



Client : **BRISBANE WATER**

Document Title : **ARCHERFIELD PUMP STATION UPGRADE**  
**OPERATION and MAINTENANCE MANUAL**

# **OXLEY-ARCHERFIELD PUMP STATION SB 254**

Issue : ***Book 1 of 1***

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**COMMON LOGIC Pty Ltd**  
**Specialist Electrical Contractors**
**Electrical Manual**

Subject: Archerfield Pump Station Upgrade

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## 1.0 GENERAL DESCRIPTION OF OPERATION

The motor starter has its own three phases moulded case circuit breaker. The pump is controlled via its Variable Speed Drive, which is controlled by the Remote Telemetry System. In order to operate the pumps the above mentioned circuit breaker has to be switched on. The VFD pump compartment has an extraction fan that removes heat from it.

### Manual Mode:

The Start PB is directly connected to the RTU. When The Start PB is pressed, the RTU sends a signal to energized Run/Stop Relay (RP-3) and the VSD inputs 12 and 18 are made. Thus, commanding the VSD to run at a preset fixed constant speed selected via the potentiometer connected to the VSD.

### Auto mode:

When the RTU sends a signal to energized Auto Selected Relay (AS-3), the VSD inputs 12 and 32 are made. Thus, commanding the VSD to run in auto mode (set up 2). The pump will run at a reference speed, determined by the RTU. The RTU controls the pump in relation with other RTU parameters.

### Pump Stop:

The pump will stop for one or more the following reasons:

1. – E/Stop. – If any of the E/stop PB's is pressed, the Emergency Stop Contactor will de-energize and the pump will stop from running. It sends a signal to the RTU.
2. – Stop PB. – If the Stop PB is pressed, the RTU will receive a signal and will de-energize the Run/Stop Relay. Thus the VFD will not be available to run.
3. – Fault signal. – If a VFD fault occurs, the RTU will remove the start signal to the VFD and the VFD will stop itself from running. Thus the VFD will not be available to run.
4. – RTU Parameters. – If the RTU receives any signal that involves malfunction or danger, it will remove the start signal to the VFD and the VFD will stop itself from running. Thus the VFD will not be available to run.

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**COMMON LOGIC Pty Ltd**  
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## 2.0 GENERAL DESCRIPTION OF SYSTEM (COMPONENTS)

The pump station consists of a 135kW-booster pump. It is started via a Variable Speed Drive.

### 2.1 PUMP MAIN SWITCH.

Existing 3 poles 400 Amps. Pump Switch is installed for over current protection and isolating the VFD and control circuits.

### 2.2 VARIABLE SPEED DRIVE.

Danfoss VLT6225 Variable Speed Drive has been installed in the pump drive for controlling the pump.

### 2.3 CONTACTOR.

Sprecher&Schun CA6-250EI-11-240VAC Contactor has been installed for driving the pump. It is connected with the Telemetry System.

### 2.4 CIRCUIT BREAKER.

Sprecher&Schu DINT6 1 pole 6 Amps. Circuit breaker has been installed for protecting the pump control circuit. Thermal and magnetic overload protection is provided by the circuit breaker. Circuit breaker must be manually re-set after tripping.

### 2.5 SENSOR RELAYS.

Multitrode MTRA-2-240VAC Sensor Relays have been installed for detecting the liquid level in the bearing housing, in the stator housing and in the terminal housing.

### 2.6 THERMISTOR RELAY.

Sprecher&Schu MTR-3 240VAC Thermistor Relay with remote reset has been installed for detecting bearing high temperature.

### 2.7 POTENTIOMETER.

RS Components TC162-805 2W 0-1 k $\Omega$  linear Potentiometer has been installed for selecting the constant speed that the VFD will run in manual mode. It is located in the VFD cubicle escutcheon door.

### 2.8 METERING

IME RQ48.0 240V Hours run meter has been installed in the door for monitoring the running hours of the pump.

### 2.9 INDICATING

Sprecher&Schun D5P indication light has been installed for indicating the status of the pump.

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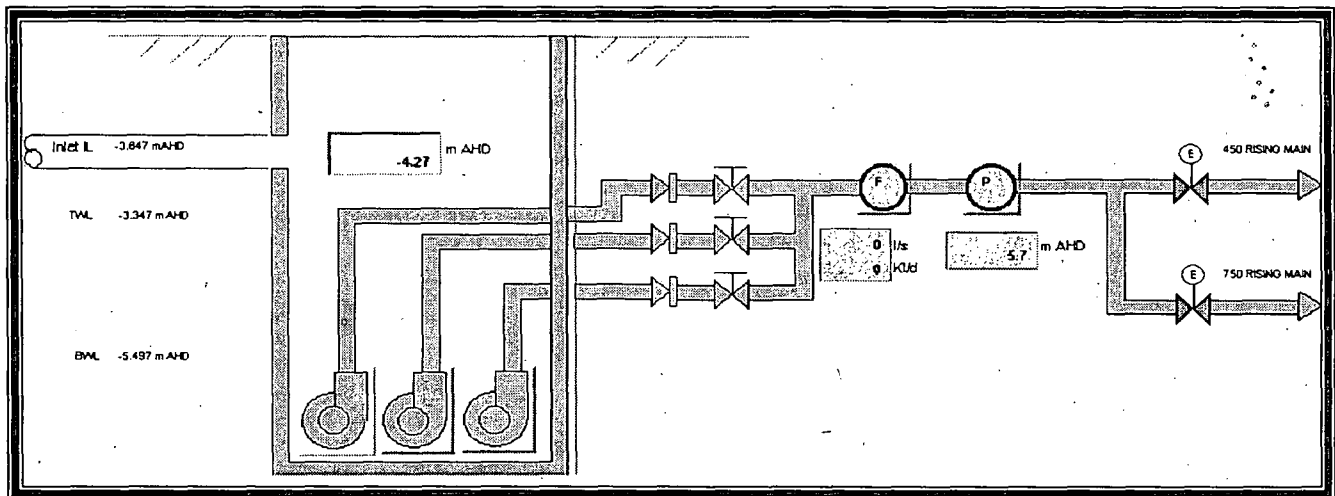






# OXLEY - ARCHERFIELD SEWAGE PUMPING STATION UPGRADE

## FUNCTIONAL SPECIFICATION



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**PROFESSIONAL SERVICES - ENGINEERING  
FUNCTIONAL SPECIFICATION**
**Oxley - Archerfield Pumping Station**
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**PROFESSIONAL SERVICES - ENGINEERING  
FUNCTIONAL SPECIFICATION**

**Oxley - Archerfield Pumping Station**

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**ATTACHMENTS:**

Archerfield Pumping Station – Pump System Curves



**PROFESSIONAL SERVICES - ENGINEERING  
FUNCTIONAL SPECIFICATION****Oxley - Archerfield Pumping Station****1 Introduction****1.1. Scope of Document**

This document outlines the functional requirements for the control, monitoring and telemetry of Archerfield submersible sewage pump station.

On the basis of this document, a new software requirement specification (SRS) will be produced which will specify the means by which the functional requirements will be translated to the programming of the pump station

**1.2. Purpose and Scope of Upgrade**

The Archerfield Pump Station and rising main is at full capacity and must be upgraded to accommodate anticipated increases in flow, in addition to the natural growth in population.

The upgrade involves the design and construction of an augmentation to the Archerfield rising main and installation of a third pump at Archerfield Pump Station. This project increases the capacity of the Archerfield/Oxley sewerage system to accommodate projected flow increases in the catchment and the ultimate plan to transfer some or all of the flows from Inala WWTP to Oxley Creek WWTP.

The work to be performed extends from the Archerfield Pump Station (SP254), located at B16 on map 199 (UBD 2000).

**1.3. Client Organisation**

This project is being undertaken by *Professional Services - Engineering* for and on behalf of Sewage Network Operations.



## PROFESSIONAL SERVICES - ENGINEERING FUNCTIONAL SPECIFICATION

## Oxley - Archerfield Pumping Station

# 2 Functional Requirements

### 2.1. Archerfield Pumping Station Overview

The Archerfield Submersible Sewage Pumping Station at present consists of two variable speed 135 kW Forrers Submersible Pump Units with provision of a future third Pump Unit.

As part of this upgrade, a third pump of similar capacity to the existing pumps will be installed. This pump will run in parallel with the existing pumps. Also, a new 750mm Rising Main will be constructed in parallel to the existing 450mm Rising Main.

The existing 450mm and the new 750mm Rising Main will be fitted with actuated valves and will be used to handle dry and wet weather flow respectively.

A new flowmeter will be supplied and installed to replace the existing faulty meter in the Pump Station.

The station pumps directly to the Oxley Creek Waste Water Treatment Plant.

The MOTOROLA RTU will perform the control and analysis of input data, on site and independent of any remote data. The RTU program and/or setpoints may be modified from a remote source and pump reset functions will be remotely available.

The control circuitry for the pumping station is shown on drawings 486/5/7-PE031 to 486/5/7-PE052 inclusive and this document should be read in conjunction with these drawings.

The Archerfield Aerodrome Pump Station after the upgrade will comprise the following:

- ◆ One duty, one lag and one standby 135 kW Raw Sewage Pumps No. 1, 2 and 3
- ◆ Wet well level transmitter type
- ◆ Surge Imminent Multitrode type level probe with the relay mounted in the RTU cabinet;
- ◆ Pump station outlet Platypus type pressure transmitter in the RTU cabinet;
- ◆ Pump station outlet flowmeter ultrasonic type;
- ◆ Variable Frequency Drives VFD1, VFD 2 (Emsby) and VFD 3 (Danfoss)
- ◆ Reflux valve limit switches;
- ◆ Emergency stop. One for each pump on the VFD compartments and starter panels;
- ◆ Pump station Local/Remote selector switch mounted in the switchboard;
- ◆ Motorola RTU mounted inside the switchboard;
- ◆ Pump motor power and current transmitters;
- ◆ Actuated valves on the 450 and 750mm Rising Main

The pump supplied has been fitted with the following protection features:

- Winding Thermistors
- Motor Bearing Thermistors
- Seal Chamber Water Sensors
- Thermal Box Water Sensors
- Motor Housing Water Sensors



**PROFESSIONAL SERVICES - ENGINEERING  
FUNCTIONAL SPECIFICATION****Oxley - Archerfield Pumping Station****2.2. Pump Station Operating States**

The Local/Remote selector switch dictates the mode of operation of the site.

This switch is located in the door of the main switchboard.

The pump station normally operates with the pump station selector switch in remote mode. This enables the pump to be started and stopped in response to the wet well level.

The Archerfield Pump Station has two operating states:

- Remote
- Local

**2.2.1. Remote State**

**REMOTE** is the usual state of operation for the Pumping Station and all pump control is performed via the RTU based on wet well level and pump station flow.

Remote control starting and stopping of the duty pump with the pumps operating on a duty/standby configuration will be based on the following:

- Wet Well level
- Time Controls
- Operator Controls
- Surge Imminent Electrodes
- Pump Station Flow

**2.2.2. Local State**

In local mode, no automatic control is performed. The RTU controls the pumps based on the manual initiation of the pumps individual start and stop pushbuttons. Once started in manual, the pumps will run until requested to stop manually. Hence the operator or electrician is fully responsible for the consequences of running the station in this mode. The speed of the pumps running in local is determined by the Variable Speed Drive speed selector potentiometer.

The local and remote facilities are identical in function.

Should the RTU be unable to provide control in either local or remote mode, the keypad on pump 3 VFD can provide local control.

**THIS KEYPAD WILL BE DISABLED TO AVOID OPERATION FROM UNTRAINED PERSONNEL.**

Electricians with proper training will be able to enable the keypad and allow the pump to be operational in an emergency situation.



## PROFESSIONAL SERVICES - ENGINEERING FUNCTIONAL SPECIFICATION

## Oxley - Archerfield Pumping Station

### 2.3. Pump Start/Stop Sequence

The pump individual control function monitors any request for the pump to start/stop. This results in the issuing of a start or a stop signal to control the pump.

The pump will start if all the following conditions are true.

- 1) The pump is available for RTU control
- 2) The pump is requested to run

The pump will stop if any of the following conditions are true:

- 1) The pump is requested to stop
- 2) The pump is no longer available for RTU control

Upon a start request being set, the pump is started using the following sequence:

- Variable Speed Drive auto relay output shall close, (Remote start only)
- Variable speed drive speed control shall be set to minimum, (Remote start only)
- Variable speed drive run pump relay output shall close,
- Variable speed drive forward relay output shall close, (Pumps 1 & 2 ONLY),
- Variable speed drive cooling fan contactor output shall close, (Pumps 1 & 2 ONLY),
- Variable speed drive speed control shall be set to the required speed depending on duty control,
- A No-Flow signal from the Magnetic Flowmeter will be inhibited via a delay timer (0- 60 seconds)
- If the No-Flow signal is not active after the time delay has expired, then the run relay remains energised.

Upon a stop request being reset, the pump is stopped using the following sequence:

- Variable speed drive auto relay output shall open (Remote start only)
- Variable speed drive forward relay output shall open (Pumps 1 & 2 ONLY)
- Time period determined by the pump forward relay open delay timer expires (Pumps 1 & 2 ONLY)
- Variable speed drive run pump relay output shall open
- Variable speed drive frequency reaches 0 Hz, the drive running light on the panel is de-energised,
- Variable speed drive speed control shall be set to zero
- Start No-flow timer (0-60 seconds),
- Timer period determined by the pump cooling fan contactor output shall open, (Pumps 1 & 2 ONLY)
- Variable speed drive cooling fan contactor output shall open, (Pumps 1 & 2 ONLY)

The emergency stop sequence for a pump will be executed in the following manner:

- Main Switchboard or VFD panel Emergency stop pushbutton is pressed
- The isolating contactor opens
- VFD run/stop relay is de-energised
- Run light on VFD panel is de-energised



## PROFESSIONAL SERVICES - ENGINEERING FUNCTIONAL SPECIFICATION

## Oxley - Archerfield Pumping Station

### 2.4. Rising Mains Valves Open/Close Sequence

Each of the rising mains will be fitted with an electrically actuated valve and at any time at least one of the rising mains will be fully open.

The Control Room operator will be able to open/close each rising main valve or these valves will be operated as part of the start/stop sequence. The valves will have the following features:

#### 2.4.1. Valve Available For Remote Control

On each Valve there is one Control State Selector Switch (LOCAL/OFF/REMOTE) and one OPEN/CLOSE switch. When the Control State Selector Switch is in the **OFF** position the valve will not move, when **LOCAL** is selected the valve can only be operated by the Open/Close switch on the actuator. The **OFF** and **LOCAL** states are hardwired to the actuator.

A Valve is available for remote control if the valve actuator Remote Control Available signal to the RTU is on.

In remote control, the valve can only be operated via the RTU.

#### 2.4.2. Valve Remote Open and Close Sequence

The remote open or close of the valve is via RTU only. There will be a minimum of 5 seconds time delay between a valve open signal and valve close signal at any time when operated via the RTU.

A valve open sequence via the RTU will execute the following steps:

- RTU valve open output on (valve starts moving),
- Set valve operating flag on,
- Confirm the valve actuator has moved off the fully closed limit,
- Confirm the valve actuator fully open position signal has been detected,
- Set the valve operating flag off,
- De-energise the valve actuator open output,
- Set valve fully open flag on

A valve close sequence via the RTU will execute the following steps:

- RTU valve close output on (valve starts moving),
- Set valve operating flag on,
- Confirm the valve actuator has moved off the fully open limit,
- Confirm the valve actuator fully closed position signal has been detected,
- Set the valve operating flag off,
- De-energise the valve actuator close output,
- Set valve fully closed flag on

On loss of power supply or a valve fault the valves shall remain in their last position.

A power loss signal will be monitored by the RTU on site and the signals monitoring the state and status of the valves will be relayed back to the Control Room.

A localised power failure to the actuated valves or a valve fault will relay an Alarm to the Control Room.

The valves can be manually opened or closed should the need arise to operate them in a manual mode.



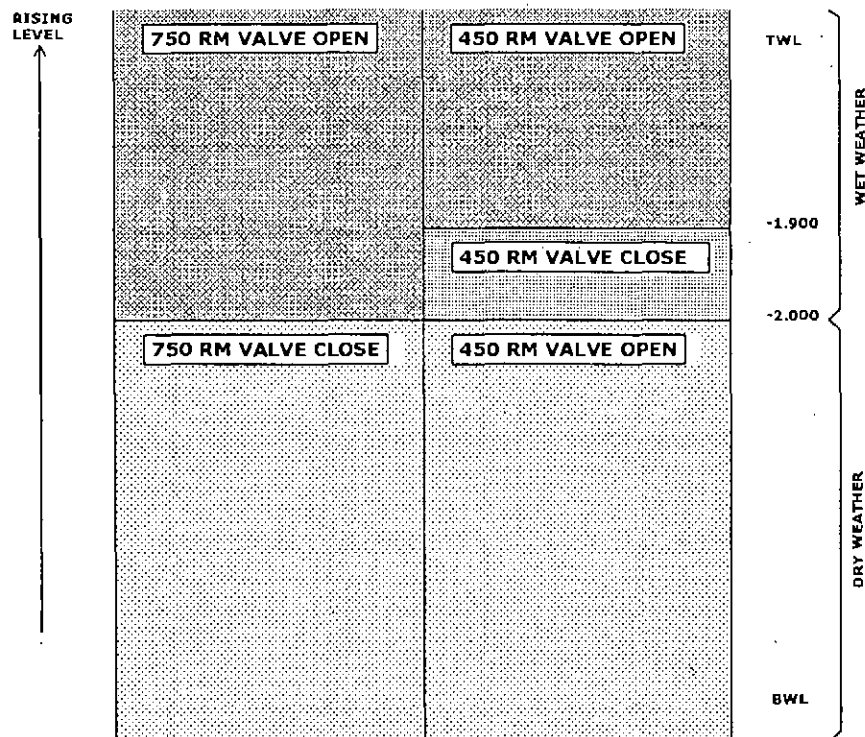
# PROFESSIONAL SERVICES - ENGINEERING FUNCTIONAL SPECIFICATION

## Oxley - Archerfield Pumping Station

The valves will operate as shown in the diagram attached.

### Rising Level

With the level rising the opening/closing of the valves will be as shown below:



With the well level increasing:

The 450mm rising main actuated valve remains open until the level reaches the -2.000 mAHd.

At this level, the 750mm rising main valve opens and the 450mm rising main valve closes.

A fully open signal must be received from the 750mm actuated valve before the 450mm actuated valve is signaled to close.

If the level rises and reaches -1.900 mAHd, the 450mm rising main valve opens.

Both rising main valves are opened.



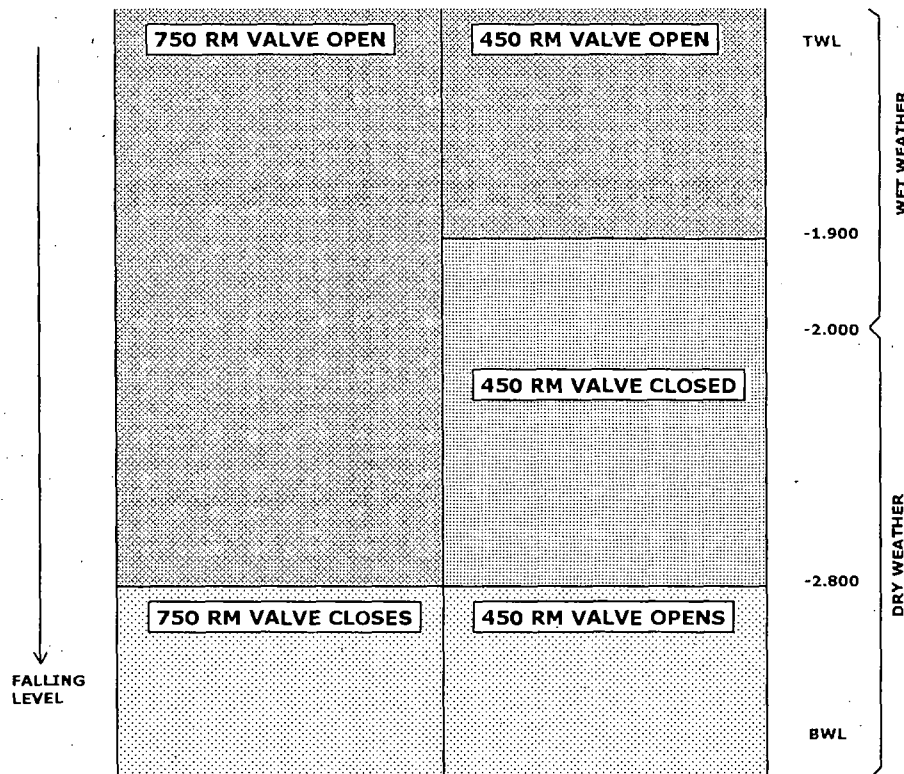
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## Oxley - Archerfield Pumping Station

Falling Level:

### Falling Level

With the level falling the opening/closing of the valves will be as shown below:



With the level decreasing:

If both the 750mm and the 450mm rising main valves are open, they shall remain open until the level reaches -2.800 mAH. The lead and the lag pumps shall run to produce the minimum required flow in this mode, which is nominally set at 540 L/s. Refer section 2.5.2 Table 1.

At this level, -2.800mAH, the 750mm rising main valve will be signaled to close. The 450mm RM valve shall remain open.

If the 450mm RM valve is closed and the 750mm RM valve is open, the 450mm RM valve shall remain closed until the level reaches -2.800 mAH. At this level the 450mm RM valve is signaled to open. Once a fully open signal is received from the actuator, the 750mm RM valve is signaled to close.

With the 750mm RM valve opened.



## PROFESSIONAL SERVICES - ENGINEERING FUNCTIONAL SPECIFICATION

## Oxley - Archerfield Pumping Station

### 2.4.3. Valve Actuator Faults

If a Valve in REMOTE mode enters a fault state, the valve will remain in the fault state until the cause has cleared and the fault is reset by pressing the pump reset push-button on the pump station panel or via the telemetry system.

A *Valve Fault* flag will latch on when any of the following faults is detected for a pre-set time.

- ❖ *Valve Actuator Failed To Open*: Either of the following conditions will latch a *DELIVERY VALVE ACTUATOR FAILED TO OPEN* fault flag:

The valve is in fully closed position and the *ACTUATOR FULLY CLOSED* signal is still on while the *VALVE OPEN RTU OUTPUT* signal has been on for 10 seconds.

The valve actuator failed to travel from fully closed position to fully open position within 10 seconds greater than the usual travel time.

- ❖ *VALVE ACTUATOR FAILED TO CLOSE*: Either one of the following conditions will latch a *VALVE ACTUATOR FAILED TO CLOSE* fault flag:

The valve is in fully open position and the actuator fully open signal is still on while the *VALVE CLOSE RTU OUTPUT* signal has been on for 10 seconds.

The valve actuator failed to travel from fully open position to fully closed position within 10 seconds greater than the usual travel time.

- ❖ *VALVE ACTUATOR LIMIT SWITCHES DISCREPANCY*: If any two of the following signals are on at the same time for 5 seconds, the respective *VALVE ACTUATOR LIMIT SWITCH DISCREPANCY* fault flag will latch: *VALVE ACTUATOR FULLY OPEN*, *VALVE ACTUATOR OPERATING* AND *VALVE ACTUATOR FULLY CLOSED*.

***The failure of either of the actuated valves is considered a major alarm requiring close monitoring and manual intervention may be required.  
The following scenarios are envisaged.***

#### **1- Dry Weather to Wet Weather      750 RM Valve Failed to Open**

Alarm signal sent to Control Room for urgent attention.  
Manual Operation of the valve may be required while the fault is corrected.  
Station keeps running with 450 RM open.

#### **2- Dry Weather to Wet Weather      450 RM Valve Failed to Close**

Alarm signal sent to Control Room for urgent attention.  
Manual Operation of the valve may be required while the fault is corrected.  
Station keeps running with 450 and 750 RM Valve Open.

#### **3- Wet Weather      450 RM Valve Failed to Open/Close**

Alarm signal sent to Control Room for urgent attention.  
Manual Operation of the valve may be required while the fault is corrected.  
Station keeps running with 450 RM Valve Open/Close

#### **4- Wet Weather to Dry Weather      750 RM Valve Failed to Close**

Alarm signal sent to Control Room for urgent attention.  
Manual Operation of the valve required while the fault is corrected.  
Station keeps running with 750 RM open.



## PROFESSIONAL SERVICES - ENGINEERING FUNCTIONAL SPECIFICATION

## Oxley - Archerfield Pumping Station

### 5- Wet Weather to Dry Weather 450 RM Valve Failed to Open

Alarm signal sent to Control Room for urgent attention.  
Manual Operation of the valve may be required while the fault is corrected.  
Station keeps running with 750 RM Valve Open and 450 RM Valve closed.

The 450 RM valve is fitted with a 375 Sluice valve. The travel time for the 375 Sluice Valve is 53 seconds.  
The 750 RM valve is fitted with a 450 Sluice valve. The travel time for the 450 Sluice Valve is 68 seconds.

### 2.5. Running Philosophy

The pump station operates on a lead/lag/standby configuration whereby one pump is designated the lead, the second pump is designated the lag, and the third pump is designated the standby. A pump lead/lag change will occur:

1. If the lead pump or lag pump becomes unavailable for RTU control,
2. When all pumps stop
3. When the lead pump operates continuously for 24 hours and the wet well is below the surcharge imminent negative deadband setpoint (SI-DB).

If the lead pump fails, then the lag pump will become the lead pump.  
If the lag pump fails, then the standby pump will become the lag pump.

The minimum flow of a single pump is 100 L/s.  
The maximum flow of a single pump is 400 L/s.

The above flow value ranges are nominal only. Exact maximum and minimum flow values will be confirmed during commissioning stage.

#### 2.5.1. Dry Weather

- ❖ During dry weather conditions, the existing 450mm rising main will be used;  
The dry weather flow range will be from 100 L/s to 320 L/s. This range is Nominal and is to be confirmed during commissioning.
- ❖ One pump effectively produces this flow range.

When the wet well reaches the **"start lead pump"** setpoint, the duty pump is started to provide a minimum flow of 100 L/s, using the flow PID loop control, see Diagram 1. It will continue to run to achieve this flow rate until the wet well level falls to the **"stop lead pump"** setpoint.

If the well level continues to rise and reaches the **"start level/flow PID control"** level, the lead pump speed will be adjusted, using a cascaded PID loop controlling both the wet well level and flow rate, see Diagram 2.

If the level on the wet well continues to increase and reaches the **"start lag pump"** level, the lag pump starts. Both pumps will run controlled by the PID loop to control the flow/level.

At the **"start lag pump"** level, the 750mm RM valve opens and the 450mm RM Valve closes and the station enters the wet weather mode.

If the level drops to the **"stop lag pump"** level, the lag pump stops while the lead pump continues to run using the flow PID control loop. Also at this level, the 750 RM closes and the 450 RM opens if it has closed. The 450 RM valve has to confirm its fully open position before the 750 RM valve is signaled to close.

If the level drops to the **"stop lead pump"**, the lead pump stops.

In the event of a failure of the flowmeter, an independent PID wet well level control loop will control the pumps. See diagram 3.

In the event of a failure of the wet well probe, all pumps will immediately stop and control of the pump station will be based on the surcharge imminent digital input alarm. When this alarm is received, two available pumps start at maximum speed and run for a predefined time.



## PROFESSIONAL SERVICES - ENGINEERING FUNCTIONAL SPECIFICATION

## Oxley - Archerfield Pumping Station

### 2.5.2.Wet Weather

- ❖ During wet weather conditions, either the 750mm rising main or both the 450mm and 750mm will be used;
- ❖ The wet weather flow range will be from 360 L/s to 750 L/s;
- ❖ This flow range is produced by two of the pumps;
- ❖ A minimum flow of 360 L/s is required through the 750mm rising main to reduce deposition.

When the level has reached the **"start lag pump"** setpoint, the 750 mm RM valve will open and the 450mm RM valve will close.

Both pumps run using the PID loop to control the level/flow.

If the level drops to the **"stop lag pump"** level, the lag pump stops while the lead pump continues to run using the flow PID control loop. Also at this level, the 750 RM closes and the 450 RM opens if it has closed. The 450 RM valve has to confirm its fully open position before the 750 RM valve is signaled to close.

If the level drops to the **"stop lead pump"**, the lead pump stops.

If the level continues rising and reaches the **"Both RM open"** setpoint, the 450mm diameter rising main is opened. By opening the 450mm rising main, a nominal maximum flow of 750 L/s should be achieved with both pumps running. Both pumps run at their maximum allowable speed.

If the level continues rising and reaches the **"Surcharge Imminent"** setpoint, both pumps continue running at their maximum allowable speed.

**Table 1**

|                         | 450mm Rising Main |                 | 750mm Rising Main |                 | 450 & 750mm Rising Main |                 |
|-------------------------|-------------------|-----------------|-------------------|-----------------|-------------------------|-----------------|
|                         | Min. Flow (L/s)   | Max. Flow (L/s) | Min. Flow (L/s)   | Max. Flow (L/s) | Min. Flow (L/s)         | Max. Flow (L/s) |
| Dry Weather (one pump)  | 100               | 320             |                   |                 |                         |                 |
| Wet Weather (two pumps) |                   |                 | 360               | 680             | 540                     | 750             |

**Note:**

**Minimum and Maximum flow rates to be confirmed during testing and commissioning.**

**Levels in well to be confirmed by Michael Doherty and provided in final Functional Specification.**

*32% high water*  
*two pump - 750 only - 572 L/s*



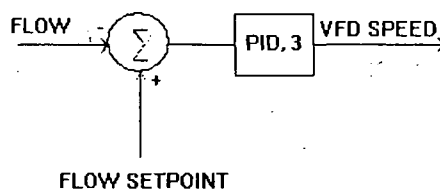
# PROFESSIONAL SERVICES - ENGINEERING FUNCTIONAL SPECIFICATION

## Oxley - Archerfield Pumping Station

The diagram below shows the PID loop control for flow, level/flow and level control.

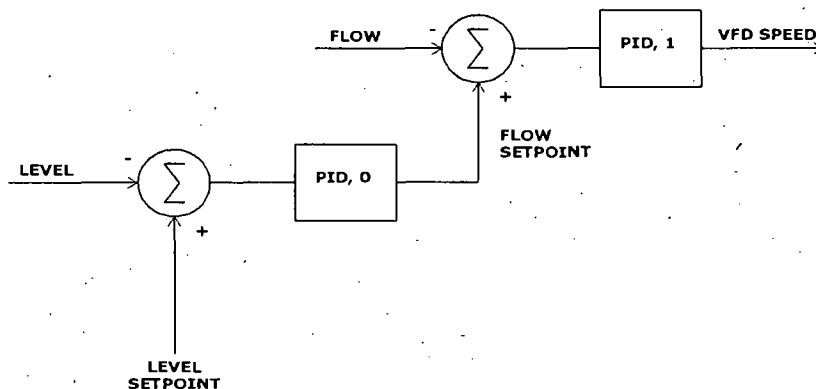
**Diagram 1**

### FLOW PID LOOP CONTROL



**Diagram 2**

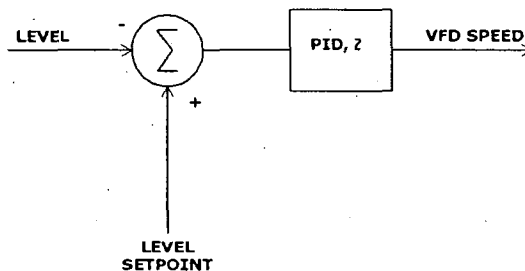
### CASCADE LEVEL/FLOW PID LOOP CONTROL



*(The control algorithm of the PID integration and output values is limited to within minimum and maximum values for flow rates and VFD speed.)*

**Diagram 3**

### LEVEL PID LOOP CONTROL



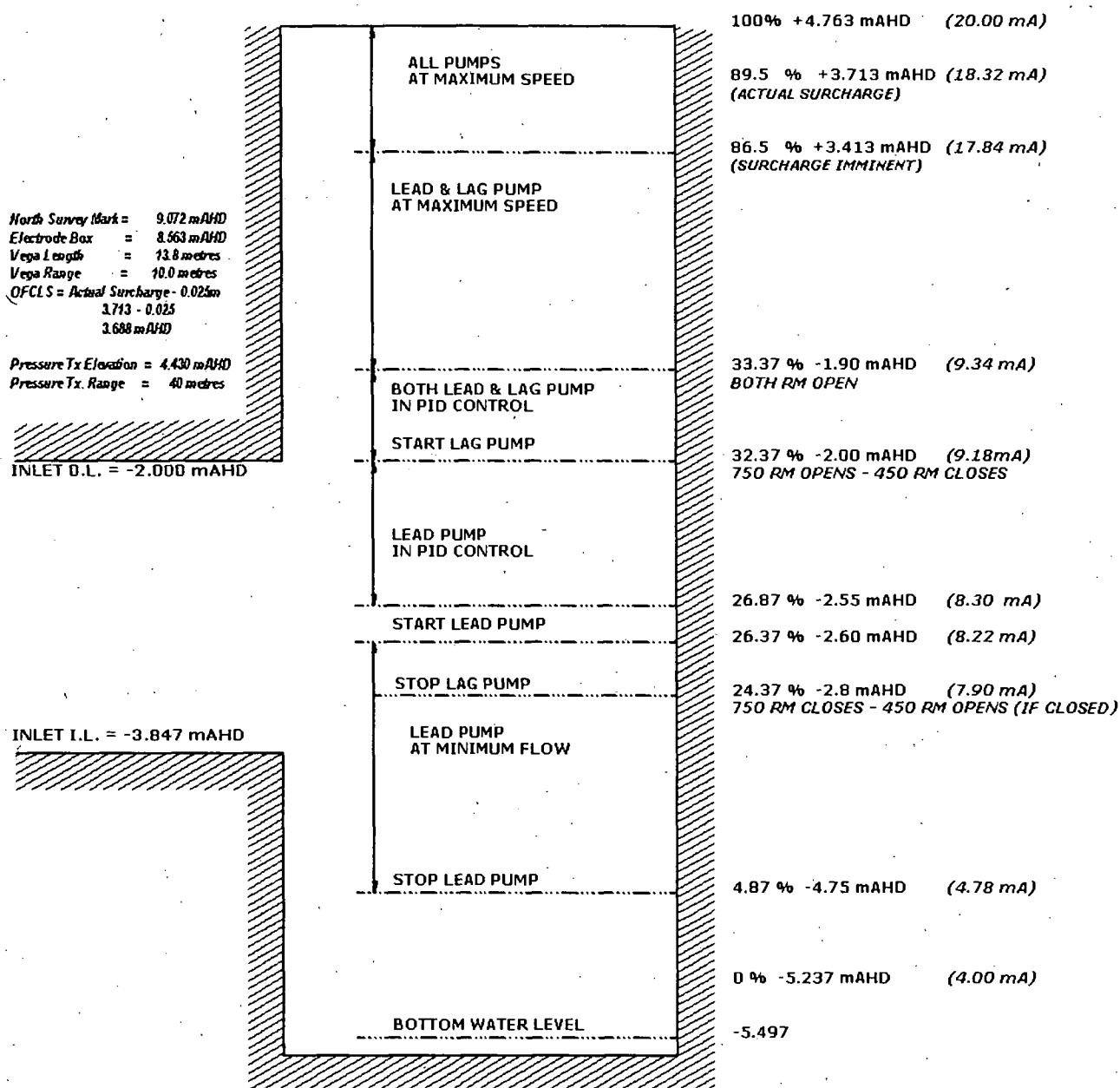


# PROFESSIONAL SERVICES - ENGINEERING FUNCTIONAL SPECIFICATION

## Oxley - Archerfield Pumping Station

### Operational Diagram

#### Wet Well Level Set points and Modes of Operation





## PROFESSIONAL SERVICES - ENGINEERING FUNCTIONAL SPECIFICATION

## Oxley - Archerfield Pumping Station

### 2.6. Pump Availability

The pump station is deemed to be available when there is power to the site, there are no failures or faults and any fault counters have not exceeded the defined limits.

An available pump is either running or can be started to run if the pump start conditions are met. If a pump becomes unavailable for RTU control it will be stopped and prevented from starting until it becomes available again as detailed below.

A pump will be available for RTU control if the following conditions are met:

Site Power Available;

- ◆ Pump power available;
- ◆ Pump Motor Protection Unit **NOT** tripped;
- ◆ Pump Motor Protection Unit **NOT** Alarm;
- ◆ No Pump Motor Protection Unit Fault Count Exceeded;
- ◆ No Pump Motor Protection Unit Trip Count Exceeded;

No Pump VFD Fault;

- ◆ No Pump Reflux fail to open;
- ◆ No Pump Emergency stop;
- ◆ No Pump Contactor failure;
- ◆ Pump VFD is ready and in Auto mode;
- ◆ No pump failure signal is on;
- ◆ No pump VFD Fault Count Exceeded;
- ◆ No pump reflux valve failed signal on;
- ◆ No pump reflux valve failed count exceeded;
- ◆ No pump Water in Oil Fault;
- ◆ No pump Blocked Fault.

If any of these conditions are not met, then the pump is unavailable for RTU control and will not be able to be started automatically or locally via the Local Start pushbutton.

A brief description of each signal is given below:

#### 2.6.1.Site Power Available

If a Phase failure signal is detected from the Phase Failure Relay that monitors power to the whole station, an alarm will be generated. This will make the pumps unavailable for RTU control.

The alarm will be monitored at Control Room. The pumps shall become available when the power has been restored.

#### 2.6.2.Pump Station Power Available

If a "Control Circuit Power Unavailable" signal is detected from either pump, an alarm will be generated.

This will make the pump where the signal was generated unavailable for RTU Control. The alarm will be monitored at Control Room. The pumps shall become available if the power has been restored and there are no other faults.

#### 2.6.3.Pump Motor Protection Unit Trip (Pumps 1 & 2 ONLY)

The pump motor protection unit configuration shall be as follows:-

- |                          |   |   |
|--------------------------|---|---|
| - Thermal overload       | = | Trip - Auto reset when $I^2t < 30\%$                  |
| - Overcurrent protection | = | Trip - Reset on pump motor protection unit panel only |
| - Current imbalance      | = | Alarm - Auto reset upon normal condition              |
| - Winding thermistor     | = | Alarm - Auto reset upon normal condition              |
| - Earth fault            | = | Trip - Reset on pump motor protection unit panel only |

The pump motor protection unit trip output relay will remain latched when operated, with the exception of the  $I^2t$  fault which will reset when the condition reduces to below 30%.



## PROFESSIONAL SERVICES - ENGINEERING FUNCTIONAL SPECIFICATION

## Oxley - Archerfield Pumping Station

The pump motor protection unit trip fault flag (PnMPUF), which inhibits the pump from being available, will be latched if power is available (site or pump) and the pump motor protection unit trip digital input (PnMPUT) fault condition becomes active. The fault flag will be unlatched when the digital input fault condition becomes inactive and any of the following resets are initiated:-

- Local reset (PnLRst) via the pump local reset pushbutton being pressed
- Remote reset (PnRRst) via an operator
- Automatic reset (PnMTAR) via an automatic reset timer having expired

The pump motor protection unit trip fault automatic reset flag (PnMTAR) is set if the pump motor protection unit trip fault flag (PnMPUF) is latched and the pump motor protection unit trip digital input (PnMPUT) fault condition becomes inactive for longer than the time period determined by the pump motor protection unit trip fault automatic reset delay timer (PnMPTT). The automatic reset flag is reset only by another pump motor protection unit trip fault. This is an indication that the last reset was automatic, not a local or remote reset.

A pump motor protection unit trip fault count exceeded flag (PnMTCE), which inhibits the pump from being available, will be latched when three faults have occurred in an eight hour sliding window. The count exceeded flag will be unlatched upon a local or remote reset being initiated.

### 2.6.4. Pump Motor Protection Unit Alarm (Pumps 1 & 2 ONLY)

The pump motor protection unit configuration shall be as follows:-

- |                          |   |   |
|--------------------------|---|---|
| - Thermal overload       | = | Trip - Auto reset when $I^2t < 30\%$                  |
| - Overcurrent protection | = | Trip - Reset on pump motor protection unit panel only |
| - Current imbalance      | = | Alarm - Auto reset upon normal condition              |
| - Winding thermistor     | = | Alarm - Auto reset upon normal condition              |
| - Earth fault            | = | Trip - Reset on pump motor protection unit panel only |

The pump motor protection unit alarm output relay is used as a remotely resettable pump trip via the RTU, because the pump motor protection unit alarms will reset when the condition returns to normal.

The pump motor protection unit alarm fault flag (PnMPAF), which inhibits the pump from being available, will be latched if power is available (site or pump) and the pump motor protection unit alarm digital input (PnMPUA) fault condition becomes active. The fault flag will be unlatched when the digital input fault condition becomes inactive and any of the following resets are initiated:-

- Local reset (PnLRst) via the pump local reset pushbutton being pressed
- Remote reset (PnRRst) via an operator
- Automatic reset (PnMAAR) via an automatic reset timer having expired

The pump motor protection unit alarm fault automatic reset flag (PnMAAR) is set if the pump motor protection unit alarm fault flag (PnMPAF) is latched and the pump motor protection unit alarm digital input (PnMPUA) fault condition becomes inactive for longer than the time period determined by the pump motor protection unit alarm fault automatic reset delay timer (PnMPAT). The automatic reset flag is reset only by another pump motor protection unit alarm fault. This is an indication that the last reset was automatic, not a local or remote reset.

A pump motor protection unit alarm fault count exceeded flag (PnMACE), which inhibits the pump from being available, will be latched when three faults have occurred in an eight hour sliding window. The count exceeded flag will be unlatched upon a local or remote reset being initiated.



## PROFESSIONAL SERVICES - ENGINEERING FUNCTIONAL SPECIFICATION

## Oxley - Archerfield Pumping Station

### 2.6.5. Pump Contactor Failure

The pump contactor fail to close fault flag, which inhibits the pump from being available, will be latched if either of the following conditions occur:-

The pump is requested to run and either of the following conditions occur for longer than the time period set by the pump contactor fail to close delay timer: -

1. Pump motor contactor digital input open condition remains active
2. Pump variable speed drive running digital input not running condition remains active

- The pump is requested to stop and either of the following conditions occur for longer than the time period set by the pump contactor fail to close delay timer:

1. Pump motor contactor digital input closed condition remains active
2. Pump variable speed drive running digital input not running condition remains active

The fault flag will be unlatched upon a local or remote reset being initiated.

### 2.6.6. Moisture in Oil

Upon detection by the RTU of pump moisture in oil fault, with power available to the station, an RTU flag will be latched on. This alarm should warn the operator of the need to check the pump for water leakage. The pump shall continue to run.

The fault flag will be unlatched when the fault condition becomes active and either of the following resets are initiated:

- Local reset
- Remote reset

### 2.6.7. No Pump VFD fault

For Pumps No. 1 & 2:

These two (2) pumps use a Fuji FVR FRN160P7-4 model of drives.

The Fuji drive has the following protection features:

- ❖ Stall Prevention
- ❖ Overcurrent
- ❖ Overvoltage
- ❖ Undervoltage
- ❖ Momentary power failure
- ❖ Inverter Overload
- ❖ Inverter overheating
- ❖ Motor Overload (Electronic thermal OL relay trip)
- ❖ Short circuit for output terminal
- ❖ Ground Fault

The pump variable speed drive fault flag which inhibits the pump from being available, will be latched if power is available (site or pump) and the pump variable speed drive digital input fault condition becomes active. The fault flag will be unlatched when the digital input becomes inactive.

Upon a fault, the pump variable speed drive will remain in the fault condition until it is reset. Therefore the pump VSD digital input fault condition would remain active. The pump variable speed drive can be reset from the pump variable speed drive reset digital output (PnRset) being pulsed for 0.5 seconds. This output will be pulsed if the fault flag is latched and any of the following resets are initiated:-

- Local reset (PnLRst) via the pump local reset pushbutton being pressed
- Remote reset (PnRRst) via an operator
- Automatic reset (PnVSAR) via an automatic reset timer having expired

The pump variable speed drive fault automatic reset flag (PnVSAR) is set if the pump variable speed drive fault flag (PnVSDF) is latched for longer than the time period determined by the pump variable speed drive fault automatic reset delay timer (PnVSDT). The automatic reset flag is reset only by another pump variable speed drive fault. This is an indication that the last reset was automatic, not a local or remote reset.



## PROFESSIONAL SERVICES - ENGINEERING FUNCTIONAL SPECIFICATION

## Oxley - Archerfield Pumping Station

A pump variable speed drive fault count exceeded flag (PnVSCE), which inhibits the pump from being available, will be latched when three faults have occurred in an eight hour sliding window. The count-exceeded flag will be unlatched upon a local or remote reset being initiated.

For Pump No. 3:

This pump uses a Danfoss VLT 6225 drive.

The VFD thermal overload protection has been inbuilt in the drive.

The fault signal from the Danfoss drive is taken from a VFD Ready signal.

A Not Ready signal from the drive means a fault has occurred in the drive.

If the thermal overload exceeds a preset limit in the VFD, then, the pump will be stopped by the VFD and the VFD Ready signal to the RTU will be off. This will make the pump unavailable for RTU control until the fault has cleared and the VFD has been reset by any of the following resets being initiated:

- Local reset via the pump local reset pushbutton being pressed
- Remote reset via an operator
- Automatic reset via an automatic reset timer having expired

### 2.6.8. Pump Emergency Stop Not Operated

There are two emergency stop push-buttons for each pump. One mounted on the VFD Panel and the other on the Main Switchboard Starter Cubicle. Upon detection of the operation of one of the pump emergency pushbuttons via the RTU digital input signal, the pump emergency stop flag will be latched on and the pump will be unavailable. If the station is in REMOTE, the flag will remain latched on until the Emergency stop pushbutton has been released and either the pump Local Reset pushbutton has been operated or the station is switched to Local. If the station is in Local, the flag will remain latched on until the Emergency stop pushbutton has been released.

### 2.6.9. No Flow

If a pump has been running and the no flow time delay timer has expired and a no flow signal is still present, the pump No-Flow flag is set. This will cause the pump to become unavailable.

As the No Flow signal is detected by the electromagnetic flowmeter located in the common line of the rising main, upon a No-Flow fault by one of the pumps shall cause the next available pump to start, if the system so requires it.

### 2.6.10. Pump Blockage

If a pump has been running for a preset time (initially set to 5 minutes) and the flow is below the Flow Block setpoint (set at 190 L/s) and the output speed is above 44 Hz, then the pump block flag is set. This will cause the pump to become unavailable.

This flag can be reset by either the local or remote reset pushbuttons.



**PROFESSIONAL SERVICES - ENGINEERING  
FUNCTIONAL SPECIFICATION****Oxley - Archerfield Pumping Station****2.7. RTU Functionality****2.7.1. RTU Alarms**

- |                                     |                |
|-------------------------------------|----------------|
| 1) I/O Mode Failure                 | (RTU internal) |
| 2) RTU Power Supply Failure         | (RTU internal) |
| 3) CPU Back up battery power low    | (RTU internal) |
| 4) RTU battery failure              | (RTU internal) |
| 5) Pump Motor Protection Unit Alarm |                |
| 6) Pump Contactor Failure           |                |
| 7) Pump Variable Speed Drive Fault  |                |
| 8) Moisture in Oil                  |                |
| 9) No Flow                          |                |
| 10) Pump Reflux Valve Failure       |                |
| 11) Pump Blockage                   |                |
| 12) Pump Emergency Stop             |                |
| 13) Flow Monitor                    |                |
| 14) Motor Power Monitor             |                |
| 15) Motor Current Monitor           |                |
| 16) Wet well level Monitor          |                |
| 17) Delivery Pressure Monitor       |                |
| 18) Surge Probable Alarm            |                |
| 19) Surge Imminent Alarm            |                |
| 20) Surge Occurring Alarm           |                |

**2.7.1.1. RTU Internal Alarms**

The RTU subprocess controls the alarms determined by the RTU internal status flags. These include the following: I/O module failure, AC Power supply failure, CPU back-up lithium battery low power, RTU battery failure.

**2.7.1.2. Pump Motor Protection Unit Trip and Alarm (Pump 1 & 2 only)**

See section 2.6.3 and 2.6.4.

**2.7.1.3. Pump Contactor Failure (Pump 1 & 2 only)**

See section 2.6.5

**2.7.1.4. Pump Variable Speed Drive Fault**

See section 2.6.7

**2.7.1.5. Moisture in Oil**

See section 2.6.6

**2.7.1.6. No Flow Alarm**

See section 2.6.9



## PROFESSIONAL SERVICES - ENGINEERING FUNCTIONAL SPECIFICATION

## Oxley - Archerfield Pumping Station

### 2.7.1.7. Pump Blockage

See section 2.6.10

### 2.7.1.8. Pump Emergency Stop

See section 2.6.8

### 2.7.1.9. Flow Alarms (Monitoring Only)

Each single and parallel pump combination have a separate upper and lower limits for each pump. The alarming for each pump shall be inhibited when the pump stops running. The high and low flow alarm flags shall not cause any control action to be initiated, eg. Stopping a pump already running. There are seven different setpoints for each high and low flow alarm.

|       |                             |
|-------|-----------------------------|
| N     | Pump Combination            |
| 1     | Pump 1 is running alone     |
| 2     | Pump 2 is running alone     |
| 3     | Pump 3 is running alone     |
| 1 2   | Both Pump 1 & 2 are running |
| 2 3   | Both Pump 2 & 3 are running |
| 3 1   | Both Pump 3 & 1 are running |
| 1 2 3 | Pumps 1 2 & 3 are running   |

The pump flow high alarm flag (FlwHAF) will be set if after a time delay expires, set by the pump flow delay timer (PnDFDT) allowing the motor to reach full speed, the pump flow is valid and above the pump flow high setpoint (PnDFHS). The alarm flag will be reset when any of the following conditions occur:-

- Pump stops
- Pump flow becomes invalid
- Pump flow falls below the pump flow high deadband setpoint (PnDFHD)

The station flow high alarm flag (FlwHAN) will be set if any of the combination flow high alarms are set/

The pump flow high deadband setpoint (PnDFHD) will be calculated using the following calculation algorithm:-

|        |   |  |
|--------|---|--|
| PnDFHD | = | $PnDFHS - ((Flw20m - Flw4mA) \times AlmHys / 100)$ |
| PnDFHS | = | Pump flow high setpoint                            |
| Flw20m | = | Pump flow analog value at 20mA                     |
| Flw4mA | = | Pump flow analog value at 4mA                      |
| AlmHys | = | Alarm hysteresis variable                          |

The pump flow low alarm flag (FlwLAF) will be set if after a time delay expires, set by the pump flow delay timer (PnDFDT) allowing the motor to reach full speed, the pump flow is valid and below the pump flow low setpoint (PnDFLS). The alarm flag will be reset when any of the following conditions occur:-

- Pump stops
- Pump flow becomes invalid
- Pump flow raises above the pump flow low deadband setpoint (PnDFLD)

The pump flow low deadband setpoint (PnDFLD) will be calculated using the following calculation algorithm:-

|        |   |  |
|--------|---|--|
| PnDFLD | = | $PnDFLS + ((Flw20m - Flw4mA) \times AlmHys / 100)$ |
| PnDFLS | = | Pump flow low setpoint                             |
| Flw20m | = | Pump flow analog value at 20mA                     |
| Flw4mA | = | Pump flow analog value at 4mA                      |
| AlmHys | = | Alarm hysteresis variable                          |

The station flow low alarm flag (FlwLAF) will be set if any of the combination flow low alarms are set.



## PROFESSIONAL SERVICES - ENGINEERING FUNCTIONAL SPECIFICATION

## Oxley - Archerfield Pumping Station

### 2.7.1.10. Motor Power Alarms (Monitoring Only)

There are twelve different set points for each pump. (See below)

| n   | Pump Combination                     |
|-----|--------------------------------------|
| 1   | Pump 1 is running alone              |
| 12  | Pump 1 is running with pump 2        |
| 13  | Pump 1 is running with pump 3        |
| 123 | Pump 1 is running with pumps 2 and 3 |
| 2   | Pump 2 is running alone              |
| 21  | Pump 2 is running with pump 1        |
| 23  | Pump 2 is running with pump 3        |
| 231 | Pump 2 is running with pumps 3 and 1 |
| 3   | Pump 3 is running alone              |
| 31  | Pump 3 is running with pump 1        |
| 32  | Pump 3 is running with pump 2        |
| 321 | Pump 3 is running with pump 2 and 1  |

#### Motor Power High Alarm

Each pump motor power high alarm flag (PnPHAn) will be set if after a time delay expires, set by the pump motor power delay timer (PnMPDT) (allowing the motor to reach full speed), the pump motor power is valid and above any of the pump combination motor power high setpoint (nkWHS).

The alarm flag will be reset when any of the following conditions occur:

- the pump stops or
- the pump motor power becomes invalid or
- the pump motor power falls below the pump motor power high deadband setpoint (nkHDB)

The pump motor power high deadband setpoint (nkHDB) will be calculated using the following calculation algorithm:-

|        |   |   |
|--------|---|---|
| nkHDB  | = | $\text{nkWHS} - ((\text{nkW20m} - \text{nkW4mA}) \times \text{AlmHys} / 100)$ |
| nkWHS  | = | Pump motor power high setpoint  |
| nkW20m | = | Pump motor power analog value at 20mA   |
| nkW4mA | = | Pump motor power analog value at 4mA  |
| AlmHys | = | Alarm hysteresis variable   |

#### Motor Power Low Alarm

Each pump motor power low alarm flag (PnPLAF) will be set if after a time delay expires, set by the pump motor power delay timer (PnMPDT) (allowing the motor to reach full speed), the pump motor power is valid and below any of the pump combination motor power low setpoints (nkWLS).

The alarm flag will be reset when any of the following conditions occur:-

- the pump stops or
- the pump motor power becomes invalid
- the pump motor power rises above the pump motor power low deadband setpoint (nkLDB)

The pump motor power low deadband setpoint (nkLDB) will be calculated using the following calculation algorithm:-

|        |   |  |
|--------|---|--|
| nkLDB  | = | $\text{PnkWHL} + ((\text{nkW20m} - \text{nkW4mA}) \times \text{AlmHys} / 100)$ |
| nkWLS  | = | Pump motor power high setpoint   |
| nkW20m | = | Pump motor power analog value at 20mA  |
| nkW4mA | = | Pump motor power analog value at 4mA   |
| AlmHys | = | Alarm hysteresis variable  |



## PROFESSIONAL SERVICES - ENGINEERING FUNCTIONAL SPECIFICATION

## Oxley - Archerfield Pumping Station

### 2.7.1.11. Motor Current Alarms (Monitoring Only)

The pump motor current high alarm flag (PnCHAF) will be set if after a time delay expires, set by the pump motor current delay timer (PnMCDT) allowing the motor to reach full speed, the pump motor current is valid and above the pump motor current high setpoint (PnCHSP). The alarm flag will be reset when any of the following conditions occur:-

- Pump stops
- Pump motor current becomes invalid
- Pump motor current falls below the pump motor current high deadband setpoint (PnCHDB)

The pump motor current high deadband setpoint (PnCHDB) will be calculated using the following calculation algorithm:-

$$\begin{aligned} \text{PnCHDB} &= \text{PnCHSP} - ((\text{nAm20m} - \text{nAm4mA}) \times \text{AlmHys} / 100) \\ \text{PnCHSP} &= \text{Pump motor current high setpoint} \\ \text{nAm20m} &= \text{Pump motor current analog value at 20mA} \\ \text{nAm4mA} &= \text{Pump motor current analog value at 4mA} \\ \text{AlmHys} &= \text{Alarm hysteresis variable} \end{aligned}$$

The pump motor current low alarm flag (PnCLAF) will be set if after a time delay expires, set by the pump motor current delay timer (PnMCDT) allowing the motor to reach full speed, the pump motor current is valid and below the pump motor current low setpoint (PnCLSP). The alarm flag will be reset when any of the following conditions occur:-

- Pump stops
- Pump motor current becomes invalid
- Pump motor current raises above the pump motor current low deadband setpoint (PnCLDB)

The pump motor current low deadband setpoint (PnCLDB) will be calculated using the following calculation algorithm:-

$$\begin{aligned} \text{PnCLDB} &= \text{PnCLSP} + ((\text{nAm20m} - \text{nAm4mA}) \times \text{AlmHys} / 100) \\ \text{PnCLSP} &= \text{Pump motor current low setpoint} \\ \text{nAm20m} &= \text{Pump motor current analog value at 20mA} \\ \text{nAm4mA} &= \text{Pump motor current analog value at 4mA} \\ \text{AlmHys} &= \text{Alarm hysteresis variable} \end{aligned}$$

### 2.7.1.12. Wet Well Level Alarms (Monitoring Only)

The wet well level high alarm flag (WWLHAF) will be latched if site power is available, the site is not in wet well level calibration mode (CalPro), the wet well level calibration alarm inhibit timer (CalAIT) has expired and the wet well level is valid and above the wet well level high setpoint (WWLHSP). The alarm flag will be unlatched if the wet well level is valid and falls below the wet well level high deadband setpoint (WWLHDB).

The wet well level high deadband setpoint (WWLHDB) will be calculated using the following calculation algorithm:-

$$\begin{aligned} \text{WWLHDB} &= \text{WWLHSP} - ((\text{WWL20m} - \text{WWL4mA}) \times \text{AlmHys} / 100) \\ \text{WWLHSP} &= \text{Wet well level high setpoint} \\ \text{WWL20m} &= \text{Wet well level analog value at 20mA} \\ \text{WWL4mA} &= \text{Wet well level analog value at 4mA} \\ \text{AlmHys} &= \text{Alarm hysteresis variable} \end{aligned}$$

The wet well level low alarm flag (WWLLAF) will be latched if site power is available and the wet well level is valid and below the wet well level low setpoint (WWLLSP). The alarm flag will be unlatched if the wet well level is valid and raises above the wet well level low deadband setpoint (WWLLDB).



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## Oxley - Archerfield Pumping Station

The wet well level low deadband setpoint (WWLLDB) will be calculated using the following calculation algorithm:-

|        |   |  |
|--------|---|--|
| WWLLDB | = | $WWLLSP + ((WWL20m - WWL4mA) \times AlmHys / 100)$ |
| WWLLSP | = | Wet well level low setpoint                        |
| WWL20m | = | Wet well level analog value at 20mA                |
| WWL4mA | = | Wet well level analog value at 4mA                 |
| AlmHys | = | Alarm hysteresis variable                          |

### 2.7.1.13. Delivery Pressure Alarm (Monitoring Only)

There are seven different set points for each high and low alarm:

| n   | Pump Combination                 |
|-----|----------------------------------|
| 1   | Pump 1 is running alone          |
| 2   | Pump 2 is running alone          |
| 3   | Pump 3 is running alone          |
| 12  | Pump 1 is running with pump 2    |
| 23  | Pump 2 is running with pump 3    |
| 31  | Pump 3 is running with pump 1    |
| 123 | All pumps 1, 2 and 3 are running |

#### Pressure High Alarm

The pump pressure high alarm (PnDPn) will be set if after a time delay expires, set by the pump delivery pressure delay timer (PnDPDT) which allows the motor to reach full speed, the pump delivery pressure is valid and above the pump delivery pressure high setpoint (PnDPHS). The alarm flag will be reset when any of the following conditions occur:-

- Pump stops
- Pump delivery pressure becomes invalid
- Pump delivery pressure falls below the pump delivery pressure high deadband setpoint (PnDPHD)

The pump delivery pressure high deadband setpoint (PnDPHD) will be calculated using the following calculation algorithm:-

|        |   |  |
|--------|---|--|
| PnDPHD | = | $PnDPHS - ((DPr20m - DPr4mA) \times AlmHys / 100)$ |
| PnDPHS | = | Pump delivery pressure high setpoint               |
| DPr20m | = | Pump delivery pressure analog value at 20mA        |
| DPr4mA | = | Pump delivery pressure analog value at 4mA         |
| AlmHys | = | Alarm hysteresis variable                          |

The station delivery pressure high alarm (DPHAF) is set if any of the combination delivery pressure high alarms are set.

#### Pressure Low Alarm

The pump pressure low alarm (PnDPn) will be set if after a time delay expires, set by the pump delivery pressure delay timer (PnDPDT) allowing the motor to reach full speed, the pump delivery pressure is valid and below the pump delivery pressure low setpoint (PnDPHS). The alarm flag will be reset when any of the following conditions occur:-

- Pump stops
- Pump delivery pressure becomes invalid
- Pump delivery pressure raises above the pump delivery pressure low deadband setpoint (PnDPLD)

The pump delivery pressure low deadband setpoint (PnDPLD) will be calculated using the following calculation algorithm:-

|        |   |  |
|--------|---|--|
| PnDPLD | = | $PnDPLS + ((DPr20m - DPr4mA) \times AlmHys / 100)$ |
| PnDPLS | = | Pump delivery pressure low setpoint                |
| DPr20m | = | Pump delivery pressure analog value at 20mA        |
| DPr4mA | = | Pump delivery pressure analog value at 4mA         |
| AlmHys | = | Alarm hysteresis variable                          |

The station delivery pressure low alarm (DPLAF) is set if any of the combination delivery pressure low alarms are set.



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### 2.7.1.14. Surge Alarms

#### Surcharge Occurring Alarm

The surcharge occurring alarm flag (SOAF) will be latched if it is not the first RTU scan and the wet well level is valid and rises above the overflow control level setpoint (OFCLSP). The alarm flag will be unlatched after a minimum time period determined by the surcharge occurring alarm timer (SOAT) and the wet well level is valid and falls below the overflow control level deadband setpoint (OFCLDB).

#### Overflow Control Level Deadband Setpoint

The overflow control level deadband setpoint (OFCLDB) will be calculated using the following calculation algorithm:-

$$\begin{aligned} \text{OFCLDB} &= \text{OFCLSP} - (\text{OFCLSP} \times \text{AlmHys} / 100) \\ \text{OFCLSP} &= \text{Overflow control level setpoint} \\ \text{AlmHys} &= \text{Alarm hysteresis variable} \end{aligned}$$

#### Surcharge Occurring Duration

The surcharge occurring duration counter in seconds (SODTS) is updated in two second increments while the wet well level is valid and above the overflow control level setpoint (OFCLSP). When this counter is equal to or greater than 60 then it is reset and the surcharge occurring duration counter in minutes (SODTM) is incremented. The surcharge occurring duration counters are not reset until the wet well level is valid and below the stop duty pump level setpoint (StpDty). The total surcharge occurring duration counter in seconds (SODTT) will be calculated using the following calculation algorithm:-

$$\begin{aligned} \text{SODTT} &= (\text{SODTM} \times 60) + \text{SODTS} \\ \text{SODTM} &= \text{Surcharge occurring duration time in minutes} \\ \text{SODTS} &= \text{Surcharge occurring duration time in seconds} \end{aligned}$$

#### Surcharge Imminent Alarm

The surcharge imminent alarm flag (SIAP) will be latched if the site is not in wet well level calibration mode (CalPro) and the surcharge imminent digital input (Surchg) alarm condition becomes active. The alarm flag will be unlatched after a minimum time period determined by the surcharge imminent alarm timer (SIAT) and digital input alarm condition becomes inactive.

#### Surcharge Probable Alarm

The predicted time until surcharge less than 30 minutes alarm flag (SPT<30) will be set if the site is not in wet well level calibration mode (CalPro), the wet well level calibration alarm inhibit timer (CalAIT) has expired, the wet well level is valid and above the pump start positive deadband setpoint (PSr+DB) and the predicted time in minutes until surcharge (SrChPT) is above zero and below 30. The alarm flag will be reset when any of the following conditions occur:-

- Wet well level invalid (WWLIF)
- NOT 0 < predicted time in minutes until surcharge (SrChPT) < 30
- Wet well level below start duty pump level setpoint (StrDty)

#### Pump Start Positive Deadband Setpoint

The pump start positive deadband setpoint (PSr+DB) will be calculated using the following calculation algorithm:-

$$\begin{aligned} \text{PSr+DB} &= \text{StrDty} + ((\text{WWL20m} - \text{WWL4mA}) \times \text{AlmHys} / 100) \\ \text{StrDty} &= \text{Start duty pump level setpoint} \\ \text{WWL20m} &= \text{Wet well level analog value at 20mA} \\ \text{WWL4mA} &= \text{Wet well level analog value at 4mA} \\ \text{AlmHys} &= \text{Alarm hysteresis variable} \end{aligned}$$



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### Predicted Time In Minutes Until Surge

The predicted time in minutes until surcharge (SrChPT) is updated if the flow is valid and the wet well level is valid and above the pump start positive deadband setpoint and will be calculated using the following calculation algorithm:-

|        |   |  |
|--------|---|--|
| SrchPT | = | $(SuVoSP - VolNow) / VolROC$   |
| SuVoSP | = | Surcharge volume setpoint  |
| VolNow | = | Current volume (Calculated using interpolation of level vs volume lookup tables) |
| VolROC | = | Volume rate of change (Calculated using 5, minute volume change rolling average) |

A divide by zero error is avoided by substituting the value with a small number (Small#) if the volume rate of change (VolROC) is calculated to be zero.

The predicted time in minutes until surcharge (SrChPT) is forced to zero if the wet well level is valid and below the start duty pump level setpoint or if the predicted time in minutes until surcharge is less than zero.

### Surcharge Imminent Clamp

The surcharge imminent clamp flag (SurchC) is set if the surcharge imminent digital input (Surchg) alarm condition becomes active. The alarm flag will be reset after a minimum time period determined by the surcharge imminent pumping timer (SIPmpT) and the digital input alarm condition becomes inactive.

### Surcharge Event History

The surcharge event history flag, which forces the surcharge history table to record current data, will be set for one scan cycle if it is not the first RTU scan and any of the following conditions occur:-

- The wet well level is valid and below the overflow control level deadband (OFCLDB)
- Surcharge imminent clamp flag (SurchC) changes state
- Surcharge occurring

Jump to subprocess DatTim to obtain RTU date and time when recording surcharge event history data.

The last 250 surcharge events are recorded in the surcharge event history table which consists of the following data:-

- RTU date and time
- Surcharge volume
- Wet well level
- Surcharge imminent clamp flag status
- Surcharge imminent digital input status
- Surcharge occurring alarm flag status

The surcharge flow and volume is calculated if the wet well level is valid and above the overflow control level deadband setpoint.

### Surcharge Flow

The surcharge flow rate is calculated using the wet well level as a reference and interpolation of a level vs volume vs surcharge flow lookup table. The surcharge flow rate (SFwNow) will be calculated using the following calculation algorithm:-

|        |   |  |
|--------|---|--|
| Y      | = | $MX + C$   |
| SfwNow | = | $(M \times WWLEGU) + C$  |
| M      | = | $(F2 - F1) / (L2 - L1)$  |
| WWLEGU | = | Wet well level in engineering units  |
| C      | = | $F1 - (M \times L1)$   |
| F2     | = | Surcharge flow constant at the next highest wet well level constant table record |
| F1     | = | Surcharge flow constant at the next lowest wet well level constant table record  |
| L2     | = | Next highest wet well level constant table record                                |
| L1     | = | Next lowest wet well level constant table record                                 |



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### Surcharge Volume

The total surcharge volume (SurVol), which is reset on every surcharge occurring alarm (SOAF), is updated every two seconds by integrating the surcharge flow using the following calculation algorithm:-

$$\begin{aligned}\text{SurVol} &= \text{SurVol} + (\text{SFwNow} \times 2) \\ \text{SFwNow} &= \text{Current surcharge flow}\end{aligned}$$

### 2.7.1.15. Pump Station Status and Alarms

To simplify communications, the pump station alarms subprocess moves the physical I/O into the internal flag tables. These include the following:-

- Pump power available flag (PnPwrF) (Only set if site power is available and pump power is available)
- Pump running flag (PnRunF)
- Pump station power fault flag (SPFF)
- Remote mode flag (RemotF)

### 2.7.2. Control

#### 2.7.2.1. Control Variables

The pump bearing temperature reset relay digital output (BTRRly) is set for one scan cycle upon power restoration.

The pump start negative deadband setpoint (PSr-DB) will be calculated using the following calculation algorithm:-

$$\begin{aligned}\text{PSr-DB} &= \text{StrDty} - ((\text{WWL20m} - \text{WWL4mA}) \times \text{AlmHys} / 100) \\ \text{StrDty} &= \text{Start duty pump level setpoint} \\ \text{WWL20m} &= \text{Wet well level analog value at 20mA} \\ \text{WWL4mA} &= \text{Wet well level analog value at 4mA} \\ \text{AlmHys} &= \text{Alarm hysteresis variable}\end{aligned}$$

The pump stop deadband setpoint (PStpDB) will be calculated using the following calculation algorithm:-

$$\begin{aligned}\text{PStpDB} &= \text{StpDty} + ((\text{WWL20m} - \text{WWL4mA}) \times \text{AlmHys} / 100) \\ \text{StpDty} &= \text{Stop duty pump level setpoint} \\ \text{WWL20m} &= \text{Wet well level analog value at 20mA} \\ \text{WWL4mA} &= \text{Wet well level analog value at 4mA} \\ \text{AlmHys} &= \text{Alarm hysteresis variable}\end{aligned}$$

The wet well level below PID control level timer (PIDTM) will be enabled when the wet well level is valid and below the start PID control level setpoint (StrPID).

The surcharge imminent pumping timer (SIPmpT) will be enabled if it is not the first RTU scan and the surcharge imminent digital input (Surchg) alarm condition becomes inactive.

The surcharge imminent clamp flag (SurchC) is set if the surcharge imminent digital input (Surchg) alarm condition becomes active. The alarm flag will be reset after a minimum time period determined by the surcharge imminent pumping timer (SIPmpT) and the digital input alarm condition becomes inactive.

The surcharge imminent positive deadband setpoint (SI+DB) will be calculated using the following calculation algorithm:-

$$\begin{aligned}\text{SI+DB} &= \text{SulmSP} + 0.1 \\ \text{SulmSP} &= \text{Surcharge imminent level setpoint}\end{aligned}$$

The surcharge imminent negative deadband setpoint (SI-DB) will be calculated using the following calculation algorithm:-

$$\begin{aligned}\text{SI-DB} &= \text{SulmSP} - 0.1 \\ \text{SulmSP} &= \text{Surcharge imminent level setpoint}\end{aligned}$$



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### 2.7.2.2. RTU Battery Duty Cycle

The RTU battery is periodically cycled to prevent dendrite accumulation and therefore shorter life of the battery. This is accomplished by setting a digital output from the RTU which opens a relay supplying 240V AC power to the RTU between 06:30 and 07:00 on a weekday. This will not occur until after a minimum time period, set by battery delay timer (BatyT), after power has been restored or after a minimum time period, set by the initialise delay timer (InitT), after the code has been downloaded.

The RTU battery duty cycle digital output (BatCyc) is set and the RTU battery fault flag (BatFlt) is unlatched when the first power up flag (1stPwr) is reset and the time is between 06:30 and 07:00 on a weekday.

The first power up flag (1stPwr) will be set upon restoration of power. The flag is reset after a minimum time period determined by the battery delay timer (BatyT).

An RTU battery failure flag (BatFlt) will be latched if the first initialise flag (1stIni) is reset and the time is between 06:30 and 07:00 on a weekday and the RTU battery duty cycle digital output (BatCyc) is reset. This indicates the RTU battery failed to keep the RTU battery duty cycle digital output (BatCyc) set when the 240V AC power supply was interrupted.

### 2.7.2.3. Pump Start/Stop Time Control

There are operator adjustable pump start and stop time controls sent from the IDTS in the format of HHMM which are calculated to produce integers in minutes past midnight. These integers are used for starting a pump at certain times and having time periods that stop the pump from running.

#### Pump Timed Start

The pump timed start flag (PTStrt) will be set for one scan cycle if the wet well level is valid and above the pump stop level deadband setpoint (PStpDB), the pump timed stop flag (PTStop) is reset, the pump start delay timer (PStrtT) has expired and the current time equals a timed start pump integer (StrtMn).

#### Pump Timed Stop

The pump timed stop flag (PTStop) is latched if the pump stop delay timer (PStopT) has expired, the surcharge imminent clamp flag (SurchC) is reset and the current time is between the timed stop pump begin integer (StpBMn) and the timed stop pump end integer (StpEMn). The flag is unlatched if either of the following conditions occur:-

- Surcharge imminent clamp flag (SurchC) is set
- Current time is not between the timed stop pump begin integer (StpBMn) and timed stop pump end integer (StpEMn)

### 2.7.2.4. Site Attention Indicator

The operator will be able to initiate and cancel the site attention indicator. When a site attention indication is generated, officers on site will be required to acknowledge the attention indicator and then contact the operator.

The site attention indicator digital output (AttInd) is latched by an operator generating a site attention indicator flag (AttSet). The output is unlatched if any of the following conditions occur:-

- Site attention indicator (AttSet) becoming reset by the operator
- Site attention indicator reset pushbutton digital input (AttRPB) being pressed
- Site attention alarm timer (AttTmr) expires

The site attention alarm timer (AttTmr) is enabled by the site attention alarm indicator digital output (AttInd).

The site attention alarm flag (AttTmF) is latched if the site attention alarm timer expires. The alarm is unlatched when the next site attention indicator output is set.



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The local indication lamp digital output (PnLocl) displays the status of the pump based on the following:-

- Lamp off = Pump stopped but available
- Lamp on = Pump running
- Lamp flashing = Pump fault



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### 2.7.3.RTU Calculations

1. Pump Operations
2. Pump Minutes Run
3. Total Volume Pumped
4. Total Inflow
5. Site Kilowatt Hours
6. Wet Well Level Rate of Change
7. Plant Utilisation Index
8. Plant Availability Index
9. Hydraulic Power Consumption
10. Electrical Power Consumption
11. Total Efficiency

A brief description of the above items are given below:

#### 2.7.3.1. Pumps Operations

The daily pump operations since midnight is incremented when the pump starts.

#### 2.7.3.2. Pump Minutes Run

The pump seconds run time (PnSecs) is updated in two second increments while the pump is running. The value is used to calculate the pump minutes run time (PnMins) and the pump hours run time (PnHrs). The operator can generate a run time reset (PnOpHR) which should be used when the pump is replaced.

#### 2.7.3.3. Total Volume Pumped

The total volume pumped in kilolitres since the start of the year is updated in two seconds increment calculated by integrating the inflow, if the wet well level and flow are valid, using the following calculation algorithm:

$$\text{TotVol} = ((\text{FlwEGU} \times 2) / 1000) + \text{TotVol}$$

FlwEGU = Flow in Engineering Units

#### 2.7.3.4. Total Inflow

The total inflow in kilolitres since the start of the year (TotInf) is updated in two second increments calculated by integrating the inflow, if the wet well level and flow are valid, using the following calculation algorithm:-

$$\begin{aligned} \text{TotInf} &= ((\text{Inflow} \times 2) / 1000) + \text{TotInf} \\ \text{Inflow} &= \text{Inflow in engineering units} \end{aligned}$$

The inflow rate (Inflow) is the change in volume plus the volume pumped out of the well and is updated in two second increments calculated, if the wet well level and flow are valid, using the following calculation algorithm:-

$$\begin{aligned} \text{Inflow} &= ((\text{VolNow} - \text{VolOld}) + (\text{FlwEGU} \times 2)) / 2 \\ \text{VolNow} &= \text{Current wet well level volume} \\ \text{VolOld} &= \text{Previous (two seconds ago) wet well level volume} \\ \text{FlwEGU} &= \text{Flow in engineering units} \end{aligned}$$

The wet well volume (VolNow) is calculated, if the wet well level is valid, using the wet well level as a



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reference and interpolation of a level vs volume vs surcharge flow lookup table and using the following calculation algorithm:-

|        |   |  |
|--------|---|--|
| Y      | = | MX + C   |
| VolNow | = | (M x WWLEGU) + C   |
| M      | = | (V2 - V1) / (L2 - L1)  |
| WWLEGU | = | Wet well level in engineering units                                      |
| C      | = | V1 - (M x L1)  |
| V2     | = | Volume constant at the next highest wet well level constant table record |
| V1     | = | Volume constant at the next lowest wet well level constant table record  |
| L2     | = | Next highest wet well level constant table record                        |
| L1     | = | Next lowest wet well level constant table record                         |

The wet well volume rate of change per minute (VolROC) is the result of the rolling average of the last five changes in volume per minute updated in one minute increments, if the wet well level is valid, and is calculated using the following calculation algorithm:-

|        |   |  |
|--------|---|--|
| VolROC | = | (VolDif,4 + VolDif,3 + VolDif,2 + VolDif,1 + VolDif,0) / 5 |
| VolDif | = | Wet well level volume difference                           |

### 2.7.3.5. Site Kilowatt Hours

The site kilowatt hours is incremented on each pulse of the kW hour meter.

### 2.7.3.6. Wet Well Level Rate Of Change

The wet well level rate of change per minute (WWLROC) is updated in one minute increments, if the wet well level rate of change timer (WLROCT) has expired, and is calculated using the following calculation algorithm:-

|        |   |   |
|--------|---|---|
| WWLROC | = | WWLEGU - WREguP   |
| WWLEGU | = | Current wet well level in engineering units                   |
| WREguP | = | Previous (one minute ago) wet well level in engineering units |

The wet well level rate of change timer (WLROCT) is enabled when a pump start flag becomes inactive.  
Plant Utilisation Index

An item of plant is utilised when it is operating normally.

The plant utilisation index (UtilIdx), which is reset at the beginning of each month, shall be the progressive mean average of the instantaneous plant utilisation percentage (T%Util) and is updated every second using the following calculation:-

|         |   |  |
|---------|---|--|
| UtilIdx | = | TUtil / TUtCnt                         |
| TUtil   | = | Total monthly plant utilisation factor |
| TUtCnt  | = | Total monthly seconds                  |

The total monthly plant utilisation factor (TUtil), which is reset at the beginning of each month, shall be the progressive total of the instantaneous plant utilisation percentage (T%Util) and is updated every second using the following calculation:-

|        |   |  |
|--------|---|--|
| TUtil  | = | TUtil + T%Util                         |
| T%Util | = | Instantaneous plant utilisation factor |

The instantaneous plant utilisation percentage (T%Util) is updated every second using the following calculation:-

|        |   |  |
|--------|---|--|
| U      | = | (Capacity operating / capacity installed) x 100              |
| T%Util | = | (P1Util + P2Util) / 2 x 100                                  |
| PnUtil | = | Pump operating capacity (pump running = 1, pump stopped = 0) |



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### 2.7.3.7. Plant Availability Index

An item of plant is available when normal operation is possible and is considered not available when either of the following conditions occur:-

- Pump unavailable
- Pump station in local mode

The plant availability index (AvIdx), which is reset at the beginning of each month, shall be the progressive mean average of the instantaneous plant availability percentage (T%Aval) and is updated every second using the following calculation:-

$$\begin{aligned} \text{AvIdx} &= \text{T\%Aval} / \text{TAvCnt} \\ \text{T\%Aval} &= \text{Total monthly plant availability factor} \\ \text{TAvCnt} &= \text{Total monthly seconds} \end{aligned}$$

The total monthly plant availability factor (TAv), which is reset at the beginning of each month, shall be the progressive total of the instantaneous plant availability percentage (T%Aval) and is updated every second using the following calculation:-

$$\begin{aligned} \text{TAv} &= \text{TAv} + \text{T\%Aval} \\ \text{T\%Aval} &= \text{Instantaneous plant availability factor} \end{aligned}$$

The instantaneous plant availability percentage (T%Aval) is updated every second using the following calculation:-

$$\begin{aligned} A &= (\text{Capacity available} / \text{capacity installed}) \times 100 \\ \text{T\%Aval} &= (\text{P1Aval} + \text{P2Aval}) / 2 \times 100 \\ \text{PnAval} &= \text{Pump available capacity (pump available} = 1, \text{ pump unavailable} = 0 \\ &\quad \text{pump station in local mode} = 0) \end{aligned}$$

The plant availability station outage alarm flag (StnOut) is only set if the instantaneous plant availability percentage (T%Aval) is below the plant availability index station outage setpoint (AISOSP).

### 2.7.3.8. Hydraulic Power Consumption

In order to calculate the hydraulic energy supplied by a pump, it is necessary to measure the pressure generated by the pump as well flow. For a sewerage wet well the pressure is the pump delivery pressure (MAHD) less the wet well suction level (MAHD).

Daily hydraulic power consumption for each pump combination is integrated in two second increments when the motor efficiency delay timer has expired, allowing the motor to reach full speed and all the input signals are valid (flow, delivery pressure and wet well level). The integral is calculated using the following formula:

$$Ph = K \times Flw \times M \times dt$$

$$\begin{aligned} K &= \text{Proportional constant} \\ Flw &= \text{Outlet Flow (L/s)} \\ M &= \text{Differential Pressure} \\ &= \text{Delivery Pressure (MAHD)} - \text{Suction Pressure (MAHD)} \\ dt &= \text{Integration time (hours)} \\ &= 2 \text{ s} / 3600 \text{ (s/hr)} \end{aligned}$$

To calculate the total power for the day, the integral is accumulated using the following calculation:

$$Pw Hy_t = Pw Hy_{t-n} + Ph_t$$

$$\begin{aligned} Pw Hy_t &= \text{Hydraulic Power consumption for the current day} \\ t-n &= \text{Previous Hydraulic power consumption for the current day} \end{aligned}$$



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### 2.7.3.9. Electrical Power Consumption

Power consumption shall be calculated by integrating the motor power (kW) over the operating time. Daily power consumption for each pump combination is integrated in two second increments when the motor efficiency delay timer has expired, allowing the motor to reach full speed and the motor power is valid. The integral is calculated using the following formula:

$$Pe = P \times dt$$

P = Motor Power (kW)  
Dt = Integration Time ( Hours)  
= 2 s / 3600 (s/hr)

To calculate the total electrical power for the day, the integral is accumulated using the following calculation:

$$PwEI_t = PwEI_{t-n} + Pe_t$$

PwEI<sub>t</sub> = Electrical Power consumption for the current day  
t-n = Previous electrical power consumption for the current day

### 2.7.3.10. Total Efficiency

The total efficiency will be calculated using the ratio between the hydraulic power consumption and the electrical power consumption.

Daily efficiency (Effn) is updated in two second increments if after a time delay expires, set by the pump motor efficiency delay timer (PnEffT) allowing the motor to reach full speed, and the daily electrical efficiency is not zero, using the following calculation:-

$$Ee = \frac{(PwHy_t)}{(PwEI_t)} \times 100$$

### 2.7.3.11. Well Spray Water Control

The spray water unit will operate based on the Spray Water selector switch via the RTU. In the off position, the output spray water control is de-energised. In the Auto position, the spray water control will be continuously energised.



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### 2.7.4. Wet Well Level Calibration

Due to the reliance on the wet well level being calibrated correctly, regular periodic checks should be performed. This is accomplished by the operator remotely generating a wet well level calibration start request. Once a wet well level calibration is initiated, the following sequence shall occur:-

- The sequence shall not commence until the pumps have stopped after pumping the wet well level to the stop duty pump level setpoint (StpDty)
- Normal controls and related wet well level alarms shall be inhibited and the pumps shall be stopped
- The wet well level will increase until the surcharge imminent electrode is reached. The wet well level shall then be compared against the known level of the surcharge imminent electrode and an alarm shall be generated if the level is not within 100 mm of the known surcharge imminent electrode level.
- The pump shall start.
- Normal wet well level alarms shall remain inhibited for a minimum time delay to allow the wet well level to fall.
- Control and associated alarms shall then return to normal.

#### 2.7.4.1. Wet Well Level Calibration Start Request

The wet well level calibration start request flag (CalStr) is latched if the pump station is in remote mode, the operator is not inhibiting wet well level calibration (CalOpl) and the operator generates a remote wet well level calibration start request flag (CalRSr). The start request flag is unlatched when any of the following conditions occur:-

- Local mode is selected
- Wet well level is valid and above the surcharge imminent positive deadband setpoint (SI+DB)
- Surcharge imminent clamp flag (SurchC) is set
- Wet well level calibration in progress exceeded eight hours alarm flag (CalAb8) is set
- RTU battery duty cycle digital output (BatCyc) is set
- The operator inhibits wet well level calibration (CalOpl)
- Wet well level is invalid

#### 2.7.4.2. Wet Well Level Calibration Local Inhibit

Wet well level calibration local inhibit flag (CalLin) is latched if the wet well level calibration start request flag (CalStr) is set and the station is switched to local. The local inhibit flag is unlatched when the station is switched to remote.

#### 2.7.4.3. Wet Well Level Calibration In Progress

The wet well level calibration in progress flag (CalPro) is latched if the wet well level calibration start request flag is set and the wet well level is valid and below the stop duty pump level setpoint (StpDty) and neither pump is running. The flag is unlatched when the wet well level calibration start request flag is reset.

#### 2.7.4.4. Wet Well Level Calibration Abort After Eight Hours

The wet well level calibration abort after eight hours alarm flag (CalAb8) is latched after the wet well level calibration in progress flag has been set for longer than the eight hour time period determined by the wet well level calibration alarm timer (CalAT). The alarm flag is unlatched when the wet well level calibration start request flag (CalStr) is set.



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### 2.7.4.5. Wet Well Level Calibration Fault

The wet well level calibration fault flag (CalFlt) is latched if it is not the first RTU scan and the wet well level calibration is not local inhibited, not aborted and not longer than eight hours and either of the following conditions occur:-

- Wet well level calibration in progress flag (CalPro) becomes reset and the wet well calibration level is below the surcharge imminent negative deadband setpoint (SI-DB)
- Wet well level calibration in progress flag (CalPro) is set and the wet well calibration level rises above the surcharge imminent positive deadband setpoint (SI+DB)

The fault flag is unlatched when the wet well level calibration start request flag (CalStr) is set.

### 2.7.4.6. Wet Well Level Calibration Aborted

The wet well level calibration aborted flag (CalAbt) is latched if the wet well level calibration start request flag (CalStr) is set and any of the following conditions occur:-

- RTU battery duty cycle digital output (BatCyc) is set
- The operator inhibits wet well level calibration (CalOpl)
- Wet well level is invalid

The aborted flag is unlatched when the wet well level calibration start request flag (CalStr) is set.

### 2.7.4.7. Wet Well Level Calibration Alarm Inhibit Timer

The wet well level calibration alarm inhibit timer (CalAIT) will be enabled when either of the following conditions occur:-

- Wet well level calibration in progress flag (CalPro) becomes reset and the wet well level is valid and above the surcharge imminent negative deadband setpoint (SI-DB)
- Wet well level calibration fault flag (CalFlt) becomes set

The calibrated wet well level (CalLvl) is recorded.

### 2.7.5. Midnight Process

At midnight following data is recorded into the daily history table and then a transmit is initiated:-

- Total daily pump minutes run (PnMinD)
- Total daily volume pumped (TotVoD)
- Total volume pumped yesterday (VolYdy)
- Plant utilisation index (UtilIdD)
- Plant availability index (AvlIdD)
- Total daily site power consumption (kWHrDy)

After the transmit routine has completed the following values are reset:-

- Total daily pump operations (PnOpDy)
- Total daily number of transmissions (TxmtDy)
- Total daily hydraulic power consumption (PwHyn)
- Total daily electrical power consumption (PwEin)

If it is the beginning of a new year the following values are reset:-

- Total volume pumped (TotVol)
- Total inflow (TotInf)
- Total site power consumption (kWHrs)



## PROFESSIONAL SERVICES - ENGINEERING FUNCTIONAL SPECIFICATION

## Oxley - Archerfield Pumping Station

### 2.7.6. Record

#### 2.7.4.8. Monitoring Change of State

A burst transmission, which updates the SCADA system with the latest data, shall be initiated by setting the request to transmit flag (TxFlag) when either of the following conditions occur:-

- Change of state of a digital alarm flag being sent to IDTS
- Percentage change in value of the following analog values being sent to IDTS:-
- Wet well level
- Flow

Once the request to transmit flag (TxFlag) has been set, the change of state monitoring subprocess shall cease until one scan cycle delay, set by the monitor delay flag (MonFlg) being reset, after the transmission has occurred.

To burst any information it must be in the form of an integer. To monitor the change of state the digital flags are moved into integer values. These integer values are compared to the value of the integers from the previous transmission.

### 2.7.7. Event History

The event history tables will be updated when either of the following conditions occur:-

- Request for transmission flag becomes set
- Maximum time period since last update determined by the event timer (EvTim) expires

There are two tables for each history point, each consisting of 250 rows, which make up the event history tables that are continuously overwritten and record the last 500 events.

Upon updating the event history table the following information is stored:-

- Date
- Time
- Level
- Alarm words consisting of 16 bits.

Any value exceeding 32767 will be displayed in twos complement.

### 2.7.8. Transmission Timers

To prevent congestion and a monopolising by a single RTU of the Motorola trunk radio network there is a delay before retransmissions of data can occur.

The daily number of transmissions from the site will be recorded in the total daily number of transmissions counter (TxmtDy). The number of transmissions over specific time periods will be recorded in the number of transmissions counter (TxCnt) and is reset if either of the following conditions occur:-

- High transmission flag (TxHigh) is reset and the transmission minimum timer (TxMinT) expires
- High transmission flag (TxHigh) is set and the transmission maximum timer (TxMaxT) expires

The high transmission flag (TxHigh) is latched if the site transmits more frequently than the transmit maximum setpoint (TxMxSP) within the time period determined by the transmission minimum timer (TxMinT). This flag is unlatched if the site transmits less frequently than the transmit maximum setpoint (TxMxSP) within the time period determined by the transmission maximum timer (TxMaxT). The result of the high transmission flag (TxHigh) being set is to increase the minimum delay between transmissions from the time period determined by the transmission delay minimum timer (TxDyMn) to the time period determined by the transmission delay maximum timer (TxDyMx).

The transmission minimum timer (TxMinT) will be enabled upon timer expiring.

The transmission maximum timer (TxMaxT) will be enabled if either of the following conditions occur:-

- Transmission maximum timer (TxMaxT) expires
- High transmission flag (TxHigh) is set



**PROFESSIONAL SERVICES - ENGINEERING  
FUNCTIONAL SPECIFICATION****Oxley - Archerfield Pumping Station****2.7.9. Transmission**

The Motorola RTU will communicate with IDTS using burst sequences to transmit data. Bursting requires a row of data to be sent at a time, the relevant data to be sent will be moved to the appropriate burst table rows and transmitted. After transmitting the information, all the current values are transferred into the previous value variables for comparison of the next change of state.

To communicate the burst routine requires the use of a destination site (Bsite), which could, either of the following:-

- Cullen Avenue
- Brisbane Administration Centre (BAC)

The alternative destination site will be selected upon detection of a communications fail flag (ComFal).

The Motorola RTU internally generated communications fail flag (ComFal) is set if a data burst is sent towards a control center and no central acknowledge (ACK) is returned. This flag is reset upon successful communication.

The RTU retries the primary communications link (Cullen Avenue) and resets the communications fail flag (ComFal) after a time period determined by the communication failure timer (ComFT) expires.

The communication failure timer (ComFT) will be enabled if the communications fail flag (ComFal) is set.

**2.7.10. Outputs**

All physical outputs are scanned in the code and are not updated until the SCAN function is called.



## PROFESSIONAL SERVICES - ENGINEERING FUNCTIONAL SPECIFICATION

## Oxley - Archerfield Pumping Station

### 3. RTU Input/Output List

The following I/O is associated with Archerfield Street Motorola RTU.

