

| Circuit breaker | Maximum setting <br> coefficient <br> 1 | Max. Ir setting at $\mathbf{4 0 0} \mathbf{~ H z}$ |
| :--- | :--- | :--- |
| NSX100 | 0.9 | 100 |
| NSX250 | 0.8 | 225 |
| NSX400 | 0.8 | 320 |
| NSX630 | 500 |  |

## Example

An NSX250N, equipped with a Micrologic 2.2, Ir $=250 \mathrm{~A}$ at 50 Hz , must be limited to use at $\mathrm{Ir}=250 \times 0.9=225 \mathrm{~A}$.
Its short-time pick-up with fixed time delay is adjustable from 1.5 to $10 \operatorname{lr}$ ( 60 to 400 A ). The instantaneous pick-up remains at 3000 A .

## OF auxiliary contacts in 400 Hz networks

Electrical characteristics of auxiliary contacts

| Contacts |  | Standard |  | Low level |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Utilisation cat. (IEC 60947-5-1) |  | AC12 | AC15 | CA12 | CA15 |
| Operational current(A) | 24 V | 6 | 6 | 5 | 3 |
|  | 48 V | 6 | 6 | 5 | 3 |
|  | 110 V | 6 | 5 | 5 | 2.5 |
|  | $220 / 240 \mathrm{~V}$ | 6 | 4 | 5 | 2 |
|  | $380 / 415 \mathrm{~V}$ | 6 | 2 | 5 | 1.5 |

## MN and MX voltage releases for Compact NSX100/630 at 400 Hz and 440 V

For circuit breakers on 400 Hz systems, only 125 V DC MN or MX releases may be used. The release must be supplied by the 400 Hz system via a rectifier bridge (to be selected from the table below) and an additional resistor with characteristics depending on the system voltage.

| $\mathbf{U}(\mathrm{V}) \mathbf{4 0 0 ~ H z}$ | Rectifier | Additional resistor |
| :--- | :--- | :--- |
| $220 / 240 \mathrm{~V}$ | Thomson 110 BHz or | $4.2 \mathrm{k} \Omega-5 \mathrm{~W}$ |
|  | General Instrument W 06 or |  |
|  | Semikron SKB at $1.2 / 1.3$ |  |
| $380 / 420 \mathrm{~V}$ | Semikron SKB at $1.2 / 1.3$ | $10.7 \mathrm{k} \Omega-10 \mathrm{~W}$ |

Note: other models of rectifier bridges may be used if their characteristics are at least equivalent to those stated above.

## SDx indication contacts

The SDx module may be used in 400 Hz systems for voltages from 24 to 440 V . An SDx relay module installed inside the circuit breaker can be used to remote the overload-trip signal.
This module receives the signal from the Micrologic electronic trip unit via an optical link and makes it available on the terminal block. The signal is cleared when the circuit breaker is closed.
These outputs can be reprogrammed to be assigned to other types of tripping or alarm (see page A-81).

Functions and characteristics

## Switch-disconnectors

Overview of applications

A switch-disconnector is a control device that can be
used to open and close a circuit under normal operating conditions.
It is suitable for isolation as indicated on the front by the symbol

## Position of switch-disconnectors

Compact NSX switch-disconnectors are used primarily for the following applications:
b busbar coupling and isolation
b isolation of industrial distribution boards and industrial control panels
b isolation of subdistribution boards for modular devices
b isolation of local enclosures
b isolation of final distribution enclosures for commercial applications
b industrial control panel switch-disconnectors.


Compact NSX100 to 630 NA switch-disconnectors are available in fixed, plug-in and withdrawable versions. They use the same accessories and offer the same connection possibilities as the circuit-breaker versions. They may be interlocked with another Compact switchdisconnector or circuit breaker to form a sourcechangeover system.


Compact NSX switch-disconnector.


Compact NSX switch-disconnector equipped with a motor mechanism module.


Compact NSX switch-disconnector equipped with a Vigi module.

## Suitability for isolation with positive contact indication

Compact NSX switch-disconnectors are suitable for isolation as defined by standard IEC 60947-3. The corresponding conformity tests guarantee:
b the mechanical reliability of the position indication, i.e. the O (OFF) position indicated by the control device always reflects the open position of the contacts: $v$ the required distance between contacts is provided $v$ padlocks may not be installed unless the contacts are open b the absence of leakage currents b overvoltage withstand capacity between upstream and downstream connections. Installation of a rotary handle or a motor mechanism does not alter the reliability of the position-indication system.

## Emergency-off function

A Compact NSX NA is combined with an MN or MX release connected to an emergency-off button. In an emergency, an operator at a remote location can interrupt the circuit at rated load to isolate the entire switchboard and the downstream loads.

## Motor mechanism

Compact NSX NA devices equipped with a motor mechanism module enable remote closing and opening. This function may be combined with the emergency-off function. In this case, the emergency off function is combined with a closing lock-out that must be intentionally reset (electrical diagram with closing lock-out).

## Earth-leakage protection

A Vigi module may be added to a switch-disconnector to monitor all leakage currents in the outgoing circuits of the switchboard on which the switch-disconnector is installed. When the Vigi module detects an earth-leakage current, the switchdisconnector interrupts the load current. This function may be combined with the motor mechanism and the emergency-off function using an MN or MX release.

## Switch-disconnector protection

The switch-disconnector can make and break its rated current. For an overload or a short-circuit, it must be protected by an upstream device, in compliance with installation standards.
The circuit-breaker/switch-disconnector coordination tables determine the required upstream circuit breaker. However, due to their high-set magnetic release, Compact NSX100 to 630 A switch-disconnectors are self-protected.

## Switch-disconnector utilisation category

Depending on the rated operational current and the mechanical durability (A for frequent operation or B for infrequent operation), standard IEC 60947-3 defines the utilisation categories as shown in the table below. Compact NSX NA switchdisconnectors comply with utilisation categories AC22A or AC23A.

| Utilisation category |  | Typical applications |
| :--- | :--- | :--- |
| Infrequent <br> operation | Frequent <br> operation | AC-21B | | Resistive loads including moderate overloads ( $\cos \varphi=$ |
| :--- |
| AC-21A |$\quad$ AC-22B $\quad$| Mixed resistive and inductive loads including moderate |
| :--- |
| overloads ( $\cos \varphi=0.65$ ) |

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Functions and characteristics

## Switch-disconnectors

Characteristics and performance of Compact NSX switch-disconnectors from 100 to 630 NA

Installation standards require upstream protection.
However Compact NSX100 to 630 NA switchdisconnectors are self-protected by their high-set magnetic release.

| Common characteristics |  |  |  |
| :---: | :---: | :---: | :---: |
| Rated voltages |  |  |  |
| Insulation voltage (V) U | Ui |  | 800 |
| Impulse withstand voltage (kV) | Uimp |  | 8 |
| Operational voltage (V) Ue | Ue | AC $50 / 60 \mathrm{~Hz}$ | 690 |
| Suitability for isolation |  | IEC/EN 60947-3 | yes |
| Utilisation category A | AC 22 | 23 A - DC 22A/DC |  |
| Pollution degree |  | IEC 60664-1 | 3 |

## Switch-disconnectors <br> Electrical characteristics as per IEC 60947-3 and EN 60947-3

| Conventional thermal current (A) | Ith $60{ }^{\circ} \mathrm{C}$ |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| Number of poles |  |  |  |  |
| Operational current (A) depending on the utilisation category |  | AC $50 / 60 \mathrm{~Hz}$ |  |  |
|  |  | 220/240 V |  |  |
|  |  | $380 / 415 \mathrm{~V}$ |  |  |
|  |  | $440 / 480 \mathrm{~V}^{(2)}$ |  |  |
|  |  | 500/525 V |  |  |
|  |  | 660/690 V |  |  |
|  |  | DC |  |  |
|  |  | 250 V (1 pole) |  |  |
|  |  | 500 poles (2 poles in series) |  |  |
|  |  | 750 V (3 poles in series) |  |  |
| Short-circuit making capacity (kA peak) | Icm | min. (switch-disconnector alone) |  |  |
|  |  | max. (protection by upstream circuit breaker) |  |  |
| Rated short-time withstand current (Arms) | Icw | for | 1 s |  |
|  |  |  | 3 s |  |
|  |  |  | 20 s |  |
| Durability (C-O cycles) | mechanical |  |  |  |
|  | electrical | AC |  |  |
|  |  |  | 440 V | In/2 |
|  |  |  |  | In |
|  |  |  | 690 V | $\mathrm{ln} / 2$ |
|  |  |  |  | In |
|  |  | DC | 250 V | $\mathrm{ln} / 2$ |
|  |  |  | 500 V |  |

Positive contact indication
Pollution degree

## Protection

| Add-on earth-leakage protection | By Vigi module <br> By Vigirex relay |
| :--- | :--- |
| Additional indication and control auxiliaries |  |
| Indication contacts |  |
| Voltages releases | MX shunt release |
|  | MN undervoltage release |
| Voltage-presence indicator |  |
| Current-transformer module |  |
| Ammeter module |  |
| Insulation monitoring module |  |
| Remote communication by bus |  |
| Device-status indication |  |
| Device remote operation |  |
| Operation counter |  |
| Installation / connections | fixed, front connections |
| Dimensions (mm) | $2 / 3 \mathrm{P}$ |
| WxHxD |  |
| Weight (kg) | fixed, front connections |
|  |  |

## Source-changeover systems (see chapter on Source-changeover systems)

Manual source-changeover systems
Remote-operated or automatic source-changeover systems
(1) $2 P$ in $3 P$ case.
(2) Suitable for 480 V NEMA.


## Source-changeover systems Presentation

## Manual source changeover

This is the most simple system. It is controlled manually by a maintenance technician and consequently the time required to switch from the normal source to the replacement source can vary.
A manual source-changeover system is made up of:
b two devices (circuit breakers or switch-disconnectors) controlled manually
b mechanical interlocking.
The interlock prevents connection to both sources at the same time, even momentarily.


Service sector:
b hospital operating rooms
b safety systems for tall buildings
b computer rooms (banks, insurance companies, etc.)
b lighting systems in shopping centres, etc.


Industry:
b assembly lines
b engine rooms on ships
b critical auxiliaries in thermal power stations, etc.


Infrastructures:
b runway lighting systems
b port and railway installations
b control systems for military installations, etc.

Remote-operated source-changeover systems
This is the most commonly employed system. No human invention is required. The transfer from the normal to the replacement source is controlled electrically. A remote-operated source-changeover system is made up of two circuit breakers or switch-disconnectors equipped with motor mechanisms and:
b an electrical interlocking system implemented in a number of manners
b a mechanical interlocking system that protects against the consequences of an electrical malfunction and prevents incorrect manual operation.

## Automatic source-changeover systems

An automatic controller may be added to the remote-operated source-changeover system for automatic source control according to programmable operating modes.
This solution ensures optimum energy management:
b switching to a replacement source depending on external requirements
b source management
b load shedding
b emergency source replacement, etc.


Interlocking of two or three toggle-controlled devices.


Interlocking of two devices with rotary handles.


Interlocking with keylocks.


Interlocking on a base plate.

## Interlocking of two or three toggle-controlled devices

## Interlocking system

Two devices can be interlocked using this system. Two identical interlocking systems can be used to interlock three devices installed side by side.
Authorised positions:
b one device closed (ON), the others open (OFF)
b all devices open (OFF).
The system is locked using one or two padlocks (shackle diameter 5 to 8 mm ).
This system can be expanded to more than three devices.
There are two interlocking-system models:
b one for Compact NSX100 to 250
b one for Compact NSX400/630.

## Combinations of Normal and Replacement devices

All toggle-controlled fixed or plug-in Compact NSX100 to 630 circuit breakers and switch-disconnectors of the same frame size can be interlocked. The devices must be either all fixed or all plug-in versions.

## Interlocking of two devices with rotary handles

## Interlocking system

Interlocking involves padlocking the rotary handles on two devices which may be either circuit breakers or switch-disconnectors.
Authorised positions:
b one device closed (ON), the other open (OFF)
b both devices open (OFF).
The system is locked using up to three padlocks (shackle diameter 5 to 8 mm ).
There are two interlocking-system models:
b one for Compact NSX100 to 250
b one for Compact NS400/630.
Combinations of Normal and Replacement devices
All rotary-handle fixed or plug-in Compact NSX100 to 630 circuit breakers and switch-disconnectors of the same frame size can be interlocked. The devices must be either all fixed or all plug-in versions.

## Interlocking of a number of devices using keylocks (captive keys)

Interlocking using keylocks is very simple and makes it possible to interlock two or more devices that are physically distant or that have very different characteristics, for example medium-voltage and low-voltage devices or a Compact NSX100 to 630 circuit breaker and switch-disconnector.

## Interlocking system

Each device is equipped with an identical keylock and the key is captive on the closed (ON) device. A single key is available for all devices. It is necessary to first open (OFF position) the device with the key before the key can be withdrawn and used to close another device.
A system of wall-mounted captive key boxes makes a large number of combinations possible between many devices.

## Combinations of Normal and Replacement devices

All rotary-handle Compact NSX100 to 630 circuit breakers and switch-disconnectors can be interlocked between each other or with any other device equipped with the same type of keylock.

## Interlocking of two devices on a base plate

## Interlocking system

A base plate designed for two Compact NSX devices can be installed horizontally or vertically on a mounting rail. Interlocking is carried out on the base plate by a mechanism located behind the devices. In this way, access to the device controls and trip units is not blocked.
Combinations of Normal and Replacement devices
All rotary-handle and toggle-controlled Compact NSX100 to 630 circuit breakers and switch-disconnectors can be interlocked. Devices must be either all fixed or all plugin versions, with or without earth-leakage protection or measurement modules.
An adaptation kit is required to interlock:
b two plug-in devices
b a Compact NSX100-250 with an NSX400-630.
Connection to the downstream installation can be made easier using a coupling accessory (see next page).

# Source-changeover systems Remote-operated and automatic sourcechangeover systems Coupling accessory on base plate 



Remote-operated source-changeover system.


1 Circuit breaker QN equipped with a motor mechanism and auxiliary contacts, connected to the Normal source
2 Circuit breaker QR equipped with a motor mechanism and auxiliary contacts, connected to the Replacement source
3 Base plate with mechanical interlocking
4 Electrical interlocking unit IVE
5 Coupling accessory (downstream connection)


Standard device accessories may be used for the coupling accessory on the base plate.

## Remote-operated systems

It is made up of two devices with motor mechanisms, mounted on a base plate and combined with:
b an electrical interlocking unit
b optional mechanical interlocking system.

## Electrical interlocking unit (IVE)

Interlocks two devices equipped with motor mechanisms and auxiliary contacts. The IVE unit is mandatory to ensure the necessary time-delays required for safe switching.
Mechanical interlocking system
The mechanical interlocking system is strongly recommended to limit the effects of design or wiring errors and to avoid manual switching errors.

## Automatic systems

An automatic controller can manage switching from one source to the other.
The controller can be:
b a device provided by the customer
b an integrated BA controller
b an integrated UA controller.
An integrated BA or UA automatic controller manages source transfer according to user-selected sequences that can include source priorities, start-up of a generator, return to the Normal source, etc. An ACP auxiliaries control plate facilitates installation of the BA and UA controllers. The plate includes two circuit breakers to protect the control circuits and two contactors to control the motor mechanisms of the devices.

## Coupling accessory on base plate

This accessory may be used with a manual or remote-operated source-changeover system (with or without an automatic controller). It respects the mounting distance between the devices secured to the ACP plate and provides downstream coupling of the two sets of busbars. It is compatible with standard device accessories.
The short terminal shields of the device can be installed on the upstream connectors of the coupling accessory. Downstream, it is possible to use the connection accessories and the long or short terminal shields of the device.

[^5]By combining a remote-operated source-changeover system with an integrated BA or UA automatic controller, it is possible to automatically control source transfer according to user-selected sequences.


BA controller.


UA controller.


Auxiliary control plate for a BA or UA controller.

Functions of the BA and UA controllers

(1) The controller is powered by the ACP auxiliaries control plate. The same voltage must be used for the ACP plate, the IVE unit and the circuit-breaker operating mechanisms. If this voltage is the same as the source voltage, then the "Normal" and "Replacement" sources can be used directly for the power supply. If not, an isolation transformer must be used.

# Accessories and auxiliaries Overview of Compact NSX100 to 630 fixed version 

Insulation accessories $>$ A-73


$$
\text { Electrical auxiliaries }>\mathrm{A}-80
$$



Protection and measurements $>\mathrm{A}-86$


Vigi module


Micrologic 5 / 6 trip unit


TM-D, TM-G trip unit


Ammeter module


Mechanical accessories $>\mathrm{A}-69$


Chassis side plate



Functions and characteristics

Accessories and auxiliaries Device installation

Compact NSX circuit breakers may be installed horizontally, vertically or flat on their back, without derating performance levels.
There are three installation versions:
b fixed
b plug-in (on a base)
b withdrawable (on a chassis).
For the last two, components must be added (base, chassis) to the fixed version.
Many connection components are shared by the three versions.


## Fixed circuit breakers

Fixed circuit breakers are designed for standard connection using bars or cables with lugs. Bare-cable connectors are available for connection to bare copper or aluminium cables.
For connection of large cables, a number of solutions with spreaders may be used for both cables with lugs or bare cables.


## Plug-in circuit breakers

The plug-in version makes it possible to:
b extract and/or rapidly replace the circuit breaker without having to touch the connections on the base
b allow for the addition of future circuits by installing bases that will be equipped with a circuit breaker at a later date
$b$ isolate the power circuits when the device is mounted on or through a panel. It acts as a barrier for the connections of the plug-in base. Insulation is made complete by the mandatory short terminal shields on the device. The degrees of protection are:
v circuit breaker plugged in $=\mathrm{IP} 4$
v circuit breaker removed = IP2
v circuit breaker removed, base equipped with shutters $=I P 4$.

## Parts of a plug-in configuration

A plug-in configuration is made by adding a "plug-in kit" to a fixed device. To avoid connecting or disconnecting the power circuits under load conditions, a safety trip causes automatic tripping if the device is ON, before engaging or withdrawing it. The safety trip, supplied with the kit, must be installed on the device. If the device is disconnected, the safety trip does not operate. The device can be operated outside the switchboard.

## Accessories

Optional insulation accessories are available.
b Terminal shields to protect against direct contact.
b Interphase barriers to reinforce insulation between phases and protect against direct contact.

## Mounting




Withdrawable Compact NSX250.


Installation positions.


Connected.


Disconnected.


## Withdrawable circuit breakers

In addition to the advantages provided by the base, installation on a chassis facilitates handling. It offers three positions, with transfer from one to the other after mechanical unlocking:
b connected: the power circuits are connected
b disconnected: the power circuits are disconnected, the device can be operated to check auxiliary operation
b removed: the device is free and can be removed from the chassis.

## Parts of a withdrawable configuration

A withdrawable configuration requires two side plates installed on the base and two sides plates mounted on the circuit breaker. Similar to the plug-in version, a safety trip causes automatic tripping if the device is ON, before engaging or withdrawing it, and enables device operation in the disconnected position.

## Accessories

Accessories are the same as for the base, with in addition:
b auxiliary contacts for installation on the fixed part, indicating the "connected" and "disconnected" positions
b locking by 1 to 3 padlocks (shackle diameter 5 to 8 mm ), to:
$v$ prevent insertion for connection
$v$ lock the circuit breaker in connected or disconnected position
b toggle collar for circuit breakers with a toggle mounted through a front panel, intended to maintain the degree of protection whatever the position of the circuit breaker (supplied with a toggle extension)
b telescopic shaft for extended rotary handles. The door can then be closed with the device in the connected and disconnected positions.


## Mounting

Mounting on a backplate.


Mounting through a front panel.

panel.


Mounting on rails.

路

Fixed circuit breakers are designed for standard front connection using bars or cables with lugs.
Cable connectors are available for bare cables. Rear connection is also possible.


Insulated bar.


Small lug for copper cables.


Small lug for AI cables.



Mounting at the back of a switchboard


Mounting behind the front panel with a raiser.

## Front connection

## Bars or cables with lugs

## Standard terminals

Compact NSX100 to 630 come with terminals comprising snap-in nuts with screws: b Compact NSX100: M6 nuts and screws. Compact NSX160/250: M8 nuts and screws
b Compact NSX400/630: M10 nuts and screws.
These terminals may be used for:
b direct connection of insulated bars or cables with lugs
b terminal extensions offering a wide range of connection possibilities.
Interphase barriers or terminal shields are recommended. They are mandatory for certain connection accessories (in which case the interphase barriers are provided).

## Bars

When the switchboard configuration has not been tested, insulated bars are mandatory.
Maximum size of bars

| Compact NSX circuit breaker |  |  | $\mathbf{1 0 0 / 1 6 0 / 2 5 0}$ |
| :--- | :--- | :--- | :--- |
| Without spreaders | pitch $(\mathrm{mm})$ | $\mathbf{4 0 0 / 6 3 0}$ |  |
|  | maximum bar size $(\mathrm{mm})$ | $20 \times 2$ | 45 |
| With spreaders | pitch $(\mathrm{mm})$ | $32 \times 6$ |  |
|  | maximum bar size $(\mathrm{mm})$ | 45 | 52.5 |

## Crimp lugs

There are two models, for aluminium and copper cables.
It is necessary to use narrow lugs, compatible with device connections. They must be used with interphase barriers or long terminal shields. The lugs are supplied with
interphase barriers and may be used for the types of cables listed below.
Cable sizes for connection using lugs

| Compact NSX circuit breaker |  | 100/160/250 | 400/630 |
| :---: | :---: | :---: | :---: |
| Copper cables | size ( $\mathrm{mm}^{2}$ ) | 120, 150, 185 | 240, 300 |
|  | crimping | hexagonal barrels or punching |  |
| Aluminium cables | size ( $\mathrm{mm}^{2}$ ) | 120, 150, 185 | 240, 300 |
|  | crimping | hexagonal barrels |  |

## Terminal extensions

Extensions with anti-rotation ribs can be attached to the standard terminals to provide numerous connection possibilities in little space:
b straight terminal extensions
b right-angle terminal extensions
b edgewise terminal extensions
b double-L extensions
b $45^{\circ}$ extensions.

## Spreaders

Spreaders may be used to increase the pitch:
b NSX100 to 250: the 35 mm pitch can be increased to 45 mm
b NSX400/630: the 45 mm pitch can be increased to 52 or 70 mm .
Bars, cable lugs or cable connectors can be attached to the ends.

## One-piece spreader for NSX100 to 250

Connection of large cables may require an increase in the distance between the device terminals.
The one-piece spreader is the means to:
b increase the 35 mm pitch of the NSX100 to 250 circuit-breaker terminals to the 45 mm pitch of a NSX400/630 device
b use all the connection and insulation accessories available for the next largest frame size (lugs, connectors, spreaders, right-angle and edgewise terminal extensions, terminal shields and interphase barriers).
It may also be used for Interpact INS switch-disconnectors.
Equipped with a single-piece spreader, Compact NSX devices can be mounted:
b at the back of a switchboard
b behind the front panel with a raiser.
The one-piece spreader is also the means to:
b align devices with different frame sizes in the switchboard
b use the same mounting plate, whatever the device.
Pitch $(\mathrm{mm})$ depending on the type of spreader

| Compact NSX circuit breaker | NSX100 to $\mathbf{2 5 0}$ | NSX100 to $\mathbf{6 3 0}$ |
| :--- | :--- | :--- |
| Without spreaders | 35 | 45 |
| With spreaders | 45 | 52.5 or 70 |
| With one-piece spreader | 45 | - |



## Bare cables

For bare cables (without lugs), the prefabricated bare-cable connectors may be used for both copper and aluminium cables.
1-cable connectors for Compact NSX100 to 250
The connectors snap directly on to the device terminals or are secured by clips to right-angle and straight terminal extensions as well as spreaders.
1-cable connectors for Compact NSX400 to 630
The connectors are screwed directly to the device terminals.

## 2-cable connectors for Compact NSX100 to 250 and 400/630

The connectors are screwed to device terminals or right-angle terminal extensions.
Distribution connectors for Compact NSX100 to 250
These connectors are screwed directly to device terminals. Interphase barriers are supplied with distribution connectors, but may be replaced by long terminal shields. Each connector can receive six cables with cross-sectional areas ranging from 1.5 to $35 \mathrm{~mm}^{2}$ each.

Polybloc distribution block for Compact NSX100 to 630
Polybloc connects directly to device terminals.
It is used to connect up to six or nine flexible or rigid cables with cross-sectional areas not exceeding $10 \mathrm{~mm}^{2}$ or $16 \mathrm{~mm}^{2}$, to each pole.
Connection is made to spring terminals without screws.

Maximum size of cables depending on the type of connector

| Compact NSX circuit breaker |  | 100/160 | 250 | 400 | 630 |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Steel connectors | 1.5 to $95 \mathrm{~mm}^{2}$ | b |  |  |  |
| Aluminium connectors | 25 to $95 \mathrm{~mm}^{2}$ | b | b |  |  |
|  | 120 to $185 \mathrm{~mm}^{2}$ | b | b |  |  |
|  | 2 cables 50 to $120 \mathrm{~mm}^{2}$ | b | b |  |  |
|  | 2 cables 35 to $240 \mathrm{~mm}^{2}$ |  |  | b | b |
|  | 35 to $300 \mathrm{~mm}^{2}$ |  |  | b | b |
| Distribution connectors | 6 cables $35 \mathrm{~mm}^{2}$ | b | b |  |  |
| Polybloc distribution blocks | 6 or 9 cables 10/16 mm ${ }^{2}$ | b | b |  |  |



Connection of bare cables to NSX100 to 250.

## Rear connection

Device mounting on a backplate with suitable holes enables rear connection.

## Bars or cables with lugs

Rear connections for bars or cables with lugs are available in two lengths. Bars may be positioned flat, on edge or at $45^{\circ}$ angles depending on how the rear connections are positioned.
The rear connections are simply fitted to the device connection terminals. All combinations of rear connection lengths and positions are possible on a given device.

## Bare cables

For the connection of bare cables, the 1-cable connectors for Compact NSX100 to 250 may be secured to the rear connections using clips.

Functions and characteristics

## Accessories and auxiliaries

 Connection of withdrawable and plug-in devicesConnection is identical for both withdrawable and plugin versions. The same accessories as for fixed devices may be used.


## Bars or cables with lugs

The plug-in base is equipped with terminals which, depending on their orientation, serve for front and rear connection.
For rear connection of a base mounted on a backplate, the terminals must be replaced by insulated, long right-angle terminal extensions.
For Compact NSX630 devices, connection most often requires the 52.5 or 70 mm pitch spreaders.


Front connection.


Front connection with spreaders.


Rear connection of a base mounted on a backplate.

## Connection accessories

All accessories for fixed devices (bars, lugs, terminal extensions and spreaders) may be used with the plug-in base (see pages A-70, A-71).

## Bare cables

All terminals may be equipped with bare-cable connectors. See the "Connection of fixed devices" section.


With a 100 to 250 A base.


With a 400/630 A base.


## Adapter for plug-in base

The adapter is a plastic component for the 100 to 250 base and the $400 / 630$ base that enables use of all the connection accessories of the fixed device.
It is required for interphase barriers and the long and short terminal shields.

DB111342


Adapter for 100 to 250 A-3P base.
Connection with bars or
cables with lugs.


Adapter for 400/630 A - 4P base. Connection with spreaders and interphase barriers.

Insulation of live parts

Terminal shields are identical for fixed and plug-in/withdrawable versions and cover all applications up to 1000 V.
They exist for the 100 to 250 A and 400/630 A ratings, in long and short versions.


Long terminal shields.


Short terminal shields.


1 Partially cut removable squares.
2 Grids with break marks.


Assembled with captive screws.

## Terminal shields

Insulating accessories used for protection against direct contact with power circuits. They provide IP40 degree of protection and IK07 mechanical impact protection.

## Terminal-shield types

Compact NSX100 to 250 and NSX400/630 3P or 4P can be equipped with:
b short terminal shields
b long terminal shields.
All terminal shields have holes or knock-outs in front for voltage-presence indicators.

## Short terminal shields

They are used with:
b plug-in and withdrawable versions in all connection configurations
b fixed versions with rear connection.

## Long terminal shields

They are used for front connection with cables or insulated bars.
They comprise two parts assembled with captive screws, forming an IP40 cover.
b The top part is equipped with sliding grids with break marks for precise adaptation to cables or insulated bars.
b The rear part completely blocks off the connection zone. Partially cut squares can be removed to adapt to all types of connection for cables with lugs or copper bars.
Long terminal shields may be mounted upstream and downstream of:
b fixed devices
b the base of plug-in and withdrawable versions, thus completing the insulation provided by the mandatory short terminal shields on the device
b the one-piece spreader for NSX100 to 250
b the 52.5 mm spreaders for NSX400/630.
Terminal shields and pitch
Combination possibilities are shown below.

| Circuit breaker <br> Short terminal shields | NSX100/160/250 | NSX400/630 |  |
| :--- | :---: | :---: | :--- |
| Pitch $(\mathrm{mm})$ | 35 | 45 |  |
| Long terminal shields | 35 | 45 | 52.5 |

## Interphase barriers

Safety accessories for maximum insulation at the power-connection points:
b they clip easily onto the circuit breaker
b single version for fixed devices and adapters on plug-in bases
b not compatible with terminal shields
b the adapter for the plug-in base is required for mounting on plug-in and withdrawable versions.

## Rear insulating screens

Safety accessories providing insulation at the rear of the device.
Their use is mandatory for devices with spreaders, installed on backplates, when terminal shields are not used.
The available screen dimensions are shown below.

| Circuit breaker |  | NSX100/160/250 | NSX400/630 |
| :--- | :--- | :--- | :--- |
| 3 P | $\mathrm{W} \times \mathrm{H} \times$ thickness $(\mathrm{mm})$ | $140 \times 105 \times 1$ | $203 \times 175 \times 1.5$ |
| 4 P | $\mathrm{W} \times \mathrm{H} \times$ thickness $(\mathrm{mm})$ | $175 \times 105 \times 1$ | $275 \times 175 \times 1.5$ |

# Accessories and auxiliaries 

Selection of auxiliaries for Compact NSX100/160/250

## Standard

All Compact NSX100/160/250 circuit breakers and switch-disconnectors have slots for the electrical auxiliaries listed below.
5 indication contacts (see page A-80)
b 2 ON/OFF (OF1 and OF2)
b 1 trip indication (SD)
b 1 fault-trip indication (SDE)
b 1 earth-fault indication (SDV), when the device is equipped with a Vigi module.
1 remote-tripping release (see page A-83)
b either 1 MN undervoltage release
b or 1 MX shunt release.

## Remote indications

Circuit breakers equipped with Micrologic trip units may be equipped with a fault-trip indication to identify the type of fault by installing:
1 indication module with two outputs (see page A-81)
b either an SDx module with Micrologic 2.2 / 5.2 A or E / 6.2 A or E
b or an SDTAM module with Micrologic 2.2 M or 6-2 E-M (motor protection).
This module occupies the slots of one OF contact and an MN/MX release.

All these auxiliaries may be installed with a motor mechanism or a rotary handle.
The following table indicates auxiliary possibilities depending on the type of trip unit.

NA, TMD, TMG, MA
Standard


## Micrologic 2 / 5 / 6

Standard
Remote indications via SDx or SDTAM



The SDx or SDTAM uses the OF1 and MN/MX slots. External connection is made via a terminal block in the OF1 slot The 24 V DC supply provides for the Micrologic 5/ 6 display when the device is OFF or under low-load conditions.

## Communication

Communication requires specific auxiliaries (see page A-26).

## Communication of status indications

b 1 BSCM module.
b 1 NSX cord (internal terminal block) for both communication and 24 V DC supply to the BSCM.
Communication of status conditions is compatible with a standard motor mechanism and a rotary handle.
Communication of status indications and controls
This requires, in addition to the previous auxiliaries:
b 1 communicating motor mechanism connected to the BSCM.

## Communication of measurements

Available on Micrologic 5 / 6, the system consists of:
b 1 NSX cord (internal terminal block) for both communication and 24 V DC supply to the Micrologic.
Communication of measurements is compatible with a standard or communicating motor mechanism and a rotary handle.
Communication of status indications, controls and measurements
Available on Micrologic 5/6, the system consists of:
b 1 BSCM module
b 1 NSX cord (internal terminal block) for both communication and 24 V DC supply to the BSCM and the Micrologic
b 1 communicating motor mechanism connected to the BSCM.

Installation of SDx or SDTAM is compatible with communication.
The following table indicates auxiliary possibilities depending on the type of trip unit.

NA, TMD, TMG, MA, Micrologic 2
Communication of status indications


Communication of status indications and controls


Functions and characteristics

## Accessories and auxiliaries

Selection of auxiliaries for Compact NSX400/630

## Standard

All Compact NSX400/630 circuit breakers and switch-disconnectors have slots for the electrical auxiliaries listed below.
7 indication contacts (see page A-80)
b 4 ON/OFF (OF1, OF2, OF3, OF4)
b 1 trip indication (SD)
b 1 fault-trip indication (SDE)
b 1 earth-fault indication (SDV), when the device is equipped with a Vigi module.
1 remote-tripping release (see page A-83)
b either 1 MN undervoltage release
b or 1 MX shunt release.

## Remote indications

Circuit breakers equipped with Micrologic trip units may be equipped with a fault-trip indication to identify the type of fault by installing:
1 indication module with two outputs (see page A-81)
b either an SDx module with Micrologic 2.2 / 5.2 A or E / 6.2 A or E
b or an SDTAM module with Micrologic 2.2 M or 6-2 E-M (motor protection).
This module occupies the slots of an MN/MX release.

All these auxiliaries may be installed with a motor mechanism or a rotary
handle.
The following table indicates auxiliary possibilities depending on the type of trip unit.

NA, Micrologic 1.3 M
Standard


Micrologic 2 / 5 / 6
Standard


The SDx or SDTAM uses the reserved slot and the MN/MX slots.
External connection is made via a terminal block in the reserved slot.
The 24 V DC supply provides for the Micrologic 5/ 6 display when the device is OFF or under low-load conditions.

## Communication

Communication requires specific auxiliaries (see page A-26).

## Communication of status indications

b 1 BSCM module
b 1 NSX cord (internal terminal block) for both communication and 24 V DC supply to the BSCM.
Communication of status conditions is compatible with a standard motor mechanism and a rotary handle.
Communication of status indications and controls
This requires, in addition to the previous auxiliaries:
b 1 communicating motor mechanism connected to the BSCM.

## Communication of measurements

Available on Micrologic 5/6, the system consists of:
b 1 NSX cord (internal terminal block) for both communication and 24 V DC supply to the Micrologic.
Communication of measurements is compatible with a standard or communicating motor mechanism and a rotary handle.
Communication of status indications, controls and measurements
Available on Micrologic 5 / 6, the system consists of:
b 1 BSCM module
b 1 NSX cord (internal terminal block) for both communication and 24 V DC supply to the BSCM and the Micrologic
b 1 communicating motor mechanism connected to the BSCM.

Installation of SDx or SDTAM is compatible with communication.
The following table indicates auxiliary possibilities depending on the type of trip unit.

NA, Micrologic 1.3 M, Micrologic 2
Communication of status indications

## Communication of status indications and controls



## Micrologic 5 / 6

## Communication of status indications

Communication of status indications, controls and measurements with or without FDM121 display



Fixed Compact NSX.

## Fixed Compact NSX

Auxiliary circuits exit the device through a knock-out in the front cover.


## Withdrawable or plug-in Compact NSX

## Automatic auxiliary connectors

Auxiliary circuits exit the circuit breaker via one to three automatic auxiliary connectors (nine wires each). These are made up of:
b a moving part, connected to the circuit breaker via a support (one support per circuit breaker)
b a fixed part, mounted on the plug-in base, equipped with connectors for bare cables up to $2.5 \mathrm{~mm}^{2}$.
Micrologic trip unit options are also wired via the automatic auxiliary connectors.

## Selection of automatic auxiliary connectors

Depending on the functions installed, one to three automatic auxiliary connectors are required.

Plug-in/withdrawable Compact NSX.

MT: motor mechanism
MTc: communicating motor mechanism.

Connector 1
Connector 2
Connector 3
Each auxiliary is equipped with a terminal block with numbered terminals for connection of wires up to: b $1.5 \mathrm{~mm}^{2}$ for auxiliary contacts and voltage releases b $2.5 \mathrm{~mm}^{2}$ for the motor-mechanism module.

| Circuit breaker | Connector 1 |  | Connector 2 | Connector 3 |
| :---: | :---: | :---: | :---: | :---: |
|  | OF1 MN/MX or SD | SDx/ SDTAM | ```OF2/SDV / ZSI out \({ }^{(1)}\) SDE NSX cord MT MTC 24 V DC``` | OF3 <br> OF4 <br> ZSI in <br> ZSI out |
| NSX100/160/250 | b |  | b | - |
| NSX400/630 | b |  | b | b |

## Accessories and auxiliaries

Indication contacts

One contact model provides circuit-breaker status indications (OF - SD - SDE - SDV).
An early-make or early-break contact, in conjunction with a rotary handle, can be used to anticipate device opening or closing.
A CE / CD contact indicates that the chassis is connected / disconnected.


Indication contacts.

$C E / C D$ carriage switches.

These common-point changeover contacts provide remote circuit-breaker status information.
They can be used for indications, electrical locking, relaying, etc.
They comply with the IEC 60947-5 international recommendation.

## Functions

Breaker-status indications, during normal operation or after a fault
A single type of contact provides all the different indication functions:
b OF (ON/OFF) indicates the position of the circuit breaker contacts
b SD (trip indication) indicates that the circuit breaker has tripped due to:
v an overload
$v$ a short-circuit
v an earth fault (Vigi) or a ground fault (Micrologic 6)
$v$ operation of a voltage release
v operation of the "push to trip" button
$v$ disconnection when the device is ON.
The SD contact returns to de-energised state when the circuit breaker is reset.
b SDE (fault-trip indication) indicates that the circuit breaker has tripped due to:
v an overload
$v$ a short-circuit
v an earth fault (Vigi) or a ground fault (Micrologic 6).
The SD contact returns to de-energised state when the circuit breaker is reset. b SDV indicates that the circuit breaker has tripped due to an earth fault. It returns to de-energised state when the Vigi module is reset.
All the above auxiliary contacts are also available in "low-level" versions capable of switching very low loads (e.g. for the control of PLCs or electronic circuits).
Rotary-handle position contact for early-make or early-break functions b CAM (early-make or early-break function) contacts indicate the position of the rotary handle.
They are used in particular for advanced opening of safety trip devices (early break) or to energise a control device prior to circuit-breaker closing (early make).
Chassis-position contacts
b CE/CD (connected/disconnected) contacts are microswitch-type carriage switches for withdrawable circuit breakers.

## Installation

b OF, SD, SDE and SDV functions: a single type of contact provides all these different indication functions, depending on where it is inserted in the device. The contacts clip into slots behind the front cover of the circuit breaker (or the Vigi module for the SDV function).
The SDE function on a Compact NSX100-250 A equipped with a magnetic, thermalmagnetic or Micrologic 2 trip unit requires the SDE actuator.
b CAM function: the contact fits into the rotary-handle unit (direct or extended)
b CE/CD function: the contacts clip into the fixed part of the chassis.

Electrical characteristics of auxiliary contacts

| Contacts |  |  | Standard |  |  |  | Low level |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Types of contacts <br> Rated thermal current (A) |  |  | $\begin{array}{\|l\|l\|} \hline \text { All } \\ 6 \end{array}$ |  |  |  | OF, SD, SDE, SDV <br> 5 |  |  |  |
| Minimum load |  |  | 100 mA at 24 V DC |  |  |  | 1 mA at 4 V DC |  |  |  |
| Utilisation cat. (IEC 60947-5-1) |  |  | AC12 | AC15 | DC12 | DC14 | AC12 | AC15 | DC12 | DC14 |
| Operational current (A) | 24 V | AC/DC | 6 | 6 | 6 | 1 | 5 | 3 | 5 | 1 |
|  | 48 V | AC/DC | 6 | 6 | 2.5 | 0.2 | 5 | 3 | 2.5 | 0.2 |
|  | 110 V | AC/DC | 6 | 5 | 0.6 | 0.05 | 5 | 2.5 | 0.6 | 0.05 |
|  | 220/240 V | AC | 6 | 4 | - | - | 5 | 2 | - | - |
|  | 250 V | DC | - | - | 0.3 | 0.03 | 5 | - | 0.3 | 0.03 |
|  | $380 / 440 \mathrm{~V}$ |  | 6 | 2 | - | - | 5 | 1.5 | - | - |
|  | 480 V | AC | 6 | 1.5 | - | - | 5 | 1 | - | - |
|  | 660/690 V |  |  | 0.1 | - | - |  | - | - | - |

## SDx and SDTAM modules for Micrologic

SDx and SDTAM are relay modules with two static outputs. They send different signals depending on the type of fault. They may not be used together.


SDx relay module with its terminal block


SDTAM relay module with its terminal block.

## SDx module

The SDx module remotes the trip or alarm conditions of Compact NSX circuit breakers equipped with electronic protection.
The SD2 output, available on all Micrologic trip units, corresponds to the overloadtrip indication.
The SD4 output, available on Micrologic 5/6, is assigned to:
b overload pre-alarm (Micrologic 5)
b ground-fault trip indication (Micrologic 6)
These two outputs automatically reset when the device is closed (turned ON).
For Micrologic 5 / 6, the SD2 and SD4 outputs can be reprogrammed to be assigned to other types of tripping or alarm.

## Output characteristics

It is possible to assign a function:
b latching with a time delay. Return to the initial state occurs at the end of the time delay
b permanent latching. In this case, return to the initial state takes place via the communication function.
Static outputs: 24 to 415 V AC / V DC; 80 mA max.

## SDTAM module

The SDTAM module is specifically for the motor-protection Micrologic trip units 2.2 M, 2.3 M and 6.2 E-M, 6.3 E-M.

The SDTAM module, linked to the contactor controller, opens the contactor when an overload or other motor fault occurs, thus avoiding opening of the circuit breaker.

## Micrologic $\mathbf{2}$ M

The SD4 output opens the contactor 400 ms before normal circuit-breaker opening in the following cases:
b overload (long-time protection for the trip class)
b phase unbalance or phase loss.
The SD2 output serves to memorise contactor opening by SDTAM.

## Micrologic 6 E-M

The SD4 output opens the contactor 400 ms before normal circuit-breaker opening in the following cases:
b overload (long-time protection for the trip class)
b phase unbalance or phase loss
b locked rotor
b underload (undercurrent protection)
b long start.
The SD2 output serves to memorise contactor opening by SDTAM.

## Output characteristics

Output reset can be:
b manual by a pushbutton included in the wiring diagram
b automatic after an adjustable time delay ( 1 to 15 minutes) to take into account the motor-cooling time.
Static outputs: 24 to 415 V AC / V DC; 80 mA max.


SDx wiring diagram.


SDTAM wiring diagram with contactor control.

Functions and characteristics

## Accessories and auxiliaries

 Motor mechanism

Compact NSX250 with motor mechanism.


1 Position indicator (positive contact indication)
2 Spring status indicator (charged, discharged)
3 Manual spring-charging lever
4 Keylock device (optional) Locking device (OFF position), using 1 to 3 padlocks, shackle diameter 5 to 8 mm , not supplied
5 I (ON) pushbutton
6 O (OFF) pushbutton
7 Manual/auto mode selection switch. The position of this switch can be indicated remotely.
8 Operation counter (Compact NSX400/630)

When equipped with a motor-mechanism module, Compact NSX circuit breakers feature very high mechanical endurance as well as easy and sure operation: b all circuit-breaker indications and information remain visible and accessible, including trip-unit settings and indications
b suitability for isolation is maintained and padlocking remains possible
b double insulation of the front face.
A specific motor mechanism is required for operation via the communication function. This communicating motor mechanism must be connected to the BSCM module to receive the opening and closing orders. Operation is identical to that of a standard motor mechanism.

## Applications

b Local motor-driven operation, centralised operation, automatic distribution control. b Normal/standby source changeover or switching to a replacement source to ensure availability or optimise energy costs.
b Load shedding and reconnection.
b Synchrocoupling.

## Operation

The type of operation is selected using the manual/auto mode selection switch (7). A transparent, lead-seal cover controls access to the switch.

## Automatic

When the switch is in the "auto" position, the ON/OFF (I/O) buttons and the charging lever on the mechanism are locked.
b Circuit-breaker ON and OFF controlled by two impulse-type or maintained signals.
b Automatic spring charging following voluntary tripping (by MN or MX), with standard wiring.
b Mandatory manual reset following tripping due to an electrical fault.

## Manual

When the switch is in the "manual" position, the ON/OFF (I/O) buttons may be used.
A microswitch linked to the manual position can remote the information.
b Circuit-breaker ON and OFF controlled by 2 pushbuttons I/O.
b Recharging of stored-energy system by pumping the lever 8 times.
b Padlocking in OFF position.

## Installation and connections

All installation (fixed, plug-in/withdrawable) and connection possibilities are maintained.
Motor-mechanism module connections are made behind its front cover to integrated terminals, for cables up to $2.5 \mathrm{~mm}^{2}$.

## Optional accessories

b Keylock for locking in OFF position.
b Operations counter for the Compact NSX400/630, indicating the number of ON/ OFF cycles. Must be installed on the front of the motor-mechanism module.

Characteristics

| Motor mechanism |  |  | MT100 to MT630 |
| :---: | :---: | :---: | :---: |
| Response time (ms) | opening closing |  | $\begin{aligned} & <600 \\ & <80 \end{aligned}$ |
| Operating frequency | cycles/minute max. |  | 4 |
| Control voltage (V) | $\frac{D C}{\text { AC } 50 / 60 \mathrm{~Hz}}$ |  | 24/30-48/60-110/130-250 |
|  |  |  | $\begin{aligned} & \hline 48(50 \mathrm{~Hz})-110 / 130- \\ & 220 / 240-380 / 440 \\ & \hline \end{aligned}$ |
| Consumption ${ }^{(1)}$ | DC (W) | opening | y 500 |
|  |  | closing | y 500 |
|  | AC (VA) | opening | y 500 |
|  |  | closing | y 500 |

(1) For NSX100 to NSX250, the inrush current is 2 In for 10 ms .

## Electrical endurance



Circuit breaker + motor mechanism module, in thousands of operations (IEC 60947 2), at 440 V .

## Remote tripping



MX or MN voltage release.


Opening conditions of the MN release.


MN release with a time-delay unit.

Wiring diagram for emergency-off function with MN + time-delay unit.


Opening conditions of the MX release.

Note: circuit breaker opening using an MN or MX release must be reserved for safety functions. This type of tripping increases wear on the opening mechanism. Repeated use reduces the mechanical endurance of the circuit breaker by $50 \%$.

MX or MN voltage releases are used to trip the circuit breaker. They serve primarily for remote, emergency-off commands.
It is advised to test the system every six months.

## MN undervoltage release

The MN release opens the circuit breaker when its supply voltage drops to a value below $35 \%$ of its rated voltage Un.
Undervoltage tripping, combined with an emergency-off button, provides fail-safe tripping. The MN release is continuously supplied, i.e. if supply is interrupted:
b either voluntarily, by the emergency-off button,
b or accidentally, through loss of power or faulty wiring,
the release provokes opening of the circuit breaker.

## Opening conditions

Circuit-breaker tripping by an MN release meets the requirements of standard IEC 60947-2.
b Automatic opening of the circuit breaker is ensured when the continuous voltage supply to the release U y 0.35 x Un.
b If the supply voltage is between 0.35 and 0.7 Un , opening is possible, but not guaranteed. Above 0.7 Un, opening does not take place.

## Closing conditions

If there is no supply to the MN release, it is impossible to close the circuit breaker, either manually or electrically. Closing is ensured when the voltage supply to the release $\mathrm{U} u 0.85 \times$ Un. Below this threshold, closing is not guaranteed.
Characteristics

| Power supply | VAC | $\frac{50}{} 50 / 60 \mathrm{~Hz}: 24-48-100 / 130-200 / 240$ |
| :--- | :--- | :--- |
|  |  | VDC |
|  | Opening | $12-24-30 / 415-48-60-125-250$ |
| Operating threshold | Closing | 0.35 to 0.7 Un |
| Operating range |  | 0.85 Un |
| Consumption (VA or W) |  | Pick-up: 30 - Hold: 5 |
| Response time (ms) |  | 50 |

## Time-delay unit for an MN release

A time delay unit for the MN release eliminates the risk of nuisance tripping due to a transient voltage dip lasting y 200 ms . For shorter micro-outages, a system of capacitors provides temporary supply to the MN at $\mathrm{U}>0.7$ to ensure non tripping.
The correspondence between MN releases and time-delay units is shown below.

| Power supply | Corresponding MN release |
| :---: | :---: |
| Unit with fixed delay 200 ms |  |
| 48 VAC | 48 V DC |
| 220 / 240 V AC | 250 V DC |
| Unit with adjustable delay y 200 ms |  |
| 48-60 VAC/DC | 48 V DC |
| 100-130 V AC/DC | 125 V DC |
| 220-250 V AC/DC | 250 V DC |

## MX shunt release

The MX release opens the circuit breaker via an impulse-type (u 20 ms ) or maintained order.

## Opening conditions

When the MX release is supplied, it automatically opens the circuit breaker. Opening is ensured for a voltage $\mathrm{U} \mathbf{u} 0.7 \times \mathrm{Un}$.

## Characteristics

| Power supply | VAC | $\frac{50 / 60 \mathrm{~Hz}: 24-48-100 / 130-200 / 240}{50 \mathrm{~Hz}: 380 / 415 \quad 60 \mathrm{~Hz}: 208 / 277}$ |
| :--- | :--- | :--- |
|  | VDC | $12-24-30-48-60-125-250$ |
| Operating range |  | 0.7 to 1.1 Un |
| Consumption (VA or W) |  | Pick-up: 30 |
| Response time (ms) | 50 |  |

## Circuit breaker control by MN or MX

When the circuit breaker has been tripped by an MN or MX release, it must be reset before it can be reclosed.
MN or MX tripping takes priority over manual closing
In the presence of a standing trip order, closing of the contacts, even temporary, is not possible.
Connection using wires up to $1.5 \mathrm{~mm}^{2}$ to integrated terminal blocks.

There are two types of rotary handle:
$b$ direct rotary handle
b extended rotary handle
There are two models:
b standard with a black handle
b red handle and yellow front for machine-tool control.


Compact NSX with a rotary handle.


Compact NSX with an MCC rotary handle.


Compact NSX with a CNOMO machine-tool rotary handle.


Compact NSX with an extended rotary handle installed at the back of a switchboard, with the keylock option and key.

## Direct rotary handle

## Standard handle

Degree of protection IP40, IK07.
The direct rotary handle maintains:
b visibility of and access to trip-unit settings
b suitability for isolation
b indication of the three positions O (OFF), I (ON) and tripped
b access to the "push to trip" button.

## Device locking

The rotary handle facilitates circuit-breaker locking.
b Padlocking:
v standard situation, in the OFF position, using 1 to 3 padlocks, shackle diameter 5 to 8 mm , not supplied
v with a simple modification, in the ON and OFF positions. Locking in the ON position does not prevent free circuit-breaker tripping if a fault occurs. In this case, the handle remains the ON position after the circuit breaker tripping. Unlocking is required to go to the tripped then the OFF position.
b Keylock (and padlock)
It is possible to install a Ronis or Profalux keylock (optional) on the base of the handle to obtain the same functions as with a padlock.
Early-make or early-break contacts (optional)
Early-make and/or early-break contacts may be used with the rotary handle. It is thus possible to:
b supply an MN undervoltage release before the circuit breaker closes
b open the contactor control circuit before the circuit breaker opens.

## MCC switchboard control

Control of an MCC switchboard is achieved by adding a kit to the standard handle. In addition to the standard functions, the kit offers the characteristics listed below.

## Higher degree of protection IP

Degree of protection IP43, IK07.
The IP is increased by a built-in gasket.

## Door locking depending on device position

b The door cannot be opened if the circuit breaker is ON or in the tripped position. For exceptional situations, door locking can be temporarily disabled with a tool to open the door when the circuit breaker is closed. This operation is not possible if the handle is locked by a padlock.
b Circuit-breaker closing is disabled if the door is open. This function can be deactivated.

## Machine-tool control in compliance with CNOMO

Control of a machine-tool is achieved by adding a kit to the standard handle. In addition to the standard functions, the kit offers the characteristics listed below.
Enhanced waterproofness and mechanical protection
b Degree of protection IP54, IK08.
b Compliance with CNOMO E03.81.501N.

## Extended rotary handle

Degree of protection IP56, IK08.
The extended rotary handle makes it possible to operate circuit breakers installed at the back of switchboards, from the switchboard front.
It maintains:
b visibility of and access to trip-unit settings
b suitability for isolation
b indication of the three positions O (OFF), I (ON) and tripped.

## Mechanical door locking when device closed

A standard feature of the extended rotary handle is a locking function, built into the shaft, that disables door opening when the circuit breaker is in the ON or tripped positions.
Door locking can be temporarily disabled with a tool to open the door without opening the circuit breaker. This operation is not possible if the handle is locked by a padlock.
Voluntary disabling of mechanical door locking
A modification to the handle, that can be carried out on site, completely disables door locking, including when a padlock is installed on the handle. The modification is reversible.
When a number of extended rotary handles are installed on a door, this disabling function is the means to ensure door locking by a single device.


## Extended rotary handle (cont.)

## Device and door padlocking

Padlocking locks the circuit-breaker handle and disables door opening: b standard situation, in the OFF position, using 1 to 3 padlocks, shackle diameter 5 to 8 mm , not supplied
b with a simple modification, in the ON and OFF positions. Locking in the ON position does not prevent free circuit-breaker tripping if a fault occurs.
In this case, the handle remains in the ON position after the circuit breaker tripping Unlocking is required to go to the tripped then the OFF position. If the door controls were modified to voluntarily disable door locking, padlocking does not lock the door, but does disable handle operation of the device.

## Device locking using a keylock inside the switchboard

It is possible to install a Ronis or Profalux keylock (optional) on the base of the rotary handle to lock the device in the OFF position or in either the ON or OFF positions.

## Accessory for device operation with the door open

When the device is equipped with an extended rotary handle, a control accessory mounted on the shaft makes it possible to operate the device with the door open.
b The device can be padlocked in the OFF position.
b The accessory complies with UL508.
Early-make or early-break contacts (optional)
The extended rotary handle offers the same possibilities with early-make and/or early-break contacts as the standard rotary handle.

## Parts of the extended rotary handles

b A unit that replaces the front cover of the circuit breaker (secured by screws). b An assembly (handle and front plate) on the door that is always secured in the same position, whether the circuit breaker is installed vertically or horizontally. b An extension shaft that must be adjusted to the distance. The min/max distance between the back of circuit breaker and door is:
v 185... 600 mm for Compact NSX100 to 250
v 209... 600 mm for Compact NS400/630.
For withdrawable devices, the extended rotary handle is also available with a telescopic shaft to compensate for device disconnection. In this case, the min/max distances are:
v 248... 600 mm for Compact NSX100 to 250
v 272... 600 mm for Compact NS400/630.


## Manual source-changeover systems

An additional accessory interlocks two devices with rotary handles to create a source-changeover system. Closing of one device is possible only if the second is open
This function is compatible with direct or extended rotary handles. Up to three padlocks can be used to lock in the OFF or ON position.

# Accessories and auxiliaries Additional measurement and indication modules 



Voltage-presence indicator.


Compact NSX with current-transformer module.


Compact NSX with ammeter module.

## Voltage-presence indicator

The indicator detects and indicates that circuit breaker terminals are supplied with power.

## Installation

b Mounted in the long or short terminal shields, via the knockouts.
b May be positioned upstream or downstream of the circuit breaker.
b Degree of protection IP40, IK04.
b Not compatible with the motor-mechanism module.
Electrical characteristics
Operates on all networks with voltages ranging from 220 to 550 V AC.

## Current-transformer module

This module enables direct connection of a measurement device such as an ammeter or a power meter.

## Installation

b The module is installed directly on the downstream circuit-breaker terminals.
b Degree of protection IP40, IK04.
b Class II insulation between front and the power circuits.
b Connection to 6 integrated connectors for cables up to $2.5 \mathrm{~mm}^{2}$.
Electrical characteristics
b Current transformer with 5 A secondary winding.
b Class 3 for the following output-power consumptions:
Accuracy:
v 100 A rating: 1.6 VA
v 150 A rating: 3 VA
v 250 A rating: 5 VA
v 400/600 A rating: 8 VA.

## Current-transformer module with voltage measurement outputs

This module enables direct connection of a digital measurement device such as a Power Meter PM700, PM800, etc. (not supplied).

## Installation

b The module is installed directly on the downstream circuit-breaker terminals.
b Degree of protection IP40, IK04.
b Class II insulation between front and the power circuits.
b Built-in connectors for cables from 1.5 to $2.5 \mathrm{~mm}^{2}$.

## Electrical characteristics

b Rated operational voltage Ue: 530 V
b Frequencies of measured values: $50 \ldots 60 \mathrm{~Hz}$
b Three CTs with 5 A secondary windings for the rated primary current In:
v class 0.5 to 1 for rated power consumption values at the output:

- 125 A, 150 A and 250 A ratings: class 1 for 1.1 VA
- 400/600 A rating: class 0.5 for 2 VA
v Connection using a 2.5 mm 2 cable up to 2.5 m long.
b Four voltage measurement outputs including protection with automatic reset.
v voltage measurement output impedance $3500 \Omega \pm 25 \%$, maximum current 1 mA $v$ The voltage measurement outputs are intended only for measurements ( 1 mA max.) and may not be used to supply the display.


## Ammeter and Imax ammeter modules

## Ammeter module

Measures and displays (dial-type ammeter) the current of each phase (selection of phases by 3-position switch in front).
Imax ammeter module
Measures and displays (dial-type ammeter) the maximum current flowing in the middle phase. The Imax value can be reset on the front.

## Installation

b Identical for both types of ammeter module.
b The module is installed directly on the downstream circuit-breaker terminals.
b The ammeter clips into the module in any of four $90^{\circ}$ positions, i.e. it can be installed of devices mounted both vertically and horizontally.
b Degree of protection IP40, IK04.
b Class II insulation between front and the power circuits.

## Electrical characteristics

b Ammeter module: accuracy class 4.5
b Imax ammeter module: accuracy $\pm 6 \%$
b Maximum currents are displayed only if they last u 15 minutes.


## Insulation monitoring module

This module detects and indicates an insulation drop on a load circuit (TN-S or TT systems).
Operation is identical to that of a Vigi module, but without circuit-breaker tripping. Indication by a red LED in front.
An auxiliary contact may be installed for remote insulation-drop indications. When insulation drops below a minimum, user-set threshold, the LED goes on and the auxiliary contact switches. The fault indication cannot be cancelled except by pressing the manual reset button.

## Installation

b The module is installed directly on the downstream circuit-breaker terminals.
b Degree of protection IP40, IK04.
b Double insulation of the front face.

## Electrical characteristics

b Settings: 100-200-500-1000mA
b Accuracy: -50 +0 \%
b Time delay following insulation drop: 5 to 10 seconds
b AC-system voltage: 200 to 440 V AC.

Accessories and auxiliaries Locks


Toggle locking using padlocks and an accessory: Removable device Fixed device attached to the case.


Rotary-handle locking using a keylock.

Locking in the OFF position guarantees isolation as per IEC 60947-2. Padlocking systems can receive up to three padlocks with shackle diameters ranging from 5 to 8 mm (padlocks not supplied). Certain locking systems require an additional accessory.

| Control device | Function | Means | Required accessories |
| :---: | :---: | :---: | :---: |
| Toggle | Lock in OFF position | Padlock | Removable device |
|  | Lock in OFF or ON position | Padlock | Fixed device |
| $\begin{array}{l}\text { Direct rotary } \\ \text { handle }\end{array}$ Standard <br>   <br> MCC  <br>   <br> CNOMO  | Lock in <br> b OFF position <br> b OFF or ON position ${ }^{(1)}$ | Padlock | - |
|  |  | Keylock | Locking device + keylock |
|  | Lock in <br> b OFF position <br> b OFF or ON position ${ }^{(1)}$ | Padlock | - |
|  | Lock in <br> b OFF position <br> b OFF or ON position (1) | Padlock | - |
| Extended rotary handle | Lock in <br> b OFF position b OFF or ON position (1) with door opening prevented (2) | Padlock | - |
|  | Lock in OFF position | Padlock | UL508 control accessory |
|  | b OFF or ON position ${ }^{(1)}$ inside the switchboard | Keylock | Locking device + keylock |
| Motor mechanism | Lock in OFF position remote operation disabled | Padlock | - |
|  |  | Keylock | Locking device + keylock |
| Withdrawable circuit breaker | Lock in b disconnected position | Padlock | - |
|  |  | Keylock | Locking device + keylock |
|  | b connected position | Keylock | Locking device + keylock |

(1) Following a simple modification of the mechanism.
(2) Unless door locking has been voluntarily disabled.


Rotary-handle locking using a padlock or a keylock.


Motor-mechanism locking using a padlock or a keylock.


## Sealing accessories



Identification accessories.


Sealing accessories.

## Outgoing-circuit identification

Compact NSX100 to 630 can be equipped with label holders supplied in sets of ten (cat. no. LV429226).
They are compatible with escutcheons.

## Sealing accessories

Sealing accessories are available. Each bag of accessories contains all the parts required for the types of sealing indicated below.
A bag contains:
b 6 sealing accessories
b 6 lead seals
b 0.5 m of wire
b 2 screws.

Types of seals and corresponding functions
Toggle control

## Accessories and auxiliaries

Individual enclosures


IP55 heavy-duty metal enclosure.


IP55 heavy-duty insulating enclosure.

Individual enclosures are available for Compact/Vigicompact NSX devices with two, three or four poles.
All fixed, front connections are possible, except right-angle, $45^{\circ}$, double-L and edgewise terminal extensions.
All spreaders may be installed in the enclosures intended for Compact/Vigicompact
NSX250 to 630 devices, except the 70 mm spreaders for NSX400/630.

## Two models of enclosures

b IP55 heavy-duty metal individual enclosure, with:
v metal enclosure
v door with keylock and cut-out for rotary handle
v extended rotary handle, IP56, IK08, black or red/yellow
$v$ device mounting plate
v removable plate (without holes) for cable entry through bottom.
b IP55 heavy-duty insulating individual enclosure, with:
v polyester insulating enclosure
v transparent cover, screwed, lead sealable, with cut-out for extended rotary handle
v extended rotary handle, IP56, IK08, black or red/yellow
$v$ device mounting plate
v 2 removable plates (without holes) for cable entry through bottom and/or top.

## Dimensions ( $\mathrm{H} \times \mathrm{W} \times \mathrm{D}$ in mm)

b Metal enclosures:
v Compact NSX100/160
$450 \times 350 \times 250$
v Compact NSX250 and Vigicompact NSX100 to 250
v Compact NSX400
v Compact NSX630 and Vigicompact NSX400/630
$650 \times 350 \times 250$
$650 \times 350 \times 250$
b Insulating enclosures:
v Compact NSX100/160
$850 \times 350 \times 250$
v Compact NSX250 and Vigicompact NSX100/160
$360 \times 270 \times 235$
$540 \times 270 \times 235$
v Compact NSX400/630
$720 \times 360 \times 235$
v Vigicompact NSX250/630
$720 \times 360 \times 235$


## Escutcheons and protection collars

Escutcheons are an optional feature mounted on the switchboard door. They increase the degree of protection to IP40, IK07. Protection collars maintain the degree of protection, whatever the position of the device (connected, disconnected).


IP30 escutcheon.


IP30 escutcheon with access to the trip unit.

## IP30 or IP40 escutcheons for fixed devices

## IP30

The three types are glued to the cut-out in the front door of the switchboard:
b escutcheon for all control types (toggle, rotary handle or motor mechanism)
$v$ without access to the trip unit
V with access to the trip unit
b for Vigi modules, can be combined with the above.

## IP40

The four types, with a gasket, are screwed to the door cut-out:
b three escutcheons identical to the previous, but IP40
b a wide model for Vigi and ammeter modules that can be combined with the above.


Escutcheon for toggle without and with access to the trip unit.


Escutcheon for Vigi module.


Wide escutcheon for ammeter.

Accessories and auxiliaries
Escutcheons and protection collars

## IP40 escutcheons for withdrawable devices

## IP40 for withdrawable devices

The two types, with a gasket, are screwed to the door cut-out:
b for rotary handle or motor mechanism: standard IP40 escutcheon
b for toggle with extension: standard escutcheon + collar for withdrawal.


Escutcheon with collar for toggle.


Escutcheon for Vigi module.


Toggle cover.


Standard escutcheon with rotary handle.


Standard escutcheon for motor mechanism.


Standard escutcheon with collar for withdrawal, for toggle.

IP40 for Vigi module on withdrawable devices
The two types, with a gasket, are screwed to the door cut-out: b for rotary handle or motor mechanism: standard IP40 escutcheon b for toggle: standard escutcheon + collar for withdrawal.


Escutcheon for Vigi module, with escutcheons for the three types of control.

## IP43 toggle cover

Available only for devices with toggles. Fits over toggle and front cover of the device. b Mounted on the front of the circuit breaker.
b Degree of protection IP43, IK07.


Toggle cover.

## Retrofit front covers

These replacement front covers make it possible to install NSX devices in existing switchboards containing NS devices by installing the NS-type retrofit covers on the NSX devices.
b NS100 to 250 cover.
b NS400/630 cover.

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Altitude derating
Altitude does not significantly affect the characteristics of Compact NSX circuit breakers up to 2000 m . Above this altitude, it is necessary to take into account the decrease in the dielectric strength and cooling capacity of air.
The following table gives the corrections to be applied for altitudes above 2000 metres.
The breaking capacities remain unchanged.

## Compact NSX100 to 630

| Altitude (m) |  | $\mathbf{2 0 0 0}$ | $\mathbf{3 0 0 0}$ | $\mathbf{4 0 0 0}$ | $\mathbf{5 0 0 0}$ |
| :--- | :--- | :--- | :--- | :--- | :--- |
| Dielectric withstand voltage (V) |  | 3000 | 2500 | 2100 | 1800 |
| Insulation voltage (V) | Ui | 800 | 700 | 600 | 500 |
| Maximum operational voltage (V) | Ue | 690 | 590 | 520 | 460 |
| Average thermal current $(\mathrm{A})$ at $40^{\circ} \mathrm{C}$ | In x | 1 | 0.96 | 0.93 | 0.9 |

## Vibrations

Compact NSX devices resist electromagnetic or mechanical vibrations.
Tests are carried out in compliance with standard IEC 60068-2-6 for the levels required by merchant-marine inspection organisations (Veritas, Lloyd's, etc.): b 2 to 13.2 Hz : amplitude $\pm 1 \mathrm{~mm}$
b 13.2 to 100 Hz : constant acceleration 0.7 g .
Excessive vibration may cause tripping, breaks in connections or damage to mechanical parts.

## Degree of protection

Compact NSX circuit breakers have been tested for degree of protection (IP) mechanical impact protection (IK). See page A-5.

## Electromagnetic disturbances

Compact NSX devices are protected against:
b overvoltages caused by circuit switching
b overvoltages caused by an atmospheric disturbances or by a distribution-system outage (e.g. failure of a lighting system)
b devices emitting radio waves (radios, walkie-talkies, radar, etc.)
b electrostatic discharges produced directly by users.
Compact NSX devices have successfully passed the electromagnetic-compatibility tests (EMC) defined by the following international standards. See page A-5.
These tests ensure that:
b no nuisance tripping occurs
b tripping times are respected

# Installation in switchboards 

## Power supply and weights



## Power supply from the top or bottom

Compact NSX circuit breakers can be supplied from either the top or the bottom, even when equipped with a Vigi earth-leakage protection module, without any reduction in performance. This capability facilitates connection when installed in a switchboard.
All connection and insulation accessories can be used on circuit breakers supplied either from the top or bottom.

| Type of device |  | Circuit breakers | Base | Chassis | Vigi module | Visu module | Motor mech. |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| NSX100 | 3P/2D | 1.79 | 0.8 | 2.2 | 0.87 | 2 | 1.2 |
|  | $3 \mathrm{P} / 3 \mathrm{D}$ | 2.05 | 0.8 | 2.2 | 0.87 | 2 | 1.2 |
|  | 4P/4D | 2.4 | 1.05 | 2.2 | 1.13 | 2.2 | 1.2 |
| NSX160 | 3P/2D | 1.85 | 0.8 | 2.2 | 0.87 | 2 | 1.2 |
|  | 3P/3D | 2.2 | 0.8 | 2.2 | 0.87 | 2 | 1.2 |
|  | 4P/4D | 2.58 | 1.05 | 2.2 | 1.13 | 2.2 | 1.2 |
| NSX250 | 3P/2D | 1.94 | 0.8 | 2.2 | 0.87 | 2 | 1.2 |
|  | 3P/3D | 2.4 | 0.8 | 2.2 | 0.87 | 2 | 1.2 |
|  | 4P/4D | 2.78 | 1.05 | 2.2 | 1.13 | 2.2 | 1.2 |
| NSX400/630 | 3P/3D | 6.19 | 2.4 | 2.2 | 2.8 | 4.6 | 2.8 |
|  | 4P/4D | 8.13 | 2.8 | 2.2 | 3 | 4.9 | 2.8 |

Weight
The table below presents the weights (in kg ) of the circuit breakers and the main accessories, which must be summed to obtain the total weight of complete configurations. The values are valid for all performance categories.

Installation recommendations

## Installation in switchboards

Safety clearances and minimum distances

## General rules

When installing a circuit breaker, minimum distances (safety clearances) must be maintained between the device and panels, bars and other protection devices installed nearby. These distances, which depend on the ultimate breaking capacity, are defined by tests carried out in accordance with standard IEC 60947-2.
If installation conformity is not checked by type tests, it is also necessary to:
b use insulated bars for circuit-breaker connections
b segregate the busbars using insulating screens.
For Compact NSX100 to 630 devices, terminal shields and interphase barriers are recommended and may be mandatory depending on the operating voltage of the device and type of installation (fixed, withdrawable, etc.).

## Power connections

The table below indicates the rules to be respected for Compact NSX100 to 630 devices to ensure insulation of live parts for the various types of connection. b fixed devices with front connection (FC) or rear connection (RC) b plug-in or withdrawable devices.
Connection accessories such as crimp lugs, bare-cable connectors, terminal extensions (straight, right-angle, double-L and $45^{\circ}$ ) and spreaders are supplied with interphase barriers.
Long terminal shields provide a degree of protection of IP40 (ingress) and IK07 (mechanical impact).

Compact NSX100 to 630: rules to be respected to ensure insulation of live parts

| Type of connection | Fixed, front connection |  |  | Fixed, rear connection | Plug-in or withdrawable |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | On backplate | Through panel |
| Possible, recommended or mandatory accessories: <br> With: | No insulating accessory | Interphase barriers |  | Short terminal shields | Short terminal shields | Short terminal shields |
|  |  |  |  |  |  |  |
| operating voltage type of conductor |  |  |  |  |  |  |
| y 500 V Insulated bars | Possible | Possible | Possible | Recommended | Recommended | Mandatory |
| Extension terminals Cables + crimp lugs | No | Mandatory (supplied) | Possible (instead of ph. barriers) | Recommended | Recommended | Mandatory |
| Bare cables + connectors | Possible for NSX100 to 250 | Possible for NSX100 to 250 | Possible for NSX100 to 250 |  |  |  |
|  | No | Mandatory <br> (supplied) | Possible (instead of ph. barriers) | Recommended | Recommended | Mandatory |
| $>500 \mathrm{~V}$ Insulated bars | No | No | Mandatory | Mandatory | Mandatory | Mandatory |
| Extension terminals Cables + crimp lugs | No | No | Mandatory | Mandatory | Mandatory | Mandatory |
|  | No | No | Mandatory | Mandatory | Mandatory | Mandatory |

## Installation example




## Remote tripping by MN or MX release <br> Power consumption is approximately:

b 30 VA for pick-up of the MN and MX releases
b 300 VA to 500 VA for the motor mechanism.
The table below indicates the maximum permissible cable length for different supply voltages and cable cross-sectional areas.
Recommended maximum cable lengths (in metres)

| Power supply voltage (V DC) Cable cross-section ( $\mathrm{mm}^{2}$ ) | $12 \text { V }$ |  |  |  | $48 \text { V }$ |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | 2.5 | 1.5 | 2.5 |  | 2.5 |
| MN U source 100 \% | 15 | - | 160 | - | 640 | - |
| U source 85 \% | 7 | - | 40 | - | 160 | - |
| MX U source 100 \% | 60 | - | 240 | - | 960 | - |
| U source 85 \% | 30 | - | 120 | - | 480 | - |
| Motor mechanism U source 100 \% | - | - | 10 | 16 | 65 | 110 |
| U source 85 \% | - | - | 2 | 4 | 17 | 28 |

Note: the indicated length is that of each of the two wires.

## External neutral voltage tap (ENVT)

This connection is required for accurate power measurements on 3-pole circuit breakers equipped with Micrologic 5 / 6 E trip units in installations with a distributed neutral. It can be used to measure phase-neutral voltages and calculate power using the 3 wattmeter method.
Compact NSX 3-pole circuit breakers come with a wire installed on the device for the connection to the ENVT.
This wire is equipped with a connector for connection to an external wire with the following characteristics:
b cross-sectional area of $1 \mathrm{~mm}^{2}$ to $2.5 \mathrm{~mm}^{2}$
b maximum length of 10 metres.

## External neutral current transformer (ENCT)

This connection is required to protect the neutral on 3-pole circuit breakers equipped with Micrologic $5 / 6$ A or E trip units in installations with a distributed neutral. For Micrologic 6 A or E , it is required for type $G$ ground-fault protection.
The ENCT is connected in the same way for fixed, plug-in or withdrawable devices: b fixed devices are connected via terminals T1 and T2 of the internal terminal block. b plug-in and withdrawable devices are not connected via the auxiliary terminals.
The wires must be connected/disconnected inside the device via terminals T1 and T2.
The ENCT must be connected to the Micrologic trip unit by a shielded twisted pair. The shielding should be connected to the switchboard earth only at the CT end, no more than 30 cm from the CT.
b the power connections of the CT to the neutral ( H 2 and H 1 ) must be made in the same way for power supply from the top or the bottom (see figure). Make sure they are not reversed for devices with power supply from the bottom.
b cross-sectional area of $0.4 \mathrm{~mm}^{2}$ to $1.5 \mathrm{~mm}^{2}$
b maximum length of 10 metres.

## ULP connection system between Micrologic, FDM 121 switchboard display and Modbus interface

The ULP (Universal Logic Plug) wiring system used by Compact NSX for connections through to the Modbus network requires neither tools nor settings. The prefabricated cords are sued for both data transfer and distribution of 24 V DC power. Connectors on each component are identified by ULP (Universal Logic Plug) symbols, ensuring total compatibility between each component.

## Available cords

All connections are made with prefabricated cords:
b NSX cord for connection of the internal terminal block to the Modbus interface or the FDM 121 display via an RJ45 connector. The cord is available in three lengths, $0.35 \mathrm{~m}, 1.3 \mathrm{~m}$ and 3 m
b ULP cords with RJ45 connectors at each end for the other connections between components. The cord is available in six lengths, $0.3 \mathrm{~m}, 0.6 \mathrm{~m}, 1 \mathrm{~m}, 2 \mathrm{~m}, 3 \mathrm{~m}$ and 5 m . For greater distances, two cords can be interconnected using the RJ45 female/ female accessory.
Maximum length of 10 m between 2 modules and 30 m in all.
A line terminator must be fitted to all components with an unused RJ45 connector.


Power supply, without the Communication function, via the terminal block with a backup battery.
 for 24 V DC supply
Supply, with the Communication function, via the Modbus interface.


## 24 V DC power-supply module

## Use

An external 24 V DC power supply is required for installations with communication, whatever the type of trip unit.
On installations without communication, it is available as an option for Micrologic 5/6 to:
b modify settings when the circuit breaker is open (OFF position)
b display measurements when the current flowing through the circuit breaker is low
b maintain the display of the cause of tripping.

## Characteristics

The external 24 V DC supply may be used for the entire switchboard. The required characteristics are indicated in the table below.

| Characteristics |  |
| :--- | :--- |
| Output voltage | 24 V DC -20 \% to +10 \% |
| Ripple | $\pm 1 \%$ |
| Overvoltage category (OVC) | OVC IV - as per IEC 60947-1 |

## Sizing

Sizing must take into account all supplied modules.

| Module | Consumption (mA) |
| :--- | :--- |
| Micrologic $5 / 6$ | 40 |
| BSCM module | 10 |
| FDM 121 | 40 |
| Modbus communication interface | 60 |
| NSX cord U $>480$ V AC | 30 |
| SDx / SDTAM module | 20 |

## Wiring

## Micrologic 5 or 6 not using the Communication function

The external 24 V DC supply is connected via the circuit breaker terminal block. Use of a 24 V DC battery provides backup power for approximate 3 hours ( 100 mA ) in the event of an interruption in the external supply.

## Micrologic 5 or 6 using the Communication function

The external 24 V DC supply is connected via the Modbus interface using a five-pin connector, including two for the power supply. Stacking accessories (see page A-27) can be used to supply a number of interfaces by fast clip-on connection.
The 24 V DC power is distributed downstream by the ULP (Universal Logic Plug) communication cords with RJ45 connectors. This system ensures both data transfer and power distribution to the connected modules.

## Recommendations for 24 V DC wiring

b Do not connect the positive terminal to earth.
b Do not connect the negative terminal to earth.
b The maximum length for each conductor (+/-) is ten metres.
b For connection distances greater than ten metres, the plus and minus conductors of the 24 V DC supply must be twisted to improve EMC.
b The 24 V DC conductors must cross the power cables perpendicularly. If this is difficult or impossible, the plus and minus conductors must be twisted.

## Modbus

Each Compact NSX circuit breaker equipped with Micrologic 5/6 and an FDM 121 display is connected to the Modbus network via the Modbus interface module. Connection of all the circuit breakers and other Modbus devices in the switchboard to a Modbus bus is made much easier by using a Modbus RJ45 junction block installed in the switchboard.

## Recommendations for Modbus wiring

b The shielding may be earthed.
b The conductors must be twisted to improve immunity (EMC).
b The Modbus conductors must cross the power cables perpendicularly.

Installation
recommendations

Temperature derating
Compact NSX100 to 250 equipped with thermal-magnetic trip units

When thermal-magnetic trip units are used at ambient temperatures other than $40^{\circ} \mathrm{C}$, the Ir pick-up is modified.


Temperature derating curve for Compact NSX100.


Example 1. Fault I = 500 A

| $\mathbf{I / I r}$ | 4.5 | 5 | 5.5 |
| :--- | :--- | :--- | :--- |
| $\mathbf{\mathbf { T } ^ { \circ } \mathrm { C }}$ | $20^{\circ} \mathrm{C}$ | $40^{\circ} \mathrm{C}$ | $60^{\circ} \mathrm{C}$ |
| $\mathbf{t}$ min. | 8 s | 6 s | 5 s |
| $\mathbf{t}$ max. | 80 s | 60 s | 50 s |

[^6]The overload protection is calibrated at $40^{\circ} \mathrm{C}$ in the lab. This means that when the ambient temperature is less or greater than $40^{\circ} \mathrm{C}$, the Ir protection pick-up is slightly modified.
To obtain the tripping time for a given temperature:
b see the tripping curves for $40^{\circ} \mathrm{C}$ (see pages E-2 and E-3)
b determine tripping times corresponding to the Ir value (thermal setting on the device), corrected for the ambient temperature as indicated in the tables below.

## Settings of Compact NSX100 to 250 equipped with TM-D and TM-G trip units, as a function of the temperature

The table indicates the real $\operatorname{Ir}(\mathrm{A})$ value for a given rating and temperature.

| Rat. Temperature $\left({ }^{\circ} \mathrm{C}\right)$ <br> $(\mathbf{A})$ |  |  |  |  |  |  |  |  | $\mathbf{1 0}$ | $\mathbf{1 5}$ | $\mathbf{2 0}$ | $\mathbf{2 5}$ | $\mathbf{3 0}$ |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| $\mathbf{3 5}$ | $\mathbf{4 0}$ | $\mathbf{4 5}$ | $\mathbf{5 0}$ | $\mathbf{5 5}$ | $\mathbf{6 0}$ | $\mathbf{6 5}$ | $\mathbf{7 0}$ |  |  |  |  |  |  |
| $\mathbf{1 6}$ | 18.4 | 18.7 | 18 | 18 | 17 | 16.6 | 16 | 15.6 | 15.2 | 14.8 | 14.5 | 14 | 13.8 |
| $\mathbf{2 5}$ | 28.8 | 28 | 27.5 | 27 | 26.3 | 25.6 | 25 | 24.5 | 24 | 23.5 | 23 | 22 | 21 |
| $\mathbf{3 2}$ | 36.8 | 36 | 35.2 | 34.4 | 33.6 | 32.8 | 32 | 31.3 | 30.5 | 30 | 29.5 | 29 | 28.5 |
| $\mathbf{4 0}$ | 46 | 45 | 44 | 43 | 42 | 41 | 40 | 39 | 38 | 37 | 36 | 35 | 34 |
| $\mathbf{5 0}$ | 57.5 | 56 | 55 | 54 | 52.5 | 51 | 50 | 49 | 48 | 47 | 46 | 45 | 44 |
| $\mathbf{6 3}$ | 72 | 71 | 69 | 68 | 66 | 65 | 63 | 61.5 | 60 | 58 | 57 | 55 | 54 |
| $\mathbf{8 0}$ | 92 | 90 | 88 | 86 | 84 | 82 | 80 | 78 | 76 | 74 | 72 | 70 | 68 |
| $\mathbf{1 0 0}$ | 115 | 113 | 110 | 108 | 105 | 103 | 100 | 97.5 | 95 | 92.5 | 90 | 87.5 | 85 |
| $\mathbf{1 2 5}$ | 144 | 141 | 138 | 134 | 131 | 128 | 125 | 122 | 119 | 116 | 113 | 109 | 106 |
| $\mathbf{1 6 0}$ | 184 | 180 | 176 | 172 | 168 | 164 | 160 | 156 | 152 | 148 | 144 | 140 | 136 |
| $\mathbf{2 0 0}$ | 230 | 225 | 220 | 215 | 210 | 205 | 200 | 195 | 190 | 185 | 180 | 175 | 170 |
| $\mathbf{2 5 0}$ | 288 | 281 | 277 | 269 | 263 | 256 | 250 | 244 | 238 | 231 | 225 | 219 | 213 |

Example 1. What is the tripping time of a Compact NSX100 equipped with a TM100D trip unit set to 100 A , for an overload $\mathrm{I}=500 \mathrm{~A}$ ?
The overload $I / I r$ is calculated as a function of the temperature. Use the above values and the curve on page E-3 (shown on the left) to determine the corresponding time. b At $40^{\circ} \mathrm{C}, \mathrm{Ir}=100 \mathrm{~A}, \mathrm{l} / \mathrm{Ir}=5$ and the tripping time is between 6 and 60 seconds.
b At $20^{\circ} \mathrm{C}, \operatorname{Ir}=110 \mathrm{~A}, \mathrm{I} / \mathrm{Ir}=4.54$ and the tripping time is between 8 and 80 seconds.
b At $60^{\circ} \mathrm{C}, \mathrm{Ir}=90 \mathrm{~A}, \mathrm{l} / \mathrm{Ir}=5.55$ and the tripping time is between 5 and 50 seconds.
Example 2. What is the setting to obtain a real Ir of 210 A , taking into account the temperature, for a Compact NSX250 equipped with a TM250D trip unit?
The necessary dial setting, in amperes, is shown below.
b At $40^{\circ} \mathrm{C}, \mathrm{Ir}=(210 / 250) \times 250 \mathrm{~A}=210 \mathrm{~A}$
b At $20^{\circ} \mathrm{C}$, $\operatorname{Ir}=(210 / 277) \times 250 \mathrm{~A}=189.5 \mathrm{~A}$
b At $60^{\circ} \mathrm{C}, \mathrm{Ir}=(210 / 225) \times 250 \mathrm{~A}=233 \mathrm{~A}$

## Additional derating coefficient for an add-on module

The values indicated in the previous tables are valid for fixed circuit breakers equipped with one of the following modules:
b Vigi module
b insulation monitoring module
b ammeter module
b current-transformer module.
They also apply for plug-in or withdrawable circuit breakers equipped with:
b ammeter module
b current-transformer module.
However, for plug-in or withdrawable circuit breakers equipped with a Vigi module or an insulation monitoring module, the coefficient 0.84 must be applied.
The table below sums up the situation for add-on modules.

| Type of <br> device | Circuit breaker | TM-D trip- <br> unit rating | Vigi or <br> insulation <br> monitoring <br> module | Ammeter or <br> current <br> transformer <br> module |
| :--- | :--- | :--- | :--- | :--- |
| Fixed | NSX100 to 250 | 16 to 100 |  |  |
|  | NSX160 to 250 | 125 |  |  |
|  | NSX160 to 250 | 160 | 1 |  |
|  | NSX250 | 200 to 250 |  | 1 |
| Plug-in or <br> withdrawable | NSX100 to 250 | 16 to 100 |  |  |
|  | NSX160 to 250 | 125 |  |  |
|  | NSX160 to 250 | 160 | 0.84 |  |
|  | NSX250 | 250 |  |  |

## Compact NSX equipped with electronic trip units

Electronic trip units are not affected by variations in temperature. If the trip units are used in hightemperature environments, the Micrologic setting must nevertheless take into account the temperature limits of the circuit breaker.

Changes in temperature do not affect measurements by electronic trip units
b The built-in CT sensors with Rogowski toroids measure the current.
b The control electronics compare the value of the current to the settings defined for $40^{\circ} \mathrm{C}$.
Because temperature has no effect on the toroid measurements, the tripping thresholds do not need to be modified.
However, the temperature rise caused by the flow of current and the ambient temperature increase the temperature of the device. To avoid reaching the thermal withstand level of the equipment, it is necessary to limit the current flowing through the device, i.e. the maximum Ir setting as a function of the temperature.

## Compact NSX100/160/250

The table below indicates the maximum long-time (LT) protection setting Ir (A) depending on the ambient temperature.

| Type of device | Rating (A) Temperature ( ${ }^{\circ} \mathrm{C}$ ) |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | 40 | 45 | 50 | 55 | 60 | 65 | 70 |
| NSX100/160 |  |  |  |  |  |  |  |  |
| Fixed, plug-in or withdr. | 40 | no derating |  |  |  |  |  |  |
|  | 100 | no derating |  |  |  |  |  |  |
| NSX250 |  |  |  |  |  |  |  |  |
| Fixed, plug-in or withdrawable | 100 | no derating |  |  |  |  |  |  |
|  | 160 | no derating |  |  |  |  |  |  |
| Fixed | 250 | 250 | 250 | 250 | 245 | 237 | 230 | 225 |
| Plug-in or withdr. | 250 | 250 | 245 | 237 | 230 | 225 | 220 | 215 |

## Compact NSX400 and 630

The table below indicates the maximum long-time (LT) protection setting Ir (A) depending on the ambient temperature.

| Type of <br> device | Rating (A) | Temperature $\left({ }^{\circ} \mathbf{C}\right)$ |  |  |  |  |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| $\mathbf{4 0}$ | $\mathbf{4 5}$ | $\mathbf{5 0}$ | $\mathbf{5 5}$ | $\mathbf{6 0}$ | $\mathbf{6 5}$ | $\mathbf{7 0}$ |
| NSX400 |  |  |  |  |  |  |

Example. A fixed Compact NSX400 equipped with a Micrologic can have a maximum Ir setting of:
b 400 A up to $50^{\circ} \mathrm{C}$
b 380 A up to $60^{\circ} \mathrm{C}$.

## Additional derating coefficient for an add-on module

For fixed or plug-in / withdrawable circuit breakers, the addition of a:
b Vigi module
b insulation-monitoring module
b ammeter module
b current-transformer module
can modify the derating values. Apply the coefficients shown below.
Derating of a Compact NSX equipped with a Micrologic trip unit

| Type of device | Circuit breaker | TM-D trip-unit rating | Vigi / Insulation monitoring module | Ammeter module I <br> External sensor (CT) |
| :---: | :---: | :---: | :---: | :---: |
| Fixed | NSX100 to 250 NSX160 to 250 NSX250 | $\begin{aligned} & 40 \text { to } 100 \\ & 125 \\ & 250 \end{aligned}$ | 1 | (CT) |
| Plug-in or withdrawable | $\begin{aligned} & \text { NSX100 to } 250 \\ & \text { NSX160 to } 250 \end{aligned}$ | $\begin{aligned} & 40 \text { to } 100 \\ & 160 \end{aligned}$ |  |  |
|  | NSX250 | 250 | 0.86 |  |
| Fixed | $\begin{aligned} & \text { NSX400 } \\ & \text { NSX630 } \end{aligned}$ | $\begin{array}{\|l\|} \hline 250 \text { to } 400 \\ 250 \text { to } 630 \\ \hline \end{array}$ | $\begin{aligned} & \hline 0.97 \\ & 0.90 \end{aligned}$ |  |
| Plug-in or withdrawable | $\begin{aligned} & \text { NSX400 } \\ & \text { NSX630 } \end{aligned}$ | $\begin{array}{\|l\|} \hline 250 \text { to } 400 \\ 250 \text { to } 630 \end{array}$ | $\begin{aligned} & 0.97 \\ & 0.90 \end{aligned}$ |  |

Note: to provide the Visu function, Compact NSX circuit breakers, with or without a Vigi module, are combined with INV switch-disconnectors. Tripping values for the selected combination are indicated in the Interpact catalogue.

Installation
recommendations

## Power loss/ Resistance <br> Compact NSX equipped with thermalmagnetic trip units

Compact NSX thermal power loss values are used to calculate total temperature rise in the switchboard in which the circuit breakers are installed.


With a Vigi module, the deviation of the $N$ and L3 bars required to pass through the toroid results in higher power losses compared to those of the L1 and L2 bars.

The values indicated in the tables below are typical values for a device at full rated load and 50/60 Hz.

## Power loss per pole (P/pole) in Watts (W)

The value indicated is the power loss at $\mathrm{I}_{N}, 50 / 60 \mathrm{~Hz}$, for a three-pole or four-pole circuit breaker. Measurement and calculation of power loss are carried out in compliance with the recommendations of Annex $G$ of standard IEC 60947-2.
Resistance per pole ( $\mathrm{R} / \mathrm{pole}$ ) in milliohms ( $\mathrm{m} \Omega$ )
The value of the resistance per pole is provided as a general indication for a new device.
The value of the contact resistance must be determined on the basis of the measured voltage drop, in accordance with the manufacturer's test procedure (ABT instruction document no. 1-BEE-02.2-A).
Note: this measurement is not sufficient to determine the quality of the contacts, i.e. the capacity of the circuit breaker to carry its rated current.

## Additional power loss

Additional power loss is equal to the sum of the power dissipated by the following: b Vigi module: note that the deviation of the $N$ and L 3 bars required to pass through the toroid results in higher power losses compared to those of the L1 and L2 bars (diagram opposite). When calculating total power loss, use L1, L2, L3 for a 3P device and $\mathrm{N}, \mathrm{L} 1, \mathrm{~L} 2, \mathrm{L3}$ for a 4P device
b disconnecting contacts (plug-in and withdrawable devices)
b ammeter module
b transformer module.

## Calculation of total power loss

Total power loss at full rated load and $50 / 60 \mathrm{~Hz}$ is equal to the sum of the device and additional power losses per pole multiplied by the number of poles ( 2,3 or 4 ). If a Vigi module is installed, it is necessary to differentiate between N and L 3 on one hand and L1 and L2 on the other.

## Compact NSX100 to 250 equipped with TM-D and TM-G trip units

| Type of device |  | Fixed device |  | Additional power / pole |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 3/4 poles |  | R/pole | P/pole | Vigi (N, L3) | Vigi $(\mathrm{L} 1, \mathrm{~L} 2)$ | Plug-in / withdr. | Ammeter module | Transfo module |
| NSX100 | 16 | 11.42 | 2.92 | 0 | 0 | 0 | 0 | 0 |
|  | 25 | 6.42 | 4.01 | 0 | 0 | 0.1 | 0 | 0 |
|  | 32 | 3.94 | 4.03 | 0.06 | 0.03 | 0.15 | 0.1 | 0.1 |
|  | 40 | 3.42 | 5.47 | 0.10 | 0.05 | 0.2 | 0.1 | 0.1 |
|  | 50 | 1.64 | 4.11 | 0.15 | 0.08 | 0.3 | 0.1 | 0.1 |
|  | 63 | 2.17 | 8.61 | 0.3 | 0.15 | 0.4 | 0.1 | 0.1 |
|  | 80 | 1.37 | 8.77 | 0.4 | 0.2 | 0.6 | 0.1 | 0.1 |
|  | 100 | 0.88 | 8.8 | 0.7 | 0.35 | 1 | 0.2 | 0.2 |
| NSX160 | 80 | 1.26 | 8.06 | 0.4 | 0.2 | 0.6 | 0.1 | 0.1 |
|  | 100 | 0.77 | 7.7 | 0.7 | 0.35 | 1 | 0.2 | 0.2 |
|  | 125 | 0.69 | 10.78 | 1.1 | 0.55 | 1.6 | 0.3 | 0.3 |
|  | 160 | 0.55 | 13.95 | 1.8 | 0.9 | 2.6 | 0.5 | 0.5 |
| NSX250 | 125 | 0.61 | 9.45 | 1.1 | 0.55 | 1.6 | 0.3 | 0.3 |
|  | 160 | 0.46 | 11.78 | 1.8 | 0.9 | 2.6 | 0.5 | 0.5 |
|  | 200 | 0.39 | 15.4 | 2.8 | 1.4 | 4 | 0.8 | 0.8 |
|  | 250 | 0.3 | 18.75 | 4.4 | 2.2 | 6.3 | 1.3 | 1.3 |

Compact NSX100 to 630 equipped with MA/1.3-M trip units

| Type of device |  | Fixed device |  | Additional power / pole |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 3 poles | Rat. <br> (A) | R/pole | P/pole | Vigi $(N, L 3)$ | Vigi (L1, L2) | Plug-in / withdr. | Ammeter module | Transfo. module |
| NSX100 | 2.5 | 148.42 | 0.93 | 0 | 0 | 0 | 0 | 0 |
|  | 6.3 | 99.02 | 3.93 | 0 | 0 | 0 | 0 | 0 |
|  | 12.5 | 4.05 | 0.63 | 0 | 0 | 0 | 0 | 0 |
|  | 25 | 1.66 | 1.04 | 0 | 0 | 0.1 | 0 | 0 |
|  | 50 | 0.67 | 1.66 | 0.2 | 0.1 | 0.3 | 0.1 | 0.1 |
|  | 100 | 0.52 | 5.2 | 0.7 | 0.35 | 1 | 0.2 | 0.2 |
| NSX160 | 150 | 0.38 | 8.55 | 1.35 | 0.68 | 2.6 | 0.45 | 0.45 |
| NSX250 | 220 | 0.3 | 14.52 | 2.9 | 1.45 | 4.89 | 0.97 | 0.97 |
| NSX400 | 320 | 0.12 | 12.29 | 3.2 | 1.6 | 6.14 | 1.54 | 1.54 |
| NSX630 | 500 | 0.1 | 25 | 13.99 | 7 | 15 | 3.75 | 3.75 |

## Compact NSX equipped with electronic trip units

The values indicated in the table below are typical values for a device at full rated load and $50 / 60 \mathrm{~Hz}$. The definitions and information are the same as that for circuit breakers equipped with thermal-magnetic trip units.

Compact NSX100 to 630 equipped with Micrologic trip units

| Type of device |  | Fixed device |  | Additional power / pole |  |  | Ammeter module | Transfo module |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $3 / 4$ poles | Rat. <br> (A) | R/pole | P/pole | Vigi $(\mathrm{N}, \mathrm{~L} 3)$ | Vigi $(\mathrm{L} 1, \mathrm{~L} 2)$ | Plug-in / withdr. |  |  |
| NSX100 | 40 | 0.84 | 1.34 | 0.1 | 0.05 | 0.2 | 0.1 | 0.1 |
|  | 100 | 0.468 | 4.68 | 0.7 | 0.35 | 1 | 0.2 | 0.2 |
| NSX160 | 40 | 0.73 | 1.17 | 0.4 | 0.2 | 0.6 | 0.1 | 0.1 |
|  | 100 | 0.36 | 3.58 | 0.7 | 0.35 | 1 | 0.2 | 0.2 |
|  | 160 | 0.36 | 9.16 | 1.8 | 0.9 | 2.6 | 0.5 | 0.5 |
| NSX250 | 100 | 0.27 | 2.73 | 1.1 | 0.55 | 1.6 | 0.2 | 0.2 |
|  | 250 | 0.28 | 17.56 | 4.4 | 2.2 | 6.3 | 1.3 | 1.3 |
| NSX400 | 400 | 0.12 | 19.2 | 3.2 | 1.6 | 9.6 | 2.4 | 2.4 |
| NSX630 | $630{ }^{(1)}$ | 0.1 | 39.69 | 6.5 | 3.25 | 19.49 | 5.95 | 5.95 |

(1) The power loss values for the Vigi modules and withdrawable circuit breakers are given for 570 A.
Easy installation
P071850270
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Installation recommendations ..... $B-1$
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Compact NSX100 to 630 plug-in version ..... C-4
Compact NSX100 to 630 withdrawable version ..... C-6
Vigicompact NSX100 to 630 plug-in and withdrawable versions ..... C-8
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Dimensions and mounting connection

## Compact NSX100 to 630 fixed version



Interphase barriers.
$\square$ Short terminal shields

(1) The $\varnothing T$ holes are required for rear connection only.

For two-pole circuit breakers, the middle holes are not required.


On DIN rail with adapter plate (NSX100 to 250)


## Vigicompact NSX100 to 630 fixed version


(1) The ØT holes are required for rear connection only.

For two-pole circuit breakers, the middle holes are not required.





## On backplate (M)

 2/3P4P
Front connection (an insulating screen is supplied with the base and must be fitted between the base and the backplate)


Connection by exterior-mounted rear connectors

(1) The ØT1 holes are required for rear connection only (for two-pole circuit breakers, the middle holes are not required).
Connection by interior-mounted rear connectors


| Type | A | A1 | A2 | A10 | A11 | B | B1 | B2 | C3 | D1 | E9 | E10 | E11 | E12 | E13 | E14 | E15 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| NSX100/160/250 | 80.5 | 161 | 94 | 175 | 210 | 52.5 | 105 | 140 | 126 | 75 | 95 | 190 | 87 | 174 | 77.5 | 155 | 79 |
| NSX400/630 | 127.5 | 255 | 142.5 | 244 | 281 | 70 | 140 | 185 | 168 | 100 | 150 | 300 | 137 | 274 | 125 | 250 | 126 |
| Type | E16 | E17 | E18 | E19 | E20 | F1 | F2 | F3 | F4 | F5 | F6 | F7 | F8 | F9 | ØT1 | U |  |
| NSX100/160/250 | 158 | 61 | 122 | 37.5 | 75 | 35 | 17.5 | 70 | 54.5 | 109 | 144 | 70 | 105 | 35 | 24 | y 32 |  |
| NSX400/630 | 252 | 101 | 202 | 75 | 150 | 45 | 22.5 | 90 | 71.5 | 143 | 188 | 100 | 145 | 50 | 33 | y 35 |  |

Dimensions and mounting
Compact NSX100 to 630 withdrawable version


## Mounting

Through front panel (N)
2/3P
NSX100 to 250
3P
4P

NSX100 to 250
NSX400/630
NSX100 to 630


## On backplate (M)

2/3P
$4 P$
Front connection (an insulating screen is supplied with the base and must be fitted between the base and the backplate)


Connection by exterior-mounted rear connectors


## Connection by interior-mounted rear connectors



| Type | A10 | A11 | A12 | A13 | B3 | B4 | B5 | B6 | B7 | C3 | D1 | E9 | E10 | E11 | E12 | E13 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| E14 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| NS $100 / 160 / 250$ | 175 | 210 | 106.5 | 103.5 | 92.5 | 185 | 216 | 220 | 251 | 126 | 75 | 95 | 190 | 87 | 174 | 77.5 |
| NSX400/630 | 244 | 281 | 140 | 140 | 110 | 220 | 250 | 265 | 295 | 168 | 100 | 150 | 300 | 137 | 274 | 125 |
| Type | E15 | E16 | E17 | E18 | E19 | E20 | F1 | F2 | F3 | F7 | F8 | F9 | F10 | F11 | F12 | ØT1 |
| U |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| NS $100 / 160 / 250$ | 79 | 158 | 61 | 122 | 37.5 | 75 | 35 | 17.5 | 70 | 70 | 105 | 35 | 74 | 148 | 183 | 24 |
| y 32 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| NSX400/630 | 126 | 252 | 101 | 202 | 75 | 150 | 45 | 22.5 | 90 | 100 | 145 | 50 | 91.5 | 183 | 228 | 33 |

SP160 Jesmond Road Indooroopilly SPS - TSR02 Transportable Switchboard Container - OM Manual Dimensions and connection

## Dimensions and mounting Vigicompact NSX100 to 630 plug-in and withdrawable versions



## Dimensions - withdrawable version

NSX100 to 630
3P
4P


Mounting
Through front panel ( N )
See Compact NSX100 to 630 plug-in version, page C-4, or withdrawable version, page C-6
On backplate (M)
See Compact NSX100 to 630 plug-in version, page C-5, or withdrawable version, page C-7
On rails
See Compact NSX100 to 630 plug-in version, page C-5, or withdrawable version, page C-7

| Type | A | A2 | A5 | A6 | A7 | A10 | A11 | B | B1 | B2 | B3 | B4 | B5 | B6 | B7 | C3 | D1 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| NSX100/160/250 | 80.5 | 94 | 155.5 | 236 | 169 | 175 | 210 | 52.5 | 105 | 140 | 92.5 | 185 | 216 | 220 | 251 | 126 | 75 |
| NSX400/630 | 127.5 | 142.5 | 227.5 | 355 | 242.5 | 244 | 281 | 70 | 140 | 185 | 110 | 220 | 250 | 265 | 295 | 168 | 100 |
| C-8 Q-Pulse Id: Schneider $\begin{gathered}\text { Id } \\ \text { C }\end{gathered}$ |  |  |  |  |  |  |  | Active: 28/09/2015 |  |  |  |  |  |  |  | Page 199 of 1302 |  |

## Visu function for Compact NSX100 to 250 fixed version



Interphase barriers.
Short terminal shields.
Long terminal shields.
Mounting
On rails or backplate


Dimensions and connection

Dimensions and mounting
Visu function for Compact NSX400/630 fixed version

Dimensions - combination with Interpact INV400 to 630 3P 4P


Interphase barriers for base. Short terminal shields. Long terminal shields.

## Mounting

On rails or backplate


Uy 35

## Motor mechanism module for Compact NSX100 to 630

## Dimensions

Fixed circuit breaker





C5: without keylock
C6: with keylock
Plug-in circuit breaker


Withdrawable circuit breaker


| Type | A14 | A15 | A16 | A17 | B | B1 | B2 | B8 | B9 | C4 | C5 | C6 | D1 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| NSX100/160/250 | 27.5 | 73 | 34.5 | 62.5 | 52.5 | 105 | 140 | 45.5 | 91 | 143 | 182 | 209.5 | 75 |
| NSX400/630 | 40 | 123 | 52 | 100 | 70 | 140 | 185 | 61.5 | 123 | 215 | 256 | 258 | 100 |

Dimensions and connection

Dimensions and mounting
Direct rotary handle for Compact and Vigicompact NSX100 to 630


C8: without keylock
C9: with keylock

Plug-in circuit breaker


Withdrawable circuit breaker


| Type | A14 | A15 | A18 | B | B1 | B2 | B8 | B9 | B10 | C7 | C8 | C9 | D1 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| NSX100/160/250 | 27.5 | 73 | 9 | 52.5 | 105 | 140 | 45.5 | 91 | 9.25 | 121 | 155 | 164 | 75 |
| NSX400/630 | 40 | 123 | 24.6 | 70 | 140 | 185 | 61.5 | 123 | 5 | 145 | 179 | 188 | 100 |

## MCC and CNOMO type direct rotary handles for Compact NSX100 to 630 fixed version



Dimensions and connection

Dimensions and mounting
Extended rotary handle for Compact NSX100 to 630

## Dimensions

Fixed and plug-in circuit breakers



| Cutout for shaft (mm) |  |
| :--- | :--- |
| Type | R1 |
| NSX100/160/250 | min. 171 |
|  | max. 600 |
| NSX400/630 | $\min .195$ <br> max. 600 |

## Withdrawable circuit breaker



| Type | A18 | B10 | D1 |
| :--- | :--- | :--- | :--- |
| NSX100/160/250 | 9 | 9.25 | 75 |
| NSX400/630 | 24.6 | 5 | 100 |

## Dimensions and mounting <br> Indication and measurement modules for Compact NSX100 to 630 fixed version



For two-pole circuit breakers, the middle holes are not required.


Dimensions and connection

Dimensions and mounting
One-piece spreader for Compact NSX100 to 250 fixed version


FDM121 switchboard display

Dimensions


Mounting
Through panel


Dimensions and connection

Front-panel accessories
Compact NSX100 to 630

## IP30 front-panel escutcheons

For toggle, rotary handle or motor mechanism module


For toggle or rotary handle with access to trip unit

${ }^{1}$



## IP40 front-panel escutcheons

For toggle, rotary handle or motor mechanism module and protection collar


For Vigicompact with protection collar or ammeter module



| Type | A | A1 | A2 | A3 | A4 | A5 | B | B1 | B2 | B3 | C |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| NSX100/160/250 | 113 | 138 | 114 | 101 | 73 | 85 | 113 | 157 | 91 | 103 | 40 |
| NSX400/630 | 163 | 215 | 164 | 151 | 122.5 | 138 | 163 | 189 | 122.5 | 138 | 60 |

Dimensions and connection

Front-panel cutouts Compact NSX100 to 630 fixed version


For toggle with access to trip unit




With IP30 front-panel escutcheon
NSX100 to 250
NSX400/630
For toggle




For toggle with access to trip unit





| With IP43 toggle cover NSX100 to 250 | NSX400/630 |
| :--- | :--- | :--- |
| For toggle |  |



| Type | P3 | P4 |
| :--- | :--- | :--- |
| NSX100/160/250 | 88 | 89 |
| NSX400/630 | 112 | 113 |

Dimensions and connection

Front-panel cutouts
Vigicompact NSX100 to 630 fixed version


For toggle with access to trip unit


| With IP30 front-panel escutcheon | NSX100 to 250 | NSX400/630 |
| :--- | :--- | :--- | :--- |
| For toggle |  |  |



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$\stackrel{6}{\circ}$
茴


| With IP30 front-panel escutcheon (cont.) NSX100 to $250 \quad$ NSX400/630 |
| :--- |
| For toggle with access to trip unit |



| Type | P3 | P4 |
| :--- | :--- | :--- |
| NSX100/160/250 | 88 | 89 |
| NSX400/630 | 112 | 113 |

Front-panel cutouts
Compact NSX100 to 630 plug-in and withdrawable versions

Plug-in version


## Bare sheet metal

See Compact NSX100 to 630 fixed version, page C-20

## With IP30 front-panel escutcheon

See Compact NSX100 to 630 fixed version, page C-20

## With IP40 front-panel escutcheon

See Compact NSX100 to 630 fixed version, page C-21

## With toggle cover

See Compact NSX100 to 630 fixed version, page C-21

## Withdrawable version

With protection collar and IP40 front-panel escutcheon


## Vigicompact NSX100 to 630 plug-in and withdrawable versions

Plug-in version


## Bare sheet metal

See Compact NSX100 to 630 fixed version, page C-22
With IP30 front-panel escutcheon
See Compact NSX100 to 630 fixed version, page C-22
With IP40 front-panel escutcheon
See Compact NSX100 to 630 fixed version, page C-23

| Withdrawable version | NSX100 to 250 | NSX400/630 |
| :---: | :---: | :---: |
| With protection collar and IP40 front-panel escutcheon |  |  |



| Type | D1 | P3 | P5 |
| :--- | :--- | :--- | :--- |
| NSX100/160/250 | 75 | 88 | 123 |
| NSX400/630 | 100 | 112 | 147 |

Dimensions and connection

Front-panel cutouts
Visu function for Compact NSX100 to 630 fixed version

Compact NSX100 to 250 with Interpact INV100 to 250 Visu function
Bare sheet metal


With IP40 front-panel escutcheon


## Compact NSX400/630 with Interpact INV400 to 630 Visu function

Bare sheet metal


With IP40 front-panel escutcheon


## Motor mechanism module for Compact and Vigicompact NSX100 to 630

Bare sheet metal

With IP40 front-panel escutcheon
NSX100 to 250
NSX400/630
Fixed, plug-in or withdrawable circuit breaker without access to Vigi module


Fixed or plug-in circuit breaker with access to Vigi module


Dimensions and connection

Front-panel cutouts
Direct rotary handle for Compact and Vigicompact NSX100 to 630

Fixed or plug-in circuit breakers
Bare sheet metal




Bare sheet metal with access to the trip unit


With IP30 front-panel escutcheon


## Fixed or plug-in circuit breakers (cont.) NSX100 to 250 NSX400/630

With IP30 front-panel escutcheon with access to the trip unit


With IP40 front-panel escutcheon


Fixed or withdrawable circuit breakers
NSX100 to 250
NSX400/630
With IP40 front-panel escutcheon


| Type | D1 | P10 | P11 | P12 |
| :--- | :--- | :--- | :--- | :--- |
| NSX100/160/250 | 75 | 89 | 90 | 123 |
| NSX400/630 | 100 | 112 | 113 | 147 |

Dimensions and connection

Front-panel cutouts
Indication and measurement modules for Compact NSX100 to 630

Fixed or plug-in circuit breakers with ammeter module and voltage-presence indicator
Bare sheet metal

With toggle


Rotary handle


With IP40 front-panel escutcheon

## With toggle

## Rotary handle



| Type | D1 | J1 | J2 | J3 | K1 | K2 | P3 | P4 | P10 | P11 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| NSX100/160/250 | 75 | 78.5 | 67.5 | 55 | 46.5 | 74 | 88 | 89 | 89 | 90 |
| NSX400/630 | 100 | 122 | 129 | 122.5 | 64.5 | 90 | 112 | 113 | 112 | 113 |

Dimensions and connection

## Power connections

Compact and Vigicompact NSX100 to 630 fixed version




Compact and Vigicompact NSX100 to 630 fixed version


Double-L terminal extensions


NSX100 to 250



One-piece spreader (for NSX100 to 250 only)


Dimensions and connection

## Power connections

Compact and Vigicompact NSX100 to 630 plug-in and withdrawable versions



Rear connection: mounting through front panel (N) or on rails (V)
NSX100 to 250


NSX400/630



## Power connections

 connection
## Compact and Vigicompact NSX100 to 630 plug-in and withdrawable versions

Connection with accessories (cont.)
$45^{\circ}$ extensions: mounting through front panel (N) or on rails (V)

## NSX100 to 250



NSX400/630


Double-L extensions: mounting on backplate (M) or rails (V)
NSX100 to 250


Double-L extensions: mounting through front panel (N) or on rails (V)

$$
\text { NSX100 to } 250
$$



Connection with accessories (cont.)
Spreaders: mounting on backplate (M) or rails (V)


Long insulated rear connectors: mounting on backplate (M) or rails (V)

Exterior-mounted rear connectors
NSX100 to 250


X
NSX400/630


Interior-mounted rear connectors


NSX400/630


Dimensions and connection

## Power connections

## Connection of insulated bars or cables with lugs to Compact and Vigicompact NSX100 to 630



Accessories for NSX100 to 250

Straight terminal extensions


Tinned copper
Spreaders:
separate parts Double-L terminal extensions



## Tinned copper

For $U>600 \mathrm{~V}$, the mandatory insulation kit is not compatible with spreaders made up of separate parts. The one-piece spreader must be used.

Accessories for NSX400 and 630
Spreaders made up of separate parts for 52.5 and 70 mm pitch


Tinned copper
For $U>600 \mathrm{~V}$, use of the 52.5 mm pitch spreaders requires a specific insulation kit.
The 70 mm pitch spreaders may not be used.
Accessories for NSX100 to 630

Right-angle terminal extensions
DB112173

Edgewise terminal extensions


Tinned copper

Tinned copper
To be mounted on upstream side.
$45^{\circ}$ terminal extensions
DB12174

| Direct connection to NSX100 to 630 |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| Dimensions |  | NSX100 | NSX160/250 | NSX400/630 |
| Bars | $\mathrm{L}(\mathrm{mm})$ | y 25 | y 25 | y 32 |
|  | I (mm) | d + 10 | d + 10 | d + 15 |
|  | $\mathrm{d}(\mathrm{mm})$ | y 10 | y 10 | y 15 |
|  | e (mm) | y 6 | y 6 | 3 yey 10 |
|  | $\varnothing$ (mm) | 6.5 | 8.5 | 10.5 |
| Lugs | $\mathrm{L}(\mathrm{mm})$ | y 25 | y 25 | y 32 |
|  | $\varnothing$ (mm) | 6.5 | 8.5 | 10.5 |
| Torque (Nm) ${ }^{(1)}$ |  | 10 | 15 | 50 |
| Torque ( Nm ) ${ }^{(2)}$ |  | 5/5 | 5/5 | 20/11 |
| Torque (Nm) ${ }^{(3)}$ |  | 8 | 8 | 20 |

(1) Tightening torque on the circuit breaker for lugs or bars.
(2) Tightening torque on fixed devices for rear connectors//tightening torque on plug-in or
withdrawable devices for power connectors.
(3) Tightening torque on the plug-in base for terminal extensions.

Connection with accessories to NSX100 to 250 (IEC 228)
Pole pitch

| Without spreaders |  |  | 35 mm |  |
| :---: | :---: | :---: | :---: | :---: |
|  |  |  | 45 mm |  |
| Dimensions |  |  | With spreaders or terminal extensions |  |
|  |  |  | NSX100 | NSX160/250 |
|  | Bars | $\mathrm{L}(\mathrm{mm})$ | y 25 | y 25 |
|  |  | $1(\mathrm{~mm})$ | 20 y y 25 | 20 y ly 25 |
|  |  | $\mathrm{d}(\mathrm{mm})$ | y 10 | y 10 |
|  |  | e (mm) | y 6 | y 6 |
|  |  | $\varnothing$ (mm) | 6.5 | 8.5 |
|  | Lugs | $\mathrm{L}(\mathrm{mm})$ | y 25 | y 25 |
|  |  | Ø(mm) | 6.5 | 8.5 |
|  | Torque | $\mathrm{Nm})^{(1)}$ | 10 | 15 |
|  | Torqu | Nm) ${ }^{(2)}$ | 5 | 5 |

(1) Tightening torque on the circuit breaker for spreaders or terminal extensions.
(2) Tightening torque on the plug-in base for spreaders or terminal extensions.

Spreaders and straight, right-angle, $45^{\circ}$, double-L and edgewise terminal extensions are supplied with flexible interphase barriers.

Connection with accessories to NSX400 and 630 (IEC 228)

| Pole pitch |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| Without spreaders |  |  | 45 mm |  |
| With spreaders |  |  | 52.5 or 70 mm |  |
| Dimensions |  |  | With spreaders | With terminal extensions |
|  | Bars | $\mathrm{L}(\mathrm{mm})$ | y 40 | y 32 |
|  |  | 1 (mm) | d + 15 | 30 y y 34 |
|  |  | $\mathrm{d}(\mathrm{mm})$ | y 20 | y 15 |
|  |  | e (mm) | 3 yey 10 | 3 yey 10 |
|  |  | $\varnothing$ (mm) | 12.5 | 10.5 |
|  | Lugs | L (mm) | y 40 | y 32 |
|  |  | $\varnothing$ (mm) | 12.5 | 10.5 |
|  | Torqu | Nm) ${ }^{(1)}$ | 50 | 50 |
|  | Torqu | $\mathrm{Nm})^{(2)}$ | 20 | 20 |

(1) Tightening torque on the circuit breaker for spreaders or terminal extensions.
(2) Tightening torque on the plug-in base for spreaders or terminal extensions.

Spreaders and right-angle, $45^{\circ}$ and edgewise terminal extensions are supplied with flexible interphase barriers.


Mounting detail: 2 cables with lugs.

## Connection of bare cables to Compact and Vigicompact NSX100 to 630



(1) For flexible cables from 1.5 to $4 \mathrm{~mm}^{2}$, connection with crimped or self-crimping ferrules


Conductor materials and electrodynamic stresses
Compact NSX circuit breakers can be connected indifferently with bare-copper, tinned-copper and tinned-aluminium conductors (flexible or rigid bars, cables). In the event of a short-circuit, thermal and electrodynamic stresses will be exerted on the conductors. They must therefore be correctly sized and held in place by supports.
Electrical connection points on switchgear devices (switch-disconnectors contactors, circuit breakers, etc.) should not be used for mechanical support. Any partition between upstream and downstream connections of the device must be made of non-magnetic material
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The diagram is shown with circuits deenergised, all devices open, connected and charged and relays in normal position.

Terminals shown in red O must be connected by the customer.

## Indication contacts

OF2 / OF1: device ON/OFF indication contacts
OF4/OF3: device ON/OFF indication contacts (NSX400/630)
SDE: fault-trip indication contact (short-circuit, overload, ground fault, earth leakage)
SD: trip-indication contact
CAF2/CAF1: early-make contact (rotary handle only)
CAO1: early-break contact (rotary handle only)
SDV: earth leakage fault trip indication contact (add-on Vigi module)

Colour code for auxiliary wiring

| RD: red | VT: |
| :--- | :--- |
| WH: | violet |
| YE: yellow | GY: |
| grey |  |
| BK: black | OR: orange |
| GN: green | BL: blue |



The diagram is shown with circuits deenergised, all devices open, connected and charged and relays in normal position.


| Micrologic A or E |  |  |
| :---: | :---: | :---: |
| A/E | Com <br> H(W <br> - (BK) | wer supply |
| A/E | ZSI <br> Z1: <br> Z2: Z <br> Z3: Z <br> Z4: Z <br> Z5: Z <br> Note: | ocking) <br> It) <br> 630 only. |
| A/E | ENC <br> - shie <br> - shie <br> Conn <br> - max <br> - cab <br> - reco | rent transform sted pair (T1, end only (CT x. <br> etres <br> Iden 8441 or |
| E | ENV <br> neutr | tage tap for co aker. |
| Colour code for auxiliary wiring |  |  |
| RD: | red | VT: violet |
| WH | white | GY: grey |
| YE: | yellow | OR: orange |
| BK: | black | BL: blue |
| GN: | green |  |

[^7]
## Remote operation

MN: undervoltage release
or
MX: shunt release

## Motor mechanism (MT)

A4: opening order
A2: closing order
B4, A1: motor mechanism power supply
L1: manual position (manu)
B2: $\quad$ SDE interlocking (mandatory for automatic or remote recharging)
BPO: opening pushbutton
BPF: closing pushbutton

## Communicating motor mechanism (MTc)

B4, A1: motor mechanism power supply
BSCM: breaker status and control module

## Indication contacts

OF2 / OF1: device ON/OFF indication contacts
OF4 / OF3: device ON/OFF indication contacts (NSX400/630)
SDE: fault-trip indication contact
(short-circuit, overload, ground fault, earth leakage)
SD: trip-indication contact
CAF2/CAF1: early-make contact (rotary handle only)
CA01: early-break contact
(rotary handle only)
SDV: earth leakage fault trip indication contact (add-on Vigi module)

The diagram is shown with circuits deenergised, all devices open, connected and charged and relays in normal position.

After tripping initiated by the "Push to trip" button or by the undervoltage (MN) release or the shunt (MX) release, device reset can be automatic, remote or manual.

Following tripping due to an electrical fault (with an SDE contact), reset must be carried out manually.

## Symbols

Q: circuit breaker
A4: opening order
A2: closing order
B4, A1:
L1: manual position (manu)
B2: SDE interlocking (mandatory for correct operation)
BPO: opening pushbutton
BPF: closing pushbutton
SDE: fault-trip indication contact (short-circuit, overload, ground fault, earth leakage)

Motor mechanism (MT) with automatic reset


Motor mechanism (MT) with remote reset


Motor mechanism (MT) with manual reset



Single-line diagram of communicating motor mechanism Opening, closing and reset orders are transmitted via the communication network. The "Enable automatic reset" and "Enable reset even if SDE" parameters must be set using the RSU software via the screen by clicking the blue text.
"Auto/manu" is a switch on the front of the motor mechanism.

| Symbols |  |
| :--- | :--- |
| Q: | circuit breaker |
| B4, A1: | motor mechanism power supply |
| BSCM: | breaker status and control module |

Terminals shown in red O must be connected by the customer.


Terminals shown in red O must be connected by the customer.

Connection


## Operation



I: charge current
PAL Ir: thermal overload pre-alarm
SDG: ground-fault signal
SDT: thermal-fault signal
Q: circuit breaker

SDTAM module with Micrologic M

The diagram is shown with circuits deenergised, all devices open, connected and charged and relays in normal position.

## Symbols

SD1, SD3: SDTAM-module power supply
SD2: thermal-fault signal output
( 80 mAmax .)
SD4: contactor-control output ( 80 mA max.)

|  | SD2 | SD4 |
| :--- | :--- | :--- |
| Micrologic 2-M | SDT | KA1 |
| Micrologic 6 E-M | SDT | KA1 |

Terminals shown in red O must be connected by the customer.

Connection


Operation


I: charge current
SDT: thermal-fault signal
KA1: auxiliary relay (e.g. RBN or RTBT relay)
KM1: motor contactor
Q: circuit breaker


## Additional characteristics

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> Tripping curves
> Compact NSX100 to 250 Protection of distribution systems

$\square$ Reflex tripping.


TM25D / TM25G


TM50D / TM63D / TM63G



TM200D / TM250D

$\square$ Reflex tripping.

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## Tripping curves <br> Compact NSX100 to 250 Protection of distribution systems (cont.)

## Micrologic 2.2 and 2.2 G electronic trip units

Micrologic 2.2-40... 160 A

$\square$ Reflex tripping.

Micrologic 2.2-250 A


## Micrologic 2.2 G-40... 160 A



Micrologic 2.2 G-250 A


Reflex tripping.

## Micrologic 5.2 and 6．2 A or E electronic trip units

Micrologic 5．2 and 6．2 A or E－40．．．160 A
Micrologic 5．2 and 6．2 A or E－250 A


$$
t(s)
$$



Micrologic 6．2 A or E（ground－fault protection）


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Tripping curves
Compact NSX100 to 250
Motor protection

MA magnetic trip units


$\square$ Reflex tripping.
Micrologic 2.2 M electronic trip units

Micrologic 2.2 M-25 A


Micrologic 2.2 M-50... 220 A


## Micrologic 6.2 E-M electronic trip units

Micrologic 6.2 E-M - 25 A


Micrologic 6.2 E-M - 50... 220 A

$\square$ Reflex tripping.

Micrologic 6.2 E-M (ground-fault protection)


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Tripping curves
Compact NSX400 to 630
Protection of distribution systems

Micrologic 2.3, 5.3 and 6.3 A or E electronic trip units

Micrologic 2.3-250... 400 A

$\square$ Reflex tripping.

Micrologic 2.3-630 A


Micrologic 5.3 and 6.3 A or E-400 A


Micrologic 5.3 and 6.3 A or E-630 A


[^8]Micrologic 6.3 A or E electronic trip units (cont.)
Micrologic 6.3 A or E (ground-fault protection)


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## Tripping curves <br> Compact NSX400 to 630 <br> Motor protection

Micrologic 1.3 M and 2.3 M electronic trip units

Micrologic 1.3 M-320 A

$\square$ Reflex tripping.

## Micrologic 2.3 M-320 A




Micrologic 1.3 M-500 A


Micrologic 2.3 M-500 A


## Micrologic 6.3 E-M electronic trip units

Micrologic 6.3 E-M - 320 A


Micrologic 6.3 E-M - 500 A

$\square$ Reflex tripping.
Micrologic 6.3 E-M (ground fault protection)


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Tripping curves
Compact NSX100 to 630
Reflex tripping

Compact NSX100 to 630 devices incorporate the exclusive reflex-tripping system.
This system breaks very high fault currents. The device is mechanically tripped via a "piston" actuated directly by the pressure produced in the breaking units by the short-circuit.
For high short-circuits, this system provides a faster break, thereby ensuring discrimination
Reflex-tripping curves are exclusively a function of the circuit-breaker rating.


# Current and energy limiting <br> curves 

The limiting capacity of a circuit breaker is its aptitude to let through a current, during a short-circuit, that is less than the prospective short-circuit current.


The exceptional limiting capacity of the Compact NSX range is due to the rotating double-break technique (very rapid natural repulsion of contacts and the appearance of two arc voltages in-series with a very steep wave front).

## Ics = 100 \% Icu

The exceptional limiting capacity of the Compact NSX range greatly reduces the forces created by fault currents in devices.
The result is a major increase in breaking performance.
In particular, the service breaking capacity Ics is equal to $100 \%$ of Icu.
The Ics value, defined by IEC standard 60947-2, is guaranteed by tests comprising the following steps:
b break three times consecutively a fault current equal to $100 \%$ of Icu
b check that the device continues to function normally, that is:
v it conducts the rated current without abnormal temperature rise
$\checkmark$ protection functions perform within the limits specified by the standard
$v$ suitability for isolation is not impaired.

## Longer service life of electrical installations

Current-limiting circuit breakers greatly reduce the negative effects of short-circuits on installations.

## Thermal effects

Less temperature rise in conductors, therefore longer service life for cables.

## Mechanical effects

Reduced electrodynamic forces, therefore less risk of electrical contacts or busbars being deformed or broken.

## Electromagnetic effects

Fewer disturbances for measuring devices located near electrical circuits.

## Economy by means of cascading

Cascading is a technique directly derived from current limiting. Circuit breakers with breaking capacities less than the prospective short-circuit current may be installed downstream of a limiting circuit breaker. The breaking capacity is reinforced by the limiting capacity of the upstream device. It follows that substantial savings can be made on downstream equipment and enclosures.

## Current and energy limiting curves

The limiting capacity of a circuit breaker is expressed by two curves which are a function of the prospective short-circuit current (the current which would flow if no protection devices were installed):
b the actual peak current (limited current)
b thermal stress ( $\left.A^{2} s\right)$, i.e. the energy dissipated by the short-circuit in a conductor with a resistance of $1 \Omega$.

## Example

What is the real value of a 150 kA rms prospective short-circuit (i.e. 330 kA peak) limited by an NSX250L upstream?
The answer is 30 kA peak (curve page E-14).

## Maximum permissible cable stresses

The table below indicates the maximum permissible thermal stresses for cables depending on their insulation, conductor ( Cu or Al ) and their cross-sectional area (CSA). CSA values are given in $\mathrm{mm}^{2}$ and thermal stresses in $\mathrm{A}^{2} \mathrm{~s}$.

| CSA |  | $1.5 \mathrm{~mm}^{2}$ | 2.5 mm ${ }^{2}$ | $4 \mathrm{~mm}^{2}$ | $6 \mathrm{~mm}^{2}$ | $10 \mathrm{~mm}^{2}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| PVC | Cu | $2.97 \times 10^{4}$ | $8.26 \times 10^{4}$ | $2.12 \times 10^{5}$ | $4.76 \times 10^{5}$ | $1.32 \times 10^{6}$ |
|  | AI |  |  |  |  | $5.41 \times 10^{5}$ |
| PRC | Cu | $4.10 \times 10^{4}$ | $1.39 \times 10^{5}$ | $2.92 \times 10^{5}$ | $6.56 \times 10^{5}$ | $1.82 \times 10^{6}$ |
|  | AI |  |  |  |  | $7.52 \times 10^{5}$ |
| CSA |  | $16 \mathrm{~mm}^{2}$ | 25 mm ${ }^{2}$ | $35 \mathrm{~mm}^{2}$ | $50 \mathrm{~mm}^{2}$ |  |
| PVC | Cu | $3.4 \times 10^{6}$ | $8.26 \times 10^{6}$ | $1.62 \times 10^{7}$ | $3.31 \times 10^{7}$ |  |
|  | AI | $1.39 \times 10^{6}$ | $3.38 \times 10^{6}$ | $6.64 \times 10^{6}$ | $1.35 \times 10^{7}$ |  |
| PRC | Cu | $4.69 \times 10^{6}$ | $1.39 \times 10^{7}$ | $2.23 \times 10^{7}$ | $4.56 \times 10^{7}$ |  |
|  | AI | $1.93 \times 10^{6}$ | $4.70 \times 10^{6}$ | $9.23 \times 10^{6}$ | $1.88 \times 10^{7}$ |  |

## Example

Is a Cu/PVC cable with a CSA of $10 \mathrm{~mm}^{2}$ adequately protected by an NSX160F? The table above indicates that the permissible stress is $1.32 \times 10^{6} \mathrm{~A}^{2} \mathrm{~s}$.
All short-circuit currents at the point where an NSX160F (Icu $=35 \mathrm{kA})$ is installed are limited with a thermal stress less than $6 \times 10^{5} \mathrm{~A}^{2} \mathrm{~s}$ (curve page $\mathrm{E}-14$ ). Cable protection is therefore ensured up to the limit of the breaking capacity of the circuit breaker.

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## Current and energy limiting curves

Current-limiting curves

Voltage 400/440 V AC
Limited short-circuit current (kÂ peak)


## Voltage 660/690 V AC

Limited short-circuit current (kÂ peak)


## Energy-limiting curves

Voltage $400 / 440$ V AC
Limited energy


Voltage 660/690 V AC
Limited energy
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# NSX100/160/250B: complete fixed/FC device Compact NSX100/160/250B (25 kA 380/415 V) 



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## Vigicompact NSX100/160/250B

## With thermal-magnetic trip unit TM



Vigicompact NSX100B ( 25 kA at $380 / 415$ V) equipped with MH Vigi module ( 200 to 440 V)

| Rating | 3P 3d | 4P 3d | 4P 4d |
| :--- | :--- | :--- | :--- | :--- |
| TM16D | LV429667 | LV429707 | LV429967 |
| TM25D | LV429666 | LV429706 | LV429966 |
| TM32D | LV429665 | LV429705 | LV429965 |
| TM40D | LV429664 | LV429704 | LV429964 |
| TM50D | LV429663 | LV429703 | LV429963 |
| TM63D | LV429662 | LV429702 | LV429961 |
| TM80D | LV429661 | LV429701 | LV429960 |

Vigicompact NSX160B ( 25 kA at $380 / 415 \mathrm{~V}$ ) equipped with MH Vigi module ( 200 to 440 V )

| Rating | 3P 3d | 4P 3d | 4P 4d |
| :--- | :--- | :--- | :--- |
| TM80D | LV430343 | LV430353 | LV430363 |
| TM100D | LV430342 | LV430352 | LV430362 |
| TM125D | LV430341 | LV430351 | LV43036 |
| TM160D | LV430340 | LV430350 | LV43036 |

Vigicompact NSX250B ( 25 kA at $\mathbf{3 8 0} / 415 \mathrm{~V}$ ) equipped with MH Vigi module ( 200 to 440 V )

| Rating | 3P 3d | 4P 3d | 4P 4d |
| :--- | :--- | :--- | :--- |
| TM125D | LV431903 | LV431913 | LV43196 |
| TM160D | LV431902 | LV431912 | LV43196 |
| TM200D | LV431901 | LV431911 | LV43196 |
| TM250D | LV431900 | LV431910 | LV43196 |

With electronic trip unit Micrologic 2.2 (LS 1 protection)


Vigicompact NSX100B ( 25 kA at $380 / 415 \mathrm{~V}$ ) equipped with MH Vigi module ( 200 to 440 V )


| 3P 3d |
| :--- |
| LV429975 |

4 3d, 4d, 3d + N/2
3P 3d LV429985 LV429975 LV429984
Vigicompact NSX160B ( 25 kA at $380 / 415 \mathrm{~V}$ ) equipped with MH Vigi module ( 200 to 440 V )

| Rating | 3P 3d | 4P 3d, 4d, 3d + N |
| :--- | :--- | :--- |
| 40 | LV430962 | LV430997 |
| 100 | LV430961 | LV430996 |
| 160 | LV430960 | LV430995 |

Vigicompact NSX250B ( 25 kA at $\mathbf{3 8 0 / 4 1 5} \mathrm{V}$ ) equipped with MH Vigi module ( 200 to 440 V )

| Rating | 3P 3d | 4P 3d, 4d, 3d + N/2 |
| :--- | :--- | :--- |
| 100 | LV431977 | LV431987 |
| 160 | LV431976 | LV431986 |
| 250 | LV431975 | LV431985 |

With electronic trip unit Micrologic 5.2 A or 5.2 E (LSI protection, ammeter or energy meter)
To be ordered with 2 catalogue numbers: 1 basic frame +1 trip unit

# NSX100/160/250F: complete fixed/FC device Compact NSX100/160/250F (36 kA 380/415 V) 



SP160 Jesmond Road Indooroopilly SPS - TSR02 Transportable Switchboard Container - OM Manual
Catalogue numbers
NSX100/160/250F:
complete fixed/FC device (cont.)
Compact NSX100/160/250F
( $36 \mathrm{kA} 380 / 415 \mathrm{~V}$ ) (cont.)

## Compact NSX100/160/250F

With magnetic trip unit MA
Compact NSX100F ( 36 kA at $380 / 415 \mathrm{~V}$ )

| Rating | 3P 3d |
| :--- | :--- |
| MA2.5 | LV429745 |
| MA6.3 | LV429744 |
| MA12.5 | LV429743 |
| MA25 | LV429742 |
| MA50 | LV429741 |
| MA100 | LV429740 |

Compact NSX160F ( 36 kA at $\mathbf{3 8 0} / 415 \mathrm{~V}$ )

| Rating | 3P 3d |
| :--- | :--- |
| MA100 | LV430831 |
| MA150 | LV430830 |

Compact NSX250F ( 36 kA at $380 / 415$ V)

| Rating | 3P 3d |
| :--- | :--- |
| MA150 | LV431749 |
| MA220 | LV431748 |

With electronic trip unit Micrologic 2.2-M (LS 1 motor protection)


With electronic trip unit Micrologic 6.2 E-M (LSIG motor protection, energy meter)
To be ordered with 2 catalogue numbers: 1 basic frame +1 trip unit

# Catalogue numbers NSX100/160/250F: complete fixed/FC device (cont.) Vigicompact NSX100/160/250F (36 kA 380/415 V) 

Vigicompact NSX100/160/250F
With thermal-magnetic trip unit TM-D


Vigicompact NSX100F ( 36 kA at $380 / 415 \mathrm{~V}$ ) equipped with MH Vigi module ( 200 to 440 V )

| Rating | 3P 3d | 4P 3d | 4P 4d |
| :--- | :--- | :--- | :--- |
| TM16D | LV429937 | LV429947 | LV429957 |
| TM25D | LV429936 | LV429946 | LV429956 |
| TM32D | LV429935 | LV429945 | LV429955 |
| TM40D | LV429934 | LV429944 | LV429954 |
| TM50D | LV429933 | LV429943 | LV429953 |
| TM63D | LV429932 | LV429942 | LV429951 |
| TM80D | LV429931 | LV429941 | LV429950 |

Vigicompact NSX160F ( $\mathbf{3 6}$ kA at $380 / 415$ V) equipped with MH Vigi module ( 200 to 440 V )

| Rating | 3P 3d | 4P 3d | 4P 4d |
| :--- | :--- | :--- | :--- |
| TM80D | LV430933 | LV430943 | LV430953 |
| TM100D | LV430932 | LV430942 | LV430952 |
| TM125D | LV430931 | LV430941 | LV430951 |
| TM160D | LV430930 | LV430940 | LV430950 |

Vigicompact NSX250F ( 36 kA at $\mathbf{3 8 0} / 415 \mathrm{~V}$ ) equipped with MH Vigi module ( 200 to 440 V )

| Rating | 3P 3d | 4P 3d | 4P 4d |
| :--- | :--- | :--- | :--- |
| TM125D | LV431933 | LV431943 | LV431953 |
| TM160D | LV431932 | LV431942 | LV431952 |
| TM200D | LV431931 | LV431941 | LV431951 |
| TM250D | LV431930 | LV431940 | LV431950 |

With electronic trip unit Micrologic 2.2 (LSOI protection)

|  | Vigicompact NSX100F ( 36 kA at $380 / 415 \mathrm{~V}$ ) equipped with MH Vigi module ( 200 to 440 V ) |  |  |
| :---: | :---: | :---: | :---: |
|  |  |  |  |
|  | 40 | LV429972 | LV429982 |
|  | 100 | LV429970 | LV429980 |
|  | Vigicompact NSX160F ( 36 kA at $\mathbf{3 8 0} / 415 \mathrm{~V}$ ) equipped with MH Vigi module ( 200 to 440 V ) |  |  |
|  | Rating | 3P 3d | 4P 3d, 4d, 3d + N/2 |
|  | 40 | LV430973 | LV430983 |
|  | 100 | LV430971 | LV430981 |
|  | 160 | LV430970 | LV430980 |
|  | Vigicompact NSX250F ( 36 kA at $380 / 415 \mathrm{~V}$ ) equipped with MH Vigi module (200 to 440 V ) |  |  |
|  | Rating | 3P 3d | 4P 3d, 4d, 3d + N/2 |
|  | 100 | LV431972 | LV431982 |
|  | 160 | LV431971 | LV431981 |
|  | 250 | LV431970 | LV431980 |
| With electronic trip unit Micrologic 5.2 A or 5.2 E (LSI protection, energy meter) |  |  |  |
| To be ordered with 2 catalogue numbers: 1 basic frame +1 trip unit |  |  |  |

SP160 Jesmond Road Indooroopilly SPS - TSR02 Transportable Switchboard Container - OM Manual Catalogue numbers

# NSX100/160/250N: complete fixed/FC device Compact NSX100/160/250N (50 kA 380/415 V) 

Compact NSX100/160/250N


Compact NSX100N ( 50 kA at $\mathbf{3 8 0} / 415 \mathrm{~V}$ )

| Compact NSX100N (50 kA at 380/415 V) | 4P 3d |  |
| :--- | :--- | :--- |
| Rating | 3P 3d | 4 |


| Rating | 3P 3d | 4P 3d | 4P 4d |
| :--- | :--- | :--- | :--- |
| TM16D | LV429847 | LV429857 | LV429867 |
| TM25D | LV429846 | LV429856 | LV429866 |
| TM32D | LV429845 | LV429855 | LV429865 |
| TM40D | LV429844 | LV429854 | LV4298643 |
| TM50D | LV429843 | LV429853 | LV429862 |
| TM63D | LV429842 | LV429851 | LV429861 |
| TM80D | LV429841 | LV429850 |  |
| TM100D | LV429840 |  |  |

LV429860

| Compact NSX160N |  |
| :--- | :--- |
| Rating | 3P 3d |
| TM80D | LV430843 |
| TM100D | LV430842 |
| TM125D | LV430841 |
| TM160D | LV430840 |
| Compact NSX250N $(50$ kA at $\mathbf{3 8 0 / 4 1 5 ~ V ) ~}$ |  |


| 4P 3d | 4P 4d |
| :--- | :--- |
| LV430853 | LV430863 |
| LV430852 | LV430862 |
| LV430851 | LV430861 |
| LV430850 | LV430860 |

Compact NSX250N (50 kA at $380 / 415 \mathrm{~V}$ )

| Rating | 3P 3d | 4P 3d | 4P 4d |
| :--- | :--- | :--- | :--- |
| TM125D | LV431833 | LV431843 | LV431853 |
| TM160D | LV431832 | LV431842 | LV431852 |
| TM200D | LV431831 | LV431841 | LV431851 |
| TM250D | LV431830 | LV431840 | LV431850 |

With electronic trip unit Micrologic 2.2 (LS 1 I protection)

|  | Compact NSX100N (50 kA at 380/415 V) |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
|  |  | Rating | 3P 3d | 4P 3d, 4d, 3d + N/2 |
|  |  | 40 | LV429797 | LV429807 |
|  |  | 100 | LV429795 | LV429805 |
|  |  | Compact NSX160N ( 50 kA at $\mathbf{3 8 0} / 415 \mathrm{~V}$ ) |  |  |
|  |  | Rating | 3P 3d | 4P 3d, 4d, 3d + N/2 |
|  |  | 100 | LV430776 | LV430786 |
|  |  | 160 | LV430775 | LV430785 |
|  |  | Compact NSX250N (50 kA at 380/415 V) |  |  |
|  |  | Rating | 3P 3d | 4P 3d, 4d, 3d + N/2 |
|  |  | 100 | LV431872 | LV431877 |
|  |  | 160 | LV431871 | LV431876 |
|  |  | 250 | LV431870 | LV431875 |
| With electronic trip unit Micrologic 5.2 A (LSI protection, ammeter) |  |  |  |  |
|  |  | Compact NSX100N ( 50 kA at $380 / 415 \mathrm{~V}$ ) |  |  |
|  |  | Rating | 3P 3d | 4P 3d, 4d, 3d + N/2, OSN |
|  |  | 40 | LV429892 | LV429897 |
|  |  | 100 | LV429890 | LV429895 |
|  |  | Compact NSX160N ( 50 kA at $380 / 415 \mathrm{~V}$ ) |  |  |
|  |  | Rating | 3P 3d | 4P 3d, 4d, 3d + N/2, OSN |
|  |  | 100 | LV430891 | LV430896 |
|  |  | 160 | LV430890 | LV430895 |
|  |  | Compact NSX250N ( 50 kA at $\mathbf{3 8 0} / 415 \mathrm{~V}$ ) |  |  |
|  |  | Rating | 3P 3d | 4P 3d, 4d, 3d + N/2, OSN |
|  |  | 100 | LV431882 | LV431887 |
|  |  | 160 | LV431881 | LV431886 |
|  |  | 250 | LV431880 | LV431885 |
|  | With electronic trip unit Micrologic 5.2 E (LSI protection, energy meter) |  |  |  |
|  | To be ordered with 2 catalogue numbers: 1 basic frame +1 trip unit |  |  |  |
|  | With electronic trip unit Micrologic 6.2 A (LSIG protection, ammeter) |  |  |  |
|  | To be ordered with 2 catalogue numbers: 1 basic frame +1 trip unit |  |  |  |
|  | With electronic trip unit Micrologic 6.2 E (LSIG protection, energy meter) |  |  |  |
|  | To be ordered with | ue numb |  |  |


| Compact NSX100/160/250N |  |  |
| :---: | :---: | :---: |
| With magnetic trip unit MA |  |  |
|  | Compact NSX100N ( 50 kA at $\mathbf{3 8 0 / 4 1 5} \mathrm{V}$ ) |  |
|  | Rating | 3P 3d |
|  | MA2.5 | LV429755 |
|  | MA6.3 | LV429754 |
|  | MA12.5 | LV429753 |
|  | MA25 | LV429752 |
|  | MA50 | LV429751 |
|  | MA100 | LV429750 |
|  | Compact NSX160N (50 kA at 380/415 V) |  |
|  | Rating | 3P 3d |
|  | MA100 | LV430833 |
|  | MA150 | LV430832 |
|  | Compact NSX250N ( 50 kA at $\mathbf{3 8 0} / 415 \mathrm{~V}$ ) |  |
|  | Rating | 3P 3d |
|  | MA150 | LV431753 |
|  | MA220 | LV431752 |
| With electronic trip unit Micrologic 2.2-M (LSol motor protection) |  |  |
|  | Compact NSX100N ( 50 kA at 380/415 V) |  |
|  | Rating | 3P 3d |
|  | 25 | LV429833 |
|  | 50 | LV429832 |
|  | 100 | LV429830 |
|  | Compact NSX160N (50 kA at 380/415 V) |  |
|  | Rating | 3P 3d |
|  | 100 | LV430989 |
|  | 150 | LV430988 |
|  | Compact NSX250N ( 50 kA at $380 / 415 \mathrm{~V}$ ) |  |
|  | Rating | 3P 3d |
|  | 150 | LV431166 |
|  | 220 | LV431165 |
| With electronic trip unit Micrologic 6.2 E-M (LSIG motor protection, energy meter) |  |  |
| To be ordered with 2 catalogue numbers: 1 basic frame +1 trip unit |  |  |

SP160 Jesmond Road Indooroopilly SPS - TSR02 Transportable Switchboard Container - OM Manual Catalogue numbers

# NSX100/160/250H: complete fixed/FC device Compact NSX100/160/250H (70 kA 380/415 V) 

Compact NSX100/160/250H

## With thermal-magnetic trip unit TM-D



Compact NSX100H ( 70 kA at $380 / 415 \mathrm{~V}$ )

| Rating | 3P 3d | 4P 3d | 4P 4d |
| :--- | :--- | :--- | :--- |
| TM16D | LV429677 | LV429687 | LV429697 |
| TM25D | LV429676 | LV429686 | LV429696 |
| TM32D | LV429675 | LV429685 | LV429695 |
| TM40D | LV429674 | LV429684 | LV429694 |
| TM50D | LV429673 | LV429683 | LV429692 |
| TM63D | LV429672 | LV429681 | LV429691 |
| TM80D | LV429671 | LV429680 | LV429690 |


| Rating | 3P 3d |
| :---: | :---: |
| TM80D | LV430673 |
| TM100D | LV430672 |
| TM125D | LV430671 |
| TM160D | LV430670 |
| Compact NSX250H ( 70 kA at $380 / 415 \mathrm{~V}$ ) |  |


| 4P 3d | 4P 4d |
| :--- | :--- |
| LV430683 | LV430693 |
| LV430682 | LV430692 |
| LV430681 | LV430691 |
| LV430680 | LV430690 |


| Rating | 3P 3d | 4P 3d | 4P 4d |
| :--- | :--- | :--- | :--- |
| TM125D | LV431673 | LV431683 | LV431693 |
| TM160D | LV431672 | LV431682 | LV431692 |
| TM200D | LV431671 | LV431681 | LV431691 |
| TM250D | LV431670 | LV431680 | LV431690 |


|  | Compact NSX100H ( 70 kA at $380 / 415 \mathrm{~V}$ ) |  |  |
| :---: | :---: | :---: | :---: |
|  | Rating | 3P 3d | 4P 3d, 4d, 3d + N/2 |
|  | 40 | LV429792 | LV429802 |
|  | 100 | LV429790 | LV429800 |
|  | Compact NSX160H (70 kA at $\mathbf{3 8 0} / 415 \mathrm{~V}$ ) |  |  |
|  | Rating | 3P 3d | 4P 3d, 4d, 3d + N/2 |
|  | 100 | LV430791 | LV430801 |
|  | 160 | LV430790 | LV430800 |
|  | Compact NSX250H ( 70 kA at $\mathbf{3 8 0} / 415 \mathrm{~V}$ ) |  |  |
|  | Rating | 3P 3d | 4P 3d, 4d, 3d + N/2 |
|  | 100 | LV431792 | LV431802 |
|  | 160 | LV431791 | LV431801 |
|  | 250 | LV431790 | LV431800 |
| With electroni | t Micro | (LSI prot |  |
|  | Compact NSX100H (70 kA at 380/415 V) |  |  |
|  | Rating | 3P 3d | 4P 3d, 4d, 3d + N/2, OSN |
|  | 40 | LV429794 | LV429804 |
|  | 100 | LV429793 | LV429803 |
|  | Compact NSX160H (70 kA at 380/415 V) |  |  |
|  | Rating | 3P 3d | 4P 3d, 4d, 3d + N/2, OSN |
|  | 100 | LV430795 | LV430805 |
|  | 160 | LV430794 | LV430804 |
|  | Compact NSX250H (70 kA at 380/415 V) |  |  |
|  | Rating | 3P 3d | 4P 3d, 4d, 3d + N/2, OSN |
|  | 100 | LV431797 | LV431807 |
|  | 160 | LV431796 | LV431806 |
|  | 250 | LV431795 | LV431805 |

With electronic trip unit Micrologic 5.2 E (LSI protection, energy meter)
To be ordered with 2 catalogue numbers: 1 basic frame +1 trip unit
With electronic trip unit Micrologic 6.2 A (LSIG protection, ammeter)
To be ordered with 2 catalogue numbers: 1 basic frame +1 trip unit
With electronic trip unit Micrologic 6.2 E (LSIG protection, energy meter)
To be ordered with 2 catalogue numbers: 1 basic frame +1 trip unit

## Catalogue numbers

# NSX100/160/250H: complete fixed/FC device (cont.) Compact NSX100/160/250H (70 kA 380/415 V) (cont.) 

Compact NSX100/160/250H
With magnetic trip unit MA


Compact NSX100H (70 kA at 380/415 V)

| Rating | 3P 3d |
| :--- | :--- |

MA2.5 LV429765 LV429765 LV429763
MA12.5
MA25 LV429762
MA50 LV429761
LV429760
Compact NSX160H (70 kA at $380 / 415$ V)

| Rating | 3P 3d |
| :--- | :--- |
| MA100 | LV430835 |
| MA150 | LV430834 |

Compact NSX250H (70 kA at 380/415 V)

| Rating | 3P 3d |
| :--- | :--- |
| MA150 | LV431757 |
| MA220 | LV431756 |

With electronic trip unit Micrologic 2.2-M (LS 1 motor protection)


Compact NSX100H (70 kA at $380 / 415$ V)

| Rating | 3P 3d |
| :--- | :--- |
| 25 | LV429838 |
| 50 | LV429837 |
| 100 | LV429835 |

Compact NSX160H (70 kA at 380/415 V)

| Rating | 3P 3d |
| :--- | :--- |
| 100 | LV430992 |
| 150 | LV430991 |

Compact NSX250H (70 kA at $380 / 415$ V)

| Rating | 3P 3d |
| :--- | :--- |
| 150 | LV431171 |
| 220 | LV431170 |

With electronic trip unit Micrologic 6.2 E-M (LSIG motor protection, energy meter)
To be ordered with 2 catalogue numbers: 1 basic frame +1 trip unit

Compact NSX100/160/250NA switch-disconnector
With NA switch-disconnector unit


| Compact NSX100NA |  |  |  |
| :---: | :---: | :---: | :---: |
| Rating | 2P | 3P | 4P |
| 100 | LV429619 | LV429629 | LV429639 |
| Compact NSX160NA |  |  |  |
| Rating | 2P | 3P | 4P |
| 160 | LV430619 | LV430629 | LV430639 |
| Compact NSX250NA |  |  |  |
| Rating | 2P | 3P | 4P |
| 250 | LV431619 | LV431629 | LV431639 |

Basic frame

|  | Compact NSX100 |  |  |
| :---: | :---: | :---: | :---: |
|  |  | 3P | 4P |
|  | NSX100B (25 kA 380/415 V) | LV429014 | LV429015 |
|  | NSX100F (36 kA 380/415 V) | LV429003 | LV429008 |
|  | NSX100N ( $50 \mathrm{kA} 380 / 415 \mathrm{~V}$ ) | LV429006 | LV429011 |
|  | NSX100H (70 kA 380/415 V) | LV429004 | LV429009 |
|  | NSX100S (100 kA 380/415 V) | LV429018 | LV429019 |
|  | NSX100L (150 kA 380/415 V) | LV429005 | LV429010 |
|  | Compact NSX160 |  |  |
|  |  | 3P | 4P |
|  | NSX160B (25 kA 380/415 V) | LV430390 | LV430395 |
|  | NSX160F (36 kA 380/415 V) | LV430403 | LV430408 |
|  | NSX160N (50 kA 380/415 V) | LV430406 | LV430411 |
|  | NSX160H (70 kA 380/415 V) | LV430404 | LV430409 |
|  | NSX160S (100 kA 380/415 V) | LV430391 | LV430396 |
|  | NSX160L (150 kA 380/415 V) | LV430405 | LV430410 |
|  | Compact NSX250 |  |  |
|  |  | 3P | 4P |
|  | NSX250B (25 kA 380/415 V) | LV431390 | LV431395 |
|  | NSX250F (36 kA 380/415 V) | LV431403 | LV431408 |
|  | NSX250N ( $50 \mathrm{kA} 380 / 415 \mathrm{~V}$ ) | LV431406 | LV431411 |
|  | NSX250H (70 kA 380/415 V) | LV431404 | LV431409 |
|  | NSX250S (100 kA 380/415 V) | LV431391 | LV431396 |
|  | NSX250L (150 kA 380/415 V) | LV431405 | LV431410 |

## + Trip unit

Distribution protection

|  | Thermal-magnetic TM-D |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
|  | Rating | 3P 3d | 4P 3d | 4P 4d |
|  | TM16D | LV429037 | LV429047 | LV429057 |
|  | TM25D | LV429036 | LV429046 | LV429056 |
|  | TM32D | LV429035 | LV429045 | LV429055 |
|  | TM40D | LV429034 | LV429044 | LV429054 |
|  | TM50D | LV429033 | LV429043 | LV429053 |
|  | TM63D | LV429032 | LV429042 | LV429052 |
|  | TM80D | LV429031 | LV429041 | LV429051 |
|  | TM100D | LV429030 | LV429040 | LV429050 |
|  | TM125D | LV430431 | LV430441 | LV430451 |
|  | TM160D | LV430430 | LV430440 | LV430450 |
|  | TM200D | LV431431 | LV431441 | LV431451 |
|  | TM250D | LV431430 | LV431440 | LV431450 |
|  | Micrologic 2.2 (LSol protection) |  |  |  |
|  | Rating | 3P 3d | 4P 3d, 4d, 3d + N/2 |  |
|  | Micrologic 2.2 40 A | LV429072 | LV429082 |  |
|  | Micrologic 2.2 100 A | LV429070 | LV429080 |  |
|  | Micrologic 2.2 160 A | LV430470 | LV430480 |  |
|  | Micrologic 2.2 250 A | LV431470 | LV431480 |  |
|  | Micrologic 5.2 A (LSI protection, ammeter) |  |  |  |
|  | Rating | 3P 3d | 4P 3d, 4d, 3d + N/2, 3d + OSN |  |
|  | Micrologic 5.2 A 40 A | LV429091 | LV429101 |  |
|  | Micrologic 5.2A 100 A | LV429090 | LV429100 |  |
|  | Micrologic 5.2A 160 A | LV430490 | LV430495 |  |
|  | Micrologic 5.2A 250 A | LV431490 | LV431495 |  |
|  | Micrologic 5.2 E (LSI protection, energy meter) |  |  |  |
|  | Rating | 3P 3d | 4P 3d, 4d, 3d + N/2, 3d + OSN |  |
|  | Micrologic 5.2 E 40A | LV429096 | LV429106 |  |
|  | Micrologic 5.2E 100 A | LV429095 | LV429105 |  |
|  | Micrologic 5.2 E 160 A | LV430491 | LV430496 |  |
|  | Micrologic 5.2 E 250 A | LV431491 | LV431496 |  |
|  | Micrologic 6.2 A (LSIG protection, ammeter) |  |  |  |
|  | Rating | 3P 3d | 4P 3d, 4d, 3d + N/2, 3d + OSN |  |
|  | Micrologic 6.2 A 40 A | LV429111 | LV429136 |  |
|  | Micrologic 6.2A 100 A | LV429110 | LV429135 |  |
|  | Micrologic 6.2A 160 A | LV430505 | LV430515 |  |
|  | Micrologic 6.2A 250 A | LV431505 | LV431515 |  |
|  | Micrologic 6.2 E (LSIG protection, energy meter) |  |  |  |
|  | Rating | 3P 3d | 4P 3d, 4d, 3d + N/2, 3d + OSN |  |
|  | Micrologic 6.2 E 40A | LV429116 | LV429141 |  |
|  | Micrologic 6.2E 100 A | LV429116 | LV429140 |  |
|  | Micrologic 6.2E 160 A | LV430506 | LV430516 |  |
|  | Micrologic 6.2 E 250 A | LV431506 | LV431516 |  |

## + Trip unit (cont.)

## Motor protection


Magnetic MA (I protection)

| Magnetic MA (I protection) | 3P 3 |
| :--- | :--- |
| Rating | LV42 |
| MA2.5 | LV42 |
| MA6.3 | LV42 |
| MA12.5 | LV42 |
| MA25 | LV42 |
| MA50 | LV42 |
| MA100 | LV43 |
| MA150 | LV43 |
| MA220 |  |
| Micrologic 2.2-M (LS I protection) |  |


| 3P 3d |
| :--- |
| LV429125 |
| LV429124 |
| LV429123 |
| LV429122 |
| LV429121 |
| LV429120 |
| LV430500 |
| LV431500 |


| 4P 3d |
| :--- |
|  |
|  |
|  |
| LV429130 |
| LV430510 |
| LV431510 |

Micrologic 2.2-M (LSol protection)
3P 3d
Micrologic 2.2-M 25A
LV429174
LV429172
LV429170
LV430520
Micrologic 2.2-M 50 A

LV431520


Micrologic 2.2-M 150 A
nergy meter)
Micrologic 2 2-M 220 A

3P 3d

| Rating | 3P 3d |
| :--- | :--- |
| Micrologic 6.2 E-M 25A | LV429184 |
| Micrologic 6.2 E-M 50A | LV429182 |
| Micrologic 6.2 E-M 80A | LV429180 |
| Micrologic 6.2 E-M 150 A | LV430521 |
| Micrologic 6.2 E-M 220 A | LV431521 |

Micrologic 6.2 E-M 220 A
LV431521

## Generator protection



Thermal-magnetic TM-G

| Rating | 3P 3d |
| :--- | :--- |
| TM16G | LV429155 |
| TM25G | LV429154 |
| TM40G | LV429153 |
| TM63G | LV429152 |

3P 3d
LV429076
LV429075
LV430475
LV431475

$|$| 4P 4d |
| :--- |
| LV429165 |
| LV429164 |
| LV429163 |
| LV429162 |


$|$| 4P 3d, 4d, 3d + N/2 |
| :--- |
| LV429086 |
| LV429085 |
| LV430485 |
| LV431485 |

Protection of public distribution systems


Micrologic 2.2 AB (LSol protection)

| Rating |
| :--- |
| Micrologic 2.2-AB 100 A |
| Micrologic 2.2-AB 160 A |

Micrologic 2.2-AB 160 A
Micrologic 2.2-AB 240 A

| 4P 3d, 4d, 3d + N/2 |
| :--- |
| LV434550 |
| LV434551 |
| LV434554 |

$16 \mathrm{~Hz} 2 / 3$ network protection


+ Vigi module or insulation monitoring module


ME type for NSX100/160 (200 to 440 V ) MH type for NSX100/160 (200 to 440 V ) MH type for NSX250 (200 to 440 V ) MH type for NSX100/160 (440 to 550 V ) MH type for NSX250 (440 to 550 V ) Connection for a 4P Vigi on a 3P breaker

3P
LV429212 LV429210 LV431535 LV429215 LV431533

3P
LV429459

4P
LV429213
LV429211
LV431536
LV429216
LV431534
LV429214

## Insulation monitoring module



200 to 440 V AC

4P
LV429460
LV429214

Connection for a 4P insulation monitoring module on a 3P breaker

Trip unit accessories
External neutral CT for 3 pole breaker with Micrologic 5／6

ZSI wiring accessory for NS630b NW with NSX


External power supply module（24 V DC－ 1 A），class 4


Withdrawable version = fixed/FC device + withdrawable kit

2P (3P)
Kit for Compact
$=$
$1 \times$ LV429288
+
$1 \times$ LV429282
+
$1 \times$ LV429283

| 3P | 4P |
| :---: | :---: |
| Kit for Compact = | Kit for Compact = |
| $1 \times$ LV429289 | $1 \times$ LV429290 |
| + | + |
| $1 \times$ LV429282 | $1 \times$ LV429282 |
| + | + |
| $1 \times$ LV429283 | $1 \times$ LV429283 |


| Kit for Vigicompact |  |  |  |
| :---: | :---: | :---: | :---: |
| $0 \cdot$ |  | 3P | 4P |
|  |  | Kit for Vigicompact | Kit for Vigicompact |
| - 7 \% | Plug-in kit | $1 \times$ LV429291 | $1 \times$ LV429292 |
| - Ont |  | + | + |
|  | Chassis side plates | $1 \times$ LV429282 | $1 \times$ LV429282 |
| 明 | for base | + | + |
| 18050 | Chassis side plates | $1 \times$ LV429283 | $1 \times$ LV429283 |

$\square$

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## Catalogue numbers

Accessories
Compact and Vigicompact
NSX100／160／250


## ＂Polybloc＂distribution block（for bare cable）



| $160 \mathrm{~A}\left(40^{\circ} \mathrm{C}\right) 6$ cables S y $10 \mathrm{~mm}^{2}$ | 1 P | 04031 |
| :--- | :--- | :--- |
| $250 \mathrm{~A}\left(40^{\circ} \mathrm{C}\right) 9$ cables S y $10 \mathrm{~mm}^{2}$ | 3 P | 04033 |
|  | 4 P | 04034 |


| Terminal extensions |  |  |  |
| :---: | :---: | :---: | :---: |
|  | $45^{\circ}$ terminal extension ${ }^{(1)}$ | Set of 3 Set of 4 |  |
|  | Edgewise terminal extensions ${ }^{(1)}$ | Set of 3 Set of 4 | $\begin{array}{\|l\|} \hline \text { LV429308 } \\ \hline \text { LV429309 } \\ \hline \end{array}$ |
| 弟 | Right－angle terminal extensions ${ }^{(1)}$ | Set of 3 Set of 4 | $\begin{array}{\|l\|} \hline \text { LV429261 } \\ \hline \text { LV429262 } \end{array}$ |
|  | Straight terminal extensions ${ }^{(1)}$ | Set of 3 Set of 4 | $\begin{array}{\|l\|} \hline \text { LV429263 } \\ \hline \text { LV429264 } \end{array}$ |
| $\begin{aligned} & \stackrel{\rightharpoonup}{*} \\ & \text { 商 } \sqrt{0} \sqrt{0} \sqrt{0} \\ & \sqrt{101} \end{aligned}$ | Double－L terminal extensions ${ }^{(1)}$ | Set of 3 Set of 4 | $\begin{array}{\|l\|} \hline \text { LV429221 } \\ \hline \text { LV429222 } \\ \hline \end{array}$ |
| 佥 | Spreaders from 35 to 45 mm pitch ${ }^{(1)}$ | $\begin{aligned} & 3 P \\ & 4 P \end{aligned}$ | $\begin{array}{\|l\|} \hline \text { LV431563 } \\ \hline \text { LV431564 } \end{array}$ |
|  | One－piece spreader from 35 to 45 mm pitch <br> Front alignment base（for one－piece spreader） | 3P 4 P 3P／4P | LV431060 <br> LV431061 <br> LV431064 |

[^9]SP160 Jesmond Road Indooroopilly SPS - TSR02 Transportable Switchboard Container - OM Manual Catalogue numbers

## Accessories (cont.)

Compact and Vigicompact NSX100/160/250 (cont.)


1) Supplied with 2 or 3 interphase barriers.

Electrical auxiliaries
Auxiliary contacts (changeover)


SDTAM contactor tripping module (early-break thermal fault signal) for Micrologic 2.2-M/6.2 E-M


SDTAM 24/415 V AC/DC overload fault indication

| Voltage releases |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
|  |  | Voltage | MX | MN |
|  | AC | $24 \mathrm{~V} 50 / 60 \mathrm{~Hz}$ | LV429384 | LV429404 |
|  |  | $48 \mathrm{~V} 50 / 60 \mathrm{~Hz}$ | LV429385 | LV429405 |
|  |  | $110-130 \mathrm{~V} 50 / 60 \mathrm{~Hz}$ | LV429386 | LV429406 |
|  |  | 220-240 V 50/60 Hz and 208-277 V 60 Hz | LV429387 | LV429407 |
|  |  | $380-415 \mathrm{~V} 50 \mathrm{~Hz}$ and $440-480 \mathrm{~V} 60 \mathrm{~Hz}$ | LV429388 | LV429408 |
|  |  | 525 V 50 Hz and 600 V 60 Hz | LV429389 | LV429409 |
|  | DC | 12 V | LV429382 | LV429402 |
|  |  | 24 V | LV429390 | LV429410 |
|  |  | 30 V | LV429391 | LV429411 |
|  |  | 48 V | LV429392 | LV429412 |
|  |  | 60 V | LV429383 | LV429403 |
|  |  | 125 V | LV429393 | LV429413 |
|  |  | 250 V | LV429394 | LV429414 |
|  | MN $48 \mathrm{~V} 50 / 60 \mathrm{~Hz}$ with fixed time delay |  |  |  |
|  | Composed of | MN 48 V DC |  | LV429412 |
|  |  | Delay unit $48 \mathrm{~V} 50 / 60 \mathrm{~Hz}$ |  | LV429426 |
|  | MN 220-240 V 50/60 Hz with fixed time delay |  |  |  |
|  | Composed of | MN 250 V DC |  | LV429414 |
|  |  | Delay unit $220-240 \mathrm{~V} 50 / 60 \mathrm{~Hz}$ |  | LV429427 |
|  | MN 48 V DC/AC $50 / 60 \mathrm{~Hz}$ with adjustable time delay |  |  |  |
|  | Composed of | MN 48 V DC |  | LV429412 |
|  |  | Delay unit $48 \mathrm{~V} 50 / 60 \mathrm{~Hz}$ |  | 33680 |
|  | MN110-130 V DC/AC 50/60 Hz with adjustable time delay |  |  |  |
|  | Composed of | MN 125 V DC |  | LV429413 |
|  |  | Delay unit 110-130 V $50 / 60 \mathrm{~Hz}$ |  | 33681 |
|  | MN 220-250 V 50/60 Hz with adjustable time delay |  |  |  |
|  | Composed of | MN 250 V DC |  | LV429414 |
|  |  | Delay unit 220-250 V $50 / 60 \mathrm{~Hz}$ |  | 33682 |

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## Accessories (cont.)

Compact and Vigicompact
NSX100/160/250 (cont.)

| Motor mechanism |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| Motor mechanism module supplied with SDE adapter |  |  |  |  |
|  |  | Voltage | MT100/160 | MT250 |
|  | AC | $48-60 \mathrm{~V} 50 / 60 \mathrm{~Hz}$ | LV429440 | LV431548 |
|  |  | $110-130 \mathrm{~V} 50 / 60 \mathrm{~Hz}$ | LV429433 | LV431540 |
|  |  | $220-240 \mathrm{~V} 50 / 60 \mathrm{~Hz}$ and $208-277 \mathrm{~V} 60 \mathrm{~Hz}$ | LV429434 | LV431541 |
|  |  | $380-415 \mathrm{~V} 50 / 60 \mathrm{~Hz}$ and | LV429435 | LV431542 |
|  |  | $440-480$ V 60 Hz |  |  |
|  | DC | 24-30 V | LV429436 | LV431543 |
|  |  | 48-60 V | LV429437 | LV431544 |
|  |  | 110-130 V | LV429438 | LV431545 |
|  |  | 250 V | LV429439 | LV431546 |
| Communicating motor mechanism module supplied with SDE adapter |  |  |  |  |
|  | Motor mechanism module | MTc 100/160 | $220-240$ V $50 / 60 \mathrm{~Hz}$ | LV429441 |
|  |  | MTC 250 | $220-240$ V $50 / 60 \mathrm{~Hz}$ | LV431549 |
|  | + |  |  |  |
| $36$ | Breaker and Status Communication Module | BSCM |  | LV434205 |
|  | + |  |  |  |
|  | NSX cord | Wire length $L=0.35 \mathrm{~m}$ |  | LV434200 |
|  |  | Wire length $L=1.3 \mathrm{~m}$ |  | LV434201 |
|  |  | Wire length L $=3 \mathrm{~m}$ |  | LV434202 |
|  |  | $\mathrm{U}>480 \mathrm{~V}$ AC wire length |  | LV434204 |

Indication and measurement modules


| Rating (A) | 100 | 160 | 250 |
| :--- | :--- | :--- | :--- |
| 3 3P | LV429455 | LV430555 | LV431565 |
| $4 P$ | LV429456 | LV430556 | LV431566 |


| I max. ammeter module |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| - | Rating (A) | 100 | 160 | 250 |
| 60 | 3P | LV434849 | LV434850 | LV434851 |

Current transformer module


| Rating (A) | 125 |
| :--- | :--- |
| 3P | LV42945 |
| LV |  |

|150

250
4 P LV430558 LV431567 | LV431568

Current transformer module and voltage output


| Rating (A) | 125 |
| :--- | :--- |
| $3 P$ | LV42946 |


| 150 |
| :--- | :--- |
| LV430561 |

250
3P (A)
LV430562
31570

Voltage presence indicator


## Rotary handles

Direct rotary handle


With black handle
LV429337
With red handle on yellow front
LV429339
LV429341
CNOMO conversion accessory
LV429342

Extended rotary handle


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Catalogue numbers
Accessories (cont.)
Compact and Vigicompact
NSX100/160/250 (cont.)

Locks
Toggle locking device for 1 to 3 padlocks


By removable device


> By fixed device
| LV429371

Locking of rotary handle


## Locking of motor mechanism module



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Catalogue numbers
Accessories (cont.)
Compact and Vigicompact
NSX100/160/250 (cont.)

## Interlocking

Mechanical interlocking for circuit breakers
With toggles
| LV429354

| With rotary handles | LV429369 |
| :--- | :--- |



Interlocking with key ( 2 keylocks / 1 key) for rotary handles


|  | LV429344 |
| :--- | :--- |
| Ronis 1351B. 500 | $\mathbf{4 1 9 5 0}$ |
| Profalux KS5 B24 D4Z | 42878 |

Installation accessories
Front-panel escutcheons


IP30


| IP40 escutcheon for all control types | LV429317 |
| :--- | :--- |
| IP40 escutcheon for Vigi module | LV429316 |

LV429316

IP43 rubber toggle cover


(1) For only 1 device.

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Catalogue numbers
Accessories (cont.)
Compact and Vigicompact NSX100/160/250 (cont.)


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Catalogue numbers
Accessories (cont.)
Compact and Vigicompact
NSX100/160/250 (cont.)


Visible break disconnect function
See catalogue dealing with "Interpact INV products (visible break)" and the associated accessories.
The visible break disconnection function is compatible with fixed front-connected/rear-connected Compact NSX devices.

## Monitoring and control (remote operation)

## Circuit breaker accessories



Breaker Status Control Module
$\operatorname{BSCM}^{(1)}$
LV434205

ULP display module ${ }^{(2)}$


Switchboard front display module FDM121
TRV00121
FDM mounting accessory (diameter 22 mm )
TRV00128

ULP communication module


Modbus interface
Modbus SL communication interface module
TRV00210

ULP wiring accessories

(3)



External power supply module 100-240 V AC 110-230 V DC / 24 V DC-3 A class 2
ABL8RPS24030


(1) SDE adapter mandatory for trip unit TM, MA or Micrologic 2 (LV429451).
(2) For measurement display with Micrologic $A$ and $E$ or status display with BSCM.
(3) See Telemecanique catalogue.

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Catalogue numbers
Monitoring and control,
test tools (cont.)
Compact and Vigicompact
NSX100/160/250 (cont.)

## Test tool, software, demo

Test tool

## Maintenance case

TRV00910
Comprising

- USB maintenance interface
- Power supply
- Micrologic cord
- USB cord
- RJ45/RJ45 male cord


| Spare USB maintenance interface | TRV00911 |
| :--- | :--- |



Spare power supply 110-240 V AC
| TRV00915

Spare Micrologic cord for USB maintenance interface
| TRV00917


Configuration and setting software RSU
LV4ST100
Monitoring software RCU
LV4ST121
LV4SM100
NSX400/630F: complete fixed/FC device ..... F-30
Compact NSX400/630F ( 36 kA 380/415 V) ..... F-30
Vigicompact NSX400/630F ( $36 \mathrm{kA} \mathrm{380/415} \mathrm{~V}$ ) ..... F-31
NSX400/630N: complete fixed/FC device ..... F-32
Compact NSX400/630N (50 kA 380/415 V) ..... F-32
Vigicompact NSX400/630N (50 kA 380/415 V) ..... F-33
NSX400/630H: complete fixed/FC device ..... F-34
Compact NSX400/630H (70 kA 380/415 V) ..... F-34
NSX400/630NA: complete fixed/FC device ..... F-35
Compact NSX400/630NA ..... F-35
NSX400/630F/N/H/S/L: fixed/FC device based on separate components ..... F-36
Compact and Vigicompact ..... F-36
Trip unit accessories ..... F-37
Compact and Vigicompact NSX400/630 ..... F-37
Installation and connection ..... F-38
Compact and Vigicompact NSX400/630 ..... F-38
Accessories ..... F-40
Compact and Vigicompact NSX400/630 ..... F-40
Monitoring and control, test tools ..... F-49
Compact and Vigicompact NSX400/630 ..... F-49
Spare Parts ..... F-51
User manuals ..... F-51

# NSX400/630F: <br> complete fixed/FC device Compact NSX400/630F (36 kA 380/415 V) 



## Electronic trip unit Micrologic 1.3-M (I motor protection)



|  |  | 3P 3d |
| :--- | :--- | :--- |
| Compact NSX400F 1.3-M (36 kA at 380/415V) | 320 A | LV432748 |
| Compact NSX630F 1.3-M (36 kA at 380/415V) | 500 A | LV432948 |

Electronic trip unit Micrologic 2.3-M (LSol motor protection)


|  |  | 3P 3d |
| :--- | :--- | :--- |
| Compact NSX400F 2.3-M (36 kA at 380/415V) | 320 A | LV432775 |
| Compact NSX630F 2.3-M (36 kA at 380/415V) | 500 A | LV432975 |

With electronic trip unit Micrologic 5.3 E (LSI protection, energy meter)
To be ordered with 2 catalogue numbers: 1 basic frame +1 trip unit
With electronic trip unit Micrologic 6.3 A (LSIG protection, ammeter)
To be ordered with 2 catalogue numbers: 1 basic frame +1 trip unit
With electronic trip unit Micrologic 6.3 E (LSIG protection, energy meter)
To be ordered with 2 catalogue numbers: 1 basic frame +1 trip unit
With electronic trip unit Micrologic 6.3 E-M (LSIG motor protection, energy meter)
To be ordered with 2 catalogue numbers: 1 basic frame +1 trip unit

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Catalogue numbers

# NSX400/630F: <br> complete fixed/FC device Vigicompact NSX400/630F (36 kA 380/415 V) 

## Vigicompact NSX400/630F

Electronic trip unit Micrologic 2.3 (LSOI protection)


Vigicompact NSX400F (36 kA at 380/415 V)
Vigicompact NSX630F (36 kA at 380/415 V)
400 A
630 A

4P 3d, 4d, 3d + N/2

To be ordered with 2 catalogue numbers: 1 basic frame +1 trip unit
With electronic trip unit Micrologic 6.3 A (LSIG protection, ammeter)
To be ordered with 2 catalogue numbers: 1 basic frame +1 trip unit
With electronic trip unit Micrologic 6.3 E (LSIG protection, energy meter)
To be ordered with 2 catalogue numbers: 1 basic frame +1 trip unit
With electronic trip unit Micrologic 6.3 E-M (LSIG motor protection, energy meter)
To be ordered with 2 catalogue numbers: 1 basic frame +1 trip unit

# NSX400/630N: <br> complete fixed/FC device Compact NSX400/630N <br> (50 kA 380/415 V) 

Compact NSX400/630N
Electronic trip unit Micrologic 2.3 (LSOI protection)


| 3P 3d |
| :--- |
| LV432707 |
| LV432693 |
| LV432893 |

4P 3d, 4d, 3d + N/2 LV432893

Electronic trip unit Micrologic 5.3 A (LSI protection, ammeter)


|  | 3P 3d | 4P 3d, 4d, 3d + N/2, 3d + OSN |  |
| :--- | :--- | :--- | :--- |
| Compact NSX400N (50 kA at 380/415 V) | 400 A | LV432699 | LV432700 |
| Compact NSX630N $(50$ kA at $380 / 415 \mathrm{~V})$ | 630 A | LV432899 | LV432900 |

Electronic trip unit Micrologic 1.3-M A (I motor protection)


|  |  | 3P 3d |
| :--- | :--- | :--- |
| Compact NSX400N 1.3-M $(50$ kA at $380 / 415 \mathrm{~V})$ | 320 A | LV432749 |
| Compact NSX630N 1.3-M (50 kA at 380/415V) | 500 A | LV432949 |

Electronic trip unit Micrologic 2.3-M (LSOI motor protection)


|  |  | 3P 3d |
| :--- | :--- | :--- | :--- |
| Compact NSX400N 2.3-M $(50 \mathrm{kA}$ at $380 / 415 \mathrm{~V})$ | 320 A | LV432776 |
| Compact NSX630N 2.3-M (50 kA at 380/415V) | 500 A | LV432976 |

With electronic trip unit Micrologic 5.3 E (LSI protection, energy meter)
To be ordered with 2 catalogue numbers: 1 basic frame +1 trip unit
With electronic trip unit Micrologic 6.3 A (LSIG protection, ammeter)
To be ordered with 2 catalogue numbers: 1 basic frame +1 trip unit
With electronic trip unit Micrologic 6.3 E (LSIG protection, energy meter)
To be ordered with 2 catalogue numbers: 1 basic frame +1 trip unit
With electronic trip unit Micrologic 6.3 E-M (LSIG motor protection, energy meter)
To be ordered with 2 catalogue numbers: 1 basic frame +1 trip unit

Vigicompact NSX400/630N
Electronic trip unit Micrologic 2.3 (LSOI protection)


Vigicompact NSX400N (50 kA at 380/415 V) 400 A

3P 3d LV432733

4P 3d, 4d, 3d + N/2
Vigicompact NSX630N (50 kA at 380/415 V) 630 A LV432933 LV432734 LV432934

To be ordered with 2 catalogue numbers: 1 basic frame +1 trip unit

# NSX400/630H: <br> complete fixed/FC device Compact NSX400/630H <br> (70 kA 380/415 V) 

Compact NSX400/630H
Electronic trip unit Micrologic 2.3 (LSOI protection)

Compact NSX400H (70 kA at $380 / 415 \mathrm{~V}$ )
$250 A$
$400 A$
$630 A$ LV432709
LV432695
LV432895 4P 3d, 4d, 3d + N/2 LV432710 LV432696
Compact NSX630H (70 kA at 380/415 V
630 A LV432895 LV432896

## Electronic trip unit Micrologic 5.3 A (LSI protection, ammeter)



Compact NSX400H (70 kA at 380/415 V)

## 400 A

3P 3d
$4 \mathrm{P} 3 \mathrm{~d}, 4 \mathrm{~d}, 3 \mathrm{~d}+\mathrm{N} / 2,3 \mathrm{~d}+\mathrm{OSN}$
Compact NSX630H ( 70 kA at $380 / 415$ V) 630 A LV432701 LV432702 LV432902

Micrologic 1.3-M (I motor protection)

| Compact NSX400H 1.3-M $(70 \mathrm{kA}$ at $380 / 415 \mathrm{~V})$ | 320 A | 3P 3d |
| :--- | :--- | :--- |
| Compact NSX630H 1.3-M $(70 \mathrm{kA}$ at $380 / 415 \mathrm{~V})$ | 500 A | LV432750 |

## Electronic trip unit Micrologic 2.3-M (LSOI motor protection)



|  |  | 3P 3d |
| :--- | :--- | :--- |
| Compact NSX400H 2.3-M (70 kA at 380/415V) | 320 A | LV432777 |
| Compact NSX630H 2.3-M (70 kA at 380/415V) | 500 A | LV432977 |

With electronic trip unit Micrologic 6.3 E (LSIG protection, energy meter)
Only available as separate components.
With electronic trip unit Micrologic 6.3 E-M (LSIG motor protection, energy meter)
Only available as separate components.

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Catalogue numbers
NSX400/630NA:
complete fixed/FC device Compact NSX400/630NA

Compact NSX400/630 0.3 NA switch-disconnector
With 0.3 NA switch-disconnector unit


## Compact and Vigicompact



## + Vigi module or insulation monitoring module



| Type MB |  |
| :--- | :--- |
|  | 200 to 440 V |
| Connection for a 4P Vigi on a 3P breaker | 440 to 550 V |


| 3P | 4P |
| :--- | :--- |
| LV432455 | LV432456 |
| LV432453 | LV432454 |
|  | LV432457 |

Connection for a 4P Vigi on a 3P breaker 440 to 550 V LV432453 LV432454 LV432457

Insulation monitoring module



Trip unit accessories
External neutral CT for 3 pole breaker with Micrologic 5/6
$\qquad$
-

| Fixed/RC device $=$ fixed/FC device + rear connection kit |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| Mixed RC kit |  |  |  |  |
|  | Kit 3P | Short RCs | 2x | LV432475 |
|  |  | Long RCs | 1x | LV432476 |
|  | Kit 4P | Short RCs | 2x | LV432475 |
|  |  | Long RCs | 2 x | LV432476 |

Fixed/FC device with 52.5 mm or 70 mm pitch = fixed/FC device with $\mathbf{4 5} \mathbf{~ m m}$ pitch + spreaders
The pitch of all Compact and Vigicompact NSX400/630 devices is 45 mm . Spreaders are available for fixed front, plug-in or withdrawable connection with pitch of 52.5 mm or 70 mm .

Upstream or downstream spreaders ${ }^{(1)}$


| 52.5 mm | 3 P | LV432490 |
| :--- | :--- | :--- |
|  | 4 P | LV432491 |
| 70 mm | $\frac{3 P}{}$ | LV432492 |
|  | 4 P | LV432493 |

Plug-in version = fixed/FC device + plug-in kit
Kit for Compact


| 3P | 4P |
| :--- | :--- |
| LV432538 | LV432539 |
| $=1 \times$ LV432516 | $=1 \times$ LV432517 |
| $+3 \times$ LV432518 | $+4 \times$ LV432518 |
| $+2 \times$ LV432591 | $+2 \times$ LV432592 |
| $+1 \times$ LV432520 | $+1 \times$ LV432520 |


| Kit for Vigicompact |  |  |  |
| :---: | :---: | :---: | :---: |
| \% |  | 3P | 4P |
| N A | Vigi plug-in kit Comprising: | LV432540 | LV432541 |
| , | Base | = $1 \times$ LV432516 | = $1 \times$ LV432517 |
|  | Power connections | +3xLV432519 | +4x LV432519 |
|  | Short terminal shields | + $2 \times$ LV432591 | + $2 \times$ LV432592 |
|  | Safety trip interlock | +1 $\times$ LV432520 | +1 $\times$ LV432520 |

(1) Supplied with 2 or 3 interphase barriers.

Withdrawable version = fixed/FC device + withdrawable kit


|  | 3P |
| :---: | :---: |
|  | Kit for Compact = |
| Plug-in kit: | $1 \times$ LV432538 |
|  | + |
| Chassis side plates | $1 \times$ LV432532 |
| for base | + |
| Chassis side plates for breaker | $1 \times$ LV432533 |

4P
Kit for Compact $1 \times 2=$
$1 \times$ LV432532
$1 \times$ LV432533

Kit for Vigicompact


| 3P | 4P |
| :---: | :---: |
| Kit for Vigicompact = | Kit for Vigicompact = |
| $1 \times$ LV432540 | $1 \times$ LV432541 |
| + | + |
| $1 \times$ LV432532 | $1 \times$ LV432532 |
| + | + |
| $1 \times$ LV432533 | $1 \times$ LV432533 |



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Accessories (cont.)
Compact and Vigicompact
NSX400/630 (cont.)



| Voltage releases |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
|  |  | Voltage | MX | MN |
|  | AC | $24 \mathrm{~V} 50 / 60 \mathrm{~Hz}$ | LV429384 | LV429404 |
|  |  | $48 \mathrm{~V} 50 / 60 \mathrm{~Hz}$ | LV429385 | LV429405 |
|  |  | $110-130 \mathrm{~V} 50 / 60 \mathrm{~Hz}$ | LV429386 | LV429406 |
|  |  | $220-240$ V $50 / 60 \mathrm{~Hz}$ and $208-277$ V 60 Hz | LV429387 | LV429407 |
|  |  | $380-415 \mathrm{~V} 50 \mathrm{~Hz}$ and $440-480 \mathrm{~V} 60 \mathrm{~Hz}$ | LV429388 | LV429408 |
|  |  | 525 V 50 Hz and 600 V 60 Hz | LV429389 | LV429409 |
|  | DC | 12 V | LV429382 | LV429402 |
|  |  | 24 V | LV429390 | LV429410 |
|  |  | 30 V | LV429391 | LV429411 |
|  |  | 48 V | LV429392 | LV429412 |
|  |  | 60 V | LV429383 | LV429403 |
|  |  | 125 V | LV429393 | LV429413 |
|  |  | 250 V | LV429394 | LV429414 |
|  | MN $48 \mathrm{~V} 50 / 60 \mathrm{~Hz}$ with fixed time delay |  |  |  |
|  | Composed of: | MN 48 V DC |  | LV429412 |
|  |  | Delay unit $48 \mathrm{~V} 50 / 60 \mathrm{~Hz}$ |  | LV429426 |
|  | MN 220-240 V 50/60 Hz with fixed time delay |  |  |  |
|  | Composed of: | MN 250 V DC |  | LV429414 |
|  |  | Delay unit $220-240 \mathrm{~V} 50 / 60 \mathrm{~Hz}$ |  | LV429427 |
|  | MN 48 V DC/AC $50 / 60 \mathrm{~Hz}$ with adjustable time delay |  |  |  |
|  | Composed of | MN 48 V DC |  | LV429412 |
|  |  | Delay unit $48 \mathrm{~V} 50 / 60 \mathrm{~Hz}$ |  | 33680 |
|  | MN110-130 V DC/AC $50 / 60 \mathrm{~Hz}$ with adjustable time delay |  |  |  |
|  | Composed of: | MN 125 V DC |  | LV429413 |
|  |  | Delay unit 110-130 V $50 / 60 \mathrm{~Hz}$ |  | 33681 |
|  | MN 220-250 V 50/60 Hz with adjustable time delay |  |  |  |
|  | Composed of | MN 250 V DC |  | LV429414 |
|  |  | Delay unit 220-250 V 50/60 Hz |  | 33682 |

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Catalogue numbers
Accessories (cont.)
Compact and Vigicompact
NSX400/630 (cont.)

Motor mechanism
Motor mechanism module


SP160 Jesmond Road Indooroopilly SPS - TSR02 Transportable Switchboard Container - OM Manual

## Catalogue numbers

Accessories (cont.)
Compact and Vigicompact
NSX400/630 (cont.)

Indication and measurement modules



Rotary handles
Direct rotary handle


With black handle
LV432597
With red handle on yellow front
MCC conversion accessory
LV432606

| CNOMO conversion accessory | LV432602 |
| :--- | :--- |



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Catalogue numbers
Accessories (cont.)
Compact and Vigicompact
NSX400/630 (cont.)



Keylock adapter (keylock not included) Keylock (keylock adapter not included)

|  | LV432604 |
| :--- | :--- |
| Ronis 1351B. 500 | 41940 |
| Profalux KS5 B24 D4Z | 42888 |

Profalux KS5 B24 D4Z
42888

SP160 Jesmond Road Indooroopilly SPS - TSR02 Transportable Switchboard Container - OM Manual
Catalogue numbers
Accessories (cont.)
Compact and Vigicompact
NSX400/630 (cont.)


## Installation accessories

Front-panel escutcheons


| IP30 escutcheon for all control types | LV432557 |
| :--- | :--- | :--- |
| IP30 trip unit access escutcheon for toggle | LV432559 |
| IP30 escutcheon for Vigi module | LV429527 |


Lead-sealing accessories Bag of accessories

[^10]SP160 Jesmond Road Indooroopilly SPS - TSR02 Transportable Switchboard Container - OM Manual
Catalogue numbers

## Accessories (cont.) <br> Compact and Vigicompact NSX400/630 (cont.)

## Plug-in/withdrawable version accessories

## Insulation accessories



Schneider
Pfige 306 of $1302-47$

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Catalogue numbers
Accessories (cont.)
Compact and Vigicompact
NSX400/630 (cont.)


## Visible break disconnect function

See catalogue dealing with "Interpact INV products (visible break)" and the associated accessories.
The visible break disconnection function is compatible with fixed front-connected/rear-connected Compact NSX devices.

## Monitoring and control (remote operation)

## Circuit breaker accessories



Breaker Status Control Module BSCM
| LV434205

ULP display module ${ }^{(1)}$


> Switchboard front display module FDM121
> FDM mounting accessory (diameter 22 mm )

TRV00121
TRV00128

ULP communication module



24 V DC battery module
| 54446
(1) For measurement display with Micrologic A and E or status display with BSCM
(2) See Telemecanique catalogue.

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Monitoring and control, test tools (cont.)
Compact and Vigicompact NSX400/630 (cont.)

## Test tool, software, demo



Pocket battery for Micrologic NSX100-630
| LV434206

## Maintenance case

| TRV00910
Comprising:

- USB maintenance interface
- Power supply
- Micrologic cord
- USB cord
- RJ45/RJ45 male cord


| Spare USB maintenance interface | TRV00911 |
| :--- | :--- |



Spare power supply 110-240 V AC
| TRV00915

| Spare Micrologic cord for USB maintenance interface | TRV00917 |
| :--- | :--- |

Bluetooth/Modbus option for USB maintenance interface
| VW3A8114


Configuration and setting software RSU
LV4ST100
Test software LTU
LV4ST121
LV4SM100
Monitoring software RCU

## Demo tool

Demo case for Compact NSX
| LV434207
(1) See Telemecanique catalogue.
(2) Downloadable from http://schneider-electric.com.

SP160 Jesmond Road Indooroopilly SPS - TSR02 Transportable Switchboard Container - OM Manual Catalogue numbers COMPACT NSX
Spare Parts

Instructions

| User manual |  |  |  |
| :---: | :---: | :---: | :---: |
|  | Circuit breaker | (French) | LV434100 |
|  |  | (English) | LV434101 |
|  | Micrologic 5.6 | (French) | LV434103 |
|  |  | (English) | LV434104 |
|  | Modbus | (French) | LV434106 |
|  |  | (English) | LV434107 |
|  | ULP | (French) | TRV99100 |
|  |  | (English) | TRV99101 |

To indicate your choices, check the applicable square boxes or note the quantity
and enter the appropriate information in the rectangles


External neutral CT
24 V DC power supply connector
ZSI wiring accessory for NSX630b NW/NT


External power supply module 24 V DC

$\frac{\text { Straight extensions }}{\text { Edgewise extensions }}$ $45^{\circ}$ termina
extension extensions


| Spreader | NSX100/250 (one piece) NSX400/630 ( 52.5 mm ) |  | ( 45 mm ) ( 70 mm ) |  |
| :---: | :---: | :---: | :---: | :---: |
| Cu cable lugs | NSX100/250 | 120 V | 150 v | 185 ${ }^{\text {V }}$ |
|  | NSX400/630 |  | $240^{\text {v }}$ | $300{ }^{\text {v }}$ |
| AI cable lugs | NSX100/250 |  | $150{ }^{\text {v }}$ | $185{ }^{\text {v }}$ |
|  | NSX400/630 |  | 240 V | $300{ }^{\text {V }}$ |

Spare Micrologic cord

Functions and characteristics ..... A-1
Installation recommendations ..... B-1
Dimensions and connection ..... C-1
Wiring diagrams ..... D-1
Additional characteristics ..... E-1
Catalogue numbers ..... F-1
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Controls ..... G-5
Discrimination / Cascading ..... G-6
Environment ..... G-7
Harmonics ..... G-8
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Protection ..... G-9
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Switchgear ..... G-10
Three-phase asynchronous motors and their protection ..... G-11
Trip units ..... G-12

For each major section (Accessories, Switchgear, etc.) and for each item (Adapter for plug-in base, Connection terminal, etc.), this glossary provides:
$b$ the page number in the concerned catalogue
b the reference standard
b the standardised IEC symbol
$b$ the definition.
Text in quotation marks is drawn from the standards.

| Adapter for plug-in base | -A-72 | The adapter is a plastic component that can be installed upstream and/or downstream of the plug-in base and enables use of all the connection accessories of the fixed device. |
| :---: | :---: | :---: |
| Bare-cable connector | -A-71 | Conducting part of the circuit breaker intended for connection to power circuits. On Compact NSX, it is an aluminium part that screws to the connection terminals of the circuit breaker. There are one or more holes (single or multiple cable connector) for the ends of bare cables. |
| Connection terminals | - A-70 | Flat copper surface, linked to the conducting parts of the circuit breaker and to which power connections are made using bars, connectors or lugs. |
| One-piece spreader | - A-70 | The spreader is a plastic component with copper connectors that can be installed upstream and/or downstream of a Compact NSX100 to 250 circuit breaker with a pole pitch of 35 mm . It increases the pitch of the circuit-breaker terminals to the 45 mm pitch of a NSX400/630 device to facilitate connection of large cables. |
| Spreaders | - A-70 | Set of three (3P device) or four (4P) flat, conducting parts made of aluminium. They are screwed to the circuit-breaker terminals to increase the pitch between poles. |

## Circuit-breaker characteristics (IEC 60947-2)

$\qquad$

| Breaking capacity | -A-6 | Value of prospective current that a switching device is capable of breaking at a <br> stated voltage under prescribed conditions of use and behaviour. Reference is <br> generally made to the ultimate breaking capacity (Icu) and the service breaking <br> capacity (Ics). |
| :--- | :--- | :--- |
| Degree of protection (IP) |  |  |


| Frame size | - A-70 | "A term designating a group of circuit breakers, the external physical dimensions of which are common to a range of current ratings. Frame size is expressed in amperes corresponding to the highest current rating of the group. Within a frame size, the width may vary according to the number of poles. This definition does not imply dimensional standardization." <br> Compact NSX has two frame sizes covering 100 to 250 A and 400 to 630 A . |
| :---: | :---: | :---: |
| Insulation class | -A-5 | Defines the type of device insulation in terms of earthing and the corresponding safety for user, in one of three classes. <br> b Class I. The device is earthed. Any electrical faults, internal or external, or caused by the load, are cleared via the earthing circuit, thus ensuring user safety. <br> b Class II. The device is not connected to a protective conductor. User safety is ensured by reinforced insulation around the live parts (an insulating case and no contact with live parts, i.e. plastic buttons, moulded connections, etc.) or double insulation. <br> b Class III. The device may be connected only to SELV (safety extra-low voltage) circuits. The Compact NSX are class II devices (front) and may be installed through the door in class II switchboards (standards IEC 61140 and IEC 60664-1), without reducing insulation, even with a rotary handle or motor mechanism module. |
| Making capacity |  | Value of prospective making current that a switching device is capable of making at a stated voltage under prescribed conditions of use and behaviour. Reference is generally made to the short-circuit making capacity Icm . |
| Maximum break time | -A-17 | Maximum time after which breaking is effective, i.e. the contacts separated and the current completely interrupted. |
| Mechanical durability | -A-6 | With respect to its resistance to mechanical wear, equipment is characterised by the number of no-load operating cycles which can be effected before it becomes necessary to service or replace any mechanical parts. |
| Non-tripping time | -A-17 | This is the minimum time during which the protective device does not operate in spite of pick-up overrun, if the duration of the overrun does not exceed the corresponding voluntary time delay. |
| Pollution degree of environment conditions IEC 60947-1 IEC 60664-1 | - A-6 | "Conventional number based on the amount of conductive or hygroscopic dust, ionized gas or salt and on the relative humidity and its frequency of occurrence, resulting in hygroscopic absorption or condensation of moisture leading to reduction in dielectric strength and/or surface resistivity". Standard IEC 60947-1 distinguishes four pollution degrees. <br> b Degree 1. No pollution or only dry, non-conductive pollution occurs. <br> b Degree 2. Normally, only non-conductive pollution occurs. Occasionally, however, a temporary conductivity caused by condensation may be expected. <br> b Degree 3. Conductive pollution occurs, or dry, non-conductive pollution occurs which becomes conductive due to condensation. <br> b Degree 4. The pollution generates persistent conductivity caused, for instance, by conductive dust or by rain or snow. Compact NSX meets degree 3, which corresponds to industrial applications. |
| Prospective short-circuit current | -E-13 | Current that would flow through the poles if they remained fully closed during the short-circuit. |
| Rated current ( In ) | -A-6 | This is the current that the device can carry continuously with the contacts closed and without abnormal temperature rise. |
| Rated impulse withstand voltage (Uimp) | -A-6 | "The peak value of an impulse voltage of prescribed form and polarity which the equipment is capable of withstanding without failure under specified conditions of test and to which the values of the clearances are referred. The rated impulse withstand voltage of an equipment shall be equal to or higher than the values stated for the transient overvoltages occurring in the circuit in which the equipment is fitted". |
| Rated insulation voltage (Ui) | -A-6 | "The rated insulation voltage of an equipment is the value of voltage to which dielectric tests and creepage distances are referred. In no case shall the maximum value of the rated operational voltage exceed that of the rated insulation voltage". |
| Rated operational current (le) |  | "A rated operational current of an equipment is stated by the manufacturer and takes into account the rated operational voltage, the rated frequency, the rated duty, the utilization category and the type of protective enclosure, if appropriate". |
| Rated operational voltage (Ue) | -A-6 | "A value of voltage which, combined with a rated operational current, determines the application of the equipment and to which the relevant tests and the utilisation categories are referred. For multipole equipment, it is generally stated as the voltage between phases". <br> This is the maximum continuous voltage at which the equipment may be used. |


| Rated short-time withstand current (Icw) |  | "Value of short-time withstand current, assigned to the equipment by the manufacturer, that the equipment can carry without damage, under the test conditions specified in the relevant product standard". Generally expressed in kA for $0.5,1$ or 3 seconds. This is an essential characteristic for air circuit breakers. It is not significant for moulded-case circuit breakers for which the design targets fast opening and high limiting capacity. |
| :---: | :---: | :---: |
| Service breaking capacity (Ics) | -A.6 | Expressed as a percentage of Icu, it provides an indication on the robustness of the device under severe conditions. It is confirmed by a test with one opening and one closing/opening at Ics, followed by a check that the device operates correctly at its rated current, i.e. 50 cycles at In , where temperature rise remains within tolerances and the protection system suffers no damage. |
| Short-circuit making capacity (Icm) | -A-58 | Value indicating the capacity of the device to make and carry a high current without repulsion of the contacts. It is expressed in kA peak. |
| Suitability for isolation (see also Positive contact indication, page G-5) | -A-5 | This capability means that the circuit breaker meets the conditions below. b In the open position, it must withstand, without flashover between the upstream and downstream contacts, the impulse voltage specified by the standard as a function of the Uimp indicated on the device. <br> b It must indicate contact position by one or more of the following systems: <br> $\checkmark$ position of the operating handle <br> $\checkmark$ separate mechanical indicator <br> $v$ visible break of the moving contacts <br> b Leakage current between each pole, with the contacts open, at a test voltage of <br> $1.1 \times$ the rated operating voltage, must not exceed: <br> v 0.5 mA per pole for new devices <br> v 2 mA per pole for devices already subjected to normal switching operations <br> $\vee 6 \mathrm{~mA}$, the maximum value that must never be exceeded. <br> b It must not be possible to install padlocks unless the contacts are open. Locking in the closed position is permissible for special applications. Compact NSX complies with this requirement by positive contact indication. |
| Suitable for isolation with positive contact indication <br> (see also Suitability for isolation, page G2) | $>\mathrm{A}-5$ | Suitability for isolation is defined here by the mechanical reliability of the position indicator of the operating mechanism, where: <br> b the isolation position corresponds to the O (OFF) position <br> b the operating handle cannot indicate the "OFF" position unless the contacts are effectively open. <br> The other conditions for isolation must all be fulfilled: <br> b locking in the open position is possible only if the contacts are effectively open <br> b leakage currents are below the standardised limits <br> b overvoltage impulse withstand between upstream and downstream connections. |
| Ultimate breaking capacity (Icu) | -A-6 | Expressed in kA , it indicates the maximum breaking capacity of the circuit breaker. It is confirmed by a test with one opening and one closing/opening at Icu, followed by a check that the circuit is properly isolated. This test ensures user safety. |
| communication. |  |  |
| BSCM <br> (Breaker status and control module) | - A-27 | The optional BSCM for Compact NSX is used to acquire device status indications and control the communicating remote-control function. It includes a memory used to manage the maintenance indicators. It serves as a converter between the analog outputs of the device indication contacts (O/F, SD, SDE) and the digital communicating functions. |
| Ethernet TCP/IP <br> (Transmission Control Protocol / Internet Protocol) | >A-28 | Ethernet is a very common network protocol and complies with IEEE standard 802.3. Ethernet TCP/IP is the protocol that brings web functions to Ethernet networks. Most PCs have an Ethernet $10 / 100$ card ( 10 or $100 \mathrm{Mbit} / \mathrm{s}$ ) for connection to the internet. Data communicated from Compact NSX via Modbus are accessible on a PC via a TCP/IP-Modbus gateway such as MPS100 or EGX100. |
| Network |  | Set of communicating devices that are interconnected by communication lines in order to share data and resources. |
| Open protocol | -3 | A protocol for system communication, interconnection or data exchange for which technical specifications are public, i.e. there are no restrictions on access or implementation. An open protocol is the opposite of a proprietary protocol. |
| Protocol | - A-28 | Standardised specification for dialog between digital components that exchange data. It is an operating mode based on the length and structure of binary words and it must be used by all the components exchanging data between themselves. Communication is not possible without using a protocol. |


| RJ45 connector | - A-26 | Universal, 8-wire connector that is widely used in digital communication networks. The RJ45 connector is used to interconnect computer equipment (Ethernet, Modbus, etc.), telephones and audiovisual equipment. |
| :---: | :---: | :---: |
| RS485 Modbus | - A-28 | Modbus is the most widely used communication protocol in industrial networks. It operates in master-slave mode. An RS485 multipoint link connects the master and slaves via a pair of wires offering throughputs of up to 38400 bits/second over distances up to 1200 m ). The master cyclically polls the slaves which send back the requested information. <br> The Modbus protocol uses frames containing the address of the targeted slave, the function (read, write), the datum and the CRC (cyclical redundancy check). |
| SDTAM | - A-81 | Relay module with two static outputs specifically for the motor-protection Micrologic trip units $1 \mathrm{M}, 2 \mathrm{M}$ and $6 \mathrm{E}-\mathrm{M}$. An output, linked to the contactor controller, opens the contactor when an overload or other motor fault occurs, thus avoiding opening of the circuit breaker. The other output stores the opening event in memory. |
| SDx | A-81 | Relay module with two outputs that remotes the trip or alarm conditions of Compact NSX circuit breakers equipped with a Micrologic electronic trip unit. |
| Static output | - A-81 | Output of a relay made up of a thyristor or triac electronic component. The low switching capability means that a power relay is required. <br> This is the case for the SDx and SDTAM outputs. |
| ULP (Universal Logic Plug) | - A-31 | Connection system used by Compact NSX to communicate information to the Modbus interface via a simple RJ45 cable. Compatible modules are indicated by the symbol opposite. |
| Components $\qquad$ |  |  |
| ASIC (Application Specific Integrated Circuit) | - A-8 | Integrated circuit designed, built and intended for a specific application. It carries out repetitive sequences of instructions engraved in the silicon chip. For that reason, it is extremely reliable because it cannot be modified and is not affected by environment conditions. <br> Micrologic trip units use an ASIC for the protection functions. The ASIC cyclically polls the network status at a high frequency, using the values supplied by captors. Comparison with the settings forms the basis for orders to the electronic trip units. |
| Microprocessor | A-8 | A microprocessor is a more general purpose device than an ASIC. In Micrologic, a microprocessor is used for measurements and it can be programmed. It is not used for the main protection functions that are carried out by the ASIC. |
| Controls $\qquad$ |  |  |
| Communicating motor mechanism | A-82 | For Compact NSX remote control via the communication system, a communicating motor mechanism is required. Except for the communication function, it is identical to the standard motor mechanism module and connects to and controlled by the BSCM module. |
| CNOMO machine-tool rotary handle | A-84 | Handle used for machine-tool control enclosures and providing IP54 and IK08. |
| Direct rotary handle | - A-84 | This is an optional control handle for the circuit breaker. It has the same three positions I (ON), O (OFF) and TRIPPED as the toggle control. It provides IP40, IK07 and the possibility, due to its extended travel, of using early-make and early-break contacts. It maintains suitability for isolation and offers optional locking using a keylock or a padlock. |
| Emergency off | -A-83 | In a circuit equipped with a circuit breaker, this function is carried out by an opening mechanism using an MN undervoltage release or an MX shunt release in conjunction with an emergency off button. |
| Extended rotary handle | -A-84 | Rotary handle with an extended shaft to control devices installed at the rear of switchboards. It has the same characteristics as direct rotary handles. It offers multiple locking possibilities using a keylock, a padlock or a door interlock. |
| Failsafe remote tripping | - A-83 | Remote tripping is carried out by an opening mechanism using an MN undervoltage release in conjunction with an emergency off button. If power is lost, the protection device opens the circuit breaker. |


| Manual toggle control | This is the standard control mechanism for the circuit breaker, with a toggle that can <br> be flipped up or down. In a moulded-case circuit breaker (MCCB), there are three <br> positions, I (ON), O (OFF) and TRIPPED. Once in the TRIPPED position, manual <br> reset is required by switching to O (OFF position before reclosing. The TRIPPED <br> position does not offer isolation with positive contact indication. This is guaranteed <br> only by the O (OFF) position. |
| :--- | :--- |
| MCC rotary handle |  |
| Motor mechanism module |  |
| Handle used for motor control centres and providing IP43 and IK07. |  |

## $\boldsymbol{E}_{\text {nvironment }}$

## EMC (Electromagnetic compatibility) $>$ A-5

## Power loss

$>B-10$
Pole resistance

EMC is the capacity of a device not to disturb its environment during operation (emitted electromagnetic disturbances) and to operate in a disturbed environment (electromagnetic disturbances affecting the device). The standards define various classes for the types of disturbances. Micrologic trip units comply with annexes F and J in standard IEC IE60947-2

The flow of current through the circuit-breaker poles produces Joule-effect losses caused by the resistance of the poles.

## Product environmental profile (PEP) $>$ A-4 LCA: Life-cycle assessment ISO 14040

An assessment on the impact of the construction and use of a product on the environment, in compliance with standard ISO 14040, Environmental management, life-cycle assessment (LCA), principles and framework.
For Compact NSX, this assessment is carried out using the standardised EIME (Environmental Impact and Management Explorer) software, which makes possible comparisons between the products of different manufacturers.
It includes all stages, i.e. manufacture, distribution, use and end of life, with set usage assumptions:
b use over 20 years at a percent load of $80 \%$ for 14 hours per day and $20 \%$ for ten hours
b according to the European electrical-energy model.
It provides the information presented below.
b Materials making up the product: composition and proportions, with a check to make sure no substances forbidden by the RoHS directive are included.
b Manufacture: on Schneider Electric production sites that have set up an environmental management system certified ISO 14001.
b Distribution: packaging in compliance with the 94/62/EC packaging directive (optimised volumes and weights) and optimised distribution flows via local centres. b Use: no aspects requiring special precautions for use. Power lost through Joule effect in Watts (W) must be $<0.02 \%$ of total power flowing through the circuit breaker. Based on the above assumptions, annual consumption from 95 to 200 kWh . b End of life: products dismantled or crushed. For Compact NSX, 81\% of materials can be recycled using standard recycling techniques. Less than $2 \%$ of total weight requires special recycling.

