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A QUALITY COMPANY TO AS/IS09001

## SP021 UPPER ESPLANADE SEWAGE PUMP STATION SWITCHBOARD

## OPERATION \& MAINTENANCE MANUAL

## JOB No A4214

HALMAC SERVICES IS A QUALITY COMPANY SERVING QUEENSLAND SINCE 1960

| Halmac Services(Qld) Pty.Ltd. 30 Palimer Place Murarrie, ald. 47 m 2 Telephone : 1077 34499500 Fox 10713249959 a OUNUIY COPPANY TO AS/S09001 | 1 | MOULDED CASE CIRCUIT BREAKER |
| :---: | :---: | :---: |
|  | 2 | MINIATURE CIRCUIT BREAKER |
|  | 3 | CONTACTOR \& THERMAL OVERLOAD |
|  | 4 | CONTROL RELAY \& PHASE FAILURE RELAY |
|  | 5 | CHASSIS |
|  | 6 | FAN \& FILTER |
|  | 7 | FUSE \& FUSE HOLDER |
| SP021 UPPER <br> ESPLANADE SEWAGE PUMP STATION | 8 | GSM MODEM |
|  | 9 | HUMAN MACHINE INTERFACE |
|  | 10 | LEVEL TRANSMITTER |
|  | 11 | multitrode level relay |
|  | 12 | POWER SUPPLY \& BATTERY |
| OPERATION \& MAINTENANCE MANUAL | 13 | PROXIMITY SWITCH |
|  | 14 | PUSHBUTTON \& INDICATOR |
|  | 15 | PRESSURE TRANSMITTER \& ADJUSTMENT UNIT |
|  | 16 | RADIO MODEM |
|  | 17 | SIGNAL ISOLATOR |
|  | 18 | SURGE DIVERTER \& SURGE REDUCTION FILTER |
|  | 19 | THERMOSTAT |
|  | 20 | TIMER |
|  | 21 | VARIABLE SPEED DRIVE |
|  | 22 | TEST SHEETS |
|  | 23 | SECTION NOT USED |
| JOB NO: A4214 | 24 | SECTION NOT USED |

1. S250PE MCCB TECHNICAL DETAILS
2. S125GJ \& S125NJ MCCB TECHNICAL DETAILS
3. MCCB ACCESSORIES

## N- $\mathbf{P}$

## Electronic type <br> S250PE

## 70kA

Current rating:

$$
50-250 A
$$

## Approvals and Tests:

Standards AS/NZS 3947-2, and IEC60947-2

## Interrupting capacity:

AC use | Voltage | Icu | IcS |
| :--- | :---: | :---: |
|  | $380 / 415$ | 70 |
| 70 |  |  |

## Over Current Relay:



- Electronic, for general \& selectivity applications
- 7 dial selectable characteristic curves suited for a variety of applications
- Base current $I r$ is adjustable from $40 \%-100 \%$ of the nominal rated current $I n$.
- STD setting 2.5-10 (x/R) 2)
- INST setting 13-14 (x/R) 2 )


## OCR Options:

- Neutral Pole protection for 4 pole MCCBs only (AN)
- Pre-Trip Alarm (AP)

| Dimensions (mm) |  |  |
| :--- | :--- | ---: |
| Poles | 3 | 4 |
| $H$ | 165 | 165 |
| $W$ | 105 | 140 |
| D (less toggle) | 103 | 103 |
| Toggle cut-out |  | Standard DIN |


| Ampere Rating NRC | $I_{R}$ Adjustment Min-Max. | Cat. No. 1) |
| :---: | :---: | :---: |
| 125 | 50-125 | S250 PE _ 125 |
| 250 | 100-250 | S250 PE_250 |

Price Adder - if OCR options are required, add the selected OCR option price below to the above MCCB price to calculate the total MCCB cost.

| 3P OCR options: PTA $_{3}$ ) | S250 PE 3 AP \# |
| :--- | :--- |
|  |  |
| 4 P OCR options: PTA $_{3}$ ) | S250 PE 4 AP \# |
| AP |  |
| PTA + NP $_{3)}$ | S250 PE 4 AN \# |

1) Add poles to complete MCCB catalogue number. Eg: 3 pole 250A: S250PE 3 250. "\#" add OCR trip unit rating where shown.
2) The STD and Instantaneous pickup currents ( $l_{\mathrm{sd}} \& l_{\mathrm{i}}$ ) settings are not individually adjustable, however by selecting different curve types and different $I_{R}$ settings the values will vary. Curve $1 \& 2 I_{\mathrm{sd}}=2.5 \times \mathrm{I}_{\mathrm{R},}$ curve $3 I_{\mathrm{sd}}=5 \times \mathrm{I}_{\mathrm{R}}$ curve $4-7 I_{\mathrm{sd}}=10 \times \mathrm{I}_{\mathrm{R}}$. $I_{\mathrm{R}}$ dial setting $0.4-0.9 h_{i}=14 \times I_{R}$ and $I_{R}$ dial setting $0.95-1.0 I_{i}=13 \times I_{R}$. Refer curve examples \& setting data on pages 18 to 30 .

NRC $=$ Nominal rated current, $\quad I_{R}=$ Current adjustment dial setting, $\quad S T D=$ Short Time Delay, $\quad$ INST $=$ instantaneous
3) To order a MCCB with the above options insert the required option after the pole to make up the cat. number. Eg: S250PE 4 APN 250 is a S250PE 4 Pole 250A MCCB c/w Pre-trip Alarm and Neutral Protection.


## ACCRSSORUES

## ACCESSORIES FOR DUAL SUPPLY CHANGEOVER SYSTEMS

## Wire Interlock (MW)

Wire interlocks consist of two mechanisms connected by a cable. The mechanisms are mounted on two MCCBs located at a distance from each other which is limited by the length and bend radius of the cable. The mechanisms and cable inhibit the closure of one MCCB unless the other is in the OFF position. Each mechanism is ordered separately. Cables of 1.0 m or 1.5 m length are also ordered as separate items.
Wire interlocks can be used on a mixture of 3 and 4 pole MCCBs of different frame sizes.
This allows potential cost savings by using lower rated MCCBs for the alternative power supply. MCCBs can be mounted in different switchboard compartment or on different planes.


Viow from above

The TemBreak 2 wire interlock is an innovative design breakthrough which will save space, time and money for switchboard builders in that:

- Installation is extremely simple. Wire interlocks are field-installable.
- Wire interlocks replace the accessory cover on the front of the breaker
- Motor operators and operating handles are compatible with wire interlocks
- Interlocking of MCCBs mounted in different compartments is possible
- No need to buy factory-built backplates with MCCBs and interlocks pre-fitted
- An automatic changeover pair consisting of an interlocked pair of MCCBs with internal control accessories and motor operators can be assembled in a few minutes!


## Slide Interlock (MS)

Slide interlocks are manually operated toggle locking devices which can be installed between two adjacent MCCB . Depending on the position of the slide, one or other of the MCCBs on either side of a slide interlock is inhibited from being in the ON position.
Slide interlocks can be used between MCCBs of the same number of poles and of the same frame size.
Slide interlocks can be installed in the field and are padlockable in both positions.


Slide Interlock Iustalled Berween noo MCCBs



## CONNECTION AND MOUNTING OPTIONS AND ACCESSORIES

Connection of Busbars and Terminated Cables
This connection method is standard for all front connected (FC) MCCB models.
Solid conductors or cables terminated with crimp lug terminals can be used.

## Serrated Terminal Surface

Each terminal on 160A and 250A models has a serrated surface. This provides excellent grip for heavy cables terminated with crimp lug terminals, thereby preventing sideways rotation of the lug.


| Maximum Dimensfonsof Compressioniarminals. |  |  |  |
| :--- | :--- | :--- | :--- |
| Frame Size $(\mathrm{A})$ | $125^{*}$ | $160 \& 250$ | $400 \& 630$ |
| Width, $\mathrm{W}(\mathrm{mm})$ | 17 | 25 | 25 |
| Diameter, $\mathrm{d}(\mathrm{mm})$ | 9 | 9 | 11 |
| Alaximum trom centre to tip, e(mm) | 8.5 | 10 | 12 |

Connection of Large Conductors and Multiple Conductors Flat bars (FB) are terminal extensions which can be fitted to line or load side terminals and are used to connect large conductors and multiple conductors. Available for field fitting in sets of 3 or 4 bars.



## 叔STRLOTRON

## CONNECTION AND MOUNTING OPTIONS AND ACCESSORIES

Direct Entry of Stranded Cable
Solderless clamp terminals (FW) can be used to secure stranded cable directly to the MCCB. Available for field fitting in sets of 3 or 4.


| MCCBMOde] |  |
| :---: | :---: |
| E125, S125, S125-NF | 1.5 to 50 (1 cable) |
| H125, L125, S160-NF | 1.5 to 70 (1 cable) |
| S160, E250, S250, H250, L250 | 35 to 120 (1 cable) |
| E400, S400, H400, L400 | 80 to 240 (1 cable) |
|  | 60 to 120 (2 cables) |

Termination in Separate Compartment
Rear connections (RC) allow termination of conductors in a different switchboard compartment to the MCCB body.

The terminal bar can be rotated in steps of 45 degrees in the field.



## INSTALLATUON

## CONNECTION AND MOUNTING OPTIONS AND ACCESSORIES

Plug-in Mounting
The plug in mounting system allows fast replacement of the MCCB body without the need to disturb the terminations. Solid conductors or cables terminated with compression terminals can be used.

## Plug-In Safety Lock



The plug-in MCCB body is automatically locked to the base when the contacts are closed (toggle ON). It cannot be removed unless the contacts are in the isolated position (toggle OFF or TRIPPED). This system ensures safe removal of the MCCB from the base.


The connection bars for plug-in bases are optional and can be configured in the field either for front or rear access. The illustrations below show possible mounting and connection options for plug in bases.


1. Mounted on base plate with connection bars mounted for front access.
Insulation plates are supplied as standard and must be fitted.

2. Terminations in separate compartment. Connection bars are mounted for top access at the top and rear access at the bottom.

3. Mounted on angle bars. Connection bars are mounted for rear access.

## OPERATMNG CHARACTRRISTICS

## LET-THROUGH PEAK CURRENT CHARACTERISTICS

H160-NJ, L160-NJ, S250-PE, H250-NJ, H250-NE, L250-NJ. 440 V AC.


E400-NJ, S400-CJ, S400-NJ, S400-NE, S400-GJ, S400-GE, 415 V AC.


H160-NJ, L160-NJ, S250-PE, H250-NJ, H250-NE,
L250-NJ. 690 V AC.


S400-CJ, S400-NJ, S400-NE, S400-GJ, S400-GE, 690 V AC.



## APPLICGTDON DATR

## SELECTIVITY (DISCRIMINATION) AND CASCADE

## Selectivity

The principle of Selectivity (Discrimination) is based upon an analysis of several circuit breaker characteristics. These include time-current (tripping) curves, peak-let-through current ( $\mathrm{I}_{\text {pax }}$ ) and energy let-through ( $\mathrm{I}^{2} \mathrm{t}$ ).
The figures stated give the maximum selectivity level with the two nominated breakers in series under short-circuit conditions. For an indication on selectivity under overloads refer to the circuit breaker tripping/characteristic curves, or use the NHP TemCurve selectivity analysis software package.
Selectivity can be enhanced beyond the breaking capacity of the downstream breaker provided it is backed up by an appropriately selected upstream breaker, which should not trip (unlatch) under the stated short circuit current.

## Cascade

Cascading is achieved by using an upstream device to assist (back-up) a downstream device in clearing a fault current. This principal is necessary should the downstream device be required to clear a prospective short circuit current greater than the devices' breaking capacity.
In most cascading applications it is generally necessary for the upstream breaker to trip (unlatch), as well as the downstream breaker to give adequate back-up protection. As such, cascade is commonly used in feeding and protecting non-essential loads, such as basic lighting.
For more information on selectivity and cascading please refer to the latest NHP Part C catalogue.

Selectivity \＆Cascade Tables
＠ 400 ／ 415 V

| Upstream MCCBs |  |  | $\begin{aligned} & \text { 삧 } \\ & \text { 苐 } \end{aligned}$ | 㟶 | 岩 | 豈 | 崩 | 岩 |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| MCCBs | （RMS） | 70 | 125 | 50 | 70 | 125 | 200 | 36 | 50 |
| ［E125NJ | 25 | 25／25 | 25／65 | 25／36 | 25／50 | 25／65 | 25／85 | 25／36 | 25／25 |
| S125NJ | 36 | 36／36 | 36／85 | 36／50 | 36／65 | 36／85 | 36／125 | 36／36 | 36／36 |
| S125GJ | 65 | 65／65 | 65／125 | 50／50 | 65／70 | 65／125 | 65／150 | 36／36 | 50／50 |
| H125NJ | 125 | 70／70 | 125／125 | 50／50 | 70\％70 | 125／125 | 125／200 | 36／36 | 50／50 |
| S160NJ | 36 | 1 |  | 36／50 | 36／65 | 36／85 | 36／425 | 36，36 | 36／50 |
| ［S160G］ | 65 |  |  | 50／50 | 65／70 | 65／125 | 65／150 | 36／36 | 50／50 |
| H160NJ | 125 | I |  |  |  | 125／125 | 125／200 | 36／36 | 50／50 |
| ［E250NJ | 25 |  |  |  |  | 25／65 | 25／85 | 25／36 | 25／25 |
| S250NJ | 36 | 1 |  |  | 1 | 36／85 | 36／125 | 36／36 | 36／36 |
| S250GN | 65 | ！ |  |  | ， | 65／125 | 65／150 | 36／36 | 50／50 |
| S250PE | 70 |  |  |  |  | 40／125 | 70／150 | 36／36 | 50／50 |
| H250NJ | 125 | ！ |  |  |  | 125／125 | 125／200 | 36／36 | 50／50 |
| H250PE | 125 | 1 |  |  |  | 125／125 | 125／200 | 36／36 | 50／50 |
| E400NJ | 25 |  |  |  | 1 |  |  | 10／25 | 10／25 |
| S4000． | 36 | ， |  |  |  |  |  | 10／36 | 10／36 |
| S400NE | 50 | I | $\because$ |  |  |  |  | 10／36 | 10／50 |
| S400NJ | 50 | 1 |  |  |  |  |  | 10／36 | 10／36 |
| S400GJ | 70 |  |  |  | ， |  |  | 10／36 | 10：50 |
| H400NJ | 125 |  |  |  |  |  |  | 10／36 | 10／50 |
| H400NE | 125 | 1 |  |  |  |  |  | 10／36 | 10／50 |
| E630NE | 36 |  |  |  | ， |  |  | ！ |  |
| E630CE | 50 |  |  |  |  |  |  |  |  |
| S630GE | 70 |  |  |  |  |  |  |  |  |
| XS630GJ | 45 |  |  |  |  |  |  |  |  |
| XS630NJ | 65 | 1 | 1 |  | ＋ |  |  | ！ |  |
| XS630PJ | 85 |  |  |  |  |  |  |  |  |
| XS630SE | 50 |  |  |  |  |  |  |  |  |
| XH630SE | 65 |  |  |  |  |  |  | ， |  |
| XH630PE | 65 |  |  |  |  | 1 |  | 1 |  |
| XS800NJ | 65 | 1 |  |  |  |  |  | I |  |
| XS800SE | 50 | i |  |  |  |  |  |  |  |
| XJ800PJ | 85 | ； |  | － |  |  |  | 1 |  |
| XH800SE | 65 | 1 |  |  |  |  |  | 1 |  |
| XH800PE | 65 | 1 |  |  |  |  |  |  |  |
| XS1250SE | 65 | ， |  | 1 |  | ！ | 1 |  |  |
| XS1600SE | 85 | 1 | 1 | 1 |  |  |  |  | 1 |


|  |  |  |  |  | $\begin{aligned} & \text { 山⿱艹⿹弔口欠 } \\ & \stackrel{y}{N} \\ & \stackrel{N}{x} \\ & 85 \\ & 8 \end{aligned}$ |  |  | $\begin{aligned} & \text { 崖 } \\ & \text { en } \\ & \text { 匂 } \\ & 85 \end{aligned}$ |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{gathered} \text { 山⿱丷天心} \\ \text { 若 } \\ 70 \\ \hline \end{gathered}$ |  |  |  |  |  |  |  |  |  |
| 25／50 | 25／25 | 25／36 | 25／36 | 25／65 | 25／25 | 25；25 | 25／25 | 25／25 | 25／25 |
| 36／65 | 36／36 | 36／50 | 36／36 | 36／36 | 36／36 | 36／36 | 36／36 | 36／36 | 36／36 |
| 65，70 | 65／65 | 65／50 | 65／65 | 65／65 | 65／65 | ，65／65 | 65／65 | 65／65 | 65／65 |
| 70／70 | 70，70 | 50／50 | 65／65 | 65／65 | 85／50 | 85／50 | 100／100 | 85／85 | 85／85 |
| 36／50 | 36／36 | 36／36 | 36／65 | 36／65 | 36／36 | 36／36 | 36／36 | 36／36 | 36／36 |
| 65：70 | 65／65 | 50，50 | 50／65 | 50／65 | 65／65 | 65／65 | 65／65 | 65／65 | 65／65 |
| 70／70 | 70／70 | 50／50 | 50／65 | 50／65 | 85／65 | 85／65 | 100／100 | 85／85 | 85／85 |
| 25／50 | 25／25 | 25／25 | 25／50 | 25／50 | 25／25 | 25／25 | 25／25 | 25／25 | 25／25 |
| 36／65 | 36／36 | 36／36 | 36／36 | 36／36 | 36／36 | 36／36 | 36／36 | 36／36 | 36／36 |
| 65／70 | 65／65 | 50，50 | 50／65 | 50／65 | 65／65 | 65／65 | 65／65 | 65／65 | 65／65 |
| 70／70 | 70，70 | 50／50 | 50／65 | 50／65 | 70／70 | 70，70 | 70\％70 | 70，70 | 70／70 |
| 70／70 | 70／70 | 50\％50 | 50／65 | 50／65 | 85／85 | 85／85 | 100／100 | 85／85 | 85／85 |
| 70，70 | 70／70 | 50／50 | 50／65 | 50／65 | 85／85 | 85／85 | 100／100 | 85／85 | 85／85 |
| 10，50 | 10／36 | 25／25 | 25／25 | 25／36 | 25／25 | 25／25 | 25／36 | 25／25 | 25／25 |
| 10／65 | 10／50 | 25／36 | 25／36 | 25／50 | 36／36 | 36／36 | 36／50 | 36／36 | 36／36 |
| 10／50 | 10／50 | 25／50 | ：25／50 | 25／50 | 50／50 | 50／50 | 50／50 | 50／50 | 50，50 |
| 10\％70 | 10／65 | 25／50 | 25／50 | 25／65 | 50／50 | 50／50 | 50／65 | 50／50 | 50／50 |
| 1070 | 1070 | 25／50 | 25／50 | 25／65 | 70／36 | 70／36 | 70／85 | 70／70 | 70：70 |
| 10／70 | 10／70 | 25／50 | 25／65 | 25／65 | 125／85 | 125／85 | 125／100 | 125／85 | 125／85 |
| 10／70 | 10／70 | 25／50 | 25／65 | 25／65 | 125／85 | 125／85 | 125／100 | 125／85 | 125／85 |
|  |  | ．25／36 | 25／36 | 25／36 | 36／36 | 36／36 | 36／36 | 36／36 | 36／36 |
|  |  | 25／50 | 25／50 | 25／50 | 50／50 | 50／50 | 50／50 | 50／50 | 50／50 |
|  |  |  |  |  | 70／70 | 70／70 | 70\％70 | 70／70 | 70\％70 |
|  |  |  | 1 |  | 30；45 | 30／45 | 30／45 | 35／45 | 35／45 |
|  |  |  | ！ |  | 30／65 | 30，65 | 30／65 | 35／65 | 36／65 |
|  |  |  |  |  | 30／85 | 30／85 | 30／85 | 35／85 | 35／85 |
|  | ， |  | ， |  | 30／65 | 30／65 | 30／85 | 30／85 | 30／85 |
|  |  |  | 1 | 1 | 30／65 | 30／65 | 30／85 | 30／85 | 30／85 |
|  |  |  |  |  | 30／65 | 30／65 | 30／85 | 30／85 | 30／85 |
|  |  |  |  |  | 15／65 | 15／65 | 20／65 | 35／65． | 35／65 |
|  |  |  | 1 |  | 15／50 | 15／50 | 20；50 | 35／50 | 35／50 |
|  |  |  | 1 |  | 15／85 | 15／85 | 20／85 | 35／85 | 35／85 |
|  |  |  |  |  | 15／65 | 15／65 | 20／65 | 35／65 | 35／65 |
| ！ |  |  | 1 | 1 | 15／65 | 15／65 | 20／65 | 35／65 | 35／65 |
| 1 |  |  |  |  |  |  | 20／65 | 35／65 | 35／65 |
| 1 |  |  |  |  |  |  |  | 35／85 | 35／85 |

חNSTALLATION
INSULATION DISTANCE IN mm (AT 440V AC MAXIMUM)

*Note: (1) Insulate the exposed conductor until it overlaps the moulded case at the terminal, or the terminal cover.

## DIMENSIONS

H125-NJ, L125-NJ, H160-NJ, L160-NJ, S250-PE, H250-NJ, H250-NE, L250-NJ. Plug-in Versions
ASL:Arrangement Standard Line


Mounting on a support or rails (shown with optonal cornection bers ortented for rear acceass)


Detail of connecting part
Orianted for rear accoss

on adjacam poles.

page 90 TemBreak Beyond the Standard ${ }^{T M}$

## OPERATMNG CHARACTERUSTICS

## ELECTRONIC CHARACTERISTICS

S250-PE, H250-NE


In = 250A; 160A; 125A; 40A


## Note

(1) $l_{\mathrm{i}}$ max. $=13 \times I_{n}$. (2) Standard setting of $I_{N}$ is $100 \%$ of $l_{n}$. For any other setting please specify when ordering.

## 

## TEMPERATURE RATINGS \& DERATINGS

Calibration Temperature: $45^{\circ} \mathrm{C}$

| MCCBTYP9 | Commection Iype | Rating cilcelibrafion Iemperature ( $50^{\circ} \mathrm{C}$ ) | Pated [Current $(\mathrm{A})$ |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | $50^{\circ} \mathrm{C}$ | $55^{\circ} \mathrm{C}$ | $60^{\circ} \mathrm{C}$ | $65^{\circ} \mathrm{C}$ |
| $\begin{aligned} & \text { E125-NJ } \\ & \text { S125-NJ } \\ & \text { S125-GJ } \end{aligned}$ | Front <br> Rear <br> Plug-in | 20A | 19 | 18.5 | 18 | 17.5 |
|  |  | 32A | 31 | 30.5 | 30 | 29 |
|  |  | 50A | 48 | 45 | 43 | 41 |
|  |  | 63A | 60 | 57 | 55 | 52 |
|  |  | 100A | 97 | 94 | 90 | 87 |
|  |  | 125A | 121 | 117 | 113 | 109 |
| $\begin{aligned} & \mathrm{H} 125-\mathrm{NJ} \\ & \mathrm{~L} 125-\mathrm{NJ} \end{aligned}$ | Front <br> Rear <br> Plug-in | 20A | 19 | 18.5 | 18 | 17.5 |
|  |  | 32A | 31 | 30 | 29 | 28 |
|  |  | 50A | 48 | 47 | 45 | 44 |
|  |  | 63A | 61 | 59 | 57 | 55 |
|  |  | 100A | 97 | 95 | 92 | 89 |
|  |  | 125A | 121 | 118 | 114 | 111 |
| $\begin{aligned} & \hline \text { S160-NJ } \\ & \text { S160-GJ } \end{aligned}$ | Front Rear Plug-in | 20 A | 19 | 18.5 | 18 | 17.5 |
|  |  | 32A | 31 | 30 | 29 | 28 |
|  |  | 50A | 48 | 46 | 44 | 42 |
|  |  | 63A | 61 | 59 | 57 | 55 |
|  |  | 100A | 97 | 94 | 91 | 88 |
|  |  | 125A | 121 | 117 | 113 | 109 |
|  |  | 160A | 156 | 151 | 146 | 141 |
| $\begin{aligned} & \text { H160-NJ } \\ & \text { L160-NJ } \end{aligned}$ | Front <br> Rear <br> Plug-in | 160A | 156 | 151 | 147 | 143 |
| E250-NJ | Front Rear Plug-in | 20 A | 19 | 18.5 | 18 | 17.5 |
|  |  | 32A | 31 | 30 | 29 | 28 |
|  |  | 50A | 48 | 46 | 44 | 42 |
|  |  | 63A | 61 | 59 | 57 | 55 |
|  |  | 100A | 97 | 94 | 91 | 88 |
|  |  | 125A | 121 | 117 | 113 | 109 |
| E250-NJ | Front | 160A | 156 | 151 | 146 | 141 |
| $\begin{aligned} & \mathrm{S} 250-\mathrm{NJ} \\ & \mathrm{~S} 250-\mathrm{GJ} \end{aligned}$ | Rear Plug-in | 250A | 243 | 235 | 227 | 219 |
| $\begin{aligned} & \mathrm{H} 250-\mathrm{NJ} \\ & \mathrm{~L} 250-\mathrm{NJ} \end{aligned}$ | Front Rear Plug-in | 160A | 156 | 151 | 147 | 143 |
|  | Front Rear | 250A | 244 | 237 | 230 | 223 |
| E400-NJ | Front Rear Plug-in | 250A | 244 | 237 | 230 | 223 |
| $\begin{aligned} & \text { S400-CJ } \\ & \text { S400-NJ } \\ & \text { S400-GJ } \end{aligned}$ |  | 400A | 390 | 380 | 369 | 358 |
| $\begin{aligned} & \mathrm{H} 400-\mathrm{NJ} \\ & \text { L400-NJ } \end{aligned}$ | Front Rear | 250A | 243 | 237 | 230 | 223 |
|  |  | 400A | 390 | 381 | 371 | 361 |
|  | Plug-in | 250A | 243 | 237 | 231 | 224 |
|  |  | 400A | 392 | 384 | 376 | 368 |

Calibration Temperature: $30^{\circ} \mathrm{C}$

| MCCBType Comection |  | Ratingatcalibration temperâture) $\left(30^{\circ} \mathrm{C}\right)$ | Ratedicurient (A) |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | $35^{\circ} \mathrm{C}$ | $40^{\circ} \mathrm{C}$ | $45^{\circ} \mathrm{C}$ | $50^{\circ} \mathrm{C}$ | $55^{\circ} \mathrm{C}$ | $60^{\circ} \mathrm{C}$ | $65^{\circ} \mathrm{C}$ |
| $\begin{aligned} & \mathrm{H} 250-\mathrm{NJ} \\ & \mathrm{~L} 250-\mathrm{NJ} \end{aligned}$ | Plug-in Conn. |  | 250A | 244 | 236 | 225 | 219 | 209 | 200 | 190 |


| MCCB ${ }^{\text {PPe }}$ | Connection Type. | Rating | Rätēd\|Cürent $(\mathrm{A})$ |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | $30^{\circ} \mathrm{C}$ | $35^{\circ} \mathrm{C}$ | $40^{\circ} \mathrm{C}$ | $45^{\circ} \mathrm{C}$ | $50^{\circ} \mathrm{C}$ | $55^{\circ} \mathrm{C}$ | $60^{\circ} \mathrm{C}$ | $65^{\circ} \mathrm{C}$ |
| $\begin{aligned} & \text { S250-PE } \\ & \text { H250-NE } \end{aligned}$ | Front Rear | 250A | 250 | 250 | 250 | 250 | 237.5 | 225 | 200 | 200 |
|  | Plug-in | 250A | 250 | 237.5 | 225 | 225 | 200 | 200 | 157.5 | 157.5 |
| $\begin{aligned} & \text { S400-NE } \\ & \text { S400-GE } \end{aligned}$ | Front | 250A | 250 | 250 | 250 | 250 | 250 | 250 | 225 | 200 |
|  | Rear Plug-in | 400A | 400 | 400 | 400 | 400 | 400 | 380 | 360 | 320 |
| $\begin{aligned} & \text { H400-NE } \\ & \text { L400-NE } \end{aligned}$ | Front Rear | 250A | 250 | 250 | 250 | 250 | 250 | 250 | 225 | 200 |
|  |  | 400A | 400 | 400 | 400 | 400 | 400 | 380 | 360 | 320 |
|  | Plug-in | 250A | 250 | 250 | 250 | 250 | 250 | 250 | 225 | 200 |
|  |  | 400A | 400 | 400 | 400 | 400 | 400 | 380 | 360 | 320 |
| $\begin{aligned} & \text { E630-NE } \\ & \text { S630-CE } \\ & \text { S630-GE } \end{aligned}$ | Front Rear* | 630 A | 630 | 630 | 630 | 630 | 598.5 | 598.5 | 567 | 504 |

## OPERATMNG CHARACTERUSTICS

## LET-THROUGH ENERGY CHARACTERISTICS

H160-N], L160-NJ, S250-PE, H250-NE, H250-NJ, L250-NJ. 440 V AC .


E400-NJ, S400-CJ, $\$ 400-\mathrm{NJ}, \mathrm{S} 400-\mathrm{NE}, \mathrm{S} 400-\mathrm{GJ}$, S400-GE. 415V AC


H160-NJ, L160-NJ, S250-PE, H250-NE, H250-N], L250NJ. 690 V AC.


S400-CJ, S400-NJ, S400-NE, S400-GJ, S400-GE. 690 V AC.


## NHP

## Thermal magnetic type S125GJ

## 65kA

Current rating:
$12.5-125 A$
Approvals and Tests:
Standards AS/NZS 3947-2, and IEC60947-2
Interrupting capacity:

|  | Voltage | lcu | ICS |
| :--- | :--- | :--- | :--- |
| AC use | $380 / 400$ | 65 | 36 |
| DC use | 250 V | 40 | 40 |

Trip unit:
Adjustable thermal ( 0.63 lr to $100 \% \mathrm{lr}$ ) and adjustable magnetic ( 6 lm to 12 lm )

| Dimensions (mm) |  |  |
| :--- | :--- | ---: |
| Poles | 3 | 4 |
| $H$ | 155 | 155 |
| $W$ | 90 | 120 |
| $D$ (less togale) | 68 | 68 |
| Toggle cut-out |  | Standard DIN |


| Ampere Rating NRC | $\begin{aligned} & \text { Adj. Ir }{ }^{1 \prime} \\ & \text { Min - Max. } \end{aligned}$ | $\begin{aligned} & \text { Adj. Im }{ }^{\prime \prime} \\ & \text { Min-Max. } \end{aligned}$ | Cat. No. |
| :---: | :---: | :---: | :---: |
| 20 | 12.5-20 | 120-240 | $\begin{aligned} & \text { S125 GJ } 320 \\ & \text { S125 GJ } 420 \end{aligned}$ |
| 32 | 20-32 | 192-384 | $\begin{aligned} & \hline \text { S125 GJ } 332 \\ & \text { S125 GJ } 432 \end{aligned}$ |
| 50 | 32-50 | 300-600 | $\begin{aligned} & \text { S125 GJ } 350 \\ & \text { S125 GJ } 450 \end{aligned}$ |
| 63 | 40-63 | 378-756 | $\begin{aligned} & \hline \text { S125 GJ } 363 \\ & \text { S125 GJ } 463 \end{aligned}$ |
| 100 | 63-100 | 600-1200 | $\begin{aligned} & \text { S125 GJ } 3100 \\ & \text { S125 GJ } 4100 \end{aligned}$ |
| 125 | 80-125 | 750-1500 | $\begin{aligned} & \hline \text { S125 GJ } 3125 \\ & \text { S125 GJ } 4125 \end{aligned}$ |
| 1) | Nominal rated current <br> Adjustable thermal setting Adjustable magnetic setting |  |  |

Replaces: XH125NJ, TL100NJ, Note: check exact ratings or dimenions to suit your application requirement

## NHP

## Thermal magnetic type S125NJ

## 36kA

Current rating: $\quad 12.5-125 \mathrm{~A}$
Approvals and Tests:
Standards AS/NZS 3947-2, and IEC60947-2


Interrupting capacity:

|  | Voltage ICu <br> AC use ICS <br>  $380 / 400$ <br> DC use 250 V | 36 | 36 |
| :--- | :--- | :--- | :--- |

Trip unit:
Adjustable thermal ( 0.63 Ir to $100 \% \mathrm{Ir}$ ) and adjustable magnetic ( 6 lm to 12 lm )

| Dimensions (mm) |  |  |
| :--- | :--- | ---: |
| Poles | 3 | 4 |
| H | 155 | 155 |
| W | 90 | 120 |
| D (less toggle) | 68 | 68 |
| Ioggle cut-out |  | Standard DIN |


| Ampere Rating NRC |  | $\begin{aligned} & \text { Adj. Ir }{ }^{1} \\ & \text { Min-Max. } \end{aligned}$ | $\begin{aligned} & \text { Adj. Im }{ }^{11} \\ & \text { Min-Max. } \\ & \hline \end{aligned}$ | Cat. No. |
| :---: | :---: | :---: | :---: | :---: |
| 20 |  | 12.5-20 | 120-240 | $\begin{aligned} & \text { S125 NJ } 320 \\ & \text { S125 NJ } 420 \end{aligned}$ |
| 32 |  | 20-32 | 192-384 | $\begin{aligned} & \text { S125 NJ } 332 \\ & \text { S125 NJ } 432 \end{aligned}$ |
| 50 |  | 32-50 | 300-600 | $\begin{aligned} & \text { S125 NJ } 350 \\ & \text { S125 NJ } 450 \end{aligned}$ |
| 63 |  | 40-63 | 378-756 | $\begin{aligned} & \hline \text { S125 NJ } 363 \\ & \text { S125 NJ } 463 \end{aligned}$ |
| 100 |  | 63-100 | 600-1200 | $\begin{aligned} & \text { S125 NJ } 3100 \\ & \text { S125 NJ } 4100 \end{aligned}$ |
| 125 |  | 80-125 | 750-1500 | $\begin{aligned} & \hline \text { S125 NJ } 3125 \\ & \text { S125 NJ } 4125 \end{aligned}$ |
| 1) | NRC: <br> Adj. II. <br> Adj. Im: |  | ated current thermal setting magnetic setting |  |

Replaces: XS125NJ, Note: check exact ratings or dimenions to suit your apolication requirement

## DIMERNSUONS

## E125-NJ, S125-NJ, S125-GJ

ASL: Arrangement Standard Line
th: Handle Frame Centre Line


0NSTALLATION

## INSULATION DISTANCE IN mm (AT 440V AC MAXIMUM)

| Moden | Type | A | B1 | B2 | C | D | E |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| E125 | NJ | 50 | 10 | 10 | 0 | 25 | * 1 ) |
| S125 | NF | 50 | 10 | 10 | 0 | 25 | ${ }^{*}(1)$ |
| S125 | NJ | 50 | 10 | 10 | 0 | 25 | * 1 ) |
| S125 | GJ | 75 | 45 | 25 | 0 | 25 | ${ }^{\prime}(1)$ |
| H125 | NJ | 100 | 80 | 60 | 0 | 50 | *(1) |
| L125 | NJ | 100 | 80 | 60 | 0 | 50 | *(1) |
| S160 | NF | 50 | 40 | 30 | 0 | 25 | ${ }^{*}(1)$ |
| S160 | NJ | 50 | 40 | 30 | 0 | 25 | *(1) |
| S160 | G. | 100 | 80 | 60 | 0 | 50 | *(1) |
| H160 | NJ | 100 | 80 | 60 | 0 | 50 | *(1) |
| L160 | NJ | 100 | 80 | 60 | 0 | 50 | *(1) |
| E250 | NJ | 50 | 40 | 30 | 0 | 25 | *(1) |
| S250 | NJ | 50 | 40 | 30 | 0 | 25 | *(1) |
| S250 | G.J | 100 | 80 | 30 | 0 | 25 | *(1) |
| 5250 | PE | 100 | 80 | 60 | 0 | 50 | (1) |
| H250 | NJ | 100 | 80 | 60 | 0 | 50 | $\bullet(1)$ |
| H250 | NE | 100 | 80 | 60 | 0 | 50 | *(1) |
| L250 | NJ | 100 | 80 | 60 | 0 | 50 | (1) |
| E400 | NJ | 100 | 80 | 40 | 0 | 30 | * 11 |
| S400 | C. | 100 | 80 | 40 | 0 | 30 | ${ }^{+}(1)$ |
| S400 | NJ | 100 | 80 | 40 | 0 | 30 | * 1 ) |
| S400 | GJ | 100 | 80 | 40 | 0 | 30 | $\cdot(1)$ |
| 5400 | GE | 100 | 80 | 40 | 0 | 30 | *(1) |
| H400 | NJ | 120 | 120 | 80 | 0 | 80 | (1) |
| H400 | NE | 120 | 120 | 80 | 0 | 80 | *(1) |
| L400 | Nu | 120 | 120 | 80 | 0 | 80 | *(1) |
| L400 | NE | 120 | 120 | 80 | 0 | 80 | - 11 |
| E630 | NE | 120 | 100 | 80 | 0 | 80 | *(1) |
| S630 | CE | 120 | 100 | 80 | 0 | 80 | *(1) |
| S630 | GE | 120 | 100 | 80 | 0 | 80 | -(1) |

*Note: (1) insulate the exposed conductor until it overlaps the moulded case at the terminal, or the terminal cover.


## SELECTIVITY (DISCRIMINATION) AND CASCADE

## Selectivity

The principle of Selectivity (Discrimination) is based upon an analysis of several circuit breaker characteristics. These include time-current (tripping) curves, peak-let-through current ( $\mathrm{I}_{\text {pak }}$ ) and energy let-through ( $\mathrm{I}^{2} \mathrm{t}$ ).

The figures stated give the maximum selectivity level with the two nominated breakers in series under short-circuit conditions. For an indication on selectivity under overloads refer to the circuit breaker tripping/characteristic curves, or use the NHP TemCurve selectivity analysis software package.
Selectivity can be enhanced beyond the breaking capacity of the downstream breaker provided it is backed up by an appropriately selected upstream breaker, which should not trip (unlatch) under the stated short circuit current.

## Cascade

Cascading is achieved by using an upstream device to assist (back-up) a downstream device in clearing a fault current. This principal is necessary should the downstream device be required to clear a prospective short circuit current greater than the devices' breaking capacity.
In most cascading applications it is generally necessary for the upstream breaker to trip (unlatch), as well as the downstream breaker to give adequate back-up protection. As such, cascade is commonly used in feeding and protecting non-essential loads, such as basic lighting.
For more information on selectivity and cascading please refer to the latest NHP Part C catalogue.

Selectivity \＆Cascade Tables
＠ 400 ／ 415 V

| D | S400Gs | 70 |  |  |  |  | ！ |  |  |  |  |  | 1 | 10／36 | 10／50 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| ） | H400NJ | 125 |  |  |  |  |  |  |  |  |  |  |  | 10／36 | 10／50 |
| O | H400NE | 125 |  |  |  |  |  |  | 1 |  |  |  | ！ | 10／36 | 10／50 |
| $\stackrel{\square}{\square}$ | E630NE | 36 | 1 |  |  |  |  |  |  |  | 1 | ， | 1 | ！ | I |
| $\stackrel{\square}{6}$ | E630CE | 50 |  |  |  |  |  |  |  |  |  |  | I | 1 |  |
| $\frac{\mathbb{C}}{\mathbf{N}}$ | S630GE | 70 |  |  |  |  | 1 |  |  |  |  |  | 1 |  |  |
| $\stackrel{3}{3}$ | XS630CJ | 45 |  |  |  |  | 1 |  |  |  |  |  |  |  |  |
| $\stackrel{0}{0}$ | XS630NJ | 65 |  |  |  |  | ！ |  |  |  |  |  |  |  |  |
| $\frac{2}{3}$ | XS630PJ | 85 |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | XS630SE | 50 |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 8 | XH630SE | 65 |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 8 | XH630PE | 65 |  |  | 1 |  | 1 |  |  |  |  |  |  | 1 |  |
| $103$ | XS800NJ | 65 |  |  |  |  |  |  |  |  |  |  |  | 1 |  |
| $\stackrel{1}{8}$ | XS800SE | 50 |  |  |  |  |  |  |  |  |  |  |  | ， |  |
| त | XJ800PJ | 85 |  |  |  |  |  |  |  |  |  |  | 1 |  |  |
|  | XH800SE | 65 |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | XH800PE | 65 |  |  |  |  |  |  |  |  |  |  |  | ！ |  |
| 80 | XS1250SE | 65 |  |  |  |  |  |  |  |  |  |  |  | 1 |  |
| $\stackrel{9}{0}$ | XS1600SE | 85 | ， |  |  |  | 1 |  |  |  |  |  | 1 | 1 | 1 |


| $\begin{gathered} X X / Y \mathrm{Y} \\ \text { Solectivity/Cascade } \end{gathered}$ |  |  |  | $\begin{array}{r} \text { 唇 } \\ \stackrel{\text { O}}{\stackrel{1}{2}} \\ 125 \end{array}$ | $\begin{aligned} & \text { 山⿱⿵人一口口内 } \\ & \stackrel{\rightharpoonup}{0} \\ & \stackrel{\rightharpoonup}{x} \\ & 85 \\ & \hline \end{aligned}$ | $\begin{gathered} \text { 쓸 } \\ \stackrel{\sim}{\sim} \\ \underset{\rightharpoonup}{\rightleftarrows} \\ 125 \end{gathered}$ | $\begin{array}{r} \text { 山 } \\ \text { 宮 } \\ \text { } \\ 100 \\ 10 \end{array}$ | $\begin{array}{r} \text { 岩 } \\ \text { 号 } \\ \text { X } \\ 85 \\ \hline \end{array}$ |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\begin{array}{r} \text { 崖 } \\ \stackrel{y}{\mid} \\ \stackrel{1}{\rightleftharpoons} \\ 125 \end{array}$ | $\begin{aligned} & \text { 岕 } \\ & \stackrel{\rightharpoonup}{\mathbf{0}} \\ & \underset{\sim}{x} \\ & 50 \\ & \hline \end{aligned}$ |  |  |  |  |  |  |  |
| 25／50 | 25／25 | 25／36 | 25／36 | 25／65 | 25／25 | 25／25 | 25／25 | 25／25 | 25／25 |
| 36／65 | 36／36 | 36／50 | 36／36 | 36／36 | 36／36 | 36／36 | 36／36 | 36／36 | 36／36 |
| 65／70 | 65／65 | 65／50 | 65／65 | 65／65 | 65／65 | 65／65 | 65／65 | 65／65 | 65／65 |
| 7070 | 70／70 | 50，50 | 65／65 | 65／65 | 85i50 | 85／50 | 100／100 | 85／85 | 85／85 |
| 36／50 | 36／36 | 36／36 | 36／65 | 36／65 | 36／36 | 36／36 | 36／36 | 36／36 | 36／36 |
| 65，70 | 65／65 | 50／50 | 50／65 | 50／65 | 65／65 | 65／65 | 65／65 | 65／65 | 65／65 |
| 70／70 | 70，70 | 50／50 | 50／65 | 50／65 | 85／65 | 85／65 | 100／100 | 85／85 | 85／85 |
| 25／50 | 25：25 | 25／25 | 25／50 | 25／50 | 25／25 | 25／25 | 25／25 | 25／25 | 25／25 |
| 36／65 | 36／36 | 36／36 | 36／36 | 36／36 | ． $36 / 36$ | 36／36 | 36／36 | 36／36 | 36／36 |
| 65／70 | 65／65 | 50／50 | 50／65 | 50／65 | 65／65 | 65／65 | 65／65 | 65／65 | 65／65 |
| 70／70 | 70／70 | 50／50 | 50／65 | 50／65 | 70，70 | 70，70 | 70／70 | 70，70 | 70／70 |
| 70／70 | 70／70 | 50／50 | 50／65 | 50／65 | 85／85 | 85／85 | 100／100 | 85／85 | 85／85 |
| 70／70 | 70，70 | 50／50 | 50／65 | 50，65 | 85／85 | 85／85 | 100／100 | 85／85 | 85／85 |
| 10\％ 50 | 10／36 | 25／25 | 25；／25 | 25／36 | 25／25 | 25／25 | 25／36 | 25／25 | 25／25 |
| 10\％65 | 10／50 | 25／36 | 25／36 | 25／50 | 36／36 | 36／36 | 36／50 | 36／36 | 36／36 |
| 10／50 | 10／50 | 25／50 | 25／50 | 25／50 | 50／50 | 50／50 | 50／50 | 50，50 | 50／50 |
| 10／70 | 10\％65 | 25／50 | 25／50 | 25／65 | 50／50 | 50／50 | 50／65 | 50／50 | 50／50 |
| 10，70 | 10：70 | 25／50 | 25／50 | 25／65 | 70／36 | 70／36 | 70／85 | 70／70 | 70／70 |
| 1070 | 10／70 | 25／50 | 25／65 | 25／65 | 125／85 | 125／85 | 125／100 | 125／85 | 125／85 |
| 10／70 | 10／70 | 25／50 | 25／65 | 25／65 | 125／85 | 125／85 | 125／100 | 125／85 | 125／85 |
|  |  | 25／36 | 25／36 | 25／36 | 36／36 | 36／36 | 36／36 | 36／36 | 36／36 |
|  |  | 25／50 | 25／50 | 25／50 | 50／50 | 50／50 | 50／50 | 50／50 | 50／50 |
|  |  |  |  |  | 70\％70 | 70／70 | 70／70 | 70／70 | 70／70 |
| ！ |  |  |  |  | 30／45 | 30／45 | 30／45 | 35／45 | 35／45 |
|  |  |  |  |  | 30／65 | 30／65 | 30／65 | 35／65 | 36／65 |
|  |  | ， |  |  | 30／85 | 30／85 | 30／85 | 35／85 | 35／85 |
|  |  |  |  |  | 30／65 | 30／65 | 30／85 | 30／85 | 30\％85 |
|  |  |  |  |  | 30／65 | 30／65 | 30／85 | 30／85 | 30／85 |
|  |  |  |  |  | 30／65 | 30，65 | 30／85 | 30／85 | 30／85 |
|  |  |  |  |  | 15／65 | 15／65 | 20／65 | 35／65 | 35／65 |
|  |  | ， |  |  | 15／50 | 15／50 | 20／50 | 35／50 | 35／50 |
|  |  |  |  |  | 15／85 | 15／85 | 20／85 | 35／85 | 35／85 |
| ， |  |  |  |  | 15／65 | 15／65 | 20／65 | 35／65 | 35／65 |
|  |  |  | 1 |  | ．15／65 | 15／65 | 20／65 | 35／65 | 35／65 |
|  |  | I |  |  |  |  | 20／65 | 35／65 | 35／65 |
| 1 | 1 |  |  |  |  |  |  | 35／85 | 35／85 |



## APPLICATMON DATR

## CASCADE TABLES

| CASCADE <br> © 380－415V AC＇） |  | $\begin{aligned} & \stackrel{m}{u} \\ & \stackrel{y}{n} \\ & \underset{\sim}{z} \end{aligned}$ | $\begin{aligned} & \stackrel{n}{N} \\ & \stackrel{y}{n} \\ & \underset{z}{2} \end{aligned}$ | $\begin{aligned} & \text { n } \\ & \\ & \end{aligned}$ | ㅍ <br> $\substack{\text { n } \\ \text { ？} \\ \hline}$ |  | $\begin{aligned} & \text { n } \\ & \stackrel{0}{0} \\ & \stackrel{3}{2} \end{aligned}$ | $\begin{aligned} & \text { 尔 } \\ & \stackrel{0}{0} \end{aligned}$ | $\begin{aligned} & \text { 포 } \\ & \text { on } \\ & \stackrel{y}{2} \end{aligned}$ | $\stackrel{5}{9}$ | $\begin{aligned} & \text { M } \\ & \stackrel{\substack{0 \\ \gtrless}}{ } \end{aligned}$ | $\begin{aligned} & \text { M } \\ & \text { K} \\ & \text { 2 } \end{aligned}$ | $\begin{aligned} & \text { N్N } \\ & \text { N్ర } \end{aligned}$ | $\begin{aligned} & \text { N } \\ & \text { W} \\ & \text { on } \end{aligned}$ | $\begin{aligned} & \text { T } \\ & \text { N } \\ & \text { 2 } \end{aligned}$ | $\begin{aligned} & \text { 겅 } \\ & \text { 售 } \end{aligned}$ | $\begin{aligned} & \text { KN } \\ & \text { O } \\ & \text { 2 } \end{aligned}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Downstream MCCBs | $\begin{gathered} \mathrm{kA} \\ (\mathrm{RMS}) \end{gathered}$ | 25 | 36 | 65 | 125 | 200 | 36 | 65 | 125 | 200 | 25 | 36 | 65 | 70 | 125 | 125 | 200 |
| E125NJ | 25. | － | 36 | 36 | 65 | 85 | ． 36 | 36 | 65 | 85. | － | 36 | 36 | － | ${ }^{65}$ | 65. | 85 |
| S125NJ | 36 | － | － | 50 | 85 | 125 | － | 50 | 85 | 125 | － | － | － | － | 85 | 85 | 125 |
| S125GJ | 6.5 | － | － | － | 125 | 150 | － | － | 125 | 150 | － | － | 65. | － | 125 | 125 | 150 |
| H125NJ | 125 | － | － | － | － | 200 | － | － | － | 200 | － | － | 65 | － | － | $-$ | 200 |
| S160NJ | 36 | － | － | 65 | － | － | － | 65 | 85 | 125 | － | $-$ | 65 | 65 | 85 | 85 | 125 |
| S160GJ | 65 | － | － | － | － | － | － | － | 125 | 150 | － | $\stackrel{-}{+}$ | － | 70 | 125 | 125 | 150 |
| ［H160NJ | 125 | － | － | － | － | － | － | － | － | 200 | － | － | － | － | － | － | 200 |
| S250NJ | 36 | － | － | － | － | － | － | 65 | － | － | － | － | － | 65 | 85 | 85 | 125 |
| S250GJ | 65 | － | － | － | － | － | － | － | － | － | － | $-$ | － | 70 | 125 | 125 | 150 |
| S250PE | 70 | － | － | － | － | － | － | － | － | － | － | － | － | － | 125 | 125 | 150 |
| H250NJ | 125 | － | － | － | － | － | － | － | $=$ | － | － | $\div$ | － | － | － | － | 200 |
| E400NJ | 25 | － | － | － | － | － | － | － | － | － | － | － | － | 36 | 65. | 65 | － |
| S400CJ | 36 | － | － | － | － | － | － | － | － | － | － | $\cdots$ | － | 50 | 70 | 70 | － |
| S400NJ | 50 | － | － | － | $\checkmark$ | － | $\div$ | － | － | $\because$ | － | $\cdots$ | 50 | 65 | 85 | 85 | － |
| S400GJ | 70 | － | － | － | － | － | － | － | － | － | － | － | 50. | － | 125 | 125 | － |
| H400NJ | 125 | － | － | － | － | － | － | － | － | － | － | $\square$ | $\div$ | － | － | － | － |

Note：＇）Ratings have not been verified where a dash＂－＂is shown．
All pick－up and time delay settings are to be set at a maximum for upstream MCCB＇s

| Upstream MCCBs |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{gathered} \text { CASCADE } \\ \text { (980-415 V AC }) \end{gathered}$ |  | n $\stackrel{\rightharpoonup}{\circ}$ $\stackrel{C}{C}$ |  | $\begin{aligned} & \text { nc } \\ & \text { +⿱艹⿱日大口亍。 } \\ & \text { مٌ } \end{aligned}$ |  | $\begin{aligned} & \text { r} \\ & \stackrel{\rightharpoonup}{0} \\ & \stackrel{\rightharpoonup}{Z} \end{aligned}$ | $\begin{aligned} & \text { 「 } \\ & \text { 合 } \\ & \text { 首 } \end{aligned}$ | $\begin{aligned} & \text { m } \\ & \stackrel{0}{0} \\ & \stackrel{0}{2} \\ & \hline \end{aligned}$ | の \＆ O in |  |  | $\times$ 0 0 0 0 0 0 | $\begin{aligned} & \times \\ & \text { X } \\ & 0.0 \\ & \hline \mathbf{O} \\ & 2 \end{aligned}$ |  |  | $\begin{aligned} & \times \\ & \text { N } \\ & \text { N } \\ & \text { H } \\ & \text { n } \end{aligned}$ |  |
| Downstream MCCBs | $\begin{gathered} \text { KA } \\ \text { (RMS) } \end{gathered}$ | 36 | 50 | 70 | 125. | 200 | 200 | 36 | 50 | 70 | 125 | 65 | 65 | 65 | 200 | 65 | 85 |
| E125NJ | 25 | 36 | 36 | 50 | 65 | 85 | 85 | 36 | － | 50 | － | 36 | 36 | 36 | － | － | － |
| S125NJ | 36 | － | 50 | 65 | 85 | 125 | 125 | － | － | 65 | － | 50 | 50 | － | － | － | － |
| S125GJ | ＂65 | － | － | 70 | 125 | 150 | 150 | － | 50 | 70 | － | － | － | 65 | － | － | － |
| H125NJ | 125 | $\because$ | － | － | － | 200. | 200 | － |  | － | － | － | － | 65 | － | 50 | － |
| S160NJ | 36 | － | 50. | 65 | ． 85 | 125 | 125 | － | 50 | 50 | － | $\checkmark$ | 65 | 65 | － | － | － |
| S160GJ | 65 | － | － | 70 | 125 | 150 | 150 | － | － | 70 | － | － | － | － | － | － | － |
| H160N」 | 125 | － | －． | － | － | 200 ＂ | 200. | － | － | － | － | － | － | 65 | － | 65 | － |
| E250NJ | 25 | 36 | 36 | 50 | 65 | 85 | B5 | 36 | － | 50 | － | $\stackrel{-}{-}$ | 36 | 50 | － | － | － |
| S250N | 36 | － | 50 | 85 | 85 | 125 | 125 | － | $\cdots$ | 65. | － | － | 65 | － | － | － | － |
| S250GJ | ： 65 | － | － | 70 | 125 | 150 | 150 | － | － | 70 | $\checkmark$ | － | － | － | － | － | － |
| S250．PE | 70 | － | － | － | 125 | 150 | 150 | － | － | － | － | － | $-$ | － | － | － | － |
| H250NJ | 125 | － | － | － | － | 200 | 200 | － | － | － | － | － | － | － | － | － | － |
| E400NJ | 25 | 36 | 36 | 50 | 65 | 85. | ． 85 | 36 | $\stackrel{-}{-}$ | 50 | 36 | － | ： | － | 36 | － | 36 |
| S400CJ | ． 36 | － | 50 | 65 | 70 | 100 | 100 | － | $-$ | 65 | 50 | － | － | － | 50 | － | 50 |
| S400NJ | r 50 | － | － | 70 | 65 | 125 | 125 | － | 36 | 70 | 65 | － | － | － 50 | 65. | － | ＇65 |
| S400GJ | $\because 70$ | － | － | － | 125 | 150 | 150 | － | 36 | － | － | － | － | 50 | － | 36 | 85 |
| H400NJ | 125 | － | － | － | － | 200 | 200 | － | － | － | － | － | － | － | － | － | － |

Note：＇）Ratings have not been verified where a dash＂－＂is shown．
All pick－up and time delay settings are to be set at a maximum for upstream MCCBs


## APPLICATDON DATA

## SELECTIVITY AND CASCADE TEMBREAK 2 MCCBs AND DIN-T / SAFE-T MCBs

| Upstream MCCB |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| SELECTIVITY / CASCADE <br> © 415 VAC |  |  | $\begin{aligned} & \text { M } \\ & \underset{N}{\mathrm{G}} \end{aligned}$ | $\begin{aligned} & \text { N } \\ & \underset{\sim}{\mathrm{G}} \end{aligned}$ | $\begin{aligned} & \text { nI } \\ & \text { NO } \end{aligned}$ | 0 0 0 | N <br> H | ¢ | $\begin{aligned} & \text { On } \\ & \text { 合 } \end{aligned}$ | $\xrightarrow{\text { I }}$ |
| Downstream MCB | Amp rating | $\begin{gathered} \text { KA } \\ \text { (RMS) } \end{gathered}$ | 2 | c | c¢ | $\underline{2}$ | $c$ | C | cm | c |
|  |  |  | 25 | 36 | 65 | 36 | 65 | 36 | 70 | 125 |
| DTCB6 | 2-20 | 6 | 18/18 | 25/25 | 35/35 | 35/35 | 35/35 | - | - | - |
|  | 25-63 | 6 | 18/18 | 20/25 | 20/25 | 30/30 | 30/30 | - | - | - |
| DṪCB10 | 0.5-32 | 10 | 18/18 | 30/30 | 30/50 | 35/35 | 40/50 | 35/35 | 40/50 | 40/50 |
|  | 40-63 | 10 | 18/18 | 20/25 | 25/25 | 30/30 | 30/30 | 30/30 | 30/30 | 30/30 |
| DSĖCBH / | 0.5-32 | 10 | 18/18 | 30/30 | 30/50 | 35/35 | 40/50 | 35/35 | 40/50 | 40/50 |
| DSRCD | 40 | 10 | 18/18 | 20/25 | 25/25 | 30/30 | 30/30 | 30/30 | 30/30. | 30/30 |
| Din-T10H | 80-125 | 10 | 4/18 | 4/25 | 4/25 | 15/15 | 15/15 | 10/10 | 10/10 |  |
| DTCH15 | 0.5-32 | 15 | 18/18 | 30 | 30/50 | 35/35 | 40/50 | 35/35 | 40/50 | 40/50 |
|  | 40-63 | 15 | 18/18 | 20 | 25/25 | $301 / 30$ | 30/30 | 30/30 | 30/30 | 30/30 |
| Safe-T | 16-20 | 6 | 3/10 | $3 / 10$ | 3/10 | - | - | - | - | - |
| SRCB | 16-20 | 6 | 3/10 | $3 / 10$ | 3/10 | - | - | - | - | - |

## Guide

| $\mathbf{X X / P Y}$ |
| :---: |
| Selectivity |
| Cascade |

Notes: All figures stated are at $400 / 415 \mathrm{~V}$ AC.

APPLICATDON DATA

## MOTOR STARTING TYPE 1 CO-ORDINATION TABLES

## Short-CIrcult Co-Ordination Motor StartIng Table

Type '1'
Terasaki MCCB's \& Sprecher + Schuh KT7's
DOL starting 50/65 KA @ 400/415 V to ASNZS 60947.4.1

|  |  | Terasakd Comblnations |  |
| :---: | :---: | :---: | :---: |
| Motor Size (kW) | Approx. amps © 400/415 V (A) | мссв | Cortactor |
| 0.37 | 1.1 | XM30PE/1.4 | CA7- |
| 0.55 | 1.5 | XM30PE82 | CA7- $\theta$ |
| 0.75 | 1.8 | XM30PE®2 | CA7- 8 |
| 1.1 | 2.6 | XM30PE/4.0 | CA7- - |
| 1.5 | 3.4 | XM30PE/5 | CA7- |
| 2.2 | 4.8 | XM30PE/8 | CA7- $\theta$ |
| 3 | 6.5 | XM30PE/10 | CA7- 8 |
| 4 | 8.2 | XM30PB/12 | CA7- 8 |
| 5.5 | 11 | S125G1/20 | CA7-12 |
| 7.5 | 14 | S125G.1/20 | CA7-18 |
| 11 | 21 | S125G/132 | CA7-28 |
| 15 | 28 | S125G//50 | CA7-30 |
| 18.5 | 34 | 8125GJ/50 | CA7-97 |
| 22 | 40 | S125G//33 | CA7-43 |
| 30 | 55 | 8125G//700 | CA7-80 |
| 37 | 66 | S125GJ/M00 | CA7-72 |
| 45 | 80 | S125G/i25 | CA7-85 |
| 55 | 100 | 8125G1/25 | CAB-110 |
| 5 | 130 | S250PE/250 | CAB-140 |
| 0 | 155 | S250PEP250 | CAB-180 |
| 10 | 200 | S250PEf250 | CA8-210 |
| 32 | 225 | S400GE/400 | CAB-210 |
| 60 | 270 | S400GE/400 | CAB-300 |
| 00 | 361 | S400GE/400 | CAB-420 |


| Terasakd Comblnations |  | Sprecher + Schuh Combinations |  |
| :---: | :---: | :---: | :---: |
| Overload Relay | Thermal Setting (A) | KT7 Circuit Breaker | Contactor |
| CT 7-24 | 1.0-1.8 | KTA7-25S-1.0A | CA7-9 |
| CT 7-24 | 1.0-1.0 | KTA7-25S-1.6A | CA7-9 |
| CT 7-24 | 1.8-2.4 | KTA7-25S-2.5A | CA7-9 |
| CT 7-24 | 2.4-4.0 | KTA7-25S-2.5A | CA7-9 |
| CT 7-24 | 2.4-4.0 | KTA7-25S-4.0A | CA7-9 |
| CT 7-24 | 4.0-8.0 | KTA7-25S-6.3A | CA7-9 |
| CT 7-24 | 6.0-10 | KTA7-25S-6.3A | CA7-9 |
| CT 7-24 | 6.0-10 | KTA 7 -25S-10A | CA7-9 |
| CT 7-24 | 10-18 | KTA7-25H-16A | CA7-12 |
| CT 7.24 | 10-10 | KTA 7 -25H-16A | CA7-16 |
| CT 7-24 | 10-24 | KTA 7 -45H-20A | CA7-23 |
| CT 7-45 | 18-30 | KTA 7 -45-32A | CA7-30 |
| CT 7-45 | 30-45 | KTA7-45H-45A | CA7-37 |
| CT 7-45 | 30-45 | KTA 7-45H-45A | CA7-43 |
| CT 7-75 | 45-80 | KTA3-100-63A | CA7-60 |
| CT 7-75 | 80-75 | KTA3-100-90A | CA7-72 |
| CT 7-100 | 70-80 | KTA3-100-90A | CA7-85 |
| CEF 1-11/12 | 20-180 | KTA3-160S-100A | CA6-110 |
| CEF 1-11/12 | 20-180 | KTA3-160S-160A | CA6-140 |
| CEF 1-11/M2 | 20-180 | KTA3-160S-160A | CA6-180 |
| CEF 1-41/42 | 180-400 | KTA3-250S-200A | CA6-210 |
| CEF 1-41/42 | 180-400 | KTA3-250S-250A | CA6-250 |
| CEF 1-41/42 | 160-400 | KTA3-400S-320A | CA6-300 |
| CEF 1-41/42 | 160-400 | KTA3-400S-400A | CA6-420 |

Notes: - Thermal or electronic overload relays may be used.
XM30PB MCCB's can be replaced with S125GJ/20 it required.
Combinations based on the thermal overload relay tripping before the circul breaker at overload currents up to the motor locked rotor current.


## APPGOCOTOON DATA

## MOTOR STARTING TYPE 2 CO-ORDINATION TABLES

Short-Clrcult Co-Ordinatlon DOL Motor Starting Table
Type ' 2 '
Terasaki MCCB's \& Sprecher + Schuh KT7's
DOL starting 50/65 KA © 400/415 V Io AS/NZS 60947.4.1

|  |  | Terasakd Combinations |  |
| :---: | :---: | :---: | :---: |
| Molor Size $(\mathrm{kW})$ | Approx. amps © $40 \mathrm{D} / 415 \mathrm{~V}$ (A) | MCCE | Contactor |
| 0.37 | 1.1 | XM30P5M. 4 | CAT- ${ }^{\text {c }}$ |
| 0.55 | 1.5 | XMSDPEP2 | CA7- |
| 0.75 | 1.8 | XMSOPER2. ${ }^{\text {a }}$ | CAT- $\theta$ |
| 1.1 | 2.6 | XM90PE/4.0 | CAT-18 |
| 1.5 | 3.4 | XM30PE/5 | CAT-1A |
| 2.2 | 4.8 | XMSOPE/B | CAT-18 |
| 3 | 6.5 | XM30РВ 40 | CAT-30 |
| 4 | 8.2 | XM30PE/12 | CA7-30 |
| 5.5 | 11 | S125G.120 | CAT-30 |
| 7.5 | 14 | S125GL20 | CA7-30 |
| 11 | 21 | S125G.1/32 | CA7-30 |
| 15 | 2 B | S125Gl/50 | CA7-43 |
| 18.5 | 34 | S125Gdis0 | CA7-43 |
| 22 | 40 | 5125G.1/68 | CA7-43 |
| 30 | 55 | S125Gu/100 | CA7-72 |
| 37 | 66 | S125GUM00 | CA7.72 |
| 45 | BO | 8125culiz | CAE-1D5 |
| 55 | 100 | 5250PE/180 | CAB-105 |
| 75 | 130 | S250PER50 | CAB-140 |
| 90 | 155 | S250PEf250 | CAE-170 |
| 110 | 200 | 8250PER50 | CAB-210 |
| 132 | 225 | S400PE/400 | CA8-2io |
| 160 | 270 | S400PE/400 | CAB-300 |
| 200 | 361 | S400PE/400 | CAE-420 |


| Tercsakl Comblnationg |  | Sprecher + Schuh Comblnations |  |
| :---: | :---: | :---: | :---: |
| Overioad Relay | Thermal Setting (A) | KT7 Clicuit Breaker | Contactor |
| CT 7.24 | 1.0-1.0 | KTA7-255-1A | CA7-9 |
| CT 7-24 | 1.0-1.8 | KTA7-25S-1.6A | CA7.9 |
| [CT 7-24 | 1.8-2.4 | KTA7-25S-2.5A | CA7.9 |
| CT 7-24 | 2.4-4.0 | KTA7-25S-2.5A | CA7.9 |
| CTT 7-24 | 2.4-4.0 | KTA7-25S-4A | CA7-9 |
| CT 7-24 | 4.0-8.0 | KTA7-255-8.3A | CA7.9 |
| CT 7-24 | 6.0-10 | KTA7-25S-6.3A | CA7-9 |
| CT 7-24 | 8. $0-10$ | KTA7-255-10A | CA7-9 |
| CT 7-24 | 10-18 | KTA 7 -25H-16A | CA7-12 |
| CT 7-24 | 10-10 | KTA 7 -25H-16A | CA7.16 |
| CT 7-24 | 18-24 | KTA7-45H-20A | CA7-23 |
| ICT 7-45 | 18-30 | KTA $7-45 \mathrm{H}-32 \mathrm{~A}$ | CA7-30 |
| CT 7-45 | 30-46 | KTA 7-45H-45A | CA7-37 |
| CT 7-45 | 30-45 | KTA 7 -45H-45A | CA7-43 |
| CT 7-75 | 45-60 | КТАЗ-100-83A | CA7 -60 |
| CT 7 -75 | 60-75 | KİA3-100-90A | CA7-72 |
| CT 7-100 | 70-80 | KTA3-100-90A | CA7-85 |
| CEF 1-11/12 | 20-180 | KTA3-1805-100A | CA6-110 |
| CEF 1-11/12 | 20-180 | KTA3-160S-160A | CA6-140 |
| CEF 1-11/12 | 20-180 | KTA3-160S-160A | CA6-180 |
| CEF 1-4/1/42 | 180-400 | KTA3-250S-200A | CAB-210 |
| CEF 1-41/42 | 180-400 | KTA3-250S-250A | CA6-250 |
| CEEF 1-41/42 | 180-400 | KTA3-400S-320A | CA5-300 |
| CEF 1-41/42 | 180-400 | KTA3-400S-400A | CA6-420 |

- XM30PB combinations can be replaced with $\$ 125 \mathrm{GJ} / 20$ and CA7.30 if required.
- Combinations based on the thermal overbad relay tripping belore the circuit breaker at overioad currents up to the motor locked rator curfent.



## APPBICATDON DATA

## MOTOR STARTING TYPE 2 CO-ORDINATION

## Short-Circult Co-OrdInation DOL Motor StartIng Table

Type '2'
Terasaki MCCB's \& Sprecher + Schuh KT7's
DOL starting 85 kA @ 400/415 V to AS/NZS 60947.4.1


|  |  | Terasakd Combinations |  |
| :---: | :---: | :---: | :---: |
| Motor Size <br> (kW) | Approx. amps © $400 / 415 \mathrm{~V}$ (A) | мссв | Contactor |
| 0.37 | 1.1 | Xм30РВ/1.4 | CA 7 - |
| 0.55 | 1.5 |  | CA $7+$ |
| 0.75 | 1.8 | XM30РВ/28 | CA $7-$ |
| 1.1 | 2.6 | XM30PB/4.0 | CA 7-18 |
| 1.5 | 3.4 | XM30P8/5 | CA 7-18 |
| 2.2 | 4.8 | Хм3ЗОРВ/日 | CA 7.30 |
| 3 | 6.5 | Хм30РР/70 | CA 730 |
| 4 | 8.2 | XM30Р8/12 | CA 730 |
| 5.5 | 11 | H125N 4120 | CA 7-30 |
| 7.5 | 14 | H125N $1 / 2 \mathrm{Ca}$ | CA 7-30 |
| 11 | 21 | H125NJ/A2 | CA 7 -80 |
| 15 | 28 | H125N//50 | CA 7-43 |
| 18.5 | 34 | H125NL/50 | CA 7-49 |
| 22 | 40 | H125N/明 | CA $7-48$ |
| 30 | 55 | H125N $/ 100$ | CA 7-72 |
| 37 | 66 | H125NL/M00 | CA 7-72 |
| 45 | 80 | H125NuM60 | CA $8-105$ |
| 55 | 100 | H180NLHEO | CA ${ }^{\text {a }} 105$ |
| 75 | 130 | . $\mathrm{H} 250 \mathrm{PE} / 250$ | CA A-210 |
| 90 | 155 | H250PER250 | CA B-210 |
| 110 | 200 | H250PE/250 | CA 8 - 210 |
| 132 | 225 | H400NE/400 | CA 8210 |
| 160 | 270 | H400NE/400 | CA Br300 |
| 200 | 361 | H400NE/400 | CA 8-420 |


| Terasakd Comblnations |  | Sprecher + Schuh Cambinations |  |
| :---: | :---: | :---: | :---: |
| Overload Relay | Thermal Setting (A) | KT7 Clicuit Breaker | Contactor |
| \|CT 7-24 | 1.0-1.8 | KTA7-25S-1A | CA 7-9 |
| CT 7-24 | 1.0-1.8 | KTA7-25S-1.6A | CA 7.9 |
| GT 7.24 | 1.8-24 | KTA7-25S-2.5A | CA 7-9 |
| CT 7.24 | 2.4-4.0 | KTA7-25H-2.5A | CA 7-9 |
| CT $7-24$ | 2.4-4.0 | KTA7-25H-4A | CA 7-9 |
| CT 7.24 | 4.0-8.0 | KTA7-25H-6.3A | CA 7-9 |
| GT 7-24 | 8.0-10 | KTA7-25H-6.3A | CA 7-9 |
| CT 7.24 | 6.0-10 | KTA7-25H-10A | CA 7-9 |
| CT 7-24 | 10-10 | KTA $7-45 \mathrm{H}-16 \mathrm{~A}$ | CA 7 -12 |
| CT 7-24 | 10-18 | KTA7-45H-16A | CA 7.16 |
| CT 7-24 | 10:24 | KTA7-45H-20A | CA 7-23 |
| CT 7-45 | 10-30 | KTA $7-45 \mathrm{H}-32 \mathrm{~A}$ | CA 7 -30 |
| CT 7-45 | 50-45 | KTA7-45H-45A | CA 7-37 |
| CT 7-45 | 80-45 | KTA7-45H-45A | CA 7-43 |
| CT 7.75 | 45-80 | KTA3-100-63A | CA7-60 |
| CT 7-75 | 30-75 | КТАЗ-100-90А | CA7-72 |
| CT 7-100 | 70-80 | KTA3-100-90A | CA7-85 |
| CEEF 1-11/12 | 20-180 | - | - |
| CEF 1-11/42 | 20-180 | - | - |
| CEF 1-11/12 | 20-180 | - | - |
| CEF 1-41/42 | 100-400 | $\cdot$ | - |
| CEF 1-41/42 | 180-400 | $\cdot$ | - |
| CEF 1-41/42 | 160-400 | - | $\cdot$ |
| CEF 1-41/42 | 180-400 | - | $\cdot$ |

Notes: - Thermal or electronic overfoad relays may be used.
( 330 PB combinations can be replaced with H125GJ/20 and CA7-30 it required
Combinations based on the thermal overload relay tripping betore the circult breaker at overload currents up to the motor locked rotor current.


## APPLICATUON DOTA

## MOTOR STARTING TYPE 2 CO-ORDINATION

## Short-Circult Co-Ordination DOL Motor Starting Table

Type '2'
Terasaki MCCB's \& Sprecher + Schuh KT7's DOL starling 100 kA 400 H 45 V to AS/NZS 60947.4 .1

|  |  | Teraerak Comblnations |  |
| :---: | :---: | :---: | :---: |
| Motor Slze <br> (kW) | Approx. amps © 400415 V (A) | мссв | Comtactor |
| 0.37 | 1.1 | H125N120 | CA 7.90 |
| 0.55 | 1.5 | H125N $/ 220$ | CA 7 -30 |
| 0.75 | 1.8 | H125N120 | CA 7-30 |
| 1.1 | 2.6 | H125NL20 | CA 7-30 |
| 1.5 | 3.4 | H125N./20 | CA 7-30 |
| 2.2 | 4.8 | H125NJ/20 | CA 7-30 |
| 3 | 6.5 | H12SNi20 | CA 7-30 |
| 4 | 8.2 | H125NJ/20 | CA 7-90 |
| 5.5 | 11 | R12sndizo | CA 7 -30 |
| 7.5 | 14 | H12SNJ/20 | CA 7-90 |
| 11 | 21 | H125N1/32 | CA $7-30$ |
| 15 | 28 | H125NL/50 | CA 7-43 |
| 18.5 | 34 | H12SN/50 | CA 7-43 |
| 22 | 40 | H125N//E3 | CA 7-43 |
| 30 | 55 | H125-NL/100 | CA $7-80$ |
| 37 | 66 | H125-N. 4100 | CA 7-72 |
| 45 | 80 | H125-N/125 | CA 7-95 |
| 55 | 100 | H2S0-NE/160 | CA 8 -85 |
| 75 | 130 | H2SO-NE/250 | CA 8-140 |
| 90 | 155 | H250-NE/250 | CA 8-140 |
| 110 | 200 | H250-NE/250 | CA 8-180 |
| 132 | 225 | H400-NE/400 | CA E-420 |
| 160 | 270 | H400-NE/400 | CA B-420 |
| 200 | 361 | H400-NE/400 | CA 8-420 |


| Terasak Combinations |  | Sprecher + Schuh Combinations |  |
| :---: | :---: | :---: | :---: |
| Overtoad Relay | Thermal Setting (A) | KT7 Circult Breaker | Contactor |
| CT 7-24 | 1.0-1.6 | KTA7-25S-1A | CA 7.9 |
| CTT 7-24 | 1.0-1.0 | KTA7-255-1.6A | CA 7-9 |
| CT 7-24 | 1.8-2.4 | KTA7-25S-2.5A | CA 7-9 |
| CT 7-24 | 2.4-4.0 | KTA7-25H-2.5A | CA $7-9$ |
| CT 7-24 | 2.4-4.0 | KTA7-25H-4A | CA 7-9 |
| CTT 7-24 | 4.0-8.0 | KTA7-25H-6.3A | CA 7-9 |
| CTT 7-24 | 8.0-10 | KTA7-25H-6.3A | CA 7-9 |
| CT 7-24 | 0.0-10 | KTA7-25H-10A | CA $7-9$ |
| 6T 7-24 | 10-18 | KTA7-45H-16A | CA 7-12 |
| CTT 7-24 | 10-16 | KTA7-45H-16A | CA 7-16 |
| \|CT 7-24 | 18-24 | KTA7-45H-20A | CA 7-23 |
| ]CT 7-45 | 15-30 | KTA7-45H-32A | CA 7-30 |
| CT, 7-45 | 30-45 | KTA7-45H-4SA | CA 7.37 |
| \|CT 7-45 | 30-45 | KTA7-45H-4SA | CA 7-43 |
| 1cT 7-75 | 45-80 | - | - |
| \|CT 7-75 | 80-75 | $\cdot$ | - |
| CT 7-100 | 70-80 | $\cdot$ | - |
| \|CEF 1-11/12 | 20-180 | $\cdot$ | - |
| CEF 1-11/2 | 20-180 | $\cdot$ | $\bullet$ |
| CEF 1-11/12 | 20-180 | $\cdot$ | - |
| CEF 1-41/42 | 160-400 | $\cdots$ | - |
| CEF 1-41/42 | 150-400 | $\cdot$ | $\cdot$ |
| GEF 1-41/42 | 180-400 | - | $\cdot$ |
| CEF 1-41/42 | 160-400 | $\cdots$ | - |



## OPERATUNG CHARACTERISTICS

## THERMAL MAGNETIC CHARACTERISTICS

125A Frame MCCBs

Time/current characteristic curves
E125-NJ, S125-NJ, S125-GJ


Time/current characteristic curves
H125-NJ, L125-NJ



## (OPERATMNG CMARACTERUSTCS

## THERMAL MAGNETIC PROTECTION

Adjustment Dials


1. $I_{\mathrm{R}}$ is the thermal element adjustment dial and is used to set the rated current to match the conductor rating.
$I_{\mathrm{R}}$ can be set between 0.63 and 1.0 times $I_{\mathrm{n}}$.
2. $I_{\mathrm{i}}$ is the magnetic element adjustment dial and is used to set the short circuit tripping threshold to suit the application.
$I_{\mathrm{i}}$ can be set between 6 and 12 times $I_{\mathrm{n}}$ on 125A and 400A frame models.
$I_{\mathrm{i}}$ can be set between 6 and 13 times $I_{\mathrm{n}}$ on 250 A frame models with ratings of $160 \mathrm{~A}, 200 \mathrm{~A}$ and 250 A .
$I_{i}$ can be set berween 6 and 12 times $I_{n}$ on 250A frame models with ratings of 125 A and less.

Models, Types and Rated Currents of Thermal Elements

| Mater | TYp | Currentiating to (A) |
| :---: | :---: | :---: |
| S125 | -NF | 16, 20, 25, 32, 40, 50, 63, 80, 100, 125 |
| E125 | -NJ | 20, 32, 50, 63, 100, 125 |
| S125 | -NJ | 20, 32, 50, 63, 100, 125 |
| S125 | -G/ | 20, 32, 50, 63, 100, 125 |
| H125 | -NJ | 20, 32, 50, 63, 100; 125 |
| L125 | -NJ | 20, 32, 50, 63, 100, 125 |
| \$160 | -NF | 16, 20, 25, 32, 40, 50, 63, 80, 100, 125, 160 |
| S160 | $-\mathrm{NJ}$ | 20, 32, 50, 63, 100, 125, 160 |
| S160 | -GJ | 50, 63, 100, 125, 160 |
| H160 | -NJ | 160 |
| L160 | - NJ | 160 |
| E250 | - NJ | 20, 32, 50, 63, 100, 125, 160, 200, 250 |
| $\mathbf{S 2 5 0}$ | -NJ | 160, 200, 250 |
| S250 | -GJ | 160, 200, 250 |
| H250 | -NJ | 160, 250 |
| $\underline{550}$ | -NJ | 160, 250 |
| E400 | -NJ | 250, 400 |
| S400 | -CJ | 250, 400 |
| S400 | - NJ | 250, 400 |
| S400 | -GJ | 250,400 |
| H400 | - NJ | 250, 400 |
| L400 | -NJ | 250, 400 |



OPERATING CHARACTERUSTICS
LET-THROUGH PEAK CURRENT CHARACTERISTICS

S125-NF. 240 VAC


E125-NJ, S125-NJ, S125-GJ. 440 V AC.


S160-NF. 240 V AC.


S125-NJ, S125-GJ. 690 V AC.


TEMBREAK 2 MCCBs

## OPERATING CHARAGTERISTICS

## LET-THROUGH ENERGY CHARACTERISTICS

S125-NF. 240V AC


Prospective short circuit current in RMS sym.(kA)
E125-NJ, S125-NJ, S125-GJ. 440 V AC.


S160-NF. 240 V AC


S125-NJ, S125-GJ. 690 V AC.



## NHP

## Accessories to suit 125-630AF MCCBs

$\square$

## External accessories

Door interlocking, variable depth Suits MCCB types


H125, L125, S160, H160, L160, E250, S250, H250, L250
IP54 rated
Grey/black T2HP25R5BNA4
Grey/black c/w key lock T2HP25R5BKA4
Red/yellow T2HP25R5RNA4
Red/yellow c/w key lock
IP65 rated
Grey/black
T2HP25R6BNA4
Grey/black c/w key lock T2HP25R6BKA4
Red/yellow T2HP25R6RNA4
Red/yellow $\mathrm{c} / \mathrm{w}$ key lock T2HP25R6RKA4

Note: Handles supplied with shaft

## aCCESSORUES

## OPERATING HANDLES \& LOCKING DEVICES

TemBreak 2 handles are extremely reliable, having been designed to endure the same switching dury as the host MCCB.
lt is easy to fit the operating unit to the MCCB. Fitting involves three easy steps:

1. Align breaker toggle with operating mechanism
2. Push handle into position (the handle's round pegs locate securely in the breaker's round holes and the handle's* square pegs in the breaker's square holes).
3. Twist locking screws through 45 degrees.*

## Safety Features

- Door interlock mechanism with override facility included as standard
- IP54 (door mounted version), IP 54 as standard (breaker mounted version)
- IP65 (door mounted version), IP 65 optional (breaker mounted version)
- Locks OFF with up to 3 padlocks ( 8 mm hasps)
- Optional keylock in OFF position
- Available in black or red and yellow
- A trip test can be performed with the handle fitted to the MCCB


## Orientation

To switch the breaker from OFF to ON the handle is rotated through 90 degrees in a clockwise direction.

The ON (I) and OFF (O) indication of the handle can be re-oriented in steps of 90 degrees with respect to the operating mechanism. This allows the indication position to remain the same whether the breaker is mounted vertically (right side up or upside down) or horizontally (on its left side or on its right side). The hole cut-out dimensions for a panel or door will remain unchanged if the handle is re-oriented. The handle's axis of rotation


MCCB ON
 is on the intersection of the centre lines of a 3 P MCCB. This means that the positioning of the door cutouts is symmetrical for breakers mounted horizontally on either side of a vertical busbar system.

Cubicle Door Cutouts


Using TenBreak 2 Operating Handles


Using other MCCB Operating Handles


## ACCESSORDES

## OPERATING HANDLES \& LOCKING DEVICES

Door Mounted Handle (HP)


Door Mounted Handle with Optional Keylock
Breaker Mounted Handle (HB)


The door mounted operating handle is used to operate a circuit breaker mounted inside a cubicle from outside the door. It consists of an operating mechanism that is mounted on the breaker, an operating handle that is mounted on the door, and a shaft that transmits the turning force from the handle to the operating unit. The shaft can be cut to the required length.

This handle is used to operate a circuit breaker mounted just behind a compartment door with the door closed. The operating unit and the handle itself are mounted directly onto the circuit breaker. The handle protrudes through a cutout in the door. A moulded door flange is supplied with the handle which covers the cutout from the front.

Padlocking and keylocking is possible in the OFF position or both the ON and OFF position depending on the mounting direction.
Breaker Mounted Handle Padlocked in the OFF Position

## Locking Devices

Toggle locking devices allow MCCBs to be locked ON or OFF using up to three padlocks. Locking devices for 125A, 160A and 250A frame models accept padlocks with 5 mm hasp diameter. Locking devices for 400 A and 630 A frame models accept padlocks with 8 mm hasp diameter.


S250 Locked OFF


S400 Locked OFF

Fittings for Castell and Fortress locks are available. They are suitable for use on toggle-operated MCCBs, or on door mounted handles (HP) for MCCBs.

## DIMENSIONS

## Door Mounted Handle

| Applicable MCCB |  | A *1 | B | C | II | Shaft support |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{aligned} & \text { E125 } \\ & \text { S125 } \end{aligned}$ |  | 540 max. | 370 | 421 |  | With + |

*1:Max. means the maximum length for $A$ without cutting the shaft.

+ The shaft can be cut to the required length. If it is necessary to cut the shaft so short that it does not protrude beyond the shaft support, the shaft support may be removed.



## DMAERNSIONS

## Door Mounted Handle

| Appltablia MCCB. .\|l | A*1 | B | C | D | Shat eupport |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{aligned} & \text { E250 } \\ & \text { S250 (except S250-PE) } \end{aligned}$ | 540 max. | 370 | 421 | 186 | With + |
| S250-PE H125 L125 H160 L160 H250 L250 | 575 max. | 370 | 421 | 221 | With + |

* 1: Max. means the maximum length for $A$ without sutting the shaft.
+ The shah can be cut to the required length. If it is necessary to cut the shaf so shon that it does not protrude beyond the shafi suppor, the shaft support may be removed.



ASL: Arrangement Standard Line K: Handle Frame Centre Line $q:$ Handle Centre Line

Padlark dimensions (mm)


TEMBREAK 2 MCCBs

## DUWENSIONS

## Door Mounted Handle

| Appilicabla mCCB | A *1 | B | C | D | Shaft mupport |
| :---: | :---: | :---: | :---: | :---: | :---: |
| E400 E630 | 270 min . | 12 | 107.5 | - | Without |
| S400 S630 | 610 max. | 280 | 447.5 | 261 | With + |
| H400 | 307 min . | 12 | 107.5 | - | Without |
| L400 | 647 max. | 280 | 447.5 | 298 | With + |

* 1: Min. means the minimum length for $A$ by cutting the shaft.

Max.means the maximum length for $A$ without curting the shaft.

+ The shaft can be cut to the required length. If it is necessary to cut the shaft so short that it does not protrude beyond the shaft support, the shaft support may be removed.


ASL:Arrangement Standard Line Padlock dimensions (mm) H: Handle Frame Centre Line $\mathrm{q}_{\mathrm{t}}$ :Handle Centre Line

## MINIATURE CIRCUIT BREAKER

## 1. MCB TECHNICAL DETAILS

2. MCB/RCD TECHNICAL DETAILS

## Miniature circuit breakers

## Din-T6 series 6 kA MCB

■ Standards AS/NZS 4898

- Approval No. N17481
- Current range 2-63 Amps 1, 2 and 3 pole
- Sealable and lockable handle
- Available in curve type C and D
- Mounts on CD chassis ( 250 A and 355 A )

1 pole 1 module

| In (A) | C - Curve 5-10 In |
| :--- | :--- |
| 2 | DTCB6102C |
| 4 | DTCB6104C |
| 6 | DTCB6106C |
| 10 | DTCB6110C |
| 13 | DTCB6113C |
| 16 | DTCB6116C |
| 20 | DTCB6120C |
| 25 | DTCB6125C |
| 32 | DTCB6132C |
| 40 | DTCB6140C |
| 50 | DTCB6150C |
| 63 | DTCB6163C |

2 pole 2 modules

| 2 | DTCB6202C |
| :--- | :--- |
| 4 | DTCB6204C |
| 6 | DTCB6206C |
| 10 | DTCB6210C |
| 13 | DTCB6213C |
| 16 | DTCB6216C |
| 20 | DTCB6220C |
| 25 | DTCB6225C |
| 32 | DTCB6232C |
| 40 | DTCB6240C |
| 50 | DTCB6250C |
| 63 | DTCB6263C |

3 pole 3 modules

| 2 | DTCB6302C |
| :--- | :--- |
| 4 | DTCB6304C |
| 6 | DTCB6306C |
| 10 | DTCB6310C |
| 13 | DTCB6313C |
| 16 | DTCB6316C |
| 20 | DTCB6320C |
| 25 | DTCB6325C |
| 32 | DTCB6332C |
| 40 | DTCB6340C |
| 50 | DTCB6350C |
| 63 | DTCB6363C |

Short circuit capacity 6 kA

| In (A) | $2-63$ |
| :--- | :--- |
| 1 P | 240 V AC |
| 2 P | $240-415 \mathrm{~V} \mathrm{AC}$ |
| 3 P | $240-415 \mathrm{~V} \mathrm{AC}$ |
| DC use | 1 P |
| Short circuit | 20 kA |
| Max.voltage (DC) | 48 V |

Use at $D C$
When using Din-T6 in a DC application the magnetic tripping current is approximately $40 \%$ higher than in AC $50 / 60 \mathrm{~Hz}$.
Shock resistance (In X, Y, Z directions).
20 g with shock duration 10 ms (minimum 18 shocks).
40 g with shock duration 5 ms (minimum 18 shocks).
Vibration resistance (In X, Y, $Z$ directions). 3 g in frequency range 10 to 55 Hz
(operating time at least 30 min ).
According to IEC 60068-2-6.
Storage temperature
From $-55^{\circ} \mathrm{C}$ to $+55^{\circ} \mathrm{C}$, according to IEC 88 part 2-1
(duration 96 hours).
Operating temperature
From $-25^{\circ} \mathrm{C}$ to $+55^{\circ} \mathrm{C}$, according to
VDE 0664 parts 1 and 2.
Use at 400 Hz
At 400 Hz the magnetic trip current is approximately $50 \%$ higher than in $\mathrm{AC} 50 / 60 \mathrm{~Hz}$.

Notes: ${ }^{1}$ ) 2 pole MCB connected in series. The line side is the "OFF" (bottom) side of the MCB, and connects to CD chassis tee-offs. (i) Available on indent only.

## Din-T MCBs Technical data

## Characteristics according to BS EN 60898

Miniature Circuit Breakers are intended for the protection of wining installations against both overloads and short-circuits in domestic or commercial wiring installations where operation is possible by uninstructed people

Tripping characteristic curves


## Magnetic release

An electromagnet with plunger ensures instantaneous tripping in the event of short-circuit. The NHP Din-T range has 3 different types, following the current for instantaneous release: types B, C and D curve.

| Icn <br> (A) | Test current | Tripping time | Applications |
| :---: | :---: | :---: | :---: |
| B | $\begin{aligned} & 3 \times \text { In } \\ & 5 \times \text { In } \end{aligned}$ | $\begin{gathered} 0.1<t<45 \mathrm{~s}(\operatorname{In} \leq 32 \mathrm{~A}) \\ 0.1<t<90 \mathrm{~s}(\mathrm{In}>32 \mathrm{~A}) \\ \mathrm{t}<0.1 \mathrm{~s} \end{gathered}$ | Only for resistive loads eg: <br> - electrical heating <br> - water heater <br> - stoves. |
| C | $\begin{aligned} & 5 \times \mathrm{In} \\ & 10 \times \mathrm{In} \end{aligned}$ | $\begin{gathered} 0.1<t<15 \mathrm{~s}(\operatorname{In} \leq 32 \mathrm{~A}) \\ 0.1<t<30 \mathrm{~s}(\operatorname{In}>32 \mathrm{~A}) \\ \mathrm{t}<0.1 \mathrm{~s} \end{gathered}$ | Usual loads such as: <br> - lighting <br> - socket outlets <br> - small motors |
| D | $\begin{aligned} & 10 \times \operatorname{In} \\ & 20 \times \mathrm{In} \end{aligned}$ | $\begin{gathered} 0.1<t<4 \mathrm{~s} \text { *** }^{*}(\mathrm{In} \leq 32 \mathrm{~A}) \\ 0.1<\mathrm{t}<8 \mathrm{~s}(\mathrm{In}>32 \mathrm{~A}) \\ \mathrm{t}<0.1 \mathrm{~s} \end{gathered}$ | Control and protection of circuits having important transient inrush currents (large motors) |

## Thermal release

The release is initiated by a bimetal strip in the event of overload. The standard defines the range of releases for specific overload values. Reference ambient temperature is $30^{\circ} \mathrm{C}$.

| Test <br> current | Tripping <br> time |
| :---: | :---: |
| $1.13 \times$ In | $\mathrm{t} \geq 1 \mathrm{~h}(\operatorname{In} \leq 63 \mathrm{~A})$ |
|  | $\mathrm{t} \geq 2 \mathrm{~h}(\mathrm{In}>63 \mathrm{~A})$ |
| $1.45 \times$ In | $\mathrm{t}<1 \mathrm{~h}(\operatorname{In} \leq 63 \mathrm{~A})$ |
|  | $\mathrm{t}<2 \mathrm{~h}(\operatorname{In}>63 \mathrm{~A})$ |
| $2.55 \times$ In | $1 \mathrm{~s}<\mathrm{t}<60 \mathrm{~s}($ In $\leq 32 \mathrm{~A})$ |
|  | $1 \mathrm{~s}<\mathrm{t}<120 \mathrm{~s}($ In $>32 \mathrm{~A})$ |

Rated short-circuit breaking capacity (Icn)
Is the value of the short-circuit that the MCB is capable of withstanding in the following test of sequence of operations: 0-t-CO.
After the test the MCB is capable, without maintenance, to withstand a dielectric strength test at a test voltage of 900 V . Moreover, the MCB shall be capable of tripping when loaded with 2.8 In within the time corresponding to 2.55 In but greater than 0.1 s .

Service short-circuit breaking capacity (Ics)
Is the value of the short-circuit that the MCB is capable of withstanding in the following test of sequence of operations: $0-t-C 0-t-C O$.

After the test the MCB is capable, without maintenance, to withstand a dielectric strength test at a test voltage of 1500 V . Moreover, the MCB shall not trip at a current of 0.96 In. The MCB shall trip within 1 h when current is 1.6 In .

0 - Represents an opening operation
C - Represents a closing operation followed by an automatic opening.
t - Represents the time interval between two successive short-circuit operations: 3 minutes.

The relation between the rated short-circuit capacity (Icn) and the rated service short-circuit breaking capacity (Ics) shall be as follows:

| Ien (A) | Ics $(A)$ |
| :---: | :---: |
| $\leq 6000$ | 6000 |
| $>6000$ | 0.75 Icn min. 6000 |
| $\leq 10000$ | 0.75 Icn min. 7500 |
| $>10000$ |  |

In both sequences all MCBs are tested for emission of ionized gases during short-circuit (grid distance), in a safety distance between two MCBs of 35 mm when devices are installed in two different rows in the enclosure. This performance allows the use of any NHP/Terasaki enclosure.


Min.
35 mm


## Din-T MCBs Technical data

## Tripping curves according to EN 60898

The following tables show the average tripping curves of the Terasaki Din-T MCBs based on the thermal and magnetic characteristics.

## Curve C



## Din-T MCBs Technical data

## Influence of ambient air temperature on the rated current

The maximum value of the current which can flow through an MCB depends on the nominal current of the MCB, the conductor cross-section and the ambient air temperature.

The values shown in the table below are for devices in free air. For devices installed with other modular devices in the same switchboard, a correction factor (K) shall be applied relative to the mounting situation of the MCB, the ambient temperature and the number of main circuits in the installation.

| No of devices | K $^{1}$ ) |
| :---: | :--- |
| 2 or 3 | 0.9 |
| 4 or 5 | 0.8 |
| 6 or 9 | 0.7 |
| $>10$ | 0.6 |

## Calculation example

Within a distribution board consisting of eight 2 Pole, $16 \mathrm{~A}, ~ ' \mathrm{C}$ ' curve type MCBs, with an operating ambient temperature of $45^{\circ} \mathrm{C}$, which is the highest temperature the MCB can operate at without unwanted tripping?

## Calculation

The correction factor $K=0.7$, for use in an eight circuit installation: $16 \mathrm{~A} \times 0.7=11.2 \mathrm{~A}$

As the MCB is working at $45^{\circ} \mathrm{C}$ it shall be given another factor ( $90 \%=0.9$ ):
In at $45^{\circ} \mathrm{C}=\mathrm{In}$ at $30^{\circ} \mathrm{C} \times 0.9=11.2 \mathrm{~A} \times 0.9=10.1 \mathrm{~A}$.

Note: ${ }^{1}$ ) Applicable for MCBs working at maximum rated currents.

The thermal calibration of the MCBs was carried out at an ambient temperature of $30^{\circ} \mathrm{C}$. Ambient temperatures different from $30^{\circ} \mathrm{C}$ influence the bimetal and this results in earlier or later thermal tripping.


## 10 A



## 16-40 A



50-63 A


- : 1P (single pole)


## Din-T MCBs Technical data

## Effects of frequency on the tripping characteristic

All the MCBs are designed to work at frequencies of $50-60 \mathrm{~Hz}$, therefore to work at different values, consideration must be given to the variation of the tripping characteristics. The thermal tripping does not change with variation of the frequency but the magnetic tripping values can be up to $50 \%$ higher than the ones at $50-60 \mathrm{~Hz}$.

Tripping current variation

| 60 Hz | 100 Hz | 200 Hz | 300 Hz | 400 Hz |
| :---: | :---: | :---: | :---: | :---: |
| 1 | 1.1 | 1.2 | 1.4 | 1.5 |

## Power losses

The power losses are calculated by measuring the voltage drop between the incoming and the outgoing terminals of the device at rated current.

Power loss per pole

| In <br> $(\mathrm{A})$ | Voltage drop <br> $(\mathrm{V})$ | Energy loss <br> $(\boldsymbol{W})$ | Resistance <br> $(\mathrm{mOhm})$ |
| :---: | :---: | :---: | :---: |
| 0.5 | 2.230 | 1.115 | 4458.00 |
| 1 | 1.270 | 1.272 | 1272.00 |
| 2 | 0.620 | 1.240 | 310.00 |
| 3 | 0.520 | 1.557 | 173.00 |
| 4 | 0.370 | 1.488 | 93.00 |
| 6 | 0.260 | 1.570 | 43.60 |
| 8 | 0.160 | 1.242 | 19.40 |
| 10 | 0.160 | 1.560 | 15.60 |
| 13 | 0.155 | 2.011 | 11.90 |
| 16 | 0.162 | 2.586 | 10.10 |
| 20 | 0.138 | 2.760 | 6.90 |
| 25 | 0.128 | 3.188 | 5.10 |
| 32 | 0.096 | 3.072 | 3.00 |
| 40 | 0.100 | 4.000 | 2.50 |
| 50 | 0.090 | 4.500 | 1.80 |
| 63 | 0.082 | 5.160 | 1.30 |
| 80 | 0.075 | 6.000 | 0.90 |
| 100 | 0.075 | 7.500 | 0.75 |
| 125 | 0.076 | 9.500 | 0.60 |
|  |  |  |  |

## Limitation curves

## Let-through energy I ${ }^{2}$ t

The limitation capacity of an MCB in short-circuit conditions, is its capacity to reduce the value of the let-through energy that the short-circuit would be generating.
Peak current Ip
Is the value of the maximum peak of the short-circuit current limited by the MCB.


See following pages

## Din-T MCBs Technical data

Din-T 6
6 kA
C curve


Id Limited peak current at 230/400 V


## Din-T MCBs Technical data

Use of standard MCB for DC use
For MCBs designed to be used in alternating current but used in installations in direct current, the following should be taken into consideration:

- For protection against overloads it is necessary to connect the two poles to the MCB. In these conditions the tripping characteristic of the MCB in direct current is similar to alternating current.

F For protection against short-circuits it is necessary to connect the two poles to the MCB. In these conditions the tripping characteristic of the MCB in direct current is $40 \%$ higher than the one in alternating current.

Use in DC selection table

| Series | Rated current (A) | 48 V 1 pole <br> Icu (kA) | 110 V 2 poles in series Icu (kA) | $\begin{aligned} & 250 \text { V } 1 \text { pole } \\ & \text { Icu (kA) } \\ & \hline \end{aligned}$ | 440 V 2 poles in series Icu (kA) |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Din-T 6 | 0.5...63 A | 20 | 25 | - | - |

## Din-T MCBs Technical data

## Text for specifiers

## MCB Series Din-T 6

- According to EN 60898 standard
- For DIN rail mounting according to DIN EN 50022; EN 50022; future EN 60715; IEC 60715 (top hat rail 35 mm )
- Grid distance 35 mm
- Working ambient temperature from $-25^{\circ} \mathrm{C}$ up to $+50^{\circ} \mathrm{C}$
- Approved by CEBEC, VDE, KEMA, IMQ.
- 1 pole is a module of 18 mm wide
- Nominal rated currents are: $0.5 / 1 / 2 / 3 / 4 / 6 / 10 / 13 / 16 / 20 / 25 / 32 / 40 / 50 / 63 \mathrm{~A}$
- Tripping characteristics: B,C,D (B curve Din-T 10 only).
- Number of poles: $1 \mathrm{P}, 1 \mathrm{P}+\mathrm{N}, 2 \mathrm{P}, 3 \mathrm{P}, 3 \mathrm{P}+\mathrm{N}, 4 \mathrm{P}$
- The short-circuit breaking capacity is: $6 / 10 \mathrm{k} A$, energy limiting class 3
- Terminal capacity from 1 up to $35 \mathrm{~mm}^{2}$ rigid wire or 1.5 up to $25 \mathrm{~mm}^{2}$ flexible wire.
- Screw head suitable for flat or Pozidrive screwdriver
- Can be connected by means of both pin or fork busbars
- The toggle can be sealed in the ON or OFF position
- Rapid closing
- Both incoming and outgoing terminals have a protection degree of IP 20 and they are sealable
- Isolator function thanks to Red/Green printing on the toggle.
- Maximum voltage between two phases; 440 V
- Maximum voltage for utilisation in DC current: $48 \vee 1 \mathrm{P}$ and 110 V 2 P
- Two position rail clip
- Mechanical shock resistance 40 g (direction $\mathrm{x}, \mathrm{y}, \mathrm{z}$ ) minimum 18 shocks 5 ms half-sinusoidal acc. to IEC 60068-2-27
- Vibration resistance: 3 g (direction $\mathrm{x}, \mathrm{y}, \mathrm{z}$ ) minimum 30 min . according to IEC 60068-2-6
- Extensions can be added on both left or right hand side
- Auxiliary contact
- Shunt trip
- Undervoltage release
- Motor operator
- Panelboard switch

Add-on RCD can be coupled.

Din-T MCBs Technical data


# Din-T MCBs Technical data <br> Miniature circuit breakers - Din-T 6 

Dimensions in mm.


## Miniature circuit breakers

Din-T15 series 15 kA, 20 kA, 25 kA MCBs
■ Standards AS/NZS 3947-2

- Current range 6-63 Amp 1, 2, 3 and 4 pole
- Seatable and lockable handle
- Modular design
- Mounts on CD chassis (250 A and 355 A )
- Industrial applications

| $\underline{\text { In (A) }}$ | Icu (kA) | C - Curve <br> 5-10 In |
| :---: | :---: | :---: |
| 6 | 25 | DTCB15106C |
| 10 | 25 | DTCB15110C |
| 13 | 25 | - DTCB15113C |
| 16 | 25 | Dicbis116C |
| 20 | 25 | DT¢CB15120C |
| 25 | 25 | DTCB15125C |
| 32 | 20 | DTCB15132C |
| 40 | 20 | DTCB15140C |
| 50 | 15 | Dicb15150C |
| 63 | 15 | Dicib15163C |

$$
3 \text { pole } 3 \text { modules }{ }^{3} \text { ) }
$$

| 6 | 25 | DICB15306C |
| :--- | :--- | :--- |
| 10 | 25 | DICB15310C |
| 13 | 25 | DTCB15313C |
| 16 | 25 | DICB15316C |
| 20 | 25 | DTCB15320C |
| 25 | 25 | DTCB15325C |
| 32 | 20 | DTCB15332C |
| 40 | 20 | DICB15340C |
| 50 | 15 | DTCB15350C |
| 63 | 15 | DTCB15363C |

2 pole 2 modules ${ }^{3}$ )

|  | In (A) | Icu (kA) |
| :--- | :--- | :--- |
| 6 | 25 | C Curve <br> $5-10$ In |
| 10 | 25 | DTCB15206C |
| 13 | 25 | DTCB15210C |
| 16 | 25 | DTCB15213C |
| 20 | 25 | DTCB15216C |
| 25 | 25 | DTCB15220C |
| 32 | 20 | DTCB15225C |
| 40 | 20 | DTCB15232C |
| 50 | 15 | DTCB15240C |
| 63 | 15 | DTCB15250C |

4 pole 4 modules ${ }^{2}$ ) ${ }^{3}$ )

| 6 | 25 | [i] DTCB15406C |
| :---: | :---: | :---: |
| 10 | 25 | DTCB15410C |
| 13 | 25 | - DTCB15413C |
| 16 | 25 | i) DTCB15416C |
| 20 | 25 | - DTCB15420C |
| 25 | 25 | DicB15425C |
| 32 | 20 | - DTCB15432C |
| 40 | 20 | (i) dTCB15440C |
| 50 | 15 | 1- picbisk50C |
| 63 | 15 | 1 D DCB15463C |



Notes: 1) 2 P MCB connected in series.
The LINE-side is the OFF or bottom of the MCB and connects to CD chassis tee-offs.
${ }^{2}$ ) All poles include overcurrent and short circuit protection.
${ }^{3}$ ) Refer Section 3 for kA ratings at $240 / 415 \mathrm{~V}$. The above ratings are at 415 V AC .
i Available on indent only.

## Din-T MCBs Technical data

## Characteristics according to EN 60947-2

Miniature Circuit Breakers are intended for the protection of the lines against both overloads and short-circuits in industrial wiring installations where normal operation is done by instructed people

Tripping characteristic curves


## Magnetic release

An electromagnet with plunger ensures instantaneous tripping in the event of short-circuit. The standard leaves the calibration of magnetic release to the manufacturers discretion.

NHP offers instantaneous tripping ranges:

- release between 5 and 10 In
- release between 10 and 20 In


## Thermal release

The release is initiated by a bimetal strip in the event of overload. The standard defines the range of release for two special overload values. Reference ambient temperature is $40^{\circ} \mathrm{C}$.

| Test <br> current | Tripping <br> time |
| :---: | :---: |
| $1.05 \times$ In | $\mathrm{t} \geq 1 \mathrm{~h}($ In $\leq 63 \mathrm{~A})$ |
|  | $\mathrm{t} \geq 2 \mathrm{~h}($ In $>63 \mathrm{~A})$ |
| $1.30 \times$ In | $\mathrm{t}<1 \mathrm{~h}($ In $\leq 63 \mathrm{~A})$ |
| $\mathrm{t}<2 \mathrm{~h}($ In $>63 \mathrm{~A})$ |  |

Rated ultimate short-circuit breaking capacity (Icu) Is the value of the short-circuit that the MCB is capable of withstanding in the following test of sequence of operations: 0-t-C0.

After the test the MCB is capable, without maintenance, to withstand a dielectric strength test at a test voltage of 1000 V . Moreover the MCB shall be capable of tripping when loaded with 2.5 In within the time corresponding to 2 In but greater than 0.1 s .

Rated service short-circuit breaking capacity (Ics) Is the value of the short-circuit that the MCB is capable of withstanding in the following test of sequence of operations: $0-\mathrm{t}-\mathrm{CO}-\mathrm{t}-\mathrm{CO}$.

After the test the MCB is capable, without maintenance, to withstand a dielectric strength test at a test voltage of twice its rated insulation voltage with a minimum of 1000 V . A verification of the overload releases on In and moreover the MCB shall trip within 1 h when current is 1.45 In (for In<63 A) and 2 h (for $\operatorname{In}>63 \mathrm{~A}$ ).

0 - Represents an opening operation
C - Represents a closing operation followed by an automatic opening.
t - Represents the time interval between two successive short-circuit operations: 3 minutes.

Category A: Without a short-time withstand current rating.

## Utilization

category Application with respect to selectivity
A Circuit breakers not specifically intended for selectivity under short-circuit conditions with respect to other short-circuit protective devices in series on the load side, i.e. without an intentional short-time delay provided for selectivity under short-circuit conditions, and therefore without a short-time withstand current rating according to 4.3.5.4

B Circuit breakers specifically intended for selectivity under short-circuit conditions with respect to other short-circuit protective devices in series on the load side, i.e. without an intentional short-time delay (which may be adjustable), provided for selectivity under short-circuit conditions. Such circuit-breakers have a short-time withstand current rating according to 4.3.5.4 current rating according to 4.3.5.4

## Din-T MCBs Technical data

## Tripping curves according to EN 60898

The following tables show the average tripping curves of the Terasaki Din-T MCBs based on the thermal and magnetic characteristics.

## Curve C



## Din-T MCBs Technical data

## Definitions related to circuit breakers

MCB $=$ Miniature Circuit Breaker

## Short-circuit (making and breaking) capacity <br> Alternating component of the prospective current, expressed by its RMS value, which the circuit breaker is designed to make, to carry for its opening time and to break under specified conditions.

Ultimate or rated short-circuit breaking capacity (Icn - EN 60898)
A breaking capacity for which the prescribed conditions, according to a specified test sequence, do not include the capability of the MCB to carry 0.96 times its rated current for the conventional time.

Ultimate short-circuit breaking capacity (Icu - EN 60947-2)
A breaking capacity for which the prescribed conditions, according to a specified test sequence, do not include the capability of the MCB to carry its rated current for the conventional time.

Service short-circuit breaking capacity (Ics - EN 60898)
A breaking capacity for which the prescribed conditions, according to a specified test sequence, include the capability of the MCB to carry 0.96 times its rated current for the conventional time.

## Prospective current

The current that would flow in the circuit, if each main current path of the MCB were replaced by a conductor of negligible impedance.

Conventional non-tripping current (Int) A specified value of current which the circuit breaker is capable of carrying for a specified time without tripping.

## Open position

The position in which the predetermined clearance between open contacts in the main circuit of the MCB is secured.

Closed position
The position in which the predetermined continuity of the main circuit of the MCB is secured.

Maximum prospective peak current (Ip) The prospective peak current when the initiation of the current takes place at the instant which leads to the highest possible value.

## Din-T MCBs Technical data

## Influence of ambient air temperature on the rated current

The maximum value of the current which can flow through an MCB depends on the nominal current of the MCB, the conductor cross-section and the ambient air temperature.
The values shown in the table below are for devices in free air. For devices installed with other modular devices in the same switchboard, a correction factor (K) shall be applied relative to the mounting situation of the MCB, the ambient temperature and the number of main circuits in the installation.

| No of devices | K $^{\prime}$ ) |
| :---: | :--- |
| 2 or 3 | 0.9 |
| 4 or 5 | 0.8 |
| 6 or 9 | 0.7 |
| $>10$ | 0.6 |

## Calculation example

Within a distribution board consisting of eight 2 Pole, $16 \mathrm{~A},{ }^{\prime} \mathrm{C}$ ' curve type MCBs, with an operating ambient temperature of $45^{\circ} \mathrm{C}$, which is the highest temperature the MCB can operate at without unwanted tripping?

## Calculation

The correction factor $K=0.7$, for use in an eight circuit installation: $16 \mathrm{~A} \times 0.7=11.2 \mathrm{~A}$

As the MCB is working at $45^{\circ} \mathrm{C}$ it shall be given another factor ( $90 \%=0.9$ ):
In at $45^{\circ} \mathrm{C}=\mathrm{In}$ at $30^{\circ} \mathrm{C} \times 0.9=11.2 \mathrm{~A} \times 0.9=10.1 \mathrm{~A}$.

Note: ${ }^{1}$ ) Applicable for MCBs working at maximum rated currents.

The thermal calibration of the MCBs was carried out at an ambient temperature of $30^{\circ} \mathrm{C}$. Ambient temperatures different from $30^{\circ} \mathrm{C}$ influence the bimetal and this results in earlier or later thermal tripping.


10 A


16-40 A


50-63 A

: 1P (single pole)

## Din-T MCBs Technical data

## Effects of frequency on the tripping characteristic

All the MCBs are designed to work at frequencies of $50-60 \mathrm{~Hz}$, therefore to work at different values, consideration must be given to the variation of the tripping characteristics. The thermal tripping does not change with variation of the frequency but the magnetic tripping values can be up to $50 \%$ higher than the ones at $50-60 \mathrm{~Hz}$.

Tripping current variation

| 60 Hz | 100 Hz | 200 Hz | 300 Hz | 400 Hz |
| :---: | :---: | :---: | :---: | :---: |
| 1 | 1.1 | 1.2 | 1.4 | 1.5 |

## Power losses

The power losses are calculated by measuring the voltage drop between the incoming and the outgoing terminals of the device at rated current.

Power loss per pole

| In <br> $(A)$ | Voltage drop <br> $(V)$ | Energy loss <br> $(W)$ | Resistance <br> $(\mathrm{mOhm})$ |
| :---: | :---: | :---: | :---: |
| 0.5 | 2.230 | 1.115 | 4458.00 |
| 1 | 1.270 | 1.272 | 1272.00 |
| 2 | 0.620 | 1.240 | 310.00 |
| 3 | 0.520 | 1.557 | 173.00 |
| 4 | 0.370 | 1.488 | 93.00 |
| 6 | 0.260 | 1.570 | 43.60 |
| 8 | 0.160 | 1.242 | 19.40 |
| 10 | 0.160 | 1.560 | 15.60 |
| 13 | 0.155 | 2.011 | 11.90 |
| 16 | 0.162 | 2.586 | 10.10 |
| 20 | 0.138 | 2.760 | 6.90 |
| 25 | 0.128 | 3.188 | 5.10 |
| 32 | 0.096 | 3.072 | 3.00 |
| 40 | 0.100 | 4.000 | 2.50 |
| 50 | 0.090 | 4.500 | 1.80 |
| 63 | 0.082 | 5.160 | 1.30 |

## Limitation curves

## Let-through energy $I^{2} t$

The limitation capacity of an MCB in short-circuit conditions, is its capacity to reduce the value of the let-through energy that the short-circuit would be generating.

Peak current Ip
Is the value of the maximum peak of the short-circuit current limited by the MCB.


[^0]
## Din-T MCBs Technical data

## Din-T 15

15 kA
C curve
$1^{2} t$ Let-through energy at 240 V


## Din-T MCBs Technical data

Use of standard MCB for DC use
For MCBs designed to be used in alternating current but used in installations in direct current, the following should be taken into consideration:

For protection against overloads it is necessary to connect the two poles to the MCB. In these conditions the tripping characteristic of the MCB in direct current is similar to alternating current.

- For protection against short-circuits it is necessary to connect the two poles to the MCB. In these conditions the tripping characteristic of the MCB in direct current is $40 \%$ higher than the one in alternating current.

