Brisbane City

Brisbane Water Project Management

Client :

BRISBANE WATER

Document Title : **KOORINGAL DVE SEWAGE PUMPING STATION OPERATION and MAINTENANCE DATA MANUAL**

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

Date of Issue : ***August 2000***

Author : ***Peter Hague***

Table of Contents *Kooringal Drive Sewage Pumping Station Electrical Upgrade* O & M manuals

1 Book 1

Maintenance copy

1.1 *Maintenance Data Manual*

Contains equipment details, supplier, programming and/or setup data.

1.2 *Functional Spec*

Functional requirement Specification

1.3 *Misc.*

Miscellaneous information on construction, installation and operation.

1.4 *VFD and Startco*

VFD manuals and Startco parameters

1.5 *Schematics.*

Contains all of the final as commissioned drawing for the project.

SET POINTS FOR KOORINGAL DR.

The set points will be as follows:

Wet Well Level Metres	Indicator %	Metres AHD	Function
		9.530	Probable slab level
		9.277	Probable Probe suspension level
		7.130	Surcharge Imminent suspension Length
		9.500	Probe Suspension Length
3.000	100.0%	2.777	Probe upper range 20mA
0.0	00.00%	-0.223	Probe lower range 4 mA
2.663	88.7%	2.440	Surcharge Level by survey
2.370	79.0%	2.147	Surcharge Imminent
1.573	52.4%	1.350	Start lead pump
0.450	16.6%	0.227	Stop lead pump (BWL)
2.023	67.4%	1.800	Start lag pump
1.123	37.4%	0.900	Stop lag pump
1.923	64.0%	1.700	Top of inlet screen. Pump is running at 50Hz
1.723	57.0%	1.500	Bottom of inlet screen. PID set point.

KOORINGAL. QLD.

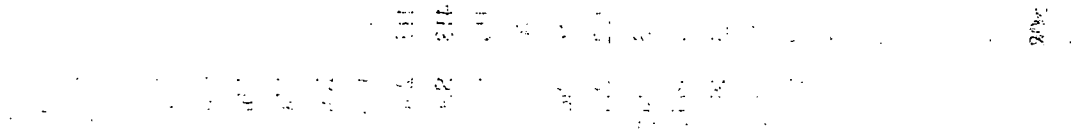
Report of all parameter settings

Drive type: 6100 **Drive bus address: None**

Date: 2/08/00 11:23:59

No.	Name	Setup 1	Setup 2	Setup 3	Setup 4
1	Language	English	English	English	English
2	Active setup	Multi setup	Multi setup	Multi setup	Multi setup
5	Custom readout	100.00	100.00	100.00	100.00
6	Cust. read. unit	%	%	%	%
8	Small readout 1	Frequency [Hz]	Frequency [Hz]	Reference [%]	Reference [%]
9	Small readout 2	Analog input 60 [mA]	Feedback [units]	Motor current [A]	Motor current [A]
10	Small readout 3	Power [kW]	Power [kW]	Power [kW]	Power [kW]
11	Unit of loc ref	Hz	Hz	Hz	Hz
12	Hand start bttn	Enable	Enable	Enable	Enable
13	Stop button	Disable	Enable	Enable	Enable
14	Auto start bttn	Enable	Enable	Enable	Enable
15	Reset button	Enable	Enable	Enable	Enable
16	Data change lock	Not locked	Not locked	Not locked	Not locked
17	Power up action	Auto restart	Auto restart	Auto restart	Auto restart
100	Config. mode	Open loop	Open loop	Open loop	Open loop
101	Vt charact.	Aeo function	Aeo function	Aeo function	Aeo function
102	Motor power	63.00 kW	63.00 kW	75.00 kW	75.00 kW
103	Motor voltage	415 V	415 V	380 V	380 V
104	Motor frequency	50 Hz	50 Hz	50 Hz	50 Hz
105	Motor current	115.00 A	115.00 A	149.47 A	149.47 A
106	Motor nom. speed	1470 RPM	1470 RPM	1480 RPM	1480 RPM
107	Auto motor adapt	No ama	No ama	No ama	No ama
108	Multim.startvolt	3.0 V	3.0 V	3.0 V	3.0 V
109	Resonance damp.	100 %	100 %	100 %	100 %
110	High start torq.	0.0 s	0.0 s	0.0 s	0.0 s
111	Start delay	0.0 s	0.0 s	0.0 s	0.0 s
112	Motor preheat	Disable	Disable	Disable	Disable
113	Preheat dc curr.	50 %	50 %	50 %	50 %
114	Dc brake current	50 %	50 %	50 %	50 %
115	Dc braking time	10.0 s	10.0 s	10.0 s	10.0 s
116	Dc brake cut-in	0.0 Hz	0.0 Hz	0.0 Hz	0.0 Hz
117	Mot.therm protec	Etr trip 1	Etr trip 1	Etr trip 1	Etr trip 1
200	Frequency range	0-120 hz	0-120 hz	0-120 hz	0-120 hz
201	Min. frequency	38 ~~0.0~~ Hz	24.0 Hz	0.0 Hz	0.0 Hz
202	Max. frequency	50.0 Hz	50.0 Hz	50.0 Hz	50.0 Hz
203	Reference site	Linked to hand/auto	Linked to hand/auto	Linked to hand/auto	Linked to hand/auto
204	Min. reference	0.000	24.000	0.000	0.000
205	Max. reference	50.000	50.000	50.000	50.000
206	Ramp up time	20 s	20 s	50 s	50 s
207	Ramp down time	20 s	20 s	100 s	100 s
208	Autoramping	Enable	Enable	Enable	Enable
209	Jog frequency	0.0 Hz	30.0 Hz	10.0 Hz	10.0 Hz

No.	Name	Setup 1	Setup 2	Setup 3	Setup 4
210	Ref. function	Sum	Sum	Sum	Sum
211	Preset ref. 1	0.00 %	0.00 %	0.00 %	0.00 %
212	Preset ref. 2	0.00 %	0.00 %	0.00 %	0.00 %
213	Preset ref. 3	0.00 %	0.00 %	0.00 %	0.00 %
214	Preset ref. 4	0.00 %	0.00 %	0.00 %	0.00 %
215	Curr limit motor	115.0 A	115.0 A	147.0 A	147.0 A
216	Freq bypass b.w.	0 Hz	0 Hz	0 Hz	0 Hz
217	Bypass freq. 1	120.0 Hz	120.0 Hz	120.0 Hz	120.0 Hz
218	Bypass freq. 2	120.0 Hz	120.0 Hz	120.0 Hz	120.0 Hz
219	Bypass freq. 3	120.0 Hz	120.0 Hz	120.0 Hz	120.0 Hz
220	Bypass freq. 4	120.0 Hz	120.0 Hz	120.0 Hz	120.0 Hz
221	Warn. current lo	0.0 A	0.0 A	0.0 A	0.0 A
222	Warn. current hi	161.7 A	161.7 A	161.7 A	161.7 A
223	Warn. freq. low	0.0 Hz	0.0 Hz	0.0 Hz	0.0 Hz
224	Warn. freq. high	120.0 Hz	120.0 Hz	120.0 Hz	120.0 Hz
225	Warn. low ref.	-999999.999	-999999.999	-999999.999	-999999.999
226	Warn. high ref.	999999.999	999999.999	999999.999	999999.999
227	Warn. low fdbk	-999999.999	-999999.999	-999999.999	-999999.999
228	Warn. high fdbk	999999.999	999999.999	999999.999	999999.999
300	Digital input 16	Reset	Reset	Reset	Reset
301	Digital input 17	Freeze reference	Freeze reference	Freeze reference	Freeze reference
302	Digital input 18	Start	Start	Start	Start
303	Digital input 19	No operation	No operation	Reversing	Reversing
304	Digital input 27	Coast inverse	Coast inverse	Coast inverse	Coast inverse
305	Digital input 29	Jog	Jog	Jog	Jog
306	Digital input 32	Setup select lsb	Setup select lsb	No operation	No operation
307	Digital input 33	No operation	No operation	No operation	No operation
308	Ai [V] 53 funct.	No operation	Reference	Reference	Reference
309	Ai 53 scale low	0.0 V	0.0 V	0.0 V	0.0 V
310	Ai 53 scale high	10.0 V	10.0 V	10.0 V	10.0 V
311	Ai [V] 54 funct.	No operation	No operation	No operation	No operation
312	Ai 54 scale low	0.0 V	0.0 V	0.0 V	0.0 V
313	Ai 54 scale high	10.0 V	10.0 V	10.0 V	10.0 V
314	Ai [mA] 60 funct	Reference	No operation	Reference	Reference
315	Ai 60 scale low	4.0 mA	4.0 mA	4.0 mA	4.0 mA
316	Ai 60 scale high	20.0 mA	20.0 mA	20.0 mA	20.0 mA
317	Live zero time	10 s	10 s	10 s	10 s
318	Live zero funct.	No function	No function	No function	No function
319	Ao 42 function	Motor cur. 4- 20 ma	Motor cur. 4- 20 ma	Motor cur. 0- 20 ma	Motor cur. 0- 20 ma
320	Ao 42 puls scale	5000 Hz	5000 Hz	5000 Hz	5000 Hz
321	Ao 45 function	Out. freq. 4- 20 ma	Out. freq. 4- 20 ma	Out. freq. 0- 20 ma	Out. freq. 0- 20 ma
322	Ao 45 puls scale	5000 Hz	5000 Hz	5000 Hz	5000 Hz
323	Relay1 function	Ready	Ready	Alarm	Alarm
324	Relay1 on delay	0 s	0 s	0 s	0 s
325	Relay1 off delay	0 s	0 s	0 s	0 s
326	Relay2 function	Running	Running	Running	Running
327	Pulse ref. max	5000 Hz	5000 Hz	5000 Hz	5000 Hz
328	Pulse fdbk. max.	25000 Hz	25000 Hz	25000 Hz	25000 Hz
400	Reset function	Manual reset	Manual reset	Manual reset	Manual reset



No.	Name	Setup 1	Setup 2	Setup 3	Setup 4
401	Autorestart time	10 s	10 s	10 s	10 s
402	Flying start	Disable	Disable	Disable	Disable
403	Sleep mode timer	301 s	301 s	301 s	301 s
404	Sleep frequency	0.0 Hz	0.0 Hz	0.0 Hz	0.0 Hz
405	Wakeup frequency	10.0 Hz	31.0 Hz	50.0 Hz	50.0 Hz
406	Boost setpoint	100 %	100 %	100 %	100 %
407	Switch freq.	3.5 kHz	3.5 kHz	3.0 kHz	3.0 kHz
408	Noise reduction	Fixed switching freq	Fixed switching freq	Asfm	Asfm
409	Funct. low curr.	Warning	Warning	Warning	Warning
410	Mains failure	Trip	Trip	Trip	Trip
411	Funct. overtemp.	Trip	Trip	Trip	Trip
412	Overload delay	61 s	61 s	61 s	61 s
413	Min. feedback	0.000	0.000	0.000	0.000
414	Max. feedback	100.000	100.000	100.000	100.000
415	Ref./fdbk. unit	%	%	%	%
416	Feedback conv.	Linear	Square root	Linear	Linear
417	2 feedback calc.	Maximum	Maximum	Maximum	Maximum
418	Setpoint 1	0.000	34.000	0.000	0.000
419	Setpoint 2	0.000	34.000	0.000	0.000
420	Pid nor/inv.ctrl	Inverse	Normal	Normal	Normal
421	Pid anti windup	Enable	Enable	Enable	Enable
422	Pid start value	50.0 Hz	24.0 Hz	0.0 Hz	0.0 Hz
423	Pid prop. gain	1.00	0.30	0.30	0.30
424	Pid integr. time	9999.00 s	9999.00 s	9999.00 s	9999.00 s
425	Pid diff. time	0.00 s	0.00 s	0.00 s	0.00 s
426	Pid diff. gain	5.0	5.0	5.0	5.0
427	Pid filter time	0.01 s	0.01 s	0.01 s	0.01 s
503	Coasting	Logic or	Logic or	Logic or	Logic or
504	Dc brake	Logic or	Logic or	Logic or	Logic or
505	Start	Logic or	Logic or	Logic or	Logic or
506	Reversing	Digital input	Digital input	Digital input	Digital input
507	Select. setup	Logic or	Logic or	Logic or	Logic or
508	Select. speed	Logic or	Logic or	Logic or	Logic or
555	Bus time inter.	60 s	60 s	60 s	60 s
556	Bus time funct.	No function	No function	No function	No function
560	N2 over.rel.time	65534 s	65534 s	65534 s	65534 s
565	Fln time inter.	60 s	60 s	60 s	60 s
566	Fln time funct.	No function	No function	No function	No function
618	Reset kwh count	Do not reset	Do not reset	Do not reset	Do not reset
619	Reset run. hour	Do not reset	Do not reset	Do not reset	Do not reset
620	Operation mode	Normal operation	Normal operation	Normal operation	Normal operation
700	Relay06 function	Drive in auto mode	Drive in auto mode	Alarm	Alarm
701	Relay6 on delay	0 s	0 s	0 s	0 s
702	Relay6 off delay	0 s	0 s	0 s	0 s
703	Relay07 function	Running	Running	Alarm	Alarm
704	Relay7 on delay	0 s	0 s	0 s	0 s
705	Relay7 off delay	0 s	0 s	0 s	0 s
706	Relay08 function	Running	Running	Alarm	Alarm
707	Relay8 on delay	0 s	0 s	0 s	0 s

No.	Name	Setup 1	Setup 2	Setup 3	Setup 4
708	Relay8 off delay	0 s	0 s	0 s	0 s
709	Relay09 function	Alarm or warning	Running	Alarm	Alarm
710	Relay9 on delay	0 s	0 s	0 s	0 s
711	Relay9 off delay	0 s	0 s	0 s	0 s

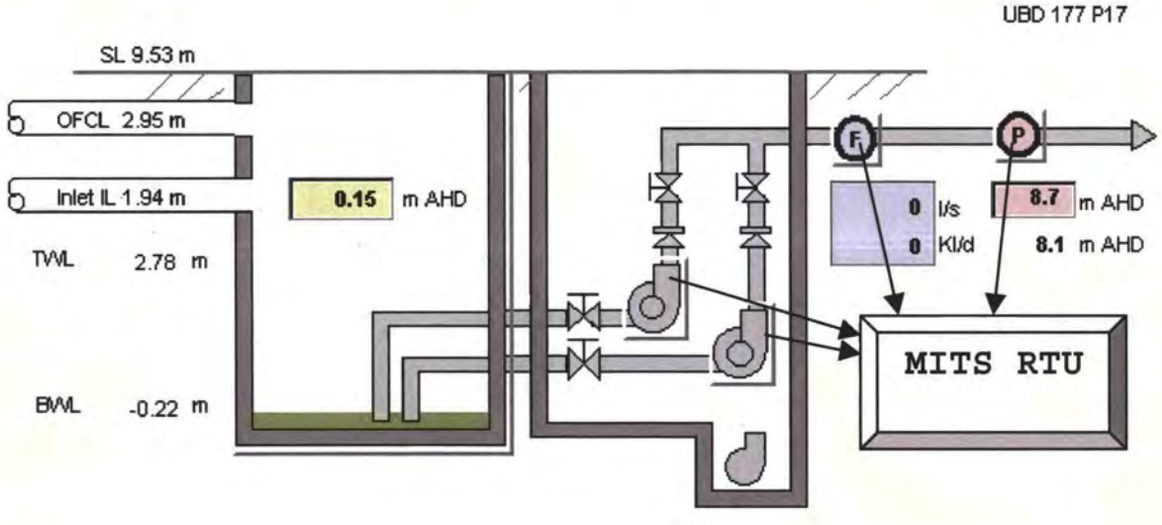
Functional Spec.

Brisbane Water Professional Services — Engineering

CENTENARY HWY (SP 19) SEWAGE PUMPING STATION

FUNCTIONAL SPECIFICATION

FOR MITS RTU



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Document Approval

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		RJ	Date	RFW	Date	KV	Date	PT	Date	S&IM	Date
Draft 1	16/12/99	✓	16/12/99	✓	7/01/00						
Draft 2	13/01/99	✓	13/01/99	✓	18/01/00						
Rev. O	13/01/99	✓	13/01/99	✓	18/01/00			✓	18/01/00		

Revisions:

Revision No.	Date	Description	Author
Draft 1	16/12/99	Draft Issue for comments;	R.J.
Draft 2	18/01/00	Comments incorporated and approved by RFW	R.J
Rev. O	24/01/00	Original Issue	R.J.
Rev. 1	11/02/00	P. Tranter's comments were incorporated	R.J.
Rev. 2	23/02/00	Incorporate control philosophy from Oldfield Rd. and revise control levels.	Peter Tranter

TABLE OF CONTENTS

Attachments

1 Introduction

1.1 Scope of Document

This document has been written based on the existing Developed Software Detailed Design Specification (DSDDS) prepared by MITS dated 1995 with updated sections that outlines the functional requirements for the control, monitoring, and telemetry of Centenary Highway (SP 19) sewerage pumping station incorporating the two new Variable Frequency Drives (VFDs).

On the basis of this document, the existing DSDDS will be updated and the MITS RTU software program will be modified to incorporate the changes associated with the installation of the two new VFDs.

The control circuitry for the pumping station is shown on drawings 486/5/7-HG001 to 486/5/7-HG013 inclusive and this document should be read in conjunction with these drawings.

The functional requirements for this pumping station have been detailed in DSDDS and there is no need to repeat them in this document in great details. Therefore, reference has been made to DSDDS wherever it was necessary in this document.

1.2 Purpose and Scope of Upgrade

Over the past several years there have been an increasing amount of odour complaints received from residents in the areas around S2 Darra Branch Sewer Duplication that stretches from Fortrose Street Pumping Station to Oxley Creek Waste Water Treatment Plant (Refer to S2 Sewer Overall Flow Diagram Drawing No. 486/5/6-S2069).

As part of S2 Sewer Odour Abatement Project, it is intended to increase flows from Fortrose Street Rising Main to reduce the sewage retention time in the rising mains. When this occurs, the Centenary Hwy Sewage Pumping Station will have to pump against increased flows in the rising main. This will require upgrading pump impellers and installing VFDs at this pumping station. Installation of (VFD's) on the existing sewage pumps will also overcome the surge problem in the rising main, which will reduce the odorous gas emission.

The upgrade works for this Sewage Pumping Station is part of the S2 Catchment Odour Abatement Project scope.

1.3 Centenary Hwy Pumping Station Overview

Refer to Drawing No. 486/5/6-S2069- Darra Branch Sewer Overall Flow Diagram;
The Centenary Hwy Sewerage Pumping Station is an existing underground conventional sewage pumping station with an Average Dry Weather Flow (ADWF) of 21.3 L/sec and an average wet well volume of 25.86 Kilo Litres. Currently there are two 63kW submersible type sewage pumps installed in the Pump Well, operating as duty/Lag units. Pumps are interlocked so only one pump can operate at a time. Current station output with one pump operating is approximately 100 L/sec with two pumps operating the station output will be limited to 140 L/sec.

An outdoor type electrical switchboard supplies the pumping station equipment and also incorporates the telemetry RTU. Currently there are two soft starters for the two main sewage pumps that are located in the upper level of the pump well. These two soft starters will be replaced with the two new 75kW Variable Frequency Drives (VFDs) as part of the S2 Catchment Odour Abatement project.

In addition there are two (2) Hydrogen Peroxide Dosing Pumps on this site one for Fortrose Street and one for Centenary Hwy. The Fortrose Street dosing pump is being controlled by both the RTU and from an existing remote micro switch already cabled to the site. The Centenary Hwy dosing pump is controlled by the RTU and operates when either of the main pumps is running.

1.4 Existing Control System

A MITS RTU that has been programmed to control the pump station and to interface with the Central Control Room at Newstead is currently controlling the pump station. Therefore, where the term "OPERATOR" or "WORKSTATION" or "MASTER STATION" is used in this document, this shall mean the Newstead Control Room Operator.

2 I/O Listing

The attached I/O List is the existing I/O List associated with the Centenary Hwy Pumping Station MITS RTU with the new I/O highlighted in *Italic* format.

Digital Input Module DIT102 ADDR 10 (DIM1)

Item:	CH.	Description:
Digital Input 1	0	RTU Battery Low
Digital Input 2	1	RTU Mains Power Fault
Digital Input 3	2	Site Attention Acknowledge
Digital Input 4	3	Cathodic Protection Door Limit Switch
Digital Input 5	4	Cathodic Protection Local Start
Digital Input 6	5	Cathodic Protection Mains Power
Digital Input 7	6	Spare
Digital Input 8	7	Sewage Pumping Station Mains Power
Digital Input 9	8	Wet Well Surcharge-Detector
Digital Input 10	9	Sewage Pumping Station Local/Remote
Digital Input 11	10	Sewage Pumping Station Pump Well Flooded
Digital Input 12	11	Sump Pump Run Status
Digital Input 13	12	Fortrose Street Sewage Pumping Station Run Status
Digital Input 14	*13*	*Pump Station Delivery Flowmeter Fault*
Digital Input 15	14	Spare
Digital Input 16	15	Spare

Digital Input Module DIT102 ADDR 11 (DIM2)

Item:	CH.	Description:
Digital Input 17	0	Sewage Pump 1 Reflux Valve
Digital Input 18	1	Sewage Pump 1 Mains Power
Digital Input 19	2	Sewage Pump 1 Thermal Overload Status
Digital Input 20	3	Sewage Pump 1 Local Start
Digital Input 21	4	Sewage Pump 1 Local Stop
Digital Input 22	5	Sewage Pump 1 Thermistor Status
Digital Input 23	*6*	*Sewage Pump 1 VFD Ready*
Digital Input 24	7	Sewage Pump 1 Local Rest
Digital Input 25	*8*	*Sewage Pump 1 VFD Running*
Digital Input 26	9	Sewage Pump 1 Line Contactor Closed
Digital Input 27	*10*	*Sewage Pump 1 VFD Auto Selected*

Digital Input 28	*11*	*Sewage Pump 1 VFD Warning*
Digital Input 29	12	Spare
Digital Input 30	13	Spare
Digital Input 31	14	Spare
Digital Input 32	15	Spare

Digital Input Module DIT102 ADDR 12 (DIM3)

Item:	CH.	Description:
Digital Input 33	0	Sewage Pump 2 Reflux Valve
Digital Input 34	1	Sewage Pump 2 Mains Power
Digital Input 35	2	Sewage Pump 2 Thermal Overload Status
Digital Input 36	3	Sewage Pump 2 Local Start
Digital Input 37	4	Sewage Pump 2 Local Stop
Digital Input 38	5	Sewage Pump 2 Thermistor Status
Digital Input 39	*6*	*Sewage Pump 2 VFD Ready*
Digital Input 40	7	Sewage Pump 2 Local Rest
Digital Input 41	*8*	*Sewage Pump 2 VFD Running*
Digital Input 42	9	Sewage Pump 2 Line Contactor Closed
Digital Input 43	*10*	*Sewage Pump 2 VFD Auto Selected*
Digital Input 44	*11*	*Sewage Pump 2 VFD Warning*
Digital Input 45	12	Spare
Digital Input 46	13	Spare
Digital Input 47	14	Spare
Digital Input 48	15	Spare

Digital Output Module DOM102 ADDR 60 (DOM1)

Item:	CH.	Description:
Digital Output 1	0	Site Attention Indicator Lamp
Digital Output 2	1	Cathodic Protection Connect Reference Electrode
Digital Output 3	2	Cathodic Protection De-energise Rectifier
Digital Output 4	3	Sewage Pump 1 Line Contactor Operate
Digital Output 5	4	Sewage Pump 1 Indicator Lamp
Digital Output 6	*5*	*Sewage Pump 1 VFD Run/Stop*
Digital Output 7	*6*	*Sewage Pump 1 Fault Reset*
Digital Output 8	7	Cathodic Protection Indicator Lamp
Digital Output 9	8	Spare
Digital Output 10	9	Spare
Digital Output 11	10	Spare
Digital Output 12	11	Spare
Digital Output 13	12	Spare
Digital Output 14	13	Spare
Digital Output 15	14	Spare
Digital Output 16	15	Spare

Digital Output Module DOM102 ADDR 61 (DOM2)

Item:	CH.	Description:
Digital Output 17	0	Sewage Pump 2 Line Contactor Operate
Digital Output 18	1	Sewage Pump 2 Indicator Lamp
Digital Output 19	*2*	*Sewage Pump 2 VFD Run/Stop*
Digital Output 20	*3*	*Sewage Pump 2 Fault Reset*

Digital Output 21	4	Spare
Digital Output 21	5	Spare
Digital Output 21	6	Centenary Hwy Oxy. Inj. Pump Start/Stop
Digital Output 22	7	Fortrose Street Oxy. Inj. Pump Start/Stop
Digital Output 9	8	Spare
Digital Output 10	9	Spare
Digital Output 11	10	Spare
Digital Output 12	11	Spare
Digital Output 13	12	Spare
Digital Output 14	13	Spare
Digital Output 15	14	Spare
Digital Output 16	15	Spare

Analog Input Module AIM 105 ADDR 40 (AIM1)

Item:	CH.	Description:
Analog Input 1	0	Cathodic Protection Rectifier Current
Analog Input 2	1	Cathodic Protection Rectifier Voltage
Analog Input 3	2	Cathodic Protection Reference Electrode Voltage
Analog Input 4	3	Cathodic Protection Reference Electrode Voltage
Analog Input 5	4	Wet Well Level
Analog Input 6	5	Delivery Pressure 16m H_2O
Analog Input 7	6	Delivery Flow 108
Analog Input 8	7	Sewage Pump 1 Motor Power 20mA = ~~150~~ KW
Analog Input 9	8	Sewage Pump 1 Motor Current 150 A 108
Analog Input 10	9	Sewage Pump 2 Motor Power 20mA = ~~150~~ KW
Analog Input 11	10	Sewage Pump 1 Motor Current 150A
Analog Input 12	*11*	*Sewage Pump 1 Running Speed*
Analog Input 13	*12*	*Sewage Pump 2 Running Speed*
Analog Input 14	13	Spare
Analog Input 15	14	Spare
Analog Input 16	15	Spare

Analog Output Module AOM 106 ADDR 49 (AOM1)

Item:	CH.	Description:
Analog Output 1	*0*	*Sewage Pump 1 Speed Control*
Analog Output 2	*1*	*Sewage Pump 2 Speed Control*
Analog Output 3	*2*	*Spare*
Analog Output 4	*3*	*Spare*
Analog Output 5	*4*	*Spare*
Analog Output 6	*5*	*Spare*
Analog Output 7	*6*	*Spare*
Analog Output 8	*7*	*Spare*
Analog Output 9	*8*	*Spare*
Analog Output 10	*9*	*Spare*
Analog Output 11	*10*	*Spare*
Analog Output 12	*11*	*Spare*
Analog Output 13	*12*	*Spare*
Analog Output 14	*13*	*Spare*
Analog Output 15	*14*	*Spare*
Analog Output 16	*15*	*Spare*

3 Pump Station Functional Requirements

The following functional requirements are as per the details of a document called: Developed Software Detailed Design Specification (DSDDS) for Kooringal Drive SP 19 (Centenary Hwy) Sewage Pumping Station prepared by MITS in 1995 with the new changes shown in ***Italics***.

The Centenary Hwy Pumping Station comprises the following:-

- One Duty and one Lag Raw Sewage Pumps No. 1 and 2
- Wet well level transmitter type: submersible Vega probe
- Surcharge imminent electrode type level switch
- Pump Station outlet Pressure Transmitter
- Pump Station outlet Flowmeter ultrasonic type that is not functioning properly *and will be replaced by a Magnetic type Flowmeter as part of this upgrade.*
- Motor Thermistor Relays
- *Variable Frequency Drives VFD1, VFD2 replacing the existing soft starters*
- Reflux Valve Limit Switches
- Emergency Stops
- On/Off Selector Switches located adjacent to pumps in the Pump Well
- Pump Station Local/Remote Selector Switch mounted in the Switchboard
- MITS RTU located in the Switchboard
- Switchboard incorporating pump power and controls
- Pump Motor Power and Current Transmitters
- Sump Pump in the Pump Well
- Oxygen Pumps 1&2

3.1 Pump Station Operation

The pump station normally operates with the Pump Station Selector Switch in Remote mode. This enables the pumps to be controlled in response to the wet well level. When the Pump Station Selector Switch is Local, both pumps can be started or stopped by using the local Start/Stop push buttons and the speed is set by means of a potentiometer. In both modes of operations the pumps will be controlled by the RTU.

The previous program in the RTU allowed only one pump to operate at any time but as part of the new modifications in the pumps starting system (ie replacing Soft Starters with VFDs), the RTU program will allow two pumps to run at the same time as required.

When the wet well level reaches a predetermined moderate value, the Primary duty pump is started, provided it satisfies all the enabling conditions.

If the wet well level reaches a high value, the lag pump is started provided it satisfies all its enabling conditions as detailed in Section 3.3.2.5.

The RTU will control the operation of the pump station as detailed in Section 3.3.2.5.

3.2 Pump Individual Control

3.2.1 Pump Availability

A sewerage pump 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:

- Pump Station Power Available
- No pump Thermal Overload Fault
- No Pump Thermistor Fault
- *Pump VFD is Ready*
- *Pump VFD is in Auto Mode*
- No Pump Failure Signal is on
- No Pump Thermal Overload Count Exceeded (Operator Adjustable)
- No Pump Thermistor Fault Count Exceeded (Operator Adjustable)
- *No Pump VFD Fault Count Exceeded* (Operator Adjustable)
- Pump Well Not Flooded
- Pump Emergency Stop Not Operated
- No Pump Reflux Valve Failed Signal on
- No Pump Reflux Valve Failed Count Exceeded (Operator Adjustable)

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 push-button.

A brief description of each signal is given below. For more details on the control algorithm refer to DSDDS.

3.2.1.1 Pump Station Power Available

If a "Station Power Failure" signal (provided by Power Failure Relay – PFR) is detected from the site, an alarm will be generated after a pre-defined time period has elapsed. This will make both pumps unavailable for RTU control. The alarm will be monitored at the Newstead Central Control Room. The pumps shall become available if the power has been restored and the fault signal has been cleared.

3.2.1.2 No pump Thermal Overload Fault

With station power available, the presence of a pump thermal overload fault will cause the pump to be unavailable for RTU control.

The pump thermal overload fault will be unlatched and the pump will become available for RTU control if any of the following conditions are true:

1. The pump thermal overload condition is reset (OverLoad signal inactive) and the

local reset push-button is pressed.

2. The pump thermal overload condition is reset (OverLoad inactive) and a reset is issued from the operator workstation at Newstead.

3. The thermal overload delay reset timer times out. This will be indicated by the pump thermal overload auto reset flag being active.

When the pump cools and the thermal overload resets automatically, the thermal overload delay reset timer (initially set to 10 minutes) will start. The thermal overload timer is used to allow a pre-set time to pass for the pump to cool down and after this time delay it will unlatch the thermal overload fault flag.

3.2.1.3 No pump Thermistor Fault

With station power available, the presence of a pump thermistor fault signal will cause the pump to be unavailable for RTU control.

The pump thermistor fault will be unlatched and the pump will become available for RTU control if any of the following conditions are true:

1. The pump thermistor fault condition is reset (thermistor relay trip signal inactive) and the local reset push-button is pressed.

2. The pump thermistor fault condition is reset (thermistor relay trip signal inactive) and a reset is issued from the operator workstation.

3. The thermistor relay trip reset delay timer times out. This will be indicated by the pump thermistor relay trip auto reset flag being active.

When the pump thermistor cools and resets, the thermistor delay reset timer will start. The thermistor delay reset timer is used to allow a preset time to pass before unlatching the fault. During this delay, the motor windings may have cooled to an acceptable level for a restart.

3.2.1.4 Pump VFD Ready and In Auto Mode

The two sewage pumps at the Centenary Hwy Pumping Station will be driven by two VFDs (type Danfoss VLT6100). The local control keypad for each VFD will be mounted on the VFD Cabinet. The following control functions are available on the keypad:

- *When the VFD is selected to Local mode at the keypad, it will be controlled via the buttons on the keypad and any remote control signal coming to the VFD will be inactive.*
- *When the VFD is selected to Auto mode with the Pump Station Mode Selector Switch in Remote, the VFD will be controlled via the remote RTU signals coming to the VFD with all local keypad control signals being inactive. When the Pump Station is selected to Local mode and the VFD is in Auto, the VFD it will be controlled via a local potentiometer and the VFD keypad signals will be inactive.*

The following VFD signals will be connected to the pump station RTU:

- *"VFD Warning" RTU digital input signal: this signal will be on when the VFD is powered up and one of the non-essential faults in the VFD is detected. Some of the non-essential faults are:*

- *Mains Imbalance;*
- *Overvoltage or Undervoltage;*
- *Inverter Overloaded;*
- *Motor Thermal Overload;*
- *Motor Thermistor Fault;*
- *Overcurrent;*
- *Refer to page 157 of the VLT 6000 Series Design Guide or Page 108 of the VLT6000 operating instruction for the full list of signals that causes VFD Warning signal to be on.*

When the VFD Warning signal is detected, the VFD will try to run the pump at a reduced load to let the motor to recover from the fault conditions without stopping it. If the fault does not clear within a time period set in the VFD, then the pump will be tripped by the VFD and the "VFD Ready" RTU input signal will be off.

- *"VFD Ready" RTU digital input signal: this signal will be on when the VFD is powered up and the following conditions are not present:*

  - *one of the VFD Warning signals listed above has not tripped the pump;*
  - *One of the VFD essential faults has not been detected. The VFD essential faults are:*
    - *Earth Fault;*
    - *Switch Mode Fault;*
    - *Short Circuit;*
    - *Auto-optimisation not OK;*
    - *Heat-sink Temperature Too High;*
    - *Motor Phase Failure;*
    - *Inverter Fault*

  If any one of these essential faults are detected, the VFD will stop the pump and the "VFD Ready" RTU input signal will be off.

- *"VFD Auto mode Selected" this signal will be on if the drive is selected to Auto on the keypad and is ready for remote control;*
- *"VFD Running" this signal will be on when the drive is running;*
- *"VFD Running Speed" RTU analog input signal will provide 4-20mA VFD running Hz to the RTU;*
- *When selected to Auto mode, each Variable Frequency Drive speed will be controlled via an analogue output from the RTU. The pump operating speed will be set by the RTU as explained in Section 3.3.2.5.*

A VFD will be available for RTU control if the "VFD Ready" and "VFD Auto Selected" signals are on.

The pump "VFD Not Ready" fault will be unlatched and the pump will become available for RTU control if any of the following conditions are true:

1. *The pump VFD Not Ready fault condition is reset (VFD Ready RTU input signal active) and the local reset push-button is pressed.*

2. *The pump VFD Not Ready fault condition is reset (VFD Ready RTU input signal active) and a reset is issued from the operator workstation.*

3. *The pump VFD Not Ready fault condition is reset (VFD Ready RTU input signal*

active) and the Pump VFD Not Ready reset delay timer in the RTU times out. This will be indicated by the pump VFD Ready auto reset flag being active.

When the pump VFD faults, the VFD Auto reset timer will start. The VFD Auto reset timer is used to allow a preset time to pass before unlatching the fault. Meanwhile the RTU may block the reset operation based on the number of "VFD Not Ready" conditions exceeded the limit (refer to Section 3.2.1.8).

For convenience, when the soft starters were replaced be the VFDs, the motor line contactor and thermal overload were left in circuit on the line side of the VFD. The contactor now provides safety isolation for the motor circuit when the Emergency Stop or Local Control Switch is operated.

3.2.1.5 No Pump Failure Signal is On

If a "Pump Failure" signal is detected from the site, an alarm will be generated after a pre-defined time period has elapsed. This will make the pump unavailable for RTU control. The alarm will be monitored at the Newstead Central Control Room.

3.2.1.6 No Pump Thermal Overload Count Exceeded

The maximum number of times an overload is permitted to reset in any 8 (eight) hour period is selected by the operator from the master station. The selection shall be 0, 1, 2, or 3 (e.g., if 0 is selected, the pump shall lockout on the first overload). If the fault count gets upto the selected limit, a fault count exceeded flag will be set. This will lockout the pump and will make it unavailable for RTU control. The pump lockout will be cleared if one of the following conditions are met:

1. The Local pump fault reset push-button is pressed;

2. The Remote pump Fault reset is issued from the operator workstation.

3.2.1.7 No Pump Thermistor Fault Count Exceeded

The maximum number of times a thermistor is permitted to trip and be re-set in any 8 (eight) hour period is selected by the operator from the master station. The selection shall be 0, 1, 2, or 3 (e.g., if 0 is selected, the pump shall lockout on the first trip). If the fault count gets upto the selected limit, a fault count exceeded flag will be set. This will lockout the pump and will make it unavailable for RTU control. The pump lockout will be cleared if one the following conditions are met:

1. The Local pump fault reset push-button is pressed;

2. The Remote pump Fault reset is issued from the operator workstation.

3.2.1.8 No Pump VFD Fault Count Exceeded

The maximum number of times a VFD Not Ready signal is permitted to trip and be re-set in any 8 (eight) hour period is selected by the operator from the master station. The selection shall be 0, 1, 2, or 3 (e.g., if 0 is selected, the pump shall lockout on the first trip). If the fault count gets upto the selected limit, a fault count exceeded flag will be set. This will lockout the pump and will make it unavailable for RTU control. The pump lockout will be cleared if one the following conditions are met:

1. The Local pump fault reset push-button is pressed;

2. *The Remote pump Fault reset is issued from the operator workstation.*

3.2.1.9 Pump Well Not Flooded

The sump pump shall start when the high level probe is reached. A sump pump running warning shall be initiated and displayed on the operator workstation. The sump pump shall continue to run until the level falls below the low level probe.

Both main pumps shall be locked out in the event of the pump well flooding. This is activated by a level probe at the pump well sump. Pump well flooding also initiates an alarm. The pump lockout condition can only be cleared by pressing the LOCAL RESET pushbutton at the switchboard.

3.2.1.10 Pump Emergency Stop Not Operated

Upon detection of the operation of the pump EMERGENCY STOP pushbutton via RTU digital input, 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.

Refer to DSDDS for more details and control algorithm.

3.2.1.11 No Pump Reflux Valve Failed Signal On

The RTU will monitor the pump reflux valve microswitch digital input when the pump is both running and stopped.

The reflux valve microswitch contact states will be as follows:

Pump Stopped	- Reflux Down & Reflux Microswitch Contact CLOSED
Pump Running	- Reflux Up & Reflux Microswitch Contact OPEN

On pump startup, an RTU reflux microswitch timer of 30 seconds shall be started. If the reflux valve fails to open within this time period, then the reflux valve fail to open flag will be latched on and the pump shall stop and become unavailable for RTU control. If a pump is running, and the reflux valve closes, and remains closed for 30 seconds, then the reflux valve fail to open flag, will be latched on and the pump shall also immediately stop and become unavailable for RTU control.

If the pump reflux fails to open, the pump reflux fail to open delay reset timer will start. The Pump Reflux Valve Fail To Open fault will be unlatched if any of the following three conditions are true:

1) The local reset pushbutton is pressed

2) A reset from the operator workstation occurs

3) The pump reflux fail to open delay reset timer times out. This will be indicated by the pump reflux fail to open fault auto reset flag being active.

If a pump stops and the reflux valve fails to close within a set time period, only an alarm "Pump Reflux Valve Closing Fault" flag will be generated on the operator computer. This condition will not cause the pump to become unavailable for RTU control. The closing fault will be cleared based on conditions 1 and 2 above.

3.2.1.12 No Pump Reflux Valve Failed Count Exceeded

The maximum number of times the reflux valve is permitted to trip in any 8 (eight) hour period is selected by the operator from the master station. The selection shall be 0, 1, 2, or 3 (e.g., if 0 is selected, the pump shall lockout on the first trip). If the fault count gets upto the selected limit, a fault count exceeded flag will be set. This will lockout the pump and will make it unavailable for RTU control. The pump lockout will be cleared if one the following conditions are met:

1. The Local pump fault reset push-button is pressed;
2. The Remote pump Fault reset is issued from the operator workstation.

3.2.2 Pump Start / Stop Sequence

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

The duty/Lag configuration will now allow one or both pumps to operate.

The primary duty pump will start if all the following conditions are true:

1) the pump is available for RTU control
2) the pump is not locked out
3) 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 RTU control

When the station is switched to local, any running pump will be stopped and the RTU will perform no automatic pump controls until the station is returned to remote.

With the station in local, the pumps can be started via the "Start" pushbutton. The pump will run only while the "Start" pushbutton is pressed.

The start-up sequence for a pump will be executed in the following manner:

- Wet well level transmitter signal reaches an intermediate value *or in local and the Start button is pressed.*
- *Check that the isolating contactor is closed, if not then energise the contactor closing relay.*

1.1.1.1 After a time delay of 10 seconds, energise VFD Run/Stop relay. The VFD ramps to minimum running speed (set within the PLC NOT the VFD) in 0 - 20 secs, VFD running relay changes state to indicate the pump is running. Set VFD fail to ramp timer at 30 secs delay (initially).

- *Reflux Valve Limit Switch delay timer (0 - 35 secs) is energised.*

- *If the Reflux Valve Limit Switch breaks before Reflux Valve Limit Switch delay timer expires, then the energised run relay remains energised.*
- *Pump running light on local panel is energised and hours run meter is started.*

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

- Wet Well Level is at its common stopping point or *in local and the Stop button has been pushed*
- *De-energise VFD Run/stop relay, VFD deceleration is initiated.*
- Start reflux timer (0 - 60 secs) delay.
- *Once the VFD has ramped down to 0 Hz, the VFD running signal will be inactive.*
- Run light on local panel is de-energised and hours run meter is stopped.

Note: for normal stop mode of operation the Contactor will remain closed after the stop sequence is completed.

The Emergency Stop sequence for a pump will be executed in the following manner:

- Local Emergency Stop push-button is pressed.
- This will open the LINE Contactor via its hard-wired circuits.
- *De-energise VFD Run/stop relay, VFD deceleration is initiated but pump will coast to a stop.*
- Run light on local panel is de-energised and hours run meter is stopped.

3.2.3 Pump Abnormal Operation

If the RTU is not available, the pump station will not be operational. In case of emergency with the RTU down, electrician (only) may operate a pump locally, by bridging the line contactor close control circuit and then selecting the VFD to Local mode on its keypad this will allow the VFD to be started via its start button on the keypad.

3.3 RTU Functionality

3.3.1 RTU Alarms and Calculations

The following is a summary of the alarms and calculations performed in the RTU:

1. Station Power Fail Alarm
2. RTU Power Fail Alarm
3. RTU Low Battery Alarm
4. Wet Well Level
5. Wet Well Volume
6. Wet Well Monitor
7. Wet Well Inflow And Inflow Integration
8. Wet Well Overflow Volume
9. Wet Well Surcharge Probable Alarm
10. Wet Well Surcharge Imminent Alarm
11. Wet Well Surcharge Occurrence Duration And Alarm
12. Flow Rate Conversion
13. Delivery Flow Rate Monitor
14. Flow Rate Integration

15. Pressure Measurement Conversion
16. Delivery Pressure Monitor
17. Pump Availability
18. Pump Running
19. Pump Number Of Starts
20. Pump Hours Run
21. Pump Thermal Overload
22. Pump Thermistor Fault
23. Pump Reflux Valve Failure
24. *Pump Variable Frequency Drive Warning*
25. *Pump Variable Frequency Drive Not Ready*
26. Pump Emergency Stop
27. Pump Lockout Due To Pump Well Flooded
28. Plant Availability Index for Pumps
29. Plant Utilisation Index for Pumps
30. Hydraulic Power Consumption
31. Electrical Power Consumption
32. Motor Current Monitor
33. Motor Power Monitor
34. Motor Efficiency
35. *Pump Not in Auto Mode*
36. *Pump Running Speed*
37. *Pump Speed Control*

A brief description of each item is given below. For full functional description and control algorithm of each of these alarms or calculations refer to DSDDS document. The items shown in *Italics* are new modifications and their functional description is given in full.

3.3.1.1 Station Power Fail Alarm: (Refer to Section 3.2.1.1);

3.3.1.2 RTU Power Fail Alarm

When a "RTU Power Failure" (derived from battery charger input under voltage) signal is detected from the site, an alarm will be generated after a pre-defined time period has elapsed. The alarm will be monitored at the master station.

3.3.1.3 RTU Low Battery Alarm

When a "Battery LOW" signal is detected from the RTU battery, an alarm will be generated after a pre-defined time period has elapsed. The alarm will be monitored at the master station.

3.3.1.4 Wet Well Level

The Wet Well level is derived from the standard 4-20mA analogue signal scaled in MAHD (Metres Australian Height Datum). For every level probe signal, the level input is validated and latched at the 4-20mA boundaries for display purposes.

The level readings will be clamped and alarmed at the minimum and maximum levels of the level probe with a preset percentage variance. A level average figure will be calculated over a 5 by 5 second sampling periods.

3.3.1.5 Wet Well Volume

The Wet Well Volume is derived from the Wet Well Level. The level is compared against an adjustable look up table that derives a volume based on level segment entries.

3.3.1.6 Wet Well Monitor

The filtered wet well level will be checked for operator adjustable limits. At RTU initialisation the limits will be set to default values stored in the RTU.

3.3.1.7 Wet Well Inflow And Inflow Integration

Flow into the wet well will be calculated using the wet well level. From the wet well level signal and using provided constants, the storage value (in cubic metres) for any wet well level can be determined. At constant specified periods an increase in storage capacity will be calculated for that period. The increase will be converted to litres per minute inflow value. This calculation will only occur when the pumps are not in operation.

During times when a pump is operating, and for a defined period after the pump has stopped, the inflow will be kept constant at the value prior to the pump operation.

The measured inflow shall be integrated to give cumulative total, in kiloLitres (kL), of the flow through the sewage system site. The daily flows shall be used in reports.

Integration of the flow during periods where the Wet Well Level signal is determined to be invalid will use a zero value for Flow Rate.

3.3.1.8 Wet Well Overflow Volume

The overflow volume shall be calculated during the overflow incident from the time that the level is above the overflow level and from the look-up table relating the volume flowing through the overflow to this height. The overflow volume shall be recorded for use in reports.

The overflow volume calculation shall be performed every 5 seconds when a surcharge is occurring.

3.3.1.9 Wet Well Surcharge Probable Alarm

A "surcharge probable" alarm for each wet well level will be generated when the predicted time to overflow is 30 minutes or less. For a particular wet well, the alarm calculations shall be initiated when the level in the wet well is above the highest pump cut-in level and shall be reset when the level falls below this level.

The rate of change in level shall then be calculated over a rolling 5 minute period.

From the actual level in the wet well, the overflow level and the rate of change of level, a predicted time to overflow shall be calculated. If this time is less than 30 minutes, an alarm shall be generated.

This alarm shall be used to initiate an indication on the detail page of the time of day when the predicted surcharge will occur (ie. time of day of alarm plus predicted time until surcharge).

3.3.1.10 Wet Well Surcharge Imminent Alarm

A "surcharge imminent" alarm for each wet well level will be generated when the "Surcharge Imminent" level switch, mounted 300mm below the overflow level is activated.