Environmental indicators are also frequently used for the PEP (sheet available on request for Compact NSX):
b Depletion of natural resources
b Depletion of energy
b Depletion of water
b Potential for atmospheric warming (greenhouse effect)
b Potential for stratospheric ozone depletion
b Creation of atmospheric ozone (ozone layer)
b Acidification of air (acid rain)
b Production of hazardous waste.

| RoHS directive <br> (Restriction of Hazardous substances) | -A-4 | European directive 2002/95/EC dated 27 January 2003 aimed at reducing or eliminating the use of hazardous substances. The manufacturer must attest to compliance, without third-party certification. Circuit breakers are not included in the list of concerned products, which are essentially consumer products. <br> That not withstanding, Schneider Electric decided to comply with the RoHS directive. Compact NSX products are designed in compliance with RoHS and do not contain (above the authorised levels) lead, mercury, cadmium, hexavalent chromium or flame retardants (polybrominated biphenyls PBB and polybrominated diphenyl ether PBDE). |
| :---: | :---: | :---: |
| Safety clearances | -A-4 | When installing a circuit breaker, minimum distances (safety clearances) must be maintained between the device and panels, bars and other protection systems installed nearby. These distances, which depend on the ultimate breaking capacity, are defined by tests carried out in accordance with standard IEC 60947-2. |
| Temperature derating | -B-8 | An ambient temperature varying significantly from $40^{\circ} \mathrm{C}$ can modify operation of magnetic or thermal-magnetic protection functions. It does not affect electronic trip units. However, when electronic trip units are used in high-temperature situations, it is necessary to check the settings to ensure that only the permissible current for the given ambient temperature is let through. |
| Vibration withstand IEC 60068-2-6 | -B-2 | Circuit breakers are tested in compliance with standard IEC 60068-2-6 for the levels required by merchant-marine inspection organisations (Veritas, Lloyd's, etc.): <br> b 2 to 13.2 Hz : amplitude of $\pm 1 \mathrm{~mm}$ <br> b 13.2 to 100 Hz : constant acceleration of 0.7 g . |
| WEEE directive <br> (Waste of Electrical and Electronic Equipment) | -A-4 | European directive on managing the waste of electrical and electronic equipment. Circuit breakers are not included in the list of concerned products. <br> However, Compact NSX products respect the WEEE directive. |

(Restriction of Hazardous substances)

Vibration withstand $\quad>B-2$
IEC 60068-2-6

WEEE directive
Circuit breakers are not included in the list of concerned products. However, Compact NSX products respect the WEEE directive.

Q-Pulse Id: TMS1395 Active: 28/09/2015 | Schneider |
| :---: |
| Ptate 220 | of 1302

| Current harmonics $\quad$ A-20 | Non-linear loads cause harmonic currents that flow in the 50 Hz (or 60 Hz ) distribution system. Total harmonic current is the sum of sinusoidal AC currents for which the rms values can be measured and broken down into: <br> b the fundamental current at the $50 / 60 \mathrm{~Hz}$ frequency of the distribution system, with an rms value of $\mathrm{IH}_{1}$ <br> b harmonic currents with whole, odd multiples ( $3,5,7$, etc.) of the $50 / 60 \mathrm{~Hz}$ frequency, called the third-order, fifth-order, etc. harmonics. For example, $\mathrm{IH}_{3}$, the third-order harmonic at $150 / 180 \mathrm{~Hz}, \mathrm{IH}_{5}$, the fifth-order harmonic at $250 / 300 \mathrm{~Hz}$, etc. The presence of harmonics in the system must be monitored and limited because it results in temperature rise, currents in the neutral (caused by the third-order harmonics and multiples), malfunctions of sensitive electronic devices, etc. Micrologic E trip units take into account harmonics up to order 15 in the THDI and THDU calculations. |
| :---: | :---: |
| Non-linear load | Systems producing harmonics are present in all industrial, commercial and residential sectors. Harmonics are caused by non-linear loads. A load is said to be non-linear when the current drawn does not have the same waveform as the supply voltage. Typically, loads using power electronics are non-linear. Examples of non-linear loads include computers, rectifiers, variable-speed drives, arc furnaces and fluorescent lighting. |
| Total harmonic distortion of current $>\mathrm{A}-21$ (THDI) | THDI characterises the distortion of the current wave by harmonics. It indicates the quantity of harmonics in the resulting waveform. It is expressed in percent. <br> The higher the THDI, the more the current is distorted by harmonics. THDI should remain below 10\%. Above that level, there is said to be harmonic pollution that is considered severe when it rises above 50\%. |
| Total harmonic distortion of voltage $>\mathrm{A}-21$ (THDU) | THDU characterises the distortion of the voltage wave by harmonics. It indicates the quantity of harmonics in the resulting waveform. It is expressed in percent. <br> The higher the THDU, the more the system voltage is distorted by harmonics. It is advised not to exceed $5 \%$ for low-voltage systems. |
| Voltage harmonics $\quad$ A-20 | For each current harmonic IHk, there is a voltage harmonic UHk of the same order k, where the resulting voltage is the sum of the two waves. <br> The voltage wave is therefore distorted with respect to the standard sinusoidal wave. |

Measurements

| Contact wear $\quad$ A-23 | Each time Compact NSX opens, the Micrologic 5 / 6 trip unit measures the interrupted current and increments the contact-wear indicator as a function of the interrupted current, according to test results stored in memory. |
| :---: | :---: |
| Current transformer with iron-core $>10$ toroid | It is made up of a coil wound around an iron frame through which a power busbar runs. The current flowing in the bar, on passing through the sensor, induces a magnetic field that reverses for each half period. This variation in the field in turn creates an induced current in the coil. This current is proportional to the current flowing in the bar. It is sufficient to supply the measurement electronics. The disadvantage of iron-core measurement current transformers (CT) is that they rapidly saturate for currents > 10 In . |
| Current transformer with Rogowski $>10$ toroid or air-core CT | It is made up of a coil without an iron frame, through which a power busbar runs. The output voltage at the coil terminals is proportional to the current flowing through the bar. The result is a current transformer (CT) with a voltage output. The advantage is that it never saturates whatever the primary current and thus enables measurement of high currents. The output is however a very low current that is too low to supply the measurement electronics. <br> For Micrologic, Rogowski CTs measure the current and a second CT, with an iron core, provides the electrical supply. |
| Demand current, demand power and / A-21 peak values | Average of the instantaneous current or power values over an adjustable fixed or sliding time interval. The highest value observed over the time interval is the peak value. The time interval runs from the last reset. |
| Instantaneous current $\quad$ A-21 | True rms value of the current measured by the current transformers over a sliding time interval. Available on Micrologic $5 / 6$ A or E. |


| Instantaneous voltage | - A-21 | True rms value of the voltage measured by the voltage sensors over a sliding time interval. Available on Micrologic $5 / 6 \mathrm{~A}$ or E . |
| :---: | :---: | :---: |
| Maximeters/minimeters | - A-20 | Micrologic 5 and 6 A or E can record the minimum and maximum values of electrical parameters over set time periods. |
| Overvoltage category <br> (OVC - Overvoltage category) <br> IEC 60947-1. Annex H | - A-32 | Standard IEC 60664-1 stipulates that it is up to the user to select a measurement device with a sufficient overvoltage category, depending on the network voltage and the transient overvoltages likely to occur. <br> Four overvoltage categories define the field of use for a device. <br> b Cat. I. Devices supplied by a SELV isolating transformer or a battery. <br> b Cat. II. Residential distribution, handheld or laboratory tools and devices connected to standardised 2P + earth electrical outlets ( 230 V ). <br> b Cat. III. Industrial distribution, fixed distribution circuits in buildings (main low voltage switchboards, rising mains, elevators, etc.). <br> b Cat. IV. Utility substations, overhead lines, certain industrial equipment. |
| Percent load | - A-23 | Percentage of current flowing through the circuit breaker with respect to its rated current. Micrologic 6 E-M offers this information and can sum it over the total operating time to provide the load profile for the following ranges, 0 to $49 \%, 50$ to $79 \%, 80$ to $89 \%$ and u $90 \%$. |
| Phase sequence | - A-23 | The order in which the phases are connected ( $\mathrm{L} 1, \mathrm{~L} 2, \mathrm{~L} 3$ or $\mathrm{L} 1, \mathrm{~L} 3, \mathrm{~L} 2$ ) determines the direction of rotation for three-phase asynchronous motors. Micrologic 6 E-M trip units provide this information. |
| Power and energy metering (consumption) | - A-21 | The digital electronics in Micrologic $5 / 6 \mathrm{E}$ calculate the instantaneous power levels, apparent (S in kVA), active (P in kW) and (Q in kV), and integrate over a time interval to determine the corresponding energies (kVAh, kWh kvarh). Calculations are for each phase and for the total. |
| Time-stamped histories | -A-23 | Micrologic trip units store information on events (e.g. alarms and their cause) that are time-stamped to within a millisecond. |
| P |  |  |
| Ground-fault protection G (lg) | - A-19 | Protection function specific to electronic circuit breakers, symbolised by G (Ground). This protection can calculate high-threshold residual earth-leakage currents (in the order of tens of Amperes) on the basis of phase-current measurements. Micrologic $5 / 6$ offers this protection function with adjustable pick-up $\lg$ and time delay. |
| Instantaneous protection I (li) | >A-19 | This protection supplements Isd. It provokes instantaneous opening of the device. The pick-up may be adjustable or fixed (built-in). This value is always lower than the contact-repulsion level. |
| Long-time protection L (Ir) | - A-19 | Protection function where the adjustable Ir pick-up determines a protection curve similar to the thermal-protection curve (inverse-time curve $I^{2 t}$ ). The curve is generally determined on the basis of the Ir setting which corresponds to a theoretically infinite tripping time (asymptote) and of the point at 6 Ir at which the tripping time depends on the rating. |
| Magnetic protection (Im) | >A-14 | Short-circuit protection provided by magnetic trip units (see this term). The pick-up setting may be fixed or adjustable. |
| Neutral protection (IN) | -A-16 | The neutral is protected because all circuit-breaker poles are interrupted. The setting may be that used for the phases or specific to the neutral, i.e. reduced neutral ( 0.5 times the phase current) or OSN (oversized neutral) at 1.6 times the phase current. For OSN protection, the maximum device setting is limited to 0.63 In . |
| Residual-current earth-leakage protection (I $\Delta \mathrm{n}$ ) | - A-34 | Protection provided by Vigi modules, in which the residual-current toroids directly detect low-threshold earth-leakage currents (in the order of tens of mA ) caused by insulation faults. |
| Short-delay protection S (Isd) | - A-19 | Protection function specific to electronic circuit breakers, symbolised by S (Short delay or short time). This protection supplements thermal protection. The reaction time is very short, but has a slight time delay to enable discrimination with the upstream device. The short-delay pick-up Isd is adjustable from approximately 1.5 to 10 lr . |
| Short-delay protection with fixed time delay So (Isd) | -A-17 | Short-delay protection, but with a fixed time delay. This function is available on Micrologic 2 . It is symbolised by So. It ensures discrimination with downstream devices. |

Thermal protection (lr) $\quad>$ A-15 $\quad$| Overload protection provided by thermal trip units (see this term) using an inverse- |
| :--- |
| time curve $\left(I^{2} t\right)$. |

## $\boldsymbol{R}$ elays and auxiliary contacts

| Auxiliary contact IEC 60947-1 |  | "Contact included in an auxiliary circuit and mechanically operated by the switching device". |
| :---: | :---: | :---: |
| Break contact IEC 60947-1 | -A-84 | "Control or auxiliary contact which is open when the main contacts of the mechanical switching device are closed and closed when they are open". |
| Make contact IEC 60947-1 | - A-84 | "Control or auxiliary contact which is closed when the main contacts of the mechanical switching device are closed and open when they are open". |
| Relay (electrical) IEC 60947-1 | - A-18 | "Device designed to produce sudden, predetermined changes in one or more electrical output circuits when certain conditions are fulfilled in the electrical input circuits controlling the device". |
| Relay module with static output | -A-81 | Output of a relay made up of a thyristor or triac electronic component. The low interrupting capacity means that a power relay is required. This is the case for the SDx and SDTAM outputs. |

## $S_{\text {witchgear }}$

Circuit breaker
IEC 60947-2
Circuit-breaker utilisation category $>$ A-6
IEC 60947-2
Contactor $\quad>$ A-36

IEC 60947-1
$\qquad$

## Contactor utilisation categories

IEC 60947-4-1
Current-limiting circuit breaker $\quad>$ A-36
IEC 60947-2

## Disconnector

IEC 60947-3


## Switch-disconnector <br> A-56

IEC 60947-3

"Mechanical switching device, capable of making, carrying and breaking currents under normal circuit conditions and also making, carrying for a specified time and breaking currents under specified abnormal circuit conditions such as those of short circuit". Circuit breakers are the device of choice for protection against overloads and short-circuits. Circuit breakers may, as is the case for Compact NSX, be suitable for isolation.

The standard defines two utilisation categories, A and B , depending on breaker discrimination with upstream breakers under short-circuit conditions. b Category A. Circuit breakers not specifically designed for discrimination applications.
b Category B. Circuit breakers specifically designed for discrimination, which requires a short time-delay (which may be adjustable) and a rated short-time withstand current in compliance with the standard.
Compact NSX100 to 630 circuit breakers are category A, however, by design, they provide discrimination with downstream devices (see the Complementary technical information guide).
"Mechanical switching device having only one position of rest, operated otherwise than by hand, capable of making, carrying and breaking currents under normal circuit conditions including operating overload conditions". A contactor is provided for frequent opening and closing of circuits under load or slight overload conditions. It must be combined and coordinated with a protective device against overloads and short-circuits, such as a circuit breaker.

The standard defines four utilisation categories, $\mathrm{AC} 1, \mathrm{AC} 2, \mathrm{AC} 3$ and AC 4 depending on the load and the control functions provided by the contactor. The class depends on the current, voltage and power factor, as well as contactor withstand capacity in terms of frequency of operation and endurance.
"A circuit-breaker with a break-time short enough to prevent the short-circuit current reaching its otherwise attainable peak value".
"Mechanical switching device which, in the open position, complies with the requirements specified for the isolating function". A disconnector serves to isolate upstream and downstream circuits. It is used to open or close circuits under no-load conditions or with a negligible current level. It can carry the rated circuit current and, for a specified time, the short-circuit current.
"Switch which, in the open position, satisfies the isolating requirements specified for a disconnector". A switch-disconnector serves for switching and isolation. The switch function breaks the circuit under load conditions and the disconnection function isolates the circuit. Protection is not provided. It may be capable of making shortcircuit currents if it has the necessary making capacity, but it cannot break shortcircuit currents. Compact NSX100 to 630 NA switch-disconnectors have a making capacity.

| Switch-disconnector utilisation $\quad$ A-57 | The standard defines six utilisation categories, AC-21A or B, AC-22 A or B, AC23 A or <br> B. They depend on the rated operational current and the mechanical durability (A for |
| :--- | :--- |
| frequent operation or B for infrequent operation). Compact NSX NA switch- |  |
| disconectors comply with utilisation categories AC22A or AC23A. |  |

## Three-phase asynchronous motors and their protection

| Locked-rotor protection (ljam) | - A-44 | This function steps in when the motor shaft cannot or can no longer drive the load. The result is a high overcurrent. |
| :---: | :---: | :---: |
| Long-start protection (llong) | - A-44 | An overly long start means the current drawn remains too high or too low for too long, with respect to the starting current. In all cases, the load cannot be driven and the start must be interrupted. The resulting temperature rise must be taken into account before restarting. |
| Phase-unbalance or phase- loss protection (lunbal) | - A-43 | This protection function steps in if the current values and/or the unbalance in the three phases supplying the motor exceeds tolerances. Currents should be equal and displacement should be one third of a period. Phase loss is a special case of phase unbalance. |
| Starting current | - A-38 | Start-up of a three-phase, asynchronous motor is characterised by: b a high inrush current, approximately $14 \ln$ for 10 to 15 ms b a starting current, approximately 7.2 In for 5 to 30 seconds b return to the rated current after the starting time. |
| Starting time | - A-38 | Time after which the motor ceases to draw the starting current and falls back to the operating current $\operatorname{lr}(\mathrm{y}$ In). |
| Thermal image of the rotor and stator | - A-44 | The thermal image models the thermal behaviour of a motor rotor and stator, taking into account temperature rise caused by overloads or successive starts, and the cooling constants. For each motor power rating, the algorithm takes into account a theoretical amount of iron and copper which modifies the cooling constants. |
| Thermal protection |  | Protection against overcurrents following an inverse time curve $\mathrm{I}^{2} \mathrm{t}=$ constant, which defines the maximum permissible temperature rise for the motor. Tripping occurs after a time delay that decreases with increasing current. |
| Trip class IEC 60947-4-1 | - A-38 | The trip class determines the trip curve of the thermal protection device for a motor feeder. The standard defines trip classes 5, 10, 20 and 30 . These classes are the maximum durations, in seconds, for motor starting with a starting current of 7.2 lr , where Ir is the thermal setting indicated on the motor rating plate. |
| Under-load protection (lund) | - A-44 | This function steps in when the driven load is too low. It detects a set minimum phase current which signals incorrect operation of the driven machine. In the example of a pump, under-load protection detects when the pump is no longer primed. |

## Tripunits

- A-16 Trip unit that continuously measures the current flowing through each phase and the neutral if it exists. For Micrologic, the measurements are provided by built-in current sensors linked to an analog-digital converter with a high sampling frequency. The measurement values are continuously compared by the ASIC to the protection settings. If a setting is overrun, a Mitop release trips the circuit-breaker operating mechanism.
This type of trip unit offers much better pick-up and delay setting accuracy than thermal-magnetic trip units. It also provides a wider range of protection functions.

Magnetic release $\quad>$ A-14 | Release actuated by a coil or a lever. A major increase in the current (e.g. a short- |
| :--- |
| circuit) produces in the coil or the lever a change in the magnetic field that moves a |
| core. This trips the circuit breaker operating mechanism. Action is instantaneous. |
| The pick-up setting may be adjustable. |

## Release

IEC 60947-1

| Shunt release (MX) | - A-83 | This type of release operates when supplied with current. The MX release provokes circuit-breaker opening when it receives a pulse-type or maintained command. |
| :---: | :---: | :---: |
| Thermal-magnetic trip unit | - A-14 | Trip unit combining thermal protection for overloads and magnetic protection. |
| Thermal release | -A-14 | Release in which a bimetal strip is heated by the Joule effect. Above a temperaturerise threshold that is a function of the current and its duration ( $l^{2}$ t curve = constant, which is representative of temperature rise in cables), the bimetal strip bends and releases the circuit-breaker opening mechanism. The pick-up setting may be adjustable. |
| Undervoltage release (MN) | - A-83 | This type of release operates when the supply voltage |

Device, mechanically connected to a mechanical switching device (e.g. a circuit breaker), which releases the holding means and permits the opening or the closing of the switching device. For circuit breakers, releases are often integrated in a trip unit.

This type of release operates when supplied with current. The MX release provokes circuit-breaker opening when it receives a pulse-type or maintained command

Release in which a bimetal strip is heated by the Joule effect. Above a temperaturerise threshold that is a function of the current and its duration ( $I^{2} t$ curve = constant, which is representative of temperature rise in cables), the bimetal strip bends and adjustable.

This type of release operates when the supply voltage drops below the set minimum.


## C60N/H miniature circuit breakers Multi 9 Merlin Gerin

The C60N circuit-breaker is a miniature circuit-breaker used for the
 protection of circuits in industry and the tertiary sector. It ensures the following functions: protection against short-circuit and overload currents, isolation, protection of persons against indirect contact.

## Operation

■ 1 to 4-pole circuit-breakers.

- Control and protection:
- B curve: against circuit overcurrents including protection of persons for longer cables than with C curve types,
- C curve: against the overcurrents of circuits feeding conventional loads,
- D curve: against the current of installations containing loads with high inrush currents (motors, transformers).


## Advantages



- Conformity with national and international standards: AS/NZS 4898 (EN 60 898).
- Ratings from 1 to 63 A .

■ Breaking capacity of $6000 / 10000 \mathrm{~A}$ under $240 / 415 \mathrm{~V}$ for C60N/H.

- Clip-on electrical auxiliaries and add-on accessories.


## The range




## IMPLEMENTATION

- Designed for installation in modular enclosures and switchboards.
- Easy mounting on symmetrical rail.
- Easy connection using serrated tunnel terminals with flap.
- Captive screws with mixed +/- indent.
- Simplified clip-on combination of circuit-breaker with auxiliaries.
- Use of comb busbars to simplify circuit-breaker connection.



## TECHNICAL DATA

## Electrical data

## - Power circuit:

- voltage rating: 440 V AC,
- ratings from 0.5 to 63 A set at 30 C (40C for D curve),
- breaking capacity:

| C60N <br> rating <br> (A) | number <br> of poles | voltage <br> (VAC) | breaking <br> capacity (A) |
| :--- | :--- | :--- | ---: |
| 1 to 63 | 1P | 230 to 240 | 6000 |
| $2 \mathrm{P}, 3 \mathrm{P}$, | 400 to 415 | 6000 |  |
| C60H <br> rating <br> (A) | number <br> of poles | voltage <br> (VAC) | breaking <br> capacity (A) |
| 1 to 63 | 1P | 230 to 240 | 10000 |
|  | $2 P, 3 P, 4 \mathrm{P}$ | 400 to 415 | 10000 |

- limitation class (EN 60 898): 3,
- fast closing: increased withstand to the high inrush currents of certain loads,
- isolation with positive break indication: opening is indicated by a green strip on the device's control toggle.
This indicates that all poles are open.
Tripping curves:
- B curve:
- magnetic releases operate between 3 and 5 ln .
- C curve:
- magnetic releases operate between 5 and 10 In .
- D curve: magnetic releases operate between 10 and 14 In .
Mechanical data
- Connection by tunnel terminals for the following cables:
- $16 \mathrm{~mm}^{2}$ flexible or $25 \mathrm{~mm}^{2}$ stranded for up to 25 A ratings,
- $25 \mathrm{~mm}^{2}$ flexible or $35 \mathrm{~mm}^{2}$ stranded for $\geq 32$ A ratings.
- Durability: 20000 cycles (O-C).
- Dimensions ( $\mathrm{w} \times \mathrm{h} \times \mathrm{dmm}$ ): $18 \times \mathrm{N}$ (number of poles) $\times 81$ $\times 70$.
■ Weight (g): 1P: 120, 240, 2P: 240, 3P: 360, 4P: 480.


## ENVIRONMENT

- Tropicalisation: treatment 2 (relative humidity: $95 \%$ at 55C).
- Degree of protection:
- of enclosure: IP 40,
- of terminals: IP 20.
- Operating temperature:
- 5 C to +60 C .
- Storage temperature:
- 40 C to +100 C .



## Function

- The circuit-breakers combine the following functions:
a protection of circuits against short-circuit currents
$\square$ protection of circuits against overload currents
- control
- isolation
$\square$ protection of persons against indirect contact with TN and IT neutral systems. C 60 H circuit-breakers are used in the tertiary and industrial sectors.


## Tripping curves

## B curve

When the short-circuit currents are weak (generators, long cables).

- Power circuit
- ratings: 6 to 63 A set at $30^{\circ} \mathrm{C}$
$\square$ tripping curve: the magnetic trip units operate between 3 and 5 In


## C curve

Cables feeding conventional loads.
■ Power circuit
$\square$ ratings: 0.5 to 63 A set at $30^{\circ} \mathrm{C}$
$\square$ tripping curve: the magnetic trip units operate between 5 and 10 In .
D curve
Loads with high inrush currents (motors, transformers).

- Power circuit
- ratings: 0.5 to 63 A set at $40^{\circ} \mathrm{C}$
tripping curve: the magnetic trip units operate between 10 and 14 In .
Technical data according to IEC 60898
■ Power circuit:
- voltage rating (Ue): 440 V AC
- breaking capacity:
- according to IEC 60898, Icn ultimate breaking capacity (O-CO cycle):

| Rating (A) | Type | Voltage (V) | Breaking capacity Icn (A) |
| :--- | :--- | :--- | :--- |
| $0.5 \ldots 63$ | 1 P | $230 / 400$ | 10000 |
|  | $1 \mathrm{P}+\mathrm{N}$ | 230 | 10000 |
| $2 \mathrm{P}, 3 \mathrm{P}, 4 \mathrm{P}$ | 400 | $\mathbf{1 0 0 0 0}$ |  |

- limitation class (IEC 60898): 3

Technical data according to IEC 60947-2

- Power circuit.
$\square$ voltage rating (Ue): 440 V AC
- impulse voltage (Uimp): 6 kV
- insulation voltage (Ui): 500 V AC
$\square$ breaking capacity:
- according to IEC 60947-2, Icu ultimate breaking capacity (O-CO cycle):

| Rating (A) | Type | Voltage (V) | Breaking capacity Icu (A) |
| :--- | :--- | :--- | :--- |
| $0.5 \ldots 63$ | $1 P$ | 130 | 30 |
|  |  | $230 \ldots 240$ | 15 |
|  |  | $400 \ldots 415$ | $4(1)$ |

(1) breaking capacity under 1 pole with IT isolated neutral system (case of double fault).

## Generals technical data

■ Fast closing: allows the high inrush currents of some loads to be better held.

- Isolation with positive break indication: opening is indicated by a green strip on the device operating handle. This indicator shows opening contacts of all the poles.
■ Number of cycles (O-C): 20000.
- Environment:
- tropicalisation: treatment 2 (relative humidity: $95 \%$ at $55^{\circ} \mathrm{C}$ ) according to

IEC 60068-1

- weight ( g ):

| Type | $\mathbf{1 P}$ | $\mathbf{2 P}$ | $\mathbf{3 P}$ | 4P |
| :--- | :--- | :--- | :--- | :--- |
|  | $\mathbf{1 2 0}$ | $\mathbf{2 4 0}$ | 360 | $\mathbf{4 8 0}$ |

■ Connection: tunnel terminals for the following cables:

- $16 \mathrm{~mm}^{2}$ flexible or $25 \mathrm{~mm}^{2}$ rigid up to 25 A ratings
- $25 \mathrm{~mm}^{2}$ flexible or $35 \mathrm{~mm}^{2}$ rigid for 32 to 63 A ratings.


## Catalogue numbers

| Type | Rating (A) | Width in mod. of 9 mm | Quantity Catalogue number per batch |  |  | D curve |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | B curve | C curve |  |
| 1P | 0.5 | 2 | 12 | - | 24900 | 25171 |
|  | 0.75 | 2 | 12 | - | 24901 | - |
|  | 1 | 2 | 12 | - | 24955 | 25152 |
|  | 2 | 2 | 12 | - | 24956 | 25155 |
|  | 3 | 2 | 12 | - | 24957 | 25157 |
|  | 4 | 2 | 12 | - | 24958 | 25158 |
|  | 6 | 2 | 12 | 24699 | 24959 | 25159 |
|  | 10 | 2 | 12 | 24700 | 24960 | 26160 |
|  | 13 | 2 | 12 | 24695 | 24891 | - |
|  | 16 | 2 | 12 | 24701 | 24961 | 25161 |
|  | 20 | 2 | 12 | 24702 | 24962 | 25164 |
|  | 25 | 2 | 12 | 24703 | 24963 | 25165 |
|  | 32 | 2 | 12 | 24704 | 24964 | 25166 |
|  | 40 | 2 | 12 | 24705 | 24965 | 25167 |
|  | 50 | 2 | 12 | 24706 | 24966 | 25168 |
|  | 63 | 2 | 12 | 24707 | 24967 | 25169 |
| 1P+N | 1 | 4 | 6 | - | 25094 | - |
|  | 2 | 4 | 6 | - | 25095 | - |
|  | 3 | 4 | 6 | - | 25096 | - |
|  | 4 | 4 | 6 | - | 25097 | - |
|  | 6 | 4 | 6 | 24712 | 25098 | - |
|  | 10 | 4 | 6 | 24713 | 25099 | - |
|  | 13 | 4 | 6 | 24708 | 25100 | - |
|  | 16 | 4 | 6 | 24714 | 25101 | - |
|  | 20 | 4 | 6 | 24715 | 25102 | - |
|  | 25 | 4 | 6 | 24716 | 25103 | - |
|  | 32 | 4 | 6 | 24717 | 25104 | - |
|  | 40 | 4 | 6 | 24718 | 25105 | - |
|  | 50 | 4 | 6 | 24719 | 25106 | - |
|  | 63 | 4 | 6 | 24720 | 25107 | - |
| 2P | 0.5 | 4 | 6 | - | 24902 | 25172 |
|  | 0.75 | 4 | 6 | - | 24903 | - |
|  | 1 | 4 | 6 | - | 24981 | 25183 |
|  | 2 | 4 | 6 | - | 24982 | 25184 |
|  | 3 | 4 | 6 | - | 24983 | 25185 |
|  | 4 | 4 | 6 | - | 24984 | 25186 |
|  | 6 | 4 | 6 | 24725 | 24985 | 25187 |
|  | 10 | 4 | 6 | 24726 | 24986 | 25188 |
|  | 13 | 4 | 6 | 24721 | 24919 | - |
|  | 16 | 4 | 6 | 24727 | 24987 | 25189 |
|  | 20 | 4 | 6 | 24728 | 24988 | 25190 |
|  | 25 | 4 | 6 | 24729 | 24989 | 25191 |
|  | 32 | 4 | 6 | 24730 | 24990 | 25192 |
|  | 40 | 4 | 6 | 24731 | 24991 | 25193 |
|  | 50 | 4 | 6 | 24732 | 24992 | 25194 |
|  | 63 | 4 | 6 | 24733 | 24993 | 25195 |
| 3P | 0.5 | 6 | 4 | - | 24906 | 25173 |
|  | 0.75 | 6 | 4 | - | 24907 | - |
|  | 1 | 6 | 4 | - | 24994 | 25196 |
|  | 2 | 6 | 4 | - | 24995 | 25197 |
|  | 3 | 6 | 4 | - | 24996 | 25198 |
|  | 4 | 6 | 4 | - | 24997 | 25199 |
|  | 6 | 6 | 4 | 24738 | 24998 | 25200 |
|  | 10 | 6 | 4 | 24739 | 24999 | 25201 |
|  | 13 | 6 | 4 | 24734 | 24933 | - |
|  | 16 | 6 | 4 | 24740 | 25000 | 25202 |
|  | 20 | 6 | 4 | 24741 | 25001 | 25203 |
|  | 25 | 6 | 4 | 24742 | 25002 | 25205 |
|  | 32 | 6 | 4 | 24743 | 25003 | 25207 |
|  | 40 | 6 | 4 | 24744 | 25004 | 25208 |
|  | 50 | 6 | 4 | 24745 | 25005 | 25209 |
|  | 63 | 6 | 4 | 24746 | 25006 | 25210 |

## C 60 H circuit-breakers

$B, C$ and $D$ curves
IEC 60898: 10000 A, IEC 60947-2: 15 kA

Catalogue numbers

| Type | Rating (A) | Width in mod. of 9 mm | Quantity per batch | Catalogue number |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | $B$ curve | C curve | D curve |
| 4P | 0.5 | 8 | 3 | - | 24908 | 25174 |
|  | 0.75 | 8 | 3 | - | 24909 | - |
|  | 1 | 8 | 3 | - | 25007 | 25211 |
|  | 2 | 8 | 3 | - | 25008 | 25212 |
|  | 3 | 8 | 3 | - | 25009 | 25213 |
|  | 4 | 8 | 3 | - | 25010 | 25214 |
|  | 6 | 8 | 3 | 24751 | 25011 | 25215 |
|  | 10 | 8 | 3 | 24752 | 25012 | 25216 |
|  | 13 | 8 | 3 | 24747 | 24947 | - |
|  | 16 | 8 | 3 | 24753 | 25013 | 25217 |
|  | 20 | 8 | 3 | 24754 | 25014 | 25218 |
|  | 25 | 8 | 3 | 24755 | 25015 | 25219 |
|  | 32 | 8 | 3 | 24756 | 25016 | 25220 |
|  | 40 | 8 | 3 | 24757 | 25017 | 25221 |
|  | 50 | 8 | 3 | 24758 | 25018 | 25222 |
|  | 63 | 8 | 3 | 24759 | 25019 | 25223 |

## Connection




4P

## Product datasheet <br> Characteristics

29363
interface - for automatic controller - ACP - 220.. 240 V


| Main |  |
| :--- | :--- |
| Range of product | Compact NS100...630 <br> Compact NS630b...1600 <br> Masterpact NT <br> Masterpact NW <br>  <br>  <br>  <br>  <br>  <br>  <br> NSX100...250 |
| Product or component type | Control plate |
| Device short name | ACP |
| Accessory / separate part <br> category | Interlocking accessory |
| $[$ Us] rated supply voltage | $220 . . .240 \mathrm{~V} \mathrm{AC} \mathrm{50/60} \mathrm{~Hz}$ |

Complementary

| Interlocked device | Compact NS100...630 |
| :--- | :--- |
|  | Compact NS630b...1600 |
|  | Masterpact NT |
|  | Masterpact NW |
|  | NSX100...250 |
|  | NSX400..630 |
| Selection modes | Circuit breaker on N <br>  <br> Circuit breaker on R |
| Input type | Contacts customer voluntary order to transfer to source R |
| Output type | Contacts customer : indication of operation in automatic or stop mode |
| Product compatibility | Compact NSX400...630 |
|  | Masterpact NT |
|  | Masterpact NW |
|  | Compact NS630b...1600 |
| Compact NSX100...250 |  |

Environment

| Contractual warranty |
| :--- | :--- |
| Period 18 months |

# Compact NS100 $\rightarrow 630$ Compact NS630b-1600 Masterpact NT, NW Merlin Gerin 

EN Installation manual
(DE) Montageanleitung
(IT) Manuale di installazione
(ES) Instrucciones de instalación

Telemecanique

## IVE



## 4

## Danger et avertissement / Danger and warning / Vorsicht Lebensgefahr Norme di sicurezza e avvertenze / Instrucciones de seguridad

Le montage de ces matériels ne peut être effectué que par des professionnels. Le non respect des indications de la présente notice ne saurait engager la responsabilité du constructeur.

RISQUE D'ELECTROCUTION, DE BRULURES OU D'EXPLOSION
■ l'installation et l'entretien de cet appareil ne doivent être effectués que par des professionnels

- coupez l'alimentation générale et auxiliaire de cet appareil avant toute intervention sur ou dans l'appareil
■ utilisez toujours un dispositif de détection de tension approprié pour confirmer l'absence de tension
- replacez tous les dispositifs, les portes et les couvercles avant de mettre cet appareil sous tension. Le non respect de ces consignes de sécurité exposerait l'intervenant et son entourage à des risques de dommages corporels graves susceptibles d'entraîner la mort.

This equipment should only be mounted by professionals. The manufacturer shall not be held responsible for any failure to comply with the instructions given in this manual

## RISK OF

ELECTROCUTION, BURNS OR EXPLOSION

- the device should only be installed and serviced by professionals
$\square$ switch off the general and auxiliary power supply to the device prior to any work on or in the device
- always use an appropriate voltage detection device to confirm the absence of voltage
- replace all interlocks, doors and covers before energising the device.
Failure to take these precautions will expose the technicians carrying out the work and anyone nearby to hazards that may result in severe bodily injury or death.

Diese Bauteile dürfen nur von qualifiziertem Personal montiert werden. Bei Nichteinhaltung der Anweisungen der vorliegenden Anleitung kann der Hersteller auf keinen Fall haftbar gemacht werden.

GEFAHR VON TÖDLICHEM ELEKTROSCHOCK, VERBRENNUNGEN UND EXPLOSION
Installierung und Wartung dieses Gerätes dürfen nur von qualifiziertem Personal vorgenommen werden

- Vor jeglichem Eingriff auf oder an dem Gerät muß die Stromversorgung des Geräts unterbrochen werden ■ Vor dem Eingriff ist mit einem geeigneten Spannungsmesser sicher zu stellen, daß keinerlei Spannung vorhanden ist ■ Bevor das Gerät erneut unter Spannung gesetzt wird, müssen sämtliche Vorrichtungen, Türen und Abdeckungen wieder angebracht sein.
Falls diese
Vorsichtsmaßnahmen nicht eingehalten werden, könnte dies zu schwere Verletzungen bis hin zum Tod führen.

II montaggio di questi materiali deve essere eseguito esclusivamente da personale competente. In caso di mancato rispetto delle indicazioni fornite nel presente manuale, il costruttore non potrà essere ritenuto responsabile

## RISCHIO DI

ELETTROCUZIONE, DI USTIONI O DI ESPLOSIONE

- linstallazione e la
manutenzione di questo apparecchio devono essere eseguite esclusivamente da personale competente - prima di qualsiasi intervento sull'apparecchio o al suo interno, interrompere l'alimentazione generale e ausiliare fornita all'impianto - verificare sempre l'assenza di tensione con uno strumento adeguato
- prima di mettere questo apparecchio sotto tensione, riportatelo alle condizioni di sicurezza iniziali rimontando gli eventuali pezzi precedentemente tolti. II mancato rispetto delle indicazioni sulla sicurezza riportate in questo documento, potrebbe causare gravi incidenti, tali da ferire o portare alla morte l'operatore.

El montaje de estos materiales sólo puede ser realizado por profesionales. El incumplimiento de las indicaciones dadas en estas instrucciones anula la responsabilidad del constructor.

RIESGO DE ELECTROCUCION, DE QUEMADURAS O DE

## EXPLOSION

- la instalación y el mantenimiento de este aparato sólo deben ser realizados por profesionales - corte la alimentación general y auxiliar del aparato antes de cualquier intervención sobre o en el mismo
- utilice siempre un dispositivo de detección de tensión apropiado para confirmar la falta de tensión - vuelva a colocar todos los dispositivos, las puertas y las tapas antes de poner este aparato bajo tensión. La falta de cumplimiento de estas precauciones puede exponer al usuario y a su entorno a riesgos de daños corporales graves susceptibles de producir la muerte .

SP160 Jesmond Road Indooroopilly SPS - TSR02 Transportable Switchboard Container - OM Manual
Avant toute intervention sur l'appareil / Before working on the device / Vor jedem Eingriff an dem Gerät / Prima di qualsiasi intervento sull'apparecchio / Antes de cualquier intervención sobre el aparato


## NS630b-1600 <br> NT <br> NW


débrochable / Drawout / Einschubtechnik /
estraibile / seccionable
estraibile / seccionable
 Sommaire / Contents / Inhalt / Sommario / Sumario
1 Outillage nécessaire / Necessary tools /
Benötigtes Werkzeug / Utensili necessari /
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Déballage / Unpacking / Auspacken /
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Schémas de câblage ..... 5
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Esquemas de cableado ..... 25Installation / Installation / Installation / Installazione /30
Instalación

SP160 Jesmond Road Indooroopilly SPS - TSR02 Transportable Switchboard Container - OM Manual Outillage nécessaire / Necessary tools / Benötigtes Werkzeuge / Utensili necessari / Herramientas necesarias
tournevis (plat $n^{\circ} 2,5$ et cruciforme 2), clef plate, pince multiprise, pince coupante, pince à dénuder
screwdrivers ( $n^{\circ} 2.5 \mathrm{~mm}$ slotted and Philips no. 2), spanner, adjustable pliers, wire cutter and wire stripper

Schraubendreher (Nr. 2. 5 ), Kreuzschraubendreher (Nr. 2), Flachschlüssel (Nr 8-9),
Wasserpumpenzange, Seitenschneider,
Abisolierzange
cacciavite (piatto $n^{\circ} 2,5$ e a croce $n^{\circ} 2$ ), chiave inglese ( $n^{\circ} 8,9$ ), Pinze
destornillador ( plano $n^{\circ} 2,5$ y estrella 2), llave fija, tenazas, alicates de corte, pelacables





IVE : Interverrouillage électrique et bornier de raccordement
Schéma représenté circuits "hors tension", tous les appareils "ouverts" et les relais en position "repos".

(1) Les ordres de transfert des sources "normal" et "remplacement" doivent être verrouillés électriquement.
(2) Schéma de principe : les informations SDE sont disponibles sur le boîtier IVE. Les contacts SDE sont montés dans les appareils.



SP160 Jesmond Road Indooroopilly SPS - TSR02 Transportable Switchboard Container - OM Manual Schémas de câblage

NT, NW




IVE: Terminal block and electrical interlocking unit
All diagrams are shown with circuits de-energised, all devices open and relays in normal position.

(1) The orders for transfers between the "Normal" and "Replacement" sources must be electrically interlocked.
(2) Simplified wiring diagram: the SDE signals are transmitted to the IVE unit.

The SDE contacts are mounted in the circuit breakers.



## Wiring diagrams

NT, NW




IVE: elektrische Verriegelung und Anschlußklemmen
Darstellung in spannungslosem Zustand, alle Schalter und Schütze in "AUS".

(1) Die Umschaltbefehle "Normal" und "Ersatz" müssen elektrisch verriegelt sein. (2) Prinzipschaltbild: Die Information SDE steht am IVE zur Verfügung Die SDE Schalter sind im Gerät eingebaut.



Schaltpläne
NT, NW




IVE: Interblocco elettrico e morsettiera di collegamento
Schema rappresentato con i circuiti "fuori tensione", tutti gli apparecchi aperti e tutti i relé in posizione "riposo".

(1) I comandi di commutazione delle alimentazioni "Normale" e "Emergenza" devono essere interbloccati elettricamente.
(2) Schema di principio: le informazion SDE sono disponibili sull'interblocco IVE.

I contatti SDE sono montati negli apparecchi.


## Schemi elettrici

NS630b-1600


## Schemi elettrici

NT, NW






 Installation / Installation / Installation / Installazione / Instalación

 Installation / Installation / Installation / Installazione / Instalación


## MSC Chassis

## Suitable for C60, C120, DPN \& Vigi RCBO's Multi 9 Merlin Gerin



MSC Chassis have been designed to provide direct connectivity to Merlin Gerin isolators \& Compact NS circuit breakers.

## Features

- Industrially proven \& robust range.
- Flexible \& easy to install.

- Standard range of MSC18, MSC27, MSC18/27, MSC36 \& MSC DC.
- Custom chassis built to your specifications.

■ Choice of 250A or 400A current rating.
Technical Data

| MSC current rating | 250 A | 400 A |
| :--- | :---: | :---: |
| Peak withstand | 52.5 kA | 60.0 kA |
| Short time withstand | 25 kA for 0.1 sec | 30 kA for 0.1 sec |
| Busbar thickness | 2 mm | 2.5 mm |
| Insulation voltage | 690 V |  |
| Standards/Conformity | AS3439-1 \& AS3439-3 |  |



Certificate of Conformity No. 6963

| Description | Pole Capacity 18mm | Length (mm) L | Rating | Reference |
| :---: | :---: | :---: | :---: | :---: |
| 3 phase | 12 | 110 | 250A | C325123 |
|  | 18 | 164 | 250A | C325183 |
|  | 24 | 218 | 250A | C325243 |
|  | 30 | 272 | 250A | C325303 |
|  | 36 | 326 | 250A | C325363 |
|  | 42 | 380 | 250A | C325423 |
|  | 48 | 434 | 250A | C325483 |
|  | 60 | 542 | 250A | C325603 |
|  | 72 | 650 | 250A | C325723 |
|  | 84 | 758 | 250A | C325843 |


| Description | Pole Capacity 27mm | Length (mm) L | Rating | Reference |
| :---: | :---: | :---: | :---: | :---: |
| 3 phase | 12 | 164 | 250A | C125123 |
|  | 18 | 245 | 250A | C125183 |
|  | 24 | 326 | 250A | C125243 |
|  | 30 | 407 | 250A | C125303 |
|  | 36 | 488 | 250A | C125363 |
|  | 42 | 569 | 250A | C125423 |
|  | 48 | 650 | 250A | C125483 |
|  | 60 | 812 | 250A | C125603 |
|  | 72 | 974 | 250A | C125723 |

MSC 18/27 - for C60 or C120 MCB

| Description | Pole Capacity 27mm18mmTotal |  |  | Length (mm) L | Rating | Reference |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 3 phase | 6 | 6 | 12 | 137 | 250A | CH25123 |
|  | 6 | 12 | 18 | 191 | 250A | CH25183 |
|  | 6 | 18 | 24 | 245 | 250A | CH25243 |
|  | 6 | 24 | 30 | 299 | 250A | CH25303 |
|  | 6 | 30 | 36 | 353 | 250A | CH25363 |
|  | 12 | 30 | 42 | 434 | 250A | CH25423 |
|  | 12 | 36 | 48 | 488 | 250A | CH25483 |
|  | 12 | 48 | 60 | 596 | 250A | CH25603 |
|  | 12 | 60 | 72 | 704 | 250A | CH25723 |

## Notes:

- For 400A MSC rating, please add "4" to the end of the 250A chassis reference number.
- Busbars extend 94.5 mm either end of pan, width is 215 mm .
- For custom built chassis' (to meet with your specific requirements), please contact Schneider Help Centre on 1300 369233.

MSC 18/4A - for C60

| Description | Pole Capacity 18mm | Length (mm) L | Rating | Reference |
| :---: | :---: | :---: | :---: | :---: |
| 3 phase \& neutral (N.R.W.B) | 8 | 74 | 250A | C3250843 |
|  | 16 | 146 | 250A | C3251643 |
|  | 24 | 218 | 250A | C3252443 |
|  | 32 | 290 | 250A | C3253243 |
|  | 40 | 362 | 250A | C3254043 |
|  | 48 | 434 | 250A | C3254843 |
|  | 56 | 506 | 250A | C3255643 |
|  | 64 | 578 | 250A | C3256443 |
|  | 72 | 650 | 250A | C3257243 |

MSC 18/4B - for C60

| Description | Pole Capacity 18 mm | Length (mm) L | Rating | Reference |
| :---: | :---: | :---: | :---: | :---: |
| 3 phase \& neutral (N.R.N.W.N.B) | 16 | 146 | 250A | C3251641 |
|  | 24 | 218 | 250A | C3252441 |
|  | 32 | 290 | 250A | C3253241 |
|  | 40 | 362 | 250A | C3254041 |
|  | 48 | 434 | 250A | C3254841 |
|  | 56 | 506 | 250A | C3255641 |
|  | 64 | 578 | 250A | C3256441 |
|  | 72 | 650 | 250A | C3257241 |

MSC 36 - for DPN. Vigi (Ph + N)

| Description | Pole Capacity | Qty of DPN's | Length (mm) L | Rating | Reference |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 3 phase \& neutral (N.R.N.W.N.B) | 12 | 6 | 110 | 250A | CD25124N |
|  | 20 | 10 | 182 | 250A | CD25204N |
|  | 24 | 12 | 218 | 250A | CD25244N |
|  | 32 | 16 | 290 | 250A | CD25324N |
|  | 36 | 18 | 326 | 250A | CD25364N |
|  | 48 | 24 | 434 | 250A | CD25484N |
|  | 72 | 36 | 650 | 250A | CD25724N |

MSC DC - for C60

| Description | Pole Capacity 18 mm | Length (mm) L | Rating | Reference |
| :---: | :---: | :---: | :---: | :---: |
|  | 12 | 110 | 250A | C3DC123 |
| 2-pole (Black/Red) | 16 | 146 | 250A | C3DC163 |
|  | 20 | 182 | 250A | C3DC203 |
|  | 24 | 218 | 250A | C3DC243 |
|  | 32 | 290 | 250A | C3DC323 |
|  | 36 | 326 | 250A | C3DC363 |
|  | 40 | 362 | 250A | C3DC403 |
|  | 48 | 434 | 250A | C3DC483 |
|  | 60 | 542 | 250A | C3DC603 |
|  | 72 | 650 | 250A | C3DC723 |

Dimensions


| DIMENSION DETAILS |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{array}{\|l\|l\|} \hline \text { CIRCUIT } \\ \text { BREAKER } \\ \text { TYPE } \\ \hline \end{array}$ | $\begin{array}{\|c\|} \text { CATALOGUE } \\ \text { No. } \end{array}$ | $\left\lvert\, \begin{aligned} & \text { POLE } \\ & \text { SIZES } \end{aligned}\right.$ | diMENSIONS |  |  | CURRENT <br> RATNG |
|  |  |  | A | L | c |  |
| NC100HNC100LS | C125123 | 12 | 353 | 164 | 108 | 250A |
|  | C125183 | 18 | 434 | 245 | 189 |  |
|  | $\mathrm{Cl25243}$ | 24 | 515 | 326 | 270 |  |
|  | C125303 | 30 | 614 | 407 | 351 |  |
|  | $\mathrm{Cl}^{125363}$ | 36 | 677 | 488 | 432 |  |
|  | $\mathrm{Cl}^{25423}$ | 42 | 758 | 569 | 513 |  |
|  | ${ }^{\text {C125483 }}$ | 48 | 839 | 650 | 594 |  |
|  | C125603 | 60 | 1001 | 812 | 756 |  |
|  | C125723 | 72 | 1163 | 974 | 918 |  |



DIMENSIINS IHE SAME FDR 400A BARS (ADD SUFFIX 4 TD CAT\#)

## SCHNEIDER ELECTRIC HELP CENTRE

Tel: 1300369233
Fax: 1300369288
Email: help@schneider.com.au


No image currently available
Catalogue Number: CPELK1W
Description: EMERGENCY LIGHT KIT WIRED
List Price: (4) Refer to our eCatalogue

Unit Of Measure: EA

Price Schedule: T4

All prices are exclusive of GST
Representative Image Only

Panelboards / Accessories
Brand: Terasaki
Type: Rotary switch

## Features

- Emergency lighting kit (Wired) for use with the CONCEPT PLUS
- panelboard range.
- Kit includes rotary control switch, timer, 24A 4P N/C
- contactor, labels and wiring diagram to complete control
- circuit complying to AS2293.1.


## Benefits

- Emergency lighting kits can be easily field fitted to CONCEPT
- PLUS panelboards using the horizontal knockout at top of
- board.


## ERTIECH

## Features

- CRITEC® TD Technology with thermal disconnect protection
- Compact design fits into DIN distribution panel boards and motor control centers
- 35 mm DIN rail mount - DIN 43880 profile matches common circuit breakers
- Indication flag and voltage-free contacts provide remote status monitoring
- Separate plug and base design facilitates replacement of a failed surge module
- 100kA 8/20 maximum surge rating provides protection suitable for sub-distribution panels and a long operational life
- Available in various operating voltages to suit most common power distribution systems


## CRITEC ${ }^{\circledR}$ TDS 1100 TDS Surge Diverter TDS 1100 Series



Surges and voltage transients are a major cause of expensive electronic equipment failure and business disruption. Damage may result in the loss of capital outlays, such as computers and communications equipment, as well as consequential loss of revenue and profits due to unscheduled system down-time.

The TDS1100 series of surge suppressors provide economical and reliable protection from voltage transients on power distribution systems. They are conveniently packaged for easy installation on 35 mm DIN rail within main distribution panelboards.

CRITEC ${ }^{\circledR}$ TD technology helps ensure reliable and continued operation during sustained and abnormal over-voltage events. Internal thermal disconnect devices help ensure safe or at end-of-life. A visual indicator flag provides user-feedback in the event of such operation. As standard, the TDS1100 provides a set of voltage-free contacts for remote signaling that maintenance is due.

The convenient plug-in module, and separate base design, facilitates replacement of a failed surge module without needing to undo installation wiring.

## ERITE둘

## CRITEC ${ }^{\circledR}$ TDS 1100 TDS Surge Diverter TDS1100 Series

| Model | TDS11002SR150 | TDS11002SR240 | TDS11002SR277 | TDS11002SR560 |
| :---: | :---: | :---: | :---: | :---: |
| Nominal Voltage Un | 120-150V~ | 220-240V~ | 240-277V~ | 480-560V~ |
| Max. Cont. Operating Voltage $\mathrm{U}_{\mathrm{c}}$ | 170V~ | 275V~ | 320 V ~ | 610V~ |
| Stand off Voltage | 240V~ | 440V~ | 480V~ | 700V~ |
| Frequency | $0-100 \mathrm{~Hz}$ |  |  |  |
| Short Circuit Current Rating ISC | 25kAIC |  |  |  |
| Required Back-up Fuse | 125 AgL , if supply > 100A |  |  |  |
| Technology Used | TD with thermal disconnect |  |  |  |
| Protection |  |  |  |  |
| Maximum Discharge Current Imax | 100kA 8/20 ${ }^{\text {s }}$ |  |  |  |
| Nominal Discharge Current In | 50kA 8/20رs | 40kA 8/20us | 40kA 8/20 $/ \mathrm{s}$ | 40kA 8/20رs |
| Protection Modes | Single mode (L-G, L-N or N-G) |  |  |  |
| Voltage Protection Level Up @ 3kA | < 400V | < 700V | < 800V | < 1.6 kV |
| Voltage Protection Level Up @ 20kA | < 650 | < 1000 | < 1.1 kV | < 2 kV |
| Alarms and Indicators |  |  |  |  |
| Status Indication | Mechanical flag / remote contacts <br> Change-over, 250V~ / 0.5A, max $1.5 \mathrm{~mm}^{2}$ (\#14AWG) terminals |  |  |  |
| Physical Data |  |  |  |  |
| Dimensions | 2 modules wide, $90 \mathrm{~mm} \times 68 \mathrm{~mm} \times 35 \mathrm{~mm}$ |  |  |  |
| Weight | 0.24 kg approx. |  |  |  |
| Enclosure | DIN 43 880, UL94V-0 thermoplastic, IP 20 (NEMA-1) |  |  |  |
| Connection | $\leq 35 \mathrm{~mm}^{2}$ (\#2AWG) solid $\leq 25 \mathrm{~mm}^{2}$ (\#4AWG) stranded |  |  |  |
| Mounting | 35 mm top hat DIN rail |  |  |  |
| Temperature | $-40^{\circ} \mathrm{C}$ to $+80^{\circ} \mathrm{C}\left(-40^{\circ} \mathrm{F}\right.$ to $\left.+176{ }^{\circ} \mathrm{F}\right)$ |  |  |  |
| Humidity | 0 to 90\% |  |  |  |
| Test Standards |  |  |  |  |
| Approvals | CE, IEC ${ }^{\text {TM }}$ 61643-1, UL® 1449 Pending |  |  |  |
| Surge Rated to Meet | IEC 61643-1 Class I and II ANSI/IEEE C62.41-1991 Cat A, Cat B, Cat C |  |  |  |

Ordering Information

| PART NUMBER | DESCRIPTION |
| :--- | :--- |
| TDS1102SR150 | TDS Surge Diverter, Uc 170V, In 50kA, Imax 100kA, Remote |
| TDS1102SR240 | TDS Surge Diverter, Uc 275V, In 40kA, Imax 100kA, Remote |
| TDS1102SR277 | TDS Surge Diverter, Uc 320V, In 40kA, Imax 100kA, Remote |
| TDS1102SR560 | TDS Surge Diverter, Uc 610V, In 40kA, Imax 100kA, Remote |
| TDS150150M | 150V Replacement Surge Module |
| TDS150240M | 240V Replacement Surge Module |
| TDS150277M | 277V Replacement Surge Module |
| TDS150560M | 560 V Replacement Surge Module |

Due to a policy of continual product development, specifications are subject to change without notice.

[^11]
## www.erico.com

## INSTALLATION INSTRUCTIONS



## 1. PREPARATION



DANGER: Electrical shock or burn hazard. Installation of this device should only be made by qualified personnel. Failure to lockout electrical power during installation or maintenance can result in fatal electrocution or severe burns. Before making any connections be sure that power has been removed from all associated wiring, electrical panels, and other electrical equipment.

## CAUTION NOTES:

1. The installation of this device should follow all applicable electrical codes, such as the National Electrical Code.
2. Check to make sure line voltage does not exceed DAR275V voltage ratings.
3. Follow all instructions to ensure correct and safe operation.
4. Do not attempt to open or tamper with the DAR in any way as this may compromise performance and will void warranty. No user serviceable parts are contained.

## 2. INTRODUCTION

Selected DSD, TDS \& TDF DINLINE Surge Protection Devices include status monitoring circuits which provide visual status display of device capacity. They may also provide a low voltage opto-coupler alarm output circuit that can be connect to the DAR to provide potential free (Form C) change-over contacts. The DAR alarm contacts may be used to provide output to external alarm systems or remote monitoring circuits.

One DAR can be used per DSD/TDS/TDF opto-coupler alarm or up to 16 DSD opto-coupler alarms can be connected in series to the one DAR to provide a common output. It is recommended that the DAR be powered from the same power circuit that feeds the device(s) being monitored, however the DAR can be powered from other circuits. This allows for example, one DAR unit to be connected to separate SPDs that are protecting a three phase circuit.

Note. Depending upon the usage of the DAR output contacts, failure of power to the DAR may be interpreted as a failure of one or more of the SPDs being monitored. Visual inspection of the DAR and SPDs status displays would determine this.

## 3. MOUNTING

The DAR is designed to clip to 35mm (top hat) DIN rails (standard EN50022). Unless otherwise mechanically restrained, use horizontal DIN rails with the DAR module spring clips to the bottom and the label text the correct way up.

NOTE: The DAR must be installed in an enclosure or panel that:

- prevents the DAR temperature from exceeding

$$
131^{\circ} \mathrm{F}\left(55^{\circ} \mathrm{C}\right)
$$

- provides adequate electrical and safety protection
- prevents the ingress of moisture and water
- allows DAR status indicators to be inspected


## 4. ELECTRICAL CONNECTION

The interconnecting wiring should:

- be of size \#10 to \#14 AWG (2.5mm² to $6 \mathrm{~mm}^{2}$ ) solid or stranded conductor.
- $\quad$ The wire insulation should be stripped back $5 / 16$ " ( 8 mm ).
- NOTE: Do not use greater than 9inlbs (1Nm) of torque when tightening the terminals.


## CONNECTION TO TELECOMMUNICATIONS NETWORKS

The DAR is approved for use in Australia where the alarm contacts may be connected to private lines or building cabling associated with the telecommunications network. NO direct connection to the public switched network should be made.

## INSTALLATION INSTRUCTIONS

## 5. INTERCONNECTION

When connecting the DAR to a single opto-coupler output the + terminal of the SPD should connect to the + terminal on the DAR. The - terminal should connect to the -- terminal.

+/- terminal connections are polarity sensitive. Do not reverse.

When connecting the DAR to multiple opto-couplers the optocouplers should be connected in series with + terminal of one connected to the - terminal of the next. The DAR + terminal should connect to + SPD terminal at one end of the series connection and the - DAR terminal connect to the - SPD terminal at the other end of the series connection.


## 5. STATUS INDICATION

| STATUS | Protection Operational | Protection Alarm | Fault Mode |
| :---: | :--- | :--- | :--- |
| DISPLAY | Normal operation | DSD in alarm mode or power <br> to DSD has been removed | Power to DAR removed <br> Protection status unknown |
| EXPLANATION | Normal (green) indicator ON <br> Red indicator OFF <br> Relay is energised <br> Power is supplied | Normal (green) indicator OFF <br> Red indicator ON <br> Relay is de-energised <br> Power is supplied | Normal (green) indicator OFF <br> Red indicator OFF <br> Relay is de-energised <br> Power is OFF |

## 6. FUSING AND ISOLATION

Overcurrent protection must be installed in the upstream circuit of the power supply to the DAR to provide protection to the unit itself and the wiring in case of fault conditions.

The fuse rating should be based on the wiring size used to connect to the DAR Ph \& N terminals. Australian regulations AS3000-1991, Table B2 specifies the following upstream protection for single phase circuits, unenclosed in air.

| Cable Size | HRC Fuse or | CB Rewirable Fuse |
| :--- | :---: | :---: |
| $1.5 \mathrm{~mm}^{2}$ | 16 A | 12 A |
| $2.5 \mathrm{~mm}^{2}$ | 20 A | 16 A |
| $4 \mathrm{~mm}^{2}$ | 25 A | 20 A |
| $6 \mathrm{~mm}^{2}$ | 32 A | 25 A |

Where overcurrent protection of the appropriate rating or smaller is already fitted in the upstream circuit, overcurrent protection at the DAR will not be required

## 6. MAINTENANCE \& TESTING

Before removing a DAR unit from service, ensure that the power has been removed. Maintenance, testing and replacement should only be undertaken by qualified personnel.

Testing of a DAR unit which is connected to a fully functional DSD unit can be accomplished by removing power to the DSD only. The DAR Status indication and output contacts should alter from the Normal to Fault condition.

Testing of the DAR unit alone may be accomplished by disconnecting the $+/$-connections to the unit. When power is applied the DAR "Fault" Status Indicator should be illuminated. By connecting the $+/$ - terminals together, the "Normal" Status Indicator should be illuminated. The output contacts should alter to the appropriate state.

## 7. USE OF OTHER INTERFACES

Only DAR units are recommended for the interfacing of equipment to the DSD, TDS \& TDF opto-coupler alarm output circuit(s). The direct connection of other equipment to these opto-coupler alarm outputs may not provide sufficient isolation or exceed the opto-coupler specifications. This may damage the SPD and/or the connected equipment. Warranty may be voided under such circumstances.

NOTE: In connecting to the SPD opto-coupler alarm output(s), do not reverse the +/- connections as damage may occur.

## Transient Discriminating Filter - TDF10A240V (700004)



- Transient Discriminating (TD) Technology provides increased service life
- In-line series protection
- High-efficiency low-pass sine wave filtering is ideal for the protection of switched mode power supplies
- Three modes of protection: L-N, L-PE and N-PE
- LED status indication and opto-isolated output for remote status monitoring

| Part Number | TDF10A240V |
| :---: | :---: |
| Article Number | 700004 |
| Max Line Current (LL) | 10 A |
| Nominal System Voltage (Un) | 220-240 V |
| Max Continuous Operating Voltage (Uc) | 340 VAC |
| Stand-off Voltage | 400 V |
| Frequency | $0-60 \mathrm{~Hz}$ |
| Max Discharge Current (Imax), L-N | $20 \mathrm{kA} 8 / 20$ н |
| Max Discharge Current (Imax), L-PE | $20 \mathrm{kA} 8 / 20$ ¢ |
| Max Discharge Current (Imax), N-PE | $10 \mathrm{kA} 8 / 20$ ¢ |
| Voltage Protection Rating (VPR) | $\begin{aligned} & 700 \text { V @ } 500 \mathrm{~A} \\ & 500 \mathrm{~V} @ 3 \mathrm{kA} \end{aligned}$ |
| Back-Up Overcurrent Protection | 10 A |
| Filtering | -65 dB @ 100 kHz |
| Distribution System | 1Ph 2W+G |
| Protection Modes | All modes protected |
| Connection, Solid | $\begin{aligned} & \# 18-\# 10 \\ & 1-6 \mathrm{~mm}^{2} \end{aligned}$ |
| Connection, Stranded | $\begin{gathered} \# 18-\# 10 \\ 1-6 \mathrm{~mm}^{2} \end{gathered}$ |
| Mounting | 35 mm top hat DIN rail |
| Status Indication | LED |
| Enclosure Material | UL® 94V-0 thermoplastic |
| Enclosure Rating | $\begin{array}{\|l\|} \hline \text { IP } 20 \\ \text { NEMA®-1 } \end{array}$ |
| Temperature | $\begin{array}{\|l\|} \hline-35 \text { to } 55^{\circ} \mathrm{C} \\ -31 \text { to } 131^{\circ} \mathrm{F} \end{array}$ |
| Module Width | 8 M |
| Depth (D) | $\begin{array}{\|l\|} \hline 2.68 " \\ 68 \mathrm{~mm} \end{array}$ |
| Height (H) | $\begin{array}{\|l\|} \hline 3.54 " \\ 90 \mathrm{~mm} \end{array}$ |
| Width (W) | $\begin{array}{\|l\|} \hline 5.67 " \\ 144 \mathrm{~mm} \end{array}$ |
| Unit Weight | $\begin{aligned} & 3.25 \mathrm{lb} \\ & 1.48 \mathrm{~kg} \end{aligned}$ |

SP160 Jesmond Road Indooroopilly SPS - TSR02 Transportable Switchboard Container - OM Manual

| Part Number | TDF10A240V |
| :--- | :--- |
| Complies With | ANSI®/EEE ${ }^{\circ}$ C62.41.2-2002 Cat A, Cat B, Cat C |
| Listing Details | UL® 1449 Edition 3 Recognized Component Type 2 <br> UL® 1283 |
| Standard Packaging Quantity | 1 pc |
| UPC | 78285644038 |
| UNSPSC | 39121610 |
| ETIM | EC002564 |
| Approvals | CURus $^{\circ}$ |

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## WARNING

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## Modular relays

Multifunction 3-phase supply control relays RM17 Tp00


RM17 Tp00

## Presentation

RM17 TT, RM17 TA, RM17 TU and RM17 TE multifunction control relays monitor the following on 3-phase supplies:

| Sequence of phases L1, L2 and L3. | RM17 TT | RM17 TA | RM17 TU | RM17 TE |
| :--- | :--- | :--- | :--- | :--- |
| Phase failure with regeneration |  |  |  |  |
| Asymmetry |  |  |  |  |
| Undervoltage |  |  |  |  |
| Overvoltage and undervoltage |  |  |  |  |

Function performed

- Function not performed

These control relays accept different nominal 3-phase voltage values: a 208... 480 V . They monitor their own supply voltage, measured as a true rms value.
Settings are protected by a sealable cover.
Control status is indicated by a LED.
The relays are designed for clip-on mounting on 5 rail

## Applications

b Control for connection of moving equipment (site equipment, agricultural equipment, refrigerated trucks).
b Control for protection of persons and equipment against the consequences of reverse running (lifting, handling, elevators, escalators, etc.).
b Control of sensitive 3-phase supplies.
b Protection against the risk of a driving load (phase failure).
b Normal/emergency power supply switching.


[^12]R Yellow LED: indicates relay output state.

# Measurement and control relays Zelio Control 

 Modular relaysMultifunction 3-phase supply control relays RM17 Tp00

## Operating principle

3-phase supply control relays monitor:
b The correct sequence of phases L1, L2, L3.
b Phase failure, including in the case of voltage regeneration
b Undervoltage from $-2 \ldots-20 \%$ of the supply voltage Un,
b Overvoltage from 2... $20 \%$ of the supply voltage Un,
b Asymmetry from $5 \ldots 15 \%$ of the supply voltage Un.
Fault signalling is by LED.
b Voltage selector switch :
v Set the switch to the 3-phase supply voltage Un.
$v$ The position of this switch is only taken into account on energisation of the device. $v$ If the switch position is changed while the device is operating, all the LEDs flash, but the product continues to operate normally with the voltage selected at the time of energisation preceding the change of position.
The LED's return to their normal state if the switch is returned to the original position selected prior to the last energisation.

## Phase control relay with voltage regeneration: RM17 TT00

b The relay monitors its own supply voltage Un:
v The relay monitors:

- correct sequence of the three phases,
- failure of at least one of the three phases (U measured < $0.7 \times \mathrm{Un}$ ).
$v$ In the event of a sequencing or phase failure fault, the relay opens instantly.
v On energisation of the device with a fault measured, the relay stays open.
Function diagram
b Function:
v Sequence of phases L1, L2, L3.
$v$ Phase failure.
V



## Phase and asymmetry control relay: RM17 TA00

b The relay monitors its own supply voltage Un:
$\checkmark$ The relay monitors:

- correct sequence of the three phases,
- failure of at least one of the three phases (U measured $<0.7 \times$ Un),
- asymmetry adjustable from 5... 15 \% of Un.
v In the event of a sequencing or phase failure fault, the relay opens instantly. $v$ In the event of an asymmetry fault, the relay opens at the end of the time delay set by the user.
v On energisation of the device with a fault measured, the relay stays open.


## Function diagram

b Function:
v Sequence of phases L1, L2, L3.
$v$ Phase failure,
v Asymmetry. Asy.


[^13]
## Phase + undervoltage control relays: RM17 TU00

## b The relay monitors its own supply voltage Un:

v The relay monitors:

- correct sequence of the three phases,
- failure of at least one of the three phases (U measured < $0.7 \times \operatorname{Un}$ ),
- undervoltage adjustable from-2 ... $20 \%$ of Un (-2 ... $-12 \%$ in the range a $3 \times 208 \mathrm{~V}$ and $-2 \% \ldots-17 \%$ in the range a $3 \times 220 \mathrm{~V}$ due to the minimum voltage a 183 V ).
$v$ In the event of a sequencing or phase failure fault, the relay opens instantly
v In the event of a voltage fault, the relay opens at the end of the time delay set by the user.
$v$ On energisation of the device with a fault measured, the relay stays open.


## Function diagrams

b Function:
$\checkmark$ Sequence of phases
L1, L2, L3.
v Phase failure.
Phase L1
Phase L2
Phase L3
Relays

$\checkmark$ Undervoltage control. U<


Tt : time delay after crossing of threshold (adjustable on front panel)

## Phase + asymmetry + undervoltage/overvoltage control relay: RM17 TE00

b The relay monitors its own supply voltage Un:
v The relay monitors:

- correct sequence of the three phases,
- failure of at least one of the three phases (U measured < $0.7 \times$ Un),
- asymmetry adjustable from $5 \ldots 15 \%$ of Un,
- the overvoltage and undervoltage difference in window mode, adjustable from 2... $20 \%$ of Un

| Un |  | 208 V | 220 V | 380, 400, 415, 440 V | 480 V |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Voltage threshold (\%) | $<$ | -12...- 2 | -17...- 2 | -20...- 2 | -20...- 2 |
|  | $>$ | +2... +20 | +2... 20 | +2... +20 | +2... +10 |

$v$ In the event of a sequencing or phase failure fault, the relay opens instantly.
v In the event of an asymmetry or voltage fault, the relay opens at the end of the time delay set by the user. On energisation of the device with a fault measured, the relay stays open.

## Function diagrams

b Function: v Sequence of phases
L1, L2, L3.
v Phase failure,
v Asymmetry. Asy.


Tt : time delay after crossing of threshold (adjustable on front panel)
$v$ Control of overvoltage and undervoltage in window mode. U> / U<


Tt : time delay after crossing of threshold (adjustable on front panel)

## Measurement and control relays Zelio Control

Modular relays
Multifunction 3-phase supply control relays RM17 Tp00

## References



RM17 TT00


RM17 TU00


RM17 TA00

| Function | Rated 3-phase <br> supply voltage | Output | Reference | Weight |
| :--- | :--- | :--- | :--- | ---: |
|  | V |  |  | $\mathbf{k g}$ |
| b Phase sequence <br> b Phase failure | a $208 \ldots 480$ | $1 \mathrm{C/O}$ | RM17 TT00 | 0.080 |


| b Phase sequence | a $208 \ldots 480$ | 1 C/O | RM17 TA00 | 0.080 |
| :--- | :--- | :--- | :--- | :--- |
| b Phase failure |  | 5 A |  |  |

b Phase failure
5 A
b Asymmetry

| b Phase sequence | a $208 \ldots 480$ | $1 \mathrm{C} / \mathrm{O}$ | RM17 TU00 | 0.080 |
| :--- | :--- | :--- | :--- | :--- |
| b Phase failure |  | 5 A |  |  |
| b Undervoltage |  |  |  |  |


| b Phase sequence | a $208 \ldots 480$ | 1 C/O | RM17 TE00 | 0.080 |
| :--- | :--- | :--- | :--- | :--- |
| b Phase failure |  | 5 A |  |  |

b Phase falur
b Asymmetry
b Undervoltage and
overvoltage in window mode


# PANEL MOUNTED 



4 Connectors
8 Fused Terminal Blocks
9 Neutral / Active / Meter Links
10 Heavy Duty Links
11 Link Bars
21 Clipsal Neutral-Active-Meter Links
27 Special Bars

## DESIGNED FOR EASY INSTALLATION

## PANEL MOUNTED

## switchboard accessories

Blue Point is a name synonymous with switchboard accessories in Australia.

Established in 1936, the company specialised in producing bakelite products before expanding into the area of switchboard accessories.

In 1947 Blue Point introduced a product that is today regarded as the generic term for all connectors, the BP1.

Purchased by Gerard Industries in 1973 to complement the Clipsal range of brass bars, connectors, terminal bars and neutral link bars, Blue Point Products is Australia's largest manufacturer of panel mounted accessories for domestic, commercial and industrial applications.



## AND TROUBLE FREE PERFORMANCE



Designed for easy installation, the Blue Point product range consists of active, neutral and earth link bars, single connectors, as well as blocks and strips, in a wide range of sizes for commercial and industrial switchboards.

Drilling and tapping are carried out using state-of-theart computerised equipment that ensures the highest quality products.

Blue Point has an excellent reputation for specialising in jobbing work where "one-off" special bars are required.

For further information on the Blue Point range, please contact your Clipsal Representative or the Blue Point Factory.

## CONNECTORS

## BP1

Insulated Single Screw Connector.
Terminal bore: 5 mm .
Terminal accommodates: $2 \times 4 \mathrm{~mm}^{2}$ or $4 \times 2.5 \mathrm{~mm}^{2}$ cables.
Temperature rating: $160^{\circ} \mathrm{C}$ maximum.


## Connector Blocks

## BP102

Two Way Double Entry 15A Connector Block with insulation barriers and platform. Two screws per tunnel.
Dimensions: $27 \times 20 \times 13 \mathrm{~mm}$.
Terminal tunnel: 3.5 mm diameter.
Tunnels accommodate up to $4 \mathrm{~mm}^{2}$ cables.
Single screw mounting
Temperature rating: $190^{\circ} \mathrm{C}$ maximum Certificate of Suitability No. CS/584/N.


## BP202

Two Way Double Entry 20A Connector Block. Two screws per tunnel.
Dimensions: $20 \times 17 \times 13 \mathrm{~mm}$.
Terminal tunnel: 3.5 mm diameter.
Tunnels accommodate up to $4 \mathrm{~mm}^{2}$ cables.
Single screw mounting.
Temperature rating: $190^{\circ} \mathrm{C}$ maximum. Certificate of Suitability No. CS/584/N.

## BP203

Two Way Triple Entry 20A Connector Block. Two screws per tunnel.
Dimensions: $28 \times 17 \times 13 \mathrm{~mm}$.
Terminal tunnel: 3.5 mm diameter.
Tunnels accommodate up to $4 \mathrm{~mm}^{2}$ cables.
Single screw mounting.
Temperature rating: $190^{\circ} \mathrm{C}$ maximum.
Certificate of Suitability No. CS/584/N.


## BP302

Two Way Double Entry 20A, 500 volt Connector Block with insulating barriers and platform. Two screws per tunnel.

Dimensions: $30 \times 25 \times 16 \mathrm{~mm}$. Terminal tunnel: 4 mm diameter.
Tunnels accommodate up to $2 \times 2.5 \mathrm{~mm}^{2}$ cables.
Single screw mounting.
Temperature rating: $160^{\circ} \mathrm{C}$ maximum.
Certificate of Suitability No. CS/584/N.


## BP303

Two Way Triple Entry 20A, 500 volt Connector Block with insulating barriers and platform. Two screws per tunnel.

Dimensions: $30 \times 33 \times 16 \mathrm{~mm}$. Terminal tunnel: 4 mm diameter. Tunnels accommodate up to $2 \times 2.5 \mathrm{~mm}^{2}$ cables.
Single screw mounting.
Temperature rating: $160^{\circ} \mathrm{C}$ maximum.
Certificate of Suitability No. CS/584/N.


## BP404

Two Way Four Entry 40A Connector Block with mounting lugs.
Two screws per tunnel.
Dimensions: $68 \times 29 \times 24 \mathrm{~mm}$.
Mounting centres: 58 mm .
Terminal tunnel: 5 mm diameter.
Tunnels accommodate up to $10 \mathrm{~mm}^{2}$ cables.
Two screw mounting.
Temperature rating: $190^{\circ} \mathrm{C}$ maximum. Certificate of Suitability No. CS/584/N.


## BP603

Two Way Triple Entry 40A Connector Block with insulating barriers and platform.

Two screws per tunnel.
Dimensions: $35 \times 36 \times 19 \mathrm{~mm}$.
Terminal tunnel: 5 mm diameter.
Tunnels accommodate up to $10 \mathrm{~mm}^{2}$ cables
Single screw mounting.
Temperature rating: $190^{\circ} \mathrm{C}$ maximum.
Certificate of Suitability No. CS/584/N.


BP604P
Two Way Four Entry 40A Connector Block with insulating barriers and platform.

Two screws per tunnel. Dimensions: $52 \times 42 \times 23 \mathrm{~mm}$ Mounting centres: 28 mm . Terminal tunnel: 5 mm diameter. All tunnels with pressure plates. All terminal screws are captive.
Tunnels accommodate up to $10 \mathrm{~mm}^{2}$ cables
Two screw mounting.
Temperature rating: $190^{\circ} \mathrm{C}$ maximum.
Certificate of Suitability No. CS/584/N.


## BP606P

Two Way Six Entry 40A Connector Block with insulating barriers and platform.

Two screws per tunnel.
Dimensions: $81 \times 43 \times 23 \mathrm{~mm}$. Mounting centres: 28 mm . Terminal tunnel: 5 mm diameter. All tunnels with pressure plates. All terminal screws are captive. Tunnels accommodate up to $10 \mathrm{~mm}^{2}$ cables.
Three screw mounting.
Temperature rating: $190^{\circ} \mathrm{C}$ maximum. Certificate of Suitability No. CS/584/N.


## BP703P

Two Way Triple Entry 40A Connector Block with insulating barriers and platform.
Two screws per tunnel.
Dimensions: $43 \times 42 \times 23 \mathrm{~mm}$.
Mounting centres: 15 mm .
Terminal tunnel: 5 mm diameter.
All tunnels with pressure plates.
All terminal screws are captive.
Tunnels accommodate up to $10 \mathrm{~mm}^{2}$ cables.
Two screw mounting.
Temperature rating: $190^{\circ} \mathrm{C}$ maximum.
Certificate of Suitability No. CS/584/N.


## BP502

Natural Nylon Two Way Double Entry 20A Connector Block with insulating barriers and platform, with snap-in mounting spigot.
Spigot fits 4.65 mm square hole, in 0.5 to 0.9 mm thick metal.

Two screws per tunnel.
Dimensions: $31 \times 17 \times 17 \mathrm{~mm}$.
Terminal tunnel: 4 mm diameter.
Tunnels accommodate up to $6 \mathrm{~mm}^{2}$ cables.
Temperature rating: continuous extreme maximum $120^{\circ} \mathrm{C}$.
Certificate of Suitability No. CS/584/N.


## BP503

Natural Nylon Two Way Triple Entry 20A Connector Block, with insulating barriers and platform, with snapping mounting spigot.
Dimensions: $31 \times 25 \times 17 \mathrm{~mm}$. All other details same as BP502. Certificate of Suitability No. CS/584/N.


## BP503PP

Natural Nylon Two Way Triple Entry 20A Connector Block with pressure plates.
All other details same as BP503.

## Porcelain Connector Blocks

## BPC112

Two Way Double Entry 15A Porcelain Connector Block.
Dimensions: $24 \times 21 \times 16 \mathrm{~mm}$. Terminal tunnel: 3.5 mm diameter
Tunnels accommodate up to $4 \mathrm{~mm}^{2}$ cables.
Single screw mounting.


## BPC113

Two Way Triple Entry 15A Porcelain Connector Block.

Dimensions: $35 \times 21 \times 16 \mathrm{~mm}$. Terminal tunnel: 3.5 mm diameter. Tunnels accommodate up to $4 \mathrm{~mm}^{2}$ cables.
Two screw mounting at 12.5 mm centres.


## BPC212

Two Way Double Entry 20A
Porcelain Connector Block.
Dimensions: $25 \times 22 \times 21 \mathrm{~mm}$.
Terminal tunnel: 4.3 mm diameter.
Tunnels accommodate up to $6 \mathrm{~mm}^{2}$ cables.
Single screw mounting.

## BPC213

Two Way Triple Entry 20A Porcelain Connector Block.

Dimensions: $38 \times 23 \times 20 \mathrm{~mm}$.
Terminal tunnel: 4.3 mm diameter.
Tunnels accommodate up to $6 \mathrm{~mm}^{2}$ cables.
Two screw mounting at 14 mm centres.


## BPC312

Two Way Double Entry 40A Porcelain Connector Block.
Dimensions: $35 \times 30 \times 22 \mathrm{~mm}$. Terminal tunnel: 5.8 mm diameter.
Tunnels accommodate up to $10 \mathrm{~mm}^{2}$ cables.
Single screw mounting.


## BPC313

Two Way Triple Entry 40A Porcelain Connector Block.
Dimensions: $51 \times 30 \times 22 \mathrm{~mm}$. Terminal tunnel: 5.8 mm diameter.
Tunnels accommodate up to $10 \mathrm{~mm}^{2}$ cables.
Two screw mounting at 18 mm centres.


## Connector Strips

## BP2

Twelve Terminal Two Way 20A Connector Strip.
Dimensions: $122 \times 17 \times 16 \mathrm{~mm}$.
Two screws per tunnel.
Terminal tunnel: 3.5 mm diameter.
Tunnels accommodate up to $4 \mathrm{~mm}^{2}$ cables.
Terminals may be cut into single units.
Temperature rating: $190^{\circ} \mathrm{C}$ maximum.


## BP3

Twelve Terminal Two Way 20A Connector Strip.
Dimensions: $139 \times 17 \times 16 \mathrm{~mm}$.
Two screws per tunnel.
Terminal tunnel: 3.5 mm diameter.
Tunnels accommodate up to $4 \mathrm{~mm}^{2}$ cables.
Mounting holes provided in each terminal pair.
Mounting hole centres: 23 mm .
Terminals may be cut into paired units.
Temperature rating: $190^{\circ} \mathrm{C}$ maximum.


## BP6

Six Terminal Heavy Duty Two Way 110A Connector Strip.
Dimensions: $110 \times 40 \times 25 \mathrm{~mm}$.
Two screws per tunnel.
Terminal tunnel: 7 mm diameter.
Tunnels accommodate up to $25 \mathrm{~mm}^{2}$ cables.
5 mounting holes at 15 mm centres.
Terminals may be cut into single units.
Temperature rating: $190^{\circ} \mathrm{C}$ maximum.


## BP7PP

Twelve Terminal Two Way 20A Connector Strip with insulating platform and pressure plates in all tunnels.


## BP7

Twelve Terminal Two Way 20A
Connector Strip with insulating platform.
Dimensions: $136 \times 25 \times 17 \mathrm{~mm}$.
Two screws per tunnel.
Terminals accommodate up to $4 \mathrm{~mm}^{2}$ cables.
11 mounting holes at 10.6 mm centres.
Terminals may be cut into single units.
Temperature rating: $190^{\circ} \mathrm{C}$ maximum.

The following Connector Strips are twelve terminal, two screws per tunnel,
two way configuration, suitable to be cut down into single units.

| Catalogue Number | Current Rating Amp. | Max. Temp. Rating | Length (mm) | Width (mm) | Height (mm) | Tunnel Diameter (mm) | $\qquad$ | Heat Resisting Material | $\begin{gathered} \hline \begin{array}{c} \text { Certificate } \\ \text { of } \\ \text { Suitability } \end{array} \\ \hline \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| BP526P | 5 | $120^{\circ} \mathrm{C}$ | 97 | 16 | 13 | 3 | $4 \mathrm{~mm}^{2}$ | Nylon | CS/840/N |
| BP558 | 6 | $100^{\circ} \mathrm{C}$ | 112 | 16 | 14 | 3 | $4 \mathrm{~mm}^{2}$ | F/R Polyethylene | CS/840/N |
| BP558P | 6 | $120^{\circ} \mathrm{C}$ | 112 | 16 | 14 | 3 | $4 \mathrm{~mm}^{2}$ | Nylon | CS/840/N |
| BP539 | 10 | $100^{\circ} \mathrm{C}$ | 129 | 20 | 16 | 3 | $4 \mathrm{~mm}^{2}$ | F/R Polyethylene | CS/840/N |
| BP539P | 30 | $120^{\circ} \mathrm{C}$ | 117 | 20 | 16 | 3 | $4 \mathrm{~mm}^{2}$ | Nylon | CS/840/N |
| BP540 | 10 | $190^{\circ} \mathrm{C}$ | 118 | 20 | 16 | 3 | $4 \mathrm{~mm}^{2}$ | Phenolic | CS/840/N |
| BP542 | 30 | $190^{\circ} \mathrm{C}$ | 178 | 29 | 22 | 6 | $16 \mathrm{~mm}^{2}$ | Phenolic | CS/840/N |
| BP543 | 15 | $100^{\circ} \mathrm{C}$ | 133 | 23 | 19 | 4 | $6 \mathrm{~mm}^{2}$ | F/R Polyethylene | CS/840/N |
| BP543P | 15 | $120^{\circ} \mathrm{C}$ | 137 | 23 | 19 | 4 | $6 \mathrm{~mm}^{2}$ | Nylon | CS/840/N |
| BP535 | 30 | $100^{\circ} \mathrm{C}$ | 175 | 28 | 21 | 4 | $16 \mathrm{~mm}^{2}$ | F/R Polyethylene | CS/840/N |
| BP535P | 30 | $120^{\circ} \mathrm{C}$ | 180 | 28 | 21 | 6 | $16 \mathrm{~mm}^{2}$ | Nylon | CS/840/N |
| BP5001 | 60 | $100^{\circ} \mathrm{C}$ | 206 | 37 | 29 | 7 | $16 \mathrm{~mm}^{2}$ | F/R Polyethylene | CS/840/N |

This range of products is designed mainly for use in commercial light fittings.

Each unit carries its own 2, 3, 5 or 10 ampere fuse.

By wiring one to each lighting unit in a large installation, main circuit breakers are not thrown if a fault occurs in one fitting.

Instead only the faulty unit blacks out and may be located quickly for repair.

Spare fuse illustrated (BPF5) not supplied as standard.

Use recommended Blue Point fuse only.

## BP504F2

250V Three Terminal Block with 2 amp. cartridge fuse.

## BP504F3

As above with 3 amp . cartridge fuse.

## BP504F5

As above with 5 amp . cartridge fuse.


## BP504F10

As BP504F2 with 10 amp. cartridge fuse. Colour: White.
Dimensions: $43 \times 33 \times 18 \mathrm{~mm}$. Terminal tunnel: 4 mm diameter. Tunnels accommodate up to $6 \mathrm{~mm}^{2}$ cables.
Single screw mounting. Temperature rating: $120^{\circ} \mathrm{C}$ maximum.

## BP504FS2

250V Three Terminal Block with 2 amp. cartridge fuse, and spigot in base to prevent unit from rotating, while fixing in position or wiring.

## BP504FS3

As above with 3 amp . cartridge fuse.


## BP504FS5

As above with 5 amp . cartridge fuse.

## BP504FS10

As BP504FS2 with 10 amp . cartridge fuse.
Dimensions, cable detail, and temperature rating same as No. BP504F Series.

## Replacement Fuses

## BPF2

2 amp. cartridge fuse. Complies with BS1362, ASTA certified.

## BPF3

3 amp . cartridge fuse.

## BPF5

5 amp . cartridge fuse.

## BPF10

10 amp . cartridge fuse.
Dimensions: 25 mm long $\times 6 \mathrm{~mm}$ diameter.


## BPT1

500V 90A 4 Hole Link. Two screws per tunnel. Black base and cover.
Dimensions: $52 \times 40 \times 39 \mathrm{~mm}$.
Terminal tunnels: 5.5 mm diameter.
Tunnels accommodate up to $16 \mathrm{~mm}^{2}$ cables.
Base mounting centres: 22 mm .
Available in red to special order.
Temperature rating: $190^{\circ} \mathrm{C}$ maximum.

## BPT1LC

As above less cover.
Overall height: 20 mm .
Standard colour: Black.
Available in red to special order.

## BPT2

500V 140A 4 Hole Link, Electro Tin Plate. Two screws per tunnel. Black base and cover.
Dimensions: $58 \times 40 \times 40 \mathrm{~mm}$.
3 terminal tunnels: 7.6 mm accommodate up to $25 \mathrm{~mm}^{2}$ cables. 1 terminal tunnel: 8.3 mm accommodates up to $35 \mathrm{~mm}^{2}$ cables. Base mounting centres: 21 mm . Available in red to special order. Temperature rating $190^{\circ} \mathrm{C}$ maximum.


## BPT2LC

As above less cover.
Overall height: 22 mm .
Standard colour: Black. Available in red to special order.

## BPT6

500V 140A 6 Hole Link. Two screws per tunnel. Black base and cover.
Dimensions: $58 \times 40 \times 40 \mathrm{~mm}$.
6 terminal tunnels: 7.6 mm accommodate up to $25 \mathrm{~mm}^{2}$ cables. Base mounting centres: 21 mm . Available in red to special order. Temperature rating: $190^{\circ} \mathrm{C}$ maximum.


## BPLS20

500V 80A 20 Hole Link. Two screws per tunnel.
Dimensions: $90 \times 75 \times 46 \mathrm{~mm}$. Terminal tunnels: 5.5 mm diameter. Tunnels accommodate up to $16 \mathrm{~mm}^{2}$ cables.
Base mounting centres: 64 mm . Standard colour: Black.
Temperature rating: $190^{\circ} \mathrm{C}$ maximum.


## BPL20LC

As above less cover.
Overall height: 29 mm .
Standard colour: Black.

## BPL9LC

As above less cover.
Overall height: 16 mm .
Standard colour: Black.

## BPL9

250V 62A 9 Hole Round Link. 2 tunnels with two screws per tunnel. 7 tunnels with one screw per tunnel. Black base and cover.
Dimensions: 50 mm diameter. 36 mm high.
Terminal tunnels: 4.8 mm diameter.
Tunnels accommodate up to $10 \mathrm{~mm}^{2}$ cables. Temperature rating: $190^{\circ} \mathrm{C}$ maximum.


## HEAVY DUTY LINKS

## BP165/7

500V 165A 7 Hole Link.


## BP165/7ETP

500V 165A 7 Hole Link with tin-plate link and screws. Two screws per tunnel. Black unbreakable, transparent polycarbonate base and cover.
Dimensions: $100 \times 43 \times 40 \mathrm{~mm}$. Terminal bar: $16 \times 16 \times 76 \mathrm{~mm}$. 2 tunnels: 9.5 mm diameter accommodate $50 \mathrm{~mm}^{2}$ cables. 1 tunnel: 8.0 mm diameter accommodates $35 \mathrm{~mm}^{2}$ cable. 2 tunnels: 7.1 mm diameter accommodate $25 \mathrm{~mm}^{2}$ cables. 2 tunnels: 5.5 mm diameter accommodate $16 \mathrm{~mm}^{2}$ cables. Mounting centres: $71 \times 29 \mathrm{~mm}$. Available in red.

## BP165/7BW

500V 165A 7 Hole Back Wiring Link.
2 terminal tunnels: 9.5 mm diameter accommodate $50 \mathrm{~mm}^{2}$ cable, have single screw connection.
5 remaining terminals have 2 screws per tunnel. See BP165/7 above. Temperature rating: $120^{\circ} \mathrm{C}$ maximum.

## BP165/13

500V 165A 13 Hole Link. Two screws per tunnel. Black unbreakable, transparent polycarbonate base and cover.
Dimensions: $120 \times 47 \times 52 \mathrm{~mm}$. Terminal Bar: $19 \times 16 \times 95.3 \mathrm{~mm}$. 2 tunnels: 9.5 mm diameter accommodate $50 \mathrm{~mm}^{2}$ cable. 5 tunnels: 6.4 mm diameter accommodate $16 \mathrm{~mm}^{2}$ cable. 6 tunnels: 4.8 mm diameter accommodate $10 \mathrm{~mm}^{2}$ cable. Mounting centres: $90 \times 34 \mathrm{~mm}$. Available in red.
Temperature rating: $125^{\circ} \mathrm{C}$ maximum.


## BP165/13ETP

Same as BP165/13 with electro tinplate link and screws.

## BP350/7

500V 7 Hole Link. Incoming cables clamped with single grub screw. Supplied with Allen key. Two screws per take off tunnel. Black base and cover.
Dimensions: $120 \times 47 \times 52 \mathrm{~mm}$. Terminal bar: $25.4 \times 19 \times 95.3 \mathrm{~mm}$. 2 tunnels: 15.0 mm diameter accommodate $120 \mathrm{~mm}^{2}$ cables. 2 tunnels: 9.5 mm diameter accommodate $50 \mathrm{~mm}^{2}$ cables. 2 tunnels: 8.0 mm diameter accommodate $35 \mathrm{~mm}^{2}$ cables. 1 tunnel: 5.5 mm diameter accommodates $16 \mathrm{~mm}^{2}$ cables. Mounting centres: $90 \times 34 \mathrm{~mm}$. Available in red.
Temperature rating $125^{\circ} \mathrm{C}$ maximum.


## BP350/7ETP

Same as BP350/7 with electro tinplate link and screws.

## BP350/13

500V 13 Hole Link. Incoming cables clamped with single grub screw. Supplied with Allen key. Two screws per take off tunnel. Black unbreakable, transparent polycarbonate base and cover.
Dimensions: $120 \times 47 \times 52 \mathrm{~mm}$. Terminal bar: $25.4 \times 19 \times 95.3 \mathrm{~mm}$. 2 tunnels: 15.0 mm diameter accommodate $120 \mathrm{~mm}^{2}$ cables. 1 tunnel: 8.0 mm diameter accommodates $35 \mathrm{~mm}^{2}$ cable. 8 tunnels: 5.5 mm diameter accommodate $16 \mathrm{~mm}^{2}$ cable. 2 tunnels: 4.8 mm diameter accommodate $10 \mathrm{~mm}^{2}$.
Mounting centres: $90 \times 34 \mathrm{~mm}$. Available in red.
Temperature rating: $125^{\circ} \mathrm{C}$ maximum.


## BP350/13ETP

Same as BP350/13 with electro tin-plate link and screws.

## LINK BARS

## BP90A Series 90A Link Bars.

Bar Section: $13 \times 9.5 \mathrm{~mm}$.
Bars have two 5.5 mm diameter tunnels with two screws, for up to $16 \mathrm{~mm}^{2}$ cables.
One 5.2 mm diameter tunnel with two screws for M.E.N.
All other tunnels 5.2 mm diameter with one screw to accommodate up to $16 \mathrm{~mm}^{2}$ cables.
Single screw tunnels are numbered.


BP165A Series 165A Link Bars Bar Section: $19 \times 9.5 \mathrm{~mm}$.
Bars have two $3 / 8$ " hexagon head bolts, for up to 165 amp . cable lugs.
One 5.8 mm diameter tunnel with two screws for M.E.N.
All other tunnels 5.8 mm diameter with one screw to accommodate up to $16 \mathrm{~mm}^{2}$ cables.
Single screw tunnels are numbered.
Available electro tin-plated.


## BP165B Series 165A Link Bars

 Bar Section: $19 \times 9.5 \mathrm{~mm}$.Bars have one $3 / 8^{\prime \prime}$ hexagon head bolt for up to 165 amp cable lug. One tunnel 5.8 mm diameter, with two screws for M.E.N.
All other tunnels 5.8 mm diameter with one screw to accommodate up to $16 \mathrm{~mm}^{2}$ cables.
Single screw tunnels are numbered.
 Available electro tin-plated.
Un-numbered bars available on request.

| Catalogue <br> Number | Single Screw <br> Tunnels | Overall <br> Length $(\mathrm{mm})$ |
| :--- | :---: | :---: |
| BP90A6 | 6 | 72 |
| BP90A12 | 12 | 110 |
| BP90A18 | 18 | 148 |
| BP90A24 | 24 | 186 |
| BP90A30 | 30 | 224 |
| BP90A36 | 36 | 262 |


| Catalogue <br> Number | Single Screw <br> Tunnels | Overall <br> Length $(\mathrm{mm})$ |
| :--- | :---: | :---: |
| BP165A12 | 12 | 145 |
| BP165A18 | 18 | 188 |
| BP165A24 | 24 | 230 |
| BP165A30 | 30 | 273 |
| BP165A36 | 36 | 315 |
| BP165A42 | 42 | 358 |
| BP165A48 | 48 | 401 |
| BP165A54 | 54 | 443 |
| BP165A60 | 60 | 486 |
| BP165A72 | 72 | 571 |
| BP165A80 | 80 | 628 |
| BP165A84 | 84 | 656 |


| Catalogue <br> Number | Single Screw <br> Tunnels | Overall <br> Length (mm) |
| :--- | :---: | :---: |
| BP165B12 | 12 | 123 |
| BP165B18 | 18 | 165 |
| BP165B24 | 24 | 208 |
| BP165B30 | 30 | 250 |
| BP165B36 | 36 | 293 |
| BP165B42 | 42 | 336 |
| BP165B48 | 48 | 378 |
| BP165B54 | 54 | 421 |
| BP165B60 | 60 | 463 |
| BP165B72 | 72 | 549 |
| BP165B80 | 80 | 605 |
| BP165B84 | 84 | 633 |

BP165C Series 165A Link Bars Bar Section: $19 \times 9.5 \mathrm{~mm}$.

Bars have one $3 / 8$ " hexagon head bolt for up to 165 amp cable lug. All tunnels 5.8 mm diameter with two screws to accommodate up to $16 \mathrm{~mm}^{2}$ cables.
Tunnels are numbered.
Available electro tin-plated.


BP165D Series 165A Link Bars Bar Section: $19 \times 9.5 \mathrm{~mm}$.
Bars have two $3 / 8$ " hexagon head bolts, for up to 165 amp . cable lugs. All tunnels 5.8 mm diameter with two screws accommodating up to $16 \mathrm{~mm}^{2}$ cables.
Tunnels all numbered.
Electro bars available on request.


| Catalogue <br> Number | Double Screw <br> Tunnels | Overall <br> Length (mm) |
| :--- | :---: | :---: |
| BP165C6 | 6 | 95 |
| BP165C12 | 12 | 116 |
| BP165C18 | 18 | 158 |
| BP165C24 | 24 | 201 |
| BP165C30 | 30 | 243 |
| BP165C36 | 36 | 286 |
| BP165C42 | 42 | 329 |
| BP165C48 | 48 | 371 |
| BP165C54 | 54 | 414 |
| BP165C60 | 60 | 456 |
| BP165C72 | 72 | 542 |
| BP165C80 | 80 | 598 |
| BP165C84 | 84 | 627 |


| Catalogue <br> Number | Double Screw <br> Tunnels | Overall <br> Length $(\mathbf{m m})$ |
| :--- | :---: | :---: |
| BP165D6 | 6 | 95 |
| BP165D12 | 12 | 138 |
| BP165D18 | 18 | 180 |
| BP165D24 | 24 | 223 |
| BP165D30 | 30 | 266 |
| BP165D36 | 36 | 308 |
| BP165D42 | 42 | 351 |
| BP165D48 | 48 | 393 |
| BP165D54 | 54 | 436 |
| BP165D60 | 60 | 478 |
| BP165D72 | 72 | 564 |
| BP165D80 | 80 | 621 |
| BP165D84 | 84 | 650 |

Un-numbered bars on request.

## BP165D18 Series 165A Link

## Bars

Bar Section: $19 \times 9.5 \mathrm{~mm}$.
Bars have two $3 / 8^{\prime \prime}$ hexagon head bolts, for up to 165 amp cable lugs. All tunnels 5.8 mm diameter with two screws, accommodate up to $16 \mathrm{~mm}^{2}$ cables.
Tunnels all numbered.
Available on request.

## Stud Connection

8 mm and 9.5 mm Threaded Studs soldered in bars with hexagonal lock nuts.

## Line Taps

Blue Point No. BP22, BP24, BP25, BP26 and BP28 Line Taps may also be incorporated if required.

## Alternative Connections for Link

Most Link Bars in the BP165A, BP165B, BP165C, BP165D and BPN Series are available with various types of connections if required.

BPM90 Series 90A Link Bars
Bar section: $13 \times 13 \mathrm{~mm}$.
All tunnels 5.6 mm diameter with two screws accommodating up to $16 \mathrm{~mm}^{2}$ cables.
Tunnels not numbered.
Available electro tin-plated.


BPM165 Series 165A Link Bars
Bar section: $16 \times 16 \mathrm{~mm}$.
One 9.5 mm tunnel with two screws for up to $50 \mathrm{~mm}^{2}$ cable.
One 8 mm tunnel with two screws for up to $25 \mathrm{~mm}^{2}$ cable.
All other tunnels 5.5 mm with two screws to accommodate up to $16 \mathrm{~mm}^{2}$ cables.
All tunnels are numbered.


## BPNT350 Series Link Bars

Bar section $25 \times 19 \mathrm{~mm}$.
One 15 mm tunnel with one socket grub screw for up to $120 \mathrm{~mm}^{2}$ cable. Supplied with Allen key.
One two screw tunnel to accommodate up to $50 \mathrm{~mm}^{2}$ cable.
One two screw tunnel to accommodate up to $25 \mathrm{~mm}^{2}$ cable. All other tunnels with two screws to accommodate up to $16 \mathrm{~mm}^{2}$ cables.
All tunnels are numbered.


## BPN350 Series Link Bars

Bar section: $25 \times 13 \mathrm{~mm}$.
One $1 / 2^{\prime \prime}$ hexagon head stud for 320A cable lug. One 3/8" hexagon head stud for 165A cable lug. One two screw tunnel to accommodate $25 \mathrm{~mm}^{2}$ cable. All other tunnels with two screws to accommodate up to $16 \mathrm{~mm}^{2}$ cable. Tunnels are all numbered.


| Catalogue <br> Number | Double Screw <br> Tunnels | Overall <br> Length $(\mathbf{m m})$ |
| :--- | :---: | :---: |
| BPM90/6 | 6 | 69 |
| BPM90/12 | 12 | 126 |
| BPM90/18 | 18 | 183 |
| BPM90/24 | 24 | 240 |
| BPM90/30 | 30 | 298 |
| BPM90/36 | 36 | 354 |


| Catalogue <br> Number | Double Screw <br> Tunnels | Overall <br> Length $(\mathbf{m m})$ |
| :--- | :---: | :---: |
| BPM165/6 | 6 | 94 |
| BPM165/12 | 12 | 136 |
| BPM165/18 | 18 | 178 |
| BPM165/24 | 24 | 220 |
| BPM165/30 | 30 | 262 |
| BPM165/36 | 36 | 304 |


| Catalogue <br> Number | Double Screw <br> Tunnels | Overall <br> Length (mm) |
| :--- | :---: | :---: |
| BPNT350/6 | 6 | 105 |
| BPNT350/12 | 12 | 147 |
| BPNT350/18 | 18 | 189 |
| BPNT350/24 | 24 | 231 |
| BPNT350/30 | 30 | 273 |
| BPNT350/36 | 36 | 315 |
| BPNT350/50 | 50 | 413 |
| BPNT350/60 | 60 | 483 |


| Catalogue <br> Number | Double Screw <br> Tunnels | Overall <br> Length (mm) |
| :--- | :---: | :---: |
| BPN350/6 | 6 | 126 |
| BPN350/12 | 12 | 168 |
| BPN350/18 | 18 | 210 |
| BPN350/24 | 24 | 252 |
| BPN350/30 | 30 | 294 |
| BPN350/36 | 36 | 336 |
| BPN350/42 | 42 | 381 |
| BPN350/50 | 50 | 437 |

## MEN Bare Links (Victoria Type) Light Duty

## BPLD Series Bare Link Bars

Bar section $10.5 \times 10.5 \mathrm{~mm}$.
Two 3/16" screws with washers for incoming cables.
All 4 mm diameter tunnels with single screw to accommodate up to $6 \mathrm{~mm}^{2}$ cables.
All tunnels are numbered.
Mounting holes 4 mm diameter and countersunk.


## MEN Bare Links (Victoria Type) Medium Duty

## BPMD Series Bare Link Bars

Bar section $13 \times 10 \mathrm{~mm}$.
One $1 / 4$ " screw with washer and one No.BP22 Line Tap provided for incoming cables.
All 4 mm diameter tunnels with single screw for up to $6 \mathrm{~mm}^{2}$ cables.
All tunnels are numbered.
Mounting holes 4 mm diameter and countersunk.


| Catalogue <br> Number | Single Screw <br> Tunnels | Overall <br> Length $(\mathrm{mm})$ |
| :--- | :---: | :---: |
| BPLD2 | 2 | 61 |
| BPLD3 | 3 | 68 |
| BPLD4 | 4 | 75 |
| BPLD5 | 5 | 82 |
| BPLD6 | 6 | 89 |
| BPLD7 | 7 | 96 |
| BPLD8 | 8 | 104 |
| BPLD9 | 9 | 110 |
| BPLD10 | 10 | 118 |
| BPLD11 | 11 | 125 |
| BPLD12 | 12 | 132 |
| BPLD13 | 13 | 139 |
| BPLD14 | 14 | 146 |
| BPLD15 | 15 | 154 |
| BPLD16 | 16 | 161 |
| BPLD18 | 18 | 175 |
| BPLD20 | 20 | 189 |
| BPLD22 | 22 | 203 |
| BPLD24 | 24 | 217 |
| BPLD30 | 30 | 259 |
| BPLD36 | 36 | 303 |


| Catalogue <br> Number | Single Screw <br> Tunnels | Overall <br> Length $(\mathrm{mm})$ |
| :--- | :---: | :---: |
| BPMD3 | 3 | 80 |
| BPMD4 | 4 | 86 |
| BPMD5 | 5 | 92 |
| BPMD6 | 6 | 98 |
| BPMD7 | 7 | 106 |
| BPMD8 | 8 | 113 |
| BPMD9 | 9 | 120 |
| BPMD10 | 10 | 127 |
| BPMD12 | 12 | 142 |
| BPMD14 | 14 | 156 |
| BPMD15 | 15 | 163 |
| BPMD18 | 18 | 184 |
| BPMD20 | 20 | 208 |
| BPMD24 | 24 | 227 |
| BPMD25 | 25 | 234 |
| BPMD26 | 26 | 241 |
| BPMD30 | 30 | 271 |
| BPMD36 | 36 | 312 |

## MEN Bare Links (Victoria

 Type) Heavy Duty
## BPHD Series Bare Link Bars

Bar section $19 \times 10 \mathrm{~mm}$.
One $5 / 16$ " screw with washer and one No. BP24 Line Tap provided for incoming cables.
All 4.4 mm diameter tunnels with single screw for up to $10 \mathrm{~mm}^{2}$ cables. All tunnels are numbered.
Mounting holes are 5.2 mm diameter and countersunk.


| Catalogue <br> Number | Single Screw <br> Tunnels | Overall <br> Length (mm) |
| :--- | :---: | :---: |
| BPHD5 | 10 | 120 |
| BPHD6 | 12 | 130 |
| BPHD7 | 14 | 140 |
| BPHD8 | 16 | 150 |
| BPHD9 | 18 | 159 |
| BPHD10 | 20 | 168 |
| BPHD12 | 24 | 188 |
| BPHD15 | 30 | 218 |
| BPHD16 | 32 | 228 |
| BPHD18 | 36 | 244 |
| BPHD20 | 40 | 263 |
| BPHD24 | 48 | 300 |
| BPHD25 | 50 | 310 |
| BPHD30 | 60 | 360 |
| BPHD33 | 66 | 390 |
| BPHD36 | 72 | 417 |

## Medium Duty Neutral Bars <br> With $2 \times$ BP22 Line Taps Front Wiring

## BPMD2/10 Series

Complete with $2 \times$ BP22 Line Taps. $13 \times 9.5 \mathrm{~mm}$ brass.

All bars have 1-1/4 Whitworth screw with flat brass washer and 2 number BPMD2 Line Taps provided for incoming cables ( $16 \mathrm{~mm}^{2}$ ).
All 4 mm diameter tunnels with single screw per tunnel for up to $6 \mathrm{~mm}^{2}$ cable.
All tunnels are numbered.
Two 4 mm diameter countersunk recessed fixing holes.
Back wired neutral bar.


## Bare Links with Mounting Blocks

## BPQL Series

90A Link Bars with moulded mounting blocks. (BP165FD)
Bar section $13 \times 13 \mathrm{~mm}$.
Temperature rating: $190^{\circ} \mathrm{C}$ maximum. Two $1 / 4$ " hexagon head studs for 90 ampere cable lugs.
All 5.5 diameter tunnels with single screw to accommodate up to $16 \mathrm{~mm}^{2}$ cables.
All tunnels are numbered.


| Catalogue <br> Number | Single Screw <br> Tunnels | Overall <br> Length (mm) |
| :--- | :---: | :---: |
| BPMD2/3 | 3 | 105 |
| BPMD2/4 | 4 | 111 |
| BPMD2/5 | 5 | 121 |
| BPMD2/7 | 7 | 135 |
| BPMD2/9 | 9 | 150 |
| BPMD2/10 | 10 | 157 |
| BPMD2/12 | 12 | 174 |
| BPMD2/15 | 15 | 195 |
| BPMD2/18 | 18 | 219 |
| BPMD2/20 | 20 | 235 |
| BPMD2/24 | 24 | 268 |
| BPMD2/25 | 25 | 275 |
| BPMD2/30 | 30 | 313 |
| BPMD2/36 | 36 | 357 |


| Catalogue <br> Number | Single Screw <br> Tunnels | Overall <br> Length $(\mathbf{m m})$ |
| :--- | :---: | :---: |
| BPQL12 | 12 | 143 |
| BPQL18 | 18 | 182 |
| BPQL24 | 24 | 219 |
| BPQL30 | 30 | 257 |
| BPQL36 | 36 | 295 |
| BPQL48 | 48 | 363 |
| BPQL50 | 50 | 383 |
| BPQL60 | 60 | 447 |

## Line Taps

Line Taps can be drilled, tapped and fitted with screws on request.

BP22
Line Tap for $16 \mathrm{~mm}^{2}$ cables.
Overall length 30 mm .


## BP22ETP

As above but electro tin-plated.

## BP24

Line Tap for $35 \mathrm{~mm}^{2}$ cables.
Overall length 35 mm .

## BP24ETP

As above but electro tin-plated.

## BP25

Line Tap for $50 \mathrm{~mm}^{2}$ cables.
Overall length 44mm.

## BP25ETP

As above but electro tin-plated.

## BP26

Line Tap for $95 \mathrm{~mm}^{2}$ cables.
Overall length 50 mm .

## BP26ETP

As above but electro tin-plated.

## BP28

Line Tap for $185 \mathrm{~mm}^{2}$ cables.
Overall length 67 mm .

## BP28ETP

As above but electro tin-plated.

## Moulded Mounting Blocks for Bare Links

## BP165F

Moulded Mounting Block for mounting bare links to switchboard panels.
Space bars 12.7 mm from panels. Sold singularly with two $16 \mathrm{~mm} x$ $5 / 32$ " Whitworth screws to fit the pre-tapped holes in the rear of the Link Bars.
Overall dimensions $45 \times 18 \times 16 \mathrm{~mm}$.
Temperature rating: $190^{\circ} \mathrm{C}$ maximum.


## BP165FD

Moulded Mounting Block for mounting bare links to switchboard panels.

## 2BPAC Series 165 Ampere Front Wiring with 2 Studs for Cable Lugs

## Compact Type

## 2BPAC Series

$19 \times 9.5 \mathrm{~mm}$ brass.
All bars have two $3 / 8$ " Whitworth hexagonal head studs with spring washer for up to 165 ampere cable lugs.
All side tunnels 5.9 mm diameter with one screw per tunnel to accommodate up to $16 \mathrm{~mm}^{2}$ cable.
All tunnels are numbered.
Two 5/32" Whitworth tapped fixing holes suitable for BP165FD Insulating Feet.
Front Wired Neutral Bar.


Space bars 21 mm from panels.
Sold singularly with two $16 \mathrm{~mm} x$ $5 / 32$ " Whitworth screws to fit the pre-tapped hole in the rear of the Link Bar.
Overall dimensions $45 \times 18 \times 24 \mathrm{~mm}$.

Block Hinge Sets BPBHS
Brass chrome plated. For electrical cabinets.
1 hinge set = 2 hinge pairs.
Tapped holes 1/4" Whitworth at 27 mm centres.


## BPAH Series - 220 Ampere, Front Wiring Neutral Bars with 2 Studs for Cable Lugs

## BPAH Series

220 Amp. Neutral Bars, front wiring with $2-3 / 8$ " Whitworth hexagon head studs for cable lugs and tunnels with single screw, for up to $10 \mathrm{~mm}^{2}$ cables.
All tunnels are numbered. 2 mounting holes $5 / 32$ " Whitworth Brass section: $19 \times 13 \mathrm{~mm}$


BPAHE Series - 220 Ampere Front Wiring, Earth Bars with 2 Studs for Cable Lugs

## BPAHE Series

220 Amp. Earth Bars, front wiring 3/8" Whitworth hexagon head studs for cable lugs and tunnels with two screws, for up to $10 \mathrm{~mm}^{2}$ cable.
Tunnels are not numbered. 2 mounting holes 4 mm diameter, countersunk.
Brass section: $19 \times 13 \mathrm{~mm}$


| Catalogue <br> Number | Single Screw <br> Tunnels | Overall <br> Length $(\mathbf{m m})$ |
| :--- | :---: | :---: |
| BPAH6 | 6 | 110 |
| BPAH12 | 12 | 145 |
| BPAH18 | 18 | 183 |
| BPAH24 | 24 | 221 |
| BPAH30 | 30 | 259 |
| BPAH36 | 36 | 297 |
| BPAH42 | 42 | 335 |
| BPAH48 | 48 | 374 |
| BPAH60 | 60 | 449 |
| BPAH80 | 80 | 580 |

Bars are available with extra studs.

| Catalogue <br> Number | Double Screw <br> Tunnels | Overall <br> Length $(\mathrm{mm})$ |
| :--- | :---: | :---: |
| BPAHE6 | 6 | 110 |
| BPAHE12 | 12 | 145 |
| BPAHE18 | 18 | 183 |
| BPAHE24 | 24 | 221 |
| BPAHE30 | 30 | 259 |
| BPAHE36 | 36 | 297 |
| BPAHE42 | 42 | 335 |
| BPAHE48 | 48 | 374 |
| BPAHE54 | 54 | 412 |
| BPAHE60 | 60 | 449 |
| BPAHE80 | 80 | 580 |

Bars are available with extra studs.

## BPML Series Mini Link Bars 55 Ampere Front Wiring

## BPML Series

$13 \times 9.5 \mathrm{~mm}$ brass. 55 amp .
All 5 mm side tunnel holes.
Two screws per tunnel. 1-4mm clear fixing hole.
Bar able to accommodate up to $10 \mathrm{~mm}^{2}$ cable.
Bar not numbered.
Front Wired Bar.


BPE Series Medium Duty Earth Bars, 90 Ampere Front Wiring

## BPE Series

90 Amp. Earth Bar. $13 \times 13 \mathrm{~mm}$ brass.
Two front tunnels 7 mm diameter to take $16 \mathrm{~mm}^{2}$ cable.
Two screws per tunnel.
Bar not numbered.
Following tunnels 5 mm diameter to take up to $10 \mathrm{~mm}^{2}$ cable, two screws per tunnel, two tapped 3/16" Whitworth fixing holes at side of bar.
Front Wired Earth Bar.


## BPMDFW Series Medium Duty Neutral Bars 90 Ampere Front Wiring

## BPMDFW6 Series

90 Amp. Neutral Bar. $13 \times 13$ brass.
Three front tunnels 7 mm to take up to $25 \mathrm{~mm}^{2}$ cable, two screws per tunnel marked EN1 following tunnels 5 mm diameter to take up to $10 \mathrm{~mm}^{2}$ cable, one screw per tunnel marked with following numbers.
Two M6x1 tapped fixing holes at side of bar.
Front Wired Neutral Bar.


## BPFW Series Light Duty Bars. Front Wiring. Two Front Tunnels 6 mm with 2 Screws

## BPFW Series

$13 \times 9.5 \mathrm{~mm}$ brass.
Two front tunnels 6 mm diameter to take $16 \mathrm{~mm}^{2}$ cable.
Two screws per tunnel.
Numbered tunnels 4.3 mm diameter to take $10 \mathrm{~mm}^{2}$ cable.
One screw per tunnel. Two 3/16" Whitworth tapped fixing holes.
Fixing hole centres 66 mm apart to all BPFW sizes.


| Catalogue <br> Number | Single Screw <br> Tunnels | Overall <br> Length (mm) |
| :--- | :---: | :---: |
| BPMDFW6 | 6 | 80 |
| BPMDFW9 | 9 | 100 |
| BPMDFW12 | 12 | 127 |
| BPMDFW15 | 15 | 142 |
| BPMDFW18 | 18 | 163 |
| BPMDFW21 | 21 | 185 |


| Catalogue <br> Number | Single Screw <br> Tunnels | Overall <br> Length $(\mathbf{m m})$ |
| :--- | :---: | :---: |
| BPFW6 | 6 | 90 |
| BPFW8 | 8 | 90 |
| BPFW9 | 9 | 95 |
| BPFW10 | 10 | 103 |
| BPFW12 | 12 | 116 |
| BPFW15 | 15 | 135 |
| BPFW18 | 18 | 154 |
| BPFW21 | 21 | 173 |


| Catalogue <br> Number | Double Screw <br> Tunnels | Overall <br> Length (mm) |
| :--- | :---: | :---: |
| BPML4 | 4 | 38 |
| BPML5 | 5 | 44 |
| BPML6 | 6 | 52 |


| Catalogue <br> Number | Double Screw <br> Tunnels | Overall <br> Length $(\mathbf{m m})$ |
| :--- | :---: | :---: |
| BPE6 | 6 | 80 |
| BPE12 | 12 | 118 |

## BPP Series Light Duty

Bars, Front Wiring with 2

## Studs for Cable Lugs

## BPP Series

$16 \times 9.5 \mathrm{~mm}$ brass.
All bars have two $5 / 6$ " Whitworth hexagon head bolts.
All side tunnels 5 mm diameter with one screw per tunnel to accommodate up to $10 \mathrm{~mm}^{2}$ cables. All tunnels are numbered.
Two 5 mm clear countersunk fixing holes.
Front Wired Bar.


## BPN Series Medium Duty

## Front Wiring Neutral Bars

## BPN Series

$13 \times 13 \mathrm{~mm}$ brass.
Three front tunnels 7 mm diameter to take up to $16 \mathrm{~mm}^{2}$ cable.
Two screws per tunnel, marked ENI following tunnels 5 mm diameter $10 \mathrm{~mm}^{2}$ cable, one screw per tunnel numbered.
Two clear 5 mm fixing holes from top.
Front Wired Neutral Bar.


| Catalogue <br> Number | Single Screw <br> Tunnels | Overall <br> Length (mm) |
| :--- | :---: | :---: |
| BPP12 | 12 | 100 |
| BPP18 | 18 | 124 |
| BPP24 | 24 | 148 |
| BPP30 | 30 | 173 |
| BPP36 | 36 | 195 |
| BPP42 | 42 | 221 |
| BPP48 | 48 | 243 |
| BPP60 | 60 | 292 |
| BPP72 | 72 | 338 |
| BPP84 | 84 | 389 |
| Catalogue |  |  |
| Number | Single Screw | Overall |
| BPN8 | Tunnels | Length (mm) |
| BPN12 | 8 | 93 |
| BPN16 | 12 | 121 |
| BPN24 | 16 | 149 |

## CLIPSAL

NEUTRAL / ACTIVE / METER
LINKS
Clipsal Links are produced from Impact Resistant materials to prevent cracking in transit or during installation.

The transparent covers enable you to check wiring and locate the sealing screw at a glance. The sealing screw (nylon with brass insert) resists stripping. Voltage and amperage ratings are clearly marked on both the cover and brass bar.

All links are available with black or red covers and bases for neutral, active or meter applications as required by local authorities.

## T-Type - 500 Volt 140 <br> Ampere

## L4T35

500V 140A 4 Hole Neutral Link with two screws per tunnel. Black base and cover.

## L4T35R

$500 V$ 140A 4 Hole Active Link. Red base and cover.
Dimensions: $65 \times 46 \times 43 \mathrm{~mm}$. Mounting centres: 28 mm . 1 tunnel 8.7 mm diameter accommodate $1 \times 25 \mathrm{~mm}^{2}$ cable.
3 tunnels 7.7 mm diameter accommodate $1 \times 25 \mathrm{~mm}^{2}$ cable. Certificate of Suitability No. CS2252N.


## Mini Links with Cover

 500V 100A2 screws per tunnel.

## L5

500V 100A 5 Hole Neutral Link with two screws per tunnel. Black base and cover.

## L5R

500V 100A 5 Hole Active Link. Red base and cover.
Dimensions: $65 \times 46 \times 43 \mathrm{~mm}$. Mounting centres: 46 mm . 3 tunnels, 6.3 mm diameter accommodate $1 \times 16 \mathrm{~mm}^{2}$. 2 tunnels, 5.8 mm diameter accommodate $1 \times 16 \mathrm{~mm}^{2}$.

## L5BW

500V 110A 5 Hole Back Wiring Neutral Link with two screws per tunnel. Black base and cover.

## L5BWR

500V 110A 5 Hole Back Wiring Active Link. Red base and cover.
Dimensions: $65 \times 46 \times 43 \mathrm{~mm}$. Mounting centres: 46 mm . 5 tunnels, 7 mm diameter accommodate $1 \times 25 \mathrm{~mm}^{2}$. Transparent black cover, with cut outs.

## L6

500V 100A 6 Hole Neutral Link with two screws per tunnel. Black base and cover.

## L6R

500 V 100A 6 Hole Active Link. Red base and cover.
Dimensions: $65 \times 46 \times 43 \mathrm{~mm}$. Mounting centres: 46 mm . 3 tunnels, 6.3 mm diameter accommodate $1 \times 16 \mathrm{~mm}^{2}$ cable. 3 tunnels, 5.8 mm diameter accommodate $1 \times 16 \mathrm{~mm}^{2}$ cable.

## L6/25

500V 110A 6 Hole Neutral Link with 2 screws per tunnel. Black base and cover.

## L6/25R

$500 V$ 110A 6 Hole Active Link. Red base and cover.
Dimensions: $65 \times 46 \times 43 \mathrm{~mm}$. Mounting centres: 46 mm . 2 tunnels, 7.5 mm diameter accommodate $2 \times 25 \mathrm{~mm}^{2}$ cable. 1 tunnel, 5.5 mm diameter accommodates $1 \times 16 \mathrm{~mm}^{2}$ cable. 3 tunnels, 4.7 mm diameter accommodate $3 \times 10 \mathrm{~mm}^{2}$ cable. Transparent black cover with cut-outs.

## L7

500V 100A 7 Hole Neutral Link with two screws per tunnel. Black base and cover.


## L7R

500V 100A 7 Hole Active Link. Red base and cover.
Dimensions: $65 \times 46 \times 43 \mathrm{~mm}$.
Mounting centres: 46 mm .
3 tunnels, 6.3 mm diameter accommodate $1 \times 16 \mathrm{~mm}^{2}$ cable.
4 tunnels, 5.8 mm diameter accommodate $1 \times 16 \mathrm{~mm}^{2}$ cable.

## L7BW

500V 100A 7 Hole Back Wiring Neutral Link with two screws per tunnel. Black base and cover.

## L7BWR

500V 100A 7 Hole Active Link. Red base and cover.
Dimensions: $65 \times 46 \times 43 \mathrm{~mm}$.
Mounting centres: 46 mm . 2 tunnels, 6.3 mm diameter accommodate $1 \times 16 \mathrm{~mm}^{2}$ cables. 5 tunnels, 5.8 mm diameter accommodate $1 \times 16 \mathrm{~mm}^{2}$ cables. Transparent black cover, with cut-outs.

## L8

500V 100A 8 Hole Neutral Link with two screws per tunnel.
Black base and cover.
Dimensions: $86 \times 57 \times 40 \mathrm{~mm}$.
Mounting centres: $59 \times 67 \mathrm{~mm}$. 3 tunnels, 6.3 mm diameter accommodate $1 \times 16 \mathrm{~mm}^{2}$ cable. 5 tunnels, 5.8 mm diameter accommodate $1 \times 16 \mathrm{~mm}^{2}$ cable.
Transparent black cover with cut-outs.

## L10

500V 100A 10 Hole Neutral Link with two screws per tunnel.
3 tunnels, 6.3 mm diameter accommodate $1 \times 16 \mathrm{~mm}^{2}$ cable. 7 tunnels, 5.8 mm diameter accommodate $1 \times 16 \mathrm{~mm}^{2}$ cable. Dimensions: $86 \times 57 \times 40 \mathrm{~mm}$.


## L10BW

500V 100A 10 Hole Back Wiring Neutral Link with two screws per tunnel.
Dimensions: $86 \times 57 \times 40 \mathrm{~mm}$.

## L12

500 V 100A 12 Hole Neutral Link with two screws per tunnel.
2 tunnels, 6.3 mm diameter accommodate $1 \times 16 \mathrm{~mm}^{2}$ cable.
4 tunnels, 5.5 mm diameter accommodate $1 \times 16 \mathrm{~mm}^{2}$ cable.
6 tunnels, 4.5 mm diameter accommodate $1 \times 10 \mathrm{~mm}^{2}$ cable.
Dimensions: $86 \times 57 \times 40 \mathrm{~mm}$.

## L14

500V 100A 14 Hole Neutral Link with two screws in 8 tunnels and one screw in 6 tunnels.
2 tunnels, 6.3 mm diameter accommodate $1 \times 16 \mathrm{~mm}^{2}$ cable. 6 tunnels, 5.5 mm diameter accommodate $1 \times 16 \mathrm{~mm}^{2}$ cable. 6 tunnels, 4.5 mm diameter accommodate $1 \times 16 \mathrm{~mm}^{2}$ cable. Dimensions: $86 \times 57 \times 40 \mathrm{~mm}$.

## L16

500V 100A 16 Hole Neutral Link with two screws in 6 tunnels and one screw in 10 tunnels.
2 tunnels, 6.3 mm diameter accommodate $1 \times 16 \mathrm{~mm}^{2}$ cable. 4 tunnels, 5.5 mm diameter accommodate $1 \times 16 \mathrm{~mm}^{2}$ cable. 10 tunnels, 4.5 mm diameter accommodate $1 \times 10 \mathrm{~mm}^{2}$ cable. Dimensions: $86 \times 57 \times 40 \mathrm{~mm}$.

## L18

500V 100A 18 Hole Neutral Link with two screws in 6 tunnels and one screw in 12 tunnels.
2 tunnels, 6.3 mm diameter accommodate $1 \times 16 \mathrm{~mm}^{2}$ cable. 4 tunnels, 5.5 mm diameter accommodate $1 \times 16 \mathrm{~mm}^{2}$ cable. 12 tunnels, 4.5 mm diameter accommodate $1 \times 10 \mathrm{~mm}^{2}$ cable. Dimensions: $86 \times 57 \times 40 \mathrm{~mm}$.

## Mini Links Less Cover

500V 100A
Mounting centres: 46 mm .

## L5A

5 Hole - two screws per tunnel.
Black base.


## L6A

6 Hole - two screws per tunnel.
Black base.

## L6RA

6 Hole - two screws per tunnel. Red base.

## L7A

7 Hole - two screws per tunnel.
Black base.
Overall dimensions: $57 \times 30 \times 26 \mathrm{~mm}$.
Mounting centres: 46 mm .
Tunnel and cable detail same as L5 to L7 Series Covered Links.

## Standard Links Less Cover

500V 100A
Mounting centres: 59-67mm.

## L8A

8 Hole - two screws per tunnel.


## L10A

10 Hole - two screws per tunnel.

## L12A

12 Hole - two screws per tunnel.

## L14A

14 Hole - two screws per tunnel.

## L16A

16 Hole - two screws in 6 tunnels, and one screw in 10 tunnels.

## L18A

18 Hole - two screws per tunnel in 6 tunnels, and one screw in 12 tunnels.
Overall dimensions: $80 \times 32 \times 22 \mathrm{~mm}$.
Mounting centres: 59-67mm.
Tunnel and cable detail same as L8 to L18 Series Covered Links.
All link bases are black.

## Brass Link Bars

500V 100A

## L5P

5 Hole - two screws per tunnel.
Length 41 mm .

## L6P

6 Hole - two screws per tunnel.
Length 48 mm .

## L7P

7 Hole - two screws per tunnel.
Length 54 mm .

## L8P

8 Hole - two screws per tunnel. Length 61 mm .


## L10P

10 Hole - two screws per tunnel.
Length 75 mm .

## L12P

12 Hole - two screws per tunnel. Length 80 mm .
Brass bar section: $13 \times 10 \mathrm{~mm}$. Tunnel and cable detail same as L5 to L12 Series Covered Links.

## L14P

14 Hole - two screws in 8 tunnels and one screw in 6 tunnels.


## L16P

16 Hole - two screws in 6 tunnels and one screw in 10 tunnels.

## L18P

18 Hole - two screws in 6 tunnels and one screw in 12 tunnels.
Brass bar section: $19 \times 10 \mathrm{~mm}$ tunnel. Cable detail same as L14 and L18 Series Covered Links.

## Maxi Links with Cover

## 500V 110A

Maxi Links with cover.
Accommodates $25 \mathrm{~mm}^{2}$ cables. 2 screws per tunnel.

## L11/25

500V 110A 11 Hole Front Wiring Neutral Link with two screws per tunnel. Black base and cover.

Dimensions: $108 \times 62 \times 55 \mathrm{~mm}$. Mounting centres: $85 \times 78 \mathrm{~mm}$ and $65 \times 59 \mathrm{~mm}$.
3 tunnels, 8 mm diameter accommodate $25 \mathrm{~mm}^{2}$ cable. 8 tunnels, 6 mm diameter accommodate $16 \mathrm{~mm}^{2}$ cable. Transparent cover with cut-outs.


## L11/25R

500V 110A 11 Hole Front Wiring Active Link.
Red base and cover.

## L11/25BW

500V 110A 11 Hole Back Wiring Neutral Link with two screws per tunnel.

## L11/25BWR

500V 110A 11 Hole Back Wiring Active Link.

## L13/25

500V 110A 13 Hole Front Wiring Neutral Link with two screws per tunnel. Black base and cover.

Dimensions: $108 \times 62 \times 55 \mathrm{~mm}$. Elongated mounting centres: $78-85 \mathrm{~mm}$ and $59-65 \mathrm{~mm}^{2}$. 2 tunnels, 8 mm diameter accommodate $25 \mathrm{~mm}^{2}$ cable. 11 tunnels, 5.5 mm diameter accomodate $16 \mathrm{~mm}^{2}$ cable.
Transparent cover with cut-outs.

## L13/25R

500V 110A 13 Hole Front Wiring Active Link. Red base and cover.

## L13/25BW

500V 110A 13 Hole Back Wiring Neutral Link with two screws per tunnel.

## L13/25BWR

500V 110A 13 Hole Back Wiring Active Link. Red base and cover.

## Maxi Links Less Cover

## 500V 110A

Accommodates $25 \mathrm{~mm}^{2}$ cables. Elongated mounting centres: $78-85 \mathrm{~mm}$ and 59-65mm. 2 screws per tunnel.

L11/25A
11 Hole - two screws per tunnel.


## L11/25BWA

11 Hole Back Wiring - two screws per tunnel. Black base.

## L13/25A

13 Hole - two screws per tunnel. Black base.

## L13/25BWA

13 Hole Back Wiring - two screws per tunnel. Black base.
Overall dimensions:
$100 \times 30 \times 24 \mathrm{~mm}$.
Elongated mounting centres: $78-85 \mathrm{~mm}$ and $59-65 \mathrm{~mm}$. Tunnel and cable detail same as L11/25 to L13/25BW Series Covered

| Iunnel Diameters |  |  |  |
| :--- | :---: | :---: | :---: |
| Catalogue <br> Number | 8 mm <br> for $25 \mathrm{~mm}^{2}$ <br> cable | $\mathbf{6 m m}$ <br> for $16 \mathrm{~mm}^{2}$ <br> cable | $\mathbf{5 . 5 m m}$ <br> for $16 \mathrm{~mm}^{2}$ <br> cable |
| L11/25 | 3 | 8 | - |
| L11/25BW | 3 | 8 | - |
| L13/25 | 2 | - | 11 |
| L13/25BW | 2 | - | 11 |

## Maxi Brass Link Bars only

500V 110A

## L11/25P

11 Hole - two screws per tunnel. Length 98mm.


## L11/25BWP

11 Hole Back Wiring - two screws per tunnel. Length 98 mm .

## L13/25P

13 Hole Back Wiring - two screws per tunnel. Length 98 mm .

## L13/25BWP

13 Hole Back Wiring - two screws per tunnel.
Length 98mm.
Brass Bar Section: 13mm square.
Tunnel and cable detail same as
L11/25 to L13/25BW Series Covered Links.

## Maxi Links with Cover

## 500V 140A

Accommodate $35 \mathrm{~mm}^{2}$ cables. 2 screws per tunnel.

## L10/35

500V 140A 10 Hole Front Wiring
Neutral Link - two screws per tunnel.
Black base and cover.
Dimensions: $108 \times 62 \times 55 \mathrm{~mm}$.
Elongated mounting centres:
$78-85 \mathrm{~mm}$ and $59-65 \mathrm{~mm}$.
3 tunnels, 9 mm diameter accommodate $35 \mathrm{~mm}^{2}$ cable. 7 tunnels, 6 mm diameter accommodate $16 \mathrm{~mm}^{2}$.
Transparent cover with cut-outs.


## L10/35R

500V 140A 10 Hole Front Wiring Active Link. Red base and cover. Maxi Link Less Cover.

## 500V 140A

Accommodate $35 \mathrm{~mm}^{2}$ cables. 2 screws per tunnel.

Elongated mounting centres: $78-85 \mathrm{~mm}$ and $59-65 \mathrm{~mm}$.

## L10/35A

10 hole - two screws per tunnel.
Black base.
Overall dimensions: $100 \times 30 \times 24 \mathrm{~mm}$ tunnel. Cable detail and mounting centres same as L10/35 Series Covered Links.


## Maxi Links with Cover

## 500V 370A

Accommodate $150 \mathrm{~mm}^{2}$ cables.

## L7/150

500V 370A 7 Hole Front Wiring Neutral Link. Black base and cover.
Dimensions: $162 \times 53 \times 55 \mathrm{~mm}$.
2 tunnels, 17 mm diameter accommodate $150 \mathrm{~mm}^{2}$ cable.
1 tunnel, 15.5 mm diameter accommodate $120 \mathrm{~mm}^{2}$ cable.
2 tunnels, 10 mm diameter accommodate $50 \mathrm{~mm}^{2}$ cable. 2 tunnels, 5.9 mm diameter accommodate $16 \mathrm{~mm}^{2}$ cable. Supplied with Allen key.

## L7/150R

500V 370A 7 Hole Front Wiring Active Link. Red base and cover.

## L7/150BW

500V 370A 7 Hole Back Wiring Neutral Link. Black base and cover.


| Iunnel Diameters |  |  |
| :--- | :---: | :---: |
| Catalogue <br> Number | 9 mm <br> for $35 \mathrm{~mm}^{2}$ <br> cable | 6 mm <br> for $16 \mathrm{~mm}^{2}$ <br> cable |
| L10/35 | 3 | 7 |

## Maxi Brass Link Bars only

## 500V 370A

Accommodate $150 \mathrm{~mm}^{2}$ cables.

## L7/150P

7 Hole Front Wiring. 3 tunnels with socket grub screws. Supplied with Allen key.
4 tunnels with 2 screws per tunnel.
Length 128.5 mm .

## L7/150BWP

7 Hole Back Wiring. Tunnels and cables accommodated details same as L7/150 Series.

Length 94 mm .

## L13/150P

13 Hole Front Wiring.
2 tunnels with socket grub screws.
Supplied with Allen key.
11 tunnels with 2 screws per tunnel.
Length 128.5 mm .


## L7/150BWR

500V 370A 7 Hole Back Wiring Active Link. Red base and cover.
Dimensions, tunnels, cables accommodated, and mounting centres detail same as L7/150 Series, front wiring links.

## L13/150

500V 370A 13 Hole Front Wiring Neutral Link. Black base and cover.

2 tunnels, 17 mm diameter accommodate $150 \mathrm{~mm}^{2}$ cable. 1 tunnel, 9.5 mm diameter accommodate $50 \mathrm{~mm}^{2}$ cable. 4 tunnels, 8 mm diameter accommodate $35 \mathrm{~mm}^{2}$ cable. 6 tunnels, 5.9 mm diameter accommodate $16 \mathrm{~mm}^{2}$ cable.


## L13/150R

500V 370A 13 Hole Front Wiring
Active Link. Red base and cover.

L13/150BW
500V 370A 13 Hole Back Wiring Neutral Link. Black base and cover.

## L13/150BWR

500V 370A 13 Hole Back Wiring Active Link. Red base and cover.
Dimensions and mounting centres detail same as L7/150 Series.

## L13/150BWP

13 Hole Back Wiring.
Tunnels and cables accommodated detail same as L13/150 Series.
Length 128.8mm. Neutral Link.
500V 55A
2 screws per tunnel.

## 1003

500V 55A 3 Hole Front Wiring Neutral Link with two screws per tunnel. Black base and cover.
Dimensions: $54 \times 30 \times 36 \mathrm{~mm}$. 3 tunnels, 5.6 mm diameter accommodate $1 \times 16 \mathrm{~mm}^{2}$ cable. Back wiring models available to special order.


| Tunnel Diameters |  |  |  |  |  |  |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: |
| Catalogue <br> Number | 17 mm <br> for $150 \mathrm{~mm}^{2}$ <br> cable | 15.5 mm <br> for $120 \mathrm{~mm}^{2}$ <br> cable | 10 mm <br> for $50 \mathrm{~mm}^{2}$ <br> cable | 9.5 mm <br> for $50 \mathrm{~mm}^{2}$ <br> cable | 8 mm <br> for $35 \mathrm{~mm}^{2}$ <br> cable | 5.9 mm <br> for $16 \mathrm{~mm}^{2}$ <br> cable |
| L7/150 | 2 | 1 | 2 | - | - | 2 |
| L7/150BW | 2 | 1 | 2 | - | - | 2 |
| L13/150 | 2 | - | - | 1 | 4 | 6 |
| L13/150BW | 2 | - | - | 1 | 4 | 6 |

## SPECIAL <br> BARS

## Special Link

## Requirements

Special Bars are made to order.
For further details contact your Clipsal office or Blue Point.

Special Links can be made to suit special applications or installations as required.


## Please supply

## information on:

- Size and number of cables.
- Covered or bare link.
- Quantity of each type of link required. (No limit on quantity.)
- Space or design limitations.
- Any special equipment to be used on the link eg. stalk lug, pyrotech, bimetal, aluminium cable.
- Is it a Front or Back Wiring Bar?
- Do you require any Line Taps?


## Please specify size.

- What size stud or bolt do you require?
- Do you require any numbering?


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|  | Townsville | $(07) 47293333$ |
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| WA | Perth | $(08) 94424444$ |
| TAS | Launceston | $(03) 63435900$ |
| NT | Darwin | $(08) 89470278$ |

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| :--- | ---: |
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|  | 0418434169 |
|  | 0418686040 |
| South West Sydney | 0419868353 |
| Tamworth | 0417714339 |
| Wagga Wagga | 0418578903 |
| Wollongong | 0418423581 |

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VIC Bendigo
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Gold Coast
Mackay
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0419847732
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Operating Instructions
VLT ${ }^{\oplus}$ AQUA Drive FC 202 0.25-90 kW

Q-Pulse Id: TMS1395

| Safety | $\mathrm{VLT}^{\circledR} \mathrm{AQUA}$ Drive |
| :--- | :--- |
|  | Operating Instructions |

## Safety

## Safety

## AWARNING

## HIGH VOLTAGE!

Frequency converters contain high voltage when connected to AC mains input power. Installation, start up, and maintenance should be performed by qualified personnel only. Failure to perform installation, start up, and maintenance by qualified personnel could result in death or serious injury.

## High Voltage

Frequency converters are connected to hazardous mains voltages. Extreme care should be taken to protect against shock. Only trained personnel familiar with electronic equipment should install, start, or maintain this equipment.

## AWARNING

## UNINTENDED START!

When the frequency converter is connected to AC mains, the motor may start at any time. The frequency converter, motor, and any driven equipment must be in operational readiness. Failure to be in operational readiness when the frequency converter is connected to AC mains could result in death, serious injury, equipment, or property damage.

## Unintended Start

When the frequency converter is connected to the AC mains, the motor may be started by means of an external switch, a serial bus command, an input reference signal, or a cleared fault condition. Use appropriate cautions to guard against an unintended start.

## AWARNING

## DISCHARGE TIME!

Frequency converters contain DC-link capacitors that can remain charged even when the frequency converter is not powered. To avoid electrical hazards, disconnect AC mains, any permanent magnet type motors, and any remote DClink power supplies, including battery backups, UPS and DC-link connections to other frequency converters. Wait for the capacitors to fully discharge before performing any service or repair work. The amount of wait time is listed in the Discharge Time table. Failure to wait the specified time after power has been removed before doing service or repair could result in death or serious injury.

| Voltage [V] | Minimum Waiting Time (Minutes) |  |  |
| :--- | :---: | :---: | :---: |
|  | 4 | 7 | 15 |
| $200-240$ | $0.25-3.7 \mathrm{~kW}$ |  | $5.5-45 \mathrm{~kW}$ |
| $380-480$ | $0.37-7.5 \mathrm{~kW}$ |  | $11-90 \mathrm{~kW}$ |
| $525-600$ | $0.75-7.5 \mathrm{~kW}$ |  | $11-90 \mathrm{~kW}$ |
| $525-690$ | $1.1-7.5 \mathrm{~kW}$ |  |  |
| High voltage may be present even when the warning LED |  |  |  |
| display lights are off. |  |  |  |

## Discharge Time

## Symbols

The following symbols are used in this manual.

## $\triangle$ WARNING

Indicates a potentially hazardous situation which could result in death or serious injury.

## $\triangle$ CAUTION

Indicates a potentially hazardous situation which can result in minor or moderate injury. It can also be used to alert against unsafe practices.

## CAUTION

Indicates a situation that could result in equipment or property-damage-only accidents.

## NOTE

Indicates highlighted information to regard with attention to avoid mistakes or operate equipment at less than optimal performance.

Approvals

## NOTE

Imposed limitations on the output frequency (due to export control regulations):
From software version 1.99 the output frequency of the frequency converter is limited to 590 Hz . Software versions 1x.xx also limit the maximum output frequency to 590 Hz , but these versions cannot be flashed, i.e. neither downgraded nor upgraded.

Safety
VLT ${ }^{\circledR}$ AQUA Drive Operating Instructions

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## 1 Introduction



Illustration 1.1 Exploded View A Size

| 1 | LCP | 10 | Motor output terminals 96 (U), 97 (V), 98 (W) |
| :--- | :--- | :--- | :--- |
| 2 | RS-485 serial bus connector (+68, -69) | 11 | Relay $2(01,02,03)$ |
| 3 | Analog I/O connector | 12 | Relay $1(04,05,06)$ |
| 4 | LCP input plug | 13 | Brake $(-81,+82)$ and load sharing (-88, +89) terminals |
| 5 | Analog switches (A53), (A54) | 14 | Mains input terminals 91 (L1), 92 (L2), 93 (L3) |
| 6 | Cable strain relief/PE ground | 15 | USB connector |
| 7 | Decoupling plate | 16 | Serial bus terminal switch |
| 8 | Grounding clamp (PE) | 17 | Digital I/O and 24 V power supply |
| 9 | Shielded cable grounding clamp and strain relief | 18 | Control cable cover plate |

Table 1.1 Legend to Illustration 1.1

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Illustration 1.2 Exploded View B and C Sizes

| 1 | LCP | 11 | Relay 2 (04, 05, 06) |
| :--- | :--- | :--- | :--- |
| 2 | Cover | 12 | Lifting ring |
| 3 | RS-485 serial bus connector | 13 | Mounting slot |
| 4 | Digital I/O and 24 V power supply | 14 | Grounding clamp (PE) |
| 5 | Analog I/O connector | 15 | Cable strain relief / PE ground |
| 6 | Cable strain relief/PE ground | 16 | Brake terminal (-81, +82) |
| 7 | USB connector | 17 | Load sharing terminal (DC bus) (-88, +89$)$ |
| 8 | Serial bus terminal switch | 18 | Motor output terminals 96 (U), 97 (V), 98 (W) |
| 9 | Analog switches (A53), (A54) | 19 | Mains input terminals 91 (L1), 92 (L2), 93 (L3) |
| 10 | Relay 1 (01, 02, 03) |  |  |

Table 1.2 Legend to Illustration 1.2

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### 1.1 Purpose of the Manual

This manual is intended to provide detailed information for the installation and of the frequency converter. 2 Installation provides requirements for mechanical and electrical installation, including input, motor, control and serial communications wiring, and control terminal functions. 3 Start Up and Functional Testing provides detailed procedures for start up, basic operational programming, and functional testing. The remaining chapters provide supplementary details. These include user interface, detailed programming, application examples, start-up troubleshooting, and specifications.

### 1.2 Additional Resources

Other resources are available to understand advanced frequency converter functions and programming.

- $\quad$ The $V L T^{\circledR}$ Programming Guide provides greater detail on working with parameters and many application examples.
- $\quad$ The $V L T^{®}$ Design Guide is intended to provide detailed capabilities and functionality to design motor control systems.
- Supplemental publications and manuals are available from Danfoss. See www.danfoss.com/BusinessAreas/DrivesSolutions/Documentations/VLT+Technical +Documentation.htm for listings.
- Optional equipment is available that may change some of the procedures described. Reference the instructions supplied with those options for specific requirements. Contact the local Danfoss supplier or visit the Danfoss website: www.danfoss.com/BusinessAreas/DrivesSolutions/ Documentations/VLT+Technical+Documentation.htm, for downloads or additional information.


### 1.3 Product Overview

A frequency converter is an electronic motor controller that converts AC mains input into a variable AC waveform output. The frequency and voltage of the output are regulated to control the motor speed or torque. The frequency converter can vary the speed of the motor in response to system feedback, such as changing temperature or pressure for controlling fan, compressor, or pump motors. The frequency converter can also regulate the motor by responding to remote commands from external controllers.

In addition, the frequency converter monitors the system and motor status, issues warnings or alarms for fault
conditions, starts and stops the motor, optimizes energy efficiency, and offers many more control, monitoring, and efficiency functions. Operation and monitoring functions are available as status indications to an outside control system or serial communication network.

For single phase frequency converters (S2 and S4) installed in the EU the following applies:
Single phase frequency converters (S2 and S4) with an input current less than 16 A and an input of more than 1 kW are intended for use as professional equipment in trades, professions, or industries. Designated application areas are:

- Public pools, public water supplies, agriculture, commercial buildings and industries.

They are not intended for general public use or use in residential areas. All other single phase frequency converters are only intended for use in private low-voltage systems interfacing with public supply only at a medium or high voltage level. Operators of private systems must ensure that the EMC environment complies with IEC 610000-3-6 and/or the contractual agreements.

### 1.4 Internal Components Functions

Illustration 1.3 is a block diagram of the frequency converter's internal components. See Table 1.3 for their functions.


Illustration 1.3 Frequency Converter Block Diagram

| Area | Title | Functions |
| :---: | :--- | :--- |
| 1 | Mains input | - Three-phase AC mains power <br> supply to the frequency <br> converter |
| 2 | Rectifier | - The rectifier bridge converts <br> the AC input to DC current to <br> supply inverter power |
| 3 | DC bus | - Intermediate DC-bus circuit <br> handles the DC current |


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| Area | Title | Functions |
| :---: | :--- | :--- |
| 4 | DC reactors | $\begin{array}{l}\text { - Filter the intermediate DC } \\ \text { circuit voltage }\end{array}$ |
| - Prove line transient protection |  |  |
| - Reduce RMS current |  |  |
| - Raise the power factor |  |  |
| reflected back to the line |  |  |\(\left.\} \begin{array}{l}- Reduce harmonics on the AC <br>


input\end{array}\right\}\)|  | Capacitor bank | - Stores the DC power <br> - Provides ride-through <br> protection for short power <br> losses |
| :--- | :--- | :--- |
| 5 | Inverter | Converts the DC into a <br> controlled PWM AC waveform <br> for a controlled variable <br> output to the motor |


| Area | Title | Functions |
| :---: | :--- | :--- |
| 7 | Output to motor | - Regulated three-phase output <br> power to the motor |
| 8 | Control circuitry | - Input power, internal <br> processing, output, and motor <br> current are monitored to <br> provide efficient operation <br> and control |
| - User interface and external |  |  |
| commands are monitored and |  |  |
| performed |  |  |
| - Status output and control can |  |  |
| be provided |  |  |

Table 1.3 Legend to Illustration 1.3

### 1.5 Frame Sizes and Power Ratings

References to frames sizes used in this manual are defined in Table 1.4.

|  | Frame Size [kW] |  |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Volts [V] | A2 | A3 | A4 | A5 | B1 | B2 | B3 | B4 | C1 | C2 | C3 | C4 |
| 200-240 | 0.25-2.2 | 3.0-3.7 | 0.25-2.2 | 0.25-3.7 | 5.5-11 | 15 | 5.5-11 | 15-18.5 | 18.5-30 | 37-45 | 22-30 | 37-45 |
| 380-480 | 0.37-4.0 | 5.5-7.5 | 0.37-4.0 | 0.37-7.5 | 11-18.5 | 22-30 | 11-18.5 | 22-37 | 37-55 | 75-90 | 45-55 | 75-90 |
| 525-600 | n/a | 0.75-7.5 | n/a | 0.75-7.5 | 11-18.5 | 22-30 | 11-18.5 | 22-37 | 37-55 | 75-90 | 45-55 | 75-90 |
| 525-690 | n/a | 1.1-7.5 | n/a | n/a | n/a | 11-30 | n/a | n/a | n/a | 37-90 | 45-55 | n/a |
| Single phase |  |  |  |  |  |  |  |  |  |  |  |  |
| 200-240 | n/a | 1.1 | n/a | 1.1 | 1.5-5.5 | 7.5 | n/a | n/a | 15 | 22 | n/a | n/a |
| 380-480 | n/a | n/a | n/a | n/a | 7.5 | 11 | n/a | n/a | 18.5 | 37 | $\mathrm{n} / \mathrm{a}$ | n/a |

Table 1.4 Frames Sizes and Power Ratings

### 1.6 Safe Stop

The frequency converter can perform the safety function Safe Torque Off (STO, as defined by EN IEC 61800-5-2 ${ }^{1}$ ) and Stop Category 0 (as defined in EN 60204-1²). Danfoss has named this functionality Safe Stop. Before integration and use of Safe Stop in an installation, perform a thorough risk analysis to determine whether the Safe Stop functionality and safety levels are appropriate and sufficient. Safe Stop is designed and approved suitable for the requirements of:

- $\quad$ Safety Category 3 according to EN ISO 13849-1
- Performance Level "d" according to EN ISO 13849-1:2008
- SIL 2 Capability according to IEC 61508 and EN 61800-5-2
- SILCL 2 according to EN 62061
${ }^{1)}$ Refer to EN IEC 61800-5-2 for details of Safe torque off (STO) function.
${ }^{\text {2) }}$ Refer to EN IEC 60204-1 for details of stop category 0 and 1.


## Activation and Termination of Safe Stop

The Safe Stop (STO) function is activated by removing the voltage at Terminal 37 of the Safe Inverter. By connecting the Safe Inverter to external safety devices providing a safe delay, an installation for a safe Stop Category 1 can be obtained. The Safe Stop function can be used for asynchronous, synchronous, and permanent magnet motors.

## AWARNING

After installation of Safe Stop (STO), a commissioning test as specified in 1.6.2 Safe Stop Commissioning Test must be performed. A passed commissioning test is mandatory after first installation and after each change to the safety installation.

## Safe Stop Technical Data

The following values are associated to the different types of safety levels:

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## Reaction time for T37

- Maximum reaction time: 20 ms

Reaction time = delay between de-energizing the STO input and switching off the frequency converter output bridge.

## Data for EN ISO 13849-1

- Performance Level "d"
- $\quad$ MTTF $_{d}$ (Mean Time To Dangerous Failure): 14000 years
- DC (Diagnostic Coverage): $90 \%$
- Category 3
- Lifetime 20 years


## Data for EN IEC 62061, EN IEC 61508, EN IEC 61800-5-2

- SIL 2 Capability, SILCL 2
- PFH (Probability of Dangerous failure per Hour) $=1 \mathrm{E}-10 / \mathrm{h}$
- SFF (Safe Failure Fraction) >99\%
- HFT (Hardware Fault Tolerance) $=0$ (1001 architecture)
- Lifetime 20 years


## Data for EN IEC 61508 low demand

- PFDavg for one year proof test: 1E-10
- PFDavg for three year proof test: $1 \mathrm{E}-10$
- PFDavg for five year proof test: 1E-10

No maintenance of the STO functionality is needed.

Security measures have to be taken by the user e.g. installation in a closed cabinet that is only accessible for skilled personnel.

## SISTEMA Data

Functional safety data is available via a data library for use with the SISTEMA calculation tool from the IFA (Institute for Occupational Safety and Health of the German Social Accident Insurance), and data for manual calculation. The library is permanently completed and extended.

### 1.6.1 Terminal 37 Safe Stop Function

The frequency converter is available with safe stop functionality via control terminal 37. Safe stop disables the control voltage of the power semiconductors of the frequency converter output stage. This in turn prevents generating the voltage required to rotate the motor. When the Safe Stop (T37) is activated, the frequency converter issues an alarm, trips the unit, and coasts the motor to a stop. Manual restart is required. The safe stop function can be used as an emergency stop for the frequency converter. In normal operating mode when safe stop is not required, use the regular stop function instead. When automatic
restart is used, ensure the requirements of ISO 12100-2 paragraph 5.3.2.5 are fulfilled.

## Liability Conditions

It is the responsibility of the user to ensure that qualified personnel installs and operates the safe stop function:

- Read and understand the safety regulations concerning health and safety/accident prevention
- Understand the generic and safety guidelines given in this description and the extended description in the relevant Design Guide
- Have a good knowledge of the generic and safety standards applicable to the specific application

User is defined as: integrator, operator, service technician, maintenance technician.

## Standards

Use of safe stop on terminal 37 requires that the user satisfies all provisions for safety including relevant laws, regulations and guidelines. The optional safe stop function complies with the following standards.

- IEC 60204-1: 2005 category 0 - uncontrolled stop
- IEC 61508: 1998 SIL2
- IEC 61800-5-2: 2007 - safe torque off (STO) function
- IEC 62061: 2005 SIL CL2
- ISO 13849-1: 2006 Category 3 PL d
- ISO 14118: 2000 (EN 1037) - prevention of unexpected startup
The information and instructions of the instruction manual are not sufficient for a proper and safe use of the safe stop functionality. The related information and instructions of the relevant Design Guide must be followed.


## Protective Measures

- Qualified and skilled personnel are required for installation and commissioning of safety engineering systems
- The unit must be installed in an IP54 cabinet or in an equivalent environment. In special applications a higher IP degree is required
- The cable between terminal 37 and the external safety device must be short circuit protected according to ISO 13849-2 table D. 4
- When external forces influence the motor axis (for example, suspended loads), additional measures are required (for example, a safety holding brake) to eliminate potential hazards

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Safe Stop Installation and Set-Up

## -WARNING

## SAFE STOP FUNCTION!

The safe stop function does NOT isolate mains voltage to the frequency converter or auxiliary circuits. Perform work on electrical parts of the frequency converter or the motor only after isolating the mains voltage supply and waiting the length of time specified in Table 1.1. Failure to isolate the mains voltage supply from the unit and waiting the time specified could result in death or serious injury.

- It is not recommended to stop the frequency converter by using the Safe Torque Off function. If a running frequency converter is stopped by using the function, the unit trips and stops by coasting. If unacceptable or dangerous, use another stopping mode to stop the frequency converter and machinery, before using this function. Depending on the application, a mechanical brake can be required.
- For synchronous and permanent magnet motor frequency converters, in a multiple IGBT power semiconductor failure: In spite of the activation of the Safe Torque Off function, the system can produce an alignment torque which maximally rotates the motor shaft by $180 /$ p degrees. p denotes the pole pair number.
- This function is suitable for performing mechanical work on the system or affected area of a machine only. It does not provide electrical safety. Do not use this function as a control for starting and/or stopping the frequency converter.

Follow these steps to perform a safe installation of the frequency converter:

1. Remove the jumper wire between control terminals 37 and 12 or 13 . Cutting or breaking the jumper is not sufficient to avoid shortcircuiting. (See jumper on Illustration 1.4.)
2. Connect an external Safety monitoring relay via a NO safety function to terminal 37 (safe stop) and either terminal 12 or 13 ( 24 V DC). Follow the instruction for the safety device. The Safety monitoring relay must comply with Category 3 /PL "d" (ISO 13849-1) or SIL 2 (EN 62061).


Illustration 1.4 Jumper between Terminal 12/13 (24 V) and 37


Illustration 1.5 Installation to Achieve a Stopping Category 0 (EN 60204-1) with Cat. 3 /PL "d" (ISO 13849-1) or SIL 2 (EN 62061).

| 1 | Frequency converter |
| :--- | :--- |
| 2 | [Reset] key |
| 3 | Safety relay (cat. 3, PL d or SIL2 |
| 4 | Emergency stop button |
| 5 | Short-circuit protected cable (if not inside installation IP54 <br> cabinet) |

Table 1.5 Legend to Illustration 1.5

## Safe Stop Commissioning Test

After installation and before first operation, perform a commissioning test of the installation using safe stop. Moreover, perform the test after each modification of the installation.

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## AWARNING

Safe Stop activation (that is removal of 24 V DC voltage supply to terminal 37 ) does not provide electrical safety. The Safe Stop function itself is therefore not sufficient to implement the Emergency-Off function as defined by EN 60204-1. Emergency-Off requires measures of electrical isolation, for example, by switching off mains via an additional contactor.

1. Activate the Safe Stop function by removing the 24 V DC voltage supply to the terminal 37.
2. After activation of Safe Stop (that is, after the response time), the frequency converter coasts (stops creating a rotational field in the motor). The response time is typically less than 10 ms .

The frequency converter is guaranteed not to restart creation of a rotational field by an internal fault (in accordance with Cat. 3 PL d acc. EN ISO 13849-1 and SIL 2 acc. EN 62061). After activation of Safe Stop, the display shows the text "Safe Stop activated". The associated help text says, "Safe Stop has been activated". This means that the Safe Stop has been activated, or that normal operation has not been resumed yet after Safe Stop activation.

## NOTE

The requirements of Cat. 3 /PL "d" (ISO 13849-1) are only fulfilled while 24 V DC supply to terminal 37 is kept removed or low by a safety device which itself fulfills Cat. 3 PL "d" (ISO 13849-1). If external forces act on the motor, it must not operate without additional measures for fall protection. External forces can arise for example, in the event of vertical axis (suspended loads) where an unwanted movement, for example caused by gravity, could cause a hazard. Fall protection measures can be additional mechanical brakes.

By default the Safe Stop function is set to an Unintended Restart Prevention behaviour. Therefore, to resume operation after activation of Safe Stop,

1. reapply 24 V DC voltage to terminal 37 (text Safe Stop activated is still displayed)
2. create a reset signal (via bus, Digital I/O, or [Reset] key.

The Safe Stop function can be set to an Automatic Restart behaviour. Set the value of 5-19 Terminal 37 Digital Input from default value [1] to value [3].
Automatic Restart means that Safe Stop is terminated, and normal operation is resumed, as soon as the 24 V DC are applied to Terminal 37. No Reset signal is required.

## AWARNING

Automatic Restart Behaviour is permitted in one of the two situations:

1. The Unintended Restart Prevention is implemented by other parts of the Safe Stop installation.
2. A presence in the dangerous zone can be physically excluded when Safe Stop is not activated. In particular, paragraph 5.3.2.5 of ISO 12100-2 2003 must be observed

### 1.6.2 Safe Stop Commissioning Test

After installation and before first operation, perform a commissioning test of an installation or application, using Safe Stop.
Perform the test again after each modification of the installation or application involving the Safe Stop.

## NOTE

A passed commissioning test is mandatory after first installation and after each change to the safety installation.

The commissioning test (select one of cases 1 or 2 as applicable):

Case 1: Restart prevention for Safe Stop is required (that is Safe Stop only where 5-19 Terminal 37 Digital Input is set to default value [1], or combined Safe Stop and MCB 112 where 5-19 Terminal 37 Digital Input is set to [6] PTC $1 \&$ Relay A or [9] PTC 1 \& Relay W/A):
1.1 Remove the 24 V DC voltage supply to terminal 37 using the interrupt device while the frequency converter drives the motor (that is mains supply is not interrupted). The test step is passed when

- the motor reacts with a coast, and
- the mechanical brake is activated (if connected)
- the alarm "Safe Stop [A68]" is displayed in the LCP, if mounted
1.2 Send Reset signal (via Bus, Digital I/O, or [Reset] key). The test step is passed if the motor remains in the Safe Stop state, and the mechanical brake (if connected) remains activated.
1.3 Reapply 24 V DC to terminal 37. The test step is passed if the motor remains in the coasted state, and the mechanical brake (if connected) remains activated.

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1.4 Send Reset signal (via Bus, Digital I/O, or [Reset] key). The test step is passed when the motor becomes operational again.

The commissioning test is passed if all four test steps 1.1, $1.2,1.3$ and 1.4 are passed.

Case 2: Automatic Restart of Safe Stop is wanted and allowed (that is, Safe Stop only where 5-19 Terminal 37 Digital Input is set to [3], or combined Safe Stop and MCB 112 where 5-19 Terminal 37 Digital Input is set to [7] PTC 1 \& Relay W or [8] PTC 1 \& Relay A/W):
2.1 Remove the 24 V DC voltage supply to terminal 37 by the interrupt device while the frequency converter drives the motor (that is mains supply is not interrupted). The test step is passed when

- the motor reacts with a coast, and
- the mechanical brake is activated (if connected)
- the alarm "Safe Stop [A68]" is displayed in the LCP, if mounted
2.2 Reapply 24 V DC to terminal 37.

The test step is passed if the motor becomes operational again. The commissioning test is passed if both test steps 2.1 and 2.2 are passed.

## NOTE

See warning on the restart behaviour in 1.6.1 Terminal 37 Safe Stop Function

## AWARNING

The Safe Stop function can be used for asynchronous, synchronous and permanent magnet motors. Two faults can occur in the power semiconductor of the frequency converter. When using synchronous or permanent magnet motors a residual rotation can result from the faults. The rotation can be calculated to Angle $=360 /($ Number of Poles). The application using synchronous or permanent magnet motors must take this residual rotation into consideration and ensure that it does not pose a safety risk. This situation is not relevant for asynchronous motors.

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## 2 Installation

### 2.1 Installation Site Check List

- The frequency converter relies on the ambient air for cooling. Observe the limitations on ambient air temperature for optimal operation
- Ensure that the installation location has sufficient support strength to mount the frequency converter
- Keep the manual, drawings, and diagrams accessible for detailed installation and operation instructions. It is important that the manual is available for equipment operators.
- Locate equipment as near to the motor as possible. Keep motor cables as short as possible. Check the motor characteristics for actual tolerances. Do not exceed
- $\quad 300 \mathrm{~m}(1000 \mathrm{ft})$ for unshielded motor leads
- $\quad 150 \mathrm{~m}(500 \mathrm{ft})$ for shielded cable.
- Ensure that the ingress protection rating of the frequency converter is suitable for the installation environment. IP55 (NEMA 12) or IP66 (NEMA 4) enclosures may be necessary.


## ACAUTION

Ingress protection
IP54, IP55 and IP66 ratings can only be guaranteed if the unit is properly closed.

- Ensure that all cable glands and unused holes for glands are properly sealed.
- Ensure that the unit cover is properly closed


## ACAUTION

## Device damage through contamination

Do not leave the frequency converter uncovered.

### 2.2 Frequency Converter and Motor Preinstallation Check List

- Compare the model number of unit on the nameplate to what was ordered to verify the proper equipment
- Ensure each of the following are rated for same voltage:


## Mains (power)

Frequency converter
Motor

- Ensure that the frequency converter output current rating is equal to or greater than motor full load current for peak motor performance

Motor size and frequency converter power must match for proper overload protection

If frequency converter rating is less than motor, full motor output cannot be achieved

### 2.3 Mechanical Installation

### 2.3.1 Cooling

- To provide cooling airflow, mount the unit to a solid flat surface or to the optional back plate (see 2.3.3 Mounting)
- Top and bottom clearance for air cooling must be provided. Generally, $100-225 \mathrm{~mm}(4-10 \mathrm{in})$ is required. See Illustration 2.1 for clearance requirements
- Improper mounting can result in over heating and reduced performance
- Derating for temperatures starting between $40^{\circ} \mathrm{C}$ $\left(104{ }^{\circ} \mathrm{F}\right)$ and $50^{\circ} \mathrm{C}\left(122^{\circ} \mathrm{F}\right)$ and elevation 1000 m ( 3300 ft ) above sea level must be considered. See the equipment Design Guide for detailed information.

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Illustration 2.1 Top and Bottom Cooling Clearance

| Enclosure | A2-A5 | B1-B4 | C1, C3 | C2, C4 |
| :---: | :---: | :---: | :---: | :---: |
| a/b $[\mathrm{mm}]$ | 100 | 200 | 200 | 225 |

Table 2.1 Minimum Airflow Clearance Requirements

### 2.3.2 Lifting

- Check the weight of the unit to determine a safe lifting method
- Ensure that the lifting device is suitable for the task
- If necessary, plan for a hoist, crane, or forklift with the appropriate rating to move the unit
- For lifting, use hoist rings on the unit, when provided


### 2.3.3 Mounting

- Mount the unit vertically
- The frequency converter allows side by side installation
- Ensure that the strength of the mounting location will support the unit weight
- Mount the unit to a solid flat surface or to the optional back plate to provide cooling airflow (see Illustration 2.2 and Illustration 2.3)
- Improper mounting can result in over heating and reduced performance
- Use the slotted mounting holes on the unit for wall mounting, when provided


Illustration 2.2 Proper Mounting with Back Plate

Item A is a back plate properly installed for required airflow to cool the unit.


Illustration 2.3 Proper Mounting with Railings

## NOTE

Back plate is needed when mounted on railings.

### 2.3.4 Tightening Torques

See 10.4 Connection Tightening Torques for proper tightening specifications.

| Installation | $\mathrm{VLT}^{\circledR}$ AQUA Drive |
| :--- | :--- |
|  | Operating Instructions |

### 2.4 Electrical Installation

This section contains detailed instructions for wiring the frequency converter. The following tasks are described.

- Wiring the motor to the frequency converter output terminals
- Connecting control and serial communication wiring
- After power has been applied, checking input and motor power; programming control terminals for their intended functions

Illustration 2.4 shows a basic electrical connection.

- Wiring the AC mains to the frequency converter input terminals


Illustration 2.4 Basic Wiring Schematic Drawing.

* Terminal 37 is an option

| Installation | $\mathrm{VLT}^{\circledR} \mathrm{AQUA}$ Drive |
| :--- | :--- |
|  | Operating Instructions |



Illustration 2.5 Typical Electrical Connection

| 1 | PLC | 6 | Min. 200 mm (7.9 in) between control cables, motor and mains |
| :--- | :--- | :--- | :--- |
| 2 | Frequency converter | 7 | Motor, 3-phase and PE |
| 3 | Output contactor (Generally not recommended) | 8 | Mains, 3-phase and reinforced PE |
| 4 | Earth (grounding) rail (PE) | 9 | Control wiring |
| 5 | Cable insulation (stripped) | 10 | Equalising min. $16 \mathrm{~mm}^{2}(0.025 \mathrm{in})$ |

Table 2.2 Legend to Illustration 2.5

| Installation | $\mathrm{VLT}^{\circledR}$ AQUA Drive |
| :--- | :--- |
|  | Operating Instructions |

### 2.4.1 Requirements

## AWARNING

## EQUIPMENT HAZARD!

Rotating shafts and electrical equipment can be hazardous. All electrical work must conform to national and local electrical codes. It is strongly recommended that installation, start up, and maintenance be performed only by trained and qualified personnel. Failure to follow these guidelines could result in death or serious injury.

## CAUTION

## WIRING ISOLATION!

Run input power, motor wiring and control wiring in three separate metallic conduits or use separated shielded cable for high frequency noise isolation. Failure to isolate power, motor and control wiring could result in less than optimum frequency converter and associated equipment performance.

For your safety, comply with the following requirements.

- Electronic controls equipment is connected to hazardous mains voltage. Extreme care should be taken to protect against electrical hazards when applying power to the unit.
- Run motor cables from multiple frequency converters separately. Induced voltage from output motor cables run together can charge equipment capacitors even with the equipment turned off and locked out.


## Overload and Equipment Protection

- An electronically activated function within the frequency converter provides overload protection for the motor. The overload calculates the level of increase to activate timing for the trip (controller output stop) function. The higher the current draw, the quicker the trip response. The overload provides Class 20 motor protection. See 8 Warnings and Alarms for details on the trip function.
- Because the motor wiring carries high frequency current, it is important that wiring for mains, motor power, and control are run separately. Use metallic conduit or separated shielded wire. Failure to isolate power, motor, and control wiring could result in less than optimum equipment performance.
- All frequency converters must be provided with short-circuit and over-current protection. Input fusing is required to provide this protection, see Illustration 2.6. If not factory supplied, fuses must be provided by the installer as part of installation.

See maximum fuse ratings in 10.3 Fuse Specifications.


Illustration 2.6 Fuses

## Wire Type and Ratings

- All wiring must comply with local and national regulations regarding cross-section and ambient temperature requirements.
- Danfoss recommends that all power connections be made with a minimum $75^{\circ} \mathrm{C}$ rated copper wire.
- $\quad$ See 10.1 Power-dependent Specifications for recommended wire sizes.


### 2.4.2 Earth (Grounding) Requirements

## AWARNING

GROUNDING HAZARD!
For operator safety, it is important to ground the frequency converter properly in accordance with national and local electrical codes as well as instructions contained within this document. Ground currents are higher than 3.5 mA . Failure to ground the frequency converter properly could result in death or serious injury.

## NOTE

It is the responsibility of the user or certified electrical installer to ensure correct grounding (earthing) of the equipment in accordance with national and local electrical codes and standards.

- Follow all local and national electrical codes to ground electrical equipment properly
- Proper protective grounding for equipment with ground currents higher than 3.5 mA must be established, see 2.4.2.1 Leakage Current ( $>3.5 \mathrm{~mA}$ )
- A dedicated ground wire is required for input power, motor power and control wiring

| Installation | $\mathrm{VLT}^{\circledR} \mathrm{AQUA}$ Drive |
| :--- | :--- |
|  | Operating Instructions |

- Use the clamps provided with the equipment for proper ground connections
- Do not ground one frequency converter to another in a "daisy chain" fashion
- Keep the ground wire connections as short as possible
- Using high-strand wire to reduce electrical noise is recommended
- Follow motor manufacturer wiring requirements


### 2.4.2.1 Leakage Current (>3.5 mA)

Follow national and local codes regarding protective earthing of equipment with a leakage current > 3.5 mA . Frequency converter technology implies high frequency switching at high power. This will generate a leakage current in the earth connection. A fault current in the frequency converter at the output power terminals might contain a DC component which can charge the filter capacitors and cause a transient earth current. The earth leakage current depends on various system configurations including RFI filtering, screened motor cables, and frequency converter power.

EN/IEC61800-5-1 (Power Drive System Product Standard) requires special care if the leakage current exceeds 3.5 mA . Earth grounding must be reinforced in one of the following ways:

- Earth ground wire of at least $10 \mathrm{~mm}^{2}$
- Two separate earth ground wires both complying with the dimensioning rules

See EN 60364-5-54 § 543.7 for further information.

## Using RCDs

Where residual current devices (RCDs), also known as earth leakage circuit breakers (ELCBs), are used, comply with the following:

Use RCDs of type B only which are capable of detecting AC and DC currents

Use RCDs with an inrush delay to prevent faults due to transient earth currents

Dimension RCDs according to the system configuration and environmental considerations

### 2.4.2.2 Grounding Using Shielded Cable

Earthing (grounding) clamps are provided for motor wiring (see Illustration 2.7).


Illustration 2.7 Grounding with Shielded Cable

### 2.4.3 Motor Connection

## AWARNING <br> INDUCED VOLTAGE!

Run output motor cables from multiple frequency converters separately. Induced voltage from output motor cables run together can charge equipment capacitors even with the equipment turned off and locked out. Failure to run output motor cables separately could result in death or serious injury.

- For maximum wire sizes see 10.1 Power-dependent Specifications
- Comply with local and national electrical codes for cable sizes
- Motor wiring knockouts or access panels are provided at the base of IP21 and higher (NEMA1/12) units
- Do not install power factor correction capacitors between the frequency converter and the motor
- Do not wire a starting or pole-changing device between the frequency converter and the motor
- Connect the 3 -phase motor wiring to terminals $96(\mathrm{U}), 97(\mathrm{~V})$, and 98 (W)
- Ground the cable in accordance with grounding instructions provided
- Torque terminals in accordance with the information provided in 10.4.1 Connection Tightening Torques
- Follow motor manufacturer wiring requirements

The three following illustrations represent mains input, motor, and earth grounding for basic frequency converters.

| Installation | $\mathrm{VLT}^{\circledR} \mathrm{AQUA}$ Drive |
| :--- | :--- |
|  | Operating Instructions |

Actual configurations vary with unit types and optional equipment.


Illustration 2.8 Motor, Mains and Earth Wiring for A-Frame Sizes


Illustration 2.9 Motor, Mains and Earth Wiring for B-Frame Sizes and Above Using Shielded Cable


Illustration 2.10 Motor, Mains and Earth Wiring for B-Frame Sizes and Above Using Conduit

### 2.4.4 AC Mains Connection

- Size wiring based upon the input current of the frequency converter. For maximum wire sizes see 10.1 Power-dependent Specifications.
- Comply with local and national electrical codes for cable sizes.
- Connect 3-phase AC input power wiring to terminals L1, L2, and L3 (see Illustration 2.11).
- Depending on the configuration of the equipment, input power will be connected to the mains input terminals or the input disconnect.


Illustration 2.11 Connecting to AC Mains

| Installation | $\mathrm{VLT}^{\circledR} \mathrm{AQUA}$ Drive |
| :--- | :--- |
|  | Operating Instructions |

- Ground the cable in accordance with grounding instructions provided in 2.4.2 Earth (Grounding) Requirements
- All frequency converters may be used with an isolated input source as well as with ground reference power lines. When supplied from an isolated mains source (IT mains or floating delta) or TT/TN-S mains with a grounded leg (grounded delta), set 14-50 RFI Filter to OFF. When off, the internal RFI filtercapacitors between the chassis and the intermediate circuit are isolated to avoid damage to the intermediate circuit and to reduce earth capacity currents in accordance with IEC 61800-3.


### 2.4.5 Control Wiring

- Isolate control wiring from high power components in the frequency converter.
- If the frequency converter is connected to a thermistor, for PELV isolation, optional thermistor control wiring must be reinforced/double insulated. A 24 V DC supply voltage is recommended.


### 2.4.5.1 Access

- Remove access cover plate with a screw driver. See Illustration 2.12.
- Or remove front cover by loosening attaching screws. See Illustration 2.13.


Illustration 2.12 Control Wiring Access for A2, A3, B3, B4, C3 and C4 Enclosures


Illustration 2.13 Control Wiring Access for A4, A5, B1, B2, C1 and C2 Enclosures

See Table 2.3 before tightening the covers.

| Frame | IP20 | IP21 | IP55 | IP66 |
| :--- | :---: | :---: | :---: | :---: |
| A4/A5 | - | - | 2 | 2 |
| B1 | - | ${ }^{*}$ | 2.2 | 2.2 |
| B2 | - | ${ }^{*}$ | 2.2 | 2.2 |
| C1 | - | ${ }^{*}$ | 2.2 | 2.2 |
| C2 | - | ${ }^{*}$ | 2.2 | 2.2 | | * No screws to tighten |
| :--- |
| - Does not exist |

* No screws to tighten
- Does not exist

Table 2.3 Tightening Torques for Covers (Nm)

| Installation | $\mathrm{VLT}^{\circledR} \mathrm{AQUA}$ Drive |
| :--- | :--- |
|  | Operating Instructions |

### 2.4.5.2 Control Terminal Types

Illustration 2.17 shows the removable frequency converter connectors. Terminal functions and default settings are summarized in Table 2.4.


Illustration 2.14 Control Terminal Locations

- Connector 1 provides four programmable digital inputs terminals, two additional digital terminals programmable as either input or output, a 24 V DC terminal supply voltage, and a common for optional customer supplied 24 V DC voltage
- Connector 2 terminals (+) 68 and (-)69 are for an RS-485 serial communications connection
- Connector 3 provides two analog inputs, one analog output, 10V DC supply voltage, and commons for the inputs and output
- Connector 4 is a USB port available for use with the MCT 10 Set-up Software
- Also provided are two Form C relay outputs that are in various locations depending upon the frequency converter configuration and size
- Some options available for ordering with the unit may provide additional terminals. See the manual provided with the equipment option.

See 10.2 General Technical Data for terminal ratings details.

| Terminal Description |  |  |  |
| :---: | :---: | :---: | :---: |
| Digital Inputs/Outputs |  |  |  |
| Terminal | Parameter | Default Setting | Description |
| 12, 13 | - | +24 V DC | 24 V DC supply voltage. Maximum output current is 200 mA total for all 24 V loads. Useable for digital inputs and external transducers. |
| 18 | 5-10 | [8] Start |  |
| 19 | 5-11 | [0] No operation |  |
| 32 | 5-14 | [0] No operation | Digital inputs. |
| 33 | 5-15 | [0] No operation |  |
| 27 | 5-12 | [2] Coast inverse | Selectable for either digital input or |
| 29 | 5-13 | [14] JOG | output. Default setting is input. |
| 20 | - |  | Common for digital inputs and 0 V potential for 24 V supply. |
| 37 | - | Safe Torque Off (STO) | (optional) Safe input. Used for STO. |
| Analog Inputs/Outputs |  |  |  |
| 39 | - |  | Common for analog output |
| 42 | 6-50 | Speed 0 - <br> High Limit | Programmable analog output. The analog signal is $0-20 \mathrm{~mA}$ or $4-20 \mathrm{~mA}$ at a maximum of $500 \Omega$ |
| 50 | - | +10 V DC | 10 V DC analog supply voltage. 15 mA maximum commonly used for potentiometer or thermistor. |
| 53 | 6-1 | Reference | Analog input. |
| 54 | 6-2 | Feedback | Selectable for voltage or current. Switches A53 and A54 select mA or V . |
| 55 | - |  | Common for analog input |
| Serial Communication |  |  |  |
| 61 | - |  | Integrated RC-Filter for cable screen. ONLY for connecting the screen when experiencing EMC problems. |


| Installation | $\mathrm{VLT}^{\circledR}$ AQUA Drive |
| :--- | :--- |
|  | Operating Instructions |


| Terminal Description |  |  |  |
| :---: | :---: | :---: | :--- |
| Digital Inputs/Outputs |  |  |  |
| Terminal | Parameter | $\begin{array}{c}\text { Default } \\ \text { Setting }\end{array}$ | Description |\(\left.| \begin{array}{l}RS-485 Interface. A <br>

control card switch is <br>
provided for <br>
termination resistance.\end{array}\right\}\)

Table 2.4 Terminal Description

### 2.4.5.3 Wiring to Control Terminals

Control terminal connectors can be unplugged from the frequency converter for ease of installation, as shown in Illustration 2.15.


Illustration 2.15 Unplugging Control Terminals

1. Open the contact by inserting a small screwdriver into the slot above or below the contact, as shown in Illustration 2.16.
2. Insert the bared control wire into the contact.
3. Remove the screwdriver to fasten the control wire into the contact.
4. Ensure the contact is firmly established and not loose. Loose control wiring can be the source of equipment faults or less than optimal operation.

See 10.1 Power-dependent Specifications for control terminal wiring sizes.

See 6 Application Set Up Examples for typical control wiring connections.


Illustration 2.16 Connecting Control Wiring

### 2.4.5.4 Using Screened Control Cables

## Correct screening

The preferred method in most cases is to secure control and serial communication cables with screening clamps provided at both ends to ensure best possible high frequency cable contact.


Illustration 2.17 Screening Clamps at Both Ends

## $50 / 60 \mathrm{~Hz}$ ground loops

With very long control cables, ground loops may occur. To eliminate ground loops, connect one end of the screen-toground with a 100 nF capacitor (keeping leads short).


Illustration 2.18 Connection with a 100 nF Capacitor

## Avoid EMC noise on serial communication

To eliminate low-frequency noise between frequency converters, connect one end of the screen to terminal 61. This terminal is connected to ground via an internal RC link. Use twisted-pair cables to reduce interference between conductors.


Illustration 2.19 Twisted-pair Cables

| Installation | $\mathrm{VLT}^{\circledR}$ AQUA Drive |
| :--- | :--- |
|  | Operating Instructions |

### 2.4.5.5 Control Terminal Functions

Frequency converter functions are commanded by receiving control input signals.

- Each terminal must be programmed for the function it will be supporting in the parameters associated with that terminal. See Table 2.4 for terminals and associated parameters.
- It is important to confirm that the control terminal is programmed for the correct function. See 4 User Interface for details on accessing parameters and 5 About Frequency Converter Programming for details on programming.
- The default terminal programming is intended to initiate frequency converter functioning in a typical operational mode.


### 2.4.5.6 Jumper Terminals 12 and 27

A jumper wire may be required between terminal 12 (or 13) and terminal 27 for the frequency converter to operate when using factory default programming values.

- Digital input terminal 27 is designed to receive a 24 V DC external interlock command. In many applications, the user wires an external interlock device to terminal 27
- When no interlock device is used, wire a jumper between control terminal 12 (recommended) or 13 to terminal 27. This provides in internal 24 V signal on terminal 27
- No signal present prevents the unit from operating
- When the status line at the bottom of the LCP reads AUTO REMOTE COASTING or Alarm 60 External Interlock is displayed, this indicates that the unit is ready to operate but is missing an input signal on terminal 27.
- When factory installed optional equipment is wired to terminal 27 , do not remove that wiring.


### 2.4.5.7 Terminal 53 and 54 Switches

- Analog input terminals 53 and 54 can select either voltage ( 0 to 10 V ) or current ( $0 / 4-20 \mathrm{~mA}$ ) input signals
- Remove power to the frequency converter before changing switch positions
- Set switches A53 and A54 to select the signal type. U selects voltage, I selects current.
- The switches are accessible when the LCP has been removed (see Illustration 2.20). Note that some option cards available for the unit may
cover these switches and must be removed to change switch settings. Always remove power to the unit before removing option cards.
- Terminal 53 default is for a speed reference signal in open loop set in 16-61 Terminal 53 Switch Setting
- Terminal 54 default is for a feedback signal in closed loop set in 16-63 Terminal 54 Switch Setting


Illustration 2.20 Location of Terminals 53 and 54 Switches

### 2.4.5.8 Mechanical Brake Control

In hoisting/lowering applications, it is necessary to be able to control an electro-mechanical brake:

- Control the brake using any relay output or digital output (terminal 27 or 29).
- Keep the output closed (voltage-free) as long as the frequency converter is unable to 'support' the motor, for example due to the load being too heavy.
- $\quad$ Select [32] Mechanical brake control in parameter group 5-4* Relays for applications with an electromechanical brake.
- The brake is released when the motor current exceeds the preset value in 2-20 Release Brake Current.
- The brake is engaged when the output frequency is less than the frequency set in 2-21 Activate Brake Speed [RPM] or 2-22 Activate Brake Speed

| Installation | $\mathrm{VLT}^{\circledR}$ AQUA Drive |
| :--- | :--- |
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[ Hz ], and only if the frequency converter carries out a stop command.

If the frequency converter is in alarm mode or in an overvoltage situation, the mechanical brake immediately cuts in.

In the vertical movement, the key point is that the load must be held, stopped, controlled (raised, lowered) in a safe mode during the entire operation. Because the frequency converter is not a safety device, the crane/lift designer (OEM) must decide on the type and number of safety devices (e.g. speed switch, emergency brakes etc.) to be used, in order to be able to stop the load in case of emergency or malfunction of the system, according to relevant national crane/lift regulations.


Illustration 2.21 Connecting the Mechanical Brake to the Frequency Converter

### 2.4.6 Serial Communication

Connect RS-485 serial communication wiring to terminals $(+) 68$ and (-)69.

- Screened serial communication cable is recommended
- $\quad$ See 2.4.2 Earth (Grounding) Requirements for proper grounding


Illustration 2.22 Serial Communication Wiring Diagram

For basic serial communication set up, select the following

1. Protocol type in 8-30 Protocol.
2. Frequency converter address in 8-31 Address.
3. Baud rate in $8-32$ Baud Rate.

- Four communication protocols are internal to the frequency converter. Follow motor manufacturer wiring requirements.
Danfoss FC
Modbus RTU
Johnson Controls N2 ${ }^{\circledR}$
- Functions can be programmed remotely using the protocol software and RS-485 connection or in parameter group 8-** Communications and Options
- Selecting a specific communication protocol changes various default parameter settings to match that protocol's specifications along with making additional protocol-specific parameters available
- Option cards for the frequency converter are available to provide additional communication protocols. See the option-card documentation for installation and operation instructions

| Start Up and Functional Tes... | VLT ${ }^{\circledR}$ AQUA Drive |
| :--- | :--- |
| Operating Instructions |  |

## 3 Start Up and Functional Testing

### 3.1 Pre-start

### 3.1.1 Safety Inspection

## AWARNING

HIGH VOLTAGE!
If input and output connections have been connected improperly, there is potential for high voltage on these terminals. If power leads for multiple motors are improperly run in same conduit, there is potential for leakage current to charge capacitors within the frequency converter, even when disconnected from mains input. For initial start up, make no assumptions about power components. Follow pre-start procedures. Failure to follow pre-start procedures could result in personal injury or damage to equipment.

1. Input power to the unit must be OFF and locked out. Do not rely on the frequency converter disconnect switches for input power isolation.
2. Verify that there is no voltage on input terminals L1 (91), L2 (92), and L3 (93), phase-to-phase and phase-to-ground,
3. Verify that there is no voltage on output terminals 96 (U), 97 (V), and $98(\mathrm{~W})$, phase-tophase and phase-to-ground.
4. Confirm continuity of the motor by measuring ohm values on U-V (96-97), V-W (97-98), and W-U (98-96).
5. Check for proper grounding of the frequency converter as well as the motor.
6. Inspect the frequency converter for loose connections on terminals.
7. Record the following motor-nameplate data: power, voltage, frequency, full load current, and nominal speed. These values are needed to program motor nameplate data later.
8. Confirm that the supply voltage matches voltage of frequency converter and motor.

| Start Up and Functional Tes... | $\mathrm{VLT}^{\circledR}$ AQUA Drive |
| :--- | :--- |
| Operating Instructions |  |

## CAUTION

Before applying power to the unit, inspect the entire installation as detailed in Table 3.1. Check mark those items when completed.

| Inspect for | Description | $\square$ |
| :---: | :---: | :---: |
| Auxiliary equipment | - Look for auxiliary equipment, switches, disconnects, or input fuses/circuit breakers that may reside on the input power side of the frequency converter or output side to the motor. Ensure that they are ready for full speed operation. <br> - Check function and installation of any sensors used for feedback to the frequency converter <br> - Remove power factor correction caps on motor(s), if present |  |
| Cable routing | - Ensure that input power, motor wiring and control wiring are separated or in three separate metallic conduits for high frequency noise isolation |  |
| Control wiring | - Check for broken or damaged wires and loose connections <br> - Check that control wiring is isolated from power and motor wiring for noise immunity <br> - Check the voltage source of the signals, if necessary <br> - The use of shielded cable or twisted pair is recommended. Ensure that the shield is terminated correctly |  |
| Cooling clearance | - Measure that top and bottom clearance is adequate to ensure proper air flow for cooling |  |
| EMC considerations | - Check for proper installation regarding electromagnetic compatibility |  |
| Environmental considerations | - See equipment label for the maximum ambient operating temperature limits <br> - Humidity levels must be $5-95 \%$ non-condensing |  |
| Fusing and circuit breakers | - Check for proper fusing or circuit breakers <br> - Check that all fuses are inserted firmly and in operational condition and that all circuit breakers are in the open position |  |
| Earthing (Grounding) | - The unit requires an earth wire (ground wire) from its chassis to the building earth (ground) <br> - Check for good earth connections (ground connections) that are tight and free of oxidation <br> - Earthing (grounding) to conduit or mounting the back panel to a metal surface is not a suitable earth (ground) |  |
| Input and output power wiring | - Check for loose connections <br> - Check that motor and mains are in separate conduit or separated screened cables |  |
| Panel interior | - Inspect that the unit interior is free of dirt, metal chips, moisture, and corrosion |  |
| Switches | - Ensure that all switch and disconnect settings are in the proper positions |  |
| Vibration | - Check that the unit is mounted solidly or that shock mounts are used, as necessary <br> - Check for an unusual amount of vibration |  |

Table 3.1 Start Up Check List

| Start Up and Functional Tes... | $\mathrm{VLT}^{\circledR}$ AQUA Drive |
| :--- | :--- |
| Operating Instructions |  |

### 3.2 Applying Power to the Frequency Converter

## AWARNING

## HIGH VOLTAGE!

Frequency converters contain high voltage when connected to AC mains. Installation, start-up and maintenance should be performed by qualified personnel only. Failure to comply could result in death or serious injury.

## AWARNING

## UNINTENDED START!

When the frequency converter is connected to AC mains, the motor may start at any time. The frequency converter, motor, and any driven equipment must be in operational readiness. Failure to comply could result in death, serious injury, equipment, or property damage.

1. Confirm that the input voltage is balanced within $3 \%$. If not, correct input voltage imbalance before proceeding. Repeat this procedure after the voltage correction.
2. Ensure that optional equipment wiring, if present, matches the installation application.
3. Ensure that all operator devices are in the OFF position. Panel doors should be closed or cover mounted.
4. Apply power to the unit. DO NOT start the frequency converter at this time. For units with a disconnect switch, turn to the ON position to apply power to the frequency converter.

## NOTE

If the status line at the bottom of the LCP reads AUTO REMOTE COASTING or Alarm 60 External Interlock is displayed, this indicates that the unit is ready to operate but is missing an input signal on terminal 27. See Illustration 1.4 for details.

### 3.3 Basic Operational Programming

### 3.3.1 Required Initial Frequency Converter Programming

Frequency converters require basic operational programming before running for best performance. Basic operational programming requires entering motornameplate data for the motor being operated and the minimum and maximum motor speeds. Enter data in accordance with the following procedure. Parameter settings recommended are intended for start up and
checkout purposes. Application settings may vary. See 4 User Interface for detailed instructions on entering data through the LCP.

Enter data with power ON, but before operating the frequency converter.

1. Press [Main Menu] twice on the LCP.
2. Use the navigation keys to scroll to parameter group 0-** Operation/Display and press [OK].


Illustration 3.1 Main Menu
3. Use navigation keys to scroll to parameter group $0-0^{*}$ Basic Settings and press [OK].


Illustration 3.2 Operation/Display
4. Use navigation keys to scroll to 0-03 Regional Settings and press [OK].


Illustration 3.3 Basic Settings
5. Use navigation keys to select [0] International or [1] North America as appropriate and press [OK]. (This changes the default settings for a number of basic parameters. See 5.4 International/North American Default Parameter Settings for a complete list.)
6. Press [Quick Menu] on the LCP.

| Start Up and Functional Tes... | $\mathrm{VLT}^{\circledR} \mathrm{AQUA}$ Drive |
| :--- | :--- |
|  | Operating Instructions |

7. Use the navigation keys to scroll to parameter group Q2 Quick Setup and press [OK].


Illustration 3.4 Quick Menus
8. Select language and press [OK].
9. A jumper wire should be in place between control terminals 12 and 27 . If this is the case, leave 5-12 Terminal 27 Digital Input at factory default. Otherwise select No Operation. For frequency converters with an optional Danfoss bypass, no jumper wire is required.
10. 3-02 Minimum Reference
11. 3-03 Maximum Reference
12. 3-41 Ramp 1 Ramp Up Time
13. 3-42 Ramp 1 Ramp Down Time
14. 3-13 Reference Site. Linked to Hand/Auto* Local Remote.

### 3.4 PM Motor Setup in VVC ${ }^{\text {plus }}$

## CAUTION

Do only use PM motor with fans and pumps.

## Initial Programming Steps

1. Activate PM motor operation 1-10 Motor

Construction, select [1) PM, non salient SPM
2. Make sure to set 0-02 Motor Speed Unit to [0] RPM

Programming motor data.
After selecting PM motor in 1-10 Motor Construction, the PM motor-related parameters in parameter groups 1-2*, $1-3^{*}$ and $1-4^{*}$ are active. The information can be found on the motor nameplate and in the motor data sheet.
Following parameters must be programmed in the listed order

1. 1-24 Motor Current
2. 1-26 Motor Cont. Rated Torque
3. 1-25 Motor Nominal Speed
4. 1-39 Motor Poles
5. 1-30 Stator Resistance (Rs)

Enter line to common stator winding resistance (Rs). If only line-line data are available, divide the line-line value with 2 to achieve the line to common (starpoint) value.
It is also possible to measure the value with an ohmmeter, which will also take the resistance of the cable into account. Divide the measured value by 2 and enter the result.
6. 1-37 d-axis Inductance (Ld)

Enter line to common direct axis inductance of the PM motor.
If only line-line data are available, divide the lineline value with 2 to achieve the line-common (starpoint) value.
It is also possible to measure the value with an inductancemeter, which will also take the inductance of the cable into account. Divide the measured value by 2 and enter the result.
7. 1-40 Back EMF at 1000 RPM

Enter line to line back EMF of PM Motor at 1000 RPM mechanical speed (RMS value). Back EMF is the voltage generated by a PM motor when no drive is connected and the shaft is turned externally. Back EMF is normally specified for nominal motor speed or for 1000 RPM measured between two lines. If the value is not available for a motor speed of 1000 RPM, calculate the correct value as follows: If back EMF is e.g. 320 V at 1800 RPM, it can be calculated at 1000 RPM as follows: Back EMF= (Voltage / RPM)*1000 = $(320 / 1800) * 1000=178$. This is the value that must be programmed for 1-40 Back EMF at 1000 RPM

Test Motor Operation

1. Start the motor at low speed ( 100 to 200 RPM). If the motor does not turn, check installation, general programming and motor data.
2. Check if start function in 1-70 PM Start Mode fits the application requirements.

## Rotor detection

This function is the recommended choice for applications where the motor starts from standstill e.g. pumps or conveyors. On some motors, an acoustic sound is heard when the impulse is sent out. This does not harm the motor.

## Parking

This function is the recommended choice for applications where the motor is rotating at slow speed eg. windmilling in fan applications. 2-06 Parking Current and 2-07 Parking Time can be adjusted. Increase the factory setting of these parameters for applications with high inertia.
Start the motor at nominal speed. In case the application does not run well, check the $\mathrm{VVC}{ }^{\text {plus }}$ PM settings.

| Start Up and Functional Tes... | $\mathrm{VLT}^{\circledR}$ AQUA Drive |
| :--- | :--- |
|  | Operating Instructions |

Recommendations in different applications can be seen in Table 3.2.

- Run this procedure on a cold motor for best results

| Application | Settings |
| :--- | :--- |
| Low inertia applications <br> $I_{\text {Load }} / I_{\text {Motor }}<5$ | $1-17$ Voltage filter time const. to be <br> increased by factor 5 to 10 <br> $1-14$ Damping Gain should be <br> reduced <br> $1-66$ Min. Current at Low Speed <br> should be reduced (<100\%) |
| Low inertia applications <br> $50>I_{\text {Load }} / I_{\text {Motor }}>5$ | Keep calculated values |
| High inertia applications <br> $I_{\text {Load }} / I_{\text {Motor }}>50$ | $1-14$ Damping Gain, $1-15$ Low Speed <br> Filter Time Const. and $1-16$ High <br> Speed Filter Time Const. should be <br> increased |
| High load at low speed <br> $<30 \%$ (rated speed) | $1-17$ Voltage filter time const. should <br> be increased <br> $1-66 ~ M i n . ~ C u r r e n t ~ a t ~ L o w ~ S p e e d ~$ <br> should be increased (>100\% for <br> longer time can overheat the motor) |

Table 3.2 Recommendations in Different Applications
If the motor starts oscillating at a certain speed, increase 1-14 Damping Gain. Increase the value in small steps. Depending on the motor, a good value for this parameter can be $10 \%$ or $100 \%$ higher than the default value.

Starting torque can be adjusted in 1-66 Min. Current at Low Speed. 100\% provides nominal torque as starting torque.

### 3.5 Automatic Motor Adaptation

Automatic motor adaptation (AMA) is a test procedure that measures the electrical characteristics of the motor to optimize compatibility between the frequency converter and the motor.

- The frequency converter builds a mathematical model of the motor for regulating output motor current. The procedure also tests the input phase balance of electrical power. It compares the motor characteristics with the data entered in parameters 1-20 to 1-25.
- It does not cause the motor to run or harm to the motor
- $\quad$ Some motors may be unable to run the complete version of the test. In that case, select [2] Enable reduced AMA
- If an output filter is connected to the motor, select Enable reduced AMA
- If warnings or alarms occur, see 8 Warnings and Alarms


## NOTE

The AMA algorithm does not work when using PM motors.

## To run AMA

1. Press [Main Menu] to access parameters.
2. Scroll to parameter group 1-** Load and Motor.
3. Press [OK].
4. Scroll to parameter group 1-2* Motor Data.
5. Press [OK].
6. Scroll to 1-29 Automatic Motor Adaptation (AMA).
7. Press [OK].
8. Select [1] Enable complete AMA.
9. Press [OK].
10. Follow on-screen instructions.
11. The test will run automatically and indicate when it is complete.

### 3.6 Check Motor Rotation

Before running the frequency converter, check the motor rotation. The motor will run briefly at 5 Hz or the minimum frequency set in 4-12 Motor Speed Low Limit [Hz].

1. Press [Main Menu].
2. Press [OK].
3. Navigate to 1-28 Motor Rotation Check.
4. Press [OK].
5. Scroll to [1] Enable.

The following text will appear: Note! Motor may run in wrong direction.
6. Press [OK].
7. Follow the on-screen instructions.

To change the direction of rotation, remove power to the frequency converter and wait for power to discharge. Reverse the connection of any two of the three motor cables on the motor or frequency converter side of the connection.

| Start Up and Functional Tes... | $\mathrm{VLT}^{\circledR}$ AQUA Drive |
| :--- | :--- |
| Operating Instructions |  |

### 3.7 Local-control Test

## ACAUTION

## MOTOR START!

Ensure that the motor, system and any attached equipment are ready for start. It is the responsibility of the user to ensure safe operation under any condition. Failure to ensure that the motor, system, and any attached equipment is ready for start could result in personal injury or equipment damage.

## NOTE

The [Hand On] key provides a local start command to the frequency converter. The [Off] key provides the stop function.
When operating in local mode, [ $\mathbf{\Delta}$ ] and [ $\mathbf{V}$ ] increase and decrease the speed output of the frequency converter. [ 4$]$ and $[\downarrow]$ move the display cursor in the numeric display.

1. Press [Hand On].
2. Accelerate the frequency converter by pressing [ $\mathbf{\Delta}$ ] to full speed. Moving the cursor left of the decimal point provides quicker input changes.
3. Note any acceleration problems.
4. Press [Off].
5. Note any deceleration problems.

If acceleration problems were encountered

- If warnings or alarms occur, see 8 Warnings and Alarms
- Check that motor data is entered correctly
- Increase the ramp-up time in 3-41 Ramp 1 Ramp Up Time
- Increase current limit in 4-18 Current Limit
- Increase torque limit in 4-16 Torque Limit Motor Mode

If deceleration problems were encountered

- If warnings or alarms occur, see 8 Warnings and Alarms.
- Check that motor data is entered correctly.
- Increase the ramp-down time in 3-42 Ramp 1 Ramp Down Time.
- Enable overvoltage control in 2-17 Over-voltage Control.

See 4.1.1 Local Control Panel for resetting the frequency converter after a trip.

## NOTE

3.2 Applying Power to the Frequency Converter to 3.3 Basic Operational Programming conclude the procedures for applying power to the frequency converter, basic programming, set-up and functional testing.

### 3.8 System Start Up

The procedure in this section requires user-wiring and application programming to be completed. 6 Application Set Up Examples is intended to help with this task. Other aids to application set-up are listed in 1.2 Additional Resources. The following procedure is recommended after application set-up by the user is completed.

## ACAUTION

## MOTOR START!

Ensure that the motor, system and any attached equipment is ready for start. It is the responsibility of the user to ensure safe operation under any condition. Failure to do so could result in personal injury or equipment damage.

1. Press [Auto On].
2. Ensure that external control functions are properly wired to the frequency converter and all programming is completed.
3. Apply an external run command.
4. Adjust the speed reference> throughout the speed range.
5. Remove the external run command.
6. Note any problems.

If warnings or alarms occur, see 8 Warnings and Alarms.

### 3.9 Acoustic Noise or Vibration

If the motor or the equipment driven by the motor - e.g. a fan blade - is making noise or vibrations at certain frequencies, try the following:

- $\quad$ Speed Bypass, parameter group 4-6*
- Over-modulation, 14-03 Overmodulation set to off
- Switching pattern and switching frequency parameter group 14-0*
- Resonance Dampening, 1-64 Resonance Dampening

| User Interface | $\mathrm{VLT}^{\circledR}$ AQUA Drive |
| :--- | :--- |
|  | Operating Instructions |

## 4 User Interface

### 4.1 Local Control Panel

The local control panel (LCP) is the combined display and keypad on the front of the unit. The LCP is the user interface to the frequency converter.

The LCP has several user functions.

- Start, stop, and control speed when in local control
- Display operational data, status, warnings and cautions
- Programming frequency converter functions
- Manually reset the frequency converter after a fault when auto-reset is inactive

An optional numeric LCP (NLCP) is also available. The NLCP operates in a manner similar to the LCP. See the Programming Guide, for details on use of the NLCP.

### 4.1.1 LCP Layout

The LCP is divided into four functional groups (see Illustration 4.1).


## Illustration 4.1 LCP

a. Display area.
b. Display menu keys for changing the display to show status options, programming, or error message history.
c. Navigation keys for programming functions, moving the display cursor, and speed control in local operation. Also included are the status indicator lights.
d. Operational mode keys and reset.

| User Interface | $\mathrm{VLT}^{\circledR}$ AQUA Drive |
| :--- | :--- |
|  | Operating Instructions |

### 4.1.2 Setting LCP Display Values

The display area is activated when the frequency converter receives power from mains voltage, a DC bus terminal, or an external 24 V DC supply.

The information displayed on the LCP can be customized for user application.

- Each display readout has a parameter associated with it
- Options are selected in the quick menu Q3-13 Display Settings
- Display 2 has an alternate larger display option
- The frequency converter status at the bottom line of the display is generated automatically and is not selectable


Illustration 4.2 Display Readouts


Illustration 4.3 Display Readouts

| Display | Parameter number | Default setting |
| :---: | :---: | :--- |
| 1.1 | $0-20$ | Motor RPMs |
| 1.2 | $0-21$ | Motor current |
| 1.3 | $0-22$ | Motor power (kW) |
| 2 | $0-23$ | Motor frequency |
| 3 | $0-24$ | Reference in percent |

### 4.1.3 Display Menu Keys

Menu keys are used for menu access for parameter set-up, toggling through status display modes during normal operation, and viewing fault log data.


Illustration 4.4 Menu Keys

| Key | Function |
| :--- | :--- |
| Status | Shows operational information. <br> - In Auto mode, press to toggle between <br> status read-out displays |
| - Press repeatedly to scroll through each |  |
| status display |  |
| - Press [Status] plus [ $\mathbf{\Delta}]$ or [ $\mathbf{v}]$ to adjust the |  |
| display brightness |  |
| - The symbol in the upper right corner of the |  |
| display shows the direction of motor |  |
| rotation and which set-up is active. This is |  |
| not programmable. |  |

Table 4.2 Function Description Menu Keys

Table 4.1 Legend to Illustration 4.2 and Illustration 4.3

| User Interface | $\mathrm{VLT}^{\circledR}$ AQUA Drive |
| :--- | :--- |
|  | Operating Instructions |

### 4.1.4 Navigation Keys

Navigation keys are used for programming functions and moving the display cursor. The navigation keys also provide speed control in local (hand) operation. Three frequency converter status indicator lights are also located in this area.


Illustration 4.5 Navigation Keys

| Key | Function |
| :--- | :--- |
| Back | Reverts to the previous step or list in the menu <br> structure. |
| Cancel | Cancels the last change or command as long as <br> the display mode has not changed. |
| Info | Press for a definition of the function being <br> displayed. |
| Navigation <br> Keys | Use the four navigation keys to move between <br> items in the menu. |
| OK | Use to access parameter groups or to enable a <br> choice. |

Table 4.3 Navigation Keys Functions

| Light | Indicator | Function |
| :--- | :--- | :--- |
| Green | ON | The ON light activates when the <br> frequency converter receives <br> power from mains voltage, a DC <br> bus terminal, or an external 24 V <br> supply. |
| Yellow | WARN | When warning conditions are met, <br> the yellow WARN light comes on <br> and text appears in the display <br> area identifying the problem. |
| Red | ALARM | A fault condition causes the red <br> alarm light to flash and an alarm <br> text is displayed. |

[^14]
### 4.1.5 Operation Keys

Operation keys are found at the bottom of the LCP.

$\left.\begin{array}{|l|l|}\hline \text { Key } & \text { Function } \\ \hline \text { Hand On } & \begin{array}{l}\text { Starts the frequency converter in local control. } \\ \text { - Use the navigation keys to control frequency } \\ \text { converter speed }\end{array} \\ \text { - An external stop signal by control input or } \\ \text { serial communication overrides the local hand } \\ \text { on }\end{array}\right\}$

Table 4.5 Operation Keys Functions

### 4.2 Back Up and Copying Parameter Settings

Programming data is stored internally in the frequency converter.

- The data can be uploaded into the LCP memory as a storage back up
- Once stored in the LCP, the data can be downloaded back into the frequency converter
- Data can also be downloaded into other frequency converters by connecting the LCP into those units and downloading the stored settings. (This is a quick way to program multiple units with the same settings).
- Initialisation of the frequency converter to restore factory default settings does not change data stored in the LCP memory

| User Interface | $\mathrm{VLT}^{\circledR}$ AQUA Drive |
| :--- | :--- |
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## AWARNING

UNINTENDED START!
When the frequency converter is connected to AC mains, the motor may start at any time. The frequency converter, motor, and any driven equipment must be in operational readiness. Failure to be in operational readiness when the frequency converter is connected to AC mains could result in death, serious injury, or equipment or property damage.

### 4.2.1 Uploading Data to the LCP

1. Press [Off] to stop the motor before uploading or downloading data.
2. Go to 0-50 LCP Copy.
3. Press $[O K]$.
4. Select All to LCP.
5. Press [OK]. A progress bar shows the uploading process.
6. Press [Hand On] or [Auto On] to return to normal operation.