Use in DC selection table

| Series | Rated <br> current (A) | 48 V 1 pole <br> $\mathrm{Icu}(\mathrm{kA})$ | 110 V 2 poles in series | 250 V 1 pole | 440 V 2 poles in series |
| :--- | :--- | :---: | :---: | :---: | :---: |
| Icu (kA) |  |  |  |  |  |

Installation of Din-T DC MCBs in direct current

## Din-T MCBs + RCDs Technical data

## Text for specifiers

## MCB Series Din-T 15

- According to EN 60947.2 standard
- For DIN rail mounting according to DIN EN 50022; EN 50022; future EN 60715; IEC 60715 (top hat rail 35 mm )
- Working ambient temperature from $-25^{\circ} \mathrm{C}$ up to $+50^{\circ} \mathrm{C}$
- 1 pole is a module of 18 mm wide
- Nominal rated currents are: 6/10/13/16/20/25/32/40/50/63 A
E Tripping characteristic: ©
- Number of poles: 1 P, 2 P, 3 P, 4 P
- Short-circuit capacity is: 15 kA
- Terminal capacity from 1 up to $35 \mathrm{~mm}^{2}$ rigid wire or 1.5 up to $25 \mathrm{~mm}^{2}$ flexible wire
- Screw head suitable for flat or Pozidrive screwdriver
- Can be connected by means of both pin or fork busbars
- The toggle can be sealed in the ON or OFF position
- Rapid closing
- Both incoming and outgoing terminals have a protection degree of IP 20 and they are sealable
- Isolator function thanks to Red/Green printing on the toggle.
- Maximum voltage between two phases; 440 V
- Maximum voltage for utilisation in $D C$ current: 48 V 1 P and 110 V 2 P
- Two position rail clip
- Mechanical shock resistance 40 g (direction $x, y, z$ ) minimum 18 shocks 5 ms half-sinusoidal acc. to IEC 60068-2-27
- Vibration resistance: 3 g (direction $\mathrm{x}, \mathrm{y}, \mathrm{z}$ ) minimum 30 min. according to IEC 60068-2-6
- Extensions can be added on both left or right hand side
- Auxiliary contact
- Shunt trip
- Undervoltage release
- Motor operator
- Panelboard switch
- Add-on RCD can be coupled.


## Din-T MCBs Technical data



## Din-T MCBs + RCDs Technical data <br> Miniature circuit breakers - Din-T 15

Dimensions in mm.


## Miniature circuit breakers

## Din-Safe single pole width residual current circuit breaker (RCBO)

[] Standards AS/NZS 61009

- Approval N17482
- One module wide ( 18 mm )
- Short circuit, overcurrent and earth leakage protection
- Short circuit protection 10 kA
( Sensitivity 10 and 30 mA
- Din rail mount

■ Suits CD chassis

- Type " $A$ " residual current device ( $A C / D C$ )


| Amp <br> rating <br> (A) | Modules <br> $(18 \mathrm{~mm})$ | Voltage <br> $(\mathrm{AC})$ | Short <br> (ircuit <br> $(\mathrm{kA})$ | Trip <br> Sensitivity <br> $(\mathrm{mA})$ | Cat. No $\left.{ }^{1}\right)^{2}$ ) |
| :--- | :--- | :--- | :--- | :--- | :--- |

Note: ${ }^{1}$ ) Neutral not switched.
${ }^{2}$ ) Will not accept side mounting accessories. i Available on indent only.

## Operation

This unit combines the overload and short circuit protection of an MCB with earth leakage protection of an RCD. The unit occupies one, sub- circuit (one pole) of the distribution board and provides single phase protection against overload, short circuit and earth leakage current.

- $\quad$ The MCB element provides thermal and magnetic tripping protection which is rated to 10 kA prospective fault current.
- The RCD element of the device provides core-balance detection of the difference between the active and neutral currents and amplification to provide high sensitivity. The rated residual operating current ( $I \Delta n$ ) is 10 mA or 30 mA .
- $\quad$ The green/yellow earth reference cable, in case of loss of supply neutral, ensures the device will continue to provide earth leakage protection and will operate normally upon detection of an earth leakage current.

Dimensions (mm)

Note: A 1.2 m long pigtail lead is included as standard.


## Application

The Din-Safe single pole width residual current circuit breaker will fit the standard Din-T chassis for use in NHP panelboards. The design makes it possible to provide an MCB complete with earth leakage protection in an 18 mm wide module, which allows a greater number of devices to be fitted into a distribution board.

Connection diagram


Note: Nuisance tripping may be experienced in VFD and motor starting applications refer NHP.

## Din-T MCBs + RCDs Technical data

## Tripping curves according to EN 60898

The following tables show the average tripping curves of the Terasaki Din-T MCBs based on the thermal and magnetic characteristics.

## Curve C



# Din-T MCBs + RCDs Technical data 

## What is an RCD?

The RCD (Residual Current Device) is a device intended to protect people against indirect contact, the exposed conductive parts of the installation being connected to an appropriate earth electrode. It may be used to provide protection against fire hazards due to a persistent earth fault current, without operation of the overcurrent protective device.
RCDs having a rated residual operating current not exceeding 30 mA are also used as a means for additional protection in case of failure of the protective means against electric shock (direct contact).

## Working Principle

The main components of an RCD are the following:

- The core transformer: which detects the earth fault current.

E The relay: when an earth fault current is detected, the relay reacts by tripping and opening the contacts.

- The mechanism: element to open and close the contacts either manually or automatically.
- The contacts: to open or close the main circuit.

The RCD constantly monitors the vectorial sum of the current passing through all the conductors. In normal conditions the vectorial sum is zero $(\mathrm{I} 1+\mathrm{I} 2=0)$ but in case of an earth fault, the vectorial sum differs from zero ( $11+12=I d$ ), this causes the actuation of the relay and therefore the release of the main contacts.


## Definitions related to RCDs

RCCB = Residual Current Circuit Breaker
without overcurrent protection.
RCBO $=$ Residual Current Circuit Breaker
with overcurrent protection.

## Breaking capacity

A value of $A C$ component of a prospective current that an RCCB is capable of breaking at a stated voltage under prescribed conditions of use and behaviour.
Residual making and breaking capacity ( $\mathrm{I} \Delta \mathrm{m}$ )
A value of the $A C$ component of a residual prospective current which an RCCB can make, carry for its opening time and break under specified conditions of use and behaviour.

## Conditional residual short-circuit current (I $\Delta \mathrm{C}$ )

$A$ value of the $A C$ component of a prospective current which an RCCB protected by a suitable SCPD (short-circuit protective device) in series, can withstand, under specific conditions of use and behaviour.
Conditional short-circuit current (Inc)
A value of the $A C$ component of a residual prospective current which an RCCB protected by a suitable SCPD in series, can withstand, under specific conditions of use and behaviour.

## Residual short-circuit withstand current

Maximum value of the residual current for which the operation of the RCCB is ensured under specified conditions, and above which the device can undergo irreversible alterations.

## Prospective current

The current that would flow in the circuit, if each main current path of the RCCB and the overcurrent protective device (if any) were replaced by a conductor of negligible impedance.

## Making capacity

A value of $A C$ component of a prospective current that an RCCB is capable to make at a stated voltage under prescribed conditions of use and behaviour.

## Open position

The position in which the predetermined clearance between open contacts in the main circuit of the RCCB is secured.

## Closed position

The position in which the predetermined continuity of the main circuit of the RCCB is secured.

## Tripping time

The time which elapses between the instant when the residual operating current is suddenly attained and the instant of arc extinction in all poles.
Residual current ( $I \Delta n$ )
Vector sum of the instantaneous values of the current flowing in the main circuit of the RCCB.

## Residual operating current

Value of residual current which causes the RCCB to operate under specified conditions.
Rated short-circuit capacity (Icn)
Is the value of the ultimate short-circuit breaking capacity assigned to the circuit breaker. (Only applicable to RCBO)
Conventional non-tripping current (Int)
A specified value of current which the circuit breaker is capable of carrying for a specified time without tripping. (Only applicable to RCBO)

## Conventional tripping current (It)

A specified value of current which causes the circuit breaker to trip within a specified time.
(Only applicable to RCBO)

## Din-T MCBs + RCDs Technical data

## RCDs classification according to EN 61008/61009

RCDs may be classified according to:
The behaviour in the presence of $D C$ current
(types for general use).

- Type $A C$
- Type A

The time-delay (in the presence of residual current)

- RCDs without time delay: type for general use
- RCDs with time delay: type $S$ for selectivity

Type $\left.A C \backsim{ }^{1}\right)^{2}$ )
The type AC RCDS are designed to release with sinusoidal residual currents which occur suddenly or slowly rise in magnitude.


| Residual current | Tripping time |
| :---: | :---: |
| $0.5 \times I \Delta n$ | $\mathrm{t}=\propto$ |
| $1 \times \mathrm{I} \Delta \mathrm{n}$ | $\mathrm{t}=<300 \mathrm{~ms}$ |
| $2 \times \mathrm{I} \Delta \mathrm{n}$ | $\mathrm{t}=<150 \mathrm{~ms}$ |
| $5 \times \mathrm{I} \Delta \mathrm{n}$ | $\mathrm{t}=\leq 40 \mathrm{~ms}$ |



Tripping curve type $A C$
') Standard in Australia
${ }^{2}$ ) Type A acceptable in Australia

## Type A <br>  <br> ${ }^{3}$ ) ")

Certain devices during faults can be the source of nonsinusoidal earth leakage currents ( $D C$ components) due to the electronic components e.g. diodes, thyristors etc.
Type A RCDs are designed to ensure that under these conditions the residual current devices operate on sinusoidal residual current and also with pulsating direct current(*) which occur suddenly or slowly rise in magnitude.
(*) Pulsating direct current: current of pulsating wave form which assumes, in each period of the rated power frequency, the value 0 or a value not exceeding 0.006 A DC during one single interval of time, expressed in angular measure of at least $150^{\circ}$.

|  | Residual current | Tripping time |
| :--- | :--- | :--- |
| 1. For sinusoidal residual current |  |  |
|  | $0.5 \times I \Delta \mathrm{n}$ | $\mathrm{t}=\infty$ |
| $1 \times \mathrm{I} \Delta \mathrm{n}$ | $\mathrm{t}=<300 \mathrm{~ms}$ |  |
| $2 \times I \Delta \mathrm{n}$ | $\mathrm{t}=<150 \mathrm{~ms}$ |  |
| $5 \times I \Delta \mathrm{n}$ | $\mathrm{t}=\leq 40 \mathrm{~ms}$ |  |

2. For residual pulsating direct current


| At point of wave $0^{\circ}$ |  |
| ---: | :--- |
| $0.35 \times \mathrm{I} \Delta \mathrm{n}$ | $\mathrm{t}=\infty$ |
| $1.4 \times \mathrm{I} \Delta \mathrm{n}$ | $\mathrm{t}=<300 \mathrm{~ms}$ |
| $2.8 \times \mathrm{I} \Delta \mathrm{n}$ | $\mathrm{t}=<150 \mathrm{~ms}$ |
| $7 \times \mathrm{I} \Delta \mathrm{n}$ | $\mathrm{t}=\leq 40 \mathrm{~ms}$ |


| At point of wave $90^{\circ}$ |  |
| ---: | :--- |
| $0.25 \times I \Delta n$ | $t=\infty$ |
| $1.4 \times I \Delta n$ | $t=<300 \mathrm{~ms}$ |
| $2.8 \times I \Delta n$ | $t=<150 \mathrm{~ms}$ |
| $7 \times I \Delta n$ | $t=\leq 40 \mathrm{~ms}$ |


| $\bumpeq$ | $0.25 \times 1 \Delta n$ | $t=\infty$ |
| :---: | :---: | :---: |
|  | $1.4 \times I \Delta n$ | $\mathrm{t}=<300 \mathrm{~ms}$ |
|  | $2.8 \times I \Delta n$ | $\mathrm{t}=<150 \mathrm{~ms}$ |
|  | $7 \times 1 \Delta n$ | $\mathrm{t}=\leq 40 \mathrm{~ms}$ |
| At point of wave $135^{\circ}$ |  |  |
| $\xrightarrow{\text { L_ }}$ | $0.11 \times \mathrm{I} \Delta \mathrm{n}$ | $t=\infty$ |
|  | $1.4 \times I \Delta n$ | $\mathrm{t}=<300 \mathrm{~ms}$ |
|  | $2.8 \times \mathrm{I} \Delta \mathrm{n}$ | $\mathrm{t}=<150 \mathrm{~ms}$ |
|  | $7 \times \mathrm{I} \Delta \mathrm{n}$ | $\mathrm{t}=\leq 40 \mathrm{~ms}$ |

Tripping curve type A
${ }^{3}$ ) Standard in New Zealand
d) DSRCBH is type A.

## Din-T MCBs + RCDs Technical data

## Nuisance tripping

All DinSafe RCDs have a high level of immunity to transient currents, against current impulses of $8 / 20 \mu \mathrm{~s}$ according to EN $61008 / 61009$ and VDE 0664.T1.
Type A, AC................................... 250 A $8 / 20 \mu \mathrm{~s}$
Type S....................................... 3000 A $8 / 20$ нs


RCDS have a high level of immunity against alternating currents of high frequency according to EN 61008/61009.


## Din-T MCBs + RCDs Technical data

Use of an RCBO (DSRCBH)


## IEST-BUTTON

To ensure the correct functioning of the RCBO, the test-button $T$ shall be pressed frequently. The device must trip when the test-button is pressed.


CONTACT POSITION INDICATOR
Printing on the toggle to provide information of the real contact position.


O-OFF
Contacts in open poșition. Ensure a distance between contacts $>4 \mathrm{~mm}$.


I-ON
Contacts in closed position. Ensure continuity in the main circuit.

## TOGGLE

To manually switch the RCBO ON or OFF

## Din-T MCBs + RCDs Technical data

## Product related information

Influence of temperature on RCBOS (DinSafe DSRCB)
The thermal calibration of the RCBO was carned out at an ambient temperature of $30^{\circ} \mathrm{C}$. Ambient temperatures different from $30^{\circ} \mathrm{C}$ influence the bimetal and this results in earlier or later thermal tripping.


10 A


16-40 A


## Din-T MCBs + RCDs Technical data

## Tripping current as a function of the frequency

All RCDs are designed to work at frequencies of $50-60 \mathrm{~Hz}$, therefore to work at different values, we must consider the variation of the tripping sensitivity according to the tables below. It should be taken into consideration that there is a no tripping risk when pushing the test-button, due to the fact that such action is made by means of an internal resistor with a fixed value.
RCBO DSRCBH ${ }^{3}$ )

| Type AC ${ }^{\text { }}$ ) | 10 Hz | 30 Hz | 50 Hz | 100 Hz | 200 Hz | 300 Hz | 400 Hz |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 30 mA | 0.62 | 0.65 | 0.80 | 0.91 | 1.24 | 1.55 | 1.88 |
| 100 mA | 0.74 | 0.71 | 0.80 | 0.95 | 1.16 | 1.38 | 1.59 |
| 300 mA | 0.80 | 0.74 | 0.80 | 0.97 | 1.19 | 1.44 | 1.64 |
| 500 mA | 1.10 | 0.81 | 0.80 | 0.89 | 1.18 | 1.38 | 1.68 |
| Type A $^{2}$ ) |  |  |  |  |  |  |  |
| 30 mA | 8.17 | 3.13 | 0.75 | 1.70 | 3.10 | 3.52 | 3.67 |
| 100 mA | 6.81 | 2.71 | 0.75 | 1.43 | 2.35 | 2.58 | 2.71 |
| 300 mA | 6.20 | 2.16 | 0.75 | 0.49 | 0.87 | 0.74 | 0.95 |
| 500 mA | 4.34 | 1.53 | 0.75 | 0.39 | 0.59 | 0.62 | 0.64 |

Notes: ${ }^{1}$ ) The standard NHP/Terasaki type is the "type $A C^{\prime \prime}$ in Australia, Type " $A$ " in New Zealand.
${ }^{2}$ ) The standard NHP/Terasaki DSRCBH single pole RCBO is "type A" in Australia and New Zealand.
${ }^{1}$ ) The numbers in the table above àre multipliers, e.g. A "DSRCD" at 50 hz has an 0.8 multiplier.
Therefore a 30 mA , "type $A C$ " RCD will trip at $(0.8 \times 30 \mathrm{~mA}) 24 \mathrm{~mA}$.

## Power losses

The power losses are calculated by means of measuring the voltage drop between the incoming and the outgoing terminal of the device at rated current. Power loss per pole:
RCBO-Single pole DSRCBH

| In (A) | $\mathbf{6}$ | $\mathbf{1 0}$ | $\mathbf{1 3}$ | $\mathbf{1 6}$ | $\mathbf{2 0}$ | $\mathbf{2 5}$ | $\mathbf{3 2}$ | $\mathbf{4 0}$ | $\mathbf{5 0}$ | $\mathbf{6 3}$ |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\mathbf{Z ( \mathbf { m O h m } )}$ | 45.8 | 16.4 | 12.5 | 10.6 | 7.3 | 5.4 | 3.2 | 2.6 | 1.9 | 1.4 |
| Pw (W) | 1.65 | 1.7 | 2.1 | 2.7 | 2.9 | 3.3 | 3.4 | 4.2 | 4.8 |  |

## Din-T MCBs + RCDs Technical data

## RCBO (DSRCB) let-through energy I ${ }^{2}$ t

The benefit of an RCBO in short-circuit conditions, is its ability to reduce the value of the let-through energy that the short-circuit would be generating.

Din-T single pole width RCD (DSRCBH)
Curve C

Let-through energy at 230 V


RCCB - Din-Safe safety switch (DSRCD)

RCBO - Din-Safe (DSRCBH)


Dimensions in mm

Din-T MCBs + RCDs Technical data


## CONTACTOR \& THERMAL OVERLOAD RELAY

1. CA7 CONTACTOR TECHNICAL DETAILS
2. CT7 THERMAL OVERLOAD RELAY TECHNICAL DETAILS

## AC contactors

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## Refer catalogue CA 6, 2212, SACS



Contactor CA 7-9


Contactor CA 7-72


Contactor CA 6-105-EI


Contactor CA 6-170-EI


Contactor CA 6-250-EI


Contactor CA 6-420-EI

Ratings to IEC 947 and AS 3497 400/415 V

- For CA 7 contactors with coil terminals on line side, add $\ldots$... AC to Catalogue No. Eg-CA 7-9-10-240 V AC ${ }^{3}$ )
- For CA 7 contactors with coil terminals on load side, add $\ldots$... AC-U to Catalogue No. Eg - CA 7-9-10-240 V AC-U

AC 3 AC $3 \quad A C 1^{6}$ ) $\left.A C 1^{\circ}\right)$ Auxiliary contacts
$400 / 415 \mathrm{~V} 400 / 415 \mathrm{~V}$ Amps Amps standard

| kW ') | Amps ') | $40^{\circ} \mathrm{C}$ | $60^{\circ} \mathrm{C}$ | N/O | N/C |  | Cat. No. ${ }^{2}$ ) |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 4 | 9 | 32 | 32 | 1 | 0 | 9 | CA 7-9-10..V AC |  |
|  |  |  |  | 0 | 1 | 9 | CA 7-9-01..V AC |  |
| 5.5 | 12 | 32 | 32 | 1 | 0 | 9 | CA 7-12-10...V AC |  |
|  |  |  |  | 0 | 1 | 9 | CA 7-12-01...V AC |  |
| 7.5 | 16 | 32 | 32 | 1 | 0 | 9 | CA 7-16-10...V AC. |  |
|  |  |  |  | 0 | 1 | 9 | CA 7-16-01...V AC |  |
| 11 | 23 | 32 | 32 | 1 | 0 | 9 | CA 7-23-10...V AC |  |
|  |  |  |  | 0 | 1 | 9 | CA 7-23-01...V AC |  |
| 15 | 30 | 50 | 45 | 0 | 0 | 8 | CA 7-30-00...V AC |  |
| 18.5 | 37 | 50 | 45 | 0 | 0 | 8 | CA 7-37-00...V AC |  |
| 22 | 43 | 85 | 63 | 0 | 0 | 8 | CA 7-43-00...VAC |  |
| 30 | 60 | 100 | 100 | 0 | 0 | 8 | CA 7-60-00...V AC |  |
| 37 | 72 | 100 | 100 | 0 | 0 | 8 | CA 7-72-00...V AC |  |
| 45 | 85 | 100 | 100 | 0 | 0 | 8 | CA 7 -85-00...V AC |  |
| 55 (45) | 95 (33) | 160 | 135 | 1 | 1 | 8 | CA 6-85-11...V AC |  |
| 75 (55) | 130 (40) | 160 | 135 | 1 | 1 | 8 | CA 6-105-11...V AC |  |
| 90 (75) | 155 (55) | 250 | 210 | 1 | 1 | 8 | CA 6:140-11...V AC |  |
| 75 (55) | 130 (40) | 160 | 135 | 1 | 1 | 8 | CA 6-105-EI-11...V AC') |  |
| 90(75) | 155 (55) | 250 | 210 | 1 | 1 | 8 | CA 6-140,El-11...V AC') |  |
| 100 (90) | 170 (65) | 250 | 210 | 1 | 1 | 8 | CA 6-170-El-11...V AC') |  |
| 132 (111) | 225 (80) | 350 | 300 | 1 | 1 | 8 | CA 6-210-EI-11...V AC ${ }^{4}$ ) |  |
| 150(133) | 258 (95) | 350 | 300 | 1 | 1 | 8 | CA 6-250-El-11...V AC') |  |
| 185 (163) | 320 (115) | 450 | 380 | 1 | 1 | 8 | CA 6-300-El-11...V AC') |  |
| 250 (225) | 425 (160) | 500 | 425 | 1 | 1 | 8 | CA 6-420-El-11...V AC) |  |
| 220 (220) | 370 (155) | 500 | 420 | 2 | 2 | 8 | CA 5-370...V AC') |  |
| 265 (280) | 450 (200) | 600 | 510 | 2 | 2 | 8 | CA 5-450,., V AC') |  |
| 325 (355) | 550 (250) | 780 | 645 | 2 | 2 | 8 | CA 5-550:. V AC') |  |
| 430 (500) | 700 (340) | 1000 | 850 | 2 | 2 | 8 | CA 5-700:..V AC) |  |
| 520 (550) | 860 (380) | 1100 | 930 | 2 | 2 | 8 | CA 5-860...V AC? |  |
| 600 | 1000 | 1200 | 1020 | 1 | 1 | 8 | CA 5-1000...V AC') |  |
| 700 | 1150 | 1350 | 1150 | 1 | 1 | 8 | CA 5-1200...V: AC) |  |

Notes: ') 1000 volt ratings ( ).
${ }^{2}$ ) Add control voltage to Cat. No. when ordering: 24, 32, 110, 240, 415, 440V 50 Hz . Slandard voltages for CA 6-105-EI...250-EI are 24, 48, 110, 240 and 415 V AC . Standard voltages for CA 6-300-EI...420-EI 48, 110, 240 and 415 V AC.
Standard voltages for CA 5-370...1200, 110, 240 and 415 VAC .
${ }^{3}$ ) All CA 7 coils can be reversed for line or load side coil terminals as required. Both versions are held in NHP stock for convenience.
*) Electronically controlled mechanism (ECM) with interface suffix (EI).
3) $55^{\circ} \mathrm{C}$ enclosed.
${ }^{5}$ ) Contact NHP for recommended cable size.
$240 / 415 \mathrm{~V}$ rated colls are suitable for use on $230 / 400 \mathrm{~V}$ in accordance with AS 60038:2000.


## Compact without compromise

Compact without compromise is the best way to describe the CA 7 range of contactors and motor protection relays from Sprecher + Schuh. In spite of the new compact dimensions, the CA 7 range features high breaking capacity and extraordinary flexibility. Up to 18.5 kW the contactors are only 45 mm wide and even the largest 45 kW frame is only 72 mm wide. The CA 7 contactors are the main component in the new Advanced Control System (ACS).

With CA 7 you have flexibility with auxiliary contacts
Common auxiliaries from 9 to 85 amps
Three fitting positions
O Front mounting

- Side mounting left
- Side mounting right

Alternatively you can choose to combine left, right and front mounting auxiliary contacts to fulfil your requirements.
Instead of the top mounted auxiliary contacts, on or off delay timing modules or mechanical latches can be fitted.



Motor switching rating AC 3 @ 400/415 V

| CA 7-9 | 4 kW | 45 mm |  | 9 A |
| :---: | :---: | :---: | :---: | :---: |
| CA 7-12 | 5.5 kW |  | - | 12 A |
| CA 7-16 | 7.5 kW |  |  | 16 A |
| CA 7-23 | 11 kW |  |  | 23 A |
| CA 7-30 | 15 kW | 45 mm |  | 30 A |
| CA 7-37 | 18.5 kW |  |  | 37 A |
| CA 7-43 | 22 kW | 54 mm |  | 43 A |
| CA 7-60 | 30 kW | 72 mm |  | 60 A |
| CA 7.72 | 37 kW |  |  | 72 A |
| CA 7-85 | 45 kW |  |  | 85 A |

## With CA 7 you have more clip on accessories

Common accessories from 9 to 85 amps
O On and off delay pneumatic timers
O Coil mounted electronic timers on delay, off delay, star delta
O Coil mounted 24 V DC interface
O Coil mounted RC and varistor suppressor modules
O Mechanical latch
O Mechanical interlock
O Mechanical interlock with integrated $N / C$ interlock contacts
O Moulded wire link sets for DOL, reversing and star delta starters
O Large choice of front and side mounting auxiliary contacts


Refer catalogue SACS

## Innovation and ease of use provide solutions for your control systems

## Coil terminals are always in the correct

 positionThe coil terminations on the CA 7 contactors can be supplied optionaliy at the top or the bottom of the contactor. It is also a simple task to change this on site should the requirements change.
When CA 7 contactors are used in combination with KTA 7 circuit motor circuit breakers the bottom coil terminations are used. For use with standard CT 7 thermal or CEP 7 electronic overloads the top coil termination should be selected.

Mechanical interlocks save space
Only 9 mm wide, the CM 7 mechanical interlock snaps into place between any of the CA 7 contactors. It is allowed also to interlock different sizes of the CA 7 range with the same interlock.
The basic mechanical interlock is supplemented by a variation with built in N/C auxiliary contacts for electrical interlocking. This version is also only 9 mm wide and further minimises space requirements.


## With Sprecher + Schuh you can choose the best protection for your motors.




CA 7 contactors provide improved wiring terminals
The main terminals of all CA 7 contactors are designed to accept at least two cables. At the same time they comply with safety standards regarding touch protection.
The larger contactors CA 7-30 and upwards employ a special cage terminal which allows the connection of two cables in separate chambers.
The ease of wiring with CA 7 contactors saves both time and money.



High tech electronic protection type CEP 7 in trip class 10 or 20.


Standard thermal overloads type CT 7

Refer Catalogue C-CO

## Automatic Type '2' co-ordination 1) with

 no-oversizing of contactorsDOL starting
50/65 kA @ 400/415 V


| Motor size kW | Approx. amps @ 400/415 V | Sprecher + Schuh circuit breaker | Setting range amps | Magnetic amps | Sprecher + Schuh contactor | AC-3 amps |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 0.18 | 0.60 | KT 7-25S | 0.40-0.63 | 8.2 | CA 7-9 | 9 |
| 0.25 | 0.80 | KT 7-25S | 0.63-1.00 | 13 | CA 7-9 | 9 |
| 0.37 | 1.10 | KT 7-25S | 1.00-1.60 | 21 | CA 7-9 | 9 |
| 0.55 | 1.50 | KT 7-25S | 1.00-1.60 | 21 | CA 7-9 | 9 |
| 0.75 | 1.80 | KT 7-25S | 1.60-2.50 | 33 | CA 7-9 | 9 |
| 1.10 | 2.60 | KT 7-25S | 2.50-4.00 | 52 | CA 7-9 | 9 |
| 1.15 | 3.40 | KT 7-25S | 2.50-4.00 | 52 | CA 7-9 | 9 |
| 2.20 | 4.80 | KT 7-25S | 4.00-6.30 | 80 | CA 7-9 | 9 |
| 3.00 | 6.50 | KT 7-25S | 6.30-10.0 | 130 | CA 7-9 | 9 |
| 4.00 | 8.20 | KT 7-25S | 6.30-10.0 | 130 | CA 7-9 | 9 |
| 5.50 | 11.00 | KT 7-25S | 10.0-16.0 | 208 | CA 7-12 | 12 |
| 7.50 | 14.00 | KT 7-25S | 10.0-16.0 | 208 | CA 7-16 | 16 |
| 9.00 | 17.00 | KT 7-25H | 14.5-20.0 | 260 | CA 7-23 | 23 |
| 11.00 | 21.00 | KT 7-25H | 18.0-25.0 | 325 | CA 7-23 | 23 |
| 15.00 | 28.00 | KT 7-45H | 23.0-32.0 | 416 | CA 7-30 | 30 |
| 18.50 | 34.00 | KT 7-45H | 32.0-45.0 | 585 | CA 7-37 | 37 |
| 22.00 | 40.00 | KT 7-45H | 32.0-45.0 | 585 | CA 7-43 | 43 |
| 30.00 | 55.00 | KT 3-100 | 40.0-63.0 | 882 | CA 7-60 | 60 |
| 37.00 | 66.00 | KT 3-100 | 63.0-90.0 | 1260 | CA 7-72 | 72 |
| 45.00 | 80.00 | KT 3-100 | 63.0-90.0 | 1260 | CA 7-85 | 85 |

Definition Type ' 2 ' co-ordination according to IEC 947-4-1:

- The contactor or the starter must not endanger persons or systems in the event of a short circuit
- The contactor or the starter must be suitable for further use
- No damage to the overload relay or other parts may occur with the exception of welding of the contactor or starter contacts provided that these can be easily separated without significant deformation (such as with a screwdriver)
- In the event of a short circuit, fast opening current limiting circuit breakers KT 7 make it possible to build economical, fully short circuit co-ordinated starter combinations in accordance with IEC 947-4-1, Type ' 2 ' co-ordination
- Type ' 2 ' co-ordination without oversizing of contactors means: Type ' 1 ' = Type ' 2 '


## Note: ') What is meant by Automatic Type ' 2 ' co-ordination?

The high speed operation of the new KT 7 motor protection circuit breakers means that contactors need not be oversized to achieve type ' 2 ' co-ordination. Simply select the normal AC 3 rated contactor and the corresponding KT 7 circuit breaker and type ' 2 co-ordination is assured.
240/415 V rating suitable for use on $230 / 400 \mathrm{~V}$ in accordance with AS 60038 : 2000


Refer Catalogue C-CO
MCCB or fuse DOL starting
50/65 kA @ 400/415 V to AS 3947.4.1

## TemBreak Moulded Case Circuit Breaker or fuse

| Motor size kW | Approx. amps | Terasaki circuit or breaker | NHP HRC fuse to BS88 | Sprecher + Schuh contactor type | Sprecher + Schuh thermal O/L relay type | Setting range amps |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 0.37 | 1.1 | XM30PB/1.4 | NTIA-6 | CA 7-9 | CT 7-24 | 1-1.6 |
| 0.55 | 1.5 | XM30PB/2 | NTIA-6 | CA 7-9 | CT 7-24 | 1-1.6 |
| 0.75 | 1.8 | XM30PB/2.6 | NTIA-10 | CA 7-9 | CT 7-24 | 1.6-2.4 |
| 1.1 | 2.6 | XM30PB/4.0 | NTIA-10 | CA 7-9 | CT 7-24 | 2.4-4 |
| 1.5 | 3.4 | XM30PB/5 | NTIA-10 | CA 7-9 | CT 7-24 | 2.4-4 |
| 2.2 | 4.8 | XM30PB/8 | NTIA-16 | CA 7-9 | CT 7-24 | 4-6 |
| 3.0 | 6.5 | XM30PB/10 | NTIA-16 | CA 7-9 | CT 7-24 | 6-10 |
| 4.0 | 8.2 | XM30PB/12 | NTIA-25 | CA 7-9 | CT 7-24 | 6-10 |
| 5.5 | 11 | XH125NJ/20 | NTIA-32 | CA 7-12 | CT 7-24 | 10-16 |
| 7.5 | 14 | XH125NJ/20 | NTIS-40 | CA 7-16 | CT 7-24 | 10-16 |
| 11 | 21 | XH125NJ/32 | NTIS-50 | CA 7-23 | CT 7-24 | 16-24 |
| 15 | 28 | XH125NJ/50 | NTIS-63 | CA 7-30 | CT 7-45 | 18-30 |
| 18.5 | 34 | XH125NJ/50 | NTCP-80 | CA 7-37 | CT 7-45 | 30-45 |
| 22 | 40 | XH125NJ/63 | NTCP-80 | CA 7-43 | CT 7-45 | 30-45 |
| 30 | 55 | XH125NJ/100 | NTCP-100 | CA 7-60 | CT 7-75 | 45-60 |
| 37 | 66 | XH125NJ/100 | NTF-160 | CA 7.72 | CT 7-75 | 60-75 |
| 45 | 80 | XH125NJ/125 ') | NTF-160 | CA 6-85 | CT 7-100 | 70-90 |
| 55 | 100 | XH125NJ/125 ') | NTF-200 | CA 6-105-EI | CT 6-110 | 85-110 |
| 75 | 130 | XH250NJ/250 | NTKF-250 | CA 6-140-EI | CT 6-150 | 105-150 |
| 90 | 155 | XH250NJ/250 ') | NTKF-250 | CA 6-170-EI | CT 6-200 | 140-200 |
| 110 | 200 | XH250NJ/250 ') | NTKF-315 | CA 6-210-EI | CEF 1-41/42 | 160-400 |
| 132 | 225 | XH400NE/400 | NTMF-355 | CA 6-210-EI | CEF 1-41/42 | 160-400 |
| 150 | 250 | XH400NE/400 | NTMF-355 | CA 6-250-EI | CEF 1-41/42 | 160-400 |
| 160 | 270 | XH400NE/400 | NTMF-400 | CA 6-300-EI | CEF 1-41/42 | 160-400 |
| 185 | 310 | XH400NE/400 | NTTF-450 | CA 6-300-EI | CEF 1-41/42 | 160-400 |
| 200 | 361 | XH400NE/400 | NTTM-500 | CA 6-420-EI/CA 5-450 | CEF 1-41/42 | 160-400 |
| 250 | 425 | XH630NE/630 | NTTM-630 | CA 6-420-EI/CA 5-450 | CEF 1-52 | 160-630 |
| 315 | 530 | XH630NE/630 | NTLM-710 | CA 5-550 | CEF 1-52 | 160-630 |

Notes: Fuses $65 \mathrm{kA} . \mathrm{XH} 125 \mathrm{NJ}$ circuit breaker combinations limited to 50 kA , others 65 kA .
Overloads may be changed to different types eg. thermal style to electronic.
Some combinations also gives Type '2' performance.
${ }^{1}$ ) Use 'magnetic only' breaker - Refer NHP.
240/415 V rating suitable for use on 230/400 V in accordance with AS 60038: 2000


Notes: ') Fuses with equal or lower let through energy may also be used.

[^1]240/445 V rating suitable for use on 230/400 V in accordance with AS 60038: 2000

TemBreak circuit breakers DOL starting $50 \mathrm{kA} @ 400 / 415 \mathrm{~V}$ to AS 3947.4.1

TemBreak MCCBs

| Motor size kW | Approx. amps | Terasaki circuit breaker | Sprecher + Schuh contactor | Sprecher + Schuh overload relay | Setting range amps |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 0.37 | 1.1 | XM30PB/1.4 | CA 7-9 | CT 7-24-1.6 | 1-1.6 |
| 0.55 | 1.5 | XM30PB/2 | CA 7-9 | CT 7-24-1.6 | 1-1.6 |
| 0.75 | 1.8 | XM30PB/2.6 | CA 7-9 | CT 7-24-2.4 | 1.6-2.4 |
| 1.1 | 2.6 | XM30PB/4.0 | CA 7-16 | CT 7-24-4 | 2.4-4 |
| 1.5 | 3.4 | XM30PB/5 | CA 7-16 | CT 7-24-4 | 2.4-4 |
| 2.2 | 4.8 | XM30PB/8 | CA 7-16 | CT 7-24-6 | 4-6 |
| 3 | 6.5 | XM30PB/10 | CA 7-30 | CT 7-24-10 | 6-10 |
| 4 | 8.2 | XM30PB/12 | CA 7-30 | CT 7-24-10 | 6-10 |
| 5.5 | 11 | XH125NJ/20 | CA 7-30 | CT 7-24-16 | 10-16 |
| 7.5 | 14 | XH125NJ/20 | CA 7-30 | CT 7-24-16 | 10-16 |
| 11 | 21 | XH125NJ/32 | CA 7-30 | CT 7-24-24 | 16-24 |
| 15 | 28 | XH125NJ/50 | CA 7-43 | CT 7-45-30 | 18-30 |
| 18.5 | 34 | XH125NJ/50 | CA 7-43 | CT 7-45-45 | 30-45 |
| 22 | 40 | XH125NJ/63 | CA 7-43 | CT 7-45-45 | 30-45 |
| 30 | 55 | XH125NJ/100 | CA 6-85 | CT 7-75 ${ }^{2}$ ) | 45-60 |
| 37 | 66 | XH125NJ/100 | CA 6-85 | CT 7-75 ${ }^{2}$ ) | 60-75 |
| 45 | 80 | XH125NJ/125 | CA 6-105-EI | CT 6-90 | 70-90 |
| 55 | 100 | XH125NJ/125 ${ }^{\text {' }}$ | CA 6-105-EI | CT 6-110 | 85-110 |
| 75 | 130 | XH250NJ/250 | CA 6-140-EI | CT 6-150 | 105-150 |
| 90 | 155 | XH250NJ/250 | C A6-170-EI | CT 6-200 | 140-200 |
| 110 | 200 | XH250NJ/250 ${ }^{\text {') }}$ | CA 6-210-EI | CEF 1-41/42 | 160-400 |
| 132 | 225 | XS400SE/400 | CA 6-210-EI | CEF 1-41/42 | 160-400 |
| 150 | 250 | XS400SE/400 | CA 6-250-EI | CEF 1-41/42 | 160-400 |
| 160 | 270 | XS400SE/400 | CA 6-300-EI | CEF 1-41/42 | 160-400 |
| 200 | 361 | XS400SE/400 | CA 6-420-EI | CEF 1-41/42 | 160-400 |
| 200 | 361 | XS400SE/400 | CA 5-450 | CEF 1-22 ${ }^{2}$ ) | 160-400 |
| 250 | 425 | XS630SE/630 | CA 5-700 | CEF 1-52 ${ }^{2}$ ) | 160-630 |
| 320 | 538 | XS630SE/630 | CA 5-700 | CEF 1-52 ${ }^{2}$ ) | 160-630 |

Notes: Overloads may be thermal or electronic.
Combinations based on the overload tripping before the circuit breaker at overload currents up to the motor locked rotor current.
${ }^{1}$ ) Use 'magnetic only' breaker or next higher circuit breaker / contactor combination.
${ }^{2}$ ) Use with separate mounting bracket.
Data for 65 kA co-ordination available refer Cat. C-CO.
240/415 V rating suitable for use on 230/400 V in accordance with AS 60038: 2000


Din-T circuit breakers with rotary isolator. DOL starting.
50 kA @ 400/415 V to AS 3947.4.1

| Motor <br> size <br> kW | Approx. amps @ 400/415 V | Sprecher + Schuh isolator | Terasaki circuit breaker | Sprecher + Schuh current limiter | Sprecher + Schuh contactor | Sprecher + Schuh thermal O/L relay | Thermal overload range |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  |  |
| 0.37 | 1.1 | LA 7-80 | Din-T 10/4 | - | CA 7-9 | CT 7-24 | 0.6-1.6 |
| 0.55 | 1.5 | LA 7-80 | Din-T 10/4 | - | CA 7-9 | CT 7-24 | 1-1.6 |
| 0.75 | 1.8 | LA 7-80 | Din-T $10 / 4$ | - | CA 7-9 | CT 7-24 | 1.6-2.4 |
| 1.1 | 2.6 | LA 7-80 | Din-T $10 / 6$ | - | CA 7-23 | CT 7-24 | 2.4-4 |
| 1.5 | 3.4 | LA 7-80 | Din-T 10/6 | - | CA 7-23 | CT 7-24 | 2.4-4 |
| 2.2 | 4.8 | LA 7-80 | Din-T 10/10 | KTL 3-65 | CA 7-23 | CT 7-24 | 4-6 |
| 3 | 6.5 | LA 7-80 | Din-T 10/16 | KTL 3-65 | CA 7-23 | CT 7-24 | 6-10 |
| 4 | 8.2 | LA 7-80 | Din-T $10 / 16$ | KTL 3-65 | CA 7-23 | CT 7-24 | 6-10 |
| 5.5 | 11 | LA 7-80 | Din-T 10/20 | KTL 3-65 | CA 7-23 | CT 7-24 | 10-16 |
| 7.5 | 14 | LA 7-80 | Din-T 10/32 | KTL 3-65 | CA 7-30 | CT 7-45 | 10-16 |
| 11 | 21 | LA 7-80 | Din-T 10/40 | KTL 3-65 | CA 7-30 | CT 7-24 | 16-24 |
| 15 | 28 | LA 7-100 | Din-T 10/63 | KTL 3-65 | CA 7-37 | CT 7-45 | 18-30 |
| 18.5 | 34 | LA 7-100 | Din-T 10/63 | KTL 3-65 | CA 7-37 | CT 7-45 | 30-45 |

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

Refer Catalogue C-CO
TemBreak circuit breakers DOL starting. $85 \mathrm{kA} @ 400 / 415 \mathrm{~V}$ to AS 3947.4.1

| Motor size kW | Approx. FLC @ 400/415 V (A) | Terasaki circuit breaker | Sprecher + Schuh contactor | Sprecher + Schuh thermal O/L type | Setting range (A) |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 0.37 | 1.1 | XM30PB/1.4 | CA 7-9 | CEP 7-M32-2.9-10 | 1.0-2.9 |
| 0.55 | 1.5 | XM30PB/2.0 | CA 7-9 | CEP 7-M32-2.9-10 | 1.0-2.9 |
| 0.75 | 1.8 | XM30PB/2.6 | CA 7-9 | CEP 7-M32-2.9-10 | 1.0-2.9 |
| 1.1 | 2.6 | XM30PB/4 | CA 7-16 | CEP 7-M32-2.9-10 | 1.0-2.9 |
| 1.5 | 3.4 | XM30PB/5 | CA 7-16 | CEP 7-M32-5-10 | 1.6-5 |
| 2.2 | 4.8 | XM30РВ/8 | CA 7-30 | CEP 7-M32-12-10 | 3.7-12 |
| 3 | 6.5 | XM30РB/8 | CA 7-30 | CEP 7-M32-12-10 | 3.7-12 |
| 4 | 8.2 | XM30PB/10 | CA 7-30 | CEP 7-M32-12-10 | 3.7-12 |
| 5.5 | 11 | TL100NJ/20 | CA 7-30 | CEP 7-M32-12-10 | 3.7-12 |
| 7.5 | 14 | TL100NJ/20 | CA 7-30 | CEP 7-M32-32-10 | 12-32 |
| 9 | 17 | TL100NJ/32 | CA 7-30 | CEP 7-M32-32-10 | 12-32 |
| 10 | 19 | TL100NJ/32 | CA 7-30 | CEP 7-M32-32-10 | 12-32 |
| 11 | 21 | TL100NJ/32 | CA 7-30 | CEP 7-M32-32-10 | 12-32 |
| 15 | 28 | TL100NJ/50 | CA 7-43 | CEP 7-M32-32-10 | 12-32 |
| 18.5 | 34 | TL100NJ/50 | CA 7-43 | CEP 7-M37-37-10 | 12-37 |
| 22 | 40 | TL100NJ/63 | CA 7-43 | CEP 7-M45-45-10 | 14-45 |
| 30 | 55 | TL100NJ/100 | CA 7-72 | CEP 7-M85-85-10 | 26-85 |
| 37 | 66 | TL100NJ/100 | CA 7-72 | CEP 7-M85-85-10 | 26-85 |
| 45 | 80 | TL250NJ/160 | CA 6-105 | CEP 7-M85-85-10 | 26-85 |
| 55 | 100 | TL250NJ/160 | CA 6-105 | CEF 1-1 1/12 | 0.5-180 |
| 75 | 135 | TL250NJ/250 | CA 6-210-EI | CEF 1-11/12 | 0.5-180 |
| 90 | 160 | TL250NJ/250 | CA 6-210-EI | CEF 1-11/12 | 0.5-180 |
| 110 | 200 | TL250NJ/250 | CA 6-210-EI | CEF 1-41/42/52 | 160-630 |
| 132 | 230 | TL400NE/400 | CA 6-210-EI | CEF 1-41/42/52 | 160-630 |
| 160 | 270 | TL400NE/400 | CA 6-300-EI | CEF 1-41/42/52 | 160-630 |
| 200 | 361 | TL400NE/400 | CA 6-420-EI | CEF 1-41/42/52 | 160-630 |

Din-T circuit breakers with rotary isolator. DOL starting. 50 kA @ 400/415 V to AS 3947.4.1

| Motor size kW | Approx. amps @ 400/415 V | Sprecher + Schuh isolator | Terasaki circuit breaker | Sprecher + Schuh current limiter | Sprecher + Schuh contactor | Sprecher + Schuh thermal O/L relay | Thermal overload range |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 0.37 | 1.1 | LA 7-80 | Din-T 10/4 | - | CA 7-9 | CT 7-24 | 0.6-1.6 |
| 0.55 | 1.5 | LA 7-80 | Din-T $10 / 4$ | - | CA 7-9 | CT 7-24 | 1-1.6 |
| 0.75 | 1.8 | LA 7-80 | Din-T $10 / 4$ | - | CA 7-9 | CT 7-24 | 1.6-2.4 |
| 1.1 | 2.6 | LA 7-80 | Din-T 10/6 | - | CA 7-23 | CT 7-24 | 2.4-4 |
| 1.5 | 3.4 | LA 7-80 | Din-T 10/6 | - | CA 7-23 | CT 7-24 | 2.4-4 |
| 2.2 | 4.8 | LA 7-80 | Din-T 10 / 10 | KTL 3-65 | CA 7-23 | CT 7-24 | 4-6 |
| 3 | 6.5 | LA 7-80 | Din-T 10 / 16 | KTL 3-65 | CA 7-23 | CT 7-24 | 6-10 |
| 4 | 8.2 | LA 7-80 | Din-T 10 / 16 | KTL 3-65 | CA 7-23 | CT 7-24 | 6-10 |
| 5.5 | 11 | LA 7-80 | Din-T 10 / 20 | KTL 3-65 | CA 7-23 | CT 7-24 | 10-16 |
| 7.5 | 14 | LA 7-80 | Din-T 10 / 32 | KTL 3-65 | CA 7-30 | CT 7-45 | 10-16 |
| 11 | 21 | LA 7-80 | Din-T 10/40 | KTL 3-65 | CA 7-30 | CT 7-24 | 16-24 |
| 15 | 28 | LA 7-100 | Din-T 10 / 63 | KTL 3-65 | CA 7-37 | CT 7-45 | 18-30 |
| 18.5 | 34 | LA 7-100 | Din-T 10 / 63 | KTL 3-65 | CA 7-37 | CT 7-45 | 30-45 |

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


ACSCOfectorcay Tectiofen idas?
Auxiliary contact data

Built-in auxiliary contacts
CA 7-9... 23

Clip-on auxiliary contacts and accessories


|  |  | Built-in auxiliary contacts CA 7-9... 85 |  |  |  |  | Front moun |  |  | auxiliary contactsSide mount |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Switching DC loads |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| L/R<1 ms, resistive loads at: | [V] | 24 | 48 | 110 | 220 | 440 | 24 | 48 | 110 | 220 | 440 | 24 | 48 | 110 | 220 | 440 |
|  | [A] | 12 | 9 | 3.5 | 0.55 | 0.2 | 12 | 9 | 3.5 | 0.55 | 0.2 | 6 | 3.2 | 0.45 | 0.18 | 0.1 |
| LR<15 ms, inductive loads with |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| economy resistor in series at: | [V] | 24 | 48 | 110 | 220 | 440 | 24 | 48 | 110 | 220 | 440 | 24 | 48 | 110 | 220 | 440 |
|  | [A] | 9 | 5 | 2 | 0.4 | 0.16 | 9 | 5 | 2 | 0.4 | 0.16 | 2 | 1.6 | 0.3 | 0.12 | 0.05 |
| DC-13, switching electro |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| magnets at: | [V] | 24 | 48 | 110 | 220 | 440 | 24 | 48 | 110 | 220 | 440 | 24 | 48 | 110 | 220 | 440 |
|  | [A] | 5 | 2 | 0.7 | 0.25 | 0.12 | 5 | 2 | 0.7 | 0.25 | 0.12 | 3 | 1.5 | 0.6 | 0.3 | 0.2 |

Additional rating data - contactors to IEC 947
Contactor $\quad$ CA 7-9 CA 7-12 CA 7-16 CA 7-23 CA 7-30 CA 7-37 CA 7-43 CA 7-60 CA 7-72 CA 7-85
AC 1 resistive load
switching 3~
Ambient temperature $40^{\circ} \mathrm{C}$

| $\left.\rho_{\theta}\right)$ | $[\mathrm{A}]$ | 32 | 32 | 32 | 32 | 50 | 50 | 85 | 100 | 100 | 100 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| $230 / 240 \mathrm{~V}$ | $[\mathrm{~kW}]$ | 10 | 10 | 13 | 13 | 18 | 20 | 25 | 36 | 36 | 40 |
| $400 / 415 \mathrm{~V}$ | $[\mathrm{~kW}]$ | 18 | 18 | 23 | 23 | 32 | 36 | 45 | 64 | 64 | 71 |
| 690 V | $[\mathrm{~kW}]$ | 30 | 30 | 38 | 38 | 54 | 60 | 75 | 108 | 108 | 120 |
| Ambient temperature $60^{\circ} \mathrm{C}$ |  |  |  |  |  |  |  |  |  |  |  |
| $\left.I_{\theta}\right)$ | $[\mathrm{A}]$ | 32 | 32 | 32 | 32 | 45 | 45 | 63 | 100 | 100 | 100 |
| $230 / 240 \mathrm{~V}$ | $[\mathrm{~kW}]$ | 8 | 8 | 10 | 10 | 14 | 16 | 20 | 29 | 29 | 34 |
| $400 / 415 \mathrm{~V}$ | $[\mathrm{~kW}]$ | 14 | 14 | 17 | 17 | 26 | 28 | 36 | 51 | 51 | 61 |
| 690 V | $[\mathrm{~kW}]$ | 24 | 24 | 29 | 29 | 44 | 48 | 60 | 86 | 86 | 102 |

$A C$ motor switching
AC $2, A C 3, A C 4$

| $230 / 240 \mathrm{~V}$ | [A] | 11.5 | 14.5 | 20 | 26.5 | 34 | 37 | 42 | 62 | 70 | 85 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $400 / 415 \mathrm{~V}$ | [A] | 9 | 12 | 16 | 23 | 30 | 37 | 43 | 60 | 72 | 85 |
| 690 V | [A] | 5 | 7 | 9.3 | 12 | 17 | 20 | 25 | 34 | 42 | 49 |
| $230 / 240 \mathrm{~V}$ | [kW] | 3 | 4 | 5.5 | 7.5 | 10 | 11 | 13 | 18.5 | 22 | 25 |
| $400 / 415 \mathrm{~V}$ | [kW] | 4 | 5.5 | 7.5 | 11 | 15 | 18.5 | 22 | 30 | 37 | 45 |
| 690 V | [kW] | 4 | 5.5 | 7.5 | 10 | 15 | 18.5 | 22 | 30 | 37 | 45 |
| Rated making capacity |  |  |  |  |  |  |  |  |  |  |  |
| $l_{\theta} \mathrm{AC} 4,50 \mathrm{~Hz}$ | max. $690 \mathrm{~V}[\mathrm{~A}]$ | 135 | 180 | 240 | 345 | 450 | 555 | 645 | 900 | 1080 | 1275 |
| Rated breaking capacity |  |  |  |  |  |  |  |  |  |  |  |
| $l_{\theta}$ AC 4 | max. $460 \mathrm{~V}[\mathrm{~A}]$ | 135 | 180 | 240 | 345 | 450 | 555 | 645 | 900 | 1080 | 1275 |
|  | max. $690 \mathrm{~V}[\mathrm{~A}]$ | 75 | 105 | 140 | 140 | 255 | 300 | 375 | 510 | 630 | 735 |

Short circuit protection
without protection relay
fuse gG to IEC 947-4-1

| co-ordination type '1' [A] | 50 | 50 | 50 | 63 | 100 | 125 | 160 | 200 | 250 | 250 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| co-ordination type '2' [A] | 20 | 25 | 25 | 35 | 50 | 80 | 100 | 100 | 125 | 160 |
| Main current circuit |  |  |  |  |  |  |  |  |  |  |
| Power dissipated by all circuits at le AC 3 <br> Total power dissipation | 0.7 | 1.2 | 2.1 | 3.2 | 5.4 | 8.2 | 8.3 | 9.7 | 14 | 19.5 |
| at le AC 3 AC control [ w ] | 3.3 | 3.8 | 4.7 | 6.2 | 8.4 | 11.2 | 11.5 | 14.2 | 18.5 | - |
| DC control [ w ] | 6.7 | 7.2 | 8.1 | 12.4 | 14.6 | 17.4 | 18.4 | 14.6 | 18.9 | - |
| Life span in millions of operations |  |  |  |  |  |  |  |  |  |  |
| Mechanical AC control | 13 | 13 | 13 | 13 | 13 | 13 | 12 | 10 | 10 | 10 |
| DC control | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 10 | 10 | 10 |
| Operating times (DC) |  |  |  |  |  |  |  |  |  |  |
| Make (mS) | 40... 70 | 40... 70 | 40...70 | 40... 70 | 50... 80 | 50... 80 | 50... 80 | 20... 40 | 20... 40 | 20... 40 |
| Break (mS) | 7... 15 | 7... 15 | 7... 15 | 7... 15 | 7... 15 | 7... 15 | - | - | - | - |

Note: ${ }^{1}$ ) Contact NHP for recommended cable size.

## ACS combtorcciv

Dtmenstons

Dimensions in (mm)


## Mounting position



Contactor (AC control)

| Type | a | b | c | c1 | c2 | od | d1 | d2 $\left.\mathbf{d}^{\prime}\right)$ |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| CA $7-9 \ldots$ CA $\left.7-23^{2}\right)$ | 45 | 81 | 80.5 | 75.5 | 6 | 4.5 | 60 | 35 |
| CA $7-30 \ldots$ CA $7-37$ | 45 | 81 | 97.5 | 92.6 | 6.5 | 4.5 | 60 | 35 |
| CA $7-43$ | 54 | 81 | 100.5 | 95.6 | 6.5 | 4.5 | 60 | 45 |
| CA $7-60 \ldots$ CA $7-85$ | 72 | 122 | 117 | 111.5 | 8.5 | 5.4 | 100 | 55 |

(DC control)

| Type | a | b | c | c1 | c2 | dd | d1 | d2') |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| CA 7-9C...CA 7-16C | 45 | 81 | 106.5 | 101.5 | 6 | 4.5 | 60 | 35 |
| CA 7-23C | 45 | 81 | 123.5 | 119 | 6 | 4.5 | 60 | 35 |
| CA 7-30C...CA 7-37C | 45 | 81 | 141.5 | 136.5 | 6.5 | 4.5 | 60 | 35 |
| CA 7-43C | 54 | 81 | 144.5 | 140 | 6.5 | 4.5 | 60 | 45 |
| CA 7-60C...CA 7-85C | 72 | 122 | 117 | 111.5 | 8.5 | 5.4 | 100 | 55 |

## Accessories

| Contactor with |  | (AC control) <br> $(\mathbf{m m})$ | (DC control) <br> $(\mathbf{m m})$ |
| :--- | :--- | :--- | :--- |
| Front mounting auxiliary contact | 2 or 4 pole | $\mathrm{c} / \mathrm{c} 1+39$ | $\mathrm{c} / \mathrm{c} 1+39$ |
| Side mounting auxiliary contact | 1 or 2 pole | $\mathrm{a}+9$ | $\mathrm{a}+9$ |
| Pneumatic timing module |  | $\mathrm{c} / \mathrm{c} 1+58$ | - |
| Electronic timing module | coil mounting | $\mathrm{b}+24$ | $\mathrm{~b}+24$ |
| Mechanical interlock | mounts between contactors | $\mathrm{a}+9$ | $\mathrm{a}+9$ |
| Mechanical latch |  | $\mathrm{c} / \mathrm{c} 1+61$ | - |
| Interface | coil mounting | $\mathrm{b}+9$ | - |
| Suppressor | coil mounting | $\mathrm{b}+3$ | $\mathrm{~b}+3$ |
| With inscriptions ${ }^{3}$ ) | labels | +0 | +0 |
|  | label support system $\mathrm{V} 4 N 5$ | +5.5 | +5.5 |

Notes: ') DIN Rail mounting 35 mm to EN 50022.
${ }^{2}$ ) Dimensions for 4 pole contactors same as 3 pole with auxiliary.
${ }^{3}$ ) Dimensions with inscriptions.

Dimensions in (mm)
CEP 7, CEP 7s and CEP 7-B mounted on CA 7 contactors


Cat. No.

| Cat. No. | $\mathbf{c}$ | $\mathbf{c}$ |  |  |  |  |  |  |  |  |  |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| CA 7-9/12/16/23 with CEP 7 or CEP 7S | 45 | 131 | 86 | 88.5 | 16.5 | 69 | 60 | 35 | 86.5 | 2 | 4.2 |
| CA 7-9/12/16/23 with CEP 7-B | 54 | 137 | 97 | 90.7 | 5.1 | 59 | 60 | 35 | 85.1 | 2 | 4.2 |
| CA 7-30/37 with CEP 7 or CEP 7S | 45 | 136.5 | 91.5 | 92 | 16.5 | 69 | 60 | 35 | 104 | 2 | 4.2 |
| CA 7-30/37 with CEP 7-B | 54 | 137 | 97 | 92.1 | 5.2 | 59 | 60 | 35 | 104.7 | 2 | 4.2 |
| CA 7-43 with CEP 7, CEP 7S or CEP 7-B | 54 | 136.5 | 91.5 | 93 | 22 | 69 | 60 | 45 | 107 | 2 | 4.2 |
| CA 7-60/72/85 with CEP 7, CEP 7S or CEP 7-B | 72 | 188.5 | 120 | 120 | 18 | 84.5 | 100 | 55 | 125.5 | 2 | 5.5 |

CEP 7 with separate mounting bracket


| Type | a | b | c | d | e |
| :--- | :---: | :---: | :---: | :---: | :---: |
| CEP 7-37-P-A | 45 | 90 | 75 | 30 | 75 |
| CEP 7-45-P-A | 55 | 90 | 96.5 | 40 | 75 |
| CEP 7-85-P-A | 70 | 115 | 110 | 55 | 105 |



Contactor, timer and overload selection chart for star delta starters

| SDS kW | Line contactor | Delta contactor | Star contactor | Timer | Overioad |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 7.5 | CA 7-9-10 | CA 7-9-01 | CA 7-9-01 | RZ7 FSY2D | CEP 7-M32-12-10 |
| 11 | CA 7-12-10 | CA 7-12-01 | CA 7-9-01 | RZ7 FSY2D | CEP 7-M32-32-10 |
| 15 | CA 7-16-10 | CA 7-16-01 | CA 7-9-01 | RZ7 FSY2D | CEP 7-M32-32-10 |
| 18.5 | CA 7-23-10 | CA 7-23-01 | CA 7-12-01 | RZ7 FSY2D | CEP 7-M32-32-10 |
| 22 | CA 7-23-10 | CA 7-23-01 | CA 7-16-01 | RZ7 FSY2D | CEP 7-M32-32-10 |
| 30-37 | CA 7-37-00 | CA 7-37-00 | CA 7-23-01 | RZ7 FSY2D | CEP 7-M45-45-10 |
| 45 | CA 7-60-11 | CA 7-60-11 | CA 7-30-00 | RZ7 FSY2D | CEP 7-M85-85-10 |
| 55 | CA 7-60-11 | CA 7-60-11 | CA 7-37-00 | RZ7 FSY2D | CEP 7-M85-85-10 |
| 75 | CA 7-85-00 | CA 7-85-00 | CA 7-43-00 | RZ7 FSY2D | CEP 7-M85-85-10 |
| 90 | CA 6-85-11 | CA 6-85-11 | CA 7-60-00 | RZ7 FSY2D | CT 6-90 |
| 110 | CA 6-105-11 | CA 6-105-11 | CA 7-72-00 | RZ7 FSY2D | CT 6-110 |
| 132 | CA 6-140EI-11 | CA 6-140EI-11 | CA 7-85-00 | RZ7 FSY2D | CT 6-150 |
| 150 | CA 6-170EI-11 | CA 6-170EI-11 | CA 6-85-00 | RZ7 FSY2D | CTA 6-200 |
| 185 | CA 6-210EI-11 | CA 6-210EI-11 | CA 6-105-11 | RZ7 FSY2D | CEF 1-41 |
| 220 | CA 6-210-EI-11 | CA 6-210-El-11 | CA 6-140-El-11 | RZ7 FSY2D | CEF 1-41 |



Mounted on CA 7 contactors
$\rightarrow$

CT 7-24, CT 7-45, CT 7.75

| Type | For contactor | a | b | b1 | c | c1 | c2 | c3 | c4 | c5 | صd | d1 | d2 | e1 | e2 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| CT 7-24 | CA 7-9... 23 | 45 | 127 | 83 | 96 | 91 | 15 | 51 | 39 | 5 | 4.5 | 60 | $35{ }^{1}$ ) | 16.5 | 51 |
|  | CA 7-30... 37 | 45 | 127 | 83 | 105 | 99 | 6.5 | 51 | 39 | 9.5 | 4.5 | 60 | $35{ }^{\prime}$ ) | 16.5 | 51 |
| CT 7-45 | CA 7-30... 37 | 60 | 140 | 97 | 105 | 99 | 6.5 | 51 | 39 | 6.5 | 4.5 | 60 | $35{ }^{1}$ ) | 16.5 | 57 |
|  | CA 7-43 | 60 | 140 | 97 | 107 | 103 | 6.5 | 51 | 39 | 8.5 | 4.5 | 60 | $45^{1}$ ) | 16.5 | 57 |
| CT 7-75 | CA 7-60... 85 | 72 | 185 | 120 | 125 | 120 | 8.5 | 51 | 39 | 28.5 | 5.4 | 100 | $55^{\text {1 }}$ ) | 16.5 | 82 |

Separate mounting with bracket


## Separate mounting



| Type | a | b | b1 | c | c1 | c2 | c3 | od | d1 | d2 | e1 | e2 |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| CT 7-24 | 45 | 85 | 44 | 95 | 70.5 | 5 | 51 | 4.5 | $60 \ldots 74$ | $\left.35^{1}\right)$ | 16 | 3 |
| CT 7-75 | 60 | 90 | 44 | 117 | 112 | 15 | 51 | 5.4 | 74 | $\left.50^{1}\right)$ | 16 | 0 |
| CT 7-90 | 100 | 120 | - | 135 | - | 5 | 51 | $6.2^{2}$ | 74 | $\left.80^{1}\right)$ | 16 | 7 |

Notes: ') Standard DIN rail to EN 50 022-35.
${ }^{2}$ ) With reset rod, maintain 9 mm maximum operating radius from centre of reset button.
c3 Reset magnet.
c4 Auxiliary contact block.


Refer catalogue SACS


Cat. No. CT 7-24


Cat. No. CT 7-45


Cat. No. CT $7-75$


Cat. No. CT 7-100

## CT 7 thermal overload

Cat. No. CT 7-24-P-A


| Motor size kW | Approx. amps | Terasaki circuit breaker | NHP HRC fuse to BS88 | Sprecher + Schuh contactor type | Sprecher + Schuh thermal $0 / L$ relay type | Setting range amps |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 0.37 | 1.1 | XM30PB/1.4 | NTIA-6 | CA 7-9 | CT 7-24 | 1-1.6 |
| 0.55 | 1.5 | XM30PB/2 | NTIA-6 | CA 7-9 | CT 7-24 | 1-1.6 |
| 0.75 | 1.8 | XM30РB/2.6 | NTIA-10 | CA 7-9 | CT 7-24 | 1.6-2.4 |
| 1.1 | 2.6 | XM30PB/4.0 | NTIA-10 | CA 7-9 | CT 7-24 | 2.4-4 |
| 1.5 | 3.4 | XM30РB/5 | NTIA-10 | CA 7-9 | CT 7-24 | 2.4-4 |
| 2.2 | 4.8 | XM30PB/8 | NTIA-16 | CA 7-9 | CT 7-24 | 4-6 |
| 3.0 | 6.5 | XM30PB/10 | NTIA-16 | CA 7-9 | CT 7-24 | 6-10 |
| 4.0 | 8.2 | XM30PB/12 | NTIA-25 | CA 7-9 | CT 7-24 | 6-10 |
| 5.5 | 11 | XH125NJ/20 | NTIA-32 | CA 7-12 | CT 7-24 | 10-16 |
| 7.5 | 14 | XH125NJ/20 | NTIS-40 | CA 7-16 | CT 7-24 | 10-16 |
| 11 | 21 | XH125NJ/32 | NTIS-50 | CA 7-23 | CT 7-24 | 16-24 |
| 15 | 28 | XH125NJ/50 | NTIS-63 | CA 7-30 | CT 7-45 | 18-30 |
| 18.5 | 34 | XH125NJ/50 | NTCP-80 | CA 7-37 | CT 7-45 | 30-45 |
| 22 | 40 | XH125NJ/63 | NTCP-80 | CA 7-43 | CT 7-45 | 30-45 |
| 30 | 55 | XH125NJ/100 | NTCP-100 | CA 7-60 | CT 7-75 | 45-60 |
| 37 | 66 | XH125NJ/100 | NTF-160 | CA 7-72 | CT 7-75 | 60-75 |
| 45 | 80 | XH125NJ/125 ') | NTF-160 | CA 6-85 | CT 7-100 | 70-90 |
| 55 | 100 | XH125NJ/125 ') | NTF-200 | CA 6-105-EI | CT 6-110 | 85-110 |
| 75 | 130 | XH250NJ/250 | NTKF-250 | CA 6-140-El | CT 6-150 | 105-150 |
| 90 | 155 | XH250NJ/250 ') | NTKF-250 | CA 6-170-EI | CT 6-200 | 140-200 |
| 110 | 200 | XH250NJ/250 ') | NTKF-315 | CA 6-210-EI | CEF 1-41/42 | 160-400 |
| 132 | 225 | XH400NE/400 | NTMF-355 | CA 6-210-EI | CEF 1-41/42 | 160.400 |
| 150 | 250 | XH400NE/400 | NTMF-355 | CA 6-250-EI | CEF 1-41/42 | 160-400 |
| 160 | 270 | XH400NE/400 | NTMF-400 | CA 6-300-EI | CEF 1-41/42 | 160-400 |
| 185 | 310 | XH400NE/400 | NTTF-450 | CA 6-300-EI | CEF 1-41/42 | 160-400 |
| 200 | 361 | XH400NE/400 | NTTM-500 | CA 6-420-E//CA 5-450 | CEF 1-41/42 | 160-400 |
| 250 | 425 | XH630NE/630 | NTTM-630 | CA 6-420-EI/CA 5-450 | CEF 1-52 | 160-630 |
| 315 | 530 | XH630NE/630 | NTLM-710 | CA 5-550 | CEF 1-52 | 160-630 |

Notes: Fuses 65 kA . XH125NJ circuit breaker combinations limited to 50 kA , others 65 kA . Overloads may be changed to different types eg. thermal style to electronic.
Some combinations also gives Type ' 2 ' performance.
${ }^{1}$ ) Use 'magnetic only' breaker - Refer NHP.
$240 / 415 \mathrm{~V}$ rating suitable for use on 230/400 V in accordance with AS 60038: 2000

Refer Catalogue C-CO

## TemBreak circuit breakers DOL starting 50 kA @ 400/415 V to AS 3947.4.1

## TemBreak MCCBs

| Motor size kW | Approx. amps | Terasaki circuit breaker | Sprecher + Schuh contactor | Sprecher + Schuh overload relay | Setting range amps |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 0.37 | 1.1 | XM30PB/1.4 | CA 7-9 | CT 7-24-1.6 | 1-1.6 |
| 0.55 | 1.5 | XM30PB/2 | CA 7-9 | CT 7-24-1.6 | 1-1.6 |
| 0.75 | 1.8 | XM30PB/2.6 | CA 7-9 | CT 7-24-2.4 | 1.6-2.4 |
| 1.1 | 2.6 | XM30PB/4.0 | CA 7-16 | CT 7-24-4 | 2.4-4 |
| 1.5 | 3.4 | XM30PB/5 | CA 7-16 | CT 7-24-4 | 2.4-4 |
| 2.2 | 4.8 | XM30PB/8 | CA 7-16 | CT 7-24-6 | 4-6 |
| 3 | 6.5 | XM30PB/10 | CA 7-30 | CT 7-24-10 | 6-10 |
| 4 | 8.2 | XM30PB/12 | CA 7-30 | CT 7-24-10 | 6-10 |
| 5.5 | 11 | XH125NJ/20 | CA 7-30 | CT 7-24-16 | 10-16 |
| 7.5 | 14 | XH125NJ/20 | CA 7-30 | CT 7-24-16 | 10-16 |
| 11 | 21 | XH125NJ/32 | CA 7-30 | CT 7-24-24 | 16-24 |
| 15 | 28 | XH125NJ/50 | CA 7-43 | CT 7-45-30 | 18-30 |
| 18.5 | 34 | XH125NJ/50 | CA 7-43 | CT 7-45-45 | 30-45 |
| 22 | 40 | XH125NJ/63 | CA 7-43 | CT 7-45-45 | 30-45 |
| 30 | 55 | XH125NJ/100 | CA 6-85 | CT 7-75 ${ }^{2}$ ) | 45-60 |
| 37 | 66 | XH125NJ/100 | CA 6-85 | CT 7-75 ${ }^{2}$ ) | 60-75 |
| 45 | 80 | XH125NJ/125 | CA 6-105-EI | CT 6-90 | 70-90 |
| 55 | 100 | XH125NJ/125 ${ }^{\text {) }}$ | CA 6-105-EI | CT 6-110 | 85-110 |
| 75 | 130 | XH250NJ/250 | CA 6-140-EI | CT 6-150 | 105-150 |
| 90 | 155 | XH250NJ/250 | C A6-170-EI | CT 6-200 | 140-200 |
| 110 | 200 | XH250NJ/250 ) | CA 6-210-EI | CEF 1-41/42 | 160-400 |
| 132 | 225 | XS400SE/400 | CA 6-210-EI | CEF 1-41/42 | 160-400 |
| 150 | 250 | XS400SE/400 | CA 6-250-EI | CEF 1-41/42 | 160-400 |
| 160 | 270 | XS400SE/400 | CA 6-300-EI | CEF 1-41/42 | 160-400 |
| 200 | 361 | XS400SE/400 | CA 6-420-EI | CEF 1-41/42 | 160-400 |
| 200 | 361 | XS400SE/400 | CA 5-450 | CEF 1-22 ${ }^{2}$ ) | 160-400 |
| 250 | 425 | XS630SE/630 | CA 5-700 | CEF 1-52 ${ }^{2}$ ) | 160-630 |
| 320 | 538 | XS630SE/630 | CA 5-700 | CEF 1-52 ${ }^{2}$ ) | 160-630 |

Notes: Overloads may be thermal or electronic.
Combinations based on the overload tripping before the circuit breaker at overload currents up to the motor locked rotor current.
${ }^{1}$ ) Use 'magnetic only' breaker or next higher circuit breaker / contactor combination.
${ }^{2}$ ) Use with separate mounting bracket.
Data for 65 kA co-ordination available refer Cat. C-CO.
240/415 V rating suitable for use on 230/400 V in accordance with AS 60038: 2000

TemBreak circuit breakers DOL starting. 85 kA @ 400/415 V to AS 3947.4.1

| Motor size kW | Approx. FLC @ 400/415 V (A) | Terasaki circuit breaker | Sprecher + Schuh contactor | Sprecher + Schuh thermal $0 / L$ type | Setting range (A) |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 0.37 | 1.1 | XM30PB/1.4 | CA 7-9 | CEP 7-M32-2.9-10 | 1.0-2.9 |
| 0.55 | 1.5 | XM30PB/2.0 | CA 7-9 | CEP 7-M32-2.9-10 | 1.0-2.9 |
| 0.75 | 1.8 | XM30РB/2.6 | CA 7-9 | CEP 7-M32-2.9-10 | 1.0-2.9 |
| 1.1 | 2.6 | XM30PB/4 | CA 7-16 | CEP 7-M32-2.9-10 | 1.0-2.9 |
| 1.5 | 3.4 | XM30PB/5 | CA 7-16 | CEP 7-M32-5-10 | 1.6-5 |
| 2.2 | 4.8 | XM30PB/8 | CA 7-30 | CEP 7-M32-12-10 | 3.7-12 |
| 3 | 6.5 | XM30РB/8 | CA 7-30 | CEP 7-M32-12-10 | 3.7-12 |
| 4 | 8.2 | XM30PB/10 | CA 7-30 | CEP 7-M32-12-10 | 3.7-12 |
| 5.5 | 11 | TL100NJ/20 | CA 7-30 | CEP 7-M32-12-10 | 3.7-12 |
| 7.5 | 14 | TL100NJ/20 | CA 7-30 | CEP 7-M32-32-10 | 12-32 |
| 9 | 17 | TL100NJ/32 | CA 7-30 | CEP 7-M32-32-10 | 12-32 |
| 10 | 19 | TL100NJ/32 | CA 7-30 | CEP 7-M32-32-10 | 12-32 |
| 11 | 21 | TL100NJ/32 | CA 7-30 | CEP 7-M32-32-10 | 12-32 |
| 15 | 28 | TL100NJ/50 | CA 7-43 | CEP 7-M32-32-10 | 12-32 |
| 18.5 | 34 | TL100NJ/50 | CA 7-43 | CEP 7-M37-37-10 | 12-37 |
| 22 | 40 | TL100NJ/63 | CA 7-43 | CEP 7-M45-45-10 | 14-45 |
| 30 | 55 | TL100NJ/100 | CA 7-72 | CEP 7-M85-85-10 | 26-85 |
| 37 | 66 | TL100NJ/100 | CA 7-72 | CEP 7-M85-85-10 | 26-85 |
| 45 | 80 | TL250NJ/160 | CA 6-105 | CEP 7-M85-85-10 | 26-85 |
| 55 | 100 | TL250NJ/160 | CA 6-105 | CEF 1-11/12 | 0.5-180 |
| 75 | 135 | TL250NJ/250 | CA 6-210-EI | CEF 1-11/12 | 0.5-180 |
| 90 | 160 | TL250NJ/250 | CA 6-210-EI | CEF 1-11/12 | 0.5-180 |
| 110 | 200 | TL250NJ/250 | CA 6-210-EI | CEF 1-41/42/52 | 160-630 |
| 132 | 230 | TL400NE/400 | CA 6-210-EI | CEF 1-41/42/52 | 160-630 |
| 160 | 270 | TL400NE/400 | CA 6-300-EI | CEF 1-41/42/52 | 160-630 |
| 200 | 361 | TL400NE/400 | CA 6-420-EI | CEF 1-41/42/52 | 160-630 |

Din-T circuit breakers with rotary isolator. DOL starting.
50 kA @ 400/415 V to AS 3947.4.1

| Motor size kW | Approx. amps @ 400/415 V | Sprecher + Schuh isolator | Terasaki circuit breaker | Sprecher + Schuh current limiter | Sprecher + Schuh contactor | Sprecher + <br> Schuh <br> thermal <br> O/L relay | Thermal overload range |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 0.37 | 1.1 | LA 7-80 | Din-T 10 / 4 | - | CA 7-9 | CT 7-24 | 0.6-1.6 |
| 0.55 | 1.5 | LA 7-80 | Din-T $10 / 4$ | - | CA 7-9 | CT 7-24 | 1-1.6 |
| 0.75 | 1.8 | LA 7-80 | Din-T $10 / 4$ | - | CA 7-9 | CT 7-24 | 1.6-2.4 |
| 1.1 | 2.6 | LA 7-80 | Din-T 10 / 6 | - | CA 7-23 | CT 7-24 | 2.4-4 |
| 1.5 | 3.4 | LA 7-80 | Din-T 10 / 6 | - | CA 7-23 | CT 7-24 | 2.4-4 |
| 2.2 | 4.8 | LA 7-80 | Din-T 10 / 10 | KTL 3-65 | CA 7-23 | CT 7-24 | 4-6 |
| 3 | 6.5 | LA 7-80 | Din-T 10 / 16 | KTL 3-65 | CA 7-23 | CT 7-24 | 6-10 |
| 4 | 8.2 | LA 7-80 | Din-T 10 / 16 | KTL 3-65 | CA 7-23 | CT 7-24 | 6-10 |
| 5.5 | 11 | LA 7-80 | Din-T 10 / 20 | KTL 3-65 | CA 7-23 | CT 7-24 | 10-16 |
| 7.5 | 14 | LA 7-80 | Din-T 10 / 32 | KTL 3-65 | CA 7-30 | CT 7-45 | 10-16 |
| 11 | 21 | LA 7-80 | Din-T 10/40 | KTL 3-65 | CA 7-30 | CT 7-24 | 16-24 |
| 15 | 28 | LA 7-100 | Din-T 10 / 63 | KTL 3-65 | CA 7-37 | CT 7-45 | 18-30 |
| 18.5 | 34 | LA 7-100 | Din-T 10 / 63 | KTL 3-65 | CA 7-37 | CT 7-45 | 30-45 |

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

| Main current circuit |  |  | $\begin{aligned} & \text { CT 7-24 } \\ & \hline 690 \\ & \hline \end{aligned}$ | $\begin{aligned} & \text { Ст 7-45 } \\ & \hline 690 \\ & \hline \end{aligned}$ | $\begin{aligned} & \text { CT 7-75 } \\ & \hline 690 \\ & \hline \end{aligned}$ | $\begin{aligned} & \text { CT 7-100 } \\ & \hline 1000 \\ & \hline \end{aligned}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Rated in | ion voltage $U_{i}$ | （V） |  |  |  |  |
| Rated im | e withstand voltage $U_{\text {imp }}$ | ［V］ | 6000 | 6000 | 6000 | 8000 |
| Rated o | ing voltage $U_{e}$ | ［V］ | 690 | 690 | 690 | 1000 |
| Pollution |  |  | 111／3 | III／3 | 111／3 | III／3 |
| Isolation voltage between main current path <br> and control circuit to DIN，VDE 106， <br> $\begin{array}{llllll}\text { Part } 101 \text { and Part } 101 \text { A1 } & \text {［V］} & 440 & 440 & 440 & 440\end{array}$ |  |  |  |  |  |  |
| Current |  |  | 0．1．． 24 | 18．．． 45 | 18．．．60（75） | 70．．． 90 |
| Heat dissipation（for 3 phase） |  |  |  |  |  |  |
| lowe | ue of adjustment | ［W］ | 2.5 | 3 | 3 （7） | $<16$ |
| upp | ue of adjustment | ［W］ | 6 | 7.5 | 7.5 （10） | ＜28 |
| Connections |  |  | $\underset{\mathbb{N}}{\underset{\sim}{4}}$ | 界 | 胃 | 界 |
|  |  |  | M4 | M6 | M6 | M8 |
| Flexible E－ | with sleeve | ［ $\mathrm{mm}^{2}$ ］ | $2 \times(1 \ldots 4)$ | $\begin{aligned} & 1 \times 25 / \\ & 2 \times(1 \ldots 10) \end{aligned}$ | $\begin{aligned} & 1 \times 25 / \\ & 2 \times(1 \ldots 10) \end{aligned}$ | $\begin{aligned} & 50 \\ & 16 \end{aligned}$ |
| Strand <br> z－ | d core | ［ $\mathrm{mm}^{2}$ ］ | $2 \times(1 \ldots 6)$ | $2 \times(1 . .16)$ | $2 \times(1 . . .16)$ | 50 |
| Tighten | rque | ［ Nm ］ | 1.8 | 3.5 | 3.5 | 6 |
| Control circuit |  |  | CT 7－24 | CT 7－45 | CT 7－75 | CT 7－100 |
| Rated i | ion voltage $U_{i}$ | ［V］ | 500 | 500 | 500 | 500 |
| Rated i | e withstand voltage $U_{\text {imp }}$ | M | 6000 | 6000 | 6000 | 6000 |
| Rated o | ing voltage $U_{\theta}$ | M | 500 | 500 | 500 | 500 |
| Pollution |  |  | III／3 | III／3 | ［11／3 | III／3 |
| Rated operating current $/ \mathrm{e}$ |  |  | N／O／N／C | N／O／N／C | N／O／N／C | N／O／N／C |
| AC 15 | $220 . .240 \mathrm{~V}$ | ［A］ | 1．5／1．5 | 1．5／1．5 | 1．5／1．5 | 1．5／1．5 |
|  | $400 . . .415 \mathrm{~V}$ | ［A］ | 0．5／0．9 | 0．5／0．9 | 0．5／0．9 | 0．5／0．9 |
|  | 500 V | ［A］ | 0．510．8 | 0．5／0．8 | 0．5／0．8 | 0．5／0．8 |
| DC 13 | 24 V | ［A］ | 0．9／0．9 | 0．9／0．9 | 0．9／0．9 | 0．9／0．9 |
|  | 60 V | ［A］ | 0．75／0．75 | 0．75／0．75 | 0．75／0．75 | 0．75／0．75 |
|  | 110 V | ［A］ | 0．4／0．4 | 0．4／0．4 | 0．4／0．4 | 0．4／0．4 |
|  | 220 V | ［A］ | 0．2／0．2 | 0．2／0．2 | 0．2／0．2 | 0．2／0．2 |

Isolation voltage between main current path and control circuit to DIN，VDE 106，

| Part 101 and Part 101 A1 | （V） | 240 | 240 | 240 | 240 |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Conventional thermal current | ［A］ | 6 | 6 | 6 | 6 |
| Short circuit protection fuse | gL［A］ | 6 | 6 | 6 | 6 |
| Connections |  | 点 | 哭 | 第 | 第 |
|  |  | M3．5 | M3．5 | M3．5 | M3．5 |
| Flexible wire with sleeve －－ | ［ $\mathrm{mm}^{2}$ ］ | $2 \times(0.75 \ldots 2.5)$ | $2 \times(0.75 \ldots .2 .5)$ | $2 \times(0.75 \ldots 2.5)$ | $2 \times(0.75 \ldots 2.5)$ |
| Stranded／solid core $\ddagger \cdot \boldsymbol{f}$ | ［ $\mathrm{mm}^{2}$ ］ | $2 \times(0.75 \ldots 4)$ | $2 \times(0.75 \ldots 4)$ | $2 \times(0.75 \ldots 4)$ | $2 \times(0.75 \ldots 4)$ |
| Tightening torque | ［ Nm ］ | 1.2 | 1.2 | 1.2 | 1.2 |



Contactor, timer and overload selection chart for star delta starters

| SDS kW | Line <br> contactor | Delta <br> contactor | Star <br> Contactor | Timer | Overload |
| :--- | :--- | :--- | :--- | :--- | :--- |
| 7.5 | CA 7-9-10 | CA 7-9-01 | CA 7-9-01 | RZ7 FSY2D | CEP 7-M32-12-10 |
| $\mathbf{1 1}$ | CA 7-12-10 | CA 7-12-01 | CA 7-9-01 | RZ7 FSY2D | CEP 7-M32-32-10 |
| $\mathbf{1 5}$ | CA 7-16-10 | CA 7-16-01 | CA 7-9-01 | RZ7 FSY2D | CEP 7-M32-32-10 |
| $\mathbf{1 8 . 5}$ | CA 7-23-10 | CA 7-23-01 | CA 7-12-01 | RZ7 FSY2D | CEP 7-M32-32-10 |
| 22 | CA 7-23-10 | CA 7-23-01 | CA 7-16-01 | RZ7 FSY2D | CEP 7-M32-32-10 |
| $30-37$ | CA 7-37-00 | CA 7-37-00 | CA 7-23-01 | RZ7 FSY2D | CEP 7-M45-45-10 |
| 45 | CA 7-60-11 | CA 7-60-11 | CA 7-30-00 | RZ7 FSY2D | CEP 7-M85-85-10 |
| 55 | CA 7-60-11 | CA 7-60-11 | CA 7-37-00 | RZ7 FSY2D | CEP 7-M85-85-10 |
| 75 | CA 7-85-00 | CA 7-85-00 | CA 7-43-00 | RZ7 FSY2D | CEP 7-M85-85-10 |
| 90 | CA 6-85-11 | CA 6-85-11 | CA 7-60-00 | RZ7 FSY2D | CT 6-90 |
| 110 | CA 6-105-11 | CA 6-105-11 | CA 7-72-00 | RZ7 FSY2D | CT 6-110 |
| 132 | CA 6-140EI-11 | CA 6-140EI-11 | CA 7-85-00 | RZ7 FSY2D | CT 6-150 |
| 150 | CA 6-170EI-11 | CA 6-170EI-11 | CA 6-85-00 | RZ7 FSY2D | CTA 6-200 |
| 185 | CA 6-210EI-11 | CA 6-210EI-11 | CA 6-105-11 | RZ7 FSY2D | CEF 1-41 |
| 220 | CA 6-210-EI-11 | CA 6-210-El-11 | CA 6-140-EI-11 | RZ7 FSY2D | CEF 1-41 |

## Acs chenmelloverloads Gur 7 Dhenstons withend withoucontactors

Mounted on CA 7 contactors


CT 7-24, CT 7-45, CT $7-75$

| Type | For contactor | a | b | b1 | c | c1 | c2 | c3 | c4 | c5 | のd | d1 | d2 | e1 | e2 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| CT 7-24 | CA 7-9... 23 | 45 | 127 | 83 | 96 | 91 | 15 | 51 | 39 | 5 | 4.5 | 60 | $\left.35^{1}\right)$ | 16.5 | 51 |
|  | CA 7-30... 37 | 45 | 127 | 83 | 105 | 99 | 6.5 | 51 | 39 | 9.5 | 4.5 | 60 | $\left.35^{1}\right)$ | 16.5 | 51 |
| CT 7-45 | CA 7-30... 37 | 60 | 140 | 97 | 105 | 99 | 6.5 | 51 | 39 | 6.5 | 4.5 | 60 | $35^{1}$ ) | 16.5 | 57 |
|  | CA 7-43 | 60 | 140 | 97 | 107 | 103 | 6.5 | 51 | 39 | 8.5 | 4.5 | 60 | $45^{1}$ ) | 16.5 | 57 |
| CT 7-75 | CA 7-60... 85 | 72 | 185 | 120 | 125 | 120 | 8.5 | 51 | 39 | 28.5 | 5.4 | 100 | $55^{1}$ ) | 16.5 | 82 |

Separate mounting with bracket


Separate mounting


| Type | a | b | b1 | c | c1 | c2 | c3 | ød | d1 | d2 | e1 | e2 |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| CT 7-24 | 45 | 85 | 44 | 95 | 70.5 | 5 | 51 | 4.5 | $60 \ldots 74$ | $\left.35^{\prime}\right)$ | 16 | 3 |
| CT 7-75 | 60 | 90 | 44 | 117 | 112 | 15 | 51 | 5.4 | 74 | $\left.50^{\prime}\right)$ | 16 | 0 |
| CT $7-90$ | 100 | 120 | - | 135 | - | 5 | 51 | 6.2 | 74 | $\left.80^{\prime}\right)$ | 16 | 7 |

Notes: ${ }^{1}$ ) Standard DIN rail to EN 50 022-35.
${ }^{2}$ ) With reset rod, maintain 9 mm maximum operating radius from centre of reset button.
c3 Reset magnet.
c4 Auxiliary contact block.


CT 7-24..., CT 7-45..., CT 7-75...


CT 7-100-90


Single phase 1 pole switching

(M)

Single phase 2 pole switching


Three phase 3 pole switching

## CONTROL RELAY \& PHASE FAILURE RELAY

## 1. IDEC CONTROL RELAY TECHNICAL DETAILS

2. PHASE FAILURE RELAY TECHNICAL DETAILS

## RH Series Compact Power Relays



1. ©Caries no Ul recognition mark.
2. PCB terminal relays are designed to mount directly to a cirevit board without any socket.

Ordering Information
When ordering, specify the Part No. and coil voltage code:
(example) RH3B-U AC120V
Pari'No. $\quad$ Coil Voltage Code

Sockets (for Blade Terminal Models)


Hold Down Springs \& Clips

| Appearance | Description | Relay | For DIN Mount Socket | For Through Paniel \& PCB Mount Sockst | Miñ Order Oty | Must use horseshoe clip when mounting in DIN mount socket. Replacement horseshoe clip part number is Y778-011. <br> 3. Two required per relay. |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Pullover Wire Spring | RH1B | SY2S-02F1 ${ }^{2}$ | SY4S-51F1 | 10 |  |
|  |  | RH2B | SY4S-02F1 ${ }^{2}$ |  |  |  |
|  |  | RH3B | SH3B-05F1 ${ }^{2}$ |  |  |  |
|  |  | RH4B | SH4B-02F-1 ${ }^{\text {2 }}$ |  |  |  |
|  | Leaf Spring (side latch) | RH1B, RH2B, RH3B, RH4B | SFA-202 ${ }^{3}$ | SFA-302 ${ }^{3}$ |  |  |
|  | Leaf Spring (top latch) | RH1B, RH2B, RH3B, RH4B | SFA-101 ${ }^{3}$ | SFA-301 ${ }^{3}$ |  |  |

AC Coil Ratings

| Voltage (V) | Ratad Current (miA) $\pm 95 \%$ at $20^{\circ} \mathrm{C}$ |  |  |  |  |  |  |  | Coil Resistance ( N ) $\pm 10 \%$ at $20^{\circ} \mathrm{C}$ |  |  |  | Operation Characteristics (against rated values at $20^{\circ} \mathrm{C}$ ) |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | AC 50Hz |  |  |  | AC 60Hz |  |  |  |  |  |  |  |  |  |  |
|  | SPDT | DPḊT | 3PDT | 4PD̄T | SPDT | DPDT | 3PDT | 4PDT | STPDT | 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\% | 80\% maximum | $30 \%$ <br> minimum |
| 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) | Rattod Curient ( mA ) $\pm 15 \%$ at $20^{\circ} \mathrm{C}$ |  |  |  | Coil Resistance ( 0 ) $\pm 10 \%$ at $20^{\circ} \mathrm{C}$ |  |  |  | Operation Characteristics (against rated values at $20^{\circ} \mathrm{C}$ ) |  |  | Standard coil voltages are in BOLD. |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | SPDT | DPDT | 3PDT | 4PDT | SPDT | DPDT | 3PDT | 4PDT | Max. Continuous Applied Vottage | Pickup Voltage | Dropout Voltage |  |
| 6 | 128 | 150 | 240 | 250 | 47 | 40 | 25 | 24 | 110\% | $\begin{gathered} 80 \% \\ \text { maximum } \end{gathered}$ | $\begin{aligned} & 10 \% \\ & \text { minimum } \end{aligned}$ |  |
| 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 |  |  |  |  |

## Contact Ratings



| Maximum Contact Capacity |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Model | Contunuous Current | Allowable Contact Power |  | Rated Load |  |  |
|  |  | Resistive Load | Inductive Load | Voltage (V) | Res. <br> Load | $\begin{aligned} & \text { Ind. } \\ & \text { Load } \end{aligned}$ |
| SPDT | 10A | $\begin{aligned} & \text { 1540VA } \\ & \text { 300W } \end{aligned}$ | $\begin{aligned} & \text { 990VA } \\ & 210 \mathrm{~W} \end{aligned}$ | 110 AC | 10A | 7 A |
|  |  |  |  | 220 AC | 7A | 4.5 A |
|  |  |  |  | 30 DC | 10A | 7 A |
| DPDT 3PDT 4PDT | 10A | 1650VA 300W | $\begin{aligned} & \text { 1100VA } \\ & 225 W \end{aligned}$ | 110 AC | 10A | 7.5A |
|  |  |  |  | 220 AC | 7.5A | 5 A |
|  |  |  |  | 30 DC | 10A | 7.5A |

Note: Inductive load for the rated load $-\cos \theta=0.3, L / R=7 \mathrm{~ms}$

## TÜV Ratings

| Voltage | RH1 | RH2 | RH3 | RH4 |
| :---: | :---: | :---: | :---: | :---: |
| 240 V AC | 10 A | 10 A | 7.5 A | 7.5 A |
| $30 \mathrm{~V} D \mathrm{C}$ | 10 A | 10 A | 10 A | 10 A |

## UL Ratings

| Voltage | Resistive |  |  | General Use |  |  | Horse Power Rating |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\begin{aligned} & \mathrm{RH} 1 \\ & \mathrm{R} 4 \end{aligned}$ | RH3 | RH4 | $\begin{aligned} & \hline \mathrm{RH} 1 \\ & \mathrm{RH} 2 \end{aligned}$ | RH3 | RH4 | $\begin{aligned} & \text { RH1 } \\ & \text { RH2 } \end{aligned}$ | RH3 | RH4 |
| 240 V AC | 10A | 7.5A | 7.5A | 7 A | 6.5A | 5A | 1/3 HP | 1/3 HP | - |
| 120 VAC | - | 10A | $\xrightarrow{10 A}$ | - | 7.5A | 7.5A | 1/6 HP | 1/6HP |  |
| 30 V DC | 10A | 10A | - | 7 A | - | - | - | - | - |
| 28 V DC | - | - | 10A | - | - | - | - | - | - |

## CSA Ratings

| Voltage | Resistive |  |  |  | Ceneral Use |  |  |  | Horse <br> Power <br> Rating <br> RH1, 2,3 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | RH1 | RH2 | RH3 | RH4 | RH1 | RH2 | RH3 | RH4 |  |
| 240 VAC | 10A | 10A | - | 7.5A | 7 A | 7A | 7A | 5 A | 1/3 HP |
| 120 V AC | 10A | 10A | 10A. | 10A | 7.5A | 7.5A | - | 7.5A | 1/6 HP |
| 30 VCC | 10A | 10A | 10A | 10A | 7A | 7.5A | - | - | - |

Socket Specifications

|  | Sockets | Terminal | Eectrical Rating | Wire Size | Torgue |
| :---: | :---: | :---: | :---: | :---: | :---: |
| DIN Reil <br> Mount <br> Sockets | SH1B-05 | (Coil) M3 screws (contact) M3.5 screws with captive wire clamp | 250V, 10A | Maximum up to 2-712AWG | $\begin{aligned} & 5.5-9 \mathrm{in} \bullet \mathrm{lbs} \\ & 9.11 .5 \mathrm{in} \bullet \mathrm{lbs} \end{aligned}$ |
|  | $\begin{aligned} & \text { SH2B-05 } \\ & \text { SH3B-05 } \\ & \text { SH4B-05 } \end{aligned}$ | M3.5 screws with captive wire clamp | 300V. 10A | Maximum up to 2-\#12AWG | $9 \cdot 11.5 \mathrm{in} \bullet \mathrm{lbs}$ |
| Finger-safe DIN Rail Mount | SH1B-05C | (coil) M3 screws <br> (contact) M3.5 screws with captive wire clamp, fingersafe | 250V, 10A | . Maximum up to 2-\$12AWG | $\begin{aligned} & 5.5-9 \mathrm{in} \bullet \mathrm{lbs} \\ & 9-11.5 \mathrm{in} \bullet \mathrm{lbs} \\ & \hline \end{aligned}$ |
|  | $\begin{aligned} & \text { SH2B-05C } \\ & \text { SH3B-05C } \\ & \text { SH4B-05C } \end{aligned}$ | M3.5 screws with captive wire clamp, fingersafe | 300V, 10A | Maximum up to 2-\$12AWG | 9-11.5 in•lbs |
| Through <br> Panel <br> Mount <br> Socket | SH1B-51 SH2B-51 SH3B-51 SH4B-51 | Solder | 300V. 10A |  | - - |
|  | SH1B-62 | PCB mount | 250V, 10A | - | - |
| PCB Mount <br> [Socket | SH2B-62 SH3B-62 SH4B-62 | PCB mount | 300V, 10A | - | - |

Accessories

| Description | Appeàrance, | Use with | Part No. | Remarks |
| :---: | :---: | :---: | :---: | :---: |
| Aluminum DIN Rail (1 meter length) |  | All DIN rail sockets | BNDN1000 | IDEC offers a low-profile DIN rail (BNDN1000). The BNDN1000 is designed to accommodate DIN mount sockets. Made of durable extuded aluminum, tha BNDN1000 measures 0.413 ( 10.5 mm ) in height and 1.37 $(35 \mathrm{~mm})$ in width (DIN standard). Standard length is $39^{\prime \prime}(1,000 \mathrm{~mm})$. |
| DIN Rail End Stop |  | DIN rail | BNL5 | 9.1 mm wide. |
| Replacement Hold-Down Spring Anchor | $88$ | DIN mount sockets and hold down springs. | Y778-011 | For use on DIN rail mount socket when using pullover wire hold down spring. 2 pieces included with each socket |

Specifications

| Contact Material |  | Silver cadmium oxide |
| :---: | :---: | :---: |
| Contact Resistance ${ }^{\text {1 }}$ |  | $50 \mathrm{~m} \Omega$ maximum |
| Minimum Applicable Load |  | 24 V DC, $30 \mathrm{~mA}: 5 \mathrm{DC}$ D, 100 mA (reference value) |
| Operate Time ${ }^{2}$ | SPDT <br> DPDT | 20ms maximum |
|  | $\begin{array}{\|l\|} \hline \text { 3PDT } \\ \text { 4PDT } \end{array}$ | 25ms maximum |
| Release Time ${ }^{2}$ | SPDT <br> DPDT | 20ms maximum |
|  | $\begin{aligned} & \text { 3PDT } \\ & \text { 4PDT } \end{aligned}$ | 25ms maximum |
| Power Consumption (approx.) | SPDT | $\mathrm{AC}: 1.1 \mathrm{VA}(50 \mathrm{~Hz}), 1 \mathrm{VA}(60 \mathrm{~Hz}) \quad \mathrm{DC}: 0.8 \mathrm{~W}$ |
|  | DPDT | $\mathrm{AC}: 1.4 \mathrm{VA}(50 \mathrm{~Hz}), 1.2 \mathrm{VA}(60 \mathrm{~Hz}) \quad \mathrm{DC}: 0.9 \mathrm{~W}$ |
|  | 3PDT | AC: $2 \mathrm{VA}(50 \mathrm{~Hz} 2) .1 .7 \mathrm{VA}(60 \mathrm{~Hz}) \quad$ DC: 1.5 W |
|  | 4PDT | AC: $2.5 \mathrm{VA}(50 \mathrm{~Hz})$, 2VA (60Hz) DC: 1.5 W |
| Insulation Resistance |  | 100M $\cap$ minimum ( 500 V DC megger) |
| Dielectric Strength ${ }^{\mathbf{3}}$ | SPDT | Between live and dead parts: $2,000 \mathrm{VAC}, 1$ minute <br> Between contact and coil: $2,000 \mathrm{~V} \mathrm{AC}, 1$ minute <br> Between contacts of the same pole: $1,000 \mathrm{~V} \mathrm{AC}, 1$ minute |
|  | $\begin{aligned} & \text { DPDT } \\ & \text { 3PDT } \\ & \text { 4PDT } \end{aligned}$ | Between live and dead parts: $2,000 \mathrm{VAC}, 1$ minute <br> Between contact and coil: $2,000 \mathrm{~V}$ AC, 1 minute <br> Between contacts of different poles: $2,000 \mathrm{VAC}, 1$ minute  <br> Between contacts of the same pole: $1,000 \mathrm{~V}$ AC, 1 minute  |
| Dperating Fraquency |  | Electrical: 1,800 operations/hour maximum <br> Mechanical: 18,000 operations/hour maximum |
| Vibration Resistance |  | Damage limits: 10 to 55 Hz , amplitude 0.5 mm <br> Operating extremes: 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: $200 \mathrm{~m} / \mathrm{s}^{2}(20 \mathrm{G}-\mathrm{SPDT}, \mathrm{DPOT})$  <br>  $10 \mathrm{~m} / \mathrm{s}^{2}(10 \mathrm{G} ~-3 P D T, 4 P D T)$ |
| 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) |
|  | $\begin{aligned} & \hline \text { DPDT } \\ & \text { 3PDT } \\ & \text { 4PDT } \\ & \hline \end{aligned}$ | -25 to $+40^{\circ} \mathrm{C}$ (no freezing) |
| Dperating Humidity |  | 45 to 85\% RH (no condensation) |
| Weight (approx.) |  | SPDT: 24g. DPDT: 37g, 3PDT: 50g. 4PDT: 74g |

1. Measured using 5V DC, 1 A voltage drop method
2. Measured at the rated voltage (at $20^{\circ} \mathrm{C}$ ). excluding contact bouncing

Release time of relays with diode: 40 ms maximum
3. Relays with indicator or diode: 1000 V AC, 1 minute
4. For use under different temperature conditions, refer to Continuous Load Current vs. Operating Temperature Curve. The operating temperature range of relays with indicator or diode is -25 to $+40^{\circ} \mathrm{C}$.

## Characteristics (Reference Data)



## DC Load





## Maximum Switching Capacity



Continuous Load Current vs. Operating Temperature Curve (Basic Type, With Check Button, and Top Bracket Mounting Type)


Internal Connection (View from Bottom) Basic Type


Contacts can be operated by pressing the check button.

With Indicator (-L type)

|  | SPDT | 3PDT | 4PDT |  | DPDT |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Below 100V $A C / D C$ |  |  | $\xrightarrow{\frac{1}{5} \triangle 1}$ | $\begin{aligned} & \text { Below } \\ & 24 \mathrm{~V} \\ & \mathrm{AC} / D \mathrm{C} \end{aligned}$ |  | When the relay is energized. the indicator goes on. <br> - Relay coils less than 100 V DC do not contain a protection diode (except DPDT). <br> - Relay coils below 100 V use LED indicator, coils above 100 V use neon lamp indicator. |
| 100 V AC/DC and over |  |  |  | 24 V AC/DC and ove |  |  |

With Diode (-D type)

| SPDT | DPDT |
| :---: | :---: |

RH Series
Relays \& Sockets

With Indicator LED \& Diode (-LD type)


RH1B-U/RH1B-UL/RH1B-UD/RH1B-ULD
RH2B-U/RH2B-UL/RH2B-UD/RH2B-ULD
RH3B-U/RH3B-UL/RH3B-D/RH3B-LD


RH1B-UT
RH2B-UT


RH3B-UT
RH4B-UT


Dimensions con't (mm)

RH1V2-U/RH1V2-UD


RH2V2-U/RH2V2-UL/RH2V2-UD


RH4V2-U/RH4V2-UL/RH4V2-UD


## SH2B-05



Standard DIN Rail Mount Sockets

## SH1B-05



## SH3B-05



SH4B-05


## Dimensions con't (mm)

## $\stackrel{n}{5}$ Finger-safe DIN Rail Mount Sockets SH1B-05C

SH2B-05C


## SH3B-05C

SH4B-05C


Through Panel Mount Socket
SH1B-51
SH2B-51


SH3B-51


SH4B-51


## Dimensions con't (mm)

PCB Mount Sockets SH1B-62


SH3B-62


SH4B-62




## Operating Instructions

Driving Circuit for Relays

1. To ensure correct relay operation, apply rated voltage to the relay coil.
2. Input voltage for the DC coil:
A complete 0C voltage is best for the coil power to make sure of stable relay
operation. When using a power supply containing a ripple voltage. suppress
the ripple factor within $5 \%$. When power is supplied through a rectification
circuit, the relay operating characteristics, such as pickup voltage and dropout
voltage, depend on the ripple factor. Connect a smoothing capacitor for better
operating characteristics as shown below.

3. Leakage current while relay is off: When driving an element at the same time as the relay operation, special consideration is needed for the circuit design. As shown in the incorrect circuit below, leakage current (lo) flows through the relay coil while the relay is off. Leakage current causes coil release failure or adversely affects the vibration resistance and shock resistance. Design a circuit as shown in the correct example.

4. Surge suppression for transistor driving circuits:

When the relay coil is turned off, a high-voltage pulse is generated, causing a transistor to deteriorate and sometimes to break. Be sure to connect a diode to suppress the back electromotive force. Then, the coil release time becomes slightly longer. To shorten the coil release time, connect a Zener diode between the collector and emitter of the transistor. Select a Zener diode with a Zener voltage slightly higher than the power voltage.


## Protection for Relay Contacts

1. The contact ratings show maximum values. Make sure that these values are not exceeded. When an inrush current flows through the load, the contact may become welded. If this is the case, connect a contact protection circuit, such as a current limiting resistor.
2. Contact protection circuit:

When switching an inductive load, arcing causes carbides to form on the contacts, resulting in increased contact resistance. In consideration of contact reliability, contact life, and noise suppression, use of a surge absorbing circuit is recommended. Note that the release time of the load becomes slightiy longer. Check the operation using the actual load. Incorrect use of a contact protection circuit will adversely affect switching characteristics. Four typical examples of contact protection circuits are shown in the following table:

| ! |  | This protection circuit can be used when the load impedance is smaller than the RC impedance in an AC load power circuit. <br> - R: Resistor of approximately the same resistance value as the load <br> - C:0. 1 to $1 \mu \mathrm{~F}$ |
| :---: | :---: | :---: |
|  | $\Gamma^{-a}$ | This protection circuit can be used for both AC and DC load power circuits. <br> R: Resistor of approximately the same resistance value as the load <br> C: 0.1 to $1 \mu \mathrm{~F}$ |
|  |  | This protection circuit can be used for DC load power circuits. Use a diode with the following ratings. Reverse withstand voltage: Power voltage of the load circuit x 10 <br> Forward current: More than the load current |
| 衰 |  | This protection circuit can be used for both $A C$ and DC load power circuits. <br> For a best result, when using a power voltage of 24 to 48 V AC/DC. connect a varistor across the load. When using a power voltage of 100 to 240 V AC/DC, connect a varistor across the contacts. |

3. Do not use a contact protection circuit as shown below:

|  | This protection circuit is very effective in arc suppression when opening the contacts. But, the capacitor is charged while the contacts are opened. When the contacts are closed, the capacitor is discharged through the contacts, increasing the possibility of contact welding. |
| :---: | :---: |
|  | This protection circuit is very effective in arc suppression when opening the contacts. But, when the contacts are closed, a current flows to charge the capacitor, causing contact welding. |

Generally, switching a $D C$ inductive load is more difficult than switching a $D C$ resistive load. Using an appropriate arc suppressor, however, will improve the switching characteristics of a DC inductive load.

## Soldering

1. When soldering the relay terminals, use a soldering iron of 30 to 60 W , and quickly complete soldering (within approximately 3 seconds).
2. Use a non-corrosive rosin flux.

## Operating Instructions con't

## Other Precautions

1. General notice

To maintain the initial characteristics, do not drop or shock the relay.
The relay cover cannot be removed from the base during normal operation. To maintain the initial characteristics, do not remove the relay cover

Use the relay in environments free from condensation, dust, sulfur dioxide $\left(\mathrm{SO}_{2}\right)$, and hydrogen sulfide $\left(\mathrm{H}_{2} \mathrm{~S}\right)$.

Make sure that the coil voltage does not exceed applicable coil voltage range.
2. UL and CSA ratings may differ from product rated values determined by IDEC.
3. Do not use relays in the vicinity of strong magnetic field, as this may affect relay operation.

## Safety Precautions

- Turn off the power to the relay before starting installation, removal, wiring, maintenance, and inspection of the relays. Failure to turn power off may cause electrical shock or fire hazard.
- Observe specifications and rated values, otherwise electrical shock or fire hazard may be caused.
- Use wires of the proper size to meet voltage and current requirements. Tighten the terminal screws on the relay socket to the proper tightening torque.
- Surge absorbing elements on AC relays with RC or DC relays with diode are provided to absorb the back electromotive force generated by the coil. When the relay is subject to an excessive external surge voltage, the surge absorbing element may be damaged. Add another surge absorbing provision to the relay to prevent damage.


## Precautions for the RU Relays

- Before operating the latching lever of the RU relay, turn off the power to the RU relay. After checking the circuit, return the latching lever to the original position.
- Do not use the latching lever as a switch. The durability of the latching lever is a minimum of 100 operations.
- When using DC loads on 4PDT relays, apply a positive voltage to terminals of neighboring poles and a negative voltage to the other terminals of neighboring poles to prevent the possibility of short circuits.
- DC relays with a diode have a polarity in the coil terminals. Apply the DC voltage to the correct terminals.



## Features

Three-phase, three or four-wire
Adjustable set point
Adjustable time delay
Internal differential
LED trip indication
Double-pole relay contacts
Automatic reset

## Benefits

Monitoring of correct phase rotation Protects against phantom or regenerated phase voltage
Protection against phase loss, reversal or sequence
Under-voltage and unbalanced voltage monitoring
Prevents reverse rotation of motor driven equipment
Ensures correct engine rotation
Protects portable electrical equipment
Nuisance tripping avoidance

## Applications

Marine panels
Switchgear
Distribution systems
Generator sets
Control panels
Process control
Motor protection
Transformers
Overload protection

## 250 Series DIN-rail and Wall Mounted Relays

## Phase Balance

The 250 series phase balance protector module provides continuous surveillance of a three-phase, three- or four-wire system and monitors the correct phase rotation or sequence of three-phase supply systems. The module protects against phase loss, reversal or sequence, phase unbalance and system under-voltage.

## Operation

Rotating machines are particularly vulnerable to incorrect phase sequence. Threephase motors can rotate in the wrong direction, potentially leading to physical damage or the risk of injury to personnel, yet voltage and current readings may appear normal. If one phase is lost because of a blown fuse, electric motors can continue to operate (single-phasing) which can result in severe electrical or mechanical damage. This relay has the added advantage that it will detect the phantom or regenerated phase that can be caused by a single-phase failure on some equipment or when running motors at low load levels.

An unbalanced supply voltage can lead to temperature rises in motors. An unbalanced voltage as little as $10 \%$ can increase operating temperature to $150 \%$ of normal. For permanent installations, this relay should be used to monitor the incoming supply, protecting all equipment against incorrect connection at initial installation or after maintenance work. Rotating machines that cannot tolerate reverse rotation or pose significant risk to personnel under this condition should be individually protected with this relay. The possibility of incorrect supply connection is much more likely in portable equipment or marine applications.

The protector continuously monitors the three-phase supply. With the correct phase sequence applied and all three voltages balanced within the required limits the front panel LED will illuminate and the output relay will be energised. An incorrect sequence, missing phase, out of balance or under-voltage condition will de-energise the relay and the LED will be extinguished.

The set point control allows adjustment of the voltage matching between $5 \%$ and $15 \%$. The time delay function operates only for the voltage unbalance condition. The delay can be used to prevent nuisance tripping due to short term unbalance situations. Incorrect phase rotation, a missing phase or an under-voltage condition trip the relay immediately.

## Product Codes

| Belay | Protection | ANSInO | Catmos |
| :---: | :---: | :---: | :---: |
| 3-phase 3-or 4-wire | Phase loss and unbalance 5-15\% | $!47$ | 252-PSF |
| 3-phase 3-or 4-wire | Phase loss, unbalance and under-voltage 5-15\% | 47/27 | 252-PSG |

Please specify system voltage, frequency and required options at time of ordering.

## Specification - Phase Balance

Nominal voltage

System frequency
Voltage burden
Overload

Set point repeatability Under-voltage set point

Trip level adjustment
Time delay
Auxiliary voltage burden
Output relay
Relay contact rating
Relay mechanical life
Relay reset
Operating temperature
Storage temperature
$110 \mathrm{~V}, 120 \mathrm{~V}, 208 \mathrm{~V}, 220 \mathrm{~V}, 230 \mathrm{~V}, 240 \mathrm{~V}, 277 \mathrm{~V}$. $380 \mathrm{~V}, 400 \mathrm{~V}, 415 \mathrm{~V}, 440 \mathrm{~V}$ or 480 V
50 or 60 Hz
3VA approx.
$1.2 \times$ rating continuously. $1.5 \times$ rating for $10 \times$ seconds
$>0.5 \%$ of full span
Pre-set at $15 \%$ of nominal voltage. Other values 10 to $30 \%$ to order (model 252-PSG only)
Phase unbalance adjustable 5 to $15 \%$
10 seconds as standard.

## Connections



Up to 30 seconds available. 4VA (max)
2-pole change over
$\mathrm{AC}: 240 \mathrm{~V} 5 \mathrm{~A}$, non inductive DC: 24 V 5 A resistive 0.2 million operations at rated loads Automatic $0^{\circ} \mathrm{C}$ to $+60^{\circ} \mathrm{C}\left(0^{\circ} \mathrm{C}\right.$ to $+40^{\circ} \mathrm{C}$ for UL models)

Temperature co-efficient $-20^{\circ} \mathrm{C}$ to $+70^{\circ} \mathrm{C}$

Interference immunity
$0.05 \%$ per ${ }^{\circ} \mathrm{C}$

|  | non-function to ANSI/IEEE C37 90a |
| :---: | :---: |
| Enclosure style | DIN-rail with wall mounting facility |
| Material | Flame retardant polycarbonate/ABS |
| Enclosure integrity | IP50 |
| Model 252 dimensions | 55 mm (2.2") wide $\times 70 \mathrm{~mm}$ (2.8") high $\times 112 \mathrm{~mm}\left(4.4^{\prime \prime}\right)$ deep |
| Weight | 0.4 Kg approx. |

## Dimensions

## Model 252



## CHASSIS

## 1. CD-2 CHASSIS TECHNICAL DETAILS

## 

## Panelboards, loadcentres and accessories

## 2

## CONCEPT•PLUS and Premier busbar chassis - Din-T

- Standards AS/NZS 3439
- Current rating 250 A
- Withstand rating $250 \mathrm{~A} / 20 \mathrm{kA}$ for 0.2 sec
- Splayed busbar to suit 160 A \& 250 A switch
- Top and bottom feed - splayed top \& bottom

Tee-offs stripped and 50\% capped

- Top power feed stripped and capped
- Full 35 mm DIN rail, improved MCB mounting security
- Improved insulation coating

Concept Din-T - 250 to suit Din-T MCBs ( 18 mm pole pitch $)^{3}$ )
250 A

| 250 A <br> Cole capacity <br> Cat. |  |
| :--- | :--- |
| 12 | CD-2-12/18-3U |
| 18 | CD-2-18/18-3U |
| 24 | CD-2-24/18-3U |
| 30 | CD-2-30/18-3U |
| 36 | CD-2-36/18-3U |
| 42 | CD-2-42/18-3U |
| 48 | CD-2-48/18-3U |
| 54 | CD-2-54/18-3U |
| 60 | CD-2-60/18-3U |
| 72 | CD-2-72/18-3U |
| 78 | CD-2-78/18-3U |
| 84 | CD-2-96/18-3U |
| 96 |  |

Notes: $\left.{ }^{1}\right) 4$ pole and other special configurations available to special order refer NHP. 'OFF' (line) side of MCB connects to chassis tee-off. MCB DIN clips may be disengaged or removed when mounting onto "CD" chassis. If applicable use insulated tool provided to disengage DIN clip when removing MCB from chassis.
${ }^{3}$ ) Not suitable for CONCEPT economy Panelboards. Contact NHP for availability. Available on indent only.
$\qquad$


3 pole CD chassis to suit Din-T MCBs
Accessories
Description Cat. No.

| Split tariff kit 250/355 A (supplied loose) | STKCD |
| :--- | :--- |
| Split tariff kit (fitted) | REFER NHP |
| Plastic tee-off cap $250 / 355$ A | CD250T0PC |


| Technical data - CD/CT busbar chassis <br> Description |  |  |
| :--- | :--- | :--- |
| CD-250 A |  |  |
| Busbar rating | (Amp) | 250 |
| Voltage rating | $(\mathrm{V})$ | 415 |
| Short circuit rating | $(\mathrm{kA})$ | 20 |
| Short circuit time | $(\mathrm{sec})$ | 0.2 |
| Insulation material |  | Polyolefin |
|  |  | PPA-441 |

Catalogue number structure - CD/CT busbar chassis


Panelboards, loadcentres and accessories

## Dimensions (mm)

CD chassis 250 to suit Din-T6, 10 and 15


Escutcheon cut-out details


Notes: ${ }^{1}$ ) " $\mathrm{X"}$ " insert $2=250 \mathrm{~A}$ or $3=355 \mathrm{~A}$, current rating does not effect above dims. Maximum current rating of tee-off $=100 \mathrm{~A}$. 'OFF' (line) side of MCB connects to chassis tee-off.
MCB DIN clips may be disengaged or removed when mounting onto "CD" chassis. Use insulated tool provided to disengage DIN clip when removing MCB from chassis.