Note that the Surcharge Imminent Alarm is not raised if a Wet Well Calibration is in progress (refer to Section 3.3.2.3). This is due to the Calibration using the Surcharge Imminent Electrode as the sequence terminator.

Once activated, an alarm dead band shall maintain this alarm active for a minimum period of ten (10) minutes.

3.3.1.11 Wet Well Surcharge Occurrence Duration And Alarm

A surcharge occurs when the sewage level is at or above a level 25mm below the overflow level. Once this alarm has been activated, an alarm dead band shall maintain this alarm for a minimum period of ten (10) minutes.

The surcharge incident duration shall also be calculated. The duration of a surcharge incident shall be defined as the time from which a "surcharge occurring" alarm becomes active until the same alarm becomes inactive. The beginning time and the end time of the surcharge incident shall be recorded for use in reports.

3.3.1.12 Flow Rate Conversion

The flow rate is derived from standard 4-20mA analogue signal scaled in litres per second (L/sec). For every flow meter signal, the "Flow Rate Conversion" is performed to get the equivalent flow rate in kilolitres per day (kL/day).

Flow rate readings will be clamped at the minimum and maximum flow rate of the flow meter range with a preset percentage variance.

3.3.1.13 Delivery Flow Rate Monitor

The Delivery Flow Rate Alarm function will monitor flow rate signal from Delivery Flow Meter. Flow meter signals exceeding alarm limits will cause alarms to be generated.

Flows which are calculated from pump characteristics shall not be alarmed.

Separate high and low alarms shall be provided for each single and parallel pump combinations.

Example, for a Two-Pump System

For Flow Meter X, the alarm limits used are:

i) with one Pump running alone:	One Pump - High Flow Limit, and One Pump - Low Flow Limit,
ii) with two Pumps running:	Two Pumps - High Flow Limit, and Two Pumps - Low Flow Limit,

The alarming for flow meter shall be inhibited when there are no pumps running to avoid nuisance

alarms.

When any one pump, begins to run or stop, the Flow Meter Inhibit Alarm Timer (set to 30 secs) shall begin timing. The alarming for flow meter shall be temporarily inhibited until after this timer expires.

The Flow Meter Alarm Inhibit Flag will be reset when the alarming for flow meter is inhibited and set when alarming is activated.

3.3.1.14 Flow Rate Integration

The flow rate from the pump station flow meter shall be integrated to give a total flow reading in kilolitres (kl).

The RTU shall calculate and retain total flow figures, similar to an ordinary flow meter, with sufficient significant figures for at least one year consumption.

Facilities shall be provided for the operator at the workstation to overwrite the calculated figures to correct errors. This includes the resetting of the total flow figure to zero.

The system shall also flag "invalid" readings due, for example, the loss of input signal from the associated flow meter. Invalid flow rate readings will not be included into the integration calculation. The total flow figure will, however, be flagged as "invalid".

The volume invalid signal will not be automatically reset after the flow rate signal comes good. All recorded data for the period that the flow rate input signal was invalid shall be flagged as "invalid" reading. The invalid signal will be reset after an updated value followed by an overwrite signal is applied to the volume figure or the volume figure is reset to zero.

At predefined periods the accumulated volume shall be reset to zero for accumulation calculations for the next period. (ie. Water flow meters will be reset once a year, where as sewage flow meters will be reset daily).

The flow integration shall be performed every 5 seconds.

3.3.1.15 Pressure Measurement Conversion

The Pressure Measurements Conversion will calculate the equivalent pressure in kiloPascals (kPa) and Metres Above Australian Height Datum (MAHD). The field input shall be read as kPa.

Pressure readings will be clamped at the minimum and maximum pressure readings for the pressure gauge range with a preset percentage variance.

The pressure in kPa is required to be converted to Meters Water Gauge (MWG).

Conversion to MWG

Pressure kPa is converted to MWG by dividing by a conversion factor.

$$\text{Pressure (MWG)} = \text{Pressure (kPa)} / k$$

Where: - Pressure (kPa) is the engineering units signal from the pressure transmitter in kPa units.

- Pressure (MWG) is the pressure in meters water gauge.
- k is the kPa to MWG conversion factor of 9.803.

Conversion to MAHD

The pressure MAHD is calculated by adding the elevation value of the pressure transducer to the pressure measurement:

Pressure (MAHD) = Pressure(MWG) + Ep(MAHD)

where: - Pressure (MWG) is the pressure in metre unit.
- Ep(MAHD) is the elevation of the pressure transducer
- Pressure(MAHD) is the pressure in MAHD unit

3.3.1.16 Delivery Pressure Monitor

The Delivery Pressure Alarm function will monitor pressure signals from Delivery Pressure meter. Pressure signals exceeding alarm limits will cause alarms to be generated.

Separate high and low alarms shall be provided for each single and parallel pump combinations.

Example, for a Two-Pump System

For Pressure meter X, the alarm limits used are:

i) with one Pump running alone:	One Pump - High Pressure Limit, and One Pump - Low Pressure Limit,
ii) with two Pumps running:	Two Pumps - High Pressure Limit, and Two Pumps - Low Pressure Limit,

The alarming for pressure meter shall be inhibited when there are no pumps running to avoid nuisance alarms.

When any one pump begins to run or stop, the pressure Inhibit Alarm Timer (set to 10 secs) for the pressure meter shall begin timing. The alarming for the pressure meter shall be temporarily inhibited until after the time expires.

The Pressure Alarm Inhibit Flag will identify the alarming inhibited period. The Pressure Alarming Enabled Flag will identify when alarming is required (ie. a pumps is running).

3.3.1.17 *Pump Availability* (Refer to Section 3.2.1.);

3.3.1.18 Pump Running

The Pump Running function will determine whether a particular pump is running or stopped by monitoring the Pump Variable Frequency Drive "VFD Running" digital input.

The function will set the pump running flag if the pump is running or reset the same flag if the pump is stopped.

3.3.1.19 Pump Number Of Starts

This function is NOT required at Kooringal Drive as the starters are VFD's.

The Pump Number Of Starts function will monitor and calculate the number of pump starts that have occurred since reset.

A pump, when selected in remote, is only permitted 12 starts within any 1 hour period. To ensure this limit is not exceeded, the pump will not be permitted to start again for five (5) minutes after the pump completes a full start-up sequence. This will ensure that only a maximum of 12 pump starts can occur for each pump every hour.

In the event of a surcharge, or the pump being selected is in LOCAL, this lockout will be disabled allowing the pump to start.

3.3.1.20 Pump Hours Run:

The Pump Hours Run function will monitor the number of hours that is run by a pump.

3.3.1.21 *Pump Thermal Overload* (Refer to Section 3.2.1.2);

3.3.1.22 *Pump Thermistor Fault* (Refer to Section 3.2.1.3);

3.3.1.23 *Pump Reflux Valve Failure* (Refer to Section 3.2.1.12);

3.3.1.24 *Pump Variable Frequency Drive Warning* (Refer to Section 3.2.1.4);

3.3.1.25 *Pump Variable Frequency Drive Not Ready* (Refer to Section 3.2.1.4);

3.3.1.26 *Pump Emergency Stop* (Refer to Section 3.2.1.11);

3.3.1.27 *Pump Lockout Due To Pump Well Flooded* (Refer to Section 3.2.1.10);

3.3.1.28 Plant Availability Index for Pumps

A progressive monthly plant availability index shall be calculated for each group of functionally related plant. An item of plant is said to be "available" whenever normal operation is possible, i.e., when the following conditions are true:

1- the equipment is available for normal operation (ie. not local, power available and no tripped faults).
2- the equipment is not locked out and a request to operate has been made.

For each item of plant, including sewage pumps, and remote controlled valves, the times and dates of changes in the "plant availability" shall be recorded for use in the calculation of a plant availability index.

NOTE: The time and date of changes in the "plant availability" will be stored in an analogue history buffer at the master station. A process called "histproc" will handle this functionality.

At any instant, percentage availability "A" shall be given by:

A = (Capacity Available / Capacity Installed) x 100

The plant availability index shall be the progressive mean of "A" above, reset at the beginning of every month.

A low priority "station outage" alarm shall be produced and used to initiate reports when the plant availability for the group of functionally related plant falls below an operator adjustable minimum percentage.

The intention is that the alarm should indicate when insufficient plant is available for normal design operation. For example, in a site with three pumps where one is normally for Lag, the alarm shall be initiated when the plant availability is less than 2/3.

3.3.1.29 Plant Utilisation Index for Pumps

A progressive monthly plant utilisation index shall be calculated for each group of functionally related plant. An item of plant is said to be "utilised" when it is operating normally, i.e., pump is on-line or running.

At any instant, the percentage utilisation "U" shall be given by:

U = (Capacity Operating / Capacity Installed) x 100

The plant utilisation index shall be the progressive mean of "U" above, reset at the beginning of every month.

3.3.1.30 Hydraulic Power Consumption

The Hydraulic Power Consumption will be used to calculate Motor Efficiency as explained in Section 3.3.1.33.

Daily hydraulic power consumption shall be calculated for each single pump from the product of pressure and flow as follows:

Ph = K * Fe * M * dT

where: Ph - the hydraulic power consumption (kWHr)
Fe - the pump delivery flow rate (L/S) derived (see "Flow Estimation")
M - the differential pressure generated by the pump (see "Differential Pressure" over leaf)
K - an estimated constant derived from the pump test characteristics relating the product of F * P to power (kW)
dT - the number of hours in the integration period (24 hrs)

In order to calculate the hydraulic energy supplied by a pump, it is necessary to measure the differential pressure (M) and the estimated generated flow (Fe).

Flow Estimation, Fe

When a pump is operating singly, the flow used in the efficiency calculation shall be the measured flow from the flow meter signal.

When pumps operate in parallel, the flow for each pump shall be estimated according to the ratio of the nominal capacity of an individual pump to the total nominal capacity of all operating units:

$$Ct = Cn + Cn+1 + ...$$

$$Fen = (Cn / Ct) * Ft$$

$$Fen+1 = ((Cn + 1) / Ct) * Ft$$

where:
- Cn - nominal capacity of pump n
- Ct - total nominal capacity of all pumps operating in parallel
- Fen - estimated flow generated by pump n
- Ft - flow signal measured from the flow meter when all pumps are operating in parallel

Differential Pressure, M

The differential pressure can be calculated using pump delivery pressures less pump suction pressure:

M = DeliveryPressure - SuctionPressure

- or -

M = DeliveryPressure - ReservoirLevel(MAHD)

- or -

M = DeliveryPressure - WetWellLevel(MAHD)

where: M is the differential pressure generated by the pump

The calculations shall not be carried out when a pump is not operating i.e., the last calculated value shall be retained as the current value.

It shall be possible for the operator to readily adjust calculations and constants. Adjustments would, for example, be required when a pump is replaced or overhauled.

3.3.1.31 Electrical Power Consumption

The Electrical Power Consumption calculation will work out the electrical power consumption of each pump. Power consumption shall be calculated using the motor kW readings and by integration over the operating time.

$$Pe = P * dT$$

where:
- Pe - the electrical power consumption (kWHr)
- P - power (kW) reading
- dT - the number of hours in the integration period Daily electrical power consumed for each single pump shall be calculated.

The calculations shall not be carried out when a pump is not operating i.e., the last calculated

value shall be retained as the current value.

It shall be possible for the operator to readily adjust calculations and constants. Adjustments would, for example, be required when a pump is replaced or overhauled.

3.3.1.32 Motor Current Monitor

The Motor Current sequence will monitor the motor current signal and generate appropriate alarms. High and low alarms shall be provided for each motor current monitored.

Alarms shall be inhibited when the pump is off. Alarms shall also be inhibited for a given period of time after the pump starts running.

Each pump will have individual operator adjustable time delay period initially set to 30 seconds.

3.3.1.33 Motor Power Monitor

The Motor Power function will monitor the motor power (kW) signal, perform signal filtering, and generate appropriate high and low alarms for each pump.

Each single and parallel pump combinations have separate upper and lower alarm limits.

The alarming for a given pump, shall be inhibited when the pump stops running. The high and low alarm flags shall not cause any control action to be initiated, e.g., stopping a pump already running.

When another pump starts to run, the Pump Power Inhibit Alarm Timer (set to 30 secs) for the operating pump shall begin timing. The alarming for pump pmpX shall be temporarily inhibited until after the timer times out.

The Pump Power Alarm Inhibit Flag will be set when the alarming for pump is inhibited and reset when alarming is activated.

3.3.1.34 Motor Efficiency

The motor efficiency will be calculated as the ratio between the hydraulic power consumption, Ph, over the electrical power consumption, Pe, measured over the same period of time:

$$Ee = \frac{Ph}{Pe} \times 100$$

where: Ee - percentage motor efficiency
Pe - electrical power consumption
Ph - hydraulic power consumption

Separate efficiency calculations shall be carried out for each pump.

3.3.1.35 Pump Not in Auto Mode (Refer to Section 3.2.1.5);

3.3.1.36 Pump Running Speed

Each pump VFD will provide a 4-20mA analog input to the RTU to indicate the pump running speed. The RTU will transfer this signal to Newstead for monitoring purposes.

3.3.1.37 Pump Speed Control

When the pumping station is in Remote mode, the pump speed will be controlled by the RTU as explained in Section 3.3.2.5.

When the Selector Switch is in Local, the pump speed will be controlled by the speed potentiometer as in Section 3.3.25 & 3.2.1.4.

3.3.2 RTU Controls and Sequences

The following is a summary of the controls and sequences performed in the RTU:

1. Site Attention Alarm
2. Cathodic Protection Test Sequence
3. Wet Well Level Instrument Calibration Check
4. Pump Duty Selection
5. Pump Station Control
6. Pump Individual Control
7. Pump Status Indication Lamp
8. Chemical Dosing Pumps
9. Chemical Dosing Pumps (Other Site)

Refer to DSDDS Section 3.2 for details of each control or sequence. Presented below are a brief description of each item and its functionality.

3.3.2.1 Site Attention Alarm

The site has been provided with an "attention alarm" and a local "acknowledge" pushbutton.

Operators shall be able to initiate and cancel the "attention alarm" from the detail displays at the workstation. Officers on site will be required to contact the relevant control room by radio or telephone when they see the alarm.

Once activated, the attention alarm shall remain on for an operator adjustable period (initially set to 15 minutes) and then reset automatically if not already reset by the control room operator or by the operation of the local "acknowledge" pushbutton.

3.3.2.2 Cathodic Protection Test Sequence

The Cathodic Protection Test Sequence will control the cathodic protection equipment and monitor its performance.

The monitoring and control sequence shall be as follows:

a) The digital input "CP door" shall be continuously monitored and logged upon a change of state. The digital input "CP power available" shall be continuously monitored and, upon change of

state, logged and alarmed.

b) The rectifier voltage and current shall be continuously monitored and alarmed and logged if the values are above or below alarm limits. These alarm limits shall be readily adjustable by the operator from the control page. Upon the above alarm being initiated, the rectifier unit shall be de-energised via the digital output "De-energise CP rectifier unit", until the local or remote reset is activated.

c) At predetermined times, selectable by the operator from a control set-up page on the workstation, a test sequence shall be initiated. It shall also be possible to initiate a sequence at any time by "manual" selection. It is likely that the sequence will be initiated no less frequently than once a month or more frequently than once every 12 hours, i.e.

12 hours <= time between test sequences <= 1 month.

d) When the test sequence is initiated, the digital output "Connect CP reference electrodes" shall be energised. After this relay is energised, the reference electrode "on potential" voltages shall be monitored, logged and alarmed if the values are above or below alarm limits. These alarms shall be readily adjustable by the operator from the control page.

e) Upon completion of the above and after a time delay of one second, the digital output "De-energise CP rectifier unit" shall operate, causing the reference voltage to decay. After an operator adjustable time delay, of between 0.1 and 60 seconds, the analog "off potential" shall be monitored, logged, and alarmed if the values are above or below limits. Theses alarm limits shall be readily adjustable by the operator from the control page.

f) After the completion of the above, the relay "Connect CP reference electrodes" and relay "De-energise CP rectifier unit" shall de-energise and the sequence returns to the start.

3.3.2.3 Wet Well Level Instrument Calibration Check

The controls for each sewerage pumping station shall include a Wet Well "Calibration Check" sequence. This sequence is used to check the validity of the level probe reading.

The sequence shall either be initiated remote manually (by an operator) or automatically (on a monthly basis at predetermined times and dates). The automatic start of the calibration shall still require operator confirmation before starting; this is to cater for wet weather conditions.

It shall be possible for the operator to readily inhibit automatic and manual operation.

Once a calibration check is initiated, the following shall occur:

1) The sequence shall not start until the wet well level reaches the lowest pump stop level and all pumps have stopped.

2) Normal controls and related level alarms shall be inhibited and the pumps shall be stopped.

3) The level in the wet well will increase until the "surcharge imminent" electrode is reached. The level of the wet well shall be recorded at this point and compared with the known level of the "surcharge imminent" electrode. An alarm shall be generated if the level is not within 25mm of the surcharge electrode level.

4) The pump or pumps shall start.

5) A short time delay shall be allowed for the level to fall during which time normal level alarms shall remain inhibited.

6) Control and associated alarms shall then return to normal.

During the calibration the following actions can take place:

1) The operator can inhibit / stop the calibration sequence.

2) If a site worker switches the pumps to local mode while the calibration sequence is in progress, the sequence is suspended.

3) The operator is notified of the suspension. Once the pumps have returned to remote mode the calibration shall restart from the beginning of the sequence, only after acknowledgment from the operator.

4) If the duration of a calibration sequence exceeds 8 hours the operator shall be notified.

3.3.2.4 Pump Duty Selection

The Pump Duty Selection function will monitor the availability of both pumps and control the rotation of the pumps so that the Duty Pump is rotated every time the current Duty Pump starts and then eventually stops. It is also rotated whenever the duty pump is unavailable.

The true duty pump will be known as "Duty Pump". The second operational duty pump will be known as "Lag Pump".

3.3.2.5 Pump Station Control :

The pump station can operate in two modes as follows:

- Remote (Auto Mode), and
- Local Manual.

These modes are selectable via a selector switch mounted on the switchboard. When Remote is selected, the control of the pump station will be based on the current state of the sewage wet well level with the station operating on a duty/Lag configuration.

When the pump station is in Remote mode, remote manual operations are also available to the Newstead operators and a pump can be started or a running pump can be stopped.

When the pump station is in Local mode, any of the pumps can be started or stopped via local start/stop push-buttons mounted on the switchboard in combination with the manual speed

potentiometer.

3.3.2.5.1 Pump Station Auto Control :

Control of the pump station will be based on the current state of the wet well level with the pumps operating on a Duty/Lag configuration. Under normal conditions, with the wet well rising and the wet well level and flow signals valid, the site will pump in a combination of level and flow control affected by a Proportional/Integral/Derivative (P.I.D) Controller that will reside in the RTU.
In the event of a failure of the wet well level probe, all pumps will immediately stop.

The set points will be as follows:

Wet Well Level	Indicator %	Metres AHD	Function
			Minimum speed = 28 Hz = 60l/sec? *Maximum speed = 31 Hz* = 140 l/sec? *Minimum flow = 60 l/sec?* *Maximum (station) flow =140 l/sec?*
		9.530 m	Probable Slab Level
		9.277 m	Probable Probe suspension level
			Probe length 9.500 m
3.000 m	100%	2.777 m	Probe upper range 20mA
0.000 m	0%	-0.223m	Probe lower range 4 mA Probe length 9.500m
2.663m	88%	2.440m	Surcharge
2.370m	79%	2.147m	Surcharge Imminent Alarm
2.323m	77%	2.100m	Start lag pump. At the same speed as the lead pump..
2.223m	74%	2.000m	The PID output will have reached 100 % ie the lead pump is running at 50Hz.
2.023m	67%	1.800m	Set Point. Invert level of inlet pipe-work in wet well

1.923m	64%	1.650m	Start duty pump at minimum speed. PID control is enabled after a delay of 45 sec. This enables the flow to stabilise and acts as an anti - integral wind-up function. Once activated this remains in activation until the pump stops
1.473m	49%	1.250m	Stop Lag Pump
0.450m (BWL)	15%	0.227m	Stop duty pump

The lead pump will be requested to start at minimum speed (this speed will be a set constant and will be used in all Auto PLC controlled conditions as the pump minimum speed.) when the wet well level exceeds the start duty pump level.
The pump will continue to run at minimum speed until a delay period expires to allow for stabilisation. The set point shall be the PID control level.

A wet well level PID control loop shall cascade to a flow PID control loop where the output of the level loop controller shall be the set-point for the flow loop controller.
Pump speed shall be capable of varying from minimum speed to maximum speed.

The modulating PID control will continue until the stop duty pump level is reached.

Should the level rise to the lag pump start set point the lag pump shall start. The flow controller shall then control both pumps at the same speed determined by the calculated PID speed.
Both pumps will continue to run until the wet well level drops to the Stop Lag Pump level Set point for a time period (initially set to 30 seconds). At this point the lag pump will stop. The lead pump will continue to run as described above.

3.3.2.5.2 Maximum Station Flow *:*

The station output flow will be limited when either 1 or 2 pumps are operating to the "Maximum Station Flow" value.
The "Maximum Station Flow" value will be determined on site based on the pump capabilities.

Note: 2 pumps operating together and delivering "Maximum Station Flow":
1. Are more efficient than 1 pump operating at the extremity of its pump curve. (The input power to output work ratio is better)
2. Is less likely to cause the pumps to cavitate and therefor wear or damage the impellor.
3. Will only occur in when one pump would be required to run for an extended period of time.

3.3.2.5.3 Surcharge imminent electrode:

Surcharge imminent electrode:

On activation of the surcharge imminent electrode
the lead pump will start, a surcharge imminent alarm shall immediately be sent to the operator.
This function while active shall override the wet well control.
The lead pump will operate at 100% speed until the surcharge imminent electrode goes inactive and has been inactive for a time period (initially set to 3 minutes).

In Remote mode, "Time" controls shall also be provided to enable pumps to be started or stopped according to the time of day. For example, time restrictions will apply to automatic pump operation during ENERGEX peak periods. A "Start Time Control" will be issued prior to the peak period time to ensure that the wet well is empty just prior to the start of the period.

Likewise, prior to the end of the peak period, any pumps operating will be stopped to try and have the wet well as full as possible. If correctly calibrated, pumping will resume once in the ENERGEX off-peak period.

Once a sewage pump has been started or stopped from a time controller or remote manual operation, control shall return to the normal set point profile level control.

Pump start control will be temporarily inhibited while the Wet Well Level Instrument Calibration Check is in progress (refer Section 3.3.2.3).

Should the current duty pump fail to start, thereby becoming unavailable for RTU control, the Lag pump shall be available to start immediately based on the wet well level set-points.

3.3.2.5.4 Auto Mode Flow Meter Failure:

In the event of a failure of the flowmeter, an alarm shall be generated at the operators SCADA system. An additional level only PID loop controller shall become the speed control output for the VFD's bypassing the flow loop..
Control shall remain as 3.3.2.5.1.

3.3.2.5.5 Slime Stripping:

The Centenary Hwy Sewage Pumping Station does not require any modification to achieve slime stripping, because the slime stripping flows in the Rising Main occurs when Fortrose Street Pumping Station operates at the same time. This is a relatively likely event (estimated to occur

15% of the time during PDWFs). The capacity increase at the Centenary Hwy Sewage Pumping Station will further improve the slime stripping process in the Rising Main.

3.3.2.6 *Pump Individual Control:* Refer to Section 3.2.

3.3.2.7 Pump Status Indication Lamp:

The Pump Status Indication Lamp RTU output will remain steady on if the pump has completed its start up sequence and the pump VFD running input is active. The lamp will remain active until this signal becomes inactive.

The pump status indication lamp will flash slow (1 sec on / 1 sec off) if the pump is unavailable for RTU control. The lamp will cease to flash slow when the pump becomes available for RTU control.

The pump status indication lamp will flash fast (0.3 sec on / 0.3 sec off) if the pump is locked out due to the lock out timer not expired. The lamp will cease to flash fast when the lockout timer expires.

3.3.2.8 Chemical Dosing Pump (Centenary Hwy)

This site has been installed with Hydrogen Peroxide dosing equipment. The RTU shall control the dosing pump via digital output. The dosing pump will operate when any of the main sewerage pumps are operating.

3.3.2.9 Chemical Dosing Pumps (Other Site)

This site has been installed with Hydrogen Peroxide dosing equipment for Fortrose Street Sewage Pumping Station. The RTU shall run the dosing pump via a digital output when the Fortrose Street Pumping Station is operating.

3.3.3 Summary of RTU Generated Alarms

The following alarms will be generated by the RTU and sent to the Newstead Central Control Room. Most of these alarms are point attributes that are set and reset using handlers in the RTU. Some, however, are actual digital inputs (DIT) and pseudo digital inputs (DIP) allocated a channel in the RTU.

Code	Alarm Description	Type
stnXmainsFail	Power Fail Alarm	DIP
rtuXmainsFail	RTU Power Fail Alarm	DIP
rtuXbatteryAlarm	RTU Battery Alarm	DIP
wwlXlevelInvalid	Wet Well Level Invalid	DIP
wwlXhighAlarm	Wet Well High level	DIP
wwlXlowAlarm	Wet Well Low Level	DIP
wwlXsurchPrbAlm	Surcharge Probable Alarm	DIP
wwlXsurchImmAlm	Wet Well Surcharge Imminent Alarm	DIP
wwlXsurchOccAlm	Surcharge Occurring Alarm	DIP
flwXinvalid	Flow rate invalid	DIP
flwXlowAlarm	Flow rate Low Alarm Flag	DIP
flwXhighAlarm	Flow rate High Alarm Flag	DIP

flwXvolInvalid	Volume Invalid Flag	DIP
preXinvalid	Pressure invalid flag	DIP
preXalarmInhibit	Pressure Alarming Inhibited	DIP
preXlowAlarm	Pressure Low Alarm Flag	DIP
preXhighAlarm	Pressure High Alarm Flag	DIP
pmpXthmlFault	Thermal Overload Fault Flag	DIP
pmpXthmlReset	Thermal Overload Fault Auto Reset Flag	DIP
pmpXthmlExcd	Thermal Overload Fault Count Exceeded Flag	DIP
pmpXthmstrFault	Thermistor Fault Flag	DIP
pmpXthmstrReset	Thermistor Fault Auto Reset Flag	DIP
pmpXthmstrExcd	Thermistor Fault Count Exceeded Flag	DIP
pmpXrflxOpenFlt	Reflux Valve Fail To Open Flag	DIP
pmpXrflxOpenRst	Reflux Fail To Open Fault Auto Reset Flag	DIP
pmpXrflxCloseFlt	Reflux Valve Closing Fault Flag	DIP
pmpXrflxOpenExcd	Reflux Valve Fault Count Exceeded Flag	DIP
pmpXVFDFault	*V. F. Drive Not Ready Flag*	*DIP*
pmpXVFDExcd	*V.F. Drive Fault Count Exceeded Flag*	*DIP*
pmpXVFDReset	*V.F. Drive Trip Auto Reset Flag*	*DIP*
pmpXemergencyStp	Emergency Stop Pushbutton Fault Flag	DIP
pmpXlockout	Lockout Flag	DIP
pmpXpmpWellFlood	Pump Well Flooded Fault Flag	DIP
stnXoutage	Plant station outage alarm	DIP
pmpXcurrLoAlarm	Current Low Alarm Flag	DIP
pmpXcurrHiAlarm	Current High Alarm Flag	DIP
pmpXmotorPwrLoAl	Power Low Alarm Flag	DIP
pmpXmotorPwrHiAl	Power High Alarm Flag	DIP
cprXrectVoltLoAl	Rectifier Voltage Low Alarm	DIP
cprXrectVoltHiAl	Rectifier Voltage High Alarm	DIP
cprXrectCrntLoAl	Rectifier Current Low Alarm	DIP
cprXrectCrntHiAl	Rectifier Current High Alarm	DIP
cprXonPtnlLoAl	Refr Electrode On Potential Lo Alarm	DIP
cprXonPtnlHiAl	Refr Electrode On Potential Hi Alarm	DIP
cprXofPtnlLoAl	Refr Electrode Off Potential Lo Alarm	DIP
cprXofPtnlHiAl	Refr Electrode Off Potential Hi Alarm	DIP
wwlXcaliFault	Calibration Error Alarm Flag	DIP
wwlXcaliStrtReq	Operator Initiate Calibration Check Request	DIP
wwlXcaliFailed	Calibration Sequence Failed Flag	DIP
wwlXcaliAborted	Calibration Aborted Flag	DIP
wwlXcaliLocAbort	Calibration suspended due to Local Mode switch	DIP
wwlXcaliRemResum	Resume Calibration Check after Suspend Rqst	DIP
stnXoperate	Duty Pump Required to Operate	DIP
pmpXfault	Pump Failure Status	DIP

ATTACHMENT 1
DRAWING SCHEDULE

Drawing Nr	Title
486/5/6-S2069	Darra Branch & Darra Branch Duplication Sewers Overall Flow Diagram
486/5/7-HG001	Switchboard Pump Circuits Power & Metering Schematic (Sht. 1 of 8)
486/5/7-HG002	Sewage Pump No.1 Power & Metering Schematic (Sht. 2 of 8)
486/5/7-HG003	Sewage Pump No.2 Power & Metering Schematic (Sht. 3 of 8)
486/5/7-HG004	Switchboard RTU Digital I/O Schematic Diagram (Sht. 4 of 8)
486/5/7-HG005	Switchboard RTU Analog I/O Schematic Diagram (Sht. 5 of 8)
486/5/7-HG006	Switchboard Equipment and Label Schedule (Sht. 6 of 8)
486/5/7-HG007	Switchboard Cubicle Construction and General Arrangement (Sht. 7 of 8)
486/5/7-HG008	Switchboard Cubicle Construction and General Arrangement (Sht. 8 of 8)
486/5/7-HG009	RTU General Arrangement
486/5/7-HG010	RTU Cubicle Wiring Diagram (Sht. 1 of 2)
486/5/7-HG011	RTU Cubicle Power Supplies Connection Diagram (Sht. 2 of 2)
486/5/7-HG012	Dry Well Electrical Equipment General Arrangement
486/5/7-HG013	Dry & Wet Wells Plan Electrical Equipment General Arrangement

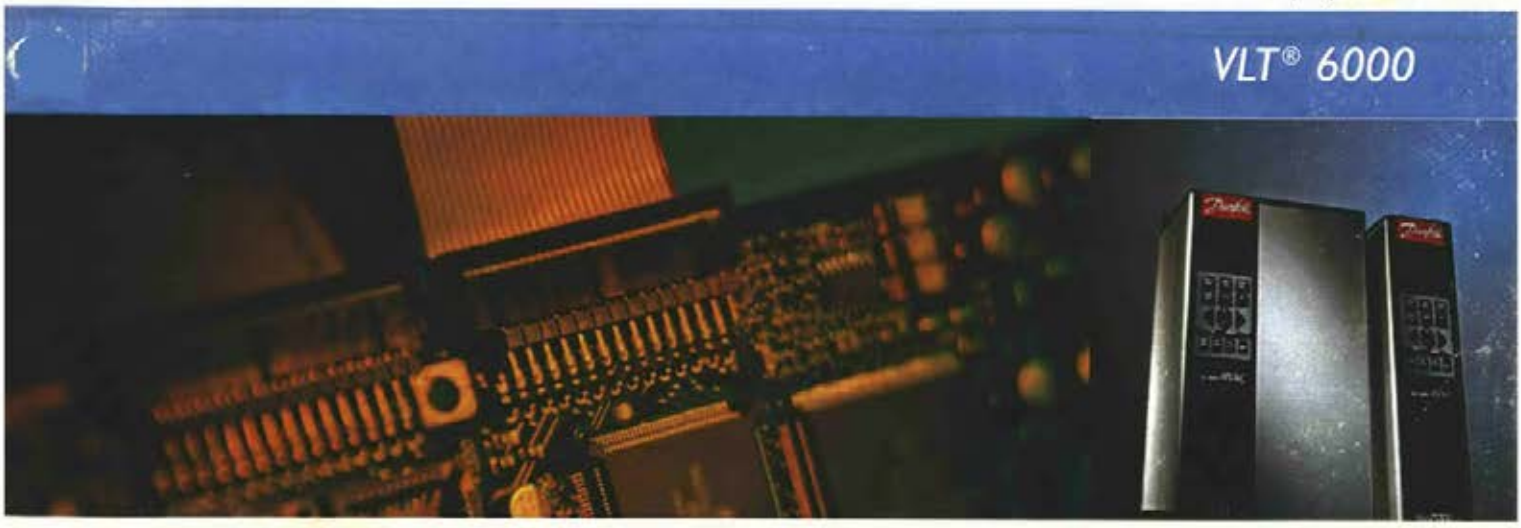
ATTACHMENT 2
ELECTRICAL DRAWINGS

VFD Manuals

Drives and Controls

Frequency converters

VLT® 6000



Operating Instructions

Contents

Programming

All about VLT 6000 HVAC

VLT 6000 HVAC

Operating Instructions
Software version: 2.0x

CE

These Operating Instructions can be used for all VLT 6000 HVAC frequency converters with software version 2.0x. The software version number can be seen from parameter 624, *Software version no.*

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 not included in the factory setting. If this function is required, set parameter 117, *Motor thermal protection*, to data value ETR trip or data value ETR warning.

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: wait at least 4 minutes
Using VLT 6006-6550: wait at least 15 minutes

■ 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.

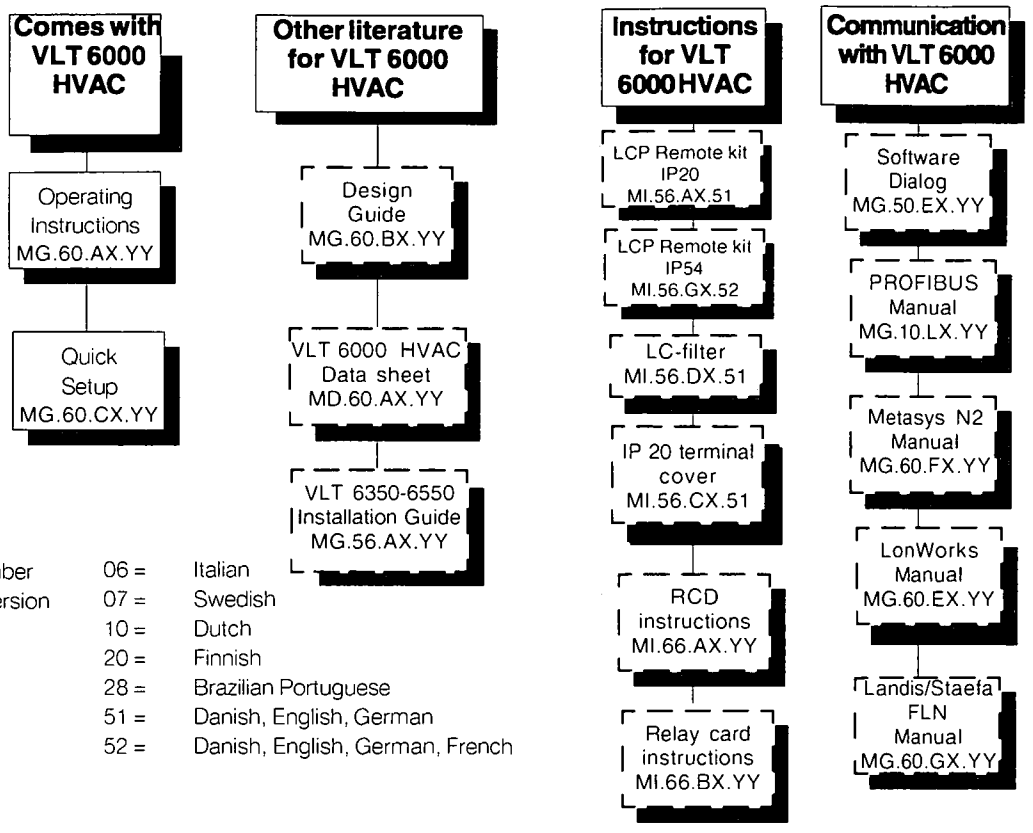
Introduction to HVAC:	This section tells you the advantages you can obtain by using a VLT 6000 HVAC - such as AEO, Automatic Energy Optimization, RFI filters and other HVAC-relevant functions. This section also contains examples of application as well as information about Danfoss and CE-labelling.
Installation: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

Indicates a high-voltage warning.

■ 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



X =	version number	06 =	Italian
yy =	language version	07 =	Swedish
01 =	Danish	10 =	Dutch
02 =	English	20 =	Finnish
03 =	German	28 =	Brazilian Portuguese
04 =	French	51 =	Danish, English, German
05 =	Spanish	52 =	Danish, English, German, French

■ VLT 6000 advantages in a HVAC installation

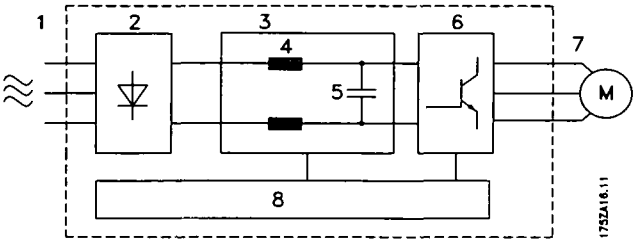
One advantage involved in using a VLT 6000 HVAC is that this unit has been designed to regulate the speed of fans and rotary pumps while consuming the smallest possible amount of energy.
Consequently, if a VLT 6000 HVAC is used in a HVAC installation, optimum energy savings are guaranteed, since less 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, with a unique design.
- IP 20 and IP 54 enclosures that can be mounted side by side. For power sizes ≥ 55 kW (≥ 30kW for 200 V) IP 00 is also available.
- All unit types 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 FLN.
Communication option cards that can be connected are LonWorks, Profibus for the 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.

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.

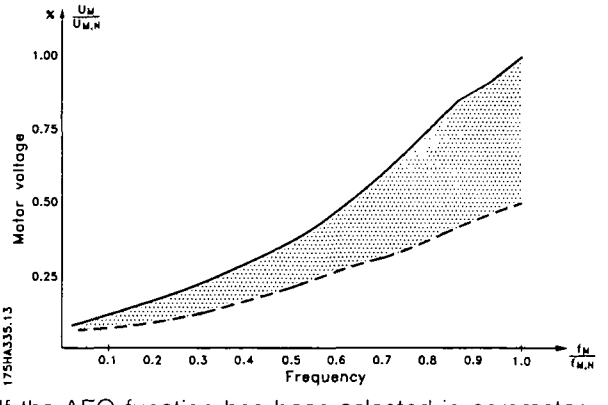
7. Motor voltage
   Variable AC voltage, 10-100% of mains supply voltage.

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.

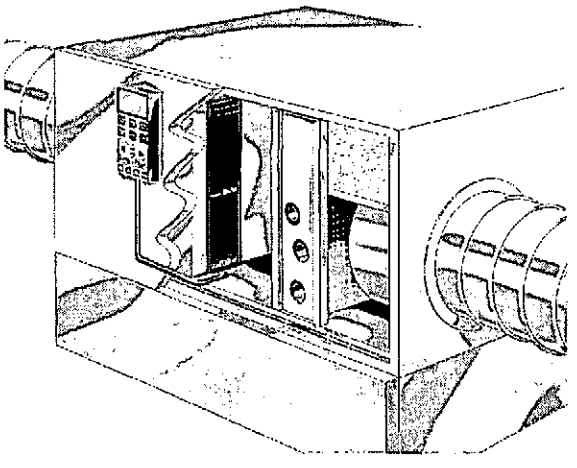
Advantages of the AEO function

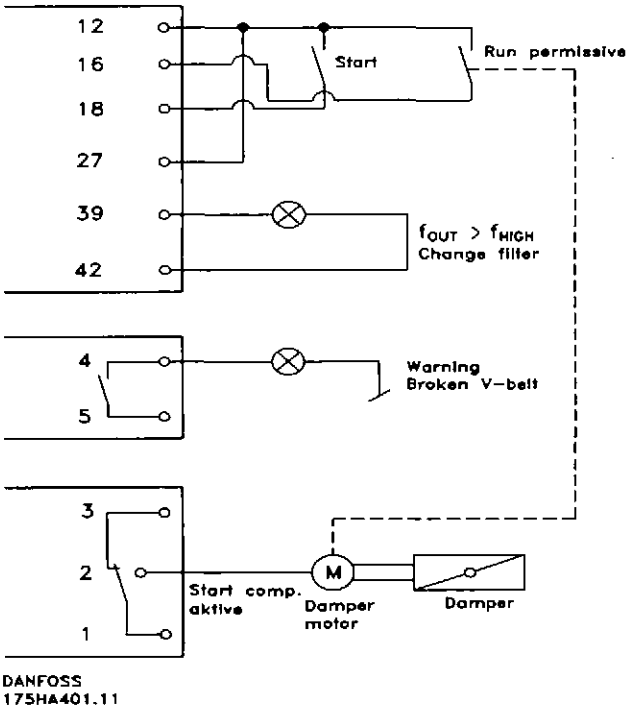
- Automatic energy optimization
- Compensation if an oversize motor is used
- AEO matches operations to daily or seasonal fluctuations
- Energy savings in a constant air volume system
- Compensation in the oversynchronous working range
- Reduces acoustic motor noise

■ 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.





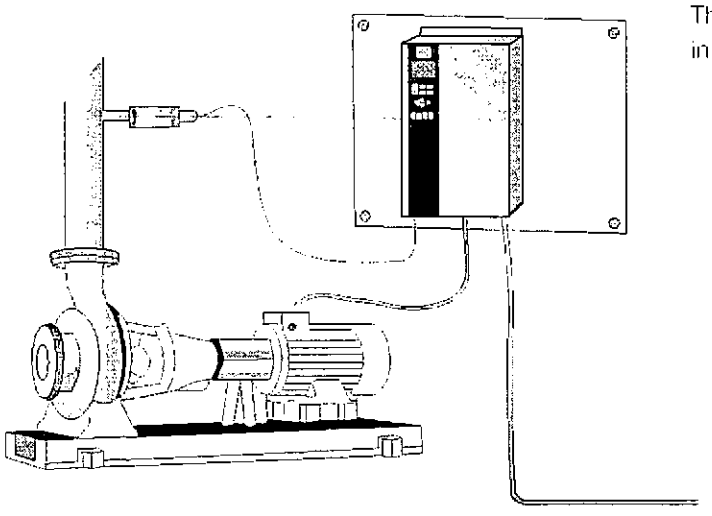
Set the following parameters:

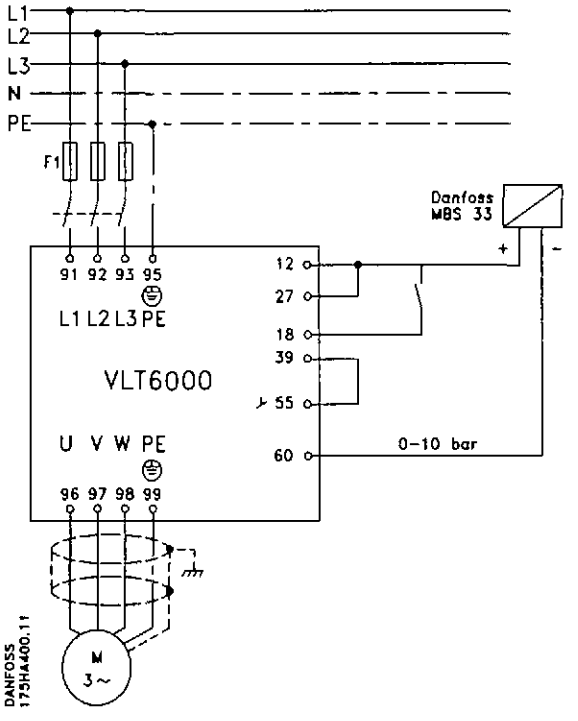
Par. 100	Configuration	Open loop [0]
Par. 221	Warning: Low current, I_{LOW}	Depends on unit
Par. 224	Warning: High frequency, f_{HIGH}	
Par. 300	Terminal 16 Digital inputs	Run permissive [8]
Par. 302	Terminal 18 Digital inputs	Start [1]
Par. 308	Terminal 53, analogue input voltage	Reference [1]
Par. 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]

■ 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. 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. 415	Process units	Bar [16]
Par. 418	Setpoint 1	5 bar

■ 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.

■ 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 *Telegramprofil* are:

- FC protocol
- Johnson Controls Metasys N2
- Landis & Staefa 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.

■ 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
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	VLT 6006
5.5 kW	VLT 6008	VLT 6008
7.5 kW	VLT 6011	VLT 6011
11 kW	VLT 6016	VLT 6016
15 kW	VLT 6022	VLT 6022
18.5 kW	VLT 6027	VLT 6027
22 kW	VLT 6032	VLT 6032
30 kW	VLT 6042	VLT 6042
37 kW	VLT 6052	VLT 6052
45 kW	VLT 6062	VLT 6062

Units in the range of 1.1-45 kW come with enclosure IP 20, IP 54.

	Mains voltage, rated:	
Motor power	400 V [1]	460 V [1]
55 kW	VLT 6075	-
75 kW	VLT 6100	VLT 6075
90 kW	VLT 6125	VLT 6100
110 kW	VLT 6150	VLT 6125
132 kW	VLT 6175	VLT 6150
160 kW	VLT 6225	VLT 6175
200 kW	VLT 6275	VLT 6225
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 come with enclosure IP 00, IP 20 or IP 54.

[1] 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.