### 4.2.2 Downloading Data from the LCP

1. Press [Off] to stop the motor before uploading or downloading data.
2. Go to 0-50 LCP Copy.
3. Press $[O K]$.
4. Select All from LCP.
5. Press [OK]. A progress bar shows the downloading process.
6. Press [Hand On] or [Auto On] to return to normal operation.

### 4.3 Restoring Default Settings

## CAUTION

Initialisation restores the unit to factory default settings.
Any programming, motor data, localization, and monitoring records will be lost. Uploading data to the LCP provides a backup before initialisation.

Restoring the frequency converter parameter settings back to default values is done by initialisation of the frequency converter. Initialisation can be through 14-22 Operation Mode or manually.

- Initialisation using 14-22 Operation Mode does not change frequency converter data such as operating hours, serial communication selections,
personal menu settings, fault log, alarm log, and other monitoring functions
- Using 14-22 Operation Mode is generally recommended
- Manual initialisation erases all motor, programming, localization, and monitoring data and restores factory default settings


### 4.3.1 Recommended Initialisation

1. Press [Main Menu] twice to access parameters.
2. Scroll to 14-22 Operation Mode.
3. Press [OK].
4. Scroll to Initialisation.
5. Press [OK].
6. Remove power to the unit and wait for the display to turn off.
7. Apply power to the unit.

Default parameter settings are restored during start up. This may take slightly longer than normal.
8. Alarm 80 is displayed.
9. Press [Reset] to return to operation mode.

### 4.3.2 Manual Initialisation

1. Remove power to the unit and wait for the display to turn off.
2. Press and hold [Status], [Main Menu], and [OK] at the same time and apply power to the unit.

Factory default parameter settings are restored during start up. This may take slightly longer than normal.

Manual initialisation does not reset the following frequency converter information

- 15-00 Operating Hours
- 15-03 Power Up's
- 15-04 Over Temp's
- 15-05 Over Volt's

| About Frequency Converter P... | $\mathrm{VLT}^{\circledR}$ AQUA Drive |
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## 5 About Frequency Converter Programming

### 5.1 Introduction

The frequency converter is programmed for its application functions using parameters. Parameters are accessed by pressing either [Quick Menu] or [Main Menu] on the LCP. (See 4 User Interface for details on using the LCP function keys.) Parameters may also be accessed through a PC using the MCT 10 Set-up Software (see )5.6 Remote Programming with MCT 10 Set-up Software.

The quick menu is intended for initial start up(Q2-** Quick Set $U p$ ) and detailed instructions for common frequency converter applications (Q3-** Function Set Up). Step-by-step instructions are provided. These instructions enable the user to walk through the parameters used for programming applications in their proper sequence. Data entered in a parameter can change the options available in the parameters following that entry. The quick menu presents easy guidelines for getting most systems up and running.
The Quick Menu also contains Q7-** Water and Pumps providing very quick access to all dedicated water and pump features of the $\mathrm{VLT}^{\circledR}$ AQUA Drive

The main menu accesses all parameters and allows for advanced frequency converter applications.

### 5.2 Programming Example

Here is an example for programming the frequency converter for a common application in open loop.

- This procedure programs the frequency converter to receive a $0-10 \mathrm{~V}$ DC analog control signal on input terminal 53
- The frequency converter will respond by providing $6-60 \mathrm{~Hz}$ output to the motor proportional to the input signal ( $0-10 \mathrm{~V} D C=6-60 \mathrm{~Hz}$ )
Select the following parameters using the navigation keys to scroll to the titles and press [OK] after each action.

[^15]| About Frequency Converter P．．． | VLT $^{\circledR}$ AQUA Drive |
| :--- | :--- |
| Operating Instructions |  |



Illustration 5．4 Analog Reference 6－10 Terminal 53 Low Voltage

5．6－11 Terminal 53 High Voltage．Set maximum external voltage reference on Terminal 53 at 10 V ． （This sets the maximum input signal at 10 V ．）


Illustration 5．5 Analog Reference 6－11 Terminal 53 High Voltage

6．6－14 Terminal 53 Low Ref．／Feedb．Value．Set minimum speed reference on Terminal 53 at 6 Hz ．（This tells the frequency converter that the minimum voltage received on Terminal 53 （ 0 V ） equals 6 Hz output．）


Illustration 5．6 Analog Reference 6－14 Terminal 53 Low Ref．／Feedb． Value

7．6－15 Terminal 53 High Ref．／Feedb．Value．Set maximum speed reference on Terminal 53 at 60 Hz ．（This tells the frequency converter that the maximum voltage received on Terminal 53 （10 V） equals 60 Hz output．）


Illustration 5．7 Analog Reference 6－15 Terminal 53 High Ref．／ Feedb．Value

With an external device providing a $0-10 \mathrm{~V}$ control signal connected to frequency converter terminal 53 ，the system is now ready for operation．Note that the scroll bar on the right in the last illustration of the display is at the bottom， indicating the procedure is complete．

Illustration 5.8 shows the wiring connections used to enable this set up．


Illustration 5．8 Wiring Example for External Device Providing 0－10 V Control Signal（Frequency Converter Left，External Device Right）

## 5．3 Control Terminal Programming Examples

Control terminals can be programmed．
－Each terminal has specified functions it is capable of performing
－Parameters associated with the terminal enable the function

See Table 2.4 for control terminal parameter number and default setting．（Default setting can change based on the selection in 0－03 Regional Settings．）

The following example shows accessing Terminal 18 to see the default setting．

| About Frequency Converter P... | $\mathrm{VLT}^{\circledR}$ AQUA Drive |
| :--- | :--- |
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1. Press [Main Menu] twice, scroll to parameter group 5-** Digital In/Out and press [OK].


Illustration 5.9 6-15 Terminal 53 High Ref./Feedb. Value
2. Scroll to parameter group 5-1* Digital Inputs and

| 14.7\% | 0.00A | $\stackrel{\sim}{1(1)}$ |
| :---: | :---: | :---: |
| Digital In/Out |  | 5- |
| 5-0* Digital I/O <br> 5-1* Digital Inp <br> 5-4* Relays <br> 5-5* Pulse Inpu |  | $-\sqrt{\Delta}$ |

Illustration 5.10 Digital In/Out
3. Scroll to 5-10 Terminal 18 Digital Input. Press [OK] to access function choices. The default setting Start is shown.


Illustration 5.11 Digital Inputs

### 5.4 International/North American Default Parameter Settings

Setting 0-03 Regional Settings to International or North America changes the default settings for some parameters. Table 5.1 lists those parameters that are effected.

| Parameter | International <br> Default Parameter <br> Value | North American <br> Default Parameter <br> Value |
| :--- | :--- | :--- |
| 0-03 Regional <br> Settings | International | North America |
| $0-71$ Date Format | YYYY-MM-DD | MM/DD/YYYY |
| $0-72$ Time Format | 24 h | 12 h |


| Parameter | International Default Parameter Value | North American Default Parameter Value |
| :---: | :---: | :---: |
| 1-20 Motor Power [kW] | See Note 1 | See Note 1 |
| 1-21 Motor Power [HP] | See Note 2 | See Note 2 |
| 1-22 Motor Voltage | $230 \mathrm{~V} / 400 \mathrm{~V} / 575 \mathrm{~V}$ | $208 \mathrm{~V} / 460 \mathrm{~V} / 575 \mathrm{~V}$ |
| 1-23 Motor Frequency | $20-1000 \mathrm{~Hz}$ | 60 Hz |
| 3-03 Maximum Reference | 50 Hz | 60 Hz |
| 3-04 Reference Function | Sum | External/Preset |
| 4-13 Motor Speed <br> High Limit [RPM] <br> See Note 3 | 1500 RPM | 1800 RPM |
| 4-14 Motor Speed <br> High Limit [Hz] <br> See Note 4 | 50 Hz | 60 Hz |
| 4-19 Max Output Frequency | $1.0-1000.0 \mathrm{~Hz}$ | 120 Hz |
| 4-53 Warning Speed High | 1500 RPM | 1800 RPM |
| 5-12 Terminal 27 Digital Input | Coast inverse | External interlock |
| 5-40 Function Relay | Alarm | No alarm |
| 6-15 Terminal 53 High Ref./Feedb. Value | 50 | 60 |
| 6-50 Terminal 42 Output | 100 | Speed 4-20mA |
| 14-20 Reset Mode | Automatic reset $\times 10$ | Infinite auto reset |
| 22-85 Speed at Design Point [RPM] See Note 3 | 1500 RPM | 1800 RPM |
| 22-86 Speed at Design Point [Hz] | 50 Hz | 60 Hz |

Table 5.1 International/North American Default Parameter Settings
Note 1: 1-20 Motor Power [kW] is only visible when 0-03 Regional Settings is set to [0] International.
Note 2: 1-21 Motor Power [HP], is only visible when 0-03 Regional Settings is set to [1] North America.
Note 3: This parameter is only visible when 0-02 Motor Speed Unit is set to [0] RPM.
Note 4: This parameter is only visible when 0-02 Motor Speed Unit is set to [1] Hz.

Changes made to default settings are stored and available for viewing in the quick menu along with any programming entered into parameters.

1. Press [Quick Menu].
2. Scroll to $Q 5$ Changes Made and press [OK].

| About Frequency Converter P... | VLT $^{\circledR}$ AQUA Drive |
| :--- | :--- |
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| 25.9\% | 0.00A | $\underset{\text { 1(1) }}{ }$ |
| :---: | :---: | :---: |
| Quick Menus |  |  |
| Q1 My Personal Menu <br> Q2 Quick Setup <br> Q3 Function Setups |  | 合 |

## Illustration 5.12 Quick Menus

3. Select Q5-2 Since Factory Setting to view all programming changes or Q5-1 Last 10 Changes for the most recent.


## Illustration 5.13 Changes Made

### 5.5 Parameter Menu Structure

Establishing the correct programming for applications often requires setting functions in several related parameters. These parameter settings provide the frequency converter with system details it needs to operate properly. System details may include such things as input and output signal types, programming terminals, minimum and maximum signal ranges, custom displays, automatic restart, and other features.

- See the LCP display to view detailed parameter programming and setting options
- Press [Info] in any menu location to view additional details for that function
- Press and hold [Main Menu] to enter a parameter number for direct access to that parameter
- Details for common application set ups are provided in 6 Application Set Up Examples.

About Frequency Converter P...
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### 5.5.1 Quick Menu Structure

| Q2 Quick Setup | 0-37 Display Text 1 | 20-12 Reference/Feedback Unit | Trending Comparison | 29-13 Derag Speed [RPM] |
| :---: | :---: | :---: | :---: | :---: |
| 0-01 Language | 0-38 Display Text 2 | 3-02 Minimum Reference | Q7 Water and Pumps | 29-14 Derag Speed [Hz] |
| 0-02 Motor Speed Unit | 0-39 Display Text 3 | 3-03 Maximum Reference | Q7-1 Pipe Fill | 29-15 Derag Off Delay |
| 1-20 Motor Power [kW] | Q3-12 Analog Output | 6-20 Terminal 54 Low Voltage | Q7-10 Horizontal Pipes | 29-22 Derag Power Factor |
| 1-22 Motor Voltage | 6-50 Terminal 42 Output | 6-21 Terminal 54 High Voltage | 29-00 Pipe Fill Enable | 29-23 Derag Power Delay |
| 1-23 Motor Frequency | 6-51 Terminal 42 Output Min Scale | 6-24 Terminal 54 Low Ref./Feedb. Value | 29-01 Pipe Fill Speed [RPM] | 29-24 Low Speed [RPM] |
| 1-24 Motor Current | 6-52 Terminal 42 Output Max Scale | 6-25 Terminal 54 High Ref./Feedb. Value | 29-02 Pipe Fill Speed [Hz] | 29-25 Low Speed [Hz] |
| 1-25 Motor Nominal Speed | Q3-13 Relays Option relays if applicable | 6-00 Live Zero Timeout Time | 29-03 Pipe Fill Time | 29-26 Low Speed Power [kW] |
| 3-41 Ramp 1 Ramp Up Time | Relay $1 \Rightarrow 5-40$ Function Relay | 6-01 Live Zero Timeout Function | 29-04 Pipe Fill Rate | 29-27 Low Speed Power [HP] |
| 3-42 Ramp 1 Ramp Down Time | Relay 2 $\Rightarrow$ 5-40 Function Relay | Q3-31 PID Settings | 29-05 Filled Setpoint | 29-28 High Speed [RPM] |
| 4-11 Motor Speed Low Limit [RPM] | Q3-2 Open Loop Settings | 20-81 PID Normal/ Inverse Control | 29-05 Filled Setpoint | 29-29 High Speed [Hz] |
| 4-13 Motor Speed High Limit [RPM] | Q3-20 Digital Reference | 20-82 PID Start Speed [RPM] | 29-06 No-Flow Disable Timer | 29-30 High Speed Power [kW] |
| 1-29 Automatic Motor Adaptation (AMA) | 3-02 Minimum Reference | 20-21 Setpoint 1 | Q7-11 Vertical Pipes | 29-31 High Speed Power [HP] |
| Q3 Function Setup | 3-03 Maximum Reference | 20-93 PID Proportional Gain | 29-00 Pipe Fill Enable | 29-32 Derag On Ref Bandwidth |
| Q3-1 General Settings | 3-10 Preset Reference | 20-94 PID Integral Time | 29-04 Pipe Fill Rate | Q7-3 Dry Run |
| Q3-10 Clock Settings | 5-13 Terminal 29 Digital Input | Q5 Changes Made | 29-05 Filled Setpoint | 22-21 Low Power Detection |
| 0-70 Date and Time | 5-14 Terminal 32 Digital Input | Q5-1 Last 10 Changes | 29-06 No-Flow Disable Timer | 22-20 Low Power Auto Set-up |
| 0-71 Date Format | 5-15 Terminal 33 Digital Input | Q5-2 Since Factory Setting | Q7-12 Mixed Systems | 22-27 Dry Pump Delay |
| 0-72 Time Format | Q3-21 Analog Reference | Q5-3 Input Assignments | 29-00 Pipe Fill Enable | 22-26 Dry Pump Function |
| 0-74 DST/Summertime | 3-02 Minimum Reference | Q6 Loggings | 29-01 Pipe Fill Speed [RPM] | Q7-4 End of Curve Detection |
| 0-76 DST/Summertime Start | 3-03 Maximum Reference | Reference [Unit] | 29-02 Pipe Fill Speed [Hz] | 22-50 End of Curve Function |
| 0-77 DST_Summertime End | 6-10 Terminal 53 Low Voltage | Analog Input 53 | 29-03 Pipe Fill Time | 22-51 End of Curve Delay |
| Q3-11 Display Settings | 6-11 Terminal 53 High Voltage | Motor current | 29-05 Filled Setpoint | Q7-5 Sleep Mode |
| 0-20 Display Line 1.1 Small | 6-14 Terminal 53 Low Ref./Feedb. Value | Frequency | 29-06 No-Flow Disable Timer | Q7-50 Low Speed |
| 0-21 Display Line 1.2 Small | 6-15 Terminal 53 High Ref./Feedb. Value | Feedback [Unit] | Q7-2 Deragging | 22-22 Low Speed Detection |
| 0-22 Display Line 1.3 Small | Q3-3 Closed Loop Settings | Energy Log | 29-10 Derag Cycles | 22-23 No-Flow Function |
| 0-23 Display Line 2 Large | Q3-30 Feedback Settings | Trending Cont Bin | 29-11 Derag at Start/Stop | 22-24 No-Flow Delay |
| 0-24 Display Line 3 Large | 1-00 Configuration Mode | Trending Timed Bin | 29-12 Deragging Run Time | 22-28 No-Flow Low Speed [RPM] |

[^16]| 22-29 No-Flow Low Speed [Hz] | 22-24 No-Flow Delay | 22-20 Low Power Auto Set-up | Q7-6 Flow Compensation | 22-90 Flow at Rated Speed |
| :---: | :---: | :---: | :---: | :---: |
| 22-40 Minimum Run Time | 22-20 Low Power Auto Set-up | 22-22 Low Speed Detection | 22-80 Flow Compensation | Q7-7 Special Ramps |
| 22-41 Minimum Sleep Time | 22-40 Minimum Run Time | 22-28 No-Flow Low Speed [RPM] | 22-81 Square-linear Curve Approximation | 3-84 Initial Ramp Time |
| 22-42 Wake-up Speed [RPM] | 22-41 Minimum Sleep Time | 22-29 No-Flow Low Speed [Hz] | 22-82 Work Point Calculation | 3-88 Final Ramp Time |
| 22-43 Wake-up Speed [Hz] | 22-42 Wake-up Speed [RPM] | 22-40 Minimum Run Time | 22-83 Speed at No-Flow [RPM] | 3-85 Check Valve Ramp Time |
| 22-44 Wake-up Ref./FB Difference | 22-43 Wake-up Speed [Hz] | 22-41 Minimum Sleep Time | 22-84 Speed at No-Flow [Hz] | 3-86 Check Valve Ramp End Speed [RPM] |
| 22-45 Setpoint Boost | 22-44 Wake-up Ref./FB Difference | 22-42 Wake-up Speed [RPM] | 22-85 Speed at Design Point [RPM] | 3-87 Check Valve Ramp End Speed [HZ] |
| 22-46 Maximum Boost Time | 22-45 Setpoint Boost | 22-43 Wake-up Speed [Hz] | 22-86 Speed at Design Point [Hz] |  |
| Q7-51 Low Power | 22-46 Maximum Boost Time | 22-44 Wake-up Ref./FB Difference | 22-87 Pressure at No-Flow Speed |  |
| 22-21 Low Power Detection | Q7-52 Low Speed/Power | 22-45 Setpoint Boost | 22-88 Pressure at Rated Speed |  |
| 22-23 No-Flow Function | 22-21 Low Power Detection | 22-46 Maximum Boost Time | 22-89 Flow at Design Point |  |

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| 5.5.2 | Main Menu Structure | 0-89 | Date and Time Readout | 1-8* | Stop Adjustments | 3-93 | Maximum Limit | 5-53 | Term. 29 High Ref./Feedb. Value |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | 1-** | Load and Motor | 1-80 | Function at Stop | 3-94 | Minimum Limit | 5-54 | Pulse Filter Time Constant \#29 |
|  |  | 1-0* | General Settings | 1-81 | Min Speed for Function at Stop [RPM] | 3-95 | Ramp Delay | 5-55 | Term. 33 Low Frequency |
|  |  | 1-00 | Configuration Mode | 1-82 | Min Speed for Function at Stop [Hz] | 4-** | Limits / Warnings | 5-56 | Term. 33 High Frequency |
| 0-** | Operation / Display | 1-01 | Motor Control Principle | 1-86 | Trip Speed Low [RPM] | 4-1* | Motor Limits | 5-57 | Term. 33 Low Ref./Feedb. Value |
| 0-0* | Basic Settings | 1-03 | Torque Characteristics | 1-87 | Trip Speed Low [Hz] | 4-10 | Motor Speed Direction | 5-58 | Term. 33 High Ref./Feedb. Value |
| 0-01 | Language | 1-06 | Clockwise Direction | 1-9* | Motor Temperature | 4-11 | Motor Speed Low Limit [RPM] | 5-59 | Pulse Filter Time Constant \#33 |
| 0-02 | Motor Speed Unit | 1-1* | Motor Selection | 1-90 | Motor Thermal Protection | 4-12 | Motor Speed Low Limit [Hz] | 5-6* | Pulse Output |
| 0-03 | Regional Settings | 1-10 | Motor Construction | 1-91 | Motor External Fan | 4-13 | Motor Speed High Limit [RPM] | 5-60 | Terminal 27 Pulse Output Variable |
| 0-04 | Operating State at Power-up | 1-1* | WVC+ PM | 1-93 | Thermistor Source | 4-14 | Motor Speed High Limit [Hz] | 5-62 | Pulse Output Max Freq \#27 |
| 0-05 | Local Mode Unit | 1-14 | Damping Gain | 2-** | Brakes | 4-16 | Torque Limit Motor Mode | 5-63 | Terminal 29 Pulse Output Variable |
| $0-1 *$ | Set-up Operations | 1-15 | Low Speed Filter Time Const. | 2-0* | DC-Brake | 4-17 | Torque Limit Generator Mode | 5-65 | Pulse Output Max Freq \#29 |
| 0-10 | Active Set-up | 1-16 | High Speed Filter Time Const. | 2-00 | DC Hold/Preheat Current | 4-18 | Current Limit | 5-66 | Terminal X30/6 Pulse Output Variable |
| 0-11 | Programming Set-up | 1-17 | Voltage filter time const. | 2-01 | DC Brake Current | 4-19 | Max Output Frequency | 5-68 | Pulse Output Max Freq \#X30/6 |
| 0-12 | This Set-up Linked to | 1-2* | Motor Data | 2-02 | DC Braking Time | 4-5* | Adj. Warnings | 5-8* | I/O Options |
| 0-13 | Readout: Linked Set-ups | 1-20 | Motor Power [kW] | 2-03 | DC Brake Cut In Speed [RPM] | 4-50 | Warning Current Low | 5-80 | AHF Cap Reconnect Delay |
| 0-14 | Readout: Prog. Set-ups / Channel | 1-21 | Motor Power [HP] | 2-04 | DC Brake Cut In Speed [Hz] | 4-51 | Warning Current High | 5-9* | Bus Controlled |
| 0-2* | LCP Display | 1-22 | Motor Voltage | 2-06 | Parking Current | 4-52 | Warning Speed Low | 5-90 | Digital \& Relay Bus Control |
| 0-20 | Display Line 1.1 Small | 1-23 | Motor Frequency | 2-07 | Parking Time | 4-53 | Warning Speed High | 5-93 | Pulse Out \#27 Bus Control |
| 0-21 | Display Line 1.2 Small | 1-24 | Motor Current | 2-1* | Brake Energy Funct. | 4-54 | Warning Reference Low | 5-94 | Pulse Out \#27 Timeout Preset |
| 0-22 | Display Line 1.3 Small | 1-25 | Motor Nominal Speed | 2-10 | Brake Function | 4-55 | Warning Reference High | 5-95 | Pulse Out \#29 Bus Control |
| 0-23 | Display Line 2 Large | 1-26 | Motor Cont. Rated Torque | 2-11 | Brake Resistor (ohm) | 4-56 | Warning Feedback Low | 5-96 | Pulse Out \#29 Timeout Preset |
| 0-24 | Display Line 3 Large | 1-28 | Motor Rotation Check | 2-12 | Brake Power Limit (kW) | 4-57 | Warning Feedback High | 5-97 | Pulse Out \#X30/6 Bus Control |
| 0-25 | My Personal Menu | 1-29 | Automatic Motor Adaptation (AMA) | 2-13 | Brake Power Monitoring | 4-58 | Missing Motor Phase Function | 5-98 | Pulse Out \#X30/6 Timeout Preset |
| 0-3* | LCP Custom Readout | 1-3* | Adv. Motor Data | 2-15 | Brake Check | 4-6* | Speed Bypass | 6-** | Analog in/Out |
| 0-30 | Custom Readout Unit | 1-30 | Stator Resistance (Rs) | 2-16 | AC brake Max. Current | 4-60 | Bypass Speed From [RPM] | 6-0* | Analog I/O Mode |
| 0-31 | Custom Readout Min Value | 1-31 | Rotor Resistance (Rr) | 2-17 | Over-voltage Control | 4-61 | Bypass Speed From [Hz] | 6-00 | Live Zero Timeout Time |
| 0-32 | Custom Readout Max Value | 1-33 | Stator Leakage Reactance (X1) | 3-** | Reference / Ramps | 4-62 | Bypass Speed To [RPM] | 6-01 | Live Zero Timeout Function |
| 0-37 | Display Text 1 | 1-34 | Rotor Leakage Reactance (X2) | 3-0* | Reference Limits | 4-63 | Bypass Speed To [Hz] | 6-1* | Analog Input 53 |
| 0-38 | Display Text 2 | 1-35 | Main Reactance (Xh) | 3-02 | Minimum Reference | 4-64 | Semi-Auto Bypass Set-up | 6-10 | Terminal 53 Low Voltage |
| 0-39 | Display Text 3 | 1-36 | Iron Loss Resistance (Rfe) | 3-03 | Maximum Reference | 5-** | Digital In/Out | 6-11 | Terminal 53 High Voltage |
| 0-4* | LCP Keypad | 1-37 | d-axis Inductance (Ld) | 3-04 | Reference Function | 5-0* | Digital I/O mode | 6-12 | Terminal 53 Low Current |
| 0-40 | [Hand on] Key on LCP | 1-39 | Motor Poles | 3-1* | References | 5-00 | Digital I/O Mode | 6-13 | Terminal 53 High Current |
| 0-41 | [Off] Key on LCP | 1-40 | Back EMF at 1000 RPM | 3-10 | Preset Reference | 5-01 | Terminal 27 Mode | 6-14 | Terminal 53 Low Ref./Feedb. Value |
| 0-42 | [Auto on] Key on LCP | 1-46 | Position Detection Gain | 3-11 | Jog Speed [Hz] | 5-02 | Terminal 29 Mode | 6-15 | Terminal 53 High Ref./Feedb. Value |
| 0-43 | [Reset] Key on LCP | 1-5* | Load Indep. Setting | 3-13 | Reference Site | 5-1* | Digital Inputs | 6-16 | Terminal 53 Filter Time Constant |
| 0-44 | [Off/Reset] Key on LCP | 1-50 | Motor Magnetisation at Zero Speed | 3-14 | Preset Relative Reference | 5-10 | Terminal 18 Digital Input | 6-17 | Terminal 53 Live Zero |
| 0-45 | [Drive Bypass] Key on LCP | 1-51 | Min Speed Normal Magnetising [RPM] | 3-15 | Reference 1 Source | 5-11 | Terminal 19 Digital Input | 6-2* | Analog Input 54 |
| 0-5* | Copy/Save | 1-52 | Min Speed Normal Magnetising [Hz] | 3-16 | Reference 2 Source | 5-12 | Terminal 27 Digital Input | 6-20 | Terminal 54 Low Voltage |
| 0-50 | LCP Copy | 1-55 | V/f Characteristic - V | 3-17 | Reference 3 Source | 5-13 | Terminal 29 Digital Input | 6-21 | Terminal 54 High Voltage |
| 0-51 | Set-up Copy | 1-56 | V/f Characteristic - f | 3-19 | Jog Speed [RPM] | 5-14 | Terminal 32 Digital Input | 6-22 | Terminal 54 Low Current |
| 0-6* | Password | 1-58 | Flystart Test Pulses Current | 3-4* | Ramp 1 | 5-15 | Terminal 33 Digital Input | 6-23 | Terminal 54 High Current |
| 0-60 | Main Menu Password | 1-59 | Flystart Test Pulses Frequency | 3-41 | Ramp 1 Ramp Up Time | 5-16 | Terminal X30/2 Digital Input | 6-24 | Terminal 54 Low Ref./Feedb. Value |
| 0-61 | Access to Main Menu w/o Password Personal Menu Password | 1-6* | Load Depen. Setting | 3-42 | Ramp 1 Ramp Down Time | 5-17 | Terminal X30/3 Digital Input | 6-25 | Terminal 54 High Ref./Feedb. Value |
| 0-65 | Personal Menu Password | 1-60 | Low Speed Load Compensation | 3-5* | Ramp 2 2 | 5-18 | Terminal X30/4 Digital Input | 6-26 | Terminal 54 Filter Time Constant |
| 0-66 | Access to Personal Menu w/o | 1-61 | High Speed Load Compensation | 3-51 | Ramp 2 Ramp Up Time | 5-19 | Terminal 37 Digital Input | 6-27 | Terminal 54 Live Zero |
|  | Password | 1-62 | Slip Compensation | 3-52 | Ramp 2 Ramp Down Time | 5-3* | Digital Outputs | 6-3* | Analog Input X30/11 |
| 0-67 | Bus Password Access | 1-63 | Slip Compensation Time Constant | 3-8* | Other Ramps | 5-30 | Terminal 27 Digital Output | 6-30 | Terminal X30/11 Low Voltage |
| 0-7* | Clock Settings | 1-64 | Resonance Dampening | 3-80 | Jog Ramp Time | 5-31 | Terminal 29 Digital Output | 6-31 | Terminal X30/11 High Voltage |
| 0-70 | Date and Time | 1-65 | Resonance Dampening Time Constant | 3-81 | Quick Stop Ramp Time | 5-32 | Term X30/6 Digi Out (MCB 101) | 6-34 | Term. X30/11 Low Ref./Feedb. Value |
| 0-71 | Date Format | 1-66 | Min. Current at Low Speed | 3-84 | Initial Ramp Time | 5-33 | Term X30/7 Digi Out (MCB 101) | 6-35 | Term. X30/11 High Ref./Feedb. Value |
| 0-72 | Time Format | 1-7* | Start Adjustments | 3-85 | Check Valve Ramp Time | 5-4* | Relays | 6-36 | Term. X30/11 Filter Time Constant |
| 0-74 | DST/Summertime | 1-70 | PM Start Mode | 3-86 | Check Valve Ramp End Speed [RPM] | 5-40 | Function Relay | 6-37 | Term. X30/11 Live Zero |
| 0-76 | DST/Summertime Start | 1-71 | Start Delay | 3-87 | Check Valve Ramp End Speed [HZ] | 5-41 | On Delay, Relay | 6-4* | Analog Input X30/12 |
| 0-77 | DST/Summertime End | 1-72 | Start Function | 3-88 | Final Ramp Time | 5-42 | Off Delay, Relay | 6-40 | Terminal X30/12 Low Voltage |
| 0-79 | Clock Fault | 1-73 | Flying Start | 3-9* | Digital Pot.Meter | 5-5* | Pulse Input | 6-41 | Terminal X30/12 High Voltage |
| 0-81 | Working Days | 1-74 | Start Speed [RPM] | 3-90 | Step Size | 5-50 | Term. 29 Low Frequency | 6-44 | Term. X30/12 Low Ref./Feedb. Value |
| 0-82 | Additional Working Days | 1-75 | Start Speed [Hz] | 3-91 | Ramp Time | 5-51 | Term. 29 High Frequency | 6-45 | Term. X30/12 High Ref./Feedb. Value |
| 0-83 | Additional Non-Working Days | 1-76 | Start Current | 3-92 | Power Restore | 5-52 | Term. 29 Low Ref./Feedb. Value | 6-46 | Term. X30/12 Filter Time Constant |

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| :--- | :--- |



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### 5.6 Remote Programming with MCT 10 Setup Software

Danfoss has a software program available for developing, storing, and transferring frequency converter programming. The MCT 10 Set-up Software allows the user to connect a PC to the frequency converter and perform live programming rather than using the LCP. Additionally, all frequency converter programming can be done off-line and simply downloaded to the frequency converter. Or the entire frequency converter profile can be loaded onto the PC for back up storage or analysis.

The USB connector or RS-485 terminal is available for connecting to the frequency converter.

MCT 10 Set-up Software is available for free download at www.VLT-software.com. A CD is also available by requesting part number 130B1000. For further information, see the Operating Instructions.

| Application Set Up Examples | $\mathrm{VLT}^{\circledR}$ AQUA Drive |
| :--- | :--- |
|  | Operating Instructions |

## 6 Application Set Up Examples

### 6.1 Introduction

## NOTE

When the optional safe stop feature is used, a jumper wire may be required between terminal 12 (or 13 ) and terminal 37 for the frequency converter to operate when using factory default programming values.

The examples in this section are intended as a quick reference for common applications.

- Parameter settings are the regional default values unless otherwise indicated (selected in 0-03 Regional Settings)
- Parameters associated with the terminals and their settings are shown next to the drawings
- Where switch settings for analog terminals A53 or A54 are required, these are also shown


### 6.2 Application Examples



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Table 6.2 Analog Voltage Feedback Transducer (3-wire)


Table 6.3 Analog Voltage Feedback Transducer (4-wire)

| Application Set Up Examples | $\mathrm{VLT}^{\circledR}$ AQUA Drive |
| :--- | :--- |
|  | Operating Instructions |



Table 6.4 Analog Speed Reference (Voltage)

## NOTE

Note switch setting for selecting voltage or current.


Table 6.5 Analog Speed Reference (Current)

## NOTE

Note switch setting for selecting voltage or current.

| Application Set Up Examples | $\mathrm{VLT}^{\circledR}$ AQUA Drive |
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Table 6.8 External Alarm Reset


Table 6.9 Speed Reference (using a manual potentiometer)


Table 6.10 Run Permissive

| Application Set Up Examples | $\mathrm{VLT}^{\circledR}$ AQUA Drive |
| :--- | :--- |
| Operating Instructions |  |




Table 6.12 Motor Thermistor

Table 6.11 RS-485 Network Connection (N2, Modbus RTU, FC)

## CAUTION

Thermistors must use reinforced or double insulation to meet PELV insulation requirements.

| Status Messages | $\mathrm{VLT}^{\circledR} \mathrm{AQUA}$ Drive |
| :--- | :--- |
|  | Operating Instructions |

## 7 Status Messages

### 7.1 Status Display

When the frequency converter is in status mode, status messages are generated automatically from within the frequency converter and appear in the bottom line of the display (see Illustration 7.1.)


Illustration 7.1 Status Display
a. The first part of the status line indicates where the stop/start command originates.
b. The second part of the status line indicates where the speed control originates.
c. The last part of the status line gives the present frequency converter status. These show the operational mode the frequency converter is in.

## NOTE

In auto/remote mode, the frequency converter requires external commands to execute functions.

### 7.2 Status Message Definitions

The next three tables define the meaning of the status message display words.

|  | Operation Mode |
| :--- | :--- |
| Off | The frequency converter does not react to any <br> control signal until [Auto On] or [Hand On] is <br> pressed. |
| Auto On | The frequency converter is controlled from the <br> control terminals and/or the serial communi- <br> cation. |
| Hand On | The navigation keys on the LCP control the <br> frequency converter. Stop commands, reset, <br> reversing, DC brake, and other signals applied <br> to the control terminals can override local <br> control. |

Table 7.1 Status Message Operation Mode

|  | Reference Site |
| :--- | :--- |
| Remote | The speed reference is given from external <br> signals, serial communication, or internal <br> preset references. |
| Local | The frequency converter uses [Hand On] <br> control or reference values from the LCP. |

Table 7.2 Status Message Reference Site

|  | Operation Status |
| :--- | :--- |
| AC Brake | AC Brake was selected in 2-10 Brake Function. <br> The AC brake over-magnetizes the motor to <br> achieve a controlled slow down. |
| AMA finish OK | Automatic motor adaptation (AMA) was <br> carried out successfully. |
| AMA ready | AMA is ready to start. Press [Hand On] to start. |
| AMA running | AMA process is in progress. |
| Braking | The brake chopper is in operation. Generative <br> energy is absorbed by the brake resistor. |
| Braking max. | The brake chopper is in operation. The power <br> limit for the brake resistor defined in <br> $2-12$ Brake Power Limit (kW) has been reached. |
| Coast | - Coast inverse was selected as a function <br> for a digital input (parameter group 5-1* <br> Digital Inputs). The corresponding terminal <br> is not connected. <br> - Coast activated by serial communication |


| Status Messages | $\mathrm{VLT}^{\circledR}$ AQUA Drive |
| :--- | :--- |
|  | Operating Instructions |


|  | Operation Status |
| :--- | :--- |
| Ctrl. Ramp-down | Control Ramp-down was selected in <br> 14-10 Mains Failure. <br> - The mains voltage is below the value set <br> in 14-11 Mains Voltage at Mains Fault at <br> mains fault <br> - The frequency converter ramps down the <br> motor using a controlled ramp down |
| Current High | The frequency converter output current is <br> above the limit set in 4-51 Warning Current <br> High. |
| Current Low | The frequency converter output current is <br> below the limit set in 4-52 Warning Speed Low |
| DC Hold | DC hold is selected in 1-80 Function at Stop <br> and a stop command is active. The motor is <br> held by a DC current set in 2-00 DC Hold/ <br> Preheat Current. |
| DC Stop | The motor is held with a DC current (2-01 DC <br> Brake Current) for a specified time (2-02 DC <br> Braking Time). <br> - DC Brake is activated in 2-03 DC Brake Cut <br> In Speed [RPM] and a Stop command is <br> active. <br> - DC Brake (inverse) is selected as a function <br> for a digital input (parameter group 5-1* <br> Digital Inputs). The corresponding terminal <br> is not active. <br> request |
| Fhe DC Brake is activated via serial |  |
| communication. |  |


|  | Operation Status |
| :---: | :---: |
| Freeze ref. | Freeze Reference was chosen as a function for a digital input (parameter group 5-1* Digital Inputs). The corresponding terminal is active. The frequency converter saves the actual reference. Changing the reference is now only possible via terminal functions Speed Up and Speed Down. |
| Jog request | A jog command has been given, but until a run permissive signal is received via a digital input, the motor is stopped |
| Jogging | The motor is running as programmed in 3-19 Jog Speed [RPM]. <br> - Jog was selected as function for a digital input (parameter group 5-1* Digital Inputs). The corresponding terminal (for example, Terminal 29) is active. <br> - The Jog function is activated via the serial communication. <br> - The Jog function was selected as a reaction for a monitoring function (for example, No signal). The monitoring function is active. |
| Motor check | In 1-80 Function at Stop, Motor Check was selected. A stop command is active. To ensure that a motor is connected to the frequency converter, a permanent test current is applied to the motor. |
| OVC control | Overvoltage control was activated in 2-17 Overvoltage Control. The connected motor is supplying the frequency converter with generative energy. The overvoltage control adjusts the $\mathrm{V} / \mathrm{Hz}$ ratio to run the motor in controlled mode and to prevent the frequency converter from tripping. |
| PowerUnit Off | (For frequency converters with an external 24 V power supply installed only.) Mains supply to the frequency converter is removed, but the control card is supplied by the external 24 V. |
| Protection md | Protection mode is active. The unit has detected a critical status (an overcurrent or overvoltage). <br> - To avoid tripping, switching frequency is reduced to 4 kHz . <br> - If possible, protection mode ends after approximately 10 s <br> - Protection mode can be restricted in 14-26 Trip Delay at Inverter Fault |


| Status Messages | $\mathrm{VLT}^{\circledR}$ AQUA Drive |
| :--- | :--- |
|  | Operating Instructions |


|  | Operation Status |
| :---: | :---: |
| QStop | The motor is decelerating using 3-81 Quick Stop Ramp Time. <br> - Quick stop inverse was chosen as a function for a digital input (parameter group 5-1*). The corresponding terminal is not active. <br> - The quick stop function was activated via serial communication. |
| Ramping | The motor is accelerating/decelerating using the active Ramp Up/Down. The reference, a limit value or a standstill is not yet reached. |
| Ref. high | The sum of all active references is above the reference limit set in 4-55 Warning Reference High. |
| Ref. low | The sum of all active references is below the reference limit set in 4-54 Warning Reference Low. |
| Run on ref. | The frequency converter is running in the reference range. The feedback value matches the setpoint value. |
| Run request | A start command has been given, but the motor is stopped until a run permissive signal is received via digital input. |
| Running | The frequency converter runs the motor. |
| Sleep Mode | The energy saving function is enabled. The motor has stopped, but will restart automatically when required. |
| Speed high | Motor speed is above the value set in 4-53 Warning Speed High. |
| Speed low | Motor speed is below the value set in 4-52 Warning Speed Low. |
| Standby | In Auto On Auto mode, the frequency converter starts the motor with a start signal from a digital input or serial communication. |
| Start delay | In 1-71 Start Delay, a delay starting time was set. A start command is activated and the motor will start after the start delay time expires. |
| Start fwd/rev | Start forward and start reverse were selected as functions for two different digital inputs (parameter group 5-1* Digital Inputs). The motor starts in forward or reverse depending on which corresponding terminal is activated. |
| Stop | The frequency converter has received a stop command from the LCP, digital input or serial communication. |
| Trip | An alarm occurred and the motor is stopped. Once the cause of the alarm is cleared, the frequency converter can be reset manually by pressing [Reset] or remotely by control terminals or serial communication. |


| Warnings and Alarms | $\mathrm{VLT}^{\circledR}$ AQUA Drive |
| :--- | :--- |
|  | Operating Instructions |

## 8 Warnings and Alarms

## 8．1 System Monitoring

The frequency converter monitors the condition of its input power，output，and motor factors as well as other system performance indicators．A warning or alarm may not necessarily indicate a problem internal to the frequency converter itself．In many cases，it indicates failure conditions from input voltage，motor load or temperature， external signals，or other areas monitored by the frequency converter＇s internal logic．Be sure to investigate those areas exterior to the frequency converter as indicated in the alarm or warning．

## 8．2 Warning and Alarm Types

## Warnings

A warning is issued when an alarm condition is impending or when an abnormal operating condition is present and may result in the frequency converter issuing an alarm．A warning clears by itself when the abnormal condition is removed．

## Alarms

Trip
An alarm is issued when the frequency converter is tripped，that is，the frequency converter suspends operation to prevent frequency converter or system damage．The motor will coast to a stop．The frequency converter logic will continue to operate and monitor the frequency converter status．After the fault condition is remedied，the frequency converter can be reset．It will then be ready to start operation again．

A trip can be reset in any of 4 ways
－Press［Reset］on the LCP
－Digital reset input command
－Serial communication reset input command
－Auto reset

An alarm that causes the frequency converter to trip－lock requires that input power is cycled．The motor will coast to a stop．The frequency converter logic will continue to operate and monitor the frequency converter status． Remove input power to the frequency converter and correct the cause of the fault，then restore power．This action puts the frequency converter into a trip condition as described above and may be reset in any of those 4 ways．

## 8．3 Warning and Alarm Displays

| Status |  | $!1(1)$ |
| :--- | :---: | ---: |
| 0.0 Hz | 0.000 psi | 0.00 A |
|  | 0.0 Hz |  |
|  | $1: 0-\mathrm{Off}$ |  |
|  |  |  |
|  |  |  |
|  |  |  |
| ！Live zero error［W2］ |  |  |
| Off Remote Stop |  |  |

An alarm or trip－lock alarm will flash on display along with the alarm number．


Illustration 8．2 Alarm Display

In addition to the text and alarm code on the frequency converter LCP，there are three status indicator lights．


Illustration 8．3 Status Indicator Lights

| Warnings and Alarms | $\mathrm{VLT}^{\circledR}$ AQUA Drive |
| :--- | :--- |
|  | Operating Instructions |


|  | Warning LED | Alarm LED |
| :--- | :--- | :--- |
| Warning | On | Off |
| Alarm | Off | On (Flashing) |
| Trip-Lock | On | On (Flashing) |

Table 8.1 Status Indicator Lights Explanations

### 8.4 Warning and Alarm Definitions

## CAUTION

Before applying power to the unit, inspect the entire installation as detailed in Table 3.1. Check mark those items when completed.

| Inspect for | Description | - Look for auxiliary equipment, switches, disconnects, or input fuses/circuit breakers that may reside <br> on the input power side of the frequency converter or output side to the motor. Ensure that they <br> are ready for full speed operation. |  |
| :--- | :--- | :--- | :--- |
| Auxiliary equipment | - Check function and installation of any sensors used for feedback to the frequency converter |  |  |
| - Remove power factor correction caps on motor(s), if present |  |  |  |

## Table 8.2 Start Up Check List

| Basic Troubleshooting | $\mathrm{VLT}^{\circledR}$ AQUA Drive |
| :--- | :--- |
|  | Operating Instructions |

## 9 Basic Troubleshooting

### 9.1 Start Up and Operation

| Symptom | Possible cause | Test | Solution |
| :---: | :---: | :---: | :---: |
| Display dark/No function | Missing input power | See Table 3.1 | Check the input power source |
|  | Missing or open fuses or circuit breaker tripped | See open fuses and tripped circuit breaker in this table for possible causes | Follow the recommendations provided |
|  | No power to the LCP | Check the LCP cable for proper connection or damage | Replace the faulty LCP or connection cable |
|  | Shortcut on control voltage (terminal 12 or 50 ) or at control terminals | Check the 24 V control voltage supply for terminals $12 / 13$ to 20-39 or 10 V supply for terminals 50 to 55 | Wire the terminals properly |
|  | Wrong LCP (LCP from VLT ${ }^{\circledR} 2800$ or 5000/6000/8000/ FCD or FCM) |  | Use only LCP 101 (P/N 130B1124) or LCP 102 (P/N 130B1107) |
|  | Wrong contrast setting |  | Press [Status] + [ $\mathbf{\Delta}] /[\mathbf{v}]$ to adjust the contrast |
|  | Display (LCP) is defective | Test using a different LCP | Replace the faulty LCP or connection cable |
|  | Internal voltage supply fault or SMPS is defective |  | Contact supplier |
| Intermittent display | Overloaded power supply (SMPS) due to improper control wiring or a fault within the frequency converter | To rule out a problem in the control wiring, disconnect all control wiring by removing the terminal blocks. | If the display stays lit, then the problem is in the control wiring. Check the wiring for shorts or incorrect connections. If the display continues to cut out, follow the procedure for display dark. |
| Motor not running | Service switch open or missing motor connection | Check if the motor is connected and the connection is not interrupted (by a service switch or other device). | Connect the motor and check the service switch |
|  | No mains power with 24 V DC option card | If the display is functioning but no output, check that mains power is applied to the frequency converter. | Apply mains power to run the unit |
|  | LCP Stop | Check if [Off] has been pressed | Press [Auto On] or [Hand On] (depending on operation mode) to run the motor |
|  | Missing start signal (Standby) | Check 5-10 Terminal 18 Digital Input for correct setting for terminal 18 (use default setting) | Apply a valid start signal to start the motor |
|  | Motor coast signal active (Coasting) | Check 5-12 Coast inv. for correct setting for terminal 27 (use default setting).. | Apply 24 V on terminal 27 or program this terminal to No operation |
|  | Wrong reference signal source | Check reference signal: Local, remote or bus reference? Preset reference active? Terminal connection correct? Scaling of terminals correct? Reference signal available? | Program correct settings. Check 3-13 Reference Site. Set preset reference active in parameter group 3-1* References. Check for correct wiring. Check scaling of terminals. Check reference signal. |


| Basic Troubleshooting | $\mathrm{VLT}^{\circledR}$ AQUA Drive |
| :--- | :--- |
|  | Operating Instructions |


| Symptom | Possible cause | Test | Solution |
| :---: | :---: | :---: | :---: |
| Motor running in wrong direction | Motor rotation limit | Check that 4-10 Motor Speed Direction is programmed correctly. | Program correct settings |
|  | Active reversing signal | Check if a reversing command is programmed for the terminal in parameter group 5-1* Digital inputs.. | Deactivate reversing signal |
|  | Wrong motor phase connection |  | See in this manual |
| Motor is not reaching maximum speed | Frequency limits set wrong | Check output limits in 4-13 Motor Speed High Limit [RPM], 4-14 Motor Speed High Limit [Hz] and 4-19 Max Output Frequency. | Program correct limits |
|  | Reference input signal not scaled correctly | Check reference input signal scaling in 6-0* Analog I/O Mode and parameter group 3-1* References. Reference limits in parameter group 3-0* Reference Limit. | Program correct settings |
| Motor speed unstable | Possible incorrect parameter settings | Check the settings of all motor parameters, including all motor compensation settings. For closed loop operation, check PID settings. | Check settings in parameter group 1-6* Analog I/O mode. For closed loop operation, check settings in parameter group 20-0* Feedback.. |
| Motor runs rough | Possible over-magnetization | Check for incorrect motor settings in all motor parameters | Check motor settings in parameter groups 1-2* Motor Data, 1-3* Adv Motor Data, and 1-5* Load Indep. Setting. |
| Motor will not brake | Possible incorrect settings in the brake parameters. Possible too short ramp down times | Check brake parameters. Check ramp time settings | Check parameter group 2-0* DC Brake and 3-0* Reference Limits. |
| Open power fuses or circuit breaker trip | Phase to phase short | Motor or panel has a short phase to phase. Check motor and panel phase for shorts | Eliminate any shorts detected |
|  | Motor overload | Motor is overloaded for the application | Perform startup test and verify motor current is within specifications. If motor current is exceeding nameplate full load current, motor may run only with reduced load. Review the specifications for the application. |
|  | Loose connections | Perform pre-startup check for loose connections | Tighten loose connections |
| Mains current imbalance greater than 3\% | Problem with mains power (See Alarm 4 Mains phase loss description) | Rotate input power leads into the frequency converter one position: A to $B, B$ to $C, C$ to $A$. | If imbalanced leg follows the wire, it is a power problem. Check mains power supply. |
|  | Problem with the frequency converter | Rotate input power leads into the frequency converter one position: A to $B, B$ to $C, C$ to $A$. | If imbalance leg stays on same input terminal, it is a problem with the unit. Contact the supplier. |
| Motor current imbalance greater than 3\% | Problem with motor or motor wiring | Rotate output motor leads one position: U to V, V to W, W to U. | If imbalanced leg follows the wire, the problem is in the motor or motor wiring. Check motor and motor wiring. |
|  | Problem with the frequency converters | Rotate output motor leads one position: U to $\mathrm{V}, \mathrm{V}$ to $\mathrm{W}, \mathrm{W}$ to U . | If imbalance leg stays on same output terminal, it is a problem with the unit. Contact the supplier. |


| Basic Troubleshooting | $\mathrm{VLT}^{\circledR}$ AQUA Drive |
| :--- | :--- |
|  | Operating Instructions |


| Symptom | Possible cause | Test | Solution |
| :--- | :--- | :--- | :--- |
| Acoustic noise or vibration | Resonances | Bypass critical frequencies by using <br> parameters in parameter group <br>  <br>  |  |
|  |  |  |  |

Table 9.1 Troubleshooting

| Specifications | $\mathrm{VLT}^{\circledR}$ AQUA Drive |
| :--- | :--- |
|  | Operating Instructions |

## 10 Specifications

### 10.1 Power-dependent Specifications

### 10.1.1 Mains Supply $1 \times 200-240$ V AC

| Mains Supply $1 \times 200-240$ V AC - Normal overload 110\% for 1 minute |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Frequency converter | P1K1 | P1K5 | P2K2 | P3K0 | P3K7 | P5K5 | P7K5 | P15K | P22K |
| Typical Shaft Output [kW] | 1.1 | 1.5 | 2.2 | 3.0 | 3.7 | 5.5 | 7.5 | 15 | 22 |
| Typical Shaft Output [HP] at 240 V | 1.5 | 2.0 | 2.9 | 4.0 | 4.9 | 7.5 | 10 | 20 | 30 |
| IP20/Chassis | A3 | - | - | - | - | - | - | - | - |
| IP21/NEMA 1 | - | B1 | B1 | B1 | B1 | B1 | B2 | C1 | C2 |
| IP55/NEMA 12 | A5 | B1 | B1 | B1 | B1 | B1 | B2 | C1 | C2 |
| IP66 | A5 | B1 | B1 | B1 | B1 | B1 | B2 | C1 | C2 |
| Output current |  |  |  |  |  |  |  |  |  |
| Continuous ( $3 \times 200-240 \mathrm{~V}$ ) [A] | 6.6 | 7.5 | 10.6 | 12.5 | 16.7 | 24.2 | 30.8 | 59.4 | 88 |
| Intermittent( $3 \times 200-240 \mathrm{~V}$ ) [A] | 7.3 | 8.3 | 11.7 | 13.8 | 18.4 | 26.6 | 33.4 | 65.3 | 96.8 |
| Continuous kVA (208 V AC) [kVA] |  |  |  |  |  | 5.00 | 6.40 | 12.27 | 18.30 |
| Max. input current |  |  |  |  |  |  |  |  |  |
| Continuous ( $1 \times 200-240 \mathrm{~V}$ ) [A] | 12.5 | 15 | 20.5 | 24 | 32 | 46 | 59 | 111 | 172 |
| Intermittent (1 x 200-240 V) [A] | 13.8 | 16.5 | 22.6 | 26.4 | 35.2 | 50.6 | 64.9 | 122.1 | 189.2 |
| Max. pre-fuses ${ }^{1 /}$ [A] | 20 | 30 | 40 | 40 | 60 | 80 | 100 | 150 | 200 |
| Additional specifications |  |  |  |  |  |  |  |  |  |
| Estimated power loss at rated max. load [W] ${ }^{4)}$ | 44 | 30 | 44 | 60 | 74 | 110 | 150 | 300 | 440 |
| Max. cable size (mains, motor, brake) [mm²]/(AWG) ${ }^{2)}$ | [0.2-4]/(4-10) |  |  |  |  | [10]/(7) | [35]/(2) | [50]/(1)/0 | [95]/(4/0) |
| Weight enclosure IP20 [kg] | 4.9 | - | - | - | - | - | - | - | - |
| Weight enclosure IP21 [kg] | - | 23 | 23 | 23 | 23 | 23 | 27 | 45 | 65 |
| Weight enclosure IP55 [kg] | - | 23 | 23 | 23 | 23 | 23 | 27 | 45 | 65 |
| Weight enclosure IP66 [kg] | - | 23 | 23 | 23 | 23 | 23 | 27 | 45 | 65 |
| Efficiency ${ }^{3}$ | 0.968 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 |

Table 10.1 Mains Supply $1 \times 200-240$ V AC - Normal Overload $110 \%$ for 1 Minute

| Specifications | $\mathrm{VLT}^{\circledR} \mathrm{AQUA}$ Drive |
| :--- | :--- |
|  | Operating Instructions |

### 10.1.2 Mains Supply $3 \times 200-240$ V AC

| Mains Supply $3 \times 200-240$ V AC - Normal overload 110\% for 1 minute |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Frequency converter | PK25 | PK37 | PK55 | PK75 | P1K1 | P1K5 | P2K2 | P3K0 | P3K7 |
| Typical Shaft Output [kW] | 0.25 | 0.37 | 0.55 | 0.75 | 1.1 | 1.5 | 2.2 | 3 | 3.7 |
| Typical Shaft Output [HP] at 208 V | 0.25 | 0.37 | 0.55 | 0.75 | 1.5 | 2.0 | 2.9 | 4.0 | 4.9 |
| IP20/NEMA Chassis | A2 | A2 | A2 | A2 | A2 | A2 | A2 | A3 | A3 |
| IP21/NEMA 1 | A2 | A2 | A2 | A2 | A2 | A2 | A2 | A3 | A3 |
| IP55/NEMA 12 | A5 | A5 | A5 | A5 | A5 | A5 | A5 | A5 | A5 |
| IP66 | A5 | A5 | A5 | A5 | A5 | A5 | A5 | A5 | A5 |
| Output current |  |  |  |  |  |  |  |  |  |
| Continuous ( $3 \times 200-240 \mathrm{~V}$ ) [A] | 1.8 | 2.4 | 3.5 | 4.6 | 6.6 | 7.5 | 10.6 | 12.5 | 16.7 |
| Intermittent ( $3 \times 200-240 \mathrm{~V}$ ) [A] | 1.98 | 2.64 | 3.85 | 5.06 | 7.26 | 8.3 | 11.7 | 13.8 | 18.4 |
| Continuous kVA (208 V AC) [kVA] | 0.65 | 0.86 | 1.26 | 1.66 | 2.38 | 2.70 | 3.82 | 4.50 | 6.00 |
| Max. input current |  |  |  |  |  |  |  |  |  |
| Continuous ( $3 \times 200-240 \mathrm{~V}$ ) [A] | 1.6 | 2.2 | 3.2 | 4.1 | 5.9 | 6.8 | 9.5 | 11.3 | 15.0 |
| Intermittent ( $3 \times 200-240 \mathrm{~V}$ ) [A] | 1.7 | 2.42 | 3.52 | 4.51 | 6.5 | 7.5 | 10.5 | 12.4 | 16.5 |
| Max. pre-fuses ${ }^{1)}$ [A] | 10 | 10 | 10 | 10 | 20 | 20 | 20 | 32 | 32 |
| Additional specifications |  |  |  |  |  |  |  |  |  |
| Estimated power loss at rated max. load [W] ${ }^{4)}$ | 21 | 29 | 42 | 54 | 63 | 82 | 116 | 155 | 185 |
| Max. cable size (mains, motor, brake) [ $\mathrm{mm}^{2}$ ]/(AWG) ${ }^{\text {2) }}$ | [0.2-4]/(4-10) |  |  |  |  |  |  |  |  |
| Weight enclosure IP20 [kg] | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 6.6 | 6.6 |
| Weight enclosure IP21 [kg] | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 7.5 | 7.5 |
| Weight enclosure IP55 [kg] | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 |
| Weight enclosure IP66 [kg] | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 |
| Efficiency ${ }^{3)}$ | 0.94 | 0.94 | 0.95 | 0.95 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 |

Table 10.2 Mains Supply $3 \times 200-240$ V AC - Normal Overload $110 \%$ for 1 Minute

| Specifications | $\mathrm{VLT}^{\circledR} \mathrm{AQUA}$ Drive |
| :--- | :--- |
|  | Operating Instructions |


| Mains supply $3 \times 200-240$ V AC - Normal overload 110\% for 1 minute |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Frequency converter | P5K5 | P7K5 | P11K |  |  |  | P30K | P37K | P45K |
| Typical Shaft Output [kW] | 5.5 | 7.5 | 11 | 15 | 18.5 | 22 | 30 | 37 | 45 |
| Typical Shaft Output [HP] at 208 V | 7.5 | 10 | 15 | 20 | 25 | 30 | 40 | 50 | 60 |
| IP20/NEMA Chassis* | B3 | B3 | B3 | B4 | B4 | C3 | C3 | C4 | C4 |
| IP21/NEMA 1 | B1 | B1 | B1 | B2 | C1 | C1 | C1 | C2 | C2 |
| IP55/NEMA 12 | B1 | B1 | B1 | B2 | C1 | C1 | C1 | C2 | C2 |
| IP66 | B1 | B1 | B1 | B2 | C1 | C1 | C1 | C2 | C2 |
| Output current |  |  |  |  |  |  |  |  |  |
| Continuous ( $3 \times 200-240 \mathrm{~V}$ ) [A] | 24.2 | 30.8 | 46.2 | 59.4 | 74.8 | 88.0 | 115 | 143 | 170 |
| Intermittent ( $3 \times 200-240 \mathrm{~V}$ ) [A] | 26.6 | 33.9 | 50.8 | 65.3 | 82.3 | 96.8 | 127 | 157 | 187 |
| Continuous kVA (208 V AC) [kVA] | 8.7 | 11.1 | 16.6 | 21.4 | 26.9 | 31.7 | 41.4 | 51.5 | 61.2 |
| Max. input current |  |  |  |  |  |  |  |  |  |
| Continuous ( $3 \times 200-240$ V) [A] | 22.0 | 28.0 | 42.0 | 54.0 | 68.0 | 80.0 | 104.0 | 130.0 | 154.0 |
| Intermittent ( $3 \times 200-240 \mathrm{~V}$ ) [A] | 24.2 | 30.8 | 46.2 | 59.4 | 74.8 | 88.0 | 114.0 | 143.0 | 169.0 |
| Max. pre-fuses ${ }^{1 /}$ [A] | 63 | 63 | 63 | 80 | 125 | 125 | 160 | 200 | 250 |
| Additional specifications |  |  |  |  |  |  |  |  |  |
| Estimated power loss at rated max. load [W] ${ }^{4)}$ | 269 | 310 | 447 | 602 | 737 | 845 | 1140 | 1353 | 1636 |
| Max. cable size (mains, motor, brake) $\left[\mathrm{mm}^{2}\right] /(\mathrm{AWG})^{2)}$ | [10]/(7) |  |  | [35]/(2) | [50]/(1/0) |  |  | [95]/(4/0) | $\begin{aligned} & {[120] /} \\ & (250 \\ & \text { MCM }) \end{aligned}$ |
| Weight enclosure IP20 [kg] | 12 | 12 | 12 | 23.5 | 23.5 | 35 | 35 | 50 | 50 |
| Weight enclosure IP21 [kg] | 23 | 23 | 23 | 27 | 45 | 45 | 65 | 65 | 65 |
| Weight enclosure IP55 [kg] | 23 | 23 | 23 | 27 | 45 | 45 | 65 | 65 | 65 |
| Weight enclosure IP66 [kg] | 23 | 23 | 23 | 27 | 45 | 45 | 65 | 65 | 65 |
| Efficiency ${ }^{3}$ | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.97 | 0.97 | 0.97 | 0.97 |

Table 10.3 Mains supply $3 \times 200-240$ V AC - Normal Overload $110 \%$ for 1 Minute

* B3+4 and C3+4 may be converted to IP21 using a conversion kit

[^18]| Specifications | $\mathrm{VLT}^{\circledR}$ AQUA Drive |
| :--- | :--- |
|  | Operating Instructions |

### 10.1.3 Mains Supply $1 \times 380-480$ V AC

| Mains Supply $1 \times 380$ V AC - Normal overload 110\% for 1 minute |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| Frequency converter | P7K5 | P11K | P18K | P37K |
| Typical Shaft Output [kW] | 7.5 | 11 | 18.5 | 37 |
| Typical Shaft Output [HP] at 460 V | 10 | 15 | 25 | 50 |
| IP21/NEMA 1 | B1 | B2 | C1 | C2 |
| IP55/NEMA 12 | B1 | B2 | C1 | C2 |
| IP66 | B1 | B2 | C1 | C2 |
| Output current |  |  |  |  |
| Continuous ( $3 \times 380-440 \mathrm{~V}$ ) [A] | 16 | 24 | 37.5 | 73 |
| Intermittent ( $3 \times 380-440 \mathrm{~V}$ ) [A] | 17.6 | 26.4 | 41.2 | 80.3 |
| Continuous ( $3 \times 441-480 \mathrm{~V}$ ) [A] | 14.5 | 21 | 34 | 65 |
| Intermittent ( $3 \times 441-480 \mathrm{~V}$ ) [A] | 15.4 | 23.1 | 37.4 | 71.5 |
| Continuous kVA (400 V AC) [kVA] | 11.0 | 16.6 | 26 | 50.6 |
| Continuous kVA (460 V AC) [kVA] | 11.6 | 16.7 | 27.1 | 51.8 |
| Max. input current |  |  |  |  |
| Continuous ( $1 \times 380-440 \mathrm{~V}$ ) [A] | 33 | 48 | 78 | 151 |
| Intermittent ( $1 \times 380-440 \mathrm{~V}$ ) [A] | 36 | 53 | 85.8 | 166 |
| Continuous ( $1 \times 441-480 \mathrm{~V}$ [A] | 30 | 41 | 72 | 135 |
| Intermittent (1 x 441-480 V [A] | 33 | 46 | 79.2 | 148 |
| Max. pre-fuses ${ }^{1 /}$ [A] | 63 | 80 | 160 | 250 |
| Additional specifications |  |  |  |  |
| Estimated power loss at rated max. load [W] ${ }^{4)}$ | 300 | 440 | 740 | 1480 |
| Max. cable size (mains, motor, brake) [mm²]/(AWG) ${ }^{2)}$ | [10]/(7) | [35]/(2) | [50]/(1/0) | [120]/(4/0) |
| Weight enclosure IP21 [kg] | 23 | 27 | 45 | 65 |
| Weight enclosure IP55 [kg] | 23 | 27 | 45 | 65 |
| Weight enclosure IP66 [kg] | 23 | 27 | 45 | 65 |
| Efficiency ${ }^{3)}$ | 0.96 | 0.96 | 0.96 | 0.96 |

Table 10.4 Mains Supply $1 \times 380$ V AC - Normal Overload $110 \%$ for 1 Minute

| Specifications | $\mathrm{VLT}^{\circledR} \mathrm{AQUA}$ Drive |
| :--- | :--- |
|  | Operating Instructions |

### 10.1.4 Mains Supply $3 \times 380-480$ V AC

Mains Supply $3 \times 380-480$ V AC - Normal overload $110 \%$ for 1 minute

| Frequency converter | PK37 | PK55 | PK75 | P1K1 | P1K5 | P2K2 | P3K0 | P4K0 | P5K5 | P7K5 |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Typical Shaft Output [kW] | 0.37 | 0.55 | 0.75 | 1.1 | 1.5 | 2.2 | 3 | 4 | 5.5 | 7.5 |
| Typical Shaft Output [HP] at 460 V | 0.5 | 0.75 | 1.0 | 1.5 | 2.0 | 2.9 | 4.0 | 5.3 | 7.5 | 10 |
| IP20/NEMA Chassis | A2 | A2 | A2 | A2 | A2 | A2 | A2 | A2 | A3 | A3 |
| IP21/NEMA 1 |  |  |  |  |  |  |  |  |  |  |
| IP55/NEMA 12 | A5 | A5 | A5 | A5 | A5 | A5 | A5 | A5 | A5 | A5 |
| IP66 | A5 | A5 | A5 | A5 | A5 | A5 | A5 | A5 | AA | A5 |

## Output current

| Continuous ( $3 \times 380-440 \mathrm{~V}$ ) [A] | 1.3 | 1.8 | 2.4 | 3 | 4.1 | 5.6 | 7.2 | 10 | 13 | 16 |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Intermittent $(3 \times 380-440 \mathrm{~V})[\mathrm{A}]$ | 1.43 | 1.98 | 2.64 | 3.3 | 4.5 | 6.2 | 7.9 | 11 | 14.3 | 17.6 |
| Continuous $(3 \times 441-480 \mathrm{~V})[\mathrm{A}]$ | 1.2 | 1.6 | 2.1 | 2.7 | 3.4 | 4.8 | 6.3 | 8.2 | 11 | 14.5 |
| Intermittent $(3 \times 441-480 \mathrm{~V})[\mathrm{A}]$ | 1.32 | 1.76 | 2.31 | 3.0 | 3.7 | 5.3 | 6.9 | 9.0 | 12.1 | 15.4 |
| Continuous kVA (400 V AC) [kVA] | 0.9 | 1.3 | 1.7 | 2.1 | 2.8 | 3.9 | 5.0 | 6.9 | 9.0 | 11.0 |
| Continuous kVA (460 V AC) [kVA] | 0.9 | 1.3 | 1.7 | 2.4 | 2.7 | 3.8 | 5.0 | 6.5 | 8.8 | 11.6 |

Max. input current

| Continuous ( $3 \times 380-440 \mathrm{~V}$ ) [A] | 1.2 | 1.6 | 2.2 | 2.7 | 3.7 | 5.0 | 6.5 | 9.0 | 11.7 | 14.4 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Intermittent ( $3 \times 380-440 \mathrm{~V}$ ) [A] | 1.32 | 1.76 | 2.42 | 3.0 | 4.1 | 5.5 | 7.2 | 9.9 | 12.9 | 15.8 |
| Continuous ( $3 \times 441-480 \mathrm{~V}$ ) [A] | 1.0 | 1.4 | 1.9 | 2.7 | 3.1 | 4.3 | 5.7 | 7.4 | 9.9 | 13.0 |
| Intermittent (3 x 441-480 V) [A] | 1.1 | 1.54 | 2.09 | 3.0 | 3.4 | 4.7 | 6.3 | 8.1 | 10.9 | 14.3 |
| Max. pre-fuses ${ }^{1}$ [A] | 10 | 10 | 10 | 10 | 10 | 20 | 20 | 20 | 30 | 30 |
| Additional specifications |  |  |  |  |  |  |  |  |  |  |
| Estimated power loss at rated max. load [W] ${ }^{4)}$ | 35 | 42 | 46 | 58 | 62 | 88 | 116 | 124 | 187 | 255 |
| Max. cable size (mains, motor, brake) [ $\left.\mathrm{mm}^{2}\right] /\left(\right.$ AWG ${ }^{2)}$ | [4]/(10) |  |  |  |  |  |  |  |  |  |
| Weight enclosure IP20 [kg] | 4.7 | 4.7 | 4.8 | 4.8 | 4.9 | 4.9 | 4.9 | 4.9 | 6.6 | 6.6 |
| Weight enclosure IP21 [kg] |  |  |  |  |  |  |  |  |  |  |
| Weight enclosure IP55 [kg] | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 | 14.2 | 14.2 |
| Weight enclosure IP66 [kg] | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 | 14.2 | 14.2 |
| Efficiency ${ }^{3)}$ | 0.93 | 0.95 | 0.96 | 0.96 | 0.97 | 0.97 | 0.97 | 0.97 | 0.97 | 0.97 |

[^19]| Specifications | $\mathrm{VLT}^{\circledR} \mathrm{AQUA}$ Drive |
| :--- | :--- |
|  | Operating Instructions |

Mains Supply $3 \times 380$ - 480V AC - Normal overload 110\% for 1 minute

| Frequency converter Typical Shaft Output [kW] | $\begin{gathered} \mathrm{P} 11 \mathrm{~K} \\ 11 \end{gathered}$ | $\begin{gathered} \mathrm{P} 15 \mathrm{~K} \\ 15 \end{gathered}$ | $\begin{gathered} \mathrm{P} 18 \mathrm{~K} \\ 18.5 \end{gathered}$ | $\begin{gathered} \text { P22K } \\ 22 \end{gathered}$ | $\begin{gathered} \text { P30K } \\ 30 \end{gathered}$ | $\begin{gathered} \text { P37K } \\ 37 \end{gathered}$ | $\begin{gathered} \mathrm{P} 45 \mathrm{~K} \\ 45 \end{gathered}$ | $\begin{gathered} \text { P55K } \\ 55 \end{gathered}$ | $\begin{gathered} \mathrm{P} 75 \mathrm{~K} \\ 75 \end{gathered}$ | $\begin{gathered} \text { P90K } \\ 90 \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Typical Shaft Output [HP] at 460 V | 15 | 20 | 25 | 30 | 40 | 50 | 60 | 75 | 100 | 125 |
| IP20/NEMA Chassis * | B3 | B3 | B3 | B4 | B4 | B4 | C3 | C3 | C4 | C4 |
| IP21/NEMA 1 | B1 | B1 | B1 | B2 | B2 | C1 | C1 | C1 | C2 | C2 |
| IP55/NEMA 12 | B1 | B1 | B1 | B2 | B2 | C1 | C1 | C1 | C2 | C2 |
| IP66 | B1 | B1 | B1 | B2 | B2 | C1 | C1 | C1 | C2 | C2 |

Output current

| Continuous (3 x 380-440 V) [A] | 24 | 32 | 37.5 | 44 | 61 | 73 | 90 | 106 | 147 | 177 |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Intermittent (3 x 380-440 V) [A] | 26.4 | 35.2 | 41.3 | 48.4 | 67.1 | 80.3 | 99 | 117 | 162 | 195 |
| Continuous (3 x 441-480 V) [A] | 21 | 27 | 34 | 40 | 52 | 65 | 80 | 105 | 130 | 160 |
| Intermittent (3 x 441-480 V) [A] | 23.1 | 29.7 | 37.4 | 44 | 61.6 | 71.5 | 88 | 116 | 143 | 176 |
| Continuous kVA (400 V AC) [kVA] | 16.6 | 22.2 | 26 | 30.5 | 42.3 | 50.6 | 62.4 | 73.4 | 102 | 123 |
| Continuous kVA (460 V AC) [kVA] | 16.7 | 21.5 | 27.1 | 31.9 | 41.4 | 51.8 | 63.7 | 83.7 | 104 | 128 |

Max. input current

| Continuous $(3 \times 380-440 \mathrm{~V})[\mathrm{A}]$ | 22 | 29 | 34 | 40 | 55 | 66 | 82 | 96 | 133 | 161 |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Intermittent $(3 \times 380-440 \mathrm{~V})[\mathrm{A}]$ | 24.2 | 31.9 | 37.4 | 44 | 60.5 | 72.6 | 90.2 | 106 | 146 | 177 |
| Continuous $(3 \times 441-480 \mathrm{~V}[\mathrm{~A}]$ | 19 | 25 | 31 | 36 | 47 | 59 | 73 | 95 | 118 | 145 |
| Intermittent $(3 \times 441-480 \mathrm{~V})[\mathrm{A}]$ | 20.9 | 27.5 | 34.1 | 39.6 | 51.7 | 64.9 | 80.3 | 105 | 130 | 160 |
| Max. pre-fuses ${ }^{1}[\mathrm{~A}]$ | 63 | 63 | 63 | 63 | 80 | 100 | 125 | 160 | 250 | 250 |

## Additional specifications

| Estimated power loss at rated max. load [W] ${ }^{4)}$ | 278 | 392 | 465 | 525 | 698 | 739 | 843 | 1083 | 1384 | 1474 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Max. cable size (mains, motor, brake) [ $\left.\mathrm{mm}^{2}\right] /\left(\right.$ AWG ${ }^{2)}$ | [10]/(7) |  |  | [35]/(2) |  | [50]/(1/0) |  |  | $\begin{aligned} & {[120] /} \\ & (4 / 0) \end{aligned}$ | $\begin{gathered} {[120] /} \\ (4 / 0) \end{gathered}$ |
| Weight enclosure IP20 [kg] | 12 | 12 | 12 | 23.5 | 23.5 | 23.5 | 35 | 35 | 50 | 50 |
| Weight enclosure IP21 [kg] | 23 | 23 | 23 | 27 | 27 | 45 | 45 | 45 | 65 | 65 |
| Weight enclosure IP55 [kg] | 23 | 23 | 23 | 27 | 27 | 45 | 45 | 45 | 65 | 65 |
| Weight enclosure IP66 [kg] | 23 | 23 | 23 | 27 | 27 | 45 | 45 | 45 | 65 | 65 |
| Efficiency ${ }^{3)}$ | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.99 |

## Table 10.6 Mains Supply $3 \times 380-480$ V AC - Normal Overload 110\% for 1 Minute

* B3+B4 and C3+C4 may be converted to IP21 using a conversion kit
(contact Danfoss)

| Specifications | $\mathrm{VLT}^{\circledR}$ AQUA Drive |
| :--- | :--- |
|  | Operating Instructions |

### 10.1.5 Mains Supply $3 \times 525-600$ V AC

| Normal overload 110\% for 1 minute |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Frequency converter | PK75 | P1K1 | P1K5 | P2K2 | P3K0 | P4K0 | P5K5 | P7K5 | P11K |
| Typical Shaft Output [kW] | 0.75 | 1.1 | 1.5 | 2.2 | 3 | 4 | 5.5 | 7.5 | 11 |
| IP20/NEMA Chassis | A2 | A2 | A2 | A2 | A2 | A2 | A3 | A3 | B3 |
| IP21/NEMA 1 | A2 | A2 | A2 | A2 | A2 | A2 | A3 | A3 | B1 |
| IP55/NEMA 12 | A5 | A5 | A5 | A5 | A5 | A5 | A5 | A5 | B1 |
| IP66 | A5 | A5 | A5 | A5 | A5 | A5 | A5 | A5 | B1 |
| Output current |  |  |  |  |  |  |  |  |  |
| Continuous ( $3 \times 525-550 \mathrm{~V}$ ) [A] | 1.8 | 2.6 | 2.9 | 4.1 | 5.2 | 6.4 | 9.5 | 11.5 | 19 |
| Intermittent ( $3 \times 525-550 \mathrm{~V}$ ) [A] |  | 2.9 | 3.2 | 4.5 | 5.7 | 7.0 | 10.5 | 12.7 | 21 |
| Continuous ( $3 \times 525-600 \mathrm{~V}$ ) [A] | 1.7 | 2.4 | 2.7 | 3.9 | 4.9 | 6.1 | 9.0 | 11.0 | 18 |
| Intermittent ( $3 \times 525-600 \mathrm{~V}$ ) [A] |  | 2.6 | 3.0 | 4.3 | 5.4 | 6.7 | 9.9 | 12.1 | 20 |
| Continuous kVA ( $525 \mathrm{~V} \mathrm{AC)} \mathrm{[kVA]}$ | 1.7 | 2.5 | 2.8 | 3.9 | 5.0 | 6.1 | 9.0 | 11.0 | 18.1 |
| Continuous kVA (575 V AC) [kVA] | 1.7 | 2.4 | 2.7 | 3.9 | 4.9 | 6.1 | 9.0 | 11.0 | 17.9 |
| Max. input current |  |  |  |  |  |  |  |  |  |
| Continuous ( $3 \times 525-600 \mathrm{~V}$ ) [A] | 1.7 | 2.4 | 2.7 | 4.1 | 5.2 | 5.8 | 8.6 | 10.4 | 17.2 |
| Intermittent (3 x 525-600 V) [A] |  | 2.7 | 3.0 | 4.5 | 5.7 | 6.4 | 9.5 | 11.5 | 19 |
| Max. pre-fuses ${ }^{1)}$ [A] | 10 | 10 | 10 | 20 | 20 | 20 | 32 | 32 | 40 |
| Additional specifications |  |  |  |  |  |  |  |  |  |
| Estimated power loss at rated max. load [W] ${ }^{4)}$ | 35 | 50 | 65 | 92 | 122 | 145 | 195 | 261 | 225 |
| Max. cable size (mains, motor, brake) $\left[\mathrm{mm}^{2}\right] /(\text { AWG })^{2)}$ | [0.2-4]/(24-10) |  |  |  |  |  |  |  | [16]/(6) |
| Weight enclosure IP20 [kg] | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.6 | 6.6 | 12 |
| Efficiency ${ }^{4)}$ | 0.97 | 0.97 | 0.97 | 0.97 | 0.97 | 0.97 | 0.97 | 0.97 | 0.98 |

## Table 10.7 Mains Supply $3 \times 525-600 \mathrm{~V}$ AC

1) For type of fuse see 10.3.2 Fuse Tables
${ }^{2)}$ American Wire Gauge
${ }^{3)}$ Measured using 5 m screened motor cables at rated load and rated frequency
${ }^{4)}$ The typical power loss is at normal load conditions and expected to be within $\pm 15 \%$ (tolerance relates to variety in voltage and cable conditions).
Values are based on a typical motor efficiency (eff2/eff3 border line). Lower efficiency motors will also add to the power loss in the frequency converter and vice versa.

If the switching frequency is raised from nominal the power losses may rise significantly.
LCP and typical control card power consumptions are included.
Further options and customer load may add up to 30 Watts to the losses. (Though typically only 4 W extra for a fully loaded control card or options for slot $A$ or slot $B$, each).
Although measurements are made with state of the art equipment, some measurement inaccuracy must be allowed for ( $\pm 5 \%$ ).
${ }^{5)}$ Motor and mains cable: 300 MCM/150 mm ${ }^{2}$

| Specifications | $\mathrm{VLT}^{\otimes} \mathrm{AQUA}$ Drive |
| :--- | :--- |
|  | Operating Instructions |


| Normal overload 110\% for 1 minute |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Frequency converter | P15K | P18K | P22K | P30K | P37K | P45K | P55K | P75K | P90K |
| Typical Shaft Output [kW] | 15 | 18.5 | 22 | 30 | 37 | 45 | 55 | 75 | 90 |
| IP20/NEMA Chassis | B3 | B3 | B4 | B4 | B4 | C3 | C3 | C4 | C4 |
| IP21/NEMA 1 | B1 | B1 | B2 | B2 | B2 | C1 | C1 | C2 | C2 |
| IP55/NEMA 12 | B1 | B1 | B2 | B2 | B2 | C1 | C1 | C2 | C2 |
| IP66 | B1 | B1 | B2 | B2 | B2 | C1 | C1 | C2 | C2 |
| Output current |  |  |  |  |  |  |  |  |  |
| Continuous ( $3 \times 525-550 \mathrm{~V}$ ) [A] | 23 | 28 | 36 | 43 | 54 | 65 | 87 | 105 | 137 |
| Intermittent ( $3 \times 525-550 \mathrm{~V}$ ) [A] | 25 | 31 | 40 | 47 | 59 | 72 | 96 | 116 | 151 |
| Continuous ( $3 \times 525-600 \mathrm{~V}$ ) [A] | 22 | 27 | 34 | 41 | 52 | 62 | 83 | 100 | 131 |
| Intermittent ( $3 \times 525-600 \mathrm{~V}$ ) [A] | 24 | 30 | 37 | 45 | 57 | 68 | 91 | 110 | 144 |
| Continuous kVA ( $525 \mathrm{~V} \mathrm{AC)} \mathrm{[kVA]}$ | 21.9 | 26.7 | 34.3 | 41 | 51.4 | 61.9 | 82.9 | 100 | 130.5 |
| Continuous kVA (575 V AC) [kVA] | 21.9 | 26.9 | 33.9 | 40.8 | 51.8 | 61.7 | 82.7 | 99.6 | 130.5 |
| Max. input current |  |  |  |  |  |  |  |  |  |
| Continuous ( $3 \times 525-600 \mathrm{~V}$ ) [A] | 20.9 | 25.4 | 32.7 | 39 | 49 | 59 | 78.9 | 95.3 | 124.3 |
| Intermittent ( $3 \times 525-600 \mathrm{~V}$ ) [A] | 23 | 28 | 36 | 43 | 54 | 65 | 87 | 105 | 137 |
| Max. pre-fuses ${ }^{1)}$ [A] | 40 | 50 | 60 | 80 | 100 | 150 | 160 | 225 | 250 |
| Additional specifications |  |  |  |  |  |  |  |  |  |
| Estimated power loss at rated max. load [W] ${ }^{4)}$ | 285 | 329 | 460 | 560 | 740 | 860 | 890 | 1020 | 1130 |
| Max. cable size (mains, motor, brake) [ $\left.\mathrm{mm}^{2}\right] /\left(\right.$ AWG ${ }^{2)}$ |  |  | [35]/(2) |  |  | [50]/(1) |  | $\left[95{ }^{5}\right] /(3 / 0)$ |  |
| Weight enclosure IP20 [kg] | 12 | 12 | 23.5 | 23.5 | 23.5 | 35 | 35 | 50 | 50 |
| Efficiency ${ }^{4)}$ | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 |

## Table 10.8 Mains Supply $3 \times 525-600$ V AC

${ }^{1)}$ For type of fuse see 10.3.2 Fuse Tables
2) American Wire Gauge
${ }^{3)}$ Measured using 5 m screened motor cables at rated load and rated frequency
4) The typical power loss is at normal load conditions and expected to be within $\pm 15 \%$ (tolerance relates to variety in voltage and cable conditions).
Values are based on a typical motor efficiency (eff2/eff3 border line). Lower efficiency motors will also add to the power loss in the frequency converter and vice versa.

If the switching frequency is raised from nominal the power losses may rise significantly.
LCP and typical control card power consumptions are included.
Further options and customer load may add up to 30 Watts to the losses. (Though typically only 4 W extra for a fully loaded control card or options for slot $A$ or slot B, each).

Although measurements are made with state of the art equipment, some measurement inaccuracy must be allowed for ( $\pm 5 \%$ ).
${ }^{5)}$ Motor and mains cable: 300 MCM/150 mm ${ }^{2}$

| Specifications | $\mathrm{VLT}^{\circledR}$ AQUA Drive |
| :--- | :--- |
|  | Operating Instructions |

### 10.1.6 Mains Supply $3 \times 525-690$ V AC

| Mains Supply 3x525-690 V AC |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Frequency Converter | P1K1 | P1K5 | P2K2 | P3K0 | P4K0 | P5K5 | P7K5 |
| Typical Shaft Output [kW] | 1.1 | 1.5 | 2.2 | 3 | 4 | 5.5 | 7.5 |
| Enclosure IP20 (only) | A3 | A3 | A3 | A3 | A3 | A3 | A3 |
| Output current High overload 110\% for 1 min |  |  |  |  |  |  |  |
| Continuous (3x525-550 V) [A] | 2.1 | 2.7 | 3.9 | 4.9 | 6.1 | 9 | 11 |
| Intermittent ( $3 \times 525-550 \mathrm{~V}$ ) [A] | 2.3 | 3.0 | 4.3 | 5.4 | 6.7 | 9.9 | 12.1 |
| Continuous kVA (3x551-690 V) [A] | 1.6 | 2.2 | 3.2 | 4.5 | 5.5 | 7.5 | 10 |
| Intermittent kVA (3x551-690 V) [A] | 1.8 | 2.4 | 3.5 | 4.9 | 6.0 | 8.2 | 11 |
| Continuous kVA 525 V AC | 1.9 | 2.6 | 3.8 | 5.4 | 6.6 | 9 | 12 |
| Continuous kVA 690 V AC | 1.9 | 2.6 | 3.8 | 5.4 | 6.6 | 9 | 12 |
| Max. input current |  |  |  |  |  |  |  |
| Continuous (3x525-550 V) [A] | 1.9 | 2.4 | 3.5 | 4.4 | 5.5 | 8 | 10 |
| Intermittent (3x525-550 V) [A] | 2.1 | 2.6 | 3.8 | 8.4 | 6.0 | 8.8 | 11 |
| Continuous kVA (3x551-690 V) [A] | 1.4 | 2.0 | 2.9 | 4.0 | 4.9 | 6.7 | 9 |
| Intermittent kVA (3x551-690 V) [A] | 1.5 | 2.2 | 3.2 | 4.4 | 5.4 | 7.4 | 9.9 |
| Additional specifications |  |  |  |  |  |  |  |
| IP20 max. cable cross section ${ }^{5 \text { ) (mains, motor, }}$ brake and load sharing) $\left[\mathrm{mm}^{2}\right] /(\mathrm{AWG})$ | [0.2-4]/(24-10) |  |  |  |  |  |  |
| Estimated power loss at rated max. load [W] ${ }^{4)}$ | 44 | 60 | 88 | 120 | 160 | 220 | 300 |
| Weight, enclosure IP20 [kg] | 6.6 | 6.6 | 6.6 | 6.6 | 6.6 | 6.6 | 6.6 |
| Efficiency ${ }^{4}$ | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 |

Table 10.9 Mains Supply $3 \times 525-690$ V AC IP20

| Specifications | $\mathrm{VLT}^{\circledR}$ AQUA Drive |
| :--- | :--- |
|  | Operating Instructions |


| Normal overload 110\% for 1 minute |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Frequency converter TypicalShaft Output [kW] | $\begin{gathered} \text { P11K } \\ 11 \end{gathered}$ | $\begin{gathered} \text { P15K } \\ 15 \end{gathered}$ | $\begin{gathered} \mathrm{P} 18 \mathrm{~K} \\ 18.5 \end{gathered}$ | $\begin{gathered} \text { P22K } \\ 22 \end{gathered}$ | $\begin{gathered} \text { P30K } \\ 30 \end{gathered}$ | $\begin{gathered} \text { P37K } \\ 37 \end{gathered}$ | $\begin{gathered} \text { P45K } \\ 45 \end{gathered}$ | $\begin{gathered} \text { P55K } \\ 55 \end{gathered}$ | $\begin{gathered} \text { P75K } \\ 75 \end{gathered}$ | $\begin{gathered} \text { P90K } \\ 90 \end{gathered}$ |
| Typical Shaft Output [HP] at 575 V | 10 | 16.4 | 20.1 | 24 | 33 | 40 | 50 | 60 | 75 | 100 |
| IP21/NEMA 1 | B2 | B2 | B2 | B2 | B2 | C2 | C2 | C2 | C2 | C2 |
| IP55/NEMA 12 | B2 | B2 | B2 | B2 | B2 | C2 | C2 | C2 | C2 | C2 |
| Output current |  |  |  |  |  |  |  |  |  |  |
| Continuous ( $3 \times 525-550 \mathrm{~V}$ ) <br> [A] | 14 | 19 | 23 | 28 | 36 | 43 | 54 | 65 | 87 | 105 |
| Intermittent ( $3 \times 525-550 \mathrm{~V}$ ) <br> [A] | 15.4 | 20.9 | 25.3 | 30.8 | 39.6 | 47.3 | 59.4 | 71.5 | 95.7 | 115.5 |
| Continuous ( $3 \times 551-690$ V) <br> [A] | 13 | 18 | 22 | 27 | 34 | 41 | 52 | 62 | 83 | 100 |
| Intermittent (3 x 551-690 V) [A] | 14.3 | 19.8 | 24.2 | 29.7 | 37.4 | 45.1 | 57.2 | 68.2 | 91.3 | 110 |
| Continuous kVA (550 V AC) [kVA] | 13.3 | 18.1 | 21.9 | 26.7 | 34.3 | 41 | 51.4 | 61.9 | 82.9 | 100 |
| Continuous kVA (575 V AC) [kVA] | 12.9 | 17.9 | 21.9 | 26.9 | 33.8 | 40.8 | 51.8 | 61.7 | 82.7 | 99.6 |
| Continuous kVA ( 690 V AC) [kVA] | 15.5 | 21.5 | 26.3 | 32.3 | 40.6 | 49 | 62.1 | 74.1 | 99.2 | 119.5 |
| Max. input current |  |  |  |  |  |  |  |  |  |  |
| Continuous ( $3 \times 525-690$ V) <br> [A] | 15 | 19.5 | 24 | 29 | 36 | 49 | 59 | 71 | 87 | 99 |
| Intermittent (3 x 525-690 V) [A] | 16.5 | 21.5 | 26.4 | 31.9 | 39.6 | 53.9 | 64.9 | 78.1 | 95.7 | 108.9 |
| Max. pre-fuses ${ }^{11}$ [A] | 63 | 63 | 63 | 63 | 80 | 100 | 125 | 160 | 160 | 160 |
| Additional specifications |  |  |  |  |  |  |  |  |  |  |
| Estimated power loss at rated max. load [W] 4) | 201 | 285 | 335 | 375 | 430 | 592 | 720 | 880 | 1200 | 1440 |
| Max. cable size (mains, motor, brake) $\left[\mathrm{mm}^{2}\right] /(\mathrm{AWG})$ 2) | [35]/(1/0) |  |  |  | [95]/(4/0) |  |  |  |  |  |
| Weight IP21 [kg] | 27 | 27 | 27 | 27 | 27 | 65 | 65 | 65 | 65 | 65 |
| Weight IP55 [kg] | 27 | 27 | 27 | 27 | 27 | 65 | 65 | 65 | 65 | 65 |
| Efficiency ${ }^{4}$ | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 |

Table 10.10 Mains Supply $3 \times 525-690$ V AC IP21-IP55/NEMA 1-NEMA 12

| Specifications | $\mathrm{VLT}^{\circledR}$ AQUA Drive |
| :--- | :--- |
|  | Operating Instructions |


| Normal overload 110\% for 1 minute |  |  |
| :---: | :---: | :---: |
| Frequency converter | P45K | P55K |
| Typical Shaft Output [kW] | 45 | 55 |
| Typical Shaft Output [HP] at 575 V | 60 | 75 |
| IP20/Chassis | C3 | C3 |
| Output current |  |  |
| Continuous ( $3 \times 525-550 \mathrm{~V}$ ) [A] | 54 | 65 |
| Intermittent ( $3 \times 525-550 \mathrm{~V}$ ) [A] | 59.4 | 71.5 |
| Continuous ( $3 \times 551-690 \mathrm{~V}$ ) [A] | 52 | 62 |
| Intermittent ( $3 \times 551-690 \mathrm{~V}$ ) [A] | 57.2 | 68.2 |
| Continuous kVA (550 V AC) [kVA] | 51.4 | 62 |
| Continuous kVA (575 V AC) [kVA] | 62.2 | 74.1 |
| Continuous kVA (690 V AC) [kVA] | 62.2 | 74.1 |
| Max. input current |  |  |
| Continuous ( $3 \times 525-550 \mathrm{~V}$ ) [A] | 52 | 63 |
| Intermittent ( $3 \times 525-550 \mathrm{~V}$ ) [A] | 57.2 | 69.3 |
| Continuous ( $3 \times 551-690 \mathrm{~V}$ ) [A] | 50 | 60 |
| Intermittent ( $3 \times 551-690 \mathrm{~V}$ ) [A] | 55 | 66 |
| Max. pre-fuses ${ }^{1)}$ [A] | 100 | 125 |
| Additional specifications |  |  |
| Estimated power loss at rated max. load [W] ${ }^{4)}$ | 592 | 720 |
| Max. cable size (mains, motor, brake) [mm2]/(AWG) ${ }^{2)}$ | 50 (1) |  |
| Weight IP20 [kg] | 35 | 35 |
| Efficiency ${ }^{4}$ | 0.98 | 0.98 |

Table 10.11 Mains Supply $3 \times 525-690$ V IP20
${ }^{1)}$ For type of fuse see 10.3.2 Fuse Tables
${ }^{2)}$ American Wire Gauge
${ }^{3)}$ Measured using 5 m screened motor cables at rated load and rated

## frequency

4) The typical power loss is at normal load conditions and expected to be within $\pm 15 \%$ (tolerance relates to variety in voltage and cable conditions).
Values are based on a typical motor efficiency (eff2/eff3 border line). Lower efficiency motors will also add to the power loss in the
frequency converter and vice versa.
If the switching frequency is raised from nominal the power losses may rise significantly.
LCP and typical control card power consumptions are included. Further options and customer load may add up to 30 W to the losses. (Though typically only 4 W extra for a fully loaded control card or options for slot $A$ or slot B, each).
Although measurements are made with state of the art equipment, some measurement inaccuracy must be allowed for ( $\pm 5 \%$ ).
${ }^{5)}$ Motor and mains cable: 300 MCM/150 mm ${ }^{2}$

| Specifications | $\mathrm{VLT}^{\circledR} \mathrm{AQUA}$ Drive |
| :--- | :--- |
|  | Operating Instructions |

### 10.2 General Technical Data

## Protection and Features

- Electronic thermal motor protection against overload.
- Temperature monitoring of the heatsink ensures that the frequency converter trips if the temperature reaches 95 ${ }^{\circ} \mathrm{C} \pm 5^{\circ} \mathrm{C}$. An overload temperature cannot be reset until the temperature of the heatsink is below $70^{\circ} \mathrm{C} \pm 5^{\circ} \mathrm{C}$ (Guideline - these temperatures may vary for different power sizes, enclosures etc.). $\mathrm{VLT}^{\circledR}$ AQUA Drive has an auto derating function to avoid it's heatsink reaching $95^{\circ} \mathrm{C}$.
- The frequency converter is protected against short-circuits on motor terminals $\mathrm{U}, \mathrm{V}, \mathrm{W}$.
- If a mains phase is missing, the frequency converter trips or issues a warning (depending on the load).
- Monitoring of the intermediate circuit voltage ensures that the frequency converter trips if the intermediate circuit voltage is too low or too high.
- The frequency converter is protected against earth faults on motor terminals $\mathrm{U}, \mathrm{V}, \mathrm{W}$.
Mains supply (L1, L2, L3)
Supply voltage
Supply voltage
Supply voltage
Supply voltage

| Mains voltage low/mains drop-out: |
| :--- |
| During low mains voltage or a mains drop-out, the frequency converter continues until the intermediate circuit voltage drops |
| below the minimum stop level, which corresponds typically to 15\% below the frequency converter's lowest rated supply voltage. |
| Power-up and full torque cannot be expected at mains voltage lower than 10\% below the frequency converter's lowest rated |
| supply voltage. |

Supply frequency $50 / 60 \mathrm{~Hz}+4 /-6 \%$

The frequency converter power supply is tested in accordance with IEC61000-4-28, $50 \mathrm{~Hz}+4 /-6 \%$.
Max. imbalance temporary between mains phases
True Power Factor ( $\lambda$ )
Displacement Power Factor (cos $\varphi$ ) near unity
Switching on input supply L1, L2, L3 (power-ups) $\leq$ enclosure type A
Switching on input supply L1, L2, L3 (power-ups) $\geq$ enclosure type B, C
Switching on input supply L1, L2, L3 (power-ups) $\geq$ enclosure type D, E, F
Environment according to EN60664-1
The unit is suitable for use on a circuit capable of delivering not more than 100.000 RMS symmetrical Amperes, 240/480/600/690
V maximum.

Motor output (U, V, W)
Output voltage
Output frequency
Switching on output
Ramp times

* Dependent on power size.

Torque characteristics
Starting torque (Constant torque) maximum $110 \%$ for 1 min.*
Starting torque maximum $135 \%$ up to $0.5 \mathrm{~s}^{*}$

Overload torque (Constant torque) maximum $110 \%$ for 1 min .
*Percentage relates to VLT AQUA Drive's nominal torque.

| Specifications | $\mathrm{VLT}^{\circledR} \mathrm{AQUA}$ Drive |
| :--- | :--- |
|  | Operating Instructions |


| Cable lengths and cross sections |
| :--- |
| Max. motor cable length, screened/armoured |
| Max. motor cable length, unscreened/unarmoured |
| Max. cross section to motor, mains, load sharing and brake * |
| Maximum cross section to control terminals, rigid wire |
| Maximum cross section to control terminals, flexible cable |
| Maximum cross section to control terminals, cable with enclosed core |
| Minimum cross section to control terminals |
| * See Mains Supply tables for more information! |
| Control card, RS-485 serial communication |
| Terminal number |
| Terminal number 61 |
| The RS-485 serial communication circuit is functionally seated from other central circuits and galvanically isolated from the |
| supply voltage (PELV). |
| Analog inputs |
| Number of analog inputs |
| Terminal number |
| Modes |
| Mode select |
| Voltage mode |
| Voltage level |
| Input resistance, $R_{i}$ |
| Max. voltage |
| Current mode |

The analog inputs are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.


## Illustration 10.1 PELV Isolation of Analog Inputs

Analog output
Number of programmable analog outputs
Terminal number
Current range at analog output
Max. resistor load to common at analog output
Accuracy on analog output
Resolution on analog output

The analog output is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

| Specifications | VLT ${ }^{\circledR}$ AQUA Drive Operating Instructions |
| :---: | :---: |
| Digital inputs |  |
| Programmable digital inputs | 4 (6) |
| Terminal number | 18, 19, 27 1), 29 1), 32, 33, |
| Logic | PNP or NPN |
| Voltage level | 0-24 V DC |
| Voltage level, logic'0' PNP | <5V DC |
| Voltage level, logic'1' PNP | $>10 \mathrm{~V}$ DC |
| Voltage level, logic '0' NPN | $>19$ V DC |
| Voltage level, logic '1' NPN | $<14$ V DC |
| Maximum voltage on input | 28 V DC |
| Input resistance, $\mathrm{R}_{\mathrm{i}}$ | approx. $4 \mathrm{k} \Omega$ |

All digital inputs are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

1) Terminals 27 and 29 can also be programmed as output.

Digital output
Programmable digital/pulse outputs 2
Terminal number 27, 291)
Voltage level at digital/frequency output $0-24 \mathrm{~V}$
Max. output current (sink or source) 10 mA
Max. load at frequency output $1 \mathrm{k} \Omega$
Max. capacitive load at frequency output 10 nF

Maximum output frequency at frequency output 32 kHz
Accuracy of frequency output Max. error: $0.1 \%$ of full scale
Resolution of frequency outputs 12 bit

1) Terminal 27 and 29 can also be programmed as input.

The digital output is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.
Pulse inputs
Programmable pulse inputs 2
Terminal number pulse $\quad 29,33$
Max. frequency at terminal, 29, $33 \quad 110 \mathrm{kHz}$ (Push-pull driven)
Max. frequency at terminal, 29, 33
Min. frequency at terminal 29, 33 4 Hz
Voltage level see 10.2.1
Maximum voltage on input 28 V DC
Input resistance, $R_{i}$ approx. $4 \mathrm{k} \Omega$
Pulse input accuracy ( $0.1-1 \mathrm{kHz}$ ) $\quad$ Max. error: $0.1 \%$ of full scale
Control card, 24 V DC output

| Terminal number |  |
| :--- | :--- | :--- |
| Max. load | 12,13 |

The 24 V DC supply is galvanically isolated from the supply voltage (PELV), but has the same potential as the analog and digital inputs and outputs.
Relay outputs
Programmable relay outputs 2
Relay 01 Terminal number

Max. terminal load (AC-1) ${ }^{1}$ on 1-3 (NC), 1-2 (NO) (Resistive load) $240 \mathrm{~V} \mathrm{AC}, 2$ A
Max. terminal load (AC-15) ${ }^{1}$ (Inductive load @ $\cos \varphi$ 0.4) 240 V AC, 0.2 A
Max. terminal load (DC-1) ${ }^{1}$ on 1-2 (NO), 1-3 (NC) (Resistive load) $60 \mathrm{~V} \mathrm{DC}$,
Max. terminal load (DC-13) ${ }^{1)}$ (Inductive load) $24 \mathrm{~V} \mathrm{DC}$,
Relay 02 Terminal number 4-6 (break), 4-5 (make)
Max. terminal load (AC-1) ${ }^{1)}$ on 4-5 (NO) (Resistive load) ${ }^{2 / 33}$
400 V AC, 2 A
Max. terminal load (AC-15) ${ }^{1)}$ on 4-5 (NO) (Inductive load @ $\cos \varphi$ 0.4) $240 \mathrm{~V} \mathrm{AC}, 0.2$ A
Max. terminal load (DC-1) ${ }^{1}$ on 4-5 (NO) (Resistive load) 80 V DC, 2 A
Max. terminal load (DC-13) ${ }^{1}$ ) on 4-5 (NO) (Inductive load) 24 V DC, 0.1 A

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| Max. terminal load (AC-1) ${ }^{1 /}$ on 4-6 (NC) (Resistive load) | $240 \mathrm{~V} \mathrm{AC}$, |
| :---: | :---: |
| Max. terminal load (AC-15) ${ }^{1}$ ) on 4-6 (NC) (Inductive load @ $\cos \varphi$ 0.4) | $240 \mathrm{~V} \mathrm{AC}, 0.2 \mathrm{~A}$ |
| Max. terminal load (DC-1) ${ }^{1}$ ) on 4-6 (NC) (Resistive load) | 50 V DC, 2 A |
| Max. terminal load (DC-13) ${ }^{1}$ ) on 4-6 (NC) (Inductive load) | 24 V DC, 0.1 A |
| Min. terminal load on 1-3 (NC), 1-2 (NO), 4-6 (NC), 4-5 (NO) | 24 V DC $10 \mathrm{~mA}, 24 \mathrm{~V}$ AC 20 mA |
| Environment according to EN 60664-1 | overvoltage category III/pollution degree 2 |
| 1) IEC 60947 parts 4 and 5 <br> The relay contacts are galvanically isolated from the rest of the circuit by reinforced isolation (PELV). <br> 2) Overvoltage Category II <br> 3) UL applications 300 V AC 2 A |  |
|  |  |
|  |  |
| Control card, 10 V DC output |  |
| Terminal number | 50 |
| Output voltage | $10.5 \mathrm{~V} \pm 0.5 \mathrm{~V}$ |
| Max. load | 25 mA |

The 10 V DC supply is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals. Control characteristics

Resolution of output frequency at $0-1000 \mathrm{~Hz}$. $\pm 0.003 \mathrm{~Hz}$
System response time (terminals 18, 19, 27, 29, 32, 33) $\leq 2 \mathrm{~ms}$
Speed control range (open loop) 1:100 of synchronous speed
Speed accuracy (open loop) $30-4000 \mathrm{rpm}$ : Maximum error of $\pm 8 \mathrm{rpm}$
All control characteristics are based on a 4-pole asynchronous motor
Surroundings

| Enclosure type A | IP20/Chassis, IP21 kit/Type 1, IP55/Type12, IP66 |
| :---: | :---: |
| Enclosure type B1/B2 | IP21/Type 1, IP55/Type12, IP66 |
| Enclosure type B3/B4 | IP20/Chassis |
| Enclosure type C1/C2 | IP21/Type 1, IP55/Type 12, IP66 |
| Enclosure type C3/C4 | IP20/Chassis |
| Enclosure type D1/D2/E1 | IP21/Type 1, IP54/Type12 |
| Enclosure type D3/D4/E2 | IP00/Chassis |
| Enclosure kit available $\leq$ enclosure type A | IP21/TYPE 1/IP4X top |
| Vibration test enclosure A/B/C | 1.0 g |
| Vibration test enclosure D/E/F | 0.7 g |

Max. relative humidity 5\%-95\% (IEC 721-3-3; Class 3K3 (non-condensing) during operation
Aggressive environment (IEC 721-3-3), uncoated class 3C2
Aggressive environment (IEC 721-3-3), coated class 3C3
Test method according to IEC 60068-2-43 H2S (10 days)
Ambient temperature
Max. $50^{\circ} \mathrm{C}$
Derating for high ambient temperature, see section on special conditions
Minimum ambient temperature during full-scale operation $0^{\circ} \mathrm{C}$
Minimum ambient temperature at reduced performance $-10^{\circ} \mathrm{C}$
Temperature during storage/transport -25 to $+65 / 70^{\circ} \mathrm{C}$
Maximum altitude above sea level without derating 1000 m
Maximum altitude above sea level with derating 3000 m
Derating for high altitude, see section on special conditions
EMC standards, Emission
EN 61800-3, EN 61000-6-3, EN 55011, IEC 61800-3
EN 61800-3, EN 61000-6-1/2,
EMC standards, Immunity
EN 61000-4-2, EN 61000-4-3, EN 61000-4-4, EN 61000-4-5, EN 61000-4-6
See section on special conditions
Control card performance
Scan interval 5 ms

Control card, USB serial communication
USB standard
1.1 (Full speed)

USB plug USB type B "device" plug

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## ACAUTION

Connection to PC is carried out via a standard host/device USB cable.
The USB connection is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.
The USB connection is not galvanically isolated from protection earth. Use only isolated laptop/PC as connection to the USB connector on VLT AQUA Drive or an isolated USB cable/converter.

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| :--- | :--- |
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### 10.3 Fuse Specifications

### 10.3.1 CE Compliance

Fuses or Circuit Breakers are mandatory to comply with IEC 60364. Danfoss recommend using a selection of the following.

The fuses below are suitable for use on a circuit capable of delivering 100,000 Arms (symmetrical) with the following voltage

### 10.3.2 Fuse Tables

| Enclosure | Power [kW] | Recommended fuse size | Recommended Max. fuse | Recommended circuit breaker Moeller | Max trip level [A] |
| :---: | :---: | :---: | :---: | :---: | :---: |
| A1 | - | gG-10 | gG-25 | PKZM0-16 | 16 |
| A2 | 0.25-2.2 | $\begin{gathered} \text { gG-10 (0.25-1.5) } \\ \text { gG-16 (2.2) } \\ \hline \end{gathered}$ | gG-25 | PKZM0-25 | 25 |
| A3 | 3.0-3.7 | $\begin{gathered} \hline \text { gG-16 (3) } \\ \text { gG-20 (3.7) } \\ \hline \end{gathered}$ | gG-32 | PKZM0-25 | 25 |
| A4 | 0.25-2.2 | $\begin{gathered} \text { gG-10 }(0.25-1.5) \\ \text { gG-16 (2.2) } \end{gathered}$ | gG-32 | PKZM0-25 | 25 |
| A5 | 0.25-3.7 | $\begin{gathered} \text { gG-10 (0.25-1.5) } \\ \text { gG-16 (2.2-3) } \\ \text { gG-20 (3.7) } \\ \hline \end{gathered}$ | gG-32 | PKZM0-25 | 25 |
| B1 | 5.5-11 | $\begin{aligned} & \hline \text { gG-25 (5.5) } \\ & \text { gG-32 (7.5) } \end{aligned}$ | gG-80 | PKZM4-63 | 63 |
| B2 | 15 | gG-50 | gG-100 | NZMB1-A100 | 100 |
| B3 | 5.5-11 | gG-25 | gG-63 | PKZM4-50 | 50 |
| B4 | 15-18 | $\begin{aligned} & \hline \text { gG-32 (7.5) } \\ & \text { gG-50 (11) } \\ & \text { gG-63 (15) } \end{aligned}$ | gG-125 | NZMB1-A100 | 100 |
| C1 | 18.5-30 | $\begin{gathered} \hline \text { gG-63 (15) } \\ \text { gG-80 (18.5) } \\ \text { gG-100 (22) } \\ \hline \end{gathered}$ | $\begin{gathered} \hline \mathrm{gG}-160(15-18.5) \\ \text { aR-160 (22) } \end{gathered}$ | NZMB2-A200 | 160 |
| C2 | 37-45 | $\begin{aligned} & \text { aR-160 (30) } \\ & \text { aR-200 (37) } \end{aligned}$ | $\begin{aligned} & \text { aR-200 (30) } \\ & \text { aR-250 (37) } \end{aligned}$ | NZMB2-A250 | 250 |
| C3 | 22-30 | $\begin{gathered} \hline \text { gG-80 (18.5) } \\ \text { aR-125 (22) } \\ \hline \end{gathered}$ | $\begin{gathered} \text { gG-150 (18.5) } \\ \text { aR-160 (22) } \\ \hline \end{gathered}$ | NZMB2-A200 | 150 |
| C4 | 37-45 | $\begin{aligned} & \text { aR-160 (30) } \\ & \text { aR-200 (37) } \end{aligned}$ | $\begin{aligned} & \text { aR-200 (30) } \\ & \text { aR-250 (37) } \end{aligned}$ | NZMB2-A250 | 250 |

[^20]| Specifications | $\mathrm{VLT}^{\circledR} \mathrm{AQUA}$ Drive |
| :--- | :--- |
|  | Operating Instructions |


| Enclosure | Power [kW] | Recommended fuse size | Recommended Max. fuse | Recommended circuit breaker Moeller | Max trip level [A] |
| :---: | :---: | :---: | :---: | :---: | :---: |
| A1 | - | gG-10 | gG-25 | PKZM0-16 | 16 |
| A2 | 1.1-4.0 | $\begin{gathered} \hline \text { gG-10 (0.37-3) } \\ \text { gG-16 (4) } \end{gathered}$ | gG-25 | PKZM0-25 | 25 |
| A3 | 5.5-7.5 | gG-16 | gG-32 | PKZM0-25 | 25 |
| A4 | 1.1-4.0 | $\begin{gathered} \mathrm{gG}-10(0.37-3) \\ \mathrm{gG}-16(4) \\ \hline \end{gathered}$ | gG-32 | PKZM0-25 | 25 |
| A5 | 1.1-7.5 | $\begin{gathered} \hline \text { gG-10 }(0.37-3) \\ \text { gG-16 (4-7.5) } \\ \hline \end{gathered}$ | gG-32 | PKZM0-25 | 25 |
| B1 | 11-18.5 | gG-40 | gG-80 | PKZM4-63 | 63 |
| B2 | 22-30 | $\begin{gathered} \text { gG-50 (18.5) } \\ \text { gG-63 (22) } \end{gathered}$ | gG-100 | NZMB1-A100 | 100 |
| B3 | 11-18 | gG-40 | gG-63 | PKZM4-50 | 50 |
| B4 | 22-37 | $\begin{gathered} \hline \text { gG-50 (18.5) } \\ \text { gG-63 (22) } \\ \text { gG-80 (30) } \\ \hline \end{gathered}$ | gG-125 | NZMB1-A100 | 100 |
| C1 | 37-55 | $\begin{gathered} \text { gG-80 (30) } \\ \text { gG-100 } \\ \text { gG-160 } \end{gathered}$ | gG-160 | NZMB2-A200 | 160 |
| C2 | 75-90 | $\begin{aligned} & \text { aR-200 (55) } \\ & \text { aR-250 (75) } \end{aligned}$ | aR-250 | NZMB2-A250 | 250 |
| C3 | 45-55 | $\begin{aligned} & \hline \text { gG-100 (37) } \\ & \text { gG-160 (45) } \end{aligned}$ | $\begin{aligned} & \hline \text { gG-150 (37) } \\ & \text { gG-160 (45) } \end{aligned}$ | NZMB2-A200 | 150 |
| C4 | 75-90 | $\begin{aligned} & \text { aR-200 (55) } \\ & \text { aR-250 (75) } \end{aligned}$ | aR-250 | NZMB2-A250 | 250 |

Table 10.13 380-480 V, Frame Sizes A, B and C

| Specifications | $\mathrm{VLT}^{\circledR} \mathrm{AQUA}$ Drive |
| :--- | :--- |
|  | Operating Instructions |


| Enclosure | Power [kW] | Recommended fuse size | Recommended Max. fuse | Recommended circuit breaker Moeller | Max trip level [ A ] |
| :---: | :---: | :---: | :---: | :---: | :---: |
| A2 | 1.1-4.0 | gG-10 | gG-25 | PKZM0-25 | 25 |
| A3 | 5.5-7.5 | $\begin{aligned} & \hline \text { gG-10 (5.5) } \\ & \text { gG-16 (7.5) } \end{aligned}$ | gG-32 | PKZM0-25 | 25 |
| A5 | 1.1-7.5 | $\begin{gathered} \hline \text { gG-10 (0.75-5.5) } \\ \text { gG-16 (7.5) } \\ \hline \end{gathered}$ | gG-32 | PKZM0-25 | 25 |
| B1 | 11-18 | $\begin{gathered} \hline \text { gG-25 (11) } \\ \text { gG-32 (15) } \\ \text { gG-40 (18.5) } \\ \hline \end{gathered}$ | gG-80 | PKZM4-63 | 63 |
| B2 | 22-30 | $\begin{aligned} & \hline \text { gG-50 (22) } \\ & \text { gG-63 (30) } \\ & \hline \end{aligned}$ | gG-100 | NZMB1-A100 | 100 |
| B3 | 11-18.5 | $\begin{aligned} & \hline \text { gG-25 (11) } \\ & \text { gG-32 (15) } \\ & \hline \end{aligned}$ | gG-63 | PKZM4-50 | 50 |
| B4 | 22-37 | $\begin{gathered} \text { gG-40 (18.5) } \\ \text { gG-50 (22) } \\ \text { gG-63 (30) } \end{gathered}$ | gG-125 | NZMB1-A100 | 100 |
| C1 | 37-55 | $\begin{gathered} \text { gG-63 (37) } \\ \text { gG-100 (45) } \\ \text { aR-160 } \end{gathered}$ | $\begin{gathered} \hline \text { gG-160 (37-45) } \\ \text { aR-250 (55) } \end{gathered}$ | NZMB2-A200 | 160 |
| C2 | 75-90 | aR-200 (75) | aR-250 | NZMB2-A250 | 250 |
| C3 | 45-55 | $\begin{gathered} \hline \text { gG-63 (37) } \\ \text { gG-100 (45) } \end{gathered}$ | gG-150 | NZMB2-A200 | 150 |
| C4 | 75-90 | $\begin{aligned} & \text { aR-160 (55) } \\ & \text { aR-200 (75) } \end{aligned}$ | aR-250 | NZMB2-A250 | 250 |

Table 10.14 525-600 V, Frame Sizes A, B and C

| Enclosure | Power [kW] | Recommended fuse size | Recommended max. fuse | Recommended circuit breaker Danfoss | Max trip level[A] |
| :---: | :---: | :---: | :---: | :---: | :---: |
| A3 | 1.1 | gG-6 | gG-25 | CTI25M 10-16 | 16 |
|  | 1.5 | gG-6 | gG-25 | CTI25M 10-16 | 16 |
|  | 2.2 | gG-6 | gG-25 | CTI25M 10-16 | 16 |
|  | 3 | gG-10 | gG-25 | CTI25M 10-16 | 16 |
|  | 4 | gG-10 | gG-25 | CTI25M 10-16 | 16 |
|  | 5.5 | gG-16 | gG-25 | CTI25M 10-16 | 16 |
|  | 7.5 | gG-16 | gG-25 | CTI25M 10-16 | 16 |
| B2 | 11 | gG-25 | gG-63 |  |  |
|  | 15 | gG-25 | gG-63 |  |  |
|  | 18 | gG-32 |  |  |  |
|  | 22 | gG-32 |  |  |  |
| C2 | 30 | gG-40 |  |  |  |
|  | 37 | gG-63 | gG-80 |  |  |
|  | 45 | gG-63 | gG-100 |  |  |
|  | 55 | gG-80 | gG-125 |  |  |
|  | 75 | gG-100 | gG-160 |  |  |
| C3 | 37 | gG-100 | gG-125 |  |  |
|  | 45 | gG-125 | gG-160 |  |  |
| D | 37 | gG-125 | gG-125 |  |  |
|  | 45 | gG-160 | gG-160 |  |  |
|  | 55-75 | gG-200 | gG-200 |  |  |
|  | 90 | aR-250 | aR-250 |  |  |

Table 10.15 525-690 V, Frame Sizes A, C and D (non UL fuses)

| Specifications | $\mathrm{VLT}^{\circledR}$ AQUA Drive |
| :--- | :--- |
|  | Operating Instructions |

### 10.3.3 UL Compliance

Fuses or Circuit Breakers are mandatory to comply with UL for NEC 2009. We recommend using a selection of the following

The fuses below are suitable for use on a circuit capable of delivering 100,000 Arms (symmetrical) with the following voltage

- $\quad 240 \mathrm{~V}$
- 480 V
- 600 V
- 690 V
depending on the drive voltage rating. With the proper fusing the drive Short Circuit Current Rating (SCCR) is 100,000 Arms.

| Recommended max. fuse |  |  |  |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Power <br> [kW] | Max prefuse size [A] | Buss- <br> mann <br> JFHR2 | Buss- <br> mann <br> RK1 | Bussmann J | Buss- <br> mann <br> T | Bussmann CC | Buss- <br> mann <br> CC | Bussmann CC | $\begin{aligned} & \hline \text { SIBA } \\ & \text { RK1 } \end{aligned}$ | Littel fuse RK1 | FerrazShawmut CC | FerrazShawmut RK1 | Ferraz- <br> Shawmut J |
| 1.1 | 15 | $\begin{array}{\|c} \hline F W X-1 \\ 5 \end{array}$ | KTN- <br> R15 | JKS-15 | JJN-15 | $\begin{aligned} & \text { FNQ- } \\ & \text { R-15 } \end{aligned}$ | $\begin{aligned} & \text { KTK- } \\ & \text { R-15 } \end{aligned}$ | $\begin{aligned} & \text { LP- } \\ & \text { CC-15 } \end{aligned}$ | $\begin{array}{\|c\|} \hline 501790 \\ 6-016 \end{array}$ | $\begin{gathered} \mathrm{KLN}- \\ \mathrm{R} 15 \end{gathered}$ | ATM-R15 | A2K-15R | HSJ15 |
| 1.5 | 20 | $\begin{gathered} \text { FWX-2 } \\ 0 \end{gathered}$ | $\begin{aligned} & \text { KTN- } \\ & \text { R20 } \end{aligned}$ | JKS-20 | JJN-20 | $\begin{aligned} & \text { FNQ- } \\ & \text { R-20 } \end{aligned}$ | $\begin{aligned} & \text { KTK- } \\ & \text { R-20 } \end{aligned}$ | $\begin{aligned} & \text { LP- } \\ & \text { CC-20 } \end{aligned}$ | $\begin{array}{\|c\|} \hline 501790 \\ 6-020 \end{array}$ | $\begin{aligned} & \mathrm{KLN}- \\ & \mathrm{R} 20 \end{aligned}$ | ATM-R20 | A2K-20R | HSJ20 |
| 2.2 | 30* | $\begin{array}{\|c} \text { FWX-3 } \\ 0 \end{array}$ | $\begin{gathered} \hline \text { KTN- } \\ \text { R30 } \end{gathered}$ | JKS-30 | JJN-30 | $\begin{aligned} & \text { FNQ- } \\ & \text { R-30 } \end{aligned}$ | $\begin{aligned} & \text { KTK- } \\ & \text { R-30 } \end{aligned}$ | $\begin{gathered} \text { LP- } \\ \text { CC-30 } \end{gathered}$ | $\begin{array}{\|c\|} \hline 501240 \\ 6-032 \end{array}$ | $\begin{aligned} & \hline \text { KLN- } \\ & \text { R30 } \end{aligned}$ | ATM-R30 | A2K-30R | HSJ30 |
| 3.0 | 35 | $\begin{gathered} \text { FWX-3 } \\ 5 \end{gathered}$ | KTNR35 | JKS-35 | JJN-35 |  |  |  | --- | $\begin{gathered} \hline \text { KLN- } \\ \text { R35 } \end{gathered}$ | --- | A2K-35R | HSJ35 |
| 3.7 | 50 | $\begin{gathered} \text { FWX-5 } \\ 0 \\ \hline \end{gathered}$ | $\begin{aligned} & \text { KTN- } \\ & \text { R50 } \end{aligned}$ | JKS-50 | JJN-50 |  |  |  | $\left\|\begin{array}{c} 501400 \\ 6-050 \end{array}\right\|$ | $\begin{gathered} \text { KLN- } \\ \text { R50 } \end{gathered}$ | --- | A2K-50R | HSJ50 |
| 5.5 | $60^{* *}$ | $\left\lvert\, \begin{gathered} \text { FWX-6 } \\ 0 \end{gathered}\right.$ | $\begin{gathered} \text { KTN- } \\ \text { R60 } \end{gathered}$ | JKS-60 | JJN-60 |  |  |  | $\left\|\begin{array}{c} 501400 \\ 6-063 \end{array}\right\|$ | $\begin{aligned} & \hline \text { KLN- } \\ & \text { R60 } \end{aligned}$ | --- | A2K-60R | HSJ60 |
| 7.5 | 80 | $\left\|\begin{array}{c} \text { FWX-8 } \\ 0 \end{array}\right\|$ | $\begin{gathered} \text { KTN- } \\ \text { R80 } \end{gathered}$ | JKS-80 | JJN-80 |  |  |  | $\begin{array}{\|c\|} \hline 501400 \\ 6-080 \end{array}$ | $\begin{gathered} \hline \text { KLN- } \\ \text { R80 } \end{gathered}$ | --- | A2K-80R | HSJ80 |
| 15 | 150 | $\begin{array}{\|c\|} \hline \text { FWX-1 } \\ 50 \\ \hline \end{array}$ | $\begin{aligned} & \text { KTN- } \\ & \text { R150 } \end{aligned}$ | $\begin{array}{\|c\|} \hline \text { JKS-15 } \\ 0 \end{array}$ | $\begin{array}{\|c\|} \hline \mathrm{JJN}-15 \\ 0 \\ \hline \end{array}$ |  |  |  | $\begin{array}{\|c\|} \hline 202822 \\ 0-150 \\ \hline \end{array}$ | $\begin{aligned} & \text { KLN- } \\ & \text { R150 } \end{aligned}$ |  | A2K-150R | HSJ150 |
| 22 | 200 | $\begin{array}{\|c} \hline \text { FWX-2 } \\ 00 \end{array}$ | $\begin{aligned} & \text { KTN- } \\ & \text { R200 } \end{aligned}$ | $\begin{gathered} \mathrm{JKS}-20 \\ 0 \end{gathered}$ | $\begin{array}{\|c} \hline \mathrm{JJN}-20 \\ 0 \end{array}$ |  |  |  | $\begin{array}{\|c\|} \hline 202822 \\ 0-200 \end{array}$ | $\begin{aligned} & \text { KLN- } \\ & \text { R200 } \end{aligned}$ |  | A2K-200R | HSJ200 |

Table $10.161 \times 200-240 \mathrm{~V}$

* Siba allowed up to 32 A
** Siba allowed up to 63 A

| Recommended max. fuse |  |  |  |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Power [kW] | Max prefuse size [A] | Bussmann JFHR2 | Buss- <br> mann <br> RK1 | Bussmann J | Bussmann T | Bussmann CC | Buss- <br> mann <br> CC | Buss- <br> mann <br> CC | $\begin{aligned} & \hline \text { SIBA } \\ & \text { RK1 } \end{aligned}$ | Littel fuse RK1 | FerrazShawmut CC | FerrazShawmut RK1 | FerrazShawmut J |
| 7.5 | 60 | $\begin{gathered} \text { FWH-6 } \\ 0 \\ \hline \end{gathered}$ | $\begin{aligned} & \text { KTS- } \\ & \text { R60 } \end{aligned}$ | JKS-60 | JJS-60 |  |  |  | $\begin{array}{\|c\|} \hline 501400 \\ 6-063 \end{array}$ | $\begin{aligned} & \text { KLS- } \\ & \text { R60 } \end{aligned}$ | - | A6K-60R | HSJ60 |
| 11 | 80 | FWH-8 <br> 0 | $\begin{aligned} & \text { KTS- } \\ & \text { R80 } \end{aligned}$ | JKS-80 | JJS-80 |  |  |  | $\begin{array}{\|c} 202822 \\ 0-100 \end{array}$ | $\begin{aligned} & \text { KLS- } \\ & \text { R80 } \end{aligned}$ | - | A6K-80R | HSJ80 |
| 22 | 150 | $\begin{gathered} \text { FWH-1 } \\ 50 \end{gathered}$ | $\begin{aligned} & \text { KTS- } \\ & \text { R150 } \end{aligned}$ | $\begin{array}{\|c} \hline \text { JKS-15 } \\ 0 \end{array}$ | $\begin{array}{\|c} \hline \text { JJS-15 } \\ 0 \end{array}$ |  |  |  | $\begin{array}{\|c\|} 202822 \\ 0-160 \end{array}$ | $\begin{aligned} & \text { KLS- } \\ & \text { R150 } \end{aligned}$ | - | A6K-150R | HSJ150 |
| 37 | 200 | $\begin{array}{\|c} \hline \text { FWH-2 } \\ 00 \end{array}$ | $\begin{aligned} & \text { KTS- } \\ & \text { R200 } \end{aligned}$ | $\begin{gathered} \hline \text { JKS-20 } \\ 0 \end{gathered}$ | $\begin{array}{\|c} \hline \text { JJS-20 } \\ 0 \end{array}$ |  |  |  | 202822 | $\begin{gathered} \text { KLS-20 } \\ 0 \end{gathered}$ |  | A6K-200R | HSJ200 |

## Table $10.171 \times 380-500 \mathrm{~V}$

KTS-fuses from Bussmann may substitute KTN for 240 V frequency converters
FWH-fuses from Bussmann may substitute FWX for 240 V frequency converters
JJS-fuses from Bussmann may substitute JJN for 240 V frequency converters
KLSR fuses from LITTLE FUSES may substitute KLNR fuses for 240 V frequency converters
A6KR fuses from FERRAZ SHAWMUT may substitute A2KR for 240 V frequency converters

| Specifications | $\mathrm{VLT}^{\otimes} \mathrm{AQUA}$ Drive |
| :--- | :--- |
|  | Operating Instructions |


|  | Recommended max. fuse |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Power [kW] | Bussmann Type RK1 ${ }^{1)}$ | Bussmann Type J | Bussmann Type T | Bussmann Type CC | Bussmann | Bussmann Type CC |
| 0.25-0.37 | KTN-R-05 | JKS-05 | JJN-05 | FNQ-R-5 | KTK-R-5 | LP-CC-5 |
| 0.55-1.1 | KTN-R-10 | JKS-10 | JJN-10 | FNQ-R-10 | KTK-R-10 | LP-CC-10 |
| 1.5 | KTN-R-15 | JKS-15 | JJN-15 | FNQ-R-15 | KTK-R-15 | LP-CC-15 |
| 2.2 | KTN-R-20 | JKS-20 | JJN-20 | FNQ-R-20 | KTK-R-20 | LP-CC-20 |
| 3.0 | KTN-R-25 | JKS-25 | JJN-25 | FNQ-R-25 | KTK-R-25 | LP-CC-25 |
| 3.7 | KTN-R-30 | JKS-30 | JJN-30 | FNQ-R-30 | KTK-R-30 | LP-CC-30 |
| 5.5-7.5 | KTN-R-50 | KS-50 | JJN-50 | - | - | - |
| 11 | KTN-R-60 | JKS-60 | JJN-60 | - | - | - |
| 15 | KTN-R-80 | JKS-80 | JJN-80 | - | - | - |
| 18.5-22 | KTN-R-125 | JKS-125 | JJN-125 | - | - | - |
| 30 | KTN-R-150 | JKS-150 | JJN-150 | - | - | - |
| 37 | KTN-R-200 | JKS-200 | JJN-200 | - | - | - |
| 45 | KTN-R-250 | JKS-250 | JJN-250 | - | - | - |

Table $10.183 \times 200-240$ V, Frame Sizes A, B and C

|  | Recommended max. fuse |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| Power <br> [kW] | SIBA <br> Type RK1 | Littel fuse Type RK1 | FerrazShawmut Type CC | Ferraz- <br> Shawmut <br> Type RK1 ${ }^{3)}$ |
| 0.25-0.37 | 5017906-005 | KLN-R-05 | ATM-R-05 | A2K-05-R |
| 0.55-1.1 | 5017906-010 | KLN-R-10 | ATM-R-10 | A2K-10-R |
| 1.5 | 5017906-016 | KLN-R-15 | ATM-R-15 | A2K-15-R |
| 2.2 | 5017906-020 | KLN-R-20 | ATM-R-20 | A2K-20-R |
| 3.0 | 5017906-025 | KLN-R-25 | ATM-R-25 | A2K-25-R |
| 3.7 | 5012406-032 | KLN-R-30 | ATM-R-30 | A2K-30-R |
| 5.5-7.5 | 5014006-050 | KLN-R-50 | - | A2K-50-R |
| 11 | 5014006-063 | KLN-R-60 | - | A2K-60-R |
| 15 | 5014006-080 | KLN-R-80 | - | A2K-80-R |
| 18.5-22 | 2028220-125 | KLN-R-125 | - | A2K-125-R |
| 30 | 2028220-150 | KLN-R-150 | - | A2K-150-R |
| 37 | 2028220-200 | KLN-R-200 | - | A2K-200-R |
| 45 | 2028220-250 | KLN-R-250 | - | A2K-250-R |

[^21]——

| Specifications | $\mathrm{VLT}^{\circledR} \mathrm{AQUA}$ Drive |
| :--- | :--- |
|  | Operating Instructions |


|  | Recommended max. fuse |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| Power [kW] | $\begin{aligned} & \text { Bussmann } \\ & \text { Type JFHR2²) } \end{aligned}$ | Littel fuse JFHR2 | Ferraz- <br> Shawmut $\text { JFHR2 }{ }^{4)}$ | Ferraz- <br> Shawmut J |
| 0.25-0.37 | FWX-5 | - | - | HSJ-6 |
| 0.55-1.1 | FWX-10 | - | - | HSJ-10 |
| 1.5 | FWX-15 | - | - | HSJ-15 |
| 2.2 | FWX-20 | - | - | HSJ-20 |
| 3.0 | FWX-25 | - | - | HSJ-25 |
| 3.7 | FWX-30 | - | - | HSJ-30 |
| 5.5-7.5 | FWX-50 | - | - | HSJ-50 |
| 11 | FWX-60 | - | - | HSJ-60 |
| 15 | FWX-80 | - | - | HSJ-80 |
| 18.5-22 | FWX-125 | - | - | HSJ-125 |
| 30 | FWX-150 | L25S-150 | A25X-150 | HSJ-150 |
| 37 | FWX-200 | L25S-200 | A25X-200 | HSJ-200 |
| 45 | FWX-250 | L25S-250 | A25X-250 | HSJ-250 |

Table $10.203 \times 200-240$ V, Frame Sizes A, B and C

1) KTS-fuses from Bussmann may substitute KTN for 240 V frequency converters.
2) FWH-fuses from Bussmann may substitute FWX for 240 V frequency converters.
3) A6KR fuses from FERRAZ SHAWMUT may substitute A2KR for 240 V frequency converters.
4) A50X fuses from FERRAZ SHAWMUT may substitute A25X for 240 V frequency converters.

|  | Recommended max. fuse |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Power <br> [kW] | Bussmann <br> Type RK1 | Bussmann Type J | Bussmann Type T | Bussmann Type CC | Bussmann Type CC | Bussmann Type CC |
| - | KTS-R-6 | JKS-6 | JJS-6 | FNQ-R-6 | KTK-R-6 | LP-CC-6 |
| 1.1-2.2 | KTS-R-10 | JKS-10 | JJS-10 | FNQ-R-10 | KTK-R-10 | LP-CC-10 |
| 3 | KTS-R-15 | JKS-15 | JJS-15 | FNQ-R-15 | KTK-R-15 | LP-CC-15 |
| 4 | KTS-R-20 | JKS-20 | JJS-20 | FNQ-R-20 | KTK-R-20 | LP-CC-20 |
| 5.5 | KTS-R-25 | JKS-25 | JJS-25 | FNQ-R-25 | KTK-R-25 | LP-CC-25 |
| 7.5 | KTS-R-30 | JKS-30 | JJS-30 | FNQ-R-30 | KTK-R-30 | LP-CC-30 |
| 11 | KTS-R-40 | JKS-40 | JJS-40 | - | - | - |
| 15 | KTS-R-50 | JKS-50 | JJS-50 | - | - | - |
| 22 | KTS-R-60 | JKS-60 | JJS-60 | - | - | - |
| 30 | KTS-R-80 | JKS-80 | JJS-80 | - | - | - |
| 37 | KTS-R-100 | JKS-100 | JJS-100 | - | - | - |
| 45 | KTS-R-125 | JKS-125 | JJS-125 | - | - | - |
| 55 | KTS-R-150 | JKS-150 | JJS-150 | - | - | - |
| 75 | KTS-R-200 | JKS-200 | JJS-200 | - | - | - |
| 90 | KTS-R-250 | JKS-250 | JJS-250 | - | - | - |

Table $10.213 \times 380-480$ V, Frame Sizes A, B and C

| Specifications | $\mathrm{VLT}^{\circledR} \mathrm{AQUA}$ Drive |
| :--- | :--- |
|  | Operating Instructions |


|  | Recommended max. fuse |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| Power [kW] | SIBA <br> Type RK1 | Littel fuse Type RK1 | Ferraz- <br> Shawmut <br> Type CC | Ferraz- <br> Shawmut <br> Type RK1 |
| - | 5017906-006 | KLS-R-6 | ATM-R-6 | A6K-6-R |
| 1.1-2.2 | 5017906-010 | KLS-R-10 | ATM-R-10 | A6K-10-R |
| 3 | 5017906-016 | KLS-R-15 | ATM-R-15 | A6K-15-R |
| 4 | 5017906-020 | KLS-R-20 | ATM-R-20 | A6K-20-R |
| 5.5 | 5017906-025 | KLS-R-25 | ATM-R-25 | A6K-25-R |
| 7.5 | 5012406-032 | KLS-R-30 | ATM-R-30 | A6K-30-R |
| 11 | 5014006-040 | KLS-R-40 | - | A6K-40-R |
| 15 | 5014006-050 | KLS-R-50 | - | A6K-50-R |
| 22 | 5014006-063 | KLS-R-60 | - | A6K-60-R |
| 30 | 2028220-100 | KLS-R-80 | - | A6K-80-R |
| 37 | 2028220-125 | KLS-R-100 | - | A6K-100-R |
| 45 | 2028220-125 | KLS-R-125 | - | A6K-125-R |
| 55 | 2028220-160 | KLS-R-150 | - | A6K-150-R |
| 75 | 2028220-200 | KLS-R-200 | - | A6K-200-R |
| 90 | 2028220-250 | KLS-R-250 | - | A6K-250-R |

Table $10.223 \times 380-480$ V, Frame Sizes A, B and C

|  | Recommended max. fuse |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| Power [kW] | Bussmann <br> JFHR2 | Ferraz- Shawmut J | Ferraz- Shawmut JFHR2 ${ }^{1)}$ | Littel fuse JFHR2 |
| - | FWH-6 | HSJ-6 | - | - |
| 1.1-2.2 | FWH-10 | HSJ-10 | - | - |
| 3 | FWH-15 | HSJ-15 | - | - |
| 4 | FWH-20 | HSJ-20 | - | - |
| 5.5 | FWH-25 | HSJ-25 | - | - |
| 7.5 | FWH-30 | HSJ-30 | - | - |
| 11 | FWH-40 | HSJ-40 | - | - |
| 15 | FWH-50 | HSJ-50 | - | - |
| 22 | FWH-60 | HSJ-60 | - | - |
| 30 | FWH-80 | HSJ-80 | - | - |
| 37 | FWH-100 | HSJ-100 | - | - |
| 45 | FWH-125 | HSJ-125 | - | - |
| 55 | FWH-150 | HSJ-150 | - | - |
| 75 | FWH-200 | HSJ-200 | A50-P-225 | L50-S-225 |
| 90 | FWH-250 | HSJ-250 | A50-P-250 | L50-S-250 |

Table $10.233 \times 380-480$ V, Frame Sizes A, B and C

1) Ferraz-Shawmut A50QS fuses may substitute for A50P fuses.

- 

Specifications
VLT ${ }^{\circledR}$ AQUA Drive Operating Instructions

|  | Recommended max. fuse |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Power [kW] | Bussmann Type RK1 | Bussmann Type J | Bussmann Type T | Bussmann Type CC | Bussmann Type CC | Bussmann Type CC |
| 0.75-1.1 | KTS-R-5 | JKS-5 | JJS-6 | FNQ-R-5 | KTK-R-5 | LP-CC-5 |
| 1.5-2.2 | KTS-R-10 | JKS-10 | JJS-10 | FNQ-R-10 | KTK-R-10 | LP-CC-10 |
| 3 | KTS-R15 | JKS-15 | JJS-15 | FNQ-R-15 | KTK-R-15 | LP-CC-15 |
| 4 | KTS-R20 | JKS-20 | JJS-20 | FNQ-R-20 | KTK-R-20 | LP-CC-20 |
| 5.5 | KTS-R-25 | JKS-25 | JJS-25 | FNQ-R-25 | KTK-R-25 | LP-CC-25 |
| 7.5 | KTS-R-30 | JKS-30 | JJS-30 | FNQ-R-30 | KTK-R-30 | LP-CC-30 |
| 11-15 | KTS-R-35 | JKS-35 | JJS-35 | - | - | - |
| 18 | KTS-R-45 | JKS-45 | JJS-45 | - | - | - |
| 22 | KTS-R-50 | JKS-50 | JJS-50 | - | - | - |
| 30 | KTS-R-60 | JKS-60 | JJS-60 | - | - | - |
| 37 | KTS-R-80 | JKS-80 | JJS-80 | - | - | - |
| 45 | KTS-R-100 | JKS-100 | JJS-100 | - | - | - |
| 55 | KTS-R-125 | JKS-125 | JJS-125 | - | - | - |
| 75 | KTS-R-150 | JKS-150 | JJS-150 | - | - | - |
| 90 | KTS-R-175 | JKS-175 | JJS-175 | - | - | - |

Table $10.243 \times 525-600$ V, Frame Sizes A, B and C

|  | Recommended max. fuse |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| Power [kW] | SIBA <br> Type RK1 | Littel fuse <br> Type RK1 | Ferraz- <br> Shawmut <br> Type RK1 | Ferraz- <br> Shawmut <br> J |
| $0.75-1.1$ | $5017906-005$ | KLS-R-005 | A6K-5-R | HSJ-6 |
| $1.5-2.2$ | $5017906-010$ | KLS-R-010 | A6K-10-R | HSJ-10 |
| 3 | $5017906-016$ | KLS-R-015 | A6K-15-R | HSJ-15 |
| 4 | $5017906-020$ | KLS-R-020 | A6K-20-R | HSJ-20 |
| 5.5 | $5017906-025$ | KLS-R-025 | A6K-25-R | HSJ-25 |
| 7.5 | $5017906-030$ | KLS-R-030 | A6K-30-R | HSJ-30 |
| $11-15$ | $5014006-040$ | KLS-R-035 | A6K-45-R-R | HSJ-35 |
| 18 | $5014006-050$ | KLS-R-050 | A6K-50-R | HSJ-45 |
| 22 | $5014006-050$ | KLS-R-060 | A6K-60-R | HSJ-50 |
| 30 | $5014006-063$ | KLS-R-075 | A6K-80-R | HSJ-60 |
| 37 | $5014006-080$ | KLS-R-100 | A6K-100-R | HSJ-80 |
| 45 | $5014006-100$ | KLS-R-125 | A6K-125-R | HSJ-100 |
| 55 | $2028220-125$ | KLS-R-150 | A6K-150-R | HSJ-125 |
| 75 | $2028220-150$ | KLS-R-175 | A6K-175-R | HSJ-150 |
| 90 | $2028220-200$ |  |  | HSJ-175 |

Table $10.253 \times 525-600$ V, Frame Sizes A, B and C

1) 170 M fuses shown from Bussmann use the -/80 visual indicator. -TN/80 Type $T,-/ 110$ or TN/110 Type $T$ indicator fuses of the same size and amperage may be substituted.

| Specifications | $\mathrm{VLT}^{\circledR} \mathrm{AQUA}$ Drive |
| :--- | :--- |
|  | Operating Instructions |


|  | Recommended max. fuse |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Power [kW] | Max. prefuse <br> [A] | $\begin{gathered} \text { Bussmann } \\ \text { E52273 } \\ \text { RK1/JDDZ } \end{gathered}$ | $\begin{gathered} \text { Bussmann } \\ \text { E4273 } \\ \text { J/JDDZ } \end{gathered}$ | $\begin{gathered} \text { Bussmann } \\ \text { E4273 } \\ \text { T/JDDZ } \end{gathered}$ | $\begin{gathered} \text { SIBA } \\ \text { E180276 } \\ \text { RK1/JDDZ } \end{gathered}$ | $\begin{gathered} \text { LittelFuse } \\ \text { E81895 } \\ \text { RK1/JDDZ } \end{gathered}$ | Ferraz- <br> Shawmut E163267/E2137 <br> RK1/JDDZ | FerrazShawmut <br> E2137 <br> J/HSJ |
| 11-15 | 30 | KTS-R-30 | JKS-30 | JKJS-30 | 5017906-030 | KLS-R-030 | A6K-30-R | HST-30 |
| 22 | 45 | KTS-R-45 | JKS-45 | JJS-45 | 5014006-050 | KLS-R-045 | A6K-45-R | HST-45 |
| 30 | 60 | KTS-R-60 | JKS-60 | JJS-60 | 5014006-063 | KLS-R-060 | A6K-60-R | HST-60 |
| 37 | 80 | KTS-R-80 | JKS-80 | JJS-80 | 5014006-080 | KLS-R-075 | A6K-80-R | HST-80 |
| 45 | 90 | KTS-R-90 | JKS-90 | JJS-90 | 5014006-100 | KLS-R-090 | A6K-90-R | HST-90 |
| 55 | 100 | KTS-R-100 | JKS-100 | JJS-100 | 5014006-100 | KLS-R-100 | A6K-100-R | HST-100 |
| 75 | 125 | KTS-R-125 | JKS-125 | JJS-125 | 2028220-125 | KLS-150 | A6K-125-R | HST-125 |
| 90 | 150 | KTS-R-150 | JKS-150 | JJS-150 | 2028220-150 | KLS-175 | A6K-150-R | HST-150 |
| * UL compliance 525-600 V only |  |  |  |  |  |  |  |  |

Table $10.263 \times 525-690$ V*, Frame Sizes B and C $^{\text {W }}$

### 10.4 Connection Tightening Torques

|  | Power (kW) |  |  | Torque ( Nm ) |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Enclosure | 200-240 V | $\begin{gathered} 380-480 / 500 \\ V \end{gathered}$ | 525-600 V | 525-690 V | Mains | Motor | $\begin{array}{\|c} \text { DC } \\ \text { connecti } \\ \text { on } \end{array}$ | Brake | Earth | Relay |
| A2 | 0.25-2.2 | 0.37-4.0 |  |  | 1.8 | 1.8 | 1.8 | 1.8 | 3 | 0.6 |
| A3 | 3.0-3.7 | 5.5-7.5 | 0.75-7.5 | 1.1-7.5 | 1.8 | 1.8 | 1.8 | 1.8 | 3 | 0.6 |
| A4 | 0.25-2.2 | 0.37-4.0 |  |  | 1.8 | 1.8 | 1.8 | 1.8 | 3 | 0.6 |
| A5 | 0.25-3.7 | 0.37-7.5 | 0.75-7.5 |  | 1.8 | 1.8 | 1.8 | 1.8 | 3 | 0.6 |
| B1 | 5.5-7.5 | 11-15 | 11-15 |  | 1.8 | 1.8 | 1.5 | 1.5 | 3 | 0.6 |
| B2 | 11 | $\begin{aligned} & 18 \\ & 22 \end{aligned}$ | $\begin{aligned} & 18 \\ & 22 \end{aligned}$ | $\begin{aligned} & 11 \\ & 22 \end{aligned}$ | $\begin{aligned} & 4.5 \\ & 4.5 \end{aligned}$ | $\begin{aligned} & 4.5 \\ & 4.5 \end{aligned}$ | $\begin{aligned} & 3.7 \\ & 3.7 \end{aligned}$ | $\begin{aligned} & 3.7 \\ & 3.7 \end{aligned}$ | $3$ | $\begin{aligned} & 0.6 \\ & 0.6 \end{aligned}$ |
| B3 | 5.5-7.5 | 11-15 | 11-15 |  | 1.8 | 1.8 | 1.8 | 1.8 | 3 | 0.6 |
| B4 | 11-15 | 18-30 | 18-30 |  | 4.5 | 4.5 | 4.5 | 4.5 | 3 | 0.6 |
| C1 | 15-22 | 30-45 | 30-45 |  | 10 | 10 | 10 | 10 | 3 | 0.6 |
| C2 | 30-37 | 55-75 | 55-75 | 30-75 | 14/24 ${ }^{1)}$ | 14/24 ${ }^{1 \text { ) }}$ | 14 | 14 | 3 | 0.6 |
| C3 | 18-22 | 37-45 | 37-45 | 45-55 | 10 | 10 | 10 | 10 | 3 | 0.6 |
| C4 | 30-37 | 55-75 | 55-75 |  | 14/24 ${ }^{1)}$ | 14/24 ${ }^{\text {1) }}$ | 14 | 14 | 3 | 0.6 |

## Table 10.27 Tightening of Terminals

1) For different cable dimensions $x / y$, where $x \leq 95 \mathrm{~mm}^{2}$ and $y \geq 95 \mathrm{~mm}^{2}$.

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VLT ${ }^{\circledR}$ AQUA Drive Operating Instructions

www.danfoss.com/drives

## Series D7 Piloł Devices

## 22mm Design Saves Panel Space

Heavy Duty<br>Ratings

## Features

## TWO OPERATOR TYPES

- Plastic operator with captive front bezel
- Metal operator with die-cast zinc housing and captive shiny metal bezel


## LESS INVENTORY, MORE CHOICES

- Wide range of style choices
- Modular design for mix and match flexibility
- Endless configurations from core components


## QUICK, EASY INSTALLATION

- Tool-less mounting latch for quick assembly
- Anti-rotation tab for one person installation
- Snap-on back panel components


## LONG ELECTRICAL \& MECHANICAL LIFE

- 10 million mechanical operations
- 10 million electrical cycles


## ENVIRONMENTAL RATINGS

- UL Type 4/4X/13, IP66 Sealing
- Chemical resistant industrial grade thermoplastic body
- Corrosion and UV resistant

Modular Design Reduces Inventory

Order Assembled
or by Component

Sprecher + Schuh's rugged D7 pilot devices offer maximum flexibility and a wide choice for all applications. This 22 mm line is aesthetically appealing and modularly designed to make assembly and interchangeability easy. The D7 operators are available in two different body styles to meet every industrial application need. Both operators exhibit a new lower profile stylish appearance while maintaining the rugged performance necessary for demanding environments.


Fast Mounillicq


## Complete Alecessortes

Superlor Deslgin


Q-Pulse Id: TMS1395


B



Selector Switch Safety

- Positive Detent
- Constant Energy


## Push Buttons

SP160－Jesma Road Indooroopilly SPS－TSR02 Transportable Switchboard Container－OM Manual



## Push－Pull Operators



2 Position Illuminated
Push－Pull，40mm Mushroom
Plastic
－D7P－LMP43 D7M－LMP43 －D7P－LMP44 D7M－LMP44 －
Complete Unit
1NC：
1 Guardian：


| Plastic | Metal |
| :--- | :--- |
| D7P－LMP33 | D7M－LMP33 |
| D7P－LMP34 | D7M－LMP34 |
| D7P－LMP35 | D7M－LMP35 | Plastic －IMP6

D7P－LMP63 D7P－LMP65

Metal
D7M－LMP63 D7M－LMP65

2 Position Non－Illuminated
Push－Pull，40mm Mushroom
Plastic Metal
$\begin{array}{ll}\text {－D7P－MP42 } & \text { D7M－MP42 } \\ \text { D7P－MP44 } & \text { D7M－MP44 }\end{array}$
Complete Unit
D7P－MP44PX01 D7M－MP44PX01 $\begin{array}{ll}\text { D7P－MP44PX01 } & \text { D7M－MP44PX01 } \\ \text { D7M－MP4PX01S }\end{array}$
3 Position Illuminated
Push－Pull，40mm Mushroom Momentary Maintained D7M－LMM40－E3 D7M－LMP40－E3 －D7M－LMM43－E3 D7M－LMP43－E3 －D7M－LMM44－E3 D7M－LMP44－E3 －D7M－LMM46－E3 D7M－LMP46－E3

3 Position Non－Illuminated
Push－Pull，40mm Mushroom Momentary Maintained $\begin{array}{ll}\text { D7M－MM42－E3 } & \text { D7M－MP42－E3 }\end{array}$ $\begin{array}{ll}\text {－D7M－MM42－E3 } & \text { D7M－MP42－E3 } \\ \text {－D7M－MM43－E3 } & \text { D7M－MP43－E3 } \\ \text {－D7M－MM44－E3 } & \text { D7M－MP44－E3 }\end{array}$

Pilot Lights
$\begin{array}{ll}\text { Plastic } & \text { Metal } \\ \text {－D7P－PO } & \text { D7M－P0 } \\ \text {－D7P－P3 } & \text { D7M－P3 }\end{array}$
$\begin{array}{ll}\text {－D7P－P3 } & \text { D7M－P3 } \\ \text {－D7P－P4 } & \text { D7M－P4 }\end{array}$
$\begin{array}{ll}- \text { D7P－P4 } & \text { D7M－P4 } \\ - \text { D7P－P5 } & \text { D7M－P5 }\end{array}$

| －D7P－P5 | D7M－P5 |
| :--- | :--- |
| －D7P－P6 | D7M－P6 |

$\begin{array}{ll}- \text { DTPPP6 } & \text { D7M－P6 } \\ -0 \text { D7P－P7 } & \text { D7M－P7 }\end{array}$
$\varnothing$ D7P－P9 D7M－P9
Piot light without tens or diftuser

MONOLITHIC
emergency STOP

SELECTOR switches

MULIIfunction push buttons

## Reset Operators

陨芭島
operators

Mechanical and／or Electrical Reset

PUSת＝PULL operators Plastic －DTP－R1
－D7P－R6



Illuminated and Non-Illuminated Knob Selector Switch Operators (D7x-LS \& D7x-S)


Illuminated and Non-Illuminated
Momentary Mushroom Operators
40 mm and 60 mm (D7x-LMM \& D7x-MM)


Illuminated and Non-Illuminated
Push-Pull Mushroom Operators $30 \mathrm{~mm}, 40 \mathrm{~mm}$, and 60 mm (D7x-MP)


Mushroom Key Release Operator 40mm (D7x-MK)


Non-Illuminated 3-Position Multi-Function Operators (D7x-U3)


Illuminated and Non-Illuminated 2-Position Multi-Function Operators (D7x-LU2 \& D7x-U2)


Toggle Switch Operators (D7M-JM)


Reset Operators (D7x-R)


Selector Jog Operators (D7x-SJ)


Potentiometer with Resistive Element (D7P- POT)


* For Monolithic Devices see the D7D Monolithic Flyer

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## Relays \& Sockets



## IDEC

For more information on this product family, visit our website.
Additional resources include:

- New and updated product information
- Downloadable software demos \& upgrades
- Part configuration tool \& cross reference
- Online stock check \& ordering
- IDEC field sales \& distributor search
- Online literature request
- Downloadable manuals \& CAD drawings
- Manufacturer's suggested retail price list
- Product training schedule \& locations
- Advertising \& trade show schedules
- Press releases \& FAQs


## Selection Guide



## Selection Guide con't

| Latching Relays |  |  |
| :---: | :---: | :---: |
|  | RR2KP Series | RY2KS |
| Appearance |  |  |
| Page | 776 | 779 |
| Contact Configuration | DPDT | DPDT |
| Terminal | Pin | Blade |
| Contact Rating (resistive) | 10A, 30V DC <br> 10A, 120V AC | $\begin{aligned} & 3 \mathrm{~A}, 30 \mathrm{~V} \text { DC } \\ & 3 \mathrm{~A}, 120 \mathrm{~V} \end{aligned}$ |
| Contact Material | Silver | Silver, gold-plated |

## Solid State Relays

|  | RSC Series | RSS Series |
| :---: | :---: | :---: |
| Appearance | NEW |  |
| Page | 783 | 786 |
| Output Configuration | 1 Form A (SPST-NO) | 1 Form A (SPST-NO) |
| Output Rating | $\begin{aligned} & 20 \mathrm{~A}, 30 \mathrm{~A}, 45 \mathrm{~A} \\ & 48 \text { - } 600 \mathrm{~V} \text { AC } \end{aligned}$ | 10A, 25A, 50A, 75A, 90A 48-660V AC |
| Output | Dual SCR (zero crossing) |  |

## RH Series Compact Power Relays

## SPDT through 4PDT, 10A contacts Compact power type relays

The RH series are miniature power relays with a large capacity. The RH relays feature 10A contact capacity as large as the RR series but in a miniature package. The compact size saves space.




Sockets (for Blade Terminal Models)

| Relays | Standard DIN Rail Mount ${ }^{1}$ | Finger-safe DIN Rail Mount ${ }^{1}$ | Through Panel Mount | PCB Mount | 1. DIN Rail mount socket comes with two horseshoe clips. Do not use unless you plan to insert pullover wire spring. Replacement horseshoe clip part number is $\mathrm{Y} 778-011$. |
| :---: | :---: | :---: | :---: | :---: | :---: |
| RH1B | SH1B-05 | SH1B-05C | SH1B-51 | SH1B-62 |  |
| RH2B | SH2B-05 | SH2B-05C | SH2B-51 | SH2B-62 |  |
| RH3B | SH3B-05 | SH3B-05C | SH3B-51 | SH3B-62 |  |
| RH4B | SH4B-05 | SH4B-05C | SH4B-51 | SH4B-62 |  |
|  |  |  |  |  |  |

## Hold Down Springs \& Clips



## AC Coil Ratings

| Voltage (V) | Rated Current ( mA ) $\pm 15 \%$ at $20^{\circ} \mathrm{C}$ |  |  |  |  |  |  |  | Coil Resistance ( $\Omega$ ) $\pm 10 \%$ at $20^{\circ} \mathrm{C}$ |  |  |  | Operation Characteristics (against rated values at $20^{\circ} \mathrm{C}$ ) |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | AC 50Hz |  |  |  | AC 60Hz |  |  |  |  |  |  |  |  |  |  |
|  | SPDT | DPDT | 3PDT | 4PDT | SPDT | DPDT | 3PDT | 4PDT | SPDT | DPDT | 3PDT | 4PDT | Max. Continuous Applied Voltage | Pickup Voltage | Dropout Voltage |
| 6 | 170 | 240 | 330 | 387 | 150 | 200 | 280 | 330 | 330 | 9.4 | 6.4 | 5.4 |  |  |  |
| 12 | 86 | 121 | 165 | 196 | 75 | 100 | 140 | 165 | 165 | 39.3 | 25.3 | 21.2 |  |  |  |
| 24 | 42 | 60.5 | 81 | 98 | 37 | 50 | 70 | 83 | 83 | 153 | 103 | 84.5 |  |  |  |
| 110 | 9.6 | - | 18.1 | 21.6 | 8.4 | - | 15.5 | 18.2 | 18.2 | - | 2,200 | 1,800 |  |  |  |
| 110-120 | - | $\begin{aligned} & 9.4- \\ & 10.8 \end{aligned}$ | - | - | - | 8.0-9.2 | - | - | - | - | - | - | 110\% | $\begin{gathered} \text { 80\% } \\ \text { maximum } \end{gathered}$ | $\begin{aligned} & 30 \% \\ & \text { minimum } \end{aligned}$ |
| 120 | 8.6 | - | 16.4 | 19.5 | 7.5 | - | 14.2 | 16.5 | 16.5 | - | 10,800 | 7,360 |  |  |  |
| 220 | 4.7 | - | 8.8 | 10.7 | 4.1 | - | 7.7 | 9.1 | 9.1 | - | 10,800 | 7,360 |  |  |  |
| 220-240 | - | 4.7-5.4 | - | - | - | 4.0-4.6 | - |  | - | 18,820 | - | - |  |  |  |
| 240 | 4.9 | - | 8.2 | 9.8 | 4.3 | - | 7.1 | 8.3 | 8.3 | - | 12,100 | 9,120 |  |  |  |

## DC Coil Ratings

| Voltage (V) | Rated Current (mA) $\pm 15 \%$ at $20^{\circ} \mathrm{C}$ |  |  |  | Coil Resistance ( $\Omega$ ) $\pm 10 \%$ at $20^{\circ} \mathrm{C}$ |  |  |  | Operation Characteristics (against rated values at $20^{\circ} \mathrm{C}$ ) |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | SPDT | DPDT | 3PDT | 4PDT | SPDT | DPDT | 3PDT | 4PDT | Max. Continuous Applied Voltage | Pickup Voltage | Dropout Voltage |
| 6 | 128 | 150 | 240 | 250 | 47 | 40 | 25 | 24 | 110\% | $\begin{gathered} \text { 80\% } \\ \text { maximum } \end{gathered}$ | $\begin{aligned} & \text { 10\% } \\ & \text { minimum } \end{aligned}$ |
| 12 | 64 | 75 | 120 | 125 | 188 | 160 | 100 | 96 |  |  |  |
| 24 | 32 | 36.9 | 60 | 62 | 750 | 650 | 400 | 388 |  |  |  |
| 48 | 18 | 18.5 | 30 | 31 | 2,660 | 2,600 | 1,600 | 1,550 |  |  |  |
| 100-110 | - | 8.2-9.0 | - | - | - | 12,250 | - | - |  |  |  |
| 110 | 8 | - | 12.8 | 15 | 13,800 | - | 8,600 | 7,340 |  |  |  |



| Specifications |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| Contact Material |  | Silver cadmium oxide |  |  |
| Contact Resistance ${ }^{1}$ |  | $50 \mathrm{~m} \Omega$ maximum |  |  |
| Minimum Applicable Load |  | 24 V DC, $30 \mathrm{~mA} ; 5 \mathrm{~V} \mathrm{DC}, 100 \mathrm{~mA}$ (reference value) |  |  |
| Operate Time ${ }^{2}$ | SPDT <br> DPDT | 20 ms maximum |  |  |
|  | $\begin{aligned} & \text { 3PDT } \\ & \text { 4PDT } \end{aligned}$ | 25 ms maximum |  |  |
| Release Time ${ }^{2}$ | SPDT <br> DPDT | 20 ms maximum |  |  |
|  | $\begin{aligned} & \text { 3PDT } \\ & \text { 4PDT } \end{aligned}$ | 25 ms maximum |  |  |
| Power Consumption (approx.) | SPDT | AC: $1.1 \mathrm{VA}(50 \mathrm{~Hz}), 1 \mathrm{VA}(60 \mathrm{~Hz})$ |  | DC: 0.8 W |
|  | DPDT | AC: $1.4 \mathrm{VA}(50 \mathrm{~Hz}), 1.2 \mathrm{VA}(60 \mathrm{~Hz})$ |  | DC: 0.9 W |
|  | 3PDT | AC: $2 \mathrm{VA}(50 \mathrm{~Hz}), 1.7 \mathrm{VA}(60 \mathrm{~Hz})$ |  | DC: 1.5 W |
|  | 4PDT | AC: $2.5 \mathrm{VA}(5 \mathrm{OHz}), 2 \mathrm{VA}(60 \mathrm{~Hz})$ |  | DC: 1.5 W |
| Insulation Resistance |  | 100M 2 minimum (500V DC megger) |  |  |
| Dielectric Strength ${ }^{3}$ | SPDT | Between live and dead parts: <br> Between contact and coil: <br> Between contacts of the same pole |  | 2,000V AC, 1 minute 2,000V AC, 1 minute 1,000V AC, 1 minute |
|  | $\begin{aligned} & \text { DPDT } \\ & \text { 3PDT } \\ & \text { 4PDT } \end{aligned}$ | Between live and dead parts: $2,000 \mathrm{~V} \mathrm{AC,1}, 1$ minute <br> Between contact and coil: $2,000 \mathrm{~V} \mathrm{AC,1}, 1$ minute <br> Between contacts of different poles: $2,000 \mathrm{~V} \mathrm{AC,1} 1$ minute  <br> Between contacts of the same pole: $1,000 \mathrm{~V} \mathrm{AC,1} 1$ minute  |  |  |
| Operating Frequency |  | Electrical: Mechanical: | 1,800 operations/hour maximum 18,000 operations/hour maximum |  |
| Vibration Resistance |  | Damage limits: Operating extremes: | 10 to 55 Hz , amplitude 0.5 mm 10 to 55 Hz , amplitude 0.5 mm |  |
| Shock Resistance |  | Damage limits: $1,000 \mathrm{~m} / \mathrm{s}^{2}(100 \mathrm{G})$ <br> Operating extremes: $200 \mathrm{~m} / \mathrm{s}^{2}(20 \mathrm{G}-\mathrm{SPDT}$, DPDT) <br>  $100 \mathrm{~m} / \mathrm{s}^{2}(10 \mathrm{G}-3 P D T, 4 P D T)$ |  |  |
| Mechanical Life |  | 50,000,000 operations minimum |  |  |
| Electrical Life | DPDT | 500,000 operations minimum (120V AC, 10A) |  |  |
|  | $\begin{aligned} & \text { SPDT } \\ & \text { 3PDT } \\ & \text { 4PDT } \end{aligned}$ | 200,000 operations minimum (120V AC, 10A) |  |  |
| Operating Temperature ${ }^{4}$ | SPDT | -25 to $+50^{\circ} \mathrm{C}$ (no freezing) |  |  |
|  | $\begin{aligned} & \text { DPDT } \\ & \text { 3PDT } \\ & \text { 4PDT } \end{aligned}$ | -25 to $+40^{\circ} \mathrm{C}$ (no freezing) |  |  |
| Operating Humidity |  | 45 to 85\% RH (no condensation) |  |  |
| Weight (approx.) |  | SPDT: 24g, DPDT: 37g, 3PDT: 50g, 4PDT: 74g |  |  |

1. Measured using $5 \mathrm{~V} \mathrm{DC}, 1 \mathrm{~A}$ voltage drop method

## Characteristics (Reference Data)

## 喜 Electrical Life Curves

AC Load


(RH3/RH4) 1000

## Maximum Switching Capacity



DC Load


(RH3/RH4)


Continuous Load Current vs. Operating Temperature Curve (Basic Type, With Check Button, and Top Bracket Mounting Type)
(RH1)

(RH2)

(RH3/RH4)


Internal Connection (View from Bottom)
Basic Type

SPDT


DPDT


3PDT


4PDT


With Indicator LED \& Diode (-LD type)


## Dimensions (mm)

RH1B-U/RH1B-UL/RH1B-UD/RH1B-ULD


RH4B-U/RH4B-UL/RH4B-UD/RH4B-LD

$\leqslant_{\text {SH4B-05: } 61.5 \text { (63.5) max., SH4B-51: } 39.6 \text { (41.6) max. }}^{\text {Total length from panel surface including relay socket }}$


RH3B-UT


## Features

- 1-channel signal conditioner
- 230 V AC supply
- Level sensing input
- Adjustable range 5 ks ... $150 \mathrm{kS} \Omega$
- Relay contact output
- Minimum/maximum control


## Function

This signal conditioner provides the AC measuring voltage for the level-sensing electrodes.
Once the measured medium reaches the electrodes, the unit reacts by energizing a form C changeover relay contact. The module is voltage and temperature stabilized and guarantees defined switching characteristics. An electronic holding circuit is used that allows minimum/maximum control. Since the conductance of the media may vary, the relay response sensitivity is adjustable.
The normal output state can be reversed through the mode of operation switch S 1 .

## Assembly


c $\epsilon$

## Connection



## General specifications

## Signal type <br> \section*{Supply}

Connection
Rated voltage
Power consumption

## Input

Connection
O pen circuit voltage/short-circuit current
Control input

Response sensitivity

## Output

Connection
Output
Contact loading
Energized/De-energized delay

## Electrical isolation

Input/O utput
Input/power supply
Output/power supply

## Directive conformity

Electromagnetic compatibility
Directive 2004/108/EC

Low voltage
Directive 2006/95/EC

## Conformity

Insulation coordination
Electrical isolation
Electromagnetic compatibility
Protection degree
Ambient conditions
Ambient temperature

## Mechanical specifications

Protection degree
Connection
Mass
Dimensions
Mounting

## Indication and operation

Controls

## General information

Supplementary information

Digital Input
terminals 11 (L1), 12 ( N )
207 ... 253 V AC, 45 ... 65 Hz
approx. 0.8 W
terminals 1 (mass), 2 (min), 3 (max)
approx. $10 \mathrm{~V} \mathrm{AC} \mathrm{(approx}$.1 Hz ) / approx. 5 mA
min./max. control system: terminals $1,2,3$
on/off control system: terminals 1,3
5 ... $150 \mathrm{k} \Omega$, adjustable via potentiometer (20 turns)
terminals $7,8,9$
1 changeover contact
$253 \mathrm{~V} \mathrm{AC} / 2 \mathrm{~A} / \cos \phi>0.7 ; 40 \mathrm{~V} \mathrm{DC} / 2 \mathrm{~A}$ resistive load
approx. 1 s/approx. 1 s
basic insulation according to EN 50178, rated insulation voltage $253 \mathrm{~V}_{\text {eff }}$
basic insulation according to EN 50178, rated insulation voltage $253 \mathrm{~V}_{\text {eff }}$
basic insulation according to EN 50178, rated insulation voltage $253 \mathrm{~V}_{\text {eff }}$

EN 61326-1:2006

EN 50178:1997

EN 50178:1997
EN 50178:1997
NE 21:2006
IEC 60529:2001
$-20 \ldots 60^{\circ} \mathrm{C}\left(-4 \ldots 140^{\circ} \mathrm{F}\right)$

IP20
screw connection, max. $2.5 \mathrm{~mm}^{2}$
approx. 110 g
$20 \times 107 \times 115 \mathrm{~mm}(0.8 \times 4.2 \times 4.5 \mathrm{in})$, housing type B1
on 35 mm DIN mounting rail acc. to EN 60715:2001
switch S 1
Position I open circuit current: In the open circuit current principle, the relay becomes active when the limit is reached.
Position II closed circuit current: In closed circuit current principle, the relay is activated when power is applied. The relay is deactivated when the limit is reached.

Statement of C onformity, Declaration of Conformity, Attestation of Conformity and instructions have to be observed where applicable. For information see www.pepperl-fuchs.com.

## AC moving iron ammeters

Current Transformer operated ammeters including scale


Cat. No.
RQ96E-ACT 5 A 5X 100 A

| 0-10/50 A | 10A |
| :---: | :---: |
| 0-12/60 A | 12A |
| 0-15/75 A | 15A |
| 0-20/100 A | 20A |
| 0-25/125 A | 25A |
| 0-30/150 A | 30A |
| 0-40/200 A | 40A |
| 0-50/250 A | 50A |
| 0-60/300 A | 60A |
| 0-75/375 A | 75A |
| 0-80/400 A | 80A |
| 0-100/500 A | 100A |
| 0-120/600 A | 120A |
| 0-150/750 A | 150A |
| 0-200/1000 A | 200A |
| 0-250/1250 A | 250A |
| 0-300/1500 A | 300A |
| 0-400/2000 A | 400A |
| 0-500/2500 A | 500A |

Other ranges available on request, up to $4 \mathrm{kA} / 20 \mathrm{kA}$.

## $240^{\circ}$ Instruments




Other ranges available on request, up to $4 \mathrm{kA} / 20 \mathrm{kA}$.

Notes: ${ }^{1}$ ) Terminal covers.
$\left.{ }^{2}\right)$ Meter ordering.
${ }^{3}$ ) Specify 1 A or 5 A CT.

Refer Catalogue ITC

Overall dimensions (mm) and weight $-R Q / 90^{\circ}$ and $A Q / 240^{\circ}$ Instruments

| Cat. No. | A | B | C | D | E | Weight (g) |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| RQ48 | $48 \times 48$ | $44.5 \times 44.5$ | 40 | 22 | 45 | 100 |
| AQ48 | $48 \times 48$ | $44.5 \times 44.5$ | 57.5 | 22 | 45 | 200 |
| RQ72 | $72 \times 72$ | $66.5 \times 66.5$ | 44 | 12 | 68 | 150 |
| AQ72 | $72 \times 72$ | $66.5 \times 66.5$ | 59 | 12 | 68 | 300 |
| RQ96 | $96 \times 96$ | $91 \times 91$ | 44 | 12 | 92 | 210 |
| AQ96 | $96 \times 96$ | $91 \times 91$ | 59 | 12 | 92 | 400 |
| RQ144 | $144 \times 144$ | $137 \times 137$ | 53.5 | 12 | 138 | 450 |
| AQ144 | $144 \times 144$ | $137 \times 137$ | 81.5 | 12 | 138 | 550 |

## Dimensions



## C191HM

Powermeter and Harmonic Manager

## Installation and Operation Manual

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## C191HM Powermeter \& H



## Installation and Operation Manual

## LIMITED WARRANTY

The manufacturer offers the customer an 24-month functional warranty on the instrument for faulty workmanship or parts from date of dispatch from the distributor. In all cases, this warranty is valid for 36 months from the date of production. This warranty is on a return to factory basis.

The manufacturer does not accept liability for any damage caused by instrument malfunction. The manufacturer accepts no responsibility for the suitability of the instrument to the application for which it was purchased.

Failure to install, set up or operate the instrument according to the instructions herein will void the warranty.

Your instrument may be opened only by a duly authorized representative of the manufacturer. The unit should only be opened in a fully anti-static environment. Failure to do so may damage the electronic components and will void the warranty.

## NOTE

The greatest care has been taken to manufacture and calibrate your instrument. However, these instructions do not cover all possible contingencies that may arise during installation, operation or maintenance, and all details and variations of this equipment are not covered by these instructions.
For additional information regarding installation, operation or maintenance of this instrument, contact the manufacturer or your local representative or distributor.

## IMPORTANT

Please read the instructions this manual before performing installation, and take note of the following precautions:

Ensure that all incoming AC power and other power sources are turned OFF before performing any work on the instrument. Failure to do so may result in serious or even fatal injury and/or equipment damage.

Before connecting the instrument to the power source, check the labels on the side of the instrument to ensure that your instrument is equipped with the appropriate power supply voltage, input voltages, currents and communication protocol f lication.

Under no circumstances should the instrument be connected to a power source if it is damaged.

To prevent potential fire or shock hazard, do not expose the instrument to rain or moisture.

The secondary of an external current transformer must never be allowed to be open circuit when the primary is energized. An open circuit can cause high voltages, possibly resulting in equipment damage, fire and even serious or fatal injury. Ensure that the current transformer wiring is made through shorting switches and is secured using an external strain relief to reduce mechanical strain on the screw terminals, if necessary.

Setup procedures must be performed only by qualified personnel familiar with the instrument and its associated electrical equipment.

DO NOT open the instrument under any circumstances.
Modbus is a trademark of Modicon, Inc.

Read this manual thoroughly before connecting the meter to the current carrying circuits. During operation of the meter, hazardous voltages are present on input terminals. Failure to observe precautions can result in serious or even fatal injury or damage to equipment.

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## Quick Start

## TYPICAL INSTALLATION

Wiring Mode 4LL3 (see Section 2.2.4 for full instructions)


## SETUP (see Chapter 4 for full $i \quad$ )

Setups can be performed directly on the front panel or via PComTest communication software.

| Press SELECT $\rightarrow$ CHG ENTER | menu | bASc |
| :---: | :---: | :---: |
| Press SELECT to activate middle wind | option | ConFer |
| Press $\Uparrow \Downarrow$ to scroll to desired option. | value | $4 L-n$ 寿 |
| Press SELECT to activate lower window. | menu | Port |
| Press $\Uparrow \Downarrow$ to scroll to desired value. | option | Prot |
| Press ENTER to save selected value. | value | ASCII酉 |
| Basic and Communications Default Setups |  |  |


| Code | I'arameter | Options | Description |
| :---: | :---: | :---: | :---: |
| ConF | Wiring mode | 4Ln3 | 4-wire Wye using 3 PTs (3 element), line to neutral voltage readings |
| Pt | PT ratio | 1.0 | The phase potential transformer ratio |
| Ct | CT primary current | 5 | The primary rating of the phase current transformer, A |
| d.P | Power demand period | 15 | The length of the demand period for power demand calculations, in minutes. E = external synchronization (1) |
| n.dp | Number of power demand periods | 1 | The number of demand periods to be averaged for sliding window demands <br> 1 = block interval demand calculation |
| A.dP | Ampere/Volt demand period | 900 | The length of the demand period for volt/ampere demand calculations, in seconds 0 = measuring peak current |
| buF | Averaging buffer size | 8 | The number of measurements for RMS sliding averaging |
| $r$ rst | Reset enable/disable | diS | Protects all reset functions, both via the front panel or communications. |
| $F$ | I frequency | 50/, 60 | The nominal power utility frequency, Hz |
| LoAd | Maximum demand load current | 0 | The maximum demand load current used in TDD calculations ( $0=$ CT primary current) |
| Prot | Communications protocol | ASCII | ASCII protocol |
| Addr | Address | 0 (ASCII) | Powermeter address |
| bAud | Baud rate | 9600 | 9600 bps |
| dAtA | Data format | $8 n$ | 8 bits, no parity |
| CPtb | ASCII compatibility mode |  | Disables ASCII compatibility mode (For more information, see ASCII Communications Protocol Reference Guide) |

## Chapter 1 Introduction

### 1.1 About This Manual

This manual is intended for the user of the C191HM Powermeter. This Powermeter is a microprocessor-based instrument used for the measurement, monitoring, and management of electrical parameters.

This chapter gives an overview of this manual and an introduction to the C191HM.

Chapter 2, Installation, provides instructions for mechanical and electrical installation.

Chapter 3, Using the Menus, presents the structure of menus for setup and status viewing

Chapter 4, Setup Menus, provides instructions for performing parameter setup via the front panel.

Chapter 5, Data Display, guides you through the display pages.
Chapter 6, Viewing Status Information, tells you how to access additional status information on the instrument. This information may be useful during installation.

Chapter 7 contains Technical $S$ the C191HM.

### 1.2 About The C191HM

The C191HM is a compact panel mounted three-phase AC Powermeter and Harmonic Manager, specially designed to meet the requirements of users ranging from electrical panel builders to substation operators. The C191HM provides basic voltage, current, frequency, power, power factor and energy measurements, plus total harmonic distortion (THD, TDD and K-Factor) and individual harmonic measurements.

The $\mathbf{C 1 9 1 H M}$ is suitable for mounting on $136 \times 136 \mathrm{~mm}$ square cut-outs.

## Features

## Harmonic Measurements

- Individual voltage and current harmonics with harmonic angles up to order 40.
- Harmonic power direction (through PAS software)
- Synthesized voltage and current waveforms (through PAS software)


## Display

The front panel features bright LED displays (three windows, up to 45 pages) with adjustable display update time. Display auto scroll is available on the main
screen with a programmable scroll interval of 2 to 15 seconds. Automatic return to the main screen is available after 30 seconds of uninterrupted use. The front panel also includes

- bar graph showing percentage load with respect to user-definable nominal (100\%) load current
- alarm LED providing a local indication when a predefined alarm condition appears. The alarm LED is shut off manually (by pressing on both up and down keys more than 5 sec )
- RXD/TXD LEDs showing communications receive/transmit status

Setu th optional password protection. 16 programmable setups are provided for alarm and control functions (for programmable parameters, see 'Measured Parameters' below).

Communications are available using an RS-232 or RS-485 standard (factory set), with ASCII/Modbus (and optional DNP3.0) protocols. 120 user assignable registers are available in ASCII/Modbus protocols.

Eight relays are provided for energy pulsing (KYZ) or alarm and remote control. Contacts of six relays may switch loads up to 250V, 5A AC and are recommended for alarm and remote control; contacts of two relays may switch loads up to $250 \mathrm{~V}, 3 \mathrm{~A}$ AC and may be used for energy pulsing.

One optically isolated analog output is provided for remote monitoring or control. Current loop options are 0-20 and 4-20 mA. The analog output must be used with an external power supply.

Four counters are provided for counting user-defined events or their duration. These can be used for counting total operation time of generators or overload time of transformers or power lines. The counters are operated and released by user-defined triggers.

One digital i tf toring external contacts or as an external synchronization input for power demand interval synchronization. When no external synchronization pulse is provided, the power demand interval can be synchronized through communications.

## Three user-selectable opti <br> Iculation mode

## Energy rollover value

This option specifies the point at which the energy value rolls over to zero.
Phase energy calculations mode
This option is used to enable or disable phase energy calculations.

## Measured Parameters

Note: Real-time values are measured over 1 cycle of fundamental frequency; Average values are of 8,16 or 32 real-time values

| Parameter | Display | Com | Output |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | Analog | Pulse | Alarm |
| Average Amps, Volts, Frequency |  |  | $\begin{aligned} & \$=\text { setup via PC } \\ & \# \text { = setup via panel } \end{aligned}$ |  |  |
| Average RMS voltage per phase L-N | $\checkmark$ | $\checkmark$ | \#\$ |  | \#\$ |
| A Itage per phase L-L (1) | $\checkmark$ | $\checkmark$ | (1) |  | (1) |
| Average RMS current per phase | $\checkmark$ | $\checkmark$ | \#\$ |  | \#\$ |
| Average frequency | $\checkmark$ | $\checkmark$ | \#\$ |  | \#\$ |
| Average neutral current | $\checkmark$ | $\checkmark$ | \#\$ |  | \#\$ |
| Voltage \& current unbalance | $\checkmark$ | $\checkmark$ |  |  |  |
| Amps \& Volt Demand Parameters |  |  |  |  |  |
| Ampere demand per phase |  | $\checkmark$ |  |  | \#\$ |
| Volt demand per phase |  | $\checkmark$ |  |  | \#\$ |
| Ampere maximum demand per phase | $\checkmark$ | $\checkmark$ |  |  |  |
| Voltage maximum demand per phase | $\checkmark$ | $\checkmark$ |  |  |  |
| Average Power Values |  |  |  |  |  |
| Average active power per phase | $\checkmark$ | $\checkmark$ |  |  |  |
| Average reactive power per phase | $\checkmark$ | $\checkmark$ |  |  |  |
| Average apparent power per phase | $\checkmark$ | $\checkmark$ |  |  |  |
| Average total active power | $\checkmark$ | $\checkmark$ | \#\$ |  | \#\$ |
| Average total reactive power | $\checkmark$ | $\checkmark$ | \#\$ |  | \#\$ |
| Average total apparent power | $\checkmark$ | $\checkmark$ | \#\$ |  | \#\$ |
| Average power factor per phase | $\checkmark$ | $\checkmark$ |  |  |  |
| Average total power factor | $\checkmark$ | $\checkmark$ | \#\$ |  | \#\$ |
| Power Demand Parameters |  |  |  |  |  |
| Active power accumulated demand |  | $\checkmark$ | \#\$ |  | \#\$ |
| Apparent power accumulated demand |  | $\checkmark$ | \#\$ |  | \#\$ |
| Active power demand |  | $\checkmark$ |  |  | \#\$ |
| Active power sliding demand |  | $\checkmark$ |  |  | \#\$ |
| Apparent power demand |  | $\checkmark$ |  |  | \#\$ |
| Apparent power sliding demand |  | $\checkmark$ |  |  | \#\$ |
| Active power predicted demand |  | $\checkmark$ |  |  | \#\$ |
| Apparent power predicted demand |  | $\checkmark$ |  |  | \#\$ |
| Active power maximum demand | $\checkmark$ | $\sqrt{ }$ |  |  |  |
| Apparent power maximum demand | $\checkmark$ | $\checkmark$ |  |  |  |
| Energy Per Phase |  |  |  |  |  |
| Active energy import per phase | $\checkmark$ | $\checkmark$ |  |  |  |
| Reactive energy import per phase | $\checkmark$ | $\checkmark$ |  |  |  |
| Apparent energy per phase | $\checkmark$ | $\checkmark$ |  |  |  |
| Total Energy |  |  |  |  |  |
| Total active energy import | $\checkmark$ | $\checkmark$ |  | \#\$ |  |


| Parameter | Display | Com | Output |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | Analog | Pulse | Alarm |
| Total active energy export | $\checkmark$ | $\checkmark$ |  | \#\$ |  |
| Total reactive energy import | $\checkmark$ | $\checkmark$ |  | \#\$ |  |
| Total reactive energy export | $\checkmark$ | $\checkmark$ |  | \#\$ |  |
| Total reactive energy net |  | $\checkmark$ |  |  |  |
| Total reactive energy absolute |  |  |  | \#\$ |  |
| Total apparent energy | $\checkmark$ | $\checkmark$ |  | \#\$ |  |
| Min/Max Log |  |  |  |  |  |
| Min/Max volts | $\checkmark$ | $\checkmark$ |  |  |  |
| Min/Max amps, neutral current | $\checkmark$ | $\checkmark$ |  |  |  |
| Min/Max frequency | $\checkmark$ | $\checkmark$ |  |  |  |
| Min/Max kW, kvar, kVA, PF | $\checkmark$ | $\checkmark$ |  |  |  |
| Real-time Amps, Volts, Frequency |  |  |  |  |  |
| RT RMS voltage per phase L-N |  | $\checkmark$ | \#\$ |  | \#\$ |
| RT RMS voltage per phase L-L (1) |  | $\checkmark$ | (1) |  | (1) |
| RT RMS current per phase |  | $\checkmark$ | \#\$ |  | \#\$ |
| RT frequency |  | $\checkmark$ | \#\$ |  | \#\$ |
| RT neutral current |  | $\sqrt{ }$ |  |  |  |
| Real-time Power Values |  |  |  |  |  |
| RT active power per phase |  | $\checkmark$ |  |  |  |
| RT reactive power per phase |  | $\checkmark$ |  |  |  |
| RT apparent power per phase |  | $\checkmark$ |  |  |  |
| RT total active power |  | $\checkmark$ | \#\$ |  |  |
| RT total reactive power |  | $\checkmark$ | \#\$ |  |  |
| RT total apparent power |  | $\checkmark$ | \#\$ |  |  |
| RT power factor per phase |  | $\checkmark$ |  |  |  |
| RT total power factor |  | $\checkmark$ | \#\$ |  |  |
| Real-time Harmonic Values |  |  |  |  |  |
| RT voltage THD per phase |  | $\checkmark$ |  |  | \#\$ |
| RT current THD per phase |  | $\sqrt{ }$ |  |  | \#\$ |
| RT current TDD per phase |  | $\checkmark$ |  |  | \#\$ |
| RT K-Factor per phase |  | $\checkmark$ |  |  | \#\$ |
| Average Harmonic Values |  |  |  |  |  |
| Average Voltage THD per phase | $\checkmark$ | $\checkmark$ |  |  |  |
| Average Current THD per phase | $\checkmark$ | $\checkmark$ |  |  |  |
| Average Current TDD per phase | $\checkmark$ | $\checkmark$ |  |  |  |
| Average K-Factor per phase | $\checkmark$ | $\checkmark$ |  |  |  |
| Fundamental Frequency Values (H01) |  |  |  |  |  |
| Voltage \& current per phase |  | $\checkmark$ |  |  |  |
| kW, PF per phase | $\checkmark$ | $\checkmark$ |  |  |  |
| kvar, kVA per phase |  | $\checkmark$ |  |  |  |
| Total kW, PF | $\checkmark$ | $\checkmark$ |  |  |  |
| Total kvar, kVA |  | $\checkmark$ |  |  |  |


| Parameter | Dis- <br> play | Com | Output |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | Analog | Pulse | Alarm |
| Individual Harmonic Distortion |  |  |  |  |  |
| Voltage harmonics 1-40 per phase |  | $\checkmark$ |  |  |  |
| Current harmonics 1-40 per phase |  | $\checkmark$ |  |  |  |
| Odd voltage harmonics 3-39 per phase | $\checkmark$ |  |  |  |  |
| Odd current harmonics 3-39 per phase | $\checkmark$ |  |  |  |  |
| High odd voltage harmonics 3-39 triggers |  |  |  |  | \# |
| High odd current harmonics 3-39 triggers |  |  |  |  | \#\$ |
| Voltage harmonics angles 1-40 per phase |  | $\checkmark$ |  |  |  |
| Current harmonics angles 1-40 per phase |  | $\checkmark$ |  |  |  |
| Phase Rotation | $\checkmark$ |  |  |  | \#\$ |
| Counters | $\checkmark$ | $\checkmark$ |  |  |  |
| Status Input | $\checkmark$ | $\checkmark$ |  |  | \#\$ |
| Relay Status | $\checkmark$ | $\checkmark$ |  |  |  |
| Remote Relay Control |  | $\checkmark$ |  |  |  |
| Alarm Trigger Status |  | $\checkmark$ |  |  | \#\$ |
| Self-Diagnostic Tests | $\checkmark$ | $\checkmark$ |  |  |  |

(1) For 4Ln3 and 3Ln3 wiring configurations line to line and line to neutral voltages are displayed and transmitted via communication simultaneously; analog output and set points use line to neutral voltages. For other configurations only line to line voltages are used.

## Instrument Dimensions



Figure 1-1 C191HM Dimensions

## Chapter 2 Installation

### 2.1 Mechanical Installation

Prepare the panel cut-out, $136 \times 136 \mathrm{~mm}$, prior to mounting.
STEP 1: Place the instrument through the cut-out.
STEP 2: Assemble the latches onto the outer wall of the enclosure.
STEP 3: Tighten the screws.


Figure 2-1 Mounting the C191HM

### 2.2 Electrical Installation

Before installation ensure that all incoming power sources are shut OFF. Failure to observe this practice can result in serious or even fatal injury and damage to equipment.

### 2.2.1 Power Supply Connection

The power supply can be dedicated-fused, or from a monitored voltage if it is within the instrument's power supply range. Use an external circuit breaker or switch.

AC power supply: line to terminal 12; neutral to terminal 10.
DC power supply: positive to terminal 12; negative to terminal 10.

### 2.2.2 Current Inputs

Connect the instrument to the current transformer as shown in Figures 2-2 through 2-8.

### 2.2.3 Ground

Connect the chassis ground C 191 HM terminal to the switchgear earth ground using dedicated wire of greater than $2.5 \mathrm{~mm}^{2} / 13$ AWG.

### 2.2.4 Voltage Inputs

Input of 690 V (Standard): Use any of the seven wiring configurations shown in Figures 2-2 through 2-8.
Input of 120V (Opti
lly implies use of a potential transformer (PT). The PT requires use of any of the four wiring configurations shown in Figures 2-4 through 2-7

| Wiring Configuration <br> (See parameter setup instructions in Section 4.1) | Wiring |  |
| :--- | :--- | :--- |
| 3-wire direct connection using 2 CTs (2-element) | Setup Mode | Connection |
| 4-wire WYE direct connection using 3 CTs (3-element) | 3dir2 | Figure 2-2 |
| 4-wire WYE connection using 3 PTs, 3 CTs (3-element) | 4Ln3 or 4LL3 | Figure 2-3 |
| 3-wire open delta connection using 2 PTs, 2 CTs (2-element) | 3OP2 | Figure 2-5 |
| 3-wire open delta connection using 2 PTs, 3 CTs (2½-element) | 3OP3 | Figure 2-4 |
| 4-wire WYE connection using 2 PTs, 3 CTs (2½-element) | 3Ln3 or3LL3 | Figure 2-7 |
| 4-wire delta direct connection using 3 CTs (3-element) | 4Ln3 or 4LL3 | Figure 2-8 |



Figure 2-2
Three Wire Direct Connection Using 2 CTs (2-element)

Wiring Mode $=3$ dir2

c99-09037


Figure 2-5
Three Wire Open Delta Connection Using 2 PTs, 2 CTs (2-element)

Wiring Mode $=30$ P2

Figure 2-6
Three Wire Open
Delta Connection
Using 2 PTs, 3 CTs
(21⁄-element) Wiring Mode $=$ 30P3



Figure 2-7
Four Wire Wye Connection Using 2 PTs, 3 CTs ( $2^{\frac{1}{2}-}$ element)

Wiring Mode = 3Ln3 or 3LL3

voltages displayed:
Line to neutral voltages: 120 V : $208 \mathrm{~V} ; 120 \mathrm{~V}$
2. Line to line voltages: $240 \mathrm{~V} ; \mathbf{2 4 0 \mathrm { V }} ; \mathbf{2 4 0 \mathrm { V }}$.
©99-09041

Figure 2-8 Four Wire Delta Direct Connection Using 3 CTs (3 element) Wiring Mode $=4 \mathrm{LL} 3$ or 4 Ln 3

### 2.2.5 Relay

Eight relays are provided for energy pulsing, alarms or remote control.


Figure 2-9 Relay Connection

### 2.2.6 Status Input

One status input is provided for status monitoring or external synchronization input f


Figure 2-10 Status Input Connection

### 2.2.7 Analog Output

The C191HM provides one optically isolated analog output with current output options of $0-20 \mathrm{~mA}$ and $4-20 \mathrm{~mA}$ (current loop load of up to 500 Ohm ). The analog output must be used with a 24 V DC external power supply.

c99-090 43
Figure 2-11 Analog Output Connection

### 2.2.8 Communications

The C191HM is provided with an RS-232 or RS-485 communication port. Connections can be made as follows:

RS-232: distance of up to 15 meters, one C191HM to one computer/PLC, using a flat or twisted pair cable of $0.33 \mathrm{~mm} 2 / 22$ AWG
RS-485: distance of up to 1200 meters, up to 32 instruments on one multi-drop line


Figure 2-12 Connection for 25-pin Modem Connector

| POWERMETER | RS-232 |  | 9-PIN DB9 MALE CONNECTOR |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | 15 | SG | GND | 5 |  |
|  | 13 | TxD | TxD | 3 | MODEM |
|  | 14 | RxD | RxD | 2 |  |

Figure 2-13 Connection for 9-pin Modem Connector


Figure 2-14 RS-232 Simple 3-Wire Computer Connection, 25-pin

| POWERMETER | RS-232 |  | 9-PIN DB9 | FEM | LE CONNECTOR |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | 15 | SG | GND | 5 | IBM PC/COMPATIBLE |
|  |  | $\begin{array}{\|l\|} \hline T \times D \\ \hline R \times D \end{array}$ | RxD | 2 |  |
|  | 14 |  | TxD |  |  |
|  |  |  |  | 3 |  |
|  |  |  | DSR | 6 |  |
|  |  |  | DTR | 4 |  |
|  |  |  | RTS |  |  |
|  |  |  |  | 7 |  |
|  |  |  | CTS | 8 |  |

Figure 2-15 RS-232 Simple 3-Wire Computer Connection, 9-pin


Figure 2-16 RS-485 Multi-drop Computer Connection
NOTE: Where an RS-232/RS-485 converter is used on a computer connection, R1 is not applicable since it is built in to the converter.

Activity on the communications port lines is indicated via the TXD and RXD LEDs, on the front panel and via the Status Information menu (see Chapter 6).
A full description of the communication protocols may be found in the C191HM ASCII, Modbus and DNP3.0 Communications Manuals provided with your
instrument.

## Chapter 3 Using The Menus

Press and release SELECT to enter the setup mode. The primary menus will appear:

| StA | $-\quad$ Status Information Menu (see Chapter 6) |
| :--- | :--- | :--- |
| OPS | Setup Options Menu |
| CHG | Setup Change Menu (see Chapter 4) |

Press SELECT again to activate the window of the desired primary menu. Press ENTER

Select CHG to initialize or modify the instrument setup, or to clear the accumulated values stored in the instrument. Entry to this menu can be protected by a password.


Select StA to view extended status information which may be useful during installation and in certain applications
SELECT $\rightarrow \quad$ StA $\quad \rightarrow \quad$ ENTER

Select OPS for viewing (not editing) the instrument setup options.
SELECT $\rightarrow$ OPS $\rightarrow$ ENTER

After selecting either OPS or CHG, the list of setup menus is displayed in the upper window. Figure 3-1 presents a complete menu list. Depending on the model of your instrument, some menus may not appear.

## Password

The Setu
-defined password comprised of 4 digits. The instrument is shipped with password protection disabled. To enable password protection, go to the Access Control Menu (see Section 4.10).

The Password Menu appears if password protection is enabled.

## To enter a password:

$\checkmark$ Set the first digit using the up and down arrow keys.
$\checkmark$ Press SELECT to advance to the next digit.
$\checkmark$ Set the other password digits in the same manner.
$\checkmark$ Press ENTER to continue setup. If your password is incorrect, you will return to the Primary Selection Menu.


Figure 3-1 Menu Structure

## Chapter 4 Setup Menus

NOTE: Instrument setup can be performed directly on the front panel using the setup menus or via communications using PComTest communication software. PComTest is supplied with your instrument and provides full setup capabilities for your instrument. For information on using PComTest, refer to the user documentation supplied with your instrument.

| Setup | Display |  | PComTest |
| :--- | :---: | :---: | :---: |
| Basic | + | + |  |
| Communication port | ++ | + |  |
| User Selectable options | ++ | + |  |
| Analog output | + | + |  |
| Digital inputs | + | + | ++ Recommended method |
| Alarm/Event set points | + | + |  |
| Pulsing output | + | + |  |
| Pulse counter | + | + |  |
| Assignable registers | - | ++ |  |
| Display | ++ | - |  |

### 4.1 Basic Setup Menu



This menu contains the basic configuration options which define the general operating characteristics of your instrument, such as wiring mode, input scales, the size of the RMS averaging buffer, etc. Table 4-1 lists the basic setup options, their code names and applicable ranges.

Activate the middle window to scroll through the list of available options, and then activate the lower window to set the option value.

## bASc

ConF
4L-n

## To select and view a setup option:

$\checkmark$ Press SELECT to activate the middle window
$\checkmark$ Use the up/down arrow keys to scroll to the desired option. The current value for this option appears in the lower window.

## To change the value of the selected option:

$\checkmark$ Press SELECT to make the lower window active.
$\checkmark$ Press the up/down arrow keys to scroll to the desired value.
$\checkmark$ Press ENTER to store the selected value, or press ESC to quit the setup menu.

Table 4-1 Basic Setup Options (* default setting)

| Code | I'arameter | Options | Description |
| :---: | :---: | :---: | :---: |
| ConF | Wiring mode | 3OP2 | 3-wire open delta using 2 CTs (2 element) |
|  |  | 4Ln3* | 4-wire Wye using 3 PTs (3 element), line to neutral voltage readings |
|  |  | 3dir2 | 3 -wire direct connection using 2 CTs (2 element) |
|  |  | 4LL3 | 4-wire Wye using 3 PTs (3 element), line to line voltage readings |
|  |  | $30 P 3$ | 3 -wire open delta using 3 CTs ( $21 / 2$ element) |
|  |  | 3Ln3 | 4-wire Wye using 2 PTs ( $21 / 2$ element), line to neutral voltage readings |
|  |  | 3LL3 | 4-wire Wye using 2 PTs ( $21 / 2$ element), line to line voltage readings |
| Pt | PT ratio | 10*-6,500.0 | The phase potential transformer ratio |
| Ct | CT primary current | $\begin{aligned} & 1-6,500 \mathrm{~A} \\ & (5 *) \end{aligned}$ | The primary rating of the phase current transformer |
| d.P | Power demand period | $\begin{aligned} & 1,2,5,10 \\ & 15^{\star}, 20,30, \\ & 60, E \end{aligned}$ | The length of the demand period for power demand calculations, in minutes. $\mathrm{E}=$ external synchronization (1) |
| n.dp | Number of power demand periods | $\begin{aligned} & 1-15 \\ & \left(1^{*}\right) \end{aligned}$ | The number of demand periods to be averaged for sliding window demands <br> 1 = block interval demand calculation |
| A.dP | Ampere/Volt demand period | $\begin{aligned} & 0-1800 \mathrm{~s} \\ & \left(900^{*}\right) \end{aligned}$ | The length of the demand period for volt/ampere demand calculations in seconds $0=$ measuring peak current |
| buF | Averaging buffer size | 8*,16,32 | The number of measurements for RMS sliding averaging |
| $r$ rt | Reset enable/disable | diS*, En | Protects all reset functions, both via the front panel or communications. |
| Freq | Nominal frequency | $50,60 \mathrm{~Hz}$ (2) | The nominal power utility frequency |
| LoAd | Maximum demand load current | $\begin{aligned} & 0-6,500 \mathrm{~A} \\ & (0 *) \end{aligned}$ | The maximum demand load current used in TDD calculations ( $0=$ CT primary current) |

(1) When the power demand period is specified in minutes, synchronization of the demand interval can be made through communications (see the C191HM ASCII/Modbus Reference Guides) or via the front panel (see Section 4.11). If the power demand period is set to External Synchronization, an external synchronization pulse denoting the start of the next demand interval can be provided through a digital input or can be simulated by using the synchronization command sent via communications.
(2) 60 Hz default for North America; elsewhere, default is 50 Hz .

## NOTES

1) The maximum value for CT PRIMARY CURRENT $\times$ PT RATIO is $10,000,000$. If this product is greater, power related values will be zeroed.
2) Always specify WIRING MODE, PT RATIO and CT PRIMARY CURRENT prior to setting up alarm setpoints, otherwise the alarm/event setpoints which use these parameters will automatically be disabled.

### 4.2 Communications Port Setup Menu

SELECT $\rightarrow$ CHG $\rightarrow$ ENTER $\uparrow \downarrow \rightarrow$ Port $\rightarrow$ ENTER

This menu allows you to access the communications port options that the C191HM uses to communicate with a master computer. Table 4-2 lists the communications options, their code names and applicable choices.

Activate the middle window to scroll through the list of available options, and then activate the lower window to set the option value.

| Port |
| :--- |
| Prot |
| ASCII |

## To select and view a setup option:

$\checkmark$ Press SELECT to activate the middle window.
$\checkmark$ Use the up/down arrow keys to scroll to the desired option. The option setting will appear in the lower window.

## To change the selected option:

$\checkmark$ Press SELECT to activate the lower window.
$\checkmark$ Press the up/down arrow keys to scroll to the desired value.
$\checkmark$ Press ENTER to store the selected value or press ESC to quit the setup menu.

Table 4-2 Communications Options ( $*$ default setting)

| Code | Parameter | Options | Description |
| :--- | :--- | :--- | :--- |
| Prot | Communications <br> protocol | ASCII* <br> rtu | ASCII protocol <br> Modbus RTU protocol |
| Addr | Address | $0 *-99$ ASCII <br> $1 *-247$ Modbus | Powermeter address |
|  |  | 110 | 110 baud |
| bAud | Baud rate | 300 | 300 baud |
|  |  | 600 | 600 baud |
|  |  | 1200 | 1200 baud |
|  |  | 2400 | 2400 baud |
|  |  | 4800 | 4800 baud |
|  |  | $9600 *$ | 9600 baud |
|  |  | 19.20 | 19,200 baud |
| dAtA | Data format | $7 E$ | 7 bits, even parity |
|  |  | $8 n *$ | 8 bits, no parity |
|  |  | $8 E$ | 8 bits, even parity |
| CPtb | ASCII compatibility | diS*, En | Disables/enables ASCII |
|  | mode |  | compatibility mode. For more |
|  |  |  | information, see ASCII |
|  |  |  | Communications Protocol |
|  |  |  | Reference Guide |

### 4.3 Digital Input Setup Menu



This menu is used to set up a digital input provided by the C191HM.
The digital input can be configured as:

- a status input to monitor external contact status, or
- an external synchronization pulse input to receive an external synchronization pulse indicating the beginning of a new demand interval f ts.

The setup menu is used for allocating an external synchronization pulse input. If you do not allocate the digital input as an external synchronization input, it is automatically configured as a status input

External synchronization
nput

| E.Snc |
| ---: | ---: |
| 2 |
| 2 |

To change the digital input allocati
SELECT to activate the middle window.
$\checkmark$ Use the up/down arrow keys to set the input allocation status.
$\checkmark$ Press ENTER to store your new inputs allocation.
$\checkmark$ Press ESC to leave the allocation unchanged or to quit the menu.
" 1 " indicates that the input is allocated as the external synchronization pulse input; " 0 " indicates that the input is allocated as the status input.

## NOTES

1. A digital input configured as the status input can be monitored via the Status Informati (see Chapter 6) and communications.
2. If the digital input has been allocated as the external synchronization pulse input synchronization of the demand interval through communications is not available.

### 4.4 Analog Output Setup Menu

[This section is relevant to instruments ordered with this option.]


This menu allows you to set up an output value and its zero and full scales for the internal analog output. Table 4-3 explains the analog output setup options, and Table 4-4 lists all measurement parameters that can be directed to analog output.

| Outpu | Zero | Full-scale output |
| :---: | :---: | :---: |
| Aout | Aout | Aout |
| Outp | Lo | Hi |
| rt U1 ${ }^{\text {ºs }}$ | 0 园 | 828 |

## To view the setup options for the analog output:

$\checkmark$ Press SELECT to activate the middle window.
$\checkmark$ Use the up/down arrow keys to scroll to the desired option. The value associated with this option is displayed in the lower window.

## To change the setu tions for the selected channel:

$\checkmark$ Press SELECT to activate the lower window.
$\checkmark$ Use the up/down arrow keys to scroll to the desired value.
$\checkmark$ Press ENTER to store the selected value, or press ESC to leave the value unchanged.
$\checkmark$ Press ENTER again to store the setup for the channel.
To quit the setu thout changes:
$\checkmark$ From the middle or lower window, press ESC.

## To quit the menu:

$\checkmark$ From the upper window, press ESC or ENTER

## NOTES

1. Except for the signed power factor, the output scale is linear within the value range. The scale range will be inverted if the full scale specified is less than the zero scale.
2. The output scale for the signed power factor is symmetrical with regard to $\pm 1.000$ and is linear from -0 to -1.000 , and from 1.000 to +0 (note that $-1.000 \equiv+1.000$ ). Negative power factor is output as [-1.000 minus measured value], and non-negative power factor is output as $[+1.000$ minus measured value]. To define the entire range for power factor from -0 to +0 , the scales would be specified as $-0.000 / 0.000$.
3. Each time you select the output parameter for the analog channel, its zero and full scales are set by default to the lower and upper parameter limits, respectively.

Table 4-3 Analog Output Setup Options

| Code | Option | Description |
| :--- | :--- | :--- |
| OutP | Output parameter | The output parameter for the analog output channel |
| Lo | Zero scale $(0 / 4 \mathrm{~mA})$ | The reading of the parameter corresponding to a zero- <br> scale current output |
| Hi | Full scale $(1 / 20 \mathrm{~mA})$ | The reading of the parameter corresponding to a full-scale <br> current output |

Table 4-4 Analog Output Parameters

| Code | Parametır | Unit | Scale |
| :---: | :---: | :---: | :---: |
| nonE | Output disabled |  | 0 |
| Real-time Measurements |  |  |  |
| r. $\cup 1$ | Voltage L1/L12 | V/kV | 0 to Vmax |
| r. U 2 | Voltage L2/L23 | V/kV | 0 to Vmax |
| r. U 3 | Voltage L3/L31 | V/kV | 0 to Vmax |
| r. C1 | Current L1 | A | 0 to Imax |
| r. C2 | Current L2 | A | 0 to Imax |
| r. C3 | Current L3 | A | 0 to Imax |
| r. $P$ | Total kW | kW/MW | -Pmax to Pmax |
| r. $q$ | Total kvar | kvar/Mvar | -Pmax to Pmax |
| r. S | Total k |  |  |
| r. PF | Total PF |  | -0.000 to 0.000 |
| r. PF.LG | Total PF lag |  | 0 to 1.000 |
| r. PF.Ld | Total PF lead |  | 0 to 1.000 |
| r. Fr | Frequency (1) | Hz | 0 to 100.00 |
| Average Measurements |  |  |  |
| A. $\cup 1$ | Voltage L1/L12 | V/kV | 0 to Vmax |
| A. $\cup 2$ | Voltage L2/L23 | V/kV | 0 to Vmax |
| A. $\cup 3$ | Voltage L3/L31 | V/kV | 0 to Vmax |
| A. C1 | Current L1 | A | 0 to Imax |
| A. C 2 | Current L2 | A | 0 to Imax |
| A. C3 | Current L3 | A | 0 to Imax |
| A. $P$ | Total kW | kW/MW | -Pmax to Pmax |
| A. $q$ | Total kvar | kvar/Mvar | -Pmax to Pmax |
| A. $S$ | Total $\mathbf{k}$ |  |  |
| A. PF | Total PF |  | -0.000 to 0.000 |
| A. PF.LG | Total PF lag |  | 0 to 1.000 |
| A. PF.Ld | Total PF lead |  | 0 to 1.000 |
| A. neU.C | Neutral current | A | 0 to Imax |
| A. Fr | Frequency (1) | Hz | 0 to 100.00 |
| Present Demands |  |  |  |
| Accd.P | Accumulated kW demand | kW/MW | 0 to Pmax |
| Accd.S | Accumulated kVA demand | kVA/MVA | 0 to Pmax |

Imax $(20 \%$ over-range $)=1.2 \times$ CT primary current [A]
Direct wiring (PT Ratio $=1$ ):
Vmax (690 V input option) $=828.0 \mathrm{~V}$
Vmax (120 V input option) $=144.0 \mathrm{~V}$
Pmax $=(I \max \times V \max \times 3)[\mathrm{kW} \times 0.001] @$ wiring modes 4Ln3, 3Ln3
Pmax $=(\operatorname{lmax} \times V \max \times 2)[k W \times 0.001] @$ wiring modes 4LL3, 3OP2, 3dir2, 3OP3, 3LL3

NOTE: Pmax is rounded to nearest whole kW units.
If Pmax is more than 9999.000 kW , it is truncated to 9999.000 kW
Wiring via PTs (PT Ratio > 1):
Vmax (690 V input option) $=144 \times$ PT Ratio [V]
Vmax $(120 \mathrm{~V}$ input option $)=144 \times$ PT Ratio [V]
Pmax $=(I \max \times V \max \times 3) / 1000$ [MW x 0.001] @ wiring modes 4Ln3, 3Ln3
Pmax $=(\operatorname{Imax} \times V \max \times 2) / 1000$ [MW $\times 0.001] @$ wiring modes 4し3, 3OP2, 3dir2, 3OP3, 3LL3
NOTE: Pmax is rounded to nearest whole kW units.
(1) The actual frequency range is $45.00-65.00 \mathrm{~Hz}$

### 4.5 Pulsing Output Setup Menu

SELECT $\rightarrow$ CHG $\rightarrow$ ENTER $\uparrow \downarrow \rightarrow$ PuIS $\rightarrow$ ENTER

This menu allows you to program any of the eight relays provided by your C191HM instrument to output energy pulses. Relays \#7 and \#8 are especially recommended for use as pulsing relays because of their high endurance. Available pulsing parameters are listed in Table 4-5.


## To select a pulse relay:

$\checkmark$ Use the up/down arrow keys to scroll to the desired relay. The pulsing parameter assigned to the relay is displayed in the middle window, and the amount of unit-hours per pulse is displayed in the lower window.

## To change the pulse relay setup:

$\checkmark$ Press SELECT to activate the middle window.
$\checkmark$ Use the up/down arrow keys to scroll to the desired output parameter. Selecting nonE disables pulsing through this relay.
$\checkmark$ Press SELECT to activate the lower window
$\checkmark$ Use the up/down arrow keys to set the amount of unit-hours per pulse. The available range is 1-9999.
$\checkmark$ Press ENTER to store the new setup, or press ESC to quit the setup without changes.