## FAN \& FILTER

## 1. FAN \& FILTER TECHNICAL DETAILS



## Umschalten auf Perfektion RITTAL

## English

| Model No. fan-and-filter units SK | $\begin{array}{\|l\|} 3322.100 \\ 3322.107 \\ 3322.600 \\ \hline \end{array}$ | 3322.115 <br> 3322.117 <br> $\mathbf{3 3 2 2 . 6 1 5}$ | $\left.\begin{array}{\|l\|} 3322.024 \\ 3322.027 \end{array} \right\rvert\,$ | $\left\|\begin{array}{l} 3322.048 \\ 3322.047 \end{array}\right\|$ | $\begin{array}{\|l\|} \hline 3323.100 \\ 3323.107 \\ 3323.600 \\ \hline \end{array}$ | $\begin{array}{\|l\|} \hline 3323.115 \\ 3323.117 \\ 3323.615 \\ \hline \end{array}$ | $\left.\begin{array}{\|l\|} 3323.024 \\ 3323.027 \end{array} \right\rvert\,$ | $\left\lvert\, \begin{array}{l\|l} 3323.048 \\ 3323.047 \end{array}\right.$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Rated voltage Volu/ Hz | 230/50/60 | 115/50/60 | 24 (DC) | 48 (DC) | 230/50/60 | 115/50/60 | 24 (DC) | 48 (DC) |
| Air throughput unimpeded airflow | 55/66 m/h |  |  |  | 105/120 m/h |  |  |  |
| Axial fan | self-starting shaded pole motor |  | DC motor |  | self-starting shaded pole motor |  | DC motor |  |
| Rated current | $\begin{aligned} & \hline 0.12 \mathrm{~A} \\ & 0.11 \mathrm{~A} \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 0.24 \mathrm{~A} \\ & 0.23 \mathrm{~A} \end{aligned}$ | 0.35 A | 0.09 A | $\begin{aligned} & \hline 0.12 \mathrm{~A} \\ & 0.11 \mathrm{~A} \\ & \hline \end{aligned}$ | $\begin{aligned} & 0.24 \mathrm{~A} \\ & 0.23 \mathrm{~A} \\ & \hline \end{aligned}$ | 0.35 A | 0.09 A |
| Nominal output | 19 W/ | 118 W | 7.7 W | 4.4 W | 19 W | 18 W | 8.0 W | 4.3 A |
| Spare filter mat | 3322.700 |  |  |  | 3171.100 |  |  |  |
| Fine filter mat | - |  |  |  | 3181.100 |  |  |  |
| Hose-proof hood | 3322.800 |  |  |  | 3323.800 |  |  |  |
| Noise level | $46 / 49 \mathrm{~dB}$ (A) |  |  |  | $46 / 49 \mathrm{~dB}$ (A) |  |  |  |


| Model No. fan-and-filter units SK | $\begin{array}{\|l\|} \hline 3324.100 \\ 3324.107 \\ 3324.600 \end{array}$ | $\begin{array}{\|l\|} \hline 3324.115 \\ 3324.117 \\ 3324.615 \end{array}$ | $\begin{aligned} & 3324.024 \\ & 3324.027 \end{aligned}$ | $\begin{array}{\|l\|l} 3324.048 \\ 3324.047 \end{array}$ | $\begin{array}{\|l\|} 3325.100 \\ 3325.107 \\ 3325.600 \end{array}$ | $\begin{array}{\|l\|} 3325.115 \\ 3325.117 \\ 3325.615 \end{array}$ | $\begin{aligned} & 3325.024 \\ & 3325.027 \end{aligned}$ | $\begin{aligned} & 3325.048 \\ & 3325.047 \end{aligned}$ | $\begin{aligned} & 3326.100 \\ & 3326.107 \\ & 3326.600 \end{aligned}$ | $\begin{aligned} & 3326.115 \\ & 3326.117 \\ & 3326.615 \end{aligned}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Rated voltage Volt/ Hz | 230/50/60 | 115/50/60 | 24 (DC) | 48 (DC) | 230/50/60 | 115/50/60 | 24 (DC) | 48 (DC) | 230/50/60 | 115/50/60 |
| Air throughput unimpeded airflow | $180 / 160 \mathrm{~m}^{3} / \mathrm{h}$ |  |  |  | 230/265 m³/h |  |  |  | 500/560 m³/h |  |
| Axial fan | self-starting shaded pole motor |  | DC motor |  | self-starting shaded pole motor |  | DC motor |  | capacitor motor |  |
| Rated current | $\begin{aligned} & 0.19 \mathrm{Al} \\ & 0.20 \mathrm{~A} \\ & \hline \end{aligned}$ | $\begin{aligned} & 0.38 \mathrm{~A} \\ & 0.40 \mathrm{~A} \end{aligned}$ | 0.30 A | 0.34 A | $\begin{aligned} & 0.28 \mathrm{~A} \\ & 0.24 \mathrm{~A} \end{aligned}$ | $\begin{aligned} & 0.53 \mathrm{~A} / \\ & 0.49 \mathrm{~A} \end{aligned}$ | 0.58 A | 0.31 A | $\begin{aligned} & \hline 0.29 \mathrm{~A} \\ & 0.35 \mathrm{~A} \end{aligned}$ | $\begin{aligned} & 0.58 \mathrm{~A} / \\ & 0.70 \mathrm{~A} \end{aligned}$ |
| Nominal output | $30 \mathrm{~W} /$ | 35 W | 7.2 W | 14 W | 41 W/ | 138 W | 14 W | 15 W | 64 W/80 W |  |
| Noise level | $52 / 48 \mathrm{~dB}$ (A) |  |  |  | $54 / 56 \mathrm{~dB}$ (A) |  |  |  | 59/61 | dB (A) |
| Spare filter mats | 3172.100 |  |  |  |  |  |  |  | 3173.100 |  |
| Fine filter mat | 3182.100 |  |  |  |  |  |  |  | 3183.100 |  |
| Hose-proof hood | 3324.800 |  |  |  |  |  |  |  | 3326.800 |  |
| Temperature range | $-10^{\circ} \mathrm{C}$ to $+55^{\circ} \mathrm{C}$ |  |  |  |  |  |  |  |  |  |
| Protection category to EN 60529/10.91 | IP 54 by using of filter mat <br> IP 55 by using of filter mat and hose-proof hood Complies with NEMA 1. |  |  |  |  |  |  |  |  |  |

## 2. Assembly

Observe sequence of assembly 1-4, and mounting position! Airflow direction can be changed by reversing the fitting of fan. Fully compatible with the cutouts and holes of the "old" units.
Quick-assembly system for fan-and-filter units and outlet filter.
Simply snap into place, and that's it.

## 3. Electrical connection

Supply voltage and frequency must correspond to the rated values stated on the nameplate. The relevant requirements of the local electricity board must be observed
Electrical connection and repair must be carried out by authorised specialist personnel only.
Use original spares only.

## 4. Filter replacement and cleaning

The frequency of filter replacements should be determined individually, depending on dust accumulation and operating period.
Note: Filter replacement must be carried out in good time.
A soiled filter mat will cause the temperature to rise inside the enclosure!
The filter mat can be regenerated by washing or blowing out.

## 5. Supply includes

1 fan-and-filter unit, ready for connection,
1 drilling template.

## 6. Guarantee

We will guarantee this unit, if used correctly, for 1 year in respect of materials and manufacturing faults, from the date of its supply.

## 7. Waste disposal

The plastic material used in the components can be recycled.

## 8. Accessories

8.1 Spare filter mats, fine filter mats
8.2 Hose-proof hood
8.3 Thermostat SK 3110.000
8.4 Temperature indicator with switch contact SK 3114.000 (only for 230 V AC fan)
8.5 Speed control SK 3120.000 (only for 230 V AC fan).
9. Colour

RAL 7032: ..... 100 /. 115 /. 048 /. 024
RAL 7035: ..... 107 /. 117 /. 047 / . 027




## FUSE \& FUSE HOLDER

## 1. FUSE LINKS TECHNICAL DETAILS

## 2. FUSE HOLDER TECHNICAL DETAILS

## BS compact fuse links

> Complies with BS 88
> Reduced dimensions
> Low watts loss

Clip-in offset tags


Note: $\left.\quad{ }^{\prime}\right)^{\prime} M$ ' in catalogue No. denotes motor starting type.

DIN and BS fuse link selection chart

## BS Fuses

| Switch-fuses |  |  |  |  |  |  |  | Fuse type Cat. No. Prefix |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 800 | 630 | 400 | 315 | 250 | 200 | 160 | 125 |  |
|  |  |  |  |  |  |  |  | NNS |
|  |  |  |  |  |  |  |  | NNIT_ |
|  |  |  |  |  |  | $\checkmark$ | $\nu$ | NTIA |
|  |  |  |  |  |  | $\checkmark$ | $\checkmark$ | NTIS_ |
|  |  |  |  |  |  | $\checkmark$ | $\checkmark$ | NOS_ |
|  |  |  |  |  |  | $\checkmark$ |  | NTCP_ |
|  |  |  |  |  |  |  |  | NTFP_ |
|  |  |  |  |  |  |  |  | NTSLOO_ |
|  |  | $\checkmark$ | $\checkmark$ | $\checkmark$ | $\checkmark$ |  |  | NTBC |
|  |  | $\checkmark$ | $\checkmark$ | $\checkmark$ | $\checkmark$ |  |  | NTC- |
|  |  | $\checkmark$ | $\checkmark$ | $\checkmark$ | $\checkmark$ |  |  | NTF_ |
|  |  | $\checkmark$ | $\checkmark$ | $\checkmark$ |  |  |  | NTKF_ |
|  |  |  |  |  |  |  |  | NTSL3- |
|  |  | $\checkmark$ |  |  |  |  |  | NTMF_ |
| $\checkmark$ | $\checkmark$ |  |  |  |  |  |  | NTM- |
| $\checkmark$ | $\checkmark$ |  |  |  |  |  |  | NTM |
| $\checkmark$ |  |  |  |  |  |  |  | NTLM- |


| NHP HRC fuse holders |  |  |  |  |  |  |  |  | Fuse type Cat. No. Prefix |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| NC (Bolt-in) |  |  |  |  |  | NV (Clip-in) |  |  |  |
| 315 | 200 | 100 | 63 | 32 | 20 | 63 | 32 | 20 |  |
|  |  |  |  |  |  |  | $\checkmark$ | $\checkmark$ | NNS |
|  |  |  |  |  |  | $\checkmark$ |  |  | NES_ |
|  |  |  |  | $\checkmark$ | $\checkmark$ |  |  |  | NNIT_ |
|  | $\left.\sim^{1}\right)$ | $\checkmark$ | $\checkmark$ |  |  |  |  |  | NTIA |
|  | (1) | $\checkmark$ | $\left.\checkmark^{2}\right)$ |  |  |  |  |  | NTIS_ |
|  | v) | $\checkmark$ |  |  |  |  |  |  | NOS_ |
|  | $\checkmark$ |  |  |  |  |  |  |  | NTCP |
|  | $\checkmark$ |  |  |  |  |  |  |  | NTFP_ |
| $\checkmark$ |  |  |  |  |  |  |  |  | NTBC_ |
| $\checkmark$ |  |  |  |  |  |  |  |  | NTC |
| $\checkmark$ |  |  |  |  |  |  |  |  | NTF_ |
| $\checkmark$ |  |  |  |  |  |  |  |  | NTKF_ |

DIN Fuses

| Switch-fuses |  |  |  |  |  | Fuse type Cat. No. <br> Prefix |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 800 | 630 | 400 | 250 | 160 | 125 |  |
|  |  |  |  | $\checkmark$ | $\checkmark$ | NOO_ |
|  |  |  | $\checkmark$ |  |  | N1 |
|  |  | $\checkmark$ |  |  |  | N2 |
| $\checkmark$ | $\checkmark$ |  |  |  |  | N3 |
| Legend: $\boldsymbol{\checkmark}$ Fuse links fit direct. <br> $\checkmark^{1}$ ) Fuses require 100MFLK adaptor, see page 11-107. <br> $\boldsymbol{V}^{2}$ ) ' $M$ ' type (motor rated) NTIS not suitable for NC63_. Use NC100 fuse holder. |  |  |  |  |  |  |

Fuse-link terminology


HR

High rupturing capacity (HRC) or High breaking capacity denotes the ability of a fuse link to interrupt extremely high fault currents, usually up to 80 kA . Current limiting fuse-link ,
A fuse-link that limits the circuit current during it's operation to a value much lower than the peak value of the prospective current. In practice, the terms HRC and current limiting are synonymous.
Rated breaking capacity
The highest value of fault current that a fuse -link has
been tested to interrupt eg. 80 k A.
Rated voltage
The maximum system" voltage that the fuse-link is
P designed to interrupt. Rated voltages may be inc,


## The minimum value of current that'will cause melting



The power released in a fuse link carrying rated current under a specified condition, usually expressed intwatts.
Time current characteristics ed (refer table 1)
A curve-detailing the prearcing or operating time as a function of prospective current.
Let through characteristics (I ${ }^{2} t$ ) (refer table 2 )
A curve or chart showing values prearcing' and prospective current, $I^{2} t$ is proportional to energy in.
CAmp ${ }^{2}$ seconds.

## Cut off characteristics (refer table 3)

A curve detailing the cut off current as a function of prospective current Cut off current being the maximum instantaneous value of current let through


Discrimination achieved 8家

Discrimination (refer tables 4 and 5 ) Discrimination is the ability of fuse-links to operate: selectively and to disconnect only the parts of the ${ }^{4} 4$ circuit that are subject to faults, Discrimination canbe checked by ensuring that the time current characteristics, including their tolerances, do not overlap at any point and that the total let through energy ( $\mathrm{I}^{2} \mathrm{t}$ ) of the downstream (or minor) fuse-link does; not exceed the pre-arcingenergy ( $\left.I^{2} t\right)$ of the,$j$, upstream (or major) fuse slink at the applied system voltage Discrimination is normally achieved with y the ratio of 1.6 between upstreamand downstream

 Table 2

$\qquad$


Discrimination NOT achieved





BStuseholders

Refer Catalogue $\hat{N} F$
Compact fuse holders (Bolt-in)
O New compact size
O Front (FW) or stud/front (SFW) versions

- Smaller dimensions

O Saves panel space


Rating (A) | Fuse link to suit
UP TO 30\% SMALLER

Front wired - bolt in

| 32 |  |  | NNIT | NC32FW |  |
| :---: | :--- | :--- | :--- | :--- | :--- |
| 63 |  | NTIA | NTIS | NC63FW |  |
| 100 | NOS | NTIA | NTIS | NC100FW |  |
| 200 |  | NTIA $\left.^{1}\right)$ | NTIS $\left.^{1}\right)$ | NC200FW |  |
|  | NTFP | NOS $\left.^{1}\right)$ | NTCP $^{2}$ |  |  |


| Dimensions (mm) |  |  | Suggested Max. |  |
| :--- | :--- | :--- | :--- | :--- |
|  | H | W | D | cable size |
| NC32_ | 87 | 27 | 50 | $10 \mathrm{~mm}^{2}$ |
| NC63_- | 109 | 31 | 62 | $25 \mathrm{~mm}^{2}$ |
| NC100_ | 118 | 35 | 72 | $50 \mathrm{~mm}^{2}$ |
| NC200_ | 154 | 54 | 108 | $95 \mathrm{~mm}^{2}$ |

Back stud/front wired - bolt in

| 32 |  |  | NNIT | NC32SFW |  |
| :---: | :--- | :--- | :--- | :--- | :--- |
| 63 |  | NTIA | NTIS | NC63SFW |  |
| 100 | NOS | NTIA | NTIS | NC100SFW |  |
| 200 |  | NTIA ' $^{\prime}$ NTIS ${ }^{\prime}$ ) | NC200SFW |  |  |
|  | NTFP | NOS ') | NTCP |  |  |

Note: ') Fuses can be fitted using adaptor 100M FLK.

Standard fuse holders (Bolt-in)
O Ratings from 20 to 200 A
O Front (FW) or stud/front (SFW) versions
O Complies with BS88


Dimensions (mm)

|  | $\mathbf{H}$ | $\mathbf{W}$ | $\mathbf{D}$ | cable size |
| :--- | :--- | :--- | :--- | :--- |
| N20__ $^{2}$ | 87 | 27 | 50 | $10 \mathrm{~mm}^{2}$ |
| N32_ $^{2}$ | 109 | 31 | 62 | $10 \mathrm{~mm}^{2}$ |
| N63_ | 118 | 35 | 72 | $50 \mathrm{~mm}^{2}$ |
| N100_ $^{2}$ | 154 | 54 | 108 | $70 \mathrm{~mm}^{2}$ |
| N200_ | 193 | 70 | 149 | $150 \mathrm{~mm}^{2}$ |

Rating (A) Fuse link to suit Cat. No.
Front wired - bolt in

| 20 | NNIT | N20FW |  |
| :---: | :---: | :---: | :---: |
| 32 | NTIA | N32FW |  |
| 63 | NTIA NTIS | N63FW |  |
| 100 | NTIA ' $^{\prime}$ NTIS ') | N100FW |  |
|  | NOS ' $^{\prime}$ NTCP |  |  |
| 200 | NTBC NTC | N200FW |  |
|  | NTF |  |  |

Back stud/front wired - bolt in

| 20 | NNIT | N20SFW |  |
| :---: | :---: | :--- | :--- |
| 32 | NTIA | N32SFW |  |
| 63 | NTIA NTIS | N63SFW |  |
| 100 | NTIA $^{\prime}$ ) NTIS ${ }^{1}$ ) | N100SFW |  |
|  | NOS ' $^{\prime}$ NTCP |  |  |
| 200 | NTBC NTC | N200SFW |  |
|  | NTF |  |  |

Clip-in fuse holders - DIN rail mount
Fast, reliable fitting and removal of fuse links


NV20FW


NV32FW


NV63FW

Rating (A)
Fuse link to suit
Cat. No.
Front wired - clip-in - Black

| 20 | NSS | NV20FW |  |
| :---: | :---: | :--- | :--- |
| 32 | NSS | NV32FW |  |
| 63 | NES | NV63FW |  |

Front wired - Clip-in - White

| 32 | NNS | NV32FWW |  |
| :---: | :---: | :---: | :---: |
| 63 | NES | NV63FWW |  |

## GSM MODEM

1. FASTRACK SUPREME GSM MODEM TECHNICAL DETAILS
2. FASTRACK SUPREME GSM MODEM USER GUIDE


Fastrack-Supreme

# GSM/GPRS/EDGE with unlimited expandability 

Fastrack Supreme is a versatile Plug \& Play Wireless CPU* that will carry your applications well into the future. It has been designed to accommodate any additional features you can imagine, thanks to a revolutionary, open standard Internal Expansion Socket which you can populate with an expansion card from Wavecom - or one of your own.

SECURE CELLULAR INTERNET
Prevent hacker attacks by using our Security software Plug-In to connect your sales terminal, meter, vehicle, asset trac king or monitoring product via GSM GPRS or high speed EDGE to the cellular Internet highway.

## POWERFUL CORE

 APPLICATION PROCESSINGEvery Fastrack Supreme features a Wavecom Q26-family Wireless CPU ${ }^{*}$ a powerful central processing unit with an ARM9 32 bit, $26-104 \mathrm{MHz}$ core, programmable via any combination of AT commands, C and Lua.

FASTRACK = YOUR PRODUCT
By designing your product value as an expansion card you save time and money in cellular learning curve, certification, mechanical design and time to market. Fastrack can now become your product.

UNHEARD-OF EXPANDABILITY
Add additional IO connectivity or features like GPS, WiFi, Bluetooth, Zigbee and more. The open interface means you can develop your own expansion modules for your specific needs.

## INTELLIGENT DEVICE SERVICES

Our Intelligent Device Services enable you to remotely monitor and securely upgrade the software of your product, in order to reduce post-deployment field maintenance costs.

PROFESSIONAL SERVICES
Accelerate your product design and ensure you capitalize on market opportunities!


Evolve to the latest cellular technology and add functionality without sacrificing the form factor you have come to rely on. The Fastrack Supreme is the same size, has the same interfaces and is completely backward compatible with previous Fastrack products, and is packed with a host of new features.

Wavecom has developed an exciting new, open-standard Internal Expansion Socket (IES) interface for you to add additiona! IO connectivity or features like GPS. WiFi, Bluetooth, Zigbee and more. The open interface means you can develop your own expansion modules and customize the product for your specific requirements, or you can look to Wavecom for new expansion modules designed to address your most-pressing needs.

## Features




## Open AT ${ }^{\text {® }}$ Software Suite 2.0

## Industrial software for industrial design demands

The Open AT* Software Suite allows you to develop, compile, test, debug, download and natively execute your applications written in standard ANSI C directly on the Fastrack Supreme, or indeed any other Wavecom Wireless CPUe. It is royalty free and comprises operating system, compiler and integrated development environments. There are no hidden costs - maintenance and qualification are provided for free by Wavecom.


- Multitasked Pre-Emptive Event-Based Real-Time Operating System
- Integrated Development Environment built on Eclipse ${ }^{T M}$
- Extensive Set of Plug-Ins (Internet Suite, C-GPS and more)
- GSM Release 99 compliant modem firmware
- Secure Intelligent Device Services (IDS) compatible


## REAL TIME OPERATING SYSTEM

Real-Time
Guarantied response time to interruption
(even during GSM/GPRS/EDGE activities, calls and transfer).
Wireless CPU* Resources Direct Access and IT Management
$\rightarrow$ Hardware and Software Timers
$\rightarrow$ DSP
$\rightarrow$ SPI
$\rightarrow$ ADC
$\rightarrow$ External Interrupt Pins
$\rightarrow$ GPIOs
$\rightarrow$ UARTS (coming in 2008)

## Multitasking

Auto shut-down feature
Feature improving the overall consumption of the application by deactivating the RS232 interface.
Application dedicated Hardware Watchdog
$\rightarrow$ application dedicated for close monitoring
$\rightarrow$ tunable depending on the complexity of the processing (ex: Pulse count Vs RSA signature calculation...)

## CROSS-PLATFORM INTEGRATED

DEVELOPMENT ENVIRONMENT
For eased application debug it can be performed on PC: for very fast and convenient application debugging through Remote Task Environment.

[^2]
## SEAMLESSLY PLUG-IN ADDITIONAL FEATURES

Plug-Ins are an optional range of software feature packages that are selected when your order your Wireless CPU*. The standard range provides access to Internet clients \& protocols, controllerless companion wireless peripherals such as Bluetooth \& GPS. Of course, the powerful flexibility of Open AT ${ }^{8}$ Software Suite means that you can also develop your own Plug-Ins and own custom AT commands.


WAVECOM BSP-BASED EMBEDDED SOFTWARE ARCHITECTURE


## Wavecom Services

The wireless products you are developing are most probably very complex, and they will stay in the field for many years. With this in mind, Wavecom has created a range of professional and operated services to make the development process easier and to help you protect your investment, enrich your products and services, and reduce the lifetime cost of your device network.

## Professional services: Less pain, more gain

Wavecom Professional Services help you be faster, sleeker and more adaptable to the ever changing needs of your market, all along the typical product lifecycle timeline:

| WAVECOM UNIVERSITY | PRODUCT BUILD |
| :--- | :--- |
| $\rightarrow$ Open AT* Doveloper course | $\rightarrow$ IMEI implementation |
| $\rightarrow$ Open AT* Expert course | $\rightarrow$ Tallored Delivery (Express a Fast) |
|  | $\rightarrow$ Tailored Product Configuration |
| PRODUCT DESIGN | AFTER SALES |
| $\rightarrow$ Customer Design Review | $\rightarrow$ Reconfiguration for Wireless CPU |
| $\rightarrow$ Customer Product Certification | $\rightarrow$ Out Of Warranty repair for Wireless CPỤ |
| $\rightarrow$ Open AT* Application Code Review | $\rightarrow$ Repair Equipment Wireless CPU |

## Intelligent Device Services: Investment protection

Wavecom has created the world's first cellular operated service portfolio to benefit from easy to use end-to-end Intelligent Device Services that enable to remotely monitor and securely upgrade the application software of your product in addition to the entire Wavecom embedded Open AT* Software:

## WIRELESS DEVICE MANAGEMENT

$\rightarrow$ Simplify your devicé installation and protect your wireless investment while reducing your field servite costs
COMMUNICATION MANAGEMENT
$\rightarrow$ Aralyze your traffic load and roaming usage; and adjust your taniff plans to your real usage APPLICATION MANAGEMENT
$\rightarrow$ Beñefit from proactive máinténance services to diagnose issues and take action before a signifficant problem occurs

See the Fastrack Supreme online: uww.wavecom.comflastracksupreme

Join the Wavecom Developer community: www.wavecom.comflorum


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MEMeconn

Smart wireless. Smart business.

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FASTRACK Supreme
User Guide

Reference: WA_DEV_Fastrk_UGD_001
Revision: 001e
Date: 5 june, 2007



| 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 |  |

The FASTRACK Supreme 10 and FASTRACK Supreme 20 are discrete, rugged cellular Plug \& Play Wireless CPU ${ }^{\oplus}$ 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 $A T^{\top}$ ). Open $A T^{\top}$ 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 ${ }^{*}$.

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 AT ${ }^{\otimes}$ 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.

# Fastrack Supreme User Guide WA_DEV_Fastrk_UGD_001 

## 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

$\square_{\circledR}$, WAVECOM ${ }^{\circledR}$, Wireless CPU ${ }^{\circledR}$, Open $A T^{\circledR}$ 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.

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# wovecom ${ }^{\text {s }}$ <br> Make if wircless <br> Fastrack Supreme User Guide WA_DEV_Fastrk_UGD_001 <br> <br> Web Site Support 

 <br> <br> 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 | TBD |
| Open AT Introduction: $^{\text {TBU }}$ | www.wavecom.com/OpenAT |
| Developer community for software and hardware: | www.wavecom.com/forum |

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## 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 AT ${ }^{\text {® }}$ Software Documentation

[1] Getting started with Open AT ${ }^{\oplus}$ (Ref.WM_ASW_OAT_CTI_001)
[2] Open $A T^{\circledR}$ Tutorial (Ref.WM_ASW_OAT_UGD_001)
[3] Tools Manual (Ref. WM_ASW_OAT_UGD_003)
[4] Open AT ${ }^{\circledR}$ Programming Guide (Ref. TBD)
[5] Open $\mathrm{AT}^{\text {® }}$ 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 AT Software 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 M1306B 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)

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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 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 | Suropean Telecommunications Standards Institute connectors (micro-FIT) |
| FIT | FR |


| 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 |




## 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

### 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 AT ${ }^{\text {® }}$ Logo
- RoHS logo
- WEEE logo


Figure 2: Packaging box
The packaging label dimensions are:


- 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 ${ }^{\oplus}$ 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

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

### 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.


SMA connector for antenna 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).


Figure 7: Power supply connector

Table 1: Power supply connector pin description

| Pin\# | Signal | I/O | VO type | Description | Reset State | Comment |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1 | V+BATTERY | I | Power <br> supply | Battery voltage input: <br> 5.5 V Min. <br>  |  |  |

## 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.

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Figure 8: Sub HD 15-pin connector

Table 2: Sub HD 15-pin connector description

| Pin\# | Signal (CCITT / EIA) | 1/0 | VO type | Description | Cornment |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 1 | CDCD/CT109 | 0 | STANDARD RS232 | RS232 Data Carrier Detect |  |
| 2 | CTXD/CT103 | 1 | STANDARD RS232 | RS232 <br> Transmit serial data |  |
| 3 | BOOT | 1 | CMOS | Boot | This signal must not be connected. Its use is strictly reserved to Wavecom or competent retailers. |
| 4 | CMIC2P | 1 | Analog | Microphone positive line |  |
| 5 | CMIC2N | 1 | Analog | Microphone negative line |  |
| 6 | CRXD/CT104 | 0 | STANDARD RS232 | RS232 <br> Receive serial data |  |
| 7 | CDSR/CT107 | 0 | STANDARD RS232 | $\begin{gathered} \text { RS232 } \\ \text { Data Set Ready } \end{gathered}$ |  |
| 8 | CDTR/CT108-2 | 1 | STANDARD <br> RS232 | RS232 Data Terminal Ready |  |
| 9 | GND | - | GND | Ground |  |

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| Pin \# | Signal <br> (CCITT/EIA) | i/O | I/O type | Description | Comment |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 10 | CSPK2P | 0 | Analog | Speaker <br> positive line |  |
| 11 | CCTS/CT106 | 0 | STANDARD <br> RS232 | RS232 <br> Clear To Send |  |
| 12 | CRTS/CT105 | 1 | STANDARD <br> RS232 | RS232 <br> Request To Send |  |
| 13 | CRI/CT125 | 0 | STANDARD <br> RS232 | RS232 <br> Ring Indicator |  |
| 14 | RESET | I/O | Schmitt | Supreme Plug \& Play reset | Active low |
| 15 | CSPK2N | 0 | 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+|/O
- IESM-GPS+USB
- IESM-USB+I/O

For detail, please refer to Document in Section 1.1.5.

General Presentation
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Figure 9: IES connector for feature expansion

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Fastrack Supreme User Guide

## General Presentation

Table 3: IES Connector Description

| Pin Number | Signal Name |  | I/O type | Voltage | I/O* | Reset State | Description | Dealing with unused pins |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Nominal | Mux |  |  |  |  |  |  |
| 1 | GND |  |  |  |  |  | Ground |  |
| 2 | GND |  |  |  |  |  | Ground |  |
| 3 | GPIO4 | COLO | C8 | GSM-1V8 | 1/0 | Pull-up | Keypad column 0 | NC |
| 4 | GPIO5 | COL1 | C8 | GSM-1V8 | 1/0 | Pull-up | Keypad column 1 | NC |
| 5 | GPIO6 | COL2 | C8 | GSM-1V8 | 1/0 | Pull-up | Keypad column 2 | NC |
| 6 | GPIO7 | COL3 | C8 | GSM-1V8 | 1/0 | Pull-up | Keypad column 3 | NC |
| 7 | VPAD-USB |  |  | VPAD-USB | 1 |  | USB Power supply input | NC |
| 8 | USB-DP |  |  | VPAD-USB | 1/0 |  | USB Data | NC |
| 9 | USB-DM |  |  | VPAD-USB | 1/0 |  | USB Data | NC |
| 10 | GSM-1V8* |  |  | GSM-1V8 | 0 |  | 1.8V Supply Output (for GPIO pull-up only) | NC |
| 11 | GSM-2V8* |  |  | GSM-1V8 | 0 |  | $\begin{aligned} & \text { 2.8V Supply Output } \\ & \text { (for GPIO pull-up only) } \end{aligned}$ | NC |
| 12 | BOOT |  |  | GSM-1V8 | 1 |  | Not Used | Add a test point / a jumper/ a switch to VCC_1V8 (Pin 10) in case Download Specific mode is used (See product specification for details) |
| 13 | $\sim$ RESET |  | C4 | GSM-1V8 | 1/0 |  | RESET Input | NC or add a test point |
| 14 | AUX-ADC |  | A2 | Analog | 1 |  | Analog to Digital Input | Pull to GND |
| 15 | ~SPI1-CS | GPIO31 | C1 | GSM-2V8 | $\bigcirc$ | 2 | SPI1 Chip Select | NC |
| 16 | SPI1-CLK | GPIO32 | C1 | GSM-2V8 | 0 | 2 | SPI1 Clock | NC |
| 17 | SPI1-1 | GPIO30 | C1 | GSM-2V8 | 1 | Z | SPI1 Data Input | NC |
| 18 | SPI1-IO | GPIO29 | C1 | GSM-2V8 | 1/0 | 2 | SPI1 Data Input/ Output | NC |
| 19 | SPI2-CLK | GPIO32 | C1 | GSM-2V8 | 0 | 2 | SPI2 Clock | NC |
| 20 | SPI2-10 | GPIO33 | C1 | GSM-2V8 | 1/0 | 2 | SPI2 Data Input / Output | NC |
| 21 | ~SP12-CS | GPIO35 | C1 | GSM-2V8 | 0 | 2 | SPI2 Chip Select | NC |
| 22 | SPI2-I | GPIO34 | C1 | GSM-2V8 | 1 | 2 | SPI2 Data Input | NC |
| 23 | $\begin{aligned} & \hline \text { CT104- } \\ & \text { RXD2 } \end{aligned}$ | GPIO15 | C1 | GSM-1V8 | 0 | z | Auxiliary RS232 Receive | Add a test point for firmware upgrade |
| 24 | CT103-TXD2 | GPIO14 | C1 | GSM-1V8 | 1 | z | Auxiliary RS232 Transmit | (TXD2) Pull-up to VCC_1V8 with $100 \mathrm{k} \Omega$ and add a test point for firmware update |
| 25 | $\begin{aligned} & \text { ~CT106- } \\ & \text { CTS2 } \end{aligned}$ | GPIO16 | C1 | GSM-1V8 | $\bigcirc$ | $z$ | Auxiliary RS232 Clear To Send | (CTS2) Add a test point for firmware update |
| 26 | $\begin{gathered} \sim \text { CT105- } \\ \text { RTS2 } \end{gathered}$ | GPIO17 | C1 | GSM-1V8 | 1 | Z | Auxiliary RS232 Request To Send | (RTS2) Pull-up to VCC_1V8 with $100 \mathrm{k} \Omega$ and add a test point for |

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| Pin Number | Signal Name |  | $\begin{aligned} & \text { I/O } \\ & \text { type } \end{aligned}$ | Voltage | 1/0* | Reset State | Description | Dealing with unused pins |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Nominal | Mux |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  | firmware update |
| 27 | GPIO8 | COL4 | C8 | GSM-1V8 | 1/0 | Pull-up | Keypad column 4 | NC |
| 28 | GP1O26 | SCL | A1 | Open Drain | 0 | Z | $1^{2} \mathrm{C}$ Clock | NC |
| 29 | GPIO19 |  | C1 | GSM-2V8 | $1 / 0$ | z |  | NC |
| 30 | GPIO27 | SDA | A1 | Open Drain | 1/0 | Z | $1^{2} \mathrm{C}$ Data | NC |
| 31 | GPIO20 |  | C1 | GSM-2V8 | 1/0 | Undefined |  | NC |
| 32 | INTO | GP1O3 | C1 | GSM-1V8 | 1 | z | Interruption 0 Input | If INTO is not used, it should be configured as GPIO |
| 33 | GPIO23 | ** | C1 | GSM-2V8 | 1/0 | z |  | NC |
| 34 | GPIO22 | ** | C1 | GSM-2V8 | I/O | z |  | NC |
| 35 | $\begin{gathered} \hline \text { CT108-2- } \\ \text { DTR1 } \end{gathered}$ | GPIO41 | C1 | GSM-2V8 | 1 | Z | Main RS232 Data Terminal Ready | (DTR1) Pull-up to VCC_2V8 with 100k』 |
| 36 | PCM-SYNC |  |  | GSM-1V8 | 0 | Pull-down | PCM Frame Synchro | NC |
| 37 | PCM-IN |  | C5 | GSM-1V8 | 1 | Pull-up | PCM Data Input | NC |
| 38 | PCM-CLK |  |  | GSM-1V8 | 0 | Pull-down | PCM Clock | NC |
| 39 | PCM-OUT |  |  | GSM-1V8 | 0 | Pull-up | PCM Data Output | NC |
| 40 | AUX-DAC |  |  | Analog | 0 |  | Digital to Analog Output | NC |
| 41 | VCC-2V8 |  |  | VCC_2V8 | 0 |  | LDO 2.8V Supply Output | NC |
| 42 | GND |  |  |  |  |  | Ground |  |
| 43 | DC-IN |  |  | $\begin{aligned} & \text { DC-IN from } \\ & 5.5 \mathrm{~V}-32 \mathrm{VDC} \end{aligned}$ | 0 |  | DC voltage input through Micro-Fit connector | NC |
| 44 | DC-IN |  |  | $\begin{gathered} \hline \text { DC-IN from } \\ 5.5 \mathrm{~V} \sim 32 \mathrm{VDC} \end{gathered}$ | 0 |  | DC voltage input through <br> Micro-Fit connector | NC |
| 45 | GND |  |  |  |  |  | Ground |  |
| 46 | 4 V |  |  | 4 V | 0 |  | $\begin{aligned} & \hline \text { 4V DC/DC converter } \\ & \text { Output } \end{aligned}$ | NC |
| 47 | 4 V |  |  | 4 V | 0 |  | $\begin{aligned} & \text { 4V DC/DC converter } \\ & \text { Output } \end{aligned}$ | NC |
| 48 | GND |  |  |  |  |  | Ground |  |
| 49 | GND |  |  |  |  |  | Ground |  |
| 50 | GND |  |  |  |  |  | Ground |  |



Fastrack Supreme User Guide
General Presentation
3.2.2 Power supply cable


Figure 10: Power supply cable

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| 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

| * Fegtures | GSM850.GSM900 | DCSTB00 PCSTEOD |
| :---: | :---: | :---: |
| Open AT ${ }^{\text {+ }}$ | Open $A T^{8}$ programmable: <br> Native execution of embedded standard ANSI C applications, Custom AT command creation, <br> Custom application library creation, 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 $2+$ small MS. | $1800 \mathrm{MHz} / 1900 \mathrm{MHz}$ <br> Output power: class 1 (1W). <br> Fully compliant with ETSI GSM phase $2+$ small MS. |
| GPRS | Class 10. <br> PBCCH support. <br> Coding schemes: CS1 to CS4. <br> Compliant with SMG31bis. <br> Embedded TCP/IP stack. |  |
| EGPRS | Output power: 0.5 W | Output power: 0.4 W |
| (for <br> FASTRACK <br> Supreme 20 only) | Class 10. <br> PBCCH support. <br> Coding schemes: MCS1 to MCS9. <br> Compliant with SMG31bis. <br> Embedded TCP/IP stack. |  |

[^3]Page: $31 / \pi$

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Features and Services

| Features | GSm850 [GSme0 m |
| :---: | :---: |
| Interfaces | RS232 (V.24N.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 .25 ter and GSM $07.05 \& 07.07$. <br> Open $A T^{\top}$ interface for embedded application. <br> Open AT ${ }^{\text {® }}$ 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. 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 | $\therefore$ CSM8500GSTME00 : | DCSTBOOUPCST900 |
| :---: | :---: | :---: |
| GSM supplement service's | 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.

### 4.2 Additional NEW Features

### 4.2.1 Support Additlonal 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 Serlal 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 Tme 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.

### 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

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# 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.


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### 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: $\mathbf{1 1 5 . 2 0 0} \mathbf{b p s}$,
- 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 $x x x x$ (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.

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### 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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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.

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# Fastrack Supreme User Guide <br> 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 (ATEO command) in order to avoid useless CPU processing.

For further information on ATE0 and ATE1 commands, refer to "AT Commands Interface Guide" [6]

[^4]
### 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:

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Table 8: AT+WMBS Band Selection

| AT+WMBS response $\left(^{*}\right)$ | Interpretation |
| :---: | :--- |
| $A T+W M B S=0, x$ | Select mono band mode 850 MHz |
| $A T+W M B S=1, x$ | Select mono band mode extended 900 MHz |
| $A T+W M B S=2, x$ | Select mono band mode 1800 MHz |
| $A T+$ 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 Interface Guide" [6].

Remark:
$\mathbf{x}=0$ : The Plug \& Play will have to be reset to start on specified band(s).
$\mathbf{x}=\mathbf{1}$ : 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

| AT+WMBS response (*) | "Interpretation |
| :---: | :--- |
| +WMBS : $0, x$ | Mono band mode 850 MHz is selected |
| +WMBS : $1, x$ | Mono band mode extended 900 MHz is selected |
| +WMBS : $2, x$ | Mono band mode 1800 MHz is selected |
| +WMBS : $3, x$ | Mono band mode 1900 MHz is selected |
| +WMBS : $4, x$ | Dual band mode $850 / 1900 \mathrm{MHz}$ are selected |
| +WMBS : $5, x$ | Dual band mode extended $900 \mathrm{MHz} / 1800 \mathrm{MHz}$ are selected |
| +WMBS : $6, x$ | Dual band mode extended $900 \mathrm{MHz} / 1900 \mathrm{MHz}$ are selected |

(*)For further information on the other possible responses and their meaning, refer to "AT Commands Interface Guide" [6].

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### 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. AT+CPIN $=x \times x \times x$ to enter PIN code $x X x X$.
b. AT+WMBS ? To check the current band setting in the Plug \& Play
c. AT+WMBS $=<$ Band $>$ [, <param>] 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 Main AT Commands 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 | $\begin{aligned} & \text { AT }+C P I N=x \times x x \\ & (x \times x x=P I N \operatorname{code}) \end{aligned}$ | 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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| 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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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 unw.wavecom.com or use the following link:
http://www.wavecom.com/support/fags.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 $=115200 \mathrm{bps}$. <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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- 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

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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: $A T+C B S T=0,0,3$ |

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.

Fastrack Supreme User Guide
Troubleshooting
Table 14: Interpretation of extended error code

| Error Code | Diagnostic |  |
| :---: | :--- | :--- |
| 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 | Check your subscription (data <br> subscription available?). |
| 50 | ACM equal or greater than ACMmax |  |
| 68 | Call barring on outgoing calls |  |
| 252 | Call barring on incoming calis |  |
| 253 | Network causes | See "AT Commands Interface Guide" [6] <br> for further details or call network provider. |
| $3,6,8,29,34,38$, <br> $41,42,43,44,47$, <br> $49,57,58,63,65$, <br> $69,70,79,254$ |  |  |

Note: For all other codes, and/or details, see AT commands documentation [6].


### 7.1 Architecture



Figure 15: Functional architecture

### 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 AT COMMAND 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 voitage ( $\mathrm{V}+\mathrm{BATTERY}$ ) from +5.5 V to +32 V at 2.2 A.

Main regulation is made with an internal $D C / D C$ 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 ( $\mathrm{V}+\mathrm{BATTERY}$ ) 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 $\Leftrightarrow \mathrm{V} 24 N 28$ ) between the internal FASTRACK Supreme Plug \& Play (DCE) and the external world (DTE).

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.

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Functional Description
7.4.3 Pin Description

| Signal | Sub HD connector <br> Pin number | I/O | IO type <br> RS232 <br> STANDARD | Description |
| :---: | :---: | :---: | :---: | :--- |
| CTXD/CT103 | 2 | 1 | TX | Transmit serial data |
| CRXD/CT104 | 6 | 0 | RX | Receive serial data |
| CRTS/CT105 | 12 | 1 | RTS | Request To Send |
| CCTS/CT106 | 11 | 0 | CTS | Clear To Send |
| CDSR/CT107 | 7 | 0 | DSR | Data Set Ready |
| CDTR/CT108-2 | 8 | 1 | DTR | Data Terminal Ready |
| CDCD/CT109 | 1 | 0 | DCD | Data Carrier Detect |
| CRI/CT125 | 13 | 0 | 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.

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 V8 | Undefined | General Purpose I/O | No mux |
| GPIO25 | 4 | $1 / O$ | 2 V8 | $Z$ | 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.


## $7.6 \quad \mathrm{BOOT}$

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.

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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 | VO type | Voltage | Description |
| :---: | :---: | :---: | :---: | :---: | :---: |
| RESET | 14 | $1 / O$ | Open Drain | 1 V8 | FASTRACK Supreme <br> Reset |

Caution: Previous generation M1306B has RESET signal of HIGH level at 2.8 V . But the FASTRACK Supreme now of 1.8 V 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 $200 \mu \mathrm{~s}$ minimum.
As soon as the reset is done, the AT interface answers "OK" to the application. For this, the application must send AT.ل.

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 | V/O type | Description |
| :---: | :---: | :---: | :---: | :---: |
| CMIC2P | 4 | 1 | Analog | Microphone positive input |
| CMIC2N | 5 | 1 | Analog | Microphone negative input |

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### 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 | 0 | Analog | Speaker positive output |
| CSPK2N | 15 | 0 | 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 + whenf $=1,0$
The Flash LED can be activated by AT command at + whonf=1,1
However, the new setting will be taken into account only after a restart. For detail, please refer to Document[6].

## Technical Characteristics

## 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) <br> $<120$ 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

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### 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 V. |

## 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 $5 * 20 \mathrm{~mm}$. 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. 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 E-GSM 900/DCS 1800 MHz - GPRS class 10 |  |  |  | E-GSM 900 | DCS 1800 |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{aligned} & \text { E } \\ & \text { K } \end{aligned}$ | $\mathrm{I}_{\text {peak }}$ | GSM900: During TX bursts @ PCL5 DCS1800 : During TX bursts @ PCLO | @ 5.5V | TBC | TBC |
|  |  |  | @ 13.2V | TBC | TBC |
|  |  |  | @ 32V | TBC | TBC |
|  | $I_{\text {avg }}$ | GSM900 : Average © PCLL DCS1800 : Average ©'PCLO | @ 5.5V | TBC | TBC |
|  |  |  | @ 13.2V | TBC | TBC |
|  |  |  | @ 32V | TBC | TBC |
|  | $I_{\text {peak }}$ | GSM900: During 1TX bursts @ PCL5 DCS1800 : During 1TX bursts @ PCLO | @ 5.5V | TBC | TBC |
|  |  |  | @ 13.2V | TBC | TBC |
|  |  |  | @ 32V | TBC | TBC |
|  | 1 avo | GSM900: Average 1TX/1RX @PCL5 DCS1800 : Average.1TX/1RX @PCL0 | @ 5.5V | TBC | TBC |
|  |  |  | @ 13.2V | TBC | TBC |
|  |  |  | @ 32V | TBC | TBC |
|  | $\mathrm{I}_{\text {peak }}$ | GSM900: During 2TX bursts @ PCL5 (Gamma 3) <br> DCS1800 : During 2TX bursts @ PCLO (Gamma 2) | @ 5.5V | TBC | TBC |
|  |  |  | @ 13.2V | TBC | TBC |
|  |  |  | @ 32V | TBC | TBC |
|  | $I_{\text {ava }}$ | GSM900: Average 2TX/3RX @ PCL5 (Gamma 3) DCS1800 : Average 2TX/3RX @ PCLO (Gamma 2) | @ 5.5V | TBC | TBC |
|  |  |  | @ 13.2V | TBC | TBC |
|  |  |  | @ 32V | TBC | TBC |
| NO00000000$U$ | $\mathrm{I}_{\text {peak }}$ | GSM900: During 1TX bursts @ PCL8 (Gamma 6) <br> DCS1800 : During 1TX bursts @ PCL2 (Gamma 5) | @ 5.5V | TBC | TBC |
|  |  |  | @ 13.2V | TBC | TBC |
|  |  |  | @ 32V | TBC | TBC |
|  | 1 mvg | GSM900: Average 1TX1RX @ PCL8 (Gamma 6) DC゙S1800: Average 1TX1RX @ PCL2 (Gamma 5) | @ 5.5V | TBC | TBC |
|  |  |  | @ 13.2V | TBC | TBC |
|  |  |  | @ 32V | TBC | TBC |

Technical Characteristics

| Power Consumption in E-GSM 900/DCS 1800 MHz - GPRS class 10 |  |  |  |  | E-GSM 900 | DCS 1800 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\mathrm{I}_{\text {peak }}$ | GSM900: During 2TX bursts @ PCL8 (Gamma 6) DCS1800 : During 2TX bursts @ PCL2 (Gamma 5) |  | @ 5.5V | TBC | TBC |
|  |  |  |  | @ 13.2V | TBC | TBC |
|  |  |  |  | @ 32V | TBC | TBC |
|  | I ang | GSM900 : Average 2TX/3RX @ PC்L8 (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 |
| $I_{\text {avg }}$ 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 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 $\left.+55^{\circ} \mathrm{C}\right)$.
( $2^{*}$ ): 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).
$\mathbf{( 4 *}^{*}$ ): In this Mode, the RF function is disabled, and there is no synchronization with the network.

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### 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 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 |

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 RESET SIgnal

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

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 |
| $\mathrm{~V}_{\mathrm{IH}}$ | 1.33 |  |  | V |

${ }^{*} \mathrm{~V}_{\mathrm{H}:}$ Hysterisis Voltage
1 This reset time is the minimum to be carried out on the ~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 Frequency Ranges

Table 27: Frequency ranges

| Characteristic | GSM $\mathbf{8 5 0}$ | 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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### 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 | 00 hm |
| 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 (IEC 60721-3-1) Class IE13 | Transportation (IEC 60721-3-2) <br> Class IE23 | Operation |  |
|  |  |  |  | Stationary (IEC 60721-3-3) Class IE35 | Non-Stationary (IEC 60721-3-7) Class IE73 |
| Cold | IEC 60068-2-1 : Ab/Ad | $-25^{\circ} \mathrm{C}, 16 \mathrm{~h}$ | $40^{\circ} \mathrm{C}, 16 \mathrm{~h}$ | $-5^{\circ} \mathrm{C}, 16 \mathrm{~h}$ | $-5^{\circ} \mathrm{C}, 16 \mathrm{~h}$ |
| Dry heat | $\begin{gathered} \text { IEC } 60068-2-2 \text { : } \\ B \mathrm{~B} / \mathrm{Bd} \end{gathered}$ | $+70^{\circ} \mathrm{C}, 16 \mathrm{~h}$ | $+70^{\circ} \mathrm{C}, 16 \mathrm{~h}$ | $+55^{\circ} \mathrm{C} .16 \mathrm{~h}$ | $+55^{\circ} \mathrm{C}, 16 \mathrm{~h}$ |
| Change of temperature | $\begin{gathered} \text { IEC } 60068-2-14: \\ \mathrm{Na} / \mathrm{Nb} \end{gathered}$ | $-33^{\circ} \mathrm{C}$ to ambient 2 cycles, $11=3 \mathrm{~h}$ $1^{\circ} \mathrm{C} . \mathrm{min}^{-1}$ | $-40^{\circ} \mathrm{C}$ to ambient 5 cycles, $\mathrm{t} 1=3 \mathrm{~h}$ $12<3 \mathrm{~min}$ | $-5^{\circ} \mathrm{C}$ to ambient 2 cycles, $11=3 \mathrm{~h}$ $0.5^{\circ} \mathrm{C}$. min $^{-1}$ | $-5^{\circ} \mathrm{C}$ to ambient 5 cycles, $\mathrm{t} 1=3 \mathrm{~h}$ $12<3$ min |
| Damp heat | IEC 60068-2-56: Cb | $\begin{gathered} +30^{\circ} \mathrm{C}, 93 \% \mathrm{RH} \\ 96 \mathrm{~h} \end{gathered}$ | $+40^{\circ} \mathrm{C}, 93 \% \mathrm{RH}$ 96 h minimum | $+30^{\circ} \mathrm{C}, \underset{h}{93 \%} \mathrm{RH}, 96$ | $+30^{\circ} \mathrm{C}, 93 \% \mathrm{RH}, 96 \mathrm{~h}$ |
| Damp heat, cyclic | $60068-2-30: \mathrm{Db}$ $\text { Vaniant } 1 \text { or } 2$ | $\begin{gathered} +40^{\circ} \mathrm{C}, 90 \% \text { to } \\ 100 \% \text { RH } \\ \text { One cycle } \\ \text { Vaniant } 2 \end{gathered}$ | $+55^{\circ} \mathrm{C}, 90 \%$ to $100 \%$ RH Two cycles Variant 2 | $\begin{gathered} +30^{\circ} \mathrm{C}, 90 \% \text { to } 100 \% \\ \text { RH } \\ \text { Two cycles } \\ \text { Vaniant } 2 \end{gathered}$ | $+40^{\circ} \mathrm{C}, 90 \%$ to $100 \% \mathrm{RH}$ Two cycles Variant 1 |
| Vibration (sinusoidal) | IEC 60068-2-6 : Fc | 1.200 Hz $2 \mathrm{m}. \mathrm{~s}^{-2}$ $0,75 \mathrm{~mm}$ 3 axes 10 sweep cycles | $\begin{gathered} 1-500 \mathrm{~Hz} \\ 10 \mathrm{~m} . \mathrm{s}^{-2} \\ 3,5 \mathrm{~mm} \\ 3 \text { axes } \\ 10 \text { sweep cycles } \end{gathered}$ | $1-150 \mathrm{~Hz}$ $2 \mathrm{~m} . \mathrm{s}^{-2}$ 0.75 mm 3 axes 5 sweep cycles | $\begin{gathered} 1.500 \mathrm{~Hz} \\ 10 \mathrm{m.s} \\ 3.5 \mathrm{~mm} \\ 3 \text { axes } \\ 10 \text { sweep cycles } \end{gathered}$ |
| Vibration (random) | IEC 60068-2-64 : Fh | - | $\begin{gathered} 10-100 \mathrm{~Hz} / 1.0 \mathrm{~m}^{2} \cdot \mathrm{~s}^{-3} \\ 100-200 \mathrm{~Hz} /-3 \mathrm{~dB} \cdot \mathrm{ctave}^{-1} \\ 200-2000 \mathrm{~Hz} / 0.5 \mathrm{~m}^{2} \cdot \mathrm{~s}^{-3} \\ 3 \text { axes } \\ 30 \mathrm{~min} \end{gathered}$ | - | - |
| 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 60058-2-29 : Eb | - | $250 \mathrm{~m} . \mathrm{s}^{-2}$ 6 ms 50 bumps vertical direction | - | - |
| Free fall | ISO 4180-2 | - | Two falls in each specified attifude | - | 2 falls in each specified attitude 0.025 m ( $<1 \mathrm{~kg}$ ) |
| Drop and topple | IEC 60068-2-31 : Ec | - | One drop on relevant comer One topple about each bottom edge | - | One drop on each relevant comer One topple on each of 4 botlom edges |

# Fastrack Supreme User Guide 

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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Make it wireless

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) |
| EN 301 489-7 (edition 2002) |  |

### 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 $800 \mathrm{~mA} / 250 \mathrm{~V}$ 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.


## 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 ${ }^{\text {© }}$ :

- 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 Wiretess CPU ${ }^{*}$. 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 ${ }^{*}$.

The use of third party equipment or accessories, not made or authorized by Wavecom may invalidate the warranty of the Wireless CPU ${ }^{\star}$.
Do contact an authorized Service Center in the unlikely event of a fault in the Wireless CPU ${ }^{\text {®. }}$.

### 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.

## 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 Antenna adaptor |  | PROCOM |
| Power adaptor (Europe) | EGSTDW P2 EF9W3 24W <br> Out:12 V-2A <br> In: 100 to $240 \mathrm{~V}-50 / 60 \mathrm{~Hz}-550 \mathrm{~mA}$ <br> Mounted with micro-fit connector | EGSTDW (for power adaptor) <br> MOLEX (for micro-fit connector)* |
| Fuse | F800L250V | Shanghai Fullness |
| IESM GPS + USB | M13SUE01 | WAVECOM |
| IESM IO + USB | M13SUE02 | WAVECOM |
| IESM IO + USB + GPS | M13SUE03 | WAVECOM |

* Information not available for this preliminary version.



## 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 $A T^{(8)}$
- 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.

1. HUMAN MACHINE INTERFACE TECHNICAL DETAILS

# MODEL G306A - GRAPHIC COLOR LCD OPERATOR INTERFACE TERMINAL WITH TFT QVGA DISPLAY AND TOUCHSCREEN 



LABORATORY EQUIPMENT

FOR USE IN HAZARDOUS LOCATIONS:
Class I, Division 2, Groups A, B, C, and D Class II, Division 2, Groups F and G
Class III, Division 2

- CONFIGURED USING CRIMSON SOFTWARE (BUILD 424 OR NEWER)
- 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 (8 MBYTE FLASH)
- COMPACTFLASH ${ }^{8}$ SOCKET TO INCREASE MEMORY CAPACITY
- 5.7-INCH TFT ACTIVE 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 G306A 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 G306A to perform many of the normal features of the Paradigm range of Operator Interfaces while improving and adding new features.

The G306A 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 G306A 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 G306A 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 safery 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 prior to installation and operation of the unit.

## CONTENTS OF PACKAGE

- G306A 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 |
| :---: | :---: | :---: |
| G306A | Operator Interface for indoor applications, textured finish with embossed keys | G306A000 |
| G3CF | 64 MB CompactFlash Card ${ }^{5}$ | G3CF064M |
|  | 256 MB CompactFlash Card ${ }^{5}$ | G3CF256M |
|  | 512 MB CompactFlash Card ${ }^{5}$ | G3CF512M |
| G3RS | RS232/485 Optional Communication Card | G3RS0000 |
| G3CN | CANopen Optional Communication Card | G3CN0000 |
| G3DN | DeviceNet option card for G3 operator interfaces lated high speed communications ports | G3DN0000 |
| G3PBDP | Profibus DP Optional Communication Card | G3PBDP00 |
| PSDR7 | DIN Rail Power Supply | PSDR7000 |
| SFCRM2 | Crimson $2.0{ }^{2}$ | SFCRM200 |
| CBL | RS-232 Programming Cable | CBLPROG0 |
|  | USB Cable | CBLUSB00 |
|  | Communications Cables ${ }^{1}$ | CBLxx ${ }^{\text {cxx }}$ |
| DR | DIN Rail Mountable Adapter Products ${ }^{3}$ | DRxxxxxx |
|  | Replacement Battery ${ }^{4}$ | BNL20000 |
| G3FILM | Protective Fitms | G3FILM06 |

1 Contact your Red Lion distributor or visit our website for complete selection.
${ }^{2}$ Use this part number to purchase the Crimson ${ }^{8}$ software on CD with a printed manual, USB cable, and RS-232 cable. Otherwise, download for free from www.redlion.net.
${ }^{3}$ 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 cycles.

## SpECIFICATIONS

## 1. POWER REQUIREMENTS

Must use Class 2 or SELV rated power supply.
Power connection via removable three position terminal block
Supply Voltage: $\quad+24 \mathrm{VDC} \pm 20 \%$
Typical Power ${ }^{1}$ : 8 W
Maximum Power ${ }^{2}$ : 14 W
Notes:

1. Typical power with $+2 \pm$ VDC. RS232/485 communications, Ethernet communications, Compactliash card installed, and displey at full brightness.
2. Maximum power indicates the most power that can be drawn from the G306A. Refer to "Power Supply Requirements" under "Installing and Powering the G306A."
3. The G306A's circuit common is not connected to the enclosure of the unit. See "Connecting to Earth Ground" in the section "Installing and Powering the G306A."
4. Read "Power Supply Requirements" in the section "Installing and Powering the G306A" for additional power supply information.
5. BATTERY: Lithium coin cell. Typical lifetime of 10 years.
6. LCD DISPLAY:

| SIZE | 5.7 -inch |
| :--- | :---: |
| TYPE | TFT |
| COLORS | 256 |
| PIXELS | $320 \times 240$ |
| BRIGHTNESS | $500 \mathrm{~cd} / \mathrm{m}^{2}$ |
| BACKLIGHT* | $40,000 \mathrm{HR} \mathrm{TYP}$. |

"Lifetime at room temperature. Refer to "Display" in "Software/Unit Operation"
4. 5-KEY KEYPAD: for on-screen menus.
5. TOUCHSCREEN: Resistive analog
6. MEMORY:

On Board User Memory: 8 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 1.I. 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 RJI2.
DH485 TXEN: Transmit enable; open collector, $\mathrm{V}_{\mathrm{OH}}=15 \mathrm{VDC}$, $\mathrm{V}_{\mathrm{OL}}=0.5 \mathrm{~V} @ 25 \mathrm{~mA}$ max.
Note: For additional information on the communications or signal common and connections to earth ground please see the "Connecting to Earth Ground" in the section "Installing and Powering the G306A."
Ethernet Port: 10 BASE-T / 100 BASE-TX
RJ45 jack is wired as a NIC (Network Interface Card).
Isolation from Ethernet 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 Humidity: $80 \%$ maximum relative humidity (noncondensing) from 0 to $50^{\circ} \mathrm{C}$.
Vibration according to IEC 68-2-6: Operational 5 to $8 \mathrm{~Hz}, 0.8^{\prime \prime}$ (p-p), 8 to 500 Hz , in X, Y, Z direction, duration: 1 hour, 3 g .
Shock according to IEC 68-2-27: Operational $40 \mathrm{~g}, 9 \mathrm{msec}$ in 3 directions.
Altitude: Up to 2000 meters.
9. CERTIFICATIONS AND COMPLIANCES:

SAFETY
UL Recognized Component, File \#E179259, UL61010-1, CSA 22.2 No.61010-1 Recognized to U.S. and Canadian requirements under the Component Recognition Program of Underwriters Laboratories, Inc.
UL Listed, File \#E211967, UL61010-1, UL1604, CSA 22.2 No. 61010.1, CSA 22.2 No. 213-M1987
LISTED by Und. Lab. Inc. to U.S. and Canadian safety standards
Type 4X Indoor Enclosure rating (Face only), ULS0
IECEE CB Scheme Test Certificate \#US/12460/UL,
CB Scheme Test Report \#E179259-A1-CB-1
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 Laboratory use.
Immunity to Industrial Locations:
Electrostatic discharge EN 61000-4-2 Criterion A 4 kV contact discharge 8 kV air discharge
Electromagnetic RF fields
Fast transients (burst)

Surge 1 kV signal
1 kV L-L,
2 kV L\&N-E power
RF conducted interference
Emissions:
Emissions EN 55011
Criterion

Nole:

1. Criterion A: Normal operation within specified limits.
2. CONNECTIONS: Compression cage-clamp terminal block.

Wire Gage: 12-30 AWG copper wire
Torque: 5-7 inch-pounds ( $56-79 \mathrm{~N}-\mathrm{cm}$ )
11. CONSTRUCTION: Steel rear metal enclosure with NEMA 4X/IP66 aluminum front plate for indoor use only when correctly fitted with the gasket provided. Installation Category II, Pollution Degree 2.
12. MOUNTING REQUIREMENTS: Maximum panel thickness is 0.25 " (6.3 mm ). For NEMA 4XЛP66 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 ( $1.92 \mathrm{~N}-\mathrm{m}$ )
13. WEIGHT: $3.0 \mathrm{lbs}(1.36 \mathrm{Kg})$

## DIMENSIONS In inches (mm)



## Installing and Powering the G306A

## 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 4X/IP66 specification. Install the ten kep nuts provided and tighten evenly for uniform gasket compression.

Note: Tightening the kep nuts beyond a maximum of 17 inch-pounds (1.92 N$m$ ) may cause damage to the front panel.


ALL NONINCENDIVE CIRCUITS MUST BE WIRED USING DIVISION 2 WRING 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 earthing system.

Each G306A 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 must be taken when connections are made to the unit. For example, a power supply with isolation between its signal common and earth ground must be used. Also, plugging in a USB cable may connect signal common 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 G306A 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. ltems 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 must 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 SELV rating is to be used. A Class 2 or SELV 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 voltage 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 G306A

## CONFIGURING A G306A

The G306A is configured using Crimson ${ }^{(1}$ 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 avaitable. By configuring the G306A 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 G306A 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 "G306A Por Pin Out Diagram" for wiring information.

The CompaciFlash 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.:Program Files\Red Lion ControlstCrimson 2.0Devicel after Crimson is installed. This may have already been accomplished if your G306A was configured using the USB port

Once the driver is installed, connect the G306A to your PC with a USB cable, and follow "Mounting the CompactFlash" 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 "G306A Port Pin Outs" for wiring information.

## ETHERNET COMMUNICATIONS

Ethernet communications can be established at either 10 BASE-T or 100 BASE-TX. The G306A 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 left. The LEDs represent the following statuses:

| LED COLOR | DESCRIPTION |
| :--- | :--- |
| YELLOW solid | Link established. |
| YELLOW 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 G306A 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 master or slave protocols with any G306A 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 G 3 product or the Modular Controller can be established. Red Lion part numbers for cables with a twist in them are CBLPROG0 ${ }^{1}$, CBLRLC01 ${ }^{2}$, or CBLRC02 ${ }^{3}$.

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 GJOGA OPERATOR
INTERFACE TO AN ICM5

${ }^{1}$ CBLPROGO can also be used to communicate with either a PC or an ICM5.
${ }^{2}$ DB9 adapter not included, 1 foot long.
${ }^{3}$ DB9 adapter not included, 10 feet long.


## RS422/485 COMMS PORT

The G306A 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 wwwiredlion.net for additional information.

## Examples of RS485 2-Wire Connections

G3 to Modular Controller (CBLRLC05)

| Connections |  |  |  |
| :---: | :---: | :---: | :---: |
| G3 | Name | Modular Controller | Name |
| 1,4 | Tx8 | 1,4 | T×B |
| 4,1 | R×B | 4,1 | R×B |
| 2,3 | T×A | 2,3 | T×A |
| 3,2 | R×A | 3,2 | R×A |
| 5 | TxEN | 5 | TxEN |
| 6 | COM | 6 | COM |
| 7 | TxB | 7 | TxB |
| 8 | T×A | 8 | T×A |

G3 to Red Lion RJ11 (CBLRLC00) DLC, IAMS, ITMS, PAXCDC4C

| Connections |  |  |  |
| :---: | :---: | :---: | :---: |
| G3: RJ45 | Name | RLC: RJ11 | Name |
| 5 | TxEN | 2 | TxEN |
| 6 | COM | 3 | COM |
| 1 | TxB | 5 | B- |
| 2 | TxA | 4 | A+ |

## DH485 COMMUNICATIONS

The G306A's RS422/485 COMMS port can also be used for Allen Bradley DH485 communications

WARNING: DO NOT use a standard DH485 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 | TxA | 2 | B |
| 3,8 | RxA | - | 24 V |
| 4,7 | RxB | - | COMM |
| 5 | TxEN | 5 | TxEN |
| 6 | COMM | 4 | SHIELD |
| 4,7 | TxB | - | COMM |
| 3,8 | TxA | - | $24 V$ |

## Software/Unit Operation

## CRIMSON ${ }^{\circledR}$ SOFTWARE

Crimson ${ }^{\infty}$ 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 crystal display (LCD) 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 turned on at full intensity. Turning the backlight off when the display is not in use can extend the lifetime of your backlight. This can be accomplished through the Crimson ${ }^{\text {® }}$ software when configuring your unit.

## FRONT PANEL LEDS

There are three front panel LEDs. Shown below is the default status of the LEDs.

| LED | INQICATION |
| :---: | :--- |
| RED (TOP, LABELED "PWR") |  |
| FLASHING | Unit is in the boot loader, no valid configuration is loaded. ${ }^{1}$ |
| STEADY | Unit is powered and running an application. |
| YELIOW (MIDDLE) |  |
| OFF | No CompactFlash card is present. |
| STEADY | Valid CompactFlash card present. |
| FLASHING <br> RAPIDLY | CompactFlash card being checked. <br> FLICKERINGUnit is writing to the CompactFlash, either because it is storing <br> data, or because the PC connected via the USB port has <br> locked the drive. ${ }^{2}$ |
| FLASHING | Incorrectly formatted CompactFlash card present. |
| SLOWLY | CREEN (BOTTOM) |
| FLASHING | A tag is in an alarm state. |
| STEADY | Valid configuration is loaded and there are no alarms present. |

I 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 LED still continues to flash, try downloading a configuration again.
${ }^{2}$ Do not tum off power to the unit while this light is flickering. The unit writes data in two minute intervals. Later Microsoft 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 CompactFlash" 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 G306A keypad consists of five keys that can be used for on-screen menus.

## TROUBLESHOOTING YOUR G306A

If for any reason you have trouble operating, connecting, or simply have questions concerning your new G306A, contact Red Lion's technical support. For contact information, refer to the back page of this bulletin for phone and fax numbers.

EMAIL: techsuppon@redlionnet Web Site: hap://www.redlion.nes

## 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 IVO WRING AND BATTERY.


WARNING - EXPLOSION HAZARD - DO NOT DISCONNECT EQUIPMENT UNLESS POWER HAS BEEN DISCONNECTED AND THE AREA IS KNOWN TO BE NON-HAZARDOUS.

A battery is used to keep time when the unit is without power. Typical accuracy of the G306A time keeping is less than one minute per month drift. The battery of a G306A unit does not affect the unit's memory, all configurations and data is stored in non-volatile memory.

## CAUTION: RISK OF ELECTRIC SHOCK

The inverter board, attached to the mounting plate, supplies the high voltage to operate the backlight. Touching the inverter board may result in injury to personnel.


CAUTION: The circuit board contains static sensitive components. Before handling the operator interface without the rear cover atlached, discharge static charges from your body by touching a grounded bare metal object. Ideally, handle the operator interface at a static controlled clean 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 G306A, 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 lifting the top side, hinge the cover, thus providing clearance for the connectors on the bothom side of the PCB as shown in the illustration below. Install in the reverse manner.


Remove the old battery* from the holder and replace with the new battery. Replace the rear cover, cables, and re-apply power. Using Crimson or the unit's keypad, enter the correct time and date.

* Please note that the old battery must be disposed of in a manner that complies with your local waste regulations. Also, the battery must not be disposed of in fire, or in a manner whereby it may be damaged and its contents come into contact with human skin.

The battery used by the G306A is a lithium type CR2025.


## Optional Features and Accessories

## OPTIONAL COMMUNICATION CARD

Red Lion offers optional communication cards for fieldbus communications. These communication cards will allow your G306A 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 and a maximum of 2 Gbytes with the G306A's CompactFlash socket. Cards are available at mosi computer and office supply retailers.

Compaciflash can be used for configuration transfers, larger configurations, data logging, and trending.
 the CompactFlash card while power is applied. Refer to
"Front Panel LEDs."
Information stored on a CompactFlash card by a G306A can be read by a card reader attached to a PC. This infonnation is stored in IBM (Windows ${ }^{\text {² }}$ ) PC compatible FAT16 file format.

## NOTE

For reliable operation in all of our products, Red Lion recommends the use of SanDisk ${ }^{(0)}$ 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

The Company warrants the products it manufactures against defects in materials and workmanship for a period limited to two years from the date of shipment, provided the products have been stored, bandled, installed, and used under proper conditions. The Company's lisbility under this limited warranty shall extend only to the repais or replacement of a defective producl, al The Company's option. The Company disclaims all liability for any affirmation, promise or representation with respect to the products.
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## LEVEL TRANSMITTER

## 1. LEVEL TRANSMITTER TECHNICAL DETAILS



## Technical Information

## Waterpilot FMX167

Hydrostatic level measurement
Reliable and robust level probe with ceramic measuring cell Compact device for level measurement in fresh water, wastewater and saltwater


## Application

The Waterpilot FMXI 67 is a pressure sensor for hydrostatic level measurement.
Three versions of FMX167 are available at Endress+Hauser:

- FMX167 with a stainless steel housing, outer diameter of $22 \mathrm{~mm}(0.87 \mathrm{inch})$ : Standard version suitable for drinking water applications and for use in bore holes and wells with small diameters
- FMX 167 with a stainless steel housing, outer diameter of 42 mm ( 1.66 inch): Heavy duty version, easy clean flush-mounted process diaphragm. Ideally suited to wastewater and sewage treatment plants
- FMXI67 with a coated housing, outer diameter of $29 \mathrm{~mm}(1.15$ inch): Corrosion resistant version generally for use in saltwater, particularly for ship ballast water tanks.


## Your benefits

- High mechanical resistance to overload and aggressive media
- High-precision, robust ceramic measuring cell with long-term stability
- Climate proofed sensor thanks to completely potted electronics and 2 -iilter pressure compensation system
- 4 to 20 mA output signal with integrated overvoltage protection
- Simultaneous measurement of level and temperature with optionally integrated Pt100 temperature sensor
- Drinking water approvals: KTW, NSF, ACS
- Approvals: ATEX, FM and CSA
- Marine certificate: GL, ABS
- Extensive range of accessories provides complete measuring point solutions


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Function and system design

| Device selection |  |  |  |
| :---: | :---: | :---: | :---: |
| Waterpilot FMX 167 |  |  |  |
| Field of application | Hydrostatic level measurement in deep wells e.g. drinking water | Hydrostatic level measurement in wastewater | Hydrostatic level measurement in salwater |
|  | d Caution! <br> The Waterpilot is not suitable for use in biogas plants since the gases can diffuse through the elastomers (seals, extension cable). Endress+Hauser offers the Deltapilot level transmitter for biogas applications. |  |  |
| Process connection | - Mounting clamp <br> - Extension cable mounting screw with G1 $1 / 2$ A or $1 / 1 / 2$ NPT thread |  |  |
| Outer diameter | 22 mm (0.87") | 42 mm (1.65*) | Max. 29 mm (1.14*) |
| Extension cable | - PE extension cable <br> - PUR extension cable <br> - FEP extension cable |  |  |
| Seals | - FKM Viton <br> - EPDM ${ }^{11}$ | - FKM Viton | - FKM Viton <br> - EPDM |
| Measuring ranges | - Nine fixed pressure measuring ranges in bar, $\mathrm{mH}_{2} \mathrm{O}$, psi and $\mathrm{fH}_{2} \mathrm{O}$, from 0 to 0.1 bar to 0 to 20 bar ( 0 to $1 \mathrm{mH}_{2} \mathrm{O}$ to 0 to $200 \mathrm{mH}_{2} \mathrm{O} /$ 0 to 1.5 psi to 0 to $300 \mathrm{psi} / 0$ to $3 \mathrm{fH}_{2} \mathrm{O}$ to 0 to $600 \mathrm{ftH}_{2} \mathrm{O}$ ) <br> - Customer-specific measuring ranges; factory-calibrated |  | - Seven fixed pressure measuring ranges in bar, $\mathrm{mH}_{2} \mathrm{O}$, psi and $\mathrm{ftH}_{2} \mathrm{O}$, from 0 to 0.1 bar to 0 to 4 bar (0 to $1 \mathrm{mH}_{2} \mathrm{O}$ to 0 to $40 \mathrm{mH}_{2} \mathrm{O}$ / 0 to 1.5 psi to 0 to $60 \mathrm{psi} /$ 0 to $3 \mathrm{ft}_{2} \mathrm{O}$ to 0 to $150 \mathrm{ft}_{2} \mathrm{O}$ ) <br> - Customer-specific measuring ranges; factory-calibrated |
| Overload | Up to 40 bar ( 580 psi ) |  | Up to 25 bar (362 psi) |
| Process temperature | -10 to $+70^{\circ} \mathrm{C}\left(14\right.$ to $\left.158^{\circ} \mathrm{F}\right)$ |  | 0 to $+50^{\circ} \mathrm{C}\left(32\right.$ to $\left.122^{\circ} \mathrm{F}\right)$ |
| Ambient temperature range | -10 to $+70^{\circ} \mathrm{C}\left(14\right.$ to $\left.158^{\circ} \mathrm{F}\right)$ |  | $010+50^{\circ} \mathrm{C}\left(32\right.$ to $\left.122^{\circ} \mathrm{F}\right)$ |
| Maximum measured error | $\pm 0.2 \%$ of upper range value (URV) |  |  |
| Supply voltage | 10 to 30 V DC |  |  |
| Output | 4 to 20 mA |  |  |
| Options | - Drinking water approval |  |  |
|  | - Integrated Pt100 temperature sensor <br> - Integrated Pt 100 temperature sensor and TMT181 temperature head transmitter (4 to $20 \mathrm{~mA} / \mathrm{HART}$ ) <br> - Marine approval |  |  |
| Specialties | - Large selection of approvals, including ATEX II 2 G, FM and CSA <br> - High-precision, robust ceramic measuring cell with long-term stability <br> - Customer-specific cable marking |  |  |

1) Recommended for drinking water applications, not suitable for use in hazardous areas

The ceramic measuring cell is a dry measuring cell, i.e. pressure acts directly on the robust ceramic process isolating diaphragm of the Waterpilot.
Any changes in the air pressure are routed through the extension cable, via a pressure compensation tube, to the rear of the ceramic process isolating diaphragm and compensated for. A pressure-dependent change in capacitance caused by the movement of the process isolating diaphragm is measured at the electrodes of the ceramic carrier. The electronics convert the movement into a pressure-proportional signal which is linear to the medium level.


Measuring principle

| l | Ceramic measuring cell |
| :--- | :--- |
| 2 | Pressure compensation tube |
| h | Level height |
| p | Total pressure $=$ hydrostatic pressure + atmospheric pressure |
| $\rho$ | Density of the medium |
| g | Gravitational acceleration |
| Phydr $_{\text {hyd }}$ | Hydrostatic pressure |
| $\mathrm{p}_{\mathrm{azm}}$ | Atmospheric pressure |

## Temperature measurement with optional $\mathrm{Pt} 100^{1)}$

Endress+Hauser also offers the Waterpilot FMX167 with an optional 4-wire Pt100 resistance thermometer to measure level and temperature simultaneously. The Pt100 belongs to Accuracy Class B in accordance with DIN EN 60751 , see also $\rightarrow$ 22, Sect. "Accessories.

Temperature measurement with optional Pt100 and TMT181 temperature head transmitter
To convert the Pt100 signal to a 4 to 20 mA signal, Endress + Hauser also offers the TMT 181 temperature transmitter.

[^6]
## Measuring system

The complete standard measuring system consists of Waterpilot and a transmittes power supply unit with supply voltage of 10 to 30 V DC.

Possible measuring point solutions with a transmitter and evaluation units from Endress+hauser:


Application examples with FMX167
OVP = Overvoltage protection e.g. HAW from Endress + Hauser (not for use in hazardous areas)

- OVP on the sensor side for field installation: HAW569/for top-hat rail/DINrail: HAW562
- OVP on the supply side for top-hat railDINrail: HAWS61 (115/230 V) and HAW561K ( $24 / 48 \mathrm{~V}$ ACIDC)

Option dependent on supply voltage.

1. Simple cost-effective measuring point solution: Power supply of Waterpilot in hazardous and nonhazardous areas using RN221N active barmier.
Power supply and additional control of two consumers, e.g. pumps, via limit switch RTA42I with onsite display.
2. Evaluation unit RIA45 (for panel mounting) provides a power supply system, an onsite display and two switch outputs.
3. If several pumps are used, the pump service life can be prolonged by alternate switching. With altemaling pump control, the pump which was out of service for the longest period of time is switched on. The evaluation unit RIA452 (for panel mounting) provides this option in additional to several other funclions.
4. State-of-the-art recording technology with graphic display recorders from Endress+Hauser, such as Ecograph $\uparrow$, Memograph $M$, or paper recorders such as Alphalog for documenting, monitoring, visualizing and archjving purposes.


Application examples with FMX 167
OVP = Overvolage protection e.g. HAW from Endress+Hauser (not for use in hazardous areas)

- OVP on the sensor side for field installation: HAW569/for top-hat rail/DINrail: HAW562
- OVP on the supply side for top-hat rai/DINrail: HAW561 ( $115 / 230 \mathrm{~V}$ ) and HAW561K ( $24 / 48 \mathrm{~V}$ AC/DC)

Option dependent on supply voltage.
5. If you want to measure, display and evaluate the temperature as well as the level, e.g. to monitor temperature in fresh water to detect temperature limits for germ formation, you have the following options:
The optional TMT 181 temperature head transmitter can convert the Pt100 signal to a 4 to 20 mA HART signal and transfer it to any common evaluation unit. The RMA421, RIA45 and RIA452 evaluation units also offer a direct input for the Pt100 signal.
6. If you want to record and evaluate the level and temperature measured value with one device, use the RMA422, RIA45 and RIA46 evaluation units with two inputs. It is even possible to mathematically link the input signals with this unit. These evaluation units are not HART-compatible.

The device can be fitted with a tag name, see $\rightarrow 21$ ff, "Ordering information", feature 995 "Marking" version "1".


| Input signal | FMX167 +Pt100 (optional) | TMT181 temperature head transmitter <br> (optional) |
| :--- | :--- | :--- |
|  | - Change in capacitance |  |
|  | - Pt100: change in resistance |  |

## Output

| Output signal | FMX167 + P4100 (optional) <br> - FMX167: 4 to 20 mA for hydrostatic pressure measured value, two-wire <br> - Pt100: Temperature-dependent resistance value of the Pt100 | TMT181 temperature head transmitter (optional) <br> - 4 to 20 mA for temperature measured value, two-wire |
| :---: | :---: | :---: |
| Load | FMX167+ Pt100 (optional) | TMT181 temperature head transmitter (optional) |
|  | $R_{\text {tol }} \leq \frac{U_{b}-10 \mathrm{~V}}{0.0225 \mathrm{~A}}-2 \cdot 0.09 \frac{\Omega}{m} \cdot 1-R_{\mathrm{add}}$ <br>  | $R_{\text {tol }} \leq \frac{\mathrm{U}_{\mathrm{b}}-8 \mathrm{~V}}{0.025 \mathrm{~A}}-\mathrm{R}_{\text {edd }}$ |

$\mathrm{R}_{\mathrm{gcs}}=$ Max. load resistance $[\Omega]$
$\mathrm{R}_{\text {edd }}=$ additional resistances such as resistance of evaluation unit and/or display unit, cable resistance $[\Omega]$
$\mathrm{U}_{\mathrm{b}}=$ Supply voltage [V]
1 = Simple length of extension cable [m] (cable resistance per wire $\leq 0.09 / \Omega \mathrm{m}$ )

Note!
When using the measuring device in hazardous areas, installation must comply with the applicable national standards and regulations and the Safety Instructions or Installation or Control Drawings.


FMX 167 load char for estimating the load resistance. Additional resistances, such as the resistance of the extension cable, have to be subtracted from the valuc calculated as shown in the equation.


Temperature head transmitter load chan for estimating the load resistance. Additional resistances have to be subtracted from the value calculated as shown in the equation.

## Power supply

## Measuring unit electrical connection

Note!

- When using the measuring device in hazardous areas, installation must comply with the applicable national standards and regulations and the Safety Instructions (XAs) or the Installation or Control Drawings (2Ds), see also $\rightarrow$ 23, Sect. "Safety instructions", "Installation/Control Drawings".
- Reverse polarity protection is integrated in the Waterpilot FMX167 and in the temperature head transmitter TMT181. Changing the polarities will not result in the destruction of the devices.
- The cable must end in a dry room or a suitable terminal box. For installation outside, use the terminal box (IP 66/IP 67) with a GORE-TEX ${ }^{\otimes}$ filter from Endress+Hauser. The terminal box can be ordered using the order code of the FMX167 ( $\rightarrow$ 21, Sect. "Ordering information") or as an accessory Accessories (order number: 52006252).

Waterpilot FMX167, standard


FMX167 electrical connection, versions "7" or " 3 " for Feature 70 "Additional options" in the order code $\left(\begin{array}{ll}\rightarrow & 21) \text {. } . . . . ~\end{array}\right.$ MX 167 electrical connection with Pt 100 , versions " 1 " or "4" for Feature 70 "Additional options" in the order code $(\rightarrow 21)$.
(1) Not for FMX167 with outer diameter $29 \mathrm{~mm}(1.15 \mathrm{in})$

Waterpilot FMX 167 with Pt100 and TMT181 temperature head transmitter TMT181) ( 4 to 20 mA )


FMX167 with Pt100 and TMT181 temperature head transmitter ( 4 to 20 mA ), version " 5 " for Feature 70 in the order code $(\rightarrow \quad 21)$.
(1) Not for FMX 167 with outer diameter 29 mm ( 1.14 in )

Wire colors: $R D=$ red, $B K=$ black, $W H=$ white,$Y E=$ yellow, $B U=$ blue, $B R=$ brown

| Supply voltage | Note! |  |
| :---: | :---: | :---: |
|  | When using the measuring device in hazardous areas, installation must comply with the applicable national standards and regulations and the Safety Instructions (XAs) or the Installation or Control Drawings (ZDs). $\rightarrow$ 23, Sect. "Safety instructions", "Installation/Control Drawings". |  |
|  | FMX167 + Pt100 (optional) | TMT181 temperature head transmitter (optional) |
|  | - FMX167: 10 to 30 V DC <br> - Pt100: 10 to 30 V DC | - 8 to 35 V DC |
| Cable specifications | FMX $167+$ Pt100 (optional) | TMT181 temperature head transmitter (optional) |
|  | - Commercially available instrument cable <br> - Terminals in terminal housing FMX167: 0.08 to $2.5 \mathrm{~mm}^{2}$ ( 20 to 14 AWG ) <br> - If the Pt100 signal is directly connected to a display and/or evaluation unit, Endress+Hauser recommends using a shielded cable. | - Commercially available instrument cable <br> - Terminals in terminal housing FMX167: 0.08 to $2.5 \mathrm{~mm}^{2}$ ( 20 to 14 AWG ) <br> - Transmitter connection: max. $1.75 \mathrm{~mm}^{2}$ (16 AWG) |
| Power consumption | FMX $167+$ Pt100 (optional) | TMT181 temperature head transmitter (optional) |
|  | $\leq 0.675 \mathrm{~W}$ at 30 V DC | $\leq 0.875 \mathrm{~W}$ at 35 V DC |
| Current consumption | FMX167 + Pt100 (optional) <br> - Max. current consumption: $\leq 22.5 \mathrm{~mA}$ Min. current consumption: $\geq 3.5 \mathrm{~mA}$ <br> - Pt100: $\leq 0.6 \mathrm{~mA}$ | TMT181 temperature head transmitter (optional) <br> - Max. current consumption: $\leq 25 \mathrm{~mA}$ <br> Min. current consumption: $\geq 3.5 \mathrm{~mA}$ <br> - Pt100 via temperature head transmitter: $\leq 0.6 \mathrm{~mA}$ |
|  |  |  |
| Residual ripple | FMX $167+$ Pt100 (optional) | TMT181 temperature head transmitter (optional) |
|  | No effect for 4 to 20 mA signal up to $\pm 5 \%$ residual ripple within permissible range | $U_{s s} \geq 5 \mathrm{~V}$ at $U_{B} \geq 13 \mathrm{~V}, \mathrm{f}_{\text {max. }}=1 \mathrm{kHz}$ |


| Accuracy |  |  |
| :---: | :---: | :---: |
| Reference operating conditions | FMX167 + Pt100 (optional) <br> DIN EN $60770 \mathrm{~T}_{\mathrm{u}}=25^{\circ} \mathrm{C}\left(77^{\circ} \mathrm{F}\right)$ | TMT 181 temperature head transmitter (optional) <br> Calibration temperature $23^{\circ} \mathrm{C} \pm 5 \mathrm{~K}\left(73^{\circ} \mathrm{F} \pm 5 \mathrm{~K}\right)$ |
| Maximum measured error | FMX167 + Pt100 (optional) <br> - Non-linearity including hysteresis and nonrepeatability as per DIN EN 60770: $\pm 0.2 \%$ of upper range value (URV) <br> - Pt100: max. $\pm 0.7 \mathrm{~K}$ (Class B to DIN EN 60751) | TMT181 temperature head transmitter (optional) <br> - $\pm 0.2 \mathrm{~K}$ <br> - With Pt100: max. $\pm 0.9 \mathrm{~K}$ |
| Long-term stability | FMX167 + Pt100 (optional) <br> $\pm 0.1 \%$ of the upper range limit (URL) per year | TMT181 temperature head transmitter (optional) $\leq 0.1 \mathrm{~K}$ per year |
| Influence of medium temperature | - Thermal change in zero signal and output span for typical application temperature range 0 to $+30^{\circ} \mathrm{C}\left(+32\right.$ to $\left.+86^{\circ} \mathrm{F}\right)$ : $\pm 0.4 \%( \pm 0.5 \%)^{*}$ of the upper range limit (URL) <br> - Thermal change in zero signal and output span for the entire medium temperature range -10 to $+70^{\circ} \mathrm{C}\left(+14\right.$ to $\left.0+158^{\circ} \mathrm{F}\right)$ : $\pm 1.0 \%( \pm 1.5 \%)^{*}$ of the upper range limit (URL) <br> - Temperature coefficient ${ }_{k}$ ) of zero signal and output span: <br> $0.15 \% / 10 \mathrm{~K}(0.3 \% / 10 \mathrm{~K})^{*}$ of the upper range limit (URL) <br> * Specifications for sensors $0.1 \operatorname{bar}\left(1 \mathrm{mH}_{2} \mathrm{O}, 1.5 \mathrm{psi}, 3 \mathrm{ftH}_{2} \mathrm{O}\right)$ and $0.6 \operatorname{bar}\left(6 \mathrm{mH}_{2} \mathrm{O}, 10 \mathrm{psi}, 20 \mathrm{ftH}_{2} \mathrm{O}\right)$ |  |
| Warm-up period | FMX167 + Pt100 (optional) $20 \mathrm{~ms}$ | TMT181 temperature head transmitter (optional) 4 s |
| Rise time | FMX167 + Pt100 (optional) <br> - FMX167: 80 ms <br> - Pt100: 160 s |  |
| Settling time | FMX167 + Pt100 (optional) <br> - FMX167: 150 ms <br> - Pt100: 300 s |  |

## Installation conditions

## Installation instructions



Installation examples, here shown with FMX 167 with an outer diameter 22 mm
Extension cable mounting screw can be ordered via order code or as an accessory, $\rightarrow 21 \mathrm{ff}$
Terminal housing can be ordered using the order code or as an accessory $\rightarrow 21$
Extension cable bending radius $>120 \mathrm{~mm}$
Mounting clamp can be ordered via order code or as an accessory, $\rightarrow 21 \mathrm{ff}$
Extension cable, cable length $\rightarrow \quad 18$
Guide pipe
7 Additional weight can be ordered as an accessory with an outer diameter of 22 mm and $29 \mathrm{~mm}\left(0.87^{\prime \prime}\right.$ and $1.14^{\prime \prime}$ ),
$\rightarrow 22$
8 Protection cup

## Note!

- Sideways movement of the level probe can result in measuring errors. For this reason, install the probe at a point free from flow and turbulence, or use a guide tube. The intemal diameter of the guide tube should be at least I mm $\left(0.04^{\prime \prime}\right)$ larger than the outer diameter of the selected FMX1 67.
- The cable must end in a dry room or a suitable terminal box. The terminal box from Endress+Hauser provides optimum humidity and climatic protection and is suitable for outdoor installation.
- Protection cap: The device is provided with a protection cap to prevent mechanical damage to the measuring cell. This cap should not be removed during the transportation and installation process.
- Endress+Hauser recommends using twisted, shielded cables for any further wiring.


## Environment




| Overvoltage protection | FMX167 +Pt100 (optional) | TMT181 temperature head transmitter (optional) |
| :--- | :--- | :--- |
|  | Integrated overvoltage protection to EN $61000-4-5$ | Install overvoitage protection, external if necessary. |
|  | $(500 \vee$ symmetrical/1000 asymmetrical) |  |
|  | Install overvoltage protection $\geq 1.0 \mathrm{kV}$, external if |  |
| necessary |  |  |$\quad$.

## Process conditions

| Medium temperature range | FMX167 + Pt100 (optional) <br> - FMX167 <br> with outer diameter of $22 \mathrm{~mm}\left(0.87^{\prime \prime}\right)$ and $42 \mathrm{~mm}\left(1.65^{\prime \prime}\right):$ -10 to $+70^{\circ} \mathrm{C}\left(14\right.$ to $\left.158^{\circ} \mathrm{F}\right)$ <br> - FMX167 with outer diameter of 29 mm ( $1.14^{\prime \prime}$ : 0 to $+50^{\circ} \mathrm{C}$ (32 to $122^{\circ} \mathrm{F}$ ) | TMT181 temperature head transmitter (optional) -40 to $+85^{\circ} \mathrm{C}\left(-40\right.$ to $\left.+185^{\circ} \mathrm{F}\right)=$ ambient temperature, install temperature head transmitter outside medium. |
| :---: | :---: | :---: |
| Medium temperature limits | FMX167 + Pt100 (optional) <br> - FMX167 <br> with outer diameter of $22 \mathrm{~mm}\left(0.87^{\prime \prime}\right)$ and $\begin{aligned} & 42 \mathrm{~mm}\left(1.65^{\prime \prime}\right): \\ & -20 \text { to }+70^{\circ} \mathrm{C}\left(-4 \text { to }+158^{\circ} \mathrm{F}\right) \end{aligned}$ <br> - FMX167 with outer diameter of 29 mm (1.14"): $0 \text { to }+50^{\circ} \mathrm{C}\left(32 \text { to } 122^{\circ} \mathrm{F}\right)$ <br> (You may operate the FMX167 in this temperature range. The specification can then be exceeded, e.g. measuring accuracy). |  |

Mechanical construction
Dimensions of the level probe

## Versions of FMX167

I FMX167, version "A" or "D" for Feature 30 "Probe tube" in the order code $\left(\begin{array}{ll}\rightarrow & 21\end{array}\right)$
FMX167, version "B" for Feature 30 "Probe tube" in the order code $\left(\begin{array}{ll}\rightarrow & 21\end{array}\right)$
FMX167, version "C" for Feature 30 "Probe tube" in the order code ( $\rightarrow$ 21)
Pressure compensation tube
Extension cable
Protection cap

Dimensions of the mounting clamp


Mounting clamp, version "2" for Feature 20 "Connection" in the order code ( $\rightarrow 21$ )

Dimensions of the extension cable mounting screws


Extension cable mounting screws
Extension cable mounting screw G1 $1 / 2 \mathrm{~A}$, version " 3 " for Feature 20 "Connection" in the order code ( $\rightarrow \quad 21$ ) Extension cable mounting screw ! $1 / 2$ NPT, version "4" for Feature 20 "Connection" in the order code $(\rightarrow 21)$

Note!
Application in unpressurized containers only.

Dimensions of the terminal box IP 66/IP 67 with filter


Terminal box
Version "3", "4" or "5" for Feature 70 "Additional options" in the order code $(\rightarrow \quad 21)$
Dummy plug M $20 \times 1.5$
GORE-TEX ${ }^{\otimes}$ filter
Terminals for 0.08 to $2.5 \mathrm{~mm}^{2}$

Dimensions of the TMT181 temperature head transmitter


TMT181 temperature head transmitter ( 4 to 20 mA )
Version "5" for Feature 70 "Additional options" in the order code $(\rightarrow 21)$. The temperature head transmitter can be used in non-hazardous areas and for EEx nA.

Terminal box with integrated TMT181 temperature head transmitter


Note!
A distance of $>7 \mathrm{~mm}\left(0.27^{\prime \prime}\right)$ must be maintained between the terminal strip and the TMT181 temperature head transmitter.

Weight

- Level probe, outer diameter $22 \mathrm{~mm}\left(0.87{ }^{\prime \prime}\right): 290 \mathrm{~g}(0.8 \mathrm{lb})$
- Level probe, outer diameter $42 \mathrm{~mm}\left(1.65^{\prime \prime}\right): 1150 \mathrm{~g}(2.5 \mathrm{lb})$
- Level probe, outer diameter $29 \mathrm{~mm}\left(1.14^{\prime \prime}\right): 340 \mathrm{~g}(0.7 \mathrm{lb})$
- PE extension cable: $52 \mathrm{~g} / \mathrm{m}(1.8 \mathrm{oz} / 3 \mathrm{ft})$
- PUR extension cable: $00 \mathrm{~g} / \mathrm{m}(2.1 \mathrm{oz} / 3 \mathrm{ft})$
- FEP extension cable: $108 \mathrm{~g} / \mathrm{m}(3.8 \mathrm{oz} / 3 \mathrm{ft})$
- Mounting clamp: $170 \mathrm{~g}(0.4 \mathrm{lb})$
- Extension cable mounting screw G $1 / 1 / 2 \mathrm{~A}: 770 \mathrm{~g}(1.7 \mathrm{lb})$
- Extension cable mounting screw $11 / 2$ NPT: 724 g ( 1.6 bb )
- Terminal box: $235 \mathrm{~g}(0.5 \mathrm{lb})$
- Temperature head transmitter TMT $181: 40 \mathrm{~g}(0.08 \mathrm{lb})$
- Additional weight: $300 \mathrm{~g}(0.7 \mathrm{lb})$
- Testing adapter: $39 \mathrm{~g}(1.4 \mathrm{lb})$

| Material | Level probe <br> - Level probe, outer diameter $22 \mathrm{~mm}\left(0.87^{\prime \prime}\right): 1.4435$ (AISI 316L SS) <br> - Level probe, outer diameter $42 \mathrm{~mm}\left(1.65{ }^{\prime \prime}\right): 1.4435$ (AISI 316L SS) <br> - Level probe, outer diameter 29 mm (1.14"): 1.4435 (AISI 316L SS) <br> - Sensor sleeve: PPS (polyphenylene sulfide) <br> - Heat-shrink sleeve/cover: Polyolefin <br> Metal does not come into contact with the medium. <br> - Process ceramic: $\mathrm{Al}_{2} \mathrm{O}_{3}$ aluminum oxide ceramic <br> - Seal (internal): EPDM or Viton <br> - Protection cap: <br> - PE-HD (high-density polyethylene) for FMX167 with outer diameter $22 \mathrm{~mm}\left(0.87^{\prime \prime}\right)$ and $29 \mathrm{~mm}\left(1.14^{\prime \prime}\right)$. <br> - PFA (perfluoroalkoxy) for FMX 167 with outer diameter 42 mm ( 1.65 "). <br> - Extension cable insulation: Either PE-LD (low-density polyethylene), FEP (fluorinated ethylene propylene) or PUR (polyurethane). For more information, see $\rightarrow 18$, "Extension cable" <br> - Mounting clamp: 1.4404 (AISI 316L SS) and fiberglass reinforced PA (polyamide) <br> - Extension cable mounting screw G 1 1/2A: 1.4301 (AISI 304 SS) <br> - Extension cable mounting screw 1 1/2NPT: 1.4301 (AISI 304 SS) <br> - Terminal box: PC (polycarbonate) <br> - Temperature head transmitter TMT181: PC housing (polycarbonate) |
| :---: | :---: |
| Extension cable | PE extension cable <br> - Abrasion-resistant extension cable with Dynema strain-relief members; shielded with aluminum-coated film; insulated with polyethylene (PE), black; copper wires, twisted <br> - Pressure compensation tube with Teflon filter |
|  | PUR extension cable <br> - Abrasion-resistant extension cable with Dynema strain-relief members; shielded with aluminum-coated film; insulated with polyurethane (PUR), black; copper wires, twisted <br> - Pressure compensation tube with Teflon filter |
|  | FEP extension cable <br> - Abrasion-resistant extension cable; shielded with galvanized steel wire netting; insulated with fluorinated ethylene propylene (FEP), black; copper wires, twisted <br> - Pressure compensation tube with Teflon filter |
|  | Cross-section of PE/PUR/FEP extension cable <br> - Total outer diameter: $8.0 \mathrm{~mm}\left(0.31^{\prime \prime}\right) \pm 0.25 \mathrm{~mm}\left(0.001^{\prime \prime}\right)$ <br> - FMX167: $3 \times 0.227 \mathrm{~mm}^{2}\left(0.0004^{\prime \prime}\right)+$ pressure compensation tube with Teflon filter <br> - FMX167 with Pt100 (optional): $7 \times 0.227 \mathrm{~mm}^{2}\left(0.0004^{\prime \prime}\right)$ + pressure compensation tube with Teflon filter <br> - Pressure compensation tube with Tefion filter: <br> Outer diameter 2.5 mm ( 0.1 inch), internal diameter 1.5 mm ( 0.06 inch) |
|  | Cable resistance of PE/PUR/FEP extension cable <br> - Cable resistance per wire: $\leq 0.09 \Omega / \mathrm{m}$ |
|  | Cable length of PE/PUR/FEP extension cable <br> - Please refer also to $\rightarrow 8$, Sect. "Load". <br> - Cable length that can be ordered <br> - Customer-specific length in meters or feet ( $\rightarrow$ 21, "Ordering information") <br> - Limited cable length when performing installation with freely suspended device with extension cable mounting screw or mounting clamp, as well as for Ex approval: max. 300 m ( 984 ft ). <br> - When using the measuring device in hazardous areas, installation must comply with the applicable national standards and regulations and the Safety Instructions (XAs) or the Installation or Control Drawings (ZDs). See also $\rightarrow 23$, "Safety instructions" and "Installation/Control Drawings" Sections. |
|  | Further technical data of PE /PUR/FEP extension cable <br> - Minimum bending radius: 120 mm (4.7") <br> - Tensile strength: max. $950 \mathrm{~N}(214 \mathrm{lbf})$ <br> - Cable extraction force: typical $\geq 450 \mathrm{~N} / 101 \mathrm{lbf}$ (FE, FEP) / typical $\geq 150 \mathrm{~N} / 34 \mathrm{lbf}$ (PUR) (The extension cable could be extracted from the level probe with a appropriate tensile force.) <br> - Resistance to UV light <br> - PE: Approved for use with drinking water |
| Terminals | - Three terminals as standard in the terminal box <br> - 4-terminal strip can be ordered as an accessory, Order No: 52008938 Conductor cross-section 0.08 to $2.5 \mathrm{~mm}^{2}$ (20 to 14 AWG) |

Installation tool indicating the customerspecific length on the cable


1 cable marking, distance to the lower end of the cable probe

## Note!

- The mark is for installation purposes only.

It must be thoroughly removed without trace in the case of devices with drinking water approval. The extension cable must not be damaged in the process.

- Not for use in hazardous areas.


## Certificates and approvals

CE mark
The device meets the legal requirements of the applicable EC Directives.
Endress+Hauser confirms successful testing of the device by affixing to it the CE mark.

| Ex approval, type of protection | - ATEX II 2 G EEx ia IIC T6 ${ }^{11}$ <br> - ATEX II 3 G EEx nA II T6) <br> - FM: IS, Class I, Division 1, Groups A-D ${ }^{11}$ <br> - CSA: IS, Class I, Division I, Groups A-D ${ }^{11}$ <br> 1) Only for Waterpilot FMX167 without Pt100 and TMT181 <br> Note! <br> - Waterpilot FMX167 is only available for use in hazardous areas with the FKM Viton seal. <br> - The cable marking cannot be ordered with the Ex approvals listed due to a potential electrostatic charge (see $\rightarrow$ 21, "Ordering information"). <br> - All explosion-protection data are given in a separate documentation which is available upon request. The Ex documentation is provided with all Ex-systems as standards, see also $\rightarrow$ 23, Sect. "Additional documentation", "Safety instructions" and "Installation/Control Drawings". |
| :---: | :---: |
| Drinking water approval (for FMX167 with Outer diameter $22 \mathrm{~mm}(0.87 \mathrm{in})$ ) | - KTW certificate <br> - NSF 61 approval <br> - ACS approval |
| Marine approval | - GL approval <br> - ABS approval |
| Standards and guidelines applied | The European standards and guidelines that have been applied are listed in the associated EC Declarations of Conformity. In addition, the following standards were also applied for the Waterpilot FMX167: <br> DIN EN 60770 (IEC 60770): <br> Transmitters for use in industrial process control systems <br> Part 1: Methods for performance evaluation <br> DIN 16086: <br> Electrical pressure measuring instruments, pressure sensors, pressure transmitters, pressure measuring instruments, concepts, specifications on data sheets |

EN 61326:
Electrical equipment for measurement, control and laboratory use - EMC requirements

## Ordering information

FMX167
You can enter the versions for the specific feature in the following table. The versions entered make up the complete order code. Options which are mutually exclusive are not marked.


FMX167 (continued)

${ }^{1)}$ incl. terminal box, see feature " 3 " or " 4 "

## Accessories

| Mounting clamp | - Endress+Hauser offers a mounting clamp for simple FMX167 mounting $\rightarrow \quad 15$ <br> - Material: I. 4404 (AISI 3I6L SS) and fiberglass reinforced PA (polyamide) <br> - Order number: 52006151 <br> See also $\rightarrow$ 21, "Ordering information" |
| :---: | :---: |
| Terminal box | - Terminal box IP $06 /$ IP 67 with GORE-TEX ${ }^{0}$-filter incl. 3 installed terminals. <br> The terminal box is also suitable for installing a temperature head transmitter (Order No, 52008794) or for four additional terminals (Order No. 52008938) $\rightarrow 23$. <br> - Order number: 52000152 |
| Additional weight (for FMX 167 with an outer diameter of 22 mm and 29 mm ) | - Endress+Hauser offers additional weights to prevent sideways movement that results in measuring errors, or to make it easier to lower the device in a guide tube. <br> You can thread several weights together. The weights are then attached directly to the FMX107. For FMX167 with outer diarneter $29 \mathrm{~mm}(1.14 \mathrm{in})$, a maximum of 5 weights may bethreaded onto the FMXI67. <br> - Material: 1.4435 (AISI 316L SS) <br> - Weight: $300 \mathrm{~g}(0.7 \mathrm{lb})$ <br> - Order number: 52006153 |

## TMT181 temperature head transmitter

- 2-wire temperature head transmitter, configured for a measuring range from -20 to $+80^{\circ} \mathrm{C}\left(-4\right.$ to $\left.+176^{\circ} \mathrm{F}\right)$. This setuling offers a temperature range of 100 K which can be easily mapped. Please note that the Pt100 resistance thermometer is designed for a temperature range from -10 to $+70^{\circ} \mathrm{C}\left(14\right.$ to $\left.158^{\circ} \mathrm{F}\right) \rightarrow 22$.
- Order number: 52008794

| Extension cable mounting screw | - Endress+Hauser offers extension cable mounting screws to simplify the installation of the FMXI 67 and to close the measuring open $\rightarrow 16$. <br> - Material: 1.4301 (AISI 304 SS) <br> - Order number for extension cable mounting screw with G $11 / 2$ A thread: 52008264 <br> - Order number for extension cable mounting screw with $11 / 2$ NPT thread: 52009311 |
| :---: | :---: |
| Terminals | - Four terminals in strip for FMX167 terminal box, suitable for wire cross-section of 0.08 to $2.5 \mathrm{~mm}^{2}$ ( 20 to 14 AWG) <br> - Order number: 52008938 |
| Test adapter <br> (for FMX167 with an outer diameter of $22 \mathrm{~mm} / 0.87$ "and $29 \mathrm{~mm} / 1.14^{\prime \prime}$ ) | - Endress+Hauser offers a testing adapter to ease function-testing of the level probes. <br> - Observe the maximum pressure for the compressed air hose and the maximum overload for the level probe $\rightarrow 7$. <br> - Maximum pressure of the quick coupling piece supplied: 10 bar (145 psi) <br> - Adiapter material: 1.4301 (AISI 304 SS) <br> - Quick coupling piece material: anodized aluminum <br> - Adapter weight: $39 \mathrm{~g}(0.1 \mathrm{lb})$ <br> - Order number: 52011868 |
|  | Testing adapter <br> A FMX167 level probe connection <br> B Compressed air hose connection, internal diameter of quick coupling piece 4 mm |

## Additional documentation

| Field of activities | - Pressure measurement: FA004P/00/EN <br> - Recording technology: FA014R/09/EN <br> - System components: FA016K/09/EN |
| :---: | :---: |
| Technical Information | - Technical Information Waterpilot FMX21 with 4 to 20 mA with HART output signal: TI431P/00/EN <br> - Technical Information Deltapilot M: TI437P/00/EN <br> - Temperature Head Transmitter iTEMP PCP TMT181: TIO70R/09/EN |
| Operating Instructions | - Waterpilot FMX167: BA231P/00/EN |
| Safety instructions | - ATEX II 2 G Ex ia IIC T6: XA131P/00/A3 <br> - ATEXII 3 G ExnA II T6: XAl32P/00/A3 |
| Installation/Control Drawings | - FM IS Class I, Div. 1, Groups A - D: 2D063P/00/EN <br> - CSA IS Class I, Div. 1, Groups A - D: ZD064P/00/EN |
| Drinking water approval | - SD126P/00/A3 |

1. MTR LEVEL RELAY TECHNICAL DETAILS
2. MTR WIRING DETAILS
3. MTRA LEVEL RELAY TECHNICAL DETAILS
4. MTRA WIRING DETAILS
5. MTR/MTRA INSTALLATION \& TROUBLESHOOTING DETAILS


- 

SAmple MTR Application
After many years of field use, the simplicity amod reliabibity of these maits is mnquestionable.



## SAmple MTR Application



Dip Switch Settings


Wiring Diagram:


Physical Dimensions


## Sample Application



Product Specifications


All MultiTrode Products carry a two year warranty

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## After many years of rigorous field use, reliability and simplicity of opperation of these units is unquestionable.

The MTRA relay offers many of the cost-effective features of the MTR relay, with the benefit of a built-in Hi level alarm.

## Note: The MTRA is intended for

tharge applications ONLY
The MultiTrode MTRA Liquid Level Control Relay with alarm is a latching conductive liquid level control device. The pump is activated when the start point, "H1", is reached and deactivated when level falls below the stop point, "LO". The alarm activates once the level reaches the alarm point and deactivates once the level drops below the alarm point.

In 2 sensor mode the the pump start point " HI " will activate the alarm after after a preset time delay $(0.5,15 \mathrm{sec})$. This alarm can be set to flash or remain steady, as required.

Any application where level control plus high level alarm, such as sumps, wells, bores, collection tanks, effluent pits, drainage ponds, sullage pits etc, can benefit from use of the MultiTrode MTRA.

- Controls One Pump and One Alarm: The MTRA was designed specifically to control a pump and an alarm at a low installed-cost.

■ Safe, extra-low, sensing voltage : Ensures safety for operators and maintenance personnel.

- 4 Sensitivities: Enables the relay to operate effectively in a wide range of conductive liquids.
- 2 Activation Delays: Each output can have a different time delay to overcome wave action and turbulence.
- LED Indication : High intensity LED indicators: Power On (green), Alarm on (red) and Pump on (yellow) via high intensity LED indicators.
- Dip Switch Programmable:

All settings are easily selected from the front panel.

- Unique Two Sensor Operation : Enables pump and alarm to be controlled using 2 or 3 sensors.
Two sensor operation is ideal for budget applications or where space is limited
- Proven Reliability : The proven design of the relay ensures long-term reliability of the MultiTrode system.
- I.S. application : Perfect for I.S. application when used with MTISB.
- DIN rail or screw mounting
- Low installed cost


## Sample Application



Sample Application


Dip Switch Settings

- Sw $4 \ldots$ Alarm activation delays: $0.5 \& 15 \mathrm{sec}$
-Sw 5 ... Alarm: Steady or Flashing output
——Sw 6 ... Input mode: 2 or 3 Sensor
Available Sensitivity settings
IK Concentrated Acids, Minerals, Alkalis.
20K Alkali's, Diluted brine,Acids, Sea water.
40K Sewerage effluentSullage, Town water.
80K Industrial effluent and Processes, Purified water.
Wiring Diagram

available models
MTRA 2 240VAC
MTRA 3 IIOVAC
MTRA 4 24VAC
MTRAS 24VDC
MTRA 6 I2VDC

$$
\begin{aligned}
& 24,110,240,415 \mathrm{VAC}-50 / 60 \mathrm{~Hz} \\
& 3.5 \text { Watts max } \quad \text { *(MTR only) } \\
& 12 \text { or } 24 \mathrm{VDC}, \\
& 3 \text { watts max }
\end{aligned}
$$

Environmental Range:

| Centigrade | $-10^{\circ}$ to $+60^{\circ} \mathrm{C}$ |
| :--- | :--- |
| Fahrenheit | $+14^{\prime}$ to $+140^{\circ} \mathrm{F}$ |

All MultiTrode Products carry a full two year warranty

## The MTRA Relay is designed for discharge operation only.

This product can also be ordered as part of a "MTSSP" Sump pack, this pack includes an MTRA and two single sensor level sensing probes (model: 0.2/1-10m) with 10 m of cable.