#### Digital Input Card No.1 - Slot 1

| ADDRESS | MNEMONIC | DESCRIPTION                               | LED OFF     | LED ON      |
|---------|----------|---|-------------|-------------|
| DI 1    | P1Pwr    | Pump No.1 Control Circuit Power Available | Unavailable | Available   |
| DI 2    | P1MPUT   | Pump No.1 MPU Trip                        | Fault       | No Fault    |
| DI 3    | P1SrPB   | Pump No.1 Start Pushbutton                | Not Pressed | Pressed     |
| DI 4    | P1SpPB   | Pump No.1 Stop Pushbutton                 | Pressed     | Not Pressed |
| DI 5    | P1EStp   | Pump No.1 Emergency Stop Pushbutton       | Pressed     | Not Pressed |
| DI 6    | P1MIO    | Pump No.1 Moisture In Oil                 | Fault       | No Fault    |
| DI 7    | P1LRst   | Pump No.1 Local Reset Pushbutton          | Not Pressed | Pressed     |
| DI 8    | P1Run    | Pump No.1 Running                         | Stopped     | Running     |
| DI 9    | P1MPUA   | Pump No.1 MPU Alarm Trip                  | Fault       | No Fault    |
| DI 10   | Spare    |   |             |             |
| DI 11   | P1VSD    | Pump No.1 V/S Drive Fault                 | Fault       | No Fault    |
| DI 12   | P1Rflx   | Pump No.1 Reflux Micro Switch             | Open        | Closed      |
| DI 13   | Spare    |   |             |             |
| DI 14   | NoFlow   | Pump Station – No flow Alarm              | Not No Flow | No Flow     |
| DI 15   | Remote   | Site Local/Remote                         | Local       | Remote      |
| DI 16   | AttRPB   | Site Attention Alarm Reset Pushbutton     | Not Pressed | Pressed     |

#### Digital Input Card No.2 - Slot 2

| ADDRESS | MNEMONIC | DESCRIPTION                               | LED OFF     | LED ON      |
|---------|----------|---|-------------|-------------|
| DI 1    | P2Pwr    | Pump No.2 Control Circuit Power Available | Unavailable | Available   |
| DI 2    | P2MPUT   | Pump No.2 MPU Trip                        | Fault       | No Fault    |
| DI 3    | P2SrPB   | Pump No.2 Start Pushbutton                | Not Pressed | Pressed     |
| DI 4    | P2SpPB   | Pump No.2 Stop Pushbutton                 | Pressed     | Not Pressed |
| DI 5    | P2EStp   | Pump No.2 Emergency Stop Pushbutton       | Pressed     | Not Pressed |
| DI 6    | P2MIO    | Pump No.2 Moisture In Oil                 | Fault       | No Fault    |
| DI 7    | P2LRst   | Pump No.2 Local Reset Pushbutton          | Not Pressed | Pressed     |
| DI 8    | P2Run    | Pump No.2 Running                         | Stopped     | Running     |
| DI 9    | P2MPUA   | Pump No.2 MPU Alarm Trip                  | Fault       | No Fault    |
| DI 10   | Spare    |   |             |             |
| DI 11   | P2VSD    | Pump No.2 V/S Drive Fault                 | Fault       | No Fault    |
| DI 12   | P2Rflx   | Pump No.2 Reflux Micro Switch             | Open        | Closed      |
| DI 13   | Spare    |   |             |             |
| DI 14   | SprWtr   | Spray Water                               | Off         | Auto        |
| DI 15   | StPwr    | Site Attention Alarm Reset Pushbutton     | Fault       | No Fault    |
| DI 16   | Surchg   | Surcharge Imminent Alarm                  | Surcharge   | Clear       |

#### Digital Input Card No.3 - Slot 3

| ADDRESS | MNEMONIC | DESCRIPTION                                | LED OFF       | LED ON      |
|---------|----------|--|---------------|-------------|
| DI 1    | P3Pwr    | Pump No.3 Control Circuit Power Available. | Unavailable   | Available   |
| DI 2    | P3SrPB   | Pump No.3 Start Pushbutton                 | Not Pressed   | Pressed     |
| DI 3    | P3SpPB   | Pump No.3 Stop Pushbutton                  | Pressed       | Not Pressed |
| DI 4    | P3EStp   | Pump No.3 Emergency Stop Pushbutton        | Pressed       | Not Pressed |
| DI 5    | P3MIO    | Pump No.3 Moisture In Oil                  | Fault         | No Fault    |
| DI 6    | P3LRst   | Pump No.3 Local Reset Pushbutton           | Not Pressed   | Pressed     |
| DI 7    | P3Run    | Pump No.3 Running                          | Stopped       | Running     |
| DI 8    | P3VSD    | Pump No.3 V/S Drive Ready (Fault)          | Fault         | No Fault    |
| DI 9    | P3AseI   | Pump No. 3 V/S Drive Auto Selected         | Not Auto      | Auto        |
| DI 10   | Spare    |  |               |             |
| DI 11   | Spare    |  |               |             |
| DI 12   | P3Rflx   | Pump No.3 Reflux Micro Switch              | Open          | Closed      |
| DI 13   | Spare    |  |               |             |
| DI 14   | Spare    |  |               |             |
| DI 15   | CP1Rst   | CP No.1 Alarm Reset                        | Not Reset     | Reset       |
| DI 16   | CP1Pwr   | CP No.1 Power Available                    | Not Available | Available   |



## PROFESSIONAL SERVICES - ENGINEERING FUNCTIONAL SPECIFICATION

## Oxley - Archerfield Pumping Station

### Digital Output Card No.1 - Slot 4

| ADDRESS | MNEMONIC | DESCRIPTION                 | LED OFF     | LED ON    |
|---------|----------|-----------------------------|-------------|-----------|
| DO 1    | P1Fwd    | Pump No.1 V/S Drive Forward | Not Enabled | Enabled   |
| DO 2    | P1Rset   | Pump No.1 V/S Drive Reset   | Reset       | Not Reset |
| DO 3    | P1Auto   | Pump No.1 V/S Drive Auto    | Not Auto    | Auto      |
| DO 4    | Spare    |                             |             |           |
| DO 5    | P1RunP   | Pump No.1 Run               | Stop        | Start     |
| DO 6    | P1LocI   | Pump No.1 Status Indication | Off         | On        |
| DO 7    | P1CFan   | Pump No.1 Cooling Fan       | Stop        | Start     |
| DO 8    | Spare    |                             |             |           |
| DO 9    | P3RunP   | Pump No.3 Run               | Stop        | Start     |
| DO 10   | P3LocI   | Pump No.3 Local Indication  | Off         | On        |
| DO 11   | P3Auto   | Pump No.3 V/S Drive Auto    | Local       | Auto      |
| DO 12   | P3Rset   | Pump No.3 Reset V/S Drive   | Not Reset   | Reset     |
| DO 13   | V4OpnC   | V450 – Open Valve           | Not Open    | Open      |
| DO 14   | V45ClsC  | V450 – Close Valve          | Not Close   | Close     |
| DO 15   | V75OpnC  | V750 – Open Valve           | Not Open    | Open      |
| DO 16   | V75ClsC  | V750 – Close Valve          | Not Close   | Close     |

### Digital Output Card No.2 - Slot 5

| ADDRESS | MNEMONIC | DESCRIPTION                   | LED OFF     | LED ON       |
|---------|----------|-------------------------------|-------------|--------------|
| DO 1    | P2Fwd    | Pump No.2 V/S Drive Forward   | Not Enabled | Enabled      |
| DO 2    | P2Rset   | Pump No.2 V/S Drive Reset     | Reset       | Not Reset    |
| DO 3    | P2Auto   | Pump No.2 V/S Drive Auto      | Not Auto    | Auto         |
| DO 4    | Spare    |                               |             |              |
| DO 5    | P2RunP   | Pump No.2 Run                 | Stop        | Start        |
| DO 6    | P2LocI   | Pump No.2 Status Indication   | Off         | On           |
| DO 7    | P2CFan   | Pump No.2 Cooling Fan         | Stop        | Start        |
| DO 8    | Spare    |                               |             |              |
| DO 9    | Spare    |                               |             |              |
| DO 10   | AttInd   | Site Attention Indicator      | Not Enabled | Enabled      |
| DO 11   | WSprOn   | Spray Water Control           | Not Enabled | Enabled      |
| DO 12   | OxInOn   | Oxygen Injection Control      | Not Enabled | Enabled      |
| DO 13   | BatCyc   | RTU Battery Duty Cycling      | Open        | Close        |
| DO 14   | CPIDE    | CP No.1 De-energise Rectifier | Energized   | De-Energized |
| DO 15   | CP1Ref   | CP No.1 Connect References    | Disconnect  | Connect      |
| DO 16   | CP1Alm   | CP No.1 Alarm Indication      | Off         | On           |

### Analog Input Card No.1 - Slot 6

| ADDRESS | MNEMONIC | DESCRIPTION                 | ENGINEERING UNITS |                |
|---------|----------|-----------------------------|-------------------|----------------|
| AI 1    | WWLevl   | Wet Well Level              | 4mA = -5.25 m     | 20mA = 4.55 m  |
| AI 2    | P1Pres   | Pump No.1 Delivery Pressure | 4mA = 0 m         | 20mA = 40 m    |
| AI 3    | P2Pres   | Pump No.2 Delivery Pressure | 4mA = 0 m         | 20mA = 40m     |
| AI 4    | Flow     | Pump Station Delivery Flow  | 4mA = 0 l/s       | 20mA = 800 l/s |
| AI 5    | P1KW     | Pump No.1 Power             | 4mA = 0 kW        | 20mA = 135 kW  |
| AI 6    | P2KW     | Pump No.2 Power             | 4mA = 0 kW        | 20mA = 135 kW  |
| AI 7    | P1Amps   | Pump No.1 Current           | 4mA = 0 A         | 20mA = 240 A   |
| AI 8    | P2Amps   | Pump No.2 Current           | 4mA = 0 A         | 20mA = 240 A   |

### Analog Input Card No.2 - Slot 7

| ADDRESS | MNEMONIC | DESCRIPTION                 | ENGINEERING UNITS |               |
|---------|----------|-----------------------------|-------------------|---------------|
| AI 1    | P3Pres   | Pump No.3 Delivery Pressure | 4mA = 0 m         | 20mA = 40 m   |
| AI 2    | P3Amps   | Pump No.3 Current           | 4mA = 0 A         | 20mA = 240 A  |
| AI 3    | P3KW     | Pump No.3 Power             | 4mA = 0 kW        | 20mA = 135 kW |
| AI 4    | Spare    |                             |                   |               |
| AI 5    | Spare    |                             |                   |               |
| AI 6    | Spare    |                             |                   |               |
| AI 7    | Spare    |                             |                   |               |
| AI 8    | Spare    |                             |                   |               |

### Analog Output Card No.1 - Slot 8

| ADDRESS | MNEMONIC | DESCRIPTION             | ENGINEERING UNITS |              |
|---------|----------|-------------------------|-------------------|--------------|
| AO 1    | P1SPC    | Pump No.1 Speed Control | 4mA = 0 %         | 20mA = 100 % |
| AO 2    | P2SPC    | Pump No.2 Speed Control | 4mA = 0 %         | 20mA = 100 % |
| AO 3    | P3SPC    | Pump No.3 Speed Control | 4mA = 0 %         | 20mA = 100 % |
| AO 4    | Spare    |                         |                   |              |



PROFESSIONAL SERVICES - ENGINEERING  
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Oxley - Archerfield Pumping Station

Digital Input Card No.4 - Slot 9

| ADDRESS | MNEMONIC | DESCRIPTION             | LED OFF          | LED ON       |
|---------|----------|-------------------------|------------------|--------------|
| DI 1    | V45FOpn  | V450 Valve Fully Open   | Not Fully Open   | Fully Open   |
| DI 2    | V45FCsd  | V450 Valve Fully Closed | Not Fully Closed | Fully Closed |
| DI 3    | V45Flt   | V450 Valve Fault        | Not Fault        | Fault        |
| DI 4    | Spare    |                         |                  |              |
| DI 5    | Spare    |                         |                  |              |
| DI 6    | Spare    |                         |                  |              |
| DI 7    | Spare    |                         |                  |              |
| DI 8    | Spare    |                         |                  |              |
| DI 9    | V75FOpn  | V750 Valve Fully Open   | Not Fully Open   | Fully Open   |
| DI 10   | V75FCsd  | V750 Valve Fully Closed | Not Fully Closed | Fully Closed |
| DI 11   | V75Flt   | V750 Valve Fault        | Not Fault        | Fault        |
| DI 12   | Spare    |                         |                  |              |
| DI 13   | Spare    |                         |                  |              |
| DI 14   | Spare    |                         |                  |              |
| DI 15   | Spare    |                         |                  |              |
| DI 16   | Spare    |                         |                  |              |



# **ATTACHMENTS**



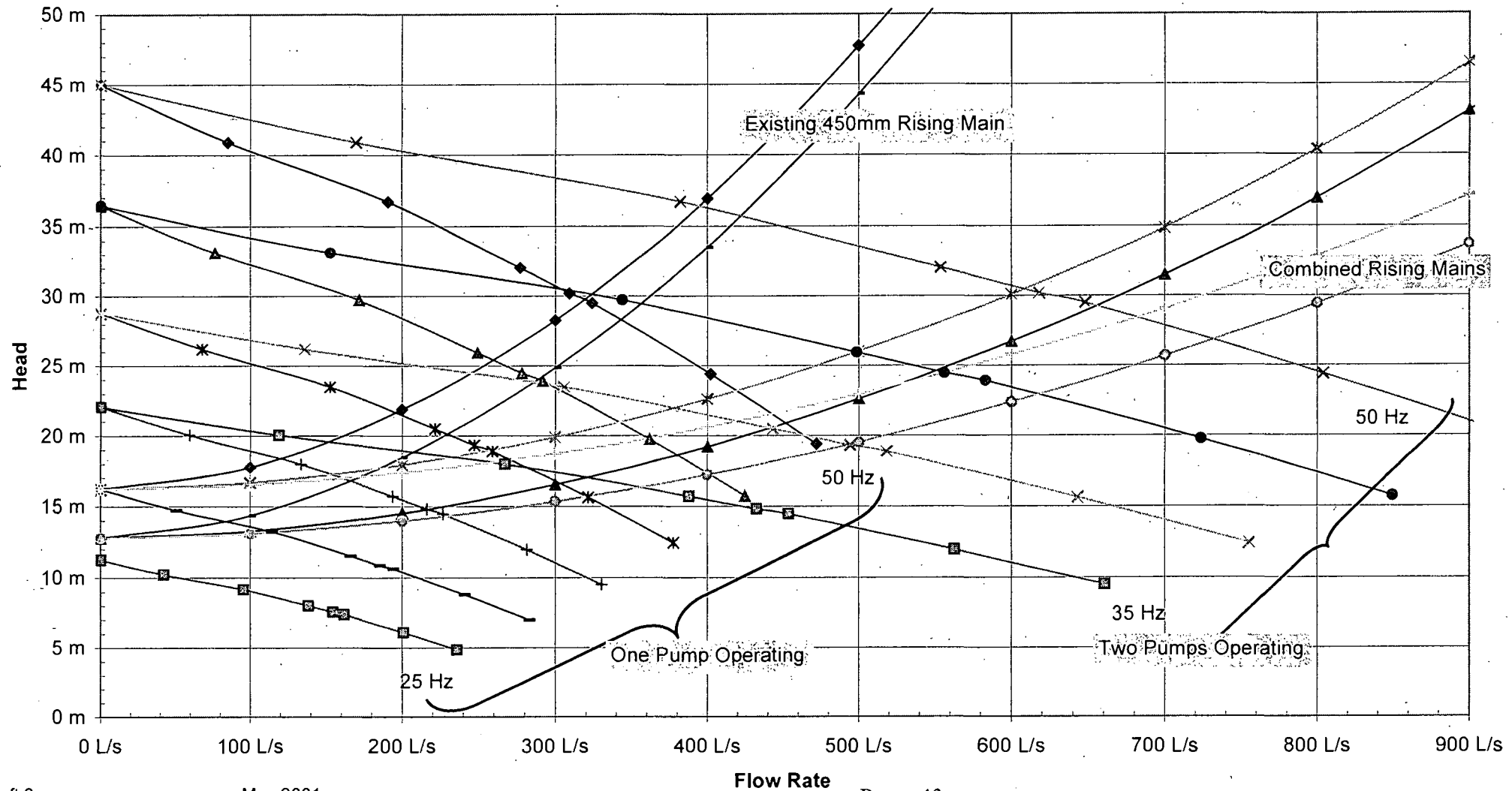




**PROFESSIONAL SERVICES - ENGINEERING  
FUNCTIONAL SPECIFICATION**

**Oxley - Archerfield Pumping Station**

**System Curves**









**COMMON LOGIC Pty Ltd**  
**Specialist Electrical Contractors****Electrical Manual**

Subject: Archerfield Pump Station Upgrade

Sheet: 4  
Of: 8Section  
1

Page Revision No: 1 Date: 10/03/03

Manual Issue No: 1 Date: 10/03/03

**3.0 AS INSTALLED DRAWINGS**

Authorised By: Grant Kerr

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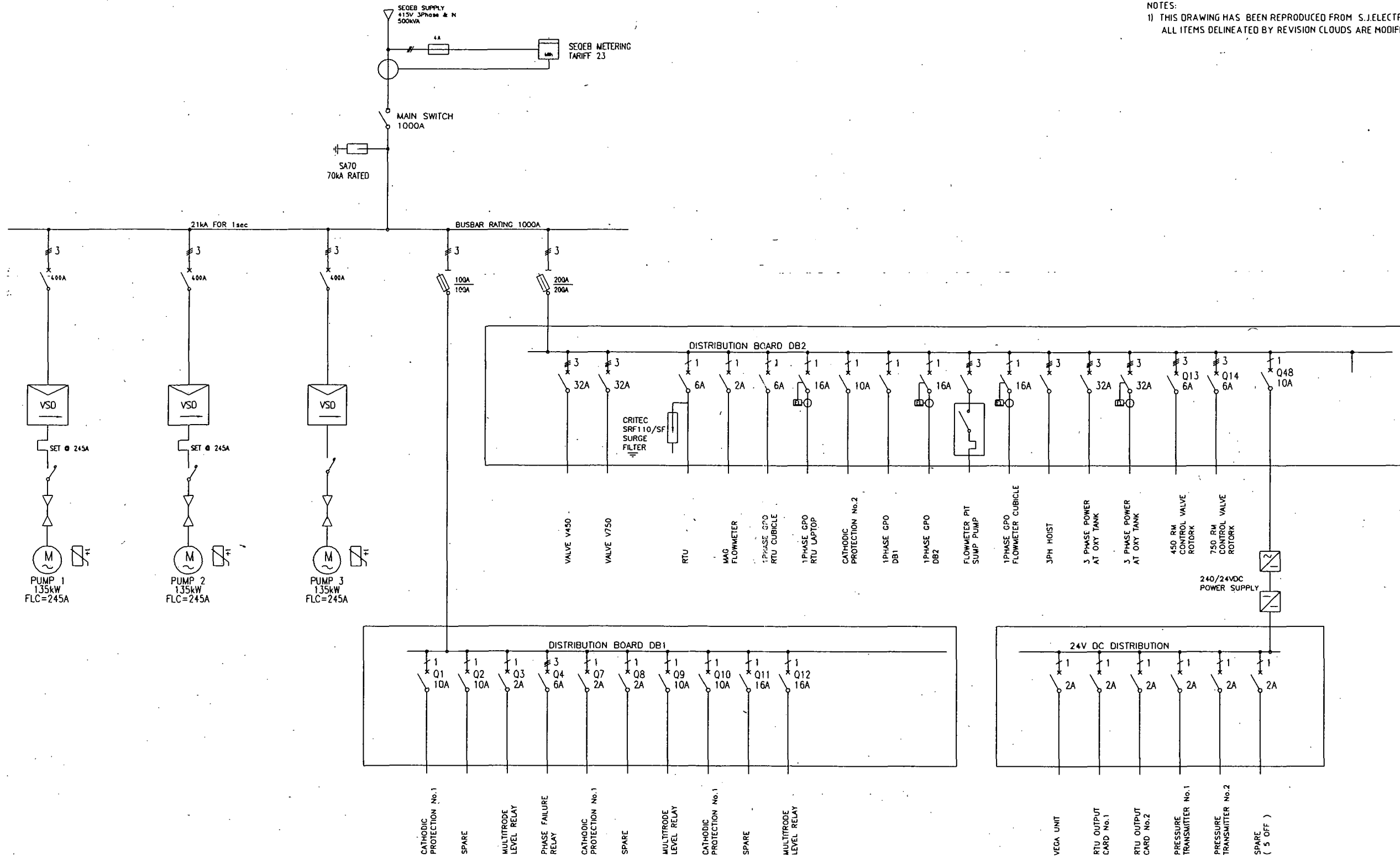


**Brisbane  
Water**



## NOTES:

1) THIS DRAWING HAS BEEN REPRODUCED FROM S.J.ELECTRIC DRAWINGS No.4700-E-001&2  
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| NO | DATE     | AMENDMENT         | INITIALS |
|----|----------|-------------------|----------|
| A  | 27.04.05 | AS BUILT          | PH       |
| O  | 08.06.01 | ISSUED FOR TENDER |          |

|   |      |
|---|------|
| MANAGER OF BUSINESS ASSET SERVICES          | DATE |
| MANAGER OF OPERATIONS                       | DATE |
| MANAGER PROFESSIONAL SERVICES - ENGINEERING | DATE |

|                      |         |              |      |
|----------------------|---------|--------------|------|
| SUPERVISING ENGINEER | NOTE 3  | R.P.E.Q. NO. | DATE |
| LEAD FILE            | 57PE033 |              |      |
| JOB FILE             |         | SURVEY NO.   |      |
| SURVEYED             |         | FIELD BOOK   |      |

|                |        |
|----------------|--------|
| DESIGN         | NOTE 3 |
| DESIGN CHECK   | NOTE 3 |
| DRAWN          | NOTE 3 |
| DRAFTING CHECK | NOTE 3 |



SUPERSEDES S.J.ELECTRIC DRG.No.s 4700-E-001&amp;2



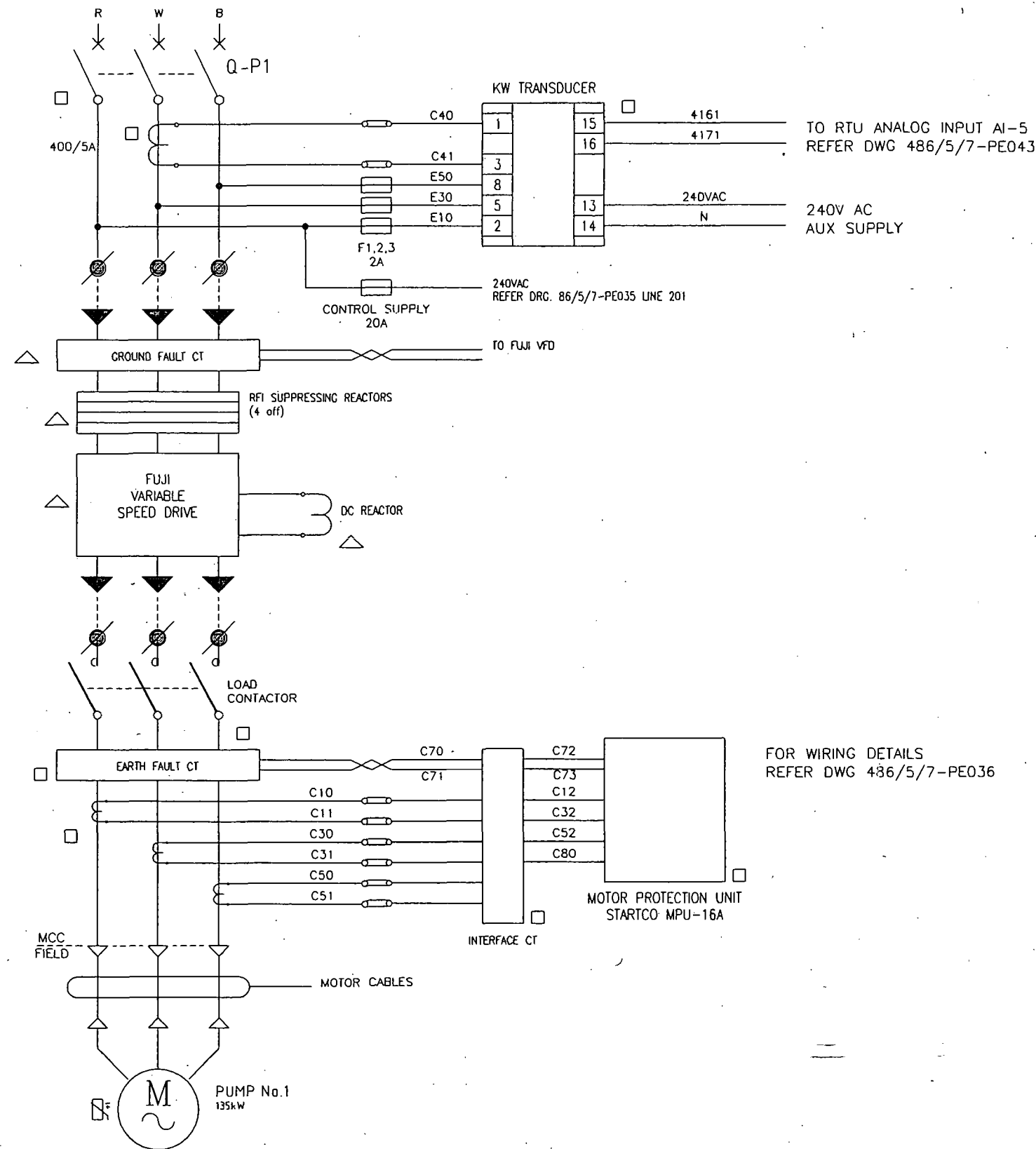
PROJECT  
OXLEY-ARCHERFIELD  
AERODROME SP254  
UPGRADE

TITLE  
SWITCHBOARD  
SINGLE LINE DIAGRAM

|               |                  |
|---------------|------------------|
| SCALE         | A.H. DATUM       |
| DRAWING N°    | N° 1 OF 1 SHEETS |
| 486/5/7-PE033 | AMEND. A         |



NOTES:  
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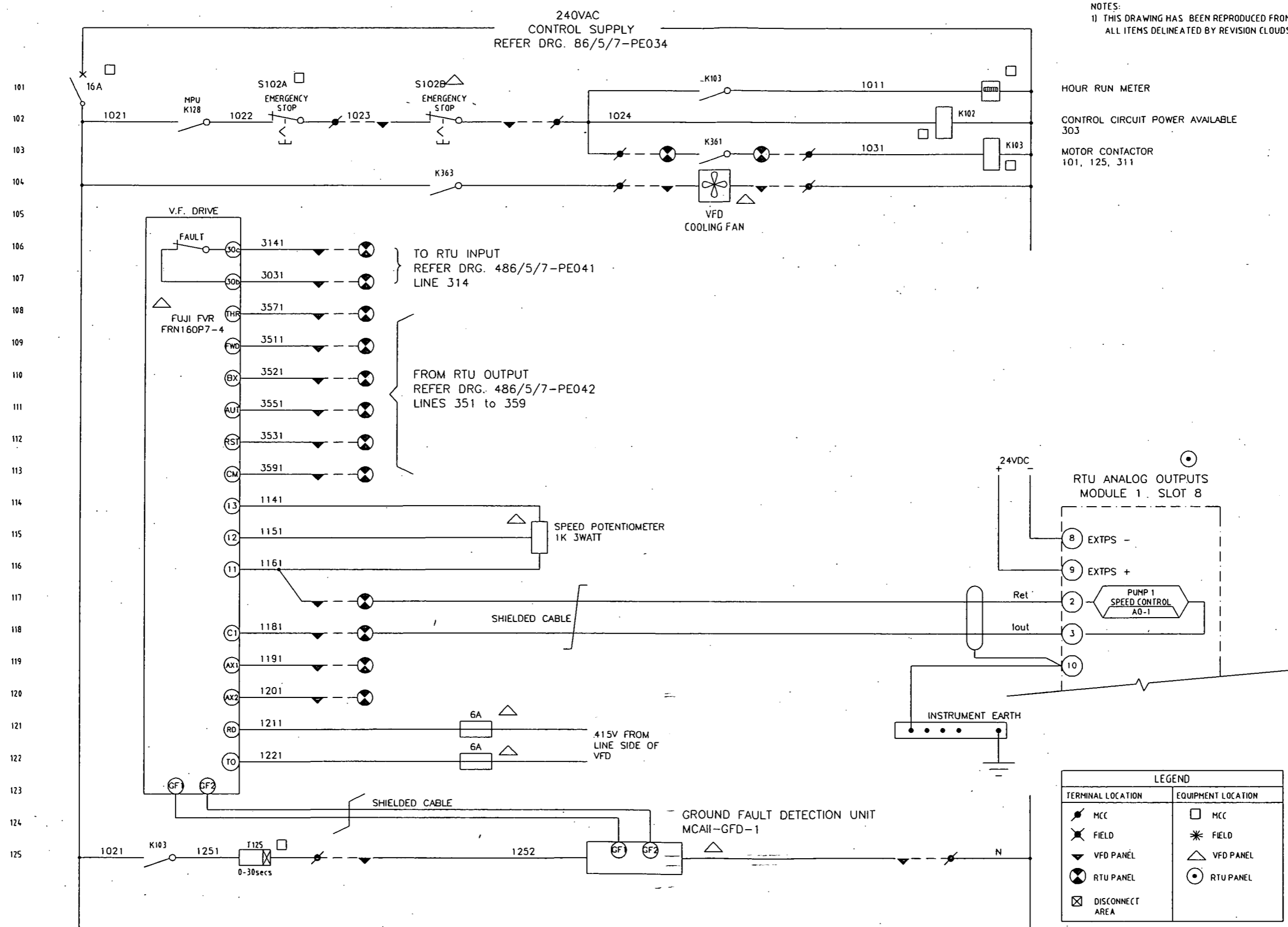


| LEGEND            |                    |
|-------------------|--------------------|
| TERMINAL LOCATION | EQUIPMENT LOCATION |
| MCC               | MCC                |
| FIELD             | FIELD              |
| VFD PANEL         | VFD PANEL          |
| RTU PANEL         | RTU PANEL          |
| DISCONNECT AREA   |                    |

SUPERSEDES S.J.ELECTRIC DRG.No.s 4700-E-003

|   |  |      |                      |  |         |              |      |                |  |        |  |   |  |                               |   |
|---|--|------|----------------------|--|---------|--------------|------|----------------|--|--------|--|---|--|-------------------------------|---|
| MANAGER OF BUSINESS ASSET SERVICES          |  | DATE | SUPERVISING ENGINEER |  | NOTE 1  | R.P.E.Q. NO. | DATE | DESIGN         |  | NOTE 1 |  | <b>PROJECT</b><br>OXLEY-ARCHERFIELD AERODROME SP254 UPGRADE | <b>TITLE</b><br>PUMP No.1 SCHEMATIC DIAGRAM SHEET 1 OF 3 | <b>SCALE</b><br>486/5/7-PE034 | <b>A.J.L. DATUM</b><br>N° 1 OF 1 SHEETS<br>AMEND. A |
| MANAGER OF OPERATIONS                       |  | DATE | CADD FILE            |  | 57PE034 |              |      | DESIGN CHECK   |  | NOTE 1 |  |   |  |                               |   |
| MANAGER PROFESSIONAL SERVICES - ENGINEERING |  | DATE | JOB FILE             |  |         | SURVEY NO.   |      | DRAWN          |  | NOTE 1 |  |   |  |                               |   |
| AMENDMENT                                   |  | DATE | SURVEYED             |  |         | FIELD BOOK   |      | DRAFTING CHECK |  | NOTE 1 |  |   |  |                               |   |





NOTES:  
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240VAC  
CONTROL SUPPLY  
REFER DRG. 86/5/7-PE034

16A

1021

MPU  
K128

1022

S102A  
EMERGENCY STOP

1023

S102B  
EMERGENCY STOP

1024

K103

1011

K102

1031

K103

K361

VFD  
COOLING FAN

V.F. DRIVE

FAULT

3141

3031

3571

3511

3521

3551

3531

3591

TO RTU INPUT  
REFER DRG. 486/5/7-PE041  
LINE 314

FROM RTU OUTPUT  
REFER DRG. 486/5/7-PE042  
LINES 351 to 359

FUJI FVR  
FRN160P7-4

1141

1151

1161

SPEED POTENTIOMETER  
1K 3WATT

1181

1191

1201

1211

1221

415V FROM  
LINE SIDE OF  
VFD

SHIELDED CABLE

GROUND FAULT DETECTION UNIT  
MCAII-GFD-1

GF1

GF2

24VDC

RTU ANALOG OUTPUTS  
MODULE 1, SLOT 8

8 EXTPS -

9 EXTPS +

2 Ret

3 lout

10

PUMP 1  
SPEED CONTROL  
A0-1

INSTRUMENT EARTH

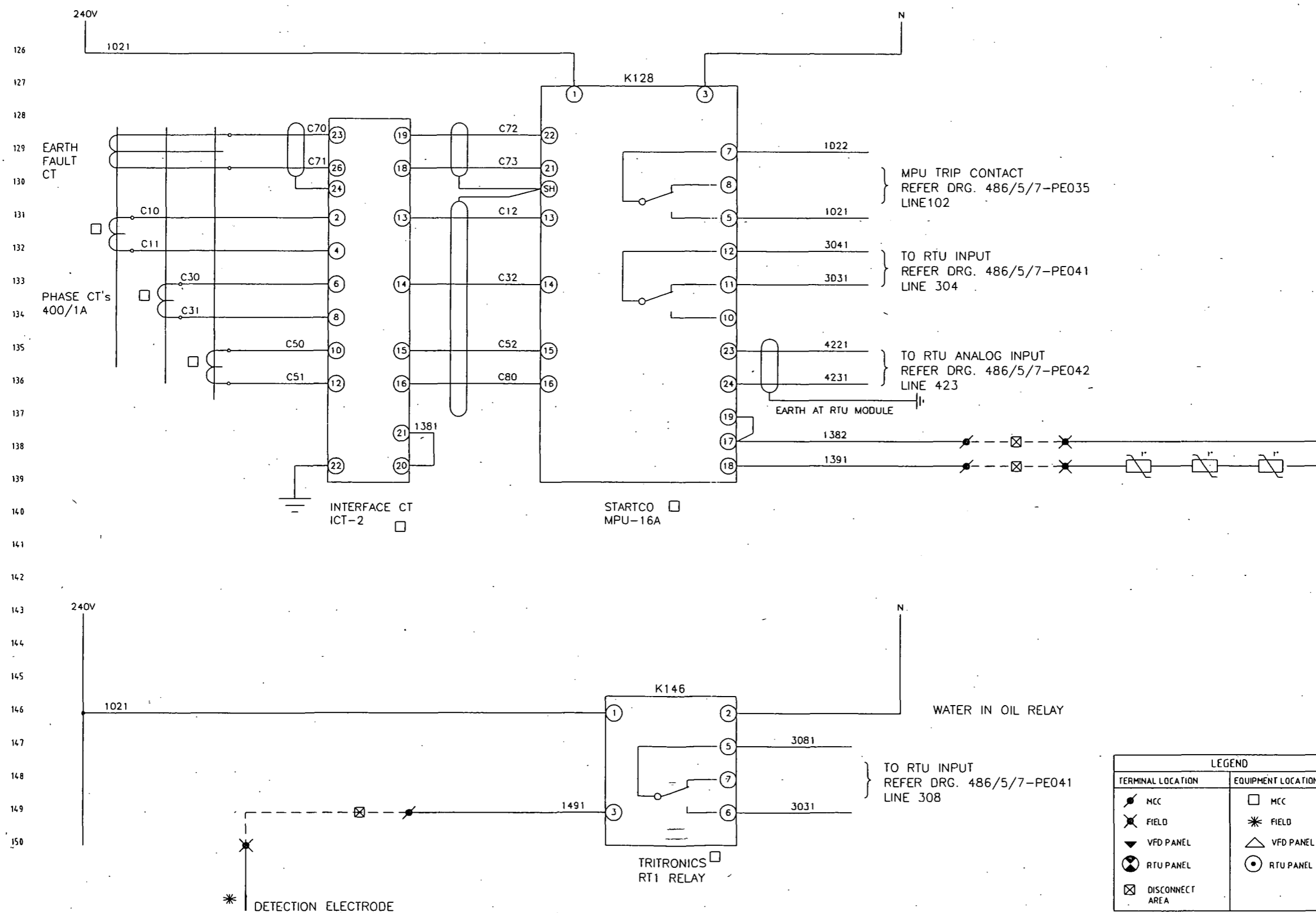
LEGEND










| TERMINAL LOCATION | EQUIPMENT LOCATION |
|-------------------|--------------------|
| MCC               | MCC                |
| FIELD             | FIELD              |
| VFD PANEL         | VFD PANEL          |
| RTU PANEL         | RTU PANEL          |
| DISCONNECT AREA   |                    |

|   |  |        |                      |          |              |            |                |        |   |  |  |  |   |  |               |                                |  |
|---|--|--------|----------------------|----------|--------------|------------|----------------|--------|---|--|--|--|---|--|---------------|--------------------------------|--|
| MANAGER OF BUSINESS ASSET SERVICES          |  | DATE   | SUPERVISING ENGINEER | NOTE 1   | R.P.E.Q. NO. | DATE       | DESIGN         | NOTE 1 | SUPERSEDES S.J.ELECTRIC DRG.No.s 4700-E-004 |  | PROJECT<br>OXLEY-ARCHERFIELD<br>AERODROME SP254<br>UPGRADE |  | TITLE<br>PUMP No.1<br>SCHEMATIC DIAGRAM<br>SHEET 2 OF 3 |  | SCALE         | A.H. DATUM<br>N° 1 OF 1 SHEETS |  |
| MANAGER OF OPERATIONS                       |  | DATE   | CADD FILE            |          | 57PE035      |            | DESIGN CHECK   | NOTE 1 | Brisbane Water                              |  | DRAWN  |  | DRAWING N°  |  | 486/5/7-PE035 | AMEND.                         |  |
| MANAGER PROFESSIONAL SERVICES - ENGINEERING |  | NOTE 1 | DATE                 | JOB FILE |              | SURVEY NO. | DRAFTING CHECK | NOTE 1 | Brisbane City                               |  | SHEET 2 OF 3   |  | A   |  |               |                                |  |



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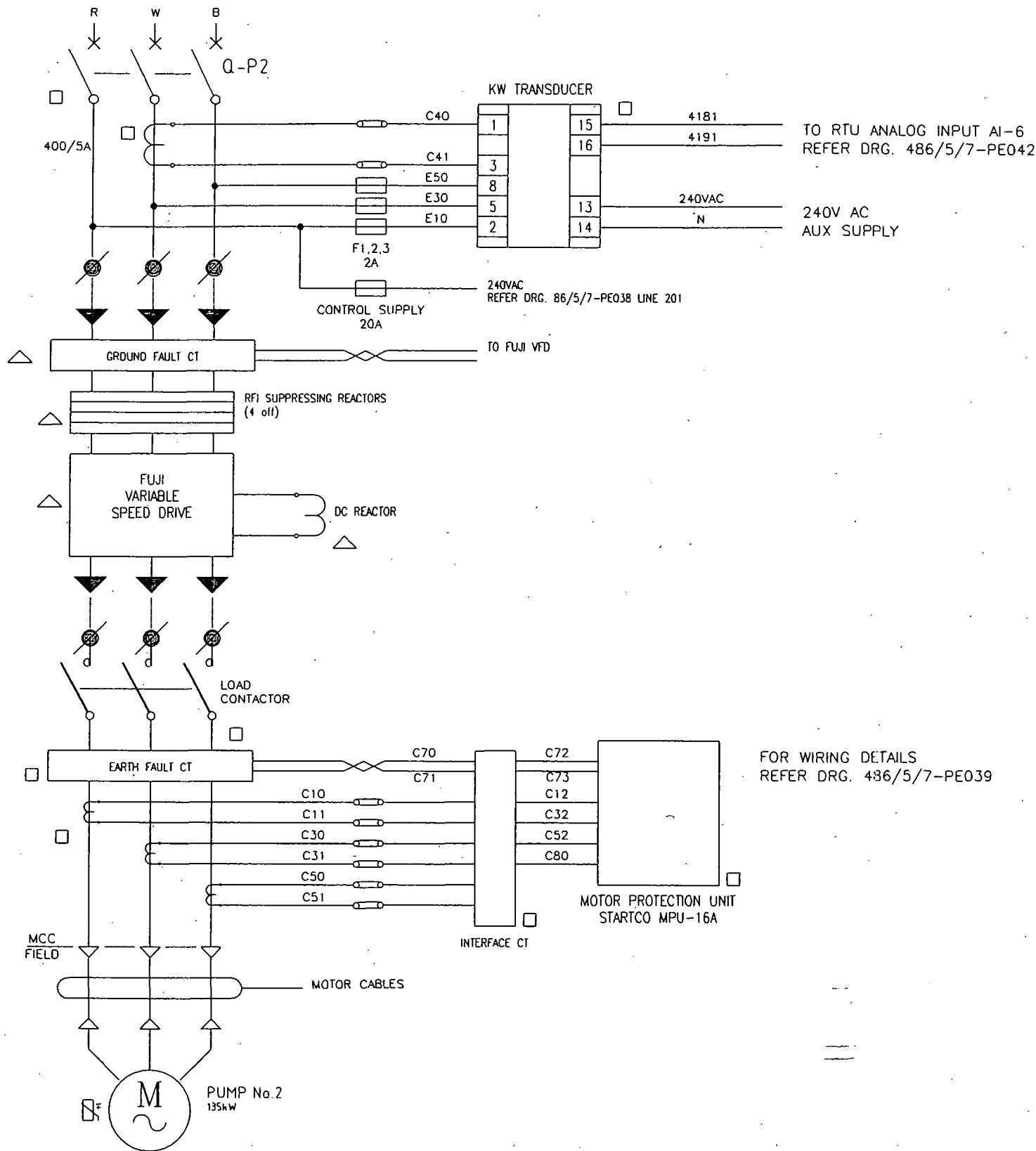
| LEGEND   |   |
|--|---|
| TERMINAL LOCATION  | EQUIPMENT LOCATION  |
|  MCC                |  MCC       |
|  FIELD              |  FIELD     |
|  VFD PANEL          |  VFD PANEL |
|  RTU PANEL          |  RTU PANEL |
|  DISCONNECT<br>AREA |   |

SUPERSEDES S.J.ELECTRIC DRG.No.s 4700-E-005

|                            |  |  |  |   |  |        |                      |          |         |              |            |                |  |        |   |  |   |  |  |  |               |  |                 |  |
|----------------------------|--|--|--|---|--|--------|----------------------|----------|---------|--------------|------------|----------------|--|--------|---|--|---|--|--|--|---------------|--|-----------------|--|
|                            |  |  |  | MANAGER OF BUSINESS ASSET SERVICES          |  | DATE   | SUPERVISING ENGINEER |          | NOTE 1  | R.P.E.Q. NO. | DATE       | DESIGN         |  | NOTE 1 |  |  | PROJECT                                   |  | TITLE                                    |  | SCALE         |  | A.J. DATUM      |  |
|                            |  |  |  | MANAGER OF OPERATIONS                       |  | DATE   | CADD FILE            |          | 57PE036 |              |            | DESIGN CHECK   |  | NOTE 1 |   |  | OXLEY-ARCHERFIELD AERODROME SP254 UPGRADE |  | PUMP No.1 SCHEMATIC DIAGRAM SHEET 3 OF 3 |  | DRAWING N°    |  | M° 1 OF 1 SHEET |  |
| A 07.04.05 AS BUILT PH     |  |  |  |   |  |        |                      |          |         |              |            | DRAWN          |  | NOTE 1 |   |  |   |  |  |  | 486/5/7-PE036 |  | AMEND.          |  |
| O 07.06.01 ORIGINAL ISSUE  |  |  |  |   |  |        | JOB FILE             |          | -       |              | SURVEY NO. | DRAFTING CHECK |  | NOTE 1 |   |  |   |  |  |  |               |  | A               |  |
| NO DATE AMENDMENT INITIALS |  |  |  | MANAGER PROFESSIONAL SERVICES - ENGINEERING |  | NOTE 1 | DATE                 | SURVEYED |         | FIELD BOOK   |            |                |  |        |   |  |   |  |  |  |               |  |                 |  |



NOTES:  
1) THIS DRAWING HAS BEEN REPRODUCED FROM S.J.ELECTRIC DRAWING No.4700-E-009  
ALL ITEMS DELINEATED BY REVISION CLOUDS ARE MODIFICATIONS.



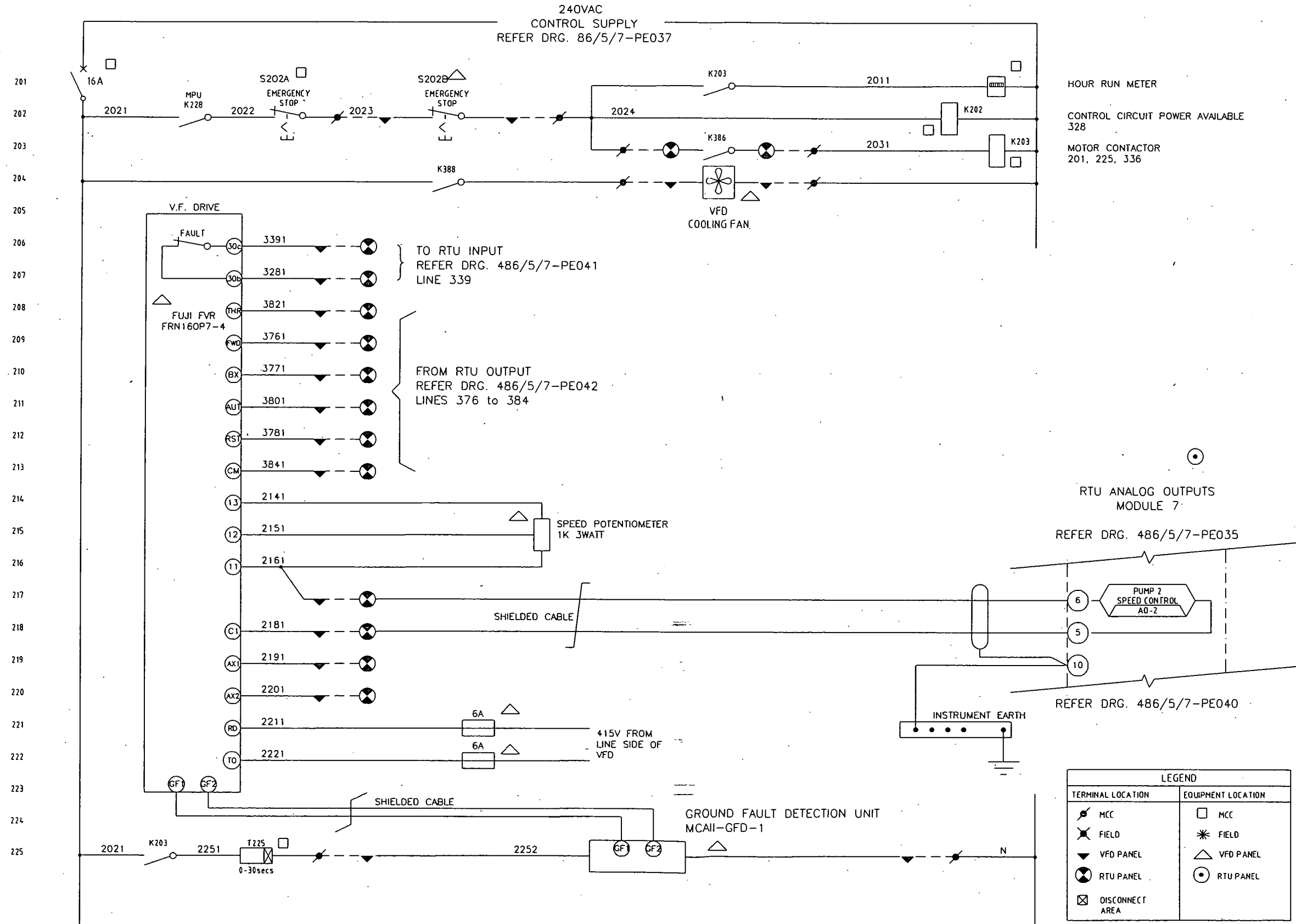
FOR WIRING DETAILS  
REFER DRG. 486/5/7-PE039

| LEGEND            |                    |
|-------------------|--------------------|
| TERMINAL LOCATION | EQUIPMENT LOCATION |
| MCC               | MCC                |
| FIELD             | FIELD              |
| VFD PANEL         | VFD PANEL          |
| RTU PANEL         | RTU PANEL          |
| DISCONNECT AREA   |                    |

|   |  |           |                      |         |              |      |                |        |   |  |   |  |  |  |                  |            |
|---|--|-----------|----------------------|---------|--------------|------|----------------|--------|---|--|---|--|--|--|------------------|------------|
| MANAGER OF BUSINESS ASSET SERVICES          |  | DATE      | SUPERVISING ENGINEER | NOTE 1  | R.P.E.O. NO. | DATE | DESIGN         | NOTE 1 | SUPERSEDES S.J.ELECTRIC DRG.No.s 4700-E-009 |  | PROJECT OXLEY-ARCHERFIELD AERODROME SP254 UPGRADE |  | TITLE PUMP No.2 SCHEMATIC DIAGRAM SHEET 1 OF 3 |  | SCALE            | A.H. DATUM |
| MANAGER OF OPERATIONS                       |  | DATE      | CADD FILE            | 57PE037 |              |      | DESIGN CHECK   | NOTE 1 | Brisbane Water                              |  | DRAWING N°  |  | 486/5/7-PE037                                  |  | N° 1 OF 1 SHEETS |            |
| MANAGER PROFESSIONAL SERVICES - ENGINEERING |  | DATE      | JOB FILE             |         | SURVEY NO.   |      | DRAWN          | NOTE 1 | Professional Services Engineering           |  | AMEND.  |  | A  |  |                  |            |
| NO. DATE                                    |  | AMENDMENT | INITIALS             | DATE    | FIELD BOOK   |      | DRAFTING CHECK | NOTE 1 | Brisbane City                               |  |   |  |  |  |                  |            |



NOTES:  
1) THIS DRAWING HAS BEEN REPRODUCED FROM S.J.ELECTRIC DRAWING No.4700-E-010  
ALL ITEMS DELINEATED BY REVISION CLOUDS ARE MODIFICATIONS.

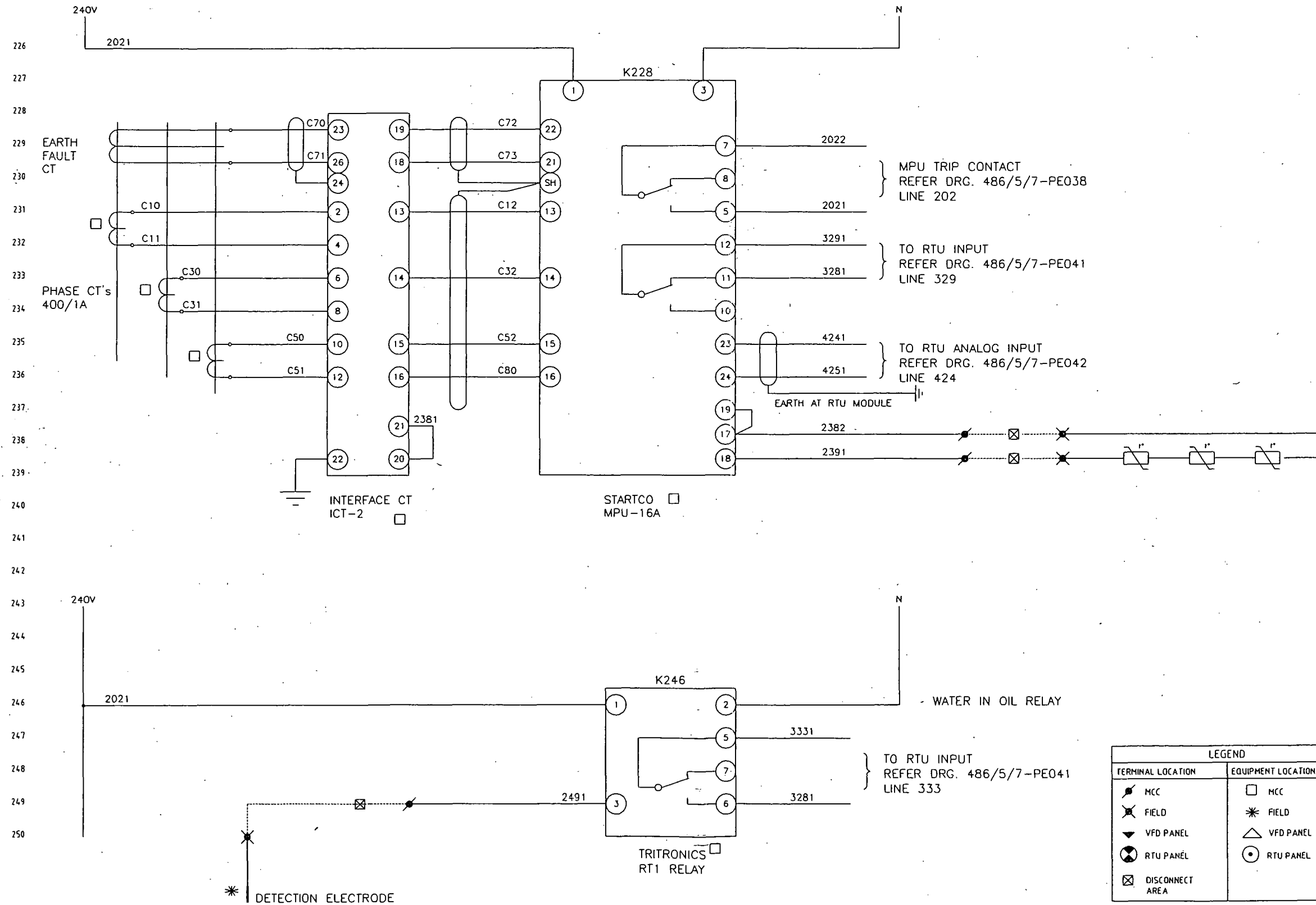


SUPERSEDES S.J.ELECTRIC DRG.No.s 4700-E-010

|                           |  |                                    |   |        |                      |           |          |              |            |              |                |        |  |  |  |   |                                      |   |
|---------------------------|--|------------------------------------|---|--------|----------------------|-----------|----------|--------------|------------|--------------|----------------|--------|--|--|--|---|--------------------------------------|---|
|                           |  | MANAGER OF BUSINESS ASSET SERVICES |   | DATE   | SUPERVISING ENGINEER |           | NOTE 1   | R.P.E.Q. NO. | DATE       | DESIGN       |                | NOTE 1 | <br>Brisbane City | <br>Professional Services Engineering | PROJECT<br>OXLEY-ARCHERFIELD AERODROME SP254 UPGRADE | TITLE<br>PUMP No.2 SCHEMATIC DIAGRAM SHEET 2 OF 3 | SCALE<br>DRAWING N°<br>486/5/7-PE038 | A.H. DATUM<br>N° 1 OF 1 SHEETS<br>AMEND.<br>A |
| A 27.04.09 AS BUILT       |  | PH                                 | MANAGER OF OPERATIONS                       |        | DATE                 | CADD FILE |          | 57PE038      |            | DESIGN CHECK |                | NOTE 1 |  |  |  |   |                                      |   |
| O 07.06.01 ORIGINAL ISSUE |  |                                    | MANAGER PROFESSIONAL SERVICES - ENGINEERING |        | DATE                 | JOB FILE  |          | -            |            | DRAWN        |                | NOTE 1 |  |  |  |   |                                      |   |
| NO. DATE                  |  | AMENDMENT                          | INITIALS                                    | NOTE 1 |                      | DATE      | SURVEYED |              | FIELD BOOK |              | DRAFTING CHECK |        |  |  |  |   |                                      |   |



NOTES:  
1) THIS DRAWING HAS BEEN REPRODUCED FROM S.J.ELECTRIC DRAWING No.4700-E-011  
ALL ITEMS DELINEATED BY REVISION CLOUDS ARE MODIFICATIONS.



|   |  |  |  |      |                      |  |  |  |         |                |      |        |  |        |  |        |
|---|--|--|--|------|----------------------|--|--|--|---------|----------------|------|--------|--|--------|--|--------|
| MANAGER OF BUSINESS ASSET SERVICES          |  |  |  | DATE | SUPERVISING ENGINEER |  |  |  | NOTE 1  | R.P.E.D. NO.   | DATE | DESIGN |  |        |  | NOTE 1 |
| MANAGER OF OPERATIONS                       |  |  |  | DATE | CADD FILE            |  |  |  | 57PE039 | DESIGN CHECK   |      |        |  | NOTE 1 |  |        |
| MANAGER PROFESSIONAL SERVICES - ENGINEERING |  |  |  | DATE | JOB FILE             |  |  |  |         | DRAWN          |      |        |  | NOTE 1 |  |        |
| AMENDMENT                                   |  |  |  | DATE | SURVEYED             |  |  |  |         | DRAFTING CHECK |      |        |  | NOTE 1 |  |        |

SUPERSEDES S.J.ELECTRIC DRG.No.s 4700-E-011



PROJECT  
OXLEY-ARCHERFIELD  
AERODROME SP254  
UPGRADE

TITLE  
PUMP No.2  
SCHEMATIC DIAGRAM  
SHEET 3 OF 3

|               |            |
|---------------|------------|
| SCALE         | A.H. DATUM |
| DRAWING N°    | AMEND.     |
| 486/5/7-PE039 | A          |



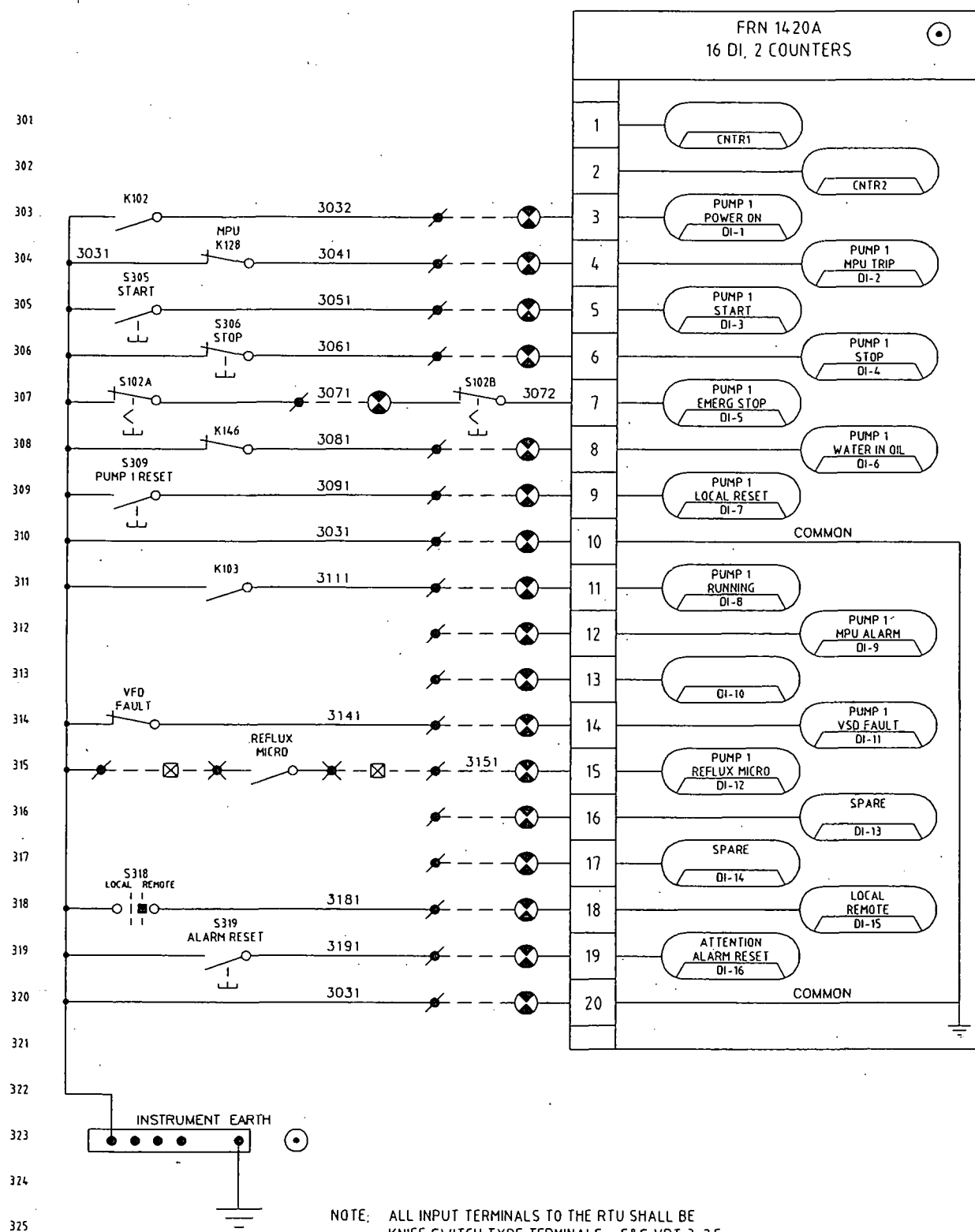




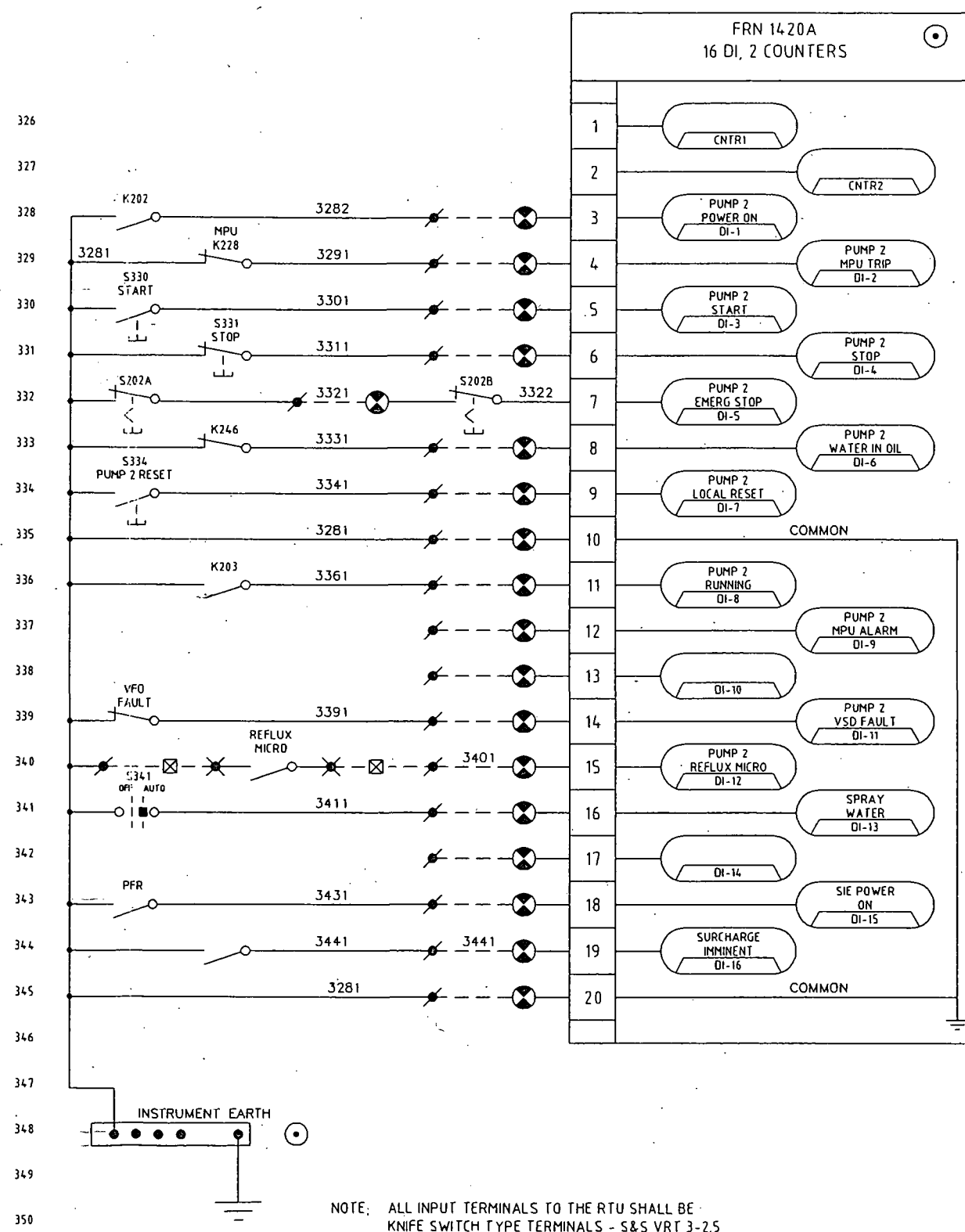
## NOTES:

1) THIS DRAWING HAS BEEN REPRODUCED FROM S.J.ELECTRIC DRAWING No.4700-E-013  
ALL ITEMS DELINEATED BY REVISION CLOUDS ARE MODIFICATIONS.

## DIGITAL INPUTS - MODULE 1 SLOT 1



## DIGITAL INPUTS - MODULE 2 SLOT 2



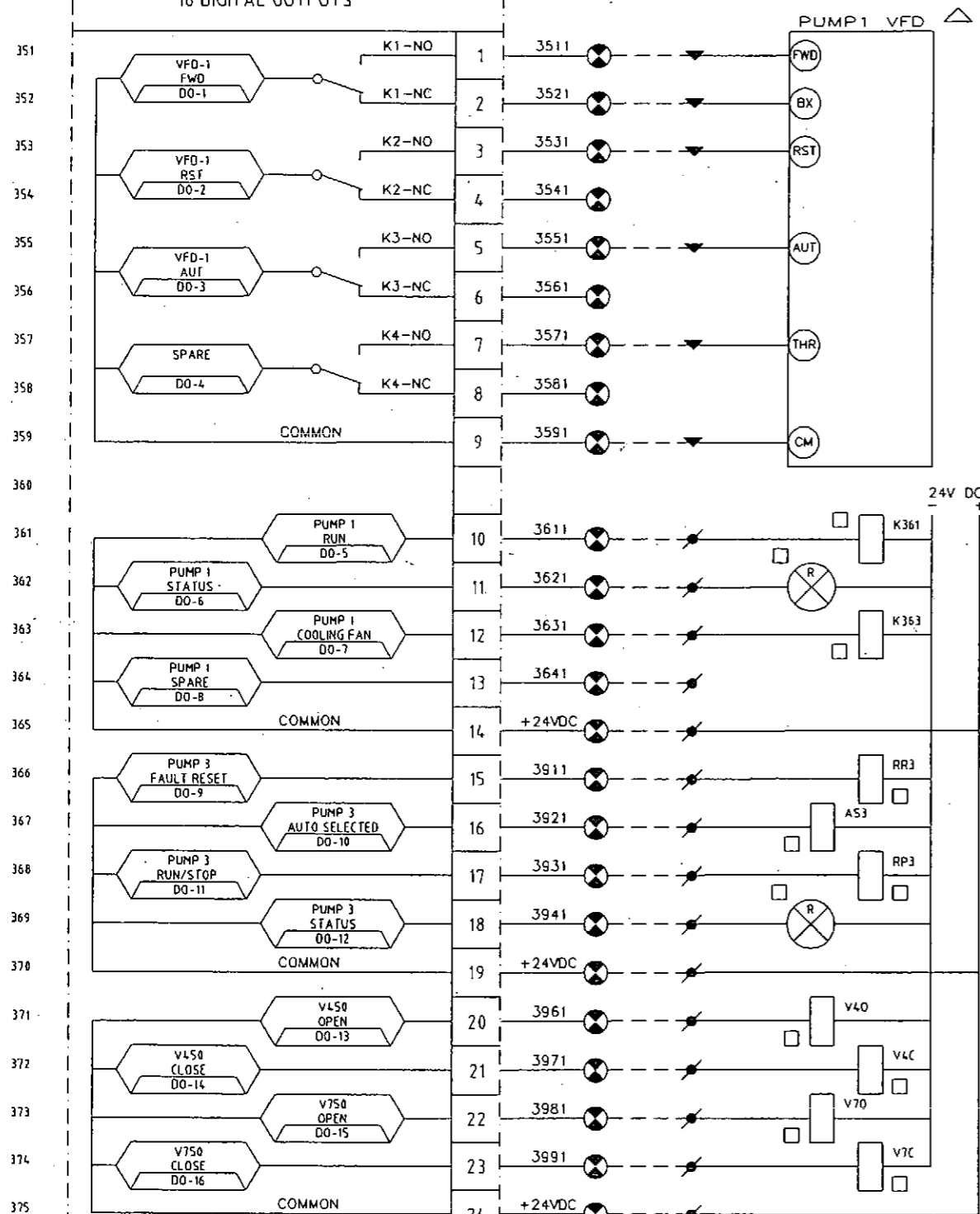
SUPERSEDES S.J.ELECTRIC DRG.No.s 4700-E-013

|  |                      |  |   |   |                                      |  |  |
|--|----------------------|--|---|---|--------------------------------------|--|--|
| MANAGER OF BUSINESS ASSET SERVICES<br>MANAGER OF OPERATIONS<br>MANAGER PROFESSIONAL SERVICES - ENGINEERING | DATE<br>DATE<br>DATE | SUPERVISING ENGINEER<br>CAD FILE<br>JOB FILE<br>SURVEYED | NOTE 1<br>R.P.E.Q. NO.<br>DATE<br>57PE041<br>SURVEY NO.<br>FIELD BOOK | DESIGN<br>DESIGN CHECK<br>DRAWN<br>DRAFTING CHECK | NOTE 1<br>NOTE 1<br>NOTE 1<br>NOTE 1 | PROJECT<br>OXLEY-ARCHERFIELD AERODROME SP254 UPGRADE | TITLE<br>RTU DIGITAL INPUTS PUMPS 1&2<br>SCALE<br>A.H. DATUM<br>N° 1 OF 1 SHEETS<br>DRAWING N°<br>486/5/7-PE041<br>AMEND.<br>A |
|--|----------------------|--|---|---|--------------------------------------|--|--|



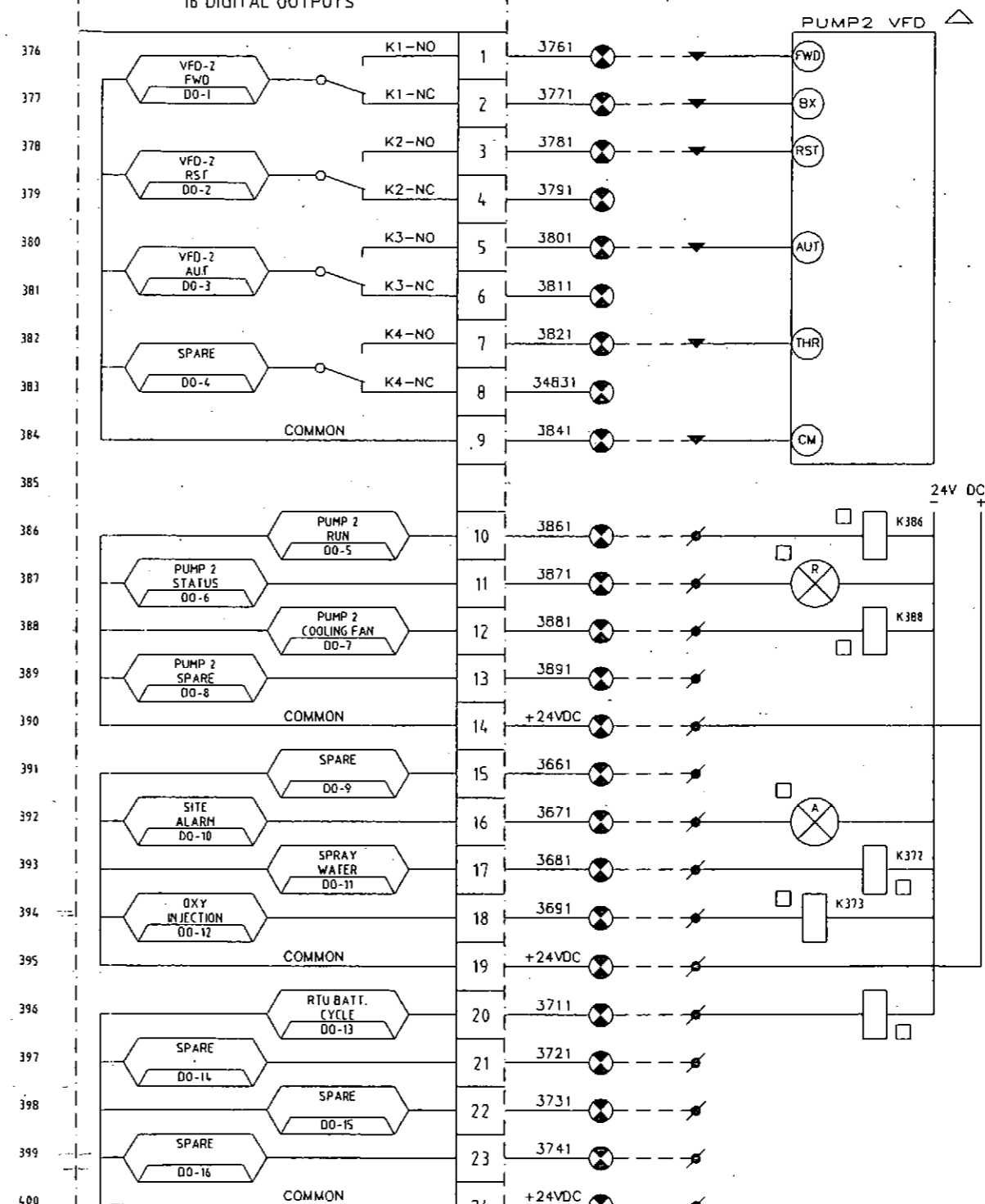
NOTES:  
1) THIS DRAWING HAS BEEN REPRODUCED FROM S.J.ELECTRIC DRAWING No.4700-E-015  
ALL ITEMS DELINEATED BY REVISION CLOUDS ARE MODIFICATIONS.

## DIGITAL OUTPUTS - MODULE 3 SLOT 4

FRN 1491A  
16 DIGITAL OUTPUTS

NOTE: ALL OUTPUT TERMINALS FROM THE PLC SHALL BE FUSED TERMINALS

## DIGITAL OUTPUTS - MODULE 4 SLOT 5

FRN 1491A  
16 DIGITAL OUTPUTS

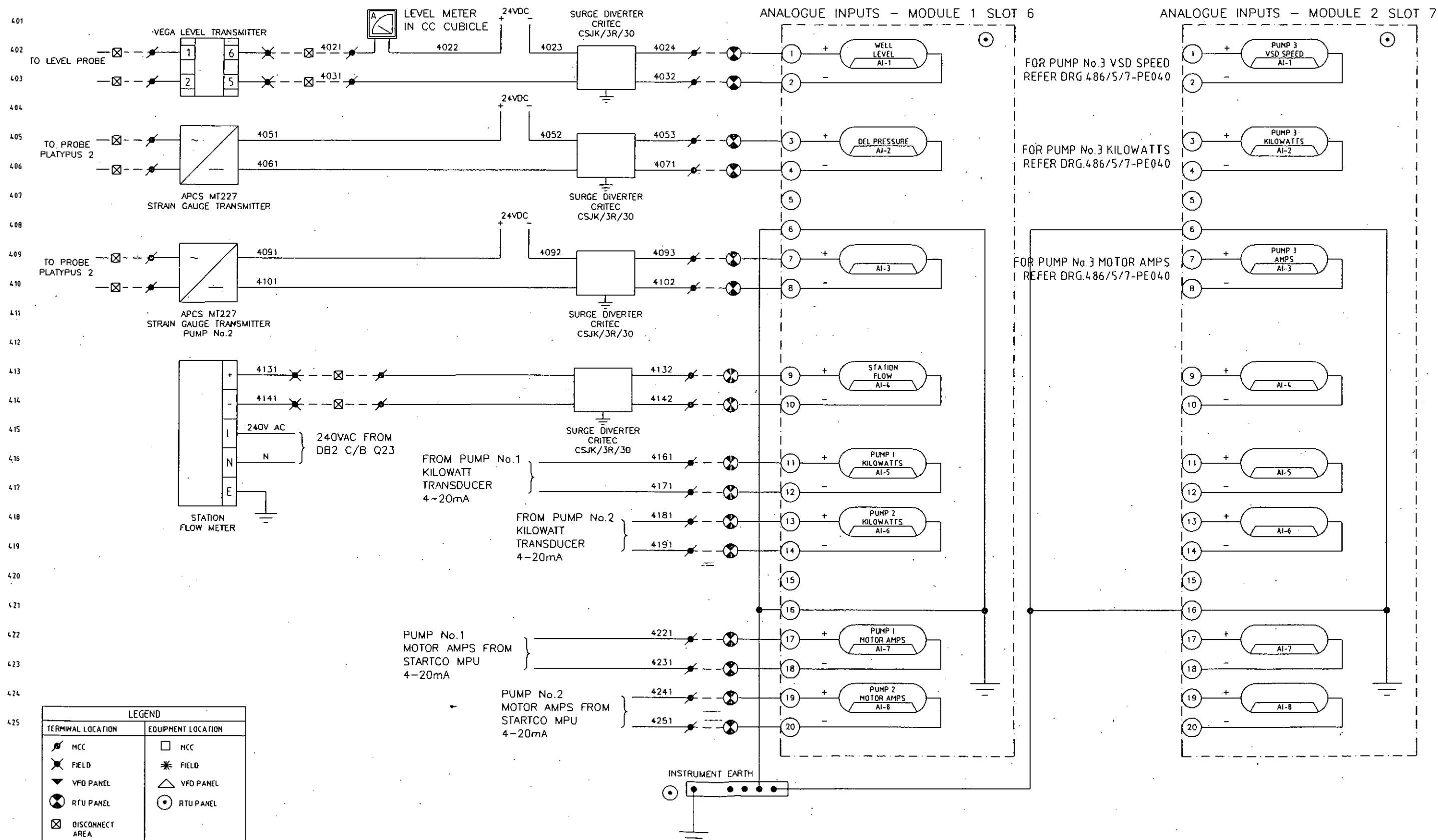
SUPERSEDES S.J.ELECTRIC DRG.No.s 4700-E-015

|   |  |           |                      |            |         |              |                |        |        |  |   |  |                  |                         |
|---|--|-----------|----------------------|------------|---------|--------------|----------------|--------|--------|--|---|--|------------------|-------------------------|
| MANAGER OF BUSINESS ASSET SERVICES          |  | DATE      | SUPERVISING ENGINEER |            | NOTE 1  | R.P.E.O. NO. | DATE           | DESIGN | NOTE 1 |  | <b>PROJECT</b><br>OXLEY-ARCHERFIELD AERODROME SP254 UPGRADE | <b>TITLE</b><br>RTU DIGITAL OUTPUTS PUMPS 1, 2 & 3 | <b>SCALE</b><br> | <b>A.H. DA FURN</b><br> |
| MANAGER OF OPERATIONS                       |  | DATE      | CAOD FILE            |            | 57PE042 |              | DESIGN CHECK   | NOTE 1 |        |  |   |  |                  |                         |
| MANAGER PROFESSIONAL SERVICES - ENGINEERING |  | DATE      | JOB FILE             |            |         |              | DRAWN          | NOTE 1 |        |  |   |  |                  |                         |
| DATE  |  | AMENDMENT | INITIALS             | SURVEY NO. |         |              | DRAFTING CHECK | NOTE 1 |        |  |   |  |                  |                         |



## NOTES:

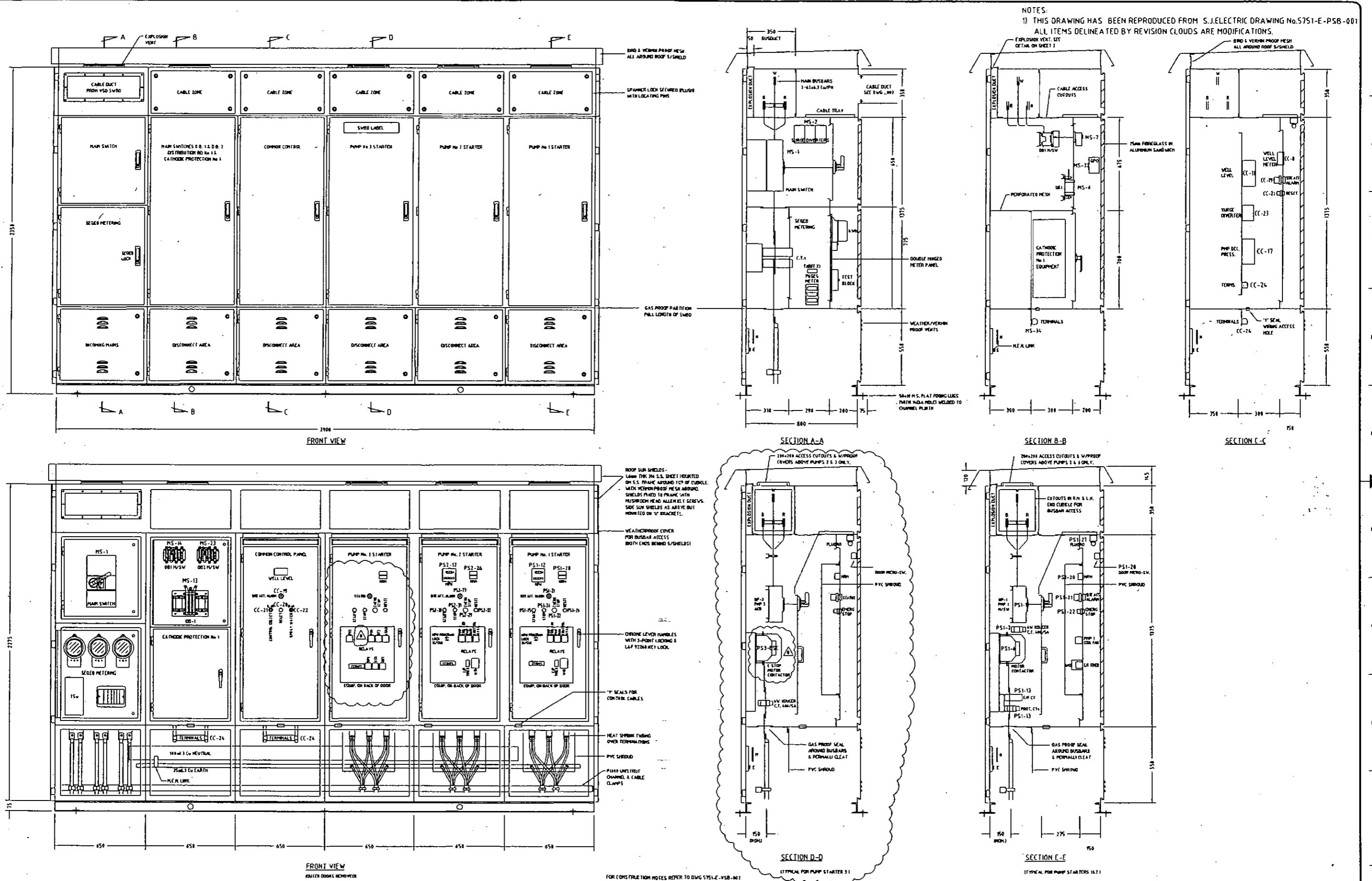
1) THIS DRAWING HAS BEEN REPRODUCED FROM S.J.ELECTRIC DRAWING No.4700-E-015  
ALL ITEMS DELINEATED BY REVISION CLOUDS ARE MODIFICATIONS.