## To quit the pulsing setup menu:

$\checkmark$ From the upper window, press ESC or ENTER.
Table 4-5 Pulsing Output Parameters

| Code | Paramete | Units |
| :--- | :--- | :--- |
| nonE | Output disabled |  |
| Ac.E |  |  |
| Ac.EE | Active energy export | kWh export (negative) |
| $r E . E i$ | Reactive energy import | kvarh import (inductive) |
| $r E . E E$ | Reactive energy export | kvarh export (capacitive) |
| $r E . E t$ | Reactive energy total | kvarh total (absolute) |
| AP.Et | Apparent energy total | kVAh total |

## NOTES

1. If your instrument is not equipped with the optional relay, then this setup parameter will not appear on the display.
2. You will not be able to store your setup in the instrument if you assigned a parameter to relay output with a zero number of unit-hours per pulse.
3. If a relay you allocated for pulsing has been manually operated or released, it reverts automatically to normal operation.
4. If a relay you allocated for pulsing has been engaged by an alarm/event setpoint, the setpoint is automatically disabled.

### 4.6 Alarm/Event Setpoints Setup Menu



Your instrument provides 16 alarm/event setpoints that can monitor a wide variety of events; in turn, these events can be programmed to trigger specific actions. This menu is used to specify the events to be monitored by the setpoints, and actions to be triggered by those events

To program a setpoint, you might need to define up to six setup parameters which include: the setpoint trigger parameter, operate and release limits, optional operate and release delays, and the setpoint action. Table 4-6 explains the setpoint setup parameters. For the entire list of available triggers and setpoint actions, refer to Tables 4-7 and 4-8.

## Example:



Trigger
parameter

Operate limit \}
\} The operate (On) and release (OFF limits which determine setpoint operation are defined as 1200A and 1100 A respectively.
Release limit \}

Operate delay \}
\} The delays before operation ( $O n d$ d) and release (OFFd) are set at 5 seconds and 10 seconds respectively.

Setpoint action The action to be triggered is operation of relay \#1.

## To select a setpoint:

$\checkmark$ Scroll to the desired setpoint using the up/down arrow keys.
To view the setup options for the setpoint:
$\checkmark$ Press SELECT to activate the middle window.
$\checkmark$ Use the up/down arrow keys to scroll to the desired setup option. The value associated with this option is displayed in the lower window.

## To change the selected setup option:

$\checkmark$ Press SELECT to activate the lower window.
$\checkmark$ Use the up/down arrow keys to scroll to the desired value.
$\checkmark$ Press ENTER to store the new value.
$\checkmark$ Press ESC to leave the value unchanged.
To store your new setup for the setpoint:
$\checkmark$ From the middle window, press ENTER.
To quit the setpoint setu thout changes:
$\checkmark$ From the middle window, press ESC.

## To quit the setpoints setup menu:

$\checkmark$ From the upper window, press ESC or ENTER

## NOTES

1. If your instrument is not equipped with the optional relay, then these setup parameters will not appear on the display.
2. When you enter the setpoints setup menu at the protected level, monitoring setpoints is temporarily suspended until you return to the main setup menu.
3. Each time you select a new trigger parameter, the operate and release limits are set by default to zero.
4. You will not be able to store your setpoint setup to the instrument if a setpoint action is directed to a relay allocated for pulsing.
5. The setpoint action directed to a relay output can be overridden using commands sent via communications. A relay can be manually operated or released. When the relay reverts to normal operation, it is automatically returned under setpoint control.

Table 4-6 Setpoint Setup Options (middle window)

| Code | Option | Description |
| :--- | :--- | :--- |
| triG | Trigger parameter | The measurement parameter or signal to be monitored <br> by the setpoint. <br> On |
| OFF | Operate limit <br> Release limit | The threshold at which the setpoint becomes operative. <br> The threshold at which the setpoint is released (becomes <br> inoperative). <br> The time delay (0.1 second resolution) before operation <br> when the operate condition is fulfilled. |
| On d | Operate delay | Release delay |
| OFF d the time delay (0.1 second resolution) before release |  |  |
| when the release condition is fulfilled. |  |  |
| Act | Setpoint action | The action performed when the setpoint is operative. |

Table 4-7 Setpoint Triggers (lower window, when middle window is triG)

| Code | Parameter | Unit | Range |
| :---: | :---: | :---: | :---: |
| nonE Setpoint disabled |  |  |  |
| Status Input |  |  |  |
| St.On Status input ON |  |  |  |
| St. OFF | Status input OFF |  |  |
| Phase Reversal |  |  |  |
| POS.ro. | Positive phase rotation reversal (1) |  |  |
| NEG.ro. Negative phase rotation reversal (1) |  |  |  |
| Real-time Values on any Phase |  |  |  |
| r. Hi. U | High voltage (3) | V | 0 to Vmax |
| r. Lo. U | Low voltage (3) | V | 0 to Vmax |
| r. Hi. C | High current | A | 0 to Imax |
| r. Lo. C | Low current | A | 0 to Imax |
| r. thd.U | High voltage THD | \% | 0 to 999.9 |
| r. thd.C | High current THD | \% | 0 to 999.9 |
| r. HFc.C | High K-f tor | \% | 1.0 to 999.9 |
| r. tdd.C | High current TDD | \% | 0 to 100.0 |
| Real-time Auxiliary Measurements |  |  |  |
| r. Hi.Fr | High frequency (2) | Hz | 0 to 100.00 |
| r. Lo.Fr | Low frequency (2) | Hz | 0 to 100.00 |
| Average Values per Phase |  |  |  |
| A. Hi.C1 | High current L1 | A | 0 to Imax |
| A. Hi.C2 | High current L2 | A | 0 to Imax |
| A. Hi.C3 | High current L3 | A | 0 to Imax |
| A. Lo.C1 | Low current L1 | A | 0 to Imax |
| A. Lo.C2 | Low current L2 | A | 0 to Imax |
| A. Lo.C3 | Low current L3 | A | 0 to Imax |
| Average Values on any Phase |  |  |  |
| A. Hi. U | High voltage (3) | V | 0 to Vmax |
| A. Lo. U | Low voltage (3) | V | 0 to Vmax |
| A. Hi. C | High current | A | 0 to Imax |
| A. Lo. C | Low current | A | 0 to Imax |
| Average Total Values |  |  |  |
| A. Hi.P.i | High total kW import (positive) | kW | 0 to Pmax |
| A. Hi.P.E | High total kW export (negative) | kW | 0 to Pmax |
| A. Hi.q.i | High total kvar import (positive) | kvar | 0 to Pmax |
| A. Hi.q.E | High total kvar export (negative) | kvar | 0 to Pmax |
| A. Hi. S | High total kVA | kVA | 0 to Pmax |
| A. PF.LG | Low total PF Lag |  | 0 to 1.000 |

Chapter 4 Setu

| Code | Parameter | Unit | Range |
| :---: | :---: | :---: | :---: |
| A. PF.Ld | Low total PF Lead |  | 0 to 1.000 |
| Average Auxiliary Measurements |  |  |  |
| ArneU.C | High neutral current | A | 0 to Imax |
| Ar Hi.Fr | High frequency (2) | Hz | 0 to 100.00 |
| Ar Lo.Fr | Low frequency (2) | Hz | 0 to 100.00 |
| Present Demands |  |  |  |
| Hi d.U1 | High volt demand L1 (3) | V | 0 to Vmax |
| Hi d.U2 | High volt demand L2 (3) | V | 0 to Vmax |
| Hi d.U3 | High volt demand L3 (3) | V | 0 to Vmax |
| Hi d.C1 | High ampere demand L1 | A | 0 to Imax |
| Hi d.C2 | High ampere demand L2 | A | 0 to Imax |
| Hi d.C3 | High ampere demand L3 | A | 0 to Imax |
| Hi d.P | High block interval kW demand | kW | 0 to Pmax |
| Hi d.S | High block interval kVA demand | kVA | 0 to Pmax |
| Hi Sd.P | High sliding window kW demand | kW | 0 to Pmax |
| Hi Sd.S | High sliding window kVA demand | kVA | 0 to Pmax |
| Hi Ad.P | High accumulated kW demand | kW | 0 to Pmax |
| Hi Ad.S | High accumulated kVA demand | kVA | 0 to Pmax |
| Hi Pd.P | High predicted sliding window kW demand | kW | 0 to Pmax |
| Hi Pd.S | High predicted sliding window kVA demand | kVA | 0 to Pmax |
| High Voltage Harmonic Distortions on any Phase |  |  |  |
| Hd03.U | High voltage harmonic H03 | \% | 0 to 100.00 |
| Hd05.U | High voltage harmonic H05 | \% | 0 to 100.00 |
| Ha39.U | High voltage harmonic H39 | \% | 0 to 100.00 |
| High Current Harmonic Distortions on any Phase |  |  |  |
| Hd03.C | High current harmonic H03 | \% | 0 to 100.00 |
| Hd05.C | High current harmonic H05 | \% | 0 to 100.00 |
| Hd39 C | High |  |  |
| Hd39.C | High current harmonic H39 | \% | 0 to 100.00 |

For parameter limits, see notes to Table 4-4.
(1) The setpoint is operated when the actual phase sequence does not match the indicated normal phase rotation.
(2) The actual frequency range is $45.00-65.00 \mathrm{~Hz}$.
(3) When the 4LN3 or 3LN3 wiring mode is selected, the voltages will be line-to-neutral; for any other wiring mode, they will be line-to-line voltages.

Table 4-8 Setpoint Actions (lower window, when middle window is Act)

| Code | Action |
| :--- | :--- |
| NonE | No action (1) |
| ALAr | Assert local alarm (2) |
| rEL. 1 | Operate relay \#1 (3) |
| rEL. 2 | Operate relay \#2 |
| rEL.3 | Operate relay \#3 |
| rEL.4 | Operate relay \#4 |
| rEL. 5 | Operate relay \#5 |
| rEL. 6 | Operate relay \#6 |
| rEL. 7 | Operate relay \#7 |
| rEL. 8 | Operate relay \#8 |
| In.Cn. 1 | Increment counter \#1 |
| In.Cn. 2 | Increment counter \#2 |
| In.Cn.3 | Increment counter \#3 |
| In.Cn.3 | Increment counter \#3 |
| In.Cn. 4 | Increment counter \#4 |
| $\boldsymbol{t}$ |  |
| ti.Cn. 1 | Count operating time using counter \#2 |
| $\boldsymbol{t}$ | t operating time using counter \#3 |
| ti.Cn. 1 | Count operating time using counter \#4 |

(1) When a setpoint is operated, its status is always stored to the alarm status register even if no action is assigned to the setpoint. The alarm status register can be polled and cleared through communications.
(2) This action causes the alarm LED on the front panel to blink that gives the user a local alarm indication. The alarm LED operates in latched mode, i.e., even if an alarm condition disappears, the alarm LED is still blinking until the user acknowledges the alarm from the front panel (see Section 5.1). An alarm LED can be operated from any number of setpoints using an OR scheme
(3) Alarm relays operate in unlatched mode. This means that a relay is operated while an alarm condition is present and is automatically released when an alarm condition disappears. Each relay can be operated from any number of setpoints using an OR scheme, i.e., a relay will be in operate state while either of the alarm conditions is stil present.
(4) This action converts a common event counter to the time counter which measures time at 0.1 hour resolution while the setpoint is in the operated state. Each time counter has a non-volatile shadow counter that counts time at 1 -second resolution before the corresponding time counter is incremented. The time counters can be inspected via the Status Information Menu. They are labeled by an hour mark in the middle window.

### 4.7 Relay Operation Control Menu SELECT $\rightarrow$ CHG $\rightarrow$ ENTER $\uparrow \downarrow \rightarrow$ EELO $\rightarrow$ ENTER

This menu allows you to set the relay operation mode: non-failsafe or failsafe. Failsafe relay operation is the opposite of normal operation where relay contacts are closed when a relay is operated (activated), and are open when a relay is released (de-activated). In failsafe mode, an alarm is activated by a nonenergized relay which will open in all cases when an alarm condition is present or an alarm setpoint is not operational either due to a loss of control power or due to corruption of the setpoint setup configuration. A failsafe relay is closed only if it is under setpoint control and no alarm conditions exist, or if it is manually operated via communications.

| rELO |
| :---: |
| rEL. 1 苜 |
| nor |

## To select a relay:

$\checkmark$ Press SELECT to activate the middle window, and then use the up/down arrow keys to scroll to the desired relay.

## To change the relay operation mode:

$\checkmark$ Press SELECT to activate the lower window.
$\checkmark$ Use the up/down arrow keys to set the desired option.
Select nor for normal (non-f Isafe) relay operation, or
select FSAFE for failsafe relay operation.
$\checkmark$ Press ENTER to store your new setting or press ESC to leave your previous setting unchanged.

## To quit the setu

From the middle window, press ESC or ENTER .

## NOTES

1. You will not be able to change the relay operation mode if a relay has been allocated for pulsing.
2. When a failsafe relay is allocated for pulsing, it automatically reverts to normal operation.

### 4.8 Display Setup Menu



This menu allows you to view and change display properties. Table 4-9 lists available options with their code names and applicable ranges.
Table 4-9 Display Options (* default setting)


## To select a display option:

$\checkmark$ Press SELECT to activate the middle window, and then use the up/down arrow keys to scroll to the desired option.
To change the display option:
$\checkmark$ Press SELECT to activate the lower window.
$\checkmark$ Use the up/down arrow keys to set the desired option.
$\checkmark$ Press ENTER to store your new setting or press ESC to leave your previous setting unchanged.
To quit the display setup menu:
$\checkmark$ From the middle window, press ESC or ENTER.

### 4.9 User Selectable Options Menu

SELECT $\rightarrow$ CHG $\rightarrow$ ENTER $\uparrow \downarrow \rightarrow$ OPtS $\rightarrow$ ENTER

This menu allows you to change options which relate to the instrument features and functionality. Table 4-10 lists all available options with their code names and applicable ranges.

| OPtS |
| :--- |
| P.cAL |
| rEAc |

## To select an option:

$\checkmark$ Press SELECT to activate the middle window, and then use the up/down arrow keys to scroll to the desired option.

## To change the selected option:

$\checkmark$ Press SELECT to activate the lower window.
$\checkmark$ Use the up/down arrow keys to set the desired value.
$\checkmark$ Press ENTER to store your new setting or ESC to leave the previous setting unchanged.

## To quit the display setu

le window, press ESC or ENTER.

Table 4-10 User Selectable Options (* default setting)

| Code | Parameter | Options | Description |
| :--- | :--- | :--- | :--- |
| P.cAL | Power calculation <br> mode (1) | $r E A c^{*}$ <br> $n A c t$ | Using reactive power <br> Using non-active power |
| roLL | Energy roll value (2) | $10 . E 4$ | $10,000 \mathrm{kWh}$ |
|  |  | $10 . E 5$ | $100,000 \mathrm{kWh}$ |
|  |  | $10 . E 6$ | $1,000,000 \mathrm{kWh}$ |
|  |  | $10 . E 7$ | $10,000,000 \mathrm{kWh}$ |
|  |  | $10 . E 8^{*}$ | $100,000,000 \mathrm{kWh}$ |
| Ph.En | Phase energy | diS*, En | Enables/disables measurements of |
|  | measurements |  | energies per phase |

(1) Power calculation mode (P.cAL):

Mode 1: Reactive power calculation ( rEAc )
Active power $P$ and reactive power $Q$ are measured directly and apparent power

$$
S=\sqrt{P^{2}+Q^{2}}
$$

Mode 2: Non-active power calculation (nAct)
Active power is measured directly, apparent power $\mathrm{S}=\mathrm{V} \times \mathrm{I}$ (where $\mathrm{V}, \mathrm{I}$ - rms voltage and currents) and non-active power $N=\sqrt{ } S^{2}-P^{2}$
Mode 1 is recommended for electrical networks with low harmonic distortion (voltage THD $<5 \%$, current THD $<10 \%$ ); Mode 2 is recommended for all other cases.
(2) Energy roll value example: If roll value $=10 . \mathrm{E} 4$, the energy counter contains 4 digits, i.e., energy is displayed up to 9.999 MWh (Mvarh, MVAh) with resolution 0.001 MWh.

| Rollover <br> Value | Maximum Energy <br> kWh (kvarh, kVAh) | Maximum Display Reading <br> MWh (Mvarh, MVAh) | Display Resolution <br> MWh (Mvarh, MVAh) |
| :--- | :--- | :--- | :--- |
| 10.E4 | 9,999 | 9.999 | 0.001 |
| 10.E5 | 99,999 | 99.999 | 0.001 |
| 10.E6 | 999,999 | 999.99 | 0.01 |
| 10.E7 | $9,999,999$ | $9,999.9$ | 0.1 |
| 10.E8 | $99,999,999$ | 99,999 | 1 |

The roll value may be changed in accordance with the average load of the power line. For example, if average power is 400 kW and the counter must be reset every 3 months (2160 hours), then energy during this period equals 864000 kWh ( 6 digits) and the roll value $=10 . \mathrm{E} 6$.

### 4.10 Access Control Menu

SELECT $\rightarrow$ CHG $\rightarrow$ ENTER $\uparrow \rightarrow$ AccS $\rightarrow$ ENTER

This menu can be only accessed via the Setu in order to:

- change the user password
- enable or disable password check


## To view an option setting:

$\checkmark$ Press SELECT to activate the middle window.
$\checkmark$ Use the up/down arrow keys to scroll to the desired option (PASS or CtrL).
Password Setting Password Protection Control

| AccS |
| :---: |
| PASS |
| 8780 |


| AccS |
| :---: |
| CtrL |
| OFF |

## To change the password:

$\checkmark$ Press SELECT to activate the lower window.
$\checkmark$ Use the up/down arrow keys to modify the password. The password can be up to four digits long
$\checkmark$ Press ENTER to store your new password, or ESC to leave the password unchanged.

## To enable/d

SELECT to activate the middle window, and then use the up/down arrow keys to move to the CtrL entry.
$\checkmark$ Press SELECT to activate the lower window.
$\checkmark$ Use the up/down arrow keys to change the password checking status: select OFF to disable password protection, or select On to enable password protection.
$\checkmark$ Press SELECT to store your new option, or ESC to leave the option unchanged.
To quit the setu
From the middle window, press ESC or ENTER
Store your password in a safe place. If you do not provide the correct password, you will need to contact your local distributor for the super-user password to override password protection.

### 4.11 Reset/Synchronization Menu



This menu allows you to reset to zero the accumulators and Min/Max registers in your instrument, and also to synchronize the power demand interval. The menu can be only accessed via the Setup Change Menu (CHG). If the reset is disabled from the Basic Setup Menu (see Section 4.1), you will not be able to enter this menu.

The following designations are used in the menu to specify a data location to be affected:

| EnrG | Resets total accumulated energies |
| :--- | :--- |
| dnd | Resets all total maximum demands |
| P.d | $\quad$ I power maximum demands |
| A.dnd | Resets volt/ampere maximum demands |
| Cnt | Resets all event/time counters |
| Cnt. 1 | Resets counter \# 1 |
| Cnt. 2 | Resets counter \# 2 |
| Cnt. 3 | Resets counter \# 3 |
| Cnt. 4 | Resets counter \# 4 |
| Lo.Hi | Resets Min/Max registers (does not affect maximum demands) |
| d.Snc | Provides synchronization of the power demand interval (see NOTES below) |



## To reset the desired locations:

$\checkmark$ Press SELECT to activate the middle window, and then use the up/down arrow keys to scroll to the desired data location entry.
$\checkmark$ Press SELECT to activate the lower window.
$\checkmark$ Press and hold ENTER for about 5 seconds until the do label is replaced with done, and then release the key. You will return to the middle window.
$\checkmark$ Press ESC to quit the menu.

## NOTES:

1. If the CHG menu is not secured by a password, fast reset of the Min/Max registers, maximum demands and energies can be done from the data display mode (see Section 5.1) and counters from the Status Information Menu (see Section 6.1) without entering the reset menu.
2. If you select the $d$. Snc entr take into consideration the following:

- Synchronization of the instrument's internal timer requires that the power demand period be specified in minutes (see Section 4.1, Basic Setup Options). If more than 30 seconds pass from the beginning of the current demand interval, the new demand interval starts immediately; otherwise synchronization is delayed until the next demand interval.
- Synchronization occurs exactly 5 seconds from the time you first pressed ENTER while you hold the key.


## Chapter 5 Data Display

### 5.1 Navigating in the Display Mode

The front panel has a simple interface that allows you to display numerous measurement parameters in up to 45 display pages. For easier reading, the parameters are divided into three groups, each accessible by a designated key. These are:

- Common measurements
- no selection key
- Min/Max measurements
- selected by the MAX/MIN key
- Total Harmonic measurements
- selected by the H/ESC key
- Individual Harmonics measurements
- selected by the H/ESC key
- Energy measurements
- selected by the ENERGY key

The up/down arrow keys are used as follows in the Display Mode:
 Scrolls through the pages downward ( $f$ ) Scrolls through the pages upward (backward) Returns to the first page within current measurement group When pressed for 5 seconds, clears the alarm LED


The front panel display is updated approximately twice per second; you can adjust the display update rate via the Display Setu
Table 5-1 lists all displayed parameters and their LED indicators.

## Load Bar Graph

The load bar graph displays the amount, in percent, of the current load with respect to user-defined nominal load current. The highest current measured by the C191HM is divided by the nominal load current as defined in the Display Setup Menu (see Section 4.8) and expressed as a percent by the LEDs ( $40 \%$ to $110 \%$ ) which are lit. For example, if all LEDs up to and including $90 \%$ are lit, this means that the load is $90 \%$ of the nominal load current. If the nominal load current is set to 0 , it is taken from the CT primary current setup.

## Alarm LED

The blinking Alarm LED gives you an alarm indication. It is controlled by the alarm/event setpoints (see Section 4.6) and operates in latched mode. Even if alarm conditions are no longer present, the alarm LED will continue to blink. To clear the alarm LED, press the up/down arrow keys simultaneously for 5 seconds.

## Auto Scroll

If display Auto Scroll option is enabled (see Section 4.8), the common measurements display (main screen) will scroll automatically after 30 seconds of uninterrupted use
$\checkmark$ To stop auto scrolling at the current page, press either arrow key.

## Auto Return to the Main Screen

If display Auto Return option is enabled (see Section 4.8), the display will automatically return to the main screen from any other measurement screen after 30 seconds of uninterrupted use.

## Fast Reset of Accumulated Data

When changing data via the front panel is not secured by a password, you can reset the Min/Max registers, maximum demands and energies from the display mode without entering the reset menu.

## NOTES

1. The common measurements display does not have a designated indicator LED. If no indicator LED is lit up below the display, this means that the common measurement parameters are being displayed at this time. To return to the common measurements from another group, press the illuminated key until it goes out.
2. When you move to another measurement group, the instrument stores your last location; when you return to the previous group, the instrument restores the last page. At power up, the instrument always returns to the common measurements group and shows you the last page that was displayed prior to loss of power.

## Selecting a Display Page

$\checkmark$ Press the down/up arrow keys to scroll through display pages.

## Selecti

$\checkmark$ Press the key pointed to by the illuminated round LED below the front panel display. If no LED is lit up, this means that the front panel displays the
common measurements parameters.

## Selecting Min/Max Measurements

$\checkmark$ Press the MAX/MIN key. Use the up/down arrow keys to scroll through Min/Max measurements.

## Selecting Total Harmonic Measurements

$\checkmark$ Press the H/ESC key until the THD/TDD LED is illuminated. Use the up/down arrow keys to scroll through the different harmonic parameters.

## Selecti

## tage Harmonics Measurements

$\checkmark$ Press the H/ESC key until the HARMONICS LED is illuminated and volts LEDs at the right are lit. Use the up/down arrow keys to scroll through the diff

## Selecting Individual Current Harmonics Measurements

$\checkmark$ Press the H/ESC key until the HARMONICS LED is illuminated and amps LEDs at the right are lit. Use the up/down arrow keys to scroll through the different harmonics readings.

## Selecting Energy Measurements

$\checkmark$ Press the ENERGY key. Use the up/down arrow keys to scroll through the different energy readings.

## Fast Reset of Accumulated Data

$\checkmark$ Select a display page where the data you want to reset is displayed. To reset:

- Min/Max log registers: select a Min/Max page from the Min/Max measurements display (where a MAX or MIN round LED is illuminated).
- Ampere and volt maximum demands: select the ampere or volt maximum demand page from the Min/Max measurements display (where a MAX DMD LED is illuminated, and volts or amps LEDs at the right are lit).
- Power maximum demands: select the power maximum demand page from the Min/Max measurements display (where a MAX DMD LED is illuminated, and kVA/MVA and kW/MW LEDs at the right are lit).
- Total and phase energies: select the energy measurements display.
$\checkmark$ While holding the SELECT key, press and hold ENTER for about 5 seconds. The displayed data is reset to zero.


### 5.2 Data Display Formats

Table 5-1 specifies all front panel local displays available in the display mode The display windows are labeled in the table as follows: 1 = upper window, $2=$ middle window, 3 = lower window.
Table 5-1 Displayed Parameters

| Page | Window | Indicator LED | Parameter (1) | Digits | Unit (2) |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | Common Measu rements |  |  |
| 1 | 1 | V1/V1-2 | Voltage L12 Voltage L23 <br> L. Voltage L31 | 4 | V/kV |
| 1 | 2 | V2/V2-3 |  | 4 | V/kV |
| 1 | 3 | V3/V3-1 |  | 4 | V/kV |
| 2 | 1 | V1/V1-2 | Voltage L1 (7) <br> Voltage L2 (7) <br> P. Voltage L3 (7) | 4 | V/kV |
| 2 | 2 | V2/V2-3 |  | 4 | V/kV |
| 2 | 3 | V3/V3-1 |  | 4 | V/kV |
| 3 | 1 | A1 | Current L1 <br> Current L2 <br> Current L3 | 4 | A |
| 3 | 2 | A2 |  | 4 | A |
| 3 | 3 | A3 |  | 4 | A |
| 4 | 1 | kVA | Total $\mathbf{k}$ |  |  |
| 4 | 2 | PF | Total power factor | 4 |  |
| 4 | 3 | kW | Total kW | 4 | kW/MW |
| 5 | 1 | A NEUT | Neutral current Frequency Total kvar | 4 | A |
| 5 | 2 | Hz |  | 4 | Hz |
| 5 | 3 | kvar |  | 4 | kvar/Mvar |
| 6 | 1 |  | Ph.L1 (4) <br> Power factor L1 kW L1 |  | Label |
| 6 | 2 | PF |  | 4 |  |
| 6 | 3 | kW |  | 4 | kW/MW |
| 7 | 1 | kVA | kVA L1 <br> Ph.L1 (4) <br> kvar L1 | 4 | kVA/MVA |
| 7 | 2 |  |  |  | Label |
| 7 | 3 | kvar |  | 4 | kvar/Mvar |
| 8 | 1 |  | Ph.L2 (4) |  | Label |
| 8 | 2 | PF | Power factor L2 | 4 |  |
| 8 | 3 | kW | kW L2 | 4 | kW/MW |
| 9 | 1 | kVA | kVA L2 <br> Ph.L2 (4) <br> kvar L2 | 4 | kVA/MVA |
| 9 | 2 |  |  |  | Label |
| 9 | 3 | kvar |  | 4 | kvar/Mvar |
| 10 | 1 |  | Ph.L3 ${ }^{4}$ |  | Label |
| 10 | 2 | PF | Power factor L3kW L3 | 4 |  |
| 10 | 3 | kW |  | 4 | kW/MW |
| 11 | 1 | kVA | kVA L3 | 4 | kVA/MVA |
| 11 | 2 |  | Ph.L3 (4) |  | Label |
| 11 | 3 | kvar | kvar L3 | 4 | kvar/Mvar |
| 12 | 1 |  | H01 (Fundamental harmonic) |  | Label |
| 12 | 2 | PF | H01 total power factor | 4 |  |
| 12 | 3 | kW | H01 total kW | 4 | kW/MW |
| 13 | 1 |  | H1.L1 (4) |  | Label |
| 13 | 2 | PF | H01 power factor L1 | 4 |  |
| 13 | 3 | kW | H01 kW L1 | 4 | kW/MW |




| Page | Window | Indicator LED | Parameter (1) | Digits | Unit (2) |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{aligned} & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\begin{aligned} & 1 \\ & 2 \\ & 3 \end{aligned}$ | Mvarh | rE.En. <br> EP. <br> Mvarh export | 5 | Label <br> Label <br> Mvarh |
|  |  |  | Phase Energ es (5) |  |  |
| 6 | 1 | MWh | Ac.En. |  | Label |
| $\begin{aligned} & \hline 6 \\ & 6 \\ & \hline \end{aligned}$ | $\begin{aligned} & 2 \\ & 3 \\ & \hline \end{aligned}$ |  | IP.L1 <br> MWh import L1 | 5 | Label MWh |
| $\begin{aligned} & 7 \\ & 7 \\ & 7 \\ & \hline \end{aligned}$ | $\begin{aligned} & 1 \\ & 2 \\ & 3 \\ & \hline \end{aligned}$ | Mvarh | rE.En. <br> IP.L1 <br> Mvarh import L1 | 5 | Label <br> Label <br> Mvarh |
| $\begin{aligned} & 8 \\ & 8 \\ & 8 \end{aligned}$ | $\begin{aligned} & 1 \\ & 2 \\ & 3 \end{aligned}$ | MVAh | AP.En. L1 MVAh L1 | 5 | Label <br> Label <br> MVAh |
| $\begin{aligned} & 9 \\ & 9 \\ & 9 \\ & \hline \end{aligned}$ | $\begin{aligned} & 1 \\ & 2 \\ & 3 \\ & \hline \end{aligned}$ | MWh | Ac.En. <br> IP.L2 <br> MWh import L2 | 5 | Label Label MWh |
| $\begin{aligned} & 10 \\ & 10 \\ & 10 \\ & \hline \end{aligned}$ | $\begin{aligned} & 1 \\ & 2 \\ & 3 \\ & \hline \end{aligned}$ | Mvarh | rE.En. <br> IP.L2 <br> Mvarh import L2 | 5 | Label Label Mvarh |
| $\begin{aligned} & 11 \\ & 11 \\ & 11 \\ & \hline \end{aligned}$ | $\begin{aligned} & 1 \\ & 2 \\ & 3 \\ & \hline \end{aligned}$ | MVAh | AP.En. L2 MVAh L2 | 5 | Label Label MVAh |
| $\begin{aligned} & 12 \\ & 12 \\ & 12 \\ & \hline \end{aligned}$ | $\begin{aligned} & 1 \\ & 2 \\ & 3 \\ & \hline \end{aligned}$ | MWh | Ac.En. <br> IP.L3 <br> MWh import L3 | 5 | Label Label MWh |
| $\begin{aligned} & 13 \\ & 13 \\ & 13 \end{aligned}$ | $\begin{aligned} & 1 \\ & 2 \\ & 3 \end{aligned}$ | Mvarh | rE.En. <br> IP.L3 <br> Mvarh import L3 | 5 | Label <br> Label <br> Mvarh |
| $\begin{aligned} & 14 \\ & 14 \\ & 14 \end{aligned}$ | $\begin{aligned} & 1 \\ & 2 \\ & 3 \end{aligned}$ | MVAh | AP.En. L3 MVAh L3 | 5 | Label Label MVAh |

(1) Display readings for all electrical quantities except Min/Max log and energies are sliding average values.
(2) When using direct wiring ( PT Ratio $=1$ ), voltages are displayed in 0.1 V units, currents in 0.01 A units, and powers in $0.001 \mathrm{~kW} / \mathrm{kvar} / \mathrm{kVA}$ units. For wiring via PTs (PT Ratio > 1), voltages are displayed in 1 V units, currents in 0.01 A units, and powers in 0.001 MW/Mvar/MVA units. When the value width is over the window resolution, the right most digits are truncated
(3) By default, the maximum range for energy readings is $99,999,999 \mathrm{MWh} / \mathrm{Mvarh} / \mathrm{MVAh}$ Beyond this value, the reading will roll over to zero. When the energy reading exceeds the window resolution, the right-most digits are truncated. To avoid truncation, you can change the energy roll value to lower limit via the User Selectable Options menu (see Section 4.9). Negative (exported) energy readings are displayed without a sign.
(4) Per phase power and power factor readings are displayed only in 4LN3/4LL3 and 3LN3/3LL3 wiring modes (see Section 4.1) if the phase powers display is enabled in the Display Setup menu (see Section 4.8).
(5) Phase energy readings are displayed only in 4LN3/4LL3 and 3LN3/3LL3 wiring modes if they are enabled in the User Selectable Options menu (see Section 4.9).
(6) When the 4LN3 or 3LN3 wiring mode is selected, the voltages will be line-to-neutral; for any other wiring mode, they will be line-to-line voltages.
(7) Displayed only in the 4LN3 or 3LN3 wiring mode.

### 5.3 Self-Test Diagnostics Display

The C191HM periodically performs self-test diagnostics during operation. If the instrument fails the test, it discards the last measurement results, and an error code is displayed for one second on all LEDs. Error codes are listed in Table 5-2. Code ' 8 ' indicates normal operation.

Frequent $f$ lures may be the result of excessive electrical noise in the region of the instrument. If the instrument continuously resets itself, contact your local distributor.
Table 5-2 Self-Test Diagnostic Codes

| Code | Meaning |
| :---: | :--- |
| 1 | ROM error |
| 2 | RAM error |
| 3 | Watch dog timer reset |
| 4 | Sampling failure |
| 5 | Out of control trap |
| 7 | Timing failure |
| 8 | Normal power up |
| 9 | External reset (warm restart) |

## NOTE

The C191HM provides a self-check alarm register accessible through communications that indicates possible problems with instrument hardware or setup configuration. The hardware problems are indicated by the appropriate bits which are set whenever the instrument $f$ Is self-test diagnostics or in the event of loss of power. The setup configuration problems are indicated by the dedicated bit which is set when either configuration register is corrupted. In this event, your instrument will use the default configuration. For more information on the self-check alarm register, refer to the communications reference guides shipped with your instrument.

## Chapter 6 Viewing Status Information

Through the Status Information Menu (StA), it is possible to view the status of various instrument $f$ tures.

### 6.1 The Status Information Menu

SELECT $\rightarrow$ StA $\rightarrow$ ENTER

## To enter the Status Information Menu:

$\checkmark$ From the display mode, press SELECT to enter the Primary Selection Menu.
$\checkmark$ Press SELECT to activate the StA window.
$\checkmark$ Press ENTER.
To select a display page:
$\checkmark$ Press the up/down arrow keys to scroll through the display pages.
To quit the menu and return to the display mode:
$\checkmark$ Press ESC or ENTER .

## Front Panel Display

When you are in the Status Information Menu, the front panel display is updated approximately four times per second and shows you a wide variety of status information that you can review by scrolling through display pages.
The status parameters are designated by the abbreviated labels in the upper and/or middle window. The upper window flashes, indicating that you are in the menu display.

## Fast Reset of Counters

When changing data via the front panel is not secured by a password, you can reset the counters from the Status Informati lay without entering the reset menu:
$\checkmark$ Select a display page where the counter you want to reset is displayed.
$\checkmark$ While holding the SELECT key, press and hold ENTER for about 5 seconds. The displayed data is reset to zero.

### 6.2 Status Display Formats

Table 6-1 lists all the displays available from the Status Information Menu. The display windows are labeled in the table as follows: $1=$ upper window, $2=$ middle window, 3 = lower window.

Table 6-1 Status Information Display

| Page | Window | Parameter | Digits | Unit |  |
| :---: | :---: | :--- | :--- | :---: | :---: |
| 1 | 1 | PHAS |  | Label |  |
| 1 | 2 | rOt |  | Label |  |
| 1 | 3 | Phase rotation sequence (POS/NEG/ERR) | 4 |  |  |
| 2 | 1 | rEL |  | Label |  |
| 2 | 2 | Relay \#1 - \#4 status | 4 |  |  |
| 2 | 3 | Relay \#5 - \#8 status | 4 | Label |  |
| 3 | 1 | St.ln | 1 |  |  |
| 3 | 3 | Status input |  | Label |  |
| 4 | 1 | Cnt.1 | 5 |  |  |
| 4 | 3 | Counter \#1 | 5 | Label |  |
| 5 | 1 | Cnt.2 |  | Label |  |
| 5 | 3 | Counter \#2 | 5 |  |  |
| 6 | 1 | Cnt.3 |  | Label |  |
| 6 | 3 | Counter \#3 | 5 |  |  |
| 7 | 1 | Cnt.4 |  |  |  |
| 7 | 3 | Counter \#4 |  |  |  |

## Appendix: Technical Specifications

Input and Output Ratings

| $\left.\begin{array}{\|ll}\hline 3 \text { galvanically } \\ i \text { lated volt }\end{array}\right)$ | IRECT INPUT (690V line-to-line voltage and 400 V line-to-neutral) Burden: <0.5 VA <br> INPUT USING PT Burden: <0.15 VA |
| :---: | :---: |
|  | INPUT USING PT (120V line-to-line voltage) Burden: <0.1 VA |
| 3 galvanically 5 A: <br> i lated current (sta <br> inputs  | INPUT VIA CT with 5A secondary output Burden: <0.1 VA Overload withstand: 10A RMS continuous, 250A RMS for 1 second |
|  | INPUT VIA CT with 1A secondary output Burden: <0.02 VA Overload withstand: 2A RMS continuous, 50A RMS for 1 second |
| Voltage and current input terminals | UL recognized Screws: Brass, M4 Maximum wire section: $2.5 \mathrm{~mm}^{2}$ (12 AWG) |
| Optically i lated communication port | EIA RS-485 or RS-232 standard (factory set) Maximum wire section: $1.5 \mathrm{~mm}^{2}$ (14 AWG) |
| Relay outputs | 5 relays rated at $5 \mathrm{~A}, 250 \mathrm{~V} \mathrm{AC} \mathrm{/} \mathrm{5A} ,30 \mathrm{~V} \mathrm{DC} \mathrm{/}$ $0.5 \mathrm{~A}, 110 \mathrm{~V}$ DC $\quad 2$ contacts (SPST Form A) 1 relay rated at $5 \mathrm{~A}, 250 \mathrm{VAC} / 5 \mathrm{~A}, 30 \mathrm{VDC} /$ $0.5 \mathrm{~A}, 110 \mathrm{~V}$ DC 3 contacts (SPDT Form C) 2 relays rated at $3 \mathrm{~A}, 250 \mathrm{VAC} / 3 \mathrm{~A}, 30 \mathrm{VDC} /$ $0.5 \mathrm{~A}, 110 \mathrm{~V}$ DC 2 contacts (SPST Form A) Maximum wire section: $1.5 \mathrm{~mm}^{2}$ (16 AWG) |
| $\begin{array}{\|l} \hline \text { Analog output (optional) } \\ 4-20 \mathrm{~mA} \\ 0-20 \mathrm{~mA} \end{array}$ | Accuracy $0.5 \%$, Non-linearity $0.2 \%$ Load up to 510 Ohm <br> 24 V DC external power supply required |
| Status input | Dry contact for external synchronization or monitoring |


| Display | 3 windows high-brightness seven-segment digit LEDs <br> 3 color LED bar graph 40-110\% |
| :--- | :--- |

## Power Supply

Galvanically isolated power supply (factory set)
120\&230V AC / 120\&220 V DC
12 V DC
24 V DC
48 V DC

85-265V AC $50 / 60 \mathrm{~Hz}$ and 88-290V DC 10 W
9.6-19 V DC

19-37 V DC
37-72V DC

```
    Environmental Conditions
O -20 C to +60 % ( }-\mp@subsup{4}{}{\circ}\textrm{F}\mathrm{ to }+14\mp@subsup{0}{}{\circ}\textrm{F}
Storage temperature }\quad-2\mp@subsup{5}{}{\circ}\textrm{C}\mathrm{ to +80 % C (-13' }\textrm{F}\mathrm{ to +176
Humidity
    0 to 95% non-condensing
```

| Construction |  |
| ---: | :--- |
| Instrument body | Case enclosure: flame resistant ABS \& Polycarbonate Blend <br> Dimensions: $144 \times 144 \times 86 \mathrm{~mm}(5.67 \times 5.67 \times 3.39$ ") |
|  | Mounting: $136 \times 136 \mathrm{~mm}$ square cut-out (DIN 43700) |
| Instrument weight | $0.9 \mathrm{~kg}(2.04 \mathrm{lb})$. |

Standards Compliance
UL File \# E129258 Pending
CE:
EMC: 89/336/EEC as amended by 92/31/EEC and 93/68/EEC
LVD: 72/23/EEC as amended by 93/68/EEC and 93/465/EEC
Harmonized standards to which conformity is declared:
EN55011:1991; EN50082-1:1992; EN61010-1:1993; A2/1995
Installation Category II, Pollution Degree 2
EN50081-2:1994 EMC Generic Emission Standard - Industrial Environment
EN50082-2:1995 EMC Generic Immunity Standard - Industrial Environment
EN55022: 1994 Class A
EN61000-4-2: 1995 Electrostatic Discharge
EN61000-4-4: 1995 Electrical Fast Transient
EN61000-4-8: 1993 Power Frequency Magnetic Field
ENV50140: 1993 Radio Frequency Electromagnetic Field, Amplitude Modulated
ENV50204: 1995 (200Hz) Radio Frequency Electromagnetic Field, Pulse Modulated
ENV50141: 1993 Radio Frequency Common Mode, Amplitude Modulated
ANSI C37.90.1: 1989 Surge Withstand Capability
ANSI IEEE C62.41-1991 Surge Voltages in Low-Voltage AC Power Circuits
Measurement Specifications

| Parameter | Full scale | Accuracy, \% |  |  | Range | Display resolution (\%Rdg) (2)@ range |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | Rdg | FS | Conditions |  |  |
| Voltage | $120 \mathrm{~V} \times \mathrm{PT}$ For L-N reading <br> $@ 120 \mathrm{~V}$ or and for <br> $400 \mathrm{~V} \times \mathrm{PT}$ 3OP2 23 OP 3 <br> $@ 690 \mathrm{~V}$ wiring modes |  | 0.25 | $\begin{aligned} & \hline 10 \% \text { to } 120 \% \\ & \text { FS } \end{aligned}$ | 0 to 999,000 V | Direct wiring ( $\mathrm{PT}=1$ ): <br> $0.1 \mathrm{~V} @ 0.1 \mathrm{~V}$ to 999.9 V <br> Wiring via PTs (PT>1): |
|  | $208 \mathrm{~V} \times$ PT For L-L reading <br> $@ 120 \mathrm{~V}$ or except <br> $690 \mathrm{~V} \times$ PT $30 \mathrm{P} 2 / 3 \mathrm{OP} 3$ <br> $@ 690 \mathrm{~V}$ wiring modes |  |  |  |  | 0.001 kV @ 0.001 kV to 9.999 kV $\leq 0.1 \%$ @ 10.00 kV to 999.0 kV <br> Starting voltage 1.5\% FS |
| Line current | CT PRIMARY CURRENT |  | 0.25 | $\begin{aligned} & \text { 2\% to } 120 \% \\ & \text { FS } \end{aligned}$ | 0 to 9999 A | $0.01 \mathrm{~A} @ 0.01 \mathrm{~A}$ to 99.99 A $\leq 0.1 \%$ @ 100.0 A to 9999 A Starting current 0.5\% FS |
| Active power | $0.36 \times \mathrm{PT} \times \mathrm{CT}$ @ 120 V input $1.2 \times$ PT×CT @ 690 V input |  | 0.5 | $\|\mathrm{PF}\| \geq 0.5$ (1) | $\begin{aligned} & -2,000,000 \mathrm{to} \\ & +2,000,000 \mathrm{~kW} \end{aligned}$ | Direct wiring (PT=1): <br> 0.001 kW @ 0.001 kW to 9.999 kW <br> Wiring via PTs (PT>1): <br> 0.001 MW @ 0.001MW to 9.999 MW <br> $\leq 0.1 \%$ @ 10.00 MW to 2000 MW |
| Reactive power | $0.36 \times \mathrm{PT} \times \mathrm{CT} @ 120 \mathrm{~V}$ input $1.2 \times \mathrm{PT} \times \mathrm{CT}$ @ 690 V input |  | 0.5 | $\|\mathrm{PF}\| \leq 0.9$ (1) | $\begin{aligned} & -2,000,000 \text { to } \\ & \text { k+2,000,000 } \\ & \text { kvar } \end{aligned}$ | Direct wiring (PT=1): <br> 0.001 kvar @ 0.001kvar to 9.999 kvar <br> Wiring via PTs (PT>1): <br> 0.001 Mvar @ 0.001Mvar to 9.999 Mvar <br> $\leq 0.1 \%$ @ 10.00 Mvar to 2000Mvar |
| Apparent power | $0.36 \times \mathrm{PT} \times \mathrm{CT}$ @ 120 V input $1.2 \times$ PT $\times$ CT @ 690 V input |  | 0.5 | $\|\mathrm{PF}\| \geq 0.5$ (1) | $\begin{array}{\|l\|} \hline 0 \text { to } \\ 2,000,000 \mathrm{kVA} \end{array}$ | Direct wiring (PT=1): <br> 0.001 kVA @ 0.001 kVA to 9.999 kVA <br> Wiring via PTs (PT>1): <br> 0.001 MVA @ 0.001MVA to 9.999 MVA <br> $\leq 0.1 \%$ @ 10.00 MVA to 2000 MVA |
| Power factor | 1 |  | 1 | $\begin{aligned} & \mid \text { PF\| } \geq 0.5, \\ & \mathrm{I} \geq 10 \% \text { FSI } \\ & \hline \end{aligned}$ | $\begin{aligned} & -0.999 \text { to } \\ & +1.000 \end{aligned}$ | 0.001 |


| Parameter | Full scale | Accuracy, \% |  |  | Range | Display resolution (\%Rdg) (2) <br> @ range |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | Rdg | FS | Conditions |  |  |
| Frequency |  | 0.1 |  |  | $\begin{aligned} & 45.00 \text { to } 65.00 \\ & \mathrm{~Hz} \end{aligned}$ | 0.01 Hz |
| Neutral (unbalanced) current | CT PRIMARY CURRENT |  | 0.5 | $\begin{aligned} & 2 \% \text { to } 120 \% \\ & \text { FS } \end{aligned}$ | 0 to 9999 A | $\begin{aligned} & \hline 0.01 \mathrm{~A} @ 0.01 \mathrm{~A} \text { to } 99.99 \mathrm{~A} \\ & \leq 0.1 \% \text { @ } 100.0 \mathrm{~A} \text { to } 9999 \mathrm{~A} \\ & \text { Starting current } 0.5 \% \mathrm{FS} \\ & \hline \end{aligned}$ |
| Ampere demand | same as for current |  |  |  |  |  |
| KW demand (block \& sliding) |  | same as for kW |  |  |  |  |
| KVA demand (block \& sliding ) |  | same as for kVA |  |  |  |  |
| Total Harmonic Distortion THD U (I), \% $\mathrm{U}_{1}\left(\mathrm{I}_{1}\right)$ | 999.9 | 1.5 | 0.2 | $\begin{array}{\|l\|} \hline \geq 0.1 \% \text { FS, } \\ \mathrm{U}(\mathrm{I}) \geq 10 \% \\ \text { FSU (FSI) } \\ \hline \end{array}$ | 0 to 999.9 | 0.1 |
| Total Demand Distortion TDD (I), \% | 100 |  | 1.5 | $\begin{aligned} & \geq 1 \% \mathrm{FS}, \\ & \mathrm{I} \geq 10 \% \mathrm{FSI} \end{aligned}$ | 0 to 100 | 0.1 |
| Individual harmonic distortion, \% | 100 | $0.4+0.3 \times$ <br> harmonic order |  | (4) | 0 to 100 | 0.01 |
| Voltage harmonic angles | $360^{\circ}$ | $0.5^{\circ}+0.6^{\circ} \times$ <br> harmonic order |  | (4) | $-180^{\circ}$ to $180^{\circ}$ | N/A |
| Current harmonic angles | $360^{\circ}$ | $0.3^{0}+0.3^{\circ} \times$ <br> harmonic order |  | (4) | $-180^{\circ}$ to $180^{\circ}$ | N/A |
| Active energy Import \& Export |  | according to power accuracy (3) |  |  | 0 to 99,999 MWh | 1 kWh @ 1 to 99,999 kWh 10 kWh @ 100 to 999.99 MWh 100 kWh @ 1,000 to 9,999.9 MWh 1MWh @ 10,000 to 99,999 MWh |
| Reactive energy Import \& Export |  | according to power accuracy (3) |  |  | 0 to 99,999 Mvarh | 1 kvarh @ 1 to 99,999 kvarh 10 kvarh @ 100 to 999.99 Mvarh 100 kvarh @ 1,000 to 9,999.9 Mvarh 1Mvarh @ 10,000 to 99,999 Mvarh |


| Parameter | Full scale | Accuracy, \% |  |  | Range | Display resolution (\%Rdg) (2) <br> @ range |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | Rdg | FS | Conditions |  |  |
| Apparent energy |  | according to power accuracy (3) |  |  | 0 to 99,999 MVAh | 1 kVAh @ 1 to 99,999 kVAh <br> 10 kVAh @ 100 to 999.99 MVAh <br> 100 kVAh @ 1,000 to 9,999.9 MVAh <br> 1MVAh @ 10,000 to 99,999 MVAh |

$\begin{array}{lll}\text { PT }=\text { external potential transformer ratio } & \text { CT, CT Primary Current }=\text { primary current rating of external current transformer } \\ \text { FSU }=\text { voltage full scale } & \text { FSI }=\text { current full scale } & U_{1}=\text { voltage fundamental } \\ I_{1}=\text { current fundamental }\end{array}$
(1) @ $10 \%$ to $120 \%$ of voltage FS and $2 \%$ to $120 \%$ of current FS
(3) Where the current is $>10 \%$ FS, the energy accuracy is better than $1.5 \%$ Rdg.
(4) $80 \%$ to $120 \%$ of voltage FS and $10 \%$ to $100 \%$ of current FS
Additional Notes

1. Accuracy is expressed as $\pm$ (percentage of reading + percentage of full scale) $\pm 1$ digit. This does not include inaccuracies introduced by the user's potential and current transformers.
2. Specifications assume: voltage and current wave forms with THD $\leq 5 \%$ for kvar, kVA and PF ; reference operating temperature: $20-26^{\circ} \mathrm{C}$.
3. Ordinary measurement error is considerably less than the specified accuracy which indicates maximum error.

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# Broad culrentrange Compact ©limensions Maximum flexilbility 

## Series CA7 Contactors

## Controls Motors to 60HP (@460/575V)

> As Little as 45mm Wide

## Reduces Panel Space

Mechanically Linked Auxiliaries

Coil terminals are field-reversible! Mount a motor circuit controller on top or an overload relay on bottom

Auxiliary contacts may be mounted on front and/or sides of contactor

All CA7 contactors are designed, tested and can be selected for Type 1 and Type 2 Coordination

Auxiliary contacts are "mechanically linked" with CA7's main contacts a requirement in safety circuits

Compact dimensions mean less panel space and lower cost

Universal accessories fit all CA7 contactors - leaving you with less inventory and more flexibility!


Dual-terminal technology maximizes wiring options and termination reliability

9-85A range covers more than 90\% of all industrial applications

Protects against manual operation and accidental contact with live parts

Dimensionally compatible with KT7 motor circuit controller and CEP7 electronic overload relay

Label your contactor for easy identification

IEC design provides a more precise fit to your application - save money by buying only what you need

Compact dimensions with maximum performance! 0 ur CA7 contactors control motors up to 60 H P, in frame sizes ranging from $45 \mathrm{~mm}\left(1-3 / 4^{\prime \prime}\right)$ to a maximum of $72 \mathrm{~mm}\left(2-3 / 4^{\prime \prime}\right)$ wide.

Because of its modular design, CA7 is flexible and easy to use. All CA7 contactors use the same accessories, reducing the need to stock additional inventory. They are also mechanically and electrically compatible with Sprecher + Schuh's CEP7 electronic
overload relay and KT 7 motor circuit controller. This provides easy, clean install ation for a variety of motor starter applications.

W hether part of a system or for individual use, the CA7 is the right contactor for the job.

## O Series CA7 Contactors



## Save space, save money

The CA7 contactor series includes ten contactors within four frame sizes. The two smallest sizes house capacities up to 25 HP (@460V) and 30 HP (@575V). They measure only 45 mm (1-3/4") in width! Even the largest of the contactors - the CA7-85, controlling motors to 60 H P - measures only $72 \mathrm{~mm}(2-3 / 4$ ") wide. The space you save with CA7 translates to smaller panels and lower cost.


## Maximum flexibility

The CA7 contactor is designed for ultimate flexibility. C oil terminals can be supplied on the top or bottom, and are field-reversible to suit individual wiring needs. Auxiliary contacts can be mounted on the top and sides, for the most efficient use of panel space. In reversing applications where space may betight, the mechanical interlock has a built-in auxiliary to save room.

Field-reversible coil terminals provide additional flexibility


Dual terminal technology provides additional wiring options, as well as increased reliability and a faster wiring process.

Dual wiring terminals speed installation

## State-of-the-art tec hnology

CA7 contactors utilize the latest design technology. C ombined with Sprecher + Schuh's CEP7 solid state electronic overload relay, the CA7 becomes the most accurate and reliable motor starter available. M echanically linked contacts provide safety for all applications. In addition, snap-on electronic timers and a PLC interface are also available.


## Modular design

The CA7 contactor series includes universal accessories to fit every frame size. This provides incredible flexibility, and eliminates the need to purchase size-specific components.

Because of their modular design, CA7 contactors are easily joined to form complete starter combinations. The CA7 is specially designed for electrical and mechanical compatibility with our overload and motor circuit controllers.

CA7 Selected Technical Data

| Catalog <br> Number | $\begin{gathered} \text { AC-1 } \\ \text { Amp Rating } \\ 40^{\circ} \mathrm{C} \end{gathered}$ | Maximum Horsepower |  |  |  |  |  | Max. Aux. Contacts |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | Single Phase |  | Three Phase |  |  |  |  |
|  |  | 115V | 230 V | 200V | 230V | 460V | 575 V |  |
| CA7-9 | 32 | 1/3 | 1 | 2 | 2 | 5 | 7-1/2 | 9 |
| CA7-12 | 32 | 1/2 | 2 | 3 | 3 | 7-1/2 | 10 | 9 |
| CA7-16 | 32 | 1 | 3 | 5 | 5 | 10 | 15 | 9 |
| CA7-23 | 32 | 2 | 3 | 5 | 7-1/2 | 15 | 15 | 9 |
| CA7-30 | 50 | 2 | 5 | 7-1/2 | 10 | 20 | 25 | 9 |
| CA7-37 | 50 | 3 | 5 | 10 | 10 | 25 | 30 | 9 |
| CA7-43 | 85 | 3 | 7-1/2 | 10 | 15 | 30 | 30 | 8 |
| CA7-60 | 100 | 5 | 10 | 15 | 20 | 40 | 50 | 8 |
| CA7-72 | 100 | 5 | 15 | 20 | 25 | 50 | 60 | 8 |
| CA7-85 | 100 | 7-1/2 | 15 | 25 | 30 | 60 | 60 | 8 |

See Sprec her + Schuh's general catalog for complete information and pricing on CA7 contactors.

Sprecher + Schuh US Division Headquarters
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Attention: To prevent electrical shock, disconnect from power source before installing or servicing. Install in suitable enclosure. Keep free from contaminants.
Achtung: Vor Installations- oder Servicearbeiten Stromversorgung unterbrechen, um Unfälle zu vermeiden. Die Geräte müssen in einem passenden Gehäuse eingebaut und gegen Verschmutzung geschützt werden.
Attention: Avant le montage et la mise en service, couper l'alimentation secteur afin d'éviter tout accident. Prévoir une mise en coffret ou armoire appropriée. Protéger le produit contre les environnements agressifs.
Attenzione: Per prevenire infortuni, togliere tensione prima dell'installazione o manutenzione. Installare in custodia idonea. Tenere Iontano da contaminanti.
Atención: Desconectar la alimentación eléctrica antes de realizar el montaje y la puesta en servico, con el objeto de evitar accidentes. Instalado en una caja o armario apropiado. Proteger el producto de los ambientes agresivos.

## sprecher + schuh

CT7N-23...



IEC/EN 60947-1,-4-1,-5-1 UL 508
CSA 22.2 No. 14

CMR7N
CA7-9... 23

(

## sprecher+ schuh

## USA / CND

Suitable For Use On A Circuit Capable Of Delivering Not More Than 5000 rms Symmetrical Amperes, 600 Volts Maximum.


ATTENTION: Do not use automatic reset mode in applications where unexpected automatic restart of the motor can cause injury to persons or damage to equipment.


ACHTUNG: Der automatische Rücksetzmodus darf nicht in Anwendungen verwendet werden, in denen der unerwartete Neustart des Motors zu Personen- oder Sachschäden führen kann.

ATTENTION: N’utilisez pas le mode réarmement automatique dans les applications où un redémarrage automatique inattendu du moteur pourrait provoquer des blessures personnelles ou des dégâts matériels.

ATTENZIONE: non usare la modalità di ripristino automatico in applicazioni dove il riavviamento automatico improvviso del motore può provocare infortuni o danni all apparecchiatura.

ATENCION: No use el modo de reseteo automático en aplicaciones donde el rerranque repentino del motor pueda causar lesiones personales o daño al equipo.

[^22]
## 1 Introduction

The MultiTrode level control relay is a solid-state electronic module in a hi-impact plastic case with a DIN rail attachment on the back, making a snap-on-snap-off installation. Any number of relays can be easily added to the DIN metal rail then wired together to form a complex pumping system that other wise may have to be controlled and operated by a programmed PLC.
The relay is normally matched with the MultiTrode probe which works in conjunction with the relay and uses the conductivity of the liquid to complete an electrical circuit.

## 2 Electrical Overview



There are 10 screw terminals on the unit. Facing the relay as shown, we look at the bottom terminals (left to right):

- Lo - (Charge mode). This is the point when the probe is dry the relay will turn on.
- Lo - (Discharge mode). This is the point when the probe in the tank is dry the relay will turn off.
- Hi - (Charge mode). This is the point when the probe in the tank is wet a relay will turn off
- Hi - (Discharge mode). This is the point when the probe in the tank is wet a relay will turn on.
- C - is common earth. All earth bonding must be terminated here for correct operation.
- "L" is "live" (240V AC)
- " $N$ " is "neutral" (240V AC)

If the tank is plastic, or if you are conducting tests in a plastic bucket, or the vessel has no earth point inside, you must install an earth rod within the tank, vessel or bucket and make sure that it is bonded back to $C$ on the relay unit.

## 3 DIP Switches

### 3.1 DIP Switches

(See Wiring Diagram for full program functions.)

### 3.1.1 DIP 1 \& 2

DIP 1 and 2 control the Sensitivity, in other words the cleaner the liquid the higher the sensitivity setting must be. Concentrated acids, minerals are by their own chemical composition highly conductive, so a low level of sensitivity is required, purified water is almost an insulator against electrical current flow so a higher sensitivity inside the relay is required.

### 3.1.2 DIP 3, 4 \& 5

DIP switches 3, 4 and 5, control delay on activation. For example, in discharge mode with DIP switches 3,4 and 5 set to 10 seconds, when the Hi point becomes wet it will activate the motor and it will take 10 seconds of continual coverage of the probe sensor to make the relay close and start the pump. This is invaluable when the probe is in a turbulent part of a well where fluid is splashing around touching the sensors momentarily, and false activation cannot be tolerated.

### 3.1.3 DIP 6

DIP switch 6 controls the charge/discharge function. Set "ON" for charge, and "OFF" for discharge

### 3.2 Relay Contacts \& their Applications

### 3.2.1 Contacts 15, 16 \& 18

Contacts 15,16 , and 18 are used for electronic or visual notification of a change in state at the pump itself. Contacts 15,16 , and 18 are used for more advanced applications because they are a changeover relay, their state may be the same as contacts 25,28 or the opposite. Both sets of contactors are triggered simultaneously. An example is when in discharge mode, (see Figure 1).

You have a gravity flow coming in so the fluid reaches the lower sensor PB1, contacts 15 and 18 are open (15 being common to both contact 16 and 18) contacts 25 and 28 are also normally open but contacts 1516 in this current situation are closed, whether PB1 is wet or dry is of no concern all will stay the same. The level now rises to PB2 and both relays change state, contacts 25 and 28 close to turn on the pump, contacts 15 and 16 are open, with 15 and 18 closed.

In advanced applications this state change may be fed into a logic device to indicate the pump is running or the pump has stopped and perhaps light an LED or incandescent light source for visual confirmation that a change has occurred in the relay.

### 3.2.2 Contacts 25 \& 28

Contacts 25 and 28 are used to control pump states. Contacts 25 and 28 are mostly used for turning on motors via a starting relay or solenoid, so, these sets of contacts react to the rising or falling levels of the fluid inside the tank, they will operate to turn on a pump in discharge mode when the top sensor is wet and in charge mode turn on the pump when the bottom sensor is dry.

## 4 Practical Overview

### 4.1 Discharge Mode - DIP switch 6 set to "OFF"



Figure 1 - Discharge Mode
Figure 1 shows two probes, (PB1 connected to Lo and PB2 connected to Hi ). The pit is mostly underground and there is a gravity-fed inlet at the top left-hand side. The pit is empty with PB1 completely dry. Dipswitch 6 is set to "OFF."


The relay operation depends on the electrical conductivity of liquid in the pit, i.e. no liquid $=$ no current flow. The level starts to rise and covers PB1.

This is a discharge operation so we do not want the relay to close and start a pump until the well is full so as the water rises it reaches PB2, the relay closes and the pump starts. The level now drops below PB2 but the pump still continues to run, the level continues to drop below PB1 the relay opens the pump stops.

### 4.2 Charge Mode - DIP switch 6 set to "On"



Figure 2 - Charge Mode
Note: " $C$ " is connected to common bonded earth. The unit will not operate correctly if not earthed.
Let's look at the same relay but in a tank that is charging (DIP 6 is now on). See Figure 3, where liquid is being pumped into a tank, and discharging through a gravity feed, the tank is on steel stands " $x$ " metres above the ground.


With the tank full, PB1 and PB2 will be wet, the relay is off, and the pump has stopped. Water is slowly fed out from the bottom, and now as PB2 (HI) becomes dry nothing happens; the water now drops to below PB1 (Lo), and the pumps restarts to fill the tank.

The pump will continue to fill the tank until PB2 (HI), becomes wet again.

### 4.3 MTRA Relay with Alarm (Discharge Applications Only)



Figure 3-MTRA Operation

The MTRA relay works in the same way as the MTR relay except the MTRA has a separate alarm output, and does not have a charge mode. The planned application is to close a contact to illuminate a warning alarm light. . Various other applications have included introducing a third probe to latch another relay.

In Figure 2 we see three probes in a pit that is plastic, note the steel rod in the tank. (In a plastic vessel a steel rod must be used to create an earth return in the liquid so probes can function.) PB1, PB2, and PB3 are dry, and the relay power LED is on. When water enters the pit and wets PB1, nothing happens, water now reaches PB2 causing contacts 13 and 14 to close, the pump LED to light, and the water to drop.

If, for example, the pump has its inlet partially blocked, the level continues to rise and wets PB3. This closes a separate relay that can activate a red flashing light, an audible fog horn or send a 5 volt pulse into another device with the common cause to warn human beings that a spill is due to occur. If the pumps become unclogged and PB3 becomes dry the alarm opens again and breaks the circuit that stops the light from flashing or the foghorn from sounding.

## 5 Most Common Installation Problems

The relay requires a path between the probes to earth through the liquid. If you are testing in a plastic bucket, have installed the probe in a plastic tank or have no good earthing in the vessel you will need to install a separate earth and make sure all earth bonding comes back to the $C$ terminal. Most problems like these are traced back to a lack of or poor earthing, or open circuits in the probe wiring.

Now is the time to check the relay by using "the bridge testing line technique" remember you must simulate a fluid flow to correctly ascertain a good relay or a bad one. (All DIPswitch settings from 1 to 6 should be off.)

Cut two pieces of insulated flexible copper wire one black one red 250 mm long, strip both ends back 10 mm on both cables, and join one black end and one red end. Insert the joined ends into C on the relay box, observing all safe electrical practises. You should have one black wire and one red wire free.

Set your relay for discharge mode (DIP switch 6 is off) with no sensors connected to the unit, connect the red wire to Lo - nothing should happen (if it does return the relay for replacement or repair*). Now connect the black wire to the Hi terminal the relay activated LED should light instantly (if it does not, the relay should be returned for repair*).

## 6 Troubleshooting

| I have checked all the DIPswitches and settings but in discharge mode as soon as the bottom sensor gets wet the pump turns on then turns off almost straight away. | This is the most common problem encountered with relay set up and commissioning, the probe in the bottom of the tank is wired into the Hi terminal instead of the Lo terminal. |
| :---: | :---: |
| The installation went fine but now and again the pump will not turn on even though I am sure the probe is wet. | - Check the sensitivity level set on the relay, some times the level is set for foul water but due to changes in the flow the water becomes grey or clear, try changing the setting from $20 \mathrm{~K} \Omega$ to $80 \mathrm{~K} \Omega$ and monitor the results carefully. |
| All wiring is complete and all DIPswitches have been checked but the pump will not turn on at all. | - If you have completed the test schedule for the relay and it passed then check the wiring to the sensors - for this is now where the problem lies or in the earthing arrangements. If possible check the resistance between the sensor cable and the steel sensor on the probe to prove a solid connection. |

* Please contact your distributor or agent before returning any product for repair or warranty claim.

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# SAFESMART FailSafe Level Alarm Relay SAFE-FS 

## Installation \& Operation Manual



SAFE-FS Relay Manual

This Manual is the support documentation for the installation, commissioning and operation of the SAFE-FS Level Alarm Relay.

Document Revision 1.0
Last updated 10-Feb-2009

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## Warnings \& Cautions

### 1.1 Information to User

Read through this manual to obtain a good working knowledge in order to get maximum performance from the product for your application. After reading, place the manual in a safe place for future reference.

### 1.2 Documentation Standards

## DANGER:

This symbol is used where non-compliance could result in injury or death.

## WARNING:

This symbol is used where non-compliance could result in incorrect operation, damage to or failure of the equipment.

## NOTE:

This symbol is used to highlight an issue or special case within the body of the manual.

### 1.3 Installation Notes

WARNING:
The SAFE-FS installation and wiring must be performed by qualified personnel.

## DANGER:

The SAFE-FS has no user serviceable parts to reduce the risk of electric shock leave all servicing to qualified Multitrode technical staff.

## 2 Introduction

The Safe-FS is the next generation of ultra-reliable high level alarming for lift stations and pump stations. It is part of the new SafeSmart family from MultiTrode. It adds failsafe probe functionality, for example, for the situation where rats have been eating through cables. The -FS verifies that the high level alarm is always functioning.

- Adds failsafe test to the ultra-reliable probe
- Relay output for loss of probe - N/O or N/C
- Relay output for high level alarm - N/O or N/C
- LED indication for power, level alarm, loss of probe alarm

Over 100,000 pump stations around the world use MultiTrode probes for primary or backup control (or both). Utilities have moved away from ball floats because they are prone to tangle up and need frequent cleaning to avoid false readings from fats, oils and grease.

The MultiTrode single sensor probe eliminates the problems of ball floats, and the new fail-safe single-sensor probe adds an extra electrical connection to the sensor. The level alarm relay checks for continuity - so if a wire has become disconnected, or if rats have eaten the cable - an output is activated. This provides continuous verification to the utility that the probe is in operation.

The MTRA-FS Level Alarm Relay is designed to be easy to install and configure and operates from a 11 - 30 VDC power supply. All connections are clearly labelled on the side of the device and options are configured using a set of DIP switches on the front of the relay. During operation, the LED's on the front panel indicate the current status including Probe Fault and Level Alarm.

## 3 Specifications

| Dimensions |  |
| :--- | :--- |
| Width | $22.5 \mathrm{~mm} \mathrm{(7/8")}$ |
| Height | $101 \mathrm{~mm} \mathrm{(4")}$ |
| Length (depth) | $\left.120 \mathrm{~mm} \mathrm{(43/4}^{\prime \prime}\right)$ |
| Environmental |  |
| Ambient <br> Temperature | -10 to $60^{\circ} \mathrm{C}$ |
| Humidity | $5 \%$ to $90 \%$ non-condensing |
| DC Power Supply |  |
| Voltage Range | $11-30 \mathrm{~V}$ DC |
| Current | 0.15 A max |
| Relay Outputs |  |
| Type | Form A |
| Current (Resistive) | 5 A |
| Current (Inductive) | 2 A |
| Voltage Rating DC | 30 V DC |
| Voltage Rating AC | 250 V AC |

Table 1-SAFE-FS Specifications

## 4 Installation

The SafeSmart SAFE-FS is designed to be mounted onto a standard DIN rail. All power supply, input and output connections are located on the top of the relay housing.

The features of the relay are listed below and are described in the following sections.

- Power Supply
- Level Alarms
- Failsafe Probe Alarm
- Probe Sensitivity
- LED Function
- DIP Switch Settings


## 5 Power Supply

The SAFE-FS is requires a $11-30 \mathrm{~V}$ DC power supply.
A switch or circuit-breaker and an over current protection device must be included in the installation. The protection device must be in close proximity to the equipment, within easy reach of the operator, and be marked as the protection device for the equipment. The input wiring and the switch/circuit-breaker/over current device must be rated to at least the nominal input voltage being used. The recommended current rating is listed in Table 2 below.

| Unit <br> Supply <br> Range | Recommended <br> Switch/Circuit-Breaker/Over <br> current Protection Device <br> Rating | Minimum Supply <br> Wiring Rating |
| :--- | :---: | :---: |
| $11-30 \mathrm{~V}$ DC | 0.15 A | 0.15 A |

Table 2 - Current Ratings

If the DC supply voltage drops below a threshold, the Power LED flashes and the Failsafe Probe Alarm output is activated. (If the power supply connected is below 24 VDC , the voltage alarm threshold is automatically set to 11.5 V . If the supply is 24 VDC or above, the voltage alarm threshold is automatically set to 23 V ).


NOTE: The MultiTrode probe uses an earth/ground return path for the signal. Ensure that the GND (DC-) terminal on the SAFE-FS relay is also grounded.

6 Level Alarms
The SAFE-FS has the following alarm inputs:
A conductive level sensor is connected to the AL Probe input to detect when the liquid level has risen above or fallen below a predetermined level.

- In High Level Alarm mode, the alarm activates when the AL Probe input detects liquid (after the activation delay has expired).
- In Low Level Alarm mode, the alarm activates when the AL Probe input no longer detects liquid (i.e. the level has dropped below the sensor) and the activation delay has expired.
- High Level Alarm - DIP Switch 1 = OFF
- Low Level Alarm - DIP Switch 1 = ON

When a level alarm is detected, the Level Alarm contacts are activated and the Level Alarm LED flashes. The alarm contacts can be used to operate a warning light or connected to a PLC / RTU or dialler for remote monitoring.
The Level Alarm output can be configured as Normally Open (N/O) or Normally Closed (N/C) via DIP Switch 4:

- N/C Level Alarm - DIP Switch 4 = OFF
- N/O Level Alarm - DIP Switch $4=O N$


### 6.1 Level Alarm Activation Delays

The activation delay can be extended from 0.5 to 10s. A 10s activation delay ignores the alarm condition (high or low level) if the sensor is triggered for less than 10s. It is configured via DIP Switch 2.

There are 2 delay periods:

- 0.5 sec - DIP Switch 2 = OFF
- 10 sec - DIP Switch 2 = ON


### 6.2 Level Alarm Deactivation Delays

The deactivation delay can be extended from 0.5 to 10 s. A 10 s deactivation maintains the alarm for 10 s after the alarm condition has passed. It is configured via DIP Switch 3.

There are 2 delay periods:

- 0.5 sec - DIP Switch 3 = OFF
- 10 sec - DIP Switch 3 = ON


## 7 Failsafe Probe Alarm

MultiTrode's Failsafe probe includes an extra connection to the top sensor which is used for failsafe detection. The SafeSmart relay utilises this connection to test the integrity of the connection to the sensor. If the cable to the sensor is broken, the relay detects this (after a short delay), the Probe LED starts flashing and the Probe Alarm contacts are activated. (The Failsafe Probe Alarm output can be configured as normally open or normally closed via DIP switch 5).

- N/C Failsafe Probe Alarm - DIP Switch 5 = OFF
- N/O Failsafe Probe Alarm - DIP Switch 5 = ON

SAFE-FS Relay Manual

If a standard or non-failsafe probe is used, a jumper must be connected between the AL Probe and Failsafe inputs to prevent probe fault alarms.


Figure 1 - Non-failsafe Probe Connection Diagram

$\triangle$

## NOTE:

The failsafe probe input must be connected to the highest probe in the system.

## 8 Probe Sensitivity

The relay is used in conjunction with a conductive level sensing device such as the MultiTrode probe. Conductive probes rely on conductivity through the liquid to earth in order to detect level. Highly conductive liquids such as saltwater, generally require the relay to be set to a lower sensitivity than for low conductivity liquids such as distilled water. For most applications, the default probe setting of 20 k ohms is satisfactory but the relay allows for the operator to adjust its sensitivity as needed for specific conditions. The sensitivity is set using Dip Switches 7 and 8, (see Table 3 below).

| Dip Sw 7 | Dip Sw <br> $\mathbf{8}$ | Sensitivity | Typical Application |
| :---: | :---: | :---: | :--- |
| OFF | OFF | 1 k ohm | Concentrates Acids, Minerals, Alkalis |
| ON | OFF | $4 k$ ohm | Acids, Alkalis, Diluted Brine, Sea <br> Water |
| OFF | ON | $20 k$ ohm | Sullage, Sewage Effluent, Town Water |
| ON | ON | 80k ohm | Industrial Effluent, Purified Water* |

Table 3 - Probe Sensitivity

- Not recommended for use with purified de-ionised water.


## 9 LED Function

Three LEDs on the front of the relay indicate the power and status of the level and probe alarms.

| LED | Status | Indication |
| :--- | :--- | :---: |
| Power | Power On | Steady |
|  | Low Voltage | Flashing |
| Level | Level Alarm Active | Flashing |
| Probe | Failsafe Alarm Active | Flashing |

Table 4 - LED Function
,

10 DIP Switch Settings
The SAFE-FS is configured using the DIP switches located on the front of the relay enclosure.

| DIP \# | Setting | Mode Description | Section |
| :---: | :---: | :--- | :---: |
| 1 | OFF | High Level Alarm | 6 |
|  | ON | Low Level Alarm | 6 |
| 2 | OFF | 0.5 sec Level Alarm Activation <br> Delay | 6.1 |
|  | ON | 10 sec Level Alarm Activation <br> Delay | 6.1 |
| 3 | OFF | 0.5 sec Level Alarm <br> Deactivation Delay | 6.1 |
|  | ON | 10 sec Level Alarm Deactivation <br> Delay | 6.1 |
| 4 | OFF | N/C Level Alarm | 6 |
|  | ON | N/O Level Alarm | 6 |
| 5 | OFF | N/C Failsafe Probe Alarm | 7 |
|  | ON | N/O Failsafe Probe Alarm | 7 |
| 6 | OFF | Not Used | - |
|  | ON | Not Used | - |
| 7 | 8 | Probe Sensitivity | 8 |
| OFF | OFF | 1k ohm |  |
| ON | OFF | $4 k$ ohm |  |
| OFF | ON | $20 k$ ohm |  |
| ON | ON | 80k ohm |  |

Table 5 - DIP Settings

## 11 Example Applications

### 11.1 Example 1 - High Level Alarm with Single Sensor Probe

A high level alarm is configured for a discharge/empty application. A Failsafe single sensor probe is used, (bridge terminal 2 to 1 if a standard probe is used). The Level Alarm contacts activate when the liquid level reaches the sensor.


Figure 2 - High Level Alarm with Single Sensor Probe

### 11.2 Example 2 - High Level Alarm with $10 \times$ Sensor Probe

A high level alarm is configured for a discharge/empty application. A Failsafe ten (10) sensor probe is used. The Level Alarm contacts activate when the liquid level reaches the highest sensor. The probe sensors can not be connected in parallel to two devices, so the highest sensor only goes to the FS relay.


Figure 3 - High Level Alarm with 10 Sensor Probe

### 11.3 Example 3 - Low Level Alarm

A low level alarm is configured for a charge/fill application. The Level Alarm contacts activate when the liquid level falls just below the sensor.
A standard probe is used as there is little advantage in using a Failsafe probe as a low level sensor. While a Failsafe probe could be used to detect a connection failure to the sensor, in a charge/fill application the failure of the sensor would generate a low level alarm regardless due the nature of the probe. (Open circuit connection is equivalent to sensor uncovered).


Figure 4 - Low Level Alarm

## SAFE-FS Relay Manual



### 11.4 Example 4 - Wiring Diagram - High Level Alarm

The following wiring diagram illustrates the SAFE-FS configured for a high level alarm, with connections to a PLC / RTU or dialler (to receive alarms via SMS).


Figure 5 - Wiring Diagram for a High Level Alarm

Appendix A. Relay SAFE-FS Label


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Visit www.multitrode.com for the latest information

## sprecher+ schuh

## Electronic Timer

Elektronisches Zeitrelais
Minuterie électronique Temporizzatore elettronico
Temporizador electronico

## Attention:

To prevent electrical shock, disconnect from power source before installing or servicing. Do not open the apparatus.

Achtung:
Um Unfälle zu vermeiden, Installations- oder Servicearbeiten nur im spannungsfreien Zustand Gehäuse niemals öffnen.

## Attention:

Avant le montage et la mise en service, couper I'alimentation secteur afin d'éviter tout accident. Ne pas ouvrir l'appareil.

Attenzione:
Per prevenire infortuni, togliere tensione prima dell'installazione o manutenzione. Non aprire l'apparecchio.

## RZ7-FS



A

## Atención:

Desconectar la alimentación eléctrica antes de realizar el montaje y la puesta en servicio, con el objeto de evitar accidentes. No abrir el aparato.

Instructions - Anleitungen - Instructions - Istruzioni - Instrucciones


| Pre-settings <br> Voreinstellungen <br> Ajustements <br> Regolazioni <br> Regulación |
| :--- |

## (A)



Technische Änderungen vorbehalten 26.511.799-99 / 03. 2002

Edition 1

Solid-State Digital Timer

## 1/16 DIN, Digital-Set Timer with

### 0.1 Second to 9,990 Hours Range

- 8 field-selectable operation modes
- Universal AC/DC supply voltage timers available
- Operations include ON-delay, Repeat cycle, Signal Interval/OFF-delay, Signal-OFF delay (I and II), Interval, Cycle and Signal ON-delay/OFF-delay
- Selectable no-voltage start, reset, gate and check inputs expand capabilities

- Time remaining LCD bar graph and LCD output status indicator
- Panel mounting adapters, sockets, and accessories may be ordered separately


## Ordering Information

## ■ TIMERS

Add the supply voltage to the part number when you order ON-delay only timers H3CA-8 and H3CA-8H. For example, H3CA-8H-AC/100/110/120.

| Timing function |  | 8 field-selectable functions |  | ON-delay only |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Contact type | Time limit | SPDT | SPDT | SPDT | DPDT |
|  | Instantaneous | - | - | SPDT | - |
| Terminal form |  | 11-pin round socket | Front mounted screw terminals | 8-pin round |  |
| Part number |  | H3CA-A | H3CA-FA | H3CA-8H | H3CA-8 |
| Supply voltages | AC | $\begin{aligned} & 24 \text { to } 240 \mathrm{~V}, 50 / 60 \mathrm{~Hz} \text { or } \\ & 12 \text { to } 240 \mathrm{~V} \end{aligned}$ |  | Specify 24 | or 200/220/240 V; 50/60 Hz |
|  | DC |  |  | Specify 12 |  |

## - ACCESSORIES

| Description |  |  | Part number |
| :---: | :---: | :---: | :---: |
| Sockets | 11-pin | Bottom surface or track mounting, top screw terminals | P2CF-11 |
|  |  | Bottom surface or track mounting, top screw terminals, finger safe terminal conforms to VDE0106/P100 | P2CF-11-E |
|  |  | Back mounting, for use with Y92F-30 mounting adapter, bottom screw terminals | P3GA-11 |
|  | 8-pin | Bottom surface or track mounting, top screw terminals | P2CF-08 |
|  |  | Bottom surface or track mounting, top screw terminals, finger safe terminal conforms to VDE0106/P100 | P2CF-08-E |
|  |  | Back mounting, for use with Y92F-30 mounting adapter, bottom screw terminals | P3G-08 |
|  |  | Terminal cover for P3G sockets, conforms to VDE0106P100 | Y92A-48G |
| Panel mounting adapter |  | Fits behind panel, ideal for side by side installation. Use P3Gロ-a sockets. | Y92F-30 |
|  |  | Flush mounting adapter ( $88 \mathrm{~mm} \times 58 \mathrm{~mm} \times 63.7 \mathrm{~mm}$ ) | Y92F-70 |
|  |  | Flush mounting adapter ( $58 \mathrm{~mm} \times 50 \mathrm{~mm} \times 63.7 \mathrm{~mm}$ ) | Y92F-71 |

Accessories table continued on the next page.

## ACCESSORIES, continued

| Description |  | Part number |
| :---: | :---: | :---: |
| Protective cover | Hard plastic cover protects against dust, dirt and water; not for use with panel covers | Y92A-48B |
|  | Soft plastic cover protects against dust, dirt and water; not for use with panel covers | Y92A-48D |
| NEMA 4 cover | Waterproof front cover | Y92A-48N |
| Colored panel covers | Light gray (Munsell No. 5Y7/1) to match case | Y92P-48GL |
|  | Medium gray (Munsell No. 5Y5/1) | Y92P-48GM |
|  | Black (Munsell No. N1.5) | Y92P-48GB |
| Mounting track | DIN rail, $50 \mathrm{~cm}(1.64 \mathrm{ft})$ length; 7.3 mm thick | PFP-50N |
|  | DIN rail, $1 \mathrm{~m}(3.28 \mathrm{ft})$ length; 7.3 mm thick | PFP-100N |
|  | DIN rail, $1 \mathrm{~m}(3.28 \mathrm{ft})$ length; 16 mm thick | PFP-100N2 |
| End plate |  | PFP-M |
| Spacer |  | PFP-S |

## r RANGE AND OPERATION MODE SELECTION



| Time unit | Timing range |
| :---: | :--- |
| 0.1 s <br> s | 0.1 to 99.9 seconds <br> 1 to 999 seconds |
| 0.1 m | 0.1 to 99.9 minutes |
| m | 1 to 999 minutes |
| 0.1 h <br> h <br> 10 h | 0.1 to 99.9 hours |


| Mode | Operation |
| :--- | :--- |
| A | ON-delay |
| B | Repeat cycle |
| C | Signal Interval/OFF-delay |
| D | Signal OFF-delay I |
| E | Interval |
| F | Cycle |
| G | Signal ON-delay/OFF-delay |
| H | Signal OFF-delay II |

Note:
*Operation mode selector not included with ON-delay only models.

## Specifications

| Part number |  |  | H3CA-A | H3CA-FA | H3CA-8H | H3CA-8 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Supply voltage |  | AC | 24 to $240 \mathrm{~V}, 50 / 60 \mathrm{~Hz}$ |  | $24 \mathrm{~V}, 100 / 110 / 120 \mathrm{~V}, 200 / 220 / 240 \mathrm{~V}$; 50/60 Hz |  |
|  |  | DC | 12 to 240 V |  | $12 \mathrm{~V}, 24 \mathrm{~V}, 48 \mathrm{~V}, 110 \mathrm{~V}$, (permissible ripple factor: $20 \%$ max. using single-phase, fullwave rectified power sources) |  |
| Operating voltage |  |  | 90 to 110\% of rated voltage |  |  |  |
| Power consumption |  | AC | 4 VA |  | 10 VA |  |
|  |  | DC | 2 W |  | 2W |  |
| $\begin{array}{\|l\|} \hline \begin{array}{l} \text { Timing } \\ \text { functions } \end{array} \end{array}$ |  |  | 8 field-selectable modes: ON-delay, Repeat cycle, Signal Interval/OFF-delay, Signal ON-/ OFF-delay, Signal OFF-delay (I and II), Interval and Cycle |  | ON-delay only |  |
| Start, reset, gate inputs |  |  | No voltage | No voltage | - | - |
| Control output | Type | Time limit | SPDT |  | SPDT | DPDT |
|  |  | Instantaneous | - |  | SPDT | - |
|  | Max. load |  | $3 \mathrm{~A}, 250$ VAC (p.f. $=1$ ) |  |  |  |
|  | Min. load |  | $10 \mathrm{~mA}, 5 \mathrm{VDC}$ |  |  |  |
| Repeat accuracy |  |  | $\pm 0.3 \%, \pm 0.05 \mathrm{sec}$ (includes variation due to voltage and temperature changes) |  |  |  |
| Setting error |  |  | $\pm 0.5 \%, \pm 0.05 \mathrm{sec}$ |  |  |  |
| Resetting system |  |  | Power-OFF, external and self-reset |  | Power-OFF |  |
| Resetting time |  |  | 0.5 sec max. |  | 0.1 sec max. |  |
| Indicators |  |  | Time Remaining (LCD bar graph), Output Status (LCD message) |  |  |  |
| Materials |  |  | Plastic case |  |  |  |
| Mounting |  |  | Panel, track, surface |  |  |  |
| Connections |  |  | 11-pin roun | Terminal screws | 8-pin round socket |  |

$S$ tion table conti the next page.

## SPECIFICATIONS, continued

| Part number |  |  | H3CA-A | H3CA-FA | H3CA-8H | H3CA-8 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Weight |  |  | $110 \mathrm{~g} \mathrm{(3.9} \mathrm{oz)}$ | 190 g (6.7 oz) | $110 \mathrm{~g} \mathrm{(3.9} \mathrm{oz)}$ |  |
| Approvals |  |  | UL/CSA/SEV |  |  |  |
| Operating ambient temperature |  |  | $-10^{\circ}$ to $55^{\circ} \mathrm{C}\left(14^{\circ}\right.$ to $\left.131^{\circ} \mathrm{F}\right)$ |  |  |  |
| Humidity |  |  | 35 to 85\% RH |  |  |  |
| Vibration | Mechanical durability |  | 10 to $55 \mathrm{~Hz} ; 0.75 \mathrm{~mm}$ (0.03 in) double amplitude |  |  |  |
|  | Malfunction durability |  | 10 to 55 Hz ; 0.5 mm ( 0.02 in ) double amplitude |  |  |  |
| Shock | Mechanical durability |  | 20 G |  |  |  |
|  |  | on durability | 10 G |  |  |  |
| Variation due to voltage change |  |  | See "Repeat Accuracy" |  |  |  |
| Variation due to temperature change |  |  | See "Repeat Accuracy" |  |  |  |
| Insulation resistance |  |  | $100 \mathrm{M} \Omega \mathrm{min}$. at 500 VDC |  |  |  |
| Dielectric strength |  |  | 2,000 VAC, $50 / 60 \mathrm{~Hz}$ for 1 minute between current-carrying and non-current-carrying parts and between contact and control circuit $1,000 \mathrm{VAC}, 50 / 60 \mathrm{~Hz}$ for 1 minute between non-continuous contacts |  |  |  |
| Service life |  | Mechanical | 10 million operations minimum (under no load, at 1,800 operations/hour) |  |  |  |
|  |  | Electrical | 100,000 operations minimum at maximum ratings |  |  |  |

## Engineering Data

## ■ ELECTRICAL SERVICE LIFE



## Timing Charts

In the schematic diagrams, each thick line indicates the external wiring necessary for the selected operation.

## ■ H3CA-A, H3CA-FA

## Mode A ON-Delay

## Power-ON Start/Power-OFF Reset

The start terminals are connected. Timing starts when power is applied. The output is energized when the accumulated time equals the set time. The output remains energized until power is disconnected or a reset input is applied.


## Signal Start

Power is applied continuously. Timing starts at the leading edge of the start input. The output is energized when the accumulated time equals the set time. Subsequent start signals during or after timing will not be accepted. The output relay will remain energized until a reset input is applied or power is interrupted.


## Mode B Repeat Cycle

## Signal Start

Power is continuously applied. The OFF/ON cycle is initiated at the leading edge of the start input. The output relay will be OFF for the set time and then ON for the set time. This cycle will be repeated until a reset input is applied or power is disconnected.


In the schematic diagrams, each thick line indicates the external wiring necessary for the selected operation.

## Power-ON Start/Power-OFF Reset

The start terminals are connected. Timing starts when power is applied. The output relay will be OFF for the set time and then ON for the set time. This cycle will be repeated until a reset input is applied or power is disconnected.



## Mode C Signal ON/OFF-Delay

Power is continuously applied. Timing begins on both the leading and trailing edges of the start input. The output relay is energized during timing. Once the timer has timed out from the trailing edge, it resets and is ready for subsequent start inputs.



## Mode D Signal OFF-Delay (I)

Power is continuously applied. The output relay is energized at the leading edge of the start input. Timing starts at the trailing edge of the start input. The output relay is de-energized when the accumulated time equals the set time.


In the schematic diagrams, each thick line indicates the external wiring necessary for the selected operation.

## Mode E Interval

## Signal Start

Power is applied continuously. Timing starts at the leading edge of the start input. The output relay is only energized during timing. The timer is reset when power is disconnected or a reset input is applied.



## Power-ON Start/Power-OFF reset

The start terminals are connected. Timing starts when power is applied. The output relay is only energized during timing. The timer is reset when power is disconnected or a reset input is applied.


## Mode F Cycle One-Shot

## Power-ON Short/Power-OFF Reset

The start terminals are connected. Timing starts when power is applied. The output relay will be OFF for the set time and then ON for the set time. The timer is reset when power is disconnected or a reset input is applied.


In the schematic diagrams, each thick line indicates the external wiring necessary for the selected operation.

## Signal Start

Power is applied continuously. The OFF/ON cycle is initiated at the leading edge of the start input. The output relay will be OFF for the set time and then ON for the set time. The timer is reset when power is disconnected or a reset input is applied.



## Mode G Signal ON-delay/OFF-delay

Power is continuously applied. Timing begins on both the leading and trailing edges of the start input. The output relay is energized when the accumulated time from the leading edge equals the set time. It is also energized for the set amount of time from the trailing edge of the start input.



## Mode H Signal OFF-Delay (II)

Power is continuously applied. Timing starts at the trailing edge of the start input. The output relay is energized during timing.



In the schematic diagrams, each thick line indicates the external wiring necessary for the selected operation.


## Dimensions

Unit: mm (inch)

## ■ TIMERS

## H3CA-A




## Panel cutout



Note: Recommended panel thickness is 1 to 3.2 mm .

Panel cutout conforms to DIN 43700.

H3CA-FA


Note: When mounting two or more timers next to one another, allow $10 \mathrm{~mm}(0.39 \mathrm{in})$ between timers (dimension L).

H3CA-8, H3CA-8H



Note: Recommended panel thickness is 1 to 3.2 mm .

Panel cutout conforms to DIN 43700.

## - ACCESSORIES

## P2CF-08-E Finger Safe Terminal Type

Conforming to VDE0106/P100


P2CF-11-E Finger Safe Terminal Type
Conforming to VDE0106/P100


Y92A-48G Finger Safe Terminal for P3G(A)
Conforming to VDE0106/P100


## Y92F-30 Panel Mounting Adapter

Adapter installs behind the panel. It is ideal for side by side installation. Use P3GA-11 or P3G-08 sockets.


## Y92F-70 Panel Mounting Adapter

Charcoal gray panel adapter installs through panel front. Timer fits bezel, rear of timer clips to adapter.


## Y92F-71 Panel Mounting Adapter

Charcoal gray panel adapter installs through panel front. Timer face fits bezel, rear of timer clips to adapter. Use P3GA-11 or P3G-08.



Y92A-48B Hard Plastic Cover


Y92A-48D Soft Plastic Cover


Hard plastic cover Y92A-48B and soft plastic cover Y92A-48D snap onto the front of the timer to protect against dust and water. The Y92A-48B hard plastic cover prevents accidental resetting. Y92A-48D soft plastic cover fits snugly over the front and allows settings to be changed. These covers are intended for use in areas where unusual service conditions do not exist.

PFP-100N/PFP-50N Mounting Track


PFP-M End Plate



PFP-S Spacer


## Connections

| Part number | \|nput terminal numbers (no-voltage only) |  |  |  |  | Power supply terminal numbers |  | Output terminal numbers |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Gate | Start | Reset | Check | COM | AC (common), DC- | AC (hot), DC+ | Type | COM | NC | NO |
| H3CA-A | 5 | 6 | 7 | 4 | 3 | 2 | 10 | Timed contact | 11 | 8 | 9 |
| H3CA-FA | D1 | C1 | B1 | E1 | X | A2 | A1 | Timed contact | 15 | 16 | 18 |
| H3CA-8H | - | - | - | - | - | 2 | 7 | Instantaneous Timed contact |  | 4 | 3 6 |
| H3CA-8 | - | - | - | - | - | 2 | 7 | Timed contact Timed contact | 1 | 4 | 3 |

## ■ CONTACT SIGNAL INPUTS

## Input Signal Requirements

| Resistance | $1 \mathrm{~K} \Omega$ max. |
| :--- | :--- |
| Residual voltage | 1 V max. when the contact makes |
| Contact material | Gold-plated contacts recommended |

## H3CA-A

- Start input contact between terminals 3 and 6 .
- Reset input contact between terminals 3 and 7 .
- Gate input contact between terminals 3 and 5 .
- Check input contact between terminals 3 and 4 .


## H3CA-FA

- Start input contact between terminals X and C 1 .
- Reset input contact between terminals $X$ and B1.
- Gate input contact between terminals $X$ and D1.
- Check input contact between terminals X and E 1 .


## H3CA-A



H3CA-FA


## SOLID-STATE SIGNAL INPUTS

Input Signal Requirements

| Input type | Open collector transistor |
| :--- | :--- |
| Voltage when collector is OFF | 20 V min. |
| Saturated voltage when transistor is ON | $1 \mathrm{~V} \mathrm{max}$. |
| Collector current | 50 mA max. |
| Input current between collector and base | $0.5 \mu \mathrm{~A}$ max. |
| Resistance when transistor is ON | $1 \mathrm{~K} \Omega$ max. |
| Residual voltage when transistor is ON | $1 \mathrm{~V} \mathrm{max}$. |
| Resistance when transistor is OFF | $200 \mathrm{~K} \Omega$ min. |

## H3CA-A and H3CA-FA

Solid-state input terminal connections are the same as those for contact signal inputs.

## Solid-State Inputs (Not Open Collector Type)

Proximity and photoelectric sensors often have NPN or PNP type solid-state output circuits and rated supply voltages ranging from 6 to 30 VDC. These signals are applied to the timer according to the diagram below.

Solid-state circuit (proximity
sensor, proximity sensor, etc.)


## ■ CUMULATIVE TIMING

## Using the Gate Input with ON-Delay

When the gate signal is closed, timing is temporarily stopped. When the gate signal opens, timing resumes at the point of interruption. The gate input terminal permits the timer to sum up times $t_{1}$ and $t_{2}$ as shown in the timing chart.


## ■ CHECK INPUT

## ON-Delay Operation

When a no-voltage input signal is applied to the timer during the lapse of a set time, the remaining set time will become 0 and the timer will enter the next control state. Also, while the Check Signal is applied, the elapsed time measurement of the set time is not performed. The Check input is especially useful where ON-delay override may be desirable.

$t-a=$ less than set time

## Repeat Cycle Operation

The Check input signal in Repeat cycle mode allows the timer to be used like a binary flip-flop or alternating relay. Set an unattainable time, such as 999 hours. Apply the no-voltage Check input to shift output status from ON to OFF, or vice-versa. Jumper terminals 3 and 6 ( X and C 1 ) to short the start function. The Check input then controls the output relay like a flip-flop or alternating relay. This may be used to alternate wear on main and secondary equipment such as pumps.


## Installation

## ■ PROPER INPUT CONNECTIONS (H3CA-A, H3CA-FA)

The neutral or common of the power supply is connected to terminal 2 (A2) of the timer. Terminal 10 (A1) should be connected to the "hot" or positive of the power supply. Do not apply voltage to Check, Gate, Start and Reset inputs. These are no-voltage type inputs.

## PROPER OUTPUT CONNECTIONS

Design your control circuit using the output relay contacts to
 switch the load. Never switch a load with the contact that is being used as an input signal. The timer's circuitry may be damaged.

## PARALLEL CONNECTIONS

Parallel connection of two or more Omron Timers is possible as shown by the diagram to the right.

This will allow the simultaneous start or restart of multiple timers using a single switch for the Start Input and a single switch for the Reset Input.

It is possible to wire only up to 4 timers in this manner. Wiring more than 4 results in poor performance due to excessive voltage drop.


## Operation

## SELECTING TIME RANGE

Use the rightmost pushwheel switch to select the time range. Use the three center pushwheel switches to select the time setting between 000 and 999. For ranges with 0.1 time units, the decimal point is assumed to be between middle and right digits.


| Time unit | Timing range |
| :---: | :--- |
| 0.1 s | 0.1 to 99.9 seconds |
| s | 1 to 999 seconds |
| 0.1 m | 0.1 to 99.9 minutes |
| m | 1 to 999 minutes |
| 0.1 h | 0.1 to 99.9 hours |
| h | 1 to 999 hours |
| 10 h | 10 to 9990 hours |

Note: *Operation mode selector not included with ON-delay timers

## SELECTING OPERATION MODES (H3CA-A, H3CA-FA)

The operation mode is selected by the leftmost pushwheel switch.

| Mode | Operation |
| :--- | :--- |
| A | ON-delay |
| B | Repeat cycle |
| C | Signal Interval/OFF-delay |
| D | Signal OFF-delay I |
| E | Interval |
| F | Cycle |
| G | Signal ON-delay/OFF-delay |
| H | Signal OFF-delay II |

## CAUTIONS

Do not change the time unit or time range while the timer is in operation. Otherwise, the timer may malfunction or be damaged. Be sure to turn off the power supply to the timer before changing any of the selections.

## Mounting

## ■ PANEL MOUNTING

## Using Y92F-30 Adapter

Insert the timer through the panel cutout. Push the Y92F-30 adapter from the rear of the timer as far forward toward the panel as possible. Wire the P3GD- $\square$ socket, then push it onto the rear of the timer. Then, tighten the two retaining screws. To release the adapter, lift the tab at the rear of the adapter.


Several timers may be mounted close together using Y92F-30 adapter as shown here. When mounting two or more timers in a vertical line, arrange the adapters so that their molded tabs are positioned on the right and left sides. When mounting two or more timers in a horizontal line, arrange the adapters so that their molded tabs are positioned on the top and bottom sides.


Panel cutout for side-by-side mounting of two timers


## Using Y92F-70 and Y92F-71 Adapters

Installation


Install the H3CA timer, face first, into the back side of the Y92F-70 or Y92F-71 adapter so the bezel fits snugly. Be sure the retaining clips at the back of the adapter fit into the slots on either side of the timer. Compress the top and bottom tabs of the adapter then push the adapter through the front side of the panel cutout. Be sure the tabs extend after installation for a secure fit.

To remove the timer from the adapter, unclip the two retaining clips at the back of the adapter. To remove the adapter and timer from the panel as a unit, compress the tabs behind the panel and push the unit out the front of the panel.

Removal


## TRACK MOUNTING

## H3CA-FA with Built-In Track Adapter

## Mounting

First hook part "A" on the rear of the timer onto an edge of the track. Then, press the timer in direction " B " until the latch on the bottom rear of the timer locks securely.


## Removal

Pull the latch " C " with a flat-blade screwdriver and remove the timer from the mounting track.


## P2CF- Socket

For H3CA-A, H3CA-8 and H3CA-8H

## Mounting

The P2CF- $\square$ socket has two hooks that secure the timer to the socket. Be sure to allow at least 20 mm ( 0.79 in ) clearance above and below the socket to gain access and to release the hooks for servicing and maintenance. Insert timer into the socket. Latch hooks. Then clip rear of the socket to the track. Push the bottom onto the track until the latch hooks securely.


## Removal

Pull the latch on the socket with a flat-blade screwdriver and remove the timer and socket as one unit.

## NOTE: DIMENSIONS ARE SHOWN IN MILLIMETERS. To convert millimeters to inches divide by 25.4 .

## OmROn

## OMRON ELECTRONICS LLC

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Schaumburg, IL 60173
1-800-55-OMRON
Cat. No. GC TMCN1

## OMRON ON-LINE

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USA - http://www.omron.com/oei
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Specifications subject to change without notice.

OMRON CANADA, INC.
885 Milner Avenue
Scarborough, Ontario M1B 5V8
416-286-6465
Printed in the U.S.A.

## Heavy duty - 690 volt

## Features



CS 7-22E


CS 7-31E


CS 7-40E


Auxiliary contact 2 pole top mount


Control relay CS 7C complete with DC control ${ }^{2}$ )

| 14 | 10 | 5 | 25 | 20 | $\left.\left.\left.\left.\left.\left.{ }_{\mathrm{K} 1}\right\|_{T_{A 2}} ^{A 1}\right\|_{12} ^{11}\right\|_{22} ^{21}\right\|_{22} ^{31}\right\|_{32} ^{41}\right\|_{42} ^{4}$ | 0 | 4 | CS 7C-04E...V |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 14 | 10 | 5 | 25 | 20 |  | 1 | 3 | CS 7C-13E...V |
| 14 | 10 | 5 | 25 | 20 | $\left.\left.\left.{ }^{{ }^{2} 1}\right\|_{T_{A 2}} ^{A 1}\right)\left.\left.\left._{14}^{13}\right\|_{22} ^{13}\right\|_{22} ^{21}\right\|_{32} ^{31}\right)_{44}^{43}$ | 2 | 2 | CS 7C-22E...V |
| 14 | 10 | 5 | 25 | 20 | ${ }^{1} 1$ | 3 | 1 | CS 7C-31E...V |
| 14 | 10 | 5 | 25 | 20 | $\left.\left.\left.\left.{ }_{k 1}\right\|_{A 1} ^{A 1} \cdot\right\|_{12} ^{13}\right\|_{22} ^{12}\right\|_{32} ^{21}\| \|_{44}^{43}$ | 4 | 0 | CS 7C-40E...V |

Top mounting auxiliary contact blocks ${ }^{3}$ )

| N/O | N/C | Diagram | Position | Suit CS 7 | Cat. No. |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 1 | 1 | $\left.\left.\right\|_{54} ^{53}\right\|_{62} ^{61}$ | 11 | All | CS 7-PV-11 |
| 0 | 2 | $\left.\dot{5}_{52}^{51}\right\|_{62} ^{61}$ | 02 | All | CS 7-PV-02 |
| 2 | 0 | $\left.\hat{S}_{54}^{53}\right\|_{64} ^{63}$ | 20 | All | CS 7-PV-20 |
| 1+1E |  | $\left.\left.f_{54}^{53}\right\|_{62} ^{61} a_{72}^{61}\right\|_{84} ^{71}$ | L22 | All | CS 7-PV-L22 |
| 3 |  | $\left.\left.\left.t_{54}^{53}\right\|_{62} ^{61}\right\|_{74} ^{61}\right\|_{84} ^{73}$ | 31 | All | CS 7-PV-31 |
| 4 | 0 | $\left.\left.\left.\left.\right\|_{54} ^{53}\right\|_{64} ^{63}\right\|_{74} ^{63}\right\|_{84} ^{73}$ | 40 | All | CS 7-PV-40 |

Notes: $\quad{ }^{1}$ ) Add coil voltage, standard voltages 24, 32, 110, $240,415 \mathrm{~V} 50 \mathrm{~Hz}$.
${ }^{2}$ ) Add coil voltage, standard voltages 24, 36, 48, 110 and 240V DC.
${ }^{3}$ ) Other contact blocks type CA 7-P can be used providing terminal numbers are acceptable (refer CA 7 contactor auxiliaries).

## Ratings to IEC 947

| Relay |  | CS 7 | Relay and accessories |
| :---: | :---: | :---: | :---: |
| AC1 resistive load switching $3 \varnothing$ |  |  |  |
|  |  |  |  |
| Ambient temperature $40^{\circ} \mathrm{C}$ |  |  |  |
| $l_{e}$ | [A] | 25 | 10 |
| 240 V | [kW] | 10 | - |
| 415 V | [kW] | 17 | - |
| 690 V | [kW] | 30 | - |
| Ambient temperature $60^{\circ} \mathrm{C}$ |  |  |  |
| $l_{\text {e }}$ | [A] | 20 | 6 |
| 240 V | [kW] | 8 | - |
| 415 V | [kW] | 14 | - |
| 690V | [kW] | 24 | - |
| AC motor switching AC $2, ~ A C ~ 3, ~ A C ~ 4 ~$ |  |  |  |
| 240 V | [A] | 11.5 | - |
| 415 V | [A] | 9 | - |
| 690 V | [A] | 5 | - |
| 240 V | [kW] | 3 | - |
| 415 V | [kW] | 4 | - |
| 690 V | [kW] | 4 | - |

AC switching of electromagnetic loads
AC 15 at rated voltage

| 24 V | $[\mathrm{~A}]$ | 16 | 6 |
| :--- | :--- | :--- | :--- |
| 48 V | $[\mathrm{~A}]$ | 16 | 6 |
| 110 V | $[\mathrm{~A}]$ | 14 | 6 |
| 240 V | $[\mathrm{~A}]$ | 10 | 3 |
| 415 V | $[\mathrm{~A}]$ | 5 | 2 |
| 500 V | $[\mathrm{~A}]$ | 2.5 | 1.5 |
| 600 V | $[\mathrm{~A}]$ | 1.8 | 1.2 |
| 690 V | $[\mathrm{~A}]$ | 1 | 0.7 |
| Short circuit protection | Fuse gG |  |  |
| Co-ordination type ' 2 ' | $[\mathrm{A}]$ | 10 | 10 |

Number of switching operations

| Mechanical | [Mill] | 15 | 15 |
| :---: | :---: | :---: | :---: |
| AC 15 (240V, 3A) | [Mill] | 1.5 | 1.5 |
| Weight with AC coil | [kg] | 0.39 | - |
| Terminals for auxiliary contacts |  | $\stackrel{\text { 㭉 }}{\stackrel{y}{4}}$ | $\stackrel{5}{\mathbb{8}}$ |
| Terminal size to IEC 947-1 |  | $2 \times \mathrm{A} 4$ | $2 \times \mathrm{A} 4$ |
| Flexible wire with sleeve | 1 wire [ $\mathrm{mm}^{2}$ ] | 1... 4 | 0.5...2.5 |
| 上 ${ }^{-1}$ | 2 wire [ $\mathrm{mm}^{2}$ ] | 1... 4 | 0.75...2.5 |
| Stranded/solid core | 1 wire [ $\mathrm{mm}^{2}$ ] | 1.5... 6 | 0.5...2.5 |
| - -7 | 2 wire [ $\mathrm{mm}^{2}$ ] | 1.5... 6 | 0.75...2.5 |
| Tightening torque | [ Nm ] | 1... 2.5 | 1...1.5 |

## Technical information

| Control circuit |  | CS 7 |
| :--- | :--- | :--- |
| Operating limits <br> AC $50 / 60 \mathrm{~Hz}$ |  |  |
| Pick-up and hold power <br> AC $50 / 60 \mathrm{~Hz}$ | Drop-out $\left[\mathrm{xU}_{\mathrm{s}}\right]$ | $0.85 \ldots 1.1$ |
| Operating times <br> AC $50 / 60 \mathrm{~Hz}$ | Pick-up $[\mathrm{VA} / \mathrm{W}]$ | $70 / 50$ |

## General data

CS 7
Rated insulation voltage $U_{i}$

| IEC | 690 V |
| :---: | :---: |
| UL, CSA | 600 V |
| Rated impulse voltage withstand $U_{\text {imp }}$ | 8kV |
| Test voltage |  |
| 1 minute (to IEC 947-4) | 2500V |
| Rated voltage $U_{e}$ |  |
| AC | 110, 240, 415, 500, 690V |
| DC | 24, 48, 110, 220, 440V |
| Rated frequency of coil | 50/60Hz, DC |
| Ambient temperature |  |
| Storage | $-55 \ldots+80^{\circ} \mathrm{C} \quad\left(-67 \ldots 176^{\circ} \mathrm{F}\right)$ |
| Operation at nominal current | $-25 \ldots+60^{\circ} \mathrm{C} \quad\left(-13 \ldots 140^{\circ} \mathrm{F}\right)$ |
| Maximum with $15 \%$ AC 1 current reduction $>60^{\circ} \mathrm{C}$ | $-25 \ldots+70^{\circ} \mathrm{C} \quad\left(-13 \ldots 158^{\circ} \mathrm{F}\right)$ |
| Climatic withstand | Cyclicly changing humid atmosphere to |
|  | IEC 68-2-30 and DIN 50 016, 56 |
| Maximum altitude | 2000m NN, to IEC 947-4 |
| Protection class |  |
| IP 2LX (IEC 529 and DIN 40050) | In connected condition |
| Protection against contact | Finger and back of hand to VDE 0106, Part 100 |

## CS 7 (AC) <br> Dimensions in (mm)



CS 7 (DC)
Dimensions in (mm)


## Relay

| Type | a | b | c | c1 | c2 | ød | d1 | d2 |  |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| CS 7 (AC) | 45 | 81 | 80.5 | 75.5 | 6 | 4.5 | 60 | 35 | $\left.{ }^{1}\right)$ |

## Accessories

| Contactor with |  | [mm] |
| :--- | :--- | ---: |
| Front mounting auxiliary contact | 2 or 4 pole | $\mathrm{c} / \mathrm{c} 1+39$ |
| Side mounting auxiliary contact | 1 or 2 pole | $\mathrm{a}+9$ |
| Pneumatic timing module |  | $\mathrm{c} / \mathrm{c} 1+58$ |
| Electronic timing module | Coil mounting | $\mathrm{b}+24$ |
| Mechanical interlock | Mounts between contactors | $\mathrm{a}+9$ |
|  |  | $\mathrm{c} / \mathrm{c} 1+61$ |
| Interface | Coil mounting | $\mathrm{b}+9$ |
| Suppressor | Coil mounting | $\mathrm{b}+3$ |
| With inscriptions | Labels | +0 |
|  | Label support system V4/V5 | +5.5 |

Note: ${ }^{1}$ ) DIN rail mounting to 35 mm to EN 50022

## Mounting position



## KRAUS \& NAIMER

 BLUE LINE SWITCHGEAR
# Catalog 100 <br> CL Switches 10 A-20 A <br> C, CA, CAD Switches 10 A-315 A L Switches 350 A-2400 A 



## Construction Data

The load switches of the C, CA, CAD and CL-series offer a solution for most cam switch applications. Different contact designs, contact materials and terminals allow for their use as control switches, instrumentation switches and motor control switches, as well as in electronic circuitry and in aggressive environments according to IEC 60947-3 and VDE 0660 part 107.
The stage is the basis for all switches and can be supplied with a maximum of 2 contacts. The terminals are accessible from the side. CA and CAD switches are supplied with open terminals to facilitate wiring and are protected against accidental finger contact according to EN 50274, VDE 0660 part 514 and BGV A3. Captive plus-minus terminal screws and integrated screwdriver guides also reduce wiring.

The switches of the new CL-series are supplied with rust-free and acidresisting IDC terminals (Insulation Displacement Connection) instead of screw type terminals. The stripping or preparation of the insulation is no longer required. Eliminate errors due to i.e., stripped end of the conductor too long or too short, incorrect sleeves used, sleeves crimped incorrectly or wrong crimping tool is used, terminal screws not tightened properly etc. The CL switches reduce installation time by $60 \%-70 \%$ compared to the screw type terminals. This translates to significant cost savings. For connecting 2 conductors to a terminal an additional screw terminal with plus-minus screw is available.
If a positive manual operation or a higher DC rating is required, many of these switches can be fitted with a snap action latching mechanism suffix "S" - to the switch type.
The cam-operated switches L350-L2000 are continuous current rated for off-load switching. They may be used to switch resistive or low inductive loads.

## Special Contact Systems

## CA4/CA4-1



High contact reliability by multiple cross-point contacts, electronic compatible, CA4 with $1 \mu$ and CA4-1 with $35 \mu$ gold plating.

## CAD11/CAD12



H-bridge with „cross-wire" contact system, high contact reliability also at lower voltages. CAD11 with gold-plated contacts, CAD12 with silver contact.

| Type | Size | Possible Switching <br> Angles | Max. No. of <br> Stages |
| :--- | :--- | :--- | :---: |
| CA4, CA4-1 | S00 | $30^{\circ}, 45^{\circ}, 60^{\circ}, 90^{\circ}$ | 9 |
| CL4 | S00 | $30^{\circ}, 45^{\circ}, 60^{\circ}, 90^{\circ}$ | 8 |
| CA10-CA25 | S0 | $30^{\circ}, 45^{\circ}, 60^{\circ}, 90^{\circ}$ | 12 |
| CA10S-CA25S | S0 | $30^{\circ}$ | on request |
| CAD11, CAD12 | S0 | $30^{\circ}, 45^{\circ}, 60^{\circ}, 90^{\circ}$ | 12 |
| CL10 | S0 | $30^{\circ}, 45^{\circ}, 60^{\circ}, 90^{\circ}$ | 10 |
| CA10B-CA25B | S1 | $30^{\circ}, 45^{\circ}, 60^{\circ}, 90^{\circ}$ | 12 |
| C26, C32, C42 | S1 | $20^{\circ}, 30^{\circ}, 45^{\circ}, 60^{\circ}, 90^{\circ}$ | 12 |
| C26S, C32S, C42S | S1 | $60^{\circ}$ | on request |
| C43, C80, C125 | S2 | $20^{\circ}, 30^{\circ}, 45^{\circ}, 60^{\circ}, 90^{\circ}$ | 12 |
| C315 | S3 | $20^{\circ}, 30^{\circ}, 45^{\circ}, 60^{\circ}, 90^{\circ}$ | 12 |
| L350/51, L630/31, | S2 | $30^{\circ}, 45^{\circ}, 60^{\circ}, 90^{\circ}$ | 12 |
| L1000/01, L1250/51 | S3 | $30^{\circ}, 45^{\circ}, 60^{\circ}, 90^{\circ}$ | 12 |
| L400, L600, L800, | S300, |  |  |



CA and CAD Switches


## C Switches



## L Switches



Above illustrates the standard terminal positions.

Nominal Ratings


|  |  |  | Type／Handle |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Function | Escutch． Plate | $\begin{aligned} & \text { CA4 } \\ & \text { CA4-1 } \\ & \text { CL4 } \end{aligned}$ | CAD．． <br> CA10－CA10B－C26－ CA25 CA25B C315 <br> CL10 | Code | Stages | Connection Diagram |

ON／OFF Switches with $60^{\circ}$ Switching

| 1 pole 2 pole 3 pole 3 pole 3 pole | with red handle with V850 padlock attachment |  | $\begin{aligned} & \text { g } \\ & \text { 可 } \\ & \text { 可 } \end{aligned}$ | $\begin{aligned} & \text { 戶 } \\ & \text { 白 } \\ & \text { 弟 } \end{aligned}$ |  | $\begin{aligned} & \text { ㅁ } \\ & \text { 可 } \\ & \text { 可 } \\ & \text { 0 } \\ & \text { 0 } \end{aligned}$ | $\begin{array}{\|l} \text { A200-600 } \\ \text { A201-600 } \\ \text { A202-600 } \\ \text { A202-626 } \\ \text { A202-627 } \end{array}$ | 1 1 2 2 2 |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 4 pole <br> 4 pole <br> 5 pole <br> 6 pole <br> 7 pole <br> 8 pole <br> 8 pole <br> 9 pole <br> 10 pole <br> 11 pole <br> 12 pole | 1 pole preclose $6^{\circ 1}$ <br> 2 pole preclose $6^{\circ 1}$ |  | $\begin{aligned} & \square \\ & \square \\ & \square \\ & \square \\ & \square \\ & \square \\ & \square \\ & \square \\ & \square \\ & \square \\ & \square \\ & \square \\ & \square \end{aligned}$ | $\square$ 9 0 0 0 0 0 0 0 0 0 0 |  |  | A203－600 <br> A653－600 <br> A341－600 <br> A342－600 <br> A343－600 <br> A344－600 <br> A654－600 <br> A345－600 <br> A346－600 <br> A347－600 <br> A348－600 | $\begin{aligned} & 2 \\ & 2 \\ & 3 \\ & 3 \\ & 4 \\ & 4 \\ & 4 \\ & 5 \\ & 5 \\ & 6 \\ & 6 \end{aligned}$ |  |
| 1 pole <br> 2 pole <br> 3 pole <br> 4 pole <br> 4 pole <br> 5 pole <br> 6 pole <br> 7 pole <br> 8 pole <br> 8 pole <br> 9 pole <br> 10 pole <br> 11 pole <br> 12 pole | 1 pole preclose $6^{\circ 1}$ <br> 2 pole preclose $6^{\circ 1}$ |  | 밥 |  |  |  | A200－620 <br> A201－620 <br> A202－620 <br> A203－620 <br> A653－620 <br> A341－620 <br> A342－620 <br> A343－620 <br> A344－620 <br> A654－620 <br> A345－620 <br> A346－620 <br> A347－620 <br> A348－620 | $\begin{aligned} & 1 \\ & 1 \\ & 2 \\ & 2 \\ & 2 \\ & 3 \\ & 3 \\ & 4 \\ & 4 \\ & 4 \\ & 5 \\ & 5 \\ & 6 \\ & 6 \end{aligned}$ |  |
| 1 pole <br> 2 pole <br> 3 pole <br> 4 pole <br> 4 pole <br> 5 pole <br> 6 pole | 1 pole preclose $6^{\circ 1}$ |  | 6 0 0 0 0 0 0 0 |  |  |  | $\begin{aligned} & \text { A200-621 } \\ & \text { A201-621 } \\ & \text { A202-621 } \\ & \text { A203-621 } \\ & \text { A653-621 } \\ & \text { A341-621 } \\ & \text { A342-621 } \end{aligned}$ | $\begin{aligned} & 1 \\ & 1 \\ & 2 \\ & 2 \\ & 2 \\ & 3 \\ & 3 \end{aligned}$ | 4 pole 1 pole preclose $6^{\circ}$ <br> $\begin{array}{llllllll}1 & 3 & 5 & 7 & 9 & 11 & 13 & 15\end{array}$ |
| 1 pole <br> 3 pole <br> 4 pole <br> 4 pole <br> 5 pole <br> 6 pole | 1 pole preclose $6^{\circ 1}$ |  | 6 0 0 0 0 0 0 0 |  |  |  | $\begin{aligned} & \text { A200-622 } \\ & \text { A201-622 } \\ & \text { A202-622 } \\ & \text { A203-622 } \\ & \text { A653-622 } \\ & \text { A341-622 } \\ & \text { A342-622 } \end{aligned}$ | 1 1 2 2 2 3 3 | $\int_{0}^{0} \int_{1}^{0} \int_{2}^{0} \int_{2}^{0}$ <br> 8 pole 2 pole preclose $6^{\circ}$ |
|  | 1 pole preclose $6^{\circ 1}$ |  |  |  |  |  | A200－623 <br> A201－623 <br> A202－623 <br> A203－623 <br> A653－623 <br> A341－623 <br> A342－623 | 1 1 2 2 2 3 3 |  |
| 1 pole 2 pole <br> 4 pole <br> 4 pole <br> 5 pole <br> 6 pole | 1 pole preclose $6^{\circ 1}$ |  |  |  | $\begin{aligned} & \text { 戶 } \\ & \text { 戶 } \\ & \text { 戶 } \\ & \text { 戶 } \\ & \text { 戶 } \\ & \text { 戶 } \end{aligned}$ |  | A200－624 A201－624 A202－624 A203－624 A653－624 A341－624 A342－624 | $\begin{aligned} & 1 \\ & 1 \\ & 2 \\ & 2 \\ & 2 \\ & 3 \\ & 3 \end{aligned}$ |  |
|  | 1 pole preclose $6^{\circ 1}$ |  |  |  |  |  | A200－625 <br> A201－625 <br> A202－625 <br> A203－625 <br> A653－625 <br> A341－625 <br> A342－625 | 1 1 2 2 2 3 3 |  |


|  |  |  | Type/Handle |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Function | Escutch. Plate | $\begin{aligned} & \text { CA4 } \\ & \text { CA4-1 } \\ & \text { CL4 } \end{aligned}$ | CAD.. <br> CA10- CA10B- <br> CA25 CA25B <br> CL10 | $\begin{aligned} & \mathrm{C} 26- \\ & \mathrm{C} 315 \end{aligned}$ | Code | Stages | Connection Diagram |

ON/OFF Switches with $90^{\circ}$ Switching


ON/OFF Switches with $30^{\circ}$ Switching

| 1 pole 2 pole 3 pole 4 pole | ${ }^{\$} \begin{aligned} & 0 \\ & \zeta^{1} \\ & \end{aligned}$ |  | [ |  |  | $\begin{aligned} & \text { A100-600 } \\ & \text { A101-600 } \\ & \text { A102-600 } \\ & \text { A103-600 } \end{aligned}$ | 1 1 2 2 |  | 1-4 pole |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1 pole with spring return | ${ }^{\Phi}$ Offon | $\square$ | $\square$ | $\square$ | $\square$ | A204-600 | 1 |  |  |
| 2 pole with spring return | 6 | $\square$ | - | ¢ | 50] | A205-600 | 1 |  |  |
| 3 pole with spring return |  | $\square$ | $\square$ | $\square$ | $\square$ | A206-600 | 2 |  |  |
| 4 pole with spring return |  | $\square$ | $\square^{1}$ | $\square$ |  | A207-600 | 2 | ${ }^{\circ}$ | 1-4 pole |
| 1 pole with spring return |  | $\square$ | $\square$ | $\square$ |  | A204-620 | 1 |  |  |
| 2 pole with spring return | $\bigcirc$ | $\square$ | - | - |  | A205-620 | 1 |  |  |
| 3 pole with spring return | - | $\square$ | - | - |  | A206-620 | 2 |  |  |
| 4 pole with spring return |  | $\square$ | $\square^{1}$ | ] |  | A207-620 | 2 |  |  |

${ }^{1}$ not available for switch type CA25

## Switch Function and Configuration

|  |  |  | Type／Handle |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Function | Escutch． Plate | $\begin{aligned} & \text { CA4 } \\ & \text { CA4-1 } \\ & \text { CL4 } \end{aligned}$ | CAD．． <br> CA10－CA10B－C26－ CA25 CA25B C315 <br> CL10 | Code | Stages | Connection Diagram |

Double－throw Switches without „OFF＂ $60^{\circ}$ Switching

| 1 pole <br> 2 pole <br> 3 pole <br> 4 pole <br> 4 pole 1 pole preclose $6^{\circ 3}$ <br> 5 pole <br> 6 pole <br> 7 pole <br> 8 pole <br> 8 pole 2 pole preclose $6^{\circ 3}$ <br> 9 pole <br> 10 pole <br> 11 pole <br> 12 pole |  | $\square$ <br> $\square$ <br> － <br> 白 <br> $\square$ <br> － <br> b <br> $\square$ <br> $\square$ <br> ■ <br> $\square^{2}$ | － <br> $\square$ <br> 5 <br> $\square$ <br> $\square$ <br> $\square$ <br> $\square$ <br> 5 <br> 5 <br> $\square$ <br> $\square$ <br> $\square$ <br> $\square^{4}$ <br> $\square^{4}$ |  |  | A220－600 A221－600 A222－600 A223－600 A673－600 A369－600 A370－600 A371－600 A372－600 A972－600 A373－600 A374－600 A375－600 A376－600 | $\begin{aligned} & 1 \\ & 2 \\ & 3 \\ & 4 \\ & 4 \\ & 5 \\ & 5 \\ & 6 \\ & \\ & 7 \\ & 8 \\ & 8 \\ & 9 \\ & 10 \\ & 11 \\ & 12 \end{aligned}$ | 6 and 7 pole <br> 8 and 9 pole <br> 8 pole 2 pole preclose $6^{\circ}$ <br> 10 and 11 pole <br> 12 pole |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |

Double－throw Switches without „OFF＂with electrically isolated contacts

| ```1 pole \\ 2 pole \\ 3 pole \\ 4 pole \\ 4 pole 1 pole preclose \(6^{\circ 3}\)``` | $s^{1} \gamma^{2}$ | $\begin{aligned} & \text { ■ } \\ & 0 \\ & \square \\ & \square \\ & \square \end{aligned}$ | 0 0 0 0 0 | $\begin{aligned} & 0 \\ & 0 \\ & 0 \\ & 0 \\ & 0 \\ & 0 \end{aligned}$ | $\begin{aligned} & \hline \text { ■ } \\ & 0 \\ & \square \\ & \square \\ & \square \end{aligned}$ | A720－600 <br> A721－600 <br> A722－600 <br> A723－600 <br> A973－600 | $\begin{aligned} & 1 \\ & 2 \\ & 3 \\ & 4 \\ & 4 \end{aligned}$ |  | 1－4 pole <br> 4 pole 1 pole preclose $6^{\circ}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1 pole with spring return | ${ }^{6} b^{2}$ | $\square$ | $\square$ | $\bigcirc$ | $\square$ | A795－600 | 1 |  | spring return |

## Double－throw Switches without „OFF＂ $30^{\circ}$ Switching

| 1 pole 2 pole 3 pole 4 pole |  |  | $\begin{aligned} & \text { bu } \\ & \text { b } \\ & \text { p } \\ & \text { b } \end{aligned}$ |  |  | A120－600 <br> A121－600 <br> A122－600 <br> A123－600 | 1 2 3 4 | $\left\{\begin{array}{cccccccc} 1 & 3 & 5 & 7 & 9 & 11 & 13 & 15 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & & 1 & & 0 & & 1 \\ 2 & & 6 & & 10 & & 14 \end{array}\right.$ | 1－4 pole |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1 pole with spring return 2 pole with spring return 3 pole with spring return | $\begin{array}{\|cc\|} \hline \infty & 1 \\ & \gamma^{2} \\ & \end{array}$ | $\begin{aligned} & \text { b } \\ & \text { b } \\ & \text { b } \end{aligned}$ | $\begin{aligned} & \text { ■ } \\ & \square^{1} \\ & \square^{1} \end{aligned}$ | $\begin{aligned} & \square \\ & \square \\ & \square \\ & \square \end{aligned}$ | $\begin{aligned} & \text { b } \\ & \text { b } \\ & \text { b } \end{aligned}$ | $\begin{aligned} & \text { A295-600 } \\ & \text { A296-600 } \\ & \text { A297-600 } \end{aligned}$ | 1 2 3 | $\begin{array}{llllll} 1 & 3 & 5 & 7 & 9 & 11 \\ 1 & d & 1 & d & \vdots & d \end{array}$ | 1－3 pole |
| 1 pole with spring return <br> 2 pole with spring return <br> 3 pole with spring return |  | $\begin{aligned} & \text { b } \\ & \text { b } \\ & \square \end{aligned}$ |  | 禺 | 景 | $\begin{aligned} & \text { A295-620 } \\ & \text { A296-620 } \\ & \text { A297-620 } \end{aligned}$ | 1 2 3 | 2610 |  |

[^23]
## Switch Function and Configuration

|  |  |  | Type／Handle |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Function | Escutch． Plate | $\begin{array}{\|l} \text { CA4 } \\ \text { CA4-1 } \\ \text { CL4 } \end{array}$ | $\begin{aligned} & \text { CAD.. } \\ & \text { CA10- CA10B- } \\ & \text { CA25 C43 } \\ & \text { CL10 } \end{aligned}$ | $\begin{aligned} & \text { C80- } \\ & \text { C315 } \end{aligned}$ | Code | Stages | Connection Diagram |

Double－throw Switches with Center „OFF＂ $60^{\circ}$ Switching


Double－throw Switches with Center „OFF＂ $90^{\circ}$ Switching

| 1 pole <br> 2 pole <br> 3 pole <br> 4 pole 1 pole preclose $60^{\circ}$ |  | $\begin{aligned} & \text { g } \\ & \text { 可 } \\ & \text { b } \\ & \text { b } \end{aligned}$ | ■ － － － |  | $\begin{aligned} & \text { g } \\ & \text { G } \\ & \square^{1} \\ & \square^{1} \end{aligned}$ | $\begin{aligned} & \text { A218-600 } \\ & \text { A219-600 } \\ & \text { A299-600 } \\ & \text { A294-600 } \end{aligned}$ | $\begin{aligned} & 1 \\ & 2 \\ & 3 \\ & 4 \end{aligned}$ |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1 pole <br> 2 pole <br> 3 pole <br> 4 pole 1 pole preclose $60^{\circ}$ | $\left[\begin{array}{cc} \hline & \text { off } \\ 1 & -1-2 \\ 1 & -2 \end{array}\right.$ | b 或 － 可 | b 可 可 可 |  |  | $\begin{aligned} & \text { A218-620 } \\ & \text { A219-620 } \\ & \text { A299-620 } \\ & \text { A294-620 } \end{aligned}$ | 1 2 3 4 |  | 1－4 pole |

Double－throw Switches with Center „OFF＂and electrically isolated contacts

| 1 pole <br> 2 pole <br> 3 pole <br> 4 pole <br> 4 pole 1 pole preclose $6^{\circ 3}$ |  | $\begin{aligned} & \text { b } \\ & \square \\ & \square \\ & \square \\ & \square \\ & \square \end{aligned}$ | $\begin{aligned} & \text { b } \\ & \text { ㅂ } \\ & \text { 可 } \\ & \text { 可 } \\ & \text { b } \end{aligned}$ |  | $\begin{aligned} & \text { b } \\ & \text { b } \\ & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | A710－600 <br> A711－600 <br> A712－600 <br> A713－600 <br> A963－600 | $\begin{aligned} & 1 \\ & 2 \\ & 3 \\ & 4 \\ & 4 \end{aligned}$ |  | 1－4 pole <br> 4 pole 1 pole preclose $6^{\circ}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1 pole with spring return 2 pole to center |  | $\begin{aligned} & \text { b } \\ & \text { b } \end{aligned}$ | $\begin{aligned} & \text { b } \\ & \text { b } \end{aligned}$ | $\begin{aligned} & \text { bor } \\ & \text { big } \end{aligned}$ | $\square^{2}$ | $\begin{aligned} & \text { A714-600 } \\ & \text { A715-600 } \end{aligned}$ | 1 2 |  | 1 and 2 pole |

[^24]
## Switch Function and Configuration

|  |  |  | Type／Handle |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Function | Escutch． Plate | $\begin{aligned} & \text { CA4 } \\ & \text { CA4-1 } \\ & \text { CL4 } \end{aligned}$ | CAD．． <br> CA10－CA10B－C26－ CA25 CA25B C315 <br> CL10 | Code | Stages | Connection Diagram |

## Double－throw Switches with Spring Return to Center

| 1 pole with spring return 2 pole to center <br> 3 pole <br> 1 pole <br> 2 pole <br> 3 pole |  | $\begin{aligned} & \square \\ & \square \\ & \square \\ & \square \\ & \square \\ & \square \\ & \square \end{aligned}$ |  | $\begin{aligned} & \square \\ & 0 \\ & 6 \\ & 6 \end{aligned}$ | $\begin{aligned} & \square^{2} \\ & \square^{3} \\ & \varpi^{4} \\ & \\ & 4 \\ & 4 \end{aligned}$ | A214－600 <br> A215－600 <br> A216－600 <br> A214－620 <br> A215－620 <br> A216－620 | $\begin{aligned} & 1 \\ & 2 \\ & 3 \\ & 1 \\ & 2 \\ & 3 \end{aligned}$ |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1 pole with spring return 2 pole from left to center 3 pole <br> 1 pole <br> 2 pole <br> 3 pole |  | $\begin{aligned} & \square \\ & b \\ & b \\ & \square \\ & \square \\ & \square \\ & b \\ & b \end{aligned}$ | $\begin{aligned} & \square^{\square} \\ & \square^{1} \\ & \square^{1} \\ & \square^{1} \\ & m^{1} \end{aligned}$ | $\begin{aligned} & \text { b } \\ & \text { b } \\ & \text { b } \\ & 0 \\ & 6 \\ & 0 \\ & 6 \end{aligned}$ |  | $\begin{aligned} & \text { A320-600 } \\ & \text { A321-600 } \\ & \text { A322-600 } \\ & \text { A320-621 } \\ & \text { A321-621 } \\ & \text { A322-621 } \end{aligned}$ | 1 2 3 1 2 3 |  |

## General Application Switches

\begin{tabular}{|c|c|c|c|c|c|c|c|c|}
\hline \begin{tabular}{l}
1 pole 2 Gang \\
2 pole Switching sequence： \\
3 pole \(0, A, A+B\) \\
1 pole \\
2 pole \\
3 pole
\end{tabular} \&  \& \begin{tabular}{l}
\(\square\)
\(\square\) \\
\(\sigma\) \\
5 \\
－
\end{tabular} \& b \& \[
\begin{aligned}
\& \text { g } \\
\& \text { b } \\
\& \square \\
\& \square \\
\& \square \\
\& \square \\
\& \square
\end{aligned}
\] \& \begin{tabular}{l}
5
5
5 \\
G \\
5 \\
\(\square\)
\end{tabular} \& \[
\begin{aligned}
\& \text { A310-600 } \\
\& \text { A312-600 } \\
\& \text { A314-600 } \\
\& \text { A310-620 } \\
\& \text { A312-620 } \\
\& \text { A314-620 }
\end{aligned}
\] \& \[
\begin{aligned}
\& 1 \\
\& 2 \\
\& 3 \\
\& \\
\& 1 \\
\& 2 \\
\& 3
\end{aligned}
\] \&  \\
\hline \begin{tabular}{l}
1 pole 3 Gang \\
2 pole Switching sequence： \\
3 pole \(0, A, A+B, A+B+C\) \\
1 pole \\
2 pole \\
3 pole
\end{tabular} \&  \& \begin{tabular}{l}
－ \\
\(\square\) \\
－ \\
\(\square\)
\(\square\)
\(\square\)
\end{tabular} \& \[
\begin{aligned}
\& \text { bu } \\
\& \text { 可 } \\
\& \text { 可 }
\end{aligned}
\]
\[
\begin{aligned}
\& \text { bu } \\
\& \text { b } \\
\& \text { b }
\end{aligned}
\] \& ■
\(\square\)
\(\square\)
6
6
6
\(\square\) \& \begin{tabular}{l}
6
5
6 \\
－ \\
G \\
\(\square\)
\end{tabular} \& \[
\begin{aligned}
\& \text { A311-600 } \\
\& \text { A313-600 } \\
\& \text { A315-600 } \\
\& \text { A311-620 } \\
\& \text { A313-620 } \\
\& \text { A315-620 }
\end{aligned}
\] \& \[
\begin{aligned}
\& 2 \\
\& 3 \\
\& 5
\end{aligned}
\] \&  \\
\hline \begin{tabular}{l}
1 pole 2 Gang \\
2 pole Series switching \\
3 pole Switching sequence：
\[
0, A, B, A+B
\] \\
1 pole \\
2 pole \\
3 pole
\end{tabular} \&  \& \begin{tabular}{l}
\(\square\) \\
5 \\
－ \\
\(\square\) \\
䀛 \\
\(\square\)
\end{tabular} \& \[
\begin{aligned}
\& \text { b } \\
\& \text { b } \\
\& 5 \\
\& 5 \\
\& 6 \\
\& 6 \\
\& 5
\end{aligned}
\] \& \[
\begin{aligned}
\& \text { g } \\
\& \text { b } \\
\& \text { b } \\
\& \square \\
\& \square \\
\& \square
\end{aligned}
\] \& \begin{tabular}{l}
5
5
5 \\
6 \\
\(\square\) \\
\(\square\)
\end{tabular} \& \[
\begin{aligned}
\& \text { A330-600 } \\
\& \text { A331-600 } \\
\& \text { A332-600 } \\
\& \text { A330-620 } \\
\& \text { A331-620 } \\
\& \text { A332-620 }
\end{aligned}
\] \& \[
\begin{aligned}
\& 1 \\
\& 2 \\
\& 3
\end{aligned}
\] \&  \\
\hline \begin{tabular}{l}
2 pole 2 Gang \\
Series－parallel Switching \\
Switching sequence： \\
\(0, A+B\) series，\(A\) ， \\
A＋B parallel
\end{tabular} \&  \& － \& 可 \&  \&  \& A339-600
A339-620 \& 2

2 \&  <br>
\hline
\end{tabular}



Coding Switches/Binary Code

| $\begin{aligned} & 0-7 \\ & 360^{\circ} \text { rotation } \end{aligned}$ |  | $\square$ | $\square$ |  | A540-600 | 2 |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 0-7 complement $360^{\circ}$ rotation | $\left[\begin{array}{ccc} 1 & 2 \\ 0 & -x_{3} \\ 0 & -K_{4}^{4} \\ \hline & 6 \end{array}\right]$ | $\square$ | $\square$ |  | A541-600 | 2 |  |
| 0-7+ complement $360^{\circ}$ rotation |  | $\square$ | $\square$ |  | A542-600 | 3 |  |
| 0-9 |  | $\square$ | $\square$ |  | A550-600 | 2 |  |
| 0-9 complement |  | $\square$ | $\square$ |  | A551-600 | 2 |  |
| 0-9 + complement |  | $\square$ | $\square$ |  | A552-600 | 4 |  |
| $\begin{aligned} & 0-11 \\ & 360^{\circ} \text { rotation } \end{aligned}$ |  | $\square$ | $\square$ |  | A543-600 | 2 |  |
| 0-11 + complement $360^{\circ}$ rotation |  | $\square$ | $\square$ |  | A545-600 | 4 |  |

## Switch Function and Configuration

|  |  |  | Type／Handle |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Function | Escutch． <br> Plate | $\begin{aligned} & \text { CA4 } \\ & \text { CA4-1 } \\ & \text { CL4 } \end{aligned}$ | $\begin{aligned} & \text { CAD.. } \\ & \text { CA10- CA10B- } \\ & \text { CA25 C43 } \\ & \text { CL10 } \end{aligned}$ | $\begin{aligned} & \mathrm{C8O} \\ & \mathrm{C} 315 \end{aligned}$ | Code | Stages | Connection Diagram |

Multi－step Switches without „OFF＂

| 1 pole 2 pole <br> 3 pol <br> 4 pol <br> 5 pole <br> 6 pol | 3 Step | $\square$ |  |  | 5 <br> $\square$ <br> 담 <br> 5 <br> － <br> $\square$ |  | A230－600 <br> A250－600 <br> A270－600 <br> A476－600 <br> A484－600 <br> A489－600 | $\begin{aligned} & 2 \\ & 3 \\ & 5 \\ & 6 \\ & 8 \\ & 9 \end{aligned}$ |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1 pol <br> 2 pol <br> 3 pol <br> 4 pol <br> 5 pol <br> 6 pol | 4 Step |  | 5 5 5 6 | $\begin{aligned} & \square \\ & \square \\ & \square \\ & \square \\ & \square \\ & \square \\ & \square \end{aligned}$ | $\square$ <br> $\square$ <br> $\square$ <br> G <br> $\square$ <br> $\square$ |  | A231－600 <br> A251－600 <br> A271－600 <br> A477－600 <br> A485－600 <br> A490－600 | $\begin{aligned} & 2 \\ & 4 \\ & 6 \\ & 8 \\ & 10 \\ & 12 \end{aligned}$ |  |
| 1 pol <br> 2 pol <br> 3 pol <br> 4 pol | 5 Step | ${ }^{+}$ | $\begin{aligned} & \text { b } \\ & \text { 句 } \\ & \text { b } \end{aligned}$ | 5 <br> 6 <br> $\square$ <br> $\square$ | $\begin{aligned} & \text { b } \\ & \text { 可 } \\ & 0 \\ & 0 \end{aligned}$ | $\begin{aligned} & 6 \\ & 5 \\ & 5 \\ & 5 \\ & 5 \\ & 5 \\ & 5 \end{aligned}$ | $\begin{array}{\|l} \text { A232-600 } \\ \text { A252-600 } \\ \text { A272-600 } \\ \text { A478-600 } \end{array}$ | $\begin{aligned} & 3 \\ & 5 \\ & 8 \\ & 10 \end{aligned}$ |  |
| 1 pol <br> 2 pol <br> 3 pol | 6 Step |  | $\begin{aligned} & \square \\ & \square \\ & \square^{2} \end{aligned}$ | $\begin{aligned} & \text { ■ } \\ & \text { b } \\ & \square \end{aligned}$ | $\begin{aligned} & \text { b } \\ & \text { 可 } \\ & \text { b } \end{aligned}$ | $\begin{gathered} 5 \\ 5 \\ 5 \\ 5 \\ 5 \\ 5 \end{gathered}$ | $\begin{array}{\|l} \text { A233-600 } \\ \text { A253-600 } \\ \text { A273-600 } \end{array}$ | $\begin{aligned} & 3 \\ & 6 \\ & 9 \end{aligned}$ |  |
| 1 pol 2 pol 3 pol | 7 Step |  | $\begin{aligned} & \text { b } \\ & \text { b } \end{aligned}$ | $\begin{aligned} & \square \\ & \square \\ & \square^{4} \end{aligned}$ | $\begin{aligned} & \text { bo } \\ & \text { 可 } \\ & \text { bu } \end{aligned}$ | $\begin{gathered} \text { 5 } \\ \substack{5 \\ 5 \\ 5 \\ 5} \end{gathered}$ | $\begin{array}{\|l} \text { A234-600 } \\ \text { A254-600 } \\ \text { A274-600 } \end{array}$ | $\begin{aligned} & 4 \\ & 7 \\ & 11 \end{aligned}$ |  |
| 1 pol 2 pol 3 pol | 8 Step |  |  | $\begin{aligned} & \text { ■ } \\ & \text { 可 } \\ & \square^{4} \end{aligned}$ | $\begin{aligned} & \text { b } \\ & \text { 可 } \\ & \text { b } \end{aligned}$ |  | $\begin{aligned} & \text { A235-600 } \\ & \text { A255-600 } \\ & \text { A275-600 } \end{aligned}$ | $\begin{aligned} & 4 \\ & 8 \\ & 12 \end{aligned}$ | 1－3 pole |
| 1 pole | 9 Step |  | $\square$ | $\square$ | ■ | $\square$ | A236－600 | 5 |  |
| 1 pole | 10 Step |  | $\square$ | $\square$ | $\square$ | $\square$ | A237－600 | 5 |  |
| 1 pole | 11 Step |  | $\square$ | $\square$ | $\square$ | $\square$ | A238－600 | 6 |  |
| 1 pol <br> 1 pol | 12 Step $360^{\circ}$ rotation |  | $\square$ | $\square$ | $\begin{aligned} & \square^{3} \\ & \square^{3} \end{aligned}$ | $\begin{aligned} & \square^{1} \\ & \square^{1} \end{aligned}$ | $\begin{array}{\|l} \text { A239-600 } \\ \text { A639-600 } \end{array}$ | $\begin{aligned} & 6 \\ & 6 \end{aligned}$ |  |

## Switch Function and Configuration

|  |  |  | Type/Handle |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Function | Escutch. Plate | $\begin{aligned} & \text { CA4 } \\ & \text { CA4-1 } \\ & \text { CL4 } \end{aligned}$ | $\begin{aligned} & \text { CAD.. } \\ & \text { CA10- CA10B- } \\ & \text { CA25 C43 } \\ & \text { CL10 } \end{aligned}$ | $\begin{aligned} & \text { C80- } \\ & \text { C315 } \end{aligned}$ | Code | Stages | Connection Diagram |

Multi-step Switches without „OFF" with electrically isolated contacts

\begin{tabular}{|c|c|c|c|c|c|c|c|c|}
\hline \begin{tabular}{l}
1 pole 3 Step \\
2 pole
\end{tabular} \& \[
\begin{aligned}
\& x_{2}, \gamma^{3} \\
\& 1^{3}
\end{aligned}
\] \& \begin{tabular}{l}
\(\square\) \\
\(\square\)
\end{tabular} \& \begin{tabular}{l}
\(\square\) \\
\(\square\)
\end{tabular} \& \begin{tabular}{l}
■ \\
\(\square\)
\end{tabular} \& \begin{tabular}{l}
\(\square\) \\
-
\end{tabular} \& A730-600
A750-600 \& \[
2
\]
\[
3
\] \&  \\
\hline \begin{tabular}{l}
1 pole 4 Step \\
2 pole
\end{tabular} \& \[
{ }^{\phi_{2}, \sigma^{3}}{ }^{1}-4
\] \& \(\square\) \& \(\square\) \& \(\square\) \& \begin{tabular}{l}
\(\square\) \\
\(\square\)
\end{tabular} \& \begin{tabular}{l}
A731-600 \\
A751-600
\end{tabular} \& 2

4 \&  <br>
\hline
\end{tabular}

Multi-step Switches with „OFF"


|  |  |  | Type/Handle |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Function | Escutch. Plate | CA4 <br> CA4- <br> CL4 | $\begin{aligned} & \text { CAD.. } \\ & \text { CA10- CA10B- } \\ & \text { CA25 C43 } \\ & \text { CL10 } \end{aligned}$ | $\begin{aligned} & \mathrm{C80} \\ & \mathrm{C} 315 \end{aligned}$ | Code | Stages | Connection Diagram |

Multi-step Switches with „OFF"

\begin{tabular}{|c|c|c|c|c|c|c|c|c|c|c|}
\hline \begin{tabular}{l}
1 pol 2 pol 3 pole 4 pole \\
1 pole \\
2 pole \\
3 pole \\
4 pole
\end{tabular} \& \&  \& \(\square\)
0
0
0
0
0
0
0 \& \(\square\)
0
0
0
0
0
0
0 \& \[
\begin{aligned}
\& 0 \\
\& 0 \\
\& 0 \\
\& 0 \\
\& 0 \\
\& 0 \\
\& 0 \\
\& 0 \\
\& 0
\end{aligned}
\] \& \[
\begin{aligned}
\& \square \\
\& 0 \\
\& 0 \\
\& 0 \\
\& 0 \\
\& 0 \\
\& 0 \\
\& 0
\end{aligned}
\] \& \[
\begin{array}{|l}
\text { A242-600 } \\
\text { A262-600 } \\
\text { A282-600 } \\
\text { A482-600 } \\
\text { A242-620 } \\
\text { A262-620 } \\
\text { A282-620 } \\
\text { A482-620 }
\end{array}
\] \& 2 \& \[
\begin{aligned}
\& \begin{array}{l}
5_{5}^{5} 3^{7} \\
1_{0} 0_{0}^{0} \\
p_{2}
\end{array} \\
\& 1-4 \text { pole }
\end{aligned}
\] \&  \\
\hline \begin{tabular}{l}
1 pole \\
2 pole \\
3 pole \\
1 pole \\
2 pole \\
3 pole
\end{tabular} \& 5 Step \&  \& \[
\begin{aligned}
\& \square \\
\& \square \\
\& \square \\
\& \square \\
\& \square \\
\& \square
\end{aligned}
\] \& \[
\begin{aligned}
\& 0 \\
\& 0 \\
\& 0 \\
\& 0 \\
\& 0 \\
\& 0 \\
\& 0
\end{aligned}
\] \& \(\square\)
0
0
0
0
0 \& \[
\begin{aligned}
\& \text { ® } \\
\& 0 \\
\& 0 \\
\& 0 \\
\& 0 \\
\& 0 \\
\& 0
\end{aligned}
\] \& \begin{tabular}{l}
A243-600 \\
A263-600 \\
A283-600 \\
A243-620 \\
A263-620 \\
A283-620
\end{tabular} \& 5
8
3
5
8 \&  \&  \\
\hline \begin{tabular}{l}
1 pole \\
2 pole \\
3 pole \\
1 pole \\
2 pole \\
3 pole
\end{tabular} \& 6 Step \&  \& \[
\begin{aligned}
\& \square \\
\& \square^{1} \\
\& \square^{1} \\
\& \square \\
\& \square^{1}
\end{aligned}
\] \& \[
\begin{aligned}
\& \square \\
\& \square \\
\& \square \\
\& \square \\
\& \square \\
\& 0 \\
\& 0
\end{aligned}
\] \& \[
\begin{aligned}
\& 0 \\
\& 0 \\
\& 0 \\
\& 0 \\
\& 0 \\
\& 0
\end{aligned}
\] \& \[
\begin{aligned}
\& \square \\
\& 0 \\
\& 0 \\
\& 0 \\
\& 0 \\
\& 0 \\
\& 0
\end{aligned}
\] \& \begin{tabular}{l}
A244-600 \\
A264-600 \\
A284-600 \\
A244-620 \\
A264-620 \\
A284-620
\end{tabular} \& 3
6
9
3
6
9 \&  \&  \\
\hline \begin{tabular}{l}
1 pol \\
2 pole \\
1 pole \\
2 pole
\end{tabular} \& \&  \& \begin{tabular}{l}
\[
\begin{aligned}
\& \square \\
\& \square
\end{aligned}
\] \\
\(\stackrel{\square}{\square}\)
\end{tabular} \& \begin{tabular}{l}
단 \\
붑
\end{tabular} \& \[
\begin{aligned}
\& \square \\
\& \square \\
\& \square \\
\& 0
\end{aligned}
\] \& \[
\begin{aligned}
\& \square \\
\& \square \\
\& \square \\
\& \square
\end{aligned}
\] \& \[
\begin{aligned}
\& \text { A245-600 } \\
\& \text { A265-600 } \\
\& \text { A245-620 } \\
\& \text { A265-620 }
\end{aligned}
\] \& 4
7
4
4 \&  \&  \\
\hline \begin{tabular}{l}
1 pole \\
1 pole
\end{tabular} \& \&  \& \begin{tabular}{l}
\(\square\) \\
\(\square\)
\end{tabular} \& \(\square\) \& \begin{tabular}{l}
- \\
\(\square\)
\end{tabular} \& \[
\square
\] \& A246-600
A246-620 \& 4
4 \&  \& \\
\hline \begin{tabular}{l}
1 pole \\
1 pole
\end{tabular} \& \[
9 \text { Step }
\] \&  \& \begin{tabular}{l}
\(\square\) \\
\(\square\)
\end{tabular} \& \(\square\) \& \begin{tabular}{l}
- \\
\(\square\)
\end{tabular} \& \[
\square
\] \& \begin{tabular}{l}
A247-600 \\
A247-620
\end{tabular} \& 5
5 \&  \& \\
\hline \begin{tabular}{l}
1 pole \\
1 pole
\end{tabular} \& \[
10 \text { Step }
\] \&  \& \begin{tabular}{l}
\(\square\) \\
\(\square\)
\end{tabular} \& \begin{tabular}{l}
\(\square\) \\
\(\square\)
\end{tabular} \& \begin{tabular}{l}
- \\
\(\square\)
\end{tabular} \& \[
\square
\] \& A248-600
A248-620 \& 5
5 \&  \& \\
\hline \begin{tabular}{l}
1 pol \\
1 pole \\
1 pole \\
1 pole
\end{tabular} \& \begin{tabular}{l}
11 Step \(360^{\circ}\) rotation \\
\(360^{\circ}\) rotation
\end{tabular} \&  \& \begin{tabular}{l}
\[
\square
\] \\
\(\square\)
\end{tabular} \& \begin{tabular}{l}
\(\square\) \\
\(\square\)
\end{tabular} \& \begin{tabular}{l}
- \\
\(\square\)
\end{tabular} \& \begin{tabular}{l}
\(\square\) \\
\(\square\)
\end{tabular} \& \[
\begin{aligned}
\& \text { A249-600 } \\
\& \text { A649-600 } \\
\& \text { A249-620 } \\
\& \text { A649-620 }
\end{aligned}
\] \& 6
6

6
6 \&  \& <br>
\hline
\end{tabular}

## Switch Function and Configuration

| Function | Escutch． <br> Plate | Type／Handle |  |  | CA4   <br> CA4－1 CA10－ CAD．．CA10B－ <br> CL4 CA25 CL10 <br> CA25B   | Code |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | Stages | Connection Diagram |
| :---: |

Voltmeter Switches without „OFF＂

| 3 phase 3 wire |  | $\square$ <br> $\square$ | $\stackrel{\square}{\square}$ <br> $\square$ | － <br> $\square$ | $\square$ <br> $\square$ | $\begin{aligned} & \text { A023-600 } \\ & \text { A023-620 } \end{aligned}$ | 2 2 | $2 \circ \text { (V) }-4$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 3 phase 3 wire 3 phase to phase and phase to neutral |  | $\square$ <br> $\square$ | $\square$ <br> $\square$ | $\square$ <br> $\square$ | $\square$ <br> $\square$ | $\begin{aligned} & \text { A025-600 } \\ & \text { A025-620 } \end{aligned}$ | 3 3 | $1 \circ \text { (V) } \circ 3$ |

Voltmeter Switches with „OFF＂

| $\begin{aligned} & 2 \text { pole } \\ & 360^{\circ} \text { rotation } \end{aligned}$ |  | $\square$ | 婁 | 㤟 | 鄲 | A002－600 | 1 |  | 20 －V－4 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 3 phase 3 wire | ${ }_{\text {st }}^{\text {st }}$ | $\square$ | － | $\square$ | $\square$ | A004－600 | 2 |  |  |
|  |  | $\square$ | 㤟 | 㤟 | 婁 | A004－620 | 2 |  |  |
|  |  | $\square$ | 㤟 | 㤟 | 㤟 | A004－621 | 2 | L1 $\rightarrow$－R |  |
|  |  | $\square$ | $\square$ | $\square$ | $\square$ | A004－622 | 2 | $175$ |  |
|  |  | $\square$ | $\square$ | $\square$ | $\square$ | A004－623 | 2 |  |  |
|  |  | $\square$ | $\square$ | $\square$ | $\square$ | A004－624 | 2 |  |  |
|  |  | $\square$ | 豊 | 㤟 | 㤟 | A011－600 | 2 |  | 20 －（V）－6 |


|  | Type/Handle |  |  |  |  | Code | Stages | Connection Diagram |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Function | Escutch. <br> Plate | CA4 <br> CA4-1 <br> CL4 | $\begin{aligned} & \text { CA10- } \\ & \text { CA25 } \end{aligned}$ | $\begin{aligned} & \text { CAD.. } \\ & \text { CL10 } \end{aligned}$ | CA10BCA25B |  |  |  |

Voltmeter Switches with „OFF"


## Switch Function and Configuration



Voltmeter Switches with „OFF＂

| 3 phase and 1 phase to neutral |  | 6 | $\square$ | $\square^{1}$ | A010－600 | 3 | $4 \circ \text { V } \circ 6$ |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | $\square$ | 曹 | 曹 ${ }^{1}$ | A010－620 | 3 |  |  |
|  |  | $\square$ | 曹 | 蓸 ${ }^{1}$ | A010－621 | 3 |  |  |
|  |  | 可 | 可 | $\square^{1}$ | A010－622 | 3 |  |  |

## Ammeter Switches

\begin{tabular}{|c|c|c|c|c|c|c|c|c|}
\hline Single pole with one current transformer \&  \& \[
\square^{2}
\]
\[
\square^{2}
\]
\[
\square^{2}
\] \& \begin{tabular}{l}
\(\square^{2}\) \\
豊 \({ }^{2}\) \\
豊 \({ }^{2}\)
\end{tabular} \& \begin{tabular}{l}
\(\square\) \\
婁 \\
䡒
\end{tabular} \&  \& \begin{tabular}{l}
A046－600 \\
A046－620 \\
A046－621
\end{tabular} \& 1
1 \&  \\
\hline Single pole with 3 current transformers without „OFF＂ \& \begin{tabular}{|c|}
\hline AMMEEER \\
\hline \begin{tabular}{c}
\(\Phi\) \\
\(1-\mathrm{O}-3\)
\end{tabular} \\
\hline
\end{tabular}
\[
\begin{array}{|cc|}
\hline \& { }^{2} \\
1 \& -1^{-}-3 \\
\hline
\end{array}
\] \& \[
\begin{gathered}
\square^{2} \\
\text { CL4 } \\
\text { CL4 }
\end{gathered}
\] \& \begin{tabular}{l}
豊 \({ }^{2}\) \\
CL10 \\
豊 \({ }^{2}\) \\
CL10
\end{tabular} \& \begin{tabular}{l}
豊 \\
曾
\end{tabular} \& \& \begin{tabular}{l}
A017－600 \\
A059－600 \\
A017－620 \\
A059－620
\end{tabular} \& 3

3 \&  <br>

\hline Single pole with 3 current transformers with „OFF＂ $360^{\circ}$ rotation \&  \& \[
$$
\begin{gathered}
\square^{2} \\
C L 4 \\
C L 4 \\
\sigma^{2} \\
C L 4 \\
C \sigma^{2} \\
C 4 \\
C L 4
\end{gathered}
$$

\] \& \[

$$
\begin{gathered}
\square^{2} \\
\text { CL10 } \\
\text { 豊 }^{2} \\
\text { CL10 } \\
\square^{2} \\
\text { CA10 } \\
\text { CL10 } \\
\square^{2} \\
\text { CL10 } \\
\text { CL10 }
\end{gathered}
$$

\] \& | $\square$ |
| :--- |
| 豊 |
| G |
| ■ |
| 曾 | \& \& | A048－600 |
| :--- |
| A058－600 |
| A048－620 |
| A058－620 |
| A048－621 |
| A058－621 |
| A048－622 |
| A058－622 |
| A048－623 |
| A058－623 | \& 3

3
3
3
3

3 \& | $3 \circ$（A）$\circ 9$ |
| :--- |
| for A058： |
| $9 \circ$（A）-11 | <br>

\hline
\end{tabular}

${ }^{1}$ available only up to switch type CA25B ${ }^{2}$ not available for switch types CL4 and CL10

|  |  |  | Type／Handle |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Function | Escutch． Plate | CA4 <br> CA4－1 <br> CL4 | $\begin{aligned} & \text { CAD.. } \\ & \text { CA10- CA10B- } \\ & \text { CA25 C42 } \\ & \text { CL10 } \end{aligned}$ | $\begin{aligned} & \mathrm{C} 43- \\ & \mathrm{C} 125 \end{aligned}$ | Code | Stages | Connection Diagram |

## Ammeter Switches

\begin{tabular}{|c|c|c|c|c|c|c|c|c|}
\hline Single pole with 2 current transformers（3 readings） \&  \& \begin{tabular}{l}
\(\square\) \\
\(\square\)
\end{tabular} \& \begin{tabular}{l}
豊 \\
豊
\end{tabular} \& \begin{tabular}{l}
豊 \\
䡒
\end{tabular} \& \& \[
\begin{aligned}
\& \text { A021-600 } \\
\& \text { A021-620 }
\end{aligned}
\] \& 2

2 \& | for CL switches： |
| :--- |
| $1 \circ$－ $\mathrm{A}-3$ |
| $5 \circ$－A -3 | <br>

\hline | Single pole with |
| :--- |
| 4 current transformers | \&  \& \[

$$
\begin{gathered}
\square^{1} \\
\text { CL4 } \\
\text { CL4 }
\end{gathered}
$$

\] \& | CL10 |
| :--- |
| 豊 ${ }^{1}$ |
| CL10 | \& 费 \& \& A036－600

A056－600
A036－620
A056－620 \& 4

4 \& | $1 \circ$（A）-5 |
| :--- |
| $13 \circ$－A－ 15 | <br>

\hline | 2 pole |
| :--- |
| 2 current transformers | \&  \& | G |
| :--- |
| G | \& | $\square$ |
| :--- |
| 豊 |
| 䡒 | \& | $\square$ |
| :--- |
| 豊 |
| 豊 | \&  \& \[

$$
\begin{aligned}
& \text { A037-600 } \\
& \text { A037-620 } \\
& \text { A037-621 }
\end{aligned}
$$
\] \& 3

3

3 \& $$
1 \circ-A-8
$$ <br>

\hline | 2 pole |
| :--- |
| 3 current transformers | \&  \& | － |
| :--- |
| $\square$ | \& | 曹 |
| :--- |
| 豊 | \& | 䡒 |
| :--- |
| 唺 | \& \& | A019-600 |
| :--- |
| A019－620 | \& 5

5 \& $$
\begin{aligned}
& 3 \circ A 1-6 \\
& 17 \circ A 2-20 \\
& 8 \circ A 3-9
\end{aligned}
$$ <br>

\hline \&  \& $$
\square^{1}
$$

四

\[
\mathrm{g}^{1}

\] \& | $\square^{1}$ |
| :--- |
| 䡒 ${ }^{1}$ |
| $\square^{1}$ | \& | $\square$ |
| :--- |
| 䡒 |
| $\square$ | \& | $\square$ |
| :--- |
| $\square$ | \& A038－600

A038－620
A038－621 \& 5
5
5 \& $2 \circ$（A）-9 <br>

\hline | 2 pole |
| :--- |
| 4 current transformers | \&  \& | $\square^{1}$ |
| :--- |
| $\square^{1}$ | \& | $\square^{1}$ |
| :--- |
| 豊 ${ }^{1}$ | \& | － |
| :--- |
| 豊 | \& 『 \& \[

$$
\begin{aligned}
& \text { A039-600 } \\
& \text { A039-620 }
\end{aligned}
$$
\] \& 6

6 \& $$
2 \circ-A-9
$$ <br>

\hline
\end{tabular}

## Switch Function and Configuration

|  |  |  | Type／Handle |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Function | Escutch． Plate | $\begin{aligned} & \text { CA4 } \\ & \text { CA4-1 } \\ & \text { CL4 } \end{aligned}$ | CAD．． <br> CA10－CA10B－ <br> CA25 CA25B <br> CL10 | $\begin{aligned} & \mathrm{C} 26- \\ & \mathrm{C} 43 \end{aligned}$ | Code | Stages | Connection Diagram |

## Volt－ammeter Switches

| 3 phase－phase to phase 3 current |  | $\square^{1}$ CL4 | $\begin{gathered} \square^{1} \\ \text { CL10 } \\ \\ \square^{1} \end{gathered}$ | ㅁ． <br> － | － | A027－600 <br> A057－600 <br> A028－600 | 6 7 | for A027： <br> 20 －（A）-12 <br> 160 －（v）-24 <br> for A057： <br> $9 \circ$－（A）$\rightarrow 11$ <br> 14－（V）－022 <br> 20－（A）$\rightarrow 11$ <br> $170-$（v）$\rightarrow 23$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 3 phase voltage 3 phase current 4 wire |  | $\square$ | 曲 | 豊 | 㤟 | A033－600 | 5 | for CL switches： <br> ＊19 instead of 11 |
| 3 phase voltage <br> 3 phase current <br> 3 wire |  | $\square$ | 蕽 | 會 | 詈 | A035－600 | 5 | for CL switches： <br> 9＊。－（A）－ 11 ＊17 instead of 9 10 －（V）－ 3 |

## Control Switches

| Stop switch |  | $\square$ | $\square$ | $\square$ | $\square$ | A174－600 | 1 | $\text { stop }{ }^{\prime} \underbrace{1}_{2}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Start switch |  | $\square$ | $\square$ | $\square$ | $\square$ | A175－600 | 1 | $\underbrace{\text { StaAt }}_{2}{ }^{\circ} 0^{1}$ |
| Stop start switch single pole |  | $\square$ | $\square$ | $\square$ | $\square$ | A176－600 | 1 |  |
| Stop start switch 2 pole |  | － | $\square$ | $\square$ | $\square$ | A183－600 | 2 |  |
| Stop start switch with spring return from start to run |  | $\square$ <br> $\square$ |  |  |  | A178－600 <br> A178－620 | 1 1 |  |
| Stop start switch with spring return to run for 2 units |  | $\square$ | $\square$ <br> $\square$ | $\square$ <br> － | $\square$ <br> $\square$ | A177－600 <br> A177－620 | 2 |  |

## Switch Function and Configuration



## Control Switches

| Stop start switch with spring return to run with contactor interlock contactors for 2 units |  | $\square$ | 단 | - | ■ | A182-600 A182-620 | $2$ $2$ |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Motor voltage control switch |  | $\square$ | 5 | 5 |  | A150-600 | 2 |  |

Control Switches with electrically isolated contacts

| Stop start switch single pole |  | $\square$ | $\square$ | $\square$ | $\square$ | A789-600 | 1 |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Stop start switch with spring return to 1 | $\left[\begin{array}{ll} 1 & 1 \\ 0 \text { ssant } \\ 0 & -5 \end{array}\right.$ | $\square$ | $\square$ | $\square$ | $\square$ | A791-600 | 1 |  |
| Stop start switch with spring return to run for 2 units | shane | $\square$ | $\square$ | $\square$ | $\square$ | A790-600 | 2 |  |
| Contactor control with spring return to „OFF" |  | $\square$ <br> $\square$ | $\square$ <br> $\square$ | $\square$ <br> $\square$ | - <br> $\square$ | A179-600 A179-620 | $2$ $2$ |  |
| Circuit breaker control |  | $\square$ | \% | \% | 0 | A537-600 | 2 | $\stackrel{\text { mip memal }}{\varphi_{2}^{1}} \frac{\dagger_{4}^{0^{3}}}{\varphi_{6}^{5}} \stackrel{y}{8}_{0^{7}}$ |

## Control and Alarm Switches ${ }^{1}$



Switch Function and Configuration

|  |  | Type/Handle |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Function | Escutch. Plate | CA4 CA4CL4 | $\begin{aligned} & \text { CAD.. } \\ & \text { CA10- } \\ & \text { CA25 } \\ & \text { CL10 } \end{aligned}$ | $\begin{aligned} & \text { СА..B } \\ & \text { C26- } \\ & \text { C43 } \end{aligned}$ | $\begin{aligned} & \mathrm{C} 80- \\ & \mathrm{C} 315 \end{aligned}$ | Code | Stages | Connection Diagram |

Motor Reversing Switches


## Motor Control Switches



|  |  |  | Type/Handle |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Function | Escutch. Plate | CA4 <br> CA4-1 <br> CL4 | CAD.. <br> CA10- CA10B- <br> CA25 CA25B <br> CL10 | C26- <br> C315 | Code | Stages | Connection Diagram |

## Motor Control Switches

| 2 speed single winding |  | $\square$ | $\square$ | $\square$ | $\square$ | $\begin{aligned} & \text { A440-600 } \\ & \text { A440-620 } \end{aligned}$ | 4 $4$ |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 2 speed single winding without „OFF" | ${ }^{\circ} \gamma^{1}$ | $\square$ | $\square$ | $\square$ | $\square$ | A466-600 | 4 |  |
| 2 speed single winding with center "OFF" |  |  | $\square$ <br> $\square$ |  | $\square$ <br> $\square$ | A441-600 <br> A441-620 | 4 <br> 4 |  |
| 2 speed single winding reversing |  | $\square$ | $\square$ <br> $\square$ | $\square$ | $\square$ <br> $\square$ | A442-600 A442-620 | 6 <br> 6 |  |
| 2 speed single winding for use with contactors |  | $\square$ | $\square$ <br> $\square$ | $\square$ | $\square$ | A444-600 <br> A444-620 | $5$ $5$ |  |
| 2 speed reversing for 2 way operation with slip clutch for „OFF" load use |  |  | $\square^{2}$ $\square^{2}$ | $\square$ | $\square$ <br> $\square$ | $\begin{aligned} & \text { A468-600 } \\ & \text { A468-620 } \end{aligned}$ | $\begin{aligned} & 10^{1} \\ & 10^{1} \end{aligned}$ |  |

## Switch Function and Configuration

|  |  | Type/Handle |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Function | Escutch. Plate | CA4 CA4CL4 | CAD.. CA25 CL10 | CA..B C26C43 | $\begin{aligned} & \mathrm{C} 80- \\ & \mathrm{C} 315 \end{aligned}$ | Code | Stages | Connection Diagram |

## Star-delta Switches

| OFF-star-delta |  | $\square$ | $\square$ <br> $\square$ | 는 <br> $\square$ | $\square$ <br> $\square$ | A410-600 A410-620 | 4 $4$ |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Reversing |  | $\square$ | $\square$ | - | $\square$ | A413-600 | 5 |  |
| With auxiliary contact closed in „OFF" position |  | $\square$ | $\square$ | $\square$ | $\square$ | A416-600 | 5 |  |
| For use with reversing contactors | $\left[\begin{array}{ll} 0 & Y \\ 0-0-\Delta \end{array}\right]$ | $\square^{1}$ | $\square^{1}$ | $\square$ | $5{ }^{\circ}$ | A419-600 | 4 |  <br> $X$ $Y$ $Z$ <br> T4! T5! T6! <br> 1 5 2 |

## Start and Run Switches

| Split-phase start |  | ■ <br> $\square$ | ■ | b <br> 『 |  | $\begin{aligned} & \text { A425-600 } \\ & \text { A425-620 } \end{aligned}$ | $2$ $2$ |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Split-phase start reversing |  |  | $\square^{2}$ $\square^{2}$ | - <br> b |  | $\begin{aligned} & \text { A426-600 } \\ & \text { A426-620 } \end{aligned}$ | 3 <br> 3 |  |
| Split-phase reversing auto cutout of start field winding |  | $\square$ | 吅 | $\square$ | $\square$ | A622-600 | 3 |  |

## Mounting

## C, CA, CAD, CL, L Switches

| Two or Four Hole Panel Mounting | Terminals rotated $90^{\circ}$ | Code | CAD. <br> CA10 <br> CA25 <br> CL10 | $\begin{aligned} & \text { CA10B- } \\ & \text { C42 } \end{aligned}$ | C43- <br> C125 <br> L350- <br> L1251 <br> Size S2 | $\begin{aligned} & \text { C315 } \\ & \text { L400- } \\ & \text { L2000 } \\ & \text { Size S3 } \end{aligned}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |



## Mounting

C, CA, CAD, CL Switches
\(\left.$$
\begin{array}{|l|l|l|l|l|l|}\hline \text { Two or Four Hole Panel Mounting } & \text { Code } & \begin{array}{l}\text { CAD.. } \\
\text { CA10B } \\
\text { CA10- } \\
\text { CA11B } \\
\text { CA20B } \\
\text { CA25 } \\
\text { CA25B } \\
\text { CL10 }\end{array}
$$ \& \begin{array}{l}C32 <br>

C26\end{array} \& C42\end{array}\right\}\)| C43 |
| :---: |


|  | Panel mounting with heavy duty latching and metal shaft <br> Four screw panel mounting Mounting plate, escutcheon plate and handle of size SO | KN2 | $\bigcirc$ |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Four screw panel mounting Mounting plate, escutcheon plate and handle of size S1 | KN1 | $\bigcirc$ | - | $\bigcirc$ |  |
|  | Four screw panel mounting Mounting plate, escutcheon plate and handle of size S 1 and 6 mm square metal shaft | KD1 | - | - | - |  |
|  | Panel mounting with protective cover |  |  |  |  |  |
|  | Four screw panel mounting <br> Protection front IP 40 <br> rear IP 30 for CA and CAD <br> IP 42 for C26-C43 <br> Four screw panel mounting with additional shaft seal <br> Protection front IP 65 <br> rear IP 30 for CA and CAD <br> IP 42 for C26-C43 | EC | CAD.. <br> CA10- <br> CA25 | - | $\bigcirc$ | $\bigcirc$ |
|  |  | ED | CAD.. <br> CA10 <br> CA25 | - | - | - |
|  | Four screw panel mounting <br> Protection front IP 40 rear IP 42 | EC1 |  | - |  |  |
|  | Four screw panel mounting with additional shaft seal Protection front IP 65 rear IP 42 | ED1 |  | - |  |  |
|  | Two screw panel mounting Protection front IP 65 rear IP 42 | ED22 | CAD. CA10CA25 |  |  |  |

## Mounting

C, CA, CAD, CL Switches

| Single Hole Mounting | Terminals <br> rotated $90^{\circ}$ | Code | CA4 <br> CA4-1 <br> CL4 | CAD.. <br> CA10- <br> CA25 <br> CL10 |
| :--- | :--- | :--- | :--- | :--- |



## Mounting

C, CA, CAD, L Switches


## Mounting

C, CA, CAD, L Switches

| Base Mounting | Code | CA4 <br> CA4-1 | CAD.. <br> CA10- <br> CA25 <br> CL10 |
| :--- | :--- | :--- | :--- |



Snap-on base mounting for track EN 50022 with escutcheon plate for 45 mm standard knock-out.


Snap-on base mounting for track EN 50022. Both the escutcheon plate for 45 mm standard knock-out and the handle are adjustable in height.


Snap-on base mounting for track EN 50022 with circular escutcheon plate for 46 mm knock-out.


Base mounting - four hole - for circular escutcheon plate with 46 mm knock-out.


## Mounting

C, CA, CAD Switches

| Mounting Plates for Plaster Depth Boxes acc. to DIN 49070 and ÖNORM E6508 | CodeCAD.. <br> CA10- <br> CA25 |
| :--- | :--- | :--- |



## Escutcheon Plates



Square and rectangular escutcheon plates are available for each size of switch. The escutcheon plate consists of a frame and a faceplate having the switch positions which is than embossed with hot-foil backing. The escutcheon plate frame is an essential part of the switch and serves as a bearing surface for the handle. If the switch is to be mounted without an escutcheon plate we would recommend for size S1, S2 and S3 the handle bearing plate T100-04.

## Standard Letterings Available

(Over 500 standard letterings, special letterings upon request.)

## $30^{\circ}$ switching


$45^{\circ}$ switching

| ${ }^{\Phi_{0}} \bigvee^{1}{ }^{2}$ | ${ }^{Q_{1}}{ }_{\gamma}^{0}{ }^{2}$ | ${ }^{{ }^{\Phi}{ }_{1 N}} \bigvee^{\text {out }}$ | ${ }^{\infty}{ }^{1} \gamma^{2}$ | ${ }^{\Phi}{ }^{R} \gamma^{I}$ | ${ }^{\phi}{ }^{1} \vee^{2}$ | ${ }^{\Phi}{ }^{W} \mathrm{w}^{\mathrm{OFF}} \bigvee^{\mathrm{RVA}}$ | ${ }^{{ }^{\Phi}{ }_{1}^{00 F} V^{2}}$ | $\begin{array}{cc} \hline \alpha & \text { Off on } \\ & \sigma^{\text {ON }} \end{array}$ |  |  | ${ }^{\phi_{r}{ }_{0}^{1} ل^{1} b^{2}}$ | ${ }_{0}^{\alpha}{ }_{0}^{1} ل^{2} ل^{3}$ |  |  | Voltmeter <br> 1.2 .2 .3 <br> off- <br> of |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| F215 | F216 | F295 | F738 | F742 | F743 | F744 |  | F747 | F792 | F793 | F107 | F109 | F114 | F115 | F212 | F213 | F214 |
| $\begin{aligned} & \Phi_{\text {AUF HALT }}^{\text {AUU }} \\ & \text { AUTOOO }^{2} \end{aligned}$ |  | $\begin{aligned} & \Phi_{\text {AuT0 }}^{\text {Aut }} \\ & \text { Aus } \\ & \text { AUS } \end{aligned}$ | ${ }^{\Phi}{ }_{1}^{2} \overbrace{}^{3} \downarrow^{4}$ | $\Phi_{\Phi_{\text {AuT }}^{1} \downarrow^{2}}^{0} \underbrace{2}$ |  |  |  | $\begin{array}{\|l\|} \hline \text { Volimeter } \\ \Phi_{\text {RYM }}{ }^{\text {YB }} \\ \text { Off } \\ \text { B }^{\text {BR }} \end{array}$ | $\begin{array}{\|l\|} \hline \text { voirmeter } \\ \hline \begin{array}{l} \Phi_{\text {RWW WB }} \\ \text { off- } \\ \hline \sigma^{\text {BR }} \end{array} \\ \hline \end{array}$ |  |  | $\begin{array}{\|l\|} \hline \text { VolTMEtER } \\ \hline \Phi_{\text {RN }}^{\text {WN }} \\ \text { Off- } \zeta^{\text {BN }} \end{array}$ |  |  |  | $\begin{aligned} & \Phi_{1.2}^{2.3} \\ & \text { off }-b^{3.1} \end{aligned}$ | $\begin{aligned} & \phi_{\mathrm{RS}} \\ & \mathrm{OFF}^{\mathrm{ST}} \bigcup^{\mathrm{C}} \end{aligned}$ |
| F217 | F267 | F289 | F330 | F375 | F376 | F383 | F408 | F409 | F410 | F411 | F412 | F413 | F426 | F427 | F430 | F729 | F752 |
| $\begin{aligned} & \Phi_{\mathrm{RS}} \mathrm{ST}^{\mathrm{ST}} \mathrm{~V}^{\mathrm{TR}} \\ & 0 \rightarrow{ }^{2} \end{aligned}$ |  |  |  | $\left[\begin{array}{l} \Phi_{\text {R0 }}^{S 0} \\ 0_{0}^{\text {So }} \underbrace{\text { To }} \end{array}\right.$ |  |  | $\left.\right\|_{\Phi_{\text {RWW }}^{\text {RB }}} ^{\text {Wef }}$ | $\begin{aligned} & \Phi_{\mathrm{KN}}^{\mathrm{KN}} \mathrm{YN}_{\mathrm{OFF}}^{\mathrm{ON}} \mathrm{C}^{\mathrm{BN}} \end{aligned}$ |  |  |  |  |  |  |  |  |  |
| F775 | F776 | F777 | F778 | F779 | F780 | F781 | F796 | F797 | F798 | F105 | F108 | F112 | F113 | F117 | F118 | F293 | F419 |
|  | $\begin{aligned} & \Phi_{\text {off }}^{2} \\ & 1-\underbrace{\text { off }}_{0} \\ & 1 \end{aligned}$ |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| F429 | F739 | F741 | F789 | F790 | F791 | F794 | F795 | F106 | F110 | F116 | F294 | F317 | F414 | F415 | F416 | F417 | F418 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| F782 | F783 | F784 | F785 | F786 | F787 | F788 | F799 | F111 | F210 | F211 | F284 | F285 | F296 | F322 | F727 | F740 |  |

## Escutcheon Plates



Handles

| Type | Color | Code | Size <br> $\mathrm{S00} \mathrm{SO} \mathrm{S} 1$ <br> $\mathrm{~S} 2 \mathrm{S3}$ |
| :--- | :--- | :--- | :--- |


| Type | Color | Code | Size <br> S00 S0 S1 S2 S3 |
| :--- | :--- | :--- | :--- |



| I-Handle | black <br> red <br> white <br> electro- <br> gray | $\begin{aligned} & \text { G251 } \\ & \text { G252 } \\ & \text { G253 } \\ & \text { G257 } \end{aligned}$ | $\begin{aligned} & \bullet \\ & \bullet \end{aligned} \cdot \bullet \cdot \bullet$ |
| :---: | :---: | :---: | :---: |
| B-Handle | black <br> red <br> white <br> electro- <br> gray | $\begin{aligned} & \text { G521 } \\ & \text { G522 } \\ & \text { G523 } \\ & \text { G527 } \end{aligned}$ |  |
| L-Handle | black <br> red <br> white <br> electro- <br> gray | $\begin{aligned} & \text { G501 } \\ & \text { G502 } \\ & \text { G503 } \\ & \text { G507 } \end{aligned}$ | $\begin{aligned} & -\quad \bullet \\ & --\quad- \\ & -\quad-\quad- \\ & -\quad-\quad- \\ & -\quad- \end{aligned}$ |
| K-Handle | black <br> red <br> white <br> electro- <br> gray | G411 <br> G412 <br> G413 <br> G417 |  |
| O-Handle | black <br> red <br> white <br> electro- <br> gray | $\begin{aligned} & \text { G321 } \\ & \text { G322 } \\ & \text { G323 } \\ & \text { G327 } \end{aligned}$ |  |



[^25]| Selection Data | CAD11 | CAD12 |
| :--- | :--- | :--- |



[^26]Two or Four Hole Panel Mounting


Two or Four Hole Panel Mounting

|  |  |  | $-\infty$ | E22 E22-V |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  |  | CA10 <br> CA11 <br> CAD11 <br> CAD12 | $\begin{aligned} & \\ & 1 \\ & 1 \\ & 2 \end{aligned} \quad \text { CL10 }$ | CA20 | CA25 |
|  |  |  |  |  |  |  | A | $\begin{aligned} & \overline{48} \\ & 1.89 \end{aligned}$ | $\begin{aligned} & \hline 48 \\ & 1.89 \end{aligned}$ | $\begin{aligned} & 48 \\ & 1.89 \end{aligned}$ | $\begin{aligned} & \hline 48 \\ & 1.89 \end{aligned}$ |
|  |  |  |  |  |  |  | B | $\begin{aligned} & \hline 43 \\ & 1.69 \end{aligned}$ | $\begin{aligned} & \hline 50 \times 56 \\ & 1.97 \times 2.20 \end{aligned}$ | $\begin{array}{ll}  & 45 \\ 0 & 1.77 \end{array}$ | $\begin{aligned} & 46 \\ & 1.81 \\ & \end{aligned}$ |
|  |  |  |  |  |  |  | C | $\begin{aligned} & \hline 4 \\ & .16 \end{aligned}$ | $\begin{aligned} & 4 \\ & .16 \\ & \hline \end{aligned}$ | $\begin{aligned} & 4 \\ & .16 \end{aligned}$ | $\begin{aligned} & 4 \\ & .16 \end{aligned}$ |
|  |  |  |  |  |  |  | D1 | $\begin{aligned} & 5 \\ & .20 \end{aligned}$ | $\begin{aligned} & 5 \\ & .20 \end{aligned}$ | $\begin{aligned} & \hline 5 \\ & .20 \end{aligned}$ | $\begin{aligned} & 5 \\ & .20 \end{aligned}$ |
|  |  |  |  |  |  |  | E | $\begin{aligned} & 30 \\ & 1.17 \end{aligned}$ | $\begin{aligned} & 30 \\ & 1.17 \end{aligned}$ | $\begin{aligned} & 30 \\ & 1.17 \end{aligned}$ | $\begin{aligned} & 30 \\ & 1.17 \end{aligned}$ |
| $\begin{aligned} & \text { EG } \\ & \text { EGF } \end{aligned}$ |  |  |  |  |  | 埗 |  |  |  |  |  |
|  |  |  | CA10 <br> CA11 <br> CAD11 <br> CAD12 | CL10 | CA20 | CA25 | C26 | C32 | C42 | C80 | C125 <br> L switches <br> Size S2 |
|  |  | A | $\begin{aligned} & \hline 64 \\ & 2.52 \\ & \hline \end{aligned}$ | $\begin{aligned} & 64 \\ & 2.52 \end{aligned}$ | $\begin{aligned} & \hline 64 \\ & 2.52 \end{aligned}$ | $\begin{aligned} & \hline 64 \\ & 2.52 \end{aligned}$ | $\begin{aligned} & \hline 88 \\ & 3.46 \end{aligned}$ | $\begin{aligned} & \hline 88 \\ & 3.46 \end{aligned}$ | $\begin{aligned} & \hline 88 \\ & 3.46 \end{aligned}$ | $\begin{aligned} & 130 \\ & 5.12 \end{aligned}$ | $\begin{aligned} & \hline 130 \\ & 5.12 \\ & \hline \end{aligned}$ |
|  |  | B | $\begin{aligned} & \overline{43} \\ & 1.69 \end{aligned}$ | $\begin{aligned} & \hline 50 \times 56 \\ & 1.97 \times 2.20 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 45 \\ & 1.77 \end{aligned}$ | $\begin{aligned} & \hline 46 \\ & 1.81 \end{aligned}$ | $\begin{aligned} & \hline 58 \\ & 2.28 \end{aligned}$ | $\begin{aligned} & 60 \\ & 2.36 \end{aligned}$ | $\begin{aligned} & 66 \\ & 2.60 \end{aligned}$ | $\begin{aligned} & 84 \\ & 3.30 \end{aligned}$ | $\begin{aligned} & \hline 88 \\ & 3.46 \end{aligned}$ |
|  |  | C | $\begin{aligned} & \hline 4 \\ & .16 \\ & \hline \end{aligned}$ | $\begin{aligned} & 4 \\ & .16 \end{aligned}$ | $\begin{aligned} & 4 \\ & .16 \\ & \hline \end{aligned}$ | $\begin{aligned} & 4 \\ & .16 \end{aligned}$ | $\begin{array}{r} 5,5 \\ .22 \\ \hline \end{array}$ | $\begin{array}{r} 5,5 \\ .22 \\ \hline \end{array}$ | $\begin{aligned} & 5,5 \\ & .22 \end{aligned}$ | $\begin{aligned} & 7 \\ & .28 \end{aligned}$ | $\begin{aligned} & 7 \\ & .28 \end{aligned}$ |
|  |  | D1 | $\begin{aligned} & 5 \\ & .20 \end{aligned}$ | $\begin{aligned} & 5 \\ & .20 \end{aligned}$ | $55$ | $\begin{aligned} & \hline 5 \\ & .20 \end{aligned}$ | $\begin{aligned} & 6 \\ & .24 \end{aligned}$ | $\begin{aligned} & \hline 6 \\ & \hline .24 \\ & \hline \end{aligned}$ | $\begin{aligned} & 6 \\ & .24 \end{aligned}$ | $\begin{aligned} & 7 \\ & .28 \\ & \hline \end{aligned}$ | $\begin{aligned} & 7 \\ & .28 \end{aligned}$ |
|  | EG | D2 | $\begin{aligned} & \hline 10-15 \\ & .39-.59 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 10-15 \\ & .39-.59 \\ & \hline \end{aligned}$ | $\begin{aligned} & 10-15 \\ & .39-.59 \end{aligned}$ | $\begin{aligned} & \hline 10-15 \\ & .39-.59 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 13-17 \\ & .51-.67 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 13-17 \\ & .51-.67 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 13-17 \\ & .51-.67 \end{aligned}$ | $\begin{aligned} & 15,5-20 \\ & .61-.79 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 15,5-20 \\ & .61-.79 \\ & \hline \end{aligned}$ |
|  | EGF | D2 | $\begin{aligned} & \hline 19-22 \\ & .75-.87 \\ & \hline \end{aligned}$ | $\begin{aligned} & \text { 19-22 } \\ & .75-.87 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 19-22 \\ & .75-.87 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 19-22 \\ & .75-.87 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 26-30 \\ & 1.02-1.18 \end{aligned}$ | $\begin{aligned} & \hline 26-30 \\ & 1.02-1.18 \end{aligned}$ | $\begin{aligned} & \hline 26-30 \\ & 1.02-1.18 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 22-25 \\ & .87-.98 \\ & \hline \end{aligned}$ | $\begin{aligned} & 22-25 \\ & .87-.98 \end{aligned}$ |
|  |  | E | $\begin{aligned} & \hline 48 \\ & 1.89 \end{aligned}$ | $\begin{aligned} & 48 \\ & 1.89 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 48 \\ & 1.89 \end{aligned}$ | $\begin{aligned} & \hline 48 \\ & 1.89 \end{aligned}$ | $\begin{aligned} & \hline 68 \\ & 2.68 \end{aligned}$ | $\begin{aligned} & \hline 68 \\ & 2.68 \end{aligned}$ | $\begin{aligned} & 68 \\ & 2.68 \end{aligned}$ | $\begin{aligned} & \hline 104 \\ & 4.09 \end{aligned}$ | $\begin{aligned} & 104 \\ & 4.09 \end{aligned}$ |
|  | EG | M | $\begin{aligned} & 6,7 \\ & .26 \end{aligned}$ | $\begin{aligned} & 6,7 \\ & .26 \end{aligned}$ | $\begin{aligned} & 6,7 \\ & .26 \end{aligned}$ | $\begin{aligned} & 6,7 \\ & .26 \end{aligned}$ | $\begin{aligned} & 0,5 \\ & .02 \end{aligned}$ | $\begin{aligned} & 0,5 \\ & .02 \end{aligned}$ | $\begin{aligned} & 0,5 \\ & .02 \end{aligned}$ | $\begin{aligned} & 2 \\ & .08 \end{aligned}$ | $\begin{aligned} & 2 \\ & .08 \end{aligned}$ |
|  | EGF | M | $\begin{aligned} & 6,7 \\ & .26 \end{aligned}$ | $\begin{aligned} & 6,7 \\ & .26 \end{aligned}$ | $\begin{aligned} & \hline 6,7 \\ & .26 \end{aligned}$ | $\begin{aligned} & \hline 6,7 \\ & .26 \end{aligned}$ | $\begin{aligned} & \hline 0,5 \\ & .02 \end{aligned}$ | $\begin{aligned} & 0,5 \\ & .02 \end{aligned}$ | $\begin{aligned} & 0,5 \\ & .02 \end{aligned}$ | $\begin{aligned} & 2 \\ & .08 \end{aligned}$ | $\begin{aligned} & \hline 2 \\ & .08 \end{aligned}$ |

${ }^{1}$ see page 51

Four Hole Panel Mounting or Mosaic Mounting


E92


E94


KN1
KD1
KN2



| KN2 | CA10 <br> CA11 <br> CAD11 <br> CAD12 | CL10 | CA20 | CA25 | KN1 <br> KD1 | $\begin{aligned} & \text { CA10 } \\ & \text { CA11 } \\ & \text { CAD11 } \\ & \text { CAD12 } \end{aligned}$ | CL10 | CA20 | CA25 | CA10B <br> CA11B <br> CA20B | CA25B | C26 | C32 | C42 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| A | $\overline{48}$ | $\begin{aligned} & 48 \\ & 180 \end{aligned}$ | $\begin{aligned} & 48 \\ & 180 \end{aligned}$ | $\begin{aligned} & 48 \\ & 189 \end{aligned}$ | A | $\begin{aligned} & \overline{64} \\ & \hline 2.52 \end{aligned}$ | $\begin{aligned} & 64 \\ & \hline 2.52 \end{aligned}$ | $\begin{aligned} & 64 \\ & \hline 2.52 \end{aligned}$ | $\begin{aligned} & 64 \\ & \hline .52 \end{aligned}$ | $\begin{aligned} & 64 \\ & .62 .52 \end{aligned}$ | $\begin{aligned} & 64 \\ & \hline 252 \end{aligned}$ | $\begin{aligned} & 64 \\ & \hline 2.52 \end{aligned}$ | $\begin{aligned} & 64 \\ & \hline 2.52 \end{aligned}$ | $\begin{aligned} & 64 \\ & \hline 2.52 \end{aligned}$ |
| B | $\begin{aligned} & \hline 43 \\ & 1.69 \end{aligned}$ | $\begin{aligned} & \text { 50×56 } \\ & 1.97 \times 2.20 \end{aligned}$ | $\begin{aligned} & 45 \\ & 1.77 \end{aligned}$ | $\begin{aligned} & 46 \\ & { }_{1.81} \end{aligned}$ | B | $\begin{aligned} & 43 \\ & 1.69 \end{aligned}$ | $\begin{aligned} & \hline 50 \times 56 \\ & 1.97 \times 2.20 \end{aligned}$ | $\begin{aligned} & \hline 45 \\ & 1.77 \end{aligned}$ | $\begin{aligned} & 46 \\ & { }_{1.81} \end{aligned}$ | $\begin{aligned} & 56 \\ & \hline 2.20 \end{aligned}$ | $\begin{aligned} & { }_{2.20}^{56} \end{aligned}$ | $\begin{aligned} & 58 \\ & \hline 2.28 \end{aligned}$ | $\begin{aligned} & \left.\hline \begin{array}{l} 6036 \\ 2.3 \end{array}\right) \end{aligned}$ | $\begin{aligned} & \hline 66 \\ & 2.60 \end{aligned}$ |
| C | .4 .16 | ${ }_{4}^{4} 16$ | $\begin{aligned} & \hline 4 \\ & .16 \end{aligned}$ | $\begin{aligned} & 4 \\ & .16 \end{aligned}$ | C | $\begin{aligned} & \hline 4 \\ & .16 \end{aligned}$ | $\begin{aligned} & 4 \\ & .16 \end{aligned}$ | $\begin{aligned} & \hline 4 \\ & .16 \end{aligned}$ | $\begin{aligned} & 4 \\ & .16 \end{aligned}$ | $\begin{aligned} & 4 \\ & .16 \end{aligned}$ | $\begin{aligned} & 4 \\ & .16 \end{aligned}$ | $\begin{aligned} & 4 \\ & .16 \end{aligned}$ | $\begin{aligned} & 4 \\ & .16 \end{aligned}$ | $\begin{aligned} & 4 \\ & .16 \end{aligned}$ |
| D1 | $\begin{aligned} & 5 \\ & .20 \end{aligned}$ | $\begin{aligned} & 5 \\ & .20 \end{aligned}$ | $\begin{aligned} & \hline 5 \\ & .20 \end{aligned}$ | $\begin{aligned} & \hline 5 \\ & .20 \end{aligned}$ | D1 | $\begin{aligned} & 5 \\ & .20 \end{aligned}$ | $\begin{aligned} & \hline 5 \\ & .20 \end{aligned}$ | $\begin{aligned} & \hline 5 \\ & .20 \end{aligned}$ | $\begin{aligned} & \hline 5 \\ & .20 \end{aligned}$ | $\begin{aligned} & \hline 5 \\ & .20 \end{aligned}$ | $\begin{aligned} & \hline 5 \\ & .20 \end{aligned}$ | $\begin{aligned} & \hline 5 \\ & .20 \end{aligned}$ | $\begin{aligned} & \hline 5 \\ & .20 \end{aligned}$ | $\begin{aligned} & \hline 5 \\ & .20 \end{aligned}$ |
| D2 | $\begin{aligned} & \hline 8-15 \\ & .31-.59 \\ & \hline \end{aligned}$ | $\begin{aligned} & 8-15 \\ & .31-.59 \end{aligned}$ | $\begin{aligned} & 8-15 \\ & .31-59 \end{aligned}$ | $\begin{array}{\|l\|l\|} \hline 8-15 \\ .31-.59 \\ \hline \end{array}$ | D2 | $\begin{aligned} & 10-15 \\ & 39-59 \end{aligned}$ | $\begin{aligned} & 10-15 \\ & .39-59 \end{aligned}$ | $\begin{aligned} & 10-15 \\ & .39-59 \end{aligned}$ | $\begin{aligned} & 10-15 \\ & .39-.59 \end{aligned}$ | $\begin{aligned} & 10-15 \\ & .39-59 \end{aligned}$ | $\begin{aligned} & 10-15 \\ & .39-59 \end{aligned}$ | $\begin{aligned} & 10-15 \\ & .39-59 \end{aligned}$ | $\begin{aligned} & 10-15 \\ & .39-59 \end{aligned}$ | $\begin{aligned} & \hline 10-15 \\ & .39-59 \end{aligned}$ |
| E | $\begin{aligned} & 36 \\ & \hline 1.42 \end{aligned}$ | $\begin{aligned} & 36 \\ & 1.42 \\ & \hline \end{aligned}$ | $\begin{aligned} & 36 \\ & 1.42 \end{aligned}$ | $\begin{aligned} & 36 \\ & 1.42 \\ & \end{aligned}$ | E | $\begin{aligned} & \hline 48 \\ & 1.89 \end{aligned}$ | $\begin{aligned} & 48 \\ & 1.89 \end{aligned}$ | $\begin{aligned} & 48 \\ & 1.89 \end{aligned}$ | $\begin{aligned} & 48 \\ & 1.89 \end{aligned}$ | $\begin{aligned} & 48 \\ & 1.89 \end{aligned}$ | $\begin{aligned} & 48 \\ & 1.89 \end{aligned}$ | $\begin{aligned} & 48 \\ & 1.89 \end{aligned}$ | $\begin{aligned} & 48 \\ & 1.89 \end{aligned}$ | $\begin{aligned} & 48 \\ & 1.89 \end{aligned}$ |
| M | $\begin{aligned} & 5,2 \\ & 20 \end{aligned}$ | $\begin{aligned} & 5,2 \\ & .20 \end{aligned}$ | $\begin{aligned} & 5,2 \\ & .20 \end{aligned}$ | $\begin{aligned} & 5,2 \\ & .20 \end{aligned}$ | M | $\begin{aligned} & 4,7 \\ & .19 \end{aligned}$ | $\begin{aligned} & 4,7 \\ & .19 \end{aligned}$ | $\begin{aligned} & 4,7 \\ & .19 \end{aligned}$ | $\begin{aligned} & 4,7 \\ & .19 \end{aligned}$ | $\begin{aligned} & 7 \\ & .28 \end{aligned}$ | 7 . .88 | $\begin{aligned} & 7 \\ & .28 \end{aligned}$ | $\begin{aligned} & 7 \\ & .28 \end{aligned}$ | $\begin{aligned} & 7 \\ & .28 \end{aligned}$ |

46

Dimensions

Two or Four Hole Panel Mounting


Single Hole Mounting or Base Mounting


48

## Base Mounting


${ }^{1}$ see page $51 \quad{ }^{2}$ not available for switch type CA20

Wall Mounting, Escutcheon Plates and Additional Length


Escutcheon plates for mounting E, EF, ER, ERF, EG, EGF, KN1, KD1, KN2, EC, EC1, ED, ED1, VE, VE1, VF


Additional length for amendment (page 4)

Latching mechanism size S1
Latching mechanism size S2
Snap action

| CA10 <br> CA11 |  |  |  |  |
| :--- | :--- | :--- | :--- | :--- |
| CAD11 | CA20 |  |  |  |
| CAD12 | CA25 | C26 | C32 | C42 |
| 5,4 | 5,4 | - | - | - |
| .21 | .21 | - | - | - |
| - | - | 9,2 | 9,2 | - |
| 14,3 | 14,3 | 12,2 | 12,2 | 12,2 |
| .56 | .56 | .48 | .48 | .48 |

Quick connects for switches CA4-4


Dimensions

Additional Length
Terminal lugs for switches C315, C316 and L switches

## Length L

| Stages | $\begin{aligned} & \text { CA4 } \\ & \text { CA4-1 } \end{aligned}$ | CL4 | CA10 <br> CAD11 <br> CAD12 | CL10 | CA11 | CA20 | CA25 | CA10B | CA11B | CA20B | CA25B | C26 | C32 | C42 | C43 | C80 | C125 <br> L switches Size S2 | C315 <br> L switches <br> Size S3 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1 | $\begin{aligned} & 30 \\ & 1.18 \end{aligned}$ | $\begin{aligned} & \hline 34 \\ & 1.34 \end{aligned}$ | $\begin{aligned} & \hline 33,5 \\ & 1.32 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 37,2 \\ & 1.46 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 36,7 \\ & 1.44 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 37,7 \\ & 1.48 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 39 \\ & 1.51 \end{aligned}$ | $\begin{aligned} & \hline 38,9 \\ & 1.53 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 42,1 \\ & 1.66 \end{aligned}$ | $\begin{aligned} & 43,1 \\ & 1.70 \end{aligned}$ | $\begin{aligned} & \hline 44,4 \\ & 1.75 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 42 \\ & 1.65 \end{aligned}$ | $\begin{aligned} & \hline 46,8 \\ & 1.84 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 50,8 \\ & 2.00 \end{aligned}$ | $\begin{aligned} & \hline 59 \\ & 2.32 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 61,5 \\ & 2.42 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 67,5 \\ & 2.66 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 78,6 \\ & 3.09 \\ & \hline \end{aligned}$ |
| 2 | $\begin{aligned} & 38 \\ & 1.50 \end{aligned}$ | $\begin{aligned} & \hline 46 \\ & 1.81 \end{aligned}$ | $\begin{aligned} & \hline 43 \\ & 1.69 \end{aligned}$ | $\begin{aligned} & \hline 49,9 \\ & 1.96 \end{aligned}$ | $\begin{aligned} & \hline 49,4 \\ & 1.94 \end{aligned}$ | $\begin{aligned} & \hline 50,4 \\ & 1.98 \end{aligned}$ | $\begin{aligned} & \hline 53 \\ & 2.09 \end{aligned}$ | $\begin{aligned} & \hline 48,4 \\ & 1.91 \end{aligned}$ | $\begin{aligned} & \hline 54,8 \\ & 2.16 \end{aligned}$ | $\begin{aligned} & \hline 55,8 \\ & 2.20 \end{aligned}$ | $\begin{aligned} & \hline 58,4 \\ & 2.30 \end{aligned}$ | $\begin{aligned} & \hline 54,7 \\ & 2.15 \end{aligned}$ | $\begin{aligned} & \hline 64,3 \\ & 2.51 \end{aligned}$ | $\begin{aligned} & \hline 72,3 \\ & 2.85 \end{aligned}$ | $\begin{aligned} & \hline 80,5 \\ & 3.17 \end{aligned}$ | $\begin{aligned} & \hline 88,0 \\ & 3.46 \\ & \hline \end{aligned}$ | $\begin{aligned} & 100 \\ & 3.94 \end{aligned}$ | $\begin{aligned} & \hline 117,2 \\ & 4.61 \end{aligned}$ |
| 3 | $\begin{aligned} & \hline 46 \\ & 1.81 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 58 \\ & 2.28 \\ & \hline \end{aligned}$ | $\begin{aligned} & 52,5 \\ & 2.07 \end{aligned}$ | $\begin{aligned} & \hline 62,6 \\ & 2.46 \\ & \hline \end{aligned}$ | $\begin{aligned} & 62,1 \\ & 2.44 \\ & \hline \end{aligned}$ | $\begin{aligned} & 63,1 \\ & 2.48 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 67 \\ & 2.64 \\ & \hline \end{aligned}$ | $\begin{aligned} & 57,9 \\ & 2.28 \\ & \hline \end{aligned}$ | $\begin{aligned} & 67,5 \\ & 2.66 \end{aligned}$ | $\begin{aligned} & 68,5 \\ & 2.70 \end{aligned}$ | $\begin{aligned} & 72,4 \\ & 2.85 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 67,4 \\ & 2.65 \\ & \hline \end{aligned}$ | $\begin{aligned} & 81,8 \\ & 3.22 \end{aligned}$ | $\begin{aligned} & 93,8 \\ & 3.69 \\ & \hline \end{aligned}$ | $\begin{aligned} & 102 \\ & 4.02 \end{aligned}$ | $\begin{aligned} & 114,5 \\ & 4.51 \end{aligned}$ | $\begin{aligned} & 132,5 \\ & 5.22 \end{aligned}$ | $\begin{aligned} & 155,8 \\ & 6.13 \end{aligned}$ |
| 4 | $\begin{aligned} & \hline 54 \\ & 2.13 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 70 \\ & 2.76 \\ & \hline \end{aligned}$ | $\begin{aligned} & 62 \\ & 2.44 \end{aligned}$ | $\begin{aligned} & 75,3 \\ & 2.96 \\ & \hline \end{aligned}$ | $\begin{aligned} & 74,8 \\ & 2.94 \\ & \hline \end{aligned}$ | $\begin{aligned} & 75,8 \\ & 2.98 \\ & \hline \end{aligned}$ | $\begin{aligned} & 81 \\ & 3.19 \end{aligned}$ | $\begin{aligned} & \hline 67,4 \\ & 2.65 \\ & \hline \end{aligned}$ | $\begin{aligned} & 80,2 \\ & 3.16 \end{aligned}$ | $\begin{aligned} & 81,2 \\ & 3.20 \end{aligned}$ | $\begin{aligned} & 86,4 \\ & 3.40 \end{aligned}$ | $\begin{aligned} & 80,1 \\ & 3.15 \end{aligned}$ | $\begin{aligned} & 99,3 \\ & 3.91 \end{aligned}$ | $\begin{aligned} & 115,3 \\ & 4.54 \end{aligned}$ | $\begin{aligned} & 123,5 \\ & 4.86 \end{aligned}$ | $\begin{aligned} & \hline 141 \\ & 5.55 \end{aligned}$ | $\begin{aligned} & 165 \\ & 6.50 \\ & \hline \end{aligned}$ | $\begin{aligned} & 194,4 \\ & 7.65 \end{aligned}$ |
| 5 | $\begin{aligned} & \hline 62 \\ & 2.44 \end{aligned}$ | $\begin{aligned} & \hline 82 \\ & 3.23 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 71,5 \\ & 2.81 \\ & \hline \end{aligned}$ | $\begin{aligned} & 88 \\ & 3.46 \\ & \hline \end{aligned}$ | $\begin{aligned} & 87,5 \\ & 3.44 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 88,5 \\ & 3.48 \end{aligned}$ | $\begin{aligned} & \hline 95 \\ & 3.74 \end{aligned}$ | $\begin{aligned} & 76,9 \\ & 3.03 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 92,9 \\ & 3.66 \\ & \hline \end{aligned}$ | $\begin{aligned} & 93,9 \\ & 3.70 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 100,4 \\ & 3.95 \end{aligned}$ | $\begin{aligned} & \hline 92,8 \\ & 3.65 \end{aligned}$ | $\begin{aligned} & 116,8 \\ & 4.60 \end{aligned}$ | $\begin{aligned} & 136,8 \\ & 5.39 \end{aligned}$ | $\begin{aligned} & \hline 145 \\ & 5.71 \\ & \hline \end{aligned}$ | $\begin{aligned} & 167,5 \\ & 6.59 \end{aligned}$ | $\begin{aligned} & 197,5 \\ & 7.78 \end{aligned}$ | $\begin{aligned} & \hline 233 \\ & 9.17 \end{aligned}$ |
| 6 | $\begin{aligned} & \hline 70 \\ & 2.76 \\ & \hline \end{aligned}$ | $\begin{aligned} & 94 \\ & 3.70 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 81 \\ & 3.19 \end{aligned}$ | $\begin{aligned} & 100,7 \\ & 3.96 \end{aligned}$ | $\begin{aligned} & 100,2 \\ & 3.94 \end{aligned}$ | $\begin{aligned} & 101,2 \\ & 3.98 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 109 \\ & 4.29 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 86,4 \\ & 3.40 \\ & \hline \end{aligned}$ | $\begin{aligned} & 105,6 \\ & 4.16 \end{aligned}$ | $\begin{aligned} & 106,6 \\ & 4.20 \end{aligned}$ | $\begin{aligned} & 114,4 \\ & 4.50 \\ & \hline \end{aligned}$ | $\begin{aligned} & 105,5 \\ & 4.15 \\ & \hline \end{aligned}$ | $\begin{aligned} & 134,3 \\ & 5.29 \end{aligned}$ | $\begin{aligned} & 158,3 \\ & 6.23 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 166,5 \\ & 6.56 \\ & \hline \end{aligned}$ | $\begin{aligned} & 194 \\ & 7.64 \end{aligned}$ | $\begin{aligned} & \hline 230 \\ & 9.06 \\ & \hline \end{aligned}$ | $\begin{aligned} & 271,6 \\ & 10.69 \\ & \hline \end{aligned}$ |
| 7 | $\begin{aligned} & \hline 78 \\ & 3.07 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 106 \\ & 4.17 \\ & \hline \end{aligned}$ | $\begin{aligned} & 90,5 \\ & 3.56 \\ & \hline \end{aligned}$ | $\begin{aligned} & 113,4 \\ & 4.46 \\ & \hline \end{aligned}$ | $\begin{aligned} & 112,9 \\ & 4.44 \end{aligned}$ | $\begin{aligned} & 113,9 \\ & 4.48 \\ & \hline \end{aligned}$ | $\begin{aligned} & 123 \\ & 4.84 \\ & \hline \end{aligned}$ | $\begin{aligned} & 95,9 \\ & 3.78 \\ & \hline \end{aligned}$ | $\begin{aligned} & 118,3 \\ & 4.66 \\ & \hline \end{aligned}$ | $\begin{aligned} & 119,3 \\ & 4.70 \\ & \hline \end{aligned}$ | $\begin{aligned} & 128,4 \\ & 5.05 \\ & \hline \end{aligned}$ | $\begin{aligned} & 118,2 \\ & 4.65 \end{aligned}$ | $\begin{aligned} & 151,8 \\ & 5.98 \\ & \hline \end{aligned}$ | $\begin{aligned} & 179,8 \\ & 7.08 \\ & \hline \end{aligned}$ | $\begin{aligned} & 188 \\ & 7.40 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 220,5 \\ & 8.68 \\ & \hline \end{aligned}$ | $\begin{aligned} & 262,5 \\ & 10.33 \\ & \hline \end{aligned}$ | $\begin{aligned} & 310,2 \\ & 12.21 \end{aligned}$ |
| 8 | $\begin{aligned} & \hline 86 \\ & 3.39 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 118 \\ & 4.65 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 100 \\ & 3.94 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 126,1 \\ & 4.96 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 125,6 \\ & 4.94 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 126,6 \\ & 4.98 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 137 \\ & 5.39 \\ & \hline \end{aligned}$ | $\begin{aligned} & 105,4 \\ & 4.15 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 131 \\ & 5.16 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 132 \\ & 5.20 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 142,4 \\ & 5.60 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 130,9 \\ & 5.15 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 169,3 \\ & 6.67 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 201,3 \\ & 7.93 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 209,5 \\ & 8.25 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 247 \\ & 9.72 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 295 \\ & 11.61 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 348,8 \\ & 13.73 \\ & \hline \end{aligned}$ |
| 9 | $\begin{aligned} & \hline 94 \\ & 3.70 \\ & \hline \end{aligned}$ | - | $\begin{aligned} & 109,5 \\ & 4.31 \\ & \hline \end{aligned}$ | $\begin{aligned} & 138,8 \\ & 5.46 \\ & \hline \end{aligned}$ | $\begin{aligned} & 138,3 \\ & 5.44 \\ & \hline \end{aligned}$ | $\begin{aligned} & 139,3 \\ & 5.48 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 151 \\ & 5.94 \\ & \hline \end{aligned}$ | $\begin{aligned} & 114,9 \\ & 4.52 \\ & \hline \end{aligned}$ | $\begin{aligned} & 143,7 \\ & 5.66 \\ & \hline \end{aligned}$ | $\begin{aligned} & 144,7 \\ & 5.70 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 156,4 \\ & 6.15 \\ & \hline \end{aligned}$ | $\begin{aligned} & 143,6 \\ & 5.65 \\ & \hline \end{aligned}$ | $\begin{aligned} & 186,8 \\ & 7.36 \\ & \hline \end{aligned}$ | $\begin{aligned} & 222,8 \\ & 8.77 \\ & \hline \end{aligned}$ | $\begin{aligned} & 231 \\ & 9.09 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 273,5 \\ & 10.77 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 327,5 \\ & 12.89 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 387,4 \\ & 15.25 \\ & \hline \end{aligned}$ |
| 10 | - | - | $\begin{aligned} & \hline 119 \\ & 4.68 \end{aligned}$ | $\begin{aligned} & \hline 151,5 \\ & 5.96 \end{aligned}$ | $\begin{aligned} & \hline 151 \\ & 5.94 \end{aligned}$ | $\begin{aligned} & \hline 152 \\ & 5.98 \end{aligned}$ | $\begin{aligned} & \hline 165 \\ & 6.50 \end{aligned}$ | $\begin{aligned} & 124,4 \\ & 4.90 \end{aligned}$ | $\begin{aligned} & \hline 156,4 \\ & 6.16 \\ & \hline \end{aligned}$ | $\begin{aligned} & 157,4 \\ & 6.20 \end{aligned}$ | $\begin{aligned} & 170,4 \\ & 6.70 \end{aligned}$ | $\begin{aligned} & \hline 156,3 \\ & 6.15 \end{aligned}$ | $\begin{aligned} & \hline 204,3 \\ & 8.04 \end{aligned}$ | $\begin{aligned} & 244,3 \\ & 9.62 \end{aligned}$ | $\begin{aligned} & 252,2 \\ & 9.54 \end{aligned}$ | $\begin{aligned} & 300 \\ & 11.81 \end{aligned}$ | $\begin{aligned} & \hline 360 \\ & 14.17 \end{aligned}$ | $\begin{aligned} & \hline 426 \\ & 16.77 \end{aligned}$ |
| 11 | - | - | $\begin{aligned} & 128,5 \\ & 5.06 \\ & \hline \end{aligned}$ | - | $\begin{aligned} & 163,7 \\ & 6.44 \end{aligned}$ | $\begin{aligned} & 164,7 \\ & 6.48 \\ & \hline \end{aligned}$ | $\begin{aligned} & 179 \\ & 7.05 \\ & \hline \end{aligned}$ | $\begin{aligned} & 133,9 \\ & 5.27 \end{aligned}$ | $\begin{aligned} & 169,1 \\ & 6.66 \end{aligned}$ | $\begin{aligned} & 170,1 \\ & 6.70 \end{aligned}$ | $\begin{aligned} & 184,4 \\ & 7.25 \end{aligned}$ | $\begin{aligned} & \hline 169 \\ & 6.65 \\ & \hline \end{aligned}$ | $\begin{aligned} & 221,8 \\ & 8.73 \end{aligned}$ | $\begin{aligned} & 265,8 \\ & 10.46 \end{aligned}$ | $\begin{aligned} & 274 \\ & 10.79 \end{aligned}$ | $\begin{aligned} & 326,5 \\ & 12.85 \end{aligned}$ | $\begin{aligned} & 392,5 \\ & 15.45 \end{aligned}$ | $\begin{array}{r} 464,6 \\ 18.29 \\ \hline \end{array}$ |
| 12 | - | $\stackrel{-}{-}$ | $\begin{aligned} & 138 \\ & 5.43 \end{aligned}$ | $\stackrel{-}{-}$ | $\begin{aligned} & 176,4 \\ & 6.94 \end{aligned}$ | $\begin{aligned} & 177,4 \\ & 6.98 \end{aligned}$ | $\begin{aligned} & 193 \\ & 7.60 \end{aligned}$ | $\begin{aligned} & 143,4 \\ & 5.65 \end{aligned}$ | $\begin{aligned} & 181,8 \\ & 7.16 \end{aligned}$ | $\begin{aligned} & 182,8 \\ & 7.20 \end{aligned}$ | $\begin{aligned} & 198,4 \\ & 7.80 \end{aligned}$ | $\begin{aligned} & 181,7 \\ & 7.15 \end{aligned}$ | $\begin{aligned} & 239,3 \\ & 9.42 \end{aligned}$ | $\begin{aligned} & 287,3 \\ & 11.31 \end{aligned}$ | $\begin{aligned} & 295,5 \\ & 11.63 \end{aligned}$ | $\begin{aligned} & 353 \\ & 13.90 \end{aligned}$ | $\begin{aligned} & \hline 425 \\ & 16.73 \end{aligned}$ | $\begin{aligned} & 503,2 \\ & 19.81 \end{aligned}$ |

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Standard Panel Mount Fitting

## Optional Mounting Types



Surface Box LIW Order Code "KEJB1"


Water Resistant Box Liw Order Code "KEWP1"


Stainless Steel


| Panel Mount | "A" Stage |  | " $B$ " |
| :---: | :---: | :---: | :---: |
|  | 1 | 2 |  |
| Digit $5=1,4,7$ | 61 mm | 70 mm | 43 mm |
| Digit 5 = 2 | 65 mm | 77 mm | 47 mm |

Max Material Thickness 4mm


| ft | "A" Stage |  | "B" |
| :---: | :---: | :---: | :---: |
| ft | 1 | 2 |  |
| Digit $5=1,4,7$ | 71 mm | 81 mm | 43 mm |
| Digit 5 = 2 | 75 mm | 88 mm | 47 mm |

Thread Max Material Thickness 22mm Cylinder Max Material Thickness 2.5 mm The "R" series uses a unique removable cylinder enabling convenient master keying and key recombination of rental properties. The key may be removed or held captive in any switched position. This series is available in a variety of mounting types including panel, lift, bezel and wall plate. It is also available in a wide range of switching configurations.