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## 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

WATER - WRETEWAER - RUVD STATIOH . IEOHNDLOG

## MTR/MTRA Installation \& Troubleshooting

### 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.

## MTR/MTRA Installation \& Troubleshooting

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

A
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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## POWER SUPPLY \& BATTERY

1. $24 V D C$ POWER SUPPLY TECHNICAL DETAILS
2. $24 \mathrm{VDC} / 13 \mathrm{VDC}$ CONVERTER TECHNICAL DETAILS
3. BATTERY TECHNICAL DETAILS

## Features

- Ultra-low noise output
- Independent battery charging output
- DC output OK \& battery OK alarms \& LEDs
- Battery-LVD and alarm
- Over-temperature protection
- Battery fuse fail LED



## STANDARDS \& APPROVALS

| Voltage: | 190 to 264 vac, or 190 to 400VDC |
| :---: | :---: |
| Line regulation: | 0.2\%typical |
| Current: | 1.4A maximum |
| Inrush current: | 10A 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. cat | Constant current |
| Short circuit protection | Indefi nite, auto-resetting |
| Over-voltage protection | 17.5 to 20 V latching ( 13.8 Vdc output) 31.5 to 39 V latching ( 27.6 Vdc output) |
| Ripple \& noise 100 MHz bandwidth | $28 \mathrm{mVp}-\mathrm{p}$ ( 13.8 Vdc output) $55 \mathrm{mVp}-\mathrm{p}$ (27.6Vdc output) |
| ENVIRONMENTAL |  |
| Operating temperature | 0 to $70^{\circ} \mathrm{C}$ ambient with derating, $5 \ldots . .90 \%$ relative humidity (non-condensing) |
| Over-temperature protection | Automatic \& auto-resetting |
| Cooling requirement | Natural convection |
| Efficiency | 80\% minimum |


| Safety | Complies with AS/NZS 60950, class 1, |
| :--- | :--- |
|  | NSW Office of Fair Trading Approval N20602 |
| EMC | Emissions comply with AS/NZS CISPR11, |
|  | Group 1, Class B. Complies with ACA EMC |
|  | Scheme, Safety \& EMC Regulatory Compliance |
|  | Marked |
| Isolation i/p-o/p | 4242 VDC for 1 minute |
| $i / p-g r o u n d$ |  |
| o/p-ground | 2121 VDC for 1 minute |
|  | 707 VDC for 1 minute |

ALARMS \& BATTERY FUNCTIONS

| Converter ON/OK alarm | Indicated by voltage-free changeover relay <br>  |
| :--- | :--- |
| green LED | ON=PSU OK |
| Battery low (\& fuse) alarm | 10.2 to 12.6 V for 12 V battery, adjustable 20.4 <br> to 25.2 V for 24 V battery, adjustable Indicated <br>  <br> green LED: $\mathrm{ON}=\mathrm{BATT}$ OK |
| Low voltage disconnect | 9.6 to 12 V for 12 V battery, adjustable |
|  | 19.2 to 24 V 2 for 4 V battery, adjustable |

## MECHANICAL

| Case size | $264 \mathrm{~L} \times 172 \mathrm{~W} \times 67 \mathrm{H} \mathrm{mm}$ |
| :--- | :--- |
| Case size with heatsink | $264 \mathrm{~L} \times 186 \mathrm{~W} \times 67 \mathrm{H} \mathrm{mm}$ |
| Rack size | $232 \mathrm{D} \times 19^{\prime \prime} \mathrm{W} \times 2 \mathrm{RU} \mathrm{H}$ |
| Weight | 1.9 kg |
| Weight with heatsink | 2.1 kg |
| Weight (rack mounted version) | 5.5 kg |

## Selection Table

| MODEL NUMBER | OUTPUT |  |  | $\begin{aligned} & \hline \text { OUTPUT } \\ & \hline \text { POWER } \end{aligned}$ | Note: Non standard battery charging current available on request. ie PB251-12CM-H-10 for 10A. |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | VDC | ILOAD | $\mathrm{I}_{\text {batt }}$ |  |  |
| PB251-12CM | 13.8 V | 16A | 2A | 220W |  |
| PB251-12CM-H | 13.8 V | 20A | 2A | 275W |  |
| PB251-24CM | 27.6 V | 11A | 2A | 300 W |  |
| PB251-24CM-H | 27.6 V | 12A | 2A | 330W |  |
| PB251-12RML | 13.8 V | 20A | 4A | 275W |  |
| PB251-12B | 13.8 V | 20A | 4A | 275W |  |
| PB251-24RML | 27.6 V | 12A | 2A | 330W |  |

## PB251 Series

275-330 WATTS DC UPS

Technical Illustrations


## PBIH Series

## 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 110 V 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 -100mV 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 <br> Output shutdown, PBIH-G, J, M, R - input must be switched off for at least $30 S$ to reactivate |
| Overcurrent protection | Fold back - PBIH-F <br> Current limiting, PBIH-G, J, M, R (PBIH-R series is adjustable); PBIH110xxR models are not adjustable |
| Drift | Output $V \times 0.5 \%+15(\mathrm{mV})$ per 8 hrs after 1 hr warm-up |
| Rise Time | $\begin{aligned} & 200 \mathrm{mS} \text { max. - PBIH-F, M, R } \\ & \left.100 \mathrm{mS} \text { max. - P8IH-G, J (at } 25^{\circ} \mathrm{C}\right) \end{aligned}$ |
| Holdup time | 10 mS (only 110 V input) |
| Remote sense | PBIH-R Series only |


| OPERATING |  |
| :---: | :---: |
| Efficiency | 70\%-89\% |
| Safety isolation (1 minute) | $\begin{aligned} & \text { Type - 12, 24, 48V input } \\ & \text { Input - Output: 1500VAC } \\ & \text { Input- Case: } 500 \mathrm{VAC} \\ & \text { Output- Case: 500VAC } \\ & \text { Type- 110V input } \\ & \text { Input- Output: 2000VAC } \\ & \text { Input- Case: 2000VAC } \\ & \text { Output- Case: 500VAC } \end{aligned}$ |
| Insulation resistance | 50M (500VDC) Input - Case |
| Parallel operation | Consult sales office for details |
| Remote control | PBIH-R Series: <br> Open link: output normal 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 | 30G, PBIH-F, G and J |
| Vibration | ( $5 \mathrm{~Hz}-10 \mathrm{~Hz}, 10 \mathrm{~mm}$ ), ( $10 \mathrm{~Hz}-50 \mathrm{~Hz}$ ) $2 \mathrm{G}, \mathrm{PBIH}-\mathrm{F}, \mathrm{G}$ and J |
| STANDARDS AND APPROVALS |  |
| Safety | Designed to UL1950 |
| C-tick | AS/NZS CISPR11 Group 1. Class A |
| MECHANICAL |  |
| Weight | PBIH-F:250g <br> PBIH-G: 380g <br> PBIH-J : 410 g <br> PBIH-M : 800g <br> PBIH-R : 1.4kg |

## PBIH Series

Selection Table

| $\begin{aligned} & \text { MODEL } \\ & \text { NUMBER } \\ & \hline \text { PBIH-1205F } \end{aligned}$ | IMPUT$9.2 \cdot 16 \mathrm{~V}$ | OUTPUT |  | $\begin{gathered} \text { OUTPUT } \\ \text { POWER } \\ \hline 15 \mathrm{~W} \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: |
|  |  | 5 V | 3A |  |
| PBIH-1212F | $9.2 \cdot 16 \mathrm{~V}$ | 12V | 1.2A | 15W |
| PBIH-1215F | $9.2-16 \mathrm{~V}$ | 15 V | 1A | 15 W |
| PBIH-1224F | $9.2-16 \mathrm{~V}$ | 24V | 0.62A | 15 W |
| PQIH-2405F | 19-32V | 5 V | 3A | 15 W |
| PBIH-2412F | 19.32V | 12 V | 1.2A | 15W |
| PBIH-2415F | 19-32V | 15V | 1A | 15 W |
| PgIH-2424F | 19.32V | 24 V | 0.62A | 15W |
| PBIH-4805F | 38-63V | 5 V | 3A | 15W |
| PBIH-4812F | $38-63 \mathrm{~V}$ | 12 V | 1.2 A | 15W |
| PBIH-4815F | $38-63 \mathrm{~V}$ | 15 V | 1A | 15W |
| PBIH-4824F | $38-63 \mathrm{~V}$ | 24 V | 0.62 A | 15W |
| PBIH-11005F | 85-140V | 5 V | 3A | 15W |
| PBIH-11012F | 85-140V | 12 V | 1.2A | 15W |
| P81H-11015F | $85-140 \mathrm{~V}$ | 15 V | 1A | 15W |
| PBIH-11024F | $85-140 \mathrm{~V}$ | 24 V | 0.62A | 15W |
| PBIH-1205G | 9.2-16V | 5 V | 5A | 25w |
| P8IH-1212G | 9.2-16V | 12 V | 2.1A | 25W |
| PBIH-1215G | 9.2-16V | 15V | 1.7A | 25W |
| PBIH-1224G | 9.2-16V | 24 V | 1.1 A | 25W |
| PBIH-1248G | $9.2-16 \mathrm{~V}$ | 4BV | 0.5A | 25w |
| PBIH-2405G | 19-32V | 5 V | 5A | 25W |
| PBIH-2412G | 19.32 V | 12V | 2.14 | 25W |
| PBIH-2415G | 19.32V | 15 V | 1.7A | 25W |
| PBIH-2424G | 19-32V | 24 V | 1.1 A | 25w |
| PBIH-2448G | 19.32V | 48 V | 0.5 A | 25w |
| PBIH-4805G | 38-63V | 5 V | 5A | 25W |
| PBIH-4812G | $38-63 \mathrm{~V}$ | 12V | 2.1A | 25W |
| PBIH-4815G | $3 \mathrm{~B}-63 \mathrm{~V}$ | 15V | 1.7A | 25W |
| PBIH-4824G | 38-63V | 24 V | 1.1A | 25W |
| PBIH-4848G | $38-63 \mathrm{~V}$ | 48 V | 0.5A | 25W |
| PBIH-11005G | B5-140V | 5 V | SA | 25W |


| MODEL NUMBER <br> PBIH-11012G | INPUT | OUTPUT |  | $\begin{gathered} \text { OUTPUT } \\ \text { POWER } \\ \hline 25 W \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: |
|  |  | 12V | 2.1A |  |
| PBIH-11015G | $85-140 \mathrm{~V}$ | 15 V | 1.7A | 25W |
| PBIH-11024G | 85-140V | 24 V | 1.1A | 25W |
| PBIH-11048G | 85.140 V | 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 | 3.3A | 50w |
| PBIH-1215J | $9.2 \cdot 16 \mathrm{~V}$ | 15 V | 2.7A | 50W |
| PBIH-1224J | 9.2 .16 V | 24 V | 1.7 A | 50W |
| PBIH-1248J | 9.2 .16 V | 48 V | 0.84 | 50w |
| PBIH-2405 | 19.32 V | 5 V | 10A | 50W |
| PBIH-2412J | 19.32 V | 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-244BJ | 19.32 V | 48 V | 1 A | 50W |
| PBIH-4805) | 38.63 V | 5 V | 10A | 50W |
| PBIH-4812 | 38.63 V | 12 V | 4.3A | 50w |
| PBIH-4815 | 38.63 V | 15 V | 3.4 A | 50w |
| P8IH-4824) | 38.63 V | 24 V | 2.5A | 50W |
| P8IH-4848! | 38.63 V | 48 V | 1A | 50W |
| P8IH-11005J | 85.140 V | 5 V | 10A | 50W |
| PQIH-11012! | 85.140 V | 12 V | 4.3A | 50W |
| PQIH-11015J | 85.140 V | 15 V | 3.4 A | 50W |
| PBIH-11024J | $85-140 \mathrm{~V}$ | 24 V | 2.5A | 50W |
| PBIH-11048J | $85-140 \mathrm{~V}$ | 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 |
| P81H-1215M | 9.2-16V | 15 V | 7A | 100W |
| P81H-1224M | 9.2-16V | 24 V | 4.5 A | 100W |
| P8IH-1248M | $9.2-16 \mathrm{~V}$ | 48 V | 2A | 100W |
| P8IH-2405M | 19-32V | 5 V | 20A | 100W |
| P81H-2412M | 19-32V | 12 V | 9A | 100W |
| P8IH-2415M | 19-32V | 15 V | 7 A | 100W |


| MODEL NUMBER | INPUT | OUT | PUT | OUTPUT POWER |
| :---: | :---: | :---: | :---: | :---: |
| P8IH-2424M | 19.32V | 24 V | 5A | 100W |
| PEIH-2448M | 19.32V | 48 V | 2A | 100W |
| PBIH-4805M | 38.63 V | 5 V | 20A | 100w |
| PBIH-4812M | 38.63 V | 12 V | 9 A | 100W |
| PBIH-4815M | 38.63 V | 15 V | 7 A | 100W |
| PBIH-4824M | 38.63 V | 24 V | SA | 100W |
| PBIH-4848M | 38.63 V | 48 V | 2A | 100W |
| PB5H-1 1005M | $85-140 \mathrm{~V}$ | 5 V | 20A | 100W |
| PBIH-1 1012M | 85-140V | 12 V | 9A | 100W |
| PBIH-11015M | 85-140V | 15 V | 7 A | 100W |
| PBIH-11029M | 85-140V | 24 V | 5A | 100W |
| PBIH-11048M | 85-140V | 48 V | 2A | 100W |
| PBIH-1205R | 9.2-16V | 5 V | 27A | 150W |
| P8! $\mathrm{H}-1212 \mathrm{R}$ | 9.2-16V | 12 V | 13A | 150W |
| PBIH-121SR | 9.2-16V | 15 V | 10A | 150W |
| PBIH-1224R | $9.2-16 \mathrm{~V}$ | 24 V | 6.5 A | 150w |
| PBIH-1248R | 9.2-16V | 48 V | 3.3 A | 150W |
| PBIH-2405R | 19-32V | 5 V | 30A | 150W |
| PBIH-2412R | 19-32V | 12V | 14A | 150W |
| PBIH-2415R | 19-32V | 15 V | 11A | 150W |
| PBIH-2424R | 19-32V | 24 V | 7A | 150W |
| PBIH-2448R | 19-32V | 48 V | 3.5 A | 150W |
| PBIH-4805R | $38-63 \mathrm{~V}$ | 5 V | 30A | 150W |
| PBIH-4812R | $38-63 \mathrm{~V}$ | 12 V | 14A | 150W |
| PBIH-4815R | 38.63 V | 15 V | 11A | 150W |
| P8IH-4824R | 38.63 V | 24 V | 7 A | 150W |
| PBIH-484BR | 38-63V | 48 V | 3.5A | 150W |
| PBIH-11005R | 85.140 V | 5 V | 30 A | 150W |
| PEIH-11012R | 85-140V | 12 V | 14A | 150W |
| PEIH-11015R | 85-140V | 15 V | 11A | 150W |
| PBIH-11024R | 85.140 V | 24 V | 7 A | 150 W |
| $\overline{\text { PBIH }} 111048 \mathrm{R}$ | 85-140V | 48 V | 3.5A | 150W |

PBIH-F



| Terminal | Connection |
| :---: | :---: |
| 0 | FG |
| 1 | $\mathrm{DC}+\mathrm{V}$ in |
| 2 | 0 V in |
| 3 | LFG |
| 4 | NO |
| 5 | NO |
| 6 | $-V$ out |
| 7 | $+V$ out |


| Terminal | Connection |
| :---: | :---: |
| 1 | FG |
| 2 | $D C+V$ in |
| 3 | $0 V$ in |
| 4 | LFG |
| 5 | $-V$ out |
| 6 | $+V$ out |
| 7 | $N C$ |

PBIH-M
Dimension in mm


PBIH-R


| Terminal | Connection |
| :---: | :---: |
| $\mathbf{1 , 2}$ | +V out |
| 3 | +S |
| 4 | -S |
| 5,6 | -V out |
| 7 | Remote |
| 8 | Control |
| 9 | $\mathrm{DC}+\mathrm{V}$ in |
| 10 | DC OV in |
| FG |  |



## General Characteristics



- CHAREING CHABACTERISTICS



## CRHPhen Davice






- A compral parkbodrica
- Cantan uod lo a a


- Spocilications sublioct bo change without prior notices


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## UXH SERIES

The lateot in YUASA's statb-of the-ari fechnology has brought about a now UXH series capable of ylalding oven greator capacily than comparable bettorite.
YUASA UXH bentarias ano dosigned with uniqua valve regulating dovites and acid free constructions, ensuring sefity and suitability to the contemporary business ervironment.

## Designed Lifo

10 years

## Feafures

Up to $15 \%$ mare capacity
Maintenance-free
Higher energy efficiency Negligiblo gas emissions Valve regulated
sypterns compatible
Fitted with explosion proof filter
(Eccept UXH100-12N and UXH200-6N) No equalizing charge required
(Option) Flame reterdant version availdale No free Acid (Non-spillable Bettary)

Applications
UPS
Telecommunications
Alarm systems
Fire \& security systems
Emergency lighting
Engine starting
Solar powered systems
Utilitit
General Specifications

|  | Nomen |  | $2$ |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | Lement |  | math | Onoll hate |  |  |
|  | 促 | ${ }_{90}^{12}$ | 70 40 | $\stackrel{\text { ns }}{\text { win }}$ | $\begin{aligned} & 128 \\ & 1280 \\ & 180 \end{aligned}$ | $\begin{aligned} & 100080 \\ & 10080 \\ & 080 \end{aligned}$ |  | ${ }_{21}^{17}$ | $\bigcirc$ |
|  |  |  |  |  |  | [100.0. | $\frac{217}{217}$ |  |  |
| S |  | 108 | 1.0 | 2 | 12 smom | 100 | (17) | ${ }_{2}^{16}$ | $\stackrel{\circ}{\circ}$ |
|  |  |  |  | -80116.0. | 1735 $(4 x)$ |  |  |  |  |
| xtocouv | ! | ${ }_{20}$ | ${ }_{\text {L }}^{1 .} 1$ | 3787 | 176 ( 60 ) | ${ }_{216} 210.0$ | ${ }_{30} 0$ | ${ }_{3}{ }^{406}$ |  |



Performance Data at $25^{\circ} \mathrm{C}\left(77^{\circ} \mathrm{F}\right)$
(Amperes and Walts per call)
Amperes to F.V.1. 60 Volts Per Cell

| $\mathrm{nincoc}^{\mathrm{nmos}}$ |  | $\frac{1}{2}$ |  | $$ | $\begin{gathered} 19 \\ \underset{\min }{ } \end{gathered}$ | $\begin{gathered} 20 \\ \min \end{gathered}$ | $28$ | $\begin{aligned} & 20 \\ & \text { nin } \end{aligned}$ | $\frac{34}{\min }$ | $\begin{aligned} & 40 \\ & \text { min } \end{aligned}$ | $\underset{\text { min }}{45}$ | $h$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| L004212 12 | A | 141.0 | 179.0 | 163 | 01.5 | mat | R6 | 17. | 01 | 30.8 | 210 | 22: |
|  | w | 270 | Tw.0 | 1540 | 1160 | 42 | $\pi /$ | $\pi .1$ | 0.5 | 36 | 51.6 | 47 |
| L00150-12 | A | 1850 | 1560 | 1140 | 22.5 | 67.0 | 54.0 | 4.5 | 140 | 0.5 | 8.0 | 30.0 |
|  | w | 3020 | 2420 | 2008 | 10.0 | 1240 | 108.0 | ${ }^{2} 5$ | 0.5 | 7.0 | 70.5 | 50.5 |
| L0T6\% 12 | A | 220.0 | 177.0 | 100 | 1050 | 1 L | 70. | 02. | 55.4 | 31.0 | 4.6 | T8 |
|  | w | 1500 | 380.0 | 2580 | 2.0 | 156.0 | 1320 | 111.0 | 50. | 97.0 | 5 | 72 |
| L00056 6 | A | 2no | L0 | 0 | 8. 0 | 10 | L4. | 713 | 4. | 00.2 | 58 | 15.0 |
|  | w | 250 | 3 Pa | 3020 | 220.0 | 116.0 | 15.0 | 1200 | 1250 | 1160 | 1040 | 18.7 |
| LeOH1009 | A | ㅈalo | 3120 | 270 | 197.0 | 1340 | 1120 | 97. 0 | 89.0 | 81.0 | 74.0 | 60.0 |
|  | w | 0230 | 80.0 | 2080 | 300.0 | 21.0 | 209.0 | 180 | 10.0 | 1540 | 1410 | 115.0 |
| L601236 | A | 4430 | 300.0 | 240 | 2090 | 1640 | 1400 | 1240 | 110.0 | 1010 |  | 78.0 |
|  | w | 7840 | -650 | 508.0 | 330.0 | 310.0 | 241.0 | 72,0 | 2090 | 193.0 | 174.0 | 140 |
| $4002100-12 \mathrm{~N}$ | A | 800.0 | 372.0 | 270 | 10.0 | 1340 | 1120 | 97.0 | 20,0 | 11.0 | 210 | $\infty$ 0, 0 |
|  | w | casa | 5240 | 4050 | 3010 | 210.0 | 309.0 | 180 | 1070 | 1540 | 111.0 | 118.0 |
| 8006 | ${ }^{\text {A }}$ | 7400 | 6240 | 1520 | 830 | 240.0 | 22.0 | 198.0 | 178.0 | 1620 | 14.0 | 120 |
|  | w | 12040 | 10480 | E20.0 | 42.0 | 498.0 | 418.0 | \% 10 | 5240 | 5000 | 2220 | 2300 |

Amperes to F.V.1. 70 Valts Per Cell

| mator |  | ! ${ }_{\text {! }}$ | $\stackrel{5}{5}$ | $\begin{aligned} & 10 \\ & \hline \text { in } \end{aligned}$ | $\begin{aligned} & 15 \\ & \text { in } \end{aligned}$ | $\begin{aligned} & 20 \\ & \min \end{aligned}$ | $\begin{aligned} & 25 \\ & \text { min } \end{aligned}$ | $\begin{aligned} & \mathbf{3 0} \\ & \min \end{aligned}$ | $\begin{aligned} & 25 \\ & \hline \text { nin } \end{aligned}$ | $\operatorname{lin}_{n i n}$ | $\begin{aligned} & 4 \min ^{2} \end{aligned}$ | $\frac{1}{4}$ | $\stackrel{2}{4}$ | $\frac{1}{4}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | A | 1270 | 1040 | 27 | 5 | 47.9 | 414 | 3.5 | 32. | 27. | 27.0 | 20.0 | 13 | 9.9 |
|  | w | 211.0 | 12s0 | 18.0 | 040 | 4, | $\pi .9$ | 4.2 | 61.4 | 55 | 51.7 | 2 | 28.6 | 19.4 |
| 40060-12 | A | 12 | 150.0 | 7.0 | 78.3 | 0.0 | 34.6 | 43.0 | 125 | 28.3 | 25.5 | 29.0 | 12.0 | 12.0 |
|  | w | 27.0 | 24.0 | 10 | 1390 | 17.0 | 1030 | 1.0 | 17.0 | 73.4 | 6.0 | 560 | 250 | 25.5 |
| 60.4872 | A | 2040 | 1730 | 120 | \% 3.1 | 71. | ${ }^{4} \mathbf{H}$ | cos | 5.4 | 4 | 4.7 | ${ }^{26}$ | 23 | 14.4 |
|  | w | 29.0 | 2040 | 271.0 | 178.0 | 1470 | 10 | 11.0 | 102 | 2. | t5 | 0.6 | M | $\underline{2}$ |
| 40068 | A | 20.0 | 209.0 | 14.0 | 111.0 | 24 | 11.8 | n20 | 0.8 | 5. | 5.3 | 1.5 | $z{ }^{2}$ | 10.5 |
|  | w | 4140 | 3070 | 289.0 | 200.0 | 176.0 | 1340 | 178 | 1220 | 1100 | 1020 | 20 | 52.5 | 34 |
| Lenldos | A | 3240 | 27.0 | 1 M 0 | 151.0 | 1280. | 109.0 | 120 | 85.0 | $\pi{ }^{1}$ | 21.0 | 91.0 | 36. | 260 |
|  | w | 5840 | 4 HH | 251.0 | 23.0 | 24.0 | 2080 | 1220 | 12 | 10.0 | 130 | 112 | 70 | 81.0 |
| Leotliss | A | coso | 280 | 24.0 | 1890 | 15.0 | 12.0 | 120.0 | 1050 | 002 | 20, | 72.5 | 150 | 12.5 |
|  | w | 6080 | 6110 | A57. 0 | 348.0 | 2020 | 236.0 | z30 | 200.0 | 1 mO | 170.0 | 14.0 | ${ }^{0} \mathbf{7}$ S | 628 |
| - 100.12 N | A | 124,0 | 27.0 | 1940 | 151.0 | 128.0 | 1090 | 20 | 85.0 | IIT | 21.0 | 510 | 36. | 26.0 |
|  | w | 5540 | 4790 | 251.0 | 270 | 2340 | 203.0 | 1020 | 1620 | 10.0 | 1\%0 | 112.0 | 70 | 510 |
| L0H2006 | A | W20 | 5580 | 2830 | 3020 | 20 | 2180 | 1220 | 170.0 | 154 | 1420 | 110.0 | 20.0 | 120 |
|  | w | 0.0 | 970 | 700 | 55 | 4 | 4040 | $\boldsymbol{4} \mathbf{1}$ | 320 | 2940 | 220 | 210 |  |  |

## Ampares to F.V.1.80 Volis Per Call















Halmac Services (Qld) Pty. Ltd. A.C.N. 098852923 ABN 40741712113

## PROXIMITY SWITCH

## 1. NCB5-18GM40-ZO PROXIMITY SWITCH TECHNICAL DETAILS <br> 2. NJ20+U1+E2 PROXIMITY SWITCH TECHNICAL DETAILS

## Dimensions


Model Number

NCB5-18GM40-Z0

## Features

- Comfort series
- 5 mm embeddable


## Connection

20


## Accessorles

EXG-18
Mounting aid
BF 18
Mounting flange

Retease date: 2009-05-07 10:31 Date of issue: 2009-05-07 089258_ENG.xml

| Technical Data |  |  |
| :---: | :---: | :---: |
| General specifications |  |  |
| Switching element function |  | DC Make function |
| Rated operating distance |  | 5 mm |
| Installation |  | embeddable |
| Output polarity |  | DC |
| Assured operating distance | $\mathrm{s}_{0}$ | $0 . .4 .05 \mathrm{~mm}$ |
| Reduction factor $\mathrm{ral}_{\text {Al }}$ |  | 0.37 |
| Reduction factor rcu |  | 0.33 |
| Reduction factor 'IV2A |  | 0.7 |
| Nominal ratings |  |  |
| Operating voliage | $U_{B}$ | $5 \ldots .60 \mathrm{~V}$ |
| Switching trequency | 1 | $0 . .350 \mathrm{~Hz}$ |
| Hysteresis |  | 1... 10 typ. 5 \% |
| Reverse polarity protection |  | tolerant |
| Short-circuit protection |  | pulsing |
| Voltage drop | $U_{\text {d }}$ | S5V |
| Operating current | L | 2...100 mA |
| Off-state curren | $\mathrm{I}_{\mathrm{r}}$ | $0 . . .0 .5 \mathrm{~mA} \mathrm{typ}$. |
| Indication of the switching state |  | all direction LED, yellow |
| Standiard contormity |  |  |
| Standards |  | IEC/EN 60947-5-2:2004 |
| Amblent condifions |  |  |
| Ambient temperature |  | $-25 \ldots 70^{\circ} \mathrm{C}(248 \ldots 343 \mathrm{~K})$ |
| Mechanical specifications |  |  |
| Connection type |  | $2 \mathrm{~m}, \mathrm{PUR}$ cable |
| Cable version |  | PA |
| Core cross-section |  | $0.34 \mathrm{~mm}^{2}$ |
| Housing materal |  | Stanless steel |
| Sensing face |  | PBT |
| Protection degree |  | $1 \mathrm{P67}$ |
| Approvals and certificates |  |  |
| CCC approval |  | Cortified by China Compulsory Coritication (CCC) |

Inductive proximity switches
Comfor series
20 mm embeddable


## C $\epsilon$

| Switching element function | PNP Make function |
| :---: | :---: |
| Rated operating distance $s_{n}$ | 20 mm |
| Installation | embeddable |
| Assured operating distance $s_{a}$ | $0 . . .16,2 \mathrm{~mm}$ |
| Reduction factor $\mathrm{r}_{\text {Al }}$ | 0,35 |
| Reduction factor $\mathrm{r}_{\mathrm{C}_{4}}$ | 0,35 |
| Reduction factor $\mathrm{r}_{\mathrm{V} 2} \mathrm{~A}$ | 0,8 |
| Operating voltage $\mathrm{U}_{\mathrm{B}}$ | $10 \ldots 60 \mathrm{~V}$ |
| Switching frequency ! | $0 \ldots 150 \mathrm{~Hz}$ |
| Hysteresis H | $1 . . .10$ typ. 5 \% |
| Reverse polarity protection | Protected against reverse polarity |
| Short circuit protection | pulsing |
| Voltage crop $U_{d}$ | $\leq 2,8 \mathrm{~V}$ |
| Operating current $I_{L}$ | $0 \ldots 200 \mathrm{~mA}$ |
| Off-state current $I_{r}$ | 0 .. 0,5 mA typ. 0,01 mA |
| No-load supply current $l_{0}$ | $\leq 10 \mathrm{~mA}$ |
| Operating voltage display | LED, green |
| Indication of the switching state | LED, yellow |
| Standards | EN 60947-5-2 |
| Ambient temperature | $-25 \ldots 70^{\circ} \mathrm{C}$ ( $248 \ldots 343 \mathrm{~K}$ ) |
| Storage temperature | $-25 \ldots 85^{\circ} \mathrm{C}(248 \ldots 358 \mathrm{~K})$ |
| Connection lype | terminal compartment |
| Core cross-section | up to $2.5 \mathrm{~mm}^{2}$ |
| Housing material | PBT |
| Sensing face | PBT |
| Protection degree | IP68 |

## Connection_type:

E2


084516_ENG.xml

Halmac Services (Qld) Pty. Ltd.

## PUSHBUTTON \& INDICATORS

## 1. PUSH BUTTON TECHNICAL DETAILS

2. HOUR RUN METER TECHNICAL DETAILS


# Series D7 Pilot Devices 

22 mm Design<br>Saves Panel Space

Heavy Duty
Ratings

Modular Design
Reduces Inventory
Reduces Inventory


#### Abstract

Order Assembled or by Component


## 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
 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.






Non-Illuminated and Illuminated
Flush Push Button Operators (D7x-F)


Non-Illuminated Guarded and Non-Illuminated
Maintained Push Button Operators (D7x-G and D7x-FA)


Illuminated and Non-lluminated Knob Selector Switch Operators ( $D 7 x-L S \& D 7 x-S$ )

mond Non-lluminated
Momentary Mushroom Operators
40 mm and 60 mm ( $D 7 x-$ LMM \& D7x-MM)


Hluminated and Non-Illuminated
Push-Pull Mushroom Operators $30 \mathrm{~mm}, 40 \mathrm{~mm}$, and 60 mm (D7x-MP)


Illuminated and Non-Illuminated Extended Push Button Operators


Pilot Light Operators ( $D 7 x-P$ )


Key Selector Switch Operators (D7x-K)


Illuminated and Non-Illuminated Twist-to-Release 0 perators $30 \mathrm{~mm}, 40 \mathrm{~mm}$, and $60 \mathrm{~mm}(07 \mathrm{x}-\mathrm{MT})$


Mushroom Key Release Operator $40 \mathrm{~mm}(\mathrm{D} 7 \mathrm{x}-\mathrm{MK})$


Non-Illuminated 3-Position Multi-Function Operators (D7x-U3)


Illuminated and Non-llluminated 2-Position Multi-Function Operators (D7x-LU2 \& D7x-U2)


Toggle Switch Operators (D7M-JM)


Reset 0perators ( $D 7 x-R$ )


Selector Jog Operators (D7x-SJ)


Potentiometer with Resistive Element (D7P- POI)
$46 \quad \because \rightarrow 28.5-$

*For Monolitictic Devices see the D7D Monolitic Fyer


[^7]Sprecher + Schuh Canarfian Division
3610 Nashua Dr., Unit 10, Mississauga, Ontario L4V 112 Tet: (905) 677-7514; Fax (905) 677-7663

## Front-of-Panel (Operators) ©

Mechanical Ratings


## Back-of-Panel Components (0

Electrical Ratings

|  |  |  |
| :--- | :--- | :--- | :--- |
| Standard contact block ratings |  |  |
|  |  |  |

(0 Performance data given in this publication is provided only as a guide for the user in determining suitability and do not constitute a performance warranty of any kind. Such data may represent the results of accelerated testing at elevated stress levels, and the user is responsible for correlating the data to actual application requirements. ALL WARRANTIES AS TO ACTUAL PERFORMANCE, WHETHER EXPRESS OR IMPLIED, ARE EXPRESSLY DISCLAIMED.
(2) Momentary mushroom operators are IP65, multi-function operators have no Type 13 rating. Plastic operators with keys have no Type 4 X rating.
(3) Operating temperatures below $0^{\circ} \mathrm{C}\left(32^{\circ} \mathrm{F}\right)$ are based on the absence of freezing moisture and liquids, UL recognized to $55^{\circ} \mathrm{C}\left(131^{\circ} \mathrm{F}\right)$ - incandescent module, max $40^{\circ} \mathrm{C}\left(104^{\circ} \mathrm{F}\right)$.
(4. Low voltage contacts are recommended for applications below $17 \mathrm{~V}, 5 \mathrm{~mA}$.
© Wires less than $\# 18\left(0.75 \mathrm{~mm}^{2}\right)$ may not hold in terminal securely.

## sprecher+ <br> schuh

Technical Information

Back-of-Panel Components © , continued


Environmental Approval Note: Front elements UL Recognized; Complete assemblies UL Approved.
See Table A2 for your application.
This table is extracted from Sprecher + Schuh's UL 508A file and can be used to determine which
D7 Pilot Device is approved for a particular enclosure type.

| TABLE A2,- Openings in Enclosure |  |
| :---: | :--- |
| Enclosure Type | Openings May Be Closed By Equipment Marked... |
| 2 | $2,3,3 R, 3 S, 4,4 \mathrm{X}, 6,6 \mathrm{P}, 11,12,12 \mathrm{~K}, 13$ |
| 3 | $3,3 \mathrm{R}, 3 \mathrm{~S}, 4,4 \mathrm{X}, 6,6 \mathrm{P}$ |
| 3 R | $3,3 \mathrm{R}, 3 \mathrm{~S}, 4,4 \mathrm{X}, 6,6 \mathrm{P}$ |
| 3 S | $3,3 \mathrm{R}, 3 \mathrm{~S}, 4,4 \mathrm{X}, 6,6 \mathrm{P}$ |
| 4 | $4,4 \mathrm{X}, 6 \mathrm{P}, 6$ |
| 4 X | 4 X |
| 6 | $6,6 \mathrm{P}$ |
| 6 P | 6 P |
| 11 | 11 |
| $12,12 \mathrm{~K}$ | $12,12 \mathrm{~K}, 13$ |
| 13 | 13 |

## Product Certifications

| Certifications | UL, UR, CSA, CCC, CE |
| :--- | :---: |
| Conformity of Standards - CE marked | NEMA ICS-5; UL 508, EN 418, EN 60947-1, EN 60947-5-1, EN 60947-5-5 |
| Terminal identification | IEC 60947-1 |
| Shipping approvals | RINA, LR, ABS |
| RoHS | $\checkmark$ |

[^8] data may represent the results of accelerated testing at elevated stress levels, and the user is responsible for correlating the data to actual application requirements. ALL WARRANTIES AS TO ACTUAL PERFORMANCE, WHETHER EXPRESS OR IMPLIED, ARE EXPRESSLY DISCLAIMED.

## Material Listing

|  | Component | For Use with | Material Used |
| :---: | :---: | :---: | :---: |
|  | Panel gasket | All operators | Nitrile, TPE |
|  | Diaphragm seal | Illuminated push bution, non-illuminated push button | Automotive industry acceptable silicone |
|  | K-seal | Selector switch, key selector switch, push/twist-to-release E-stop, key E-stop, push/pull mushroom | Nitrile |
|  | Diaphragm retainer, return spring I | Illuminated push bution, non-illuminated push button, momentary mushroom | Staintess steel |
|  | Return spring II | Reset, selector switch, key selector switch, maintained action, push/twist-to-release E-stop, key E-stop, push/pull mushroom | Zinc coated music wire |
| $\square \square^{\square}$ | Button cap/mushroom head | Non-ililuminated push button, momentary mushroom, reset, puṣh/twist-torelease E-stop, key E-stop, push/pull mushroom, multi-function | PBT/polycarbonate blend |
|  | 2-color molded bytton cap | Non-illuminated push button | PBT/polycarbonate blend |
| ¢ | Lens | Multi-function | Acetal |
| 点 | Lens, knob | Illuminated push buton, illuminated momentary mushroom, illuminated selector switch | Polyamide |
| 莫 | Xnob | Non-illuminated selector switch | Glass-filled polyamide |
| - 07 | Plastic bezelvoushing I | Non-illuminated push bution, illuminated push button, momentary mushroom, selector switch, key selector switch, push/twist-to-release E-stop, key E-stop, push/pull mushroom, multi-function, reset | Glass-filled polyamide |
|  | Plastic bezeVbushing II, jam nut | Pilot light, reset jam nut, reset pusher | Glass-filled PBT |
|  | Metal bezel/bushing | All metal operators | Zinc |
|  | Oiffuser | Inuminated push button, piloot light | Polycarbonate |
|  | Legend frames | - | Glass-filled polyamide |
|  | Plastic mounting ring | All plastic operators | Glass-filled polyamide |
|  | Metal mounting ring | All metal operators | Chromated zinc |
|  | Plastic latch | - | Glass-filled polyamide |
|  | Metal latch | - | Chromated zinc + stainless steel |
|  | Plastic enclosure | - | PBT/polycarbonate biend |
|  | Metal enclosure | - | Aluminum |
|  | Terminal screws | LED module, incandescent module, contact blocks | Zinc-plated steel with chromate |
|  | Terminals | LED module, incandescent module, contact blocks | Brass with silver-nickel contacls |
|  | Screwless | LED module, incandescent module, contact blocks | Stainless steel |
|  | Lamp socket | Incandescent module | Brass |
|  | Housing | Incandescent module, LED module | Glass-filled polyamide |
|  | Low voltage terminals | Contact blocks | Gold plated silver-nickel contacts |
|  | Low voHage spanner | Contact blocks | Gold-plated silver-nickel contacis |
|  | Spanner | Contact blocks | Brass with silver-nickel contacts |
|  | Boot | Toggle Switch, illuminated push button, non-illuminated push button, muthi-function illuminated an nen-illuminated | Automotive industry acceptable silicone |

## sprecher+ schuh

## Specifications

| Mechanical Ratings |  |  | Environmental |  |
| :---: | :---: | :---: | :---: | :---: |
| Vibration (assembled to panelf | Tested at $10 . . .2000 \mathrm{~Hz}, 1.52 \mathrm{~mm}$ displacement (peak-to-peak) max. 10 G max. for 3 hr duration, no damage |  | Temperature range (operating) © | $-25 \ldots+60^{\circ} \mathrm{C}\left(-13 \ldots 140^{\circ} \mathrm{F}\right)$ |
| Shock | Tested at $1 / 2$ cycle sine wave for 11 ms ; no damage at 100 G |  | Temperature range | F |
| Degree of protection | IP 66 (Type 3/3R/4/4X/12/13) |  | (short term storage) | -40... +85 C (-40...185') |
| mechanical durability per EN 60947-5-1 (Annex C) | 2,000,000 Cycles | Momentary Push Button | Humidity | 50...95\% RH from |
|  | 300,000 Cycles | Selector Switch and E-Stop |  | 25...60 6 ( $77 . . .140^{\circ} \mathrm{F}$ ) |
| Operating forces | Flush/Extended $=9 \mathrm{~N}, \mathrm{E}$-stop $=36 \mathrm{~N}$ |  |  |  |
| Operating torque (typical application with one contact block) | Selector Switch $=0.25 \mathrm{~N} \bullet \mathrm{~m}$ |  |  |  |
| Contact operation | N.O. | Slow double make and break |  |  |
|  | N.C. | Slow double make and break - positive opening $\theta$ |  |  |
| Push button travel to change electrical state | N.O. | 2.5 mm (0.1 in.) |  |  |
|  | N.C. | 1.5 mm ( 0.060 in .) |  |  |

Electrical Ratings


| Materials |  |
| :--- | :--- |
| Springs | Stainless steel and zinc coated music wire |
| Electical contacts | Brass with siver-nickel contacts |
| Terminals | Brass and phosphor bronze |
| Panel gasket | nitrile and polyester-based TPE |
| Seal | Nitrile |
| Button cap/mushroom head | Polyester/polycartonate blend |
| Lens (pilot light) | Acrylic |
| Knob (selector switch) | Glass-filled polyamide |
| Bezel/bushing, housing | Glass filled polyester |
| Legend frames | Glass filled polyamide |
| Mounting ring | Glas filled polyamide |
| Terminal screws | Zinc-plated steel with chromate |
| Lamp Socket | Brass and Phosphor bronze |
| Product Certifications |  |
| Certifications | Ul, CSA, CCC, CE |
| Conformity to standards - CE marked | UL 508, EN 60947-1, EN 60947-5-1, EN 60947-5-5 |
| Terminal Identification | ENIEC 60947-1 |

Pilot Devices

Approximate Dimensions - millimeters ©
Panel Hole Spacing

(0) Dimensions are not intended to be used for manufacturing purposes.

## sprecher + schuh

Approximate Dimensions - millimeters (1)



Mushroom Key Release Operator 40mm (D7x-MK)


Back-of-Panel Components -
Contact Cartridges with Latch (D7-X/O + D7-ALP/M)


Back-of-Panel Components -
Dual Circuit Contact Block (Max. of 1 Deep) (D7x-X_D/D7-X01S)


$30 \times 40 \mathrm{~mm}$ Snap-in-Legend Plate (07-11)
$30 \times 50 \mathrm{~mm}$ Snap-in-Legend Plate (D7-12)


[^9]Pilot Devices

Approximate Dimensions - millimeters 0 (2)

© Dimensions are not intended to be used for manufacturing purposes.
(2) Panel thickness range is 1.0 ... 6.0 maximum. Panel thickness reduced to 4.5 when optional legend plates are used.

## sprecher + schuh

Pilot Devices | Series D7 - Heavy Duty/Oil Tight

Approximate Dimensions - millimeters ©

(1) Dimensions are not intended to be used for manufacturing purposes.

Approximate Dimensions - millimeters ©


Approximate Dimensions - millimeters ©



(1) Dimensions are not intended to be used for manufacturing purposes.

## DIN HALF SIZE HOUR METER

## TH63:TH64 Hour Meters



## IS Directive compatibility information http://www.nais-e.com/

## Features

1. Compact to save panel space

The $24 \times 48 \mathrm{~mm}$ hour meters are just half the DIN $48 \times 48$ standard size. They help save the panel space.

## UL File No.: E42876 <br> CSA File No.: LR39291

2. Reset button

The hour meters can be reset to zero (TH64 series).
3. Wide-ranging measurement display

The measurement can be displayed from 0.1 hour up to 99999.9 hours (TH63 series). The dial size is the same as that of $48 \times 48$ DIN size hour meters (TH14 and TH24 series).
4. Easy to install

The flat terminals (\#187) are used for easier wiring. There is no need to undo the lock spring.
5. High-performance sync motor with $50 / 60 \mathrm{~Hz}$ selector The noise-resistant, accurately turning motor is employed to provide for longer period of measurement. The power frequency can be selected for 50 or 60 Hz .

## 6. Rotary indicator

The rotary indicator makes one turn every 72 seconds for monitoring.
7. Compliant with UL, CSA and CE.

## Typical applications

Management of small generators and food processing machines; hour counting for leased equipment; maintenance management of various equipment, etc.

## Specifications

| Fated operating, volta |  | $12 \mathrm{~V} \mathrm{AC}$,24 V AC, $49 \mathrm{~V}, \mathrm{AC}, 100 \mathrm{~V}$ AC, $110 \mathrm{~V} \mathrm{AC}$,115 to $120 \mathrm{~V} \mathrm{AC} ,200 \mathrm{~V} \mathrm{AC} ,220 \mathrm{~V} \mathrm{AC}$, |
| :---: | :---: | :---: |
| Allowable operating | ge range | 85 to $115 \%$ of rated operating voltage |
| Rated frequency |  | $50 / 60 \mathrm{~Hz}$ (selectable by switch) |
| Counting range |  | 0 to 99999.9 hours (TH63 series) <br> 0 to 9999.9 hours (TH64 series) |
| Minimum time display |  | 0.1 hours ( 6 min ) |
| Rated power consum | \% | Approx. 1.5 W |
| Insulation resistañce | al value) | Min. $100 \mathrm{M} \Omega$, Between live and dead metal parts (At 500 V DC) |
| LBreakdown voltage ( | value) | $2,000 \mathrm{Vrms}$, Between live and dead metal parts |
| temperature is | - | $55^{\circ} \mathrm{C} 131{ }^{\circ} \mathrm{F}$ |
| diton resistance | Functional | 101055 Hz : 1 cycle/min double amplitude of 0.5 mm ( 10 min on 3 axes ) |
|  | Functionäl | Min $98 \mathrm{~m} / \mathrm{s}^{2}\{10 \mathrm{G}\}$ ( 4 times on 3 axes ) |
| Shock resistance | Destructive | Min $980 \mathrm{~m} / \mathrm{s}^{2}\{100 \mathrm{G}\}$ ( 5 times on 3 axes) |
| Ambient temperature |  | -10 to $+50^{\circ} \mathrm{C}+1410+122^{\circ} \mathrm{F}$ |
| Ambient humidity | : | Max. 85\% RH (non-condensing) |
| Weight |  | Approx. 80 g 2.82 oz |

## Product types

| Type | Operating voltage | Part number | Operating voltage | Part number | Opereting voltage | Part number |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| TH63 series (without reset button) | 100 V AC | TH631 | 24 VAC | TH634 | 115 to 120V AC | TH637 |
|  | 200 VAC | TH632 | 48 V AC | TH635 | 220 V AC | TH638 |
|  | 12 VAC | TH633 | 110 VAC | TH636 | 240 V AC | TH639 |
| TH64 serles (with reset buttion) | 100 V AC | TH641 | 24 VAC | TH644 | 115 to 120 V AC | TH647 |
|  | 200 V AC | TH642 | 48 V AC | TH645 | 220 V AC | TH648 |
|  | 12 VAC | TH643 | 110 V AC | TH646 | 240 V AC | TH649 |

Notes) 1 . Only the metallic-looking (silver) panel mounting type is available,
2. Standard products are UL-recognized as well as CSA-certified. There is no need to add " $U$ " at the end of the part number. Just specity the standard part number when ordering.

## Applicable standard

| Safoty standard | EN61010-1 | Pollution Degree 2/Overvoltage Category II |
| :---: | :---: | :---: |
| EMC | (EMI)EN61000-6-4 <br> Radiation interference electric field strength <br> Noise terminal voltage <br> (EMS)EN61000-6-2 <br> Static discharge immunity <br> RF electromagnetic field immunity <br> EFT/B immunity <br> Surge immunity <br> Conductivity noise immunity <br> Power frequency magnetic field immunity <br> Voltage dip/Instantaneous stop/Noltage fluctuation immunity | EN55011 Group1 ClassA <br> EN55011 Group1 ClassA <br> EN61000-4-2 4 kV contact <br> 8 kV air <br> EN61000-4-3 $10 \mathrm{~V} / \mathrm{m}$ AM modulation ( 80 MHz to 1 GHz ) <br> $10 \mathrm{~V} / \mathrm{m}$ pulse modulation ( 895 MHz to 905 MHz ) <br> EN61000-4-4 2 kV (power supply line) <br> EN61000-4-5 1 kV (power line) <br> EN61000-4-6 $\quad 10 \mathrm{~V} / \mathrm{m}$ AM modulation ( 0.15 MHz to 80 MHz ) <br> EN61000-4-8 $30 \mathrm{~A} / \mathrm{m}(50 \mathrm{~Hz})$ <br> EN61000-4-11 $10 \mathrm{~ms}, 30 \%$ (rated voltage) <br> $100 \mathrm{~ms}, 60 \%$ (rated voltage) <br> $1,000 \mathrm{~ms}, 60 \%$ (rated voltage) <br> $5,000 \mathrm{~ms}, 95 \%$ (rated voltage) |

## Dimensions



## Wiring diagram

- Panel cutout dimensions


Operating power supply


## Mounting

1. Cut a $22.22_{0}^{+0.3} \times 455_{0}^{+0.6} \mathrm{~mm}\left(.8740_{0}^{+012} \times\right.$ $1.7722_{0}^{+024}$ inch) opening in the panel.
2. Swing the mounting spring to the rear of the hour meter and fit the hour meter into the panel opening. (There is no need to detach the mounting spring from the hour meter.) If the panel is 5 to 9 mm .197 to .354 inch thick, move the mounting spring to the other hole toward the rear of the hour meter.
3. Swing the mounting spring to the front of the hour meter to secure the hour meter to the panel.
4. Wire the supplied quick connectors and connect to the hour meter. Be sure to use the supplied insulating sleeves to cover the connectors.


## PRECAUTIONS IN USING THE HOUR METERS

## 1. Frequency setting

Frequency is specified for AC motor-driven hour meters. Before installing, be sure to check your local power frequency.
2. Connections

- TH13,23,14,24,40,50,63,64


Note) Make the connection with the accompanying flat connector first and then with the hour meter's terminal (\#187). In such case, be sure to cover the connection with the accompanying insulating sleeve.

- TH70, TH8


Note) Solder the lead wires in position.

## 3. Safety precautions

Do not use the hour meters in the following places.

- Where ambient temperature is below $-10^{\circ}$ or above $+50^{\circ} \mathrm{C}$
- In wet, dusty or gaseous environments
- Where exposed to vibrations and shocks
- Outdoors, or where exposed to rain or direct sunlight

4. Compliant with CE.

- LH2H

Ambient conditions:
Overvoltage category III, contamination factor 2, indoor use. Ambient temperature and humidity -10 and $+55^{\circ} \mathrm{C}$ and $35 \%$ to $85 \% \mathrm{RH}$ respectively.

- TH13, 23, 14, 24, 40, 50, 63, 64

Ambient conditions:
Overvoltage category II, contamination factor 2 , indoor use. Ambient temperature and humidity -10 and $+50^{\circ} \mathrm{C}$ and below $85 \% \mathrm{RH}$ respectively.

## 5. Reset-type hour meter

- Precautions for use

If the number indications are off before use, press the reset button and confirm that all zeroes ("0") are displayed.

- Resetting caution

Exercise due caution as an insufficient amount of pressure on the reset button may result in abnormal readings.

## 6. Acquisition of CE marking

Please abide by the conditions below when using in applications that comply with EN 61010-1/IEC 61010-1

1) Ambient conditions

- Overvoltage category II, pollution level 2
- Indoor use
- Acceptable temperature and humidity range: -10 to $+55^{\circ} \mathrm{C}$, 35 to $85 \% \mathrm{RH}$ (with no condensation at $20^{\circ} \mathrm{C}$ )
- Under 2000 m elevation

2) Use the main unit in a location that matches the following conditions.

- There is minimal dust and no corrosive gas.
- There is no combustible or explosive gas.
- There is no mechanical vibration or impacts.
- There is no exposure to direct sunlight.
- Located away from large-volume electromagnetic switches and power lines with large electrical currents.

3) Connect a breaker that conforms to EN60947-1 or EN609473 to the voltage input section.
4) Applied voltage should be protected with an overcurrent protection device (example: $T 1 \mathrm{~A}, 250 \mathrm{~V}$ AC time lag fuse) that conforms to the EN/IEC standards. (Free voltage input type)

## PRESSURE TRANSMITTER \& ADJUSTMENT UNIT

## 1. VEGABAR74 PRESSURE TRANSMITTER TECHNICAL DETAILS

2. VEGADIS PRESSURE ADJUSTMENT UNIT TECHNICAL DETAILS

Process pressure/Hydrostatic


## Product Information



## Content

1 Description of the measuring principle ..... 3
2 Type overview ..... 4
3 Mounting instructions. ..... 5
4 Electrical connection
4.1 General prerequisites ..... 6
4.2 Voltage supply ..... 6
4.3 Connection cable ..... 6
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## Take note of safety Instructions for Ex applications

Please note the Ex specific safety information which you can find on our homepage www.vega.comiservicesldownloads and which comes with every instrument. in hazardous areas you should take note of the appropriate regulations, conformity and type approval certificates of the sensors and power supply units. The sensors must only be operated on intrinsically safe circuits. The permissible electrical values are stated in the certificate.

## 1 Description of the measuring principle

## Measuring principle

VEGABAR 74 and 75 pressure transmitters are specially adapted to their respective application areas. That is why different sensor elements and measuring units are implemented.

## VEGABAR 74

The sensor element of VEGABAR 74 is the dry ceramic-capacitive CERTEC ${ }^{(9}$ measuring cell. Base element and diaphragm consist of high purity sapphire-ceramic ${ }^{\oplus}$.
The process pressure causes via the diaphragm a change in an electrical parameter of the measuring cell. This change is converted into an appropriate output signal.
The CERTEC ${ }^{(8)}$ measuring cell is also equipped with a temperature sensor. The temperature value can be displayed via the indicating and adjustment module or processed via the signal output.


Fig. 1: Configuration of the CERTEC© measuring cell in VEGABAR 74
1 Diaphragm
2 Soldered glass bond
3 Base elemant
The advantages of the CERTEC ${ }^{\left({ }^{( }\right)}$measuring cell are:

- Very high overload resistance
- No hysteresis
- Excellent long-term stability
- Completely front flush installation
- Good corrosion resistance
- Very high abrasion resistance


## VEGABAR 75

The METEC ${ }^{\oplus}$ measuring cell is the measuring unit of VEGABAR 75. This unit consists of a CERTEC ${ }^{\oplus}$ measuring cell and a special isolating system with metallic process diaphragm. A special feature of this isolating system is the direct mechanical compensation of temperature influence.
The process pressure causes via the diaphragm a change in an electrical parameter of the measuring cell. This change is converted into an appropriate output signal.


Fig. 2: Configuration of the METEC ${ }^{6}$ measuring cell in VEGABAR 75
1 Diaphragm Hastelloy C276
Isolating liquid (approx. $0.3 \mathrm{~cm}^{3}$, FDA-listed)
FoNi adapter
4 CERTEC ${ }^{\oplus}$ measuring cell
The advantages of the METEC ${ }^{\otimes}$ measuring cell are:

- Completely welded, elastomer-free
- Very high overload resistance
- Full vacuum resistance (also with 0.1 bar measuring range)
- Good thermo-shock reaction
- Excellent long-term stability
- High degree of flushness


## Wide application range

VEGABAR 74 and 75 transmitters are designed for front flush process pressure measurement of gases, vapours and liquids. Their application-optimised housings in IP 68 and high resistance materials ensure reliable use even in harsh environments and in extremely moist areas. Thanks to their compact configuration with completely integrated electronics, the instruments can be connected directly to the respective signal processing equipment.
VEGABAR 74 is best suited for use in abrasive media in the paper industry or in waste water treatment.
VEGABAR 75 with its hygienic fittings is particularly suitable for the food processing and pharmaceutical industries.

## Information:

Continuative documentation such as operating instructions manuals:

- 28432 - VEGABAR 74
- 28433 - VEGABAR 75 Type overview


## 2 Type overview

## VEGABAR 74



## VEGABAR 75

| Measuring cell: | CERTEC ${ }^{\text {® }}$ | METEC ${ }^{\text {® }}$ |
| :---: | :---: | :---: |
| Diaphragm: | Ceramic | Metal |
| Media: | gas, vapours and liquids, also abrasive | gases, vapours and liquids also with higher temperatures |
| Process fitting: | Thread from $11 / 2^{\circ}$, flanges from DN 40 , fittings for the food processing and paper industry | Thread from $1 / 2^{\prime \prime}$, flanges from DN 40 , fittings for the food processing industry |
| Material: | 316L | 316L |
| Measuring range: | -1 ... 60 bar (-14.5 .. 870 psi ) | -1 ... 25 bar (-14.5 ... 363 psi ) |
| Smallest measuring range: | 0.1 bar (1.45 psi) | 0.1 bar (1.45 psi) |
| Process temperature: | $-40 \ldots+120^{\circ} \mathrm{C}\left(-40 \ldots+248^{\circ} \mathrm{F}\right)$ | $-12 \ldots+200^{\circ} \mathrm{C}\left(-40 \ldots+392^{\circ} \mathrm{F}\right)$ |
| Deviation in characteristics: | < $0.075 \%$ | $<0.075 \%$ |
| Signal output: | $4 . .20 \mathrm{~mA} / \mathrm{HART}$ | $4 \ldots 20$ mA/HART |
| Remote adjustment/ indication: | VEGADIS 12 | VEGADIS 12 | indication:



METEC ${ }^{\text {® }}$
Metal
gases, vapours and liquids also with higher temperatures
Thread from $11 / 2^{\prime \prime}$, flanges from DN 40 , fittings for the food processing industry

316L
$-1 \ldots 25$ bar (-14.5 ... 363 psi)
0.1 bar ( 1.45 psi )
$-12 \ldots+200^{\circ} \mathrm{C}\left(-40 \ldots+392^{\circ} \mathrm{F}\right)$
$<0.075 \%$

VEGADIS 12

## 3 Mounting instructions

## Installation position

VEGABAR functions in any installation position. Depending on the measuring system, the installation position can influence the measurement. This can be compensated by a position correction.

[^10]
## 4 Electrical connection

### 4.1 General prerequisites

The supply voltage range can difer depending on the instrument version. You can find exact specifications in chapter "Technical data".
The national installation standards as well as the valid safety regulations and accident prevention rules must be observed.


In hazardous areas you should take note of the appropriate regulations, conformity and type approval certificates of the sensors and power supply units.

### 4.2 Voltage supply

Supply voltage and current signal are carried on the same twowire cable. The requirements on the power supply are specified in chapter "Technical data".
The VEGA power supply units VEGATRENN 149AEx, VEGASTAB 690, VEGADIS 371 as well as VEGAMET signal conditioning instruments are suitable for power supply. When one of these instruments is used, a reliable separation of the supply circuits from the mains circuits according to DIN VDE 0106 part 101 is ensured.

### 4.3 Connection cable

## Generally

The sensors are connected with standard cable without screen. An outer cable diameter of $5 . . .9 \mathrm{~mm}$ ensures the seal effect of the cable entry.

## 4 ... 20 mA HART two-wlre and four-wire

If electromagnetic interference is expected which is above the test values of EN 61326 for industrial areas, screened cable should be used. In HART multidrop mode the use of screened cable is generally recommended.


In Ex applications, the corresponding installation regulations must be noted for the connection cable.

### 4.4 Cable screening and grounding

If screened cable is necessary, the cable screen must be connected on both ends to ground potential. If potential equalisation currents are expected, the connection on the evaluation side must be made via a ceramic capacitor (e.g. $1 \mathrm{nF}, 1500 \mathrm{~V}$ ).

### 4.5 Wiring plan VEGABAR 74, 75

Direct connection


Fig. 3: Wire assignment, connection cable
1 brown (+): to power supply or to the processing system
2 blue ( - ): to power supply or to the processing system
3 yellow: ts only required with VEGADIS 12, otherwise connect to minus
4 Screen
5 Braather capillaries with fither alement

Connection via VEGABOX 02


Fig. 4: Terminal assignment VEGABAR
1 To power supply or the processing system
2 Screen

## Connection vala VEGADIS 12



Fig. 5: Tarminal assignment, VEGADIS 12
1 To power supply or the processing system
2 Control instrument (4 ... 20 mA measurement)
3 Screen
4 Breathercapillerles
5 Suspension cable

## 5 Operation

### 5.1 Overview

VEGABAR 74 and 75 can be adjusted with the following adjustment media:

- Indication/Adjustment VEGADIS 12
- Adjustment software according to FDT/DTM standard, e.g. PACTware ${ }^{\text {TM }}$ and PC
- HART handheld


### 5.2 Adjustment with VEGADIS 12

## VEGADIS 12

VEGADIS 12 is connected directly to the connection or suspension cable of VEGABAR or VEGAWELL. It is looped into the supply and signal circuit and requires no separate external energy.


Fig. 6: Adjustment elements of VEGADIS 12
1 Rotary switch: choose the requested function
2 [+] key change value
3 l-Jkey change value

### 5.3 Adjustment with PACTware ${ }^{\text {TM }}$

## PACTware ${ }^{\text {TM/DTM }}$

VEGABAR 74 and 75 sensors are adjusted via the signal cable by means of PACTware ${ }^{\text {TM }}$.

An instrument driver for the respective VEGABAR is necessary for the adjustment with PACTware ${ }^{\text {TM }}$.
All currently available VEGA DTMs are provided as DTM Collection with the current PACTware ${ }^{\text {TM }}$ version on CD. They are available from the responsible VEGA agency for a token fee. The basic version of this DTM Collection incl. PACTware ${ }^{\text {TM }}$ is available as a free-of charge download from the Internet.
To use the entire range of functions of a DTM, incl. project documentation, a DTM licence is required for that particular instrument family, e.g. VEGABAR. This licence can be bought from the VEGA agency serving you.

## Connection of the PC via VEGACONNECT 3



Fig. 7: Connecting the PC to the signal cable
1 RS232 connection (with VEGACONNECT 3) or USB connection (with VEGACONNECT 4)
2 VEGABAR
3 HART adapter cable
4 HART resistor $250 \Omega$

Connection of the PC via VEGACONNECT 4


Fig. 8: Connecting the PC via HART to the signal cable
1 VEGABAR
2 HART resistor $250 \Omega$ (optional depending on processing)
3 Connection cable with 2 mm pins and terminals
4 Processing systemPLCNottage supply

### 5.4 Adjustment with other adjustment programs

## PDM

For VEGA PA sensors, instrument descriptions for the adjustment program PDM are available as EDD. The instrument descriptions are already implemented in the current version of PDM. For older versions of PDM, a free-of-charge download is available via Internet.

## AMS

For VEGA FF sensors, instrument descriptions for the adjustment program $A M S^{\text {TM }}$ are available as $D D$. The instrument descriptions are already implemented in the current version of AMS'M. For older versions of AMS ${ }^{\text {M }}$, a free-of-charge download is available via Internet.

## 6 Technical data

## General data

Material 316L corresponds to 1.4404 or 1.4435
VEGABAR 74
Materials, wetted parts

- Process fitting

316L

- Diaphragm
sapphire ceramic ${ }^{\text {© }}$ ( $99.9 \%$ oxide ceramic)
- Seal
- Seal process fitting thread $G 1 / 2 A, G 11 / 2 A$

FKM (Viton), Kalrez 6375, EPDM, Chemraz 535

VEGABAR 75
Materials, wetted parts

- Process fitting

316L

- Process diaphragm

Hastelloy C276
Materials, non-wetted parts

- Isolating liquid
med. white oil, FDA listed (silicone-free)


## Common data

Materials, non-wetted parts

- Housing
- Ground terminal

316 L

- Connection cable
- type label support on cable

Weight
316Ti/316L
PUR, FEP, PE
PE-HART
$0.8 \ldots 8 \mathrm{~kg}$ ( $1.764 \ldots 17.64 \mathrm{lbs})$, depending on process fitting

## Output varlable

| Output signal | $4 \ldots 20 \mathrm{mA/HART}$ |
| :--- | :--- |
| Failure signal | $22 \mathrm{~mA}(3.6 \mathrm{~mA})$ ad |

Failure signal
4... 20 mA/HART

Max. output current
Damping ( $63 \%$ of the input variable)
Step response or adjustment time
Fulfilled NAMUR recommendations
22.5 mA
$0 \ldots 10 \mathrm{~s}$, adjustable
70 ms (ti: $0 \mathrm{~s}, 0 \ldots 63 \%$ )
NE 43

Additional output variable - temperature (with VEGABAR 74)
Processing is made via HART-Multidrop
Range $-50 \ldots+150^{\circ} \mathrm{C}\left(-58 \ldots+302{ }^{\circ} \mathrm{F}\right)$
Resolution $1^{\circ} \mathrm{C}\left(1.8^{\circ} \mathrm{F}\right)$
Accuracy

- in the range of $0 \ldots+100^{\circ} \mathrm{C}\left(+32 \ldots+212^{\circ} \mathrm{F}\right)$
$\pm 3 \mathrm{~K}$
- in the range of $-50 \ldots 0^{\circ} \mathrm{C}\left(-58 \ldots+32^{\circ} \mathrm{F}\right)$ and $+100 \ldots+150^{\circ} \mathrm{C} \quad$ typ. $\pm 4 \mathrm{~K}$ $\left(+212 \ldots+302^{\circ} \mathrm{F}\right)$


## Input variable

| Parameter | Level <br> see product code |
| :--- | :--- |
| Measuring range |  |
| Turn down | $1: 10$ |
| - recommended | $1: 30$ |

## Reference conditions and actuating variables (similar to DIN EN 60770-1)

Reference conditions according to DIN EN 61298-1

- Temperature
- Relative humidity
- Air pressure

Determination of characteristics
Characteristics
Calibration position
$+18 \ldots+30^{\circ} \mathrm{C}\left(+64 \ldots+86^{\circ} \mathrm{F}\right)$
45 ... $75 \%$
$860 \ldots 1060 \mathrm{mbar} / 86 \ldots 106 \mathrm{kPa}(12.5 \ldots 15.4 \mathrm{psi})$
limit point adjustment according to DIN 16086
linear
upright, diaphragm points downward

Deviation determined according to the limit point method according to IEC 60770"
Applies to digital HART interface as well as to analogue current
output $4 \ldots 20 \mathrm{~mA}$. Specifications refer to the set span. Turn down
(TD) = nominal measuring range/set span.
Deviation

- Turn down 1:1 up to 5:1 < $0.075 \%$
- Turn down > 10:1 <0.015\% x TD

Deviation with absolutely flush process fittings EV, FT

- Turn down 1: 1 up to $5: 1<0.05 \%$
- Turn down > 10:1 < $0.01 \% \times$ TD

Deviation with absolute pressure measuring range 0.1 bar

- Turn down 1: 1 up to $5: 1$
$<0.25 \% \times$ TD
- Turn down > 10:1 <0.05\% x TD


## Influence of the product or amblent temperature

Applies to digital HART interface as well as to analogue current
output $4 \ldots 20 \mathrm{~mA}$. Specifications refer to the set span. Turn down
(TD) = nominal measuring range/set span.
Average temperature coefficient of the zero signal
In the compensated temperature range $0 \ldots+100^{\circ} \mathrm{C}\left(212^{\circ} \mathrm{F}\right)$,
reference temperature $20^{\circ} \mathrm{C}\left(68^{\circ} \mathrm{F}\right)$.
Average temperature coefficient of the zero signal

- Turn down $1: 1 \quad<0.05 \% / 10 \mathrm{~K}$
- Turn down $1: 1$ up to $5: 1 \quad<0.1 \% / 10 \mathrm{~K}$
- Turn down up to $10: 1 \quad<0.15 \% / 10 \mathrm{~K}$

Outside the compensated temperature range
Average temperature coefficient of the zero signal

- Turn down $1: 1 \quad$ typ. $<0.05 \% / 10 \mathrm{~K}$

Thermal change, current output
Applies also to the analogue $4 \ldots 20 \mathrm{~mA}$ current output and
refers to the set span.
Thermal change, current output $<0.15 \%$ at $-40 \ldots+80^{\circ} \mathrm{C}\left(-40 \ldots+176{ }^{\circ} \mathrm{F}\right)$

## Long-term stability (similar to DIN 16086, DINV 19259-1 and IEC 60770-1)

Applies to digital interfaces (HART, Profibus PA, Foundation
Fieldbus) as well as for the analogue current output $4 \ldots 20 \mathrm{~mA}$.
Specifications refer to the sel span. Turn down (TD) = nominal
measuring range/set span.
Long-term drift of the zero signal $<(0.1 \% \times$ TD $) / 1$ year

## Ambient conditions

Ambient, storage and transport temperature

- Connection cable PE
$-40 \ldots+60^{\circ} \mathrm{C}\left(-40 \ldots+140^{\circ} \mathrm{F}\right)$
- Connection cable PUR, FEP
$-40 \ldots+85^{\circ} \mathrm{C}\left(-40 \ldots+185^{\circ} \mathrm{F}\right)$


## Process conditions

VEGABAR 74
Product temperature depending on the measuring cell sea

- FKM (e.g. Viton)
- EPDM
- Kalrez 6375 (FFKM)
- Chemraz 535
$-20 \ldots+100^{\circ} \mathrm{C}\left(-4 \ldots+212^{\circ} \mathrm{F}\right)$
$-40 \ldots+100^{\circ} \mathrm{C}\left(-40 \ldots+212^{\circ} \mathrm{F}\right), 1 \mathrm{~h}: 140^{\circ} \mathrm{C} / 284^{\circ} \mathrm{F}$ cleaning temperature
$-10 \ldots+100^{\circ} \mathrm{C}\left(+14 \ldots+212^{\circ} \mathrm{F}\right)$
$-30 \ldots+100^{\circ} \mathrm{C}\left(-22 \ldots+212^{\circ} \mathrm{F}\right)$


## VEGABAR 75

Medium temperature (temperature: $\mathrm{p}_{\mathrm{abs}}>1$ bar ( 14.5 psi )/ $\mathrm{p}_{\mathrm{abs}}<1$ bar ( 14.5 psi )

| - Standard | $-12 \ldots+150^{\circ} \mathrm{C} /-12 \ldots+130^{\circ} \mathrm{C}\left(+10 \ldots+302{ }^{\circ} \mathrm{F} /+10 \ldots+266{ }^{\circ} \mathrm{F}\right)$ |
| :--- | :--- |
| - with cooling element | $-12 \ldots+180^{\circ} \mathrm{C} /-12 \ldots+130^{\circ} \mathrm{C}\left(+10 \ldots+356^{\circ} \mathrm{F} /+10 \ldots+266^{\circ} \mathrm{F}\right)$ |
| - with cooling element and screening sheet | $-12 \ldots+200^{\circ} \mathrm{C} /-12 \ldots+130^{\circ} \mathrm{C}\left(+10 \ldots+392^{\circ} \mathrm{F} /+10 \ldots+266^{\circ} \mathrm{F}\right)$ |

${ }^{1)}$ Incl. non-linearity, hysteresis and non-repeatability.

Common data
Vibration resistance
Shock resislance
mechanical vibrations with 4 g and $5 \ldots 100 \mathrm{~Hz}^{2)}$
Acceleration $100 \mathrm{~g} / 6 \mathrm{~ms}^{3}$

## Electromechanical data

Connection cable

- Configuration
- Wire cross-section
four wires, one suspension cable, one breather capillary, screen braiding, metal foil, mantle
- wire resistance
- Standard length
- max. lengith with VEGADIS 12
- Min. bending radius al $25^{\circ} \mathrm{C} / 77^{\circ} \mathrm{F}$
$0.5 \mathrm{~mm}^{2}$ (AWG no. 20) $<0.036 \Omega / \mathrm{m}(0.011 \Omega / 1)$
$6 \mathrm{~m}(19.69 \mathrm{ft})$
- Diameter approx.
$200 \mathrm{~m}(656.2 \mathrm{H})$
- Colour - standard PE
$25 \mathrm{~mm}(0.985 \mathrm{in})$
Black
- Colour - Ex-version

Blue
Blue

## Voltage supply

Supply voltage

- Non-Ex instrument
$12 \ldots 36 \vee D C$
- EEx-ia instrument
$12 \ldots 29$ V DC
Permissible residual ripple
- < 100 Hz
$U_{5 s}<1 \mathrm{~V}$
- 100 Hz ... 10 kHz
$U_{s s}<10 \mathrm{mV}$
Load
see diagram


Fig. 9: Vonage diagram

## HART load

Vohage limit Ex instrument
3 Vohage limit non-Ex instrument
4 Supply vohage
Load in conjunction with VEGADIS 12

> see diagram

[^11]

Fig. 10: Voltage diagram
1 HART load
2 Vottage limit Ex instrument
3 Voltage limit non-Ex instrument
4 Supply votlage

## Electrical protective measures

| Protection | IP 68 (25 bar)/IP 69 K |
| :--- | :--- |
| Overvoltage category | III |
| Protection class | III |

Approvals ${ }^{\text {4/5) }}$
ATEX ia
ATEX D
ATEX ia+D
Ship approval
Other approvals

ATEX II 1G EEx ia IIC T6, ATEX \|I 2G EEx ia IIC T6
ATEXD
ATEX II 1/2D, 2D IP6X T
Ship approval
ATEX II 1G EEx ia IIC T6, ATEX II 1/2D, 2D IP6X T

Other approvals
GL, LRS, ABS, CCS, RINA, DNV
WHG

## CE conformity

EMC (89/336/EWG)
Emission EN 61326: 1997 (class B), susceptibility EN 61326: 1997/A1: 1998
LVD (73/23/EWG)
EN 61010-1: 2001

## Environmental instructions

VEGA environment management system
certified according to DIN EN ISO 14001
You can find detailed information under www.vega.com.

[^12]
## 7 Dimensions

VEGABAR 74 - threaded fitting


Fig. 11: VEGABAR 74 - threaded ftting: $G V=G 1 / 2$ A manometerconnection $E N 837$, $G I=G 1 / 2 A$ inner $G 1 / 4 A, G G=G 11 / 2 A, G N=1 / 2 N P T, G M=G 11 / 2 A 70 \mathrm{~mm}$

VEGABAR 74 - hyglenic fitting 1


Fig. 12: VEGABAR 74 - hygienic fitting: $C C=$ Tri-Clamp 1㳊", $C A=$ Tri-Clamp 2", LA $=$ hygienic fitting with compression nut F40, TA = Tuchenhagen Varivent $D N 32, T B=$

Tuchenhagen Varivent DN 25, RA/RB = bolting DN 4OVN 50 according to DIN 11851, KA = conus DN 40

VEGABAR 74 - hygienic fitting 2


Fig. 13: VEGABAR $74 A A=D R D, K A=$ conus $D N 40$
VEGABAR 74 - flange fitting


Fig. 14: VEGABAR 74 - flange fitting
1 Flange connection according to DIN 2501
2 Flange fitting according to ANSI B16.5
3 Flange with extension
4 Order-specific

VEGABAR 74 - threaded fitting for paper Industry


Fig. 15: VEGABAR - connection for paper industry: BAABB $=$ M44 $\times 1.25$
VEGABAR 74 - extension fitting for paper Industry


Fig. 16: VEGABAR-extensionfiting for paper industry: $E V / F T=$ absolutely fush for pulper (EV 2-times flattened), $E G=$ extension for ball valve fitining ( $L=$ order-specific)

VEGABAR 75 - threaded fitting


Fig. 17: VEGABAR - threaded fiting: $G G=G 11 / 2 A, G N=11 / 2 N P T, G L=G 11 / 2$ thread length $55 \mathrm{~mm}, B B=M 44 \times 1.25, B E=M 56 \times 1.25$

VEGABAR 75 - hyglenic fitting 1


Fig. 18: VEGABAR 75 - hygienic fitting: CACF $=$ Tri-Clamp $2 * \pi r$-Clamp 212 ${ }^{*}$ ", $L A=$ hygienic fitting with compression nut F40, TA = Tuchenhagen Varivent DN 32, RV/ $R W=$ bolting $D N 4 O D N 50$ according to $\operatorname{DIN} 11851, K A=$ conus $D N 40, A A=D R D$

VEGABAR 75 - hygienic fitting 2


Fig. 19: VEGABAR 75 - hygienic fitting: $S A=S M S$ DN $38, S B=S M S D N 51$

8 Product code

VEGABAR 74


VEGABAR 75

```
M,
"Only in conjunction with Approval 'XX' or 'AX'
```

Indicating and adjustment


## Product Information

## Content

1 Product description ..... 3
2 Type overview ..... 5
3 Mounting instructions． ..... 6
4 Connecting to power supply
4．1 Preparing the connection ..... 8
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## Take note of safety instructions for Ex applications

Please note the Ex specific safety information which you will find on our homepage www．vega．comlservicesldownloads and which come with the appropriate instrument with Ex approval．In hazardous areas you should take note of the appropriate regulations，conformity and type approval certificates of the sensors and power supply units．Each VEGADIS with Ex approval is an associated，intrinsically safe instrument and must not be installed in hazardous areas．

## 1 Product description

In continuous measurement, the level in a vessel or the pressure in a pipeline, for example, is detected by a sensor. The measured value is converted into an analogue $4 \ldots 20 \mathrm{~mA}$ output signal or a digital output signal, e.g. Profibus PA. The output signal is then further processed, e.g. in a PLCS or a control system.

On-site indication of the measured value or sensor adjustment is offen desired. To fulfill this need, VEGA offers a wide range of indicating instruments. Indication, power supply and mounting differ depending on the model. This product information manual provides an overview and helps you select a suitable instrument.

## VEGADIS 11

VEGADIS 11 is a universal, digital indicating instrument that operates without additional power. It is used for remote (i.e. at some distance from the measuring site) measured value indication. VEGADIS 11 can be connected at any point to the $4 \ldots 20 \mathrm{~mA}$ signal cable. It is suitable for any VEGA sensor as well as sensors from other manufacturers, i.e. for active (four-wire) as well as passive (two-wire) sensors.


Fig. 1: Configuration VEGADIS 11
1 To the sensor
2 To the processing system

## Advantages:

- Universal use for active or passive $4 \ldots 20 \mathrm{~mA}$ sensors
- No separate external energy required
- mounting to the wall or on carrier rail


## VEGADIS 12

VEGADIS 12 is a digital indicating instrument that operates without additional power. It is used for remote (i.e. at some distance from the measuring site) measured value indication and adjustment of VEGABAR 74, 75 and VEGAWELL $72-4 \ldots 20 \mathrm{~mA}$ HART hydrostatic pressure transmitters. VEGADIS 12 can be connected at any point to the $4 \ldots 20 \mathrm{~mA}$ signal cable. It is provided with a breather facility for sensor ventilation via the capillary line in the special cable.


Fig. 2: Configuration VEGADIS 12
1 To the sensor
2 To the processing system

## Advantages:

- No separate external energy required
- mounting to the wall or on carrier rail


## VEGADIS 61

VEGADIS61 is an external indicating and adjustment module that operates without additional power. It is used for remote (i.e. at some distance from the measuring site) measured value indication and adjustment of VEGA plics ${ }^{\oplus}$ sensors. The sensors can be 4 ... 20 mA , Profibus PA or Foundation Fieldbus sensors. VEGADIS 61 is connected to the sensors with a standard four-wire screened cable up to 25 m long. Communication is carried out via this cable and, what is more, VEGADIS 61 is powered by the sensor. An additional power supply is not required.

## PLICSCOM

The indicating and adjustment module PLICSCOM is used for measured value indication, adjustment and diagnosis of VEGA plics ${ }^{\oplus}$ sensors. It is mounted in the respective sensor housing or in the external indicating and adjustment module VEGADIS 61. After mounting, the sensor and PLICSCOM are splash-proof even without housing cover.
An integrated backlight enables reading evenunder unfavourable lighting conditions. As an option, the display can also be equipped with heating that ensures good readability at low temperatures down to $-40^{\circ} \mathrm{C}\left(-40^{\circ} \mathrm{F}\right)$.


Fig. 3: Configuration VEGADIS 61 and PLICSCOM
1 Sensor
2 VEGADIS 61
3 PLICSCOM

## Advantages:

- Universal use for all plics ${ }^{\circledR 3}$ sensors
- Splash-proof adjustment with open cover
- No separate external energy required
- mounting VEGADIS 61 to the wall, on carrier rail or tube


## VEGADIS 175

VEGADIS 175 is a digital indicating instrument for front panel mounting. It can be connected at any point to the $4 \ldots 20 \mathrm{~mA}$ signal cable and is suitable for active (four-wire) as well as passive (two-wire) sensors.


Fig. 4: Configuration VEGADIS 175
1 To the sensor
2 VEGADIS 175
3 To the processing system

## Advantages:

- Universal use for passive or 4 ... 20 mA sensors
- No separate external energy required


### 1.1 Application examples

## Pump shatt



Fig. 5: Level measurement in a pump shaft with VEGAWELL 72, remote indication and adjustment with VEGADIS 12

For hydrostatic level measurement in a pump shaft, VEGADIS 12 together a VEGAWELL 72 is well suited for remote indication and adjustment. The min./max. adjustment is carried out on site and the actual measured value can be read out during operation.

Chip silo


Fig. 6: Level measurement in a chip silo with VEGAPULS 68, remote indication and adjustment with VEGADIS 61

In non-contact level measurement in a chip silo with VEGAPULS 68 , the mounting location is not directly accessible. For that reason VEAGDIS 61 is an excellent solution for remote indication
and adjusiment. The min./max. adjustment can be carried out locally with or without filling.

## 2 Type overview

Indication:
Signal:
Sensors:

Mounting:
Ambient temperature:

## Indication:

Signal:
Sensors:
Mounting:
Ambient temperature:

VEGADIS 11

digital and quasi-analogue
4 ... $20 \mathrm{~mA}, 4 \ldots 20 \mathrm{~mA} / \mathrm{HART}$
4 ... 20 mA passive or active

Wall, rail mounting
$-20 \ldots+70^{\circ} \mathrm{C}\left(-4 \ldots+158^{\circ} \mathrm{F}\right)$

PLICSCOM


Dot-Matrix
$1^{2} \mathrm{C}$ bus
plics ${ }^{\left({ }^{( }\right)}$sensors
in the sensor or in VEGADIS 61
$-15 \ldots+70^{\circ} \mathrm{C}\left(+5 \ldots+158^{\circ} \mathrm{F}\right)$

VEGADIS 12

digital and quasi-analogue
4 ... $20 \mathrm{~mA}, 4$... $20 \mathrm{~mA} / \mathrm{HART}$
VEGABAR 74, 75; VEGAWELL
72-4 ... 20 mA/HART
Wall, rail mounting
$-20 \ldots+70^{\circ} \mathrm{C}\left(-4 \ldots+158^{\circ} \mathrm{F}\right)$

VEGADIS 175

digital
$4 \ldots 20 \mathrm{~mA}, 4 \ldots 20 \mathrm{~mA} / \mathrm{HART}$
4 ... 20 mA passive or active
Front panel
$-10 \ldots+60^{\circ} \mathrm{C}\left(+14 \ldots+140^{\circ} \mathrm{F}\right)$

## 3 Mounting instructions

## VEGADIS 11 and VEGADIS 12

VEGADIS 11 and VEGADIS 12 are configured for the following installation and mounting options：
－Carrier rail $35 \times 7.5$ according to EN 50022
－Wall mounting

## Carrier rall mounting



Fig．7：VEGADIS 11 and VEGADIS 12 camier rail mounting
1 Carnier rail

## Wall mounting



Fig．8：VEGADIS 11 and VEGADIS 12 wall mounting
1 Drill dimension

## VEGADIS 61

VEGADIS 61 can be mounted in the following ways：
－Carrier rail $35 \times 7.5$ according to EN 50022
－Wall mounting
－Tube mounting

## Wall mounting

VEGADIS 61 for wall mounting is supplied with a mounting sock－ et．


Fig．9：VEGADIS 61 for wall mounting，bottom view of mounting plate．
1 Drill dimension

Carrier rall mounting
VEGADIS 61 for mounting on carrier rail is supplied with a mount－ ing adapter．


Fig．10：VEGADIS 61 for mounting on carrier rail

```
1 Adapter plate
2 Scrow M4 x 6
3 Camier rail
```

Tube mounting
VEGADIS 61 for tube mounting is supplied with the measuring instrument holder BARMONT．C（comes with delivery as mount－ ing accessory）．


Fig．11：VEGADIS 61 for tube mounting
14 screws M5 $\times 12$
2 Measuring instrument holder BARMONT．C
Tube


Fig. 12: Measuring instimment holder BARMONT.C
$14 \times$ holes 5 mm for mounting screws M5× 12

## PLICSCOM

The indicating and adjustment module PLICSCOM can be inserled in the following housing versions and instruments:

- All sensors of the plics ${ }^{{ }^{\text {a }}}$ instrument family, in the single as well as in the double chamber housing (optionally in the electronics or connection compartment)
- External indicating and adjustment unit VEGADIS 61


## VEGADIS 175

VEGADIS 175 can be mounted in the following ways:

- Front panel mounting


## Front panel mounting



Fig. 13: VEGADIS 175 for panel mourting
1 Front panel
2 Fixinghook
3 Screw

## 4 Connecting to power supply

## 4．1 Preparing the connection

## Note safety instructions

Always keep in mind the following safety instructions：
－Connect only in the complete absence of line voltage
－If overvoltage surges are expected，overvoltage arresters should be installed

Tip：
1
We recommend VEGA overvoltage arresters B61－300 （power supply VEGADIS）and B62－36G（sensor supply）．

## Take note of safety instructions for Ex applications

In hazardous areas you should take note of the appro－ priate regulations，conformity and type approval certifi－ cates of the sensors and power supply units．

## Selecting connection cable

Standard two－wire cable without screen is used for connection of the sensors．

## Cable screening and grounding

Connect the cable screen on both ends to ground potential．In the sensor，the screen must be connected directly to the internal ground terminal．The ground terminal outside on the housing must be connected to the potential equalisation．
If potential equalisation currents are expected，the screen con－ nection on VEGADIS 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 fre－ quency interference signals remains．

## Select connection cable for Ex applications

Take note of the corresponding installation regulations for Ex applications．In particular，make sure that no po－ tential equalisation currents flow over the cable screen． In case of grounding on both sides this can be achieved by the use of a capacitor or a separate potential equal－ isation．

## 4．2 Wiring plan，VEGADIS 11

Passive sensors


Fig．14：Wiring plan，VEGADIS 11 for passive sensors
1 Sensor（passiva）
2 Indicating module（assignment see chart）
3 Controlinstrument
Note：
Passive sensors need a power supply．They represent current sinks and emboss a current of $4 \ldots 20 \mathrm{~mA}$ to the supply circuit．The supply voltage is loop through VEGA－ DIS 11．On the output（terminals $1 / 2$ ），VEGADIS 11 pro－ vides the power supply for the connected sensors． Power supply and measured value transmission are car－ ried along the same two－wire cable．

Active sensors


Fig．15：Wiring plan，VEGADIS 11 for active sensors
1 Sensor（active）
2 Indicating module
3 Control instrument
4 Vottage supply／Signal output

## Note：

The input（terminals 10／11）is provided for connection of transmitters with own，separate power supply．The out－ put（terminal $1 / 2$ ）is bridged．

Sensors with signal conditioning instrument


Fig. 16: Wiring plan, VEGADIS 11 for signal conditioning instrument
1 Signal conditioning instrument
2 Indicating moduls
3 Control instrument
1
Note:
The input (terminals 10/11) is provided for connection of signal conditioning instruments. Connection and operation in Ex ia is not possible. The output (terminal $1 / 2$ ) is bridged.
4.3 Wiring plan, VEGADIS 12


Fig. 17: Wiring plan, VEGADIS 12

```
1 brown (+)
2 blue (-)
Yellow
Screen
Breather capillanies with filter element
Indicating module
7 Control irstrument
8 Vohtage supply/Signal output
```


### 4.4 Wiring plan, VEGADIS 61

## Wiring plan



Fig. 18: Wiring plan, single chamber housing
1 plics ${ }^{\text {® }}$ sensor
2 Grounding on both ends with non-Ex. With Ex, grounding at orie sensor end is recommended, see EN 6007914.

### 4.5 Wiring plan, VEGADIS 175

## Passive sensors



Fig. 19: Wining plan, VEGADIS 175 for passive sensors
1 Sensor (passive)
Bridged internally
Voltage supply/Signal output
Exarea
5 Non-Ex area

## Active sensors



Fig. 20: Wiring plan, VEGADIS 175 for active sensors

## 5 Operation

### 5.1 Adjustment on VEGADIS 11

The display is located in the housing cover, the adjustment elements are accessible after removing the cover.


Fig. 21: Indicating and adjustment elements
1 Digital indication
2 Bar graph indication
3 Tendency indication
4 Rotary switch
5 Adjustment keys +/-

## Key functions

- [Rotary switch] to select:
- Operate $=$ Measured value indication
- $2 E R O=$ Adjustment of the min. value
- SPAN = Adjustment of the max. value
- Point $=$ Shifting of the decimal point
- [+/-] key:
- Change value of the digital indication


### 5.2 Adjustment on VEGADIS 12

The display is located in the housing cover, the adjustment elements are accessible after removing the cover.


Fig. 22: Indicating and adjustment elements
1 Digital indication
2 Bar graph indication
3 Tendency indication
4 Rotary switch "ndication*
5 Adjustment keys +/-display
6 Rotary switch "Pressure transmitter"
7 Adjustment keys +/- Pressure transmitter

## Key functions

- [Rotary sw/tch] to select:
- Operate $=$ Measured value indication
- ZERO = Adjustment of the min. value
- SPAN = Adjustment of the max. value
- Point $=$ Shifting of the decimal point
- [+/-] key:
- Change value of the digital indication


### 5.3 Adjustment on VEGADIS 61 and PLICSCOM



Fig. 23: Indicating and adjustment elements
1 LC display
2 Indication of the menu item number
3 Adjustment keys

## Key functions

- [OK] key:
- Move to the menu overview
- Confirm selected menu
- Edit parameter
- Save value
- $[->]$ key to select:
- menu change
- list entry
- Select editing position
- [+] key:
- Change value of the parameter
- [ESC]key:
- interrupt input
- jump to the next higher menu


### 5.4 Adjustment on VEGADIS 61 with PACTware ${ }^{\text {TM }}$

## PACTware ${ }^{\text {TM }} / D T M$

plics ${ }^{\oplus}$ sensors can be adjusted via PACTware ${ }^{\text {TM }}$ independent of the respective signal output $4 \ldots 20 \mathrm{mA/HART}$, Profibus PA or Foundation Fieldbus via VEGADIS 61. To adjust with PACTware ${ }^{T M}$, an instrument driver for the particular sensor is required.

All currently available VEGA DTMs are provided as DTM Collection with the current PACTware ${ }^{\text {TM }}$ version on CD. They are available from the responsible VEGA agency for a token fee. The basic version of this DTM Collection incl. PACTware ${ }^{\text {TM }}$ is available as a free-of charge download from Internet.

To use the entire range of functions of a DTM, incl. project documentation, a DTM licence is required for that particular instrument family. This licence can be bought from the VEGA agency serving you.

## Connection of the PC to VEGADIS 61



Fig. 24: Connection to VEGADIS 61
1 RS232 connection
2 VEGADIS 61
$3 I^{2} C$ adapler cabla for VEGACONNECT 3
To adjust with PACTware ${ }^{\text {TM }}$, a VEGACONNECT 3 with $I^{2} \mathrm{C}$ adapter cable (art. no. 2.27323) as well as a power supply unit is necessary in addition to the PC and the suitable VEGA-DTM.

### 5.5 Adjustment on VEGADIS 175

Indication and adjustment are carried out on the front via a clear LC display and three keys.


Fig. 25: Indicating and adjustment elements
1 Digital indication
2 Key (OK)

## Key functions

- [OK]key:
- Move to the menu overview
- Confirm selected menu
- Edit parameter
- Save value
- $[+\lambda /-]$ keys:
- Change value of the parameter

6 Technical data

General data

VEGADIS 11, 12
Series
Materials

- Housing
- Inspection window of the indication
- Breather facility
- Ground terminal

Weight approx.
VEGADIS 61
Series

Materials

- Housing
- Inspection window in housing cover
- Ground terminal

Weight, depending on the housing material and mounting technology

PLICSCOM
Series
Matenals

- Housing
- Inspection window

Weight approx.
VEGADIS 175
Series
Materials

- Housing front
- Housing
- Rear of the housing

Weight approx.

Instrument for panel or wall mounting or mounting on carrier rail $35 \times 7.5$ according to EN 50022
plastic PBT
Lexan
PTFE filter element
316Ti/316L
$400 \mathrm{~g}(0.882 \mathrm{lbs})$

Instrument for panel or wall mounting or mounting on carrier rail $35 \times 7.5$ according to EN 50022

Plastic PBT, Alu die-casting powder-coated, 316L
Polycarbonate (UL-746-C listed)
316Ti/316L
$500 \ldots 1300 \mathrm{~g}(1.10 \ldots 2.87 \mathrm{lbs})$

Module for insertion in VEGADIS 61

ABS
Polyester foil
100 g ( 0.22 lbs )

Module unit for front panel mounting

Alu die-casting
Sheet steel galvanized
ABS
$300 \mathrm{~g}(0.66 \mathrm{lbs})$

Input

VEGADIS 11
Connection to

Transmission
Max. input current
Connection cable to the sensor
Voliage loss
VEGADIS 12
Connection to

Transmission
Max. input current
Connection cable to the sensor
Max. cable length
Vottage loss
VEGADIS 61
Connection to
Data transmission
Connection cable
Max. cable length
VEGADIS 175
Transmission
individual passive or active sensors $4 \ldots 20 \mathrm{~mA} / \mathrm{HART}$
analogue, $4 \ldots 20 \mathrm{~mA}$
150 mA
2-wire
4.5 V at 20 mA

VEGAWELL 72-4... 20mA/HART, VEGABAR 74, 75
analogue, $4 \ldots 20 \mathrm{~mA}$
150 mA
3-wire (VEGA special cable with breather capillaries or standard cable)
200 m
4.5 V at 20 mA

VEGA plics ${ }^{(*)}$ sensors
digital ( $\left.\right|^{2} \mathrm{C}$-Bus)
4-wire, screened
25 m
analogue, 4 ... 20 mA (reverse battery protection)

HART protocol
Max．input current
Voltage loss

The indicator is suitable for transmission of the HART protocol 150 mA （shontcircuit current） $<2 \mathrm{~V}$ with 20 mA

## Indications

VEGADIS 11， 12
LC multiple function display
－Bargraph（quasianalogue indication）
20 segments
－Digital value
－Tendency indicators
VEGADIS 61，PLICSCOM
LC display
Power supply display light
Power supply display heating
－Operating voltage
－Power
－Switch on point
Symbols for rising or falling values

VEGADIS 175
LC display

| －Height of figures | 17 mm |
| :--- | :--- |
| －Indication range | $-19999 \ldots 19999$ |
| －Offset | $-19999 \ldots 32767$ |

## Amblent conditions

## VEGADIS 11， 12

Ambient temperature
Storage and transport temperature
$-20 \ldots+70^{\circ} \mathrm{C}\left(-4 \ldots+158^{\circ} \mathrm{F}\right)$

VEGADIS 61，PLICSCOM
Ambient temperature
Ambient temperature with heating
Storage and transport temperature

## VEGADIS 175

Ambient temperature
Storage and transport temperature
Climatic class

```
-40\ldots+85 ' C (-40 .. +185 ' F)
-15\ldots+70 }\mp@subsup{}{}{\circ}\textrm{C}(+5\ldots+15\mp@subsup{8}{}{\circ}\textrm{F}
-40\ldots+70 }\mp@subsup{}{}{\circ}\textrm{C}(-40\ldots+15\mp@subsup{8}{}{\circ}\textrm{F}
-40\ldots+80 }\mp@subsup{}{}{\circ}\textrm{C}(-40\ldots+176\mp@subsup{}{}{\circ}\textrm{F}
-10\ldots+60 员(+14 \ldots.+140 % F)
-25\ldots+70 }\mp@subsup{}{}{\circ}\textrm{C}(-13\ldots+158\mp@subsup{}{}{\circ}\textrm{F}
according to EN 60654-1, class B2
```


## Electrical protective measures

VEGADIS 11， 12
Prolection IP 67
Overvoltage category III
Protection class III
VEGADIS 61
Protection
Overvoltage category III
Protection class II
PLICSCOM
Protection
－unassembled IP 20
－mounted into VEGADIS 61 without cover IP 40
VEGADIS 175
Protection

| －between front frame and front panel | IP 65 |
| :--- | :--- |
| －Terminal | IP 20 |


| ESD | $6 \mathrm{kV} / 8 \mathrm{kV}$ |
| :--- | :--- |
| Electromagnetic fields | $10 \mathrm{~V} / \mathrm{m}$ |
| Burst (power supply) | 2 kV |
| Surge | 1 kV |
| Electromagnetic fields | $10 \mathrm{~V} / \mathrm{m}$ |

## Approvals"

VEGADIS 11
ATEX
ATEX II 2 G EEx ia IIC T6
VEGADIS 12
ATEX
ATEX II 2G EEx ia IIC T6
UL
CI. I,II,II; Div. 1; Gr. A-G

VEGADIS 61
ATEXia
ATEX II 1G, 2G EEx ia IIC T6
ATEX D
ATEXII 1/2D IP6X T
IEC IEC Ex ia IIC T6
FM
FM CI.I-III, Div1 (IS)
CSA
CSA CI.I-III, Div1 (IS)
VEGADIS 175
ATEX ATEXII 1G EEx ia IIC T6

Environmental instructions
VEGA environment management system
certified according to DIN EN ISO 14001
You can find detailed information under www.vega.com.

1) Deviating data in Ex applications: see separate satety instructions.

## 7 Dimensions

## VEGADIS 11， 12



Fig．26：VEGADIS 11， 12

## VEGADIS 61



Fig．27：VEGADIS 61

PLICSCOM


Fig．28：PLICSCOM
VEGADIS 175


Fig．29：VEGADIS 175

## 8 Product code

## VEGADIS 11



## VEGADIS 12



## VEGADIS 61



## PLICSCOM



VEGADIS 175


## RADIO MODEM

## 1. DR-900 DATA RADIO MODEM TECHNICAL DETAILS

## 2. TC-900DR USER MANUAL

## (D) Series

## Data Radio Modem

## 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)
* Inbuith data routing and multiplexing capabilties, mult-port operation
- Simuttaneous delivery of multiple protocols using Trio DataCom's unique MultiStreamm ${ }^{\text {™ }}$ technology
* Digital Signal Processing (DSP) modem
\& Selectable 300-19,200 bps asynchronous RS232 user interface


## * Built-In antenna diplexer*

* Integrated supervisory data channel
* Unique collision avoidance facility, for unsolicited report-byexception
* Software selectable configuration parameters
* Internal repeater operation
* Housed in an attractive yet robust metal enclosure
* Range of ancillary equipment - full duplex base / repeater stations and hot-standby base station


## 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.


## 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), Railways, 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 carnier data networking.

Alarm Monitoring - Fire, Power, Intrusion \& Essential Services Alarm Reporting.

## designs products \& SOlutions

## D Series - Data Radio Modem

DR900 - Digital Radios

## Configuration

Configuration using Trio's D Series programming software (DRProg) is completely Windows ${ }^{\bullet}$ 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 ${ }^{\text {TM }}$ 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:



## 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

$\therefore \quad$ Base Stations (DB900)
$\therefore \quad$ Hot Standby Base Station (DH900)
$\therefore \quad 9$ Port Stream Router Multiplexer (MSR)
$\therefore \quad$ Network Management and Diagnostic Software (TView ${ }^{\top M}$ )
$\therefore \quad$ D Series Programming Software (DRProg ${ }^{\text {M }}$ )

## GonEGUOUS

| User Data Port | $2 \times$ DB9 RS232 female ports |
| :--- | :--- |
| Antenna | SMA female bulkhead (optional N) |
| Power | 2 pin locking. Mating connector supplied |


|  |  |
| :---: | :---: |
| 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, 300-9800 bps asynchronous, software handshaking |
| Data Storage | On-board RAM |
| Channel Data Rate | $4800 / 9600 \mathrm{bps}$, full duplex |
| Bit Error Rate | $<1 \times 10^{-6}$ @ -108 dBm (4800 bps) |
|  | < $1 \times 10^{-6}$ @ -105 dBm (9600 bps) |
| Collision Avoidance | Trio DataCom's unique supervisory channel C/DSMA collision avoidance system |
| MultiStream ${ }^{\text {m/ }}$ | Trio DataCom's unique simultaneous dellvery of multiple data streams (protocols) |
| ATATHL |  |
| Power Supply Transmit Current | 13.8 Vdc nominal (11-16 Vdc) |
|  | 600 mA max. © 1 W <br> 1700 mA max. © 5 W |
|  |  |
| Receive Current | 1700 mA max. @ 5 W 175 mA |
| Dimensions | $260 \times 161 \times 65 \mathrm{~mm}$ (robust metal enclosure) |
| Weight | 1.3 kg |

- Available lor DR900 full duplex i W version ( $853 \pm 5 \mathrm{MHz} / 929 \pm 5 \mathrm{MHz}$ )
- Various sub-thequency bands available.

Note: Model codes previoushy known as xaxDR are now depieted as DRuxx.
designs products \& SOlutions

Local regulatory conditions may deternume the suitability of individual versions in different regulatory conditions may determune the suitability of individual versions in different
countriess. It in the responsibity of the buyer to confirm these regulatory condtions

Performance date indicates typical vahies related to the deacribed unit. - Copyright 2004 Trio information subject to change without notice. - Copyright 2004 Trio DataCom Pty Ltd. All rights reserved. Issue 11104
$\square$


## TC-900DR

## 900 MHz <br> Full Duplex Data Transceiver

## User Manual

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## IMPORTANT NOTICE

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This handbook is for the installation, operation and maintenance of the TC-900DR. The specifications described are typical only, and are subject to normal manufacturing and service tolerances.

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## Modifications

| Issue 1 | February 1993 (Preliminary) |
| :---: | :---: |
| Issue 2 | May 1993 Major Changes to Section 3 |
| Issue 3 | September 1993 |
|  | $\begin{array}{ll}\text { Minor Changes to sections, } & 3.1,3.2 .1,3.2 .2 .1,3.2 .7,3.4 .3,3.4 .4, \\ 4.4,4.5,4.7,4.7 .2,4.7 .3\end{array}$ |
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|  | Removed Filter Alignment Setup Diagram |
|  | Inserted RSSI Level cf Received Signal (typical) |
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## Modifications (cont.)

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Deleted Section 1.6, 4.5.1
Replaced Section 5

Issue 12 July 2000
Minor Change to Section 7

Issue 13 February 2001
Change of Company Name

## SECTION 1

## INTRODUCTION

## 1 INTRODUCTION

### 1.1 GENERAL

The TC-900DR is a Full Duplex 900 MHz Radio, featuring a fully integrated 4800 or 9600 bps data modem.

The entire unit is housed in a robust metal enclosure that provides a compact and transportable means for the transmission of data over radio.

The product has been fully designed and developed in Australia, by an Australian owned and managed company.

The TC-900DR meets the ACA SP4/89 specification which covers radio data transmissions over point-to-point and point-to-multipoint systems.

It is ideally suited for applications such as :
" Transaction Processing.
, Public Utility Telemetry Systems.
" Alarm Monitoring.
" Supervisory Control and Data Acquisition.
, Energy Distribution.
" Inventory Control
" Common Carrier Data Services.
" Temporary Installations
The modem provides byte oriented packet data communications over narrow band FM systems, using digital filtered binary FSK modulation.

The TC-900DR can be supplied for use with $12.5 \mathrm{kHz}, 15 \mathrm{kHz}, 25 \mathrm{kHz}$ or 30 kHz channel spacings. Its operational parameters can be programmed with the TC-D Series installation programmer. This is a separate software package that runs on an IBM compatible PC under Windows 95/98/NT.

### 1.2 FACTORY QUALITY ASSURANCE

The TC-900DR has been designed and manufactured with particular emphasis placed on the following points :
\{ State of the art design techniques.
\{ Simple assembly/disassembly.
\{ Minimal alignment requirements.
\{ Manufactured using quality components.
All units have been manufactured using automated assembly procedures. This assures attention to detail and a high level of quality control.

All components used are of high quality, and conform to Trio DataCom's required specifications. The component suppliers provide batch, date and manufacturing criteria that are required to meet quality control standards.

Each unit is individually tested with an inbuilt self diagnostic program. It is then passed through a set of automatic test procedures with minimal human intervention. This ensures a consistently manufactured and performing product. Many of the alignments are factory set and should not require re-alignment in the field.

Trio DataCom's quality control does not finish here. Once each unit has passed its individual tests, it is placed in a cyclic heat/cooling chamber. This chamber is automatically cycled from $-10^{\circ} \mathrm{C}$ to $+65^{\circ} \mathrm{C}$, twice, over a twenty hour period. During this time, the modem controller - using external precision calibrated test equipment - monitors and stores frequency stability versus temperature data. The TC-900DR uses this information to achieve its temperature compensated, frequency stability level of 1 ppm .

Power output is measured during the temperature cycling. This is achieved by having the unit connected to a PC and various test equipment via a GPIB. Units that fail any of these tests are reported by the test program and corrective action taken before going through the complete cycle once again. Each unit shipped from the factory comes with a factory alignment printout which details:
, Configuration.
„ Transmit frequency.
" Receive frequency.
, Receiver sensitivity.
, Transmitter power output.
" Transmitter modulation.
In most cases, the radio transmitter as shipped from the factory will require no re-alignment.

It is this care and quality control that ensures that the purchaser of a TC-900DR radio modem, obtains a consistently manufactured and performance specified product, which has been "burned in" to minimise any operational failures.

### 1.3 FEATURES

Advanced microwave and digital techniques were employed during the design phase of the TC-900DR, ensuring an innovative and state of the art product.

Features include :
\{ Fully integrated full duplex radio and modem
\{ Built in antenna diplexer
\{ Power output +30 dBm (1 Watt nom) at antenna connector
\{ Radio meets ACA SP4/89 requirements 2/90
\{ In-built transparent remote diagnotics capability.
\{ Custom single chip modem - digital signal processing
\{ 4800 \& 9600 bps transfer rates, full duplex
\{ Selectable 110..19k2 asynchronous RS-232 host interface
\{ Unique collision avoidance facilities
\{ Integrated supervisory signalling channel
\{ Software selectable configuration parameters
\{ Configurable bit error rate testing
\{ Excessive temperature power fold-back
\{ Auxiliary port for use with an optional supervisory audio handset

### 1.4 SPECIFICATIONS

### 1.4.1 RADIO SECTION

Rx frequency range
923 MHz to 933 MHz (see note 1 )
Tx frequency range : $\quad 847 \mathrm{MHz}$ to 857 MHz (see note 2)
Channel spacing : Fully synthesized $12.5 \mathrm{kHz} / 25 \mathrm{kHz}$, [opt $15 / 30$ ] with programmable $1 / 2$ channel raster offset

Frequency stability : $\quad 1 \mathrm{ppm}\left(-10^{\circ} \mathrm{C}\right.$ to $65^{\circ} \mathrm{C}$ amb), $\left[\mathrm{opt}-30^{\circ} \mathrm{C}\right.$ to $\left.70^{\circ} \mathrm{C}\right]$, aging $<=1 \mathrm{ppm} /$ Annum

Power output : $\quad+30 \mathrm{dBm} \pm 1 \mathrm{dBm}$ ( 1 W nom)
at Antenna connector
switchable under software control $200 \mathrm{~mW} / 1 \mathrm{~W}$
Duty cycle : Continuous
Output impedance
Timeout timer
Tx key up time
Rx sensitivity

Rx intermodulation : $\quad>=70 \mathrm{~dB}$ spurious free dynamic range.
Rx spurious responses : $<=-65 \mathrm{~dB}$.
Tx spurious emissions : <=-65 dBc (ref unmodulated carrier).
Full duplex with single antenna.

Note 1. The reciprocal frequency option for point-to-point operation or point to multi-point base repeaters is available as follows :

- Rx frequency range 847 MHz to 857 MHz .
- Tx frequency range 923 MHz to 933 MHz .

Note 2. The transmitter is normally supplied, with its frequency offset from the receiver by 76 MHz .

### 1.4.2 MODEM SECTION

| User Ports | $:$ | DB-9 connector, EIA RS232, DCE, serial <br> asynchronous, $300 . .19 \mathrm{k} 2$ baud, $7 / 8 \mathrm{bit}$, <br> no/odd/even parity. |
| :--- | :--- | :--- |
| Data Rate | $:$ | $4800 / 9600$ bps Full Duplex. |
| BER | $:$ | Less than 10E-6 @ -105dbm measured at antenna port |
| Data Format | $:$ | Narrow band digital filtered binary FSK Modulation, <br> using Trio DataCom's DFM4-9 digital modem chipset, <br> including Trio's unique supervisory signalling channel <br> C/DSMA collision avoidance scheme. |
| Synchronisation Delay : | 20 milliseconds. |  |

### 1.4.3 RADIO AND MODEM SECTIONS COMBINED

| Occupied bandwidth | $:$ | Meets ACA SP4/89 guidelines for point-to-point and <br> point-to-multipoint assignments. |
| :--- | :--- | :--- |
| Mean deviation | $:$ | $\pm 1.5 \mathrm{kHz}(4800 \mathrm{bps})$, <br> $\pm 2.75 \mathrm{kHz}(9600 \mathrm{bps})$ |
| Power requirements | $:$ | 14 Volts AC 10 VA or $13.8 \mathrm{Volts} \mathrm{DC}(11 \mathrm{to} 16 \mathrm{~V}$ Max). |
| Transmit current | $:$ | $<=$ to 600 mA. |
| Receive current | $:$ | 175 mA. |
| Size | $:$ | $241 \mathrm{~mm} \times 161 \mathrm{~mm} \times 65 \mathrm{~mm}$. |
| Weight | $:$ | 1.3 Kg. |

### 1.4.4 CONNECTORS



### 1.5 OPTIONAL ACCESSORIES

Trio stock a large range of ancillary devices including coax cables, RF connectors, antennas, lightning protection, power supplies, etc.

Please contact Sales for futher information.

## SECTION 2

## HARDWARE TECHNICAL DESCRIPTION

## 2 HARDWARE TECHNICAL DESCRIPTION

### 2.1 GENERAL

The TC-900DR is a 900 MHz full duplex radio complete with radio modem and antenna diplexer. In this and subsequent descriptions to follow, references have been made to block diagrams, circuit diagrams and component loading diagrams.

These can be found in appendix $A$, at the rear of this manual.
The unit can be divided into five major sub-blocks :
Radio section.
Antenna diplexer section.
Audio handset.
Modem section.
Unit housing assembly.

### 2.2 RADIO SECTION

The radio section is built on a single PCB with approximate dimensions of $193 \mathrm{~mm} \times$ $152 \mathrm{~mm} \times 1.6 \mathrm{~mm}$.

This section consists of the following main blocks :
Receiver.
Transmitter.
Frequency control.
Interfaces.
Each of these blocks can be further broken down as follows :
Receiver.
Pre-amplifier.
Mixer.
45 MHz I.F. filter.
FM I.F. \& Demodulator
Audio processing.

- Data.
- Voice.

RSSI processing.
Transmitter.
Audio processing.

- Data.
- Voice.

Modulator.
Multiplier.
Mixer.
Power amplifier.
Control.

- PTT.
- Power.

Frequency control
Synthesiser.
Local oscillator.
AFC
Interfaces
Modem section.
Antenna diplexer.
Audio handset.

### 2.2.1 RECEIVER

The general form of the receiver circuitry is shown in diagrams "DR9 Macro Block Diagram" (drawing number TC01-05-19 sheet $3 / 3$ ), and " 900 MHz Radio - Block Diagram" (drawing number TC01-05-19 sheet 2/3).

### 2.2.1.1 PRE-AMPLIFIER

The receiver pre-amplifier obtains signal direct from the antenna diplexer port connector X 2 . It consists of two stages. The first stage is optimised to give a low noise figure, while the second is optimised to produce gain.

The central devices used are MRF5711 high frequency transistors. They provide the basis for a wide band amplifier that can receive from the lowest band frequency range of 852 to 854 MHz to the higher band frequency range of 928 to 930 MHz .

The RF selectivity is provided by the diplexer filter.
Strip line impedance matching networks are employed to ensure optimum performance of the amplifier.

The overall gain of the pre-amplifier is set to 20 dB .

### 2.2.1.2 MIXER

The receiver mixer consists of a 180 "rat race hybrid ring" followed by a passive Schottky mixer diode.

The mixer injection frequency is set 45 MHz from the required receive frequency, (high side injection for 930 MHz receive and low side for 850 MHz receive). This results in an I.F. frequency output of 45 MHz .

The level of the injection is set to 6 dBm by the amplifier stage Q3.

### 2.2.1.3 FIRST I.F. STRIP FILTER

The required receiver mixer product is filtered by the first I.F. filter. The filter is a bandpass crystal controlled device, centred on 45 MHz , and provides image rejection for the second IF Mixer.

The filter is aligned for optimum response by adjustment of inductors L4,L3 and L5.

### 2.2.1.4 FM IF and DEMODULATOR

The heart of the demodulator section is an NE615D high performance low power mixer FM IF system IC.

This device incorporates a mixer/oscillator, two limiting intermediate frequency amplifiers, a quadrature detector, muting circuitry, logarithmic RSSI, and a voltage regulator.

The input to the device is from the output of the 45 MHz first IF strip filter. This is applied at $R F_{\text {in }}$ and $R F_{\text {bypass }}$ pins (U2-p1,p2).

This signal is applied internally to a Gilbert cell mixer, which is set to convert the signal down to 455 kHz .

The mixer injection is supplied by an internal oscillator, which is driven by an external oscillating signal applied at the XTAL OSC pins (U2-p3,p4).

The basic injection frequency is governed by the 44.545 MHz crystal XTAL1. This produces a mixer output product of 455 kHz .

The output of the mixer is available at MIXER OUT (U1-p20). This is applied to a 455 kHz centred bandpass filter. This acts as the "front end" filter, CF1.

The bandwidth and rolloff characteristics of this filter are set, depending on the required baud rate of the data being used on the modem, and the required channel spacing. Refer to Circuit Diagram for filter types.
The filtered output is then applied to the input of the internal IF amplifier, IF AMPIN (U1-p18). The bandwidth of the amplifier is about 40 MHz , with a gain of about 39 $\mathrm{dB}(\mathrm{uv})$. C10 and C11 provide IF amplifier decoupling.
The output is available at IF AMP OUT (U1-p16). This is applied to a 455 kHz centered bandpass filter. This acts as the "rear end" filter, CF2.

Again the filter selection depends on the required bandwidth. Refer to Circuit Diagram for filter types.

The filtered output is then applied to the input of the internal IF limiter, LIMITER IN (U1-p14). The bandwidth of the limiter is about 28 MHz , with a gain of about $62 \mathrm{~dB}(\mathrm{uv})$. C13 and C14 provide IF limiter decoupling.

The signal from the second limiting amplifier is passed to an internal Gilbert cell quadrature detector, as well as to LIMITER OUT (U1-p11).

One of the Gilbert cell ports is driven directly by the IF, the other by a tuned quadrature network, which is driven by the IF signal from LIMITER OUT. The tuned network is based around a ceramic resonator CF3. The Q of the network is varied depending on the required baud rate used by the modem. For 9600 baud the link LK3 is inserted, giving a higher damping factor than that required for 4800 baud, where the link is removed.

This gives the two input signals applied to the Gilbert cell a 90 degree phase relationship, the output of which is the demodulated audio/data signal.

The output signal is available at UNMUTED AUDIO OUT (U1-p9). A gated output is also available at MUTED AUDIO OUT (U1-p8).

### 2.2.1.5 AUDIO PROCESSING

### 2.2.1.5.1 DATA

The demodulated data signal output has been assigned to the UNMUTED AUDIO OUT pin (U1-p9). This ensures no interruption to the flow of data.

The signal is filtered by the C22, R20, R29 and C23 filter network. This is to remove any high frequency components produced at the output of the quadrature detector.

It is then amplified and DC level shifted by op-amp U1:C. The amount of DC bias applied to the signal can be varied by the potentiometer VR2. For correct processing by the modem, this level is set to 2 V . The AC level of the signal is set to about $1 \mathrm{~V}_{\text {p-p }}$

### 2.2.1.5.2 AUDIO

The demodulated audio signal output has been assigned to the MUTED AUDIO OUT pin (U1-p8). This allows switching control of the audio passed to the handset earpiece.

The signal is filtered by R23 and C17. This is to remove any high frequency components produced at the output of the quadrature detector.

It is then buffered, amplified and level shifted by op-amp U1:D, and presented to the handset via coupling capacitor C 20 and connector $\mathrm{X} 3-\mathrm{p} 2$.

The mute control signal is applied to the NE615 (FM IF system IC) MUTE IN pin (U2-p5). When active, the audio output signal from the IC is attenuated by greater than 60 dB .

### 2.2.1.6 RSSI

The RSSI output is presented by the NE615 at RSSI OUT (U2-p7). This signal is logarithmic with an output range greater than 90 dB . It is used for audio mute processing, and by the modem section as a data qualifier signal.