SUPERSEDES S.J.ELECTRIC DRG.No.s 4700-E-015

|   |  |          |                      |  |                  |              |      |                |  |        |  |   |  |  |  |
|---|--|----------|----------------------|--|------------------|--------------|------|----------------|--|--------|--|---|--|--|--|
| MANAGER OF BUSINESS ASSET SERVICES          |  | DATE     | SUPERVISING ENGINEER |  | NOTE 1           | R.P.E.O. NO. | DATE | DESIGN         |  | NOTE 1 |  | <b>PROJECT</b><br>OXLEY-ARCHERFIELD<br>AERODROME SP254<br>UPGRADE | <b>TITLE</b><br>RTU<br>ANALOG INPUTS<br>PUMPS 1, 2 & 3 | <b>SCALE</b><br>DRAWING NO.<br>486/5/7-PE043 | <b>A.H. DATUM</b><br>N° 1 OF 1 SHEETS<br>AMEND.<br>A |
| MANAGER OF OPERATIONS                       |  | DATE     | CADD FILE            |  | 57PE043-Rev7.dwg |              |      | DESIGN CHECK   |  | NOTE 1 |  |   |  |  |  |
| MANAGER PROFESSIONAL SERVICES - ENGINEERING |  | DATE     | JOB FILE             |  |                  | SURVEY NO.   |      | DRAWN          |  | NOTE 1 |  |   |  |  |  |
| AMENDMENT                                   |  | INITIALS | SURVEYED             |  |                  | FIELD BOOK   |      | DRAFTING CHECK |  | NOTE 1 |  |   |  |  |  |





|                                    |  |   |  |          |                      |  |         |              |      |                |  |        |
|------------------------------------|--|---|--|----------|----------------------|--|---------|--------------|------|----------------|--|--------|
| B 19.09.02 EMERG STOP OCT REVISED  |  | MANAGER OF BUSINESS ASSET SERVICES          |  | DATE     | SUPERVISING ENGINEER |  | NOTE 1  | R.P.E.O. NO. | DATE | DESIGN         |  | NOTE 1 |
| A 29.04.02 ISSUED FOR CONSTRUCTION |  | MANAGER OF OPERATIONS                       |  | DATE     | CADD FILE            |  | 57PE044 |              |      | DESIGN CHECK   |  | NOTE 1 |
| O 07.06.01 ORIGINAL ISSUE          |  | MANAGER PROFESSIONAL SERVICES - ENGINEERING |  | DATE     | JOB FILE             |  |         | SURVEY NO.   |      | DRAWN          |  | NOTE 1 |
| NO. DATE                           |  | AMENDMENT                                   |  | INITIALS | SURVEYED             |  |         | FIELD BOOK   |      | DRAFTING CHECK |  | NOTE 1 |



SUPERSEDES S.J.ELECTRIC DRG.No.5751-E-PSB-001

PROJECT  
OXLEY-ARCHERFIELD  
AERODROME SP254  
UPGRADE

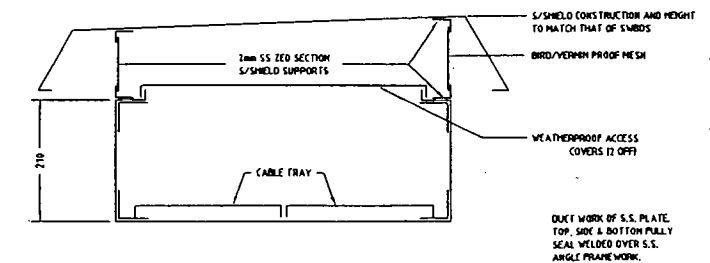
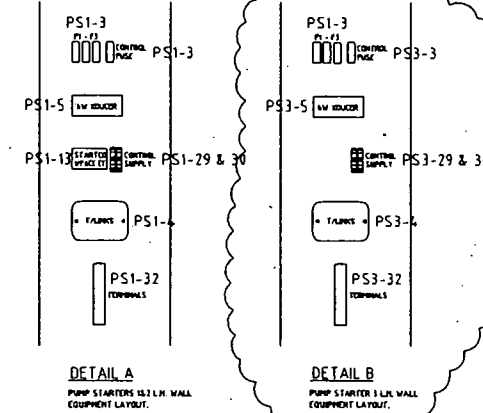
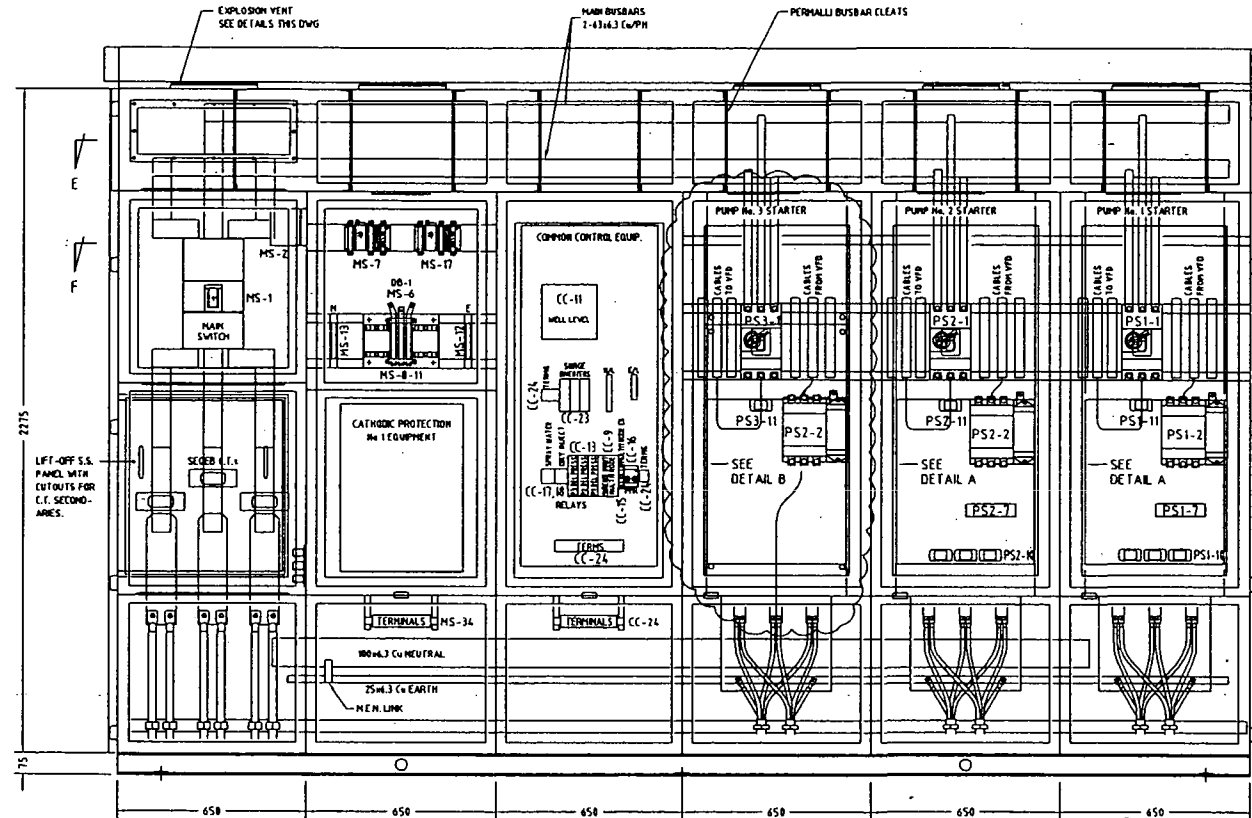
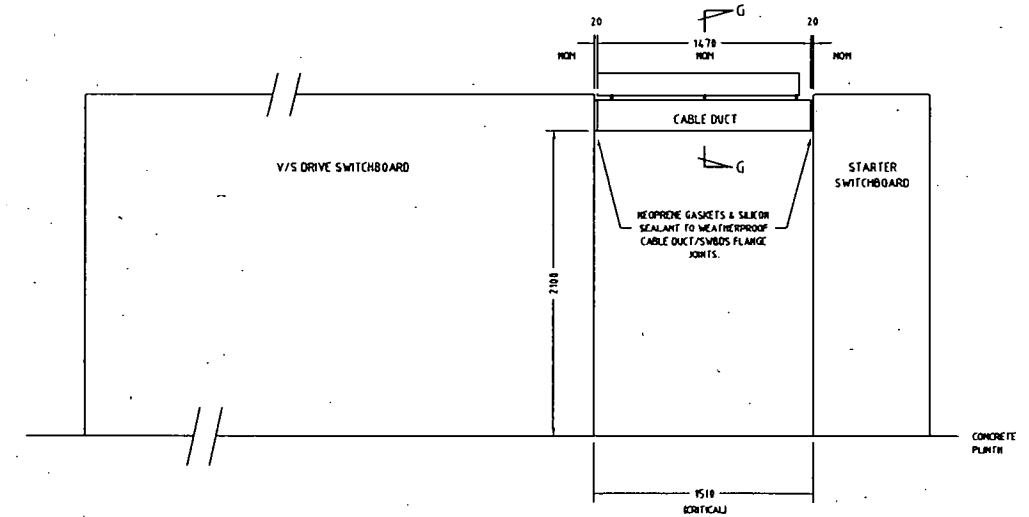
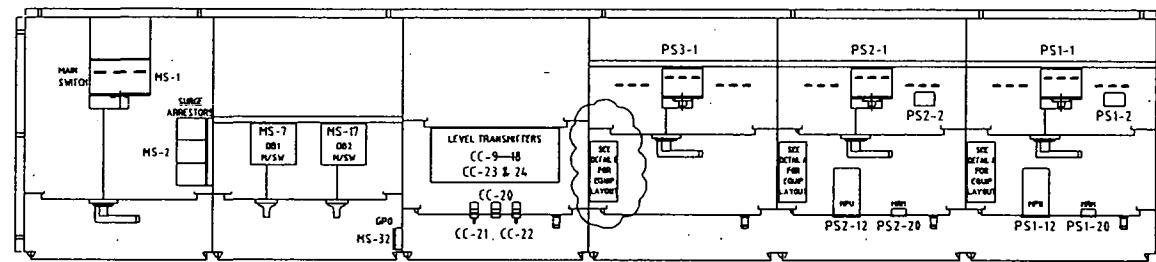
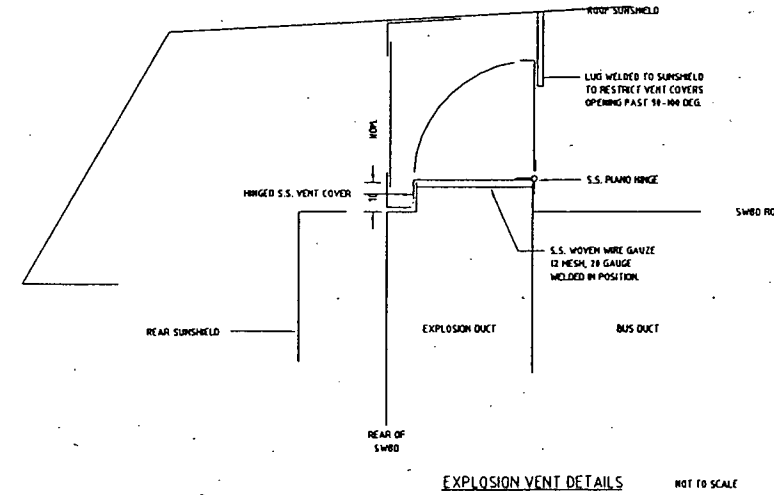
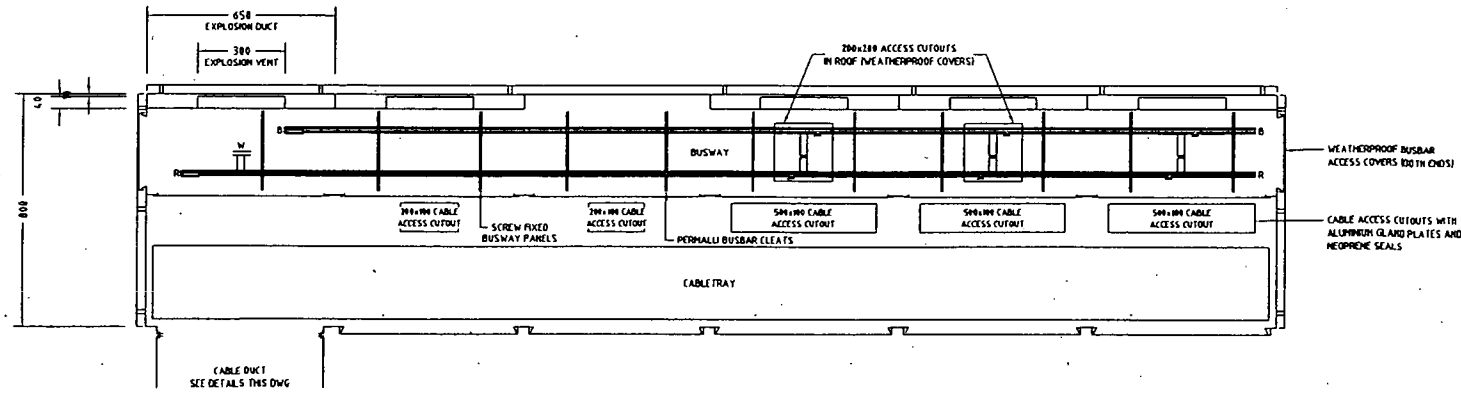
TITLE  
SWITCHBOARD  
LAYOUT  
SHEET 1 OF 4

SCALE  
DRAWING NO.  
486/5/7-PE044

APP. DATUM  
N° 1 OF 1 SHEETS  
AMEND.  
B



NOTES:  
1) THIS DRAWING HAS BEEN REPRODUCED FROM S.J.ELECTRIC DRAWING No.5751-E-PSB-002



FOR CONSTRUCTION NOTES REFER TO DWG 5751-E-VSB-002

SUPERSEDES S.J.ELECTRIC DRG.No.5751-E-PSB-002

| NO. | DATE     | AMENDMENT      | INITIALS | MANAGER OF BUSINESS ASSET SERVICES          | DATE | SUPERVISING ENGINEER | NOTE 1 | R.P.E.O. NO. | DATE | DESIGN         | NOTE 1 |
|-----|----------|----------------|----------|---|------|----------------------|--------|--------------|------|----------------|--------|
| 0   | 07.06.01 | ORIGINAL ISSUE |          | MANAGER OF OPERATIONS                       |      |                      |        | 57PE045      |      | DESIGN CHECK   | NOTE 1 |
|     |          |                |          | MANAGER PROFESSIONAL SERVICES - ENGINEERING |      |                      |        |              |      | DRAWN          | NOTE 1 |
|     |          |                |          |   |      |                      |        |              |      | DRAFTING CHECK | NOTE 1 |



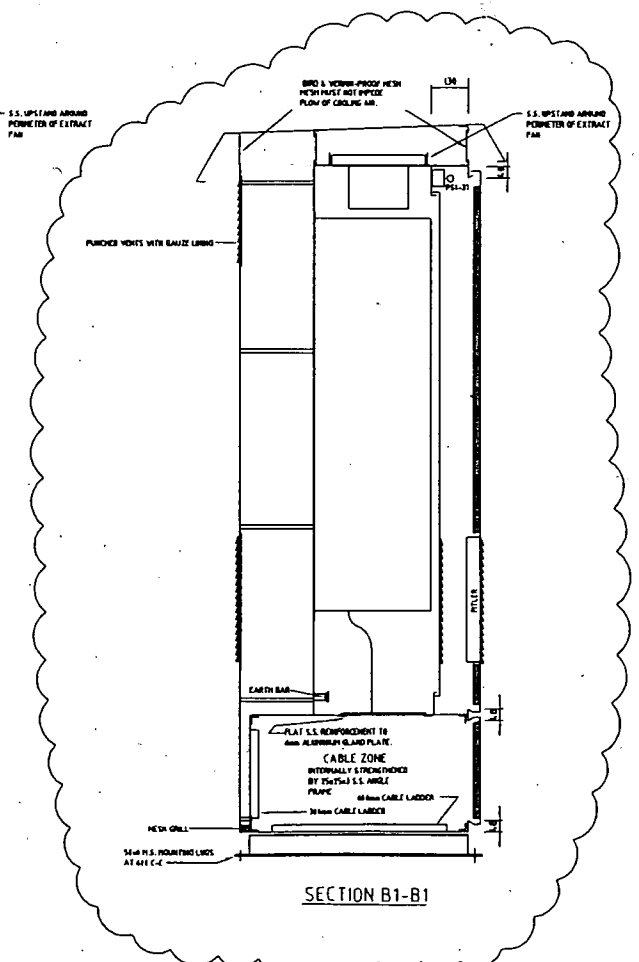
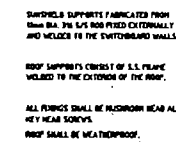
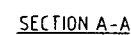
PROJECT  
OXLEY-ARCHERFIELD  
AERODROME SP254  
UPGRADE

TITLE  
SWITCHBOARD  
LAYOUT  
SHEET 2 OF 4

ISSUED FOR CONSTRUCTION

| SCALE                       | A.M. DATUM                      |
|-----------------------------|---------------------------------|
| DRAWING N°<br>486/5/7-PE045 | N° 1 OF 1 SHEETS<br>AMEND.<br>0 |

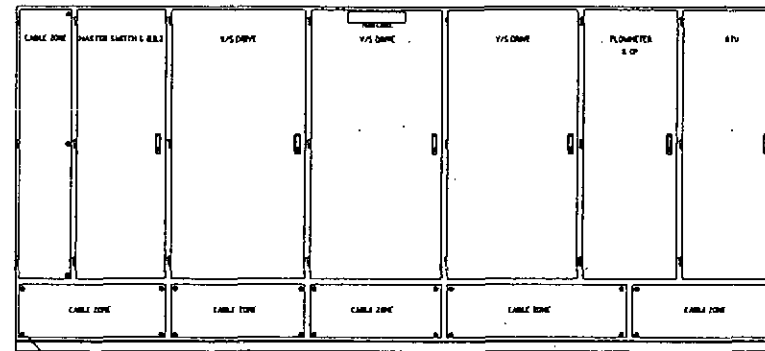




|               |            |           |
|---------------|------------|-----------|
| SCALE         | A.M. DATUM |           |
|               | N°         | OF SHEETS |
| DRAWING N°    |            | AMEND.    |
| 486/5/7-PE046 |            | 0         |



NOTES:  
1) THIS DRAWING HAS BEEN REPRODUCED FROM S.JELECTRIC DRAWING No.5751-E-VSB-001

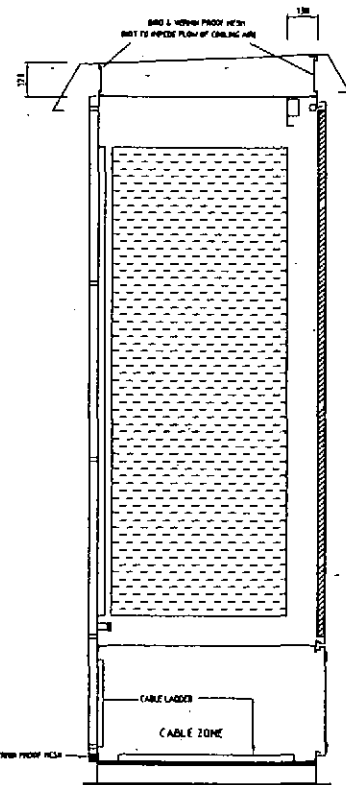


SEAL TABLE ZONE OPENING  
SHALL HAVE LOCATING PIN  
WHICH IS 10MM LONG AND VISIBLE

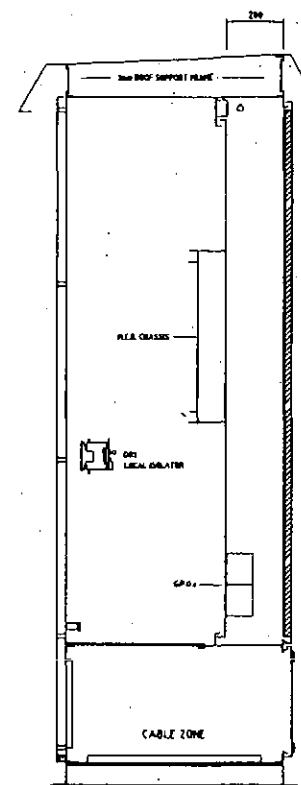
DOOR LAYOUT  
SCALE 1:10

**SPECIFICATIONS**

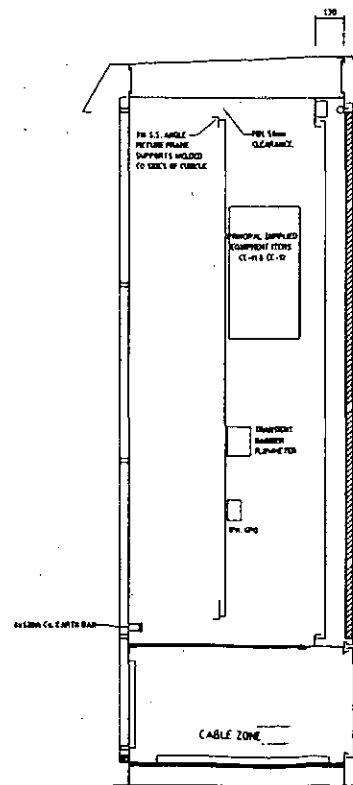
- CONSTRUCTED FROM 316 STAINLESS STEEL BODY - 2mm THICK GAUGE  
SURFACES - 1.5mm GAUGE  
FOLDED AND WELDED AS SHOWN DOORS AND ESCUTCHEONS STRIPPED AS NECESSARY.  
ALL DOORS SHALL HAVE A BROAD STIFFENING 17 CHANNEL.  
INSULATION - 100mm POLYURETHANE INSULATION AS SHOWN.  
EQUIPMENT PLATES OVER 1000mm IN ANY DIMENSION SHALL BE 3mm P.S. SECURED WITH WELDED STUDS AND NUTS.  
ALL DOORS WELDED ON CHROME PINTLE LIFT-OFF HINGES, 3 FOR DOORS OVER 1000mm HIGH.  
DEGREE OF PROTECTION - IP 45, VANDALPROOF AND WEATHERPROOF.
- FORM OF SEGREGATION - FORM 3
- PAINT WITHSTAND - 2500
- ALL EXTERNAL DOORS SECURED WITH ELECTRIC 100-5000 LOCKS. INTERNAL DOORS SHALL BE SECURED WITH T-HANDLES AND ESCUTCHEONS WITH ALUMINUM NUTS TO WELDED STUDS.
- GLAND PLATES - 6mm ALUMINUM U.N.D. WITH PEXING HOLES AT 100mm P.S. C.C. OPENINGS SHALL BE SEALED WITH 25mm WIDE NEOPRENE GASKETS GLUED TO THE SWITCHBOARD.
- PLINTH - 75x100mm P.S. CHANNEL 100mm HIGH WITH EXTERNAL LUGS FOR BOLTING DOWN. NOT TO BE GALVANIZED AFTER FABRICATION.
- PROVIDE LOUVERED VENTS IN DOORS AND ROOF AS SHOWN. 150mm SO. BRONZE MESH AND DUST FILTER TO INSIDE.
- FINISH - SANDBLAST EXTERNAL SURFACES, NATURAL FINISH - INTERNAL SURFACES. ESCUTCHEONS ETC. - GLOSS WHITE.



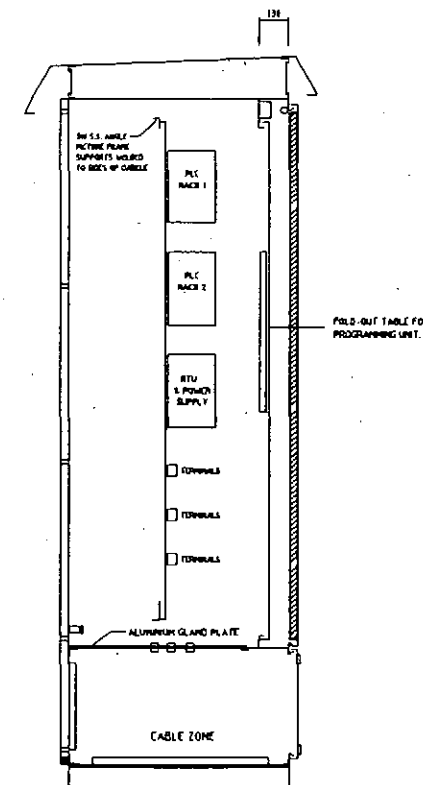
SECTION C-C



SECTION D-D



SECTION E-E



SECTION F-F

|                        |  |                |           |          |                                       |      |                         |        |              |      |        |        |              |        |       |        |                |        |   |   |   |   |   |  |
|------------------------|--|----------------|-----------|----------|---------------------------------------|------|-------------------------|--------|--------------|------|--------|--------|--------------|--------|-------|--------|----------------|--------|---|---|---|---|---|--|
| O 07.06.01<br>NO. DATE |  | ORIGINAL ISSUE | AMENDMENT | INITIALS | MANAGER OF BUSINESS<br>ASSET SERVICES | DATE | SUPERVISING<br>ENGINEER | NOTE 1 | R.P.E.O. NO. | DATE | DESIGN | NOTE 1 | DESIGN CHECK | NOTE 1 | DRAWN | NOTE 1 | DRAFTING CHECK | NOTE 1 |  | SUPERSEDES S.J.ELECTRIC DRG.No.5751-E-VSB-001<br><b>Brisbane Water</b><br> | PROJECT<br><b>OXLEY-ARCHERFIELD<br/>AERODROME SP254<br/>UPGRADE</b> | TITLE<br><b>SWITCHBOARD<br/>LAYOUT<br/>SHEET 4 OF 4</b> | SCALE<br>DRAWING N°<br><b>486/5/7-PE047</b> | A.M. DATUM<br>N° 1 OF 1 SHEETS<br>AMEND.<br><b>0</b> |
|------------------------|--|----------------|-----------|----------|---------------------------------------|------|-------------------------|--------|--------------|------|--------|--------|--------------|--------|-------|--------|----------------|--------|---|---|---|---|---|--|



| CABLE No.  | FROM  | TO                       | TYPE    | SIZE                         | LENGTH | REMARKS            |
|------------|---|--------------------------|---------|------------------------------|--------|--------------------|
| T1-SWB-PIA | 11KV/415V TRANSFORMER LV SIDE (RED PHASE)   | PUMP STARTER SWITCHBOARD | PVC/PVC | 1C x 4.00mm <sup>2</sup>     |        |                    |
| T1-SWB-PIB | 11KV/415V TRANSFORMER LV SIDE (RED PHASE)   | PUMP STARTER SWITCHBOARD | PVC/PVC | 1C x 4.00mm <sup>2</sup>     |        |                    |
| T1-SWB-P2A | 11KV/415V TRANSFORMER LV SIDE (WHITE PHASE) | PUMP STARTER SWITCHBOARD | PVC/PVC | 1C x 4.00mm <sup>2</sup>     |        |                    |
| T1-SWB-P2B | 11KV/415V TRANSFORMER LV SIDE (WHITE PHASE) | PUMP STARTER SWITCHBOARD | PVC/PVC | 1C x 4.00mm <sup>2</sup>     |        |                    |
| T1-SWB-P3A | 11KV/415V TRANSFORMER LV SIDE (BLUE PHASE)  | PUMP STARTER SWITCHBOARD | PVC/PVC | 1C x 4.00mm <sup>2</sup>     |        |                    |
| T1-SWB-P3B | 11KV/415V TRANSFORMER LV SIDE (BLUE PHASE)  | PUMP STARTER SWITCHBOARD | PVC/PVC | 1C x 4.00mm <sup>2</sup>     |        |                    |
| T1-SWB-N   | 11KV/415V TRANSFORMER LV SIDE (NEUTRAL)     | PUMP STARTER SWITCHBOARD | PVC/PVC | 1C x 4.00mm <sup>2</sup>     |        |                    |
|            | 11KV/415V TRANSFORMER LV SIDE (EARTH)       | PUMP STARTER SWITCHBOARD | PVC/PVC | 1C x 120mm <sup>2</sup>      |        |                    |
| PP1-P1     | PUMP No.1 STARTER                           | PUMP No.1 V/S DRIVE      | PVC/PVC | 3C+E 185mm <sup>2</sup>      |        |                    |
| PP1-P2     | PUMP No.1 STARTER                           | PUMP No.1 V/S DRIVE      | PVC/PVC | 3C+E 185mm <sup>2</sup>      |        |                    |
| PP1-P3A    | PUMP No.1 STARTER                           | PUMP No.1                | PVC/PVC | 4C 50mm <sup>2</sup>         |        | SUPPLIED WITH PUMP |
| PP1-P3B    | PUMP No.1 STARTER                           | PUMP No.1                | PVC/PVC | 4C 50mm <sup>2</sup>         |        | SUPPLIED WITH PUMP |
| PP1-C1     | PUMP No.1 STARTER                           | PUMP No.1                | PVC/PVC | 4C 1mm <sup>2</sup>          |        | SUPPLIED WITH PUMP |
| PP1-C2     | PUMP No.1 STARTER                           | PLC SECTION              | PVC/PVC | 12C 1.5mm <sup>2</sup>       |        |                    |
| PP1-C3     | PUMP No.1 STARTER                           | PLC SECTION              | PVC/PVC | 15C 1.5mm <sup>2</sup>       |        |                    |
| PP1-PLC-1  | PUMP No.1 STARTER                           | PLC ANALOG INPUT SLOT 7  | DEKORON | 1PR 0/A SCRIN                |        |                    |
| PP1-PLC-2  | PUMP No.1 STARTER                           | PLC ANALOG OUTPUT SLOT 8 | DEKORON | 1PR 0/A SCRIN                |        |                    |
| PP2-P1     | PUMP No.2 STARTER                           | PUMP No.2 V/S DRIVE      | PVC/PVC | 3C+E 185mm <sup>2</sup>      |        |                    |
| PP2-P2     | PUMP No.2 STARTER                           | PUMP No.2 V/S DRIVE      | PVC/PVC | 3C+E 185mm <sup>2</sup>      |        |                    |
| PP2-P3A    | PUMP No.2 STARTER                           | PUMP No.2                | PVC/PVC | 4C 50mm <sup>2</sup>         |        | SUPPLIED WITH PUMP |
| PP2-P3B    | PUMP No.2 STARTER                           | PUMP No.2                | PVC/PVC | 4C 50mm <sup>2</sup>         |        | SUPPLIED WITH PUMP |
| PP2-C1     | PUMP No.2 STARTER                           | PUMP No.2                | PVC/PVC | 4C 1mm <sup>2</sup>          |        | SUPPLIED WITH PUMP |
| PP2-C2     | PUMP No.2 STARTER                           | PLC SECTION              | PVC/PVC | 12C 1.5mm <sup>2</sup>       |        |                    |
| PP2-C3     | PUMP No.2 STARTER                           | PLC SECTION              | PVC/PVC | 15C 1.5mm <sup>2</sup>       |        |                    |
| PP2-PLC-1  | PUMP No.2 STARTER                           | PLC ANALOG INPUT SLOT 7  | DEKORON | 1PR 0/A SCRIN                |        |                    |
| PP2-PLC-2  | PUMP No.2 STARTER                           | PLC ANALOG OUTPUT SLOT 8 | DEKORON | 1PR 0/A SCRIN                |        |                    |
| PP3-P1     | PUMP No.3 STARTER                           | PUMP No.3 V/S DRIVE      | PVC/PVC | 3C+E 185mm <sup>2</sup>      |        | (POWER TO VSD)     |
| PP3-P2     | PUMP No.3 V/S DRIVE                         | PUMP No.3 STARTER        | PVC/PVC | 3C+E+SCRN 185mm <sup>2</sup> |        | (VSD LOAD SIDE)    |
| PP3-P3A    | PUMP No.3 STARTER                           | PUMP No.3 MOTOR          | PVC/PVC | 4C 50mm <sup>2</sup>         |        | SUPPLIED WITH PUMP |
| PP3-P3B    | PUMP No.3 STARTER                           | PUMP No.3 MOTOR          | PVC/PVC | 4C 50mm <sup>2</sup>         |        | SUPPLIED WITH PUMP |
| PP3-C1     | PUMP No.3 STARTER                           | PUMP No.3 MOTOR          | PVC/PVC | 12C 1mm <sup>2</sup>         |        | SUPPLIED WITH PUMP |
| PP3-C2a    | PUMP No.3 STARTER                           | PLC SECTION              | DEKORON | 10PR 0/A SCRIN               |        |                    |
| PP3-C2b    | PUMP No.3 STARTER                           | PLC SECTION              | PVC/PVC | 10C 1mm <sup>2</sup>         |        |                    |
| PP3-C2c    | PUMP No.3 STARTER                           | PLC SECTION              | DEKORON | 1PR SCRIN                    |        |                    |
| PP3-C3     | PUMP No.3 V/S DRIVE                         | PLC SECTION              | DEKORON | 10PR SCRIN + 0/A SCRIN       |        |                    |
| PP3-C4a    | PUMP No.3 V/S DRIVE                         | PUMP No.3 STARTER        | PVC/PVC | 10C 1mm <sup>2</sup>         |        |                    |
| PP3-C4b    | PUMP No.3 V/S DRIVE                         | PUMP No.3 STARTER        | DEKORON | 1PR SCRIN                    |        |                    |
| V4-C5      | 450 VALVE V4                                | PLC SECTION              | DEKORON | 3PR 0/A SCRIN                |        |                    |
| V7-C6      | 750 VALVE V7                                | PLC SECTION              | DEKORON | 3PR 0/A SCRIN                |        |                    |
| V4-C7      | 450 VALVE V4                                | PUMP No.3 STARTER        | PVC/PVC | 3C+E 1mm <sup>2</sup>        |        |                    |
| V7-C8      | 750 VALVE V7                                | PUMP No.3 STARTER        | PVC/PVC | 3C+E 1mm <sup>2</sup>        |        |                    |

NOTES:  
 II. THIS DRAWING HAS BEEN REPRODUCED FROM DRG. 486/7/7-PEC0040E  
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SUPERSEDES DRG. 486/7/7-PEC0040E

ISSUED FOR CONSTRUCTION

|                                     |  |   |  |          |                      |  |         |              |                |        |        |   |  |   |                                       |  |
|-------------------------------------|--|---|--|----------|----------------------|--|---------|--------------|----------------|--------|--------|---|--|---|---------------------------------------|--|
| B 31.10.02 PUMP 3 CABLES REVISED    |  | MANAGER OF BUSINESS ASSET SERVICES          |  | DATE     | SUPERVISING ENGINEER |  | NOTE 1  | R.P.E.Q. NO. | DATE           | DESIGN | NOTE 1 |  | PROJECT<br>OXLEY-ARCHERFIELD<br>AERODROME SP254<br>UPGRADE | TITLE<br>PUMP STATION<br>CABLE SCHEDULE<br>SHEET 1 OF 3 | SCALE<br>DRAWING NO.<br>486/5/7-PE048 | A.M. DATUM<br>NO. 1 OF 1 SHEETS<br>AMEND.<br>B |
| A 30.10.02 PP3-P1 & P2 SCREEN ADDED |  | MANAGER OF OPERATIONS                       |  | DATE     | CADD FILE            |  | 57PE048 |              | DESIGN CHECK   | NOTE 1 |        |   |  |   |                                       |  |
| O 07.06.01 ORIGINAL ISSUE           |  | MANAGER PROFESSIONAL SERVICES - ENGINEERING |  | DATE     | JOB FILE             |  |         |              | DRAWN          | NOTE 1 |        |   |  |   |                                       |  |
| NO. DATE                            |  | AMENDMENT                                   |  | INITIALS | SURVEY NO.           |  |         |              | DRAFTING CHECK | NOTE 1 |        |   |  |   |                                       |  |





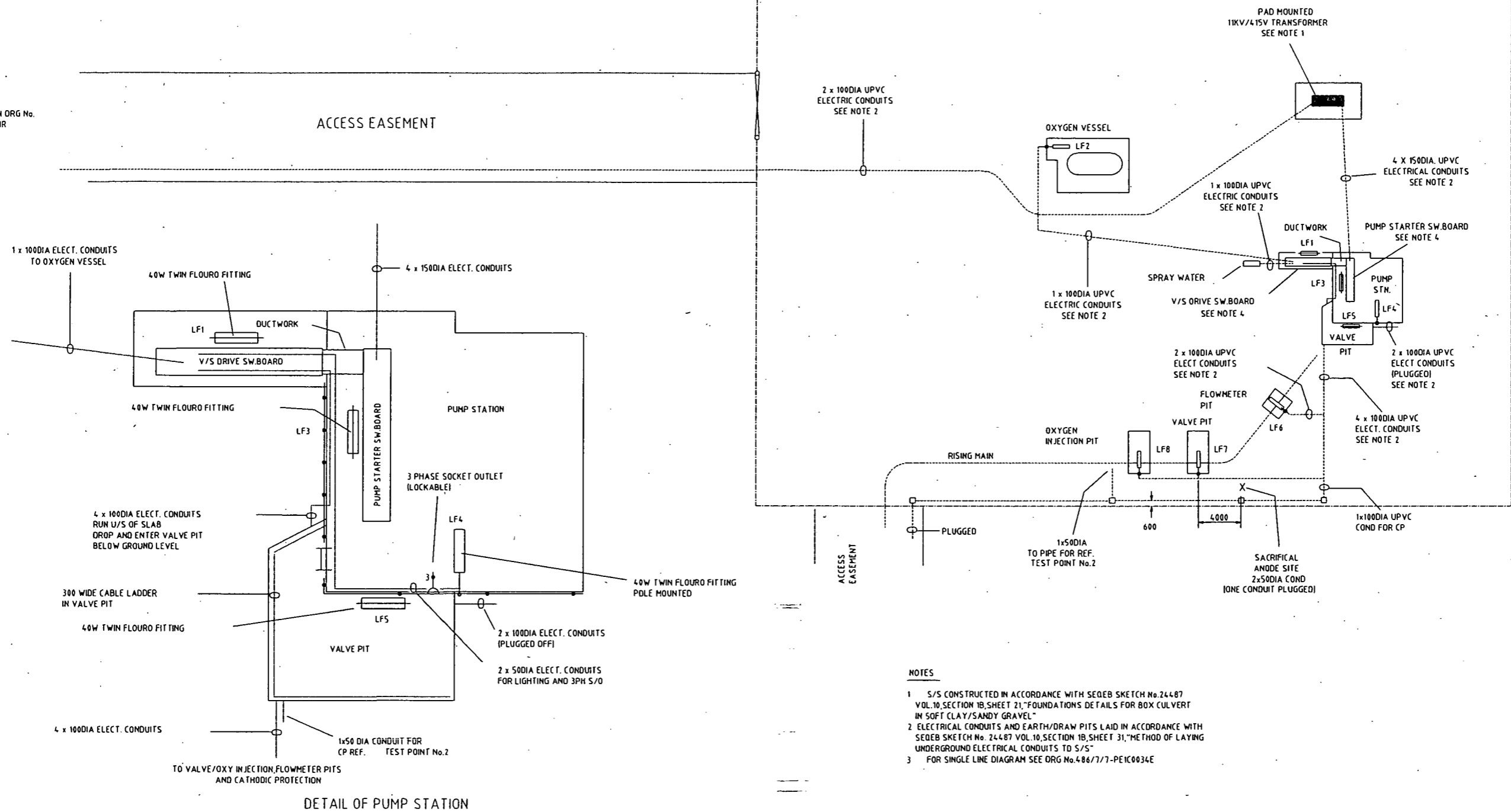






NOTES:  
1) THIS DRAWING HAS BEEN REPRODUCED FROM DRG.486/7/7-PE1C0035E  
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CONTINUED ON DRG No.  
486/5/7-PE13R



## NOTES

- 1 S/S CONSTRUCTED IN ACCORDANCE WITH SECEB SKETCH No.24487 VOL.10, SECTION 18, SHEET 21, "FOUNDATIONS DETAILS FOR BOX CULVERT IN SOFT CLAY/SANDY GRAVEL"
- 2 ELECTRICAL CONDUITS AND EARTH/DRAW PITS LAID IN ACCORDANCE WITH SECEB SKETCH No. 24487 VOL.10, SECTION 18, SHEET 31, "METHOD OF LAYING UNDERGROUND ELECTRICAL CONDUITS TO S/S"
- 3 FOR SINGLE LINE DIAGRAM SEE DRG No.486/7/7-PE1C0034E

SUPERSEDES DRG.486/7/7-PE1C0035E



PROJECT:  
OXLEY-ARCHERFIELD  
AERODROME SP254  
UPGRADE

TITLE  
PUMP STATION  
LAYOUT

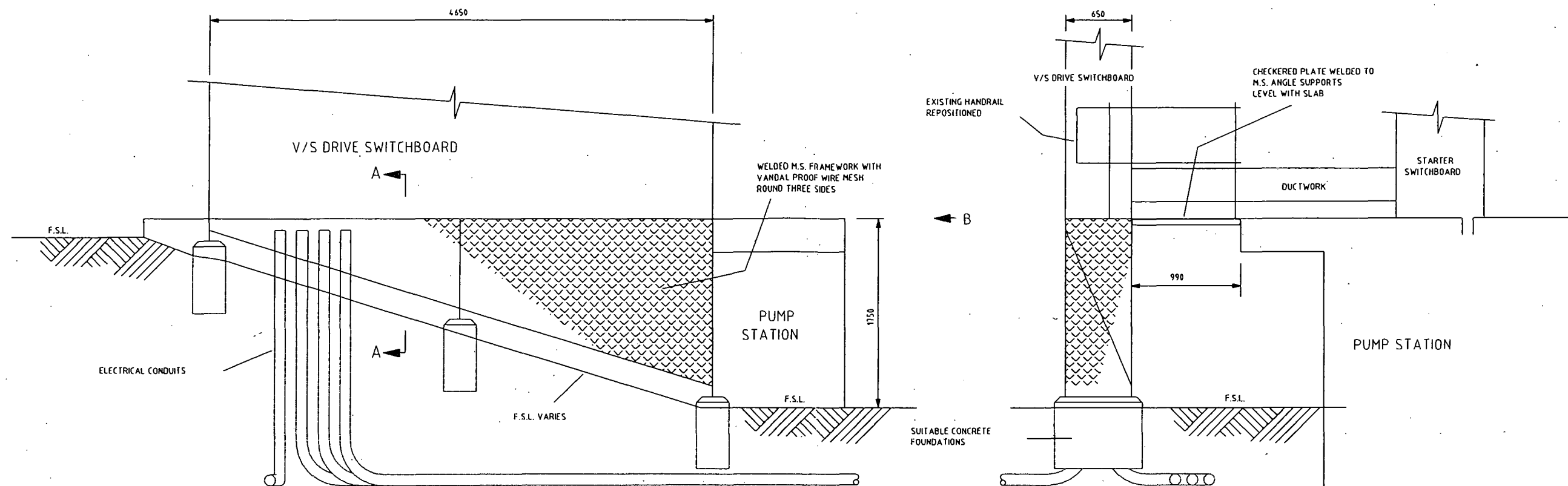
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SCALE: - A1: DATUM  
N° 1 OF 1 SHEETS  
DRAWING N° 486/5/7-PE051  
AMEND. 0

|  |        |                         |         |              |      |                |        |
|--|--------|-------------------------|---------|--------------|------|----------------|--------|
| MANAGER OF BUSINESS<br>ASSET SERVICES          | DATE   | SUPERVISING<br>ENGINEER | NOTE 1  | R.P.E.O. NO. | DATE | DESIGN         | NOTE 1 |
| MANAGER OF<br>OPERATIONS                       | DATE   | CADD FILE               | 57PE051 |              |      | DESIGN CHECK   | NOTE 1 |
| MANAGER PROFESSIONAL<br>SERVICES - ENGINEERING | NOTE 1 | JOB FILE                |         | SURVEY NO.   |      | DRAWN          | NOTE 1 |
|  |        | SURVEYED                |         | FIELD BOOK   |      | DRAFTING CHECK | NOTE 1 |

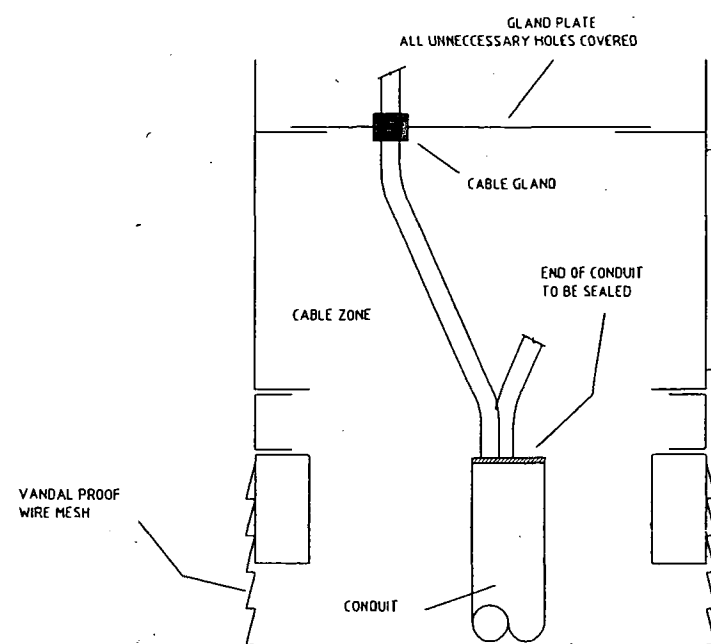


NOTES:  
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ELEVATION


VIEW ON ARROW B



SECTION ON A-A

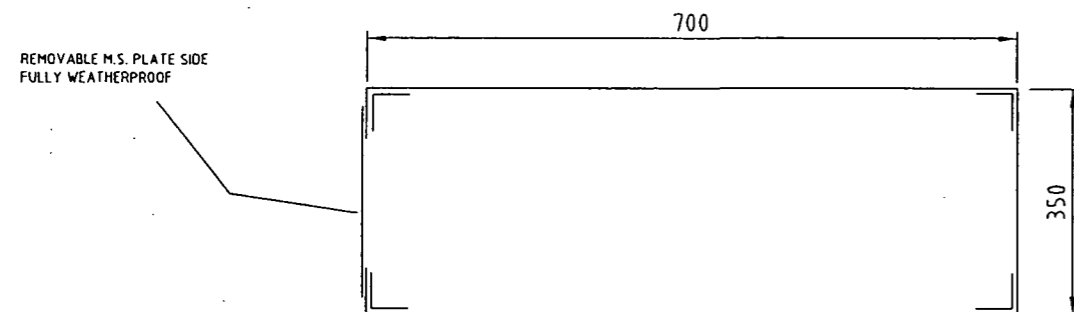
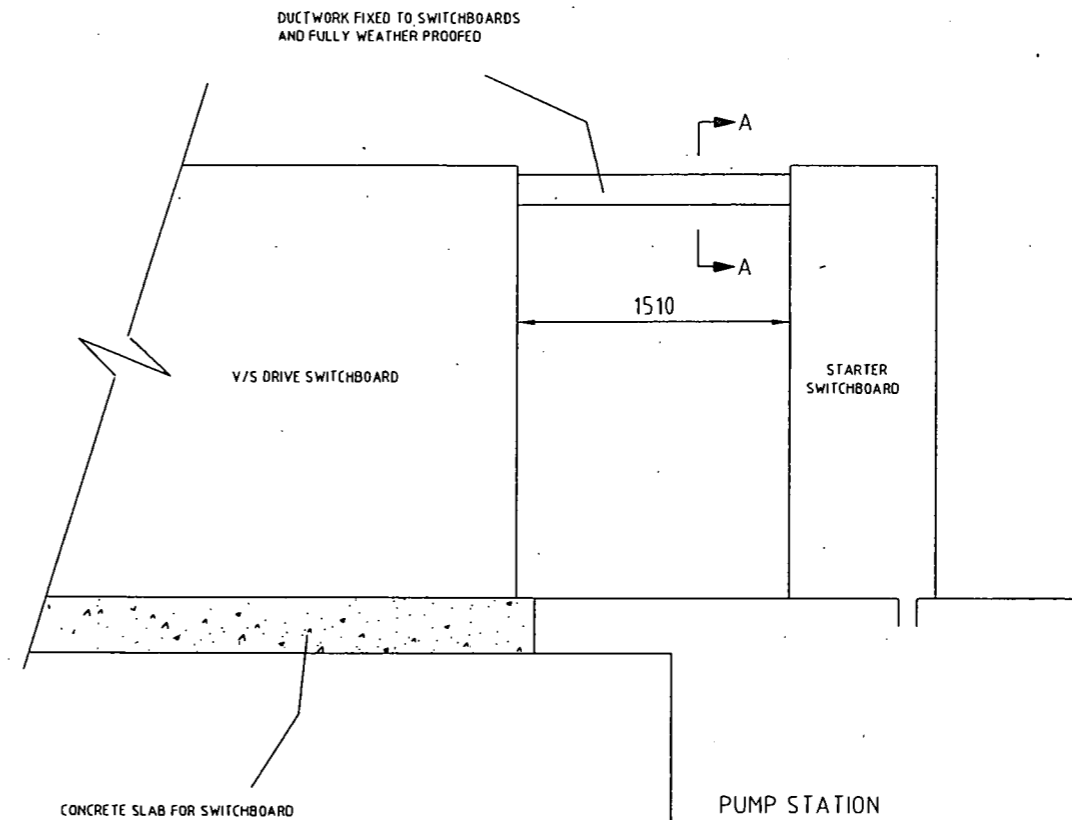
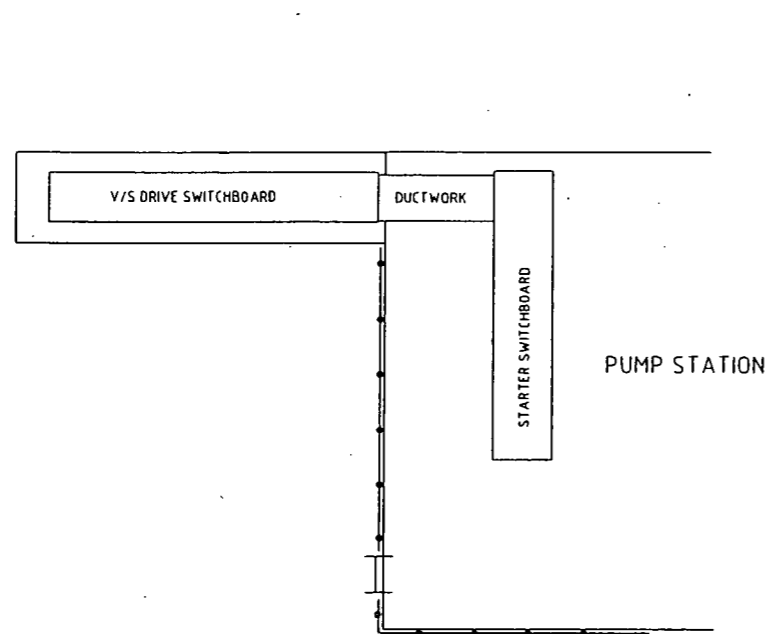
SUPERSEDES DRG.486/7/7-PE1C0?

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|            |  |                                    |  |          |   |  |         |              |  |      |              |  |        |  |                |  |   |  |       |  |   |  |       |  |            |  |                  |  |            |  |               |  |        |  |   |  |
|------------|--|------------------------------------|--|----------|---|--|---------|--------------|--|------|--------------|--|--------|--|----------------|--|---|--|-------|--|---|--|-------|--|------------|--|------------------|--|------------|--|---------------|--|--------|--|---|--|
|            |  | MANAGER OF BUSINESS ASSET SERVICES |  | DATE     | SUPERVISING ENGINEER                        |  | NOTE 1  | R.P.E.O. NO. |  | DATE | DESIGN       |  | NOTE 1 | <br>Brisbane City | PROJECT        |  | OXLEY-ARCHERFIELD AERODROME SP254 UPGRADE |  | TITLE |  | SWITCHBOARD SUPPORT GENERAL ARRANGEMENT |  | SCALE |  | A.H. DATUM |  | N° 1 OF 1 SHEETS |  | DRAWING N° |  | 486/5/7-PE052 |  | AMEND. |  | 0 |  |
|            |  | MANAGER OF OPERATIONS              |  | DATE     | CADD FILE                                   |  | 57PE052 |              |  |      | DESIGN CHECK |  | NOTE 1 |  | DRAWN          |  | NOTE 1                                    |  |       |  |   |  |       |  |            |  |                  |  |            |  |               |  |        |  |   |  |
| 0 07.06.01 |  | ORIGINAL ISSUE                     |  |          | JOB FILE                                    |  | -       |              |  |      | SURVEY NO.   |  |        |  | DRAFTING CHECK |  | NOTE 1                                    |  |       |  |   |  |       |  |            |  |                  |  |            |  |               |  |        |  |   |  |
| NO. DATE   |  | AMENDMENT                          |  | INITIALS | MANAGER PROFESSIONAL SERVICES - ENGINEERING |  | NOTE 1  | DATE         |  |      | SURVEYED     |  |        |  | FIELD BOOK     |  |   |  |       |  |   |  |       |  |            |  |                  |  |            |  |               |  |        |  |   |  |



NOTES:  
1) THIS DRAWING HAS BEEN REPRODUCED FROM DRG.486/7/7-PE1C0039E  
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DUCTWORK OF M.S. PLATE TOP, SIDE AND BOTTOM FULLY SEAL WELDED OVER A FRAMEWORK OF M.S. ANGLE

| NO | DATE     | AMENDMENT      | INITIALS |
|----|----------|----------------|----------|
| 0  | 07.06.01 | ORIGINAL ISSUE |          |

|   |      |
|---|------|
| MANAGER OF BUSINESS ASSET SERVICES          | DATE |
| MANAGER OF OPERATIONS                       | DATE |
| MANAGER PROFESSIONAL SERVICES - ENGINEERING | DATE |

|                      |        |              |      |
|----------------------|--------|--------------|------|
| SUPERVISING ENGINEER | NOTE 1 | R.P.E.O. NO. | DATE |
| CADD FILE            |        | 57PE053      |      |
| JOB FILE             |        | SURVEY NO.   |      |
| SURVEYED             |        | FIELD BOOK   |      |

|                |        |
|----------------|--------|
| DESIGN         | NOTE 1 |
| DESIGN CHECK   | NOTE 1 |
| DRAWN          | NOTE 1 |
| DRAFTING CHECK | NOTE 1 |



SUPERSEDES DRG.486/7/7-PE1C0039E



|         |   |
|---------|---|
| PROJECT | OXLEY-ARCHERFIELD AERODROME SP254 UPGRADE |
|---------|---|

|       |  |
|-------|--|
| TITLE | SWITCHBOARD DUCTWORK GENERAL ARRANGEMENT |
|-------|--|

FOR INFORMATION ONLY

|               |                  |
|---------------|------------------|
| SCALE         | A.M. DATUM       |
| DRAWING N°    | N° 1 OF 1 SHEETS |
| 486/5/7-PE053 | AMEND. 0         |











| Supplier Name                    | Part No              | Item Description                       | Qty |
|----------------------------------|----------------------|--|-----|
| ABK Electrical Wholesale Pty Ltd | CAGU50EMC/L          | 50MM EMX GLAND LONG THREAD 26-35MM O/D | 4   |
| Control Logic Pty Ltd            | P2RF-08-E            | BASES 2POLE                            | 4   |
| Control Logic Pty Ltd            | G2R-2-SN             | 2POLE 24V DC RELAY                     | 8   |
| Crompton Instruments             | 256-TWL              | BALANCED LOAD Kw TRANSDUCER            | 1   |
| MultiTrobe Pty Ltd               | MTR2                 | LEVEL CONTROL RELAY                    | 2   |
| NHP Electrical Engineering       | D5PP43RL7            | RED PILOT LIGHT ROUND 240V             | 1   |
| NHP Electrical Engineering       | DINT6306C            | DINT 6KA 3P 6A CB                      | 2   |
| NHP Electrical Engineering       | TAI4004005A          | CURRENT TRANSFORMER 400/5A             | 1   |
| NHP Electrical Engineering       | DINT10116C           | DINT10, 1P, 16AMPS                     | 1   |
| NHP Electrical Engineering       | 56.32 0054 240VAC    | RLY W/PB+LED FPIN 2CO 12A              | 10  |
| NHP Electrical Engineering       | 96.72                | 2P 12AMP RELAY BASE FOR 56.32 RLY      | 17  |
| NHP Electrical Engineering       | RQ480-240VAC         | 48MM 240VAC HOUR RUN METER 50HZ        | 1   |
| NHP Electrical Engineering       | D5PF33LX10           | GREEN PUSH BUTTON 1 NO CONTACT         | 1   |
| NHP Electrical Engineering       | D5PF63LX10           | BLUE PUSHBUTTON 1NO CONTACT            | 1   |
| NHP Electrical Engineering       | D5-3TH7              | TRANSFORMER LAMP 220-240V/24V          | 1   |
| NHP Electrical Engineering       | BA9S-RL-M-24V        | 24V DC LED RED                         | 1   |
| NHP Electrical Engineering       | DINT10120C           | DINT 10KA 1P 20A CB                    | 1   |
| NHP Electrical Engineering       | D5PF43LX01           | RED PUSHBUTTON 1NC CONTACT             | 1   |
| NHP Electrical Engineering       | CA6-250-EI-11-240VAC | CA6 CONTACTOR FOR 250kW 240VAC         | 1   |
| NHP Electrical Engineering       | RT3-M240VAC          | KIT FOR RELAY THERMISTOR 240VA         | 1   |
| RS Components                    | TC162-805            | 21MM 2W CERNET 0-1K LINEAR POT         | 1   |
| RS Components                    | TC581-969            | 35MM KNOB SKIRT 5/PK                   | 1   |
| RS Components                    | TC581-931            | 28.4MM DIAM SKIRT STYLE KNOB 5/PK      | 1   |
| Weidmuller                       | 47456                | ASK1 FUSE TERMINAL                     | 30  |
| Weidmuller                       | 102010               | WDU4 TERMINAL                          | 200 |
| Ziehl-ebm Australia Pty Ltd      | W2S130AA0363         | 45WATT FAN                             | 1   |





PASTEL  
MANILLA  
DIVIDERS  
5 TAB A4



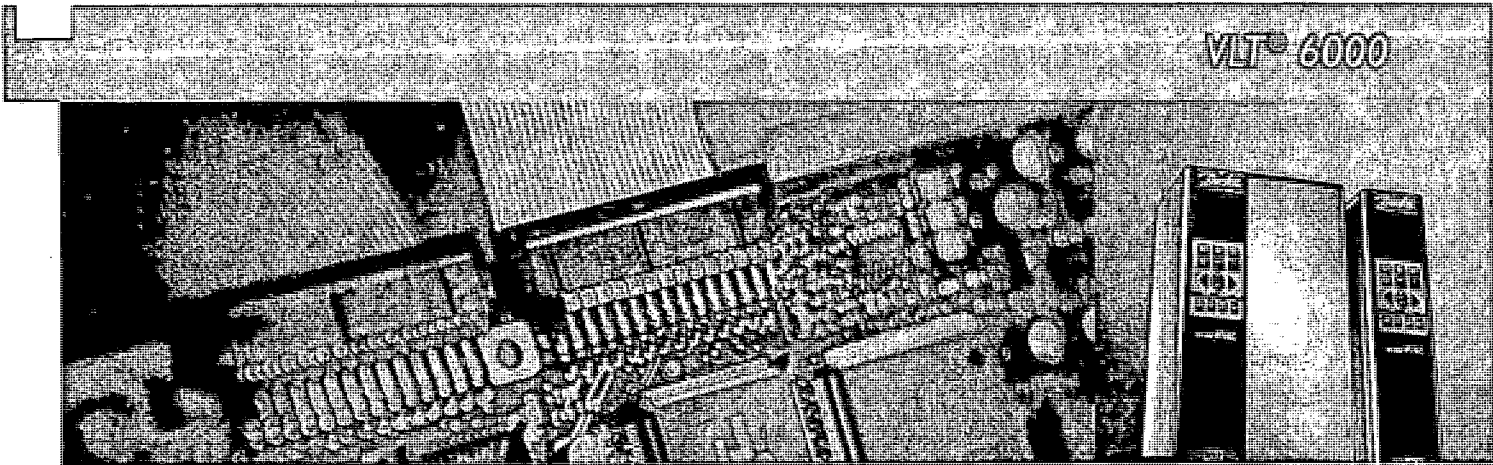
Ref. No. 37000  
Made in China  
Distributed by ACCO Australia



9 312311 370002



Frequency converters



# Operating Instructions

VLT®600 /AC



VLT® is a trademark of Danfoss A/S




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## Addendum

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### VLT® 6000 Series

#### Instruction Manuals MG.60.A6.02

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#### Software Version 2.40

(Software version number can be read in parameter 624)

#### Additions:

- New parameter 118: *Motor power factor (Cos Ø)*. This parameter allows the user to calibrate the AEO function to the power factor of the motor so that AEO can be used with motors of 6, 8, and 12 poles as well as 2- and 4-pole motors as in the past. Value: 0.50 - 0.99. Default: 0.75.
- Add note to parameter 215, *Current limit*. NB! If the drive is in current limit and a stop command is initiated with the stop button on the LCP keypad, the drive output is immediately turned off and the motor will coast to a stop.
- New choice in parameter 001, *Language*.  
Finnish (SUOMI) [9].
- New choices in parameter 007, *Large display readout*.  
Status word (STATUS WORD [HEX]) [28]  
Displays the actual drive status word (see parameter 608).  
Control word (CONTROL WORD [HEX]) [29]  
Displays the actual control word (see parameter 609).  
Alarm word (ALARM WORD [HEX]) [30]  
Displays the actual alarm word.

#### LCP procedure for entering text:

After selecting *Display Text* in parameter 007, select display line parameter (533 or 534) and press the **CHANGE DATA** key. Enter text directly into the selected line by using the UP, DN & LEFT, RIGHT arrow keys on the LCP. The UP and DN arrow keys scroll through the available characters. The Left and Right arrow keys move the cursor through the line of text.

To lock in the text, press the **OK** key when the line of text is completed. The **CANCEL** key will cancel the text.

The available characters are:

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z Å Ø Ä Å Ö Ü É Ì Ù è  
 . / - ( ) 0 1 2 3 4 5 6 7 8 9 'space'

'space' is the default value of parameter 533 & 534.

To erase a character that has been entered, it must be replaced with 'space'.

- New choices in parameter 417, *Feedback function*.  
Feedback 1 Only [7]  
If *Feedback 1 Only* is selected, terminal 53 is read as the feedback signal and terminal 54 ignored.  
*Feedback 1* is compared to *Setpoint 1* for drive control.  
Feedback 2 Only [8]  
If *Feedback 2 Only* is selected, terminal 54 is read as the feedback signal and terminal 53 ignored.  
*Feedback 2* is compared to *Setpoint 2* for drive control.

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August 2002



## VLT® 6000 HVAC

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HVAC

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Programming

All about  
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**VLT® 6000 HVAC**


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VLT® 6000 HVAC

# VLT 6000 HVAC

**Operating instructions**  
**Software version: 2.2x**



These operating instructions can be used for all VLT 6000 HVAC frequency converters with software version 2.2x. The software version number can be seen from parameter 624.

175ZA691.10



## VLT® 6000 HVAC



The voltage of the frequency converter is dangerous whenever the equipment is connected to mains. Incorrect installation of the motor or the frequency converter may cause damage to the equipment, serious personal injury or death. Consequently, the instructions in this manual, as well as national and local rules and safety regulations, must be complied with.

### ■ Safety regulations

1. The VLT 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 [OFF/STOP] key on the control panel of the VLT 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 included in the factory setting. Parameter 117, *Motor thermal protection*, default value is ETR trip 1.



**NB!**

The function is initialised at 1.0 x rated motor current and rated motor frequency (see parameter 117, *Motor thermal protection*).

For the North American market: The ETR functions ensure overload protection of the motor, Class 20, in accordance with NEC.

6. Do not remove the plugs for the motor and mains supply while the VLT 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. Reliable galvanic isolation (PELV) is not complied with if the RFI switch is placed in OFF position. This means that all control in- and outputs can only be considered low-voltage terminals with basic galvanic isolation.
8. Please note that the VLT frequency converter has more voltage inputs than L1, L2, L3 when the DC-bus terminals are used.  
Check that all voltage inputs have been disconnected and that the necessary time has passed before repair work is commenced.

### ■ 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 [OFF/STOP] must always be activated, following which data can be modified.
3. A stopped motor may start if a fault occurs in the electronics of the VLT 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.

|                                     |                          |
|-------------------------------------|--------------------------|
| Using VLT 6002-6005, 220 and 500 V: | wait at least 4 minutes  |
| Using VLT 6006-6550, 220 and 500 V: | wait at least 15 minutes |
| Using VLT 6002-6006, 550-600 V:     | wait at least 4 minutes  |
| Using VLT 6008-6027, 550-600 V:     | wait at least 15 minutes |
| Using VLT 6032-6275, 550-600 V:     | wait at least 30 minutes |



## VLT® 6000 HVAC

### ■ Introduction to Operating Instructions

These Operating Instructions are intended as a tool for you as the person who is going to install, operate and program the VLT 6000 HVAC.

A VLT 6000 HVAC comes with *Operating Instructions* as well as a *Quick Setup Guide*. In addition, a *Design Guide* can be ordered for use when designing installations that will include a VLT 6000 HVAC. See *Available literature*.

**Operating Instructions:** These are instructions in how to ensure optimum mechanical and electrical installation, commissioning and service. The Operating Instructions also include a description of the software parameters, thereby enabling easy adaptation of the VLT 6000 HVAC to your application.

**Quick Setup Guide:** Helps you to quickly install and commission the VLT 6000 HVAC.

**Design Guide:** Used when designing installations that include a VLT 6000 HVAC. The *Design Guide* gives detailed information about VLT 6000 HVAC and HVAC installations, including a selection tool to enable you to choose the right VLT 6000 HVAC with its relevant options and modules. The *Design Guide* also contains examples of the most common HVAC applications. Furthermore, the *Design Guide* has all information relating to serial communication.

These Operating Instructions are divided into four sections with information about VLT 6000 HVAC.

**Introduction to HVAC:** This section tells you the advantages you can obtain by using a VLT 6000 HVAC - such as AEO, Automatic Energy Optimization, RFI filters and other HVAC-relevant functions. This section also contains examples of application as well as information about Danfoss and CE-labelling.

**Installation:** This section tells you how to carry out mechanically correct installation of the VLT 6000 HVAC. In addition, this section includes a description of how to ensure that the installation of your VLT 6000 HVAC is EMC-correct. Furthermore, a list is given of mains and motor connections, together with a description of the control card terminals.

**Programming:** This section describes the control unit and the software parameters for the VLT 6000 HVAC. Also included is a guide to the Quick Setup menu, which allows you to get started on your application very quickly.

**All about VLT 6000 HVAC:** This section gives information about status, warning and error messages from the VLT 6000 HVAC. Additionally, information is given on technical data, service, factory settings and special conditions.



Indicates something to be noted by the reader.



Indicates a general warning.



Indicates a high-voltage warning.

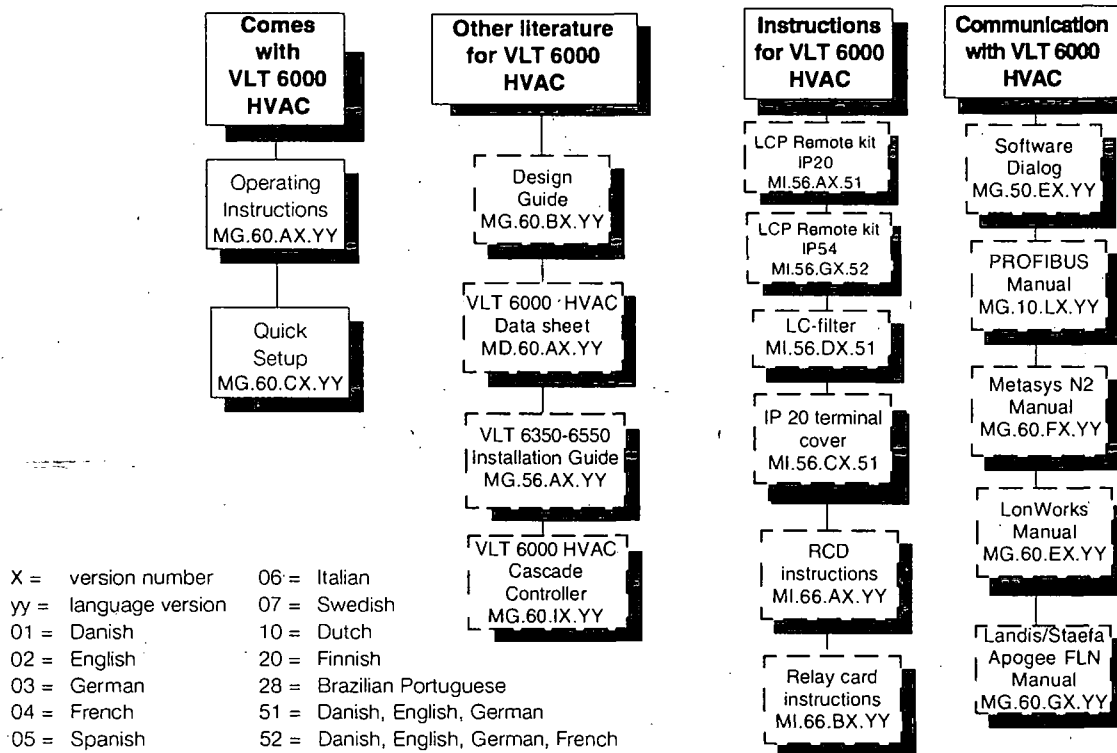


## VLT® 6000 HVAC

### ■ Available literature

The chart below gives an overview of the literature available for the VLT 6000 HVAC.

Please note that variations may occur from one country to the next



Introduction to HVAC

### ■ VLT 6000 advantages in a HVAC installation

One advantage involved in using a VLT 6000 HVAC is that this unit has been designed to regulate the speed of fans and rotary pumps while consuming the smallest possible amount of energy. Consequently, if a VLT 6000 HVAC is used in a HVAC installation, optimum energy savings are guaranteed, since less energy is used with a VLT frequency converter than with the traditional HVAC regulation principles. Another advantage in using the VLT 6000 HVAC is that regulation is improved and can easily adapt to a new flow or pressure requirement in an installation. The use of a VLT 6000 HVAC offers the following additional advantages:

- VLT 6000 HVAC has been designed for HVAC applications.
- A wide power range - from 1.1-250 kW, 1.1-200 kW for 550-600 V units with a unique design.
- IP 20 and IP 54 enclosures that can be mounted side by side. For power sizes  $\geq 55$  kW ( $\geq 30$  kW for 200 V) IP 00 is also available.
- All unit types, except 550-600 V units, are available with an integral RFI filter, complying with EN 55011 class 1-A in the case of a 150 m screened/armoured motor cable and EN 55011 class 1-B in the case of a screened/armoured motor cable up to 50 m long.
- User-friendly design, which makes VLT 6000 HVAC easy to install, both mechanically and electrically.
- Detachable LCP control panel with Hand-Off-Auto buttons and a graphics display of local speed.
- High starting torque owing to Automatic Energy Optimization (AEO).
- Automatic Motor Adaptation (AMA) ensures optimum motor utilisation.
- Integral PID regulator with option of connecting two feedback signals (in connection with zoning), as well as setting of two set-points.
- Sleep mode, which automatically turns the motor off, e.g. when there is no need for more pressure or flow in a system.
- The "flying start" function enables the unit to catch a rotating fan.
- Automatic ramp up/down to ensure that the VLT 6000 HVAC will not trip during acceleration or deceleration.
- All standard units have three integral, serial protocols - RS 485 FC protocol, Johnson's Metasys N2 and Landis/Staefa Apogee FLN. Communication option cards that can be connected are LonWorks, Profibus for the VLT 6000 HVAC.

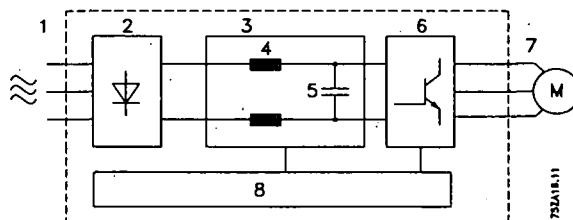


## VLT® 6000 HVAC

### ■ Control principle

A frequency converter rectifies AC voltage from mains into DC voltage, after which this DC voltage is converted into an AC current with a variable amplitude and frequency.

The motor is thus supplied with variable voltage and frequency, which enables infinitely variable speed regulation of three-phased, standard AC motors.



#### 1. Mains voltage

- 3 x 200 - 240 V AC, 50 / 60 Hz
- 3 x 380 - 460 V AC, 50 / 60 Hz
- 3 x 550 - 600 V AC, 50 / 60 Hz

#### 2. Rectifier

A three-phase rectifier bridge that rectifies AC current into DC current.

#### 3. Intermediate circuit

DC voltage =  $\sqrt{2}$  x mains voltage [V].

#### 4. Intermediate circuit coils

Even out the intermediate circuit voltage and reduce the harmonic current feedback to the mains supply.

#### 5. Intermediate circuit capacitors

Even out the intermediate circuit voltage.

#### 6. Inverter

Converts DC voltage into variable AC voltage with a variable frequency.

#### 7. Motor voltage

Variable AC voltage, 10-100% of mains supply voltage.

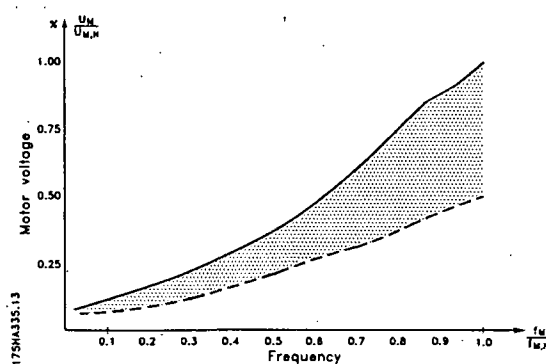
#### 8. Control card

This is where to find the computer that controls the inverter which generates the pulse pattern by which the DC voltage is converted into variable AC voltage with a variable frequency.

### ■ AEO - Automatic Energy Optimization

Normally, the U/f characteristics have to be set on the basis of the expected load at different frequencies. However, knowing the load at a given frequency in an installation is often a problem. This problem can be solved by using a VLT 6000 HVAC with its integral Automatic Energy Optimization (AEO), which ensures optimum energy utilization. All VLT 6000 HVAC units feature this function as a factory setting, i.e. it is not necessary to adjust the frequency converter U/f ratio in order to obtain maximum energy savings. In other frequency converters, the given load and voltage/frequency ratio (U/f) must be assessed to carry out correct setting of the frequency converter. Using Automatic Energy Optimization (AEO), you no longer need to calculate or assess the system characteristics of the installation, since Danfoss VLT 6000 HVAC units guarantee optimum, load-dependent energy consumption by the motor at all times.

The figure on the right illustrates the working range of the AEO function, within which energy optimization is enabled.



If the AEO function has been selected in parameter 101, *Torque characteristics*, this function will be constantly active. If there is a major deviation from the optimum U/f ratio, the VLT frequency converter will quickly adjust itself.

#### Advantages of the AEO function

- Automatic energy optimization
- Compensation if an oversize motor is used
- AEO matches operations to daily or seasonal fluctuations
- Energy savings in a constant air volume system
- Compensation in the oversynchronous working range
- Reduces acoustic motor noise



## VLT® 6000 HVAC

### ■ Example of application - Speed control of fan in ventilation system

The AHU installation is able to distribute air throughout the building or to one or several parts of a building.

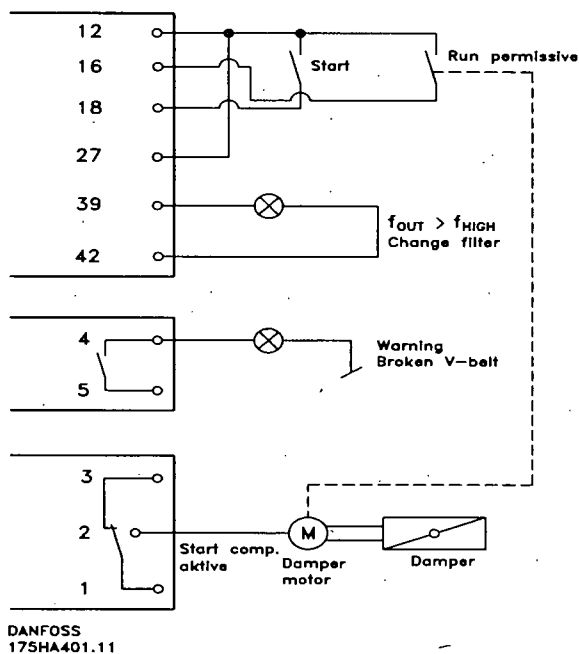
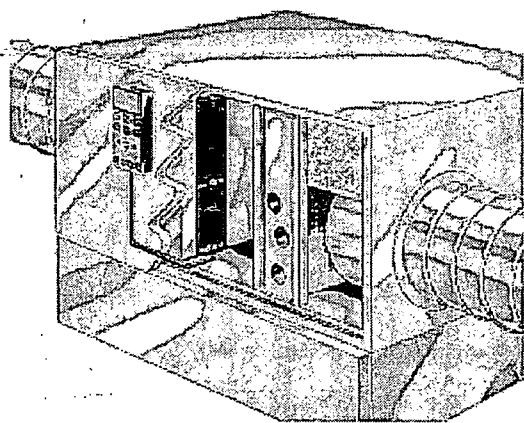
Normally, an AHU installation consists of a fan and a motor that supply air, a fan scroll and a duct system with filters. If centralised air distribution is applied, the efficiency of the installation will increase and major energy savings can be made.

A VLT 6000 HVAC enables excellent control and monitoring, thereby ensuring perfect conditions in the building at all times.

This example shows an application with *Run permissive*, warning against no load and warning for filter change.

The *Run permissive* function ensures that the VLT frequency converter will not start the motor until the discharge damper has opened. If the V-belt to the fan breaks and if the filter is to be changed, this application will also give a warning on an output.

Introduction to HVAC



Set the following parameters:

|          |                                     |   |
|----------|-------------------------------------|---|
| Par. 100 | Configuration                       | Open loop [0]                                     |
| Par. 221 | Warning: Low current, $I_{LOW}$     | Depends on unit                                   |
| Par. 224 | Warning: High frequency, $f_{HIGH}$ |   |
| Par. 300 | Terminal 16 Digital inputs          | Run permissive [8]                                |
| Par. 302 | Terminal 18 Digital inputs          | Start [1]   |
| Par. 308 | Terminal 53, analogue input voltage | Reference [1]                                     |
| Par. 309 | Terminal 53, min. scaling           | 0 V   |
| Par. 310 | Terminal 53, max. scaling           | 10 V  |
| Par. 319 | Output                              | Output frequency greater than $f_{HIGH}$ par. 224 |
| Par. 323 | Relay 1                             | Start command active [27]                         |
| Par. 326 | Relay 2                             | Alarm or warning [12]                             |
| Par. 409 | Function at no load                 | Warning [1]                                       |



## VLT® 6000 HVAC

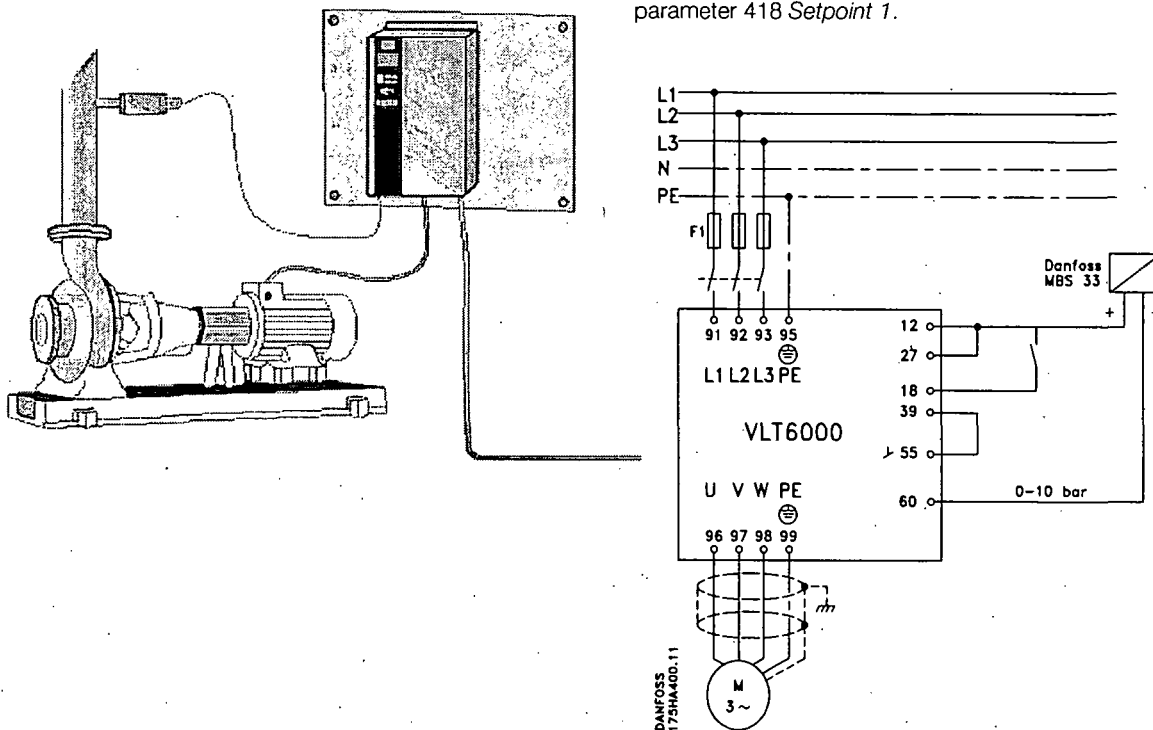
### ■ Example of application - Constant pressure regulation in water supply system

The demand for water from waterworks varies considerably over the 24 hours of a day. In the night, practically no water is used, while in the morning and in the evening the consumption is high. In order to maintain a suitable pressure in the water supply lines in relation to the current demand, the water supply pumps are equipped with speed control. The use of frequency converters enables the energy consumed by the pumps to be kept at a minimum, while optimizing the water supply to consumers.

A VLT 6000 HVAC with its integral PID controller ensures simple and quick installation. For example, an IP 54 unit can be mounted close to the pump on the wall and the existing mains cables can be used as mains supply to the frequency converter.

A Danfoss MBS 33 0-10 bar can be fitted a couple of metres from the joint outlet point from the waterworks to obtain closed loop regulation. Danfoss MBS 33 is a two-wire transmitter (4-20 mA) that can be powered directly from a VLT 6000 HVAC.

The required setpoint (e.g. 5 bar) can be set locally in parameter 418 *Setpoint 1*.



Set the following parameters:

|          |                                     |                     |
|----------|-------------------------------------|---------------------|
| Par. 100 | Configuration                       | Closed loop [1]     |
| Par. 205 | Maximum reference                   | 5 Hz                |
| Par. 302 | Terminal 18 Digital inputs          | Start [1]           |
| Par. 314 | Terminal 60, analogue input current | Feedback signal [2] |
| Par. 315 | Terminal 60, min. scaling           | 4 mA                |
| Par. 316 | Terminal 60, max. scaling           | 20 mA               |
| Par. 403 | Sleep mode timer                    | 10 sec              |
| Par. 404 | Sleep frequency                     | 15 Hz               |
| Par. 405 | Wake-up frequency                   | 20 Hz               |
| Par. 406 | Boost setpoint                      | 125%                |
| Par. 414 | Maximum feedback                    | 10                  |
| Par. 415 | Process units                       | Bar [16]            |
| Par. 418 | Setpoint 1                          | 5 bar               |
| Par. 423 | PID Proportional gain               | 0.6                 |
| Par. 424 | PID integration time                | 10                  |



## VLT® 6000 HVAC

### ■ CE-labelling

#### What is CE-labelling ?

The purpose of CE-labelling is to avoid technical obstacles to trade within EFTA and the EU. The EU has introduced the CE-label as a simple way of showing whether a product complies with the relevant EU directives. The CE-label says nothing about the quality or specifications of a product.

Three EU directives relate to frequency converters:

- **The machine directive (89/392/EEC)**  
All machines with critical, moving parts are comprised by the machine directive which came into force on 1 January 1995. Since a frequency converter is largely electrical by function, it does not fall under the machine directive. However, if a frequency converter is supplied for use in a machine, we provide information about the safety aspects relating to the frequency converter. We do that by means of a manufacturer's declaration.
- **The low voltage directive (73/23/EEC)**  
Frequency converters must be CE-labelled in accordance with the low voltage directive which came into force on 1 January 1997. This directive applies to all electrical equipment and units used in the 50-1000 V AC and 75-1500 V DC voltage ranges. Danfoss provides its units with CE-labels in accordance with the directive and issues declarations of conformity upon request.
- **The EMC directive (89/336/EEC)**  
EMC is short for electromagnetic compatibility. The presence of electromagnetic compatibility means that the mutual interference between different components/appliances is so small that the functioning of the appliances is not affected. The EMC directive came into force on 1 January 1996. In accordance with the directive, Danfoss CE-labels its products and issues a declaration of conformity upon request.

To help ensure that your installation is EMC-correct, the manual provides detailed instructions for installation. Furthermore, we specify which norms that are complied with by which of our products. We offer the filters that can be seen from the specifications and gladly provide other types of assistance that can help you obtain the best possible EMC result.

In most cases the VLT frequency converter is used by professionals of the trade as a complex component forming part of a larger appliance, system or installation. It must be noted that the responsibility for the final EMC properties of the appliance, system or installation rests with the installer.

NOTE: 550-600 V units are not CE labelled.

### ■ PC software and serial communication

Danfoss offers a number of serial communication options. Serial communication allows monitoring, programming and controlling one or several units from a centrally placed computer.

All VLT 6000 HVAC units have a RS 485 port as standard with a choice of three protocols. The three protocols selectable in parameter 500 *Protocols* are:

- FC protocol
- Johnson Controls Metasys N2
- Landis/Stefa Apogee FLN

A bus option card allows higher transmission speed than RS 485. In addition, a higher number of units can be linked to the bus and alternative transmission media can be used. Danfoss offers the following option cards for communication:

- Profibus
- LonWorks

### ■ Software Dialogue

Using the RS 485 port enables communication, e.g. with a PC. A Windows™ program, called *Software Dialog*, is available for this purpose. It can be used to monitor, program and control one or several VLT 6000 HVAC units.

### ■ Modules

Information on the installation of various modules is not included in this manual. See the Design Guide for VLT 6000 HVAC or contact Danfoss.

### 500-566 Serial communication



#### NB!

Information on the use of RS-485 serial interface is not included in this manual. Please contact Danfoss and ask for the Design Guide.



## VLT® 6000 HVAC

### ■ Unpacking and ordering a VLT frequency converter

Are you are in doubt as to which VLT frequency converter you have received and which options it contains? Use the following table to find out. The table can also be used for ordering a VLT 6000 HVAC.

### ■ Type code ordering number string

On the basis of your order, the VLT frequency converter is given an ordering number that can be seen from the nameplate on the unit. The number may look as follows:

**VLT-6008-H-T4-B20-R3-DL-F10-A10**

This means that the frequency converter ordered is a VLT 6008 for three-phase mains voltage of 380-460 V (T4) in Bookstyle enclosure IP 20 (B20). The hardware variant is with integral RFI filter, classes A & B (R3). The frequency converter features a control unit (DL) with a PROFIBUS option card (F10). Character no. 8 (H) indicates the application range of the unit: H = HVAC.

#### Bookstyle IP 20

| Mains voltage, rated:           |          |          |  |
|---------------------------------|----------|----------|--|
| Motor power 200-240 V 380-460 V |          |          |  |
| 1.1 kW                          | VLT 6002 | VLT 6002 |  |
| 1.5 kW                          | VLT 6003 | VLT 6003 |  |
| 2.2 kW                          | VLT 6004 | VLT 6004 |  |
| 3.0 kW                          | VLT 6005 | VLT 6005 |  |
| 4.0 kW                          |          | VLT 6006 |  |
| 5.5 kW                          |          | VLT 6008 |  |
| 7.5 kW                          |          | VLT 6011 |  |

#### Mains voltage, rated:

| Motor power | 200-240 V | 380-460 V | 550-600 V |
|-------------|-----------|-----------|-----------|
| 1.1 kW      | VLT 6002  | VLT 6002  | VLT 6002  |
| 1.5 kW      | VLT 6003  | VLT 6003  | VLT 6003  |
| 2.2 kW      | VLT 6004  | VLT 6004  | VLT 6004  |
| 3.0 kW      | VLT 6005  | VLT 6005  | VLT 6005  |
| 4.0 kW      | VLT 6006  | VLT 6006  | VLT 6006  |
| 5.5 kW      | VLT 6008  | VLT 6008  | VLT 6008  |
| 7.5 kW      | VLT 6011  | VLT 6011  | VLT 6011  |
| 11 kW       | VLT 6016  | VLT 6016  | VLT 6016  |
| 15 kW       | VLT 6022  | VLT 6022  | VLT 6022  |
| 18.5 kW     | VLT 6027  | VLT 6027  | VLT 6027  |
| 22 kW       | VLT 6032  | VLT 6032  | VLT 6032  |
| 30 kW       | VLT 6042  | VLT 6042  | VLT 6042  |
| 37 kW       | VLT 6052  | VLT 6052  | VLT 6052  |
| 45 kW       | VLT 6062  | VLT 6062  | VLT 6062  |

Units in the range of 1.1-45 kW, 220-240 V and 380-460 V come with enclosure IP 20, IP 54. For 550-600 V units, 1.1-7.5 kW are IP20 and NEMA 1 units; 11 kW-45 kW are available in NEMA 1 enclosures.

| Mains voltage, rated: |                     |                     |           |
|-----------------------|---------------------|---------------------|-----------|
| Motor power           | 400 V <sup>1)</sup> | 460 V <sup>1)</sup> | 550-600 V |
| 55 kW                 | VLT 6072            | -                   | VLT 6072  |
| 75 kW                 | VLT 6100            | VLT 6072            | VLT 6100  |
| 90 kW                 | VLT 6125            | VLT 6100            | VLT 6125  |
| 110 kW                | VLT 6150            | VLT 6125            | VLT 6150  |
| 132 kW                | VLT 6175            | VLT 6150            | VLT 6175  |
| 160 kW                | VLT 6225            | VLT 6175            | VLT 6225  |
| 200 kW                | VLT 6275            | VLT 6225            | VLT 6275  |
| 250 kW                | VLT 6350            | VLT 6275            |           |
| 315 kW                | VLT 6400            | VLT 6350            |           |
| 355 kW                | VLT 6500            | VLT 6400            |           |
| 400 kW                | VLT 6550            | VLT 6500            |           |
| 450 kW                | -                   | VLT 6550            |           |

Units in the range of 55-450 kW, 400 and 460 V come with enclosure IP 00, IP 20 or IP 54.

550-600 V units are available in IP00 and NEMA 1 enclosures in the range of 55-200 kW.

<sup>1)</sup> The max. output depends on the mains voltage connected to the unit.

#### Hardware variants

All units in the programme are available in the following hardware variants:

ST: Standard unit with or without control unit.

EX: Extended unit for VLT type 6350 - 6550 with control unit, connection of external 24 V DC supply for back-up of control PCB.

DX: Extended unit for VLT type 6350 - 6550 with control unit, built-in mains fuses and disconnector, connection of external 24 V DC supply for back-up of control PCB.

#### RFI-filter

Bookstyle units always come with an integral RFI filter that complies with EN 55011-1B with 20 m screened /armoured motor cable and EN 55011-1A with 150 m screened/armoured motor cable.

Units for a mains voltage of 240 V and a motor power of up to and including 3.0 kW (VLT 6005) and units for a mains voltage of 380-460 V and a motor power of up to 7.5 kW (VLT 6011) are always supplied with an integral class 1A & 1B filter.

Units for higher motor power than these (3.0 and 7.5 kW, respectively) can be ordered either with or without an RFI filter. 550-600 V units are not available with RFI filters.

#### Control unit (keypad and display)

All types of units in the programme, except for IP 54 units, can be ordered either with or without the control unit. IP 54 units always come with a control unit.

#### Conformal Coating

All types of units in the programme are available with or without conformal coating of the PCB.

■ Ordering form VLT 6000 HVAC

## Introduction to HVAC

[illegible]

13



## VLT® 6000 HVAC

### ■ General technical data

#### Mains supply (L1, L2, L3):

|   |                                      |
|---|--------------------------------------|
| Supply voltage 200-240 V units .....                                    | 3 x 200/208/220/230/240 V $\pm 10\%$ |
| Supply voltage 380-460 V units .....                                    | 3 x 380/400/415/440/460 V $\pm 10\%$ |
| Supply voltage 550-600 V units .....                                    | 3 x 550/575/600 V $\pm 10\%$         |
| Supply frequency .....  | 50/60 Hz $\pm 1\%$                   |
| Max. imbalance of supply voltage: .....                                 | $\pm 3\%$                            |
| VLT 6002-6011/380-460 V and 550-600 V and VLT 6002-6005/200-240 V ..... | $\pm 2.0\%$ of rated supply voltage  |
| VLT 6016-6072/380-460 V and 550-600 V and VLT 6006-6032/200-240 V ..... | $\pm 1.5\%$ of rated supply voltage  |
| VLT 6075-6550/380-460 V and VLT 6042-6062/200-240 V .....               | $\pm 3.0\%$ of rated supply voltage  |
| VLT 6100-6275/550-600 V .....   | 13% of rated supply voltage          |
| True Power Factor ( $\lambda$ ) .....                                   | 0.90 nominal at rated load           |
| Displacement Power Factor ( $\cos. \phi$ ) .....                        | near unity ( $> 0.98$ )              |
| No. of switches on supply input L1, L2, L3 .....                        | approx. 1 time/2 min.                |
| Max. short-circuit current .....  | 100.000 A                            |

#### VLT output data (U, V, W):

|  |                           |
|--|---------------------------|
| Output voltage .....                       | 0-100% of supply voltage  |
| Output frequency .....                     | 0 - 120 Hz, 0 - 1000 Hz   |
| Rated motor voltage, 200-240 V units ..... | 200/208/220/230/240 V     |
| Rated motor voltage, 380-460 V units ..... | 380/400/415/440/460/500 V |
| Rated motor voltage, 550-600 V units ..... | 550/575 V                 |
| Rated motor frequency .....                | 50/60 Hz                  |
| Switching on output .....                  | Unlimited                 |
| Ramp times .....                           | 1 - 3600 sec.             |

#### Torque characteristics:

|  |                                |
|--|--------------------------------|
| Starting torque .....  | 110% for 1 min.                |
| Starting torque (parameter 110 <i>High break-away torque</i> ) ..... | Max. torque: 160% for 0.5 sec. |
| Acceleration torque .....  | 100%                           |
| Overload torque .....  | 110%                           |

#### Control card, digital inputs:

|   |                                 |
|---|---------------------------------|
| Number of programmable digital inputs ..... | 8                               |
| Terminal nos. ....                          | 16, 17, 18, 19, 27, 29, 32, 33  |
| Voltage level .....                         | 0-24 V DC (PNP positive logics) |
| Voltage level, logical '0' .....            | $< 5$ V DC                      |
| Voltage level, logical '1' .....            | $> 10$ V DC                     |
| Maximum voltage on input .....              | 28 V DC                         |
| Input resistance, $R_i$ .....               | 2 k $\Omega$                    |
| Scanning time per input .....               | 3 msec.                         |

*Reliable galvanic isolation: All digital inputs are galvanically isolated from the supply voltage (PELV). In addition, the digital inputs can be isolated from the other terminals on the control card by connecting an external 24 V DC supply and opening switch 4. See Switches 1-4.*

#### Control card, analogue inputs:

|   |                             |
|---|-----------------------------|
| No. of programmable analogue voltage inputs/thermistor inputs ..... | 2                           |
| Terminal nos. ....  | 53, 54                      |
| Voltage level .....   | 0 - 10 V DC (scalable)      |
| Input resistance, $R_i$ .....                                       | approx. 10 k $\Omega$       |
| No. of programmable analogue current inputs .....                   | 1                           |
| Terminal no. ground .....   | 55                          |
| Current range .....   | 0/4 - 20 mA (scalable)      |
| Input resistance, $R_i$ .....                                       | 200 $\Omega$                |
| Resolution .....  | 10 bit + sign               |
| Accuracy on input .....   | Max. error 1% of full scale |
| Scanning time per input .....                                       | 3 msec.                     |

*Reliable galvanic isolation: All analogue inputs are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.*



## VLT® 6000 HVAC

### ■ General technical data

#### Control card, pulse input:

|  |                                 |
|--|---------------------------------|
| No. of programmable pulse inputs .....   | 3                               |
| Terminal nos. ....   | 17, 29, 33                      |
| Max. frequency on terminal 17 .....  | 5 kHz                           |
| Max. frequency on terminals 29, 33 .....   | 20 kHz (PNP open collector)     |
| Max. frequency on terminals 29, 33 .....   | 65 kHz (Push-pull)              |
| Voltage level .....  | 0-24 V DC (PNP positive logics) |
| Voltage level, logic '0' .....   | < 5 V DC                        |
| Voltage level, logic '1' .....   | > 10 V DC                       |
| Maximum voltage on input .....   | 28 V DC                         |
| Input resistance, $R_i$ .....  | 2 k $\Omega$                    |
| Scanning time per input .....  | 3 msec.                         |
| Resolution .....   | 10 bit + sign                   |
| Accuracy (100-1 kHz), terminals 17, 29, 33 .....   | Max. error: 0.5% of full scale  |
| Accuracy (1-5 kHz), terminal 17 .....  | Max. error: 0.1% of full scale  |
| Accuracy (1-65 kHz), terminals 29, 33 .....  | Max. error: 0.1% of full scale  |
| <i>Reliable galvanic isolation: All pulse inputs are galvanically isolated from the supply voltage (PELV). In addition, pulse inputs can be isolated from the other terminals on the control card by connecting an external 24 V DC supply and opening switch 4. See Switches 1-4.</i> |                                 |

#### Control card, digital/pulse and analogue outputs:

|   |                                |
|---|--------------------------------|
| No. of programmable digital and analogue outputs .....  | 2                              |
| Terminal nos. ....  | 42, 45                         |
| Voltage level at digital/pulse output .....   | 0 - 24 V DC                    |
| Minimum load to ground (terminal 39) at digital/pulse output .....  | 600 $\Omega$                   |
| Frequency ranges (digital output used as pulse output) .....  | 0-32 kHz                       |
| Current range at analogue output .....  | 0/4 - 20 mA                    |
| Maximum load to ground (terminal 39) at analogue output .....   | 500 $\Omega$                   |
| Accuracy of analogue output .....   | Max. error: 1.5% of full scale |
| Resolution on analogue output .....   | 8 bit                          |
| <i>Reliable galvanic isolation: All digital and analogue outputs are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.</i> |                                |

#### Control card, 24 V DC supply:

|   |        |
|---|--------|
| Terminal nos. ....  | 12, 13 |
| Max. load .....   | 200 mA |
| Terminal nos. ground .....  | 20, 39 |
| <i>Reliable galvanic isolation: The 24 V DC supply is galvanically isolated from the supply voltage (PELV), but has the same potential as the analogue outputs.</i> |        |

#### Control card, RS 485 serial communication:

|   |                              |
|---|------------------------------|
| Terminal nos. ....  | 68 (TX+, RX+), 69 (TX-, RX-) |
| <i>Reliable galvanic isolation: Full galvanic isolation (PELV).</i> |                              |

#### Relay outputs:

|   |   |
|---|---|
| No. of programmable relay outputs .....                               | 2                                       |
| Terminal nos., control card .....                                     | 4-5 (make)                              |
| Max. terminal load on 4-5, control card .....                         | 50 V AC, 1 A, 60 VA, 75 V DC, 1 A, 30 W |
| Max. terminal load on 4-5, control card for UL/cUL applications ..... | 30 V AC, 1 A / 42.5 V DC, 1A            |
| Terminal nos., power card and relay card .....                        | 1-3 (break), 1-2 (make)                 |
| Max. terminal load on 1-3, 1-2, power card and relay card .....       | 240 V AC, 2 A, 60 VA                    |
| Max. terminal load on 1-3, 1-2, power card .....                      | 50 V DC, 2 A                            |



## VLT® 6000 HVAC

### ■ General technical data

External 24 Volt DC supply: (only available with VLT 6350 - 6550):

|                     |   |
|---------------------|---|
| Terminal nos.       | 35, 36  |
| Voltage range       | 24 V DC $\pm 15\%$ (max. 37 V DC for 10 sec.) |
| Max. voltage ripple | 2 V DC  |
| Power consumption   | 15 W - 50 W (50 W for start-up, 20 msec.)     |
| Min. pre-fuse       | 6 Amp   |

Reliable galvanic isolation: Full galvanic isolation if the external 24 V DC supply is also of the PELV type.