## Features

Incorporates specialised lock cylinders for key removable in multiple positions.
Cylinder removable from front without risk of the switch falling apart.
May be master keyed into most common lock brands and high security lock systems.
Electrical isolated cylinder for added safety

## How To Order



## Optional Mounting Types



## General-purpose Basic Switch

## Best-selling Basic Switch Boasting High Precision and Wide Variety

- A large switching capacity of 15 A with high repeat accuracy.
- A wide range of variations in contact form for your selection: basic, split-contact and maintained-contact.
- A series of standard models for micro loads is available.
- A series of molded terminal-type models incorporating safety terminal protective cover is available.



## Model Number Structure

## Available types



## Basic Models

## General-purpose

- A variety of actuators is available for a wide range of application.
- The contact mechanism of models for micro loads is a crossbar type with gold-alloy contacts, which ensures highly reliable operations for micro loads.
- Contact Gap:
$\mathrm{H} 2: \quad 0.20 \mathrm{~mm}$ (extra-high-sensitivity)
$\mathrm{H}: \quad 0.25 \mathrm{~mm}$ (high-sensitivity, micro voltage current load)
G: $\quad 0.5 \mathrm{~mm}$ (standard)
E: $\quad 1.8 \mathrm{~mm}$ (high-capacity)
F: $\quad 1.0 \mathrm{~mm}$ (split-contact models)


## Drip-proof

- These Switches use a rubber boot on the actuator and adhesive fill between the case and cover to increase resistance to drips.
- Models with drip-proof terminal protective covers and molded terminals with resin filling are also available.


## Split-contact Models

- This type is identical in construction to the general-purpose basic switch except that it has two pairs of simultaneous acting contacts by splitting moving contacts.
- Since the moving contacts are connected to a common terminal, either parallel or series connection is possible.
- Highly reliable micro load switching is ensured if the model is used as a twin-contact switch.


## Maintained-contact Models

- The maintained-contact type has a reset button at the bottom of the switch case, in addition to the pushbutton (plunger) located on the opposite side of the reset button. Use these buttons alternately.
- Since the Switch has greater pretravel than overtravel, it is suitable for use in reversible control circuits, manual reset circuits, safety limit circuits, and other circuits which are not preferable for automatic resetting. (For further details, refer to individual datasheets.)


## Model Number Legend

## Basic Models



1. Ratings

01: 0.1 A (micro load)
15: 15 A
2. Contact Gap

H2: 0.20 mm
(extra-high sensitivity)
H: 0.25 mm
(high-sensitivity, micro load)
G: 0.5 mm
E: 1.8 mm (high-capacity)
3. Actuator

| None: Pin plunger | W44: | Long hinge lever <br> S:$\quad$Slim spring plunger | None: General-purpose <br> D: | Short spring plunger |
| :--- | :--- | :--- | :--- | :--- |

## Split-contact Models

## $Z-\frac{10}{1} \frac{F}{2} \underset{3}{\square} \frac{Y}{4}-\frac{B}{5}$

1. Ratings

10: 10 A (split-contact models)
2. Contact Gap

F: 1 mm (high-capacity)

## 3. Actuator

None: Pin plunger
S: Slim spring plunger
D: Short spring plunger
Q: Panel mount plunger
Q22: Panel mount roller plunger
W: Hinge lever
W22: Short hinge roller lever
W2: Hinge roller lever
M22: Reverse short hinge roller lever
4. Construction

Y: Split-contact type
5. Terminals

None: Solder terminal
B: Screw terminal (with toothed washer)

## Maintained-contact models

## $Z-\frac{15}{1} \frac{E}{2} \frac{\square}{3} \frac{R}{4}$

1. Ratings

15: 15 A
2. Contact Gap

E: 1.8 mm (high-capacity)

## Drip-proof with Molded Terminal Models


3. Actuator

None: Pin plunger
S : Slim spring plunger
W: Hinge lever

## 4. Construction

R: Maintained-contact models
$\frac{\mathrm{Z}-\square 55}{1}-\mathrm{M} \square \frac{\square}{2} \frac{\square \mathrm{M}}{4}$

1. Drip-proof model
(Insert model number of basic, drip-proof version with solder terminals)
2. Drip proof
3. Lead Outlets

None: VSF
E: VCT
3. Direction of Lead Outlets

L: Left
R: Right
D: Descending

4. Length of Leads

1: 1 m
3: 3 m

## Ordering Information

Basic Models（General－purpose）

| Actuator | Classification <br> Contact gap Terminal＊1 |  | Standard | High－sensitivity | Extra－high sensitivity | High－capacity | Micro load |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | G（ 0.5 mm ） | H（ 0.25 mm ） | H2（ 0.20 mm ） | E（1．8 mm） | H（ 0.25 mm ） |
|  |  |  | Model | Model | Model | Model | Model |
| Pin plunger | ก－ | ！ | Z－15G | Z－15H | Z－15H2 | Z－15E | Z－01H |
|  |  | 笉 | Z－15G－B | Z－15H－B | Z－15H2－B | Z－15E－B | Z－01H－B |
| Slim spring plunger | 目 | b | Z－15GS | Z－15HS | －－－ | －－－ | Z－01HS |
|  |  | 鸹 | Z－15GS－B | Z－15HS－B |  |  | Z－01HS－B |
| Short spring plunger | ค | ！ | Z－15GD | Z－15HD | －－－ | Z－15ED | Z－01HD |
|  |  | 笉 | Z－15GD－B | Z－15HD－B |  | Z－15ED－B | Z－01HD－B |
| Panel mount plunger | Low OP | ๒ | Z－15GQ3 | －－－ | －－－ | －－－ | －－－ |
|  |  | 笉 | Z－15GQ3－B |  |  |  |  |
|  | Medium OP | ＠ | Z－15GQ | Z－15HQ |  | Z－15EQ | Z－01HQ |
|  |  | 䂞 | Z－15GQ－B | Z－15HQ－B |  | Z－15EQ－B | Z－01HQ－B |
|  | High OP | ！ | Z－15GQ8 | －－－ |  | －－－ | －－－ |
|  |  | 写 | Z－15GQ8－B |  |  |  |  |
| Panel mount roller plunger | ® | ＠ | Z－15GQ22 | Z－15HQ22 | －－－ | Z－15EQ22 | －－－ |
|  |  | 写 | Z－15GQ22－B | Z－15HQ22－B |  | Z－15EQ22－B |  |
| Panel mount cross roller plunger | 号 | ＠ | Z－15GQ21 | Z－15HQ21 | －－－ | Z－15EQ21 | －－－ |
|  |  | 鸢 | Z－15GQ21－B | Z－15HQ21－B |  | Z－15EQ21－B |  |
| Leaf spring |  | ＠ | Z－15GL | －－－ | －－－ | －－－ | －－－ |
|  |  | 写 | Z－15GL－B |  |  |  |  |
| Roller leaf spring | $8$ | ๒ | Z－15GL2 | －－－ | －－－ | －－－ | －－－ |
|  |  | 笉 | Z－15GL2－B |  |  |  |  |
| Short hinge lever | nel | ¢ | Z－15GW21 | －－－ | －－－ | －－－ | －－－ |
|  |  | 鸢 | Z－15GW21－B |  |  |  |  |
| Hinge lever | Low OP | ！ | Z－15GW | Z－15HW | －－－ | －－－ | －－－ |
|  |  | 亳 | Z－15GW－B | Z－15HW－B |  |  |  |
|  | Medium | ！ | Z－15GW3 | －－－ |  |  |  |
|  |  | 鸢 | Z－15GW3－B |  |  |  |  |
|  | High OP | ！ | Z－15GW32 |  |  |  |  |
|  | High OP | 写 | Z－15GW32－B |  |  |  |  |
| Low－force hinge lever | n | ＠ | Z－15GW4 | Z－15HW24 | －－－ | －－－ | －－－ |
|  |  | 鸢 | Z－15GW4－B | Z－15HW24－B |  |  |  |
| Low－force wire hinge lever | Low OP | 〕 | －－－ | Z－15HW78 | －－－ | －－－ | －－－ |
|  |  | 写 |  | Z－15HW78－B |  |  |  |
|  | High OP | ๒ |  | Z－15HW52 |  |  |  |
|  |  | 写 |  | Z－15HW52－B |  |  |  |
| Short hinge roller lever | $n_{0}^{Q}$ | ！ | Z－15GW22 | Z－15HW22 | －－－ | Z－15EW22 | Z－01HW22 |
|  |  | 笉 | Z－15GW22－B | Z－15HW22－B |  | Z－15EW22－B | Z－01HW22－B |
| Short hinge cross roller lever | IIII | ＠ | Z－15GW49 | －－－ | －－－ | －－－ | －－－ |
|  |  | 写 | Z－15GW49－B |  |  |  |  |
| Hinge roller lever | Standard | ๒ | Z－15GW2 | Z－15HW2 | －－－ | －－－ | －－－ |
|  |  | 笉 | Z－15GW2－B | Z－15HW2－B |  |  |  |
|  | Large roller | ＠ | Z－15GW25 | －－－ |  | －－－ | －－－ |
|  |  | 笉 | Z－15GW25－B |  |  |  |  |


| Actuator | Classification <br> Contact gap Terminal＊1 |  | Standard | High－sensitivity | Extra－high sensitivity | High－capacity | Micro load |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | G（ 0.5 mm ） | H（ 0.25 mm ） | H2（ 0.20 mm ） | $\mathrm{E}(1.8 \mathrm{~mm})$ | H（0．25 mm） |
|  |  |  | Model | Model | Model | Model | Model |
| Hinge cross roller lever |  | ๒ | Z－15GW54 | －－－ | －－－ | －－－ | －－－ |
|  | ne． | 写 | Z－15GW54－B |  |  |  |  |
| Unidirectional shorthinge roller lever | Parallel | ๒ | Z－15GW2277 | －－－ | －－－ | －－－ | －－－ |
|  |  | 写 | Z－15GW2277－B |  |  |  |  |
| Reverse hinge lever ＊2 | mb | ＠ | Z－15GM | －－－ | －－－ | －－－ | －－－ |
|  |  | 写 | Z－15GM－B |  |  |  |  |
| Reverse short hinge roller lever＊2 | Q | ๒ | Z－15GM22 | －－－ | －－－ | －－－ | －－－ |
|  |  | 哥 | Z－15GM22－B |  |  |  |  |
| Reverse hinge roller lever＊2 | - | 〕 | Z－15GM2 | －－－ | －－－ | －－－ | －－－ |
|  |  | 鸢 | Z－15GM2－B |  |  |  |  |

＊1．！：Solder terminal 茑：Screw terminal
＊2．The pin plungers of reverse－type models are continuously pressed by the actuator levers with compression coil springs and the pin plungers are freed by operating the levers．Reverse－type models are highly vibration－and shock－resistive because the pin plungers are normally pressed．

## Split－contact Models

| Actuator | Contact gap <br> Terminal |  | F |
| :--- | :---: | :---: | :---: | F（1．0 mm）

## Maintained－contact Models

| Actuator |  | Model |
| :--- | :--- | :---: |
| Pin plunger |  | Z－15ER |
| Slim spring plunger | Z－15ESR |  |
| Hinge lever | Z－15EWR |  |

＊1．り ：Solder terminal 写：Screw terminal
＊2．The pin plungers of reverse－type models are continuously pressed by the actuator levers with compression coil springs and the pin plungers are freed by operating the levers．Reverse－type models are highly vibration－and shock－resistive because the pin plungers are normally pressed．

## Drip－proof Models

| Actuator | Classification <br> Contact gap <br> Drip－proof terminal <br> protective cover <br> Terminal＊1 |  | Standard |  | High－sensitivity | Micro load |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | G（ 0.5 mm ） |  | H（ 0.25 mm ） | H（ 0.25 mm ） |
|  |  |  | Not provided | Provided | Not provided | Not provided |
|  |  |  | Model | Model | Model | Model |
| Pin plunger | － | ＠ | Z－15G55 | －－－ |  | Z－01H55 |
|  |  | 鸢 | Z－15G55－B | Z－15GA55－B5V |  | Z－01H55－B |
| Short spring plunger | صـ | ๒ | Z－15GD55 | －－－ |  | Z－01HD55 |
|  |  | 鸢 | Z－15GD55－B |  |  | Z－01HD55－B |
| Spring plunger | $\begin{aligned} & \text { Low } \\ & \text { OP } \end{aligned}$ | d | Z－15GK55 | －－－ |  | －－－ |
|  |  | 鸢 | Z－15GK55－B |  |  |  |
|  | ค ${ }^{\text {¢ }}$（ ${ }^{\text {High }}$ | ๒ | Z－15GK355 | －－－ |  | －－－ |
|  |  | 鹄 | Z－15GK355－B | Z－15GK3A55－B5V |  |  |
| Panel mount plunger | 옥 | 」 | Z－15GQ55 | －－－ |  | －－－ |
|  |  | 鸢 | Z－15GQ55－B | Z－15GQA55－B5V |  |  |
| Panel mount roller plunger | $\begin{aligned} & \text { ® } \\ & \hline \end{aligned}$ | ！ | Z－15GQ2255 | －－－ |  | －－－ |
|  |  | 哥 | Z－15GQ2255－B | Z－15GQ22A55－B5V |  |  |
| Panel mount cross roller plunger | 号 | ！ | －－－ | －－－ |  | －－－ |
|  |  | 鸢 | Z－15GQ2155－B | Z－15GQ21A55－B5V |  |  |
| Leaf spring |  | 」 | Z－15GL55 | －－－ |  | －－－ |
|  |  | 鹊 | Z－15GL55－B |  |  |  |
| Roller leaf spring |  | 〕 | Z－15GL255 | －－－ |  | －－－ |
|  |  | 鸢 | Z－15GL255－B |  |  |  |
| Short hinge lever | nem | 〕 | Z－15GW2155 | －－－ |  | －－－ |
|  |  | 窎 | Z－15GW2155－B |  |  |  |
| Long hinge lever |  | ！ | Z－15GW4455 | －－－ |  | －－－ |
|  |  | 写 | Z－15GW4455－B | Z－15GW44A55－B5V |  |  |
| Hinge lever | ner | ！ | Z－15GW55 | －－－ |  | －－－ |
|  |  | 鹄 | Z－15GW55－B | Z－15GWA55－B5V |  |  |
| Short hinge roller lever | R | 〕 | Z－15GW2255 | －－－ |  | Z－01HW2255 |
|  |  | 䔅 | Z－15GW2255－B | Z－15GW22A55－B5V |  | Z－01HW2255－B |
| Hinge roller lever | $\frac{8}{n=-}$ | 」 | Z－15GW255 | －－－ |  | －－－ |
|  |  | 殇 | Z－15GW255－B | Z－15GW2A55－B5V |  |  |
| Unidirectional short hinge roller lever | $\rightarrow 9$ | 」 | Z－15GW227755 | －－－－ |  | －－－ |
|  |  | 笉 | Z－15GW227755－B | Z－15GW2277A55－ B5V |  |  |
| Reverse hinge lever＊2 | －mm | 〕 | Z－15GM55 | －－－ |  | －－－ |
|  |  | 宁 | Z－15GM55－B |  |  |  |
| Reverse short hinge roller lever＊2 | $\xrightarrow[0]{P}$ | 〕 | Z－15GM2255 | －－－ |  | －－ |
|  |  | 宮 | Z－15GM2255－B |  |  |  |
| Reverse hinge roller lever＊2 | $\xrightarrow{\infty}$ | 〕 | Z－15GM255 | －－－ |  | －－－ |
|  |  | 䂞 | Z－15GM255－B |  |  |  |
| Flexible rod（coil spring） |  | ね | Z－15GNJ55 | －－－ |  | －－－ |
|  |  | 高 | Z－15GNJ55－B |  |  |  |
| Flexible rod （steel wire） | $\begin{gathered} \stackrel{l}{\underline{⿳ 亠 口 冋}} \\ \\ \hline \end{gathered}$ | 」 | －－－ | －－－ | Z－15HNJS55 | －－－ |
|  |  | 高 |  |  | Z－15HNJS55－B |  |

＊1．ㅇ．：Solder terminal 写：Screw terminal
＊2．The pin plungers of reverse－type models are continuously pressed by the actuator levers with compression coil springs and the pin plungers are freed by operating the levers．
＊3．The tip is made of resin．

## Specifications

## Characteristics

| Item | Classification | Z-15(except micro load <br> and flexible rod) | Z-01H | Z Zlexible rod) | Z-10F | Z-15H2 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Operating speed |  | 0.01 mm to $1 \mathrm{~m} / \mathrm{s}$ (*1) |  | 1 mm to $1 \mathrm{~m} / \mathrm{s}$ | 0.1 mm to $1 \mathrm{~m} / \mathrm{s}$ (*1) | 0.01 mm to $1 \mathrm{~m} / \mathrm{s}$ |
| Operating frequency | Mechanical | 240 operations/min |  | 120 operations/min | 240 operations/min | 240 operations/min |
|  | Electrical | 20 operations/min |  |  |  |  |
| Contact resistance |  |  |  |  |  |  |
| Insulation resistance |  | $100 \mathrm{M} \Omega$ min. (at 500 VDC) |  |  |  |  |
| Dielectric strength ( $50 / 60 \mathrm{~Hz}$ for 1 min .) |  | Between contacts of same polarity <br> Contact gap G: 1,000 VAC <br> Contact gap H: 600 VAC <br> Contact gap E: 1,500 VAC |  | Between contacts of same polarity Contact gap G: 1,000 VAC Contact gap H: 600 VAC | Between contacts of same polarity Contact gap F: 1,500 VAC | Between contacts of same polarity 600VAC |
|  |  | Between current-carrying metal parts and ground, and between each terminal and non-current-carrying metal parts: 2,000 VAC |  |  |  |  |
| Vibration resistance | Malfunction | 10 to $55 \mathrm{~Hz}, 1.5-\mathrm{mm}$ double amplitude (*5) |  | 10 to $20 \mathrm{~Hz}, 1.5-\mathrm{mm}$ double amplitude (*5) | 10 to $55 \mathrm{~Hz}, 1.5-\mathrm{mm}$ double amplitude (*5) |  |
| Shock resistance | Destruction | 1,000 m/s ${ }^{2}$ max. |  |  |  |  |
|  | Malfunction | $300 \mathrm{~m} / \mathrm{s}^{2} \mathrm{max} .\left(* 2,{ }^{\text {* }} 5\right.$ ) |  | $50 \mathrm{~m} / \mathrm{s}^{2}$ max. (*5) | $300 \mathrm{~m} / \mathrm{s}^{2} \mathrm{max} .(* 3, ~ * 5)$ | $100 \mathrm{~m} / \mathrm{s}^{2} \mathrm{max}$. |
| Degree of protection | Generalpurpose | IP00 |  |  |  |  |
|  | Drip-proof | Equivalent to IP62 (except terminals) |  |  |  |  |
| Degree of protection against electric shock |  | Class I |  |  |  |  |
| Proof tracking index (PTI) |  | 175 |  |  |  |  |
| Ambient operating temperature | Generalpurpose | $-25^{\circ} \mathrm{C}$ to $80^{\circ} \mathrm{C}$ (with no icing) |  |  |  |  |
|  | Drip-proof | $-15^{\circ} \mathrm{C}$ to $80^{\circ} \mathrm{C}$ (with no icing) |  |  |  |  |
| Ambient operating humidity | Generalpurpose | $35 \%$ to 85\%RH |  |  |  |  |
|  | Drip-proof | 35\% to 95\%RH |  |  |  |  |
| Service life | Mechanical | Contact gap H2: 10,000,000 operations min. Contact gap G, H: 20,000,000 operations min.(*4) Contact gap E: 300,000 operations |  | 1,000,000 operations min. | 500,000 operations min. (*1) | 20,000,000 operations min. |
|  | Electrical | Contact gap G, H: 500,000 operations min. Contact gap E: 100,000 operations min. |  | 100,000 operations min. | 100,000 operations min. | 500,000 operations min. |
| Weight |  | Approx. 22 to 58 g |  | Approx. 42 to 48 g | Approx. 34 to 61 g | Approx. 22 g |

*1 The values are for the plunger models. (For the lever models, the values are at the plunger section.)
2 The values are for the Z-15G pin plunger.
*3 The values are for the Z-10FY-B

## Ratings (Basic, Split-contact and Maintained contact Models)

## Z-15 (Except Micro Load and Flexible Rod Models)

| Contact gap | ItemRated voltage | Non-inductive load (A) |  |  | Inductive load (A) |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | Resistive load | Lamp load |  | Inductive load | Motor load |  |
|  |  | NC ${ }^{\text {NO }}$ | NC | NO | NC ${ }^{\text {NO }}$ | NC | NO |
|  | 125 VAC | 15 (10) * | 3 | 1.5 | 15 (10) * | 5 | 2.5 |
| G, H, H2, E | 250 VAC | 15 (10) * | 2.5 | 1.25 | 15 (10) * | 3 | 1.5 |
|  | 500 VAC * | 10 | 1.5 | 0.75 | 6 | 1.5 | 0.75 |
| G | 8 VDC | 15 | 3 | 1.5 | 15 | 5 | 2.5 |
|  | 14 VDC | 15 | 3 | 1.5 | 10 | 5 | 2.5 |
|  | 30 VDC | 6 | 3 | 1.5 | 5 | 5 | 2.5 |
|  | 125 VDC | 0.5 | 0.5 | 0.5 | 0.05 | 0.05 | 0.05 |
|  | 250 VDC | 0.25 | 0.25 | 0.25 | 0.03 | 0.03 | 0.03 |
| H, H2 | 8 VDC | 15 | 3 | 1.5 | 15 | 5 | 2.5 |
|  | 14 VDC | 15 | 3 | 1.5 | 10 | 5 | 2.5 |
|  | 30 VDC | 2 | 2 | 1.4 | 1 | 1 | 1 |
|  | 125 VDC | 0.4 | 0.4 | 0.4 | 0.03 | 0.03 | 0.03 |
|  | 250 VDC | 0.2 | 0.2 | 0.2 | 0.02 | 0.02 | 0.02 |
|  | 8 VDC | 15 | 3 | 1.5 | 15 | 5 | 2.5 |
|  | 14 VDC | 15 | 3 | 1.5 | 15 | 5 | 2.5 |
| E | 30 VDC | 15 | 3 | 1.5 | 10 | 5 | 2.5 |
|  | 125 VDC | 0.75 | 0.75 | 0.75 | 0.4 | 0.4 | 0.4 |
|  | 250 VDC | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 |

* Figures in parentheses are for the Z-15HW52, Z-15HW78(-B) and Z-15H2(-B) models, the AC ratings of these models are 125 and 250 V only.

Z-15 (Flexible Rod Models)


Z-10F

| Contact gap | Item <br> Rated <br> voltage | Non-inductive load (A) |  |  |  | Inductive load (A) |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | Resistive load |  | Lamp load |  | Inductive load |  | Motor load |  |
|  |  | NC | NO | NC | NO | NC | NO | NC | NO |
|  | $\begin{aligned} & 125 \text { VAC } \\ & 250 \text { VAC } \end{aligned}$ | $\begin{aligned} & 1 \\ & 10 \\ & 10 \\ & \hline \end{aligned}$ |  | $\begin{gathered} \hline 4 \\ 2.5 \end{gathered}$ | $\begin{gathered} 2 \\ 1.5 \end{gathered}$ | $\begin{aligned} & \hline 6 \\ & 6 \end{aligned}$ |  | $\begin{aligned} & \hline 5 \\ & 3 \end{aligned}$ | $\begin{aligned} & 2.5 \\ & 1.5 \end{aligned}$ |
| Series connection | $\begin{aligned} & \hline 30 \text { VDC } \\ & 125 \text { VDC } \\ & 250 \text { VDC } \end{aligned}$ | $\begin{gathered} 10 \\ 1 \\ 0.6 \end{gathered}$ |  | $\begin{gathered} 4 \\ 1 \\ 0.6 \end{gathered}$ | $\begin{gathered} \hline 2 \\ 1 \\ 0.6 \end{gathered}$ | $\begin{gathered} \hline 6 \\ 0.1 \\ 0.05 \end{gathered}$ |  | $\begin{gathered} 6 \\ 0.1 \\ 0.05 \end{gathered}$ | $\begin{gathered} 3 \\ 0.1 \\ 0.05 \end{gathered}$ |
| Parallel connection | $\begin{array}{\|l\|} \hline 125 \text { VAC } \\ 250 \text { VAC } \\ \hline \end{array}$ | 66 |  | $\begin{gathered} 3 \\ 2.5 \end{gathered}$ | $\begin{gathered} 1.5 \\ 1.25 \end{gathered}$ |  | $\begin{aligned} & 4 \\ & 4 \\ & 4 \end{aligned}$ | $\begin{aligned} & 4 \\ & 2 \end{aligned}$ | $\begin{aligned} & 2 \\ & 1 \end{aligned}$ |
|  | $\begin{array}{\|l\|} \hline 30 \text { VDC } \\ 125 \text { VDC } \\ 250 \text { VDC } \end{array}$ | $\begin{gathered} \hline 6 \\ 0.6 \\ 0.3 \\ \hline \end{gathered}$ |  | $\begin{gathered} 4 \\ 0.6 \\ 0.3 \end{gathered}$ | $\begin{gathered} 2 \\ 0.6 \\ 0.3 \end{gathered}$ |  | $\begin{gathered} \hline 4 \\ 0.1 \\ 0.05 \end{gathered}$ | $\begin{gathered} \hline 6 \\ 0.1 \\ 0.05 \\ \hline \end{gathered}$ | $\begin{gathered} 3 \\ 0.1 \\ 0.05 \\ \hline \end{gathered}$ |

Z-01H

| Rated voltage | Resistive load (A) |  |
| :--- | :--- | :--- |
|  | NC | NO |
| $\mathbf{1 2 5}$ VAC | 0.1 |  |
| 8 VDC | 0.1 |  |
| 14 VDC | 0.1 |  |
| 30 VDC | 0.1 |  |

## Applicable Load Range



|  | Z-01H | Z-15 $\square, \mathbf{Z - 1 0 F Y}$ |
| :--- | :---: | :---: |
| Minimum applicable load | 1 mA at 5 VDC | 160 mA at 5 VDC |

Note: 1. The above current ratings are the values of the steady-state current.
2. Inductive load has a power factor of 0.4 min . AC ) and a time constant of 7 ms max. (DC).
3. Lamp load has an inrush current of 10 times the steady-state current.
4. Motor load has an inrush current of 6 times the steady-state current.
5. The normally closed and normally open ratings of reverse hinge lever models are opposite to each other.

■ Contacts Specification

| Item | Classification | Z-15 | Z-01H | Z-10F |
| :---: | :--- | :---: | :---: | :---: |
| Contacts | Shape | Rivet | Single <br> crossbar | Rivet |
|  | Material | Silver | Gold alloy | Silver |
| Inrush current | NC | 30 A max. | 0.1 A max. | 40 A max. |
|  | NO | 15 A max. | 0.1 A max. | 20 A max. |

## ■ Safety Standards Ratings <br> UL/CSA (General ratings only)

| Rated <br> voltage Model | Z-15 | Z-10F | Z-01H |
| :--- | :---: | :---: | :---: |
| 125 VAC | 15A and 1/8HP | 6 A and 1/10HP | 0.1 A |
| 250 VAC | 15A and 1/4HP | 6 A and 1/8HP | --- |
| 480 VAC | 15 A | 6 A | --- |
| 30 VDC | --- | --- | 0.1 A |
| 125 VDC | 0.5 A | 0.6 A | --- |
| 250 VDC | 0.25 A | 0.3 A | --- |

TÜV (EN61058-1)

| Rated <br> voltage Model | Z-15H $\square$-B | Z-15G $\square$-B | Z-01H $\square$-B |
| :--- | :---: | :---: | :---: |
| 250 VAC | 15 A | 15 A | --- |
| 125 VAC | --- | --- | 0.1 A |
| 30 VDC | --- | --- | 0.1 A |

6. The AC ratings of molded terminals are 125 and 250 V only.
7. The ratings values apply under the following test conditions:
(1) Ambient temperature: $20 \pm 2^{\circ} \mathrm{C}$
(2) Ambient humidity: $65 \pm 5 \%$ RH
(3) Operating frequency: 20 operations $/ \mathrm{min}$

## Engineering Data

## Mechanical Durability (Z-15G)



## Structure

## Basic Models

## Contact Form (SPDT)



Note: The Z-15GM is a reversible model and the NO and NC positions are reversed.

## Drip-proof Construction

Without Terminal Protective Cover


## Split-Contact Models

## Contact Form



Note: The NO and NC terminal arrangement is reversed for Models with reverse operation (Z-10FM).

## Maintained-contact Models

## Contact Form



## Electrical Durability (Z-15G)



## Molded Terminals


( ) indicates wire color.
Note: The Z-15GM is a reversible model and the NO and NC positions are reversed.

With Terminal Protective Cover
Rubber boot (weather-resistive
chloroprene is used)


Rubber packing (improves sealing between switch housing and terminal cover)

Terminal protective covers are sold separately for maintenance purposes, which can be, however, used with the Z- $\square$-B5V models only.

Connection Example Series Connection


Parallel Connection


## Dimensions

## General-purpose and Split Contact Models

Note: Unless otherwise specified, all units are in millimeters and a tolerance of $\pm 0.4 \mathrm{~mm}$ applies to all dimensions

## Terminals

Screw Terminals (-B)
Appropriate terminal screw tightening
torque: 0.78 to $1.18 \mathrm{~N} \cdot \mathrm{~m}$.

## Mounting

All switches can be side mounted using M4 mounting screws with plane washers or spring washers to securely mount the Switch. Tighten the screws to a torque of 1.18 to $1.47 \mathrm{~N} \cdot \mathrm{~m}$.


Versions with panel mount plungers can be panel mounted via the plunger, provided that the hexagonal nut of the actuator is tightened to a torque of 2.94 to $4.9 \mathrm{~N} \cdot \mathrm{~m}$.

Panel Mount Plunger


Panel Mount Roller Plunger


Note: Mount using either the side mounting holes or the panel mount plunger, not both. If using the side mounting holes, then remove the hexagonal nut(s) from the panel mount plunger.

Note: 1. All drawings show the switches with screw terminals. For versions with solder terminals, remove the "-B" from the end of the part number.
2. Unless otherwise specified, all units are in millimeters and a tolerance of $\pm 0.4 \mathrm{~mm}$ applies to all dimensions.

## Hinge Roller Lever

Z-15GW255-B


| OF max. | 130 gf |
| :--- | :---: |
| RF min. | 21 gf |
| OT min. | 4 mm |
| MD max. | 1.6 mm |
| FP max. | 36.5 mm |
| OP | $30.2 \pm 0.8 \mathrm{~mm}$ |

## Unidirectional Short Hinge Roller Lever

## Z-15GW227755-B



Reverse Hinge Lever * Z-15GM55-B


| OF max. | 200 gf |
| :--- | :---: |
| RF $\min$. | 28 gf |
| OT min. | 5.6 mm |
| MD max. | 0.89 mm |
| FP max. | 23.8 mm |
| OP | $19 \pm 0.8 \mathrm{~mm}$ |

## Reverse Short Hinge Roller Lever *



Reverse Hinge Roller Lever *

## Z-15GM255-B



[^27]
## Safety Precautions

Be sure to read the precautions and information common to all Snap Action and Detection Switches, contained in the Technical User's Guide, "Snap Action Switches, Technical Information" for correct use.

## Precautions for Safe Use

## Terminal Connection

When soldering lead wires to the Switch, make sure that the capacity of the soldering iron is 60 W maximum. Do not take more than 5 s to solder any part of the Switch. The characteristics of the Switch will deteriorate if a soldering iron with a capacity of more than 60 W is applied to any part of the Switch for 5 s or more.

## Operation

- Make sure that the switching frequency or speed is within the specified range.

1. If the switching speed is extremely slow, the contact may not be switched smoothly, which may result in a contact failure or contact welding.
2. If the switching speed is extremely fast, switching shock may damage the Switch soon. If the switching frequency is too high, the contact may not catch up with the speed.
The rated permissible switching speed and frequency indicate the switching reliability of the Switch.
The life of a Switch is determined at the specified switching speed. The life varies with the switching speed and frequency even when they are within the permissible ranges. In order to determine the life of a Switch model to be applied to a particular use, it is best to conduct an appropriate durability test on some samples of the model under actual conditions.

- Make sure that the actuator travel does not exceed the permissible OT position. The operating stroke must be set to $70 \%$ to $100 \%$ of the rated OT.


## Precautions for Correct Use

 Mounting Location- Do not use the switch alone in atmospheres such as flammable or explosive gases. Arcing and heat generation associated with switching may cause fires or explosions.
- Switches are generally not constructed with resistance against water. Use a protective cover to prevent direct spraying if the switch is used in locations subject to splashing or spurting oil or water, dust adhering.

- Install the switch in a location that is not directly subject to debris and dust from cutting. The actuator and the switch body must be protected from accumulated cutting debris and dirt.

- Do not use the switch in locations subject to hot water (greater than $60^{\circ} \mathrm{C}$ ) or in water vapor.
- Do not use the switch outside the specified temperature and atmospheric conditions.
The permissible ambient temperature depends on the model. (Refer to the specifications in this catalog.) Sudden thermal changes may cause thermal shock to distort the switch and result in faults.

- Mount a cover if the switch is to be installed in a location where worker inattention could result in incorrect operation or accidents.

- Subjecting the switch to continuous vibration or shock may result in contact failure or faulty operation due to abrasion powder and in reduced durability. Excessive vibration or shock will cause the contacts to operate malfunction or become damaged. Mount the switch in a location that is not subject to vibration or shock and in a direction that does not subject the switch to resonance.
- If silver contacts are used with relatively low frequency for a long time or are used with microloads, the sulfide coating produced on the contact surface will not be broken down and contact faults will result. Use a microload switch that uses gold contacts.
- Do not use the switch in atmospheres with high humidity or heat or in harmful gases, such as sulfide gas $\left(\mathrm{H}_{2} \mathrm{~S}, \mathrm{SO}_{2}\right)$, ammonia gas $\left(\mathrm{NH}_{3}\right)$, nitric acid gas $\left(\mathrm{HNO}_{3}\right)$, or chlorine gas $\left(\mathrm{Cl}_{2}\right)$. Doing so may impair functionality, such as with damage due to contacting faults or corrosion.
- The switch includes contacts. If the switch is used in an atmosphere with silicon gas, arc energy may cause silicon oxide $\left(\mathrm{SiO}_{2}\right)$ to accumulate on the contacts and result in contact failure. If there is silicon oil, silicon filling, silicon wiring, or other silicon products in the vicinity of the switch, use a contact protection circuit to limit arcing and remove the source of the silicon gas.


## Mounting

Always make sure that the power is turned OFF before mounting, removing, or wiring the Switch, or performing maintenance.
Electric shock or burning may occur.

## Selecting Models

We recommend using Drip-proof Models (protection equivalent to IP62) in locations subject to floating dirt and dust. Other models do not have a protective structure.

## Wiring

For wiring, use a wire size that is appropriate for the applied voltage and the supplied current. When soldering the Switch, make sure that the capacity of the soldering iron is 60 W maximum. Do not take more than 5 s to solder any part of the Switch. Using the Switch with incomplete soldering may result in errors and heat, which may cause burning. The characteristics of the Switch will deteriorate if a soldering iron with a capacity of more than 60 W is used or if any part of the Switch is soldered for 6 s or longer.

## Tightening

The suitable tightening torque for screw terminals is given below.

- Screw terminals except for those on Split-contact Models (Z-10FY-B): 0.78 to $1.18 \mathrm{~N} \cdot \mathrm{~m}$
- Screw terminals on Split-contact Models (Z-10FY-B): 0.49 to $1.18 \mathrm{~N} \cdot \mathrm{~m}$


## Operation

- Make sure that the switching speed and frequency are is within the specified ranges.

1. If the switching speed is extremely slow, the contacts may not be switched smoothly, which may result in a contact failure or contact welding.
2. If the switching speed is extremely fast, switching shock may damage the Switch prematurely. If the switching frequency is too high, the contacts may not be able to keep up with the speed.
The rated permissible switching speed and frequency indicate the switching reliability of the Switch.
The life of a Switch is determined at the specified switching speed. The life varies with the switching speed and frequency even when they are within the permissible ranges.
Always conduct appropriate durability tests under actual conditions before using a Switch.

- Make sure that the actuator travel does not exceed the permissible OT position. The operating stroke must be set to $70 \%$ to $100 \%$ of the rated OT.

Panel Mount Switch (Z-15 $\square \square \square, \mathrm{Z}-01 \square \mathbf{Q} \square$ )

- When mounting the panel mount plunger model with screws on a side surface, be careful of the dog angle and operation speed. Excessive dog angle or operation speed may damage the Switch.
- When using the panel mount plunger model mounted with screws on a side surface, be careful not to apply a large shock. Applying a shock exceeding $1,000 \mathrm{~m} / \mathrm{s}^{2}$ may damage the Switch.
- When using the panel mount plunger model mounted with screws on a side surface, remove the hexagonal nuts from the actuator.


## High-sensitivity Switch (Z-15H)/

## Extra-high-sensitivity Switch (Z-15H2)

- When using the Switch in a DC circuit, be sure to provide an arc suppressor as well because the small contact gap of the Switch may result in contact troubles.
- In an application where a high repeat accuracy is required, limit the current that flows through the Switch to within 0.1 A . Also, use a relay to control a high-capacity load if the Switch is connected to such a load. (In this case, the exciting current of the relay coil is the load of the Switch.)
- Do not apply a force of 19.6 N or higher to the pin plunger.
- Exercise care that the environment conditions such as temperature and humidity do not change abruptly.


## Micro Load Applicable Range

Using a model for ordinary loads to open or close the contact of a micro load circuit may result in faulty contact. Use models that operate in the following range. However, even when using micro load models within the operating range shown here, if inrush current occurs when the contact is opened or closed, it may increase contact wear and so decrease durability. Therefore, insert a contact protection circuit where necessary.
The minimum applicable load is the N -level reference value. This value indicates the malfunction reference level for the reliability level of $60 \%\left(\lambda_{60}\right)$. The equation, $\lambda_{60}=0.5 \times 10^{-6} /$ operations indicates that the estimated malfunction rate is less than $1 / 2,000,000$ operations with a reliability level of $60 \%$.


|  | Z-01H | Z-15 $\square$, Z-10FY |
| :--- | :---: | :---: |
| Minimum applicable load | 1 mA at 5 VDC | 160 mA at 5 VDC |

Models with Drip-proof Terminal Cover (Z- $\square$ A55-B5V) Wiring

- To attach the Protective Cover to the case, hold the cover in almost parallel to the case and then push it to the case. If the cover is pushed diagonally, the rubber packing may slip off, degrading the sealability of the Switch.


Rubber packing


- Use round solderless terminals having the following dimensions to connect leads to the terminals. Tighten the screws of terminals to a torque of 0.78 to $1.18 \mathrm{~N} \cdot \mathrm{~m}$. Use the terminal shown below.

- A cable 8.5 to 10.5 mm in diameter can be applicable to the sealing rubber of the lead outlet of the Switch. A two-core or three-core VCT cable having a cross-sectional area of $1.25 \mathrm{~mm}^{2}$ is especially suitable for this.
- M4 small screws with spring toothed washer are used as the terminal screws.


## Drip-proof Switch (Z- $\square 55$ )

- The Switch is not perfectly oil-tight; so do not dip it in oil or water.
- The rubber boots are made from weather-resistive chloroprene rubber.
- Do not use Basic Switches in places with radical changes in temperature.
- Rubber boots and rubber caps will tend to harden at lower ambient temperatures. If an Actuator is used in a pressed state for an extended period of time at low temperatures, it may return slowly or it may not return at all. OMRON can provide special Actuators for use at low temperature with rubber boots or rubber caps made of silicon rubber, which has superior resistance to cold. Ask your OMRON representative for details.

Split-contact Switch (Z-10F $\square$ Y)
The applicable current varies depending on how the contacts are used. If the Switch is connected in series, the Switch can endure a current 1.5 to 2 times higher than the current that can be applied in parallel connection.

## Flexible Rod Switch (Z-15 $\square$ NJ $\square 55$, Drip-proof)

- When the rod is fully swung, the Switch may operate when the lever returns, causing chattering. Use a circuit that compensates for chattering wherever possible.
- Do not switch the rod to the fullest extent when the Switch is to break a power circuit because such a practice may cause metal deposition to occur between the mating contacts of the Switch.


## Other Precautions

- Do not apply excessive force with a screwdriver or other tool when attaching or removing the Protective Cover. Doing so may deform the Switch.

- The Drip-proof Terminal Protective Cover (AP-DV) can be used only with Switches with model numbers ending in "-B5V."
- The Drip-proof Terminal Protective Cover is only available for maintenance purposes.


## Accessories (Order Separately)

Refer to "Z/A/X/DZ Common Accessories" datasheet for details about Terminal Covers, Separators, and Actuators.

## Drip-proof Terminal Cover (Order Separately)

The Drip-proof Terminal Protective Cover is provided for maintenance for Z- $\square$ A55-B5V Switches.

## Ordering Information

| Name | Model |
| :---: | :---: |
| Drip-proof Terminal <br> Protective Cover | AP-DV |

Dimensions (Unit: mm)


SP160 Jesmond Road Indooroopilly SPS - TSR02 Transportable Switchboard Container - OM Manual

## Omron Electronic Components, LLC

## Terms and Conditions of Sales

## I. GENERAL

1. Definitions: The words used herein are defined as follows
(a) Terms: $\quad$ These terms and conditions
(b) Seller: Omron Electronic Components LLC and its subsidiaries
(c) Buyer: The buyer of Products, including any end user in section III through VI (d) Products: Products and/or services of Seller
(e) Including: Including without limitation
2. Offer; Acceptance: These Terms are deemed part of all quotations, acknowledgments, invoices, purchase orders and other documents, whether electronic or in writing, relating to the sale of Products by Seller. Seller hereby objects to any Terms proposed in Buyer's purchase order or other documents which are inconsistent with, or in addition to, these Terms.
3. Distributor: Any distributor shall inform its customer of the contents after and including section III of these Terms.
4. Prices; Payment: All prices stated are current, subject to change without notice by Seller. Buyer agrees to pay the price in effect at the time the purchase order is accepted by Seller. Payments for Products received are due net 30 days unless otherwise stated in the invoice. Buyer shall have no right to set off any amounts against the amount owing in respect of this invoice.
5. Discounts: Cash discounts, if any, will apply only on the net amount of invoices sent to Buyer after deducting transportation charges, taxes and duties, and will be allowed only if (a) the invoice is paid according to Seller's payment terms and (b) Buyer has no past due amounts owing to Seller.
6. Interest: Seller, at its option, may charge Buyer $1.5 \%$ interest per month or the maximum legal rate, whichever is less, on any balance not paid within the stated terms.
7. Orders: Seller will accept no order less than 200 U.S. dollars net billing.
8. Currencies: If the prices quoted herein are in a currency other than U.S. dollars, Buyer shall make remittance to Seller at the then current exchange rate most favorable to Seller; provided that if remittance is not made when due, Buyer will convert the amount to U.S. dollars at the then current exchange rate most favorable to Seller available during the period between the due date and the date remittance is actually made.
9. Governmental Approvals: Buyer shall be responsible for all costs involved in obtaining any government approvals regarding the importation or sale of the Products.
10. Taxes: All taxes, duties and other governmental charges (other than general real property and income taxes), including any interest or penalties thereon, imposed directly or indirectly on Seller or required to be collected directly or indirectly by Seller for the manufacture, production, sale, delivery, importation, consumption or use of the Products sold hereunder (including customs duties and sales, excise, use, turnover and license taxes) shall be charged to and remitted by Buyer to Seller.
11. Financial: If the financial position of Buyer at any time becomes unsatisfactory to Seller, Seller reserves the right to stop shipments or require satisfactory security or payment in advance. If Buyer fails to make payment or otherwise comply with these Terms or any related agreement, Seller may (without liability and in addition to other remedies) cancel any unshipped portion of Products sold hereunder and stop any Products in transit until Buyer pays all amounts, including amounts payable hereunder, whether or not then due, which are owing to it by Buyer. Buyer shall in any event remain liable for all unpaid accounts.
12. Cancellation; Etc: Orders are not subject to rescheduling or cancellation unless Buyer indemnifies Seller fully against all costs or expenses arising in connection therewith.
13. Force Majeure: Seller shall not be liable for any delay or failure in delivery resulting from causes beyond its control, including earthquakes, fires, floods, strikes or other labor disputes, shortage of labor or materials, accidents to machinery, acts of sabotage, riots, delay in or lack of transportation or the requirements of any government authority.
14. Shipping: Delivery: Unless otherwise expressly agreed in writing by Seller:
(a) All sales and shipments of Products shall be FOB shipping point (unless otherwise stated in writing by Seller), at which point title to and all risk of loss of the Products shall pass from Seller to Buyer, provided that Seller shall retain a security interest in the Products until the full purchase price is paid by Buyer;
(b) Delivery and shipping dates are estimates only; and
(c) Seller will package Products as it deems proper for protection against normal handling and extra charges apply to special conditions.
15. Claims: Any claim by Buyer against Seller for shortage or damage to the Products occurring before delivery to the carrier or any claim related to pricing or other charges must be presented in detail in writing to Seller within 30 days of receipt of shipment.

## III. PRECAUTIONS

1. Suitability: IT IS THE BUYER'S SOLE RESPOINSIBILITY TO ENSURE THAT ANY OMRON PRODUCT IS FIT AND SUFFICIENT FOR USE IN A MOTORIZED VEHICLE APPLICATION. BUYER SHALL BE SOLELY RESPONSIBLE FOR DETERMINING APPROPRIATENESS OF THE PARTICULAR PRODUCT WITH RESPECT TO THE BUYER'S APPLICATION INCLUDING (A) ELECTRICAL OR ELECTRONIC COMPONENTS, (B) CIRCUITS, (C) SYSTEM ASSEMBLIES, (D) END PRODUCT, (E) SYSTEM, (F) MATERIALS OR SUBSTANCES OR (G) OPERATING ENVIRONMENT. Buyer acknowledges that it alone has determined that the Products will meet their requirements of the intended use in all cases. Buyer must know and observe all prohibitions of use applicable to the Product/s.
2. Use with Attention: The followings are some examples of applications for which particular attention must be given. This is not intended to be an exhaustive list of all possible use of any Product, nor to imply that any use listed may be suitable for any Product:
(a) Outdoor use, use involving potential chemical contamination or electrical interference.
(b) Use in consumer Products or any use in significant quantities.
(c) Energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, safety equipment, and installations subject to separate industry or government regulations.
(d) Systems, machines, and equipment that could present a risk to life or property.
3. Prohibited Use: NEVER USE THE PRODUCT FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, AND THAT THE PRODUCT IS PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.
4. Motorized Vehicle Application: USE OF ANY PRODUCT/S FOR A MOTORIZED VEHICLE APPLICATION MUST BE EXPRESSLY STATED IN THE SPECIFICATION BY SELLER.
5. Programmable Products: Seller shall not be responsible for the Buyer's programming of a programmable Product.

## IV. WARRANTY AND LIMITATION

1. Warranty: Seller's exclusive warranty is that the Products will be free from defects in materials and workmanship for a period of twelve months from the date of sale by Seller (or such other period expressed in writing by Seller). SELLER MAKES NO WARRANTY OR REPRESENTATION, EXPRESS OR IMPLIED, ABOUT ALL OTHER WARRANTIES, NON-INFRINGEMENT, MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OF THE PRODUCTS.
2. Buyer Remedy: Seller's sole obligation hereunder shall be to replace (in the form originally shipped with Buyer responsible for labor charges for removal or replacement thereof) the non-complying Product or, at Seller's election, to repay or credit Buyer an amount equal to the purchase price of the Product; provided that there shall be no liability for Seller or its affiliates unless Seller's analysis confirms that the Products were correctly handled, stored, installed and maintained and not subject to contamination, abuse, misuse or inappropriate modification. Return of any Products by Buyer must be approved in writing by Seller before shipment.
3. Limitation on Liability: SELLER AND ITS AFFILIATES SHALL NOT BE LIABLE FOR SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES, LOSS OF PROFITS OR PRODUCTION OR COMMERCIAL LOSS IN ANY WAY CONNECTED WITH THE PRODUCTS, WHETHER SUCH CLAIM IS BASED IN CONTRACT, WARRANTY, NEGLIGENCE OR STRICT LIABILITY. FURTHER, IN NO EVENT SHALL LIABILITY OF SELLER OR ITS AFFILITATES EXCEED THE INDIVIDUAL PRICE OF THE PRODUCT ON WHICH LIABILITY IS ASSERTED.
4. Indemnities: Buyer shall indemnify and hold harmless Seller, its affiliates and its employees from and against all liabilities, losses, claims, costs and expenses (including attorney's fees and expenses) related to any claim, investigation, litigation or proceeding (whether or not Seller is a party) which arises or is alleged to arise from Buyer's acts or omissions under these Terms or in any way with respect to the Products.

## V. INFORMATION; ETC.

1. Intellectual Property: The intellectual property embodied in the Products is the exclusive property of Seller and its affiliates and Buyer shall not attempt to duplicate it in any way without the written permission of Seller. Buyer (at its own expense) shall indemnify and hold harmless Seller and defend or settle any action brought against Seller to the extent that it is based on a claim that any Product made to Buyer specifications infringed intellectual property rights of another party.
2. Property; Confidentiality: Notwithstanding any charges to Buyer for engineering or tooling, all engineering and tooling shall remain the exclusive property of Seller. All information and materials supplied by Seller to Buyer relating to the Products are confidential and proprietary, and Buyer shall limit distribution thereof to its trusted employees and strictly prevent disclosure to any third party.
3. Performance Data: Performance data is provided as a guide in determining suitability and does not constitute a warranty. It may represent the result of Seller's test conditions, and the users must correlate it to actual application requirements.
4. Change In Specifications: Product specifications and descriptions may be changed at any time based on improvements or other reasons. It is Seller's practice to change part numbers when published ratings or features are changed, or when significant engineering changes are made. However, some specifications of the Product may be changed without any notice.
5. Errors And Omissions: The information on Seller's website or in other documentation has been carefully checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical or proofreading errors or omissions.
6. Export Controls: Buyer shall comply with all applicable laws, regulations and licenses regarding (a) export of the Products or information provided by Seller; (b) sale of Products to forbidden or other proscribed persons or organizations; (c) disclosure to noncitizens of regulated technology or information.

## VI. MISCELLANEOUS

1. Waiver: No failure or delay by Seller in exercising any right and no course of dealing between Buyer and Seller shall operate as a waiver of rights by Seller.
2. Assignment: Buyer may not assign its rights hereunder without Seller's written consent.
3. Law: These Terms are governed by Illinois law (without regard to conflict of laws). Federal and state courts in Cook County, Illinois have exclusive jurisdiction for any dispute hereunder.
4. Amendment: These Terms constitute the entire agreement between Buyer and Seller relating to the Products, and no provision may be changed or waived unless in writing signed by the parties.
5. Severability: If any provision hereof is rendered ineffective or invalid, such provision shall not invalidate any other provision.

## Certain Precautions on Specifications and Use

1. Suitability for Use. Seller shall not be responsible for conformity with any standards, codes or regulations which apply to the combination of the Product in Buyer's application or use of the Product. At Buyer's request, Seller will provide applicable third party certification documents identifying ratings and limitations of use which apply to the Product. This information by itself is not sufficient for a complete determination of the suitability of the Product in combination with the end product, machine, system, or other application or use. Buyer shall be solely responsible for determining appropriateness of the particular Product with respect to Buyer's application, product or system. Buyer shall take application responsibility in all cases but the following is a nonexhaustive list of applications for which particular attention must be given:
(i) Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this document.
(ii) Energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, safety equipment, and installations subject to separate industry or government regulations.
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ALL DIMENSIONS SHOWN ARE IN MILLIMETERS.
To convert millimeters into inches, multiply by 0.03937 . To convert grams into ounces, multiply by 0.03527 .

## OMROM

OMRON ELECTRONIC COMPONENTS LLC
55 E. Commerce Drive, Suite B
Schaumburg, IL 60173

## 847-882-2288

## IIDEC

## LF1B series LED Illumination Units $\mathbb{L} \mathbb{M} \mathbb{M F} \mathbb{F}^{m}$



IDEC CORPORATION

| Illumination Colors \& Application Examples |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | Ment |  |
| Illumination Color |  | Cool White | Warm White | Yellow | Red |
| Power Voltage |  | 24 V DC |  |  |  |
|  | Clear Cover | $\rightarrow$ 000000001 |  | $-3, \cdots$ | $\rightarrow, \ldots 1$ |
|  | White Cover |  | $-3 \cdot 7$ | $-4$ | -d Etwonomomal |
| Spectrum |  |  |  |  |  |
|  | atures | Suppressing glare, the bright, clear cool white illumination color lights up a target object clearly. This illumination color gives off a color temperature of 5500K. | Warm color similar to that of incandescent lamps. This illumination color gives off a color temperature of 2800 K . | Yellow illumination color gives off an emission spectrum with a dominant wavelength of 590 nm . | Red illumination color gives off an emission spectrum with a dominant wavelength of 625 nm . |
| Applications |  | - Control panel <br> - Plant equipment <br> - Refrigerator/freezer <br> - Inspection/test equipment <br> - Advertising display/board <br> - Machine tool | - Food processing machines <br> - Cosmetic plants <br> - Chemical plants <br> - Showcases <br> - Food display cases | - Manufacturing equipment <br> - IC foundries | - Photosensitive materials <br> - Semiconductor manufacturing equipment |
|  |  |  |  |  |  |

## Features

- Brightness: 62.5 Lumens/Watt
- Low heat generation.
- Less energy usage, longer operation life, smaller mounting space, and no electrical noise.
- 71\% reduction of power and $\mathrm{CO}_{2}$ emission when compared to 20W fluorescent lamps (LF1B-C/D)
- Thin and slim style fits into compact spaces.
- Two cover colors: clear and white (diffused light)
- Cool white, warm white, yellow and red illumination colors available.
- UL Listed \& IP54 protection against dust and water splash (IEC 60529)

Part No. Development

## LF1B- C 3 S -2 THWW4

LED Module Arrangement
A: 3 LEDs $\times 1$ row
B: 6 LEDs $\times 1$ row
C: 12 LEDs $\times 1$ row
D: 24 LEDs $\times 1$ row

LED Illumination Color
THWW4: Cool white TLWW4: Warm white SHY6: Yellow SHR6: Red

Degree of Protection S: IP54
Cover
3: Clear plastic
4: White plastic

## LED Optics Specifications

| Illumination Color |  | Cool White | Warm White | Yellow | Red |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Luminous Intensity (typ.) (Single LED module) |  | 5000 mcd | 4500 mcd | 2300 mcd | 1800 mcd |
| Color Temperature (typ.)/Dominant Wavelength (typ.) |  | 5500 K | 2800K | 590 nm | 625 nm |
| Reference Illuminance (typ.) at 500 mm (clear cover) | 3 LEDs $\times 1$ row | 90 lx | 60 lx | 20 lx | 20 lx |
|  | 6 LEDs $\times 1$ row | 170 lx | 110 lx | 40 lx | 40 lx |
|  | 12 LEDs $\times 1$ row | 330 Ix | 200 lx | 75 lx | 75 lx |
|  | 24 LEDs $\times 1$ row | 560 lx | 350 lx | 125 lx | 125 lx |

Note: Illumination colors and illuminance may vary. Specifications shown in the above table are typical values and may vary depending upon actual environment.

LF1B Series Illumination Units

## Performance Specifications

| Rated Voltage |  | 24V DC (non-polarized) |
| :---: | :---: | :---: |
| Input Current (typ.) (at the rated voltage) | LF1B-A | 30 mA |
|  | LF1B-B | 60 mA |
|  | LF1B-C | 120 mA |
|  | LF1B-D | 240 mA |
| Power Consumption (typ.) (at the rated voltage) | LF1B-A | 0.8W |
|  | LF1B-B | 1.5W |
|  | LF1B-C | 2.9W |
|  | LF1B-D | 5.8W |
| Insulation Resistance |  | $100 \mathrm{M} \Omega$ minimum (500V DC megger) |
| Dielectric Strength |  | 1000 V AC, 1 minute (between live and dead parts) |
| Vibration Resistance (damage limits) |  | Frequency: 5 to 55 Hz Amplitude: 0.5 mm |
| Shock Resistance (damage limits) |  | $1000 \mathrm{~m} / \mathrm{s}^{2}$ |
| Operating Temperature |  | -30 to $+55^{\circ} \mathrm{C}$ (no freezing) |
| Operating Humidity |  | 45 to 85\% RH (no condensation) |
| Storage Temperature |  | -35 to $+70^{\circ} \mathrm{C}$ (no freezing) |
| Operating Atmosphere |  | No corrosive gas |
| Life |  | 40000 hours (The total illumination duration in which the luminance maintains a minimum of $70 \%$ of the initial value.) |
| Degree of Protection |  | IP54 |
| Material |  | End cover, conduit: polyamide Cover: polycarbonate Wire: US20276T AWG24 $\times 2 \mathrm{C}$ |
| Weight (approx.) | LF1B-A | 95g |
|  | LF1B-B | 125 g |
|  | LF1B-C | 165 g |
|  | LF1B-D | 255 g |

- Do not use the LF1B illumination units in environments subject to corrosive gases, otherwise illuminance may deteriorate.


## Dimensions



| Type No. | A | B | C |
| :---: | :---: | :---: | :---: |
| LF1B-A | 134 | 64 | 123 |
| LF1B-B | 210 | 140 | 199 |
| LF1B-C | 330 | 260 | 319 |
| LF1B-D | 580 | 510 | 569 |



All dimensions in mm.

## Internal Circuit



## VEGA

## Operating Instructions VEGADIS 62




Document ID: 36469

Indication
and adjustment

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## Safety instructions for Ex areas

Please note the Ex-specific safety information for installation and operation in Ex areas. These safety instructions are part of the operating instructions manual and come with the Ex-approved instruments.

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## 1 About this document

### 1.1 Function

This operating instructions manual provides all the information you need for mounting, connection and setup as well as important instructions for maintenance and fault rectification. Please read this information before putting the instrument into operation and keep this manual accessible in the immediate vicinity of the device.

### 1.2 Target group

This operating instructions manual is directed to trained qualified personnel. The contents of this manual should be made available to these personnel and put into practice by them.

### 1.3 Symbolism used

Information, tip, note
This symbol indicates helpful additional information.
Caution: If this warning is ignored, faults or malfunctions can result.
Warning: If this warning is ignored, injury to persons and/or serious damage to the instrument can result.
Danger: If this warning is ignored, serious injury to persons and/or destruction of the instrument can result.

Ex applications
This symbol indicates special instructions for Ex applications.

- List

The dot set in front indicates a list with no implied sequence.
$\rightarrow$ Action
This arrow indicates a single action.

1 Sequence
Numbers set in front indicate successive steps in a procedure.

## 2 For your safety

### 2.1 Authorised personnel

All operations described in this operating instructions manual must be carried out only by trained specialist personnel authorised by the plant operator.

During work on and with the device the required personal protective equipment must always be worn.

### 2.2 Appropriate use

The VEGADIS 62 is an indicating and adjustment unit without external energy for looping into $4 \ldots 20 \mathrm{~mA} / \mathrm{HART}$ circuits.

You can find detailed information on the application range in chapter "Product description".

Operational reliability is ensured only if the instrument is properly used according to the specifications in the operating instructions manual as well as possible supplementary instructions.

### 2.3 Warning about misuse

Inappropriate or incorrect use of the instrument can give rise to application-specific hazards, e.g. vessel overfill or damage to system components through incorrect mounting or adjustment.

### 2.4 General safety instructions

This is a state-of-the-art instrument complying with all prevailing regulations and guidelines. The instrument must only be operated in a technically flawless and reliable condition. The operator is responsible for the trouble-free operation of the instrument.

During the entire duration of use, the user is obliged to determine the compliance of the necessary occupational safety measures with the current valid rules and regulations and also take note of new regulations.

The safety instructions in this operating instructions manual, the national installation standards as well as the valid safety regulations and accident prevention rules must be observed by the user.

For safety and warranty reasons, any invasive work on the device beyond that described in the operating instructions manual may be carried out only by personnel authorised by the manufacturer. Arbitrary conversions or modifications are explicitly forbidden.

The safety approval markings and safety tips on the device must also be observed.

### 2.5 CE conformity

The device fulfills the legal requirements of the applicable EC guidelines. By affixing the CE marking, we confirm successful testing of the product.

You can find the conformity certificate in the download section under www.vega.com

### 2.6 Fulfillment of NAMUR recommendations

The device fulfills the requirements of the applicable NAMUR recommendations.

### 2.7 Environmental instructions

Protection of the environment is one of our most important duties. That is why we have introduced an environment management system with the goal of continuously improving company environmental protection. The environment management system is certified according to DIN EN ISO 14001

Please help us fulfil this obligation by observing the environmental instructions in this manual:

- Chapter "Packaging, transport and storage"
- Chapter "Disposal"

VECA
3 Product description

## 3 Product description

### 3.1 Structure

## Constituent parts

Type label

## Serial number

36469-EN-120329 versions:

- Software from 2.00
- Software from 2.10 (with the functions Password and Logout)

Operation The VEGADIS 62 is suitable for operation of all continuously measuring VEGA sensors with HART output＞ 5.0 ：

- Radar and ultrasonic sensors
- Sensors with guided microwave
- Capacitive probes
- Pressure transmitter
- Previous instrument versions (replacement for VEGADIS 12)

The operation of respective sensors from other manufacturers is also possible.

The VEGADIS 62 acts like a HART handheld with limited functions. The following adjustment functions are available:

- Min./Max. adjustment
- zero/span adjustment (live adjustment)
- Damping

Modes
Basic mode: when used in a $4 \ldots 20 \mathrm{~mA}$ signal cable, the VEGADIS 62 works as a pure indicating instrument. It measures the current in the current loop and shows it as digital value as well as via a bargraph. All settings of VEGADIS 62 are carried out manually via the buttons in the front.

Adjustment volume: Indication scaling
HART standard: when used with a $4 \ldots 20 \mathrm{~mA} / \mathrm{HART}$ sensor, the VEGADIS 62 operates as automatic indicating and HART adjustment instrument. The VEGADIS 62 powered via the current loop listens continuously to the HART communication of the control system with the sensor. Changes of unit and/or measuring range are adapted automatically.

The parameter adjustment of the sensor is carried out via HART communication. During the parameter adjustment, the VEGADIS 62 operates as a Secondary Master to the sensor.

Adjustment volume: Sensor functions, indication scaling
HART multidrop: The VEGADIS 62 can also be used as indicator for a bus participant on a HART multidrop system. For this purpose, it is looped into the bus and the address of the participant is set in the VEGADIS 62. The instrument reads out the measured values with unit via the HART signal and displays them.

Adjustment volume: Sensor function damping, indication scaling

### 3.3 Packaging, transport and storage

Your instrument was protected by packaging during transport. Its capacity to handle normal loads during transport is assured by a test according to DIN EN 24180.

The packaging of standard instruments consists of environmentriendly, recyclable cardboard. For special versions, PE foam or PE foi s also used. Dispose of the packaging material via specialised recycling companies.

Transport Transport must be carried out under consideration of the notes on the transport packaging. Nonobservance of these instructions can cause damage to the device.

Transport inspection The delivery must be checked for completeness and possible transit damage immediately at receipt. Ascertained transit damage or concealed defects must be appropriately dealt with.

| StorageUp to the time of installation, the packages must be left closed and <br> stored according to the orientation and storage markings on the <br> outside. <br> Unless otherwise indicated, the packages must be stored only under |
| :--- |

Unless otherwise indicated, the packages must be stored only under the following conditions:

- Not in the open
- Dry and dust free
- Not exposed to corrosive media
- Protected against solar radiation
- Avoiding mechanical shock and vibration

Storage and transport temperature

- Storage and transport temperature see chapter "Supplement Technical data - Ambient conditions"
- Relative humidity 20 ... $85 \%$


## 4 Mounting

### 4.1 General instructions

Use the recommended cables (see chapter "Connecting to power supply") and tighten the cable gland.

You can give your instrument additional protection against moisture penetration by leading the connection cable downward in front of the cable entry. Rain and condensation water can thus drain off. This applies mainly to outdoor mounting as well as installation in areas where high humidity is expected (e.g. through cleaning processes) or on cooled or heated vessels.

### 4.2 Instructions for installation

VEGADIS 62 for wall mounting is supplied with a mounting socket.


Fig. 3: VE 62 for wall mounting, bottom view of mounting plate.
1 Drilling dimensions

Carrier rail mounting
VEGADIS 62 for mounting on carrier rail is supplied with a mounting adapter.


Fig. 4: VE 62 for carrier rail mounting
1 Carrier rail adapter
2 Carrier rail

Tube mounting
VEGADIS 62 for tube mounting is supplied with a meas. instrument holder and four screws M5 x 12 as mounting accessory. The meas. instrument holder is mounted to the socket of VEGADIS 62.


Fig. 5: VEGADIS 62 for tube mounting

[^28]
## 5 Connecting to power supply

### 5.1 Preparing the connection

Safety instructions

Voltage supply

Cable gland $1 / 2$ NPT

Cable screening and grounding

Always keep in mind the following safety instructions:

- Connect only in the complete absence of line voltage
- If voltage surges are expected, install overvoltage arresters

Power supply and current signal are carried on the same two-wire cable. The voltage supply range can differ depending on the sensor.

The data for power supply are specified in chapter "Technical data".
Provide a reliable separation between the supply circuit and the mains circuits according to DIN VDE 0106 part 101.

Keep in mind the following additional factors that influence the operating voltage:

- Output voltage of the power supply unit can be lower under nominal load (with a sensor current of 20.5 mA resp. 22 mA in case of fault message)
- Influence of additional instruments in the circuit (see load values in chapter "Technical data")

Operation of VEGADIS 62 in a HART multidrop system with the signal conditioning instruments VEGAMET 625 or VEGASCAN 693 is not supported.

The instrument is connected with standard two-wire cable without screen. If electromagnetic interference is expected which is above the test values of EN 61326-1 for industrial areas, screened cable should be used.

For instruments with housing and cable gland, use cable with round cross-section. A cable outer diameter of $5 \ldots 9 \mathrm{~mm}$ ( $0.2 \ldots 0.35 \mathrm{in}$ ) ensures the seal effect of the cable gland. If you are using cable with a different diameter, exchange the seal or use a suitable cable gland.

We generally recommend the use of screened cable for HART multidrop mode.

With plastic housing, the NPT cable gland or the Conduit steel tube must be screwed without grease into the threaded insert.

Max. torque for all housings see chapter "Technical data"

If screened cable is necessary, connect the cable screen on both ends o ground potential. In the sensor, the screen must be connected directly to the internal ground terminal. The ground terminal on the outside of the housing must be connected to the potential equalisation (low impedance).

If potential equalisation currents are expected, the connection on the processing side must be made via a ceramic capacitor (e. g. 1 nF , 1500 V ). The low frequency potential equalisation currents are thus suppressed, but the protective effect against high frequency interference signals remains.

## Warning:

Significant potential differences exist inside galvanization plants as well as on vessels with cathodic corrosion protection. Considerable equalisation currents can flow over the cable screen if the screen is grounded on both ends.

To avoid this in such applications, the cable screen must be connected to ground potential only at one end (in the switching cabinet). The cable screen must not be connected to the internal ground terminal in the sensor and the outer ground terminal on the housing must not be connected to the potential equalisation!

## Information:

The metal parts of the instrument (antenna, transmitter, concentric tube, etc.) are conductive connected with the inner and outer ground terminal on the housing. This connection exists either directly metallic or with instruments with external electronics via the screen of the special connection cable.

You can find specifications to the potential connections within the instrument in chapter "Technical data".

### 5.2 Connection technology and steps

Connection technology The connection of the signal cable is carried out via spring-loaded terminals in the housing.

The indicating and adjustment module is connected via a cable with coupling to the housing.

## Connection procedure Proceed as follows:

1 Unscrew the housing cover

2 Remove the indicating and adjustment module by turning it slightly to the left


Fig. 6: Dismounting of the indicating and adjustment module

3 Loosen compression nut of the cable glands
4 Remove approx. 10 cm (4 in) of the signal cable mantle, strip approx. $1 \mathrm{~cm}(0.4 \mathrm{in})$ insulation from the ends of the individual wires

5 Insert the cable into the sensor through the cable entry


Fig．7：Connection steps 5 and 6

6 Insert the wire ends into the terminals according to the wiring plan

## －Note：

Solid cores as well as flexible cores with cable end sleeves are inserted directly into the terminal openings．In case of flexible cores without end sleeves，press the terminal with a small screwdriver；the terminal opening is freed．When the screwdriver is released，the terminal closes again．

7 Check the hold of the wires in the terminals by lightly pulling on them
8 Connect the screen to the internal ground terminal，connect the outer ground terminal to potential equalisation
9 Attach the indicating and adjustment module again and turn it slightly to the right
10 Tighten the compression nut of the cable glands．The seal ring must completely encircle the cable
11 Screw the housing cover back on
The electrical connection is finished．
－Note：
1．The terminal block is pluggable and can be removed from the electronics．To do this，lift the terminal block with a small screwdriver and pull it out．When inserting the terminal block again，you should hear it snap in．

### 5.3 Wiring plan



Fig. 8: Wiring plan VEG IS 62
1 To the sensor
2 For power supply
3 Coupling for the connection cable to the indicating and adjustment module

### 5.4 Connection HART standard

The following illustrations show in a simplified way the use of VEGADIS 62 in conjunction with a HART sensor. The HART communication resistance in the signal cable is always required for a low impedance power supply. It is absolutely necessary to install it between voltage supply and the VEGADIS 62.

Note:
. If the instrument is powered via a VEGAMET signal conditioning instrument, then the communication resistor is already included in the signal conditioning instrument. A communication resistor in the signal cable must not be installed.

## Overview



Fig. 9: VEGADIS 62 in conjunction with an individual sensor

## Sensor

 VEGADIS 62HART resistance > $150 \Omega$ (necessary with low impedance power supply)
Voltage supply/Processing

Connection with low impedance power supply

(4)

Fig. 10: Connection of VEGADIS 62 with low impedance power supply
1 Sensor
2 VEGADIS 62
3 HART resistor > $150 \Omega$
4 Voltage supply/Processing

### 5.5 Connection HART multidrop

The following illustrations show in a simplified way the use of VEGADIS 62 in conjunction with a HART sensor. The HART communication resistance in the signal cable is always required for a low impedance power supply. It is absolutely necessary to install it between voltage supply and the VEGADIS 62.

## 1

Note:
If the instrument is powered via a VEGAMET signal conditioning instrument, then the communication resistor is already included in the signal conditioning instrument. A communication resistor in the signal cable must not be installed.

5 Connecting to power supply

## Overview

Fig. 11: Installation example with one VEGADIS 62 per sensor in a Multidrop system

Sensor
VE
HART resistance > $150 \Omega$ (necessary with low impedance power supply) Voltage supply/Processing


Fig. 12: Installation example with one VEGADIS 62 for several sensors in a Multidrop system
1 Sensor
VE IS 62
36469-EN-120329
3 HART resistance > $150 \Omega$ (necessary with low impedance power supply)
Voltage supply/Processing


Fig. 13: Connection of VEGADIS 62 with low impedance power supply
1 Sensor
2 VEGADIS 62
3 HART resistor > $150 \Omega$
4 Voltage supply/Processing

### 5.6 Connection signal conditioning instruments

The following illustrations show the simplified connection of VEGADIS 62 to a signal conditioning instrument VEGAMET or a four-wire sensor with active 4 ... 20 mA output.


Fig. 14: Connection of the VEG 62 as external indication to a signal conditioning instrument or a four-wire sensor
1 Sensor
2 Signal conditioning instrument
3 VEGADIS 62

Hence terminals 1 and 2 on the VEGADIS 62 must be closed with a bridge.


Fig. 15: Bridge on terminals 1 and 2 on the VEG IS 62
1 Bridge
2 VEGADIS 62
3 Signal conditioning instrument

### 5.7 Switch-on phase

During the start-up process, the VEGADIS 62 tries automatically to get in contact with the connected sensor via HART and to accept the settings (unit, adjustment and damping) of this sensor. During connection, the status line displays "CONNECT HART".

If a HART sensor is identified, then the HART symbol is displayed. The VEGADIS 62 switches to HART mode and and starts operation with the settings accepted from the sensor.

Note:
This procedure is repeated whenever the voltage supply is connected.
If during the start process an individual key is pressure or if the instrument has not identified within approx. 70 seconds a HART sensor, then the digital indication switches to basic mode and starts operation with the default settings.

If the HART address is modified by the control system during operation, a new connection is established, however, the sensor must answer immediately in order for the connection to be set up.

## 6 Set parameters

## 6．1 Adjustment system



Fig．16：Indicating and adjustment elements
1 Status information（HART mode，unit lock，warning or error information） 2 Unit and information line
3 Digital measured value indication
4 Bar graph for quasianalogue measured value indication
5 Adjustment keys

Key functions
You adjust VEGADIS 62 via the four front keys．The individual menu items are displayed on the LC display．The individual keys have the following functions：
－［ $\uparrow$ ］key：
－One menu higher in the menu system
－Increase actual value（increment）
－［E ］key：
－interrupt input
－Return to higher－ranking menu
－［OK］key：
－Move to the menu overview
－Confirm selected menu
－Edit parameter
－Save value
－［ $\downarrow$ ］key：
－One menu item downward in the menu system
－Reduce actual value（decrement）
Approx． 10 minutes after the last pressing of a key，an automatic reset to measured value indication is triggered．Any values not confirmed with［OK］will not be saved．

Start parameter adjustment

By pushng the [OK] key, the parameter adjustment mode will be started. The parameter adjustment is carried out via an adjustment menu. The same menu window is opened from which the parameter adjustment mode is quit during the last parameter adjustment. Single points in the menu can be selected with the [ $\uparrow$ ] and [ $\downarrow$ ] keys. The branching to the next submenu is carried out by pushing the [OK] key again.

In a submenu you change with [OK] to the editing function, this means the displayed settings can be changed. If the indication is in the editing mode, then the edited value flashes. Editing is carried out with the [ $\uparrow$ ] and $[\downarrow]$ keys.

In the editing mode, you jump to the range end when you hold the [ $\uparrow$ ] or [ $\downarrow$ ] key by pushing [ESC]. by pushing [OK] you jump to the range start. When holding the [ $\uparrow$ ] keyand by pushing the [ $\downarrow$ ] key (and vice versa), then the value zero is adjusted, When increasing a value at the end of the adjustment range, you jump to the range start and vice versa.

The editing function and be quit with [E ] (without accepting the modifications) and with [OK] (accepting the modifications).

### 6.2 Modes

In the following cases, the VEGADIS 62 goes automatically to basic mode:

- If it does not find a HART sensor within approx. 70 s after switching on
- If a key was pressed in the switching on phase

In basic mode, it works exclusively as an indicating instrument on the $4 \ldots 20 \mathrm{~mA}$ cable, the HART symbol is not displayed.

The VEGADIS 62 goes automatically to the mode HART standard when a functioning HART communication to the sensor was established.

The displayed measured value is calculated from the loop current and the adjustment data of the sensor.

During operation, the VEGADIS 62 monitors the current loop constantly for a HART communication between control system and sensor. If the unit changes or adjustments of the connected sensor are carried out by the control system, the unit and the corresponding indicating range are automatically adapted in VEGADIS 62. The prerequisite, however, is that the unit set in the sensor must be stored in VEGADIS 62.

The VEGADIS 62 also allows the measuring range and calibration of the connected HART sensor to be modified. For this, no additional instruments or tools are necessary. Further changes to the configuration of the sensor cannot be carried out.

## HART multidrop

## Measurement／Unit

A flashing heart symbol is displayed as long as a HART communi－ cation takes place for the first time and the instrument is hence set to the HART mode．The heart symbol is displayed permanently if the HART communication is finished and the digital indication is configured according to the measuring range and the unit of the connected sensor．

When there is a HART communication through the control room during operation，then the heat symbol flashes during the communication．

The VEGADIS 62 goes to HART multidrop mode if in the menu ＂Measurement＂，menu item＂Address＂an address unequal 0 is adjusted．In this mode for HART sensors，the current signal is fixed to 4 mA and the measurement information is transmitted only via the HART communication to the control room．

The VEGADIS 62 enquires the Primary Value（PV）of the transmitter with the suitable address once．Afterwards the display behaves passively，i．e．the transmission of additional measured values must be requested from the control system．The bargraph is not displayed in HART multidrop．

## 6．3 Parameter description

Through the parameter adjustment the instrument is adapted to the application conditions．The parameter adjustment is carried out via an adjustment menu．

The adjustment menu is divided into three sections with the following functions：


Measurement：Contains for example unit，measuring range，live adjustment，damping，HART address

Indication：Contains for example unit，unit locking，display format， filter，alarms min．／max．storage

Configuration：Contains for example language，contrast，reset，user unit，min．／max．failure message，firmware version

Selection of the unit for the measuring range adjustment of the connected transmitter ${ }^{1}$ ）When opening this menu item，first of all the basic unit of the connected sensor is displayed．
－Distance：m，cm，mm，ft，in

1）Is not available with HART multidrop．

- Pressure: bar, mbar, PSI, hPa, kPa, MPa, mmH2O, mH2O, inHg
- Temperature: ${ }^{\circ} \mathrm{C},{ }^{\circ} \mathrm{F}, \mathrm{K}$
- Electrical variables: V, mA, Ohm
- User-specific unit: USER

The previously listed units can be initially edited. A storing in the VEGADIS 62 is however only possible if the unit is supported by the sensor.

## Note:

A unit adjusted in the sensor, for example, via PACTware/DTM will not be modified by the unit adjusted here.

If a unit is selected which is not supported by the sensor, the message "HART Error 7" is displayed. With "ESC" the setting can be interrupted and the message reset.

Due to the selection of the unit " $U$ " the HART communication to the sensor is switched off. Hence no measuring range settings are possible. The unit "USER" can be individually programmed by the user in the menu "Configuration". After a reset to a unit supported by the sensor, the HART communication is again started.


Measurement/Measuring range begin

Adjustment of the measuring range initial value of the connected sensor (for example 0 bar at a measuring range of $-1 \ldots 5$ bar) ${ }^{2}$ The measuring range beginning point is initially adopted by the sensor when starting with connected sensor. Thereafter the measuring range beginning point of the sensor can be changed.

This is a min. adjustment to which $0 \%$ current output is assigned. The value entered here does not change the measuring range endpoint.

If the unit is set to "USER", then this menu item is used for free scaling of the indication.

Adjustment range: -9999 ... 99999

2) Is not available with HART multidrop.

Measurement／Measu－ ring range end

Measurement／Measu－ ring range decimal point

Adjustment of the measuring range final value of the connected transmitter（for example 4 bar at a measuring range of $-1 \ldots 5$ bar）3）The measuring range endpoint is initially adopted by the sensor when starting with connected sensor．Thereafter，the measuring range endpoint of the sensor can be changed．

This is a max．adjustment to which 100 \％current output is assigned． The value entered here does not change the measuring range beginning point．

If the unit is set to＂$U \quad$＂，then this menu item is used for free scaling of the indication．

Adjustment range：－9999 ．．． 99999


Adjustment of the decimal point for the measuring range of the connected transmitter ${ }^{4}$

If the unit is set to＂$U E R$＂，then this menu item is used for free scaling of the indication．

Adjustment range：0，0．0，0．00， 0.000


In this menu item，the actual measured value is accepted as span setting for the sensor ${ }^{5}$ ）

This is a span adjustment to which $100 \%$ of the current output are assigned．The value accepted here，does not change the zero point．


3）Is not available with HART multidrop．
4）Is not available with HART multidrop
5）Is not available with HART multidrop．

Measurement/Live adjustment zero point

In this menu item, the actual measured value is accepted as min. adjustment for the sensor6)

This is a zero adjustment to which $0 \%$ of the current output are assigned. The value accepted hier, shifts the measuring range end! The difference between measuring range begin and end however remains.


Measurement/Damping
In this menu item, the integration time for damping the measured value is entered.

Adjustment range: $0.0 \ldots 999$ s


Indication/Unit

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Adjustment of the HART address of the assigned transmitter in Multidrop mode. With standard current loop operation, this address must always be set to 0

Adjustment range: $0 \ldots 15$


Adjustment of the unit for the digital indication. First of all the unit selected in the menu "Measurement", for example m appears. Furthermore the units from the same unit group such as e.g. mm, cm, m etc. are available. The measured values are automatically converted into the selected unit.

If \% is selected as unit, then the VEGADIS 62 converts the actual loop current into a \% value relating to the max. loop current. If mA is selected as a unit, then the actual loop current is displayed in mA.
6) Is not available with HART multidrop.

The units \％and mA are not available in multidrop operation because in this case the loop current is fixed．

Adjustment range：mbar，bar，PSI，hPa，kPa，MPa，mmH2O，mH2O， $\mathrm{mHg}, \mathrm{mm}, \mathrm{cm}, \mathrm{m}, \mathrm{in}, \mathrm{ft}, \%,{ }^{\circ} \mathrm{C},{ }^{\circ} \mathrm{F}, \mathrm{K}, \mathrm{V}, \mathrm{mA}$ ，Ohm，USER


## Indication／Unit locking

DurcBy activating the unit locking，the set indication unit is locked against changes by the sensors，the display shows the sign＂GESP／ LoC＂．Hence it is possible to adjust for the VEGADIS 62 another indicating unit than the sensor unit，e．g．\％．It will also not be overwritten in case of a restart of the sensor．Adjustment changes on the sensor however are automatically converted．The unit locking functions onyl if the units of measuring range and indication come from the same unit group．
When connecting a transmitter and its configuration via HART with a unit from another unit group，then the unit locking will be deactivated． For this purpose，the indicating unit is adjusted according to the configured measuring range unit．

Adjustment range：
－nGESP／UnLoC
－GESP／LoC


Indication／Indication de－ cimal point

Adjustment of the decimal point for the indication area of the digital indication

Adjustment range：0，0．0，0．00， 0.000


Indication／Digital filter Activation of the digital filter 1．order．
Adjustment range： 0 ．．． 10


## ndication/Alarm

From this menu item you jump to the alarm configuration by pushing OK.


Switching on or switching off the alarm function. If an adjusted alarm limit is exceeded or decreased, the warning symbol is displayed in the indication and the measured value begins to flash.

Adjustment range: Off/On


## Indication/Min. alarm

Setting the value that triggers the alarm function if it is underrun.
Adjustment range: Initial value of the indicating range up to the adjusted value of the max. alarm

Indication/Max. alarm
Setting the value that triggers the alarm function if it is exceeded.
Adjustment range: adjusted value of the min. alarm up to the final value of the indicating range.


6 Set parameters


Indication／Min．／Max．sto－ rage pushing＂$[\mathrm{OK}]$＂．


Indication／Delete min．／Function to delete the memory．By pushing the OK key twice，the max． memories will be deleted．


Indication／Min．value， max．value

Activation of the min．／max．value indication．If the min．／max．value indication is switched on，the indication switches over cyclically between the actual measured value（indication period 5 s ），the min． value and the max．value（indication period each 2 s ）．With the presentation of the max．values the displayed unit is replaced by the min．or max．value．

Adjustment range：On，Off


Language setting
Adjustment range：dEU（German），EnG（English）


## Configuration/Contrast Adjustment of the display contrast

Adjustment range: 0 ... 4


## Configuration/Reset

With a reset, all settings of the digital indication will be reset to the default values. For activating the reset, the "OK" key must be pushed once. After pushing the " $O K^{\prime}$ " key for a second time, the indication will be completely faded out and the reset is carried out. The VEGADIS 62 carries out a restart, starts again the HART communication and passes over to the measured value indication.


The following table shows the default values:

| Menu section | Menu item | Default value |  |
| :--- | :--- | :--- | :---: |
| Measurement | Unit | (if no HART adjustment was carried <br> out) |  |
|  | Measuring range <br> begin | 4.000 |  |
|  | Measuring range <br> end | 20.000 |  |
|  | Measuring range <br> decimal point | 0.000 |  |
|  | Damping | 2 |  |
|  | Address | 0 |  |
| Indication | Unit | mA |  |
|  | Unit locking | nGESP |  |
| 31 |  |  |  |
|  |  |  |  |

6 Set parameters

| Menu section | Menu item | Default value |
| :---: | :---: | :---: |
|  | Indication range decimal point | 0.000 |
|  | Filter | 0 |
|  | Alarm | － |
|  | Alarm On／Off | Off |
|  | Min．alarm | 4.000 |
|  | Max．alarm | 20.000 |
|  | Min．／Max．value memory | － |
|  | Delete min．／max． | dEL |
|  | Min．／Max．On／Off | Off |
| Configuration | Language | EnG |
|  | Contrast | 2 |
|  | Reset | － |
|  | USER unit | USER |
|  | Min．failure mes－ sage | 3.6 |
|  | Max．failure mes－ sage | 21.0 |

Configuration／USER unit A 6－digit user unit can be individually programmed by the user．An alphanumerical character set is available．

By pushing the［OK］key，the first position is selected，this position begins to flash．With the arrow keys the requested character can be selected．By pushing the［OK］key again，the character is confirmed and the next position is selected．


Configuration／Min．failu－ re message

Setting the current value that triggers the min．failure message when it is reached or underrun．The min．failure message is shown in the display with 5 underlines（ $\qquad$ ）and the message＂AUSMIN＂（or ＂OUTMIN＂）．

Adjustment range： $3.5 \ldots 3.9$



Configuration/Max. failure message

Setting the current value that triggers the max. failure message when it is reached or exceeded. The max. failure message is shown in the display with 5 overlines ( ${ }^{-----}$) and the message "AUSMAX" (or "OUTMAX").

Adjustment range: 20.1 ... 21.5


Configuration/Firmware The number of the firmware used is displayed.


Configuration/Password This menu item is available from software 2.10.
The menu area "Measurement" as well as the function "Reset" are protected by a password. For the access, a login by entering the password is required. The login is displayed if you try to use one of the protected functions. All functions are accessible after a successful login.

The logoff is carried out in the menu item "Logoff" or automatically after 3 minutes without user activity.

The default setting is: 123456
The password has max. 6 characters and can be modified in the menu item "Password". For this purpose, the actual password is entered and confirmed with "OK" until the string "******" appears. With "OK" the entered password is edited again and can now be modified.

The master password AWI001 allows access if the password setting is no longer known.

6 Set parameters


## Configuration/Logout

This menu item is available from software 2.10. It enables the early logout after entering the password.


## 7 Set up sensors

### 7.1 Adjust the sensor

The min./max. adjustment of the connected sensor is carried out via the menu "Measurement", menu items "Unit", "Measuring range begin", "Measuring range end" and if necessary "Measuring range decimal point". The entered values are taken over when storing into the sensor.


- Note:
- It is recommended to note the transmitted data for the plant documentation or a possible later correction of the adjustment.


### 7.2 Scale the indication

After the min./max. adjustment of the sensor, the actual measured value is displayed on the VEGADIS 62. The original sensor value, for example, in "bar" with pressure transmitters or in " $m$ " distance with radar sensors is converted into the unit set in the menu "Measurement", menu item "Unit" and is displayed digitally. First of all the $4 \ldots 20 \mathrm{~mA}$ current is measured and shown quasianalogue on the bargraph. This value takes the min./max. adjustment into consideration.

The VEGADIS 62 allows via the unit "USER" a free, applicationspecific indication scaling. The VEGADIS 62 acts here as a pure indicating instrument without HART communication with the connected sensor.

For the indication scaling proceed as follows:
1 Set in the menu "Configuration", menu item "USER unit" the requested unit with the available characters.


2 Select in the menu "Measurement", menu item "Unit" the unit "USER".


3 Enter in the menu "Measurement", menu item "MB begin" the initial value of the requested scaling.


4 Enter in the menu "Measurement", menu end "MB begin" the final value of the requested scaling.


5 Enter in the menu "Measurement", menu item "MB format" the requested position of the decimal point.


The display shows in the measured value indication the $4 \ldots 20 \mathrm{~mA}$ current in the adjusted scaling as digital value or quasianalogue in the set unit.

## Note:

The menu items used for the adjustment are also used for entering the scaling data. We thus recommend writing down the scaling data for plant documentation or for a possible later correction of the adjustment.

### 7.3 Correct sensor adjustment

For a correction of the sensor adjustment, the HART communication must be again activated. This is carried out in the menu "Measurement", menu item "Unit". Enter here the unit in which the adjustment was carried out.


The HART communication is now started again. The VEGADIS 62 is again Secondary Master for the sensor and loads the adjustment data from the sensor.

Then enter the modified values for the "Measuring range begin" and Measuring range end"

The entered value for the measuring range begin and end are transferred to the sensor when saving.

Proceed as previously described for a new indication scaling.

### 7.4 PACTware/DTM and PLICSCOM

With an existing HART connection from VEGADIS 62 to the sensor, adjustment changes in the sensor can also be carried out via other adjustment systems such as PACTware/DTM or PLICSCOM. This does not cause conflicts, but the changes are not updated automatically in VEGADIS 62. For updating, a HART connection is required. To do this, the signal circuit must be interrupted and then re-connected.

As an alternative, it is possible to set the unit in the menu
"Measurement" briefly to "USER". If it is then again reset to a unit supported by the sensor such as for example "bar" or "m", the changes carried out in the meantime via other adjustment systems are updated in the VEGADIS 62.


## 8 Diagnosis and service

### 8.1 Maintenance

If the device is used correctly, no maintenance is required in normal operation.

### 8.2 Error messages

HART communication errors are signalled with numerical codes 1-7. An error message is sent if a transaction was not successful after multiple attempts

An error message is only displayed if an error occurs due to a transmitted command, this means only if the error is caused by an adjustment of the user. Errors in the communication between control system and sensor are detected but not displayed.

The measured value line shows "Error", the status line "HART n" whereby " $n$ " represents the numerical error code. The error message is displayed up to the next key pressing.

The following table shows the error codes and gives information on the failure reason and removal.

| Error code | Description | Cause |
| :--- | :--- | :--- |
| 1 | Transmitter does not answer |  |
| 2 | Communication error | - Parity, checksum, package <br> length faulty during recep- <br> tion <br> - Transmitter signals receipt <br> error |
| 3 | Command not implemented | Command is not supported by <br> the transmitter. |
| 4 | Error of the transmitter is not <br> specified in detail | Sensor signals an error in the <br> Supported by the sensor <br> - Requested measuring unit <br> is not supported |
| status byte which was not |  |  |
| itemized. |  |  |$|$

## 8．3 Remove interferences

Reaction when malfunc－ tions occur

Check the $4 \ldots 20 \mathrm{~mA}$ signal

The operator of the system is responsible for taking suitable measures to rectify faults．

Connect a handmultimeter in the suitable measuring range according to the wiring plan．The following table describes possible errors in the current signal and helps to remove them：

| Error | Cause | Rectification |
| :---: | :---: | :---: |
| 4 ．．． 20 mA signal not stable | －Level fluctua－ tions | －Set damping according to the in－ strument via the indicating and adjustment module or PACTware／ DTM |
| 4 ．．． 20 mA signal missing | Electrical con－ nection faulty | －Check connection according to chapter＂Connection steps＂and if necessary，correct according to chapter＂Wiring plan＂． |
|  | －Voltage supply missing | －Check cables for breaks；repair if necessary |
|  | －Operating vol－ tage too low or load resis－ tance too high | －Check，adapt if necessary |
| Current signal greater than 22 mA or less than 3.6 mA | －Electronics module in the sensor defecti－ ve | －Exchange the instrument or send it in for repair |

Reaction after fault rec－ tification

24 hour service hotline

Depending on the reason for the fault and the measures taken，the steps described in chapter＂Setup＂must be carried out again or must be checked for plausibility and completeness．

Should these measures not be successful，please call in urgent cases the VEGA service hotline under the phone no．＋49 1805858550.

The hotline is also available outside the normal working hours on seven days a week around the clock．

Since we offer this service worldwide，the support is in the English language．The service itself is free of charge，the only costs involved are the normal call charges．

## 8．4 How to proceed in case of repair

If a repair is necessary，please proceed as follows：
 vega.com under: "Downloads - Forms and certificates - Repair form".

By doing this you help us carry out the repair quickly and without having to call back for needed information.

- Print and fill out one form per instrument
- Clean the instrument and pack it damage-proof
- Attach the completed form and, if need be, also a safety data sheet outside on the packaging
- Please ask the agency serving you for the address of your return shipment. You can find the competent agency on our website www.vega.com.


## 9 Dismounting

### 9.1 Dismounting steps



Warning:
Before dismounting, be aware of dangerous process conditions such as e.g. pressure in the vessel, high temperatures, corrosive or toxic products etc.

Take note of chapters "Mounting" and "Connecting to power supply" and carry out the listed steps in reverse order.

### 9.2 Disposal

The instrument consists of materials which can be recycled by specialised recycling companies. We use recyclable materials and have designed the electronics to be easily separable.

WEEE directive 2002/96/EG
This instrument is not subject to the WEEE directive 2002/96/EG and the respective national laws. Pass the instrument directly on to a specialised recycling company and do not use the municipal collecting points. These may be used only for privately used products according to the WEEE directive.

Correct disposal avoids negative effects on humans and the environmont and ensures recycling of useful raw materials.

Materials: see chapter "Technical data"
If you have no way to dispose of the old instrument properly, please contact us concerning return and disposal.

VEGA

## 10 Supplement

### 10.1 Technical data

## General data

316 L corresponds to 1.4404 or 1.4435 , 316 Ti corresponds to 1.4571
Materials

- Housing plastic PBT, Alu die-casting, 316L
- Inspection window in housing cover for Polycarbonate (UL-746-C listed) indicating and adjustment module
- Ground terminal 316Ti/316L
Weight $\quad 0.35 \mathrm{~kg}$ (0.772 lbs)


## Supply circuit

Voltage supply and data transmission
Voltage loss

- at 4 mA approx. 3 V
- at 20 mA

Current range
Current increase with command/enquiry of the VEGADIS 62 to the sensor

Overcurrent resistance
interpolation protection
approx. 2 V
$3.5 \ldots 22.5 \mathrm{~mA}^{7}$ ) $\leq 500 \mu \mathrm{~A}$ for approximately 20 ms , decay after efunction

100 mA available, max. current 100 mA

| Current measurement |  |
| :--- | :--- |
| Measuring range loop current | $3.5 \ldots 22.5 \mathrm{~mA}^{8)}$ |
| Deviation ${ }^{9}$ ) | $\pm 0.05 \%$ of the span |
| Temperature coefficient ${ }^{10)}$ | $\pm 0.1 \%$ of the span $/ 10 \mathrm{~K}$ |
| Interval | 250 ms |

## Indicating and adjustment module

Display

- Principle
- Measured value presentation
- Bar graph
- Info line

LCD
7 segments, 5 -digit, height of digits 9 mm ( 0.354 in ), indication range -99999 ... 99999
20 segments
14 segments, 6-digit, height of digits 5.5 mm (0.217 in)
7) The indication remains dark if the loop current is not sufficient for operation.
8) For measured values outside the measuring range, an instructions is displayed instead of the measured value.
with reference temperature $20^{\circ} \mathrm{C}$
with reference temperature $20^{\circ} \mathrm{C}$

| Adjustment elements | 4 keys |
| :---: | :---: |
| Protection rating |  |
| - unassembled | IP 20 |
| - mounted into VEGADIS 62 without cover | IP 40 |
| Materials |  |
| - Housing | ABS |
| - Inspection window | Polyester foil |
| Ambient conditions |  |
| Ambient temperature | $-20 \ldots+70^{\circ} \mathrm{C}\left(-4 \ldots+158{ }^{\circ} \mathrm{F}\right)$ |
| Storage and transport temperature | $-40 \ldots+80^{\circ} \mathrm{C}\left(-40 \ldots+176{ }^{\circ} \mathrm{F}\right)$ |
| Electromechanical data |  |
| Cable gland | $2 \times$ cable entry M20 $\times 1.5$ (cable: $\varnothing 5 \ldots 9 \mathrm{~mm}$ ) |
| Spring-loaded terminals for wire cross-section |  |
| - Massive wire, cord | $0.2 \ldots 2.5 \mathrm{~mm}^{2}$ (AWG $24 \ldots 14$ ) |
| - Stranded wire with end sleeve | $0.2 \ldots 1.5 \mathrm{~mm}^{2}$ (AWG $24 . . .16$ ) |
| Electrical protective measures |  |
| Protection rating |  |
| - Housing plastic | IP 66/IP 67 |
| - Housing Aluminium, stainless steel | IP 66/IP 68 (0.2 bar) |
| Overvoltage category | III |
| Protection class | II |

### 10.2 HART communication

The HART protocol operates with the technology of the frequency shift keying (FSK = frequency shift keying) based on the data communication standard Bell 202. The digital signal is generated out of the frequencies 1200 and 2200 Hz representing each the bit information 1 and 0 . Sinus curves with these frequencies are superimposed to the direct current in the wire pair of the field device. The average value of the superimposed signal is zero. Hence the $4 \ldots 20 \mathrm{~mA}$ signal is not influenced by the digital data transmission.

## Commands when transmitting

During transmission, only the long address format is used which is supported by all sensors as of HART revision 5.

| Command no. | Command name | Description |
| :--- | :--- | :--- |
| 0 | Read UID | For determination of the UID from the HART address |
| 1 | Read primary variable | For reading out the measured value |
| 15 | Read output information | To update the scaling of the display after ZERO or <br> SPAN |
| 34 | Write damping value | - |
| 35 | Write range values | Adjustment of the transmitter scaling |
| 36 | Set upper range value | Max. adjustment/SPAN |
| 37 | Set lower range value | Min. adjustment/ZERO |
| 44 | Write PV units | Adjustment of the transmitter unit |

## Command during reception

Only messages are received the return address of which correspond with adjusted polling address or the determined UID.

| Command no. | Command name | Description |
| :---: | :---: | :---: |
| 1 | Write polling adress | HART address modified by the control room is accepted by the display |
| 6 | Read current \& 4 vars | For checking the set measuring unit |
| 15 | Read output information | Accept transmitter scaling |
| 34 | Write damping value | Setting transmitter damping by control room |
| 35 | Write range values | Transmitter scaling by control room |
| 36 | Set upper range value | Max. adjustment/SPAN through control system After receipt, the new scaling is read out with command 15 |
| GADIS 6 |  |  |

10 Supplement

| Command no. | Command name | Description |
| :--- | :--- | :--- |
| 37 | Set lower range value | Min. adjustment/ZERO through control system <br> After receipt, the new scaling is read out with command <br> 15 |
| 44 | Write PV units | Unit through control system <br> After receipt, the new scaling is read out with command <br> 15 |
| 156 | Service command | Control calibration, parameter adjustment and function <br> test |

Hart codes of the supported units

| Unit | HART code |
| :--- | :--- |
| mbar | 8 |
| bar | 7 |
| hPa | 174 |
| kPa | 12 |
| MPa | 237 |
| PSI | 6 |
| inHg | 2 |
| mH 2 O | 171 |
| mmH 2 O | 4 |
| mm | 49 |
| cm | 48 |
| m | 45 |
| in | 47 |
| ft | 44 |
| ${ }^{\circ} \mathrm{C}$ | 32 |
| ${ }^{\circ} \mathrm{K}$ | 33 |
| K | 35 |
| mV | 36 |
| V | 58 |
| Ohm | 37 |
| mA | 57 |
| $\%$ |  |

10 Supplement

### 10.3 Dimensions

VEGADIS 62 housing


Fig. 17: VE 62 housing versions
1 Plastic housing
2 Stainless steel housing - precision casting
Stainless steel housing, electropolished
Aluminium housing

$$
48 \quad \text { VEGADIS } 62
$$

Mounting adapter VEGADIS 62


Fig. 18: Mounting adapter VEGADIS 62
1 Mounting plate for wall mounting
2 Clip for carrier rail mounting
3 Strap for tube mounting

## 10．4 Industrial property rights

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www.vega.com


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## Process pressure

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## VEGABAR

## Level and pressure measurement

## Measuring principle

The pressure measuring cell converting the pressure into an electrical signal is the heart of the pressure transmitter. This pressure-dependent signal is converted by the integrated electronics into a standardised output signal. Different measuring cells are used to detect the pressure. The ceramic cells characterise by an excellent long-term stability and high overload resistance. The metal METEC ${ }^{\circledR}$ measuring cell enables fully welded versions and covers even higher measuring ranges.

## VEGABAR series 10

## Pressure measurement in gases and liquids

The pressure transmitters are designed for pressure measurements of liquids and gases in all areas of industrial measurement technology. The available measuring ranges are suitable for detection of absolute pressure, gauge pressure and vacuum in the range from $-1 \ldots+1000$ bar. The focus however, are smaller process fittings of $1 / 2^{\prime \prime}$ and $1^{\prime \prime}$.


## VEGABAR series 50

## For all industries

This instrument series is developed for all applications of the industrial measurement technique. The VEGABAR series 50 can be used universally for the measurement of gases, vapours and liquids.
The pressure transmitter is suitalbe for special as well as standard applications. the setup remains always the same. The VEGABAR series 50 offers maximum reliability and safety. It can be used in all industries.


## Overview - VEGABAR series 10



|  | VEGABAR 14 | VEGABAR 17 |
| :--- | :--- | :--- |
| Measuring cell | CERTEC ${ }^{\circledR}$ | Piezoresistive/thin film strain <br> gauge |
| Measuring range | $-1 \ldots+60 \mathrm{bar}$ | $-1 \ldots+1000 \mathrm{bar}$ |
|  | $(-100 \ldots+6000 \mathrm{kPa})$ | $(-100 \ldots+100000 \mathrm{kPa})$ |
| Deviation in characteristics | $0.3 \%$ | $0.5 \%$ |
| Process temperature | $-40 \ldots+100^{\circ} \mathrm{C}$ | $-40 \ldots+150^{\circ} \mathrm{C}$ |
| Process fitting | Thread from $\mathrm{G}^{1} / 2,1 / 2 \mathrm{NPT}$ | Thread from $\mathrm{G}^{1} / 2,1 / 2 \mathrm{NPT}$ |

## Overview - VEGABAR series 50



## VEGABAR 51

Chemical seal system

$$
\begin{aligned}
& -1 \ldots+400 \mathrm{bar} \\
& (-100 \ldots+40000 \mathrm{kPa}) \\
& 0.2 \% \\
& -40 \ldots+400^{\circ} \mathrm{C} \\
& \text { Flanges from DN } 25,1^{\prime \prime}
\end{aligned}
$$



VEGABAR 54

| Measuring cell | MINI-CERTEC ${ }^{\circledR}$ |
| :--- | :--- |
| Measuring range | $-1 \ldots+60 \mathrm{bar}$ |
|  | $(-100 \ldots+6000 \mathrm{kPa})$ |
| Deviation in characteristics | $0.2 \% ; 0.1 \%$ |
| Process temperature | $-40 \ldots+120^{\circ} \mathrm{C}$ |
| Process fitting | Thread from $\mathrm{G} 1 / 2$, <br> flanges from $\mathrm{DN} 25,1 "$ |
|  |  |



## VEGABAR 52

CERTEC ${ }^{\circledR}$
$-1 \ldots+60$ bar
$(-100 \ldots+6000 \mathrm{kPa})$
0.2 \%; 0.1 \%; 0.075 \%
$-40 \ldots+150^{\circ} \mathrm{C}$
Flanges from DN 25, 1½", hygienic fittings


## VEGABAR 53

Piezoresistive/thin film strain gauge
$-1 \ldots+1000$ bar
(-100 $\ldots+100000 \mathrm{kPa})$
0.2 \%; 0.1 \%: 0.075 \%
$-40 \ldots+150{ }^{\circ} \mathrm{C}$
Flanges from DN 40, hygienic fittings

## VEGABAR 52

Pressure transmitter with CERTEC ${ }^{\circledR}$ measuring cell

## Application area

The VEGABAR 52 pressure transmitter can be used universally for measurement of gases, vapours and liquids. Also substances such as sand can be easily measured through the abrasion-resistant ceramic measuring cell. The VEGABAR 52 offers maximum reliability and safety and can be used in all industries.


## Advantages

- High plant availability by maximum overload and vacuum resistance of the ceramic measuring cell
- Measurement down to the last drop through smallest measuring ranges with high reliability
- Low maintenance costs through wear-free ceramic measuring cell


## Technical data

Measuring cell:
Measuring range:
Process fitting:

Process temperature:
Deviation in characteristics:
SIL qualification:

```
CERTEC }\mp@subsup{}{}{\circledR
-1 \ldots.+60 bar (-100 \ldots. +6000 kPa)
thread from G1⁄2, 1/2 NPT
flanges from DN 25, 11/2"
hygienic fittings
-40\ldots+150 %}\textrm{C
0.2 %; 0.1 %; 0.075 %
up to SIL2
```


## Approval

## XX without

XM Ship approval
CX ATEX II 1G, 1/2G, 2G Exia IIC T6
CA ATEX II 1G, 1/2G, 2G Ex ia IIC T6 + WHG
CM ATEX II 1G, 1/2G, 2G Ex ia IIC T6 + Ship approval
CI IEC Ex ia IIC T6
DX ATEX II $1 / 2 \mathrm{G}$, 2G Ex dia IIC T6
GX ATEX II 1/2D,2D Ex tD IP66T.

## Process fitting / Material

GV Thread $\mathrm{G} 1 / 2($ EN837) manometer PN60 / 316L
GP Thread G $1 / 2$, inner $\mathrm{G}^{1} / 4$ (ISO228-1) PN60 / 316L
GG Thread G1½A (DIN3852-A) PN60 / 316L
GW Thread G1½A (DIN3852-A-B) PN10 / PVDF
CA Clamp 2" PN16(ø64mm) DIN32676,ISO2852 /316L
LA Hyg. fitting with compression nut F40 PN40 / 316L
TA Varivent N50-40 PN25 / 316L
RD Bolting DN50PN25 Form A DIN11864-1 / 316L
BB Thread M44x1.25(DIN13)pressure screw StSt PN60 / 316L
FB Flange DN50PN40 Form C, DIN2501 / 316L
FE Flange DN80PN40 Form C, DIN2501 / 316L
FH Flange 2" 150 lb RF, ANSI B16.5 / 316L
FI Flange 3" 150lb RF, ANSI B16.5 / 316L
Seal measuring cell / Process temperature
1 FKM (A+P 70.16) /-40...120 ${ }^{\circ} \mathrm{C}$
3 EPDM (A+P 75.5/KW75F) / -40... $120^{\circ} \mathrm{O}$
M FFKM (Perlast G75B) / $-15 \ldots . .120^{\circ} \mathrm{C}$

## Pressure / Measuring range

A rel. / 0...0.1bar (0...10kPa)
B rel. / 0...0.2bar ( $0 . . .20 \mathrm{kPa}$ )
C rel. / 0...0.4bar ( $0 . . .40 \mathrm{kPa}$ )
D rel. / 0...1.Obar (0...100kPa)
E rel. / 0...2.5bar (0...250kPa)
F rel. / 0...5.0bar ( $0 . . .500 \mathrm{kPa}$ )
G rel. / $0 \ldots . .10 .0 \mathrm{bar}(0 . . .1000 \mathrm{kPa})$
P rel. / -1...0.0bar (-100...0kPa)
Q rel. / -1...1.5bar (-100... 150 kPa )
R rel. / -1...5.0bar ( $-100 \ldots . .500 \mathrm{kPa}$ )
S rel. / -1...10.0bar (-100...1000kPa)
K rel. / -0.05...0.05bar (-5...5kPa)
L rel. / -0.1...0.1bar (-10...10kPa)
M rel. / -0.2...0.2bar (-20...20kPa)
1 abs. / 0 ... 1.0bar (0 ... 100kPa) 2 abs. / 0 ... 2.5bar ( $0 . .250 \mathrm{kPa}$ ) 3 abs. / 0 ... 5.0bar ( 0 ... 500kPa)

## Electronics

Z $4 . . .20 \mathrm{~mA}$
H $4 . . .20 \mathrm{~mA} / \mathrm{HART}$ ®
P Profibus PA
F Foundation Fieldbus
Housing / Protection
K Plastic / IP66/IP67
A Aluminium / IP66/IP67
D Aluminium double chamber / IP66/IP67
8 StSt (electropolished) 316L / IP66/IP67
P PUR cable axial IP 68, ext. housing plastic IP 65
W StSt double chamber / IP66/IP67
R Plastic double chamber / IP66/IP67
Cable entry / Cable gland / Plug connection
M M20×1.5 / with / without
N 1/2NPT / without / without
Indicating/adjustment module (PLICSCOM)
X without
A mounted
Accuracy class
M $0.075 \%$
E $0.10 \%$
S $0.20 \%$

Cable length
per 100 mm cable of PUR

## Valve

## Application area

The use of a valve allows the simple installation and setup of the pressure transmitter.

## Advantages

- Simple mounting and dismounting of the pressure transmitter
- Ensures the simple sensor calibration without process interruption


(3)


## Measuring instrument holder for wall/tube mounting

## (3) SPEED

For mounting of pressure transmitters
The measuring instrument holder is used for mounting of pressure transmitters of VEGABAR series 50 as well as suspension pressure transmitters VEGAWELL 52.
The adaptation to different instrument diameters is enabled via an attached reduction piece.
The materials used are 316L and 304.


## Siphon



Siphon in U-form


Siphon in circular form


## Welded sleeve VEGABAR 14



## Welded sleeve VEGABAR 17



## Welded sleeve VEGABAR 52



You will find further welded sleeves and welded sockets in chapter "Accessory".

## Welded sleeve VEGABAR 53



You will find further welded sleeves and welded sockets in chapter "Accessory"

## Welded sleeve VEGABAR 54



You will find further welded sleeves and welded sockets in chapter "Accessory".

## Welded sleeve VEGABAR 55



You will find further welded sleeves and welded sockets in chapter "Accessory".


## Operating Instructions VEGABOX 02




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## Supplementary operating instructions manuals

$i$Tip:
For safe use and operation of your VEGABOX 02, the operating instructions manual of the respective pressure transmitter is also required:

- 32465 - VEGAWELL 51-4... 20 mA
- 32468 -VEGAWELL 51-4 ... $20 \mathrm{~mA} / H A R T$
- 27501-VEGAWELL 72-4 ... 20 mA
- 27630-VEGAWELL 72-4 ... 20 mA/HART
- 28432-VEGABAR 74-4... $20 \mathrm{~mA} /$ HART
- 28433-VEGABAR 75-4... $20 \mathrm{~mA} /$ HART

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## 1 About this document

## 1．1 Function

This operating instructions manual has all the information you need for quick setup and safe operation．Please read this manual before you start setup．

## 1．2 Target group

This operating instructions manual is directed to trained， qualified personnel．The contents of this manual should be made available to these personnel and put into practice by them．

## 1．3 Symbolism used

Information，tip，note
This symbol indicates helpful additional information．
Caution：If this warning is ignored，faults or malfunctions can result．
Warning：If this warning is ignored，injury to persons and／or serious damage to the instrument can result．
Danger：If this warning is ignored，serious injury to persons and／or destruction of the instrument can result．

## Ex applications

x）This symbol indicates special instructions for Ex applications．
－List
The dot set in front indicates a list with no implied sequence．

## $\rightarrow$ Action

This arrow indicates a single action．

## 1 Sequence

Numbers set in front indicate successive steps in a procedure．

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## 2 For your safety

### 2.1 Authorised personnel

All operations described in this operating instructions manual must be carried out only by trained specialist personnel authorised by the operator. For safety and warranty reasons, any internal work on the instruments must be carried out only by personnel authorised by the manufacturer.

### 2.2 Appropriate use

VEGABOX 02 is a breather housing for pressure transmitters.
The optionally integrated temperature transmitter is used for connection to the resistance thermometer PT 100 in pressure transmitter VEGAWELL 51-4 ... $20 \mathrm{~mA} / H A R T$.

### 2.3 Warning about misuse

Inappropriate or incorrect use of the instrument can give rise to application-specific hazards, e.g. vessel overfill or damage to system components through incorrect mounting or adjustment.

### 2.4 General safety instructions

VEGABOX 02 are high-tech instruments requiring the strict observance of standard regulations and guidelines. The user must take note of the safety instructions in this operating instructions manual, the country-specific installation standards (e.g. the VDE regulations in Germany) as well as all prevailing safety regulations and accident prevention rules.

### 2.5 Safety instructions for Ex areas

Please note the Ex-specific safety information for installation and operation in Ex areas. These safety instructions are part of the operating instructions manual and come with the Exapproved instruments.

### 2.6 Environmental instructions

Protection of the environment is one of our most important duties. That is why we have introduced an environment management system with the goal of continuously improving company environmental protection. The environment management system is certified according to DIN EN ISO 14001.

SP160 Jesmond Road Indooroopilly SPS - TSR02 Transportable Switchboard Container - OM Manual For your safety


Please help us fulfil this obligation by observing the environmental instructions in this manual:

- Chapter "Packaging, transport and storage"
- Chapter "Disposal"

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## 3 Product description

### 3.1 Configuration

The scope of delivery encompasses:

- VEGABOX 02 breather housing
- Protective cover (optional)
- Documentation
- this operating instructions manual


## Components

Area of application


Fig. 1: VEGABOX 02
1 Housing cover
2 Housing
3 Breather facility

### 3.2 Principle of operation

VEGABOX 02 is a breather housing for pressure transmitters with connection cable with integrated capillary cable. It is particularly suitable for the following VEGA pressure transmitters:

- VEGAWELL 51-4... 20 mA
- VEGAWELL 51-4 ... 20 mA/HART
- VEGAWELL 72-4... 20 mA
- VEGAWELL 72-4 ... 20 mA/HART
- VEGABAR 74-4 ... $20 \mathrm{~mA} / \mathrm{HART}$
- VEGABAR 75-4 ... $20 \mathrm{~mA} / \mathrm{HART}$

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Supply
Packaging
Storage and transport tem－
perature

The connection cable of the sensor as well as the power supply cable are connected to the VEGABOX 02．Connection is carried out via screw terminals．

## 3．3 Storage and transport

Your instrument was protected by packaging during transport． Its capacity to handle normal loads during transport is assured by a test according to DIN EN 24180.

The packaging of standard instruments consists of environ－ ment－friendly，recyclable cardboard．For special versions，PE foam or PE foil is also used．Dispose of the packaging material via specialised recycling companies．
－Storage and transport temperature see＂Supplement－ Technical data－Ambient conditions＂
－Relative humidity $20 \ldots 85 \%$

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## 4 Mounting

### 4.1 General instructions

Installation position

## Moisture

Mounting versions

VEGABOX 02 can be mounted in any position. However, vertical mounting is recommended. This avoids pollution of the breather facility and moisture penetration.

## Note:

There must be the same atmospheric pressure on the breather facility as well as on the measurement loop. Otherwise the measured value can be adulterated.

Use the recommended cables (see chapter "Connecting to power supply") and tighten the cable gland.

### 4.2 Mounting instructions

VEGABOX 02 can be mounted as follows:

- on carrier rail $35 \times 7.5$ according to EN 50022
- on mounting plate or on the wall

SP160 Jesmond Road Indooroopilly SPS－TSR02 Transportable Switchboard Container－OM Manual Connecting to power supply

## 5 Connecting to power supply

## 5．1 Preparing the connection

Always keep in mind the following safety instructions：
－Connect only in the complete absence of line voltage In hazardous areas you should take note of the appropriate regulations，conformity and type approval certificates of the sensors and power supply units．

VEGABOX 02 is connected with standard two－wire cable without screen．

When the optionally integrated temperature transmitter is also connected，a four－wire cable is required；when an external temperature transmitter is connected，a six－wire cable is required．


Fig．2：Connection of VEGABOX 02 to the sensor

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Select connection cable for Ex applications

Cable screening and grounding

An outer cable diameter of $5 \ldots 9 \mathrm{~mm}$ ensures the seal effect of the cable entry. If electromagnetic interference is expected which is above the test values of EN 61326 for industrial areas, we recommend the use of screened cable.

Take note of the corresponding installation regulations for Ex applications.

If screened cable is necessary, connect the cable screen on both ends to ground potential. In VEGABOX 02, the screen must be connected directly to the internal ground terminal. The ground terminal on the outside of the housing must be connected to the potential equalisation (low impedance).

If potential equalisation currents are expected, the connection on the processing side must be made via a ceramic capacitor (e.g. $1 \mathrm{nF}, 1500 \mathrm{~V}$ ). The low frequency potential equalisation currents are thus suppressed, but the protective effect against high frequency interference signals remains.

In Ex applications, one-sided grounding on the sensor is recommended, see EN 60079-14.

### 5.2 Connection procedure

Proceed as follows:
1 Snap VEGABOX 02 onto the carrier rail or screw it to the mounting plate
2 Loosen the cover screws and remove the cover
3 Insert the sensor cable into VEGABOX 02 through the cable entry
4 Loosen the screws with a screwdriver
5 Insert the wire ends into the open terminals according to the wiring plan
6 Tighten the screws with a screwdriver
7 Check the hold of the wires in the terminals by lightly pulling on them
8 Tighten the compression nut of the cable entry. The seal ring must completely encircle the cable
9 Connect the supply cable according to steps 3 to 8
10 Screw the housing cover back on
The electrical connection is finished.

### 5.3 Wiring plan

## Connection to VEGAWELL 51,

 72-4... 20 mAConnection to VEGAWELL 72, VEGABAR 74, 75-4... $20 \mathrm{~mA} /$ HART


Fig. 4: Terminal assignment VEGABOX 02
1 To power supply or the processing system
2 Screen²)

| Wire number | Wire colour/Polarity | VEGABOX 02 terminal |
| :--- | :--- | :--- |
| 1 | brown $(+)$ | 1 |
| 2 | blue (-) | 2 |
| 3 | yellow | 2 |
|  | Screen | Ground |

${ }^{1)}$ Connect screen, to ground terminal. Connect ground terminal outside on the housing as prescribed. The two terminals are galvanically connected.
${ }^{2)}$ Connect screen to ground terminal. Connect ground terminal on the outside of the housing as prescribed. The two terminals are galvanically connected.

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Connection to VEGAWELL 72 - 4 ... 20 mA/HART


Fig. 5: Terminal assignment VEGABOX 02
1 To power supply or the processing system (signal pressure transmitter)
2 To power supply or the processing system (connection cables resistance thermometer PT 100)
3 Screen ${ }^{3)}$

| Wire number | Wire colour/Polarity | VEGABOX 02 terminal |
| :--- | :--- | :--- |
| 1 | brown (+) | 1 |
| 2 | blue (-) | 2 |
| 3 | white | 3 |
| 4 | yellow | 4 |
| 5 | red | 5 |
| 6 | black | 6 |
|  | Screen | Ground |



Fig. 6: Terminal assignment VEGABOX 02 with integrated temperature transmitter
1 To power supply or the processing system (signal pressure transmitter)
2 To power supply or the processing system (signal temperature transmitter)
3 Screen ${ }^{4)}$
3) Connect screen to ground terminal. Connect ground terminal on the outside of the housing as prescribed. The two terminals are galvanically connected.
4) Connect screen to ground terminal. Connect ground terminal on the outside of the housing as prescribed. The two terminals are galvanically connected.

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Connecting to power supply


| Wire number | Wire colour／Polarity | VEGABOX 02 terminal |
| :--- | :--- | :--- |
| 1 | brown（＋） | 1 |
| 2 | blue（－） | 2 |
|  | Screen | Ground |


| Wire number | Wire colour／Polarity | Terminal，temperature <br> transmitter for PT 100 |
| :--- | :--- | :--- |
| 3 | white | 1 |
| 4 | yellow | 2 |
| 5 | red | 3 |
| 6 | black | 4 |

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## 6 Set up

### 6.1 Setup steps, pressure transmitter

Setup and adjustment of the respective sensor is carried out according to the operating instructions manual of the respective sensor.

### 6.2 Setup steps, temperature transmitter

Setup and adjustment of the temperature transmitter are carried out according to the respective operating instructions manual "Temperature transmitter type T32" on www.wika.com.

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## 7 Maintenance and fault rectification

## 7．1 Maintenance

When used as directed in normal operation，VEGABOX 02 is completely maintenance free．

## 7．2 Instrument repair

If a repair is necessary，please proceed as follows：
You can download a return form（ 23 KB ）from the Internet on our homepage www．vega．com under：＂Downloads－Forms and certificates－Repair form＂．

By doing this you help us carry out the repair quickly and without having to call for needed information．
－Print and fill out one form per instrument
－Clean the instrument and pack it damage－proof
－Attach the completed form and，if need be，also a safety data sheet outside on the packaging
－Please ask the agency serving you for the address of your return shipment．You can find the respective agency on our website www．vega．com under：＂Company－VEGA world－ wide＂

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## 8 Dismounting

### 8.1 Dismounting steps

## Warning:

Before dismounting, be aware of dangerous process conditions such as e.g. pressure in the vessel, high temperatures, corrosive or toxic products etc.

Take note of chapters "Mounting" and "Connecting to power supply" and carry out the listed steps in reverse order.

### 8.2 Disposal

The instrument consists of materials which can be recycled by specialised recycling companies. We use recyclable materials and have designed the electronics to be easily separable.

## WEEE directive 2002/96/EG

This instrument is not subject to the WEEE directive 2002/96/ $E G$ and the respective national laws (in Germany, e.g. ElektroG). Pass the instrument directly on to a specialised recycling company and do not use the municipal collecting points. These may be used only for privately used products according to the WEEE directive.

Correct disposal avoids negative effects to persons and environment and ensures recycling of useful raw materials.

Materials: see chapter "Technical data"
If you cannot dispose of the instrument properly, please contact us about disposal methods or return.

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## 9 Supplement

## 9．1 Technical data

## General data

316 L corresponds to 1.4404 or 1.4435 ，316Ti corresponds to 1.4571
Materials
－Housing plastic PBT
－Ground terminal 316Ti／316L
Weight approx． 0.5 kg （1．1 lbs）

## Ambient conditions

| Ambient temperature | $-40 \ldots+85^{\circ} \mathrm{C}\left(-40 \ldots+185^{\circ} \mathrm{F}\right)$ |
| :--- | :--- |
| Storage and transport temperature | $-40 \ldots+85^{\circ} \mathrm{C}\left(-40 \ldots+185^{\circ} \mathrm{F}\right)$ |

## Supply and signal circuit，pressure transmitter

Supply voltage

Signal current
see operating instructions manual of the respective pressure transmitter depending on pressure transmitter 4 ．．． 20 mA or $4 \ldots 20 \mathrm{~mA} / \mathrm{HART}$

## Supply and signal circuit temperature transmitter

The data are an excerpt of the WIKA data sheet TE 32．01．You can find the complete data sheet under www．wika．com

Resistance thermometer（integrated in
VEGAWELL 51－4 ．．． $20 \mathrm{~mA} /$ HART）
Supply voltage $U_{B}$
Signal current
Error of measurement according to DIN
EN 60770， $23{ }^{\circ} \mathrm{C} \pm 5 \mathrm{~K}$
Temperature coefficient $\mathrm{T}_{\mathrm{K}}{ }^{5}$
Load $\mathrm{R}_{\mathrm{A}}$

PT 100 according to DIN EN 60751
12 ．．． 42 V DC
4 ．．． $20 \mathrm{~mA} / \mathrm{HART}$
$\pm 0.04 \%$ of the span
$\pm 0.1 \%$ of the span／ $10 \mathrm{~K}_{\text {Ta }}$
$\mathrm{R}_{\mathrm{A}} \leq\left(\mathrm{U}_{\mathrm{B}}-12 \mathrm{~V}\right) / 0.0255 \mathrm{~A}$ with $\mathrm{R}_{\mathrm{A}}$ in Ohm and $\mathrm{U}_{\mathrm{B}}$ in $V$

## Electromechanical data

Cable gland $2 x$ cable entry M20x1．5（cable－ø $5 \ldots 9 \mathrm{~mm}$ ）
Screw terminals

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## Electrical protective measures

Protection ..... IP 65
Overvoltage category ..... III
Protection class ..... III
Approvals VEGABOX 026)
ATEX for connection to pressure transmitters with ATEX certificate
Ship approvals GL, LRS, ABS, CCS, RINA, DNV
Approvals, temperature transmitter ${ }^{7}$ )
ATEX iaII 1G EEx ia IIB/IIC T4/T5/T6

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## 9．2 Dimensions

## VEGABOX 02



Fig．7：VEGABOX 02

## VEGABOX 02 with protective cover



Fig．8：VEGABOX 02 with protective cover

## 9．3 Industrial property rights

> VEGA product lines are global protected by industrial property rights.
> Further information see http://www.vega.com.
> Only in U.S.A.: Further information see patent label at the sensor housing.
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## 9．4 Trademark

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SP160 Jesmond Road Indooroopilly SPS－TSR02 Transportable Switchboard Container－OM Manual Supplement


SP160 Jesmond Road Indooroopilly SPS - TSR02 Transportable Switchboard Container - OM Manual VEEA

SP160 Jesmond Road Indooroopilly SPS－TSR02 Transportable Switchboard Container－OM Manual

## ，居固合

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www．vega．com
＂$C \in$
All statements concerning scope of delivery，application， practical use and operating conditions of the sensors and processing systems correspond to the information avail－ able at the time of printing．
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## Features

- Ultra-low noise output
- Independent battery charging
- DC OK \& battery charger OK alarms \& LEDs
- Battery disconnected alarm
- Battery Low Voltage Disconnect - LVD
- Battery fuse fail LED
- Over-temperature protection
- Analogue meters on standard model

- Optional : Liquid Crystal Display
- Optional : Network Enabled
- Models available Q1 2010


## Specifications <br> INPUT

| Voltage: | 190 to 264 vac, or 190 to 400VDC |
| :--- | :--- |
| Line regulation: | $0.2 \%$ typical |
| Current: | 1.4 A maximum |
| Inrush current: | 10 A maximum |
| Frequency: | 45 to 65 Hz |

## OUTPUT

| Voltage | See table |
| :--- | :--- |
| Current | See table |
| Load regulation | $0.5 \%$ typical |
| Current limit type | load cct Constant current |
| Current limit type | batt. cct Constant current |
| Short circuit protection | Indefinite, auto-resetting |
|  |  |
| Over-voltage protection | 17.5 to 20V latching (13.8Vdc output) |
|  | 31.5 to 39V latching (27.6Vdc output) |
| Ripple \& noise | 100 MHz bandwidth |
|  | $28 \mathrm{mVp}-\mathrm{p}(13.8 \mathrm{Vdc}$ output) |
|  | $55 \mathrm{mVp}-\mathrm{p}(27.6 \mathrm{Vdc}$ output) |

## ENVIRONMENTAL

| Operating temperature | 0 to 70 oC ambient with derating, 5...90\% <br> relative humidity (non-condensing) |
| :--- | :--- |
| Over-temperature protection | Automatic \& auto-resetting |
| Cooling requirement | Natural convection |
| Efficiency | $80 \%$ minimum |

STANDARDS \& APPROVALS

| Safety | Complies with AS/NZS 60950, class 1, |
| :--- | :--- |
|  | NSW Office of Fair Trading Approval N20602 |

## Selection Table

| MODEL | OUTPUT |  |  |  | OUTPUT |
| :--- | :---: | :---: | :---: | :---: | :--- |
| NUMBER | VDC | ILOAD | OUTPUT |  |  |
|  | 13.8 V | 16 A | 2 A | POWER | MECHANICAL |
| PB251A-12CM | 27.6 V | 11 | 220 W | chassis mount |  |
| PB251A-24CM | 3.8 V | 20 A | 2 A | 300 W | chassis mount |
| PB251A-12CM-H | 27.6 V | 12 A | 2 A | 275 W | chassis mount $/$ heatsink |
| PB251A-24CM-H | 13.8 V | 20 A | 330 W | chassis mount / heatsink |  |
| PB251A-12RML | 27.6 V | 12 A | 4 A | 275 W | rack mount / screw terminals |
| PB251A-24RML | 13.8 V | 20 A | 20 A | 330 W | rack mount / screw terminals |
| PB251A-12B | 27.6 V | 12 A | 12 A | 330 W | rack mount / Hirose connector |

Q-Pulse Id: TMS1395
Active: 28/09/2015
NOTE: Non standard battery
charging current available on request. ie PB251-12CM-H-10 for

## PB251A Series

$220-330$ WAT T S D C U P S


PB251A-**RML \& -12B MECHANICAL OUTLINE

## NOTES.

1. $2 R \mathrm{~K} \times 19{ }^{\prime \prime}$ rack enclosure per IEC 297
2. Mounting slots are suitable for M6 hardware.
3. Input connector is a 10 A Class 1 IEC 60320 inlet.
4. 2 meter IEC mains cord with Australian plug is supplied with unit.
5. PB251A-12B alarm terminal is DB25 female.
6. PB251A-12B output and battery connector is Hirose pn. HS 28R-4A.

Mating connector is Hirose pn. HS 28P-4A (not supplied).
7. PB251A-**RML alarm and output terminals are M3.5 screws suitable for ring or fork lugs up to 8 mm wide.


REAR VIEW (PB251A-**RML)


## 15-150 WATTS DC/DC SINGLE OUTPUT

## Features

- Wide selection of models
- 4 input voltage ranges
- High efficiency
- Low output ripple
- Proven reliability
- Good thermal margins



## Specifications

INPUT

| Input voltage | 12VDC (9.2-16) |
| :---: | :---: |
|  | 24VDC (19-32) |
|  | 48VDC (38-63) |
|  | 110VDC (85-140) |
| Inrush current | 20A max. for 110V only |
| OUTPUT |  |
| Output voltage | See table |
| Voltage adjustment | $\pm 10 \%, \pm 5 \%$ for PBIH-F |
| Output current | See table |
| Ripple \& noise | Output Volts $\times 1 \%+50 \mathrm{mV}$ to -100 mV pk-pk |
| Line regulation | $0.8 \%$ over input range |
| Load regulation | 0.9\%, 0\%-100\% load |
| Temperature coefficient | $0^{\circ} \mathrm{C}$ to $50^{\circ} \mathrm{C}, 0.03 \%$ per ${ }^{\circ} \mathrm{C}$ |
| Overvoltage protection | O.V. clamp, PBIH-F |
|  | Output shutdown, PBIH-G, J, M, R - input must be switched off for at least 30S to reactivate |
| Overcurrent protection | Fold back - PBIH-F |
|  | Current limiting, PBIH-G, J, M, R (PBIH-R series is adjustable); PBIH110xxR models are not adjustable |
| Drift | Output $\mathrm{V} \times 0.5 \%+15(\mathrm{mV})$ per 8 hrs after 1 hr warm-up |
| Rise Time | 200mS max. - PBIH-F, M, R |
|  | $\left.100 \mathrm{mS} \text { max. - PBIH-G, J (at } 25^{\circ} \mathrm{C}\right)$ |
| Holdup time | 10 mS (only 110V input) |
| Remote sense | PBIH-R Series only |

## OPERATING

| Efficiency | 70\%-89\% |
| :--- | :--- |
| Safety isolation (1 minute) | Type - 12, 24, 48V input <br> Input - Output: 1500VAC <br> Input- Case: 1500VAC <br> Output- Case: 500VAC <br> Type- 110V input <br> Input- Output: 2000VAC <br> Input- Case: 2000VAC <br> Output- Case: 500VAC |
| Insulation resistance | 50M (500VDC) Input - Case |
| Parallel operation | Consult sales office for details |
| Remote control | PBIH-R Series: <br> Open link: output normal <br> Short link: output off |

## ENVIRONMENTAL

| Operating temperature | $0^{\circ} \mathrm{C}$ to $50^{\circ} \mathrm{C}$ full load |
| :--- | :--- |
| Cooling | Convection cooled |
| Storage temperature | $-20^{\circ} \mathrm{C}$ to $+85^{\circ} \mathrm{C}$ |
| Humidity | $85 \%$ |
| Shock | $30 \mathrm{G}, \mathrm{PBIH}-\mathrm{F}, \mathrm{G}$ and J |
| Vibration | $(5 \mathrm{~Hz}-10 \mathrm{~Hz}, 10 \mathrm{~mm})$, <br>  <br> $(10 \mathrm{~Hz}-50 \mathrm{~Hz}) 2 \mathrm{G}, \mathrm{PBIH}-\mathrm{F}, \mathrm{G}$ and J |

STANDARDS AND APPROVALS

| Safety | Designed to UL1950 |
| :--- | :--- |
| C-tick | AS/NZS CISPR11 Group 1, Class A |
| MECHANICAL |  |
| Weight | PBIH-F $: 250 \mathrm{~g}$ |
|  | PBIH-G : 380g |
|  | PBIH-J :410g |
|  | PBIH-M : 800g |
|  | PBIH-R :1.4kg |

Selection Table

| MODEL <br> NUMBER | INPUT | OUTPUT | OUTPUT |
| :--- | :---: | :---: | :---: | :---: |
| POWER |  |  |  |


| MODEL NUMBER | INPUT | OUTPUT |  | OUTPUT POWER |
| :---: | :---: | :---: | :---: | :---: |
| PBIH-11012G | 85-140V | 12 V | 2.1A | 25W |
| PBIH-11015G | 85-140V | 15 V | 1.7A | 25W |
| PBIH-11024G | 85-140V | 24 V | 1.1 A | 25W |
| PBIH-11048G | 85-140V | 48 V | 0.5A | 25W |
| PBIH-1205J | $9.2-16 \mathrm{~V}$ | 5 V | 8A | 50W |
| PBIH-1212J | $9.2-16 \mathrm{~V}$ | 12 V | 3.3 A | 50W |
| PBIH-1215J | $9.2-16 \mathrm{~V}$ | 15 V | 2.7 A | 50W |
| PBIH-1224J | $9.2-16 \mathrm{~V}$ | 24 V | 1.7A | 50W |
| PBIH-1248J | $9.2-16 \mathrm{~V}$ | 48 V | 0.8A | 50W |
| PBIH-2405J | 19-32V | 5 V | 10A | 50W |
| PBIH-2412J | 19-32V | 12 V | 4.3 A | 50W |
| PBIH-2415J | 19-32V | 15 V | 3.4 A | 50W |
| PBIH-2424J | 19-32V | 24 V | 2.5 A | 50W |
| PBIH-2448J | 19-32V | 48 V | 1A | 50W |
| PBIH-4805J | $38-63 \mathrm{~V}$ | 5 V | 10A | 50W |
| PBIH-4812J | $38-63 \mathrm{~V}$ | 12 V | 4.3 A | 50W |
| PBIH-4815J | $38-63 \mathrm{~V}$ | 15 V | 3.4 A | 50W |
| PBIH-4824J | $38-63 \mathrm{~V}$ | 24 V | 2.5 A | 50W |
| PBIH-4848J | $38-63 \mathrm{~V}$ | 48 V | 1A | 50W |
| PBIH-11005J | $85-140 \mathrm{~V}$ | 5 V | 10A | 50W |
| PBIH-11012J | $85-140 \mathrm{~V}$ | 12 V | 4.3 A | 50W |
| PBIH-11015J | 85-140V | 15 V | 3.4 A | 50W |
| PBIH-11024J | $85-140 \mathrm{~V}$ | 24 V | 2.5 A | 50W |
| PBIH-11048J | 85-140V | 48 V | 1A | 50W |
| PBIH-1205M | $9.2-16 \mathrm{~V}$ | 5 V | 18A | 100W |
| PBIH-1212M | $9.2-16 \mathrm{~V}$ | 12 V | 9A | 100W |
| PBIH-1215M | $9.2-16 \mathrm{~V}$ | 15 V | 7 A | 100W |
| PBIH-1224M | $9.2-16 \mathrm{~V}$ | 24 V | 4.5A | 100W |
| PBIH-1248M | $9.2-16 \mathrm{~V}$ | 48 V | 2A | 100W |
| PBIH-2405M | 19-32V | 5 V | 20A | 100W |
| PBIH-2412M | 19-32V | 12 V | 9A | 100W |
| PBIH-2415M | 19-32V | 15 V | 7 A | 100W |


| MODEL NUMBER | INPUT | OUTPUT |  | OUTPUT POWER |
| :---: | :---: | :---: | :---: | :---: |
| PBIH-2424M | 19-32V | 24 V | 5 A | 100W |
| PBIH-2448M | 19-32V | 48 V | 2 A | 100W |
| PBIH-4805M | $38-63 \mathrm{~V}$ | 5 V | 20A | 100W |
| PBIH-4812M | $38-63 \mathrm{~V}$ | 12 V | 9A | 100W |
| PBIH-4815M | $38-63 \mathrm{~V}$ | 15 V | 7 A | 100W |
| PBIH-4824M | $38-63 \mathrm{~V}$ | 24 V | 5 A | 100W |
| PBIH-4848M | $38-63 \mathrm{~V}$ | 48 V | 2A | 100W |
| PBIH-11005M | 85-140V | 5 V | 20A | 100W |
| PBIH-11012M | 85-140V | 12 V | 9A | 100W |
| PBIH-11015M | $85-140 \mathrm{~V}$ | 15 V | 7 A | 100W |
| PBIH-11024M | $85-140 \mathrm{~V}$ | 24 V | 5 A | 100W |
| PBIH-11048M | 85-140V | 48 V | 2A | 100W |
| PBIH-1205R | $9.2-16 \mathrm{~V}$ | 5 V | 27A | 150W |
| PBIH-1212R | $9.2-16 \mathrm{~V}$ | 12 V | 13A | 150W |
| PBIH-1215R | $9.2-16 \mathrm{~V}$ | 15 V | 10A | 150W |
| PBIH-1224R | $9.2-16 \mathrm{~V}$ | 24 V | 6.5 A | 150W |
| PBIH-1248R | $9.2-16 \mathrm{~V}$ | 48 V | 3.3 A | 150W |
| PBIH-2405R | 19-32V | 5 V | 30A | 150W |
| PBIH-2412R | 19-32V | 12 V | 14 A | 150W |
| PBIH-2415R | 19-32V | 15 V | 11A | 150W |
| PBIH-2424R | 19-32V | 24 V | 7 A | 150W |
| PBIH-2448R | 19-32V | 48 V | 3.5 A | 150W |
| PBIH-4805R | $38-63 \mathrm{~V}$ | 5 V | 30 A | 150W |
| PBIH-4812R | $38-63 \mathrm{~V}$ | 12 V | 14A | 150W |
| PBIH-4815R | $38-63 \mathrm{~V}$ | 15 V | 11A | 150W |
| PBIH-4824R | $38-63 \mathrm{~V}$ | 24 V | 7 A | 150W |
| PBIH-4848R | $38-63 \mathrm{~V}$ | 48 V | 3.5 A | 150W |
| PBIH-11005R | $85-140 \mathrm{~V}$ | 5 V | 30A | 150W |
| PBIH-11012R | $85-140 \mathrm{~V}$ | 12 V | 14A | 150W |
| PBIH-11015R | 85-140V | 15 V | 11A | 150W |
| PBIH-11024R | $85-140 \mathrm{~V}$ | 24 V | 7A | 150W |
| PBIH-11048R | 85-140V | 48 V | 3.5 A | 150W |

## PBIH-F



PBIH-G

| Terminal | Connection |
| :---: | :---: |
| 0 | FG |
| 1 | DC +V in |
| 2 | OV in |
| 3 | LFG |
| 4 | NO |
| 5 | NO |
| 6 | -V out |
| 7 | +V out |

PBIH-J


| Terminal | Connection |
| :---: | :---: |
| 1 | FG |
| 2 | DC +V in |
| 3 | OV in |
| 4 | LFG |
| 5 | - V out |
| 6 | +V out |
| 7 | NC |

PBIH-M


PBIH-R


| Terminal | Connection |
| :---: | :---: |
| 1,2 | + V out |
| 3 | +S |
| 4 | -S |
| 5,6 | -V out |
| 7 | Remote |
| 8 | Control |
| 8 | DC +V in |
| 9 | DC OV in |
| 10 | FG |

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Fon: +49 5231 14-0
Fax: +49 5231 14-292083
www.weidmueller.com


PRO-M = Power-Reliable-Optimized
The perfectly reliable power supply for automation technology.
The ten different versions for the 24V-DC power supply all feature a solid but thin metal housing which enables them to be installed without any side gaps. This results in less space required on the mounting rail. Wide range of $A C / D C$ inputs and a wide temperature range enable them to be used anywhere. Because of its high efficiency, resistance to overloads and high power reserves, the PRO$M$ is a trusted power supply for use in any application. The three-phase PRO-M power supply modules continue to function reliably when one phase fails (i.e., in twophase mode).

General ordering data

|  |  |
| :--- | :--- |
| Type | CP M SNT 120W 24V 5A |
| Order No. | 8951340000 |
| Version | Power supply, switch-mode power supply unit |
| GTIN (EAN) | 4032248742554 |
| Qty. | $1 \mathrm{pc}(\mathrm{s})$. |

## Dimensions and weights

|  |  |  |  |
| :--- | :--- | :--- | :--- |
| Width | 40 mm |  |  |
| Depth | 125 mm | Height | 130 mm |
| Net weight | 724.3 g | Weight | 0.7 kg |
| Temperatures |  |  |  |
|  | $-25^{\circ} \mathrm{C} . . .+70^{\circ} \mathrm{C}$ |  |  |
| Operating temperature |  |  |  |

## Input

| AC current consumption | $\begin{aligned} & 1.1 \mathrm{~A} @ 230 \mathrm{VAC} / 2.0 \mathrm{~A} \\ & @ 115 \mathrm{~V} \text { AC } \end{aligned}$ | DC current consumption | 0.4 A @ 370 V DC / 1.2 A <br> @ 120 V DC |
| :---: | :---: | :---: | :---: |
| $\overline{\mathrm{DC}}$ input voltage range | $\begin{aligned} & 80 . . .370 \text { V DC (Derating @ } \\ & 120 \text { V DC) } \end{aligned}$ | Frequency range AC | $47 . . .63 \mathrm{~Hz}$ |
| Input fuse | Yes | Input fuse (internal) | Yes |
| Input voltage range AC | $\begin{aligned} & 85 . . .264 \text { V AC (Derating @ } \\ & 100 \text { V AC) } \end{aligned}$ | Inrush current | max. 40 A |
| Recommended back-up fuse | 4 A / DI, safety fuse <br> 6 A, Char. B, circuit breaker <br> 3... 5 A, Char. C, circuit <br> breaker | Wire connection method | Screw connection |
| rated input voltage | 100... 240 V AC (widerange input) |  |  |
| output |  |  |  |
| Output current | 5 A | Output power | 120 W |
| Output voltage type | DC | Output voltage, max. | 29.5 V |
| Output voltage, min. | 22.5 V | Output voltage, note | (adjustable via potentiometer on front) |
| Overload protection | Yes | Parallel connection option | yes, max. 5 |
| Powerboost @ 24 V DC, $60{ }^{\circ} \mathrm{C}$ | 6 A for $1 \mathrm{~min}, \mathrm{ED}=5 \%$ | Rated (nominal) output current @ U $\mathrm{U}_{\text {Nom }}$ | $5 \mathrm{~A} @ 60^{\circ} \mathrm{C}$ |
| Wire connection method | Screw connection | continous output current @ 24 V DC | 6.0 A @ $45^{\circ} \mathrm{C}, 5.3 \mathrm{~A} @ 55$ <br> ${ }^{\circ} \mathrm{C}, 3.8 \mathrm{~A} @ 70^{\circ} \mathrm{C}$ |
| rated output voltage | 24 V DC $\pm 1$ \% | residual ripple, breaking spikes | $<50 \mathrm{mV}$ Ss @ $24 \mathrm{VDC}, \mathrm{I}_{\mathrm{N}}$ |

## General data

| AC failure bridging time @ $\mathrm{I}_{\text {Nom }}$ | $\begin{aligned} & >100 \mathrm{~ms} @ 230 \mathrm{~V} \text { AC / > } \\ & 20 \mathrm{~ms} @ 115 \mathrm{~V} \mathrm{AC} \end{aligned}$ | Current limiting | $>120 \% I_{N}$ |
| :---: | :---: | :---: | :---: |
| Degree of efficiency | $90 \text { \% @ } 230 \text { V AC / } 88 \text { \% }$ $\text { @ } 115 \text { V AC }$ | Housing version | Metal, corrosion resistant |
| Indication | Operation, green LED | MTBF | $\begin{aligned} & >500,000 \mathrm{~h} \text { acc. to IEC } \\ & 1709 \text { (SN29500 } \end{aligned}$ |
| Mounting position, installation notice | Horizontal on TS35 mounting rail, with 50 mm of clearance at top and bottom for air circulation. Can be mounted side by side with no space in between. | Operating temperature | $-25^{\circ} \mathrm{C} \ldots+70^{\circ} \mathrm{C}$ |
| Power factor (approx.) | $\begin{aligned} & >0.5 @ 230 \mathrm{~V} \text { AC / > } 0.6 \\ & @ 115 \mathrm{~V} \text { AC } \end{aligned}$ | Protection against over-heating | Yes |
| Protection against reverse voltages from the load | 30... 35 V DC | Short-circuit protection | Yes |
| Weight | 0.7 kg |  |  |

## EMC / shock / vibration

| Limiting of mains voltage harmonic currents | in accordance with EN 61000-3-2 | Noise emission acc. to EN55022 | Class B |
| :---: | :---: | :---: | :---: |
| Interference immunity test acc. to | EN 61000-4-2 (ESD)\| <br> EN 61000-4-3 and EN <br> 61000-4-8 (fields)\|EN <br> 61000-4-4 (burst)\|EN <br> 61000-4-5 (surge)\|EN <br> 61000-4-6 (conducted)\| <br> EN 61000-4-11 (dips) | Shock resistance IEC 60068-2-27 | 30 g in all directions |

## Insulation coordination

|  | Class of protection | I, with PE connection | Insulation voltage | 3 kV input/ouput; 2 kV input/earth; 0.5 kV output/earth |
| :---: | :---: | :---: | :---: | :---: |
|  | Pollution severity | 2 | electrical isolation, input-earth | 2 kV |
|  | electrical isolation | 3 kV | electrical isolation, output-earth | 0.5 kV |

## Electrical safety (applied standards)

| Electrical machine equipment |  |  | For use with electronic equipment | Acc. to EN50178 / <br> VDE0160 |  |
| :--- | :--- | :--- | :--- | :--- | :--- |
| Protection against dangerous shock <br> currents | Acc. to EN60204 |  |  | Protective separation protection against VDEO100-410 / acc. to <br> electrical shock | DiN57100-410 |

Connection data (input)

| Conductor cross-section, AWGcmil , max. | 12 | Conductor cross-section, AWGcmil , min. |  |
| :---: | :---: | :---: | :---: |
| Conductor cross-section, flexible , min. | $0.5{ }^{\circ} \mathrm{C}$ | Conductor cross-section, rigid, max. | $6^{\circ} \mathrm{C}$ |
| Conductor cross-section, rigid, min. | $0.5{ }^{\circ} \mathrm{C}$ | Number of terminals [Input] | 3 for L/N/PE |
| Tightening torque, max. | 0.6 Nm | Tightening torque, min. | 0.5 Nm |
| Wire connection cross section, flexible (input), max. | $2.5{ }^{\circ} \mathrm{C}$ |  |  |

## Connection data (output)

| Conductor cross-section, AWGcmil, max. | 12 | Conductor cross-section, AWGcmil , min. 26 |  |
| :---: | :---: | :---: | :---: |
| Conductor cross-section, flexible , max. | $2.5{ }^{\circ} \mathrm{C}$ | Conductor cross-section, flexible , min. | $0.5{ }^{\circ} \mathrm{C}$ |
| Conductor cross-section, rigid, max. | $6{ }^{\circ} \mathrm{C}$ | Conductor cross-section, rigid , min. | $0.5{ }^{\circ} \mathrm{C}$ |
| Number of terminals [Output] | 5 (++ / -) | Tightening torque, max. | 0.6 Nm |
| Tightening torque, min. | 0.5 Nm |  |  |

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D-32758 Detmold
Germany
Fon: +49 5231 14-0
Fax: +49 5231 14-292083
Technical data


## Classifications

| ETIM 3.0 | ECOO1039 |  |  |
| :--- | :--- | :--- | :--- |
| eClass 6.2 | $27-04-90-04$ |  | eClass 5.1 |
| eClass 7.1 | $27-04-90-02$ |  |  |

## Product information

| Descriptive text ordering data | The internal varistor found in a switch-mode power unit does not replace the necessary surge protection in a <br> system. |
| :--- | :--- |
| Descriptive text technical data | *) Recommendation applies only to AC operation; the max. permissible <br> operating voltage is to be observed in all cases! |

## Approvals



## Electric symbol


win DC comecton, note poterty


## UXH SERIES

The latast in YUASA's state-of-the-art technology has brought about a new UXH series capable of yielding even greater capacity than comparable batheries.
YUASA UXH bafteries are designed with unique valve regulafing devices and acid free constructions, ensuring safely and suitability to the contemporary business environment.

## Designed Life

10 years

## Features

Up to $15 \%$ more capacity Maintenance-free Higher energy efficiency
Negligible gas emissions
Valve regulated
Systems compalible
Filted with explosion proof filter
(Except UXH100-12N and UXH200-6N)
No equalizing charge required
(Option) Flame relerdant version available No free Acid (Non-spillable Battery)

## Applications

UPS
Telecommunications
Alarm systems
Float charge voltoge: $\mathbf{2 . 2 7 5}$ V par cell
Permissible operating temperature: $-15-45^{\circ} \mathrm{C}$
Container material; ABS
Fire \& security systems
Emergency lighting
Engine starting
Solar powered systems
Utilities
Rail

## General Specifications

| Batery Mode | Nomhal <br> Nallagin | 20HiR Rend <br>  | Intirnal$\frac{2}{2}$7 | Appeex Dinuralons, mm(nat) |  |  |  |  |  |  | Approx <br> ह15) |  | Equation <br> hour <br> Riter |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | Lengh | With |  | Height |  | Owerdil Height |  |  |  |  |
| W0rsa-12 | 12 | 38 | 7.0 | 2385 (9.3) | 128 | (350] | 190 | (7.5) | 217 | (2.3) | 17 | (इ) | 0 |
| W0450-12 | 12 | 50 | 8.0 | 299 (11.5) | 128 | (5.0) | 190 | (7.5) | 217 | (8.5) | 21 | (14) | 0 |
| U0H6S 12 | 12 | 63 | 5.9 | 389 [14.3) | 129 | (5.0) | 190 | (7.5) | 217 | (8.5) | 25 | (55) | 0 |
| L00-75-8 | ${ }^{4}$ | 78 | 22 | 217 (1.5) | 128 | (30) | 190 | (75) | 217 | (1.3) | 16 | (15) | 0 |
| Wrico-6 | 8 | 100 | 11 | 281 \{11.1) | 128 | (5.0) | 190 | (7.5) | 217 | (18.5) | 20 | (4) | 0 |
| Ux+hI25-6 | 6 | 125 | 1.5 | $345113.6)$ | 129 | 15.0] | 180 | (7) 5 | 217 | 38.9 | 24 | (53] | 0 |
| L50H200 12N | 12 | 109 | 4.0 | 407 [14.0, | 172.5 | 16.0.0 | 210 | (8.3) | 240 | (9,4) | 39 | (36) | $\times$ |
| $400000-6 \mathrm{~N}$ | 6 | 200 | 1.2 | 398 \{15.6) | 176 | 46.9] | 216 | (8,5) | 270 | (9.0) | 39 | [86) | $\times$ |

© 1 Ring Vologec 1.00V/oel. Temperolva: $25^{\circ} \mathrm{C} \mid 77$ FI
*2 in a fuly charged shote and mapurnd frough o 1000 Hz AC, bridge.

Performance Data at $25^{\circ} \mathbf{C}\left(77^{\circ} \mathrm{F}\right)$
(Amperes and Watts per cell)
Amperes to F.V.1.60 Volts Per Cell

| Pentrin Time |  | $\frac{1}{\min }$ | $\begin{gathered} 5 \\ \mathrm{~min} \\ \hline \end{gathered}$ | $\begin{aligned} & 10 \\ & \mathrm{~min} \\ & \hline \end{aligned}$ | $\begin{aligned} & 15 \\ & \mathrm{~min} \\ & \hline \end{aligned}$ | $\begin{aligned} & 20 \\ & \text { min } \\ & \hline \end{aligned}$ | $\begin{array}{r} 25 \\ \mathrm{mh} \\ \hline \end{array}$ | $\begin{aligned} & 30 \\ & \text { min } \\ & \hline \end{aligned}$ | $\begin{aligned} & 35 \\ & \text { min } \\ & \hline \end{aligned}$ | $\begin{aligned} & 40 \\ & \mathrm{~min} \\ & \hline \end{aligned}$ | $\begin{aligned} & 45 \\ & \mathrm{~min} \\ & \hline \end{aligned}$ | $\begin{aligned} & 1 \\ & h \end{aligned}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| UNT3s-12 | A | 141.0 | 119.0 | 86.3 | 63.5 | 50.9 | 426 | 37.6 | 33.4 | 30.8 | 20.0 | 208 |
|  | W | 2780 | 199.0 | 1510 | 118.0 | 942 | 78.4 | 7.1 | 63.5 | 59.5 | 81.6 | 137 |
| 140450-12 | A | 165.0 | 158.0 | 1140 | 83.5 | 67.9 | 56.0 | 195 | 44.0 | 10.1 | 37.0 | 30.0 |
|  | W | 3020 | 262.0 | 2030 | 1530 | 124.0 | 105.0 | 90.5 | 83.5 | 77.0 | T0. | 57.3 |
| LDPHE3-12 | A | 2330 | 197.0 | 1430 | 1050 | 34.4 | 70.6 | 62.4 | 55.4 | 51.0 | 46.6 | 378 |
|  | W | 3800 | 330.0 | 2550 | 1930 | 156.0 | 1320 | 118.0 | 1030 | \$7.0 | 83.8 | 72.5 |
| WHO5-6 | A | 27.0 | 2300 | 170.0 | 1250 | 101.0 | 84.0 | 743 | 66.0 | 60.8 | 5.5 | 410 |
|  | W | 4520 | 333.0 | 3040 | 2300 | 186.0 | 157.0 | 1.400 | 125.0 | 1160 | 108.0 | 85.3 |
| L80H100 a | A | 3700 | 3120 | 227,0 | 167.0 | 134,0 | 112.0 | 98.8 | 88.0 | 01.0 | 740 | 60.0 |
|  | W | 4600 | 5240 | 4050 | 306.0 | 248.0 | 209.0 | 187.0 | 187.0 | 154.0 | 141.0 | 115.0 |
| UWH125 6 | A | 463.0 | 390.0 | 280 | 209.0 | 168.0 | $1 / 40.0$ | 1240 | 1100 | 101,0 | 92.5 | 75.0 |
|  | W | 7540 | 655.0 | 506.0 | 3830 | 310.0 | 261.0 | 2200 | 209.0 | 193.0 | 174.0 | 14.0 |
| UWH100.12N | A | 3700 | 3120 | 2970 | 1670 | 134.0 | 1120 | 99.0 | 88.0 | 81.0 | 740 | 60.0 |
|  | W | 608.0 | 5240 | 4050 | 3000 | 249.0 | 209.0 | 1878 | 167.0 | 154.0 | 141.0 | 115.0 |
| LWH200-8 | A | 7400 | 62.0 | 4220 | 3340 | 269,0 | 2240 | 194.0 | 178.0 | 1620 | 1490 | 120.0 |
|  | W | 12040 | 1048.0 | 8020 | 6120 | 496.0 | 4160 | 3740 | 334.0 | 304.0 | 2820 | 230.0 |

Amperes to F.V. 1,70 Volts Per Cell

|  |  | $\begin{gathered} 1 \\ \mathrm{~min} \\ \hline \end{gathered}$ | $\begin{gathered} 5 \\ \mathrm{~min} \end{gathered}$ | $\begin{aligned} & 10 \\ & \min \end{aligned}$ | $\begin{array}{r} 18 \\ \text { min } \end{array}$ | $\begin{aligned} & 20 \\ & \mathrm{~min} \end{aligned}$ | $\begin{aligned} & 25 \\ & m h \\ & \hline \end{aligned}$ | $\begin{aligned} & 30 \\ & m h \end{aligned}$ | $\begin{gathered} 35 \\ \text { min } \\ \hline \end{gathered}$ | $\begin{gathered} 40 \\ \min \\ \hline \end{gathered}$ | $\begin{gathered} 14 \\ \text { min } \end{gathered}$ | $\begin{aligned} & 1 \\ & h \end{aligned}$ | $\begin{aligned} & 2 \\ & h \\ & \hline \end{aligned}$ | $\begin{aligned} & 3 \\ & h \end{aligned}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| WH33-12 | A | 1290 | 108.0 | 737 | 574 | 47.9 | 41. | 36.5 | 32.7 | 29.3 | 27.0 | 220 | 137 | 9.9 |
|  | W | 211.0 | 1880 | 1330 | 1050 | 88. | 77.9 | 69.2 | 61.6 | 55.9 | 517 | 126 | 28. | 194 |
| L80 50.12 | A | 162.0 | 139.0 | 77.0 | 75.5 | 63.0 | 51.5 | 49.0 | 42.5 | 38.5 | 15. | 29.0 | 18.8 | 13.0 |
|  | W | 277.0 | 245.0 | 176.0 | 139.0 | 117.0 | 108.0 | 91.0 | 81.0 | 73.5 | 68.0 | 580 | 350 | 25.5 |
| UWH63-12 | A | 2040 | 175.0 | 122.0 | 95.1 | 79.4 | 68.7 | 60.5 | 53.6 | 48.5 | 447 | 36.5 | 227 | 16.4 |
|  | W | 34 | 3020 | 2210 | 1750 | 1770 | 129.0 | 11.0 | 1020 | 926 | 857 | 70.6 | 4.1 | 32.1 |
| WHO5 6 | A | 243.0 | 2090 | 146.0 | 1130 | 94.5 | 81.8 | 72.0 | 638 | 578 | 53.3 | 43.5 | 270 | 19.8 |
|  | W | 416.0 | 3670 | 263.0 | 209.0 | 176.0 | 1540 | 137.0 | 1220 | 110.0 | 1020 | 14.0 | 52.5 | 38.3 |
| LWH100 ${ }^{\text {d }}$ | A | 324.0 | UR 0 | 1940 | 151.0 | 1250 | 109.0 | 98.0 | 85.0 | 77.0 | 71.0 | 590 | 36.0 | 260 |
|  | W | 484.0 | 489.0 | 351.0 | 278.0 | 24.0 | 2050 | 182.0 | 162.0 | 147.0 | 1360 | 1120 | 700 | 51.0 |
| Wern25 6 | A | 405.0 | 3480 | 24.0 | 189.0 | 1880 | 1340 | 120.0 | 1080 | 96.3 | 88.8 | 72. | 480 | 32.3 |
|  | W | 693.0 | 611. ${ }^{\text {d }}$ | 439.0 | 348.0 | 293.0 | 258.0 | 2200 | 2030 | 1810 | 1700 | 140.0 | 87.5 | 628 |
| LSEHIDC-12N | A | 324.0 | 278.0 | 1940 | 151.0 | 1260 | 1080 | \%,0 | 85.0 | 78.0 | 710 | 58.0 | 36 | 200 |
|  | W | 5340 | 489.0 | 351.0 | 27.0 | 2340 | 2050 | 162.0 | 162.0 | 147.0 | 1360 | 1120 | 700 | 51.0 |
| Un+200-6 | A | 6 Na | 3560 | 398.0 | 3020 | 2520 | 21.20 | 192.0 | 1700 | 154.0 | 142.0 | 1160 | 720 | 52.0 |
|  | W | 1106.0 | 976.0 | 7000 | 565.0 | 488.0 | 4080 | 3640 | 3240 | 2900 | 2720 | 2210 | 1100 | 1020 |

Amperes to F.V.1.80 Volts Per Cell

| Bull |  | $\begin{gathered} 1 \\ \mathrm{~min} \\ \hline \end{gathered}$ | $\begin{gathered} 5 \\ \mathrm{~min} \\ \hline \end{gathered}$ | $\begin{aligned} & 10 \\ & \mathrm{~min} \end{aligned}$ | $\begin{aligned} & 15 \\ & \mathrm{~min} \end{aligned}$ | $\begin{aligned} & \text { 20 } \\ & \text { min } \end{aligned}$ | $\begin{aligned} & 25 \\ & \mathrm{mh} \\ & \hline \end{aligned}$ | $\begin{aligned} & 30 \\ & \mathrm{~min} \\ & \hline \end{aligned}$ | $\begin{gathered} 35 \\ \text { min } \end{gathered}$ | $\begin{gathered} \text { m } \\ m \\ \hline \end{gathered}$ | $\begin{gathered} 45 \\ \mathrm{mln} \\ \hline \end{gathered}$ | $\mathrm{h}$ | $\frac{2}{2}$ | $\frac{3}{h}$ | $5$ | $\begin{aligned} & 6 \\ & h \end{aligned}$ | $\begin{aligned} & 10 \\ & 6 \end{aligned}$ | 30 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| U 4 H38-12 | A | W. 2 | 86.3 | 63.8 | 52.8 | 4 | 38. | 25.0 | 31.2 | 28.1 | 262 | 21.3 | 12.9 | 98 | 6.1 | 42 | 35 | 1.10 |
|  | W | 179.0 | 157.0 | 118.0 | 992 | 047 | 737 | 66.9 | 59.7 | 54.3 | 50.5 | 41.4 | 25.1 | 18.6 | 122 | 4 | 6.5 | 280 |
| 100450-12 | A | 131.0 | 114.0 | 84.0 | 69.5 | 59.0 | 51.0 | 46.0 | 41.0 | 3.0 | 34.5 | 28.0 | 17.0 | 12.5 | 3.0 | 5.5 | 4.8 | 2.50 |
|  | W | 236.0 | 207.0 | 156.0 | 131.0 | 1120 | 97.0 | 08.0 | 78,5 | 71.5 | 86.5 | 54.5 | 33.0 | 24.5 | 16.0 | 11.0 | 9.0 | 5.00 |
| U0H63-12 | A | 16 | 14.0 | 1060 | 178 | 743 | 64.3 | 58.0 | 517 | 46.6 | 49.5 | 3 | 21 | 18.8 | 10.1 | 49 | 18 | 1.15 |
|  | W | 297.0 | 250.0 | 18:0 | 164.0 | 140.0 | 1220 | 1110 | 98.9 | 90.1 | 83, | 88 | 41.4 | 30.9 | 20.2 | 13.7 | 11.3 | 6.30 |
| LSATV5-d | A | 196.0 | 170.0 | $126: 0$ | 1940 | 88 | 76.5 | 69.0 | 61.5 | 55.5 | 518 | 420 | 25.5 | 18, $\mathrm{H}^{\text {¢ }}$ | 120 | 3.3 | 8,9.9 | 275 |
|  | W | 353.0 | 310.0 | 239.0 | 186.0 | 167.0 | 1460 | 132.0 | 1180 | 107.0 | 9\% | 81.8 | 49.5 | 34.8 | 240 | 16.5 | 13.5 | 7.50 |
| L0H100-8 | A | 261.0 | 227.0 | 181.0 | 139.0 | 1180 | 1020 | 92.0 | 320 | 74.0 | 69.0 | 350 | 34.0 | 250 | 160 | 11.0 | 93 | 5.00 |
|  | W | 47 | 413.0 | 311.0 | 261.0 | 223.0 | 194.0 | 176.0 | 187.0 | 143.0 | 1330 | 109.0 | 68.0 | 49.0 | 320 | 220 | 180 | 0 |
| L08, 128.4 | A | 326.0 | 284.0 | 210.0 | 1740 | 148.0 | 128.0 | 115.0 | 103.0 | 92.5 | 86.1 | 70.0 | 425 | 31.3 | 20.0 | 138 | 11.6 | 8.75 |
|  | W | 509.0 | 518.0 | 399.0 | 32x.0 | 279.0 | 2430 | 220.0 | 18.0 | 178.0 | 166.0 | 1360 | 025 | 61.3 | 100 | 27.5 | 29.5 | 2.50 |
| WH100-12N | A | 261.0 | 227.0 | 168.0 | 139.0 | 118.0 | 1020 | 92.0 | 820 | 74.0 | 120.0 | 56. | 34,0. | 25.0 | 160 | 11.0 | 93. | 100 |
|  | W | O1.0 | 113.0 | 311.0 | 261.0 | 223.0 | 1920 | 176.0 | 15.0 | 1430 | 1330 | 109.0 | 64.0 | 49.0 | 320 | 220 | 180 | 10 |
| UWH200 4 | A | 520.0 | 1520 | 336.0 | 278.0 | 23.0 | 204.0 | 184.0 | 1640 | 1480 | 13880 | 1120 | 68.0 | 50.0 | 320 | 220 | 18.6 | 1000 |
|  | W | 940.0 | 824.0 | 620.0 | 5200 | 44.0 | 388.0 | 352,0 | 314.0 | 286.0 | 26d.0 | 218.0 | 1320 | 以. 0 | 640 | 440 | 36.0 | 2000 |

## General Characteristics

EDISCHARGE CHARACTERISTICS


■CHARGING CHARACTERISTICS


## Peripheral Device


 Battery IVlo can be diognosed without dieconnecting a power wuphy os a roeutt of meoving battwry intomal lmpedance during flocilng thergen

- Diognoes bollery life dering Focting chorge.
- A compoct, partoble device.
- Con be used for a large voriey of valvo regulased lood ood boterias.
- Mounisd with compariolor lunction.
- Mouniod with comparibor luncion.

Fyou hitwod to wo the device for UPS, plowe contod ws for conwilation.!

## eSpectications subject to change without prior notlce

## Depributud by:

GS Yuasa international Lto
18-1, Nishl Shimbeshl, Minato - la
Tbiye 105-0003
Jupan
Tel $+81-3-3597-2403$
Fax + 81 3 3597 2405

# D Series Data Radio Modem <br> <br> DR900 - Digital Radios 

 <br> <br> DR900 - Digital Radios}

Trio DataCom's D Series are high performance cost effective data radio modems designed as an alternative to hard wired data transport. Transmit your data over radio with a fully integrated data radio modem designed for fixed point-to-point and point-to-multipoint applications.
The D Series is available as either a half duplex or a full duplex* $853-929 \mathrm{MHz}+/-5 \mathrm{MHz}$ radio, including a fully integrated $4800 / 9600 \mathrm{bps}$ data modem. These units operate equally well in either a stand-alone configuration, or as part of a large communication system.


This complete package forms an attractively priced product for the transmission of data over radio in fixed applications thus providing a viable alternative to costly networks of buried media.

## Features:

* Fully integrated half and full duplex* radio and modem
* Transparent and non-intrusive remote diagnostic facilities (Optional)
* Inbuilt data routing and multiplexing capabilties, multi-port operation
* Simultaneous delivery of multiple protocols using Trio DataCom's unique MultiStream ${ }^{\text {TM }}$ technology
* Digital Signal Processing (DSP) modem
* Selectable 300-19,200 bps asynchronous RS232 user interface


## Radio

The D Series radio has been designed to meet worldwide regulatory guidelines, including FCC , and has adjustable power output up to 5 Watts. This fully synthesised radio is programmable in $6.25 / 7.5 \mathrm{kHz}$ increments to accommodate various worldwide channel spacings. The receiver section has a wide tuning range with an excellent signal-to-noise ratio. Exceptional frequency stability is achieved by intelligent microprocessor controlled temperature compensation. An extended operating temperature range of -30 to $60^{\circ} \mathrm{C}$ makes the unit ideal for commercial and industrial applications.

## Modem

The in-built modem includes a custom DSP developed for data communications over narrow band radio systems.

This system offers minimum occupied bandwidth and optimal data integrity (using the standard HDLC protocol with CCITT CRC error detection) inhibiting the transfer of any rogue unwanted data caused by interference or squelch headers / tails.
The Trio DataCom DSP provides:

- the interface between the asynchronous RS232 user communication and the synchronous radio link layer.
- an inbuilt multipexer / router which allows for simultaneous transportation of multiple protocols over the one radio network.
* Built-in antenna diplexer*
\& Integrated supervisory data channel
* Unique collision avoidance facility, for unsolicited report-byexception
\& Range of ancillary equipment - full duplex base / repeater stations and hot-standby base station


## Applications

The D Series is ideal for use in a variety of sophisticated and critical SCADA and Distributed Information Systems, where complex routing of multiple data protocols and remote diagnostics and wireless network management are important factors.
Remote units and a number of full duplex base station / repeater models, suitable for a variety of requirements, make up the D Series. At the top of the range, the DH model is a genuine, duplicated hot standby base for systems where nothing short of ultra reliability is acceptable.

Telemetry Systems - Utilities (Gas, Water, Electricity), Rallways, Mining, Telecommunications, Industry. Where network status, system control, data collection and fault conditions are required.

Transaction Processing - Point of Sale Credit Terminals, Stock Control, Direct Order, Banks, Building Societies, Stock Brokers, Gambling Organizations, etc, where Point of Sale, inventory, credit, or transaction data requires collection and distribution.

Common Carrier Data Services - The high speed, low cost and spectrum efficiency of this device make it well suited to all forms of common carrier data networking.

Alarm Monitoring - Fire, Power, Intrusion \& Essential Services Alarm Reporting.

# D Series - Data Radio Modem 

DR900 - Digital Radios

## Configuration

Configuration using Trio's D Series programming software (DRProg) is completely Windows ${ }^{\circ}$ based for all parameters, such as; frequency, transmitter power, digital mute level, PTT timer, system configurations, port settings.

## Network Management \& Diagnostic (Optional)

A large distributed network, or even a simple point-to-point link, requires comprehensive fault reporting and diagnostics to ensure a high level of availability. Trio D Series data radio modem products offer sophisticated in-built diagnostics using the optional TView ${ }^{\text {™ }}$ software. This capability allows the customer to remotely monitor and maintain their system, minimising the likelihood of failures, by pointing out component degradation and decreasing the time to diagnose and repair. There is no necessity to visit the master station or interfere with the host data integrity, other than additional data transfer. For further details, consult the TView data sheet.

Specifications:

| RADIO |  |
| :---: | :---: |
| Frequency Range** | $853-929 \mathrm{MHz}+1-5 \mathrm{MHz}$ |
| Channel Selection | Fully programmable |
| Frequency Splits | $76 \mathrm{MHz} \mathrm{Tx/Rx}$ frequency split available including simplex |
| Frequency Stability | $\pm 1 \mathrm{ppm}\left(-10\right.$ to $60^{\circ} \mathrm{C}$ ambient, opt -30 to $70^{\circ} \mathrm{C}$ ) Higher frequency stability options are available due to intelligent processor controlled temperature compensation |
| Aging | <= 1ppm/annum |
| Haif / Full Duplex | haif duplex or full duplex* |
| Data Rate (ff) | $4800 / 9600 \mathrm{bps}$ |
| Configuration | All configuration via Windows software |
| TRANSMITTER |  |
| Tx Power | $5 \mathrm{~W}(+37 \mathrm{dBm})$ or $1 \mathrm{~W}^{( }(+30 \mathrm{dBm})$ (software programmable) |
| Modulation | Narrow band digital filtering binary GMSK |
| Occupied Bandwidth | Meets various international regulatory guidelines for point-to-point and point-to-multipoint |
| Tx Attach Time | $<1 \mathrm{mSecond}$ |
| Timeout Timer | Programmable 1-255 seconds |
| Tx Spurious | $<=-65 \mathrm{dBm}$ |
| RECEIVER |  |
| Sensitivity | -115 dBm for 12 dB SINAB |
| Blocking | $>75 \mathrm{~dB}$ (EIA) |
| Intermodulation | $<=70 \mathrm{~dB}$ (EIA) |
| Spurious Response | $<=70 \mathrm{~dB}$ (EIA) |
| Select. and Desense | 70 dB (EIA) |
| AFC Tracking | $\pm 3 \mathrm{kHz}$ tracking @ -90 dBm/attack time < 10 mS |
| Mute | Programmable digital mute |

## Collision Avoidance

A unique fully integrated, yet independent, low speed supervisory data channel embedded within the primary bit-stream provides collision avoidance facilities which are transparent to the user. The use of this feature makes this product ideally suited for reliable. error free data transmissions between stations in high density point-to-multipoint data networks.
The benefits include:

- Multiple asynchronous applications operating on the one radio channel.
- Enhanced performance of report-by-exception networks.


## Related Products

* Base Stations (DB900)
* Hot Standby Base Station (DH900)
* 9 Port Stream Router Muitiplexer (MSR)

4. Network Management and Diagnostic Soffware (TView ${ }^{\text {TM }}$ )

* D Series Programming Software (DRProg*)


## CONNECTIONS

| User Data Port | $2 \times$ DB9 RS232 female ports |
| :--- | :--- |
| Antenna | SMA female bulkhead (optional N) |
| Power | 2 pin locking. Mating connector supplied |

## MODEM

| Data Serial Port \#1 | Full duplex, DB9 RS232, DCE (modem), 300$19,200 \mathrm{bps}$ asynchronous, hardware/software handshaking |
| :---: | :---: |
| Data Serial Port \#2 | Full duplex, DB9 RS232, 300-9600 bps asynchronous, software handshaking |
| Data Storage | On-board RAM |
| Channel Data Rate | 4800 / 9600 bps , full duplex |
| Bit Error Rate | $\begin{aligned} & <1 \times 10^{6} @-108 \mathrm{dBm}(4800 \mathrm{bps}) \\ & <1 \times 10^{6} @-105 \mathrm{dBm}(9600 \mathrm{bps}) \end{aligned}$ |
| Collision Avoidance | Trio DataCom's unique supervisory channel C/DSMA collision avoidance system |
| MultiStream ${ }^{\text {m }}$ | Trio DataCom's unique simultaneous delivery of multiple data streams (protocols) |
| GENERAL |  |
| Power Supply | 13.8 Vdc nominal (11-16 Vdc) |
| Transmit Current | 600 mA max. @ 1 W <br> 1700 mA max. @ 5 W |
| Receive Current | 175 mA |
| Dimensions | $260 \times 161 \times 65 \mathrm{~mm}$ (robust metal enclosure) |
| Weight | 1.3 kg |


designs products \& Solutions

 Pertormanice tata indicates tppital valoes ielated to the deserited unit informatien subject to change whout nobice


| REVISIONS |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| REV. | DESCRIPTION | ECN | DATE | APPROVED |
| G | REFER TO ECN | 11902 | $8 / 9 / 13$ | JLJ |



HARDWARE KIT INCLUDES:

| QTY | DESCRIPTION |
| :---: | :---: |
| 1 | SCREW 10-32 X .50 SLOT F PAN 4-10 SS |
| 1 | SCREW 10-32x.50 SLOT MS PAN 18-8 SS |
| 1 | NUT 10-32 HEX 18-8 SS |
| 2 | WASHER 10 EXT TOOTH SS STAINLESS STEEL |

SURGE:
50kA IEC 61000-4-5 8/20 $\mu \mathrm{s}$ WAVEFORM (TESTED) 20kA (RATED)
TURN-ON:
$600 \mathrm{Vdc} \pm 20 \%$
TURN-ON TIME.
2.5ns FOR 2kV/ns

FREQUENCY RANGE:
125 MHz TO 1 GHz
<1.1:1 OVER FREQUENCY RANGE
NSERTION LOSS:
$\leq 0.1 \mathrm{~dB}$ OVER FREQUENCY RANGE
MAX POWER:
375W @ 125MHz TO 220 MHz 125W@ 220MHz TO 700MHz 50W @ 700MHz TO 1000MHz
THROUGHPUT ENERGY:
$\leq 220 \mu \mathrm{~J}$ FOR $3 \mathrm{kA}, 8 / 20 \mu \mathrm{~s}$ WAVEFORM
TEMPERATURE
STORAGE: $-55^{\circ} \mathrm{C}$ TO $+85^{\circ} \mathrm{C}$
OPERATING: $-50^{\circ} \mathrm{C}$ TO $+50^{\circ} \mathrm{C}$
VIBRATION:
1G UP TO 100Hz
CE COMPLIANT
RoHS COMPLIANT
THESE COMMODITIESS TECHNOLOGY OR SOFTWARE WERE EXPORTED FROM THE UNITED STATES IN ACCORDANCE
WITH THE EXPORTADMIIITRATION REGULATIONS. DVERSION CONTRARY TOU.S. LAW PROHHBITED.

## Owner's Manual

## ACE3600 RTU

## a b

## 6802979C35-E



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Hereby, Motorola declares that these products comply with RoHS European Directive no. 2002/95/EC (Restriction of the use of Hazardous Substances) and WEEE Directive no. 2002/96/EC (Strategy of Waste management), with the exception of models listed in Appendix B.

Motorola, Inc.
1301 E. Algonquin Road,
Schaumburg, IL 60196 U.S.A.

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## GLOSSARY

| ACE | Advanced Control Equipment |
| :--- | :--- |
| AI | Analog Input |
| AO | Analog Output |
| AWG | American Wire Gauge |
| DCD | Data Carrier Detect |
| DFM | Direct Frequency Modulation |
| DI | Digital (Discrete) Input |
| DNP | Distributed Network Protocol |
| DO | Digital (Discrete) Output |
| DPSK | Differential Phase Shift Keying |
| EMI | Expansion Microcode Interface |
| EPP | Environmentally Preferred Product |
| ESD | Electrostatic Discharge |
| EU | European Union |
| FCC | Federal Communication Commission |
| FEP | Front End Processor (MCP-M, MCP-T, or FIU) |
| FET | Field Effect Transistor |
| FPGA | Field Programmable Gate Array |
| FSK | Phase Shift Keying |
| FIU | Field Interface Unit |
| GND | Ground |
| GPRS | General Packet Radio Service |
| GPS | Global Positioning Satellite |
| GSM | Global System for Mobile Communications |
| GW | ACE IP Gateway |
| HV | High Voltage |
| HW | Hardware |
| IEC | International Electrotechnical Commission |
| IO (I/O) | Inputs Outputs |
| IP | IPGW |


| LAN | Local Area Network |
| :--- | :--- |
| LED | Light Emitting Diode |
| MCC | Master Control Center |
| MCP-M | Motorola Communication Processor - MODBUS |
| MDLC | Motorola Data Link Communication |
| MODBUS | MODICON BUS Protocol |
| MOSCAD | Motorola SCADA |
| MOSCAD-L | Motorola SCADA-Light |
| NEMA | National Electrical Manufacturers Association (issues enclosure standards) |
| NTP | Network Time Protocol |
| OPC | Open Connectivity |
| OVF | Overflow |
| PC | Personal Computer |
| PLC | Programmable Logic Controller |
| PPC | Power PC |
| PPH | Pulse per Hour |
| PPM | Parts Per Million |
| PPP | Point-to-Point Protocol |
| PPS | Pulse per Second |
| PSTN | Public Switched Telephone Network |
| RAM | Random Access Memory |
| RF | Single Pole Double Trigger Single Trigger |
| ROM | Radio Frequency |
| RST | Read Only Memory |
| RTS | Reset |
| RTU | Request to Send |
| RX | Remote Terminal Unit (can be MOSCAD or MOSCAD-L) |
| SCADA | Receive |
| SBO | Supervisory Control and Data Acquisition |
| SDRAM | Select Before Operate |
| SNMP | Simple Network Management Protocol |
| SNTP | SPD |


| STS | System Tools Suite |
| :--- | :--- |
| SW | Software |
| TB | Terminal Block |
| TCP | Transmission Control Protocol |
| TDPSK | Trunked Differential Phase Shift Keying |
| TX | Transmit |
| UDF | Underflow |
| UDP | User Datagram Protocol |
| UHF | Ultra High Frequency |
| USB | Universal Serial Bus |
| VHF | Very High Frequency |
| WAN | Wide Area Network |
| WB | Wire Break |

## DESCRIPTION

## Product Overview

The ACE3600 is a programmable Remote Terminal Unit (RTU). Almost any automation task can be implemented with a suitable choice of ACE3600 components. Typically the RTU monitors and controls local equipment and communicates with a control center and with other RTUs in the system. The ACE3600 is the newest Motorola SCADA (MOSCAD) RTU, a member of MOSCAD family of RTUs and Control Center Front End Processors.

The ACE3600 System Tools Suite (STS) can be run on a local or remote PC to perform all the setup, programming and monitoring operations such as RTU configuration, system/application, download, monitoring, etc.

## Features of the ACE3600

The ACE3600 combines all the advantages of the legacy MOSCAD and MOSCAD-L RTUs with those of modern hardware and software technologies.

Among these are:

- A modern CPU platform with powerful microprocessor
- Real-time operating system based on Wind Rivers VxWorks OS
- Enhanced communication and networking capabilities
- Rugged modular design
- Extended operating temperature range
- Improved power supply/charger
- Modules with a high component density
- System building tools
- Interoperability with legacy MOSCAD family RTUs


## General Description

The ACE3600 RTU is a modular unit, comprised of removable modules installed in a multislot frame. These modules include

- Power supply
- CPU
- I/O modules

The basic (default) model includes one power supply and one CPU module. The number of I/O modules is selected as an option of the base model.

Figure 1-1 provides a general view of the ACE3600 RTU with five I/O modules.


Figure 1-1 ACE3600 RTU - General View

## I/O Module Options

The following types of I/O modules are available:

- Digital Inputs (DI), including High Voltage
- Digital Outputs (DO), including High Voltage
- Analog Inputs (AI)
- Analog Outputs (AO)
- $\quad$ Mixed I/O
- Mixed Analog


## Communication Interfaces

The ACE3600 CPU includes the following serial ports:

- Configurable RS232 or RS485 serial port
- Configurable RS232 with GPS receiver support (for time sync)
- Ethernet $10 / 100 \mathrm{Mb} / \mathrm{s}$ (ACE3600 CPU3640, CPU3680 models)
- Two USB full speed host ports ( 12 Mbs ) for MotoTrbo radios only (ACE3600 CPU3680 and ACE IP Gateway only)
- One USB device port (ACE3600 CPU3680 and ACE IP Gateway only) (future option)

Two additional plug-in ports can be added to the CPU. The following types of communication modules are available for the plug-in ports:

- RS232
- RS485
- General radio interface (Conventional or Trunking, DPSK 1200, FSK 2400, DFM 4800)
- Ethernet $10 \mathrm{Mb} / \mathrm{s}$
- Ethernet $10 / 100 \mathrm{Mb} / \mathrm{s}$ (on plug-in Port 1 only)


## ACE3600 RTU Construction

The ACE3600 is available in various structures:

- Frame which can accommodate a varied number and type of modules
- Metal chassis which accommodates the frame, and optional radios, backup battery and communication interfaces
- Protective housing which accommodates the frame, and optional radios, backup battery and communication interfaces (suitable for outdoor installation)

The ACE3600 frame consists of the following elements:

- Plastic slots which accommodate the power supply, CPU and I/O modules, and backplane bus motherboard
- Mounting plate for attaching the plastic slots together and mounting the frame on a wall
- Backplane bus motherboard which connect the modules to each other via the signal buses and connects the modules with operating voltages
- Power junction box for AC or DC power source and ground connections

A frame can be mounted on the wall or installed in a 19" rack or customer enclosure. For more information, see the Installation chapter below

The ACE3600 frame can include wide or narrow plastic slot units:

- Wide slot unit - can hold a power supply and a CPU or up to three I/O modules
- Narrow slot unit - can hold up to two I/O modules


## RTU Options

Each RTU can include a number of options, including portable and mobile radios, and plastic boxes with interface card for communication, etc.

| Housing/Mounting Type | Capacity/Options |
| :--- | :--- |
| No I/O slot frame <br> Basic (default) model. <br> Can be installed on a wall. | Power supply and CPU <br> Chassis or housing options. <br> Can be ordered with 19" <br> frame metal back. |
| 2 I/O slot frame <br> Can be installed on a wall. | Power supply and CPU, <br> up to 2 I/Os <br> Can be ordered with metal <br> chassis or housing. <br> Can be ordered with 19" <br> frame metal back. |
| Power supply and CPU, <br> Can be in 3 I/Os |  |
| Can be ordered with metal |  |
| chassis or housing. |  |
| Can be ordered with 19" |  |
| frame metal back. |  |, | Power supply and CPU, |
| :--- |
| up to 5 I/Os |
| Can be ordered with large |
| metal chassis or housing. |
| Can be ordered with 19" |
| frame metal back. |


| Housing/Mounting Type | Capacity/Options |
| :--- | :--- | :--- |
| $8 \mathrm{I} / \mathrm{O}$ slot frame | Power supply and CPU, <br> up to 8 I/Os |
| 19 " rack/enclosure. |  |
| Can be ordered with metal |  |
| chassis option for accessories: |  |
| 6.5 or 10 Ah Lead-Acid |  |
| backup battery |  |
| 1 radio; up to 4 plastic boxes. |  |
| For all possible combinations, |  |
| see 19" Metal Chassis |  |
| Installation Combinations in |  |
| the Installation chapter |  |
| below. |  |, | I/O expansion power supply, |
| :--- |
| I/O expansion module, up to |
| 8 I/Os. |
| Can be connected to the main |
| RTU frame. |
| Can be ordered with large |
| metal chassis or housing. |


| Housing/Mounting Type | Capacity/Options | Power supply and CPU, <br> $0,3,5$, or 8 I/Os, 1 radio, 6.5 <br> or 10 Ah Lead-Acid backup <br> battery, and up to 4 plastic <br> boxes. (Not all combinations metal back <br> are valid together.) <br> Can be ordered with ACE IP <br> Gateway, power supply, <br> backup battery and other <br> accessories. <br> radio, 6.5 or 10 Ah Lead- <br> Acid backup battery and up <br> to 2 plastic boxes. <br> on a wall. |
| :--- | :--- | :--- |
| For all possible combinations, |  |  |
| see 19" Metal Chassis $19 "$ rack or |  |  |
| Installation Combinations in |  |  |
| the Installation chapter |  |  |
| below. |  |  |

For installation instructions of each housing/mounting type, see the Installation chapter.
For information on I/O expansion, see the I/O Expansion chapter.
For the dimensions and weight of each combination, see Appendix A: General Specifications.
For a detailed list of all ACE3600 options, see the ACE3600 price pages and ordering information.

For a detailed description of the individual modules, see the appropriate chapter below.

## RTU Components

The ACE3600 RTU can include the following components.

| Component | Function | Notes |
| :--- | :--- | :--- |
| Power supply module | Converts the main AC or DC <br> power source to the voltages <br> required by the modules, <br> radio/modems and <br> accessories. <br> Charges the backup battery <br> and switches to the battery <br> voltage when the main power <br> fails (in models with charger.) | See Power Supply Module <br> and Backup Battery chapter. |
| CPU module | Stores and runs the user <br> application program, stores <br> data collected by the I/O <br> modules and communicates <br> with the control center, RTUs <br> and other devices via the <br> communication ports. | See CPU Module chapter. |
| CPU plug-in port | Enables adding various <br> communication ports to the <br> CPU modules. | See CPU Module chapter. |
| CPU plug-in SRAM | Provides static RAM. | See CPU Module chapter. |
| I/O module | Matches between the <br> ACE3600 and signals of <br> various types/levels. <br> Interfaces between the <br> ACE3600 and the process <br> signals. | See I/O Modules chapter. |
| I/O expansion module | Connects the signals to the <br> I/O modules. | See I/O Modules chapter. |
| Plug-in 24V DC power supply | Enables adding 24 V floating <br> power supplies to I/O <br> modules for contact "wetting" <br> and sensor operation. | See I/O Modules chapter. |
| Connects the I/O modules on <br> an I/O expansion frame to the <br> CPUU module on the RTU's <br> main frame (frame 0), <br> directly or via an expansion <br> LAN switch). | See Expansion Module <br> chapter. |  |
|  | blocks (TB) | Cerm |


| Component | Function | Notes |
| :---: | :---: | :---: |
| I/O expansion power supply | Connects 12 V power and 12 V DO from the power supply on the RTU's main frame to an I/O expansion frame, or from one I/O expansion frame to another. | See Expansion Power Supply Module chapter. |
| I/O expansion LAN switch | One switch enables connection of up to seven expansion frames to the main frame CPU. <br> Two switches allow connection of up to thirteen expansion frames to the main frame CPU. | See Expansion LAN Switch chapter. |
| ACE IP Gateway module | Serves as a front end unit between <br> ACE3600/MOSCAD RTUs and control center SCADA clients using TCP/IP protocol. | See ACE IP Gateway Module chapter. |
| TB holder kit | Holds Module TBs. | See I/O Modules chapter. |
| Cable with TB holder | A cable to connect signals to the I/O modules. | See I/O Modules chapter. |
| Backup battery | Enables backup RTU operation when main power fails. | See Power Supply Module and Backup Battery chapter. |
| Radio installation kit | Mechanical support and cables that enable installation of radio. | See Radio Types and Installation Kits chapter. |
| RS485 Connection Box | Enables connection of up to 6 devices to the RS485 port on the CPU ( 2 W multi-drop). | See the RS485 Connection Box chapter. |
| RTU to PC RS232 cable | Enables connection of the RTU to a PC via the RS232 port. | For use of the ACE3600 Software Tools Suite (STS) to perform operations such as RTU configuration, system/application, download, monitoring, etc. See the ACE3600 STS User Guide. |


| Component | Function | Notes |
| :--- | :--- | :--- |
| RTU to PC Ethernet cable | Enables connection of the <br> RTU to a PC via the Ethernet <br> port. | For use of the ACE3600 <br> Software Tools Suite (STS) <br> to perform operations such <br> as RTU configuration, <br> system/application, <br> download, monitoring, etc. <br> See the ACE3600 STS User <br> Guide. |
| Ethernet cable | Enables the following <br> connections: <br> 1. CPU to LAN switch <br> 2. LAN switch to expansion <br> frame <br> 3. LAN switch to LAN <br> switch | See Expansion Module <br> chapter. |
| Ethernet cross cable | Enables the following <br> connections: <br> 1. A single I/O expansion <br> frame directly to the RTU <br> main frame. <br> 2. PC (STS) directly to one of <br> the CPU Ethernet ports. | See Expansion Module <br> chapter. |

## Model Options and Accessories

F7500 - ACE3600 System Tools Suite Software
F7600 - ACE3600 'C' Toolkit Software
The full list of ACE3600 options and accessories are listed in the ACE3600 System Planner.

## Product Safety and RF Exposure

Before using an ACE3600 RTU model with a radio installed, read the operating instructions and RF exposure booklet for the specific radio contained in the product.

## INSTALLATION

## General

The ACE3600 RTU is shipped from the factory with the modules and plug-in ports assembled. The RTU frame is ready for mounting directly on a wall or in a customer's enclosure. The eight I/O frame can be installed on a 19 " rack.

Modules can be added to the slots in a frame before or after mounting the RTU on a wall/enclosure.


## WARNING

Installation of the ACE3600 should be done only by authorized and qualified service personnel in accordance with the US National Electrical Code. Only UL Listed parts and components will be used for installation. Use UL Listed devices having an environmental rating equal to or better than the enclosure rating to close all unfilled openings.

If the installation involves high-voltage connections, technicians must be specifically qualified to handle high voltage.

If the I/O connections are powered by a hazardous voltage (>60VDC or >42Vpeak), all inputs should be defined as hazardous and the unit must be installed in a restricted access area for service personnel only.

If the I/O connections are powered by a safety extra low voltage (SELV) (<60VDC or <42Vpeak), all inputs should be defined SELV.

## INSTALLATION CODES

This device must be installed according to the latest version of the country's national electrical codes. For North America, equipment must be installed in accordance to the applicable requirements in the US National Electrical Code and the Canadian Electrical Code.

## INTERCONNECTION OF UNITS

Cables for connecting RS232 and Ethernet Interfaces to the unit must be UL-certified type DP-1 or DP-2. (Note- when residing in a non LPS circuit.)

## OVERCURRENT PROTECTION

A readily accessible Listed branch circuit overcurrent protective device rated 20 A must be incorporated in the building wiring.

CAUTION

External wiring which connects an I/O module to instruments/devices may not exceed 42.67 m (140 feet).
If the ACE3600 is subject to high levels of shock or vibration, you must take suitable measures to reduce the acceleration or amplitude. We recommend that you install the ACE3600 on vibration-damping materials (for example, rubber-metal anti-vibration mountings).

METAL PARTS OF THE POWER SUPPLY MAY BE VERY HOT.
After removing the power supply module, allow the metal parts to cool down before servicing the unit.


## NOTE

A TORX screwdriver is required for installation.

## Mounting the ACE3600 Frame on a Wall



## WARNING

Before drilling holes for mounting the frame, make sure there are no electrical wires installed inside the wall at the holes' location.

Four holes are provided, one in each corner of the RTU frame, for wall mounting the RTU. Figure 2-1, Figure 2-2, and Figure 2-3 show the dimensions of the various frames/metal chassis and the distances between the holes. For convenient installation of the ACE3600 RTU on a wall, allow an additional $6 \mathrm{~cm}\left(2.4^{\prime \prime}\right)$ (in W, H) and $7 \mathrm{~cm}\left(2.75^{\prime \prime}\right)$ (in D) around the plate.



Figure 2-2 No I/O, 2 I/O, and 3 I/O Frame Installation Dimensions and Screw Holes for Installation


5 I/O Frame


7 I/O Large Frame

Figure 2-3 5 I/O and 7 I/O Frame Installation Dimensions and Screw Holes for Installation

The following screw mount installation procedure should be used to install all ACE3600 frames (with or without a metal chassis) on a wall, except the 8 I/O (19") frame. For the 8 I/O frame, see Installing the ACE3600 in a 19 " Rack and Mounting the ACE3600 8 I/O Frame on a Wall below.

## Procedure 2-1 How to Mount the RTU Frame on a Wall

1) Drill four holes in the wall at the horizontal and vertical distances shown in Figure 2-1, Figure 2-2, and Figure 2-3.
2) Insert M4 screws (not supplied) with head size DIN $7981 \mathrm{C} /$ ST4, $2 \times 38 \mathrm{~mm}$ into the holes.
3) Remove the modules from the frame.
4) Lift the RTU frame and hang over the four screws.
5) Remove the outermost modules in order to access the screws.
6) Tighten all four screws with a screwdriver to secure the frame firmly against the wall.
7) Replace the removed modules in their slots.

## Installing the ACE3600 in a 19" Rack

The following screw mount installation procedure should be used to install the ACE3600 8 I/O (19") frame / 19" frame metal back in a 19 " rack unit.

Note: The brackets for 19 " rack installation are not provided with the RTU and should be ordered separately.

Procedure 2-2 How to Mount the RTU in a 19" Rack Unit

1) Using three M4 screws supplied with kit FHN7420A, attach the metal bracket ( $\mathrm{p} / \mathrm{n}$ 07013005001 from kit FHN7420A) to the side of the 19" frame metal back, according to the desired depth of the unit on the rack. Repeat with the second bracket on the other side of the 19" frame metal back. See Figure 2-4.


Figure 2-4 Attaching Brackets to 19" Frame - Exploded View
2) Screw one M5 screw (not supplied) into the upright of the 19" rack unit, to correspond to the top keyhole on the metal bracket. Repeat on the opposite upright. See Figure 2-5.


Figure 2-5 Screws for Hanging 19" Frame in Rack Unit - Exploded View
3) Align the keyholes on the brackets with the two screws on the rack metal uprights, and hang the frame on the rack metal uprights. See Figure 2-6. Tighten the two screws to the uprights.
4) To reinforce the installation, add three more M5 screws (not supplied), through the remaining three holes on the metal bracket, into the upright of the 19 " rack unit. Repeat on the opposite upright. See Figure 2-6.


Figure 2-6 Installation of ACE3600 RTU 19" Frame in Rack Unit - Exploded View

## Installing the ACE3600 in a 19" Rack (for RTUs Ordered before October 2010)

The following screw mount installation procedure should be used to install the ACE3600 8 I/O (19") frame in a $19^{\prime \prime}$ rack, for RTUs ordered before October 2010.

Note: The brackets for 19 " rack installation are not provided with the RTU and should be ordered separately.

Procedure 2-3 How to Mount the RTU in a 19" Rack Unit

1) Press the small metal bracket into the slot of the larger bracket. See Figure 2-7.
2) Secure the two brackets together with two M5 screws (supplied), according to the desired depth of the unit on the rack. See Figure 2-7.
3) Repeat steps 1-2 for the other pair of brackets.
4) Using the supplied two screws, attach the combined brackets to the metal upright of a 19" rack unit. See Figure 2-7. Repeat on other side.


Figure 2-7 Installation of Brackets for 19" Rack Units
5) Hang the 19 " metal chassis on the brackets, so that the two teeth on the back of the metal chassis hook onto the groove of the larger bracket. See Figure 2-8.


Figure 2-8 Installation of ACE3600 RTU 19" Rack- Exploded View
6) From the standard rack unit, remove the two modules from the leftmost slots and the two modules from the rightmost slots. For the 19" accessories metal chassis, no accessories need to be removed. (See Figure 2-9.)
7) Using two supplied M5 (X6) screws and a 16 cm (6.3") long screwdriver, from inside the slot secure the 19 " metal chassis to the small bracket. Repeat on the second side. See Figure 2-8.
8) Replace any removed modules to their slots.


Figure 2-9 Installation of ACE3600 RTU 19" Rack Accessories - General View

## Mounting the ACE3600 8 I/O Frame on a Wall


*Additional screws for extra fortification
Figure 2-10 8 I/O Frame (19") Metal Back Installation Dimensions
The following screw mount installation procedure should be used to install the ACE3600 8 I/O (19") frame on the wall.

Note: The brackets for 19 " wall mount installation are not provided with the RTU and should be ordered separately.

## Procedure 2-4 How to Mount the RTU 19" Metal Frame Back on a Wall

1) Remove the CPU, Power Supply and I/O modules from the RTU frame.
2) Drill four holes into the wall at the horizontal and vertical distances shown in Figure 2-10. (If you choose to further secure the 19 " frame, drill four additional four holes, at the distances shown in Figure 2-10.)
3) Using two M5 screws (not supplied), secure the rectangular wall mounting bracket (07013022001 from kit FHN7419A) to the wall, as shown in Figure 2-11. Repeat for the second bracket.


Figure 2-11 19" Frame Metal Back Bracket Installation
4) Fit the metal frame in between the two brackets, lining up the holes on the sides. (See Figure 2-12.)
5) Using three supplied M4 screws, secure the left bracket to the left side of the frame. (See Figure 2-12.) Using three more screws, secure the right bracket to the right side of the frame.
6) If you choose to further secure the 19" frame, screw two additional M5 screws (not supplied) into the two middle holes on the left bracket, as shown in Figure 2-12. Repeat for the right bracket.


Figure 2-12 19" Frame Metal Back Installation

## Mounting the ACE3600 8 I/O Frame on a Wall (for RTUs Ordered before October 2010)



Figure 2-13 RTU Metal Chassis Installation Dimensions
Procedure 2-5 How to Mount the RTU 19" Metal Chassis on a Wall
The following installation procedure should be used to install the 8 I/O (19") frame on a wall, using the special wall mount brackets provided with the RTU.

1) Remove the CPU, Power Supply and I/O modules from the RTU frame.
2) Drill four holes into the wall at the horizontal and vertical distances shown in Figure 2-13.
3) Using two supplied screws, secure the rectangular wall mounting bracket to the wall. Repeat for the second bracket.
4) Hang the metal chassis on brackets so that the two teeth of the metal chassis hook onto the groove of the brackets. (See Figure 2-14.)
5) Using two M4 screws (not supplied) with head size DIN 7981C/ST4, 2x38mm screws, secure the top and bottom of the frame to the left bracket. Repeat for the right bracket.


Figure 2-14 RTU Metal Chassis Installation

## Mounting the ACE3600 NEMA 4 Housing on a Wall

The following screw mount installation procedure should be used to install ACE3600 frames in NEMA 4 housing on a wall.