The signal is first passed through a unity gain buffer, op-amp U1:B, before it is split.
The RSSI level is compared with the setting of "audio mute adj" potentiometer VR1, by op-amp U1:A. The result is passed to the MUTE IN pin of the NE615.

This allows a suitable mute cutoff point to be set for the received audio sent to the handset earpiece.

The RSSI signal is also passed to the modem section for processing via R19 and connector X1-p21.

### 2.2.2 TRANSMITTER

The general form of the transmit circuitry is shown in diagrams "DR9 Macro Block Diagram" (drawing number TC01-05-19 sheet $3 / 3$ ), and " 900 MHz Radio - Block Diagram" (drawing number TC01-05-19 sheet 2/3).

### 2.2.2.1 AUDIO PROCESSING

### 2.2.2.1.1 DATA

The transmit data signal enters the radio section via connector J*3-p13, from the modem section. It is biased via R68 and R75 to a DC level of about 0.86 V . The signal is then passed through a level setting potentiometer VR2, used to set the level of transmit deviation.

It is then presented to the input of the modulator circuit.

### 2.2.2.1.2 VOICE

The transmit voice signal enters the radio section via connector X 3 -p4, from the microphone in the handset. The pre-amp in the microphone circuit is given some bias via R76.

The signal is first passed through a clipping circuit. This consists of back to back clamping diode pair D2, AC-coupled via C154. This ensures that a maximum transmit deviation level is imposed.

The modulator circuitry is based around a low power FM transmitter system IC,MC2833. Included in this device is a microphone amplifier and clipper. The audio is passed to the amplifier via R76 at the MIC AMP INPUT pin (U7-p5).

Feedback for gain is supplied by R76, and band limiting by C50. The amplifier output is presented at MIC AMP OUTPUT (U7-p4).

Further low pass filtering is provided by the network of R71, C49, R59.. and C42... C43 provides a rising response below 100 Hz . This filtering is needed to shape the base band signal, so as the transmit frequency spectrum stays within channel boundaries.

The audio is coupled into the modulator circuit at the MODULATOR INPUT pin of the MC2833 (U7-p3).

### 2.2.2.2 MODULATOR

The heart of the modulator section is an MC2833 low power FM transmitter system IC. This device is a one chip FM transmitter subsystem designed for FM communication equipment. It includes a microphone amplifier, a variable reactance modulator, a voltage controlled oscillator, and two auxiliary transistors.

Data is fed directly to the input of the reactance modulator at the MODULATOR INPUT pin (U7-p3). The audio channel is fed via an inbuilt clipper amplifier in the MC2833. The output of this variable reactance circuit is used to modulate the FM carrier.

The carrier frequency of the modulator is provided by an internal oscillator, which is driven by an external oscillating signal applied at the RF OSC pins (U7-p15,p16).

This oscillating signal is governed by the 20.166 MHz crystal XTAL3. The actual applied frequency is set by the modulating signal, which slightly varies ("pulls") the crystal frequency. This is achieved by connection of the crystals circuit to the output of the variable reactance circuit VARIABLE REACTANCE OUTPUT (U7-p1). This output is coupled to the crystal via a frequency trimming coil L6.

The output FM signal is presented at the RF OUTPUT pin (U7-p14).

### 2.2.2.3 MULTIPLIER

The output of the modulator is passed to a frequency tripler stage employing auxiliary transistor TR2. This places the carrier frequency at 60.5 MHz .

It then passes to a frequency doubler stage employing auxiliary transistor TR1, where the carrier is moved up to 121 MHz .

The signal is amplified through these stages to a level of about -4 dBm at 121 MHz .

### 2.2.2.4 MIXER

The transmit FM signal at 121 MHz when mixed with the VCO frequency by U8 produces a transmitter signal 76 MHz from the receiver frequency.

The mixer employed is an MCL SBL-1X monolithic doubly balanced mixer (U8).
The transmit VCO signal is amplified to a level of about +6 dBm by Q2, and applied to the "L" input of the mixer. The 121 MHz signal is applied to the "l" input of the mixer.

To select the correct mixing product for the transmitter, a tunable filter using C78 and a coupled stripline circuit is used.

The output signal is then buffered by two MRF5711 transistors Q4 and Q5, to provide about +4 dBm of signal level, which is applied to the final amplifier section.

### 2.2.2.5 POWER AMPLIFIER

The power amplifier provides an overall gain of about 30 dB . This is achieved by three stages of amplification.

The first stage uses an MRF5711 transistor (Q8). This device is primarily designed for high gain, low-noise, small signal amplifiers, and is ideal for a transmitter pre amplifier. This stage provides about 13 dB of gain. The power control circuit acts on this stage to provide constant power at the PA. output connector.

The second stage uses an MRF8372 transistor (Q9). This device is primarily designed for wideband, large signal predriver stages, in the 800 MHz range. This provides a further 10 dB of gain.

The final stage uses two MRF8372 transistors (Q10, Q11) in a parallel configuration to provide the final output power. Each of these stages provides about 10 dB of gain. The output impedance is matched to 50 ohms via the use of balanced impedance strip lines.

The transmitted signal is presented at connector X 4 , at a level of about +32 dBm , where it is passed to the diplexer section.

### 2.2.2.6 CONTROL

### 2.2.2.6.1 PTT

PTT must be activated for the TC-900DR to transmit an RF signal. There are two sources of PTT, the audio handset, and the modem section.

PTT from the audio handset is referred to as "manual PTT". It enters the radio section via connector X3-p6. It is passed to the PTT control switch transistor Q12. PTT is active LOW, and turns on Q12 when applied.
PTT from the modem section enters the radio section via connector X1-p12, "/PTT". It is connected to the PTT control switch transistor Q12.

When PTT is not activated the transmitter is totally disabled. All stages of the transmit chain are turned off. This is to ensure that power consumption is kept to a minimum.

The PTT signal connects to the start of the transmit chain at the multiplier stage.
The internal transistors of the MC2833 IC, TR1 and TR2 have their bases effective grounded, turning off the devices. Similarly the mixer output buffer and amplifier transistors Q4 and Q5 are turned off as are the final amplifier stages employing Q8, Q9, Q11 and Q10.

When the PTT is activated, bias is applied to all these stages and transmission is possible.

Note : Tx enable must also be active to allow transmission.

### 2.2.2.6.2 TRANSMIT ENABLE

Transmit enable is a further control placed on the transmitter circuits. No transmission is possible unless the transmit enable signal is active. The signal enters the radio section via connector X1-p11, "/TX EN", from the modem section.

This signal basically enables the PTT switching transistor Q12, thus providing VCC for the 20.166 MHz oscillator section of the MC2833 modulator IC, and bias to the handset microphone.

### 2.2.2.6.3 POWER

The RF power output of the TC-900DR can be set to two levels. Low power level is 200 mW , and high power is 1 W .

This level is controlled by two dc levels. One signal is a control level from the modem section, the other from an RF detector located at the output of the transmitter itself. These two signals are used in conjunction to hold the output power constant.

The signal from the modem section enters the radio section via connector X1-p10, "TXPWR". The signal is fed to an op-amp comparison circuit U9:A, via level setting potentiometer VR4.

The level is compared to that actually detected at the output of the transmitter, by the circuit based around diode D3. The comparator output is then used to bias the first stage of the P.A. section (Q8) of the transmitter, hence varying the transistor gain performance and ultimately the output RF power. This basic feedback network is required to keep the power at a constant level, regardless of any external conditions.

The detected output power level is also fed back to the modem section for monitoring and analysis via connector X1-p9, "TXPWR SENSE".

### 2.2.2.6.4 TEMPERATURE SENSE

A temperature sensing device is included in the radio section. The device used is an LM335 precision temperature sensor, U6. It is operated as a two terminal zener diode, with a breakdown voltage directly proportional to absolute temperature, with an output of +10 mV per degree kelvin.

The temperature data output is passed to the modem section for analysis and processing via connector $\mathrm{X} 1-\mathrm{p} 14$, "TEMP SENSE".

During the "Burn In " cycle, that the TC-900DR is passed through during production, the unit calibrates the output of the sensor to the test temperature. In particular it stores the hottest temperature reached by the test cycle (about 65C).

If the unit reaches this maximum temperature setting while operating in the field, the modem section of the TC-900DR will automatically signal the power control circuit to place the transmitter into low power mode $(200 \mathrm{~mW})$.

This low level of output power is retained until the temperature sensor signals the modem section, that the temperature has fallen back below the maximum temperature. When this occurs the transmitter is placed back to its previous power setting. A hysteresis is built into the microprocessor control circuitry to stop power jitter.

This scheme is referred to as "High Temperature Fold Back". It is used to protect the transmitter final power transistors from any damage that may be encountered under extreme temperature conditions.

### 2.2.3 FREQUENCY CONTROL

### 2.2.3.1 SYNTHESISER

The synthesiser section provides a local oscillator for use by the receiver and transmitter sections.

The synthesiser circuitry is based around a TBB206 PLL frequency synthesiser IC.
This device is a complex PLL circuit in CMOS technology for processor controlled frequency synthesis. The processor resides in the modem section, and three basic control lines are used to interface to the device. The enable "EN", data "DA" and clock "CL" control signals are passed to the TBB206 via connector X1-p16,p17,p18 respectively.

The reference frequency for the synthesiser is applied to the "RI" pin of the TBB206 (U3-p2). This reference is provided by a 12.000 MHz voltage adjustable temperature compensated crystal oscillator (VTCXO), XTAL2. This input has a sensitive preamplifier for a 16-bit ( $R$ )eference divider. C33 provides AC coupling for the input.
The VCO frequency is applied to the "FI" input pin of the TBB206 (U3-p8). This input has a highly sensitive preamplifier for a 12 -bit N divider and a 7 -bit A divider. C29 provides AC coupling for the input.
The actual signal applied to the "FI" input is from the output of a TBB202 dual modulus divider IC (U4-p4). This is to transform the actual VCO frequency of between 786 MHz and 996 MHz , down to a frequency acceptable for use by the "FI" input.

The divider ratio selected by the TBB202 is determined by the state of the "MOD" input pin (U4-p6). If the signal is HIGH, then a ratio of $1: 128$ is used. If the signal is LOW, a ratio of 1:129 is used. The state of this signal is controlled by the TBB206 synthesiser "MOD" output pin (U3-p7). The TBB206 drives this output LOW at the beginning of a cycle. When the A divider has reached its set value, the "MOD" output is set to HIGH. When the $N$ divider reaches its set value, the output is set LOW again and the cycle is repeated.

The input to the TBB202 divider is from the VCO output via a strip line impedance matching network. The signal is applied to the " 11 " pin (U44-p1).

The TBB202 can be placed into standby mode, when not in use. This is achieved by connection of the "STB" pin (U4-p7), to the multi function output port of the TBB206 synthesiser (U3-p6). This port is driven by the DFM4-9 modem IC located in the modem section.

The phase detector signal is provided on the "PD" pin of the TBB206 (U3-p12). This signal has especially short anti backlash pulses to avoid any "dead zones", and to neutralise any small phase deviations. This signal is passed to the loop filter of the VCO circuit.

A lock detect indication is given by the TBB206 synthesiser at the "LD" output pin (U3-p14). This signal is filtered and shaped by the network using R47 and C36, and presented to the modem section for monitoring and processing, via connector X1-p19.

### 2.2.3.2 VCO

The VCO used is an MQC309 series VCO. The exact device used depends on the required frequencies that the unit has to work with.

Two types are used:
A. MQC309 798 - Frequency range of 784 MHz to 816 MHz

Gives unit frequency ranges of :

- Transmit : 905 MHz to 937 MHz
- Receive : 829 MHz to 861 MHz
B. MQC309 978 - Frequency range of 962 MHz to 994 MHz

Gives unit frequency ranges of :

- Transmit : 841 MHz to 873 MHz
- Receive : 917 MHz to 949 MHz

The 798 type employs low side injection to the mixers, whereas the 978 type employs high side injection.

The loop filter consists of R44, C40, C41 and R43.
The output of the VCO is passed to the receiver mixer via RXMIX, and to the transmitter mixer via TXMIX signal lines. Each of these is impedance matched by strip line circuits for optimum performance.

The layout and selection of all these components has been done in such a way so as to minimise VCO noise being impressed onto either the transmitted or received RF signals.

### 2.2.3.3 VCO TEMPERATURE COMPENSATION

Frequency temperature compensation is provided for by an input to the reference oscillator circuit.

During the "Burn In " cycle, that the TC-900DR is passed through during production, the unit calibrates the output of the temperature sensor to the test temperature and to any frequency variations that occur, and stores the results.

When the unit is operating in the field, the temperature of the unit is constantly being analysed. Should a frequency offset be required based on the calibration measurements, the modem section signals to the 12.000 MHz reference oscillator to vary its frequency slightly. This signal is passed to the radio section via connector X1-p15, "TEMP COMP". The voltage on this line "pulls" the reference oscillator XTAL2 onto a new frequency, which corresponds to the correct offset required.

Note : Because the temperature compensation for the installed VTCXO is held in the NVRAM of the modem it is imperative that modems and radio boards are maintained as matched pairs. Should either the VCO or NVRAM require replacement it is highly recommended that the unit be returned to the manufacturer for re-calibration.

### 2.2.3.4 RECEIVER AFC

Automatic frequency control is provided for the received signal. The control signal is applied to the radio section from the modem section via connector X1-p22, "AFC CTL".
The basic injection frequency to the front end mixer of the NE615 FM demodulator IC (U2), is governed by the 44.545 MHz crystal XTAL1. The actual applied frequency can be set by the level of the AFC signal, which slightly varies ("pulls") the XTAL1 crystal frequency via the varactor diode DV1.

The modem section monitors the average DC level of the received signal (DATA signal X1-p13), which gives an indication of received frequency drift.

From this the modem section calculates the required compensation necessary and applies it to the "AFC CTL" signal line.

A reference signal is passed back to the modem section from the radio section via connector X1-p23, "AFC REF". This is processed by the modem section, and used to help determine the level of AFC signal level.

### 2.2.4 INTERFACES

### 2.2.4.1 MODEM SECTION

The radio section interfaces to the modem section via connector X 1 . Attached permanently to this connector is a 90 mm length of 26 way ribbon cable, fitted with a female 26 way connector at the other end. This attaches to connector JX3 on the modem section PCB.

Refer to interface diagram "RADIO MODEM INTERFACE", drawing number TC01-05-18 sheet $1 / 3$.

CONNECTOR $\times 1 / J \times 3$ SIGNAL DESCRIPTION
PIN NUMBERS

| 1 |  |  |
| :--- | :--- | :--- |
| 2 | 13V8 POWER SUPPLY RAIL |  |
| 3 | 13V8 POWER SUPPLY RAIL |  |
| 4 | 13V8 POWER SUPPLY RAIL. |  |
| 5 | GROUND |  |
| 6 | GROUND |  |
| 7 | GROUND |  |
| 8 | $8 V$ POWER SUPPLY |  |
| 9 | 8V POWER SUPPLY |  |
| 10 | TXPWR SENSE | (o/p- TRANSMIT POWER SENSE) |
| 11 | TXPWR | (i/p-TRANSMIT POWER LEVEL) |
| 12 | TXX EN | (i/p-TRANSMIT ENABLE) |
| 13 | IPTT | (i/p-PRESS TO TALK) |
| 14 | DATA | (i/p-TRANSMIT DATA) |
| 15 | TEMP SENSE | (o/p-TEMPERATURE SENSOR) |
| 16 | TEMPCOMP | (i/p-TEMPERATURE COMPENSATION) |
| 17 | EN | (i/p-ENABLE FOR SYNTH) |
| 18 | DA | (i/p-DATA FOR SYNTH) |
| 19 | CK | (i/p-CLOCK FOR SYNTH) |
| 20 | LD | (o/p-LOCK DETECT FROM SYNTH) |
| 21 | DATA OUT | (o/p-RECEIVED DATA) |
| 22 | RSSI | (o/p-RSSI SIGNAL) |
| 23 | AFC CTL | (i/p-AFC CONTROL) |
| 24 |  | (UNUSED) |
| 25 | SUPPLY/MIC | (UNUSED) |
| 26 | TEST1 | (UNUSED) |
|  | TEST2 | (UNUSED) |

### 2.2.4.2 ANTENNA DIPLEXER

The interface between the radio section and the antenna diplexer section is via coaxial connectors X4 and X2, and low loss coaxial cables.

| CONNECTOR | SIGNAL DESCRIPTION |
| :--- | :--- |
| $X 4$ | TRANSMITTER OUTPUT |
| X2 | RECEIVER INPUT |

### 2.2.4.3 AUDIO HANDSET

The interface between the radio section and the audio handset is via the modular-6 pin connector X3.

```
CONNECTOR X3 SIGNAL DESCRIPTION
PIN NUMBERS
```

6

SIGNAL DESCRIPTION

8V POWER SUPPLY
AUDIO OUT ( $\mathrm{o} / \mathrm{p}$ - AUDIO TO EARPIECE)
GROUND
MIC (i/p - MICROPHONE AUDIO)
GROUND
MANUAL PTT (i/p-HANDSET PTT)

### 2.3 ANTENNA DIPLEXER SECTION

### 2.3.1 GENERAL

The antenna diplexer section of the TC-900DR is a separate plug in module, that "piggy backs" the radio section PCB.

The diplexer performs two major tasks. Firstly it couples both the transmit and receive RF paths to the antenna while providing high isolation between them, and secondly it provides image and spurious rejection for each of these paths, with high $Q$ bandpass filters.

The isolation between the transmit side and the receive side is greater than 50 dB .
The diplexer consists of two teflon PCB's bonded together using a critical temperature and pressure process. The top and bottom outer layers are connected via brass eyelets, that are pressed through the PCB. This eliminates the need for through hole plating of Teflon, which requires the use of dangerous chemicals.

The design is essentially two continuous ground planes, filled in between, with laminate dielectric, and stripline filter tracks which are centrally located between these ground planes.

The etching of the filter tracks is closely monitored and controlled to ensure an accuracy of better than $0.001^{\prime \prime}$ in track width and spacing.

The diplexer has been factory tested to ensure bandpass and performance characteristics are met. The diplexer has approximately 3 dB of loss at 930 MHz and 2 dB of loss at 850 MHz .

This diplexer requires no alignment in the field.

### 2.3.2 INTERFACES

The antenna diplexer connects to the radio section via low loss coaxial cables and connectors, and to the units antenna via a SMA connector.

Two versions of the diplexer are available, depending on the transmit and receive frequencies used. The difference between the two is the loading of the SMA connector.

```
TYPE-A CONNECTIONS (Transmit frequency = 930 MHz range)
DIPLEXER CONNECTOR SIGNAL DESCRIPTION AND DESTINATION
    850 MHz port RF RECEIVE - RADIO SECTION X2
    930 MHz port RF TRANSMIT - RADIO SECTION X4
    ANT port
    ANTENNA
```

| TYPE-B CONNECTIONS (Transmit frequency $=850 \mathrm{MHz}$ range) |  |
| :---: | :--- |
| DIPLEXER CONNECTOR |  |
| 850 MHz port | RF TRANSMIT - RADIO SECTION X4 |
| 930 MHz port | RF RECEIVE - RADIO SECTION X2 |
| ANT port | ANTENNA |

### 2.4 AUDIO HANDSET SECTION

### 2.4.1 GENERAL

Refer to diagram "MTCU HANDSET MAIN PCB \& MIC PCB CIRCUIT DIAGRAM", drawing number 5015-A200-50.

The handset provides an audio link between units, to assist in link setup and commissioning. It is not intended for general use and the equipment is not licensed for voice operation only.

Caution: When the handset is inserted into the TC-900DR, reliable data transmission or reception is not possible. Unintentional voice traffic on a point to multi point system may cause data corruption to other units.

The data transmission section of the modem is totally disabled, if the handset is plugged in when the TC-900DR is turned on.

The handset contains two PCB's, a receive board and a microphone board, which are connected by a 10 way ribbon cable. Acoustic padding is also included in the handset for improved performance.

The microphone board contains an ECM30 electret microphone, along with a common emitter preamplifier stage (Q1), to provide transmit voice audio.

There are four indication LED's that are not used by the TC-900DR.
The receiver board contains a 78L05 5V voltage regulator (REG1). This is used to supply power to the LF353 receive amplifier (U2-p7), which drives a DH32-30 ohm earpiece.

The sidetone circuit provided by U2-p1 is disabled and not used by the TC-900DR. Similarly, the LED drivers are disabled.

The PTT switch places a ground connection onto its output signal line, for processing by the radio section.

### 2.4.2 INTERFACES

The audio handset connects directly to the radio section via the RJ11 connector, X3. Attached to the handset is an 8 way flexible curly cord.

| PIN NUMBER | HANDSET CONNECTOR | X3 PIN NUMBER | RADIO SECTION CONNECTOR X3 |
| :---: | :---: | :---: | :---: |
| 1 | LED CLK | - | UNUSED |
| 2 | LED DATA | - | UNUSED |
| 3 | 13V2 | 1 | 8V POWER SUPPLY |
| 4 | DGND | 3 | GROUND |
| 5 | PTT | 6 | MANUAL PTT |
| 6 | MIC | 4 | MIC |
| 7 | MIC RET | 5 | GROUND |
| 8 | EAR PHONE | 2 | AUDIO OUT |

### 2.5 MODEM SECTION

The modem section is built on a single PCB with approximate overall dimensions of $165 \mathrm{~mm} \times 152 \mathrm{~mm} \times 18 \mathrm{~mm}$.

It consists of the following main blocks :
Modem control

- DFM4-9 modem.
- Reset and watchdog.
- Memory.
- External NVRAM.
- External RAM.

Host interface.
Radio interface.
Transmit signal conditioning.
Receive signal conditioning.

- Data recovery.
- Clock recovery.

User indications.
Power supply
Interfaces.

- Radio section.
- Port A.
- Port B.
- Power.


### 2.5.1 MODEM CONTROL

### 2.5.1.1 DFM4-9 MODEM

The modem section is controlled by a DFM4-9 Trio DataCom modem IC, (U5).
This device is specifically designed to provide data communications from a host computer over a radio channel.

The DFM4-9 is capable of full duplex operation, at data rates of 4800 baud or 9600 baud over the radio channel. The transmitter and receiver data rates may be set independently. The host computer interface provides two RS232 asynchronous serial ports, configurable for a variety of baud rates, and data formats.

In the standard delivery format of the modem, only one asynchronous serial port is operational. (Port A).

Advanced data recovery techniques are employed to ensure excellent performance in both good and noisy signal environments.

The data transmission method used, employs advanced optimal waveform shaping techniques. This maximises the recovered signal at the destination receiver, while remaining within the allocated RF channel bandwidths. The method uses computer generated Finite Impulse Response (FIR) techniques, to derive the transmitted waveform data.

The modem features a unique supervisory signalling channel, which embeds low speed data in the primary bit-stream, and is transparent to the user of the primary channel.

To drive the DFM4-9 modem clocking circuits, an external resonator is required. A 19.6608 MHz crystal (XTAL1) is applied to the OSC pins (U5-p9,10) of the device to achieve this.

A 4 way DIP switch is supplied to set up some configuration parameters of the modem. These are only read by the DFM4-9 at device power up. They connect to the "ESx" pins of the device (U5-p3,p5,p6,p7). Switches 1 and 2 are presently unused, switches 3 and 4 are defined in section 4.5.1.

### 2.5.1.2 RESET AND WATCHDOG

A MAX690 reset and watchdog IC (U3), is used to perform a variety of ancillary functions. This device provides a fixed length reset pulse for the proper initialisation of the modem chip on power up and reinitialisation. The MAX690 monitors the level of the VCC power supply line. If the voltage moves out of specification, the reset output is activated. This ensures that the modem chip recovers correctly in the event of a power failure. The reset signal is applied to the "RESET" pin of the modem (U5-p8).

The MAX690 provides a power monitoring function, which gives advance warning of imminent power supply failure. The DFM4-9 modem checks this signal, applied to its "PF" pin (U5-p2), before performing any transactions with the non-volatile memory, thus preventing accidental corruption of the contents of this memory. This "advance warning", is the length of time that the power supply capacitors hold their charge, after loss of power, before the Vcc supply rail drops below its cutoff level, and a reset pulse is generated.

The MAX690 also includes a "watchdog" timer. This timer must be strobed at a minimum rate, to prevent a reset pulse being generated. The DFM4-9 provides this signal at its "WDO" pin (U5-p22). Should the DFM4-9 modem operation go astray for some reason, it is probable that it will no longer perform this strobing function correctly. This condition is treated as irrecoverable and the MAX690 will timeout on its watchdog function and re-initialise the modem.

### 2.5.1.3 MEMORY

### 2.5.1.3.1 EXTERNAL NVRAM

The DFM4-9 modem, has a wide variety of configurable operating parameters, all of which are stored in an ST24C04 NVRAM IC, (U4). These parameters are read at power up, and determine the operating characteristics of the modem.

The NVRAM has 4096 bits of memory. It is accessed using the standard $I^{2} C$, two wire, bus interface. A feature of this particular device, is a write protect function for one area of the memory.

This write protect feature prevents configuration data being inadvertently corrupted should some anomaly in modem operation occur. A hardware signal line is used to override this write protection feature, so that the configuration data may be changed by manual means. This signal can be accessed via the front panel connector, and is used when the TC-DFM9IP modem programmer is connected.

### 2.5.1.3.2 EXTERNAL RAM

External RAM is used to store data frames.
The RAM used may be either a $6264-8 \mathrm{~K}$ or $62256-32 \mathrm{~K}$ byte IC (U9). The standard TC-900DR is supplied with an 8 K package. The DFM4-9 modem, tests the size of the attached RAM on power up.

All of the externally connected RAM is used to store packet data, and is allocated evenly between transmit and receive data. This memory is connected to the modem chip, by an 8 bit bus, and 3 control lines.

Two 8 bit 74HC573 latches (U8 and U10), are used to latch the memory address off the bus, before the data read or write cycle. The read/write control line to the RAM, is passed as the top address line in the MSB address latch.

The RAM read cycle operates as follows :

- The modem sets the two latch control lines, LADR_EN and HADR_EN, high.
- The high-address/R_select is then placed on the 8 bit bus.
- The HADR_EN line is set low to latch the data into U8.
- The lower eight address bits are placed on the bus.
- The LADR_EN line is set to low to latch the data into U10.
- The modem bus port is set to input mode.
- The RAM CE line is set low.
- The modem reads the data off the bus.

The RAM write cycle operates as follows:

- The modem sets the two latch control lines LADR_EN and HADR_EN, high.
- The high-address $W_{\text {_ }}$ select is then placed on the 8 bit bus.
- The HADR_EN line is set low to latch the data into U8.
- The lower eight address bits are placed on the bus.
- The LADR_EN line is set to low to latch the data into U10.
- The modem bus port is set to output mode.
- The modem writes the data to the bus.
- The RAM CE line is set low to write the data into the RAM.


## Note: WARNING

A modem containing a $32 K$ RAM package will not be compatible with a modem containing an 8K RAM package if end to end flow control is being used over the data link.

### 2.5.2 HOST INTERFACE

The host interface is provided by two RS232 ports, configured as DCE. These ports are presented to the user as 9 way female DMIN connectors, designated as PORT A and PORT B.

With the standard TC-900DR, only PORT A is operational.
The RS232 level translation is performed by two LT1081/MAX232 line transceivers (U1 and U2). These require a single five volt supply, and include internal charge pumps to generator the required +10 V and -10 V rails.

The four input and four output lines implement one full duplex serial port with RTS/CTS/DTR and DCD. This is PORT A. A second full duplex port with no handshake lines is provided on PORT B.

### 2.5.3 RADIO INTERFACE

The interface to the radio is via a 26 pin PCB header connector, $X 4$.
The modem section has full control over the connected radio transceiver. It provides:

- Four lines for synthesiser control (used for RF channel selection).
- RSSI detection.
- Temperature sense input.
- Transmit power sense input.
- Temperature compensation for the synthesiser reference frequency.
- Receiver AFC.
- PTT control.
- Analogue lines for receive and transmit data signals.
- Regulated +13.8 V and +8 V power supplies.

Input to the receiver signal port, RXSIG , is offset by 2.0 V DC , with a signal level of $1 \mathrm{Vp}-\mathrm{p}$ AC.

The transmit signal output, TXSIG, has a signal level of $1 \mathrm{Vp}-\mathrm{p}$ for 4800 BPS , and $2 \mathrm{Vp}-\mathrm{p}$ for 9600 BPS , with a nominal DC offset of 2.0 V . This offset may vary by $\pm 1 \mathrm{~V}$ according to the modulator temperature compensation requirements.

An ADC0834 four channel ADC (U6), is used to monitor various analogue quantities within the radio. The DFM4-9 modem communicates with the ADC by controlling 3 lines. An active high chip select, "ADCS" line (U5-p33), a data clock, "DCLK" line (U5-p35), and a serial data, "SD" line (U5-p36).

The state of the data line from the ADC is clocked into internal registers of the DFM4-9 on the rising edge of the clock line. The data stream consists of a four bit preamble, which includes the channel address. From the 5 th clock pulse onward, the ADC drives the data line with the data of the conversion, MSB first. The transaction is terminated with the CS line being set to inactive low.

The first channel is used to monitor temperature, by measuring the voltage from an LM335 monolithic temperature sensor U6. The LM335 is situated in the radio section, adjacent to the 20.1666 MHz XTAL and VCXO synthesiser reference oscillator, and is fed into the modem section via connector X4-p14, ADC0.

The second channel is used to monitor RSSI, by measuring the RSSI output of the NE615 IF circuit. This signal is fed to the modem section from the radio section via connector X4-p21, ADC1.

The third channel is used to monitor the power level output by the RF transmitter, by measuring a voltage derived in the power control section of the radio. This is used to determine the "health" of the radio transmitter. This signal is fed to the modem section from the radio section via connector $\mathrm{X} 4-\mathrm{p} 9, \mathrm{ADC2}$.

The fourth channel of the ADC, is used to measure the voltage of the +13.8 volt supply rail and to sense the presence of the audio handset at power up. The handset derives microphone bias from the modulator stage, and the voltage at this point is measured and compared with a fixed nominal value, to determine if the handset is connected at the time of TC-900DR power up. This signal is fed to the modem section from the radio section via connector $\mathrm{X} 4-\mathrm{p} 24, \mathrm{ADC} 3$. This 4 th ADC channel is also multiplexed to measure the AFC control voltage so that an indication of received signal frequency can be made. U14:D is used to perform this switching function.

An auxiliary latch (U11) is provided to supply some of the output control to the radio section.

The latch receives data from the same data buss as the RAM. The lower six bits are fed to an R/2R ladder network DAC (RN2), which is used to present an analogue voltage to the radio's local oscillator synthesiser frequency reference. This correction voltage provides for excellent temperature stability of the radio. This signal is fed to the radio section via connector X4-p15, TEMP COMP.

The two top bits of the latch, drive auxiliary functions within the radio section.
Bit 6 is used to control the power of the RF transmitter in the radio section. This can be set to a HIGH level of 1 W , or to a LOW level of 200 mW . This signal is fed to the radio section via connector X4-p10, TXPWR.

Bit 7 provides the RF transmitter enable signal to the radio section. No RF signal can be transmitted unless this signal is set to active. This signal is fed to the radio section via connector X4-p11, TX EN.

### 2.5.4 TRANSMIT SIGNAL CONDITIONING

The transmit section of the DFM4-9 modem, outputs a byte of data, four times per bit period, on the "TDx" pins (TD1..TD7, U5-p56..49).

The parallel data is presented to an eight bit R/2R ladder network (RN1). This is a simple DAC which produces the transmit waveform at its output.

This signal is fed into opamp (U13:C) for amplification and filtering. This stage is a single pole low pass filter, used to attenuate clocking noise in the waveform. Two more filter stages follow, U13:B and U13:D.

By using 4 samples per bit, and an 8 bit resolution, precise control of the waveform shape is possible.

The gain and pole frequency of amplifier stage U13:C is switched by the DFM4-9 modem, via a 74 HC 4066 CMOS FET switches (U14:A). This is to produce the required waveform for the two data rates currently available. The bit rate output signal, "BRO" is provided at U5-p44.

For 4800 baud, components C43 and R45, are "included" in the feedback loop of the amplifier stage. When 9600 baud is selected, switch U14:A is turned OFF, and the components are "excluded" from the circuit.

### 2.5.5 RECEIVE SIGNAL CONDITIONING

The data receiver, consists of several functional blocks. Some of these are implemented by internal functions of the modem IC, and the remainder by external circuitry.

The incoming analogue signal, is routed to two separate sections of circuitry. One to process the received clock, the other to process the received data.

### 2.5.5.1 DATA RECOVERY

The data recovery is based around an "Integrating Data Slicer" circuit.
This circuit consists of a non-inverting, resetable integrator (U16:A, U12:C and U15:D), a dual peak detector ( $\mathrm{U} 12: \mathrm{A}, \mathrm{B}$ ) and a reference divider.
The received signal is passed into the modem section from the radio section via connector X4-p20, "RXSIG".

The signal is integrated by the non-inverting integrator formed by U16:A, and U12:C, and then forwarded on to a comparator ( $\mathrm{U} 7: \mathrm{B}$ ), where it is "squared up", ready to be read by the DFM4-9 modem.

An output signal is provided by the modem IC, to indicate the sampling point. In fact this signal, called "RxCLKOUT", is pulsed high immediately after the sampling operation has taken place.

The integrator is reset at the end of each bit period, by the 74 HC 4066 FET switch, U15:D, after the value of the bit has been read. The DFM4-9 provides this reset signal at the reset integrator "RxCLKOUT" pin (U5-p19).

The integrated receive signal, is then fed to the dual peak detector, where the positive and negative peaks of the integrated signal are detected, and stored on the capacitors C28 and C27.

The peak detector's attack time is determined by the output resistance of the opamps (U12:A,B) and the bulk resistance of the diodes (D7, D4). The decay time however is determined by the values of the hold capacitors (C28, C27) and the summing resistors (R24, R25).

Four diodes (D5, D6, D8, D9) are used to clamp the reference rail. If the incoming signal has a large DC shift, this clamping arrangement ensures that the data slicer reference level is quick to settle somewhere near its final operating point. This clamp however does impose a maximum allowable input signal level. Exceeding this level will cause the integrated signal to directly modulate the reference rail. The derived reference voltage level, is amplified and output back to the radio section, where it is used for AFC in the receiver.

### 2.5.5.2 CLOCK RECOVERY

The received clock signal is presented to the DFM4-9 modem at its "RXCLK" input (U5-p4).

Within the DFM4-9, a phase-locked-loop is used for data clock recovery, which relies on level transitions in the data signal.

This mechanism maintains the data sampling point in the center of the bit cells by comparing the signal's level transitions with an internal clock.

An error in the relative phase of the RXCLK signal and the internal clock, causes the internal clock to increase or decrease in speed, to bring the phase error to zero.

The phase-locked-loop clock recovery mechanism within the DFM4-9 modem, maintains the sampling point in the center of the bit cells, but the use of the integrator demands that this take place at the end of the bit cell. This means that the signal fed to the DFM4-9 modem RXCLK input must be delayed by half a bit period.

To obtain this, the received signal is passed through a half bit delay, low-pass filter (U16:D, U12:D, U7:A). The delay characteristics of this filter, are switchable between the available data rates of 4800 and 9600 baud operation, by five 74 HC 4066 FET switches. These switches are controlled by the "BRO" output of the DFM4-9.

### 2.5.6 USER INDICATIONS

There are four indication LED's supplied for user information. POWER, TXMIT, SYNC and RXSIG. The POWER LED is green, TXMIT LED is red and the other two are yellow.

The POWER LED (LED4), is driven from the 13 V 8 power supply line. When supply is present the LED is activated.

The TXMIT LED (LED3), is activated when PTT is present. It is driven when the switching transistor Q3 is turned ON by the DFM4-9 modem "PTT" output going active (UX3-p38).

The SYNC LED (LED2), is activated when a valid data stream has been detected. It is driven when the switching transistor Q2 is turned ON by the DFM4-9 modem "SYNC" output going active (U5-p43).
The RXSIG LED (LED1), is activated when the received signal level is at a usable level. It is driven when the switching transistor Q1 is turned ON by the DFM4-9 modem "RXSIG" output going active (U5-p43).

### 2.5.7 POWER SUPPLY

The power supply is based around the use of three voltage regulators that supply +13 V 8 , +8 V and +5 V .

The incoming power is applied to a bridge rectifier (BR1),. Normally two legs of this bridge are linked out, so it provides only reverse polarity protection shunt diodes. A special manufacturing option allows for AC input, where the links are removed. A 2200uF electrolytic capacitor (C2), provides filtering for AC inputs.

This is then applied to an LT1086 low dropout regulator (REG1). The output of this is set to 13V8 and feeds the RF final amplifier, and the following two regulators.

The 8 V regulator (REG2) takes it's input directly from the 13 V 8 rail, its output is routed to the radio section, and provides supply for one of the amplifier devices.

The 5 V regulator (REG3) provides the supply rail for the modem section logic circuits. It takes it's input from the 13 V 8 rail via diode D1. Extra filtering capacitance is provided by C7.

### 2.5.8 INTERFACES

### 2.5.8.1 RADIO SECTION

The modem section interfaces to the radio section via connector JX3. The physical link between the two sections is achieved via a 90 mm length of 26 way ribbon cable.

Refer to interface diagram "RADIO MODEM INTERFACE", drawing number TC01-05-18 sheet 1/3.

CONNECTOR JX3 SIGNAL DESCRIPTION PIN NUMBER

| 1 | 13V8 POWER SUPPLY RAIL |  |
| :---: | :---: | :---: |
| 2 | 13V8 POWER | LY RAIL |
| 3 | 13V8 POWER SUPPLY RAIL |  |
| 4 | GROUND |  |
| 5 | GROUND |  |
| 6 | GROUND |  |
| 7 | 8V POWER SUPPLY |  |
| 8 | 8V POWER SUPPLY |  |
| 9 | ADC2 | ( $\mathrm{i} / \mathrm{p}$ - TRANSMIT POWER SENSE) |
| 10 | TXPWR | (o/p - TRANSMIT POWER LEVEL) |
| 11 | ITX EN | (o/p - TRANSMIT ENABLE) |
| 12 | /PTT OUT | (o/p - PRESS TO TALK) |
| 13 | TXSIG | (o/p - TRANSMIT DATA) |
| 14 | ADC0 | (i/p - TEMPERATURE SENSOR) |
| 15 | TEMPCOMP | (o/p- TEMPERATURE COMPENSATION) |
| 16 | EN | (o/p - ENABLE FOR SYNTH) |
| 17 | DA | (o/p - DATA FOR SYNTH) |
| 18 | CK | (o/p - CLOCK FOR SYNTH) |
| 19 | LD | (i/p - LOCK DETECT FROM SYNTH) |
| 20 | RXSIG | (i/p - RECEIVED DATA) |
| 21 | ADC1 | (i/p - RSSI SIGNAL) |
| 22 | AFC CTL | (o/p - AFC CONTROL) |
| 23 | SPARE | (UNUSED) |
| 24 | ADC3 | (FOR SUPPLY/HANDSET) |
| 25 | TEST1 | (UNUSED) |
| 26 | TEST2 | (UNUSED) |

### 2.5.8.2 PORT A

The modem section interfaces to the host user via the 9 way female DMIN type connector JX1.

## CONNECTOR JX1 SIGNAL DESCRIPTION PIN NUMBER

| DATA CARRIER DETECT | (DCD) |
| :--- | :--- |
| RECEIVE DATA OUTPUT | (RXD) |
| TRANSMIT DATA IN | (TXD) |
| DATA TERMINAL READY | (DTR) |
| COMMON | (COM) |
| DATA SET READY/prog mode | (DSR) |
| REQUEST TO SEND | (RTS) |
| CLEAR TO SEND | (CTS) |
| RING INDICATE/BER Test Mode | (RI) |

Note: Pin 6 and pin 9 provide a dual function which depends on the mode that the TC-900DR is operating in.

### 2.5.8.3 PORT B

For the standard delivery version of the TC-900DR, port B is normally not enabled. This port provides no handshake lines except DCD (parallel connected with DCD on Port A) and DSR which is wired active.

CONNECTOR JX1
PIN NUMBER
1
2
3
4
5
6
7
8
9

SIGNAL DESCRIPTION

| DATA CARRIER DETECT | (DCD) |
| :--- | :--- |
| RECEIVE DATA OUTPUT | (RXD) |
| TRANSMIT DATA IN | (TXD) |
|  | (COM) |
| COMMON | (DSR) |
| DATA SET READY/prog mode |  |
|  |  |
| RECEIVE SIGNAL STRENGTH INDICATOR | (RSSI) |

DATA CARRIER DETECT RECEIVE DATA OUTPUT TRANSMIT DATA IN

Pin 9 is used to output the RSSI signal for external measurement.
The RSSI output ranges from 0 to 5 Volts, where 5 volts indicates the strongest signal. It is important to note that this port output has a high impedance of around 50 K ohms and loading will decrease accuracy of the recorded measurement.

### 2.5.8.4 POWER

Power is supplied to the modem section via connector X 1 . Typically +13.8 V DC is applied to the top pin, with the common connected to the bottom pin.

## SECTION 3

## OPERATIONAL DESCRIPTION

## 3 OPERATIONAL DESCRIPTION

### 3.1 GENERAL

The Trio DataCom TC-900DR radio modem, is a full duplex 4800/9600 bits per second device, which converts digital data into an analogue form suitable for transmission over a radio channel. It uses specially filtered direct binary frequency modulation techniques to achieve this. It conversely, converts the analogue signal derived from a radio channel into a digital data signal.

The heart of the unit is the DFM4-9 modem IC. This performs all waveform shaping, randomising and de-randomising, NRZ/NRZI conversion, clock recovery, and HDLC framing and CRC error generation and checking. These functions are performed simultaneously, allowing full duplex operation at up to 9600bps.

The modem is fully HDLC compatible. The user is provided with two RS232 compatible ports, which may each be configured with a standard PAD interface or SLIP/KISS protocol driver. The unit may also be configured for repeater operation.

It may be configured to use RS232 handshake lines, or XON/XOFF flow control on Port A.

The modem features a unique supervisory signalling channel, which embeds low speed data in the primary bit-stream, and is transparent to the user of the primary channel.

The supervisory signalling channel can be disabled if not required. It could be used to pass low speed data such as E and M status or C/DSMA control schemes.

The data rate of the supervisory signalling channel can be set independently for transmit and receive. It can range from about 40 to 533 bps with the primary channel rate at 4800 baud, and 80 to 1067 bps at a primary channel rate of 9600 baud.

NOTE: with the supervisory signalling channel active, the bit-stream is not compatible with standard HDLC interface devices (such as 8530).

The host user port may be configured for baud rates of 300 to 19K2, with 7 or 8 bit character size, 1 or 2 stop bits, and parity off/odd/even.

The DFM4-9 modem includes several data tables which are used to generate waveforms with different characteristics. This is primarily for optimum performance at differing baud rates. A custom data table can be placed into the NVRAM of the modem, for specialised applications.

Configuration of the modem is fully programmable, with parameters held in non-volatile memory. All configuration parameters are accessible with the TC-DFM9IP Installation Program.

Configuration parameters include but are not limited to:
Supervisory Signalling Channel rate.
XON/XOFF or RTS/CTS/DTR/DCD handshake mode.
Default transmitter lead in delay.
Constant specifying minimum RF RSSI for valid receive.
Constant specifying minimum Tx power level.
Asynchronous serial port parameters.
User interface operating mode :

- User port interface protocol
- PAD Parameters


### 3.2 TC-900DR MODEM FIRMWARE REVISION VA2.3.0

### 3.2.1 FUNCTIONAL CHANGES AND ADDITIONS

The Diagnostics " M " command (serial port Mode) completed. The implementation of this command was not finished in time for VA2.2 release. This command is used to configure either of the two user ports, for character length, number of stop bits, parity odd/even/off.

1 Bit 7 is used to address which port is being referenced (set to " 0 " for Port B, or set to "1" for Port A).

2 Bit 6 determines the character size. Set to " 0 " for 8 bit, or "1" for 7 bit character size.

3 Bit 5 is set to " 1 " to enable parity, " 0 " to disable parity.
4 Bit 4 determines Odd (set bit to "1"), or Even (set bit to " 0 ") parity if Bit 5 is set.
5 Bit 3 determines the number of stop bits. Set to " 0 " for 1 stop bit, or set to " 1 " for 2 stop bits.

6 Bits 2, 1, and 0 are used to select the baud rate. The following table shows the available rates. The 19.2 K baud selection should only be made for Port A if Port $B$ is disabled. The last selection of 110 baud may be deleted from future firmware revisions.

| Bit | Bit 1 | Bit 0 | Baud Rate |
| :---: | :---: | :---: | ---: |
| 0 | 0 | 0 | 300 |
| 0 | 0 | 1 | 600 |
| 0 | 1 | 0 | 1,200 |
| 0 | 1 | 1 | 2,400 |
| 1 | 0 | 0 | 4,800 |
| 1 | 0 | 1 | 9,600 |
| 1 | 1 | 0 | 19,200 |
| 1 | 1 | 1 | 110 |

Channel Access Strategy 3 is now defined. This is selected by setting bits 1 and 0 (TxCtri1 and TxCtri0) in "Config1", both to "1". This mode forces a randomly generated delay before transmission begins, even if the channel is perceived to be clear. This delay mechanism is similar to that used in Channel Access Strategy 2 when the channel is perceived to be busy. This operating mode is useful in systems that include remote terminals that generate reports at regular fixed intervals. In such a system, slight differences in this interval between two remotes, would cause them to become synchronised for some time, and thus transmissions from them would consistently
collide. Inserting a randomly generated delay before all transmissions will reduce the incidence of this effect.

The RS232 DCD handshake line now becomes active only during output of received data. Formerly, the DCD line indicated real time SYNC status of the modem data receiver. To facilitate the use of RS232 to RS422/RS485 converters, the DCD line is driven active a short time (approximately 0.5 mS ) before the received data is output to the user port, and lingers for approximately 2 to 3 character times (i.e. is proportional to baud rate of user port). The modem generates only one DCD function, which is available on pin 1 of both Port A and Port B. Thus the DCD pin of both user ports will be activated when either port is outputting received data.

### 3.2.2 OTHER ENHANCEMENTS

Improvements in handling of the RS232 RTS line (Port A), makes the modem more tolerant in the timing of rapid OFF transitions of this handshake line, immediately after the end of the last character of a message. It has been observed that communications drivers in many PLCs turn their RTS output line OFF very shortly after the end of a message, resulting in the loss of the last character of the message with previous modem firmware revisions. This revision does not suffer this problem.

The random number generator used for the Channel Access Timer, has been improved to make it more random.

### 3.3 FACILITIES AND CONFIGURATION INFORMATION FIRMWARE VERSION 2.2

### 3.3.1 GENERAL

The TC-900DR provides fully transparent remote diagnostics facilities, and expanded data stream switching, which supports advanced stream trunking applications.

The diagnostics core, supports the reporting of current analogue conditions, including temperature, RSSI (Received Signal Strength Indication), RF transmitter power, AFC (i.e. received signal frequency offset), and supply voltage. Also, an extensive range of operating parameters may be changed remotely, including remote (RF) channel change.

Configuration options, allow various system topology's, so that the location of the system's diagnostics controller is flexible.

The data stream switching mechanism has been upgraded to allow either MUX/DeMUXing or multi-stream routing functions, independently for each port.

A few other minor upgrades to previous revisions of firmware are:

* Two different "ticker clocks" implemented, one running at 1 mS , and used for a) PAD Character Input Timers, and b) Channel Access Timer when running in Collision Avoidance mode. The other "ticker clock" runs at 10 mS , and is used for the PTT timer, and a host of other internal functions, not accessible by configuration programming.
* When XON/XOFF flow control is enabled on PortA, the CTS output line continues to operate correctly, indicating the flow control state. XON/XOFF characters are generated in addition to, and reflect state changes on this line. As before, the DTR input line is ignored while XON/XOFF flow control is set, and the RTS line is not required to be true to validate transmit data.
* The modem stores data for transmission in buffer memory, which is limited. It also keeps track of frame boundaries of the stored data, and the number of frames it can manage is also limited by the amount of memory used to record the position of the frame boundaries. Thus it is possible that the modem can approach overflow before exhausting data buffer space, if frames are small. This flow control state is activated when the "frame boundary memory" approaches half full, for similar reasons used in data buffer management.
* If the Supervisory Signalling Channel is enabled in both transmit and receive directions, and PortA is configured in Repeater Mode, then the received Supervisory Signalling Channel data is also repeated, by being copied from the Supervisory Signalling Channel receiver to the Supervisory Signalling Channel transmitter.
* RSSI measurements are full eight bit conversion, so the "min_RSSI" configuration parameter lies in the range $0-255$ (decimal). This is only important when setting this parameter without the aid of the DRPROG programmer.


### 3.3.2 INTERNAL DATA STREAM ROUTING

Essentially, all data streams travelling in both directions (transmit and receive), are examined and tested for a match with the diagnostics receive SID header code. If this match test is successful, then the data frame is copied into a buffer for the diagnostics core to process. The data frame also continues in the original direction as well. Thus diagnostics frames received from the radio channel (receive data), and from the stream switcher (transmit data, from one of the physical ports), are copied as they pass between the HDLC "device" and the data stream "switcher". Messages generated by the diagnostics core in response to received commands, are always sent back to the source of the command. That is, if a status request is received from the radio channel side of the modem, then the response is directed back out of the radio channel.

This dual access structure, allows the diagnostics controller to be located on either side of the modem, and thus supports any system topology.

### 3.3.3 DIAGNOSTICS REPEAT FUNCTION

Some applications will require that the "base" unit in a point to multi-point system repeats diagnostics frames. This will be the case where the system diagnostics controller is attached to a remote terminal in the system, and polls the system population from this point. The "base" unit must re-transmit diagnostics frames which are not addressed to itself. A "diagnostics repeat" configuration bit enables this function.

### 3.3.4 DIAGNOSTICS FRAME STRUCTURE

Diagnostics data frames, are structured according to a defined protocol. A frame consists 1 st of the SID header code, which would normally (but not necessarily) be 00 . Following this is a three byte address of the destination unit, followed by a three byte source address. An addressed unit responding to a diagnostics command, will swap these two address fields around, in the response frame. The destination address in a diagnostics frame to a TC-900DR unit, is in fact the unique (factory) serial number of the unit. By convention, the diagnostics controller (a DOS based PC), will use a unique address for itself, outside the range of permissible TC-900DR addresses (e.g. 000000). Following the two address fields, is a single character command/response code, which is in turn followed by any operands that may or may not be required for the command/response. Total frame size is limited to 17 bytes. After the SID header, address fields, and command/response mnemonic, this allows up to nine bytes of data to be transferred per diagnostics frame.

### 3.3.5 DIAGNOSTICS COMMAND SET

The following is a list of the command set recognised by the diagnostics core in the TC-900DR Firmware. Also is tabulated the response to each command. The following examples use address 123456 for the TC-900DR unit address, and 000000 for the address of the system diagnostics controller. For the purposes of clarity only, each byte in the example messages is separated by a comma. Mnemonics are represented in quoted form to indicate an ASCII character (e.g. "C" is actually binary byte h'43).

## B Warm Boot Command.

This command forces the addressed unit to perform a "warm boot". Previous to this, the unit will have been halted (see " H " command), and one or more parameters changed with "P" and "W" commands.

Syntax:-
Command:- $\quad 12,34,56,00,00,00, " B "$
Response:- $\quad 00,00,00,12,34,56, " b "$

## C Calibration Constant Poll.

This command requests the addressed unit to reply with it's internal Analogue To Digital Converter (ADC) calibration constants. These are necessary to accurately interpret the data sent in Status Poll ("S") replies. This command has no operands, and the response mnemonic is " c ". The form of the command and reply is:

Syntax:-
Command:- $\quad 12,34,56,00,00,00, " \mathrm{C"}$
Response:- $\quad 00,00,00,12,34,56, " c ", t t, r r, p p, f f, s s$
Where:-
$\mathrm{tt}=$ Temperature calibration code
rr $=$ RSSI calibration code
pp = Transmit Power calibration code
$\mathrm{ff}=$ Received Frequency Offset calibration code
ss = Power Supply calibration code

## D Powered Up Response

This command is sent from the modem to the controller in response to a status poll ("S") immediately after the modem has been powered up. The modem will continue to send this command in response to a status poll until the controller acknowledges the command with a "d". The modem will then respond normally to a status poll.

This mechanism is used by the controller to determine whether it requires calibration data from the modem.

Syntax:-
Command:- 00,00,00,12,34,56"D"
Response:- $\quad 12,34,56,00,00,00 " d "$

F Set New RF Synthesiser Frequency.
This command forces the unit to set the RF synthesiser to a new frequency, thus selecting another radio channel. This command has one operand, which defines the source of the synthesiser data. A value of zero, indicates that the frequency data has already been set with a parameter set command. Values from one to four select one of the channels stored in the NVRAM of the modem configuration. The addressed unit responds with an "f" reply, before executing the channel change command (i.e. on the old channel).

Syntax:-
Command:- $\quad 12,34,56,00,00,00, " F ", n n$
Response:- $\quad 00,00,00,12,34,56$, " ${ }^{\prime \prime}$
Where:-
$\mathrm{nn}=00$ to 04 to select data source.

H Halt Command.
This command forces the addressed unit to halt all internal operations, except diagnostics processing. This is necessary, when changing some parameters, before a warm boot command is issued to the re-configured unit.

Syntax:-
Command:- $\quad 12,34,56,00,00,00, " H "$
Response:- $\quad 00,00,00,12,34,56, " h "$

## M Set Serial Port Mode.

This command forces the addressed unit to change the operating mode of one or both serial ports. Parameters such as character size, number of stop bits, parity etc. are changed with this command. It should be noted, that data may be lost while the operating mode of the serial ports is changed.

Syntax:-
Command:- $\quad 12,34,56,00,00,00, " \mathrm{M}^{\prime}, \mathrm{xx}$
Response:- $\quad 00,00,00,12,34,56, " m "$
Where:-
$x x=$ Serial port address bit and mode data

## P Parameter Set command.

This command stores the contents of the operand string to a storage buffer. No other action is taken. This command should be immediately followed by a "W" command. See "W" command below. The parameter may be either a bit quantity, a byte quantity, a word quantity, or a string quantity. The diagnostics core in the modem firmware determines this from the parameter indentifier, which indexes an internal lookup table. String quantities are of indefinite length, and determined by the length of the operand string in the received " $P$ " command. The " $P$ " command response (" $p$ "), echoes the complete received string. This is unique to the " $P$ " and "W" commands.

Syntax:-
Command:- $\quad 12,34,56,00,00,00, " P ", n n, a a, b b, c c, \ldots$
Response:- $\quad 00,00,00,12,34,56, " p ", n n, a a, b b, c c, \ldots$
Where:-
$n n=$ parameter identifier
$\mathrm{aa}, \mathrm{bb}, \mathrm{cc}, \ldots$ are data value(s) for selected parameter

## R Parameter Readback command.

This command forces the addressed unit to read the state of the addressed parameter, and send this data back the the command originator (diagnostics controller) in a reply message. Again the size of the parameter (bit, byte, word, or string) is determined by the parameter identifier. String parameters are returned as a string of eight consecutive bytes.

Syntax:-
Command:- $\quad 12,34,56,00,00,00, " R ", n n$
Response:- $\quad 00,00,00,12,34,56, " r ", n n, a a, b b, . . . h h$

## S Status Poll.

This command requests the addressed unit to reply with the current value of analogue quantities, present temperature, last/present received RSSI, transmit power of last transmission, received frequency offset of last/present received signal, and present supply voltage.

Syntax:-
Command:- $\quad 12,34,56,00,00,00, " S^{"}$
Response:- $\quad 00,00,00,12,34,56, " s "$,tt,rr,pp,ff,ss
Where:-
$\mathrm{tt}=$ Temperature conversion code
rr $=$ RSSI conversion code
$\mathrm{pp}=$ Transmit Power conversion code
ff = Received Frequency Offset conversion code
ss $=$ Power Supply conversion code

T Diagnostics Watchdog Timer command.
This command forces the addressed unit to (re)set a special watchdog timer. The operand value is a word (16_bit) quantity. A zero value will disable the timer. A non-zero value will initialise the timer. This timer, while non-zero, will be decremented periodically. If the timer is decremented to zero, then the TC-900DR will perform a cold boot, thus restoring operating parameters from the NVRAM configuration memory. This command should be used in conjunction with parameter set and write commands. If a parameter change renders the unit in-operable, then either it will not continue to receive further "T" commands to reset the timer, or the system diagnostics controller may cease to send the timer reset commands, thus will eventually cause the unit to cold boot.

Syntax:-
Command:- $\quad 12,34,56,00,00,00, " T ", n n n n$
Response:- $\quad 00,00,00,12,34,56, \mathrm{tt}$
Where:-
nnnn = timer reset value (16 bit value)

V Request Firmware Version String command.
This command requests the addressed unit to reply with a string indicating it's firmware version number. Future firmware versions may provide further facilities that may then be used, by sending appropriate commands.

Syntax:-
Command:- $\quad 12,34,56,00,00,00, " V "$
Response:- 00,00,00,12,34,56,"v","A2.2.0"

## W Write Parameter command.

This command is used in conjunction with the "P" parameter set command. This parameter write command must be identical to the previous parameter set command. Providing they are identical (excepting the command mnemonic), then the operand is written to the selected modem operating parameter. Changing some parameters while normal operation continues could produce improper operation, possibly resulting in corrupted parameters, so the unit should be halted with a HALT command before such parameters are changed.

Syntax:-
Command:- $\quad 12,34,56,00,00,00, " W ", n n, a a, b b, c c, \ldots$
Response:- $\quad 00,00,00,12,34,56, " w ", n n, a a, b b, c c, \ldots$
Where:-
nn = parameter identifier
$a \mathrm{a}, \mathrm{bb}, \mathrm{cc}_{,} .$. are data value(s) for selected parameter

### 3.3.6 PARAMETER SET

The following is a list of parameters which may be remotely set. Parameters marked with a "*", should only be changed while the unit is in a halted state, followed by a warm boot command. Parameters marked with a "\#", may only be referenced in an "R" readback command. Attempts to change these with "P" and "W" commands may produce unpredictable results.

| Parameter Identifier | Parameter Type(Size) | Parameter Name |
| :---: | :---: | :---: |
| 00 (^@) | undefined | not defined, reserved to facilitate future expansion |
| 01 (^A) | undefined | not defined, Trio DataCom test use only |
| 02 (^B) | byte | Drift_Offset |
| 03 (^) | word | PTT_Time |
| 04 (^D) | string | Synthesiser Data for channel change |
| 05 (^E) | byte | min_RSSI |
| 06 (^F) | byte | Tx_LID |
| 07 (^G) | byte | Slot_Num |
| $08(\wedge)$ | byte | Slot_Time |
| 09 (^) | word | SIDA1 and SIDA2 |
| OA (^J) | word | SIDB1 and SIDB2 |
| OB (^K) | word | SIDD1 and SIDD2 |
| OC (^L) | byte | KISS_adrA |
| OD (^M) | byte | KISS_adrB |
| OE (^N) | byte | EOMA_code |
| OF (^O) | byte | EOMB_code |
| 10 (^P) | byte | input_timeA |
| 11 (^Q) | byte | input_timeB |
| 12 (^R) | byte | frame_sizeA |
| 13 (^S) | byte | frame_sizeB |
| 14 (^) | bit * | SLIP/KISS_mode portA |
| 15 (^U) | bit * | SLIP/KISS_mode portB |
| 16 (^V) | bit | EOM_enable portA |
| 17 (^W) | bit | EOM_enable portB |
| 18 (^X) | bit * | KISS_mode portA |
| 19 (^Y) | bit * | KISS_mode portB |
| $\left.1 \mathrm{~A}{ }^{\wedge} \mathrm{Z}\right)$ | bit | RTS/CTS_interlock portA |
| 1B (^) | bit * | PORTB_enable |
| 1C (^) | bit * | Repeat_Enable portA |
| 1D (^]) | bit * | Repeat_Enable portB |


| 1E (^^) | bit * | (Not defined, reserved for Error Recovery Enable) |
| :---: | :---: | :---: |
| 1F (^_) | bit * | (Not defined, reserved for Error Recovery Enable) |
| 20 () | bit | LiveFrame portA |
| 21 (!) | bit | LiveFrame portB |
| 22 (") | bit | XonXoffMode portA |
| 23 (\#) | bit | XonXoffMode portB |
| 24 (\$) | byte | PORTA_Config |
| 25 (\%) | byte | PORTB_Config |
| 26 (\&) | bit | diags_repeat |
| 27 (') | bit | TxPWR_HI/LOW |
| 28 () | bit | SID_Enable |
| 29 ()) | bit | RTS2PTT |
| $2 \mathrm{~A}{ }^{*}$ ) | bit | SYNC2PTT |
| 2B (+) | bit | SCDO_Default |
| 2 C (,) | bit | SupChnFunc |
| 2D (-) | bit | TxCtri1 |
| 2E (.) | bit | TxCtrio |
| 2 F (/) | byte | Config1 |
| 30 (0) | byte \# | SMR1 (portA serial port mode) |
| 31 (1) | byte \# | SMR0 (portB serial port mode) |
| 32 (2) | byte \# | BRR1 (portA serial port baud rate) |
| 33 (3) | byte \# | BRR0 (portB serial port baud rate) |
|  |  | Additions for version A2.3.0 |
| 34 (4) | byte | err_limit (Frame Error output for Base Station) |
| 35 (5) | byte | err_flags |
| 36 (6) | word | good_cnt |
| 37 (7) | word | bad_cnt |
| 38 (8) | word | lost_sync_cnt |
| 39 (9) | word | lost_RSSI_cnt |
|  |  | Additions for version A2.3.1 |
| 3A (:) | byte | DCD_timeA |
| 3B (;) | byte | DCD_timeB |
| $3 \mathrm{C}(<)$ | byte | Diags_Delay |

### 3.3.7 ADVANCED STREAM ROUTING FUNCTIONS

The TC-900DR provides advanced stream routing functions. For each port, there is allocated two SID (Stream IDentifier) codes, and a configuration flag that determines how these two codes are used.

With the flag off, SIDx1 (where x is A or B for portA and portB respectively) defines the SID code of received frames that are de-multiplexed to the port, and SIDx2 defines the SID code that is inserted by the modem at the front of every frame it transmits. Thus only one data stream passes through the port, and the modem manages the insertion and extraction of SID header codes.

With the configuration flag on, SIDx1 and SID×2 define a range of streams that will be passed from the received data to the port. SIDx1 defines the lowest stream, while SIDx2 defines the highest stream. The SID header codes remain on the received frames, and are passed to the port. For transmit data, the modem assumes that the SID header codes are already in place, being inserted by some external device, and no processing is performed on the transmit data. For this application, it is highly desirable that a SLIP (or KISS) driver be employed so that frame boundaries are defined.

These functions are independent for each port, so it is possible to construct (say), a multi-drop, multi-hop repeated data system, where one stream can be "peeled off" at each repeater site. There are many other possibilities, the TC-900DR product simply requiring suitable configuration to construct a vast range of network topologies.

### 3.4 FACILITIES AND CONFIGURATION INFORMATION VERSION 2

### 3.4.1 GENERAL

The TC-900DR, provides two independent user data streams, which are multiplexed onto the radio channel data stream. The stream switching protocol also provides for an embedded remote diagnostics facility.

The two (asynchronous) user ports can be configured for a variety of baud rates, character sizes, parity, and stop bits.

Flow control on user Port_A may be set to use RTS/CTS/DTR/DCD handshake lines, or XON/XOFF characters. Flow control for Port_B may be set to use XON/XOFF characters, or no flow control. Port_B is not supported by RTS/CTS/DTR handshake lines.

Data is transported in (HDLC) frames, protected by a 16 bit CRC error checking sequence, conforming to the CCITT standard. Received frames found to contain errors are discarded. The TC-900DR does not release received data frames to the user port, until completely received, and error checked.

Maximum frame size is configurable for each port independently, and may be set to any value between 4 and 255 . Frame size limiting is disabled by setting this parameter to zero (0).

Each user port, is supported with PAD functions conforming to X 3 , or SLIP*1 or KISS* protocol interface.

For Point To Multipoint applications, a unique collision avoidance mechanism is available, with configurable channel access parameters.

All configuration parameters are held in a non-volatile memory. Normally, this memory can only be written when the radio modem is connected to a programmer.

### 3.4.2 BRIEF OVERVIEW OF MODEM INTERNAL OPERATION.

### 3.4.2.1 DATA TRANSMITTER

Each physical user port, is supported by a "driver", in this case a PAD (Packet Assembler/Dis-assembler) or SLIP/KISS. This function transfers the data from the port, to a buffer memory. This buffer not only stores the raw user data, but also keeps track of frame boundaries. Another functional block, retrieves that stored data, and feeds it to a third mechanism, which generates the data waveform which is applied to the radio transmitter modulator.
$1 \quad$ *SLIP $\circledR^{\text {TM }}$ KISS $®^{\text {TM }}$

### 3.4.2.2 DATA RECEIVER.

The receiver extracts data frames from the received signal, and stores the contents of the frames into buffer memory. It may also perform a steering function, if more than one port is enabled. A second function is to retrieve the stored data, and send it to the user port(s), consistent with some flow control regime.

### 3.4.3 SELECTING FRAME SIZE

The selection of maximum frame size is a compromise between channel through-put and data propagation time over the link.

The receiving modem collects and stores the incoming data frame, and on detecting the end of the frame, checks if an error has occurred. If not, then the stored data is released for transfer to the user data port. If an error has occurred, then the stored data is "flushed" from the data store. Thus a delay is introduced between the time the frame data begins to enter the destination radio modem, and the time this data begins to emanate from the user port. This delay is effectively the length of the data frame, which consists of the user's data, plus the framing overhead. This overhead will include at least 24 bits for the HDLC Flag and FCS (error checking data), plus another 8 bits if SID (Stream IDentifier) codes are enabled (refer to detailed description elsewhere in this document), plus the duration of the transmitter Lead-In-Delay, if the radio transmitter had to be started up to send the data. Thus larger frames reduce the proportional overhead, but increase the end to end propagation delay.

On the assumption that the radio transmitter was already on, and that the frames include the SID header, then every frame includes 32 bits of overhead.

Assuming that the user port is configured for 8 bit character size ( 8 bit data no parity, or 7 bit data and parity), and 1 stop bit, then each character is carried as a 10 bit sequence on the asynchronous user channel. On the radio channel data stream, user data is stripped of the start and stop bits used on the asynchronous user port, and transmitted as eight bit "octets", and so the character rate is $1 / 8$ th of the bit rate, while on the asynchronous user port, the character rate is $1 / 10$ th of the bit rate. For every 16 user characters 32 bits are stripped off, so if the maximum frame size parameter is set to 16 , and the nominal baud rates are the same, then the effective character rates on the asynchronous user channel and the synchronous radio data channel will be the same. This also assumes that the supervisory signalling channel is not enabled, and does not allow for the overhead introduced by the HDLC "dummy zero" stuffing mechanism.

### 3.4.4 CONFIGURING PAD PARAMETERS

The Packet Assembler/Dis-assembler (PAD) can be configured with a variety of parameters. Each user port is supported by an identical but independent PAD.

The configuration parameters of the PAD, control how the user data (to be transmitted) is framed. There are three distinct mechanisms that can cause the frame that will carry the user data to be closed.

The first of these is the Maximum Frame Size parameter, already discussed above. As each character is input to the modem, a counter is incremented, and when this counter reaches the set maximum frame size, the data storage mechanism that operates within the modem, will close the frame. This function may be disabled, by setting the parameter to zero.

The second mechanism, is the use of a specified End Of Message (EOM) character. This function is enabled/disabled by a flag in a configuration byte for the port driver. The EOM character may be any 8 bit character. When the EOM function is enabled, all incoming user data is compared to the selected EOM character code, and in the event of a match, the current frame is closed. Note that this match only triggers the frame closure mechanism. The matching character is not deleted from the user data stream, and in fact becomes the last user character in the frame.

The third mechanism, is the implementation of a timer. If the timer is enabled, each character received from the user port re-starts the timer. If the time duration between successive user characters allows the timer to expire, then the frame closure mechanism is invoked. The timer counts in units of "ticker clocks", which is a time interval generated by the modem internally, and is approximately 2.5 mS . The reload value for the timer can be set from 1 to 255 ticker clocks. The timer mechanism is disabled by setting the PAD timer parameter to zero.

There is a single bit configuration flag, that allows the radio modem to begin transmitting user data, even before the frame is deemed to be complete. In this case, as soon as there is any data in the storage buffer, the modem begins the transmission procedure. Providing that the input character rate is greater than or equal to the character rate on the synchronous radio channel, then there is no danger of an under-run condition, where the modem transmitter runs out of data before the PAD deems a frame end. However, should this occur, the modem data transmitter function simply closes the frame itself. Further data is carried in the next frame. This may or may not cause problems elsewhere in a system context. If higher protocol layers are employed (e.g. X. 25, AX. 25 etc.), where address and control fields normally occupy fixed positions in data frames, then the above scenario should not be allowed to occur.

The major advantage of allowing the radio modem to begin the transmission procedure before the frame is deemed to be complete, is that it avoids a (store and forward) delay in the modem transmitter, similar to that required in the receiver. For applications where a transparent point to point link is all that is required, this mode provides the most time efficient transport mechanism.

In fact with the immediate transmission function enabled, there is little necessity to enable the EOM or timer functions of the PAD.

### 3.4.5 SUPERVISORY SIGNALLING CHANNEL: APPLICATIONS \& CONFIGURATION.

The reader is referred to drawing number TC01-05-18, which provides a diagramatic view of this section.

The Supervisory Signalling Channel (SSC) is implemented by the insertion of extra data bits in the primary bit-stream on the synchronous radio channel. These extra bits are inserted between primary data octets, at a rate which can be set to range from once every octet, to once every 15 octets. The SSC operates independently for transmit and receive directions, and can be disabled by setting the rate variable to zero.

The SSC, when enabled, can be configured either to provide end-to-end flow control for Port_A data, or implement the collision avoidance mechanism.

### 3.4.5.1 PORT_A END TO END FLOW CONTROL APPLICATION.

In this configuration, the SSC is used to carry flow control information for data on Port_A at each end of the link.

SSC data inserted into the transmitted bit-stream, relates to the flow of the primary data stream received. When handshake lines are employed, the DTR line locally controls the flow of receive data to the user port. The state of this line is also logically combined with the "fill" state of the receive buffer, and the result is then sent as SSC data in the transmit data stream. Thus the state of the transmitted SSC data bit is one ("1") if the DTR line is in a "false" state, OR the receive buffer is more than half (approximately) full. In the case where XON/XOFF flow control is used, the DTR line input is instead replaced with the state of the last received XON or XOFF control character.

SSC data extracted from the received bit-stream, is logically combined with the "fill" state of the transmit buffer, and the result is output to the CTS line of the modem. The CTS output line is set to "false" if the transmit buffer is more than half (approximately) full, OR the received SSC data bit is a one ("1"). Thus the CTS line is set to "false" if the local transmit buffer is more than half (approximately) full, OR the remote receive buffer is more than half full, OR the remote DTR input line is "false" (or equivalent XOFF received).

Data flow control is exercised only at the user port. No flow control is used on the radio channel, so once data is entered into the transmit buffer, it will be transmitted. This is the reason why the buffers are only allowed to become half full before the flow control mechanism engages. If the flow of receive data is stopped by deactivating the DTR line, the remaining data in the transmit buffer will not overflow the receive buffer. It should be noted that some hysteresis is used in the buffer occupancy tests, to prevent the CTS line from changing state too often, as some hosts (e.g. DOS machines) appear to get confused when this happens.

If the SSC is not configured for end to end flow control, or is disabled, then the flow control mechanisms still operate at a local level. That is, the CTS line (or equivalent XON/XOFF control regime) reflects the fill state of the local transmit buffer.

### 3.4.5.2 COLLISION AVOIDANCE APPLICATION.

When the SSC is allocated to transporting collision avoidance data, the transmitted SSC data reflects the state of the radio receiver. Other processes in the modem, measure the RSSI signal from the radio receiver, and compare this measurement to a preset threshold level. This threshold value is also held in the non-volatile configuration memory. The result of the comparison is copied to the modem pin that drives the RXSIG LED. The transition of the RXSIG signal from off to on, (re)starts an internal timer. This time is a fixed value of $35 \pm 5 \mathrm{mS}$. The SSC data transmitted, is simply a copy of the RXSIG pin state, until the timer terminates, and there-after, the modem data receiver must be "SYNC'd" to maintain the "1" state of the SSC transmit data. Thus the SSC data transmitted by the modem will indicate that the radio channel receiver is busy, using only RSSI for the first $35 \pm 5 \mathrm{mS}$, but after this time, data receiver SYNC is used to qualify this state. This prevents low level RF interference from effectively blocking the channel.

At the receiving end, the recovered SSC data is used by the radio modem to determine when the receiver of the destination station is free. This data can then be used to control it's channel access strategy. Channel access strategies are dealt with in more detail elsewhere in this document.

In such a data transport system, there is a single unit which performs the function of Master, and two or more stations which operate as Slaves. The SSC need only operate in one direction, that from Master to Slaves. In the reverse direction, the SSC can be disabled. That is the SSC in the Slaves is enabled in the data receiver only, while in the Master, it is enabled only in the data transmitter.

### 3.4.5.3 RECEIVED SSC DATA DEFAULT STATE

The received SSC data bit is stored in an internal latch. This latch is updated each time a SSC data bit is extracted from the incoming bit-stream. However, if the radio receiver looses signal, then a default state is forced into the latch. This default state is configurable.

For applications which use the SSC for collision avoidance, this configuration bit would normally be set to " 1 ", so that the remote station would not attempt channel access while the signal from the base is lost.

For applications which use the SSC for end to end flow control, setting the default state of the SSC receive data latch to " 0 ", would cause the CTS output line to indicate local flow control status only, until the destination unit enables it's transmitter, where-upon the received SSC data would reflect the state of the destination receive buffer and DTR input line. Alternatively, setting the default state to "1", would ensure that the CTS output line would be in a "FALSE" state, until the destination unit enables it's transmitter, where-upon the received SSC data would reflect the state of the destination receive buffer and DTR input line.

An associated configuration bit, is one that allows the automatic activation of the radio transmitter, whenever the data receiver attains SYNC. When this configuration bit is set to "1", the modem will automatically activate the radio transmitter's PTT control line when the data receiver is SYNC'd. This could be used at the base end of a small point to multipoint network, using the SSC for flow control, and would not require the host connected to base, to specifically activate the radio transmitter to establish the end to end link.

### 3.4.6 SLIP/KISS PROTOCOL DRIVERS

In addition to a generic PAD, two other host interface protocols are supported, "Serial Line Interface Protocol", SLIP, which hails from the world of UNIX(tm), and an extension of SLIP, KISS "Keep It Simple Stupid", (a rather unfortunate phrase in the present context, but a protocol standard proposed by Phil Kahn, USA, specifically for the control of radio connected data terminals) which includes a facility to send commands which are addressed to the DCE device itself. These commands set operating parameters of the radio-modem DCE, such as transmitter lead-in delay, or radio channel (RF frequency).

Neither of these protocol standards, specify anything about the construction of data packets on the radio channel. Allocation of address, control, and information fields is the user's responsibility.

As standard, the modem is equipped with an 8 K ( 8192 bytes, 32 K optional) data storage memory to hold transmit and receive data. This memory is divided equally between transmit and receive buffer space, and equally between the two user ports, so the largest frame size is 4095 bytes, if only PortA is enabled, (or 2047 bytes each if both user ports are enabled), before the frame check sequence (FCS)is appended.

Additionally, the modem can store up to sixty four separate frames for each direction, again split between the two user ports if both are enabled, though the total byte count is still limited to 8192 total.

### 3.4.6.1 SLIP Protocol Description/Definition

The SLIP protocol, is a data transport protocol, originated and used extensively in UNIX(tm) based systems, and thus also closely associated with TCP/IP networked systems. Although not truly a "standard" it is so widely used that it has become the defacto standard for serial interface in UNIX and many other networked systems. SLIP is a method of framing messages containing binary data, on asynchronous channels. The asynchronous serial channel is configured for eight bit character size, no parity, and one stop.

A specific binary code called FEND (Frame End, hexadecimal value $=C 0$ ) is reserved to define a frame boundary. Should this same code occur in the data message to be transferred across the channel controlled under SLIP, then an escape sequence is used so that the message byte will not be confused for a FEND. This escape sequence, involves replacing the message hexadecimal CO code with a two byte sequence FESC, TFEND. FESC (Frame Escape) is the binary code hexadecimal DB, and TFEND (Transposed FEND) is binary code hexadecimal DC. Likewise, if the FESC character ever appears in the user data, it is replaced with the two character sequence FESC, TFESC (Transposed FESC). The TFESC is the binary code hexadecimal DD. The following table clarifies this.

| ABBREVIATION | DESCRIPTION | HEX.VALUE |
| :---: | :--- | :--- |
| FEND | Frame end | C0 (192) |
| FESC | Frame escape | DB (219) |
| TFEND | Transposed frame end | DC (220) |
| TFESC | Transposed frame escape | DD (221) |

As characters arrive at the SLIP receiver, they are appended to a buffer containing the current frame. Receiving a FEND marks the end of the frame, and consequently, succeeding bytes are considered part of the next frame.

Receipt of a FESC code puts the SLIP receiver into "escaped mode", causing it to translate a following TFESC or TFEND back to a FESC or FEND code, appending it to the buffer, and resuming it's normal state. Receipt of any byte other than TFESC or TFEND while in escaped mode, is an error. No translation occurs, and the SLIP receiver leaves escaped mode. A TFESC or TFEND received while not in escaped mode is treated as an ordinary character and stored accordingly. Reception of consecutive FEND characters, causes no action to be taken (i.e. is not interpreted as zero length frames).

An example of a typical SLIP frame is shown below. The message consists of the string DA,C4,C0,C5,DB, 20,BD,DC,DD. The SLIP frame will be:-
<FEND>,DA,C4,<FESC>,<TFEND>,C5,<FESC>,<TFESC>,20,BD,DC,DD,<FEND>

$$
==>\quad \mathrm{C} 0, \mathrm{DA}, \mathrm{C} 4, \mathrm{DB}, \mathrm{DC}, \mathrm{C} 5, \mathrm{DB}, \mathrm{DD}, 20, \mathrm{BD}, \mathrm{DC}, \mathrm{DD}, \mathrm{C} 0
$$

### 3.4.6.2 KISS Protocol Description/Definition

The KISS protocol is an extension of SLIP. It uses the same method of framing packets, using FEND, FESC, TFEND, and TFESC codes. However, the first byte in each frame is reserved as a control code, that defines the function/content of the frame, and also contains an address.

This addressing scheme allows up to sixteen "Terminal node controllers" (TNC's), to share a multidrop buss. The top nibble of the control code carries the TNC address, and the lower nibble carries the command code. Normally the address is set at zero for installations containing only one TNC. Note that some extensions have been proposed for the KISS protocol, that properly support addressed multidrop line operation of multiple TNCs, that the present TC-900DR modem firmware does not implement. The following table shows the commands defined by KISS, and the comment column indicates how the TC-900DR modem interprets them.

| COMMAND | FUNCTION | COMMENTS |
| :---: | :---: | :---: |
| 0 | Data Frame | The rest of the frame is data to be transmitted. |
| 1 | TxDelay | The next byte is the RF transmitter key-up delay in octets. |
| 2 | Slotnum | The next byte is the Slotnum parameter. |
| 3 | Slot-Time | The next byte is the "Slot" interval in "ticker clocks". |
| 4 | TxTail | The next byte is the time to hold up the RF transmitter after the closing FLAG has been sent. This command is obsolete, and not implemented in the TC-900DR. |
| 5 | FullDuplex | The next byte is zero for half duplex, non-zero for full duplex. This command is not implemented in the TC-900DR, as it always operates in full duplex mode. |
| 6 | SetHardware | Specific for each TNC. This parameter has values between 00 and 03, and commands the TC-900DR to set RF channels 0 to 3 . Values above 3 are ignored by the present modem firmware, but may be used in future versions. |
| F | ExitKISS | Exit KISS and return control to higher level TNC control program. This command is not implemented in the TC-900DR. |

### 3.4.7 RF TRANSMITTER CONTROL AND CHANNEL ACCESS STRATEGIES

There are three conditions which cause the modem to activate the radio transmitter. These are: a) receiver SYNC if enabled, as described above; b) RTS if enabled, as described below; and c) the existence of a data frame ready for transmission. The first two mechanisms are absolute, and if enabled, cause an immediate activation of the radio transmitter. There are two configuration bits that control how the availability of a data frame, will activate the radio transmitter, and thus gain access to the channel. For the purposes of this description, these are referred to as Modes $\mathrm{A}, \mathrm{B}$, and C .

In Mode A, channel access is immediate. The radio transmitter is activated, and the modem then proceeds to send a preamble sequence, followed by the data. The preamble sequence is necessary for receiver synchronisation, and the length is a configuration parameter. Further discussion of these aspects of the modem configuration are dealt with elsewhere in this document.

In Mode B, the modem will attempt channel access only if the radio receiver is NOT receiving a signal (i.e. the measured RSSI level is below the minimum RSSI threshold as described elsewhere in this document). This method could be used for small point to multipoint systems, where the base station would enable it's radio transmitter on receiving a transmission. Typically this would be done at the base unit by enabling the SYNC-PTT function, as described above. This implements a basic collision avoidance system, without the use of the Supervisory Signalling Channel, which then remains available for flow control applications.

In Mode C, the modem will attempt channel access only if the data receiver is SYNC'd, and the SSC data is " 0 " (i.e. base receiver free). This is the full Collision Avoidance system as described in detail above.

In the latter two cases, if another data frame is ready for transmission at the time the present one is ending, then it is automatically appended as another frame, and the transmission continues. Obviously since the radio transmitter is already enabled, no preamble is required or sent. The modem itself does not limit the number of consecutive frames it will transmit. If data continues to be input to the modem, once channel access is gained, it continues to be transmitted. It is the responsibility of the user to manage any maximum channel access time in overall system design. However, if the PTT timer is enabled (dealt with in detail elsewhere in this document), and the set time is reached, then the modem will disable the radio transmitter PTT line. User data will now be lost.

For the two latter strategies, if channel access fails (i.e. signal at radio receiver in the former case, or SSC=1 in latter case), then the modem uses a timed delay mechanism before testing for channel availability again.

### 3.4.7.1 SELECTING "SLOTIME" AND "SLOTNUM" VALUES

This delay time is necessary to prevent multiple remotes from attempting to gain access to the channel as soon as it is signalled to be clear after another transmission has finished, as this would result in the transmissions from all these remotes colliding Instead, when a modem fails to gain channel access, it generates a randomly selected delay time, and when this time has expired, it again tests for channel availability

There are two parameters which are used to generate the delay time. The "Slotime" parameter defines the size of the time increment used in selecting the delay. This value defines a time counted in "ticker clocks" (approximately 2.5 mS ), and has an allowable range of 0 to 255 . The "SlotNum" parameter defines the upper limit of the random number generator. The random number generator selects an integer between one and the value of "SlotNum", and then multiplies this by the value of "Slotime" to derive the delay time. The "SlotNum" parameter has a maximum allowable range of 1 to 16 .

These two parameters together provide a very flexible method of tuning the channel access characteristics of a system, and should be regarded as system tuning parameters. In the absence of any knowledge of a system configuration, Trio DataCom's set default values for these to parameters to 4 and 16 for "Slotime" and "SlotNum" respectively.

### 3.4.7.2 PTT CONTROL BY RTS LINE

Applications relying on establishing a point to point link before data is transferred, would normally require some "manual" method of activating the radio transmitter. A configuration bit enables the RTS input line to be used as a PTT control. The modem is always generating a data signal. During the time when no user data is available, the modem continually generates an "idle" bit-stream of HDLC FLAGs. This sequence produces no data output at the receiving radio modem.

### 3.4.8 SELECTING FLOW CONTROL REGIMES

The type of flow control to be used on the radio modem port(s), depends on the user's application and capabilities of the equipment which the user interfaces to the TC-900DR.

Port_A, which is always active, can be configured to use the standard RS232 handshake lines RTS/CTS/DTR, or use XON/XOFF protocol.

### 3.4.8.1 PORT_A, HARDWARE HANDSHAKE FLOW CONTROL

If hardware handshake lines are configured, then RTS must be active to validate characters input to the modem for transmission. As each character is received (i.e. at the end of each character bit sequence) the state of the RTS input line is tested to validate the character. If the RTS line is tested "true", then the character is stored ready for transmission. If "false", then the character is discarded. The modem provides flow control of transmit data with the CTS line. The CTS line is set "false" to indicate that no more transmit data should be input. Normally, most terminals or hosts will still send one or two more characters after the CTS line is set "false", and this is normal and allowed for in the CTS control logic. In fact the modem will continue to accept and store transmit data (providing the RTS line is still active) even though it has set the CTS line to "false", however the user then risks the occurrence of an overflow condition. If the transmit buffer becomes full, then further data is discarded.

A configuration bit, further controls the state of the CTS output line in relation to the RTS input line. If the bit is clear, then the CTS output will always indicate the flow control state, regardless of the state of the RTS input. If the bit is set, the CTS line is conditional on the state of the RTS input. If the RTS input is "false", then the CTS output is also "false". If the RTS input is "true", then the CTS output indicates the flow control state. This latter configuration is typical of a "wired" modem.

The modem's internal data store holds both the raw user data, and records the position of frame boundaries (as defined by PAD operation) in the data. A limited amount of memory is allocated to storing the frame boundary data. When this memory space is full, the modem sets the CTS output to false, even though the character storage space may not be full. The frame boundary storage space is sufficient to hoid data for 64 frames. If the modem has both ports (Port_A and Port_B) enabled, then this space is evenly divided between the two, or if Port_B is disabled, then up to 64 frames can be stored for Port_A. If data continues to be input when the CTS line has been set to "false" because no more frame boundaries can be recorded, then the frame closure mechanism may abort. This has the effect that a frame will not be closed when defined by PAD configuration. An example of this, is where the PAD is configured to close the frame on receiving a <CR> (carriage return) EOM. If the frame boundary space is full, when a <CR> is input, then the subsequent characters will be appended to the same frame. Another attempt to create a new frame will not occur until the same or another frame close condition (as defined by PAD configuration) occurs, in this case another <CR>. This logic avoids the unnecessary loss of data.

Situations where the data storage space or frame boundary storage space become full, would be rare, and would only be likely to occur if the transmitter could not gain access to the channel, or the input data rate exceeds the channel transmission rate for some time.

Normally the TC-900DR is manufactured with an 8 kilobyte memory for data storage. This memory space is divided equally between transmit and receive data storage. If both user ports are enabled, then each half is equally divided between the ports (i.e. 2K/2K/2K/2K for Port_A transmit, Port_A receive, Port_B transmit, Port_B receive). If Port_B is disabled, then $4 K$ is available for each of the transmit and receive data storage functions for Port_A.

The DTR line controls the flow of receive data to the user port. While the DTR input line is "true", available received data is output from the port. If the DTR input is "false", then receive data output ceases.

### 3.4.8.2 PORT_A XON/XOFF FLOW CONTROL PROTOCOL

When XON/XOFF flow control is configured for Port_A, the CTS line is set "true", the RTS input line is not required to validate input data, and receive data is not dependent on the state of the DTR line. Instead of controlling the CTS line, the modem sends XON/XOFF characters (embedded in the receive data stream), to the port. The flow of receive data is controlled by the receipt of XON/XOFF characters in the transmit data stream. These control characters are trapped out of the transmit data stream, and are not transmitted.

The underlying flow control logic is the same as RTS/CTS/DTR control. An XON is sent instead of a "false" to "true" transition of the CTS line, and an XOFF is sent instead of a "true" to "false" transition on the CTS line. A received XON is recorded by an internal flag that emulates a "true" state on the DTR line, and a received XOFF is recorded by the flag to emulate a "false" state on the DTR line.

This method of flow control would be considered to be less reliable, since a lost XON or XOFF control character could cause either an overflow condition, or data flow to stop altogether.

### 3.4.8.3 PORT_B FLOW CONTROL

User Port_B can be configured for no flow control, or XON/XOFF flow control. When XON/XOFF flow control is configured, it operates identically to Port_A, except that this port has no CTS line to set "true". Flow control on Port_B operates at a local level only, since end to end flow control via the SSC is available only for Port_A.

If XON/XOFF flow control is disabled, then no flow control is used on Port_B, as there are no RTS/CTS/DTR lines implemented on Port_B. Users should be careful to avoid overflow conditions, to avoid loss of data.

It will now be obvious that the RTS input line on Port_A can be used by more than one function in the modem. RTS can have no function, or be used in Port_A flow control, and/or provide a manual PTT facility.

### 3.4.9 SETTING MINIMUM RSSI LEVEL

The data receiver of the modem is continually running. It will be in one of two states. It is not SYNC'd, and thus looking for HDLC FLAGs in the radio receiver signal, or it is SYNC'd, and recovering frame data to be checked and stored. If the radio receiver is not receiving a signal, then the recovered signal applied to the data receiver of the modem, will consist only of noise. To prevent the modem from erroneously locking onto noise, a minimum RSSI level must be present to validate the recovered signal applied to the modem data decoder. This threshold level, is stored in the non-volatile configuration memory. It should be set by applying a signal to the radio receiver, which produces a desired SiNaD result, a desired bit error rate, or more crudely, a predetermined absolute signal level into the antenna connector of the TC-900DR. The modem (operating in Test/Program mode) is then commanded to measure the RSSI level, which produces a response of a message indicating the measured level, in hexadecimal. This process should be repeated several times, then an average taken. The analogue to digital conversion performed in this way, is an eight bit conversion. In normal operation, the modem performs a six bit conversion when measuring the RSSI level, so the average of the levels measured in the test mode should now be divided by four. The result should now be stored in the configuration memory, at the address reserved for it.

### 3.4.10 SETTING PTT TIMER

The modem implements a PTT timer. This timer can be disabled entirely by setting the PTT Timer configuration value to zero. The timer value is a 16 bit number, that counts in "ticker clocks". If the timer is enabled, whenever the modem activates the PTT control to the radio transmitter, it initialises the timer with the configured value. The timer is decremented while the PTT control remains active, and if it terminates, the PTT control is deactivated. No other action is taken, and all other functions within the modem are oblivious to this condition, so data frames continue to be output, and thus lost. The PTT timer is to be considered an emergency override mechanism only, in case an error occurs in the operation of the user's host equipment and/or software. To reset this time-out state, conditions must be met that would cause the modem to normally deactivate the PTT control. The PTT timer will then be re-initialised the next time the PTT control is activated. The time-out period may be set in "ticker clock" ( 2.5 mS ) increments to over 160 seconds.

### 3.4.11 DATA STREAM SWITCHING, SELECTING AND ENABLING SID CODES

The TC-900DR radio modem includes a feature that provides data stream switching. This is achieved by placing a Stream Identifier code (SID) at the beginning of every frame. This code functions as a simple addressing function. If both user ports of the TC-900DR are enabled, then SID codes should also be enabled, so that data frames carry a code which identifies the originating port ( $A$ or $B$ ), thus the port to which the frame data should be directed when the frame is received at the destination station.

However this stream switching mechanism is not only confined to this simple application. The SID codes for each user port, are contained in the configuration memory, and are thus "soft". It would be possible to engineer a small (up to 256 stations) network using an individual SID code for each remote station. Since the modem receiver will discard frames which are headed by an SID code which is not recognised, only frames specifically addressed would be stored and passed on to the attached host. The SID code is allocated to the port, so the modem uses the same SID code both for transmission and receipt of frames. Therefore in such a system, the master would be configured with SID codes disabled. The host attached to the master would preface each message with the eight bit address of the destination remote. The message from the remote emanating from the port will have the SID code removed. A message received from a remote, will have the SID code of the sending station at the beginning as the first byte. The remote modem itself places this code at the head of the frame.

Another application of the stream switching feature, is a remote diagnostics facility. This is a facility which is planned for release in the next firmware version. A reserved SID code will be used to address a diagnostics function within the modem. A command/addressing protocol is being developed that employs the units own unique serial number for addressing. "Stay tuned for further updates!".

The SID code is placed in the first octet of each frame. This provides up to 256 unique codes. However, to avoid possible future compatibility problems where higher level protocols are in use on the same channel (e.g. AX.25, etc.), it is suggested that the SID codes used have bit0 set to "1". Such higher level protocols normally use extended addressing where more than one octet is used to carry the destination/source address. A frame using an SID code with bit0 set, will fail an address test and be discarded by such systems. Conversely, if this modem receives a frame containing a higher level protocol, bit 0 of the first octet will normally be set to " 0 ", so will not match any SID code stored in the configuration memory, and be discarded.

By default, Trio DataCom sets the SID codes to 03 and 05 for ports $A$ and $B$ respectively. We have also reserved SID code 00 for the diagnostics facilities.

### 3.4.11.1 Separate Tx And Rx SID Codes. (Firmware Revision V2.1 onwards)

Firmware revision V2.1.0 onwards allows the Transmit and Receive SID codes to be different. Normally the RxSID and TxSID parameters (separate for each port) would be programmed the same. By programming them to be different, means that a TC-900DR unit will receive frames carrying a SID code that matches the configured RxSID code, but transmit frames which carry a SID code that is specified by the TxSID code configuration parameter. Applications for this feature are in small point to multipoint systems, using a central "community" repeater.

### 3.4.11.2 Repeater Operation Mode. (Firmware Revision V2.1 onwards)

The TC-900DR radio modem may also be configured in a repeater mode. The repeater function is enabled as a protocol driver on a port. Thus each user port driver can individually be configured for repeater operation. Essentially, what this does is automatically routes the received data frames back to the transmitter. If SID codes are enabled, then the original SID codes are stored as part of the data frame, and thus the retransmitted frame is identical to that received. Note that only frames received error free will be repeated.

When a port driver is configured for repeater operation, the RxSID and TxSID codes stored in configuration data in the NVRAM are used to define a range of streams to be repeated. The RxSID code configuration parameter defines the lowest SID stream to be repeated, and the TxSID code configuration parameter defines the highest SID stream that will be repeated. Thus it is possible to configure a unit to perform a repeater function for two separate ranges of streams, by configuring both user ports with a repeater driver, or to configure one end of a data link to also be a repeater for a range of other streams.

### 3.4.12 SETTING TRANSMITTER LEAD_IN_DELAY

Whenever the radio transmitter is activated a timer is started. No data frames are transmitted until this timer terminates, so that the destination unit receiver has time to synchronise it's data receiver before frame data is begun. The radio transmitter is very fast, reaching final output power and frequency stability in a matter of a few hundred microseconds (other sections of this document deal with the receiver synchronising aspects). This timer counts in octets, not "ticker clocks" as most other timed functions do, so the actual time elapsed is a function of the radio channel bit rate. However, the synchronisation time is primarily a function of the number of bits to the receiver. Trio DataCom would suggest a value of 25 to 50 (decimal) for this parameter, but it's final value will depend on signal strength and quality at the receiving point, and should best be determined by test.

### 3.5 FACTORS AFFECTING MODEM SYNCHRONISATION TIME

### 3.5.1 (UN)SCRAMBLER AND HDLC STATE MACHINE

It can be shown, that the un-scrambler in the receiving unit will synchronise to the scrambler in the sending unit in 17 bits maximum.

The receiving unit must then detect an HDLC FLAG, which will take another 15 bits maximum. Thus the HDLC state machine and unscrambler should be synchronised in 32 bits maximum.

### 3.5.2 PHASE LOCKED LOOP

Before valid data can be read for the unscrambler, the phase locked loop (PLL) must lock. The time required for this to occur is affected by signal quality and content. The PLL relies on level transitions of the binary signal, on which to lock. It essentially compares the phase of an internal counter, with the phase of the incoming data bits. A detected phase error, will cause the internal counter to speed up or slow down, to reduce the phase error. The greater the error, then the greater the speed adjustment to the internal counter.

If the incoming data stream has few transitions, then the internal counter will "catch up" to it quicker, since it's speed is adjusted less often. The PLL will synchronise to within $90 \%$ of the correct phase (from $0 \%$ ), in 16 to 36 bits time, depending on the number of transitions.

In practice, even though the PLL has not reached $90 \%$ lock, meaningful data will still be obtained as long as a good strength, clean signal is available.

### 3.5.3 ERROR CONTROL

Having recovered the raw data, the modem then applies the bit-stream to a de-ramdomiser, which is based on a recursive tapped shift register, described by the polynomial:

$$
X^{17}+X^{12}+1
$$

The output of the de-randomiser is then fed through another conversion function, to convert the NRZI data to NRZ.

The data is now an HDLC data stream, conforming to ISO3309. It is then applied to a function which detects HDLC FLAGs, and extracts "dummy zeros", which were inserted by the transmitter. Frame boundaries are detected at this point.

The modem calculates and appends a 16 bit Cyclic Redundancy Checksum (CRC) word to the end of each frame. This calculation uses the polynomial:

$$
X^{16}+X^{12}+X^{5}+1
$$

This is sometimes referred to as CRC-CCITT since it is a CCITT standard.

The 1's complement is taken of the calculation result and this FCS is appended to the end of the data frame and sent MSB first. (Refer to ISO 3309 for more information)

At the receiver, this calculation is repeated on the received data, and the result checked. A detected error, will cause the receiver to discard the entire frame. A higher protocol level (determined by the user) will detect the lost packet, and initiate a re-send of the packet.
In terms of the reliability of this FCS, it can be claimed that the following will be detected: 2

All single bit errors.
All double bit errors.
Any odd number of errors.
Any burst error less than 16 bits long.
Most large burst errors.
From here emanates the original frame data, provided the FCS was correct. If not then the frame data is discarded. The data is stored in externally addressed memory, connected to the modem IC. Maximum data packet size is determined by the amount of available memory. Normally the modem is fitted with an 8 K CMOS RAM, of which half (4096 bytes) is allocated to the receiver. The modem can be fitted with an external memory up to 32 K with no other modifications. The receiver section of the modem can store up to 32 separate data packets.

How this data is handled from this point on, depends on the user protocol implemented by the modem on the user interface.

### 3.5.4 TRANSMISSION FORMAT AND TIMING

The data to be transmitted is input to the modem, via the user interface protocol implemented on the user interface. The modem stores the data packet(s) in externally addressed memory, connected to the DFM4-9 modem IC. Maximum data packet size is determined by the amount of available memory. Normally the modem is fitted with an 8 K CMOS RAM, of which half ( 4096 bytes) is allocated to the transmitter. The modem can be fitted with an external memory up to 32 K with no other modifications. The transmitter section of the modem can store up to 32 separate data packets.

Most of the transmitter functions are performed internally in the modem IC, with only a DAC (Digital to Analogue Converter) and final low pass filter implemented by external circuitry.

The data is placed into an HDLC frame (consistent with ISO3309), complete with dummy zeroes where required. During transmission, a CRC calculation (CRC-CCITT) is performed, and when the end of the data packet is reached, this FCS (Frame Check Sequence) is appended to the end of the frame, before the closing HDLC FLAG.

Where two or more consecutive frames are sent, only one FLAG octet is used to delimit the frames. All frames are composed of an integral number of octets.

[^13]Data from the HDLC formatting stage is fed through a function, to convert the NRZ data to NRZI format.

The NRZI encoded data stream is now fed to a data randomiser, to ensure that there is no DC component to the data stream. This is based on a recursive seventeen bit shift register with two taps.

### 3.5.5 COLLISION AVOIDANCE SCHEME

The unique supervisory signalling channel facility available in this product is ideally suited to the implementation of a highly effective collision avoidance mechanism. This is a highly desirable feature in a multipoint data network, in that it allows vastly increased usage of the available channel capacity.

For instance, take a point-to-multipoint network, with a central base station, and a large number of remote data terminals scattered around the central station.

This is a split frequency duplex channel, where the central station is able to transmit on frequency F1, and simultaneously receive on frequency F2. Remote stations transmit on frequency F2, and receive on frequency F1.

If a transmission by one remote station is "crashed" by a transmission by another remote station, then the base station may not get the message correctly, and thus not acknowledge it. If there is no control over when the remote stations transmit, then because the remote stations cannot "hear" each other, their transmissions will begin to collide more often as the data traffic increases. This type of system will suffer a total blockage as the total traffic requirement approaches about $50 \%$ of the channel capacity.

Now, if the base station could quickly inform all other remote terminals, when the base receiver is busy because one of the remote terminals is transmitting, then this message can be delivered to the base receiver without being "jumped on" by another terminal blindly "crashing in". The next terminal can then deliver it's message when the receiver is signaled to be free. Of course collisions are still possible, but the occurrence of these can be dramatically reduced by this type of scheme.

Now to implementation specifics. The supervisory signalling channel in the modem, can be set independently for transmit and receive directions. For the purposes of this collision avoidance scheme, the supervisory signalling channel is only required in the base transmit direction. In the reverse direction, the supervisory signalling channel is disabled. The base transmitter is active full time, sending only FLAGs when it has no real data to send. The base controller, then indicates to the whole population of remote terminals, the current status of the base receiver, in the value of the supervisory signalling channel data bits.

The remote data terminals are programmed so that they will not begin a transmission if the received supervisory signalling channel data indicates that the base receiver is currently busy. This would result in remote terminals queuing for access to the base receiver. To prevent all these remote terminals all beginning a transmission as soon as the base indicates a free receiver, a "windowed" timing mechanism would be implemented, with a random factor added in the terminal's selection of a "window".

There are many factors that would determine the quantification of system variables, but this short description serves to illustrate a basic approach.

### 3.6 TEMPERATURE COMPENSATION

Periodically, the modem controller reads the voltage on the temperature transducer mounted on the radio section. This value is then used in a table look-up procedure, to derive correction data to be applied to the modulator circuitry via a transmit waveform offset voltage. This is provided by the output of the six bit DAC (UX8/RN2), which is fed to the correction voltage input of the 12 MHz reference oscillator.

The offset table is constructed in the temperature calibration cycle performed during the factory testing procedure. The radio-modem is temperature cycled twice from -10C to +65 C . During this time, the necessary data is determined to correct the temperature induced frequency errors. At the end of the cycle, the final database is constructed and written to the non-volatile memory.

### 3.7 USER INDICATIONS

The TC-900DR provides three LED's that show status information to the user - RXSIG, SYNC, and TXMIT indications.

In all operation modes of the modem except "Programmer mode" (see the section below on special modes of operation), the RXSIG LED indicates the level of the RSSI signal from the radio IF strip, compared to a threshold set in the configuration data read from the non-volatile memory. If the signal is above the threshold, then the LED indicator is turned on. There is no hysteresis applied in this process.

In normal operation, the SYNC LED indicates when the modem has detected a valid data stream. The SYNC LED is activated, when the modem detects a valid HDLC flag sequence, and remains active until an invalid sequence of seven or more consecutive "1" bits is detected. The SYNC LED will not be turned on if the RSSI signal strength (as indicated by the RXSIG LED) is below the minimum threshold. This prevents false SYNC detection from noise. While the modem is SYNC'd, it does not continue to measure RSSI levels.

The TXMIT LED indicator is connected directly to the modem's PTT output transistor. It is active whenever the PTT line to the radio section is active low.

### 3.8 SPECIAL MODES OF OPERATION

### 3.8.1 GENERAL

Part of the power-up/reset initialisation phase of the TC-900DR modem, is a set of tests to determine whether the modem should enter a special operation mode.

There are three of these "special" modes. Whilst in these modes the TC-900DR will not operate in its standard run mode.

- Programmer mode.
- Bit error rate test mode.
- Handset mode.

These modes are only entered if the required setup conditions are present at power up of the TC-900DR. An error mode of operation can also be entered into, if during normal operation of the TC-900DR modem, an error condition occurs.

### 3.8.2 PROGRAMMER MODE

Pin 6 on the DB9 connector of Port A, is normally the DSR line. This pin is pulled high by a resistor to +13.8 v , so that to a connected DTE the DSR signal implies that this DCE is ready.

However, if this pin is connected to pin 5 when the modem is powered up, the controller senses this, and attempts to enter "Programmer mode". The modem sends out of the serial port, an ASCII "?" (question mark) character, and waits for the programmer to reply with a password. The SYNC LED toggles on and off with every output of the "?" prompt until the correct password is entered. This mode is sustained for approximately 30 seconds. Failure to supply the correct password in time, will cause the modem to abandon the "Programmer mode" attempt, and go on with it's normal power-up procedure. This password protection scheme provides some defense against unauthorised tampering with the TC-900DR modems configuration data.


### 3.8.3 BIT ERROR RATE TEST MODE

Pin 9 of the DB9 connector of Port A, is normally the Ring Indicate output line. The modem includes a resistive pulldown to ground to show a negative condition on this line. However, if this pin is driven positive (typically by connecting it to pin 6), then the modem's data transmitter and receiver will enter the BER test mode.

It will activate the RF transmitter and generate a scrambled bit pattern which should be decoded at a receiver as a constant logic "1" level in the unscrambled data.

A test point on the modem section PCB, is available to monitor this point with a frequency counter. (In fact this test point is always active, and may be used to monitor the received data decoded by the DFM4-9 modem IC at any time). Any errors in the decoded bitstream, will be " 0 ", and the receiver portion of the modem in this mode, will activate the SYNC LED every time it sees a "0" bit.

An internal timer is used to generate a time equivalent to 1000 bits. Every error bit detected, will activate the SYNC LED, and restart the timer. If and when the timer expires, the SYNC LED is deactivated. Thus, for error rates of 1 in 103 and above, the SYNC LED will be ON most of the time. A 1 in 104 error rate will show the SYNC LED active for approximately $10 \%$ of the time. This function provides a crude indication of Bit Error Rate for installation purposes.

Other functions performed in this state include RXSIG indication, and temperature compensation. The state of pin 9 is constantly monitored in this mode. If the pin ceases to be driven positive, then the BER Test mode is terminated, and the modem restarts it's initialisation phase.

### 3.8.4 HANDSET MODE

The DFM4-9 modem tests for the presence of a handset plugged into the handset audio port at power up.

This is done by measuring the voltage on channel 4 of the analogue to digital converter (UX10-p6). This signal is passed into the modem section from the radio section via connector X4-p24, "ADC3".

If a handset is plugged in, then the measured voltage will be about 2 V , but if it isn't installed, then the voltage will be about 4 V . The measured voltage is compared to 3 V to determine whether the handset is plugged in. If this test succeeds, then the modem will not generate a data stream. However, it will continue to indicate received RF signal strength, and perform temperature compensation. The handset has a PTT button, and this signal is connected across the modem's PTT output. Thus the handset PTT switch will activate the TXMIT LED.

### 3.8.5 ERROR INDICATION MODES

### 3.8.5.1 GENERAL

There are three error conditions that will cause the RXSIG and SYNC LEDs to be used for error indications and not their normal purpose. Two of these are fatal conditions, that cause the modem to restart after the duration of the error indication phase.

### 3.8.5.2 TRANSMIT POWER LOW

While the modem activates the radio transmitter, it periodically checks the transmit power. If the power measurement is less than a threshold set in the non-volatile memory, then the RXSIG and SYNC LEDs are made to alternate, approximately four times per second. The TXMIT LED will also be on during this process. This indication condition will persist for the duration of the transmission. As soon as the transmission is discontinued, the error indication will cease, and the two LEDs revert to their normal function.

### 3.8.5.3 NVRAM READ ERROR

The DFM4-9DR modem accesses the non-volatile memory as part of it's initialisation phase, to get configuration data. If the communication protocol with the device is violated, or the non-volatile memory CRC checksum is found to be incorrect, then the modem indicates this by flashing the RXSIG and SYNC LEDs twice alternately. That is, one LED operates ON and OFF twice, then the other. A total of five cycles of this occurs, then the modem restarts it's initialisation from scratch.

### 3.8.5.4 SYNTHESISER LOCK DETECT ERROR

If at any time during normal operation, BER mode, or handset mode, the TBB206 frequency synthesiser indicates an out of lock condition, the modem enters an error indication mode for a short time before restarting. One LED is turned ON ( $O$ ), the LEDs are swapped, then both turned $\operatorname{OFF}(\bullet)$. Then the latter LED ON again, swap LEDS, and then OFF. This will give the appearance of a sweeping motion between the LEDs.

The following table shows all error condition displays for comparison.

| Tx PWR Error |  | NVRAM Error |  | TBB206 Error Synthesiser |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| RXSIG | SYNC | RXSIG | SYNC | RXSIG | SYNC |
| 0 | - | 0 | - | 0 | - |
| - | 0 | - | - | - | 0 |
| 0 | - | 0 | - | - | - |
| - | 0 | - | - | - | 0 |
| 0 | - | - | 0 | 0 | - |
| - | 0 | - | - | - | $\bullet$ |
| 0 | - | $\bullet$ | 0 |  | repeat |
| $\bullet$ | 0 | $\bullet$ | - |  |  |
| continue |  |  | repeat |  |  |

### 3.9 SYNCHRONOUS OPERATION MODE FIRMWARE REVISION: V2.1

### 3.9.1 GENERAL

The TC-900DR when operating in Synchronous mode, implements a V. 24 like interface. The unit uses a special wiring harness that converts the two 9 pin "D" connectors on the end panel of the TC-900DR to a standard 25 pin "D" connector for user interface.

Synchronous Mode implements a bit level interface. Data is carried on a bit by bit basis. No framing or error detection is performed. Modem operation is full duplex.

Current implementations of SYNC mode, do not provide a DCD signal in the 25 pin RS232 interface.

### 3.9.2 DATA RECEIVER

While sufficient RF signal is present into the radio receiver, the data decoder is continually extracting data bits from the received signal, and outputting these to the user interface connector. If the received RF signal into the radio receiver falls below the minimum threshold, then the data decoder stops.

### 3.9.3 SETTING MINIMUM RSSI LEVEL

The data decoder of the modem is continually running while sufficient RF signal is present into the radio receiver. If the radio receiver is not receiving a signal, then the recovered signal applied to the data decoder of the modem, will consist only of noise. To prevent the modem from erroneously locking onto noise and producing "garbage" at the RxD pin, a minimum RSSI level must be present to validate the recovered signal applied to the modem data decoder. This threshold level, is stored in the non-volatile configuration memory. It should be set by applying a signal to the radio receiver, which produces a desired bit error rate, a desired SiNaD result, or more crudely, a predetermined absolute signal level ${ }^{\circ}$ into the antenna connector of the TC-900DR. The modem (operating in Test/Program mode) is then commanded to measure the RSSI level, which produces a response of a message indicating the measured level, in hexadecimal. This process should be repeated several times, then an average taken. The analogue to digital conversion performed in this way, is an eight bit conversion. In normal operation, the modem performs a six bit conversion when measuring the RSSI level, so the average of the levels measured in the test mode should now be divided by four. The result should now be stored in the configuration memory, at the address reserved for it. The DR9_PRGM programmer available from Trio DataCom Pty Ltd facilitates this process.
*Use a signal generator modulated with a sine wave frequency of half the nominal bit rate of the unit (e.g. for a 4800BPS unit, use 2400 Hz modulation).

### 3.9.4 DATA RECEIVER CLOCK OUTPUT

The receive section of the modem, includes a clock line driven by the modem. This signal is used to synchronise the transfer of receive data to the user system. The RCO (Rx_Clock_Output, pin17 in the DB25 connector) line changes from ON (TRUE) to OFF (FALSE) as the RxD (Receive_Data, pin3 in the DB25 connector) line outputs the next bit, and from OFF (FALSE) to ON (TRUE) in the nominal centre of the bit cell. This conforms to the V. 24 specification.

### 3.9.5 OTHER RS232 RECEIVER CONTROL LINES

The DSR (Data_Set_Ready) line is driven true by the modem. This line is in fact merely tied to the internal +13.8 volt rail via a 4 K 7 resistor. The DTR (Data_Terminal_Ready) input is unused in Synchronous mode.

### 3.9.6 DATA TRANSMITTER

The transmit data input is continually sampled and coded for transmission. This process consists of sampling the data input, randomising the bit pattern so that the DC component of the transmitted stream is zero, and generating a waveform suitable for application to the modulator of the FM radio transmitter.

### 3.9.7. DATA TRANSMITTER CLOCKS

The modem transmit data interface, includes two clock lines. One clock line, TCO (Transmit_Clock_Out, pin15 in DB25 connector) is driven by the modem, the other, TCI (Transmit_Clock_In, pin24 in the DB25 connector) can be enabled to allow the external user to supply a transmit data clock. This is implemented by synchronising the internal clock generator to the user's clock (within a small frequency range). This function is essentially a Phase Locked Loop, and effectively adjusts the phase of the internal clock to match that of the input clock. If the user clock source stops, then the modem will continue to generate the internal clock at it's nominal rate. In accordance with specification V.24, the state of the transmit data line (TxD, pin2 in the DB25 connector) is sampled on the ON to OFF transition of the clock, the bit cell boundary occurs with the OFF to ON transition of the clock.

### 3.9.8 TRANSMITTER RTS/CTS LINES

Two other control lines are included in the transmitter interface. The RTS (Ready_To_Send) input line, is used to control the radio RF transmitter. The CTS (Clear_To_Send) output line is driven by the modem, to indicate that the modem transmitter is ready to accept transmit data. The RTS to CTS time is determined by an internal timer. A configuration parameter is used to load the internal timer when the RTS line is activated, which must expire before the modem activates the CTS line. This time is necessary to allow the remote receiver to settle and synchronise to the data stream, before the user at the transmitting end begins sending data. However it should be noted, that the CTS signal does not perform any flow control function within the modem.

### 3.9.9 PHASE SYNCHRONISM WITH GLOBAL CLOCKS

When data is transferred over more than short distances, and synchronism must be maintained to some external global master clock (e.g. Telecom DDN network), then the propagation delay, and thus phase shift of the data becomes significant. A facility is provided, to introduce a phase delay in the transmitted data stream, of up to $3 / 4$ of a bit, in $1 / 4$ bit steps. This delay is adjusted so that minimum phase offset results at the receiver of the destination station.

### 3.9.10 TRANSMIT TIMER

The modem implements a transmit (PTT) timer. This timer can be disabled entirely by setting the PTT Timer configuration value to zero. The timer value is a 16 bit number, that counts in increments of 2.5 milliseconds. If the timer is enabled, whenever the modem activates the PTT control to the radio transmitter, it initialises the timer with the configured value. The timer is decremented while the RTS line remains active, and if it terminates, the PTT control is deactivated. No other action is taken, and all other functions within the modem are oblivious to this condition, including the CTS line, so data continues to be "carried", and thus lost. The PTT timer is to be considered an emergency override mechanism only, in case an error occurs in the operation of the user's host equipment and/or software. To reset this timeout state, the RTS line must be taken from ON to OFF. The PTT timer will then be re-initialised the next time the RTS line is activated. The timeout period may be set in 2.5 mS increments to over 160 seconds.