Cable lengths and cross-sections:

|  |  |
|--|--|
| Max. motor cable length, screened cable                    | 150 m                                    |
| Max. motor cable length, unscreened cable                  | 300 m                                    |
| Max. motor cable length, screened cable VLT 6011 380-460 V | 100 m                                    |
| Max. motor cable length, screened cable VLT 6011 550-600 V | 50 m                                     |
| Max. DC-bus cable length, screened cable                   | 25 m from frequency converter to DC bar. |

Max. cable cross-section to motor, see next section

Max. cross-section for control cables ..... 1.5 mm<sup>2</sup>/16 AWG

Max. cross-section for serial communication ..... 1.5 mm<sup>2</sup>/16 AWG

If UL/cUL is to be complied with, cable with temperature class 60/75 °C must be used (VLT 6002 - 6072 380 - 500 V)

If UL/cUL is to be complied with, cable with temperature class 75 °C must be used (VLT 6042 - 6062 200 - 240 V, VLT 6072 - 6550 380 - 500 V, 6100-6275 550-600)

Control characteristics:

|                                  |  |
|----------------------------------|--|
| Frequency range                  | 0 - 1000 Hz  |
| Resolution on output frequency   | $\pm 0.003$ Hz   |
| System response time             | 3 msec.  |
| Speed, control range (open loop) | 1:100 of synchro. speed  |
| Speed, accuracy (open loop)      | < 1500 rpm: max. error $\pm 7.5$ rpm<br>> 1500 rpm: max. error of 0.5% of actual speed |
| Process, accuracy (closed loop)  | < 1500 rpm: max. error $\pm 1.5$ rpm<br>> 1500 rpm: max. error of 0.1% of actual speed |

All control characteristics are based on a 4-pole asynchronous motor

Accuracy of Display readout (parameters 009-012 Display readout):

|  |   |
|--|---|
| Motor current [5], 0 - 140% load         | Max. error: $\pm 2.0\%$ of rated output current |
| Power kW [6], Power HP [7], 0 - 90% load | Max. error: $\pm 5.0\%$ of rated output power   |

Externals:

|  |   |
|--|---|
| Enclosure  | IP 00, IP 20, IP 54   |
| Vibration test   | 0.7 g RMS 18-1000 Hz random. 3 directions for 2 hours (IEC 68-2-34/35/36) |
| Max. relative humidity   | 93 % $\pm 2\%$ , -3 % (IEC 68-2-3) for storage/transport                  |
| Max. relative humidity   | 95% non condensing (IEC 721-3-3; class 3K3) for operation                 |
| Ambient temperature  |   |
| VLT 6002-6005 200-240V, 6002-6011 380-460V, 6002-6011 550-600 V Bookstyle, IP 20 | Max. 45°C (24-hour average max. 40°C)                                     |
| VLT 6006-6062 200-240V, 6016-6550 380-460V, 6016-6275 550-600 V IP 00, IP 20     | Max. 40°C (24-hour average max. 35°C)                                     |
| VLT 6002-6062 200-240V, 6002-6550 380-460V, IP 54                                | Max. 40°C (24-hour average max. 35°C)                                     |

See Derating for high ambient temperature

|   |                |
|---|----------------|
| Min. ambient temperature in full operation      | 0°C            |
| Min. ambient temperature at reduced performance | -10°C          |
| Temperature during storage/transport            | -25 - +65/70°C |
| Max. altitude above sea level                   | 1000 m         |

See Derating for high air pressure

EMC standards applied,

|          |   |
|----------|---|
| Emission | EN 50081-1/2, EN 61800-3, EN 55011, EN 55014  |
| Immunity | EN 50082-2, EN 61000-4-2, IEC 1000-4-3, EN 61000-4-4<br>EN 61000-4-5, ENV 50204, EN 61000-4-6, VDE 0160/1990.12 |



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**VLT® 6000 HVAC**

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**NB!**

**VLT 6002-6275, 550-600 V units do not  
comply with EMC, Low Voltage  
or PELV directives.**

**VLT 6000 HVAC protection:**

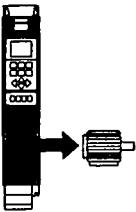
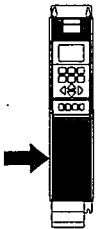
- Electronic motor thermal protection against overload.
- Temperature monitoring of heat-sink ensures that the VLT frequency converter cuts out auto-derates if the temperature reaches 90°C for IP 00 and IP 20. For IP 54, the cut-out temperature is 80°C. An overtemperature can only be reset when the temperature of the heat-sink has fallen below 60°C.
- The VLT frequency converter is protected against short-circuiting on motor terminals U, V, W.
- The VLT frequency converter is protected against earth fault on motor terminals U, V, W.
- Monitoring of the intermediate circuit voltage ensures that the VLT frequency converter cuts out if the intermediate circuit voltage gets too high or too low.
- If a motor phase is missing, the VLT frequency converter cuts out or auto-derates.
- If there is a mains fault, the VLT frequency converter is able to carry out a controlled deramping.
- If a mains phase is missing, the VLT frequency converter will cut out when a load is placed on the motor.

**Installation**



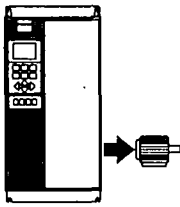
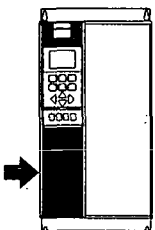
## VLT® 6000 HVAC

### ■ Technical data, mains supply 3 x 200 - 240 V

| According to international requirements   | VLT type                                     | 6002                                | 6003  | 6004  | 6005  | 6006  | 6008 | 6011  |
|---|--|-------------------------------------|-------|-------|-------|-------|------|-------|
|  | Output current <sup>4)</sup>                 |                                     |       |       |       |       |      |       |
|   | $I_{VTN}$ [A]                                | 6.6                                 | 7.5   | 10.6  | 12.5  | 16.7  | 24.2 | 30.8  |
|   | $I_{VT,MAX}$ (60 s) [A]                      | 7.3                                 | 8.3   | 11.7  | 13.8  | 18.4  | 26.6 | 33.9  |
|   | Output power (240 V)                         |                                     |       |       |       |       |      |       |
|   | $S_{VTN}$ [kVA]                              | 2.7                                 | 3.1   | 4.4   | 5.2   | 6.9   | 10.1 | 12.8  |
|  | Typical shaft output                         |                                     |       |       |       |       |      |       |
|   | $P_{VTN}$ [kW]                               | 1.1                                 | 1.5   | 2.2   | 3.0   | 4.0   | 5.5  | 7.5   |
|   | Typical shaft output                         |                                     |       |       |       |       |      |       |
|   | $P_{VTN}$ [HP]                               | 1.5                                 | 2     | 3     | 4     | 5     | 7.5  | 10    |
|   | Max. cable cross-section to motor and DC-bus |                                     |       |       |       |       |      |       |
|   | [mm <sup>2</sup> /AWG]                       | 4/10                                | 4/10  | 4/10  | 4/10  | 4/10  | 16/6 | 16/6  |
| Max. input current (200 V) (RMS) $I_{LN}$ [A]                                     |  | 6.0                                 | 7.0   | 10.0  | 12.0  | 16.0  | 23.0 | 30.0  |
| Max. cable cross-section power [mm <sup>2</sup> /AWG] <sup>2)</sup>               |  | 4/10                                | 4/10  | 4/10  | 4/10  | 4/10  | 16/6 | 16/6  |
| Max. pre-fuses [A/UL <sup>1)</sup> [A]  |  | 16/10                               | 16/15 | 25/20 | 25/25 | 35/30 | 50   | 60    |
| Mains contactor [Danfoss type]  |  | CI 6                                | CI 6  | CI 6  | CI 6  | CI 6  | CI 9 | CI 16 |
| Efficiency <sup>3)</sup>  |  | 0.95                                |       |       |       |       |      |       |
| Weight IP 20 [kg]   |  | 7                                   | 7     | 9     | 9     | 23    | 23   | 23    |
| Weight IP 54 [kg]   |  | 11.5                                | 11.5  | 13.5  | 13.5  | 35    | 35   | 38    |
| Power loss at max. load. [W]  |  | Total                               |       |       |       |       |      |       |
|   |  | 76                                  | 95    | 126   | 172   | 194   | 426  | 545   |
| Enclosure VLT type  |  | Bookstyle IP 20/Compact IP 20/IP 54 |       |       |       |       |      |       |

(Bookstyle IP 20 is available in power range VLT 6002-6005).

### ■ Mains supply 3 x 200 - 240 V

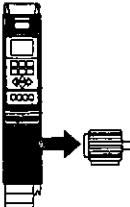



| According to international requirements   | VLT type  | 6016                            | 6022  | 6027  | 6032  | 6042                 | 6052                    | 6062                     |
|---|---|---------------------------------|-------|-------|-------|----------------------|-------------------------|--------------------------|
|  | Output current $I_{VTN}$ [A] (200-230 V)                            | 46.2                            | 59.4  | 74.8  | 88.0  | 115                  | 143                     | 170                      |
|   | $I_{VT,MAX}$ (60 s) [A] (200-230 V)                                 | 50.6                            | 65.3  | 82.3  | 96.8  | 127                  | 158                     | 187                      |
|   | $I_{VTN}$ [A] (240 V)   | 46.0                            | 59.4  | 74.8  | 88.0  | 104                  | 130                     | 154                      |
|   | $I_{VT,MAX}$ (60 s) [A] (240 V)                                     | 50.6                            | 65.3  | 82.3  | 96.8  | 115                  | 143                     | 170                      |
|   | Output power $S_{VTN}$ [kVA] (240 V)                                | 19.1                            | 24.7  | 31.1  | 36.6  | 41.0                 | 52.0                    | 61.0                     |
|  | Typical shaft output  |                                 |       |       |       |                      |                         |                          |
|   | $P_{VTN}$ [kW]  | 11                              | 15    | 18.5  | 22    | 30                   | 37                      | 45                       |
|   | Typical shaft output  |                                 |       |       |       |                      |                         |                          |
|   | $P_{VTN}$ [HP]  | 15                              | 20    | 25    | 30    | 40                   | 50                      | 60                       |
|   | Max. cable cross-section to motor and DC-bus [mm <sup>2</sup> /AWG] |                                 |       |       |       |                      |                         |                          |
|   | copper  | 16/6                            | 35/2  | 35/2  | 50/0  | 70/1/0               | 95/3/0                  | 120/4/0                  |
|   | aluminium   | 16/6                            | 35/2  | 35/2  | 50/0  | 95/3/0 <sup>8)</sup> | 90/250mcm <sup>8)</sup> | 120/300mcm <sup>8)</sup> |
| Min. cable cross-section to motor and DC-bus [mm <sup>2</sup> /AWG]                 |   | 10/8                            | 10/8  | 10/8  | 16/6  | 10/8                 | 10/8                    | 10/8                     |
| Max. input current (200 V) (RMS) $I_{LN}$ [A]                                       |   | 46.0                            | 59.2  | 74.8  | 88.0  | 101.3                | 126.6                   | 149.9                    |
| Max. cable, cross-section power [mm <sup>2</sup> /AWG]                              |   |                                 |       |       |       |                      |                         |                          |
|   |   | copper                          | 16/6  | 35/2  | 35/2  | 50/0                 | 70/1/0                  | 95/3/0                   |
|   |   | aluminium                       | 16/6  | 35/2  | 35/2  | 50/0                 | 95/3/0 <sup>8)</sup>    | 90/250mcm <sup>8)</sup>  |
| Max. pre-fuses [A/UL <sup>1)</sup> [A]  |   | 60                              | 80    | 125   | 125   | 150                  | 200                     | 250                      |
| Mains contactor [Danfoss type]  |   | CI 32                           | CI 32 | CI 37 | CI 61 | CI 85                | CI 85                   | CI 141                   |
|   |   | [AC value]                      | AC-1  | AC-1  | AC-1  | AC-1                 |                         |                          |
| Efficiency <sup>3)</sup>  |   | 0.95                            |       |       |       |                      |                         |                          |
| Weight IP 00 [kg]   |   | -                               | -     | -     | -     | 90                   | 90                      | 90                       |
| Weight IP 20 [kg]   |   | 23                              | 30    | 30    | 48    | 101                  | 101                     | 101                      |
| Weight IP 54 [kg]   |   | 38                              | 49    | 50    | 55    | 104                  | 104                     | 104                      |
| Power loss at max. load: [W]  |   | 545                             | 783   | 1042  | 1243  | 1089                 | 1361                    | 1613                     |
| Enclosure   |   | IP 20+NEMA 1 kit, IP 54/NEMA 12 |       |       |       |                      |                         |                          |

1. If UL/cUL is to be complied with, pre-fuses type Bussmann KTN-R, or Ferraz Shawmut type ATMR must be used. Fuses must be designed for protection in a circuit capable of supplying a maximum of 100,000 Amps ms (symmetrical), 500 V maximum.
2. American Wire Gauge.
3. Measured using 30 m screened motor cable at rated load and rated frequency.
4. Current ratings fulfill UL requirements for 208-240 V
5. Connection stud 1 x M8 / 2 x M8.







## VLT® 6000 HVAC

## ■ Technical data, mains supply 3 x 380 - 460 V

| According to international requirements  |                      | VLT type                                | 6002  | 6003  | 6004  | 6005  | 6006  | 6008  | 6011  |
|--|----------------------|---|---|-------|-------|-------|-------|-------|-------|
|   | Output current       | $I_{VTN}$ [A] (380-440 V)               | 3.0   | 4.1   | 5.6   | 7.2   | 10.0  | 13.0  | 16.0  |
|  |                      | $I_{LT,MAX}$ (60 s) [A] (380-440 V)     | 3.3   | 4.5   | 6.2   | 7.9   | 11.0  | 14.3  | 17.6  |
|  |                      | $I_{VTN}$ [A] (441-460 V)               | 3.0   | 3.4   | 4.8   | 6.3   | 8.2   | 11.0  | 14.0  |
|  |                      | $I_{LT,MAX}$ (60 s) [A] (441-460 V)     | 3.3   | 3.7   | 5.3   | 6.9   | 9.0   | 12.1  | 15.4  |
|  | Output power         | $S_{VTN}$ [kVA] (400 V)                 | 2.2   | 2.9   | 4.0   | 5.2   | 7.2   | 9.3   | 11.5  |
|  |                      | $S_{VTN}$ [kVA] (460 V)                 | 2.4   | 2.7   | 3.8   | 5.0   | 6.5   | 8.8   | 11.2  |
|   | Typical shaft output | $P_{VTN}$ [kW]                          | 1.1   | 1.5   | 2.2   | 3.0   | 4.0   | 5.5   | 7.5   |
|  | Typical shaft output | $P_{VTN}$ [HP]                          | 1.5   | 2     | 3     | -     | 5     | 7.5   | 10    |
| Max. cable cross-section to motor  |                      | [mm <sup>2</sup> /AWG]                  | 4/10  | 4/10  | 4/10  | 4/10  | 4/10  | 4/10  | 4/10  |
|   | Max. input current   | $I_{LN}$ [A] (380 V)                    | 2.8   | 3.8   | 5.3   | 7.0   | 9.1   | 12.2  | 15.0  |
|  | (RMS)                | $I_{LN}$ [A] (460 V)                    | 2.5   | 3.4   | 4.8   | 6.0   | 8.3   | 10.6  | 14.0  |
| Max. cable cross-section, power  |                      | [mm <sup>2</sup> ]/[AWG] <sup>2,1</sup> | 4/10  | 4/10  | 4/10  | 4/10  | 4/10  | 4/10  | 4/10  |
| Max. pre-fuses   |                      | [A]/UL <sup>1)</sup> [A]                | 16/6  | 16/10 | 16/10 | 16/15 | 25/20 | 25/25 | 35/30 |
| Mains contactor  |                      | [Danfoss type]                          | CI 6  | CI 6  | CI 6  | CI 6  | CI 6  | CI 6  | CI 6  |
| Efficiency <sup>3)</sup>   |                      |   | 0.96  |       |       |       |       |       |       |
| Weight IP 20   |                      | [kg]                                    | 8   | 8     | 8.5   | 8.5   | 10.5  | 10.5  | 10.5  |
| Weight IP 54   |                      | [kg]                                    | 11.5  | 11.5  | 12    | 12    | 14    | 14    | 14    |
| Power loss at max. load. [W]   |                      | Total                                   | 67  | 92    | 110   | 139   | 198   | 250   | 295   |
| Enclosure  |                      | VLT type                                | Bookstyle IP 20/Compact IP 20/IP 54                             |       |       |       |       |       |       |
|  |                      |   | (Bookstyle IP 20 is available in the VLT 6002-6011 power range) |       |       |       |       |       |       |

## ■ Mains supply 3 x 380 - 460 V

| According to international requirements   |                      | VLT type                            | 6016        | 6022  | 6027  | 6032  | 6042  | 6052    | 6062    | 6072    |
|---|----------------------|-------------------------------------|-------------|-------|-------|-------|-------|---------|---------|---------|
|  | Output current       | $I_{VTN}$ [A] (380-440 V)           | 24.0        | 32.0  | 37.5  | 44.0  | 61.0  | 73.0    | 90.0    | 106     |
|   |                      | $I_{LT,MAX}$ (60 s) [A] (380-440 V) | 26.4        | 35.2  | 41.3  | 48.4  | 67.1  | 80.3    | 99.0    | 117     |
|   |                      | $I_{VTN}$ [A] (441-460 V)           | 21.0        | 27.0  | 34.0  | 40.0  | 52.0  | 65.0    | 77.0    | 106     |
|   |                      | $I_{LT,MAX}$ (60 s) [A] (441-460 V) | 23.1        | 29.7  | 37.4  | 44.0  | 57.2  | 71.5    | 84.7    | 117     |
|  | Output power         | $S_{VTN}$ [kVA] (400 V)             | 17.3        | 23.0  | 27.0  | 31.6  | 43.8  | 52.5    | 64.7    | 73.4    |
|   |                      | $S_{VTN}$ [kVA] (460 V)             | 16.7        | 21.5  | 27.1  | 31.9  | 41.4  | 51.8    | 61.3    | 84.5    |
|  | Typical shaft output | $P_{VTN}$ [kW]                      | 11          | 15    | 18.5  | 22    | 30    | 37      | 45      | 55      |
|   | Typical shaft output | $P_{VTN}$ [HP]                      | 15          | 20    | 25    | 30    | 40    | 50      | 60      | 75      |
| Max. cable cross-section to motor and DC-bus  |                      | [mm <sup>2</sup> /AWG]              | 16/6        | 16/6  | 16/6  | 16/6  | 35/2  | 35/2    | 50/0    | 50/0    |
| Min. cable cross-section to motor and DC-bus <sup>4)</sup>                          |                      | [mm <sup>2</sup> /AWG]              | 10/8        | 10/8  | 10/8  | 10/8  | 10/8  | 10/8    | 16/6    | 16/6    |
|  | Max. input current   | $I_{LN}$ [A] (380 V)                | 24.0        | 32.0  | 37.5  | 44.0  | 60.0  | 72.0    | 89.0    | 104     |
|   | (RMS)                | $I_{LN}$ [A] (460 V)                | 21.0        | 27.6  | 34.0  | 41.0  | 53.0  | 64.0    | 77.0    | 104     |
| Max. cable cross-section, power   |                      | [mm <sup>2</sup> ]/[AWG]            | 16/6        | 16/6  | 16/6  | 16/6  | 35/2  | 35/2    | 50/0    |         |
| Max. pre-fuses  |                      | [A]/UL <sup>1)</sup> [A]            | 63/40       | 63/40 | 63/50 | 63/60 | 80/80 | 100/100 | 125/125 | 150/150 |
| Mains contactor   |                      | [Danfoss type]                      | CI 9        | CI 16 | CI 16 | CI 32 | CI 32 | CI 37   | CI 61   | CI 85   |
| Efficiency at rated frequency   |                      |                                     | 0.96        |       |       |       |       |         |         |         |
| Weight IP 20  |                      | [kg]                                | ?           | 21    | 22    | 27    | 28    | 41      | 42      | 43      |
| Weight IP 54  |                      | [kg]                                | ?           | 41    | 42    | 42    | 54    | 56      | 56      | 80      |
| Power loss at max. load. [W]  |                      |                                     | 419         | 559   | 655   | 768   | 1065  | 1275    | 1571    | 1851    |
| Enclosure   |                      |                                     | IP 20/IP 54 |       |       |       |       |         |         |         |

1. To comply with UL/cUL, use pre-fuses type Bussmann KTS-R or Ferraz Shawmut type ATMR. Place the fuses to protect a circuit capable of supplying max. 100,000 amps rms (symmetrical), 500 V max.
2. American Wire Gauge.
3. Measured using 30 m screened motor cable at rated load and rated frequency.
4. Min. cable cross-section is the smallest cable cross-section allowed to be fitted on the terminals. Always comply with national and local regulations on min. cable cross-section.



## VLT® 6000 HVAC

## ■ Technical data, mains supply 3 x 380 - 460 V

| According to international requirements   | VLT type | 6075 <sup>a</sup>     | 6100    | 6125    | 6150    | 6175     | 6225     | 6275     |
|---|----------|-----------------------|---------|---------|---------|----------|----------|----------|
| Output current  |          |                       |         |         |         |          |          |          |
| $I_{M,T,N}$ [A] (380-440 V)   |          | 106                   | 147     | 177     | 212     | 260      | 315      | 368      |
| $I_{M,T,MAX}$ (60 s) [A] (380-440 V)  |          | 117                   | 162     | 195     | 233     | 286      | 347      | 405      |
| $I_{M,T,N}$ [A] (441-460 V)   |          | 106                   | 130     | 160     | 190     | 240      | 302      | 361      |
| $I_{M,T,MAX}$ (60 s) [A] (441-460 V)  |          | 117                   | 143     | 176     | 209     | 264      | 332      | 397      |
| Output power  |          |                       |         |         |         |          |          |          |
| $S_{M,T,N}$ [kVA] (400 V)   |          | 73                    | 102     | 123     | 147     | 180      | 218      | 255      |
| $S_{M,T,N}$ [kVA] (460 V)   |          | 84.5                  | 104     | 127     | 151     | 191      | 241      | 288      |
| Typical shaft output (380-440 V) $P_{M,T,N}$ [kW]   |          | 55                    | 75      | 90      | 110     | 132      | 160      | 200      |
| Typical shaft output (441-460 V) $P_{M,T,N}$ [HP]   |          | 75                    | 100     | 125     | 150     | 200      | 250      | 300      |
| Max. cross-section of copper cable to motor and DC-bus (380-440 V) [mm <sup>2</sup> ] <sup>3</sup>    |          | 70                    | 95      | 120     | 2x70    | 2x70     | 2x95     | 2x120    |
| Max. cross-section of copper cable to motor and DC-bus (441-460 V) [mm <sup>2</sup> ] <sup>3</sup>    |          | 70                    | 70      | 95      | 2x70    | 2x70     | 2x95     | 2x120    |
| Max. cross-section of aluminium cable to motor and DC-bus (380-440 V) [mm <sup>2</sup> ] <sup>3</sup> |          | 95                    | 90      | 120     | 2x70    | 2x95     | 2x120    | 2x150    |
| Max. cross-section of aluminium cable to motor and DC-bus (441-460 V) [mm <sup>2</sup> ] <sup>3</sup> |          | 70                    | 120     | 150     | 2x70    | 2x120    | 2x120    | 2x150    |
| Max. cross-section of copper cable to motor and DC-bus (380-440 V) [AWG] <sup>3</sup>                 |          | 1/0                   | 3/0     | 4/0     | 2x1/0   | 2x2/0    | 2x3/0    | 2x250mcm |
| Max. cross-section of copper cable to motor and DC-bus (441-460 V) [AWG] <sup>3</sup>                 |          | 1/0                   | 2/0     | 3/0     | 2x1/0   | 2x1/0    | 2x3/0    | 2x4/0    |
| Max. cross-section of aluminium cable to motor and DC-bus (380-440 V) [AWG] <sup>3</sup>              |          | 3/0                   | 250mcm  | 300mcm  | 2x2/0   | 2x4/0    | 2x250mcm | 2x350mcm |
| Max. cross-section of aluminium cable to motor and DC-bus (441-460 V) [AWG] <sup>3</sup>              |          | 3/0                   | 4/0     | 250mcm  | 2x2/0   | 2x3/0    | 2x250mcm | 2x300mcm |
| Max. cross-section of cable to motor, and DC-bus <sup>4</sup> [mm <sup>2</sup> /AWG] <sup>3</sup>     |          | 10/8                  | 10/8    | 10/8    | 10/8    | 10/8     | 16/6     | 16/6     |
| Max. input current  |          |                       |         |         |         |          |          |          |
| $I_{L,N}$ [A] (380 V)   |          | 103                   | 145     | 174     | 206     | 256      | 317      | 366      |
| (RMS) $I_{L,N}$ [A] (460 V)   |          | 103                   | 128     | 158     | 185     | 236      | 304      | 356      |
| Max. cross-section of copper cable to power (380-440 V) [mm <sup>2</sup> ] <sup>3</sup>               |          | 70                    | 95      | 120     | 2x70    | 2x70     | 2x95     | 2x120    |
| Max. cross-section of copper cable to power (441-460 V) [mm <sup>2</sup> ] <sup>3</sup>               |          | 70                    | 70      | 95      | 2x70    | 2x70     | 2x95     | 2x120    |
| Max. cross-section of aluminium cable to power (380-440 V) [mm <sup>2</sup> ] <sup>3</sup>            |          | 95                    | 90      | 120     | 2x70    | 2x95     | 2x120    | 2x150    |
| Max. cross-section of aluminium cable to power (441-460 V) [mm <sup>2</sup> ] <sup>3</sup>            |          | 70                    | 120     | 150     | 2x70    | 2x120    | 2x120    | 2x150    |
| Max. cross-section of copper cable to power (380-440 V) [AWG] <sup>3</sup>                            |          | 1/0                   | 3/0     | 4/0     | 2x1/0   | 2x2/0    | 2x3/0    | 2x250mcm |
| Max. cross-section of copper cable to power (441-460 V) [AWG] <sup>3</sup>                            |          | 1/0                   | 2/0     | 3/0     | 2x1/0   | 2x1/0    | 2x3/0    | 2x4/0    |
| Max. cross-section of aluminium cable to power (380-440 V) [AWG] <sup>3</sup>                         |          | 3/0                   | 250mcm  | 300mcm  | 2x2/0   | 2x4/0    | 2x250mcm | 2x350mcm |
| Max. cross-section of aluminium cable to power (441-460 V) [AWG] <sup>3</sup>                         |          | 3/0                   | 4/0     | 250mcm  | 2x2/0   | 2x3/0    | 2x250mcm | 2x300mcm |
| Min. cable cross-section to motor, and DC-bus <sup>4</sup> [mm <sup>2</sup> /AWG] <sup>3</sup>        |          | 10/8                  | 10/8    | 10/8    | 10/8    | 10/8     | 16/6     |          |
| Max. pre-fuses [A]/UL <sup>1)</sup> [A]   |          | 150/150               | 250/220 | 250/250 | 300/300 | 350/350  | 450/400  | 500/500  |
| Integral pre-fuses [A]/UL <sup>1)</sup> [A]   |          | 15/15                 | 15/15   | 15/15   | 30/30   | 30/30    | 30/30    | 30/30    |
| Mains contactor [Danfoss Type]  |          | CI 85                 | CI 85   | CI 141  | CI 141  | CI 250EL | CI 250EL | CI 300EL |
| Pre-fuses SMPS [A]/UL <sup>1)</sup> [A]   |          | 5.0/5.0               |         |         |         |          |          |          |
| Weight IP 00 [kg]   |          | 109                   | 109     | 109     | 146     | 146      | 146      | 146      |
| Weight IP 20 [kg]   |          | 121                   | 121     | 121     | 161     | 161      | 161      | 161      |
| Weight IP 54 [kg]   |          | 124                   | 124     | 124     | 177     | 177      | 177      | 177      |
| Efficiency at rated frequency   |          | 0.96-0.97             |         |         |         |          |          |          |
| Power loss at max. load [W]   |          | 1430                  | 1970    | 2380    | 2860    | 3810     | 4770     | 5720     |
| Enclosure   |          | IP 00 / IP 20 / IP 54 |         |         |         |          |          |          |

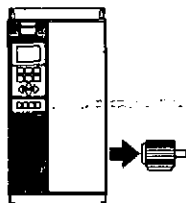
1. To comply with UL/cUL, use pre-fuses type Bussmann KTN-R, or Ferraz Shawmut type ATMR. The fuses protect a circuit capable of supplying max. 100,000 amps rms (symmetrical), 500 V max.
2. American Wire Gauge.
3. Measured using 30 m screened motor cable at rated load and rated frequency.
4. Min. cable cross-section is the smallest cable cross-section allowed to be fitted on the terminals. Always comply with national and local regulations on min. cable cross-section.
5. Connection stud 1 x M8 / 2 x M8.
6. Not for new designs. For new designs, use VLT 6072



## VLT® 6000 HVAC

### ■ Technical data, mains supply 3 x 380 - 460 V

| According to international requirements                                    |                                      | VLT type                         | 6350                  | 6400                     | 6500                     | 6550                     |
|--|--------------------------------------|----------------------------------|-----------------------|--------------------------|--------------------------|--------------------------|
| Output current   | $I_{M,TN}$ [A] (380-440 V)           |                                  | 480                   | 600                      | 658                      | 745                      |
|  | $I_{VLT,MAX}$ (60 s) [A] (380-440 V) |                                  | 528                   | 660                      | 724                      | 820                      |
|  | $I_{M,TN}$ [A] (441-460 V)           |                                  | 443                   | 540                      | 590                      | 678                      |
|  | $I_{VLT,MAX}$ (60 s) [A] (441-460 V) |                                  | 487                   | 594                      | 649                      | 746                      |
| Output power   | $S_{M,TN}$ [kVA] (440 V)             |                                  | 345                   | 431                      | 473                      | 536                      |
|  | $S_{M,TN}$ [kVA] (460 V)             |                                  | 353                   | 430                      | 470                      | 540                      |
| Typical shaft output (380-440 V) $P_{M,TN}$ [kW]                           |                                      |                                  | 250                   | 315                      | 355                      | 400                      |
| Typical shaft output (441-500 V) $P_{M,TN}$ [HP]                           |                                      |                                  | 350                   | 450                      | 500                      | 600                      |
| Max. cross-section of copper cable to motor and loadsharing (380-440 V)    |                                      | (mm <sup>2</sup> ) <sup>2)</sup> | 2 x 150<br>3 x 70     | 2 x 185<br>3 x 95        | 2 x 240<br>3 x 120       | 2 x 300<br>3 x 150       |
| Max. cross-section of copper cable to motor and loadsharing (441-460 V)    |                                      | (mm <sup>2</sup> ) <sup>2)</sup> | 2 x 120<br>3 x 70     | 2 x 150<br>3 x 95        | 2 x 185<br>3 x 95        | 2 x 300<br>3 x 120       |
| Max. cross-section of aluminium cable to motor and loadsharing (380-440 V) |                                      | (mm <sup>2</sup> ) <sup>2)</sup> | 2 x 185<br>3 x 120    | 2 x 240<br>3 x 150       | 2 x 300<br>3 x 185       | 2 x 300<br>3 x 185       |
| Max. cross-section of aluminium cable to motor and loadsharing (441-460 V) |                                      | (mm <sup>2</sup> ) <sup>2)</sup> | 2 x 150<br>3 x 95     | 2 x 185<br>3 x 120       | 2 x 240<br>3 x 150       | 2 x 240<br>3 x 185       |
| Max. cross-section of copper cable to motor and loadsharing (380-440 V)    |                                      | [AWG] <sup>2)</sup>              | 2 x 250mcm<br>3 x 2/0 | 2 x 350mcm<br>3 x 3/0    | 2 x 400mcm<br>3 x 4/0    | 2 x 500mcm<br>3 x 250mcm |
| Max. cross-section of copper cable to motor and loadsharing (441-460 V)    |                                      | [AWG] <sup>2)</sup>              | 2 x 4/0<br>3 1/0      | 2 x 300mcm<br>3 x 3/0    | 2 x 350mcm<br>3 x 3/0    | 2 x 500mcm<br>3 x 4/0    |
| Max. cross-section of aluminium cable to motor and loadsharing (380-440 V) |                                      | [AWG] <sup>2)</sup>              | 2 x 350mcm<br>3 x 4/0 | 2 x 500mcm<br>3 x 250mcm | 2 x 600mcm<br>3 x 300mcm | 2 x 700mcm<br>3 x 350mcm |
| Max. cross-section of aluminium cable to motor and loadsharing (441-460 V) |                                      | [AWG] <sup>2)</sup>              | 2 x 300mcm<br>3 x 3/0 | 2 x 400mcm<br>3 x 4/0    | 2 x 500mcm<br>3 x 250mcm | 2 x 600mcm<br>3 x 300mcm |



Installation

1. If UL/cUL is to be complied with, pre-fuses type Bussmann KTN-R, KTS-R must be used. The fuses must be placed to protect a circuit capable of supplying max. 100,000 amps rms (symmetrical), 500 V maximum.
2. American Wire Gauge.
3. Measured using 30 m screened motor cable at rated load and rated frequency.
4. Min. cable cross-section is the smallest cable cross-section allowed to be fitted on the terminals.  
Always comply with national and local regulations on min. cable cross-section.
5. Connection stud 1 x M8 / 2 x M8.

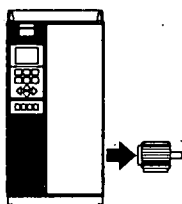


## VLT® 6000 HVAC

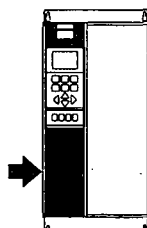
### ■ Technical data, mains supply 3 x 550-600 V

According to international requirements

|  | 6002 | 6003 | 6004 | 6005 | 6006 | 6008 | 6011 |
|--|------|------|------|------|------|------|------|
| Output current $I_{VLT,N}$ [A] (550 V)   | 2.6  | 2.9  | 4.1  | 5.2  | 6.4  | 9.5  | 11.5 |
| $I_{VLT,MAX}$ (60 s) [A] (550 V)   | 2.9  | 3.2  | 4.5  | 5.7  | 7.0  | 10.5 | 12.7 |
| $I_{VLT,N}$ [A] (575 V)  | 2.4  | 2.7  | 3.9  | 4.9  | 6.1  | 9.0  | 11.0 |
| $I_{VLT,MAX}$ (60 s) [A] (575 V)   | 2.6  | 3.0  | 4.3  | 5.4  | 6.7  | 9.9  | 12.1 |
| Output $S_{VLT,N}$ [kVA] (550 V)   | 2.5  | 2.8  | 3.9  | 5.0  | 6.1  | 9.0  | 11.0 |
| $S_{VLT,N}$ [kVA] (575 V)  | 2.4  | 2.7  | 3.9  | 4.9  | 6.1  | 9.0  | 11.0 |
| Typical shaft output $P_{VLT,N}$ [kW]  | 1.1  | 1.5  | 2.2  | 3    | 4    | 5.5  | 7.5  |
| Typical shaft output $P_{VLT,N}$ [HP]  | 1.5  | 2    | 3    | 4    | 5    | 7.5  | 10   |
| Max. copper cable cross-section to motor<br>brake and loadsharing <sup>1)</sup> [mm <sup>2</sup> ] | 4    | 4    | 4    | 4    | 4    | 4    | 4    |
| [AWG] <sup>2)</sup>  | 10   | 10   | 10   | 10   | 10   | 10   | 10   |



|   |                 |      |      |      |      |      |      |
|---|-----------------|------|------|------|------|------|------|
| Rated Input Current $I_{VLT,N}$ [A] (550 V)   | 2.5             | 2.8  | 4.0  | 5.1  | 6.2  | 9.2  | 11.2 |
| $I_{VLT,N}$ [A] (600 V)   | 2.2             | 2.5  | 3.6  | 4.6  | 5.7  | 8.4  | 10.3 |
| Max. copper cable cross-section,<br>power, NEMA 1 <sup>3)</sup><br>[mm <sup>2</sup> ] | 4               | 4    | 4    | 4    | 4    | 4    | 4    |
| [AWG] <sup>2)</sup>   | 10              | 10   | 10   | 10   | 10   | 10   | 10   |
| Max. prefuses (mains) <sup>1)</sup> [-]/UL [A]  | 3               | 4    | 5    | 6    | 8    | 10   | 15   |
| Efficiency  | 0.96            |      |      |      |      |      |      |
| Weight IP00   | [kg]            |      |      |      |      |      |      |
|   | [lbs]           |      |      |      |      |      |      |
| Weight IP20/NEMA 1  | [kg]            | 10.5 | 10.5 | 10.5 | 10.5 | 10.5 | 10.5 |
|   | [lbs]           | 23   | 23   | 23   | 23   | 23   | 23   |
| Estimated power loss at<br>max. load (550 V)  | [W]             | 65   | 73   | 103  | 131  | 161  | 238  |
| Estimated power loss at<br>max. load (600 V)  | [W]             | 63   | 71   | 102  | 129  | 160  | 236  |
| Enclosure   | IP20 and NEMA 1 |      |      |      |      |      |      |



1. If UL/cUL is to be complied with, pre-fuses type Bussmann KTS-Rtype or exact equivalent must be used for VLT 6002-6072.  
If UL/cUL is to be complied with, prefuses type Bussman FWP semi-conductor type or exact equivalent must be used for VLT 6100-6275.  
If UL/cUL is to be complied with, use type gG fuse for VLT 6002-6072 and type gR for VLT 6100-6275.  
Not following the recommendation may result in unnecessary damage of the drive in case of malfunction. Fuses must be designed for protection in a circuit capable of supplying a maximum of 100,000 Arms (symmetrical), 600 V maximum.
2. American Wire Gauge (AWG).
3. Min. cable cross-section is the smallest cable cross-section allowed to be fitted into the terminals to comply with IP20.  
Always comply with national and local regulations on min. cable cross-section.
4. Connection stud 1 x M8 / 2 x M8 for VLT 6100-6275.



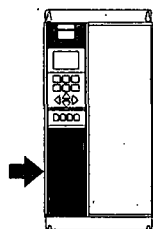
## VLT® 6000 HVAC

### ■ Technical data, mains supply 3 x 550-600 V

According to international requirements



|  | 6016 | 6022 | 6027 | 6032 | 6042 | 6052 | 6062 | 6072 |
|--|------|------|------|------|------|------|------|------|
| Output current $I_{VTN}$ [A] (550 V)   | 18   | 23   | 28   | 34   | 43   | 54   | 65   | 81   |
| $I_{VT, MAX}$ (60 s) [A] (550 V)   | 20   | 25   | 31   | 37   | 47   | 59   | 72   | 89   |
| $I_{VTN}$ [A] (550 V)  | 17   | 22   | 27   | 32   | 41   | 52   | 62   | 77   |
| $I_{VT, MAX}$ (60 s) [A] (575 V)   | 19   | 24   | 30   | 35   | 45   | 57   | 68   | 85   |
| Output $S_{VTN}$ [kVA] (550 V)   | 17   | 22   | 27   | 32   | 41   | 51   | 62   | 77   |
| $S_{VTN}$ [kVA] (575 V)  | 17   | 22   | 27   | 32   | 41   | 52   | 62   | 77   |
| Typical shaft output $P_{VTN}$ [kW]  | 11   | 15   | 18.5 | 22   | 30   | 37   | 45   | 55   |
| Typical shaft output $P_{VTN}$ [HP]  | 15   | 20   | 25   | 30   | 40   | 50   | 60   | 75   |
| Max. copper cable cross-section to motor<br>brake and loadsharing <sup>a)</sup> [mm <sup>2</sup> ] | 16   | 16   | 16   | 35   | 35   | 50   | 50   | 50   |
| [AWG] <sup>a)</sup>  | 6    | 6    | 6    | 2    | 2    | 1/0  | 1/0  | 1/0  |
| Min. cable cross-section to motor<br>brake and loadsharing <sup>a)</sup> [mm <sup>2</sup> ]        | 0.5  | 0.5  | 0.5  | 10   | 10   | 16   | 16   | 16   |
| [AWG] <sup>a)</sup>  | 20   | 20   | 20   | 8    | 8    | 6    | 6    | 6    |



|   |        |     |     |     |     |      |      |      |
|---|--------|-----|-----|-----|-----|------|------|------|
| Rated Input Current $I_{VTN}$ [A] (550 V)   | 18     | 22  | 27  | 33  | 42  | 53   | 63   | 79   |
| $I_{VTN}$ [A] (600 V)   | 16     | 21  | 25  | 30  | 38  | 49   | 58   | 72   |
| Max. copper cable cross-section,<br>power, NEMA 1 <sup>a)</sup><br>[mm <sup>2</sup> ] | 16     | 16  | 16  | 35  | 35  | 50   | 50   | 50   |
| [AWG] <sup>a)</sup>   | 6      | 6   | 6   | 2   | 2   | 1/0  | 1/0  | 1/0  |
| Max. prefuses (mains) <sup>b)</sup> [-]/UL [A]  | 20     | 30  | 35  | 45  | 60  | 75   | 90   | 100  |
| Efficiency  | 0.96   |     |     |     |     |      |      |      |
| Weight IP00   | [kg]   |     |     |     |     |      |      |      |
|   | [lbs]  |     |     |     |     |      |      |      |
| Weight IP20/NEMA 1  | [kg]   | 23  | 23  | 23  | 30  | 30   | 48   | 48   |
|   | [lbs]  | 51  | 51  | 51  | 66  | 66   | 106  | 106  |
| Estimated power loss at<br>max. load (550 V)  | [W]    | 451 | 576 | 702 | 852 | 1077 | 1353 | 1628 |
| Estimated power loss at<br>max. load (600 V)  | [W]    | 446 | 576 | 707 | 838 | 1074 | 1362 | 1624 |
| Enclosure   | NEMA 1 |     |     |     |     |      |      |      |

1. If UL/cUL is to be complied with, pre-fuses type Bussmann KTS-Rtype or exact equivalent must be used for VLT 6002-6072.  
If UL/cUL is to be complied with, prefuses type Bussman FWP semi-conductor type or exact equivalent must be used for VLT 6100-6275.  
If UL/cUL is to be complied with, use type gG fuse for VLT 6002-6072 and type gR for VLT 6100-6275.  
Not following the recommendation may result in unnecessary damage of the drive in case of malfunction. Fuses must be designed for protection in a circuit capable of supplying a maximum of 100,000 Arms (symmetrical), 600 V maximum.
2. American Wire Gauge (AWG).
3. Min. cable cross-section is the smallest cable cross-section allowed to be fitted into the terminals to comply with IP20.  
Always comply with national and local regulations on min. cable cross-section.
4. Connection stud 1 x M8 / 2 x M8 for VLT 6100-6275.

Installation



## VLT® 6000 HVAC

### ■ Technical data, mains supply 3 x 550-600 V

According to international requirements



|   | 6100            | 6125      | 6150      | 6175      | 6225      | 6275      |
|---|-----------------|-----------|-----------|-----------|-----------|-----------|
| Output current $I_{VLT,N}$ [A] (550 V)  | 104             | 131       | 151       | 201       | 253       | 289       |
| $I_{VLT,MAX}$ (60 s) [A] (550 V)  | 114             | 144       | 166       | 221       | 278       | 318       |
| $I_{VLT,N}$ [A] (550 V)   | 99              | 125       | 144       | 192       | 242       | 289       |
| $I_{VLT,MAX}$ (60 s) [A] (575 V)  | 109             | 138       | 158       | 211       | 266       | 318       |
| Output $S_{VLT,N}$ [kVA] (550 V)  | 99              | 125       | 144       | 191       | 241       | 275       |
| $S_{VLT,N}$ [kVA] (575 V)   | 99              | 124       | 143       | 191       | 241       | 288       |
| Typical shaft output $P_{VLT,N}$ [kW]   | 75              | 90        | 110       | 132       | 160       | 200       |
| Typical shaft output $P_{VLT,N}$ [HP]   | 100             | 125       | 150       | 200       | 250       | 300       |
| Max. copper cable cross-section to motor<br>brake and loadsharing <sup>1)</sup> [mm <sup>2</sup> ]    | 120             | 120       | 120       | 2x120     | 2x120     | 2x120     |
| [AWG] <sup>2)</sup>   | 4/0             | 4/0       | 4/0       | 2x4/0     | 2x4/0     | 2x4/0     |
| Max. aluminium cable cross-section to motor<br>brake and loadsharing <sup>1)</sup> [mm <sup>2</sup> ] | 185             | 185       | 185       | 2x185     | 2x185     | 2x185     |
| [AWG] <sup>2)</sup>   | 300 mcm         | 300 mcm   | 300 mcm   | 2x300 mcm | 2x300mcm  | 2x300mcm  |
| Min. cable cross-section to motor<br>brake and loadsharing <sup>1)</sup> [mm <sup>2</sup> ]           | 6               | 6         | 6         | 2x6       | 2x6       | 2x6       |
| [AWG] <sup>2)</sup>   | 8               | 8         | 8         | 2x8       | 2x8       | 2x8       |
| Rated Input Current $I_{VLT,N}$ [A] (550 V)   | 101             | 128       | 147       | 196       | 246       | 281       |
| $I_{VLT,N}$ [A] (600 V)   | 92              | 117       | 134       | 179       | 226       | 270       |
| Max.copper cable cross-section,<br>power, NEMA 1 <sup>4)</sup><br>[mm <sup>2</sup> ]                  | 120             | 120       | 120       | 2x120     | 2x120     | 2x120     |
| [AWG] <sup>2)</sup>   | 4/0             | 4/0       | 4/0       | 2x4/0     | 2x4/0     | 2x4/0     |
| Max. aluminium cable cross-section,<br>power, NEMA 1 <sup>4)</sup><br>[mm <sup>2</sup> ]              | 185             | 185       | 185       | 2x185     | 2x185     | 2x185     |
| [AWG] <sup>2)</sup>   | 300 mcm         | 300 mcm   | 300 mcm   | 2x300 mcm | 2x300 mcm | 2x300mcm  |
| Max. prefuses (mains) <sup>1)</sup> [-]/UL [A]  | 125             | 175       | 200       | 250       | 350       | 400       |
| Integral prefuses<br>(softcharge circuit, AC) <sup>5)</sup> [-]/UL [A]                                | 15(Qty.3)       | 15(Qty.3) | 15(Qty.3) | 30(Qty.3) | 30(Qty.3) | 30(Qty.3) |
| Integral prefuses<br>(softcharge resistors, DC) <sup>6)</sup> [-]/UL [A]                              | 12(Qty.1)       | 12(Qty.1) | 12(Qty.1) | 12(Qty.2) | 12(Qty.2) | 12(Qty.2) |
| Integral prefuses <sup>6)</sup> (SMPS) [-]/UL [A]   | 5               | 5         | 5         | 5         | 5         | 5         |
| Efficiency  | 0.96-0.97       |           |           |           |           |           |
| Weight IP00 [kg]  | 109             | 109       | 109       | 146       | 146       | 146       |
| [lbs]   | 240             | 240       | 240       | 322       | 322       | 322       |
| Weight IP20/NEMA 1 [kg]   | 121             | 121       | 121       | 161       | 161       | 161       |
| [lbs]   | 267             | 267       | 267       | 355       | 355       | 355       |
| Estimated power loss at<br>max. load (550 V) [W]  | 2605            | 3285      | 3785      | 5035      | 6340      | 7240      |
| Estimated power loss at<br>max. load (600 V) [W]  | 2560            | 3275      | 3775      | 5030      | 6340      | 7570      |
| Enclosure   | IP00 and NEMA 1 |           |           |           |           |           |

1. If UL/cUL is to be complied with, pre-fuses type Bussmann KTS-Rtype or exact equivalent must be used for VLT 6002-6072.  
If UL/cUL is to be complied with, prefuses type Bussman FWP semi-conductor type or exact equivalent must be used for VLT 6100-6275.  
If UL/cUL is to be complied with, use type gG fuse for VLT 6002-6072 and type gR for VLT 6100-6275.  
Not following the recommendation may result in unnecessary damage of the drive in case of malfunction. Fuses must be designed for protection in a circuit capable of supplying a maximum of 100,000 Arms (symmetrical), 600 V maximum.
2. American Wire Gauge (AWG).
3. Min. cable cross-section is the smallest cable cross-section allowed to be fitted into the terminals to comply with IP20.  
Always comply with national and local regulations on min. cable cross-section.
4. Connection stud 1 x M8 / 2 x M8 for VLT 6100-6275.
5. Integral prefuses (softcharge circuit, AC) must be AC Littelfuse KLK or exact equivalent.  
Integral prefuse (softcharge resistors, DC) must be KLKD or exact equivalent.
6. Integral prefuse (SMPS) must be Bussman KTK type or exact equivalent.



## VLT® 6000 HVAC

## ■ Mechanical dimensions

All measurements in mm.

| VLT type                  | A    | B    | C   |    | a    | b   | aa/bb    | Type |
|---------------------------|------|------|-----|----|------|-----|----------|------|
| Bookstyle IP 20 200-240 V |      |      |     |    |      |     |          |      |
| 6002 - 6003               | 395  | 90   | 260 |    | 384  | 70  | 100      | A    |
| 6004 - 6005               | 395  | 130  | 260 |    | 384  | 70  | 100      | A    |
| Bookstyle IP 20 380-460 V |      |      |     |    |      |     |          |      |
| 6002 - 6005               | 395  | 90   | 260 |    | 384  | 70  | 100      | A    |
| 6006 - 6011               | 395  | 130  | 260 |    | 384  | 70  | 100      | A    |
| IP 00 200-240 V           |      |      |     |    |      |     |          |      |
| 6042 - 6062               | 800  | 370  | 335 |    | 780  | 270 | 225      | B    |
| IP 00 380-460 V           |      |      |     |    |      |     |          |      |
| 6075 - 6125               | 800  | 370  | 335 |    | 780  | 270 | 225      | B    |
| 6150 - 6275               | 1400 | 420  | 400 |    | 1380 | 350 | 225      | B    |
| 6350 - 6550               | 1896 | 1099 | 490 |    | -    | -   | 400 (aa) | H    |
| IP 20 200-240 V           |      |      |     |    |      |     |          |      |
| 6002 - 6003               | 395  | 220  | 160 |    | 384  | 200 | 100      | C    |
| 6004 - 6005               | 395  | 220  | 200 |    | 384  | 200 | 100      | C    |
| 6006 - 6011               | 560  | 242  | 260 |    | 540  | 200 | 200      | D    |
| 6016 - 6022               | 700  | 242  | 260 |    | 680  | 200 | 200      | D    |
| 6027 - 6032               | 800  | 308  | 296 |    | 780  | 270 | 200      | D    |
| 6042 - 6062               | 954  | 370  | 335 |    | 780  | 270 | 225      | E    |
| IP 20 380-460 V           |      |      |     |    |      |     |          |      |
| 6002 - 6005               | 395  | 220  | 160 |    | 384  | 200 | 100      | C    |
| 6006 - 6011               | 395  | 220  | 200 |    | 384  | 200 | 100      | C    |
| 6016 - 6027               | 560  | 242  | 260 |    | 540  | 200 | 200      | D    |
| 6032 - 6042               | 700  | 242  | 260 |    | 680  | 200 | 200      | D    |
| 6052 - 6072               | 800  | 308  | 296 |    | 780  | 270 | 200      | D    |
| 6075 - 6125               | 954  | 370  | 335 |    | 780  | 270 | 225      | E    |
| 6150 - 6275               | 1554 | 420  | 400 |    | 1380 | 350 | 225      | E    |
| 6350 - 6550               | 2010 | 1200 | 600 |    | -    | -   | 400 (aa) | H    |
| VLT type                  |      |      |     |    |      |     |          |      |
| IP 54 200-240 V           |      |      |     |    |      |     |          |      |
| 6002 - 6003               | 460  | 282  | 195 | 85 | 260  | 258 | 100      | F    |
| 6004 - 6005               | 530  | 282  | 195 | 85 | 330  | 258 | 100      | F    |
| 6006 - 6011               | 810  | 355  | 280 | 70 | 560  | 330 | 200      | F    |
| 6016 - 6032               | 940  | 400  | 280 | 70 | 690  | 375 | 200      | F    |
| 6042 - 6062               | 937  | 495  | 421 | -  | 830  | 374 | 225      | G    |
| IP 54 380-460 V           |      |      |     |    |      |     |          |      |
| 6002 - 6005               | 460  | 282  | 195 | 85 | 260  | 258 | 100      | F    |
| 6006 - 6011               | 530  | 282  | 195 | 85 | 330  | 258 | 100      | F    |
| 6016 - 6032               | 810  | 355  | 280 | 70 | 560  | 330 | 200      | F    |
| 6042 - 6072               | 940  | 400  | 280 | 70 | 690  | 375 | 200      | F    |
| 6075 - 6125               | 937  | 495  | 421 | -  | 830  | 374 | 225      | G    |
| 6150 - 6275               | 1572 | 495  | 425 | -  | 1465 | 445 | 225      | G    |
| 6350 - 6550               | 2010 | 1200 | 600 | -  | -    | -   | 400 (aa) | H    |

aa: Min. air above enclosure

bb: Min. air below enclosure



## VLT® 6000 HVAC

### ■ Mechanical dimensions

All measurements are in mm.

| VLT type                       | A          | B         | C         | a          | b         | aa/bb* | Type |
|--------------------------------|------------|-----------|-----------|------------|-----------|--------|------|
| IP 00 550-600 V                |            |           |           |            |           |        |      |
| 6100-6150                      | 800/31.55  | 370/14.57 | 335/13.19 | 780/30.71  | 270/10.63 | 250    | B    |
| 6175-6275                      | 1400/55.12 | 420/16.54 | 400/15.75 | 1380/54.33 | 350/13.78 | 300    | B    |
| IP 20/NEMA 1 550-600 V         |            |           |           |            |           |        |      |
| 6002-6011                      | 395/15.55  | 220/8.66  | 200/7.87  | 384/15.12  | 200/7.87  | 100    | C    |
| 6016-6027                      | 560/22.05  | 242/9.53  | 260/10.23 | 540/21.26  | 200/7.87  | 200    | D    |
| 6032-6042                      | 700/27.56  | 242/9.53  | 260/10.23 | 680/26.77  | 200/7.87  | 200    | D    |
| 6052-6072                      | 800/31.50  | 308/12.13 | 296/11.65 | 780/30.71  | 270/10.63 | 200    | D    |
| 6100-6150                      | 954/37.60  | 370/14.57 | 335/13.19 | 780/30.71  | 270/10.63 | 250    | E    |
| 6175-6275                      | 1554/61.22 | 420/16.54 | 400/15.75 | 1380/54.33 | 350/13.78 | 300    | E    |
| Option for IP 00 VLT 6075-6275 | A1         | B1        | C1        |            |           |        |      |
| IP 20 bottom cover             |            |           |           |            |           |        |      |
| 6100 - 6125                    | 175        | 370       | 335       |            |           |        |      |
| 6150 - 6275                    | 175        | 420       | 400       |            |           |        |      |

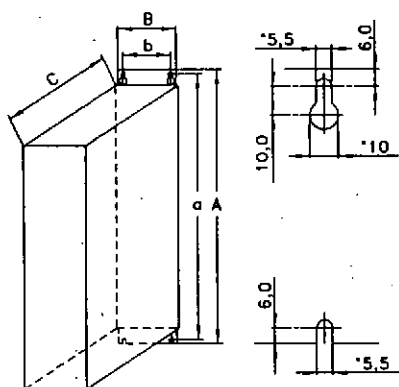
\*) aa: Min. air above enclosure

bb: Min. air below enclosure

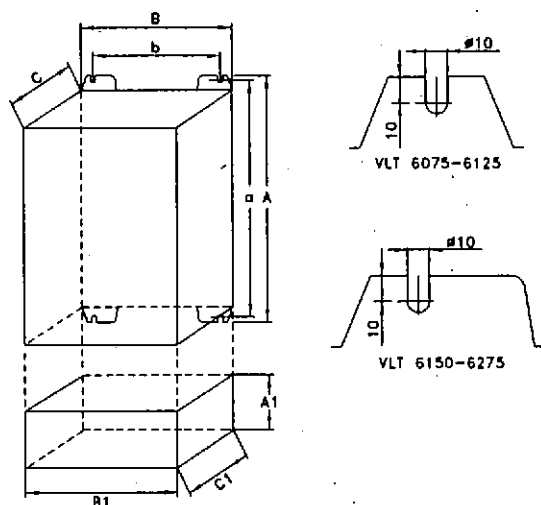


## VLT® 6000 HVAC

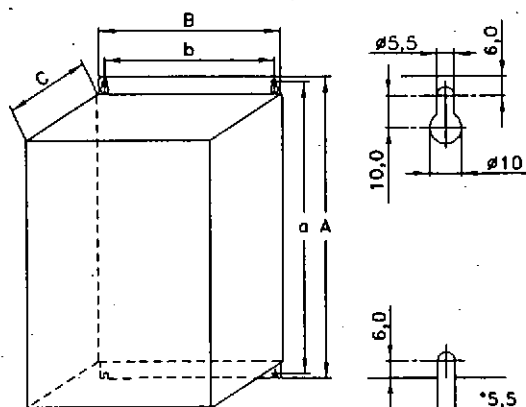
### ■ Mechanical dimensions



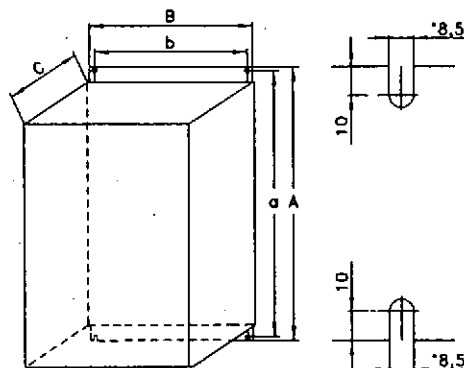
Type A, IP20



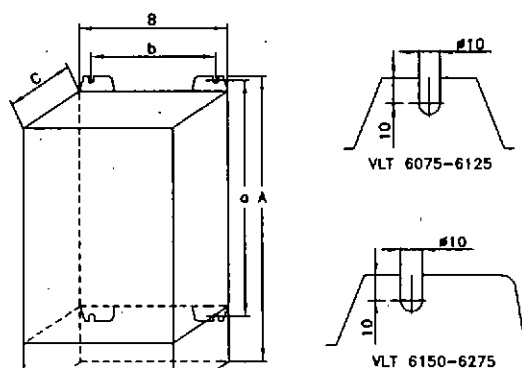
Type B, IP00  
With option and enclosure IP20



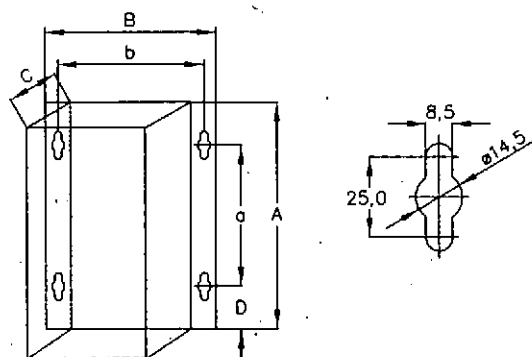
Type C, IP20



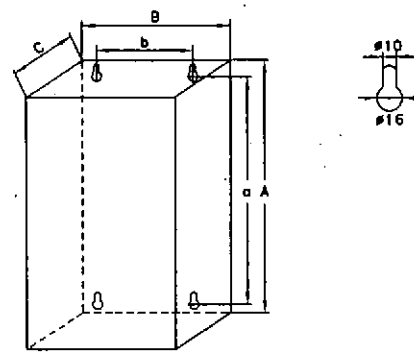
Type D, IP20



Type E, IP20



Type F, IP54



Type G, IP54

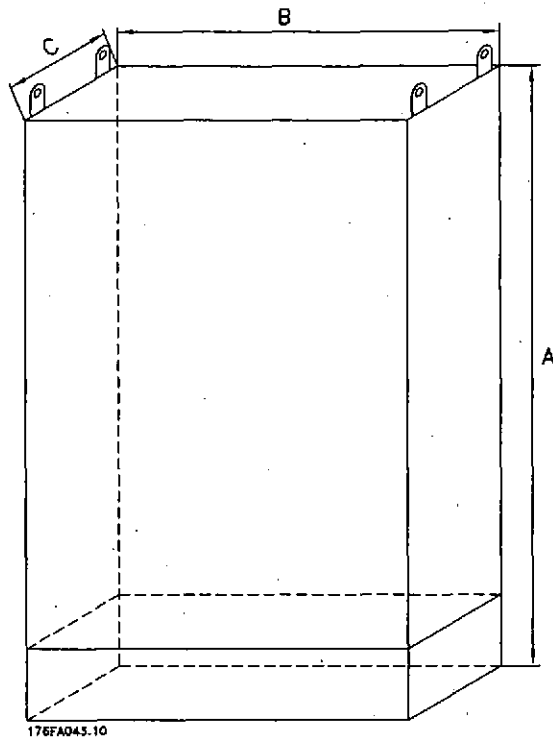
Installation



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**VLT® 6000 HVAC**

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**■ Mechanical dimensions (cont.)**

Type H, IP 00, IP 20, IP 54



## VLT® 6000 HVAC

### ■ Mechanical installation



Please pay attention to the requirements that apply to integration and field mounting kit, see the below list. The information given in the list must be observed to avoid serious damage or injury, especially when installing large units.

The VLT frequency converter *must* be installed vertically.

The VLT frequency converter is cooled by means of air circulation. For the unit to be able to release its cooling air, the *minimum* distance over and below the unit must be as shown in the illustration below.

To protect the unit from overheating, it must be ensured that the ambient temperature *does not rise above the max. temperature stated for the VLT frequency converter* and that the 24-hour average temperature *is not exceeded*. The max. temperature and 24-hour average can be seen from the *General Technical Data*.

If the ambient temperature is in the range of 45°C - 55°C, derating of the VLT frequency converter will become relevant, see *Derating for ambient temperature*.

The service life of the VLT frequency converter will be reduced if derating for ambient temperature is not taken into account.

### ■ Enclosure protection

|                         | IP 00 | IP 20 | NEMA 1 | IP 54 |
|-------------------------|-------|-------|--------|-------|
| Bookstyle               | -     | OK    | -      | -     |
| VLT 6002-6032 200-240 V | -     | OK    | -      | OK    |
| VLT 6002-6550 380-460 V | OK    | OK    | -      | OK    |
| VLT 6002-6011 550-600 V | -     | OK    | OK     | -     |
| VLT 6016-6072 550-600 V | -     | -     | OK     | -     |
| VLT 6100-6275 550-600 V | OK    | -     | OK     | -     |

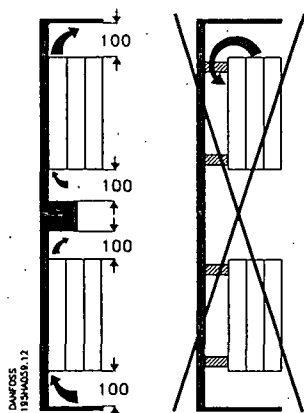
### ■ Field-mounting

|                         | IP 00 | IP 20 | NEMA 1 | IP 54 |
|-------------------------|-------|-------|--------|-------|
| Bookstyle               | -     | No    | -      | -     |
| VLT 6002-6032 200-240 V | -     | No    | -      | OK    |
| VLT 6002-6550 380-460 V | No    | No    | -      | OK    |
| IP 20 with 4x top cover | -     | OK    | -      | OK    |
| VLT 6002-6005 200-240 V | -     | OK    | -      | OK    |
| VLT 6002-6016 380-460 V | -     | OK    | -      | OK    |
| VLT 6002-6011 550-600 V | -     | OK    | OK     | -     |
| IP 20 terminal cover    | -     | OK    | -      | OK    |
| VLT 6006-6032 200-240 V | -     | OK    | -      | OK    |
| VLT 6022-6072 380-460 V | -     | OK    | -      | OK    |
| VLT 6016-6072 550-600 V | -     | -     | OK     | -     |

Installation

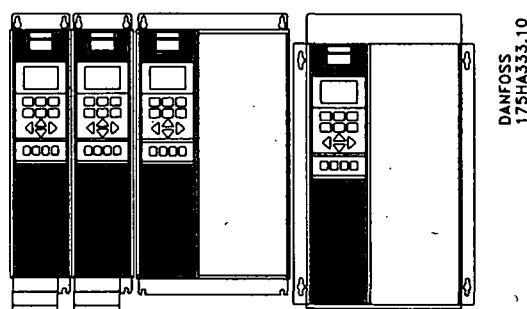
### ■ Spacing when installing of VLT 6002-6005 200-240 V, VLT 6002-6011 380-460 V, VLT 6002-6011 550-600 V, Bookstyle IP 00, IP 20, NEMA 1 and IP 54.

#### Cooling



All the above-mentioned units require a minimum space of 100 mm above and below the enclosure.

#### Side-by-side



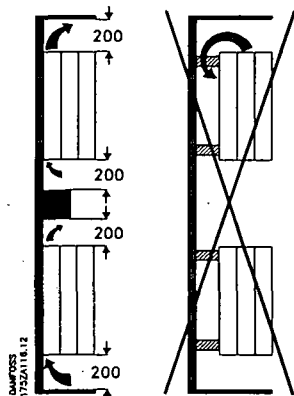
All the above-mentioned units can be installed side by side without any space, since these units do not require any cooling on the sides.



## VLT® 6000 HVAC

### ■ Installation of VLT 6006-6032 200-240 V, VLT 6016-6072 380-460 V, VLT 6016-6072 550-600 V, IP 20, NEMA 1 and IP 54

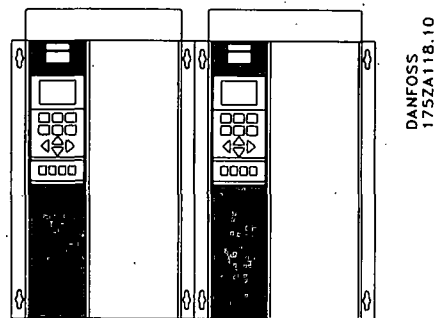
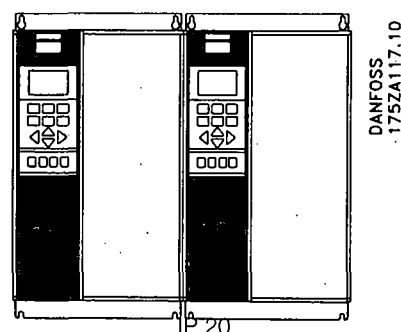
#### Cooling



All units in the above-mentioned series require a minimum space of 200 mm above and below the enclosure and must be installed on a plane, vertical surface (no spacers). This applies both to IP 20, NEMA 1, and IP 54 units.

These units can be installed side by side without any spacing, since they do not require any cooling on the sides.

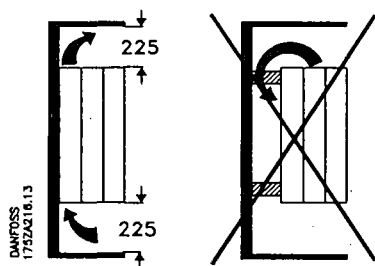
#### Side-by-side



IP 54 (flange-by-flange)

### ■ Installation of VLT 6042-6062 200-240 V, VLT 6075-6275 380-460 V, VLT 6100-6275 550-600 V, IP 00, IP 20, NEMA 1, and IP 54

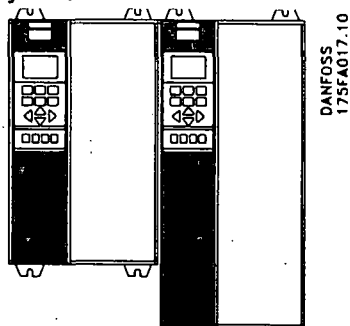
#### Cooling



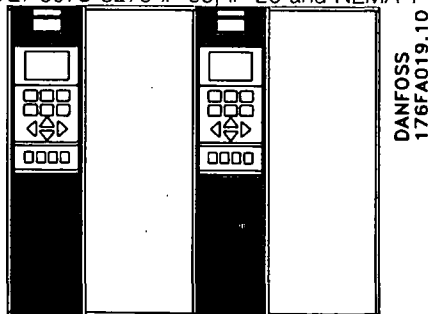
VLT 6075-6275

All units require a minimum space of 225 mm above and below the enclosure and must be installed on a plane, vertical surface (no spacers). This applies to IP 00, IP 20 and IP 54 units alike.

#### Side-by-side



VLT 6075-6275 IP 00, IP 20 and NEMA 1



VLT 6075-6275 IP 54

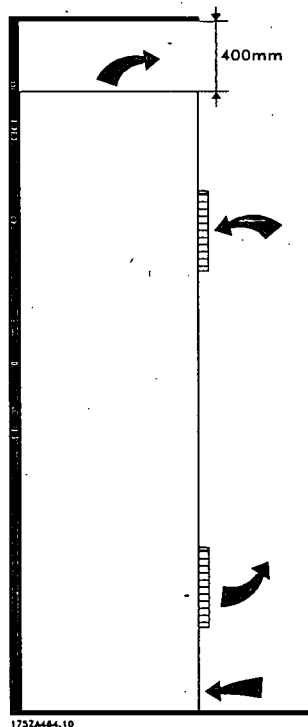
All IP 00 and IP 20 units in the above-mentioned series can be installed side by side without any spacing.



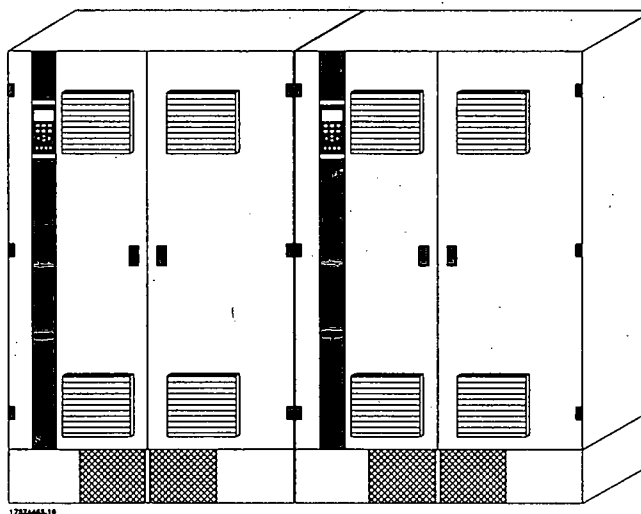
## VLT® 6000 HVAC

### ■ Installation of VLT 6350-6550 380-500 V Compact IP 00, IP 20 and IP 54

Cooling



Side-by-side



All units in the above-mentioned series require a minimum space of 400 mm above the enclosure and must be installed on a plane floor. This applies to both IP 00, IP 20 and IP 54 units.

Gaining access to VLT 6350-6550 requires a minimum space of 605 mm in front of the VLT frequency converter.

Compact IP 00, IP 20 and IP 54

All IP 00, IP 20 and IP 54 units in the above-mentioned series can be installed side by side without any space between them, since these units do not require cooling on the sides.

### ■ IP 00 VLT 6350-6550 380-460 V

The IP 00 unit is designed for installation in a cabinet when installed according to the instructions in the VLT 6350-6550 Installation Guide MG:56.AX.YY.

Please note, that the same conditions as for NEMA 1/ IP20 and NEMA 12/ IP54 must be fulfilled.



## VLT® 6000 HVAC

### ■ General information about electrical installation

#### ■ High voltage warning



The voltage of the frequency converter is dangerous whenever the equipment is connected to mains. Incorrect installation of the motor or the frequency converter may cause damage to the equipment, serious personal injury or death.

Consequently, the instructions in this Design Guide, as well as national and local safety regulations, must be complied with.

Touching the electrical parts may be fatal - even after disconnection from mains:

Using VLT 6002-6005 wait at least 4 minutes and using VLT 6006-6550 wait at least 30 minutes.



**NB!**

It is the user's or certified electrician's responsibility to ensure correct earthing and protection in accordance with applicable national and local norms and standards.

#### ■ Earthing

The following basic issues need to be considered when installing a frequency converter, so as to obtain electromagnetic compatibility (EMC).

- **Safety earthing:** Please note that the frequency converter has a high leakage current and must be earthed appropriately for safety reasons. Apply local safety regulations.
- **High-frequency earthing:** Keep the earth wire connections as short as possible.

Connect the different earth systems at the lowest possible conductor impedance. The lowest possible conductor impedance is obtained by keeping the conductor as short as possible and by using the greatest possible surface area. A flat conductor, for example, has a lower HF impedance than a round conductor for the same conductor cross-section  $C_{Vess}$ .

If more than one device is installed in cabinets, the cabinet rear plate, which must be made of metal, should be used as a common earth reference plate. The metal cabinets of the different devices are mounted on the cabinet rear plate using the lowest possible HF impedance. This avoids having different HF voltages for the individual devices and avoids the risk of radio interference currents running in connection cables that may be used between the devices. The radio interference will have been reduced.

In order to obtain a low HF impedance, use the fastening bolts of the devices as HF connection to the rear plate. It is necessary to remove insulating paint or similar from the fastening points.

### ■ Cables

Control cables and the filtered mains cable should be installed separate from the motor cables so as to avoid interference overcoupling. Normally, a distance of 20 cm will be sufficient, but it is recommended to keep the greatest possible distance wherever possible, especially where cables are installed in parallel over a substantial distance.

With respect to sensitive signal cables, such as telephone cables and data cables, the greatest possible distance is recommended with a minimum of 1 m per 5 m of power cable (mains and motor cable). It must be pointed out that the necessary distance depends on the sensitivity of the installation and the signal cables, and that therefore no precise values can be stated.

If cable jaws are used, sensitive signal cables are not to be placed in the same cable jaws as the motor cable or brake cable.

If signal cables are to cross power cables, this should be done at an angle of 90 degrees.

Remember that all interference-filled in- or outgoing cables to/from a cabinet should be screened/armoured or filtered.

See also *EMC-correct electrical installation*.

#### ■ Screened/armoured cables

The screen must be a low HF-impedance screen. This is ensured by using a braided screen of copper, aluminium or iron. Screen armour intended for mechanical protection, for example, is not suitable for an EMC-correct installation.

See also *Use of EMC-correct cables*.

#### ■ Extra protection with regard to indirect contact

ELCB relays, multiple protective earthing or earthing can be used as extra protection, provided that local safety regulations are complied with.

In the case of an earth fault, a DC content may develop in the faulty current.

Never use ELCB relays, type A, since such relays are not suitable for DC fault currents. If ELCB relays are used, this must be done in accordance with local regulations.

If ELCB relays are used, they must be:

- Suitable for protecting equipment with a direct current content (DC) in the faulty current (3-phase bridge rectifier)
- Suitable for power-up with short charging current to earth
- Suitable for a high leakage current.



## VLT® 6000 HVAC

### ■ RFI switch

Mains supply isolated from earth:

When the VLT frequency converter is supplied from an isolated mains source (IT mains), the RFI switch must be closed (OFF). In the OFF position, the internal RFI capacitors (filter capacitors) between the chassis and the intermediate circuit are cut out so as to avoid damaging the intermediate circuit and to reduce the earth leakage currents (see IEC 1800-3). The position of the RFI switch can be seen from in VLT 6000 enclosures.



**NB!**

When the RFI switch is set to OFF parameter 407 Switching frequency max is only allowed to be set to factory setting.



**NB!**

The RFI switch is not to be operated with mains supply connected to the unit. Check that the mains supply has been disconnected before operating the RFI switch.



**NB!**

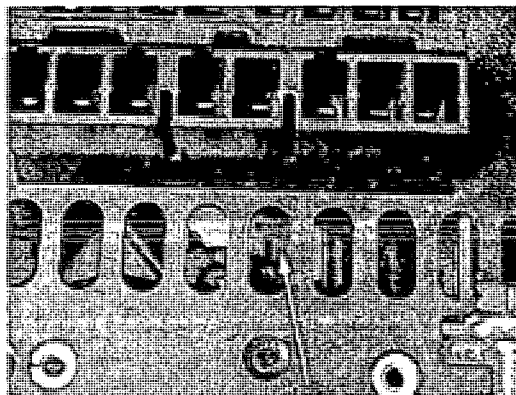
The RFI switch disconnects the capacitors galvanically; however, transients higher than approx. 1,000 V will be bypassed by a spark gap.



Reliable galvanic isolation (PELV) is lost if the RFI switch is placed in the OFF position. This means that all control in- and outputs can only be considered low-voltage terminals with basic galvanic isolation. In addition, the VLT 6000 HVAC EMC performance will be reduced if the RFI switch is placed in the OFF position.

Mains supply connected to earth:

The RFI switch must be ON for all installations on earthed mains supplies.

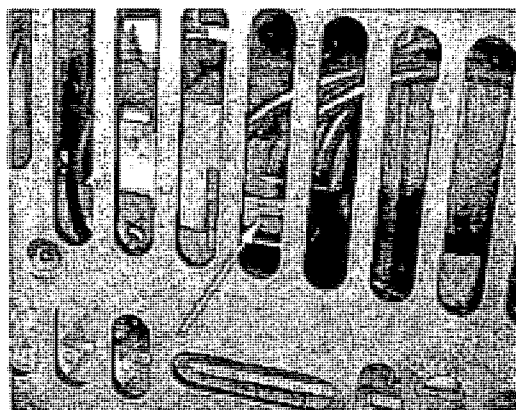


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### Bookstyle IP 20

VLT 6002 - 6011 380 - 460 V

VLT 6002 - 6005 200 - 240 V



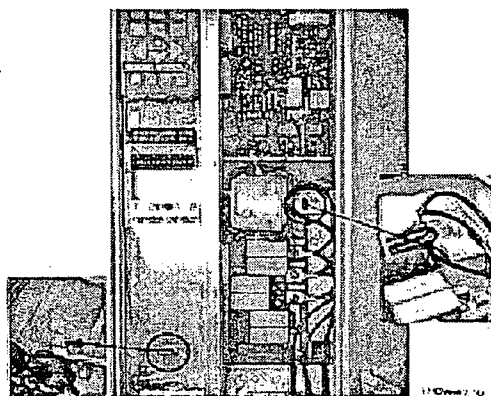
1752AE50.10

### Compact IP 20 and NEMA 1

VLT 6002 - 6011 380 - 460 V

VLT 6002 - 6005 200 - 240 V

VLT 6002 - 6011 550 - 600 V



### Compact IP 20 and NEMA 1

VLT 6016 - 6027 380 - 460 V

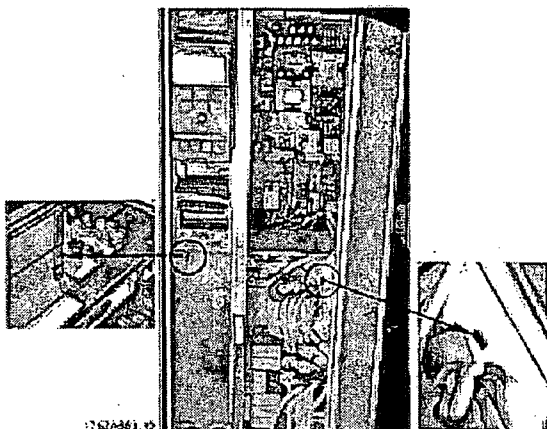
VLT 6006 - 6011 200 - 240 V

VLT 6016 - 6027 550 - 600 V

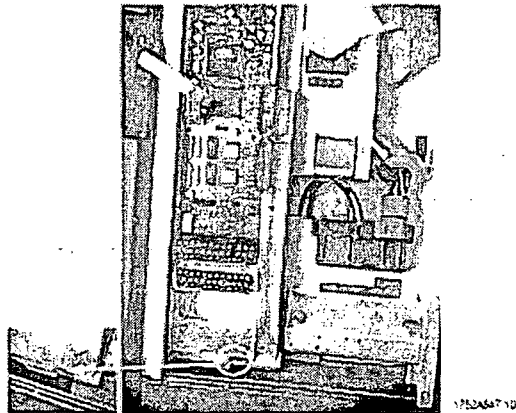
Installation



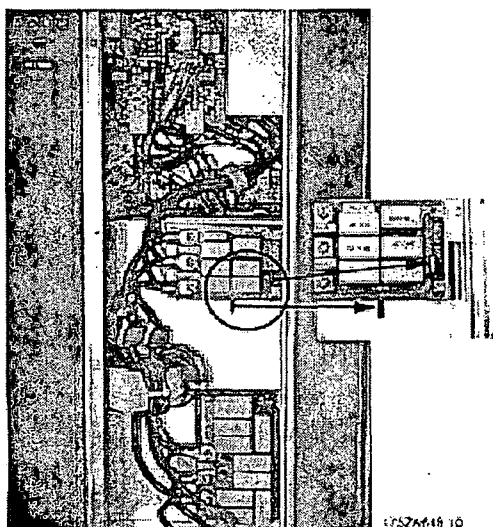
## VLT® 6000 HVAC



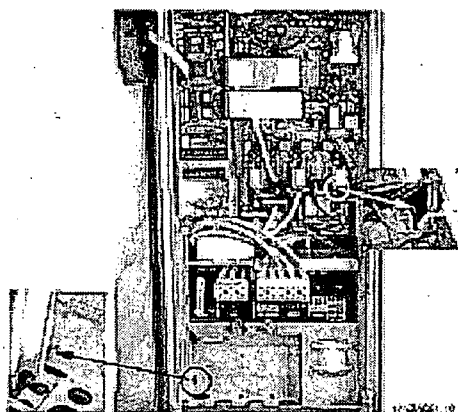
**Compact IP 20 and NEMA 1**  
 VLT 6032 - 6042 380 - 460 V  
 VLT 6016 - 6022 200 - 240 V  
 VLT 6032 - 6042 550 - 600 V



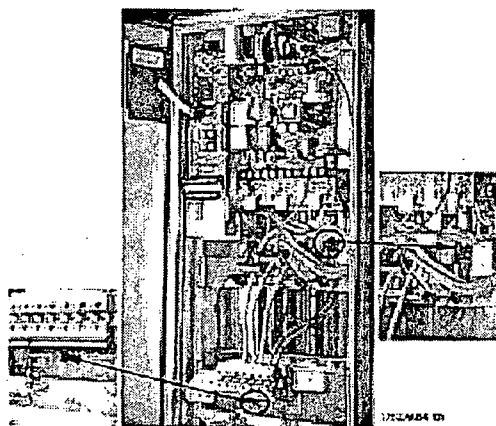
**Compact IP 54**  
 VLT 6002 - 6011 380 - 460 V  
 VLT 6002 - 6005 200 - 240 V



**Compact IP 20 NEMA 1**  
 VLT 6052 - 6072 380 - 460 V  
 VLT 6027 - 6032 200 - 240 V  
 VLT 6052 - 6072 550 - 600 V



**Compact IP 54**  
 VLT 6016 - 6032 380 - 460 V  
 VLT 6006 - 6011 200 - 240 V



**Compact IP 54**  
 VLT 6042 - 6072 380 - 460 V  
 VLT 6016 - 6032 200 - 240 V



## VLT® 6000 HVAC

### ■ High voltage test

A high voltage test can be carried out by short-circuiting terminals U, V, W, L<sub>1</sub>, L<sub>2</sub> and L<sub>3</sub> and energizing by max. 2.5 kV DC for one second between this short-circuit and the chassis.



#### NB!

The RFI switch must be closed (position ON) when high voltage tests are carried out. The mains and motor connection must be interrupted in the case of high voltage tests of the total installation if the leakage currents are too high.

### ■ Heat emission from VLT® 6000 HVAC

The tables in *General technical data* show the power loss  $P_{\phi}(W)$  from VLT 6000 HVAC. The maximum cooling air temperature  $t_{IN, MAX}$  is 40° at 100% load (of rated value).

### ■ Ventilation of integrated VLT 6000 HVAC

The quantity of air required for cooling frequency converters can be calculated as follows:

1. Add up the values of  $P_{\phi}$  for all the frequency converters to be integrated in the same panel. The highest cooling air temperature ( $t_{IN}$ ) present must be lower than  $t_{IN, MAX}$  (40°C). The day/night average must be 5°C lower (VDE 160). The outlet temperature of the cooling air must not exceed:  $t_{OUT, MAX}$  (45° C).
2. Calculate the permissible difference between the temperature of the cooling air ( $t_{IN}$ ) and its outlet temperature ( $t_{OUT}$ ):  
 $\Delta t = 45^{\circ} C - t_{IN}$ .
3. Calculate the required

$$\text{quantity of air} = \frac{\Sigma P_{\phi} \times 3.1}{\Delta t} \quad \text{m}^3/\text{h}$$

Insert  $\Delta t$  in Kelvin

The outlet from the ventilation must be placed above the highest-mounted frequency converter. Allowance must be made for the pressure loss across the filters and for the fact that the pressure is going to drop as the filters are choked.

### ■ EMC-correct electrical installation

Following these guidelines is advised, where compliance with EN 50081, EN 55011 or EN 61800-3 *First environment* is required.

If the installation is in EN 61800-3 *Second environment*, then it is acceptable to deviate from these guidelines. It is however not recommended. See also *CE labelling, Emission and EMC test results* under special conditions in the Design Guide for further details.

Good engineering practice to ensure EMC-correct electrical installation:

- Use only braided screened/armoured motor cables and control cables.  
The screen should provide a minimum coverage of 80%. The screen material must be metal, not limited to but typically copper, aluminium, steel or lead. There are no special requirements for the mains cable.
- Installations using rigid metal conduits are not required to use screened cable, but the motor cable must be installed in conduit separate from the control and mains cables. Full connection of the conduit from the drive to the motor is required. The EMC performance of flexible conduits varies a lot and information from the manufacturer must be obtained.
- Connect the screen/armour/conduit to earth at both ends for motor cables and control cables. See also *Earthing of braided screened/armoured control cables*.
- Avoid terminating the screen/armour with twisted ends (pigtailed). Such a termination increases the high frequency impedance of the screen, which reduces its effectiveness at high frequencies. Use low impedance cable clamps or glands instead.

- Ensure good electrical contact between the mounting plate and the metal chassis of the VLT frequency converter. This does not apply to IP54/NEMA 12 units as they are designed for wall mounting and VLT 6075-6550, 380-460 VAC, VLT 6042-6062, 200-240 VAC, and VLT 6100-6275 550-600 V in IP20/NEMA1 enclosure.
- Use starwashers and galvanically conductive installation plates to secure good electrical connections for IP00, IP20, and NEMA 1 installations.
- Avoid using unscreened/unarmoured motor or control cables inside cabinets housing the drive(s), where possible.
- An uninterrupted high frequency connection between the VLT frequency converter and the motor units is required for IP54/NEMA 12 units.

PLC etc.

Panel

VLT6000

PLC

Output contactor etc.

Earthing rail

Cable insulation stripped

Min. 16mm<sup>2</sup> Equalizing cable

Control cables

Min. 200mm between control cables, motor cable and mains cable

Mains-supply

L1

L2

L3

PE

Min. 10mm<sup>2</sup>

Motor thermistor

Motor cable

Motor

PE: min. 10mm<sup>2</sup>

DAIYOS 175A38112

All cable entries in one side of panel



## VLT® 6000 HVAC

### ■ Use of EMC-correct cables

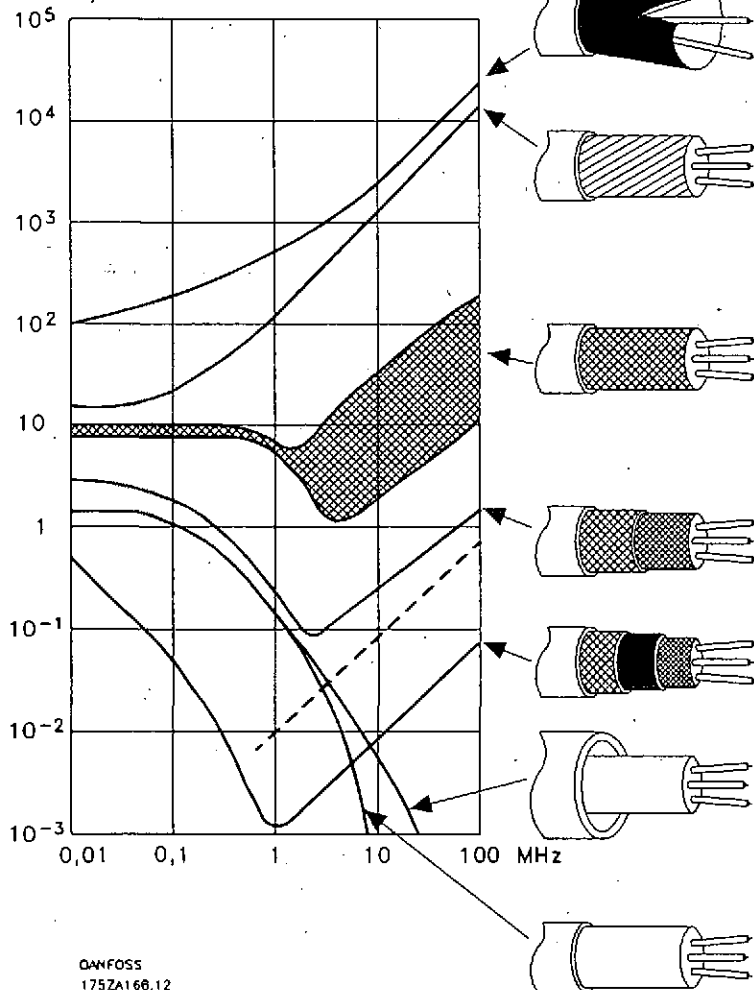
Braided screened/armoured cables are recommended to optimise EMC immunity of the control cables and the EMC emission from the motor cables.

The ability of a cable to reduce the in- and outgoing radiation of electric noise depends on the switching impedance ( $Z_T$ ). The screen of a cable is normally designed to reduce the transfer of electric noise; however, a screen with a lower  $Z_T$  value is more effective than a screen with a higher  $Z_T$ .  $Z_T$  is rarely stated by cable manufacturers, but it is possible to estimate  $Z_T$  by looking at the cable and assessing its physical design.

$Z_T$  can be assessed on the basis of the following factors:

- The contact resistance between the individual screen conductors.
- The screen coverage, i.e. the physical area of the cable covered by the screen - often stated as a percentage value. Should be min. 85%.
- The screen type, i.e. braided or twisted pattern. A braided pattern or a closed tube is recommended.

Transfer impedance,  $Z_T$   
mΩm/m



Aluminium-clad with copper wire.

Twisted copper wire or armoured steel wire cable.

Single-layer braided copper wire with varying percentage screen coverage.

Double-layer braided copper wire.