For convenient installation of the ACE3600 RTU with the NEMA 4 housing, allow an additional $6 \mathrm{~cm}\left(2.4^{\prime \prime}\right)$ (in W, H) and 7 cm (2.75") (in D) around the housing.

Four mounting brackets are provided, one in each corner of the RTU, for wall mounting the RTU housing (see Figure 2-15 through Figure 2-17). Figure 2-15 and Figure 2-16 show the distances between the bracket holes.


Figure 2-16 Small NEMA 4 Housing - Installation Dimensions

Procedure 2-6 How to Mount the RTU NEMA 4 Housing

1) Drill four holes in the wall at the horizontal and vertical distances shown in Figure 2-15 (for the large housing) and in Figure 2-16 (for the small housing.)
2) Using the brackets and the screws supplied in the plastic bag, fasten the mounting brackets, either horizontally or vertically, onto the four back corners of the housing. See Figure 217.
3) Mount the RTU onto the wall and secure with M4 screws (not supplied) with head size DIN 7981C/ST4, 2x38mm through the bracket hole. See Figure 2-17.


Figure 2-17 Mounting the NEMA 4 Housing

## Connecting Power and Ground

All internal electrical connections except for the main power, ground and battery are performed in the factory and supplied with the RTU. The electrical interconnection diagrams are provided in the Break-Fix Procedures chapter.

The procedures for the main power, ground and battery connections are provided below.


## WARNING

The power and ground connections should be performed only by qualified and authorized service personnel. All power and ground connections must be in accordance with local standards and laws.

Per UL 60950 / EN 60950, install an external circuit breaker rated at 6 A between the power source and the ACE3600 Power supply.

Per UL 60950 / EN 60950, for all I/O modules connections, the maximum voltage should not exceed 60V DC or 30 V AC unless it is specifically written otherwise.

To maintain Overvoltage (Installation) Category II, install a suitable surge suppressor device in the branch circuit to limit expected transients to Overvoltage Category II values. The limits are based on IEC60664 and are also located in Table 2H of UL60950 (for mains $=150 \mathrm{~V}$, the transient rating is 1500 V ; for 150 V < mains $=300 \mathrm{~V}$, the transient rating is 2500 V ; and for 300 V < mains $=600 \mathrm{~V}$, the transient rating is 4000 V ).


## NOTE

Make sure that the ground wire on the user cable is long enough to reach the grounding strip.

## Connecting AC/DC Main Power

The power connection to all the ACE3600 power supply types is via the power junction box located on the frame beneath the power supply slot.

## IMPORTANT

Safety standards require that the power cable be attached to the unit at two anchor points:

- Anchor point 1 for all units is inside the power junction box. (See Figure 2-18 below.)
- Anchor point 2 for the basic model (No I/O Slots Frame) is located on the right of the power junction box. (See Figure 2-18 below.)
Anchor point 2 for all units with housing (other than No I/O Slots) is in the housing power cable gland. (See Figure 2-22 below.)
Anchor point 2 for all other units without housing (other than No I/O Slots) is near the unit's ground strip. (See Figure 2-19 below.)


Figure 2-18 RTU on No I/O Frame - Cable Anchor Points 1 and 2


Figure 2-19 RTU on Metal Chassis - Cable Anchor Point 2

Procedure 2-7 How to Connect the RTU to Main Power Source (Units with Frames and Metal Chassis)

1) Using a screwdriver, open the power junction box cover (save the screws) and unscrew the power terminals screws inside the power junction box.
2) Thread the user's main power cable through the two supplied clamps.
3) Attach the wires of the user cable, according to the labels ( $\sim / 0$ for AC and $+/$ - for DC.) For the No I/O Frame, connect the ground cable to the lower wire terminals (third pair). See Figure 2-20 and Figure 2-21.


Figure 2-20 RTU Power and Ground Connections - No I/O Frame Installation


Figure 2-21 RTU Power and Ground Connections - All Other Installations
4) Pass the power cable to the right of the wire terminals inside the junction box, over the horizontal ridge.
5) Close the first clamp around the user cable and screw it onto the junction box, into the hole next to wire terminals (anchor point \#1).
6) Close the second clamp and screw it onto the anchor point near the grounding strip (or on the bottom of the plastic to the right of the junction box in case of the No I/O Slots frame.)
7) Replace the junction box cover over the junction box.
8) Secure the junction box cover with two saved screws.
9) For all installations except the No I/O frame, loosen the two screws on the grounding strip at the bottom of the metal chassis/housing and connect the ground cable to the protective ground. Tighten the screws firmly.
10) Open the door of the power supply module and press in the cable holder downwards.

11) Plug the connector of the power supply cable (FKN8381A/3089004V64 for DC, FKN8382A/3089004V65 for AC) into the cable inlet on the power supply module (on the bottom of the front panel.) and rotate the cable holder upwards to secure.

Procedure 2-8 How to Connect the RTU to Main Power Source (Units with Housing)

1) Using a screwdriver, open the power junction box cover (save the screws) and unscrew the power terminals screws inside the power junction box.
2) Insert the rubber grommet (supplied) into the threaded plastic cable gland, and place it into the hole on the bottom of the housing (from the outside.) (See Figure 2-22.)
3) Place the nut into the same hole from inside the housing and screw the nut onto the cable gland. (See Figure 2-22.)
4) Thread the user's main power cable ( $110 / 220 \mathrm{VAC}$ or $24-48 \mathrm{VDC}$ ) through the cable gland cover from below, through the cable gland, and into the housing. (See Figure 2-22.)


Figure 2-22 RTU in NEMA 4 Housing - Cable Gland Anchor Point 2
5) Attach the wires of the user cable, according to labels ( $\sim / 0$ for AC and $+/-$ for DC.) See Figure 2-20 and Figure 2-21. For the No I/O frame, connect the ground cable to the lower wire terminals (third pair).
6) Tighten the screws of the wire terminals and screw the wire terminals onto the junction box.
7) Pass the power cable into the right side of the junction box, over the horizontal ridge.
8) Place the user cable into the clamp, close the clamp and screw it onto the junction box, into the hole next to wire terminals (anchor point \#1).
9) Replace the junction box cover over the junction box.
10) Secure the junction box cover with the two saved screws.
11) For all installations except the No I/O frame, loosen two screws on the grounding strip at the bottom of the metal chassis/housing and connect the ground cable to the protective ground. Tighten the screws firmly.
12) Screw the top of the cable gland tightly to the cable gland to secure the cable (anchor point \#2).
13) Open the door of the power supply module and release the cable holder (press downward).
14) Plug the connector of the power supply cable (FKN8381A/3089004V64 for DC, FKN8382A/3089004V65 for AC) into the cable inlet on the power supply module (on the bottom of the front panel.) and close the cable holder.

## Connecting the Expansion Power Supply to the Main Frame Power Supply

When an I/O Expansion frame with an I/O Expansion power supply is added to the RTU, connect the power as follows:

Procedure 2-9 How to Connect the Expansion Power Supply to the Main Frame Power Supply

1) Using a DC power cable (FKN8559A/\#3002360C26), connect the Rack Exp connector from the power supply on the main frame to the Power In connector on the Expansion power supply.
2) If the RTU includes more than one Expansion frame, use a DC power cable (FKN8559A/\#3002360C26), to connect the Expansion Power Out connector on the preceding Expansion power supply to the Power In connector on the next Expansion power supply.

IMPORTANT

Before connecting I/O Expansion frames to the main frame, make sure that the power supplies in question meet the power requirements of the RTU. For information, see the ACE3600 System Planner.

## Connecting the Backup Battery

The backup battery of ACE3600 is shipped from factory disconnected. Use this procedure to connect the battery cable to the power supply charger.


Before using the Lead Acid backup battery, it is strongly recommended to read the information on the battery provided in the Power Supply Module and Backup Battery chapter.

Lead acid batteries will self-discharge if they are stored without charging. Selfdischarge below the manufacturer's recommended voltage will result in internal permanent damage to the battery rendering it inoperable. When this occurs, if connected to a power supply/charger, the battery may produce excessive internal heat and therefore deform and/or leak.

## WARNING

A battery contains diluted sulfuric acid, a toxic and corrosive substance. Avoid any bodily contact with the leaking liquid when handling leaking batteries and affected parts. If the battery leaks and the liquid inside touch the skin or clothing, immediately wash it off with plenty of clean water. If the liquid splashes into eyes, immediately flush the eyes with plenty of clean water and consult a doctor. Sulfuric acid in the eyes may cause loss of eyesight and acid on the skin will cause burns.

Procedure 2-10 How to Connect the Backup Battery

1) Check the battery visually. If the battery looks deformed and / or you notice corrosion on the battery terminals and / or the battery leaks, DO NOT use the battery and replace it with a new battery.
2) Check the battery terminal voltage level before connecting it. If the battery voltage is less than 12.5 V DC, DO NOT use the battery and replace it with a charged battery that measures at least 12.5 V DC.
3) If the battery passes a visual inspection and the terminal voltage is correct, plug the battery cable (FKN8376A/\#3089927V10) into the Battery In/Out connector on the power supply module.
4) Fully charge the battery prior to initial use ( $\sim 10$ hours).

## Connecting I/O Modules to Ground

Before operating the I/Os in the ACE3600, the I/O modules must be connected to ground.
Procedure 2-11 How to Connect an I/O Module to Ground

1) Identify the PGND pin(s) on the I/O module using the Module Block Diagram or

Connection Charts in the relevant chapter for the I/O module type. See the symbol next to the Protective Ground in the Module Block Diagrams.
2) If user-supplied cables are used, connect the ground wire(s) to the PGND pin(s) on the I/O module and to the grounding strip at the bottom of the RTU. (See grounding strip in Figure 2-19 above.)
3) If the wired cable braid is used, identify the ground wire(s) based on the pin number printed on the wire label.
Connect the ground wire(s) from the cable braid to the PGND pin(s) on the I/O module and to the grounding strip at the bottom of the RTU. (See grounding strip in Figure 2-19 above.)
4) Repeat steps 1-3 for the PGND wires on all I/O modules.

## Connecting an RTU to Ground

When an RTU is installed, individual ground wires (from the power cable and from the PGND pin on the I/O module cables) are connected to the grounding strip on the chassis. The grounding strip must then be connected to the grounding point of the cabinet or 19 " rack.

In an RTU with I/O expansion, the grounding strip of each frame must be connected to the grounding point of the cabinet or 19 " rack. Figure 2-23 below depicts the ground connections of an RTU with a single expansion frame and Figure 2-24 depicts the ground connections of an RTU with multiple expansion frames.


Figure 2-23 Ground Connections of an RTU with a Single Expansion Frame


Figure 2-24 Ground Connections of an RTU with Multiple Expansion Frames

## Connecting the Radio

A radio which is shipped in the ACE3600 is fully connected. To add a radio to the ACE3600, use the appropriate radio installation kit. For information on radio types, radio installation kits and connections, see the Radio Types and Installation Kits chapter.

## Opening/Closing the Housing Door

The door to the small ACE3600 NEMA 4 housing is equipped with a latch or with an optional padlock accessory. See Figure 2-25. The door to the large ACE3600 NEMA 4 housing is equipped with two door latches or with an optional padlock accessory plus a latch. See Figure 2-26.

Procedure 2-12 How to Open and Close the Housing Door

1) To open a small RTU housing equipped with a door latch, turn the latch clockwise. The door will open.
To open a small RTU housing equipped with the padlock accessory, remove the usersupplied padlock (if one exists) and turn the padlock accessory clockwise. The door will open.
To open a large RTU housing equipped with two door latches, turn both latches clockwise.
The door will open.
To open a large RTU housing equipped with the padlock accessory and a latch, remove the user-supplied padlock (if one exists) and turn the padlock accessory and latch clockwise. The door will open.
2) To close a small RTU housing equipped with a door latch, turn the latch counterclockwise and push the door closed until the latch clicks.
To close a small RTU housing equipped with the padlock accessory, turn the padlock accessory counterclockwise and push the door closed until the latch clicks. Add the usersupplied padlock (if one exists) to lock the door.
To close a large RTU housing equipped with two door latches, turn both latches counterclockwise and push the door closed until the latch clicks.
To close a large RTU housing equipped with the padlock accessory and a latch, turn the padlock accessory and latch counterclockwise and push the door closed until the latch clicks. Add the user-supplied padlock (if one exists) to the padlock accessory to lock the door.


Figure 2-25 Small ACE3600 NEMA 4 Housing/Housing with Padlock


Figure 2-26 Large ACE3600 NEMA 4 Housing/Housing with Padlock

## Installing Plastic Box Interfaces

Cards such as RS485 interface card can be attached to the ACE3600 RTU using a plastic box. The plastic box can be attached to the 19 " accessories metal chassis, small/large metal chassis, or small/large NEMA housing.

Procedure 2-13 How to Install the Plastic Box Interface on the Metal Chassis

1) To connect the plastic box interface to the metal chassis, place the box on the metal plate and click the two pegs on the back of the plastic box into the desired holes on the metal chassis. See Figure 2-27.
Note: This figure is for illustration purposes only. It is not relevant to install all the accessories below on the same metal chassis.

## Portable Radio



Figure 2-27 Accessories Installed on a Metal Chassis
2) To remove the plastic box interface from the metal chassis, insert a screwdriver into the notch located in the snap securing the unit to the chassis. Slightly bend the snap outwards to release it from the slot, and carefully pull out the unit.

## 19" Metal Chassis Installation Combinations

The 19 " metal chassis can be ordered with a variety of frames, modules, and accessories (e.g. battery, radio, plastic box.) In certain cases, choosing a certain accessory reduces the other options. For example, the portable radio is installed on the 19 " metal chassis with the No I/O Frame in place of one plastic box. Likewise a battery is installed on the $19^{\prime \prime}$ metal chassis with the No I/O Frame in place of one plastic box.

For diagrams of the various combinations, see Figure 2-28 below.


Figure 2-28 19" Metal Chassis Installation Combinations

## POWER SUPPLY MODULE AND BACKUP BATTERY

## General Description/Module Overview

The ACE3600 power supply module provides the other modules in the RTU with their operating voltages via the motherboard bus.

The following power supply options are available:

- DC power supply low-tier (10.8-16V)
- DC power supply (10.8-16V) - provided by default with the ACE3600 RTU
- DC power supply (18-72V)
- DC power supply (18-72V) with battery charger
- AC power supply- $100-240 \mathrm{~V}$
- AC power supply- $100-240 \mathrm{~V}$ with battery charger

Common characteristics of all power supply modules (not including the DC power supply lowtier):

- On/Off switch on the front panel
- Controlled auxiliary voltage outputs
- Heat convection cooling (no need for fans)
- Short protection outputs
- Over heating protection
- Status LEDs in the front panel
- PS located on the leftmost slot of the frame
- Input current protection fuse
- Controlled power line enables centralized disabling of Electrically Energized relay outputs in selectable DO modules.

Note: The DC power supply low-tier does not support radios that require input power other than $10.8-16 \mathrm{~V}$. Do not use portable radios which require 7.5 V input with this option.

Note: The low limit of the DC power supply $(10.8-16 \mathrm{~V})$ can be configured to 10.5 V . The default is 10.8 .

Common characteristics of power supply modules with battery charger:

- Automatic switchover to battery on power fail
- Automatic switchover to main power on power return
- Temperature compensated charging
- Over-charging protection
- Over-discharge protection
- Battery test and diagnostics, including battery controlled discharge

Characteristics of the DC power supply low-tier:

- Two auxiliary voltage outputs
- Short circuit protection outputs
- PS located on the leftmost slot of the frame
- Overvoltage protection for CPU and I/Os
- Reverse voltage protection

Figure 3-1 below depicts a general view of the power supply.


Power Supply


DC Power Supply Low-Tier

Figure 3-1 ACE3600 Power Supply - General View

Note: An additional power supply module for use with I/O expansion frames is described in the Expansion Power Supply Module chapter below.


## CAUTION

METAL PARTS OF THE POWER SUPPLY MAY BE VERY HOT. After removing the power supply module, allow the metal parts to cool down before servicing the unit.

Figure 3-2 below depicts a detailed view of the power supply front panel.


## ON/OFF Switch

The front panel of the power supply module includes an ON/OFF switch for the module. In the OFF (down) position, all the power outputs except Battery In/Out are disabled. A mechanism is provided to prevent accidentally changing the switch position.

## NOTE

In power supply modules equipped with a battery charger, if the ON/OFF switch is in the OFF position, and the RTU main power is connected, the Battery In/Out is not disabled to ensure battery charging.

## Input/Output Connectors

The front panel of the power supply module (not including DC power supply low-tier) includes the following connectors.

| Connector Name | Description | Notes |
| :--- | :--- | :--- |
| Auxiliary Output 1A | 13.8 V DC ( $\pm 5 \%$ ) @ 20 ${ }^{\circ} \mathrm{C}$ <br> User controlled power <br> output. <br> Short protected. | This output is used for powering radios, <br> modems, etc. <br> The output can be switched ON/OFF <br> either by the user application program <br> or using the STS hardware test. <br> (Default = ON) <br> For more information, see the <br> Performing Hardware Tests section or <br> Application Programmer section of <br> ACE3600 STS User Guide. |
| Auxiliary Output 1B | Same as Auxiliary Output <br> 1 A | Same as Auxiliary Output 1A |
| Caution: Auxiliary Output 1A and 1B are ON by default with 13.8V DC. Do NOT plug in a <br> radio which requires less voltage or the radio may be damaged. |  |  |
| Auxiliary Output 2A | DC Power Output <br> Selectable/programmable <br> 3.3 to 9V DC or <br> 13.8V DC ( $\pm 5 \%$ ) @ 20 ${ }^{\circ} \mathrm{C}$. <br> User controlled power <br> output. <br> Short protected. | This output is used for powering radios, <br> modems, etc. <br> The output voltage can be set by the <br> user using the STS site configuration. <br> The output can be switched ON/OFF <br> either using the STS hardware test or by <br> the user application program. (Default $=$ <br> OFF) <br> If both 2A and 2B are ON, they must <br> have the same output level. The voltage <br> levels of AUX2A and AUX2B are the <br> same. |
| Auxiliary Output 2B | Same as Auxiliary Output <br> 2A | Note: Auxiliary Output 2B can be ON <br> independently of 2A. <br> The voltage levels of AUX2A and <br> AUX2B are the same. |

$\left.\begin{array}{|l|l|l|}\hline \text { Connector Name } & \text { Description } & \text { Notes } \\ \hline \begin{array}{l}\text { Caution: If both 2A and 2B are ON, they must have the same output level. If cables are } \\ \text { connected to Auxiliary Output 2A and 2B, they must use the same voltage. }\end{array} \\ \hline \text { 12V DO Control } & \begin{array}{l}\text { Control input that enables } \\ \text { centralized disabling of } \\ \text { Electrically Energized (EE) } \\ \text { relay outputs in selectable } \\ \text { DO modules. }\end{array} & \begin{array}{l}\text { This input controls a dedicated 12V } \\ \text { power line that is available to all the } \\ \text { slots in the frame. In each relay DO } \\ \text { module, the user can mechanically } \\ \text { select to power the relay coils from this } \\ \text { dedicated 12V power line. }\end{array} \\ & \begin{array}{l}\text { Input open = Relays are } \\ \text { disabled. (ML relays do not } \\ \text { change state) } \\ \text { Input shorted = Relays are } \\ \text { enabled. }\end{array} & \begin{array}{l}\text { For details on setting this control, see } \\ \text { the Module Configuration section of the } \\ \text { DO Relay Module chapter. }\end{array} \\ & \begin{array}{l}\text { The power supplies on I/O expansion } \\ \text { frames can be attached via DC cable to } \\ \text { the power supply on the previous I/O }\end{array} \\ \text { expansion frame in a daisy-chain } \\ \text { manner, or directly to the main power } \\ \text { supply. In this case, the 12V DO } \\ \text { control on the main power supply can } \\ \text { control all DO EE relays in the entire } \\ \text { RTU that were configured by dip switch } \\ \text { for 12V DO. This enables the user to }\end{array}\right\}$

| Connector Name | Description | Notes |
| :--- | :--- | :--- |
| 12V Out | In systems with I/O <br> expansion, provides 12V <br> output to expansion power <br> supplies on expansion <br> frames. | Pin 1- PGND <br> Pin 2- 12V DO <br> Pin 3- GND <br> Pin 4- MAIN (12V) |

The front panel of the DC power supply low-tier includes the following connectors.

| Connector Name | Description | Notes |
| :--- | :--- | :--- |
| Auxiliary Output 1A | Vin=Vout <br> Shorted to Power IN. | This output is used for powering radios, <br> modems, etc. |


| Connector Name | Description | Notes |
| :--- | :--- | :--- |
| Auxiliary Output 1B | Vin=Vout <br> Shorted to Power IN. | This output is used for powering radios, <br> modems, etc. |
| 10.8-16V DC Main <br> Power Input | Cable inlet for main power <br> cable (DC) | The cable is part of the RTU frame <br> (connected to the power junction box. <br> Note: When the cable male connected is <br> place in this input, it locks the power <br> supply module in its slot. To remove <br> the power supply module, first unplug <br> the power input cable. |

## LEDs

The front panel of the power supply module (not including the DC power supply low-tier) includes five indication LEDs.

| LED Name | Description | Status |
| :--- | :--- | :--- |
| PWR | Power LED | Indicates the existence of AC or DC main power in <br> the Main Power input. <br> When the ON/OFF switch is in ON position - the <br> LED is lit in Green. <br> When the ON/OFF switch is in OFF position, but <br> there is AC or DC input or battery- <br> the LED is lit in Red. <br> When the ON/OFF switch is in ON position and the <br> unit is powered from the battery - <br> the LED is lit in Orange. <br> When there is no AC or DC input or battery <br> connected - the LED is OFF. |
| AUX1 | Auxiliary Output 1 <br> LED | AUX1A is ON - Green <br> AUX1B is ON - Red <br> AUX1A and AUX1B are ON - Orange |
| AUX2 | Auxiliary Output 2 <br> LED | AUX2A is ON - Green <br> AUX2B is ON - Red <br> AUX2A and AUX2B are ON - Orange |
| DO | Digital Output Control <br> LED | Relays enabled - LED ON - Green <br> Relays disabled - LED OFF |


| LED Name | Description | Status |
| :--- | :--- | :--- |
| BATT | Battery LED | No battery/thermistor - LED OFF <br> Battery is fully charged (charging current $<20 \mathrm{~mA}$ ) - <br> LED ON - Green <br> Battery is being charged (charging current $>20 \mathrm{~mA}$ <br> and <600mA)- LED ON - Green/Yellow Blinking <br> Battery is being charged (charging current $>600 \mathrm{~mA}$ )- <br> LED ON - Yellow <br> Battery is discharging (battery voltage is higher than <br> voltage of power supply) - LED ON - Red. <br>  |
|  |  | Battery charging current is stabilizing - LED ON - <br> Yellow Blinking. <br> When battery capacity test is being performed - the <br> LED is lit in Green Blinking. |
|  |  | Battery tests are performed using the STS Hardware <br> Test function or the user application program. |

## Battery Charger

Power supply modules with a battery option support a 6.5 or 10 Ah Lead-Acid battery. The power supply automatically switches to the backup battery as a 12 V DC power source for the RTU and communications when the main AC or DC power source fails.

Power supply modules with a 12 VDC smart battery charger option charge the backup battery when not in use, and protect the battery from over-discharge. The charger performs battery tests/diagnostics, including controlled battery discharge, when requested by the user. If the battery is failed, the charger will not charge it and will send a failed status signal to the CPU. If the battery is remotely located, long battery cables can be used.

The DC power supply low-tier does not include a battery option.

## Charging the Battery

The charging voltage of the Lead-Acid battery is controlled by the charger as a function of the battery temperature. The charging profile is set to comply with the temperature-compensated float-voltage of the ACE3600 battery.

## Diagnostics

A battery test can be performed on the Lead-Acid battery, either from the ACE3600 STS Hardware Test utility or from the user application program. The battery test includes disabling the battery charger, discharging the battery and measuring the capacitance. For more information, see the Hardware Test section or the Creating a User Application section of the ACE3600 STS User Guide.


## NOTE

It is recommended to run a battery capacity test once per month (for more exact results perform at $+10^{\circ}$ to $+30^{\circ} \mathrm{C}$ ), and a charge level test once per day. The capacity test lowers the main DC to a safety net level $(\sim 12 \mathrm{~V})$ so that the battery will be activated. The battery is heavily loaded for $\sim 45$ seconds, the power supply LED blinks green, and the battery capacity is measured. If the capacity is below the manufacturer recommended level, the battery should be replaced with a new one. (See Replacing the Backup Battery below.) Note that the capacity test is only available for the battery types supplied by Motorola.

The results of the battery capacity test can be:

- Battery OK
- Battery needs to be replaced
- Test blocked - bad environment

The battery capacity test will be blocked under the following conditions:

1. If the battery is discharging (battery is main power source of RTU),
2. If the battery or thermistor is disconnected,
3. If the battery temperature is outside the specified range,
4. If the battery type is not properly configured,
5. If the battery is not fully loaded.

For test accuracy, all heavy current consumers should be turned off. In the Hardware Test, the user should freeze the power supply before performing the battery capacity test.

## Connecting the Power Supply to a Power Source

The power supply can be connected to an AC or DC power source. The DC power supply lowtier can be connected to a DC power source only.

The expansion power supply module is connected to another ACE36000 power supply using a DC power cable (FKN8559A/\#3002360C26).

For instructions on connecting the power supply to a power source, see the Power and Ground Connections section of the Installation chapter above.

All power and ground connections must be in accordance with local standards and laws.

## Power Supply Module Specifications

The following charts detail the specifications of the various power supply modules. For specifications of the power supply module used with I/O expansion frames, see the Expansion Power Supply Module chapter below.

| 12V DC Power Supply Module (Default) |  |
| :---: | :---: |
| Input Voltage | DC $10.8-16 \mathrm{~V}$ <br> The low limit of the DC power supply (10.8-16V) can be configured to 10.5 V . The default is 10.8 . |
| Outputs | Motherboard connector (to CPU and I/O modules): equal to input voltage, max. 4 A <br> AUX1A/AUX1B: equal to input voltage, max. 8 A , on/off controlled by user program <br> AUX2A/AUX2B (configurable): equal to input voltage (default), max. 8A, or 3.3 (default), $5,7.5,9 \mathrm{~V} \mathrm{DC} \pm 10 \%$, max. 2.5 A , on/off (default) controlled by user program <br> Note: max. 8 A total current consumption from all outputs |
| No Load Power Consumption | Max. 50 mA |
| Diagnostic LEDs | Status LED for: input voltage, AUX1 and AUX2 outputs, 12V control for DO modules |
| Input Protection | Internal line fuse, replaceable |
| Output Protection | AUX2A/B short circuit, automatic recovery on 3.3, 5, 7.5, 9 V |
| Dimensions | 56 mm W x 225 mm H x 180 mm D (2.2" W x 8.7" H x 7.1" D) |
| Weight | Approx. $0.43 \mathrm{Kg}(0.95 \mathrm{Lb})$ |
| 12V DC Low-Tier Power Supply Module |  |
| Input voltage | 10.8-16 V DC |
| Outputs | Motherboard connector (to CPU and I/O modules): The same as input voltage / max. 4 A <br> AUX1A/AUX1B: equal to input voltage max. 8 A <br> Note: max. 8 A total current consumption from all outputs |
| Input Protection | Internal line fuse, replaceable |
| Dimensions | 56 mm W x 225 mm H x 180 mm D (2.2" W x 8.7" H x 7.1" D) |
| Weight | Approx. 0.43 Kg ( 0.95 Lb ) |

Specifications subject to change without notice.

| 18-72V DC Power Supply Modules |  |
| :---: | :---: |
| Input Voltage | 18-72 V DC |
| Total Power | 18-72 V DC Max. 60 W continuous; max. 105 W peak @ $25 \%$ duty cycle |
| Outputs | Motherboard connector (to CPU and I/O modules): 13.2 V DC $\pm 20 \%$, max. 4 A AUX1A/AUX1B: $13.2 \mathrm{~V} \mathrm{DC} \pm 20 \%$, max. 8 A , on/off controlled by user program <br> AUX2A/AUX2B (configurable): equal to AUX1A/AUX1B voltage, max. 8 A, or 3.3 (default), $5,7.5,9 \mathrm{~V} \mathrm{DC} \pm 10 \%$, max. 2.5 A , on/off (default) controlled by user program <br> Note: max. 8 A total current consumption from all outputs |
| Battery Charger | 12 V Lead Acid battery charger (in PS model with charger) <br> Automatic charging of 6.5 or 10 Ah backup battery, battery temperature sensing, overcharging protection, battery capacity test and diagnostics, automatic battery switch-over |
| Diagnostic LEDs | Status LED for: input voltage, AUX1 and AUX2 outputs, 12 V Control DO for DO modules, and battery |
| No Load Power Consumption | Max. 250 mA |
| Efficiency | 80\% typical, $76 \%$ with full load |
| Inrush Current | 10 A maximum, for 2 mSec . Max, cold start at $25^{\circ} \mathrm{C}$ |
| Protection | Internal line input fuse (replaceable), short circuit automatic recover |
| Output Protection | AUX2A/B short circuit, automatic recovery on 3.3, 5, 7.5, 9 V |
| Insulation | Input to case: 500 V DC, input to output 500 V DC |
| Dimensions | $\left.56 \mathrm{~mm} \mathrm{~W} \mathrm{x} 225 \mathrm{~mm} \mathrm{H} \mathrm{x} 180 \mathrm{~mm} \mathrm{D} \mathrm{(2.2"} \mathrm{~W} \mathrm{x} 8.7{ }^{\prime \prime} \mathrm{H} \times 7.1^{\prime \prime} \mathrm{D}\right)$ |
| Weight | Approx. 1 Kg ( 2.2 Lb ) |

Specifications subject to change without notice.

## AC Power Supply Module

| Input voltage | $100-240 \mathrm{~V} \mathrm{AC}, 50 / 60 \mathrm{~Hz}$ |
| :---: | :---: |
|  | 100-240 V AC, $50 / 60 \mathrm{~Hz}$ with 12 V smart battery charger |
| Total Power | Maximum 60 W continuous; maximum 105 W peak@ 25\% duty cycle |
| Outputs | Motherboard connector (to CPU and I/O modules): 13.2 V DC $\pm 20 \%$, max. 4 A AUX1A/AUX1B: 13.2 V DC $\pm 20 \%$, max. 8 A, on/off controlled by user program <br> AUX2A/AUX2B (configurable): equal to AUX1A/AUX1B voltage, max. 8 A, or 3.3 (default), $5,7.5,9 \mathrm{~V} \mathrm{DC} \pm 10 \%$, max. 2.5 A , on/off (default) controlled by user program <br> Note: max. 8 A total current consumption from all outputs |
| Battery Charger | 12 V Lead Acid battery charger (in PS with charger) <br> Automatic charging of 6.5 or 10 Ah backup battery, battery temperature sensing, overcharging protection, battery capacity test and diagnostics, automatic battery switch-over |
| Diagnostic LEDs | Status LED for: input voltage, AUX1 and AUX2 outputs, 12V Control for DO modules, and battery |
| No Load Power Consumption | 130 mA @ 220 V AC |
| Efficiency | 80\% typical @230 V AC, 76\% typical @ 115 V AC (full load) |
| Inrush Current | 25 A maximum, for 2 mSec . Max, cold start at $25^{\circ} \mathrm{C}$ |
| Power Factor | 0.98 typical at $230 \mathrm{~V} \mathrm{AC}, 0.99$ typical at 115 V AC |
| Protection | Internal line fuse, replaceable |
| Output Protection | AUX2A/B short circuit, automatic recovery on 3.3, 5, 7.5, 9 V |
| Insulation | Input to case: 1500 V AC , input to output: 3000 V AC |
| Dimensions | 56 mm W x 225 mm H x 180 mm D (2.2" W x 8.7" H x 7.1" D) |
| Weight | Approx. 1kg (2.2 lb) |

Specifications subject to change without notice.

## Backup Battery

## Overview

The ACE3600 backup 12V Lead-Acid battery provides backup for the main input power. The battery is available in two capacities: 6.5 Ah and 10 Ah . Switching from main input power to the battery and charging of the battery is performed by the ACE3600 power supply module.

Sealed Lead Acid technology batteries can be recharged and discharged at a temperature range of $-30^{\circ}$ to $+60^{\circ} \mathrm{C}$. Storage and operating temperatures affect the battery capacity and lifespan. ACE3600 power supply modules include a special charging power supply designed to fit the specific temperature-compensated float-voltage-charging curve of the battery.


## CAUTION

Lead Acid batteries will self-discharge if they are stored without charging. Selfdischarge below the manufacturer's recommended voltage will result in internal permanent damage to the battery rendering it inoperable. When this occurs, if connected to a power supply/charger, the battery may produce excessive internal heat and therefore deform and / or leak.

The batteries are shipped disconnected from the power supply/charger. To ensure that there are no battery problems on your ACE3600 project, each Lead Acid battery MUST be fully charged and checked before connecting it to the ACE3600 power supply/charger. To verify that the battery is fit for use, measure the BATTERY OPEN CIRCUIT voltage (when the battery is not connected to the power supply/charger) with a digital voltmeter. If the battery voltage is less than 12.5 V DC, DO NOT use the battery and replace it with a new ACE3600 battery that measures more than 12.5 V DC.

Before transporting the battery, read and follow all safety information located on the battery case.

## IMPORTANT

ACE3600 batteries are shipped from the factory tested, fully charged and with a label stating the next time it should be recharged when stored at temperatures of $30^{\circ} \mathrm{C}$ or less.

Motorola battery warranty is valid only when the battery is charged with the original Motorola ACE3600 charging power supplies. Use of any other power supply/charger will void the battery warranty.

Under various state or local laws, the batteries must be recycled or disposed of properly and cannot be disposed of in landfills or incinerators. Environmental protection regulations classify used Lead Acid batteries as hazardous waste, unless certain exemptions apply. Consideration should be given to the methods of collecting, labeling, handling and shipping used Lead Acid batteries. Please consult the environmental protection authority for specific legal requirements and for recycling options in your country/area.

## Backup Battery Storage, Lifespan, Inspection and Replacement

The manufacturer's recommendations for handling during each of the battery's life stages are:

- Transportation:

Batteries must be handled with care to prevent falls, impact, short circuit or exposure to high temperatures and fire.

- Battery Storage:

Storage of batteries in a warehouse requires a periodic recharge. The time between these recharge cycles depends upon the storage temperature. The minimum open circuit voltage allowed on the battery before recharging is 12.42 V , which represents remaining capacity of approximately $30 \%$. Therefore it is recommended to perform a full charging cycle every few months depending upon the storage temperature of the battery. Please refer to Table 3-1 to determine the suggested maximal period between recharge cycles that suits the actual storage conditions. Improper storage may cause deep discharge of the battery, which might cause degradation of the battery operating life and lower the actual delivered capacity. Motorola performs a periodic full charge cycle procedure on stored batteries and a final full charge operation prior to shipment.

- Lifespan:

The average temperature of the battery environment affects the lifespan of batteries installed in the field. Please refer to the battery vendor information at the following website:

- (Sonnenschein A512/6.5S and A512/10S): http://www.sonnenschein.org/A500.htm
- Inspection and Replacement:

It is important to inspect the batteries periodically (recommended every 6-12 month) and replace any battery that has corrosion on the leads or it is deformed or leaks. Such a battery should be disposed according to the local environmental laws. To assure the battery availability and proper operation, the battery should be replaced at the end of its lifespan (approximately $30 \%$ capacity) even if it is still functional. Measure the battery open circuit voltage using a digital voltmeter as described above. Please note that using a battery beyond its lifespan period may cause a battery heating, leakage and/or deformation.

Table 3-1: Recommended Time between Periodic Battery Recharge vs. Storage Temperature

| Average Storage <br> Temp ( ${ }^{\circ}$ C) | Recharge Interval <br> (Months) |
| :---: | :---: |
| 25 | 12 |
| 45 | 4 |
| 60 | 1 |

## Replacing the Backup Battery



## WARNING

A battery contains diluted sulfuric acid, a toxic and corrosive substance. Avoid any bodily contact with the leaking liquid when handling leaking batteries and affected parts. If the battery leaks and the liquid inside touch the skin or clothing, immediately wash it off with plenty of clean water. If the liquid splashes into eyes, immediately flush the eyes with plenty of clean water and consult a doctor. Sulfuric acid in the eyes may cause loss of eyesight and acid on the skin will cause burns.

## Procedure 3-1 How to Replace the Lead Acid Backup Battery

To replace the Lead-Acid backup battery, follow the procedure below.

1) Disconnect the battery cable from the Battery connector of the power supply (see Figure 3-2) and from the battery.
2) Unscrew the battery holders (two screws in the small battery and four screws in the large battery) with the attached battery temperature sensor. (See Figure 3-3 below.)


Figure 3-3 Backup Batteries - Exploded View
3) Remove the old battery from the RTU.
4) Check the replacement battery visually. If the battery looks deformed, if you notice corrosion on the battery terminals, or the battery leaks, DO NOT use the replacement battery; get another replacement battery.
5) Check the replacement battery terminal voltage level before connecting it. If the battery voltage is less than 12.42 V DC, DO NOT use the battery and replace it.
6) If the replacement battery passed the visual inspection and the terminal voltage is satisfactory, put the battery into place on the RTU and screw in the battery holders.
7) Connect the battery cable to the battery terminals in the correct polarity.
8) Connect the battery cable to the Battery In/Out connector on the front panel of the power supply module.
9) Recharge the replacement battery for 10 hours to be fully charged.

## CPU MODULE

## General Description

The main element of the ACE3600 is the CPU module. It controls the I/O modules, processes the gathered data and communicates with the outside world.

The core of the module is Freescale's MPC8270 32-bit microprocessor which has extended communication capabilities, high speed core, DMA and floating point calculation support. The module includes on-board memory, communication ports, I/O bus interface and other circuits. The firmware is based on Wind River's VxWorks operating system.

Module Location: The CPU is a removable module located in a dedicated slot in the RTU rack. The CPU module must be plugged into the wide slot to the right of the Power Supply module. (Inserting the module in the wrong slot will not cause any damage to the CPU.)

Figure 4-1 provides a general view of the ACE3600 CPU (Models 3610, 3640, and 3680).


The CPU panel includes status LEDs, user LEDs, communication port LEDs, two pushbuttons, and communication ports. The panel is covered by the module door.

Figure 4-2 provides a detailed view of the CPU front panel.


Figure 4-2 ACE3600 CPU (Models 3610/3640/3680) - Front Panel

## Front Panel

## Communication Ports

The CPU module includes several communication ports:
On Board ports:

- USB Host $1 / 2$ (HU1/HU2) - USB Type A host full speed ports for MDLC over IP communication via the MotoTrbo digital mode radio system (up to two radios attached to two USB host ports at one time) No USB devices or USB Hubs other than MotoTrbo radios are supported.
- Serial 1 (SI1) - RS232/RS485 serial port (configurable)
- Serial 2 (SI2) - RS232 serial port
- Ethernet (Eth1) - 10/100BaseT Ethernet port (CPU 3640 or 3680 only)
- DU1 - USB device port, Type B connector (future option)

Plug-in port bays, where different types of ports can be installed:

- Plug-in 1 (PI1) - fits RS232, RS485, 10 MB Ethernet, 10/100 MB Ethernet, or Radio Modem Plug-in option
- Plug-in 2 (PI2) - fits RS232, RS485, 10 MB Ethernet, or Radio Modem Plug-in port option.

For the detailed specifications of each port, see CPU 3610/CPU 3640 Module Specifications and CPU 3680 Module Specifications below. For information on the cables and connectors, see Appendix C.


The ACE3600 Ethernet port performs an Auto-Negotiation procedure whenever a peer device connection is detected at a $10 / 100 \mathrm{Mbps}$ Ethernet port.. The Auto-Negotiation procedure guarantees that the speeds of ACE3600 and peer Ethernet ports will match, whether or not the peer supports Auto-Negotiation. If the peer supports AutoNegotiation, the duplex of ACE3600 and the peer Ethernet ports also match.

It is recommended to configure the Ethernet port of the device connected to the ACE3600 Ethernet port (e.g. switch, etc.) to Auto-Negotiation mode. This will guarantee a full match of speed and duplex between the ACE3600 and the peer device Ethernet ports. If the peer device Ethernet port does not support Auto-Negotiation, set the duplex of the peer to half duplex to avoid the duplex mismatch problem.

|  | Peer Ethernet Port Mode |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Auto | 100 Mbs Full Duplex | 100 Mbs Half Duplex | 10 Mbs Full Duplex | 10 Mbs Half Duplex |
| Speed Match with ACE3600 | $\checkmark$ | $\checkmark$ | $\checkmark$ | $\checkmark$ | $\checkmark$ |
| Duplex Match with ACE3600 | $\checkmark$ | $\times$ | $\checkmark$ | $\times$ | $\checkmark$ |

## Buzzer

The CPU module includes a buzzer (audio indication), which is used to indicate task completion (such as end of download/upload, restart etc.) and can also be controlled from the user application program.

## Pushbuttons

The CPU includes two pushbuttons on the front panel, PB1 and PB2.
These pushbuttons are used for activating and testing the modules LED, restarting the unit, erasing the user Flash memory and activating memory test. Table 4-2 describes the pushbuttons functionality.

The pushbuttons can also be monitored by the user application program (when it is running) for the application purposes.

## LEDs

The CPU includes CPU status LEDs, port status LEDs, and user LEDs. Some of the LEDs are single color (green) and some are bicolor LEDs (red, green or orange).

Status LEDS indicate the CPU status in startup (boot), run-time or when there is a failure. The communication LEDs are used to indicate the communication port status. The user LEDs can be used by the user application program. Note that during startup or failure, the communication and user LEDs are used to indicate various situations. Table 4-4 details the LEDs functionality.

## CPU Memory

The ACE3600 CPU includes Flash, SDRAM, and optional SRAM Plug-in memory.
The Flash stores the firmware, the user application program, and the user data.
The SDRAM memory stores the temporary data.
The optional SRAM memory expansion is used for logging user data. The SRAM data is retained using an on-board rechargeable lithium battery. See Backup Battery for SRAM and RTC for more information.

The size of the CPU memory is determined by the model as shown in the table below.
Table 4-1 ACE3600 CPU Memory

|  | Model <br> 3610 | Model <br> 3640 | Model <br> 3680 |
| :--- | :---: | :---: | :---: |
| Flash memory | 16 MB | 16 MB | 32 MB |
| SDRAM <br> memory: | 32 MB | 32 MB | 128 MB |
| User Flash: | 3 MB | 3 MB | 19 MB |
| User SDRAM: | 10 MB | 10 MB | 118 MB |
| SRAM Plug-In | 4 MB | 4 MB | 4 MB |

## Real Time Clock (RTC)

The CPU includes a low drift RTC. The date and time are retained using an on-board rechargeable lithium battery.

The CPU date and time can be set using the ACE3600 STS. The CPU can also be synchronized with other RTUs in the system, using the system clock. For more information, see the Setting/Getting a Site's Date and Time section or the Creating a User Application section of the ACE3600 STS User Guide.

## Backup Battery for SRAM and RTC

The CPU module includes a rechargeable lithium battery that provides backup power and data retention for the SRAM and RTC.

The lithium battery is located on the CPU board and cannot be replaced.
Typically, the battery will retain the SRAM data and RTC for 60 continuous days without power and no Lead-Acid backup battery. When the SRAM option is not used, the Lithium battery will keep the Real Time Clock running for a longer period of time.

## CPU Firmware and Operation Modes

The CPU firmware is a real-time multitasking operating system, based on the Wind River VxWorks OS. The CPU shipped from the factory with the most recent firmware version, and it can be updated/replaced using a remote or local connection. Downloading firmware updates is performed using the STS. (See Downloading to a Site in the ACE3600 STS manual.) If the new firmware download stops or fails, the CPU will restart with the existing firmware.

## Power-up and Restart

The CPU requires DC voltage provided by the power supply module via the motherboard (when the PS switch is ON). The CPU will power-up and restart in the range of 10.8 V to 16 V DC. During power-up, the processor performs fast memory tests, initiates the RTU and starts the user program (if one was downloaded). The end of the power-up sequence is indicated by the buzzer. The length of time from the beginning of CPU power-up until the user program starts running is approximately $10-15$ seconds.

It is possible to perform a comprehensive memory test during power-up by pressing pushbutton PB1 for few seconds while switching the power supply from OFF to ON. In this case the power-up period is about $30-35$ seconds long.

If the startup fails, the RTU will freeze (boot sequence stops), the PWR LED will blink and the four indicator LEDs (see LEDs Location in Table 4-3) will blink seven times. The four LEDs will then display the failure error in binary code, as described in Table 4-3.

## Restart after Firmware Download

The RTU will restart after downloading system firmware. If the firmware is faulty or the firmware download failed, the RTU, if protected by the Safe Firmware Download feature, will restart and roll back to the previous firmware version. A failure message will appear in the STS Downloader screen. For information on using the Safe Firmware Download feature, see the Safe Firmware Download section of the ACE3600 STS Advanced Features manual.

## Restart after Configuration Download

The RTU will restart after downloading a site configuration. For information on downloading to the RTU, see the Operation chapter of the ACE3600 STS User Guide.

If the RTU fails to restart after the user-defined site configuration was downloaded, a unique LED display (in the range of the PI1-TX and SI2-RX LEDs) and a series of buzzer tones will follow. The RST LED will turn RED and the RTU will restart itself with the previous "good" configuration. The following message will appear in the RTU Error Logger "Configuration file was deleted due to failure in startup. Rolling back to the last configuration file". Errors can be retrieved from the RTU using the ACE3600 STS Error Logger utility.

If the startup succeeds after configuration download but has errors, these errors are reported in the RTU Error Logger. It is, therefore, recommended to check for errors after downloading a configuration file to the RTU. Errors can be retrieved from the RTU using the ACE3600 STS Error Logger utility.

For information on retrieving errors from the RTU Error Logger, see the Operation chapter of the ACE3600 STS User Guide.

## Restart after Erase Flash

After the User Flash is erased, the RTU will restart successfully with the default site configuration.

## Power-down

When the voltage provided to the CPU module drops below the minimum level, the CPU will shut down in an orderly fashion. This level is configurable for all power supply modules other
than the 12 V DC power supply low-tier. See the 'Minimum DC operation voltage' parameter in Appendix A: Site Configuration Parameters of the ACE3600 STS User Guide.

## CPU Status and Diagnostics

The CPU status is indicated on the front panel LED. Detailed CPU status and diagnostics information can be retrieved from the module using the CPU Hardware Test utility. For more details, see the Hardware Test section of the ACE3600 STS User Guide.

## CPU Warnings and Errors

CPU warnings and errors are logged in the CPU memory to indicate issues or errors during power-up, restart, user application program execution and other modes of CPU operation. The existence of CPU warnings and errors are indicated in the ERR LED on the front panel of the module. Green indicates a message, orange indicates a warning and red indicates an error.

The CPU error logger information can be retrieved using the STS Error Logger utility. For more details, see the Error Logger section of the ACE3600 STS User Guide.

## CPU Serial Number

Each CPU has a unique serial number. This number is printed on a label on the side of the CPU module front panel. The serial number can be read using the STS Hardware. For more information, see the Hardware Test section of the ACE3600 STS User Guide.

## Connecting Plug-In Ports to the CPU Module

In general, the plug-in ports are ordered as options with the RTU and are installed in the factory. However, it is also possible to add plug-in ports to the CPU after it is shipped from the factory. Several plug-in ports are available. See Communication Ports above.

Note: A TORX screwdriver is required for installation of the plug-in ports.

Figure 4-3 depicts a plug-in port board attached to the ACE3600 CPU module.


Figure 4-3 Plug-In Port in CPU Module
Procedure 4-1 describes how to connect a plug-in port to the CPU.
Procedure 4-1 How to Connect a Plug-in Port to the CPU

1) Remove the CPU module from the RTU.
2) Remove the cover from the desired opening on the front panel.
3) Connect two supporting pins with screws to the plug-in port.
4) Place the plug-in board with the RJ-45 connector facing the panel. Carefully insert the plug-in board connector into the appropriate connector on the CPU board.
For Ethernet 10/100 MB, use the J14 connector on the CPU (Plug-in 1 only.) For all other plug-in ports, use the J 5 (Plug-in 1) or J6 (plug-in 2) connector.
5) Connect the two supporting pins with screws to the other side of the CPU board.
6) Replace the CPU module in the slot.

## Connecting SRAM Expansion Memory to the CPU Module

In general the plug-in SRAM is ordered as an option with the RTU and is installed in the factory. However, it is also possible to add plug-in SRAM to the CPU after it is shipped from the factory.

Note: A TORX screwdriver is required for installation of the SRAM.
Figure 4-4 depicts the user SRAM Plug-in memory in the ACE3600 CPU module.


Figure 4-4 SRAM Expansion in CPU Module

Procedure 4-3 describes how to connect a plug-in SRAM memory card to the CPU.
Procedure 4-2 How to Connect a Plug-in SRAM Memory Card to the CPU

1) Remove the CPU module from the RTU.
2) Remove the cover from the connector marked P12 on the CPU board.
3) Place the plug-in SRAM memory card with the connector facing the panel. Carefully insert the plug-in board connector into the connector on the CPU board.
4) Secure the memory card to the CPU board with the supplied screw.
5) Replace the CPU module in the slot.

## Pushbutton Functionality

The table below describes the use of the two pushbuttons in various scenarios, during power-up and run-time. To press a pushbutton during startup, first press the pushbutton(s), then turn on the RTU using the On/Off switch on the front panel. Keep the pushbutton(s) depressed for the required number of seconds, as specified in the scenarios below.

Table 4-2 ACE3600 Pushbutton Functionality

| Scenario | Trigger | Action |
| :--- | :--- | :--- |
| LEDs Test | During run-time, press PB1 <br> for five or more consecutive <br> seconds (but less than 30). | All the LEDS on the CPU and I/O modules <br> will be lit until let go of PB1 and then <br> returned to their previous states. |
| RTU Restart | During run-time, press PB1 <br> for 30 consecutive seconds. | All the LEDs will be lit. Then all the LEDs <br> will blink once. <br> The buzzer will buzz several short beeps. <br> (If PB1 is released during this time the <br> restart will not be performed.) <br> At the long beep, release PB1 and the RTU <br> will restart (and the buzzer will buzz.) |
| Turn LEDs ON | During run-time, press PB1 <br> for one second. | Those LEDs which are currently active <br> will be turned on for a period of time <br> (configured in the RTU configuration <br> using the STS.) |
| RAM Test | During startup, press PB1. | A detailed memory test of SDRAM and <br> SRAM plug-in is performed. |
| (At the beginning of the RAM test, the |  |  |
| four indicator LEDs (see LEDs Location in |  |  |
| Table 4-3) will blink three times. During |  |  |
| the RAM test, the LEDs may blink or be |  |  |
| lit. |  |  |
| If the RAM test succeeds, the four LEDs |  |  |
| will blink three times and turn off and the |  |  |
| restart sequence will continue. |  |  |
| If the RAM test fails, the RTU will freeze |  |  |
| (restart sequence stops), the PWR LED |  |  |
| will blink and the four LEDs will blink |  |  |
| seven times. The failure error code will |  |  |
| then be displayed on the LEDs, in binary |  |  |
| code, as described in Table 4-3. |  |  |
| - |  |  |


| Scenario | Trigger | Action |
| :--- | :--- | :--- |
| Erase User <br> Flash | During startup, press both <br> PB1 and PB2 simultaneously <br> until the buzzer buzzes five <br> times quickly, then <br> continuously for three <br> seconds. | All the user Flash memory content <br> excluding logging files (files tagged as <br> data logging files) is erased, including the <br> site configuration, user application <br> programs, user tables, etc. |
| Bootstrap | During startup, press PB2 <br> continuously for five <br> seconds. <br> Note: Before initiating <br> bootstrap, the CPU must be <br> connected directly to the <br> STS PC in standalone mode. <br> No other components can be <br> on the network which might <br> create a conflict with the <br> default IP address. | The RTU will start up in diagnostic mode. <br> Communication with the RTU is for <br> diagnostic purposes only (Error Logger/ <br> SW Diagnostics.) You cannot download to <br> the RTU and no application will run. <br> If the bootstrap fails, the four indicator <br> will display the failure error in binary <br> code, as described in Table 4-3. |

Table 4-3 ACE3600 Failure - Error Code Display on LEDs


## CPU LEDs Behavior

The table below describes the behavior of the LEDs on the CPU module.
Table 4-4 ACE3600 CPU LEDs Behavior

| LED Name | Description | Status |
| :--- | :--- | :--- |
| PWR | Power LED |  |
| Bicolor LED (Red, Green) | Flashing Red - Power exists; CPU FPGA not <br> loaded. <br> Green - Power exists; CPU is running from a <br> recognized power supply (one of the six <br> power supply options.) <br> Red - Failure on power-up. CPU is running <br> from an unrecognized power supply. |  |
| ERR | Error Logger Status LED <br> Bicolor LED (Red, Green) | OFF - No new errors or warnings. <br> Green - New message logged. <br> Orange - New warning logged. <br> Red - New error logged. <br> Note: In systems with I/O expansion, the ERR <br> LED can indicate an error in either the main <br> or expansion frame. |
| RST | Reset LED <br> Bicolor LED (Red, Green) | Green - On startup <br> OFF - Successful power-up or restart. <br> Red - Power-up or restart failed. |
| APPL | Application LED <br> Bicolor LED (Red, Green) | OFF - No user application program in the <br> Flash memory. <br> Green - User application program is running. <br> Orange - User application program was <br> paused by user (during Hardware Test.) |
| CONF | Configuration LED <br> Bicolor LED (Red, Green) | OFF - Configuration was not loaded. <br> Green - Configuration was loaded. <br> Red - Configuration error. |
| USB Host1 LNK (link) | ON - A USB device is connected. <br> OFF - No link exists between the CPU and <br> the MotoTrbo radio. |  |

[^29]| LED Name | Description | Status |
| :--- | :--- | :--- |
| H1 LNK2 $^{*}$ | USB Host2 LNK (link) <br> Green LED | ON - A USB device is connected. <br> OFF - No link exists between the CPU and <br> the MotoTrbo radio. |
| PI1 TX | Plug-in Port 1 - TX <br> (transmit) <br> Green LED | ON- Transmitting Data |
| PI1 RX | Plug-in Port 1- RX (receive) <br> Green LED | ON - Receiving Data |
| PI1 CM | Plug-in Port 1 - CM (channel <br> monitor) <br> Green LED | ON - Channel Busy (if port is in use by radio, <br> RS485, or RS232) <br> - Network Connected (if an IP plug-in is <br> used) |
| SI1 TX | Serial Port 1 - TX (transmit) <br> Green LED | ON - Transmitting Data |
| SI1 RX | Serial Port 1 - RX (receive) <br> Green LED | ON - Receiving Data |
| SI1 CM | Serial Port 1 - CM (channel <br> monitor) <br> Green LED | ON - Channel Monitor is ON. |
| S2 TX | Serial Port 2 - TX (transmit) <br> Green LED | ON - Transmitting Data |
| E2 LNK | Sther <br> Green LED <br> Green LED | Serial Port 2 - CM (channel <br> monitor) <br> Green LED |
| ON - Channel Monitor is ON |  |  |
| Green LED |  |  |

[^30]| LED Name | Description | Status |
| :--- | :--- | :--- |
| PI2 TX | Plug-in Port 2 - TX <br> (transmit) <br> Green LED | ON - Transmitting Data |
| PI2 RX | Plug-in Port 2 - RX (receive) <br> Green LED | ON - Receiving Data |
| PI2 CM | Plug-in Port 2 - CM (channel <br> monitor) <br> Green LED | ON - Channel Busy (if port is in use by radio, <br> RS485, or RS232) <br> - Network Connected (if an IP plug-in is <br> used) |
| D1 RX | For future use | For future use |
| USR1- <br> USR4 | User application program <br> LEDs <br> Green LED | Controlled by the user application program. <br> Light consecutively and repeatedly one after <br> the other when entering boot mode. |

** The LED names E1 LNK and RX appear only in CPU 3640 and CPU 3680.

## CPU 3610/CPU 3640 Module Specifications

| Microprocessor | Freescale - Power PC II MPC8270, 32-bit, extended communication capability, DMA and floating point calculation support |
| :---: | :---: |
| Microprocessor Clock | 200 MHz |
| Memory | Flash: $16 \mathrm{MB} / 3 \mathrm{MB}$ free for user DRAM: $32 \mathrm{MB} / 10 \mathrm{MB}$ free for user SRAM plug-in (Optional): 4 MB total, all free for user |
| Real-Time Clock | Full calendar with leap year support (year, month, day, hours, minutes, seconds). <br> Time drift: max. 2.5 Seconds per day (when power is on) |
| SRAM and RTC Retention | 3 V Rechargeable lithium backup battery |
| Serial Port 1 | Configurable RS232 or RS485 port: <br> - RS232: Asynch, Full Flow Control, up to $230.4 \mathrm{~kb} / \mathrm{s}$, GPS receiver interface <br> - RS485, multi-drop 2-Wire up to $230.4 \mathrm{~kb} / \mathrm{s}$ |
| Serial Port 2 | RS232, Asynch, Full Flow Control, up to $230.4 \mathrm{~kb} / \mathrm{s}$, GPS receiver interface |
| Ethernet Port 1 | $10 / 100 \mathrm{Mb} / \mathrm{s}$ (on CPU 3640 only) |
| Plug-In Port 1 | Supports the following plug-in ports: <br> - Radio Modem, DPSK $1.2 \mathrm{~kb} / \mathrm{s}$, FSK $1.2 / 1.8 / 2.4 \mathrm{~kb} / \mathrm{s}$, DFM 2.4/3.6/4.8 kb/s <br> - RS232, Sync/Asynch, Full Flow Control, up to $230.4 \mathrm{~kb} / \mathrm{s}$, GPS receiver interface <br> - RS485, multi-drop 2-Wire up to $230.4 \mathrm{~kb} / \mathrm{s}$ <br> - Ethernet $10 / 100 \mathrm{Mb} / \mathrm{s}$ |
| Plug-In Port 2 | Supports the following plug-in ports: <br> - Radio Modem, DPSK $1.2 \mathrm{~kb} / \mathrm{s}$, FSK $1.2 / 1.8 / 2.4 \mathrm{~kb} / \mathrm{s}$, DFM 2.4/3.6/4.8 kb/s <br> - RS232, Sync/Asynch, Full Flow Control, up to $230.4 \mathrm{~kb} / \mathrm{s}$, GPS receiver interface <br> - RS485, multi-drop 2-Wire up to $230.4 \mathrm{~kb} / \mathrm{s}$ <br> - Ethernet $10 \mathrm{Mb} / \mathrm{s}$ |
| LEDs Display | 4 CPU diagnostic LEDs, Port status LEDs and user application LEDs |
| Power Consumption | Refer to Appendix D: ACE3600 Maximum Power Ratings. |
| Operating Voltage | 10.8-16 V DC (from the motherboard connector) |
| Dimensions | 56 mm W x 225 mm H x 180 mm D (2.2" W x 8.7" H x 7.1" D) |
| Weight | Approx. $0.38 \mathrm{Kg}(0.84 \mathrm{Lb})$ |

Specifications subject to change without notice.

## CPU 3680 Module Specifications

| Microprocessor | Freescale - Power PC II MPC8270, 32-bit, extended communication capability, <br> DMA and floating point calculation support |
| :--- | :--- |
| Microprocessor Clock | 200 MHz |
| Memory | Flash: 32 MB/19 MB free for user <br> SDRAM: 128 MB/118 MB free for user <br> SRAM plug-in (Optional): 4 MB total, all free for user |
| Real-Time Clock | Full calendar with leap year support (year, month, day, hours, minutes, seconds). <br> Time drift: max. 2.5 Seconds per day (when power is on) |
| SRAM, RTC, and <br> Security Chip Retention | 3 V Rechargeable lithium backup battery |
| USB Host Port 1, 2 | Type A host full speed 12 Mbs ports (HU1 on left and HU2 on right) for MDLC <br> over IP communication via the MotoTrbo digital mode radio system (on CPU 3680 <br> only). For MotoTrbo radio only; No other USB devices or USB Hubs are <br> supported. |
| Serial Port 1 | Configurable RS232 or RS485 port: <br> - RS232: Asynch, Full Flow Control, up to 230.4 kb/s, GPS receiver interface <br> - RS485, multi-drop 2-Wire up to 230.4 kb/s |
| Serial Port 2 | RS232, Asynch, Full Flow Control, up to 230.4 kb/s, GPS receiver interface |
| Ethernet Port 1 | Ethernet 10/100 Mb/s |
| USB Device Port 1 | USB device port, Type B connector (for future use) |
| Plug-In Port 1 | Supports the following plug-in ports: <br> - Radio Modem, DPSK 1.2 kb/s, FSK 1.2/1.8/2.4 kb/s, <br> DFM 2.4/3.6/4.8 kb/s |
| - RS232, Sync/Asynch, Full Flow Control, up to 230.4 kb/s, |  |
| GPS receiver interface |  |
| - RS485, multi-drop 2-Wire up to 230.4 kb/s |  |
| - Ethernet 10/100 Mb/s |  |

Specifications subject to change without notice.

## I/O MODULES

## General Description

The ACE3600 RTU can include up to eight I/O modules, depending on the frame size. A variety of I/O modules are available. Additional I/O modules can be added using the I/O Expansion frame. For information, see the I/O Expansion chapter below.

The I/O modules can be positioned in the slots to the right of the CPU. As with all ACE3600 modules, the I/O modules can be replaced while the power is on (hot-swap.)

Figure 5-1 provides a general view of an ACE3600 I/O module.


I/O Module with Two TBs I/O Module with Three TBs Figure 5-1 ACE3600 I/O Module - General View

Each I/O module includes an ERR status LED, individual I/O status LEDs, an array of I/O connectors, and a coding mechanism for the terminal cable connector or TB holder option.

Figure 5-2 provides a detailed view of the I/O front panel.


Figure 5-2 ACE3600 I/O Module - Front Panel (without TB Holder)

## I/O Module LEDs

The ERR LED indicates an I/O module fault and errors. It will remain lit until all the errors have been eliminated. Diagnostic and error messages can be retrieved from the module using the ACE3600 STS Error Logger or SW Diagnostics. For more information, see the ACE3600 STS User Guide.

The I/O status LEDs in Digital Input (DI) and Digital Output (DO) modules indicate ON and OFF (LED lit when the I/O is ON.) In Analog Input (AI) modules, each input has two LEDs, indicating Overflow (OF) and Underflow (UF). In Analog Output (AO) modules, each output has three LEDs, indicating voltage output (Vout), current output (Iout), and calibration (Cal). In the 8 DO Select Before Operate (SBO) module, the Controlled DO LED indicates whether 12 V is controlled or not.

## I/O Module Test

The I/O modules can be tested using the STS Hardware Test utility. For more information, see the ACE3600 STS User Guide.

The I/O module LEDs can be tested using the STS Hardware Test utility- all the LEDS are lit for a number of seconds, and then turned back to their previous state.

## Panel Terminal Block (TB) Connectors

Each I/O module is equipped with a set of two, three or four TB connectors. Each TB connector has a fixed female side on the module and a male plug for the sensor/device wire connection. The TB male side in all modules is screw type for up to 1 mm ( 18 AWG) wire in modules with two/four TBs ( 3.5 mm pitch) or 1.6 mm ( $14 \mathrm{AWG)} \mathrm{wire} \mathrm{in} \mathrm{modules} \mathrm{with} \mathrm{three}$

TBs ( 5 mm pitch). A TB holder can also be ordered for all I/O module types. (See TB Holder and Cables below.) Two TB extractor tools (FHN7063A) are provided for easy removal of TBs, one for modules with two/four TBs and one for modules with three TBs.


Figure 5-3 TB Connector-Male/Female

Procedure 5-1 Extracting the TB Connector from the I/O Module

1) Open the door of the I/O module to expose the TB connectors (2-4).
2) Position the TB extractor over the desired TB connector, with the small notch facing to the right. (See Figure 5-4.)
3) Press the center of the TB extractor from both sides to open the two sides of the clamp end.
4) Clamp the open TB extractor over the desired TB connector and pull on the back handle to extract the TB connector from the I/O module.


Figure 5-4 TB Extractor

## TB Holder and Cables

The TB holder secures the male TBs neatly in place and forms a single connector plug per module. The wires connected to the TBs are concealed in the holder. The module and the TB holder provide a coding mechanism to prevent cabling errors. Ejector handles enable easy release of the TB holder connector from the module. An optional three-meter cable braid, completely wired with holder and cable, is available.

A TB holder kit is available to enable self-assembly of cables. User assembled cables should
 up to 0.8 mm ( 20 AWG ) in modules with three $\mathrm{TBs}(5 \mathrm{~mm}$ pitch). The TB holder kit does not include a cable.

Note that a Philips screwdriver is required for assembling the TB holder and a flat screwdriver is required for setting the code key pin.


Figure 5-5 Terminal Block (TB) Holder-Front and Back View

## Assembling the TB Holder Parts

Procedure 5-1 Assembling the TB Holder Parts
If the TB holder kit is ordered, follow the procedure below. (See Figure 5-6.)

1) Prepare the cable by cutting the wires to fit the TBs. Connect the wires of the userassembled cables to the TBs, following the pin descriptions on the module panel label (where pin 1 is at the top of first TB and so on downwards.)
2) Place the TBs onto the left part of the TB holder plastic.
3) Add the top ejector handle, the code key and the positioner.
4) Close the right side of the plastic TB holder over the left side.
5) Screw together the assembly using the three screws provided in the kit. Note the lower screw holds the positioner into place.)
6) Insert the lower ejector handle at the bottom of the TB holder.
7) Slide the metal axis into lower ejector handle from the side.

Once the TB holder is assembled, it can be connected to the I/O module.

Figure 5-6 provides an exploded view of the TB holder assembly for four TBs.


Figure 5-6 Terminal Block (TB) Holder Assembly - Exploded View with Coding

## Attaching the TB Holder Clip to the I/O Module

An optional TB holder clip can be added to the I/O module to secure the cable.
Procedure 5-2 Attaching the TB Holder Clip to the I/O Module

1) Remove the I/O module from the ACE 3600 RTU.
2) Using the supplied screw, attach the TB holder clip to the bottom of the I/O module. (See Figure 5-7.)
3) Replace the I/O module in the RTU slot.


Figure 5-7 I/O Module with Terminal Block (TB) Holder Clip

## Connecting the TB Holder to the I/O Module

Procedure 5-3 Connecting the TB Holder to the I/O Module

1) Open the door of the $I / O$ module.
2) On the TB holder, loosen the screw and turn the positioner so that the arrow points to either A or B.
3) Tighten the screw.
4) With a flat screwdriver, set the code key pin to a number from 1 to 6 .
5) On the I/O module, using a flat screwdriver, set the pin to the same number (from 1 to 6 .) This ensures that the TB holder will not be accidentally connected to the wrong I/O module.
6) Slide the plastic lip on the bottom of the I/O module to either A (up) or B (down) (as in Step 2).
7) Align the plastic lip with the flat edge of positioner on the TB holder and snap the TB holder into the I/O module, (see Figure 5-8), fitting the code key pin into the code key.
8) If the ejector handles are extended, push them inwards, against the TB holder (see Figure 5-8.)
9) If a TB holder clip was attached to the I/O module, slide the cable between the two edges of the clip, and press the clip closed to secure the TB holder to the module. See Figure 5-7.
10) Label the TBs wires with any desired user notes. The wires are numbered 1-20 or 1-40 depending on the model. The wire numbers correspond to the module pins.
11) To extract the TB holder from the I/O module front panel, extend the ejector handles outward away from the module and pull on the handles.

Figure 5-8 provides a general view of the TB holder and an I/O module.


Figure 5-8 Terminal Block (TB) Holder on I/O Module - General View with Coding

## Wired Cable Braid

The optional three-meter cable braid is completely wired with a TB holder and either 20-wire or 40 wire cable. Each wire in the cable is labeled with the corresponding pin number. This information is useful when connecting the PGND to the grounding strip. See the Connecting I/O Modules to Ground section of the Installation chapter.

## User Label

Each I/O module is provided with a blank label on the module door for user notes.

## Inserting/Removing an I/O Module from the Frame

I/O modules support hot-swap and can be inserted and extracted while the system is powered up. For instructions on removing/inserting an I/O module from/into a frame, see the Replacing an I/O Module section of the Break-Fix Procedures chapter below.

Note: The hot-swap of an I/O module in the expansion frame of an RTU which is running without a configuration from the STS (i.e. running the default configuration as from the factory) will not be successful in the following situation: If the expansion module restarts while the main CPU is running and during this restart, a I/O module is removed. In such a case, when the expansion module powers up, it will not recognize the removed I/O module and will not report the hot-swap to the main CPU when the I/O module is replaced in the slot.

## Automatic Module ID

Each I/O module has a unique module type ID number. When the RTU is powered up or when an I/O module is inserted into a slot (hot-swap), the CPU automatically identifies the module type.

The module ID can be viewed from the STS Hardware Test utility. For more information, see the Hardware Test section of the ACE STS User Guide.

## 24V DC Floating Plug-In Power Supply

Up to two 24V DC floating plug-in power supplies can be added to certain I/O modules, as detailed in the table below. Up to four 24V DC floating plug-in power supplies can be added per power supply module. (For guidelines on remaining within the maximum system power consumption, see Appendix D: ACE3600 Maximum Power Ratings below.)

Table 5-1 Number of Plug-In Power Supplies in ACE3600 I/O Modules

| Module Type | Number of Power <br> Supplies |
| :---: | :---: |
| 32 DI | 2 |
| 16 DI | 1 |
| 16 AI | 1 |
| 8 AI | 1 |
| Mixed I/O | 1 |
| Mixed Analog | 1 |

The plug-in power supply is ordered separately.
Before installing the 24 V DC floating plug-in power supply card on the I/O module, please verify that the FPGA version of the I/O module is as follows:

## I/O Module Type

AI module (all types)
DI module (all types)
Mixed I/O module (all types)

## FPGA Version

Version 1.5.002 or higher.
Version 2.1.004 or higher.
Version 1.5.004 or higher.

Use the ACE36000 STS Hardware Test utility to retrieve the FPGA version from the unit. If the FPGA version listed in the Module Diagnostics is lower than the version in the chart above, you must upgrade the I/O version by downloading a higher version FPGA file using the STS. Contact your local support team for the updated FPGA file.

Procedure 5-4 Attaching the Power Supply to the I/O Module
Attach the power supply to the I/O module using the following procedure. Note that a TORX screwdriver is required.

1) Remove the cap from the 40 -pin connector on the power supply plug-in.
2) Place the plug-in onto the board with the connector attached and the spacers over the holes on the board.
3) Screw the four supplied metals screws into the spacers to secure the plug-in. The RTU will automatically recognize the 24 V power supply.

Each plug-in power supply output is controlled by the CPU module. By default, the plug-in power supply is ON and can supply up to 150 mA . The power supply plug-in can be turned ON/OFF via the user application program or Hardware Test utility.

Figure 5-9 provides a general view of an I/O module with one plug-in.


Figure 5-9 ACE3600 I/O Module with a 24V Floating Power Supply Plug-In

# 24V DC Floating Plug-In Power Supply Module Detailed Specifications 

| Input Voltage | $10.8-16 \mathrm{~V}$ (from I/O module) |
| :--- | :--- |
| Outputs | 24 V floating, max. 150 mA |
| Power Consumption | Refer to Appendix D: ACE3600 Maximum Power Ratings. |
| Efficiency | $75 \%$ typical |
| Protection | Automatic output shut down on overvoltage and overcurrent |
| Insulation | Input to output: 1500 V AC |
| Dimensions | $78 \mathrm{~mm} \mathrm{~W} \mathrm{x} 15 \mathrm{~mm} \mathrm{H} \mathrm{x} 68 \mathrm{~mm} \mathrm{D}\left(3.1^{\prime \prime} \mathrm{W} \mathrm{x} 0.6^{\prime \prime} \mathrm{H} \mathrm{x} \mathrm{2.7"} \mathrm{D}\right)$ |
| Weight | Approx. $0.04 \mathrm{Kg}(0.09 \mathrm{Lb})$ |

Specifications subject to change without notice.

## DIGITAL INPUT MODULE

## General Description

The ACE3600 Digital Input (DI) module can have 16 or 32 inputs.
The following DI modules are available.

- 16 DI Fast 24 V
- 32 DI Fast 24 V
- 16 DI Fast 24 V IEC TYPE 2
- 32 DI Fast 24V IEC TYPE 2
- 32 DI Fast 48 V

Two types of voltage ("wet") inputs are supported, IEC 61131-2 Type II compliant inputs and 24 V "MOSCAD compatible" inputs. In the 32 DI module, the first 20 inputs can function as fast counters. In the 16 DI module, all inputs can function as fast counters. A counter's maximum rate is dependent on the module type (see the specifications below.)

All the inputs are optically isolated. All DI modules except the 32 DI 48 V module support optional 24V DC floating plug-in power supplies (for contact "wetting" or other purposes).

Each DI can be an event trigger (interrupt-driven) to a high priority fast process. The high priority fast process enables very fast activation of an output in response to an input trigger and logical conditions. This high priority fast process is not dependent on the I/O scan (refer to the STS Application Programmer manual.)

For a description of I/O module construction, location, LEDs, TBs, and other common I/O module features, see the I/O Modules chapter above.

Figure 6-1 provides a general view of the ACE3600 DI module.


Figure 6-2 provides a detailed view of the ACE3600 DI module front panel.


16 DI Module


32 DI Module

## DI Module Configuration

The 16 DI Fast 24 V and 32 DI Fast 24 V modules can handle AC and DC input signals. The user can select DC or AC operation per module. When AC configuration is selected, the Fast Capture, Counter Function and Input Filters (see below) are disabled. The 32 DI 48V modules can handle DC input signals only.

## Fast Capture (DC Configuration)

When the DI module is in DC mode, each DI can be configured as a Fast Capture DI. Fast capture causes the SCAN ladder output operation to get the first change that occurred since the previous scan. When fast capture is disabled, the scan gets the current value of the DI (in this case, any DI changes between scans are missed.)

## Input Filters (DC Configuration)

When the DI module is in DC mode, each input has a HW input filter to make sure that the input reading is stable. The range of the HW DI filter is 0 to 50.8 millisecond (in 0.2 mS steps). The Fast Counter DI filter range is 0 to 12.75 millisecond (in 0.05 mS steps).

## Event Time Tagging

Each DI can be set in the user application program's I/O link table to trigger recording of time tagged events upon any input change of state. The time tagged events are recorded in the CPU memory and can be retrieved for various purposes.

## Keep Last Value (KLV) and Predefined Value (PDV)

Each input can be configured to $\operatorname{KLV}$ or to a $\operatorname{PDV}(0,1)$. This value is shown to the user application program in the event of DI module failure. The PDV can also be used during normal operation to force a value that masks the actual input value. In this case the user program will get the PDV instead of the actual input value.

## DI Module Configuration Options

The DI module features which can be configured are listed in the table below. Some parameters are per module and some are per input.

Table 6-1 ACE3600 DI Module Configurable Features

| Feature | Parameter <br> Settings | Default Setting | Per Module / <br> Input | Parameter Setup <br> Location |
| :--- | :--- | :--- | :--- | :--- |
| DC or AC <br> operation | AC / DC | DC | Module | STS site <br> configuration |
| Fast Capture | Disabled <br> /Enabled | Disabled | Input | STS site <br> configuration |
| DI Filter (DC) | $0-254(x 0.2$ <br> $\mathrm{mS})$ | $50 * 0.2 \mathrm{mS}$ <br> $(=10 \mathrm{mS})$ | Module | STS site <br> configuration; <br> 'C' User Program |
| Counter Filter <br> (DC) | $0-255(\mathrm{x} 0.05$ <br> $\mathrm{mS})$ | $20 * 0.2 \mathrm{mS}$ <br> $(=1 \mathrm{~ms})$ | Module | STS site <br> configuration <br> 'C' User Program |
| Event Time <br> Tagging | Disabled/ <br> Enabled | Disabled | Input | User Program I/O <br> link table |
| Keep Last Value <br> and Predefined <br> Value | KLV/PDV <br> PDV=0/1 | KLV | Input | User Program I/O <br> link table |
| Mask | No /Yes | No | Input | User Program I/O <br> link table |

[^31]
## Sleep Mode

Each DI module can be switched by the user application program to Sleep Mode. In Sleep Mode, the module does not function and the power consumption is minimized. During Sleep mode, the user application program will get the predefined values (PDV) for each I/O.

## Module Status and Diagnostics

In the event of DI Module failure, the I/O module ERR LED will be lit. This event is registered by the CPU in the Error Logger. DI Module failure status is also visible to the user application program.

The DI module can be diagnosed and monitored using the STS Hardware Test utility. This test verifies that the module is operational, presents the module configuration and shows the actual value of each input. It is also possible to change the input filter setup temporarily for the duration of the Hardware Test.

In the Hardware Test utility, it is possible to set the DI module to Freeze Mode. In this mode the user application program will get the predefined value of each input in the module, instead of the actual input value. Freeze mode enables testing the inputs while the user application program is running.

For details on configuring the DI modules, see the Site Configuration section, and the Application Programming section of the STS User Guide.

## I/O Circuit Diagram

## DI - Typical Input Circuit



|  | Fast 24 V | Fast 48V |
| :---: | :---: | :---: |
| R | $255 \Omega$ | $3.32 \mathrm{~K} \Omega$ |
| Vz | 33 V | 68 V |
| Current <br> Limiter | 3.5 mA | 3 mA |

## Module Block Diagram

16 DI


Digital Input Module

32 DI


## Connection Charts

| 16 DI |  |  |  |
| :--- | :--- | :--- | :--- |
| Pin | Function | Pin | Function |
| 1 | DI1 | 11 | DI11 |
| 2 | DI2 | 12 | DI12 |
| 3 | DI3 | 13 | DI13 |
| 4 | DI4 | 14 | DI14 |
| 5 | DI5 | 15 | DI15 |
| 6 | DI6 | 16 | DI16 |
| 7 | DI7 | 17 | $+24 V$ |
| 8 | DI8 | 18 | COM1 |
| 9 | DI9 | 19 | PGND1 |
| 10 | DI10 | 20 | PGND1 |


| 32 DI |  |  |  |
| :--- | :--- | :--- | :--- |
| Pin | Function | Pin | Function |
| 1 | DI1 | 21 | DI17 |
| 2 | DI2 | 22 | DI18 |
| 3 | DI3 | 23 | DI19 |
| 4 | DI4 | 24 | DI20 |
| 5 | DI5 | 25 | DI21 |
| 6 | DI6 | 26 | DI22 |
| 7 | DI7 | 27 | DI23 |
| 8 | DI8 | 28 | DI24 |
| 9 | DI9 | 29 | DI25 |
| 10 | DI10 | 30 | DI26 |
| 11 | DI11 | 31 | DI27 |
| 12 | DI12 | 32 | DI28 |
| 13 | DI13 | 33 | DI29 |
| 14 | DI14 | 34 | DI30 |
| 15 | DI15 | 35 | DI31 |
| 16 | DI16 | 36 | DI32 |
| 17 | $+24 V^{*}$ | 37 | $+24 V^{*}$ |
| 18 | COM1 | 38 | COM2 |
| 19 | PGND1 | 39 | PGND2 |
| 20 | PGND1 | 40 | PGND2 |
|  |  |  |  |

[^32]
## I/O Connection Diagram

Connection of a dry contact sensor to the DI module requires "wetting" the contact with a voltage. This can be done using the 24 V DC floating plug-in power supplies that can be added to the module (in $16 / 32$ DI Fast $24 \mathrm{~V} /$ Fast 24 V IEC TYPE 2 modules only). The 24 V can be also used to power "wet" sensors.


| DI Module Specifications |  |
| :---: | :---: |
| 16/32 DI FAST 24V Modules |  |
| Total Number of Inputs | 16 DI ; 32 DI |
| Input Arrangement | Isolated groups of 16 inputs with shared common |
| Fast Counter Inputs | Inputs that can be used as fast counters: <br> - All inputs in 16 DI module; - First 20 inputs in 32 DI module |
| AC Input Frequency | $45-65 \mathrm{~Hz}$ |
| AC Input Delay | Maximum 0.2 mS |
| Fast Counter Input Frequency | $0-12.5 \mathrm{KHz}$, minimum pulse width $40 \mu \mathrm{~S}$ |
| Max. DC Input Voltage | Max. $\pm 40 \mathrm{~V}$ DC (relative to input common) |
| "ON" DC Voltage Range | +9 to +30 V DC, -30 to -9 V DC |
| "OFF" DC Voltage Range | -3 to +3 V DC |
| "ON" AC Voltage Range | 10 to $27 \mathrm{~V} \mathrm{AC} \mathrm{(RMS)}$ |
| "OFF" AC Voltage Range | 0 to 5 V AC (RMS) |
| Input Current | Max. 3.5 mA |
| Fast Capture Resolution | 1 mS (Interrupt upon change of state) |
| Event Time Tagging Resolution | 1 mS (Interrupt upon change of state) |
| Input Filtering | 0 to 50.8 mS (DC, programmable in 0.2 mSec steps) |
| Counter Input Filtering | 0 to 12.75 mS (programmable in 0.05 mSec steps for inputs configured as high speed counters) |
| 24 V DC Output | Supports optional isolated 24 V plug-in "Wetting" Power Supply (one in 16 DI , two in 32 DI ) |
| Diagnostic LEDs | Status LED per each input, module error LED, 24 V plug-in status LED |
| User Connection | 2 or 4 Terminal Blocks ( 3.5 mm pitch), Maximum 18 AWG |
| Cable and TB Holder | 20 or 40 Wire Cable with TB Holder connector, 26 AWG wires |
| Module Replacement | Hot swap replacement - module extraction/insertion under voltage |
| Input Isolation | 2.5 kV RMS between input and module logic per IEC60255-5 |
| Input Insulation | Insulation resistance $100 \mathrm{M} \Omega$ @ 500 V DC per IEC60255-5 |
| Operating Voltage | $10.8-16 \mathrm{~V} \mathrm{DC}$ and 3.3 V DC (from the motherboard connector) |
| Power Consumption | Refer to Appendix D: ACE3600 Maximum Power Ratings. |
| Dimensions | $37 \mathrm{~mm} \mathrm{~W} \mathrm{x} 225 \mathrm{~mm} \mathrm{H} \times 180 \mathrm{~mm} \mathrm{D}$, (1.5" W x 8.7" H x 7.1" D) |
| Weight | 16 DI : approx. $0.28 \mathrm{Kg}(0.62 \mathrm{Lb}) ; 32 \mathrm{DI}$ : approx. $0.29 \mathrm{Kg}(0.63 \mathrm{Lb})$ |


| 16/32 DI FAST 24V IEC 61131-2 TYPE II Modules |  |
| :---: | :---: |
| Total Number of Inputs | 16 DI |
|  | 32 DI |
| Input Arrangement | Isolated groups of 16 inputs with shared common |
| Fast Counter Inputs | Inputs that can be used as fast counter: <br> - All inputs in 16 DI module <br> - First 20 inputs in 32 DI module |
| Fast Counter Input Frequency | $0-10 \mathrm{KHz}$, minimum pulse width $50 \mu \mathrm{~S}$ |
| Max. DC Input Voltage | Max. $\pm 40 \mathrm{~V}$ DC (relative to input common) |
| "ON" DC Voltage Range | +11 to +30 V DC, -30 to -11 V DC |
| "OFF" DC Voltage Range | -5 to +5 V DC |
| Input Current | 6-10 mA |
| Fast Capture Resolution | 1 mSS (Interrupt upon change of state) |
| Event Time Tagging Resolution | 1 mSS (Interrupt upon change of state) |
| Input Filtering | 0 to 50.8 mS (DC, programmable in 0.2 mSec steps) |
| Counter Input Filtering | 0 to 12.75 mS (programmable in 0.05 mSec steps for inputs configured as high speed counter) |
| 24V DC Output | Supports optional isolated 24 V plug-in "Wetting" Power Supply (one in 16 DI , two in 32 DI ) |
| Diagnostic LEDs | Status LED per each input, module error LED, 24V Plug-in status LED |
| User Connection | 2 or 4 Terminal Blocks ( 3.5 mm pitch), Maximum 18 AWG |
| Cable and TB Holder | 20 or 40 Wire Cable with Terminal Block Holder connector, 26 AWG wires |
| Module Replacement | Hot swap replacement - module extraction/insertion under voltage |
| Input Isolation | 2.5 kV RMS between input and module logic per IEC60255-5 |
| Input Insulation | Insulation resistance $100 \mathrm{M} \Omega$ @ 500 V DC per IEC60255-5 |
| Operating Voltage | 10.8-16 V DC and 3.3 V DC (from the motherboard connector) |
| Power Consumption (measured at power supply in) | Refer to Appendix D: ACE3600 Maximum Power Ratings. |
| Dimensions | $37 \mathrm{~mm} \mathrm{~W} \times 225 \mathrm{~mm} \mathrm{H} \mathrm{x} 180 \mathrm{~mm} \mathrm{D}$, (1.5"W x 8.7" H x 7.1" D) |
| Weight | 16 DI: approx. 0.28 Kg ( 0.62 lb ) 32 DI : approx. $0.29 \mathrm{Kg}(0.63 \mathrm{lb})$ |


| 32 DI FAST 48V Modules |  |
| :---: | :---: |
| Total Number of Inputs | 32 DI |
| Input Arrangement | Isolated groups of 16 inputs with shared common |
| Fast Counter Inputs | Inputs that can be used as fast counters: First 20 inputs |
| Fast Counter Input Frequency | 2.0 KHz (minimum pulse width $250 \mu \mathrm{~S}$ ) |
| Max. DC Input Voltage | Max. $\pm 72 \mathrm{~V}$ DC (relative to input common) |
| "ON" DC Voltage Range | +36 to +60 V DC |
| "OFF" DC Voltage Range | 0 to +6 V DC |
| Input Current | Max. 3 mA |
| Fast Capture Resolution | 1 mS (Interrupt upon change of state) |
| Event Time Tagging Resolution | 1 mS (Interrupt upon change of state) |
| Input Filtering | 0 to 50.8 mS (DC, programmable in 0.2 mSec steps) |
| Counter Input Filtering | 0 to 12.75 mS (programmable in 0.05 mSec steps for inputs configured as high speed counters) |
| Diagnostic LEDs | Status LED per each input, module error LED |
| User Connection | 4 Terminal Blocks ( 3.5 mm pitch), Maximum 18 AWG |
| Cable and TB Holder | 40 Wire Cable with TB Holder connector, 26 AWG wires |
| Module Replacement | Hot swap replacement - module extraction/insertion under voltage |
| Input Isolation | 2.5 kV RMS between input and module logic per IEC60255-5 |
| Input Insulation | Insulation resistance $100 \mathrm{M} \Omega$ @ 500 V DC per IEC60255-5 |
| Operating Voltage | $10.8-16 \mathrm{~V}$ DC and 3.3 V DC (from the motherboard connector) |
| Power Consumption | Refer to Appendix D: ACE3600 Maximum Power Ratings. |
| Dimensions | $37 \mathrm{~mm} \mathrm{~W} \mathrm{x} 225 \mathrm{~mm} \mathrm{H} \times 180 \mathrm{~mm} \mathrm{D}$, (1.5" W x 8.7" H x 7.1" D) |
| Weight | 16 DI : approx. $0.28 \mathrm{Kg}(0.62 \mathrm{Lb}) ; 32 \mathrm{DI}$ : approx. $0.29 \mathrm{Kg}(0.63 \mathrm{Lb})$ |

Specifications subject to change without notice.

## DIGITAL INPUT 120/230V MODULE

## General Description

The ACE3600 Digital Input 120/230V (High Voltage DI) module has 16 inputs.
Each input can be connected to 120 V or 230 V (AC or DC). All the inputs are optically isolated.

Each DI can be an event trigger (interrupt-driven) to a high priority fast process. The high priority fast process enables very fast activation of an output in response to an input trigger and logical conditions. This high priority fast process is not dependent on the I/O scan (refer to the STS Application Programmer manual.)

For a description of I/O module construction, location, LEDs, TBs, and other common I/O module features, see the I/O Modules chapter above.

Figure 7-1 provides a general view of the ACE3600 High Voltage DI module.


Figure 7-1 ACE3600 High Voltage DI Module - General View

Figure 7-2 provides a detailed view of the ACE3600 High Voltage DI Module front panel.


Figure 7-2 ACE3600 High Voltage DI Module - Front Panel

## DI Module Configuration

The High Voltage DI module can handle AC and DC input signals. The user can select DC or AC (default) operation per module. When AC configuration is selected, the Input Filters (see below) are disabled.

Note: The default configuration for the DI $120 / 230 \mathrm{~V}$ module is different than that of a regular DI module.

## Input Filters (DC Configuration)

When the High Voltage DI module is in DC mode, each input has a HW input filter to make sure that the input reading is stable. The range of the HW DI filter is 0 to 50.8 milliseconds (in 0.2 msec steps).

Note: In this module, the minimum effective filter value is 7.0 msec .

## Keep Last Value (KLV) and Predefined Value (PDV)

Each input can be configured to $\operatorname{KLV}$ or to a $\operatorname{PDV}(0,1)$. This value is shown to the user application program in the event of High Voltage DI module failure. The PDV can also be used during normal operation to force a value that masks the actual input value. In this case the user program will get the PDV instead of the actual input value.

## DI Module Configuration Options

The High Voltage DI module features which can be configured are listed in the table below. Some parameters are per module and some are per input.

Table 7-1 ACE3600 High Voltage DI Module Configurable Features

| Feature | Parameter <br> Settings | Default Setting | Per Module / <br> Input | Parameter Setup <br> Location |
| :--- | :--- | :--- | :--- | :--- |
| DC or AC <br> operation | AC / DC | DC | Module | STS site <br> configuration |
| DI Filter (DC) | $0-254(x 0.2$ <br> $\mathrm{msec})$ | $50 * 0.2 \mathrm{msec}$ <br> $(=10 \mathrm{msec})$ | Module | STS site <br> configuration; <br> 'C' User Program |
| Keep Last Value <br> and Predefined <br> Value | KLV/PDV <br> PDV=0/1 | KLV | Input | User Program I/O <br> link table |
| Mask | No /Yes | No | Input | User Program I/O <br> link table |

## Sleep Mode

Each High Voltage DI module can be switched by the user application program to Sleep Mode. In Sleep Mode, the module does not function and the power consumption is minimized. During Sleep mode, the user application program will get the predefined values (PDV) for each I/O.

## Module Status and Diagnostics

In the event of High Voltage DI Module failure, the I/O module ERR LED will be lit. This event is registered by the CPU in the Error Logger. DI Module failure status is also visible to the user application program.

The High Voltage DI module can be diagnosed and monitored using the STS Hardware Test utility. This test verifies that the module is operational, presents the module configuration and shows the actual value of each input. It is also possible to change the input filter setup temporarily for the duration of the Hardware Test.

In the Hardware Test utility, it is possible to set the High Voltage DI module to Freeze Mode. In this mode the user application program will get the predefined value of each input in the module, instead of the actual input value. Freeze mode enables testing the inputs while the user application program is running.

For details on configuring the High Voltage DI modules, see the Site Configuration section, and the Application Programming section of the STS User Guide.

## I/O Circuit Diagram



Digital Input 120/230V Module

## Module Block Diagram

## 16 DI High Voltage



## Connection Charts

| Pin | Function |
| :--- | :--- |
| 1 | DI1 |
| 2 | DI2 |
| 3 | DI3 |
| 4 | DI4 |
| 5 |  |
| 6 |  |
| 7 | DI5 |
| 8 | DI6 |
| 9 |  |
| 10 | COM1-6 |
| 11 | DI7 |
| 12 | DI8 |
| 13 | DI9 |
| 14 | DI10 |
| 15 |  |
| 16 |  |
| 17 | DI11 |
| 18 | DI12 |
| 19 |  |
| 20 | COM7-12 |


| Pin | Function |
| :--- | :--- |
| 21 | DI13 |
| 22 | DI14 |
| 23 | DI15 |
| 24 | DI16 |
| 25 |  |
| 26 |  |
| 27 |  |
| 28 |  |
| 29 |  |
| 30 | COM13-16 |

## I/O Connection Diagram



## Digital Input 120/230V Module Specifications

| High Voltage 16DI Module |  |
| :---: | :---: |
| Total Number of Inputs | 16 DI |
| Input Characteristics | IEC 61131-2 Type 1 |
| Input Arrangement | Two isolated groups of 6 inputs and one isolated group of 4 inputs. |
| AC Input Frequency | $47-63 \mathrm{~Hz}$ |
| AC Input Change Delay | Maximum 25.0 msec |
| Max. DC Input Voltage | Max. $\pm 264$ V DC (relative to input common) |
| DC Input Pulse Width | Minimum $7.0 \mathrm{msec} @ 230 \mathrm{~V}$ DC |
| "ON" DC Voltage Range | +79.0 V DC to +264.0 V DC, -79.0 V DC to -264.0 V DC |
| "OFF" DC Voltage Range | -40 to +40 V DC |
| "ON" AC Voltage Range | 79 to 264 V AC (RMS) |
| "OFF" AC Voltage Range | 0 to $40 \mathrm{~V} \mathrm{AC} \mathrm{(RMS)}$ |
| Input Current | At 110 V DC 1.0 to 3.0 mA <br> At 230 V DC 0.4 to 2.0 mA <br> At 110 V AC $>2.0 \mathrm{~mA} \mathrm{RMS}$ <br> At 230 V AC $>3.0 \mathrm{~mA} \mathrm{RMS}$ |
| Permitted Voltage Difference Between Groups | 2.5 kV RMS |
| Input Filtering | 0 to 50.8 msec (DC, programmable in 0.2 msec steps) <br> Note: Minimum effective filter value is 7.0 msec . |
| Diagnostic LEDs | Status LED per each input, module error LED |
| User Connection | 3 Terminal Blocks ( 5.00 mm pitch), Maximum 14 AWG |
| Cable and TB Holder | 30 Wire Cable with TB Holder connector, 20 AWG wires |
| Module Replacement | Hot swap replacement - module extraction/insertion under voltage |
| Input Isolation | 2.5 kV RMS between input and module logic per IEC60255-5 |
| Input Insulation | Insulation resistance $100 \mathrm{M} \Omega$ @ 500 V DC |
| Operating Voltage | 10.8-16 V DC and 3.3 V DC $\pm 10 \%$ (from the motherboard connector) |
| Power Consumption | Refer to Appendix D: ACE3600 Maximum Power Ratings. |
| Dimensions | 37 mm W x 225 mm H x 180 mm D , (1.5" W x 8.7" H x 7.1" D) |
| Weight | approx. $0.367 \mathrm{~kg}(0.80 \mathrm{lbs})$ |
|  | Specifications subject to change without notice. |

## DIGITAL OUTPUT/DIGITAL INPUT FET MODULE

## General Description

The Digital Output/Digital Input (DO/DI) FET module has 16 or 32 configurable user connections, organized in four groups. Each group can be configured as an 8 DO group or as an 8 DI group.

The following Digital Output/Digital Input (DO/DI) FET modules are available.

- 16 (DO/DI) FET
- 32 (DO/DI) FET

The outputs are optically isolated current sink FET type with back indication. The inputs are optically isolated Dry Contact type with internal "wetting" voltage.

For a description of I/O module construction, location, LEDs, TBs, and other common I/O module features, see the I/O Modules chapter above.

Figure 8-1 provides a general view of the ACE3600 DO/DI FET module.


16 DO/DI FET Module
Figure 8-1 ACE3600 DO/DI FET Module - General View

Figure 8-2 provides a detailed view of the ACE3600 DO/DI FET module front panel.


16 DO/DI FET Module


32 DO/DI FET Module

Figure 8-2 ACE3600 DO/DI FET Module - Front Panel

## Module Configuration

## Input/Output

The following combinations can be configured in the STS site configuration (16 DO/DI).

| I/O combination | DI location | DO location |
| :--- | :--- | :--- |
| 16DO | - | $1-16$ |
| 8DI +8 DO | $1-8$ | $9-16$ |
| 16DI | $1-16$ | - |

The following combinations can be configured in the STS site configuration (32 DO/DI).

| I/O combination | DI location | DO location |
| :--- | :--- | :--- |
| 32 DO | - | $1-32$ |
| $8 \mathrm{DI}+24 \mathrm{DO}$ | $1-8$ | $9-32$ |
| $16 \mathrm{DI}+16 \mathrm{DO}$ | $1-16$ | $17-32$ |
| $24 \mathrm{DI}+8 \mathrm{DO}$ | $1-24$ | $25-32$ |
| 32 DI | $1-32$ | - |

The appropriate combination is selected as the I/O module type, when configuring the I/Os in the ACE3600 STS site configuration.

## DI Fast Capture

Each DI can be configured as Fast Capture DI in the STS advanced I/O configuration. Fast capture causes the SCAN ladder output operation to get the first change that occurred since the previous scan. When fast capture is disabled (default), the scan gets the current value of the DI (in this case DI changes between scans are missed).

## DI Input Filters

Each inputs has a hardware input filter to make sure that the input reading is stable. The hardware DI filter range is 0 to 50.8 mS (in 0.2 mS steps). Counter DI filter range is 0 to 12.75 mS (in 0.05 mS steps). The DI filter can be set in the STS advanced I/O configuration.

Note: In this module, the minimum effective filter value is 1 mS .

## DI Event Time Tagging

Each DI can be set in the Application Programmer I/O link table to trigger recording of time tagged events upon any input change of state. The time tagged events are recorded in the CPU memory and can be retrieved for various purposes.

## DI Keep Last Value (KLV) and Predefined Value (PDV)

Each input can be configured to $\operatorname{KLV}$ or to a $\operatorname{PDV}(0,1)$ in the Application Programmer I/O link table. This value is shown to the user application program in the event of DI module failure. Also, the predefined value can be used during normal operation to force a value that masks the actual input value. In this case the user application program will get the PDV instead of the actual input value.

## DO Keep Last Value (KLV) and Predefined Value (PDV)

Each output can be configured to $\operatorname{KLV}$ or to a $\operatorname{PDV}(0,1)$. This value is executed when the user application program stops or when the module has no communication with the CPU module. Also, the predefined value can be used during normal operation to force a value on the output by ignoring the user application program value.

## DO/DI FET Module Configuration Options

The DO/DI FET module features which can be configured are listed in the table below. Some parameters are per module and some are per input.

Table 8-1 ACE3600 DO/DI FET Module Configurable Features

| Parameter | Selection | Default Setup | Per Module/ <br> Input | Parameter <br> Setup Location |
| :--- | :--- | :--- | :--- | :--- |
| DI Fast Capture | Disabled <br> /Enabled | Disabled | Input | RTU <br> configuration |
| DI Filter | $0-254(x 0.2 \mathrm{mS})$ | $50 * 0.2 \mathrm{mS}$ <br> $(=10 \mathrm{mS})$ | Module | RTU <br> configuration; <br> 'C' Program |
| DI Counter <br> Filter | $0-255(\mathrm{x} 0.05 \mathrm{mS})$ | $20 * 0.2 \mathrm{mS}$ <br> $(=1 \mathrm{~ms})$ | Module | RTU <br> configuration; |
| 'C' Program |  |  |  |  |

## Sleep Mode

Each DO/DI module can be switched by the user application program to Sleep Mode. In Sleep Mode, the module does not function and the power consumption is minimized. During Sleep mode, the user application program will get the KLV or PDV per each DI.

## Module Status and Diagnostics

In the event of a $\mathrm{DO} / \mathrm{DI}$ module failure, the ERR LED on the module will be lit. This event is registered by the CPU in the Error Logger. DO/DI module failure status is also visible to the user application program.

The DO/DI module can be diagnosed and monitored using the STS Hardware Test utility. The Hardware Test verifies that the module is operational, presents the module configuration and
shows the actual value of each input and output. It is also possible to change the input filter setup for the duration of the Hardware test and change the value of the DOs.

In the Hardware Test utility, it is possible to set the module to Freeze Mode. In this mode the user application program will get the KLV/PDV of each input in the module instead of the actual input value. The DO values will keep the last value they had when the module was switched to Freeze Mode. Freeze mode enables testing the inputs and outputs while the user application program is running.

## I/O Circuit Diagram

## DO/DI - Typical I/O Circuit



## Module Block Diagram

16 DO/DI FET


Digital Output/Digital Input FET Module

32 DO/DI FET


## Connection Charts

| 16 DO/DI FET |  |  |  |
| :--- | :--- | :--- | :--- |
| Pin | Function | Pin | Function |
| 1 | DO/DI1 | 11 | DO/DI9 |
| 2 | DO/DI2 | 12 | DO/DI10 |
| 3 | DO/DI3 | 13 | DO/DI11 |
| 4 | DO/DI4 | 14 | DO/DI12 |
| 5 | DO/DI5 | 15 | DO/DI13 |
| 6 | DO/DI6 | 16 | DO/DI14 |
| 7 | DO/DI7 | 17 | DO/DI15 |
| 8 | DO/DI8 | 18 | DO/DI16 |
| 9 | COM1 | 19 | COM2 |
| 10 | PGND1 | 20 | PGND2 |


| 32 DO/DI FET |  |  |  |
| :--- | :--- | :--- | :--- |
| Pin | Function | Pin | Function |
| 1 | DO/DI1 | 21 | DO/DI17 |
| 2 | DO/DI2 | 22 | DO/DI18 |
| 3 | DO/DI3 | 23 | DO/DI19 |
| 4 | DO/DI4 | 24 | DO/DI20 |
| 5 | DO/DI5 | 25 | DO/DI21 |
| 6 | DO/DI6 | 26 | DO/DI22 |
| 7 | DO/DI7 | 27 | DO/DI23 |
| 8 | DO/DI8 | 28 | DO/DI24 |
| 9 | COM1 | 29 | COM3 |
| 10 | PGND1 | 30 | PGND3 |
| 11 | DO/DI9 | 31 | DO/DI25 |
| 12 | DO/DI10 | 32 | DO/DI26 |
| 13 | DO/DI11 | 33 | DO/DI27 |
| 14 | DO/DI12 | 34 | DO/DI28 |
| 15 | DO/DI13 | 35 | DO/DI29 |
| 16 | DO/DI14 | 36 | DO/DI30 |
| 17 | DO/DI15 | 37 | DO/DI31 |
| 18 | DO/DI16 | 38 | DO/DI32 |
| 19 | COM2 | 39 | COM4 |
| 20 | PGND2 | 40 | PGND4 |

## I/O Connection Diagram



DO wiring


## DO/DI FET Module Specifications

| Total Number of I/Os | 16; 32 |
| :---: | :---: |
| I/O Arrangement | Two or four group of 8 I/Os with shared common <br> Each group can be configured as FET DO or dry contact DI. <br> Selectable combinations ( $32 \mathrm{DO} / \mathrm{DI}$ ): $32 \mathrm{DO} / 8 \mathrm{DI}+24 \mathrm{DO} /$ <br> 16 DI+16 DO/24 DI+8 DO/32 DI <br> Selectable combinations (16 DO/DI): 16 DO/8 DI+8 DO/16 DI |
| Counter Inputs | 32 DI: 20 first inputs can be used as counter inputs. 16 DI: All 16 inputs can be used as counter inputs. |
| Counter Input Frequency | $0-1 \mathrm{KHz}$, minimum pulse width $500 \mu \mathrm{~S}$. Note: Although filters are defined in steps of 0.2 mSec and 0.05 mSec , it is relevant only from 1 mSec and above. |
| Max. DC Input Voltage | Max. 30 V DC (relative to input common) |
| Input "ON" Resistance | 0-4 k $\Omega$ |
| Input "OFF" Resistance | $\geq 50 \mathrm{k} \Omega$ |
| Fast Capture Resolution | 1 mS (Interrupt upon change of state) |
| Event Time Tagging Resolution | 1 mS (Interrupt upon change of state) |
| Input Current | Max. 0.3 mA (when the input is shorted) |
| Input Filtering | 0 to 50.8 mS (programmable in 0.2 mSec steps), minimum effective filter value -1 mSec |
| Counter Input Filtering | 0 to 12.75 mS (programmable in 0.05 mSec steps), minimum effective filter value -1 mSec |
| Output Type | MOSFET |
| Output Voltage Range | 5-30 V DC (user supplied voltage) |
| DO Frequency | Max. 1 KHz (resistive load) |
| DO Output Current | Max. 500 mA sink current (resistive load) |
| Output Fail State | Configurable output state on CPU fail: On, Off or 'last value' |
| Diagnostic LEDs | LED per each input / output status, module error LED |
| User Connection | 4 Terminal Blocks ( 3.5 mm pitch), Maximum 18 AWG |
| Cable and TB Holder | 20 or 40 Wire Cable with Terminal Block Holder connector, 26 AWG |
| Module Replacement | Hot swap replacement- module extraction / insertion under voltage |
| Input / Output Isolation | 1.5 kV between input/output and module logic |
| Input Insulation | Insulation resistance $100 \mathrm{M} \Omega$ @ 500 V DC per IEC60255-5 |
| Operating Voltage | $10.8-16 \mathrm{~V}$ DC and 3.3 V DC (from the motherboard connector) |
| Power Consumption | Refer to Appendix D: ACE3600 Maximum Power Ratings. |
| Dimensions | $37 \mathrm{~mm} \mathrm{~W} \mathrm{x} 225 \mathrm{~mm} \mathrm{H} \times 180 \mathrm{~mm} \mathrm{D}\left(1.5{ }^{\prime \prime} \mathrm{W} \times 8.7^{\prime \prime} \mathrm{H} \times 7.1^{\prime \prime} \mathrm{D}\right.$ ) |
| Weight | Approx. $0.25 \mathrm{Kg}(0.55 \mathrm{Lb})$ |
| Werser |  |

## DIGITAL OUTPUT RELAY MODULE

## General Description

The DO Relay modules have 8 or 16 outputs.
There are two types of DO relays:

- Electrically Energized (EE) - the outputs return to the non-energized state in case of power off or module failure.
- Magnetically Latched (ML) - Relay outputs are magnetically latched, the outputs maintain their state in case of power off or module failure.

The following DO relays modules are available:

- 8 DO EE Relay 2A
- 16 DO EE Relay 2A
- 8 DO ML Relay 2A
- 16 DO ML Relay 2A

For a description of I/O module construction, location, LEDs, TBs, and other common I/O module features, see the I/O Modules chapter above.

Figure 9-1 provides a general view of the ACE3600 DO Relay Module.

Digital Output Relay Module


Figure 9-1 ACE3600 DO Relay Module - General View

Figure 9-2 provides a detailed view of the ACE3600 DO Relay Module front panel.


8DO Relay


16DO Relay

Figure 9-2 ACE3600 I/O Module - Front Panel

In the 8 DO modules, the relays of outputs 1 through 5 are Single Pole Single Throw (SPST) normally open (NO) and are referred to as the "Form A" relays. The relays of outputs 6 through 8 are Single Pole Double Throw (SPDT) and are referred to as the "Form C" relays.

In the 16 DO modules, the relays of outputs 1 through 5 and 9 through 13 are Single Pole Single Throw (SPST) normally open (NO) "Form A" relays. The relays of outputs 6 through 8 and 14 through 16 are Single Pole Double Throw (SPDT) "Form C" relays.

The physical position of each relay is monitored by the module logic, using a back indication signal which is connected to the relay's second contact set. Any contradiction between the required position and the back indication signal is reported to the CPU and is available to the user program.

In some applications it is necessary to inhibit relay output operation when attending the site for safety reasons. In all DO relay modules, it is possible to inhibit all relays per DO module. When a module is configured to enable relay inhibiting, the power to the relays is provided from the power supply via a dedicated power line ( 12 V DO), controlled from the " 12 V DO" input (TB located on the power supply module panel). When the input's terminals are shorted, the relays are operational. When the input's terminals are open, the relays are inhibited (EE relays in 0 position and ML relays do not change state.)

Note: In systems with I/O expansion, the power supplies on I/O expansion frames can be attached via DC cable to the power supply on the previous I/O expansion frame in a daisychain manner, or directly to the main power supply. In this case, the 12 V DO control on the main power supply can control all DO EE relays in the entire RTU that were configured by dip switch for 12 V DO. This enables the user to inhibit all DO EE relays in the entire RTU simply by removing the plug from the 12 V DO control in the main power supply. For more information, see the I/O Expansion and Expansion Power Supply Module chapters below.

The user program can monitor the relay inhibiting status and act accordingly. Also, when the module's relays are inhibited, any mismatch between the relay position and the output logical state is ignored.

## Module Configuration

## Relay Inhibiting



## NOTE

When the dip switch is set to 12 V DO, the position of the 2-pin 12V DO Control connector on the front panel of the power supply module (see Power Supply Module chapter above) acts as a safety mechanism. When the 2-pin TB is unplugged from the 12 V DO Control (e.g. for maintenance), power is not supplied via the motherboard to the relays and the relays are disabled. The 12 V DO affects all relays in the system that are programmed to work from the 12V DO and not the (default) 12V Main.

EE relays that are programmed for 12 V DO operation will disconnect when

12V DO power is shut down and cannot be changed in this state. ML relays that are programmed for 12 V DO operation will freeze in their current state when 12 V DO power is shut down and cannot be changed. Therefore, setting the dip switch for ML will not necessarily inhibit them.
A dual selector dip switch (S3) on the DO Relay module has 4 selectable positions as described in the following table:

Table 9-1 DO Relay Module- Dip Switch Settings

| S3 <br> SW 1 | S3 <br> SW 2 | Configuration mode |
| :--- | :--- | :--- |
| OFF | OFF | 12V_DO - Relay inhibiting enabled |
| ON | OFF | Software selectable - inhibiting is set in site configuration |
| OFF | ON | 12V_DO - Relay inhibiting enabled |
| ON | ON | $12 \mathrm{~V}-$ (factory default) Relay inhibiting disabled |



Figure 9-3 12V DO Dip Switch

When S3 is set to Software Selectable mode, the inhibiting configuration is set using the module configuration in the STS Site Configuration (see Table 9-2 below).

Procedure 9-1 describes how to set the 12V DO dip switch to enable relay inhibiting.
Procedure 9-1 How to Set the 12V DO Dip Switch to Enable Relay Inhibiting.

1) If the 2-pin TB is plugged into the 12 V DO Control on the front panel of the power supply module, unplug it.
2) Remove the DO module from the slot in the rack.
3) Carefully remove the plastic wrap covering from the S3 dip switch (see Figure 9-3) on the DO module board. Note: Ignore text on the board that OFF/OFF is the factory default.
4) Set the S 3 dip switch to the desired position, according to the legend in Table 9-1.
5) Replace the DO module in the rack.
6) If the new dip switch position causes DO relay power to be drawn from the 12 VDO , plug the 2-pin TB back into the 12 V DO Control on the front panel of the power supply module.

## DO Keep Last Value (KLV) and Predefined Value (PDV)

Each output can be configured to $\operatorname{KLV}$ or to a $\operatorname{PDV}(0,1)$. This value is executed when the user program stops or when the module has no communication with the CPU module. Also, the

PDV can be used during normal operation to force a value on the output by ignoring the user program value (mask).

## Reset DO at Startup

It is possible to configure the module to reset all the ML relays positions on startup. This is set in the STS site configuration.

Table 9-2 ACE3600 DO Relay Module Software Configurable Features

| Parameter | Selection | Default Setup | Per Module/ <br> Input | Parameter <br> Setup Location |
| :--- | :--- | :--- | :--- | :--- |
| DO Keep Last <br> Value \& Pre <br> Defined Value | KLV/PDV <br> PDV $=0 / 1$ | KLV | Output | Application <br> Programmer I/O <br> link table |
| DO Mask | No /Yes | No | Output | Application <br> Programmer I/O <br> link table |
| Reset DO at <br> Startup | No/Yes | Yes | Module | Site <br> configuration |
| Relay Inhibiting <br> (SW selectable) | 12V DO <br> (Enabled)/ 12V <br> (Disabled) | 12V DO <br> (Enabled) | Module | Site <br> configuration |

## Sleep Mode

Each DO module can be switched by the user program to Sleep Mode. In Sleep Mode, the module is not functioning and the power consumption is minimized.

## Module Status and Diagnostics

In the event of module failure, the module's ERR LED will be lit. This event is registered by the CPU in the Error Logger. Module failure status is also visible to the user program.

The DO module can be diagnosed and monitored using the STS Hardware Test utility. This test verifies that the module is operational, presents the module configuration and shows the actual value of each output. It is also possible to change the DO's value.

In the Hardware Test utility, it is possible to set the module to Freeze Mode. In this mode, the DOs will keep the last value they had at the time they were frozen. Freeze mode enables testing the inputs and outputs while the user program is running.

For details on configuring the DO modules, see the Configuring a Site section and the Application Programmer section of the ACE3600 STS User Guide.

## I/O Circuit Diagram

## DO EE Relay (SPST) - Typical Output Circuit



Digital Output Relay Module

## DO EE Relay (SPDT) - Typical Output Circuit



## DO ML Relay (SPDT) - Typical Output Circuit



Digital Output Relay Module

## Module Block Diagram

8 DO



## Connection Charts

| 8 DO |  |  |  |
| :--- | :--- | :--- | :--- |
| Pin | Function | Pin | Function |
| 1 | NO1 | 11 | NO6 |
| 2 | COM1 | 12 | COM6 |
| 3 | NO2 | 13 | NC6 |
| 4 | COM2 | 14 | NO7 |
| 5 | NO3 | 15 | COM7 |
| 6 | COM3 | 16 | NC7 |
| 7 | NO4 | 17 | NO8 |
| 8 | COM4 | 18 | COM8 |
| 9 | NO5 | 19 | NC8 |
| 10 | COM5 | 20 | PGND1 |
|  |  |  |  |


| 16 DO |  |  |  |
| :--- | :--- | :--- | :--- |
| Pin | Function | Pin | Function |
| 1 | NO1 | 21 | NO9 |
| 2 | COM1 | 22 | COM9 |
| 3 | NO2 | 23 | NO10 |
| 4 | COM2 | 24 | COM10 |
| 5 | NO3 | 25 | NO11 |
| 6 | COM3 | 26 | COM11 |
| 7 | NO4 | 27 | NO12 |
| 8 | COM4 | 28 | COM12 |
| 9 | NO5 | 29 | NO13 |
| 10 | COM5 | 30 | COM13 |
| 11 | NO6 | 31 | NO14 |
| 12 | COM6 | 32 | COM14 |
| 13 | NC6 | 33 | NC14 |
| 14 | NO7 | 34 | NO15 |
| 15 | COM7 | 35 | COM15 |
| 16 | NC7 | 36 | NC15 |
| 17 | NO8 | 37 | NO16 |
| 18 | COM8 | 38 | COM16 |
| 19 | NC8 | 39 | NC16 |
| 20 | PGND1 | 40 | PGND2 |
|  |  |  |  |
| 10 |  |  |  |

## DO Relay Module Specifications

| Total Number of Outputs | 8 EE relay outputs |
| :---: | :---: |
|  | 16 EE relay outputs |
|  | 8 ML relay outputs |
|  | 16 ML relay outputs |
| Output Arrangement | 8 DO : 3 X Form C (SPDT) and 5 X Form A (SPST) |
|  | 16 DO: 6 X Form C (SPDT) and 10 X Form A (SPST) |
| Contact Voltage Ratings | Max. 60 V DC or 30 V AC RMS (42.4 V peak). |
| Contact Power Ratings | 2A@30 V DC, 0.6A@ 60V DC or 0.6A@30V AC (resistive load) |
| Relay Back Indication | Contact position - hardware back indication |
| DO Frequency | Max. 10 Hz |
| Diagnostic LEDs | LED per each output status, module error LED |
| User Connection | 2 or 4 Terminal Blocks ( 3.5 mm pitch), Maximum 18 AWG |
| Cable and TB Holder | 20 or 40 Wire Cable with Terminal Block Holder connector, 26 AWG |
| Fail State | Configurable relay state on CPU fail: On, Off or 'last value' |
| All Relays Disable/Enable | Selectable per module, controlled from the power supply |
| Module Replacement | Hot swap replacement - module extraction/insertion under voltage |
| Output Isolation | Between open contacts: 1 kV , <br> Between contact and coil: 1.5 kV , <br> Between contact sets: 1.5 kV |
| Insulation | Insulation resistance $100 \mathrm{M} \Omega$ @ 500 V DC per IEC60255-5, Insulation impulse 1.5 kV per IEC60255-5 |
| Operating Voltage | 10.8-16 V DC and 3.3 V DC (from the motherboard connector) |
| Power Consumption | Refer to Appendix D: ACE3600 Maximum Power Ratings. |
| Dimensions | $\begin{aligned} & 37 \mathrm{~mm} \text { W x } 225 \mathrm{~mm} \mathrm{H} \times 180 \mathrm{~mm} \text { D } \\ & \left(1.5^{\prime \prime} \mathrm{W} \times 8.7^{\prime \prime} \mathrm{H} \times 7.1^{\prime \prime} \mathrm{D}\right) \end{aligned}$ |
| Weight | $\begin{aligned} & 8 \mathrm{DO}: \text { : approx. } 0.29 \mathrm{Kg}(0.64 \mathrm{Lb}) \\ & 16 \mathrm{DO}: \text { approx. } 0.32 \mathrm{Kg}(0.7 \mathrm{Lb}) \end{aligned}$ |

Specifications subject to change without notice.

## 8 DIGITAL OUTPUT SBO RELAY MODULE

## General Description

The 8 DO Select Before Operate (SBO) Relay modules have Electrically Energized (EE) 2 Form A relay outputs. The modules are supported by ACE3600 firmware v14.00 and above. The 8 DO SBO module is used to ensure that the correct DO has been selected before actually activating the relay.

Each DO in the module has two relays. When the module is in Idle state, the operate signal is disabled and no relay is activated. On "DO Select" command, both DO relays are selected. The select command is physically monitored by a back indication signal ("Check Select".) After validation that only the requested relays were selected, the "Operate" command is set and enables the relay activation. The physical back indications from both relay contacts can be monitored by the application program to verify successful operation.

Note that only a single SBO DO can be selected at a time.
Each output has two types of back indications:
a. Back indication of the relay select command.
b. Back indication from the relay auxiliary contact (each relay has 2 contacts- one connected to user and the other as back indication.)

By default, the operation of the relays uses the 12 V controlled source (controlled by the jumper on the main power supply.) If the 12 V control in the main power supply is switched to OFF, there will be no activating voltage to the relays, regardless the status of the Operate signal.

For a description of the SBO feature, see Select Before Operate DOs in the ACE3600 I/Os chapter of the ACE3600 STS Advanced Features manual.

For a description of I/O module construction, location, LEDs, TBs, and other common I/O module features, see the I/O Modules chapter above.

Figure 11-1 provides a general view of the ACE3600 DO SBO Relay Module.


Figure 11-1 ACE3600 8DO SBO Relay Module - General View

Figure 11-2 provides a detailed view of the ACE3600 8DO SBO Relay Module front panel.


Figure 11-2 ACE3600 8DO SBO Relay Module - Front Panel

In the 8 DO SBO modules, the relays of the 8 outputs are Single Pole Single Throw (SPST) normally open (NO) and are referred to as the "Form A" relays.

In some applications, it is necessary to inhibit relay output operation when attending the site for safety reasons. In all DO relay modules, it is possible to inhibit all relays per DO module. When a module is configured to enable relay inhibiting (the default in the SBO module), the power to the relays is provided from the power supply via a dedicated power line ( 12 V DO), controlled from the " 12 V DO" input (TB located on the power supply module panel). When the input's terminals are shorted, the relays are operational. When the input's terminals are open, the relays are inhibited (EE relays in the 0 position.)

Note: In systems with I/O expansion, the power supplies on I/O expansion frames can be attached via DC cable to the power supply on the previous I/O expansion frame in a daisychain manner, or directly to the main power supply. In this case, the 12 V DO control on the main power supply can control all DO EE relays in the entire RTU that were configured by dip switch for 12 V DO. This enables the user to inhibit all DO EE relays in the entire RTU simply by removing the plug from the 12 V DO control in the main power supply. For more information, see the I/O Expansion and Expansion Power Supply Module chapters below.

The user program can monitor the relay inhibiting status and act accordingly. Also, when the module's relays are inhibited, any mismatch between the relay position and the output logical state is ignored.

## Module Configuration

## Relay Inhibiting



When the dip switch is set to 12 V DO, the position of the 2-pin 12V DO Control connector on the front panel of the power supply module (see Power Supply Module chapter above) acts as a safety mechanism. When the 2 -pin TB is unplugged from the 12 V DO Control (e.g. for maintenance), power is not supplied via the motherboard to the relays and the relays are disabled. The 12 V DO affects all relays in the system that are programmed to work from the 12 V DO (the default in the SBO module) and not the 12 V Main.

EE relays that are programmed for 12 V DO operation will disconnect when 12 V DO power is shut down and cannot be changed in this state.

The state of the Controlled DO LED (CDO) on the bottom of the front panel reflects the 12 V control as follows:
a. OFF -12 V is not controlled.
b. $\mathrm{ON}-12 \mathrm{~V}$ is controlled and exists.
c. Blinking -12 V is controlled and does not exist.

A dual selector dip switch (S3) on the DO Relay module has 4 selectable positions as described in the following table:

Table 11-1 DO Relay Module- Dip Switch Settings

| S3 <br> SW 1 | S3 <br> SW 2 | Configuration mode |
| :--- | :--- | :--- |
| OFF | OFF | 12V - Relay inhibiting disabled |
| ON | OFF | Software selectable - inhibiting is set in site configuration |
| OFF | ON | 12V - Relay inhibiting disabled |
| ON | ON | 12V_DO - Relay inhibiting enabled (factory default) |



Figure 11-3 12V DO Dip Switch

When S3 is set to Software Selectable mode, the inhibiting configuration is set using the module configuration in the STS Site Configuration (see Table 11-2 below).

For instructions on setting the 12 V DO dipswitch to enable relay inhibiting, see Procedure 9-1 in the Digital Output Relay Module chapter above.

## DO Keep Last Value (KLV) and Predefined Value (PDV)

Each output can be configured to $\operatorname{KLV}$ or to a $\operatorname{PDV}(0,1)$. This value is executed when the user program stops or when the module has no communication with the CPU module. Also, the PDV can be used during normal operation to force a value on the output by ignoring the user program value (mask).

## Reset DO at Startup

Table 11-2 ACE3600 DO Relay Module Software Configurable Features

| Parameter | Selection | Default Setup | Per Module/ <br> Input | Parameter <br> Setup Location |
| :--- | :--- | :--- | :--- | :--- |


| Parameter | Selection | Default Setup | Per Module/ <br> Input | Parameter <br> Setup Location |
| :--- | :--- | :--- | :--- | :--- |
| DO Keep Last <br> Value \& Pre <br> Defined Value | KLV/PDV <br> PDV = 0/1 | PDV = 0 | Output | Application <br> Programmer I/O <br> link table |
| DO Mask | No /Yes | No | Output | Application <br> Programmer I/O <br> link table |
| Relay Inhibiting <br> (SW selectable) | 12V DO <br> (Enabled)/ 12V <br> (Disabled) | 12V DO <br> (Enabled) | Module | Site <br> configuration |

## Sleep Mode

Each DO module can be switched by the user program to Sleep Mode. In Sleep Mode, the module is not functioning and the power consumption is minimized.

## Module Status and Diagnostics

In the event of module failure, the module's ERR LED will be lit. This event is registered by the CPU in the Error Logger. Module failure status is also visible to the user program.

The DO module can be diagnosed and monitored using the STS Hardware Test utility. This test verifies that the module is operational, presents the module configuration and shows the actual value of each output. It is also possible to change the DO's value.

In the Hardware Test utility, it is possible to set the module to Freeze Mode. In this mode, the DOs will keep the last value they had at the time they were frozen. Freeze mode enables testing the inputs and outputs while the user program is running.

For details on configuring the DO modules, see the Configuring a Site section and the Application Programmer section of the ACE3600 STS User Guide.

## I/O Circuit Diagram

DO SBO EE Relay (SPST) - Typical Output Circuit


## Module Block Diagram



## Connection Charts

|  | 8 DO SBO |  |  |
| :--- | :--- | :--- | :--- |
| Pin | Function | Pin | Function |
| 1 | NO1A | 21 | NO5A |
| 2 | COM1A | 22 | COM5A |
| 3 | NO1B | 23 | NO5B |
| 4 | COM1B | 24 | COM5B |
| 5 | NO2A | 25 | NO6A |
| 6 | COM2A | 26 | COM6A |
| 7 | NO2B | 27 | NO6B |
| 8 | COM2B | 28 | COM6B |
| 9 |  | 29 |  |
| 10 | PGND | 30 | PGND |
| 11 | NO3A | 31 | NO7A |
| 12 | COM3A | 32 | COM7A |
| 13 | NO3B | 33 | NO7B |
| 14 | COM3B | 34 | COM7B |
| 15 | NO4A | 35 | NO8A |
| 16 | COM4A | 36 | COM8A |
| 17 | NO4B | 37 | NO8B |
| 18 | COM4B | 38 | COM8B |
| 19 |  | 39 |  |
| 20 | PGND | 40 | PGND |
|  |  |  |  |

## 8 DO SBO Relay Module Specifications

| Total Number of Outputs | 8 EE relay outputs |
| :---: | :---: |
| Output Arrangement | 8 DO : 2 X Form A (SPST) - (two Normally Open contacts per DO) |
| Contact Voltage Ratings | Max. 60 V DC or 30 V AC RMS ( 42.4 V peak). |
| Contact Power Ratings | 2A@30 V DC, 0.6A@ 60V DC or 0.6A @ 30V AC (resistive load) |
| Relay Back Indication | Contact Back Indication: Indicating Contact position |
| Relay Select Back Indication | Indicating relay selection before relay activation |
| DO Frequency | Max. 10 Hz |
| Diagnostic LEDs | LED per each output status, module error LED, Controlled DO LED <br> Controlled DO LED states: <br> a. OFF - 12 V is not controlled. <br> b. ON - 12 V is controlled and exists. <br> c. Blinking - 12 V is controlled and does not exist. |
| User Connection | 4 Terminal Blocks ( 3.5 mm pitch), Maximum 18 AWG |
| Cable and TB Holder | 40 Wire Cable with Terminal Block Holder connector, 26 AWG |
| Fail State | Configurable relay state on CPU fail: On, Off or 'last value' |
| All Relays Disable/Enable | Selectable per module, controlled from the power supply |
| Module Replacement | Hot swap replacement - module extraction/insertion under voltage |
| Output Isolation | Between open contacts: 1 kV , <br> Between contact and coil: 1.5 kV , <br> Between contact sets: 1.5 kV |
| Insulation | Insulation resistance $100 \mathrm{M} \Omega$ @ 500 V DC per IEC60255-5, Insulation impulse 1.5 kV per IEC60255-5 |
| Operating Voltage | $10.8-16 \mathrm{~V}$ DC and 3.3 V DC (from the motherboard connector) |
| Power Consumption | Refer to Appendix D: ACE3600 Maximum Power Ratings. |
| Dimensions | $\begin{aligned} & 37 \mathrm{~mm} \text { W x } 225 \mathrm{~mm} \mathrm{H} \times 180 \mathrm{~mm} \mathrm{D} \\ & \left(1.5^{\prime \prime} \mathrm{W} \times 8.7^{\prime \prime} \mathrm{H} \times 7.1^{\prime \prime} \mathrm{D}\right) \end{aligned}$ |
| Weight | 8 DO : approx. $0.29 \mathrm{Kg}(0.64 \mathrm{Lb})$ |

Specifications subject to change without notice.

## DIGITAL OUTPUT RELAY 120/230V MODULE

## General Description

The ACE3600 DO Relay 120/230V (High Voltage DO) modules have 12 outputs. Each output is switched by a relay.

There are two types of DO relays:

- Electrically Energized (EE) - the outputs return to the non-energized state in case of power off or module failure.
- Magnetically Latched (ML) - Relay outputs are magnetically latched, the outputs maintain their state in case of power off or module failure.

The following DO relays modules are available:

- 12 DO EE Relay $120 / 230 \mathrm{~V} 3 \mathrm{~A}$
- 12 DO ML Relay $120 / 230$ V 3A

For a description of I/O module construction, location, LEDs, TBs, and other common I/O module features, see the I/O Modules chapter above.

Figure 10-1 provides a general view of the ACE3600 High Voltage DO Relay Module.


Figure 10-1 ACE3600 High Voltage 12 DO Relay Module - General View

Figure 10-2 provides a detailed view of the ACE3600 High Voltage DO Relay Module front panel.


Figure 10-2 ACE3600 High Voltage 12 DO Module - Front Panel

In the High Voltage 12 DO modules, the relays of all outputs (1 through 12) are normally open (NO) "Form A".

The physical position of each relay is monitored by the module logic, using a back indication signal which is connected to the relay's second contact set. Any contradiction between the required position and the back indication signal is reported to the CPU and is available to the user program.

In some applications it is necessary to inhibit relay output operation when attending the site for safety reasons. In all EE DO relay modules, it is possible to inhibit all relays per DO module. When a module is configured to enable relay inhibiting, the power to the relays is provided from the power supply via a dedicated power line ( 12 V DO), controlled from the " 12 V DO" input. (The 12V DO TB is located on the front panel of the power supply modules, except for the low-tier and expansion models.) When the input's terminals are shorted, the relays are operational. When the input's terminals are open, the relays are inhibited (EE relays in 0 position.)

ML relays cannot be inhibited.
Note: In systems with I/O expansion, the power supplies on I/O expansion frames can be attached via DC cable to the power supply on the previous I/O expansion frame in a daisychain manner, or directly to the main power supply. In this case, the 12 V DO control on the main power supply can control all DO EE relays in the entire RTU that were configured by dip switch for 12 V DO. This enables the user to inhibit all DO EE relays in the entire RTU simply by removing the plug from the 12 V DO control in the main power supply. For more information, see the I/O Expansion and Expansion Power Supply Module chapters below.

The user program can monitor the relay inhibiting status and act accordingly. Also, when the module's relays are inhibited, any mismatch between the relay position and the output logical state is ignored.

## Module Configuration

## Relay Inhibiting for EE Relays



When the dip switch on EE relays is set to 12 V DO, the position of the 2-pin 12V DO Control connector on the front panel of the power supply module (see Power Supply Module chapter above) acts as a safety mechanism. When the 2-pin TB is unplugged from the 12V DO Control (e.g. for maintenance), power is not supplied via the motherboard to the relays and the relays are disabled. The 12 V DO affects all relays in the system that are programmed to work from the 12V DO and not the (default) 12V Main.

EE relays that are programmed for 12 V DO operation will disconnect when 12 V DO power is shut down and cannot be changed in this state.

ML relays cannot be inhibited.

A dual selector dip switch (S3) on the EE DO Relay module has four selectable positions as described in the following table:

Table 10-1 DO Relay Module- Dip Switch Settings

| S3 <br> SW 1 | S3 <br> SW 2 | Configuration mode |
| :--- | :--- | :--- |
| OFF | OFF | 12V_DO - Relay inhibiting enabled |
| ON | OFF | Software selectable - inhibiting is set in site configuration |
| OFF | ON | 12V_DO - Relay inhibiting enabled |
| ON | ON | $12 \mathrm{~V}-$ (factory default) Relay inhibiting disabled |



Figure 10-3 12V DO Dip Switch

When S3 is set to Software Selectable mode, the inhibiting configuration is set using the module configuration in the STS Site Configuration (see Table 10-2 below).

Procedure 10-1 describes how to set the 12 V DO dip switch in order to enable relay inhibiting of EE relays.

Procedure 10-1 How to Set the 12V DO Dip Switch to Enable Relay Inhibiting.

1) If the 2-pin TB is plugged into the 12 V DO Control on the front panel of the power supply module, unplug it.
2) Remove the DO module from the slot in the rack.
3) Carefully remove the plastic wrap covering from the S3 dip switch (see Figure 10-3) on the DO module board.
4) Set the S 3 dip switch to the desired position, SW1 $=$ OFF, SW2 $=\mathrm{OFF}$, according to the legend in Table 10-1.
5) Replace the DO module in the rack.
6) Replace the 2 -pin TB back into the 12 V DO Control on the front panel of the power supply module.

## DO Keep Last Value (KLV) and Predefined Value (PDV)

Each output can be configured to $\operatorname{KLV}$ or to a $\operatorname{PDV}(0,1)$. This value is executed when the user program stops or when the module has no communication with the CPU module. Also, the PDV can be used during normal operation to force a value on the output by ignoring the user program value (mask).

## Reset DO at Startup

It is possible to configure the module to reset all the ML relays positions on startup. This is set in the STS site configuration.

Table 10-2 ACE3600 High Voltage DO Relay Module Configurable Features

| Parameter | Selection | Default Setup | Per Module/ <br> Input | Parameter <br> Setup Location |
| :--- | :--- | :--- | :--- | :--- |
| DO Keep Last <br> Value \& Pre | KLV/PDV <br> PDV $=0 / 1$ | KLV | Output | Application <br> Programmer I/O |


| Defined Value |  |  |  | link table |
| :--- | :--- | :--- | :--- | :--- |
| DO Mask | No /Yes | No | Output | Application <br> Programmer I/O <br> link table |
| Reset DO at <br> Startup | Disable/Enable | Disable | Module | Site <br> configuration |
| Relay Inhibiting <br> (SW selectable) | Disable/Enable | Disable | Module | Site <br> configuration |

## Sleep Mode

Each High Voltage DO module can be switched by the user program to Sleep Mode. In Sleep Mode, the module is not functioning and the power consumption is minimized.

## Module Status and Diagnostics

In the event of module failure, the module's ERR LED will be lit. This event is registered by the CPU in the Error Logger. Module failure status is also visible to the user program.

The High Voltage DO module can be diagnosed and monitored using the STS Hardware Test utility. This test verifies that the module is operational, presents the module configuration and shows the actual value of each output. It is also possible to change the High Voltage DO's value.

In the Hardware Test utility, it is possible to set the module to Freeze Mode. In this mode, the High Voltage DOs will keep the last value they had at the time they were frozen. Freeze mode enables testing the inputs and outputs while the user program is running.

For details on configuring the High Voltage DO modules, see the Configuring a Site section and the Application Programmer section of the ACE3600 STS User Guide.

## I/O Circuit Diagram



Digital Output Relay 120/230V Module

## Module Block Diagram



## Connection Charts

| Pin | Function | Pin | Function |
| :---: | :---: | :---: | :---: |
| 1 | NO1 | 21 | NO9 |
| 2 |  | 22 |  |
| 3 | NO2 | 23 | NO10 |
| 4 |  | 24 |  |
| 5 | Not used | 25 | Not used |
| 6 | Not used | 26 | Not used |
| 7 | NO3 | 27 | NO11 |
| 8 |  | 28 |  |
| 9 | NO4 | 29 | NO12 |
| 10 |  | 30 |  |
| 11 | NO5 |  |  |
| 12 |  |  |  |
| 13 | NO6 |  |  |
| 14 |  |  |  |
| 15 | Not used |  |  |
| 16 | Not used |  |  |
| 17 | NO7 |  |  |
| 18 |  |  |  |
| 19 | NO8 |  |  |
| 20 |  |  |  |

## DO Relay 120/230V Module Specifications

| Total Number of Outputs | 12 EE relay outputs |
| :---: | :---: |
|  | 12 ML relay outputs |
| Output Arrangement | $12 \times 1$ Form A |
| Contact Power Ratings | 3A@ $250 \mathrm{~V} \mathrm{AC}, 3 \mathrm{~A}$ @ 30 V DC, or 0.20A@ 125 V DC (resistive load) |
| Minimum Contact Load Current | 10.0 mA @+5.00 V DC |
| Maximum Switching Current | 3.00 A |
| Relay Back Indication | Contact position - hardware back indication |
| DO Frequency | Max. 10 Hz (resistive load) |
| Diagnostic LEDs | LED per each output status, module error LED |
| User Connection | 3 Terminal Blocks ( 5.00 mm pitch), Maximum 14 AWG |
| Cable and TB Holder | 30 Wire Cable with Terminal Block Holder connector, 20 AWG |
| Fail State | Configurable relay state on CPU fail: On, Off or 'last value' |
| All Relays Disable/Enable | Selectable per module, controlled from the power supply |
| Module Replacement | Hot swap replacement - module extraction/insertion under voltage |
| Output Isolation | Between output and module logic 2.5 kV per IEC60255-5 |
| Insulation | Insulation resistance $100 \mathrm{M} \Omega$ @ 500 V DC per IEC60255-5, Insulation impulse 5 kV per IEC60255-5 |
| Operating Voltage | $10.8-16 \mathrm{~V} \mathrm{DC}$ and $3.3 \mathrm{~V} \mathrm{DC} \pm 10 \%$ (from the motherboard connector) |
| Power Consumption | Refer to Appendix D: ACE3600 Maximum Power Ratings. |
| Dimensions | $37 \mathrm{~mm} \mathrm{~W} \times 225 \mathrm{~mm} \mathrm{H} \mathrm{x} 180 \mathrm{~mm} \mathrm{D}\left(1.5^{\prime \prime} \mathrm{W} \times 8.7^{\prime \prime} \mathrm{H} \times 7.1^{\prime \prime} \mathrm{D}\right)$ |
| Weight | approx. $0.423 \mathrm{~kg}(0.90 \mathrm{lbs})$ |

Specifications subject to change without notice.

## ANALOG INPUT MODULE

## General Description

The Analog Input (AI) modules have 8 or 16 inputs. The modules sample and convert analog data into digital format and transfer the digital data to the CPU module.

The following modules are available:

- $8 \mathrm{AI} \pm 20 \mathrm{~mA}$ (supports $4-20 \mathrm{~mA}$ )
- $16 \mathrm{AI} \pm 20 \mathrm{~mA}$ (supports 4-20 mA)
- $8 \mathrm{AI} \pm 5 \mathrm{~V}$ (supports $0-5 \mathrm{~V}$ and $1-5 \mathrm{~V}$ )
- $16 \mathrm{AI} \pm 5 \mathrm{~V}$ (supports $0-5 \mathrm{~V}$ and $1-5 \mathrm{~V}$ )

The module's analog-to-digital conversion resolution is 16 bit (including sign). Each input is fully isolated from the other inputs on the module and also optically isolated from the module internal circuits. The modules are fully calibrated and can be tested and recalibrated in the field.

The measured values are digitally filtered to reduce the 50 or 60 Hz noise. The user can select the filtering frequency per module.

The measured values can be smoothed by digital filtering. Smoothing is accomplished by calculating the running average values of a defined number of converted analog values (samples). The user can select the level of smoothing per module. The higher the smoothing level chosen, the more stable is the smoothed analog value and the longer it takes until the smoothed analog signal is applied after a step response.

The user can select how the analog values are represented to the user application program as unit-less numeric values or as scaled values that represent certain Engineering Units (EGU).

Each AI module can include an optional plug-in floating 24V DC power supply to power external devices.

Each analog input has two status LEDs:

- UF - indicates Underflow when lit
- OF - indicates Overflow when lit

For a description of I/O module construction, location, LEDs, TB holder, and other common I/O module features, see the I/O Modules chapter above.

For details on specific AI parameters and configuration, see AI Module Configuration below.
Figure 12-1 provides a general view of the ACE3600 AI module.


8 AI Module


16 Al Module

Figure 12-1 ACE3600 AI Module - General View
Figure 12-2 provides a detailed view of the AI module front panel.


8 AI Module
Figure 12-2 ACE3600 AI Module Front

## AI Module Configuration

## 50/60 Hz Filtering

This parameter enables the user to configure the module to use 50 or 60 Hz filter on all inputs.

## AI Filter (Smoothing)

This parameter enables the user to configure the level smoothing (averaging) on all inputs. It can be set to $1,2,4,8,16,32,64,128$ samples.

## Change Of State (COS) Delta

This parameter sets a delta value to each input. This enables the user application program to get an indication when the input value change is more than $\pm$ delta value.

## Input Range

This parameter sets the overflow and underflow limits (refer to AI Module value representation below.)

In the current input modules, the ranges that can be selected are: $\pm 20 \mathrm{~mA}$ (default) and 4-20 mA .

In voltage input modules, the ranges that can be selected are $\pm 5 \mathrm{~V}$ (default), $0-5 \mathrm{~V}$ and $1-5 \mathrm{~V}$.

## Keep Last Value (KLV) and Predefined Value (PDV)

Each input can be configured to KLV or to a PDV. This value is shown to the user application program in the event of AI module failure. The predefined value can also be used during normal operation to force a value that masks the actual input value. In this case the user application program will get the PDV instead of the actual input value.

## I/O Legacy Resolution Parameter

In systems with both ACE3600 RTUs and legacy (MOSCAD/MOSCAD-L) RTUs, some MOSCAD/MOSCAD-L applications can be upgraded to ACE3600 without modifying the references to analog values in the applications ('C' or ladder). The I/O Legacy Resolution STS advanced parameter sets the Analog I/O bit resolution to either Actual (ACE3600) or Legacy (MOSCAD/MOSCAD-L).

For values and restrictions, see Appendix A: Site Configuration Parameters in the ACE3600 STS User Guide.

## AI Module Configuration Options

The AI module features which can be configured are listed in the table below. Some parameters are per module and some are per input.

Table 12-1 ACE3600 AI Module Configurable Parameters

| Parameter | Selection | Default setup | Per Module / <br> Input | Parameter <br> Setup location |
| :--- | :--- | :--- | :--- | :--- |
| $50 / 60 \mathrm{~Hz}$ <br> Filtering | $50 / 60$ | 50 Hz | Module | STS Site <br> configuration |
| AI Filter <br> (Smoothing) | $1 / 2 / 4 / 8 / 16 / 32 / 64 / 128$ <br> $(\mathrm{x} 10 \mathrm{mS})$ | 32 | Module | STS Site <br> configuration |
| Input Range | Current: $\pm 20 \mathrm{~mA} /$ <br> $4-20 \mathrm{~mA}$ <br> Voltage: $\pm 5 \mathrm{~V} / 0-5 \mathrm{~V} /$ <br> $1-5 \mathrm{~V}$ | Current: $\pm 20 \mathrm{~mA}$ <br> Voltage: $\pm 5 \mathrm{~V}$ | Module | STS Site <br> configuration |
| COS Delta | value | 0 (disabled) | Input | Application <br> Programmer I/O <br> link table |
| KLV \& PDV | KLV/PDV <br> PDV=value | KLV | Input | Application <br> Programmer I/O <br> link table |
| Mask | No /Yes | No | Input | Application <br> Programmer I/O <br> link table |

## Sleep Mode

Each AI module can be switched by the user application program to Sleep Mode. In Sleep Mode, the module does not function and the power consumption is minimized. During Sleep mode the user application program will get the predefined values for each I/O.

## Module Status and Diagnostics

In the event of AI Module failure, the I/O module ERR LED will be lit. The event is registered by the CPU in the Error Logger. AI Module failure status is also visible to the user application program.

In addition to the ERR LED, the module includes an Underflow (UDF) and Overflow (OVF) LED for each input.

- When the UDF LED is lit, it indicates that the signal level in the corresponding input is below the nominal range.
- When the OVF LED is lit, this indicates that the signal level in the corresponding AI is above the nominal range.
- If both the UDF and OVF LEDs of the same channel are lit, the channel is uncalibrated.

The AI module can be diagnosed and monitored using the STS Hardware Test utility. The Hardware Test verifies that the module is operational, presents the module configuration and shows the actual value of each input, including overflow and underflow. It is also possible to change the input filter setup for the duration of the Hardware test.

In the HW Test utility, it is possible to set the AI module to Freeze Mode. In this mode the program user will get the KLV or PDV of each input in the module instead of the actual input value. Freeze mode enables testing the inputs while the user application program is running.

## AI Module Value Representation

| In $\mathbf{2 0} \mathbf{~ m A}$ <br> current inputs | Decimal Value | Input Current | Indication |
| :---: | ---: | ---: | :--- |
|  | $<-32256$ | $<-20.16 \mathrm{~mA}$ | Underflow LED ON |
|  | -32000 | -20 mA |  |
|  | 0 | 0 mA |  |
| active) |  |  |  |


| In 1-5 V <br> current inputs | Decimal Value | Input Voltage | Indication |
| :---: | :---: | :---: | :--- |
|  | $<6144$ | $<0.96 \mathrm{~V}$ | Underflow LED ON |
|  | 6400 | 1 V | Rated range (no LED <br> active) |
|  | 32000 | +5 V | Overflow LED ON |

## I/O Circuit Diagram

## AI $\pm 20 \mathrm{~mA}$ - Typical Input Circuit


$\mathrm{Al} \pm 10 \mathrm{~V}-$ Typical Input Circuit


Analog Input Module

## Module Block Diagram

8 AI


16 AI


## Connection Charts

| 8 AI |  |  |  |
| :--- | :--- | :--- | :--- |
| Pin | Function | Pin | Function |
| 1 | AI1+ | 11 | AI5+ |
| 2 | AI1- | 12 | AI5- |
| 3 | AI2+ | 13 | AI6+ |
| 4 | AI2- | 14 | AI6- |
| 5 | AI3+ | 15 | AI7+ |
| 6 | AI3- | 16 | AI7- |
| 7 | AI4+ | 17 | AI8+ |
| 8 | AI4- | 18 | AI8- |
| 9 | PGND | 19 | +24 V |
| 10 | PGND | 20 | -24 V |


| 16 Al |  |  |  |
| :--- | :--- | :--- | :--- |
| Pin | Function | Pin | Function |
| 1 | AI1+ | 21 | AI9+ |
| 2 | AI1- | 22 | AI9- |
| 3 | AI2+ | 23 | AI10+ |
| 4 | AI2- | 24 | AI10- |
| 5 | AI3+ | 25 | AI11+ |
| 6 | AI3- | 26 | AI11- |
| 7 | AI4+ | 27 | AI12+ |
| 8 | AI4- | 28 | AI12- |
| 9 | PGND | 29 | GND |
| 10 | PGND | 30 | PGND |
| 11 | AI5+ | 31 | AI13+ |
| 12 | AI5- | 32 | AI13- |
| 13 | AI6+ | 33 | AI14+ |
| 14 | AI6- | 34 | AI14- |
| 15 | AI7+ | 35 | AI15+ |
| 16 | AI7- | 36 | AI15- |
| 17 | AI8+ | 37 | AI16+ |
| 18 | AI8- | 38 | AI16- |
| 19 | $+24 V$ | 39 |  |
| 20 | $-24 V$ | 40 |  |
|  |  |  |  |

## I/O Connection Diagram

The diagram below describes the connection of two-wire and four-wire current sensors/transmitters to the Analog Input module.


The diagram below describes the connection of two-wire and four-wire current sensors using the 24 V PS plug-in on the Analog Input module.


## AI Module Specifications

| Total Number of Inputs | $\begin{aligned} & 8 \mathrm{AI} \pm 20 \mathrm{~mA}(4-20 \mathrm{~mA}) \\ & 16 \mathrm{AI} \pm 20 \mathrm{~mA}(4-20 \mathrm{~mA}) \\ & 8 \mathrm{AI} \pm 5 \mathrm{~V}(0-5 \mathrm{~V}, 1-5 \mathrm{~V}) \\ & 16 \mathrm{AI} \pm 5 \mathrm{~V}(0-5 \mathrm{~V}, 1-5 \mathrm{~V}) \end{aligned}$ |
| :---: | :---: |
| Input Configuration | Isolated (floating) analog inputs |
| A to D Resolution | 16 bit (including sign) |
| Input Accuracy | $\pm 0.1 \%$ of full scale @ $-40^{\circ} \mathrm{C}$ to $+70^{\circ} \mathrm{C}$ |
| Input Sampling Time | $10 \mathrm{mSec} @ 50 \mathrm{~Hz}$ filtering; $8.33 \mathrm{mSec} @ 60 \mathrm{~Hz}$ filtering |
| Smoothing | Selectable input averaging:1,2,4,8,16,32,64,128 samples (x10 mS) |
| Permitted Potential Between Inputs | 75 V DC, 60 V AC (RMS) |
| Input Impedance | $\begin{aligned} & \pm 20 \mathrm{~mA} \text { input: } \text { Rin }<250 \Omega \\ & \pm 5 \mathrm{~V} \text { input: } \mathrm{Rin}>1 \mathrm{M} \Omega \end{aligned}$ |
| Crosstalk Rejection | Better than 80 dB between any pair of inputs |
| Temperature Stability | $25 \mathrm{PPM} /{ }^{\circ} \mathrm{C}$ |
| Interference Suppression | Selectable 50 or 60 Hz filtering, <br> Common mode rejection $>100 \mathrm{~dB}$, <br> Differential mode rejection $>50 \mathrm{~dB}$ |
| 24 V DC Output | Supports optional isolated 24V Plug-in Power Supply (one in 8 DI, two in 16 DI) |
| Diagnostic LEDs | Overflow and Underflow LED per each input status, Module error LED, 24V Plug-in status LED <br> The module Overflow and Underflow levels can be configured to: <br> Current inputs: $\pm 20 \mathrm{~mA} / 4-20 \mathrm{~mA}$ <br> Voltage inputs: $\pm 5 \mathrm{~V} / 0-5 \mathrm{~V} / 1-5 \mathrm{~V}$ |
| User Connection | 2 or 4 Terminal Blocks ( 3.5 mm pitch), Maximum 18 AWG |
| Cable and TB Holder | 20 or 40 Wire Cable with TB Holder connector, 26 AWG |
| Module Replacement | Hot swap replacement- module extraction/insertion under voltage |
| Input Isolation | 1.5 kV RMS between input and module logic, per IEC60255-5 |
| Input Insulation | Insulation resistance $100 \mathrm{M} \Omega$ @ 500 V DC, per IEC60255-5 |
| Operating Voltage | $10.8-16 \mathrm{~V} \mathrm{DC}$ and 3.3 V DC (from the motherboard connector) |
| Power Consumption | Refer to Appendix D: ACE3600 Maximum Power Ratings. |
| Dimensions | 37 mm W x 225 mm H x 180 mm D, (1.5" W x 8.7" H x 7.1" D) |
| Weight | 8 AI : approx. 032 Kg ( 0.71 Lb ) <br> 16 AI : approx. $0.34 \mathrm{Kg}(0.75 \mathrm{Lb})$ |

Specifications subject to change without notice.

## ANALOG OUTPUT MODULE

## General Description

The Analog Output (AO) modules have four optically-isolated analog output channels for controlling user devices (see Figure 13-1). Each channel has two possible outputs: 0-20 mA Interface industry standard current output and $0-10 \mathrm{~V}$ Interface industry standard voltage output. Only one of the outputs can be enabled in a particular channel - either current or voltage.

The module's digital to analog converter resolution is 14 bit. The Analog Output channels are optically isolated from the module internal logic circuits. The modules are fully calibrated and can be tested and recalibrated in the field.

Each analog output has three status LEDs, Vout, Iout, and CAL which represent the calibration status of each output for voltage/current. See Module Status and Diagnostics below for the LEDs behavior.

For a description of I/O module construction, location, LEDs, TBs, and other common I/O module features, see the I/O Modules chapter above.

For details on specific AO parameters and configuration, see AO Module Configuration below.

Figure 13-1 provides a general view of the ACE3600 AO module.


Figure 13-1 ACE3600 AO Module - General View

Figure 13-2 provides a detailed view of the AO module front panel.


Figure 13-2 ACE3600 AO Module - Front Panel

## AO Module Configuration

## AO Type

The analog outputs can be set to voltage, current, or raw data. See Module Status and Diagnostics for details.

## AO Value

The analog outputs can be set to a numeric value (in the range of 0 to 16000) or either in voltage or current according to the output type. The values for voltage are 0 to 10 V and the values for current are 0 to 20 mA . See Module Status and Diagnostics for details.

The AO module value representation is as follows:

| In 0-20 mA current <br> outputs | Decimal Value | Output <br> Current |
| :--- | :--- | :--- |
|  | 0 | 0 |
|  | 4000 | 5 mA |
|  | 8000 | 10 mA |
| In 0-10 V voltage <br> outputs | 16000 | 20 mA |
|  | 0 | Output <br> Voltage |
|  | 4000 | 0 V |
|  | 8000 | 2.5 V |
|  | 16000 | 5 V |

## AO Calibration

The upper and lower limits of analog outputs can be calibrated - either as current ( 20 mA upper limit and 4 mA lower limit) or voltage ( 10 V upper limit and 2 V lower limit). Default upper and lower calibration limits are provided from the factory. See Module Status and Diagnostics for details.

## Keep Last Value (KLV) and Predefined Value (PDV)

Each output can be configured to KLV or to a PDV. This value is maintained in the event of AO module failure or communication failure with the CPU.

The predefined value can also be used during normal operation to force a value that masks the actual output value.

## I/O Legacy Resolution Parameter

In systems with both ACE3600 RTUs and legacy (MOSCAD/MOSCAD-L) RTUs, some MOSCAD/MOSCAD-L applications can be upgraded to ACE3600 without modifying the references to analog values in the applications (' C ' or ladder). The I/O Legacy Resolution STS advanced parameter sets the Analog I/O bit resolution to either Actual (ACE3600) or Legacy (MOSCAD/MOSCAD-L).

For values and restrictions, see Appendix A: Site Configuration Parameters in the ACE3600 STS User Guide.

## AO Module Configuration Options

The AO module features which can be configured are listed in the table below. Some parameters are per module and some are per output.

Table 13-1 ACE3600 AO Module Configurable Parameters

| Parameter | Selection | Default setup | Per <br> Module / <br> Output | Parameter <br> Setup location |
| :--- | :--- | :--- | :--- | :--- |
| AO Type | Voltage/Current | User Defined | Output | STS HW <br> Test/User <br> application <br> program |
| AO Value | Voltage - 0 to 10 V <br> Current - 0 to 20 mA | User Defined | Output | STS HW <br> Test/User <br> application <br> program |
| AO <br> Calibration | Voltage -2 to 10 V <br> Current -4 to 20 mA | Voltage - 2 to 10 V <br> Current - 4 to 20 mA | Output | STS HW Test |
|  <br> PDV | KLV/PDV <br> PDV=value | KLV | Output | Application <br> Programmer I/O <br> link table |
| Mask | No /Yes | No | Output | Application <br> Programmer I/O <br> link table |

## Sleep Mode

Each AO module can be switched by the user application program to Sleep Mode. In Sleep Mode, the module does not function and the power consumption is minimized. During Sleep mode the user application program will get the predefined values for each output.

## Module Status and Diagnostics

In the event of AO Module failure, the I/O module ERR LED will be lit. The event is registered by the CPU in the Error Logger. AO Module failure status is also visible to the user application program.

In addition to the ERR LED, the module includes a voltage output (Vout), current output (Iout), and calibration (CAL) LED for each output.

| CAL | Vout | lout | Indication |
| :--- | :--- | :--- | :--- |
| On | On | On | Neither output is calibrated. |
| On | Off | On | Iout is uncalibrated. |
| On | On | Off | Vout is uncalibrated. |
| Off | On | On | Row value for testing purpose is defined by the user, <br> either using HW test or user application program to send <br> raw data. |
| Off | On | Off | Vout is defined by the user, either using HW test or user <br> application program. |
| Off | Off | On | Iout is defined by the user, either using HW test or user <br> application program. |

The AO module can be diagnosed and monitored using the STS Hardware Test utility. The Hardware Test verifies that the module is operational, shows the type and actual value of each output, enables calibration, and presents the ROM data calibration factors. The AO type can be set either in the user application program or in the Hardware Test. To set the output value in the Hardware test, the user application program must be stopped or the AO module frozen. To calibrate the output in the Hardware test, the user application program must be stopped or the AO module frozen.

In the Hardware Test utility, it is possible to set the AO module to Freeze Mode. In this mode, the AOs will keep the last value they had at the time they were frozen. Freeze mode enables testing the inputs and outputs while the user program is running.

## I/O Circuit Diagram

## AO - Typical Output Circuit



## Module Block Diagram

## 4 AO



## Connection Charts

4 AO

| Pin | Function | Pin | Function |
| :--- | :--- | :--- | :--- |
| 1 | Vout1 | 11 | Vout3 |
| 2 | Ret1 | 12 | Ret3 |
| 3 | Iout1 | 13 | Iout3 |
| 4 | PGND1 | 14 | PGND1 |
| 5 | PGND1 | 15 | PGND1 |
| 6 | Vout2 | 16 | Vout4 |
| 7 | Ret2 | 17 | Ret4 |
| 8 | Iout2 | 18 | Iout4 |
| 9 | PGND1 | 19 | PGND1 |
| 10 | PGND1 | 20 | PGND1 |

## I/O Connection Diagram



## AO Module Specifications

| Total Number of Outputs | 4 AO current $(0-20 \mathrm{~mA})$ or voltage $(0-10 \mathrm{~V})$ |
| :--- | :--- |
| Output Arrangement | Isolated floating channels, each channel can be connected as <br> $0-20 \mathrm{~mA}$ or $0-10 \mathrm{~V} \mathrm{DC} \mathrm{voltage}$ |
| D to A Resolution | 14 bit |
| Output Accuracy | $\pm 0.1 \%$ full scale @ $25^{\circ} \mathrm{C}$ |
| Temperature Stability | $25 \mathrm{PPM} /{ }^{\circ} \mathrm{C}$ |
| Internal Settling Time | Max. 1.0 msec |
| Output Load | Voltage: $>1.0 \mathrm{k} \Omega,<1.0 ~ \mu \mathrm{f}$ <br> Current: < $750 \Omega$ (internal power source $)$ |
| Crosstalk Rejection | Better than 50 dB between any pair of outputs |
| Interference Suppression | Common mode rejection $>60 \mathrm{~dB}$ |
| Output Protection | Voltage output: short circuit current, max. 30 mA <br> Current output: No-load voltage max. 22 V DC |
| Diagnostic LEDs | Module error LED, Voltage mode LED, Current mode LED, <br> Calibration LED per channel |
| User Connection | 2 Terminal Blocks (3.5mm pitch), Maximum 18 AWG |
| Cable and TB Holder | 20 Wire Cable with TB Holder connector, 26 AWG |
| Module Replacement | Hot swap replacement- module extraction/insertion under voltage |
| Isolation | 1.5 kV between output and module logic |
| Insulation | Insulation resistance $100 \mathrm{M} \Omega$ @ 500 V DC, per IEC60255-5 |
| Operating Voltage | $10.8-16 \mathrm{~V}$ DC and 3.3 V DC (from the motherboard connector) |
| Power Consumption | Refer to Appendix D: ACE3600 Maximum Power Ratings. |
| Dimensions | 37 mm W x 225 mm H x 180 mm D, (1.5" W x 8.7" H x 7.1" D) |
| Weight | Approx. 0.29 Kg (0.64 Lb) |
|  | Specifications subject to change without notice. |

## MIXED I/O MODULE

## General Description

The ACE3600 Mixed I/O modules include a mixture of Digital Inputs, Relay Outputs and Analog Inputs on the same module.

The available Mixed I/O modules are:

- 16 Digital Inputs +4 EE DO Relay Outputs +4 Analog Inputs $( \pm 20 \mathrm{~mA})$
- 16 Digital Inputs +4 ML DO Relay Outputs +4 Analog Inputs ( $\pm 20 \mathrm{~mA}$ )

Figure 14-1 provides a general view of the ACE3600 Mixed I/O module.


Figure 14-1 ACE3600 Mixed I/O Module - General View

Another type of mixed I/O is found on the Digital Output/Digital Input (DO/DI) FET module. See the Digital Output/Digital Input (DO/DI) FET module chapter above for more information.

Figure 14-2 provides a detailed view of the Mixed I/O module front panel.


Figure 14-2 ACE3600 Mixed I/O Module - Front Panel

The Digital Input (DIs) on the Mixed I/O modules are voltage ("wet") inputs IEC 61131-2 Type II compliant. The first 12 DIs can function as fast counters. All DIs are optically isolated.

Each DI can be an event trigger (by interrupt) to a high priority fast process. A high priority fast process enables very fast activation of an output in response to an input trigger and logical conditions. This high priority fast process is independent of the I/O scan (refer to the STS Application Programmer manual).

All four relay outputs are Single Pole Double Throw (SPDT) and are referred to as the "Form C" relays. The physical position of each relay is monitored by the module logic, by using a back indication signal which is connected to the relay's second contact set. Any contradiction between the required position and the back indication signal, is reported to the CPU and is available to the user application program.

In some applications, it is necessary to inhibit relay output operation when attending the site for safety reasons. In all DO relay modules; it is possible to inhibit all relays per DO module. When a module is configured to enable relay inhibiting, the power to the relays is provided from the power supply via a dedicated power line ( 12 V DO ), controlled from the " 12 V DO" input (TB located on the power supply module panel). When the input's terminals are shorted, the relays are operational. When the input's terminals are open, the relays are inhibited (EE relays in the OFF (0) position and ML relays do not change state.)

The user application program can monitor the relay inhibiting status and act accordingly. Also, when the module's relays are inhibited, any mismatch between the relay position and the output logical state is ignored.

The Mixed I/O modules Analog-to-Digital conversion resolution is 16 Bit (including sign). Each input is fully isolated from the other inputs on the module and also optically isolated from the module internal circuits. The modules are fully calibrated. It is possible to test and recalibrate the module in the field.

The measured values are digitally filtered to reduce the 50 or 60 Hz noise. The user can select the filtering frequency per module.

The measured values can be smoothed by digital filtering. Smoothing is accomplished by calculating the running average values of a defined number of converted analog values (samples). The user can select the level of smoothing per module. The higher the smoothing level chosen, the more stable is the smoothed analog value and the longer it takes until the smoothed analog signal is applied after a step response.

The user can select how the analog values are represented to the user application program, as unitless numeric values or as scaled values that represent certain Engineering Units (EGU).

Each AI module can include an optional plug-in floating 24 V DC power supply to power external devices.

Each analog input has two Status LEDs:

- UF - indicates Underflow when lit
- OF - indicates Overflow when lit

The Mixed I/O modules support an optional 24 V DC floating plug-in power supply (for contact "wetting" or other purposes).

For a description of I/O module construction, location, LEDs, TB holder, and other common I/O module features, see the I/O Modules chapter above. For details on Mixed I/O Module specific parameters and configuration, see the Mixed I/O Module Configuration section below.

## Mixed I/O Module Configuration

For configuration of the DIs, refer to the DI Module chapter.
For configuration of the DOs, refer to the DO/DI FET Module or DO Relay Module chapter.
For configuration of the AIs, refer to the AI Module chapter.

## Sleep Mode

Each Mixed I/O module can be switched by the user application program to Sleep Mode. In Sleep Mode, the module does not function and the power consumption is minimized. During Sleep mode the user application program will get the predefined values per each I/O.

## Module Status and Diagnostics

In the event of Mixed I/O Module failure, the ERR LED will be lit. This event is registered by the CPU in the Error Logger. DI Module failure status is also visible to the user application program.

The Mixed I/O module can be diagnosed and monitored using the STS Hardware Test utility.
For Hardware Test of the DIs, refer to the DI Module chapter.
For Hardware Test of the DOs, refer to the DO/DI FET Module or DO Relay Module chapter.
For Hardware Test of the AIs, refer to the AI Module chapter.

## Module Block Diagram

## Mixed I/O



Connection Charts

| Mixed I/O |  |  |  |
| :--- | :--- | :--- | :--- |
| Pin | Function | Pin | Function |
| 1 | DI1 | 21 | COM1 |
| 2 | DI2 | 22 | NC1 |
| 3 | DI3 | 23 | NO2 |
| 4 | DI4 | 24 | COM2 |
| 5 | DI5 | 25 | NC2 |
| 6 | DI6 | 26 | NO3 |
| 7 | DI7 | 27 | COM3 |
| 8 | DI8 | 28 | NC3 |
| 9 | DI9 | 29 | NO4 |
| 10 | DI10 | 30 | COM4 |
| 11 | DI11 | 31 | NC4 |
| 12 | DI12 | 32 | AI1+ |
| 13 | DI13 | 33 | AI1- |
| 14 | DI14 | 34 | AI2+ |
| 15 | DI15 | 35 | AI2- |
| 16 | DI16 | 36 | AI3+ |
| 17 | $24 \mathrm{~V}+$ | 37 | AI3- |
| 18 | COM1 | 38 | AI4+ |
| 19 | PGND1 | 39 | AI4- |
| 20 | NO1 | 40 | PGND |
|  |  |  |  |

## Mixed I/O Module Specifications

| Total Number of Inputs / <br> Outputs | 16 Digital Inputs + 4 EE Relay Outputs + 4 Analog Inputs <br> $( \pm 20 \mathrm{~mA})$ <br> 16 Digital Inputs + 4 ML Relay Outputs + 4 Analog Inputs <br> $( \pm 20 \mathrm{~mA})$ |
| :--- | :--- |
| I/O Arrangement | 1 group of 16 DIs with shared common <br> 4 <br> 4 relay outputs - Form C |
| 4isolated analog inputs |  |


| AI Temperature Stability | $25 \mathrm{PPM} /{ }^{\circ} \mathrm{C}$ |
| :--- | :--- |
| AI Interference Suppression | Selectable 50 or 60 Hz filtering, common mode rejection $>100 \mathrm{~dB}$, <br> differential mode rejection $>50 \mathrm{~dB}$ |
| Diagnostic LEDs | Module error LED, Status LED per each DO and DI. <br> Overflow and Underflow LED per each AI, <br> 24V Plug-in status LED (AI) |
|  | AI Overflow and Underflow levels can be configured to: <br> Current inputs: $\pm 20 \mathrm{~mA} / 4-20 \mathrm{~mA}$ <br> Voltage inputs: $\pm 5 \mathrm{~V} / 0-5 \mathrm{~V} / 1-5 \mathrm{~V}$ |
| 24 V DC Output | Supports one isolated 24 V A plug-in "wetting" power supply |
| User Connection | 4 Terminal Blocks (3.5mm pitch), Maximum 18 AWG |
| Cable and TB Holder | 40 wire cable with Terminal Block Holder connector, 26 AWG |
| Module Replacement | Hot swap replacement- module extraction/insertion under voltage |
| Input / Output Isolation | DI: 2.5 kV RMS between input and module logic per IEC60255-5 <br> DO: Between open contacts: 1 kV, <br> between output and module logic: 1.5 kV per IEC60255-5 |
| AI: 1.5 kV between input and module logic per IEC60255-5 |  |

Specifications subject to change without notice.

## MIXED ANALOG MODULE

## General Description

The ACE3600 Mixed Analog modules include a mixture of Analog Inputs and Analog Outputs on the same module.

The available Mixed Analog modules are:

- 4 Analog Outputs +8 Analog Inputs ( $\pm 20 \mathrm{~mA}$ ) (supports $4-20 \mathrm{~mA}$ )
- 4 Analog Outputs +8 Analog Inputs $( \pm 5 \mathrm{~V})$ (supports $0-5 \mathrm{~V}$ and $1-5 \mathrm{~V}$ )

Figure 15-1 provides a general view of the ACE3600 Mixed Analog module.


Figure 15-1 ACE3600 Mixed Analog Module - General View

Figure 15-2 provides a detailed view of the Mixed Analog module front panel.


Figure 15-2 ACE3600 Mixed Analog Module - Front Panel

For a description of the AIs in the Mixed Analog modules, see the Analog Input Module chapter. For a description of the AOs in the Mixed Analog modules, see the Analog Output Module chapter.

The Mixed Analog modules support an optional 24V DC floating plug-in power supply to power external devices.

For a description of I/O module construction, location, LEDs, TB holder, and other common I/O module features, see the I/O Modules chapter above. For details on Mixed Analog Module specific parameters and configuration, see the Mixed Analog Module Configuration section below.

## Mixed Analog Module Configuration

For configuration of the AIs, refer to the AI Module chapter.
For configuration of the AOs, refer to the AO Module chapter.

## Sleep Mode

Each Mixed Analog module can be switched by the user application program to Sleep Mode. In Sleep Mode, the module does not function and the power consumption is minimized. During Sleep mode the user application program will get/set the predefined values per each I/O.

## Module Status and Diagnostics

In the event of Mixed Analog Module failure, the ERR LED will be lit. This event is registered by the CPU in the Error Logger. AI Module failure status is also visible to the user application program.

The Mixed Analog module can be diagnosed and monitored using the STS Hardware Test utility.

For Hardware Test of the AIs, refer to the AI Module chapter.
For Hardware Test of the AOs, refer to the AO Module chapter.

## Module Block Diagram

## Mixed Analog



## Connection Charts

## 4AO/8AI

| Pin | Function | Pin | Function |
| :--- | :--- | :--- | :--- |
| 1 | Vout1 | 21 | AI1+ |
| 2 | Ret1 | 22 | AI1- |
| 3 | Iout1+ | 23 | AI2+ |
| 4 | PGND1 | 24 | AI2- |
| 5 | PGND1 | 25 | AI3+ |
| 6 | Vout2 | 26 | AI3- |
| 7 | Ret2 | 27 | AI4+ |
| 8 | Iout2 | 28 | AI4- |
| 9 | PGND1 | 29 | PGND2 |
| 10 | PGND1 | 30 | PGND2 |
| 11 | Vout3 | 31 | AI5+ |
| 12 | Ret3 | 32 | AI5- |
| 13 | Iout3 | 33 | AI6+ |
| 14 | PGND1 | 34 | AI6- |
| 15 | PGND1 | 35 | AI7+ |
| 16 | Vout4 | 36 | AI7- |
| 17 | Ret4 | 37 | AI8+ |
| 18 | Iout4 | 38 | AI8- |
| 19 | PGND1 | 39 | $+24 V$ |
| 20 | PGND1 | 40 | $-24 V$ |
|  |  |  |  |

## Mixed Analog Module Specifications

| Total Number of I/Os | 4 Analog Outputs +8 Analog Inputs $( \pm 20 \mathrm{~mA})$ or <br> 4 Analog Outputs +8 Analog Inputs ( $\pm 5 \mathrm{~V}$ DC) |
| :---: | :---: |
| I/O Arrangement | AO - each channel can be connected as $0-20 \mathrm{~mA}$ or $0-10 \mathrm{~V}$, AI - Isolated (floating) analog inputs |
| AO D to A Resolution | 14 bit |
| AO Accuracy | $\pm 0.1 \%$ full scale @ $25^{\circ} \mathrm{C}$ |
| AO Temperature Stability | $25 \mathrm{PPM} /{ }^{\circ} \mathrm{C}$ |
| AO Internal Settling Time | Max. 1.0 msec |
| AO Load | $\begin{aligned} & \text { Voltage: }>1.0 \mathrm{k} \Omega,<1.0 \mu \mathrm{f} \\ & \text { Current: }<750 \Omega \text { (with internal power supply) } \end{aligned}$ |
| AO Crosstalk Rejection | Better than 50 dB between any pair of outputs |
| AO Interference Suppression | Common mode rejection $>60 \mathrm{~dB}$ |
| AO Voltage Output Protection | Short circuit protection, max. 30 mA (all other operating channels remain fully functional) |
| AO Current Output No-load Voltage | Max. 22.0 V DC |
| AO Isolation | 1.5 kV between output and module logic |
| AO Insulation | Insulation resistance $100 \mathrm{M} \Omega$ @ 500 V DC per IEC60255-5 |
| AI A to D Resolution | 16 Bit (including sign) |
| AI Accuracy | $\pm 0.1 \%$ full scale |
| AI Sampling Time | $10 \mathrm{mSec} @ 50 \mathrm{~Hz}$ filtering 8.33 mSec @ 60 Hz filtering |
| AI Smoothing | Selectable input averaging: $1,2,4,8,16,32,64$ or 128 samples (x10 mS) |
| Permitted. Potential between Inputs | $75 \mathrm{~V} \mathrm{DC} ,60 \mathrm{~V} \mathrm{AC} \mathrm{(RMS)}$ |
| AI Input Impedance | $\begin{aligned} & \pm 20 \mathrm{~mA} \text { input: } \operatorname{Rin}<250 \Omega \\ & \pm 5 \mathrm{~V} \text { input: } \operatorname{Rin}>1 \mathrm{M} \Omega \end{aligned}$ |
| AI Crosstalk Rejection | Better than 80 dB between any pair of inputs |
| AI Temperature Stability | $25 \mathrm{PPM} /{ }^{\circ} \mathrm{C}$ |
| AI Interference Suppression | Selectable 50 or 60 Hz filtering, common mode rejection > 100 dB , differential mode rejection $>50 \mathrm{~dB}$ |
| 24 V DC Output | Supports one isolated 24V Plug-in "wetting" power supply |


| Diagnostic LEDs | AO - Voltage mode LED, Current mode LED, Calibration LED <br> per channel |
| :--- | :--- |
|  | AI - Overflow and Underflow LED per each input, 24V Plug-in |
| status LED |  |
|  | The module Overflow and Underflow levels can be configured to: <br> Current inputs: $\pm 20 \mathrm{~mA} / 4-20 \mathrm{~mA}$ <br> Voltage inputs: $\pm 5 \mathrm{~V} / 0-5 \mathrm{~V} / 1-5 \mathrm{~V}$ <br> General - Module error LED |
| AI Input Isolation | 1.5 kV between input and module logic |
| AI Input Insulation | Insulation resistance $100 \mathrm{M} \Omega$ @ 500 V DC per IEC60255-5 |
| User Connection | 4 Terminal Blocks (3.5mm pitch), Maximum 18 AWG |
| Cable and TB Holder | 40 wire cable with Terminal Block Holder connector, 26 AWG |
| Module Replacement | Hot swap replacement- module extraction/insertion under voltage |
| Operating Voltage | $10.8-16 \mathrm{~V}$ DC and 3.3 V DC (from the motherboard connector) |
| Power Consumption | Refer to Appendix D: ACE3600 Maximum Power Ratings. |
| Dimensions | $37 \mathrm{~mm} \mathrm{~W} \mathrm{x} 225 \mathrm{~mm} \mathrm{H} \mathrm{x} 180 \mathrm{~mm} \mathrm{D} \mathrm{(1.5"} \mathrm{~W} \mathrm{x} \mathrm{8.7"} \mathrm{H} \mathrm{x} \mathrm{7.1"} \mathrm{D)}$ |
| Weight | Approx. $0.34 \mathrm{Kg}(0.75 \mathrm{Lb})$ |

Specifications subject to change without notice.

## I/O EXPANSION

## General Description

The ACE3600 RTU includes the option of expanding the number of I/O modules controlled by a single CPU module on the main frame. The I/O expansion frames can be co-located with RTU on the main frame (installed in the same 19" rack or cabinet) or distributed in the same site (up to 50 meters from the main frame.)

I/O expansion is based on a 100 Base-T full duplex Ethernet connection between the CPU module and the expansion modules. This type of connection enables the user program application to control and monitor the I/O modules on the expansion frames transparently in the same way it controls and monitors the I/O modules on the main frame.

The user can diagnose all the modules on the expansion frames using the STS via the CPU on the main frame. The STS can also be connected locally through the expansion module's STS1 RS232 port.

I/O expansion is based on three modules:

- Expansion LAN Switch: This module is part of the expansion frame. It is installed in the main frame in an I/O module slot. Up to seven expansion frames can be connected through a single expansion LAN switch. (For one expansion frame, the switch is not required.) Eight to thirteen expansion frames can be connected using a combination of two expansion LAN switches. For information, see the Expansion LAN Switch chapter below.
- Expansion Power Supply: This module is installed in the I/O expansion frame. It extends power (and 12V DO control) from the power supply on the RTU's main frame to the I/O expansion frame, or from one I/O expansion frame to another. For more information, see the Expansion Power Supply Module chapter below. This module can be replaced by another ACE3600 power supply option per power requirements or when the expansion frame is not co-located with the main frame. For a list of power supply options, see the Power Supply Module and Backup Battery chapter above.
- Expansion Module: This module is part of the expansion frame. It is installed in the I/O expansion frame next to the power supply. It is connected via LAN to the RTU's main frame, either to the CPU module or to the expansion LAN switch, depending on the configuration. For more information, see the Expansion Module Chapter below.

Note: Only a dedicated LAN should be used by the main CPU and expansion modules to communicate with each other. Connecting other elements to the LAN may disrupt system operation.

Note: The main CPU must include an Eth1 Ethernet port. Therefore, only the CPU 3640 can be used for I/O expansion.

Figure 16-1 provides a general view of an ACE3600 CPU with a single I/O expansion frame. The expansion module on the I/O expansion frame is connected using a crossed LAN cable to the CPU3640 on the main frame (Port Eth1.) The expansion power supply on the I/O expansion frame is attached via DC cable to the power supply on the main frame. Accessories such as a mobile radio, battery, and plastic box are attached to a separate optional 19 " chassis.


Figure 16-1 ACE3600 I/O Expansion - Single Frame Example

Figure 16-2 provides a general view of an ACE3600 CPU with multiple I/O expansion frames (two to seven.) The CPU on the main frame (Port Eth1) is connected using a LAN cable to the LAN switch on the main frame (Port Eth 1-M). The expansion modules on each of the seven I/O expansion frames are connected using a LAN cable to the expansion LAN switch (Eth2Eth8) on the main frame. The expansion power supply on the first I/O expansion frame is attached via DC cable to the power supply on the main frame. The power supplies on the other I/O expansion frames are each attached via DC cable to the power supply on the previous I/O expansion frame, in a daisy-chain manner. Accessories such as a mobile radio, battery, and plastic box are attached to a separate 19 " chassis.

Note that the number of chained frames is limited by the total power and voltage drop.


Figure 16-2 ACE3600 I/O Expansion - Multi-Frame Example

Note: The number of expansion power supplies that can be cascaded to the power supply on the main frame is limited. When required, DC or AC power supplies should be installed on the expansion frames to meet the accumulated power consumption requirements.

In the maximal configuration, up to $110 \mathrm{I} / \mathrm{Os}$ can be connected to the ACE3600, by using two expansion LAN switches on the main frame and thirteen I/O expansion frames. See Figure 163.


Figure 16-3 ACE3600 I/O Expansion - Maximal I/O Configuration

## I/O Expansion Frame

An I/O expansion frame must always include an expansion module to enable the CPU in the main frame to communicate with and control the expansion frame and its I/O modules. The expansion module is provided with each expansion frame model.

Like the ACE3600 main frame, the I/O expansion frame can contain 3, 5, 7 or 8 I/O slots. The expansion frame is compatible with the existing chassis and housing options.

## I/O Expansion Power

The choice of power supplies for a system with I/O expansion is determined by the specific configuration and the power requirements of the system.

In a co-located system where the power supply on the main frame feeds the I/O expansion frame, a low-tier power supply cannot serve as the main power supply.

In a distributed system where the power supply on the I/O expansion frame is not connected to the main frame, any power supply modules can be used which suit the power requirements of the system. When applicable, it is recommended to have an external single power on/off
switch to control all power supplies simultaneously. Similarly, it is recommended to have a single on/off for all 12 V DO controls. If a DC power supply low tier is used on the expansion frame, it does not include the 12 V DO control, and it cannot provide power (in a daisy-chain manner) to other expansion power supplies.

For guidelines on selecting the power supplies for a particular ACE3600 RTU with I/O expansion, see the ACE3600 System Planner.

## Power-up/Restart/Power-down

In a system where the power supply on the main frame feeds the I/O expansion frame, powering up/restarting the main power supply will power-up/restart the expansion frames as well. Powering down the main power supply will power-down the expansion I/Os as well.

In a system where the power supply on the I/O expansion frame is not connected to the main frame, powering down or restarting the main power supply will not power-down the I/Os on the expansion frame. However, these expansion I/Os may be reset after a period of time as a result of this action. If the expansion frame loses communication with the main frame for more than a certain number of seconds (configurable), it will restart. For more information, see the Expansion Module chapter below. For information on configurable timeouts which may cause the expansion module to restart, see the ACE3600 STS User Guide - Appendix A: Site Configuration Parameters.

## Status and Diagnostics

Status and diagnostics information can be retrieved from the expansion module, LAN switch, and power supply using the STS Hardware Test utility and SW Diagnostics and Loggers, via the CPU on the main frame. In a system where the expansion is not co-located with the main frame, status and diagnostics information on the expansion components can be retrieved by connecting directly to the expansion module. For more details, see the relevant chapter in this manual and the Hardware Test section of the ACE3600 STS User Guide.

## EXPANSION MODULE

## General Description

The expansion module provides an interface from the CPU module (either directly or via the expansion LAN switch) on the ACE3600 main frame to the I/O modules on the expansion frame. This enables the CPU on the main frame to control the I/O modules on the expansion frame and process the gathered data.

This module is installed in the I/O expansion frame in the second slot from the left and is connected via dedicated LAN to the RTU's main frame.

Figure 17-1 provides a general view of the ACE3600 expansion module.


Figure 17-1 ACE3600 Expansion Module - General View

The front panel includes status LEDs, expansion address LEDs, communication port LEDs, two pushbuttons, communication ports and rotary switch. The panel is covered by the module door.

Figure 17-2 provides a detailed view of the expansion module front panel.


Figure 17-2 ACE3600 Expansion Module - Front Panel

## Front Panel

## Pushbuttons

The expansion module includes two pushbuttons on the front panel, PB1 and PB2.
These pushbuttons are used for activating and testing the modules LED, restarting the unit, and activating memory test. See the Pushbutton Functionality section below for information on pushbutton functionality.

Note: The pushbuttons cannot be monitored by the user application program (when it is running) for the application purposes. The pushbutton status can be checked using the Hardware Test utility.

## Frame Number Selector Switch

The expansion module includes a (rotary) selector switch which enables the user to determine the frame number in the expanded RTU. The frame number is used during communication with the main CPU, with the STS, etc. For instructions on setting the frame number, see Setting the Frame Number below.

## Communication Ports

The expansion module includes two on board communication ports:

- Exp Eth1 (E1) - 10/100BaseT Ethernet port, used to connect to the expansion LAN switch or to the main CPU
- STS 1 (STS1) - RS232 port 115200 bps , used to connect a PC running the ACE3600 STS to perform diagnostics and other STS operations (for distributed I/O), as if it is connected directly to the main CPU (i.e. it provides access to the whole system.)

For the detailed specifications of each port, see the Expansion Module Specifications below. For information on the cables and connectors, see Connecting the Expansion Module below and Appendix C.

Note: When connecting an Ethernet cable to the main CPU, add one Fair-Rite ferrite core (\#7683477X01 from the supplied ferrite kit FHN7007A) on each end of the cable, near the connectors. Each core has two turns. When connecting an Ethernet cable to the expansion module, add one Fair-Rite ferrite core (\#7683477X01 from the supplied ferrite kit FHN7007A) on each end of the cable, near the connectors. Each core has two turns. (The number of turns when using ferrite cores is determined by the times the cable/wire crosses the internal aperture of the core.)

## LEDs

The expansion modules include module status LEDs, port status LEDs, and expansion address LEDs. Some of the LEDs are single color (green) and some are bicolor LEDs (red, green or orange).

Status LEDS indicate the expansion module status in startup (boot), run-time or when there is a failure. The communication LEDs are used to indicate the communication port status. The expansion address LEDs indicate the address selected with the rotary frame number selector switch, as detected during startup. Note that during startup or failure, the communication and expansion address (EXP ADDR) LEDs are used to indicate various situations. Table 17-1 details the LEDs functionality.

## Module Firmware and Operation Modes

The expansion module firmware extends the main CPU control to the I/O modules located in the expansion frame. The expansion module (expansion CPU) is shipped from the factory with dedicated firmware called Expansion Loader. After connecting to the main CPU (MCPU), the expansion module loads the Expansion Firmware Image from the main CPU to ensure that all modules use the same firmware version. The diagram below depicts the initiation process of an expansion module after power-up/restart and during run-time:


## Power-up and Restart

The MCOM LED (see LED description in Table 17-1) on the expansion module indicates the connection status between the expansion module and the main CPU and expansion frame initialization progress.

The main CPU expects the expansion frames to complete the initialization within a configurable period of time ( 60 seconds default). After this period of time elapses, the main CPU will operate normally with the connected frames and their I/O modules. Any expansion frame that has not completed initialization within that time (e.g. because it was connected later to the RTU) will be ignored until the next main CPU restart.

Note that after the main CPU starts up, it waits for the expansion modules to complete the initialization process. The wait time is derived from the number of expansion frames configured in the RTU. After all the expansion frames have completed the initialization, the main CPU will continue its system startup. The main CPU will wait 60 seconds (default) for all expansion frames to connect.

## Restart after Firmware Download

After a new version of the firmware is downloaded to the main CPU, the CPU and all expansion modules will restart (as with configuration download or main CPU power reset.) Note that the restart includes the time to identify all expansion frames, as described above. After a new version of the Expansion Loader firmware is downloaded to the expansion module (using the STS Hardware Test feature), the expansion module will restart itself. For information on upgrading the Expansion Loader firmware, see the ACE3600 STS User Guide.

## Restart after Configuration Download

After a site configuration is downloaded to the main CPU , the CPU will restart and will instruct the expansion modules to restart as well. Note that the restart includes the time to identify all expansion frames, as described above. For information on downloading to the RTU, see the Operation chapter of the ACE3600 STS User Guide.

If the RTU fails to restart after the user-defined site configuration was downloaded, a unique LED display (in the range of the PI1-TX and SI2-RX LEDs) will follow. The RST LED will turn RED and the RTU will restart itself with the previous "good" configuration. The expansion module will be restarted. The following message will appear in the RTU Error Logger "Configuration file was deleted due to failure in startup. Rolling back to the last configuration file." Errors can be retrieved from the RTU using the ACE3600 STS Error Logger utility.

If the newly-downloaded configuration has a problem which prevents the expansion module from connecting to the main CPU, the expansion module is restarted, and will operate in Expansion Loader mode. It will restart every two minutes, and be unable to perform discovery/load image from main CPU. If the site's I/O configuration includes one or more frames, a warning is displayed in the main CPU. If no frames were configured for the site, the main CPU will ignore all Expansion Loader discovery requests.

If the startup succeeds after configuration download but has errors, these errors are reported in the RTU Error Logger. It is, therefore, recommended to check for errors after downloading a configuration file to the RTU. Errors can be retrieved from the RTU using the ACE3600 STS Error Logger utility.

For information on retrieving errors from the RTU Error Logger, see the Operation chapter of the ACE3600 STS User Guide.

## Restart after Erase Flash

After the User Flash is erased in the main CPU, the RTU will restart with the default site configuration and all expansion modules will restart. Note that the restart includes the time to identify all expansion frames, as described above.

## Expansion Module during Run-Time

The expansion module constantly exchanges I/O data and status data with the main CPU, using the Ethernet Microcode Interface (EMI). The EMI enables the main CPU to be updated by all the expansion modules at very short intervals via the expansion Ethernet LAN. The main CPU constantly synchronizes the expansion module date and time, and periodically polls the errors, pushbuttons and time tagged data from all the connected expansion modules.

If the connection between the expansion module and the main CPU is lost (e.g. due to main CPU restart, cable disconnection, etc.) for a configurable period of time (1 minute default), the expansion module will restart and the initialization process will begin again.

After the expansion frames have initialized, it is possible to download to the RTU a user program or other user defined files. After successful download, the main CPU automatically updates each expansion module. Note that if the main CPU tries to download a user program or other files to an expansion module during initialization, the expansion module is restarted.

## Power-down

When the voltage provided to the expansion module (from the power supply on the expansion frame) drops below the minimum level, the module will shut down in an orderly fashion. When the expansion frame is powered using an expansion power supply (or 12 V low-tier power supply), it may shut down when the voltage drops below 10.8 V . When the expansion frame is powered using other types of ACE3600 power supplies, this level is configurable. See the 'Minimum DC operation voltage' parameter in Appendix A: Site Configuration Parameters of the ACE3600 STS User Guide.

## File Download without Restart

When certain files (e.g. I/O FPGA, encryption keys, compiled ladder) are downloaded from the STS to the main CPU, the main CPU will "forward" the files to the expansion modules, without forcing a restart. The main CPU will restart the expansion modules if the "forward" operation fails for some reason (e.g. temporary loss of communication.)

## Module Status and Diagnostics

The module status is indicated on the front panel LED. Detailed module status and diagnostics information can be retrieved via the main CPU using the STS Hardware Test utility. For more details, see the Hardware Test section of the ACE3600 STS User Guide.

## Module Warnings and Errors

Expansion module warnings and errors are logged in the main frame CPU memory to indicate issues or errors during power-up, restart, run-time, and other modes of CPU operation. If a warning or error occurs in any one of the RTU frames, the ERR LED will light up on the front panel of the main CPU and the MERR LEDs will light up on the front panel of all expansion modules. Green indicates a message, orange indicates a warning, and red indicates an error.

The RTU error logger information can be retrieved using the STS Error Logger utility. For more details, see the Error Logger section of the ACE3600 STS User Guide.

## Connecting the Expansion Module

Install the expansion module in the second slot from the left in the expansion frame.
Direct connection: In a system with a single expansion frame, connect the Exp. Eth1 port on the expansion module directly to the Eth1 port on the main CPU, using the crossed Ethernet cable described below.

Switch connection:

- In an RTU with more than one expansion frame (and up to seven), connect the Exp. Eth1 port on the expansion module to one of the Ethernet ports Eth2-Eth8 on the expansion LAN switch (situated on the main frame). Note: The Eth. 1 (M) port on the expansion LAN switch is reserved for connection to the main CPU.
- If two switches are used (more than seven expansion frames), connect the Exp. Eth1 port on the expansion module to one of the Ethernet ports (Eth3-Eth8) on the first expansion LAN switch or to one of the Ethernet ports (Eth2-Eth8) on the second switch. (Connect the Eth2 port on the first switch to the Eth1 (M) port on the second switch Ethernet LAN, as described in the Expansion LAN Switch chapter below.)

Expansion frames are provided without cables. For connection, use one of the cables listed below or use any other standard Category 5E shielded (FTP) LAN cable (up to 50m, per cable length limit.)

Four different Ethernet cables are available for this purpose. Choose the cable length based on the distance from the main frame to the expansion frame.

- 0.6 meter (Motorola $\mathrm{p} / \mathrm{n}$ FKN8561A) - This cable is for local connection of the main CPU to the expansion switch.
- 2 meter (Motorola p/n FKN8562A)
- 3 meter (Motorola p/n FKN8563A)
- 3 meter (Motorola $\mathrm{p} / \mathrm{n}$ FKN8525A) crossed cable - This cable is for direct connection of the expansion module to the main CPU.

For more on switch connection, see the Expansion LAN Switch chapter below.

## Setting the Frame Number

The expansion module shipped from the factory is set by default to 1 . If more than one I/O expansion frame is added, this frame number (also known as frame ID) must be changed. Procedure 17-1 describes how to set the expansion frame number using the rotary selector switch on the front panel of the expansion module. The frame number should be changed before powering up the module.

## Procedure 17-1 How to Set the I/O Expansion Frame Number

1) Make sure that the expansion module is not connected to a power source.
2) Insert a small flat screwdriver into the groove on the rotary frame number selector. See Figure 17-3.
3) Using the screwdriver, turn the dial until the arrow points to the desired frame number. Note: The selected frame number must not already be assigned to another expansion module and must be in the range of 1-13 (1-9, A, B, C, D hexadecimal.)
4) Connect the expansion module to a power source.
5) When the expansion module is powered up, verify the selected frame number via the four binary Expansion Address (EXP ADDR) LEDs on the front panel. This is the frame number that will be used when communicating with the main CPU .


Figure 17-3 Expansion Module Rotary Frame Number Selector Switch and Expansion Address LEDs


NOTE

The rotary frame number selector switch should not be changed while the expansion module is running. If the switch is changed while the expansion module is running,
the frame number will not be changed. A message will be logged in the Error Logger notifying the user of the switch change (specifying the actual frame number.)

If the frame number was set to a number other than 1-9/A-D before power-up, the expansion module will restart itself continually until the frame number is changed. The MERR LED will be red, but no error is logged. The invalid number (1-15) will be reflected in the Expansion Address LEDs.

If the frame number is changed after the Expansion Loader has begun discovery, but before the Expansion Image is started, the expansion module will restart itself and use the new frame number (assuming it is 1-9/A-D.)

It is recommended to set the frame numbers in sequential order (i.e. frame number 1 connected to the expansion LAN switch port Eth2, frame number 2 connected to expansion LAN switch port Eth3, etc.)

0 is an illegal frame number and is not represented by the EXP ADDR LEDs.

## Pushbutton Functionality

In general, the two pushbuttons on the front panel of the expansion module behave like the pushbuttons on the front panel of the CPU module, with the exception of the Erase User Flash functionality and user application access which are not available.

Note: PB2 is not relevant during run time in the expansion module.

| Scenario | Trigger | Action |
| :--- | :--- | :--- |
| LEDs Test | During run-time, press PB1 <br> for five or more consecutive <br> seconds (but less than 30). | All the LEDS on the expansion module <br> and I/O modules on that expansion frame <br> will be lit until let go of PB1 and then <br> returned to their previous states. |
| Turn LEDs ON | During run-time, press PB1 <br> for one second. | Those LEDs which are currently active <br> will be turned on for a period of time <br> (configured in the RTU configuration <br> using the STS.) |
| Bootstrap | During startup, press PB2 <br> continuously for five <br> seconds. <br> Note: Before initiating <br> bootstrap, the expansion <br> module must be connected <br> directly to the STS PC in <br> standalone mode. No other <br> components can be on the <br> network which might create <br> a conflict with the default IP <br> address. | The expansion will start up in diagnostic <br> mode. Communication with the RTU is <br> for diagnostic purposes only (Error <br> Logger/ SW Diagnostics) or for <br> downloading new primary image firmware <br> to the module. (See Module Firmware and <br> Operation Modes below.) <br> If the bootstrap fails, the four indicator <br> LEDs (see LEDs Location in Table 17-2) <br> will display the failure error in binary <br> code. |


| Scenario | Trigger | Action |
| :--- | :--- | :--- |
| RAM Test | During startup, press PB1. | A detailed memory test of SDRAM and <br> SRAM plug-in is performed. <br> - At the beginning of the RAM test, the <br> four indicator LEDs (see LEDs Location in <br> Table 17-2) will blink three times. During <br> the RAM test, the LEDs may blink or be <br> lit. <br> If the RAM test succeeds, the four LEDs <br> will blink three times and turn off and the <br> restart sequence will continue. <br> If the RAM test fails, the RTU will freeze <br> (restart sequence stops), the PWR LED <br> will blink and the four LEDs will blink <br> seven times. The failure error code will <br> then be displayed on the LEDs, in binary <br> code, as described in Table 17-3. <br> - |
|  |  | To exit/abort the RAM test in the middle, <br> restart the RTU using the On/Off switch on <br> the front panel. |

## LEDs Behavior

The table below describes the behavior of the LEDs on the expansion module.
Table 17-1 Expansion Module LEDs Behavior

| LED Name | Description | Status |
| :--- | :--- | :--- |
| PWR | Power LED | Flashing Red - Power exists; Module FPGA <br> not loaded. |
|  | Bicolor LED (Red, Green) | Green - Power exists; Module is running from <br> a recognized power supply. <br> Red - Failure on power-up. Module is <br> running from an unrecognized power supply. |

$\left.\begin{array}{|l|l|l|}\hline \text { LED Name } & \text { Description } & \text { Status } \\ \hline \text { MERR } & \begin{array}{l}\text { Main CPU } \\ \text { Error Logger Status LED } \\ \text { Bicolor LED (Red, Green) }\end{array} & \begin{array}{l}\text { OFF - No new errors or warnings logged in } \\ \text { main CPU. } \\ \text { Green - New message logged. } \\ \text { Orange - New warning logged. } \\ \text { Red - New error logged. } \\ \text { Note: In systems with I/O expansion, all error } \\ \text { messages from I/O expansion frames are } \\ \text { periodically collected by the main CPU and } \\ \text { saved with the main frame error messages. } \\ \text { When an error message is logged in either the } \\ \text { main frame or I/O expansion frames, the ERR } \\ \text { LED is lit on the main CPU front panel and } \\ \text { the MERR LEDs are lit on all expansion } \\ \text { modules. When the messages are cleared, the } \\ \text { ERR/MERR LED(s) are turned off. }\end{array} \\ \hline \text { RST } & \begin{array}{ll}\text { Reset LED } \\ \text { Bicolor LED (Red, Green) }\end{array} & \begin{array}{l}\text { Green - On startup } \\ \text { OFF - Successful power-up or restart. } \\ \text { Red - Power-up or restart failed. }\end{array} \\ \hline \text { MCOM } & \begin{array}{ll}\text { Main CPU } \\ \text { Communication LED } \\ \text { Bicolor LED (Red, Green) }\end{array} & \begin{array}{l}\text { Red - Slow blink - Expansion Loader looking } \\ \text { for main CPU (discovery). } \\ \text { Red - Fast blink - Expansion Loader loading } \\ \text { image. } \\ \text { Red - Expansion module firmware initializing }\end{array} \\ \text { image. } \\ \text { Green - Slow blink - Expansion module } \\ \text { registered with main CPU. } \\ \text { Green - Fast blink - Expansion module ready. } \\ \text { (If this occurs after connection was } \\ \text { established - solid green, it is a sign that the } \\ \text { Expansion module is disconnected from the } \\ \text { main CPU.) } \\ \text { Green - Solid - Expansion module connected. }\end{array}\right\}$

| LED Name | Description | Status |
| :--- | :--- | :--- |
| MCNF | Main CPU <br> Configuration LED <br> Bicolor LED (Red, Green) | This LED reflects the state of the CONF LED <br> in the main CPU: <br> OFF - Configuration was not loaded in the <br> main CPU. <br> Green - Configuration was loaded in the main <br> CPU. <br> Red - Configuration error in the main CPU. <br> This LED is only relevant after the main CPU <br> has completed its startup. |
| SI1 TX | STS Port 1 - TX (transmit) <br> Green LED | ON - Transmitting Data |
| SI1 RX | STS Port 1 - RX (receive) <br> Green LED | ON - Receiving Data |
| SI1 CM | STS Port 1 - CM (channel <br> monitor) <br> Green LED | ON - Channel Monitor is ON. |
| E1 LNK | Ethernet Port 1 (link) <br> Green LED | ON - Network Connected <br> In case of RAM test, see Table 17-3. |
| E1 RX | Ethernet Port 1 (receive) <br> Green LED | ON - Receiving Data <br> In case of RAM test, see Table 17-3. |
| EXP <br> ADDR <br> x1, x2, x4, <br> x8 | Expansion address LEDs <br> Green LED | Reflects the expansion address set in the <br> rotary frame number selector switch. The <br> four LEDs together form the binary <br> representation of the addresses 1-D. See <br> Figure 17-3. <br> During module startup, the LEDs reflect <br> communication errors. See Table 17-2. |

Table 17-2 Expansion Module - Error Code Display on LEDs

| LEDs Location | LED Error Code | Description |
| :---: | :---: | :---: |
|  | ERR Code 1 | Invalid ID in expansion module, or incompatible board type. |
|  | ERR Code 2 | Timeout getting discovery response. |
|  | ERR Code 3 | Failed sending discovery request or getting invalid response. |
|  | ERR Code 4 | Failed to configure expansion port. |
|  | ERR Code 5 | Timeout getting image. |
|  | ERR Code 6 | Failed to initialize image. |
|  | ERR Code 7 | Timeout initializing expansion module (while getting ready.) |
|  | ERR Code 8 | Received illegal file. |
|  | ERR Code 9 | Failed to burn file. |
|  | ERR Code 10 | Failed to read local I/O, or to send it to main CPU. |
|  | ERR Code 11 | Failed to send READY or START signal. |
|  | ERR Code 12 | Timeout getting EMI 'Connect' after EMI was started. |
|  | ERR Code 13 | Failed a few times to send/connect keepalive signal. |
|  | ERR Code 14 | Failed to start EMI or disconnected due to 'fail timeout'. |
|  | ERR Code 15 | Other system startup failure. |

Table 17-3 Expansion Module - RAM Test Error Code Display on LEDs

| LEDs Location | LED Error Code | Description |
| :--- | :--- | :--- | :--- |
| ERR Code 1 |  | ERR Code $1=$ Error in Flash |

## Expansion Module Specifications

| Microprocessor | Freescale - Power PC II, MPC8270, 32-bit |
| :--- | :--- |
| Microprocessor Clock | 200 MHz |
| Serial Port | RS232C Asynch, Full Flow Control port, up to $230.4 \mathrm{~kb} / \mathrm{s}$; used for STS only |
| Ethernet Port | $10 / 100 \mathrm{Mb} / \mathrm{s}$ - connection to the main frame |
| LAN Cable | Category 5E shielded (FTP), up to 50 meter |
| LEDs Display | 4 CPU diagnostic LEDs, Port status LEDs and Expansion Address LEDs |
| Power Consumption | Refer to Appendix D: ACE3600 Maximum Power Ratings. |
| Operating Voltage | $10.8-16 \mathrm{~V} \mathrm{DC} \mathrm{(from} \mathrm{the} \mathrm{motherboard} \mathrm{connector})$ |
| Dimensions | $56 \mathrm{~mm} \mathrm{~W} \mathrm{x} 225 \mathrm{~mm} \mathrm{H} \mathrm{x} 180 \mathrm{~mm} \mathrm{D}\left(2.2^{\prime \prime} \mathrm{W} \mathrm{x} 8.7^{\prime \prime} \mathrm{H} \mathrm{x} \mathrm{7.1"} \mathrm{D)}\right.$ |
| Weight | Approx. $0.38 \mathrm{Kg}(0.84 \mathrm{Lb})$ |

Specifications subject to change without notice.

## EXPANSION LAN SWITCH

## General Description

The expansion LAN switch provides an interface from the ACE3600 CPU (on the master RTU frame) to up to seven expansion modules (on I/O expansion frames), or up to 13 expansion modules when two switches are used. This enables the use of up to $110 \mathrm{I} / \mathrm{O}$ modules. The expansion modules can be co-located with the switch (installed in the same 19 " frame or cabinet) or distributed in other locations.

The expansion LAN switch is installed in the main frame only, in either of the first two I/O module slots.


Figure 18-1 Expansion LAN Switch - General View

The front panel includes an Error LED, communication port LEDs, and communication ports. The panel is covered by the module door.

Figure 18-2 provides a detailed view of the expansion LAN switch front panel.


Figure 18-2 Expansion LAN Switch - Front Panel

The ACE3600 expansion LAN switch is configured to prioritize different Ethernet data frame types. A special EMI protocol, used for communication between the expansion LAN switch and the main CPU, quickly collects I/O information from the expansion frames to the main CPU and adds the highest priority and special tags to these Ethernet frames. The switch recognizes these frames and gives them the highest priority in the buffer queue, higher than the frames of the standard protocols (MDLC, TCP/IP) used for communication in the ACE3600 system. For this reason, only the ACE3600 expansion LAN switch can be used in an I/O expansion system.

## IMPORTANT

When an expansion LAN switch is used on an I/O expansion LAN, only the main CPU and the expansion frames (expansion modules) can be connected to the expansion switch(es). Any attempt to connect other devices to the expansion switch(es) may result in unpredictable communication delays between the main CPU and the expansion frames and malfunction of the expanded RTU.

## Front Panel

## Communication Ports

The expansion LAN switch includes eight 100BaseT Ethernet communication ports.

## LEDs

The expansion LAN switch includes an error LED and communication port status. All of the LEDs are single color.

Table 18-1 details the LEDs functionality.

## Inserting/Removing an Expansion LAN Switch from the Frame

The expansion LAN switch supports hot-swap and can be inserted and extracted while the system is powered up. For instructions on removing/inserting a switch from/into a frame, see the Replacing an I/O Module or Expansion LAN Switch section of the Break-Fix Procedures chapter below.

Note that removing the LAN switch disconnects all I/O modules in the expansion frames connected by LAN. If the expansion frame is disconnected from the main frame for a (configurable) period of time, the expansion module will restart and try to find the main CPU again.

## Switch Status and Diagnostics

LAN switch status and diagnostics information can be retrieved via the main CPU using the STS Hardware Test utility. For more details, see the Hardware Test section of the ACE3600 STS User Guide.

## Switch Warnings and Errors

LAN switch warnings and errors are logged in the main frame CPU memory. The RTU error logger information can be retrieved using the STS Error Logger utility. For more details, see the Error Logger section of the ACE3600 STS User Guide.

## Connecting the Expansion LAN Switch to the Main CPU

Install the expansion in either of the first two I/O module slots in the main frame.
The expansion LAN switch option includes a 0.6 meter Ethernet cable (Motorola p/n FKN8561A). Use this cable to connect from the Eth1 port on the main CPU to the Eth 1 (M) port on the expansion switch. For the second switch in a system (if such exists), use this cable to connect from the Eth2 port on first switch to the Eth1 (M) port on the second switch.

## Connecting the Expansion LAN Switch to I/O Expansion Frames

Use one of the following Ethernet cables to connect an Ethernet port on the expansion LAN switch to an expansion module in an expansion frame. If the system includes one switch (for up to seven frames), ports Eth2-Eth8 are available. If the system includes two switches (for up to thirteen frames), ports Eth3-Eth8 are available on the first switch and ports Eth2-Eth8 are
available on the second switch. Note: The Eth. 1 (M) port on the expansion LAN switch is reserved for connection to the main CPU.

Choose the cable length based on the distance from the main frame to the expansion frame.

- 0.6 meter (Motorola p/n FKN8561A) - This cable is used for local connection of the main CPU to the expansion switch, or connection of the first LAN switch to the second, if such exists.
- 2 meter (Motorola p/n FKN8562A)
- 3 meter (Motorola p/n FKN8563A)


## IMPORTANT

The main CPU must be connected to the Eth1 (M) port only. If an additional switch is used, the Eth2 port on first switch should be connected to the Eth $1(\mathrm{M})$ port on the second switch.

No devices or equipment other than the main CPU or expansion modules may be connected to the expansion LAN switch ports.

In systems with several expansion frames, the ACE3600 STS can be used to provide automatic switch connection configuration. The following physical connections are assumed:

- A system with one expansion frame is connected directly to the main CPU.
- A system with 1-7 frames (frame IDs 1-7) is connected via one switch (to expansion LAN switch ports Eth2-Eth8 respectively.)
- A system with 1-13 frames is connected via two switches (frame IDs 1-6 connected to expansion LAN switch 1 ports Eth3-Eth8 respectively and frame IDs 7-13 connected to expansion LAN switch 2 ports Eth2-Eth8 respectively.)

If the expansion frames are not physically connected as described above, the switch connection must be manually configured in the STS Switch Connections dialog. For more information, see the ACE3600 STS User Guide.