### 3.9.11 LED INDICATORS

### 3.9.11.1 Received Signal Strength Indication. RXSIG LED

In all operation modes of the modem except "Programmer Mode" (see section below on special modes of operation), the RXSIG LED indicates the level of the RSSI signal from the radio IF strip, compared to a threshold set in the configuration data read from the non-volatile memory. If the signal is above the threshold, then the LED indicator is turned on. There is no hysteresis applied in this process.

### 3.9.11.2 Data Carrier Detect Indication. SYNC LED

In "Synchronous" operation mode (V2.1.x), prior to modem hardware revision "D", and firmware revision "V2.1.4", the SYNC LED is superfluous and not driven.

## Note that firmware revision V2.1.5 onwards should only be used in SYNC mode.

From modem hardware Revision D onwards, the SYNC LED drive is used to generate a DCD function in the user interface connector, and requires firmware revision V2.1.4 onwards (i.e. firmware revision V2.1.4 onwards drives the SYNC LED ON 20 mS after the "leading edge" of the RxSig LED).

This means that the SYNC LED drive should always show this function and not be allowed to show low Tx Power (see Error indication modes section 3.8.5.2). To facilitate this the Min Tx Pwr parameter in the TC-900DR modem should be set to zero, when the modem is built for synchronous operation.

### 3.9.11.3 Radio Transmitter Active Indication. TXMIT LED

This LED indicator is connected directly to the modem's PTT output drive. It is illuminated whenever the PTT line to the radio board is active.

### 3.9.12 SPECIAL MODES OF OPERATION

### 3.9.12.1 Programmer Mode

Part of the power-up/reset initialisation phase of the modem, are tests to determine whether the modem should enter a special operation mode. The first, is a test for "Programmer Mode". Pin6 on the DB9 connector of Port A, is normally the DSR line. To this end, this pin is pulled high by a resistor to +13.8 v , so that to a connected DTE this signal says that this DCE is ready. However, if this pin is connected to pin5 (Com) when the modem is powered up, the modem senses this, and attempts to enter "Programmer Mode". The modem sends out of PORTA, an ASCII "?" (question mark) character, and waits for the programmer to reply with a password. Failure to supply the correct password in time, will cause the modem to abandon the "Programmer Mode" attempt, and go on with it's normal power-up procedure. This password protection scheme provides some defence against unauthorised tampering with the radio/modem's configuration data.

### 3.9.12.2 Bit Error Rate Test Mode

The next test, is one for "Bit Error Rate Test Mode". Pin9 of the DB9 connector of Port A, is normally the Ring Indicate output line. The modem includes a resistive pulldown to Gnd to show a negative condition on this line. However, if this pin is driven positive (typically by connecting it to pin6), then the modem's data transmitter and receiver will enter the BER test mode. It will activate the RF transmitter and generate a scrambled bit pattern which should be decoded at a receiver as a constant logic "1" level in the unscrambled data. A test point on the modem PCB, is available to monitor this point with
a frequency/event counter. (In fact this test point is always active, and may be used to monitor the received data decoded by the modem IC). Each error bit in the decoded bitstream, will be " 0 ", and the receiver portion of the modem in this mode, will activate the SYNC LED every time it sees a " 0 " bit. An internal timer is used to generate a time equivalent to 1000 bits. Every error bit detected, will activate the SYNC LED, and restart the timer. If and when the timer expires, the SYNC LED is deactivated. Thus, for error rates of 1 in $10^{3}$ and above, the SYNC LED will be ON most of the time. A 1 in $10^{4}$ error rate will show the SYNC LED active for approximately $10 \%$ of the time. This function provides a crude indication of Bit Error Rate for installation purposes. Other functions performed in this state include RXSIG indication, and temperature compensation. The state of pin9 is constantly monitored in this mode. If the pin ceases to be driven positive, then the BER Test mode is terminated, and the modem restarts it's initialisation phase.

### 3.9.12.3 Order_Wire/Handset Mode

Failure of the BERT Mode test, brings the modem to test for the presence of a handset plugged into the handset audio port. This is done by measuring the voltage on channel 4 of the analogue to digital converter. If a handset is plugged in, then the measured voltage will be about 2 volt, but if it isn't installed, then the voltage will be about 4 volt. The measured voltage is compared to 3 volt to determine whether the handset is plugged in. If this test succeeds, then the modem will not generate a data waveform to the radio transmitter. However, it will continue to indicate received RF signal strength, and perform temperature compensation. The handset has a PTT button, and this signal is connected across the modem's PTT output. Thus the handset PTT switch will activate the TXMIT LED.

### 3.9.12.4 Error Indication Modes

There are three error conditions that will cause the RXSIG and SYNC LEDs to be used for error indications and not their normal purpose. Two of these are "fatal" conditions, that cause the modem to restart after the duration of the error indication phase.

### 3.9.12.5 Transmit Power Low

While the modem activates the radio transmitter, it periodically checks the level of the radio transmitter output power. If the power measurement is less than a threshold set in the non-volatile memory, then the RXSIG and SYNC LEDs are made to alternate, approximately four times per second. Of course, the TXMIT LED will also be on in this case. This indication condition will persist for the duration of the transmission. As soon as the transmission is discontinued, the error indication will cease, and the two LEDs revert to their normal function. The user should be aware that from Revision D of the modem PCB, this state will cause incorrect operation of the DCD output line. As stated above, the Min Tx Pwr parameter should be set to zero.

### 3.9.12.6 NVRAM Read Error

The modem accesses the non-volatile memory as part of it's initialisation phase, to get configuration data. If the communication protocol with the memory device is violated, or the non-volatile memory CRC checksum is found to be incorrect, then the modem indicates this by flashing the RXSIG and SYNC LEDs twice alternately. That is, one LED winks on and off twice, then the other. A total of five cycles of this occurs, then the modem restarts it's initialisation from scratch.

### 3.9.12.7 Radio Frequency Synthesiser, Lock Detect Error

If at any time during normal operation, BERT mode, or handset mode, the frequency synthesiser indicates an out of lock condition, the modem enters an error indication mode for a short time before restarting. One LED is turned ON, the LEDs are swapped, then both off. Then the latter LED ON again, swap LEDS, and OFF. This will give the appearance of a sweeping motion between the LEDs. The following table shows all three modes for comparison.

| Tx PWR Error |  | NVRAM Error |  | TBB206 Error Synthesiser |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| RXSIG | SYNC | RXSIG | SYNC | RXSIG | SYNC |
| 0 | - | 0 | - | 0 | - |
| $\bullet$ | 0 | $\bullet$ | $\bullet$ | $\bullet$ | . 0 |
| 0 | $\bullet$ | 0 | $\bullet$ | $\bullet$ | - |
| - | 0 | - | - | - | 0 |
| 0 | - | - | 0 | 0 | - |
| - | 0 | - | - | $\bullet$ | $\bullet$ |
| 0 | - | $\bullet$ | 0 |  | repeat |
| - | 0 | - | - |  |  |
| continue |  |  | repeat |  |  |

### 3.9.13 WIRING ADAPTOR HARNESS FOR TC-900DR SYNCHRONOUS MODEL



## SECTION 4

## ALIGNMENT PROCEDURE

## 4 ALIGNMENT PROCEDURE

### 4.1 GENERAL

This section details operational performance and alignment procedures that may be required for the TC-900DR. During servicing it may also be necessary to measure specific performance parameters as a means of verifying the presence of a fault condition.

### 4.2 TEST EQUIPMENT REQUIRED

The following list of test equipment is required to carry out all of the procedures detailed below.

- Frequency counter accurate to better than 100 Hz at 1 GHz
- FM Signal generator. 455 kHz to $1 \mathrm{GHz} .-120 \mathrm{dBm}$ to +10 dbm . Synthesised in 100 Hz steps.
- Spectrum analyser 10 MHz to 1 GHz . Dispersion down to $2 \mathrm{kHz} / \mathrm{cm} .80+$ dB dynamic range. IF b/w down to 1 kHz .
- RF Power meter to $1 \mathrm{GHz} .-20$ to +30 dbm . Accuracy $\pm 0.25 \mathrm{~dB}$.
- Digital volt meter.
- HP3406 RF Millivoltmeter or similar.
- RF Test leads, MCX male and SMA male.
- Audio noise and distortion test set.
- Audio oscillator.
- Surface mount repair tools.


### 4.3 TEST POINT LOCATIONS

Both the radio section PCB and the modem section PCB contain numerous test points. They are easily located on the PCB's, and are detailed below.

### 4.3.1 MODEM SECTION PCB

| TEST POINT | SIGNAL | DESCRIPTION |
| :---: | :---: | :---: |
| TP1 | TxCLK | Transmit clock |
| TP2 | BER TST | BER test output |
| TP3 | SYNC | Synchronised output |
| TP4 | RxCLKOUT | Integrator reset |
| TP5 | RxCLK | Receive clock |
| TP6 | RxDATA | Receive data |
| TP7 | DATA OUT | Transmit data |
| TP8 | INTEGRATOR | Rx integrator reset |

### 4.3.2 RADIO SECTION PCB

| TEST POINT | SIGNAL DE | DESCRIPTION |
| :---: | :---: | :---: |
| FINAL PA SECTION |  |  |
| TP31 | TXPWR-2 | R-2 Bias to Q8 |
| TP25 | TXPWR-3 | R-3 Bias to Q8 |
| TP27 | TXPWR-4 | R-4 Bias to Q9 |
| TP14 | +8 v Po | Power Supply |
| TP15 | TXEN Tr | Transmit enable |
| TP20 | RxMIXOU | XOUT Rx mixer bias |
| TP28 | TXPA-1 Bias | Bias to Q10 |
| TP29 | TXPA-2 Bias | Bias to Q11 |
| TP26 | +13V8 Po | Power supply |
| TP33 | PWR CONT Po | Power control supply |
| TP30 | PTT+8V Pr | Press to talk |
| 121 MHz SECTION |  |  |
| TP13 | DATA Tx | Tx data input |
| TP17 | 60.5 MHz M | Modulated 60.5 MHz |
| TP16 | 121 MHz Out | Output of doubler |
| TP18 | 121 MHz M | Modulated 121 MHz |
| TP32 | MIC Tx | Tx Mic audio input |
| NE615 IF SECTION |  |  |
| TP6 | $415 \mathrm{kHz} \mathrm{l/P} 45$ | 455 filter input/second mixer output |
| TP9 | QUAD Qu | Quad detector |
| TP8 | DATA Rx | Rx data out |
| TP10 | AUDIO Rx | Rx audio out |
| TP7 | RSSI RS | RSSI output |
| TP4 | MUTE M | Mute control output |
| TP1 | 2nd L.O Se | Second Xtal oscillator |
| TP2 | 2nd L.O Se | Second Xtal oscillator |
| TP3 | IF Input 45 | 45 MHz IF filter input |
| TP5 | IF Output 45 | 45 MHz IF filter output |
| TP19 | VCO VC | VCO oscillator injection |
| SYNTHESISERNCO SECTION |  |  |
| TP12 | LOCK DET Sy | Synthesiser lock detect |
| TP11 | +5V Sy | Synthesiser +5 v supply |
| AUXILIARY HANDSET INTERFACE SECTION |  |  |
| TP21 | MIC Tx | Tx mic audio input |
| TP22 | PTT M | Manual press to talk |
| TP23 | +8V H | Handset +8 V supply |
| TP24 | AUDIO OUT Rx | Rx audio output |

### 4.4 ADJUSTMENT POINTS

All adjustment points are located on the radio section PCB. The following is a list of these adjustable components.

COMPONENT
XTAL2
VR3
L10
L9
L7
L8 $\quad 121 \mathrm{MHz}$ final filter
L6
VR4
C78
VR1
VR2
L3
L1
L4
L5

ADJUSTMENT
VCO reference frequency
Deviation level set
Tripler filter
Doubler filter
121 MHz filter

Tx frequency set ( 121 MHz Osc )
Tx power control adjust
Tx mixer tunable filter
Rx audio mute adjust
Rx data DC BIAS offset adjust
45 MHz filter alignment
44.545 oscillator adjust

45 MHz filter alignment
45 MHz filter alignment

### 4.5 LINK OPTIONS

Several options are set in the TC-900DR modem by the setting of links on the radio section PCB. Listed below is an option table for the various combinations.

| LINK NUMBER |  | SETTING |  | DESCRIPTION |  |
| :--- | :--- | :--- | :--- | :--- | :--- |
| LK2 |  |  |  |  |  |
|  | IN |  | AFC option disabled |  |  |
|  | OUT |  | AFC option enabled | (factory standard) |  |
| LK4 | IN |  | PWR control disable |  |  |
|  | OUT |  | PWR control enabled |  |  |

### 4.6 HOUSING

The TC-900DR has been designed with the serviceability of the unit in mind. Construction of the unit is robust yet easily dismantled. The unit is primarily assembled in an aluminium extrusion with a central chassis that is fixed to the front panel.

### 4.6.1 DISASSEMBLY PROCEDURE

To disassemble the unit, simply remove the two silver screws on the underside of the unit and the six black screws located on the front panel (the front panel of the unit has the two DB9 connectors protruding from it). Ensure you do not loose the attached nylon washers, as these prevent the Lexan front panel label being damaged upon replacing and tightening the six screws. Simply slide the unit out of the extrusion clasping front panel and the complete unit is exposed to you.

Caution: When re-assembling be careful not to foul the ribbon cable against the case when sliding the unit into its case as this may inadvertently damage the cable.

### 4.6.2 MODEM AND POWER SUPPLY PCB

All components and connections to the modem section PCB are accessible without removing the PCB from the chassis. If access to the rear of the PCB is required, firstly remove two nuts that clamp the C TO-220 power supply regulator to the front panel. Once this is removed, simply remove the four screws securing the PCB to the chassis.

The PCB is now free to work on, and can be folded out so as to service the unit in an open accessible condition whilst still connected to the radio section PCB. If required, the modem section PCB can be separated from the radio section PCB by simply unplugging the ribbon cable.

NOTE: Regulators will need to have heat-sinks fitted if unit is to be operated in this condition for excessive time periods.

### 4.6.3 ANTENNA DIPLEXER

The antenna diplexer is mounted on top of the radio section PCB. It is easily removed by firstly disconnecting the two miniature RF connectors (MCX type) from the PCB.

Care should be taken when unplugging these connectors so as not to damage them, it is important to remove and insert connectors in a vertical direction.

Secondly, remove the nut securing the antenna output connector from the central mounting chassis. The last two remaining screws must be removed which secure the diplexer to two metal PCB standoffs on the radio section PCB. The diplexer can now be removed.

Testing of the radio section PCB can be continued without the antenna diplexer, by connecting to the receiver and transmitter ports separately.

Miniature MCX RF Connectors are available from Trio DataCom if required.

### 4.6.4 RADIO SECTION PCB

The radio section consists of a two sided PCB which has surface mount components on one side and conventional components on the other. Several critical test points are accessible on the component side of the PCB which minimises removal of the PCB from the chassis.

To remove the PCB from the chassis, fifteen screws must be removed. Upon removal of these screws, the PCB can be manoeuvred from the chassis and once again can fold out so as to be serviceable as a complete unit.

NOTE: It is essential that all RF Deck mounting bolts are fitted and secure upon reassembly as many of these bolts provide inter-stage isolation and secure grounding ensuring the product meets all specifications.

Once service of the unit is complete, reassembly is simply the reversal of the above procedures.

Care should be taken when sliding the complete chassis assembly back into the extrusion. Ensure that the ribbon cable connecting the modem and radio section PCB's is carefully "tucked" away within its designated slot so as not to damage the cable.

### 4.7 ALIGNMENT DESCRIPTION

CAUTION - As the TC-900DR is capable of full duplex operation, care should be taken to avoid damage to sensitive test equipment such as signal generators or spectrum analysers. It is recommended that a 30 db 2 Watt pad be connected between the unit and any test equipment prior to testing.

This section is for alignment/adjustment of the RF Deck and should be read in conjunction with Section 2 (Hardware Technical Description) and Section 7 (Fault Finding) if faults or difficulties are experienced.

For initial alignment, proceed in the following order :
Reference oscillator \& synthesiser.
121 MHz Tx modulated injection oscillator.
Tx final stage/Power control.
Receiver and audio mute

### 4.7.1 REFERENCE OSCILLATOR AND SYNTHESIZER

1 Check VCXO (XTAL2) for reference frequency o/p at a level of 550 mV rms with an RF Millivoltmeter, and the VCO o/p for an RF level of around 150 mV rms.
2 Check that the TBB202 dual modulus prescaler (U4) is producing an output of approximately 7 MHz and a level of 550 mV rms at the "IF" $\mathrm{i} / \mathrm{p}$ to the TBB206 synthesiser I.C.(U3-p8)
3 Ensure that the synthesiser has been programmed to a frequency within the range of the VCO, and check that the VCO is locked by observing a high ( 5 V ) level on Lock detect output of the synthesiser I.C.(U3-p14). Note that very short duration pulses to ground is normal.

4 Program the synthesiser with the following VCO frequencies according to VCO type and ensure lock occurs at both ends of the frequency range. These frequencies are 2 MHz beyond the published specification.
VCO TYPE: MQC-798
Maximum 786 MHz VCO $=907 \mathrm{MHz}$ Tx or 831 MHz Rx
Minimum 814 MHz VCO $=935 \mathrm{MHz}$ Tx or 859 MHz Rx
VCO TYPE: MQC-978
Maximum 996 MHz VCO $=875 \mathrm{MHz}$ Tx or 951 MHz Rx
Minimum $960 \mathrm{MHz} \mathrm{VCO}=839 \mathrm{MHz}$ Tx or 915 MHz Rx
5 Program the VCO to a given frequency within the range as specified above and measuring the VCO o/p frequency, adjust the 12 MHz (VCXO) reference trimmer to bring the frequency within 250 Hz of the VCO frequency.
Note: Unit is temperature compensated at factory and no field adjustment of Ref. Oscillator is possible. If VCO frequency is not correct ( $\pm 1500 \mathrm{~Hz}$ ), consult factory for service advice.
Note ensure that the VCXO control input is within its active range (1-4 Volts).

6 Check the VCO power o/p by monitoring the Rx mixer bias at TP20, where approximately 200 mVDC should be measured.

7 With a spectrum analyser set to the VCO frequency and a dispersion of about 5 or 10 kHz per cm , check that the reference sidebands are less than -60 dBc in the adjacent channel.

8 Check VTCXO Reference frequency is $\mathrm{F}(\mathrm{tx})+121 \mathrm{MHz}$ for 853 remote units or $\mathrm{F}(\mathrm{tx})-121 \mathrm{MHz}$ for master units. If Reference is out by more than $\pm 1.5 \mathrm{kHz}$, drift offset should be applied via the programmer or unit should be returned for factory service. attempting to alter Reference trimmer will void temperature compensation process and should only be done in an emergency and as a temporary measure.

### 4.7.2 121 MHZ MODULATOR

## Note - make sure the transmitter is loaded with a suitable attenuator on the antenna or Tx o/p socket before energising

1. For Initial alignment set all coil cores to their nominal positions as per the table below:

Miller coils

| L9 | 5 turns from top of coil can |
| :--- | :--- |
| L10 | 2 turns |
| L7 | 4 turns |
| L8 | 5 tums |
| L6 | 0 turns |

To prevent the final transmitter stages from producing excessive power whilst low level stages are being aligned, it is suggested that the Tx post mixer tunable filter be de-tuned. Energise the transmitter via manual PTT from the auxiliary handset.
2. Tune L 7 through L 10 for peak $\mathrm{o} / \mathrm{p}$. For initial alignment this can be done by monitoring the 121 MHz level at TP18 initially and then at the input to the SBL-1X transmit mixer (U8), where a level of about 75 mV should be measured by an RF millivoltmeter (e.g HP11960).

Typical RF millivoltmeter readings for each stage are :

| TP17 | $125 \mathrm{mVRF}=0.25 \mathrm{VDC}$ on HP11960 probe. |
| :--- | :--- |
| TP16 | $40 \mathrm{mVRF}=0.06 \mathrm{VDC}$ on HP11960 probe. |
| TP18 | $550 \mathrm{mVRF}=1.0 \mathrm{VDC}$ on HP11960 probe. |
| 121 MHz i/p to mixer | $75 \mathrm{mVRF}=0.13 \mathrm{VDC}$ on HP11960 probe. |

Note: The signal at TP17 is present as long as "Tx En" is active. The subsequent test points require PTT to also be active.

If the complete transmit chain is known to be operative then the $121 \mathrm{MHz} \mathrm{o/p} \mathrm{can}$ be peaked by first de-tuning C 78 on the tunable Tx filter until the Tx power o/p is less than 100 mW and then tuning inductors L7 to L10 for maximum output at the Tx frequency.
3. With the radio section links set for the desired data rate (see link table above), set the peak deviation as per the chart below with VR3, and center frequency to 121.000 MHz with L6.

NOTE : THESE ADJUSTMENTS ARE INTERACTIVE. ENSURE ALL COILS ARE SECURE
BAUD RATE DEVIATION LEVEL
$4800 \mathrm{bps} \quad \pm 1.5 \mathrm{kHz}$ peak
$9600 \mathrm{bps} \quad \pm 2.75 \mathrm{kHz}$ peak
4. Note that temperature compensation is applied to the 121 MHz oscillator so attempting to adjust either VR3 or L6 will upset compensation and should only be done as a temporary measure. Return unit to factory for repair if errors $> \pm 500 \mathrm{~Hz}$ are detected.

### 4.7.3 TX FINAL

NOTE: It is essential that all RF Deck mounting bolts are fitted and secure upon reassembly as many of these bolts provide inter-stage isolation and secure grounding ensuring the product meets all specifications.

1 Ensure the 121 MHz Tx injection is operating correctly.
2 Check Q2,4,5,8, are all biased correctly as per the voltage chart.
Temporarily disable the Tx power control circuitry by shorting LK4 located on the top side of the board near the ribbon cable.
Energise the transmitter via the manual PTT on the auxiliary handset.
3 Tune the Tx filter tuning capacitor C 78 for a peak output power measured at Antenna port or X 4 .

4 With full drive, Q9 driver collector current as seen across TP26/TP27 should be approximately $45 \mathrm{~mA}(100 \mathrm{mVDC})$, and NOT MORE THAN 55 mA ( 120 mVDC ).
5 With full drive at Q9 each final transistor should be drawing around 175 $\mathrm{mA}(385 \mathrm{mVDC})$ as seen across TP26/TP29 or TP28. The output power measured directly at the final connector should be between +32 and +34 dbm without power control.

6 Re-enable the power control circuitry and with the 'Txpwr' control line set at +5 VDC , set VR4 for $+32 \mathrm{dbm}+/-0.25 \mathrm{~dB}$ at the tx o/p socket X 4 . Check that the current in EACH final collector does NOT EXCEED 225 mA .

7 Check with the spectrum analyser that the $T \times 0 / p$ is free from spurious signals.
Note 1. Prior to the diplexer the VCO level is nominally about -20 dbc .
Note 2. Close in mixing products (less than $+/-30 \mathrm{MHz}$ ) must be greater than $65 d b$ below the carrier, as they are not attenuated by the diplexer filters.

## D.C. Voltages of Radio Section

RF Output Power set to +32 dbm at X 4 (diplexer input) with 13.8 VDC supply

| Transistor | Base | Emitter | Collector |
| :--- | :--- | :--- | :--- |
| Q2 | 1.66 VDC | 0.92 VDC | 6.96 VDC |
| Q4 | 1.79 VDC | 1.06 VDC | 6.46 VDC |
| Q5 | 1.80 VDC | 1.08 VDC | 7.51 VDC |
| Q8 | 1.05 VDC | 0.31 VDC | 4.02 VDC |
| Q9 | 0.47 VDC | 0 VDC | 13.35 VDC |
| Q10 | 0.28 VDC | 0 VDC | 13.05 VDC |
| Q11 | 0.29 VDC | 0 VDC | 13.16 VDC |
| Q12 | 7.17 VDC | 7.97 VDC | 7.88 VDC |
| Q1 | 7.29 VDC | 7.97 VDC | 7.91 VDC |
| Q13 | 4.56 VDC | 3.84 VDC | 7.97 VDC |
| Q7 | 1.14 VDC | 0.41 VDC | 6.68 VDC |
| Q6 | 1.13 VDC | 0.40 VDC | 7.52 VDC |
| Q3 | 1.06 VDC | 0.33 VDC | 7.59 VDC |

### 4.7.4 RECEIVER

The receiver section requires little or no alignment once factory aligned.

### 4.7.4.1 No AFC Models (Xtal $1=45.455 \mathrm{MHz}$ )

1 Adjust L1 for 45.455 MHz measured with pickup loop near L1.
2 In emergency adjust coils L3, L4 and L5 for best SINAD at TP8.
3 Adjust audio mute VR1 to mute handset audio at 10dB SINAD
4 Adjust VR2 for 2.0 VDC at TP8 whilst receiving data off-air.

### 4.7.4.2 AFC Models

Monitor 44.545 MHz with pickup at L1. Test for $44.545 \pm 1.5 \mathrm{KHz}$
Consult factory for alignment or service information.

## SECTION 5

## INSTALLATION AND COMMISSIONING

## 5 INSTALLATION OVERVIEW

All Data Radio Modem devices needs to be properly installed and commissioned in order to function reliably. It is important that installers are familiar with RF products / installations and are geared up with appropriate tools necessary to confirm the ongoing reliability of a communications system.

This chapter is intended as a short form checklist to ensure such radio devices are installed correctly and that important tests are made and recorded at each site for future reference should a problem eventuate.

Installers should check that each data radio has been programmed to suit their specific requirements before installation.

### 5.1 GENERAL

Installations play a critical role in network performance. Although this is a known fact, installations are often performed poorly or given little regard. It is essential that the installation is performed in a professional manner with careful attention and consideration to the following items :

1. Adequate primary power cable - relative to the length of cable to minimise voltage drop.
2. Shielded data cable between the unit and any external data equipment.
3. Low loss coax used for antenna feed line.
4. Careful termination of RF connectors.
5. A suitable antenna for the requirement.
6. Suitable placement of the antenna.
7. Adequate signal strength from the base station / other radio communications device.

### 5.2 INSTALLATION

The following information should assist when installing and commissioning data radio systems.

### 5.2.1 DATA CONNECTION

In industrial environments connection to any external device should be by shielded data cable with the shield connected to the connector shell to minimise data corruption, and/or radio interference.

### 5.2.2 MOUNTING

The radio modem should be mounted in a cool, dry, and vibration free environment. Mounting of the unit should be in a location providing easy access to screws and all connections.

### 5.2.3 POWER CONNECTIONS

The power required for $5 \mathrm{Watt}(\mathrm{Tx})$ at 13.8 VDC , is typically 2.0 Amps. As the Tx key up current is significant, the gauge of primary power wiring should be considered. It is suggested that a minimum of 18 gauge stranded copper wire be used for distances of up to two metres and a minimum of 14 gauge for longer distances up to 5 metres.

Ensure correct polarity to avoid costly repairs.

### 5.2.4 COAX CABLE CONNECTION

It is important to select the correct cable and connectors for each application as a poor selection can seriously degrade the performance of the unit.

As an example, for each 3dB of cable and connector loss, half the transmitter power is lost and twice the receiver signal power is required to produce the same bit error rate.

In some installations where strong signals are present, a compromise of cable and connector cost may be acceptable.
It is essential that all connector terminations are performed as per the manufacturers specifications (especially at 900 MHz and above) and if connectors are to be used outside, it is essential that a sealant such as amalgamating tape be used to seal connectors. DO NOT use acetic cure silicon to seal the connectors.

It is also important that coax cables are not stressed by tight bends, kinking or excessive flexing. Ensure that coax cables have sufficient strain relief and are secure. If large diameter rigid or semi rigid cable is used, it is recommended to use a short length of high quality RG58 or RG223 cable between the unit and main cable feed.

The following chart is a guide to losses in various types of coaxes at 400 MHz and 900 MHz over distance, please consider this when installing the unit.

| CABLE TYPE | LOSS RELATIVE TO DISTANCE |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | 1 dB |  | 3 dB |  | $6 d B$ |  | 9 dB |  |
|  | 450 MHz | 900 MHz | 450 MHz | 900 MHz | 450 MHz | 900 MHz | 450 MHz | 900 MHz |
| RG58C/U | 2.3 m | 1.6m | 7 m | 5 m | 14m | 10m | 20m | 15m |
| RG223/U | 3.1 m | 2.3m | 9 m | 7m | 18m | 14m | 28m | 21m |
| RG213/U | 6.1 m | 4m | 18m | 12m | 37m | 24m | 55m | 37m |
| $\begin{aligned} & \text { HELIAX } \\ & \text { LDF4-50A } \end{aligned}$ | 19m | 14m | 57m | 43m | 114m | 87m | 171m | 130m |
| $\begin{aligned} & \mathrm{HELIAX} \\ & \text { LDF5-50A } \end{aligned}$ | 38m | 25m | 114m | 75m | 229m | 150m | 343m | 225m |

### 5.3 ANTENNA INSTALLATION

The selection of antennas and their placement is one of the most important factors when installing a radio based network. People often use a simile, it is like putting square wheels on a Mercedes Benz..... very true comparison.

Antennas are generally mounted to a vertical pole with either vertical or horizontal polarisation as per the licence requirement.

Antennas should be mounted as high as practical and away from metal surfaces which can cause reflections.

Determining the type of antenna is very important and as a typical generic example, Point to Multipoint (PTMP) systems generally employ high gain (3, 6, or 9dB gain) omni directional antennas at the base station sites and either omni directional whips (unity gain) or preferably high gain directional yagi antennas ( 9 or 14 dB gain) at the remote sites.

### 5.3.1 YAGI ANTENNAS

Yagi antennas not only provide signal gain and directivity, but also provides protection from interfering signals which are outside the beam width of the antenna. Yagi antennas are essential when communicating over very long distances.

Yagi antennas are polarised and must be mounted either vertically (elements pointing from the ground to the sky) or horizontally (elements in parallel with the horizon).

As a general rule, Point to Multipoint remote units are vertically polarised, while Point to Point links are horizontally polarised.

When mounting yagi antennas with vertical polarisation, it should be noted that the dipole (loop section of antenna) has a drain hole. The small drain hole on one end of the dipole must be pointed towards the ground so that water will drain out of the antenna.

### 5.3.2 OMNI DIRECTIONAL ANTENNAS

Omni directional antennas provide a radiation pattern of equal strength through $360^{\circ}$ in the horizontal plane. This makes them ideal for base antennas in point to multipoint systems because they can reach the remote antennas.

Omni directional antennas are also used at remote sites (although yagi antennas are preferred) and are typically ground independent "whip" type antennas. The main reason for using whips at remote sites is for aesthetics as they are far less obtrusive than a yagi.

Regardless of the type, antennas need to be mounted properly and in a suitable location as covered below.

### 5.3.3 ANTENNA PLACEMENT

Antenna placement is of paramount importance and plays a big part of the antennas and in turn systems performance.

When choosing antenna locations the aim is to find the largest path of unobstructed space and locate the antennas within that space. It is important to locate antennas as high as possible and definitely clear of any moving obstructions.

Where possible it is important to avoid mounting antennas:

1. Against or adjacent to steel structures.
2. In an area which will have constant intermittent obstructions - people walking past, vehicles driving past etc. That is, mount antennas well above such moving obstructions.
3. Near any electrical equipment.
4. Near metal beams, structures etc.
5. Inside any metal enclosures, tin sheds / warehouses etc. - note meshed wire fences act like a "brick wall" to RF transmissions.
6. Away from guard rails or support beams.

Note: Sometimes installations in such environments are unavoidable and where this is the case, certain care can be taken to still ensure a reliable installation. Please consult Trio for assistance on a case by case basis.

If tests indicate poor signal strength then the antennas at one or both ends of the link should be raised, and/or moved clear of obstructing objects, or if directional antennas are employed they should be checked for correct directional orientation and polarisation (horizontal or vertical signal orientation).

### 5.3.4 REFLECTIONS AND OUTPUT POWER

Ideally, the propagation path should be clear Line of Site (LOS).
The biggest problem with UHF radio when used within "steel" buildings or obstructed paths is the large presence of signals randomly reflected from the surrounding obstructions or "steel" walls. These signals cannot be eliminated, but by maintaining a 10 to 20 dB margin between the wanted and unwanted signals, problems should not be experienced. The simplest way to do this is to use directional gain antennas.

These antennas will provide attenuation to all signals arriving from a direction other than the direct path. Where steel walls or structure exist immediately behind the antenna location, the high front to back ratio of such antennas will negate such high level reflections. Power output should be set at the minimum level required to achieve a 25 dB fade margin, in order to minimise the amount of RF being reflected, and to avoid saturating the receiver front end and therefore reducing the margin between wanted and unwanted signals.

### 5.4 COMMISSIONING - RSSI LEVEL

When commissioning a data radio network, it is important to ensure that the incoming received signal strength ( RSSI ) is adequate to provide reliable communications.

Note: A good signal path should allow for approximately 30 dB fade margin.
Received signal strength (RSSI) of the incoming signal is available as an analogue output on Trio data radio modems. This RSSI output ranges from 0 to approx 4 Volts, where 4 Volts indicates the strongest signal. The actual values of received signal strength can be determined by comparing the output voltage against the calibrated graph supplied in the handbook.

By referring to the RSSI chart alignment of aerials can be optimised to achieve the greatest signal strength (highest output voltage).

Note: Be sure to stand clear of aerials when measuring this output voltage, touching or standing in close proximity to aerials will give inaccurate readings.

### 5.4.1 CHECKING DATA COMMUNICATIONS

If the host computer and remote equipment are capable of performing data integrity tests then connect the host and terminal data equipment to the radio modems.

Remove and re-apply power to each radio modem to ensure they are both in data comms mode, and run data tests on the link.

### 5.4.2 BIT ERROR RATE (BER) TESTING

If the connected data equipment is NOT capable of running data integrity tests then the TC-450DS modems can be put into a BER test mode, whereby the data channel can be tested in each direction to a reasonable level without external test equipment. To run a link test with the radio modems themselves, they must BOTH be put into BER test mode.

To place the unit in BER mode connect pin 6 and pin 9 of port A together and apply power.

The transmitter can be activated by driving the RTS pin (7) of port A positive. The unit will then send a predefined pseudo random sequence which is tested for accuracy by the receiving unit and any errors displayed on the front panel 'SYNC' lamp.

Each error bit will illuminate the lamp for approximately 1000 bits duration, therefore error rates above 1 in 1000 will show an almost constant error indication.

To return the unit to normal data transmission mode simply power it up without pin 9 connected to pin 6.

For further information on radio path problems please contact Trio DataCom for detailed advice.

Note : BER testing is not viable in an operational point to multi-point environment as the $B E R$ test will interfere with other operative units.

### 5.4.3 OUTPUT POWER - VSWR

Upon installation of equipment an output power measurement should be done using a suitable power meter. Forward and reflected power should be measured at the antenna port and recorded for future reference. The reflected power measurement should be as a minimum $3: 1$ of the forward power. If this is not the case, investigate possible causes such as poor terminations, faulty antenna etc.

### 5.4.4 DATA CONNECTION

The data connection is via a DB9 connector labelled 'Port A', which is wired as a DCE as shown below. The port labelled 'Port B ' is not used for the standard configuration but can be enabled by the programmer for use as a totally independent second data channel. In industrial environments connection to the modem should be by shielded data cable with the shield connected to the connector shell to minimise data corruption, and radio interference.

## - User Serial "Port A" Pin Assignment

PIN NO. \& FUNCTION
EXTERNAL VIEW OF 'PORT A'

1. DATA CARRIER DETECT (DCD)
2. RECEIVE DATA OUTPUT (RXD)
3. TRANSMIT DATA IN (TXD)
4. DATA TERMINAL READY (DTR)
5. COMMON (COM) $\qquad$
6. PROGRAM PIN (PGM)
7. REQUEST TO SEND (RTS)
8. CLEAR TO SEND (CTS)

9. BIT ERROR RATE PIN (BER)

NOTE: Pin 6 and pin 9 provide a dual function which depends on the mode that the $T C-450 D R$ is operating in.

## - User Serial "Port B" Pin Assignment.

Port B of the TC450DR is essentially unused in its standard configuration but can be enabled by the Programmer for use as a totally independent second data channel. This port is essentially used for specific applications and only has one connection that may be of use for installation purposes. This connection (Pin 9) is Receive Signal Strength Indicator (RSSI) output.

This RSSI output ranges from 0 to 5 Volts, where 5 Volts indicates the strongest signal. It is important to note that this Port output has a high impedance of around 10 K ohms and loading will decrease accuracy of the recorded measurement.

PIN NO. \& FUNCTION

1. DATA CARRIER DETECT
2. RECEIVE DATA O/P (RxD)
3. TRANSMIT DATA O/P (TxD)
4. DATA TERMINAL READY (DTR)
5. COMMON
6. DATA SET READY (DSR)
7. REQUEST TO SEND (RTS)
8. CLEAR TO SEND (CTS)
9. RECEIVE SIGNAL STRENGTH

EXTERNAL VIEW OF 'PORT B'

### 5.5 GENERAL CHECKLIST

The following is a simple commissioning checklist which should be used at every site not only to ensure correct installation, but also as a reference list for problems which may eventuate.

| TRIO SITE COMMISSIONING CHECK LIST / RECORD |  |  |  |
| :--- | :--- | :--- | :--- |
| Company: | Operator: |  |  |
| Site Location: | Date: |  |  |
| Link to: | Serial \#: |  |  |
| Radio Type: | Config File Name: |  |  |
| Antenna Type / Gain | Path Distance |  |  |
| Tx Power at Radio | Measured RSSI Volts |  |  |
| Reflected Power | Fade Margin |  |  |
| VSWR |  | Line of Site to Base |  |
| Tx Power at Antenna |  | DC volts at Radio (Tx) |  |
| Site QA Inspection: |  |  |  |
|  |  |  |  |
| Notes: |  |  |  |

## SECTION 6

## FAULT FINDING

## 6 FAULT FINDING

This section is to assist with difficulties that may be experienced when installing or working on the TC-900DR.

### 6.1 MODEM/GENERAL

The following is a list of possible problem areas, and suggested checks that can be made to isolate any general problem that may have occurred.

1. POWER SUPPLY
a) Check for +13.8 Volts at supply input.
b) Check fuse on Modem PIS PCB ( 1 Amp SLO-BLOW).
c) Check supply volts:

Modem PIS i) 13.8 Volts
ii) 8 Volts
iii) 5 Volts

RF Deck i) 13.8 Volts
ii) 8 Volts
iii) 5 Volts

## 2. ANTENNA

a) Check antenna, cable and connectors for damage or water
b) Check forward and reflected power at antenna connector of unit.

VSWR should be $<=1.5: 1$

## 3. PROGRAMMING

Check programming information. e.g.
i) Transmit and receive frequencies are within the operating band of the unit
ii) User interface configuration.

## 4. INTERFACE

a) Check connections to Port A (DB9 Connector).
b) Check cable to host communications.
c) Interface commands to unit are incorrect or communications are not established correctly.
5. POOR TRANSMITTER PERFORMANCE
a) Check correct transmit frequency programmed.
b) Check transmitter carrier frequency.
c) Check transmitter deviation.
d) Check RF output power level.

## 6. POOR RECEIVER PERFORMANCE

a) Check correct receive frequency programmed.
b) Check receive sensitivity.
c) Check audio output level and DC bias to modem.
d) Check mute threshold.

### 6.2 RECEIVER

The following is a list of problem areas, and suggested checks that can be made to isolate any receiver specific problems that may have occurred.

### 6.2.1 RECEIVE SENSITIVITY LOW

1 Check mixer drive level by measuring DC bias developed across R27.
2 Check for correct DC bias conditions and supply volts on RF Amp, Local Osc buffer, and IF Strip, compared to voltage charts.

3 Ensure 44.545 MHz oscillator (part of NE615 IF IC) is within $\pm 250 \mathrm{~Hz}$. This is best carried out by using a communications test set such as an IFR1200 or similar in receiver mode with frequency error displayed.

4 Ensure that the local oscillator is netted to frequency by monitoring the Tx mixer injection with a pick up loop connected to a sensitive frequency counter of high stability. Adjust the VCXO frequency reference until correct L.O. frequency is observed. Note that the VCO and synthesiser use the VCXO as the frequency standard. Measure the Synthesiser LOCK signal to ensure the VCO is in phase lock.

5 With a 50 ohm signal generator tuned to 455 kHz , apply signal via a 1 nF capacitor to the inputs of the 1st and second IF Amp sections of the 615 IF IC and compare the level required to produce the correct RSSI level.

6 With a 50 OHM signal generator tuned to 45.000 MHz , apply signal to the points defined on the IF test chart and compare RF level required to produce the reference RSSI level as specified at TP4.

7 Apply signal frequency to the RF input connector at X2 and compare the level required to produce RSSI reference level at TP4 with that shown in the IF Level Chart.

8 Reconnect the Antenna Diplexer and apply the signal generator to the Antenna terminal of the diplexer. Adjust the generator level to provide the same Rx mixer bias from applied RF signal as was noted in 7) above. The level required should be no more than 3 dB ( Rx diplexer path loss) greater.

Note that the RSSI signal provided by the IF IC is a fairly accurate logarithmic scale between 0.5 and 4 VDC , providing about 0.5 VDC for each 10 dB of signal applied to the input of the IF Strip, and can be used as a reasonable measure of signal providing it is unmodulated and on center frequency at 455 kHz .

### 6.2.2 RECEIVER LEVEL CHART

The following chart lists the level (terminated) of a 50 OHM signal generator to produce 2.0VDC of RSSI at TP4 when applied as specified to the point shown and at the frequency indicated.

| FREQUENCY | CONNECTION POINT AND APPLICATION | NOM LEVEL |
| :--- | :--- | :--- |
| 455 kHz | Pin 20 of IC U2 NE615 via 1 nF | -72 dBm |
| 455 kHz | Pin 18 of IC U2 NE615 via 1 nF | -74 dBm |
| 455 kHz | Pin 1 (i/p) of IF Filter CF2 via 1nF | -58 dBm |
| 455 kHz | Pin 14 of IC U2 NE615 via 1 nF | -43 dBm |
| 45 MHz | Rxi/p at X2 via coax direct | -49 dBm |
| 45 MHz | Mixer i/p following R.F. Amp | -62 dBm |
| 45 MHz | Mixer diode (D1) o/p across C100 | -61 dBm |
| 45 MHz | Junction of 1st \& 2nd 45 MHz crystal filter | -77 dBm |

### 6.3 TRANSMITTER

The following is a list of problem areas, and suggested checks that can be made to isolate any transmitter specific problems that may have occurred.

1. NO TRANSMIT
2. Check PTT circuit.
3. Check unit is programmed within its operational range.
4. Check if manual PTT (Rear Aux connector) keys transmitter.
5. Check if any transmitter output is present. Tuning required?

## 2. TRANSMITTER SPURIOUS EXCESSIVE

The probable cause is dependent upon the nature of the spurious as follows:
Carrier $\pm 910 \mathrm{kHz}$. - IF detector signal ( $2 \times 455$ ) modulating or mixing with carrier. Check 1 n bypass on reference $\mathrm{i} / \mathrm{p}$ to power control op-amp. Check bypasses on collectors and supply lines of low level transmitter stages, and L.O. buffer.

Carrier $\pm 20.166$ and/or 40.333. - Excessive harmonics of 20.166 crystal oscillator in 121 MHz FM driver IC (U7). Check all pins of IC (U7) for correct DC conditions. Check all tuning inductors for 'normal Q ', as 'soft' tuning will almost surely indicate an incorrect or faulty capacitor, or inductor.

Carrier $\pm$ VCXO reference frequency (approximately 7 MHz ). - Reference signal modulating VCO, or mixing with carrier in L.O.buffers. - Check Synthesiser supply bypasses, check for defective joints or components in and around the resistive divider at output of VCO.

Note that it is imperative that low frequency divider products be attenuated before they can reach the base/emitter junctions of the L.O. buffer transistors where they can mix with the VCO frequency.

Note also that poor SMD solder joints will provide nonlinear conductance and give rise to frequency mixing in this area. Check for faulty components or poor joints around the Synthesiser to VCO frequency control area, or VCO supply line bypassing.

Excessive Transmitter power radiated or conducted to the area of the VCO can also cause spurious effects and may enhance the levels of otherwise-acceptable levels of spurious. If this is suspected, check that ALL chassis securing bolts are fitted and tight on the RF deck, and that ALL bypass capacitors and chokes are fitted and correct in and around the final Tx stages.

## 3. TRANSMITTER POWER LOW OR UNSTABLE :

1 Firstly - Ensure that ALL RF Deck mounting bolts are fitted and secure.
2 Check that the feed resistors used for current indication on all stages of the final are of correct value and firmly in circuit.

3 Check that the Tx L.O. buffer and post mixer buffers are correctly biased as per the voltage charts.

4 If necessary disconnect the final stages from the Tx post mixer buffers by removing the solder bridge between Q5 and Q8, and with an appropriate instrument measure the RF power available from the Tx buffers to the final pre-driver.
Note that the o/p impedance of the buffer is 50 OHM and must be measured by a 50 OHM instrument. It is highly recommended that a measuring spectrum analyser be used here as this instrument will also display the relationship between the wanted signal and other spurious or unwanted mixing products.
The nominal display seen at this point by a spectrum analyser is shown on the spectrum charts attached.

5 To test the final stages separate from the buffers - inject a signal from a 50 OHM generator at Tx frequency into pre-driver (Q8) via C122. The level required to drive the final to full output is shown on the Tx level chart.

6 Check that the current drawn by the driver transistor as measured across the feed resistor (TP28 to TP27) is within spec, and if not check and or replace the driver transistor or associated components as necessary.

7 Check that the current drawn by each final transistor as indicated by the voltage across the 2.2 OHM ( $2 \times 4.7$ ohm in parallel) collector feed resistors (TP26 to TP28 and TP29) is within the range stated in the voltage charts, and that both are within $10 \%$ of each other. If in error check components around final pair and replace final transistors as necessary.

NOTE it is possible for power transistors to be partly defective due to current or thermal abuse, and the fact that the devices are actually drawing current does not always indicate that they are producing full power at the collector.

TX LEVEL CHART :

| Frequency | Connection Point <br> \& Application | Level Remarks |
| :--- | :--- | :--- |
| Base band | Data from modem section TP13 (4800 <br> baud) | $2 \mathrm{VD.C}$ |
| Base band | Applied data signal to modulator U7 pin | $1 \mathrm{~V}_{\text {p-p }}$ |
|  | 3 (4800 baud level from modem) |  |

## SECTION 7

## APPENDIX A

## DRAWINGS

## 7 APPENDIX A DRAWINGS

TC01-08-12 Data Radio Mounting Details
TC01-08-11 Data Radio Assembly Details
TC01-04-05 Data Radio Basic Modem 9K6/4K8 Component Loading Details
TC01-00-05 450DR / 900DR Packet Modem (2 sheets)
TC01-08-10 PWB Manufacturing Details 900DR Data Radio - Radio Board (2 sheets)
TC01-00-10 Data Radio Project Sheet
TC01-00-10 Data Radio Final PA (AFC Fitted)
TC01-00-10 Data Radio 121 MHz OSC (AFC Fitted)
TC01-00-10 Data Radio - Synthesiser - VCO (AFC Fitted)
TC01-00-10 Data Radio - NE6154K8/9K6 (AFC Fitted)
TC01-04-15 850-930 MHz Antenna Diplexer Component Side Assembly
TC01-05-10 Radio Board Top Side (C/S) Test Point \& Adjustment Location Details
TC01-05-10 Radio Board Bottom Side (S/S) Test Point \& Adjustment Location Details

TC01-05-16 Duplex Radio BER/S+N/N vs Sig
TC01-05-17 AFC Alignment Setup - Block Diagram
TC01-05-12 4800/9600 BPS Modem Functional Diagram
TC01-05-23 Asynchronous Modem Functional Diagram
TC01-05-19 Macro Block Diagram
TC01-05-18 Radio Section - Modem Section Interface
DR9-BLOK 900 MHz Radio Block Diagram
RSSI Level cf Received Signal (typical)

## SECTION 8 <br> APPENDIX B <br> GLOSSARY of TERMS and ABBREVIATIONS

## 8 APPENDIX B GLOSSARY

ADC: Analogue to digital converter.
AFC: Automatic frequency control.
BER: Bit error rate.
bps: Bits per second.
C/DSMA: Carrier or data sense, multiple access scheme.
COM: Common.
CRC: Cyclic redundancy checksum.
CTS: Clear to send.
DAC: Digital to analogue converter.
DCD: Data carrier detect.
DCE: Data communications equipment.
DFM4-9: Trio DataCom digital modem chipset.
DIP: Dual in line package.
DOTAC: Department of Transport and Communications.
DSR: Data set ready.
DTR: Data terminal ready.
FCS: Frame check sequence.
FEND: Frame end.
FESC: Frame escape.
FIFO: First in first out.
FIR: Finite impulse response.

FM: $\quad$ Frequency modulation.
FSK: Frequency shift keying.
GPIB: General purpose interface bus.
HADR_EN: High address enable signal.
IC: Integrated circuit.
I.F.: Intermediate frequency.
$\mathrm{i} / \mathrm{p}: \quad$ Input.
KISS: Keep it simple stupid.
LADR_EN: Low address enable signal.
MSB: Most significant bit.
NVRAM: Non volatile RAM.
NRZ: $\quad$ Non return to zero.
NRZI: $\quad$ Non return to zero - inverted.
o/p: Output.
PCB: Printed circuit board.
PLL: Phase locked loop.
PMP: Point-to-multipoint.
ppm: Parts per million.
PTP: Point-to-point.
PTT: Press to talk.
RF: Radio frequency.
RI: Ring indicate.
R_select: RAM read select signal.
SIO: Serial input/output.
RSSI: Receive signal strength indication.
RTS: Request to send.
Rx: Receive.
RXD: Receive data output.
SCADA: Supervisory control and data acquisition.
SLIP: Serial line interface protocol.

TC-900DR: Trio DataCom 900MHz full duplex data transceiver.
TC-DFM9IP: Trio DataCom TC-900DR parameter programming software suite.
TFEND: Transposed Frame End.
TFESC: Transposed Frame Escape.
TNC: Terminal node controller.
Tx: Transmit.
TXD: Transmit data in.
VCO: Voltage controlled oscillator.
W_select: RAM write select signal

## Halmac Services (Qld) Pty. Ltd. ACN 098852923 <br> ABN 40741712113

## SIGNAL ISOLATOR

## 1. ECT SIGNAL ISOLATOR TECHNICAL DETAILS

ECT-DIN
Signal Isolator, Converter, Repeater, Booster and Splitter

## June 2009

## Description

ECT DIN-style signal isolators, converters, repeaters, boosters and splitters feature solid metal housings that stand up to the continuous, daily rigors of process control and factory automation applications.

Rugged and reliable, the ECT is available in 2-wire (loop) and 4-wire (line/mains) powered models. The complete family delivers economical solutions for an expansive range of signal interface applications.

- Isolate Signals to stop erratic measurements caused by ground loops.
- Convert Signals so field instruments can interface directly with an indicator, recorder, DCS, PLC or PC-based SCADA system.
- Split One Signal to allow one primary measurement to be sent to two separate systems.
- Get two isolators in one. The ECT is available in dual channel I/O models that provide application flexibility while reducing space requirements and costs.
- Protect Equipment and Signals (Area Isolation) by eliminating common electrical paths.
- Amplify (Boost) Signals so that more instruments can be added to an overburdened loop.
- Solve "Bucking" Power Supplies by stopping a conflict caused by a 4 -wire transmitter and a DCS both trying to power the same process loop.
- Step Down Dangerous, high voltage signals to safer levels to protect plant personnel.
- Solve DCS Start-Up Problems caused by non-isolated transmitters by installing an ECT in each troublesome loop.

To choose the right ECT for your application, first determine the power supply characteristics:

| RowerSuppliype: | Page |
| :--- | :---: |
| 2-Wire, Output-Loop Powered <br> $(12-42 \mathrm{Vdc})$ | $2-3$ |
| 2-Wire, Input-Loop Powered <br> (5.5VIp) | $4-5$ |
| $4-$ Wire, Line/Mains Powered <br> $(117 \mathrm{Vac}, 230 \mathrm{Vac}, 24 \mathrm{Vdc})$ | $6-7$ |



Featuring metal DIN-style housings, the ECT snaps securely onto standard G-type and Top Hat rails.

## Features

- Current and voltage inputs. Available models handle Current and Voltage Signals.
- 2-wire (loop) and 4-wire (line/mains) powered. Versatile choices allow you to match the ECT to the type of AC or DC power available at each location.
- Superior signal isolation (up to 1500 Vrms ). Industrial-strength protection stops ground loops, motor noise, and other electrical interferences from affecting process signals.
- RFI/EMI protection. The ECT provides an effective barrier against the unpredictable, harmful effects of radio frequency and electromagnetic interference. When ordered with the -RF option, the ECT delivers enhanced protection for especially noisy environments.


## Certifications

UL
Underwriter's Laboratories: General Location*
us
( $€$ CE: Conformant to EMC 89/336/EEC EN 61326
"Certification not applicable to ECT-DIN models equipped with the RF option.

## ECT-DIN

Signal Isolator, Converter, Repeater, Booster and Splitter

## 2-Wire, Output-Loop Powered Models

This ECT model derives operating power from its output side where loop power is typically made available by the receiving device, such as a DCS.

## Stop Ground Loop Noise

Differences in potential between a grounded transmitter and a grounded receiving device may result in unpredictable ground loop problems, which can lead to signal drift. Use the ECT to break the galvanic path between the field instrument and receiving device (Figure 1).

## Convert Signals

The ECT takes one process signal type (such as $1-5 \mathrm{~V}$ ) and converts it to a standard, isolated $4-20 \mathrm{~mA}$, allowing devices with incompatible signal types to interface with one another (Figure 1).

Divert and Protect (Area Isolation) Signals Using the ECT, you can send the output from one transmitter to a second location; protect expensive monitoring/control equipment by eliminating common electrical paths; or create a buffer between devices to allow interruption of one leg of a loop without impacting the other (Figure 2).

## Amplify (Boost) Signals

If you need to add an instrument to an overloaded loop, use the ECT. It features a high drive capability of 600 ohms (with a 24 V power supply) and a low input impedance of just 50 ohms (Figure 3).

## Solve "Bucking" Power Supplies

When two devices (such as a 4 -wire transmitter and a DCS) are trying to source power to a loop, the result is a non-functioning loop. When neither of the devices can be eliminated, the solution is the ECT. It can operate with powered inputs from both sides, thus restoring normal operations to the loop (Figure 4).

Figure 1. Inputoutput loop isolation and signal conversion.


Figure 2. Divert a process signal, or protect expensive equipment by eliminating a common electrical path.


Figure 3. Boost process signals to allow another instrument to be added to an otherwise overloaded loop.


Figure 4. Restore a loop experiencing "bucking" power supplies to normal operation.


## Specifications

| Performance Accuracy: $\pm 0.1 \%$ of $\operatorname{span}( \pm 0.2 \%$ for $0-150 \mathrm{AC}$ inputs) <br> Stability: $\pm 0.2 \%$ of reading per year Isolation: WITHOUT -RF OPTION: 1500Vrms between input and output; WITH -RF OPTION: 500 V rms between input and output Output Response Time: DC Inputs, 100 msec to $99 \%$ of output maximum; AC Inputs, 400 msec to $99 \%$ of output Ripple: 10 mV peak-topeak maximum measured across a 250 ohm resistor Over-Voltage Protection: 48V, maximum on output; 48 V reverse polarity protection on output | Performance Maximum Input <br> (continued) Overrange: Current Inputs $250 \%$ of full scale; DC Voltage Inputs, $150 \%$ of full scale <br> Burden: IV maximum with $4-20 \mathrm{~mA}$ input; 0.01 V maximum with 0-5A input Load Capability: $\frac{\mathrm{Vs}-12 \mathrm{Vdc}}{0.02 \mathrm{~A}}=\mathrm{ohms}$ <br> Output Current Limiting: 25mA typical; 30 mA maximum <br> Ambient Operating Range: <br> Conditions $-40^{\circ} \mathrm{C}$ to $+85^{\circ} \mathrm{C}$ $\left(-40^{\circ} \mathrm{F} \text { to }+185^{\circ} \mathrm{F}\right)$ <br> Storage Range: <br> $-40^{\circ} \mathrm{C}$ to $+85^{\circ} \mathrm{C}$ <br> $\left(-40^{\circ} \mathrm{F}\right.$ to $\left.+185^{\circ} \mathrm{F}\right)$ | Ambient Conditions (Continued) <br> Adjustments <br> Weight | Ambient Temperature <br> Effect: $\pm 0.007 \%$ of span $/{ }^{\circ} \mathrm{C}$ typical; $\pm 0.015 \%$ of span ${ }^{\circ} \mathrm{C}$ maximum Relative Humidity: $0-95 \%$ non-condensing RFVEMI Protection: Less than $\pm 0.1 \%$ of span error when tested at $10 \mathrm{~V} / \mathrm{m}$ @ $20-1000 \mathrm{MHz}$ WITH -RF OPTION: Less than $\pm 0.1 \%$ of span error when tested at $30 \mathrm{~V} / \mathrm{m}$ (6) $20-1000 \mathrm{MHz}$ <br> Common Mode Rejection: <br> Exceeds 95 dB @60Hz with a limit of 1500 Vrms <br> Type: Front panel pots <br> Span: $\pm 10 \%$ <br> Zero: $\pm 5 \%$ <br> (non-interactive when span is set first) $145 \mathrm{~g}(5 \mathrm{oz})$ |
| :---: | :---: | :---: | :---: |

Ordering Information

| Unii | 埌pul | Qufpul | Rower | Qptions | Housfig, |
| :---: | :---: | :---: | :---: | :---: | :---: |
| ECT <br> 2-wire <br> (Output-Loop <br> Powered) <br> Isolator/Converter | 4-20MA into 50 ohms <br> 1-5V into 1 Mohm <br> 0-10V into 1 Mohm <br> 0-150AC into <br> 100 kohms <br> 0-5AAC into <br> 0.002 ohms | 4-20MA <br> into 600 <br> ohms with 24 Vdc power supply | 12-42DC | -RF Enhanced RFI/EMI filtering provides $30 \mathrm{~V} / \mathrm{m}$ @ $20-1000 \mathrm{MHz}$ protection with less than $\pm 0.1 \%$ of span error <br> -EM Externally-mounted input transformer for current input (available with $0-5 A$ ac input type only) | DIN Aluminum DIN-style housing mounts on 32 mm G-type (EN50035) and 35 mm Top Hat (EN50022) rails FLB2 Externallymounted flange provides a secure mount and ensures resistance to vibration |

When ordering, specify: Unit / Input / Output / Power / Options [Housing]
Model number example: ECT / 4-20MA / 4-20MA / 12-42DC / -RF [DIN]

## Step Down Unsafe High Level Signals

To protect plant personnel, the ECT comes with an optional external input transformer (-EM option) to step down high level AC current inputs to a low level signal. This permits safer servicing without opening the secondary of a current transformer (Figure 5).

Figure 5. To protect plant personnel, step down potentially dangerous high level $A C$ current signals to lower level signals.


## ECT-DIN

Signal Isolator, Converter, Repeater, Booster and Splitter

## 2-Wire, Input-Loop Powered Models

The 2-wire, input-loop powered ECT derives its operating power from the input side of the process loop (Figure 6). This model provides loop isolation when line power or output-loop power is not available. Its simple hook-up method provides a cost-effective interface between field signals and a computer, DCS or other multiple-input system.

IMPORTANT NOTE: When choosing this type of isolator, notice the total load imposed on the input loop. Because it derives all operating power from the input loop, that loop must be able to handle the isolator's input impedance and output load (maximum output load is 250 ohms).

## Single and Multiple Unit Instrument Enclosures

Designed to meet NEMA 4X and IP66 ratings, the $R$-BOX is the perfect solution for protecting the ECT in field and control room applications. Rugged and versatile, it delivers a high impact structure and resistance to ultraviolet rays and chemicals.

The $R$-BOX mounts on a pipe, panel or surface, and comes in a variety of widths to economically accommodate just one, or up to 10, ECTs. It features a pre-installed mounting rail; customizable conduit entry options; a clear cover; and a secure locking mechanism.

For more information, see the $R$ - $B O X$ FieldMount Enclosure for DIN Instruments data sheet.

Figure 6. The input-loop powered ECT provides loop isolation when line power or output-loop power is not available.


Figure 7. Available in a variety of widths, our R-BOX field-mount instrument enclosure is designed to protect DIN-rail instruments in even the most rugged environments.


## Specifications

| Performance Accuracy: $\pm 0.075 \%$ <br> of span <br> Stability: <br> $\pm 0.2 \%$ of reading per year <br> Isolation: 500 Vrms be- <br> tween input and output <br> Output Response: <br> 20 msec maximum to $99 \%$ of output <br> Ripple: 10 mV peak-topeak maximum measured across a 250 ohm resistor Over-Voltage Protection: 48 V , maximum on output; 48 V , reverse polarity protection on output Maximum Input Overrange: 200\% of full scale Burden: 5.5V when out- | Performance puts are shorted for <br> (continued) $4-20 \mathrm{~mA}$ inputs, 10.5 V with <br>  250 ohm load (Output <br>  load voltage is reflected <br>  on input. Output should <br>  be trimmed for anticipated <br>  output load) <br>  Output Current <br>  Limiting: 30 mA with <br>  250 ohm output load <br>   <br> Ambient Operating Range: <br> Conditions $-29^{\circ} \mathrm{C}$ to $+82^{\circ} \mathrm{C}$ <br>  $-20^{\circ} \mathrm{F}$ to $+180^{\circ} \mathrm{F}$ <br>  Storage Range: <br>  $-40^{\circ} \mathrm{C}$ to $+85^{\circ} \mathrm{C}$ <br>  $\left(-40^{\circ} \mathrm{F}\right.$ to $\left.+185^{\circ} \mathrm{F}\right)$ | Ambient Conditions (Continued) <br> Adjustments <br> Weight | Ambient Temperature Effect: <br> $\pm 0.018 \%$ of span $/{ }^{\circ} \mathrm{C}$; <br> $\pm 0.005 \%$ of span $/{ }^{\circ} \mathrm{C}$ <br> gain change <br> Relative Humidity: <br> $0-95 \%$ non-condensing <br> RFVEMI Protection: <br> Less than $\pm 0.1 \%$ of span error when tested at <br> $10 \mathrm{~V} / \mathrm{m}$ @ $20-1000 \mathrm{MHz}$ <br> WITH -RF OPTION: Less <br> than $\pm 0.1 \%$ of span error when tested at <br> $30 \mathrm{~V} / \mathrm{m@} 20-1000 \mathrm{MHz}$ <br> Common Mode <br> Rejection: Exceeds <br> 95 dB © 60 Hz with a limit of 1500 V rms <br> Type: Front panel pots <br> Trim: $\pm 1 \%$ <br> $145 \mathrm{~g}(5 \mathrm{oz})$ |
| :---: | :---: | :---: | :---: |

Ordering Information

| Outpun Rower |  |  |  | Qpfions : $\quad$ : Prusfing |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| ECT <br> 2-wire <br> (Input-Loop <br> Powered) <br> Isolator/ <br> Converter | $\begin{aligned} & \text { 4-20MA } \\ & \text { into } \\ & 275 \text { ohms } \end{aligned}$ | 4-20MA into $0-250$ ohms | Current Loop Excitation at 4mA: 5.5VLP 5.5 volts loop powered with $4-20 \mathrm{~mA}$ (plus voltage across output load) | -RF Enhanced RFI/EMI filtering provides $30 \mathrm{~V} / \mathrm{m}$ © $20-1000 \mathrm{MHz}$ protection with less than $\pm 0.1 \%$ of span error | DIN Aluminum <br> DIN-style housing mounts on 32 mm G-type (EN50035) and 35 mm Top Hat (EN50022) rails FLB2 Externally-mounted flange provides a secure mount and ensures resistance to vibration |

When ordering, specity: Unit / Input / Output / Power / Options [Housing]
Model number example: ECT / 4-20MA / 4-20MA / 5.5VLP / -RF [DIN]

## Need Enhanced Features?

## PC-Programmable Universal Interface

Our model SIY signal isolator, converter, and repeater is the ideal plant standard. This 2-wire (loop-powered), microprocessor-based instrument programs in less than a minute to handle a wide range of current and voltage inputs. It even allows creation of custom input linearization curves. For detailed information, see the SIY data sheet.

## Unusual Input and Outputs

We have instruments that handle a wide array of non-standard inputs and outputs.

## Custom Signal Isolators

We have engineers on hand to modify our instrument to meet your unique needs.

RTD, T/C, mV, Potentiometer, I/P, P/I, Strain Gage, and Frequency Signals We are the Interface Solution Experts. When you need to interface field processes with computerbased systems, readout equipment, and other instrumentation... our technology, services, and experience help you do it efficiently, safely, and cost-effectively.

## ECT-DIN

Signal Isolator, Converter, Repeater, Booster and Splitter

## 4-Wire, Line/Mains Powered Models

These ECT models are powered by standard 117 Vac , 230 Vac , and 24 Vdc power supplies (Figure 8). They are designed for applications where line/mains power is readily available, such as the back of a panel or in a control room.

## Step Down Unsafe, High Level Signals

To protect plant personnel, the 4-wire ECT comes with an optional external input transformer (-EM option) to step down high level AC current inputs to a low level signal. This permits safer servicing without opening the secondary of a current transformer (Figure 9).

## Power a 2-Wire Transmitter

With the -TX option, our 4 -wire ECTs provide 24 V power to a 2-wire, output-loop powered instrument. This eliminates the need for an additional power supply (Figure 10). IMPORTANT: Our 2X4-20MA dual input model provides a transmitter excitation of 16 V . Refer to Figure 12 for an illustration of dual input model operation.

## "Sharing" or "Splitting" a Process Signal

The ECT with dual outputs will take one input and deliver two identical, completely isolated outputs to two separate monitoring or control devices (Figure 11). This is valuable for viewing one process variable at two locations, such as in custody transfer, where two parties require identical information for accountability or billing purposes. Maintenance of one system does not disturb the information being collected at the second location. In addition, a failure at one receiver will not affect the second loop.

## One Isolator Does the Work of Two

When ordered with dual input and output channels, the ECT will perform the functions of two isolators (Figure 12). Each of the ECT's two input-to-output channels is independent and completely isolated from the other.

Figure 8. 4-wire ECT models are ideal for use where line (mains) power is readily available.


Figure 9. When ordered with the EM option, the ECT comes with an externally-mounted current transformer to "step down" high level signals.


Figure 10. With the -TX Transmitter Excitation option, the ECT will supply loop power to a 2-wire transmitter.


Figure 11. The ECT takes one process input and delivers two completely isolated signal outputs.


Flgure 12. The ECT takes two process inputs and delivers two completely isolated signal outputs.


Page 6

## Specifications

| Performance Accuracy: $\pm 0.1 \%$ of span Stability: $\pm 0.2 \%$ of reading per year <br> Isolation: WITHOUT -RF OPTION: 1500 V rms between input and ouput and power; WITH -RF OPTION: 500Vrms between input and output, 1500 V rms power terminals; DUAL I/O WITHOUT -RF OPTION: 1500 V rms Output Response Time: DC Input: 100 msec , maximum to $99 \%$ of output; AC Input: 400 msec , maximum, from $0-99 \%$ of output DC Input Resistance: 50 ohms Ripple: 10 mV peak-to-peak maximum measured across 250 ohm resistor Load Effect: $0.01 \%$ of span from $0-100 \%$ of rated output (current only) | Performance (continued) <br> Ambient Conditions | Power Supply Rejection: <br> Exceeds 90dB for current input unit Maximum Input <br> Overrange: Current inputs, $250 \%$ of full scale DC Voltage inputs $150 \%$ of full scale <br> Burden: 1V maximum with $4-20 \mathrm{~mA}$ input; 0.01 V maximum with 0-5A input <br> Output Current Limiting: 25mA, typical; 30mA, maximum <br> Operating Range: $-40^{\circ} \mathrm{C} \text { to }+85^{\circ} \mathrm{C}$ <br> $-40^{\circ} \mathrm{F}$ to $+185^{\circ} \mathrm{F}$ <br> Storage Range: <br> $-40^{\circ} \mathrm{C}$ to $+85^{\circ} \mathrm{C}$ <br> ( $-40^{\circ} \mathrm{F}$ to $+185^{\circ} \mathrm{F}$ ) <br> Ambient Temperature <br> Effect: $\pm 0.007 \%$ of span $/{ }^{\circ} \mathrm{C}$, typical; $\pm 0.015 \%$ of span $/{ }^{\circ} \mathrm{C}$, maximum <br> Relative Humidity: <br> $0-95 \%$ non-condensing | Ambient Conditions (Continued) <br> Adjustments <br> Weight | RFIEMI Protection: Less than $\pm 0.1 \%$ of span error when tested at $10 \mathrm{~V} / \mathrm{m} 920-1000 \mathrm{MHz}$ WITH -RF OPTION: Less than $\pm 0.1 \%$ of span error when tested at $30 \mathrm{~V} / \mathrm{m}$ @ $20-1000 \mathrm{MHz}$; DUAL I/O WITHOUT -RF OPTION: Output unaffected by more than $\pm 0.5 \%$ of span@ $10 \mathrm{~V} / \mathrm{M}$ $20-1000 \mathrm{MHz}$ <br> Common Mode <br> Rejection: <br> Exceeds $95 \mathrm{~dB} @ 60 \mathrm{~Hz}$ with <br> a limit of 1500 Vrms <br> Front panel pots <br> Span: $\pm 10 \%$ <br> Zero: $\pm 5 \%$ <br> (non-interactive when span is set first) <br> Single VO Channel: <br> 384 g ( 13.7 oz ) <br> Dual IVO Channels: <br> 431g (15.4 oz) |
| :---: | :---: | :---: | :---: | :---: |

## Ordering Information

| Unil | ': Input | Outpr | Power | Qptions : | Housing |
| :---: | :---: | :---: | :---: | :---: | :---: |
| ECT <br> 4-Wire <br> (Line/Mains) <br> Powered <br> Isolator/ <br> Converter | SINGLE INPUT CHANNEL: <br> 4-20MA into 50 ohms $1-5 \mathrm{~V}$ into 1 Mohm $0-10 \mathrm{~V}$ into 1 Mohm 0-150AC into 100 kohms 0-5AAC into 0.002 ohms <br> DUAL INPUT CHANNELS: 2X4-20MA into 25 ohms 2×1-5V into 1 Mohm 2X0-10V into 1 Mohm (Other AC ranges also available) | SINGLE OUTPUT <br> CHANNEL: <br> 4-20MA into <br> 1000 ohms <br> $0-10 \mathrm{~V}$ into <br> 5 kohms minimum <br> DUAL OUTPUT <br> CHANNELS: <br> 600 ohms <br> 2X1-5V into 5 kohms minimum <br> 2×0-10V into 5 kohms minimum <br> DUAL OUTPUT <br> CHANNELS <br> (Signal Splitter): <br> 2X4-20MA into <br> 600 ohms <br> (available with <br> 4-20mA input only) | $\begin{aligned} & 24 \mathrm{DC}, \pm 10 \% \\ & 117 \mathrm{AC}, \\ & 50 / 60 \mathrm{~Hz}, \pm 10 \% \\ & 230 \mathrm{AC}, \\ & 50 / 60 \mathrm{~Hz}, \pm 10 \% \\ & \text { (3 watts maximum } \\ & \text { for single channel } \\ & \text { models; } 5 \text { watts } \\ & \text { maximum for } \\ & \text { dual output } \\ & \text { channel models) } \end{aligned}$ | -EM Externally-mounted input transformer for current input (available with 0-5AAC input only) -TX 24 V transmitter excitation ( 16 V for $2 \times 4$ 20MA DUAL INPUT model) for powering a 2 -wire transmitter (available on 4-20mA input models only; standard on models with 2X4-20mA output) <br> -RF Enhanced RFI/EMI filtering provides $30 \mathrm{~V} / \mathrm{m}$ © $20-1000 \mathrm{MHz}$ protection with less than $\pm 0.1 \%$ of span error (-EM option required for $A C$ current input) <br> -EP External power, output stage powered by external source (only available on signal splitter in DIN housing) | DIN Aluminum DIN-style housing mounts on 32 mm G-type (EN50035) and 35 mm Top Hat (EN50022) rails FLB2 Externallymounted flange provides a secure mount and ensures resistance to vibration |

When ordering, specity: Unit / Input / Output / Power / Options [Housing]
Model number example: ECT / 1-5V / 4-20MA / 117AC /-RF [DIN]

## ECT-DIN

Signal Isolator, Converter, Repeater, Booster and Splitter

Figure 13. Dimensions for 2-Wire and 4-Wire ECT-DIN models


Table 1. Terminal Designations for 2-Wire Units

| 2-Wire Output-Loop <br> Powered Models |  |  |  |  |  |  | Top Terminals <br> (left to right) |  | Bottom Terminals <br> (left to right) |  |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Output-Loop Powered | +IN | -IN | +PS | -PS |  |  |  |  |  |  |
| Output-Loop Powered with-EM Option | CT/PT | CT/PT | +PS | -PS |  |  |  |  |  |  |
| 2-Wire Input-Loop <br> Powered Models | Top Terminals <br> (left to right) |  |  |  |  |  |  |  |  |  |
| Input-Loop Powered | +IN | -IN | +OUT | -OUT |  |  |  |  |  |  |

Table 4. Key to Table Abbreviations

| Key | Definition |
| :--- | :--- |
| A | Channel 1 on dual output models |
| B | Channel 2 on dual output models |
| AC | AC line power input |
| ACC | AC line power return (neutral) |
| CT/PT | Current Transformer/Potential Transformer input |
| DC | -OC power input |
| DCC | -DC power input |
| GND | Ground |
| IN | Input signal (+ or -) |
| OUT | Output signal (+ or -) |
| -TX | Transmitter excitation for powering 2-wire transmitter |

Table 2. Terminal Designations for 4-Wire Units

| 4-Wire (Line/Mains-Powered) Models | Top Terminals (left to right) |  |  | Bottom Terminals (left to right) |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | T1 | T2 | T3 | B1 | B2 | B3 | B4 | B5 | B6 | B7 | B8 |
| AC Power Single Inpul/Dual Outputs \&-TX | +TX | +IN | -IN | A +OUT | A.OUT | B +OUT | B-OUT |  | AC | ACC | GND |
| DC Power Single Inpul/ual Outputs \& -TX | +TX | $+1 \mathrm{~N}$ | -1N | A + OUT | A OUT | B +OUT | B.OUT |  | DC | OCC | GND |
|  | T1 | T2 | T3 | B1 | B2 | B3 | B4 | B5 | B6 |  |  |
| Power with AC Inputs or -EM Option |  | CT/PT | CT/PT | +OUT | -OUT |  | AC | ACC | GND |  |  |
| AC Power with -TX Option | +TX | $+\mathrm{IN}$ | -IN | +OUT | -OUT |  | AC | ACC | GND |  |  |
| Power with DC Inputs or - EM Option |  | CT/PT | CT/PT | +OUT | OUT |  | DC | DCC | GND |  |  |
| DC Power with .TX Option | +TX | +IN | $\cdot \mathrm{N}$ | +OUT | -OUT |  | DC | OCC | GND |  |  |

Table 3. Terminal Designations for 4-Wire Dual I/O Units

| 4-Wire (Line/Mains-Powered) Dual I/O Models | Top Terminals (left to right) |  |  |  |  |  |  |  |  | Bottom Terminals (left to right) |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | T1 | T2 | T3 | T4 | T5 | T6 | 77 | T8 | T9 | B1 | B2 | B3 | B4 | B5 | B6 | B7 | B8 | B9 |
| AC Power \& Dual Inputs/Dual Outputs | A + TX | $A+$ N | A - ${ }^{\text {N }}$ |  |  |  | B +TX | B $\operatorname{lin}$ | B-IN | A + OUT | A OUT |  | B +OUT | B -out |  | AC | ACC | GND |
| DC Power \& Dual Inputs/Dual Outputs | A + TX | $A+1 \mathrm{~N}$ | A- N |  |  |  | B +TX | $\mathrm{B}+\mathbb{N}$ | $\mathrm{B}-\mathrm{N}$ | A +OUT | A -OUT |  | $\mathrm{B}+\mathrm{OUT}$ | 3.OUT |  | DC | DCC | GND | AB.N. 40741712113

## SURGE DIVERTER \& SURGE REDUCTION FILTER

## 1. TDS1100 SURGE DIVERTER TECHNICAL DETAILS

2. DAR ALARM RELAY TECHNICAL DETAILS
3. TDF SURGE REDUCTION FILTER TECHNICAL DETAILS


- GRITEC 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 modüle
$\rightarrow 100 \mathrm{kA} 8 / 20$ maximum surge rating provides protection suitable for sub-distribution panels and along operationalilife.
- Available in various operating voltages to suit most common power distribution systems

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 TDS 1100 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.

CRTEC ${ }^{*}$ 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 TDS 1100 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.

| Model | TDS11002SR150 | TDS11002SR240 | TDS110025R277 | TDS11002SR560 |
| :---: | :---: | :---: | :---: | :---: |
| Nominal Voltage $U_{n}$ | 120-150V- | 220-240V- | 240-277V - | 480-560V- |
| Max. Cont. Operating Volizge $U_{\text {: }}$ | 170V- | 275V- | 320V- | $610 \mathrm{~V}-$ |
| Stand off Voltage | 240V - | 440 V - | 480 V - | $700 \mathrm{~V}-$ |
| Frequency | O. 100 Hz |  |  |  |
| Short Circuit Current Rating Is | 25kAIC |  |  |  |
| Required Back-up Fuse | 125AgL, il supply $>100 \mathrm{~A}$ |  |  |  |
| Technology Used | TO with thermal disconnect |  |  |  |
| Protection |  |  |  |  |
| Maximum Oischarge Current Imax | 100kA $8 / 20 \mu \mathrm{~s}$ |  |  |  |
| Nominal Discharge Current In | 50kA 8/20ws | 40kA 8/20 $/$ s | 40kA 8/20 $/ 5$ | 40kA $8 / 20 \mu \mathrm{~s}$ |
| Protection Modes | Single mode (L-G, L-N or N-G) |  |  |  |
| Vollage Protection Level Up © 3 3 A | <400V | $<700 \mathrm{~V}$ | $<800 \mathrm{~V}$ | < 1.6 kV |
| Vollage Protection Level Up © 20kA | $<650$ | < 1000 | < 1.1 kV | $<2 \mathrm{kV}$ |
| Alarms and Indicators |  |  |  |  |
| Status Indication | Mechanical fiag / remote contacts ( R model only) Change-over, $250 \mathrm{~V}-10.5 \mathrm{~A}$, max $1.5 \mathrm{~mm}^{2}$ ( H 14 AWG ) 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 | $\leq 35 \mathrm{~mm}^{2}$ (H2AWG) 50lid <br> $\leq 2.5 \mathrm{~mm}^{2}$ (\#4AWG) stranded |  |  |  |
| Mounting | 35 mm top hat DIN rail |  |  |  |
| Temperature | $-40^{\circ} \mathrm{C}$ to $+80^{\circ} \mathrm{C}$ ( $-40^{\circ} \mathrm{F}$ to $+176^{\circ} \mathrm{F}$ ) |  |  |  |
| Humidity | 0 to 90\% |  |  |  |
| Test Standards |  |  |  |  |
| Approvals | CE, IEC ${ }^{\text {4/ }} 61643-1, U^{*} 1449$ Pending |  |  |  |
| Surge Rated to Meel | IEC 61643-1 Class I and II ANSMEEE C62.41-1901 Cal A, Cal B, Cat C |  |  |  |

Due to a policy of continual product development, specifications are subject to change without notice.

## CRITEC DDVDAR/TDSSC

# DIN Decoupling Inductor/ DINLINE Alarm Relay \& Surge Counter 

Europe


- Use for decoupling of spark gaps and MOVs - allows correct
coordination of different SPD technologies
- $35 \mathrm{~mm}^{2}$ tunnel terminals - accepts large cable size
- 63A model features top and bottom terminals flexible installation
- The DINLINE Alarm Relay (DAR) is used with TDF products where alarm contacts are required for remote signaling
- The TDS-SC Surge Counter provides a non-resettable record of the number of surges diverted

Decoupling inductors are installed between spark gap and MOV protection devices to ensure correct coordination. As the decoupling inductors are installed in series with the load, two units are available, a compact unit for circuits up to 35A and a larger unit for 63A circuits.

The DAR (DINLINE Alarm Relay) can be connected to TDF units to provide potential free change-over alarm contacts. The TDS SC (Surge Counter) unit is designed to provide visual indication of the number of surges registered. It uses a current transformer through which the ground conductor connecting to one, or all, of the surge protection modules is fed. Current diverted by the operation of the surge module, which exceeds a 300A trip threshold, will be registered on the counter.


| Model | DDI 35 | DDI 63 | DAR275V | TDS SC |
| :---: | :---: | :---: | :---: | :---: |
| Item Number for Europe | 700465 | 700475 | 700900 | 701250 |
| Nominal Voliage Un | - | - | 20-110V-, 100-240V- | - |
| System Compatibility(1) | - | - | TN-C, TN-S, TN-C-S \& TT |  |
| Max. Cont. Operating Voltage $U_{c}$ | $500 \mathrm{~V} \sim 200 \mathrm{~V}$ - |  | 275 V | - |
| Stand-off Voltage | - | - | 275 V | - |
| Operating Current © Un | $-$ | $=$ | 20 mA | - |
| Frequency | 0 to 60 Hz |  |  | - |
| Max. Line Current $I_{1}$ | $35 A$ @ $40^{\circ} \mathrm{C}$ | 63A $940^{\circ} \mathrm{C}$ | - | - |
| Temperature Increase | $45^{\circ} \mathrm{C}$ © max line current ( 1.$)$ |  | - | - |
| Inductance | $7.5 \mu \mathrm{H}$ | $15 \mu \mathrm{H}$ | - | - |
| Resistance | $4.5 \mathrm{~m} \Omega$ | $1.7 \mathrm{~m} \Omega$ | - | - |
| Technology | - | - | CT - trip threshold 300A 8/20 |  |
| Status | - | - | Red/Green LEDs <br> Change-over contact"1 | Maximum count 9999 Non-resettable |
| Dimensions | $2 \mathrm{M} .90 \mathrm{~mm} \times 68 \mathrm{~mm} \times 36 \mathrm{~mm}$ ( $3.5^{\prime \prime} \times 2.6^{\prime \prime} \times 1.4^{\prime \prime}$ ) approx. | $4 \mathrm{M} .90 \mathrm{~mm} \times 68 \mathrm{~mm} \times 72 \mathrm{~mm}$ $\left(3.5^{\prime \prime} \times 2.6^{\circ} \times 2.8^{\circ}\right)$ approx. | 2 M . <br> $90 \mathrm{~mm} \times 68 \mathrm{~mm} \times 36 \mathrm{~mm}$ $\left(3.5^{\prime \prime} \times 2.6^{\prime \prime} \times 1.4^{\prime \prime}\right)(e$ | $\lg (T)$ |
| Weight | 0.45 kg (1 lb) approx. | $1 \mathrm{~kg}(2.2 \mathrm{lb})$ approx. | $0.2 \mathrm{~kg}(0.44 \mathrm{lb})$ |  |
| Enclosure | DiN 43880, UL94V-0 thermoplastic, IP 20 (NEMA-1) |  |  |  |
| Connection | $\begin{aligned} & \leq 35 \mathrm{~mm}^{2} \text { (\#2AWG) solid } \\ & \mathrm{s} 25 \mathrm{~mm}^{2} \text { (\#4AWG) stranded } \\ & \hline \end{aligned}$ |  | $1 \mathrm{~mm}^{2}$ to $6 \mathrm{~mm}^{2}$ (\#18AWG to \#10) |  |
| Mounting | 35 mm top hat DIN rail |  |  |  |
| Back-up Overcurrent Protection | 35A | 63A. | - | - |
| Temperature | $-40^{\circ} \mathrm{C}$ to $+70^{\circ} \mathrm{C}\left(-40^{\circ} \mathrm{F}\right.$ to $\left.+158^{\circ} \mathrm{F}\right)$ |  | $-35^{\circ} \mathrm{C}$ to $+55^{\circ} \mathrm{C}\left(-31^{\circ} \mathrm{F}\right.$ to $\left.+131^{\circ} \mathrm{F}\right)$ |  |
| Humidity | 0\% to 90\% |  |  |  |
| Warranty Approvals | $\begin{aligned} & 5 \text { years } \\ & \text { CE } \\ & \hline \end{aligned}$ |  | $\begin{aligned} & \text { CSAZ2. } 2 \\ & \text { C-Tick, AS 3260, CE } \end{aligned}$ | - |

(1) Form $C=$ Change-over contact (Form $C$ dry contact), 400V~/3A $1 \mathrm{~mm}^{2}$ to $6 \mathrm{~mm}^{2}$ (\#18AWG to \#10AWG) connecting wire

## CRITEC PTDF

## Transient Discriminating Filter



- In-line series protection
- High efficiency low pass sine wave filtering - ideal for the protection of switched mode power supplies
- Three modes of protection: L-N, L-PE \& N-PE
- 35 mm DIN rail mount - simple installation
- Transient Discriminating (TD) Technology provides increased service life
- LED status indication and opto-isolated output for remote status monitoring

The TDF series has been specifically designed for process control pplications to protect the switched mode power supply units on evices such as PLC controllers, SCADA systems and motor controllers. Units are UL Recognized and available for 3A, 10A and 20A loads and suitable for $110-120 \mathrm{~V}$ ac/dc and $220-240 \mathrm{Vac}$ circuits.

The TDF is a series connected, single phase surge filter providing an aggregate surge capacity of $50 \mathrm{kA}(8 / 20 \mu \mathrm{~s})$ across L-N, L-PE, and N-PE. The low pass filter provides up to 65 dB of attenuation to voltage transients. Not only does this reduce the residual letthrough voltage, but it also helps further reduce the steep voltage rate-of-rise providing superior protection for sensitive electronic equipment.

| Model | $\begin{aligned} & \text { TDF3A } \\ & 120 \mathrm{~V} \\ & \hline \end{aligned}$ | $\begin{aligned} & \text { TDF3A } \\ & 240 \mathrm{~V} \\ & \hline \end{aligned}$ | TDF10A 120 V | $\begin{aligned} & \text { TDF10A } \\ & 240 \mathrm{~V} \\ & \hline \end{aligned}$ | $\begin{aligned} & \text { TDF20A } \\ & 120 \mathrm{~V} \\ & \hline \end{aligned}$ | $\begin{aligned} & \text { TDF20A } \\ & 240 \mathrm{~V} \\ & \hline \end{aligned}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Item Number for Europe | 700001 | 700002 | 700003 | 700004 | 700005 | 700006 |
| Nominal Voltage $U_{n}$ | 120 V | 240 V | 120 V | 240 V | 120 V | 240 V |
| Distribution System | 1Ph 2W+G, TN-S \& TN-C-S |  |  |  |  |  |
| Max. Cont. Operating Voltage $U_{c}$ | 170 V | 340 V | 170 V | 340 V | 170 V | 340 V |
| Stand-off Voltage | 240 V | 400 V | 240 V | 400 V | 240 V | 400 V |
| Frequency | 0 to 60 Hz | 50/60Hz | 0 to 60Hz | 0 to 60Hz | 0 to 60 Hz | 50/60Hz |
| Max. Line Current IL | 3A |  | 10A |  | 20A |  |
| Operating Current @ $\mathrm{U}_{\mathrm{n}}$ | 135 mA | 1250 mA | 240 mA | 480 mA | 240 mA | 480 mA |
| Max. Discharge Current $I_{\text {max }}$ |  |  |  |  |  |  |
| Protection Modes | All modes protected |  |  |  |  |  |
| Technology | TD Technology In-line series low pass sine wave filter |  |  |  |  |  |
| $\begin{aligned} & \text { Voltage Protection Level Up } \\ & \text { @ } 500 \mathrm{~A}, 8 / 20 \mu \mathrm{~s} \text { (UL SVR) } \\ & @ \text { Cat } \mathrm{B} 3,3 \mathrm{kA} 8 / 20 \mu \mathrm{~s} \end{aligned}$ | $\begin{aligned} & 500 \mathrm{~V} \\ & <250 \mathrm{~V} \end{aligned}$ | $\left\lvert\, \begin{aligned} & 700 \mathrm{~V} \\ & <600 \mathrm{~V} \end{aligned}\right.$ | $\begin{aligned} & 500 \mathrm{~V} \\ & <250 \mathrm{~V} \end{aligned}$ | $\begin{aligned} & 700 \mathrm{~V} \\ & <600 \mathrm{~V} \end{aligned}$ | $\begin{aligned} & 500 \mathrm{~V} \\ & <250 \mathrm{~V} \end{aligned}$ | $\begin{aligned} & 700 \mathrm{~V} \\ & <600 \mathrm{~V} \end{aligned}$ |
| Filtering @100kHz | -62dB |  | -65dB |  | -53dB |  |
| Status | Green LED. On=Ok. Isolated opto-coupler output ${ }^{11}$ |  |  |  |  |  |
| Dimensions | $4 \mathrm{M} .90 \mathrm{~mm} \times 68 \mathrm{~mm} \times 72 \mathrm{~mm}$ $8 \mathrm{M} .90 \mathrm{~mm} \times 68 \mathrm{~mm} \times 144 \mathrm{~mm}$ <br> $\left(3.5^{\prime \prime} \times 2.6^{\prime \prime} \times 2.8^{\prime \prime}\right)$ $\left(3.5^{\prime \prime} \times 2.6^{\prime \prime} \times 5.6^{\prime \prime}\right)$ |  |  |  |  |  |
| Weight | $0.35 \mathrm{~kg} \mathrm{(0.77} \mathrm{lb)}$ ( $0.75 \mathrm{~kg}(0.77 \mathrm{lb})$ |  |  |  | $0.8 \mathrm{~kg}(1.7 \mathrm{lb})$ |  |
| Enclosure | DIN 43 880, UL94V-0 thermoplastic, IP 20 (NEMA-1) |  |  |  |  |  |
| Connection | $1 \mathrm{~mm}^{2}$ to $6 \mathrm{~mm}^{2}$ (\#18AWG to \#10) |  |  |  |  |  |
| Mounting | 35 mm top hat DIN rail |  |  |  |  |  |
| Back-up Overcurrent Protection | 3A |  | 10A |  | 20A |  |
| Temperature | $-35^{\circ} \mathrm{C}$ to $+55^{\circ} \mathrm{C}\left(-31^{\circ} \mathrm{F}\right.$ to $\left.+131^{\circ} \mathrm{F}\right)$ |  |  |  |  |  |
| Humidity | 0\% to 90\% |  |  |  |  |  |
| Warranty | 5 years |  |  |  |  |  |
| Approvals | Ut 1449, Ut 1283, CSA 22.2, C-Tick, CE (NOM 3A, 120V) |  |  |  |  |  |
| Surge Rated to Meet | ANSIAEEE C62.41.2 Cat A, Cat B, Cat C |  |  |  |  |  |

[^14]
## THERMOSTAT

## 1. FZK011 THERMOSTAT TECHNICAL DETAILS



B Adjustable temperature
A High switching capacity

- Small hysteresis

Terminals easily accessible

- Clip fixing

2. Change-over contact

The mechanical thermostat is used for controlling heating and cooling equipment, filter fans or signal devices. The thermostat registers the surrounding air and can switch both inductive and resistive loads via snap-action contact.

## C

Technical Data

| Switsh temperature difference | 4K ( $\pm$ 1.5K tolerance) |
| :---: | :---: |
| Sensor element | thermostatic bimetal |
| Comtact type | change-over snag-action contert. |
| Contact resistance | < 10 m 0 hm |
| Seryice life | $\geq 100,000 \mathrm{cyg} / \mathrm{cs}$ |
| Max. Switching capacity, NC | 250VAC, 10 (4) A |
|  | DC 30W |
| Max. Switthing capacity, NO | 250VAC, 5 (2) A |
|  | DC 30W |
| EMC | acc. to EN 55014-1-2. EN 61000-3-2, EN 61000-3-3 |
| Connection | 4-pole tambual for 2.5mm², clamping worque D.ENm |
| Mounting | clip for 35mm DIN rail. EN50022 |
| Casing | plastic according to UL.94 V-0, light grey |
| Dimensions | $67 \times 50 \times 38 \mathrm{~mm}$ |
| Weight | approx 0.10 kg |
| Fitting position | variable |
| Operating/Storage temperature | -20 to $+80^{\circ} \mathrm{C}\left(-4\right.$ to $+176^{\circ} 9 /-45$ to $+80^{\circ} \mathrm{C}\left(-49\right.$ to $\left.+176^{\circ} \mathrm{F}\right)$ |
| Protection type | 1P20 |
| Approvals | - |

"Connecting terminal "N" (AF heating resistor) causes the thermal feedback to work and so reduces the switch temperature difference to approx. 0.5K.


Load $1=$ Enclosure heater Load 2 = Filter fan, Cooling equipment, Signal device


Examples of connection

| Art No. | Operating valtaga* | Setting range |
| :---: | :---: | :---: |
| 01700.00 | 230 VAC | +5 to $+60^{\circ} \mathrm{C}$ |
| $01170.0-02$ | 230 VAC | -20 to $+30^{\circ} \mathrm{C}$ |

[^15]
## TIMER

## 1. IDEC DIGITAL TIMER TECHNICAL DETAILS

## 2. ELECTRONIC TIMING RELAY TECHNICAL DETAILS

## GT3D - Digital Timers

## Key features of the GT3D series include:

- Precise time setting using digital thumbwheel switches
- Elapsed or time remaining LCD display
- 6 time ranges, 16 timing functions
- Time delays up to 99.9 hours



## Specifications



## Part Number List

| Mode of Operation | Time Range | Output | Contact | Rated Vottage Code | Complate Part No. |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | 8-Pin | 11-Pin |
| 1-A: ON-delay 1 <br> 1-B: Interval 1 first <br> 1-C: Cycle 1 (Off first) <br> 1-D: Cycle 3 ( ON first) | 0.01 s to <br> 99.9 hours | 250 V AC, 3 A , <br> 3OV DC, 1A <br> (resistive load) | Delayed SPDT <br> + instantaneous SPDT | 100 to 240V AC ( $50 / 60 \mathrm{~Hz}$ ) | GT3D-2AF20 | GT3D-2EAF20 |
|  |  |  |  | 24V AC/DC | GT3D-2AD24 | - |
|  |  | 240 V AC, <br> 24V DC. 5A <br> (resistive load) | Delayed DPDT | 100 to 240 V AC $(50 / 60 \mathrm{~Hz})$ | GT3D-3AF20 | GT3D-3EAF20 |
|  |  |  |  | 24 V AC/DC | GT3D-3AD24 | - |



## Part Numbers: GT3D-8

| Made of Operation | $\begin{gathered} \text { Time } \\ \text { Range } \\ \hline \end{gathered}$ | Output | Contact | Rated Vottage Code | Complete Part Ho. (11-Pin) |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 1: ON-deley one-shot 1 <br> 2: Cycle one-shot <br> 3: 0 N -delay one-shot 2 | 0.01 s to 99.9 hours | 240 V AC/24V DC. 5 A (resistiva load) | Delayed DPDT | 100 to 240 V AC ( $50 / 60 \mathrm{~Hz}$ ) | GT3D-8AF20 |
|  |  |  |  | 24V AC/DC | GT30-8AD24 |

1. For wiring schematics and timing diagrams GT3D, see pages 815 to 822 .
2. For more details about time ranges, see instructions on page 823.
3. $A(11$-pin) and $B(11$-pin $)$ differ in the way inputs are wired.
4. For socket and accessory part numbers, see page 838 .
5. For timing diagrams oveview, see page 794.

## Timing Diagrams/Schematics

GT3D-2 Timing Diagrams
Delayed SPDT + Instantaneous SPDT


Interval 1


GT3D-3 Timing Diagrams
Delayed DPDT
Switches \& Pilot Liglits





Cycle 3
( 0 N first)
Time Remaining


## GT3D-4 Timing Diagrams

These timers require a start input. A gate and reset input are optional. Inputs are controlled by external pushbuttons. Reset occurs when the power is removed or when the reset input is supplied. The gate signal can be used to interrupt (freeze) timer functions. Timer functions resume when the gate input is removed. B style timers are not equipped for gate input.

## Delayed DPDT



## ON-Delay 1



## Interval 1

Time Remaining
1

Time Elapsed
1 - B

GT3D Series
Timers

GT3D-4 Timing Diagrams


Terminal Blocks

Timers

GT3D-4 Timing Diagrams


Signal ON/OFF-Delay 1
Time Remaining



Singal OFF-Delay 1
Time Remaining
$2-D$
Time Elapsed
$2-D$



## GT3D-4 Timing Diagrams



## GT3D-4 Timing Diagrams




Instructions: Setting GT3D-2, GT3D-3 Timers



It is important to remember that the © Time Range Selector not only selects the lime range but also influences the interpretation of the Digital Time Display. Changing the (T) Time Ronge Selector senting changes the units of time measurement (seconds, minutes, hours) as well os the decimal point location.

## Instructions: Setting GT3D-4 Timers



|  | Step 1 |  | Desired | lode/Selection: |  | Remarks |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Select the desired time display and operation modes. | Time Display Mode. | (1) Indicator Mode Selector | Operation Mode | (2) Operation Mode Selector | 1. Use a flat screwdriver to set the selectors. Since selectors do not tum all. the way around, both clockwise and counterclockwise rotation is necessary. <br> 2. The (1) Indicator Mode Selector determines whether the Digital Time Display shows the time elapsed or time remaining. The (2) Operation Mode Selector determines the desired operation mode. Decide which display and mode is desired; then use these two. selectors(1) to set the operation mode. <br> 3. When using the indicator mode setting "1," the (20peration Mode Selector has two blank modes which are not intended for use. When using mode setting "1," always have the operation mode selector set to A, B. C, or D. |
|  |  | Time elapsed | 1 | ON-delay 1 <br> Interval 1 <br> Cycle 1 <br> D: Cycle. 3 | $\begin{aligned} & A \\ & B \\ & C \\ & D \end{aligned}$ |  |
|  |  | Time remaining | 1 |  |  |  |
|  |  | Time elapsed | 2 | ON -delay 2 <br> Cycle 2 <br> Signal ON/OFF-delay 2 <br> Signal OFF-delay 1 <br> Interval 2 <br> One-shot cycle | $\begin{aligned} & A \\ & \text { B } \\ & C \\ & C \\ & D \\ & E \\ & F \end{aligned}$ |  |
|  |  | Time remaining | 2 |  |  |  |
| 帚 |  | Time elapsed | 3 | Signal ON/OFF-delay 2 <br> Signal OFF-delay 2 <br> One-shot 1 <br> One-shot 0 N -delay <br> One-shot 2 <br> Signal ON/OFF-delay 3 | A |  |
|  | Stap 2 | Desired Operation |  | Selection |  | Remarks |
|  | Select a time range that contains the desired period of time. | Base Time Ranges |  | (3) Time Range Selector |  | 1. The (3) Time Range Selector controls both the decimal point indicator ( $9.99,99.9,999$ ) and the time increment indicators $S$ (seconds), M (minutes), and H (hours). |
|  |  |  |  | Deciñal Point Indicator | Time Increinent Indicator |  |
|  |  | 0.01 seconds to 9.99 seconds |  | 9.99 | S |  |
|  |  | 0.1 seconds to 99.9 seconds |  | 99.9 |  | 2. Chose which base time range contains the targeted timer setting. Then use the (1) Time Range Selector to set the decimal point indicator and time increment indicator to its corresponding pair of sottings. |
|  |  | 1 second to 999 seconds |  | 999 |  |  |
|  |  | 0.1 minutes to 99.9 minutes |  | 99.9 | M | 3. Since these configurations offer a complete range of settings from 0.01 seconds to 99.9 hours, the setting of 9.99 for minutes and the 9.99 and 999 settings for hours are not listed and should not be used. |
|  |  | 1 minute to 999 minutes |  | 999 |  |  |
|  |  | 0.1 hours to 99.9 hours |  | 99.9 | H |  |
|  | Step 3 | Dessired Operatioñ |  | Selections |  | Remarks |
|  | Set the precise period of time desired by using the (4) Time Setting Digital Switch. |  |  |  |  | Use the © Time Setting Digital Switch to set the desired period of time. It is important to remember that the setting of the (3) Time Range Selector determines the units of time measurement as well as the implied decimal point location. |

It is important to remember that the $(1)$ Time Range Selector not only selects the time range but also influences the interpretation of the Digital Time Display.
Changing the © Time Range Selector setting changes the units of time measurement (seconds, minutes, hours) as well as the decimal point location.

## Instructions: Setting GT3D-8Timers



| Step, 1 | - Dosirad Made of. Operation |  |  | tion | Remarks |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Select the time display and operation modes. | Operation Miode | Time Display Mode | (1) Indicator | Iode Solector | 1. Use a flat screwdriver to set the selectors. Since selectors do not tum all the way around, both clockwise and counterlockwise rotation is necessary. <br> 2. The GT3D-8 © Indicator Mode Selector selects both whether the Digital Time Display displays the time elapsed or time remaining and also the mode of operation. Decide which display and mode is desired. Then.use this selector to set the operation mode. |
|  | ON-Delay One-Shot | Time elapsed |  |  |  |
|  |  | Time remaining |  |  |  |
|  | Cycle One-Shot | Time elapsed |  |  |  |
|  |  | Time remaining |  |  |  |
|  | ON-Delay One-Shot 2 | Time elapsed |  | 3 |  |
|  |  | Time remaining |  | 3 |  |
| Stup 2 | Desired Mode of Operation |  | Sele | ction | Rëmarks |
| Select the single shot output time. | Desired Si Output | ingle-Shot Time | (2) Single Time | hot Output elactor | On the GT3D-8 timers, the desired single-shot output time can be selected from the A, B, C, D, E, and F modes using the (2) Dne-Shot Dutput Time Selector. |
|  | 0.1 seconds |  |  | A |  |
|  | 0.5 seconds |  |  | B |  |
|  | 1 second |  | D |  |  |
|  | 5 seconds |  |  |  |  |
|  | 10 seconds |  | E |  |  |
|  | 50 seconds |  | F |  |  |
| Stop 3 | \% Dosired Operation |  | Selection |  | R Remarks |
| Select a time range that contains the desired period of time. | Bäse Time Ranges |  | (1) Time Range Selector |  | 1. The (3) Time Renge Selector controls both the decimal point indicator ( $9.99,99.9 .999$ ) and the time increment indicators S .(seconds). M (minutes), and H (hours). <br> 2. Chose which base time range contains the targeted timer setting. Then use the ( 1 Time Range Selector to set the decimal point indica tor and time increment indicator to its corresponding pair of settings. 3. Since these configurations offer a complete range of settings from 0.01 seconds to 99.9 hours, the setting of 9.99 for minutes and the 9.99 and 999 settings for hours are not listed and should not be used. |
|  |  |  | Dacimál Pöint Indicator | Time Increment Indicator |  |
|  | 0.01 seconds to 9.99 seconds |  | 9.99. | S |  |
|  | 0.1 seconds to 99.9 seconds |  | 99.9 |  |  |
|  | 1 second to 999 seconds |  | 999 |  |  |
|  | 0.1 minutes to 99.9 minutes |  | 99.9 | M |  |
|  | 1 minute to 999 minutes |  | 999. |  |  |
|  | 0.1 hours to 99.9 hours |  | 99.9 | H |  |
| Step 4 | Dasiried Operation |  | 1. Seloction |  | Remarks |
| Set the precise period of time desired by using the © Time Setting Digital Switch. |  |  |  |  | Use the (4) Tiṃe Setting Digital Switch to set the desired period of time. It is important to remember that the setting of the (1) Time Range Selector determines the units of time measurement as well as the implied decimal point location. |

It is important to remember that the (©) Time Range Selector not only selects the time range but also influences the interpretation of the Digital Time Display. Changing the (I) Time fange Selector setting changes the units of time measurement (seconds, minutes, hours) as well as the decimal point location.


## Panel Mounting Accessories

Panel Mount Sockets and Hold-Down Springs

| . . . | Panel Mount Socket |  |  | Applicable HD Springs |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Style | Appearance | Usa with Timers | Part No. | Appearance | Part No. |
| 8-Pin Solder Terminal |  | GT3A- (8-pin) <br> GT3D-(8-pin) <br> GT3W-(8-pin) <br> GT3F-(B-pin) GT3S | SR2P-51 |  |  |
| 11-Pin Solder Terminal |  | GT3A-(11-pin) <br> GT3D-(11-pin) <br> GT3W- (11-pin) <br> GT3F-(11-pin) | SR3P-51 |  |  |

For information on installing the hold-down springs, see page 838

Flush Panel Mount Adapter and Sockets that use an Adapter

| Accessory ${ }^{+}$ | $\cdots$ Description | Appearance | Use with Timers | Part No. | $\stackrel{\text { P }}{\text { \% }}$ |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Panel Mount Adapter | Adaptor for flush panel mourting GT3 timers |  | All GT3 timers | RTB-G01 | $\begin{aligned} & \infty \\ & \infty \\ & \infty \\ & \frac{0}{\pi} \\ & \frac{\pi}{\infty} \end{aligned}$ |
| Sockets for use with Panel Mount Adapter | 8-pin screw terminal |  | All 8 -pin timers | SR6P-M08G | 0 |
|  | 11-pin screw terminal | (Shown: SR6P-M08G for Wiring Socket Adapter) | All 11-pin timers | SR6P-M11G |  |
|  | 8-pin solder terminal |  | All 8 -pin timers | SR6P-S08 |  |
|  | 11-pin solder terminal |  | All 11-pin timers | SR6P-S11 |  |
| $A$ <br> No hold down springs are available for flush panel mounting. |  |  |  |  |  |

## Instructions: Wiring Inputs for GT3 Series



Input signal lines must be made as short as possible and installed away from power cables and power lines. Use shielded wires or a separate conduit for input wiring.

## Inputs Instructions, continued

For contact input, use gold-plated contacts to make sure that the residual voltage is less than 1 V when the contacts are closed.


For transistor input, use transistors with the following specifications; $V C E=40 \mathrm{~V}, \mathrm{VCES}=1 \mathrm{~V}$ or less, $\mathrm{IC}=50 \mathrm{~mA}$ or more, and $I C B O=50 \mu \mathrm{~A}$ or less. The resistance should be less than $1 \mathrm{k} \Omega$ when the transistor is on. When the output transistor switches on, a signal is input to the timer.


Inputs: GT3A-1, -2, -3
Transistor output equipment such as proximity switches and photoelectric switches can input signals if they are voltage/current output type, with power voltage ranges from 18 to 30 V and have 1 V . When the signal voltage switches from H to L , a signal is input to the timer

Inputs: GT3A-4, -5, $\mathbf{- 6}$

| Start Input | The start input initiates a time-delay operation and controls <br> output status. | No-voltage contact inputs and NPN open collector transis- <br> tor inputs are applicable. |
| :--- | :--- | :--- |
| Reset Input | When the reset input is activated, the time is reset, and <br> contacts return to original state. | 24V DC. 1mA maximum |
| Gate Input | The time-delay operation is suspended while the gate input <br> is on (pause). | Input response time: 50msec maximum |

## Dimensions

suy 6 ! IDI!d 8 say.ums

Display Lights
Analog GT3 Timer, 8-Pin with SR2P-06


Digital GT3 Timer, 8-Pin with SR2P-06


Analog GT3 Timer, 11-Pin with SR3P-05


Analog GT3 Timer, 11-Pin with SR3P-06


Digital GT3 Timer, 11-Pin with SR3P-06


Digital GT3 Timer, 11-Pin with SR3P-05


## Panel Mount Adapter

Analog GT3 Timer, 8-Pin and 11-Pin with SR6P-S08 or SR6P-S11


Digital GT3 Timer, 8-Pin and 11-Pin with SR6P-S08 or SR6P-S11


Mounting Hole Layout


Tolerance: +0.5 to 0 N : No. of timers mounted

Analog and Digital GT3 Timer, 8-Pin with SR6P-M08G



# General Instructions for All Timer Series 

## Enviranment

Avoid contact between the timer and sulfurous or ammonia gases, organic solvents (alcohol, benzine, thinner, etc.), strong alkaline substances, or strong acids. Do not use the timer in an environment where such substances are prevalent. Do not allow water to run or splash on the timer.

## Load Current

With inductive, capacitive, and incandescent lamp loads, inrush current more than 10 times the rated current may cause welded contacts and other undesired effects. The inrush current and steady-state current must be taken into consideration when specifying a timer.

## Contact Protection

Switching an inductive load generates a counter-electromotive force (back EMF) in the coil. The back EMF will cause arcing, which may shorten the contact life and cause imperfect contact. Application of a protection circuit is recommended to safeguard the contacts.

## Temperature and Humidity

Use the timer within the operating temperature and operating humidity ranges and prevent freezing or condensation. After the timer has been stored below its operating temperature, leave the timer at room temperature for a sufficient period of time to allow it to return to operating temperatures before use. not allow water to run or splash on the timer

## Vibration and Shock

Excessive vibration or shocks can cause the output contacts to bounce, the timer should be used only within the operating extremes for vibration and shock resistance. In applications with significant vibration or shock, use of hold down springs or clips is recommended to secure a timer to its socket.

## Time Setting

The time range is calibrated at its maximum time scale; so it is desirable to use the timer at a setting as close to its maximum time scale as possible. For a more accurate time delay, adjust the control knob by measuring the operating time with a watch before application.

## Input Contacts

Use mechanical contact switch or relay to supply power to the timer. When driving the timer with a solid-state output device (such as a two-wire proximity switch, photoelectric switch, or solid-state relay), malfunction may be caused by leakage current from the solid-state device. Since AC types comprise a capacitive load, the SSR dielectric strength should be two or more times the power voltage when switching the timer power using an SSR.

Generally, it is desirable to use mechanical contacts whenever possible to apply power to a timer or its signal inputs. When using solid state devices, be cautious of inrushes and back-EMF that may exceed the ratings on such devices. Some timers are specialiy designed so that signal inputs switch at a lower voltage than is used to power the timer (models designated as " $B$ " type).

## Timing Accuracy Formulas

Timing accuracies are calculated from the following formulas:

| Repeat Error | $= \pm \frac{1 \times \text { Maximum Measured Value }- \text { Minimum Measured Value } \times 100 \%}{2 \text { Maximum Scale Value }}$ |
| :--- | :--- |
| Voltage Error | $= \pm \frac{\mathrm{TV}-\operatorname{Tr} \times 100 \%}{\mathrm{Tr}}$ |

Tv: Average of measured values at voltage $V$
Ir: Average of measured values at the rated voltage

## Temperature Error

$$
= \pm \frac{\mathrm{Tt}-\mathrm{T} 20 \times 100 \%}{\mathrm{~T} 20}
$$

Tt: Average of measured values at ${ }^{\circ} \mathrm{C}$
T20: Average of measured values at $20^{\circ} \mathrm{C}$
Setting Error

$$
= \pm \frac{\text { Average of Measured Values }- \text { Set Value } \times 100 \%}{\text { Maximum Scale Value }}
$$

Technical Data


## $\square H$ <br> Dimensions



Panel Mount Adaptor (26.506.221-01)

- Dimensions are in millimeters
- Dimensions not intended for manufacturing purposes



## 1. VARIABLE SPEED DRIVE TECHNICAL DETAILS

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## 5how to Read theseorereing tastructions

## VLT AQUA Drive FC 200 Series <br> Software version: 1.33



This guide can be used with all FC 200 frequency converters with software version 1.33 or later.
The actual software version number can be read from par. 15-43 Software Version.

### 1.1.1 Copyright, limitation of liability and revision rights

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### 1.1.2 Available literature for VLT ${ }^{\circledR}$ AQUA Drive FC 200

- VLT® ${ }^{(8)}$ AQUA Drive Operating Instructions MG.20.Mx.yy provide the neccessary information for getting the drive up and running.
- VLT ${ }^{\text {® }}$ AQUA Drive High Power Operating Instructions MG.20.Px.yy provide the neccessary information for getting the HP drive up and running.
- VLT ${ }^{(8)}$ AQUA Drive Design Guide MG.20.Nx.yy entails all technical information about the orive and customer design and applications.
- VLT ${ }^{\text {© }}$ AQUA Drive Programming Guide MN.20.Ox.yy provides information on how to programme and includes complete parameter descriptions.
- VLT© AQUA Drive FC 200 Profibus MG.33.Cx.yy
- VLT® AQUA Drive FC 200 DeviceNet MG.33.Dx.yy
- Output Filters Design Guide MG.90.Nx.yy
- VLTB AQUA Drive FC 200 Cascade Controller MI.38.Cx.vy
- Application Note MN20A102: Submersible Pump Application
- Application Note MN20B102: Master/Follower Operation Application
- Application Note MN20F102: Drive Closed Loop and Sleep Mode
- Instruction MI.38.Bx.yy: Installation Instruction for Mounting Brackets Enclosure type A5, B1, B2, C1 and C2 IP21, IP55 or IP66
- Instruction MI.90.Lx.yy: Analog I/O Option MCB109
- Instruction MI.33.Hx.yy: Panel through mount kit
$x=$ Revision number
$y y=$ Language code

Danfoss technical literature is also available online at
unw.danfoss.com/BusinessAreas/DrivesSolutions/Documentations/Technical+Documentation.htm.

### 1.1.3 Approvals

### 1.1.4 Symbols

Symbols used in these Operating Instructions.


- Indicates default setting


## 

### 2.1.1 Safety note

## Safety Regulations

1. The frequency converter must be disconnected from mains if repair work is to be carried out. Check that the mains supply has been disconnected and that the necessary time has passed before removing motor and mains plugs.
2. The [STOP/RESET] key on the control panel of the frequency converter does not disconnect the equipment from mains and is thus not to be used as a safety switch.
3. Correct protective earthing of the equipment must be established, the user must be protected against supply voltage, and the motor must be protected against overload in accordance with applicable national and local regulations.
4. The earth leakage currents are higher than 3.5 mA .
5. Protection against motor overload is set by par. 1-90 Motor Thermal Protection. If this function is desired, set par. 1-90 to data value [ETR trip] (default value) or data value [ETR warning]. Note: The function is initialised at $1.16 \times$ rated motor current and rated motor frequency. For the North American market: The ETR functions provide class 20 motor overioad protection in accordance with NEC.
6. Do not remove the plugs for the motor and mains supply while the frequency converter is connected to mains. Check that the mains supply has been disconnected and that the necessary time has passed before removing motor and mains plugs.
7. Please note that the frequency converter has voltage inputs other than $L 1, L 2$ and $L 3$, when load sharing (linking of $D C$ intermediate circuit) and external 24 V DC have been installed. Check that all voltage inputs have been disconnected and that the necessary time has passed before commencing repair work.
Installation at High Altitudes


## Installation at high altitude:

380-480 V: At altitudes above 3 km , please contact Danfoss Drives regarding PELV.
525-690 V: At altitudes above 2 km , please contact Danfoss Drives regarding PELV.