Twin layer of braided copper wire with a magnetic, screened/armoured intermediate layer.

Cable that runs in copper tube or steel tube.

Lead cable with 1.1 mm wall thickness with full coverage.

The lower the  $Z_T$  the better the cable screening performance

Installation



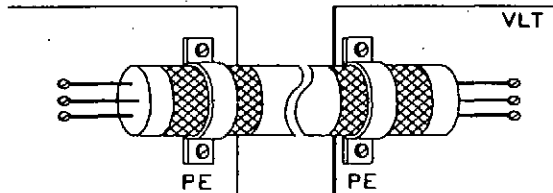
## VLT® 6000 HVAC

### ■ Earthing of screened/armoured control cables

Generally speaking, control cables must be screened/armoured and the screen must be connected by means of a cable clamp at both ends to the metal cabinet of the unit.

The drawing below indicates how correct earthing is carried out and what to be done if in doubt.

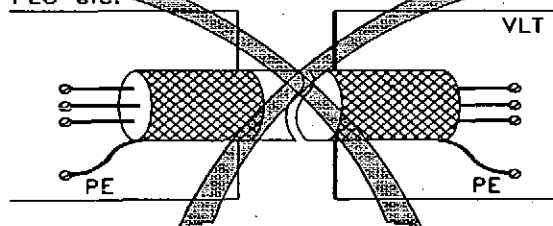
PLC etc.



#### Correct earthing

Control cables and cables for serial communication must be fitted with cable clamps at both ends to ensure the best possible electrical contact.

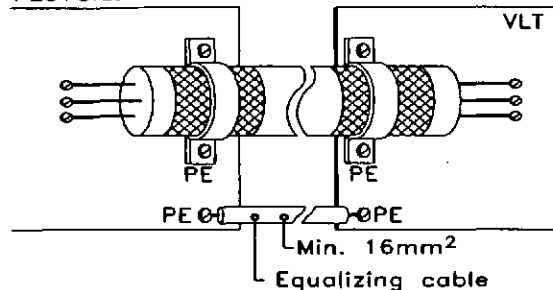
PLC etc.



#### Wrong earthing

Do not use twisted cable ends (pigtails), since these increase the screen impedance at high frequencies.

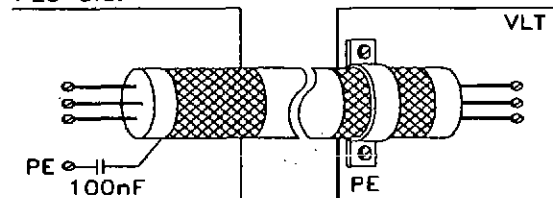
PLC etc.



#### Protection with respect to earth potential between PLC and VLT

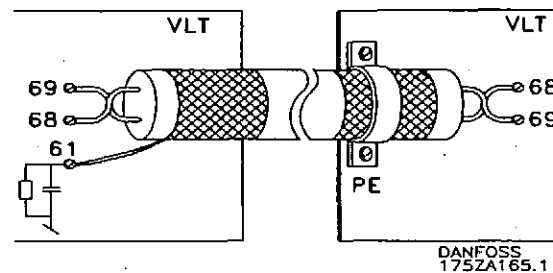
If the earth potential between the VLT frequency converter and the PLC (etc.) is different, electric noise may occur that will disturb the whole system. This problem can be solved by fitting an equalizing cable, to be placed next to the control cable. Minimum cable cross-section: 16 mm<sup>2</sup>.

PLC etc.



#### For 50/60 Hz earth loops

If very long control cables are used, 50/60 Hz earth loops may occur that will disturb the whole system. This problem can be solved by connecting one end of the screen to earth via a 100nF condenser (keeping leads short).



#### Cables for serial communication

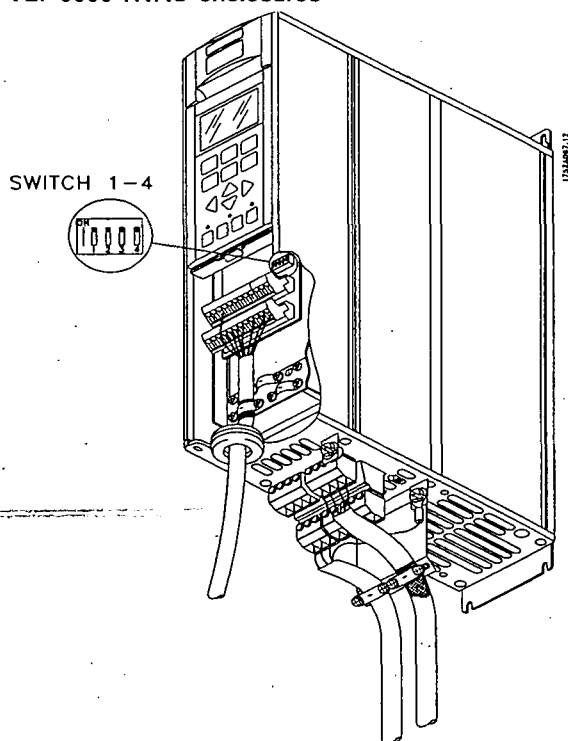
Low-frequency noise currents between two VLT frequency converters can be eliminated by connecting one end of the screen to terminal 61. This terminal is connected to earth via an internal RC link. It is recommended to use twisted-pair cables to reduce the differential mode interference between the conductors.

DANFOSS  
175ZA165.11

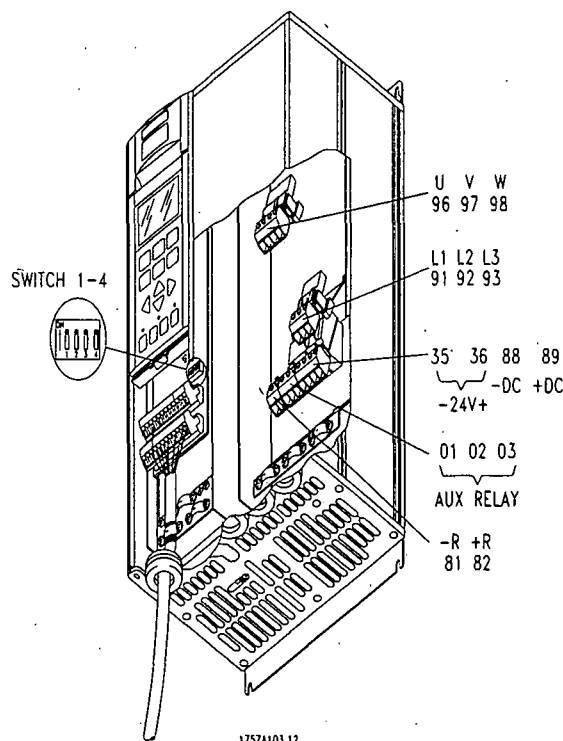


## VLT® 6000 HVAC

### ■ VLT 6000 HVAC enclosures

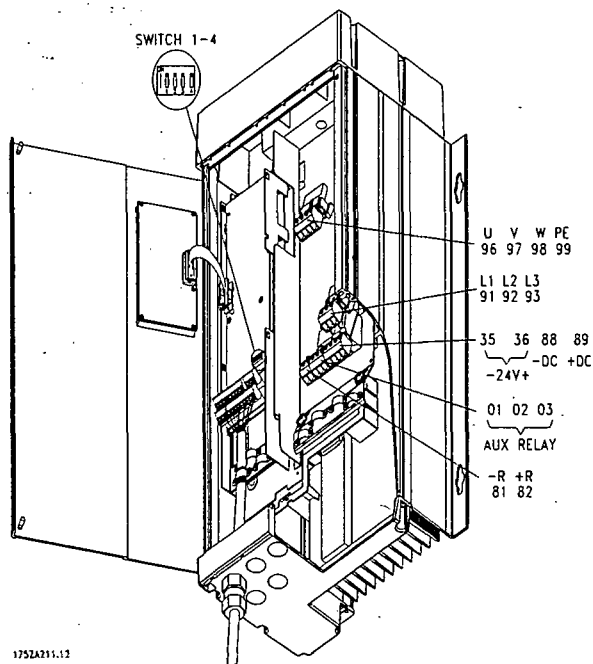


**Bookstyle IP 20**  
VLT 6002-6005, 200-240 V  
VLT 6002-6011, 380-460 V

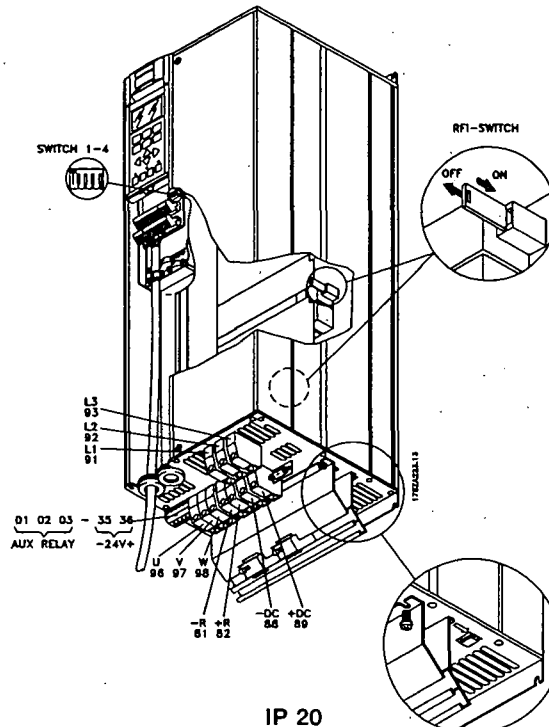


**Compact IP 20 and NEMA 1**  
VLT 6002-6005, 200-240 V  
VLT 6002-6011, 380-460 V  
VLT 6002-6011, 550-600 V

Installation



**Compact IP 54**  
VLT 6002-6005, 200-240 V  
VLT 6002-6011, 380-460 V

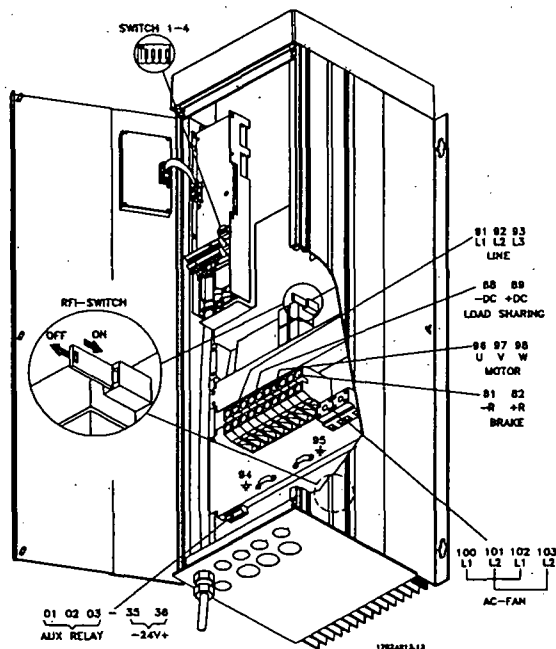


**IP 20**  
VLT 6006-6032, 200-240 V  
VLT 6016-6072, 380-460 V  
VLT 6016-6072, 550-600 V



## VLT® 6000 HVAC

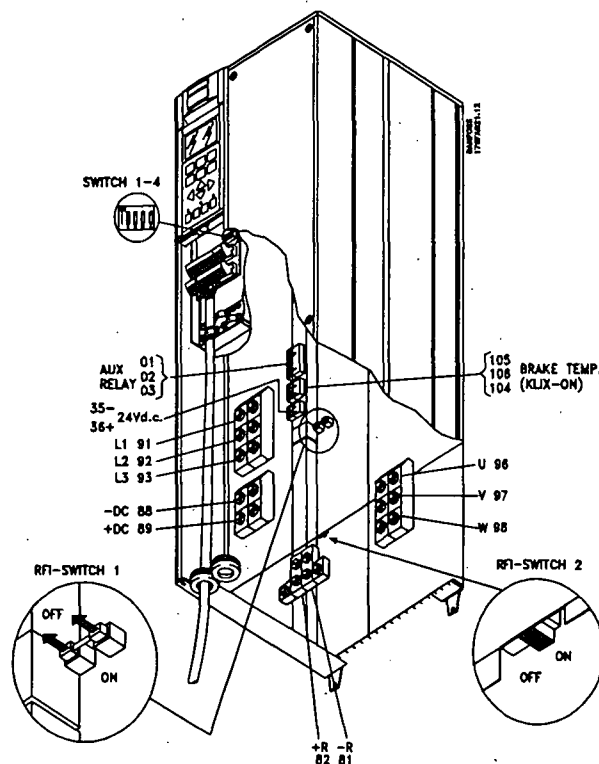
### ■ VLT 6000 HVAC enclosures



IP 54

VLT 6006-6032, 200-240 V

VLT 6016-6062, 380-460 V

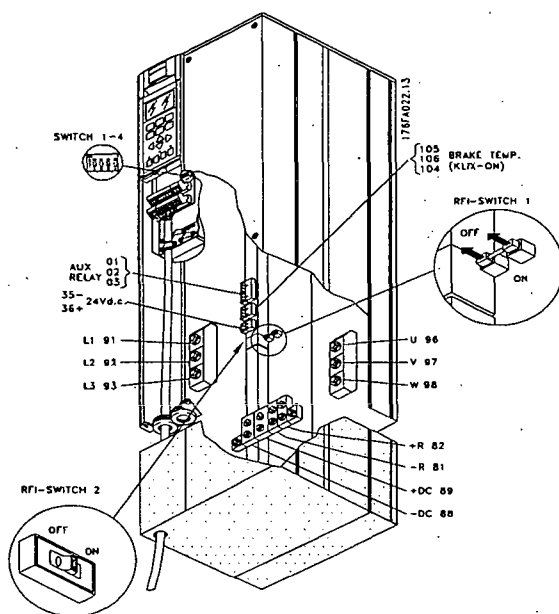


IP 00

VLT 6042-6062, 200-240 V

VLT 6075-6125, 380-460 V

VT 6100-6150, 550-600 V

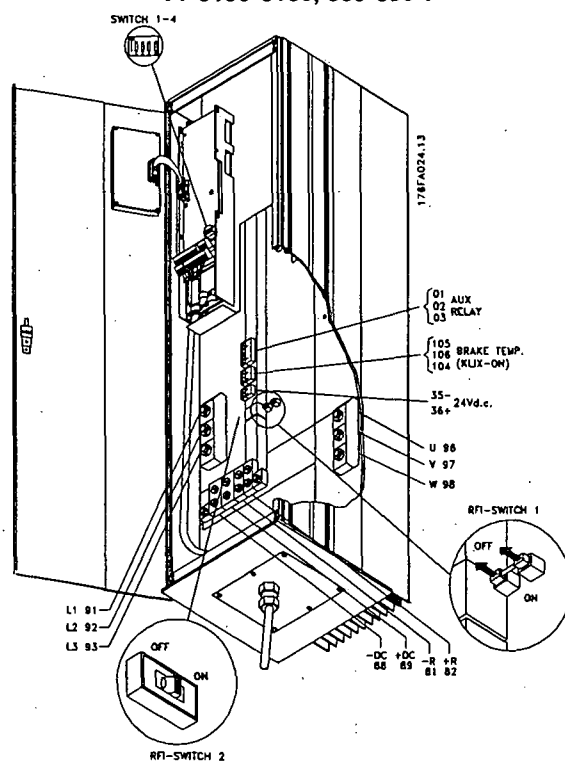


NEMA 1

VLT 6042-6062, 200-240 V

VLT 6075-6125, 380-460 V

VLT 6100-6150, 550-600 V



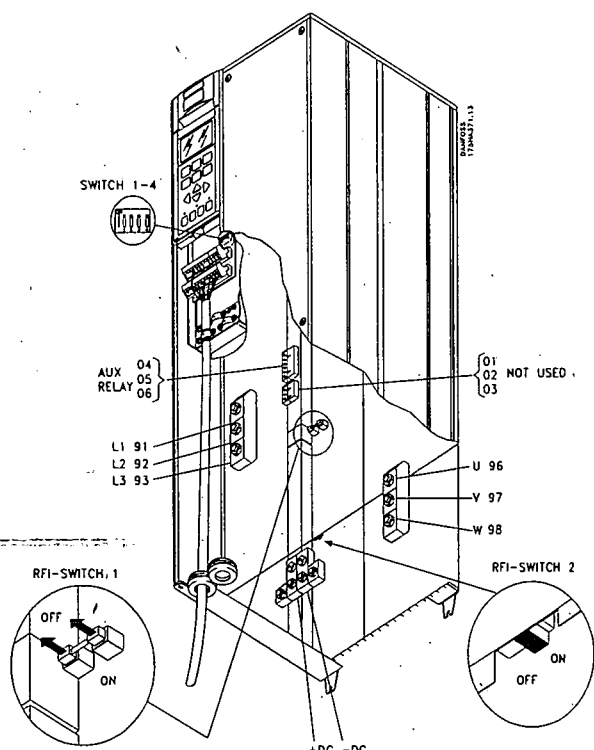
IP 54

VLT 6042-6062, 200-240 V

VLT 6075-6125, 380-460 V

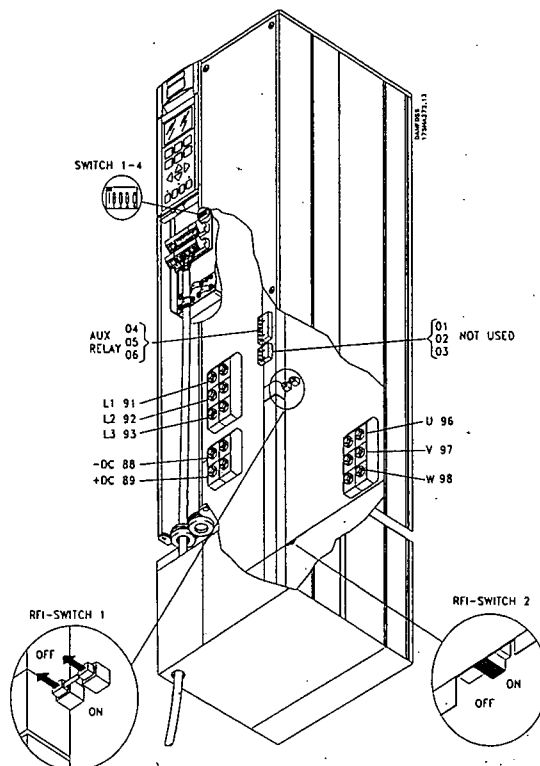


## VLT® 6000 HVAC



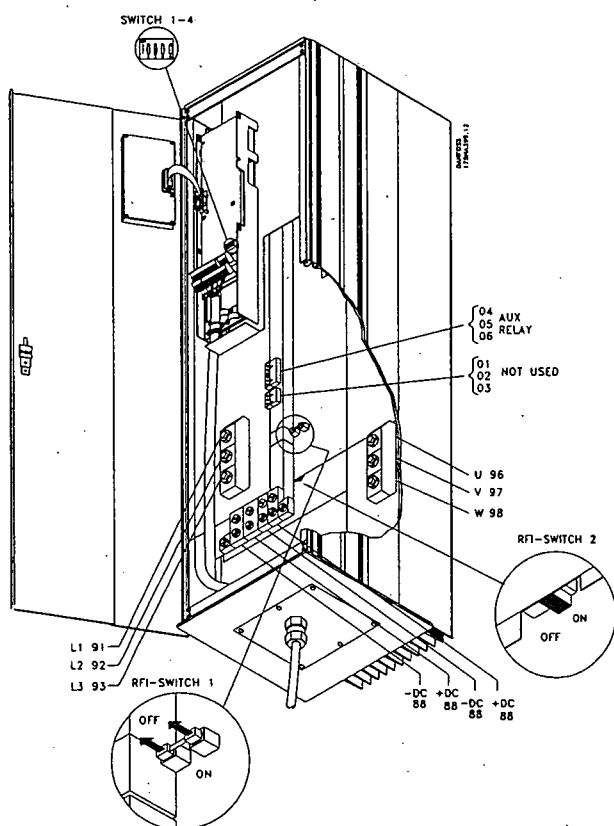
### IP 00

VLT 6150-6275, 380-460 V  
VLT 6175-6275, 550-600 V



### NEMA 1

VLT 6150-6275, 380-460 V  
VLT 6175-6275, 550-600 V



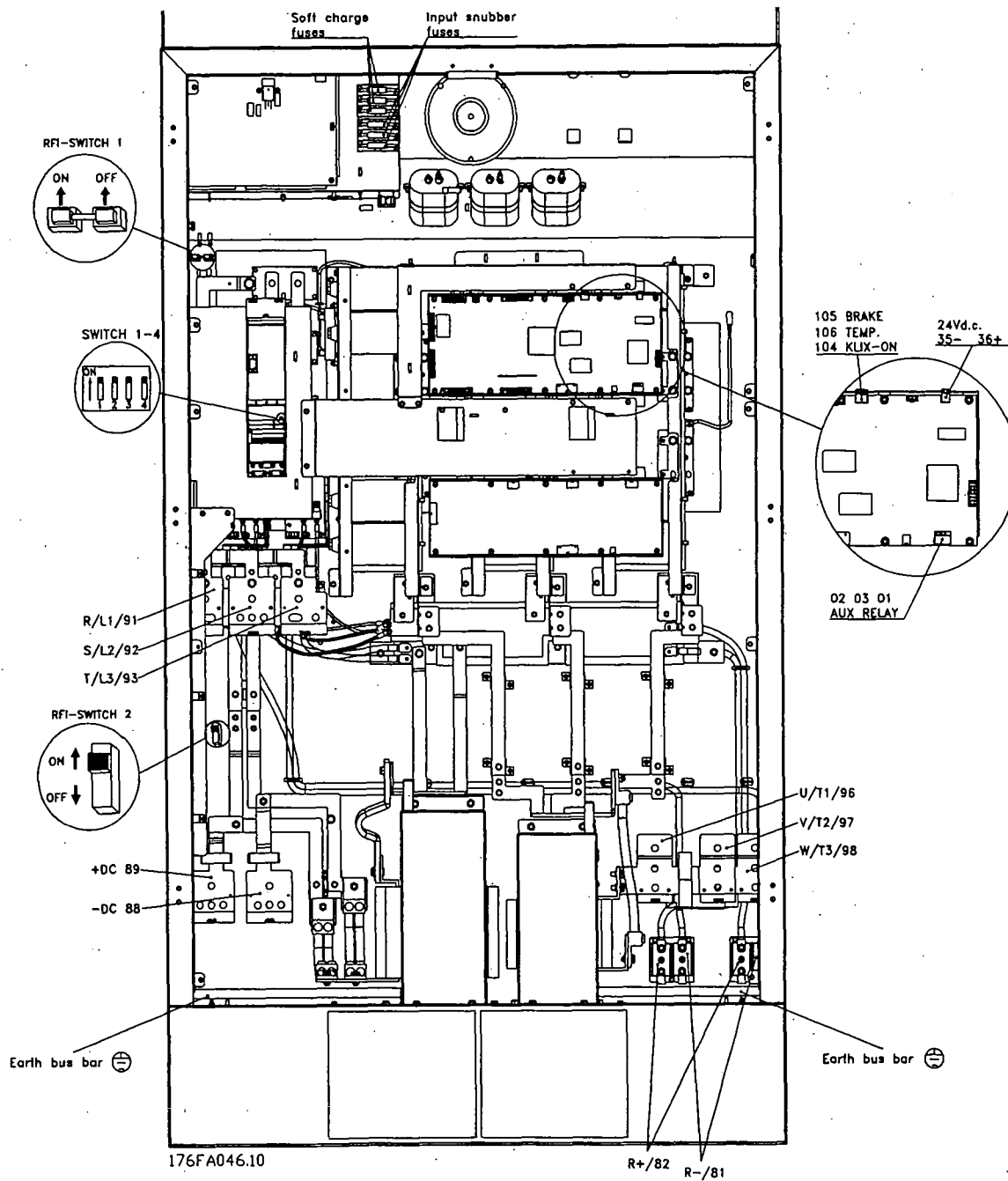
### IP 54

VLT 6150-6275, 380-460 V



## VLT® 6000 HVAC

### ■ Electrical installation, enclosures

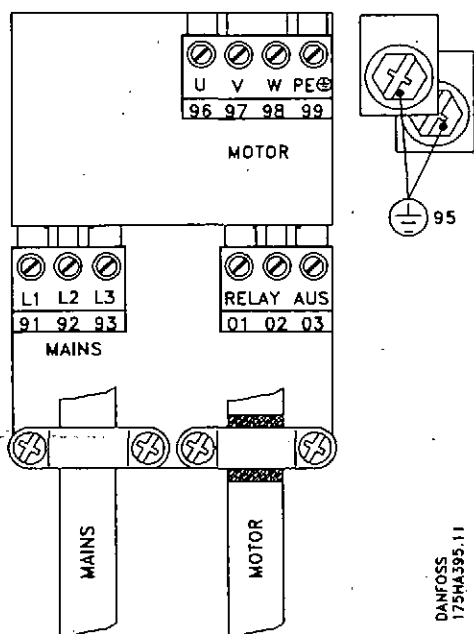


Compact IP 20, NEMA 1, and IP 54  
VLT 6350-6550, 380-500 V

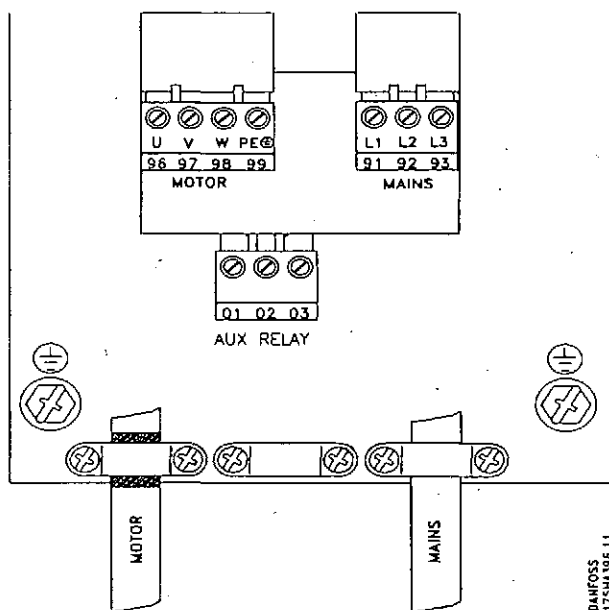


## VLT® 6000 HVAC

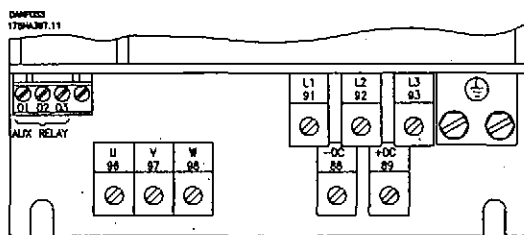
### ■ Electrical installation, power cables



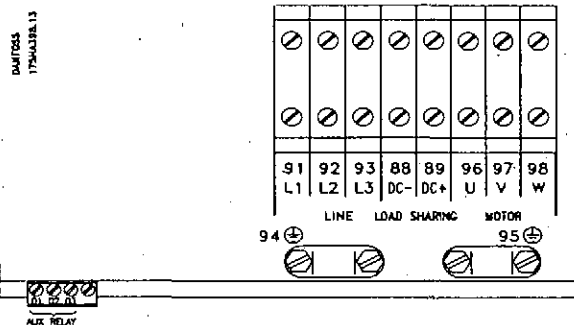
Bookstyle IP 20  
VLT 6002-6005, 200-240 V  
VLT 6002-6011, 380-460 V



Compact IP 20, NEMA 1, and IP 54  
VLT 6002-6005, 200-240 V  
VLT 6002-6011, 380-460 V  
VLT 6002-6011, 550-600 V



IP 20 and NEMA 1  
VLT 6006-6032, 200-240 V  
VLT 6016-6072, 380-460 V  
VLT 6016-6072, 550-600 V



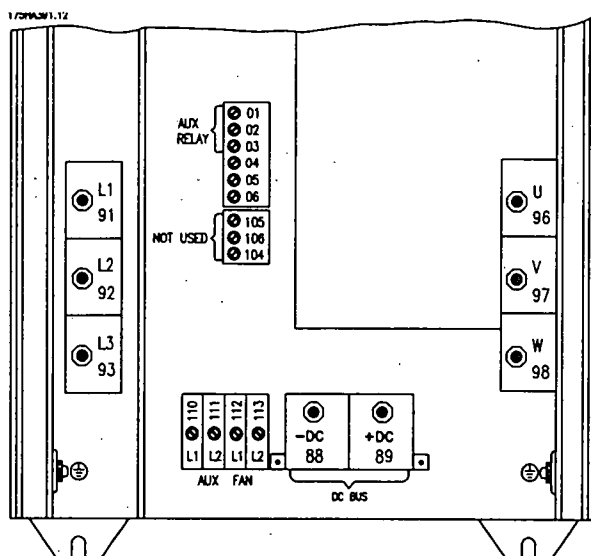
IP 54  
VLT 6006-6032, 200-240 V  
VLT 6016-6072, 380-460 V

Installation

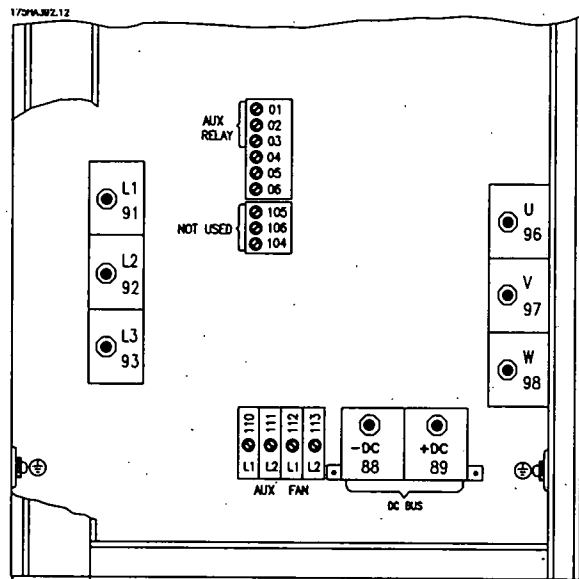


## VLT® 6000 HVAC

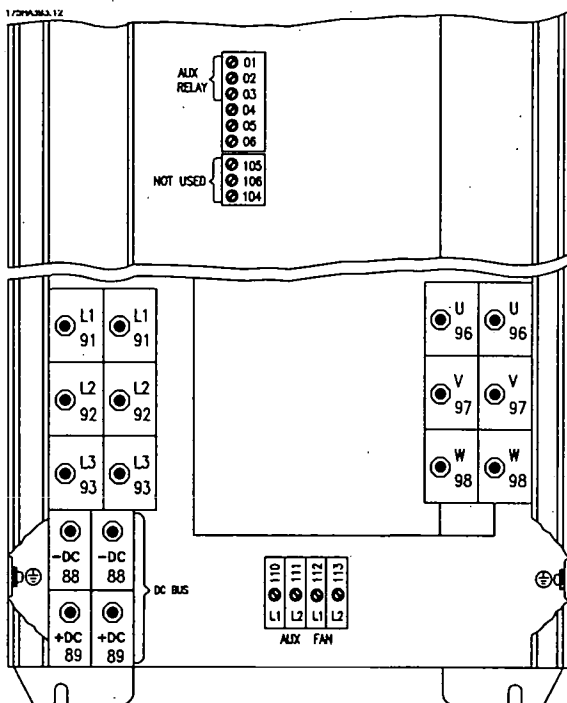
### ■ Electrical installation, power cables



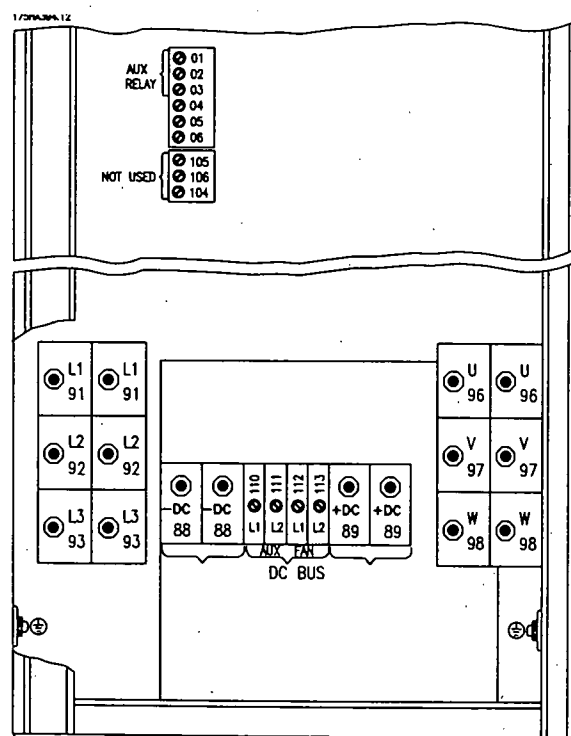
IP 00/20 and NEMA 1  
VLT 6042-6062, 200-240 V  
VLT 6075-6125, 380-460 V  
VLT 6100-6150, 550-600 V



IP 54  
VLT 6042-6062, 200-240 V  
VLT 6075-6125, 380-460 V



IP 00/20 and NEMA 1  
VLT 6150-6275, 380-460 V  
VLT 6175-6275, 550-600 V

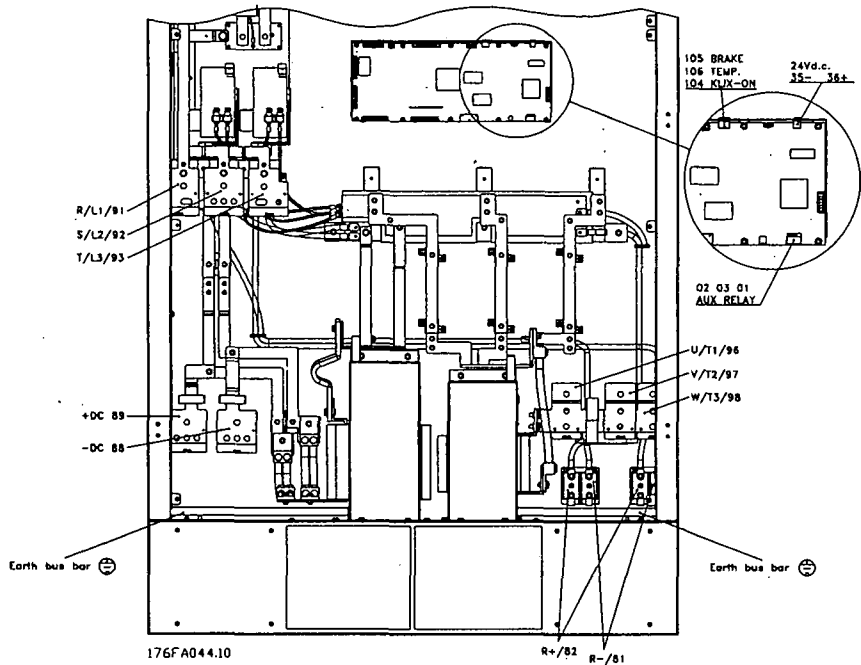


IP 54  
VLT 6150-6275, 380-460 V

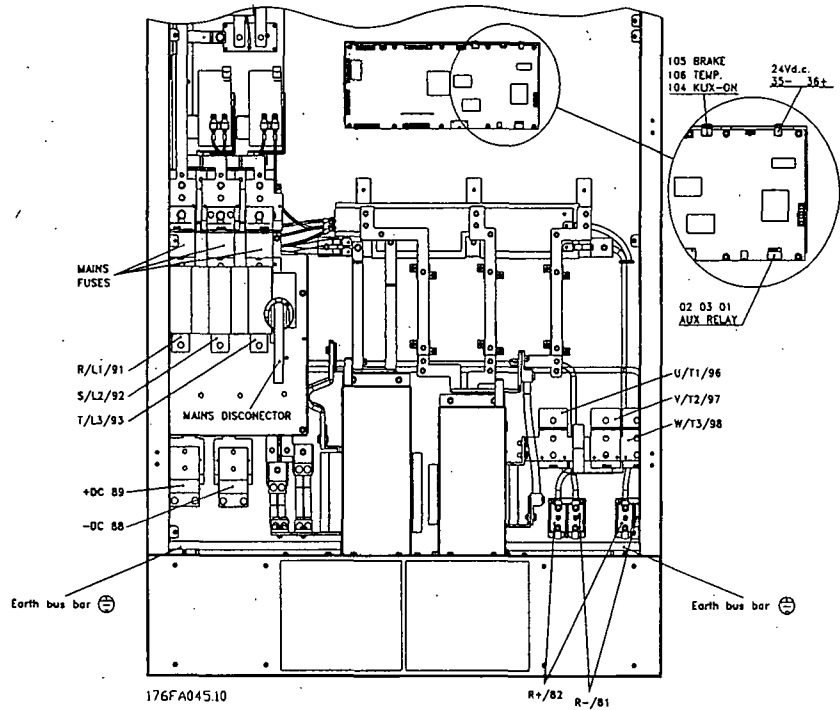


VLT® 6000 HVAC

■ Electrical installation, power cables



Compact IP 20, NEMA 1, and IP 54  
without disconnectors and mains fuses



Compact IP 20, NEMA 1, and IP 54  
with disconnectors and mains fuses



## VLT® 6000 HVAC

### ■ Tightening-up torque and screw sizes

The table shows the torque required when fitting terminals to the VLT frequency converter. For VLT 6002-6032, 200-240 V, VLT 6002-6072, 380-460 V, the cables must be fastened with screws. For VLT 6042-6062, 200-240 V and for VLT 6075-6550, the cables must be fastened with bolts.

These figures apply to the following terminals:

#### Mains terminals

**Nos. 91, 92, 93**

**L1, L2, L3**

#### Motor terminals

**Nos. 96, 97, 98**

**U, V, W**

#### Earth terminal

**No. 99**

| VLT type      | Tightening-up torque | Screw size |
|---------------|----------------------|------------|
| 3 x 200-240 V |                      |            |
| VLT 6002-6005 | 0.5 - 0.6 Nm         | M3         |
| VLT 6006-6011 | 1.8 Nm               | M4         |
| VLT 6016-6027 | 3.0 Nm               | M5         |
| VLT 6032      | 4.0 Nm               | M6         |

| VLT type      | Tightening-up torque | Bolt size |
|---------------|----------------------|-----------|
| 3 x 200-240 V |                      |           |
| VLT 6042-6062 | 11.3 Nm              | M8        |

| VLT type      | Tightening-up torque | Screw size |
|---------------|----------------------|------------|
| 3 x 380-460 V |                      |            |
| VLT 6002-6011 | 0.5 - 0.6 Nm         | M3         |
| VLT 6016-6027 | 1.8 Nm               | M4         |
| VLT 6032-6072 | 3.0 Nm               | M5         |

| VLT type      | Tightening-up torque | Bolt size |
|---------------|----------------------|-----------|
| 3 x 380-460 V |                      |           |
| VLT 6075-6125 | 11.3 Nm              | M8        |
| VLT 6150-6275 | 11.3 Nm              | M8        |
| VLT 6350-6550 | 42.0 Nm              | M12       |

| VLT type      | Tightening-up torque | Screw size |
|---------------|----------------------|------------|
| 3 x 550-600 V |                      |            |
| VLT 6002-6011 | 0.5 - 0.6 Nm         | M3         |
| VLT 6016-6027 | 1.8 Nm               | M4         |
| VLT 6032-6042 | 3.0 Nm               | M5         |
| VLT 6052-6072 | 4.0 Nm               | M6         |
| VLT 6100-6150 | 11.3 Nm              | M8         |
| VLT 6175-6275 | 11.3 Nm              | M8         |

### ■ Mains connection

Mains must be connected to terminals 91, 92, 93.

**Nos. 91, 92, 93**

**L1, L2, L3**

Mains voltage 3 x 200-240 V

Mains voltage 3 x 380-460 V

Mains voltage 3 x 550-600 V

#### NB!



Check that the mains voltage fits the mains voltage of the VLT frequency converter, which can be seen from the nameplate.

See *Technical data* for correct sizing of cable cross-sections.

### ■ Pre-fuses

See *Technical data* for correct sizing of pre-fuses.

### ■ Motor connection

The motor must be connected to terminals 96, 97, 98. Earth to terminal 94/95/99.

**Nos. 96, 97, 98**

**U, V, W**

**No.**

Motor voltage 0-100% of mains voltage.

Earth connection.

See *Technical data* for correct sizing of cable cross-sections.

All types of three-phase asynchronous standard motors can be used with a VLT 6000 HVAC unit.

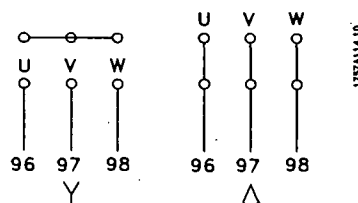
Small-size motors are normally star-connected. (220/380 V,  $\Delta/Y$ ). Large-size motors are delta-connected (380/660 V,  $\Delta/Y$ ).

The correct connection and voltage can be read from the motor nameplate.

#### NB!



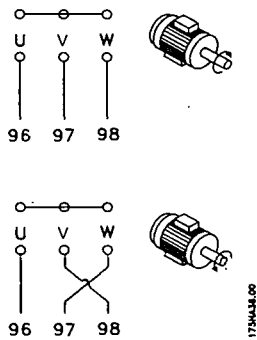
In older motors without phase coil insulation, a LC filter should be fitted to the VLT frequency converter output. See the Design Guide or contact Danfoss.





VLT® 6000 HVAC

Direction of motor rotation

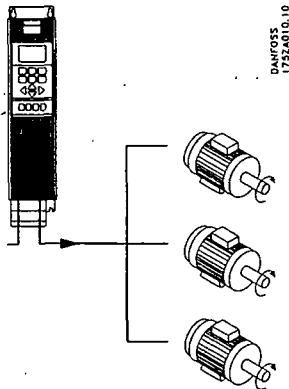


The factory setting is for clockwise rotation with the VLT frequency transformer output connected as follows.

- Terminal 96 connected to U-phase
- Terminal 97 connected to V-phase
- Terminal 98 connected to W-phase

The direction of rotation can be changed by switching two phases in the motor cable.

Parallel coupling of motors



VLT 6000 HVAC is able to control several motors connected in parallel. If the motors are to have different rpm values, the motors must have different rated rpm values. Motor rpm is changed simultaneously, which means that the ratio between the rated rpm values is maintained across the range.

The total current consumption of the motors is not to exceed the maximum rated output current  $I_{VLT,N}$  for the VLT frequency converter.

Problems may arise at the start and at low rpm values if the motor sizes are widely different. This is because the relatively high ohmic resistance in small motors calls for a higher voltage at the start and at low rpm values.

In systems with motors connected in parallel, the electronic thermal relay (ETR) of the VLT frequency converter cannot be used as motor protection for the individual motor. Consequently, additional motor protection is required, such as thermistors in each motor (or individual thermal relays).



**NB!** Parameter 107 *Automatic Motor Adaptation*, *AMA* and *Automatic Energy Optimization*, *AEO* in parameter 101 *Torque characteristics* cannot be used if motors are connected in parallel.

Motor cables

See *Technical data* for correct sizing of motor cable cross-section and length. Always comply with national and local regulations on cable cross-sections.



**NB!** If an unscreened cable is used, some EMC requirements are not complied with, see *EMC test results*.

If the EMC specifications regarding emission are to be complied with, the motor cable must be screened, unless otherwise stated for the RFI filter in question. It is important to keep the motor cable as short as possible so as to reduce the noise level and leakage currents to a minimum.

The motor cable screen must be connected to the metal cabinet of the frequency converter and to the metal cabinet of the motor. The screen connections are to be made with the biggest possible surface (cable clamp). This is enabled by different installation devices in the different VLT frequency converters. Mounting with twisted screen ends (pigtailed) is to be avoided, since these spoil the screening effect at higher frequencies.

If it is necessary to break the screen to install a motor isolator or motor contactor, the screen must be continued at the lowest possible HF impedance.





## VLT® 6000 HVAC

### ■ Motor thermal protection

The electronic thermal relay in UL-approved VLT frequency converters has received UL-approval for single motor protection, as long as parameter 117 *Motor thermal protection* has been set to ETR Trip and parameter 105 *Motor current*,  $I_{VLTN}$  has been programmed for the rated motor current (can be read from the motor nameplate).

### ■ Earth connection

Since the leakage currents to earth may be higher than 3.5 mA, the VLT frequency converter must always be earthed in accordance with applicable national and local regulations. In order to ensure good mechanical connection of the earth cable, its cable cross-section must be at least 10 mm<sup>2</sup>. For added security, an RCD (Residual Current Device) may be installed. This ensures that the VLT frequency converter will cut out if the leakage currents get too high. See RCD instructions MI.66.AX.02.

### ■ Installation of 24 Volt external DC supply:

Torque: 0.5 - 0.6 Nm

Screw size: M3

No.                      Function

**35 (-), 36 (+)** 24 V external DC supply

(Available with VLT 6350-6550 only)

24 V external DC supply can be used as low-voltage supply to the control card and any option cards installed. This enables full operation of the LCP (incl. parameter setting) without connection to mains. Please note that a warning of low voltage will be given when 24 V DC has been connected; however, there will be no tripping. If 24 V external DC supply is connected or switched on at the same time as the mains supply, a time of min. 200 msec. must be set in parameter 111, *Start delay*.

A pre-fuse of min. 6 Amp, slow-blow, can be fitted to protect the external 24 V DC supply. The power consumption is 15-50 W, depending on the load on the control card.



#### NB!

Use 24 V DC supply of type PELV to ensure correct galvanic isolation (type PELV) on the control terminals of the VLT frequency converter.

### ■ DC bus connection

The DC bus terminal is used for DC back-up, with the intermediate circuit being supplied from an external DC source. In addition, a 12-pulse option can be connected to reduce the total harmonic distortion.

Terminal nos. **Nos. 88, 89**

Contact Danfoss if you require further information.

### ■ High-voltage relay

The cable for the high-voltage relay must be connected to terminals 01, 02, 03. The high-voltage relay is programmed in parameter 323, *Relay 1, output*.

**No. 1** Relay output 1  
1+3 break, 1+2 make.  
Max. 240 V AC, 2 Amp.  
Min. 24 V DC, 10 mA or  
24 V AC, 100 mA.

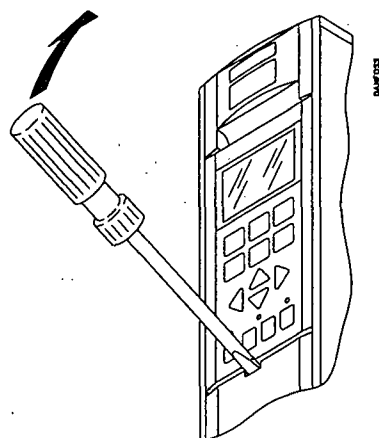
Max. cross-section: 4 mm<sup>2</sup>/10 AWG.

Torque: 0.5 - 0.6 Nm.

Screw size: M3.

### ■ Control card

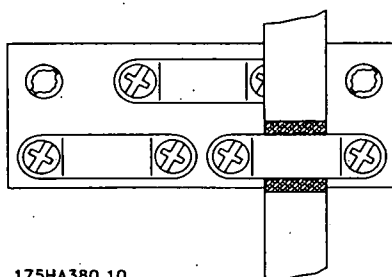
All terminals for the control cables are located under the protective cover of the VLT frequency converter. The protective cover (see drawing below) can be removed by means of a pointed object - a screwdriver or similar.





## VLT® 6000 HVAC

### ■ Electrical installation, control cables



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Torque: 0.5 - 0.6 Nm.  
Screw size: M3.

Generally speaking, control cables must be screened/ armoured and the screen must be connected by means of a cable clamp at both ends to the metal cabinet of the unit (see *Earthing of screened/ armoured control cables*). Normally, the screen must also be connected to the body of the controlling unit (follow the instructions for installation given for the unit in question).

If very long control cables are used, 50/60 Hz earth loops may occur that will disturb the whole system. This problem can be solved by connecting one end of the screen to earth via a 100nF condenser (keeping leads short).

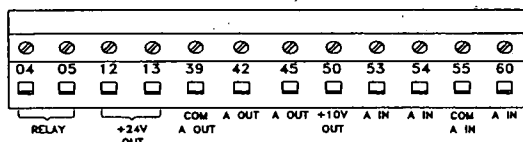
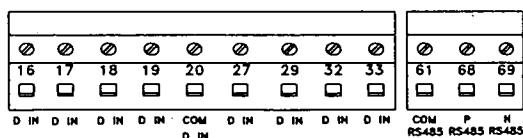
### ■ Electrical installation, control cables

Max. control cable cross section: 1.5 mm<sup>2</sup>/16 AWG

Torque: 0.5-0.6 Nm

Screw size: M3

See *Earthing of screened/armoured control cables* for correct termination of control cables.

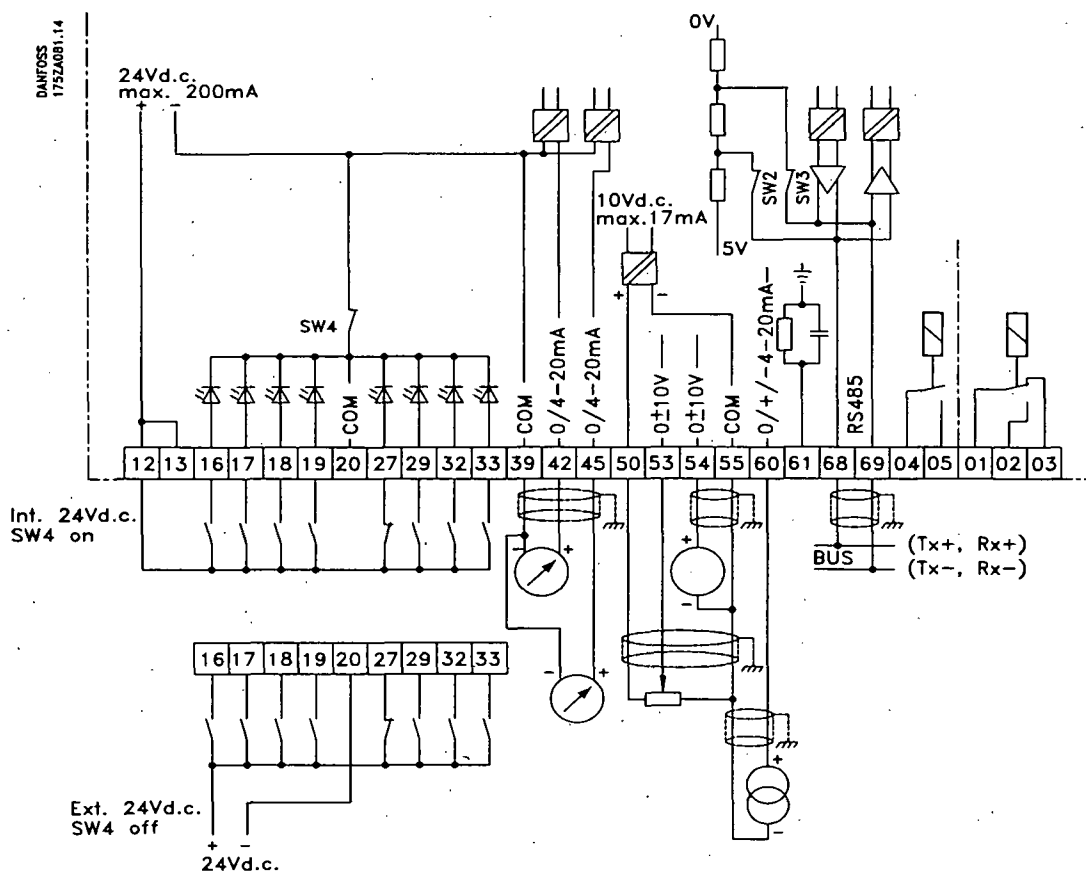
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| No.    | Function   |
|--------|--|
| 04, 05 | Relay output 1 can be used for indicating status and warnings.   |
| 12, 13 | Voltage supply to digital inputs. For the 24 V DC to be used for digital inputs, switch 4 on the control card must be closed, position "on".   |
| 16-33  | Digital inputs. See parameters 300-307 <i>Digital inputs</i> .   |
| 20     | Ground for digital inputs.   |
| 39     | Ground for analogue/digital outputs. Must be connected to terminal 55 by means of a three-wire transmitter. See <i>Examples of connection</i> .  |
| 42, 45 | Analogue/digital outputs for indicating frequency, reference, current and torque. See parameters 319-322 <i>Analogue/digital outputs</i> .   |
| 50     | Supply voltage to potentiometer and thermistor 10 V DC.  |
| 53, 54 | Analogue voltage input, 0 - 10 V DC.   |
| 55     | Ground for analogue voltage inputs.  |
| 60     | Analogue current input 0/4-20 mA. See parameters 314-316 <i>Terminal 60</i> .  |
| 61     | Termination of serial communication. See <i>Earthing of screened/armoured control cables</i> .<br>This terminal is not normally to be used.  |
| 68, 69 | RS 485 interface, serial communication. Where the VLT frequency converter is connected to a bus, switches 2 and 3 (switches 1- 4 - see next page) must be closed on the first and the last VLT frequency converter. On the remaining VLT frequency converters, switches 2 and 3 must be open. The factory setting is closed (position on). |

**Installation**

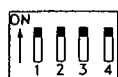


## VLT® 6000 HVAC



#### Switches 1-4

The dipswitch is located on the control card. It is used for serial communication and external DC supply. The switching position shown is the factory setting.

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Switch 1 has no function.

Switches 2 and 3 are used for terminating an RS-485 interface to the serial communication bus



#### NB!

When the VLT is the first or last device on the serial communication bus, switches 2 and 3 must be ON in that designated VLT. Any other VLTs on the serial communication bus must have switches 2 and 3 set to OFF.



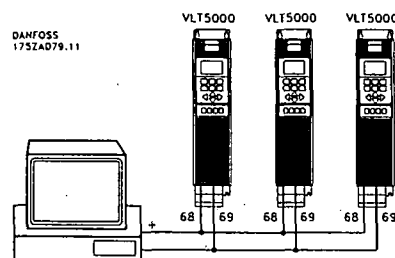
#### NB!

Please note that when Switch 4 is in position "OFF," the external 24 V DC supply is galvanically isolated from the VLT frequency converter.

#### Bus connection

The serial bus connection in accordance with the RS 485 (2-conductor) norm is connected to terminals 68/69 of the frequency converter (signals P and N). Signal P is the positive potential (TX+,RX+), while signal N is the negative potential (TX-,RX-).

If more than one frequency converter is to be connected to a given master, use parallel connections.



In order to avoid potential equalizing currents in the screen, the cable screen can be earthed via terminal 61, which is connected to the frame via an RC-link.



## VLT® 6000 HVAC

### ■ Connection example, VLT 6000 HVAC

The diagram below gives an example of a typical VLT 6000 HVAC installation.

The mains supply is connected to terminals 91 (L1), 92 (L2) and 93 (L3), while the motor is connected to 96 (U), 97 (V) and 98 (W). These numbers can also be seen from the terminals of the VLT frequency converter.

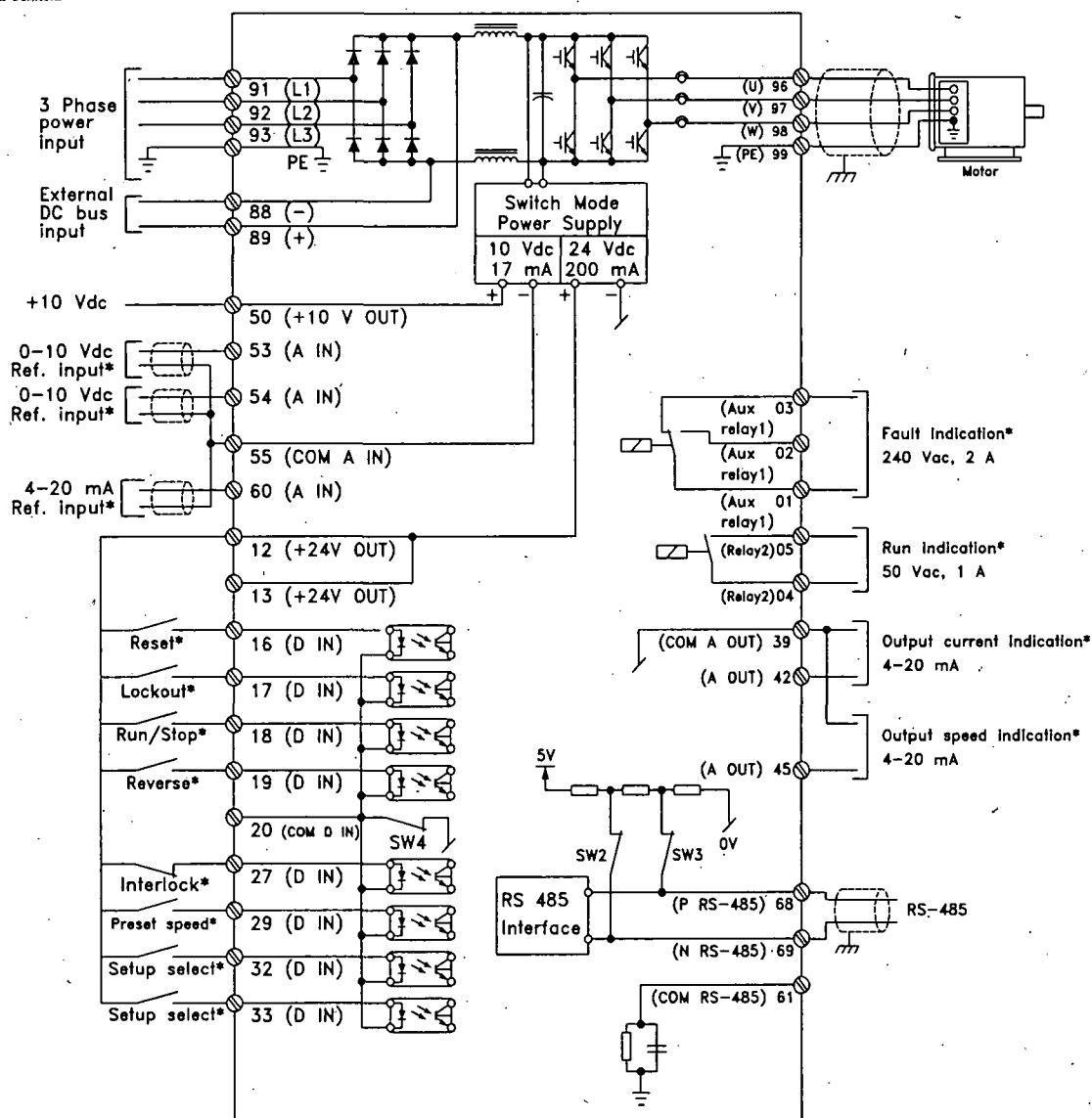
An external DC supply or a 12-pulse option can be connected to terminals 88 and 89. Please ask Danfoss for a Design Guide to learn more.

Analogue inputs can be connected to terminals 53 [V], 54 [V] and 60 [mA]. These inputs can be programmed for either reference, feedback or thermistor. See *Analogue inputs* in parameter group 300.

There are 8 digital inputs, which can be connected to terminals 16-19, 27, 29, 32, 33. These inputs can be programmed in accordance with the table in *Inputs and outputs* 300-328.

There are two analogue/digital outputs (terminals 42 and 45), which can be programmed to show the present status or a process value, such as  $0-f_{MAX}$ . Relay outputs 1 and 2 can be used for giving the present status or a warning.

On terminals 68 (P+) and 69 (N-) RS 485 interface, the VLT frequency converter can be controlled and monitored via serial communication.



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\* These terminals can be programmed for other functions.

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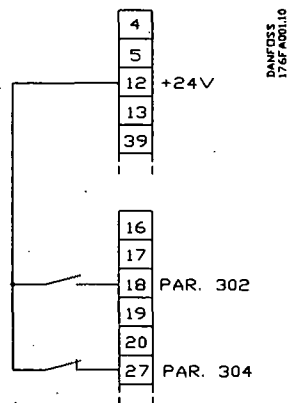
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Installation



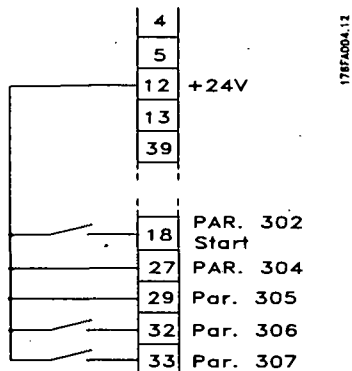
## VLT® 6000 HVAC

### Connection examples Single-pole start/stop



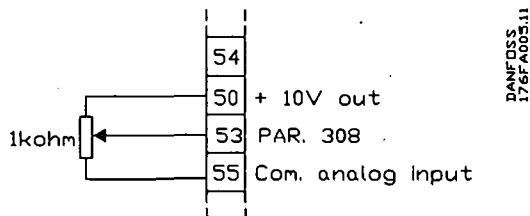
- Start/stop using terminal 18.  
Parameter 302 = *Start* [1]
- Quick-stop using terminal 27.  
Parameter 304 = *Coasting stop, inverse* [0]

### Digital speed up/down



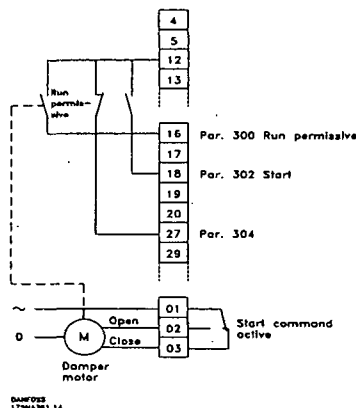
- Speed up and down using terminals 32 and 33.  
Parameter 306 = *Speed up* [7]  
Parameter 307 = *Speed down* [7]  
Parameter 305 = *Freeze reference* [2]

### Potentiometer reference



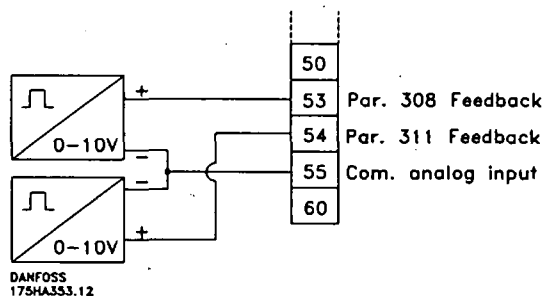
- Parameter 308 = *Reference* [1]  
Parameter 309 = *Terminal 53, min. scaling*  
Parameter 310 = *Terminal 53, max. scaling*

### Run permissive



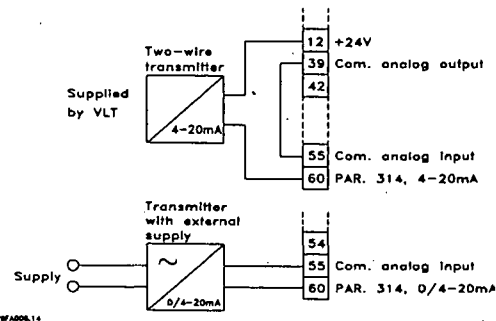
- Start permitted with terminal 16.  
Parameter 300 = *Start enabled* [8].
- Start/stop with terminal 18.  
Parameter 302 = *Start* [1].
- Quickstop with terminal 27.  
Parameter 304 = *Coasting stop, inverse* [0].
- Activated damper (motor)  
Parameter 323 = *Start command active* [13].

### 2-zone regulation



- Parameter 308 = *Feedback* [2].
- Parameter 311 = *Feedback* [2].

### Transmitter connection



- Parameter 314 = *Reference* [1]
- Parameter 315 = *Terminal 60, min. scaling*
- Parameter 316 = *Terminal 60, max. scaling*



## VLT® 6000 HVAC

### ■ Control unit LCP

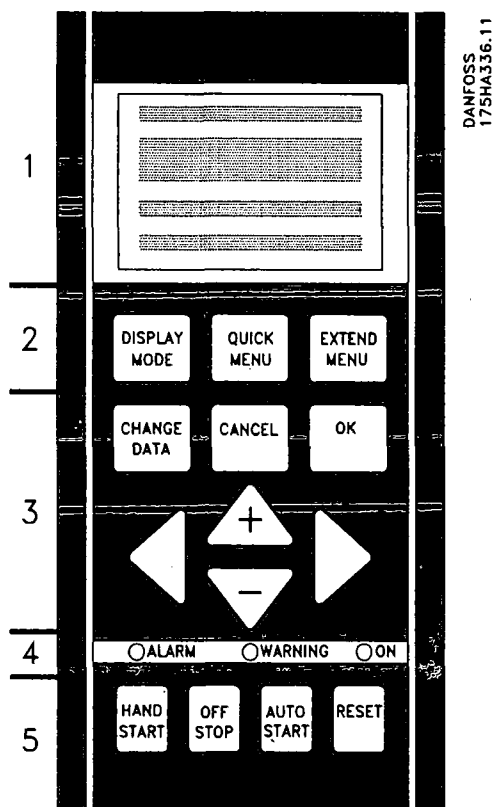
The front of the VLT frequency converter features a control panel - LCP (Local Control Panel). This is a complete interface for operation and programming of the VLT 6000 HVAC.

The control panel is detachable and can - as an alternative - be installed up to 3 metres away from the VLT frequency converter, e.g. on the front panel, by means of a mounting kit option.

The functions of the control panel can be divided into five groups:

1. Display
2. Keys for changing display mode
3. Keys for changing program parameters
4. Indicator lamps
5. Keys for local operation.

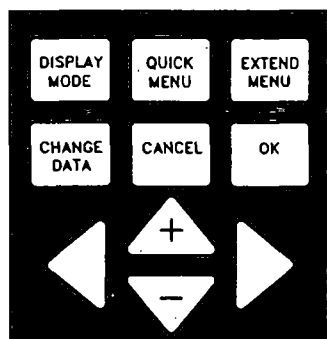
All data are indicated by means of a 4-line alpha-numeric display, which, in normal operation, is able to show 4 operating data values and 3 operating condition values continuously. During programming, all the information required for quick, effective parameter Setup of the VLT frequency converter will be displayed. As a supplement to the display, there are three indicator lamps for voltage (ON), warning (WARNING) and alarm (ALARM), respectively. All VLT frequency converter parameter Setups can be changed immediately via the control panel, unless this function has been programmed to be *Locked* [1] via parameter 016 *Lock for data change* or via a digital input, parameters 300-307 *Lock for data change*.



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### ■ Control keys for parameter Setup

The control keys are divided into functions. This means that the keys between display and indicator lamps are used for parameter Setup, including selecting the display indication during normal operation.



DISPLAY  
MODE

[DISPLAY / STATUS] is used for selecting the indication mode of the display or when returning to the Display mode from either the Quick menu or the Extend menu mode.

QUICK  
MENU

[QUICK MENU] gives access to the parameters used for the Quick menu. It is possible to switch between the Quick menu and the Extend menu modes.

EXTEND  
MENU

[EXTEND MENU] gives access to all parameters. It is possible to switch between the Extend menu and the Quick menu modes.

CHANGE  
DATA

[CHANGE DATA] is used for changing a setting selected either in the Extend menu or the Quick menu mode.

CANCEL

[CANCEL] is used if a change of the selected parameter is not to be carried out.

OK

[OK] is used for confirming a change of the parameter selected.

Programming



## VLT® 6000 HVAC



[+/-] is used for selecting parameters and for changing a chosen parameter. These keys are also used to change the local reference.

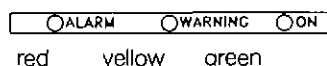
In addition, the keys are used in Display mode to switch between operation variable readouts.



[<>] is used when selecting a parameter group and for moving the cursor when changing numerical values.

### Indicator lamps

At the bottom of the control panel is a red alarm lamp and a yellow warning lamp, as well as a green voltage LED.



If certain threshold values are exceeded, the alarm and/or warning lamp is activated, and a status or alarm text is displayed.

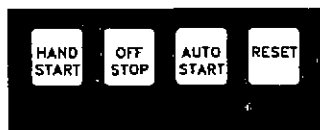


#### NB!

The voltage indicator lamp is activated when the VLT frequency converter receives voltage.

### Local control

Underneath the indicator lamps are keys for local control.



HAND  
START

[HAND START] is used if the VLT frequency converter is to be controlled via the control unit. The VLT frequency converter will start the motor, since a start command is given by means of [HAND START].

On the control terminals, the following control signals will still be active when [HAND START] is activated:

- Hand start - Off stop - Auto start
- Safety Interlock
- Reset
- Coasting stop inverse
- Reversing
- Setup select lsb - Setup select msb
- Jog
- Run permissive
- Lock for data change
- Stop command from serial communication



#### NB!

If parameter 201 *Output frequency low limit*  $f_{MBV}$  is set to an output frequency greater than 0 Hz, the motor will start and ramp up to this frequency when [HAND START] is activated.



[OFF/STOP] is used for stopping the connected motor. Can be selected as Enable [1] or Disable [0] via parameter 013. If the stop function is activated, line 2 will flash.



[AUTO START] is used if the VLT frequency converter is to be controlled via the control terminals and/or serial communication. When a start signal is active on the control terminals and/or the bus, the VLT frequency converter will start.



#### NB!

An active HAND-OFF-AUTO signal via the digital inputs will have higher priority than the control keys [HAND START]-[AUTO START].



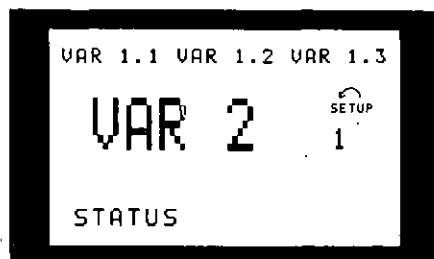
[RESET] is used for resetting the VLT frequency converter after an alarm (trip). Can be selected as *Enable* [1] or *Disable* [0] via parameter 015 *Reset on LCP*.

### Display mode

In normal operation, any 4 different operating variables can be indicated continuously: 1.1 and 1.2 and 1.3 and 2. The present operating status or alarms and warnings that have arisen are shown in line 2 in the form of a number. In the case of alarms, the alarm in question will be shown in lines 3 and 4, accompanied by an explanatory note. Warnings will flash in line 2, with an explanatory note in line 1. In addition, the display shows the active Setup.

The arrow indicates the direction of rotation; here the VLT frequency converter has an active reversing signal. The arrow body disappears if a stop command is given or if the output frequency falls below 0.01 Hz. The bottom line gives the status of the VLT frequency converter. See next page.

The scroll list on the next page gives the operating data that can be shown for variable 2 in display mode. Changes are made via the [+/-] keys.





## VLT® 6000 HVAC

### ■ Display mode, cont.

The table below gives the operating data options for the first and second line of the display.

| Scroll-list:              | Unit:  |
|---------------------------|--------|
| Resulting reference, %    | [%]    |
| Resulting reference, unit | [unit] |
| Frequency                 | [Hz]   |
| Frequency                 | [%]    |
| Motor current             | [A]    |
| Power                     | [kW]   |
| Power                     | [HP]   |
| Output energy             | [kWh]  |
| Hours run                 | [h]    |
| Used-defined readout      | [unit] |
| Setpoint 1                | [unit] |
| Setpoint 2                | [unit] |
| Feedback 1                | [unit] |
| Feedback 2                | [unit] |
| Feedback                  | [unit] |
| Motor voltage             | [V]    |
| DC voltage                | [V]    |
| Thermal-motor load        | [%]    |
| Thermal drive load        | [%]    |
| Digital input             | [BIN]  |
| Analogue input 53         | [V]    |
| Analogue input 54         | [V]    |
| Analogue input 60         | [mA]   |
| Pulse reference           | [Hz]   |
| Ext. reference            | [%]    |
| Heat sink temp.           | [°C]   |
| Free Prog Array           | [--]   |
| Comm Opt Warn             | [HEX]  |

Three operating data values can be shown in the first display line, while one operating variable can be shown in the second display line. To be programmed via parameters 007, 008, 009 and 010 *Display readout*.

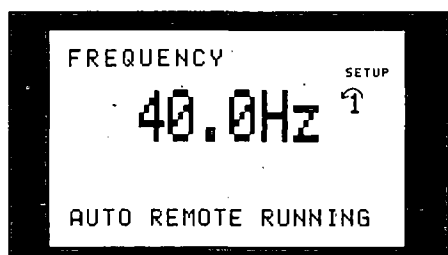
### ■ Display mode I:

VLT 6000 HVAC offers different display modes depending on the mode selected for the VLT frequency converter. The figure on the next page shows the way to navigate between different display modes.

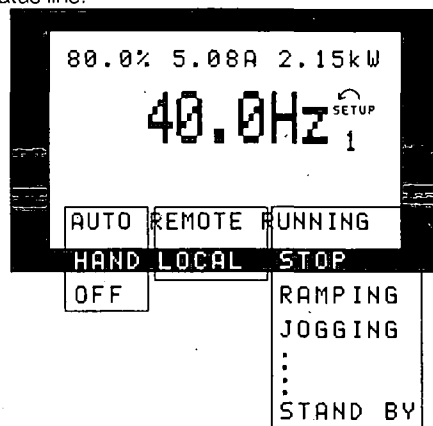
Below is a display mode, in which the VLT frequency converter is in Auto mode with remote reference at an output frequency of 40 Hz.

In this display mode, reference and control are determined via the control terminals.

The text in line 1 gives the operating variable shown in line 2.



### • Status line:



The left part of the status line indicates the control element of the VLT frequency converter that is active.

AUTO means that control is via the control terminals, while HAND indicates that control is via the local keys on the control unit.

OFF means that the VLT frequency converter ignores all control commands and stops the motor.

The centre part of the status line indicates the reference element that is active. REMOTE means that the reference from the control terminals is active, while LOCAL indicates that the reference is determined via the [+/-] keys on the control panel.

The last part of the status line indicates the current status, for example "Running", "Stop" or "Alarm".

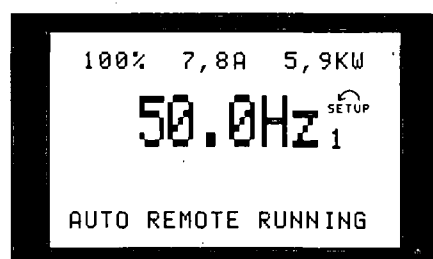
Line 2 gives the current output frequency and the active Setup.

Line 4 says that the VLT frequency converter is in Auto mode with remote reference, and that the motor is running.

### ■ Display mode II:

This display mode makes it possible to have three operating data values displayed at the same time in line 1.

The operating data values are determined in parameters 007-010 *Display readout*.

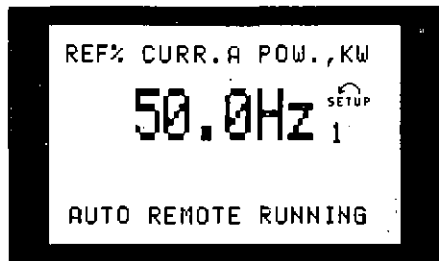




## VLT® 6000 HVAC

### ■ Display mode III:

This display mode can be generated as long as the [DISPLAY MODE] key is kept depressed. In the first line, operating data names and units of operating data are displayed. In the second line, operating data 2 remains unchanged. When the key is released, the different operating data values are shown.



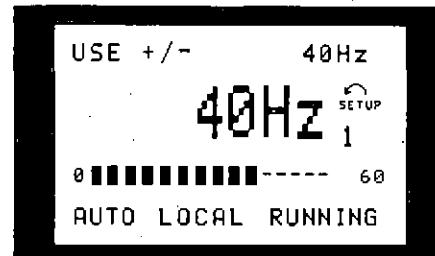
### ■ Display mode IV:

This display mode is only generated in connection with local reference, see also *Reference handling*.

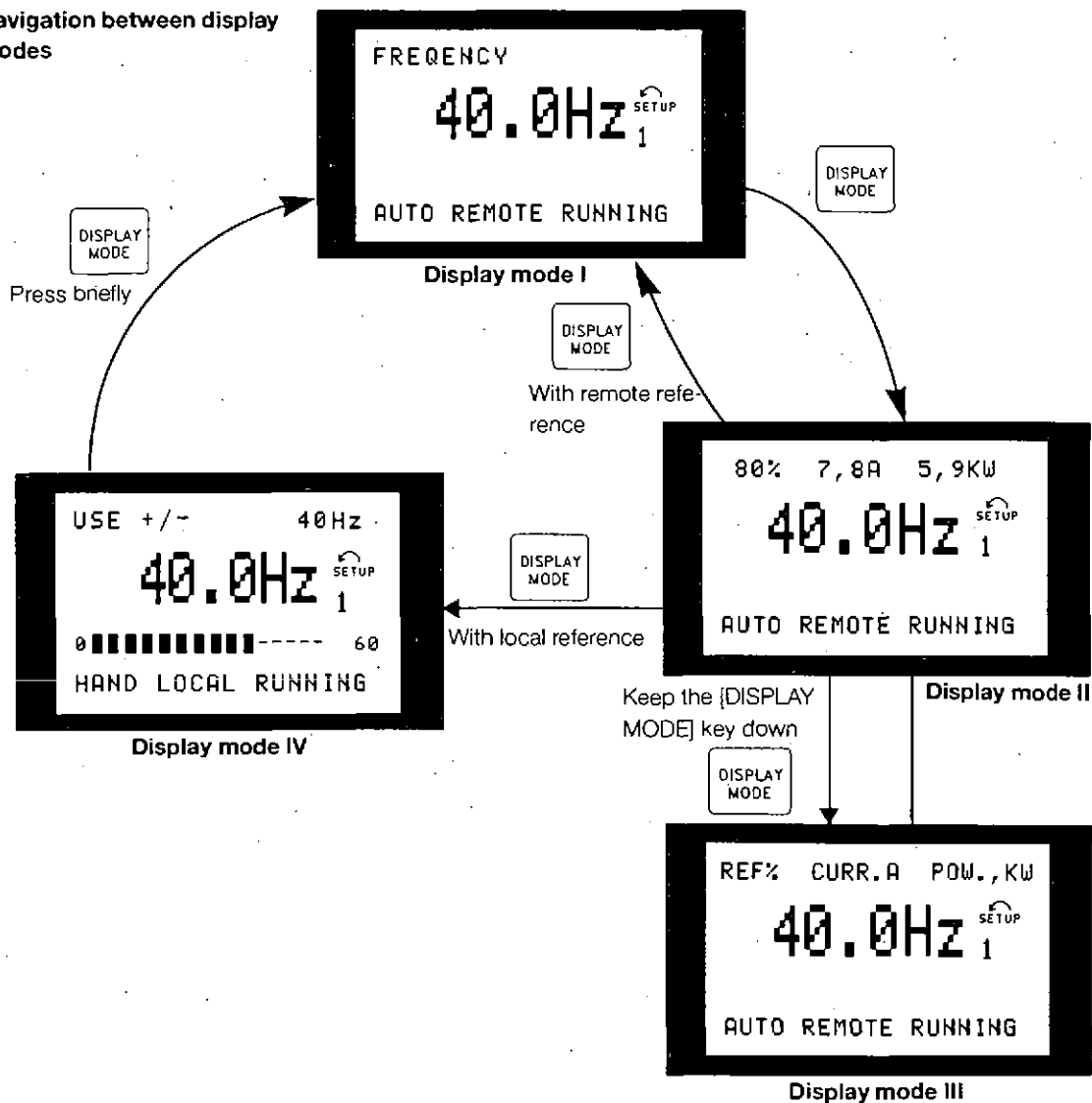
In this display mode, the reference is determined via the [+/-] keys and control is carried out by means of the keys underneath the indicator lamps.

The first line indicates the required reference.

The third line gives the relative value of the present output frequency at any given time in relation to the maximum frequency. The display is in the form of a bar graph.



### ■ Navigation between display modes





## VLT® 6000 HVAC

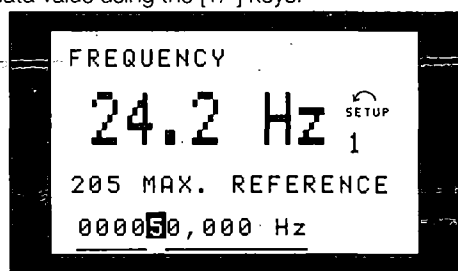
### ■ Changing data

Regardless of whether a parameter has been selected under the Quick menu or the Extend menu, the procedure for changing data is the same.

Pressing the [CHANGE DATA] key gives access to changing the selected parameter, following which the underlining in line 4 will flash on the display.

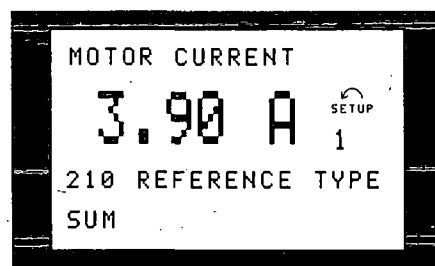
The procedure for changing data depends on whether the selected parameter represents a numerical data value or a functional value.

If the chosen parameter represents a numeric data value, the first digit can be changed by means of the [+/-] keys. If the second digit is to be changed, first move the cursor by using the [<>] keys, then change the data value using the [+/-] keys.



The selected digit is indicated by a flashing cursor. The bottom display line gives the data value that will be entered (saved) when signing off by pressing the [OK] button. Use [CANCEL] to cancel the change.

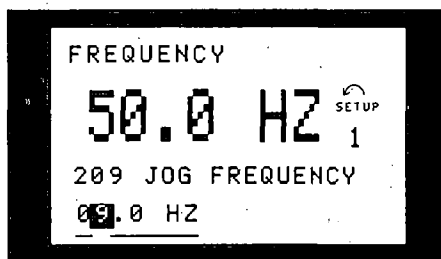
If the selected parameter is a functional value, the selected text value can be changed by means of the [+/-] keys.



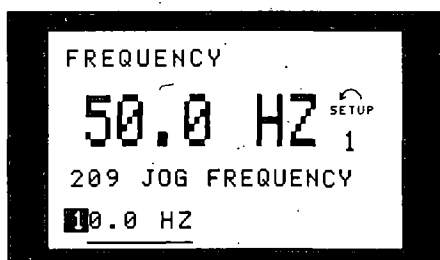
The functional value flashes until signing off by pressing the [OK] button. The functional value has now been selected. Use [CANCEL] to cancel the change.

### ■ Infinitely variable change of numeric data value

If the chosen parameter represents a numeric data value, a digit is first selected by means of the [<>] keys.



Then the chosen digit is changed infinitely variably by means of the [+/-] keys:



The chosen digit is indicated by the digit flashing. The bottom display line shows the data value that will be entered (saved) when signing off with [OK].

### ■ Changing of data value, step-by-step

Certain parameters can be changed both step by step and infinitely variably. This applies to *Motor power* (parameter 102), *Motor voltage* (parameter 103) and *Motor frequency* (parameter 104).

This means that the parameters are changed both as a group of numeric data values and as numeric data values infinitely variably.

### ■ Manual initialisation

Disconnect from mains and hold the [DISPLAY/STATUS] + [CHANGE DATA] + [OK] keys down while at the same time reconnecting the mains supply. Release the keys; the VLT frequency converter has now been programmed for the factory setting.

The following parameters are not zeroed by means of manual initialisation:

- parameter 500, *Protocol*
- 600, *Operating hours*
- 601, *Hours run*
- 602, *kWh counter*
- 603, *Number of power-ups*
- 604, *Number of overtemperatures*
- 605, *Number of overvoltages*

It is also possible to carry out initialisation via parameter 620 *Operating mode*.



## VLT® 6000 HVAC

### Quick Menu

The QUICK MENU key gives access to 12 of the most important setup parameters of the drive. After programming, the drive will, in many cases, be ready for operation. The 12 Quick Menu parameters are

shown in the table below. A complete description of the function is given in the parameter sections of this manual.

| Quick Menu<br>Item Number | Parameter<br>Name       | Description  |
|---------------------------|-------------------------|--|
| 1                         | 001 Language            | Selects language used for all displays.  |
| 2                         | 102 Motor Power         | Sets output characteristics of drive based on kW size of motor.  |
| 3                         | 103 Motor Voltage       | Sets output characteristics of drive based on voltage of motor.  |
| 4                         | 104 Motor Frequency     | Sets output characteristics of drive based on nominal frequency of motor. This is typically equal to line frequency. |
| 5                         | 105 Motor Current       | Sets output characteristics of drive based on nominal current in amps of motor.                                      |
| 6                         | 106 Motor Nominal Speed | Sets output characteristics of drive based on nominal full load speed of motor.                                      |
| 7                         | 201 Minimum Frequency   | Sets minimum controlled frequency at which motor will run.   |
| 8                         | 202 Maximum Frequency   | Sets maximum controlled frequency at which motor will run.   |
| 9                         | 206 Ramp Up Time        | Sets time to accelerate motor from 0 Hz to nominal motor frequency set in Quick Menu Item 4.                         |
| 10                        | 207 Ramp Down Time      | Sets time to decelerate motor from nominal motor frequency set in Quick Menu Item 4 to 0 Hz.                         |
| 11                        | 323 Relay 1 Function    | Sets function of high voltage Form C relay.  |
| 12                        | 326 Relay 2 Function    | Sets function of low voltage Form A relay.   |

### Parameter Data

Enter or change parameter data or settings in accordance with the following procedure.

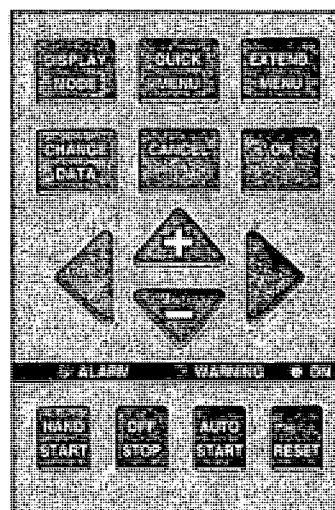
1. Press Quick Menu key.
2. Use '+' and '-' keys to find parameter you choose to edit.
3. Press Change Data key.
4. Use '+' and '-' keys to select correct parameter setting. To move to a different digit within parameter, use ◀ and ▶ arrows. *Flashing cursor indicates digit selected to change.*
5. Press Cancel key to disregard change, or press OK key to accept change and enter new setting.

### Example of Changing Parameter Data

Assume parameter 206, *Ramp Up Time*, is set at 60 seconds. Change the ramp up time to 100 seconds in accordance with the following procedure.

1. Press Quick Menu key.
2. Press '+' key until you reach Parameter 206, *Ramp Up Time*.
3. Press Change Data key.
4. Press ◀ key twice – hundreds digit will flash.
5. Press '+' key once to change hundreds digit to '1.'

6. Press ▶ key to change to tens digit.
7. Press '-' key until '6' counts down to '0' and setting for *Ramp Up Time* reads '100 s.'
8. Press OK key to enter new value into drive controller.



### NB!

Programming of extended parameters functions available through EXTENDED MENU key is done in accordance with same procedure as described for Quick Menu functions.



## VLT® 6000 HVAC

### ■ Programming

EXTEND  
MENU

Using the [EXTEND MENU] key, it is possible to have access to all the parameters for the VLT frequency converter.

### ■ Operation and Display 000-017

This parameter group makes it possible to set up the control unit, e.g. with respect to language, display readout and the possibility of making the function keys on the control unit inactive.

#### 001 Language (LANGUAGE)

| Value:                  |     |
|-------------------------|-----|
| ★ English (ENGLISH)     | [0] |
| German (DEUTSCH)        | [1] |
| French (FRANCAIS)       | [2] |
| Danish (DANSK)          | [3] |
| Spanish (ESPAÑOL)       | [4] |
| Italian (ITALIANO)      | [5] |
| Swedish (SVENSKA)       | [6] |
| Dutch (NEDERLANDS)      | [7] |
| Portuguese (PORTUGUESA) | [8] |

State when delivered may vary from factory setting.

#### Function:

The choice in this parameter defines the language to be used on the display.

#### Description of choice:

There is a choice of the languages indicated.

### ■ The Setup configuration

VLT 6000 HVAC has four Setups (parameter Setups) that can be programmed independently of each other. The active Setup can be selected in parameter 002 *Active Setup*. The active Setup number will be shown in the display under "Setup".

It is also possible to set the VLT frequency converter to *Multi-Setup* to allow switching of Setups with the digital inputs or serial communication.

Setup shifts can be used in systems where, e.g., one Setup is used during the day and another at night.

Parameter 003 *Copying of Setups* enables copying from one Setup to another.

By means of parameter 004 *LCP copy*, all Setups can be transferred from one VLT frequency converter to another by moving the control panel. First all parameter values are copied to the control panel. This can then be moved to another VLT frequency converter, where all parameter values can be copied from the control unit to the VLT frequency converter.

#### 002 Active Setup (ACTIVE SETUP)

| Value:                        |     |
|-------------------------------|-----|
| Factory Setup (FACTORY SETUP) | [0] |
| ★ Setup 1 (SETUP 1)           | [1] |
| Setup 2 (SETUP 2)             | [2] |
| Setup 3 (SETUP 3)             | [3] |
| Setup 4 (SETUP 4)             | [4] |
| MultiSetup (MULTI SETUP)      | [5] |

#### Function:

The choice in this parameter defines the Setup number you want to control the functions of the VLT frequency converter.

All parameters can be programmed in four individual parameter Setups, Setup 1 - Setup 4.

In addition, a pre-programmed Setup called the Factory Setup exists. This only allows specific parameters to be changed.

#### Description of choice:

*Factory Setup* [0] contains the parameter values pre-set at the factory. Can be used as a data source if the other Setups are to be returned to a known state. In this case Factory Setup is selected as the active Setup.

*Setups 1-4* [1]-[4] are four individual Setups that can be selected as required.

*MultiSetup* [5] is used if remote switching between different Setups is required. Terminals 16/17/29/32/33 and the serial communication port can be used for switching between Setups.

Programming

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port

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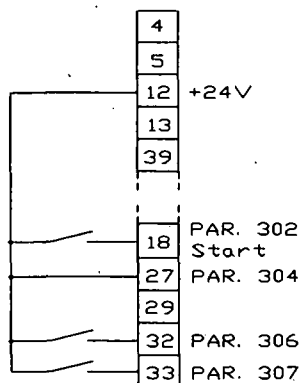
59



## VLT® 6000 HVAC

### Connection examples

#### Setup change



- Selection of Setup using terminals 32 and 33.
- Parameter 306 = *Selection of Setup, lsb* [4]
- Parameter 307 = *Selection of Setup, msb* [4]
- Parameter 004 = *MultiSetup* [5].

### 003 Copying of Setups (SETUP COPY)

#### Value:

- ★ No copying (NO COPY) [0]
- Copy active Setup to Setup 1 (COPY TO SETUP 1) [1]
- Copy active Setup to Setup 2 (COPY TO SETUP 2) [2]
- Copy active Setup to Setup 3 (COPY TO SETUP 3) [3]
- Copy active Setup to Setup 4 (COPY TO SETUP 4) [4]
- Copy active Setup to all (COPY TO ALL) [5]

#### Function:

A copy is made from the active Setup selected in parameter 002 Active Setup to the Setup or Setups selected in parameter 003 Copying of Setups.



#### NB!

Copying is only possible in Stop mode (motor stopped on a Stop command).

#### Description of choice:

The copying starts when the required copying function has been selected and the [OK] key has been pressed.

The display indicates when copying is in progress.

### 004 LCP copy (LCP COPY)

#### Value:

- ★ No copying (NO COPY) [0]
- Upload all parameters (UPLOAD ALL PARAMET.) [1]
- Download all parameters (DOWNLOAD ALL PARAM.) [2]
- Download power-independent par. (DOWNLOAD SIZE INDEP.) [3]

#### Function:

Parameter 004 *LCP copy* is used if the integrated copying function of the control panel is to be used. This function is used if all parameter Setups are to be copied from one VLT frequency converter to another by moving the control panel.