## Expansion LAN Switch LEDs Behavior

The table below describes the behavior of the LEDs on the expansion LAN switch.
Table 18-1 ACE3600 Expansion LAN Switch LEDs Behavior
$\left.\begin{array}{|l|l|l|}\hline \text { LED Name } & \text { Description } & \text { Status } \\ \hline \text { ERR } & \text { Error Logger Status LED } & \begin{array}{l}\text { OFF - No new errors or warnings. } \\ \text { Red - New error logged - Either the switch } \\ \text { could not configure itself on startup or it has } \\ \text { lost communication with the main CPU } \\ \text { module. } \\ \text { Flashing - FPGA is being loaded into the } \\ \text { switch. }\end{array} \\ \hline \begin{array}{l}\text { E[1-8] } \\ \text { L/RX }\end{array} & \begin{array}{l}\text { Ethernet Port [1-8] - Link/RX } \\ \text { (receive) } \\ \text { Green LED }\end{array} & \begin{array}{l}\text { Flashing - Link is up and Receiving Data. } \\ \text { ON - Link is up. }\end{array} \\ \hline \text { E[1-8] TX } & \begin{array}{l}\text { Ethernet Port [1-8] - TX } \\ \text { (transmit) } \\ \text { Green LED }\end{array} & \text { Flashing or ON - Transmitting Data } \\ \hline \text { E[1-8] SPD } & \begin{array}{l}\text { Ethernet Port [1-8] - Speed } \\ \text { Green LED }\end{array} & \begin{array}{l}\text { ON - 100MBase-T Ethernet link is up (when } \\ \text { L/RX is active). } \\ \text { OFF - 10MBase-T Ethernet link is up (when } \\ \text { L/RX is active) or no link (when L/RX is not }\end{array} \\ \text { lit). } \\ \text { Note: If the speed is not 100M, the system } \\ \text { will not perform properly- frames may be lost } \\ \text { and the RTU components may not be } \\ \text { synchronized. }\end{array}\right]$

## Expansion LAN Switch Specifications

| Ethernet Port 1-8 | 8 on board $10 / 100 \mathrm{Mb} / \mathrm{s}$ Ethernet ports (Auto crossover) |
| :---: | :---: |
| LEDs Display | Error LED, Port status LEDs |
| Power Consumption | Refer to Appendix D: ACE3600 Maximum Power Ratings. |
| Module Replacement | Hot swap replacement - module extraction/insertion under voltage |
| Operating Voltage (from the motherboard connector) | $\begin{aligned} & 10.8-16 \mathrm{~V} \mathrm{DC} \\ & 3.30 \mathrm{VDC}+/-10 \% \end{aligned}$ |
| User Connection (Ethernet Ports) | 8 shielded RJ45 connectors |
| LAN Cable | Category 5E shielded (FTP), up to 50 meter |
| Dimensions | $37 \mathrm{~mm} \mathrm{~W} \times 225 \mathrm{~mm} \mathrm{H} \times 180 \mathrm{~mm} \mathrm{D}\left(1.5{ }^{\prime \prime} \mathrm{W} \times 8.7^{\prime \prime} \mathrm{H} \times 7.1^{\prime \prime} \mathrm{D}\right)$ |
| Weight | Approx. $0.32 \mathrm{Kg}(0.7 \mathrm{Lb})$ |

Specifications subject to change without notice.

## EXPANSION POWER SUPPLY MODULE

## General Description/Module Overview

The expansion power supply module ( $10.8-16 \mathrm{~V}$ DC) extends power from the power supply on the RTU's main frame to the I/O expansion frame, or from one I/O expansion frame to another. This module is installed in each I/O expansion frame.

Characteristics of the expansion power supply module:

- Located on the leftmost slot of the frame
- Overvoltage protection for the I/O expansion frame

Figure 19-1 below depicts a general view of the power supply.


Figure 19-1 ACE3600 Expansion Power Supply - General View

Figure 19-2 below depicts a detailed view of the power supply front panel.


Figure 19-2 ACE3600 Expansion Power Supply - Front Panel

## Input/Output Connectors

The front panel of the expansion power supply includes the following connectors.

| Connector Name | Description | Notes |
| :--- | :--- | :--- |
| Expansion Power <br> Output | DC Power Output | Vin=Vout <br> Shorted to Power IN. <br> powering other I/O expansion <br> frames. |
| $10.8-16 \mathrm{~V}$ DC | It also controls a dedicated 12V <br> DO power line that is available <br> to all the slots in the frame to <br> power the relay coils. See the <br> Notes below. |  |


| Connector Name | Description | Notes |
| :--- | :--- | :--- |
| Power In 10.8-16V DC | Cable inlet for main power cable <br> (DC) | Connect this input to the <br> "RACK EXP" output of a <br> regular power supply or to the <br> "Expansion power out" of an <br> expansion power supply, using <br> a dedicated cable - FKN8559A <br> (3002360C26.) <br> Important: When adding <br> expansion power supplies, make <br> sure that you do not exceed the <br> total power limit of the main <br> power supply, as all connected <br> expansion power supplies drain <br> energy from it. Also make sure <br> that the power provided to each <br> power supply (when connected <br> in a daisy-chain manner) does <br> not fall below the minimum <br> operating voltage. |

## Module Status and Diagnostics

Detailed module status and diagnostics information can be retrieved via the main CPU using the STS Hardware Test utility. For more details, see the Hardware Test section of the ACE3600 STS User Guide.

## Module Warnings and Errors

Power supply module warnings and errors are logged in the main frame CPU memory. The RTU error logger information can be retrieved using the STS Error Logger utility. For more details, see the Error Logger section of the ACE3600 STS User Guide.

## Connecting the Expansion Power Supply to the Main Frame Power Supply

The expansion power supply can only be connected to the power supply on the ACE3600 RTU main frame and to other expansion power supply modules.

For instructions on connecting the expansion power supply, see the Connecting the Expansion Power Supply to the Main Frame Power Supply section of the Installation chapter above.

If all the power supplies on I/O expansion frames are attached via DC cable to the power supply on the previous I/O expansion frame in a daisy-chain manner, the main power supply controls the entire RTU. This enables the user to turn off the entire RTU simply by turning off the main power supply.

If the main power supply does not control all other power supplies in the RTU (e.g. when the total power consumption required does not allow all frames to be daisy chained), it is recommended that the main power provided to the power supplies be connected to a single external on/off power switch.

IMPORTANT

All power and ground connections must be in accordance with local standards and laws.

## Connecting the Expansion Power Supply to Ground

The power supply on each expansion frame must be connected to the grounding strip of its frame. For important warnings on ground connections, see Connecting Power and Ground in the Installation chapter above.

Connect the terminal ring on the (green/yellow) ground wire of the DC cable (FKN8559A/3002360C26) to the grounding strip located on the frame beneath the power supply slot. Make sure to tighten the screw firmly. See Figure 19-3 below.


Figure 19-3 ACE3600 Expansion Power Supply - Ground Connection

For instructions on connecting the entire site to ground, see Connecting an RTU to Ground in the Installation chapter above.

## Expansion Power Supply Fuses

The expansion power supply includes two slow blow fuses, one 4A fuse for overcurrent protection for the I/O expansion frame and one 8 A fuse for maximum current via the Power in/out circuit. See Figure 19-4. For instructions on replacing these fuses, see the Break-Fix Procedures chapter later in this manual.


Figure 19-4 ACE3600 Expansion Power Supply - Fuses

## Expansion Power Supply Module Specifications

| Input Voltage | DC $10.8-16 \mathrm{~V}$ |
| :--- | :--- |
| Outputs | To Motherboard connector -+10.80 to +16.00 VDC, max. 4A |
|  | To cascaded expansion power supply -+10.80 to +16.00 VDC, max. 8 A |
| Over Current <br> Protection | 4.0 A (Slow blow fuse), protecting the expansion frame |
| Maximum Current <br> via Power IN/OUT <br> circuit | 8.0 A (Slow blow fuse), protecting the cascaded expansion power supply |
| Over Voltage <br> Protection | $+17.00 \pm 1 \mathrm{VDC}$ (protecting the expansion frame) |
| Absolute Maximum <br> Voltage | +18.00 VDC |
| Dimensions | $56 \mathrm{~mm} \mathrm{~W} \times 225 \mathrm{~mm} \mathrm{H} \mathrm{x} 180 \mathrm{~mm} \mathrm{D}\left(2.2^{\prime \prime} \mathrm{W} \times 8.7^{\prime \prime} \mathrm{H} \mathrm{x} \mathrm{7.1"} \mathrm{D)}\right.$ |
| Weight | Approx. $0.43 \mathrm{Kg}(0.94 \mathrm{Lb})$ |

Specifications subject to change without notice.

## ACE IP GATEWAY MODULE

## General Description

The ACE IP Gateway module (CPU4600) is a Front End Processor (FEP) which enables SCADA control centers to communicate and interface with ACE3600 RTUs and legacy (MOSCAD-M, MOSCAD, and MOSCAD-L) RTUs in a control system. It acts as an interface between the MDLC world and the TCP/IP world.

The ACE IP Gateway (IPGW) supports MDLC connection to multiple RTUs (ACE3600 and legacy MOSCAD RTUs) via terminal server ports from multiple SCADA clients.

Data exchange between the SCADA (client) and the ACE IPGW (server) is carried out using "peer -to-peer" communication over a LAN. SCADA clients can be located on the same TCP/IP segment (location), connected directly to the ACE IPGW, or on different TCP/IP segments (locations), connected to the ACE IPGW via a WAN or a bridge device.

The ACE IP Gateway, like all ACE3600 RTUs supports NTP time synchronization, both as client and as server, encryption, and dynamic IP conversion table update at run time. The Gateway supports all ACE3600 RTU data types.

The ACE IP Gateway does not run a user application and does not support I/O modules.
Like the legacy MOSCAD IP Gateway, the ACE IP Gateway supports redundancy. The primary and secondary ACE IPGWs share the same site ID. The primary ACE IPGW enables bi-directional transfer of both SCADA application messages and Gateway management messages. The secondary ACE3600 IPGW enables transferring of Gateway management messages only. (It does not send or receive any MDLC messages and is logically disconnected from the link.)

For general information on using the ACE IPGW module, see the ACE IP Gateway section of the ACE3600 STS Advanced Features manual. For instructions on configuring the ACE IPGW module, see the ACE3600 STS User Guide. For information on the ACE IPGW Application Programming Interface (API) used by SCADA driver developers to build the TCP/IP and Ethernet-based ACE IPGW Interface, see the ACE IP Gateway API User Manual.

The ACE IPGW module can be installed on any of the existing ACE3600 chassis options including 19" rack configuration.

Figure 20-1 provides a general view of the ACE IP Gateway Module.


Figure 20-1 ACE IP Gateway Module- General View

The ACE IP Gateway front panel includes status LEDs, communication port LEDs, two pushbuttons, and communication ports. The panel is covered by the module door.

Figure 20-2 provides a detailed view of the ACE IP Gateway front panel.


## *Optional

Figure 20-2 ACE IP Gateway Module - Front Panel

## Front Panel

## Communication Ports

The ACE IP Gateway module includes several communication ports:

## On Board ports:

- USB Host $1 / 2$ (HU1/HU2) - USB Type A host full speed ports for MDLC over IP communication via the MotoTrbo digital mode radio system (up to two radios attached to two USB host ports at one time) No USB devices or USB Hubs other than MotoTrbo radios are permitted.
- Serial 1 (SI1) - RS232/RS485 serial port (configurable)
- Serial 2 (SI2) - RS232 serial port
- Ethernet (Eth1)-10/100BaseT Ethernet port
- DU1 - USB device port, Type B connector (future option)

Plug-in port bays, where different types of ports can be installed:

- Plug-in 1 (PI1) - fits RS232, RS485, 10 MB Ethernet, 10/100 MB Ethernet, or Radio Modem Plug-in option
- Plug-in 2 (PI2) - fits RS232, RS485, 10 MB Ethernet, or Radio Modem Plug-in port option.

For the detailed specifications of each port, see ACE IP Gateway Module Specifications below. For information on the cables and connectors, see Appendix C.


The ACE3600 Ethernet port performs an Auto-Negotiation procedure whenever a peer device connection is detected at a $10 / 100 \mathrm{Mbps}$ Ethernet port. The Auto-Negotiation procedure guarantees that the speeds of ACE3600 and peer Ethernet ports will match, whether or not the peer supports Auto-Negotiation. If the peer supports AutoNegotiation, the duplex of ACE3600 and the peer Ethernet ports also match.

It is recommended to configure the Ethernet port of the device connected to the ACE3600 Ethernet port (e.g. switch, etc.) to Auto-Negotiation mode. This will guarantee a full match of speed and duplex between the ACE3600 and the peer device Ethernet ports. If the peer device Ethernet port does not support Auto-Negotiation, set the duplex of the peer to half duplex to avoid the duplex mismatch problem.

|  | Peer Ethernet Port Mode |  |  |  |  |
| :--- | :---: | :---: | :---: | :---: | :---: |
|  | Auto | 100 Mbs <br> Full Duplex | 100 Mbs <br> Half Duplex | Full Duplex | 10 Mbs |
| Half Duplex |  |  |  |  |  |

## Buzzer

The ACE IP Gateway module includes a buzzer (audio indication), which is used to indicate task completion (such as end of download/upload, restart etc.)

## Pushbuttons

The Gateway includes two pushbuttons on the front panel, PB1 and PB2.
These pushbuttons are used for activating and testing the modules LED, restarting the unit, erasing the user Flash memory and activating memory test. Table 20-2 describes the pushbuttons functionality.

## LEDs

The Gateway includes Gateway CPU status LEDs, and port status LEDs. Some of the LEDs are single color (green) and some are bicolor LEDs (red, green or orange).

Status LEDS indicate the Gateway CPU status in startup (boot), run-time or when there is a failure. The communication LEDs are used to indicate the communication port status. Note that during startup or failure, the communication LEDs are used to indicate various situations. Table 20-4 details the LEDs functionality.

## Gateway CPU Memory

The Gateway CPU includes Flash, and SDRAM.
The Flash stores the firmware and configuration files.
The SDRAM memory stores the temporary data.
The size of the ACE IP Gateway CPU memory is determined by the model as shown in the table below.

Table 20-1 ACE IP Gateway CPU Memory

|  | ACE IP <br> Gateway |
| :--- | :---: |
| Flash memory | 32 MB |
| SDRAM memory: | 128 MB |
| User Flash: | 19 MB |

## Real Time Clock (RTC)

The CPU includes a low drift RTC. The date and time are retained using an on-board rechargeable lithium battery.

The CPU date and time can be set using the ACE3600 STS. The CPU can also be synchronized with other RTUs in the system, using the system clock. For more information, see the Setting/Getting a Site's Date and Time section of the ACE3600 STS User Guide.

## Backup Battery for RTC

The CPU module includes a rechargeable lithium battery that provides backup power and data retention for the RTC.

The lithium battery is located on the CPU board and cannot be replaced.
Typically, the battery will retain the RTC for 60 continuous days without power and no LeadAcid backup battery.

## ACE IP Gateway Firmware and Operation Modes

The ACE IP Gateway firmware is a real-time multitasking operating system, based on the Wind River VxWorks OS. The GW shipped from the factory with the most recent firmware version, and it can be updated/replaced using a remote or local connection. Downloading firmware updates is performed using the STS. (See Downloading to a Site in the ACE3600 STS manual.) If the new firmware download stops or fails, the GW will restart with the existing firmware.

## Power-up and Restart

The CPU requires DC voltage provided by the power supply module via the motherboard (when the PS switch is ON). The CPU will power-up and restart in the range of 10.8 V to 16 V DC. During power-up, the processor performs fast memory tests, and initiates the GW. The end of the power-up sequence is indicated by the buzzer. The length of time from the beginning of CPU power-up until the GW starts running is approximately $10-15$ seconds.

It is possible to perform a comprehensive memory test during power-up by pressing pushbutton PB1 for few seconds while switching the power supply from OFF to ON. In this case the power-up period is about $30-35$ seconds long.

If the startup fails, the RTU will freeze (boot sequence stops), the PWR LED will blink and the four indicator LEDs (see LEDs Location in Table 20-3) will blink seven times. The four LEDs will then display the failure error in binary code, as described in Table 20-3.

When the unit is shipped from the factory, it will start up initially (before site configuration download), as a Primary Gateway in Standalone mode, even in systems with redundant Gateways.

## Restart after Firmware Download

The RTU will restart after downloading system firmware. If the firmware is faulty or the firmware download failed, the RTU, if protected by the Safe Firmware Download feature, will restart and roll back to the previous firmware version. A failure message will appear in the STS Downloader screen. For information on using the Safe Firmware Download feature, see the Safe Firmware Download section of the ACE3600 STS Advanced Features manual.

## Restart after Configuration Download

The RTU will restart after downloading a site configuration. For information on downloading to the RTU, see the Operation chapter of the ACE3600 STS User Guide.

If the RTU fails to restart after the user-defined site configuration was downloaded, a unique LED display (in the range of the PI1-TX and SI2-RX LEDs) and a series of buzzer tones will follow. The RST LED will turn RED and the RTU will restart itself with the previous "good" configuration. The following message will appear in the RTU Error Logger "Configuration file was deleted due to failure in startup. Rolling back to the last configuration file". Errors can be retrieved from the RTU using the ACE3600 STS Error Logger utility.

If the startup succeeds after configuration download but has errors, these errors are reported in the RTU Error Logger. It is, therefore, recommended to check for errors after downloading a configuration file to the RTU. Errors can be retrieved from the RTU using the ACE3600 STS Error Logger utility.

For information on retrieving errors from the RTU Error Logger, see the Operation chapter of the ACE3600 STS User Guide.

In a system with redundant Gateways, one unit is set to startup mode Redundant GW1 (in the site configuration) and the other unit which is set to Redundant GW2. After startup, both will act as Secondary Gateways until the SCADA designates one as Primary and the other as Secondary. For information on the setting the startup mode, see the Operation chapter of the ACE3600 STS User Guide. For information on ACE IPGW redundancy, see the ACE IP Gateway section of the ACE3600 STS Advanced Features manual.

## Restart after Erase Flash

After the User Flash is erased, the RTU will restart successfully with the default site configuration.

## Power-down

When the voltage provided to the CPU module drops below the minimum level, the CPU will shut down in an orderly fashion. This level is configurable for all power supply modules other than the 12 V DC power supply low-tier. See the 'Minimum DC operation voltage' parameter in Appendix A: Site Configuration Parameters of the ACE3600 STS User Guide.

## ACE IP Gateway Status and Diagnostics

The ACE IP Gateway status is indicated on the front panel LED. Detailed CPU status and diagnostics information can be retrieved from the module using the CPU Hardware Test utility. For more details, see the Hardware Test section of the ACE3600 STS User Guide.

## ACE IP Gateway Warnings and Errors

ACE IP Gateway warnings and errors are logged in the CPU memory to indicate issues or errors during power-up, restart, and other modes of CPU operation. The existence of CPU warnings and errors are indicated in the ERR LED on the front panel of the module. Green indicates a message, orange indicates a warning and red indicates an error.

The CPU error logger information can be retrieved using the STS Error Logger utility. For more details, see the Error Logger section of the ACE3600 STS User Guide.

## ACE IP Gateway Serial Number

Each IPGW has a unique serial number. This number is printed on a label on the side of the GW module front panel. The serial number can be read using the STS Hardware. For more information, see the Hardware Test section of the ACE3600 STS User Guide.

## Pushbutton Functionality

The table below describes the use of the two pushbuttons in various scenarios, during power-up and run-time. To press a pushbutton during startup, first press the pushbutton(s), then turn on the RTU using the On/Off switch on the front panel. Keep the pushbutton(s) depressed for the required number of seconds, as specified in the scenarios below.

Table 20-2 ACE IP GW Pushbutton Functionality

| Scenario | Trigger | Action |
| :---: | :---: | :---: |
| LEDs Test | During run-time, press PB1 for five or more consecutive seconds (but less than 30). | All the LEDS on the GW will be lit until let go of PB1 and then returned to their previous states. |
| RTU Restart | During run-time, press PB1 for 30 consecutive seconds. | All the LEDs will be lit. Then all the LEDs will blink once. <br> The buzzer will buzz several short beeps. (If PB1 is released during this time the restart will not be performed.) <br> At the long beep, release PB1 and the RTU will restart (and the buzzer will buzz.) |
| Turn LEDs ON | During run-time, press PB 1 for one second. | Those LEDs which are currently active will be turned on for a period of time (configured in the RTU configuration using the STS.) |
| RAM Test | During startup, press PB1. | A detailed memory test of SDRAM is performed. <br> - At the beginning of the RAM test, the four indicator LEDs (see LEDs Location in Table 20-3) will blink three times. During the RAM test, the LEDs may blink or be lit. <br> If the RAM test succeeds, the four LEDs will blink three times and turn off and the restart sequence will continue. <br> If the RAM test fails, the RTU will freeze (restart sequence stops), the PWR LED will blink and the four LEDs will blink seven times. The failure error code will then be displayed on the LEDs, in binary code, as described in Table 20-3. <br> - To exit/abort the RAM test in the middle, restart the RTU using the On/Off switch on the front panel. |


| Scenario | Trigger | Action |
| :--- | :--- | :--- |
| Erase User <br> Flash | During startup, press both <br> PB1 and PB2 simultaneously <br> until the buzzer buzzes five <br> times quickly, then <br> continuously for three <br> seconds. | All the user Flash memory content <br> excluding logging files (files tagged as <br> data logging files) is erased, including the <br> site configuration, etc. |
| Bootstrap | During startup, press PB2 <br> continuously for five <br> seconds. <br> Note: Before initiating <br> bootstrap, the CPU must be <br> connected directly to the <br> STS PC in standalone mode. <br> No other components can be <br> on the network which might <br> create a conflict with the <br> default IP address. | The RTU will start up in diagnostic mode. <br> Communication with the RTU is for <br> diagnostic purposes only (Error Logger/ <br> SW Diagnostics.) You cannot download to <br> the RTU. <br> If the bootstrap fails, the four indicator <br> will display the failure error in binary <br> code, as described in Table 20-3. |

Table 20-3 ACE IP GW Failure - Error Code Display on LEDs

| LEDs Location | LED Error Code | Description |
| :--- | :--- | :--- |

## ACE IP Gateway LEDs Behavior

The table below describes the behavior of the LEDs on the ACE IP Gateway module.
Table 20-4 ACE IP Gateway LEDs Behavior

| LED Name | Description | Status |
| :---: | :---: | :---: |
| PWR | Power LED <br> Bicolor LED (Red, Green) | Flashing Red - Power exists; CPU FPGA not loaded. <br> Green - Power exists; CPU is running from a recognized power supply (one of the six power supply options.) <br> Red - Failure on power-up. CPU is running from an unrecognized power supply. |
| ERR | Error Logger Status LED <br> Bicolor LED (Red, Green) | OFF - No new errors or warnings. <br> Green - New message logged. <br> Orange - New warning logged. <br> Red - New error logged. |
| RST | Reset LED <br> Bicolor LED (Red, Green) | Green - On startup <br> OFF - Successful power-up or restart. <br> Red - Power-up or restart failed. |
| CONF | Configuration LED <br> Bicolor LED (Red, Green) | OFF - Configuration was not loaded. <br> Green - Configuration was loaded. <br> Red - Configuration error. |
| H1 LNK1 | USB Host1 LNK (link) Green LED | ON - A USB device is connected. <br> OFF - No link exists between the CPU and the device. |
| H1 LNK2 | USB Host2 LNK (link) Green LED | ON - A USB device is connected. <br> OFF - No link exists between the GW and the device. |
| PI1 TX | Plug-in Port 1 - TX (transmit) <br> Green LED | ON- Transmitting Data |
| PI1 RX | Plug-in Port 1-RX (receive) Green LED | ON - Receiving Data |


| LED Name | Description | Status |
| :---: | :---: | :---: |
| PI1 CM | Plug-in Port 1 - CM (channel monitor) <br> Green LED | ON - Channel Busy (if port is in use by radio, RS485, or RS232) <br> - Network Connected (if an IP plug-in is used) |
| SI1 TX | Serial Port 1 - TX (transmit) Green LED | ON - Transmitting Data |
| SI1 RX | Serial Port 1 - RX (receive) Green LED | ON - Receiving Data |
| SI1 CM | Serial Port 1 - CM (channel monitor) <br> Green LED | ON - Channel Monitor is ON. |
| S2 TX | Serial Port 2 - TX (transmit) Green LED | ON - Transmitting Data |
| S2 RX | Serial Port 2 - RX (receive) Green LED | ON - Receiving Data |
| S2 CM | Serial Port 2 - CM (channel monitor) <br> Green LED | ON - Channel Monitor is ON |
| E1 LNK | Ethernet Port 1 (link) <br> Green LED | ON - Network Connected <br> In case of RAM test and startup failure, see Table 20-2 and Table 20-3. |
| E1 RX | Ethernet Port 1 (receive) Green LED | ON - Receiving Data <br> In case of RAM test and startup failure, see Table 20-2 and Table 20-3. |
| PI2 TX | Plug-in Port 2 - TX (transmit) <br> Green LED | ON - Transmitting Data |
| PI2 RX | Plug-in Port 2 - RX (receive) <br> Green LED | ON - Receiving Data |
| PI2 CM | Plug-in Port 2 - CM (channel monitor) <br> Green LED | ON - Channel Busy (if port is in use by radio, RS485, or RS232) <br> - Network Connected (if an IP plug-in is used) |
| D1 RX | For future use | For future use |

## ACE IP Gateway Module Specifications

| Microprocessor | Freescale - Power PC II MPC8270, 32-bit, extended communication capability, <br> DMA and floating point calculation support |
| :--- | :--- |
| Microprocessor <br> Clock | 200 MHz |
| Memory | Flash: 32 MB <br> SDRAM: 128 MB |
| Real-Time Clock | Full calendar with leap year support (year, month, day, hours, minutes, seconds). <br> Time drift: max. 2.5 Seconds per day (when power is on) |
| RTC Retention | 3 V Rechargeable lithium backup battery |
| Serial Port 1 | Configurable RS232 or RS485 port: <br> - RS232: Asynch, Full Flow Control, up to 230.4 kb/s, GPS receiver interface <br>  <br> - RS485, multi-drop 2-Wire up to 230.4 kb/s |
| Rerial Port 2 | RS232, Asynch, Full Flow Control, up to 230.4 kb/s, GPS receiver interface |
| Plug-In Port 1 | Supports the following plug-in ports: <br> - Radio Modem, DPSK 1.2 kb/s, FSK 1.2/1.8/2.4 kb/s, DFM 2.4/3.6/4.8 kb/s |
| - RS232, Sync/Asynch, Full Flow Control, up to 230.4 kb/s, |  |
| GPS receiver interface |  |

Specifications subject to change without notice.

## RADIO TYPES AND INSTALLATION KITS

## ACE3600 Radio Types



## CAUTION

In order to prevent overheating of the radio and degradation of radio performance, the radio should not exceed operating duty factors of $\mathbf{3 0 \%}$ transmission and 70\% receive mode.

Note that the operating temperature range of ACE3600 RTU models that include a radio is from $-30^{\circ} \mathrm{C}$ to $+60^{\circ} \mathrm{C}\left(-22^{\circ} \mathrm{F}\right.$ to $\left.+140^{\circ} \mathrm{F}\right)$. (The operating temperature range of the ACE3600 RTU models without a radio is from -40 ${ }^{\circ} \mathrm{C}$ to $+70^{\circ} \mathrm{C}\left(-40^{\circ} \mathrm{F}\right.$ to $\left.+158{ }^{\circ} \mathrm{F}\right)$ ).

The ACE3600 RTU supports conventional, analog trunked radios and digital trunked radios. It also supports data radios and various wireless modems. Conventional and analog trunked radios are connected to a plug-in radio modem port. Digital trunked radios and wireless modems are connected to an RS232 port. For information on configuring CPU ports for various radios/modems, see the ACE3600 STS User Guide. For information on IP communications over such modems, see the ACE3600 STS Advanced Features manual.

The following conventional/trunked mobile analog and digital radios and conventional portable analog and digital radios can be used with the ACE3600 RTU:

|  | Analog Motorola Radios | Digital Motorola Radios | Third Party Radios |
| :---: | :---: | :---: | :---: |
| Trunked | XTL5000*/XTL2500 | XTL5000/XTL2500 |  |
|  |  | XTS2500 |  |
|  |  | MTM800 |  |
| Conventional | CM200/CM140/EM200/ GM3188 |  | $\begin{aligned} & \text { MDS 9810/MDS 4710/ } \\ & \text { MDS } 9710 \end{aligned}$ |
|  | $\begin{aligned} & \text { GP320/GP328/HT750/ } \\ & \text { PRO5150 } \end{aligned}$ |  | TransNET 900 ${ }^{\text {Tм }}{ }^{* *}$ OEM |
|  | CDM750 |  | iNET $900{ }^{\text {TM }}$ |
| MotoTrbo |  | $\begin{aligned} & \text { XPR4350/XPR4380/ } \\ & \text { DM3400/ XiR } \\ & \text { M8220/DGM4100 } \end{aligned}$ |  |

[^33]For complete radio specifications such as modulations, standards, Tx power output, Rx sensitivity, supply voltage, and power consumption, see the specific radio owner's manual. Please note that third party radios are not provided with the RTUs.

The following table lists all the ACE3600 models that include radios.

| Conventional VHF Radio | ACE3600 Model |
| :--- | :--- |
| ACE3600 for CM200/CM140/EM200/GM3188 VHF | F7573A |
| ACE3600 with CDM750 136-174 MHz | F7563A |
| ACE3600 for HT750/GP320/GP328 /PRO5150 VHF | F7553A |
| Conventional UHF Radio |  |
| ACE3600 for CM200/CM140/EM200/GM3188 UHF | F7574A |
| ACE3600 with CDM750 403-512 MHz | F7564A |
| ACE3600 for HT750/GP320/GP328 /PRO5150 UHF | F7554A |
| Trunked VHF Radio |  |
| ACE3600 with XTL2500 136-174 MHz Analog | F7533A |
| ACE3600 with XTL2500 136-174 MHz Digital | F7593A |
| ACE3600 with XTS2500 136-174 MHz Digital | F7543A |
| Trunked UHF Radio | F7534A |
| ACE3600 with XTL2500 380-520 MHz Analog |  |
| ACE3600 with XTL2500 380-520 MHz Digital | F7544A |
| ACE3600 with XTS2500 380-520 MHz Digital |  |
| Trunked 800MHz Radio | F7538A |
| ACE3600 with XTL2500 800MHz Analog | F7598A |
| ACE3600 with XTL2500 800MHz Digital | F7548A |
| ACE3600 with XTS2500 800 MHz Digital | F7583A |
| MotoTrbo Digital Mobile Radio | F7584A |
| ACE3600 for XPR4350/DM3400/XiR M8220/DGM4100 VHF | F7588A |
| ACE3600 for XPR4350/DM3400/XiR M8220/DGM4100 UHF |  |
| ACE3600 for XPR4380 800/900 MHZ |  |

For a list of the radio models and regional options for the CM/EM/GM radios, see CM/EM/GM Radio Models and Regional Options for ACE3600 below. For a list of the radio models and regional options for the GP/HT/PRO radios, see GP/HT/PRO Radio Models and Regional

[^34]Options for ACE3600 below. For a list of the regional options for the MotoTrb radios, see XPR4350/XPR4380/DM3400/XiR M8220/DGM4100 Options for ACE3600 below.

IMPORTANT: Only model F7509A and all its options, including radio installation kits, may be shipped to European Union (EU) countries. The installer must confirm that there are no emissions or harmful interference to the spectrum due integrating the radio into this model.

The radios in the models listed in the table above are installed on the RTU using the installation radio kits described below.

## Radio Installation Kits

The following radio installation kits enable the user to install a radio in the ACE3600 RTU.

|  |  |  |  |  | Option/Kit |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Analog |  |  | M750 |  | V143AH/ |
|  | NA | EMEA | APAC | LA |  |
|  | CM200 | CM140 | GM3188 | EM200 | $\begin{aligned} & \text { V148AC/ } \\ & \text { FLN3635A } \end{aligned}$ |
| Digital Conventional | MD | 9810, MD | 4710, MD | 9710 | $\begin{aligned} & \text { V152AK/ } \\ & \text { FLN3853A } \end{aligned}$ |
|  |  | TransNE | 900 OEM |  | $\begin{aligned} & \text { VA00225AA/ } \\ & \text { FLN3852A } \end{aligned}$ |
|  |  |  | T 900 |  | $\begin{aligned} & \text { V680AH/ } \\ & \text { FLN3854A } \end{aligned}$ |
| Conventional | NA | EMEA | APAC | LA |  |
|  | HT750 | GP320 | GP328 | PRO5150 | $\begin{aligned} & \text { V154AE/ } \\ & \text { FLN3637A } \end{aligned}$ |
| Analog Trunking Mobile Radios |  | XTL500 | /XTL2500 |  | V157AB/ <br> FLN3640A |
| Digital Trunking Mobile Radios |  | XTL500 | /XTL2500 |  | V681AT/ <br> FLN3649A |
|  |  |  | 2500 |  | V156AG/ <br> FLN3814A |
|  |  |  | M800 |  | FLN4109A |
| MotoTrbo | NA | EMEA | APAC | LA |  |
|  | XPR4350/ <br> XPR4380 | DM3400 | $\begin{aligned} & \text { XiR } \\ & \text { M8220 } \end{aligned}$ | DGM4100 | $\begin{aligned} & \text { V682AF/ } \\ & \text { FLN4102A } \end{aligned}$ |

For instructions on mounting the radio on the ACE3600 frame, see the desired installation instructions below.

For general instructions on mounting a radio on the wall, see Mounting the ACE3600 Radios on a Wall below.

Note: A TORX screwdriver is required for the installation kits.

## XTL5000/XTL2500 Radio Installation Kit

The XTL5000/XTL2500 radio installation kit (ACE3600 option V681AT or V157AB) enables the user to install the XTL5000/XTL2500 radio in ACE3600 Remote Terminal Units (RTU). The ACE3600 can use the XTL5000/XTL2500 in two operation modes, depending on the system used.

- Digital mode (ACE3600 option V681AT) - suitable for Astro 6.x/7.x system trunked ASTRO IV\&D only
- Analog mode (ACE3600 option V157AB) - suitable for SmartNet 3.x system or Astro 4.x system (on the analog part only)

The following hardware and firmware are required:

- Radio firmware version 6.3E and above for digital trunked ASTRO IV\&D. (For 6.3E, HOST R04.51.01 DSP R04.50.00; for 6.5 HOST R05.00.00 and DSP R05.00.00)
- Radio firmware version 6.5E and above for analog trunked system (DSP version R06.00.00 for radio firmware R06.01.00)
- ASTRO Infrastructure version SR6.3 and above for trunked ASTRO IV\&D
- Smartnet version 3.x or Astro version 4.x for analog trunked system
- ACE3600 firmware 10.00 and above
- ACE3600 System Tools Suite (STS) version 10.50 and above

The FLN3649A/FLN3640A installation kits include a bracket, cables, and screws.
IMPORTANT: The XTL5000/XTL2500 radio control head must be radio option O5 for revolving power button control head.

## Installation

The XTL5000/XTL2500 radio can be mounted on the ACE3600 RTU using the metal bracket and cables as follows:

Procedure 21-1 How to Install the XTL5000/XTL2500 Radio on the Metal Chassis

1. Attach the radio plug-in port from the installation kit (FLN3696A) to the desired opening on the ACE3600 CPU module. For instructions on attaching plug-in ports, see Connecting Plug-In Ports to the CPU Module in the CPU Module chapter above.
2. Attach the XTL5000/XTL2500 radio to the metal bracket (\#0789422V41 from FHN6895A) using the four supplied radio screws (\#0310906A67), two on each side. (See Figure 21-1.) The wider side of the bracket should be on the right side of the radio (closer to the knobs.)
3. Connect the 26-pin connector of the signal cable (FKN8432A for digital mode or FKN8438A for analog mode) to the Accessory connector on the radio. In analog mode only, place one Fair-Rite soft ferrite (\#7683477X01 from the supplied ferrite kit

FHN7007A) on the signal cable (FKN8438A) near the bottom of the CPU door, loop the cable one turn around it, and clamp the ferrite on the cable.
Connect the other end of the communication cable to the ACE3600 CPU module port configured for the radio. (See Figure 21-2 and Figure 21-4.) For digital mode use any of the serial on-board or plug-in ports. For analog mode only the plug-in ports may be used. See RTU Port Configuration for the Astro IV\&D Digital Radio and RTU Port Configuration for the Astro IV\&D Analog Trunked Radio below.
4. Connect the DC power cable (FKN8436A) to the Power connector on the radio and the free red wire to the ignition pin on the FKN8432A/FKN8438A cable. Connect the opposite end of the power cable to the AUX2A or AUX2B connector on the ACE3600 power supply unit. (See Figure 21-2 and Figure 21-4.)


Figure 21-1 XTL5000/XTL2500 Radio and Metal Bracket


Figure 21-2 XTL5000/XTL2500 Radio Cable Connections- Rear View
5. Mount the bracket on the RTU chassis above the CPU and I/O modules, using the four built-in screws. (See Figure 21-4.) The wider side of the bracket is attached to the chassis.
6. Connect the antenna cable (FKN8437A) to the Antenna connector on the radio. Run the cable through the small white clips along the edge of the chassis and attach the connector to the opening on the bottom of the ACE3600 RTU housing. (See Figure 21-2 and Figure 21-4.)


Figure 21-3 XTL5000/XTL2500 Radio Bracket with Four Bracket Mounting Screws


Figure 21-4 XTL5000/XTL2500 Radio Installed on ACE3600 Chassis

## RTU Port Configuration for the Astro IV\&D Digital Radio

To enable MDLC communication using Astro XTL5000/XTL2500 radios, use the ACE3600 STS site configuration utility to configure the ACE3600 RTU port connected to the radio. For more information, refer to the IP Communications chapter of the ACE3600 STS Advanced Features manual.

The following figures show the port configuration and advanced parameter configuration. Although these show Port SI1, the same values can be applied to other ports, where relevant.

## Port Type (for Astro IV\&D Digital Radio)

Procedure 21-2 How to Configure the ACE3600 Port for the Astro IV\&D Digital Radio

1. In the ACE3600 STS click on the desired site, and open the site view.
2. In the Port Tab, click on the on-board or plug-in port through which the RTU will communicate with the XTL5000/XTL2500 radio.
3. Confirm that the port parameters and data speed are as shown in the screen below.
4. Define desired links.
5. If you plan to synchronize the RTU time from the Front End Processor (FEP) in the Customer Enterprise Network (CEN), specify the IP address of the FEP in the NTP field. This IP address information is provided by your ASTRO IV\&D system operator.
6. Save the changes.

| SII | Media <br> Operation Mode | RS-232 | - | Links... | LINE 1 |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | Asyme | $\checkmark$ | Data Speed: | [ 9600 Bps ]: | 9600 Bps | - |
|  | Connection Type | PPP | $\checkmark$ | DNS server IP addresses (up to 3) |  |  |  |
|  | Connected to | ASTROIVED | $\checkmark$ | NTP |  |  |  |

Figure 21-5 RTU Site Configuration for MDLC over ASTRO IV\&D - Port Type Parameters

## Advanced Parameter Configuration (for Astro IV\&D Digital Radio)



Figure 21-6 RTU Site Configuration for MDLC over ASTRO IV\&D - Advanced Parameters

Generally no other changes are required to Advanced Physical or Link Layer parameters. For information on these parameters, see the MDLC over IP chapter of the ACE3600 STS Advanced Features manual.

Procedure 21-3 How to Configure the Advanced Parameters of the ACE3600 Port for the Astro IV\&D Digital Radio

1. (ASTRO System 6.3-6.5 only) Make sure that the Advanced Link parameter Registration life time to 28800 seconds (default) in order to restart the radio periodically.
2. If any changes are required, click on the appropriate screen in the Port Tab.
3. Change the settings as necessary.

Note: The Default Group ID Address should be left 000.000 .000 . The actual values will be read by the RTU from the radio upon connection.
4. Save any changes.
5. Save the project.
6. Download the site configuration to the ACE3600 RTU.

## IP Conversion Table (for Astro IV\&D Digital Radio)

Prepare an IP conversion table if the RTU must communicate with another RTU or an IP Gateway. In the IP conversion table, specify the IP address of each RTU port (site ID + link ID). This IP address is assigned by the infrastructure operator.

Note that an IP address is obtained from the radio once it is connected to the RTU port over PPP. The IP address obtained from the radio is not the real IP address set by the infrastructure, but rather a dummy address. This dummy is configured in the radio via the CPS Mobile Computer IP address parameter (by default 192.168.128.2).

When device LINxL level 0 is retrieved using the ACE3600 STS Software Diagnostics tool, the IP Address displayed is this dummy address and not the actual IP address assigned by the infrastructure operator.

It is recommended to create two IP conversion tables:

1. The first is downloaded to the FIU or IP Gateway on the LAN and includes the site and IP information for each RTU.
2. The second is downloaded to all RTUs which are connected to the infrastructure with ASTRO IV\&D radios, and includes the site and IP information for the FIU and IP Gateway.

For detailed instructions on preparing the IP conversion table, refer to the IP Communications chapter of the ACE3600 STS Advanced Features manual.

## Radio Programming using CPS for the Astro IV \&D Digital

The XTL5000/XTL2500 radio is programmed for ACE3600 in the factory and is ready for ASTRO IV\&D communication. For user programming of site-specific parameters, the radio should be brought to the Motorola Service Center.

## Radio Connections

To program the XTL5000/XTL2500 radio with Customer Programming Software (CPS), the radio must be connected to a PC.

Procedure 21-4 How to Connect the XTL5000/XTL2500 Radio to the CPS

1. Connect one end of the programming cable (HKN6155) to the microphone connector on the front of the radio. This cable is not supplied and must be ordered separately.
2. Connect the other end to the serial port of a PC on which the ASTRO CPS software (RVN4185) is installed.

## Radio Disassembly

If the XTL5000/XTL2500 radio is to be programmed outside of the ACE3600 housing, disassemble the radio as follows:

Procedure 21-5 How to Disassemble the XTL5000/XTL2500 Radio from the ACE3600 Metal Chassis

1. Disconnect the antenna cable (FKN8437A) from the Antenna connector on the radio.
2. Remove the radio/bracket unit from the RTU chassis by unscrewing the four built-in screws.
3. Disconnect the DC power cable (FKN8436A) from the Power connector on the radio.
4. Disconnect the 26-pin connector of the signal cable (FKN8432A/FKN8438A) from the Accessory connector on the radio.
5. Detach the metal bracket (\#0789422V41 from FHN6895A) by unscrewing the four radio screws (\#0310906A67), two on each side. (See Figure 21-1.)
6. Take the radio to a laboratory for programming, as described in CPS Programming Settings below.

## CPS Programming Settings

Before programming the radio, read the codeplug file from the radio and save it to your PC using the File $>$ Read Device command in the CPS (R04.01.01 for radio firmware 6.3E; R05.00.00 for firmware 6.5). Open the codeplug file in the CPS and set the parameters as follows.

Procedure 21-6 How to Program the XTL5000/XTL2500 Digital Radio

1. In the CPS, click on the codeplug in the tree view to view and select the items below or select them from the Feature menu.
2. Under Radio Configuration, double-click on Radio Wide.
a. In the Transmit Power Levels tab, reduce the radio power level to low: Change TX Power Level Low for Freq. Range A from 16.5 to 10. (Range A 700Mhz UHF and VHF).
1) Change TX Power Level Low for Freq. Range B from 19.0 to 10. (Range B 800 Mhz and UHFR2 ( $470-520 \mathrm{Mhz}$ ).
2) Change TX Power Level High for Freq. Range A from 33.0 to 15.
3) Change TX Power Level High for Freq. Range B from 38.5 to 15.
b. In the General tab, set the Out of Range Indicator and Imbalanced Coverage Indicator to Alert \& Display.
c. (Recommended) In the Data tab, enable SNMP Traps. (You can disable it, but the RTU will only detect a loss of context activation the next time it polls the radio (every 10 seconds by default).
d. (Optional) Specify the Mobile Computer IP address. This is the dummy IP address assigned to the RTU by the radio (by default it is 192.168.128.2). For each radio, it is recommended to change the last digit in the Mobile Computer IP address (e.g. to the Unit ID in Trunking systems.)
e. (CPS R05.00.00 only) In the Advanced tab, make sure that "MOSCAD Data Enable" is not enabled (not checked.) (For IV\&D only. For communication over analog ASTRO Trunking, leave it enabled.) Set Extended DEK to Enable and Ignition Switch to Soft Power Off.
3. Double-click on NAT List -> NAT List Entry 1.
a. Add an entry to the NAT List:
1) WAN port $=$ MDLC over IP port number (e.g. 2002)
2) LAN port $=$ MDLC over IP port number (e.g. 2002)
3) Static NAT IP Address $=$ Mobile Computer IP Address (e.g. 192.168.128.2).
4) The Mobile Computer address should match the Mobile Computer IP Address assigned on the Radio Configuration $>$ Radio Wide $>$ Data tab in Step 2 above.
4. Double-click on Trunking -> Trunking System -> Trunking System 1.
a. In the General tab, set the Type to ASTRO 25. If the proper system key was loaded, the System Key field should already be enabled.
b. Set the ASTRO 25 Home System ID, Home WACN ID and Unit ID to values obtained from the radio system administrator.
c. Under Coverage Type, set the type to SmartZone.
d. In the Astro 25 Channel ID tab, enable the first channel.
e. In the $700 / 800$ Astro 25 Control Channels tab (700_800 or OBT depending on the band), enter the control channels with which the data subscriber should be able to affiliate. Consult your radio system administrator for the list of control channels.
f. In the Data tab, enable Packet Data Capable System (PDS), and Terminal Data and disable (uncheck) Rx Voice Interrupts Data.
5. Double-click on Trunking -> Trunking Personality -> Trunking Personality 1.
a. In the General tab, set the Protocol Type to ASTRO 25 and set the System \& ID to 1 .
b. In the 700/800 Failsoft tab, data only subscribers should set Failsoft Type to disabled. (There is no data service unless the subscriber is affiliated to a widearea trunking site.)
c. In the Talkgroup tab, set the radio talkgroup value in hexadecimal. Consult your radio system administrator for the talkgroup information.
d. (Recommended) In the Preferred Sites tab, set the status of the first record to None. (This means that data only subscribers are not locked into preferred sites.)
6. Double-click on Zone Channel Assignment ->Zone Channel Assignment.
a. In the Zone tab, set the Zone to the desired zone name (e.g. ZONE1).
b. In the Channels tab, set the Channel to the name which will be displayed on the radio screen (if the radio is Model II or III).
c. Select the Personality type of that channel.
d. Specify the Personality \# of that channel.
e. Specify the Talkgroup \# of that channel.
7. From the Tools menu, select the Change Control Head command. Make sure the Control Head Type is set to O5(M5) for new models and to W4 for old models, and click OK.
8. From the File Menu, select Save to save changes to the radio.
9. From the File Menu, select Write Device to download the configuration to the radio.

## Infrastructure Configuration for the Astro IV\&D Digital Radio

In order for the ACE3600 RTU to communicate over the ASTRO IV\&D infrastructure (6.4 or later) using the XTL5000/XTL2500 digital radio, the infrastructure must be properly configured using the UCM (User Configuration Manager) tool.

Note: If configuring a border router or any firewall within the CEN (Customer Enterprise network), make sure that the ACE3600's MDLC over IP UDP port number 2002 is enabled for inbound and outbound messages.

Note: In the UCM Radio User Data Settings tab, be sure to set the IP address as Static, to enable Generate ICMP and Source Address Checking, and the Ready timer set to 10 seconds.

## RTU Port Configuration for the Astro IV \&D Analog Trunked Radio

To enable MDLC communication using Astro XTL5000/XTL2500 radios, use the ACE3600 STS site configuration utility to configure the ACE3600 RTU port (either on-board serial or plug-in port) connected to the radio. For more information, refer to the IP Communications chapter of the ACE3600 STS Advanced Features manual.

## Port Type (for Analog Trunked Radio)

Procedure 21-7 How to Configure the ACE3600 Port for the Astro IV\&D Analog Radio

1. In the ACE3600 STS click on the desired site, and open the site view.
2. In the Port Tab, click on the plug-in port through which the RTU will communicate with the XTL5000/XTL2500 radio.
3. Set the port parameters as shown in the screen below. The Trunk system parameter should reflect the type of trunking system (e.g. SmartNet, SmartZone.)
4. Save the changes.

| P11 | Media | Radio | - | Link name: |  | RADIO 1 | $\checkmark$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Radio System | Trunking | $\checkmark$ | Data Speed: | [ 1200 Bps ]: | 1200 Bps |  |
|  | Radio Type | XTL5000 Trunked Analog | $\checkmark$ | Default routing: | [ None]: | None | $\checkmark$ |
|  | Trunk system | SmartNet | $\checkmark$ |  |  |  |  |
|  | Modem | DPSK | $\checkmark$ |  |  |  |  |

Figure 21-7 RTU Site Configuration for MDLC over Analog Trunked System - Port Type Parameters

## Programming the XTL5000/XTL2500 Analog Trunked Radio using CPS

The XTL5000/XTL2500 radio is programmed for ACE3600 in the factory and is ready for analog trunked communication. For user programming of site-specific parameters, the radio should be brought to the Motorola Service Center.

## Radio Connections

Follow the Radio Connections instructions described under Radio Programming using CPS for the Astro IV \& D Digital above.

## Radio Disassembly

Follow the Radio Disassembly instructions described under Radio Programming using CPS for the Astro IV\&D Digital above.

## CPS Programming Settings

Before programming the radio, read the codeplug file from the radio and save it to your PC using the File $>$ Read Device command in the CPS (DSP version R06.00.00 for radio firmware R06.01.00.) Open the codeplug file in the CPS and set the parameters as follows.

Procedure 21-8 How to Program the XTL5000/XTL2500 Analog Radio

1. In the CPS, click on the codeplug in the tree view to view and select the items below or select them from the Feature menu.
2. Under Radio Configuration, double-click on Radio Wide.
a. In the Transmit Power Levels tab, reduce the radio power level to low: Change TX Power Level Low for Freq. Range A from 28.0 to 10.
1) Change TX Power Level High for Freq. Range A from 53.5 to 15 .
b. In the Advanced tab, make sure that "MOSCAD Data Enable" is enabled. Set Extended DEK to Enable and Ignition Switch to Soft Power Off.
c. In the Time Out Timer tab, make sure the Time \# is set to 3 (for 60 sec ).
3. Double-click on Controls.
a. Click on Control Head.
b. Make sure the Control Head is O5(M5) for new models and W4 for old models.
c. Click on Radio VIP.
1) Set VIP In for VIP 1, VIP 2, and VIP 3 to Blank.
2) Set VIP Out for VIP 1 to MOSCAD CG.
3) Set VIP Out for VIP 2 to MOSCAD TXE/CM.
4) Set VIP Out for VIP 3 to NULL.
4. Double-click on Conventional $->$ Conventional Personality $->$ Conventional Personality 1.
a. In the Rx Options tab, set Unmute/Mute Type to UnMute, Or Mute.
b. Set Rx Voice/Signal Type to Non-Astro.
c. Enable (check) Rx Emphasis and Busy LED.
d. In the Tx Options tab, make sure that the Time Out Timer is set to 3 (for 60 sec ).
e. Set Tx Voice/Signal Type to Non-Astro.
f. Set Transmit Power Level to High.
5. Double-click on Trunking -> Trunking System -> Trunking System 1.
a. In the General tab, if the proper system key was loaded, the System Key field should already be enabled.
b. Set the Type to II.
c. Set the Type II System ID, and Connect Tone to values obtained from the radio system administrator for the site.
d. Under Coverage Type, set the type to Disabled.
e. In the Type II tab, set the Individual ID to the value obtained from the radio system administrator for the site.
f. Set the Affiliation type to Automatic.
g. In the Channel Assignment tab, enter the Rx and Tx channel ranges. Consult your radio system administrator for the list of values.
h. In the OBT Control Channels tab, set the RX Frequency and TX Frequency of each control channel with which the data subscriber should be able to affiliate. Consult your radio system administrator for the list of control channels.
6. Double-click on Trunking ->Trunking Personality ->Trunking Personality 1.
a. In the General tab, set the Protocol Type to II and set the System ID to the value obtained from the radio system administrator for the site. Make sure that the Time Out Timer is set to 3 (for 60 sec ). Check that the Type II Individual ID is set to the value obtained from the radio system administrator for the site.
b. In the Talkgroup tab, set the radio talkgroup value in hexadecimal. Consult your radio system administrator for the talkgroup information. (Note: Talkgroup for voice in analog trunking is the same for voice and data on analog trunk.
7. From the File Menu, select Save to save changes to the radio.
8. From the File Menu, select Write Device to download the configuration to the radio.

## XTL5000/XTL2500 Radio Models and Options for ACE3600

The XTL5000/XTL2500 radio installation kit is used with one of the following XTL5000/ XTL2500 radios:

| Description | Nomenclature | Band |
| :--- | :--- | :--- |
| XTL5000 Mobile 10-35 W, 764-870MH | M20URS9PW1 N | $764-870 \mathrm{MHz}$ |
| XTL5000 UHF R1 Mobile 10-40 W 380-470 | M20QSS9PW1 N | $380-470 \mathrm{Mhz}$ |
| XTL5000 UHF R2 450-520 MHZ 10-45 W | M20SSS9PW1 N | $450-520 \mathrm{Mhz}$ |
| XTL5000 VHF Mobile 10-50 W 136-174 MHZ | M20KSS9PW1 N | $136-174 \mathrm{Mhz}$ |
| XTL2500 Mobile 10-35 W, 764-870MHz | M21URM9PW1N | $764-870 \mathrm{MHz}$ |
| XTL2500 Mobile 10-40 W, 380-470MHz | M21QSM9PW1 N | $380-470 \mathrm{MHz}$ |
| XTL2500 Mobile 10-45 W, 450-520MHz | M21SSM9PW1 N | $450-520 \mathrm{MHz}$ |
| XTL2500 Mobile 10-50 W, 136-174MHz | M21KSM9PW1 N | $136-174 \mathrm{MHz}$ |

All of the following options may be ordered with the XTL2500 radio:

| Option Name | Option Number |
| :--- | :--- |
| ADD: O5 CONTROL HEAD | G442 |
| ADD: NO MICROPHONE NEEDED | G90 |
| ENH: SOFTWARE ASTRO DIGITAL CAI OPERATION | G806 |
| ENH: ASTRO PROJECT 25 TRUNKING SOFTWARE | G361 |
| ADD: CONTROL HEAD SOFTWARE, O5 | G444 |
| ENH: SMARTZONE OPERATION | G51 |
| ENH: RS232 PACKET DATA INTERFACE | W947 |

Radio Types and Installation Kits

| Option Name | Option Number |
| :--- | :--- |
| ADD: DASH MOUNT | G66 |
| ADD: NO SPEAKER | G142 |
| ADD: NO ANTENNA | G89 |

## XTS2500 Radio Installation Kit

The XTS2500 radio installation kit (ACE3600 option V156AG or kit FLN3814A) enables the user to install the XTS2500 radio in ACE3600 Remote Terminal Units (RTU). The RTU can use the XTS2500 in digital mode to communicate over the ASTRO 6.x/7.x system. The following hardware and firmware are required:

- Radio firmware version 6.4 and above for trunked IV \&D
- ASTRO Infrastructure version SR6.5 and above for trunked IV\&D
- ACE3600 firmware 10.00 and above
- ACE3600 System Tools Suite (STS) version 10.50 and above

The installation kit includes brackets, cables, screws and installation instructions.
After the XTS2500 radio is installed in the RTU, the RTU port is configured, the IP address information is downloaded, the radio is context activated and finally, communication from the RTU over the air is verified. For more information on MDLC over ASTRO IV\&D (Integrated Voice \& Data), refer to the MDLC over IP chapter of the ACE3600 STS Advanced Features Manual.

## Installation



## CAUTION

Before installing the XTS2500 radio on the RTU, configure the power supply AUX2A/B connector to 7.5 V DC in the ACE3600 STS site configuration (using the Power Supply <n> Auxiliary 2 voltage parameter.) Download the updated site configuration to the RTU. Failure to do so might damage the radio.

The installation kit includes a radio bracket, metal bracket with built-in screws, power cables, communication cable, antenna cable and plastic strips. The XTS2500 can be mounted on the ACE3600 RTU using the kit as follows:

Procedure 21-9 How to Install the XTS2500 Radio on the Metal Chassis

1. Attach the XTS 2500 radio to the radio bracket (from FHN6674A). (See Figure 21-8.)
2. Connect the programming cable (RKN4106A) provided with the radio to the Accessory connector on the radio. (See Figure 21-10.) Connect the other end of the programming cable to the 9-pin D-type (Radio) connector on the communication cable (FKN8516A) and tighten the screws attached to the programming cable. Do not use the 25 -pin connector; it is for programming only.
3. Connect the other end of the communication cable (RJ45 connector) to the plug-in port of the ACE3600 CPU.
4. Connect the 7.5 V DC power cable (FKN8515A) to the AUX2A or AUX2B auxiliary power output connector on the RTU power supply. Connect the other end of the power cable to the DC adapter on the radio bracket (FHN6674A). (See Figure 21-9 and Figure 21-10.)


Figure 21-8 XTS2500 Radio and Metal Bracket
5. Add the BNC adapter (\#5871143Y04) to the XTS2500 radio antenna connector. (See Figure 21-9.)
6. Attach the BNC connector of the antenna cable (FKN8434A) to the radio's BNC adapter. Route the antenna cable through the small wire clamps along the left side edge of the RTU chassis, according to the placement of the radio on the chassis. Attach the N-type connector at the other end to the opening on the bottom of the RTU housing using the supplied locking washer and nut. (See Figure 21-9.)
7. Mount the radio/bracket unit on the metal bracket (\#0789422V40 from FHN6674A) using the four supplied screws.
8. Mount the metal bracket on the RTU chassis above the I/O modules, using the three builtin screws, with the bottom of the radio towards the chassis. (See Figure 21-9.)
9. Attach all cables to the chassis using the supplied wire clamps.

Radio Types and Installation Kits


Figure 21-9 XTS2500 Radio Installed on ACE3600 Chassis


Figure 21-10 XTS2500 Radio Installed on ACE3600 Chassis - Cable Connections

## RTU Port Configuration

To enable MDLC communication over ASTRO IV\&D, use the ACE3600 STS ( $\geq$ V10.50) to configure the RTU port connected to the XTS25000 radio. For more information, refer to the MDLC over IP chapter of the ACE3600 STS Advanced Features manual.

The following figures show the port configuration and advanced parameter configuration. Although these show Port SI1, the same values can be applied to other ports, where relevant.

## Port Type

Procedure 21-10 How to Configure the ACE3600 Port for the Astro XTS2500 Digital Radio

1. In the ACE3600 STS click on the desired site, and open the site view.
2. In the Port Tab, click on the on-board or plug-in port through which the RTU will communicate with the XTS2500 radio.
3. Confirm that the port parameters and data speed are as shown in the screen below.
4. Define desired links.
5. If you plan to synchronize the RTU time from the Front End Processor (FEP) in the Customer Enterprise Network (CEN), specify the IP address of the FEP in the NTP field. This IP address information is provided by your ASTRO IV\&D system operator.
6. Save the changes.

| 511 | Media <br> Operation Mode | $\begin{aligned} & \text { RS-232 } \\ & \hline \text { Async } \\ & \hline \end{aligned}$ | $\frac{\nabla}{-}$ | Links... $\quad$ [9600 Bps]: |  | LINE 1 |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  | 9600 Bps | - |
|  | Connection Type | PPP | $\checkmark$ | DNS server IP addresses (up to 3) |  |  |  |
|  | Connected to | ASTRTO V\&D | $\checkmark$ | NTP |  |  |  |

Figure 21-11 RTU Site Configuration for MDLC over ASTRO IV\&D - Port Type Parameters

## Advanced Parameter Configuration



Figure 21-12 RTU Site Configuration for MDLC over ASTRO IV\&D - Advanced Parameters

Generally no other changes are required to Advanced Physical or Link Layer parameters. For information on these parameters, see the MDLC over IP chapter of the ACE3600 STS Advanced Features manual.

Procedure 21-11 How to Configure the Advanced Parameters of the ACE3600 Port for the Astro XTS2500 IV\&D Digital Radio

1. (ASTRO System 6.3-6.5 only) Make sure that the Advanced Link parameter Registration life time to 28800 seconds (default) in order to restart the radio periodically.
2. If any changes are required, click on the appropriate screen in the Port Tab.
3. Change the settings as necessary.

Note: The Default Group ID Address should be left 000.000 .000 . The actual values will be read by the RTU from the radio upon connection.
4. Save any changes.
5. Save the project.
6. Download the site configuration to the ACE3600 RTU.

## IP Conversion Table (for Astro XTS2500 IV\&D Digital Radio)

Prepare an IP conversion table if the RTU must communicate with another RTU or an IP Gateway. In the IP conversion table, specify the IP address of each RTU port (site ID + link ID). This IP address is assigned by the infrastructure operator.

Note that an IP address is obtained from the radio once it is connected to the RTU port over PPP. The IP address obtained from the radio is not the real IP address set by the infrastructure, but rather a dummy address. This dummy is configured in the radio via the CPS Mobile Computer IP address parameter (by default 192.168.128.2).

When device LINxL level 0 is retrieved using the ACE3600 STS Software Diagnostics tool, the IP Address displayed is this dummy address and not the actual IP address assigned by the infrastructure operator.

It is recommended to create two IP conversion tables:

1. The first is downloaded to the FIU or IP Gateway on the LAN and includes the site and IP information for each RTU.
2. The second is downloaded to all RTUs which are connected to the infrastructure with ASTRO IV\&D radios, and includes the site and IP information for the FIU and IP Gateway.

For detailed instructions on preparing the IP conversion table, refer to the IP Communications chapter of the ACE3600 STS Advanced Features manual.

## Radio Programming using CPS for the Astro XTS2500 IV\&D Digital

The XTS2500 radio is programmed for ACE3600 in the factory and is ready for ASTRO IV\&D communication. For user programming of site-specific parameters, the radio should be brought to the Motorola Service Center.

## Radio Connections

To program the XTS2500 radio with Customer Programming Software (CPS), the radio must be connected to a PC.

Procedure 21-12 How to Connect the XTS2500 Radio to the CPS

1. Power on the radio.
2. Disconnect the programming cable (RKN4106A) from the 9-pin D-type (Radio) connector on the data cable (FKN8516A).
3. Connect the D-type connector of the programming cable (RKN4106A) to the serial port of a PC on which the ASTRO CPS software is installed.
4. Program the radio using the CPS, as described in CPS Programming Settings below.
5. After radio programming, reconnect the communication and programming cables as described in the Installation section above.

## Radio Disassembly

If the XTS2500 radio is to be programmed outside of the ACE3600 housing, disassemble the radio as follows:

Procedure 21-13 How to Disassemble the XTS2500 Radio from the ACE3600 Metal Chassis

1. Disconnect the antenna cable (FKN8434A) from the Antenna connector on the radio.
2. Remove the radio/bracket unit from the RTU chassis by unscrewing the three built-in screws.
3. Disconnect the DC power cable (FKN8515A) from the Power connector on the radio.
4. Disconnect the 13-pin connector of the programming cable (RKN4106A) from the Accessory connector on the radio.
5. Detach the metal bracket (\#0789422V40 from FHN6674A) by unscrewing the four radio screws (\#0310906A67), two on each side. (See Figure 21-9.)
6. Take the radio to a laboratory for programming, as described in CPS Programming Settings below.

## CPS Programming Settings

Before programming the radio, read the codeplug file from the radio and save it to your PC using the File->Read command in the CPS (R05.00.00 or above). Open the codeplug file in the CPS and set the parameters as follows.

Procedure 21-14 How to Program the XTS2500 Digital Radio

1. In the CPS, click on the codeplug in the tree view to open the items below.
2. Under Radio Configuration, double-click on Radio Wide.
a. In the General tab, set the Out of Range Indicator and Imbalanced Coverage Indicator to Alert \& Display.
b. (Recommended) In the Data tab, enable SNMP Traps. (You can disable it, but the RTU will only detect a loss of context activation the next time it polls the radio (every 10 seconds by default).
c. (Optional) Specify the Mobile Computer IP address. This is the dummy IP address assigned to the RTU by the radio (by default it is 192.168.128.2). For each radio, it is recommended to change the last digit in the Mobile Computer IP address (e.g. to the Unit ID in Trunking systems.)
3. Double-click on NAT List -> NAT List Entry 1.
a. Add an entry to the NAT List:
1) WAN port = MDLC over IP port number (e.g. 2002)
2) LAN port = MDLC over IP port number (e.g. 2002)
3) Static NAT IP Address = Mobile Computer IP Address (e.g. 192.168.128.2).

The Mobile Computer address should match the Mobile Computer IP Address assigned on the Radio Configuration $>$ Radio Wide $>$ Data tab in Step 2 above.
4. Double-click on Trunking ->Trunking System ->Trunking System 1.
a. In the General tab, set the Type to ASTRO 25. If the proper system key was loaded, the System Key field should already be enabled.
b. Set the ASTRO 25 Home System ID, Home WACN ID and Unit ID to values obtained from the radio system administrator.
c. Under Coverage Type, set the type to SmartZone.
d. In the Astro 25 Channel ID tab, enable the first channel.
e. In the $700 / 800$ Astro 25 Control Channels tab (700_800 or OBT depending on the band), enter the control channels with which the data subscriber should be able to affiliate. Consult your radio system administrator for the list of control channels.
f. In the Data tab, enable Packet Data Capable System (PDS), and Terminal Data and disable (uncheck) Rx Voice Interrupts Data.
5. Double-click on Trunking ->Trunking Personality ->Trunking Personality 1.
a. In the General tab, set the Protocol Type to ASTRO 25 and set the System \& ID to 1 .
b. In the 700/800 Failsoft tab, data only subscribers should set Failsoft Type to disabled. (There is no data service unless the subscriber is affiliated to a widearea trunking site.)
c. In the Talkgroup tab, set the radio talkgroup value in hexadecimal. Consult your radio system administrator for the talkgroup information.
d. (Recommended) In the Preferred Sites tab, set the status of the first record to None. (This means that data only subscribers are not locked into preferred sites.)
6. Double-click on Zone Channel Assignment ->Zone Channel Assignment.
a. In the Zone tab, set the Zone to the desired zone name (e.g. ZONE1).
b. In the Channels tab, set the Channel to the name which will be displayed on the radio screen (if the radio is Model II or III).
c. Select the Personality type of that channel.
d. Specify the Personality \# of that channel.
e. Specify the Talkgroup \# of that channel.
7. From the File Menu, select Save to save changes to the radio.
8. From the File Menu, select Write Device to download the configuration to the radio.

## Infrastructure Configuration for the Astro IV\&D XTS2500 Digital Radio

In order for the ACE3600 RTU to communicate over the ASTRO IV\&D infrastructure (6.4 or later) using the XTS2500 digital radio, the infrastructure must be properly configured using the UCM (User Configuration Manager) tool.

Note: If configuring a border router or any firewall within the CEN (Customer Enterprise network), make sure that the ACE3600's MDLC over IP UDP port number 2002 is enabled for inbound and outbound messages.

Note: In the UCM Radio User Data Settings tab, be sure to set the IP address as Static, to enable Generate ICMP and Source Address Checking, and the Ready timer set to 10 seconds.

## XTS2500 Radio Models and Options for ACE3600

The XTS2500 radio installation kit is used with one of the following XTS2500 radio:

| Description | Nomenclature | Band |
| :--- | :--- | :--- |
| XTS2500 PORTABLE 1-3 WATTS, 764-870MH | H46UCC9PW5 N | $764-870 \mathrm{MHz}$ |
| XTS2500 VHF PORTABLE 1-5 WATTS 136-174 | H46KDC9PW5 N | $136-174 \mathrm{MHz}$ |
| XTS2500 UHF R1 PORTABLE 1-5 WATTS 380-470 | H46QDC9PW5 N | $380-470 \mathrm{MHz}$ |
| XTS2500 UHF R1 PORTABLE 1-5 WATTS 450-520 | H46SDC9PW5 N | $450-520 \mathrm{MHz}$ |

All of the following options may be ordered with the XTS2500 radio:

| Option Name | Option Number |
| :--- | :--- |
| ENH: SOFTWARE TRUNKING 9600 BAUD Includes: 9600 <br> Baud, Wide Area SmartZone, OmniLink, ASTRO Digital CAI, <br> \& PTT-ID Display | Q574 |
| ENH: RADIO PACKET DATA | Q947 |
| DEL: ANTENNA | H112 |
| DEL: BATTERY ALL TOGETHER | H207 |
| DEL: BELT CLIP | H301 |
| ADD: DATA CABLE | Q157 |

## CDM750 Radio Installation Kit

The CDM750 radio installation kit (ACE3600 option V143AH/kit FLN3638A) enables the user to install the CDM750 radio series in ACE3600 Remote Terminal Units (RTU). The FLN3638A installation kit includes a bracket, adapter, and cables.

## Installation

The CDM750 radio can be mounted on the ACE3600 RTU as follows:
Procedure 21-15 How to Install the CDM750 Radio on the Metal Chassis

1. Attach the radio plug-in port from the installation kit (FLN3696A) to the desired opening on the ACE3600 CPU module. For instructions on attaching plug-in ports, see Connecting Plug-In Ports to the CPU Module in the CPU Module chapter above.
2. Connect the radio adapter (FLN3639A) 16-pin connector to the radio Accessory connector (See Figure 21-13.)
3. Connect the power cable (FKN8436A) to the radio power connector, and the opposite end of the cable to the AUX1A or AUX1B connector on the ACE3600 power supply module. Connect the free red wire to the ignition pin on the radio adapter.
4. Connect the communication cable (FKN8427A) to the rear connector (8-pin RJ45 connector) of FLN3639A. Place one Fair-Rite soft ferrite (\#7683477X01 from the supplied ferrite kit FHN7007A) on the cable near the bottom of the CPU door, loop the cable one turn around it, and clamp the ferrite on the cable.
Connect the other end of the communication cable to the plug-in port of the ACE3600 CPU module.


Figure 21-13 CDM750 Antenna, Power and Communication Cable Connections
4. Connect the antenna cable (FKN8437A) to the Antenna connector on the radio and to the opening on the bottom of the ACE3600 RTU housing, using the four supplied screws. See Figure 21-13 and Figure 21-15.)
5. Attach the radio to the bracket (0789422V45 from FHN6898A) by using screws and washers from kit FHN6898A. See Figure 21-14 below.


Figure 21-14 CDM750 Radio and Metal Bracket
6. Attach the complex (radio + bracket) using the four supplied screws to the ACE3600 chassis. See Figure 21-15 below.


Figure 21-15 CDM750 Radio Installed on ACE3600 Chassis

## RTU Port Configuration for the CDM750 Radio

To enable MDLC communication using CDM750 radios, use the ACE3600 STS site configuration utility to configure the ACE3600 RTU plug-in port connected to the radio.

The following figures show the port configuration and advanced parameter configuration. Although these show Port PI1, the same values can be applied to port PI2 as well, where relevant.

## Port Type

Procedure 21-16 How to Configure the ACE3600 Port for the CDM750 Radio

1. In the ACE3600 STS, click on the desired site, and open the site view.
2. In the Port Tab, click on the plug-in port through which the RTU will communicate with the radio.
3. Confirm that the port parameters and data speed are as shown in the screen below.
4. Define desired radio links and zones if necessary.
5. Save the changes. Generally no other changes are required to Advanced Physical or Link Layer parameters.

| Pl1 | Media | Radio | - | LLink name: |  | RAADIO 1 | $\checkmark$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Radio System | Conventional | $\checkmark$ | Zones... |  |  |  |
|  | Radio Type | CDM750 | - | Data Speed: | [ 1200 Bps . | 1200 Bps | $\checkmark$ |
|  | Max no. of repeaters | No repeater | $\checkmark$ | Default routing: | [ None]: | None | $\checkmark$ |
|  | Modem | DPSK | $\checkmark$ |  |  |  |  |

Figure 21-16 RTU Site Configuration for MDLC over CDM750 Radio - Port Type Parameters

## Programming the CDM750 Radio using CPS

The CDM750 radio is programmed for ACE3600 in the factory and is ready for communication. For user programming of site-specific parameters, follow the instructions below.

## Radio Connections

To program the CDM750 radio with Customer Programming Software (CPS), the radio is connected to a PC using the standard Radio Interface Box (RIB).

Procedure 21-17 How to Connect the CDM750 Radio to the CPS

1. Connect one end of the programming cable (PMKN4004) to the radio Accessory connector and the other end to the 25 -pin connector on the RIB (RLN4008). The RIB and cable are not supplied and must be ordered separately.
2. Using the 9-pin interface cable (3080369B72), connect the RIB to the serial port of a PC on which the CDM750 CPS software (HVN9025) is installed.
3. Connect the RIB to a power RIB power supply or 9 V battery.

## Radio Disassembly

If the CDM750 radio is to be programmed outside of the ACE3600 housing, disassemble the radio as follows:

Procedure 21-18 How to Disassemble the CDM750 Radio from the ACE3600 Metal Chassis

1. Disconnect the antenna cable (FKN8437A) from the radio Antenna connector.
2. Remove the radio/bracket unit from the RTU chassis by unscrewing the four built-in screws.
3. Disconnect the DC power cable (FKN8436A) from the radio Power connector.
4. Disconnect the radio adapter (FLN3639A) 16-pin connector from the radio Accessory connector.
5. Detach the metal bracket (FHN6898A) by unscrewing the two radio screws (\#0387839V89), one on each side. (See Figure 21-14.)

## CPS Programming Settings

The following programming instructions must be performed before connecting a CDM750 radio to the ACE3600 family Remote Terminal Units (RTU). These instructions define miscellaneous settings and the function of each pin in the radio's general purpose I/O connector.

## Procedure 21-19 How to Program the CDM750 Radio

1. Before programming the radio, read the codeplug file from the radio and save it to your PC using the File $>$ Read Device command in the CPS.
2. Open the codeplug file in the CPS. Click on the codeplug in the tree view to view and select the items below or select them from the Feature menu.
3. Under Radio Configuration, change the settings on the Basic, Tx Power, Accessory Configuration, and Accessory Pins tabs, as shown in the screens below.
4. Under Controls and Menus->Conventional Buttons, change the settings to the Mobile Key Buttons and Programmable Buttons tabs, as shown in the screens below.
5. Under Conventional Personality 1, change the settings to the Basic, Options and Advanced tabs, as shown in the screens below.
6. Under Personality Assignment to Zone 1, make sure that the desired channel(s) appear on the list on the Channels tab. If not all the assigned channels are required, remove them from the assignment list.
7. From the File Menu, select Save to save changes to the radio.
8. From the File Menu, select Write Device to download the configuration to the radio.


Figure 21-17 Radio Configuration- Basic Settings


Figure 21-18 Radio Configuration- Tx Power


Figure 21-19 Radio Configuration - Accessory Connector Configuration


Figure 21-20 Radio Configuration - Accessory Pins Definition


Figure 21-21 Conventional Buttons Configuration - Mobile Key Buttons


Figure 21-22 Conventional Buttons Configuration - Programmable Buttons


Figure 21-23 Conventional Personality Configuration - Basic Settings


Figure 21-24 Conventional Personality Configuration - Options


Figure 21-25 Conventional Personality Configuration - Advanced Settings


Figure 21-26 Radio Channel Assignment - Personality Assignment to Zone

## GP/HT/PRO Radio Installation Kit

The GP/HT/PRO Radio Installation Kit for ACE3600 (V154AE, FLN3637A) enables the user to install the GP320/GP328/HT750/PRO5150 portable radios in ACE3600 Remote Terminal Units (RTU). Each kit includes a bracket, radio interface, adapters, and cables.

## Volume Knob Retainer

The volume knob retainer sets a fixed position for the volume knob on the GP/HT/PRO radios, for optimal operation in an ACE3600 RTU installation. To implement this option, follow the procedure below.

Procedure 21-20 How to Attach the Volume Knob Retainer for the GP/HT/PRO Radio

1. Remove the original plastic volume knob cover from the radio by pulling it out with pliers, as shown in Figure 21-27.


Figure 21-27 Removing the Volume Knob
2. Place the hole of the volume knob retainer (shown in Figure 21-28) over the exposed metal volume rod on the radio (shown in Figure 21-29.)


Figure 21-28 Volume Knob Retainer
3. Fasten the bottom of the volume knob retainer to the radio body. (See Figure 21-29.)


Figure 21-29 Attach Retainer to Radio

## Installation



## CAUTION

Before installing the GP/HT/PRO radio on the RTU, configure the power supply AUX2A/B connector to 7.5 V DC in the ACE3600 STS site configuration (using the Power Supply <n> Auxiliary 2 voltage parameter.) Download the updated site configuration to the RTU. Failure to do this might damage the radio.

The GP/HT/PRO radio can be mounted on the ACE3600 RTU as follows:

1. Attach the radio plug-in port from the installation kit (FLN3696A) to the desired opening on the ACE3600 CPU module. For instructions on attaching plug-in ports, see Connecting Plug-In Ports to the CPU Module in the CPU Module chapter above.
2. Connect the audio accessory adapter (HLN9716) (Item 1) to the radio. See Figure 21-30.
3. Insert the communication cable (FKN8431A) (Item 2) into the audio accessory adapter.
4. Insert the BNC antenna adapter (FTN6045B) into the radio antenna connector (Item 3).
5. Snap the radio into the DC adapter (FCN5516B) (Item 4).
6. Insert the 7.5 V DC power cable (FKN8515A) into the DC connector of the DC adapter (Item 5).


Figure 21-30 GP/HT/PRO Radio Installation
7. Using the two screws, attach the radio assembly to the radio bracket (FHN6899A).
8. Using the three screws on the bracket, attach the bracket with the radio to the chassis of the ACE3600. (See Figure 21-31.)
9. Connect the audio communication cable (FKN8431A) to the audio adapter (attached to the radio). Place one Fair-Rite soft ferrite (\#7683477X01 from the supplied ferrite kit FHN7007A) on the cable near the bottom of the CPU door, loop the cable one turn around it, and clamp the ferrite on the cable. Connect the other end of the communication cable to the plug-in port on the front panel of the CPU module.
10. Connect the DC power cable (FKN8515A) from the DC adapter (attached to the radio) to the AUX2A or AUX2B connector of the power supply module.
11. Route the antenna cable (FKN8434A) from the bottom of the RTU box to the BNC adapter on the radio.
12. Use the clamps provided in the kit to route and secure the audio communication and DC power cables. (See Figure 21-31.)


Figure 21-31 GP/HT/PRO Radio Installed on ACE3600 Chassis

## RTU Port Configuration for the GP320/GP328/HT750/PRO5150 Radio

To enable MDLC communication using GP320/GP328/HT750/PRO5150 radios, use the ACE3600 STS site configuration utility to configure the ACE3600 RTU plug-in port connected to the radio.

The following figures show the port configuration and advanced parameter configuration. Although these show Port PI1, the same values can be applied to port PI2 as well, where relevant.

## Port Type

Procedure 21-21 How to Configure the ACE3600 Port for the GP/HT/PRO Radio

1. In the ACE3600 STS click on the desired site, and open the site view.
2. In the Port Tab, click on the plug-in port through which the RTU will communicate with the radio.
3. Confirm that the port parameters and data speed are as shown in the screen below.
4. Define desired radio links and zones if necessary.
5. Save the changes. Generally no other changes are required to Advanced Physical or Link Layer parameters.

| Pl1 | Media | Radio | - | Link name: |  | RADIO 1 | - |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Radio System | Conventional | $\checkmark$ | Zones... |  | RADI01 |  |
|  | Radio Type | HT750/GP320/PRO5150 | $\checkmark$ | Data Speed: | [ 1200 Bps ]: | 1200 Bps | $\checkmark$ |
|  | Max no. of repeaters No repeater |  | $\checkmark$ | Default routing: | [ None]: | None | $\checkmark$ |
|  | Modem | DPSK | $\checkmark$ |  |  |  |  |

Figure 21-32 RTU Site Configuration for MDLC over GP320/GP328/HT750/PRO5150 Radio Port Type Parameters

## GP/HT/PRO Radio Models and Regional Options for ACE3600

The GP/HT/PRO models of the ACE3600 RTU, F7553A (VHF) and F7554A (UHF) include the following regional options:

| Option | Region | Radio |
| :--- | :--- | :--- |
| V951 | North America (NA) | HT750 |
| V952 | EMEA | GP320 |
| V953 | Asia | GP328 |
| V954 | Latin America (LA) | PRO5150 |
| V154AE | GP/HT/PRO INSTALL KIT |  |
| FLN3637A GP/HT/PRO INSTALL KIT |  |  |

Note:

1. When ordering ACE3600 model with a GP/HT/PRO radio, a V95x option must be added.
2. For models/options availability, see the latest sales price list.
3. Orders to EMEA should be placed as model without radio and radio as a kit

## CM/EM/GM Radio Installation Kit

The CM/EM/GM Installation Kit for ACE3600 (V148AC/FLN3635A) enables the user to install the CM/EM/GM mobile radio (CM200, CM140, EM200, GM3188) in ACE3600 Remote Terminal Units (RTU). Each kit includes a bracket, adapter, and cables.

## Installation

The CM/EM/GM can be mounted on the ACE3600 RTU as follows:
Procedure 21-22 How to Install the CM/EM/GM Radio on the Metal Chassis

1. Attach the radio plug-in port from the installation kit (FLN3696A) to the desired opening on the ACE3600 CPU module. For instructions on attaching plug-in ports, see Connecting Plug-In Ports to the CPU Module in the CPU Module chapter above.
2. Connect the 16-pin connector radio adapter (FLN3636A) to the accessory connector on the radio. (See Figure 21-33.)


Figure 21-33 CM/EM/GM Radio, Adapter and Power Cable
3. Connect the power cable (FKN8428A) to the radio's power connector. (See Figure 21-33 and Figure 21-34.) Connect the other end of the power cable to the AUX1A or AUX1B connector on the ACE3600 RTU Power Supply unit. (See Figure 21-35.)


Figure 21-34 CM/EM/GM Radio Cable Connections
4. Connect the communication cable (FKN8427A) to the back of the radio adapter (FLN3636A) connector (10-pin RJ45 connector). (See Figure 21-34.) Place one Fair-Rite soft ferrite (\#7683477X01 from the supplied ferrite kit FHN7007A) on the cable near the bottom of the CPU door, loop the cable one turn around it, and clamp the ferrite on the cable. Connect the other end of the communication cable to the plug-in port of the ACE3600 CPU.
5. Mount the CM/EM/GM radio onto the metal bracket (\#0789422V45) using the two supplied radio mounting screws from kit FHN6894A, \# 0387839 V 89 on the top and bottom of the radio. (See Figure 21-33, Figure 21-34 and Figure 21-35.)
6. Connect the antenna cable (FKN8429A*) to the antenna connector on the radio and to the opening on the bottom of the ACE3600 housing using the four supplied screws. (See Figure 21-34 and Figure 21-35.) Mount the complex (bracket and radio) on the RTU chassis above the CPU and I/O modules, using the four built-in screws. (See Figure 21-35.)

[^35]

Figure 21-35 CM/EM/GM Radio Installed on ACE3600 Chassis

## RTU Port Configuration for the CM/EM/GM Radio

To enable MDLC communication using CM/EM/GM radios, use the ACE3600 STS site configuration utility to configure the ACE3600 RTU plug-in port connected to the radio.

Follow the instructions for RTU Port Configuration for the CDM750 Radio above.

## Programming the CM/EM/GM Radio using CPS

The following programming instructions must be performed before connecting a CM/EM/GM radio to an ACE3600 RTU. These steps define miscellaneous settings and the function of each pin in the radio's general purpose I/O connector.

## Radio Information

The picture below shows the radio model information screen in the CPS.


Figure 21-36 CM/EM/GM CPS Radio Information Screen

## Radio Power Settings

The picture below shows the TX power setting (1-25 W) in CPS.


Figure 21-37 CM/EM/GM CPS General Settings Screen

## Radio Accessory Connector Pins Definition

The picture below shows the setting of the radio's accessories pins required for interfacing with the ACE3600.


Figure 21-38 CM/EM/GM CPS Radio Accessories Screen

## Frequency and Bandwidth Settings

The picture below shows the setting of the radio's frequency, bandwidth and power level.


Figure 21-39 CM/EM/GM CPS Radio Personality Tx/Rx Screen

Note: The Power Level should be set according to the power output.

## CM/EM/GM Radio Models and Regional Options for ACE3600

The CM/EM/GM models of the ACE3600 RTU, F7573A (VHF) and F7574A (UHF) include the following regional options:

| Option | Region | Radio |
| :--- | :--- | :--- |
| V851 | North America (NA) | CM200, 1-25W |
| V852 | EMEA | CM140, 1-25W |
| V853 | Asia | GM3188, 1-25W |
| V854 | Latin America (LA) | EM200, 1-25W |
| V148AC | CM/EM/GM INSTALL KIT |  |
| FLN3635A CM/EM/GM INSTALL KIT |  |  |

Note:

1. When ordering an ACE 3600 model with a CM/EM/GM radio, a V95x option must be added.
2. For models/options availability, see the latest sales price list.
3. The kit FLN3635A includes an adapter for use with antenna cable FKN8429A in EMEA and Asia.

## MotoTrbo - XPR4350, XPR4380, DM3400, XiR M8220, DGM4100 Radio Installation Kit

The MotoTrbo - XPR4350, XPR4380, DM3400, XiR M8220, DGM4100 Installation Kit for ACE3600 (FLN4102A/V682AF) enables the user to install the XPR4350/XPR4380/
DM3400/XiR M8220/DGM4100 mobile radios in ACE3600 Remote Terminal Units (RTU). Each kit includes a radio bracket (FHN6894A), power cable (FKN8436A), USB data cable (FKN8644A) and antenna cable (FKN8437A).

## Installation

The MotoTrbo can be mounted on the ACE3600 RTU (CPU 3680 only) as follows:

1. Attach the MotoTrbo radio to the metal bracket (p/n 0789422 V 45 from kit FHN6894A) using the two supplied radio mounting screws. (See Figure 21-40.)


Figure 21-40 MotoTrbo Radio and Metal Bracket
2. Connect the USB connector of the USB data cable (FKN8644A) to one of the USB host ports on the ACE3600 CPU module. Connect the other side of the cable (26-pin connector) to the Accessory connector on the radio. (See Figure 21-41.)


Figure 21-41 MotoTrbo Radio Cable Connections
3. Connect the DC power cable (FKN8436A) to the Power connector on the radio. Connect the male pin on the data cable (FKN8644A) to the female pin on the DC power cable (FKN8436A) to ensure ignition sense operation. Connect the opposite end of the power cable to the AUX1A or AUX1B connector on the ACE3600 power supply unit. Important: Only one MotoTrbo radio can be attached to a given power supply.
4. Mount the radio/bracket unit onto the RTU chassis above the CPU and I/O modules, using the four built-in screws. (See Figure 21-46.)
5. Connect the antenna cable (FKN8437A) to the Antenna connector on the radio. If the radio type is DM4300 (EMEA) or XIR M8220 (Asia), use the RF adapter 5871143 Y01.
6. Run the cable through the small white clips along the edge of the chassis and attach the connector to the opening on the bottom of the ACE3600 RTU housing.


Figure 21-42 MotoTrbo Radio Installed on ACE3600 Chassis

## RTU Port Configuration for the MotoTrbo Radio

The RTU port is configured using the ACE3600 STS as follows:

## Port Type

Procedure 21-23 How to Configure the ACE3600 Port for the MotoTrbo Radio

1. In the ACE3600 STS, click on the desired site, and open the site view.
2. In the Port Tab, click on the USB port (HU1/HU2) through which the RTU will communicate with the radio. (HU1 is the left USB port and HU2 is the right USB port.)
3. Confirm that the port parameters are as shown in the screen below.
4. Define the desired Line links.
5. Save the changes. Generally no other changes are required to Advanced Physical or Link Layer parameters.

| HU1 | Media | USB Host | $\checkmark$ | Links... | LINE 1 |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Operation Mode | Async | $\cdots$ | DNS Servers |  |
|  | Connection type | Remote NDIS Host | $\checkmark$ | NTP Servers |  |
|  | Connected to | MotoTibo | $\square$ |  |  |

Figure 21-43 RTU Site Configuration for MDLC over MOTOTRBO Radio - Port Type Parameters

## Advanced Parameter Configuration

The STS provides default settings for advanced port parameters for use with the MotoTrbo radio. These settings should be used.

## Programming the MotoTrbo Radio using CPS

The MotoTrbo radio is programmed for ACE3600 in the factory and is ready for communication. For user programming of site-specific parameters, bring the radio to the Motorola Service Center or use the CPS which can be ordered with the radio and follow the instructions below.

## Radio Connections

To program the MotoTrbo radio with Customer Programming Software (CPS), the radio is connected to a PC USB port using the standard ACE3600 MotoTrbo communication cable FKN8644A.

Procedure 21-24 How to Connect the MotoTrbo Radio to the CPS

1. Connect the 26-pin connector to the radio Accessory connector, and the USB connector to the PC on which the MotoTrbo CPS software is installed.
2. Connect the power cable to the radio.

## Radio Disassembly

If the MotoTrbo radio is to be programmed outside of the ACE3600 housing, disassemble the radio as follows:

Procedure 21-25 How to Disassemble the MotoTrbo Radio from the ACE3600 Metal Chassis

1. Disconnect the antenna cable (FKN8437A) from the radio Antenna connector.
2. Remove the radio/bracket unit from the RTU chassis by unscrewing the four built-in screws.
3. Disconnect the DC power cable (FKN8436A) from the radio Power connector.
4. Disconnect the data cable (FKN8644A) from the radio.
5. Detach the metal bracket (FHN6894A) by unscrewing the two radio screws (\#0387839V89), one on each side. (See Figure 21-14.)

## CPS Programming Settings

The following programming instructions must be performed before connecting a MotoTrbo radio to the ACE3600 family Remote Terminal Units (RTU). These instructions define miscellaneous settings and the function of each pin in the radio's general purpose I/O connector.

## Procedure 21-26 How to Program the MotoTrbo Radio

1. Before programming the radio, read the codeplug file from the radio and save it to your PC using the File $>$ Read Device command in the CPS.
2. Open the codeplug file in the CPS. Verify that you are using the right radio.
3. Under the radio's General Settings, change the Radio ID number as required and the TX High Power value to VHF 25W/UHF 20W. (View->Expert displays the full layout of General Settings.)
4. Under Accessories, verify that Ignition Sense is set to On/Off Or Ignition.
5. Under Network, verify that the CAI Network number (default 12) is identical for all radios in the system.
Verify that CAI group number (default 225) is identical for all radios in the system. Verify that the Forward to PC window is marked enabled (required for time sync and broadcast).
6. Under Channels $->$ Zone $<\mathrm{n}>->$ Channell, set the TX and RX frequencies as required. Verify that the color code and the repeater slot are equal in all radios in the group.
7. From the File Menu, select Save to save changes to the radio.
8. From the File Menu, select Write Device to download the configuration to the radio.

Note: The radio configuration must match the repeater topology (direct mode, single repeater, IP site connect.)

For more information on configuring the MotoTrbo radio and the ACE3600 RTUs for MDLC over MotoTrbo, see the MDLC over MotoTrbo section of the ACE3600 STS Advanced Features manual. For information on adding IP addresses to the IP conversion table and downloading to the relevant attached RTUs, see the Operation chapter of the ACE3600 STS User Guide.

## XPR4350/XPR4380/DM3400/XiR M8220/DGM4100 Options for ACE3600

One of the following MotoTrbo options must be ordered with the F7583A/F7584A models:

| Option Name | Option Number |
| :--- | :--- |
| ADD: XPR4350 Radio 403-470 MHz for NAG | V751AA |
| ADD: XPR4350 Radio 450-512 MHz for NAG | V751AB |
| ADD: XPR4350 Radio $136-174 \mathrm{MHz}$ for NAG | V751AC |
| ADD: XPR4380 Radio 800/900 MHZ FOR NAG | V751AD |
| ADD: DM3400 Radio 403-470 MHz for EMEA \& Australia | V752AA |


| ADD: DM3400 Radio 450-527 MHz for EMEA \& Australia | V752AB |
| :--- | :--- |
| ADD: DM3400 Radio 136-174 MHz for EMEA \& Australia | V752AC |
| ADD: XiR M8220 Radio 403-470 MHz for Asia | V753AA |
| ADD: XiR M8220 Radio 450-512 MHz for Asia | V753AB |
| ADD: XiR M8220 Radio 136-174 MHz for Asia | V753AC |
| ADD: DGM4100 Radio 403-470 MHz for LA | V754AA |
| ADD: DGM4100 Radio 450-527 MHz for LA | V754AB |
| ADD: DGM4100 Radio 136-174 MHz for LA | V754AC |

## TransNET 900 OEM Radio Installation Kit

The TransNETTM 900 OEM radio installation kit (VA00225AA/FLN3852A) enables the user to install MDS TransNET 900 OEM (board version) radio modems in ACE3600 Remote Terminal Units (RTU). Each kit includes a bracket, adapter, and cables.

## Installation

The TransNET 900 radio modem is housed in a plastic housing, as shown below:


Figure 21-44 TransNET 900 Radio Modem and Connectors

The TransNET 900 can be mounted on the ACE3600 RTU as follows:
Procedure 21-27 How to Install the TransNET 900 Radio on the Metal Chassis

1. Attach the TransNET 900 radio modem to the metal bracket (\#0789971V39 from FHN7067A) using the four supplied screws, inserting the screws from above. (See Figure 21-45 below.)


Figure 21-45 TransNET 900 Radio Modem Mounted on Metal Bracket - Front and Rear View
2. Mount the bracket on the RTU chassis above the I/O modules, using the four built-in screws. (See Figure 21-46 and Figure 21-47 below.)
3. Connect one end of the power cable (FKN8508A) to the TransNET's PWR (9-30VDC) connector and tighten the attached screws. Connect the other end of the cable to the AUX1A connector on the RTU's power supply module.
4. Connect one end of the data cable (FKN8514A) to the TransNET's DATA connector using the attached screws. Connect the other end of the communication cable to the ACE3600 CPU module port configured for the radio.
5. Connect the small end of the antenna cable (FKN8511A) to the TransNET's ANT (Antenna) connector.
Unscrew the nut and locking washer from the other end of the antenna cable. If the RTU is inside an enclosure, thread the end of the cable through the opening on the bottom of the enclosure and screw on the nut and locking washer from outside the enclosure.
6. Connect the antenna cable to an external antenna.


Figure 21-46 TransNET 900 Radio Modem Installed on ACE3600 Chassis


Figure 21-47 TransNET 900 Radio Modem Installed on ACE3600 Chassis - Cable Connections

## Setting Radio Parameters

The TransNET 900 radio has certain parameters which are set in the MDS factory.

- The radio address $\operatorname{ADDR}=\mathrm{xx}$, where xx is the same number for all radios in the system The address appears on the radio itself.
- Mode - either MASTER or REMOTE (Slave). The mode setting appears on the radio itself.
- Baud rate (factory default $=9600$ 8N1)

These radio settings are determined in the MDS factory and are not generally changed by the user. If it is necessary to change these settings, refer to the TransNET 900 radio documentation.

## RTU Configuration

The RTU port is configured using the ACE3600 STS as follows:
Procedure 21-28 How to Configure the ACE3600 Port for the TransNET 900 Radio

1. In the ACE3600 STS click on the desired site, and open the site view.
2. In the Port Tab, click on the on-board or plug-in port through which the RTU will communicate with the TransNET radio.
3. Confirm that the port parameters and data speed are as shown in the screen below. Note: If the baud rate of the radio is not the default value (9600), the baud rate of the port should be configured accordingly.
4. Define desired links.
5. Save the changes.

| 511 | Media | RS-232 | - | Link name: |  | LINE 1 | $\checkmark$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Operation Mode | Async | $\checkmark$ | Data Speed: | [ 9600 Bps ]: | 9600 Bps | $\checkmark$ |
|  | Connection Type | External modem | $\checkmark$ | Default routing: | [ None]: | None | $\checkmark$ |
|  | Connection Mode | Multi-drop hall-duplex without CD | $\checkmark$ |  |  |  |  |

Figure 21-48 RTU Site Configuration for TransNET Radio- Port Type Parameters

## iNET 900 Radio Installation Kit

The iNET ${ }^{\text {TM }} 900$ installation kit (V680AH/FLN3854A) enables the user to install MDS iNET 900 (board version) radio modems in ACE3600 Remote Terminal Units (RTU). Each kit includes a bracket, adapter, and cables.

## Installation

The iNET 900 radio modem is housed in a plastic housing, as shown below:


Figure 21-49 iNET 900 Radio Modem

The iNET 900 can be mounted on the ACE3600 RTU as follows:
Procedure 21-29 How to Install the iNET 900 Radio on the Metal Chassis

1. Attach the iNET 900 radio modem to the metal bracket (\#0789971V39 from FHN7067A) using the four supplied screws, inserting the screws from below. (See Figure 21-50 below.) Note: The radio must be placed in the bracket with the connectors to the left side, so that the bracket can be mounted on the RTU chassis and the cables can reach the CPU.


Figure 21-50 iNET 900 Radio Modem Mounted on Metal Bracket - Front and Rear View
2. Mount the bracket on the RTU chassis above the I/O modules, using the four built-in screws. (See Figure 21-51 below.)
3. Connect one end of the power cable (FKN8508A) to the iNET's PWR connector and tighten the attached screws. Connect the other end of the cable to the AUX1A connector on the RTU's power supply module. See Figure 21-51 and Figure 21-52 below.)
4. Connect one end of the data cable (FKN8512A) to the iNET's COM2 connector using the attached screws. Connect the other end of the communication cable to the ACE3600 CPU module port configured for the radio.
5. Connect the small end of the antenna cable (FKN8511A) to the iNET's ANT (Antenna) connector.
Unscrew the nut and locking washer from the other end of the antenna cable. If the RTU is inside an enclosure, thread the end of the cable through the opening on the bottom of the enclosure and screw on the nut and locking washer from outside the enclosure.
6. Connect the antenna cable to an external antenna.

Radio


Figure 21-51 iNET 900 Radio Modem Installed on ACE3600 Chassis


Figure 21-52 iNET 900 Radio Modem Installed on ACE3600 Chassis - Cable Connections

## Configuring the iNET 900 to Work with ACE3600

The iNET 900 radio modem can be configured to work with ACE3600 RTUs in several ways as described below. Configurations 1-3 below represent External Modem configurations. Configurations 4-7 represent MDLC over IP configurations.

With iNET radios (firmware version $\geq$ V4.4.0) any remote can communicate with any other remote. An MDLC network (with zones) is no longer needed. The iNET should be set in Multipoint to Multipoint topology, in order to enable communication between RTUs with no zones.

Notes:

- It is recommended to enable flow control on the RS232 serial port.
- An RTU configured for MDLC over IP cannot communicate with an RTU configured for External Modem over the iNET network. If both exist, they should be allocated different Link IDs.


## External Modem Port Configurations

## Configuration 1



## Configuration 2



Configuration 3


## MDLC over IP Port Configurations

## Configuration 4



## Configuration 5



## Configuration 6



## Configuration 7



## Radio Configuration <br> External Modem Port

iNET radios can be configured to work with the External Modem port on ACE3600 RTUs (see Configurations 1, 2 and 3 above.)

Use the iNET radio programming software to program the AP (Access Point) and then the remote with the following settings.

Note:

- Radio firmware should be 4.4 .0 or above.
- IP Address refers to the Ethernet port IP and not the "over the air" IP.

The initial screen is as follows:

```
MDS iNET 900
Starting Information Screen
\begin{tabular}{ll} 
Device Mode: & Access Point \\
Device Name: & AP Demo Set I \\
Network Name: & Demo Set 1 \\
IP Address: & 169.254 .0 .12 \\
Device Status: & Operational \\
Uptime: & 01 hrs, 51 min \\
Firmware Version: & 4.4 .0 \\
Hardware Version: & 1.0 .3 \\
Serial Number: & 1069975 \\
& \\
\multicolumn{1}{r}{ Press 'G' to go to Main Menu } \\
\hline
\end{tabular}
```

1. Press ' G ' and the Main Menu will be displayed.
2. Press ' D ' and the Serial Gateway Configuration Menu will be displayed.
3. Press 'D' to enable COM2 (if it is not enabled). Use the SPACE bar to cycle between Enabled and Disabled. COM2 should be Enabled and COM1 Disabled. Press ENTER once Enabled is shown.
4. Press 'E' and the Serial Configuration Wizard will be displayed. This wizard will assist you in the configuration of your available Serial Data Ports.
5. Press 'A' and the IP Protocol selection menu will appear.
6. Select the IP Protocol you would like to use. The following modes are supported:

- TCP - Cannot be used for ACE3600.
- UDP - to be used as ACE3600external modem.
- PPP - to be used for MDLC over IP (Not relevant for External Modem.)

Press 'B' to select the UDP port.
7. If you selected UDP above, you will be prompted to select the Topology. You have the following choices:

- Point to Point is used if you have a single AP and a single remote unit.
- Point to MultiPoint is used if you transmit to a single radio. This radio is the point, and all radios are the multipoint. For example: An FNE is a point, and all other RTUs are multipoint. No RTU to RTU is provided.
- MultiPoint to MultiPoint works like a real radio where any radio (RTU) can communicate with another.

Press 'C' (Multipoint to MultiPoint) to enable routing between any RTU to any RTU.
8. Next, set the values for the Multicast IP Address and Multicast Port. These are the addresses used when transmitting and receiving. They should be the same on all radios. Press 'A' and enter "224.254.1.1" for the Multicast IP Address.
9. Press 'B' and enter " 30011 " for the Multicast Port.
10. Press ' C ' to continue the wizard until the final screen, or abort it by pressing ' Q '.
11. When the final wizard screen appears prompting you to "Change values (if necessary) for UDP Data Connection Settings", do not change any values. Press 'Q' to quit wizard.
12. The COM2 Serial Data Port values will be displayed. Press ' $G$ ' and set the appropriate Baud Rate (from 1200 bps to 115200 bps.)
13. The Hardware Configuration values will be displayed. Press 'G' to select the 8 N 1 hardware configuration for the port.
14. It is recommended to have Hardware Flow Control on the serial port enabled. When prompted, press 'A' to enable Hardware Flow Control.
15. When prompted to select the Serial Packet Mode, press 'A' to use the default value (Seamless Mode.) Press Q to exit wizard.

The settings for the COM2 Serial Data Port should appear as follows:

```
AP Demo Set I
Serial Configuration Wizard
```


## COM2 Serial Data Port

A) Status enabled
B) IP Protocol UDP Multipoint to Multipoint
C) Multicast IP Address 224.254.1.1
D) Multicast Port 30011
E) Time to Live 1
F) Packet Redundancy Mode Single Packet Mode
G) Data Baud Rate 9600
H) Configuration 8 N 1
I) Flow Control enabled
J) Serial Mode Seamless
K) Seamless Inter-Frame Delay 4
X) Commit Changes and Exit Wizard

These changes will take effect immediately...
Are you sure ( $\mathrm{y} / \mathrm{n}$ )?
Select a letter to choose an item, $<\mathrm{ESC}>$ for the prev menu, 'Q' to quit wizard
16. Press ' X ' to save the changes and exit the wizard. When prompted with "These changes will take effect immediately... Are you sure ( $\mathrm{y} / \mathrm{n}$ )?", press ' y ' and ENTER. There is no need to power up the iNET radio. Note that these settings are saved and you do not need to reset them when powering up the radio unit again.
17. Press ESC to return to the Main Menu.
18. From the Main Menu, press ' B ' to select Network Configuration. This is needed if you want to set an IP connection to the radio unit (recommended). Ethernet port is needed if you are using an IP Interface on RTUs and Ethernet port on IP Gateway (MDLC over IP). In any case, it is recommended that you set it.
19. Next press ' G ' for IP Address configuration.
20. In the IP Address Configuration Menu, press 'B' to set the Static IP Address to 169.254.0.12.
21. Next press ' C ' to set the Static IP subnet mask to 255.255.0.0. It is recommended that all units having the same AP (Access Point) be on the same subnet mask.
22. Press ESC to return to the Network Configuration Menu.
23. Finally press 'D' and enter the maximum number of remotes. By default this value is 50 . If the AP has more than that, you must change the value.
24. Your configuration of the AP is complete. Return to the Starting Information screen (Step 1 above) and repeat all steps with the remote unit. All of the settings/values are the same.

## MDLC over IP Port

iNET radios can be configured to work with the MDLC over IP port on ACE3600 RTUs (see Configurations 4-7 above.)

MDLC over IP supports:

- IP Gateway 4.xx configured with MDLC over IP over Ethernet port.
- ACE3600 RTU Ethernet port
- ACE3600 RTU RS232 port configured as MDLC over IP over PPP connected to Standard modem.

When using an RTU with EP Ethernet port, connect the RTU Ethernet port to the iNET Ethernet port. The IP Port should be on the same subnet as the iNET. Its Subnet mask and IP Gateway should be the same. The rest of the configuration should be the same as an MDLC over IP port (i.e. configuring the port and setting the appropriate baud rate and Link ID, and downloading the IP Conversion Table.) The P Conversion Table is needed to communicate with other RTUs connected over PPP or Ethernet.

The rest of the configuration should be the same as an MDLC over IP port (as above). All IP settings are obtained dynamically from the modem when connecting to it. The RTU PPP port should be connected to COM2 on the iNET radio using a computer adapter. The following describes how to configure iNET COM2 modem for PPP.

After configuring the IP Gateway, EPIB for Ethernet, and RTU (for PPP) with MDLC over IP port, they can all communicate on the iNET network as if they all reside on a LAN. All routing between them is done via the iNET network, and if a LAN is involved, using other routers as well. Any RTU can communicate with any other RTU or IP Gateway. A single Link ID should be set for all RTUs/ IP Gateways on these ports.

Note however, that if the MDS radio was connected via External Modem port (serial), or via a Terminal Server (e.g. Equinox) over serial port, it is a completely different MDLC link/protocol. A different Link ID should be set in the RTU/IP Gateway when using this configuration. If both coexist on the same iNET network, each should have its own Link ID with MDLC network configuration downloaded to all units.

Use the iNET radio programming software to program the AP (Access Point) and then the remote with the following settings.

Note:

- Radio firmware should be 4.4 .0 or above.
- IP Address refers to the Ethernet port IP and not the "over the air" IP.

The following shows Access point configuration for MDLC over IP but it is exactly the same for Remote.

The initial screen is as follows:

```
MDS iNET 900
Starting Information Screen
```

Device Mode: Access Point
Device Name: AP Demo Set I
Network Name: Demo Set 1
IP Address: $\quad 169.254 .0 .12$
Device Status: Operational
Uptime: $\quad 01 \mathrm{hrs}, 51 \mathrm{~min}$
Firmware Version: 4.4.0
Hardware Version: 1.0.3
Serial Number: 1069975
Press 'G' to go to Main Menu

1. Press ' G ' and the Main Menu will be displayed.
2. Press 'B' and the Network Configuration Menu will be displayed.
3. Press ' G ' for IP Address configuration.
4. In the IP Address Configuration Menu, press 'B' to set the Static IP Address to 169.254.0.12.
5. Next press ' C ' to set the Static IP subnet mask to 255.255.0.0. It is recommended that all units having the same AP (Access Point) be on the same subnet mask.

Note that the Static (sub)Net Mask and Static IP Gateway addresses should be the same as those of the IP Gateway and EPIB. Their IP Address should be on the same subnet. For example 169.254.0.100 for an IP Gateway address of 169.254.0.012 is suitable.

Also note that when using PPP it is recommended to have the IP Address of PPP on the same subnet, for example 169.254.0.13. See Configuring for PPP below.
6. Press 'E' to commit changes. Press ESC to return to the Network Configuration Menu.
7. Finally press 'D' and enter the maximum number of remotes. By default this value is 50 . If the AP has more than that, you must change the value.
8. Your configuration of the AP is complete. Return to the Starting Information screen (Step 1 above) and repeat all steps with the remote unit. All of the settings/values are the same.

## Configuring for PPP

9. From the Main Menu, press 'D' and the Serial Gateway Configuration Menu will be displayed.
10. Press 'D' to enable COM2 (if not enabled). SPACE to cycle between Enabled and Disabled. COM2 should be Enabled and COM1 Disabled. Press ENTER once Enabled is shown.
11. Press 'E' and the Serial Configuration Wizard will be displayed. This wizard will assist you in the configuration of your available Serial Data Ports.
12. Press 'A' to begin the Wizard and the IP Protocol selection menu will appear.
13. Select the IP Protocol you would like to use. The following modes are supported:

- TCP - to be used as a Terminal Server. (IP Gateway does not support this option.)
- UDP - to be used as External Modem.
- PPP - to be used as PPP port (same as Ethernet).

Press 'C' to select PPP.
14. The wizard will prompt you to change the value of the IP Address. Press 'A' and enter the Remote IP Address. This is the address that is uniquely assigned to the RTU. It should be different from the other addresses used in the iNET network and in the LAN (if connected to LAN).

A good scheme is to add 1 to the Static IP Address set in the Network Configuration screen above. For example, if the address 169.254.0.12 was assigned to the iNET Ethernet port, the PPP would be assigned 169.254.0.13. Both addresses reside in the same subnet 255.255.0.0 as was set in the Network Configuration. When using a PPP port, two IP addresses are set for iNET, one for the Ethernet port, and another (on the same subnet) for PPP. It is recommended to make those addresses consecutive where possible.
15. Press ' B ' and the Data Baud Rate screen is displayed.
16. Select the baud rate according to the RTU, e.g. 'D' for 9600 .
17. Next press ' G ' to select the 8 N 1 hardware configuration.
18. It is recommended to have Hardware Flow Control on the serial port enabled. When prompted, press 'A' to enable Hardware Flow Control.
19. When prompted to select the Serial Packet Mode, press 'A' to use the default value (Seamless Mode.)

The settings for the COM2 Serial Data Port should appear as follows:

## Serial Configuration Wizard

COM2 Serial Data Port

| A) Status | enabled |  |
| :--- | :---: | :---: |
| B) IP Protocol | Point to Point Protocol (PPP) |  |
| C) Device IP Address | 169.254 .0 .13 |  |
| D) Data Baud Rate | 9600 |  |
| E) Configuration | 8N1 |  |
| F) Flow Control enabled <br> G) Serial Mode Custom <br> H) Custom Inter-Frame Delay 4 <br> I) Custom Data Buffer Size 64$l$ |  |  |

Select a letter to choose item, <ESC $>$ for the prev menu, 'Q' to quit wizard
20. Press ' $X$ ' to save the changes and exit the wizard. There is no need to power up the iNET radio. Note that these settings are saved and you do not need to reset them when powering up the radio unit again.
21. From the Serial Gateway Configuration, press ESC to return to the Main Menu.

Your configuration of the PPP is complete.

## RTU Configuration

The RTU port is configured using the ACE3600 STS.

## Site Configuration

Procedure 21-30 How to Configure the ACE3600 Port for the iNET 900 Radio
In the ACE3600 STS click on the desired site, and open the site view.
2. In the Port Tab, click on the on-board or plug-in port through which the RTU will communicate with the iNET radio.
3. Confirm that the port parameters and data speed are as shown in the screen below.

Note: If the baud rate of the radio is not the default value (9600), the baud rate of the port should be configured accordingly.
4. Define desired links.
5. Save the changes.

Radio Types and Installation Kits

| SII | Media | RS-232 | $\checkmark$ | Link name: |  | LINE 1 | - |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Operation Mode | Asyne | $\checkmark$ | Data Speed: | [ 9600 Bps ]: | 9600 Bps | $\checkmark$ |
|  | Connection Type | External modem | $\checkmark$ | Default routing: | [ None]: | None | $\checkmark$ |
| 5 | Connection Mode | Multi-drop half-duplex without CD | - |  |  |  |  |

Figure 21-53 RTU Site Configuration for iNET Radio- External Modem Port Port Type Parameters

| SII | Media | RS-232 | - | Links... |  | LINE 1 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Operation Mode | Async | $\checkmark$ | Data Speed: | [ 9600 Bps . | 9600 Bps - |
|  | Connection Type | PPP | $\checkmark$ | DNS Servers |  |  |
|  | Connected to | Null modem | - | NTP Servers |  |  |

Figure 21-54 RTU Site Configuration for iNET Radio- MDLC over IP Port Port Type Parameters

| $\square$ Physical Link |  |  |  |
| :---: | :---: | :---: | :---: |
| Advanced Link Layer |  |  |  |
| Parameter | Default |  | $\Delta$ |
| TX to failedRTU every <0:DISABLE 0-30> min | [ 3]: | 3 |  |
| Periodic check of failed RTU | [ Disable]: | Disable | $\checkmark$ |
| Default group IP address: | [ 0.0.0.0]: | 0.0.0.0 |  |
| Get host by name using DNS | [ Enable]: | Enable | - |
| MDLC over IP port number: | [ 2002]: | 2002 |  |
| Enable sync | [ Disable]: | Disable | $\checkmark$ |
| Enable routing on MDLC over IP port | [ Disable]: | Disable | $\checkmark$ |
| Notify IP address when connecting | [ Enable]: | Enable | $\checkmark$ |
| Check alive timeout (sec) < $0-65535$ > | $\left[\begin{array}{ll}{[35}\end{array}\right]$ | 300 |  |
| Poll interval (sec) <0-255> | [ 10]: | 10 |  |
| Maximum number of polls <0-255> | [ 3]: | 3 |  |
| Disconnect on icmp:netunreach | [ Disable]: | Disable | - |
| Disconnect on idle timeout (sec) <0-65535> | [ 0]: | 0 |  |
| Does modem support abort sequence | [ Enable]: | Enable | $\checkmark$ |
| Ignore CD | [ Never]: | When connect | - |
| Modem configuration timeout (sec) < 1-255> | [ 30]: | 30 |  |
| Registration life time (sec) <0-65535> | [ 0]: | 0 | $\square$ |

Figure 21-55 RTU Site Configuration for iNET Radio- MDLC over IP Port Advanced Link Layer Parameters

## IP Conversion Table

Prepare an IP Conversion Table and download it to the RTU. The IP Address of the RTU is the one assigned by the iNET 900 to the RTU, referred to as Remote IP Address in Configuring for PPP above. This IP address can be retrieved using the ACE3600 STS SW Diagnostics \& Loggers utility in Device LIN1L, level 0.

Verify that the connection succeeded using the SW Diagnostics \& Loggers utility. In Device LIN1L, level 101, make sure that the "State of configuration task" field is set to "connected and registered". This may take between $30-60$ seconds.

## MDS Radio Installation Kit

The MDS installation kit (V152AK/FLN3853A) enables the user to install the 9810 Spread Spectrum, $9710 \mathrm{~A}-900 \mathrm{MHz}$ and 4710 UHF Transceiver radio modems in ACE3600 Remote Terminal Units (RTU). The kit includes a bracket and cables.

## Installation

The MDS radio can be mounted on the ACE3600 RTU as follows:
Procedure 21-31 How to Install the MDS 900 Radio on the Metal Chassis

1. Connect the radio to the bracket provided in the Hardware Kit (\#0789971V39 from FHN7066A) using the four screws, supplied with the bracket. (See Figure 21-56 below.)


Figure 21-56 MDS Radio Mounted on Metal Bracket - Front and Rear View
2. Connect the communication cable (FKN8513A) to the 25 -pin connector on the side of the radio and tighten the screws.
3. Insert the DC power cable (FKN8510A) connector into the DC power connector on the radio.
4. If the RTU is to be installed inside an enclosure, screw the antenna cable (FKN8509A) into the antenna connector on the radio. Otherwise, an external antenna can be connected directly to the antenna connector on the radio.
5. Mount the bracket (\#0789971V39 from FHN7066A) on the RTU chassis above the I/O modules, using the four built-in screws. (See Figure 21-57 below.)
6. Route the antenna cable (FKN8509A) cable through the small wire clamps along the left side edge of the RTU chassis, according to the placement of the radio on the chassis, as in Figure 21-57 and Figure 21-58.
7. Unscrew the nut and locking washer from the N-type connector at the other end of the antenna cable. Thread the end of the cable through the opening on the bottom of the enclosure and screw on the nut and locking washer from outside the enclosure.
8. Connect the other end of the DC power cable (FKN8510A) to the AUX1A/B connector on the RTU's power supply module.
9. Connect the other end of the communication cable (FKN8513A) to the ACE3600 CPU module port configured for the radio. See RTU Configuration below.
10. Connect the antenna cable to an external antenna.

Radio Types and Installation Kits


Figure 21-57 MDS Radio Modem Installed on ACE3600 Chassis


Figure 21-58 MDS Radio Modem Installed on ACE3600 Chassis - Cable Connections

## RTU Configuration

The RTU port is configured using the ACE3600 STS as follows:
Procedure 21-32 How to Configure the ACE3600 Port for the MDS Radio

1. In the ACE3600 STS click on the desired site, and open the site view.
2. In the Port Tab, click on the on-board or plug-in port through which the RTU will communicate with the MDS radio.
3. Confirm that the port parameters and data speed are as shown in the relevant screen below. Note: If the baud rate of the radio is not the default value (9600), the baud rate of the port should be configured accordingly.
4. Define desired links.
5. Save the changes.

| SII | Media | RS-232 | $\checkmark$ | Link name: |  | LINE 1 | $\checkmark$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Operation Mode | Async | $\checkmark$ | Data Speed: | [ 9600 Bps ]: | 9600 Bps | $\checkmark$ |
|  | Connection Type | External modem | $\checkmark$ | Default routing: | [ None]: | None | $\checkmark$ |
|  | Connection Mode | Multr-drop hall-duplex without CD | - |  |  |  |  |

Figure 21-59 RTU Site Configuration for MDS 9810 Spread Spectrum/4710 UHF Transceiver Radio- Port Type Parameters

| Sl1 | Media | RS-232 | - | Link name: |  | RADIO 1 | - |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Operation Mode | Async | $\checkmark$ | Zones... |  |  |  |
|  | Connection Type | External modem | $\checkmark$ | Data Speed: | 9600 Bpss : | 9600 Bps | $\checkmark$ |
|  | Connection Mode | MAS (Radios) | $\checkmark$ | Default routing: | [ None]: | None | $\checkmark$ |
|  | Type | Multi-drop half duplex | - |  |  |  |  |

Figure 21-60 RTU Site Configuration for MDS 9710A- 900 MHz Radio- Port Type Parameters

## MTM800 Radio Installation Kit

The MTM800 Installation Kit for ACE3600 (FLN4109A) enables the user to install the MTM800 mobile radio in ACE3600 Remote Terminal Units (RTU). Each kit includes a bracket, adapter, and cables.

## Installation

The MTM800 can be mounted on the ACE3600 RTU as follows:
Procedure 21-33 How to Install the MTM800 Radio on the Metal Chassis

1. If you choose to attach the MTM800 radio to a plug-in port, attach the radio plug-in port from the installation kit (FLN4109A) to the desired opening on the ACE3600 CPU module. For instructions on attaching plug-in ports, see Connecting Plug-In Ports to the CPU Module in the CPU Module chapter above.
2. Connect the 20-pin connector radio signal and power cable (FKN8517A) to the accessory connector on the radio. (See Figure 21-61 and Figure 21-62.)


Radio Accessory Connector

Power Connector

Radio
Bracket
(FHN6894A)

Figure 21-61 MTM800 Radio and Metal Bracket
3. Connect the end of the power cable (FKN8517A) to the radio's power connector. (See Figure 21-61 and Figure 21-62.) Connect the other end of the power cable to the AUX1A or AUX1B connector on the ACE3600 RTU Power Supply unit. (See Figure 21-63.)


Figure 21-62 MTM800 Radio Cable Connections
4. Connect the communication cable (FKN8516A) to the end of the power and signal cable using the attached screws (FKN8517A). (See Figure 21-62.) Place one Fair-Rite soft ferrite (\#7683477X01 from the supplied ferrite kit FHN7007A) on the cable near the bottom of the CPU door, loop the cable one turn around it, and clamp the ferrite on the cable. Connect the other end of the communication cable to the plug-in port of the ACE3600 CPU.
5. Mount the MTM800 radio onto the metal bracket ( $\# 0789422 \mathrm{~V} 45$ ) using the two supplied radio mounting screws from kit FHN6894A, \# 0387839 V 89 on the top and bottom of the radio. (See Figure 21-61, Figure 21-62 and Figure 21-63.)
6. Connect the antenna cable (FKN8430A/FKN8437A*) to the antenna adapter connector on the radio and to the opening on the bottom of the ACE3600 housing using the appropriate bushing. (See Figure 21-63.) Mount the complex (bracket and radio) on the RTU chassis above the CPU and I/O modules, using the four built-in screws. (See Figure 21-63.)

[^36]

Figure 21-63 MTM800 Radio Installed on ACE3600 Chassis

## RTU Port Configuration for the MTM800 Radio

To enable MDLC communication using MTM800 radios (for packet data only), use the ACE3600 STS site configuration utility to configure the ACE3600 RTU plug-in port connected to the radio.

The figure below shows the port configuration and advanced parameter configuration. Although this shows Port PI1, the same values can be applied to other serial or plug-in ports, where relevant.

## Port Type

Procedure 21-34 How to Configure the ACE3600 Port for the MTM800 Radio

1. In the ACE3600 STS, click on the desired site, and open the site view.
2. In the Port Tab, click on the on-board or plug-in port through which the RTU will communicate with the MTM800 radio.
3. Confirm that the port parameters and data speed are as shown in the screen below.

| P11 | Media | RS-232 | - | Links... |  | LINE 2 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Operation Mode | Async | $\checkmark$ | Data speed: | [ 9600 Bps | 9600 Bps - |
|  | Connection Type | PPP | $\checkmark$ | DNS Servers |  |  |
|  | Connected to | TTETRA | $\checkmark$ | NTP Servers |  |  |
|  |  |  |  | Protocols... |  |  |

4. Define desired links.
5. If you plan to synchronize the RTU time using an NTP server, use a DNS server, or use third party protocols, specify these with the relevant information for your system.
6. Save the changes.

## Advanced Parameter Configuration

The STS provides default settings for advanced port parameters for use with the MTM800. These settings should be used.

## Programming the MTM800 Radio using CPS

Before connecting a MTM800 radio to an ACE3600 RTU, the radio should be programmed as necessary for packet data. For this purpose, use the CPS which can be ordered with the radio or bring the radio to the Motorola Service Center.

## Mounting the ACE3600 Radios on a Wall

ACE3600 radios can be mounted on a wall near the ACE3600 frame/housing, using a special metal bracket. This bracket is part of the specific radio installation kit and must be ordered.


CM/EM/GM/CDM750 Bracket


XTL5000/XTL2500 Bracket


GP/HT/PRO Bracket
Figure 21-64 Radio Wall Mount Brackets
Procedure 21-35 How to Mount a Radio on a Wall
The following installation procedure should be followed to install radios on a wall near the ACE36000 frame. A special wall mount bracket is provided with the radio installation kit, which can be ordered separately from the frame. Allow extra space around the bracket for the radio and wires.

1. Drill four holes in the wall at the horizontal and vertical distances (in mm) shown in Figure 21-64 for the desired radio wall mount bracket, at the desired angle/orientation.
2. Place the bracket on the wall, lining up the bracket holes with the drilled holes.
3. Insert four M3 Phillips 10 mm screws (not supplied) into the holes and tighten with a screwdriver to secure the bracket firmly against the wall.
4. Attach the radio to the bracket using the supplied screws.

## RS485 CONNECTION BOX

## General Description

The RS485 Connection Box (V186AD/FLN3641A) provides an interface to up to seven RS485 connections. (See Figure 22-1.)


Figure 22-1 RS485 Connection Box - Front Panel

## Installation

The RS485 Connection Box can be easily installed on the RTU chassis.

## Mounting the RS485 Connection Box on the RTU Chassis

1) To connect the plastic box interface to the metal chassis, place the box on the metal plate and click the two pegs on the back of the plastic box into the desired holes on the metal chassis.

## Wire Connections

1) To interface to an RTU, connect the communication cable (FKN8427A) between the connection box input port and the ACE3600 RS485 port. *
2) To interface to an external device, connect the communication cable (FKN8427A) between the connection box port and an external RS485 modem with an RJ45 connector.


Figure 220-2 RS485 Connection Box - Wire Connections

[^37]
# AUDIO CONTROL AND TONE (ACT) MODULE 

## Introduction

The Audio Control and Tone (ACT) module (V155AE/FLN3851A) serves as a player of recorded voice and alarm sounds in ACE3600 based alert systems. The ACT module also routes low-level sound signals to high-level amplifiers. The high-level sound can be directed to specified alert speakers in a set of six speakers, mounted in different locations.

The ACT module contains an internal audio memory that allows custom tones or audio sounds to be recorded and stored in the ACT module. Recording of audio may be done directly from a low-level output source (tape recorder, laptop or radio output).

## Front Panel Description

The ACT module is enclosed in a compact plastic box. See the ACT module below.


Figure 23-1 ACT Module - Front Panel

## ACT Module Features

The ACT module features are described below:

- Controlled by the RTU via an RS232 serial port using a simple instruction set.
- Digitally records audio signals (alarm tones, voice announcements, etc).
- Plays stored audio signal.
- Interface to an external low-level audio signal source (microphone, radio audio out, etc.).
- Interface to input of one audio amplifier and up to two outputs of audio amplifiers.
- Connects to up to six speakers.
- Selective output to any combination of six speakers.
- Routes the audio signals from the amplifier(s) output to selected speakers.
- Routes data coming from the RTU to a serial printer to allow printing of information by alternative use of the RTU serial port.

The ACT module block diagram is shown below:


Figure 23-2 ACT Module - Simplified Block Diagram

## Audio Handling Capabilities

The ACT module has built-in hardware which records and stores audio signals by digitizing the signal from an audio source connected directly to the module's low-level audio input. The module can play these pre-recorded audio signals once or repeatedly.

To facilitate the recording process, audio signals may be formed or saved in "WAV" file format on a PC (or on any other audio format provided it can be played by a PC) and then downloaded to the module through the PC audio out.

The module's total recording capacity is 240 seconds. As default, the recording space is divided into eight "cells" (each of which holds up to 30 seconds). The number of cells is configurable and can be set to $1,2,4,8,16,30$ and 60 .

NOTE: Recording will automatically terminate 2 seconds after the module detects silence. Recording will also be stopped when the "cell" has run out of recording capacity.

The module's low-level audio input also enables the connection of an external low-level audio source (such as a radio audio output) for direct routing to an audio amplifier. Thus the audio routed to this output can be either a pre-recorded audio signal or an external source, connected to the low-level audio input.

Two high-level audio inputs are used to route amplified audio signals into the module. The ACT module has six high-level audio outputs that can be routed to selected speakers.

## Interface to the RTU

The ACT module interfaces to the RTU via an RS232 port, marked as COM IN. The communication with the RTU is based on an 8-bit code protocol.

The ACT module also enables the RTU to have more than one use for its RS232 port. The application on board the RTU may select its serial port connected to COM IN to control the ACT module or to send data to COM OUT. This is very useful for connecting a dot matrix printer to the RTU without requiring an additional serial port which could necessitate the another CPU.

The destination of the serial data sent to the COM IN port is selected via the following mechanism:

- Set DTR signal "Off" - Data is routed to COM OUT.
- Set DTR signal "On" - Data protocol controlling the ACT.

The ACT module operates on 9 to 16 VDC , usually supplied by the RTU's auxiliary power supply.

An RTU application program controls the ACT module via a user port using an 8-bit instruction set.

The ACT module returns simple 8-bit codes as a response to instructions.

The instruction set is comprised of the following set of operations:

- Play
- Repeat Play \# times
- Stop - Play
- Enable low-level Audio Output
- Disable low-level Audio Output
- Configure the number of recorded signals (cells)
- Record
- Report Status
- Connect/Disconnect Speakers

For the ACT module instruction set, see ACT Instruction Set below.

## Installation and Wiring

The ACT can be installed in various locations on the RTU chassis (mounted on holes prepared for installation).

Note: Connect the ACT to the High Power Audio Amplifier only via the Isolation Board FCN6294A (connected to the SIG IN/SIG OUT connector).

Procedure 23-1 How to Install the ACT Module

1) Place the ACT module on the metal plate and click the two pegs on the back of the plastic box into the desired holes on the metal chassis.
2) Connect one end of the power cable (FKN8433A) to the PWR connector on the ACT module. Connect the other end of the cable to the one of the AUX connectors (configured to 12 V ) on the ACE3600 power supply module.
3) Connect one end of the communication cable (FKN8427A) to the COM IN port on the ACT module. Connect the other end of the cable to the RS232 port on the ACE3600 CPU.
4) To use high-level audio speakers, connect up to six speakers to the High-Level Audio Out (1-6) relays on the top of the ACT module front panel. See Figure 23-3 below.
5) To enable playing prerecorded tones, connect the input of the first high power audio amplifier to the SIG OUT/GND connectors, using the Isolation Board (FCN6294A). Connect the output of the amplifier to the Normally Open connector on the top left corner of the ACT module front panel. See Figure 23-3 below.
6) To enable radio voice channel audio (low level signal), connect the external speaker of the voice radio to the SIG IN/GND connectors, using a simple wire cable (can be shielded). See Figure 23-3 below.
7) To add a second high power audio amplifier for local microphone, connect the output of the second amplifier Normally Closed (C) connector on the top of the ACT module front panel. Also connect the output of the second amplifier to the output of the first amplifier. See the warning in Figure 23-3 below.
8) To use a local microphone (low-level audio signal), connect the microphone to the second amplifier.
9) To attach a dot matrix printer or other serial device, connect the device to the COM OUT connector on the ACT module using a data cable (with connector adaptors as necessary.) See Figure 23-3 below.


Figure 23-3 ACT Module - Wiring Diagram

Table 23-1 ACT Module Communication Ports Connection Chart

| COM IN |  | COM OUT |
| :--- | :--- | :--- |
| RxD - In | 1 | TxD |
| TxD - Out | 2 | RxD |
| DTR - Out | 3 | CTS |
| GND | 4 | GND |
| RTS - Out | 5 | CD |


| CD - In | 6 | RTS |
| :--- | :--- | :--- |
| Not Used | 7 | Not Used |
| CTS - In | 8 | DTR |

## RTU Port Configuration

Before using the ACT module with the RTU, configure the communication port to which the ACT module is connected.

Procedure 23-2 How to Configure the ACE3600 Port for the ACT Module

1) In the ACE 3600 STS click on the desired site, and open the site view.
2) In the Port Tab, click on the on-board or plug-in port through which the RTU will communicate with the ACT Module.
3) Set Media to RS-232, Operation Mode to Async, Connection Type to User Port (Ladder Controlled).
4) Save the changes.

Generally no other changes are required to Advanced Physical or Link Layer parameters. For information on the RTU port parameters, see Appendix A: Site Configuration Parameters of the ACE3600 STS User Guide.

## Controlling the Module

The RTU (or PC) is interfaced to the ACT via the RS232 port. The communication parameters of the RTU (or PC) port must be set to: 9600 BPS, 1 stop bit, no parity.

The ACT is operated using a simple instruction set. Each instruction must be sent twice. If the second instruction sent does not correspond to the first, that instruction is rejected. When the ACT recognizes a valid instruction, it echoes an acknowledgement. While the module is playing a stored audio signal, the instructions should be sent only once.

## ACT Instruction Set

| Instruction | Code | Description |
| :---: | :---: | :---: |
| Play Signal \# | $\begin{aligned} & " 01 \mathrm{XXXXXX} " \\ & (X X X X X X=1-60) \end{aligned}$ | Plays recorded audio signal number \#. <br> The recorded audio is played into the low-level Output. The low-level Output is disabled. Example: Play signal $6=$ "01000110" |
| Record Signal \# | 10XXXXXX $(X X X X X X=1-60)$ | Records audio signal number \#. <br> Example: Record signal $6=$ "10000110" |
| Connect/Disconnect Speakers | $\begin{aligned} & 11 \mathrm{X}_{5} \mathrm{X}_{4} \mathrm{X}_{3} \mathrm{X}_{2} \mathrm{X}_{1} \mathrm{X}_{0} \\ & \mathrm{X}_{\mathrm{n}}=\text { Speaker } \mathrm{n}(\mathrm{n}=0-5) \\ & 0=\text { disconnect } \\ & 1=\text { connect } \end{aligned}$ | Connects or disconnects speakers. |
| Repeat the Played Signal \# times | 001XXXXX $\mathrm{XXXXX}=1-31$ | Repeats playing the audio signal \# times. <br> Note: This command can be instructed and performed only while the unit plays a signal. <br> Example: Repeat playing the played signal 4 times $=$ "00100100" |
| Stop Play | "00011111" | Stops the played signal. |
| Enable Low-level Audio Output | "00100000" | Low-level Audio Input is routed to Low- Audio Output |
| Disable Low-level Audio Output | "00000000" | Low-level Audio Output is disabled (no audio is routed to the output). Played signal is stopped. |
| Configure the number of recorded signals | $\begin{aligned} & " 000 X X X X X " \\ & \text { XXXXX=1,2,4,8,15, } 30 \\ & \mathrm{~N}=2 *(\mathrm{XXXXX}) \end{aligned}$ | Configures the number of different signals that can be recorded to $\mathrm{n}=2,4,8,16,30,60$ <br> Example: Set to 16 signals $=" 00001000 "$ |
| One signal | "00000011" | Configures the number of recorded signals to only one. |
| Report Status | "01000000" | Use this command to interrogate the ACT. The ACT then returns the following 4 byte sequence with the |



## Response to Instructions

The ACT acknowledgements are the 8 -bit codes described below:

| Response | Code | Description |
| :--- | :--- | :--- |
| Record completed | $" 01111110 "$ | Recording has been completed. |
| Play started | $" 10000000 "$ | Signal is currently being played. |
| Play completed | $" 01111101 "$ | Signal play has been completed. |
| Instruction <br> inconsistency | $" 01111111 "$ | Instruction was not the same as the first one <br> (when not playing); the instruction is not <br> performed. |
| Instruction time out | $" 01000000 "$ | Instruction received only once, (when not <br> playing); the instruction is not performed. |

## Recording Audio Signals

Manual recording enables the recording of up to eight audio signals using the pushbutton (PB) and LEDs on the ACT unit front panel. Follow the steps below to record audio from PC/Laptop/Recorder:

Procedure 23-3 How to Manually Record Audio Signals

1) Connect the "Speaker Out" of the PC/Laptop/Recorder to the "Audio In" port (Use Mono adapter if needed).
2) Pause the audio and tune the volume to approximately $3 / 4$ of full scale.
3) Press the PB for more than two seconds; all four LEDs will light up.
4) Press the PB to select the audio cell (from a selection of eight) to which you want to record. (The audio signal number is displayed as a binary number represented by four LEDs).
5) Start playing the audio. The unit will identify the input as audio and start recording. The LEDs will start to blink and will stop when audio input ceases (or when the maximum recording time has elapsed).
6) Repeat steps 4 and 5 to record additional audio signals (up to eight).
7) When recording is completed, all the LEDs will turn off.

## ACT Module* Specifications

| General |  |
| :---: | :---: |
| Operation Voltage | 9 to 16VDC |
| Power Consumption | Refer to Appendix D: ACE3600 Maximum Power Ratings. |
| Dimensions (Hx W x L) | $25 \mathrm{~mm} \times 95 \mathrm{~mm} \times 115 \mathrm{~mm}$ (1" x 3.6 " x 4.5 ") |
| Operating Temperature | $-30^{\circ}$ to $+60^{\circ} \mathrm{C}\left(-22^{\circ}\right.$ to $\left.+140^{\circ} \mathrm{F}\right)$ |
| Relative Humidity | 0-95\% @ 50 ${ }^{\circ} \mathrm{C}$ without condensation |
| User Connection |  |
| Power connector | Molex 2 pin with polarity |
| COM IN RS232 | Phone 8-pin |
| COM OUT RS232 | Phone 8-pin |
| Low-level Audio In/Out | 4 screw TB connector |
| High-level In/Out | 8 screw TB |
| Audio |  |
| Low-level Audio Input | 0.8 to $1.5 \mathrm{Vp}-\mathrm{p}, 300-3300 \mathrm{~Hz}$, Minimum $50 \mathrm{~kW} \pm 10 \%$ input impedance -4.6 KV isolated. |
| Low-level Audio Output | $1 \mathrm{Vp}-\mathrm{p} \pm 60 \%-4.6 \mathrm{KV}$ isolated, via Isolation Board. |
| High-level Audio Input | Maximum 30 VAC RMS, 0.5 A RMS Maximum 0.05 W-output Impedance Minimum signal: $100 \mathrm{mV}, 100 \mu \mathrm{~A}$. |
| High-level Audio Output | 30 V RMS, 0.5 A RMS maximum per one output |
| EMC |  |
| Electrostatic Discharge | IEC 1000-4-2, level 3 |
| Radiated Electromagnetic Field | IEC 1000-4-3, level 3 |
| Electrical Fast Transient / Burst | IEC 1000-4-4, level 3 |
| Radiated Emission | EN55022 |

Specifications subject to change without notice.

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## CONFIGURATION

## General

For information on setting the 12 V DO dip switch in the DO relay module board, see the Digital Output Relay Module chapter above. For information on setting the 12V DO dip switch in the DO relay 120/230V module board (for EE relays only), see the Digital Output Relay 120/230V Module chapter above.

## OPTIMIZATION

## General

No optimization is required for the ACE3600 units.

## OPERATION

## General

The operational functions of the ACE3600 unit are performed using the ACE3600 System Tools Suite (STS). These are administrative and diagnostic tasks, generally performed by technicians and administrators. The functions available depend on the specific software applications installed in the unit.

## Opening/Closing the Housing Door

For instructions on opening and closing the housing door and locking the door with the optional padlock accessory, see the Opening/Closing the Housing Door section in the Installation chapter.

## MAINTENANCE

## General

The following maintenance procedures are recommended for the ACE3600 RTU.

## Lead Acid Battery Maintenance

It is recommended to perform the following maintenance procedures for the lead acid battery using the ACE STS Hardware Test utility or the user application program:

- Once per month - run a full battery test (battery capacity) of the lead acid battery.
- Once per day - read the charge level of the lead acid battery.

If the capacity is below the manufacturer recommended level, replace the battery. See the Power Supply Module and Backup Battery chapter above.

## TROUBLESHOOTING

| Symptom | Action |
| :--- | :--- |
| The PWR LED on the <br> CPU/expansion module front panel <br> is not lit. | Check power connections to the unit. <br> If all connections are correct, check cables. |
| The PWR LED on the <br> CPU/expansion module front panel <br> is solid red. | The CPU/expansion module has received an error <br> from the power supply (AC fail, Bat Error, etc.) or <br> fails to recognize the power supply. Check the AC <br> power supply, backup battery, etc. |
| The PWR LED on the <br> CPU/expansion module front panel <br> is flashing red. | The boot did not complete and the FPGA is not <br> loaded. Download a new system to the unit. |
| The ERR LED on the CPU module <br> front panel is red (or the MERR <br> LED on the expansion module is <br> red.) | The unit has a problem. Check the Error Logger to <br> read error message. <br> Note: If there are many errors logged about lost <br> frames, check the expansion Ethernet SPD LED to <br> make sure that the LAN is working at 100Mb. |
| The ERR LED on the CPU module <br> front panel is orange (or the MERR <br> LED on the expansion module is <br> orange.) | The unit has a warning. Check the Error Logger to <br> read warning. |
| The ERR LED on the CPU module <br> front panel is green (or the MERR <br> LED on the expansion module is <br> green.) | The unit has a message. Check the Error Logger to <br> read message. |
| The APPL LED on the CPU <br> module front panel is red. | The user application is not running. Check the Error <br> Logger to read error. |
| The APPL LED on the CPU <br> module front panel is blinking | The user application is running for more than 1.2 <br> seconds continuously. Check the application. |
| The CONF LED on the CPU <br> module front panel is red (or the <br> MCNF LED on the expansion <br> module is red.) | There is a configuration error (such as an <br> incompatible plug-in or mismatch between a physical <br> I/O module and the I/O configuration for the frame.) <br> Check the Error Logger to read error. |
| RTU startup fails and some/all of <br> the four user LEDs are lit. | Check the four LEDs for the binary error code, as <br> described in Table 4-3, and act accordingly. |
| Startup of expansion module fails <br> and some/all of the four EXP <br> ADDR LEDs are lit. | Check the four Exp Addr LEDs for the binary error <br> code, as described in Table 16-2, and act <br> accordingly. |

$\left.\begin{array}{|l|l|}\hline \text { Symptom } & \text { Action } \\ \hline \begin{array}{l}\text { The MCOM LED on the expansion } \\ \text { module is red or blinking green. }\end{array} & \begin{array}{l}\text { The expansion module is in the process of loading, } \\ \text { initializing, or registering. Wait a few seconds until } \\ \text { the LED is solid green for the module to be } \\ \text { connected to the main CPU. }\end{array} \\ \text { If the LED continues to blink red slowly, the } \\ \text { expansion module has failed in the discovery process } \\ \text { with the main CPU. This could be related to one of } \\ \text { the following causes: } \\ \text { - The main CPU is not fully powered up; } \\ \text { - A cable between the main and expansion frame } \\ \text { (perhaps via the expansion LAN switch) is not } \\ \text { connected properly; }\end{array}\right\}$ - The rotary switch on the expansion module is not $\left.\begin{array}{l}\text { set correctly; } \\ \text { - The expansion frame is not defined in the site } \\ \text { configuration. }\end{array}\right\}$

Troubleshooting

| Symptom | Action |
| :--- | :--- |
| The DO EE relays are connected to <br> the main power supply and the 2- <br> pin TB is not plugged into the <br> 12VDO connector on the main <br> power supply, but the DO EE <br> relays are enabled. | Check the position of the dip switch on the DO EE <br> relays. For more information, see the Digital Output <br> Relay Module chapter above. |

## BREAK-FIX PROCEDURES

## General

## IMPORTANT

This chapter refers only to replacement of removable modules, plug-ins, motherboard, power supply fuses, and backup battery. If any other components in the unit require replacement, contact your local service center.

Before replacing modules or plug-ins, see safety issues/warnings in the Installation chapter above.

Note: A TORX screwdriver is required for component replacement. A Philips screwdriver is required for assembling the TB holder and a flat screwdriver is required for setting the code key pin.

For information on installation of the frame/housing on the wall, see the Installation chapter above.

The ACE3600 has a hot swap capability, which means that the modules can be removed from their slots and inserted without powering down the unit. The only exception to this rule is the main power supply module, which cannot be removed during normal operation. See Replacing a Power Supply Module below for details.

If a module is inserted once the system is running, the system will recognize the module, but will not operate it using the application until the unit has been rebooted.

## Replacing a CPU/Gateway Module

## Procedure 29-1 How to Replace a CPU/Gateway Module

1. To replace a CPU module, open the door of the CPU module and press the cable holder downward.
2. Disconnect all cables from the connectors.
3. Simultaneously press on the tabs on the top and bottom of the plastic front of the old module, and pull the module from its slot. See Figure 29-1.


Figure 29-1 ACE3600 Module Release Tabs
4. Remove any SRAM plug-in memory from the old CPU module and plug in to the new CPU module.
5. Slide the new module all the way into the slot until the tabs click into place.
6. Reconnect the cables and press the cable holder back up into place.

## Replacing a Power Supply Module



## CAUTION

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## Break/Fix Procedures

## Procedure 29-2 How to Replace a Redundant/Expansion Power Supply Module

1. To replace the second power supply module in a site which has redundant power supplies, or an expansion power supply in an I/O expansion frame, open the door of the power supply module and press the cable holder downward.
2. Disconnect the cables from the connectors.
3. Simultaneously press on the tabs on the top and bottom of the plastic front of the old module, and pull the module from its slot.
4. Slide the new module all the way into the slot until the tabs click into place.
5. Reconnect the cables and press the cable holder back up into place.

The main power supply cannot be removed under power and a safeguard is added in order to prevent unplanned removal. (Note: The dual power supply feature is not currently available.)

Procedure 29-3 How to Replace the Main Power Supply Module

1. To replace the main power supply module, open the door of the power supply module.
2. Press down on the top of the main power cable connector to disconnect the user's main power cable from the cable inlet on the bottom of the power supply module front panel.
3. Follow steps 1-5 in Procedure 29-2 to replace the power supply.

## Replacing an I/O Module or Expansion LAN Switch

To replace an I/O module or Expansion LAN Switch, follow the procedure below.
Procedure 29-4 How to Replace an I/O Module or LAN Switch

1. If the I/O module includes a TB holder, remove TB holder by pulling on the extractor handles.
If the I/O module does not include a TB holder, remove the TBs by hand or using one of the TB extractor tools (FHN7063A) provided with the RTU.
2. Simultaneously press on the tabs on the top and bottom of the plastic front of the old module, and pull the module from its slot.
3. Remove any plug-in 24 V power supplies from the old I/O module and plug-in to the new I/O module.
4. For DO relay modules, reset the 12 VDO dip switch, if necessary. See the Configuration chapter.
5. Slide the new module all the way into the slot until the tabs click into place.
6. If the I/O module includes a TB holder, reconnect the TB holder as described in the I/O Module section.
If the I/O module does not include a TB holder, replace the TBs on the connectors on the front of the I/O module by hand.

## Inserting a New I/O Module into an Empty Slot

When the RTU is shipped, a protective rubber cover is inserted into any empty module slots, on the mother board connectors. The procedure below describes how to remove this cover from the slot and insert a new I/O module onto the RTU frame.

Procedure 29-5 How to Replace an I/O Module

1. Grip the protective rubber cover ( $\mathrm{p} / \mathrm{n} 1571435 \mathrm{Y} 04$ ) firmly with your thumb and index finger. Gradually ease the cover out of the desired module slot.
2. Insert the desired I/O module into the empty slot.

## Replacing a Plug-in Port on the CPU Module

## Procedure 29-6 How to Replace a Plug-in Port on the CPU Module

1. To replace a plug-in port on the CPU module, remove the CPU module from the RTU.
2. Unscrew the two supporting pins on the other side of the CPU board. Save the screws.
3. Unscrew the two supporting pins on the plug-in port. Save the screws.
4. Connect the two supporting pins with screws to the new plug-in port.
5. Replace the plug-in board with the RJ-45 connector facing the panel. Carefully insert the plug-in board connector into the appropriate connector on the CPU board.
For Ethernet 10/100 MB, use the J14 connector on the CPU (Plug-in 1 only.)
For all other plug-in ports, use the J5 (Plug-in 1) or J6 (plug-in 2) connector.
6. Connect the two supporting pins with screws to the other side of the CPU board.
7. Replace the CPU module in the slot.

## Replacing a Plug-in SRAM Memory Card in the CPU Module

Procedure 29-7 How to Replace a Plug-in SRAM Memory Card in the CPU Module

1. To replace an SRAM memory card on the CPU module, remove the CPU module from the RTU.
2. Remove the old plug-in SRAM memory card from the board.
3. Place the new plug-in SRAM memory card with the connector facing the panel. Carefully insert the plug-in board connector into the connector marked P12 on the CPU board.
4. Secure the memory card to the CPU board with the supplied screw.
5. Replace the CPU module in the slot.

For more information, see Connecting SRAM Expansion Memory to the CPU Module in the CPU Module chapter.

## Replacing the Motherboard

To replace the motherboard of the ACE3600 RTU, follow the procedure below.

## Procedure 29-8 How to Replace the Motherboard

1. If the unit is installed in a NEMA 4 housing, unscrew the four large screws and remove the metal chassis from the housing.
2. Remove all modules from the outermost slots, generally the power supply module from the leftmost slot and I/O module from the rightmost slot.
3. Unscrew the M5 screws on each side which secure the motherboard to the metal chassis. Save the screws. See Figure 29-2.


Figure 29-2 ACE3600 Motherboard on Metal Chassis
4. From inside the cage, push out the small cover on the side of the RTU cage. Save the cover.
5. Slide the damaged motherboard out of the cage, through the opening on the side of the RTU cage.
6. Slide the new motherboard into the frame, through the opening on the side of the RTU cage.
7. Secure the motherboard to the cage and metal chassis using the M5 screws saved in step 3 .
8. Replace the cover on the cage.
9. If the unit was installed in a NEMA 4 housing, replace the metal chassis in the housing and screw the four large screws from the metal chassis into the housing.
10. Replace the modules in their respective slots.
11. Make sure that the ground is reconnected.

## Replacing the Fuses on the Power Supply Module for AUX1/AUX2 or I/O Expansion

To replace a fuse for AUX1 1A/1B or AUX2 2A/2B on the power supply module, or one of the fuses on the expansion power supply, follow the procedure below.

## Procedure 29-9 How to Replace the Fuse for AUX1 1A/1B or AUX2 2A/2B or I/O Expansion

1. Disconnect the cables from the connectors. If the faulty fuses are attached to the main power supply, press down on the top of the main power cable connector to disconnect the user's main power cable from the cable inlet on the bottom of the power supply module front panel.
2. Simultaneously press on the tabs on the top and bottom of the plastic front of the old module, and pull the module from its slot.
3. Using narrow pliers, remove the faulty fuse from its groove on the board. For a diagram of the fuses in the expansion power supply, see Expansion Power Supply Fuses in the Expansion Power Supply Module chapter above.
4. Press the new fuse into the groove on the board.
5. Slide the power supply module all the way into the slot until the tabs click into place.
6. Reconnect the cables as in installation.

## Replacing the Backup Battery on the RTU

For instructions on replacing the backup battery on the RTU, see Replacing the Backup Battery in the Power Supply and Backup Battery chapter above.

## Interconnection Diagrams

All internal electrical connections except for the main power, ground and battery are performed in the factory and supplied with the RTU. The electrical interconnection diagrams are provided below.


Figure 29-3 Electrical Interconnection (RTUs with I/O slots)


Figure 29-4 Electrical Interconnection (RTUs with no I/O slots)

## APPENDIX A: GENERAL SPECIFICATIONS

## Specifications

The specifications below are for the RTU as a whole. For the individual technical and performance specifications of each module in the RTU, see the specific module chapter.

Table A-1 ACE3600 Specifications

| General |  |
| :---: | :---: |
| Frames | No I/O slots - PS and CPU modules only, wall mount, Dimensions (WxHxD): $117 \times 209 \times 198^{*} \mathrm{~mm}\left(4.61 \mathrm{x}\right.$ x 5.30 " x $7.80^{* *}$ ), Weight: $0.95 \mathrm{Kg}(2.1 \mathrm{lb})$ |
|  | 2 I/O slots - PS, CPU and 2 I/O modules, wall mount, Dimensions (WxHxD): $194 \times 244 \times 198^{*} \mathrm{~mm}\left(7.64 \mathrm{x}\right.$ x 9.61" x $7.80^{\prime *}$ ), Weight: approx. $1.6 \mathrm{Kg}(3.56 \mathrm{lb})$ |
|  | 3 I/O slots - PS, CPU and 3 I/O modules, wall mount, Dimensions (WxHxD): $234 \times 244 \times 198^{*} \mathrm{~mm}\left(9.21 \mathrm{x}\right.$ x 9.61 l x $7.80^{\prime *}$ ), Weight: approx. $1.9 \mathrm{Kg}(4.19 \mathrm{lb})$ |
|  | $5 \mathrm{I} / \mathrm{O}$ slots - PS, CPU and $5 \mathrm{I} / \mathrm{O}$ modules, wall mount, Dimensions (WxHxD): $314 \times 244 \times 198^{*} \mathrm{~mm}$ (12.36" x 9.61" x 7.80"*), Weight: approx. $2.4 \mathrm{Kg}(5.3 \mathrm{lb})$ |
|  | $7 \mathrm{I} / \mathrm{O}$ slots - PS, CPU and $7 \mathrm{I} / \mathrm{O}$ modules; wall mount, Dimensions (WxHxD): $391 \times 244 \times 198^{*} \mathrm{~mm}$ (15.39" x 9.61" x 7.80"*), Weight: $3.0 \mathrm{Kg}(6.6 \mathrm{lb})$ |
|  | 8 I/O slots - PS, CPU and 8 I/O modules, wall mount OR 19 " rack Dimensions (WxHxD): $435 \times 244 \times 198^{*} \mathrm{~mm}$ (17" x 9.61" x 7.80"*), Weight: approx. $3.3 \mathrm{Kg}(7.3 \mathrm{lb})$ |
|  | * Depth including Module panel |
| Expansion Frame | Number of I/O slots - $3,5,7$, or 8 |
|  | Default power supply - Expansion power supply |
|  | Compatible power supplies - All except: $10.8-16 \mathrm{~V}$ DC low-tier power supply |


| General |  |
| :---: | :---: |
| Metal Chassis | 19" frame metal back - for PS, ACE IP Gateway, radio and 6.5 or 10 Ah backup battery, 2 plastics boxes; wall/rack mount, <br> OR PS, CPU, radio and 6.5 or 10 Ah backup battery, $0,3,5,8$ I/O slot frame, up to 2 plastic boxes, wall/rack mount, <br> Dimensions (WxHxD): $434.5 \times 310.4 \times 200^{*} \mathrm{~mm}$ (17.11"x $12.22^{\prime \prime} \mathrm{x}$ 7.88"*). <br> Large - for PS, CPU and up to 7 I/O slot frame, two radios and 6.5 or 10 <br> Ah backup battery, wall mount, <br> Dimensions (WxHxD): 448 x $468 \times 200^{*} \mathrm{~mm}$ (17.64" x $18.43^{\prime \prime} \times 7.88^{\prime *}$ ) <br> Medium - for PS, CPU and up to $3 \mathrm{I} / \mathrm{O}$ slot frame, one radio and 6.5 Ah backup battery, wall mount, <br> Dimensions (WxHxD): $335 \times 355 \times 198^{*} \mathrm{~mm}$ (13.19" x $13.98^{\prime \prime} \times 7.8^{* *}$ ) <br> Small - for PS, CPU, 2 I/O slot frame, 1 radio (or 1 plastic box), and 6.5Ah backup battery, wall mount, <br> Dimensions (WxHxD): $264 \times 365 \times 200^{*} \mathrm{~mm}$ (11.02"x 14.17" x 7.88"*). <br> * Depth including Frame and Module |
| Housing | Large Nema 4/IP66 painted metal - up to 7 I/O slot frame, two radios and 6.5 or 10 Ah , backup battery, <br> Dimensions (WxHxD): $500 \times 500 \times 210 \mathrm{~mm}$ (19.7" x19.7" x $8.26^{\prime \prime}$ ) <br> Small Nema 4/IP66 painted metal - up to 3 I/O slot frame one radio and 6.5 <br> Ah backup battery, <br> Dimensions (WxHxD): $380 \times 380 \times 210 \mathrm{~mm}$ ( $15^{\prime \prime} \mathrm{x} 15^{\prime \prime} \times 8.26^{\prime \prime}$ ) |
| Power Supply | $\begin{aligned} & 10.8-16 \mathrm{~V} \text { DC low-tier } \\ & 10.8-16 \mathrm{~V} \mathrm{DC} \mathrm{(default)} \\ & 18-72 \mathrm{~V} \mathrm{DC} \\ & 18-72 \mathrm{~V} \text { DC with } 12 \mathrm{~V} \text { smart battery charger } \\ & 100-240 \mathrm{~V} \mathrm{AC}, 50-60 \mathrm{~Hz} \\ & 100-240 \mathrm{~V} \mathrm{AC}, 50-60 \mathrm{~Hz} \text {, with } 12 \mathrm{~V} \text { smart battery charger } \\ & 10.8-16 \mathrm{~V} \text { DC Expansion } \\ & \hline \end{aligned}$ |
| Backup Battery | 6.5 Ah - Sealed Lead-Acid <br> 10 Ah - Sealed Lead-Acid |
| Operating Temperature | $-40^{\circ} \mathrm{C} \text { to }+70^{\circ} \mathrm{C}\left(-40^{\circ} \mathrm{F} \text { to } 158^{\circ} \mathrm{F}\right)$ <br> Notes: 1) When using a metal housing option, the maximum operating temperature outside the housing is $+60^{\circ} \mathrm{C}\left(140^{\circ} \mathrm{F}\right)$. <br> 2) ACT module and Motorola radios operating temperature range is: $-30^{\circ} \mathrm{C}$ to $+60^{\circ} \mathrm{C}\left(-22^{\circ} \mathrm{F}\right.$ to $\left.140^{\circ} \mathrm{F}\right)$. |
| Storage Temperature | $-55^{\circ} \mathrm{C}$ to $+85{ }^{\circ} \mathrm{C}\left(-67^{\circ} \mathrm{F}\right.$ to $\left.185{ }^{\circ} \mathrm{F}\right)$ |
| Operating Humidity | $5 \%$ to $95 \%$ RH @ $50{ }^{\circ} \mathrm{C}$ without condensation |


| General |  |
| :---: | :---: |
| Mechanical Vibrations | Per EIA / TIA 603 Base-station, Sinusoidal 0.07 mm @ 10 to $30 \mathrm{~Hz}, 0.0035$ mm @ 30-60 Hz |
| Operating Altitude | -400 m to +4000 meter $(-1312 \mathrm{ft}$ to $+13120 \mathrm{ft})$ above sea level Note: When using $18-72 \mathrm{~V}$ DC or $100-240$ VAC Power supply the operating altitude is -400 to +3000 m |
| Regulatory Standards |  |
| Safety | UL 60950-1 (UL listed), CSA 22.2-950-1, EN60950-1, IEC 60950-1, AS/NZS 60950 |
|  | FM/cFM certified as Nonincendive Class I, Division 2 - standard FM 3611 (Note: FM approval refers to model F7509 only and most of the ACE3600 options.) |
| Emission | Emission standards for industrial environments |
|  | CFR 47 FCC part 15, subpart B (class A); CE EMC: EN50081-2/EN61000-6-4 |
|  | (CISPER 11 / EN55011 class A) |
| Immunity | Immunity standards for industrial environments |
|  | Per EN50082-2 /IEC 61000-6-2 |
| Communications |  |
| Communication Ports | Up to 4 ports per CPU (CPU 3610), up to 5 ports per CPU (CPU 3640), up to 7 ports per CPU (CPU 3680/4600) |
|  | Serial - up to $4 \times$ RS232 ports |
|  | Multi-drop - up to $3 \times$ RS485 port |
|  | Ethernet - up to $2 \times 10 / 100 \mathrm{MB}$ ports and $1 \times 10 \mathrm{MB}$ |
|  | Two-way radio / analog trunked radio - up $2 \times$ modem ports |
|  | MotoTrbo- two Remote NDIS USB ports |
| Motorola Radio Support | $\frac{\text { Mobile conventional two-way radios }}{200, \text { CDM750 }}-\text { CM } 200, \text { CM 340, GM 3188, EM }$ |
|  | Portable conventional two-way radios - HT750, GP320, GP328, PRO5150 |
|  | Analog trunked radios - XTL5000, XTL2500 |
|  | $\frac{\text { Digital trunked radios }}{\text { (TETRA) }} \text { - XTL5000, XTL2500, XTS2500, MTM800 }$ |
|  | MotoTrbo radios -XPR4350/4380, DM3400, XiR M8220, DGM4100 |
| Third Party Radio Support | Two-way radios, Data radios, TETRA radios (PD) |
| Modem Support | Dial-up modems, Cellular modems (dial mode and PD) |
| Protocols | MDLC, TCP, UDP, IP, PPP, NTP, DHCP |


\left.| Third Party Protocol | MODBUS RTU: master on RS232/RS485/Ethernet, |
| :--- | :--- |
| Support | slave on RS232/RS485/Ethernet |$\right]$| DF1 (Allen Bradley): master on RS232 |
| :--- |
|  |
|  |
|  |
| DNP 3.0: master/slave on RS232/RS485/Ethernet |
| IEC 60870-5-101: slave on RS232 |

Specifications subject to change without notice.

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## APPENDIX B: ENVIRONMENTAL PROTECTION

## Disposal of Components

All components of the ACE3600 should be properly disposed of, in accordance with local regulatory standards and laws.

All ACE3600 models comply with RoHS European Directive no. 2002/95/EC (Restriction of the use of Hazardous Substances) and WEEE Directive no. 2002/96/EC (Strategy of Waste management), with the exception of parts:

- XTL5000 radio (included in models F7523A/F7513A/F7524A/F7514A/F7585A/F7586A)
- XTL2500 radio (F7533A/F7593A/F7534A/F7594A/F7538A/F7598A)
- XTS2500 radio (F7543A/F7544A/F7548A)
- CDM750 radio (F7563A/F7564A)
- ACT Module (option V155AE and kit FLM)

Note: The ACE3600 RTU is categorized as Monitoring and Control Equipment. Currently (2010) Monitoring and Control Equipment are exempt from RoHS compliance. This exemption may be cancelled in the future.

# APPENDIX C: ACCESSORIES, ADAPTORS, AND CABLES 

## General



Note: On all of the Motorola RJ45 connector heads (except for Ethernet cables), the numbering of the pins is different than the standard, as shown in the figure below. Pin $1-8$ are left to right rather than right to left, as shown below. Therefore, only original Motorola cables should be used.


This appendix provides the information required for connecting an RTU RS232 port to various units, as detailed below:

- Connection to a computer/terminal (MDLC protocol or User port)
- Connection to a modem (MDLC protocol or User port)
- Connection to the GPS receiver (Motorola Binary protocol)
- Connecting a User port to a printer
- Connecting a User port to an external unit
- Connection to a radio (MDLC and PPP protocols)
- RTU-to-RTU connection using MDLC protocol through RS232 ports (RS-Link)
- ACE3600 RTU-to-ACE3600 RTU connection using MDLC protocol through RS485 ports (RS-Link)
- ACE3600 RTU-to-MOSCAD RTU connection using MDLC protocol through RS485 ports (RS-Link)
- ACE3600 RTU-to-PC Ethernet port connection without a hub


## Connection to a Computer or Terminal

To connect one of the RTU RS232 ports to a computer/terminal, use the FLN6457B adaptor, which ends with the female 25 -pin or 9-pin, D-type connector. The port may be defined either as a MDLC protocol port or as a User port.
The signals that appear on the female 25-pin or 9-pin D-type connector are according to the RS232 standard - see the following table. In this case, the RTU serves as DCE (Data Communication Equipment).

Appendix C: Accessories, Adaptors and Cables

| RS232 Function | 8-pin <br> Connector (on <br> RTU) | 25-pin Female | 9-pin Female | Direction |
| :--- | :--- | :--- | :--- | :--- |
| TX-DATA | $2 \leftarrow$ | 2 | 3 | from DTE |
| RX-DATA | $1 \rightarrow$ | 3 | 2 | to DTE |
| RTS | $5 \leftarrow$ | 4 | 7 | from DTE |
| CTS | $8 \rightarrow$ | 5 | 8 | to DTE |
| DSR | $7 \rightarrow$ | 6 | 6 | to DTE |
| GND | 4 | 7 | 5 | - |
| DTR | $3 \leftarrow$ | 20 | 4 | from DTE |
| DCD (Rec line) | $6 \rightarrow$ | 8 | 1 | to DTE |

To extend the cable, you may use any extension cable with male and female D-type connectors (connected pin-to-pin, not crossed).
Note: When a User port is defined as Computer/Terminal with DTR support:
The RTU will not transmit unless it receives $\mathrm{DTR}=\mathrm{ON}$ from the computer/terminal.
The RTU will not receive unless it receives RTS=ON from the computer/terminal.

## Connection to a Modem

To connect one of the RTU RS232 ports to an RS232 modem, use one of the adaptors provided in kit FLN6458B (option V213AE):

- 9-pin adaptor for Async ( $\# 0189968 \mathrm{~V} 32$ )
- RS232-E adaptor (\#0189968V33) as in Connection to IDEN Radio below.
- RS232-E+ adaptor (\#0189968V34) as in Connection to TETRA Radio below.

The asynchronous adaptor (\#0189968V32) ends with the male 9-pin D-type connector. The port may be defined either as a MDLC protocol port or as a User port.
The signals that appear on the male 9-pin D-type (or 25-pin) connector are according to the RS232 standard - see the following table. In this case, the RTU serves as DTE (Data Terminal Equipment).

| RS232 Function | 8-pin <br> Connector(on <br> RTU) | 25-pin Male | 9-pin Male | Direction |
| :--- | :--- | :--- | :--- | :--- |
| TX-DATA | $1 \rightarrow$ | 2 | 3 | from RTU |
| RX-DATA | $2 \leftarrow$ | 3 | 2 | to RTU |
| RTS | $6 \rightarrow$ | 4 | 7 | from RTU |
| CTS | $3 \leftarrow$ | 5 | 8 | to RTU |
| GND | 4 | 7 | 5 | - |

Appendix C: Accessories, Adaptors and Cables

| RS232 Function | 8-pin <br> Connector(on <br> RTU) | 25-pin Male | 9-pin Male | Direction |
| :--- | :--- | :--- | :--- | :--- |
| DTR | $8 \rightarrow$ | 20 | 4 | from RTU |
| DCD (Rec line) | $5 \leftarrow$ | 8 | 1 | to RTU |

To extend the cable, you may use any extension cable with male and female D-type connectors (connected pin-to-pin, not crossed).
Before transmitting, the RTU sends RTS=ON to the modem, and waits for $\mathrm{CTS}=\mathrm{ON}$ from the modem as a condition for transmitting.
The RTU will receive data from the modem only when $\mathrm{DCD}=\mathrm{ON}$.
When using a modem in auto-answer mode (connected to a Computer port) for remote service, the RTU does not support RTS/CTS protocol since the port is designated to operate with a local computer as well as with a modem.
For modems which support RS232-E, use either the RS232-E adaptor (\#0189968V33) as in Connection to IDEN Radio below, or the RS232-E+ adaptor (\#0189968V34), as in Connection to TETRA Radio below.

## Connection to GPS Receiver

When an off-the-shelf GPS timing receiver is purchased (e.g. Synergy SynPaQ/E PPS Sensor with $\mathrm{M} 12+$ ), the data and power cable for that receiver should be purchased as well.
Connect the data wire of the cable to the CPU port using the ACE3600 asynchronous RS232-E adaptor cable. The port should be defined as a GPS receiver port (RS232, Async).
Connect the power wire of the cable to a cable with the following connectors:
RTU side: The connector should fit the auxiliary power connector on the ACE3600 power supply module.

GPS Receiver side: The connector should fit the power connector on the GPS receiver cable.

## Connecting a User Port to a Printer

To connect one of the RTU RS232 ports defined as a User port to a printer, you may use one of the two cables described in the previous paragraphs. Since the connection to the printer is not defined by the RS232 standard, every printer manufacturer has defined the connectors for his own convenience. Therefore, select the adaptor according to the functions of the various pins.
If the FLN6458B adaptor (with the male 9-pin D-type connector) is used, refer to the following table.

| RS232 Function | 9-pin Male | Used as | Direction |
| :--- | :--- | :--- | :--- |
| TX-DATA | 3 | Serial Data | to Printer |
| CTS | 8 | Printer Ready | from Printer |
| GND | 5 | GND | - |

Appendix C: Accessories, Adaptors and Cables

If the FLN6457B adaptor (with the female 9-pin, D-type connector) is used, refer to the following table.

| RS232 Function | 9-pin Female | Used as | Direction |
| :--- | :--- | :--- | :--- |
| RX-DATA | 2 | Printer Rx-Data | to Printer |
| DTR | 4 | Printer Ready | from Printer |
| GND | 5 | GND | - |

## Connecting a User Port to an External Unit

To connect one of the RTU RS232 ports defined as a User port to an external unit (which supports RS232), you may use one of the two adaptors (FLN6457B or FLN6458B) according to the port definition in the site configuration.

If the FLN6457B adaptor is used, refer to the pin assignment given in Connection to a Computer or Terminal in this chapter.

If the FLN6458B adaptor is used, refer to the pin assignment given in Connection to a Modem in this chapter.

## Connection to a Radio

For detailed instructions on connecting a radio to the ACE3600 RTU, see the Radio Types and Installation Kits chapter above.

## Connection to IDEN Radio

To connect the RTU (via onboard serial or plug-in port) to an IDEN radio, use an adaptor which ends with the male 9-pin, D-type connector. The port should be defined as RS-232, Async, PPP, iDEN, MDLC over IP.

| RS232 Function | 8-pin Connector(on <br> RTU) | 9-pin Male | Direction |
| :--- | :--- | :--- | :--- |
| TX-DATA | $1 \rightarrow$ | 3 | from RTU |
| RX-DATA | $2 \leftarrow$ | 2 | to RTU |
| CTS | $3 \leftarrow$ | 8 | to RTU |
| GND | 4 | 5 | - |
| CD (Rec line) | $5 \leftarrow$ | 1 | to RTU |
| RTS | $6 \rightarrow$ | Not used |  |
|  | $7 \rightarrow$ | 4 | from RTU |
| DTR | $8 \rightarrow$ | 7 | from RTU |

Appendix C: Accessories, Adaptors and Cables

## Connection to TETRA Radio

To connect the RTU (via onboard serial or plug-in port) to a TETRA radio, use an RS232-E + type adaptor which ends with the male 9-pin, D-type connector. The port should be defined as RS232, Async, PPP, Tetra, MDLC over IP.

| RS232 Function | 8-pin Connector(on <br> RTU) | 9-pin Male | Direction |
| :--- | :--- | :--- | :--- |
| TX-DATA | $1 \rightarrow$ | 3 | from RTU |
| RX-DATA | $2 \leftarrow$ | 2 | to RTU |
| CTS | $3 \leftarrow$ | 8 | to RTU |
| GND | 4 | 5 | - |
| CD (Rec line) | $5 \leftarrow$ | 1 | to RTU |
| RTS | $6 \rightarrow$ | 4 | from RTU |
|  | 7 | Not used |  |
| DTR | $8 \rightarrow$ | 7 | from RTU |

## Connection to MotoTrbo Radio

To connect the RTU (via Host USB port) to a MotoTrbo radio, use a cable FKN8644A. The port should be defined as USB Host, Async, Remote NDIS Host, MotoTrbo.

| Function | USB Type A <br> (on RTU) | 26-pin Female <br> (on Radio) | Direction |
| :--- | :--- | :--- | :--- |
| +5 VDC/ <br> VBUS + | $1 \rightarrow$ | 3 | from RTU |
| Data - | $2 \leftrightarrow$ | 2 | to/from <br> RTU |
| Data + | $3 \leftrightarrow$ | 1 | to/from <br> RTU |
| GND | 4 | 4 | - |
| Ignition |  | 25 | from radio <br> power cable |

## RTU-to-RTU Connection Using MDLC Protocol through RS232

To establish a link between two RTUs using MDLC protocol, the ports of both RTUs should be defined as RS232 RTU-to-RTU (RS-Link). The ports of the two RTUs should be connected by the FLN6457B and FLN6458B adaptors, when the adaptors are connected.


## IMPORTANT

Do not connect between RTUs without the adaptor cables. A direct connection will cause a short circuit between the pins that have the same function.

## Appendix C: Accessories, Adaptors and Cables

## RTU-to-RTU Synchronous Communication Using Plug-in Port

The pin assignment of the cable to be used for RTU-to-RTU synchronous communication (using a plug-in port) is given below.

| RS232 Function | 8-pin Connector <br> (on sending RTU) | 8-pin Connector <br> (on receiving RTU) | Direction |
| :--- | :--- | :--- | :--- |
| TX-DATA | $1 \rightarrow$ | $2 \leftarrow$ | from RTU |
| RX-DATA | $2 \leftarrow$ | $1 \rightarrow$ | to RTU |
| CTS | $3+6 \rightarrow^{*}$ | $5 \leftarrow$ | from RTU |
| Signal GND | 4 | 4 | - |
| CD (Rec line) | $5 \leftarrow$ | $3+6 \rightarrow^{*}$ | to RTU |
| RTS | $6+3 \rightarrow^{*}$ | $5 \leftarrow$ | from RTU |
| TX_CLK | $7 \rightarrow$ | $8 \leftarrow$ | from RTU |
| RX_CLK | $8 \leftarrow$ | $7 \rightarrow$ | to RTU |

*Pins 3 and 6 are shorted

## ACE3600 RTU-to-ACE3600 RTU Connection Using MDLC Protocol through RS485

To establish a link between more than two ACE3600 RTUs using MDLC protocol, the ports of all RTUs should be defined as RS485 RTU multidrop. The ports of the RTUs should be connected using the RS485 connection box V186AD (FLN3641A). Cable FKN8427A should be connected between ACE3600 RS485 port and one of the seven inlets of the connection box.

| RS485 Function | 8-pin <br> Connector* <br> (on ACE3600) |
| :--- | :--- |
| B (RX/TX-) | 1 |
| A (RX/TX + ) | 8 |

*Note: All seven connectors are shorted.

## ACE3600 RTU-to-MOSCAD RTU Connection Using MDLC Protocol through RS485

To establish a link between an ACE3600 unit and a MOSCAD RTU using MDLC protocol, the ports of both RTUs should be defined as RS485 RTU multidrop. The ports of the two RTUs should be connected using the FKN8527A cable.

# Appendix C: Accessories, Adaptors and Cables 



## IMPORTANT

Do not connect between RTUs without the adaptor cables. A direct connection will cause a short circuit between the pins that have the same function.

| RS485 Function | 8-pin <br> Connector <br> (on ACE3600) | 4-pin <br> Connector (on <br> MOSCAD) |
| :--- | :--- | :--- |
| B (RX/TX-) | 1 | 2 |
| A (RX/TX+ $)$ | 8 | 3 |

## ACE3600 RTU-to-PC Ethernet Port Direct Connection without Hub

## NOTE

Note: The RJ45 connector head for this connection is standard. The numbering of the pins is according to the standard, as shown in the figure below. Pin 1-8 are right to left, as shown below. Therefore, any standard Ethernet crossover cable may be used.


To establish a link between an ACE3600 unit and the Ethernet port of a PC, without using a hub, the RTU port should be defined as an IP port (10/100 BT, Static, Ethernet LAN) with an IP address. The ports should be connected using an Ethernet crossover cable.

| IP Function | 8-pin <br> Connector <br> (Plug 1) | 8-pin <br> Connector <br> (Plug 2) |
| :--- | :--- | :--- |
| TX-DATA + | $1 \rightarrow$ | $3 \leftarrow$ |
| TX-DATA - | $2 \rightarrow$ | $6 \leftarrow$ |
| RX-DATA + | $3 \leftarrow$ | $1 \rightarrow$ |
| N/A | 4 | 7 |
| N/A | 5 | 8 |
| RX-DATA - | $6 \leftarrow$ | $2 \rightarrow$ |
| N/A | 7 | 4 |
| N/A | 8 | 5 |

## ACE3600 RTU Main CPU to Expansion Module Direct Connection

To establish a direct link between an ACE3600 main frame CPU and an expansion module, the CPU's ETH1 port must be configured either as Static LAN or as I/O Expansion Comm. Connect the CPU's ETH1 port and the expansion module's Exp. Eth1 port using an Ethernet crossover cable, with wiring as in ACE3600 RTU-to-PC Ethernet Port Direct Connection without Hub above.

## Appendix C: Accessories, Adaptors and Cables

## ACE3600 RTU Main CPU to Expansion Module Connection via LAN Switch

## NOTE

Note: The RJ45 connector head for this connection is standard. The numbering of the pins is according to the standard, as shown in the figure below. Pin 1-8 are right to left, as shown below. Therefore, any standard Ethernet cable may be used.


The ACE3600 RTU main CPU can be connected to an expansion module via one or two expansion LAN switches. The CPU's ETH1 port must be configured either as Static LAN or as I/O Expansion Comm.

For the connections below, use a standard standard Category 5E shielded (FTP) LAN cable (up to 50 m .)

- ACE3600 RTU main CPU to expansion LAN switch connection or connection of the first LAN switch to the second, if such exists (for systems with I/O expansion only)
- ACE3600 RTU expansion LAN switch to expansion module connection (for systems with I/O expansion only)

| IP Function | 8-pin <br> Connector <br> (Plug 1) | 8-pin <br> Connector <br> (Plug 2) |
| :--- | :--- | :--- |
| TX-DATA + | $1 \rightarrow$ | $1 \leftarrow$ |
| TX-DATA - | $2 \rightarrow$ | $2 \leftarrow$ |
| RX-DATA + | $3 \leftarrow$ | $3 \rightarrow$ |
| N/A | $4 \rightarrow$ | $4 \leftarrow$ |
| N/A | $5 \rightarrow$ | $5 \leftarrow$ |
| RX-DATA - | $6 \leftarrow$ | $6 \rightarrow$ |
| N/A | $7 \rightarrow$ | $7 \leftarrow$ |
| N/A | $8 \rightarrow$ | $8 \leftarrow$ |

## APPENDIX D: ACE3600 MAXIMUM POWER RATINGS

## Power Rating Tables

The tables below list the typical maximum power consumption (at room temperature) for each of the ACE3600 RTU building blocks (CPU, Power Supply, I/O modules, radios, etc.) and the maximum peak power allowed for a fully loaded RTU, based on the housing type.
The values in the tables below are derived by using the power supply (AC: 100 to 240 VAC or DC: 18 to 72 VDC and 13.8 VDC ) and have the power supply efficiency factor included in them.
Before deploying your RTU, add up the power consumption of all components of your system to verify that it is within the maximum peak power for your housing type. In systems with I/O expansion, consider all modules which consume power from their respective AC/DC main power sources when calculating the required power requirements.

Table D-1 Maximum Peak Power Allowed for Fully Loaded RTU

| Housing Type <br> Description | Maximum Input Power into Power Supply Module <br> (Watts) |
| :--- | :--- |
| 19" Rack (w/out metal enclosure) | 100 |
| Large NEMA metal housing $(50 \times 50 \mathrm{~cm})$ | $120^{*}$ |
| Small NEMA metal housing $(40 \times 40 \mathrm{~cm})$ | $105^{*}$ |

* NOTE: When powered at Vin $=100 \mathrm{VAC}$, the maximum input power of the power supply module is limited to 80 Watts ONLY.

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Appendix D: ACE3600 Maximum Power Ratings

Table D-2 Power Consumption per RTU Module

| Module Name | Self Power Consumption (no active I/O) (Watts) | Maximum Power Consumption per Active I/O (Watts) | Self Power Consumption (no active I/O) Watts | Maximum Power Consumption per Active I/O Watts | Maximum Power Consumption all I/Os, LEDs Active Watts |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | AC: 100 to 240 VAC DC: 18 to 72 VDC |  | Vin $=+13.8$ VDC |  |  |
| Power Supply (maximum) | 12.60 | N/A | $\begin{aligned} & 2.20(156 \mathrm{~mA}) \\ & (12 \mathrm{VDC} \\ & \text { Power Supply } \\ & \text { Module } \\ & \text { ONLY) } \\ & \hline \end{aligned}$ | N/A | N/A |
| Power Supply (Expansion) | 0.0 | N/A | 0.0 | N/A | N/A |
| $\begin{aligned} & \hline \text { CPU } \\ & (3640 / 3610) \\ & \hline \end{aligned}$ | 5.20 | N/A | 4.20 (304 mA) | N/A | 4.00 (290 mA) |
| Expansion Module | 5.20 | N/A | 4.20 (304 mA) | N/A | 4.00 ( 290 mA ) |
| Expansion LAN Switch | 1.50 | 0.220 | 1.20 (87 mA) | $\begin{array}{\|l\|} \hline 0.176 \\ (12.75 \mathrm{~mA}) \\ \hline \end{array}$ | $\begin{array}{\|l} \hline 3.10(225 \mathrm{~mA}) \\ (\mathrm{x} 8 \text { ports ON) } \end{array}$ |
| Digital Input <br> Fast 24V <br> (x16/x32) | 0.100 | 0.100 (powered by internal 24 V PS) | $\begin{aligned} & 0.080 \\ & (5.8 \mathrm{~mA}) \end{aligned}$ | $\begin{aligned} & 0.100 \\ & (7 \mathrm{~mA}) \\ & \text { (powered by } \\ & \text { internal } 24 \mathrm{~V} \\ & \text { PS) } \end{aligned}$ | $\begin{array}{\|l\|} \hline 3.50(254 \mathrm{~mA}) \\ \text { (x32 inputs ON } \\ \text { powered by x1 } \\ \text { internal } 24 \mathrm{~V} \\ \text { PS) } \\ \hline \end{array}$ |
| Digital Input <br> Fast 24V <br> IEC Type 2 <br> (x16/x32) | 0.100 | 0.230 <br> (powered by internal 24V PS) | $\begin{aligned} & 0.080 \\ & (5.8 \mathrm{~mA}) \end{aligned}$ | $0.230(17 \mathrm{~mA})$ <br> (powered by internal 24 V PS) | $\begin{array}{\|l} \hline 8.20(594 \mathrm{~mA}) \\ \text { (x32 inputs ON } \\ \text { powered by x2 } \\ \text { internal } 24 \mathrm{~V} \\ \text { PS) } \\ \hline \end{array}$ |
| Digital Input <br> Fast 48V <br> (x32) | 0.100 | 0.100 (powered by internal 24 V PS) | $\begin{aligned} & 0.080 \\ & (5.8 \mathrm{~mA}) \end{aligned}$ | $\begin{array}{\|l\|} \hline 0.100 \\ (7 \mathrm{~mA}) \\ \text { (powered by } \\ \text { internal } 24 \mathrm{~V} \\ \text { PS) } \\ \hline \end{array}$ | $\begin{array}{\|l} \hline 3.50(254 \mathrm{~mA}) \\ \text { (x32 inputs ON } \\ \text { powered by x1 } \\ \text { internal } 24 \mathrm{~V} \\ \text { PS) } \\ \hline \end{array}$ |
| Digital Input $120 / 230 \mathrm{~V}$ | 0.100 | 0.015 | 0.080 ( 5.8 mA ) | $0.012(1 \mathrm{~mA})$ | $\begin{aligned} & 0.524(38 \mathrm{~mA}) \\ & (\times 16 \text { inputs } \\ & \mathrm{ON}) \end{aligned}$ |
| Digital Output <br> ML Relay <br> (x8/x16) | 0.120 | 0.010 | $\begin{aligned} & 0.100 \\ & (7.2 \mathrm{~mA}) \end{aligned}$ | $\begin{aligned} & 0.008 \\ & (0.5 \mathrm{~mA}) \end{aligned}$ | $\begin{aligned} & 0.483(35 \mathrm{~mA}) \\ & \text { (x16 relays } \\ & \text { ON) } \\ & \hline \end{aligned}$ |

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Appendix D: ACE3600 Maximum Power Ratings

| Module Name | Self Power Consumption (no active I/O) (Watts) | Maximum Power Consumption per Active I/O (Watts) | Self Power Consumption (no active I/O) Watts | Maximum Power Consumption per Active I/O Watts | Maximum Power Consumption all I/Os, LEDs Active Watts |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | AC: 100 to 240 VAC DC: 18 to 72 VDC |  | Vin $=+13.8$ VDC |  |  |
| Digital Output EE Relay (x8/x16) | 0.170 | 0.200 | $0.136(10 \mathrm{~mA})$ | $\begin{aligned} & 0.160 \\ & (11.6 \mathrm{~mA}) \end{aligned}$ | $\begin{aligned} & 3.26(236 \mathrm{~mA}) \\ & \text { (x16 relays } \\ & \text { ON) } \\ & \hline \end{aligned}$ |
| Digital Output SBO EE Relay $(\mathrm{x} 8)$ | 0.170 | 0.400 | $0.136(10 \mathrm{~mA})$ | $\begin{aligned} & 0.320 \\ & (23.2 \mathrm{~mA}) \end{aligned}$ | 3.26 (236 mA) |
| Digital Output <br> ML Relay <br> $120 / 230 \mathrm{~V}$ | 0.200 | 0.006 | $\begin{aligned} & 0.160 \\ & (11.6 \mathrm{~mA}) \end{aligned}$ | $0.005(0.4 \mathrm{~mA})$ | $\begin{array}{\|l} \hline 0.248 \\ (18.0 \mathrm{~mA}) \\ \\ (x 12 \text { relays } \\ \mathrm{ON}) \\ \hline \end{array}$ |
| Digital Output EE Relay $120 / 230 \mathrm{~V}$ | 0.290 | 0.260 | $0.232(17 \mathrm{~mA})$ | $\begin{aligned} & 0.210 \\ & (0.15 \mathrm{~mA}) \end{aligned}$ | $\begin{aligned} & 3.12(226 \mathrm{~mA}) \\ & (\mathrm{x} 12 \text { relays } \\ & \mathrm{ON}) \\ & \hline \end{aligned}$ |
| FET Digital Output/Digital Input | 0.120 | DI $=0.014$ (per input channel) $\mathrm{DO}=0.014$ (per output channel) | $\begin{aligned} & 0.100 \\ & (7.2 \mathrm{~mA}) \end{aligned}$ | DI $=0.011$ (per input channel) $\mathrm{DO}=0.011$ <br> (per output channel) | $0.552(40 \mathrm{~mA})$ <br> (x32 LEDs/ inputs ON) |
| Mixed I/O <br> (DO ML +DI <br> IEC Type 2) | 0.480 | DI $=0.250$ <br> (powered by internal 24 V PS) $\mathrm{DO}=0.010$ | $0.384(28 \mathrm{~mA})$ | $\mathrm{DI}=0.250$ <br> (powered by internal 24 V PS) $\mathrm{DO}=0.008$ | $\begin{array}{\|l} \hline 4.70(341 \mathrm{~mA}) \\ \text { (x4 relays ON } \\ \text { x16 inputs ON } \\ \text { x4 AI ON } \\ \text { powered by } \\ \text { internal } 24 \mathrm{~V} \\ \mathrm{PS} \text { ) } \\ \hline \end{array}$ |
| Mixed I/O <br> (DO EE + DI <br> IEC Type 2) | 0.480 | DI $=0.250$ <br> (powered by internal 24 V PS) $\mathrm{DO}=0.200$ | $0.384(28 \mathrm{~mA})$ | DI $=0.250$ <br> (powered by internal 24 V PS) $\mathrm{DO}=0.160$ | $\begin{aligned} & \text { 5.50 }(400 \mathrm{~mA}) \\ & \text { (x4 relays ON } \\ & \text { x16 inputs ON } \\ & \text { x4 AI ON } \\ & \text { powered by } \\ & \text { internal } 24 \mathrm{~V} \\ & \text { PS) } \\ & \hline \end{aligned}$ |

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Appendix D: ACE3600 Maximum Power Ratings

| Module Name | Self Power Consumption (no active I/O) (Watts) | Maximum Power Consumption per Active I/O (Watts) | Self Power Consumption (no active I/O) Watts | Maximum Power Consumption per Active I/O Watts | Maximum Power Consumption all I/Os, LEDs Active Watts |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | AC: 100 to 240 VAC DC: 18 to 72 VDC |  | Vin $=+13.8$ VDC |  |  |
| Analog Output | 1.10 | 0.600 (per output channel @ 20.0 mA ) | 0.880 (64 mA) | $\begin{aligned} & 0.480(35 \mathrm{~mA}) \\ & \text { (per output } \\ & \text { channel @20.0 } \\ & \mathrm{mA}) \end{aligned}$ | $\begin{array}{\|l} \hline 3.33(241 \mathrm{~mA}) \\ \text { (x4 outputs } \\ \begin{array}{l} \text { sourcing } 20.0 \\ \mathrm{~mA}) \end{array} \\ \hline \end{array}$ |
| Mixed Analog Current/Voltage | 1.40 | 0.600 (per output channel @20.0 mA) | 1.12 (81 mA) | $\begin{aligned} & 0.480(35 \mathrm{~mA}) \\ & \text { (per output } \\ & \text { channel @ } 20.0 \\ & \mathrm{~mA} \text { ) } \end{aligned}$ | $\begin{aligned} & 3.61(261 \mathrm{~mA}) \\ & \text { (x4 outputs } \\ & \text { sourcing } 20.0 \\ & \mathrm{~mA} \text { ) } \\ & \hline \end{aligned}$ |
| Analog Input Current/Voltage (x8/x16) | 0.530 | N/A | $\begin{aligned} & 0.440 \\ & (32.0 \mathrm{~mA}) \end{aligned}$ | N/A | $\begin{aligned} & 0.870 \\ & (63.0 \mathrm{~mA}) \end{aligned}$ |
| 24V Floating Plug-In Power Supply (No load) | 0.410 | N/A | 0.328 (24 mA) | N/A | N/A |
| 24V Floating <br> Plug-In Power <br> Supply <br> (externally <br> loaded 150 mA ) | 4.80 | N/A | 3.84 (278 mA) | N/A | N/A |

Appendix D: ACE3600 Maximum Power Ratings

| Plastic Box <br> Interface | Typical <br> Power <br> (Watts) | Power when all <br> I/Os are on <br> (Watts) | Typical Power <br> (Watts) | Power when all I/Os <br> are on <br> (Watts) |
| :--- | :--- | :---: | :--- | :--- |
|  | AC: 100 to 240 VAC <br> DC: 18 <br> to 72 <br> VDC |  | Vin $=+13.8$ VDC |  |
|  | 0.60 | 2.20 | $0.480(35 \mathrm{~mA})$ | $1.76(127.50 \mathrm{~mA})$ |
| Module |  |  |  |  |


| Radios | Power in RX Mode (Watts) | Power in TX Mode (Watts) | Power in RX Mode (Watts) | Power in TX Mode (Watts) |
| :---: | :---: | :---: | :---: | :---: |
|  | AC: 100 to 240 VAC DC: 18 to 72 VDC |  | Vin $=+13.8$ VDC |  |
| $\begin{array}{\|l} \hline \text { XTL5000 } \\ \text { (15 Watt) } \\ \hline \end{array}$ | 8.80 | 66.90 | 7.10 ( 515 mA ) | 53.50 (4.0 A) |
| $\begin{aligned} & \text { XTL2500 } \\ & \text { (15 Watt) } \end{aligned}$ | 8.80 | 66.90 | 7.10 (515 mA) | 53.50 (4.0 A) |
| XTS2500 <br> (3 Watt) | 1.20 | 9.90 | 1.00 (72.5 mA) | 8.00 (580 mA) |
| HT750/GP320/P <br> RO5150/GP328 <br> (UHF 4 Watt/ <br> VHF 5 Watt) | 0.70 | 13.10 | 0.560 ( 40.6 mA ) | 10.50 (761 mA) |
| CM200/CM140/ EM200/GM318 <br> 8 (UHF 20 Watt/ VHF 25 Watt) | 3.70 | 75.10 | 3.00 (217 mA) | 60.00 (4.40 A) |
| $\begin{array}{\|l} \hline \text { GM328/338/339 } \\ \text { /340 } \\ \text { (UHF } 20 \text { Watt// } \\ \text { VHF } 25 \text { Watt) } \\ \hline \end{array}$ | 3.60 | 73.20 | 2.90 (210 mA) | 59.00 (4.3 A) |
| $\begin{aligned} & \text { CDM750 (UHF } \\ & 20 \text { Watt/VHF } \\ & 25 \text { Watt) } \\ & \hline \end{aligned}$ | 3.90 | 74.50 | 3.20 (232 mA) | 60.00 (4.40 A) |
| XPR4350/4380 <br> DM3400/ <br> XiR M8220/ <br> DGM4100 <br> UHF 20 Watt/ <br> VHF 25 Watt) | 10.50 | 51.5 | 8.4 (600 mA) | 41.5 (3 A) |

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# Fastrack Supreme User Guide <br> WA＿DEV＿Fastrk＿UGD＿001 <br> Plug and Play Wireless CPU® 

FASTRACK Supreme
User Guide

Reference：WA＿DEV＿Fastrk＿UGD＿001
Revision：001e
Date： 5 june， 2007


Supports Open $\mathrm{AT}^{\circledR}$ embedded ANSI C applications

##  <br> 

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## Document History

| Revision | Date | List of revisions |  |
| :---: | :---: | :--- | :--- |
| 001 | 9 February，07 | First Issue |  |
| 001 a | 23 February，2007 | Update DC cable GPIO mapping，add AutoShutDown |  |
| 001 b | 21 May，07 | Add detail of IES，RTC and serial port autoshutdown |  |
| 001 c | 1 Jun，07 | Change to Quad Band |  |
| 001 d | 4 Jun，07 | Update label／packaging photo |  |
| 001 e | 5 Jun，07 | Comment |  |

# Fastrack Supreme User Guide WA_DEV_Fastrk_UGD_001 

## Overview

The FASTRACK Supreme 10 and FASTRACK Supreme 20 are discrete, rugged cellular Plug \& Play Wireless CPU ${ }^{\circledR}$ offering state-of-the-art GSM/GPRS (and EGPRS for FASTRACK Supreme 20) connectivity for machine to machine applications.

Proven for reliable, stable performance on wireless networks worldwide, Wavecom's latest generation of FASTRACK Supreme continues to deliver rapid time to market and painless integration.
Having comparable size with the previous M1306B generation, and updated with new features, the FASTRACK Supreme offers an Internal Expansion Socket (IES) interface accessible for customer use. Expanding application features is easy without voiding the warrantee of the FASTRACK Supreme by simply plugging in of an Internal Expansion Socket Module (IESM) board.
Fully certified, the quad band $850 / 900 / 1800 / 1900 \mathrm{MHz}$ FASTRACK Supreme 10 offers GPRS Class 10 capability and FASTRACK Supreme 20 offers GPRS/EGPRS Class 10 capability. Both support a powerful open software platform (Open $A T^{\circledR}$ ). Open $A T^{\circledR}$ is the world's most comprehensive cellular development environment, which allows embedded standard ANSI C applications to be natively executed directly on the Wireless CPU ${ }^{\circledR}$.

FASTRACK Supreme is controlled by firmware through a set of AT commands.
This document describes the FASTRACK Supreme and gives information on the following topics:

- general presentation,
- functional description,
- basic services available,
- technical characteristics,
- installing and using the FASTRACK Supreme,
- user-level troubleshooting.
- recommended accessories to be used with the product.


## Note:

This document covers the FASTRACK Supreme Plug \& Play alone and does not include

- The programmable capabilities provided via the use of Open $A T^{\circledR}$ Software Suites.
- The development guide for IESM for expanding the application feature through the IES interface.

For detailed, please refer to the documents shown in the "Reference documents" section.

## 

## RoHS Directive

The FASTRACK Supreme is now compliant with RoHS Directive 2002／95／EC，which sets limits for the use of certain restricted hazardous substances．This directive states that＂from 1st July 2006，new electrical and electronic equipment put on the market does not contain lead，mercury，cadmium，hexavalent chromium， polybrominated biphenyls（PBB），and polybrominated diphenyl ethers（PBDE）＂．

Plug \＆Plays which are compliant with this directive are identified by the

RoHS logo on their label．

## Disposing of the product

This electronic product is subject to the EU Directive 2002／96／EC for Waste Electrical and Electronic Equipment（WEEE）．As such，this product must not be disposed off at a municipal waste collection point．Please refer to local regulations for directions on how to dispose off this product in an environmental friendly manner．


## Cautions

Information furnished herein by WAVECOM is accurate and reliable. However, no responsibility is assumed for its use. Please read carefully the safety recommendations given in Section 9 for an application based on FASTRACK Supreme Plug \& Play.

## Trademarks

®, WAVECOM ${ }^{\circledR}$, Wireless $\mathrm{CPU}^{\circledR}$, Open $\mathrm{AT}^{\circledR}$ and certain other trademarks and logos appearing on this document, are filed or registered trademarks of Wavecom S.A. in France or in other countries. All other company and/or product names mentioned may be filed or registered trademarks of their respective owners.

## Copyright

This manual is copyrighted by WAVECOM with all rights reserved. No part of this manual may be reproduced in any form without the prior written permission of WAVECOM. No patent liability is assumed with respect to the use of their respective owners.

## Web Site Support

| General information about Wavecom and its range of <br> products: | www.wavecom.com |
| :--- | :--- |
| Specific support is available for the FASTRACK Supreme <br> Plug \& Play Wireless CPU |  |
| Open AT $^{\circledR}$ Introduction: | TBD |
| Developer community for software and hardware: | www.wavecom.com/OpenAT |


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# Fastrack Supreme User Guide 

## References

## 1 References

### 1.1 Reference Documents

For more details, several reference documents may be consulted. The Wavecom reference documents are provided in the Wavecom documents package contrary to the general reference documents, which are not Wavecom owned.

### 1.1.1 Open $A T^{\circledR}$ Software Documentation

[1] Getting started with Open $\mathrm{AT}^{\circledR}$ (Ref.WM_ASW_OAT_CTI_001)
[2] Open $\mathrm{AT}^{\circledR}$ Tutorial (Ref.WM_ASW_OAT_UGD_001)
[3] Tools Manual (Ref. WM_ASW_OAT_UGD_003)
[4] Open $A T^{\circledR}$ Programming Guide (Ref. TBD)
[5] Open $\mathrm{AT}^{\circledR}$ Customer Release Note (Ref. WM_ASW_OAT_DVD_00062)
Remark: The document above is for Open AT3.12 and FASTRACK Supreme will use new release of Open AT4.21. Reference document not yet available and TBC.

### 1.1.2 ATSoftware Documentation

[6] AT commands interface Guide for X51 (Ref. WM_ASW_OAT_UGD_00016)
[7] Customer Release Note X51 (Ref. WM_ASW_OAT_DVD_00120)
Remark: The document above is for X51 and FASTRACK Supreme will use new release of FW6.63. Reference document not yet available and TBC.

### 1.1.3 Firmware Upgrade Documents

[8] Firmware upgrade procedure (Ref. WM_SW_GEN_UGD_001)

### 1.1.4 Delta between M 1306B Documents

[9] Delta between M1306B and FASTRACK Supreme (Ref. WA_DEV_Fastrk_UGD_004)

### 1.1.5 IESM Related Documents

[10] IESM Product Technical Specification (Ref. WA_DEV_Fastrk_PTS_001)
[11] IESM-GPS+USB User Guide (Ref. WA_DEV_Fastrk_UGD_002)
[12] IESM-GPS+USB Installation Guide (Ref. WA_DEV_Fastrk_UGD_003)
[13] IESM-IO+USB Installation Guide (Ref. WA_DEV_Fastrk_UGD_005)
[14] IESM-IO+USB User Guide (Ref. WA_DEV_Fastrk_UGD_006)

## 

# Fastrack Supreme User Guide 

## References

## Note：

New versions of software may be available．Wavecom recommends customers to check the web site for the latest documentation．

## 1．2 Abbreviations

| Abbreviation | Definition |
| :---: | :---: |
| AC | Alternating Current |
| ACM | Accumulated Call Meter |
| AMR | Adaptive Multi－Rate |
| AT | ATtention（prefix for Wireless CPU ${ }^{\circledR}$ commands） |
| CLK | CLocK |
| CMOS | Complementary Metal Oxide Semiconductor |
| CS | Coding Scheme |
| CTS | Clear To Send |
| dB | Decibel |
| dBc | Decibel relative to the Carrier power |
| dBi | Decibel relative to an Isotropic radiator |
| dBm | Decibel relative to one milliwatt |
| DC | Direct Current |
| DCD | Data Carrier Detect |
| DCE | Data Communication Equipment |
| DCS | Digital Cellular System |
| DSR | Data Set Ready |
| DTE | Data Terminal Equipment |
| DTMF | Dual Tone Multi－Frequency |
| DTR | Data Terminal Ready |
| EEPROM | Electrically Erasable Programmable Read－Only Memory |
| EFR | Enhanced Full Rate |
| E－GSM | Extended GSM |
| EMC | ElectroMagnetic Compatibility |
| EMI | ElectroMagnetic Interference |
| ESD | ElectroStatic Discharges |
| ETSI | European Telecommunications Standards Institute |
| FIT | Series of connectors（micro－FIT） |
| FR | Full Rate |


| Abbreviation | Definition |
| :---: | :---: |
| FTA | Full Type Approval |
| GCF | Global Certification Forum |
| GND | GrouND |
| GPIO | General Purpose Input Output |
| GPRS | General Packet Radio Service |
| GSM | Global System for Mobile communications |
| HR | Half Rate |
| I | Input |
| IEC | International Electrotechnical Commission |
| IES | Internal Expansion Socket |
| IESM | Internal Expansion Socket Module |
| IMEI | International Mobile Equipment Identification |
| I／O | Input／Output |
| LED | Light Emitting Diode |
| MAX | MAXimum |
| ME | Mobile Equipment |
| MIC | MICrophone |
| Micro－Fit | Family of connectors from Molex |
| MIN | MINimum |
| MNP | Microcom Networking Protocol |
| MO | Mobile Originated |
| MS | Mobile Station |
| MT | Mobile Terminated |
| NOM | NOMinal |
| 0 | Output |
| Pa | Pascal（for speaker sound pressure measurements） |
| PBCCH | Packet Broadcast Control CHannel |
| PC | Personal Computer |
| PCL | Power Control Level |
| PDP | Packet Data Protocol |
| PIN | Personal Identity Number |
| PLMN | Public Land Mobile Network |
| PUK | Personal Unblocking Key |
| RF | Radio Frequency |

[^40]

| Abbreviation | Definition |
| :--- | :--- |
| RFI | Radio Frequency Interference |
| RI | Ring Indicator |
| RMS | Root Mean Square |
| RTS | Request To Send |
| RX | Receive |
| SIM | Subscriber Identification Module |
| SMA | SubMiniature version A RF connector |
| SMS | Short Message Service |
| SNR | Signal-to-Noise Ratio |
| SPL | Sound Pressure Level |
| SPK | SpeaKer |
| SRAM | Static RAM |
| TCP/IP | Transmission Control Protocol / Internet Protocol |
| TDMA | Time Division Multiple Access |
| TU | Typical Urban fading profile |
| TUHigh | Typical Urban, High speed fading profile |
| TX | Transmit |
| TYP | TYPical |
| VSWR | Voltage Stationary Wave Ratio |

[^41]

## 2 Packaging

## 2．1 Contents

The complete package content of the FASTRACK Supreme consists of（see）：
－one packaging box（A），
－one FASTRACK Supreme（B），
－two holding bridles（C），
－one power supply cable with fuse integrated（D）
－a mini notice（E）with：
－a summary of the main technical features
－safety recommendations，
－EC declaration of conformity．


Figure 1：Complete package contents

[^42]
### 2.2 Packaging Box

The packaging box is a carton box (see) with the following external dimensions:

- width: 54.5 mm ,
- height: 68 mm ,
- length: 108 mm .

A packaging label is slicked on the packaging box cover and supports the:

- WAVECOM logo,
- Product reference (Supreme),
- CE marking
- 15-digit IMEI code
- Open $\mathrm{AT}^{\circledR}$ Logo
- RoHS logo
- WEEE logo


Figure 2: Packaging box
The packaging label dimensions are:

- height: 40 mm ,
- length: 65 mm .


### 2.3 Production Labelling

A production label (see Figure 3) located at the FASTRACK Supreme back side gives the following information:

- product reference (FASTRACK Supreme 10 or FASTRACK Supreme 20),
- part number (WM19183),
- CE marking,
- 15-digit IMEI code,
- OpenAT ${ }^{\circledR}$ logo

Figure 3: Production Label

## 3 General Presentation

## 3．1 Description

The FASTRACK Supreme description is given in the Figure 4 below．


Figure 4：FASTRACK Supreme general description


# Fastrack Supreme User Guide <br> General Presentation 

CAUTION: Users are free to remove the back plate for IESM board plug in/unplug without voiding the warrantee of the FASTRACK Supreme. However, the warrantee will be voided if unscrewing any screw of the back cap.

In addition, two holding bridles are provided to tighten the FASTRACK Supreme on a support.


Figure 5: FASTRACK Supreme holding bridles

| Veveconn |  |
| :---: | :---: |
|  |  |
|  |  |

## 3．2 External Connections

## 3．2．1 Connectors

## 3．2．1．1 Antenna Connector

The antenna connector is a SMA type connector for a $50 \Omega$ RF connection．


Figure 6：SMA connector for antenna connection

## 3．2．1．2 Power Supply Connector

The power supply connector is a 4－pin Micro FIT connector for：
－external DC Power Supply connection，
－GPIOs connection（two General Purpose Input／Output signals available）．

# Fastrack Supreme User Guide <br> General Presentation 



Figure 7：Power supply connector

Table 1：Power supply connector pin description

| Pin \＃ | Signal | I／O | I／O type | Description | Reset State | Comment |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1 | V＋BATTERY | I | Power <br> supply | Battery voltage input： <br> $=$ <br> 5.5 V Min． <br> 13.2 V Typ． <br> - <br> $32 \mathrm{~V} \mathrm{Max}$. |  | High current |
| 2 | GND |  | Power <br> supply | Ground |  |  |
| 3 | GPIO21 | I／O | $2 \mathrm{V8}$ | General Purpose Input／output | Undefined | Not mux |
| 4 | GPIO25 | I／O | 2 V 8 | General Purpose Input／output | Z | Multiplex with INT1 |

## Warning：

Both pin 3 and pin 4 are used by GPIO interface．It is strictly prohibited to connect them to any power supply at the risk of damage to the FASTRACK Supreme．

## 3．2．1．3 Sub HD 15－pin Connector

The Sub D high density 15－pin connector is used for：
－RS232 serial link connection，
－Audio lines（microphone and speaker）connection，
－BOOT and RESET signal connection．


Figure 8：Sub HD 15－pin connector

Table 2：Sub HD 15－pin connector description

| Pin \＃ | Signal <br> （CCITT／EIA） | I／O | I／O type | Description | Comment |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 1 | CDCD／CT109 | O | STANDARD <br> RS232 | RS232 <br> Data Carrier Detect |  |
| 2 | CTXD／CT103 | I | STANDARD <br> RS232 | RS232 <br> Transmit serial data |  |
| 3 | BOOT | I | CMOS | Boot | This signal must not <br> be connected．Its use <br> is strictly reserved to <br> Wavecom or <br> competent retailers． |
| 4 | CMIC2P | । | Analog | Microphone <br> positive line |  |
| 5 | CMIC2N | I | Analog | Microphone <br> negative line |  |
| 7 | CRXD／CT104 | O | STANDARD <br> RS232 | RS232 <br> Receive serial data |  |
| 8 | CDSR／CT107 | O | STANDARD <br> RS232 | RS232 <br> Data Set Ready |  |
| 9 | GTR／CT108－2 | I | STANDARD <br> RS232 | RS232 <br> Data Terminal Ready |  |

## 




Fastrack Supreme User Guide
General Presentation

| Pin \＃ | Signal <br> （CCITT／EIA） | I／O | I／O type | Description | Comment |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 10 | CSPK2P | O | Analog | Speaker <br> positive line |  |
| 11 | CCTS／CT106 | O | STANDARD <br> RS232 | RS232 <br> Clear To Send |  |
| 12 | CRTS／CT105 | I | STANDARD <br> RS232 | RS232 <br> Request To Send |  |
| 13 | CRI／CT125 | O | STANDARD <br> RS232 | RS232 <br> Ring Indicator |  |
| 14 | RESET | I／O | Schmitt | Supreme Plug \＆Play reset | Active low |
| 15 | CSPK2N | O | Analog | Speaker <br> negative line |  |

## 3．2．1．4 IES Connector

The IES connector is a 50 pins board－to－board connector for expanding application features like GPS，USB， I／O expander．．．Currently there are already 3 IESM boards available for customer to expand the FASTRACK Supreme features immediately．They are：
－IESM－GPS＋USB＋I／O
－IESM－GPS＋USB
－IESM－USB＋I／O
For detail，please refer to Document in Section 1．1．5．

For sales and support, please contact Wavecom sales/FAE or your distributor.