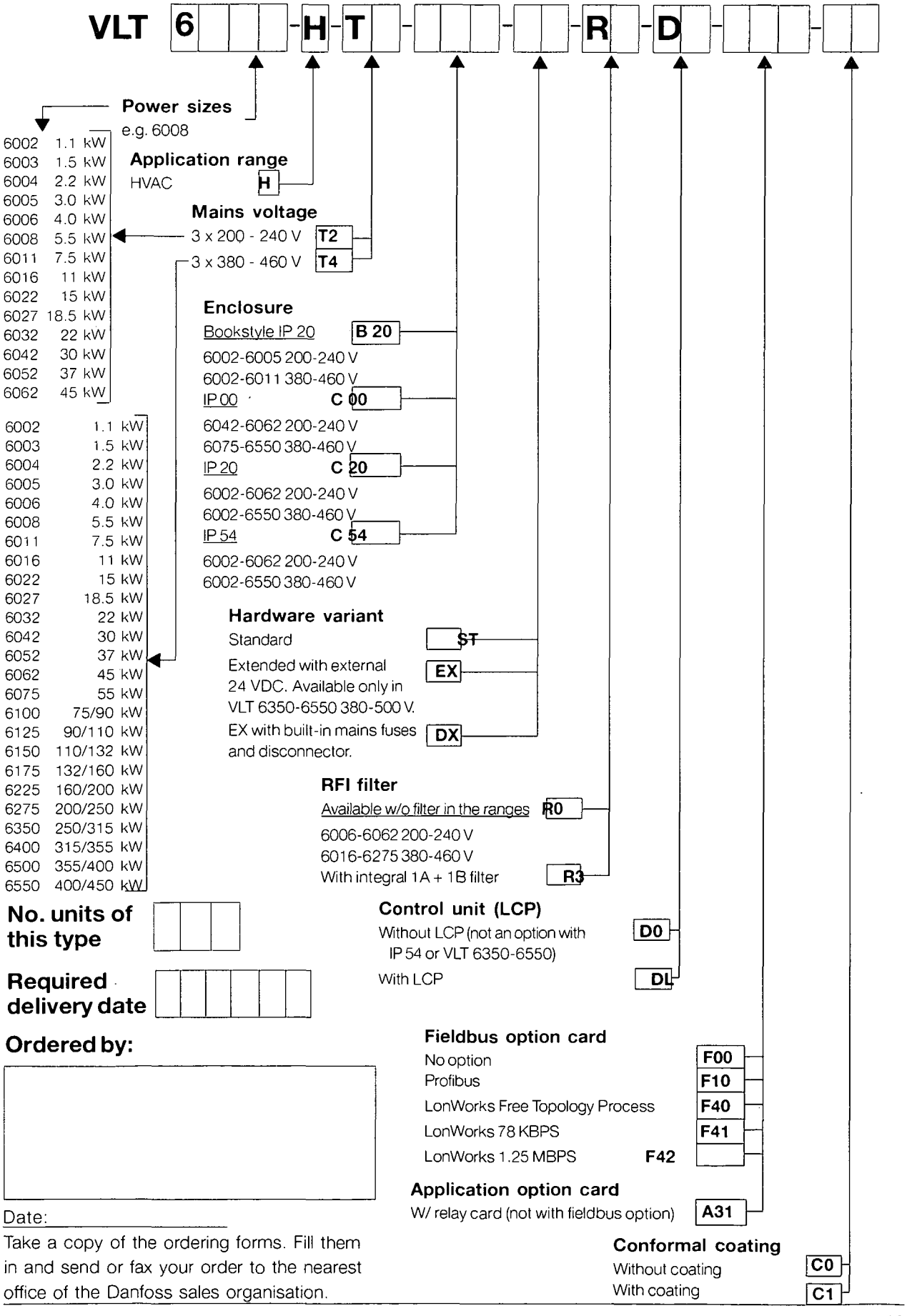
Control unit (keypad and display)

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



Take a copy of the ordering forms. Fill them in and send or fax your order to the nearest office of the Danfoss sales organisation.

■ General technical data

Mains supply (L1, L2, L3):

Supply voltage 200-240 V units	3 x 200/208/220/230/240 V ±10%
Supply voltage 380-460 V units	3 x 380/400/415/440/460 V ±10%
Supply frequency	50/60 Hz ±1%
Max. imbalance of supply voltage:	
VLT 6002 - 6011 / 380 - 460 V and VLT 6002 - 6005 / 200 - 240 V	±2.0% of rated supply voltage
VLT 6016 - 6062 / 380 - 460 V and VLT 6006 - 6032 / 200 - 240 V	±1.5% of rated supply voltage
VLT 6075 - 6550 / 380 - 460 V and VLT 6042 - 6062 / 200 - 240 V	±3.0% of rated supply voltage
Power factor / cos. φ	0.90/1.0 at rated load
No. of switches on supply input L1, L2, L3	approx. 1 time/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 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 *High break-away torque*)	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	approx. 2 kΩ
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 kΩ
No. of programmable analogue current inputs	1
Terminal no. ground	55
Current range	0/4 - 20 mA (scalable)
Input resistance, R_i	approx. 200 Ω
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.

■ 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	approx. 2 kΩ
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

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.

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 Ω
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 Ω
Accuracy of analogue output	Max. error: 1.5% of full scale
Resolution on analogue output.	8 bit

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

Control card, 24 V DC supply:

Terminal nos.	12, 13
Max. load	200 mA
Terminal nos. ground	20, 39

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.

Control card, RS 485 serial communication:

Terminal nos.	68 (TX+, RX+), 69 (TX-, RX-)

Reliable galvanic isolation: Full galvanic isolation (PELV).

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

Installation

■ General technical data

External 24 Volt DC supply:

Terminal nos.	35, 36
Voltage range	24 V DC ±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. 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 mm²/16 AWG
Max. cross-section for serial communication	1.5 mm²/16 AWG

Control characteristics:

Frequency range	0 - 1000 Hz
Resolution on output frequency	±0.003 Hz
System response time	3 msec.
Speed, control range (open loop)	1:100 of synchro. speed
Speed, control range (closed loop)	1:1000 of synchro. speed
Speed, accuracy (open loop)	< 1500 rpm: max. error ± 7.5 rpm
	> 1500 rpm: max. error of 0.5% of actual speed
Process, accuracy (closed loop)	< 1500 rpm: max. error ± 1.5 rpm
	> 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: ±2.0% of rated output current
Power kW [6], Power HP [7], 0 - 90% load	Max. error: ±5.0% of rated output power

■ General technical data

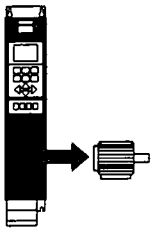
Externals:

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 % +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, Bookstyle, IP20 ..... Max. 45°C (24-hour average max. 40°C)
VLT 6006-6062 200-240V, 6016-6550 380-460V, IP00, IP20 ..... Max. 40°C (24-hour average max. 35°C)
VLT 6002-6062 200-240V, 6002-6550 380-460V, IP54 ..... 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
EN 61000-4-5, ENV 50204, EN 61000-4-6, VDE 0160/1990.12

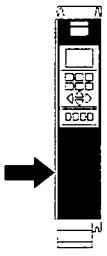
VLT 6000 HVAC protection:

- Electronic motor thermal protection against overload.
- Temperature monitoring of heat-sink ensures that the VLT frequency converter cuts out 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.
- 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.

■ Mains supply 3 x 200 - 240 V

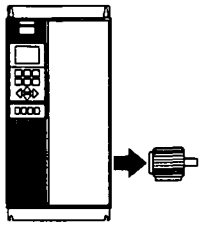


According to international requirements	VLT type	6002	6003	6004	6005	6006	6008	6011
Output current [4]	$I_{VLT,N}$ [A]	6.6	7.5	10.6	12.5	16.7	24.2	30.8
	$I_{VLT,MAX}$ (60 s) [A]	7.3	8.3	11.7	13.8	18.4	26.6	33.9
Output (240 V)	$S_{VLT,N}$ [kVA]	2.7	3.1	4.4	5.2	6.9	10.1	12.8
Typical shaft output	$P_{VLT,N}$ [kW]	1.1	1.5	2.2	3.0	4.0	5.5	7.5
Typical shaft output	$P_{VLT,N}$ [HP]	1.5	2	3	4	5	7.5	10
Max. cable cross-section to motor and DC-bus	[mm²/AWG]	4/10	4/10	4/10	4/10	4/10	16/6	16/6

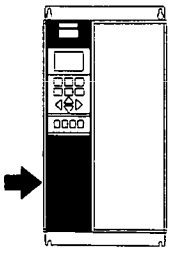


Max. input current (200 V) (RMS) $I_{L,N}$ [A]		6.0	7.0	10.0	12.0	16.0	23.0	30.0
Max. cable cross-section power [mm²]/[AWG] [2]		4/10	4/10	4/10	4/10	4/10	16/6	16/6
Max. pre-fuses	[A]/UL [1] [A]	16/10	16/15	25/20	25/25	35/30	50	60
Mains contactor	[Danfoss type]	CI 6	CI 9	CI 12	CI 12	CI 6	CI 9	CI 16
	[AC value]	AC-3	AC-3	AC-3	AC-3	AC-1	AC-1	AC-1
Efficiency [3]		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



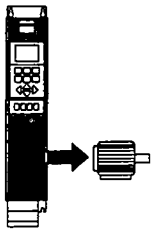
According to international requirements	VLT type	6016	6022	6027	6032	6042	6052	6062
Output current	$I_{VLT,N}$ [A] (200-230 V)	46.2	59.4	74.8	88.0	115	143	170
	$I_{VLT,MAX}$ (60 s) [A] (200-230 V)	50.6	65.3	82.3	96.8	127	158	187
	$I_{VLT,N}$ [A] (240 V)	46.0	59.4	74.8	88.0	104	130	154
	$I_{VLT,MAX}$ (60 s) [A] (240 V)	50.6	65.3	82.3	96.8	115	143	170
Output	$S_{VLT,N}$ [kVA] (240 V)	19.1	24.7	31.1	36.6	41.0	52.0	61.0
Typical shaft output	$P_{VLT,N}$ [kW]	11	15	18.5	22	30	37	45
Typical shaft output	$P_{VLT,N}$ [HP]	15	20	25	30	40	50	60
Max. cable cross-section to motor and DC-bus [mm²/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 [5]	90/250mcm [5]	120/300mcm [5]
Min. cable cross-section to motor and DC-bus	[mm²/AWG]	10/8	10/8	10/8	16/6	10/8	10/8	10/8



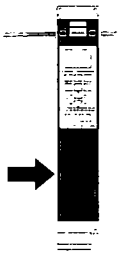
Max. input current (200 V) (RMS) $I_{L,N}$ [A]		46.0	59.2	74.8	88.0	101.3	126.6	149.9
Max. cable, cross-section power [mm²/AWG]	copper	16/6	35/2	35/2	50/0	70/1/0	95/3/0	120/4/0
	aluminium	16/6	35/2	35/2	50/0	95/3/0 [5]	90/250mcm [5]	120/300mcm [5]
Max. pre-fuses	[A]/UL [1] [A]	60	80	125	125	150	200	250
Mains contactor	[Danfoss type]	CI 32	CI 32	CI 37	CI 45	-	-	-
	[AC value]	AC-1	AC-1	AC-1	AC-1			
Efficiency [3]		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, FWH and FWX or similar must be used. Pre-fuses type gG must be used for VLT 6002 - VLT 6032, 200/240 V and VLT 6002 - VLT 6062, 380/460 V. Pre-fuses type gR must be used for VLT 6042 - 6062, 200/240 V and VLT 6075 - VLT 6550, 380/460 V. 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.

Technical data, mains supply 3 x 380 - 460 V

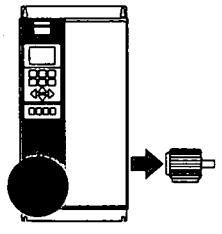


According to international requirements	VLT type	6002	6003	6004	6005	6006	6008	6011
Output current	$I_{VLT,N}$ [A] (380-415 V)	3.0	4.1	5.6	7.2	10.0	13.0	16.0
	$I_{VLT,MAX}$ (60 s) [A] (380-415 V)	3.3	4.5	6.2	7.9	11.0	14.3	17.6
	$I_{VLT,N}$ [A] (440-460 V)	3.0	3.4	4.8	6.3	8.2	11.0	14.0
	$I_{VLT,MAX}$ (60 s) [A] (440-460 V)	3.3	3.7	5.3	6.9	9.0	12.1	15.4
Output	$S_{VLT,N}$ [kVA] (400 V)	2.2	2.9	4.0	5.2	7.2	9.3	11.5
	$S_{VLT,N}$ [kVA] (460 V)	2.4	2.7	3.8	5.0	6.5	8.8	11.2
Typical shaft output	$P_{VLT,N}$ [kW]	1.1	1.5	2.2	3.0	4.0	5.5	7.5
Typical shaft output	$P_{VLT,N}$ [HP]	1.5	2	3	-	5	7.5	10
Max. cable cross-section to motor	[mm²/AWG]	4/10	4/10	4/10	4/10	4/10	4/10	4/10

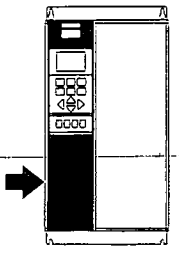


Max. input current (RMS)	$I_{L,N}$ [A] (380 V)	2.8	3.8	5.3	7.0	9.1	12.2	15.0
	$I_{L,N}$ [A] (460 V)	2.5	3.4	4.8	6.0	8.3	10.6	14.0
Max. cable cross-section. power	[mm²]/[AWG] [2]	4/10	4/10	4/10	4/10	4/10	4/10	4/10
Max. pre-fuses	[A]/UL [1] [A]	16/6	16/10	16/10	16/15	25/20	25/25	35/30
Mains contactor	[Danfoss type]	CI 6	CI 6	CI 6	CI 9	CI 12	CI 5	CI 6
	[AC value]	AC-3	AC-3	AC-3	AC-3	AC-3	AC-1	AC-1
Efficiency [3]		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
Output current	$I_{VLT,N}$ [A] (380-415 V)	24.0	32.0	37.5	44.0	61.0	73.0	90.0
	$I_{VLT,MAX}$ (60 s) [A] (380-415 V)	26.4	35.2	41.3	48.4	67.1	80.3	99.0
	$I_{VLT,N}$ [A] (440-460 V)	21.0	27.0	34.0	40.0	52.0	65.0	77.0
	$I_{VLT,MAX}$ (60 s) [A] (440-460 V)	23.1	29.7	37.4	44.0	57.2	71.5	84.7
Output	$S_{VLT,N}$ [kVA] (400 V)	17.3	23.0	27.0	31.6	43.8	52.5	64.7
	$S_{VLT,N}$ [kVA] (460 V)	16.7	21.5	27.1	31.9	41.4	51.8	61.3
Typical shaft output	$P_{VLT,N}$ [kW]	11	15	18.5	22	30	37	45
Typical shaft output	$P_{VLT,N}$ [HP]	15	20	25	30	40	50	60
Max. cable cross-section to motor and DC-bus	[mm²/AWG]	16/6	16/6	16/6	16/6	35/2	35/2	50/0
Min. cable cross-section to motor and DC-bus [4]	[mm²/AWG]	10/8	10/8	10/8	10/8	10/8	10/8	16/6



Max. input current (RMS)	$I_{L,N}$ [A] (380 V)	24.0	32.0	37.5	44.0	60.0	72.0	89.0
	$I_{L,N}$ [A] (460 V)	21.0	27.6	34.0	41.0	53.0	64.0	77.0
Max. cable cross-section, power	[mm²]/[AWG]	16/6	16/6	16/6	16/6	35/2	35/2	50/0
Max. pre-fuses	[A]/UL [1] [A]	63/40	63/40	63/50	63/60	80/80	100/100	125/125
Efficiency at rated frequency		0.96						
Weight IP 20	[kg]	23	23	23	30	30	48	48
Weight IP 54	[kg]	48	48	48	51	61	67	70
Power loss at max. load.	[W]	419	559	655	768	1065	1275	1571
Enclosure		IP 20/IP 54						

1. ~~If UL/cUL is to be complied with, pre-fuses type Bussmann KTS-R or similar must be used. Pre-fuses type gG must be used for~~ VLT 6002 - VLT 6032, 200/240 V and VLT 6002 - VLT 6062, 380/460 V. Pre-fuses type gR must be used for VLT 6042 - 6062, 200/240 V and VLT 6075 - VLT 6550, 380/460 V. 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.

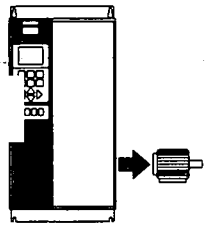
■ Technical data, mains supply 3 x 380 - 460 V

According to international requirements	VLT type	6075	6100	6125	6150	6175	6225	6275
Output current	$I_{VLT,N}$ [A] (380-415 V)	106	147	177	212	260	315	368
	$I_{VLT,MAX}$ (60 s) [A] (380-415 V)	117	162	195	233	286	347	405
	$I_{VLT,N}$ [A] (440-460 V)	106	130	160	190	240	302	361
	$I_{VLT,MAX}$ (60 s) [A] (440-460 V)	117	143	176	209	264	332	397
Output	$S_{VLT,N}$ [kVA] (400 V)	73	102	123	147	180	218	255
	$S_{VLT,N}$ [kVA] (460 V)	84.5	104	127	151	191	241	288
Typical shaft output (380-415 V)	$P_{VLT,N}$ [kW]	55	75	90	110	132	160	200
Typical shaft output (440-460 V)	$P_{VLT,N}$ [HP]	75	100	125	150	200	250	300
Max. cross-section of copper cable to motor and DC-bus (380-415 V)	[mm²][5]	70	95	120	2x70	2x70	2x95	2x120
Max. cross-section of copper cable to motor and DC-bus (440-460 V)	[mm²][5]	70	70	95	2x70	2x70	2x95	2x120
Max. cross-section of aluminium cable to motor and DC-bus (380-415 V)	[mm²][5]	95	90	120	2x70	2x95	2x120	2x150
Max. cross-section of aluminium cable to motor and DC-bus (440-460 V)	[mm²][5]	70	120	150	2x70	2x120	2x120	2x150
Max. cross-section of copper cable to motor and DC-bus (380-415 V)	[AWG][5]	1/0	3/0	4/0	2x1/0	2x2/0	2x3/0	2x250mcm
Max. cross-section of copper cable to motor and DC-bus (440-460 V)	[AWG][5]	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 (380-415 V)	[AWG][5]	3/0	250mcm	300mcm	2x2/0	2x4/0	2x250mcm	2x350mcm
Max. cross-section of aluminium cable to motor and DC-bus (440-460 V)	[AWG][5]	3/0	4/0	250mcm	2x2/0	2x3/0	2x250mcm	2x300mcm
Max. cross-section of cable to motor, and DC-bus[4]	[mm² AWG][5]	10/8	10/8	10/8	10/8	10/8	16/6	16/6
Max. input current (RMS)	$I_{L,N}$ [A] (400 V)	103	145	174	206	256	317	366
	$I_{L,N}$ [A] (460 V)	103	128	158	185	236	304	356
Max. cross-section of copper cable to power (380-415 V)	[mm²][5]	70	95	120	2x70	2x70	2x95	2x120
Max. cross-section of copper cable to power (440-460 V)	[mm²][5]	70	70	95	2x70	2x70	2x95	2x120
Max. cross-section of aluminium cable to power (380-415 V)	[mm²][5]	95	90	120	2x70	2x95	2x120	2x150
Max. cross-section of aluminium cable to power (440-460 V)	[mm²][5]	70	120	150	2x70	2x120	2x120	2x150
Max. cross-section of copper cable to power (380-415 V)	[AWG][5]	1/0	3/0	4/0	2x1/0	2x2/0	2x3/0	2x250mcm
Max. cross-section of copper cable to power (440-460 V)	[AWG][5]	1/0	2/0	3/0	2x1/0	2x1/0	2x3/0	2x4/0
Max. cross-section of aluminium cable to power (380-415V)	[AWG][5]	3/0	250mcm	300mcm	2x2/0	2x4/0	2x250mcm	2x350mcm
Max. cross-section of aluminium cable to power (440-460 V)	[AWG][5]	3/0	4/0	250mcm	2x2/0	2x3/0	2x250mcm	2x300mcm
Min. cable cross-section to motor, and DC-bus [4]	[mm²/AWG][5]	10/8	10/8	10/8	10/8	10/8	16/6	
Max. pre-fuses	[A]/UL [1] [A]	150/150	250/220	250/250	300/300	350/350	450/400	500/500
Integral pre-fuses	[A]/UL [1] [A]	15/15	15/15	15/15	30/30	30/30	30/30	30/30
Pre-fuses SMPS	[A]/UL [1] [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. If UL/cUL is to be complied with, pre-fuses type Bussmann KTN-R, KTS-R or similar must be used.
   Pre-fuses type gG must be used for VLT 6002 - VLT 6032, 200/240 V and VLT 6002 - VLT 6062, 380/460 V. Pre-fuses type gR must be used for VLT 6042 - 6062, 200/240 V and VLT 6075 - VLT 6550, 380/460 V. 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.

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

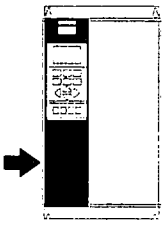
According to international requirements	VLT type	6350	6400	6500	6550
Output current	$I_{VLT,N}$ [A] (380-415 V)	480	600	658	745
	$I_{VLT,MAX}$ (60 s) [A] (380-415 V)	528	660	724	820
	$I_{VLT,N}$ [A] (440-460 V)	443	540	590	678
	$I_{VLT,MAX}$ (60 s) [A] (440-460 V)	487	594	649	746
Output	$S_{VLT,N}$ [kVA] (415 V)	345	431	473	536
	$S_{VLT,N}$ [kVA] (460 V)	353	430	470	540
Typical shaft output (380-440 V)	$P_{VLT,N}$ [kW]	250	315	355	400
Typical shaft output (441-500 V)	$P_{VLT,N}$ [HP]	350	450	500	600
Max. cross-section of copper cable to motor and loadsharing (380-415 V)	[mm²][3]	2 x 150 3 x 70	2 x 185 3 x 95	2 x 240 3 x 120	2 x 300 3 x 150
Max. cross-section of copper cable to motor and loadsharing (440-460 V)	[mm²][3]	2 x 120 3 x 70	2 x 150 3 x 95	2 x 185 3 x 95	2 x 300 3 x 120
Max. cross-section of aluminium cable to motor and loadsharing (380-415 V)	[mm²][3]	2 x 185 3 x 120	2 x 240 3 x 150	2 x 300 3 x 185	3 x 185
Max. cross-section of aluminium cable to motor and loadsharing (440-460 V)	[mm²][3]	2 x 150 3 x 95	2 x 185 3 x 120	2 x 240 3 x 150	3 x 185
Max. cross-section of copper cable to motor and loadsharing (380-415 V)	[AWG][2][3]	2 x 250mcm 3 x 2/0	2 x 350mcm 3 x 3/0	2 x 400mcm 3 x 4/0	2 x 500mcm 3 x 250mcm
Max. cross-section of copper cable to motor and loadsharing (440-460 V)	[AWG][2][3]	2 x 4/0 3 1/0	2 x 300mcm 3 x 3/0	2 x 350mcm 3 x 3/0	2 x 500mcm 3 x 4/0
Max. cross-section of aluminium cable to motor and loadsharing (380-415 V)	[AWG][2][5]	2 x 350mcm 3 x 4/0	2 x 500mcm 3 x 250mcm	2 x 600mcm 3 x 300mcm	2 x 700mcm 3 x 350mcm
Max. cross-section of aluminium cable to motor and loadsharing (440-460 V)	[AWG][2][5]	2 x 300mcm 3 x 3/0	2 x 400mcm 3 x 4/0	2 x 500mcm 3 x 250mcm	2 x 600mcm 3 x 300mcm



1. If UL/cUL is to be complied with, pre-fuses type Bussmann KTN-R, KTS-R or similar must be used.
   Pre-fuses type gG must be used for VLT 6002 - VLT 6032, 200/240 V and VLT 6002 - VLT 6062, 380/460 V. Pre-fuses type gR must be used for VLT 6042 - 6062, 200/240 V and VLT 6075 - VLT 6550, 380/460 V. 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.

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

According to international requirements



VLT type		6350	6400	6500	6550
Max. input current	$I_{L,MAX}$ [A] (400 V)	389	467	584	648
(RMS)	$I_{L,MAX}$ [A] (460 V)	356	431	526	581
Max. cross-section of copper cable		2 x 150	2 x 185	2 x 240	2 x 300
to power (380-415 V)	[mm²][5]	3 x 70	3 x 95	3 x 120	3 x 150
Max. cross-section of copper cable		2 x 120	2 x 150	2 x 185	2 x 300
to power (440-460 V)	[mm²][5]	3 x 70	3 x 95	3 x 95	3 x 120
Max. cross-section of aluminium cable		2 x 185	2 x 240	2 x 300	
to power (380-415 V)	[mm²][5]	3 x 120	3 x 150	3 x 185	3 x 185
Max. cross-section of aluminium cable		2 x 150	2 x 185	2 x 240	
to power (440-460 V)	[mm²][5]	3 x 95	3 x 120	3 x 150	3 x 185
Max. cross-section of copper cable		2 x 250mcm	2 x 350mcm	2 x 400mcm	2 x 500mcm
to power (380-415 V)	[AWG][2][5]	3 x 2/0	3 x 3/0	3 x 4/0	3 x 250mcm
Max. cross-section of copper cable		2 x 4/0	2 x 300mcm	2 x 350mcm	2 x 500mcm
to power (440-460 V)	[AWG][2][5]	3 1/0	3 x 3/0	3 x 3/0	3 x 4/0
Max. cross-section of aluminium cable		2 x 350mcm	2 x 500mcm	2 x 600mcm	2 x 700mcm
to power (380-415 V)	[AWG][2][5]	3 x 4/0	3 x 250mcm	3 x 300mcm	3 x 350mcm
Max. cross-section of aluminium cable		2 x 300mcm	2 x 400mcm	2 x 500mcm	2 x 600mcm
to power (440-460 V)	[AWG][2][5]	3 x 3/0	3 x 4/0	3 x 250mcm	3 x 300mcm
Max. pre-fuses (mains)	[-]/UL [1] [A]	630/600	700/700	800/800	800/800
Integral pre-fuses (softcharge circuit)	[-]/UL [1] [A]	15/15	15/15	15/15	30/30
Integral pre-fuses (softcharge resistors)	[-]/UL [1] [A]	12/12	12/12	12/12	12/12
Integral pre-fuses (SMPS)	[-]/UL [1] [A]	5.0/5.0			
Efficiency		0.97			
Weight IP 00	[kg]	480	515	560	585
Weight IP 20	[kg]	595	630	675	700
Weight IP 54	[kg]	605	640	685	710
Power loss at max. load	[W]	7500	9450	10650	12000
Enclosure		IP 00 / IP 20/ IP 54			

1. If UL/cUL is to be complied with, pre-fuses type Bussmann KTN-R, KTS-R or similar must be used. Pre-fuses type gG must be used for VLT 6002 - VLT 6032, 200/240 V and VLT 6002 - VLT 6062, 380/460 V. Pre-fuses type gR must be used for VLT 6042 - 6062, 200/240 V and VLT 6075 - VLT 6550, 380/460 V. 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.

■ Mechanical dimensions

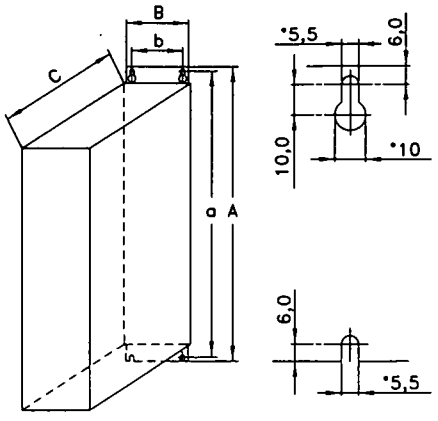
All measurements in mm.

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 - 6062	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

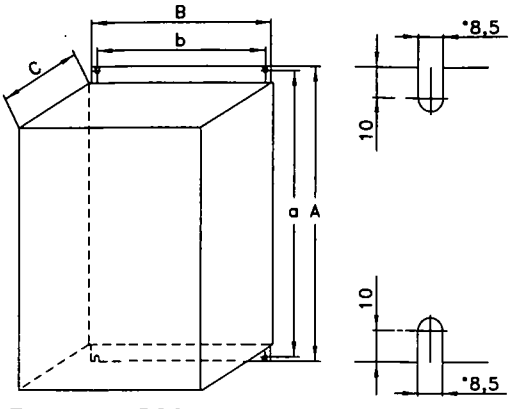
VLT type	A	B	C	D	a	b	a/b	Type
IP 54 200-240 V								
6002 - 6003	460	282	195	85	260	258	100	F
6004 - 6005	530	282	195	85	330	258	100	F
6006 - 6011	810	355	280	70	560	330	200	F
6016 - 6032	940	400	280	70	690	375	200	F
6042 - 6062	937	495	421	-	830	374	225	G
IP 54 380-460 V								
6002 - 6005	460	282	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 - 6062	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

Option for IP 00 VLT 6075-6275	A1	B1	C1	
IP 20 bottom cover				
6075 - 6125	175	370	335	aa: Min. air above enclosure
6150 - 6275	175	420	400	ab: Min. air below enclosure

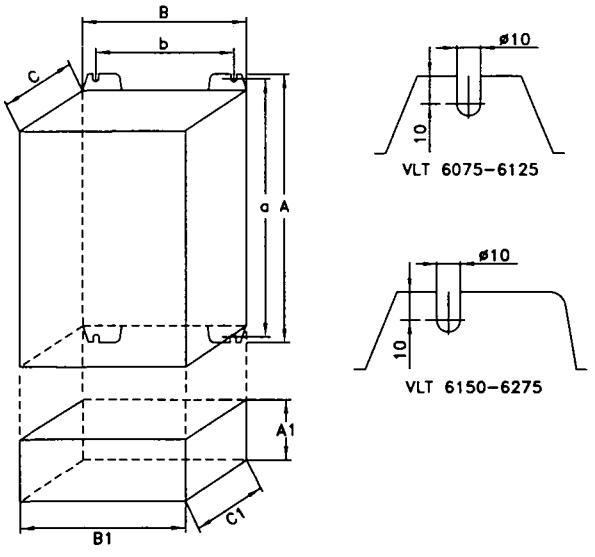
■ Mechanical dimensions



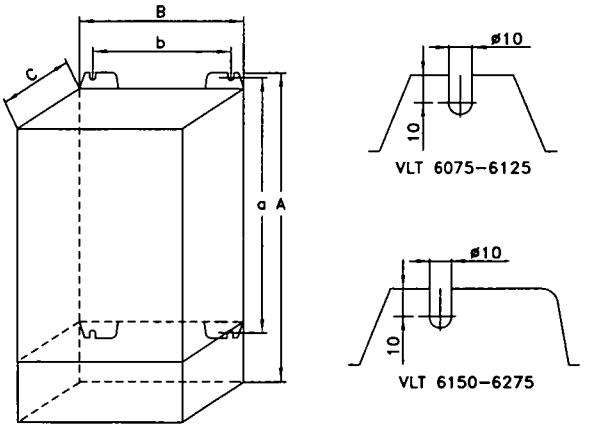
Type A, IP20



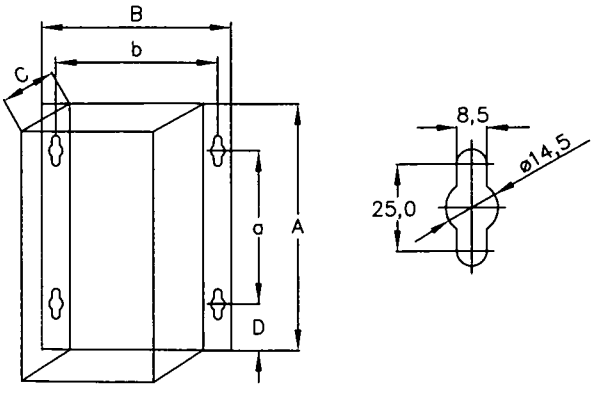
Type D, IP20



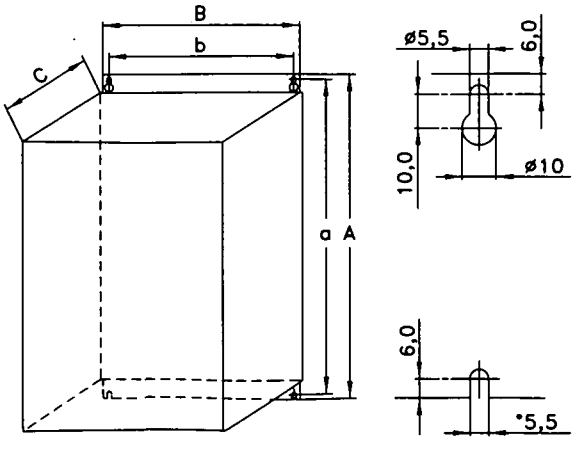
Type B, IP00
With option and enclosure IP20



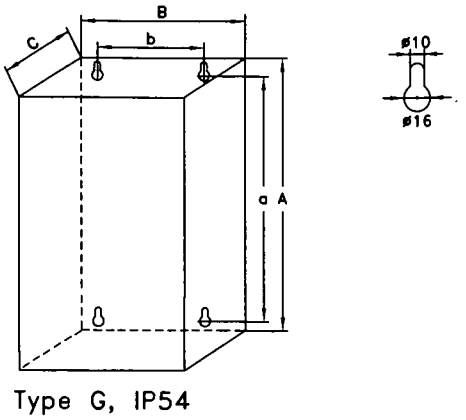
Type E, IP20



Type F, IP54

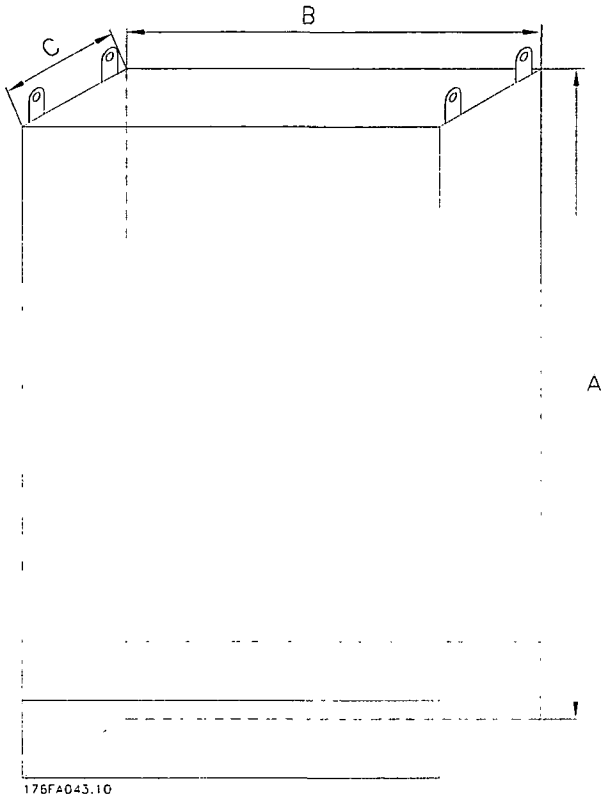


Type C, IP20



Type G, IP54

■ Mechanical dimensions (cont.)



Type H, IP00, IP20, IP54

■ 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

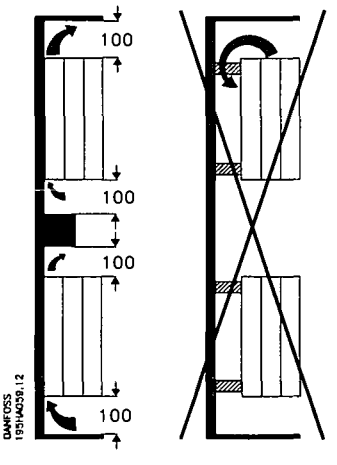
	IP 00	IP 20	IP 54
Bookstyle	-	OK	-
VLT 6002-6032 200-240 V	-	OK	OK
VLT 6002-6550 380-460 V	OK	OK	OK

■ Field-mounting

	IP 00	IP 20	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			
VLT 6002-6005 200-240 V	-	OK	OK
VLT 6002-6016 380-460 V	-	OK	OK
IP 20 terminal cover			
VLT 6006-6032 200-240 V	-	OK	OK
VLT 6022-6062 380-460 V	-	OK	OK

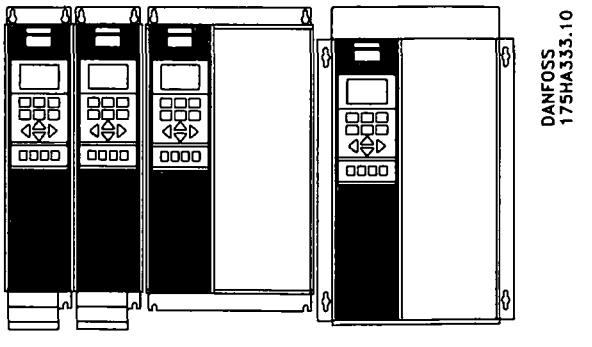
■ Spacing when installing of VLT 6002-6005 200-240 V, VLT 6002-6011 380-460 V Bookstyle IP 20, IP 20 and IP 54.

Cooling



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

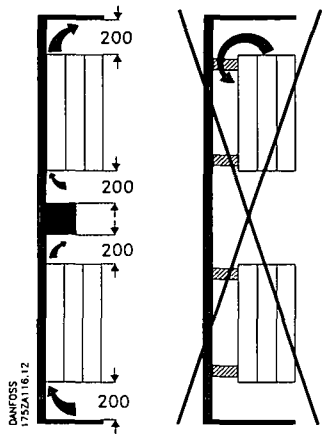
Side-by-side



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.

■ Installation of VLT 6006-6032 200-240 V, VLT 6016-6062 380-460 V IP 20 and IP 54

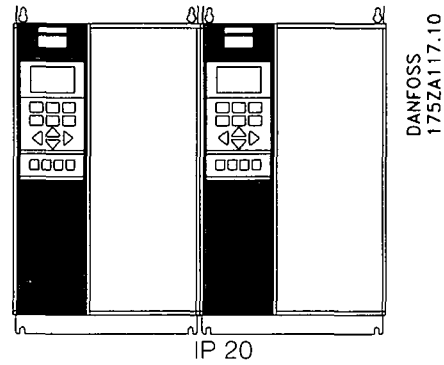
Cooling



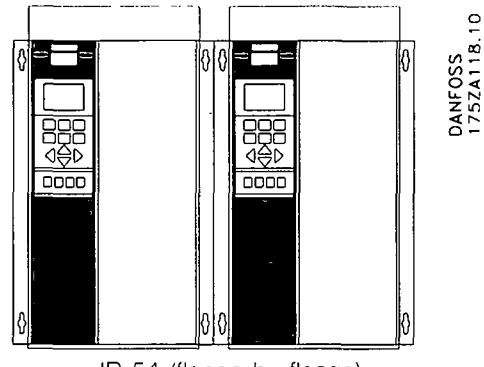
All units in the above-mentioned series require a minimum space of 200 mm above and below the enclosure and must be installed on a plane, vertical surface (no spacers). This applies both to IP 20 and IP 54 units.

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

Side-by-side



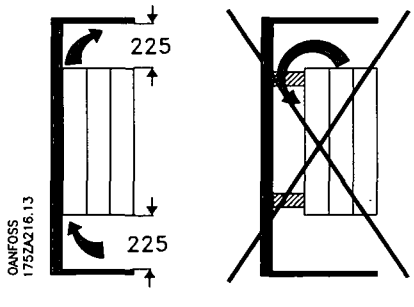
IP 20



IP 54 (flange-by-flange)

■ Installation of VLT 6042-6062 200-240 V, VLT 6075-6275 380-460 V IP 00, IP 20 and IP 54

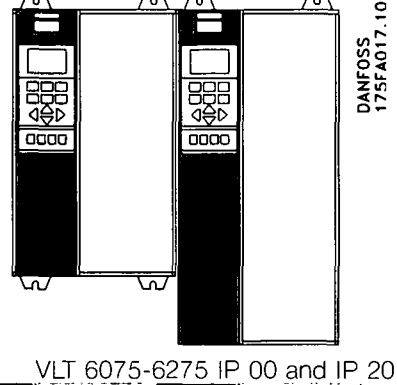
Cooling



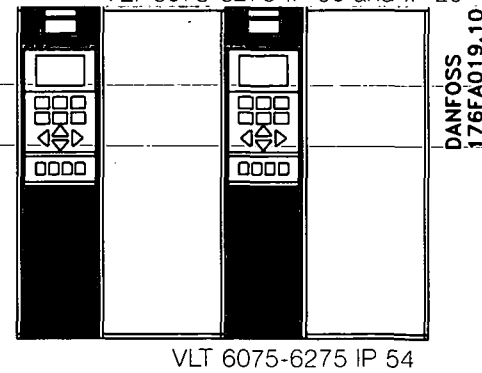
VLT 6075-6275

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 and IP 20



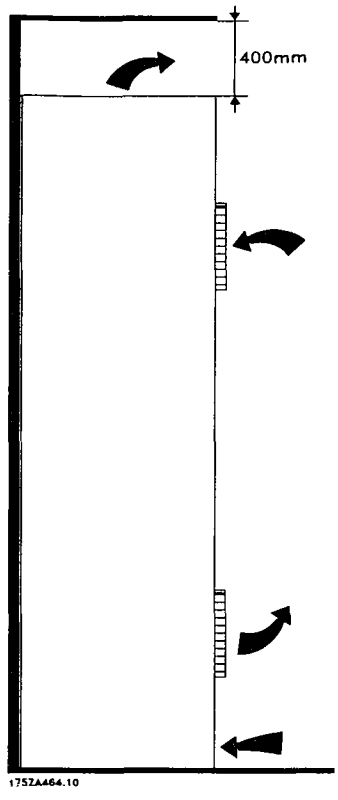
VLT 6075-6275 IP 54

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

Installation

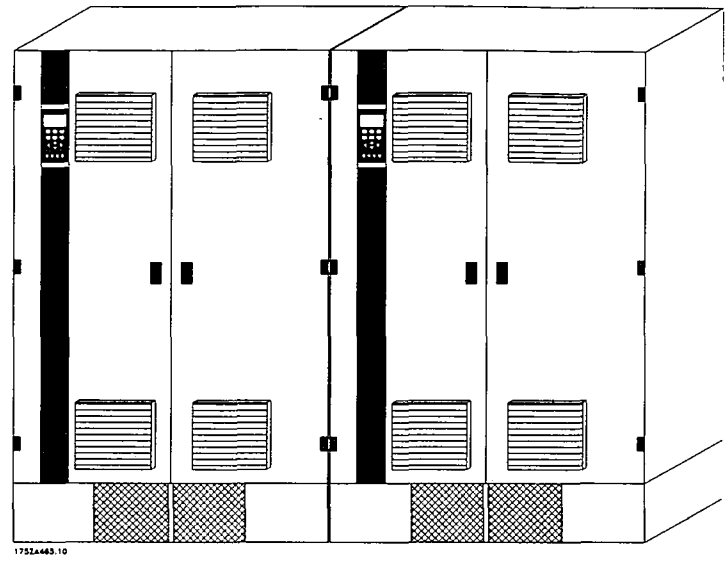
■ Installation of VLT 6350-6550 380-460 V Compact IP 00, IP 20 and IP 54

Cooling



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

Side-by-side



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.

■ 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 15 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 cobber, 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

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.

■ 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.

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.

■ High voltage test

A high voltage test can be carried out by short-circuiting terminals U, V, W, L_1, L_2 and L_3 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_{ϕ}(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_{ϕ} 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}):
   Δt= 45° C-t_{IN}.
3. Calculate the required

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

Insert Δt in Kelvin

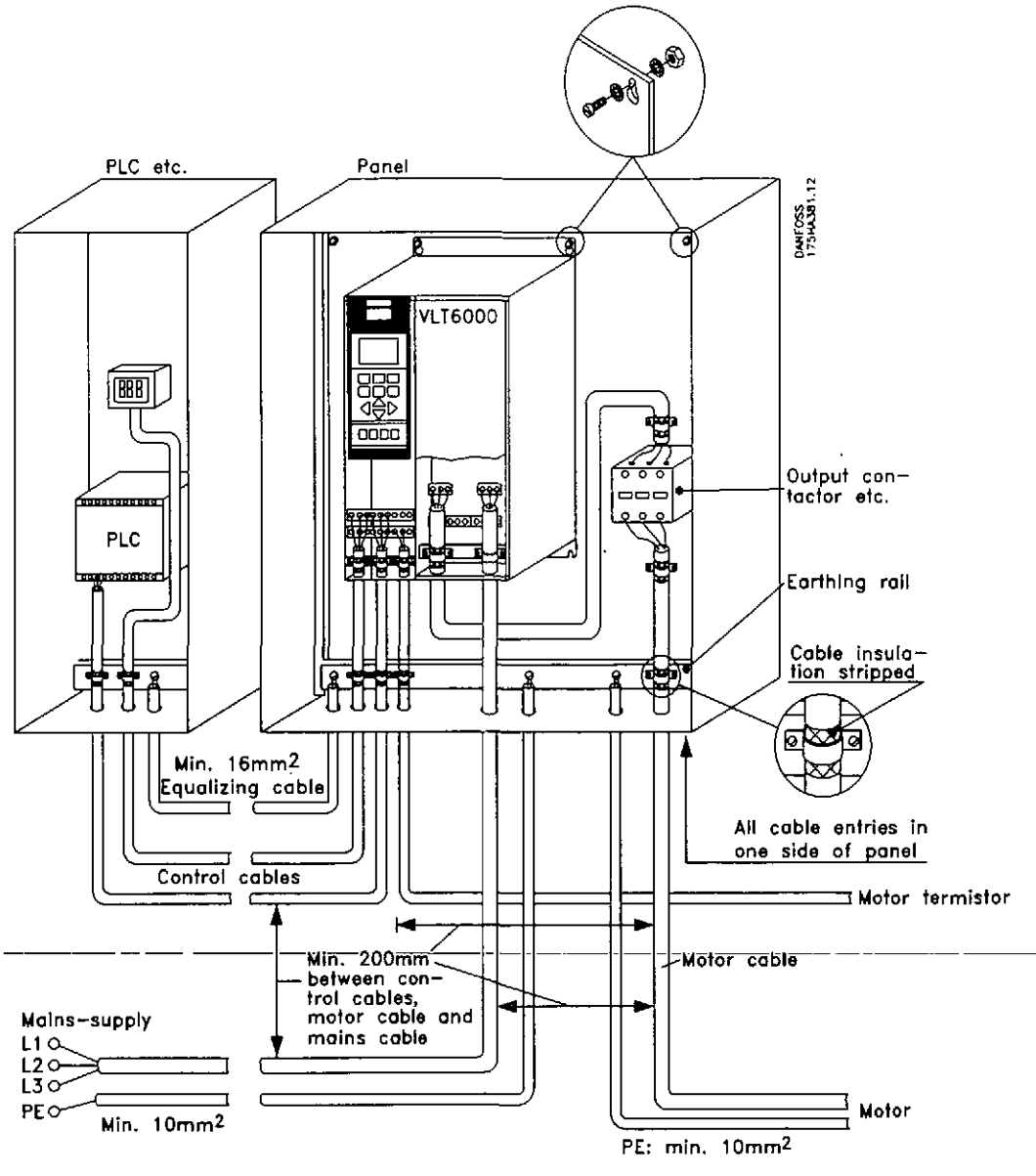
The outlet from the ventilation must be placed above the highest-mounted frequency converter. Allowance must be made for the pressure loss across the filters and for the fact that the pressure is going to drop as the filters are choked.

■ EMC-correct electrical installation

General points to be observed to ensure EMC-correct electrical installation:

- Use only braided screened/armoured motor cables and braided screened/armoured control cables.
- Connect the screen to earth at both ends.
- Avoid installation with twisted screen ends (pigtails), since this ruins the screening effect at high frequencies. Use cable clamps instead.
- It is important to ensure good electrical contact from the installation plate through the installation screws to the metal cabinet of the VLT frequency converter.
- Use starwashers and galvanically conductive installation plates.
- Do not use unscreened/unarmoured motor cables in the installation cabinets.

The illustration below shows EMC-correct electrical installation; the VLT frequency converter has been fitted in an installation cabinet and connected to a PLC.