## Warning against Unintended Start

1. The motor can be brought to a stop by means of digital commands, bus commands, references or a local stop, while the frequency converter is connected to mains. If personal safety considerations make it necessary to ensure that no unintended start occurs, these stop functions are not sufficient. 2. While parameters are being changed, the motor may start. Consequently, the stop key [RESET] must always be activated; following which data can be modified. 3. A motor that has been stopped may start if faults occur in the electronics of the frequency converter, or if a temporary overload or a fault in the supply mains or the motor connection ceases.


## Warning:

Touching the electrical parts may be fatal - even after the equipment has been disconnected from mains.

Also make sure that other voltage inputs have been disconnected, such as external 24 VDC , load sharing (linkage of DC intermediate circuit), as well as the motor connection for kinetic back up.

### 2.1.2 General warning

Leakage Current<br>The earth leakage current from the VLT AQUA Drive FC 200 exceeds 3.5 mA . According to IEC 61800-5-1 a reinforced Protective Earth connection must be ensured by means of: a min. $10 \mathrm{~mm}^{2} \mathrm{Cu}$ or $16 \mathrm{~mm}^{2} \mathrm{Al}$ PE-wire or an addtional PE wire - with the same cable cross section as the Mains wiring - must be terminated separately.<br>\section*{Residual Current Device}<br>This product can cause a D.C. current in the protective conductor. Where a residual current device ( $R C D$ ) is used for extra protection, only an RCD of Type B (time delayed) shall be used on the supply side of this product. See also RCD Application Note MN.90.GX.02. Protective earthing of the VLT AQUA Drive FC 200 and the use of RCD's must always follow national and local regulations.

### 2.1.3 Before commencing repair work

1. Disconnect the frequency converter from mains
2. Disconnect DC bus terminals 88 and 89
3. Wait at least the time mentioned in section General Warning above
4. Remove motor cable

### 2.1.4 Special conditions

## Electrical ratings:

The rating indicated on the nameplate of the frequency converter is based on a typical 3-phase mains power supply, within the specified voltage, current and temperature range, which is expected to be used in most applications.
The frequency converters also support other special applications, which affect the electrical ratings of the frequency converter. Special conditions which affect the electrical ratings might be:

- Single phase applications
- High temperature applications which require derating of the electrical ratings
- Marine applications with more severe environmental conditions.

Consult the relevant clauses in these instructions and in the VLT ${ }^{*}$ AQUA Drive Design Guide for information about the electrical ratings.

## Installation requirements:

The overall electrical safety of the frequency converter requires special installation considerations regarding:

- Fuses and circuit breakers for over-current and short-circuit protection
- Selection of power cables (mains, motor, brake, loadsharing and relay)
- Grid configuration (П,TN, grounded leg, etc.)
- Safety of low-voltage ports (PELV conditions).

Consult the relevant clauses in these instructions and in the VLT AQUA Drive Design Guide for information about the installation requirements.

### 2.1.5 Caution

The frequency converter DC link capacitors remain charged after power has been disconnected. To avoid an electrical shock hazard, disconnect the frequency converter from the mains before carrying out maintenance. Wait at least as follows before doing service on the frequency converter:


### 2.1.6 Avoid un-intended start

## NB!

While the frequency converter is connected to mains, the motor can be started/stopped using digital commands, bus commands, references or via the Local Control Panel.

- Disconnect the frequency converter from mains whenever personal safety considerations make it necessary to avoid unintended start.
- To avoid unintended start, always activate the [OFF] key before changing parameters.
- Unless terminal 37 is turned off, an electronic fault, temporary overload, a fault in the mains supply, or lost motor connection may cause a stopped motor to start.


### 2.1.7 IT mains



## IT mains

Do not connect frequency converters with RFI-filters to mains supplies with a voltage between phase and earth of more than 440 V for 400 V converters and 760 V for 690 V converters.
For 400 V IT mains and delta earth (grounded leg), mains voltage may exceed 440 V between phase and earth.
For 690 V IT mains and delta earth (grounded leg), mains voltage may exceed 760 V between phase and earth.
par. 14-50 RFI Filter can be used to disconnect the internal RFI capacitors from the RFI filter to ground.

### 2.1.8 Disposal instruction



Equipment containing electrical components must not be disposed of together with domestic waste. It must be separately collected with electrical and electronic waste according to local and currently valid legislation.

### 2.1.9 Safe Stop of the frequency converter (optional)

For versions fitted with a Safe Stop terminal 37 input, the frequency converter can perform the safety function Safe Torque Off (As defined by draft CD IEC 61800-5-2) or Stop Category $O$ (as defined in EN 60204-1).

It is designed and approved suitable for the requirements of Safety Category 3 in EN 954-1. This functionality is called Safe Stop. Prior to integration and use of Safe Stop in an installation, a thorough risk analysis on the installation must be carried out in order to determine whether the Safe Stop functionality and safety category are appropriate and sufficient. In order to install and use the Safe Stop function in accordance with the requirements of Safety Category 3 in EN 954-1, the related information and instructions of the VLT AQUA Drive Design Guide MG.20.NX.YY must be followed! The information and instructions of the Operating Instructions are not sufficient for a correct and safe use of the Safe Stop functionality!

Prüf－und Zertifizierungsstelle im BG－PRÜFZERT


BGIA
Berufsgenossenschaftliches Institut für Arbeilsschutz

Hauptverband der gowerblichen Berufsgenossenschuffen
Tranalation
In amy coss，The German
original shall provail．

Type Test Certificate

| 0506004 |
| :--- |
| No．of cortificate |


| Nome and address of the <br> holder of the cortificals： <br> （eustomer） | Danfoss Drives A／S，Ulnaes 1 <br> DK 6300 Groosten，Dönemark |
| :--- | :--- |
| Nome and address of the Donfoss Drives A／S，Ulnaes 1 <br> manufacturer： DK－ 6300 Groasten，Dänemark |  |


| Ref．of customer： | Ref．of Test and Cortification Body： <br> Api／Köh VE－Nr． 200323220 | Dato of hssue： <br> 13.04 .2005 |
| :--- | :--- | :--- |

Produd dasignation：Frequency converter with integrated sofety functions

Typ：$\quad$ VLT® Automation Drive FC 302
Intendod purpose：Implementation of sofety function＂Sofe Stop＂

Tosting beisod on：EN 954－1，1997－03，
DKE AK 226．03，1998－06，
EN ISO 13849－2；2003．12，
EN 61800－3，2001：02，
EN 61800－5－1，2003－09；
Test contificote：$\quad$ No．：2003．23220 from 13．04．2005
Romanks：The presented types of the frequency converter FC 302 meet the requirements laid down in the test boses．
With correct wiring o cotegory 3 according to DIN EN 954． 1 is reached for the safety function．

The type tested complies with the provisions laid down in the directive 98／37／EC（Mochinery）．

Funther conditions are laid down in the Rulos of Procedure for Teating and Centification of April 2004.
Hood of contifigation body

Certification officer

（Dipl．－Ing．R．Apfold）


## Brifioduction

### 3.1.1 Type code string - medium power





Table 3.1: Type code description.

### 3.1.2 Frequency converter identification

Below is an example of an identification label. This label is situated on the frequency converter and shows the type and options fitted to the unit. See table 2.1 for details of how to read theType code string (T/C).


Illustration 3.1: This example shows an identification label for VLT AQUA Drive.

Please have T/C (type code) number and serial number ready before contacting Danfoss.

### 3.1.3 Abbreviations and standards

| Abbreviations: | Terms: | SI-units: | I-P units: |
| :---: | :---: | :---: | :---: |
| a | Acceleration | $\mathrm{m} / \mathrm{s}^{2}$ | $\mathrm{f} / \mathrm{s}^{2}$ |
| AWG | American wire gauge |  |  |
| Auto Tune | Automatic. Motor Tuning |  |  |
| ${ }^{\circ} \mathrm{C}$ | Celsius |  |  |
| 1 | Cument | A | Amp |
| ILM | Current limit |  |  |
| Joule | Energy | J=N:m | f-lib, Btu |
| ${ }^{\circ} \mathrm{F}$ | Fahrenheit |  |  |
| FC | Frequency Converter. |  |  |
| $f$ | Frequency | Hz | Hz |
| kt | Kilohertz | ldz | Ut |
| LCP | Local Control Panel |  |  |
| mA | Milliampere |  |  |
| ms | Millisecond |  |  |
| min | Minute |  |  |
| MCT | Motion Control Tool |  |  |
| M-TYPE | Motor Type Dependent |  |  |
| Nm | Newton Metres |  | in-10s |
| InN | Nominal motor aument |  |  |
| $\mathrm{fm}_{\mathrm{M}, \mathrm{N}}$ | Nominal motor frequency |  |  |
| PMN | Nominal motor power: |  |  |
| $U_{M, N}$ | Nominal motor voltage |  |  |
| рar. | Parameter |  |  |
| PELV | Protective Extra Low Voltage |  |  |
| Watt | Power | W | Btu/hr, hp |
| Pascal | Pressure | $\mathrm{Pa}=\mathrm{N} / \mathrm{m}^{2}$ | psi, psf, ft of water |
| Invi | Rated Inverter Output Current |  |  |
| RPM | Revolutions Per Minute |  |  |
| SR | Size Related |  |  |
| T | Temperature | C | F |
| t | Time | 5 | S,hr |
| Tum | Torque limit |  |  |
| U | Voltage | V | V |

Table 3.2: Abbreviation and standards table .

## 4 Medhancell fristandion

### 4.1 Before starting

### 4.1.1 Checklist

When unpacking the frequency converter, ensure that the unit is undamaged and complete. Use the following table to identify the packaging:

| Enclosure type: | $\begin{gathered} \text { A2 } \\ \text { (IP 20/21) } \end{gathered}$ | $\begin{gathered} \text { A3 } \\ \text { (IP 20/21) } \\ \hline \end{gathered}$ | $\begin{gathered} \text { A5 } \\ \text { (IP } 55 / 66 \text { ) } \end{gathered}$ | $\begin{gathered} \mathrm{B} 1 / \mathrm{B} 3 \\ (\mathrm{IP} 20 / 21 / 55 / 66) \end{gathered}$ | $\left\lvert\, \begin{gathered} \mathrm{B} 2 / \mathrm{B4} \\ (\mathrm{IP} 20 / 21 / 55 / 66) \end{gathered}\right.$ | $\begin{gathered} \mathrm{C} 1 / \mathrm{C} 3 \\ (\mathrm{IP} 20 / 21 / 55 / 66) \end{gathered}$ | $\begin{gathered} \mathrm{C} 2 / \mathrm{C} 4 \\ (\mathrm{IP} 20 / 21 / 55 / 66) \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  |  |
| Unit size (kW): |  |  |  |  |  |  |  |
| $200-240 \mathrm{~V}$ | 0.25-3.0 | 3.7 | 0.25-3.7 | $\begin{gathered} 5.5-11 / \\ 5.5-11 \end{gathered}$ | $\begin{gathered} \hline 15 / \\ 15-18.5 \end{gathered}$ | $\begin{gathered} \hline 18.5-30 / \\ 22-30 \\ \hline \end{gathered}$ | $\begin{aligned} & 37-45 / \\ & 37-45 \end{aligned}$ |
| $380-480 \mathrm{~V}$ | 0.37-4.0 | 5.5-7.5 | 0.37-7.5 | $\begin{gathered} 11-18.5 / \\ 11-18.5 \end{gathered}$ | $\begin{gathered} 22-30 / \\ 22 \cdot 37 \end{gathered}$ | $\begin{aligned} & 37-55 / \\ & 45-55 \end{aligned}$ | $\begin{gathered} 75-90 / \\ 75-90 \end{gathered}$ |
| $525-600 \mathrm{~V}$ |  | 0.75-7.5 | 0.75-7.5 | $\begin{gathered} 11-18.5 / \\ 11-18.5 \end{gathered}$ | $\begin{gathered} 22-371 \\ 22-37 \end{gathered}$ | $\begin{gathered} 45-55 / \\ 45-55 \end{gathered}$ | $\begin{gathered} 75-90 / \\ 75-90 \end{gathered}$ |
| $525-690 \mathrm{~V}$ | - | - | - | $\%$ | 11-30/ | $-1$ | 37-90/ |

[^16]Please note that a selection of screwdrivers (philips or cross-thread screwdriver and torx), a side-cutter, drill and knife is also recommended to have handy for unpacking and mounting the frequency converter. The packaging for these enclosures contains, as shown: Accessories bag(s), documentation and the unit. Depending on options fitted there may be one or two bags and one or more booklets.
4.2.1 Mechanical front views

| A2 | A3 | A5 | B1 | B2 | B3 | B4 | C1 | C2 | C3 | C4 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  |  |  |  |  |
| IP20/21* | [P20/21* | IP55/66 | IP21/55/66 | 1P21/55/66 | IP20/21* | IP20/21* | IP21/55/66 | IP21/55/66 | IP20/21* | IP20/21* |
| Illustration 4.1: Top and bottom mounting holes. |  |  |  |  |  |  | Illustration 4.2 | Top and bottom mount | gholes. ( $B 4+C 3+C 4$ only |  |

### 4.2.2 Mechanical dimensions

| Frame'slze (kW) : sefation |  | - Mechanical dimensions |  |  |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | $\frac{C 1}{18.5-30}$ | $\frac{C 2}{37-45}$ | $\frac{C 3}{22-30}$ | C4 |
| 200-240 V | T2 |  |  |  |  |  |  |  |  |  | $0.25-3.0$ |  | 3.7 |  | 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 V | T4 | $\begin{aligned} & 5.5-7.5 \\ & 0.75-7.5 \end{aligned}$ |  | 0.37-7.5 | 11-18.5 | 22-30 | 11-18.5 | 22-37 | 37-55 | 75-90 |  |  | 45-55 | 75-90 |
| 525-600 V | T6 |  |  | - |  | 0.75-7.5 | 11-18.5 | 22-30 | 11-18.5 | 22-37 | 37-55 | 75-90 | 45-55 | 75-90 |
| 525-690 V | T7 |  |  |  |  | - | - | 11-30 | 11- | - | - | 37-90 | - | - |
| $\prod_{\text {NEMA }}^{\text {IP }}$ |  | $\stackrel{.20}{C^{20}}$ | $\begin{aligned} & 21 \\ & \text { Type } 1 \end{aligned}$ | $\begin{gathered} 20^{-} \\ \text {chassis } \end{gathered}$ | $\begin{gathered} 21 \\ \text { Type } 1 \end{gathered}$ | $=55 / 66$ <br> Type 12 | 21/55/66 <br> Type 1/12 | 21/55/66 <br> Type 1/12 | $\begin{aligned} & 20 \\ & \text { Chasss: } \end{aligned}$ | $\begin{gathered} 20 \\ \text { Chassis } \\ \hline \end{gathered}$ | $\begin{aligned} & 21 / 55 / 66 \\ & \text { Type } 1 / 12 \\ & \hline \end{aligned}$ | $\begin{array}{\|c\|} \hline 21 / 55 / 66 \\ \text { Type 1/12 } \end{array}$ | $\begin{aligned} & -20 \\ & \text { Chassis } \end{aligned}$ | $\begin{gathered} 20 \div \\ \text { Chassis } \end{gathered}$ |
| Height (mm) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Enidosure | $A^{* *}$ | 246 | 372 | 246 | 372. | 420 | 480 | 650 | 350 | 460 | 680 | 770 | 490 | 600 |
| ..with de-coupling plate | A2 | 374 | - | 374 |  | - | . | - | 419 | 595 | - | . | 630 | 800 |
| Back plate | A1 | 268 | 375 | 268 | 375 | 420 | 480 | - 650 | 399. | 520 | 680 | 770. | 550 | 660 |
| Distance between mount. holes | a | 257 | 350 | 257 | 350 | 402 | 454 | 624 | 380 | 495 | 648 | 739 | 521 | 631 |
| Whath (mm) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Enclosure | B | 90 | 90 | 130 | 130 | 242 | 242 | 242 | 165 | 231 | 308 | 370 | 308 | 370 |
| With one C option | B | 130 | 130 | 170 | 170 | 242 | 242 | 242 | 205 | 231 | 308 | 370 | 308 | 370 |
| Back plate | B | 90 | 90 | 130 | 130 | 242 | 242 | 242 | 165 | 231 | 308 | 370 | 308 | 370 |
| Distance between mount. holes | b | 70 | 70 | 110 | 110 | 215 | 210 | 210 | 140 | 200 | 272 | 334 | 270 | 330 |
| Depth (mm) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Whthout option A/B | C | 205. | 205 | 205 | 205. | $\because 200$ | $260^{\circ}$ | -260 | 248 | 242 | 310 | 335 | 333 | 333 |
| With option $A / B$ | C* | 220 | 220 | 220 | 220 | 200 | 260 | 260 | 262 | 242 | 310 | 335 | 333 | 333 |
| Screw holes (mim) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | c | 8.0 | 8.0 | 8.0 | 8.0 | 8.2 | 12 | 12 | 8 | - | 12 | 12 | - | - |
| [Dlameters | d | 11 | 11 | 11 | 11 | 12 | 19 | 19 | 12. | - | 19 | 19 | - | - |
| Diameter $\varnothing$ | e | 5.5 | 5.5 | 5.5 | 5.5 | 6.5 | 9 | 9 | 6.8 | 8.5 | 9.0 | 9.0 | 8.5 | 8.5 |
|  | f | 9 | . 9 | 9 | 9 | -9 | 9 | 9 | 7.9 | 15 | 9.8 | 9.8 | 17 | 17 |
| $\begin{aligned} & \text { Max weight } \\ & (\mathrm{kg}) \end{aligned}$ |  | 4.9 | 5.3 | 6.6 | 7.0 | 14 | 23 | 27 | 12 | 23.5 | 45 | 65 | 35 | 50 |
| * Depth of endosure will vary with different options installed. |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

### 4.2.3 Mechanical mounting

All IP20 enclosure sizes as well as IP21/ IP55 enclosure sizes except A2 and A3 allow side-by-side installation.

If the IP 21 Enclosure kit (130B1122 or 130B1123) is used on enclosure $A 2$ or $A 3$, there must be a clearance between the drives of min. 50 mm .

For optimal cooling conditions allow a free air passage above and below the frequency converter. See table below.


1. Drill holes in accordance with the measurements given.
2. You must provide screws suitable for the surface on which you want to mount the frequency converter. Re-tighten all four screws.


Table 4.2: Mounting frame sizes $\mathrm{A} 5, \mathrm{~B} 1, \mathrm{~B} 2, \mathrm{~B} 3, \mathrm{B4}, \mathrm{C} 1, \mathrm{C} 2, \mathrm{C} 3$ and C 4 on a non-solid back wall, the drive must be provided with a back plate A due to insufficient cooling air over the heat sink.

With heavier drives ( $B 4, C 3, C 4$ ) use a lift. First wall-mount the 2 lower bolts - then lift the drive onto the lower bolts - finally fasten the drive against the wali with the 2 top bolts.

### 4.2.4 Safety requirements of mechanical installation

Pay attention to the requirements that apply to integration and field mounting kit. Observe the information in the list to avoid serious damage or injury, especially when installing large units.

The frequency converter is cooled by means of air circulation.
To protect the unit from overheating, it must be ensured that the ambient temperature does not exceed the maximum temperature stated for the frequency converter and that the 24 -hour average temperature is not exceeded. Locate the maximum temperature and 24 -hour average in the paragraph Derating for Ambient Temperature.
If the ambient temperature is in the range of $45^{\circ} \mathrm{C}-55^{\circ} \mathrm{C}$, derating of the frequency converter will become relevant, see Derating for Anbient Temperature.
The service life of the frequency converter is reduced if derating for ambient temperature is not taken into account.

### 4.2.5 Field Mounting

For field mounting the IP 21/IP 4 X top/TYPE 1 kits or IP 54/55 units are recommended.

### 4.2.6 Panel through mounting

A Panel Through Mount Kit is available for frequency converter series, VLT Aqua Drive and.

In order to increase heatsink cooling and reduce panel depth, the frequency converter may be mounted in a through panel. Furthermore the in-built fan can then be removed.

The kit is available for endosures A5 through C2.

## NB!

This kit cannot be used with cast front covers. No cover or IP21 plastic cover must be used instead.

Information on ordering numbers is found in the Design Guide, section Ordering Numbers.
More detailed information is available in the Panel Through Mount Kit instruction, MI.33.HI.YY, where yy=language code.

## 

### 5.1 How to Connect

### 5.1.1 Cables general

NB!
Always comply with national and local regulations on cable cross-sections.

Details of terminal tightening torques.

|  | Power (kW) |  |  | Torque ( Nm ) |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Enclosure | 200-240 V | $380-480 \mathrm{~V}$ | 525-600 V | Mains | Motor | DC connec | Brake | Earth | Relay |
| A2 | 0.25-3.0 | 0.37-4.0 |  | 1.8 | 1.8 | 1.8 | 1.8 | 3 | 0.6 |
| A3 | 3.7 | 5.5-7.5 | 0.75-7.5 | 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 | 5:5-11 | 11-18.5 | - | 1.8 | 1.8 | 1.5 | 1.5. | 3 | 0.6 |
| B2 | 15 | 22 |  | 4.5 | 4.5 | 3.7 | 3.7 | 3 | 0.6 |
| B3 | $\frac{15}{5-11}$ | 11.185 | 11-185 | 4.5 ${ }^{2}$ | 4.5 ${ }^{2}$ | 3.7 | 3.7 | 3 | 0.6 |
| B4 | 15-18.5 | 22-37 | 22-37 | 4.5 | 4.5 | 4.5 | 4.5 | 3 | 0.6 |
| C1. | 18.5-30 | 37-55 | - | 10 | 10 | 10 | 10 | 3 | 0.6 |
| Q2 | $\begin{aligned} & 37 \\ & 45 \end{aligned}$ | $\begin{aligned} & 75 \\ & 90 \end{aligned}$ | - | $\begin{array}{r} 14 \\ 24 \\ \hline \end{array}$ | $\begin{aligned} & 14 \\ & 24 \\ & \hline \end{aligned}$ | $\begin{aligned} & 14 \\ & 14 \end{aligned}$ | 14 | $\begin{aligned} & 3 \\ & 3 \\ & \hline \end{aligned}$ | $\begin{aligned} & 0.6 \\ & 0.6 \\ & \hline \end{aligned}$ |
| C3 | $\begin{array}{r} 22- \\ 30 \\ \hline \end{array}$ | $\begin{array}{r} 45 \\ \hline 55 \\ \hline \end{array}$ | $\begin{array}{r} 45 \\ \hline \end{array}$ | 10 | 10 | 10 | 10 | 3 | 0.6 |
| C4 | $\begin{gathered} 37 \\ 45 \end{gathered}$ | $\begin{gathered} 75- \\ 90 \end{gathered}$ | $\begin{gathered} 75 \\ 90 \end{gathered}$ | $\begin{gathered} 14 \\ 24^{1} \end{gathered}$ | $\begin{gathered} 14 \\ 24^{1} \end{gathered}$ | 14 | 14 | 3 | 0.6 |

Table 5.1: Tightening of terminals

1. For different cable dimensions $x / y$ where $x \leq 95 \mathrm{~mm}^{2}$ and $y \geq 95 \mathrm{~mm}^{2}$.
2. Cable dimensions above $18.5 \mathrm{~kW} \geq 35 \mathrm{~mm}^{2}$ and below $22 \mathrm{~kW} \leq 10 \mathrm{~mm}^{2}$

### 5.1.2 Earthing and IT mains

$\square$

The mains is connected to the main disconnect switch if this is included.


## IT Mains

Do not connect 400 V frequency converters with RFI-filters to mains supplies with a voltage between phase and earth of more than 440 V .
For $\Pi$ mains and delta earth (grounded leg), mains voltage may exceed 440 V between phase and earth.
5.1.3 Mains wiring overview


### 5.1.4 Mains connection for $A 2$ and $A 3$



Illustration 5.2: First mount the two screws on the mounting plate, slide it into place and tighten fully.


130BA262.1C
Illustration 5.3: When mounting cables, first mount and tighten earth cable.

The earth connection cable cross section must be at least $10 \mathrm{~mm}^{2}$ or 2 rated mains wires terminated separately according to $E N 50178 /$ IEC 61800-5-1.



1308A264.10
Illustration 5.5: Finally tighten support bracket on mains wires.

NB!
With single phase A3 use L1 and L2 terminals.

### 5.1.5 Mains connection for A5



Illustration 5.6: How to connect to mains and earthing without mains disconnect switch. Note that a cable clamp is used.


Illustration 5.7: How to connect to mains and earthing with mains disconnect switch.

```
NB!
With single phase AS use L1 and L2 terminals.
```


### 5.1.6 Mains connection for B1, B2 and B3



## NB!

For correct cable dimensions please see the section General Specifications at the back of this manual.

### 5.1.7 Mains connection for B4, C1 and C2


5.1.8 Mains connection for C3 and C4


### 5.1.9 How to connect motor - introduction

See section General Specifications for correct dimensioning of motor cable cross-section and length.

- Use a screened/armoured motor cable to comply with EMC emission specifications (or install the cable in metal conduit).
- Keep the motor cable as short as possible to reduce the noise level and leakage currents.
- Connect the motor cable screen/armour to both the decoupling plate of the frequency converter and to the metal of the motor. (Same applies to both ends of metal conduit if used instead of screen.)
- Make the screen connections with the largest possible surface area (cable clamp or by using an EMC cable gland). This is done by using the supplied installation devices in the frequency converter.
- Avoid terminating the screen by twisting the ends (pigtails), as this will spoil high frequency screening effects.
- If it is necessary to break the continuity of the screen to install a motor isolator or motor relay, the continuity must be maintained with the lowest possible HF impedance.


## Cable length and cross-section

The frequency converter has been tested with a given length of cable and a given cross-section of that cable. If the cross-section is increased, the cable capacitance - and thus the leakage current - may increase, and the cable length must be reduced correspondingly.

## Switching frequency

When frequency converters are used together with sine wave filters to reduce the acoustic noise from a motor, the switching frequency must be set according to the sine wave filter instruction in par. 14-01 Switching Frequency.

## Precautions while using Aluminium conductors

Aluminium conductors are not recommended for cable cross sections below $35 \mathrm{~mm}^{\mathbf{2}}$. Terminals can accept aluminium conductors but the conductor surface has to be clean and the oxidation must be removed and sealed by neutral acid free vaseline grease before the conductor is connected.
Furthermore, the terminal screw must be retightened after two days due to the softness of the aluminium. It is crucial to ensure the connection makes a gas tight joint, otherwise the aluminium surface will oxidize again.

All types of three-phase asynchronous standard motors can be connected to the frequency converter. Normally, small motors are star-connected ( $230 / 400 \mathrm{~V}, \mathrm{D} / \mathrm{Y}$ ). Large motors are delta-connected (400/690 V, D/Y). Refer to the motor name plate for correct connection mode and voltage.


Illustration 5.15: Terminals for motor connection

## NB!

In motors without phase insulation paper or other insulation reinforcement suitable for operation with voltage supply (such as a frequency converter), fit a sine-wave filter on the output of the frequency converter. (Motors that comply with IEC 60034-17 do not require a Sine-wave filter).

| No. | 96 | 97 | 98 | Motor voltage 0-100\% of mains voltage. |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | U | V | W | 3 cables out of motor |  |
|  | U1 | V1 | W1 |  |  |
|  | W2 | U2 | $V 2$ | 6 cables out of motor, Deita-connected |  |
|  | U1 | V1 | W1 | 6 cables out of motor, Star-connected |  |
|  | " |  |  | U2, V2, W2 to be interconnected separately |  |
|  |  |  |  | (optional terminal block) |  |
| No. | 99 |  |  | Earth connection |  |
|  | PE |  |  |  |  |

Table 5.3: 3 and 6 cable motor connection.
5.1.10 Motor wiring overview

| Enclosure: | $\begin{gathered} \text { A2 } \\ \text { (IP 20/IP 21) } \end{gathered}$ | $\begin{gathered} \text { A3 } \\ \text { (IP 20/IP 21) } \end{gathered}$ | $\begin{gathered} \text { A5 } \\ \text { (IP 55/IP 66) } \end{gathered}$ | $\begin{gathered} \text { B1 } \\ \text { (IP 21/IP 55/ } \\ \text { IP 66) } \\ \hline \end{gathered}$ | $\begin{gathered} \text { B2 } \\ \text { (IP 21/IP 55/ } \\ \text { IP 66) } \end{gathered}$ | $\begin{gathered} 83 \\ (\mathrm{IP} 20) \\ \hline \end{gathered}$ | $\begin{gathered} \mathrm{B4} \\ (\mathrm{IP} 20) \\ \hline \end{gathered}$ | $\begin{array}{c\|} \mathrm{Cl} \\ \text { (IP 21/IP 55/66) } \end{array}$ | $\begin{gathered} C 2 \\ \text { (IP 21/IP 55/66) } \end{gathered}$ | $\begin{gathered} \text { C3 } \\ (\mathrm{IP} 20) \\ \hline \end{gathered}$ | $\begin{gathered} \mathrm{C4} \\ (\mathrm{IP} 20) \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | 19046164 |  |  |  |  |  |  |  |  |  |
| Motor size (kW): |  |  |  |  |  |  |  |  |  |  |  |
| 200-240 V | 0.25-3.0 | 3.7 | 1.1-3.7 | 5.5-11 | 15 | 5.5-11 | 15-18.5 | 18.5-30 | 37-45 | 22-30 | 37-45 |
| $380-480 \mathrm{~V}$ | 0.37-4.0 | 5.5-7.5 | 1.1-7.5 | 11-18.5 | 22-30 | 11-18.5 | 22-37 | 37-55 | 75-90 | 45-55 | 75-90 |
| $525-600 \mathrm{~V}$ |  | 1.1-7.5 | 1.1-7.5 | 11-18.5 | 22-30 | 11-18.5 | 22-37 | 37-55 | 75-90 | 45-55 | 75-90 |
| $525-690 \mathrm{~V}$ <br> Goto: | 5.1.13 |  | 5.1.14 | 5.1.15 ${ }^{11-30}$ |  | 5.1.16 |  | 5.1.17 ${ }^{37-90}$ |  | 5.1 .18 |  |

### 5.1.11 Motor connection for A2 and A3

Follow these drawings step by step for connecting the motor to the frequency converter.


Illustration 5.16: First terminate the motor earth, then place motor $U, V$ and $W$ wires in plug and tighten.


Illustration 5.17: Mount cable clamp to ensure 360 degree connection between chassis and screen, note the outer insulation of the motor cable is removed under the damp.

### 5.1.12 Motor connection for A5



Illustration 5.18: First terminate the motor earth, then place motor $U, V$ and $W$ wires in terminal and tighten. Please ensure that the outer insulation of the motor cable is removed under the EMC damp.

### 5.1.13 Motor connection for B1 and B2



Illustration 5.19: First terminate the motor earth, then Place motor $U, V$ and $W$ wires in terminal and tighten. Please ensure that the outer insulation of the motor cable is removed under the EMC clamp.

### 5.1.14 Motor connection for B3 and B4




Illustration 5.21: First terminate the motor earth, then Place motor $\mathrm{U}, \mathrm{V}$ and W wires in terminal and tighten. Please ensure that the outer insulation of the motor cable is removed under the EMC clamp.

### 5.1.15 Motor connection for C1 and C2



Illustration 5.22: First terminate the motor earth, then Place motor $U, V$ and $W$ wires in terminal and tighten. Please ensure that the outer insulation of the motor cable is removed under the EMC damp.

### 5.1.16 Motor connection for C3 and C4



Illustration 5.23: First terminate the motor earth, then place motor $U, V$ and $W$ wires into the appropriate terminals and tighten. Please ensure that the outer insulation of the motor cable is removed under the EMC clamp.


Illustration 5.24: First terminate the motor earth, then place motor $U, V$ and $W$ wires into the appropriate terminals and tighten. Please ensure that the outer insulation of the motor cable is removed under the EMC clamp.

### 5.1.17 DC bus connection

The DC bus terminal is used for DC back-up, with the intermediate circuit being supplied from an external source.

```
Terminal numbers used: 88,89
```



Please contact Danfoss if you require further information.

### 5.1.18 Brake connection option

The connection cable to the brake resistor must be screened/armoured.

| Brake resistor |  |  |  |  |
| :--- | :--- | :--- | :--- | :--- |
| Terminal númber | $\ddots$ | $\therefore$ | 81 | 82 |
| Terminals |  | $\mathrm{R}-$ | $\mathrm{R}+$ |  |

$\square$

1. Use cable clamps to connect the screen to the metal cabinet of the frequency converter and to the decoupling plate of the brake resistor.
2. Dimension the cross-section of the brake cable to match the brake current.
$\square$


Illustration 5.31: Brake connection terminal for C3.


Illustration 5.32: Brake connection terminal for C4.


NB!
If a short circuit in the brake IGBT occurs, prevent power dissipation in the brake resistor by using a mains switch or contactor to disconnect the mains for the frequency converter. Only the frequency converter shall control the contactor.

NB!
Place the brake resistor in an environment free of fire risk and ensure that no external objects can fall into the brake resistor through ventilation slots.
Do not cover ventilation slots and grids.

### 5.1.19 Relay connection

To set relay output, see par. group 5-4* Relays.

| No. | $01-02$ | make (normally open) |
| :--- | :--- | :--- |
|  | $01-03$ | break (normally dosed) |
|  | $04-05$ | make (normally open) |
|  | $04-06$ | break (normally dosed) |




Illustration 5.33: Terminals for relay connection ( C 1 and C 2 enclosures).
The relay connections are shown in the cut-out with relay plugs (from the Accessory Bag) fitted.


Illustration 5.34: Terminals for relay connections for B3. Only one relay input is fitted from the factory. When the second relay is needed

## remove knock-out.



Illustration 5.35: Terminals for relay connections for B4.


Illustration 5.36: Terminals for relay connections for $C 3$ and $C 4$. Located in the upper right corner of the frequency converter.

VLT ${ }^{\circledR}$ AQUA Drive
Operating Instructions

### 5.1.20 Relay output

## Relay 1

## Relay 2

- Terminal 01: common
- Terminal 04: common
- Terminal 02: normal open 240 VAC
- Terminal 05: normal open 400 V AC
- Terminal 03: normal closed 240 V AC

Relay 1 and relay 2 are programmed in par. 5-40 Function Relay, par. 5-41 On Delay, Relay, and par. 5-42 Off Delay, Relay.

Additional relay outputs by using option module MCB 105.

- Terminal 06: normal closed 240 V AC



### 5.1.21 Wiring example and testing

The following section describes how to terminate control wires and how to access them. For an explanation of the function, programming and wiring of the control terminals, please see chapter, How to programme the frequency converter.

### 5.1.22 Access to control terminals

## All terminals to the control cables are located underneath the terminal cover <br> on the front of the frequency converter. Remove the terminal cover with a screwdriver.



Illustration 5.37: Access to control terminals for $A 2, A 3, B 3, B 4, C 3$ and C4 enclosures

Remove front-cover to access control terminals. When replacing the frontcover, please ensure proper fastening by applying a torque of 2 Nm .


Illustration 5.38: Access to control terminals for A5, B1, B2, C1 and Q2 enclosures

### 5.1.23 Control terminals

## Drawing reference numbers:

1. 10-pole plug digital I/O.
2. 3-pole plug RS-485 Bus.
3. 6 -pole analog I/O.
4. USB connection.


### 5.1.24 Control cable clamp

1. Use a clamp from the accessory bag to connect screen to frequency converter decoupling plate for control cables.
See section entitled Earthing of Screened/Armoured Control Cables for the correct termination of control cables.


Illustration 5.40: Control cable clamp.

VLT ${ }^{\circledR}$ AQUA Drive
Operating Instructions

### 5.1.25 Electrical installation and control cables



Illustration 5.41: Diagram showing all electrical terminals. (Terminal 37 present for units with Safe Stop Function only.)

| Terminal number | Terminal description | Parameter number | Factory default |
| :---: | :---: | :---: | :---: |
| 1+2+3 | Terminal 1+2+3-Relay 1 | 5-40. | No operation |
| 4+5+6 | Terminal 4+5+6-Relay2 | 5-40 | No operation |
| 12 | Teminal 12 Supply | - | +24VDC |
| 13 | Terminal 13 Supply | - | +24VDC |
| 18 | Terminal 18 Digital Input | 5-10 | Start |
| 19 | Terminal 19 Digital Input | 5-11 | No operation |
| 20 | Terminal 20 | - | Common |
| 27 | Terminal 27 Digital Input/Output | 5-12/5-30 | Coast inverse |
| 29 | Terminal 29 Digital Input/Output | 5-13/5-31 | log |
| 32 | Terminal 32 Digital Input | 5-14 | No operation |
| 33. | Terminal 33 Digital Input | 5-15 | No operation |
| 37 | Terminal 37 Digital Input | - | Safe Stop |
| 42 | Terminal 42 Analog Output | 6-50 | Speed O-HighLim |
| 53 | Terminal 53 Analog Input | 3-15/6-1*/20-0* | Reference |
| 54 | Terminal 54 Analog Input | 3*15/6-2*/20-0* | Feedback |

Table 5.5: Terminal connections

Very long control cables and analog signals may, in rare cases and depending on installation, result in $50 / 60 \mathrm{~Hz}$ earth loops due to noise from mains supply cables.

If this occurs, break the screen or insert a 100 nF capacitor between screen and chassis.

NB!
The common of digital / analog inputs and outputs should be connected to separate common terminals 20,39 , and 55 . This will avoid ground current interference among groups. For example, it avoids switching on digital inputs disturbing analog inputs.

## NB!

Control cables must be screened/armoured.

### 5.1.26 How to test motor and direction of rotation



Note that unintended motor start can occur, ensure no personnel or equipment is in danger!

Illustration 5.42:
Step 1: First remove the insulation on both ends of a 50 to 70 mm piece of wire.

(2)

Illustration 5.43:
Step 2: Insert one end in terminal 27 using a suitable terminal screwdriver. (Note: For units with Safe Stop function, the existing jumper between terminal 12 and 37 should not be removed for the unit to be able to run!)

Please follow these steps to test the motor connection and direction of rotation. Start with no power to the unit.



Illustration 5.45:
Step 4: Power-up the unit and press the [Off] button. In this state the motor should not rotate. Press [Off] to stop the motor at any time. Note the LED at the [OFF] button should be lit. If alarms or warnings are flashing, please see chapter 7 regarding these.


Illustration 5.46:
Step 5: By pressing the [Hand on] button, the LED above the button should be lit and the motor may rotate.


Illustration 5.47:
Step 6: The speed of the motor can be seen in the LCP. It can be adjusted by pushing the up 4 and down $\mathbf{V}$ arrow buttons.


Illustration 5.49:
Step 8: Press the [Off] button to stop the motor again.


Illustration 5.48:
Step 7: To move the cursor, use the left - and right - arrow buttons. This enables changing the speed in larger increments.


Illustration 5.50:
Step 9: Change two motor wires if the desired rotation of direction is not achieved.

## Remove mains power from the frequency converter before changing motor wires.

### 5.1.27 Switches S201, S202, and S801

Switches S201 (Al 53) and S202 (Al 54) are used to select a current (0-20 mA ) or a voltage ( 0 to 10 V ) configuration of the analog input terminals 53 and 54 respectively.

Switch S 801 (BUS TER.) can be used to enable termination on the RS-485 port (terminals 68 and 69).

Please note that the switches may be covered by an option, if fitted.

## Default setting:

S201 (AI 53) $=$ OFF (voltage input)
S202 (AI 54) = OFF (voltage input)
S801 (Bus termination) $=$ OFF


### 5.2 Final Optimization and Test

### 5.2.1 Final optimization and test

To optimize motor shaft performance and optimize the frequency converter for the connected motor and installation, please follow these steps. Ensure that frequency converter and motor are connected, and power is applied to frequency converter.

## NB!

Before power up ensure that connected equipment is ready for use.

Step 1. Locate motor name plate

NB!
The motor is either star- $(Y)$ or delta- connected $(\Delta)$. This information is located on the motor name plate data.


Illustration 5.52: Motor name plate example

Step 2. Enter motor name plate data in following parameter list. To access list first press [QUICK MENU] key then select "Q2 Quick Setup".

| 1. | Motor Power [kW] <br> or Motor Power [HP] | par. 1-20 <br> par. 1-21 |
| :--- | :--- | :--- |
| 2. | Mötor Vótage | par. 1-22 |
| 3. | Motor Frequency | par. 1-23 |
| 4. | Mótor Current | par. 1-24 |
| 5. | Motor Nominal Speed | par. 1-25 |

Table 5.6: Motor related parameters

## Step 3. Activate Automatic Motor Adaptation (AMA)

Performing AMA ensures best possible performance. AMA automatically takes measurements from the specific motor connected and compensates for installation variances.

1. Connect terminal 27 to terminal 12 or use [MAJN MENU] and set Terminal 27 par. 5-12 to No operation (par. 5-12 [0])
2. Press [QUIGK MENU], select "Q2 Quick Setup", scroll down to AMA par. 1-29.
3. Press [OK] to activate the AMA par. 1-29.
4. Choose between complete or reduced AMA. If sine wave filter is mounted, run only reduced AMA, or remove sine wave filter during AMA procedure.
5. Press [OK] key. Display should show "Press [Hand on] to start".
6. Press [Hand on] key. A progress bar indicates if AMA is in progress.

## Stop the AMA during operation

1. Press the [OFF] key - the frequency converter enters into alarm mode and the display shows that the AMA was terminated by the user.

## Successful AMA

1. The display shows "Press [OK] to finish AMA".
2. Press the (OK) key to exit the AMA state.

## Unsuccessful AMA

1. The frequency converter enters into alarm mode. A description of the alarm can be found in the Troubleshooting section.
2. "Report Value" in the [Alarm Log] shows the last measuring sequence carried out by the AMA, before the frequency converter entered alarm mode. This number along with the description of the alarm will assist troubleshooting. If contacting Danfoss Service, make sure to mention number and alarm description.

## NB!

Unsuccessful AMA is often caused by incorrectly entered motor name plate data or too big difference between the motor power size and the frequency converter power size.

## Step 4. Set speed limit and ramp time

Set up the desired limits for speed and ramp time.

| Minimum Reference | par. 3-02 |
| :--- | :--- |
| Maximum Reference | par. 3-03 |



Ramp 1 Ramp Up Time [s] $\quad$ par. 3-41
Ramp 1 Ramp Down Time 1 [s] par. 3-42

## GCommissimino and Arillocton Examiles

### 6.1 Quick Setup

### 6.1.1 Quick Menu Mode

The GLCP provides access to all parameters listed under the Quick Menus. To set parameters using the [Quick Menu] bulton:

Pressing [Quick Menu] the list indicates the different areas contained in the Quick menu.

## Efficient parameter set-up for water applications

The parameters can easily be set up for the vast majority of the water and wastewater applications only by using the [Quick Menu].
The optimum way to set parameters through the [Quick Menu] is by following the below steps:

1. Press [Quick Setup] for selecting basic motor seltings, ramp times, etc.
2. Press [Function Setups] for setting up the required functionality of the frequency converter - if not already covered by the settings in [Quick Setup].
3. Choose between General Settings, Open Loop Settings and Closed Loop Settings.

It is recommended to do the set-up in the order listed.


| Par. | Designation | [Units] |
| :---: | :---: | :---: |
| $0-01$ | Language $\vdots$ |  |
| 1-20 | Motor Power | [kW] |
| 1-22 | Motor Vottage | [V] |
| 1-23 | Motor Frequency | [ Hz ] |
| 1-24 | Motor Current | [A] |
| 1-25 | Motor Nominal Speed | [RPM] |
| 3-41 | Ramp 1 Ramp up Time | [5] |
| 3-42 | Ramp 1 Ramp down Time | [s] |
| 411 | Motor Speed Low Linit | [RPM] |
| 4-13 | Motor Speed High Limit | [RPM] |
| 1-29 | Autiomatic Motor Adaptation (AMA) |  |

Table 6.1: Quick Setup parameters. Please see section Commonty Used Parameters - Explanations

If No Operation is selected in terminal 27 no connection to +24 V on terminal 27 is necessary to enable start.
If Coast Inverse (factory default value) is selected in Terminal 27 , a connection to +24 V is necessary to enable start.

```
NB!
For detailed parameter descriptions, please see the following section on Commonty Used Parameters - Explanations.
```


### 6.2.1 Start/Stop

Terminal $18=$ start/stop par. 5-10 [8] Start
Terminal $27=$ No operation par. 5-12 [0] No operation (Default coast inverse

Par. 5-10 Digital Input, Terminal $18=$ Start (default)
Par. 5-12 Digital Input, Terminal $27=$ coast inverse (default)


### 6.2.2 Closed loop wiring

Terminal $12 / 13:+24 \mathrm{~V}$ DC
Terminal 18: Start par. 5-18 [8] Start (Default)
Terminal 27: Coast par. 5-12 [2] coast inverse (Default)
Terminal 54: Analog input

L1-L3: Mains terminals
U,V and W: Motor terminals


### 6.2.3 Submersible pump application

The system consists of a submersible pump controlled by a Danfoss VLT AQUA Drive and a pressure transmitter. The transmitter gives a $4-20 \mathrm{~mA}$ feedback signal to the VLT AQUA Drive, which keeps a constant pressure by controlling the speed of the pump. To design a drive for a submersible pump application, there are a few important issues to take into consideration. Therefore the drive used must be chosen according to motor current.

1. The motor is a so called "Can motor" with a stainless steel can between the rotor and stator. There is a larger and a more magnetic resistant air-gap than on a normal motor hence a weaker field which results in the motors being designed with a higher rated current than a norm motor with similar rated power.
2. The pump contains thrust bearings which will be damaged when running below minimum speed which normally will be 30 Hz .
3. The motor reactance is nonlinear in submersible pump motors and therefore Automatic Motor Adaption (AMA) may not be possible. However, normally submersible pumps are operated with very long motor cables that might eliminate the nonlinear motor reactance and enable the drive to perform AMA. If AMA fails, the motor data can be set from parameter group 1-3* (see motor datasheet). Be aware that if AMA has succeeded the drive will compensate for voltage drop in the long motor cables, so if the Advanced motor data are set manually, the length of the motor cable must be taken into considerations to optimize system performance.
4. It is important that the system is operated with a minimum of wear and tear of the pump and motor. A Danfoss Sine-Wave filter can lower the motor insulation stress and increase lifetime (check actual motor insulation and the frequency converter du/dt specification). It is recommended to use a filter to reduce the need for service.
5. EMC performance can be difficult to achieve due to the fact that the special pump cable which is able to withstand the wet conditions in the well normally is unscreened. A solution could be to use a screened cable above the well and fix the screen to the well pipe if it is made of steel (can also be made of plastic). A Sine-Wave filter will also reduce the EMI from unscreened motor cables.

The special "can motor" is used due to the wet installation conditions. The drive needs to be designed for the system according to output current to be able to run the motor at nominal power.

To prevent damage to the thrust bearings of the pump, it is important to ramp the pump from stop to min. speed as quick as possible. Well-known manufacturers of submersible pumps recommend that the pump is ramped to min. speed ( 30 Hz ) in max. $2-3$ seconds. The new VLT© AQUA Drive is designed with initial and final Ramp for these applications. The initial and final ramps are 2 individual ramps, where Initial Ramp, if enabled, will ramp the motor from stop to min. speed and automatically switch to normal ramp, when min. speed is reached. Final ramp will do the opposite from min. speed to stop in a stop situation.

Pipe-Fill mode can be enabled to prevent water hammering. The Danfoss frequency converter is capable of filling vertical pipes using the PID controller to slowly ramp up the pressure with a user specified rate (units/sec). If enabled the drive will, when it reaches min. speed after startup, enter pipe fill mode. The pressure will slowly be ramped up until it reaches a user specified Filled Set Point, where after the drive automatically disables Pipe Fill Mode and continues in normal closed loop operation.
This feature is designed for irrigation applications.

## Electrical Wiring

| Typical parameter settings (Typical/recommended settings in brack- <br> ets.) |
| :--- |
| Parameters: Par. 1-20 / par. 1-21 <br> Motor Rated Power Par. 1-22 <br> Motor Rated Voltage Par. 1-24 <br> Motor Current Par. 1-28. <br> Motor Rated Speed  <br> Enable Reduced Automatic Motor Adaptation (AMA in par. 1-29)  |

[^17]


| Pipe Fill Mode |  |  |
| :---: | :---: | :---: |
| Pipe Fill Enable | Par. 2900 |  |
| Pipe Fill Rate | Par. 29-04 | (Feedback units/sec.) |
| Filled Set Point | Par. 2905 | (Feedback units) |



7 How to Operate the Frequency Converter

## 

### 7.1 Ways of Operation

### 7.1.1 Ways of operation

## The frequency converter can be operated in 3 ways:

1. Graphical Local Contral Panel (GLCP), see 6.1.2
2. Numeric Local Control Panel (NLCP), see 6.1.3
3. RS-485 serial communication or USB, both for PC connection, see 6.1.4

If the frequency converter is fitted with fieldbus option, please refer to relevant documentation.

### 7.1.2 How to operate graphical LCP (GLCP)

The following instructions are valid for the GLCP (LCP 102).

The GLCP is divided into four functional groups:

1. Graphical display with Status lines.
2. Menu keys and indicator lights (LED's) - selecting mode, changing parameters and switching between display functions.
3. Navigation keys and indicator lights (LEDs).
4. Operation keys and indicator lights (LEDs).

## Graphical display:

The LCD-display is back-lit with a total of 6 alpha-numeric lines. All data is displayed on the LCP which can show up to five operating variables while in [Status] mode.

## Display lines:

a. Status line: Status messages displaying icons and graphics.
b. Line 1-2: Operator data lines displaying data and variables defined or chosen by the user. By pressing the [5tatus] key, up to one extra line can be added.
c. Status line: Status messages displaying text.

The display is divided into 3 sections:

## Top section (a)

shows the status when in status mode or up to 2 variables when not in status mode and in the case of Alarm/Waming.


The number of the Active Set-up (selected as the Active Set-up in par. $0-10$ ) is shown. When programming in another Set-up than the Active Set-up, the number of the Set-up being programmed appears to the right in brackets.

## Middle section (b)

shows up to 5 variables with related unit, regardless of status. In case of alarm/warning, the warning is shown instead of the variables.
It is possible to toggle between three status read-out displays by pressing the [Status] key.
Operating variables with different formatting are shown in each status screen - see below.

Several values or measurements can be linked to each of the displayed operating variables. The values / measurements to be displayed can be defined via par. $0-20,0-21,0-22,0-23$, and $0-24$, which can be accessed via [QUICK MENU], "Q3 Function Setups", "Q3-1 General Settings", "Q3-11 Display Seltings".

Each value / measurement readout parameter selected in par. 0-20 to par. 0-24 has its own scale and number of digits after a possible decimal point. Larger numeric values are displayed with few digits after the decimal point.
Ex.: Current readout
5.25 A; 15.2 A 105 A.

## Status display 1

This read-out state is standard after start-up or initialization.
Use [INFO] to obtain information about the value/measurement linked to the displayed operating variables ( $1.1,1.2,1.3,2$, and 3 ).
See the operating variables shown in the display in this illustration. 1.1, 1.2 and 1.3 are shown in small size. 2 and 3 are shown in medium size.

## Status display II

See the operating variables (1.1, 1.2, 1.3, and 2) shown in the display in this illustration.
In the example, Speed, Motor current, Motor power and Frequency are selected as variables in the first and second lines.
1.1, 1.2 and 1.3 are shown in small size. 2 is shown in large size.


## Status display III:

This state displays the event and action of the Smart Logic Control. For further information, see section Smart Logic Control.


## Bottom section

always shows the state of the frequency converter in Status mode.


## Display contrast adjustment

Press [status] and [ A ] for darker display
Press [status] and [ $\mathbf{\nabla}$ ] for brighter display

## Indicator lights (LEDs):

If certain threshold values are exceeded, the alarm and/or warning LED lights up. A status and alarm text appear on the control panel.
The On LED is activated when the frequency converter receives power from mains voltage, a DC bus terminal, or an external 24 V supply. At the same time, the back light is on.

- Green LED/On: Control section is working.
- Yellow LED/Warn.: Indicates a warning.
- Flashing Red LED/Alarm: Indicates an alarm.



## GLCP keys

## Menu keys

The menu keys are divided into functions. The keys below the display and indicator lamps are used for parameter set-up, including choice of display indication during normal operation.


## [Status]

Indicates the status of the frequency converter and/or the motor. 3 different readouts can be chosen by pressing the [Status] key: 5 line readouts, 4 line readouts or Smart Logic Control.
Use [Status] for selecting the mode of display or for changing back to Display mode from either the Quick Menu mode, the Main Menu mode or Alarm mode. Also use the [Status] key to toggle single or double read-out mode.

## [Quick Menu]

Allows quick set-up of the frequency converter. The most common functions can be programmed here.

## The [Quick Menu] consists of:

- Q1: My Personal Menu
- Q2: Quick Setup
- Q3: Function Setups
- Q5: Changes Made
- Q6: Loggings

The Function set-up provides quick and easy access to all parameters required for the majority of water and wastewater applications including variable torque, constant torque, pumps, dosing pumps, well pumps, booster pumps, mixer pumps, aeration blowers and other pump and fan applications. Amongst other features it also includes parameters for selecting which variables to display on the LCP, digital preset speeds, scaling of analog references, closed loop single zone and multi-zone applications and specific functions related to water and wastewater applications.

The Quick Menu parameters can be accessed immediately unless a password has been created via par. 0-60, 0-61, 0-65 or 0-66.
It is possible to switch directly between Quick Menu mode and Main Menu mode.

## [Main Menu]

is used for programming all parameters.
The Main Menu parameters can be accessed immediately unless a password has been created via par. 0-60, 0-61, 0-65 or 0-66. For the majority of water and wastewater applications it is not necessary to access the Main Menu parameters but instead the Quick Menu, Quick Setup and Function Setups provides the simplest and quickest access to the typical required parameters.
It is possible to switch directly between Main Menu mode and Quick Menu mode.
Parameter shortcut can be carried out by pressing down the [Main Menu] key for 3 seconds. The parameter shortcut allows direct access to any parameter.

## [Alarm Log]

displays an Alarm list of the five latest alarms (numbered A1-A5). To obtain additional detaits about an alarm, use the arrow keys to manoeuvre to the alarm number and press [ OK ]. Information is displayed about the condition of the frequency converter before it enters the alarm mode.

## [Back]

reverts to the previous step or layer in the navigation structure.
[Cancel]
last change or command will be cancelled as long as the display has not been changed.

## [Info]

displays information about a command, parameter, or function in any display window. [Info] provides detailed information when needed. Exit Info mode by pressing either [Info], [Back], or [Cancel].

## Navigation keys

The four navigation arrows are used to navigate between the different choices available in [Quick Menu], [Main Menu] and [Alarm Log]. Use the keys to move the cursor.
[OK]
is used for choosing a parameter marked by the cursor and for enabling the change of a parameter.


## Operation keys

for local control are found at the bottom of the control panel.


## [Hand on]

enables control of the frequency converter via the GLCP. [Hand on] also starts the motor, and it is now possible to give the motor speed reference by means of the arrow keys. The key can be Enabled [1] or Disabled [0] via par. 0-40 [Hand on] Key on LCP.

The following control signals will still be active when [Hand on] is activated:

- [Hand on] - [Off] - [Auto on]
- Reset
- Coasting stop inverse (motor coasting to stop)
- Reversing
- Set-up select Isb - Set-up select msb
- Stop command from serial communication
- Quick stop
- DC brake


## NB!

External stop signals activated by means of control signals or a serial bus will override a "start" command via the LCP.
[Off]
stops the connected motor. The key can be Enabled [1] or Disabled [0] via par. 0-41 [OF7] key on LCP. If no external stop function is selected and the [Off] key is inactive the motor can only be stopped by disconnecting the mains supply.
[Auto on]
enables the frequency converter to be controlled via the control terminals and/or serial communication. When a start signal is applied on the control terminals and/or the bus, the frequency converter will start. The key can be Enabled [1] or Disabled [0] via par. 0-42 [Auto on] key on LCP.


## [Reset]

is used for resetting the frequency converter after an alarm (trip). The key can be Enabled [1] or Disabled [0] via par. 0-43 Reset Keys on LCP.
The parameter shortcut
can be carried out by holding down the [Main Menu] key for 3 seconds. The parameter shortaut allows direct access to any parameter.

### 7.1.3 How to operate numeric LCP (NLCP)

The following instructions are valid for the NLCP (LCP 101).

## The control panel is divided into four functional groups:

1. Numeric display.
2. Menu key and indicator lights (LEDS) - changing parameters and switching between display functions.
3. Navigation keys and indicator lights (LEDS).
4. Operation keys and indicator lights (LEDS).


NB!
Parameter copy is not possible with Numeric Local Control Panel (LCP101).

## Select one of the following modes:

Status Mode: Displays the status of the frequency converter or the motor.
If an alarm occurs, the NLCP automatically switches to status mode.
A number of alarms can be displayed.
Quick Setup or Main Menu Mode: Display parameters and parameter settings.



## Indicator lights (LEDs):

- Green LED/On: Indicates if control section is on.
- Yellow LED/Wm.: Indicates a warning.
- Flashing red LED/Alarm: Indicates an alarm.


## Menu key

Select one of the following modes:

- Status
- Quick Setup
- Main Menu


## Main Menu

is used for programming all parameters.
The parameters can be accessed immediately unless a password has been created via par. 0-60 Main Menu Password, par. 0-61 Access to Main Menu w/o Password, par. 0-65 Personal Menu Password or par. 0-66 Access to Personal Menu w/o Password.
Quick Setup is used to set up the frequency converter using only the most essential parameters.
The parameter values can be changed using the up/down arrows when the value is flashing.
Select Main Menu by pressing the [Menu] key a number of times until the Main Menu LED is lit.
Select the parameter group [ $\mathrm{x} \alpha-\ldots$ ] and press [OK]
Select the parameter [_-xx] and press [OK]
If the parameter is an array parameter select the array number and press [OK]
Select the wanted data value and press [OK]

## Navigation keys

## [Back]

for stepping backwards

## Arrow [4] [ ${ }^{\text {] }]}$

keys are used for manoeuvring between parameter groups, parameters and within parameters
[OK]
is used for choosing a parameter marked by the cursor and for enabling the change of a parameter.


## Operation keys

Keys for local control are found at the bottom of the control panel.


Illustration 7.5: Operation keys of the numerical LCP (NLCP)

## [Hand on]

enables control of the frequency converter via the LCP. [Hand on] also starts the motor and it is now possible to enter the motor speed data by means of the arrow keys. The key can be Enabled [1] or Disabled [0] via par. 0-40 [Hand on] Key on LCP.
External stop signals activated by means of control signals or a serial bus will override a 'start' command via the LCP.

7 How to Operate the Frequency Converter

## The following control signals will still be active when [Hand on] is activated:

- [Hand on] - [Off] - [Auto on]
- Reset
- Coasting stop inverse
- Reversing
- Set-up select lsb - Set-up select msb
- Stop command from serial communication
- Quick stop
- DC brake
[Off]
stops the connected motor. The key can be Enabled [1] or Disabled [0] via par. 0-41 [Off] Key on LCP.
If no external stop function is selected and the [Off] key is inactive the motor can be stopped by disconnecting the mains supply.


## [Auto on]

enables the frequency converter to be controlled via the control terminals and/or serial communication. When a start signal is applied on the control terminals and/or the bus, the frequency converter will start. The key can be Enabled [1] or Disabled [0] via par. 0-42 [Auto on] Key on LCP.

NB! | An active HAND-OFF-AUTO signal via the digital inputs has higher priority than the control keys [Hand on] [Auto on]. |
| :--- |

## [Reset]

is used for reselting the frequency converter after an alarm (trip). The key can be Enabled [1] or Disabled [0] via par. 0-43 [Reset] Key on LCP.

### 7.1.4 Changing data

1. Press [Quick Menu] or [Main Menu] key.
2. Use [ $\mathbf{\Delta}$ ] and [ $\mathbf{v}$ ] keys keys to find parameter group to edit.
3. Press [OK] key.
4. Use [ $\mathbf{~}$ ] and [ $\mathbf{v}$ ] keys to find parameter to edit.
5. Press [OK] key.
6. Use [ $\mathbf{4}$ ] and [ $\mathbf{V}$ ] keys to select correct parameter setting. Or, to move to digits within a number, use keys. Cursor indicates digit selected to change. [ $\mathbf{4}$ ] key increases the value, [ $\mathbf{V}$ ] key decreases the value.
7. Press [Cancel] key to disregard change, or press [OK] key to accept change and enter new setting.

### 7.1.5 Changing a text value

If the selected parameter is a text value, change the text value by means of the up/down navigation keys.
The up key increases the value, and the down key decreases the value. Place the cursor on the value to be saved and press [OK].


Illustration 7.6: Display example.

### 7.1.6 Changing a group of numeric data values

If the chosen parameter represents a numeric data value, change the chosen data value by means of the [ 4 ] and [ $*$ ] navigation keys as well as the up/down [ 4 ] [ $\mathbf{\nabla}$ ] navigation keys. Use the $*$ ] and [ $*$ ] navigation keys to move the cursor horizontally.

Use the up/down navigation keys to change the data value. The up key enlarges the data value, and the down key reduces the data value. Place the cursor on the value to be saved and press [OK].


Illustration 7.7: Display example.


Illustration 7.8: Display example.

### 7.1.7 Changing of data value, Step-by-Step

Certain parameters can be changed step by step or infinitely variably. This applies to par. 1-20 Motor Power [kW], par. 1-22 Motor Voltage and par. 1-23 Motor Frequency.
The parameters are changed both as a group of numeric data values and as numeric data values infinitely variably.

### 7.1.8 Read-out and programming of indexed parameters

Parameters are indexed when placed in a rolling stack.
Par. 15-30 Alarm Log: Error Code to par. 15-32 Alarm Log: Time contain a fault log which can be read out. Choose a parameter, press [OK], and use the up/down navigation keys to scroll through the value log.

Use par. 3-10 Preset Reference as another example:
Choose the parameter, press [OK], and use the up/down navigation keys keys to scroll through the indexed values. To change the parameter vatue, select the indexed value and press [OK]. Change the value by using the up/down keys. Press [OK] to accept the new setting. Press [Cance!] to abort. Press [Back] to leave the parameter.

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### 7.1.9 Tips and tricks



Table 7.1: Tips and tricks

### 7.1.10 Quick transfer of parameter settings when using GLCP

Once the set-up of a frequency converter is complete, it is recommended to store (backup) the parameter settings in the GLCP or on a PC via MCT 10 Set-up Software Tool.

## NB!

Stop the motor before performing any of these operations.

## Data storage in LCP:

1. Go to par. 0-50 $\angle C P$ COPY
2. Press the $[\mathrm{OK}]$ key
3. Select "All to LCP"
4. Press the $[O K]$ key

All parameter settings are now stored in the GLCP indicated by the progress bar. When $100 \%$ is reached, press [OK].

The GLCP can now be connected to another frequency converter and the parameter settings copied to this frequency converter.

## Data transfer from LCP to Frequency converter:

1. Go to par. 0-50 LCP COpy
2. Press the [OK] key
3. Select "All from LCP"
4. Press the [OK] key

The parameter settings stored in the GLCP are now transferred to the frequency converter indicated by the progress bar. When $100 \%$ is reached, press [OK].

### 7.1.11 Initialisation to default settings

There are two ways to initialise the frequency converter to default: Recommended initialisation and manual initialisation.
Please be aware that they have different impact according to the below description.

## Recommended initialisation (via par. 14-22 Operation Mode)

1. Select par. 14-22 Operation Mode
2. Press [OK]
3. Select "Initialisation" (for NLCP select "2")
4. Press [OK]
5. Remove power to unit and wait for display to turn off.
6. Reconnect power and the frequency converter is reset. Note that first start-up takes a few more seconds
7. Press [Reset]
```
par. 14-22 Operation Mode initialises all except:
par. 14-50 RFI Fiter
par. 8-30 Protocol
par. 8-31 Address
par. 8-32 Baud Rate
par. 8-35 MIntmum Response Delar
par. 8-36 Max Response Delay
par. 8-37 Maxdmum Inter-Char Dekay
par. 15-00 Operating Hours to par. 15-05 Over Volt's
par. 15-20 Hbstork Log: Event to par. 15-22 Hbtork Log: Thme
par. 15-30 Alarm Log: Error Code to par. 15-32 Alarm Log: Time
```



NB!
Parameters selected in par. 0-25 My Personal Menu, will stay present, with default factory setting.

## Manual initialisation

When carrying out manual initialisation, serial communication, RFI filter settings and fault log settings are reset.
Removes parameters selected in par. 0-25 My Personal Menu

1. Disconnect from mains and wait until the display turns off.

2a. Press [Status] - [Main Menu] - [OK] at the same time while power up for Graphical LCP (GLCP)
2b. Press [Menu] while power up for LCP 101, Numerical Display
3. Release the keys after 5 s

## This parameter initialises all except:

par. 15-00 Operating Hours
par. 15-03 Power Up's
par. 15-04 Over Temp's
par. 15-05 Over Volt's

### 7.1.12 RS-485 bus connection

One or more frequency converters can be connected to a controller (or master) using the RS-485 standard interface. Terminal 68 is connected to the $P$ signal ( $T X+, R X+$ ), while terminal 69 is connected to the $N$ signal (TX-, RXX-).

If more than one frequency converter is connected to a master, use parallel connections.


Illustration 7.9: Connection example.

In order to avoid potential equalizing currents in the screen, earth the cable screen via terminal 61 , which is connected to the frame via an RC-link.

## Bus termination

The RS-485 bus must be terminated by a resistor network at both ends. If the drive is the first or the last device in the RS-485 loop, set the switch S801 on the control card for ON.

For more information, see the paragraph Switches S201, S202, and S801.

VLT ${ }^{\circledR}$ AQUA Drive Operating Instructions

### 7.1.13 How to connect a PC to the frequency converter

## To control or program the frequency converter from a PC, install the PC-based Configuration Tool MCT 10.

The PC is connected via a standard (host/device) USB cable, or via the RS-485 interface as shown in the Design Guide, chapter How to Install > Installation of misc. connections.

## NB!

The USB connection is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals. The USB connection is connected to protection earth on the frequency converter. Use only isolated laptop as PC connection to the USB connector on the frequency converter.


### 7.1.14 PC software tools

## PC-based Configuration Tool MCT 10

All Frequency converters are equipped with a serial communication port. Danfoss provides a PC tool for communication between PC and frequency converter, PC-based Configuration Tool MCT 10. Please check the section on Available Literature for detailed information on this tool.

## MCT 10 set-up software

MCT 10 has been designed as an easy to use interactive tool for setting parameters in our frequency converters. The software can be downloaded from the Danfoss internet site http://www.Danfoss.com/BusinessAreas/DrivesSolutions/Softwaredown/oad/DDPC + Software + Program.htm. The MCT 10 set-up software will be useful for:

- Planning a communication network off-line. MCT 10 contains a complete frequency converter database
- Commissioning frequency converters on line
- Saving settings for all frequency converters
- Replacing a frequency converter in a network
- Simple and accurate documentation of frequency converter settings after commissioning.
- Expanding an existing network
- Future developed frequency converters will be supported

MCT 10 set-up software supports Profibus DP-V1 via a Master class 2 connection. It makes it possible to on line read/write parameters in a frequency converter via the Profibus network. This will eliminate the need for an extra communication network.

## Save frequency converter settings:

1. Connect a PC to the unit via USB com port. (Note: Use a PC, which is isolated from the mains, in conjunction with the USB port. Failure to do so may damage equipment.)
2. Open MCT 10 Set-up Software
3. Choose "Read from drive"
4. Choose "Save as"

All parameters are now stored in the PC.

## Load frequency converter settings:

1. Connect a PC to the frequency converter via USB com port
2. Open MCT 10 Set-up software
3. Choose "Open"-stored files will be shown
4. Open the appropriate file
5. Choose "Write to drive"

All parameter settings are now transferred to the frequency converter.

A separate manual for MCT 10 Set-up Software is available: MG. $10 . R x . y y$.

The MCT 10 Set-up software modules
The following modules are included in the software package:


## Ordering number:

Please order the CD containing MCT 10 Set-up Software using code number 13081000.

MCT 10 can also be downloaded from the Danfoss Internet: Www.DANFOSS.COM, Business Area: Motion Controls.

## 

### 8.1 How to Programme

### 8.1.1 Parameter set-up

## Overview of parameter groups

| Group | Title | Function |
| :---: | :---: | :---: |
| O- | Operation / Display | Parameters related to the fundamental functions of the frequency converter, function of the LOP buttons and configuration of the LOP display. $\qquad$ |
| 1. | Load / Motor | Parameter group for motor settings. |
| 2- | Brakes | Parameter group for setting brake features in the frequency converter. |
| $3-$ | Reference / Ramps | Parameters for reference handling, definitions of limitations, and configuration of the reaction of the frequency converter to changes. |
| 4 | Umits / Wamings | Parameter group for configuring llmits and wamings. |
| $5 \cdot$ | Digital In/Out | Parameter group for configuring the digital inputs and outputs. |
| 6 | Analog. In/Out | Parameter group for conflouration of the analog liputs and outputs. |
| $8-$ | Communication and Options | Parameter group for configuring communications and options. |
| 9 | Profibus | Parameter group for Profibus-specific parameters. |
| $10-$ | DeviceNet Fieldbus | Parameter group for DeviceNet-specific parameters. |
| 13 | Smart Logic | Parameter group for Smart Logic Control |
| 14 | Special Functions | Parameter group for configuring special frequency converter functions. |
| 15 | Drive Information | Parameter group containing frequency converter information such as operating data, hardware conflouration and softwane, versions. |
| 16. | Data Readouts | Parameter group for data read-outs, e.g. actual references, voltages, control, alarm, warning and status words. |
| 18- | Info and Readouts | This parameter group contains the last 10 Preventive Maintenance logs. |
| 20- | Drive dosed Loop | This parameter group is used for configuring the closed loop PID Controller that controls the output frequency of the unit. |
| 21- | Extended Closed Loop | Parameters for configuring the three, Extended Cosed Loop PID Controllers. |
| 22- | Application Functions | These parameters monitor water applications. |
| 23 | Time-based Functions | These parameters are for actions needed to be performed on a daily or weeldy basts, e.g. different references for working, hours/non-wonking, hours. |
| 25- | Basic Cascade Controller Functions | Parameters for configuring the Basic Cascade Controller for sequence control of multiple pumps. |
| 26 | Analog 1/0 O D A O M M 109 | Parameters for configuring the Analog I/0 Ontion MCB 109. |
| $27-$ | Extended Cascade Control | Parameters for configuring the Extended Cascade Control. |
| 29 | Weter Appllication Functions | Parameters for setting water specific functions. |
| 31- | Bypass Option | Parameters for configuring the Bypass Option |

Table 8.1: Parameter groups

Parameter descriptions and selections are displayed on the graphic (GLCP) or numeric (NLCP) in the display area. (See Section 5 for details.) Access the parameters by pressing the [Quick Menu] or [Main Menu] key on the control panel. The quick menu is used primarity for commissioning the unit at startup by providing those parameters necessary to start operation. The main menu provides access to all parameters for detailed application programming.

All digital input/output and analog input/output terminals are multifunctional. All terminals have factory default functions suitable for the majority of water applications but if other special functions are required, they must be programmed in parameter group 5 or 6 .

### 8.1.2 Q1 My Personal Menu

Parameters defined by the user can be stored in Q1 My Personal Menu.

Select My Persona/ Menu to display only the parameters, which have been pre-selected and programmed as personal parameters. For example, a pump or equipment OEM may have pre-programmed these to be in My Personal Menu during factory commissioning to make on site commissioning / fine tuning simpler.. These parameters are selected in par. 0-25 My Personal Menu. Up to 20 different parameters can be defined in this menu.
Q1 My Personal Menu

### 8.1.3 Q2 Quick Setup

The parameters in Q2 Quick Setup are the basic parameters which are always needed to set-up the frequency converter to operation.


### 8.1.4 Q3 Function Setups

The Function Setup provides quick and easy access to all parameters required for the majority of water and wastewater applications induding variable torque, constant torque, pumps, dosing pumps, well pumps, booster pumps, mixer pumps, aeration blowers and other pump and fan applications. Amongst other features it also includes parameters for selecting which variables to display on the LCP, digital preset speeds, scaling of analog references, closed loop single zone and multi-zone applications and specific functions related to water and wastewater applications.

## How to access Function Set-up - example:



Illustration B.5: Step 5: Use the up/down navigation keys to scrall down to i.e. 03-12 Analog Outputs. Press [OK].



Illustration 8.3: Step 3: Use the up/down navigation keys to scroll down to Function Setups. Press [OK].

Ilustration 8.7: Step 7: Use the up/down navigation keys to select between the different choices. Press [ $O K$ ].

The Function Setup parameters are grouped in the following way:

| Q3-1 General Settings |  |  |  |
| :---: | :---: | :---: | :---: |
| 103-10 Clock Settings | Q3-1.1 Display Settings | Q3-12 Analog Ofrtput | Q3-13 Relays |
| 0-70 Set Date and Time | 0-20 Display Line 1.1 Small | 6-50 Terminal 42 Output | Relay $1 \Rightarrow 5-40$ Function Relay |
| 0-71 Date Format | 0-21 Dtsplay Une 1.2 Small | 6-51 Terminal 42 Output.M1n Scale | Relay $2 \Rightarrow 5-40$ Function Relay |
| 0-72 Time Format | 0-22 Display Line 1.3 Small | 6-52 Terminal 42 Output Max Scale | Option relay $7 \Rightarrow 5-40$ Function Relay |
| 0-74 DST/Summertime | 0-23-Display Line 2 Large |  | Option relay $8=5-40$ Function Relay $\qquad$ |
| 0-76 DST/Summertime Start | 0-24 Display Line 3 Large |  | Option relay $9 \Rightarrow 5-40$ Function Relay |
| 0-77 DST/Summertme End | 0-37 Display Text 1 |  |  |
|  | 0-38 Display Text 2 |  |  |
|  | 0-39.DsplayText 3 |  |  |


| Q3-2 Open Loop Settings |  |
| :---: | :---: |
| 103-20 Digttal Reference | Q3-21 Analog Referenco |
| 3-02 Minimum Reference | 3-02 Minimum Reference |
| 3-03 Maximum Reference | 3 -03 Madimum Reference |
| 3-10 Preset Reference | 6-10 Terminal 53 Low Voltage |
| [-13Terminal 29-igital Input | 6-11 Teminal 53 High Vottoge |
| 5-14 Terminal 32 Digital Input | 6-14 Terminal 53 Low Ref/Feedb. Value |
| [-15 Teminal 33-ightolinput | 6-15 Teminal 53 Hiligh. Ref/Feedb. Value |


| Q3-3 Closed Loop Settings |  |
| :---: | :---: |
| O3-30 Feedback Settings | 03-31 PID Settings |
| 1-00 Configuration Mode | 20-81 PID Normal/Inverse Control |
| 20-12. Reference/Feedb.Uñt | 20-82 PID Stait Speed [RPM] |
| 3-02 Minimum Reference | 20-21 Setpoint 1 |
| 3-03. Maximum Reference | 20-93. PID Proportional Gain |
| 6-20 Terminal 54 Low Voltage | 20-94 PID Integral Time |
| 6-21 Terminal 54 High Vottoge |  |
| 6-24 Terminal 54 Low Ref/Feedb Value |  |
| 6-25 Teminal 54 High Ref/Eeedb Value |  |
| 6-00 Live Zero Timeout Time |  |
| 6-01 Live Zero Timeont Function |  |

### 8.1.5 Q5 Changes Made

Q5 Changes Made can be used for fault finding.

## Select Changes made to get information about:

- the last 10 changes. Use the up/down navigation keys to scroll between the last 10 changed parameters.
- the changes made since default setting.

Select Loggings to get information about the display line read-outs. The information is shown as graphs.
Only display parameters selected in par. 0-20 and par. 0-24 can be viewed. It is possible to store up to 120 samples in the memory for later reference.

Please notice that the parameters listed in the below tables for Q5 only serve as examples as they will vary depending on the programming of the particular frequency converter.

| Q5-1 Last 10 Changes |  |
| :--- | :--- |
| 20-94. PID Integral T]me |  |


| Q5-2 Since Factory Setting |  |
| :---: | :---: |
| 20-93 PID Proportional Gain |  |
| 20-94 PID Integral Time |  |


| Analog, Input 53 |
| :--- | :--- | :--- |
| Analog Input 54 |

### 8.1.6 Q6 Loggings

Q6 Loggings can be used for fault finding.

Please notice that the parameters listed in the below table for Q 6 only serve as examples as they will vary depending on the programming of the particular frequency converter.
Referenge
Analog Input 53
Motor Cument
Frequency
Feedback
Energy Log
Trending Cont Bin
Trending Timed Bin
Trending Comparison

### 8.1.7 Main Menu mode

Both the GLCP and NLCP provide access to the main menu mode. Select the Main Menu mode by pressing the [Main Menu] key. Illustration 6.2 shows the resulting read-out, which appears on the display of the GLCP. Lines 2 through 5 on the display show a list of parameter groups which can be chosen by toggling the up and down buttons.


Illustration 8.8: Display example.

Each parameter has a name and number which remain the same regardless of the programming mode. In the Main Menu mode, the parameters are divided into groups. The first digit of the parameter number (from the left) indicates the parameter group number.

All parameters can be changed in the Main Menu. The configuration of the unit (par. 1-00 Configuration Mode) will determine other parameters available for programming. For example, selecting Closed Loop enables additional parameters related to closed loop operation. Option cards added to the unit enable additional parameters associated with the option device.

### 8.1.8 Parameter selection

In the Main Menu mode, the parameters are divided into groups. Select
a parameter group by means of the navigation keys.
The following parameter groups are accessible:


Table 8.2: Parameter groups.

After selecting a parameter group, choose a parameter by means of the navigation keys.
The middle section on the GLCP display shows the parameter number and


### 8.2 Commonly Used Parameters - Explanations

### 8.2.1 Main Menu

The Main Menu indudes ali available parameters in the VLT AQUA Drive FC 200 frequency converter.
All parameters are grouped in a logic way with a group name indicating the function of the parameter group.
All parameters are listed by name and number in the section Parameter Options in these Operating Instructions.

All parameters included in the Quick Menus (Q1, Q2, Q3, Q5 and Q6) can be found in the following.

Some of the most used parameters for VLT AQUA Drive applications are also explained in the following section.

For a detailed explanation of all parameters, please refer to the VLT* AQUA Drive Programming Guide MG.20.OX.YY which is available on www.danfoss.com or by ordering at the local Danfoss office.

VLT ${ }^{\circledR}$ AQUA Drive Operating Instructions

### 8.2.2 0-** Operation / Display

Parameters related to the fundamental functions of the frequency converter, function of the LCP buttons and configuration of the LCP display.


| [1006] | Readout Receive Error Counter | View the number of CAN control receipt errors since the last power-up. |
| :---: | :---: | :---: |
| [1007] | Readout Bus Off Counter | View the number of Bus Off events since the last power-up. |
| [1013] | Warning Parameter | View a DeviceNet-specific warning word. One separate bit is assigned to every warning. |
| [1115] | LON Waming Word | Shows the LON-spectic wamings. |
| [1117] | XIF Revision | Shows the version of the external interface file of the Neuron C chip on the LON option. |
| [1118] | LON Works Revision | Shows the software version of the application program of the Neuron C chip on the LON option. |
| [1500] | Operating Hours | View the number of running hours of the frequency converter. |
| [1501] | Running Hours | Vew the number of running hours of the motor. |
| [1502] | kWh Counter | View the mains power consumption in kWh . |
| [1600] | Control Word | View the Control Word sent from the frequency comverter via the serial communication port in hex code. |
| [1601]* | Reference [Unit] | Total reference (sum of digital/analog/preset/bus/freeze ref./catch up and slow-down) in selected unit. |
| [1602] | Reference \% | Total reference (sum of digita/analog/preset/bus/freeze ref/catch up and slow-down) in percent. |
| [1603] | Status Word | Present status word |
| [1605] | Main Actual Value [\%] | One or more wamings in a Hex code |
| [1609] | Custom Readout | View the user-defined readouts as defined in par. 0-30, 0-31 and 0-32. |
| [1610] | Power [kW] | Actual power consumed by the moter in KW. |
| [1611] | Power [hp] | Actual power consumed by the motor in HP. |
| [1612] | Motor Voltage | Voltage supplied to the motor. |
| [1613] | Motor Frequency | Motor frequency, i.e. the output frequency from the frequency converter in Hz . |
| [1614] | Motor Current | Phase current of the motor measured as effective value. |
| [1615] | Frequency [\%] | Motor frequency, i.e. the output frequency from the frequency converter in percent. |
| [1616] | Torque [ Nm ] | Present motor load as a percentage of the rated motor torque. |
| [1617] | Speed [RPM] | Speed in RPM (revolutions per minute) i.e. the motor shaft speed in dosed loop based on the entered motor nameplate data, the output frequency and the load on the frequency converter. |
| [1618] | Motor Thermal | Themal load on the motor, catculated by the ETR function. See also parameter group 1-9* Motor Temperatire. |
| [1622] | Torque [\%] | Shows the actual torque produced, in percentage. |
| [1630] | DC Link Voltage | Intermediate cirait voltage in the frequency converter. |
| [1632] | BrakeEnergy/s | Present brake power transferred to an external brake resistor. Stated as an instantaneous value. |
| [1633] | BrakeEnergy/2 min | Brake power transferred to an external brake reststor. The mean power is caloulatied contlnuously for the most recent 120 seconds. |
| [1634] | Heatsink Temp. | Present heat sink temperature of the frequency converter. The cut-out limit is $95 \pm 5 \mathrm{oC}$; cutting back in occurs at $70 \pm 5^{\circ} \mathrm{C}$. |
| [1635] | Thermal Drive Load | Percentage load of the inverters |
| [1636] | Inv. Nom. Current | Nominal current of the frequency converter |
| [1637] | Inv. Max Current | Maxdmum current of the frequency converter |
| [1638] | SL Control State | State of the event executed by the control |
| [1639] | Control Card Temp. | Temperature of the control card. |
| [1650] | External Reference | Sum of the external reference as a percentage, i.e. the sum of analog/pulse/bus. |
| [1652] | Feedbadk [UnIt] | Stignal value in units from the programmed digital Input(s). |
| [1653] | Digi Pot Reference | View the contribution of the digital potentiometer to the actual reference Feedback. |
| [1654] | Feedback 1 [Unit] | View the value of Feedback 1. See also par. 20-0*. |
| [1655] | Feedback 2 [Unit] | View the value of Feedback 2. See also par. 20-0*. |
| [1656] | Feedback 3 [Unit] | Vew the value of Feedback 3. See also par. 20-0*. |
| [1658] | PID Output [\%] | Returns the Drive Closed Loop PID controller output value in percent. |



| [2157] | Ext. 3 Reference [Unit] | The value of the reference for extended Closed Loop Controller 3 |
| :---: | :---: | :---: |
| [2158] | Ext. 3 Feedback [Unit] | The value of the feedback signal for extended Closed Loop Controller 3 |
| [2159] | Ext Output [\%] | The value of the output from extrended Closed Loop Controller 3 |
| [2230] | No-Flow Power | The calculated No Flow Power for the actual operating speed |
| [2580] | Cascade Status | Status for the operation of the Cascade Controller |
| [2581] | Pump Status | Status for the operation of each individual pump controlled by the Cascade Controller |
| [2791] | Cascade Reference | Reference output for use with follower drives. |
| [2792] | \% Of Total Capacity | Readout parameter to show the system operating point as a \% capacity of total system capacity. |
| [2793] | Cascade Option Status | Readout parameter to show the staus of the cascade system. |
| 027 D9PG74nc¢26men |  |  |

Option:

## Function:

Select a variable for display in line 1, middle position.
[1662] * Analog input $53 \quad$ The optons are the same as those listed for par. 0-20 Dxplay Lne 1.1 Small

| Option: | Function: <br> Select a variable for display in line 1, right position. |
| :--- | :--- |
| [1614] * Motor Current | The options are the same as those listed for par. 0-20 Dispday Line 1.1 Smafl |
| 0.23 Display thne? |  |

Option:

## Function:

Select a variable for display in line 2.

| $[1615]$ | Frequency | The options are the same as those listed for par. 0-20 Display Line 1.1 Small |
| :--- | :--- | :--- |
| 29 Display theg torge |  |  |

## Option:

[1652] * Feedback [Unit]

## Function:

The options are the same as those listed for par. 0-20 Display Line 1.1 Small.
Select a varable for display in line 2.

## $0-37$ Displayでext?

| Range: |  | Function: |
| :---: | :---: | :---: |
| 0 N/A* | [ $0-0 \mathrm{~N} / \mathrm{A}$ ] | In this parameter it is possibte to write an individual text string for display in the LCP or to be read via serial communication. If to be displayed permanently setect Display Text 1 in par. 0-20 Display Une 1.1 Small, par, 0-21 Display Line 1.25 nmalh par. 0-22 Dsplay Line 1.3 Small, par. 0-23 Display Une 2 Large or par. 0-24 Dksplay Lhe. 3 Large. Use the 4 or $\overline{\text { V }}$ buttons on the LCP to change a character. Use the 4 and buttons to move the cursor. When a character is highilighted by the cursor, it can be changed. Use the $\triangle$ or $\boldsymbol{\nabla}$ buttions on the LCP to ctiange a character. A charecter can be inserted by plading the cursor between two characters and pressing $\triangle$ or $\nabla$. |


| O38 Displayuext |  |  |
| :---: | :---: | :---: |
| Range: |  | Function: |
| O N/A* | $[0-0 \mathrm{~N} / \mathrm{A}]$ | In this parameter it is possible to write an individual text string for display in the LOP or to be read via serial communication. If to be displayed permanently select Display Text 2 in par. 0-20 Display Line. 1.1 Small, par. 0-21 Display. Line 1.2 Small, par. 0-22 Display. Line 1.3 Small; par. 0-23 Display Line 2 Large or par. 0-24 Display Lhe 3 Laige. Use the 4 or. Vuttons on the LCP to criange a character. Use the 4 and m. buttons to move the cursor. When a character is highl!ghted by the cursor, this character can be changed. A character can be inserted by pladng the cursor between two characters and pressing 4 or $\bar{\nabla}$. |



|  |  |
| :---: | :---: |
| Range: | Function: |
| 2000-01-01 [2000-01-01 00:00] | Sets the date and time of the iteralal cock. The formet to be seed is set in par.0.71 and a-72. |
| 00:00 | Ns! |
| 2099912.01 | This prameler does not display the atual time. This can de read in par. 0.89 . |
|  | The lock will l ot begin counting untlo setting different from defaut has been |




| [0] * Off |  |
| :---: | :---: |
| [2] Manual | \% |
|  |  |
| Range: | Function: |
| 0N/A*: [0-0N/A] | Sets the date and time when summertme/DST stats. The date is programmed in the format se lected In pari, 0-71 Date Format |


| OLd DSTSUMmethenend |  |
| :---: | :---: |
| Range: | Function: |
| $0 \mathrm{~N} / \mathrm{A}^{*} \quad$ [ 0 -0 NA] | Sets the date and time when summertime/DST ends. The date is programmed in the format selected In par. 0-7í Date Fomat |

### 8.2.3 General Settings, 1-0*

Define whether the frequency converter operates in open loop or closed loop.


## NB!

When set for Closed Loop, the commands Reversing and Start Reversing will not reverse the direction of the motor.

## 2-20 Motor Power [k wi]





[^18]| 20 M Motcrinent |  |
| :---: | :---: |
| Range: | Function: |
| $7.20 \mathrm{~A}^{*} \quad[0.10-10000.00 \mathrm{~A}]$ | Enter the nominal motor current value from the motor nameplate data. This data is used for cal ollating motor torque, mator thermal protection etc. |

NB! This parameter cannot be adjusted while the motor is running.

| ExS Moforinonne] Specd | + |
| :---: | :---: |
| Range: | Function: |
| 1420. RPM** [100-60000 RPM] | Enter the nominal motor speed value from the motor nameplate data. This data is used for calar lating automatic motor compensations. |

NB! | This parameter cannot be changed while the motor is running. |
| :--- |


[0] * Off No function

| [1] | Enable complete AMA | performs AMA of the stator reststarice $R_{s}$, the rotor resktance $R$, the stator ieakage reactance $X_{1}$, the rotor leakage reactence $X_{2}$ and the main reactonce $X_{h}$. |
| :---: | :---: | :---: |
| [2] | Enable reduced AMA | performs a reduced AMA of the stator resistance $R_{s}$ in the system only. Select this option if an LC filter is used between the frequency converter and the motor. |

Activate the AMA function by pressing [Hand on] after selecting [1] or [2]. See also the section Automatic Motor Adaptation. After a normal sequence, the display will read: "Press [OK] to finish AMA". After pressing the [OK] key the frequency converter is ready for operation.

Note:

- For the best adaptation of the frequency converter, run AMA on a cold motor
- AMA cannot be performed while the motor is running



## NB!

It is important to set motor par. 1-2* Motor Data correctly, since these form part of the AMA algorithm. An AMA must be performed to achieve optimum dynamic motor performance. It may take up to 10 min ., depending on motor power rating.


| N8! |
| :--- |
| If one of the settings in par. $1+2^{*}$ Motor Data is changed, par. 1-30 Stator Resistance (Rs) to par. 1-39 Motor Poles, the advanced |
| motor parameters, will return to default setting. |
| This parameter cannot be adjusted while the motor is running |



See section: Application Examples > Automatic Motor Adaptation in the Design Guide.

### 8.2.4 3-0* Reference Limits

Parameters for setting the reference unit, limits and ranges.

## K02 WhatumRererenco

Range: Function:
0.000 Ref- [-999999.999 - par. 3-03 Referen- Enter the Minimum Reference. The Minimum Reference is the lowest value obtainable by summing erencefeed-cefeedbackUnit] all references. The Minimum Reference value and unit matches the conflguration choloe made in
$\square$

## 8503 Maxfunumefernce

Range:
Function:
50.000 Ref- [par, 3-02 - 999999.999 Refeien- Enter the maxdmum zcceptable value for the remote reference. The Madmum Reference value and erencefeed-cefeedbacdunit] backlnit" unit matches the configuration chisice made In par, 1-00 Configuration Mace and par, 20-12 Reference/Feedback Unit, respectively.


NB!
If operating with par, $1-0$, Configuration Mode set for Closed Loop [3], par. 20-14, Maxdmum Reference/feedb. must be used.

| O20 Qresengerenso |  |  |
| :---: | :---: | :---: |
| Array [8] |  |  |
| Range: |  | Function: |
| $0.00 \%^{*}$ | $[-100.00-100.00 \%]$ | Enter up to eight different preset references ( $0-7$ ) in this parameter, using array programming. The preset reference is stated as a percentage of the value Refmax (par. 3-03 Maximum Reference, for dosed loop see par. 20-14 Maximum Reference/Feedh). When using preset references, select Pre set ref. bit 0/1/2 [16], [17] or [18] for the corresponding digital inputs in parameter group 5-1* Dtgital Inputs. |





Range: Function:

| $20.00 \mathrm{~s}^{*} n \quad[1.00-3600.00 \mathrm{~s}]$ | Enter the ramp-down tme, l.e. the deceleration time from par. 1-25 Motor Nommal Speed to 0 RPM. Choose a ramp-down time such that no over-voltage arises in the inverter due to regenerative operation of the motor, and such that the generated courrent does not exceed the current limit set in par. 4-18 Current Limit. See ramp-up time in par. 3-41 Ramp 1 Ramp Lop Time. $p a r .3-42=\frac{\text { rdec } \times \text { nnorm }[\text { par. } 1-25]}{\operatorname{ref}[r p m]}[s]$ |
| :---: | :---: |

## 

Range:
$0 s^{*} \quad[0-60 s]$

## Function:

Enter the initial ramp up time from zero speed to Motor Speed Low Limit, par. 4-11 or 4-12. Submersible deep well pumps can be damaged by running below minimum speed. A fast ramp time below minimum pump speed is recommended. This parameter may be applied as a fast ramp rate from zero speed to Motor Speed Low Limit.


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## Fiss Check olveramplue

## Range:

$0 \mathrm{~s}^{*} \quad[0-60 \mathrm{~s}]$

## Function:

In order to protect ball check valves in a stop situation, the check valve ramp can be utilized as a slow ramp rate from par. 4-11 Motor Speed Low Limit (RPM) or par. 4-12 Motor Speed Low Limit [Hz], to Check Valve Ramp End Speed, set by the user in par. 3-86 or par. 3-87. When par. 3-85 is different from 0 seconds, the Check Valve Ramp Time is effectuated and will be used to ramp down the speed from Motor Speed Low Limit to the Check Valve End Speed in par. 3-86 or par. 3-87.


## For Chedkrar Ramp End

## Range:

## Function:

0 [RPM]* [0 - Motor Speed Low Limit [RPM]] Set the speed in [RPM] below Motor Speed Low Limit where the Check Valve is expected to be closed and the Check Valve no longer shall be active.


## 387 GhedzUelveRemp[nd Speci[Az]

## $0[\mathrm{~Hz}]^{*} \quad[0-$ Motor Speed Low Limit [Hz]]

Set the speed in [Hz] below Motor Speed Low Limit where the Check Valve Ramp will no longer be active.


## Function:

Enter the Final Ramp Time to be used when ramping down from Motor Speed Low Limit, par. 4-11 or 4-12, to zero speed.
Submersible deep well pumps can be damaged by running below minimum speed. A fast ramp time below minimum pump speed is recommended. This parameter may be applied as a fast ramp rate from Motor Speed Low Limit to zero speed.


### 8.2.5 4-** Limits and Warnings

Parameter group for configuring limits and warnings.

## 4-99 Moforspecdtowntmi[R:M]

| Range: | Function: |
| :---: | :---: |
| 0 RPM** [0-par. 413 RPM ] | Enter the minimum limit for mator speed. The Motor Speed Low Limit can be set to correspond to the manufacturer's recommended minimum motor speed. The Motor Speed Low Limit must not exceed the setting in par. 4-13 Motor Speed High Limit [RPM]. |

Q
Range:

## Function:

1500. RPM* [par. 4-11-60000. RPM] Enter the maximum limit for motor speed. The Motor Speed High Imit can be set to correspond to the manufacturer's maximum rated motor. The Motor Speed High Imit must exceed the setting in par. 4-11 Motor Speed Low Limit [RPM]. Only par, 4-11 Motor Speed Low Limit [RPM] or par. 4-12 Motor Speed Low Limit [Hz]/will be displayed depending on other parameters in the Main Menu and depending on default settings dependant on global location.


NB!
Max. output frequency cannot exceed $10 \%$ of the inverter switching frequency (par. 14-01 Switching Frequency).


## NB!

Any changes in par. 4-13 Motor Speed High Limit [RPM] will reset the value in par. 4-53 Warning Speed High to the same value as set in par. 4-13 Motor Speed High Limit [RPM].

### 8.2.6 5-** Digital In/Out

Parameter group for configuring the digital input and output.
EOn Terminal 27 Mode
Option:

| $[0]^{*}$ | Input | Function: |
| :--- | :--- | :--- |
| $[1]$ | Output | Defines terminal 27 as a digital input. |

Please note that this parameter cannot be adjusted while the motor is running.

### 8.2.7 5-1* Digital Inputs

Parameters for configuring the input functions for the input terminals.
The digital inputs are used for selecting various functions in the frequency converter. All digital inputs can be set to the following functions:


8 How to Programme the Frequency Converter


All $=$ Terminals $18,19,27,29,32, \times 30 / 2, \times 30 / 3, \times 30 / 4 . \times 30 /$ are the terminals on MCB 101.

Functions dedicated to only one digital input are stated in the associated parameter.

All digital inputs can be programmed to these functions:

| [0] | No operation | No reaction to slgnals transmitued to terminal. $\%$ |
| :---: | :---: | :---: |
| [1] | Reset | Resets frequency converter after a TRIP/ALARM. Not all alarms can be reset. |
| [2] | - Coast inverse | Leaves motor in free mode. Logic ' $\mathrm{D}^{\prime}=>$ coasting stop. (Default Digital inpit 27): Coasting stop, invertéd input (NC). |
| [3] | Coast and reset inverse | Reset and coasting stop Inverted input (NC). <br> Leaves motor in free mode and resets the frequency converter. Logic ' $0^{\prime}=>$ coasting stop and reset. |
|  | DC-brake Inverse | Inverted input for $D C$ braking (NC). <br> Stops motor by energling it with a DC current for a certain time perlod. See par. 2-01 to par. 2-03. The.function is only active whien the value in par. 2-02 is different from 0 . Logic ' $\mathrm{O}^{\prime} \Rightarrow D C$ braking. |
| [6] | Stop inverse | Stop Inverted function. Generates a stop function when the selected terminal goes from logical level ' 1 ' to ' 0 '. The stop is performed according to the selected ramp time (par. 3-42 and par. 3-52. <br> NB! <br> When the frequency converter is at the torque limit and has received a stop command, it may not stop by itself. To ensure that the frequency converter stops, configure a digital output to Torque limit \& stop [27] and connect this digital output to a digital input that is configured as coast. |
| $[7]$ | Extemal Intertock | Same function as Coasting stop, Inverse, but Eidemal Intertock generates the alarm message 'extemal fault' on the display when the terminal whith is programmed for Coast Inverse st logic $0^{\prime}$ '. The alarm message will also be adtve va digital outputs and relay outputs, if programmed for External Interlock. The alarm can be reset using a digital inpuitt or the [RESET] key if the cause for the External Interlock has been removed. A delay can be programmed in par. 22-00, External Interlock Time. After applying a signal to the input; the reaction described above will be delayed with the time set in par. 22-00. |
| [8] | Start | Select start for a start/stop command. Logic ' 1 ' = start, logic ' 0 ' = stop. (Default Digital input 18) |
| [9] | 2. Latched start | Motor starts; if a pulse is applled for min. 2 ms . Motor stops when Stoip Inverse is activated |
| [10] | Reversing | Changes direction of motor shaft rotation. Select Logic ' 1 ' to reverse. The reversing signal only changes the direction of rotation. It does not activate the start function. Select both directions in par. 4-10 Motor Speed Direction. <br> (Default Digital input 19). |
|  | 7. Start reversing | Used for stat/stop and for reversing on the same wire. Signals on stait are not allowed at the same time. |
| [14] | Jog | Used for activating jog speed. See par. 3-11. (Default Digital input 29) |


| [15] | Preset reference on | Used for shifting between extemal reference and preset reference. It is assumed that Exterialy preset [1] has been selected in par. 3-04. Loglc ' 6 ' = external reference active; logic ' 1 ' = one of the eight presed references is adive. |
| :---: | :---: | :---: |
| [16] | Preset ref bit 0 | Enables a choice between one of the eight preset references according to the table below. |
| [17] | Preset ref bit 1 | Enables a doice between one of the eight preset references according to the table below. |
| [18] | Preset ref bit 2 | Enables a choice between one of the eight preset references according to the table below. |
|  |  | Preset ref. bit 20 |
|  |  | Presetref. 0 _-0 0 |
|  |  | Preset ref. 1 O 0 l |
|  |  | Presetref. 2 |
|  |  | Preset ref. 3 O-0 |
|  |  | Presetref. 4 _, |
|  |  |  |
|  |  | Presetref. $6 \ldots \ldots$ |
|  |  | $\begin{array}{lllll}\text { Preset ref. } 7 & 1 & 1 & 1\end{array}$ |


| [19] | Freere ref | Freezes actual referenoe. The frozen reference is now the point of enable/condtrion for speed up and Speed down to be used. If Speed up/down is used, the speed change always follows rimp 2 (par. 3-51 and 3-52) in the range 0-par. 3-03 Maximum Referenco. |
| :---: | :---: | :---: |

[20] Freeze output

| [21] | Speed up | For digtal control of the up/down speed is desired (motor potientioneter). Activate thls function by selecting either Freere reference or Freens output. When Speed up is activated for less than 400 msec. the resuilting reference will be increased by $0.1 \%$. If Speed up is activated for more than 400 . msec . the ressulting reference will ramip according to Ramp 1in par. 3-41. |
| :---: | :---: | :---: |
| [22] | Speed down | Same as Speed up [21]. |
| [23] | Set-up select bit 0 | Selects one of the four set-ups. Set par. 0-10 Active Set-up to Mult Set-up. |
| [24] | Set-up select bit 1 | Same as Set-up select bit 0 [23]. <br> (Default Digital input 32) |
| [32] | Puse input | Seted Pube input when using a pulse sequence as either referenoe or feedback Scaling is done in par. group 5-5*. |
| [34] | Ramp bit 0 | Select which ramp to use. Logic "0" will select ramp 1 while logic " 1 " will select ramp 2. |
| [36] | Malns fallure Inverse | Activates par. 14-10 mahas faftime: Matrs fallure Imverse is active ti the Logk "0' stivation. |
| [52] | Run Permissive | The input terminal, for which the Run permissive has been programmed must be logic " 1 " before a start command can be accepted. Run permissive has a logic 'AND' function related to the terminal which is programmed for START[8], Jog [14] or Freeze Output [20], which means that in order to start running the motor, both conditions must be fulfilled. If Run Permissive is programmed on multiple terminals, Run permissive needs only be logic ' 1 ' on one of the terminals for the function to be carried out. The digital output signal for Run Request (Start [8], Jog [14] or Freeze output [20]) programmed in par. 5-3* Digital outputs, or par. 5-4* Relays, will not be affected by Run Permissive. |
| [53] | Hand trart | A signal appiled will put the frequency dorverter into Hand mode as if button thand On on the LOP has been pressed and a normal stop command will be overtdden. If disconnecting the shgnal; the motor will stop. To make any other tart commands valld, another dighal input must be asslgn to Auto. Stast and a skinal applled to thls. The Hand On and Auto Onbuttons on the LTP has no Impact. The Oiffutton on the LCP wlll owertde Hand S̈rrt and Auto Shatt. Press elther the Hand On or Auto On button to make ttand Shart and Auto Slart active agaln. If no stgnal on neither Hand Slart nor Auto. Start, the motor will stop regardiess of any normal Sart command appled. If stgnal applled to both Hand Sigst and Auto Siart, the function will be Auto Sigrt if pressing the Offlutton on the LOP the motor will stop regardkess of signal's on Hand Stort and Auto Start |


[78] Reset Preventive MaIntenance Word Resets all data In par. 16-96, Preventive Maintenance Word, to 0.
The below setting options are all related to the Cascade Controller. Wiring diagrams and settings for parameter, see group $25-* *$ for more details.


## 

## Option:

[0] * No Operation

## Function:

Same options and functions as par. 5-1* Digital Inputs.

## E-29 Terminal

Same options and functions as par. 5-1*, except for Pulse input.
Option:
Function:

## [0] * No operation

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## ETO Terinfinity <br> 

Same options and functions as par. 5-1* Digital Inputs.


Same options and functions as par. 5-3*.


Select options to define the function of the relays.
The selection of each mechanical relay is realized in an array parameter.


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| Range: | Function: |
| :---: | :---: |
| $100.000 \mathrm{~N} /[-999999.999-999999.999 \mathrm{~N} / \mathrm{A}]$ | Enter the high reference value [RPM] for the motor shaft speed and the high feedback value, see also par. 5-58 Term. 33 High Ref/FFedb. Value. |

### 8.2.8 6-** Analog In/Out

Parameter group for configuration of the analog input and output.

## GOO Hivercroftreontitue

| Range: |  | Function: |
| :---: | :---: | :---: |
| 10 s * | [1-99 s] | Enter the Uve Zero Mime-out tme perlod. Uve Zero Mime-out Time is active for analog injuts, i.e. terminal 53 or terminal 54, used as reference or feedback sources. If the reference signal value assodated with the selected ourrent input falls below $50 \%$ of the value set in par. 6-10 Termina/ 53 Low Vothage, par. 6-12 Terminal 53 Low Cument, par. 6-20 Terminal 54 Low Votrage or par. 6-22 Terminal 54 Low Currentfor a time period longer than the time set in par. 6-00 Live Zero Timeout Time, the function selected in par. 6-01 Live Zero Timeout Function will be activated. |

## 6-01 [ivenarofimeorshuntion

| Option: | Function: |
| :---: | :---: |
|  | Select the time-out function. The function set in par. 6-01 Live Zero Timeout Function will be actvated if the input signal on terminal 53 or 54 k below $50 \%$ of the value in par. 6-10 Terminal 53 Low Voltoge, par. 6-12 Terminal 53 Low Ourrent, par. 6-20 Terminal 54 Low Vatoge or par, 6-22 Terminal 54 Low Qurrent for a time perlod defined In par. 6-00 Lwe Zero. Tmeout Tlme. If several time-outs ocour simultaneously, the frequency converter priontises the time out functions as follows: <br> 1. par. 6-01 Live Zero Timeout Function <br> 2. par. 8-04 Control Imeout Function <br> The output frequency of the frequency converter can be: <br> - [1] frozen at the present value <br> - [2] overinuled to stop <br> - [3] overruled to jog speed <br> - [4] overruled to max. speed <br> - [5] overruled to stop with subsequent trip |


| $[0] *$ | Off |
| :--- | :--- |
| $[1]$ | Freeze output |
| $[2]$ | Stop |
| $[3]$ | Jogging |
| $[4]$ | Max. speed |
| $[5]$ | Stop and trip |





| Range: |  | Function: |
| :---: | :---: | :---: |
| $\begin{aligned} & 100.000 \mathrm{~N} / \\ & \mathrm{A}^{*} \end{aligned}$ | [-999999.999-999999.999 N/A] | Enter the analog input scaling value that corresponds to the high voltage/high current value set in par. 6-21 Terminal 54 High Voltoge and par. 6-23 Terminal 54 High Current |
| O-50 Ternins] 20 utp |  |  |
| Option: |  | Function: |
|  |  | Select the function of Terminal 42 as an analog current output A motor arrent of 20 mA comesponds to Imer: |
| [0] * No operation |  |  |
| [100] | Output freq. 0-100 | : 0-100 $\mathrm{Hz},(0-20 \mathrm{~mA})$ |
| [101] | Reference Min-Max | : Minimum reference - Maximum reference, (0-20 mA) |
| [102] | Feedback +-200\% | : $-200 \%$ to $+200 \%$ of par. 20-14, (0-20 mA) |
| [103] | Motor cur. O-Imax | : 0 - Inverter Max. Current (par. 16-37), (0-20 mA) |
| [104] | Torque 0-Tlm | : 0 - Torque llmit (par. 416), (0-20 mA) |
| [105] | Torque 0-Tnom | : 0 - Motor rated torque, ( $0-20 \mathrm{~mA}$ ) |
| [106] | Power 0-Pnomin | : 0 - Mator rated power, (0-20 mA) |
| [107] * | Speed 0-HighLim | : 0 - Speed High Limit (par. 4-13 and par. 4-14), (0-20 mA) |
| [113] | Ext. Cosed Loop 1 | : 0-100\%, (0-20 mA) |
| [114] | Ext. Closed Loop 2 | : 0-100\%, (0-20 mA) |
| [115] | Ext. Cosed Loop 3 | : 0-100\%, (0-20 mA) |
| [130] | Out frq 0-100 4-20mA | : $0-100 \mathrm{~Hz}$ |
| [131] | Reference 4-20mA | : Minimum Reference - Maxdmum Reference |
| [132] | Feedback 4-20mA | : $-200 \%$ to $+200 \%$ of par. 20-14 Maximum Reference/Feedb. |
| [133] | Motor aur. 420 mA | : 0- Inverter Máx. Current (par. 16-37 Liv. Max Current) |
| [134] | Torq. $0-\lim 4-20 \mathrm{~mA}$ | : 0 - Torque limit (par. 4-16) |
| [135] | Torq.0-nom 4-20ma | : 0 - Mator rated torque |
| [136] | Power 4-20mA | : 0 - Motor rated power |
| [137] | Speed 4-20mA | : 0 - Speed High Limit (4-13 and 414) |
| [139] | Bus ctrl. | : 0-100\%, (0-20 mA) |
| [140] | Bus ctr. 4.20 mA | : 0-100\% |
| [141] | Bus ctrl t.o. | : 0-100\%, (0-20 mA) |
| [142] | Bus ctil to. 420 mA | : 0-100\% |
| [143] | Ext. CL $14-20 \mathrm{~mA}$ | : 0-100\% |
| [144] | Ext, CL 2 420mA | : 0-100\% |
| [145] | Ext. CL 3 4-20mA | : 0-100\% |

## NB!

Values for setting the Minimum Reference is found in open loop par. 3-02 Minimum Reference and for closed loop par. 20-13 Minimum Reference/ Feedb. - values for maximum reference for open loop is found in par. 3-03 Maximum Reference and for closed loop par. 20-14 Maximum Reference/ Feedb..

|  | 9 |
| :---: | :---: |
| Range: | Function: |
| $0.00 \%^{*}{ }^{[0.00-200.00 \%]}$ | Scale for the minimum output ( 0 or 4 mA ) of the anatogue skgnal at terminal 42. Set the value to be the percentage of the full range of the varlable selected in par. 6-50 Temm 42 Outbut |




It is possible to get a value kwier than 20 mA at full scate by programming values $>100 \%$ by using a formula as follows:

20 mA / desired max/mum current $\times 100 \%_{\text {., }}$
i.e. $10 \pi / A: \frac{20 \mathrm{~mA}}{10 \mathrm{~mA}} \times 100 \%=200 \%$

EXAMPLE 1:
Variable value $=$ OUTPUT $F R E Q U E N C Y$, range $=0-100 \mathrm{~Hz}$
Range needed for output $=0-50 \mathrm{~Hz}$
Output signal 0 or 4 mA is needed at 0 Hz ( $0 \%$ of range) - set par. 6-51 Terminal 42 Output Min Scale to $0 \%$
Output signal 20 mA is needed at 50 Hz ( $50 \%$ of range) - set par. 6-52 Terminal 42 Output Max Scale to $50 \%$


EXAMPLE 2:
Variable $=$ FEEDBACK, range $=-200 \%$ to $+200 \%$
Range needed for output=0-100\%
Output signal 0 or 4 mA is needed at $0 \%$ ( $50 \%$ of range) - set par. 6-51 Terminal 42 Output Min Scale to $50 \%$
Output signal 20 mA is needed at $100 \%$ ( $75 \%$ of range) - set par. 6.52 Terminal 42 Output Max Scale to $75 \%$


## EXAMPLE 3:

Variable value $=$ REFERENCE, range $=$ Min ref - Max ref
Range needed for output= $\operatorname{Min}$ ref $(0 \%)-$ Max ref $(100 \%), 0-10 \mathrm{~mA}$
Output signal 0 or 4 mA is needed at Min ref - set par. 6-51 Terminal 42 Output Min Scale to $0 \%$
Output signal 10 mA is needed at Max ref ( $100 \%$ of range) - set par. 6-52 Terminal 42 Output Max Scale to $200 \%$
( $20 \mathrm{~mA} / 10 \mathrm{~mA} \times 100 \%=200 \%$ ).
(

### 8.2.9 Drive Closed Loop, 20-**

This parameter group is used for configuring the closed loop PID Controller, that controls the output frequency of the frequency converter.

## 




| 20-2i Setpofit |  |
| :---: | :---: |
| Range: | Function: |
| 0.000 Proc- [-999999.999-999999.999 PTOC-escarlu- esscriunit] | Setpoint 1 is used in Closed Loop Mode to enter a setpoint reference that is used by the frequency converter's PID Controller. See the description of par. 20-20 Feedbact Function. |
| nit** | NBI <br> Setpolnt reference entered here is added to ary other references that are enabled (see par. group 3-1*). |

## 

## Option:

## Function:

| [0]* Normal | Nommal [ 0 ] causes the frequency converter's output frequency to decrease when the feedback is <br> greater than the setpoint reference. This is common for pressure-controled supply fan and pump <br> applications. |
| :--- | :--- |
| Inverse [1] causes the frequency converter's output frequency to increase when the feedback is |  |
| greater than the setpoint reference. |  |

## 20-82 RTDStat Sped [RMM]

| Range: |  | Function: |  |
| :---: | :---: | :---: | :---: |
| 0 RPM* | [0-par. 4-13 RPM] | When the frequency converter is first stated, it initsally ramps up to this output speed in Open Loop Mode, following the active Ramp Up Time. When the output speed progremmed here is reached, the frequency converter will auttomatically switch to Closed Loop Mode and the PID Controller will begin to function. This is useful in applications in which the driven load must first quildly acceterate to a minimum speed when it is started. |  |
|  |  |  | NBI This parameter will only be visble if par. 0-02 Motor Speed Unitls set to [0], RPM. |
| 20-93 PTDPropotionalgan |  |  |  |
| Range: |  | Function: |  |
| $0.50 \mathrm{~N} / \mathrm{A}^{*}$ | [0.00-10.00 N/A] |  |  |

If (Error $\times$ Gain) jumps with a value equal to what is set in par. 20-14 Maximum Reference/Feedb. the PID controller will try to change the output speed equal to what is set in par. 4-13 Motor Speed High Limit [RPM]/par. 4-14 Motor Speed High Limit [Hz] but in practice of course limited by this setting. The proportional band (error causing output to change from $0.100 \%$ ) can be calculated by means of the formula:

$$
\left(\frac{1}{\text { Proportiona/ Gain }}\right) \times(\text { Max Reference })
$$

NB!
Always set the desired for par. 20-14 Maximum Reference/Feedb. before setting the values for the PID controller in par. group 20-9*.


### 8.2.10 22-** Miscellaneous

This group contains parameters used for monitoring water/ wastewater applications.

NB!
It is important that the par. 4-13 Motor Speed High Limit [RPM] or par. 4-14 Motor Speed High Limit [Hz] is set to the max. operational
speed of the motor!
It is important to do the Auto Set-up before configuring the integrated PI Contoller as settings will be reset when changing from Closed
to Open Loop in par. 1-00 Configuration Mode.

## NB!

Carry out the tuning with the same settings in par. 1-03 Torque Characteristics, as for operation after the tuning.