#### Description of choice:

Select *Upload all parameters* [1] if all parameter values are to be transmitted to the control panel.

Select *Download all parameters* [2] if all transmitted parameter values are to be copied to the VLT frequency converter on which the control panel has been mounted.

Select *Download power-independent par.* [3] if only the power-independent parameters are to be downloaded. This is used if downloading to a VLT frequency converter that has a different rated power than the one from where the parameter Setup originates.



#### NB!

Uploading/Downloading can only be carried out in Stop mode.

### ■ Setup of user-defined readout

Parameter 005 *Max. value of user-defined readout* and 006 *Unit for user-defined readout* allow users to design their own readout which can be seen if user-defined readout has been selected under display readout. The range is set in parameter 005 *Max. value of user-defined readout* and the unit is determined in parameter 006 *Unit for user-defined readout*. The choice of unit decides whether the ratio between the output frequency and the readout is a linear, square or cubed ratio.

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port



## VLT® 6000 HVAC

**005 Max. value of user-defined readout  
(CUSTOM READOUT)**

Value:

0.01 - 999,999.99

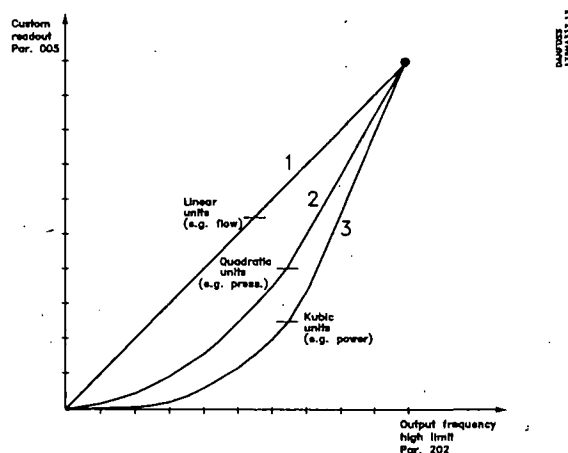
★100.00

**Function:**

This parameter allows a choice of the max. value of the user-defined readout. The value is calculated on the basis of the present motor frequency and the unit selected in parameter 006 *Unit for user-defined readout*. The programmed value is reached when the output frequency in parameter 202 *Output frequency high limit*,  $f_{MAX}$  is reached. The unit also decides whether the ratio between output frequency and readout is linear, square or cubed.

**Description of choice:**

Set the required value for max. output frequency.

**Function:**

Select a unit to be shown in the display in connection with parameter 005 *Max. value of user-defined readout*.

If units such as flow or speed units are selected, the ratio between readout and output frequency will be a linear one.

If pressure units are selected (bar, Pa, MWG, PSI, etc.), the ratio will be square.

If power units (kW, HP) are selected, the ratio will be cubed.

The value and the unit are shown in display mode whenever *User-defined readout* [10] has been selected in one of parameters 007-010 *Display readout*.

**Description of choice:**

Select the required unit for *User-defined readout*.

**006 Unit for user-defined readout  
(CUST. READ. UNIT)**

Value:

|                                  |      |                                   |      |
|----------------------------------|------|-----------------------------------|------|
| ★ No unit <sup>1</sup>           | [0]  | GPM <sup>1</sup>                  | [21] |
| % <sup>1</sup>                   | [1]  | gal/s <sup>1</sup>                | [22] |
| rpm <sup>1</sup>                 | [2]  | gal/min <sup>1</sup>              | [23] |
| ppm <sup>1</sup>                 | [3]  | gal/h <sup>1</sup>                | [24] |
| pulse/s <sup>1</sup>             | [4]  | lb/s <sup>1</sup>                 | [25] |
| l/s <sup>1</sup>                 | [5]  | lb/min <sup>1</sup>               | [26] |
| l/min <sup>1</sup>               | [6]  | lb/h <sup>1</sup>                 | [27] |
| l/h <sup>1</sup>                 | [7]  | CFM <sup>1</sup>                  | [28] |
| kg/s <sup>1</sup>                | [8]  | ft <sup>3</sup> /s <sup>1</sup>   | [29] |
| kg/min <sup>1</sup>              | [9]  | ft <sup>3</sup> /min <sup>1</sup> | [30] |
| kg/h <sup>1</sup>                | [10] | ft <sup>3</sup> /h <sup>1</sup>   | [31] |
| m <sup>3</sup> /s <sup>1</sup>   | [11] | ft <sup>3</sup> /min <sup>1</sup> | [32] |
| m <sup>3</sup> /min <sup>1</sup> | [12] | ft/s <sup>1</sup>                 | [33] |
| m <sup>3</sup> /h <sup>1</sup>   | [13] | in wg <sup>2</sup>                | [34] |
| m/s <sup>1</sup>                 | [14] | ft wg <sup>2</sup>                | [35] |
| mbar <sup>2</sup>                | [15] | PSI <sup>2</sup>                  | [36] |
| bar <sup>2</sup>                 | [16] | lb/in <sup>2</sup>                | [37] |
| Pa <sup>2</sup>                  | [17] | HP <sup>3</sup>                   | [38] |
| kPa <sup>2</sup>                 | [18] |                                   |      |
| MWG <sup>2</sup>                 | [19] |                                   |      |
| kW <sup>3</sup>                  | [20] |                                   |      |

Flow and speed units are marked with 1. Pressure units with 2, and power units with 3. See figure in next column.

**007 Large display readout (LARGE READOUT)**

Value:

|   |      |
|---|------|
| Resulting reference [%] (REFERENCE [%])       | [1]  |
| Resulting reference [unit] (REFERENCE [UNIT]) | [2]  |
| ★ Frequency [Hz] (FREQUENCY [HZ])             | [3]  |
| % of maximum output frequency [%]             |      |
| (FREQUENCY [%])                               | [4]  |
| Motor current [A] (MOTOR CURRENT [A])         | [5]  |
| Power [kW] (POWER [KW])                       | [6]  |
| Power [HP] (POWER [HP])                       | [7]  |
| Output energy [kWh] (ENERGI [UNIT])           | [8]  |
| Hours run [Hours] (HOURS RUN [h])             | [9]  |
| User-defined readout [-]                      |      |
| (CUSTOM READ.[UNITS])                         | [10] |
| Setpoint 1 [unit] (SETPOINT 1 [UNITS])        | [11] |

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port

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**Programming**



## VLT® 6000 HVAC

|  |      |
|--|------|
| Setpoint 2 [unit] (SETPOINT 2 [UNITS])                     | [12] |
| Feedback 1 (FEEDBACK 1 [UNITS])                            | [13] |
| Feedback 2 (FEEDBACK 2 [UNITS])                            | [14] |
| Feedback [unit] (FEEDBACK [UNITS])                         | [15] |
| Motor voltage [V] (MOTOR VOLTAGE [V])                      | [16] |
| DC link voltage [V] (DC VOLTAGE [V])                       | [17] |
| Thermal load, motor [%]<br>(THERM.MOTOR LOAD [%])          | [18] |
| Thermal load, VLT [%]<br>(THERM.DRIVE LOAD [%])            | [19] |
| Digital input [Binary code]<br>(DIGITAL INPUT [BIN])       | [20] |
| Analogue input 53 [V] (ANALOG INPUT 53 [V])                | [21] |
| Analogue input 54 [V] (ANALOG INPUT 54 [V])                | [22] |
| Analogue input 60 [mA]<br>(ANALOG INPUT 60 [mA])           | [23] |
| Relay status [binary code] (RELAY STATUS)                  | [24] |
| Pulse reference [Hz] (PULSE REFERENCE [HZ])                | [25] |
| External reference [%] (EXT. REFERENCE [%])                | [26] |
| Heat sink temp. [°C] (HEATSINK TEMP [°C])                  | [27] |
| Communication option card warning<br>(COMM OPT WARN [HEX]) | [28] |
| LCP display text (FREE PROG.ARRAY)                         | [29] |

### Function

This parameter allows a choice of the data value to be shown in the display, line 2, when the VLT frequency converter is turned on. The data values will also be included in the display mode scroll-list. Parameters 008-010 *Small display readout* allow a choice of another three data values, shown in line 1.

See the description of the *control unit*.

### Description of choice

*No readout* can only be selected in parameters 008-010 *Small display readout*.

*Resulting reference [%]* gives a percentage for the resulting reference in the range from *Minimum reference*,  $Ref_{MIN}$  to *Maximum reference*,  $Ref_{MAX}$ . See also *reference handling*.

*Reference [unit]* gives the resulting reference in Hz in *Open loop*. In *Closed loop*, the reference unit is selected in parameter 415 *Process units*.

*Frequency [Hz]* gives the output frequency from the VLT frequency converter.

*% of maximum output frequency [%]* is the present output frequency as a percentage value of parameter 202 *Output frequency high limit*,  $f_{MAX}$ .

*Motor current [A]* states the phase current of the motor measured as effective value.

*Power [kW]* states the actual power consumed by the motor in kW.

*Power [HP]* states the actual power consumed by the motor in HP.

*Output energy [kWh]* states the energy consumed by the motor since the latest reset was made in parameter 618 *Reset of kWh counter*.

*Hours run [Hours]* states the number of hours that the motor has run since the latest reset in parameter 619 *Reset of hours-run counter*.

*User-defined readout [-]* is a user-defined value, calculated on the basis of the present output frequency and unit, as well as the scaling in parameter 005 *Max. value of user-defined readout*. Select unit in parameter 006 *Unit for user-defined readout*.

*Setpoint 1 [unit]* is the programmed setpoint value in parameter 418 *Setpoint 1*. The unit is decided in parameter 415 *Process units*. See also *Feedback handling*.

*Setpoint 2 [unit]* is the programmed setpoint value in parameter 419 *Setpoint 2*. The unit is decided in parameter 415 *Process units*.

*Feedback 1 [unit]* gives the signal value of the resulting feedback 1 (Term. 53). The unit is decided in parameter 415 *Process units*. See also *Feedback handling*.

*Feedback 2 [unit]* gives the signal value of the resulting feedback 2 (Term. 53). The unit is decided in parameter 415 *Process units*.

*Feedback [unit]* gives the resulting signal value using the unit/scaling selected in parameter 413 *Minimum feedback*,  $FB_{MIN}$ , 414 *Maximum feedback*,  $FB_{MAX}$  and 415 *Process units*.

*Motor voltage [V]* states the voltage supplied to the motor.

*DC link voltage [V]* states the intermediate circuit voltage in the VLT frequency converter.

*Thermal load, motor [%]* states the calculated/estimated thermal load on the motor. 100% is the cut-out limit. See also parameter 117 *Motor thermal protection*.

*Thermal load, VLT [%]* states the calculated/estimated thermal load on the VLT frequency converter. 100% is the cut-out limit.

*Digital input [Binary code]* states the signal status from the 8 digital inputs (16, 17, 18, 19, 27, 29, 32 and 33). Terminal 16 corresponds to the bit at the far left. '0' = no signal, '1' = connected signal.

*Analogue input 53 [V]* states the voltage value on terminal 53.

*Analogue input 54 [V]* states the voltage value on terminal 54.

*Analogue input 60 [mA]* states the voltage value on terminal 60.

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port



## VLT® 6000 HVAC

**Relay status [binary code]** indicates the status of each relay. The left (most significant) bit indicates relay 1 followed by 2 and 6 through 9. A "1" indicates the relay is active, a "0" indicates inactive. Parameter 007 uses an 8-bit word with the last two positions not used. Relays 6-9 are provided with the cascade controller and four relay option cards. **Pulse reference [Hz]** states a pulse frequency in Hz connected to terminal 17 or terminal 29.

**External reference [%]** gives the sum of the external references as a percentage (the sum of analogue/pulse/serial communication) in the range from *Minimum reference, Ref<sub>MIN</sub>* to *Maximum reference, Ref<sub>MAX</sub>*.

**Heat sink temp. [°C]** states the present heat sink temperature of the VLT frequency converter. The cut-out limit is  $90 \pm 5^\circ\text{C}$ ; cutting back in occurs at  $60 \pm 5^\circ\text{C}$ .

**Communication option card warning [Hex]** gives a warning word if there is a fault on the communication bus. This is only active if communication options have been installed. Without communication options, 0 Hex is displayed.

**LCD display text** shows the text programmed in parameter 533 *Display text 1* and 534 *Display text 2* via the serial communication port.

#### 008 Small display readout 1.1 (SMALL READOUT 1)

##### Value:

See parameter 007 *Large display readout*

★ Reference [Unit] [2]

##### Function:

This parameter enables a choice of the first of three data values to be shown on the display, line 1, position 1.

This is a useful function, i.e. when setting the PID regulator, in order to see how the process reacts to a change of reference.

For display read-outs, press the [DISPLAY/STATUS] button. Data option *LCP display text* [27] cannot be selected with *Small display readout*.

##### Description of choice:

There is a choice of 26 different data values, see parameter 007 *Large display readout*.

#### 009 Small display readout 1.2 (SMALL READOUT 2)

##### Value:

See parameter 007 *Large display readout*

★ Motorcurrent [A] [5]

##### Function:

See the functional description for parameter 008 *Small display readout*.

##### Description of choice:

There is a choice of 26 different data values, see parameter 007 *Large display readout*.

#### 010 Small display readout 1.3 (SMALL READOUT 3)

##### Value:

See parameter 007 *Large display readout*

★ Power [kW] [6]

##### Function:

See the functional description for parameter 008 *Small data readout*.

##### Description of choice:

There is a choice of 26 different data values, see parameter 007 *Large display readout*.

#### 011 Unit of local reference (UNIT OF LOC REF)

##### Value:

★ Hz (HZ) [0]  
% of output frequency range (%) (% OF FMAX) [1]

##### Function:

This parameter decides the local reference unit.

##### Description of choice:

Choose the required unit for local reference.

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port



## VLT® 6000 HVAC

**012 Hand start on LCP****(HAND START BTTN)****Value**

Disable (DISABLE) [0]

★ Enable (ENABLE) [1]

**Function:**

This parameter allows selection/deselection of the Hand start key on the control panel.

**Description of choice:**

If *Disable* [0] is selected in this parameter, the [HAND START] key will be inactive.

**013 OFF/STOP on LCP (STOP BUTTON)****Value**

Disable (DISABLE) [0]

★ Enable (ENABLE) [1]

**Function:**

This parameter allows selection/deselection of the local stop key on the control panel.

**Description of choice:**

If *Disable* [0] is selected in this parameter, the [OFF/STOP] key will be inactive.

**NB!**

If *Disable* is selected, the motor cannot be stopped by means of the [OFF/STOP] key.

**014 Auto start on LCP (AUTO START BTTN)****Value**

Disable (DISABLE) [0]

★ Enable (ENABLE) [1]

**Function:**

This parameter allows selection/deselection of the auto start key on the control panel.

**Description of choice:**

If *Disable* [0] is selected in this parameter, the [AUTO START] key will be inactive.

**015 Reset on LCP (RESET BUTTON)****Value**

Disable (DISABLE) [0]

★ Enable (ENABLE) [1]

**Function:**

This parameter allows selection/deselection of the reset key on the control panel.

**Description of choice:**

If *Disable* [0] is selected in this parameter, the [RESET] key will be inactive.

**NB!**

Only select *Disable* [0] if an external reset signal has been connected via the digital inputs.

**016 Lock for data change****(DATA CHANGE LOCK)****Value**

★ Not locked (NOT LOCKED) [0]

Locked (LOCKED) [1]

**Function:**

This parameter allows the control panel to be 'locked', which means that it is not possible to carry out data modifications via the control unit.

**Description of choice:**

If *Locked* [1] is selected, data modifications in the parameters cannot be made, although it will still be possible to carry out data modifications via the bus. Parameters 007-010 *Display readout* can be changed via the control panel.

It is also possible to lock for data modifications in these parameters by means of a digital input, see parameters 300-307 *Digital inputs*.

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port



## VLT® 6000 HVAC

**017 Operating state at power up, local control (POWER UP ACTION)**

Value:

- ★ Auto restart (AUTO RESTART) [0]  
OFF/Stop (OFF/STOP) [1]

**Function:**

Setting of the desired operating mode when the mains voltage is reconnected.

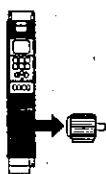
**Description of choice:**

*Auto restart* [0] is selected if the VLT frequency converter is to start up in the same start/stop condition as immediately before power to the converter is cut off.

*OFF/Stop* [1] is selected if the VLT frequency converter is to remain stopped when the mains voltage is connected, until a start command is active. To restart, activate the key [HAND START] or [AUTO START] by using the control panel.

**NB!**

If [HAND START] or [AUTO START] cannot be activated by the keys on the control panel (see parameter 012/014 Hand/Auto start on LCP) the motor will not be able to restart if OFF/Stop [1] is selected. If Handstart or Autostart has been programmed for activation via the digital inputs, the motor will not be able to restart if OFF/Stop [1] is selected.

**Load and Motor 100-117**

This parameter group allows the configuration of regulation parameters and the choice of torque characteristics to which the VLT frequency converter is to be adapted.

The motor nameplate data must be set and automatic motor adaptation can be carried out. In addition, DC brake parameters can be set and the motor thermal protection can be activated.

**Configuration**

The selection of configuration and torque characteristics influences the parameters that can be seen in the display. If *Open loop* [0] is selected, all parameters relating to PID regulation will be hidden.

Consequently, the user is only able to see the parameters that are of significance for a given application.

**100 Configuration (CONFIG. MODE)**

Value:

- ★ Open loop (OPEN LOOP) [0]  
Closed loop (CLOSED LOOP) [1]

**Function:**

This parameter is used for selecting the configuration to which the VLT frequency converter is to be adapted.

**Description of choice:**

If *Open loop* [0] is selected, normal speed control is obtained (without feedback signal), i.e. if the reference is changed, the motor speed will change. If *Closed loop* [1] is selected, the internal process regulator is activated to enable accurate regulation in relation to a given process signal.

The reference (setpoint) and the process signal (feedback) can be set to a process unit as programmed in parameter 415 *Process units*. See *Feedback handling*.

**101 Torque characteristics****(VT CHARACT)**

Value:

- ★ Automatic Energy Optimisation (AEO FUNCTION) [0]  
Parallel motors (MULTIPLE MOTORS) [1]

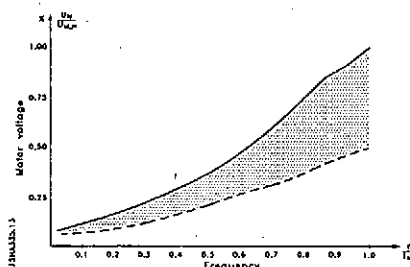
**Function:**

This parameter allows a choice of whether the VLT frequency converter has one or several motors connected to it.

**Description of choice:**

If *Automatic Energy Optimisation* [0] has been selected, only one motor may be connected to the VLT frequency converter. The AEO function ensures that the motor obtains its maximum efficiency and minimises motor interference.

Select *Parallel motors* [1] if more than one motor is connected to the output in parallel. See the description under parameter 108 *Start voltage of parallel motors* regarding the setting of parallel motor start voltages.



★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port

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## VLT® 6000 HVAC

**NB!**

It is important that the values set in parameters 102-106 *Nameplate data* correspond to the nameplate data of the motor with respect to either star coupling Y or delta coupling Δ.

**102 Motor power,  $P_{M,N}$  (MOTOR POWER)**

Value:

|                    |         |
|--------------------|---------|
| 0.25 kW (0.25 kW)  | [25]    |
| 0.37 kW (0.37 kW)  | [37]    |
| 0.55 kW (0.55 kW)  | [55]    |
| 0.75 kW (0.75 kW)  | [75]    |
| 1.1 kW (1.10 kW)   | [110]   |
| 1.5 kW (1.50 kW)   | [150]   |
| 2.2 kW (2.20 kW)   | [220]   |
| 3 kW (3.00 kW)     | [300]   |
| 4 kW (4.00 kW)     | [400]   |
| 5.5 kW (5.50 kW)   | [550]   |
| 7.5 kW (7.50 kW)   | [750]   |
| 11 kW (11.00 kW)   | [1100]  |
| 15 kW (15.00 kW)   | [1500]  |
| 18.5 kW (18.50 kW) | [1850]  |
| 22 kW (22.00 kW)   | [2200]  |
| 30 kW (30.00 kW)   | [3000]  |
| 37 kW (37.00 kW)   | [3700]  |
| 45 kW (45.00 kW)   | [4500]  |
| 55 kW (55.00 kW)   | [5500]  |
| 75 kW (75.00 kW)   | [7500]  |
| 90 kW (90.00 kW)   | [9000]  |
| 110 kW (110.00 kW) | [11000] |
| 132 kW (132.00 kW) | [13200] |
| 160 kW (160.00 kW) | [16000] |
| 200 kW (200.00 kW) | [20000] |
| 250 kW (250.00 kW) | [25000] |
| 300 kW (300.00 kW) | [30000] |
| 315 kW (315.00 kW) | [31500] |
| 355 kW (355.00 kW) | [35500] |
| 400 kW (400.00 kW) | [40000] |
| 450 kW (450.00 kW) | [45000] |
| 500 kW (500.00 kW) | [50000] |

★ Depends on the unit

**Function:**

This is where to select the kW value  $P_{M,N}$  that corresponds to the rated power of the motor. At the works, a rated kW value  $P_{M,N}$  has been selected that depends on the type of unit.

**Description of choice:**

Select a value that equals the nameplate data on the motor. There are 4 possible undersizes or 1 oversize in comparison with the factory setting. Also, alternatively it is possible to set the value for motor power as an *infinitely variable* value, see the procedure for *Infinitely variable change of numeric data value*.

**103 Motor voltage,  $U_{M,N}$  (MOTOR VOLTAGE)**

Value:

|       |       |
|-------|-------|
| 200 V | [200] |
| 208 V | [208] |
| 220 V | [220] |
| 230 V | [230] |
| 240 V | [240] |
| 380 V | [380] |
| 400 V | [400] |
| 415 V | [415] |
| 440 V | [440] |
| 460 V | [460] |
| 480 V | [480] |
| 500 V | [500] |
| 575 V | [575] |

★ Depends on the unit

NOTE: 550 motor voltage must be manually programmed - pre-sets are not available.

**Function:**

This is where the rated motor voltage  $U_{M,N}$  is set for either star Y or delta Δ.

**Description of choice:**

Select a value that equals the nameplate data on the motor, regardless of the mains voltage of the VLT frequency converter. Furthermore, alternatively it is possible to set the value of the motor voltage *infinitely variable*, see also the procedure for *Infinitely variable change of numeric data value*.

**NB!**

Changing parameters 102, 103 or 104 will automatically reset parameters 105 and 106 to default values. If changes are made to parameters 102, 103 or 104, go back and reset parameters 105 and 106 to correct values.

★ = factory setting. ( ) = display text { } = value for use in communication via serial communication port



## VLT® 6000 HVAC

**104 Motor frequency,  $f_{M,N}$** **(MOTOR FREQUENCY)**

Value:

- ★ 50 Hz (50 Hz) [50]  
60 Hz (60 Hz) [60]

Function:

This is where the rated motor frequency  $f_{M,N}$  is selected.

Description of choice:

Select a value that equals the nameplate data on the motor.  
Furthermore, it is also possible to set the value for motor frequency infinitely variably in the 24-1000 Hz range.

**105 Motor current,  $I_{M,N}$  (MOTOR CURRENT)**

Value:

- 0.01 -  $I_{VLT,MAX}$  A ★Depends on the unit

Function:

The rated motor current  $I_{M,N}$  forms part of the VLT frequency converter calculations i.e. of torque and motor thermal protection. Set the motor current  $I_{M,N}$ , taking into account the star Y or delta  $\Delta$  connected motor.

Description of choice:

Set a value that equals the nameplate data on the motor.

**NB!**

It is important to enter the correct value, since this forms part of the VVC+ control feature.

**106 Rated motor speed,  $n_{M,N}$** **(MOTOR NOM. SPEED)**

Value:

100 -  $f_{M,N} \times 60$  (max. 60000 rpm)

- ★ Depends on parameter 102 Motor power,  $P_{M,N}$

Function:

This is where the value is set that corresponds to the rated motor speed  $n_{M,N}$ , which can be seen from the nameplate data.

Description of choice:

Choose a value that corresponds to the motor nameplate data.

**NB!**

It is important to set the correct value, since this forms part of the VVC+ control feature.  
The max. value equals  $f_{M,N} \times 60$ .  
 $f_{M,N}$  is set in parameter 104 Motor frequency,  $f_{M,N}$ .

**107 Automatic motor adaptation, AMA****(AUTO MOTOR ADAPT)**

Value:

- ★ Optimisation disable (NO AMA) [0]  
Automatic adaptation (RUN AMA) [1]  
Automatic adaptation with LC-filter (RUN AMA WITH LC-FILT) [2]

Function:

Automatic motor adaptation is a test algorithm that measures the electrical motor parameters at motor standstill. This means that AMA itself does not supply any torque.  
AMA is useful when commissioning systems, where the user wants to optimise the adjustment of the VLT frequency converter to the motor applied. This feature is used in particular where the factory setting does not adequately cover the motor in question.

For the best adjustment of the VLT frequency converter, it is recommended to carry out AMA on a cold motor.

It must be noted that repeated AMA runs may lead to a heating of the motor that will result in an increase of the stator resistance  $R_s$ . However, this is not normally critical.

**NB!**

It is important to run AMA with any motors  $\geq 55$  kW/ 75 HP

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It is possible via parameter 107 *Automatic motor adaptation, AMA* to choose whether a complete automatic motor adaptation *Automatic adaptation* [1] is to be carried out, or whether reduced automatic motor adaptation *Automatic adaptation with LC-filter* [2] is to be made.

It is only possible to carry out the reduced test if a LC-filter has been placed between the VLT frequency converter and the motor. If a total setting is required, the LC-filter can be removed and, after completion of the AMA, it can be reinstalled. In *Automatic optimisation with LC-filter* [2] there is no test of motor symmetry and of whether all motor phases have been connected. The following must be noted when the AMA function is used:

- For AMA to be able to determine the motor parameters optimally, the correct nameplate data for the motor connected to the VLT frequency converter must be entered in parameters 102 to 106.
- The duration of a total automatic motor adaptation varies from a few minutes to approx. 10 minutes for small motors, depending on the rating of the motor used (the time for a 7.5 kW motor, for example, is approx. 4 minutes).
- Alarms and warnings will be shown in the display if faults occur during motor adaptation.
- AMA can only be carried out if the rated motor current of the motor is min. 35% of the rated output current of the VLT frequency converter.
- If automatic motor adaptation is to be discontinued, press the [OFF/STOP] key.



### NB!

AMA is not allowed on motors connected in parallel.

### Description of choice:

Select *Automatic adaptation* [1] if the VLT frequency converter is to carry out a complete automatic motor adaptation.

Select *Automatic adaptation with LC-filter* [2] if a LC-filter has been placed between the VLT frequency converter and the motor.

### Procedure for automatic motor adaptation:

1. Set the motor parameters in accordance with the motor nameplate data given in parameters 102-106 *Nameplate data*.
2. Connect 24 V DC (possibly from terminal 12) to terminal 27 on the control card.
3. Select Automatic adaptation [1] or Automatic adaptation with LC-filter [2] in parameter 107 *Automatic motor adaptation, AMA*.

4. Start up the VLT frequency converter or connect terminal 18 (start) to 24 V DC (possibly from terminal 12).
5. After a normal sequence, the display reads: AMA STOP. After a reset, the VLT frequency converter will be ready to start operation again.

### If the automatic motor adaptation is to be stopped:

1. Press the [OFF/STOP] key.

### If there is a fault, the display reads:

#### ALARM 22

1. Press the [Reset] key.
2. Check for possible causes of the fault in accordance with the alarm message. See *List of warnings and alarms*.

### If there is a warning, the display reads:

#### WARNING 39-42

1. Check for possible causes of the fault in accordance with the warning. See *List of warnings and alarms*.
2. Press the [CHANGE DATA] key and select "Continue" if AMA is to continue despite the warning, or press the [OFF/STOP] key to stop the automatic motor adaptation.

### 108 Start voltage of parallel motors (MULTIM.START VOLT)

#### Value:

0.0 - parameter 103 *Motor voltage,  $U_{M,N}$*

★ Depends on par. 103 *Motor voltage,  $U_{M,N}$*

#### Function:

This parameter specifies the start-up voltage of the permanent VT characteristics at 0 Hz for motors connected in parallel.

The start-up voltage represents a supplementary voltage input to the motor. By increasing the start-up voltage, motors connected in parallel receive a higher start-up torque. This is used especially for small motors (< 4.0 kW) connected in parallel, as they have a higher stator resistance than motors above 5.5 kW.

This function is only active if *Parallel motors* [1] has been selected in parameter 101 *Torque characteristics*.

#### Description of choice:

Set the start-up voltage at 0 Hz. The maximum voltage depends on parameter 103 *Motor voltage,  $U_{M,N}$* .

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port



## VLT® 6000 HVAC

### 109 Resonance damping

#### (RESONANCE DAMP.)

Value:

0 - 500 %

★ 100 %

Function:

High-frequency electric resonance problems between the VLT frequency converter and the motor can be eliminated by adjusting the resonance damping.

Description of choice:

Adjust the damping percentage until the motor resonance has disappeared.

### 110 High break-away torque

#### (HIGH START TORQ.)

Value:

0.0 (OFF) - 0.5 sec.

★ OFF

Function:

In order to secure a high starting torque, the maximum torque for max. 0.5 sec. is allowed. However, the current is limited by the protection limit of the VLT frequency converter (inverter). 0 sec. corresponds to no high break-away torque.

Description of choice:

Set the necessary time in which a high starting torque is desired.

### 111 Start delay (START DELAY)

Value:

0.0 - 120.0 sec.

★ 0.0 sec.

Function:

This parameter enables a delay of the starting time after the conditions for start have been fulfilled. When the time has passed, the output frequency will start by ramping up to the reference.

Description of choice:

Set the desired time until acceleration is to begin.

### 112 Motor preheater (MOTOR PREHEAT)

Value:

★ Disable (DISABLE)

[0]

Enable (ENABLE)

[1]

Function:

The motor preheater ensures that no condensate develops in the motor at stop. This function can also be used to evaporate condensed water in the motor. The motor preheater is only active during stop.

Description of choice:

Select *Disable* [0] if this function is not required. Select *Enable* [1] to activate motor preheating. The DC current is set in parameter 113 *Motor preheater DC current*.

### 113 Motor preheater DC current

#### (PREHEAT DC-CURR.)

Value:

0 - 100 %

★ 50 %

The maximum value depends on the rated motor current, parameter 105 *Motor current*,  $I_{M,N}$ .

Function:

The motor can be preheated at stop by means of a DC current to prevent moisture from entering the motor.

Description of choice:

The motor can be preheated by means of a DC current. At 0%, the function is inactive; at a value higher than 0%, a DC current will be supplied to the motor at stop (0 Hz). In fans that rotate because of the air flow when they are not in operation (windmilling), this function can also be used to generate a holding torque.



If too high a DC current is supplied for too long, the motor can be damaged.

Programming

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## VLT® 6000 HVAC

## ■ DC braking

In DC braking, the motor receives a DC current that brings the shaft to a halt. Parameter 114 *DC braking current*, decides the DC braking current as a percentage of the rated motor current  $I_{M,N}$ .

In parameter 115 *DC braking time*, the DC braking time is selected, and in parameter 116 *DC brake cut-in frequency*, the frequency is selected at which DC braking becomes active.

If terminal 19 or 27 (parameter 303/304 *Digital input*) has been programmed to *DC braking inverse* and shifts from logic '1' to logic '0', the DC braking will be activated.

When the start signal on terminal 18 changes from logic '1' to logic '0', the DC braking will be activated when the output frequency becomes lower than the brake coupling frequency.



## NB!

The DC brake is not to be used if the inertia of the motor shaft is more than 20 times the inertia of the motor itself.

**114 DC braking current  
(DC BRAKE CURRENT)**

Value:

$$0 - \frac{I_{VLTMAX}}{I_{M,N}} \times 100 [\%]$$

★ 50 %

The maximum value depends on the rated motor current. If the DC braking current is active, the VLT frequency converter has a switching frequency of 4 kHz.

## Function:

This parameter is used for setting the DC braking current that is activated upon a stop when the DC brake frequency set in parameter 116 *DC brake cut-in frequency* has been reached, or if DC brake inverse is active via terminal 27 or via the serial communication port. The DC braking current will be active for the duration of the DC braking time set in parameter 115 *DC braking time*.

## Description of choice:

To be set as a percentage value of the rated motor current  $I_{M,N}$  set in parameter 105 *Motor current*,  $I_{VLTN}$ . 100% DC braking current corresponds to  $I_{M,N}$ .



Make sure not to supply too high abraking current for too long, since otherwise the motor will be damaged because of mechanical overload or the heat generated in the motor.

**115 DC braking time  
(DC BRAKE TIME)**

Value:

0.0 - 60.0 sec.

★ OFF

## Function:

This parameter is for setting the DC braking time for which the DC braking current (parameter 113) is to be active.

## Description of choice:

Set the desired time.

**116 DC brake cut-in frequency  
(DC BRAKE CUT-IN)**

Value:

0.0 (OFF) - par. 202 *Output frequency*  
high limit,  $f_{MAX}$

★ OFF

## Function:

This parameter is used for setting the DC brake cut-in frequency at which DC braking is to be activated in connection with a stop command.

## Description of choice:

Set the desired frequency.

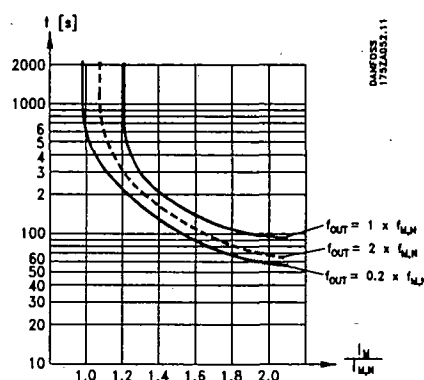
★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port



## VLT® 6000 HVAC

**117 Motor thermal protection  
(MOT. THERM PROTEC)**

| Value:                                  |      |
|---|------|
| No protection (NO PROTECTION)           | [0]  |
| Thermistor warning (THERMISTOR WARNING) | [1]  |
| Thermistor trip (THERMISTOR FAULT)      | [2]  |
| ETR Warning 1 (ETR WARNING 1)           | [3]  |
| ★ ETR Trip 1 (ETR TRIP 1)               | [4]  |
| ETR Warning 2 (ETR WARNING 2)           | [5]  |
| ETR Trip 2 (ETR TRIP 2)                 | [6]  |
| ETR Warning 3 (ETR WARNING 3)           | [7]  |
| ETR Trip 3 (ETR TRIP 3)                 | [8]  |
| ETR Warning 4 (ETR WARNING 4)           | [9]  |
| ETR Trip 4 (ETR TRIP 4)                 | [10] |


**Function:**

The VLT frequency converter is able to monitor the motor temperature in two different ways:

- Via a thermistor sensor fitted to the motor. The thermistor is connected to one of the analogue input terminals 53 and 54.
- Calculation of the thermal load (ETR - Electronic Thermal Relay), based on the current load and the time. This is compared with the rated motor current  $I_{M,N}$  and the rated motor frequency  $f_{M,N}$ . The calculations made take into account the need for a lower load at lower speeds because of less cooling in the motor itself.

ETR functions 1-4 do not start calculating the load until there is a switch-over to the Setup in which they were selected. This enables the use of the ETR function, even where two or several motors alternate.

**Description of choice:**

Select *No protection* [0] if no warning or tripping is required when the motor is overloaded.

Select *Thermistor warning* [1] if a warning is desired when the connected thermistor gets too hot.

Select *Thermistor trip* [2] if cutting out (trip) is desired when the connected thermistor overheats.

Select *ETR Warning 1-4*, if a warning is to come up on the display when the motor is overloaded according to the calculations.

The VLT frequency converter can also be programmed to give off a warning signal via one of the digital outputs.

Select *ETR Trip 1-4* if tripping is desired when the motor is overloaded according to the calculations.

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port

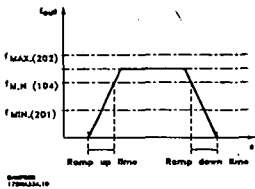
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■ References & Limits 200 - 228



In this parameter group, the frequency and reference range of the VLT frequency converter are established.

This parameter group also includes:

- Setting of ramp times
- Choice of four preset references
- Possibility of programming four bypass frequencies.
- Setting of maximum current to motor.
- Setting of warning limits for current, frequency, reference and feedback.

200 Output frequency range

(FREQUENCY RANGE)

Value:

★ 0 - 120 Hz (0 - 120 HZ) [0]

0 - 1000 Hz (0 - 1000 HZ) [1]

Function: This is where to select the maximum output frequency range to be set in parameter 202 *Output frequency high limit, f<sub>MAX</sub>*.

Description of choice: Select the required output frequency range.

201 Output frequency low limit, f<sub>MIN</sub>

(MIN. FREQUENCY)

Value:

0.0 - f<sub>MAX</sub> ★ 0.0 Hz

Function: This is where to select the minimum output frequency.

Description of choice: A value from 0.0 Hz to the *Output frequency high limit, f<sub>MAX</sub>* frequency set in parameter 202 can be selected.

202 Output frequency high limit, f<sub>MAX</sub>

(MAX. FREQUENCY)

Value:

f<sub>MIN</sub> - 120/1000 Hz

(par. 200 *Output frequency range*) ★ 50 Hz

Function: In this parameter, a maximum output frequency can be selected that corresponds to the highest speed at which the motor can be.

**NB!** The output frequency of the VLT frequency converter can never assume a value higher than 1/10 of the switching frequency (parameter 407 *Switching frequency*).

Description of choice: A value from f<sub>MIN</sub> to the choice made in parameter 200 *Output frequency range* can be selected.



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### Reference handling

Reference handling is shown in the block diagram underneath.

The block diagram shows how a change in a parameter can affect the resulting reference.

Parameters 203 to 205 *Reference handling, minimum and maximum reference* and parameter 210 *Reference type* define the way reference handling can be carried out. The mentioned parameters are active both in a closed and in an open loop.

Remote references are defined as:

- External references, such as analogue inputs 53, 54 and 60, pulse reference via terminal 17/29 and reference from serial communication.
- Preset references.

The resulting reference can be shown in the display by selecting *Reference [%]* in parameters 007-010 *Display readout* and in the form of a unit by selecting *Resulting reference [unit]*.

See the section on *Feedback handling* in connection with a closed loop.

The sum of the external references can be shown in the display as a percentage of the range from *Minimum reference*,  $Ref_{MIN}$  to *Maximum reference*,  $Ref_{MAX}$ . Select *External reference, %* [25] in parameters 007-010 *Display readout* if a readout is required.

It is possible to have both preset references and external references at the same time. In parameter 210 *Reference type* a choice is made of how the preset references are to be added to the external references.

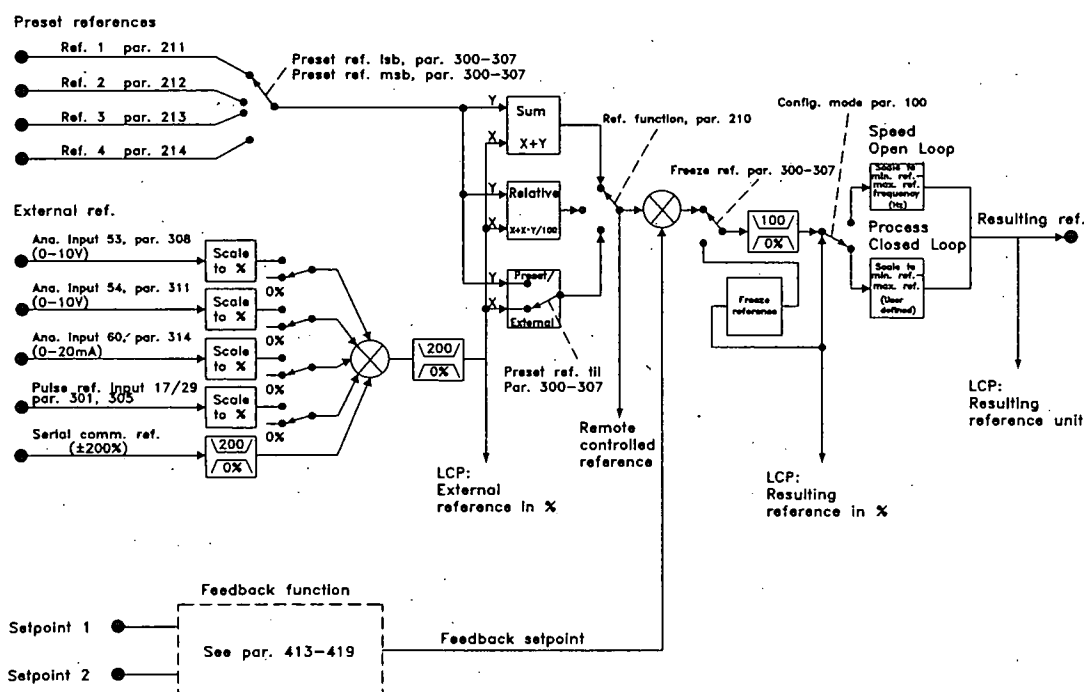
Furthermore, an independent local reference exists, where the resulting reference is set by means of the [+/-] keys. If local reference has been selected, the output frequency range is limited by parameter 201 *Output frequency low limit*,  $f_{MIN}$  and parameter 202 *Output frequency high limit*,  $f_{MAX}$ .



**NB!**

If the local reference is active, the VLT frequency converter will always be in *Open loop* [0], regardless of the choice made in parameter 100 *Configuration*.

The unit of the local reference can be set either as Hz or as a percentage of the output frequency range. The unit is selected in parameter 011 *Unit of local reference*.



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**203 Reference site****(REFERENCE SITE)****Value:**

- ★ Hand/Auto linked reference  
(LINKED TO HAND/AUTO)) [0]
- Remote reference (REMOTE) [1]
- Local reference (LOCAL) [2]

**Function:**

This parameter decides which resulting reference is to be active. If *Hand/Auto linked reference* [0] is selected, the resulting reference will depend on whether the VLT frequency converter is in Hand or Auto mode.

The table shows which references are active when *Hand/Auto linked reference* [0], *Remote reference* [1] or *Local reference* [2] has been selected. The Hand mode or Auto mode can be selected via the control keys or via a digital input, parameters 300-307 *Digital inputs*.

| Reference handling | Hand mode          | Auto mode          |
|--------------------|--------------------|--------------------|
| Hand/Auto [0]      | Local ref. active  | Remote ref. active |
| Remote [1]         | Remote ref. active | Remote ref. active |
| Local [2]          | Local ref. active  | Local ref. active  |

**Description of choice:**

If *Hand/Auto linked reference* [0] is chosen, the motor speed in Hand mode will be decided by the local reference, while in Auto mode it depends on remote references and any setpoints selected. If *Remote reference* [1] is selected, the motor speed will depend on remote references, regardless of whether Hand mode or Auto mode has been chosen.

If *Local reference* [2] is selected, the motor speed will only depend on the local reference set via the control panel, regardless of whether Hand mode or Auto mode has been selected.

**204 Minimum reference, Ref<sub>MIN</sub>****(MIN. REFERENCE)****Value:**

- Parameter 100 *Configuration* = *Open loop* [0].  
0.000 - parameter 205 Ref<sub>MAX</sub> ★ 0.000 Hz
- Parameter 100 *Configuration* = *Closed loop* [1].  
- Par. 413 *Minimum feedback*  
- par. 205 Ref<sub>MAX</sub> ★ 0.000

**Function:**

The *Minimum reference* gives the minimum value that can be assumed by the sum of all references. If *Closed loop* has been selected in parameter 100 *Configuration*, the minimum reference is limited by parameter 413 *Minimum feedback*.

Minimum reference is ignored when the local reference is active (parameter 203 *Reference site*).

The unit for the reference can be seen from the following table:

|  | Unit     |
|--|----------|
| Par. 100 <i>Configuration</i> = <i>Open loop</i>   | Hz       |
| Par. 100 <i>Configuration</i> = <i>Closed loop</i> | Par. 415 |

**Description of choice:**

*Minimum reference* is set if the motor is to run at a minimum speed, regardless of whether the resulting reference is 0.

**205 Maximum reference, Ref<sub>MAX</sub>****(MAX. REFERENCE)****Value:**

- Parameter 100 *Configuration* = *Open loop* [0]  
Parameter 204 Ref<sub>MIN</sub> - 1000.000 Hz ★ 50.000 Hz
- Parameter 100 *Configuration* = *Closed loop* [1]  
Par. 204 Ref<sub>MIN</sub>  
- par. 414 *Maximum feedback* ★ 50.000 Hz

**Function:**

The *Maximum reference* gives the maximum value that can be assumed by the sum of all references. If *Closed loop* [1] has been selected in parameter 100 *Configuration*, the maximum reference cannot be set above parameter 414 *Maximum feedback*. The *Maximum reference* is ignored when the local reference is active (parameter 203 *Reference site*).

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## VLT® 6000 HVAC

**Function, cont.**

The reference unit can be determined on the basis of the following table:

|                                      | Unit     |
|--------------------------------------|----------|
| Par. 100 Configuration = Open loop   | Hz       |
| Par. 100 Configuration = Closed loop | Par. 415 |

**Description of choice**

Maximum reference is set if the motor speed is not to exceed the set value, regardless of whether the resulting reference is higher than *Maximum reference*.

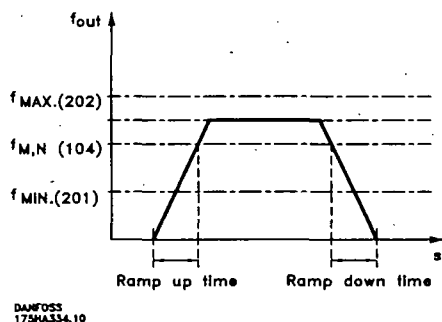
**206 Ramp-up time (RAMP UP TIME)****Value:**

1 - 3600 sec.

★ Depends on the unit

**Function:**

The ramp-up time is the acceleration time from 0 Hz to the rated motor frequency  $f_{M,N}$  (parameter 104 *Motor frequency,  $f_{M,N}$* ). It is assumed that the output current does not reach the current limit (set in parameter 215 *Current limit  $I_{LM}$* ).

**Description of choice**

Program the desired ramp-up time.

**207 Ramp-down time (RAMP DOWN TIME)****Value:**

1 - 3600 sec.

★ Depends on the unit

**Function:**

The ramp-down time is the deceleration time from the rated motor frequency  $f_{M,N}$  (parameter 104 *Motor frequency,  $f_{M,N}$* ) to 0 Hz; provided there is no overvoltage in the inverter because of the motor acting as a generator.

**Description of choice**

Program the desired ramp-down time.

**208 Automatic ramp-down****(AUTO RAMPING)****Value:**

Disable (DISABLE)

[0]

★ Enable (ENABLE)

[1]

**Function:**

This function ensures that the VLT frequency converter does not trip during deceleration if the ramp-down time set is too short. If, during deceleration, the VLT frequency converter registers that the intermediate circuit voltage is higher than the max. value (see *List of warnings and alarms*), the VLT frequency converter automatically extends the ramp-down time.

**NB!**

If the function is chosen as *Enable* [1], the ramp time may be considerably extended in relation to the time set in parameter 207, *Ramp-down time*.

**Description of choice**

Program this function as *Enable* [1] if the VLT frequency converter periodically trips during ramp-down. If a quick ramp-down time has been programmed that may lead to a trip under special conditions, the function can be set to *Enable* [1] to avoid trips.

**209 Jog frequency (JOG FREQUENCY)****Value:**

Par. 201 Output frequency Low limit - par. 202

Output frequency high limit

★ 10.0 Hz

**Function:**

The jog frequency  $f_{JOG}$  is the fixed output frequency at which the VLT frequency converter is running when the jog function is activated.

Jog can be activated via the digital inputs.

**Description of choice**

Set the desired frequency.

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## VLT® 6000 HVAC

### Reference type

The example shows how the resulting reference is calculated when Preset references are used together with Sum and Relative in parameter 210, *Reference type*. See *Calculation of resulting reference*. See also the drawing in *Reference handling*.

The following parameters have been set:

|                                       |               |
|---------------------------------------|---------------|
| Par. 204 Minimum reference:           | 10 Hz         |
| Par. 205 Maximum reference:           | 50 Hz         |
| Par. 211 Preset reference:            | 15%           |
| Par. 308 Terminal 53, analogue input: | Reference [1] |
| Par. 309 Terminal 53, min. scaling:   | 0 V           |
| Par. 310 Terminal 53, max. scaling:   | 10 V          |

When parameter 210 *Reference type* is set to Sum [0], one of the adjusted *Preset references* (par. 211-214) will be added to the external references as a percentage of the reference range. If terminal 53 is energized by an analogue input voltage of 4 V, the resulting reference will be as follows:

Par. 210 *Reference type* = Sum [0]

|                               |           |
|-------------------------------|-----------|
| Par. 204 Minimum reference    | = 10.0 Hz |
| Reference contribution at 4 V | = 16.0 Hz |
| Par. 211 Preset reference     | = 6.0 Hz  |
| Resulting reference           | = 32.0 Hz |

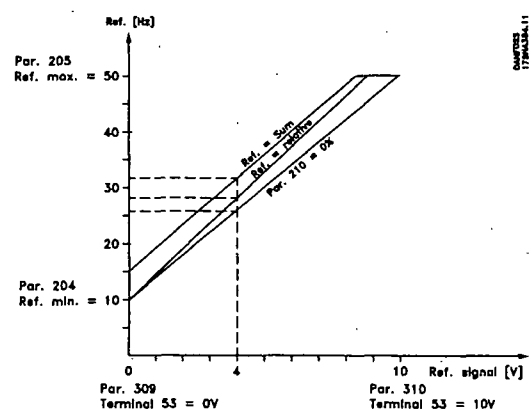
If parameter 210 *Reference type* is set to Relative [1], one of the adjusted *Preset references* (par. 211-214) will be totaled as a percentage of the sum of the present external references. If terminal 53 is energized by an analogue input voltage of 4 V, the resulting reference will be as follows:

Par. 210 *Reference type* = Relative [1]

|                               |           |
|-------------------------------|-----------|
| Par. 204 Minimum reference    | = 10.0 Hz |
| Reference contribution at 4 V | = 16.0 Hz |
| Par. 211 Preset reference     | = 2.4 Hz  |
| Resulting reference           | = 28.4 Hz |

The graph in the next column shows the resulting reference in relation to the external reference varied from 0-10 V.

Parameter 210 *Reference type* has been programmed for Sum [0] and Relative [1], respectively. In addition, a graph is shown in which parameter 211 *Preset reference* 1, is programmed for 0%.



### 210 Reference type

#### (REF. FUNCTION)

#### Value:

|                                   |     |
|-----------------------------------|-----|
| ★ Sum (SUM)                       | [0] |
| Relative (RELATIVE)               | [1] |
| External/preset (EXTERNAL/PRESET) | [2] |

#### Function:

It is possible to define how the preset references are to be added to the other references. For this purpose, *Sum* or *Relative* is used. It is also possible - by using the *External/preset* function - to select whether a shift between external references and preset references is wanted.

See *Reference handling*.

#### Description of choice:

If *Sum* [0] is selected, one of the adjusted preset references (parameters 211-214 *Preset reference*) is added to the other external references as a percentage of the reference range ( $Ref_{MIN} - Ref_{MAX}$ ).

If *Relative* [1] is selected, one of the adjusted preset references (parameters 211-214 *Preset reference*) is totaled as a percentage of the sum of the present external references.

If *External/preset* [2] is selected, it is possible to shift between external references and preset references via terminal 16, 17, 29, 32 or 33 (parameter 300, 301, 305, 306 or 307 *Digital inputs*). Preset references will be a percentage value of the reference range. External reference is the sum of the analogue references, pulse references and any references from serial communication.



#### NB!

If *Sum* or *Relative* is selected, one of the preset references will always be active. If the preset references are to be without influence, they should be set to 0% (as in the factory setting) via the serial communication port.

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port



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**211 Preset reference 1 (PRESET REF. 1)****212 Preset reference 2 (PRESET REF. 2)****213 Preset reference 3 (PRESET REF. 3)****214 Preset reference 4 (PRESET REF. 4)****Value:**

-100.00 % - +100.00 %      ★ 0.00%  
of the reference range/external reference

**Function:**

Four different preset references can be programmed in parameters 211-214 *Preset reference*. The preset reference is stated as a percentage value of the reference range ( $\text{Ref}_{\text{MIN}} - \text{Ref}_{\text{MAX}}$ ) or as a percentage of the other external references, depending on the choice made in parameter 210 *Reference type*.

The choice between the preset references can be made by activating terminal 16, 17, 29, 32 or 33, cf. the table below.

| Terminal 17/29/33<br>preset ref. msb | Terminal 16/29/32<br>preset ref. lsb |               |
|--------------------------------------|--------------------------------------|---------------|
| 0                                    | 0                                    | Preset ref. 1 |
| 0                                    | 1                                    | Preset ref. 2 |
| 1                                    | 0                                    | Preset ref. 3 |
| 1                                    | 1                                    | Preset ref. 4 |

**Description of choice:**

Set the required preset reference(s) that is/are to be the options.

**215 Current limit,  $I_{\text{LM}}$   
(CURRENT LIMIT)****Value:**

0.1 - 1.1 x  $I_{\text{LTN}}$       ★ 1.1 x  $I_{\text{LTN}}$  [A]

**Function:**

This is where the maximum output current  $I_{\text{LM}}$  is set. The factory setting corresponds to the rated output current. Current limit should not be used for motor protection; parameter 117 is for motor protection. Current limit is for protection of the VLT frequency converter. If the current limit is set within the range of 1.0-1.1 x  $I_{\text{LTN}}$  (the rated output current of the VLT frequency converter), the VLT frequency converter can only handle a load intermittently, i.e. for short periods at a time. After the load has been higher than  $I_{\text{LTN}}$ , it must be ensured that for a period the load is lower than  $I_{\text{LTN}}$ .

Please note that if the current limit is set to less than  $I_{\text{LTN}}$ , the acceleration torque will be reduced correspondingly.

**Description of choice:**

Set the required maximum output current  $I_{\text{LM}}$ .

**216 Frequency bypass, bandwidth  
(FREQUENCY BYPASS B.W.)****Value:**

0 (OFF) - 100 Hz      ★ Disable

**Function:**

Some systems call for some output frequencies to be avoided because of mechanical resonance problems.

The frequencies to avoid can be programmed in parameters 217-220 *Frequency bypass*.

In this parameter (216 *Frequency bypass, bandwidth*), a definition can be given of a bandwidth around each of these frequencies.

**Description of choice:**

The bypass bandwidth is equal to the programmed bandwidth frequency. This bandwidth will be centered around each bypass frequency.

**217 Frequency bypass 1****(BYPASS FREQ. 1)****218 Frequency bypass 2****(BYPASS FREQ. 2)****219 Frequency bypass 3****(BYPASS FREQ. 3)****220 Frequency bypass 4****(BYPASS FREQ. 4)****Value:**

0 - 120/1000 Hz      ★ 120.0 Hz

The frequency range depends on the selection made in parameter 200 *Output frequency range*.

**Function:**

Some systems call for some output frequencies to be avoided because of mechanical resonance problems in the system.

**Description of choice:**

Enter the frequencies to be avoided.

See also parameter 216 *Frequency bypass, bandwidth*.

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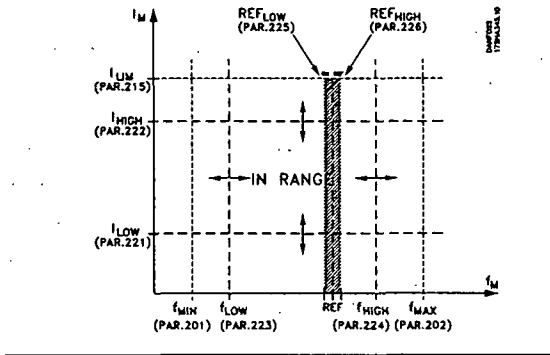
VLT® 6000 HVAC

221 Warning: Low current,  $I_{LOW}$   
(WARN. LOW CURR.)

Value:  
0.0 - par. 222 Warning: High current,  $I_{HIGH}$  ★0.0A

**Function:**  
When the motor current is below the limit,  $I_{LOW}$ , programmed in this parameter, the display shows a flashing CURRENT LOW, provided Warning [1] has been selected in parameter 409 *Function in case of no load*. The VLT frequency converter will trip if parameter 409 *Function in case of no load* has been selected as *Trip* [0].  
The warning functions in parameters 221-228 are not active during ramp-up after a start command, ramp-down after a stop command or while stop-ped. The warning functions are activated when the output frequency has reached the resulting reference.  
The signal outputs can be programmed to generate a warning signal via terminal 42 or 45 and via the relay outputs.

**Description of choice:**  
The lower signal limit  $I_{LOW}$  must be programmed within the normal working range of the frequency converter.



222 Warning: High current,  $I_{HIGH}$   
(WARN. HIGH CURR.)

Value:  
Parameter 221 -  $I_{VLT,MAX}$  ★  $I_{VLT,MAX}$

**Function:**  
If the motor current is above the limit,  $I_{HIGH}$ , programmed in this parameter, the display shows a flashing CURRENT HIGH.  
The warning functions in parameters 221-228 are not active during ramp-up after a start command, ramp-down after a stop command or while stop-ped. The warning functions are activated when the output frequency has reached the resulting reference.  
The signal outputs can be programmed to generate a warning signal via terminal 42 or 45 and via the relay outputs.

**Description of choice:**  
The upper signal limit of the motor frequency,  $f_{HIGH}$ , must be programmed within the normal working range of the frequency converter. See drawing at parameter 221 *Warning: Low current,  $I_{LOW}$* .

223 Warning: Low frequency,  $f_{LOW}$   
(WARN. LOW FREQ.)

Value:  
0.0 - parameter 224 ★ 0.0 Hz

**Function:**  
If the output frequency is below the limit,  $f_{LOW}$ , programmed in this parameter, the display will show a flashing FREQUENCY LOW.  
The warning functions in parameters 221-228 are not active during ramp-up after a start command, ramp-down after a stop command or while stop-ped. The warning functions are activated when the output frequency has reached the resulting reference.  
The signal outputs can be programmed to generate a warning signal via terminal 42 or 45 and via the relay outputs.

**Description of choice:**  
The lower signal limit of the motor frequency,  $f_{LOW}$ , must be programmed within the normal working range of the frequency converter. See drawing at parameter 221 *Warning: Low current,  $I_{LOW}$* .

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port



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**224 Warning: High frequency,  $f_{HIGH}$**   
**(WARN. HIGH FREQ.)**
**Value:**

Par. 200 Output frequency range = 0-120 Hz [0].  
 parameter 223 - 120 Hz ★ 120.0 Hz

Par. 200 Output frequency range = 0-1000 Hz [1].  
 parameter 223 - 1000 Hz ★ 120.0 Hz

**Function:**

If the output frequency is above the limit,  $f_{HIGH}$ , programmed in this parameter, the display will show a flashing FREQUENCY HIGH.

The warning functions in parameters 221-228 are not active during ramp-up after a start command, ramp-down after a stop command or while stop-ped. The warning functions are activated when the output frequency has reached the resulting reference.

The signal outputs can be programmed to generate a warning signal via terminal 42 or 45 and via the relay outputs.

**Description of choice:**

The higher signal limit of the motor frequency,  $f_{HIGH}$ , must be programmed within the normal working range of the frequency converter. See drawing at parameter 221 Warning: Low current,  $I_{LOW}$ .

**225 Warning: Low reference,  $REF_{LOW}$**   
**(WARN. LOW REF)**
**Value:**

-999,999.999 -  $REF_{HIGH}$  (par.226) ★ -999,999.999

**Function:**

When the remote reference lies under the limit,  $REF_{LOW}$ , programmed in this parameter, the display shows a flashing REFERENCE LOW.

The warning functions in parameters 221-228 are not active during ramp-up after a start command, ramp-down after a stop command or while stop-ped. The warning functions are activated when the output frequency has reached the resulting reference.

The signal outputs can be programmed to generate a warning signal via terminal 42 or 45 and via the relay outputs.

The reference limits in parameter 226 Warning: High reference,  $Ref_{HIGH}$ , and in parameter 227 Warning: Low reference,  $Ref_{LOW}$ , are only active when remote reference has been selected.

In *Open loop mode* the unit for the reference is Hz, while in *Closed loop mode* the unit is programmed in parameter 415 *Process units*.

**Description of choice:**

The lower signal limit,  $Ref_{LOW}$ , of the reference must be programmed within the normal working range of the frequency converter, provided parameter 100 Configuration has been programmed for *Open loop* [0]. In *Closed loop* [1] (parameter 100),  $Ref_{LOW}$  must be within the reference range programmed in parameters 204 and 205.

**226 Warning: High reference,  $REF_{HIGH}$**   
**(WARN. HIGH REF)**
**Value:**

$REF_{LOW}$  (par. 225) - 999,999.999 ★ 999,999.999

**Function:**

If the resulting reference lies under the limit,  $Ref_{HIGH}$ , programmed in this parameter, the display shows a flashing REFERENCE HIGH.

The warning functions in parameters 221-228 are not active during ramp-up after a start command, ramp-down after a stop command or while stop-ped. The warning functions are activated when the output frequency has reached the resulting reference.

The signal outputs can be programmed to generate a warning signal via terminal 42 or 45 and via the relay outputs.

The reference limits in parameter 226 Warning: High reference,  $Ref_{HIGH}$ , and in parameter 227 Warning: Low reference,  $Ref_{LOW}$ , are only active when remote reference has been selected.

In *Open loop* the unit for the reference is Hz, while in *Closed loop* the unit is programmed in parameter 415 *Process units*.

**Description of choice:**

The upper signal limit,  $Ref_{HIGH}$ , of the reference must be programmed within the normal working range of the frequency converter, provided parameter 100 Configuration has been programmed for *Open loop* [0]. In *Closed loop* [1] (parameter 100),  $Ref_{HIGH}$  must be within the reference range programmed in parameters 204 and 205.

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**227 Warning: Low feedback,  $FB_{LOW}$   
(WARN LOW FDBK)**
**Value:**-999,999.999 -  $FB_{HIGH}$  (parameter 228)

★ -999.999,999

**Function:**

If the feedback signal is below the limit,  $FB_{LOW}$ , programmed in this parameter, the display will show a flashing FEEDBACK LOW.

The warning functions in parameters 221-228 are not active during ramp-up after a start command, ramp-down after a stop command or while stop-ped. The warning functions are activated when the output frequency has reached the resulting reference.

The signal outputs can be programmed to generate a warning signal via terminal 42 or 45 and via the relay outputs.

In *Closed loop*, the unit for the feedback is programmed in parameter 415 *Process units*.

**Description of choice:**

Set the required value within the feedback range (parameter 413 *Minimum feedback*,  $FB_{MIN}$ , and 414 *Maximum feedback*,  $FB_{MAX}$ ).

**228 Warning: High feedback,  $FB_{HIGH}$   
(WARN. HIGH FDBK)**
**Value:** $FB_{LOW}$  (parameter 227) - 999,999.999

★ 999.999,999

**Function:**

If the feedback signal is above the limit,  $FB_{HIGH}$ , programmed in this parameter, the display will show a flashing FEEDBACK HIGH.

The warning functions in parameters 221-228 are not active during ramp-up after a start command, ramp-down after a stop command or while stop-ped. The warning functions are activated when the output frequency has reached the resulting reference.

The signal outputs can be programmed to generate a warning signal via terminal 42 or 45 and via the relay outputs.

In *Closed loop*, the unit for the feedback is programmed in parameter 415 *Process units*.

**Description of choice:**

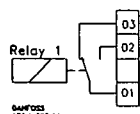
Set the required value within the feedback range (parameter 413 *Minimum feedback*,  $FB_{MIN}$ , and 414 *Maximum feedback*,  $FB_{MAX}$ ).

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port



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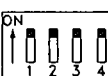
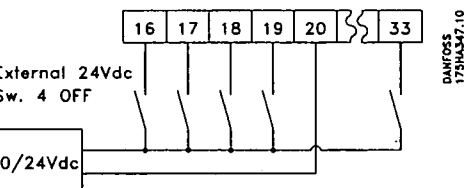
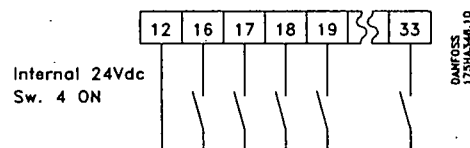
## ■ Inputs and outputs 300-328

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In this parameter group, the functions that relate to the input and output terminals of the VLT frequency converter are defined. The digital inputs (terminals 16, 17, 18, 19, 27, 32 and 33) are programmed in parameters 300-307. The table below gives the options for programming the inputs. The digital inputs require a signal of 0 or 24 V DC. A signal lower than 5 V DC is a logic '0', while a signal higher than 10 V DC is a logic '1'.

The terminals for the digital inputs can be connected to the internal 24 V DC supply, or an external 24 V DC supply can be connected.

The drawings in the next column show one Setup using the internal 24 V DC supply and one Setup using an external 24 V DC supply.

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Switch 4, which is located on the Dip switch control card, is used for separating the common potential of the internal 24 V DC supply from

the common potential of the external 24 V DC supply. See *Electrical installation*.

Please note that when Switch 4 is in the OFF position, the external 24 V DC supply is galvanically isolated from the VLT frequency converter.

| Digital inputs                   | terminal no.            | 16   | 17   | 18   | 19   | 27   | 29    | 32   | 33   |
|----------------------------------|-------------------------|------|------|------|------|------|-------|------|------|
|                                  | parameter               | 300  | 301  | 302  | 303  | 304  | 305   | 306  | 307  |
| Value:                           |                         |      |      |      |      |      |       |      |      |
| No function                      | (NO OPERATION)          | [0]  | [0]  | [0]  | [0]  |      | [0]   | ★[0] | ★[0] |
| Reset                            | (RESET)                 | ★[1] | [1]  |      |      |      | [1]   | [1]  | [1]  |
| Coasting stop, inverse           | (COAST INVERSE)         |      |      |      |      | ★[0] |       |      |      |
| Reset and coasting stop, inverse | (RESET & COAST INVERSE) |      |      |      |      | [1]  |       |      |      |
| Start                            | (START)                 |      |      | ★[1] |      |      |       |      |      |
| Reversing                        | (REVERSE)               |      |      |      | ★[1] |      |       |      |      |
| Reversing and start              | (START REVERSE)         |      |      |      | [2]  |      |       |      |      |
| DC-braking, inverse              | (DC BRAKE INVERSE)      |      |      |      | [3]  | [2]  |       |      |      |
| Safety interlock                 | (SAFETY INTERLOCK)      |      |      |      |      | [3]  |       |      |      |
| Freeze reference                 | (FREEZE REFERENCE)      | [2]  | ★[2] |      |      |      | [2]   | [2]  | [2]  |
| Freeze output                    | (FREEZE OUTPUT)         | [3]  | [3]  |      |      |      | [3]   | [3]  | [3]  |
| Selection of Setup, lsb          | (SETUP SELECT LSB)      | [4]  |      |      |      |      | [4]   | [4]  |      |
| Selection of Setup, msb          | (SETUP SELECT MSB)      |      | [4]  |      |      |      | [5]   |      | [4]  |
| Preset reference, on             | (PRESET REF. ON)        | [5]  | [5]  |      |      |      | [6]   | [5]  | [5]  |
| Preset reference, lsb            | (PRESET REF. LSB)       | [6]  |      |      |      |      | [7]   | [6]  |      |
| Preset reference, msb            | (PRESET REF. MSB)       |      | [6]  |      |      |      | [8]   |      | [6]  |
| Speed down                       | (SPEED DOWN)            |      | [7]  |      |      |      | [9]   |      | [7]  |
| Speed up                         | (SPEED UP)              | [7]  |      |      |      |      | [10]  | [7]  |      |
| Run permissive                   | (RUN PERMISSIVE)        | [8]  | [8]  |      |      |      | [11]  | [8]  | [8]  |
| Jog                              | (JOG)                   | [9]  | [9]  |      |      |      | ★[12] | [9]  | [9]  |
| Data change lock                 | (PROGRAMMING LOCK)      | [10] | [10] |      |      |      | [13]  | [10] | [10] |
| Pulse reference                  | (PULSE REFERENCE)       |      | [11] |      |      |      | [14]  |      |      |
| Pulse feedback                   | (PULSE FEEDBACK)        |      |      |      |      |      |       |      | [11] |
| Hand start                       | (HAND START)            | [11] | [12] |      |      |      | [15]  | [11] | [12] |
| Auto start                       | (AUTOSTART)             | [12] | [13] |      |      |      | [16]  | [12] | [13] |

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Programming



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**Function:**  
In parameters 300-307 *Digital inputs* it is possible to choose between the different possible functions related to the digital inputs (terminals 16-33). The functional options are given in the table on the previous page.

**Description of choice:**  
*No function* is selected if the VLT frequency converter is not to react to signals transmitted to the terminal.

*Reset* resets the VLT frequency converter after an alarm; however, trip locked alarms cannot be reset by cycling mains power supply. See table in *List of warnings and alarms*. Reset will occur on the rising edge of the signal.

*Coasting stop, inverse* is used to force the VLT frequency converter to "release" the motor immediately (the output transistors are "turned off") to make it coast freely to stop. Logic '0' implements coasting to stop.

*Reset and coasting stop, inverse* is used for activating coasting stop at the same time as reset. Logic '0' implements coasting stop and reset. Reset will be activate on the falling edge of the signal.

*DC braking, inverse* is used for stopping the motor by energizing it with a DC voltage for a given time, see parameters 114-116 *DC brake*. Please note that this function is only active if the value of parameters 114 *DC brake current* and 115 *DC braking time* is different from 0. Logic '0' implements DC braking. See *DC braking*.

*Safety interlock* has the same function as *Coasting stop, inverse*, but *Safety interlock* generates the alarm message 'external fault' on the display when terminal 27 is logic '0'. The alarm message will also be active via digital outputs 42/45 and relay outputs 1/2, if programmed for *Safety interlock*. The alarm can be reset using a digital input or the [OFF/STOP] key.


*Start* is selected if a start/stop command is required. Logic '1' = start, logic '0' = stop.

*Reversing* is used for changing the direction of rotation of the motor shaft. Logic '0' will not implement reversing. Logic '1' will implement reversing. The reversing signal only changes the direction of rotation; it does not activate the start function. Is not active together with *Closed loop*.

*Reversing and start* is used for start/stop and reversing using the same signal. A start signal via terminal 18 at the same time is not allowed. Is not active together with *Closed loop*.

*Freeze reference* freezes the present reference. The frozen reference can now only be changed by means of *Speed up* or *Speed down*. The frozen reference is saved after a stop command and in case of mains failure.

*Freeze output* freezes the present output frequency (in Hz). The frozen output frequency can now only be changed by means of *Speed up* or *Speed down*.

**NB!**  
 If *Freeze output* is active, the VLT frequency converter cannot be stopped via terminal 18. The VLT frequency converter can only be stopped when terminal 27 or terminal 19 has been programmed for *DC braking, inverse*.

*Selection of Setup, lsb* and *Selection of Setup, msb* enables a choice of one of the four Setups. However, this presupposes that parameter 002 *Active Setup* has been set at *Multi Setup* [5].

|         | Setup, msb | Setup, lsb |
|---------|------------|------------|
| Setup 1 | 0          | 0          |
| Setup 2 | 0          | 1          |
| Setup 3 | 1          | 0          |
| Setup 4 | 1          | 1          |

*Preset reference, on* is used for switching between remote reference and preset reference. This assumes that *Remote/preset* [2] has been selected in parameter 210 *Reference type*. Logic '0' = remote references active; logic '1' = one of the four preset references is active in accordance with the table below.

*Preset reference, lsb* and *Preset reference, msb* enables a choice of one of the four preset references, in accordance with the table below.

|               | Preset ref. msb | Preset ref. lsb |
|---------------|-----------------|-----------------|
| Preset ref. 1 | 0               | 0               |
| Preset ref. 2 | 0               | 1               |
| Preset ref. 3 | 1               | 0               |
| Preset ref. 4 | 1               | 1               |



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**Speed up and Speed down** are selected if digital control of the up/down speed is desired. This function is only active if *Freeze reference* or *Freeze output* has been selected.

As long as there is a logic '1' on the terminal selected for *Speed up*, the reference or the output frequency will increase by the *Ramp-up time* set in parameter 206.

As long as there is a logic '1' on the terminal selected for *Speed down*, the reference or the output frequency will increase by the *Ramp-down time* set in parameter 207.

Pulses (logic '1' minimum high for 3 ms and a minimum pause of 3 ms) will lead to a change of speed of 0.1% (reference) or 0.1 Hz (output frequency).

Example:

|                 | Terminal<br>(16) | Terminal<br>(17) | Freeze ref./<br>Freeze output |
|-----------------|------------------|------------------|-------------------------------|
| No speed change | 0                | 0                | 1                             |
| Speed down      | 0                | 1                | 1                             |
| Speed up        | 1                | 0                | 1                             |
| Speed down      | 1                | 1                | 1                             |

The speed reference frozen via the control panel can be changed even if the VLT frequency converter has stopped. In addition, the frozen reference will be remembered in case of a mains failure.

**Run permissive.** There must be an active start signal via the terminal, where *Run permissive* has been programmed, before a start command can be accepted. *Run permissive* has a logic 'AND' function related to Start (terminal 18, parameter 302 *Terminal 18, Digital input*), which means that in order to start the motor, both conditions must be fulfilled. If *Run permissive* is programmed on several terminals, *Run permissive* must only be logic '1' on one of the terminals for the function to be carried out. See *Example of application - Speed control of fan in ventilation system*.

**Jog** is used to override the output frequency to the frequency set in parameter 209 *Jog frequency* and issue a start command. If local reference is active, the VLT frequency converter will always be in *Open loop* [0], regardless of the selection made in parameter 100 *Configuration*.

Jog is not active if a stop command has been given via terminal 27.

**Data change lock** is selected if data changes to parameters are not to be made via the control unit; however, it will still be possible to carry out data changes via the bus.

**Pulse reference** is selected if a pulse sequence (frequency) is selected as a reference signal. 0 Hz corresponds to  $Ref_{MIN}$ , parameter 204 *Minimum reference,  $Ref_{MIN}$* .

The frequency set in parameter 327 *Pulse reference, max. frequency* corresponds to parameter 205 *Maximum reference,  $Ref_{MAX}$* .

**Pulse feedback** is selected if a pulse sequence (frequency) is selected as a feedback signal. Parameter 328 *Pulse feedback, max. frequency* is where the maximum frequency for pulse feedback is set.

**Hand start** is selected if the VLT frequency converter is to be controlled by means of an external hand/off or H-O-A switch. A logic '1' (Hand start active) will mean that the VLT frequency converter starts the motor. A logic '0' means that the connected motor stops. The VLT frequency converter will then be in OFF/STOP mode, unless there is an active *Auto start signal*. See also the description in *Local control*.



**NB!**

An active *Hand* and *Auto* signal via the digital inputs will have higher priority than the [HAND START]-[AUTO START] control keys.

**Auto start** is selected if the VLT frequency converter is to be controlled via an external auto/off or H-O-A switch. A logic '1' will place the VLT frequency converter in auto mode allowing a start signal on the control terminals or the serial communication port. If *Auto start* and *Hand start* are active at the same time on the control terminals, *Auto start* will have the highest priority. If *Auto start* and *Hand start* are not active, the connected motor will stop and the VLT frequency converter will then be in OFF/STOP mode.

Programming

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port



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■ Analogue inputs

Two analogue inputs for voltage signals (terminals 53 and 54) are provided for reference and feedback signals. Furthermore, an analogue input is available for a current signal (terminal 60). A thermistor can be connected to voltage input 53 or 54.  
The two analogue voltage inputs can be scaled in the range of 0-10 V DC; the current input in the range of 0-20 mA.

The table below gives the possibilities for programming the analogue inputs.  
Parameter 317 *Time out* and 318 *Function after time out* allow activation of a time-out function on all analogue inputs. If the signal value of the reference or feedback signal connected to one of the analogue input terminals drops to below 50% of the minimum scaling, a function will be activated after the time out determined in parameter 318, *Function after time out*.

| Analogue inputs | terminal no.   | 53(voltage) | 54(voltage) | 60(current) |
|-----------------|----------------|-------------|-------------|-------------|
|                 | parameter      | 308         | 311         | 314         |
| Value:          |                |             |             |             |
| No operation    | (NO OPERATION) | [0]         | [0] ★       | [0]         |
| Reference       | (REFERENCE)    | [1] ★       | [1]         | [1] ★       |
| Feedback        | (FEEDBACK)     | [2]         | [2]         | [2]         |
| Thermistor      | (THERMISTOR)   | [3]         | [3]         | [3]         |

**308 Terminal 53, analogue input voltage**  
**(AI [M] 53 FUNCT.)**  
Function:

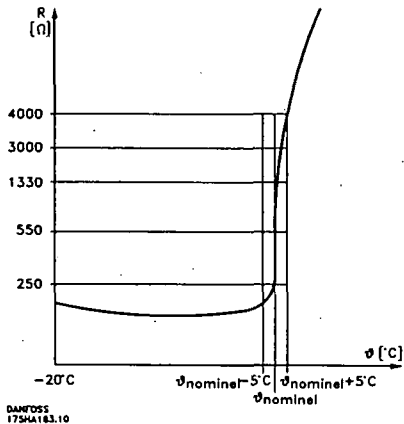
This parameter is used to select the required function to be linked to terminal 53.

Description of choice:  
**No operation.** Is selected if the VLT frequency converter is not to react to signals connected to the terminal.

**Reference.** Is selected to enable change of reference by means of an analogue reference signal.  
If reference signals are connected to several inputs, these reference signals must be added up.

**Feedback.** If a feedback signal is connected, there is a choice of a voltage input (terminal 53 or 54) or a current input (terminal 60) as feedback. In the case of zone regulation, feedback signals must be selected as voltage inputs (terminals 53 and 54).  
See *Feedback handling*.

**Thermistor.** Is selected if a thermistor integrated in the motor is to be able to stop the VLT frequency converter in case of motor overtemperature. The cut-out value is 3 kohm.  
If a motor features a Klixon thermal switch instead, this can also be connected to the input. If motors run in parallel, the thermistors/thermal switches can be connected in series (total resistance < 3 kohm).  
Parameter 117 *Motor thermal protection* must be programmed for *Thermal warning* [1] or *Thermistor trip* [2], and the thermistor must be inserted between terminal 53 or 54 (analogue voltage input) and terminal 50 (+10 V supply).



★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port



## VLT® 6000 HVAC

**309 Terminal 53, min. scaling****(AI 53 SCALE LOW)****Value:**

0.0 - 10.0 V

★ 0.0 V

**Function:**

This parameter is used for setting the signal value that has to correspond to the minimum reference or the minimum feedback, parameter 204 *Minimum reference*,  $Ref_{MIN}$ /413 *Minimum feedback*,  $FB_{MIN}$ . See *Reference handling* or *Feedback handling*.

**Description of choice:**

Set the required voltage value.

For reasons of accuracy, voltage losses in long signal lines can be compensated for.

If the time-out function is to be applied (parameters 317 *Time out* and 318 *Function after time out*), the value must be set to > 1 V.

**310 Terminal 53, max. scaling****(AI 53 SCALE HIGH)****Value:**

0.0 - 10.0 V

★ 10.0 V

**Function:**

This parameter is used for setting the signal value that has to correspond to the maximum reference value or the maximum feedback, parameter 205 *Maksimum reference*,  $Ref_{MAX}$ /414 *Maximum feedback*,  $FB_{MAX}$ . See *Reference handling* or *Feedback handling*.

**Description of choice:**

Set the required voltage value.

For reasons of accuracy, voltage losses in long signal lines can be compensated for.

**311 Terminal 54, analogue input voltage****(AI [V] 54 FUNCT.)****Value:**

See description of parameter 308. ★ No operation

**Function:**

This parameter chooses between the different functions available for the input, terminal 54. Scaling of the input signal is effected in parameter 312 *Terminal 54, min. scaling* and in parameter 313 *Terminal 54, max. scaling*.

**Description of choice:**

See description of parameter 308.

For reasons of accuracy, voltage losses in long signal lines should be compensated for.

**312 Terminal 54, min. scaling****(AI 54 SCALE LOW)****Value:**

0.0 - 10.0 V

★ 0.0 V

**Function:**

This parameter is used for setting the signal value that corresponds to the minimum reference value or the minimum feedback, parameter 204 *Minimum reference*,  $Ref_{MIN}$ /413 *Minimum feedback*,  $FB_{MIN}$ . See *Reference handling* or *Feedback handling*.

**Description of choice:**

Set the required voltage value.

For reasons of accuracy, voltage losses in long signal lines can be compensated for.

If the time-out function is to be applied (parameters 317 *Time out* and 318 *Function after time out*), the value must be set to > 1 V.

**313 Terminal 54, max. scaling****(AI 54 SCALE HIGH)****Value:**

0.0 - 10.0 V

★ 10.0 V

**Function:**

This parameter is used for setting the signal value that corresponds to the maximum reference value or the maximum feedback, parameter 205 *Maximum reference*,  $Ref_{MAX}$ /414 *Maximum feedback*,  $FB_{MAX}$ . See *Reference handling* or *Feedback handling*.

**Description of choice:**

Set the required voltage value.

For reasons of accuracy, voltage losses in long signal lines can be compensated for.

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## VLT® 6000 HVAC

**314 Terminal 60, analogue input current  
(AI [mA] 60 FUNCT.)**
**Value:**

See description of parameter 308. ★ Reference

**Function:**

This parameter allows a choice between the different functions available for the input, terminal 60.

Scaling of the input signal is effected in parameter 315 *Terminal 60, min. scaling* and in parameter 316 *Terminal 60, max. scaling*.

**Description of choice:**

See description of parameter 308 *Terminal 53, analogue input voltage*.

**315 Terminal 60, min. scaling  
(AI 60 SCALE LOW)**
**Value:**

0.0 - 20.0 mA ★ 4.0 mA

**Function:**

This parameter determines the signal value that corresponds to the minimum reference or the minimum feedback, parameter 204 *Minimum reference*,  $Ref_{MIN}$ /413 *Minimum feedback*,  $FB_{MIN}$ . See *Reference handling* or *Feedback handling*.

**Description of choice:**

Set the required current value.

If the time-out function is to be used (parameters 317 *Time out* and 318 *Function after time out*), the value must be set to > 2 mA.

**316 Terminal 60, max. scaling  
(AI 60 SCALE HIGH)**
**Value:**

0.0 - 20.0 mA ★ 20.0 mA

**Function:**

This parameter determines the signal value that corresponds to the maximum reference value, parameter 205 *Maximum reference value*,  $Ref_{MAX}$ . See *Reference handling* or *Feedback handling*.

**Description of choice:**

Set the desired current value.

**317 Time out  
(LIVE ZERO TIME)**
**Value:**

1 - 99 sec. ★ 10 sec.

**Function:**

If the signal value of the reference or feedback signal connected to one of the input terminals 53, 54 or 60 drops to below 50% of the minimum scaling during a period longer than the preset time, the function selected in parameter 318 *Function after time out* will be activated.

This function will only be active if, in parameter 309 or 312, a value has been selected for *terminals 53 and 54, min. scaling* that exceeds 1 V, or if, in parameter 315 *Terminal 60, min. scaling*, a value has been selected that exceeds 2 mA.

**Description of choice:**

Set the desired time.

**318 Function after time out  
(LIVE ZERO FUNCT.)**
**Value:**

- |  |     |
|--|-----|
| ★ Off (NO FUNCTION)                              | [0] |
| Freeze output frequency<br>(FREEZE OUTPUT FREQ.) | [1] |
| Stop (STOP)                                      | [2] |
| Jog (JOG FREQUENCY)                              | [3] |
| Max. output frequency (MAX FREQUENCY)            | [4] |
| Stop and trip (STOP AND TRIP)                    | [5] |

**Function:**

This is where to select the function to be activated after the end of the time-out period (parameter 317 *Time out*).

If a time-out function occurs at the same time as a bus time-out function (parameter 556 *Bus time interval function*), the time-out function in parameter 318 will be activated.

**Description of choice:**

The output frequency of the VLT frequency converter can be:

- frozen at the present value [1]
- overruled to stop [2]
- overruled to jog frequency [3]
- overruled to max. output frequency [4]
- overruled to stop with subsequent trip [5].

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port



## VLT® 6000 HVAC

## ■ Analogue/digital outputs

The two analogue/digital outputs (terminals 42 and 45) can be programmed to show the present status or a process value such as  $0 - f_{MAX}$ .

If the VLT frequency converter is used as a digital output, it gives the present status by means of 0 or 24 V DC.

If the analogue output is used for giving a process value, there is a choice of three types of output signal:

0-20 mA, 4-20 mA or 0-32000 pulses (depending on the value set in parameter 322 *Terminal 45, output, pulse scaling*).

If the output is used as a voltage output (0-10 V), a pull-down resistor of 500  $\Omega$  should be fitted to terminal 39 (common for analogue/digital outputs). If the output is used as a current output, the resulting impedance of the connected equipment should not exceed 500  $\Omega$ .

| Analogue/digital outputs   | terminal no. | 42     | 45     |
|--|--------------|--------|--------|
|  | parameter    | 319    | 321    |
| Value:   |              |        |        |
| No function (NO FUNCTION)  |              | [0]    | [0]    |
| Drive ready (UN. READY)  |              | [1]    | [1]    |
| Standby (STAND BY)   |              | [2]    | [2]    |
| Running (RUNNING)  |              | [3]    | [3]    |
| Running at ref. value (RUNNING AT REFERENCE)   |              | [4]    | [4]    |
| Running, no warning (RUNNING NO WARNING)   |              | [5]    | [5]    |
| Local reference active (DRIVE IN LOCAL REF.)   |              | [6]    | [6]    |
| Remote references active (DRIVE IN REMOTE REF.)  |              | [7]    | [7]    |
| Alarm (ALARM)  |              | [8]    | [8]    |
| Alarm or warning (ALARM OR WARNING)  |              | [9]    | [9]    |
| No alarm (NO ALARM)  |              | [10]   | [10]   |
| Current limit (CURRENT LIMIT)  |              | [11]   | [11]   |
| Safety interlock (SAFETY INTERLOCK)  |              | [12]   | [12]   |
| Start command active (START SIGNAL APPLIED)  |              | [13]   | [13]   |
| Reversing (RUNNING IN REVERSE)   |              | [14]   | [14]   |
| Thermal warning (THERMAL WARNING)  |              | [15]   | [15]   |
| Hand mode active (DRIVE IN HAND MODE)  |              | [16]   | [16]   |
| Auto mode active (DRIVE IN AUTO MODE)  |              | [17]   | [17]   |
| Sleep mode (SLEEP MODE)  |              | [18]   | [18]   |
| Output frequency lower than $f_{LOW}$ parameter 223 (F OUT < F LOW)                                      |              | [19]   | [19]   |
| Output frequency higher than $f_{HIGH}$ parameter 223 (F OUT > F HIGH)                                   |              | [20]   | [20]   |
| Out of frequency range (FREQ. RANGE WARN.)   |              | [21]   | [21]   |
| Output current lower than $I_{LOW}$ parameter 221 (I OUT < I LOW)  |              | [22]   | [22]   |
| Output current higher than $I_{HIGH}$ parameter 222 (I OUT > I HIGH)                                     |              | [23]   | [23]   |
| Out of current range (CURRENT RANGE WARN.)   |              | [24]   | [24]   |
| Out of feedback range (FEEDBACK RANGE WARN.)   |              | [25]   | [25]   |
| Out of reference range (REFERENCE RANGE WARN.)   |              | [26]   | [26]   |
| Relay 123 (RELAY 123)  |              | [27]   | [27]   |
| Mains imbalance (MAINS IMBALANCE)  |              | [28]   | [28]   |
| Output frequency, $0 - f_{MAX} \Rightarrow 0-20$ mA (OUT. FREQ. 0-20 mA)                                 |              | [29]   | ★ [29] |
| Output frequency, $0 - f_{MAX} \Rightarrow 4-20$ mA (OUT. FREQ. 4-20 mA)                                 |              | [30]   | [30]   |
| Output frequency (pulse sequence), $0 - f_{MAX} \Rightarrow 0-32000$ p (OUT. FREQ. PULSE)                |              | [31]   | [31]   |
| External reference, $Ref_{MIN} - Ref_{MAX} \Rightarrow 0-20$ mA (EXT. REF. 0-20 mA)                      |              | [32]   | [32]   |
| External reference, $Ref_{MIN} - Ref_{MAX} \Rightarrow 4-20$ mA (EXTERNAL REF. 4-20 mA)                  |              | [33]   | [33]   |
| External reference (pulse sequence), $Ref_{MIN} - Ref_{MAX} \Rightarrow 0-32000$ p (EXTERNAL REF. PULSE) |              | [34]   | [34]   |
| Feedback, $FB_{MIN} - FB_{MAX} \Rightarrow 0-20$ mA (FEEDBACK 0-20 mA)                                   |              | [35]   | [35]   |
| Feedback, $FB_{MIN} - FB_{MAX} \Rightarrow 4-20$ mA (FEEDBACK 4-20 mA)                                   |              | [36]   | [36]   |
| Feedback (pulse sequence), $FB_{MIN} - FB_{MAX} \Rightarrow 0 - 32000$ p (FEEDBACK PULSE)                |              | [37]   | [37]   |
| Output current, $0 - I_{MAX} \Rightarrow 0-20$ mA (MOTOR CUR. 0-20 mA)                                   |              | ★ [38] | [38]   |
| Output current, $0 - I_{MAX} \Rightarrow 4-20$ mA (MOTOR CUR. 4-20 mA)                                   |              | [39]   | [39]   |
| Output current (pulse sequence), $0 - I_{MAX} \Rightarrow 0 - 32000$ p (MOTOR CUR. PULSE)                |              | [40]   | [40]   |
| Output power, $0 - P_{NOM} \Rightarrow 0-20$ mA (MOTOR POWER 0-20 mA)                                    |              | [41]   | [41]   |
| Output power, $0 - P_{NOM} \Rightarrow 4-20$ mA (MOTOR POWER 4-20 mA)                                    |              | [42]   | [42]   |
| Output power (pulse sequence), $0 - P_{NOM} \Rightarrow 0 - 32000$ p (MOTOR POWER PULSE)                 |              | [43]   | [43]   |

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## VLT® 6000 HVAC

### Function:

This output can act both as a digital or an analogue output. If used as a digital output (data value [0]-[59]), a 0/24 V DC signal is transmitted; if used as an analogue output, either a 0-20 mA signal, a 4-20 mA signal or a pulse sequence of 0-32000 pulses is transmitted.

### Description of choice:

**No function.** Selected if the VLT frequency converter is not to react to signals.

**Drive ready.** The VLT frequency converter control card receives a supply voltage and the frequency converter is ready for operation.

**Stand by.** The VLT frequency converter is ready for operation, but no start command has been given. No warning.

**Running.** A start command has been given.

**Running at ref. value.** Speed according to reference.

**Running, no warning.** A start command has been given. No warning.

**Local reference active.** The output is active when the motor is controlled by means of the local reference via the control unit.

**Remote references active.** The output is active when the VLT frequency converter is controlled by means of the remote references.

**Alarm.** The output is activated by an alarm.

**Alarm or warning.** The output is activated by an alarm or a warning.

**No alarm.** The output is active when there is no alarm.

**Current limit.** The output current is greater than the value programmed in parameter 215 *Current limit*  $I_{LM}$ .

**Safety interlock.** The output is active when terminal 27 is a logic '1' and *Safety interlock* has been selected on the input.