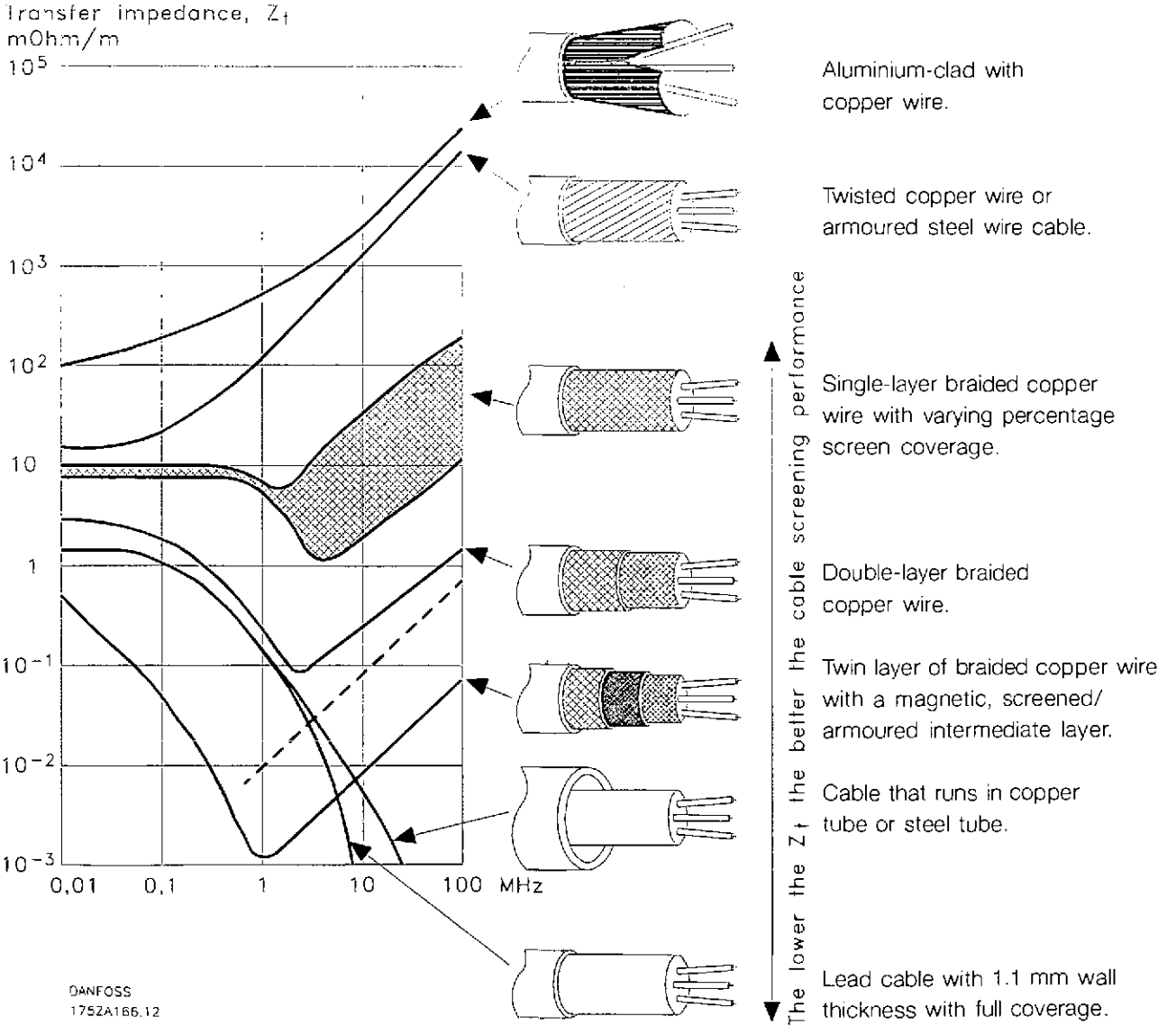
■ Use of EMC-correct cables

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:

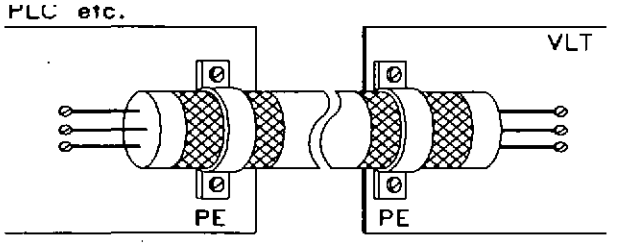
- The contact resistance between the individual screen conductors.
- The screen coverage, i.e. the physical area of the cable covered by the screen - often stated as a percentage value. Should be min. 85%.
- The screen type, i.e. braided or twisted pattern. A braided pattern or a closed tube is recommended.



■ Earthing of screened/armoured control cables

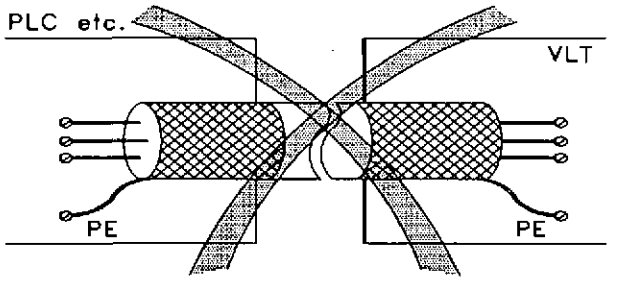
Generally speaking, control cables must be screened/armoured and the screen must be connected by means of a cable clamp at both ends to the metal cabinet of the unit.

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



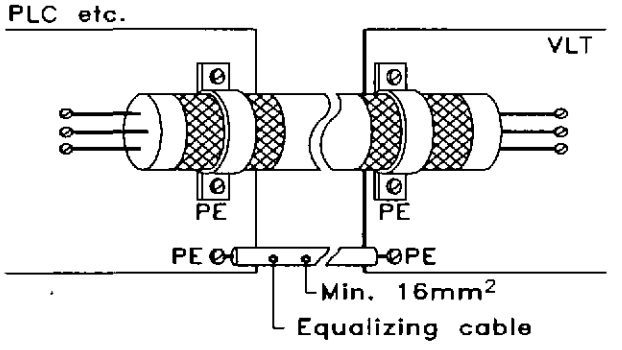
Correct earthing

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



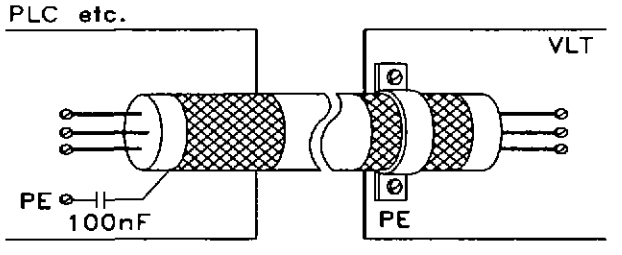
Wrong earthing

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



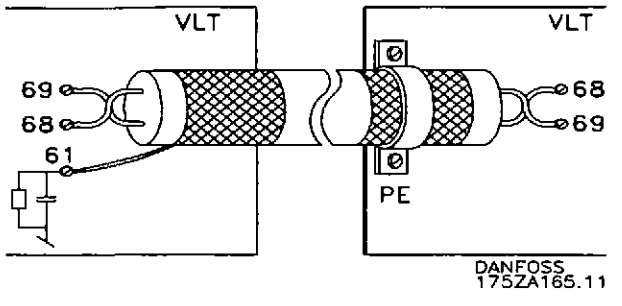
Protection with respect to earth potential between PLC and VLT

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 mm² .



For 50/60 Hz earth loops

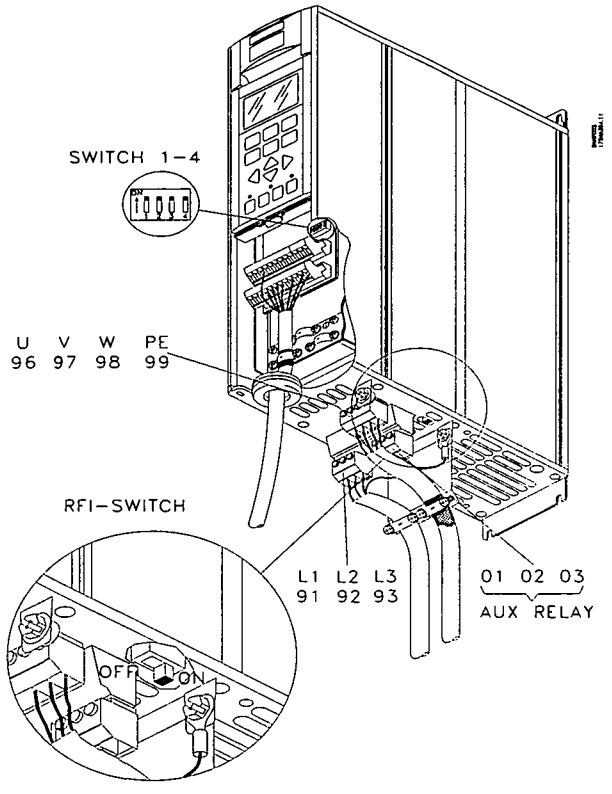
If very long control cables are used, 50/60 Hz earth loops may occur that will disturb the whole system. This problem can be solved by connecting one end of the screen to earth via a 100nF condenser (keeping leads short).



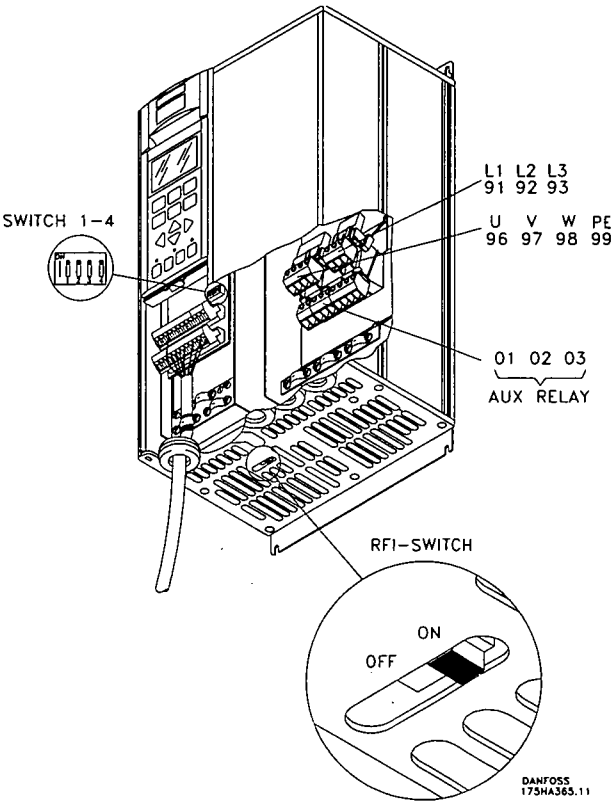
Cables for serial communication

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.

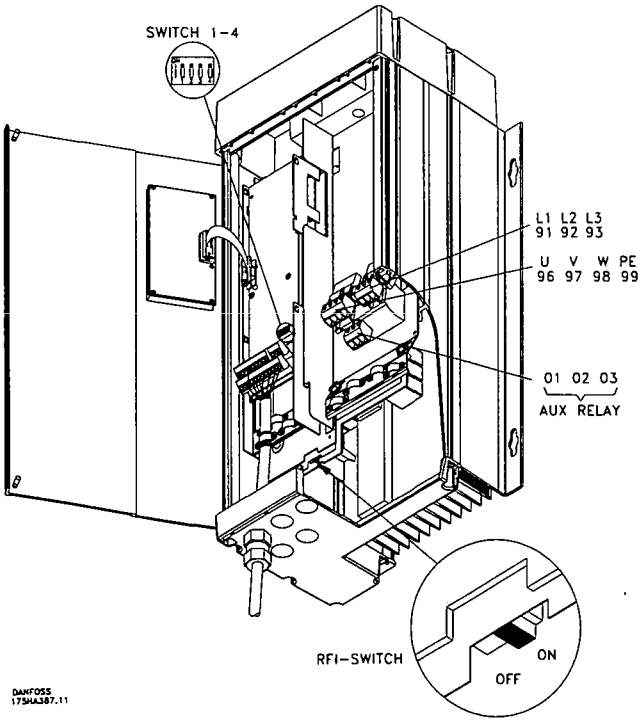
■ VLT 6000 HVAC enclosures



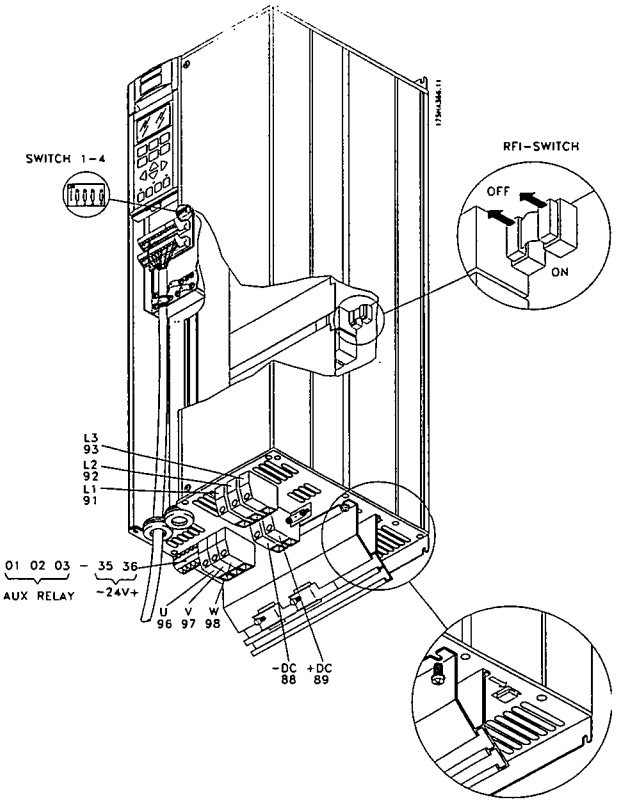
Bookstyle IP 20
VLT 6002-6005, 200-240 V
VLT 6002-6011, 380-460 V



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

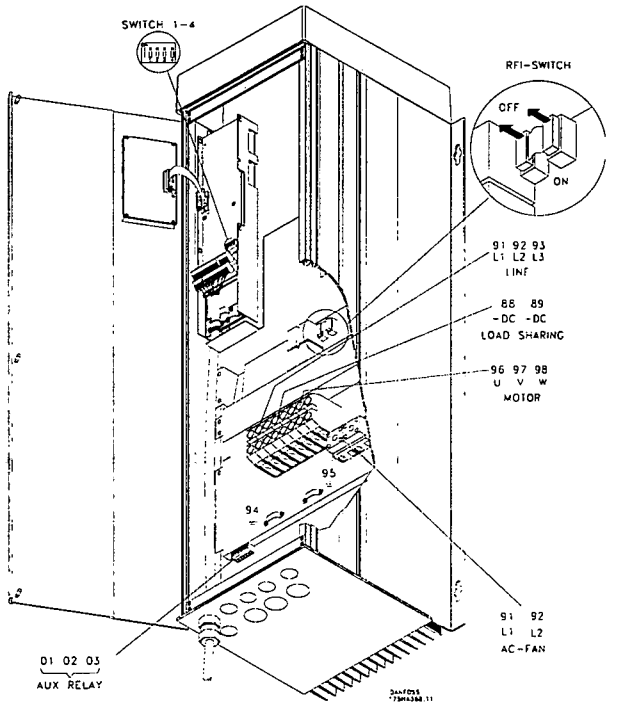


Compact IP 54
VLT 6002-6005, 200-240 V
VLT 6002-6011, 380-460 V

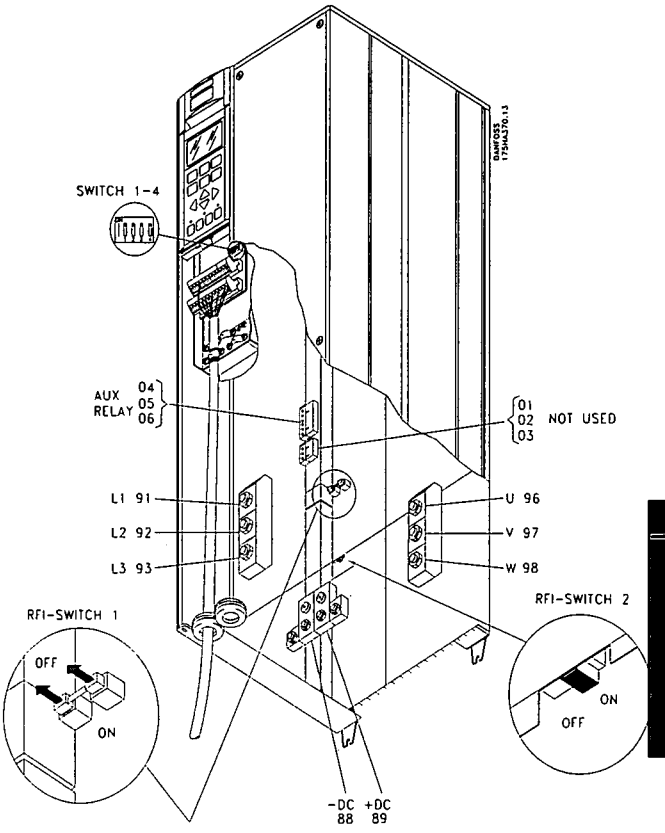


IP 20
VLT 6006-6032, 200-240 V
VLT 6016-6062, 380-460 V

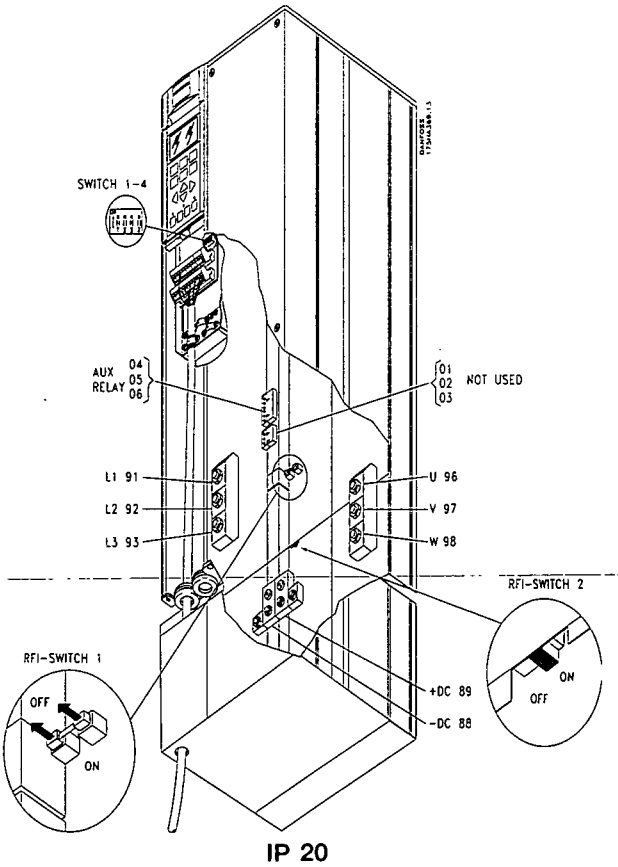
■ VLT 6000 HVAC enclosures



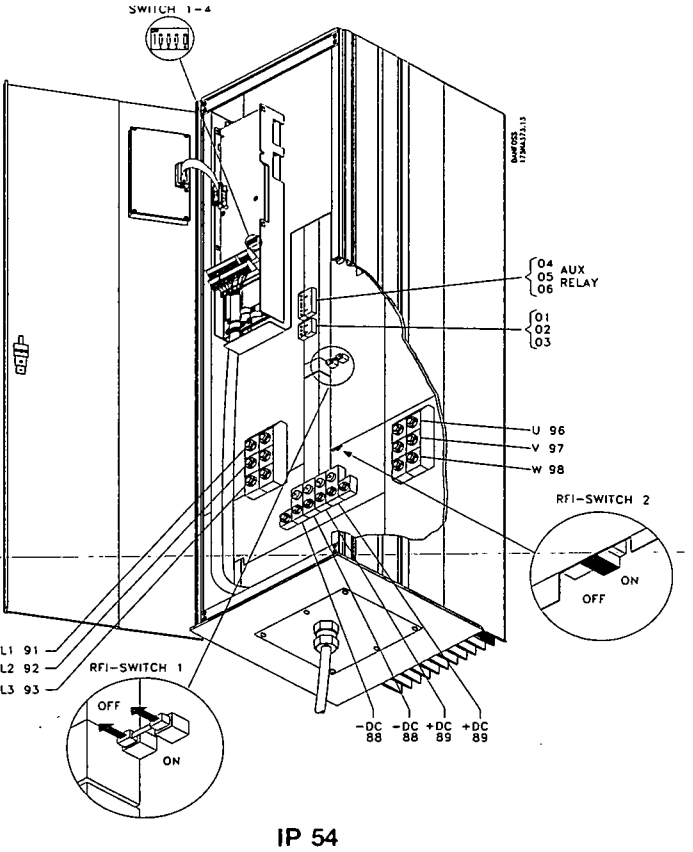
IP 54
VLT 6006-6032, 200-240 V
VLT 6016-6062, 380-460 V



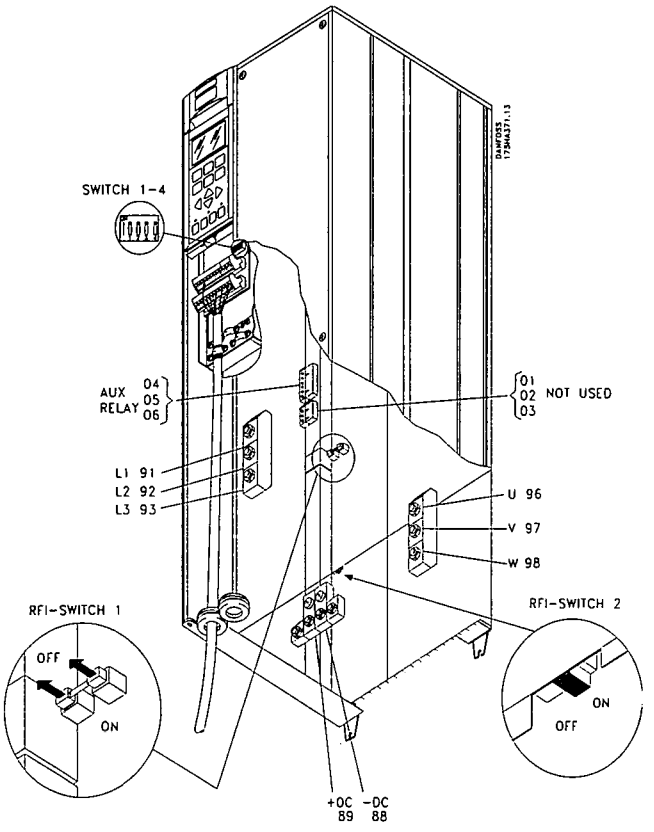
IP 00
VLT 6042-6062, 200-240 V
VLT 6075-6125, 380-460 V



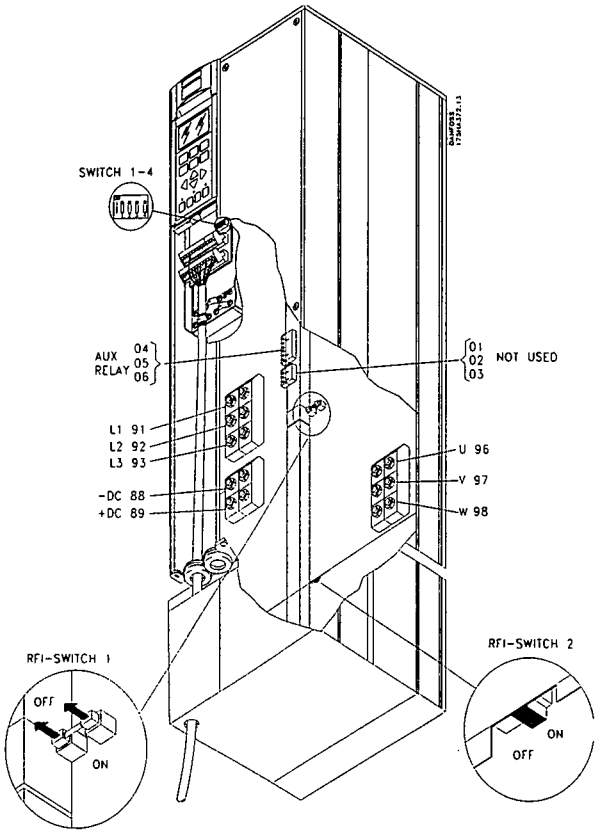
IP 20
VLT 6042-6062, 200-240 V
VLT 6075-6125, 380-460 V



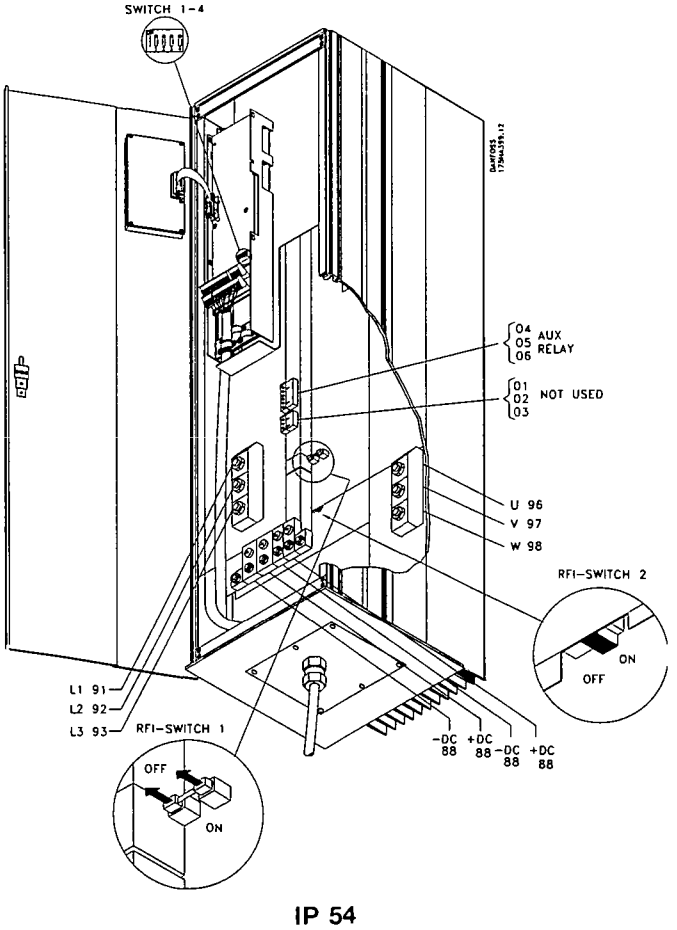
IP 54
VLT 6042-6062, 200-240 V
VLT 6075-6125, 380-460 V



IP 00
VLT 6150-6275, 380-460 V

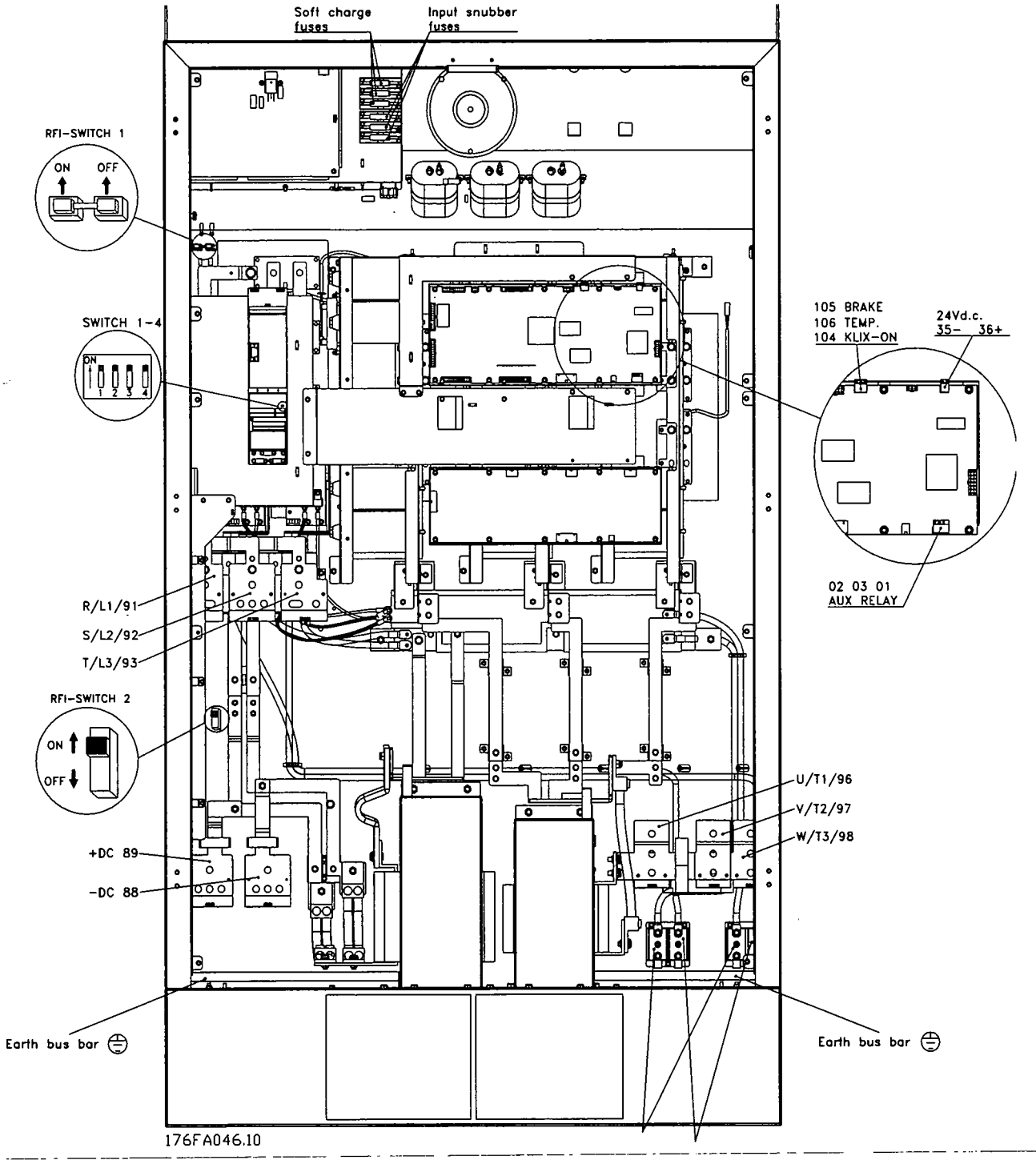


IP 20
VLT 6150-6275, 380-460 V



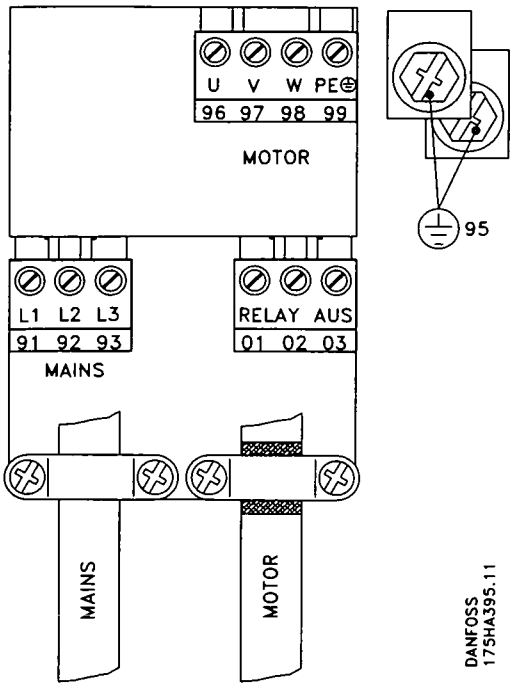
IP 54
VLT 6150-6275, 380-460 V

■ Electrical installation, enclosures

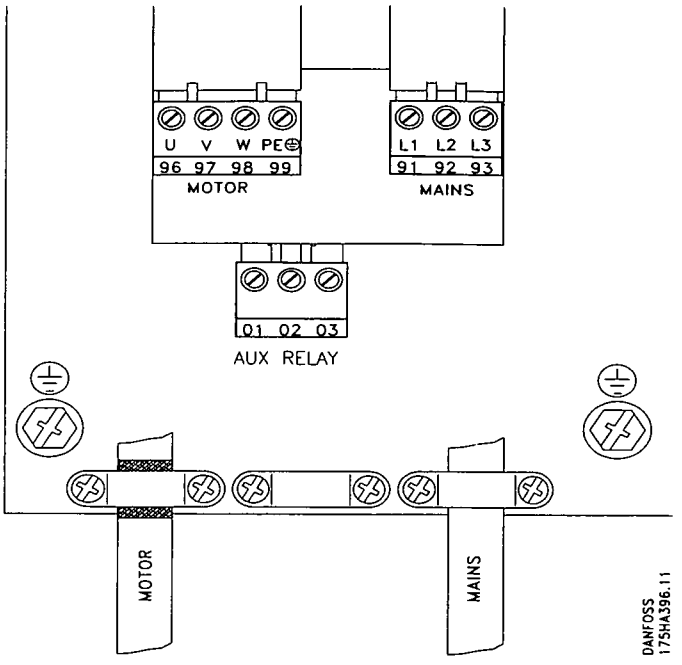


Compact IP 20 / IP 54
VLT 6350-6550, 380-500 V

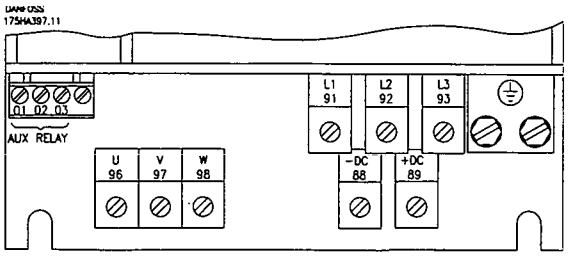
■ Electrical installation, power cables



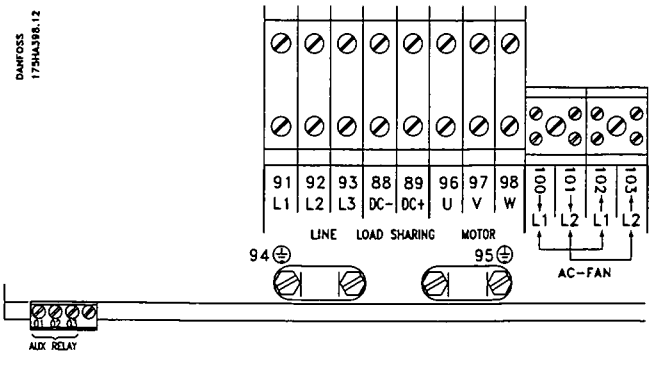
Bookstyle IP 20
VLT 6002-6005, 200-240 V
VLT 6002-6011, 380-460 V



Compact IP 20/IP 54
VLT 6002-6005, 200-240 V
VLT 6002-6011, 380-460 V

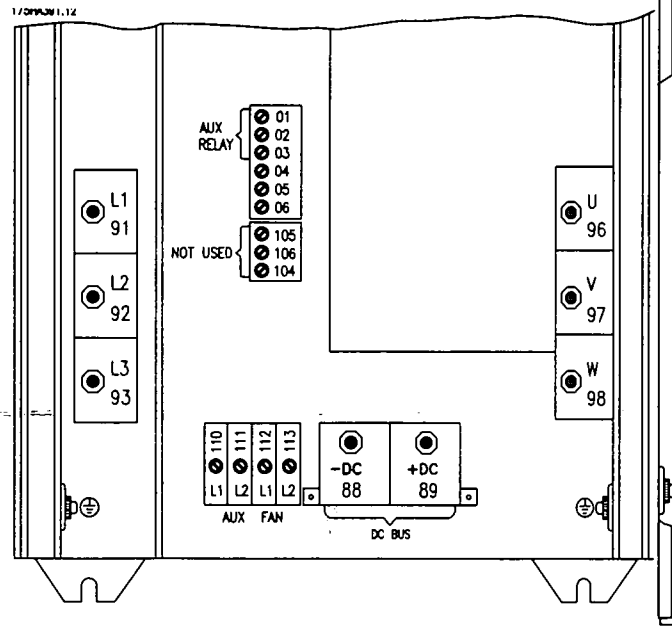


IP 20
VLT 6006-6032, 200-240 V
VLT 6016-6062, 380-460 V

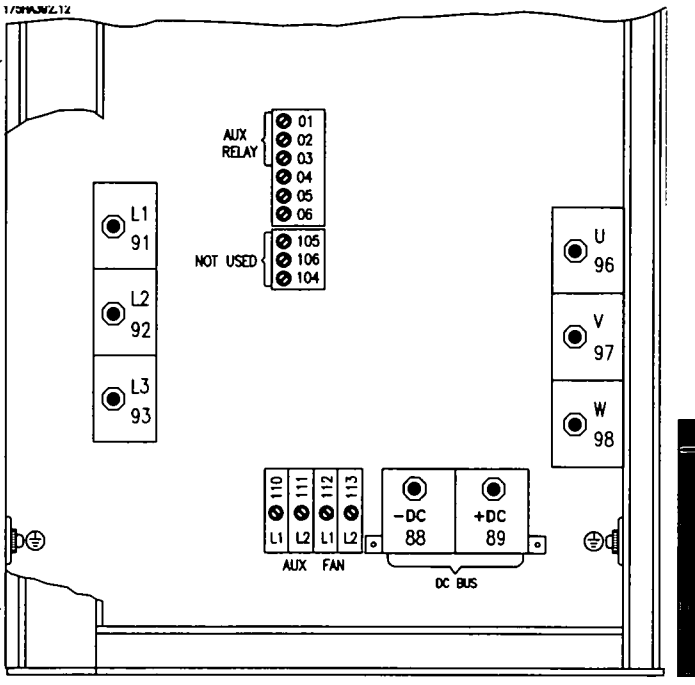


IP 54
VLT 6006-6032, 200-240 V
VLT 6016-6062, 380-460 V

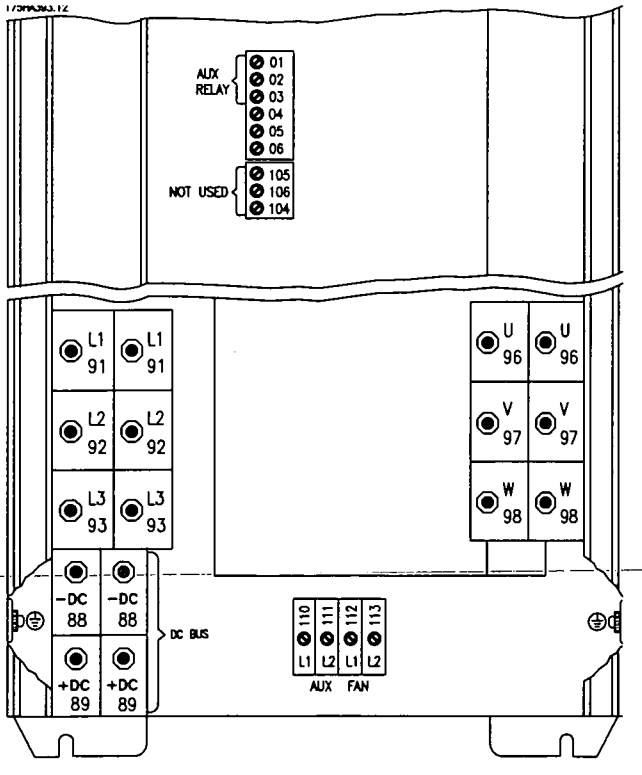
■ Electrical installation, power cables



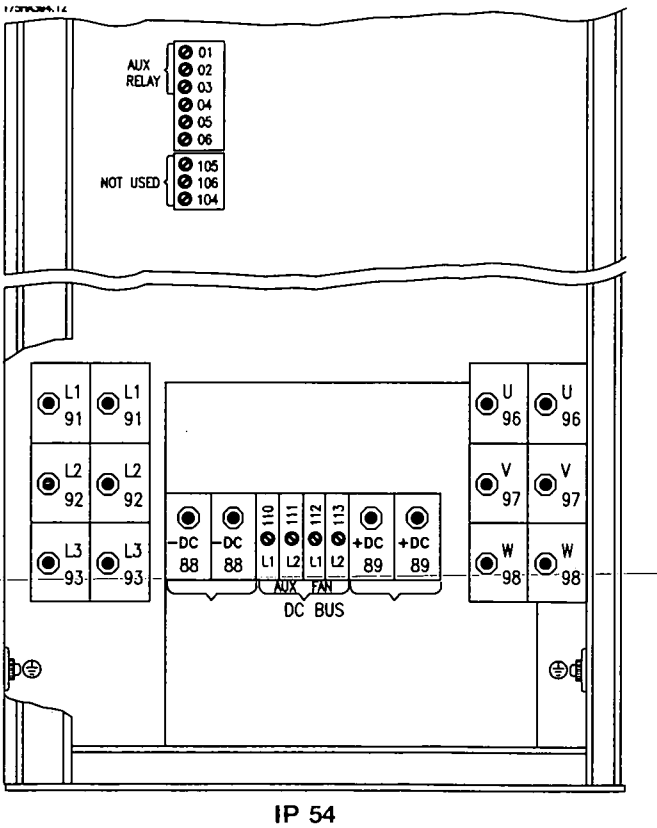
IP 00/20
VLT 6042-6062, 200-240 V
VLT 6075-6125, 380-460 V



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



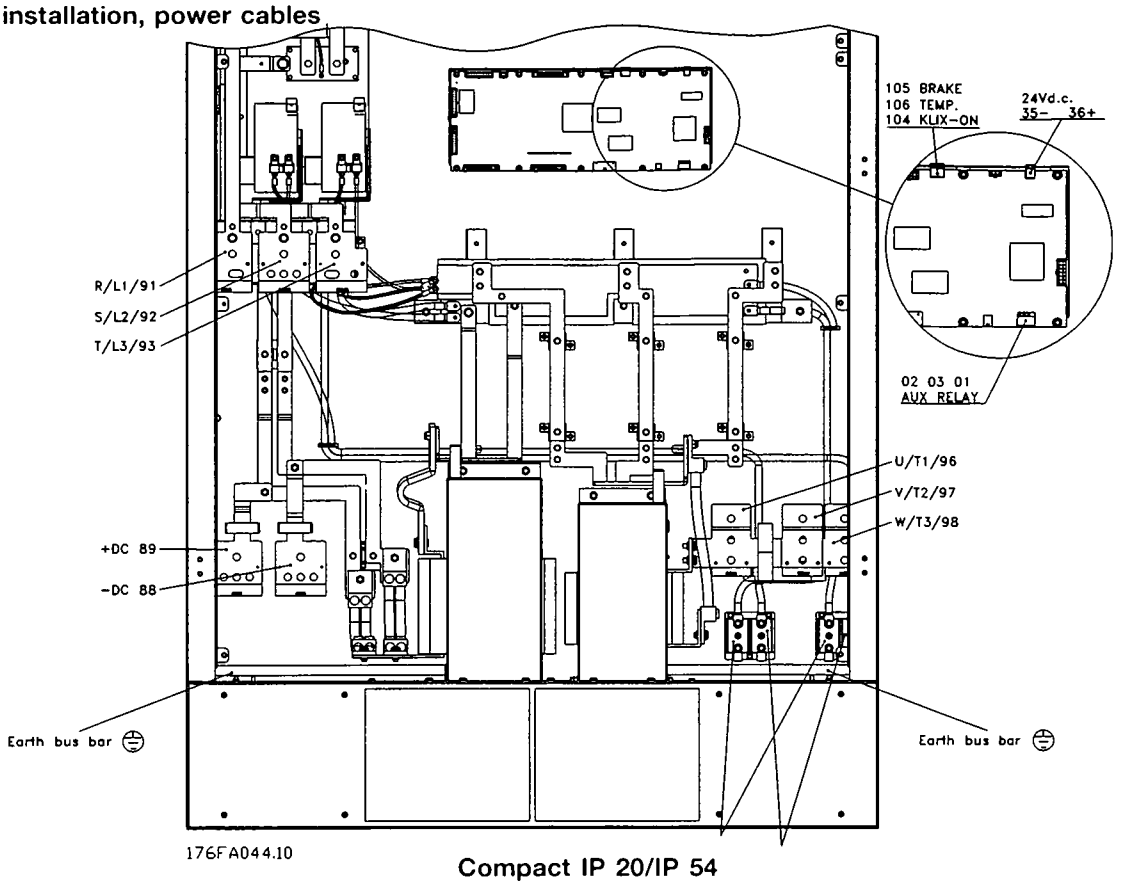
IP 00/20
VLT 6150-6275, 380-460 V



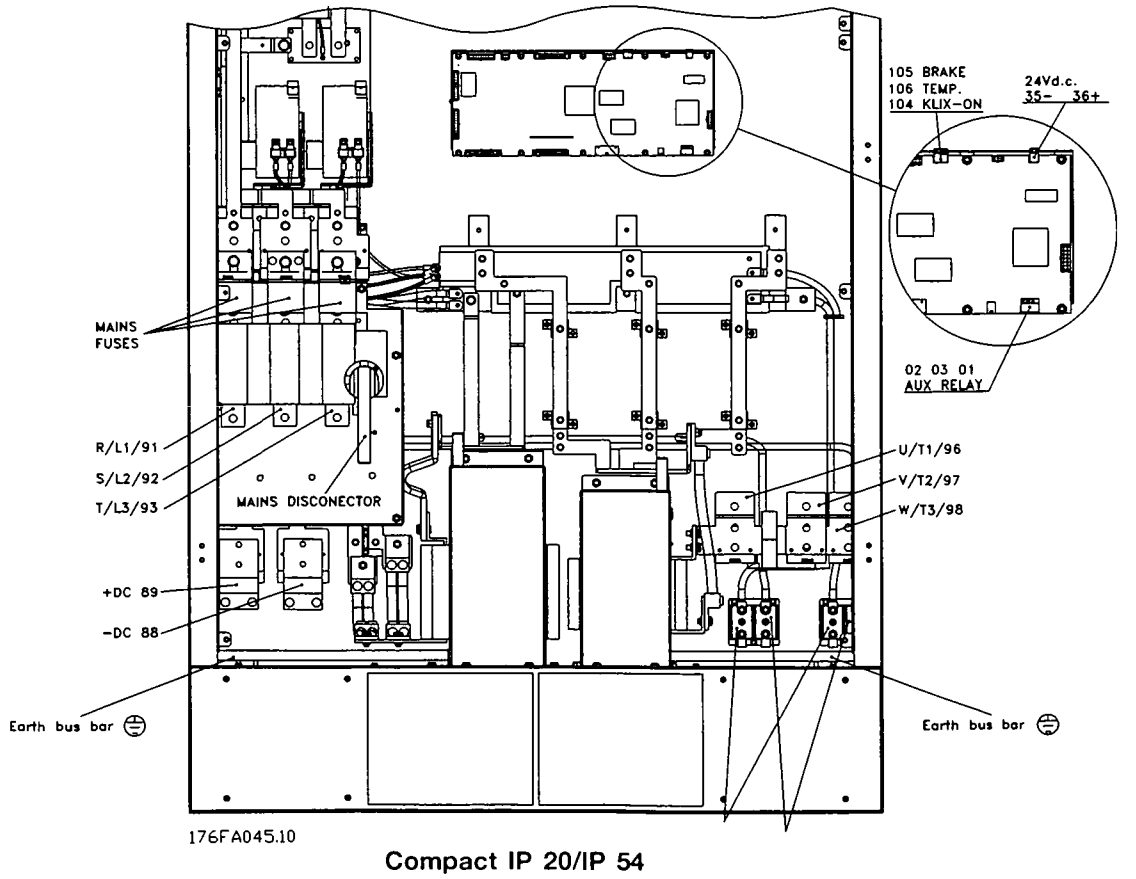
IP 54
VLT 6150-6275, 380-460 V

Installation

■ Electrical installation, power cables



Compact IP 20/IP 54
without disconnector and mains fuses
200 kW - 500 kW



Compact IP 20/IP 54
with disconnector and mains fuses
200 - 500 kW

■ 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 6002-6062, 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 3 x 200-240 V	Tightening-up torque	Screw size
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 3 x 200-240 V	Tightening-up torque	Bolt size
VLT 6042-6062	11.3 Nm	M8

VLT type 3 x 380-460 V	Tightening-up torque	Screw size
VLT 6002-6011	0.5 - 0.6 Nm	M3
VLT 6016-6027	1.8 Nm	M4
VLT 6032-6062	3.0 Nm	M5

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

■ 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

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

For VLT type 6002-6275, external pre-fuses must be installed in the mains supply to the frequency converter. For UL/cUL applications with a mains voltage of 200-240 V, pre-fuses of type Bussmann KTN-R (200-240 V) or similar must be used. For UL/cUL applications with a mains voltage of 380-460 V, pre-fuses of type Bussmann KTS-R (380-460 V) or similar must be used.