## 23F23 Mornownunctos



| 22426 Dry |
| :--- | :--- |
| Option: Function: <br>  Low Power Detection must be Enabled (par. 22-21 Low Power Detection) and conimissloned (using <br> either parameter group 22-3*, No Foo Power Tuning, or par. 22-20 Low Power Auto Set-up) in <br> order to use Dry Pump Detection. |


| $[0]$ * | Off |  |
| :--- | :--- | :--- |
| $[1]$ | Warming | Messages in the Local Control Panel display (if mounted) and/or signal via a relay or a digital output. |
| $[2]$ | Alarm | The frequency converter trips and motor stays stopped until reset. |





|  |  |
| :---: | :---: |
| Range: | Function: |
| $\mathrm{OHz}^{*} \quad[0.0-\mathrm{para} .22 .37 \mathrm{Hz]}$ | To be used If par. 0-02 Motor Speed Un/t has been set for Hz (parameter not visible if RPM selected). <br> Set used speed for the $50 \%$ level. <br> The function iss used for storing values needed to tune No Flow Detection. |
|  |  |
| Range: | Function: |
|  | To be used if par. 0-03 Regional Settings has been set for Intemational (parameter not visible if <br> North Amentia selected). <br> Set power consumption at $50 \%$ speed level, <br> This function is used for storing values needed to tune No Flow Detection. |
|  |  |
| Range: | Function: |
| O hp** [0.00-0.00 hp] | To be used if par. $0-03$ Regiona/ Settings has been set for North America (parameter not visible if - Intermational sélected). <br> Set power consumption at $50 \%$ speed level. <br> This function $k$ used for storing values needed to tine No Fow Detection. |




## Range:

| $0 \mathrm{hp}{ }^{*}$ | [0.00-0.00 hp] | To be used if par. 0-03 Reglonal Settings has been set for North Amerka (parameter not visible if |
| :---: | :---: | :---: |
| $\because$ |  | - International selected). |
|  |  | Set power cinsumption at 85\% speed level. 'is |
|  | , | This function is used for storing values needed to tine No Flow Detection. |




## 22-45 Setponfecost







## 

Option:


## 

| Range: | Function: |
| :---: | :---: |
| 300. RPM** [0-par. 22-85 RPM] | Resolution 1 RPM. <br> The speed of the motor at whict fiow is zero and minlmum pressure Hran is actieved should be entered here in RPM. Attematively, the sppeed in tit can be entered in par. 22-84 Speed at No-flow [ 4 Q$]$. If it has been decided to use RPM in par. 002 Motor Speed Unit then par. 22-85 Speed at Design Point [RPM] shouild așo be used. Olosing the valves and reducing the speed until minimum pressure H rex ts achleved will determine thls value. |



| 2383 Specder Desporoft RFM] | 4 | 4 |
| :---: | :---: | :---: |

Range: Function:

| $\text { 1500. RPM }{ }^{*} \text { : [par. 22-83-60000. RPM] }$ | Resolution 1 ŔPM. <br> Only visible when par. 22-82 Work Point Claculation is set to Disable. The speed of the motor at which the System Design Working Point is achieved should be entered here in RPM. Aternatively, the speed in Hz cann be. enitered in par. 22-86 Speed at Deston! Point [rez]. If it has been dedded to use RPM in par. 0.02 Motor Speed Unit then par. 22-83 Spieed at No-Ftow [RPM] should also be used. |
| :---: | :---: |
|  |  |
| Range: | Function: |
| $\begin{aligned} & \text { 50;60.0 [par. 22-84-par: } 419 \mathrm{~Hz}] \\ & \mathrm{hz} \mathrm{Z}^{*} \end{aligned}$ | Resolution 0.033 Hz <br> Only visible when par. 22-82 Work Point Cakudation is set to Disiable. The speed of the motor at which the System Design Working Point is actieved stiould be entered here in Hz Aternatively, the speed in RPM can be entered in par. 22-85 Speed at Design Point [RPM]. If it has been decided to use Hz in par. 0-02 Motor Speed Unit, theń par. 22-83 Speed at No-Flow [RPM/ should also be used. |


| 22837 Ressmreatnontow Specd |  |
| :---: | :---: |
| Range: | Function: |
| $0.000 \mathrm{~N} / \mathrm{A}^{*}$, [0.000-par. 22-88 N/A] | Enter the pressure Hwoy Comesponding to Speed at No Fow in Reference/Feedback Units. |
| 22Fi8 Pressurefrited Spach |  |
| Range: | Function: |
| 999999.999; [par. $22-87-999999.999 \mathrm{~N} / \mathrm{A}]$ $\mathrm{N} / \mathrm{A}^{*}$ | Enter the valiue corresponding to the Pressure at Rated Speed, In Reference/Feedback Unitc. Thls value can be defined using the pump datasteet. |
| 2ze0 [0wenkited |  |
| Range: | Function: |
| 0.000 N/A* [0.000-999999.999 N/A] | Enter the value coiresponding to fow ât Rated Speed. This value can be defñed using the pump datasheet |

### 8.2.11 23-0* Timed Actions

Use Timed Actions for actions needing to be performed on a daily or weekly basis, e.g. different references for working hours / non-working hours. Up to 10 Timed Actions can be programmed in the frequency converter. The Timed Action number is selected from the list when entering parameter group 23-0* from the LCP. par. 23-00 ON Time - par. 23-04 Occurrence then refer to the selected Timed Action number. Each Timed Action is divided into an ON time and an OFF time, in which two different actions may be performed.

The actions programmed in Timed Actions are merged with corresponding actions from digital inputs, control work via bus and Smart Logic Controller, according to merge rules set up in 8-5*, Digital/Bus.
$\square$
The clock (parameter group 0-7*) must be correctly programmed for Timed Actions to function correctly.




## 

```
Array [10]
```

| Range: |  | Function: |
| :---: | :---: | :---: |
| $0 \mathrm{~N} / \mathrm{A}^{*}$ | [ $0-0 \mathrm{~N} / \mathrm{A}$ ] | Sets the Off time for the Timed Action. |
|  |  | NBI <br> The frequency converter has no back up of the'dock function and the set date/ time will reset to defautt (2000-01-01 00:00) after a power down unless a Real Tlme Cook module with back up is installed. In par. 0-79 Cock Fautt it is possble to program for a Waming in case dock has nat been set property, e.g. after a power down. |



| [74] Start Tmer 7 |  |  |
| :---: | :---: | :---: |
|  |  |  |
| 23-0, Oceurrence |  |  |
| Array [10] |  |  |
| Option: |  | Function: |
|  |  | Select which day(s) the Timed Action applies to. Specify working/non-working days in par. 0-81 Warking Days, par. 0-82 Additional Working Davs and par. 0-83 Additiona/ Nor-Warking Days |
| [0]* All days |  |  |
| [1] Workng days |  |  |
| [2] Non-working days |  |  |
| [3] Monday |  |  |
| [4] Tuesday |  |  |
| [5] Wednesday |  |  |
| [6] Thursday |  |  |
| [ ${ }^{\text {c }}$ | Friday |  |
| [8] | Saturday |  |
| [9] | Sunday |  |

### 8.2.12 Water Application Functions, 29-**

The group contains parameters used for monitoring water / wastewater applications.

## 

Option:

| [0]* 1 Disabled |
| :--- |
| [1] |
| 2901 Enabled |
| Range: |
| Speed Low [Speed Low Limit - Speed High Lim- |
| Limit* it] |

2902 Fiparimesped][[27]

## Range:

Motor [Speed Low Limit - Speed High Lim-
Speed Low it]
Limit*

## Function:

Select Enabled to fill pipes at a user specified rate.
Select Enabled to fill pipes with a user spedfled rate.

## Function:

Set the filling speed for filling horizontal pipe systems. The speed can be selected in Hz or RPM depending on the choices made in par. 4-11/par. 4-13 (RPM) or in par. 4-12/par. 4-14 (Hz).

## Function:

Set the filling speed for filling horizontal pipe systems. The speed can be selected in Hz or RPM depending on the choices made in par. 4-11/par, 4-13 (RPM) or in par. 4-12 / par. 4-14 (Hz).

## Function:

Set the specified time for pipe filling of horizontal pipe systems.

| 2903 Prpendrato | 5 |
| :---: | :---: |
| Range: | Function: |
| $\begin{aligned} & 0.001 \text { units/ [0.001-9999.99.999 units/s] } \\ & s^{*} \end{aligned}$ | Specifies the filling rate in units/second using the PI controller. Filling rate units are feedback units/ second. This function is used for filling-up vertical pipe systems but will be active when the fillingtime has expired, no matter what, until the pipe fill-set-point set in par. 29-05 is reached. |

## 29:05 Fille Sxppotis

Range:

## Function:

0 s* [0-999999,999 s]

Specifies the Filled Set-point at which the Pipe Fill Function will be disabled and the PID controller will take control. This function can be used both for horizontal and vertical pipe systems.

### 8.3 Parameter Options

### 8.3.1 Default settings

## Changes during operation:

"TRUE" means that the parameter can be changed while the frequency converter is in operation and "FALSE" means that the frequency converter must be stopped before a change can be made.

## 4-Set-uD:

'All set-up': the parameter can be set individually in each of the four set-ups, i. e. one single parameter can have four different data values.
' 1 set-up': data value will be the same in all set-ups.

## SR: <br> N/A:

Size related
No default value available.

Conversion index:
This number refers to a conversion figure used when writing or reading by means of a frequency converter.

| Corry index | 100 | 67 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | -1 | -2 | -3 | -4 | -5 | -6 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Conv. factor | 1 | 1/60 | 1000000 | 100000 | 10000 | 1000 | 100 | 10 | 1 | 0.1 | 0.01 | 0.001 | 0.0001 | 0.00001 | 0.000001 |


| Data type | Description | Type |
| :---: | :---: | :---: |
| 2. | Lruerer 8 | Wix |
| 3 | Integer 16 | Int16 |
| 4 | Intere 32 | If 32 |
| 5 | Unsigned B | Uint8 |
| 6 | Hiskned 16 | प50+16 |
| 7 | Unsigned 32 | Uint 32 |
| 19 | Vald Sting | Vosin |
| 33 | Normalized value 2 bytes | N2 |
| [35] | But sequence of 16 bootmen vartables | $\sqrt{2}$ |
| 54 | Time difference w/o date | TimD |

### 8.3.2 Operation/Display 0-**

| Par. No. \# | Parameter description | Default value | 4-set-up | Change during operatlon | Conversion index | Type |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 00:0* Basic Settings |  |  |  |  |  |  |
| 0-01 | Language | [0] English | 1 set-up | TRUE | - | Uint8 |
| 0002 | Motors Speed Unit | [0]RPM | 2 set-ups | EALSE |  | U1int |
| 0-03 | Regional Settings | [0] International | 2 set-ups | FALSE | - | Uint8 |
| [0004 | Operating Stite at Power-up | [0] Resume | All set-ups | TRUE | - | Uint8 |
| 0-05 | Local Mode Unit | [0] As Motor Speed Unit | 2 set-ups | FALSE | - | Uint8 |
| 0-1* Set-up Operations |  |  |  |  |  |  |
| 0-10 | Active Set-up | [1] Set-up 1 | 1 set-up | TRUE | - | Uint8 |
| $0-11$ | Programmling Set-up | [9] Acture Set-up. | All set-ups | TRUE | - | Ulint |
| 0-12 | This Set-up Linked to | [0] Not linked | All set-ups | FALSE | - | Uint8 |
| [013 | Readout:Unked Set-ups | ON/A | All set-ups | FALSE | 0 | Unt16 |
| 0-14 | Readout: Prog. Set-ups / Channel | 0 N/A | All set-ups | TRUE | 0 | Int32 |
| 0-2* LCP Display |  |  |  |  |  |  |
| 0-20 | Display Line 1.1 Small | 1601 | All set-ups | TRUE | - | Uint16 |
| [021 | Disolay Une 12.2 Small | 1662 | A, set-ups | TRUE | $\square$ | Uliti6- |
| 0-22 | Display Line 1.3 Small | 1614 | All set-ups | TRUE | . | Uint16 |
| 0-23 | Display Lne 2, Large | 1613 | All set-ups | TRUE | - | Unt16 |
| 0-24 | Display Line 3 Large | 1652 | All set-ups | TRUE | - | Uint16 |
| 0-25 | My Personal Menu | SR | 1 set-up | TRUE | 0 | Ulnt16 |
| 0-3* LCP Custom Readout |  |  |  |  |  |  |
| 10-30 | Custom Readout Unit | [1]\% | All set-ups | TRUE |  | Uinto |
| 0.31 | Custom Readout Min value | SR | All set-ups | TRUE | -2 | Int32 |
| 0-32 | Custom Readout Max Vafue | 100.00 Custom Readoutunit | All set-ups | TRUE | -2 | Int32 |
| 0-37 | Display Text 1 | $0 \mathrm{~N} / \mathrm{A}$ | 1 set-up | TRUE | 0 | VisStr[25] |
| [0-38 | DisplayText 2 | ON/A | 1 set-up | TRUE | 0 | Vissti 25$]$ |
| 0-39 | Display Text 3 | $0 \mathrm{~N} / \mathrm{A}$ | 1 set-up | TRUE | 0 | VisStr[25] |
| 10-4* LCP Kgypad |  |  |  |  |  |  |
| 0-40 | [Hand on] Key on LCP | [1] Enabled | All set-ups | TRUE | - | Uint8 |
| 0-41 | [Of] Key on LCP | [1]. Enabled | All set-ups | TRUE | - | U1n 8 |
| 0-42 | [Auto on] Key on LCP | [1] Enabled | All set-ups | TRUE | $\cdots$ | Uint8 |
| $0-43$ | [Reset] Keyonicp. | [ [1] Enabled | AD set-ups | TRUE | - | U1İt8 |
| 0-44 | [Off/Reset] Key on LCP | [1] Enabled | All set-ups | TRUE | - | Uint8 |
| 0-45 | [Drive Bypassi Key on LOP | [1] Enabled | All set-ups | TRUE | - | Ulint |
| 0-5* Copy/Save |  |  |  |  |  |  |
| $10-50$ | Lorcopy | [0].No copy | All set-ups | FALSE | - | Ulin8 |
| 0.51 | Set-up Copy | [0] No copy | All set-ups | FALSE | - | Uint8 |


| Par. No. \# | Parameter description | Default value | 4-set-up | Change during operation | Conversion index | Type |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 10-6* Password |  |  |  |  |  |  |
| 0-60 | Main Menu Password | $100 \mathrm{~N} / \mathrm{A}$ | 1 set-up | TRUE | 0 | Uint16 |
| 0-61_Access to Maln Menu w/o Password$0-65 \quad$ Personal Menu Password |  | $=\left[\begin{array}{c} {[0] \text { Fulla } \mathrm{access}} \\ 200 \mathrm{~N} / \mathrm{A} \end{array}\right.$ | 1.set-up | TRUE | - | Uints |
|  |  | 1 set-up | TRUE | 0 | Uint16 |
| 0-7* Clock Settings |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
| $0-70$ | Date and Jime: | SR | Allset-ups | TRUE | 0 | Timeorbay |
| 0-71 | Date Format | [0] YMY-MM-DD | 1 set-up | TRUE |  | Uint8 |
| 0072 | Time Fomit | [0] 24 h | 1 set-up | TRUE | - | UIIti |
| 0-74 | DST/Summertime | [0] SR | 1 set-up | TRUE | - | Uint8 |
| $0-76$ | DST/Summertime Start |  | 1.set-up | TRUE | 0 | Timeorday |
| 0-77 | DST/Summertime End | SR | 1 set-up | TRUE | 0 |  |
| 0-79 | Cod Failt | null | $\begin{aligned} & 1 \text { set-up } \\ & 1 \text { set-up } \end{aligned}$ | TRUE | - Uinte |  |
| 0-81 | Working Days | null |  | TRUE | $-$ | Uint8 |
| 0-82, | Additonal Wondrio Days | SR | 1 set-up | TRUE | 0 |  |
| 0.83 | Additional Non-Working Days | SR | 1 set-up |  | 0 | Timeofory |
| [0-89] | Date and Ilme Readout | $0 \mathrm{~N} / \mathrm{A}$ | All set | TRUE | 0 | Vistin 25$]$ |




[^19]|  | 8.3.4 Brakes 2-** |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\stackrel{\leftrightarrow}{\bullet}$ | Par. No. \# Parameter description | Default value | 4-set-up | Change during operation | Conversion index | Type |
|  | 2-0** DC-Brake |  |  |  |  |  |
|  | 2-00 DC Hold/Preheat Current | 50 \% | All set-ups | TRUE | 0 | Uint8 |
|  | 2-01 DCBrake Current | 50\% | All set-ups | TRUE | 0 | Uint16 |
|  | 2-02 DC Braking Time | 10.0 s | All set-ups | TRUE | -1 | Uint16 |
|  | [2-03 DC Brake Out.In Speed [RPM] | SR | All set-ups | TRUE | 67 | Unti6 |
|  | 2-04 DC Brake Cut In Speed [Hz] | SR | All set-ups | TRUE | $-1$ | Uint16 |
|  | [2-1* Brake Energy Funct. |  |  |  |  |  |
|  | 2-10 Brake Function | [0] Off | All set-ups | TRUE | $-$ | Uint8 |
|  | [2-11___Brake Resistor (ohm) | SR | All set-ups | TRUE | 0 | Uint16 |
|  | 2-12 Brake Power Limit (kW) | SR | All set-ups | TRUE | 0 | Uint32 |
|  | 2-13 Brake Power Monitoring | [0]0f | Anlset-ups | TRUE | - | Ulint |
|  | 2-15 Brake Check | [0] Off | All set-ups | TRUE | - | Uint8 |
|  | 2-16___AC brake Max Current | 100.0\% | Al Set-ups | TRUE | -1 | Ulnt32 |
|  | 2-17 Over-voltage Control | [2] Enabled | All set-ups | TRUE | - | Uint8 |



| Par. No. \# | Parameter description | Default value | 4-set-up | Change during operation | Conversion index | Type |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 14-1* Motor Limlts |  |  |  |  |  |  |
| 4-10 | Motor Speed Direction | [0] Clockwise | All set-ups | FALSE | - | Uint8 |
| 411 | Mobor Speed Low Limit [RPM] | SR | All set-ups | TRUE | 67 | Uint16 |
| 4-12 | Motor Speed Low Limit [ Hz ] | SR | All set-ups | TRUE | $-1$ | Uint16 |
| $4-13$ | Motor Speed High Umit [RPM] | SR | All set-ups | TRUE | 67 | Unt16 |
| 4-14 | Motor Speed High Limit [Hz] | SR | All set-ups | TRUE | -1 | Uint16 |
| $4-16$ | Torque Umit Motor Mode | SR | Al set-ips | TRUE | -1 | Uint16 |
| 4.17 | Torque Limit Generator Mode | 100.0\% | All set-ups | TRUE | -1 | Uint16 |
| 418 | Current Umit | SR | All set-ups | TRUE | $-1$ | Uni 32 |
| 4-19 | Max Output Frequency | SR | All set-ups | FALSE | -1 | Uint16 |
| [4-5* Ad, Wamings |  |  |  |  |  |  |
| $4-50$ | Warning Current Low | 0.00 A | All set-ups | TRUE | -2 | Uint32 |
| 4.51 | Waming Ourrent. High | Imax $\mathrm{L}^{\text {T }}$ (12637) | An set-ups | TRUE | -2 | Uint32 |
| 4-52 | Warning Speed Low | 0 RPM | All set-ups | TRUE | 67 | Uint16 |
| 4453 | Waming Speed High | OutputSpeedHighúmite(P413) | All set-ups | TRUE | 67 | Uint16 |
| 4-54 | Warning Reference Low | -999999.999 N/A | All set-ups | TRUE | -3 | Int32 |
| 4.55 | Waming Reference High | $999999.999 \mathrm{~N} / \mathrm{A}$ | All set-ups | TRUE | -3 | Int32 |
| 4-56 | Warning Feedback Low | -999999.999 ReferenceFeedbackUnit | All set-ups | TRUE | -3 | Int32 |
| 4.57 | Waming, Feedback Hilg | 999999.999 ReferencefeedbadkUnlt | All set-ups | TRUE | -3 | Int32 |
| 4-58 | Missing Motor Phase Function | [2] Trip 1000 ms | All set-ups | TRUE | - | Uint8 |
| 14-6*Spoed Bypass |  |  |  |  |  |  |
| $4-60$ | Bypass Speed From [RPM] | SR | All set-ups | TRUE | 67 | Uint16 |
| $4-61$ | Bypass Speed From [ $[\mathrm{Hz}]$ | SR | All set-ups | TRUE | -1 | UTint16 |
| $4-62$ | Bypass Speed To [RPM] | SR | All set-ups | TRUE | 67 | Uint16 |
| 463 | Bypass Speed To [ $[\mathrm{Hz}]$ | SR | All set-ups | TRUE | -1 | Unt16 |
| 4-64 | Semi-Auto Bypass Set-up | [0] Off | All set-ups | FALSE | - | Uint8 |

### 8.3.7 Digital In/Out 5-**







|  | 8.3.12 Smart Logic 13- |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\stackrel{\square}{\oplus}$ | Par, No, \# Parameter description | Default value | 4-set-up | Change during operation | Conversion index | Type |
|  | 13-0* SLC Settings |  |  |  |  |  |
|  | 13-00 SL Controller Mode | nult | 2 set-ups | TRUE | - | Uint8 |
|  | 13-01 Start Event | null | 2 set-ups | TRUE | - | UInt8 |
|  | 13-02 Stop Event | null | 2 set-ups | TRUE | . | Uint8 |
|  | 13-03 - Reset SLC | [0] 00 not reset SLC | An set-ups | TRUE | - | UInt8 |
|  | 13-1* Comparators |  |  |  |  |  |
|  | 13-10_Comparator_Operand | nuull | 2 set-ups | TTRUE | - | Uint8 |
|  | 13-11 Comparator Operator | null | 2 set-ups | TRUE | - | Uint8 |
|  | 13-12 Comparator Value | SR | 2 set-ups | TRUE | -3 | Int32 |
|  | 13-2* Timers |  |  |  |  |  |
|  | 13-20 SL Controller Tmer | SR | 1 set-up | TRUE | -3 | TImD |
|  | 13-4* Logic Rules |  |  |  |  |  |
|  | 13-40_Logle Rule Boolean 1 | null | 2. set-ups | TRUE | - | U/nts |
|  | 13-41 Loglc Rule Operator 1 | null | 2 set-ups | TRUE | - | Uint8 |
|  | 13-42_Loplc Rule Boolean 2 | null | 2 set-Ups | TRUE | $=$ | Ulint8 |
|  | 13-43 Logic Rule Operator 2 | null | 2 set-ups | TRUE | - | Uint8 |
|  | 13-44 Logle Rule Boolean 3 | null | 2 set-ups | TRUE | - | Unte |
|  | 13-5* States |  |  |  |  |  |
| N | [13-51__St Controller Event | null. | 2 s.et-ups | TRUE | . | Uints |
| 3 | 13-52 SL Controller Action | null | 2 set-ups | TRUE | - | Uint8 |



| ~ | Par. No. \# Parameter description | Default value | 4-set-up | Change during operation | Conversion index | Type |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | 15-0* Operating Data. |  |  |  |  |  |
|  | 15-00 Operating Hours | 0 h | All set-ups | FALSE | 74 | Uint32 |
|  | 15-01_ Ruinning Hours | 0 h | Allset-ups | FALSE | 74 | U1nt32 |
|  | 15-02 KWh Counter | 0 kWh | All set-ups | FALSE | 75 | Uint32 |
|  | 15-03 Power_U''s | 0 N/A | All Set-ups | FALSE | 0 | UInt32 |
|  | 15-04 Over Temp's | $0 \mathrm{~N} / \mathrm{A}$ | All set-ups | FALSE | 0 | Uint16 |
|  | 15-05-Overvatt | 0 N/A | All.set-ups | FALSE | 0 | Uint16 |
|  | 15-06 Reset kWh Counter | [0] Do not reset | All set-ups | TRUE | - | Uint8 |
|  | 15-07_Reset Runing Hours Counter | [0] Donot reset | An set-ups | TRUE | - | 4106 |
|  | 15-08 Number of Starts | $0 \mathrm{~N} / \mathrm{A}$ | All set-ups. | FALSE | 0 | Uint32 |
|  | 15-1* Data Log Setting |  |  |  |  |  |
|  | 15-10 Logging Source | 0 | 2 set-ups | TRUE |  | Uint16 |
|  | 15-11 _Logoing interval | SR | 2, set-ups | TRUE | -3 | Timb |
|  | 15-12 Trigger Event | [0] False | 1 set-up | TRUE | - | Uint8 |
|  | $[15-13$ $\qquad$ Loging Mode | [0] Log ahwars | 2 2.set-ups | TRUE | $\cdots$ | Unin |
|  | 15-14 Samples Before Trigger | $50 \mathrm{~N} / \mathrm{A}$ | 2 set-ups | TRUE | 0 | Uint8 |
|  | 15-2* Historic Lor |  |  |  |  |  |
| 号 | 15-20 Historic Log: Event | $0 \mathrm{~N} / \mathrm{A}$ | All set-ups | FALSE | 0 | Uint8 |
|  | 15-21 Historic Log: Value | ON/A | All Set-ups | FALSE | 0 | Uint32 |
|  | 15-22 Historic Log: Time | 0 ms | All set-ups | FALSE | -3 | Uint32 |
|  | 15-23 Historic Log: Date and 7ime | SR | All set-ups | FALSE | 0 | TImeotbay |
|  | 15-3* Alarm Log |  |  |  |  |  |
|  | [15-30 _ Alarm Log: Error Code | $0 \mathrm{~N} / \mathrm{A}$ | All Set-ups | FALSE | 0 | Uint16 |
| $\leq$ | 15-31 Alarm Log: Value | 0 N/A | All set-ups | FALSE | 0 | Int16 |
| $\stackrel{-1}{6}$ | [15-32 Alarm Log: 11 me | -0.5 | All Set-ups | FAlSE | 0 | Uint32 |
| $\stackrel{\rightharpoonup}{*}$ | 15-33 Alarm Log: Date and Time | SR | All set-ups | FALSE | 0 | TimeofDay |
| $\stackrel{0}{0}$ | [15-34 Alarme | 0.000 Processoriunit | An Set-ups | FALSE | -3 | $1 n 632$ |
| $\stackrel{\text { ¢ }}{\text { ¢ }}$ | 15-35 Alarm Log: Feedback | 0.000 ProcessCtrilunit | All set-ups | FALSE | -3 | Int32 |
| \% | [15-36 - Aarm Les: Current Demand | 0\% | All set-ups | FALSE | 0 | Uinte |
| 冎 | 15-37 Alarm Log: Process Ctr Unit | [0] | All set-ups | FALSE | - | Uint8 |
|  | 15-4* Drvie Identfication . . . . |  |  |  |  |  |
|  | 15-40 FC Type | 0 N/A | All set-ups | FALSE | 0 | Visstr [6] |
|  | 15-41 Rower Section | $0 \mathrm{~N} / \mathrm{A}$ | All Set-ups | FALSE | 0 | Vissiof 20$]$ |
|  | 15-42 Voltage | 0 N/A | All set-ups | FALSE | 0 | VisStr[20] |
|  | 15-43 Software version | 0, N/A | All set-ups | FALSE | 0 | Visstr 5 ] $]$ |
|  | 15-44 Ordered Typecode String | $0 \mathrm{~N} / \mathrm{A}$ | All set-ups | FALSE | 0 | Visstr [40] |
|  | [15-45 - Actual Typecode Sting - | O ON/A | An set-yps | FALSE | 0 | Vissu [40] $]$ |
|  | 15-46 Frequency Converter Ordering No | $0 \mathrm{~N} / \mathrm{A}$ | All set-ups | FALSE | 0 | VisStr [8] |
|  | 15-47 P- Power Card Ordeting No | ON/A | Anl set-ups | FALSE | 0 | VISSt[ $[8]$ |
|  | 15-48 LCP Id No | $0 \mathrm{~N} / \mathrm{A}$ | All set-ups | FALSE | 0 | Vis5tr [20] |
|  | 15-49 SW ID Control Card | ON/A | All set-up | FALSE | 0 | Vssiri 20$]$ |
|  | 15-50 SW ID Power Card | $0 \mathrm{~N} / \mathrm{A}$ | All set-ups | FALSE: | 0 | VisStr $[20]$ |
|  | [15-51 Crequencoconverter Serial Number | O,NA | All set-ups, | FALSE | 0 | VSST[10] |
|  | 15-53 Power Card Serial Number | $0 \mathrm{~N} / \mathrm{A}$ | All set-ups | FALSE | 0 | Visstr[19] |


| Par. No. \# Parameter description | Default value | 4-set-up | Change during operation | Conversion index | Type |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 15-6*0ption 1dent |  |  |  |  |  |
| 15-60 Option Mounted | $0 \mathrm{~N} / \mathrm{A}$ | All set-ups | FALSE | 0 | Vis 5 Str 30$]$ |
| 15:61 Opton SW Version | ON/A | All set-üps | FALSE | 0 | Visstr [20]] |
| 15-62 Option Ordering No | $0 \mathrm{~N} / \mathrm{A}$ | All set-ups | FALSE | 0 | VisStr [8] |
| 15-63 Optoon Serial No | $0 \mathrm{~N} / \mathrm{A}$ | All set-ups | FALSE | 0 | VIsstr [18]] |
| 15-70 Option in Slot A | $0 \mathrm{~N} / \mathrm{A}$ | All set-ups | FALSE | 0 | Visstr [30] |
| 15-71 Slot AOption SW Version | $0 \mathrm{~N} / \mathrm{A}$ | AM Set-üps | EALSE | 0 | VISStr[20]] |
| 15-72 Option in Slot B | 0 N/A | All set-ups | FAL.SE | 0 | Visstr $[30]$ |
| 15-73 Slot B Optoion SW Verston | ON/A | All set-ups | FALSE | 0 | VIsstr [20] |
| 15-74 Option in slot CO | 0 N/A | All set-ups | FALSE | 0 | VisStr [30] |
| [15-75 Slot Co Option SWVersion. | ON/A | All set-ups | FALSE | 0 | V ISSt[ 20$]$ ] |
| 15.76 Option in Slot C 1 | $0 \mathrm{~N} / \mathrm{A}$ | All set-ups | FALSE | 0 | Visstr [30] |
| 15-77 Sot Cl optoo SW Version | ON/A | All set-ups | FALSE | 0 | VESE[20]] |
| 15-9* Parameter Info |  |  |  |  |  |
| 15-92*_Defined Parameters | $0 . \mathrm{N} / \mathrm{A}$ | All set-ups | FALSE | 0 | Uint16 |
| 15-93 Modified Parameters | $0 \mathrm{~N} / \mathrm{A}$ | All set-ups | FALSE | 0 | Uint16 |
| 15-98___Drtve Identufication | $0 \mathrm{~N} / \mathrm{A}$ | All seteup | FALSE | 0 | Visstr [40] |
| 15-99 Parameter Metadata | ON/A | All set-ups | FALSE | 0 | Uint16 |


| Par. No. \# Parameter description | Default value | 4-set-up | Change during operation | Conversion index | Type |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 16-0* General Status |  |  |  |  |  |
| 16-00 Control Word | $0 \mathrm{~N} / \mathrm{A}$ | All set-ups | TRUE | , | V2 |
| [16-01 Reference. [Unit]] | 0.000 ReferenceFeedbadk Unit | All set-ups | TRUE | -3 | Int32 |
| 16-02 Reference [\%] | $0.0 \%$ | All set-ups | TRUE | -1 | Int16 |
| 16-03 Stotus Word | $0 \mathrm{~N} / \mathrm{A}$ | Al set-ups | TRUE | 0 | $\sqrt{2}$ |
| 16-05 Main Actual Value [\%] | $0.00 \%$ | All set-ups | TRUE | -2 | N2 |
| 16-09 Custom Readout | 0.00 CustomReadoütunit | All set-ups | TRUE | -2 | Int32 |
| 16-1* Motor Status |  |  |  |  |  |
| [16-10_ Power [KW] | 0.00 kW | All set-ups | TRUE | 1 | Int32 |
| 16-11 Power [ hp ] | 0.00 hp | All set-ups | TRUE | -2 | Int 32 |
| 16-12_Motor Votage | 0.0 V | Anset-ups | TRUE | -1 | Unit16 |
| 16-13 Frequency | 0.0 Hz | All set-ups | TRUE | -1 | Uint16 |
| 16-14 Motor Qument | 0.00 A | All set-ups | TRUE | -2 | Int32 |
| 16-15 Frequency [\%] | 0.00\% | All set-ups | TRUE | -2 | N2 |
| [16-16 Torque. $[\mathrm{Nm}]$ ] | 0.0 Nm | All ${ }^{\text {Set-ups }}$ | TRUE | -1 | Int32 |
| 16-17 Speed [RPM] | 0 RPM | All set-ups | TRUE | 67 | Int32 |
| 16-18_Motor Thermal | 0\% | All set-ups | TRUE | 0 | Unint |
| 16-22 Torque [\%] | $0 \%$ | All set-ups | TRUE | 0 | Int16 |
| 16-3* Drive Status |  |  |  |  |  |
| 16-30 DC Link Voltage | 0 V | All set-ups | TRUE | 0 | Uint16 |
| 16-32 Brake Energy/s | 0.000 kW | Al Set-ups | TRUE | 0 | Unt 32 |
| 16-33 Brake Energy $/ 2 \mathrm{~min}$ | 0.000 kW | All set-ups | TRUE | 0 | Uint32 |
| 16-34 Heatsink Temp: | $0^{\circ}{ }^{\circ} \mathrm{C}$ | All set-ups | TRUE | 100 | Unti |
| 16-35 Inverter Thermal | $0 \%$ | All set-ups | TRUE | 0 | Uint8 |
| 16-36 Inv. Nom. Current | SR | All set-ups | TRUE | -2 | Un+32 |
| 16-37 Inv. Max. Current | SR | All set-ups | TRUE | -2 | Uint32 |
| 16-38 SL Controller Stute | 0 N/A | All set-ups | TRUE | 0 | Ulint8 |
| 16-39 Control Card Temp. | $0^{\circ} \mathrm{C}$ | All set-ups | TRUE | 100 | Uint8 |
| 16-40 Logging Buffer Füll | [0]No | All set-ups | TRUE | - | Ulint8 |
| 16-5* Ref. \& Feedb. |  |  |  |  |  |
| 16-50 Extemal Reference | $0.0 \mathrm{~N} / \mathrm{A}$ | All set-ups | TRUE | - 1 | Int16 |
| 16-52 Feedback [Unit] | 0.000 ProcessCtriUnit | All set-ups | TRUE | -3 | Int32 |
| 16-53 _ Dlgi Pot Reference | $0.00 \mathrm{~N} / \mathrm{A}$ | All set-ups | TRUE | -2 | Int16 |
| 16-54 Feedback 1 [Unit] | 0.000 ProcessCtrlunit | All set-ups | TRUE | -3 | Int32 |
| [16-55 —Eeedback. 2 [Unit]] | 0.000 Processcriunit | All set-ups | TRUE | -3 | Int32 |
| 16-56 Feedback 3 [Unit] | 0.000 ProcessCtrilunit | All set-ups | TRUE | -3 | Int32 |
| [16-58__PID Output[[\%] | 0.0\% | All set-ups | TRUE | -1 | Int16 |
| 16-59 Adjusted Setpoint | 0.000 ProcessCtrlunit | All set-ups | TRUE | -3 | Int32 |


| Par. No. \# | Parameter description | Default value | 4-set-up | Change during operation | Conversion index | Type |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| 16.61 Terminal 53 Swtth Setting |  |  |  |  |  |  |
| 16-62 | Analog Input 53 | $0.000 \mathrm{~N} / \mathrm{A}$ All set-ups |  | TRUE | -3 | $\begin{aligned} & \text { Uint } 48 \\ & \text { Int } 32 \\ & \hline \end{aligned}$ |
| 16-53: | Teminal 54. Situth Sett | [0]'Gurient | Al set-ups | TRUE | $\cdots$ | Uints |
| 16-64 | Analog input 54 | $0.000 \mathrm{~N} / \mathrm{A}$ | All set-ups | TRUE | -3 | Int32 |
| 16-65 | Anălog Outpuit 42 [ mA ] | $0.000 \mathrm{~N} / \mathrm{A}$ | Al set-uns | TRUE | -3 | Intic |
| 16-66 | Digital Output [bin] | $0 \mathrm{~N} / \mathrm{A}$ | All set-ups | TRUE | 0 | Int16 |
| 16067 | Pulse Inputiv29 [-2] | $0 \mathrm{~N} / \mathrm{A}$ | All set-ups | TRUE | 0 | Int32 |
| 16-68 | Pulse Input \#33 [Hz] | $0 \mathrm{~N} / \mathrm{A}$ | All set-ups | TRUE | 0 | Int32 |
| 1669 |  | $0 \mathrm{~N} / \mathrm{A}$ | Al Set-up | TRUE | 0 |  |
| 16-70 | Pulse Output \#29 [Hz] | 0 N/A | All set-ups | TRUE | 0 | Int32 |
| 16:71 | Relay Output [b] | ON/ | All Set-ups | TRUE | 0 | Unt16 |
| 16-72 | Counter A | 0 N/A | All set-ups | TRUE | 0 | Int32 |
| [16-73 | Counter 8 | $0 \mathrm{~N} / \mathrm{A}$ | All set-ups | \%-TRUE | 0 | Int32 |
| 16-75 | Analog in $\times 30 / 11$ | $0.000 \mathrm{~N} / \mathrm{A}$ | All set-ups | TRUE | -3 |  |
| 16-76 | Analog $10 \times 30 / 12$ | $0.000 \mathrm{~N} / \mathrm{A}$ | All set-ups | TRUE | -3 | Int32 |
| 16.77 | Analog Out X $30 / 8$ [mA] | $0.000 \mathrm{~N} / \mathrm{A}$ | All set-ups | TRUE | -3 | Int16 |
|  |  |  |  |  |  |  |
| 16-80 | Fieldbus CTW 1 | ON/A | All set-ups | TRUE | 0 | V2 |
| 16-82\% | Feldous REF 1 | ON/A | Alset-ups | $\cdots$ TRUE | 0 |  |
| 16-84 | Comm. Option STW | $0 \mathrm{~N} / \mathrm{A}$ | All set-ups | TRUE | 0 | V2 |
| [16-85 | EPootcTu 1 | ON/A | Alsetiups | TRUE | 0 | V2 |
| 16-86 | FC Port REF 1 | ON/A | All set-ups | TRUE | 0 | N2 |
|  |  |  |  |  |  |  |
| 16-90 | Alarm Word | ON/A | All set-ups | TRUE | 0 | Uint32 |
| 116-91 | Alam Word 2 | 0 NA | Alset-ups | TRUE | 0 | Uint32 |
| 16-92 | Warning Word | 0 N/A | All set-ups | TRUE | 0 |  |
| [16-93 | Wamlog Word 2 | ON/A | AAl sest-up | $\cdots \mathrm{CO}$ | 0 | Uint32 |
| 16.94 | Ext. Status Word | $0 \mathrm{~N} / \mathrm{A}$ | All set-ups | TRUE | 0 | Uint32 |
| 16-95 | Ext Stotus Word 2 | ON/A | Allset-ups | TRUE | 0 | Uint32 |
| 16-96 | Maintenance Word | $0 \mathrm{~N} / \mathrm{A}$ | All set-ups | TRUE | 0 | Uint32 |


| Par. No. \# Parameter description | Default value | 4-set-up | Change during operation | Conversion index | Type |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 18-0* Maintenance Log. |  |  |  |  |  |
| 18-00 Maintenance Log: Item | $0 \mathrm{~N} / \mathrm{A}$ | All set-ups | FALSE | 0 | Uint8 |
| [18-01_Maintenance Lo9: Action | ON/A | Allset-ups | FALSE | 0 | UInt8 |
| 18-02 Maintenance Log: Time | 0 s | All set-ups | FALSE | 0 | Uint32 |
| 18-03 Malntenance Log: Date and Tlime | SR | All set-ups | FAISE | 0 | Timeoforay |
| 18-3* Inputs \& Outputs |  |  |  |  |  |
| [18-30 Analog. Input X42/1 | $0.000 \mathrm{~N} / \mathrm{A}$ | All set-ups | FALSE | -3 | Int32 |
| 18-31 Analog Input $\times 42 / 3$ | $0.000 \mathrm{~N} / \mathrm{A}$ | All set-ups | FALSE | -3 | Int32 |
| [18-32 Analog, Input X42/5 | $0.000 \mathrm{~N} / \mathrm{A}$ | All set-ups | FALSE | -3 | Int 32 |
| 18-33 Analog Out X42/7 [V] | $0.000 \mathrm{~N} / \mathrm{A}$ | All set-ups | FALSE | -3 | Int16 |
| [18-34_Analogout X42/9[V] | $0.000 \mathrm{~N} / \mathrm{A}$ | All set-ups | FALSE | -3 | Int16 |
| 18-35 Analog Out X42/11 [V] | $0.000 \mathrm{~N} / \mathrm{A}$ | All set-ups | FALSE | -3 | Int16 |

### 8.3.17 FC Closed Loop 20-**



### 8.3.18 Ext. Closed Loop 21-**



| Par. No. \# | Parameter description | Default value | 4-set-up | Change during operation | Conversion index | Type |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 2f-5wErt CL 3 Ref/feb. |  |  |  |  |  |  |
| 21.50 | Ext. 3 Ref./Feedback Unit | [0] | All set-ups | TRUE | - | Uint8 |
| [21-51-: | Ext 3 Mnimum Reference | 5 , 0.0000 ExPID3Unit | All set-ups | TRUE | -3 | Int32 |
| 21-52 | Ext. 3 Maximum Reference | 100,000 ExtPID3Unit | All set-ups | TRUE | -3 | Int 32 |
| , 21-53 | Ext 3 Reference Source | [0], No fundion | Anset-ups | TRUE | - | Unit8 |
| 21-54 | Ext. 3 Feedback Source | [0] No function | All set-ups | TRUE | - | Uint8 |
| 21-55 | Ext 3'Setpolint | 0.000 Ex+PID 3Unit | All setetups | TRUE | -3 | Int32 |
| 21.57 | Ext. 3 Reference [Unit] | 0,000 ExtPID3Unit | All set-ups | TRUE | -3 | Int 32 |
| 21-58] | Ext, 3, Feedback [Unt] | 0.000 Extop 3 3 | Al set-ups | TRUE | -3 | Int32 |
| 21-59 | Ext. 3 Qutput [\%] | 0\% | All set-ups | TRUE | 0 | Int 32 |
| 219 Ext $\mathrm{CL}^{\text {PID }}$ |  |  |  |  |  |  |
| 21-60 | Ext. 3 Norma//Inverse Control | [0] Normal | All set-ups | TRUE | $-$ | Uint8 |
| 21-61 | Ext 3 Proportonal Galn | $0.50 \mathrm{~N} / \mathrm{A}$ | All set-ups | IRUE | 2 | Unt15 |
| 21-62 | Ext. 3 Integral Time | 20.005 | All set-ups | TRUE | -2 | Uint32 |
| 21-63] | Ext 3 Differentituon Time | 0.00 S | Allset-ups | TRUE | -2 | Ulint16 |
| 21-64 | Ext. 3 Dif. Gain Limit | $5.0 \mathrm{~N} / \mathrm{A}$ | All set-ups | TRUE | -1 | Uint16 |



| Par. No. \# | Parameter description | Default value | 4-set-up | Change during operation | Conversion index | Type |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 22-8] Fow Compensetion |  |  |  |  |  |  |
| 22-80 | Flow Compensation. | [0] Disabled | All set-ups | TRUE |  | Uint8 |
| [22-81 | Squarenolinear Cume Approximation | 100\% | All sett-ups | TRUE | 0 | Uint8 |
| 22-82 | Work Point Calculation | [0] Disabled | All set-ups | TRUE |  | Uint8 |
| [22.83 | Speedat No, Fow [RTM] | SR | Allset-ups | TRUE | 67 | Unt16 |
| 22-84 | Speed at No-Flow [ Hz$]$ | SR | All set-ups | TRUE | -1 | Uint16 |
| [22-85 | Speed at Des[In Polnt. [RPM] | SR | All set-ip | TRUE |  | Uint16 |
| 22-86 | Speed at Design Point [ Hz ] | SR | All set-ups | TRUE | -1 | Uint16 |
| [22-87 | Pressureat No-How Speed | $0.000 \mathrm{~N} / \mathrm{A}$ | All set-ips | TRUE |  | Int32 |
| 22-88 | Pressure at Rated Speed | 999999.999 N/A | All set-ups | TRUE | -3 | Int32 |
| [22-69] | How at Desion Point | $0.000 \mathrm{~N} / \mathrm{A}$ | All Set-ups | TRUE | -3 | Int32 |
| 22-90 | Flow at Rated Speed | $0.000 \mathrm{~N} / \mathrm{A}$ | All set-ups | TRUE | -3 | Int32 |

## 8,3.20 Timed Actions 23-**

| Par. No. \# | Parameter description | Default value | 4-set-up | Change during operation | Conversion index | Type |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 23-0* Timed Actions |  |  |  |  |  |  |
| 23-00 | ON Time | SR | 2 set-ups | TRUE | 0 | TimeorDayWoDate |
| 23-01 | ONAAtion | [0]Disabled | 2.set-ips | TRUE | $=$ | Ulno8 |
|  |  |  |  |  |  | TimeOfDay- |
| 23-02 | OFF Time | SR | 2 set-ups | TRUE | 0 | WoDate |
| 2303 | OfFAction | [0]Disabled | 2 Set-ups | TRUE | - | Unis |
| 23-04 | Occurrence | [0] All days | 2 set-ups | TRUE | - | Uint8 |
| 123-1* Malntenance |  |  |  |  |  |  |
| 23-10 | Maintenance Item | [1] Motor bearings | 1 set-up | TRUE | - | Uint8 |
| [23-11 | Maintenance Action | [1] Liubricate | 1 setiup | TRUE | - | UTni8 |
| 23-12 | Maintenance Time Base | [0] Disabled | 1 set-up | TRUE | $\cdots$ | Uint8 |
| [23-13] | Malntenance Done Interval | 1.h | 1 set-up | TRUE | 74 | Uint32 |
| 23-14 | Maintenance Date and Time | SR | 1 set-up | TRUE | 0 | Timeafory |
| 123-1* Malmberance Reset |  |  |  |  |  |  |
| 23-15 | Resat Maintenance Word | [0] Do not reset | All set-ups | TRUE | - | Uint8 |
| 23-16 | Malntenance Text | ON/A | 1 set-up | TRUE | 0 | Vissif(20] |
| 23-5* Energy Log |  |  |  |  |  |  |
| [23-50] | Energy Log Resolution. | [5] Last 24, Hours | 2 2set-ivp | TRUE | $\square$ | U1nt8 |
| 23-51 | Period Start | SR | 2 set-ups | TRUE | 0 | TimeOfDay |
| [23-53] | Enemy Log | ON/ | And set-ups | TRUE | 0 | Uint32 |
| 23-54 | Reset Energy Log | [0] Do not reset | All set-ups | TRUE | - | Uint8 |
| 123-6* Trendling |  |  |  |  |  |  |
| 23-60 | Trend Variable | [0] Power [kW] | 2 set-ups | TRUE | - | Uint8 |
| [23-61] | Continuous bin Data | $0 \mathrm{~N} / \mathrm{A}$ | All set-ups | TRUE | 0 | Ulin 32 |
| 23-62 | Timed Bin Oata | $0 \mathrm{~N} / \mathrm{A}$ | All set-ups | TRUE | 0 | Uint32 |
| 23-63 | Trined Perrod Start | SR | 2 set- | TRUE | 0 | Timeofory |
| 23-64 | Timed Period Stop | SR | 2 set-ups | TRUE | 0 | TimeofDay |
| 23-65 | Minimum Bin value. | SR | 2 set-ups | TRUE | 0 | U1in |
| 23-66 | Reset Continuous Bin Data | [0] Do not reset | All set-ups | TRUE | . | Uint8 |
| 23-67 | Reset Timed Bin Data | [0] Do not reset | All set-ups | TRUE | - | Ulint8 |
| 23-8* Payback Counter |  |  |  |  |  |  |
| 123-80 | Power Reference, Factor | 100\% | 2 set-ups | TRUE | 0 | Uints |
| 23-81 | Energy Cost | $1.00 \mathrm{~N} / \mathrm{A}$ | 2 set-ups | TRUE | -2 | Uint32 |
| [23-82] | Investment | 0.N/A | 2.set-ups | TRUE | 0 | UTH 32 |
| 23-83 | Energy Savings | 0 kWh | All set-ups | TRUE | 75 | Int32 |
| [23-84] | Cost Savings | ON/A | An Set-up | TRUE | 0 | Int32 |



| $\stackrel{\sim}{\omega}$ | Par. No. \# Parameter description | Default value | 4-set-up | Change during operation | Conversion index | Type |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | 25-8\# Statis |  |  |  |  |  |
|  | 25-80 Cascade Status | ON/A | All set-ups | TRUE | 0 | Visstr[25] |
|  | [25-81 Pump Status | ON/A | Al set-ups | TRUE | 0 | VISST[25] |
|  | 25-82 Lead Pump | $0 \mathrm{~N} / \mathrm{A}$ | All set-ups | TRUE | 0 | Uint8 |
|  | [25-83 Relay Status | ON/A | All set-ups | TRUE | 0 | Vistit [4] |
|  | 25-84 Pump ON Time | 0 h | All set-ups | TRUE | 74 | Uint32 |
|  | 25-85 RelayONTIme | 0 h | Allset-ubs | TRUE | 74 | Uint32 |
|  | 25-86 Reset Relay Counters | [0] Do not reset | All set-ups | TRUE | - | Uint8 |
|  | 25-9: Service - |  |  |  |  |  |
|  | 25-90 Pump Interlock | [0] Off | All set-ups | TRUE | $\cdots$ | Uint8 |
|  | 25-91 Manual Altemation | 0 N/A | All Set-ups | TRUE | 0 | Ulint |



| Par. No. \# | Parameter description | Default value | 4-set-up | Change during operation | Conversion index | Type |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 27-0* Control 8i Status |  |  |  |  |  |  |
| 27-01 | Pump Status | [0] Ready | All set-ups | TRUE | - | Uint8 |
| [27-02 | Manual Pump Control | [0] No Operation | 2. set-ups | TRUE | $\square$ | UInt8 |
| 27-03 | Current Runtime Mours | 0 h | All set-ups | TRUE | 74 | Uint32 |
| 27-04 | Pump Total Lfetime Hours | 0 h | All set-ups | TRUE | 74 | Uint32 |
| 27-1* Configuration |  |  |  |  |  |  |
| [27-10 | Cascade Controller | [0].Disabled | 2 set-ups | FALSE | $\cdots$ | Ulinte |
| 27-11 | Number Of Drives | $1 \mathrm{~N} / \mathrm{A}$ | 2 set-ups | FALSE | 0 | Uint8 |
| [27-12 | Number Of Pumps | SR | 2 set-ups | FALSE | 0 | Ulint8 |
| 27-14 | Pump Capacity | $100 \%$ | 2 set-ups | FALSE | 0 | Uint16 |
| [27-16 | Runtme Ealanding | [0]:Balanced Pronty_1 | 2, set-ups | TRUE | - | Ulint8 |
| 27-17 | Motor Starters | [0] Direct Online | 2 set-ups | FALSE | - | Uint8 |
| 27-18 | Spin Inme for Unused Pumps | SR | All set-ups | IRUE | 0 | Unt16 |
| 27-19 | Reset Current Runtime, Hours | [0] Do not reset | All set-ups | TRUE | - | Uint8 |
| 127-2* Bandwidth Settings |  |  |  |  |  |  |
| 27-20 | Normal Operating Range | SR | All set-ups | TRUE | 0 | Uint8 |
| [27-21 | Overnde Umit | 100\% | All set-ups | TRUE | 0 | Unti8 |
| 27-22 | Fixed Speed Only Operating Range | SR | All set-ups | TRUE | 0 | Uint8 |
| [27-23 | Staglog Delay | 15 s | All set-ups | TRUE | 0 | Ulint16 |
| 27-24 | Destaging Delay | 15 s | All set-ups | TRUE | 0 | Uint16 |
| 27-25 | Overide Hold Time | 10.5 | All set-ups | TRUE | 0 | Uint 16 |
| 27-27 | Min Speed Destage Delay | SR | All set-ups | TRUE | 0 | Uint16 |
| 127-3* Staging Speed |  |  |  |  |  |  |
| 27-30 | Auto Tune Staging Speeds | [1] Enabled | All set-ups | TRUE | - | Uint8 |
| [27-31 | Stage On Speed [ $\mathrm{RPM}^{\text {ch }}$ | SR | All set-ups | TRUE | 67 | UInt16 |
| 27-32 | Stage On Speed [ $[\mathrm{Hz}]$ | SR | All set-ups | TRUE | -1 | Uint16 |
| 27-33 | Strge Off Speed [RPM] | SR | All set-ups | TRUE | 67 | Uint16 |
| 27-34 | Stage Off Speed [ Hz ] | SR | All set-ups | TRUE | $-1$ | Uint16 |
| [27-4* Staging Settings |  |  |  |  |  |  |
| $27-40$ | Auto Tune Staging Settings | [0] Disabled | All set-ups | TRUE | - | Uint8 |
| 27-41 | Ramp Down Delay | 10.0.5 | All set-ups | TRUE | -1 | Unint 16 |
| 27-42 | Ramp Up Delay | 2.0 s | All set-ups | TRUE | -1 | Uint16 |
| 27-43 | Stoging Threshold | SR | All set-ups | TRUE | 0 | Uints |
| 27-44 | Destaging Threshold | SR | All set-ups | TRUE | 0 | Uint8 |
| 27-45 | Staging Speed [RPM] | O.RPM | All set-ups | TRUE | 67 | Unint 16 |
| 27-46 | Staging Speed [ Hz ] | 0.0 Hz | All set-ups | TRUE | -1 | Uint16 |
| [27-47 | Destoging Speed [ $[$ PM] | ORPM | All Set-ups | TRUE | 67 | Uint16 |
| 27-48 | Destaging Speed [ Hz ] | 0.0 Hz | All set-ups | TRUE | -1 | Uint16 |



| \% | Par. No. \# Parameter description | Default value | 4-set-up | Change during opera- | Conversion index | Type |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | [29-0* Plpe Fill |  |  |  |  |  |
|  | 29-00 Pipe Fill Enable | [0] Disabled | 2 set-ups | FALSE |  | Uint8 |
|  | [29-01 Pripe EIII Speed [RPM] | SR | All set-ups | TRUE | 67 | Uint16 |
|  | $29-02$ Pipe Fill Speed [Hz] | SR | All set-ups | TRUE | -1 | Uint16 |
|  |  | 0.00 s | All set-ups | TRUE | -2 | Unit32- |
|  | (29-04 Pipe Fill Rate | 0.001 ProcessCtriunit | $\frac{\text { All set-ups }}{\text { All }}$ | TRUE | ${ }_{-}^{-3}$ | Int32 |

### 8.3.25 Bypass Option 31-**

| Par. No. \# | Parameter description | Default value | 4-set-up | Change during operation | Conversion index | Type |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 31-00 Bypass Mode |  | [0]. Ditue. | All set-ups | TRUE | $\cdots$ | Uint8 |
| 31-01 | Bypass Start Time Delay | 30 s | All set-ups | TRUE | 0 | Uint16 |
| 31-02 | Bypass Tip Time Delay | 05 | All set-ups | TRUE | 0 | Unit16 |
| 31-03 | Test Mode Activation | [0] Disabled | All set-ups | TRUE | - | Uint8 |
| [31-10. | Bypass Status Word | ON/A | All'set-ups | FALSE: | 0 | V2 |
| 31-11 | Bypass Running Hours | 0 h | All set-ups | FALSE | 74 | Uint32 |
| 31-19 R-Remote Bypass Activation |  | [0].Disäbled | 2 Set-ups | TRUE |  | Ulnt8 |

## Q inomeshooting

### 9.1 Alarms and Warnings

A warning or an alarm is signalled by the relevant LED on the front of the frequency converter and indicated by a code on the display.

A warning remains active until its cause is no longer present. Under certain circumstances operation of the motor may still be continued. Warning messages may be critical, but are not necessarily so.

In the event of an alarm, the frequency converter will have tripped. Alarms must be reset to restart operation once their cause has been rectified.

## This may be done in four ways:

1. By using the [RESET] control button on the LCP control panel.
2. Via a digital input with the "Reset" function.
3. Via serial communication/optional fieldbus.
4. By resetting automatically using the [Auto Reset] function, which is a default selting for VLT AQUA Drive. see par. 14-20 Reset Mode in VLT AQUA Drive Programming Guide

## NB!

After a manual reset using the [RESET] button on the LCP, the [AUTO ON] or [HAND ON] button must be pressed to restart the motor.

If an alarm cannot be reset, the reason may be that its cause has not been rectified, or the alarm is trip-locked (see also table on following page).

Alarms that are trip-locked offer additional protection, means that the mains supply must be switched off before the alarm can be reset. After being switched back on, the frequency converter is no longer blocked and may be reset as described above once the cause has been rectified.

Alarms that are not trip-locked can also be reset using the automatic reset function in par. 14-20 Reset Mode (Warning: automatic wake-up is possible!)

If a warning and alarm is marked against a code in the table on the following page, this means that either a warning occurs before an alarm, or it can be specified whether it is a warning or an alarm that is to be displayed for a given fault.

This is possible, for instance, in par. 1-90 Motor Thermal Protection. After an alarm or trip, the motor carries on coasting, and the alarm and warning flash on the frequency converter. Once the problem has been rectified, only the alarm continues flashing.

| No. | Description | Warning | Alarm/Trip | Alarm/Trip Lock | Parameter Reference |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 1 | 10 Volts low | X |  |  |  |
| 2 | Live zero error | (X) | (X) |  | 6.01 |
| [3] | No motor | (x) |  |  | $1-80$ |
| 4 | Mains phase loss | ( ${ }^{\text {x }}$ | (X) | (X) | 14-12 |
| 5 | DC link voltage hilgh | X |  |  |  |
| 6 | DC link voltage low | X |  |  |  |
| 7 | DC over voltage | X | X |  |  |
| 8 | DC under voltage | X | X |  |  |
| 9 | Inverter overloaded | X | X |  |  |
| 10 | Motor ETR over temperature | (X) | (X) |  | 1-90 |
| 11 | Motor thermistor over temperature | (X) | (X) |  | $1-90$ |
| 12 | Torque limit | $x$ | X |  |  |
| 13 | OverCument | X | X | X |  |
| 14 | Earth fault | $\times$ | X | X |  |
| 15. | Hardware mismatch |  | X | X |  |
| 16 | Short Circuit |  | $\times$ | X |  |
| 17 | Control word timeout | (X) | ( ${ }^{\text {a }}$ |  | 804 |
| 23 | Internal Fan Fault | X |  |  |  |
| 24 | Extemal Fan Fault. | X |  |  | 1453 |
| 25 | Brake resistor short-circuited | $X$ |  |  |  |
| 26 | Brake reststor power llimit | (x) | (x) |  | 2-13 |
| 27 | Brake chopper short-circuited | $\chi$ | X |  |  |
| 28 | Brake ched | (X) | ( |  | 2-15 |
| 29 | Drive over temperature | X | X | X |  |
| 30 | Motor phase U missing | (X) | (x) | (X) | $4-58$ |
| 31 | Motor phase V missing | (X) | (X) | (X) | 4-58 |
| 32 | Motor phase W missing | (X) | (x) | (2) | 458 |
| 33 | Inrush fault |  | X | X |  |
| 34 | Fiedous communication fault | X | X |  |  |
| 35 | Out of frequency range | X | X |  |  |
| 35 | Mains failure | X | X |  |  |
| 37 | Phase Imbalance | X | X |  |  |
| 39 | Heatsink sensor |  | X | $x$ |  |
| 40 | Overload of Digital Output Terminal 27 | (X) |  |  | 5-00, 5-01 |
| 41 | Overtoad of Digital Output Terminal 29 | (X) |  |  | 5-0, 5-02 |
| 42 | Overload of Digital Output On $\times 30 / 6$ | ( $\times$ |  |  | 5-32 |
| 42 | Overload of Digtal output on $\times 30 / 7$ | (X) |  |  | 5-33 |
| 46 | Pwr. card supply |  | X | $x$ |  |
| 47 | 24.1 | X | X | X |  |
| 48 | 1.8 V supply low |  | X | X |  |
| 49 | Speed limit | X |  |  |  |
| 50 | AMA calibration failed |  | X |  |  |
| 51 | AMA check Unon and Iman |  | X |  |  |
| 52 | AMA low Inom |  | X |  |  |
| 53 | AMA motor too bl9 |  | X |  |  |
| 54 | AMA motor too small |  | X |  |  |
| 55 | AMA parameter out of range |  | X |  |  |
| 56 | AMA interrupted by user |  | X |  |  |
| 57 | AMA timeout |  | X |  |  |
| 58 | AMA internal fault | $X$ | X |  |  |
| 59 | Current limit | $\bar{x}$ |  |  |  |
| 60 | External Interlock | X |  |  |  |
| 62 | Output Frequency at Maximum Limit | X |  |  |  |
| 64 | Voltage Limit | X |  |  |  |
| 65 | Control Board Over-temperature | X | X | X |  |
| 66 | Heat sink Temperature Low | X |  |  |  |
| 67 | Option Configuration has Changed |  | X |  |  |
| 68 | Safe Stop Activated |  | $\mathrm{X}^{1}$ |  |  |
| 69 | Pwr. Card Temp |  | X | X |  |
| 70 | Illegal FC configuration |  |  | X |  |
| 71 | PTC 1 Safe Stop | $x$ | ${ }^{11}$ |  |  |
| 72 | Dangerous Failure |  |  | ${ }^{1}{ }^{1}$ |  |
| 73 | Safe Stop Auto Restait |  |  |  |  |
| 76 | Power Unit Setup | $\underline{ }$ |  |  |  |
| 79 | Illegal PS config |  | X | $x$ |  |
| 80 | Drive Initialised to Default Value |  | X |  |  |
| 91 | Analog iniput 54 wrong, settings |  |  | X |  |
| 92 | NoFlow | X | X |  | 22-2* |
| 93 | DryPump | X | X |  | 22-2* |
| 94 | End of Curve | X | X |  | 22-5* |
| 95 | Broken Belt | X | X |  | 22-6* |
| 96 | Start Delayed | X |  |  | 22-7* |
| 97 | Stop Delayed | $\frac{X}{x}$ |  |  | 22-7 |
| 98 | Clock Fault | X |  |  | 0-7* |

Table 9.1: Alarm/Warning code list

| No. | Description | Warning | Alarm/Trip | Alarm/Trip Lock | Parameter Reference |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 220 | Overtoad Trip |  | $\underline{X}$ |  |  |
| 243 | Brake IGBT | X | X |  |  |
| 244 | Heatsink temp | X | X | X |  |
| 245 | Heatsink sensor |  | X | X |  |
| 246 | Pwr.cand supply |  | X | $x$ |  |
| 247 | Pwr.card temp |  | $X$ | X |  |
| 248 | Illegal PS confg |  | x | $x$ |  |
| 250 | New spare part |  |  | X |  |
| 251 | New Trpe Code |  | X | X |  |

Table 9.2: Alarm/Warning code list
(X) Dependent on parameter

1) Can not be Auto reset via par. 14-20 Reset Mode

A trip is the action when an alarm has appeared. The trip will coast the motor and can be reset by pressing the reset button or make a reset by a digital input (Par. 5-1* [1]). The origin event that caused an alarm cannot damage the frequency converter or cause dangerous conditions. A trip lock is an action when an alarm occurs, which may cause damage to frequency converter or connected parts. A Trip Lock situation can only be reset by a power cycling.


| Alarm Word and Extended Status Word |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Blt | Hex. | Dec | Alarm Word. | Waming Word | Extended Status Word |
| 0 | 00000001 | 1 | Brake Check | Brake Check | Ramping |
| 1 | 00000002 | 2 | Pwr. Card Temp | Pwr. Card Temp | AMA Running |
| 2 | 00000004 | 4 | Earth Fault | Earth Fault | Start CW/CCW |
| 3 | 00000008 | 8 | Cil.Card Temp | CH.Card Temp | Slow Down |
| 4 | 00000010 | 16 | Ctrl. Word TO | Ctrr. Word TO | Catch Up |
| 5 | 00000020 | 32 | Over Current: | Over Cument | Feedback High |
| 6 | 00000040 | 64 | Torque Limit | Torque Limit | Feedback Low |
| 7 | 00000080 | 128 | Motor Thover | Motor Th over | Output Cument High |
| 8 | 00000100 | 256 | Motor ETR Over | Motor ETR Over | Output Current Low |
| 9 | 00000200 | 512 | Inverteroverld. | Inverter Overdd. | Output Freq.ilgh |
| 10 | 00000400 | 1024 | DC under volt | DC under Volt | Output Freq Low |
| 11 | 00000800 | 2048 | DCover Volt | DCover Volt | Brake Check OK. |
| 12 | 00001000 | 4096 | Short Circuit | DC Voltage Low | Braking Max |
| 13 | 0,0002000 | 8192 | Indish Fault | DC Vofage High | Braking |
| 14 | 00004000 | 16384 | Mains ph. Loss | Mains ph. Loss | Out of Speed Range |
| 15 | 00008000 | 32768 | AMA Not OK | NoMotor | OVCActive |
| 16 | 00010000 | 65536 | Live Zero Error | Live Zero Error |  |
| 17 | 00020000 | 131072 | Internal Fault | 10VLow |  |
| 18 | 00040000 | 262144 | Brake Overload | Brake Overload |  |
| 19 | 00080000 | 524288 | U D Dasase Loss | Brake Resistor |  |
| 20 | 00100000 | 1048576 | $\checkmark$ phase Loss | Brake IGBT |  |
| 21 | 00200000 | 2097152 | Wphase Loss | Speed Umit |  |
| 22 | 00400000 | 4194304 | Fieldbus Fault | Fieldbus Fault |  |
| 23 | 00800000 | 8388608 | 24. | 24 V Supply Low |  |
| 24 | 01000000 | 16777216 | Mains Failure | Mains Failure |  |
| 25 | 02000000 | 33554432 | $1.8 V$ Supply Low | Current Umit. |  |
| 26 | 04000000 | 67108864 | Brake Resistor | Low Temp |  |
| 27 | 08000000 | 134217728 | Brake IGBT | Voltage Unit |  |
| 28 | 10000000 | 268435456 | Option Change | Unused |  |
| 29 | 20000000 | 536870912 | Ditve Initialised | Unused |  |
| 30 | 40000000 | 1073741824 | Safe Stop | Unused |  |

Table 9.3: Description of Alarm Word, Warning Word and Extended Status Word

The alarm words, warning words and extended status words can be read out via serial bus or optional fieldbus for diagnosis. See also par. 16-90 Alarm Word, par. 16-92 Waming Word and par. 16-94 Ext. Status Word.

## 9 Troubleshooting

VLT ${ }^{\circledR}$ AQUA Drive Operating Instructions

### 9.1.1 Fault messages

## WARNING 1, 10 Volts low:

The 10 V voltage from terminal 50 on the control card is below 10 V . Remove some of the load from terminal 50, as the 10 V supply is overloaded. Max. 15 mA or minimum $590 \Omega$.

## WARNING/ALARM 2, Live zero error:

The signal on terminal 53 or 54 is less than $50 \%$ of the value set in par. 6-10 Terminal 53 Low Voltage, par. 6-12 Terminal 53 Low Current, par. 6-20 Terminal 54 Low Voltage, or par. 6-22 Terminal 54 Low Current respectively.

## WARNING/ALARM 3, No motor:

No motor has been connected to the output of the frequency converter.

## WARNING/ALARM 4, Mains phase loss:

A phase is missing on the supply side, or the mains voltage imbalance is too high.
This message also appears in case of a fault in the input rectifier on the frequency converter.
Check the supply voltage and supply currents to the frequency converter.

## WARNING 5, DC link voltage high:

The intermediate circuit voltage (DC) is higher than the over-voltage limit of the control system. The frequency converter is still active.

## WARNING 6, DC link voltage low:

The intermediate circuit voltage (DC) is below the undervoltage limit of the control system. The frequency converter is still active.

## WARNING/ALARM 7, DC over voltage:

If the intermediate circuit voltage exceeds the limit, the frequency converter trips after a time.

## Possible corrections:

Select Over Voltage Control function in par. 2-17 Over-voltage Control

Connect a brake resistor
Extend the ramp time
Activate functions in par. 2-10 Brake Function
Increase par. 14-26 Trip Delay at Inverter Fault
Selecting OVC function will extend the ramp times.

| Alarm/warning limits: |  |  |  |
| :---: | :---: | :---: | :---: |
| Voltage Range | $\begin{gathered} 3 \times 200-240 \mathrm{VAC} \\ \mathrm{IVDC}] \end{gathered}$ | $\begin{gathered} 3 \times 380-500 \\ \text { VAC } \\ {[\text { VDC] }} \end{gathered}$ | $\begin{gathered} 3 \times 550-600 \\ \text { VAC } \\ {[\mathrm{VDCD}]} \end{gathered}$ |
| Under voltage | 185 | 373 | 532 |
| Voltage wamt Ing low | 205 | 410 | 585 |
| Voltage warning high (w/o brake - w/ brake) $\qquad$ | 390/405 | 810/840 | 943/965 |
| OVer voltage | 410 | 855 | 975 |
| The voltages stated are the intermediate circuit voltage of the frequency converter with a tolerance of $\pm 5 \%$. The corresponding mains voltage is the intermediate circuit voltage (DC-link) divided by 1.35 |  |  |  |

## WARNING/ALARM B, DC under voltage:

If the intermediate circuit voltage (DC) drops below the "voltage warning low" limit (see table above), the frequency converter checks if 24 V backup supply is connected.
If no 24 V backup supply is connected, the frequency converter trips after a given time depending on the unit.

To check whether the supply voltage matches the frequency converter, see 3.1 General Specifications.

## WARNING/ALARM 9, Inverter overloaded:

The frequency converter is about to cut out because of an overload (too high current for too long). The counter for electronic, thermal inverter protection gives a warning at $98 \%$ and trips at $100 \%$, while giving an alarm. You cannot reset the frequency converter until the counter is below 90\%.
The fault is that the frequency converter is overloaded by more than nominal current for too long.

## WARNING/ALARM 10, Motor ETR over temperature:

According to the electronic thermal protection (ETR), the motor is too hot. You can choose if you want the frequency converter to give a warning or an alarm when the counter reaches 100\% in par. 1-90 Motor Thermal Protection. The fault is that the motor is overloaded by more than nominal current for too long. Check that the motor par. 1-24 Motor Current is set correctly.

## WARNING/ALARM 11, Motor thermistor over temp:

The thermistor or the thermistor connection is disconnected. You can choose if you want the frequency converter to give a warning or an alarm in par. 1-90 Motor Thermal Protection. Check that the thermistor is connected correctly between terminal 53 or 54 (analog voltage input) and terminal 50 ( +10 Volts supply), or between terminal 18 or 19 (digital input PNP only) and terminal 50. If a KTY sensor is used, check for correct connection between terminal 54 and 55.

## WARNING/ALARM 12, Torque limit:

The torque is higher than the value in par. 4-16 Torque Limit Motor Mode (in motor operation) or the torque is higher than the value in par. 4-17 Torque Limit Generator Mode (in regenerative operation).

## WARNING/ALARM 13, Over Current:

The inverter peak current limit (approx. 200\% of the rated current) is exceeded. The warning will last approx. 8-12 sec., then the frequency converter trips and issues an alarm. Turn off the frequency converter and check if the motor shaft can be turned and if the motor size matches the frequency converter.

## ALARM 14, Earth fault:

There is a discharge from the output phases to earth, either in the cable between the frequency converter and the motor or in the motor itself. Turn off the frequency converter and remove the earth fault.

## ALARM 15, In-complete hardware:

A fitted option is not handled by the present control board (hardware or software).

## ALARM 16, Short-circuit:

There is short-circuiting in the motor or on the motor terminals.
Turn off the frequency converter and remove the short-circuit.

## WARNING/ ALARM 17, Control word timeout:

There is no communication to the frequency converter.
The warning will only be active when par. 8-04 Control Timeout Function is NOT set to OFF.
If par. 8-04 Control Timeout Function is set to Stop and Trip, a warning appears and the frequency converter ramps down to zero speed, while giving an alarm.
par. 8-03 Control Timeout Time could possibly be increased.

WARNING 23, Internal fans:
External fans have failed due to defect hardware or fans not mounted.

## WARNING 24, External fan fault:

The fan warning function is an extra protection function that checks if the fan is running / mounted. The fan warning can be disabled in par. 14-53 Fan Monitor, [0] Disabled.

## WARNING 25, Brake resistor short-circuited:

The brake resistor is monitored during operation. If it short-circuits, the brake function is disconnected and the warning appears. The frequency converter still works, but without the brake function. Turn off the frequency converter and replace the brake resistor (see par. 2-15 Brake Check).

## ALARM/WARNING 26, Brake resistor power limit:

The power transmitted to the brake resistor is calculated as a percentage, as a mean value over the last 120 s , on the basis of the resistance value of the brake resistor (par. 2-11 Brake Resistor (ohm)) and the intermediate circuit voltage. The warning is active when the dissipated braking power is higher than $90 \%$. If Trip [2] has been selected in par. 2-13 Brake Power Monitoring, the frequency converter cuts out and issues this alarm, when the dissipated braking power is higher than $100 \%$.

WARNING/ALARM 27, Brake chopper fault:
The brake transistor is monitored during operation and if it short-circuits, the brake function disconnects and the warning comes up. The frequency converter is still able to run, but since the brake transistor has shortcircuited, substantial power is transmitted to the brake resistor, even if it is inactive.
Turn off the frequency converter and remove the brake resistor.


Warning: There is a risk of substantial power being transmitted to the brake resistor if the brake transistor is short-circuited.

## ALARM/WARNING 28, Brake check failed:

Brake resistor fault: the brake resistor is not connected/working.

## WARNING/ALARM 29, Drive over temperature:

If the enclosure isIPOO or IP20/Nemal the cut-out temperature of the heat-sink is $90^{\circ} \mathrm{C}$. If $1 P 54$ is used, the cut-out temperature is $80^{\circ} \mathrm{C}$.

The fault could be:

- Ambient temperature too high
- Too long motor cable

ALARM 30, Motor phase U missing:
Motor phase $U$ between the frequency converter and the motor is missing.
Turn off the frequency converter and check motor phase $U$.

## ALARM 31, Motor phase V missing:

Motor phase V between the frequency converter and the motor is missing. Turn off the frequency converter and check motor phase V .

## ALARM 32, Motor phase $\mathbf{W}$ missing:

Motor phase $W$ between the frequency converter and the motor is missing.
Turn off the frequency converter and check motor phase $W$.

ALARM 33, Inrush fault:
Too many powerups have occured within a short time period. See the chapter General Specifications for the allowed number of power-ups within one minute.

## WARNING/ALARM 34, Fieldbus communication fault:

The fieldbus on the communication option card is not working.
WARNING/ALARM 35, Option Fault:
Option fault. Please contact your supplier.

## WARNING/ALARM 36, Mains failure:

This warning/alarm is only active if the supply voltage to the frequency converter is lost and parameter $14-10$ is NOT set to OFF. Possible correction: check the fuses to the frequency converter

## WARNING/ALARM 37, Phase Imbalance:

There is a current imbalance between the power units.
ALARM 39, Heatsink Sensor:
No feedback from the heatsink sensor.
WARNING 40, Overload of Digital Output Terminal 27
Check the load connected to terminal 27 or remove short-circuit connection. Check parameters 5-00 and 5-01.

WARNING 41, Overioad of Digital Output Terminal 29:
Check the load connected to terminal 29 or remove short-circuit connection. Check parameters 5-00 and 5-02.

WARNING 42, Overload of Digital Output On X30/6:
Check the load connected to $\times 30 / 6$ or remove short-circuit connection. Check parameter 5-32.

WARNING 42, Overload of Digital Output On $\times 30 / 7$ :
Check the load connected to $\times 30 / 7$ or remove short-circuit connection. Check parameter 5-33.

ALARM 46, Pwr. card supply:
The supply on the power card is out of range.
WARNING 47, 24 V supply low:
The external 24 V DC backup power supply may be overloaded, otherwise contact your Danfoss supplier.

ALARM 48, 1.8 V supply low:
Contact your Danfoss supplier.
WARNING 49, Speed Iimit:
The speed has been limited by range in par. 4-11 Motor Speed Low Limit [RPM] and par. 4-13 Motor Speed High Limit [RPM].

ALARM 50, AMA calibration failed:
Contact your Danfoss supplier.
ALARM 51, AMA check Unom and Inom:
The setting of motor voltage, motor current, and motor power is presumably wrong. Check the settings.

ALARM 52, AMA low Inom:
The motor current is too low. Check the settings.
ALARM 53, AMA motor too big:
The motor is too big for the AMA to be carried out.
ALARM 54, AMA motor too small:
The motor is too small for the AMA to be carried out.
ALARM 55, AMA par. out of range:
The par. values found from the motor are outside acceptable range.

ALARM 56, AMA interrupted by user:
The AMA has been interrupted by the user.

## ALARM 57, AMA timeout:

Try to start the AMA again a number of times, until the AMA is carried out. Please note that repeated runs may heat the motor to a level where the resistance $\mathrm{R}_{5}$ and Rr are increased. In most cases, however, this is not critical.
WARNING/ALARM 58, AMA internal fault:
Contact your Danfoss supplier.
WARNING 59, Current limit:
The current is higher than the value in par. 4-18 Current Limit.

## WARNING 60, External Interlock:

External Interlock has been activated. To resume normal operation, apply 24 VDC to the terminal programmed for External Interlock and reset the frequency converter (via Bus, Digital I/O or by pressing [Reset]).

WARNING 62, Output Frequency at Maximum Limit:
The output frequency is limited by the value set in par, 4-19 Max Outpout Frequency

WARNING/ALARM/TRIP 65, Control Card Over Temperature:
Control card over temperature: The cut-out temperature of the control card is $80^{\circ} \mathrm{C}$.

## WARNING 66, Low Temp.:

The heat sink temperature is measured to be low. This could indicate that the temperature sensor is defective and thus the fan speed is increased to the maximum in case the power part or control card is very hot.

ALARM 67, Option Configuration has Changed:
One or more options has either been added or removed since the last power-down.

## ALARM 68, Safe Stop:

Safe Stop has been activated. To resume normal operation, apply 24 VOC to terminal 37 then send a Reset signal (via Bus, Digital 1/O or by pressing [Reset]).
ALARM 69, Pwr. Card Temp:
Power card over temperature.
WARNING 76, Power Unit Setup:
The requlred number of power units does not match the detected number of active power units.

ALARM 70, Illegal Frequency Converter Comfiguration:
Actual combination of control board and power board is illegal.

## ALARM 90, Feedback Mon.:

ALARM 92, NoFlow:
A no load situation has been detected for the system. See parameter group 22-2*.
ALARM 93, Dry Pump:
A no flow situation and high speed indicates that the pump has run dry. See parameter group 22-2*

## ALARM 94, End of Curve:

Feed back stays lower than the set point, which may be indicates a leakage in the pipe system. See parameter group 22-5*

## ALARM 95, Broken Belt:

Torque is below the torque level set for no load indicating a broken belt. See parameter group 22-6*

## ALARM 96, Start Delayed:

Start of the motor has been delayed due to short cycle protection is active. See parameter group 22-7*.

## ALARM 220, Overload Trip:

Motor overload has tripped. Indicates excess motor load. Check motor and driven load. To reset press the "Off Reset" key. Then, to restart the system, press the "Auto On " or "Hand $\mathrm{On}^{n}$ key.

## WARNING/ALARM 243, Brake IGET:

The brake transistor is short-circuited or the brake function is disconnected. Turn off the frequency converter as a fire precaution. Report value indicates source of alarm (from teft): 1-4 Inverter 5-8 Rectifier.

## WARNING/ALARM 244, Heatsink Temp:

Drive heatsink over temperature: Report value indicates source of alarm (from left): 1-4 Inverter 5-8 Rectifier.

## ALARM 245, Meatsink Sensor:

No feedback from the heatsink sensor Report value indicates source of alarm (from left): 1-4 Inverter 5-8 Rectifier.
ALARM 246, Pwr. Card Supply:
The supply on the power card is out of range Report value indicates source of alarm (from left): 1-4 Inverter 5-8 Rectifier.

ALARM 247, Pwr. Card Temp:
Power card over temperature Report value indicates source of alarm (from left): 1-4 Inverter 5-8 Rectifier.

## ALARM 248, Illegal PS Config:

Power size configuration fault on the power card Report value indicates source of alarm (from left): 1-4 Inverter 5-8 Rectifier.

## ALARM 250, New Spare Part:

The power or Switch Mode Power Supply has been exchanged. The frequency converter type code must be restored in the EEPROM. Select the correct type code in Par 14-23 according to the label on unit. Remember to select 'Save to EEPROM' to complete.

ALARM 251, New Type Code:
The frequency converter has got a new type code.

## Ho Grecilicertong

### 10.1 General Specifications



### 10.1.2 Mains Supply $3 \times 200-240$ VAC



| IP 20 / NEMA Chassis <br> ( $\mathrm{B} 3+4$ and $\mathrm{C}+4$ may be converted to IP21 using a_converslon. ktt. (Please contact Danfoss) | B3 | B3 | B3 | B4 | B4 | C3 | C3 | C4 | C4 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| ip $21 /$ NEMAA 1 | B1 | B1 | B1 | 82 | C1 | C1 | C1 | C2 | C2 |
| [IP 55/NEMA 12 | B1 | 81 | B1 | 82 | C1 | C1 | C1 | 0 | 0 |
| IP66 | B1 | B1 | B1 | B2 | C1 | C1 | C1 | C2 | C2 |
| Frequency converter | P5K5 | P7K5 | P11K | P15K | P18K | P22K | P30K | P37K | P45K |
| Typlcal 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 |
| Output current |  |  |  |  |  |  |  |  |  |
| Continuous $(3 \times 200-240 \mathrm{~V})[\mathrm{A}]$ | 24.2 | 30.8 | 46.2 | 59.4 | 74.8 | 88.0 | 115 | 143 | 170 |
| $\left[\begin{array}{l}\text { Intermittent } \\ (3 \times 200-240 \mathrm{~V})\end{array}\right]$ | 26.6 | 33.9 | 50.8 | 65.3 | 82.3 | 96.8 | 127 | 157 | 187 |
|  | 8.7 | 11.1 | 16.6 | 21.4 | 26.9 | 31.7 | 41.4 | 51.5 | 61.2 |
| Max cable stze: $\qquad$ (mains, motor, brake) [ $\left.\mathrm{mm}^{2} / \mathrm{AWG}\right]^{2)}$ |  |  |  |  | $50 / 1 / 0$ |  |  |  | $\begin{gathered} 120 / 250 \\ \mathrm{MCM} \\ \hline \end{gathered}$ |
|  |  | 10/7 |  | 35/2 |  |  |  |  |  | 95/4/0 |
| Max. Input current |  |  |  |  |  |  |  |  |  |
| Continuous $(3 \times 200-240 \mathrm{~V})[\mathrm{A}]$ | 22.0 | 28.0 | 42.0 | 54.0 | 68.0 | 80.0 | 104.0 | 130.0 | 154.0 |
| $\left[\begin{array}{l} \text { Intemititent } \\ (3 \times 200-240 \mathrm{~V}) \end{array}\right]$ | 24.2 | 30.8 | 46.2 | 59.4 | 74.8 | 88.0 | 114.0 | 143.0 | 169.0 |
| Soor Max. pre-fuses ${ }^{1)}$ [A] | 63 | 63 | 63 | 80 | 125 | 125 | 160 | 200 | 250 |
| (igion ${ }^{\circ}$ |  |  |  |  |  |  |  |  |  |
| Estimated power loss at rated max. load [W] ${ }^{\text {4) }}$ | 269 | 310 | 447 | 602 | 737 | 845 | 1140 | 1353 | 1636 |
| [Welght endosure IP20 [kg]. | 12 | 12 | 12 | 23.5 | 23.5 | 35 | 35 | 50 | 50 |
| $\square$ Weight enclosure IP21 [kg] | 23 | 23 | 23 | 27 | 45 | 45 | 65 | 65 | 65 |
| [Welight endosure IP55 [kg] | 23 | 23 | 23 | 27 | 45 | 45 | 65 | 65 | 65 |
| Weight enclosure IP 66 [kg] | 23 | 23 | 23 | 27 | 45 | 45 | 65 | 65 | 65 |
| [Effidency ${ }^{3}$ | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.97 | 0.97 | 0.97 | 0.97 |

10.1.3 Mains Supply $1 \times 380$ - 480 VAC

Mains Supply 1x 380 VAC - Normal overload 110\% for 1 minute Frequency converter.
Typkal Shaft Output [kW]
Typical Shaft Output [HP] at 460 V
IP 21 / NEMA 1


IP 66 NEMA IPutput'cument



150

### 10.1.4 Mains Supply $3 \times 380-480$ VAC





### 10.1.5 Mains Supply $3 \times 525-600$ VAC



Table 10.1: ${ }^{\text {s) }}$ Motor and mains cable: $300 \mathrm{MCM} / 150 \mathrm{~mm}^{2}$

2014
10.1.6 Mains Supply $3 \times 525-690$ VAC

| Normal overload 110\% for 1 minute |  |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Stre: |  | P11K | P15K | P18K | P22K | P30K | P37K | P45K | P55K | P75K | P90K |
| Typical Shaft Output [ kW ] |  | 11 | 15 | 18.5 | 22 | 30 | 37 | 45 | 55 | 75 | 90 |
| Typical Shatt Output [HP] | 575 V | 10 | 16.4 | 20.1 | 24 | 33 | 40 | 50 | 60 | 75 | 100 |
| IP 21 / NEMA 1 |  | B2 | B2 | B2 | B2 | B2 | C2 | C2 | C2 | C2 | C2 |
| IP 55/NEMA 12 |  | B2 | B2 | B2 | B2 | B2 | C2 | C2 | Q | C | Q |
| Output current |  |  |  |  |  |  |  |  |  |  |  |
|  | $\begin{aligned} & \text { Continuous } \\ & \left(3 \times 525-550,{ }_{2}\right)[A] \end{aligned}$ | 14 | 19 | 23 | 28 | 36 | 43 | 54 | 65 | 87 | 105 |
| $\square$ | $\left[\begin{array}{l}\text { Intermitent } \\ (3 \times 525-550 \mathrm{~V})\end{array} \mathrm{AD}\right]$ | 15.4 | 20.9 | 25.3 | 30.8 | 39.6 | 47.3 | 59.4 | 71.5 | 95.7 | 115.5 |
|  | Continuous | 13 | 18 | 22 | 27 | 34 | 41 | 52 | 62 | 83 | 100 |
|  | $\left[\begin{array}{l} \text { Intermittent } \\ (3 \times 551-690 \mathrm{~V}) \end{array}\right]$ | 14.3 | 19.8 | 24.2 | 29.7 | 37.4 | 45.1 | 57.2 | 68.2 | 91.3 |  |
|  | Contnuous kVA ( 550 V AC) [ $[\mathrm{kVA}]$ | 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 |
|  | Contthuous, kVA ( 690 V AC) [ LKVA ] | 15.5 | 21.5 | 26.3 | 32.3 | 40.6 | 49 | 62.1 | 74.1 | 99.2 | 119.5 |
|  | Max. cable size (mains, motor, brake) $\left.\mathrm{mm}^{2}\right] /\left[\mathrm{m}^{2}\right]^{22}$ |  |  | $\begin{aligned} & 35 \\ & 1 / 0 \end{aligned}$ |  |  |  |  | $\begin{aligned} & 95 \\ & 4 / 0 \end{aligned}$ |  |  |
| Max Input current |  |  |  |  |  |  |  |  |  |  |  |
|  | $\begin{aligned} & \text { Continuous } \\ & (3 \times 525-690 \mathrm{~V})[\mathrm{A}] \end{aligned}$ | 15 | 19.5 | 24 | 29 | 36 | 49 | 59 | 71 | 87 | 99 |
|  | $\left[\begin{array}{l} \text { Intermilttent } \\ (3 \times 525-690 \vee)[A] \end{array}\right.$ | 16.5 | 21.5 | 26.4 | 31.9 | 39.6 | 53.9 | 64.9 | 78.1 | 95.7 | 108.9 |
|  | Max. pre-fuses ${ }^{1}$ [ $\left.{ }^{\text {a }}\right]$ | 63 | 63 | 63 | 63 | 80 | 100 | 125 | 160 | 160 | 160 |
|  | [Environiment:- |  |  |  |  |  |  |  |  |  |  |
|  | Estimated power loss at rated max. load [W] 4) | 201 | 285 | 335 | 375 | 430 | 592 | 720 | 880 | 1200 | 1440 |
|  | Weloht: |  |  |  |  |  |  |  |  |  |  |
|  | IP21 [kg] | 27 | 27 | 27 | 27 | 27 | 65 | 65 | 65 | 65 | 65 |
|  | [P55 [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 10.2: ${ }^{5}$ ) Motor and mains cable: $300 \mathrm{MCM} / 150 \mathrm{~mm}^{2}$
10.1.7 Mains Supply $3 \times 525$ - 690 VAC

## Normal overload 110\% for 1 minute

| Frequency converter Typical Shaft Output [kW] | $\begin{array}{r} \text { P45K } \\ \times 45 \\ \hline \end{array}$ | $\begin{aligned} & \text { PS5K } \\ & 55 \\ & \hline \end{aligned}$ | $\begin{array}{r} P 75 K \\ 75 \\ \hline \end{array}$ | $\begin{gathered} \text { P90K } \\ 90 \\ \hline \end{gathered}$ | $\begin{aligned} & \hline \text { P110 } \\ & 110 \\ & \hline \end{aligned}$ | $\begin{gathered} P 132 \\ 132 \\ \hline \end{gathered}$ | $\begin{aligned} & \hline \text { P160 } \\ & 160 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline \mathbf{P 2 0 0} \\ & 200 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline P 250 \\ & i 250 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline \text { P315 } \\ & 315 \\ & \hline \end{aligned}$ | $\begin{array}{r} \text { P400 } \\ 400 \\ \hline \end{array}$ | $\begin{array}{\|l\|} \hline 8450 \\ 450 \\ \hline \end{array}$ | $\begin{aligned} & \hline P 500 \\ & 500^{\prime} \end{aligned}$ | $\begin{aligned} & \hline P 560 \\ & 560 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline \text { P630 } \\ & 630 \end{aligned}$ | $\begin{array}{r} \hline \text { P710 } \\ \hline 710 \\ \hline \end{array}$ | $\begin{aligned} & \hline 8800 \\ & 800 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 9900 \\ & \hline 900 \\ & \hline \end{aligned}$ | $\begin{aligned} & \text { P1M0 } \\ & 1000 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline \text { P1M2 } \\ & 1200^{\circ} \\ & \hline \end{aligned}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Typical Shaft Output [HP] at 575 V | 50 | 60 | 75 | 100 | 125 | 150 | 200 | 250 | 300 | 350 | 400 | 450 | 500 | 600 | 650 | 750 | 950 | 1050 | 1150 | 1350 |
| 1 P 00 | D3 | D3 | D3. | D3 | D3 | 03 | D3 | D4 | D4 | 04 | D4, | E2 | E2 | E2 | E2 | $-$ | $\stackrel{-}{-}$ | $\stackrel{-}{-}$ |  |  |
| IP 21 / Nema 1 | D1 | D1 | D1 | D1 | D1 | D1 | D1 | D2 | D2 | D2 | D2 | E1 | E1 | E1 | E1 | F1/F3 ${ }^{6}$ ) | F1/ F3) | F1/F3 ${ }^{6}$ | F2/ F46) | F2/F4 ${ }^{6}$ |
| IP 54/ Nema 12 | D1 | D1 | D1 | D1 | D1 | D1 | D1 | D2 | D2 | D2 | D2 | E1 | E1 | E1 | E1 | F1/F3 ${ }^{\text {] }}$ | $\begin{aligned} & \text { F1/ } \\ & \text { F3 } \end{aligned}$ | F1/F36) | $\begin{gathered} \text { F1 } \\ { }^{2} 3^{6} \\ \hline \end{gathered}$ | 1/F36) |
| Output current |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| ( $\quad \therefore \quad \therefore \quad \begin{aligned} & \text { Continuous }(3 \times 550 \mathrm{~V})[\mathrm{A}] \\ & \text { Intermittent }(3 \times 550 \mathrm{~V})[\mathrm{A}\end{aligned}$ | 56 | 76 | 90 | 113 | 137 | 162 | 201 | 253 | 303 | 360 | 418 | 470 | 523 | 596 | 630 | 763 | 889 | 988 | 1108-1317 |  |
|  | 62 | 84 | 99 | 124 | 151 | 178 | 221 | 278 | 333 | 396 | 460 | 517 | 575 | 656 | 693 | 839 | 978 | 1087 | 1219 1449 |  |
|  | 54 | 73 | 86 | 108 | 131 | 155 | 192 | -242 | <290: | 344 | 400 | 450 | 500 | 570 | 630 | $\begin{array}{r} 730 \\ 803 \\ \hline \end{array}$ | 850 | 945 | 1060-1260] |  |
| Intermittent ( $3 \times 690 \mathrm{~V}$ ) [A] | 59 | 80 | 95 | 119 | 144 | 171 | 211 | 266 | 319 | 378 | 440 | 495 | 550 | 627 | 693 |  | 935 | 1040 | $1166 \quad 1386$ |  |
|  | 53 | 72 | 86 | 108 | 131. | 154 | 191 | -241 | 289 | 343 | 398 | 448 | 498 | 568 | 600 | -727 847 |  | 941 | 1056-1255] |  |
|  | 54 | 73 | 86 | 108 | 130 | 154 | 191 | 241 | 289 | 343 | 398 | 448 | 498 | 568 | 627 | $\frac{727}{872}$ | $\begin{array}{r} 847 \\ \hline 1016 \\ \hline \end{array}$ | 941 | 10561255 |  |
|  | 65 | 87 | 103 | 129 | 157 | 185 | 229 | 289 | 347 | 411 | 478 | 538 | 598 | 681 | 753 |  |  | 1129 | 1267 1506 |  |
| \% Max. cable size: |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | $\begin{gathered} 8 \times 240 \\ 8 \times 500 \mathrm{mcm} \end{gathered}$ |  |
| (Mains) [mm² AWG] ${ }^{2)}$ |  |  |  | $\begin{array}{r} 2 \times 70 \\ -2 \times 2 / 0 \end{array}$ |  |  |  |  | $2 \times 30$ | 85 mcm |  |  |  | $240$ |  | $\begin{gathered} 8 \times 240 \\ -8 \times 500 \mathrm{man} \end{gathered}$ |  |  |  |  |
| (Motor) [mm²/ AWG] ${ }^{2)}$ |  |  |  | $\begin{aligned} & 2 \times 70 \\ & 2 \times 210 \end{aligned}$ |  |  |  |  |  | 85 mcm |  |  | $4 \times$ $4 \times 500$ | $\begin{aligned} & 240 \\ & \mathrm{mcm} \\ & \hline \end{aligned}$ |  | $\begin{array}{r} 8 \times 150 \\ 8 \times 300 \mathrm{mcm} \\ \hline \end{array}$ |  |  | - $12 \times 150$ |  |
| (Brake) $\left[\mathrm{mm}^{2} / \mathrm{AWG}\right]^{2)}$ |  |  |  | $\begin{aligned} & 2 \times 10 \\ & 2 \times 20 \\ & 20210 \end{aligned}$ |  |  |  |  |  | $\begin{aligned} & 185 \\ & \mathrm{mcm} \end{aligned}$ |  |  |  | $\begin{aligned} & 185 \\ & \mathrm{mom} \end{aligned}$ |  | $\begin{gathered} 4 \times 185 \\ 4 \times 350 \mathrm{mom} \\ \hline \end{gathered}$ |  |  | $\begin{gathered} 6 \times 185 \\ 6 \times 350 \mathrm{mcm} \\ \hline \end{gathered}$ |  |
| Max. input current |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Continuous ( $3 \times 550 . \mathrm{V}$ [ [A] | 60 | 77 | 89 | 110 | 130 | 158 | 198 | 245 | 299 | 355 | 408 | 453 | 504 | 574 | 607 | -743 866_962 |  |  | 1079-1282] |  |
| [Continuous $(3 \times 575 \mathrm{~V}$ ) $[\mathrm{A}]$ | 58 | 74 | 85 | 106 | 124 | 151 | 189 | 224 | 286 | 339 | 390 | 434 | 482 | 549 | 607 | 711 | 828 | 920 | 1032 1227 |  |
| Continuous ( $3 \times 690$ V. $[$ A $]$ | 58. | 77 | 87 | 109 | 128 | 155 | 197 | 240 | 296 | 352 | 400 | 434 | 482 | 549 | 607 | $\begin{array}{r} 711 \\ \hline 2000 \\ \hline \end{array}$ | 828 | $\begin{aligned} & 920 \\ & 2000 \\ & \hline \end{aligned}$ | $1032-1227$ <br> $2000-2000$ |  |
| Max. mains pre-fuses ${ }^{1}$ [ $A$ ] | 125 | 160 | 200 | 200 | 250 | 315 | 350 | 350 | 400 | 500 | 550 | 700 | 700 | 900 | 900 |  | 2000 |  |  |  |
| Eivironment: |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | $2000$ |  |  | $-2000-2000$ |  |
| Estimated power loss at 690 VAC at rated max. load [W] 4) | 1458 | 1717 | 1913 | 2262 | 2662 | 3430 | 3612 | 4292 | 5156 | 5821 | 6149 | 6440 | 7249 | 8727 | 9673 | $\begin{array}{llll}11315 & 1290314533\end{array}$ |  |  | 1637519207 |  |
| Estlmated power loss at 575 VAC at rated max load [W] 9) | 1398 | 1645 | 1827 | . 2157 | 2533 | 2963. | 3430 | 4051 | ¢ 4867 | 5493 | 5852 | 6132 | 6903 | 8343 | . 9244 | $10771 \quad 12272 \quad 13835$ |  |  | 1559218281 |  |
| Weight enclosure IP00 [kg] | 82 | 82 | 82 | 82 | 82 | 82 | 91 | 112 | 123 | 138 | 151 | 221 | 221 | 236 | 277 | $\cdots$ |  |  | -- |  |
|  | 96 | 196\% | 96 | - 96 | 96- | 96 | 104 | 125 | 136 | 151 | 165 | 263 : | 263 | 272 | -313: | 1004 1004 1004 <br> 1004 1004 1004 |  |  | 1246-1246 |  |
| Weight enclosure IP 54 [ kg$]^{\text {6 }}$ ) | 96 | 96 | 96 | 96 | 96 | 96 | 104 | 125 | 136 | 151 | 165 | 263 | 263 | 272 | 313 |  |  |  | 1246 | 1246 |
| Effidency ${ }^{3)}$ | 0.97 | 0.97 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98. | 0.98 |

## For type of fuse see section fuses

2) American Wire Gauge
${ }^{\text {3) }}$ ) 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 $+/-15 \%$ (tolerance relates to variety in voltage and cable conditions). Values are based on a typical motor efficiency (eff $2 /$ eff 3 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 ( $+1.5 \%$ ).
${ }^{6)}$ Adding the F -enclosure option cabinet (resulting in the F3 and F4 enclosure sizes) adds 295 kg to the estimated weight.

- 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.). VLT AQUA Drive has an auto derating function to avoid it's heatsink reaching 95 deg $C$.
- The frequency converter is protected against short-circuits on motor terminals $U, V, W$.
- 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 $U, V, W$.

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 FC continues until the intermediate circuit voltage drops below the minimum stop level, which corresponds typically to $15 \%$ below the FC's lowest rated supply voltage. Power-up and full torque cannot be expected at mains voltage lower than $10 \%$ below the FC's lowest rated supply voltage.
Supply frequency
The frequency converter power supply is tested in accordance with IEC61000-4-28, $50 \mathrm{~Hz}+4 /-6 \%$.

| Max. imbalance temporary between mains phases | $3.0 \%$ of rated supply voltage |
| :---: | :---: |
| True Power Factor ( $\lambda$ ) | $\geq 0.9$ nominal at rated load |
| Displacement Power Factor ( $\cos \varphi$ ) near unity | ( $>0.98$ ) |
| Switching on input supply L1, L2, L3 (power-ups) $\leq$ enclosure type A | maximum 2 times/min. |
| Switching on input supply $\mathrm{L1}, \mathrm{~L} 2, \mathrm{L3}$ (power-ups) $\geq$ enclosure type B, C | maximum 1 time/min. |
| Switching on input supply L1, L2, L3 (power-ups) $\geq$ enclosure type D, E, F | maximum 1 time/2 min. |
| Environment according to EN60664-1 | category III/pollution degree 2 |

The unit is suitable for use on a circuit capable of delivering not more than 100.000 RMS symmetrical Amperes, 240/480 V maximum. Motor output ( $\mathrm{U}, \mathrm{V}, \mathrm{W}$ ):
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 sec ." |
| Overload torque (Constant torque) | maximum $110 \%$ for 1 min.* |
| *Percentage relates to VLT AQUA Drive's nominal torque. |  |
| Cable lengths and cross sections: |  |
| Max. motor cable length, screened/armoured | VIT AQUA Drive: 150 m |
| Max. motor cable length, unscreened/unarmoured | VIT AQUA Drive: 300 m |
| Max. cross section to motor, mains, load sharing and brake * |  |
| Maximum cross section to control terminals, rigid wire | $1.5 \mathrm{~mm}^{2} / 16 \mathrm{AWG}\left(2 \times 0.75 \mathrm{~mm}^{2}\right)$ |
| Maximum cross section to control terminals, flexible cable | $1 \mathrm{~mm}^{2} / 18$ AWG |
| Maximum cross section to control terminals, cable with enclosed core | $0.5 \mathrm{~mm}^{2} / 20$ AWG |
| Minimum cross section to control terminals | $0.25 \mathrm{~mm}^{2}$ |
| * See Mains Supply tables for more information! |  |
| Control card, RS-485 serial communication: |  |
| Terminal number | 68 (P,TX+, RXX), 69 (N,TX-, RX-) |
| Terminal number 61 | Common for terminals 68 and 69 |

The RS-485 serial communication circuit is functionally seated from other central circuits and galvanically isolated from the supply voltage (PELV).


The analog inputs are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.
$\xrightarrow{\text { Functional }}$

## Analog output:

Number of programmable analog outputs $\quad 1$
Terminal number
Current range at analog output
Max. resistor load to common at analog output $\quad 500 \Omega$
Accuracy on analog output $\quad$ Max. error: $0.8 \%$ of full scale

Resolution on analog output 8 bit

The analog output is ga/vanically isolated from the supply voltage (PELV) and other high-voltage terminals.
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 | $<5 \mathrm{VDC}$ |
| Voltage level, logic'1' PNP | $>10 \mathrm{VDC}$ |
| Voltage level, logic '0' NPN | > 19 VDC |
| Voltage level, logic '1' NPN | $<14 \mathrm{VDC}$ |
| Maximum voltage on input | 28 VDC |
| Input resistance, $\mathrm{R}_{1}$ | approx. 4 k |

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
Terminal number
Voltage level at digital/frequency output
Max, output current (sink or source)
Max, load at frequency output
Max. capacitive load at frequency output
Minimum output frequency at frequency output
Maximum output frequency at frequency output
Accuracy of frequency output
Resolution of frequency outputs

## 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-voitage terminals.
Pulse inputs:
Programmable pulse inputs

Max. frequency at terminal, 29, 33
Max. frequency at terminal, 29,33
Min, frequency at terminal 29, 33
Voltage level
Maximum voltage on input

| Input resistance, $\mathrm{R}_{4}$ | approx. $4 \mathrm{k} \Omega$ |
| :---: | :---: |

Pulse input accuracy ( $0.1-1 \mathrm{kHz}$ ) Max. error: $0.1 \%$ of full scale

Control card, 24 V DC output:
Terminal number
Max. load
Max

The 24 V OC 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

Relay 01 Terminal number
Max, terminal load (AC-1) ${ }^{1}$ on $1-3(N C), 1-2(N O)$ (Resistive load)
Max. terminal load (AC-15) ${ }^{1}$ (Inductive load @ $\cos 90.4$ ) $240 \vee \mathrm{AC}, 0.2 \mathrm{~A}$

Max. terminal load (DC-13) ${ }^{1)}$ (Inductive load) $24 \mathrm{VDC}, 0.1 \mathrm{~A}$
Relay 02 Terminal number
Max. terminal load $(A C-1)^{1}$ on $\left.4-5(\mathrm{NO})(\text { Resistive load })^{231}\right)$
Max. terminal load (AC-15) on $4-5(N O)$ (Inductive load @ $\cos \varphi 0.4$ ) $240 \mathrm{VAC}, 0.2 \mathrm{~A}$
Max. terminal load ( $\mathrm{OC}-1)^{1}$ ) on $4-5(\mathrm{NO})$ (Resistive load) $80 \mathrm{DDC}, 2 \mathrm{~A}$
Max, terminal load (DC-13) i) on 4-5 (NO) (Inductive load)
Max, terminal load (AC-1)1 on 4-6 (NC) (Resistive load) $240 \mathrm{VAC}, 2 \mathrm{~A}$
Max, terminal load (AC-15) ) on 4-6 ( NC ) (Inductive load @ $\cos \varphi$ 0.4)
Max. terminal load ( $D C-1)^{1)}$ on 4-6 (NC) (Resistive load)
Max. terminal load ( $\mathrm{DC}-13)^{1}$ ) on 4-6 (NC) (Inductive load)
Min. terminal load on $1-3(\mathrm{NC}), 1-2(\mathrm{NO}), 4-6(\mathrm{NC}), 4-5(\mathrm{NO}) \quad 24 \mathrm{VDC} 10 \mathrm{~mA}, 24 \mathrm{VAC} 20 \mathrm{~mA}$
Environment according to EN 60664-1

1) IEC $60947 t 4$ and 5
The relay contacts are galvanically isolated from the rest of the circuit by reinforced isolation (PELV).
2) Overvoltage Category II
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.


VLT® AQUA Drive Operating Instructions

### 10.2 Special Conditions

### 10.2.1 Purpose of Derating

Derating must be taken into account when using the frequency converter at low air pressure (heights), at low speeds, with long motor cables, cables with a large cross section or at high ambient temperature. The required action is described in this section.

### 10.2.2 Derating for low air pressure

The cooling capability of air is decreased at lower air pressure.

Below 1000 m altitude no derating is necessary but above 1000 m the ambient temperature ( $\mathrm{T}_{\text {AMB }}$ ) or max. output current (lout) should be derated in accordance with the shown diagram.


Illustration 10.1: Derating of output current versus altitude at $T_{\text {AMB, max }}$ for frame sizes $A, B$ and $C$. At altitudes above 2 km , please contact Danfoss regarding PELV.

An alternative is to lower the ambient temperature at high altitudes and thereby ensure $100 \%$ output current at high altitudes. As an example of how to read the graph, the situation at 2 km is elaborated. At a temperature of $45^{\circ} \mathrm{C}$ ( $\mathrm{T}_{\mathrm{AMB}, \mathrm{max}}-3.3 \mathrm{~K}$ ), $91 \%$ of the rated output current is available. At a temperature of $41.7^{\circ} \mathrm{C}, 100 \%$ of the rated output current is available.



Derating of output current versus altitude at $T_{\text {Amb, max }}$ for frame sizes $D, E$ and $F$.

### 10.2.3 Derating for running at low speed

When a motor is connected to a frequency converter, it is necessary to check that the cooling of the motor is adequate.
The level of heating depends on the load on the motor, as well as the operating speed and time.

## Constant torque applications (CT mode)

A problem may occur at low RPM values in constant torque applications. In a constant torque application samor may over-heat at low speeds due to less cooling air from the motor integral fan.
Therefore, if the motor is to be run continuously at an RPM value lower than half of the rated value, the motor must be supplied with additional air-cooling (or a motor designed for this type of operation may be used).

An alternative is to reduce the load level of the motor by choosing a larger motor. However, the design of the frequency converter puts a limit to the motor size.

Variable (Quadratic) torque applications (VT)

In VT applications such as centrifugal pumps and fans, where the torque is proportional to the square of the speed and the power is proportional to the cube of the speed, there is no need for additional cooling or de-rating of the motor.

In the graphs shown below, the typical VT curve is below the maximum torque with de-rating and maximum torque with forced cooling at all speeds.

Maximum load for a standard motor at $40^{\circ} \mathrm{C}$ driven by a frequency converter type VLT FCxxx


Legend: --- Typical torque at $V T$ load $\longrightarrow$ Max torque with forced cooling ——Max torque
Note 1) Over-syncronous speed operation will result in the available motor torque decreasing inversely proportional with the increase in speed. This must be considered during the design phase to avoid over-loading of the motor.

### 10.2.4 Automatic adaptations to ensure performance

The frequency converter constantly checks for critical levels of internal temperature, load current, high voltage on the intermediate circuit and low motor speeds. As a response to a critical level, the frequency converter can adjust the switching frequency and / or change the switching pattern in order to ensure the performance of the frequency converter. The capability to automatically reduce the output current extends the acceptable operating conditions even further.

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## TEST SHEET

## 1. PUMP STATION SP021 TEST SHEET

## DESIGN \& INSPECTION ROUTE SCHEDULE

एU

| CUSTOMER: BEGEAET |  | PROJECT OFFICER: DI |
| :---: | :---: | :---: |
|  | SWITCHBOARD NAME:SySoil | DRAWING NO: 4.96170 |

IS THIS SWITCHBOARD IDENTICAL, OR SIMILAR, TO A PREVIOUS DESIGN? YES (DELETE AS APPLICABLE) If "No" COMPLETE SWITCHBOARD dESIGN REVIEW. IF "YES" PROVIDE PREVIOUS DRAWING NO. REFERENCE.
(TICK APPLICA日LE SECTION BELOW: YES/ NO / N/A (Not Applicable)



| Inspected by: | J.CL.4YTON | of | QUM U. | DATE: | 9.1.12/09 |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Accepted by: |  | of | ................................ | DATE: | .................. |
| Release Authoriz | by: | of | ........... | DATE: | .................. |



30 Palmer Place, Murarrie Qld 4172 PO Box 3467, Tingalpa DC Qld 4173 All hours Telephone (07) $32499500^{\circ}$ Facsimile (07) 32499599
30 Palmer Place, Murarrie Qld. 4172 P.O. Box 3467,

Tingalpa DC QId. 4173

Wendy Wong
Contracts Manager
Major Projects \& Commercial Services Branch Queensland Urban Utilities
12.04.10

Dear Wendy:
Halmac Services Qld has recently supplied and installed 5 replacement switchboards for Queensland Urban Utilities.
The switchboards being :-
SP 021 Esplanade, Manly
SP 049 Kianawah Road, Wynnum
SP272 Greendale Way, Carindale
SP280 Lawson Place, Drewvale
SP281 Metroplex Place, Murarrie

Halmac Services Qld cerifies that all work carried out is compliant with AS/NZ 3000.2000 Australian / New Zealand Wiring Rules

If you have any questions please don't hesitate to contact me.


Regards,
Dave Jackson
Project Supervisor
0411691013

Halmac Services (Qld) Pty Ltd

BRISBANE CITY COUNCIL SENIOR CONIRACTS MANAGER BRISBANE WATER GPO BOX 1434 BRISBANE
INVOICE 126784
DATE 23/02/10

CUST. No. BR27
JOB No. A4214

ORDER No. . 70103-028

| LOCATION | We cerlify that any electrical installation, to the extent it is affected by the electrical work, has been tested to ensure it is electrically <br> safe and is in accordance with the requirements of the wiring rules and any other standard apply ing to the electrical installation under the |
| :--- | ---: | :--- |
| JOB | Electrical Safety Regulation, 2002. We certify that the data and communications cabling work described below complies with the |


| Description | Quantity | Price | Gst \% | Total |
| :--- | :--- | :--- | :--- | :---: |
|  |  |  |  |  |
| BRISBANE CITY COUNCIL S/BOARDS $\times 5$ | 5 |  |  |  |
| S \& I SWITCHBOARDS:- SP021 MANLY;SPO49 WYNNUM WEST |  |  |  |  |
| SP272 CARINDALE; SP280 DREWVALE; SP281 METROPLEX |  |  |  |  |

TERMS: 30 DAYS NETT



[^0]:    See following pages

[^1]:    ${ }^{2}$ ) Thermal overloads may be used instead of electronic CEP 7.
    ${ }^{3}$ ) Above 37 kW overloads may also be electronic or thermal.
    4) CET 4 may be used instead of CEF 1

[^2]:    On target for final Integration and time-critical
    behavior management:
    $\rightarrow$ Live through Traces
    $\rightarrow$ Post mortem through BackTraces

    ## On field:

    $\rightarrow$ for difficult error causing operating scenarios through IDS device monitoring services and BackTraces over the air retrieval.

[^3]:    wavecom ${ }^{\text {S }}$ confidential $\odot$
    
    

[^4]:    wovecom ${ }^{\Theta_{\text {conflidental }} \text { e }}$
    Page:40/7
    
    Mr_me_ratictutan
    5 June, 2007

[^5]:    wevecom ${ }^{\text {© }}$ confitential ©
    This document is the sole and exclashe property of Wavecom. Mot to be distribated or dhvalged without prior written agreement
    

[^6]:    1) Not for use in hazardous areas.
[^7]:    Spreahar + Schuh US Division Hoadquarters
    15910 International Plaza Dr., Houston, TX 77032
    Tel: (281) 442-9000; Fax: (800) 739-7370
    www.sprectierschuh.com
    Puthlication Mo: F-DTDentcas_107 11/07

[^8]:    (1) Performance data given in this publication is provided only as a guide for the user in determining suitability and do not constitute a performance warranty of any kind. Such

[^9]:    - Dimensions are not intended to be used for manufacturing purposes.

[^10]:    1
    Information:
    We recommend using parts from the line of VEGA mounting accessories.

[^11]:    ${ }^{2)}$ Tested according to the regulations of German Lloyd, GL directive 2.
    3) Tested according to EN 60068-2-27.

[^12]:    4) Deviating data in Ex applications: see separate safety instructions.
    5) You can find detailed information under www.vega.com.
[^13]:    2 "Data and Computer Communications" William Stallings
    © Copyright Trio DataCom Pty Ltd
    Page 68

[^14]:    (1) Opto-coupler output can be connected to DAR275V to provide Form C dry contacts, Page 35

[^15]:    *operating voltage 120 VAC with setting range in ${ }^{\circ} \mathrm{F}$ upon request

[^16]:    Table 4.1: Unpacking table

[^17]:    NB!
    Note the analog input 2, (terminal (54) format must be set to mA. (switch 202).

[^18]:    NB!
    This parameter cannot be adjusted while the motor is running.

[^19]:    VLT ${ }^{\circledR}$ AQUA Drive
    Operating Instructions