Figure 9: IES connector for feature expansion

Fastrack Supreme User Guide
General Presentation
Table 3：IES Connector Description

| Pin <br> Number | Signal Name | I／O <br> type | Voltage | I／O＊ | Reset <br> State | Description | Dealing with <br> unused pins |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\mathbf{n}$ | Nominal | Mux |  |  |  | Ground | Ground | N |

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Fastrack Supreme User Guide
General Presentation

| Pin Number | Signal Name |  | $\begin{aligned} & \text { I/O } \\ & \text { type } \end{aligned}$ | Voltage | I/O* | Reset State | Description | Dealing with unused pins |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Nominal | Mux |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  | firmware update |
| 27 | GPIO8 | COL4 | C8 | GSM-1V8 | I/0 | Pull-up | Keypad column 4 | NC |
| 28 | GPIO26 | SCL | A1 | Open Drain | $\bigcirc$ | z | $1^{2} \mathrm{C}$ Clock | NC |
| 29 | GPIO19 |  | C1 | GSM-2V8 | I/0 | z |  | NC |
| 30 | GPIO27 | SDA | A1 | Open Drain | I/O | z | $1^{2} \mathrm{C}$ Data | NC |
| 31 | GPIO20 |  | C1 | GSM-2V8 | I/O | Undefined |  | NC |
| 32 | INTO | GPIO3 | C1 | GSM-1V8 | 1 | z | Interruption 0 Input | If INT0 is not used, it should be configured as GPIO |
| 33 | GPIO23 | ** | C1 | GSM-2V8 | I/0 | z |  | NC |
| 34 | GPIO22 | ** | C1 | GSM-2V8 | I/0 | z |  | NC |
| 35 | $\begin{gathered} \hline \sim \text { CT108-2- } \\ \text { DTR1 } \end{gathered}$ | GPIO41 | C1 | GSM-2V8 | 1 | z | Main RS232 Data Terminal Ready | (DTR1) Pull-up to VCC_2V8 with 100k $\Omega$ |
| 36 | PCM-SYNC |  |  | GSM-1V8 | $\bigcirc$ | Pull-down | PCM Frame Synchro | NC |
| 37 | PCM-IN |  | C5 | GSM-1V8 | 1 | Pull-up | PCM Data Input | NC |
| 38 | PCM-CLK |  |  | GSM-1V8 | $\bigcirc$ | Pull-down | PCM Clock | NC |
| 39 | PCM-OUT |  |  | GSM-1V8 | $\bigcirc$ | Pull-up | PCM Data Output | NC |
| 40 | AUX-DAC |  |  | Analog | $\bigcirc$ |  | Digital to Analog Output | NC |
| 41 | VCC-2V8 |  |  | VCC_2V8 | $\bigcirc$ |  | LDO 2.8 V Supply Output | NC |
| 42 | GND |  |  |  |  |  | Ground |  |
| 43 | DC-IN |  |  | DC-IN from 5.5V~32VDC | $\bigcirc$ |  | DC voltage input through Micro-Fit connector | NC |
| 44 | DC-IN |  |  | DC-IN from $5.5 \mathrm{~V} \sim 32 \mathrm{VDC}$ | $\bigcirc$ |  | $\begin{aligned} & \hline \text { DC voltage input through } \\ & \text { Micro-Fit connector } \end{aligned}$ | NC |
| 45 | GND |  |  |  |  |  | Ground |  |
| 46 | 4 V |  |  | 4 V | $\bigcirc$ |  | 4V DC/DC converter Output | NC |
| 47 | 4 V |  |  | 4 V | $\bigcirc$ |  | 4V DC/DC converter Output | NC |
| 48 | GND |  |  |  |  |  | Ground |  |
| 49 | GND |  |  |  |  |  | Ground |  |
| 50 | GND |  |  |  |  |  | Ground |  |

## 

### 3.2.2 Power supply cable



Figure 10: Power supply cable

Fastrack Supreme User Guide
General Presentation

| Component | Characteristics |
| :--- | :--- |
| Micro－Fit connector <br> 4－pin | Part number：MOLEX 43025－0400 |
| Cable | Cable length：$\sim 1.5 \mathrm{~m}$ |
| Wire | Core：tinned copper $24 \times 0.2 \mathrm{~mm}$ |
|  | Section： $0.75 \mathrm{~mm}^{2}$ |

# Fastrack Supreme User Guide 

Features and Services

## 4 Features and Services

## 4．1 Basic Features and Services

Basic features of the FASTRACK Supreme and available services are summarized in the table below．
Table 4：Basic features of the FASTRACK Supreme

| Features | GSM850／GSM900 | DCS1800／PCS1900 |
| :--- | :--- | :--- |
| Open AT ${ }^{\circledR}$ | Open AT ${ }^{\circledR}$ programmable： <br> Native execution of embedded standard ANSI C applications， <br> Custom AT command creation， <br> Custom application library creation， <br> Standalone operation． |  |
| Standard | $850 \mathrm{MHz} / 900 \mathrm{MHz}$. <br> E－GSM compliant． <br> Output power：class 4（2W）． <br> Fully compliant with ETSI GSM phase 2＋ <br> small MS． | Output power：class 1（1W）． <br> Fully compliant with ETSI GSM phase 2＋ <br> small MS． |
| GPRS | Class 10． <br> PBCCH support． <br> Coding schemes：CS1 to CS4． <br> Compliant with SMG31bis． <br> Embedded TCP／IP stack． |  |
| EGPRS <br> （for <br> FASTRACK <br> Supreme <br> only） | Output power：0．5W |  | | Class 10． |
| :--- |
| PBCCH support． |
| Coding schemes：MCS1 to MCS9． |
| Compliant with SMG31bis． |
| Embedded TCP／IP stack． |

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Features and Services

| Features | GSM850 / GSM900 DCS1800 / PCS1900 |
| :---: | :---: |
| Interfaces | RS232 (V.24/V.28) Serial interface supporting: <br> - Baud rate (bits/s): $300,600,1200,2400,4800,9600,19200,38400,57600$, 115200, 230400, 460800 and 921600. <br> - Autobauding (bits/s): from 1200 to 921600. <br> 2 General Purpose Input/Output gates (GPIOs) available. <br> $1.8 \mathrm{~V} / 3 \mathrm{~V}$ SIM interface. <br> AT command set based on V.25ter and GSM 07.05 \& 07.07. <br> Open $\mathrm{AT}^{\circledR}$ interface for embedded application. <br> Open $A T^{\circledR}$ Plug-In Compatible. |
| SMS | Text \& PDU. <br> Point to point (MT/MO). <br> Cell broadcast. |
| Data | Data circuit asynchronous. <br> Transparent and Non Transparent modes. <br> Up to 14.400 bits/s. <br> MNP Class 2 error correction. <br> V42.bis data compression. |
| Fax | Automatic fax group 3 (class 1 and Class 2). |
| Audio | Echo cancellation <br> Noise reduction <br> Telephony. <br> Emergency calls. <br> Full Rate, Enhanced Full Rate, Half Rate operation and Adaptive Multi-Rate (FR/EFR/HR/AMR). <br> Dual Tone Multi Frequency function (DTMF). |

Features and Services

| Features | GSM850/GSM900 | DCS1800 / PCS1900 |
| :--- | :--- | :--- |
| GSM <br> supplement <br> services | Call forwarding. <br> Call barring. <br> Multiparty. <br> Call waiting and call hold. <br> Calling line identity. <br> Advice of charge. <br> USSD |  |
| Other | DC power supply <br> Real Time Clock with calendar <br> Complete shielding |  |

For other detailed technical characteristics, refer to Section 8.

# Fastrack Supreme User Guide <br> Features and Services 

### 4.2 Additional NEW Features

### 4.2.1 Support Additional GSM850/ PCS1900 Bands

Apart from GSM900/DCS1800, the FASTRACK Supreme Plug \& Play now supports also the GSM850/PCS1900 bands. FASTRACK Supreme is fully compliant to PTCRB and FCC also.

### 4.2.2 IES Interface for Easy Expansion of Application Features

The FASTRACK Supreme Plug \& Play offers a 50 pin Internal Expansion Socket (IES) Interface accessible for customer use. It is the additional interface which is easy for customers to expand their application features without voiding the warrantee of the FASTRACK Supreme, by simply plugging in an Internal Expansion Socket Module (IESM) board through the matting connector of the IES interface.

Thanks to the flexible IES interface, customers are ready to expand the application features by plugging in the corresponding Internal Expansion Socket Module (IESM) of GPS, I/O expander..., etc.

For brief description of the interface, please refer to Section 3.2.1.4.
For technical detail, please refer to Document [11] or contact your Wavecom distributor or Wavecom FAE.

### 4.2.3 Serial Port Auto Shut Down or Improving Power Consumption

In order to save power consumption when there is no data communication between the Plug \& Play and the DTE, FASTRACK Supreme has now implement the Serial Port Auto Shut Down feature. User can activate or deactivate the Serial Port Auto Shut Down mode by simple AT-command.

For detail, please refer to Section 7.3.4.

### 4.2.4 Real Time Clock (RTC) for Saving Date and Time

The FASTRACK Supreme has now implemented the Real Time Clock for saving date and time when the Plug \& Play is unplugged from the DC power supply through the DC power cable.
For detail, please refer to Section 7.8.

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## 4．2．5 SIM Card Lock Feature

The FASTRACK Supreme has now implemented a SIM connector having a carrier with lock．This helps ensuring the user to have proper SIM card insertion and locked before proper use of GSM network．


SIM card is inserted but not locked．GSM network is not ready for use．Only emergency call 112 is possible．


SIM card is inserted and being locked properly． GSM network is ready for use．

Figure 11：SIM card lock feature

# Fastrack Supreme User Guide Using the FASTRACK Supreme Plug \& Play 

## 5 Using the FASTRACK Supreme Plug \& Play

### 5.1 Getting Started

### 5.1.1 Mount the FASTRACK Supreme

To mount the FASTRACK Supreme on its support, bind it using the holding bridles as shown in the Figure 12 below.


Figure 12: FASTRACK Supreme mounting

For the drill template, refer to Figure 18.

### 5.1.2 Set up the FASTRACK Supreme

To set up the FASTRACK Supreme, perform the following operations:

- Insert the SIM card into the SIM card holder of the FASTRACK Supreme.
- Lock the SIM card by sliding the lever towards the SIM card.
- Connect the antenna to the SMA connector.
- Connect both sides of the serial and control cable (15-pin Sub HD connector on the FASTRACK Supreme side).
- Connect the power supply cable to the external power supply source.


## Note:

For automotive application, it is recommended to connect the V+BATTERY line of the FASTRACK Supreme directly to the battery positive terminal.

- Plug the power supply cable into the FASTRACK Supreme and switch on the external power supply source.
- The FASTRACK Supreme is ready to work. Refer to Section 5.10 for the description of AT commands used to configure the FASTRACK Supreme.

```
wovecom}\mp@subsup{}{}{*}*\mathrm{ #*****
```


# Fastrack Supreme User Guide Using the FASTRACK Supreme Plug \& Play 

### 5.1.3 Check the communication with the FASTRACK Supreme

To check the communication with the FASTRACK Supreme, do the following operations:

- Connect the RS232 link between the DTE (port COM) and the FASTRACK Supreme (DCE).
- Configure the RS232 port of the DTE as follows:
- Bits per second: $\mathbf{1 1 5 . 2 0 0}$ bps,
- Data bits: 8,
- Parity: None,
- Stop bits: 1,
- Flow control: hardware.
- Using a communication software such as a HyperTerminal, enter the AT」 command. The response of the FASTRACK Supreme must be OK displayed in the HyperTerminal window.
- If the communication cannot be established with the FASTRACK Supreme, do the following:
- Check the RS232 connection between the DTE and the FASTRACK Supreme (DCE),
- Check the configuration of the port COM used on the DTE.
- Example of AT commands which can be used after getting started the FASTRACK Supreme:
- AT+CGMI: FASTRACK Supreme answer is "WAVECOM MODEM" when serial link is OK .
- AT+CPIN=xXXX : to enter a PIN code xxxx (if activated).
- AT+CSQ: to verify the received signal strength.
- AT+CREG?: to verify the registration of the FASTRACK Supreme Plug \& Play on the network.
- ATD<phone number>;: to initiate a voice call.
- ATH: to hang up (end of call).

For further information on these AT commands and their associated parameters, refer to "AT Commands Interface Guide" [6].

### 5.1.4 Reset the FASTRACK Supreme

To reset the FASTRACK Supreme, a hardware reset signal is available on pin 14 of the Sub HD 15-pin connector (RESET).

The FASTRACK Supreme reset is carried out when this pin is low for at least $200 \mu \mathrm{~s}$.
Warning This signal has to be considered as an emergency reset only. For further details on the FASTRACK Supreme reset, refer to Section 7.7.

[^44]

## Fastrack Supreme User Guide

 Using the FASTRACK Supreme Plug \& Play
### 5.2 Specific Recommendations when Using the FASTRACK Supreme on Trucks

Warning: The power supply connection of the FASTRACK Supreme must NEVER be directly connected to the truck battery.

### 5.2.1 Recommended Power Supply Connection on Trucks

All trucks have a circuit breaker on the exterior of the cabin. The circuit breaker is used for safety reasons: if a fire blazes in the trucks, (for example, on the wiring trunk) the driver may cut the current source to avoid any damage (explosion). The circuit breaker is connected to the truck ground, most often associated with the fuse box.

Most of truck circuit breakers do not cut the Positive Supply line of the battery, but cut the ground line of the later.


Figure 13: Recommended power supply connection on trucks
Figure 13 gives the recommended power supply connection where the ground connection of the FASTRACK Supreme is not directly connected to the battery but is connected after the Circuit Breaker (on the truck ground or the fuse box).

### 5.2.2 Technical Constraints on Trucks

It is highly not recommended to connect directly the power supply on the battery rather than on the circuit breaker. The FASTRACK Supreme may be damaged when starting the truck if the circuit breaker is switched OFF (in this case, the truck ground and the battery ground will be connected through the FASTRACK Supreme as shown in the figure below).


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# Fastrack Supreme User Guide Using the FASTRACK Supreme Plug \＆Play 



Figure 14：Example of electrical connection which may dramatically damage the FASTRACK Supreme

Figure 14 gives an example of electrical connection which may dramatically damage the FASTRACK Supreme when its ground connection is directly connected to the battery ground．
In this example，when the circuit breaker is switched OFF，the current flows through the FASTRACK Supreme and powers the electrical circuit of the truck（for example，dashboard）．

Furthermore，when the Starter Engine command will be used，it will destroy the cables or the FASTRACK Supreme．

Since the internal tracks are not designed to support high current（up to 60 A when starting the truck），they will be destroyed．

## 5．3 FASTRACK Supreme Operational Status

The FASTRACK Supreme operational status is given by the red LED status located next to the SIM connector on the FASTRACK Supreme panel．
The Table 5 below gives the meaning of the various statuses available．

## 





Fastrack Supreme User Guide
Using the FASTRACK Supreme Plug \& Play
Table 5: FASTRACK Supreme operational status

| LED Status | LED light activity | FASTRACK Supreme Plug \& Play status |
| :--- | :--- | :--- |
| ON | LED ON permanent | FASTRACK Supreme is switched ON but <br> not registered on the network |
|  | LED Flashing slowly | FASTRACK Supreme is switched ON and registered <br> on the network, but no communication is in progress <br> (Idle mode) |
|  | LED Flashing rapidly | FASTRACK Supreme is switched ON and <br> registered on the network, and a communication is <br> in progress |
|  | LED OFF | FASTRACK Supreme is switched OFF, or Flash <br> LED is disabled* by the user. |

*: Flash LED can be disabled by user when in Slow Standby mode in order to save power consumption. For detail, please refer to Section 7.9.

### 5.4 Echo Function Disabled

If no echo is displayed when entering an AT command, that means:

- The "local echo" parameter of your communication software (such as HyperTerminal) is disabled.
- The FASTRACK Supreme echo function is disabled.

To enable the FASTRACK Supreme echo function, enter the ATE1.
When sending AT commands to the FASTRACK Supreme by using a communication software, it is recommended:

- to disable the "local echo" parameter of your communication software (such as HyperTerminal),
- to enable the FASTRACK Supreme echo function (ATE1 command).

In a Machine To Machine communication with the FASTRACK Supreme, it is recommended to disable the FASTRACK Supreme echo function (ATE0 command) in order to avoid useless CPU processing.

For further information on ATE0 and ATE1 commands, refer to "AT Commands Interface Guide" [6].

## 

# Fastrack Supreme User Guide Using the FASTRACK Supreme Plug \& Play 

### 5.5 Verify the Received Signal Strength

The FASTRACK Supreme establishes a call only if the received signal is sufficiently strong.
To verify the received signal strength, do the following operations:

- Using a communication software such as HyperTerminal, enter the AT command AT+CSQ.

The response returned has the following format:
+CSQ: <rssi>, <ber> with:

- <rssi> = received signal strength indication,
- <ber> = channel bit error rate.
- Verify the <rssi> value returned using the Table 6 below.

Table 6: Values of received signal strength

| Value of received signal <br> strength indication (<rssi>) | Interpretation of the <br> received signal strength |
| :---: | :---: |
| $0-10$ | Insufficient(*) |
| $11-31$ | Sufficient(*) |
| $32-98$ | Not defined |
| 99 | No measure available |

(*) Based on general observations.
For further information on AT commands, refer to "AT Commands Interface Guide" [6].

### 5.6 Check the Pin Code Status

To check that the pin code has been entered, use a communication software such as a HyperTerminal, then enter AT+CPIN? command.

The table below gives the main responses returned:
Table 7: AT+CPIN Responses

| AT+CPIN response (*) | Interpretation |
| :---: | :--- |
| +CPIN: READY | Code PIN has been entered |
| +CPIN: SIM PIN | Code PIN has not been entered |

(*)For further information on the other possible responses and their meaning, refer to "AT Commands Interface Guide" [6].

### 5.7 Switch between EU/ US Band(s)

To switch between EU/US band(s) for the FASTRACK Supreme, use a communication software such as a HyperTerminal, then enter AT+WMBS=<band> [, <param>] command.

The table below gives the commands for various band(s) selection:

## 



# Fastrack Supreme User Guide <br> Using the FASTRACK Supreme Plug \& Play 

Table 8: AT+WMBS Band Selection

| AT+WMBS response (*) | Interpretation |
| :---: | :--- |
| AT+WMBS $=0, x$ | Select mono band mode 850 MHz. |
| AT+WMBS $=1, x$ | Select mono band mode extended 900 MHz |
| AT+WMBS $=2, x$ | Select mono band mode 1800 MHz |
| AT+WMBS $=3, x$ | Select mono band mode 1900 MHz |
| AT+WMBS $=4, x$ | Select dual band mode $850 / 1900 \mathrm{MHz}$ |
| AT+WMBS $=5, x$ | Select dual band mode extended $900 \mathrm{MHz} / 1800 \mathrm{MHz}$ |
| AT+WMBS $=6, x$ | Select dual band mode extended $900 \mathrm{MHz} / 1900 \mathrm{MHz}$ |

(*) For further information on the other possible responses and their meaning, refer to "AT Commands $_{\text {" }}$ Interface Guide" [6].
Remark:
$\mathbf{x}=\mathbf{0}$ : The Plug \& Play will have to be reset to start on specified band(s).
$\mathbf{x = 1}$ : The change is effective immediately. This mode is forbidden while in communication and during Plug \& Play initialization.
Refer to "AT Commands Interface Guide" [6] for further information on AT commands.

### 5.8 Check the Band(s) Selection

To check the band selection for the FASTRACK Supreme, use a communication software such as a HyperTerminal, then enter AT+WMBS? command.
The table below gives the main responses returned:
Table 9: AT+WMBS Responses


## 

# Fastrack Supreme User Guide Using the FASTRACK Supreme Plug \& Play 

### 5.9 Verify the FASTRACK Supreme Network Registration

1. Make sure a valid SIM card has been previously inserted and locked in the FASTRACK Supreme SIM card holder.
2. Using a communication software such as a HyperTerminal, enter the following AT commands:
a. $\mathbf{A T + C P I N}=\mathbf{X X X X}$ to enter PIN code xxxx .
b. AT+WMBS? To check the current band setting in the Plug \& Play
c. AT+WMBS=<Band>[, <par am>] To switch band/mode when needed
d. AT+CREG? . To ascertain the registration status.

The format of the returned response is as follows:
+CREG: <mode>,<stat> with:

- <mode> = unsolicited registration message configuration,
- <stat> = registration state.

3. Verify the state of registration according the returned value given in the table below.

Table 10: Values of network registration

| Returned Value (*) <br> <mode>,<stat> | Network registration |
| :---: | :--- |
| +CREG: 0,0 | No (not registered) |
| +CREG: 0,1 | Yes (registered, home network) |
| +CREG: 0,5 | Yes (registered, roaming) |

${ }^{*}$ )For further information on the other returned values and their meaning, refer to "AT Commands Interface Guide" [6].

If the FASTRACK Supreme is not registered, perform the following procedure:

- Check the connection between the FASTRACK Supreme and the antenna.
- Verify the signal strength to determine the received signal strength (refer to Section 5.5).

Note: For information on AT command relating to the network registration in GPRS mode, and in particular:
CGREG, CGCLASS, CGATT, refer to "AT Commands Interface Guide" [6].

### 5.10 M ain ATCommands for the Plug \& Play

The table below lists the main AT commands required for starting the Plug \& Play.
For other AT commands available or further information on the AT commands, refer to "AT Commands Interface Guide" [6].

Table 11: Main usual AT commands for the Plug \& Play

| Description | AT commands | FASTRACK Supreme Plug \& Play response | Comment |
| :---: | :---: | :---: | :---: |
| Check for selected band(s) | AT+WMBS? | +WMBS:<Band>,<ResetFlag> OK | Current selected band mode is return |
| Band(s) switch | AT+WMBS $=$ <Band $>$ | OK | Band switch is accepted, Plug \& Play has to be reset for change to be effective |
|  | AT+WMBS $=<$ Band $>$, 0 | OK | Band switch is accepted, Plug \& Play has to be reset for change to be effective |
|  | AT+WMBS=<Band>, 1 | OK | Band switch is accepted and GSMS stack restarted |
|  | AT+WMBS=<Band> | +CME ERROR: 3 | Band not allowed |
| Enter PIN Code | $\begin{aligned} & \text { AT+CPIN=xxxx } \\ & (x x x x=\text { PIN code }) \end{aligned}$ | OK | PIN Code accepted. |
|  |  | +CME ERROR: 16 | Incorrect PIN Code (with +CMEE = 1 mode) (1*) |
|  |  | +CME ERROR: 3 | PIN code already entered (with +CMEE = 1 mode) ( $1^{*}$ ) |
| Network registration checking | AT+CREG? | +CREG: 0,1 | FASTRACK Supreme Plug \& Play registered on the network. |
|  |  | +CREG: 0,2 | FASTRACK Supreme Plug \& Play not registered on the network, registration attempt. |

## 

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Using the FASTRACK Supreme Plug \＆Play

| Description | AT commands | FASTRACK Supreme Plug <br> \＆Play response | Comment |
| :--- | :--- | :--- | :--- |
|  |  | ＋CREG：0，0 | FASTRACK Supreme Plug <br> \＆Play not registered <br> on the network，no <br> registration attempt． |
| Receiving an <br> incoming call | ATA | OK | Answer the call． |
| Initiate a call | ATD＜phone number＞； <br> （Don＇t forget the «；» at the <br> end for « voice » call） | OK | ＋CME ERROR：11 |

（1＊）The command＂AT＋CMEE＝1＂switch to a mode enabling more complete error diagnostics．

## 5．11 Firmware Upgrade Procedure

The firmware upgrade procedure is used to update the firmware embedded into the FASTRACK Supreme．
That procedure consists in downloading the firmware into internal memories through the RS232 serial link available on the SUB－D 15－pin connector．
Refer to＂Firmware upgrade procedure＂［8］for a detailed description of this procedure．

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# Fastrack Supreme User Guide 

Troubleshooting

## 6 Troubleshooting

This section of the document describes possible problems encountered when using the FASTRACK Supreme and their solutions.
To review other troubleshooting information, refer the 'FAQs' (Frequently Asked Questions) page at www.wavecom.com or use the following link:
http://www.wavecom.com/support/faqs.php

### 6.1 No Communication with the FASTRACK Supreme through the Serial Link

If the FASTRACK Supreme does not answer to AT commands through the serial link, refer to the table below for possible causes and solutions.

Table 12: Solutions for no connection with FASTRACK Supreme through serial link

| If the Supreme returns | then ask | Action |
| :---: | :---: | :---: |
| Nothing | Is the FASTRACK Supreme powered correctly? | Make sure the external power supply is connected to the FASTRACK Supreme and provides a voltage in the range of 5.5 V to 32 V. |
|  | Is the serial cable connected at both sides? | Check the serial cable connection |
|  | Does the serial cable follow correctly pin assignment shown in paragraph 3.2.1.2. | Connect the cable by following pin assignment given in paragraph 3.2.1.1. |
| Nothing or nonsignificant characters | Is the communication program properly configured on PC? | Ensure the setting of the communication program is fit to setting of FASTRACK Supreme. <br> FASTRACK Supreme factory setting is: <br> Data bits $=8$ <br> Parity = none <br> Stop bits $=1$ <br> Baud $=115200$ bps. <br> Flow control = hardware |
|  | Is there another program interfering with the communication program (i.e. Conflict on communication port access) | Close the interfering program. |

### 6.2 Receiving "ERROR" Message

The FASTRACK Supreme returns an "ERROR" message (in reply to an AT command) in the following cases:

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# Fastrack Supreme User Guide 

## Troubleshooting

- AT command syntax is incorrect: check the command syntax (refer to "AT Commands Interface Guide" [6]),
- AT command syntax is correct, but transmitted with wrong parameters:
- Enter the AT+CMEE=1 command in order to change the error report method to the verbose method, which includes the error codes.
- Enter again the AT command which previously caused the reception of "ERROR" message in order to get the Mobile Equipment error code.

When the verbose error report method is enabled, the response of the FASTRACK Supreme in case of error is as follows:

- Either +CME ERROR: <error result code>,
- Or +CMS ERROR: <error result code>.

Refer to "AT Commands Interface Guide" [6] for error result code description and further details on the AT +CMEE command.

Note: It is strongly recommended to always enable the verbose error report method to get the Mobile Equipment error code (enter AT +CMEE=1 command).

### 6.3 Receiving "NO CARRIER" Message

If the FASTRACK Supreme returns a "NO CARRIER" message upon an attempted call (voice or data), then refer to the table below for possible causes and solutions.

[^45]
*

Table 13: Solutions for "NO CARRIER" message

| If the Supreme returns... | Then ask... | Action... |
| :---: | :---: | :---: |
| "NO CARRIER" | Is the received signal strong enough? | Refer to section 5.5 to verify the strength of the received signal. |
|  | Is the FASTRACK Supreme registered on the network? | Refer to section 5.9 to verify the registration. |
|  | Is the antenna properly connected? | Refer to section 8.2.7.3 for antenna requirements. |
|  | Is the band selection correction? | Refer to Section 7.2 for band switch |
| "NO CARRIER" (when trying to issue a voice communication) | Is the semicolon (;) entered immediately after the phone number in the AT command? | Ensure that the semicolon (;) is entered immediately after the phone number in the AT command. e.g. ATD\#\#\#\#\#\#; |
| "NO CARRIER" (when trying to issue a data communication) | Is the SIM card configured for data / fax calls? | Configure the SIM card for data / fax calls (Ask your network provider if necessary). |
|  | Is the selected bearer type supported by the called party? | Ensure that the selected bearer type is supported by the called party. |
|  | Is the selected bearer type supported by the network? | Ensure that the selected bearer type is supported by the network. <br> If no success, try bearer selection type by AT command: $\mathrm{AT}+\mathrm{CBST}=0,0,3$ |

If the FASTRACK Supreme returns a "NO CARRIER" message, you may have the extended error code by using AT command AT+CEER. Refer to the table below for interpretation of extended error code.

Table 14: Interpretation of extended error code

| Error Code | Diagnostic | Hint |
| :---: | :---: | :---: |
| 1 | Unallocated phone number |  |
| 16 | Normal call clearing |  |
| 17 | User busy |  |
| 18 | No user responding |  |
| 19 | User alerting, no answer |  |
| 21 | Call rejected |  |
| 22 | Number changed |  |
| 31 | Normal, unspecified |  |
| 50 | Requested facility not subscribed | Check your subscription (data subscription available?). |
| 68 | ACM equal or greater than ACMmax | Credit of your pre-paid SIM card expired. |
| 252 | Call barring on outgoing calls |  |
| 253 | Call barring on incoming calls |  |
| $\begin{gathered} 3,6,8,29,34,38, \\ 41,42,43,44,47, \\ 49,57,58,63,65, \\ 69,70,79,254 \end{gathered}$ | Network causes | See "AT Commands Interface Guide" [6] for further details or call network provider. |

Note: For all other codes, and/or details, see AT commands documentation [6].



Fastrack Supreme User Guide
Functional Description

## 7 Functional Description

### 7.1 Architecture



Figure 15: Functional architecture

## 

# Fastrack Supreme User Guide 

Functional Description

## 7．2 EU and US Bands

## 7．2．1 General Presentation

The FASTRACK Supreme is a quad band Plug \＆Play．It supports either EU bands（EGSM900／DCS1800） or US bands（GSM850／PCS1900），depending on the band setting within the Plug \＆Play．Users are free to switch between EU bands and US bands by simple AT commands when the selected bands are supported．

## 7．2．2 ATCOM M AND for Bands Switch

EU／US band is easily switched／checked by AT command AT＋WMBS．
For detail，please refer to Section 5.7 and 5．8．

## 7．3 Power Supply

## 7．3．1 General Presentation

The FASTRACK Supreme is supplied by an external DC voltage（ $\mathrm{V}+\mathrm{BATTERY}$ ）from +5.5 V to +32 V at 2.2 A．

Main regulation is made with an internal DC／DC converter in order to supply all the internal functions with a DC voltage．

Correct operation of the FASTRACK Supreme in communication mode is not guaranteed if input voltage （V＋BATTERY）falls below 5.5 V ．
Note：The minimum input voltage specified here is at the FASTRACK Supreme input．Be careful of the input voltage decrease caused by the power cable．See paragraph 8．2．1 for more information．

## 7．3．2 Protections

The FASTRACK Supreme is protected by a $800 \mathrm{~mA} / 250 \mathrm{~V}$ fuse directly bonded on the power supply cable．
The FASTRACK Supreme is also protected against voltage over +32 V ．
Filtering guarantees：
－EMI／RFI protection in input and output，
－Signal smoothing．

## 7．4 RS232 Serial Link

## 7．4．1 General Presentation

The RS232 interface performs the voltage level adaptation（V24／CMOS $\Leftrightarrow \mathrm{V} 24 / \mathrm{V} 28$ ）between the internal FASTRACK Supreme Plug \＆Play（DCE）and the external world（DTE）．

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# Fastrack Supreme User Guide 

Functional Description
The RS232 interface is internally protected (by ESD protection) against electrostatic surges on the RS232 lines.

Filtering guarantees:

- EMI/RFI protection in input and output,
- Signal smoothing.

Signals available on the RS232 serial link are:

- TX data (CT103/TX),
- RX data (CT104/RX),
- Request To Send (CT105/RTS),
- Clear To Send (CT106/CTS),
- Data Terminal Ready (CT108-2/DTR),
- Data Set Ready (CT107/DSR),
- Data Carrier Detect (CT109/DCD),
- Ring Indicator (CT125/RI).


Figure 16: RS232 Serial Link signals

RS232 interface has been designed to allow flexibility in the use of the serial interface signals. However, the use of TX, RX, CTS and RTS signals is mandatory, which is not the case for DTR, DSR, DCD and RI signals which can be not used.

### 7.4.2 Autobauding Mode

The autobauding mode allows the FASTRACK Supreme to detect the baud rate used by the DTE connected to the RS232 serial link.

Autobauding mode is controlled by AT commands. See "AT Commands Interface Guide" [6] for details on this function.

## 




Fastrack Supreme User Guide
Functional Description

### 7.4.3 Pin Description

| Signal | Sub HD connector <br> Pin number | I/O | I/O type <br> RS232 <br> STANDARD | Description |
| :---: | :---: | :---: | :---: | :--- |
| CTXD/CT103 | 2 | I | TX | Transmit serial data |
| CRXD/CT104 | 6 | O | RX | Receive serial data |
| CRTS/CT105 | 12 | I | RTS | Request To Send |
| CCTS/CT106 | 11 | O | CTS | Clear To Send |
| CDSR/CT107 | 7 | O | DSR | Data Set Ready |
| CDTR/CT108-2 | 8 | I | DTR | Data Terminal Ready |
| CDCD/CT109 | 1 | O | DCD | Data Carrier Detect |
| CRI/CT125 | 13 | O | RI | Ring Indicator |
| CT102/GND | 9 |  | GND | Ground |

### 7.4.4 Serial Port Auto shut down Feature

The UART1 can be shut down when there is no activity between the DTE and the FASTRACK Supreme Plug \& Play. This can help for improving power consumption performance.

Serial Port Auto shut down feature is easily controlled by AT command AT+WASR.

- AT+WASR=1 for entering the serial port auto shut down mode
- AT+WASR=0 for exiting the serial port auto shut down mode

Refer to "AT Commands Interface Guide" [6] for further information on AT commands.
CAUTION: GPIO24 is reserved for serial port auto shut down feature. It is prohibited for customer use. Improper access to GPIO24 by customer may lead to unexpected behavior on UART1 performance.

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# Fastrack Supreme User Guide 

Functional Description

### 7.5 General Purpose Input/ Output (GPIO)

The FASTRACK Supreme provides two General Purpose Input / Output lines available for external use: GPIO21 and GPIO25.

These GPIOs may be controlled by AT commands:

- AT+WIOW for a write access to the GPIO value, when the GPIO is used as an output,
- AT+WIOR for a read access to the GPIO value, when the GPIO is used as an input.

Refer to "AT Commands Interface Guide" [6] for further information on AT commands.
After reset, both GPIOs are configured as inputs. The AT+WIOM command has to be used to change this configuration (refer to "AT Commands Interface Guide" [6] for further details).

Pin description

| Signal | Power Supply <br> connector <br> (4-pin Micro-Fit) | I/O | I/O <br> Voltage | Reset <br> state | Description | Mulitplex with |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| GPIO21 | 3 | I/O | 2 V 8 | Undefined | General Purpose I/O | No mux |
| GPIO25 | 4 | I/O | 2 V 8 | Z | General Purpose I/O | INT1 |

## Notes:

- The power supply cable may need to be modified due to the GPIO signals (GPIO21 \& GPIO25) available on the 4-pin Micro-FIT connector of the FASTRACK Supreme.
- The previous generation M1306B have GPIO4 and GPIO5 being replaced by GPIO21 and GPIO25 respectively, for which both are of LOW level at reset state.


### 7.6 BOOT

This signal must not be connected. Its use is strictly reserved to Wavecom or competent retailers.
Caution: Previous generation M1306B has BOOT signal of HIGH level at 2.8 V . But the FASTRACK Supreme now of 1.8 V BOOT instead.

### 7.7 RESET

### 7.7.1 General presentation

This signal is used to force a reset procedure by providing low level during at least $200 \mu \mathrm{~s}$.
This signal must be considered as an emergency reset only. A reset procedure is automatically driven by an internal hardware during the power-up sequence.


# Fastrack Supreme User Guide 

Functional Description
This signal may also be used to provide a reset to an external device．It then behaves as an output．If no external reset is necessary，this input may be left open，if used（emergency reset），it has to be driven either by an open collector or an open drain output：
－RESET pin 14 ＝0，for FASTRACK Supreme Reset，
－RESET pin 14 ＝1，for normal mode．

## Pin description

| Signal | Sub HD 15－Pin connector <br> Pin number | I／O | I／O type | Voltage | Description |
| :---: | :---: | :---: | :---: | :---: | :---: |
| RESET | 14 | I／O | Open Drain | 1V8 | FASTRACK Supreme <br> Reset |

Caution：Previous generation M1306B has RESET signal of HIGH level at 2．8V．But the FASTRACK Supreme now of 1．8V RESET instead．

## Additional comments on RESET：

The RESET process is activated either by the external RESET signal or by an internal signal（coming from a RESET generator）．This automatic reset is activated at Power－up．

The FASTRACK Supreme remains in RESET mode as long as the RESET signal is held low．
Caution：This signal should be used only for＂emergency＂reset．
A software reset is always preferred to a hardware reset．
Note：See＂AT Commands Interface Guide＂［6］for further information on software reset．

## 7．7．2 Reset Sequence

To activate the＂emergency＂reset sequence，the RESET signal has to be set to low for $200 \mu$ s minimum．
As soon as the reset is done，the AT interface answers＂OK＂to the application．For this，the application must send AT」．

If the application manages hardware flow control，the AT command may be sent during the initialization phase．Another solution is to use the AT＋WIND command to get an unsolicited status from the FASTRACK Supreme．

For further details，refer to AT commands＂AT Commands Interface Guide＂［6］．

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Figure 17: Reset sequence diagram

### 7.8 Audio

Audio interface is a standard one for connecting a phone handset.
Echo cancellation and noise reduction features are also available to improve the audio quality in case of hand-free application.

### 7.8.1 Microphone Inputs

The microphone inputs are differential ones in order to reject common mode noise and TDMA noise.
They already include the convenient biasing for an electret microphone ( 0.5 mA and 2 Volts) and are ESD protected.

This electret microphone may be directly connected to these inputs allowing an easy connection to a handset.

The microphone impedance must be around $2 \mathrm{k} \Omega$.
AC coupling is already embedded in the Wireless $C P U^{\circledR}$.
The gain of the microphone inputs is internally adjusted and may be tuned from 30 dB to 51 dB using an AT +VGT command (refer to AT commands documentation [6]).

Pin description

| Signal | Sub D 15-pin <br> Pin \# | I/O | I/O type | Description |
| :---: | :---: | :---: | :---: | :---: |
| CMIC2P | 4 | I | Analog | Microphone positive input |
| CMIC2N | 5 | I | Analog | Microphone negative input |

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# Fastrack Supreme User Guide <br> Functional Description 

### 7.8.2 Speaker Outputs

This connection is differential to reject common mode noise and TDMA noise.
Speaker outputs are connected to internal push-pull amplifiers and may be loaded down between 32 to 150 Ohms and up to 1 nF (see details in table Speaker gain vs Max output voltage, in "AT Commands Interface Guide" [6]). These outputs may be directly connected to a speaker.

The output power may be adjusted by step of 2 dB . The gain of the speaker outputs is internally adjusted and may be tuned using an AT +VGR command (refer to AT commands documentation [6]).

## Pin description

| Signal | Sub D 15-pin Pin \# | I/O | I/O type | Description |
| :---: | :---: | :---: | :---: | :---: |
| CSPK2P | 10 | O | Analog | Speaker positive output |
| CSPK2N | 15 | O | Analog | Speaker negative output |

## 7．9 Real Time Clock（RTC）

The FASTRACK Supreme has now implemented the Real Time Clock for saving date and time when the Plug \＆Play is unplugged from the DC power supply through the DC power cable．

| Item | Min | Typical | Max |  |
| :---: | :---: | :---: | :---: | :---: |
| Charging Time start from fully discharged to fully charged |  | 940 min |  |  |
| RTC Time Period＊ | Guarantee |  | 2475 min |  |
|  | Non－guarantee |  | 5225 min |  |

Remark：The RTC time period is measured from the RTC battery is fully charged before being unplugged from the DC power source．

## 7．10 FLASH LED

The FASTRACK Supreme has a red LED indicator to show the status of the GSM network．For detail description of the various status，please refer to Section 5．3．

However，during operation mode of Slow Standby，there will be no network registration and so the red LED indicator will always be ON．It is possible for user to deactivate the LED indication during Slow Standby mode，in order to reduce power consumption．

The Flash LED can be deactivated by AT command at＋whcnf＝1，0
The Flash LED can be activated by AT command at＋whcnf＝1，1
However，the new setting will be taken into account only after a restart．For detail，please refer to Document［6］．

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## 8 Technical Characteristics

### 8.1 Mechanical Characteristics

Table 15: Mechanical characteristics

| Dimensions | $73 \times 54.5 \times 25.5 \mathrm{~mm}$ (excluding connectors) |
| :---: | :--- |
| Overall Dimension | $88 \times 54.5 \times 25.5 \mathrm{~mm}$ |
| Weight | $\approx 80$ grams (FASTRACK Supreme only) |
|  | $<120$ grams (FASTRACK Supreme + bridles + power supply cable) |
| Volume | $101.5 \mathrm{~cm}^{3}$ |
| Housing | Aluminum profiled |

The next page gives the dimensioning diagram of the FASTRACK Supreme including the clearance areas to take into account for the FASTRACK Supreme installation.

Technical Characteristics


Figure 18：Dimensioning diagram

### 8.2 Electrical Characteristics

### 8.2.1 Power Supply

Table 16: Electrical characteristics

| Operating Voltage ranges | 5.5 V to 32 V DC. |
| :---: | :--- |
| Maximum current | 480 mA Average at 5.5 V. <br> 2.1 A Peak at $5.5 \mathrm{~V} .(\mathrm{TBC})$ |

## Note:

The FASTRACK Supreme is permanently powered once the power supply is connected. The following table describes the consequences of over-voltage and under-voltage with the FASTRACK Supreme.

## Warning:

All the input voltages specification described in this Section are at the FASTRACK Supreme input. While powering the FASTRACK Supreme, take into account the input drop caused by the power cable. With the delivered cable, this input drop is around 700 mV at 5.5 V and 220 mV at 32 V .

Table 17: Effects of power supply defect

| If the voltage | then |
| :--- | :--- |
| falls below 5.5 V , | the GSM communication is not guaranteed. |
| is over 32 V <br> (Transient peaks), | the FASTRACK Supreme guarantees its own protection. |
| Is over 32 V <br> (continuous overvoltage) | the protection of the FASTRACK Supreme is done by the <br> fuse (the supply voltage is disconnected). |

The fuse is a $800 \mathrm{~mA} / 250$ V FAST-ACTING 5*20mm. See Section 10 for recommended references.
The following table provides information on power consumption of the FASTRACK Supreme, assuming an operating temperature of $+25^{\circ} \mathrm{C}$ and using a 3 V SIM card.

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# Fastrack Supreme User Guide 

 Technical Characteristics
### 8.2.2 Power Consumption

The following table provides information on power consumption of the FASTRACK Supreme, assuming an operating temperature of $+25^{\circ} \mathrm{C}$ and using a 3 V SIM card.

Table 18: Power consumption (1*)

| Power Consumption in <br> E-GSM 900/DCS 1800 MHz - GPRS class 10 |  | E-GSM 900 | DCS 1800 |
| :--- | :--- | :--- | :--- | :--- | :--- |

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Fastrack Supreme User Guide Technical Characteristics

| Power Consumption in E－GSM 900／DCS 1800 MHz－GPRS class 10 |  |  |  |  | E－GSM 900 | DCS 1800 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | $I_{\text {peak }}$ | GSM900：During 2TX bursts＠PCL8（Gamma 6） <br> DCS1800 ：During 2TX bursts＠PCL2（Gamma 5） |  | ＠5．5V | TBC | TBC |
|  |  |  |  | ＠13．2V | TBC | TBC |
|  |  |  |  | ＠32V | TBC | TBC |
|  | I avg | GSM900 ：Average 2TX／3RX＠PCL8（Gamma 6） DCS1800 ：Average 2TX／3RX＠PCL2（Gamma 5） |  | ＠5．5V | TBC | TBC |
|  |  |  |  | ＠13．2V | TBC | TBC |
|  |  |  |  | ＠32V | TBC | TBC |
| $I_{\text {avg }}$ in Fast Idle mode Page 9$\left(2^{*}\right)$ |  |  | Serial port auto shut down deactivated | ＠5．5V | 33 | TBC |
|  |  |  | ＠13．2V | TBC | TBC |
|  |  |  | ＠32V | TBC | TBC |
|  |  |  | Serial port auto shut down activated | ＠5．5V | 17 | TBC |
|  |  |  | ＠13．2V | TBC | TBC |
|  |  |  | ＠32V | TBC | TBC |
| I avg in Slow Idle mode Page 9$\left(3^{*}\right)$ |  |  |  | Serial port auto shut down deactivated | ＠5．5V | 23 | TBC |
|  |  |  | ＠13．2V |  | TBC | TBC |
|  |  |  | ＠32V |  | TBC | TBC |
|  |  |  | Serial port auto shut down activated | ＠5．5V | 5 | TBC |
|  |  |  | ＠13．2V | TBC | TBC |
|  |  |  | ＠32V | TBC | TBC |
| $I_{\text {avg }}$ in Fast Standby mode$\left(4^{*}\right)$ |  |  |  | Serial port auto shut down deactivated | ＠5．5V | 52 | TBC |
|  |  |  | ＠13．2V |  | TBC | TBC |
|  |  |  | ＠32V |  | TBC | TBC |
|  |  |  | Serial port auto shut down activated | ＠5．5V | 35 | TBC |
|  |  |  | ＠13．2V | TBC | TBC |
|  |  |  | ＠32V | TBC | TBC |

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| Power Consumption in E－GSM 900／DCS 1800 MHz－GPRS class 10 |  |  | E－GSM 900 | DCS 1800 |
| :---: | :---: | :---: | :---: | :---: |
| $I_{\text {avg }}$ in Slow Standby mode （with FLASH LED activated） （4＊） | Serial port auto shut down deactivated | ＠5．5V | 24 | TBC |
|  |  | ＠13．2V | TBC | TBC |
|  |  | ＠32V | TBC | TBC |
|  | Serial port auto shut down activated | ＠5．5V | 8 | TBC |
|  |  | ＠13．2V | TBC | TBC |
|  |  | ＠32V | TBC | TBC |
| $I_{\text {avg }}$ in Slow Standby mode （with FLASH LED deactivated） （4＊） | Serial port auto shut down deactivated | ＠5．5V | TBC | TBC |
|  |  | ＠13．2V | TBC | TBC |
|  |  | ＠32V | TBC | TBC |
|  | Serial port auto shut down activated | ＠5．5V | 4 | TBC |
|  |  | ＠13．2V | TBC | TBC |
|  |  | ＠32V | TBC | TBC |

（1＊）：The power consumption might vary by $5 \%$ over the whole operating temperature range $\left(-20^{\circ} \mathrm{C}\right.$ to $\left.+55^{\circ} \mathrm{C}\right)$ ．
$\left(2^{*}\right)$ ：In this Mode，the RF function is active and the FASTRACK Supreme synchronized with the network，but there is no communication．
（3＊）：In this Mode，the RF function is disabled，but regularly activated to keep the synchronization with the network．This Mode works only when the DTE send AT command to shut down the serial link by software approach（DTE turns DTR in inactive state）．
（4＊）：In this Mode，the RF function is disabled，and there is no synchronization with the network．

# Fastrack Supreme User Guide 

### 8.2.3 Audio Interface

The audio interface is available through the Sub HD 15-pin connector.
Table 19: Audio parameters caracteristics

| Audio parameters | Min | Typ | Max | Unit | Comments |
| :--- | :---: | :---: | :---: | :---: | :---: |
| Microphone input current @2 $\mathrm{V} / 2 \mathrm{k} \Omega$ |  | 0.5 |  | mA |  |
| Absolute microphone input voltage |  |  | 100 | mVpp | AC voltage |
| Speaker output current $150 \Omega / / 1 \mathrm{nF}$ |  | 16 |  | mA |  |
| Absolute speaker impedance | 32 | 50 |  | $\Omega$ |  |
| Impedance of the speaker amplifier output in <br> differential mode |  |  | 1 | $\Omega$ | $+/-10 \%$ |

Table 20: Microphone inputs internal audio filter characteristics

| Frequency | Gain |
| :--- | :--- |
| $0-150 \mathrm{~Hz}$ | $<-22 \mathrm{~dB}$ |
| $150-180 \mathrm{~Hz}$ | $<-11 \mathrm{~dB}$ |
| $180-200 \mathrm{~Hz}$ | $<-3 \mathrm{~dB}$ |
| $200-3700 \mathrm{~Hz}$ | 0 dB |
| $>4000 \mathrm{~Hz}$ | $<-60 \mathrm{~dB}$ |

Table 21: Recommended characteristics for the microphone:

| Feature | Value |
| :--- | :--- |
| Type | Electret $2 \mathrm{~V} / 0.5 \mathrm{~mA}$ |
| Impedance | $\mathrm{Z}=2 \mathrm{k} \Omega$ |
| Sensitivity | -40 dB to -50 dB |
| SNR | $>50 \mathrm{~dB}$ |
| Frequency response | compatible with the GSM specifications |

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# Fastrack Supreme User Guide 

Technical Characteristics
Table 22：Recommended characteristics for the speaker：

| Feature | Value |
| :--- | :--- |
| Type | 10 mW, electro－magnetic |
| Impedance | $\mathrm{Z}=32$ to $50 \Omega$ |
| Sensitivity | 110 dB SPL min．$(0 \mathrm{~dB}=20 \mu \mathrm{~Pa})$ |
| Frequency response | compatible with the GSM specifications |

## 8．2．4 General Purpose Input／Output

Both GPIO21 and GPIO25 may be interfaced with a component that comply with 3 Volts CMOS levels．
Table 23：Operating conditions

| Parameter | I／O type | Min | Typ | Max | Condition |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $\mathbf{V}_{\mathrm{IL}}$ | CMOS |  |  | 0.84 V |  |
| $\mathrm{~V}_{\mathrm{IH}}$ | CMOS | 1.96 V |  |  |  |
| $\mathrm{~V}_{\mathrm{OL}}$ | CMOS |  |  | 0.4 V | $\mathrm{I}_{\mathrm{OL}}=-4 \mathrm{~mA}$ |
| $\mathrm{~V}_{\mathrm{OH}}$ | CMOS | 2.4 V |  |  | $\mathrm{I}_{\mathrm{OH}}=4 \mathrm{~mA}$ |
| $\mathrm{I}_{\mathrm{OH}}$ |  |  |  | 4 mA |  |
| $\mathrm{I}_{\mathrm{OL}}$ |  |  |  | -4 mA |  |

Clamping diodes are present on I／O pads．

## 8．2．5 SIM Interface

Table 24：SIM card characteristics

| SIM card | $1.8 \mathrm{~V} / 3 \mathrm{~V}$ |
| :---: | :--- |

## 8．2．6 RESETSignal

Table 25：Electrical characteristics

| Parameter | Min | Typ | Max | Unit |
| :---: | :---: | :---: | :---: | :---: |
| Input Impedance（ R ）＊ |  | 330 K |  | $\mathrm{k} \Omega$ |
| Input Impedance（ C ） |  | 10 n |  | nF |

＊Internal pull－up

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# Fastrack Supreme User Guide 

Table 26: Operating conditions

| Parameter | Minimum | Typ | Maximum | Unit |
| :---: | :---: | :---: | :---: | :---: |
| $\sim$ RESET time (Rt) ${ }^{1}$ | 200 |  |  | $\mu \mathrm{~s}$ |
| $\sim$ RESET time (Rt) ${ }^{2}$ at power up only | 20 | 40 | 100 | ms |
| Cancellation time (Ct) |  | 34 |  | ms |
| $\mathrm{~V}_{\mathrm{H}}$ | 0.57 |  |  | V |
| $\mathrm{~V}_{\mathrm{IL}}$ | 0 |  | 0.57 | V |
| $\mathrm{~V}_{\text {IH }}$ | 1.33 |  |  | V |

${ }^{*} \mathrm{~V}_{\mathrm{H}}$ : Hysterisis Voltage
1 This reset time is the minimum to be carried out on the $\sim$ RESET signal when the power supply is already stabilized.
2 This reset time is internally carried out by the Wireless CPU power supply supervisor only when the Wireless CPU power supplies are powered ON.

### 8.2.7 RF Characteristics

### 8.2.7.1 FrequencyRanges

Table 27: Frequency ranges

| Characteristic | GSM 850 | E-GSM 900 | DCS 1800 | PCS 1900 |
| :--- | :---: | :---: | :---: | :---: |
| Frequency TX | 824 to 849 MHz | 880 to 915 MHz | 1710 to 1785 MHz | 1850 to 1910 MHz |
| Frequency RX | 869 to 894 MHz | 925 to 960 MHz | 1805 to 1880 MHz | 1930 to 1990 MHz |

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### 8.2.7.2 RF Performances

RF performances are compliant with the ETSI recommendation GSM 05.05.
The RF performances for receiver and transmitter are given in the table below.
Table 28: Receiver and transmitter RF performances

| Receiver |  |
| :--- | :--- |
| E-GSM900/GSM850 Reference Sensitivity | -104 dBm Static \& TUHigh |
| DCS1800/PCS1900 Reference Sensitivity | -102 dBm Static \& TUHigh |
| Selectivity @ 200 kHz | $>+9 \mathrm{dBc}$ |
| Selectivity @ 400 kHz | $>+41 \mathrm{dBc}$ |
| Linear dynamic range | 63 dB |
| Co-channel rejection | $>=9 \mathrm{dBc}$ |
| Transmitter |  |
| Maximum output power (E-GSM 900/GSM850) <br> at ambient temperature | $33 \mathrm{dBm}+/-2 \mathrm{~dB}$ |
| Maximum output power (DCS1800/PCS1900) <br> at ambient temperature | $30 \mathrm{dBm}+/-2 \mathrm{~dB}$ |
| Minimum output power (E-GSM 900/GSM850) <br> at ambient temperature | $5 \mathrm{dBm}+/-5 \mathrm{~dB}$ |
| Minimum output power (DCS1800/PCS1900) <br> at ambient temperature | $0 \mathrm{dBm}+/-5 \mathrm{~dB}$ |

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# Fastrack Supreme User Guide 

Technical Characteristics

### 8.2.7.3 External Antenna

The external antenna is connected to the FASTRACK Supreme via the SMA connector.
The external antenna must fulfill the characteristics listed in the table below.
Table 29: External antenna characteristics

| Antenna frequency range | Quad-band GSM 850/GSM900/DCS1800/PCS1900 MHz |
| :--- | :--- |
| Impedance | 50 Ohms nominal |
| DC impedance | 0 Ohm |
| Gain (antenna + cable) | 0 dBi |
| VSWR (antenna + cable) | 2 |

Note: Refer to Section 10 for recommended antenna.

### 8.3 Environmental Characteristics

The FASTRACK Supreme Plug \& Play is compliant with the following operating class. To ensure the proper operation of the FASTRACK Supreme, the temperature of the environment must be within a specific range as described in the table below.

Table 30: Ranges of temperature

| Conditions | Temperature range |
| :---: | :---: |
| Operating / Class A | $-20^{\circ} \mathrm{C}$ to $+55^{\circ} \mathrm{C}$ |
| Operating / Class B | $-30^{\circ} \mathrm{C}$ to $+85^{\circ} \mathrm{C}$ |
| Storage | $-40^{\circ} \mathrm{C}$ to $+85^{\circ} \mathrm{C}$ |

## Function Status Classification:

## Class A:

The FASTRACK Supreme remains fully functional, meeting GSM performance criteria in accordance with ETSI requirements, across the specified temperature range.

## Class B:

The FASTRACK Supreme remains fully functional, across the specified temperature range. Some GSM parameters may occasionally deviate from the ETSI/PTCRB specified requirements and this deviation does not affect the ability of the FASTRACK Supreme to connect to the cellular network and function fully, as it does within the Class A range.

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The detailed climatic and mechanics standard environmental constraints applicable to the FASTRACK Supreme are listed in the table below:

Table 31: Environmental standard constraints

| Environmental Tests (IEC TR 60721-4) |  | Environmental Classes(IEC 60721-3) |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Tests | Standards | Storage | Transportation <br> (IEC 60721-3-2) <br> Class IE23 | Operation |  |
|  |  | (IEC 60721-3-1) Class IE13 |  | Stationary (IEC 60721-3-3) Class IE35 | Non-Stationary (IEC 60721-3-7) Class IE73 |
| Cold | $\begin{gathered} \text { IEC 60068-2-1 : } \\ \text { Ab/Ad } \end{gathered}$ | $-25^{\circ} \mathrm{C}, 16 \mathrm{~h}$ | $-40^{\circ} \mathrm{C}, 16 \mathrm{~h}$ | $-5^{\circ} \mathrm{C}, 16 \mathrm{~h}$ | $-5^{\circ} \mathrm{C}, 16 \mathrm{~h}$ |
| Dry heat | $\begin{gathered} \text { IEC 60068-2-2 : } \\ \mathrm{Bb} / \mathrm{Bd} \end{gathered}$ | $+70^{\circ} \mathrm{C}, 16 \mathrm{~h}$ | $+70^{\circ} \mathrm{C}, 16 \mathrm{~h}$ | $+55^{\circ} \mathrm{C}, 16 \mathrm{~h}$ | $+55^{\circ} \mathrm{C}, 16 \mathrm{~h}$ |
| Change of temperature | $\begin{gathered} \text { IEC 60068-2-14 : } \\ \mathrm{Na} / \mathrm{Nb} \end{gathered}$ | $-33^{\circ} \mathrm{C}$ to ambient 2 cycles, $\mathrm{t} 1=3 \mathrm{~h}$ $1^{\circ} \mathrm{C} . \mathrm{min}^{-1}$ | $-40^{\circ} \mathrm{C}$ to ambient 5 cycles, $\mathrm{t} 1=3 \mathrm{~h}$ t2<3 min | $-5^{\circ} \mathrm{C}$ to ambient 2 cycles, $\mathrm{t} 1=3 \mathrm{~h}$ $0,5^{\circ} \mathrm{C} . \mathrm{min}^{-1}$ | $-5^{\circ} \mathrm{C}$ to ambient 5 cycles, $\mathrm{t} 1=3 \mathrm{~h}$ t2<3 min |
| Damp heat | IEC 60068-2-56 : Cb | $\begin{gathered} +30^{\circ} \mathrm{C}, 93 \% \mathrm{RH} \\ 96 \mathrm{~h} \end{gathered}$ | $\begin{aligned} & +40^{\circ} \mathrm{C}, 93 \% \mathrm{RH} \\ & 96 \mathrm{~h} \text { minimum } \end{aligned}$ | $\underset{h}{+30^{\circ} \mathrm{C}, 93 \% \mathrm{RH}, 96}$ | $+30^{\circ} \mathrm{C}, 93 \% \mathrm{RH}, 96 \mathrm{~h}$ |
| Damp heat, cyclic | $\begin{aligned} & \text { 60068-2-30 : Db } \\ & \text { Variant } 1 \text { or } 2 \end{aligned}$ | $+40^{\circ} \mathrm{C}, 90 \%$ to $100 \% \mathrm{RH}$ One cycle Variant 2 | $+55^{\circ} \mathrm{C}, 90 \%$ to $100 \% \mathrm{RH}$ Two cycles Variant 2 | $+30^{\circ} \mathrm{C}, 90 \% \text { to } 100 \%$ <br> RH <br> Two cycles Variant 2 | $+40^{\circ} \mathrm{C}, 90 \%$ to $100 \% \mathrm{RH}$ Two cycles Variant 1 |
| Vibration (sinusoidal) | IEC 60068-2-6 : Fc | $1-200 \mathrm{~Hz}$ $2 \mathrm{~m} . \mathrm{s}^{-2}$ $0,75 \mathrm{~mm}$ 3 axes 10 sweep cycles | $1-500 \mathrm{~Hz}$ $10 \mathrm{~m} . \mathrm{s}^{-2}$ $3,5 \mathrm{~mm}$ 3 axes 10 sweep cycles | $\begin{gathered} 1-150 \mathrm{~Hz} \\ 2 \mathrm{~m} . \mathrm{s}^{-2} \\ 0,75 \mathrm{~mm} \\ 3 \mathrm{axes} \\ 5 \text { sweep cycles } \end{gathered}$ | $1-500 \mathrm{~Hz}$ $10 \mathrm{~m} . \mathrm{s}^{-2}$ $3,3 \mathrm{~mm}$ 3 axes 10 sweep cycles |
| Vibration (random) | IEC 60068-2-64 : Fh | - | $10-100 \mathrm{~Hz} / 1,0 \mathrm{~m}^{2} . \mathrm{s}^{-3}$ $100-200 \mathrm{~Hz} /-3 \mathrm{~dB} . \mathrm{octave}^{-1}$ $200-2000 \mathrm{~Hz} / 0,5 \mathrm{~m}^{2} . \mathrm{s}^{-3}$ 3 axes 30 min | - | - |
| Shock (half-sine) | IEC 60068-2-27 : Ea | - | - | $50 \mathrm{~m} . \mathrm{s}^{-2}$ 6 ms 3 shocks 6 directions | $\begin{gathered} 150 \mathrm{~m} . \mathrm{s}^{-2} \\ 11 \mathrm{~ms} \\ 3 \text { shocks } \\ 6 \text { directions } \end{gathered}$ |
| Bump | IEC 60068-2-29 : Eb | - | $250 \mathrm{~m} \cdot \mathrm{~s}^{-2}$ 6 ms 50 bumps vertical direction | - | - |
| Free fall | ISO 4180-2 | - | Two falls in each specified attitude | - | 2 falls in each specified attitude 0,025 m (<1kg) |
| Drop and topple | IEC 60068-2-31 : Ec | - | One drop on relevant corner One topple about each bottom edge | - | One drop on each relevant corner One topple on each of 4 bottom edges |

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# Fastrack Supreme User Guide <br> Technical Characteristics 

## Notes：

Short description of Class IE13（For more information see standard IEC 60721－3－1）
＂Locations without controlled temperature and humidity，where heating may be used to raise low temperatures，locations in buildings providing minimal protection against daily variations of external climate， prone to receiving rainfall from carrying wind＂．

## Short description of Class IE23（For more information，see standard IEC 60721－3－2）

＂Transportation in unventilated compartments and in conditions without protection against bad weather，in all sorts of trucks and trailers in areas of well developed road network，in trains equipped with buffers specially designed to reduce shocks and by boat＂．
Short description of Class IE35（For more information see standard IEC 60721－3－3）
＂Locations with no control on heat or humidity where heating may be used to raise low temperatures，to places inside a building to avoid extremely high temperatures，to places such as hallways，building staircases，cellars，certain workshops，equipment stations without surveillance＂．
Short description of Class IE73（For more information see standard IEC 60721－3－7）
＂Transfer to places where neither temperature nor humidity are controlled but where heating may be used to raise low temperatures，to places exposed to water droplets，products can be subjected to ice formation， these conditions are found in hallways and building staircases，garages，certain workshops，factory building and places for industrial processes and hardware stations without surveillance＂．

Warning：The specification in the above table applies to the FASTRACK Supreme product only． Customers are advised to verify that the environmental specification of the SIM Card used is compliant with the FASTRACK Supreme environmental specifications．Any application must be qualified by the customer with the SIM Card in storage，transportation and operation．

The use of standard SIM cards may drastically reduce the environmental conditions in which the Product can be used．These cards are particularly sensible to humidity and temperature changes．These conditions may produce oxidation of the SIM card metallic layers and cause，in the long term，electrical discontinuities．This is particularly true in left alone applications，where no frequent extraction／insertion of the SIM card is performed．

In case of mobility when the application is moved through different environments with temperature variations， some condensation may appear．These events have a negative impact on the SIM and may favor oxidation．
If the use of standard SIM card，with exposition to the environmental conditions described above，can not be avoided，special care must be taken in the integration of the final application in order to minimize the impact of these conditions．The solutions that may be proposed are：
－Lubrication of the SIM card to protect the SIM Contact from oxidation．
－Putting the FASTRACK Supreme Plug \＆Play in a waterproof enclosure with desiccant bags．
Lubrication of the SIM card had been tested by Wavecom（using Tutela Fluid 43EM from MOLYDUVAL）and gives very good results．
If waterproof enclosure with a desiccant solution is used，check with your desiccant retailer the quantity that must be used according to the enclosure dimensions．Ensure humidity has been removed before sealing the enclosure．
Any solution selected must be qualified by the customer on the final application．
To minimize oxidation problem on the SIM card，its manipulation must be done with the greatest precautions． In particular，the metallic contacts of the card must never be touched with bare fingers or any matter which

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# Fastrack Supreme User Guide 

## Technical Characteristics

may contain polluted materials liable to produce oxidation (such as, e.g. substances including chlorine). In case a cleaning of the Card is necessary, a dry cloth must be used (never use any chemical substance).

### 8.4 Conformity

The complete product complies with the essential requirements of article 3 of R\&TTE 1999/5/EC Directive and satisfied the following standards:

| Domain | Applicable standard |
| :--- | :--- |
| Safety standard | EN 60950 (ed.1999) |
| Efficient use of the radio frequency <br> spectrum | EN 301 419-(v 4.1.1) <br> EN 301 511 (V 7.0.1) |
| EMC | EN 301 489-1 (edition 2002) <br> EN 301 489-7 (edition 2002) |
| Global Certification Forum - Certification <br> Criteria | GCF-CC V3.13.0 |
| PTCRB |  |
| FCC |  |
| IC |  |

### 8.5 Protections

### 8.5.1 Power Supply

The FASTRACK Supreme is protected by a $800 \mathrm{~mA} / 250 \mathrm{~V}$ fuse directly bonded on the power supply cable. The model of fuse used is: FSD 800 mA / 250 V FAST-ACTING.

## 

# Fastrack Supreme User Guide <br> Technical Characteristics 

### 8.5.2 Overvoltage

The FASTRACK Supreme is protected against voltage over +32 V .
When input voltages exceed +32 V , the supply voltage is disconnected in order to protect the internal electronic components from an overvoltage.

### 8.5.3 Electrostatic Discharge

The FASTRACK Supreme withstands ESD according to IEC 1000-4-2 requirements for all accessible parts of the FASTRACK Supreme except the RF part:

- 8 kV of air discharge,
- 4 kV of contact discharge.


### 8.5.4 Miscellaneous

Filtering guarantees:

- EMI/RFI protection in input and output,
- Signal smoothing.


# Fastrack Supreme User Guide 

Safety recommendations

## 9 Safety recommendations

### 9.1 General Safety

It is important to follow any special regulations regarding the use of radio equipment due in particular to the possibility of radio frequency (RF) interference. Please follow the safety advice given below carefully.
Switch OFF your Wireless CPU ${ }^{\circledR}$ :

- When in an aircraft. The use of cellular telephones in an aircraft may endanger the operation of the aircraft, disrupt the cellular network and is illegal. Failure to observe this instruction may lead to suspension or denial of cellular telephone services to the offender, or legal action or both,
- When at a refueling point,
- When in any area with a potentially explosive atmosphere which could cause an explosion or fire,
- In hospitals and any other place where medical equipment may be in use.

Respect restrictions on the use of radio equipment in:

- Fuel depots,
- Chemical plants,
- Places where blasting operations are in progress,
- Any other area where signalization reminds that the use of cellular telephone is forbidden or dangerous.
- Any other area where you would normally be advised to turn off your vehicle engine.

There may be a hazard associated with the operation of your FASTRACK Supreme Plug \& Play close to inadequately protected personal medical devices such as hearing aids and pacemakers. Consult the manufacturers of the medical device to determine if it is adequately protected.

Operation of your FASTRACK Supreme Plug \& Play close to other electronic equipment may also cause interference if the equipment is inadequately protected. Observe any warning signs and manufacturers' recommendations.

The FASTRACK Supreme Plug \& Play is designed for and intended to be used in "fixed" and "mobile" applications:

- "Fixed" means that the device is physically secured at one location and is not able to be easily moved to another location.
- "Mobile" means that the device is designed to be used in other than fixed locations and generally in such a way that a separation distance of at least 20 cm ( 8 inches) is normally maintained between the transmitter's antenna and the body of the user or nearby persons.

The FASTRACK Supreme Plug \& Play is not designed for and intended to be used in portable applications (within 20 cm or 8 inches of the body of the user) and such uses are strictly prohibited.

### 9.2 Vehicle Safety

Do not use your FASTRACK Supreme Plug \& Play while driving, unless equipped with a correctly installed vehicle kit allowing 'Hands-Free' Operation.
Respect national regulations on the use of cellular telephones in vehicles. Road safety always comes first.

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# Fastrack Supreme User Guide 

## Safety recommendations

If incorrectly installed in a vehicle，the operation of FASTRACK Supreme Plug \＆Play telephone could interfere with the correct functioning of vehicle electronics．To avoid such problems，make sure that the installation has been performed by a qualified personnel．Verification of the protection of vehicle electronics should form part of the installation．

The use of an alert device to operate a vehicle＇s lights or horn on public roads is not permitted．

## 9．3 Care and Maintenance

Your FASTRACK Supreme Plug \＆Play is the product of advanced engineering，design and craftsmanship and should be treated with care．The suggestion below will help you to enjoy this product for many years．
Do not expose the FASTRACK Supreme Plug \＆Play to any extreme environment where the temperature or humidity is high．

Do not use or store the FASTRACK Supreme Plug \＆Play in dusty or dirty areas．Its moving parts（SIM holder for example）can be damaged．

Do not attempt to disassemble the Wireless CPU ${ }^{\circledR}$ ．There are no user serviceable parts inside．
Do not expose the FASTRACK Supreme Plug \＆Play to water，rain or spilt beverages．It is not waterproof．
Do not abuse your FASTRACK Supreme Plug \＆Play by dropping，knocking，or violently shaking it．Rough handling can damage it．

Do not place the FASTRACK Supreme Plug \＆Play alongside computer discs，credit or travel cards or other magnetic media．The information contained on discs or cards may be affected by the Wireless CPU ${ }^{\circledR}$ ．
The use of third party equipment or accessories，not made or authorized by Wavecom may invalidate the warranty of the Wireless CPU ${ }^{\circledR}$ ．
Do contact an authorized Service Center in the unlikely event of a fault in the Wireless CPU ${ }^{\circledR}$ ．

## 9．4 Your Responsibility

This FASTRACK Supreme Plug \＆Play is under your responsibility．Please treat it with care respecting all local regulations．It is not a toy．Therefore，keep it in a safe place at all times and out of the reach of children．
Try to remember your Unlock and PIN codes．Become familiar with and use the security features to block unauthorized use and theft．

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# Fastrack Supreme User Guide 

Recommended Accessories

## 10 Recommended Accessories

Accessories recommended by Wavecom for the FASTRACK Supreme are given in the table below．
Table 32：List of recommended accessories

| Designation | Part number | Supplier |
| :--- | :--- | :--- |
| Quad－band antenna | 1140.26 | ALLGON |
|  | MA112VX00 | MAT Equipement |
|  | MCA1890 MH／PB／SMA m | HIRSCHMANN |
| SMA／FME <br> adaptor |  | PROCOM <br> Power adaptor（Europe） <br> adaptor） <br> MOLEX（for micro－fit |
| EGSTDW P2 EF9W3 24W <br> Out：12 V－2A <br> In：100 to 240 V－50／60 Hz－550 mA <br> Mounted with micro－fit connector | connector）＊ |  |

＊Information not available for this preliminary version．

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# Fastrack Supreme User Guide 

Online Support

## 11 Online Support

Wavecom provides an extensive range on online support which includes the following areas of Wavecom＇s wireless expertise：
－the latest version of this document
－new versions of our Operating System user guides
－comprehensive support for Open $\mathrm{AT}^{\circledR}$
－regulatory certifications
－carrier certifications
－application notes
To gain access to this support，simply visit our web site at www．wavecom．com or click on the desire link in Page．Privileged access via user login is provided to Wavecom authorized distributors．

## Cellular Transit Antenna

The TLA2000 is an ideal antenna solution for GSM data applications in both fixed and mobile situations. Designed to offer true dual band performance the TLA2000 is ready for use with the latest GSM (GPRS) modems. With a high impact resistant vacuum formed ABS radome and neoprene mounting gasket, the TLA2000 can be used for indoor or outdoor applications.

- Applications include public vending machines, ATM kiosks and industrial automotive use
- Designed for use on conductive or nonconductive surfaces
- TLA3000 model incorporates integrated GPS antenna


Typical VSWR response GSM900


MHz From Centre Frequency

Typical VSWR response GSM1800


MHz From Centre Frequency

Typical E-Plane response @ 890MHz


## Electrical

| Model No. | TLA2000/3000 |
| :--- | :---: |
| Gain dBi | 2 |
| Frequency MHz | $890-960 / 1710-1880$ |
| Power W | 10 |
| Tuned Bandwidth | Entire specified band @<2.5:1 VSWR |
| Tuning | Pre-tuned |

## Mechanical

| Model No. | TLA2000 |  |
| :--- | :---: | :---: |
| Construction | White Geloy ASA radome |  |
| Diameter mm | 135 |  |
| Height mm | 61 (including gasket) |  |
| Mounting | M4 hardware (not included) |  |
| Cable and Connector | 500mm low loss 9014 RG58 type | Cellular: 5m 9014 RG58 type - FME connector |
|  |  | GPS: 5m low loss RG174 type - MCX connector |

## GPS Specifications

| Fo | 1575.42 MHz |
| :--- | :---: |
| Operation Temperature | -40 to $+85^{\circ} \mathrm{C}$ |
| Storage Temperature | -40 to $+100^{\circ} \mathrm{C}$ |
| System Gain at Fo | 28 dBi including cable and filter losses |
| Impedance | 50 Ohm |
| Polarization | RHCP |
| VSWR at Fo | $1.5: 1$ |
| Noise Figure at Fo | $<1.8 \mathrm{~dB}$ max. |
| Power Input | +2.5 Vdc to +12 Vdc input, Auto Switching |
| Power Consumption | 11 mA to 13 mA (max) |
| Power Input | Reverse Polarity Short Circuit Shutdown |
| Over-Current | Thermal over-current shutdown $>+150^{\circ} \mathrm{C}$ |

## EDS-205/208 Series

## 5 and 8-port entry-level unmanaged Ethernet switches


> 10/100BaseT(X) (RJ45 connector), 100BaseFX (multi-mode, SC/ST connectors)
$>$ IEEE802.3/802.3u/802.3x support
$>$ Broadcast storm protection
> DIN-Rail mounting ability
$>-10$ to $60^{\circ} \mathrm{C}$ operating temperature range

## : Introduction

The EDS-205/208 series of industrial Ethernet switches are entrylevel industrial 5 and 8 -port Ethernet switches that support IEEE 802.3/802.3u/802.3x with 10/100M, full/half-duplex, MDI/MDIX autosensing RJ45 ports. The EDS-205/208 switches are rated to operate at temperatures ranging from -10 to $60^{\circ} \mathrm{C}$, and are rugged enough for
any harsh industrial environment. The switches can be easily installed on a DIN-Rail as well as in distribution boxes. The DIN-Rail mounting capability, wide operating temperature, and the the IP30 housing with LED indicators make the plug-and-play EDS-205/208 switches easy to use and reliable.

## : Specifications

## Technology

Standards:
IEEE 802.3 for 10BaseT
IEEE 802.3u for 100BaseT(X) and 100BaseFX
IEEE 802.3x for Flow Control
Processing Type: Store and Forward
FIow Control: IEEE 802.3x flow control, back pressure flow control

## Switch Properties

MAC Table Size: 1 K
Packet Buffer Size: 512 Kbit

## Interface

Fiber Ports: 100BaseFX ports (SC/ST connector, multi-mode) RJ45 Ports: 10/100BaseT(X) auto negotiation speed, Full/Half duplex mode, and auto MDI/MDI-X connection
LED Indicators: Power, 10/100M (TP port), 100M (fiber port)

## Optical Fiber

|  | 100BaseFX |  |
| :--- | :---: | :---: |
|  | Multi-mode | Single-mode |
| Wavelength | 1300 nm | 1310 nm |
| Max. TX | -10 dBm | 0 dBm |
| Min. TX | -20 dBm | -5 dBm |
| RX Sensitivity | -32 dBm | -34 dBm |
| Link Budget | 12 dB | 29 dB |
| Typical Distance | 5 km <br> 4 kmb <br> Saturation | -6 dBm |

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## Power Requirements

Input Voltage:
EDS-205: 12 to 48 VDC, 18 to 30 VAC ( 47 to 63 Hz )
EDS-208 series: 12 to 45 VDC, 18 to 30 VAC ( 47 to 63 Hz )
Input Current:
EDS-205: 0.12 A @ 24 V
EDS-208: 0.14 A @ 24 V
EDS-208-M: 0.23 A @ 24 V
Overload Current Protection: 1.1 A
Connection: 1 removable 3-contact terminal block
Reverse Polarity Protection: Present
Physical Characteristics
Housing: Plastic, IP30 protection
Dimensions:
EDS-205: $24.9 \times 100 \times 86.5 \mathrm{~mm}(0.98 \times 3.94 \times 3.41 \mathrm{in})$
EDS-208: $40 \times 100 \times 86.5 \mathrm{~mm}(1.57 \times 3.94 \times 3.41 \mathrm{in})$
Weight:
EDS-205: 135 g
EDS-208: 170 g
Installation: DIN-Rail mounting
Environmental Limits
Operating Temperature: -10 to $60^{\circ} \mathrm{C}$ (14 to $140^{\circ} \mathrm{F}$ )
Storage Temperature: -40 to $85^{\circ} \mathrm{C}\left(-40\right.$ to $\left.185^{\circ} \mathrm{F}\right)$
Ambient Relative Humidity: 5 to $95 \%$ (non-condensing)

## Standards and Certifications

Safety:
EDS-205: UL 508, EN 60950-1
EDS-208: UL 508, UL 60950-1, EN 60950-1
EMI: FCC Part 15 Subpart B Class A, EN 55022 Class A
EMS:
EN 61000-4-2 (ESD) Level 2, EN 61000-4-3 (RS) Level 3,
EN 61000-4-4 (EFT) Level 3, EN 61000-4-5 (Surge) Level 3,
EN 61000-4-6 (CS) (EDS-205: Level 3; EDS-208: Level 2),
EN 61000-4-8, EN 61000-4-11
Shock: IEC 60068-2-27
Freefall: IEC 60068-2-32
Vibration: IEC 60068-2-6
Note: Please check Moxa's website for the most up-to-date certification status.

MTBF (mean time between failures)
Time:
EDS-205: 768,000 hrs
EDS-208: 368,000 hrs

## Database:

EDS-205: Telcordia (Bellcore), GB
EDS-208: MIL-HDBK-217F, GB $25^{\circ} \mathrm{C}$
Warranty
Warranty Period: 5 years
Details: See www.moxa.com/warranty

: Ordering Information

| Available Models | Port Interface |  |  | Housing Material | Power Range |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Standard Temperature$\left(-10 \text { to } 60^{\circ} \mathrm{C}\right)$ | 10/100BaseT(X) | 100BaseFX |  |  |  |
|  |  | Multi-mode, SC Connector | Multi-mode, <br> ST Connector |  |  |
| EDS-205 | 5 | - | - | Plastic | 12 to 48 VDC |
| EDS-208 | 8 | - | - | Plastic | 12 to 45 VDC |
| EDS-208-M-SC | 7 | 1 | - | Plastic | 12 to 45 VDC |
| EDS-208-M-ST | 7 | - | 1 | Plastic | 12 to 45 VDC |

Optional Accessories (can be purchased separately) DR-4524/75-24/120-24: 45/75/120 W DIN-Rail 24 VDC power supplies MDR-40-24/60-24: 40/60 W DIN-Rail 24 VDC power supplies, -20 to $70^{\circ} \mathrm{C}$ operating temperature RK-4U: 4U-high 19" rack mounting kit

## Package Checklist

- EDS-205 or EDS-208 switch
- Hardware installation guide (printed)
- Warranty card Bulletin No. G306-E Drawing No. LP0588 Released 4/06

- CONFIGURED USING CRIMSON SOFTWARE (VERSION 2.0 OR LATER)
- UP TO 5 RS-232/422/485 COMMUNICATIONS PORTS (2 RS-232 AND 1 RS-422/485 ON BOARD, 1 RS-232 AND 1 RS422/485 ON OPTIONAL COMMUNICATIONS CARD)
- 10 BASE T/100 BASE-TX ETHERNET PORT TO NETWORK UNITS AND HOST WEB PAGES
- USB PORT TO DOWNLOAD THE UNIT'S CONFIGURATION FROM A PC OR FOR DATA TRANSFERS TO A PC
- UNIT'S CONFIGURATION IS STORED IN NON-VOLATILE MEMORY (4 MBYTE FLASH)
- COMPACTFLASH SOCKET TO INCREASE MEMORY CAPACITY
- 5.7-INCH STN PASSIVE MATRIX 256 COLOR QVGA $320 \times 240$ PIXEL LCD
- 5-BUTTON KEYPAD FOR ON-SCREEN MENUS
- THREE FRONT PANEL LED INDICATORS
- POWER UNIT FROM 24 VDC $\pm 20 \%$ SUPPLY
- RESISTIVE ANALOG TOUCHSCREEN


## GENERAL DESCRIPTION

The G306 Operator Interface Terminal combines unique capabilities normally expected from high-end units with a very affordable price. It is built around a high performance core with integrated functionality. This core allows the G306 to perform many of the normal features of the Paradigm range of Operator Interfaces while improving and adding new features.

The G306 is able to communicate with many different types of hardware using high-speed RS232/422/485 communications ports and Ethernet 10 Base T/100 Base-TX communications. In addition, the G306 features USB for fast downloads of configuration files and access to trending and data logging. A CompactFlash socket is provided so that Flash cards can be used to collect your trending and data logging information as well as to store larger configuration files.

In addition to accessing and controlling of external resources, the G306 allows a user to easily view and enter information. Users can enter data through the touchscreen and or front panel 5 -button keypad

## SAFETY SUMMARY

All safety related regulations, local codes and instructions that appear in the manual or on equipment must be observed to ensure personal safety and to prevent damage to either the instrument or equipment connected to it. If equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired

Do not use the controller to directly command motors. valves, or other actuators not equipped with safeguards. To do so can be potentially harmful to persons or equipment in the event of a fault to the controller.


The protective conductor terminal is bonded to conductive parts of the equipment for safety purposes and must be connected to an external protective earthing system.
WARNING - EXPLOSION HAZARD - SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS I, DIVISION 2/CLASS II, DIVISION 2/CLASS III, DIVISION 2


CAUTION: Risk Of Danger. Read complete instructions pricr to istallation and operation of the unit


CAUTION: Risk of electric shock

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## CONTENTS OF PACKAGE

- G306 Operator Interface
- Panel gasket.
- Template for panel cutout.
- Hardware packet for mounting unit into panel
- Terminal block for connecting power


## ORDERING INFORMATION

| model no. | DESCRIPTION | PART NUMBER |
| :---: | :---: | :---: |
| G306 | Operator Interface for indoor applications, textured finish with embossed keys | G306C000 |
| G3CF | 64 MB CompactFlash Card ${ }^{5}$ | G3CF064M |
|  | 256 MB CompactFlash Card ${ }^{5}$ | G3CF256M |
|  | 512 MB CompactFlash Card 5 | G3CF512M |
| G3RS | RS232/485 Optional Communications Cards | G3RS0000 |
| G3CN | CANopen Optional Communications Cards | G3CNO000 |
| PSDR7 | DIN Rail Power Supply | PSDR7000 |
| SFCRM2 | Crimson $2.0{ }^{2}$ | SFCRM200 |
| CBL | RS-232 Programming Cable | CBLPROGO |
|  | USB Cable | CBLUSB00 |
|  | Communications Cables ' | CBLxocox |
| DR | DIN Rail Mountable Adapter Products ${ }^{\text {3 }}$ | DRococox |
|  | Replacement Battery ${ }^{4}$ | BAL3R004 |
| G3FILM | Protective Films | G3FILM06 |

1 Contact your Red Lion distributor or visit our website for complete selection.
${ }^{2}$ Use this part number to purchase Crimson on CD with a printed manual, USB cable, and RS-232 cable Otherwise, download for free from www redionnet.
${ }^{3}$ Red Lion offers RJ modular jack adapters. Refer to the DR literature for complete details
${ }^{4}$ Battery type is lithium coin type CR2025
${ }^{5}$ Industrial grade two million write eycles

## SPECIFICATIONS

## 1. POWER REQUIREMENTS

Must use Class 2 or SELV rated power supply
Power connection via removable three position terminal block
Supply Volage: $\quad+24 \mathrm{VDC}+20 \mathrm{H}_{\mathrm{o}}$
Typical Power $\quad 8 \mathrm{~W}$
Maximum Power ${ }^{2}$ 14 W
Notes:

1. Typicol ponver with +24 VDC, RS232485 conmmurications, Ehkernel communications, CompactFlash candinstalled, and disploy al fidl hrigitaness.
2. Maximum power indicatex the most power that can be drann from the G306. Refer to "Power Supply Requirements" under "hustalling and Powering the G306."
3. The G306) circuit common is not comected to the enclosure of the umit. See "Commecting to Earth Ground" in the section "Instolling and Powering the G306,"
4. Read "Power Supply Requirements" in the section "Installing and Powering the G306" for additional power supply information.
5. BATTERY: Lithium coin cell. Typical lifetime of 10 years.
6. LCD DISPIAY

| SIZE | 5.7 -inch |
| :--- | :---: |
| TYPE | STN |
| COLORS | 256 |
| PIXELS | $320 \times 240$ |
| BRIGHTNESS | $165{\mathrm{~cd} / \mathrm{m}^{2}}^{\text {BACKLIGHT* }}$ |
|  | 20,000 HR TYP. |

"Lifetime at room temperature. Refer to "Display" in "Soffware/Unit Operation"
4. 5-KEY KEYPAD: for on-screen menus.
5. TOUCHSCREEN: Resistive analog
6. MEMIORY:

On Board User Memory: 4 Mbyte of non-volatile Flash memory
Memory Card CompactFlash Type II slot for Type I and Type II CompactFlash cards.
7. COMMUNICATIONS

USB Port: Adheres to USB specification I.1. Device only using Type B connection.


WARNING - DO NOT CONNECT OR DISCONNECT CABLES WHILE POWER IS APPLIED UNLESS AREA IS KNOWN TO BE NON-HAZARDOUS, USB PORT IS FOR SYSTEM SET-UP AND DIAGNOSTICS AND IS NOT INTENDED FOR PERMANENT CONNECTION

Serial Ports: Format and Baud Rates for each port are individually software programmable up to 115,200 baud
PGM Port RS232 port via RJ12
COMMS Ports: RS422/485 port via RJ45; and RS232 port via RJ12
DH485 TXEN: Transmit enable; open collector, $\mathrm{V}_{\text {On }}=15 \mathrm{VDC}$. $\mathrm{V}_{\mathrm{OL}}=0.5 \mathrm{~V}$ (t 25 mA max
Note: For additional information on the communications or signal common and comnections to earth ground please see the "Connecting to Earth Ground" in the section "Installing and Powering the G306,"
Ethernet Port: 10 BASE-T / 100 BASE-TX
RJ45 jack is wired as a NIC (Network Interface Card).
Isolation from Ethemet network to G3 operator interface: 1500 Vrms
8. ENVIRONMENTAL CONDITIONS

Operating Temperature Range: 0 to $50^{\circ} \mathrm{C}$
Storage Temperature Range. -20 to $70^{\circ} \mathrm{C}$
Operating and Storage Itumidity: $80 \%$ maximum relative humidity (noncondensing) from 0 to $50^{\circ} \mathrm{C}$
Vibration: Operational 5 to $8 \mathrm{~Hz} .0 .8^{n}(\mathrm{p}-\mathrm{p})$. 8 to 500 Hz , in X. Y, $Z$ difection, duration. I hour, 3 e
Shock: Operational 40 g .9 msec in 3 directions.
Altitude: Up to 2000 meters.
9. CERTIFICATIONS AND COMPLIANCES

SAFETY
UL Recognized Component. Filc iEE179259, UL.61010-1, CSA 222 No. $61010-1$ Recognized to U.S. and Canadian requirements under the Componem Recognition Program of Underwriters Laboratories, Inc.
UL. Listed. File \#E211967, UL.61010-1, Ut.1604, CSA 22.2 No. 61010.1 , CSA 22.2 No. 213-M1987
LISTED by Und Lab. Inc. to U.S. and Comadian safety standards
Type 4X Enclosure rating (Face only), UL. 50
IECEE CB Scheme Test Certificate \#US/9737/UL.
CB Scheme Test Report \#E179259-V01-S04
Issued by Underwriters Laboratories Inc.
IEC 61010-1, EN 61010-1: Safety requirements for electrical equipment for measurement, control, and laboratory use, Part I
IP66 Enclosure rating (Face only), IEC 529
ELECTROMAGNETIC COMPATIBILITY
Emissions and Immunity to EN 61326; Electrical Equipment for Measurement, Control and Luboratory use.

## Immunity to Industrial Locations:

| Electrostatic discharge | EN 61000-4-2 | Criterion A |
| :---: | :---: | :---: |
|  |  | 4 kV contact discharge |
|  |  | 8 kV air discharge |
| Electromagnetic RF fields | EN 61000-4-3 | Criterion A |
|  |  | $10 \mathrm{~V} / \mathrm{m}$ |
| Fast transients (burst) | EN 61000-4-4 | Criterion A |
|  |  | 2 kV power |
|  |  | 1 kV signal |
| Surge | EN 61000-4-5 | Criterion A |
|  |  | $1 \mathrm{kVL-L}$, |
|  |  | 2kVI.\&N-E power |
| RF conducted interference | EN 61000-4-6 | Criterion A |
|  |  | $3 \mathrm{~V} / \mathrm{mms}$ |
| Emissions: |  |  |
| Emissions | EN 55011 | Class A |

Note:

1. Criterion A: Normal operation within specified himits.

10 CONSTRUCTION: Steel rear metal enclosure with NEMA 4 X/IP66 aluminum fromt plate for indoor use only when correctly fitted with the gasket provided. Installation Category II, Pollution Degree 2
11. MOUNTING REQUIREMENTS: Maximum panel thickness is $0.25^{\circ}$ (6.3 mm ). For NEMA 4XAP66 sealing a steel panel with a minimum thickness of $0.125^{\prime \prime}(3.17 \mathrm{~mm})$ is recommended.
Maximum Mounting Stud Torque: 17 inch-pounds ( $1.92 \mathrm{~N}-\mathrm{m}$ )
12. WEIGHT: $3.0 \mathrm{lbs}(1.36 \mathrm{Kg})$

## DIMENSIONS In inches (mm)



## Installing and Powering the G306

## MOUNTING INSTRUCTIONS

This operator interface is designed for through-panel mounting. A panel cutout diagram and a template are provided. Care should be taken to remove any loose material from the mounting cut-out to prevent that material from falling into the operator interface during installation. A gasket is provided to enable sealing to NEMA 4XIP66 specification. Install the ten kep nuts provided and tighten evenly for uniform gasket compression.
Note: Tightening the Rep nuts bejond a maximum of 17 inch-poands 11.92 N . 1 m) mon-couse damage to the front panet.


ALL NONINCENDIVE CIRCUITS MUST BE MRED USING DIVISION 2 WIRING METHODS AS SPECIFIED IN ARTICLE 501 4 (b), 502-4 (b), AND 503-3 (b) OF THE NATIONAL ELECTRICAL CODE, NFPA 70 FOR INSTALLATION WTHIN THE UNITED STATES, OR AS SPECIFIED IN SECTION 19-152 OF CANADIAN ELECTRICAL CODE FOR INSTALLATION IN CANADA.
CONNECTING TO EARTH GROUND


The protective conductor terminal is bonded to conductive parts of the equipment for safety purposes and must be connected to an external protective carthing system.

Each G306 has a chassis ground terminal on the back of the unit. Your unit should be connected to earth ground (protective earth).

The chassis ground is not connected to signal common of the unit. Maintaining isolation between earth ground and signal common is not required to operate your unit But, other equipment connected to this unit may require isolation between signal common and earth ground. To maintain isolation between signal common and earth ground care mass be taken when comwections ore made to the sunit. For example, a power supply with isolation between its signat common and earth ground must be used. Also, plugging in a USB cable may connect signal conmon and earth ground '

1. USB's shield may be connected to earth ground at the host. USB's shield in turn may also be connected to signal common.

## POWER SUPPLY REQUIREMENTS

The G306 requires a 24 VDC power supply. Your unit may draw considerably less than the maximum rated power depending upon the options being used. As additional features are used your unit will draw increasing amounts of power. Items that could cause increases in current are additional communications, optional communications card, CompactFlash card, and other features programmed through Crimson.

In any case, it is very important that the power supply is mounted correctly if the unit is to operate reliably. Please take care to observe the following points:

- The power supply musi be mounted close to the unit, with usually not more than 6 feet ( 1.8 m ) of cable between the supply and the operator interface. Ideally, the shortest length possible should be used.
- The wire used to connect the operator interface's power supply should be at least 22-gage wire. If a longer cable run is used, a heavier gage wire should be used. The routing of the cable should be kept away from large contactors, inverters, and other devices which may generate significant electrical noise.
- A power supply with a Class 2 or SEL.V rating is to be used. A Class 2 or SEL.V power supply provides isolation to accessible circuits from hazardous voltage levels generated by a mains power supply due to single faults. SELV is an acronym for "safety extra-low voltage." Safety extra-low volage circuits shall exhibit voltages safe to touch both under normal operating conditions and after a single fault, such as a breakdown of a layer of basic insulation or after the failure of a single component has occurred.


## Communicating With the G306

## CONFIGURING A G306

The G306 is configured using Crimson software. Crimson is available as a free download from Red Lion's website, or it can be purchased on CD. Updates to Crimson for new features and drivers are posted on the website as they become available. By configuring the G306 using the latest version of Crimson, you are assured that your unit has the most up to date feature set. Crimson software can configure the G306 through the RS232 PGM port, USB port, or CompactFlash.

The USB port is connected using a standard USB cable with a Type B connector. The driver needed to use the USB port will be installed with Crimson.

The RS232 PGM port uses a programming cable made by Red Lion to connect to the DB9 COM port of your computer. If you choose to make your own cable. use the "G306 Port Pin Out Diagram" for wiring information

The CompactFlash can be used to program a G3 by placing a configuration file and firmware on the CompactFlash card. The card is then inserted into the target G3 and powered. Refer to the Crimson literature for more information on the proper names and locations of the files.

## USB, DATA TRANSFERS FROM THE COMPACTFLASH CARD



WARNING - DO NOT CONNECT OR DISCONNECT CABLES WHILE POWER IS APPLIED UNLESS AREA IS KNOWN TO BE NON-HAZARDOUS. USB PORT IS FOR SYSTEM SET-UP AND DIAGNOSTICS AND IS NOT INTENDED FOR PERMANENT CONNECTION.
In order to transfer data from the CompactFlash card via the USB port, a driver must be installed on your computer. This driver is installed with Crimson and is located in the folder C:Mrogram Files Red Lion Controls Crimson 20 Device afler Crimson is installed. This may have already been accomplished if your G3.306 was configured using the USB port

Once the driver is installed, connet the G306 to your PC with a USB cable, and follow "Mounting the Compact Flash" instructions in the Crimson 2 user manual.

## CABLES AND DRIVERS

Red Lion has a wide range of cables and drivers for use with many different communication types. A list of these drivers and cables along with pin outs is available from Red Lion's website. New cables and drivers are added on a regular basis. If making your own cable, refer to the "G306 Port Pin Outs" for wiring information.

## ETHERNET COMMUNICATIONS

Ethernet communications can be established at either 10 BASE-T or 100 BASE-TX. The G306 unit's RJ45 jack is wired as a NIC (Network Interface Card). For example, when wiring to a hub or switch use a straight-through cable, but when connecting to another NIC use a crossover cable

The Ethernet connector contains two LEDs. A yellow LED in the upper right, and a bi-color green/amber LED in the upper lef. The LEDs represent the following statuses:

| LED COLOR | DESCRIPTION |
| :--- | :--- |
| YELLOW solid | Link established. |
| YELL.OW flashing | Data being transferred. |
| GREEN | 10 BASE-T Communications |
| AMBER | 100 BASE-TX Communications |

On the rear of each unit is a unique 12 -digit MAC address and a block for marking the unit with an IP address. Refer to the Crimson manual and Red Lion's website for additional information on Ethernet communications.

## RS232 PORTS

The G306 has two RS232 ports. There is the PGM port and the COMMS port Although only one of these ports can be used for programming, both ports can be used for communications with a PLC.

The RS232 ports can be used for either masier or slave protocols with any G306 configuration

Examples of RS232 communications could involve another Red Lion product or a PC. By using a cable with RJ12 ends on it, and a twist in the cable, RS232 communications with another G3 product or the Modular Controller can be established. Red Lion part numbers for cables with a twist in them are CBLPROG0 ' CBL.RLCO1 ${ }^{2}$, or CBL.RCO2 ${ }^{3}$

G3 RS232 to a PC

| Connections |  |  |  |
| :---: | :---: | :---: | :---: |
| G3: RJ12 | Name | PC. DB9 | Name |
| 4 | COMM | 1 | DCD |
| 5 | Tx | 2 | Rx |
| 2 | Rx | 3 | Tx |
|  | N/C | 4 | DTR |
| 3 | COM | 5 | GND |
|  | N/C | 6 | DSR |
| 1 | CTS | 7 | RTS |
| 6 | RTS | 8 | CTS |
|  | N/C | 9 | Ri |

CONNECTING A G3OG OPERATOR
INTERFACE TO AN ICM5

${ }^{1}$ CBL.PROG0 can also be used to communicate with either a PC or an ICM5
${ }^{2}$ DB9 adapter not included, I foot long
${ }^{3}$ DB9 adapter not included, 10 feet long.


## RS422/485 COMMS PORT

The G306 has one RS422-485 port. This port can be configured to act as either RS422 or RS485.


Note: All Red Lion devices connect A to A and B to B, except for Paradigm devices. Refer to wimerndilion net for additional information.

## DH485 COMMUNICATIONS

The G306's RS422/485 COMMS port can also be used for Allen Bradley DH485 communications.

WARNING: DO NOT use a standard DH 485 cable to connect this port to Allen Bradley equipment. A cable and wiring diagram are available from Red Lion.

G3 to AB SLC 500 (CBLAB003)

| Connections |  |  |  |
| :---: | :---: | :---: | :---: |
| RJ45: RLC | Name | RJ45: A-B | Name |
| 1 | TxB | 1 | A |
| 2 | T×A | 2 | $B$ |
| 3,8 | R×A | - | 24 V |
| 4,7 | R×B | - | COMM |
| 5 | TxEN | 5 | TxEN |
| 6 | COMM | 4 | SHIELD |
| 4,7 | TxB | - | COMM |
| 3,8 | TxA | - | $24 V$ |

## Examples of RS485 2-Wire Connections

G3 to Red Lion RJ11 (CBLRLC00) DLC, IAMS, ITMS, PAXCDC4C

| Connections |  |  |  |
| :---: | :---: | :---: | :---: |
| G3: R.J45 | Name | RL.C: RJ11 | Name |
| 5 | TxEN | 2 | TxEN |
| 6 | COM | 3 | COM |
| 1 | TxB | 5 | B |
| 2 | TxA | 4 | A+ |

G3 to Modular Controller (CBLRLC05)

| Connections |  |  |  |
| :---: | :---: | :---: | :---: |
| G3 | Name | Modular Controller | Name |
| 1,4 | TxB | 1,4 | TxB |
| 4,1 | RxB | 4,1 | RxB |
| 2,3 | TxA | 2,3 | TxA |
| 3,2 | R×A | 3,2 | R×A |
| 5 | TxEN | 5 | TxEN |
| 6 | COM | 6 | COM |
| 7 | TxB | 7 | TxB |
| 8 | TxA | 8 | TxA |

## Software/Unit Operation

## CRIMSON SOFTWARE

Crimson software is available as a free download from Red Lion's website or it can be purchased on a CD, see "Ordering Information" for part number. The latest version of the software is always available from the website, and updating your copy is free.

## DISPLAY

This operator interface uses a liquid erystal display (L.CD) for displaying text and graphics. The display utilizes a cold cathode fluorescent tube (CCFL) for lighting the display. The CCFL tubes can be dimmed for low light conditions.

These CCFL tubes have a limited lifetime. Backlight lifetime is based upon the amount of time the display is tumed on at full intensity. Tuming the backlight off when the display is not in use can extend the lifetime of your backlight. This can be accomplished through the Crimson software when configuring your unit

## FRONT PANEL LEDS

There are three front pancl LEDs. Shown below is the default status of the L.EDs

| LED | nNDICATION |
| :---: | :--- |
| RED (TOP, LABELED "PWR") |  |
| FLASHING | Unit is in the boot loader, no valid configuration is loaded.' |
| STEADY | Unit is powered and running an application. |
| YELLOW (MIDDLE) |  |
| OFF | No CompactFlash card is present. |
| STEADY | Valid CompactFlash card present. |
| FLASHING <br> RAPIDLY | CompactFlash card being checked. |
| FLICKERING | Unit is witing to the CompactFlash, either because it is storing <br> data, or because the PC connected via the USB port has <br> locked the drive. |
| FLASHING <br> SLOWLY | Incorrectly formatted CompactFlash card present. |
| GREEN (BOTTOM) |  |
| FLASHING | A tag is in an alarm state. |
| STEADY | Valid configuration is loaded and there are no alarms present. |

1. The operator interface is shipped without a configuration. After downloading a configuration, if the light remains in the flashing state continuously, try cycling power. If the LFD still continues to flash, try downloading a configuration again.
2. Do not turn off power to the unit while this light is flickering. The unit writes data in two minute intervals. Later Microsof operating systems will not lock the drive unless they need to write data; Windows 98 may lock the drive any time it is mounted, thereby interfering with logging. Refer to "Mounting the CompaetFlash" in the Crimson 2 User Manual.

## TOUCHSCREEN

This operator interface utilizes a resistive analog touchscreen for user input The unit will only produce an audible tone (beep) when a touch on an active touchscreen cell is sensed. The touchscreen is fully functional as soon as the operator interface is initialized, and can be operated with gloved hands

## KEYPAD

The G306 keypad consists of five keys that can be used for on-screen menus

## TROUBLESHOOTING YOUR G306

If for any reason you have trouble operating, connecting, or simply have questions concerning your new G306, contact Red Lion's technical support. For contact information, refer to the back page of this bulletin for phone and fax numbers

EMAIL: ischsupportiuredlionens!
Web Site: hti. Mพา. redlion net

## BATTERY \& TIME KEEPING



WARNING - EXPLOSION HAZARD - THE AREA MUST BE KNOWN TO BE NON-HAZARDOUS BEFORE SERVICING/ REPLACING THE UNIT AND BEFORE INSTALLING OR REMOVING IO WIRING AND BATTERY


WARNING - EXPLOSION HAZARD - DO NOT DISCONNECT EQUIPMENT UNLESS POWER HAS BEEN DISCONNECTED AND THE AREA IS KNOWN TO BE NON-HAZARDOUS

A thattery is used to keep time when the unit is without power Typical accuracy of the G306 time keeping is less than one minute per month drift. The batlery of a G306 unit does nof affect the unit's memory, all conligurations and data is stored in non-volutile memory


## CAUTION: RISK OF ELECTRIC SHOCK

The inverter board, attached to the mounting plate, supplies the high voltage to operate the backlight. Touching the inverer board may result in injury to personnel.


CAUTION: The circuit board contains static sensitive components. Before handling the operator interface without the rear cover attached, discharge static charges from your body by touching a grounded bare metal object. Ideally. handle the operator interface at a static controlled elean workstation. Also, do not touch the surface areas of the circuit board. Dirt, oil, or other contaminants may adversely affect circuit operation
To change the battery of a G306, remove power, cabling, and then the rear cover of the unit. To remove the cover, remove the four screws designated by the arrows on the rear of the unit. Then, by lifling the top side, linge the cover, thus providing elearance for the connectors on the bottom side of the PCB as shown in the illustration below. Install in the reverse manner


## Optional Features and Accessories

## OPTIONAL COMMUNICATION CARD

Red Lion offers optional communication cards for fieldbus communications. These communication cards will allow your G306 to communicate with many of the popular fieldbus protocols
Red Lion is also offering a communications card for additional RS232 and RS422/485 communications. Visit Red Lion's website for information and availability of these cards.

## CUSTOM LOGO

Each G3 operator interface has an embossed area containing the Red Lion logo Red Lion can provide custom logos to apply to this area. Contact your distributor for additional information and pricing


## COMPACTFLASH SOCKET

CompactFlash socket is a Type II socket that can accept either Type I or II cards. Use cards with a minimum of 4 Mbytes with the G306's CompactFlash socket. Cards are available at most computer and office supply retailers.

CompactFlash can be used for configuration transfers, larger configurations. data logging, and trending.
 the CompoctFlash cand while power is applied. Refer to
"Front Panel LEDs."
Information stored on a Compactillash card by a G306 can be read by a card reader attached to a PC. This information is stored in IBM (Windows ${ }^{*}$ ) PC compatible FATI 6 file format.

## NOTE

For reliable operation in all of our products. Red Lion recommends the use of SanDisk" and SimpleTech brands of CompactFlash cards.

Industrial grade versions that provide up to two million write/erase cycles minimum are available from Red Lion.

## LIMITED WARRANTY

Thie Company warrants the products it manufoctures ayainst defeets in materials and workmanship for a period linuited to two years from the date of shipment, provided the products have been stoved, handled, installed, and used under proper conditions The Company's liability under this limited warranty shall extend only to the repair or replacenent of a defective product. at The Compary 's option. The Company disclaims all liahility for any affimation, promise or representation with respect to the products. The custoner ayrees to hold Red Lion Controls haunless from, defend, and indennify RL.C against damages claims and expenses arising out of subsequent sales of RLC prodocts or prodocts containing components manafictured by RL.C and based upon personal injuries, deaths. property damage. lost profits, and other maters which Buyer, its employees. or sab-coatractors are or nay be to any ectent liable, including without limitation penalties imposed by the Consumer Prodnct Salety Act (PL. 92-573) and liability imposed upon any person pursaant to the Magnuson-Moss Warranty Act (PL 93-637) as now in effect or as amended hereafter.
No warranties expressed or implied are created with respect to The Company's prodacts exeept those expressly contained herein. The Customer achnowledjes the disclainers and limitations contained herein and relies on no other warranties or affirmations.

Red Lion Controts
20 Willow Springs Circle York PA 17402 Tel +1 (717) 767-6511 Fax +1 (717) 764-0839

## Red Lion Controls BV

 Basicweg 11bNL - 3821 BR Amersfoort Tel + 31 (0) 334723225 Fax +31 (0) 334893793

## Universal Transient Barrier, Single Pair - UTB30SP (702863)



- Compact design universal transient barrier provides protection of low-voltage circuits and transducers
- Separate plug and base design allows hot swappable module replacement
- Multi-stage protection and fine over-voltage protection helps ensure lowest residual surge voltages reach sensitive equipment
- Common-mode and differential-mode protection protects against both possible surge conditions
- Surge rating to $20 \mathrm{kA} 8 / 20 \mu \mathrm{~s}$ is ideal for exposed wiring
- Allows for protection of 25 analog signals or 50 digital signals per linear foot ( $0,3 \mathrm{~m}$ ) of DIN rail space

| Part Number | UTB30SP |
| :---: | :---: |
| Article Number | 702863 |
| Nominal System Voltage (Un) | $\begin{aligned} & 10-21 \mathrm{VAC} \\ & 15-30 \mathrm{VDC} \end{aligned}$ |
| Max Continuous Operating Voltage (Uc) | $\begin{aligned} & 23 \mathrm{VAC} \\ & 33 \mathrm{VDC} \end{aligned}$ |
| Max Line Current (IL) | 2 A |
| Frequency | 2 MHz |
| Loop Resistance | $1 \Omega$ |
| Max Discharge Current (Imax), L+L-PE | $20 \mathrm{kA} 8 / 20 \mu \mathrm{~s}$ |
| Protection Modes | Common Differential |
| Technology | Gas Discharge Tube (GDT) Metal Oxide Varistor (MOV) Silicon Avalanche Diode (SAD) |
| Voltage Protection Level (Up), L-L | 44 V @ 3 kA |
| Connection, Stranded | $\begin{aligned} & \# 18-\# 12 \\ & 1-4 \mathrm{~mm}^{2} \end{aligned}$ |
| Mounting | 35 mm top hat DIN rail |
| Temperature | $\begin{array}{\|l} \hline-20 \text { to } 65^{\circ} \mathrm{C} \\ -4 \text { to } 149{ }^{\circ} \mathrm{F} \end{array}$ |
| Enclosure Material | UL® 94V-0 thermoplastic |
| Enclosure Rating | IP 20 NEMA®-1 |
| Depth (D) | $\begin{array}{\|l\|} \hline 2.83 " \\ 72 \mathrm{~mm} \end{array}$ |
| Height (H) | $\begin{array}{\|l\|} \hline 3.54 " \\ 90 \mathrm{~mm} \end{array}$ |
| Width (W) | $\begin{aligned} & \hline 0.47^{\prime \prime} \\ & 12 \mathrm{~mm} \end{aligned}$ |
| Unit Weight | $\begin{aligned} & 0.15 \mathrm{lb} \\ & 0.07 \mathrm{~kg} \end{aligned}$ |
| Listing Details | UL* 497B |
| Complies With | ANSI®/EEE® C62.41.2-2002 Cat A, Cat B, Cat C |
| Replacement Module | UTB30SPM |
| Standard Packaging Quantity | 1 pc |


| Part Number | UTB30SP |
| :--- | :--- |
| UPC | 78285662198 |
| UNSPSC | 39121610 |
| ETIM | EC000943 |
| Approvals | UR |

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## WARNING

ERICO products shall be installed and used only as indicated in ERICO's product instruction sheets and training materials. Instruction sheets are available at www.erico.com and from your ERICO customer service representative. Improper installation, misuse, misapplication or other failure to completely follow ERICO's instructions and warnings may cause product malfunction, property damage, serious bodily injury and death.

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## DATA SHEET

Coax Cable Connector
N-203HS
N -201

## Description



Straight Cable Plug Crimp
Suits Cables: LMR400 CNT400 BELDEN 9913

## Technical Data

Electrical
Impedance 50 Ohm
Max Frequency $\quad 11 \mathrm{GHz}$

## Mechanical \& Environmental Data

| Centre contact | Crimp |  |  |
| :---: | :---: | :---: | :---: |
| Outer Contact | Crimp |  |  |
| Mating | 5/8"-24 threaded coupling |  |  |
| Durability | 500 matings |  |  |
| Coupling nut retention | 1001bs Max |  |  |
| Cable Retention | 40 lbs min |  |  |
| Tempreture Range | $-65^{\circ}$ to $165^{\circ} \mathrm{C}$ |  |  |
| Vibration | MIL-STD-202 Test Cond B |  |  |
| Salt Spray | MIL-STD-101 Test Cond B |  |  |
| Thermal Shock | MIL-STD-107 Test Cond B |  |  |
| Material Data |  |  |  |
| Parts | Material | Plating |  |
|  |  | N-203HS | N-201 |
| Connector Body | Brass | Silver | White Bronze |
| Centre contact | Brass | Gold | Gold |
| Insulation | Teflon | - | - |
| Gasket | Silicone Rubber | - | - |
| Crimp Ferrule | Anneald Copper | Silver | White Bronze |

## (1acisinix

## Extract from the online catalog

## TCP 0,25A

Order No.: 0712123

The illustration shows version TCP 2A
http://catalog.phoenixcontact.net/phoenix/treeViewClick.do?UID=0712123

Thermal miniature circuit breaker, pluggable in screw-type fuse terminal block UK 6-FSI/C and spring-cage fuse terminal block ST 4FSI/C

| Commercial data |  |
| :--- | :--- |
| EAN | $4\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|$ |
| 048422 |  |$|$

## Product notes <br> WEEE/RoHS-compliant since: 01/01/2003

## http://

www.download.phoenixcontact.com Please note that the data given here has been taken from the online catalog. For comprehensive information and data, please refer to the user documentation. The General Terms and Conditions of Use apply to Internet downloads.

## Technical data

## General

| Installation instructions | When mounted in rows, the nominal device current can be limited <br> to just $80 \%$ or must be overdimensioned accordingly. |
| :--- | :--- |
| Mounting type | On base element |
| Color | black |
| Number of positions | 1 |

TCP 0,25A Order No.: 0712123
http://catalog.phoenixcontact.net/phoenix/treeViewClick.do?UID=0712123

| Surge voltage category | II |
| :--- | :--- |
| Insulating material | PPS |
| Inflammability class according to UL 94 | V0 |

## Electrical data

| Fuse | Slow-blow |
| :---: | :---: |
| Fuse type | Automatic device |
| Rated surge voltage | 2.5 kV |
| Rated voltage | 250 V AC |
|  | 65 V DC |
|  | 250 V (AC according to UL 1077) |
|  | 72 V (DC according to UL 1077) |
| Rated current $\mathrm{I}_{\mathrm{n}}$ | 0.25 A |
| Insulation resistance $\mathrm{R}_{\text {iso }}$ | > $100 \mathrm{M} \Omega(500 \mathrm{~V}$ DC) |
| Rated short-circuit switching capacity $\mathrm{I}_{\mathrm{cn}}$ | 1.5 A (250 V AC / 65 V DC) |
|  | 6.25 A (30 V DC) |
| Short-circuit switching capacity $\mathrm{I}_{\mathrm{k}}$ | 2000 A 250 V AC / UL 1077 |
|  | 2000 A 72 V DC / UL 1077 |
| Dielectric strength | 3000 V AC (Actuation area) |
|  | 1500 V AC (Installation area) |
| Cycles, max. | 6000 (At $1 \times \mathrm{I}_{\mathrm{n}}$, low-induction) |
|  | 3000 (At $1 \times \mathrm{I}_{\mathrm{n}}$, inductive) |
|  | 500 (At $2 \times \mathrm{I}_{\mathrm{n}}$, inductive) |
| Pollution degree | 2 |
| Surge voltage category | 11 |
| Insulating material group | IIIb |

Dimensions

| Height | 24.4 mm |
| :--- | :--- |
| Width | 8.2 mm |
| Depth | 44.5 mm |
| Height NS 35/7,5 | 55 mm |
| Complete module height | 64 mm |
| Complete module width | 8.2 mm |
| Complete module depth | 88.5 mm |

TCP 0,25A Order No.: 0712123
http://catalog.phoenixcontact.net/phoenix/treeViewClick.do?UID=0712123

## Ambient conditions

| Degree of protection | IP40 (Actuation area) |
| :--- | :--- |
| Ambient temperature (operation) | $-20^{\circ} \mathrm{C} \ldots 60^{\circ} \mathrm{C}$ |
| Standards and Regulations |  |
| Standards/specifications | EN 60934 |
| Certificates / Approvals |  |

## (1) M 會 तI 队

Certification
CSA, cULus Recognized, GOST, VDE Zeichengenehmigung

Certifications applied for:
Certification Ex:

| Accessories |  |  |
| :--- | :--- | :--- |
| Item | Designation | Description |
| Marking | ZBFM 5/OG:UNBEDRUCKT | Flat zack marker sheet, Sheet, orange, Unlabeled, can be labeled <br> with: Plotter, Mounting type: Snap into flat marker groove, for <br> terminal block width: 5.2 mm, Lettering field: $5 \times 4.5 \mathrm{~mm}$ |
| 0807180 | ZBFM 5/WH:UNBEDRUCKT | Flat zack marker sheet, Sheet, white, Unlabeled, can be labeled <br> with: Plotter, Mounting type: Snap into flat marker groove, for <br> terminal block width: 5.2 mm, Lettering field: $5 \times 4.5 \mathrm{~mm}$ |
| 0803595 | ZBFM 5:SO/CMS | Flat zack marker sheet, white, for terminal block width: 5.2 mm |
| 0803647 |  |  |

## Additional products

Item Designation Description

## General

| 3036372 | ST 4-FSI/C | Fuse modular terminal block, Connection method: Spring-cage <br> connection, Cross section: $0.08 \mathrm{~mm}^{2}-6 \mathrm{~mm}^{2}$, AWG: $28-10$, <br> Nominal current: 30 A, Nominal voltage: 400 V, Width: 8.2 mm, |
| :--- | :--- | :--- |
| Fuse type: C, Fuse type: Flat, Mounting type: NS 35/7,5, NS |  |  |
| $35 / 15$, Color: black |  |  |, | Fuse terminal block with LED for mounting on NS 35, for miniature |
| :--- |
| circuit breakers, terminal width: 8.2 mm, color: Black |

TCP 0,25A Order No.: 0712123
http://catalog.phoenixcontact.net/phoenix/treeViewClick.do?UID=0712123

| 3118203 | UK 6-FSI/C | Flat-type fuse terminal block, cross section: $0.2-6 \mathrm{~mm}^{2}$, AWG: 26 <br> -8, width: 8.2 mm, color: black |
| :--- | :--- | :--- |
| 3118203 | UK 6-FSI/C | Flat-type fuse terminal block, cross section: $0.2-6 \mathrm{~mm}^{2}$, AWG: 26 <br> -8 , width: 8.2 mm , color: black |
| 3001925 | UK 6-FSI/C-LED12 | Flat-type fuse terminal block, cross section: $0.2-6 \mathrm{~mm}^{2}$, AWG: 26 <br> -8, width: 8.2 mm , color: black, with light indicator, voltage light <br> indicator: $12 \mathrm{~V} \mathrm{DC} ,\mathrm{current} \mathrm{light} \mathrm{indicator:} 2 \mathrm{~mA}$ |
| 3001938 | UK 6-FSI/C-LED24 | Flat-type fuse terminal block, cross section: $0.2-6 \mathrm{~mm}^{2}$, AWG: 26 <br> -8, width: 8.2 mm, color: black, with light indicator, voltage light <br> indicator: $24 \mathrm{~V} \mathrm{DC} ,\mathrm{current} \mathrm{light} \mathrm{indicator:} 2 \mathrm{~mA}$ |

## Drawings

Application drawing


Fuse terminal block in single arrangement, block consisting of one fuse terminal block and 4 feed-through terminal blocks



Fuse terminal blocks in interconnected arrangement,
block consisting of 5 fuse terminal blocks

TCP 0,25A Order No.: 0712123
http://catalog.phoenixcontact.net/phoenix/treeViewClick.do?UID=0712123

Diagram


Dimensioned drawing


## RPMㅇNNN

## Extract from the online catalog

## PT 2,5

Order No.: 3209510
http://catalog.phoenixcontact.net/phoenix/treeViewClick.do?UID=3209510

Feed-through terminal block, Connection method: Push-in connection,
Cross section: $0.14 \mathrm{~mm}^{2}-4 \mathrm{~mm}^{2}$, AWG: 26-12, Width: 5.2 mm , Height: 35.3 mm, Color: gray, Mounting type: NS 35/7,5, NS 35/15

| Commercial data |  |
| :--- | :--- |
| EAN | $4\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|$ |$|$

## http://

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Technical data

General

| Number of levels | 1 |
| :--- | :--- |
| Number of connections | 2 |
| Color | gray |
| Insulating material | PA |
| Inflammability class according to UL 94 | V0 |

PT 2,5 Order No.: 3209510
http://catalog.phoenixcontact.net/phoenix/treeViewClick.do?UID=3209510

| Area of application | Railway industry |
| :---: | :---: |
|  | Mechanical engineering |
|  | Plant engineering |
|  | Process industry |
| General |  |
| Maximum load current | 30 A (with $4 \mathrm{~mm}^{2}$ conductor cross section) |
|  | 24 A (with $2.5 \mathrm{~mm}^{2}$ conductor cross section) |
| Rated surge voltage | 6 kV |
| Pollution degree | 3 |
| Surge voltage category | III |
| Insulating material group | 1 |
| Connection in acc. with standard | IEC 60947-7-1 |
| Nominal current $I_{N}$ | 24 A (For $2.5 \mathrm{~mm}^{2}$ ) |
| Nominal voltage $U_{N}$ | 800 V |
| Open side panel | ja |
| Shock protection test specification | DIN EN 50274 (VDE 0660-514):2002-11 |
| Back of the hand protection | guaranteed |
| Finger protection | guaranteed |
| Surge voltage test setpoint | 9.8 kV |
| Result of surge voltage test | Test passed |
| Power frequency withstand voltage setpoint | 2 kV |
| Result of power-frequency withstand voltage test | Test passed |
| Checking the mechanical stability of terminal points ( $5 \times$ conductor connection) | Test passed |
| Bending test rotation speed | 10 rpm |
| Bending test turns | 135 |
| Bending test conductor cross section/weight | $0.14 \mathrm{~mm}^{2} / 0.2 \mathrm{~kg}$ |
|  | $2.5 \mathrm{~mm}^{2} / 0.7 \mathrm{~kg}$ |
|  | $4 \mathrm{~mm}^{2} / 0.9 \mathrm{~kg}$ |
| Result of bending test | Test passed |
| Conductor cross section tensile test | $0.14 \mathrm{~mm}^{2}$ |
| Tractive force setpoint | 10 N |
| Conductor cross section tensile test | $2.5 \mathrm{~mm}^{2}$ |
| Tractive force setpoint | 50 N |
| Conductor cross section tensile test | $4 \mathrm{~mm}^{2}$ |

PT 2,5 Order No.: 3209510
http://catalog.phoenixcontact.net/phoenix/treeViewClick.do?UID=3209510

| Tractive force setpoint | 60 N |
| :---: | :---: |
| Tensile test result | Test passed |
| Tight fit on carrier | NS 35 |
| Setpoint | 1 N |
| Result of tight fit test | Test passed |
| Requirements, voltage drop | $\leq 3.2 \mathrm{mV}$ |
| Result of voltage drop test | Test passed |
| Temperature-rise test | Test passed |
| Conductor cross section short circuit testing | 2.5 mm ${ }^{2}$ |
| Short-time current | 0.3 kA |
| Conductor cross section short circuit testing | $4 \mathrm{~mm}^{2}$ |
| Short-time current | 0.48 kA |
| Short circuit stability result | Test passed |
| Ageing test for screwless modular terminal block temperature cycles | 192 |
| Result of aging test | Test passed |
| Proof of thermal characteristics (needle flame) effective duration | 30 s |
| Result of thermal test | Test passed |
| Test specification, oscillation, broadband noise | DIN EN 50155 (VDE 0115-200):2008-03 |
| Test spectrum | Service life test category 2 , bogie mounted |
| Test frequency | $\mathrm{f}_{1}=5 \mathrm{~Hz}$ to $\mathrm{f}_{2}=250 \mathrm{~Hz}$ |
| ASD level | $6.12\left(\mathrm{~m} / \mathrm{s}^{2}\right)^{2} / \mathrm{Hz}$ |
| Acceleration | 3.12 g |
| Test duration per axis | 5 h |
| Test directions | X-, Y- and Z-axis |
| Oscillation, broadband noise test result | Test passed |
| Test specification, shock test | DIN EN 50155 (VDE 0115-200):2008-03 |
| Shock form | Half-sine |
| Acceleration | 30 g |
| Shock duration | 18 ms |
| Number of shocks per direction | 3 |
| Test directions | X-, Y- and Z -axis (pos. and neg.) |
| Shock test result | Test passed |
| Temperature index, insulating material (DIN EN 60216-1 (VDE 0304-21)) | $125{ }^{\circ} \mathrm{C}$ |
| Static insulating material application in cold | $-60^{\circ} \mathrm{C}$ |

PT 2,5 Order No.: 3209510
http://catalog.phoenixcontact.net/phoenix/treeViewClick.do?UID=3209510

| Dimensions |  |
| :---: | :---: |
| Width | 5.2 mm |
| Length | 48.5 mm |
| Height | 35.3 mm |
| Height NS 35/7,5 | 36.5 mm |
| Height NS 35/15 | 44 mm |
| Connection data |  |
| Connection in acc. with standard | IEC 60947-7-1 |
| Connection method | Push-in connection |
| Conductor cross section solid min. | $0.14 \mathrm{~mm}^{2}$ |
| Conductor cross section solid max. | $4 \mathrm{~mm}^{2}$ |
| Conductor cross section AWG/kcmil min. | 26 |
| Conductor cross section AWG/kcmil max | 12 |
| Conductor cross section stranded min. | $0.14 \mathrm{~mm}^{2}$ |
| Conductor cross section stranded max. | $2.5 \mathrm{~mm}^{2}$ |
| Min. AWG conductor cross section, stranded | 26 |
| Max. AWG conductor cross section, stranded | 14 |
| Conductor cross section stranded, with ferrule without plastic sleeve min. | $0.14 \mathrm{~mm}^{2}$ |
| Conductor cross section stranded, with ferrule without plastic sleeve max. | $2.5 \mathrm{~mm}^{2}$ |
| Conductor cross section stranded, with ferrule with plastic sleeve min. | $0.14 \mathrm{~mm}^{2}$ |
| Conductor cross section stranded, with ferrule with plastic sleeve max. | $2.5 \mathrm{~mm}^{2}$ |
| 2 conductors with same cross section, stranded, TWIN ferrules with plastic sleeve, max. | $0.5 \mathrm{~mm}^{2}$ |
| Minimum stripping length | 8 mm |
| Maximum stripping length | 10 mm |
| Internal cylindrical gage | A3 |

## Certificates / Approvals

Certification

CSA, cULus Recognized, GOST, VDE Zeichengenehmigung, ABS, BV, GL, LR, NK, RS, IECEE CB Scheme

| Software | CLIP-PROJECT ADVANCED | Multilingual software for easy planning of Phoenix Contact on <br> DIN rails together with the integrated TRABTECH-select software <br> module for planning comprehensive surge protection concepts. |
| :--- | :--- | :--- |
| 5146040 | CLIP-PROJECT <br> PROFESSIONAL | Multi-lingual software for terminal strip project planning. A marking <br> module allows professional labeling of markers and labels for <br> marking terminal blocks, conductors, cables and devices. The <br> additionally integrated software module TRABTECH-select for <br> planning comprehensive surge protection concepts. |
| 5146053 |  |  |
| Tools | SZF 1-0,6X3,5 | Actuation tool, for ST terminal blocks, also suitable for use as a <br> bladed screwdriver, size: $0.6 \times 3.5 \times 100$ mm, 2-component grip, <br> with non-slip grip |
| 1204517 |  |  |
| Drawings |  |  |



## DPHCNIX

## Extract from the online catalog

## PT 2,5-MT

Order No.: 3210156

The figure shows a version of the article


## Product notes

WEEE/RoHS-compliant since: 12/07/2007


## http://

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Technical data

General

| Number of levels | 1 |
| :--- | :--- |
| Number of connections | 2 |
| Color | gray |
| Insulating material | PA |

PT 2,5-MT Order No.: 3210156
http://catalog.phoenixcontact.net/phoenix/treeViewClick.do?UID=3210156

Inflammability class according to UL 94 Vo

General

| Rated surge voltage | 6 kV |
| :---: | :---: |
| Pollution degree | 3 |
| Surge voltage category | III |
| Insulating material group | I |
| Connection in acc. with standard | IEC 60947-7-1 |
| Nominal current $I_{N}$ | 20 A |
| Nominal voltage $\mathrm{U}_{\mathrm{N}}$ | 400 V |
| Open side panel | ja |
| Shock protection test specification | DIN EN 50274 (VDE 0660-514):2002-11 |
| Back of the hand protection | guaranteed |
| Finger protection | guaranteed |
| Surge voltage test setpoint | 7.3 kV |
| Result of surge voltage test | Test passed |
| Power frequency withstand voltage setpoint | 1.89 kV |
| Result of power-frequency withstand voltage test | Test passed |
| Checking the mechanical stability of terminal points (5 x conductor connection) | Test passed |
| Bending test rotation speed | 10 rpm |
| Bending test turns | 135 |
| Bending test conductor cross section/weight | $0.14 \mathrm{~mm}^{2} / 0.2 \mathrm{~kg}$ |
|  | $2.5 \mathrm{~mm}^{2} / 0.7 \mathrm{~kg}$ |
|  | $4 \mathrm{~mm}^{2} / 0.9 \mathrm{~kg}$ |
| Result of bending test | Test passed |
| Conductor cross section tensile test | $0.14 \mathrm{~mm}^{2}$ |
| Tractive force setpoint | 10 N |
| Conductor cross section tensile test | $2.5 \mathrm{~mm}^{2}$ |
| Tractive force setpoint | 50 N |
| Conductor cross section tensile test | $4 \mathrm{~mm}^{2}$ |
| Tractive force setpoint | 60 N |
| Tensile test result | Test passed |
| Tight fit on carrier | NS 35 |
| Setpoint | 1 N |
| Result of tight fit test | Test passed |

PT 2,5-MT Order No.: 3210156
http://catalog.phoenixcontact.net/phoenix/treeViewClick.do?UID=3210156

| Requirements, voltage drop | $\leq 6,4 \mathrm{mV}$ |
| :---: | :---: |
| Result of voltage drop test | Test passed |
| Temperature-rise test | Test passed |
| Conductor cross section short circuit testing | 2.5 mm ${ }^{2}$ |
| Short-time current | 0.3 kA |
| Conductor cross section short circuit testing | $4 \mathrm{~mm}^{2}$ |
| Short-time current | 0.48 kA |
| Short circuit stability result | Test passed |
| Ageing test for screwless modular terminal block temperature cycles | 192 |
| Result of aging test | Test passed |
| Proof of thermal characteristics (needle flame) effective duration | 30 s |
| Result of thermal test | Test passed |
| Test specification, oscillation, broadband noise | DIN EN 50155 (VDE 0115-200):2008-03 |
| Test spectrum | Service life test category 1 , class B, body mounted |
| Test frequency | $\mathrm{f}_{1}=5 \mathrm{~Hz}$ to $\mathrm{f}_{2}=150 \mathrm{~Hz}$ |
| ASD level | $1.857\left(\mathrm{~m} / \mathrm{s}^{2}\right)^{2} / \mathrm{Hz}$ |
| Acceleration | 0.8 g |
| Test duration per axis | 5 h |
| Test directions | X-, Y- and Z-axis |
| Oscillation, broadband noise test result | Test passed |
| Test specification, shock test | DIN EN 50155 (VDE 0115-200):2008-03 |
| Shock form | Half-sine |
| Acceleration | 5 g |
| Shock duration | $30 \mathrm{~ms}$ |
| Number of shocks per direction | 3 |
| Test directions | X-, Y- and Z-axis (pos. and neg.) |
| Shock test result | Test passed |
| Temperature index, insulating material (DIN EN 60216-1 (VDE 0304-21)) | $125{ }^{\circ} \mathrm{C}$ |
| Static insulating material application in cold | $-60^{\circ} \mathrm{C}$ |
| Dimensions |  |
| Width | 5.2 mm |
| Length | 62 mm |
| Height | 35.30 mm |

PT 2,5-MT Order No.: 3210156
http://catalog.phoenixcontact.net/phoenix/treeViewClick.do?UID=3210156

| Height NS 35/7,5 | 36.5 mm |
| :---: | :---: |
| Height NS 35/15 | 44 mm |
| Connection data |  |
| Connection in acc. with standard | IEC 60947-7-1 |
| Connection method | Push-in connection |
| Conductor cross section solid min. | $0.14 \mathrm{~mm}^{2}$ |
| Conductor cross section solid max. | $4 \mathrm{~mm}^{2}$ |
| Conductor cross section AWG/kcmil min. | 26 |
| Conductor cross section AWG/kcmil max | 12 |
| Conductor cross section stranded min. | $0.14 \mathrm{~mm}^{2}$ |
| Conductor cross section stranded max. | $2.5 \mathrm{~mm}^{2}$ |
| Min. AWG conductor cross section, stranded | 26 |
| Max. AWG conductor cross section, stranded | 14 |
| Conductor cross section stranded, with ferrule without plastic sleeve min. | $0.14 \mathrm{~mm}^{2}$ |
| Conductor cross section stranded, with ferrule without plastic sleeve max. | $2.5 \mathrm{~mm}^{2}$ |
| Conductor cross section stranded, with ferrule with plastic sleeve min. | $0.14 \mathrm{~mm}^{2}$ |
| Conductor cross section stranded, with ferrule with plastic sleeve max. | $2.5 \mathrm{~mm}^{2}$ |
| 2 conductors with same cross section, stranded, TWIN ferrules with plastic sleeve, max. | $0.5 \mathrm{~mm}^{2}$ |
| Minimum stripping length | 8 mm |
| Maximum stripping length | 10 mm |
| Internal cylindrical gage | A3 |

Certificates / Approvals

## 

Certification

CSA, cULus Recognized, GOST, VDE Gutachten mit Fertigungsüberwachung, ABS, BV, GL, LR, NK, RS, IECEE CB Scheme

Certifications applied for:
Certification Ex:

PT 2,5-MT Order No.: 3210156
http://catalog.phoenixcontact.net/phoenix/treeViewClick.do?UID=3210156

| 5146053 | CLIP-PROJECT <br> PROFESSIONAL | Multi-lingual software for terminal strip project planning. A marking <br> module allows professional labeling of markers and labels for <br> marking terminal blocks, conductors, cables and devices. The <br> additionally integrated software module TRABTECH-select for <br> planning comprehensive surge protection concepts. |
| :--- | :--- | :--- |
| Tools |  |  |
| 1204517 | SZF 1-0,6X3,5 | Actuation tool, for ST terminal blocks, also suitable for use as a <br> bladed screwdriver, size: $0.6 \times 3.5 \times 100$ mm, 2-component grip, <br> with non-slip grip |
| Drawings |  |  |
| Circuit diagram |  |  |



## [aptanin

## Extract from the online catalog

## PT 4

Order No.: 3211757

http://catalog.phoenixcontact.net/phoenix/treeViewClick.do?UID=3211757

Feed-through terminal block, Connection method: Push-in connection,
Cross section: $0.2 \mathrm{~mm}^{2}-6 \mathrm{~mm}^{2}$, AWG: 24 - 10, Width: 6.2 mm , Height: 35.3 mm, Color: gray, Mounting type: NS 35/7,5, NS 35/15

| Commercial data |  |
| :--- | :--- |
| EAN | $4\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|$ |
| sales group | A600 |
| Pack | 50 Pcs. |
| Customs tariff | 85369010 |
| Gross weight in pieces | 0.00964 KG |
| Net weight per piece | 0.009348 KG |
| Catalog page information | Page 105 (C-3-2013) |



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Technical data

General

| Number of levels | 1 |
| :--- | :--- |
| Number of connections | 2 |
| Color | gray |
| Insulating material | PA |
| Inflammability class according to UL 94 | V0 |

PT 4 Order No.: 3211757
http://catalog.phoenixcontact.net/phoenix/treeViewClick.do?UID=3211757

| Area of application | Railway industry |
| :---: | :---: |
|  | Mechanical engineering |
|  | Plant engineering |
|  | Process industry |
| General |  |
| Rated surge voltage | 8 kV |
| Pollution degree | 3 |
| Surge voltage category | III |
| Insulating material group | I |
| Connection in acc. with standard | IEC 60947-7-1 |
| Nominal current $I_{N}$ | 32 A |
| Nominal voltage $\mathrm{U}_{\mathrm{N}}$ | 800 V |
| Open side panel | ja |
| Shock protection test specification | DIN EN 50274 (VDE 0660-514):2002-11 |
| Back of the hand protection | guaranteed |
| Finger protection | guaranteed |
| Surge voltage test setpoint | 9.8 kV |
| Result of surge voltage test | Test passed |
| Power frequency withstand voltage setpoint | 2 kV |
| Result of power-frequency withstand voltage test | Test passed |
| Checking the mechanical stability of terminal points (5 x conductor connection) | Test passed |
| Bending test rotation speed | 10 rpm |
| Bending test turns | 135 |
| Bending test conductor cross section/weight | $0.2 \mathrm{~mm}^{2} / 0.2 \mathrm{~kg}$ |
|  | $4 \mathrm{~mm}^{2} / 0.9 \mathrm{~kg}$ |
|  | $6 \mathrm{~mm}^{2} / 1.4 \mathrm{~kg}$ |
| Result of bending test | Test passed |
| Conductor cross section tensile test | $0.2 \mathrm{~mm}^{2}$ |
| Tractive force setpoint | 10 N |
| Conductor cross section tensile test | $4 \mathrm{~mm}^{2}$ |
| Tractive force setpoint | 60 N |
| Conductor cross section tensile test | $6 \mathrm{~mm}^{2}$ |
| Tractive force setpoint | 80 N |
| Tensile test result | Test passed |

PT 4 Order No.: 3211757
http://catalog.phoenixcontact.net/phoenix/treeViewClick.do?UID=3211757

| Tight fit on carrier | NS 35 |
| :---: | :---: |
| Setpoint | 1 N |
| Result of tight fit test | Test passed |
| Requirements, voltage drop | $\leq 3.2 \mathrm{mV}$ |
| Result of voltage drop test | Test passed |
| Temperature-rise test | Test passed |
| Conductor cross section short circuit testing | $4 \mathrm{~mm}^{2}$ |
| Short-time current | 0.48 kA |
| Conductor cross section short circuit testing | $6 \mathrm{~mm}^{2}$ |
| Short-time current | 0.72 kA |
| Short circuit stability result | Test passed |
| Ageing test for screwless modular terminal block temperature cycles | 192 |
| Result of aging test | Test passed |
| Proof of thermal characteristics (needle flame) effective duration | 30 s |
| Result of thermal test | Test passed |
| Test specification, oscillation, broadband noise | DIN EN 50155 (VDE 0115-200):2008-03 |
| Test spectrum | Service life test category 1 , class B, body mounted |
| Test frequency | $\mathrm{f}_{1}=5 \mathrm{~Hz}$ to $\mathrm{f}_{2}=150 \mathrm{~Hz}$ |
| ASD level | $1.857\left(\mathrm{~m} / \mathrm{s}^{2}\right)^{2} / \mathrm{Hz}$ |
| Acceleration | 0.8 g |
| Test duration per axis | 5 h |
| Test directions | X-, Y- and Z-axis |
| Oscillation, broadband noise test result | Test passed |
| Test specification, shock test | DIN EN 50155 (VDE 0115-200):2008-03 |
| Shock form | Half-sine |
| Acceleration | 5 g |
| Shock duration | 30 ms |
| Number of shocks per direction | 3 |
| Test directions | X-, Y- and Z -axis (pos. and neg.) |
| Shock test result | Test passed |
| Temperature index, insulating material (DIN EN 60216-1 (VDE 0304-21)) | $130{ }^{\circ} \mathrm{C}$ |
| Static insulating material application in cold | $-60^{\circ} \mathrm{C}$ |


| Dimensions |  |
| :--- | :--- |
| Width | 6.2 mm |
| Length | 56 mm |
| Height | 35.3 mm |
| Height NS 35/7,5 | 36.5 mm |
| Height NS 35/15 | 44 mm |

Connection data

| Connection in acc. with standard | IEC 60947-7-1 |
| :--- | :--- |
| Connection method | Push-in connection |
| Conductor cross section solid min. | $0.2 \mathrm{~mm}^{2}$ |
| Conductor cross section solid max. | $6 \mathrm{~mm}^{2}$ |
| Conductor cross section AWG/kcmil min. | 24 |
| Conductor cross section AWG/kcmil max | 10 |
| Conductor cross section stranded min. | $0.2 \mathrm{~mm}^{2}$ |
| Conductor cross section stranded max. | $4 \mathrm{~mm}^{2}$ |
| Min. AWG conductor cross section, stranded | 24 |
| Max. AWG conductor cross section, stranded | 12 |
| Conductor cross section stranded, with ferrule <br> without plastic sleeve min. | $0.25 \mathrm{~mm}^{2}$ |
| Conductor cross section stranded, with ferrule <br> without plastic sleeve max. | $4 \mathrm{~mm}^{2}$ |
| Conductor cross section stranded, with ferrule <br> with plastic sleeve min. | $0.25 \mathrm{~mm}^{2}$ |
| Conductor cross section stranded, with ferrule <br> with plastic sleeve max. | $4 \mathrm{~mm}^{2}$ |
| 2 conductors with same cross section, stranded, | $0.5 \mathrm{~mm}^{2}$ |
| TWIN ferrules with plastic sleeve, min. | $1 \mathrm{~mm}^{2}$ |
| 2 conductors with same cross section, stranded, | $10 \mathrm{~mm}^{\text {TWIN ferrules with plastic sleeve, max. }}$ |
| Minimum stripping length | $12 \mathrm{~mm}^{\text {Maximum stripping length }}$ A4 |
| Internal cylindrical gage |  |

## Certificates / Approvals

## 

PT 4 Order No.: 3211757
http://catalog.phoenixcontact.net/phoenix/treeViewClick.do?UID=3211757

## Tools

| 1204517 | SZF 1-0,6X3,5 | Actuation tool, for ST terminal blocks, also suitable for use as a <br> bladed screwdriver, size: $0.6 \times 3.5 \times 100 \mathrm{~mm}, 2$-component grip, <br> with non-slip grip |
| :--- | :--- | :--- |

## Drawings

## Circuit diagram



## [aptasin

## Extract from the online catalog

## PTTB 2,5

Order No.: 3210567
http://catalog.phoenixcontact.net/phoenix/treeViewClick.do?UID=3210567


Double-level terminal block, Cross section: $0.14 \mathrm{~mm}^{2}-4 \mathrm{~mm}^{2}$, AWG: 26-12, Connection type: Push-in connection, Width: 5.2 mm , Color: gray, Mounting type: NS 35/7,5, NS 35/15

| Commercial data | $\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|$ |
| :--- | :--- |
| EAN | $4\left\\|\left\\|_{046356}\right\\|\right.$ |
| sales group | A632 |
| Pack | 50 Pcs. |
| Customs tariff | 85369010 |
| Gross weight in pieces | 0.012897 KG |
| Net weight per piece | 0.012786 KG |
| Catalog page information | Page 129 (C-3-2013) |



## http://

www.download.phoenixcontact.com Please note that the data given here has been taken from the online catalog. For comprehensive information and data, please refer to the user documentation. The General Terms and Conditions of Use apply to Internet downloads.

Technical data

General

| Number of levels | 2 |
| :--- | :--- |
| Number of connections | 4 |
| Color | gray |
| Insulating material | PA |
| Inflammability class according to UL 94 | V0 |

PTTB 2,5 Order No.: 3210567
http://catalog.phoenixcontact.net/phoenix/treeViewClick.do?UID=3210567

| Area of application | Railway industry |
| :---: | :---: |
|  | Mechanical engineering |
|  | Plant engineering |
|  | Process industry |
| General |  |
| Rated surge voltage | 6 kV |
| Pollution degree | 3 |
| Surge voltage category | III |
| Insulating material group | 1 |
| Connection in acc. with standard | IEC 60947-7-1 |
| Nominal current $\mathrm{I}_{\mathrm{N}}$ | 22 A (the maximum load current must not be exceeded by the total current of all connected conductors) |
| Nominal voltage $\mathrm{U}_{\mathrm{N}}$ | 500 V |
| Open side panel | ja |
| Shock protection test specification | DIN EN 50274 (VDE 0660-514):2002-11 |
| Back of the hand protection | guaranteed |
| Finger protection | guaranteed |
| Surge voltage test setpoint | 7.3 kV |
| Result of surge voltage test | Test passed |
| Power frequency withstand voltage setpoint | 1.89 kV |
| Result of power-frequency withstand voltage test | Test passed |
| Checking the mechanical stability of terminal points (5 x conductor connection) | Test passed |
| Bending test rotation speed | 10 rpm |
| Bending test turns | 135 |
| Bending test conductor cross section/weight | $0.14 \mathrm{~mm}^{2} / 0.2 \mathrm{~kg}$ |
|  | $2.5 \mathrm{~mm}^{2} / 0.7 \mathrm{~kg}$ |
|  | $4 \mathrm{~mm}^{2} / 0.9 \mathrm{~kg}$ |
| Result of bending test | Test passed |
| Conductor cross section tensile test | $0.14 \mathrm{~mm}^{2}$ |
| Tractive force setpoint | 10 N |
| Conductor cross section tensile test | $2.5 \mathrm{~mm}^{2}$ |
| Tractive force setpoint | 50 N |
| Conductor cross section tensile test | $4 \mathrm{~mm}^{2}$ |
| Tractive force setpoint | 60 N |
| Tensile test result | Test passed |

PTTB 2,5 Order No.: 3210567
http://catalog.phoenixcontact.net/phoenix/treeViewClick.do?UID=3210567

| Tight fit on carrier | NS 35 |
| :---: | :---: |
| Setpoint | 1 N |
| Result of tight fit test | Test passed |
| Requirements, voltage drop | $\leq 3.2 \mathrm{mV}$ |
| Result of voltage drop test | Test passed |
| Temperature-rise test | Test passed |
| Conductor cross section short circuit testing | $2.5 \mathrm{~mm}^{2}$ |
| Short-time current | 0.3 kA |
| Conductor cross section short circuit testing | $4 \mathrm{~mm}^{2}$ |
| Short-time current | 0.48 kA |
| Short circuit stability result | Test passed |
| Ageing test for screwless modular terminal block temperature cycles | 192 |
| Result of aging test | Test passed |
| Proof of thermal characteristics (needle flame) effective duration | 30 s |
| Result of thermal test | Test passed |
| Test specification, oscillation, broadband noise | DIN EN 50155 (VDE 0115-200):2008-03 |
| Test spectrum | Service life test category 1 , class B, body mounted |
| Test frequency | $\mathrm{f}_{1}=5 \mathrm{~Hz}$ to $\mathrm{f}_{2}=150 \mathrm{~Hz}$ |
| ASD level | $1.857\left(\mathrm{~m} / \mathrm{s}^{2}\right)^{2} / \mathrm{Hz}$ |
| Acceleration | 0.8 g |
| Test duration per axis | 5 h |
| Test directions | X-, Y- and Z -axis |
| Oscillation, broadband noise test result | Test passed |
| Test specification, shock test | DIN EN 50155 (VDE 0115-200):2008-03 |
| Shock form | Half-sine |
| Acceleration | 5 g |
| Shock duration | 30 ms |
| Number of shocks per direction | 3 |
| Test directions | X-, Y- and Z-axis (pos. and neg.) |
| Shock test result | Test passed |
| Temperature index, insulating material (DIN EN 60216-1 (VDE 0304-21)) | $125^{\circ} \mathrm{C}$ |
| Static insulating material application in cold | $-60^{\circ} \mathrm{C}$ |

PTTB 2,5 Order No.: 3210567
http://catalog.phoenixcontact.net/phoenix/treeViewClick.do?UID=3210567

| Dimensions |  |
| :--- | :--- |
| Width | 5.2 mm |
| Length | 68 mm |
| Height NS 35/7,5 | 47.5 mm |
| Height NS 35/15 | 55 mm |
| Connection data | Push-in connection |
| Connection method | $0.14 \mathrm{~mm}^{2}$ |
| Conductor cross section solid min. | $4 \mathrm{~mm}^{2}$ |
| Conductor cross section solid max. | $0.14 \mathrm{~mm}^{2}$ |
| Conductor cross section stranded min. | $2.5 \mathrm{~mm}^{2}$ |
| Conductor cross section stranded max. | 26 |
| Conductor cross section AWG/kcmil min. | 12 |
| Conductor cross section AWG/kcmil max | $0.14 \mathrm{~mm}^{2}$ |
| Conductor cross section stranded, with ferrule <br> without plastic sleeve min. | $2.5 \mathrm{~mm}^{2}$ |
| Conductor cross section stranded, with ferrule <br> without plastic sleeve max. | $0.14 \mathrm{~mm}^{2}$ |
| Conductor cross section stranded, with ferrule <br> with plastic sleeve min. | $2.5 \mathrm{~mm}^{2}$ |
| Conductor cross section stranded, with ferrule <br> with plastic sleeve max. | $0.5 \mathrm{~mm}^{2}$ |
| 2 conductors with same cross section, stranded, |  |
| TWIN ferrules with plastic sleeve, max. | $10 \mathrm{~mm}^{\text {Stripping length }}$ A3 |
| Internal cylindrical gage |  |

## Certificates / Approvals



Certification

Certification Ex:

Certifications applied for:

CSA, cULus Recognized, GOST, VDE Zeichengenehmigung, ABS, BV, GL, LR, NK, RS, IECEE CB Scheme

ATEX, IECEx

PTTB 2,5 Order No.: 3210567
http://catalog.phoenixcontact.net/phoenix/treeViewClick.do?UID=3210567

| Software |  | CLIP-PROJECT ADVANCED |
| :--- | :--- | :--- | \(\left.\begin{array}{l}Multilingual software for easy planning of Phoenix Contact on <br>

DIN rails together with the integrated TRABTECH-select software <br>

module for planning comprehensive surge protection concepts.\end{array}\right]\)| 5146040 | Multi-lingual software for terminal strip project planning. A marking <br> module allows professional labeling of markers and labels for <br> marking terminal blocks, conductors, cables and devices. The <br> additionally integrated software module TRABTECH-select for <br> planning comprehensive surge protection concepts. |
| :--- | :--- | :--- |
| 5146053 | CLIP-PROJECT <br> PROFESSIONAL |

Drawings

Circuit diagram


## $\mathrm{O}-\mathrm{O}$

## (1acisinix

## Extract from the online catalog

## UBE

Order No.: 0800310
http://catalog.phoenixcontact.net/phoenix/treeViewClick.do?UID=0800310

Terminal strip marker carriers for marking terminal groups, for end bracket E/UK or end clamp E/U, lettering field size: $40 \times 17 \mathrm{~mm}$

|  |  |
| :--- | :--- |
| Commercial data | $\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|\\|$ |
| EAN | $4\left\\|\left\\|_{005917}\right\\|\right.$ |
| sales group | B108 |
| Pack | 10 Pcs. |
| Customs tariff | 39269097 |
| Gross weight in pieces | 0.006815 KG |
| Net weight per piece | 0.004685 KG |
| Catalog page information | Page 501 (C-5-2013) |

## Product notes

WEEE/RoHS-compliant since: 01/01/2003

[^48]
## Technical data

## Dimensions

| Length (b) | 41.4 mm |
| :--- | :--- |
| Width (a) | 20 mm |

## Ambient conditions

| Ambient temperature (operation) | $-40^{\circ} \mathrm{C} \ldots 100^{\circ} \mathrm{C}$ |
| :--- | :--- |

## General

| Color | gray |
| :--- | :--- |
| Components | free from silicone and halogen |
| Inflammability class according to UL 94 | V2 |
| Material | PA |
| Marking mounting type | Plug in |
| Certificates / Approvals |  |

## Certification

Certifications applied for:
Certification Ex:

| Accessories |  |
| :--- | :--- |
| Item | Designation |
| Marking |  |
| 0808095 | ESL 40X17 | | Insert strip, Sheet, white, Unlabeled, can be labeled with: Office |
| :--- |
| printing systems, Plotter, Perforated, Mounting type: Insert, |
| Lettering field: $40 \times 17 \mathrm{~mm}$ |

## [aparisix

## Extract from the online catalog

## FBS 10-5

Order No.: 3030213
http://catalog.phoenixcontact.net/phoenix/treeViewClick.do?UID=3030213

Plug-in bridge, Number of positions: 10, Color: red

|  |  | Product notes |
| :---: | :---: | :---: |
| Commercial data |  | WEEE/RoHS-compliant since: 01/01/2003 |
| EAN |  |  |
| sales group | A690 |  |
| Pack | 10 Pcs. |  |
| Customs tariff | 85389099 | http:// <br> www.download.phoenixcontact.com Please note that the data given here has been taken from the online catalog. For comprehensive information and data, please refer to the user documentation. The General Terms and Conditions of Use apply to Internet downloads. |
| Gross weight in pieces | 0.00871 KG |  |
| Net weight per piece | 0.00867 KG |  |
| Catalog page information | Page 472 (C-3-2013) |  |
| Technical data |  |  |
| Technical data |  |  |
| Color | red |  |
| Number of positions | 10 |  |
| Pitch | 5.20 mm |  |
| Maximum load current | 24 A (The current values for the jumpers can deviate when used in different modular terminal blocks. The precise values can be found in the accessories data for the respective modular terminal blocks.) |  |

## Certificates / Approvals

## Certification

Certifications applied for:
Certification Ex:

## \$PHCNIXX

## Extract from the online catalog

## PS-5

Order No.: 3030983
http://catalog.phoenixcontact.net/phoenix/treeViewClick.do?UID=3030983

Test plugs, Color: red


## Technical data

## General

| Color | red |
| :--- | :--- |

## Certificates / Approvals

Certification
Certifications applied for:
Certification Ex:

PS-5 Order No.: 3030983
http://catalog.phoenixcontact.net/phoenix/treeViewClick.do?UID=3030983

## Drawings

Dimensioned drawing


## 모려워NN

## Extract from the online catalog

## AP 2-TU

Order No.: 5022630
http://catalog.phoenixcontact.net/phoenix/treeViewClick.do?UID=5022630

Cover profile carrier for mounting on NS 32 or NS 35/7.5 DIN rail for attaching the cover profile AP 2.2 mm thick

|  |  | Product notes |
| :---: | :---: | :---: |
| Commercial data |  | WEEE/RoHS-compliant since:01/01/2003 |
| EAN |  |  |
| sales group | A097 |  |
| Pack | 50 Pcs. |  |
| Customs tariff | 85389099 | http:// <br> www.download.phoenixcontact.com Please note that the data given here has been taken from the online catalog. For comprehensive information and data, please refer to the user documentation. The General Terms and Conditions of Use apply to Internet downloads. |
| Gross weight in pieces | 0.005803 KG |  |
| Net weight per piece | 0.005803 KG |  |
| Catalog page information | Page 505 (C-5-2013) |  |
| Technical data |  |  |
| Dimensions |  |  |
| Length (b) | 55.6 mm |  |
| Height | 68.5 mm |  |
| Width (a) | 2.1 mm |  |
| General |  |  |
| Color | gray |  |

[^49]Page 1 / 3

AP 2-TU Order No.: 5022630
http://catalog.phoenixcontact.net/phoenix/treeViewClick.do?UID=5022630

| Inflammability class according to UL 94 | V2 |
| :--- | :--- |
| Material | PA |

## Certificates / Approvals

## Certification

Certifications applied for:
Certification Ex:

## Drawings

Dimensioned drawing


## Rppocin

## Extract from the online catalog


http://catalog.phoenixcontact.net/phoenix/treeViewClick.do?UID=5022889

Cover profile for covering terminal strips, snaps onto cover profile carrier AP 2-TU, can be labeled with insert strip AP-ES. A cover profile carrier is to be positioned at the ends and at intervals of approx. 40 cm. Maximum supply length: As per customer order

| Commercial data | Made-to-order |
| :--- | :--- |
| Note | B232 |
| sales group | 1 Pcs. |
| Pack | 39162000 |
| Customs tariff | Page 505 (C-5-2013) |
| Catalog page information |  |

## Product notes

WEEE/RoHS-compliant since: 01/01/2005

## http://

www.download.phoenixcontact.com Please note that the data given here has been taken from the online catalog. For comprehensive information and data, please refer to the user documentation. The General Terms and Conditions of Use apply to Internet downloads.

Technical data

Dimensions

| Length (b) | 1 m |
| :--- | :--- |
| Height | 33 mm |
| Width (a) | 60 mm |

## AP 2 CM Order No.: 5022889

http://catalog.phoenixcontact.net/phoenix/treeViewClick.do?UID=5022889

## Ambient conditions

| Ambient temperature (operation) | $-15^{\circ} \mathrm{C} \ldots 65^{\circ} \mathrm{C}$ |  |
| :--- | :--- | :---: |
| General |  |  |
| Color | transparent |  |
| Inflammability class according to UL 94 | V 2 |  |
| Material | PVC |  |

## Certificates / Approvals

## Certification

Certifications applied for:
Certification Ex:

## Drawings

Dimensioned drawing



STANDARD
GERIEG


No other range is up to Standard.


## TWIN SWITCHED SOCKET OUTLETSHORIZONTALLY MOUNTED

STANDARD SIZE TWIN SWITCHED SOCKET OUTLETS - HORIZONTALLY MOUNTED


## Improved Chemical Resistance

The majority of Clipsal products are manufactured from polycarbonate, which provides excellent performance across a broad spectrum of specific applications. However, the high standards of hygiene required in hospitals and food related industries sometimes involve the use of harsh chemicals which can degrade polycarbonate.
To address these problems, Clipsal have worked closely with their material suppliers to develop an alloy resistant to these chemicals and with only a minimal reduction in impact strength.

The Standard Industrial Range is limited at this time to 16 products and 2 colours. Resistant White (RW)
has been colour matched to standard White Electric. Resistant Soft Grey (RS) has been matched to standard Soft Grey.
Standard Industrial Range products are identifiable by a small symbol on the front of the plate. The ' CR ' is for Chemical Resistant and the numeral ' 1 ' identifies the material. If other materials come into use at a later time for different applications, different numerals will be used.

To order Standard Industrial Range products use standard product codes and specify Resistant White (RW) or Resistant Soft Grey (RS). All ratings and specifications are the same as the corresponding product in the Standard Range.



| Cat No | Description | Length | Width | Depth | Mounting Centres | PAGE |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 10 | 10A, single pole. | 115 mm | 73 mm | 16 mm | 84mm apart | 33 |
| 10D | 10A, double pole. | 115mm | 73 mm | 16 mm | 84 mm aparf | 33 |
| 10DS | 10A, double pole with safety shutters. | 115 mm | 73 mm | 16 mm | 84mm apart | 33 |
| 10DN | 10A, double pole with safery shutters \& neon. | 115 mm | 73 mm | 16 mm | 84 mm aparf | 33 |
| 10DLS | 10A, round earth, double pole with safety shutter. | 115 mm | 73 mm | 16 mm | 84 mm apart | 33 |
| 10D15S | 15A, double pole with safety shutter. | 115mm | 73 mm | 16 mm | 84mm apart | 33 |
| 10DWP | 10A, double pole flush weather proof. | 93 mm | 82 mm | 12 mm | $70 \times 54 \mathrm{~mm}$ | 33 |
| 10DWP15 | 15A, double pole flush weather proof. | 93 mm | 82 mm | 12 mm | $70 \times 54 \mathrm{~mm}$ | 33 |
| 415VF | 10A, double pole with flap, IP34 rating. | 101 mm | 80 mm | 37 mm | $76 \times 65 \mathrm{~mm}$ | 33 |
| 415VF15 | 15A, double pole with flap, IP34 rating. | 101 mm | 80 mm | 37 mm | $76 \times 65 \mathrm{~mm}$ | 33 |
| 10PL | 10A, single pole with security flap. | 115mm | 73 mm | 22 mm | 84 mm aparf | 33 |
| STANDARD SIZE TWIN AUTOMATICALIY SWITCHED SOCKET OUTLETS - 10A, HORIZONTALIY MOUNTED |  |  |  |  |  |  |
| 20 | Single pole. | 115 mm | 73 mm | 16 mm | 84 mm apart | 34 |
| 20D | Double pole. | 115 mm | 73 mm | 16 mm | 84 mm apart | 34 |
| 20DS | Double pole with sofety shutters. | 115 mm | 73 mm | 16 mm | 84 mm apart | 34 |
| 20DN | Double pole with sofety shutters \& neons. | 115 mm | 73 mm | 16 mm | 84mm apart | 34 |
| 20DLS | Round earth, double pole \& sffety shutters. | 115 mm | 73 mm | 16 mm | 84 mm apart | 34 |
| SKIRTING MOUNTIED SINCLE AUTOMAIICALIY SWIICHED SOCKET OUTLET |  |  |  |  |  |  |
| 11 | Single Auto Switched Socket Outte, skiring mounted, 10A, single pole, $99 \times 45 \mathrm{~mm}$ at centre. | 95 mm | 45 mm | 17 mm | 78 mm apart | 34 |
| SKIRTING MOUNTED TWIN AUTOMATICALIY SWITCHED SOCKET OUTLETS - 10A |  |  |  |  |  |  |
| 11/2 | Single pole. | 125 mm | 50 mm | 17 mm | 104 mm apart | 34 |
| 11/2MF | Single pole to suit ducting. | 125mm | 50 mm | 17 mm | 104 mm apart | 34 |
| 11/2MFN | Single pole, sofety shutters, neons, suits ducting. | 125 mm | 50 mm | 17 mm | 104 mm apart | 34 |
| AUTOMATICALIY SWIICHED SOCKET OUTLLETS - SINCLE |  |  |  |  |  |  |
| 10M | 10A, single pole. | 97 mm | 43 mm | 29 mm | 84mm apart | 35 |
| 10MD | 10A, double pole. | 97 mm | 43 mm | 29 mm | 84 mm apart | 35 |
| 10MDS | 10A, double pole with sfefety shutter. | 97 mm | 43 mm | 29 mm | 84 mm apart | 35 |
| 10MDLS | 10A, round earth, double pole with sfefery shuter. | 97 mm | 43mm | 29 mm | 84mm apart | 35 |
| 10MD15S | 15A, double pole with shutter. | 97 mm | 43 mm | 29 mm | 84 mm apart | 35 |
| 10MD20 | 20A, double pole. | 97 mm | 43 mm | 29 mm | 84mm apart | 35 |
| SPECIAL PURPOSE AUTOMATICALIY SWITCHED SOCKET OUTLETS |  |  |  |  |  |  |
| 10MP | Single Auto Switched Socket Outlet Mechanism, 10A, single pole. Fascia - 42mm Ø. | 42 mm | 43mm | $\begin{array}{c\|} 33 \mathrm{~mm} \\ \text { (Room protrusion }-3.5 \mathrm{~mm}) \\ \hline \end{array}$ | $\begin{gathered} \text { See mounting detail } \\ \text { Pg. } 38 \\ \hline \end{gathered}$ | 35 |
| 10MDP | Single Auto Switched Socket Outlet Mechanism, 10A, double pole. Fascia - 42mm Ø. | 42 mm | 43mm | $\begin{array}{c\|} 33 \mathrm{~mm} \\ \hline \text { (Room protrusion }-3.5 \mathrm{~mm}) \\ \hline \end{array}$ | $\begin{gathered} \text { See mounting detail } \\ \text { Pg. } 38 \\ \hline \end{gathered}$ | 35 |
| 10MDPL | Single Auto Switched Socket Outlet Mechanism, 10A, round earth, double pole. Fascia - 42 mm Ø. | 42mm | 43mm | $\begin{array}{c\|} \hline 33 \mathrm{~mm} \\ \text { (Room protrusion }-3.5 \mathrm{~mm}) \end{array}$ | $\begin{aligned} & \text { See mounting detail } \\ & \text { Pg. } 38 \end{aligned}$ | 35 |
| 10MDP15 | Single Auto Switched Socket Outlet Mechanism, 15A, double pole. Fascia - 42mm Ø. | 42 mm | 43mm | $\begin{array}{c\|} 33 \mathrm{~mm} \\ (\text { Rooom protrusion }-3.5 \mathrm{~mm}) \\ \hline \end{array}$ | $\begin{gathered} \text { See mounting detail } \\ \text { Pg. } 38 \\ \hline \end{gathered}$ | 35 |
| 10MDLB | Single Auto Switched Socket Outlet Mechanism, 10A, double pole. | 60 mm | 42 mm | 33 mm | 50 mm apart | 36 |
| 10MDSLB | Single Auto Swithed Socket Outlet Mechanism, 10A, double pole with sofety shutter. | 60 mm | 42 mm | 33 mm | 50 mm apart | 36 |
| 10MDLSLB | Single Auto Switched Socket Outtet Mechanism, round earth, double pole, sofety shutter. | 60 mm | 42 mm | 33 mm | 50 mm apart | 36 |
| 10MD15SLB | Single Auto Switched Socket Outlet Mechanism, 15A, double pole with sofety shutter. | 60 mm | 42 mm | 33 mm | 50 mm apart | 36 |
| 10MD20LB | Single Auto Swithed Socket Outlet Mechanism, 20A, double pole. | 60 mm | 42 mm | 33 mm | 50 mm apart | 36 |
| G10MDS | GEC Miniplug Mechanism, 10A, double pole with safety shutter. | 46 mm | 46 mm | 34 mm | N/A | 36 |
| G10FMDS | GEC AF Series Mechanism, 10A, double pole with safety shutter. |  |  | 31 mm | 64mm apart | 36 |
| G10FMD15S | GEC AF Series Mechanism, 15A, double pole with safety shutter. |  |  | 31 mm | 64 mm apart | 36 |
| G10FMDLS | GEC AF Series Mechanism, 10A, round earth with safety shutter. |  |  | 31 mm | 64 mm apart | 36 |
| SKIRTING MOUNTED SIDE CONNECTING SOCKET OUTLETS - 250V/10A, SINGLE POLE |  |  |  |  |  |  |
| 12M | Single Auto Swithed Socket Outlet. | 63 mm | 43 mm | 29 mm | N/A | 37 |
| 17M | Single Auto Swithed Socket Outlet. | 90 mm | 43 mm | 29 mm | N/A | 37 |
| STANDARD SIZE SINGLE TOGCLE SWITCHED SOCKET OUTLETS - 250V/20A, HORIZONTALIY MOUNTED |  |  |  |  |  |  |
| 42/20 | Single Swithed Socket Outle, toggle switch, single pole. | 115mm | 70 mm | 15mm | 84mm apart | 37 |
| 42/20N | Single Swithed Socket Outet, toggle swith, single pole with sfefers sutter \& neon. | 115mm | 70 mm | 15 mm | 84mm apart | 37 |
| SINCLE TOCGLE NARROW ARCHITRAVE SIZE SWIICHED SOCKET OUTLLETS - 250V/10A, VERIICAIIY MOUNIED |  |  |  |  |  |  |
| 40 | Single pole. | 115mm | 48 mm | 15 mm | 98 mm apart | 37 |
| 40D | Double pole. | 115mm | 48 mm | 15 mm | 98 mm aparf | 37 |

UNSWITCHED SOCKET OUTLETS- SINGLE

| Cat ${ }^{\text {No }}$ | Description | Length | Width | Depth | Mounting Centres | PAGE |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 405 | 250V/10A, 2 pin parallel. | 96 mm | 42mm | $\begin{gathered} 33 \mathrm{~mm} \\ \text { (Room protusion }-3.5 \mathrm{~mm}) \end{gathered}$ | 84 mm apart | 38 |
| 405/32 | 32V/15A, 2 pin polarised, extra low voltage. | 96 mm | 42 mm |  | 84mm apart | 38 |
| 415 | 250V/10A, 3 pin. | 96 mm | 42 mm | $\begin{array}{r} 33 \mathrm{~mm} \\ \text { (Room mortuin }-3.5 \mathrm{~mm}) \end{array}$ | 84 mm apart | 38 |
| 415L | 250V/10A, 3pin, round earth pin. | 96 mm | 42 mm | ${ }_{\text {(Room porusision }-3.5 \mathrm{~mm} \text { ) }}^{\text {3nm }}$ | 84mm apart | 38 |
| 415/110 | 110V/10A, 3 pin, 2 round live pins. | 96 mm | 42 mm | $\begin{gathered} 33 \mathrm{~mm} \\ \text { (Room mortision }-3.5 \mathrm{~mm}) \end{gathered}$ | 84 mm apart | 38 |
| 415/15 | 250V/15A, 3 pin. | 96 mm | 42 mm | $\begin{gathered} 33 \mathrm{~mm} \\ \text { (Room mortusion }-3.5 \mathrm{~mm}) \end{gathered}$ | 84mm apart | 38 |
| 415MP | 250V/10A, 3 pin, panel mount. | 43 mm | 42 mm | $\begin{gathered} 33 \mathrm{~mm} \\ \text { (Room protusion }-3.5 \mathrm{~mm}) \end{gathered}$ | See mounting detaiil <br> Po. 38 | 38 |
| 415MP15 | 250V/15A, 3 pin, panel mount. | 43 mm | 42 mm |  | See mounting detail Pa. 38 | 38 |
| 415MPL | S250V/10A, 3 pin, round earth, panel mount. | 43 mm | 42 mm | $\begin{aligned} & 33 \mathrm{~mm} \cdot 3.5 \mathrm{~mm} \\ & \text { (Room mortusin }-3.5 \end{aligned}$ | See mounting detaif Po. 38 | 38 |
| 426 | 250V/10A, 3 pin, suits round J - Box . | 66 mm Ø |  | 24 mm | 50 mm apart | 38 |
| 426L | 250V/10A, 3 pin, round earth pin, suits round J-Box. | 66 mm Ø |  | 24 mm | 50 mm aparf | 38 |
| 426/15 | 250V/15A, 3 pin, suits round J -Box. | 66 mm Ø |  | 24 mm | 50mm apart | 38 |

WIICO SOCKET OUTLETIS (GREY ONIY) - SINCIE

| FOS106 | $250 \mathrm{~V} / 10 \mathrm{~A}, 3$ flat pins. | 96 mm | 42 mm | 28 mm | 84 mm apart | 39 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| FOS106R | $250 \mathrm{~V} / 10 \mathrm{~A}, 3$ pins, round earth pin. | 96 mm | 42 mm | 28 mm | 84 mm apart | 39 |
| FOS106/2R | $110 \mathrm{~V} / 10 \mathrm{~A}, 3$ Sins, 2 round live pins. | 96 mm | 42 mm | 28 mm | 84 mm apart | 39 |
| FOS106/15 | $250 \mathrm{~V} / 15 \mathrm{~F}, 3$ flat p pins. | 96 mm | 42 mm | 28 mm | 84 mm apart | 39 |
| FOS105T | 2 flat polarised, extra low voltage. | 96 mm | 42 mm | 28 mm | 84 mm apart | 39 |

ELECTRIC CLOCK CONNECTION ACCESSORIES - 250V

| 408/3 | Clock Point Recessed Socket, 15A, 50Hz, 3 pin. | 106 mm | 59mm | 25 mm | 84 mm apart | 39 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 408/3A | Clock Point Recessed Socket, 3 pin, suitable for other than 50Hz. | 106 mm | 59mm | 25 mm | 84mm apart | 39 |
| 408/4 | Clock Point Recessed Socket, 5A, 4 pin. | 106 mm | 59mm | 25 mm | 84 mm apart | 39 |
| 409/3 | Clock Point Plug, 5A, 50Hz, 3 pin. | 48mm | 35mm | 11 mm | N/A | 39 |
| 409/3A | Clock Point Plug, 3 pin, suitable for other than 50 Hz . | 48 mm | 35 mm | 11 mm | N/A | 39 |
| 409/4 | Clock Point Plug, 5A, 50Hz, 4 pin. | 48mm | 35 mm | 11 mm | N/A | 39 |

STANDARD SIZE SINCLE SWITCHED SOCKET OUTILETS - 250V, HORIZONTALIY MOUNTIED

| 15 | 10A. | 115 mm | 73mm | 14mm | 84mm apart | 41 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 155 | 10 A with safety shuter. | 115 mm | 73mm | 14mm | 84 mm apart | 41 |
| 15N | 10 A with safety shutter and neon. | 115 mm | 73 mm | 14 mm | 84 mm apart | 41 |
| 15D | 10A, double pole. | 115 mm | 73mm | 14mm | 84mm apart | 41 |
| 15D15 | 15, double pole. | 115 mm | 73mm | 14 mm | 84 mm apart | 41 |
| 15DN | S10A, double pole, with safety shutter \& neon. | 115 mm | 73 mm | 14 mm | 84 mm apart | 41 |
| 15DD | 10A, double pole, deep plate. | 115 mm | 73mm | 33mm | 84 mm apart | 41 |
| 15DX | 10A, double pole with extra switch. | 115 mm | 73mm | 14mm | 84mm apart | 41 |
| 15/15 | 15A. | 115 mm | 73 mm | 14 mm | 84 mm apart | 41 |
| 15/15S | 15 A with sofety shutter. | 115 mm | 73mm | 14mm | 84 mm apart | 41 |
| 15/15N | 15 A with safety shulter and neon. | 115 mm | 73mm | 14 mm | 84 mm apart | 41 |
| 15L | 10A, round earth pin. | 115 mm | 73mm | 14mm | 84 mm apart | 41 |
| 15LN | 10A, round earth pin with safety shutter and neon. | 115 mm | 73mm | 14 mm | 84 mm apart | 41 |
| 15X | S10A with extra switch. | 115 mm | 73 mm | 14 mm | 84 mm apart | 41 |
| 15XS | 10 A with extra switch ond safety shutter. | 115 mm | 73 mm | 14 mm | 84 mm apart | 41 |
| 15XN | 10 A with extra switch, safety shutter and neon. | 115 mm | 73mm | 14 mm | 84 mm apart | 41 |
| 15XX | 10 A with two extra switches. | 115 mm | 73 mm | 14 mm | 84 mm apart | 41 |

STANDARD SIZE TWIN SWITCHED SOCKET OUTLETS - 250V, HORIZONTALIY MOUNTED

| 25 | 10A. | 115 mm | 73 mm | 16 mm | 84mm apart | 42 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 25S | 10 A with safety shutters. | 115 mm | 73 mm | 16 mm | 84mm apart | 42 |
| 25N | 10 A with safety shutters and neons. | 115 mm | 73 mm | 16 mm | 84 mm apart | 42 |
| 25D | 10A, double pole. | 115 mm | 73mm | 16 mm | 84mm apart | 42 |
| 25D15 | 15A, double pole. | 115 mm | 73mm | 16 mm | 84mm apart | 42 |
| 25/15 | 15A. | 115 mm | 73 mm | 16 mm | 84mm apart | 42 |
| 25/15S | 15 A with safety shutters. | 115 mm | 73 mm | 16 mm | 84 mm apart | 42 |
| 25/15N | 15 A with safety shutters and neons. | 115 mm | 73mm | 16 mm | 84 mm apart | 42 |

STANDARD SIZE TWIN SWITCHED SOCKET OUTLETS - 250V, HORIZONTALIY MOUNTED (continued)

| Cat ${ }^{\text {No }}$ | Description | Length | Width | Depth | Mounting Centres | PAGE |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 25/1510 | 15 \& 10A. | 115 mm | 73 mm | 16 mm | 84mm apart | 42 |
| 25L | 10A, round earth pin. | 115 mm | 73 mm | 16 mm | 84 mm apart | 42 |
| 25X | 10A, with extra one way switch. | 115 mm | 73 mm | 16 mm | 84mm apart | 42 |
| 25XS | 10A, extra one way switch and shutters. | 115 mm | 73 mm | 16 mm | 84mm apart | 42 |
| MF25X | 10A, marked with "FAN" on extra switch. | 115 mm | 73 mm | 16 mm | 84 mm apart | 42 |
| ML25X | 10A, marked with "LIGHT" on extra switch. | 115 mm | 73 mm | 16 mm | 84mm apart | 42 |
| 25XA | 10A with removable extra switch. | 115 mm | 73 mm | 16 mm | 84mm apart | 42 |
| 25XAN | 10A, removable extra switch, safety shutters \& neons. | 115 mm | 73 mm | 16 mm | 84mm apart | 42 |
| 25XD | 10A, double pole \& removable extra switch. | 115 mm | 73 mm | 16 mm | 84 mm apart | 42 |
| STANDARD SIZE SINCLE SWIICHED SOCKET OUTLETS - 250V, VERTICALIY MOUNTED |  |  |  |  |  |  |
| 15V | 10 A . | 115 mm | 73 mm | 14 mm | 84mm apart | 43 |
| 15VS | 10A with safety shutter. | 115 mm | 73 mm | 14 mm | 84mm apart | 43 |
| 15VN | 10A with safety shutter and neon. | 115 mm | 73 mm | 14 mm | 84mm apart | 43 |
| 15V15 | 15A. | 115 mm | 73 mm | 14 mm | 84mm apart | 43 |
| 15V15N | 15A with safety shutter and neon. | 115 mm | 73 mm | 14 mm | 84mm apart | 43 |
| 15VX | 10A with removable extra switch. | 115 mm | 73 mm | 14 mm | 84mm apart | 43 |
| 15VXS | 10A with safety shutters and removable extra switch. | 115 mm | 73 mm | 14 mm | 84mm apart | 43 |
| 15VXN | 10 A with safety shutters, neon and removable extra switch. | 115 mm | 73 mm | 14 mm | 84mm apart | 43 |
| 15VXX | 10A with two removable extra switches. | 115 mm | 73 mm | 14 mm | 84mm apart | 43 |
| STANDARD SIZE TWIN SWITCHED SOCKET OUTLETS - 250V/10A, VERTICALIY MOUNTED |  |  |  |  |  |  |
| 15/2V | Two piece base. | 115 mm | 73 mm | 14mm | 84mm apart | 43 |
| 15/2VS | With safety shutters, two piece base. | 115 mm | 73 mm | 14 mm | 84mm apart | 43 |
| 15/2VN | With neons and safety shutters, two piece base. | 115 mm | 73 mm | 14 mm | 84mm apart | 43 |
| 15D2V | Double pole, two piece base. | 115 mm | 73 mm | 14 mm | 84mm apart | 43 |
| 15DD2V | Double pole with deep plate, two piece base. | 133 mm | 83 mm | 37 mm | 97 mm apart | 43 |
| 25V | Twin Switched Socket Outlet, 250V/10A. | 115 mm | 73 mm | 16 mm | 84mm apart | 43 |
| 25VXA | With removable extra switch. | 115 mm | 73 mm | 16 mm | 84mm apart | 43 |
| SKIRTING MOUNIED SINGLE SWIICHED SOCKET OUTLETS - 250V |  |  |  |  |  |  |
| 16 | 10A with safety shutter. | 98 mm | 45 mm | 14 mm | 78 mm apart | 44 |
| 16N | 10 A with safety shutter and neon. | 98 mm | 45 mm | 14 mm | 78 mm apart | 44 |
| 16F | 10A, in line terminals. | 98 mm | 45 mm | 14 mm | 78 mm apart | 44 |
| 16/15 | 15A. | 98 mm | 45 mm | 14 mm | 78 mm apart | 44 |
| 16X | 10A with extra switch. | 125 mm | 45 mm | 14 mm | 104 mm apart | 44 |
| 16D | 10A, double pole. | 98 mm | 45 mm | 14 mm | 78 mm apart | 44 |
| SKIRTING MOUNTED TWIN SWITCHED SOCKET OUTLETS - 250V |  |  |  |  |  |  |
| 16/2 | 10 A . | 168 mm | 45 mm | 13 mm | 145 mm apart | 44 |
| 16/2S | 10 A with safety shutters. | 168 mm | 45 mm | 13 mm | 145 mm apart | 44 |
| 16/2N | 10 with neons \& safety shutters. | 168 mm | 45 mm | 13 mm | 145 mm apart | 44 |
| 16/2F | 10A with straight sides. | 168 mm | 45 mm | 13 mm | 145 mm apart | 44 |
| 16/2MF | 10A, suits ducting. | 156 mm | 44 mm | 18 mm | 136 mm apart | 44 |
| 16/2MF1510 | T15A \&10A, suits ducting. | 156 mm | 44 mm | 18 mm | 136 mm apart | 44 |
| 16/2MFD | 10A, double pole. | 156 mm | 44 mm | 18 mm | 136 mm apart | 44 |
| INTERMEDIATE SINCLE SWIICHED SOCKET OUILETS - HORIZONTALIY MOUNTED |  |  |  |  |  |  |
| 14 | Single Switched Socket Outlet, intermediate size, 250V/10A, horizontal. | 115 mm | 61 mm | 13 mm | 84mm apart | 44 |
| LARCE FORMAT SIZE SINCLE SWITCHED SOCKET OUTLETS - 250V/10A, HORIZONTALLY MOUNTED |  |  |  |  |  |  |
| 15/2 | Single pole. | 115 mm | 115 mm | 14 mm | $84 \times 46 \mathrm{~mm}$ | 45 |
| 15/2S | Single pole with safety shutter. | 115 mm | 115 mm | 14 mm | $84 \times 46 \mathrm{~mm}$ | 45 |
| 15/2N | Single pole with safety shutter \& neon. | 115 mm | 115 mm | 14 mm | $84 \times 46 \mathrm{~mm}$ | 45 |
| LARCE FORMAT SIZE TWIN SWITCHED SOCKET OUILETS - 250V/10A, (115mm x 115 mm ), VERTICALIY MOUNTED |  |  |  |  |  |  |
| 25/2V | Twin Switched Socket Outlet. | 115 mm | 115 mm | 11 mm | $84 \times 46 \mathrm{~mm}$ | 45 |
| 25/2VS | With safety shutters. | 115 mm | 115 mm | 11 mm | $84 \times 46 \mathrm{~mm}$ | 45 |
| 25-2VN | With neons and safety shutters . | 115 mm | 115 mm | 11 mm | $84 \times 46 \mathrm{~mm}$ | 45 |
| LARCE FORMAT SIZE TWIN SWITCHED SOCKET OUTLETS - HORIZONTALLY MOUNTED |  |  |  |  |  |  |
| 23 | Twin Switched Socket Outlet, large format, 250V/10A. | 145 mm | 86 mm | 15 mm | 120 mm apart | 45 |

# innovative energies 

## User Manual

## SR250K <br> AC/DC FLOAT CHARGER FOR LEAD ACID BATTERIES IN MOTOR HOMES



## General

The SR250K has been specifically designed as a float battery charger in motor homes and the 12 V model has no cooling fan for reduced noise levels during operation. It must be installed with adequate ventilation with an ambient of less than $35^{\circ} \mathrm{C}$.
The 24 V model may be used up to $50^{\circ} \mathrm{C}$ ambient.

## Connection polarity

It is critical to check the polarity carefully when connecting DC devices. The SR250K has an internal fuse which needs to be replaced if the battery is connected in reverse. Usually, however, a reverse polarity connection results in instant destruction of the device, especially if there is a battery involved.

## Safety

The user is responsible for ensuring that input and output wiring segregation complies with local standards and that in the use of the equipment, access is confined to operators and service personnel. A low resistance earth connection is essential to ensure safety and additionally, satisfactory EMI suppression (see below).

## HAZARDOUS VOLTAGES EXIST WITHIN A POWER SUPPLY ENCLOSURE AND ANY REPAIRS MUST BE CARRIED OUT BY A QUALIFIED SERVICEPERSON.

## Electrical Strength Tests

Components within the power supply responsible for providing the safety barrier between input and output are constructed to provide electrical isolation as required by the relevant standard. However EMI filtering components could be damaged as result of excessively long high voltage tests between input, output and ground. Please contact our technicians for advice regarding electric strength tests.

## Earth Leakage

The EMI suppression circuits causes earth leakage currents which may be to the maximum allowable of 3.5 mA .

## Ventilation

High operating temperature is a major cause of power supply failures, for example it has been well documented that a $10^{\circ} \mathrm{C}$ rise in the operating temperature of a component will halve its expected life. Therefore always ensure that there is adequate ventilation for the equipment. Batteries and cooling fans also suffer shortened lifetimes if subjected to high ambient temperatures - both should be included in a routine maintenance schedule to check for signs of reduced efficiency.

## Water / Dust

Every effort must be made in the installation to minimise the risk of ingress of water or dust. Water will almost always cause instant failure; the effects of dust are slower in causing failure of electronic equipment. All electrical equipment should be cleaned free of any dust accumulation at regular intervals.

## Electromagnetic Interference (EMI)

Switching power supplies and converters inherently generate electrical noise. Power supply wiring should be as short as practicable and segregated from all equipment wiring which is sensitive to EMI. Residual noise can be reduced by looping DC wiring through ferrite cable sleeves. These are most effective as close to the power supply as possible and as many turns of the wire taken through the core (+ and - in the same direction) as the core will accommodate.

## Fuses

The charger is fitted with AC and DC fuses but external fuses may be used by the installer for added protection.

## - Industrial quality AC/DC float charger

- Convection cooled
- Conservative design for long life
- Standalone - bench top or fixed mounting
- Fuse for reverse polarity protection
- Design features aimed at increasing reliability:
$\diamond$ Double sided PCB construction
$\diamond$ Extra ventilated case
$\diamond$ High temperature rated components
$\diamond$ Efficient heat sinking of power components
- Precise voltage and current control
- Efficient switch mode design
- ISO9001 design management system
- 24 Month Warranty

SPECIFICATIONS All specifications are typical at nominal input, full load and at $20^{\circ} \mathrm{C}$ unless otherwise stated.

| ELECTRICAL |  |  | PHYSICAL |  |
| :---: | :---: | :---: | :---: | :---: |
| Input Voltages <br> - standard $180-264 \mathrm{~V}, 45-65 \mathrm{~Hz}$ |  |  | AC Input connector IEC320 socket <br> DC Connections 'Phoenix combicon' plug-in / screw terminal <br> block |  |
| Fusing <br> Overcurrent Protection | Internal input fuse, | t fuse | Enclosure | Steel, powder coat/ zinc plate |
|  | Constant current lim short circuit conditi | der overload and | Dimensions <br> Weight | $150 \mathrm{~W} \times 61 \mathrm{H} \times 242 \mathrm{D}$ (excl. terminals) $1.7 \mathrm{Kg}$ |
| Reverse battery con- Blows output fuse nection protection |  |  | Indication LED | Green : Power On |
| Isolation | 1KV DC input - out | earth |  |  |
| Efficiency | $\geq 85 \%$ |  |  |  |
| Inrush current | Soft start circuit |  |  |  |
| Output Power | 250W |  | ENVIRONMENTAL |  |
| Line Regulation | <0.2\% over AC inp |  | Operating temperature | 12V: 0 to $+35^{\circ} \mathrm{C}$ ambient <br> 24V: 0 to $+50^{\circ} \mathrm{C}$ ambient |
| Load Regulation | <0.4\% open circuit | 0\% load | Storage temperature | -10 to $85{ }^{\circ} \mathrm{C}$ ambient |
| Thermal Protection | Yes |  | Humidity | 0-95\% relative humidity non-condensing |
| OVP | 130\% of nominal out | voltage | Cooling | Convection cooled |
|  |  |  | ACCESSORIES SUPPLIED |  |
|  |  |  | Mounting feet together with screws AC power cord 1.5 m with IEC320 socket and NZ/Aust plug DC screw terminal plug-in connector |  |
| STANDARD MODEL TABLE |  |  | STANDARDS |  |
| MODEL CODE | Output Voltage | Output Current | EMI | To CISPR 22 / EN55022 class A |
| SR250K12X | 13.8V | 18A |  |  |
| SR250K24X | 27.6 V | 9 A |  |  |

Global Solutions Personal Focus
DIMENSIONS FOR SR250K


## TERMS OF WARRANTY

Innovative Energies Ltd warrants its power supplies for 24 months (two years) from date of shipment against material and workmanship defects.

Innovative Energies' liability under this warranty is limited to the replacement or repair of the defective product as long as the product has not been damaged through misapplication, negligence, or unauthorized modification or repair.

## Innovative Energies Limited

23/12/11

Product data sheet
Characteristics

LV429632
circuit breaker Compact NSX100F - TMD - 63
A - 3 poles 3d


| Range of product | NSX100... 250 |
| :---: | :---: |
| Product or component type | Circuit breaker |
| Circuit breaker name | Compact NSX100F |
| Device short name | Compact NSX100F |
| Circuit breaker application | Distribution |
| Poles description | 3P |
| Protected poles description | 3 t |
| Network type | AC |
| Network frequency | $50 / 60 \mathrm{~Hz}$ |
| [In] rated current | $100 \mathrm{~A}\left(40^{\circ} \mathrm{C}\right.$ ) |
| [Ui] rated insulation voltage | 800 V AC 50/60 Hz |
| [Uimp] rated impulse withstand voltage | 8 kV |
| [Ue] rated operational voltage | 690 V AC 50/60 Hz |
| Breaking capacity code | F |
| Breaking capacity | Icu 85 kA at $220 / 240 \mathrm{~V}$ AC $50 / 60 \mathrm{~Hz}$ conforming to IEC 60947-2 <br> Icu 8 kA at 660/690 V AC 50/60 Hz conforming to IEC 60947-2 <br> Icu 36 kA at $380 / 415 \mathrm{~V}$ AC $50 / 60 \mathrm{~Hz}$ conforming to IEC 60947-2 <br> Icu 35 kA at 440 V AC $50 / 60 \mathrm{~Hz}$ conforming to IEC 60947-2 <br> Icu 25 kA at 500 V AC $50 / 60 \mathrm{~Hz}$ conforming to IEC 60947-2 <br> Icu 22 kA at 525 V AC $50 / 60 \mathrm{~Hz}$ conforming to IEC 60947-2 <br> 85 kA at 240 V AC $50 / 60 \mathrm{~Hz}$ conforming to UL 508 85 kA at 240 V AC $50 / 60 \mathrm{~Hz}$ conforming to NEMA AB1 <br> 8 kA at 600 V AC $50 / 60 \mathrm{~Hz}$ conforming to NEMA AB1 <br> 35 kA at 480 V AC $50 / 60 \mathrm{~Hz}$ conforming to NEMA AB1 <br> 25 kA at 480 V AC 50/60 Hz conforming to UL 508 10 kA at 600 V AC $50 / 60 \mathrm{~Hz}$ conforming to UL 508 |
| [lcs] rated service breaking capacity | Ics 12.5 kA 500 V AC $50 / 60 \mathrm{~Hz}$ conforming to IEC 60947-2 <br> Ics 85 kA 220/240 V AC $50 / 60 \mathrm{~Hz}$ conforming to IEC 60947-2 <br> Ics 4 kA 660/690 V AC 50/60 Hz conforming to IEC 60947-2 <br> Ics 36 kA 380/415 V AC $50 / 60 \mathrm{~Hz}$ conforming to IEC 60947-2 <br> Ics 35 kA 440 V AC $50 / 60 \mathrm{~Hz}$ conforming to IEC 60947-2 <br> Ics 11 kA 525 V AC $50 / 60 \mathrm{~Hz}$ conforming to IEC 60947-2 |
| Suitability for isolation | Yes conforming to IEC 60947-2 <br> Yes conforming to EN 60947-2 |
| Utilisation category | Category A |
| Trip unit name | TM-D |
| Trip unit technology | Thermal-magnetic |
| Trip unit protection functions | LI |
| Trip unit rating | $63 \mathrm{~A}\left(40^{\circ} \mathrm{C}\right)$ |
| Protection type | Overload protection (thermal) Short-circuit protection (magnetic) |
| Pollution degree | 3 conforming to IEC 60664-1 |


| Complementary |  |
| :---: | :---: |
| Control type | Toggle |
| Mounting mode | Fixed |
| Mounting support | Backplate |
| Upside connection | Front |
| Downside connection | Front |
| Mechanical durability | 50000 cycles |
| Electrical durability | 50000 cycles $440 \mathrm{~V} \operatorname{In} / 2$ conforming to IEC 60947-2 30000 cycles 440 V In conforming to IEC 60947-2 20000 cycles $690 \mathrm{~V} \operatorname{In} / 2$ conforming to IEC 60947-2 10000 cycles 690 V In conforming to IEC 60947-2 |
| Connection pitch | 35 mm |
| Local signalling | Positive contact indication |
| Long time pick-up adjstment type Ir | Adjustable |
| Long time pick-up adjustment range | 0.7... $1 \times \mathrm{ln}$ |
| Long time delay adjustment type | Fixed |
| [Tr] long-time delay adjustment | $\begin{aligned} & 15 \mathrm{~s} 6 \mathrm{x} \text { Ir } \\ & 120 \ldots . . .400 \mathrm{~s} 1.5 \times \mathrm{ln} \end{aligned}$ |
| Short-time pick-up adjustment type Isd | Fixed |
| [lsd] short-time pick-up adjustment range | 500 A |
| Short-time delay adjustment type | Fixed |
| Height | 161 mm |
| Width | 105 mm |
| Depth | 86 mm |
| Product weight | 2.05 kg |

Environment

| Electrical shock protection class | Class II |
| :--- | :--- |
| Standards | EN 60947-2 |
|  | IEC 60947-2 |
|  | NEMA AB1 |
|  | UL 508 |
| Product certifications | CSA |
|  | UL |
| IP degree of protection | IP40 conforming to IEC 60529 |
| IK degree of protection | IK07 conforming to IEC 62262 |
| Ambient air temperature for operation | $-35 \ldots 70^{\circ} \mathrm{C}$ |
| Ambient air temperature for storage | $-55 \ldots 85^{\circ} \mathrm{C}$ |

Offer Sustainability

| Sustainable offer status | Green Premium product |
| :---: | :---: |
| RoHS | Compliant - since 0819 - 匀Schneider Electric declaration of conformity |
| REACh | Reference not containing SVHC above the threshold |
| Product environmental profile | Available |
| Product end of life instructions | Need no specific recycling operations |

Contractual warranty
Period 18 months

## VPCITM EMITTING SYSTEMS \& ELECTRONIC PRODUCTS

## VpCl ${ }^{\circledR}-110$ Emitter, Patented



## PRODUCT DESCRIPTION

Cortec ${ }^{\circledR} \mathrm{VpCl}-110$ emitters are designed to provide corrosion protection for metal components and parts enclosed in non-ventilated control boxes, cabinets, or tool boxes up to 10 cubic feet (283 liters) in volume. The Vapor phase Corrosion Inhibitor ( VpCl ) emits vapors which form a molecular layer on internal metal surfaces to protect critical, complex, and expensive electronic equipment and other metal components during operation, shipping, or storage. VpCl-110 is a small foam emitter through which corrosion inhibitors are slowly released, and moisture and air pollutants can enter to be absorbed. It provides long-term protection against corrosion even in the presence of adverse conditions including salt, moisture, airborne contaminants, $\mathrm{H}_{2} \mathrm{~S}$, $\mathrm{SO}_{2}, \mathrm{NH}_{3}$, and others.

## TYPICAL APPLICATIONS

$\mathrm{VpCl}-110$ can be effectively used for:

- O perations, packaging, and storage electrical equipment
- Marine navigation and communication electronic equipment
- Aerospace electrical controls
- Electric motors
- Switching equipment
- Fuse boxes and power boxes
- Medical equipment
- Electrical wireways and terminal boxes
- Scientific and measuring instruments
- Telecommunications equipment
- Remote electronics devices
- Tool-boxes, parts-storage, and other containers holding metals


## FEATURES

- Economical to use
- Provides continuous protection for up to 24 months during operation and/or shutdown
- Effective in polluted and humid environments
- Does not interfere with electrical, optical, or mechanical performance
- Multimetal protection
- Q uick and easy installation
- Non-toxic and safe to handle
- Compact and space-saving
- Free of nitrites, halogens, and phosphates
- No spraying, wiping, or dipping required
- Low VO C values
- Meets Southern California Clean Air Act and other National and local regulations
- Self-stick back
- Self-stick date label
- Accepted by FDA for corrosion protection of electrical and electronic equipment within food processing plants
- Canadian Food Inspection Agency acceptance for indirect food contact
- NSN 6850-01-456-2971
- Conforms to MIL I-22110C
- Federal Standard 101, Ardec Technical Report 9905, Picatinny Arsenal, N ew J ersey, USA

CORTEC
CORPORATION

## METHOD OF APPLICATION

$\mathrm{VpCl}-110$ is extremely simple and convenient to install. The device should be installed at the earliest possible time. Simply select a space within enclosure where corrosion protection would be useful. Verify the surface is clean and free of debris. Peel off the protective peel strip from the bottom of the device and attach it to the clean surface.

VpCl-110 emitters can be installed in any position. For volumes greater than 10 cubic feet (283 liters), use more than one device. If the enclosure is not totally airtight, or if the access doors are opened frequently, replace the $\mathrm{VpCl}-110$ device more often than every 2 years. After periods of heavy maintenance replace the device. For additional protection spray the enclosure very lightly with ElectriCorr ${ }^{\circledR} \mathrm{VpCI}-238$ or $\mathrm{VpCl}-239$.

## SPECIFICATIONS

## Packaging

Protection
Standard Size

12 individually wrapped emitters per carton up to $10 \mathrm{ft}^{3}$ (283 liters) per device
Foam device with adhesive backing $2.5^{\prime \prime} \mathrm{D} \times 2^{\prime \prime} \mathrm{H}$ ( 6.4 cm D x 5 cm H )

## FOR INDUSTRIAL USE ONLY

## KEEP OUT OF REACH OF CHIDREN

## KEEP CONTAINER TIGHTLY SEALED

## NOT FOR INTERNAL CONSUMPTION

## CONSULT MATERIAL SAFETY DATA SHEET FOR MORE INFORMATION

## LIMITED WARRANTY

All statements, technical information and recommendations contained herein are based on tests Cortec Corporation believes to be reliable, but the accuracy or completeness thereof is not guaranteed.
Cortec Corporation warrants Cortec ${ }^{\circledR}$ products will be free from defects when shipped to customer. Cortec Corporation's obligation under this warranty shall be limited to replacement of product that proves to be defective. To obtain replacement product under this warranty, the customer must notify Cortec Corporation of the claimed defect within six months after shipment of product to customer. All freight charges for replacement products shall be paid by customer
Cortec Corporation shall have no liability for any injury, loss or damage arising out of the use of or the inability to use the products.

BEFO RE USING, USER SHALL DETERMINE THE SUITABILITY OF THE PRO DUCT FOR ITS INTENDED USE, AND USER ASSUMES ALL RISK AND LIABILITY WHATSO EVER IN CONNECTION THEREWITH. No representation or recommendation not contained herein shall have any force or effect unless in a written document signed by an officer of Cortec Corporation.
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## VpCl ${ }^{\circledR}-111$ Emitter, Patented



## PRODUCT DESCRIPTION

$\mathrm{VpCl}-111$ emitters are unique devices designed to provide corrosion protection for metal components and parts enclosed in non-ventilated control boxes, cabinets or tool boxes up to 11 cubic feet ( 312 liters). The Vapor phase Corrosion Inhibitor ( VpCl ) emit vapors, which form a molecular layer on internal metal surfaces to protect critical, complex, and expensive electronic equipment during operation, shipping, or storage. $\mathrm{VpCl}-111$ is a small patented plastic emitter with a breathable Tyvek ${ }^{\circledR}$ membrane through which corrosion inhibitors are slowly released. VpCl-111 provides long term protection against corrosion even in the presence of adverse conditions including salt, moisture, airborne contaminants, $\mathrm{H}_{2} \mathrm{~S}, \mathrm{SO}_{2}$, $\mathrm{NH}_{3}$, and others.

## TYPICAL APPLICATIONS

- Operating, packaged, and stored electrical equipment
- Marine navigation and communication equipment
- Aerospace electrical controls
- Electric motors
- Switching equipment
- Fuse boxes and power boxes
- Medical equipment
- Electrical wireways and terminal boxes
- Scientific and measuring instruments
- Telecommunications equipment and remote electronics devices


## FEATURES

- Economical to use
- Provides continuous protection for up to 24 months during operation and/or shutdown
- Effective in polluted and humid environments
- Does not interfere with electrical, optical, or mechanical performance
- Contains desiccant properties
- Multimetal protection
- Quick and easy installation
- Very convenient to install
- Non-toxic and safe to handle
- Compact and space-saving
- Free of nitrites, halogens, and phosphates
- No spraying, wiping, or dipping required
- VOC values meet Southern California Clean Air Act and other National and local regulations
- Self-stick back
- Self-stick date label
- NSN\# 6850-01-408-9025
- Accepted by FDA for corrosion protection of electrical and electronic equipment within food processing plants

CORTEC
CORPORATION

- Canadian Food Inspection Agency acceptance for indirect food contact
- Approved for U.S. military and NATO
- Conforms to MIL I-22110C
- IBM approval \# 44V5421


## METHOD OF APPLICATION

$\mathrm{VpCl}-111$ is extremely simple and convenient to install. $\mathrm{VpCl}-111$ emitters should be installed as early as possible, preferably during manufacturing or assembly. Simply select a space within enclosed device where corrosion protection would be useful. Verify that the surface on which the device will be installed is clean and free of debris. Peel off the protective peel strip from the bottom of the device and attach it to the clean surface. The peel strip can be separated to reveal a self-adhesive sticker on which the installation and replacement dates can be noted. $\mathrm{VpCl}-111$ emitters can be installed in any position. For volumes greater than $11 \mathrm{ff}^{3}$ ( 312 L ), install more than one $\mathrm{VpCl}-111$. If the enclosure is not totally air-tight or if the access doors are opened frequently, replace the $\mathrm{VpCl}^{\circledR}-111$ emitter more often than every two years. After periods of heavy maintenance, replace the emitter. For additional protection spray the enclosure very lightly with ElectriCorr ${ }^{\circledR} \mathrm{VpCl}-238$. wrapped emitters per carton.

## PROPERTIES

| Appearance | Green cup with Tyvek ${ }^{\circledR}$ lid |
| :--- | :--- |
| Protection | $11 \mathrm{ff}^{3}(312$ Liters $)$ emitter |
| Standard size | Plastic device cup with <br> breathable membrane 2.25 in. <br> diameter $\times 1.27$ in H <br> $(5.7 \mathrm{~cm} \times 3.2 \mathrm{~cm})$ |

## PACKAGING AND STORAGE

Products should not be exposed to temperatures of over $185^{\circ} \mathrm{F}\left(85^{\circ} \mathrm{C}\right) . \mathrm{VpCl}-111$ is available in 10 individually wrapped emitters per carton.

## FOR INDUSTRIAL USE ONLY

## KEEP OUT OF REACH OF CHILDREN

## KEEP CONTAINER TIGHTLY SEALED

NOT FOR INTERNAL CONSUMPTION

## CONSULT SAFETY DATA SHEET FOR MORE

## INFORMATION

## LIMITED WARRANTY

All statements, technical information and recommendations contained herein are based on tests Cortec Corporation believes to be reliable, but the accuracy or completeness thereof is not guaranteed.
Cortec Corporation warrants Cortec ${ }^{\oplus}$ products will be free from defects when shipped to customer. Cortec Corporation's obligation under this warranty shall be limited to replacement of product that proves to be defective. To obtain replacement product under this warranty, the customer must notify Cortec Corporation of the claimed defect within six months affer shipment of product to customer. All freight charges for replacement products shall be paid by customer
Cortec Corporation shall have no liability for any injury, loss or damage arising out of the use of or the inability to use the products.

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[^1]:    
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[^2]:    Company Electrical Licence No． 756

[^3]:    * RoHS = Restriction of Hazardous Substances
    ** WEEE = Waste Electrical and Electronic Equipment

[^4]:    Separate toroids.

[^5]:    1 Short terminal shields
    2 Terminals
    3 Interphase barriers
    4 Long terminal shields

[^6]:    $\square$ Thermal-protection curve with minimum and maximum values.

[^7]:    Terminals shown in red V/O must be connected by the customer.

[^8]:    $\square$ Reflex tripping.

[^9]:    （1）Supplied with 2 or 3 interphase barriers．

[^10]:    (1) For only 1 device.

[^11]:    WARNING
    ERICO products shall be installed and used only as indicated in ERICO's product instruction sheets and training materials. Instruction sheets are available at www.erico.com and from your ERICO customer service representative. Improper installation, misuse, misapplication or other failure to completely follow ERICO's instructions and warnings may cause product malfunction, property customer service representative. Improper
    damage, serious bodily injury and death.

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    UL is a registered trademark of The Underwriters Laboratories, Inc.
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[^12]:    Un Green LED: indicates that supply to the relay is on.

[^13]:    Tt : time delay after crossing of threshold (adjustable on front panel).

[^14]:    Table 4.4 Indicator Lights Functions

[^15]:    1. 3-15 Reference 1 Source
[^16]:    Table 5.2 Quick Menu Structure

[^17]:    Table 6.1 Analog Current Feedback Transducer

[^18]:    (contact Danfoss)

[^19]:    Table 10.5 Mains Supply $3 \times 380-480$ V AC - Normal Overload $110 \%$ for 1 Minute

[^20]:    Table 10.12 200-240 V, Frame Sizes A, B and C

[^21]:    Table $10.193 \times 200-240$ V, Frame Sizes A, B and C

[^22]:    Technische Änderungen vorbehalten 22.503.903-01 / 08. 2008

    Ausgabe 3

[^23]:    ${ }^{1}$ not available for switch type CA25 $\quad{ }^{2}$ not available for switch type CL4 $\quad{ }^{3}$ for use in a three phase four－wire system with switched neutral
    ${ }^{4}$ not available for switch type CL10

[^24]:    ${ }^{1}$ switch type C315 with handle ${ }^{2}$ not available for switch type C315 ${ }^{3}$ for use in a three phase four－wire system with switched neutral ${ }^{4}$ switch type C80 with handle

[^25]:    ${ }^{1}$ Valid for lines with grounded common neutral termination, overvoltage category III, pollution degree 3 . Values for other supply systems on request. ${ }^{2}$ Valid for CA 4 only. ${ }^{3} \mathrm{DC}$ switching capacity applies to ON/OFF switches. Switching capacity for other configurations on request. ${ }^{4}$ International Standards and Approvals, refer to page $39 .{ }^{5}$ For electromagnetic optional extras see additional data in Catalog 101. ${ }^{6}$ Values for switches with spring return on request. ${ }^{7}$ Storage temperature: $-40^{\circ} \mathrm{C}$ to $85^{\circ} \mathrm{C}$ (in case of temperature below $-5{ }^{\circ} \mathrm{C}$ no shock load permissible).

[^26]:    ${ }^{1}$ Valid for lines with grounded common neutral termination, overvoltage category III, pollution degree 3 . Values for other supply systems on request.
    ${ }^{2}$ International Standards and Approvals, refer to page $39 .{ }^{3} \mathrm{Max} .300 \mathrm{~V}$. ${ }^{4}$ For electromagnetic optional extras see additional data in Catalog 101.
    ${ }^{5}$ Values for switches with spring return on request. ${ }^{6}$ Storage temperature: $-40^{\circ} \mathrm{C}$ to $85^{\circ} \mathrm{C}$ (in case of temperature below $-5^{\circ} \mathrm{C}$ no shock load permissible).

[^27]:    * The pin plungers of reverse-type models are continuously pressed by the actuator levers with compression coil springs and the pin plungers are freed by operating the levers.

[^28]:    14 screws M5 $\times 12$
    2 Measuring instrument holder
    3 Tube

[^29]:    The LED names I1 ACTV, I1 L/RX, H1 LNK1/LNK2, and D1 RX appear only in CPU 3680.

[^30]:    * The LED names I1 ACTV, I1 L/RX, H1 LNK1/LNK2, and D1 RX appear only in CPU 3680.
    ** The LED names E1 LNK and RX appear only in CPU 3640 and CPU 3680.

[^31]:    * in Fast 24V IEC TYPE II modules -only DC

[^32]:    * In 32 DI 24 V modules only.

[^33]:    * XTL5000 Radio with O5 Control Head is not available.
    ** TransNET 900 and iNET 900 are trademarks of GE MDS.

[^34]:    * Note that the MotoTurbo radios can work as conventional analog radios or as digital radios. ACE3600 supports the digital mode only.

[^35]:    In EMEA and Asia, add the adapter provided in kit FLN3635A to the radio before attaching the antenna cable.

[^36]:    * Antenna Cable provided may be either FKN8437A (with UHF connector plus antenna adapter 5871143Y01) or FKN8430A.

[^37]:    * For connection to MOSCAD port, use FKN8527A. See Appendix C.

[^38]:    * The ACT module is not compliant with RoHS European Directive no. 2002/95/EC.

[^39]:    METAL PARTS OF THE POWER SUPPLY MAY BE VERY HOT.
    After removing the power supply module, allow the metal parts to cool down before servicing the unit.

[^40]:    Meyeconn ${ }^{\text {＊}}$＊＊＊
    

[^41]:    
    

[^42]:    wavecoms ${ }^{*}$ п＂＊wa
    
    

[^43]:    wavecom ${ }^{3}$ * $\boldsymbol{m}$ *
    
    

[^44]:    wavecom ${ }^{3}$ * $\boldsymbol{m}$ *
    
    *

[^45]:    
    

[^46]:    a. $50 / 125 \mu \mathrm{~m}, 800 \mathrm{MHz}^{*} \mathrm{~km}$ fiber optic cable
    b. $62.5 / 125 \mu \mathrm{~m}, 500 \mathrm{MHz}^{*} \mathrm{~km}$ fiber optic cable
    c. $9 / 125 \mu \mathrm{~m}$ single-mode fiber optic cable

[^47]:    CompactFlash is a registered trademark of CompactFlash Association

[^48]:    http://
    www.download.phoenixcontact.com Please note that the data given here has been taken from the online catalog. For comprehensive information and data, please refer to the user documentation. The General Terms and Conditions of Use apply to Internet downloads.

[^49]:    PHOENIX CONTACT Deutschland GmbH http://www.phoenixcontact.com