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

■ Motor connection

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

Nos. 96, 97, 98 / **U, V, W** — Motor voltage 0-100% of

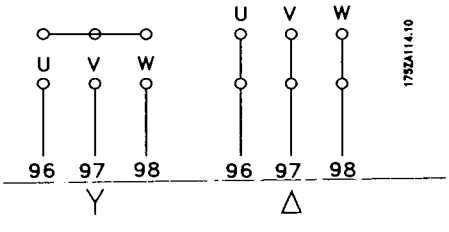
No. 99 — Earth connection.

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.

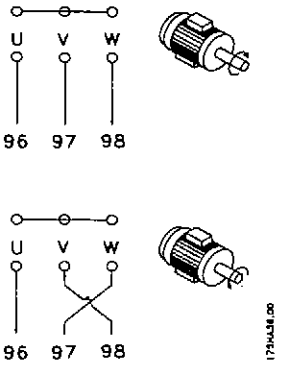
Small-size motors are normally star-connected. (220/380 V, Δ/Y). Large-size motors are delta-connected (380/660 V, Δ/Y).
The correct connection and voltage can be read from the motor nameplate.

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.



Installation

■ Direction of motor rotation

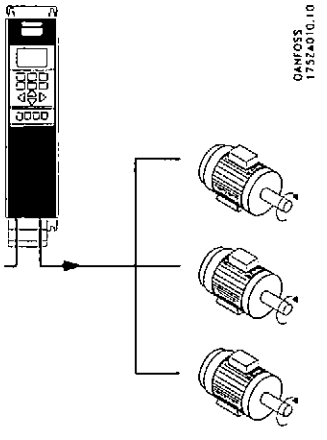


The factory setting is for clockwise rotation with the VLT frequency transformer output connected as follows.

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 (pigtails) 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.

■ 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,* $I_{VLT,N}$ 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 mm². 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

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

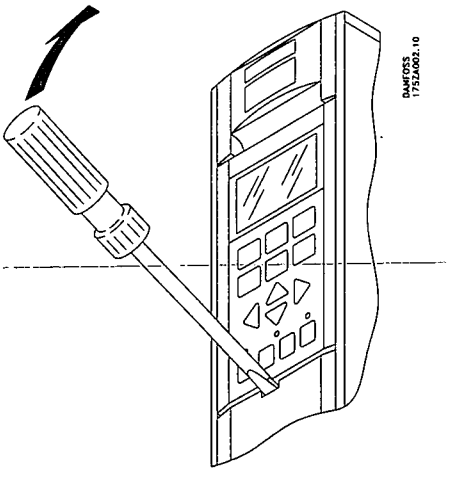
The cable for the high-voltage relay must be connected to terminals 01, 02, 03. The high-voltage relay is programmed in parameter 323, *Relay 1, output*.

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 mm²/10 AWG.
Torque:	0.5 - 0.6 Nm.
Screw size:	M3.

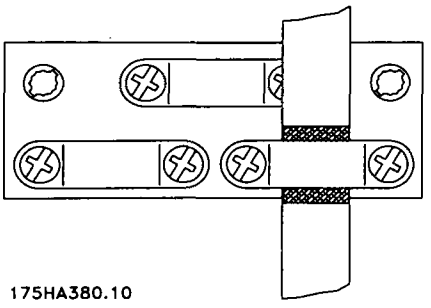
■ Control card

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.



Installation

■ Electrical installation, control cables



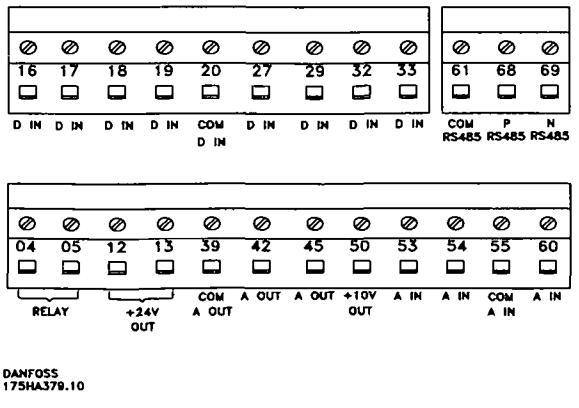
175HA380.10

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

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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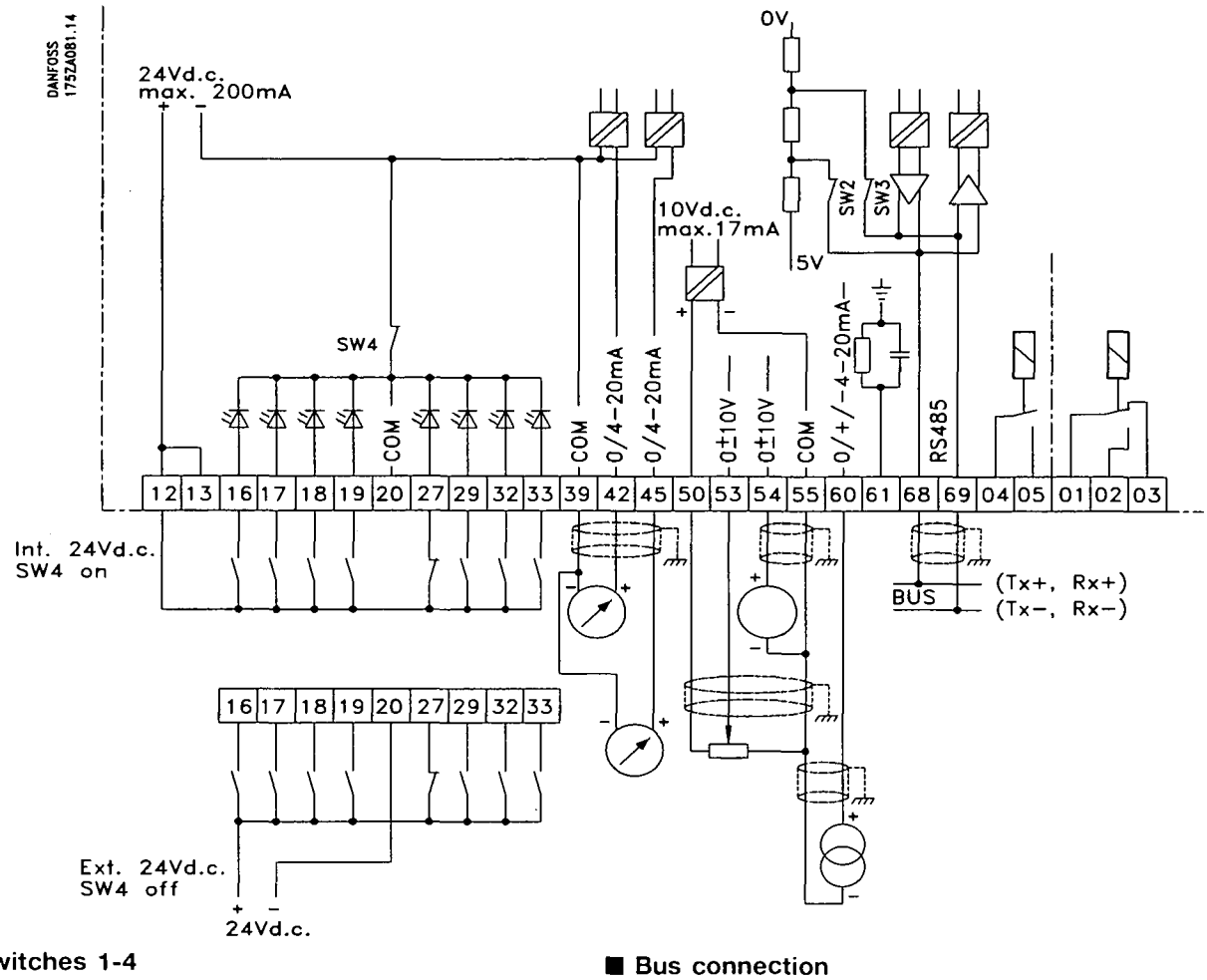
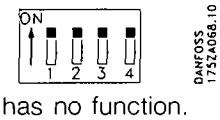
No.	Function
04, 05	Relay output 1 can be used for indicating status and warnings.
12, 13	Voltage supply to digital inputs. For the 24 V DC to be used for digital inputs, switch 4 on the control card must be closed, position "on".
16-33	Digital inputs. See parameters 300-307 *Digital inputs*.
20	Ground for digital inputs.
39	Ground for analogue/digital outputs. Must be connnected to terminal 55 by means of a three-wire transmitter. See *Examples of connection*.
42, 45	Analogue/digital outputs for indicating frequency, reference, current and torque. See parameters 319-322 *Analogue/digital outputs*.
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 *Terminal 60*.
61	Termination of serial communication. See *Earthing of screened/armoured control cables*. 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).



■ 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.



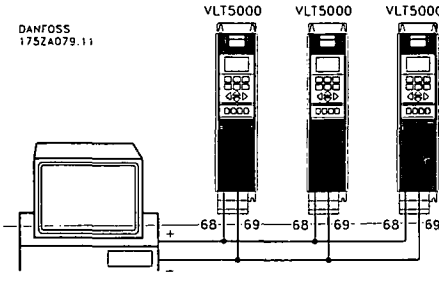
Switch 1 has no function.
Switches 2 and 3 are used for terminating an RS 485 interface, serial communication. In the first and the last VLT frequency converter, switches 2 and 3 must be ON. In the other VLT frequency converters, switches 2 and 3 must be OFF.
Switch 4 is used if an external 24 V DC supply is required for the control terminals.
Switch 4 separates the common potential for the internal 24 V DC supply from the common potential of the external 24 V DC supply.

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.

Bus termination
The bus must be terminated by a resistor network at both ends. For this purpose, set switches 2 and 3 on the control card for "ON".

■ 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.

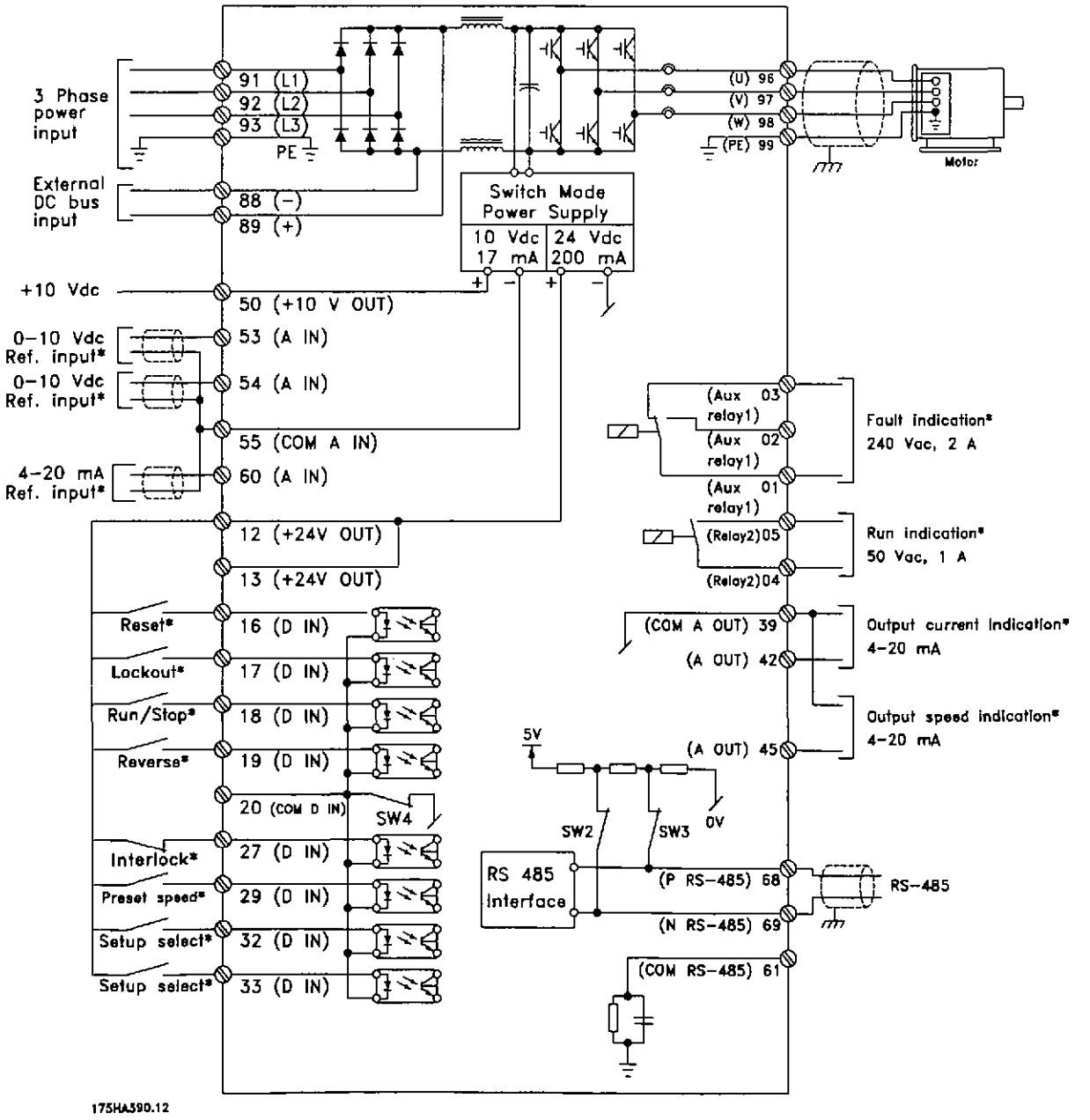
Analogue inputs can be connected to terminals 53 [V], 54 [V] and 60 [mA]. These inputs can be programmed for either reference, feedback or thermistor. See *Analogue inputs* in parameter group 300.

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.

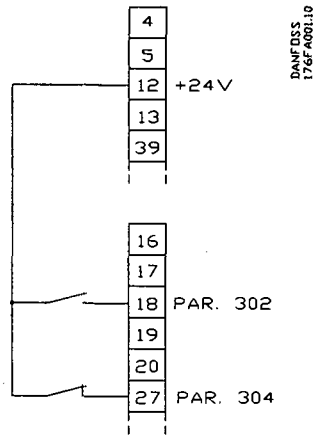
On terminals 68 (P+) and 69 (N-) RS 485 interface, the VLT frequency converter can be controlled and monitored via serial communication.



* These terminals can be programmed for other functions.

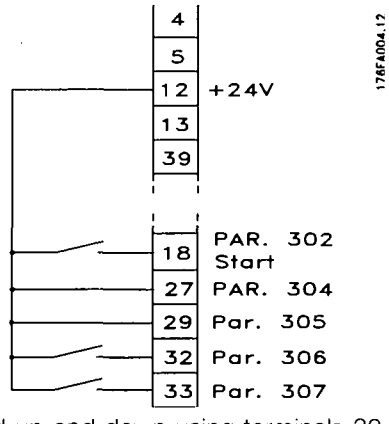
■ Connection examples

Single-pole start/stop



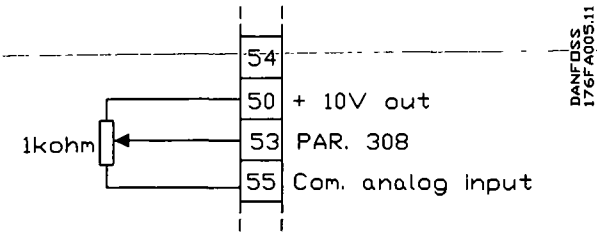
Start/stop using terminal 18.
Parameter 302 = *Start* [1]
- Quick-stop using terminal 27.
  Parameter 304 = *Coasting stop, inverse* [0]

Digital speed up/down



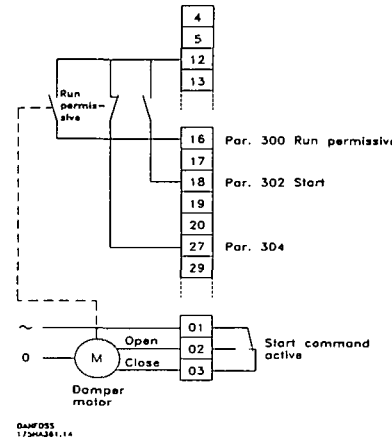
- Speed up and down using terminals 32 and 33.
  Parameter 306 = *Speed up* [7]
  Parameter 307 = *Speed down* [7]
  Parameter 305 = *Freeze reference* [2]

Potentiometer reference



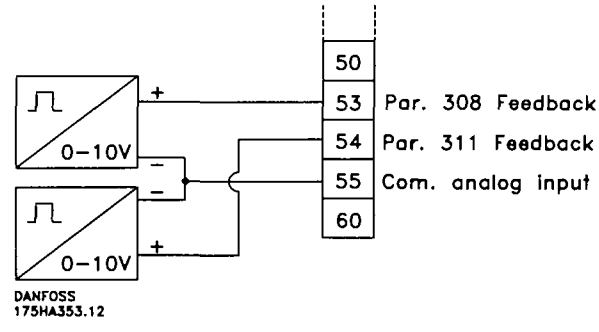
- Parameter 308 = *Reference* [1]
  Parameter 309 = *Terminal 53, min. scaling*
  Parameter 310 = *Terminal 53, max. scaling*

Run permissive



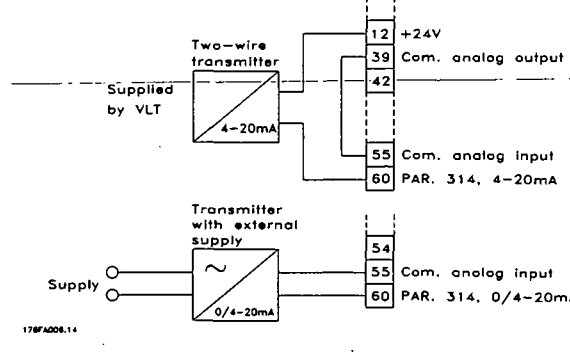
- Start permitted with terminal 16.
  Parameter 300 = *Start enabled* [8].
- Start/stop with terminal 18.
  Parameter 302 = *Start* [1].
- Quickstop with terminal 27.
  Parameter 304 = *Coasting stop, inverse* [0].
- Activated damper (motor)
  Parameter 323 = *Start command active* [13].

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*

Installation

■ 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.

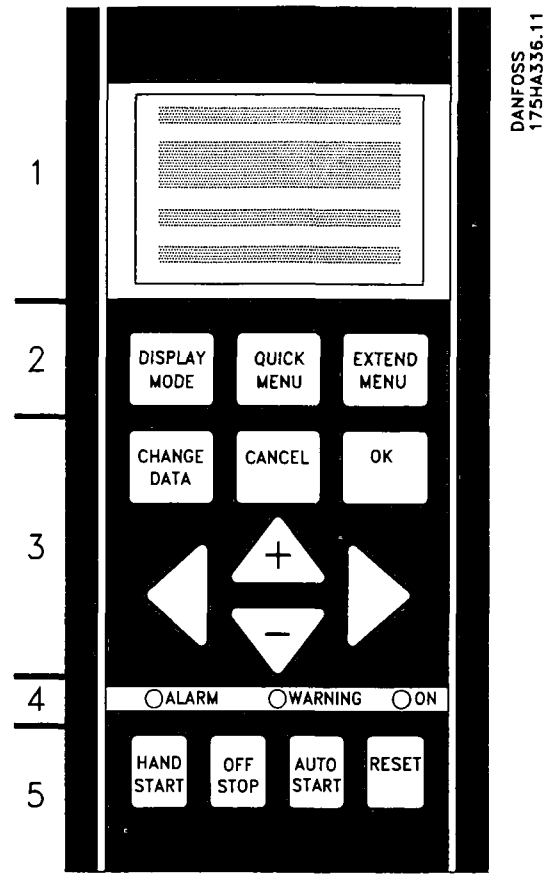
The control panel is detachable and can - as an alternative - be installed up to 3 metres away from the VLT frequency converter, e.g. on the front panel, by means of a mounting kit option.

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.

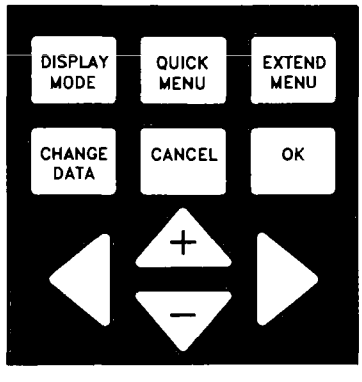
All data are indicated by means of a 4-line alpha-numeric display, which, in normal operation, is able to show 4 operating data values and 3 operating condition values continuously. During programming, all the information required for quick, effective parameter Setup of the VLT frequency converter will 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*.



■ 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

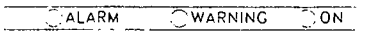
[OK] is used for confirming a change of the parameter selected.

[+/-] 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.



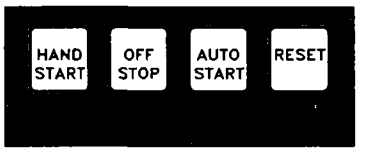
red yellow green

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_{MIN} 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

[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

[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.

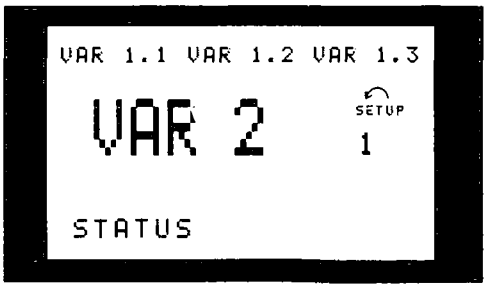
NB!
An active HAND-OFF-AUTO signal via the digital inputs will have higher priority than the control keys [HAND START]-[AUTO START].

RESET

[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.



Programming

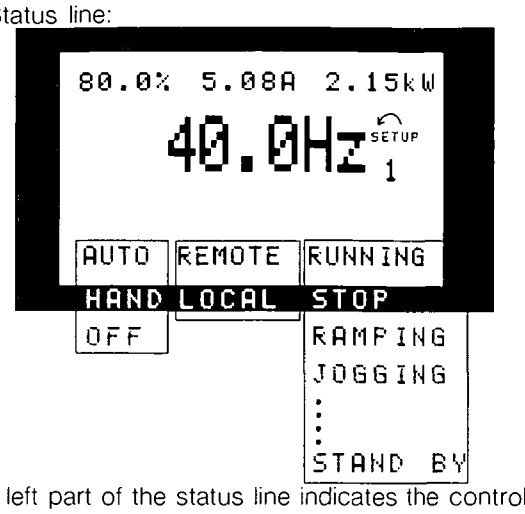
■ Display mode, cont.

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]
% of maximum output frequency	[%]
Motor current	[A]
Power	[kW]
Power	[HP]
Output energy	[kWh]
Hours run	[hours]
Used-defined readout	[unit]
Setpoint 1	[unit]
Setpoint 2	[unit]
Feedback 1	[unit]
Feedback 2	[unit]
Feedback	[unit]
Motor voltage	[V]
DC-link voltage	[V]
Thermal load on motor	[%]
Thermal load on VLT	[%]
Input status, dig. input	[binary code]
Input status, analogue terminal 53	[V]
Input status, analogue terminal 54	[V]
Input status, analogue terminal 60	[mA]
Pulse reference	[Hz]
External reference	[%]
Heat sink temperature	[°C]
User-defined text	[-]

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*.

- Status line:

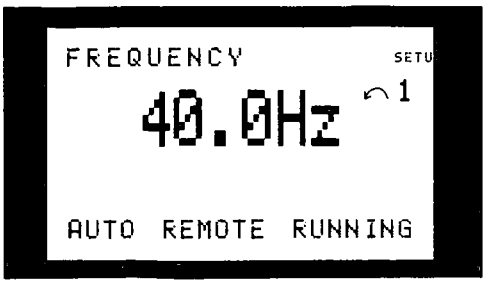


The left part of the status line indicates the control element of the VLT frequency converter that is active. AUTO means that control is via the control terminals, while HAND indicates that control is via the local keys on the control unit.
OFF means that the VLT frequency converter ignores all control 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".

■ Display mode I:

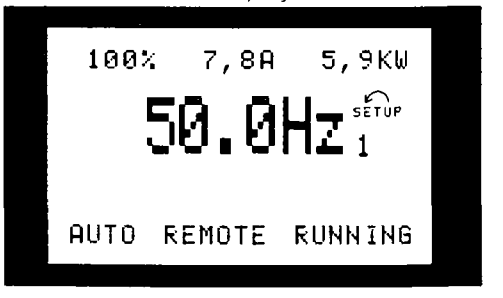
VLT 6000 HVAC offers different display modes depending on the mode selected for the VLT frequency converter. The figure on the next page shows the way to navigate between different display modes.
Below is a display mode, in which the VLT frequency converter is in Auto mode with remote reference at an 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.



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.

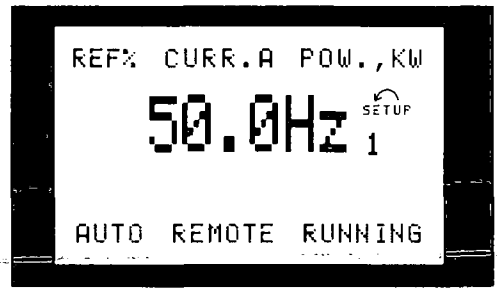
■ Display mode II:

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*.



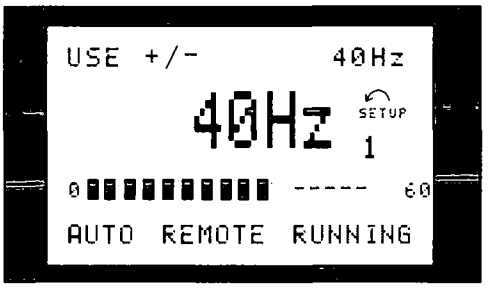
■ Display mode III:

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.

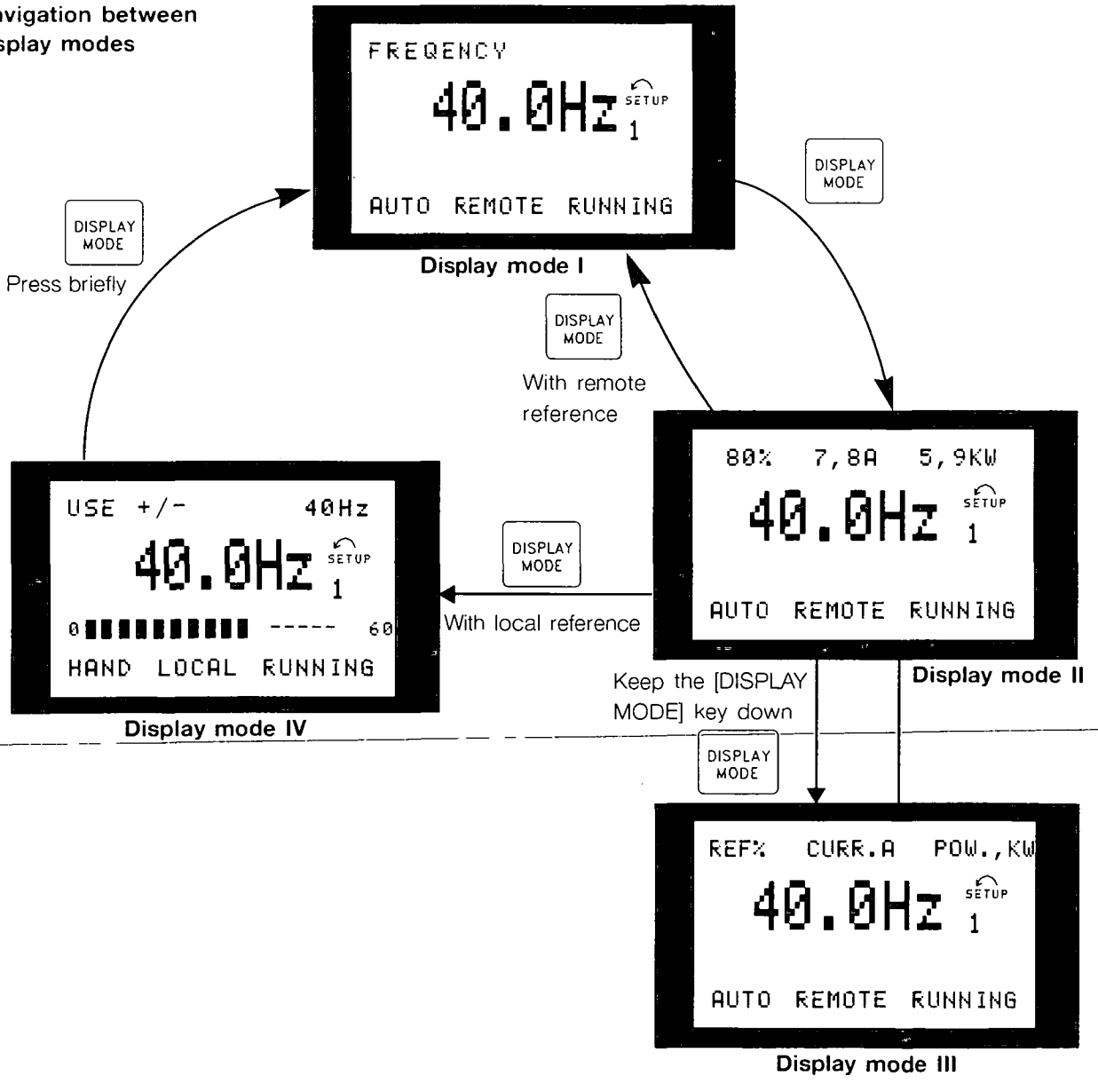


■ Display mode IV:

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.



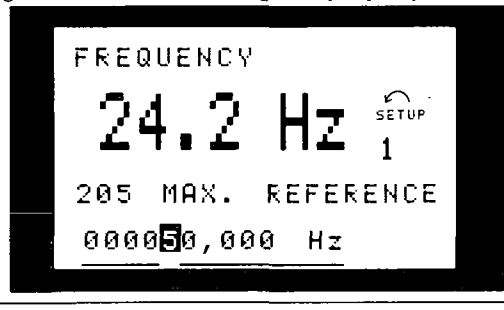
■ Navigation between display modes



Programming

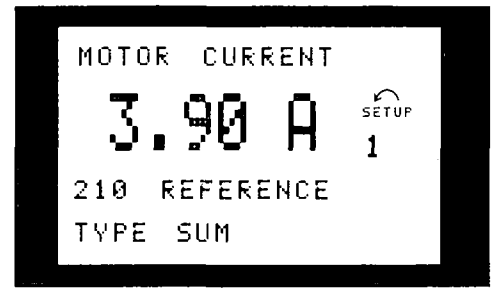
■ Changing data

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.

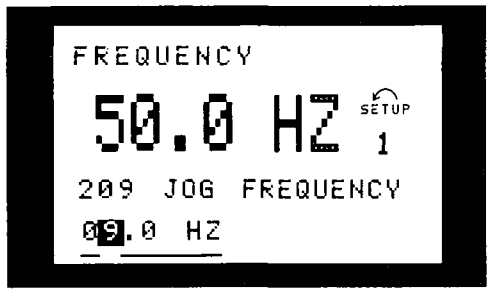
If the selected parameter is a functional value, the selected text value can be changed by means of the [+/-] keys.



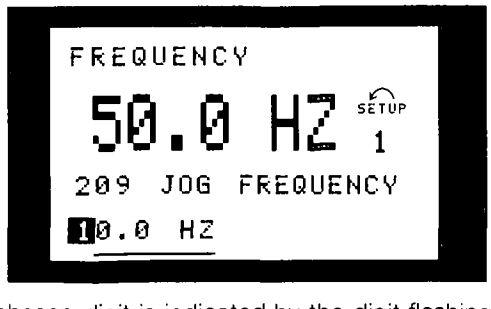
The functional value flashes until signing off by pressing the [OK] button. The functional value has now been selected. Use [CANCEL] to cancel the change.

■ 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*.

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 Item Number	Parameter 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

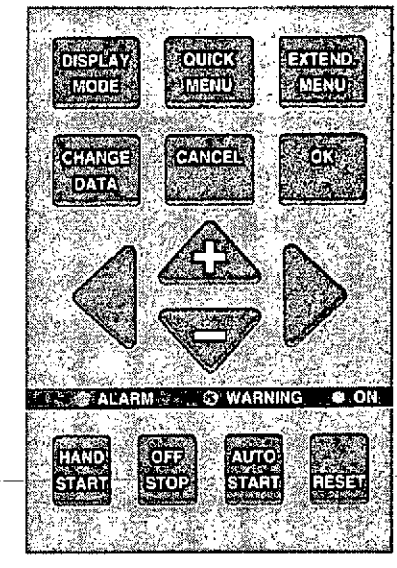
Enter or change parameter data or settings in accordance with the following procedure.

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.

Programming

■ 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]

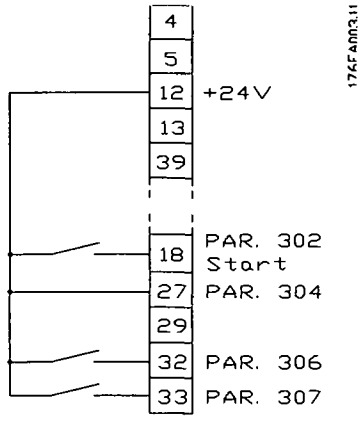
Function:

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.

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 the 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

Programming

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port

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.

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.

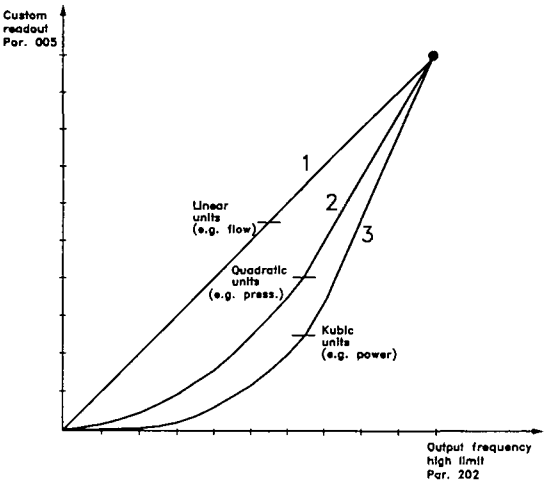
Description of choice:

Set the required value for max. output frequency.

006 Unit for user-defined readout (CUST. READ. UNIT)

Value:

★ No unit [1]	[0]	GPM [1]	[21]
% [1]	[1]	gal/s [1]	[22]
rpm [1]	[2]	gal/min [1]	[23]
ppm [1]	[3]	gal/h [1]	[24]
pulse/s [1]	[4]	lb/s [1]	[25]
l/s [1]	[5]	lb/min [1]	[26]
l/min [1]	[6]	lb/h [1]	[27]
l/h [1]	[7]	CFM [1]	[28]
kg/s [1]	[8]	ft^3/s [1]	[29]
kg/min [1]	[9]	ft^3/min [1]	[30]
kg/h [1]	[10]	ft^3/h [1]	[31]
m^3/s [1]	[11]	ft^3/min [1]	[32]
m^3/min [1]	[12]	ft/s [1]	[33]
m^3/h [1]	[13]	in wg [2]	[34]
m/s [1]	[14]	ft wg [2]	[35]
mbar [2]	[15]	PSI [2]	[36]
bar [2]	[16]	lb/in^2	[37]
Pa [2]	[17]	HP [3]	[38]



kPa [2]	[18]
MWG [2]	[19]
kW [3]	[20]

Flow and speed units are marked with 1. Pressure units with 2, and power units with 3. See figure in next column.

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*.

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]

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port

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]
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 [%] (THERM.MOTOR LOAD [%])	[18]
Thermal load, VLT [%] (THERM.DRIVE LOAD [%])	[19]
Digital input [Binary code] (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] (ANALOG INPUT 53 [mA])	[23]
Pulse reference [Hz] (PULSE REFERENCE [HZ])	[24]
External reference [%] (EXT. REFERENCE [%])	[25]
Heat sink temp. [°C] (HEATSINK TEMP [°C])	[26]
LCP Display text (FREE PROG.ARRAY)	[27]

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.

Programming

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port

Analogue input 54 [V] states the voltage value on terminal 54.
Analogue input 60 [mA] states the voltage value on terminal 60.
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_{MIN}* to *Maximum reference, Ref_{MAX}*.
Heat sink temp. [°C] states the present heat sink temperature of the VLT frequency converter. The cut-out limit is 90 ± 5°C; cutting back in occurs at 60 ± 5°C.
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.a. 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:
Se 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.

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.

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port

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*.

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*P*) 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.

Programming

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port

■ 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]

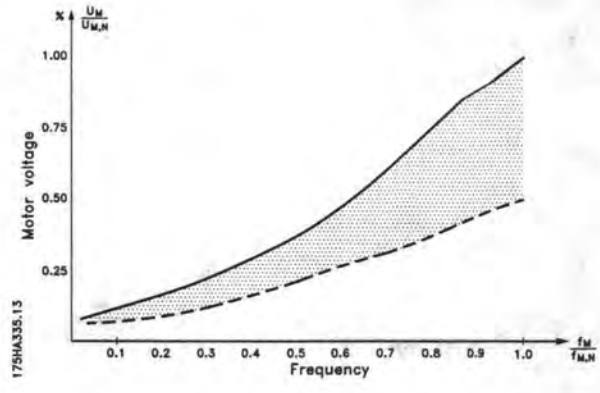
Function:

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

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 D.

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]

★ Depends on the unit

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 variably, see also the procedure for *Infinitely variable change of numeric data value*.

Programming

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 choice of motor.

Function:

The rated motor current $I_{M,N}$ forms part of the VLT frequency converter calculations i.a. of torque and motor thermal protection. Set the motor current $I_{VLT,N}$, taking into account the star Y or delta Δ 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 - $f_{M,N}$ x 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 $f_{M,N}$ x 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.
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*.

Programming

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port

Description of choice:
Set the start-up voltage at 0 Hz. The maximum voltage depends on parameter 103 *Motor voltage, $U_{M,N}$*.

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 - 0.5 sec.	★ 0.0 sec.

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.

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port

■ 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:

$0 - \frac{I_{VLT,MAX}}{I_{M,N}} \times 100\ [\%]$ ★ 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*, $I_{VLT,N}$. 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.

Programming

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port

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.

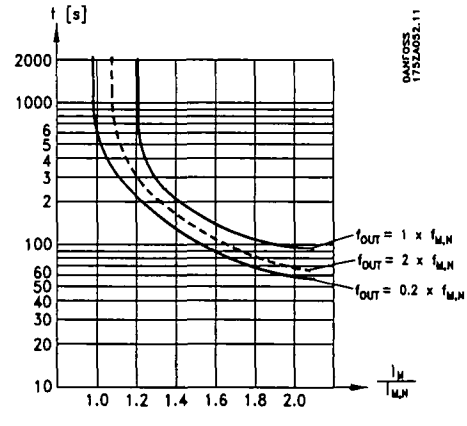
Select *Thermistor warning* [1] if a warning is desired when the connected thermistor gets too hot.

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.

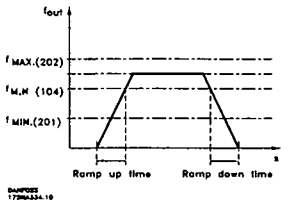
The VLT frequency converter can also be programmed to give off a warning signal via one of the digital outputs.

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

■ 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_{MAX}*.

Description of choice:
Select the required output frequency range.

---

201 Output frequency low limit, f_{MIN} (MIN. FREQUENCY)

Value:

0.0 - f_{MAX} ★ 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_{MAX}* frequency set in parameter 202 can be selected.

---

202 Output frequency high limit, f_{MAX} (MAX. FREQUENCY)

Value:

f_{MIN} - 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_{MIN} to the choice made in parameter 200 *Output frequency range* can be selected.

Programming

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port

■ 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.

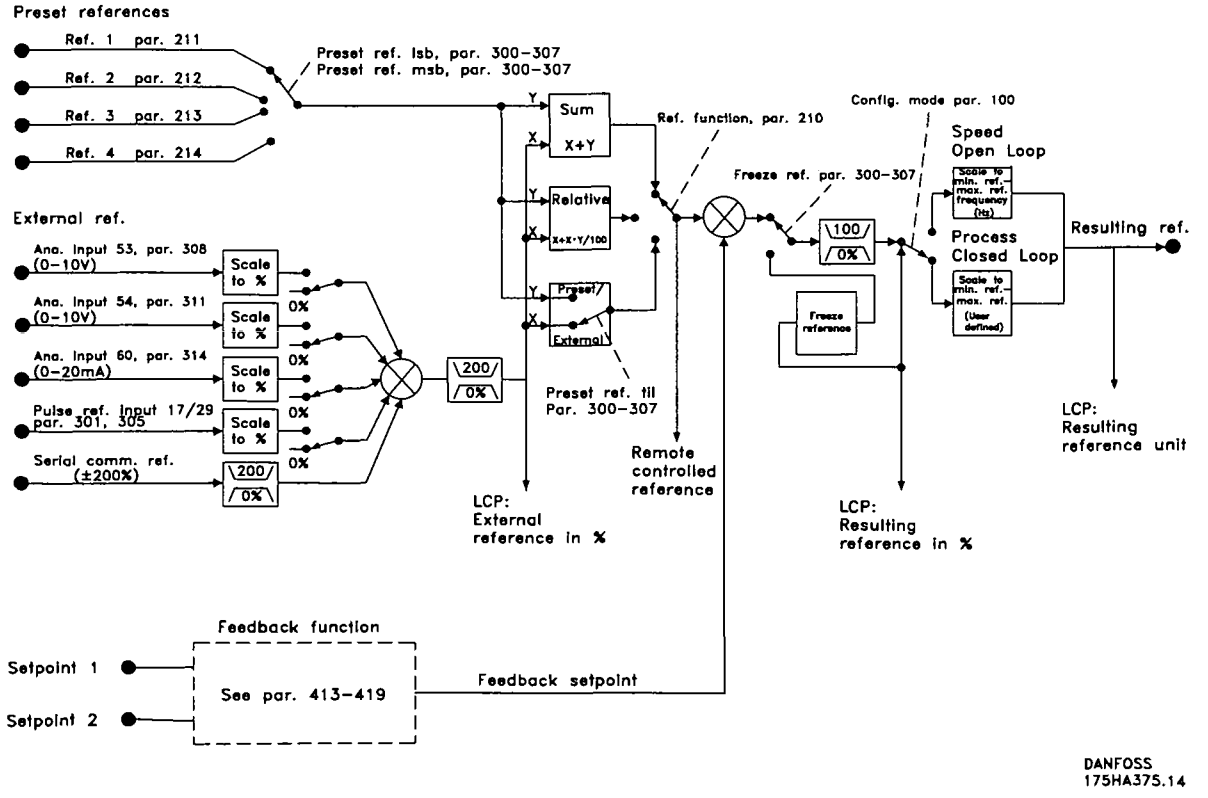
The sum of the external references can be shown in the display as a percentage of the range from *Minimum reference, Ref_{MIN}* to *Maximum reference, Ref_{MAX}*. Select *External reference,* % [25] in parameters 007-010 *Display readout* if a readout is required.

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*.



★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port

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_{MIN} (MIN. REFERENCE)

Value:

Parameter 100 *Configuration* = *Open loop* [0].
0.000 - parameter 205 Ref_{MAX} ★ 0.000 Hz

Parameter 100 *Configuration* = *Closed loop* [1].
-Par. 413 *Minimum feedback*
- par. 205 Ref_{MAX} ★ 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 *Configuration* = *Open loop*	Hz
Par. 100 *Configuration* = *Closed loop*	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_{MAX} (MAX. REFERENCE)

Value:

Parameter 100 *Configuration* = *Open loop* [0]
Parameter 204 Ref_{MIN} - 1000.000 Hz★ 50.000 Hz

Parameter 100 *Configuration* = *Closed loop* [1]
Par. 204 Ref_{MIN}
- 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*).

Programming

Function, cont.:
The reference unit can be determined on the basis of the following table:

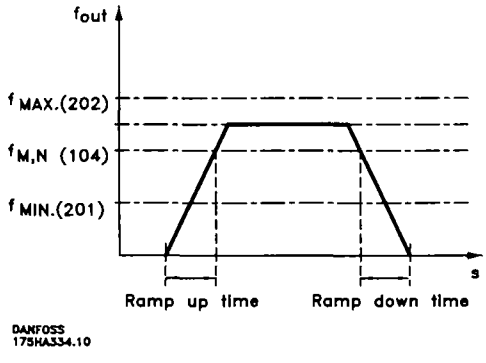
	Unit
Par. 100 *Configuration = Open loop*	Hz
Par. 100 *Configuration = Closed loop*	Par. 415

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_{LIM}*).



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.

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port

■ 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]

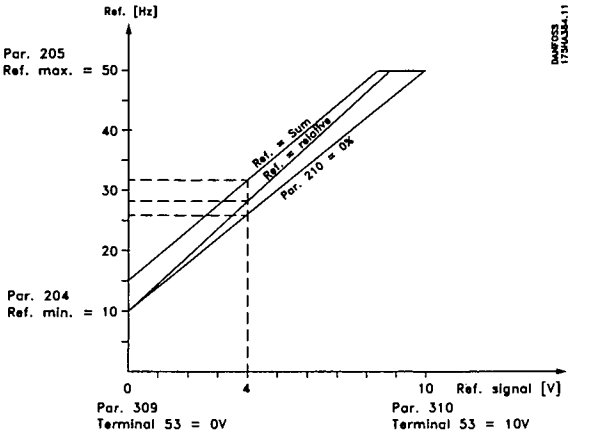
Par. 204 *Minimum reference*	= 10.0 Hz
Reference contribution at 4 V	= 16.0 Hz
Par. 211 *Preset reference*	= 6.0 Hz
Resulting reference	= 32.0 Hz

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.

Programming

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port

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 (Ref_{MIN} - Ref_{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 preset ref. msb	Terminal 16/29/32 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_{LIM}
(CURRENT LIMIT)

Value:

0.1 - 1.1 x $I_{VLT,N}$ ★ 1.0 x $I_{VLT,N}$ [A]

Function:

This is where the maximum output current I_{LIM} is set.
The factory setting corresponds to the rated output current. If the current limit is to be used as motor protection, the rated motor current must be set. If the current limit is set within the range of 1.0-1.1 x $I_{VLT,N}$ (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 $I_{VLT,N}$, it must be ensured that for a period the load is lower than $I_{VLT,N}$.
Please note that if the current limit is set to less than $I_{VLT,N}$, the acceleration torque will be reduced correspondingly.