**Start command active.** Is active when there is a start command or the output frequency is above 0.1 Hz.

**Reversing.** There is 24 V DC on the output when the motor rotates anti-clockwise. When the motor rotates clockwise, the value is 0 V DC.

**Thermal warning.** The temperature limit in either the motor, the VLT frequency converter or a thermistor connected to an analogue input has been exceeded.

**Hand mode active.** The output is active when the VLT frequency converter is in Hand mode.

**Auto mode active.** The output is active when the VLT frequency converter is in Auto mode.

**Sleep mode.** Active when the VLT frequency converter is in Sleep mode.

**Output frequency lower than  $f_{LOW}$ .** The output frequency is lower than the value set in parameter 223 *Warning: Low frequency,  $f_{LOW}$ .*

**Output frequency higher than  $f_{HIGH}$ .** The output frequency is higher than the value set in parameter 224 *Warning: High frequency,  $f_{HIGH}$ .*

**Out of frequency range.** The output frequency is outside the frequency range programmed in parameter 223 *Warning: Low frequency,  $f_{LOW}$  and 224 *Warning: High frequency,  $f_{HIGH}$ .**

**Output current lower than  $I_{LOW}$ .** The output current is lower than the value set in parameter 221 *Warning: Low current,  $I_{LOW}$ .*

**Output current higher than  $I_{HIGH}$ .** The output current is higher than the value set in parameter 222 *Warning: High current,  $I_{HIGH}$ .*

**Out of current range.** The output current is outside the range programmed in parameter 221 *Warning: Low current,  $I_{LOW}$  and 222 *Warning, High current,  $I_{HIGH}$ .**

\* = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port

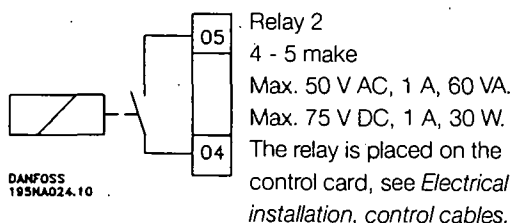
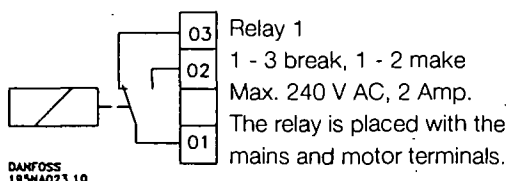




## VLT® 6000 HVAC

### Relay outputs

Relay outputs 1 and 2 can be used to give the present status or a warning.



| Relay outputs  | Relay no.<br>parameter | 1<br>323 | 2<br>326 |
|--|------------------------|----------|----------|
| Value:   |                        |          |          |
| No function (NO FUNCTION)  |                        | [0]      | [0]      |
| Ready signal (READY)   |                        | [1]      | [1]      |
| Standby (STAND BY)   |                        | [2]      | [2]      |
| Running (RUNNING)  |                        | [3]      | ★ [3]    |
| Running at ref. value (RUNNING AT REFERENCE)                           |                        | [4]      | [4]      |
| Running, no warning (RUNNING NO WARNING)                               |                        | [5]      | [5]      |
| Local reference active (DRIVE IN LOCAL REF)                            |                        | [6]      | [6]      |
| Remote references active (DRIVE IN REMOTE REF)                         |                        | [7]      | [7]      |
| Alarm (ALARM)  |                        | ★ [8]    | [8]      |
| Alarm or warning (ALARM OR WARNING)                                    |                        | [9]      | [9]      |
| No alarm (NO ALARM)  |                        | [10]     | [10]     |
| Current limit (CURRENT LIMIT)  |                        | [11]     | [11]     |
| Safety interlock (SAFETY INTERLOCK)                                    |                        | [12]     | [12]     |
| Start command active (START SIGNAL APPLIED)                            |                        | [13]     | [13]     |
| Reversing (RUNNING IN REVERSE)   |                        | [14]     | [14]     |
| Thermal warning (THERMAL WARNING)                                      |                        | [15]     | [15]     |
| Hand mode active (DRIVE IN HAND MODE)                                  |                        | [16]     | [16]     |
| Auto mode active (DRIVE IN AUTO MODE)                                  |                        | [17]     | [17]     |
| Sleep mode (SLEEP MODE)  |                        | [18]     | [18]     |
| Output frequency lower than $f_{LOW}$ parameter 223 (F OUT < F LOW)    |                        | [19]     | [19]     |
| Output frequency higher than $f_{HIGH}$ parameter 224 (F OUT > F HIGH) |                        | [20]     | [20]     |
| Out of frequency range (FREQ RANGE WARN.)                              |                        | [21]     | [21]     |
| Output current lower than $I_{LOW}$ parameter 221 (I OUT < I LOW)      |                        | [22]     | [22]     |
| Output current higher than $I_{HIGH}$ parameter 222 (I OUT > I HIGH)   |                        | [23]     | [23]     |
| Out of current range (CURRENT RANGE WARN.)                             |                        | [24]     | [24]     |
| Out of feedback range (FEEDBACK RANGE WARN.)                           |                        | [25]     | [25]     |
| Out of reference range (REFERENCE RANGE WARN.)                         |                        | [26]     | [26]     |
| Relay 123 (RELAY 123)  |                        | [27]     | [27]     |
| Mains imbalance (MAINS IMBALANCE)                                      |                        | [28]     | [28]     |
| Control word 11/12 (CONTROL WORD 11/12)                                |                        | [29]     | [29]     |

#### Description of choice:

See description of [0] - [28] in *Analogue/digital outputs*.

**Control word bit 11/12**, relay 1 and relay 2 can be activated via the serial communication. Bit 11 activates relay 1 and bit 12 activates relay 2.

If the parameter 556 *Bus time interval function* becomes active, relay 1 and relay 2 will become cut off if they are activated via the serial communication. See paragraph *Serial communication* in the Design Guide.

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port



## VLT® 6000 HVAC

**323 Relay 1, output function**  
**(RELAY1 FUNCTION)**
**Function:**

This output activates a relay switch.  
 Relay switch 01 can be used for bringing status and warnings. The relay is activated when the conditions for the relevant data values have been fulfilled.  
 Activation/deactivation can be programmed in parameter 324 *Relay 1, ON delay* and parameter 325 *Relay 1, OFF delay*.  
 See *General technical data*.

**Description of choice:**

See data choice and connections in *Relay outputs*.

**324 Relay 01, ON delay**  
**(RELAY1 ON DELAY)**
**Value:**

0 - 600 sec. ★ 0 sec.

**Function:**

This parameter allows a delay of the cut-in time of relay 1 (terminals 1-2).

**Description of choice:**

Enter the desired value.

**325 Relay 01, OFF delay**  
**(RELAY1 OFF DELAY)**
**Value:**

0 - 600 sec. ★ 0 sec.

**Function:**

This parameter makes it possible to delay the cut-out time of relay 01 (terminals 1-2).

**Description of choice:**

Enter the desired value.

**326 Relay 2, output function**  
**(RELAY2 FUNCTION)**
**Value:**

See functions of relay 2 on previous page.

**Function:**

This output activates a relay switch.  
 Relay switch 2 can be used for bringing status and warnings. The relay is activated when the conditions for the relevant data values have been fulfilled.  
 See *General technical data*.

**Description of choice:**

See data choice and connections in *Relay outputs*.

**327 Pulse reference, max. frequency**  
**(PULSE REF. MAX)**
**Value:**

100 - 65000 Hz at terminal 29 ★ 5000 Hz  
 100 - 5000 Hz at terminal 17

**Function:**

This parameter is used to set the pulse value that must correspond to the maximum reference, parameter 205 *Maximum reference, Ref<sub>MAX</sub>*.  
 The pulse reference signal can be connected via terminal 17 or 29.

**Description of choice:**

Set the required maximum pulse reference.

**328 Pulse feedback, max. frequency**  
**(PULSE FDBK MAX.)**
**Value:**

100 - 65000 Hz at terminal 33 ★ 25000 Hz

**Function:**

This is where the pulse value that must correspond to the maximum feedback value is set. The pulse feedback signal is connected via terminal 33.

**Description of choice:**

Set the desired feedback value.

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port

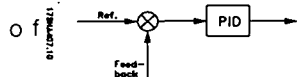
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## VLT® 6000 HVAC

## ■ Application functions 400-427

In



this parameter group, the special functions the VLT frequency converter are set up, e.g. PID regulation,

setting of the feedback range and the Setup of the Sleep mode function.

Additionally, this parameter group includes:

- Reset function.
- Flying start.
- Option of interference reduction method.
- Setup of any function upon loss of load, e.g. because of a damaged V-belt.
- Setting of switching frequency.
- Selection of process units.

**400 Reset function (RESET FUNCTION)**

Value:

- |   |     |
|---|-----|
| ★ Manual reset (MANUAL RESET)                 | [0] |
| Automatic reset x 1 (AUTOMATIC X 1)           | [1] |
| Automatic reset x 2 (AUTOMATIC X 2)           | [2] |
| Automatic reset x 3 (AUTOMATIC X 3)           | [3] |
| Automatic reset x 4 (AUTOMATIC X 4)           | [4] |
| Automatic reset x 5 (AUTOMATIC X 5)           | [5] |
| Automatic reset x 10 (AUTOMATIC X 10)         | [6] |
| Automatic reset x 15 (AUTOMATIC X 15)         | [7] |
| Automatic reset x 20 (AUTOMATIC X 20)         | [8] |
| Infinite automatic reset (INFINITE AUTOMATIC) | [9] |

**Function:**

This parameter allows a choice of whether to reset and restart manually after a trip, or whether the VLT frequency converter is to be reset and restarted automatically. In addition, there is a choice of the number of times the unit is to attempt a restart. The time between each reset attempt is set in parameter 401, *Automatic restart time*.

**Description of choice:**

If *Manual reset* [0] is selected, resetting must be effected via the "Reset" key or via a digital input. If the VLT frequency converter is to carry out an automatic reset and restart after a trip, select data value [1]-[9].



The motor may start without warning.

**401 Automatic restart time****(AUTORESTART TIME)**

Value:

0 - 600 sec.

★ 10 sec.

**Function:**

This parameter allows setting of the time from tripping until the automatic reset function begins.

It is assumed that automatic reset has been selected in parameter 400 *Reset function*.

**Description of choice:**

Set the desired time.

**402 Flying start****(FLYING START)**

Value:

- |   |     |
|---|-----|
| Disable (DISABLE)                       | [0] |
| ★ Enable (ENABLE)                       | [1] |
| DC brake and start (DC BRAKE AND START) | [3] |

**Function:**

This function makes it possible for the VLT frequency converter to 'catch' a spinning motor, which - e.g. because of a mains failure - is no longer controlled by the VLT frequency converter.

This function is activated whenever a start command is active.

For the VLT frequency converter to be able to catch the spinning motor, the motor speed must be lower than the frequency that corresponds to the frequency in parameter 202 *Output frequency high limit,  $f_{max}$* .

**Description of choice:**

Select *Disable* [0] if this function is not required. Select *Enable* [1] if the VLT frequency converter is to be able to 'catch' and control a spinning motor. Select *DC brake and start* [2] if the VLT frequency converter is to brake the motor by means of the DC brake first, and then start. It is assumed that parameters 114-116 *DC braking* are enabled. In the case of a substantial 'windmilling' effect (spinning motor), the VLT frequency converter is not able to 'catch' a spinning motor unless *DC brake and start* has been selected.



When parameter 402, *Flying Start*, is enabled, motor may turn in forward and backward directions a few revolutions even with no speed reference applied.

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port



## VLT® 6000 HVAC

### ■ Sleep mode

Sleep mode makes it possible to stop the motor when it is running at low speed and thus has almost no load. If consumption in the system goes back up, the VLT frequency converter will start the motor and supply the power required.



#### NB!

Energy can be saved with this function, since the motor is only in operation when the system needs it.

Sleep mode is not active if *Local reference* or *Jog* has been selected

The function is active in both *Open loop* and *Closed loop*.

In parameter 403 *Sleep mode timer*, the Sleep mode is activated. In parameter 403 *Sleep mode timer*, a timer is set that determines for how long the output frequency can be lower than the frequency set in parameter 404 *Sleep frequency*. When the timer runs out, the VLT frequency converter will ramp down the motor to stop via parameter 207 *Ramp-down time*. If the output frequency rises above the frequency set in parameter 404 *Sleep frequency*, the timer is reset.

While the VLT frequency converter has stopped the motor in sleep mode, a theoretical output frequency is calculated on the basis of the reference signal. When the theoretical output frequency rises above the frequency in parameter 405 *Wake up frequency*, the VLT frequency converter will restart the motor and the output frequency will ramp up to the reference.

In systems with constant pressure regulation, it is advantageous to provide extra pressure to the system before the VLT frequency converter stops the motor. This extends the time during which the VLT frequency converter has stopped the motor and helps to avoid frequent starting and stopping of the motor, e.g. in the case of system leaks.

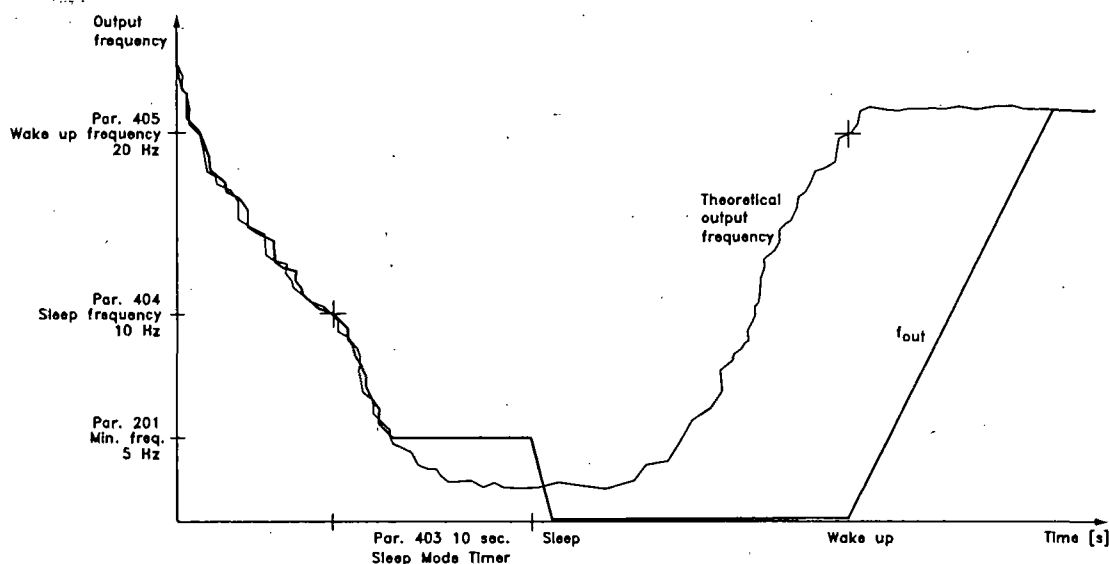
If 25% more pressure is required before the VLT frequency converter stops the motor, parameter 406 *Boost setpoint* is set to 125%.

Parameter 406 *Boost setpoint* is only active in *Closed loop*.



#### NB!

In highly dynamic pumping processes, it is recommended to switch off the *Flying Start* function (parameter 402).



Programming

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port

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## VLT® 6000 HVAC

**403 Sleep mode timer****(SLEEP MODE TIMER)****Value:**

0 - 300 sec. (301 sec. = OFF)

★ OFF

**Function:**

This parameter enables the VLT frequency converter to stop the motor if the load on the motor is minimal. The timer in parameter 403 *Sleep mode timer* starts when the output frequency drops below the frequency set in parameter 404 *Sleep frequency*. When the time set in the timer has expired, the VLT frequency converter will turn off the motor. The VLT frequency converter will restart the motor, when the theoretical output frequency exceeds the frequency in parameter 405 *Wake up frequency*.

**Description of choice:**

Select OFF if this function is not wanted.  
Set the threshold value that is to activate Sleep mode after the output frequency has fallen below parameter 404 *Sleep frequency*.

**404 Sleep frequency (SLEEP FREQUENCY)****Value:**000,0 - par. 405 *Wake up frequency*

★ 0.0 Hz

**Function:**

When the output frequency falls below the preset value, the timer will start the time count set in parameter 403 *Sleep mode*. The present output frequency will follow the theoretical output frequency until  $f_{\min}$  is reached.

**Description of choice:**

Set the required frequency.

**405 Wake up frequency (WAKEUP FREQUENCY)****Value:**Par 404 *Sleep frequency* - par. 202  $f_{\max}$  ★ 50 Hz**Function:**

When the theoretical output frequency exceeds the preset value, the VLT frequency converter restarts the motor.

**Description of choice:**

Set the required frequency.

**406 Boost setpoint (BOOST SETPOINT)****Value:**

0 - 200 %

★ 100 % of setpoint

**Function:**

This function can only be used if *Closed loop* has been selected in parameter 100.

In systems with constant pressure regulation, it is advantageous to increase the pressure in the system before the VLT frequency converter stops the motor. This extends the time during which the VLT frequency converter stops the motor and helps to avoid frequent starting and stopping of the motor, e.g. in the case of leaks in the water supply system.

**Description of choice:**

Set the required *Boost setpoint* as a percentage of the resulting reference under normal operation. 100% corresponds to the reference without boost (supplement).

**407 Switching frequency****(SWITCHING FREQ.)****Value:**

Depends on the size of the unit.

**Function:**

The preset value determines the switching frequency of the inverter, provided *Fixed switching frequency* [1] has been selected in parameter 408 *Interference reduction method*. If the switching frequency is changed, this may help to minimise possible acoustic noise from the motor.

**NB!**

The output frequency of the VLT frequency converter can never assume a value higher than 1/10 of the switching frequency.

**Description of choice:**

When the motor is running, the switching frequency is adjusted in parameter 407 *Switching frequency*, until the frequency has been achieved at which the motor is as quiet as possible.

**NB!**

Switching frequencies higher than 4.5 kHz implement automatic derating of the maximum output of the VLT frequency converter. See *Derating of high switching frequency* in this manual.

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port



## VLT® 6000 HVAC

**408 Interference reduction method  
(NOISE REDUCTION)**

Value:

- |  |     |
|--|-----|
| ★ ASFM (ASFM)  | [0] |
| Fixed switching frequency<br>(FIXED SWITCHING FREQ.) | [1] |
| LC filter fitted (LC-FILTER CONNECTED)               | [2] |

Function:

Used to select different methods for reducing the amount of acoustic interference from the motor.

Description of choice:

*ASFM* [0] guarantees that the maximum switching frequency, determined by parameter 407, is used at all times without derating of the VLT frequency converter. This is done by monitoring the load.

*Fixed switching frequency* [1] makes it possible to set a fixed high/low switching frequency. This can generate the best result, as the switching frequency can be set to lie outside the motor interference or in a less irritating area. The switching frequency is adjusted in parameter 407 *Switching frequency*. *LC-filter fitted* [2] is to be used if an LC-filter is fitted between the VLT frequency converter and the motor, as the VLT frequency converter will otherwise not be able to protect the LC-filter.

**409 Function in case of no load  
(FUNCT. LOW CURR.)**

Value:

- |                     |     |
|---------------------|-----|
| Trip (TRIP)         | [0] |
| ★ Warning (WARNING) | [1] |

Function:

This parameter can be used e.g. for monitoring the V-belt of a fan to make sure it has not snapped. This function is activated when the output current goes below parameter 221 *Warning: Low current*.

Description of choice:

In the case of a *Trip* [1], the VLT frequency converter will stop the motor.

If *Warning* [2] is selected, the VLT frequency converter will give a warning if the output current drops below the threshold value in parameter 221 *Warning: Low current,  $I_{Low}$* .

**410 Function at mains failure  
(MAINS FAILURE)**

Value:

- |  |     |
|--|-----|
| ★ Trip (TRIP)                                  | [0] |
| Autoderate & warning<br>(AUTODERATE & WARNING) | [1] |
| Warning (WARNING)                              | [2] |

Function:

Select the function which is to be activated if the mains imbalance becomes too high or if a phase is missing.

Description:

At *Trip* [0] the VLT frequency converter will stop the motor within a few seconds (depending on drive size).

If *Autoderate & warning* [1] is selected, the drive will export a warning and reduce the output current to 30 % of  $I_{VTN}$  to maintain operation.

At *Warning* [2] only a warning will be exported when a mains failure occurs, but in severe cases, other extreme conditions might result in a trip.

**NB!**

If *Warning* has been selected, the life expectancy of the drive will be reduced when the mains failure persists.

**NB!**

At phase loss the cooling fans of IP 54 drives cannot be powered and the VLT might trip on overheating. This applies to drive types VLT 6042-6062, 200-240 V and 6075-6550, 380-460 V.

**411 Function at overtemperature  
(FUNCT. OVERTEMP)**

Value:

- |  |     |
|--|-----|
| ★ Trip (TRIP)                                  | [0] |
| Autoderate & warning<br>(AUTODERATE & WARNING) | [1] |

Function:

Select the function which is to be activated when the VLT is exposed to an overtemperature condition.

Description:

At *Trip* [0] the VLT frequency converter will stop the motor and export an alarm.

At *Autoderate & warning* [1] the VLT will first reduce the switching frequency to minimize internal losses. If the overtemperature condition persists, the VLT will reduce the output current until the heat sink temperature stabilizes. When the function is active, a warning will be exported.

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**Programming**



## VLT® 6000 HVAC

**412 Trip delay overcurrent,  $I_{LM}$**   
**(OVERLOAD DELAY)**

Value:

0 - 60 sec. (61=OFF)

★ 60 sec.

**Function:**

When the frequency converter registers that the output current has reached the current limit  $I_{LM}$  (parameter 215 *Current limit*) and stays there for the duration selected, a cut-out will be performed.

**Description of choice:**

Select for how long the frequency converter is to be able to keep up with the output current at the current limit  $I_{LM}$  before it cuts out.

In OFF mode, parameter 412 *Trip delay overcurrent*,  $I_{LM}$  is inactive, i.e. cut-outs are not performed.

**■ Feedback signals in open loop**

Normally, feedback signals and thus feedback parameters are only used in *Closed loop* operation; in VLT 6000 HVAC units, however, the feedback parameters are also active in *Open loop* operation. In *Open loop mode*, the feedback parameters can be used to show a process value in the display. If the present temperature is to be displayed, the temperature range can be scaled in parameters 413/414 *Minimum/Maximum feedback*, and the unit (°C, °F) in parameter 415 *Process units*.

**413 Minimum feedback,  $FB_{MIN}$**   
**(MIN. FEEDBACK)**

Value:

-999,999.999 -  $FB_{MAX}$ 

★ 0.000

**Function:**

Parameters 413 *Minimum feedback*,  $FB_{MIN}$  and 414 *Maximum feedback*,  $FB_{MAX}$  are used to scale the display indication, thereby ensuring that it shows the feedback signal in a process unit proportionally to the signal at the input.

**Description of choice:**

Set the value to be shown on the display at minimum feedback signal value (par. 309, 312, 315 *Min. scaling*) on the selected feedback input (parameters 308/311/314 *Analogue inputs*).

**414 Maximum feedback,  $FB_{MAX}$**   
**(MAX. FEEDBACK)**

Value:

 $FB_{MIN}$  - 999,999.999

★ 100.000

**Function:**

See the description of par. 413 *Minimum feedback*,  $FB_{MIN}$ .

**Description of choice:**

Set the value to be shown on the display when maximum feedback (par. 310, 313, 316 *Max. scaling*) has been achieved at the selected feedback input (parameters 308/311/314 *Analogue inputs*).

**415 Units relating to closed loop**  
**(REF. / FDBK. UNIT)**

Value:

|         |      |         |      |
|---------|------|---------|------|
| No unit | [0]  | °C      | [21] |
| ★ %     | [1]  | GPM     | [22] |
| rpm     | [2]  | gal/s   | [23] |
| ppm     | [3]  | gal/min | [24] |
| pulse/s | [4]  | gal/h   | [25] |
| l/s     | [5]  | lb/s    | [26] |
| l/min   | [6]  | lb/min  | [27] |
| l/h     | [7]  | lb/h    | [28] |
| kg/s    | [8]  | CFM     | [29] |
| kg/min  | [9]  | ft³/s   | [30] |
| kg/h    | [10] | ft³/min | [31] |
| m³/s    | [11] | ft³/h   | [32] |
| m³/min  | [12] | ft/s    | [33] |
| m³/h    | [13] | in wg   | [34] |
| m/s     | [14] | ft wg   | [35] |
| mbar    | [15] | PSI     | [36] |
| bar     | [16] | lb/in²  | [37] |
| Pa      | [17] | HP      | [38] |
| kPa     | [18] | °F      | [39] |
| mV/S    | [19] |         |      |
| kW      | [20] |         |      |

**Function:**

Selection of unit to be shown on the display. This unit will be used if *Reference [unit]* [2] or *Feedback [unit]* [3] has been selected in one of the parameters 007-010, as well as in the Display mode. In *Closed loop*, the unit is also used as a unit for *Minimum/Maximum reference* and *Minimum/Maximum feedback*, as well as *Setpoint 1* and *Setpoint 2*.

**Description of choice:**

Select the required unit for the reference/feedback signal.

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port



## VLT® 6000 HVAC

### ■ PID for process control

The PID controller maintains a constant process condition (pressure, temperature, flow, etc.) and adjusts motor speed on the basis of a reference/setpoint and the feedback signal.

A transmitter supplies the PID controller with a feedback signal from the process to indicate its actual state. The feedback signal varies with the process load.

This means that deviations occur between the reference/setpoint and the actual process state. Such deviations are evened out by the PID regulator, in that it regulates the output frequency up or down in relation to the deviation between the reference/setpoint and the feedback signal.

The integral PID regulator in VLT 6000 HVAC units has been optimised for use in HVAC applications.

This means that a number of specialised functions are available in VLT 6000 HVAC units.

Formerly, it was necessary to get a BMS (Building Management System) to handle these special functions by installing extra I/O modules and by programming the system.

Using the VLT 6000 HVAC, there is no need for extra modules to be installed. For example, only one required reference/setpoint and the handling of feedback need to be programmed.

There is in-built a option for connecting two feedback signals to the system, making two-zone regulation possible.

Correction for voltage losses in long signal cables can be carried out when using a transmitter with a voltage output. This is done in parameter group 300 *Min./Max. scaling*.

#### Feedback

The feedback signal must be connected to a terminal on the VLT frequency converter. Use the list below to decide which terminal to use and which parameters to program.

| <u>Feedback type</u> | <u>Terminal</u> | <u>Parameters</u>                 |
|----------------------|-----------------|-----------------------------------|
| Pulse                | 33              | 307                               |
| Voltage              | 53, 54          | 308, 309, 310 or<br>311, 312, 313 |
| Current              | 60              | 314, 315, 316                     |
| Bus feedback 1       | 68+69           | 535                               |
| Bus feedback 2       | 68+69           | 536                               |

Please note that the feedback value in parameter 535/536 Bus feedback 1 and 2 can only be set via serial communication (not via the control unit).

Furthermore, the minimum and maximum feedback (parameters 413 and 414) must be set to a value in the process unit that corresponds to the minimum and maximum scaling value for signals connected to the terminal. The process unit is selected in parameter 415 *Process units*.

#### Reference

In parameter 205 *Maximum reference*,  $Ref_{MAX}$ , a maximum reference that scales the sum of all references, i.e. the resulting reference, can be set.

The *minimum reference* in parameter 204 indicates the smallest value that the resulting reference can assume.

The reference range cannot exceed the feedback range.

If *Preset references* are required, set these in parameters 211 to 214 *Preset reference*. See *Reference type*.

See also *Reference handling*.

If a current signal is used as a feedback signal, voltage can be used as analogue reference. Use the list below to decide which terminal to use and which parameters to program.

| <u>Reference type</u> | <u>Terminal</u> | <u>Parameters</u>                 |
|-----------------------|-----------------|-----------------------------------|
| Pulse                 | 17 or 29        | 301 or 305                        |
| Voltage               | 53 or 54        | 308, 309, 310 or<br>311, 312, 313 |
| Current               | 60              | 314, 315, 316                     |
| Preset reference      | 214             | 211, 212, 213,                    |
| Setpoints             |                 | 418, 419                          |
| Bus reference         | 68+69           |                                   |

Please note that the bus reference can only be set via serial communication.



#### **NB!**

Terminals that are not in use may preferably be set to *No function* [0].

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port



## VLT® 6000 HVAC

### ■ PID for process regulation, cont.

#### Inverse regulation

Normal regulation means that the motor speed increases when the reference/setpoint is higher than the feedback signal. If there is a need for inverse regulation, in which the speed is reduced when the feedback signal is lower than the reference/setpoint, Inverse must be programmed in parameter 420 *PID normal/inverse control*.

#### Anti Windup

The process regulator is factory preset with an active anti-windup function. This function ensures that when either a frequency limit, current limit or voltage limit is reached, the integrator will be initialised for a frequency that corresponds to the present output frequency. This avoids integration on a deviation between the reference/setpoint and the actual state of the process, the controller of which is not possible by means of a speed change. This function can be disabled in parameter 421 *PID anti windup*.

#### Start-up conditions

In some applications, optimum setting of the process regulator will mean that it takes an excessive time for the required process state to be reached. In such applications it might be an advantage to fix an output frequency to which the VLT frequency converter is to bring the motor before the process regulator is activated. This is done by programming a *PID start-up frequency* in parameter 422.

#### Differentiator gain limit

If there are very quick variations in a given application with respect to the reference/setpoint signal or the feedback signal, the deviation between reference/setpoint and the actual process state will quickly change. The differentiator may thus become too dominant. This is because it reacts to the deviation between the reference/setpoint and the actual process state. The quicker the deviation changes, the stronger the resulting differentiator frequency contribution. The differentiator frequency contribution can thus be limited to allow the setting of a reasonable differentiation time for slow changes and a suitable frequency contribution for quick changes. This is done in parameter 426, *PID Differentiator gain limit*.

#### Lowpass filter

If there are ripple currents/voltages on the feedback signal, these can be dampened by means of a built-in lowpass filter. Set a suitable lowpass filter time constant. This time constant represents the limit frequency of the ripples occurring on the feedback signal.

If the lowpass filter has been set to 0.1s, the limit frequency will be 10 RAD/sec., corresponding to  $(10/2 \times \pi) = 1.6$  Hz. This means that all currents/voltages that vary by more than 1.6 oscillations per second will be removed by the filter.

In other words, regulation will only be carried out on a feedback signal that varies by a frequency of less than 1.6 Hz. Choose a suitable time constant in parameter 427, *PID Lowpass filter time*.

#### Optimisation of the process regulator

The basic settings have now been made; all that remains to be done is to optimise the proportional gain, the integration time and the differentiation time (parameters 423, 424 and 425). In most processes, this can be done by following the guidelines given below.

1. Start the motor.
2. Set parameter 423 *PID proportional gain* to 0.3 and increase it until the process shows that the feedback signal is unstable. Then reduce the value until the feedback signal has stabilised. Now lower the proportional gain by 40-60%.
3. Set parameter 424 *PID integration time* to 20 s and reduce the value until the process shows that the feedback signal is unstable. Increase the integration time until the feedback signal stabilises, followed by an increase of 15-50%.
4. Parameter 425 *PID differentiation time* is only used in very fast-acting systems. The typical value is 1/4 of the value set in parameter 424 *PID Integration time*. The differentiator should only be used when the setting of the proportional gain and the integration time have been fully optimised.



#### **NB!**

If necessary, start/stop can be activated a number of times in order to provoke an unstable feedback signal.

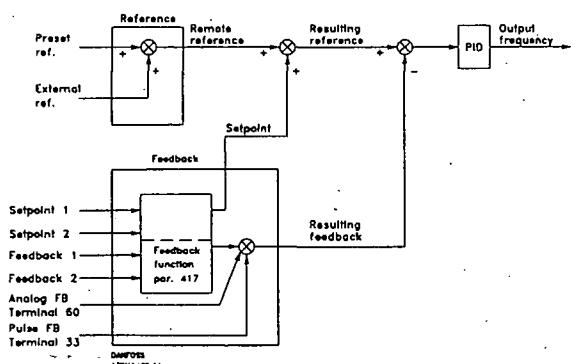
★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port



## VLT® 6000 HVAC

### ■ PID overview

The block diagram below shows reference and setpoint in relation to the feedback signal.



As can be seen, the remote reference is totalled with setpoint 1 or setpoint 2. See also *Reference handling*. Which setpoint is to be totalled with the remote reference depends on the selection made in parameter 417 *Feedback function*.

### ■ Feedback handling

The feedback handling can be seen from the block diagram on the next page.

The block diagram shows how and by which parameters the feedback handling can be affected. Options as feedback signals are: voltage, current, pulse and bus feedback signals. In zone regulation, feedback signals must be selected as voltage inputs (terminals 53 and 54). Please note that *Feedback 1* consists of bus feedback 1 (parameter 535) totalled with the feedback signal value of terminal 53. *Feedback 2* consists of bus feedback 2 (parameter 536) totalled with the feedback signal value of terminal 54.

In addition, the VLT 6000 HVAC has an integral calculator capable of converting a pressure signal into a "linear flow" feedback signal. This function is activated in parameter 416 *Feedback conversion*.

The parameters for feedback handling are active both in closed and open loop modes. In *open loop*, the present temperature can be displayed by connecting a temperature transmitter to a feedback input. In a closed loop, there are - roughly speaking - three possibilities of using the integral PID regulator and setpoint/feedback handling:

1. 1 setpoint and 1 feedback
2. 1 setpoint and 2 feedbacks
3. 2 Setpoints and 2 feedbacks

#### 1 setpoint and 1 feedback

If only 1 setpoint and 1 feedback signal are used, parameter 418 *Setpoint 1* will be added to the remote reference. The sum of the remote reference and *Setpoint 1* becomes the resulting reference, which will then be compared with the feedback signal.

#### 1 setpoint and 2 feedbacks

Just like in the above situation, the remote reference is added to *Setpoint 1* in parameter 418. Depending on the feedback function selected in parameter 417 *Feedback function*, a calculation will be made of the feedback signal with which the sum of the references and the setpoint is to be compared. A description of the individual feedback functions is given in parameter 417 *Feedback function*.

#### 2 Setpoints and 2 feedbacks

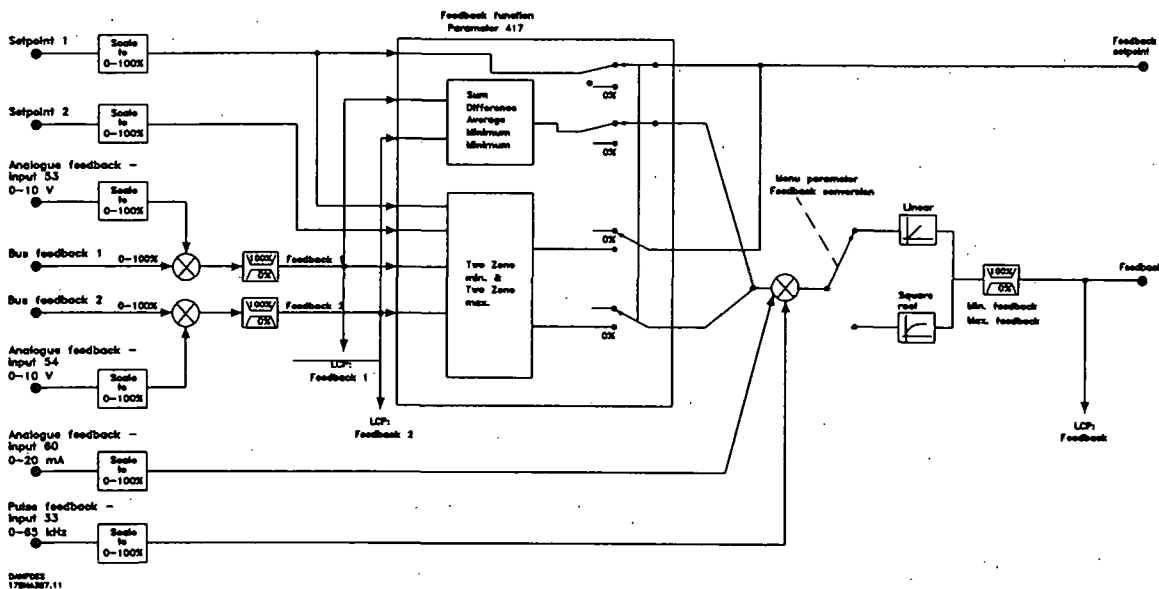
Used in 2-zone regulation, where the function selected in parameter 417 *Feedback function* calculates the setpoint to be added to the remote reference.

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port



## VLT® 6000 HVAC

## ■ Feedback handling (continued)

**416 Feedback conversion (FEEDBACK CONV)**

Value:

- ★ Linear (LINEAR) [0]  
 Square root (SQUARE ROOT) [1]

**Function:**

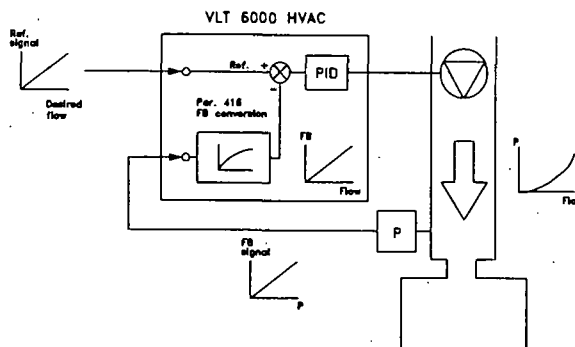
In this parameter, a function is selected which converts a connected feedback signal from the process to a feedback value that equals the square root of the connected signal.

This is used, e.g. where regulation of a flow (volume) is required on the basis of pressure as feedback signal (flow = constant  $\times \sqrt{\text{pressure}}$ ). This conversion makes it possible to set the reference in such a way that there is a linear connection between the reference and the flow required. See drawing in next column. Feedback conversion should not be used if 2-zone regulation in parameter 417 *Feedback function* has been selected.

**Description:**

If *Linear* [0] is selected, the feedback signal and the feedback value will be proportional.

If *Square root* [1] is selected, the VLT frequency converter translates the feedback signal to a squared feedback value.



★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port



## VLT® 6000 HVAC

**417 Feedback function****(2 FEEDBACK, CALC.)**

| Value:                      |     |
|-----------------------------|-----|
| Minimum (MINIMUM)           | [0] |
| ★ Maximum (MAXIMUM)         | [1] |
| Sum (SUM)                   | [2] |
| Difference (DIFFERENCE)     | [3] |
| Average (AVERAGE)           | [4] |
| 2-zone minimum (2 ZONE MIN) | [5] |
| 2-zone maximum (2 ZONE MAX) | [6] |

**Function:**

This parameter allows a choice between different calculation methods whenever two feedback signals are used.

**Description of choice:**

If *Minimum* [0] is selected, the VLT frequency converter will compare *feedback 1* with *feedback 2* and regulate on the basis of the lower feedback value.

*Feedback 1* = Sum of parameter 535 *Bus feedback 1* and the feedback signal value of terminal 53.

*Feedback 2* = Sum of parameter 536 *Bus feedback 2* and the feedback signal value of terminal 54.

If *Maximum* [1] is selected, the VLT frequency converter will compare *feedback 1* with *feedback 2* and regulate on the basis of the higher feedback value.

If *Sum* [2] is selected, the VLT frequency converter will total *feedback 1* with *feedback 2*. Please note that the remote reference will be added to *Setpoint 1*.

If *Difference* [3] is selected, the VLT frequency converter will subtract *feedback 1* from *feedback 2*.

If *Average* [4] is selected, the VLT frequency converter will calculate the average of *feedback 1* and *feedback 2*. Please note that the remote reference will be added to the *Setpoint 1*.

If *2-zone minimum* [5] is selected, the VLT frequency converter will calculate the difference between *Setpoint 1* and *feedback 1* as well as *Setpoint 2* and *feedback 2*.

After this calculation, the VLT frequency converter will use the larger difference. A positive difference, i.e. a setpoint higher than the feedback, is always larger than a negative difference.

If the difference between *Setpoint 1* and *feedback 1* is the larger of the two, parameter 418 *Setpoint 1* will be added to the remote reference.

If the difference between *Setpoint 2* and *feedback 2* is

the larger of the two, the remote reference will be added to the parameter 419 *Setpoint 2*.

If *2-zone maximum* [6] is selected, the VLT frequency converter will calculate the difference between *Setpoint 1* and *feedback 1* as well as *Setpoint 2* and *feedback 2*.

After the calculation, the VLT frequency converter will use the smaller difference. A negative difference, i.e. one where the setpoint is lower than the feedback, is always smaller than a positive difference.

If the difference between *Setpoint 1* and *feedback 1* is the smaller of the two, the remote reference will be added to the parameter 418 *Setpoint 1*.

If the difference between *Setpoint 2* and *feedback 2* is the smaller of the two, the remote reference will be added to parameter 419 *Setpoint 2*.

**418 Setpoint 1 (SETPOINT 1)****Value:**Ref<sub>MIN</sub> - Ref<sub>MAX</sub>

★ 0.000

**Function:**

*Setpoint 1* is used in closed loop as the reference to compare the feedback values with. See description of parameter 417 *Feedback function*.

The setpoint can be offset with digital, analog or bus references, see *Reference handling*.

Used in *Closed loop* [1] parameter 100 *Configuration*.

**Description of choice:**

Set the required value. The process unit is selected in parameter 415 *Process units*.

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**419 Setpoint 2 (SETPOINT 2)****Value:**Ref<sub>MIN</sub> - Ref<sub>MAX</sub>

★ 0.000

**Function:**

Setpoint 2 is used in closed loop as the reference to compare the feedback values with. See description of parameter 417 *Feedbackfunction*.

The setpoint can be offset with digital, analog or bus signals, see reference handling.

Used in *Closed loop* [1] parameter 100 *Configuration* and only if 2-zone minimum/maximum is selected in parameter 417 *Feedbackfunction*.

**Description of choice:**

Set the required value. The process unit is selected in parameter 415 *Process units*.

**420 PID normal/inverse control  
(PID NOR/INV. CTRL)****Value:**

★ Normal (NORMAL)

[0]

Inverse (INVERSE)

[1]

**Function:**

It is possible to choose whether the process regulator is to increase/reduce the output frequency if there is a deviation between reference/setpoint and the actual process state.

Used in *Closed loop* [1] (parameter 100).

**Description of choice:**

If the VLT frequency converter is to reduce the output frequency in case the feedback signal increases, select *Normal* [0].

If the VLT frequency converter is to increase the output frequency in case the feedback signal increases, select *Inverse* [1].

**421 PID anti windup****(PID ANTI WINDUP)****Value:**

Off (DISABLE)

[0]

★ On (ENABLE)

[1]

**Function:**

It is possible to choose whether the process regulator is to continue regulating on a deviation even if it is not possible to increase/reduce the output frequency. Used in *Closed loop* [1] (parameter 100).

**Description of choice:**

The factory setting is *On* [1], which means that the integration link is adjusted to the actual output frequency if either the current limit, the voltage limit or the max./min. frequency has been reached. The process regulator will not be engaged again, until either the deviation is zero or its prefix has changed. Select *Off* [0] if the integrator is to continue integrating to the deviation even if it is not possible to remove the deviation by regulation.

**NB!**

If *Off* [0] is selected, it will mean that when the deviation changes its prefix, the integrator will first have to integrate down from the level obtained as a result of the former error, before any change to the output frequency occurs.

**422 PID start-up frequency****(PID START VALUE)****Value:**f<sub>MIN</sub>-f<sub>MAX</sub> (parameter 201 and 202)

★ 0 Hz

**Function:**

When the start signal comes, the VLT frequency converter will react in the form of *Open loop* [0] following the ramp. Only when the programmed start frequency has been obtained, will it change over to *Closed loop* [1]. In addition, it is possible to set a frequency that corresponds to the speed at which the process normally runs, which will enable the required process conditions to be reached sooner. Used in *Closed loop* [1] (parameter 100).

**Description of choice:**

Set the required start frequency.

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port



## VLT® 6000 HVAC

**NB!**

If the VLT frequency converter is running at the current limit before the desired start frequency is obtained, the process regulator will not be activated. For the regulator to be activated anyway, the start frequency must be lowered to the required output frequency. This can be done during operation.

**NB!**

PID start frequency is always applied in clockwise direction.

**423 PID proportional gain  
(PID PROP. GAIN)**

Value:

0.00 - 10.00

★ 0.01

**Function:**

The proportional gain indicates the number of times the deviation between the reference/setpoint and the feedback signal is to be applied.

Used in *Closed loop* [1] (parameter 100).

**Description of choice:**

Quick regulation is obtained by a high gain, but if the gain is too high, the process may become unstable.

**424 PID integration time  
(PID INTEGR.TIME)**

Value:

0.01 - 9999.00 sec. (OFF)

★ OFF

**Function:**

The integrator provides a constant change of the output frequency during constant error between the reference/setpoint and the feedback signal.

The greater the error, the quicker the integrator frequency contribution will increase. The integration time is, the time needed by the integrator to reach the same gain as the proportional gain for a given deviation.

Used in *Closed loop* [1] (parameter 100).

**Description of choice:**

Fast regulation is obtained in connection with a short integration time. However, this time

**NB!**

Some value other than OFF must be set or the PID will not function correctly.

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port

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may be too short, which means that the process may be destabilised as a result of overshoots. If the integral time is long, major deviations from the required set point may occur, since the process regulator will take a long time to regulate in relation to a given error.

**425 PID differentiation time**
**(PID DIFF.TIME)**

Value:

0.00 (OFF) - 10.00 sec.

★ OFF

**Function:**

The differentiator does not react to a constant error. It only contributes when the error changes.

The quicker the error changes, the stronger the contribution from the differentiator will be. This influence is proportional to the speed by which the deviation changes.

Used in *Closed loop* [1] (parameter 100).

**Description of choice:**

Fast regulation can be obtained by means of a long differentiation time. However, this time may be too long, which means that the process may be destabilised as a result of overshoots.

**426 PID differentiator gain limit  
(PID DIFF. GAIN)**

Value:

5.0 - 50.0

★ 5.0

**Function:**

It is possible to set a limit for the differentiator gain.

The differentiator gain will increase if there are fast changes, which is why it can be beneficial to limit this gain, thereby obtaining a pure differentiator gain at slow changes and a constant differentiator gain where quick changes to the deviation are made.

Used in *Closed loop* [1] (parameter 100).

**Description of choice:**

Select a limit to differentiator gain as required.



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**427 PID lowpass filter time  
(PID FILTER TIME)**

Value

0.01 - 10.00

★ 0.01

**Function:**

Oscillations on the feedback signal are dampened by the lowpass filter in order to reduce their impact on the process regulation. This can be an advantage e.g. if there is a lot of noise on the signal.

Used in *Closed loop* [1] (parameter 100).

**Description of choice:**

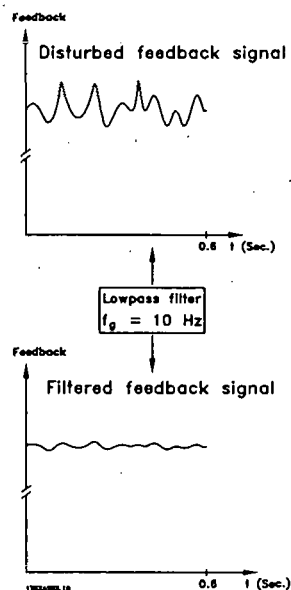
Select the desired time constant ( $\tau$ ). If a time constant ( $\tau$ ) of 0.1 s is programmed, the break frequency for the lowpass filter will be  $1/0.1 = 10 \text{ RAD/sec.}$ , corresponding to  $(10/(2 \times \pi)) = 1.6 \text{ Hz.}$

The process regulator will thus only regulate a feedback signal that varies by a frequency lower than 1.6 Hz.

If the feedback signal varies by a higher frequency than 1.6 Hz, the Process regulator will not react.

**500-566 Serial communication**

All information concerning the use of RS 485 serial interface is not included in this manual. Please contact Danfoss and ask for the VLT 6000 HVAC Design Guide.



★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port



## VLT® 6000 HVAC

### ■ Service functions 600-631

This parameter group contains functions such as operating data, data log and fault log. It also has information on the nameplate data of the VLT frequency converter.

These service functions are very useful in connection with operating and fault analysis in an installation.

### 600-605 Operating data

| Parameter No. | Description         | Display text      | Unit  | Range         |
|---------------|---------------------|-------------------|-------|---------------|
| 600           | Operating hours     | (OPERATING HOURS) | Hours | 0 - 130,000.0 |
| 601           | Hours run           | (RUNNING HOURS)   | Hours | 0 - 130,000.0 |
| 602           | kWh counter         | (KWH COUNTER)     | kWh   | -             |
| 603           | No. of cut-ins      | (POWER UP'S)      | Nos.  | 0 - 9999      |
| 604           | No. of overtemps.   | (OVER TEMP'S)     | Nos.  | 0 - 9999      |
| 605           | No. of overvoltages | (OVER VOLT'S)     | Nos.  | 0 - 9999      |

- Unit-dependent

#### Function:

These parameters can be read out via the serial communication port, as well as via the display in the parameters.

#### Description of choice:

##### Parameter 600. Operating hours:

Gives the number of hours in which the VLT frequency converter has been in operation. The value is saved every hour and when the power supply to the unit is cut off. This value cannot be reset.

##### Parameter 601 Hours run:

Gives the number of hours in which the motor has been in operation since being reset in parameter 619 *Reset of hours-run counter*. The value is saved every hour and when the power supply to the unit is cut off.

##### Parameter 602 kWh. counter:

Gives the output power of the VLT frequency converter. The calculation is based on the mean value in kWh over one hour. This value can be reset using parameter 618 *Reset of kWh counter*. Range: 0 - depends on unit.

##### Parameter 603 No. of cut-ins:

Gives the number of cut-ins of supply voltage to the VLT frequency converter.

##### Parameter 604 No. of overtemps:

Gives the number of overtemperature errors on the heat-sink of the VLT frequency converter.

##### Parameter 605 No. of overvoltages:

Gives the number of overvoltages on the intermediate circuit voltage of the VLT frequency converter. The count is only taken when Alarm 7 *Overvoltage* is active.

Programming

★ = factory setting, ( ) = display text [ ] = value for use in communication via serial communication port

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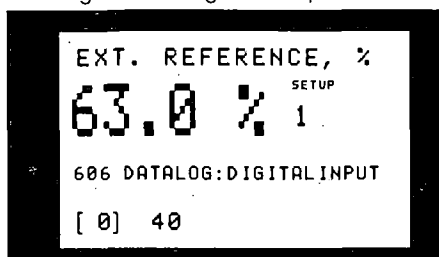
### 606 - 614 Data log

| Value:        |                       |                     |          |                            |
|---------------|-----------------------|---------------------|----------|----------------------------|
| Parameter No. | Description Data log: | Display text        | Unit     | Range                      |
| 606           | Digital input         | (LOG: DIGITAL INP)  | Decimal  | 0 - 255                    |
| 607           | Control word          | (LOG: BUS COMMAND)  | Decimal  | 0 - 65535                  |
| 608           | Status word           | (LOG: BUS STAT WD)  | Decimal  | 0 - 65535                  |
| 609           | Reference             | (LOG: REFERENCE)    | %        | 0 - 100                    |
| 610           | Feedback              | (LOG: FEEDBACK)     | Par. 414 | -999,999.999 - 999,999.999 |
| 611           | Output frequency      | (LOG: MOTOR FREQ.)  | Hz       | 0.0 - 999.9                |
| 612           | Output voltage        | (LOG: MOTOR VOLT)   | Volt     | 50 - 1000                  |
| 613           | Output current        | (LOG: MOTOR CURR.)  | Amp      | 0.0 - 999.9                |
| 614           | DC link voltage       | (LOG: DC LINK VOLT) | Volt     | 0.0 - 999.9                |

#### Function:

With these parameters, it is possible to see up to 20 saved values (data logs) - [1] being the most recent and [20] the oldest log. When a start command has been given, a new entry to the data log is made every 160 ms. If there is a trip or if the motor has stopped, the 20 latest data log entries will be saved and the values will be visible in the display. This is useful, e.g. in the case of service after a trip.

The data log number is given in square brackets; [1]



Data logs [1]-[20] can be read by first pressing [CHANGE DATA], followed by the [+/-] keys to change data log numbers.

Parameters 606-614 *Data log* can also be read out via the serial communication port.

#### Description of choice:

##### Parameter 606 *Data log: Digital input:*

This is where the latest log data are shown in decimal code, representing the status of the digital inputs. Translated into binary code, terminal 16 corresponds to the bit to the extreme left and to decimal code 128. Terminal 33 corresponds to the bit to the extreme right and to decimal code 1.

The table can be used, e.g., for converting a decimal number into a binary code. For example, digital 40 corresponds to binary 00101000. The nearest smaller decimal number is 32, corresponding to a signal on terminal 18.  $40 - 32 = 8$ , corresponds to the signal on terminal 27.

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port

|                |     |    |    |    |    |    |    |    |
|----------------|-----|----|----|----|----|----|----|----|
| Terminal       | 16  | 17 | 18 | 19 | 27 | 29 | 32 | 33 |
| Decimal number | 128 | 64 | 32 | 16 | 8  | 4  | 2  | 1  |

##### Parameter 607 *Data log: Control word:*

This is where the latest log data are given in decimal code for the control word of the VLT frequency converter.

The control word read can only be changed via serial communication.

The control word is read as a decimal number which is to be converted into hex.

See the control word profile under the section *Serial communication* in the Design Guide.

##### Parameter 608 *Data log: Status word:*

This gives the latest log data in decimal code for the status word.

The status word is read as a decimal number which is to be converted into hex.

See the status word profile under the section *Serial communication* in the Design Guide.

##### Parameter 609 *Data log: Reference:*

This gives the latest log data for the resulting reference.

##### Parameter 610 *Data log: Feedback:*

This gives the latest log data for the feedback signal.

##### Parameter 611 *Data log: Output frequency:*

This gives the latest log data for the output frequency.

##### Parameter 612 *Data log: Output voltage:*

This gives the latest log data for the output voltage.

##### Parameter 613 *Data log: Output current:*

This gives the latest log data for the output current.

##### Parameter 614 *Data log: DC-link voltage:*

This gives the latest log data for the intermediate circuit voltage.



## VLT® 6000 HVAC

### 615 Fault log: Error code

#### (F. LOG: ERROR CODE)

Value:

[Index 1-10]

Error Code: 0 - 99

#### Function:

This parameter makes it possible to see the reason why a trip (cut-out of the VLT frequency converter) occurs.

10 [1-10] log values are stored.

The lowest log number [1] contains the latest/most recently saved data value; the highest log number [10] contains the oldest data value.

If there is a trip on the VLT 6000 HVAC, it is possible to see its cause, the time and possibly the values for output current or output voltage.

#### Description of choice:

Stated as an error code in which the number refers to a table in *List of warnings and alarms*.

The fault log is only reset after manual initialisation. (See *Manual initialisation*).

### 616 Fault log: Time

#### (F. LOG: TIME)

Value:

[Index 1-10]

Hours: 0 - 130,000.0

#### Function:

This parameter makes it possible to see the total number of hours run in connection with the 10 latest trips.

10 [1-10] log values are stored.

The lowest log number [1] contains the latest/most recently saved data value, while the highest log number [10] contains the oldest data value.

#### Description of choice:

The fault log is only reset after manual initialisation. (See *Manual initialisation*).

### 617 Fault log: Value

#### (F. LOG: VALUE)

Value:

[Index 1 - 10]

Value: 0 - 9999

#### Function:

This parameter makes it possible to see the value at which a trip occurred. The unit of the value depends on the alarm active in parameter 615 *Fault log: Error code*.

#### Description of choice:

The fault log is only reset after manual initialisation. (See *Manual initialisation*).

### 618 Reset of kWh counter

#### (RESET KWH COUNT)

Value:

★ No reset (DO NOT RESET)

[0]

Reset (RESET COUNTER)

[1]

#### Function:

Reset to zero of parameter 602 *kWh counter*.

#### Description of choice:

If *Reset* [1] has been selected and when the [OK] key is pressed, the kWh counter of the VLT frequency converter is reset. This parameter cannot be selected via the serial port, RS 485.



**NB!**

When the [OK] key has been activated, the reset has been carried out.

### 619 Reset of hours-run counter

#### (RESET RUN. HOUR)

Value:

★ No reset (DO NOT RESET)

[0]

Reset (RESET COUNTER)

[1]

#### Function:

Reset to zero of parameter 601 *Hours-run*.

#### Description of choice:

If *Reset* [1] has been selected and when the [OK] key is pressed, parameter 601 *Hours-run* is reset. This parameter cannot be selected via the serial port, RS 485.



**NB!**

When the [OK] key has been activated, the reset has been carried out.

Programming

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port

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## VLT® 6000 HVAC

### 620 Operating mode (OPERATION MODE)

#### Value:

|   |     |
|---|-----|
| ★ Normal function (NORMAL OPERATION)                          | [0] |
| Function with de-activated inverter<br>(OPER. W/INVERT.DISAB) | [1] |
| Control card test (CONTROL CARD TEST)                         | [2] |
| Initialisation (INITIALIZE)                                   | [3] |

#### Function:

In addition to its normal function, this parameter can be used for two different tests.

Furthermore, it is possible to reset to the default factory settings for all Setups, except parameters 500 Address, 501 Baud rate, 600-605 Operating data and 615-617 Fault log.

#### Description of choice:

Normal function [0] is used for normal operation of the motor.

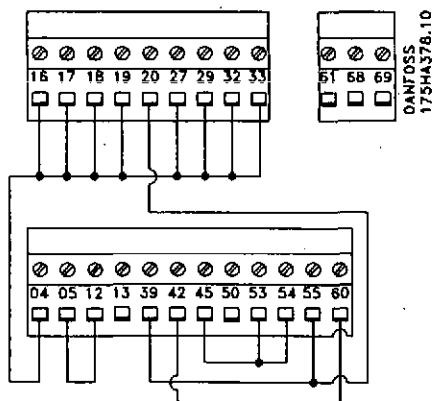
Function with de-activated inverter [1] is selected if control is desired over the influence of the control signal on the control card and its functions - without the motor shaft running.

Control card [2] is selected if control of the analogue and digital inputs, analogue and digital outputs, relay outputs and the control voltage of +10 V is desired.

A test connector with internal connections is required for this test.

The test connector for the Control card [2] is set up as follows:

connect 4-16-17-18-19-27-29-32-33;  
connect 5-12;  
connect 39-20-55;  
connect 42 - 60;  
connect 45-53-54.



Use the following procedure for the control card test:

- 1) Select *Control card test*.
- 2) Cut off the mains supply and wait for the light in the display to go out.
- 3) Insert the test plug (see preceding column).
- 4) Connect to mains.
- 5) The VLT frequency converter expects the [OK] key to be pressed (the test cannot be run without LCP).
- 6) The VLT frequency converter automatically tests the control card.
- 7) Remove the test connector and press the [OK] key when the VLT frequency converter displays "TEST COMPLETED".
- 8) Parameter 620 *Operating mode* is automatically set to *Normal function*.

If the control card test fails, the VLT frequency converter will display "TEST FAILED". Replace the control card.

Initialisation [3] is selected if the factory setting of the unit is to be generated without resetting parameters 500 Address, 501 Baud rate, 600-605 Operating data and 615-617 Fault log.

Procedure for initialisation:

- 1) Select *Initialisation*.
- 2) Press the [OK] key.
- 3) Cut off the mains supply and wait for the light in the display to go out.
- 4) Connect to mains.
- 5) Initialisation of all parameters will be carried out in all Setups with the exception of parameters 500 Address, 501 Baud rate, 600-605 Operating data and 615-617 Fault log.

Manual initialisation is another option. (See *Manual initialisation*).

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port



VLT® 6000 HVAC

621 - 631 Nameplate

Value:

| Parameter No. | Description Nameplate:             | Display text       |
|---------------|------------------------------------|--------------------|
| 621           | Unit type                          | (DRIVE TYPE)       |
| 622           | Power component                    | (POWER SECTION)    |
| 623           | VLT ordering no.                   | (ORDERING NO)      |
| 624           | Software version no.               | (SOFTWARE VERSION) |
| 625           | LCP identification no.             | (LCP ID NO.)       |
| 626           | Database identification no.        | (PARAM DB ID)      |
| 627           | Power component identification no. | (POWER UNIT DB ID) |
| 628           | Application option type            | (APPLIC. OPTION)   |
| 629           | Application option ordering no.    | (APPLIC. ORDER NO) |
| 630           | Communication option type          | (COM. OPTION)      |
| 631           | Communication option ordering no.  | (COM. ORDER NO)    |

Function:

The main data for the unit can be read from parameters 621 to 631 *Nameplate* via the display or the serial communication port.

Description of choice:

Parameter 621 *Nameplate: Unit type:*

VLT type gives the unit size and mains voltage.  
Example: VLT 6008 380-460 V.

Parameter 622 *Nameplate: Power component:*

This gives the type of power card fitted to the VLT frequency converter. Example: STANDARD.

Parameter 623 *Nameplate: VLT ordering no.:*

This gives the ordering number for the VLT type in question. Example: 1757805.

Parameter 624 *Nameplate: Software version no.:*

This gives the present software version number of the unit. Example: V 1.00.

Parameter 625 *Nameplate: LCP identification no.:*

This gives the identification number of the LCP of the unit. Example: ID 1.42 2 kB.

Parameter 626 *Nameplate: Database identification no.:*

This gives the identification number of the software's database. Example: ID 1.14.

Parameter 627 *Nameplate: Power component identification no.:*

This gives the identification number of the database of the unit. Example: ID 1.15.

Parameter 628 *Nameplate: Application option type:*

This gives the type of application options fitted with the VLT frequency converter.

Parameter 629 *Nameplate: Application option ordering no.:*

This gives the ordering number for the application option.

Parameter 630 *Nameplate: Communication option type:*

This gives the type of communication options fitted with the VLT frequency converter.

Parameter 631 *Nameplate: Communication option ordering no.:*

This gives the ordering number for the communication option.

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port



## VLT® 6000 HVAC



### NB!

Parameters 700-711 for the relay card are only activated if a relay option card is installed in the VLT 6000 HVAC.

#### 700 Relay 6, function (RELAY6 FUNCTION)

#### 703 Relay 7, function (RELAY7 FUNCTION)

#### 706 Relay 8, function (RELAY8 FUNCTION)

#### 709 Relay 9, function (RELAY9 FUNCTION)

#### Function:

This output activates a relay switch.

Relay outputs 6/7/8/9 can be used for showing status and warnings. The relay is activated when the conditions for the relevant data values have been fulfilled.

Activation/deactivation can be programmed in parameters 701/704/707/710 Relay 6/7/8/9, ON delay and parameters 702/705/708/711 Relay 6/7/8/9, OFF delay.

#### Description of choice:

See data choice and connections in *Relay outputs*.

#### 701 Relay 6, ON delay (RELAY6 ON DELAY)

#### 704 Relay 7, ON delay (RELAY7 ON DELAY)

#### 707 Relay 8, ON delay (RELAY8 ON DELAY)

#### 710 Relay 9, ON delay (RELAY9 ON DELAY)

#### Value:

0 - 600 sec.

★ 0 sec.

#### Function:

This parameter allows a delay of the cut-in time of relays 6/7/8/9 (terminals 1-2).

#### Description of choice:

Enter the required value.

#### 702 Relay 6, OFF delay (RELAY6 OFF DELAY)

#### 705 Relay 7, OFF delay (RELAY7 OFF DELAY)

#### 708 Relay 8, OFF delay (RELAY8 OFF DELAY)

#### 711 Relay 9, OFF delay (RELAY9 OFF DELAY)

#### Value:

0 - 600 sec.

★ 0 sec.

#### Function:

This parameter is used to delay the cut-out time of relays 6/7/8/9 (terminals 1-2).

#### Description of choice:

Enter the required value.

### ■ Electrical installation of the relay card

The relays are connected as shown below.

Relay 6-9:

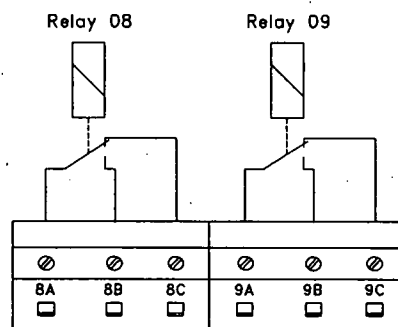
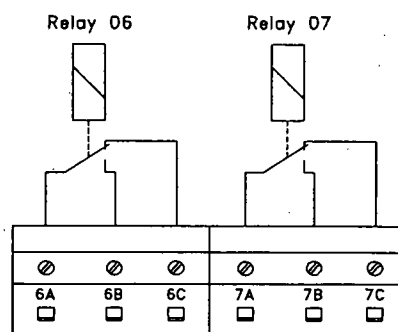
A-B make, A-C break

Max. 240 V AC, 2 Amp.

Max. cross-section: 1.5mm<sup>2</sup> (AWG 28-16).

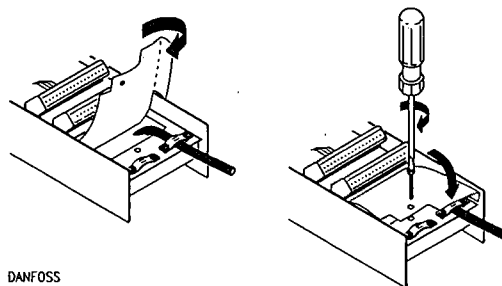
Torque: 0.22 - 0.25 Nm.

Screw size: M2.



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175HA442.11

To achieve double isolation, the plastic foil must be mounted as shown in the drawing below.



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175HA475.10

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port



## VLT® 6000 HVAC

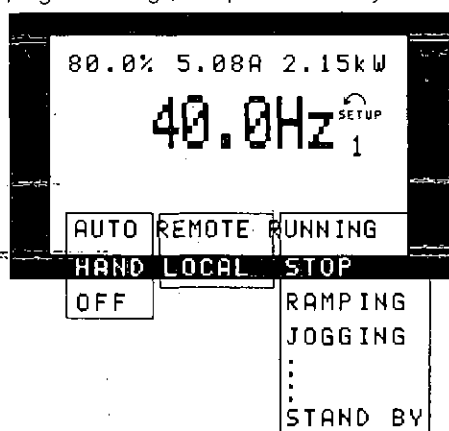
### ■ Status messages

Status messages appear in the 4th line of the display - see example below.

The left part of the status line indicates the active type of control of the VLT frequency converter.

The centre part of the status line indicates the active reference.

The last part of the status line gives the present status, e.g. "Running", "Stop" or "Stand by".



#### Auto mode (AUTO)

The VLT frequency converter is in Auto mode, i.e. control is carried out via the control terminals and/or serial communication. See also *Auto start*.

#### Hand mode (HAND)

The VLT frequency converter is in Hand mode, i.e. control is carried out via the control keys. See also *Hand start*.

#### OFF (OFF)

OFF/STOP is activated either by means of the control key, or by the digital inputs *Hand start* and *Auto start* both being a logic '0'. See also *OFF/STOP*.

#### Local reference (LOCAL)

If LOCAL has been selected, the reference is set via the [+/-] keys on the control panel. See also *Display modes*.

#### Remote reference (REM.)

If REMOTE has been selected, the reference is set via the control terminals or via serial communication. See also *Display modes*.

#### Running (RUNNING)

The motor speed now corresponds to the resulting reference.

#### Ramp operation (RAMPING)

The output frequency is now changed in accordance with the preset ramps.

#### Auto-ramp (AUTO RAMP)

Parameter 208 *Automatic ramp-down* is enabled, i.e. the VLT frequency converter is trying to avoid a trip from overvoltage by increasing its output frequency.

#### Sleep Boost (SLEEP .BST)

The boost function in parameter 406 *Boost setpoint* is enabled. This function is only possible in *Closed loop* operation.

#### Sleep mode (SLEEP)

The energy saving function in parameter 403 *Sleep mode timer* is enabled. This means that at present the motor has stopped, but that it will restart automatically when required.

#### Start delay (START DEL)

A start delay time has been programmed in parameter 111 *Start delay*. When the delay has passed, the output frequency will start by ramping up to the reference.

#### Run request (RUN REQ.)

A start command has been given, but the motor will be stopped until a *Run permissive* signal is received via a digital input.

#### Jogging (JOG)

Jog has been enabled via a digital input or via serial communication.

#### Jog request (JOG REQ.)

A JOG command has been given, but the motor will remain stopped until a *Run permissive* signal is received via a digital input.

#### Freeze output (FRZ.OUT.)

Freeze output has been enabled via a digital input.

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**VLT® 6000 HVAC**


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**Status messages, cont.****Freeze output request (FRZ.REQ.)**

A freeze output command has been given, but the motor will remain stopped until a *Run permissive* signal is received via a digital input.

**Reversing and start (START F/R)**

*Reversing and start* [2] on terminal 19 (parameter 303 *Digital inputs*) and *Start* [1] on terminal 18 (parameter 302 *Digital inputs*) are enabled at the same time. The motor will remain stopped until one of the signals becomes a logic '0'.

**Automatic Motor Adaptation running (AMA RUN)**

Automatic motor adaptation has been enabled in parameter 107 *Automatic Motor Adaptation, AMA*.

**Automatic Motor Adaptation completed (AMA STOP)**

Automatic motor adaptation has been completed. The VLT frequency converter is now ready for operation after the *Reset* signal has been enabled. Please note that the motor will start after the VLT frequency converter has received the *Reset* signal.

**Stand by (STANDBY)**

The VLT frequency converter is able to start the motor when a start command is received.

**Stop (STOP)**

The motor has been stopped via a stop signal from a digital input, [OFF/STOP]-button or serial communication.

**DC stop (DC STOP)**

The DC brake in parameter 114-116 has been enabled.

**DRIVE ready (UN. READY)**

The VLT frequency converter is ready for operation, but terminal 27 is a logic '0' and/or a *Coasting command* has been received via the serial communication.

**Control ready (CTR.READY)**

This status is only active when a profibus option card is installed.

**Not ready (NOT READY)**

The VLT frequency converter is not ready for operation, because of a trip or because OFF1, OFF2 or OFF3 is a logic '0'.

**Start disabled (START IN.)**

This status will only be displayed if, in parameter 599 *Statemachine, Profidrive* [1] has been selected and OFF2 or OFF3 is a logic '0'.

**Exceptions XXXX (EXCEPTIONS XXXX)**

The microprocessor of the control card has stopped and the VLT frequency converter is out of operation. The cause may be noise on the mains, motor or control cables, leading to a stop of the control card microprocessor.

Check for EMC-correct connection of these cables.



## VLT® 6000 HVAC

### ■ List of warnings and alarms

The table gives the different warnings and alarms and indicates whether the fault locks the VLT frequency converter. After Trip locked, the mains supply must be cut and the fault must be corrected. Reconnect the mains supply and reset the VLT frequency converter before being ready. A Trip can be reset manually in three ways

- 1) Via the control key [RESET]
- 2) Via a digital input
- 3) Via serial communication

In addition, an automatic reset may be selected in parameter 400 *Reset function*.

Wherever a cross is placed under both Warning and Alarm, this can mean that a warning precedes the alarm. It can also mean that it is possible to program whether a given fault is to result in a warning or an alarm. This is possible, e.g. in parameter 117 *Motor thermal protection*. After a trip, the motor will be coasting and on the VLT frequency converter alarm and warning will flash. If the fault is removed, only the alarm will flash. After a reset, the VLT frequency converter will be ready to start operation again.

| No. | Description   | Warning | Alarm | Trip locked |
|-----|---|---------|-------|-------------|
| 1   | 10 Volts low (10 VOLT LOW)                          | X       |       |             |
| 2   | Live zero fault (LIVE ZERO ERROR)                   | X       | X     |             |
| 4   | Mains imbalance (MAINS IMBALANCE)                   | X       | X     | X           |
| 5   | Voltage warning high (DC LINK VOLTAGE HIGH)         | X       |       |             |
| 6   | Voltage warning low (DC LINK VOLTAGE LOW)           | X       |       |             |
| 7   | Overvoltage (DC LINK OVERVOLT)                      | X       | X     |             |
| 8   | Undervoltage (DC LINK UNDERVOLT)                    | X       | X     |             |
| 9   | Inverter overloaded (INVERTER TIME)                 | X       | X     |             |
| 10  | Motor overloaded (MOTOR TIME)                       | X       | X     |             |
| 11  | Motor thermistor (MOTOR THERMISTOR)                 | X       | X     |             |
| 12  | Current limit (CURRENT LIMIT)                       | X       | X     |             |
| 13  | Overcurrent (OVERCURRENT)                           | X       | X     | X           |
| 14  | Earth fault (EARTH FAULT)                           |         | X     | X           |
| 15  | Switch mode fault (SWITCH MODE FAULT)               |         | X     | X           |
| 16  | Short-circuit (CURR.SHORT CIRCUIT)                  |         | X     | X           |
| 17  | Serial communication timeout (STD BUSTIMEOUT)       | X       | X     |             |
| 18  | HPFB bus timeout (HPFB TIMEOUT)                     | X       | X     |             |
| 19  | Fault in EEprom on power card (EE ERROR POWER)      | X       |       |             |
| 20  | Fault in EEprom on control card (EE ERROR CONTROL)  | X       |       |             |
| 22  | Auto-optimisation not OK (AMA FAULT)                |         | X     |             |
| 29  | Heat-sink temperature too high (HEAT SINK OVERTEMP) |         | X     |             |
| 30  | Motor phase U missing (MISSING MOT.PHASE U)         |         | X     |             |
| 31  | Motor phase V missing (MISSING MOT.PHASE V)         |         | X     |             |
| 32  | Motor phase W missing (MISSING MOT.PHASE W)         |         | X     |             |
| 34  | HPFB communication fault (HPFB COMM. FAULT)         | X       | X     |             |
| 37  | Inverter fault (GATE DRIVE FAULT)                   |         | X     | X           |
| 39  | Check parameters 104 and 106 (CHECK P.104 & P.106)  | X       |       |             |
| 40  | Check parameters 103 and 105 (CHECK P.103 & P.106)  | X       |       |             |
| 41  | Motor too big (MOTOR TOO BIG)                       | X       |       |             |
| 42  | Motor too small (MOTOR TOO SMALL)                   | X       |       |             |
| 60  | Safety stop (EXTERNAL FAULT)                        |         | X     |             |
| 61  | Output frequency low (FOUT < FLOW)                  | X       |       |             |
| 62  | Output frequency high (FOUT > FHIGH)                | X       |       |             |
| 63  | Output current low (I MOTOR < I LOW)                | X       | X     |             |
| 64  | Output current high (I MOTOR > I HIGH)              | X       |       |             |
| 65  | Feedback low (FEEDBACK < FDB LOW)                   | X       |       |             |
| 66  | Feedback high (FEEDBACK > FDB HIGH)                 | X       |       |             |
| 67  | Reference low (REF. < REF. LOW)                     | X       |       |             |
| 68  | Reference high (REF. > REF. HIGH)                   | X       |       |             |
| 69  | Temperature auto derate (TEMP.AUTO DERATE)          | X       |       |             |
| 99  | Unknown fault (UNKNOWN ALARM)                       |         | X     | X           |

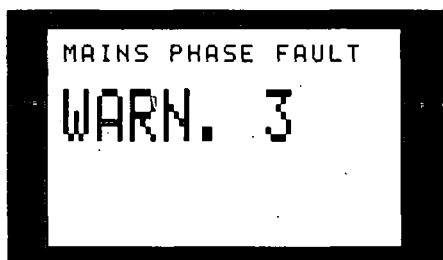
All about  
VLT 6000 HVAC



## VLT® 6000 HVAC

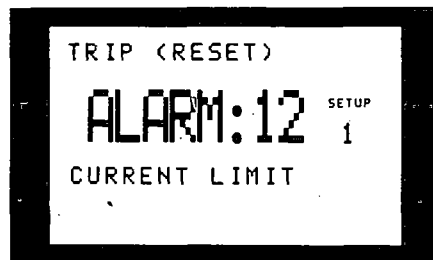
### ■ Warnings

A warning will flash in line 2, while an explanation is given in line 1.



### ■ Alarms

If an alarm is given, the present alarm number will be shown in line 2. Lines 3 and 4 of the display will offer an explanation.



#### WARNING 1

##### Under 10 V (10 VOLT 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 Volts supply is overloaded. Max. 17 mA/min. 590 Ω.

#### WARNING/ALARM 2

##### Live zero fault (LIVE ZERO ERROR)

The current or voltage signal on terminal 53, 54 or 60 is below 50% of the value preset in parameter 309, 312 and 315 *Terminal, min. scaling*.

#### WARNING/ALARM 4

##### Mains imbalance (MAINS IMBALANCE)

High imbalance or phase missing on the supply side. Check the supply voltage to the VLT frequency converter.

#### WARNING 5

##### Voltage warning high (DC LINK VOLTAGE HIGH)

The intermediate circuit voltage (DC) is higher than *Voltage warning high*, see table below. The controls of the VLT frequency converter are still enabled.

#### WARNING 6

##### Voltage warning low (DC LINK VOLTAGE LOW)

The intermediate circuit voltage (DC) is lower than *Voltage warning low*, see table below. The controls of the VLT frequency converter are still enabled.

#### WARNING/ALARM 7

##### Overvoltage (DC LINK OVERVOLT)

If the intermediate circuit voltage (DC) is higher than the *Overvoltage limit* of the inverter (see table below), the VLT frequency converter will trip after a fixed period. The length of this period depends on the unit.

#### Alarm/warning limits:

| VLT 6000 HVAC        | 3 x 200 - 240 V<br>[VDC] | 3 x 380 - 460 V<br>[VDC] | 3 x 550-600 V<br>[VDC] |
|----------------------|--------------------------|--------------------------|------------------------|
| Undervoltage         | 211                      | 402                      | 557                    |
| Voltage warning low  | 222                      | 423                      | 613                    |
| Voltage warning high | 384                      | 762                      | 943                    |
| Overvoltage          | 425                      | 798                      | 975                    |

The voltages stated are the intermediate circuit voltage of the VLT frequency converter with a tolerance of  $\pm 5\%$ . The corresponding mains voltage is the intermediate circuit voltage divided by 1,35.



## VLT® 6000 HVAC

### Warnings and alarms, cont.

#### WARNING/ALARM 8

##### Undervoltage (DC LINK UNDERVOLT)

If the intermediate circuit voltage (DC) drops below the *undervoltage limit* of the inverter, the VLT frequency converter will trip after a fixed period, the length of the period depending on the unit.

Furthermore, the voltage will be stated in the display. Check whether the supply voltage matches the VLT frequency converter, see *Technical data*.

#### WARNING/ALARM 9

##### Inverter overload (INVERTER TIME)

The electronic, thermal inverter protection reports that 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. The VLT frequency converter cannot be reset until the counter is below 90%.

The fault is that the VLT frequency converter is overloaded by more than 100% for too long.

#### WARNING/ALARM 10

##### Motor overtemperature (MOTOR TIME)

According to the electronic thermal protection (ETR), the motor is too hot. Parameter 117 *Motor thermal protection* allows a choice of whether the VLT frequency converter is to give a warning or an alarm when the *Motor thermal protection* reaches 100%. The fault is that the motor is overloaded by more than 100% of the preset, rated motor current for too long. Check that the motor parameters 102-106 have been set correctly.

#### WARNING/ALARM 11

##### Motor thermistor (MOTOR THERMISTOR)

The thermistor or the thermistor connection has been disconnected. Parameter 117 *Motor thermal protection* allows a choice of whether the VLT frequency converter is to give a warning or an alarm. Check that the thermistor has been correctly connected between terminal 53 or 54 (analogue voltage input) and terminal 50 (+ 10 V supply).

#### WARNING/ALARM 12

##### Current limit (CURRENT LIMIT)

The current is higher than the value in parameter 215 *Current limit*  $I_{LM}$  and the VLT frequency converter trips after the time set in parameter 412 *Trip delay overcurrent*,  $I_{LM}$  has passed.

#### WARNING/ALARM 13

##### Overcurrent (OVER CURRENT)

The inverter peak current limit (approx. 200% of the rated current) has been exceeded. The warning will last approx. 1-2 seconds, following which the VLT frequency converter will trip and give off an alarm. Turn off the VLT frequency converter and check whether the motor shaft can be turned and whether the motor size matches the VLT frequency converter.

#### ALARM: 14

##### Earth fault (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 VLT frequency converter and remove the earth fault.

#### ALARM: 15

##### Switch mode fault (SWITCH MODE FAULT)

Fault in the switch mode power supply (internal  $\pm 15$  V supply).

Contact your Danfoss supplier.

#### ALARM: 16

##### Short-circuiting (CURR. SHORT CIRCUIT)

There is short-circuiting on the motor terminals or in the motor itself.

Cut off the mains supply to the VLT frequency converter and remove the short-circuit.

#### WARNING/ALARM 17

##### Serial communication timeout (STD BUSTIMEOUT)

There is no serial communication with the VLT frequency converter.

This warning will only be enabled if parameter 556 *Bus time interval function* has been set to a value different from OFF.

If parameter 556 *Bus time interval function* has been set to *Stop and trip* [5], the VLT frequency converter will first give off an alarm, then ramp down and finally trip while giving off an alarm. It is possible to increase parameter 555 *Bus time interval*.



## VLT® 6000 HVAC

### Warnings and alarms, cont.

#### WARNING/ALARM 18

##### HPFB bus timeout (HPFB TIMEOUT)

There is no serial communication with the communication option card of the VLT frequency converter. The warning will only be enabled if parameter 804 *Bus time interval function* has been set to anything but OFF. If parameter 804 *Bus time interval function* has been set to *Stop and trip*, the VLT frequency converter will first give off an alarm, then ramp down and finally trip while giving off an alarm. Parameter 803 *Bus time interval* could possibly be increased.

#### WARNING 19

##### Fault in the EEPROM on the power card (EE ERROR POWER)

There is a fault on the power card EEPROM. The VLT frequency converter will continue to function, but is likely to fail at the next power-up. Contact your Danfoss supplier.

#### WARNING 20

##### Fault in the EEPROM on the control card (EE ERROR CONTROL)

There is a fault in the EEPROM on the control card. The VLT frequency converter will continue to function, but is likely to fail at the next power-up. Contact your Danfoss supplier.

#### ALARM: 22

##### Auto-optimisation not OK (AMA FAULT)

A fault has been found during automatic motor adaptation. The text shown in the display indicates a fault message.



#### NB!

AMA can only be carried out if there are no alarms during tuning.

#### CHECK 103, 105

[0]

Parameter 103 or 105 has a wrong setting. Correct the setting and start AMA all over.

#### LOW P.105

[1]

The motor is too small for AMA to be carried out. If AMA is to be enabled, the rated motor current (parameter 105) must be higher than 35% of the rated output current of the VLT frequency converter.

#### ASYMMETRICAL IMPEDANCE

[2]

AMA has detected an asymmetrical impedance in the motor connected to the system. The motor could be defective.

#### MOTOR TOO BIG

[3]

The motor connected to the system is too big for AMA to be carried out. The setting in parameter 102 does not match the motor used.

#### MOTOR TOO SMALL

[4]

The motor connected to the system is too small for AMA to be carried out. The setting in parameter 102 does not match the motor used.

#### TIME OUT

[5]

AMA fails because of noisy measuring signals. Try to start AMA all over a number of times, until AMA is carried out. Please note that repeated AMA runs may heat the motor to a level where the stator resistance  $R_s$  is increased. In most cases, however, this is not critical.

#### INTERRUPTED BY USER

[6]

AMA has been interrupted by the user.

#### INTERNAL FAULT

[7]

An internal fault has occurred in the VLT frequency converter. Contact your Danfoss supplier.

#### LIMIT VALUE FAULT

[8]

The parameter values found for the motor are outside the acceptable range within which the VLT frequency converter is able to work.

#### MOTOR ROTATES

[9]

The motor shaft rotates. Make sure that the load is not able to make the motor shaft rotate. Then start AMA all over.



## VLT® 6000 HVAC

### Warnings and alarms, cont.

#### ALARM 29

##### Heat sink temperature too high (HEAT SINK OVER TEMP.):

If the enclosure is IP 00, IP 20 or NEMA 1, the cut-out temperature of the heat-sink is 90°C. If IP 54 is used, the cut-out temperature is 80°C.

The tolerance is  $\pm 5^\circ\text{C}$ . The temperature fault cannot be reset, until the temperature of the heat-sink is below 60°C.

The fault could be the following:

- Ambient temperature too high
- Too long motor cable
- Too high switching frequency.

#### ALARM: 30

##### Motor phase U missing (MISSING MOT.PHASE U):

Motor phase U between VLT frequency converter and motor is missing.

Turn off the VLT frequency converter and check motor phase U.

#### ALARM: 31

##### Motor phase V missing (MISSING MOT.PHASE V):

Motor phase V between VLT frequency converter and motor is missing.

Turn off the VLT frequency converter and check motor phase V.

#### ALARM: 32

##### Motor phase W missing (MISSING MOT.PHASE U):

Motor phase W between VLT frequency converter and motor is missing.

Turn off the VLT frequency converter and check motor phase W.

#### WARNING/ALARM: 34

##### HPFB communication fault (HPFB COMM. FAULT)

The serial communication on the communication option card is not working.

#### ALARM: 37

##### Inverter fault (GATE DRIVE FAULT):

IGBT or the power card is defective. Contact your Danfoss supplier.

#### Auto-optimisation warnings 39-42

Automatic motor adaptation has stopped, since some parameters have probably been set wrongly, or the motor used is too big/small for AMA to be carried out. A choice must thus be made by pressing [CHANGE DATA] and choosing 'Continue' + [OK] or 'Stop' + [OK]. If parameters need to be changed, select 'Stop'; start up AMA all over.

#### WARNING: 39

##### CHECK PAR. 104, 106

Parameters 104 *Motor frequency*  $f_{M,N}$  or 106 *Rated motor speed*  $n_{M,N}$  have probably not been set correctly. Check the setting and select 'Continue' or [STOP].

#### WARNING: 40

##### CHECK PAR. 103, 105

Parameter 103 *Motor voltage*,  $U_{M,N}$  or 105 *Motor current*,  $I_{M,N}$  has not been set correctly. Correct the setting and restart AMA.

#### WARNING: 41

##### MOTOR TOO BIG (MOTOR TOO BIG)

The motor used is probably too big for AMA to be carried out. The setting in parameter 102 *Motor power*,  $P_{M,N}$  may not match the motor. Check the motor and choose 'Continue' or [STOP].

#### WARNING: 42

##### MOTOR TOO SMALL (MOTOR TOO SMALL)

The motor used is probably too small for AMA to be carried out. The setting in parameter 102 *Motor power*,  $P_{M,N}$  may not match the motor. Check the motor and select 'Continue' or [STOP].

#### ALARM: 60

##### Safety stop (EXTERNAL FAULT)

Terminal 27 (parameter 304 *Digital inputs*) has been programmed for a *Safety interlock* [3] and is a logic '0'.

#### WARNING: 61

##### Output frequency low (FOUT < FLOW)

The output frequency is lower than parameter 223  
Warning: Low frequency,  $f_{LOW}$

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## VLT® 6000 HVAC

### WARNING: 62

#### Output frequency high (FOUT > FHIGH)

The output frequency is higher than parameter 224

Warning: High frequency,  $f_{HIGH}$ .

### WARNING/ALARM: 63

#### Output current low (I MOTOR < I LOW)

The output current is lower than parameter 221

Warning: Low current,  $I_{LOW}$ . Select the required function in parameter 409 Function in case of no load.

### WARNING: 64

#### Output current high (I MOTOR > I HIGH)

The output current is higher than parameter 222

Warning: High current,  $I_{HIGH}$ .

### WARNING: 65

#### Feedback low (FEEDBACK < FDB LOW)

The resulting feedback value is lower than parameter

227 Warning: Low feedback,  $FB_{LOW}$ .

### WARNING: 66

#### Feedback high (FEEDBACK > FDB HIGH)

The resulting feedback value is higher than parameter

228 Warning: High feedback,  $FB_{HIGH}$ .

### WARNING: 67

#### Remote reference low (REF. < REF LOW)

The remote reference is lower than parameter 225

Warning: Low reference,  $REF_{LOW}$ .

### WARNING: 68

#### Remote reference high (REF. > REF HIGH)

The remote reference is higher than parameter 226

Warning: High reference,  $REF_{HIGH}$ .

### WARNING: 69

#### Temperature auto derate (TEMP.AUTO DERATE)

The heat sink temperature has exceeded the maximum value and the auto derating function (par. 411) is active. Warning: Temp. Auto derate.

### WARNING: 99

#### Unknown fault (UNKNOWN ALARM)

An unknown fault has occurred which the software is not able to handle.

Contact your Danfoss supplier.

### ■ Aggressive environments

In common with all electronic equipment, a VLT frequency converter contains a large number of mechanical and electronic components, all of which are vulnerable to environmental effects to some extent.



The VLT frequency converter should not therefore be installed in environments with airborne liquids, particles or gases capable of affecting and damaging the electronic components. Failure to take the necessary protective measures increases the risk of stoppages, thus reducing the life of the VLT frequency converter.

Liquids can be carried through the air and condense in the VLT frequency converter. In addition to this, liquids may cause corrosion of components and metal parts.

Steam, oil and salt water may cause corrosion of components and metal parts.

In such environments, equipment with enclosure rating IP 54 is recommended.

Airborne particles such as dust particles may cause mechanical, electrical or thermal failure in the VLT frequency converter.

A typical indicator of excessive levels of airborne particles is dust particles around the VLT frequency converter fan.

In very dusty environments, equipment with enclosure rating IP 54 or a cabinet for IP 00/20 equipment is recommended.

In environments with high temperatures and humidity, corrosive gases such as sulphur, nitrogen and chlorine compounds will cause chemical processes on the VLT frequency converter components. Such chemical reactions will rapidly affect and damage the electronic components.

In such environments, it is recommended that equipment is mounted in a cabinet with fresh air ventilation, keeping aggressive gases away from the VLT frequency converter.



## VLT® 6000 HVAC



### NB!

Mounting VLT frequency converters in aggressive environments will increase the risk of stoppages and furthermore considerably reduce the life of the converter.

Before the installation of the VLT frequency converter, the ambient air should be checked for liquids, particles and gases. This may be done by observing existing installations in this environment. Typical indicators of

harmful airborne liquids are water or oil on metal parts, or corrosion of metal parts.

Excessive dust particle levels are often found on installation cabinets and existing electrical installations. One indicator of aggressive airborne gases is blackening of copper rails and cable ends on existing installations.

### ■ Calculation of resulting reference

The calculation made below gives the resulting reference when parameter 210 *Reference type* is programmed for *Sum* [0] and *Relative* [1], respectively.

External reference is the sum of references from terminals 53, 54, 60 and serial communication. The sum of these can never exceed parameter 205 *Max. reference*.

External reference can be calculated as follows:

$$\text{Ext. ref.} = \frac{(\text{Par. 205 Max. ref.} - \text{Par. 204 Min. ref.}) \times \text{Ana. signal Term 53 [V]} + (\text{Par. 205 Max. ref.} - \text{Par. 204 Min. ref.}) \times \text{Ana. signal Term 54 [V]} + (\text{Par. 205 Max. ref.} - \text{Par. 204 Min. ref.}) \times \text{Par. 314 Term 60 [mA]} + \text{serial com. reference} \times (\text{Par. 205 Max. ref.} - \text{Par. 204 Min. ref.})}{\text{Par. 310 Term. 53 Max. scaling} - \text{Par. 309 Term. 53 Min. scaling} + \text{Par. 313 Term. 54 Max. scaling} - \text{Par. 312 Term. 54 Min. scaling} + \text{Par. 316 Term. 60 Max. scaling} - \text{Par. 315 Term. 60 Min. scaling} + 16384 (4000 \text{ Hex})}$$

Par. 210 *Reference type* is programmed = *Sum* [0].

$$\text{Res. ref.} = \frac{(\text{Par. 205 Max. ref.} - \text{Par. 204 Min. ref.}) \times \text{Par. 211-214 Preset ref.}}{100} + \text{External ref.} + \text{Par. 204 Min. ref.} + \text{Par. 418/419 Setpoint (only in closed loop)}$$

Par. 210 *Reference type* is programmed = *Relative* [1].

$$\text{Res. ref.} = \frac{\text{External reference} \times \text{Par. 211-214 Preset ref.}}{100} + \text{Par. 204 Min. ref.} + \text{Par. 418/419 Setpoint (only in closed loop)}$$

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VLT 6000 HVAC



## VLT® 6000 HVAC

### ■ Galvanic isolation (PELV)

PELV offers protection by way of extra low voltage. Protection against electric shock is considered to be ensured when the electrical supply is of the PELV type and the installation is made as described in local/national regulations on PELV supplies.