Description of choice:

Set the required maximum output current I_{LIM}.

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 in the system.
These output frequencies 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*.

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port

221 Warning: Low current, I_{LOW} (WARN. LOW CURR.)

Value:

0.0 - par. 222 *Warning: High current, I_{HIGH}* ★0.0A

Function:

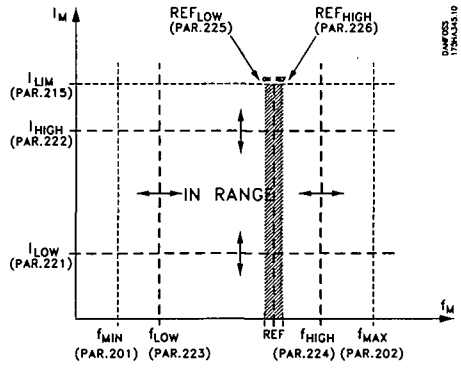
When the motor current is below the limit, I_{LOW}, programmed in this parameter, the display shows a flashing CURRENT LOW, provided *Warning* [1] has been selected in parameter 409 *Function in case of no load*. The VLT frequency converter will trip if parameter 409 *Function in case of no load* has 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 stopped. 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 stopped. 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 stopped. 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}*.

Programming

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port

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 stopped. 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 stopped. 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 stopped. 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.

---

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 stopped. 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}*).

---

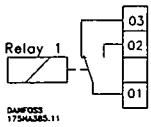
228 Warning: High feedback, FB_{HIGH}
(WARN. HIGH FDBK)

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 stopped. 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}*).

■ Inputs and outputs 300-328



In this parameter group, the functions that relate to the input and output terminals of the VLT frequency converter are defined.

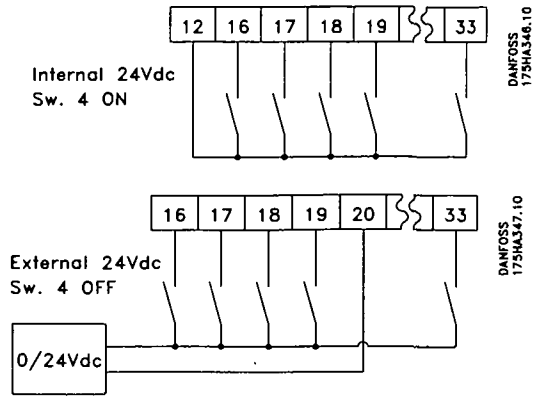
The digital inputs (terminals 16, 17, 18, 19, 27, 32 and 33) are programmed in parameters 300-307.

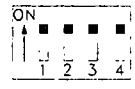
The table below gives the options for programming the inputs.

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.





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]

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port

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, not all alarms can be reset (trip locked) cycling mains power supply. See table in *List of warnings and alarms*. Reset will be activate 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

Programming

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port

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

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 (16)	Terminal (17)	Freeze ref./ 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 rememberd 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.

■ 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]	

308 Terminal 53, analogue input voltage (AI [V] 53 FUNCT.)

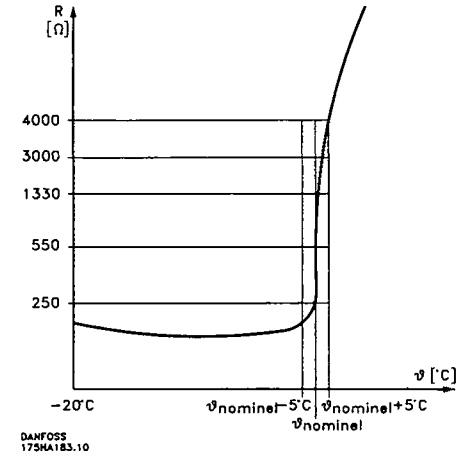
Function:
This parameter is used to select the required function to be linked to terminal 53.

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 in 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).



Programming

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port

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.

---

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 (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].

Programming

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port

■ 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 470 Ω (max. 500 Ω) 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 Ω.

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} ⇒ 0-20 mA (OUT. FREQ. 0-20 mA)		[29]	★ [29]
Output frequency, 0 - f_{MAX} ⇒ 4-20 mA (OUT. FREQ. 4-20 mA)		[30]	[30]
Output frequency (pulse sequence), 0 - f_{MAX} ⇒ 0-32000 p (OUT. FREQ. PULSE)		[31]	[31]
External reference, Ref_{MIN} - Ref_{MAX} ⇒ 0-20 mA (EXT. REF. 0-20 mA)		[32]	[32]
External reference, Ref_{MIN} - Ref_{MAX} ⇒ 4-20 mA (EXTERNAL REF. 4-20 mA)		[33]	[33]
External reference (pulse sequence), Ref_{MIN} - Ref_{MAX} ⇒ 0-32000 p (EXTERNAL REF. PULSE)		[34]	[34]
Feedback, FB_{MIN} - FB_{MAX} ⇒ 0-20 mA (FEEDBACK 0-20 mA)		[35]	[35]
Feedback, FB_{MIN} - FB_{MAX} ⇒ 4-20 mA (FEEDBACK 4-20 mA)		[36]	[36]
Feedback (pulse sequence), FB_{MIN} - FB_{MAX} ⇒ 0 - 32000 p (FEEDBACK PULSE)		[37]	[37]
Output current, 0 - I_{MAX} ⇒ 0-20 mA (MOTOR CUR. 0- 20 mA)	★	[38]	[38]
Output current, 0 - I_{MAX} ⇒ 4-20 mA (MOTOR CUR. 4- 20 mA)		[39]	[39]
Output current (pulse sequence), 0 - I_{MAX} ⇒ 0 - 32000 p (MOTOR CUR. PULSE)		[40]	[40]
Output power, 0 - P_{NOM} ⇒ 0-20 mA (MOTOR POWER 0-20 mA)		[41]	[41]
Output power, 0 - P_{NOM} ⇒ 4-20 mA (MOTOR POWER 4-20 mA)		[42]	[42]
Output power (pulse sequence), 0 - P_{NOM} ⇒ 0- 32000 p (MOTOR POWER PULSE)		[43]	[43]

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port

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_{LIM}.

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}.*

Programming

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port

Out of feedback range. The feedback signal is outside the range programmed in parameter 227 *Warning: Low feedback, FB_{LOW}* and 228 *Warning: High feedback, FB_{HIGH}*.

Out of reference range. The reference lies outside the range programmed in parameter 225 *Warning: Low reference, Ref_{LOW}* and 226 *Warning, High reference, Ref_{HIGH}*.

Relay 123. This function is only used when a profibus option card is installed.

Mains imbalance. This output is activated at too high mains imbalance or when a phase is missing in the mains supply. Check the mains voltage to the VLT frequency converter.

$0\text{-}f_{MAX} \Rightarrow 0\text{-}20\ mA$ and
$0\text{-}f_{MAX} \Rightarrow 4\text{-}20\ mA$ and
$0\text{-}f_{MAX} \Rightarrow 0\text{-}32000\ p$, which generates an output signal proportional to the output frequency in the interval 0 - f_{MAX} (parameter 202 *Output frequency, high limit, f_{MAX}*).

External Ref_{MIN} - $Ref_{MAX} \Rightarrow 0\text{-}20\ mA$ and
External Ref_{MIN} - $Ref_{MAX} \Rightarrow 4\text{-}20\ mA$ and
External Ref_{MIN} - $Ref_{MAX} \Rightarrow 0\text{-}32000\ p$, which generates an output signal proportional to the resulting reference value in the interval *Minimum reference, Ref_{MIN} - Maximum reference, Ref_{MAX}* (parameters 204/205).

FB_{MIN}-$FB_{MAX} \Rightarrow 0\text{-}20\ mA$ and
FB_{MIN}-$FB_{MAX} \Rightarrow 4\text{-}20\ mA$ and
FB_{MIN}-$FB_{MAX} \Rightarrow 0\text{-}32000\ p$, an output signal proportional to the reference value in the interval *Minimum feedback, FB_{MIN} - Maximum feedback, FB_{MAX}* (parameters 413/414) is obtained.

0 - $I_{VLT,MAX} \Rightarrow 0\text{-}20\ mA$ and
0 - $I_{VLT,MAX} \Rightarrow 4\text{-}20\ mA$ and
0 - $I_{VLT,MAX} \Rightarrow 0\text{-}32000\ p$, an output signal proportional to the output current in the interval 0 - $I_{VLT,MAX}$ is obtained.

0 - $P_{NOM} \Rightarrow 0\text{-}20\ mA$ and
0 - $P_{NOM} \Rightarrow 4\text{-}20\ mA$ and
0 - $P_{NOM} \Rightarrow 0\text{-}32000\ p$, which generates an output signal proportional to the present output power. 20 mA corresponds to the value set in parameter 102 *Motor power, $P_{M,N}$*.

320 Terminal 42, output, pulse scaling (AO 42 PULS SCALE)

Value:

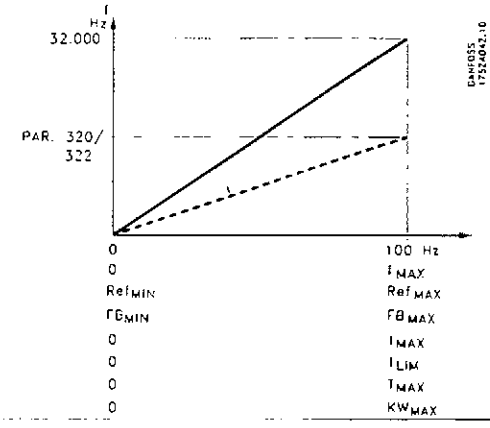
1 - 32000 Hz ★ 5000 Hz

Function:

This parameter allows scaling of the pulse output signal.

Description of choice:

Set the desired value.



321 Terminal 45, output (AO 45 FUNCTION)

Value:

See description of parameter 319 *Terminal 42, Output*.

Function:

This output can function both as a digital or an analogue output. When used as a digital output (data value [0]-[26]) it generates a 24 V (max. 40 mA) signal. For the analogue outputs (data value [27] - [41]) there is a choice of 0-20 mA, 4-20 mA or a pulse sequence.

Description of choice:

See description of parameter 319 *Terminal 42, Output*.

322 Terminal 45, output, pulse scaling (AO 45 PULS SCALE)

Value:

1 - 32000 Hz ★ 5000 Hz

Function:

This parameter allows scaling of the pulse output signal.

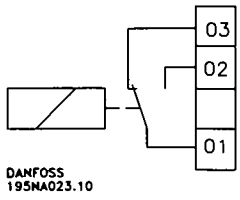
Description of choice:

Set the desired value.

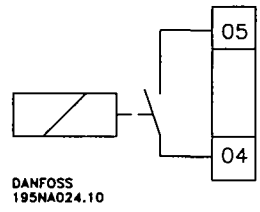
★ = factory setting. () = display text [ ] = value for use in communication via serial communication port

■ Relay outputs

Relay outputs 1 and 2 can be used to give the present status or a warning.



Relay 1
1 - 3 break, 1 - 2 make
Max. 240 V AC, 2 Amp.
The relay is placed with the mains and motor terminals.



Relay 2
4 - 5 make
Max. 50 V AC, 1 A, 60 VA.
Max. 75 V DC, 1 A, 30 W.
The relay is placed on the control card, see *Electrical installation, control cables.*

Relay outputs	Relay no.	1	2
	parameter	323	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 Design Guide.

Programming

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port

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_{MAX}*.
The pulse reference signal can be connected via terminal 17 or 29.

Description of choice:
Set the required maximum pulse reference.

---

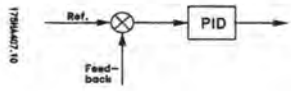
328 Pulse feedback, max. frequency
(PULSE FDBK MAX.)

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 fedback signal is connected via terminal 33.

Description of choice:
Set the desired feedback value.

■ Application functions 400-427



In this parameter group, the special functions of 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.

Programming

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port

■ 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.

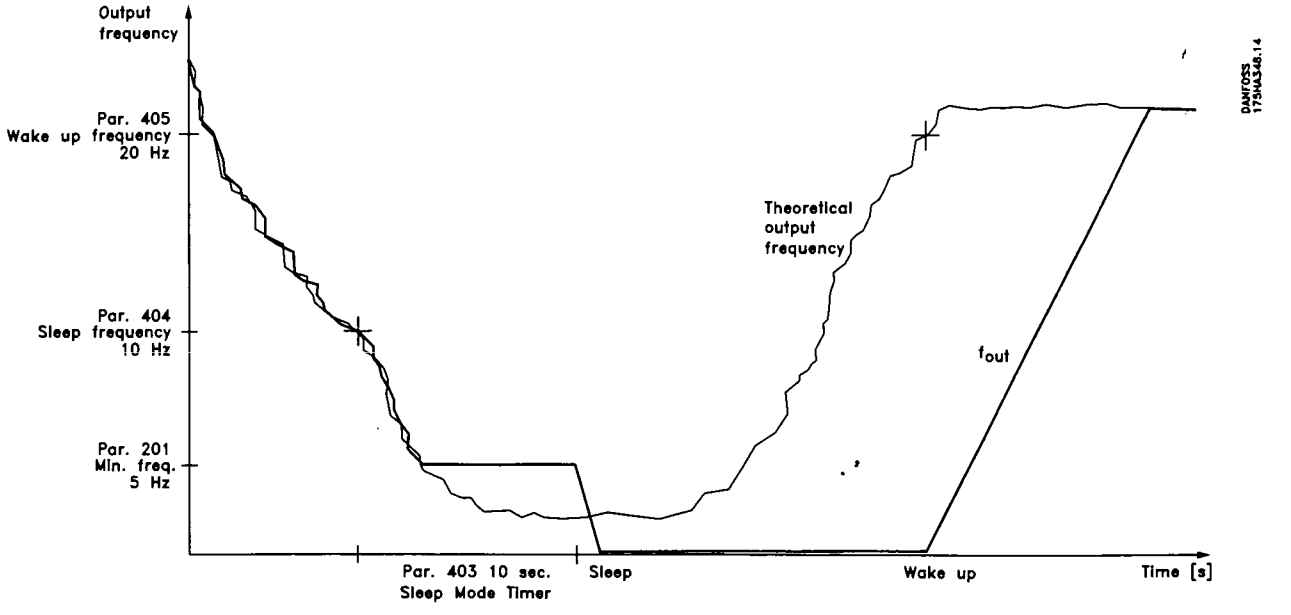
Sleep mode is not active if *Local reference* or *Jog* has been selected
The function is active in both *Open loop* and *Closed loop*.

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).



★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port

403 Sleep mode timer (SLEEP MODE TIMER)

Value:

0 - 300 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*.

Programming

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port

408 Interference reduction method (NOISE REDUCTION)

Value:

★ ASFM (ASFM)	[0]
Fixed switching frequency (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}.

tion at mains failure (MAINS FAILURE)

Value:

★Trip (TRIP)	[0]
Autoderate & warning (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 $I_{VLT,N}$ 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 IP54 drives cannot be powered. In order to avoid overheating, an external power supply can be connected, see Electrical installation.

411 Function at overtemperature (FUNCT. OVERTEMP)

Value:

★Trip (TRIP)	[0]
Autoderate & warning (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.

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port

412 Trip delay overcurrent, I_{LIM} (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_{LIM} (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_{LIM} before it cuts out.

In OFF mode, parameter 412 *Trip delay overcurrent, I_{LIM}* 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]	ft^3/s	[30]
kg/h	[10]	ft^3/min	[31]
m^3/s	[11]	ft^3/h	[32]
m^3/min	[12]	ft/s	[33]
m^3/h	[13]	in wg	[34]
m/s	[14]	ft wg	[35]
mbar	[15]	PSI	[36]
bar	[16]	lb/in^2	[37]
Pa	[17]	HP	[38]
kPa	[18]	°F	[39]
mVS	[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.

Programming

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port

■ 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.

Feedback type	Terminal	Parameters
Pulse	33	307
Voltage	53, 54	308, 309, 310
or		
		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.

Reference type	Terminal	Parameters
Pulse	17 or 29	301 or 305
Voltage	53 or 54	308, 309, 310 or
		311, 312, 313
Current	60	314, 315, 316
Preset reference		211, 212, 213, 214
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

■ 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 x π) = 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.

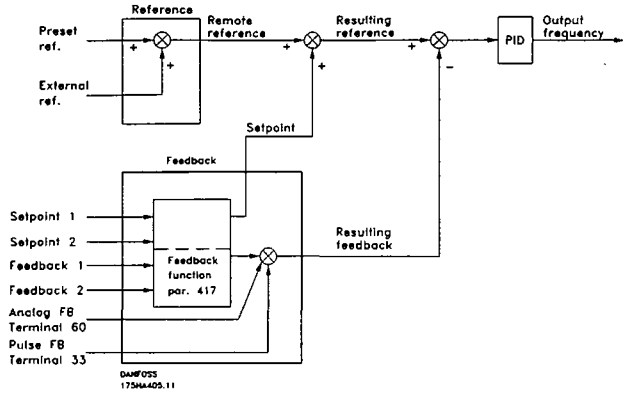
1. Start the motor.
2. Set parameter 423 *PID proportional gain* to 0.3 and increase it until the process shows that the feedback signal is unstable. Then reduce the value until the feedback signal has stabilised. Now lower the proportional gain by 40-60%.
3. Set parameter 424 *PID integration time* 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.

Programming

■ 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.

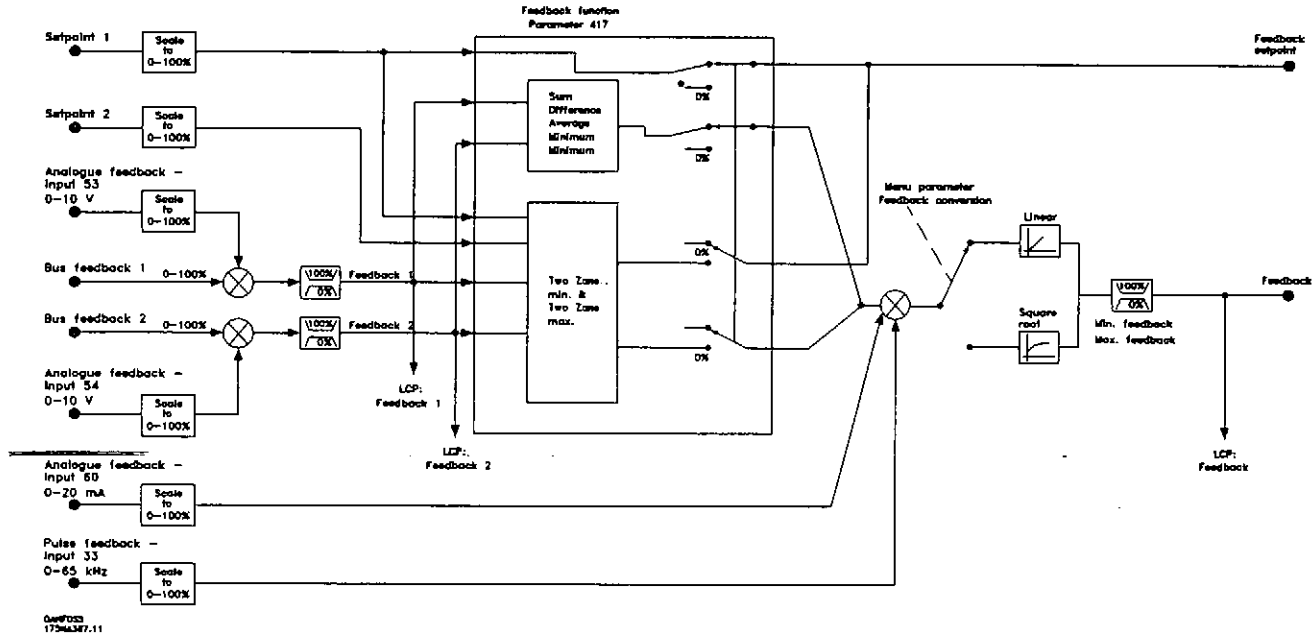
1 setpoint and 2 feedbacks

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.

Feedback handling, cont.

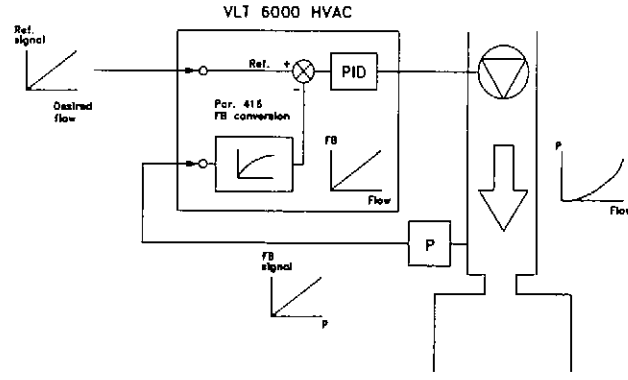


416 Feedback conversion (FEEDBACK CONV.)

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 x √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.

Programming

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port

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_{MIN} - Ref_{MAX}	★ 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*.

419 Setpoint 2 (SETPOINT 2)

Value:

Ref_{MIN} - Ref_{MAX} ★ 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_{MIN}-f_{MAX} (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.

Programming

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port

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 may be too short, which means that the process may be destabilised as a result of overswings.

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 overswings.

---

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.

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port

427 PID lowpass filter time (PID FILTER TIME)

Value:

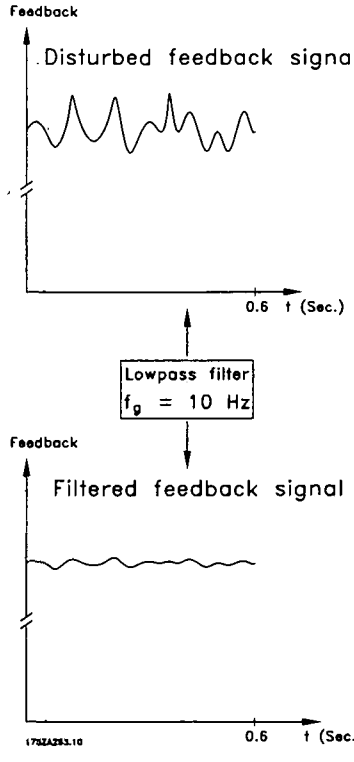
0.01 - 10.00 ★ 0.01

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 (τ). If a time constant (τ) of 0.1 s is programmed, the break frequency for the lowpass filter will be 1/0.1 = 10 RAD/sec., corresponding to (10/(2 x π)) = 1.6 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

■ 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

Value:

Parameter no.	Description Operating data:	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.

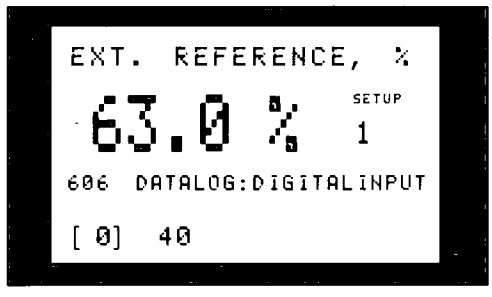
606 - 614 Data log

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.

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 work 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.

Programming

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port

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.

620 Operating mode (OPERATION MODE)

Value:

★ Normal function (NORMAL OPERATION) [0]
Function with de-activated inverter (OPER. W/INVERT.DISAB) [1]
Control card test (CONTROL CARD TEST) [2]
Initialisation (INITIALIZE) [3]

Function:

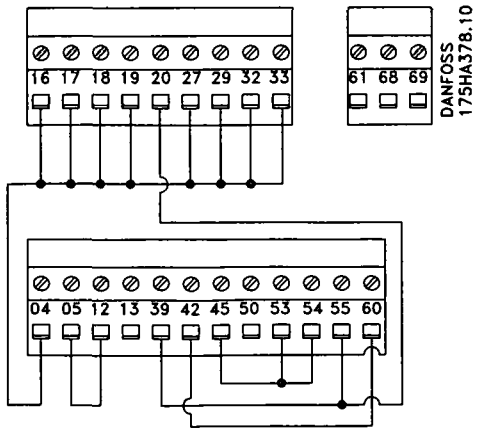
In addition to its normal function, this parameter can be used for two different tests.
Furthermore, it is possible to reset to the default factory settings for all Setups, except parameters 500 *Address*, 501 *Baud rate*, 600-605 *Operating data* and 615-617 *Fault log*.

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*.)

Programming

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port

621 - 631 Nameplate

Value:

Parameter nr.	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

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.

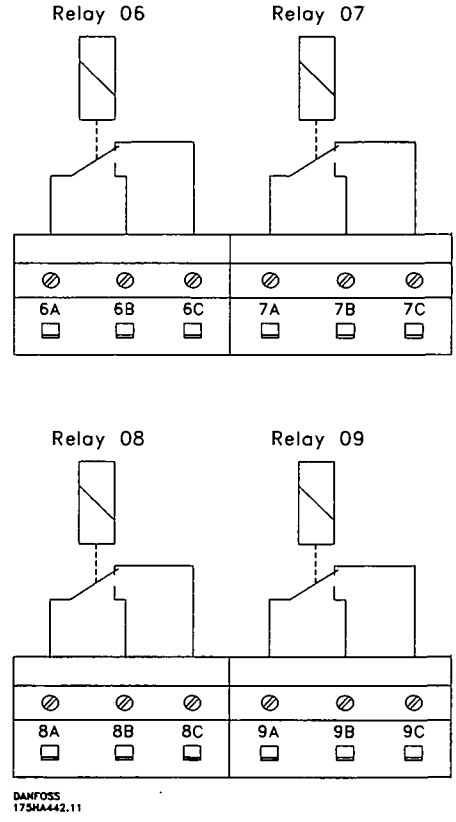
Function:
This parameter is used to delay the cut-out time of relays 6/7/8/9 (terminals 1-2).

Description of choice:
Enter the required value.

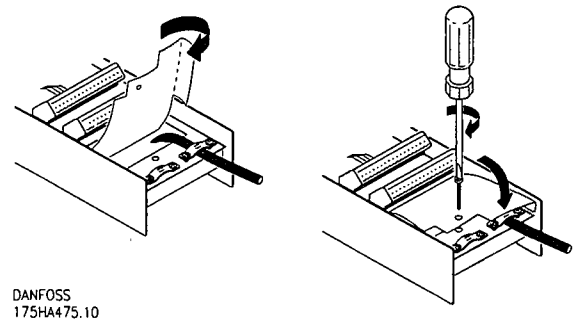
■ Electrical installation of the relay card

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: 1.5mm² (AWG 28-16).
Torque: 0.22 - 0.25 Nm.
Screw size: M2.



To achieve double isolation, the plastic foil must be mounted as shown in the drawing below.



Programming

★ = factory setting. ( ) = display text [ ] = value for use in communication via serial communication port

■ 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 i 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.

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 ben 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]-buttom 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 communi-cation.

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.

■ 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

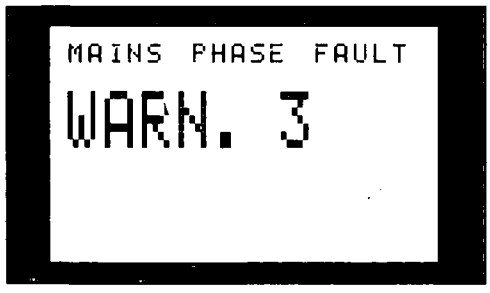
In addition, an automatic reset may be selected in parameter 400 *Reset function*.

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

■ 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 [VDC]	3 x 380 - 460 V [VDC]
Undervoltage	211	402
Voltage warning low	222	423
Voltage warning high	384	737
Overvoltage	425	765

The voltages stated are the intermediate circuit voltage of the VLT frequency converter with a tolerance of ± 5 %. The corresponding mains voltage is the intermediate circuit voltage divided by 1,35.

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 projection* 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_{LIM} and the VLT frequency converter trips after the time set in parameter 412 *Trip delay overcurrent,* I_{LIM} 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 ± 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*.

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.

NOTE:
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.

Warnings and alarms, cont.

ALARM 29
Heat sink temperature too high
(HEAT SINK OVER TEMP.):
If the enclosure is IP 00 or IP 20, 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 ± 5°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 in 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}.

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.

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:

$$\text{Ext. ref.} = \frac{(\text{Par. 205 } \textit{Max. ref.} - \text{Par. 204 } \textit{Min. ref.}) \times \text{Ana. signal } \textit{Term. 53} \text{ [V]}}{\text{Par.310 } \textit{Term. 53 Max scaling} - \text{Par.309 } \textit{Term. 53 Min. scaling}} + \frac{(\text{Par. 205 } \textit{Max. ref.} - \text{Par. 204 } \textit{Min. ref.}) \times \text{Ana. signal } \textit{Term. 54} \text{ [V]}}{\text{Par.313 } \textit{Term. 54 Max scaling} - \text{Par.312 } \textit{Term. 54 Min scaling}} +$$
$$\frac{(\text{Par. 205 } \textit{Max. ref.} - \text{Par. 204 } \textit{Min. ref.}) \times \text{Par. 314 } \textit{Term. 60} \text{ [mA]}}{\text{Par.316 } \textit{Term. 60 Max scaling} - \text{Par.315 } \textit{Term. 60 Min scaling}} + \frac{\text{serial com. reference} \times (\text{Par. 205 } \textit{Max. ref.} - \text{Par. 204 } \textit{Min. ref.})}{16384 \text{ (4000 Hex)}}$$

Par. 210 *Reference type* is programmed = *Sum* [0].

$$\text{Res. ref.} = \frac{(\text{Par. 205 } \textit{Max. ref.} - \text{Par. 204 } \textit{Min. ref.}) \times \text{Par. 211-214 } \textit{Preset ref.}}{100} + \text{External ref.} + \text{Par. 204 } \textit{Min. ref.} + \text{Par. 418/419 Setpoint (only in closed loop)}$$

Par. 210 *Reference type* is programmed = *Relative* [1].

$$\text{Res. ref.} = \frac{\text{External reference} \times \text{Par. 211-214 } \textit{Preset ref.}}{100} + \text{Par. 204 } \textit{Min. ref.} + \text{Par. 418/419 Setpoint (only in closed loop)}$$

■ 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 creapage/clearance distances. These requirements are described in the EN 50178 standard.

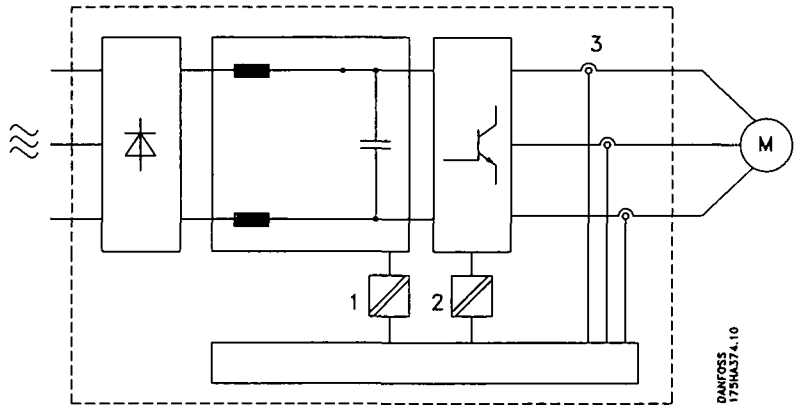
For additional information on PELV see *RFI switching*.

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 IGTBs (trigger transformers/opto-couplers).
3. Current transducers (Hall effect current transducers).

Galvanic isolation



■ 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

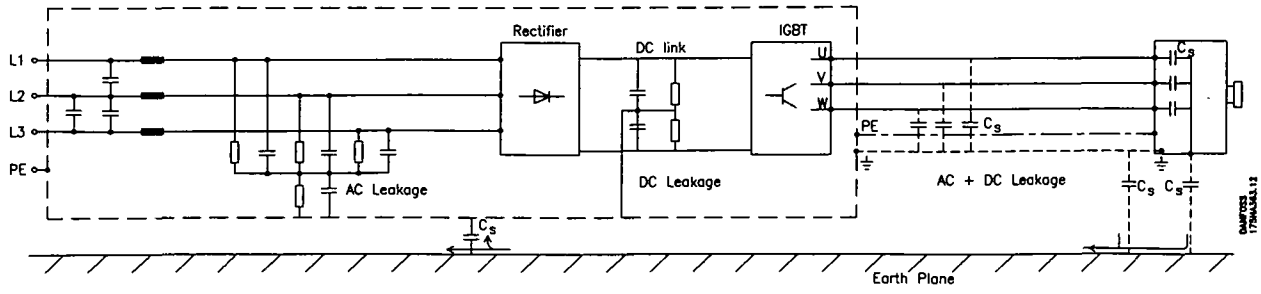
The leakage current is of importance to safety during handling/operation of the frequency converter if (by mistake) the frequency converter has not been earthed.

NOTE:

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)



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 5-10 ms 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 100 ms 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_{LIM} 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_{LIM}.

■ 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 overshot 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 metres), 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 µsec.	850 V
50 metres	460 V	0.4 µsec.	950 V
150 metres	380 V	1.2 µsec.	1000 V
150 metres	460 V	1.3 µsec.	1300 V

VLT 6008-6027 200 V, VLT 6016-6062 400 V

Cable length	Mains voltage	Rise time	Peak voltage
50 metres	380 V	0.1 µsec.	900 V
150 metres	380 V	0.2 µsec.	1000 V

VLT6075-6275 380-460V, 6042-6062 200-240V

Cable length	Mains voltage	Rise time	Peak voltage
13 metres	460 V	670 V/µsec.	815 V
20 metres	460 V	620 V/µsec.	915 V

VLT6350-6550 380-460V

Cable length	Mains voltage	Rise time	Peak voltage
20 metres	460 V	415 V/µsec.	760 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 distanceof 1 m from the unit at full load:

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

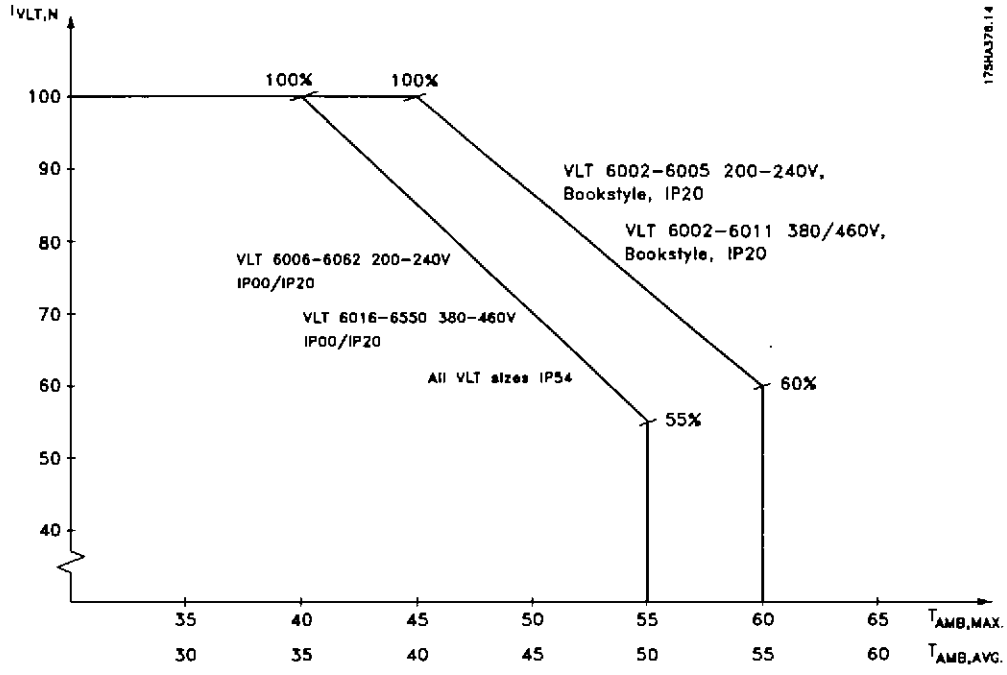
IP 00/20 units:	70 dB(A)
IP 54 units:	65 dB(A)

VLT 6075-6275 380-460 V

IP 00/20 units:	70 dB(A)
IP 54 units:	75 dB(A)

■ 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.

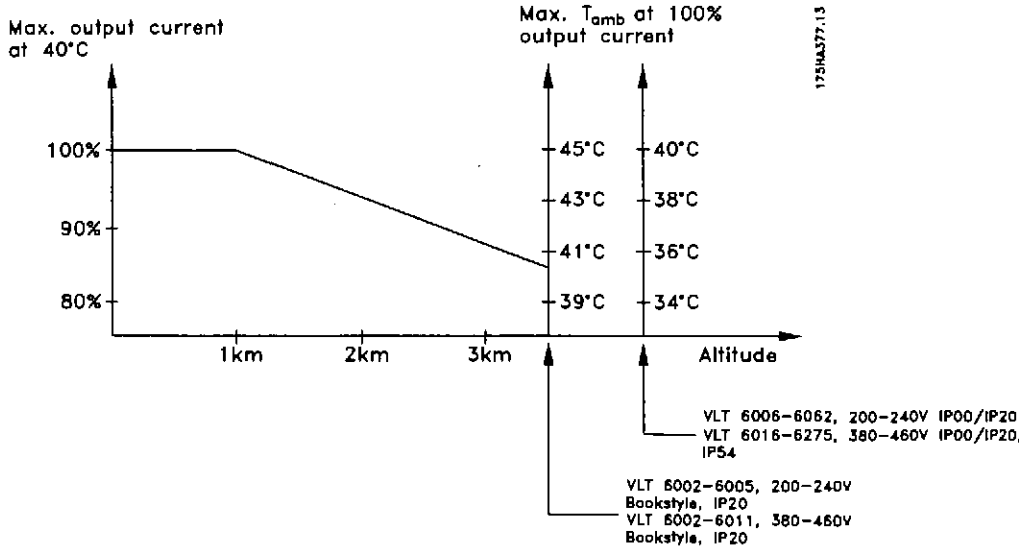


■ Derating for air pressure

Below 1000 m altitude no derating is necessary.

Above 1000 m the ambient temperature (T_{AMS}) 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} = max. 45°C
2) Derating of max. T_{AMB} versus altitude at 100% output current.



■ 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 characterstic 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 $I_{VLT,N}$, when the switching frequency exceeds 4.5 kHz.

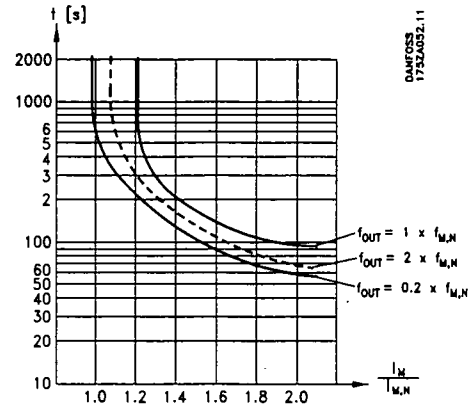
In both cases, the reduction is carried out linearly, down to 60% of $I_{VLT,N}$.

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 6016-6062, 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

■ 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 - general requirements
IEC 68-2-35:	Random vibration broad-band - high reproducibility
IEC 68-2-36:	Random vibration broad-band - medium reproducibility

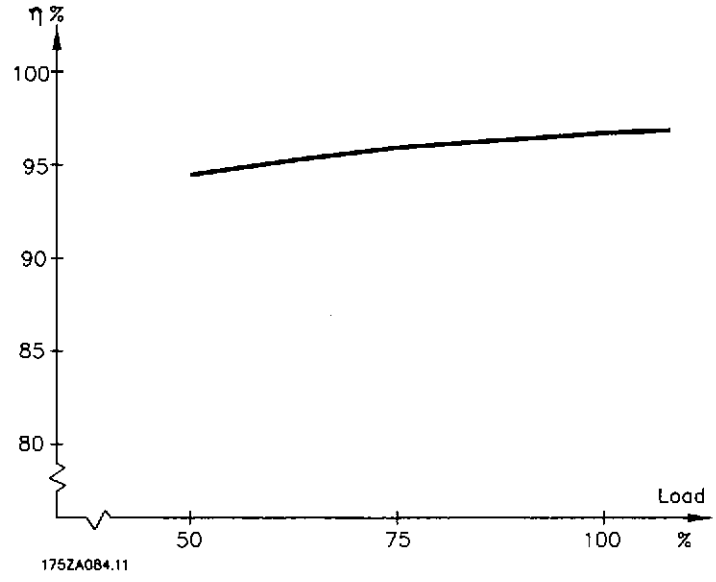
VLT 6000 HVAC complies with requirements that correspond to conditions when the unit is mounted on the walls and floors of production premises, as well as in panels bolted to walls or floors.

■ 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.*

■ 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 (η_{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 (η_{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 (η_{SYSTEM})

To calculate the system efficiency, the efficiency of VLT 6000 HVAC (η_{VLT}) is multiplied by the efficiency of the motor (η_{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.

■ 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.

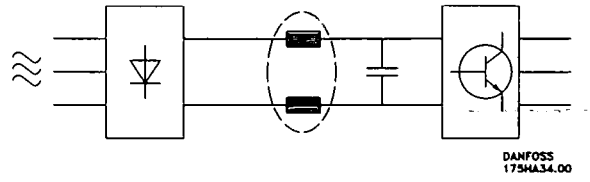
Harmonic currents compared to the RMS input current:

	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 1000-3-4
- 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:

$$THD\% = \sqrt{U_5^2 + U_7^2 + \cdots U_N^2} \qquad (U_N\% \text{ of } U)$$

■ 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.

$$I_{RMS} = \sqrt{I_1^2 + I_5^2 + I_7^2 + \ldots + I_n^2}$$

■ 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 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 55014
Setup	Motor cable	Conducted 150 kHz-30 MHz	Radiated 30 MHz-1 GHz	Conducted 150 kHz-30 MHz	Radiated 30 MHz-1 GHz	Conducted 150 kHz-230 MHz
VLT 6000 with RFI filter option	300 m unscreened/ unarmoured	Yes [1]	No	No	No	No
	50 m br. screened/ armoured (Bookstyle 20m)	Yes	Yes	Yes	No	No
	150m br. screened/ armoured	Yes	Yes	No	No	No
VLT 6000 with integrated RFI-filter (+ LC-module)	300 m unscreened/ unarmoured	Yes	No	No	No	No
	50 m br. screened/ armoured	Yes	Yes	Yes	No	No
	150m br. screened/ armoured	Yes	Yes	No	No	No

1) Depending on installation conditions

VLT 6016-6550/380-460 V 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 150 kHz-30 MHz	Radiated 30 MHz-1 GHz	Conducted 150 kHz-30 MHz	Radiated 30 MHz-1 GHz
VLT 6000 w/o RFI filter option	300 unscreened/ unarmoured	No	No	No	No
	150 m br. screened/ armoured	No	Yes	No	No
VLT 6000 with RFI-module (integrated)	300 m unscreened/ unarmoured	Yes [1,2]	No	No	No
	50 m br. screened/ armoured	Yes	Yes	Yes	No
	150 m br. screened/ armoured	Yes	Yes	No	No

1) Does not apply to VLT 6350 - 6550.
2) Depending on installation conditions

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.

■ 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.

■ Immunity, continued

VLT 6002-6550 380-460 V, VLT 6002-6027 200-240 V

Basic standard	Burst IEC 1000-4-4	Surge IEC 1000-4-5		ESD 1000-4-2	Radiated electro-magnetic field IEC 1000-4-3	Mains distortion VDE 0160	RF common mode voltage ENV 50141	Radiated radio freq.elect.field 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	-
Basic specifications								
Line	4 kV/5kHz/DCN	2 kV/2Ω	4 kV/12Ω	-	-	2.3 x U_N [2]	10 V_{RMS}	-
Motor	4 kV/5kHz/CCC	-	-	-	-	-	10 V_{RMS}	-
Control lines	2 kV/5kHz/CCC	-	2 kV/2Ω [1]	-	-	-	10 V_{RMS}	-
PROFIBUS option	2 kV/5kHz/CCC	-	2 kV/2Ω [1]	-	-	-	10 V_{RMS}	-
Signal interface<3 m	1 kV/5kHz/CCC	-	-	-	-	-	10 V_{RMS}	-
Enclosure	-	-	-	8 kV AD 6 kV CD	10 V/m	-	-	-
Load sharing	4 kV/5kHz/CCC	-	-	-	-	-	10 V_{RMS}	-
Standard bus	2 kV/5kHz/CCC	-	4 kV/2Ω [1]	-	-	-	10 V_{RMS}	-

DM: Differential mode
CM: Common mode
CCC: Capacitive clamp coupling
DCN: Direct coupling network
[1] Injection on cable shield
[2] 2.3 x U_N: max. test pulse 380 V_{AC}: Class 2/1250 V_{PEAK}, 415 V_{AC}: Class 1/1350 V_{PEAK}

■ 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.

$I_{VLT,MAX}$
The maximum output current.

$I_{VLT,N}$
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.

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).

η_{VLT}
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 overtemperature. 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).

$U_{VLT, MAX}$
The maximum output voltage.

VT characteristics:
Variable torque characteristics, used for pumps and fans.

■ 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 - 500 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 - $I_{VLT,MAX}$	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 brake-away torque	0.0 sec.	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	No protection		Yes	Yes	0	5

■ 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 x $I_{VLT,N}$ [A]	0.1-1.1 x $I_{VLT,N}$ [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}	$I_{VLT,MAX}$	Par. 221 - $I_{VLT,MAX}$	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

Changes during operation:

"Yes" means that the parameter can be changed, while the VLT frequency converter is in operation. "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:

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 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

■ 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} ⇒ 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 - f_{MAX} ⇒ 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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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 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

■ 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 mais failure	Trip		Yes	Yes	0	5
411	Function at overtemperature	Trip		Yes	Yes	0	5
412	Trip delay overcurrent, I_{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	Minimum		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 start-up frequency	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

■ 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	-1	No
523	Data read-out: Terminal 54, analogue input				No	-1	No
524	Data read-out: Terminal 60, analogue input				No	4	No
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
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

■ 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	2	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.

Data type	Description
3	Integer 16
4	Integer 32
5	Unsigned 8
6	Unsigned 16
7	Unsigned 32
9	Text string


1956700000005010

1956700000005010

VLT® 6000

Operating Instructions

Danfoss can accept no responsibility for possible errors in catalogues, brochures and other printed material.
Danfoss reserves the right to alter its products without notice. This applies to products already on order provided that such alterations can be made without subsequential changes being necessary in specifications already agreed.

Danfoss

175R0106 MG60A302

MG60A302

240V AC
AUX. SUPPLY FROM
DISTRIBUTION BOARD
CIRCUIT BREAKER
REF DWG:-
486/S/7-HG001

REF DWG:-
486/S/7-HG001

E N R W B

TL1
TEST
LINKS

CT1
5A

2A 2A 2A

IF1

(NOTE 2)

250A

C13

DANFOSS VLT6100
V.F. DRIVE No 1

91 L1
92 L2
93 L3
94
U 96
V 97
W 98
99

(NOTE 1)

MAIN PUMP No.1
63kW
FLC=115A

RP14-1 136 THR1-1 135

RP13-1 138

139

6A (37) (NOTE 6)

SMC
REMOTE LOCAL 140

REF DWG:-
486/S/7-HG004
LINE No 13

CABLE C18
(10 CORE)

18 RUN/STOP
27
16 RESET
12 COMMON
32 SELECT SET UP 2

CABLE C12

50 3W PR+
53 3Bk PR-

MANUAL SPEED CONTROL
1K POTENTIOMETER

652

60 2W 651 VFD 1 SPEED CONTROL CHANNEL 0
55 2Bk 652
45 1W 642 VFD 1 RUNNING SPEED CHANNEL 11
39 1Bk 641
5Bk 641 VFD 1 MOTOR AMPS CHANNEL 8
42 5W 153 A 152

0-115A ANALOG AMMETER (4-20mA)

REF DWG:-
486/S/7-HG005

VFD1W-1
9A
98

RELAY 06
VFD1A-1
6A
6B

RELAY 07
VFD1R-1
7A
7B

RELAY 08
VFD1R-2
8A
8B

68
69
61

RS485 CONNECTOR
MOUNTED IN THE
MAIN SWITCHBOARD

V.F.D. 2
RS485 TERM'LS
REF DWG:-
486/S/7-HG003

10 121+ V.F. DRIVE WARNING REF DIM2 R.T.U. INPUT CHANNEL 11

9 120+ V.F. DRIVE IN AUTO REF DIM2 R.T.U. INPUT CHANNEL 10

7 118- V.F. DRIVE RUNNING
8 118+ REF DIM2 R.T.U. INPUT CHANNEL 8

CABLE C18

N1

MAIN PUMP No.1

126 (38) HOURS RUN

125 R 1 READY 2 W 141 RL11 (42)

V.F. DRIVE No 1
READY RELAY

CABLE C14

PUMP No 1 - DANFOSS VLT6100
VARIABLE FREQUENCY DRIVE CABINET

MI01

MOISTURE IN OIL RELAY
(ZIEHL NSIF)

CABLE C21 135 136
103 3 4 104
PROBES

125 THR1 (39)
133

THERMISTOR RELAY
(AUTO RESET)

TO DIM2 CHANNEL 4
REFER RTU INPUT MODULE
114+
114-

CABLE C21 MOTOR THERMISTOR CABLE C21 134
101 1 2 102

125 129 ON OFF 130 RP12-1 132 C13 (07)

LINE CONTACTOR

EMERGENCY STOP

(NOTE 5)

CABLE C10
2 CORE

PR1 (41)

CONTROL CIRCUIT
POWER ON

REFERENCE LINE 30

RTU INPUTS MODULE (DIM2)

24N1 R.T.U. 24V DC (REF 486/S/7-HG010) DIM2+

2 CORE CABLE C8 (NOTE 4)

110- 110+ 0 REFLUX MICRO SWITCH CHANNEL 0
111- PR1-1 111+ 1 POWER ON CHANNEL 1
112- MI01-1 112+ 2 MOISTURE IN OIL CHANNEL 2
113- (47) 113+ 3 LOCAL START CHANNEL 3
114- (48) 114+ 4 EMERGENCY STOP CHANNEL 4
115- THR1-2 115+ 5 THERMISTOR TRIP CHANNEL 5
116- RL11-1 116+ 6 V.F.D. No 1 READY CHANNEL 6
117- (49) 117+ 7 LOCAL RESET CHANNEL 7
7 118- VFD1R-1 8 118+ 8 VFD No 1 RUNNING CHANNEL 8
7A 7B
119- C13-2 119+ 9 CONTACTOR CLOSE CHANNEL 9
VFD1A-1 120+ 10 VFD No 1 AUTO SEL'D CHANNEL 10
6A 6B
9 10 VFD1W-1 121+ 11 V.F.D. No 1 WARNING CHANNEL 11
9A 9B

SPARES
122+ 12 SPARE CHANNEL 12
123+ 13 SPARE CHANNEL 13
124+ 14 SPARE CHANNEL 14
125+ 15 SPARE CHANNEL 15

RTU OUTPUTS MODULE (DOM1)

DOM1+ R.T.U. 24V DC (REF 486/S/7-HG010) DOM1-

(NOTE 4)

SITE ALARM ATTENTION INDRS CHANNEL 0 0
CONNECT REF. ELECTRODES CHANNEL 1 1
CATHODIC PROTECTION DE-ENERG. RECTIFIER CHANNEL 2 2
CLOSE LINE CONT'R CHANNEL 3 3
PUMP STATUS CHANNEL 4 4
RUN/STOP VFD No 1 CHANNEL 5 5
VFD 1 FAULT RESET CHANNEL 6 6
CATHODIC PROTECTION ALARM INDICATOR CHANNEL 7 7

606+ (59) A 606-
W (60)

123+ (44) RP12 123- 123-
(46) 122+ R 122-
140+ (40) RP14 140- 140-
124+ (45) RP13 124-

SPARE CHANNEL 8 8
SPARE CHANNEL 9 9
SPARE CHANNEL 10 10
SPARE CHANNEL 11 11
SPARE CHANNEL 12 12
SPARE CHANNEL 13 13
SPARE CHANNEL 14 14
SPARE CHANNEL 15 15

SPARES

LEGEND:

- RELAY OR CONTACTOR COIL
- FIELD DEVICE
- R.T.U. FUSE TERMINAL
- R.T.U. LINK TERMINAL
- SWITCHBOARD TERMINAL
- CATHODIC PROTECTION TERMINAL
- FUNCTION / ADDRESS — RTU DIGITAL INPUT
- FUNCTION / ADDRESS — RTU DIGITAL OUTPUT
- FUNCTION / ADDRESS — RTU ANALOG INPUT
- FUNCTION / ADDRESS — RTU ANALOG OUTPUT
- 00 — EQUIPMENT ITEM No.
- 6 — CABLE CORE NUMBER

NOTES:

1. MAIN PUMP DECONTACTORS ARE LOCATED IN UPPER SECTION OF PUMP WELL.
2. CIRCUIT BREAKERS RATINGS TO SUIT LOAD & ENSURE TYPE 2 COORDINATION WITH CONTACTORS & OVERLOADS TO IEC 947-4-1.
3. ALL WIRES & CABLE CORES ARE FERRULED WITH GRAFOPLAST COMPATIBLE LABELLING.
   THE FOLLOWING PREFIXES ARE USED:
   MAIN PUMP No. 1 = 1
   MAIN PUMP No. 2 = 2
   MAIN PUMP No. 3 = 3
   SUMP PUMP = 5
   COMMON WIRING = 6 (i.e. FLOW, LEVEL, PRESSURE)
   OXYGEN PUMP No. 1 = 7
   OXYGEN PUMP No. 2 = 8
4. 24V DC INPUT/OUTPUT INDIVIDUAL PROTECTION FUSES NOT SHOWN. (i.e. PART OF INTERFACE TERMINAL STRIP)
5. ON / OFF ISOLATOR SWITCHES LOCATED ADJACENT TO MOTORS IN PUMP WELL.
6. PUMP CONTROL CIRCUIT BREAKERS RATED AT 9KA FOR 1 SEC.
7. THE VARIABLE FREQUENCY SPEED CONTROLLERS SHALL BE LOCATED EXTERNALLY TO THE SWITCHBOARD IN WALL MOUNTED CABINETS IN THE UPPER SECTION OF THE PUMP WELL.
8. THIS DRAWING HAS BEEN PRODUCED FROM DRAWING No:- E94-BM6000/A0 & A2 REVISION E.
9. ALL ITEMS IN THE AREAS DELINEATED BY THE REVISION CLOUDS ARE NEW REVISIONS.

AS CONSTRUCTED
PLOTTED ____ DATE ____
CHECKED B. [illegible] DATE 2/6/04

NO.	DATE	AMENDMENT	INITIALS
B	2-3-04	CONTROLS REVISED	CI
A	4/99	AS CONSTRUCTED ISSUE	--
0	11/98	ORIGINAL ISSUE	RFM

DIRECTOR OF P.D. & P.S. — DATE
ENGINEER IN CHARGE — R. BOWRING — 21/12/99 — DATE
SUPERVISING ENGINEER — NOTE 8 — R.P.E.Q. NO. — DATE

	NAME	DATE
DESIGN	NOTE 8 R.F.	3-12-99
DRAWN	NOTE 8	3-12-99
CHECKED		

Brisbane City

JOB FILE
ACAD FILE S7HG002-RevB SHEET SIZE A1
SURVEY No. FIELD BOOK
SURVEYED A.H. DATUM

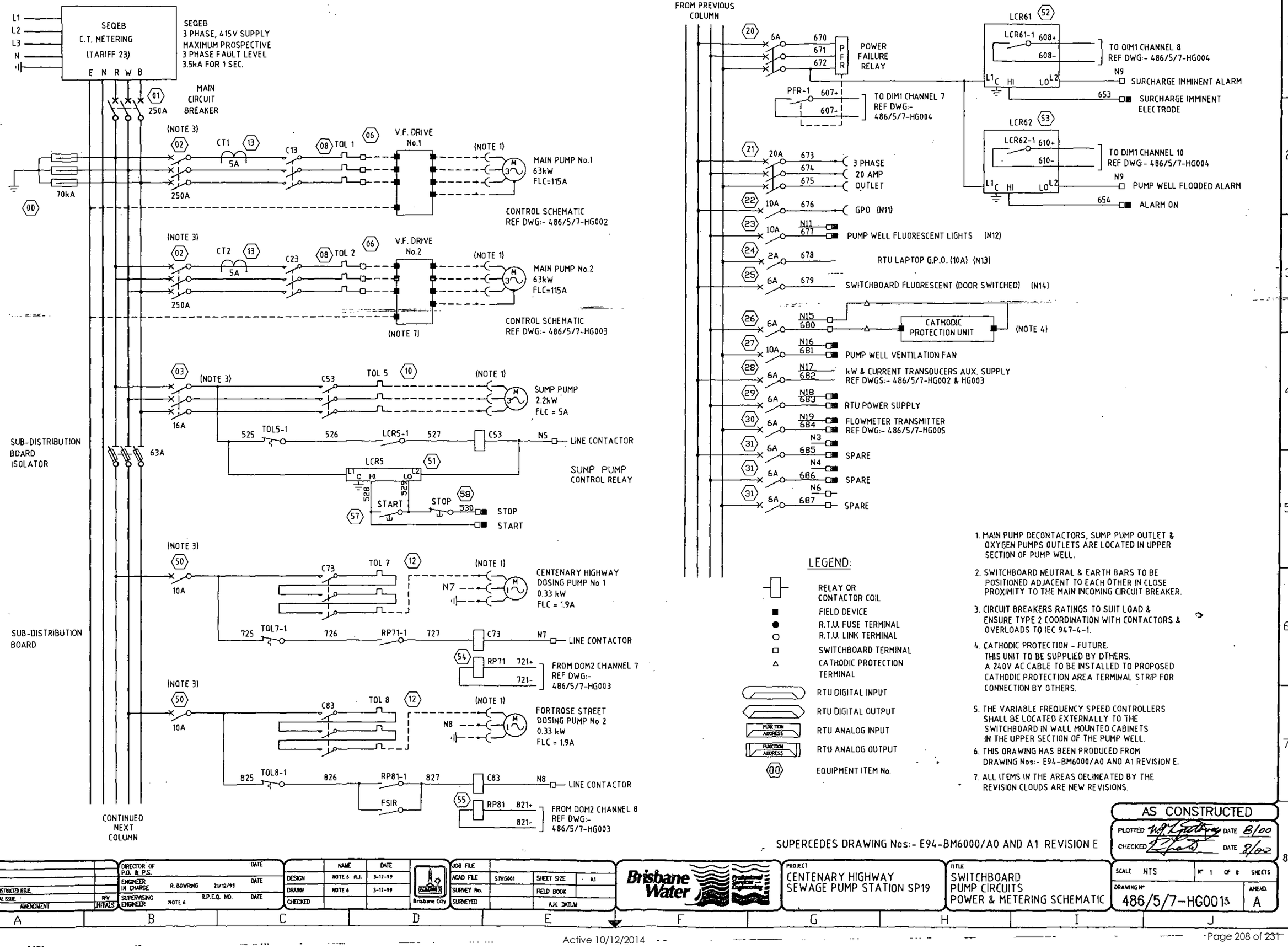
Brisbane Water

PROJECT
CENTENARY HIGHWAY
SEWAGE PUMP STATION SP19

TITLE
SEWAGE PUMP No 1
POWER & CONTROL
SCHEMATIC DIAGRAM

SCALE NTS — N° 2 OF 8 SHEETS
DRAWING N° 486/S/7-HG002 — AMEND. B

Q:\PSEDRAWINGS\SEWERAGE\INFRASTR\Centenary Hwy Sp19\S7HG002-RevB.dwg, 01/06/2004 02:[illegible] PM


SEQEB
C.T. METERING
(TARIFF 23)
E N R W B
L1
L2
L3
N
SEQEB
3 PHASE, 415V SUPPLY
MAXIMUM PROSPECTIVE
3 PHASE FAULT LEVEL
3.5kA FOR 1 SEC.
01
250A
MAIN
CIRCUIT
BREAKER
70kA
00
(NOTE 3)
02
CT1
13
5A
C13
08
TOL 1
06
V.F. DRIVE
No.1
(NOTE 1)
250A
MAIN PUMP No.1
63kW
FLC=115A
CONTROL SCHEMATIC
REF DWG:- 486/5/7-HG002
CT2
C23
TOL 2
V.F. DRIVE
No.2
(NOTE 7)
MAIN PUMP No.2
63kW
FLC=115A
CONTROL SCHEMATIC
REF DWG:- 486/5/7-HG003
03
16A
C53
TOL 5
10
SUMP PUMP
2.2kW
FLC = 5A
SUB-DISTRIBUTION
BOARD
ISOLATOR
63A
525
TOL5-1
526
LCR5-1
527
CS3
N5
LINE CONTACTOR
LCR5
51
L1
C
HI
LO
L2
528
529
START
57
STOP
58
530
STOP
START
SUMP PUMP
CONTROL RELAY
50
10A
C73
TOL 7
12
N7
CENTENARY HIGHWAY
DOSING PUMP No 1
0.33 kW
FLC = 1.9A
SUB-DISTRIBUTION
BOARD
725
TOL7-1
726
RP71-1
727
C73
N7
LINE CONTACTOR
54
RP71
721+
721-
FROM DOM2 CHANNEL 7
REF DWG:-
486/5/7-HG003
C83
TOL 8
N8
FORTROSE STREET
DOSING PUMP No 2
0.33 kW
FLC = 1.9A
825
TOL8-1
826
RP81-1
827
C83
N8
LINE CONTACTOR
FSIR
55
RP81
821+
821-
FROM DOM2 CHANNEL 8
REF DWG:-
486/5/7-HG003
CONTINUED
NEXT
COLUMN
CONTINUED
FROM PREVIOUS
COLUMN
20
6A
670
671
672
PFR
POWER
FAILURE
RELAY
PFR-1
607+
607-
TO DIM1 CHANNEL 7
REF DWG:-
486/5/7-HG004
LCR61
52
LCR61-1
608+
608-
TO DIM1 CHANNEL 8
REF DWG:- 486/5/7-HG004
N9
SURCHARGE IMMINENT ALARM
653
SURCHARGE IMMINENT
ELECTRODE
LCR62
53
LCR62-1
610+
610-
TO DIM1 CHANNEL 10
REF DWG:- 486/5/7-HG004
N9
PUMP WELL FLOODED ALARM
654
ALARM ON
21
20A
673
674
675
3 PHASE
20 AMP
OUTLET
22
10A
676
GPO (N11)
23
10A
N11
677
PUMP WELL FLUORESCENT LIGHTS (N12)
24
2A
678
RTU LAPTOP G.P.O. (10A) (N13)
25
6A
679
SWITCHBOARD FLUORESCENT (DOOR SWITCHED) (N14)
26
6A
N15
680
CATHODIC
PROTECTION
UNIT
(NOTE 4)
27
10A
N16
681
PUMP WELL VENTILATION FAN
28
6A
N17
682
kW & CURRENT TRANSDUCERS AUX. SUPPLY
REF DWGS:- 486/5/7-HG002 & HG003
29
6A
N18
683
RTU POWER SUPPLY
30
6A
N19
684
FLOWMETER TRANSMITTER
REF DWG:- 486/5/7-HG005
31
6A
N3
685
SPARE
31
6A
N4
686
SPARE
31
6A
N6
687
SPARE
LEGEND:
RELAY OR
CONTACTOR COIL
FIELD DEVICE
R.T.U. FUSE TERMINAL
R.T.U. LINK TERMINAL
SWITCHBOARD TERMINAL
CATHODIC PROTECTION
TERMINAL
RTU DIGITAL INPUT
RTU DIGITAL OUTPUT
FUNCTION
ADDRESS
RTU ANALOG INPUT
FUNCTION
ADDRESS
RTU ANALOG OUTPUT
00
EQUIPMENT ITEM No.
1. MAIN PUMP DECONTACTORS, SUMP PUMP OUTLET & OXYGEN PUMPS OUTLETS ARE LOCATED IN UPPER SECTION OF PUMP WELL.
2. SWITCHBOARD NEUTRAL & EARTH BARS TO BE POSITIONED ADJACENT TO EACH OTHER IN CLOSE PROXIMITY TO THE MAIN INCOMING CIRCUIT BREAKER.
3. CIRCUIT BREAKERS RATINGS TO SUIT LOAD & ENSURE TYPE 2 COORDINATION WITH CONTACTORS & OVERLOADS TO IEC 947-4-1.
4. CATHODIC PROTECTION - FUTURE.
THIS UNIT TO BE SUPPLIED BY OTHERS.
A 240V AC CABLE TO BE INSTALLED TO PROPOSED CATHODIC PROTECTION AREA TERMINAL STRIP FOR CONNECTION BY OTHERS.
5. THE VARIABLE FREQUENCY SPEED CONTROLLERS SHALL BE LOCATED EXTERNALLY TO THE SWITCHBOARD IN WALL MOUNTED CABINETS IN THE UPPER SECTION OF THE PUMP WELL.
6. THIS DRAWING HAS BEEN PRODUCED FROM DRAWING Nos:- E94-BM6000/A0 AND A1 REVISION E.
7. ALL ITEMS IN THE AREAS DELINEATED BY THE REVISION CLOUDS ARE NEW REVISIONS.
AS CONSTRUCTED
PLOTTED M.P. Gutteridge DATE 8/00
CHECKED R. Ford DATE 8/02
SUPERCEDES DRAWING Nos:- E94-BM6000/A0 AND A1 REVISION E
NO. DATE AMENDMENT INITIALS
A 8/00 AS CONSTRUCTED ISSUE
B 6/99 ORIGINAL ISSUE
DIRECTOR OF P.O. & P.S. DATE
ENGINEER IN CHARGE R. BOWRING 21/12/99 DATE
SUPERVISING ENGINEER NOTE 6 R.P.E.Q. NO. DATE
DESIGN NOTE 6 R.J. 3-12-99
DRAWN NOTE 6 3-12-99
CHECKED
NAME DATE
Brisbane City
JOB FILE
ACAD FILE S7HG001
SURVEY No.
SURVEYED
SHEET SIZE A1
FIELD BOOK
A.H. DATUM
Brisbane Water
PROJECT
CENTENARY HIGHWAY
SEWAGE PUMP STATION SP19
TITLE
SWITCHBOARD
PUMP CIRCUITS
POWER & METERING SCHEMATIC
SCALE NTS
Nº 1 OF 8 SHEETS
DRAWING Nº
486/5/7-HG0013
AMEND.
A

240V AC
AUX. SUPPLY FROM
DISTRIBUTION BOARD
CIRCUIT BREAKER
REF DWG:-
486/5/7-HG001

REF DWG:-
486/5/7-HG001

E N R W B

TL2 TEST LINKS

CT2 5A

2A 2A 2A IF2

(NOTE 2)

250A

C23

DANFOSS VLT6100
V.F. DRIVE No 1

91 L1
92 L2
93 L3
94

U 96
V 97
W 98
99

(NOTE 1)

MAIN PUMP No.2
63kW
FLC=115A

RP24-1 236 THR2-1 235

RP23-1 238 239

6A (NOTE 6)

18 RUN/STOP
27
16 RESET
12 COMMON
32 SELECT SET UP 2

SMC
REMOTE LOCAL
240

REF DWG:-
486/5/7-HG004
LINE No 13

CABLE C20
(10 CORE)

CABLE C13

50 3W PR+
53 3Bk PR-

MANUAL SPEED CONTROL
1K POTENTIOMETER

653

60 2W 654 0+ VFD 2 SPEED CONTROL CHANNEL 1
55 2Bk 653 0-
45 1W 643 11+ VFD 2 RUNNING SPEED CHANNEL 12
39 1Bk 644 11-
5Bk 644 10- VFD 2 MOTOR AMPS CHANNEL 10
42 5W 253 A 252 10+

REF DWG:-
486/5/7-HG005

0-115A ANALOG AMMETER (4-20mA)

V.F.D. 1
RS485 TERM'LS
REF DWG:-
486/5/7-HG002

68
69
61

VFD2W-1 9A 9B — 10 — 221+ V.F. DRIVE WARNING REF DIM2 R.T.U. INPUT CHANNEL 11

RELAY 06 VFD2A-1 6A 6B — 9 — 220+ V.F. DRIVE IN AUTO REF DIM2 R.T.U. INPUT CHANNEL 10

RELAY 07 VFD2R-1 7A 7B — 7 — 218- V.F. DRIVE RUNNING
8 — 218+ REF DIM2 R.T.U. INPUT CHANNEL 8

CABLE C20

RELAY 08 VFD2R-2 8A 8B

B — 226 — HOURS RUN

225 — R — 1 READY 2 — W — 241 — RL21 — V.F. DRIVE No 2 READY RELAY

CABLE C15

PUMP No 2 - DANFOSS VLT6100
VARIABLE FREQUENCY DRIVE CABINET

N2 — MAIN PUMP No.2

MI02 — MOISTURE IN OIL RELAY (ZIEHL NSIF)

235 236

203 CABLE C22 204 — PROBES

THR2 — THERMISTOR RELAY (AUTO RESET)

225 233

TO DIM3 CHANNEL 4
REFER RTU INPUT MODULE
214+ 214-

CABLE C22 MOTOR THERMISTOR CABLE C22 234

225 229 ON OFF (NOTE 5) 230 RP22-1 232 C23 — LINE CONTACTOR

EMERGENCY STOP

CABLE C11
2 CORE

PR2 — CONTROL CIRCUIT POWER ON

RTU INPUTS MODULE [DIM3]

24N1 — R.T.U. 24V DC [REF 486/5/7-HG010] — DIM3+

2 CORE CABLE C9

(NOTE 4)

210-	210+	0	REFLUX MICRO SWITCH CHANNEL 0
211- PR2-1	211+	1	POWER ON CHANNEL 1
212- MI02-1	212+	2	MOISTURE IN OIL CHANNEL 2
213- 47	213+	3	LOCAL START CHANNEL 3
214- 48	214+	4	EMERGENCY STOP CHANNEL 4
215- THR2-2	215+	5	THERMISTOR TRIP CHANNEL 5
216- RL21-1	216+	6	V.F.D. No 2 READY CHANNEL 6
217- 49	217+	7	LOCAL RESET CHANNEL 7
7 218- VFD2R-1 8	218+	8	VFD No 2 RUNNING CHANNEL 8
7A 7B C23-2	219+	9	CONTACTOR CLOSE CHANNEL 9
VFD2A-1 9	220+	10	VFD No 2 AUTO SEL'D CHANNEL 10
6A 6B VFD2W-1	221+	11	V.F.D. No 2 WARNING CHANNEL 11
9A 9B 10			
SPARES	222+	12	SPARE CHANNEL 12
	223+	13	SPARE CHANNEL 13
	224+	14	SPARE CHANNEL 14
	225+	15	SPARE CHANNEL 15

RTU OUTPUTS MODULE [DOM2]

DOM2+ — R.T.U. 24V DC [REF 486/5/7-HG010] — DOM2-

(NOTE 4)

CLOSE LINE CONT'R CHANNEL 0	0	223+ 44	RP22 223-
PUMP STATUS CHANNEL 1	1	222+ 46 R	222-
RUN/STOP VFD No 2 CHANNEL 2	2	240+ 40	RP24 240-
VFD 2 FAULT RESET CHANNEL 3	3	224+ 45	RP23 224-
SPARE CHANNEL 4	4	SPARES	
SPARE CHANNEL 5	5		
CENTENARY HIGHWAY DOSING P1 RUN/STOP CHANNEL 7	6	721+ 54	RP71 721-
FORTROSE STREET DOSING P2 RUN/STOP CHANNEL 7	7	821+ 55	RP81 821-
SPARE CHANNEL 8	8	SPARES	
SPARE CHANNEL 9	9		
SPARE CHANNEL 10	10		
SPARE CHANNEL 11	11		
SPARE CHANNEL 12	12		
SPARE CHANNEL 13	13		
SPARE CHANNEL 14	14		
SPARE CHANNEL 15	15		

LEGEND:

- RELAY OR CONTACTOR COIL
- FIELD DEVICE
- R.T.U. FUSE TERMINAL
- R.T.U. LINK TERMINAL
- SWITCHBOARD TERMINAL
- CATHODIC PROTECTION TERMINAL
- FUNCTION / ADDRESS — RTU DIGITAL INPUT
- FUNCTION / ADDRESS — RTU DIGITAL OUTPUT
- FUNCTION / ADDRESS — RTU ANALOG INPUT
- FUNCTION / ADDRESS — RTU ANALOG OUTPUT
- 00 — EQUIPMENT ITEM No.
- ---6--- CABLE CORE NUMBER

NOTES:

1. MAIN PUMP OECONTACTORS ARE LOCATED IN UPPER SECTION OF PUMP WELL.
2. CIRCUIT BREAKERS RATINGS TO SUIT LOAD & ENSURE TYPE 2 COORDINATION WITH CONTACTORS & OVERLOADS TO IEC 947-4-1.
3. ALL WIRES & CABLE CORES ARE FERRULED WITH GRAFOPLAST COMPATIBLE LABELLING.
   THE FOLLOWING PREFIXES ARE USED:
   MAIN PUMP No. 1 = 1
   MAIN PUMP No. 2 = 2
   MAIN PUMP No. 3 = 3
   SUMP PUMP = 5
   COMMON WIRING = 6 (i.e. FLOW, LEVEL, PRESSURE)
   OXYGEN PUMP No. 1 = 7
   OXYGEN PUMP No. 2 = 8
4. 24V DC INPUT/OUTPUT INDIVIDUAL PROTECTION FUSES NOT SHOWN. (i.e. PART OF INTERFACE TERMINAL STRIP)
5. ON / OFF ISOLATOR SWITCHES LOCATED ADJACENT TO MOTORS IN PUMP WELL.
6. PUMP CONTROL CIRCUIT BREAKERS RATED AT 9KA FOR 1 SEC.
7. THE VARIABLE FREQUENCY SPEED CONTROLLERS SHALL BE LOCATED EXTERNALLY TO THE SWITCHBOARD IN WALL MOUNTED CABINETS IN THE UPPER SECTION OF THE PUMP WELL.
8. THIS DRAWING HAS BEEN PRODUCED FROM DRAWING No:- E94-BM6000/A0 & A2 REVISION E.
9. ALL ITEMS IN THE AREAS DELINEATED BY THE REVISION CLOUDS ARE NEW REVISIONS.

AS CONSTRUCTED
PLOTTED ____ DATE ____
CHECKED B.L. DATE 2/6/04

NO.	DATE	AMENDMENT	REV INITIALS
B	2-7-03	CONTROLS REVISED	CJ
A	00/00	AS CONSTRUCTED ISSUE.	--
0	00/00	ORIGINAL ISSUE.	

		NAME	DATE
DIRECTOR OF P.D. & P.S.	DATE		
ENGINEER IN CHARGE	R. BOWRING 21/12/99	DESIGN	NOTE 8 R.J. 3-12-99
SUPERVISING ENGINEER	NOTE 8 R.P.E.Q. NO. DATE	DRAWN	NOTE 8 3-12-99
		CHECKED	

Brisbane City

JOB FILE			
ACAD FILE	S:\HG003-RevB	SHEET SIZE	A1
SURVEY No.		FIELD BOOK	\
SURVEYED		A.H. DATUM	

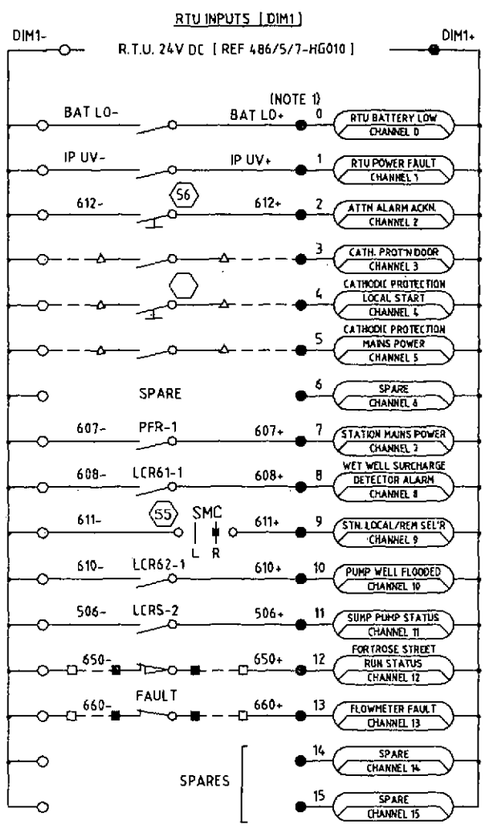
Brisbane Water

PROJECT
CENTENARY HIGHWAY
SEWAGE PUMP STATION SP19

TITLE
SEWAGE PUMP No 2
POWER & CONTROL
SCHEMATIC DIAGRAM

SCALE NTS | N° 3 OF 8 SHEETS
DRAWING N° 486/5/7-HG003 | AMEND. B

Q:\PSEDRAWING2\SEWERAGEINFRASTR\Centenary Hwy Sp19\57HG003-RevB.dwg, 01/06/2004 02:



RTU INPUTS [DIM2]
[REF 486/5/7-HG002]

RTU INPUTS [DIM3]
[REF 486/5/7-HG003]

RTU OUTPUTS [DOM1]
[REF 486/5/7-HG002]

RTU OUTPUTS [DOM2]
[REF 486/5/7-HG003]

[NOTE:- SMC SELECTOR
ADDITIONAL POLES FOR LOCAL CONTROL
REF DWGS:- 486/5/7-HG002 AND HG003
LINE 16]

[REF DWG No:- 486/5/7-HG005]

NOTES:

1. 24V D.C. INPUT/OUTPUT INDIVIDUAL PROTETCION FUSES NOT SHOWN. [ie PART OF INTERFACE TERMINAL STRIP]
2. ALL WIRES & CABLE CORES ARE FERRULED WITH GRAFOPLAST COMPATIBLE LABELLING.
   THE FOLLOWING PREFIXES ARE USED:
   MAIN PUMP No. 1 = 1
   MAIN PUMP No. 2 = 2
   MAIN PUMP No. 3 = 3
   SUMP PUMP = 5
   COMMON WIRING = 6 (i.e. FLOW, LEVEL, PRESSURE)
   OXYGEN PUMP No. 1 = 7
   OXYGEN PUMP No. 2 = 8
3. THIS DRAWING HAS BEEN PRODUCED FROM DRAWING No:- E94-BM6000/A3 REVISION E.
4. ALL ITEMS IN THE AREAS DELINEATED BY THE REVISION CLOUDS ARE NEW REVISIONS.

LEGEND:

- RELAY OR CONTACTOR COIL
- FIELD DEVICE
- R.T.U. FUSE TERMINAL
- R.T.U. LINK TERMINAL
- SWITCHBOARD TERMINAL
- CATHODIC PROTECTION TERMINAL
- FUNCTION / ADDRESS — RTU DIGITAL INPUT
- FUNCTION / ADDRESS — RTU DIGITAL OUTPUT
- FUNCTION / ADDRESS — RTU ANALOG INPUT
- FUNCTION / ADDRESS — RTU ANALOG OUTPUT
- 00 — EQUIPMENT ITEM No.

SUPERCEDES DRAWING No:- E94-BM6000/A3 REVISION E

AS CONSTRUCTED
PLOTTED [illegible] DATE 8/00
CHECKED [illegible] DATE 8/00

NO.	DATE	AMENDMENT	INITIALS
A	08/99	AS CONSTRUCTED ISSUE.	
D	07/99	ORIGINAL ISSUE.	

DIRECTOR OF P.D. & P.S. — DATE
ENGINEER IN CHARGE: R. BOWRING 21/12/99 — DATE
SUPERVISING ENGINEER: NOTE 3 R.P.E.Q. NO. — DATE

	NAME	DATE
DESIGN	NOTE 3 R.J.	3-12-99
DRAWN	NOTE 3	3-12-99
CHECKED		

Brisbane City

JOB FILE			
ACAD FILE	S7HG004	SHEET SIZE	A1
SURVEY No.		FIELD BOOK	
SURVEYED		A.H. DATUM	

Brisbane Water

PROJECT: CENTENARY HIGHWAY SEWAGE PUMP STATION SP19

TITLE: SWITCHBOARD R.T.U. DIGITAL I/O SCHEMATIC DIAGRAM

SCALE NTS | Nº 1 OF 8 SHEETS

DRAWING Nº 486/5/7-HG004 | AMEND. A

RTU ANALOG INPUTS [AIM1]

(NOTE 2)

CATHODIC PROTECTION UNIT

4-20 mA	616	0-	RECTIFIER CURRENT CHANNEL 0	
	617	0+		
4-20 mA	618	1-	RECTIFIER VOLTAGE CHANNEL 1	
	619	1+		
4-20 mA	620	2-	REF ELECT. 1 VOLTAGE CHANNEL 2	
	621	2+		
4-20 mA	622	3-	REF ELECT. 2 VOLTAGE CHANNEL 3	
	623	3+		
		COM-		
		COM+	WELL LEVEL CHANNEL 4	
4-20mA	626	~~625~~ 4+		
	624	COM-		
		COM+	DELIVERY PRESSURE CHANNEL 5	
4-20mA	629	5+		
	628	COM-		
4-20mA	632	6-	DELIVERY FLOW CHANNEL 6	
	631	6+		
4 - 20mA	151	7-	PUMP 1 KILOWATTS CHANNEL 7	
	150	7+		
4 - 20mA	641	8-	PUMP 1 AMPS CHANNEL 8	
	152	8+		
4 - 20mA	250	9-	PUMP 2 KILOWATTS CHANNEL 9	
	251	9+		
4 - 20mA	644	10-	PUMP 2 AMPS CHANNEL 10	
	252	10+		
4 - 20mA	641	11-	V.F.D. 1 RUNNING SPEED CHANNEL 11	
	642	11+		
4 - 20mA	644	12-	V.F.D. 2 RUNNING SPEED CHANNEL 12	
	643	12+		
		13-	SPARE CHANNEL 13	
		13+		
		14-	SPARE CHANNEL 14	
		14+		
		15-	SPARE CHANNEL 15	
		15+		

R.T.U. 24V DC
REF DWG:- HG011
COM1+
COM1-

ANALOG LEVEL METER

(VEGA E25 OSCILLATOR) WELL LEVEL TRANSMITTER — 24P3

DELIVERY LINE PRESSURE TRANSMITTER (APCS WT227)

MAGNETIC FLOWMETER TRANSMITTER FT1 REFER CONNECTION DETAIL BELOW REFER NOTE 3 — (70)

PUMP No 1 KILOWATT TRANSDUCER REF DWG:- 486/5/7-HG002 — (17) KWT1

PUMP No 1 V.F. DRIVE MOTOR AMPS REF DWG:- 486/5/7-HG002 — 39, 42, 153, A, 0-115AMP AMMETER

PUMP No 2 KILOWATT TRANSDUCER REF DWG:- 486/5/7-HG003 — (17) KWT1

PUMP No 2 V.F. DRIVE MOTOR AMPS REF DWG:- 486/5/7-HG003 — 39, 42, 253, A, 0-115AMP AMMETER

MAIN PUMP No 1 V.F. DRIVE UNIT REF DWG:- 486/5/7-HG002 — 39, 45

MAIN PUMP No 2 V.F. DRIVE UNIT REF DWG:- 486/5/7-HG003 — 39, 45

SPARES

RTU ANALOG OUTPUTS [AOM1]

VFD1 SPEED CONTROL CHANNEL 0	0-	652	MAIN PUMP No 1 V.F. DRIVE UNIT SPEED CONTROL REF:- 486/5/7-HG002 (55, 60)
	0+	651	
VFD2 SPEED CONTROL CHANNEL 1	1-	653	MAIN PUMP No 2 V.F. DRIVE UNIT SPEED CONTROL REF:- 486/5/7-HG003 (55, 60)
	1+	654	
SPARE CHANNEL 2	2-		
	2+		
SPARE CHANNEL 3	3-		
	3+		
SPARE CHANNEL 4	4-		
	4+		
SPARE CHANNEL 5	5-		
	5+		
SPARE CHANNEL 6	6-		
	6+		
SPARE CHANNEL 7	7-		
	7+		
SPARE CHANNEL 8	8-		
	8+		
SPARE CHANNEL 9	9-		
	9+		
SPARE CHANNEL 10	10-		
	10+		
SPARE CHANNEL 11	11-		
	11+		
SPARE CHANNEL 12	12-		
	12+		
SPARE CHANNEL 13	13-		
	13+		
SPARE CHANNEL 14	14-		
	14+		
SPARE CHANNEL 15	15-		
	15+		

SPARES

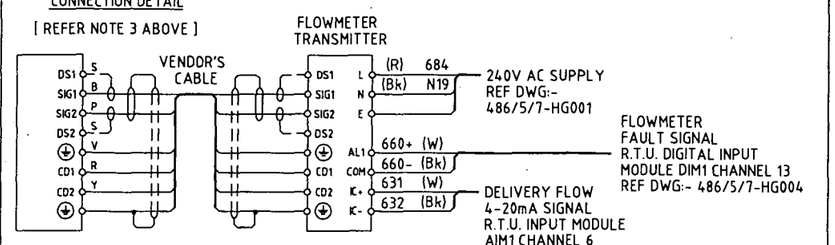
NOTES:

1. TRANSIENT PROTECTION INTEGRAL TO RTU ANALOGUE INPUTS.
2. CATHODIC PROTECTION - FUTURE. THIS UNIT TO BE SUPPLIED BY OTHERS. RTU I/O CABLING TO BE INSTALLED TO PROPOSED CATHODIC PROTECTION AREA TERMINAL STRIP FOR CONNECTION BY OTHERS
3. FLOWMETER SENSOR CABLES:-
   - UNSCREENED CABLE ENDS MUST BE KEPT AS SHORT AS POSSIBLE AND THE TWO CABLES MUST BE KEPT SEPARATE.
   - THE CABLES MUST BE IN ONE LENGTH AND MUST NOT BE TAKEN TO A DISTRIBUTION BOX OR SIMILAR TERMINAL ARRANGEMENT.
   - TERMINALS 81 AND 84 ARE ONLY CONNECTED WHEN SPECIAL ELECTRODE CABLE WITH DOUBLE SCREENING IS USED.
   - NORMALLY THE EXTERNAL SHIELD IS NOT CONNECTED TO THE SIGNAL CONVERTER.
   - IN ENVIRONMENTS WITH STRONG ELECTRICAL NOISE, THE EXTERNAL SCREEN MUST BE EARTHED AT BOTH ENDS.
4. THIS DRAWING HAS BEEN PRODUCED FROM DRAWING No:- E94-BM6000/A4 REVISION E.
5. ALL ITEMS IN THE AREAS DELINEATED BY REVISION CLOUDS ARE NEW MODIFICATIONS.

LEGEND:

- RELAY OR CONTACTOR COIL
- FIELD DEVICE
- R.T.U. FUSE TERMINAL
- R.T.U. LINK TERMINAL
- SWITCHBOARD TERMINAL
- CATHODIC PROTECTION TERMINAL
- FUNCTION / ADDRESS — RTU DIGITAL INPUT
- FUNCTION / ADDRESS — RTU DIGITAL OUTPUT
- FUNCTION / ADDRESS — RTU ANALOG INPUT
- FUNCTION / ADDRESS — RTU ANALOG OUTPUT
- (00) EQUIPMENT ITEM No.

ABB MAGMASTER MAGNETIC FLOWMETER FT1 CONNECTION DETAIL [REFER NOTE 3 ABOVE]



AS CONSTRUCTED
PLOTTED [illegible] DATE 8/00
CHECKED [illegible] DATE 8/00

SUPERCEDES DRAWING No:- E94-BM6000/A4 REVISION E

NO.	DATE	AMENDMENT	INITIALS
A	08/00	AS CONSTRUCTED ISSUE.	
0	01/00	ORIGINAL ISSUE.	RFW

DIRECTOR OF P.D. & P.S. — DATE
ENGINEER IN CHARGE — R. BOWRING — 21/12/99 — DATE
SUPERVISING ENGINEER — NOTE 4 — R.P.E.Q. NO. — DATE

	NAME	DATE
DESIGN	NOTE 4 R.J.	3-12-99
DRAWN	NOTE 4	3-12-99
CHECKED		

Brisbane City

JOB FILE			
ACAD FILE	57HG005	SHEET SIZE	A1
SURVEY No.		FIELD BOOK	
SURVEYED		A.H. DATUM	

Brisbane Water — Professional Services Engineering

PROJECT: CENTENARY HIGHWAY SEWAGE PUMP STATION SP19

TITLE: SWITCHBOARD R.T.U. ANALOG I/O SCHEMATIC DIAGRAM

SCALE NTS — N° 5 OF 8 SHEETS

DRAWING N° 486/5/7-HG005 — AMEND. A

SWITCHBOARD EQUIPMENT AND LABEL SCHEDULE

ITEM	QTY	MAKE and NUMBER	DESCRIPTION	LABEL
00	3	TERCEL IP70SD 70KA	LIGHTNING ARRESTORS	LIGHTNING ARRESTORS
01	1	TERASAKI XH-400NE/250 WITH XFHA34 HANDLE	MAIN CIRCUIT BREAKER	MAIN SWITCH
02	2	TERASAKI XH-250NJ/250 WITH XFHA23 HANDLE	MAIN PUMP No 1 & No 2	PUMP No 1 / No 2
			CIRCUIT BREAKERS	
03	1	TERASAKI DIN-T9-316	SUMP PUMP CIRCUIT BREAKER	REFER LEGEND CARD
04	1	NHP LKSI-63 WITH 3 X GEC TIS63 CARTRIDGES	SUB DISTRIBUTION BOARD ISOLATOR	SUB-DIST BOARD ISOLATOR
05	1	TERASAKI ND250A/24	SUB DISTRIBUTION CIRCUIT BREAKER CHASSIS	
06	2	DANFOSS VLT6100 VARIABLE SPEED DRIVE	MAIN PUMP No 1 & No 2 VARIABLE SPEED DRIVES	VFD1/VFD2
07	2	SPRECHER & SCHUH CA6-140-E-10-240V WITH CEF1-VS2 BUSBAR	MAIN PUMP No.1 & No.2 LINE CONTACTORS	C13/C23
08	2	SPRECHER & SCHUH CEF1-11-415V	MAIN PUMP No.1 & No.2 THERMAL OVERLOAD	TOL1/TOL2
09	1	SPRECHER & SCHUH CA3-23-10-A240	SUMP PUMP LINE CONTACTOR	C53
10	1	SPRECHER & SCHUH CT3-12 3.8-6.0A	SUMP PUMP THERMAL OVERLOAD	
11	2	SPRECHER & SCHUH CA3-23-10-A240	OXYGEN PUMPS No 1 & No 2 LINE CONTACTORS	C73/C83
12	2	SPRECHER & SCHUH CT3-12 1.6-2.5A	OXYGEN PUMPS No 1 & No 2 THERMAL OVERLOADS	
13	2	CROMPTON 782-943 150/5A CLASS 1 5VA	MAIN PUMP INSTRUMENT CURRENT TRANSFORMERS	PUMP No 1 / No 2
14	6	GEC SC20H WITH 6 X NS2 CARTRIDGES	MAIN PUMP INSTRUMENT FUSES	PUMP No 1 / No 2
15	4	KLIPPON SAKT2/35 TERMINALS	CURRENT TRANSFORMER	
	2	QVS2 SLIDELINKS	TEST LINKS	
	8	VH19 SLEEVES		
	8	BS SCREWS		
16	2	CROMPTON 243-01AG SCALE 0-115A (ANALOG 4-20mA INPUT)	MAIN PUMP No 1 & No 2 AMMETERS	PUMP No 1 / No 2
17	2	MULTITEK M100-WA2 UHA (240VAC)	MAIN PUMP No 1 & No 2 KILOWATT TRANSDUCERS	KWT1/2
18	2	MULTITEK M100-AL1 UHA (240VAC)	MAIN PUMP No 1 & No 2 CURRENT TRANSDUCERS	IT1/2
19	1	CROMPTON 252-PSGW 3 WIRE 50 HZ 415 VAC	PHASE FAILURE RELAY	PFR
20	1	TERASAKI DIN-T8-306	PHASE FAILURE RELAY CIRCUIT BREAKER	REFER LEGEND CARD
21	1	TERASAKI DIN-T8-320	THREE PHASE 20A OUTLET CIRCUIT BREAKER	REFER LEGEND CARD
22	1	TERASAKI DIN-T8-110	SINGLE PHASE GPO CIRCUIT BREAKER	REFER LEGEND CARD
23	1	TERASAKI DIN-T8-110	PUMP WELL LIGHTING CIRCUIT BREAKER	REFER LEGEND CARD
24	1	TERASAKI DIN-T8-102	RTU LAPTOP GPO CIRCUIT BREAKER	REFER LEGEND CARD
25	1	TERASAKI DIN-T8-106	SWITCHBOARD FLUORESCENT LIGHT CIRCUIT BREAKER	REFER LEGEND CARD
26	1	TERASAKI DIN-T8-106	CATHODIC PROTECTION UNIT CIRCUIT BREAKER	REFER LEGEND CARD
27	1	TERASAKI DIN-T8-110	PUMP WELL VENTILATION FAN CIRCUIT BREAKER	REFER LEGEND CARD
28	1	TERASAKI DIN-T8-106	KW & CURRENT TRANSDUCERS AUX SUPPLY C/B	REFER LEGEND CARD
29	1	TERASAKI DIN-T8-106	RTU POWER SUPPLY CIRCUIT BREAKER	REFER LEGEND CARD
30	1	TERASAKI DIN-T8-106	FLOWMETER EVALUATION UNIT CIRCUIT BREAKER	REFER LEGEND CARD
31	3	TERASAKI DIN-T8-106	SPARE 240VAC CIRCUIT BREAKER	REFER LEGEND CARD
32	3	BURGESS DS3	SWITCHBOARD DOOR SWITCHES	
33	3	LANSON LBB113	13W FLUROESCENT SWITCHBOARD LIGHTS	
34	1	CROMPTON 243-01AG WITH SUPPLIMENTRY RED POINTER 4-20mA INPUT SCALE 0-100%	WELL LEVEL INDICATOR	WELL LEVEL
35	1	PLATYPUS 2 WITH APCS-WT227	DELIVERY PRESSURE TRANSMITTER	DELIVERY PRESSURE TRANSMITTOR
36	1	VEGA 137M/E258	WELL LEVEL TRANSMITTER	WELL LEVEL TRANSMITTER
37	2	TERASAKI DIN-T9-106	MAIN PUMP No 1 & No 2 CONTROL CIRCUIT BREAKER	PUMP No1/PUMP No2 CONTROL
38	2	CROMPTON 242-155G-240V	MAIN PUMP No 1 & No 2 HOUR RUN METER	
39	2	SPRECHER & SCHUH RT3-A-240V	MAIN PUMP No 1 & No 2 THERMISTOR RELAY	THR1/2
40	2	IZUMI RM2S-U-240V WITH SM2S-05U BASE	MAIN PUMP No 1&2 SOFT STR START RELAY	RP14/RP24
41	2	IZUMI RM2S-U-240V WITH SM2S-05U BASE	CONTROL CIRCUIT POWER ON RELAY	PR1/2
42	2	IZUMI RM2S-U-240V WITH SM2S-05U BASE	PUMP No 1 & No 2 V.F. DRIVE READY RELAY	RL11/21
44	2	IZUMI RM2S-U-24VDC WITH SM2S-05U BASE	RTU MAIN PUMP No1&2 CONTACTOR CLOSE RELAY	RP12/22
45	2	IZUMI RM2S-U-24VDC WITH SM2S-05U BASE	RTU MAIN PUMP No 1 & No 2 V.F. DRIVE FLT RESET	RP13/23
46	2	SPRECHER & SCHUH DL3-GRYW-EM WITH Bo 9s-I3-24V-2W (RED USED)	MAIN PUMPS No 1 & No 2 STATUS INDICATION LAMP	STATUS ON = RUNNING SLOW FLASH = FAULT FAST FLASH = START
47	2	SPRECHER & SCHUH DT3P-G-10M	MAIN PUMP No 1 & No 2 START PUSHBUTTON	START
48	2	SPRECHER & SCHUH DN3-30-01 WITH DE3-01 CONTACT BLOCK	MAIN PUMP No 1 & No 2 STOP PUSHBUTTON	EMERGENCY STOP
49	2	SPRECHER & SCHUH DT3P-MB-10M	MAIN PUMP No 1 & No 2 RESET PUSHBUTTON	LOCAL RESET
50	2	TERASAKI DIN-T8-310	OXYGEN PUMP No 1 & No 2 CIRCUIT BREAKER	REFER LEGEND CARD
51	1	MULTITRODE MTR-2	SUMP PUMP CONTROL RELAY	LCR5
52	1	MULTITRODE MTR-2	SURCHARGE ALARM RELAY	LCR61
53	1	MULTITRODE MTR-2	PUMP WELL FLOODED RELAY	LCR62
54	2	IZUMI RM2S-U-240V WITH SM2S-05U BASE	RTU OXYGEN PUMP No 1 & No 2 RUN RELAYS	RP71/81
55	1	KRAUS & NAIMER CG8-A220-E-604 HEADING STATION CONTROL LABEL LOCAL-REMOTE	STATION CONTROL MODE SELECTOR	
56	1	SPRECHER & SCHUH DT3P-MB-10M	SITE ATTENTION ALARM RESET PUSHBUTTON	ALARM RESET
57	1	SPRECHER & SCHUH DT3P-G-10M	SUMP PUMP START PUSHBUTTON	START
58	1	SPRECHER & SCHUH DT3P-R-01M	SUMP PUMP STOP PUSHBUTTON	STOP
59	1	SPRECHER & SCHUH DL3-GRYW-EM WITH Bo9s-I3-24V-2W (YELLOW USED)	SWITCHBOARD ATTENTION ALARM	ATTENTION ALARM
60	1	WATTMASTER KOBISHI 160K24-CLEAR	PUMP WELL SITE ATTENTION ALARM	
61	1	CLIPSAL 56C420	THREE PHASE OUTLET	415VAC
62	2	CLIPSAL 15	SINGLE PHASE OUTLET & RTU SINGLE PHASE OUTLET	240VAC/RTU LAPTOP SUPPLY
63	2	CLIPSAL BP165D12 WITH 2 X BP165F FEET	NEUTRAL LINKS	NEUTRAL
64	2	CLIPSAL BP165D12	EARTH LINKS	EARTH
65	77	KLIPPON SAK4 "G" RAIL	SWITCHBOARD TERMINALS	
66	16	KLIPPON SAKR "DIN" RAIL	LINK TERMINALS	
68	3	DIN-T DTLD LOCKDOGS	CIRCUIT BREAKER LOCKDOGS	
69	3	KLIPPON EK2.5/35 (066106) AND PARTITION (013016)	EARTH TERMINALS	
70	1	ABB MAGMASTER MAGNETIC FLOWMETER		
71	2		1K POTENTIOMETER	FT1 PUMP 1/2 MANUAL SPEED CONTROL

1. THIS DRAWING HAS BEEN PRODUCED FROM DRAWING No:- E94-BM6000/A5 REVISION D.
2. ALL ITEMS IN THE AREAS DELINEATED BY REVISION CLOUDS ARE NEW MODIFICATIONS.