In VLT 6000 HVAC all control terminals as well as terminals 1-3 (AUX relay) are supplied from or in connection with extra low voltage (PELV).

Galvanic (ensured) isolation is obtained by fulfilling requirements concerning higher isolation and by providing the relevant creepage/clearance distances. These requirements are described in the EN 50178 standard.

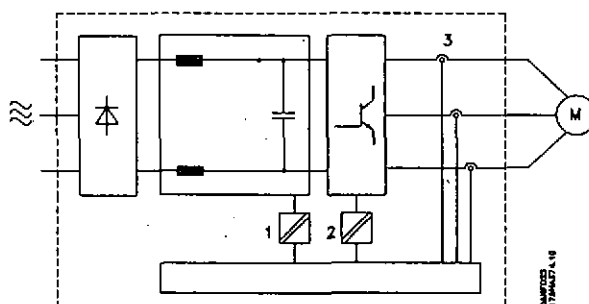
For additional information on PELV see *RFI switching*.  
Galvanic isolation

The components that make up the electrical isolation, as described below, also comply with the requirements concerning higher isolation and the relevant test as described in EN 50178.

The galvanic isolation can be shown in three locations (see drawing below), namely:

1. Power supply (SMPS) incl. signal isolation of  $U_{DC}$ , indicating the intermediate current voltage.
2. Gate drive that runs the IGBTs (trigger transformers/opto-couplers).
3. Current transducers (Hall effect current transducers).

NOTE: 550-600 V units do not meet PELV requirements in accordance with EN 50178.



### ■ Earth leakage current

Earth leakage current is primarily caused by the capacitance between motor phases and the motor cable screen. When an RFI filter is used, this contributes additional leakage current, as the filter circuit is connected to earth through capacitors. See drawing on the following page.

The size of the leakage current to the ground depends on the following factors, in order of priority:

1. Length of motor cable
2. Motor cable with or without screen
3. Switching frequency
4. RFI filter used or not
5. Motor grounded on site or not.

The leakage current is of importance to safety during handling/operation of the frequency converter if (by mistake) the frequency converter has not been earthed.



#### NB!

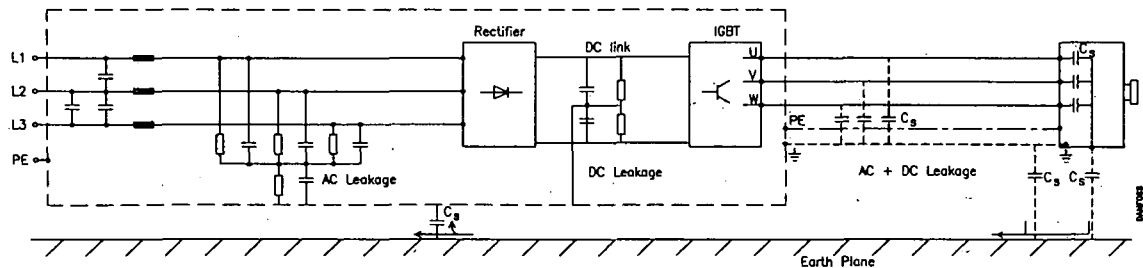
Since the leakage current is  $> 3.5$  mA, reinforced earthing must be established, which is required if EN 50178 is to be complied with. Never use ELCB relays (type A) that are not suitable for DC fault currents from three-phase rectifier loads.

If ELCB relays are used, they must be:

- Suitable for protecting equipment with a direct current content (DC) in the fault current (3-phase bridge rectifier)
- Suitable for power-up with short pulse-shaped charging current to earth
- Suitable for a high leakage current (300 mA).



## VLT® 6000 HVAC



Leakage currents to earth

### ■ Extreme running conditions

#### Short circuit

VLT-6000 HVAC is protected against short circuits by means of current measurement in each of the three motor phases. A short circuit between two output phases will cause an overcurrent in the inverter. However, each transistor of the inverter will be turned off individually when the short circuit current exceeds the permitted value.

After a few microseconds the driver card turns off the inverter and the frequency converter will display a fault code, although depending on impedance and motor frequency.

#### Earth fault

The inverter cuts out within a few microseconds in case of an earth fault on a motor phase, although depending on impedance and motor frequency.

#### Switching on the output

Switching on the output between the motor and the frequency converter is fully permitted. It is not possible to damage VLT 6000 HVAC in any way by switching on the output. However, fault messages may appear.

#### Motor-generated overvoltage

The voltage in the intermediate circuit is increased when the motor acts as a generator. This occurs in two cases:

1. The load drives the motor (at constant output frequency from the frequency converter), i.e. the load generates energy.
2. During deceleration ("ramp-down") if the moment of inertia is high, the load is low and the ramp-down time is too short for the energy to be dissipated as a loss in the VLT frequency converter, the motor and the installation.

The control unit attempts to correct the ramp if possible.

The inverter turns off to protect the transistors and the intermediate circuit capacitors when a certain voltage level is reached.

#### Mains drop-out

During a mains drop-out, VLT 6000 HVAC continues until the intermediate circuit voltage drops below the minimum stop level, which is typically 15% below VLT 6000 HVAC's lowest rated supply voltage.

The time before the inverter stops depends on the mains voltage before the drop-out and on the motor load.

#### Static overload

When VLT 6000 HVAC is overloaded (the current limit in parameter 215 *Current limit*,  $I_{LM}$  has been reached), the controls will reduce the output frequency in an attempt to reduce the load. If the overload is excessive, a current may occur that makes the VLT frequency converter cut out after approx. 1.5 sec.

Operation within the current limit can be limited in time (0-60 s) in parameter 412 *Trip delay overcurrent*,  $I_{LM}$ .

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## VLT® 6000 HVAC

### ■ Peak voltage on motor

When a transistor in the inverter is opened, the voltage across the motor increases by a  $dV/dt$  ratio that depends on:

- the motor cable (type, cross-section, length screened/armoured or unscreened/unarmoured)
- inductance

The natural induction causes an overshoot  $U_{PEAK}$  in the motor voltage before it stabilises itself at a level which depends on the voltage in the intermediate circuit. The rise time and the peak voltage  $U_{PEAK}$  affect the service life of the motor. If the peak voltage is too high, motors without phase coil insulation are the ones that will primarily be affected. If the motor cable is short (a few meters), the rise time and peak voltage are lower.

If the motor cable is long (100 m), the rise time and peak voltage will increase.

If very small motors are used without phase coil insulation, it is recommended to fit a LC filter after the frequency converter. Typical values for the rise time and peak voltage  $U_{PEAK}$  measured on the motor terminals between two phases:

| VLT 6002-6006 200 V, VLT 6002-6011 400 V |               |                |              |
|--|---------------|----------------|--------------|
| Cable length                             | Mains voltage | Rise time      | Peak voltage |
| 50 metres                                | 380 V         | 0.3 $\mu$ sec. | 850 V        |
| 50 metres                                | 460 V         | 0.4 $\mu$ sec. | 950 V        |
| 150 metres                               | 380 V         | 1.2 $\mu$ sec. | 1000 V       |
| 150 metres                               | 460 V         | 1.3 $\mu$ sec. | 1300 V       |

### ■ Switching on the input

Switching on the input depends on the mains voltage in question.

The table below states the waiting time between cut-ins.

| Mains voltage | 380 V | 415 V | 460 V |
|---------------|-------|-------|-------|
| Waiting time  | 48 s  | 65 s  | 89 s  |

### ■ Acoustic noise

The acoustic interference from the frequency converter comes from two sources:

1. DC intermediate circuit coils
2. Integral fan.

Below are the typical values measured at a distance of 1 m from the unit at full load and are nominal maximum values:

| VLT 6002-6006 200 V, VLT 6002-6011 400 V |          |
|--|----------|
| IP 20 units:                             | 50 dB(A) |
| IP 54 units:                             | 62 dB(A) |
| VLT 6008-6027 200 V, VLT 6016-6062 400 V |          |
| IP 20 units:                             | 61 dB(A) |
| IP 54 units:                             | 66 dB(A) |
| VLT 6042-6062 200-240 V                  |          |
| IP 00/20 units:                          | 70 dB(A) |
| IP 54 units:                             | 65 dB(A) |
| VLT 6072 380-460 V                       |          |
| IP 20 units:                             | 67 dB(A) |
| IP 54 units:                             | 66 dB(A) |

| VLT 6008-6027 200 V, VLT 6016-6072 400 V |               |                |              |
|--|---------------|----------------|--------------|
| Cable length                             | Mains voltage | Rise time      | Peak voltage |
| 50 metres                                | 380 V         | 0.1 $\mu$ sec. | 900 V        |
| 150 metres                               | 380 V         | 0.2 $\mu$ sec. | 1000 V       |

| VLT 6075-6275 380-460 V, 6042-6062 200-240 V |               |                   |              |
|--|---------------|-------------------|--------------|
| Cable length                                 | Mains voltage | $du/dt$           | Peak voltage |
| 13 metres                                    | 460 V         | 670 V/ $\mu$ sec. | 815 V        |
| 20 metres                                    | 460 V         | 620 V/ $\mu$ sec. | 915 V        |

| VLT 6350-6550 380-460 V |               |                   |              |
|-------------------------|---------------|-------------------|--------------|
| Cable length            | Mains voltage | $du/dt$           | Peak voltage |
| 20 metres               | 460 V         | 415 V/ $\mu$ sec. | 760 V        |

| VLT 6002-6011 550-600 V |               |                 |              |
|-------------------------|---------------|-----------------|--------------|
| Cable length            | Mains Voltage | Rise Time       | Peak Voltage |
| 35 m                    | 600 V         | 0.36 $\mu$ sec. | 1360 V       |

| VLT 6016-6072 550-600 V |               |                 |              |
|-------------------------|---------------|-----------------|--------------|
| Cable length            | Mains Voltage | Rise Time       | Peak Voltage |
| 35 m                    | 575 V         | 0.38 $\mu$ sec. | 1430 V       |

| VLT 6100-6275 550-600 V |               |                 |              |
|-------------------------|---------------|-----------------|--------------|
| Cable length            | Mains Voltage | Rise Time       | Peak Voltage |
| 13 m                    | 600 V         | 0.80 $\mu$ sec. | 1122 V       |

| VLT 6075-6275 380-460 V |          |
|-------------------------|----------|
| IP 00/20 units:         | 70 dB(A) |
| IP 54 units:            | 75 dB(A) |

| VLT 6350-6550 380-460 V |          |
|-------------------------|----------|
| IP 00 units:            | 71 dB(A) |
| IP 20/54 units:         | 82 dB(A) |

| VLT 6002-6011 550-600 V |       |
|-------------------------|-------|
| IP 20/NEMA 1 units:     | 62 dB |

| VLT 6016-6072 550-600 V |       |
|-------------------------|-------|
| IP 20/NEMA 1 units:     | 66 dB |

| VLT 6100-6275 550-600 V |       |
|-------------------------|-------|
| IP 20/NEMA 1 units:     | 75 dB |

\* Measured 1 meter from the unit at full load.

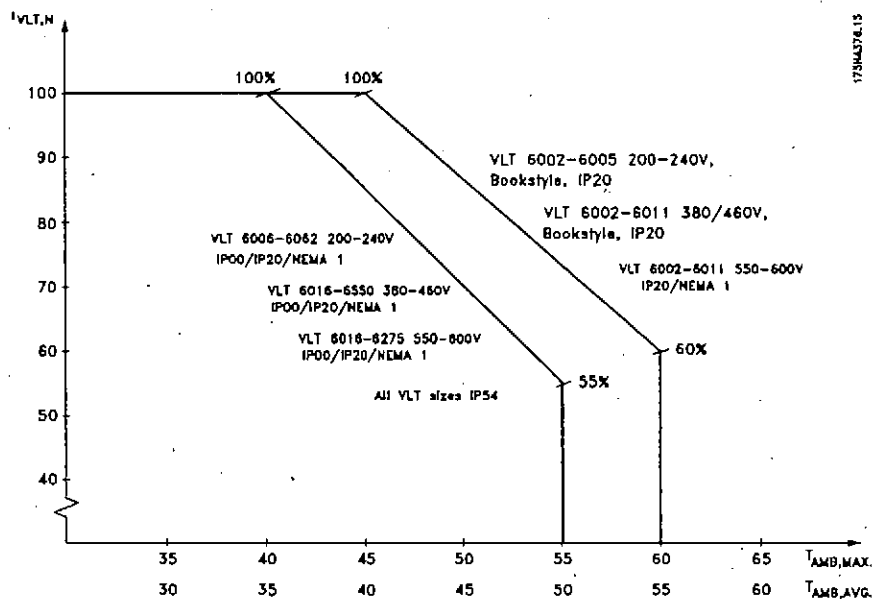


## VLT® 6000 HVAC

### Derating for ambient temperature

The ambient temperature ( $T_{AMB,MAX}$ ) is the maximum temperature allowed. The average ( $T_{AMB,AVG}$ ) measured over 24 hours must be at least 5°C lower.

If VLT 6000 HVAC is operated at temperatures above 45 °C, a derating of the continuous output current is necessary.

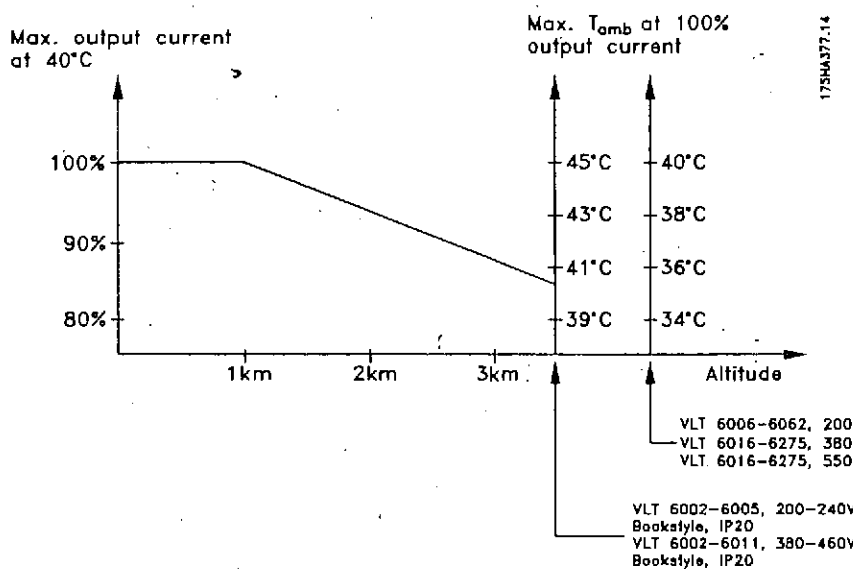


### Derating for air pressure

Below 1000 m altitude no derating is necessary.

Above 1000 m the ambient temperature ( $T_{AMB}$ ) or max. output current ( $I_{VLT,MAX}$ ) must be derated in accordance with the diagram below:

- 1) Derating of output current versus altitude at  $T_{AMB} = \text{max. } 45^{\circ}\text{C}$
- 2) Derating of max.  $T_{AMB}$  versus altitude at 100% output current.



All about  
VLT 6000 HVAC



## VLT® 6000 HVAC

### ■ Derating for running at low speed

When a centrifugal pump or a fan is controlled by a VLT 6000 HVAC frequency converter, it is not necessary to reduce the output current at low speed because the load characteristic of the centrifugal pumps/fans, automatically ensures the necessary reduction.

### ■ Derating for long motor cables or cables with larger cross-section

VLT 6000 HVAC has been tested using 300 m unscreened/unarmoured cable and 150 m screened/armoured cable.

VLT 6000 HVAC has been designed to work using a motor cable with a rated cross-section. If a cable with a larger cross-section is to be used, it is recommended to reduce the output current by 5% for every step the cross-section is increased. (Increased cable cross-section leads to increased capacity to earth, and thus an increased earth leakage current).

### ■ Derating for high switching frequency

A higher switching frequency (to be set in parameter 407, *Switching frequency*) leads to higher losses in the electronics of the VLT frequency converter.

VLT 6000 HVAC has a pulse pattern in which it is possible to set the switching frequency from 3.0-10.0/14.0 kHz.

The VLT frequency converter will automatically derate the rated output current  $I_{M,TN}$ , when the switching frequency exceeds 4.5 kHz.

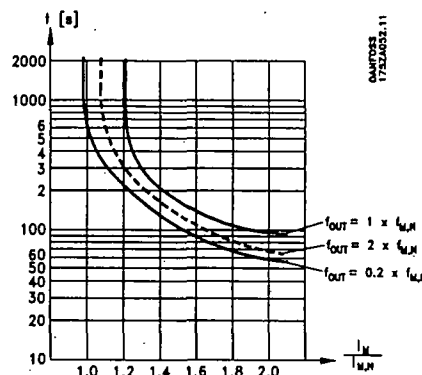
In both cases, the reduction is carried out linearly, down to 60% of  $I_{M,TN}$ .

The table gives the min., max. and factory-set switching frequencies for VLT 6000 HVAC units.

| Switching frequency [kHz] | Min. | Max. | Fact. |
|---------------------------|------|------|-------|
| VLT 6002-6005, 200 V      | 3.0  | 10.0 | 4.5   |
| VLT 6006-6032, 200 V      | 3.0  | 14.0 | 4.5   |
| VLT 6002-6011, 460 V      | 3.0  | 10.0 | 4.5   |
| VLT 6016-6072, 460 V      | 3.0  | 14.0 | 4.5   |
| VLT 6042-6062, 200 V      | 3.0  | 4.5  | 4.5   |
| VLT 6075-6550, 460 V      | 3.0  | 4.5  | 4.5   |
| VLT 6002-6011, 600 V      | 4.5  | 7.0  | 4.5   |
| VLT 6016-6032, 600 V      | 3.0  | 14.0 | 4.5   |
| VLT 6042-6062, 600 V      | 3.0  | 10.0 | 4.5   |
| VLT 6072-6275 600 V       | 3.0  | 4.5  | 4.5   |

### ■ Motor thermal protection

The motor temperature is calculated on the basis of motor current, output frequency and time. See parameter 117, *Motor thermal protection*.



### ■ Vibration and shock

VLT 6000 HVAC has been tested according to a procedure based on the following standards:

|              |   |
|--------------|---|
| IEC 68-2-6:  | Vibration (sinusoidal) - 1970                           |
| IEC 68-2-34: | Random vibration broad-band<br>- general requirements   |
| IEC 68-2-35: | Random vibration broad-band<br>- high reproducibility   |
| IEC 68-2-36: | Random vibration broad-band<br>- medium reproducibility |

VLT 6000 HVAC complies with requirements that correspond to conditions when the unit is mounted on the walls and floors of production premises, as well as in panels bolted to walls or floors.

### ■ Air humidity

VLT 6000 HVAC has been designed to meet the IEC 68-2-3 standard, EN 50178 pkt. 9.4.2.2/DIN 40040, class E, at 40°C.

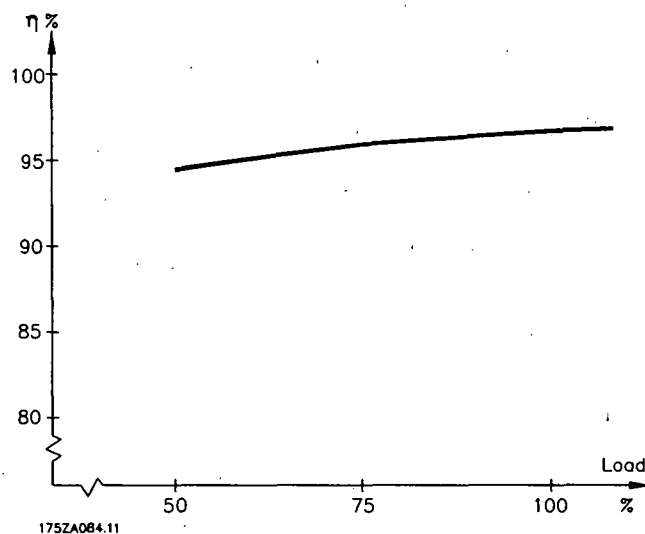
See specifications under *General technical data*.



## VLT® 6000 HVAC

### ■ Efficiency

To reduce energy consumption it is very important to optimize the efficiency of a system. The efficiency of each single element in the system should be as high as possible.



#### Efficiency of VLT 6000 HVAC ( $\eta_{VLT}$ )

The load on the frequency converter has little effect on its efficiency. In general, the efficiency is the same at the rated motor frequency  $f_{M,N}$ , regardless of whether the motor supplies 100% of the rated shaft torque or only 75%, i.e. in case of part loads.

The efficiency declines a little when the switching frequency is set to a value of above 4 kHz (parameter 407 *Switching frequency*). The rate of efficiency will also be slightly reduced if the mains voltage is 460 V, or if the motor cable is longer than 30 m.

#### Efficiency of the motor ( $\eta_{MOTOR}$ )

The efficiency of a motor connected to the frequency converter depends on the sine shape of the current. In general, the efficiency is just as good as with mains operation. The efficiency of the motor depends on the type of motor.

In the range of 75-100% of the rated torque, the efficiency of the motor is practically constant, both when it is controlled by the frequency converter and when it runs directly on mains.

In small motors, the influence from the U/f characteristic on efficiency is marginal; however, in motors from 11 kW and up, the advantages are significant.

In general, the switching frequency does not affect the efficiency of small motors. Motors from 11 kW and up have their efficiency improved (1-2%). This is because the sine shape of the motor current is almost perfect at high switching frequency.

#### Efficiency of the system ( $\eta_{SYSTEM}$ )

To calculate the system efficiency, the efficiency of VLT 6000 HVAC ( $\eta_{VLT}$ ) is multiplied by the efficiency of the motor ( $\eta_{MOTOR}$ ):

$$\eta_{SYSTEM} = \eta_{VLT} \times \eta_{MOTOR}$$

Based on the graph outlined above, it is possible to calculate the system efficiency at different speeds.

All about  
VLT 6000 HVAC



## VLT® 6000 HVAC

### ■ Mains supply interference/harmonics

A frequency converter takes up a non-sinusoidal current from mains, which increases the input current  $I_{RMS}$ . A non-sinusoidal current can be transformed by means of a Fourier analysis and split up into sine wave currents with different frequencies, i.e. different harmonic currents  $I_N$  with 50 Hz as the basic frequency:

| Harmonic currents | $I_1$ | $I_5$  | $I_7$  |
|-------------------|-------|--------|--------|
| Hz                | 50 Hz | 250 Hz | 350 Hz |

The harmonics do not affect the power consumption directly, but increase the heat losses in the installation (transformer, cables). Consequently, in plants with a rather high percentage of rectifier load, it is important to maintain harmonic currents at a low level to avoid overload of the transformer and high temperature in the cables.

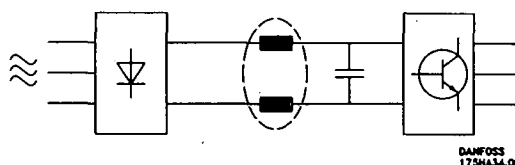
Harmonic currents compared to the RMS input current:

|             | Input current |
|-------------|---------------|
| $I_{RMS}$   | 1.0           |
| $I_1$       | 0.9           |
| $I_5$       | 0.4           |
| $I_7$       | 0.3           |
| $I_{11-49}$ | < 0.1         |

To ensure low, harmonic currents, VLT 6000 HVAC has intermediate circuit coils as standard. This normally reduces the input current  $I_{RMS}$  by 40%.

Some of the harmonic currents might disturb communication equipment connected to the same transformer or cause resonance in connection with power-factor correction batteries. VLT 6000 HVAC has been designed in accordance with the following standards:

- IEC 1000-3-2
- IEEE 519-1992
- IEC 22G/WG4
- EN 50178
- VDE 160, 5.3.1.1.2



The voltage distortion on the mains supply depends on the size of the harmonic currents multiplied by the mains impedance for the frequency in question. The total voltage distortion THD is calculated on the basis of the individual voltage harmonics using the following formula:

$$THD\% = \sqrt{U_5^2 + U_7^2 + \dots + U_N^2} \quad (U_N\% \text{ of } U)$$

### ■ Power factor

The power factor is the relation between  $I_1$  and  $I_{RMS}$ .

The power factor for 3-phase control

$$= \frac{\sqrt{3} \times U \times I_1 \times \cos \varphi_1}{\sqrt{3} \times U \times I_{RMS}}$$

$$\text{Power factor} = \frac{I_1 \times \cos \varphi_1}{I_{RMS}} = \frac{I_1}{I_{RMS}} \quad \text{since } \cos \varphi = 1$$

The power factor indicates the extent to which the frequency converter imposes a load on the mains supply.

The lower the power factor, the higher the  $I_{RMS}$  for the same kW performance.

In addition, a high power factor indicates that the different harmonic currents are low.

$$I_{RMS} = \sqrt{I_1^2 + I_5^2 + I_7^2 + \dots + I_n^2}$$



## VLT® 6000 HVAC

## ■ EMC test results (Emission, Immunity)

The following test results have been obtained using a system with a VLT frequency converter (with options if relevant), a screened control cable, a control box with potentiometer, as well as a motor and motor cable.

| VLT 6002-6011/380-460V<br>VLT 6002-6005/200-240V | Emission                                       |                             |                          |                                      |                          |                                      |
|--|--|-----------------------------|--------------------------|--------------------------------------|--------------------------|--------------------------------------|
|  | Environment                                    | Industrial environment      |                          | Housing, trades and light industries |                          |                                      |
|  | Basic standard                                 | EN 55011 Class A1           |                          | EN 55011 Class B1                    |                          | EN 61800-3                           |
| Setup  | Motor cable                                    | Conducted<br>150 kHz-30 MHz | Radiated<br>30 MHz-1 GHz | Conducted<br>150 kHz-30 MHz          | Radiated<br>30 MHz-1 GHz | Conducted/radiated<br>150 kHz-30 MHz |
| VLT 6000 with<br>RFI filter option               | 300 m unscreened/<br>unarmoured                | Yes <sup>1)</sup>           | No                       | No                                   | No                       | Yes/No                               |
|  | 50 m br. screened/<br>armoured (Bookstyle 20m) | Yes                         | Yes                      | Yes                                  | No                       | Yes/Yes                              |
|  | 150m br. screened/<br>armoured                 | Yes                         | Yes                      | No                                   | No                       | Yes/Yes                              |
| VLT 6000<br>with<br>RFI-filter<br>(+ LC-module)  | 300 m unscreened/<br>unarmoured                | Yes                         | No                       | No                                   | No                       | Yes/No                               |
|  | 50 m br. screened/<br>armoured                 | Yes                         | Yes                      | Yes                                  | No                       | Yes/Yes                              |
|  | 150m br. screened/<br>armoured                 | Yes                         | Yes                      | No                                   | No                       | Yes/Yes                              |

1) Depending on installation conditions

| VLT 6016-6550/380-460 V<br>VLT 6006-6062/200-240 V | Emission                        |                             |                          |                                      |                          |
|--|---------------------------------|-----------------------------|--------------------------|--------------------------------------|--------------------------|
|  | Environment                     | Industrial environment      |                          | Housing, trades and light industries |                          |
|  | Basic standard                  | EN 55011 Class A1           |                          | EN 55011 Class B1                    |                          |
| Setup  | Motor cable                     | Conducted<br>150 kHz-30 MHz | Radiated<br>30 MHz-1 GHz | Conducted<br>150 kHz-30 MHz          | Radiated<br>30 MHz-1 GHz |
| VLT 6000 w/o<br>RFI filter option                  | 300 unscreened/<br>unarmoured   | No                          | No                       | No                                   | No                       |
|  | 150 m br. screened/<br>armoured | No                          | Yes                      | No                                   | No                       |
| VLT 6000<br>with RFI-module                        | 300 m unscreened/<br>unarmoured | Yes <sup>1,2)</sup>         | No                       | No                                   | No                       |
|  | 50 m br. screened/<br>armoured  | Yes                         | Yes                      | Yes <sup>1, 3)</sup>                 | No                       |
|  | 150 m br. screened/<br>armoured | Yes                         | Yes                      | No                                   | No                       |

1) Does not apply to VLT 6350 - 6550.

2) Depending on installation conditions

3) VLT 6100-6125, 380-460 V and VLT 6042-6062, 200-240 V with 176F1818, VLT 6150-6275, 380-460 V with 176F1819

**All about  
VLT 6000 HVAC**

In order to minimise the conducted noise to the mains supply and the radiated noise from the frequency converter system, the motor cables should be as short as possible and the screen ends should be made in accordance with the section on electrical installation.




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**VLT® 6000 HVAC**


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**■ EMC Immunity**

In order to confirm immunity against interference from electrical phenomena, the following immunity test has been made on a system consisting of a VLT frequency converter (with options, if relevant), a screened/armoured control cable and control box with potentiometer, motor cable and motor.

The tests were made in accordance with the following basic standards:

- **EN 61000-4-2 (IEC 1000-4-2): Electrostatic discharges (ESD)**  
Simulation of electrostatic discharges from human beings.
- **EN 61000-4-3 (IEC 1000-4-3): Incoming electromagnetic field radiation, amplitude modulated**  
Simulation of the effects of radar and radio communication equipment as well as mobile communications equipment.
- **EN 61000-4-4 (IEC 1000-4-4): Burst transients**  
Simulation of interference brought about by switching with a contactor, relays or similar devices.
- **EN 61000-4-5 (IEC 1000-4-5): Surge transients**  
Simulation of transients brought about e.g. by lightning that strikes near installations.
- **ENV 50204: Incoming electromagnetic field, pulse modulated**  
Simulation of the impact from GSM telephones.
- **ENV 61000-4-6: Cable-borne HF**  
Simulation of the effect of radio transmission equipment connected to supply cables.
- **VDE 0160 class W2 test pulse: Mains transients**  
Simulation of high-energy transients brought about by main fuse breakage, switching of power factor-correction capacitors, etc.



## VLT® 6000 HVAC

### ■ Immunity, continued

VLT 6002-6550 380-460 V, VLT 6002-6027 200-240 V.

| Basic standard              | Burst<br>IEC 1000-4-4 | Surge<br>IEC 1000-4-5   | ESD<br>1000-4-2    | Radiated electro-<br>magnetic field<br>IEC 1000-4-3 | Mains<br>distortion<br>VDE 0160    | RF common<br>mode voltage<br>ENV 50141 | Radiated radio<br>freq. elect. field<br>ENV 50140 |
|-----------------------------|-----------------------|-------------------------|--------------------|---|------------------------------------|--|---|
| Acceptance criterion        | B                     | B                       | B                  | A   |                                    | A                                      | A   |
| Port connection             | CM                    | DM CM                   |                    | DM  | CM                                 | DM                                     |   |
| Line                        | OK                    | OK OK                   | -                  | -   | OK                                 | OK                                     | -   |
| Motor                       | OK                    | - -                     | -                  | -   | -                                  | -                                      | -   |
| Control lines               | OK                    | - OK                    | -                  | -   | -                                  | OK                                     | -   |
| PROFIBUS option             | OK                    | - OK                    | -                  | -   | -                                  | -                                      | -   |
| Signal Interface<3 m        | OK                    | - -                     | -                  | -   | -                                  | -                                      | -   |
| Enclosure                   | -                     | - -                     | OK                 | OK  | -                                  | -                                      | OK  |
| Load sharing                | OK                    | - -                     | -                  | -   | -                                  | OK                                     | -   |
| Standard bus                | OK                    | - OK                    | -                  | -   | -                                  | OK                                     | -   |
| <b>Basic specifications</b> |                       |                         |                    |   |                                    |  |   |
| Line                        | 4 kV/5kHz/DCN         | 2 kV/2Ω 4 kV/12Ω        | -                  | -   | 2,3 x U <sub>N</sub> <sup>2)</sup> | 10 V <sub>RMS</sub>                    | -   |
| Motor                       | 4 kV/5kHz/CCC         | - -                     | -                  | -   | -                                  | 10 V <sub>RMS</sub>                    | -   |
| Control lines               | 2 kV/5kHz/CCC         | - 2 kV/2Ω <sup>1)</sup> | -                  | -   | -                                  | 10 V <sub>RMS</sub>                    | -   |
| PROFIBUS option             | 2 kV/5kHz/CCC         | - 2 kV/2Ω <sup>1)</sup> | -                  | -   | -                                  | 10 V <sub>RMS</sub>                    | -   |
| Signal interface<3 m        | 1 kV/5kHz/CCC         | - -                     | -                  | -   | -                                  | 10 V <sub>RMS</sub>                    | -   |
| Enclosure                   | -                     | - -                     | 8 kV AD<br>6 kV CD | 10 V/m  | -                                  | -                                      | -   |
| Load sharing                | 4 kV/5kHz/CCC         | - -                     | -                  | -   | -                                  | 10 V <sub>RMS</sub>                    | -   |
| Standard bus                | 2 kV/5kHz/CCC         | - 4 kV/2Ω <sup>1)</sup> | -                  | -   | -                                  | 10 V <sub>RMS</sub>                    | -   |

DM: Differential mode

CM: Common mode

CCC: Capacitive clamp coupling

DCN: Direct coupling network

<sup>1)</sup> Injection on cable shield

<sup>2)</sup> 2.3 x U<sub>N</sub>: max. test pulse 380 V<sub>AC</sub>: Class 2/1250 V<sub>PEAK</sub>, 415 V<sub>AC</sub>: Class 1/1350 V<sub>PEAK</sub>

All about  
VLT 6000 HVAC



## VLT® 6000 HVAC

### ■ Definitions

Definitions are given in alphabetical order.

#### Analogue inputs:

The analogue inputs can be used for controlling various functions of the VLT frequency converter.

There are two types of analogue inputs:

Current input, 0-20 mA

Voltage input, 0-10 V DC.

#### Analogue ref.

A signal transmitted to input 53, 54 or 60. Can be voltage or current.

#### Analogue outputs:

There are two analogue outputs, which are able to supply a signal of 0-20 mA, 4-20 mA or a digital signal.

#### Automatic motor adjustment, AMA:

Automatic motor adjustment algorithm, which determines the electrical parameters for the connected motor, at standstill.

#### AWG:

Means American Wire Gauge, i.e. the American measuring unit for cable cross-section.

#### Control command:

By means of the control unit and the digital inputs, it is possible to start and stop the connected motor.

Functions are divided into two groups, with the following priorities:

Group 1 Reset, Coasting stop, Reset and Coasting stop, DC braking, Stop and the [OFF/STOP] key.

Group 2 Start, Pulse start, Reversing, Start reversing, Jog and Freeze output

Group 1 functions are called Start-disable commands. The difference between group 1 and group 2 is that in group 1 all stop signals must be cancelled for the motor to start. The motor can then be started by means of a single start signal in group 2.

A stop command given as a group 1 command results in the display indication STOP.

A missing stop command given as a group 2 command results in the display indication STAND BY.

#### Digital inputs:

The digital inputs can be used for controlling various functions of the VLT frequency converter.

#### Digital outputs:

There are four digital outputs, two of which activate a relay switch. The outputs are able to supply a 24 V DC (max. 40 mA) signal.

#### $f_{jog}$

The output frequency from the VLT frequency converter transmitted to the motor when the jog function is activated (via digital terminals or serial communication).

#### $f_M$

The output frequency from the VLT frequency converter transmitted to the motor.

#### $f_{M,N}$

The rated motor frequency (nameplate data).

#### $f_{MAX}$

Maximum output frequency transmitted to the motor.

#### $f_{MIN}$

Minimum output frequency transmitted to the motor.

#### $I_M$

The current transmitted to the motor.

#### $I_{M,N}$

The rated motor current (nameplate data).

#### Initializing:

If initializing is carried out (see parameter 620 *Operating mode*), the VLT frequency converter returns to the factory setting.

#### $I_{VLTMAX}$

The maximum output current.

#### $I_{VLTN}$

The rated output current supplied by the VLT frequency converter.

#### LCP:

The control panel, which makes up a complete interface for control and programming of VLT 6000 HVAC. The control panel is detachable and may, as an alternative, be installed up to 3 metres away from the VLT frequency converter, i.e. in a front panel, by means of the installation kit option.



## VLT® 6000 HVAC

### LSB:

Least significant bit.  
Used in serial communication.

### MCM:

Stands for Mille Circular Mil, an American measuring unit for cable cross-section.

### MSB:

Most significant bit.  
Used in serial communication.

### $n_{M,N}$

The rated motor speed (nameplate data).

### $\eta_{VT}$

The efficiency of the VLT frequency converter is defined as the ratio between the power output and the power input.

### On-line/off-line parameters:

On-line parameters are activated immediately after the data value is changed. Off-line parameters are not activated until OK has been entered on the control unit.

### PID:

The PID regulator maintains the desired speed (pressure, temperature, etc.) by adjusting the output frequency to match the varying load.

### $P_{M,N}$

The rated power delivered by the motor (nameplate data).

### Preset ref.

A permanently defined reference, which can be set from -100% to +100% of the reference range. There are four preset references, which can be selected via the digital terminals.

### $Ref_{MAX}$

The maximum value which the reference signal may have. Set in parameter 205 *Maximum reference*,  $Ref_{MAX}$ .

### $Ref_{MIN}$

The smallest value which the reference signal may have. Set in parameter 204 *Minimum reference*,  $Ref_{MIN}$ .

### Setup:

There are four Setups, in which it is possible to save parameter settings. It is possible to change between the four parameter Setups and to edit one Setup, while another Setup is active.

### Start-disable command:

A stop command that belongs to group 1 of the control commands - see this group.

### Stop command:

See Control commands.

### Thermistor:

A temperature-dependent resistor placed where the temperature is to be monitored (VLT or motor).

### Trip:

A state which occurs in different situations, e.g. if the VLT frequency converter is subjected to an over-temperature. A trip can be cancelled by pressing reset or, in some cases, automatically.

### Trip locked:

A state which occurs in different situations, e.g. if the VLT frequency converter is subject to an overtemperature. A locked trip can be cancelled by cutting off mains and restarting the VLT frequency converter.

### $U_M$

The voltage transmitted to the motor.

### $U_{M,N}$

The rated motor voltage (nameplate data).

### $U_{VT,MAX}$

The maximum output voltage.

### VT characteristics:

Variable torque characteristics, used for pumps and fans.



## VLT® 6000 HVAC

## ■ Factory settings

| PNU # | Parameter description                      | Factory setting                 | Range               | Changes during operation | 4-Setup | Conversion index | Data type |
|-------|--|---------------------------------|---------------------|--------------------------|---------|------------------|-----------|
| 001   | Language                                   | English                         |                     | Yes                      | No      | 0                | 5         |
| 002   | Active Setup                               | Setup 1                         |                     | Yes                      | No      | 0                | 5         |
| 003   | Copying of Setups                          | No copying                      |                     | No                       | No      | 0                | 5         |
| 004   | LCP copy                                   | No copying                      |                     | No                       | No      | 0                | 5         |
| 005   | Max value of user-defined readout          | 100.00                          | 0 - 999.999,99      | Yes                      | Yes     | -2               | 4         |
| 006   | Unit for user-defined readout              | No unit                         |                     | Yes                      | Yes     | 0                | 5         |
| 007   | Big display readout                        | Frequency, Hz                   |                     | Yes                      | Yes     | 0                | 5         |
| 008   | Small display readout 1.1                  | Reference, Unit                 |                     | Yes                      | Yes     | 0                | 5         |
| 009   | Small display readout 1.2                  | Motor current, A                |                     | Yes                      | Yes     | 0                | 5         |
| 010   | Small display readout 1.3                  | Power, kW                       |                     | Yes                      | Yes     | 0                | 5         |
| 011   | Unit of local reference                    | Hz                              |                     | Yes                      | Yes     | 0                | 5         |
| 012   | Hand start on LCP                          | Enable                          |                     | Yes                      | Yes     | 0                | 5         |
| 013   | OFF/STOP on LCP                            | Enable                          |                     | Yes                      | Yes     | 0                | 5         |
| 014   | Auto start on LCP                          | Enable                          |                     | Yes                      | Yes     | 0                | 5         |
| 015   | Reset on LCP                               | Enable                          |                     | Yes                      | Yes     | 0                | 5         |
| 016   | Lock for data change                       | Not locked                      |                     | Yes                      | Yes     | 0                | 5         |
| 017   | Operating state at power-up, local control | Auto restart                    |                     | Yes                      | Yes     | 0                | 5         |
| 100   | Configuration                              | Open loop                       |                     | No                       | Yes     | 0                | 5         |
| 101   | Torque characteristics                     | Automatic Energy Optimisation   |                     | No                       | Yes     | 0                | 5         |
| 102   | Motor power, $P_{M,N}$                     | Depends on the unit             | 0.25-500 kW         | No                       | Yes     | -1               | 6         |
| 103   | Motor voltage, $U_{M,N}$                   | Depends on the unit             | 200 - 575 V         | No                       | Yes     | 0                | 6         |
| 104   | Motor frequency, $f_{M,N}$                 | 50 Hz                           | 24-1000 Hz          | No                       | Yes     | 0                | 6         |
| 105   | Motor current, $I_{M,N}$                   | Depends on the unit             | 0.01 - $I_{VLTMAX}$ | No                       | Yes     | -2               | 7         |
| 106   | Rated motor speed, $n_{M,N}$               | Depends on par. 102 Motor power | 100-60000 rpm       | No                       | Yes     | 0                | 6         |
| 107   | Automatic motor adaptation, AMA            | Optimisation disable            |                     | No                       | No      | 0                | 5         |
| 108   | Start voltage of parallel motors           | Depends on par. 103             | 0.0 - par. 103      | Yes                      | Yes     | -1               | 6         |
| 109   | Resonance dampening                        | 100 %                           | 0 - 500 %           | Yes                      | Yes     | 0                | 6         |
| 110   | High break-away torque                     | OFF                             | 0.0 - 0.5 sec.      | Yes                      | Yes     | -1               | 5         |
| 111   | Start delay                                | 0.0 sec.                        | 0.0 - 120.0 sec.    | Yes                      | Yes     | -1               | 6         |
| 112   | Motor preheater                            | Disable                         |                     | Yes                      | Yes     | 0                | 5         |
| 113   | Motor preheater DC current                 | 50 %                            | 0 - 100 %           | Yes                      | Yes     | 0                | 6         |
| 114   | DC braking current                         | 50 %                            | 0 - 100 %           | Yes                      | Yes     | 0                | 6         |
| 115   | DC braking time                            | OFF                             | 0.0 - 60.0 sec.     | Yes                      | Yes     | -1               | 6         |
| 116   | DC brake cut-in frequency                  | OFF                             | 0.0-par. 202        | Yes                      | Yes     | -1               | 6         |
| 117   | Motor thermal protection                   | ETR-Trip 1                      |                     | Yes                      | Yes     | 0                | 5         |



## VLT® 6000 HVAC

## ■ Factory settings

| PNU # | Parameter description                  | Factory setting            | Range                           | Changes during operation | 4-Setup | Conversion index | Data type |
|-------|--|----------------------------|---------------------------------|--------------------------|---------|------------------|-----------|
| 200   | Output frequency range                 | 0 - 120 Hz                 | 0 - 1000 Hz                     | No                       | Yes     | 0                | 5         |
| 201   | Output frequency low limit, $f_{MIN}$  | 0.0 Hz                     | 0.0 - $f_{MAX}$                 | Yes                      | Yes     | -1               | 6         |
| 202   | Output frequency high limit, $f_{MAX}$ | 50 Hz                      | $f_{MIN}$ - par. 200            | Yes                      | Yes     | -1               | 6         |
| 203   | Reference site                         | Hand/Auto linked reference |                                 | Yes                      | Yes     | 0                | 5         |
| 204   | Minimum reference, $Ref_{MIN}$         | 0.000                      | 0.000 - par. 100                | Yes                      | Yes     | -3               | 4         |
| 205   | Maximum reference, $Ref_{MAX}$         | 50.000                     | par. 100 - 999,999,999          | Yes                      | Yes     | -3               | 4         |
| 206   | Ramp-up time                           | Depends on the unit        | 1 - 3600                        | Yes                      | Yes     | 0                | 7         |
| 207   | Ramp-down time                         | Depends on the unit        | 1 - 3600                        | Yes                      | Yes     | 0                | 7         |
| 208   | Automatic ramp-up/down                 | Enable                     |                                 | Yes                      | Yes     | 0                | 5         |
| 209   | Jog frequency                          | 10.0 Hz                    | 0.0 - par. 100                  | Yes                      | Yes     | -1               | 6         |
| 210   | Reference type                         | Sum                        |                                 | Yes                      | Yes     | 0                | 5         |
| 211   | Preset reference 1                     | 0.00 %                     | -100.00 - 100.00 %              | Yes                      | Yes     | -2               | 3         |
| 212   | Preset reference 2                     | 0.00 %                     | -100.00 - 100.00 %              | Yes                      | Yes     | -2               | 3         |
| 213   | Preset reference 3                     | 0.00 %                     | -100.00 - 100.00 %              | Yes                      | Yes     | -2               | 3         |
| 214   | Preset reference 4                     | 0.00 %                     | -100.00 - 100.00 %              | Yes                      | Yes     | -2               | 3         |
| 215   | Current limit, $I_{LIM}$               | $1.0 \times I_{VLTN} [A]$  | 0.1 - $1.1 \times I_{VLTN} [A]$ | Yes                      | Yes     | -1               | 6         |
| 216   | Frequency bypass, bandwidth            | 0 Hz                       | 0 - 100 Hz                      | Yes                      | Yes     | 0                | 6         |
| 217   | Frequency bypass 1                     | 120 Hz                     | 0.0 - par. 200                  | Yes                      | Yes     | -1               | 6         |
| 218   | Frequency bypass 2                     | 120 Hz                     | 0.0 - par. 200                  | Yes                      | Yes     | -1               | 6         |
| 219   | Frequency bypass 3                     | 120 Hz                     | 0.0 - par. 200                  | Yes                      | Yes     | -1               | 6         |
| 220   | Frequency bypass 4                     | 120 Hz                     | 0.0 - par. 200                  | Yes                      | Yes     | -1               | 6         |
| 221   | Warning: Low current, $I_{LOW}$        | 0.0 A                      | 0.0 - par. 222                  | Yes                      | Yes     | -1               | 6         |
| 222   | Warning: High current, $I_{HIGH}$      | $I_{VLTMAX}$               | Par. 221 - $I_{VLTMAX}$         | Yes                      | Yes     | -1               | 6         |
| 223   | Warning: Low frequency, $f_{LOW}$      | 0.0 Hz                     | 0.0 - par. 224                  | Yes                      | Yes     | -1               | 6         |
| 224   | Warning: High frequency, $f_{HIGH}$    | 120.0 Hz                   | Par. 223 - par. 200/202         | Yes                      | Yes     | -1               | 6         |
| 225   | Warning: Low reference, $Ref_{LOW}$    | -999,999,999               | -999,999,999 - par. 226         | Yes                      | Yes     | -3               | 4         |
| 226   | Warning: High reference, $Ref_{HIGH}$  | 999,999,999                | Par. 225 - 999,999,999          | Yes                      | Yes     | -3               | 4         |
| 227   | Warning: Low feedback, $FB_{LOW}$      | -999,999,999               | -999,999,999 - par. 228         | Yes                      | Yes     | -3               | 4         |
| 228   | Warning: High feedback, $FB_{HIGH}$    | 999,999,999                | Par. 227 - 999,999,999          | Yes                      | Yes     | -3               | 4         |

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"No" means that the VLT frequency converter must be stopped before a change can be made.

## 4-Setup:

"Yes" means that the parameter can be programmed individually in each of the four setups, i.e. the same parameter can have four different data values. "No" means that the data value will be the same in all four setups.

## Conversion index:

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## Conversion index

## Conversion factor

|    |        |
|----|--------|
| 74 | 0.1    |
| 2  | 100    |
| 1  | 10     |
| 0  | 1      |
| -1 | 0.1    |
| -2 | 0.01   |
| -3 | 0.001  |
| -4 | 0.0001 |

## Data type:

Data type shows the type and length of the telegram.

| Data type | Description |
|-----------|-------------|
| 3         | Integer 16  |
| 4         | Integer 32  |
| 5         | Unsigned 8  |
| 6         | Unsigned 16 |
| 7         | Unsigned 32 |
| 9         | Text string |

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## VLT® 6000 HVAC

## ■ Factory settings

| PNU # | Parameter description               | Factory setting                   | Range                     | Changes during operation | 4-Setup | Conversion index | Data type |
|-------|-------------------------------------|-----------------------------------|---------------------------|--------------------------|---------|------------------|-----------|
| 300   | Terminal 16 Digital input           | Reset                             |                           | Yes                      | Yes     | 0                | 5         |
| 301   | Terminal 17 Digital input           | Freeze output                     |                           | Yes                      | Yes     | 0                | 5         |
| 302   | Terminal 18 Digital input           | Start                             |                           | Yes                      | Yes     | 0                | 5         |
| 303   | Terminal 19 Digital input           | Reversing                         |                           | Yes                      | Yes     | 0                | 5         |
| 304   | Terminal 27 Digital input           | Coasting stop, inverse            |                           | Yes                      | Yes     | 0                | 5         |
| 305   | Terminal 29 Digital input           | Jog                               |                           | Yes                      | Yes     | 0                | 5         |
| 306   | Terminal 32 Digital input           | No operation                      |                           | Yes                      | Yes     | 0                | 5         |
| 307   | Terminal 33 Digital input           | No operation                      |                           | Yes                      | Yes     | 0                | 5         |
| 308   | Terminal 53, analogue input voltage | Reference                         |                           | Yes                      | Yes     | 0                | 5         |
| 309   | Terminal 53, min. scaling           | 0.0 V                             | 0.0 - 10.0 V              | Yes                      | Yes     | -1               | 5         |
| 310   | Terminal 53, max. scaling           | 10.0 V                            | 0.0 - 10.0 V              | Yes                      | Yes     | -1               | 5         |
| 311   | Terminal 54, analogue input voltage | No operation                      |                           | Yes                      | Yes     | 0                | 5         |
| 312   | Terminal 54, min. scaling           | 0.0 V                             | 0.0 - 10.0 V              | Yes                      | Yes     | -1               | 5         |
| 313   | Terminal 54, max. scaling           | 10.0 V                            | 0.0 - 10.0 V              | Yes                      | Yes     | -1               | 5         |
| 314   | Terminal 60, analogue input current | Reference                         |                           | Yes                      | Yes     | 0                | 5         |
| 315   | Terminal 60, min. scaling           | 4.0 mA                            | 0.0 - 20.0 mA             | Yes                      | Yes     | -4               | 5         |
| 316   | Terminal 60, max. scaling           | 20.0 mA                           | 0.0 - 20.0 mA             | Yes                      | Yes     | -4               | 5         |
| 317   | Time out                            | 10 sec.                           | 1 - 99 sec.               | Yes                      | Yes     | 0                | 5         |
| 318   | Function after time out             | Off                               |                           | Yes                      | Yes     | 0                | 5         |
| 319   | Terminal 42, output                 | 0 : $I_{MAX} \Rightarrow 0-20$ mA |                           | Yes                      | Yes     | 0                | 5         |
| 320   | Terminal 42, output, pulse scaling  | 5000 Hz                           | 1 - 32000 Hz              | Yes                      | Yes     | 0                | 6         |
| 321   | Terminal 45, output                 | 0 : $I_{MAX} \Rightarrow 0-20$ mA |                           | Yes                      | Yes     | 0                | 5         |
| 322   | Terminal 45, output, pulse scaling  | 5000 Hz                           | 1 - 32000 Hz              | Yes                      | Yes     | 0                | 6         |
| 323   | Relay 1, output function            | Alarm                             |                           | Yes                      | Yes     | 0                | 5         |
| 324   | Relay 01, ON delay                  | 0.00 sec.                         | 0 - 600 sec.              | Yes                      | Yes     | 0                | 6         |
| 325   | Relay 01, OFF delay                 | 0.00 sec.                         | 0 - 600 sec.              | Yes                      | Yes     | 0                | 6         |
| 326   | Relay 2, output function            | Running                           |                           | Yes                      | Yes     | 0                | 5         |
| 327   | Pulse reference, max. frequency     | 5000 Hz                           | Depends on input terminal | Yes                      | Yes     | 0                | 6         |
| 328   | Pulse feedback, max. frequency      | 25000 Hz                          | 0 - 65000 Hz              | Yes                      | Yes     | 0                | 6         |

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## 4-Setup:

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## Conversion index:

This number refers to a conversion figure to be used when writing or reading to or from a VLT frequency converter by means of serial communication.

| Conversion index | Conversion factor |
|------------------|-------------------|
| 74               | 0.1               |
| 2                | 100               |
| 1                | 10                |
| 0                | 1                 |
| -1               | 0.1               |
| -2               | 0.01              |
| -3               | 0.001             |
| -4               | 0.0001            |

## Data type:

| Data type | Description |
|-----------|-------------|
| 3         | Integer 16  |
| 4         | Integer 32  |
| 5         | Unsigned 8  |
| 6         | Unsigned 16 |
| 7         | Unsigned 32 |
| 9         | Text string |



## VLT® 6000 HVAC

## ■ Factory settings

| PNU # | Parameter description             | Factory setting     | Range                     | Changes during operation | 4-Setup | Conversion index | Data type |
|-------|-----------------------------------|---------------------|---------------------------|--------------------------|---------|------------------|-----------|
| 400   | Reset function                    | Manual reset        |                           | Yes                      | Yes     | 0                | 5         |
| 401   | Automatic restart time            | 10 sec.             | 0 - 600 sec.              | Yes                      | Yes     | 0                | 6         |
| 402   | Flying start                      | Disable             |                           | Yes                      | Yes     | 1                | 5         |
| 403   | Sleep mode timer                  | Off                 | 0 - 300 sec.              | Yes                      | Yes     | 0                | 6         |
| 404   | Sleep frequency                   | 0 Hz                | $f_{MIN}$ - Par. 405      | Yes                      | Yes     | 1                | 6         |
| 405   | Wake up frequency                 | 50 Hz               | Par. 404 - $f_{MAX}$      | Yes                      | Yes     | 1                | 6         |
| 406   | Boost setpoint                    | 100%                | 1 - 200 %                 | Yes                      | Yes     | 0                | 6         |
| 407   | Switching frequency               | Depends on the unit | 3.0 - 14.0 kHz            | Yes                      | Yes     | 2                | 5         |
| 408   | Interference reduction method     | ASFM                |                           | Yes                      | Yes     | 0                | 5         |
| 409   | Function in case of no load       | Warning             |                           | Yes                      | Yes     | 0                | 5         |
| 410   | Function at mains failure         | Trip                |                           | Yes                      | Yes     | 0                | 5         |
| 411   | Function at overtemperature       | Trip                |                           | Yes                      | Yes     | 0                | 5         |
| 412   | Trip delay overcurrent, $t_{LIM}$ | 60 sec.             | 0 - 60 sec.               | Yes                      | Yes     | 0                | 5         |
| 413   | Minimum feedback, $FB_{MIN}$      | 0.000               | -999,999.999 - $FB_{MIN}$ | Yes                      | Yes     | 3                | 4         |
| 414   | Maximum feedback, $FB_{MAX}$      | 100.000             | $FB_{MIN}$ - 999,999.999  | Yes                      | Yes     | 3                | 4         |
| 415   | Units relating to closed loop     | %                   |                           | Yes                      | Yes     | 1                | 5         |
| 416   | Feedback conversion               | Linear              |                           | Yes                      | Yes     | 0                | 5         |
| 417   | Feedback calculation              | Maximum             |                           | Yes                      | Yes     | 0                | 5         |
| 418   | Setpoint 1                        | 0.000               | $FB_{MIN}$ - $FB_{MAX}$   | Yes                      | Yes     | 3                | 4         |
| 419   | Setpoint 2                        | 0.000               | $FB_{MIN}$ - $FB_{MAX}$   | Yes                      | Yes     | 3                | 4         |
| 420   | PID normal/inverse control        | Normal              |                           | Yes                      | Yes     | 0                | 5         |
| 421   | PID anti windup                   | On                  |                           | Yes                      | Yes     | 0                | 5         |
| 422   | PID start-up frequency            | 0 Hz                | $f_{MIN}$ - $f_{MAX}$     |                          |         | 1                | 6         |
| 423   | PID proportional gain             | 0.01                | 0.00 - 10.00              | Yes                      | Yes     | 2                | 6         |
| 424   | PID integration time              | Off                 | 0.01 - 9999.00 s. (Off)   | Yes                      | Yes     | 2                | 7         |
| 425   | PID differentiation time          | Off                 | 0.0 (Off) - 10.00 sec.    | Yes                      | Yes     | 2                | 6         |
| 426   | PID differentiator gain limit     | 5.0                 | 5.0 - 50.0                | Yes                      | Yes     | 1                | 6         |
| 427   | PID lowpass filter time           | 0.01                | 0.01 - 10.00              | Yes                      | Yes     | 2                | 6         |

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## VLT® 6000 HVAC

### ■ Factory settings

| PNU # | Parameter description                      | Factory setting | Range               | Changes during operation | 4-Setup | Conversion index | Data type |
|-------|--|-----------------|---------------------|--------------------------|---------|------------------|-----------|
| 500   | Protocol                                   | FC-protocol     |                     | Yes                      | Yes     | 0                | 5         |
| 501   | Address                                    | 1               | Depends on par. 500 | Yes                      | No      | 0                | 6         |
| 502   | Baudrate                                   | 9600 Baud       |                     | Yes                      | No      | 0                | 5         |
| 503   | Coasting                                   | Logic or        |                     | Yes                      | Yes     | 0                | 5         |
| 504   | DC-brake                                   | Logic or        |                     | Yes                      | Yes     | 0                | 5         |
| 505   | Start                                      | Logic or        |                     | Yes                      | Yes     | 0                | 5         |
| 506   | Direction of rotation                      | Logic or        |                     | Yes                      | Yes     | 0                | 5         |
| 507   | Selection of Setup                         | Logic or        |                     | Yes                      | Yes     | 0                | 5         |
| 508   | Selection of preset reference              | Logic or        |                     | Yes                      | Yes     | 0                | 5         |
| 509   | Data read-out: Reference %                 |                 |                     | No                       | No      | -1               | 3         |
| 510   | Data read-out: Reference unit              |                 |                     | No                       | No      | -3               | 4         |
| 511   | Data read-out: Feedback                    |                 |                     | No                       | No      | -3               | 4         |
| 512   | Data read-out: Frequency                   |                 |                     | No                       | No      | -1               | 6         |
| 513   | User defined read-out                      |                 |                     | No                       | No      | -2               | 7         |
| 514   | Data read-out: Current                     |                 |                     | No                       | No      | -2               | 7         |
| 515   | Data read-out: Power, kW                   |                 |                     | No                       | No      | 1                | 7         |
| 516   | Data read-out: Power, HP                   |                 |                     | No                       | No      | -2               | 7         |
| 517   | Data read-out: Motor voltage               |                 |                     | No                       | No      | -1               | 6         |
| 518   | Data read-out: DC link voltage             |                 |                     | No                       | No      | 0                | 6         |
| 519   | Data read-out: Motor temp.                 |                 |                     | No                       | No      | 0                | 5         |
| 520   | Data read-out: VLT temp.                   |                 |                     | No                       | No      | 0                | 5         |
| 521   | Data read-out: Digital input               |                 |                     | No                       | No      | 0                | 5         |
| 522   | Data read-out: Terminal 53, analogue input |                 |                     | No                       | No      | -1               | 3         |
| 523   | Data read-out: Terminal 54, analogue input |                 |                     | No                       | No      | -1               | 3         |
| 524   | Data read-out: Terminal 60, analogue input |                 |                     | No                       | No      | 4                | 3         |
| 525   | Data read-out: Pulse reference             |                 |                     | No                       | No      | -1               | 7         |
| 526   | Data read-out: External reference %        |                 |                     | No                       | No      | -1               | 3         |
| 527   | Data read-out: Status word, hex            |                 |                     | No                       | No      | 0                | 6         |
| 528   | Data read-out: Heat sink temperature       |                 |                     | No                       | No      | 0                | 5         |
| 529   | Data read-out: Alarm word, hex             |                 |                     | No                       | No      | 0                | 7         |
| 530   | Data read-out: Control word, hex           |                 |                     | No                       | No      | 0                | 6         |
| 531   | Data read-out: Warning word, hex           |                 |                     | No                       | No      | 0                | 7         |
| 532   | Data read-out: Extended status word, hex   |                 |                     | No                       | No      | 0                | 7         |
| 533   | Display text 1                             |                 |                     | No                       | No      | 0                | 9         |
| 534   | Display text 2                             |                 |                     | No                       | No      | 0                | 9         |
| 535   | Busfeedback 1                              |                 |                     | No                       | No      | 0                | 3         |
| 536   | Busfeedback 2                              |                 |                     | No                       | No      | 0                | 3         |
| 537   | Data read-out: Relay status                |                 |                     | No                       | No      | 0                | 5         |
| 555   | Bus time interval                          | 1 sec.          | 1 - 99 sec.         | Yes                      | Yes     | 0                | 5         |
| 556   | Bus time interval function                 | OFF             |                     | Yes                      | Yes     | 0                | 5         |
| 560   | N2 Override release time                   | OFF             | 1 - 65534 sec.      | Yes                      | No      | 0                | 6         |
| 565   | FLN Bus time interval                      | 60 sec.         | 1 - 65534 sec.      | Yes                      | Yes     | 0                | 6         |
| 566   | FLN Bus time interval function             | OFF             |                     | Yes                      | Yes     | 0                | 5         |



## VLT® 6000 HVAC

### ■ Factory settings

| PNU # | Parameter description                         | Factory setting | Range | Changes during operation | 4-Setup | Conversion index | Data type |
|-------|---|-----------------|-------|--------------------------|---------|------------------|-----------|
| 600   | Operating data: Operating hours               |                 |       | No                       | No      | 74               | 7         |
| 601   | Operating data: Hours run                     |                 |       | No                       | No      | 74               | 7         |
| 602   | Operating data: kWh counter                   |                 |       | No                       | No      | 3                | 7         |
| 603   | Operating data: No. of cut-ins                |                 |       | No                       | No      | 0                | 6         |
| 604   | Operating data: No. of overtemps              |                 |       | No                       | No      | 0                | 6         |
| 605   | Operating data: No. of overvoltages           |                 |       | No                       | No      | 0                | 6         |
| 606   | Data log: Digital input                       |                 |       | No                       | No      | 0                | 5         |
| 607   | Data log: Control word                        |                 |       | No                       | No      | 0                | 6         |
| 608   | Data log: Status word                         |                 |       | No                       | No      | 0                | 6         |
| 609   | Data log: Reference                           |                 |       | No                       | No      | -1               | 3         |
| 610   | Data log: Feedback                            |                 |       | No                       | No      | -3               | 4         |
| 611   | Data log: Output frequency                    |                 |       | No                       | No      | -1               | 3         |
| 612   | Data log: Output voltage                      |                 |       | No                       | No      | -1               | 6         |
| 613   | Data log: Output current                      |                 |       | No                       | No      | -2               | 3         |
| 614   | Data log: DC link voltage                     |                 |       | No                       | No      | 0                | 6         |
| 615   | Fault log: Error code                         |                 |       | No                       | No      | 0                | 5         |
| 616   | Fault log: Time                               |                 |       | No                       | No      | 0                | 7         |
| 617   | Fault log: Value                              |                 |       | No                       | No      | 0                | 3         |
| 618   | Reset of kWh counter                          | No reset        |       | Yes                      | No      | 0                | 5         |
| 619   | Reset of hours-run counter                    | No reset        |       | Yes                      | No      | 0                | 5         |
| 620   | Operating mode                                | Normal function |       | Yes                      | No      | 0                | 5         |
| 621   | Nameplate: Unit type                          |                 |       | No                       | No      | 0                | 9         |
| 622   | Nameplate: Power component                    |                 |       | No                       | No      | 0                | 9         |
| 623   | Nameplate: VLT ordering no.                   |                 |       | No                       | No      | 0                | 9         |
| 624   | Nameplate: Software version no.               |                 |       | No                       | No      | 0                | 9         |
| 625   | Nameplate: LCP identification no.             |                 |       | No                       | No      | 0                | 9         |
| 626   | Nameplate: Database identification no.        |                 |       | No                       | No      | -2               | 9         |
| 627   | Nameplate: Power component identification no. |                 |       | No                       | No      | 0                | 9         |
| 628   | Nameplate: Application option type            |                 |       | No                       | No      | 0                | 9         |
| 629   | Nameplate: Application option ordering no.    |                 |       | No                       | No      | 0                | 9         |
| 630   | Nameplate: Communication option type          |                 |       | No                       | No      | 0                | 9         |
| 631   | Nameplate: Communication option ordering no.  |                 |       | No                       | No      | 0                | 9         |

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| 2                | 100               |
| 1                | 10                |
| 0                | 1                 |
| -1               | 0.1               |
| -2               | 0.01              |
| -3               | 0.001             |
| -4               | 0.0001            |

#### Data type:

Data type shows the type and length of the telegram.

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|-----------|-------------|
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| 4         | Integer 32  |
| 5         | Unsigned 8  |
| 6         | Unsigned 16 |
| 7         | Unsigned 32 |
| 9         | Text string |

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## VLT® 6000 HVAC

|  |          |                                     |         |
|--|----------|-------------------------------------|---------|
| <b>A</b>   |          | Mains drop-out .....                | 121     |
| Acoustic noise .....                               | 122      | Motor-generated overvoltage .....   | 121     |
| AEO - Automatic Energy Optimization .....          | 8        | Short circuit .....                 | 121     |
| Air humidity .....                                 | 124      | Static overload .....               | 121     |
| Alarms .....                                       | 113      | Switching on the output .....       | 121     |
| Analogue output .....                              | 87       | <b>F</b>                            |         |
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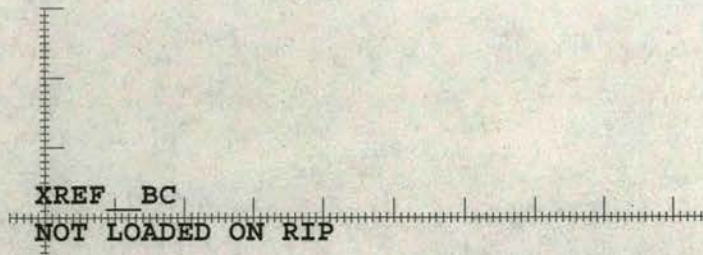
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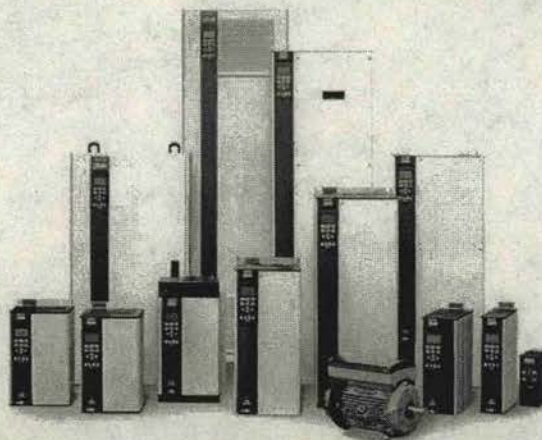
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VLT® 6000

## Operating Instructions



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**Specialist Electrical Contractors**

## Electrical Manual

Subject: Archerfield Pump Station Upgrade

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Of: 8

Section  
1

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### 6.0 TEST SHEETS & FINAL COMMISSIONING

Authorised By: Grant Kerr

Jg86mc01.doc



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**Specialist Electrical Contractors**

# Factory Acceptance Tests

Subject: FAT for Archerfield PS Upgrade

Sheet: 1  
Of: 7

Section

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# Factory Acceptance Tests

Subject: FAT for Archerfield PS Upgrade

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## 1.0 FACTORY ACCEPTANCE TEST

### 1.1 Introduction

Complete EVERY box below, if items are not applicable indicate by a N/A in the check box, any comments can be completed at the end of the checklist.

**Aim:** This Commissioning list is to be completed by the person/s who are undertaking the commissioning and testing of the switchboard in question. The commissioning list is designed to check the fundamental wiring of the switchboard.

**Scope:** This Commissioning list is designed to test the operation of the MSB and Controls only. Building wiring is subject to test by building services qualified personnel.

### Legend of Symbols

☐ Check Box,    ⊗ Setting to be recorded,    → Action to take

### 1.2 Production Unit Information

|                 |            |                 |                        |
|-----------------|------------|-----------------|------------------------|
| Job Number      | JG86       | Job Description | Archerfield PS Upgrade |
|                 | Name       | Signature       | Date                   |
| Testing Officer | BEATRIZ R. | Beatriz R.      | 06/01/03               |
| Witness         |            |                 |                        |

### 1.3 Safety precautions

Outlined below are some common safety procedures and First Aid Instruction :

## SAFETY FIRST

- 1) Keep the area around the switchboard clean.
- 2) Never test live boards alone. Always inform others of your actions and intentions.
- 3) Isolate mains REMOVE TEST PLUG and locate close to testing area under your control.
- 4) Isolate the switchboard main switch and all circuitbreakers and fuses to completely remove all possibility of switching a live conductor when not deliberately required.
- 5) Tag all Distribution as DO NOT OPERATE removing only after tested and safe.
- 6) Insure NO LIVE WIRES are exposed at any time and a CLEAR TESTING AREA and escape route at all times.
- 7) PROTECTIVE CLOTHING and eyewear should be worn at all times.

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## 2.0 ELECTRICAL EARTHING SYSTEM

### 2.1 Electrical continuity and resistance of earthing system

☒ Maximum resistance of the Earthing system within the switchboard is 0.5 ohms (AS/NZS 3000:2000)

☐ Test resistance of the Earthing system 0 ohms

### 2.2 Continuity Test Sheet

| ITEM | DETAIL   | COMPARTMENT DESIGNATION AND TEST RESULT |  |  |  |  |  |
|------|--|---|--|--|--|--|--|
|      |  |   |  |  |  |  |  |
| 1    | All Earth's wired and continuous                                 | ✓                                       |  |  |  |  |  |
| 2    | All metal work earthed where required                            | ✓                                       |  |  |  |  |  |
| 3    | Isolate Individual Earth Systems and check continuity.           | ✓                                       |  |  |  |  |  |
| 4    | Test resistance of Earthing system to compartment Answer in Ohms | ✓                                       |  |  |  |  |  |

## 3.0 INSULATION RESISTANCE TEST

### 3.1 Insulation Resistance Test

Insulation resistance of whole or part of an installation must be a minimum of 1 Meg/ohm (AS/NZS 3000:2000)

- ☐ Insulation test conducted on all internal circuits (Refer test over page)
- ☐ Insulation test conducted on all busbar (Refer test over page)
- All Selector Switches, Isolators and CB's are in the off position
- Surge Diverter Disconnected
- Remove MEN LINK before insulation test
- All electronic equipment susceptible to high voltage damage to be isolated.

### 3.2 Low Voltage Switchboards Insulation Test

MEGGAR VOLTAGE \_\_\_\_\_ VOLTS

INSTRUMENT DETAILS \_\_\_\_\_

| ACROSS   | RESULT (MOHM) | COMMENTS |
|--|---------------|----------|
| Join Red, White & Blue Phases and Neutral, Test to Earth |               |          |
| Red Phase to White, Blue & N                             |               |          |
| White Phase to Red, Blue and N                           |               |          |
| Blue Phase to Red, White & N                             |               |          |
| N to Red, White & Blue                                   |               |          |

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# Factory Acceptance Tests

Subject: FAT for Archerfield PS Upgrade

Sheet: 4

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## 4.0 GENERAL WIRING AND VISUAL INSPECTION

### 4.1 General Wiring and Visual Inspection

☐ Electrical Construction Coversheet DWG No. JG86DA00 Completed and correct.

### 4.2 Switchgear Visual Checklist

→ Carry out visual and mechanical checks to Switchgear

| ITEM NO: | DETAIL                                     | COMPARTMENT DESIGNATION |  |  |  |  |  |  |  |
|----------|--|-------------------------|--|--|--|--|--|--|--|
|          |  | 2/1                     |  |  |  |  |  |  |  |
| 1        | Main Switch totally isolates SWBD          | ✓                       |  |  |  |  |  |  |  |
| 2        | Cables tight and correct phase rotation.   | ✓                       |  |  |  |  |  |  |  |
| 3        | Main Switch Correct Rating/Label           | ✓                       |  |  |  |  |  |  |  |
| 4        | Main Switch fuse in place marked correctly | N/A                     |  |  |  |  |  |  |  |

| ITEM NO: | DETAIL  | COMPARTMENT NUMBER |  |  |  |  |  |  |  |
|----------|---|--------------------|--|--|--|--|--|--|--|
|          |   | 1/1                |  |  |  |  |  |  |  |
| 1        | All CB correct size designation correct all connections tight.                              | ✓                  |  |  |  |  |  |  |  |
| 2        | All CB switches mechanically operate correctly  | ✓                  |  |  |  |  |  |  |  |
| 3        | All incoming terminal numbers as per drawings   | ✓                  |  |  |  |  |  |  |  |
| 4        | All wires numbered as per drawings (random inspection)                                      | ✓                  |  |  |  |  |  |  |  |
| 5        | Cable colours and size correct to cover sheet and specification                             | ✓                  |  |  |  |  |  |  |  |
| 6        | Wire numbering method correct to cover sheet and specification                              | ✓                  |  |  |  |  |  |  |  |
| 7        | Cables loomed and bushed correctly to all compartments as per cover sheet and specification | ✓                  |  |  |  |  |  |  |  |

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# Factory Acceptance Tests

Subject: FAT for Archerfield PS Upgrade

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## 4.3 Terminal Visual Checklist

→ Carry out visual and mechanical checks on Terminals

| ITEM NO: | DETAIL  | COMPARTMENT DESIGNATION |  |  |  |  |  |  |  |  |  |
|----------|---|-------------------------|--|--|--|--|--|--|--|--|--|
|          |   | 1/1                     |  |  |  |  |  |  |  |  |  |
| 1        | All Terminals tight ( Randomly check )                                    | ✓                       |  |  |  |  |  |  |  |  |  |
| 2        | All Voltage types separated by segregation plate (Check All)              | ✓                       |  |  |  |  |  |  |  |  |  |
| 3        | Correct current ratings for cable as per DWG. (Check all)                 | ✓                       |  |  |  |  |  |  |  |  |  |
| 4        | Secure by End Clamps (Check All)  | ✓                       |  |  |  |  |  |  |  |  |  |
| 5        | Labelled correctly as per drawings and contract specification             | ✓                       |  |  |  |  |  |  |  |  |  |
| 6        | Easily accessible.  | ✓                       |  |  |  |  |  |  |  |  |  |
| 7        | Field connection Terminals are correct type as per contract specification | ✓                       |  |  |  |  |  |  |  |  |  |
| 8        | High Voltage Terminal Shrouded  | N/A                     |  |  |  |  |  |  |  |  |  |

## 4.4 Relay Visual Checklist

→ Carry out visual and mechanical checks on Relays

| ITEM NO: | DETAIL  | COMPARTMENT DESIGNATION |  |  |  |  |  |  |  |  |  |
|----------|---|-------------------------|--|--|--|--|--|--|--|--|--|
|          |   | 1/1                     |  |  |  |  |  |  |  |  |  |
| 1        | All AC RELAYS have correct relay base types (Octal, etc)                          | ✓                       |  |  |  |  |  |  |  |  |  |
|          | All DC RELAYS types have correct Relay Base types (Flat pin)                      | ✓                       |  |  |  |  |  |  |  |  |  |
| 3        | Relays labelled correctly as per Drns   | ✓                       |  |  |  |  |  |  |  |  |  |
| 4        | All relay coils correct voltage rating as per drawings 240, 24, AC, DC            | ✓                       |  |  |  |  |  |  |  |  |  |
| 5        | Does relay require Diode correct voltage (240VAC, 24VDC) Check polarity of wiring | ✓                       |  |  |  |  |  |  |  |  |  |
| 6        | Are all terminals tight   | ✓                       |  |  |  |  |  |  |  |  |  |

## 4.5 Contactor Visual Checklist

→ Carry out visual and mechanical checks on Contactors

| ITEM NO: | DETAIL  | COMPARTMENT DESIGNATION |  |  |  |  |  |  |  |  |  |
|----------|---|-------------------------|--|--|--|--|--|--|--|--|--|
|          |   | 2/1                     |  |  |  |  |  |  |  |  |  |
| 1        | Labelled correctly as per drawings            | ✓                       |  |  |  |  |  |  |  |  |  |
| 2        | Correct Coil Rating (240vac, 50Hz, 110, 60Hz) | ✓                       |  |  |  |  |  |  |  |  |  |
| 3        | Terminals mechanically sound                  | ✓                       |  |  |  |  |  |  |  |  |  |

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Signed...

Date...

Test witnessed by.....

Signed...

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# Factory Acceptance Tests

Subject: FAT for Archerfield PS Upgrade

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|   |  |   |  |  |  |  |  |  |  |  |  |
|---|--|---|--|--|--|--|--|--|--|--|--|
| 4 | Fitted with correct Auxiliary Contact (NC, NO, Late Break) | ✓ |  |  |  |  |  |  |  |  |  |
| 5 | Cables tight in Terminals (Incoming, Outgoing)             |   |  |  |  |  |  |  |  |  |  |

## 5.0 CONTINUITY TEST

### 5.1 Continuity Test

- ☒ Wiring of circuits and connections are correct to constructed wiring schematics.
- ☒ Random Continuity Test using Buzzer.
- ☒ Visual Check of all wiring.

- Open all Circuit breakers and remove all fuse links
- Test each cubicle in turn with corresponding drawings
- Continue to carry out visual and drawing checks (ie wire numbers, etc)
- Bridge control points to check operation if possible.

| ITEM NO: | Drawing Number/ Section | (1/1) Door | COMPARTMENT DESIGNATION |  |  |  |  |  |  |  |  |
|----------|-------------------------|------------|-------------------------|--|--|--|--|--|--|--|--|
| 1        | 986/5/7 - P6040         | ✓          |                         |  |  |  |  |  |  |  |  |
| 2        |                         |            |                         |  |  |  |  |  |  |  |  |
| 3        |                         |            |                         |  |  |  |  |  |  |  |  |
| 4        |                         |            |                         |  |  |  |  |  |  |  |  |
| 5        |                         |            |                         |  |  |  |  |  |  |  |  |
| 6        |                         |            |                         |  |  |  |  |  |  |  |  |
| 7        |                         |            |                         |  |  |  |  |  |  |  |  |

## 6.0 COMPONENT OPERATIONAL TEST

### 6.1 Component Operation Test

- ☐ Correct Operation and Voltages
- ☐ All set points and parameters set to test values if required.

### 6.2 AC Control Systems

- Open all circuit breakers and remove all fuse links
- Test each cubicle individually, replacing fuses and closing circuit breakers in turn.

#### AFTER VOLTAGE APPLIED

- Apply mains supply
- Carry out voltage and operational checks (ie switch operation etc)
- Bridge control points to check operation

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# Factory Acceptance Tests

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| ITEM NO: | DETAIL                                    | COMPARTMENT DESIGNATION |  |  |  |  |  |  |  |  |  |
|----------|---|-------------------------|--|--|--|--|--|--|--|--|--|
| 1        | Mains Incoming Voltage Measured OK        | NA                      |  |  |  |  |  |  |  |  |  |
| 2        | All CB's are turned off and isolate Crt's | ✓                       |  |  |  |  |  |  |  |  |  |
| 3        | Phase Fail operates correctly             | NA                      |  |  |  |  |  |  |  |  |  |
| 4        | Phase Fail Hysteresis time setting _sec   | NA                      |  |  |  |  |  |  |  |  |  |

## 6.3 Motor protection and Operation

→ Carry out voltage, settings and Operational Checks

| ITEM NO | DETAIL   | MOTOR DESIGNATION |  |  |  |  |  |  |  |  |  |
|---------|--|-------------------|--|--|--|--|--|--|--|--|--|
| 1       | Confirm operation of Motor Overloads                     | NA                |  |  |  |  |  |  |  |  |  |
| 2       | Confirm and label Overload Settings                      | NA                |  |  |  |  |  |  |  |  |  |
| 3       | Confirm Voltage supply to all Motors (415, 240)          | ✓                 |  |  |  |  |  |  |  |  |  |
| 4       | Confirm operation of Auxiliary Contacts                  | ✓                 |  |  |  |  |  |  |  |  |  |
| 5       | Confirm operation of Heater Contacts                     | NA                |  |  |  |  |  |  |  |  |  |
| 6       | Confirm operation of Contacts (manual start, auto start) | ✓                 |  |  |  |  |  |  |  |  |  |
| 7       | Complete motor Installation Test Sheet                   | ✓                 |  |  |  |  |  |  |  |  |  |

## 6.4 Miscellaneous Operational Tests

→ Carry out Voltage and Operational Checks of Miscellaneous Circuits

| ITEM NO | DETAIL | ITEMS TESTED | COMPARTMENT DESIGNATION |  |  |  |  |  |  |  |  |  |
|---------|--------|--------------|-------------------------|--|--|--|--|--|--|--|--|--|
|         |        |              |                         |  |  |  |  |  |  |  |  |  |
|         |        |              |                         |  |  |  |  |  |  |  |  |  |
|         |        |              |                         |  |  |  |  |  |  |  |  |  |
|         |        |              |                         |  |  |  |  |  |  |  |  |  |
|         |        |              |                         |  |  |  |  |  |  |  |  |  |
|         |        |              |                         |  |  |  |  |  |  |  |  |  |
|         |        |              |                         |  |  |  |  |  |  |  |  |  |
|         |        |              |                         |  |  |  |  |  |  |  |  |  |
|         |        |              |                         |  |  |  |  |  |  |  |  |  |
|         |        |              |                         |  |  |  |  |  |  |  |  |  |

## 7.0 SWITCHBOARD FUNCTIONAL TEST

### 7.1 Switchboard Functional Tests

☒ Correct sequential operation of all components.

Test Carried out by.....

Signed...

Date...

Test witnessed by.....

Signed...

Date...

Authorised By:







**COMMON LOGIC Pty Ltd**  
**Specialist Electrical Contractors**

## Electrical Manual

Subject: Archerfield Pump Station Upgrade

Sheet: 8  
Of: 8

Section  
1

Page Revision No: 1 Date: 10/03/03

Manual Issue No: 1 Date: 10/03/03

### 7.0 TECHNICAL INFORMATION

Authorised By: Grant Kerr

Jg86mc01.doc

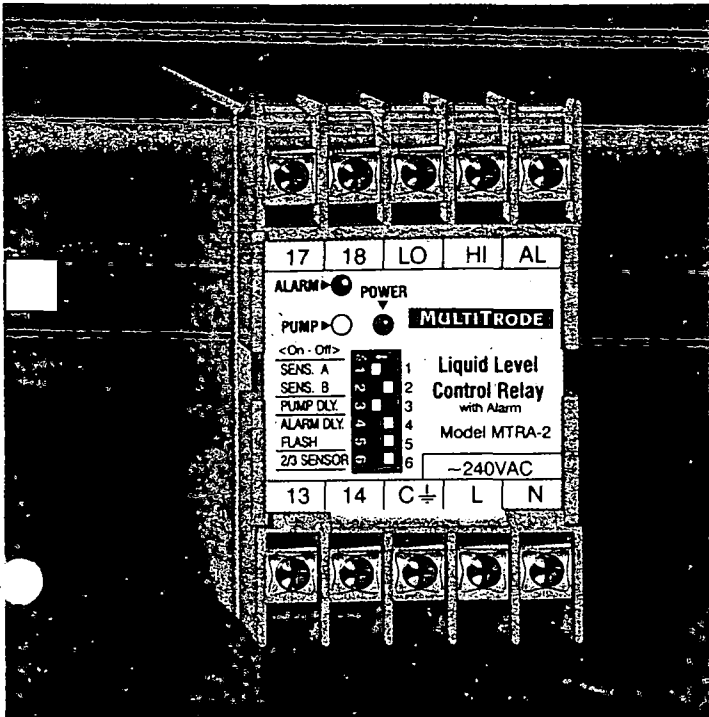
10/12/2014

# Relay with Alarm

**MTRA**  
MultiTrobe  
Relay with Alarm

Controls one pump and one alarm

**MULTITRODE**



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

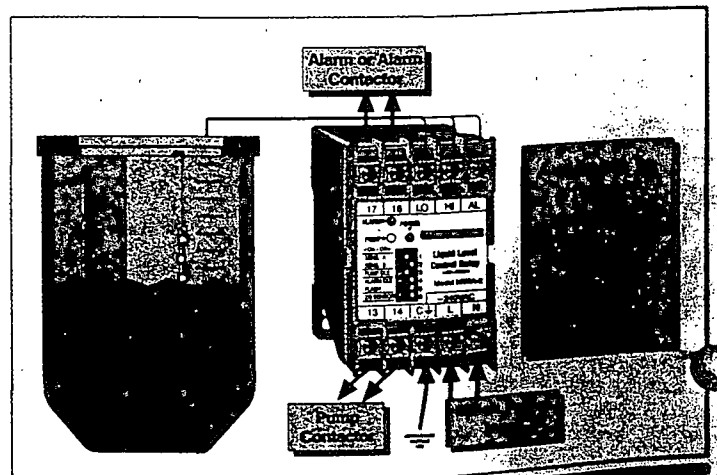
3: The MTRA is intended for discharge applications ONLY.

The MultiTrobe MTRA Liquid Level Control Relay with alarm is a latching conductive liquid level control device. The pump is activated when the **start** point, "HI", 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 sec). This alarm can be set to flash or remain steady, as required.

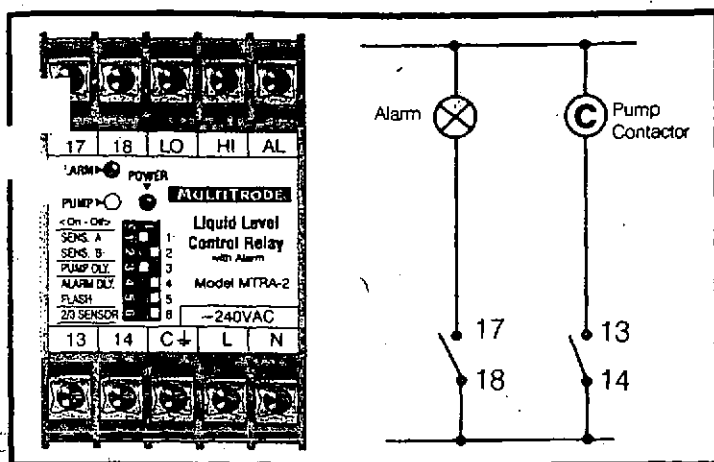
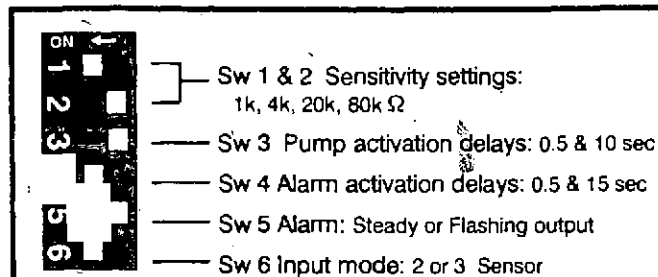
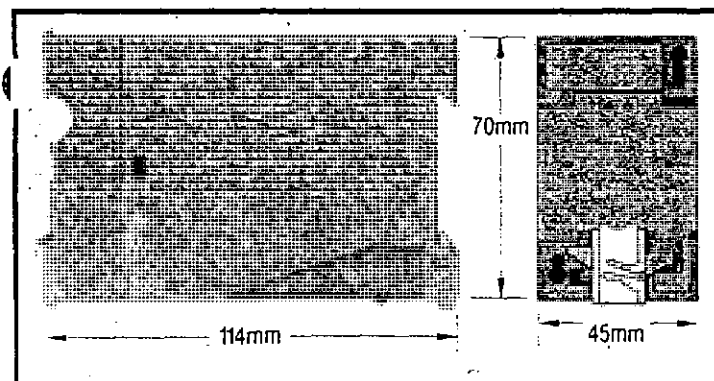
Any application where level control plus high level alarm, such as sumps, wells, bores, collection tanks, effluent pits, urainage ponds, sullage pits etc, can benefit from use of the MultiTrobe MTRA.

- ❑ **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 MultiTrobe system.
- ❑ **I.S. application :** Perfect for I.S. application when used with MTISB.
- ❑ **DIN rail or screw mounting**
- ❑ **Low installed cost**



**All MultiTrobe Products carry a full two year warranty**



**MTRA. I/O Terminal Listing****Dip Switch Settings****Dimensions**

**Note:**  
the MTRA is a discharge  
( Empty ) only controller.

**Approvals**

UL listed 2P27



Approved for I.S. applications  
when installed in conjunction  
with a MultiTrobe MTISB  
Intrinsically Safe Barrier

# MULTITRODE

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**MTRA Specifications****Mode of Operation**Discharge **ONLY** ( Empty )**Probe Inputs**

|                |                           |
|----------------|---------------------------|
| Sensor inputs  | 3                         |
| Sensor Voltage | 12VAC Nominal             |
| Sensor current | 0.8mA max. per sensor     |
| Sensitivity    | 1k, 4k, 20k, 80k $\Omega$ |

**Other Inputs**

None

**Relay Outputs**

|                      |                                     |
|----------------------|-------------------------------------|
| No. of relay outputs | 2 Sets N/O                          |
| Output delays        | Pump - 0.5, 10; Alarm - 0.5, 15 sec |
| Relay contact rating | 250 VAC 5A Resistive, 2A Inductive  |
| Relay contact life   | 10 <sup>5</sup> Operations          |
| Terminal size        | 2 x 2.5mm <sup>2</sup> 13#          |

**Other outputs**

None

**Display**

|      |        |            |
|------|--------|------------|
| LEDs | Green  | : Power On |
|      | Red    | : Alarm On |
|      | Yellow | : Pump On  |

**Communications**

None

**Physical Product**

|               |                                 |
|---------------|---------------------------------|
| Dimensions mm | 72H x 45W x 114D                |
| Mounting      | DIN Rail or 2 x M4 Screws #6    |
| Enclosure     | Makrolon ( self extinguishing ) |

**Power Supply**

|                   |  |
|-------------------|--|
| Supply Voltage AC | 24, 110, 220-240, 415VAC Nominal 50/60Hz |
| Power Consumption | 3.4VA max.                               |
| Supply Voltage DC | 10 to 30VDC, 3 Watts max.                |

**Working Temperature Range**

- 10<sup>0</sup> to + 60<sup>0</sup> C  
+ 14<sup>0</sup> to + 140<sup>0</sup> F

**Ordering Information****AVAILABLE MODELS**

|        |           |
|--------|-----------|
| MTRA-1 | 415VAC,   |
| MTRA-2 | 240VAC,   |
| MTRA-3 | 110VAC,   |
| MTRA-4 | 24VAC,    |
| MTRA-7 | 10-30VDC, |

**Ordering Example**

e.g. **MTRA** - **2** **Model Voltage**  
This order code is for a 240VAC MTRA relay

**All MultiTrobe Products carry a  
full two year warranty**