LEGEND:

- RELAY OR CONTACTOR COIL
- FIELD DEVICE
- R.T.U. FUSE TERMINAL
- R.T.U. LINK TERMINAL
- SWITCHBOARD TERMINAL
- CATHODIC PROTECTION TERMINAL
- FUNCTION / ADDRESS — RTU DIGITAL INPUT
- FUNCTION / ADDRESS — RTU DIGITAL OUTPUT
- FUNCTION / ADDRESS — RTU ANALOG INPUT
- FUNCTION / ADDRESS — RTU ANALOG OUTPUT
- 00 — EQUIPMENT ITEM No.

SUPERCEDES DRAWING No:- E94-BM6000/A5 REVISION D

AS CONSTRUCTED
PLOTTED [signature] DATE 8/00
CHECKED [signature] DATE 8/00

NO.	DATE	AMENDMENT	INITIALS
A	08/99	AS CONSTRUCTED ISSUE.	
0	01/99	ORIGINAL ISSUE.	RFW

DIRECTOR OF P.D. & P.S. — DATE
ENGINEER IN CHARGE — R. BOWRING — 21/12/99 — DATE
SUPERVISING ENGINEER — NOTE 1 — R.P.E.Q. NO. — DATE

	NAME	DATE
DESIGN	NOTE 1 R.J.	3-12-99
DRAWN	NOTE 1	3-12-99
CHECKED		

Brisbane City

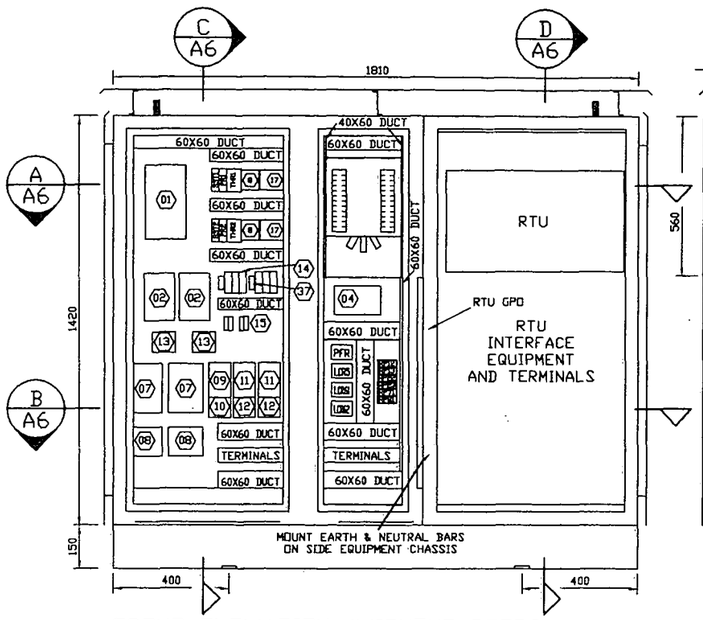
JOB FILE
ACAD FILE — S7HG006 — SHEET SIZE — A1
SURVEY No. — FIELD BOOK
SURVEYED — A.H. DATUM

Brisbane Water — Professional Service Engineering

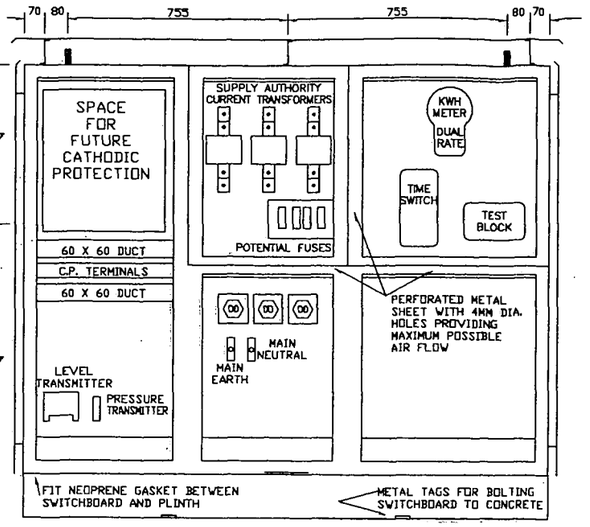
PROJECT: CENTENARY HIGHWAY SEWAGE PUMP STATION SP19

TITLE: SWITCHBOARD EQUIPMENT AND LABEL SCHEDULE

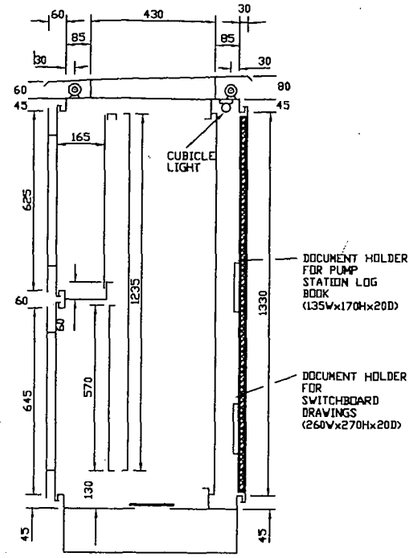
SCALE NTS — N° 8 OF 8 SHEETS
DRAWING N° 486/5/7-HG006 — AMEND. A



FRONT ELEVATION (WITHOUT DOORS



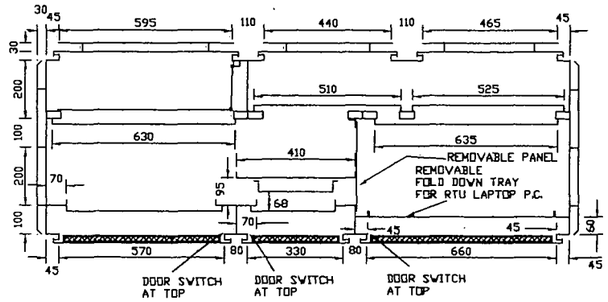
REAR ELEVATION (WITHOUT DOORS)



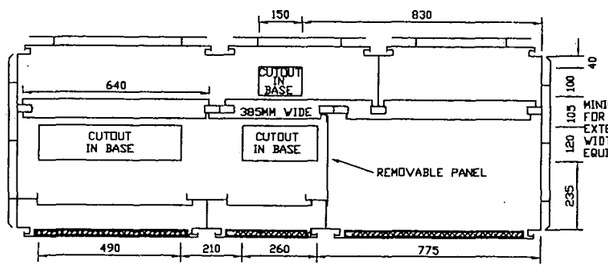
SECTION 'C' (WITHOUT EQUIPMENT)

NOTES

1. EQUIPMENT CHASSIS SHALL BE BOLTED TO PICTURE FRAME SUPPORTS AT SIDES ONLY
2. A MINIMUM 50MM AIR GAP TO BE PROVIDED AT TOP AND BOTTOM OF EQUIPMENT CHASSIS TO ALLOW AIR MOVEMENT
3. EXTEND DIN RAIL FULL WIDTH OF EQUIPMENT CHASSIS FIELD INTERFACE TERMINAL DIN RAIL ALLOW 20% ADDITIONAL LENGTH
4. DOORS SHALL BE HELD OPEN BY DOOR STAYS
5. DOOR LOCKS SHALL BE SELECTRIX SEMIFLUSH SWING HANDLES WITH B.C.C. LOCKS
6. FOLD DOWN RTU TRAY TO BE REMOVABLE TO ALLOW EQUIPMENT CHASSIS INSTALLATION AND REMOVAL
7. GLAND PLATES TO BE 6MM THICK BAKELITE
8. SEGREGATION OF SEQEB METER AND CT COMPARTMENTS TO BE OBTAINED USING PERFORATED 316 S.S. SHEET TO ALLOW MAXIMUM POSSIBLE AIR FLOW
9. DOOR INSULATION TO BE 25MM THICK FIBERGLASS THERMAL INSULATION
10. THE SUNSHIELD TO BE 1.6MM THICK 316 S.S. SHEET. 30MM LONG S.S. STANDOFFS TO BE MOUNTABLE FROM INSIDE THE CUBICLE BUT WELDED TO THE SUNSHIELD. THE TOP SUNSHIELD TO BE SUPPORTED BE 316 S.S. 'Z' SECTIONS WELDED TO THE TOP OF THE CUBICLE AND BOLTED TO THE SUNSHIELD
11. EQUIPMENT TO BE MOUNTED NO LOWER THAN 200MM ABOVE CUBICLE FLOOR
12. THIS DRAWING HAS BEEN PRODUCED FROM DRAWING No:- E94-BM6000/A6 REVISION C.

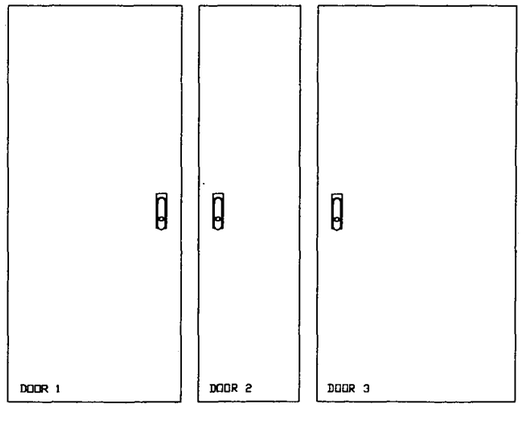


SECTION 'A' (WITHOUT EQUIPMENT)

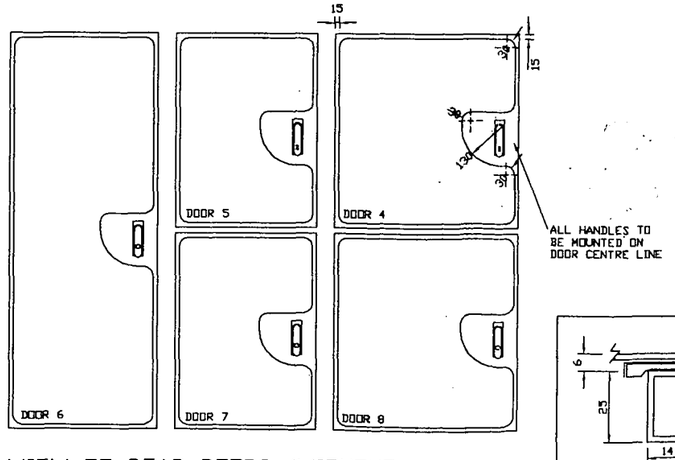


SECTION 'B' (WITHOUT EQUIPMENT)

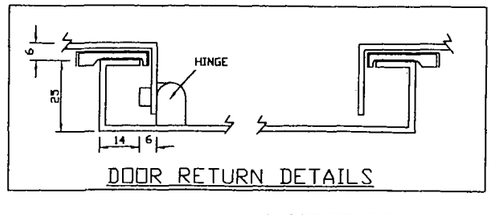
SECTION 'D' (WITHOUT EQUIPMENT)



VIEW OF FRONT DOORS (WITHOUT HINGES)



VIEW OF REAR DOORS (WITHOUT HINGES)



DOOR RETURN DETAILS

SUPERCEDES DRAWING No:- E94-BM6000/A6 REVISION C

AS CONSTRUCTED
PLOTTED DATE 8/00
CHECKED DATE 8/00

NO.	DATE	AMENDMENT	INITIALS
D	10/99	ORIGINAL ISSUE	

	NAME	DATE
DIRECTOR OF P.D. & P.S.		DATE
ENGINEER IN CHARGE	R. BOWRING	21/12/99 DATE
SUPERVISING ENGINEER	NOTE 12	R.P.E.Q. NO. DATE
DESIGN	NOTE 12 R.J.	3-12-99
DRAWN	NOTE 12	3-12-99
CHECKED		

Brisbane City

JOB FILE			
ACAD FILE	S7HG007	SHEET SIZE	A1
SURVEY No.		FIELD BOOK	
SURVEYED		A.H. DATUM	

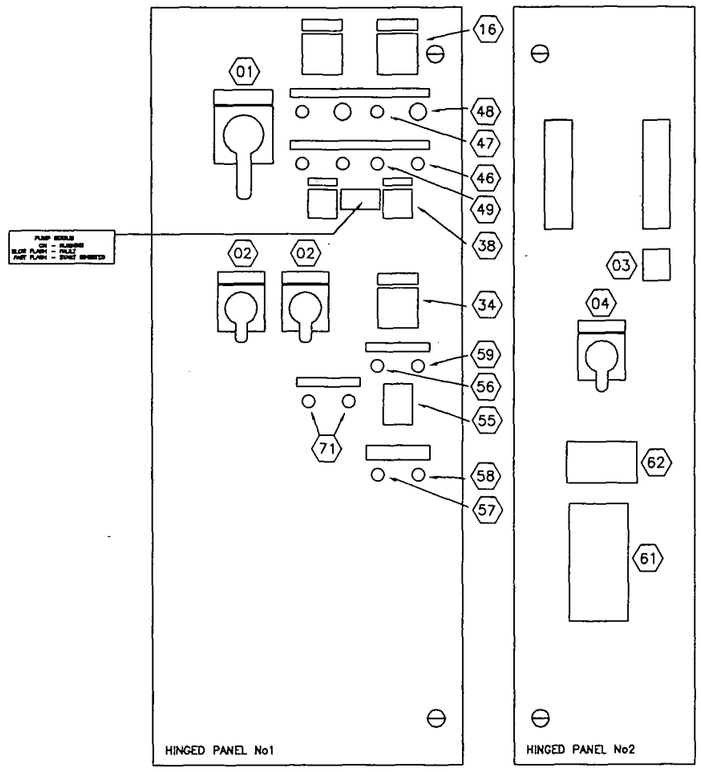
Brisbane Water

PROJECT: CENTENARY HIGHWAY SEWAGE PUMP STATION SP19

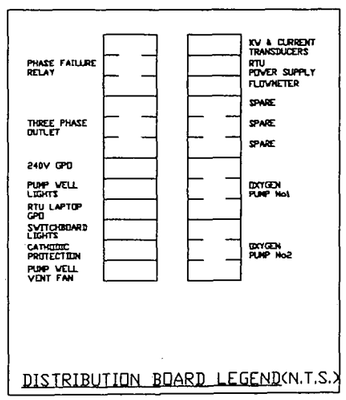
TITLE: SWITCHBOARD CUBICLE CONSTRUCTION & GENERAL ARRANGEMENT

SCALE NTS | N° 7 OF 8 SHEETS

DRAWING N° 486/5/7-HG007 | AMEND. A



VIEW OF HINGED PANEL
(WITHOUT HINGES) (SCALE 1:5)



DISTRIBUTION BOARD LEGEND (N.T.S.)

SWITCHBOARD CONSTRUCTION NOTES

CONSTRUCTION
- Cubicle to be of 1.6mm thick Grade 316 Stainless Steel 2B finish sheet folded, fully welded at joints, stiffened where necessary to form a rigid Weather and vermin proof Plinth mounting enclosure, IP33 to AS1939.
- Hinged Panels to be 2.0mm thick Zinc Anneal sheet folded, fully welded at joints and stiffened where necessary.
- Door seals to be retained by use of metal framing.
- Equipment panels to be 3.0mm Steel sheet.
- Fit 4 M12 Lifting Lugs to the top of the cubicle.
- Fit 6mm thick bakelite gland plates to cutouts in Base of cubicle.
- Fit one spare fuse receptacle in cubicle.
- Meter Panel to be double hinged 6mm thick laminated phoenetic resin.
- Fit catch stays to doors and hinged panels to allow minimum opening of 110° (Doors with external heat shields to open to 90o).
- Rear of Hinged Panels to be shrouded to IP21 of AS 1939.
- Fit 6mm earthing studs to doors, hinged panels and cubicle for earth continuity.
- Fit one drawing holder and one log book holder to the Rear of Door No.1 as shown on General Arrangement Drawing.
- Fit one Legend Card Holder to Front of hinged panel No.2.
- Termination schedule to be mounted on hinged panel to show terminals and their connections. Schedule to be covered by Clear Perspex sheet of A4 size.
- Allow 20% spare terminal rail for future.

PAINTWORK - CUBICLE (EXTERNAL)
- Grind smooth all welds, descale, degrease and acid dip.

PAINTWORK - PLINTH
- Plinth to be 150mm x 50mm x 6mm Mild Steel Channel.
- Grind smooth all welds, descale and degrease and Hot Dip Galvanise.

PAINTWORK - EQUIPMENT CHASSIS, HINGED PANELS, LOG BOOK HOLDER AND DRAWING HOLDER
- Grind smooth all welds, descale and degrease. Finish with electrostatically applied, oven cured, polyester Powderkote to colour white.

HINGES - DOORS
- Lowe & Fletcher CP lift off Type KIS.

HINGES - HINGED PANEL
- Lowe & Fletcher CP lift off Type KIS.

LOCKS DOORS 4 & 5
- Selectrix 1107SSC04 handle (2 off).
- Selectrix 1107-U6 3 Point CAM (2 off).
- Emka 3 Point Locking Bars (2 off).
- SEGEB Lockwood No 234B 45mm brass pin tumbler padlock (2 off).

LOCKS DOORS 1-3, 6-8
- Selectrix 1107SSCU3 Handle (6 off).
- Selectrix 1109-77W Barrel Lock (6 off).
- Selectrix 1107-U6 3 Point CAM (6 off).
- Emka 3 Point Locking Bars (6 off).

LOCKS - HINGED PANELS
- EMKA 1000-U45 housing with 1000-u142 slotted insert and 1000-25 Tongue and seal

LABELS
- Internal labels to be W-B-W (except MAIN SWITCH and WARNING labels which are to be R-W-R) traffolyte inscribed as shown in label schedule. Main Switch labels' letter size to be 10mm, compartment labels' letter size to be 10mm and remainder labels' letter size to be 4mm. Internal labels to be secured with M3 Chrome Plated metal threads. External labels to be secured with M3 316 Grade Stainless Steel metal threads.
- Where Switchboard wiring obstructs labels mounted on equipment chassis the labels shall be mounted on duct lid and the lid secured by a single cable tie at one corner.

WIRING
All wiring to be PVC V75 600V Grade. Control and instrumentation wiring to be minimum 1.5mm2 tinned flexible copper conductors colour coded as shown below, numbered at each end and terminated by use of metal ferrules or crimp lugs. Power wiring to be minimum 2.5mm2 multistrand copper conductors phase colour coded as shown below. Wire numbering system shall be Grafoplast.

COLOUR CODE

Phase wiring (A, B & C)	- red, white and blue
Voltmeter and current transformer connections	- red, white, blue and BLACK.
240V control active	- white
Thermistors and no volt contacts	- orange
240V neutral	- black
24V ELV positive	- grey
24V ELV negative	- grey
Intrinsically safe wiring	- blue
Earth	- green-yellow

Labels:
1. 'TERMINALS 133, 134, 233, 234 THERMISTORS - DO NOT TEST ABOVE 2.2v'
   - 4mm R-W-R
   - Fit Adjacent to Terminal Strip
2. 'SP19' - 20mm W-B-W 316 Stainless Steel Fit to Door 2, label dimensions 150mm x 35mm.
3. 'DANGER 415V' 8mm R-W-R 316 Stainless Steel Fit to Door 2, label dimensions 120mm x 15mm.
4. 'SUPPLY AUTHORITY METER PANEL' 10mm W-B-W 316 Stainless Steel Fit to Door 4, label dimensions 300mm x 20mm.
   'PLEASE CHECK THAT THE')
   'STATION IS IN REMOTE') - Single Label 8mm W-B-W 316 Stainless Steel
   'MODE BEFORE LEAVING SITE') Fit to Door 2, label dimensions 210mm x 60mm.
- Use 4mm2 earth wire for door/cubicle connection.
- Gland plate opening to be re-inforced with 25mm X 6mm metal strips drilled and tapped with 6mm holes.
- Fitting holes for gland plates to be spaced at a maximum of 150mm apart.
- Gland plate openings to be sealed with 25mm wide neoprene gaskets glued to the Switchboard.
- Sunshields to have rounded corners with all edges turned in.

NOTES:-
1. THIS DRAWING HAS BEEN PRODUCED FROM DRAWING No:- 1006-0353 SHEET 2 REV'N 3.
2. MANUAL SPEED CONTROL POTENTIOMETERS FOR PUMPS 1 AND 2 TO BE INSTALLED.

SUPERCEDES DRAWING No:- 1006-0353 SHEET 2 REV'N 03

AS CONSTRUCTED
PLOTTED W.J. Lyttleton DATE 8/00
CHECKED [illegible] DATE 8/00

NO.	DATE	AMENDMENT	REV INITIALS
A	08/00	AS CONSTRUCTED ISSUE.	
0	01/00	ORIGINAL ISSUE.	

DIRECTOR OF P.O. & P.S.			DATE
ENGINEER IN CHARGE	R. BOWRING	21/12/99	DATE
SUPERVISING ENGINEER	NOTE 1	R.P.E.Q. NO.	DATE

	NAME	DATE
DESIGN	NOTE 1 R.J.	3-12-99
DRAWN	NOTE 1	3-12-99
CHECKED		

Brisbane City

JOB FILE			
ACAD FILE	S7HG008	SHEET SIZE	A1
SURVEY No.		FIELD BOOK	
SURVEYED		A.H. DATUM	

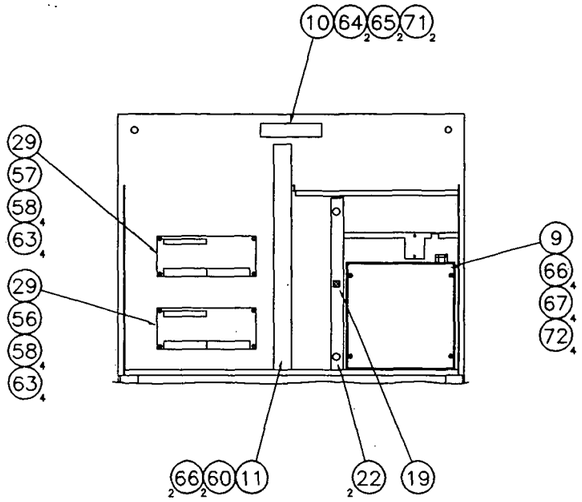
Brisbane Water

PROJECT: CENTENARY HIGHWAY SEWAGE PUMP STATION SP19

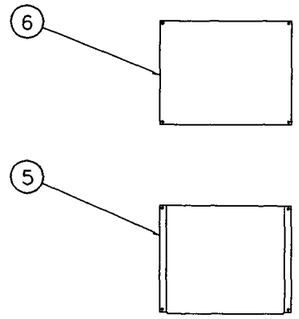
TITLE: SWITCHBOARD CUBICLE CONSTRUCTION & GENERAL ARRANGEMENT

SCALE NTS | N° 8 OF 8 SHEETS

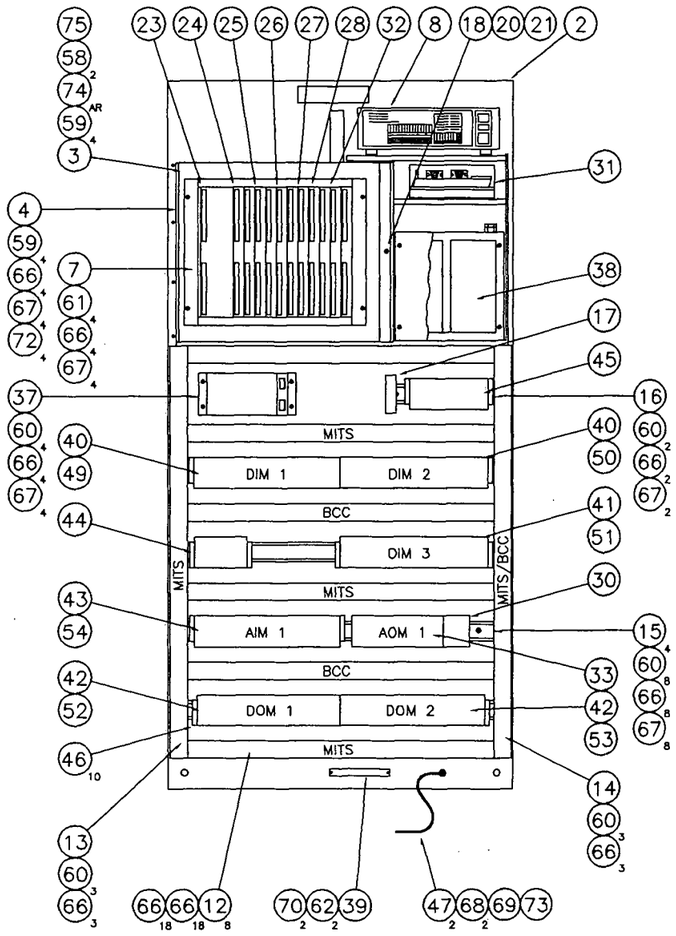
DRAWING N° 486/5/7-HG008 | AMEND. A



PART VIEW WITH SWING FRAME, RADIO & PSU REMOVED



ABOVE ITEMS ARE TO BE SUPPLIED LOOSE FOR FITTING TO THE SWITCHBOARD DOOR



PART FRONT VIEW DETAILING TERMINAL LAYOUT

EQUIPMENT SCHEDULE

ITEM	PART NO	DESCRIPTION	QTY
1	486/5/7-HG010 & 11	WIRING DIAGRAM	REF
2		MTG PLATE	1
3		FRAME	1
4	400-1477	HINGE	1
5		DOCUMENT POCKET	1
6		PERSPEX COVER	1
7	400-1449	CARD FRAME ASSEMBLY	1
8	400-1295	POWER SUPPLY UNIT PSU-11	1
9	400-1477	G.A. BATTERY BOX	1
10	400-1477	LABEL	1
11	400-1477	DUCTING	1
12	400-1477	DUCTING	8
13	400-1481	DUCTING	1
14	400-1482	DUCTING	1
15	400-1479/1	RAIL	4
16	400-1479/2	RAIL	1
17	DTP9691	PUSHBUTTON SWITCH 'NHP'	1
18	82-11-480-16	1/4 TURN FASTENER 'SOUTHCO'	1
19	82-35-309-56	RECEPTACLE 'SOUTHCO'	1
20	82-48-101-39	WEAR WASHER 'SOUTHCO'	1
21	82-32-201-20	RETAINER 'SOUTHCO'	1
22	880	RUBBER BUFFER 'MACAM'	2
23	701-300-589	DCM-105	1
24	701=300-570	PM-121	1
25	701-300-552	CIM-107	1
26	701-300-543	DIM-102	3
27	701-300-505	DOM-102	2
28	701-300-582	AIM-105	1
29	701-300-581	RTM-101	2
30	1006-0120	AC TERMINALS	1
31	TC-9000R	RADIO 'TRIO'	1
32	701-300-503	AOM	1
33	1006-0109	AOM FIELD TERMINALS	
35			
36			
37	IEXR/24-12	DC-DC POWER SUPPLY 'POWERBOX'	1
38	AS12/16	BATTERY 'SONNENSCHIEN'	2
39	BP90A12	12 WAY EARTH BLOCK 'CLIPSAL'	1
40	1006-0110	DIM FIELD TERMINALS	2
41	1006-0102	DIM FIELD TERMINALS	1
42	1006-0104	DOM FIELD TERMINALS	2
43	1006-0109	AIM FIELD TERMINALS	1
44	1006-0105	COMMON TERMINALS	1
45	1006-0113	POWER TERMINALS	1
46	EW35/038356	END BRACKET 'KUPPON'	10
47	300-510	EARTH STRAP	1
48	300-588	CABLE ASSEMBLY - CIM/TRIO	1
49	300-502/9	CABLE ASSEMBLY - DIM	1
50	300-502/10	CABLE ASSEMBLY - DIM	1

EQUIPMENT SCHEDULE

ITEM	PART NO	DESCRIPTION	QTY
51	300-502/11	CABLE ASSEMBLY - DIM	1
52	300-504/4	CABLE ASSEMBLY - RTM/FIELD	1
53	300-504/5	CABLE ASSEMBLY - RTM/FIELD	1
54	300-501/10	CABLE ASSEMBLY - AIM	1
55			
56	300-508/3	CABLE ASSEMBLY - DOM/RTM	1
57	300-508/4	CABLE ASSEMBLY - DOM/RTM	1
58		SCREW M3 X 6 PAN HD. M.S. ZINC PLATE	10
59		SCREW M4 X 8 PAN HD. M.S. ZINC PLATE	8
60		SCREW M4 X 8 PAN HD. M.S. ZINC PLATE	40
61		SCREW M4 X 10 PAN HD. M.S. ZINC PLATE	4
62		SCREW 5/32" WHIT X 3/8" CH HD. M.S. ZINC PLATE	2
63		WASHER M3 NYLON	8
64		WASHER M3 PLAIN EXTRA LARGE M.S. ZINC PLATE	2
65		WASHER M3 INT. STAR C.S. ZINC PLATE	2
66		WASHER M4 PLAIN M.S. ZINC PLATE	52
67		WASHER M4 INT. STAR C.S. ZINC PLATE	28
68		WASHER M6 PLAIN M.S. ZINC PLATE	2
69		WASHER M6 INT. STAR C.S. ZINC PLATE	2
70		WASHER 5/32 INT. STAR C.S. ZINC PLATE	2
71		NUT M3 HEX M.S. ZINC PLATE	2
72		NUT M4 HEX M.S. ZINC PLATE	8
73		NUT M6 HEX M.S. ZINC PLATE	2
74		LOCKTITE 242	AR
75	400-1490/12	LABEL	1
76			
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NOTES:-

1. THIS DRAWING HAS BEEN PRODUCED FROM DRAWING No:- 1006-0353 SHEETS 1 & 2 REV'N 3.
2. ALL ITEMS IN THE AREAS DELINEATED BY REVISION CLOUDS ARE NEW MODIFICATIONS.

SUPERCEDES DRAWING No:- 1006-0353 SHEETS 1 & 2 REV'N 03

AS CONSTRUCTED
PLOTTED W.J. Gatling DATE 8/00
CHECKED DATE 8/00

NO.	DATE	AMENDMENT	INITIALS
A	8/00	AS CONSTRUCTED ISSUE.	RFW
0	6/99	ORIGINAL ISSUE.	

DIRECTOR OF P.D. & P.S. — DATE
ENGINEER IN CHARGE — R. BOWRING — 21/12/99 — DATE
SUPERVISING ENGINEER — NOTE 1 — R.P.E.Q. NO. — DATE

	NAME	DATE
DESIGN	NOTE 1 R.J.	3-12-99
DRAWN	NOTE 1	3-12-99
CHECKED		

Brisbane City

JOB FILE
ACAD FILE 57HG009 — SHEET SIZE A1
SURVEY No. — FIELD BOOK
SURVEYED — A.H. DATUM

Brisbane Water

PROJECT: CENTENARY HIGHWAY SEWAGE PUMP STATION

TITLE: R.T.U. GENERAL ARRANGEMENT

SCALE NTS — N° OF SHEETS
DRAWING N° 486/5/7-HG009 — AMEND. A

CARD FRAME

QC9 + | QC12 + | QC13 − | QC11 ⏚ | PM | 0 PLB2 | 1 PLB3 | 2 PLB4 CIM | 3 PLB5 DIM1 | 4 PLB6 DIM2 | 5 PLB7 DIM3 | 6 PLB8 DOM1 | 7 PLB9 DOM2 | 8 PLB10 AIM1 | 9 PLB11 AOM1 | PLB12

CF+ (R) CF− (Bk) CF (G/Y) — 7 4

300-508 | 300-502/9 | 300-502/10 | 300-502/11 | 300-508/3 | 300-508/4 | 300-501/10 | 300-503/1

SKA 1 PLA — QC2 — 7 2 — RTM 2 — 18 PLC 1 — 18 PLD 1 — SKC — SKD — 0 C 1 C 2 C 3 C 4 C 5 C 6 C 7 C 8 C 9 C 10 C 11 C 12 C 13 C 14 C 15 COM

SKA PLA — QC2 — 7 — RTM 2 — 18 PLC 1 — 18 PLD 1 — SKC — SKD — 0 C 1 C 2 C 3 C 4 C 5 C 6 C 7 C 8 C 9 C 10 C 11 C 12 C 13 C 14 C 15 COM

300-504/4 | 300-504/5

SHT.2

5 3 DIM2 — GND, COM, DIM2, DIM2 +, DIM2 −, G/Y, R, Bk — 0 1 2 3 15 — REFER TO DWG No:- 486/S/7-HG002

5 3 DIM3 — G/Y, R, Bk, DIM3, DIM3 +, DIM3 −, GND, COM — 0 1 2 3 15 — REFER TO DWG No:- 486/S/7-HG003

5 2 DOM1 — R, Bk, DOM1 +, DOM1 −, COM, Bk — 0 1 2 3 15 — REFER TO DWG No:- 486/S/7-HG002

5 3 AOM1 — GND, −VE, +VE, AOM1, AOM1 −, AOM1 +, G/Y, Bk, R — 0+ 0− 1+ 1− 2+ 2− 3+ 3− 7+ 7− — 651 652 653 654 — REFER TO DWG No:- 486/S/7-HG005 — NOT USED

5 6 14 2 DIM1 — GND, COM, DIM1, DIM1 +, DIM1 −, G/Y, R, Bk — 0 1 2 3 15 — REFER TO DWG No:- 486/S/7-HG004

5 6 14 2 — BAT LO +, BAT LO −, I/P UV +, I/P UV −, AL+, AL− — 0 1 2 3 15 — REFER TO DWG No:- 486/S/7-HG004

5 4 COM1 — COM1 +, COM1 −, Bk — 0+ 0− 6+ 6− 15+ 15− — SEE NOTE 1

5 4 AIM1 — GND1, GND2, AIM1, AIM1, G/Y, G/Y — 0+ 0− 6+ 6− 15+ 15− — REFER TO DWG No:- 486/S/7-HG005

5 2 DOM2 — R, Bk, DOM2 +, DOM2 −, COM, Bk — 0 1 2 3 15 — REFER TO DWG No:- 486/S/7-HG003

1. WIRING BETWEEN AIM's/COM's TERMINALS SHOW TYPICAL WIRING.
   i.e. EXTERNALLY POWERED CHANNELS 0 & 15
   INTERNALLY POWERED CHANNELS 6
   FOR ACTUAL INTERNAL POWERED CHANNELS REFER TO THE LIST BELOW:-
   AIM1/COM1 - 4, 5
   ALL OTHER CHANNELS ARE EXTERNALLY POWERED.
2. THIS DRAWING HAS BEEN PRODUCED FROM DRAWING No:- 1006-0553 SHEET 1 REV'N 5.
3. ALL ITEMS IN THE AREAS DELINEATED BY REVISION CLOUDS ARE NEW MODIFICATIONS.

SUPERCEDES DRAWING No:- 1006-0553 SHEET 1 REV'N 05

AS CONSTRUCTED
PLOTTED W.J. Lightbody DATE 8/00
CHECKED [illegible] DATE 8/00

NO.	DATE	AMENDMENT	INITIALS
A	8/00	AS CONSTRUCTED ISSUE	BPW
0	9/99	ORIGINAL ISSUE	

DIRECTOR OF P.D. & P.S. — DATE
ENGINEER IN CHARGE — R. BOWRING — 21/12/99 — DATE
SUPERVISING ENGINEER — NOTE 2 — R.P.E.Q. NO. — DATE

	NAME	DATE
DESIGN	NOTE 2 R.J.	20-12-99
DRAWN	NOTE 2	20-12-99
CHECKED		

Brisbane City

JOB FILE			
ACAD FILE	57HG010	SHEET SIZE	A1
SURVEY No.		FIELD BOOK	
SURVEYED		A.H. DATUM	

Brisbane Water

PROJECT: CENTENARY HIGHWAY SEWAGE PUMP STATION SP19

TITLE: R.T.U. CUBICLE POWER SUPPLIES WIRING DIAGRAM

SCALE NTS | N° 1 OF 2 SHEETS
DRAWING N° 486/5/7-HG010 | AMEND. A

DC–DC CONVERTER
I/P
O/P
DC–DC
DC–DC

PSU–11
RTU+ AUX1+ AUX2+ AUX3+ AUX4+ RTU– AUX1– AUX2– AUX3– AUX4– BAT+ BAT– BAT LO+ BAT LO– I/P UV+ I/P UV– GND GND
PL
SK
GND STUD
300–520/4
240V AC IN

1. THIS DRAWING HAS BEEN PRODUCED FROM DRAWING No:- 1006–0553 SHEET 2 REV'N 5.
2. ALL ITEMS IN THE AREAS DELINEATED BY REVISION CLOUDS ARE NEW MODIFICATIONS.

300–588
300–518
PL
SK
PORT A
PORT B
TRIO RADIO
SMA
TO ANTENNA LIGHTNING ARRESTOR

BAT–
BAT+
BATTERY
BATTERY
300–517

SHT.1 DWG.

POWER TERMINALS
AUX1+
DIM1+ RD
DIM2+ RD
DIM3+ RD
1+
AUX1–
DIM1– BK
DIM2– BK
DIM3– BK
1–
AUX1+
DOM1+ RD
DOM2+ RD
2+
AUX1–
DOM1– BK
DOM2– BK
2–
AUX2+
COM1+ RD
3+
AUX2–
COM1– BK
3–
AOM1+ RD
AOM1– BK
AUX2+
AUX–
CF+ RD
CF– BK
4+ RTU+
4– RTU–
DC–DC+ RD
DC–DC– BK
R+ AUX3+
R– AUX3–

EARTH BLOCK
DIM1 GN/YL
DIM2 GN/YL
DIM3 GN/YL
AIM1 GN/YL
AIM1 GN/YL
AOM1 GN/YL
CF GN/YL
1 2 3 4 5 6 7 8 9 10 11 12
GND (PSU STUD) GN/YL
TO CUBICLE EARTH

AL+
AL–
ATTENTION LIGHT RESET SWITCH

SUPERCEDES DRAWING No:- 1006–0553 SHEET 2 REV'N 05

AS CONSTRUCTED
PLOTTED DATE 8/00
CHECKED DATE 8/00

NO.	DATE	AMENDMENT	INITIALS
A	8/00	AS CONSTRUCTED ISSUE.	
0	01/99	ORIGINAL ISSUE.	RFW

DIRECTOR OF P.D. & P.S. DATE
ENGINEER IN CHARGE R. BOWRING 21/12/99 DATE
SUPERVISING ENGINEER NOTE 1 R.P.E.Q. NO. DATE

	NAME	DATE
DESIGN	NOTE 1 R.L.	3-12-99
DRAWN	NOTE 1	3-12-99
CHECKED		

Brisbane City

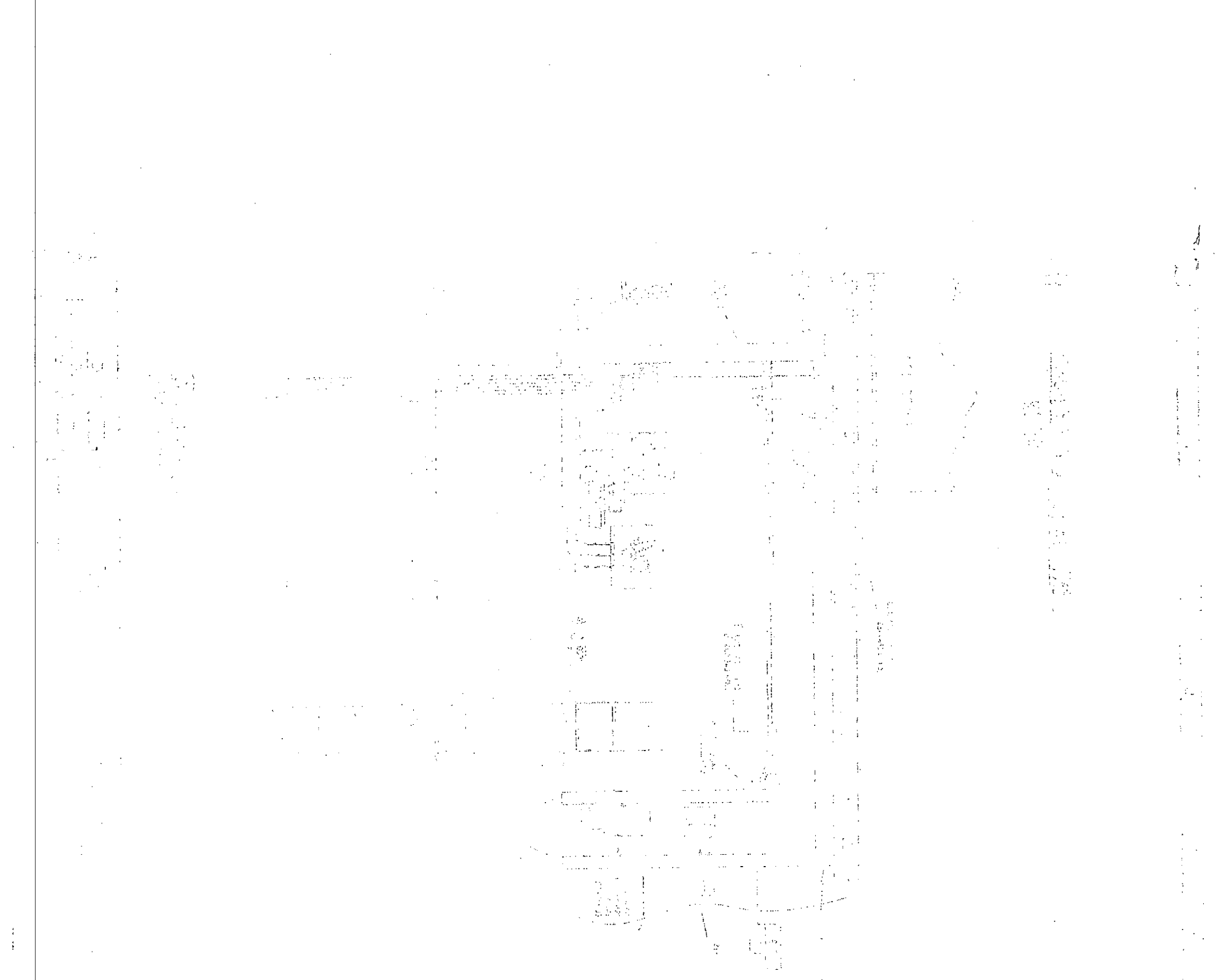
JOB FILE
ACAD FILE 57HG011 SHEET SIZE A1
SURVEY No. FIELD BOOK
SURVEYED A.H. DATUM

Brisbane Water

PROJECT
CENTENARY HIGHWAY
SEWAGE PUMP STATION SP19

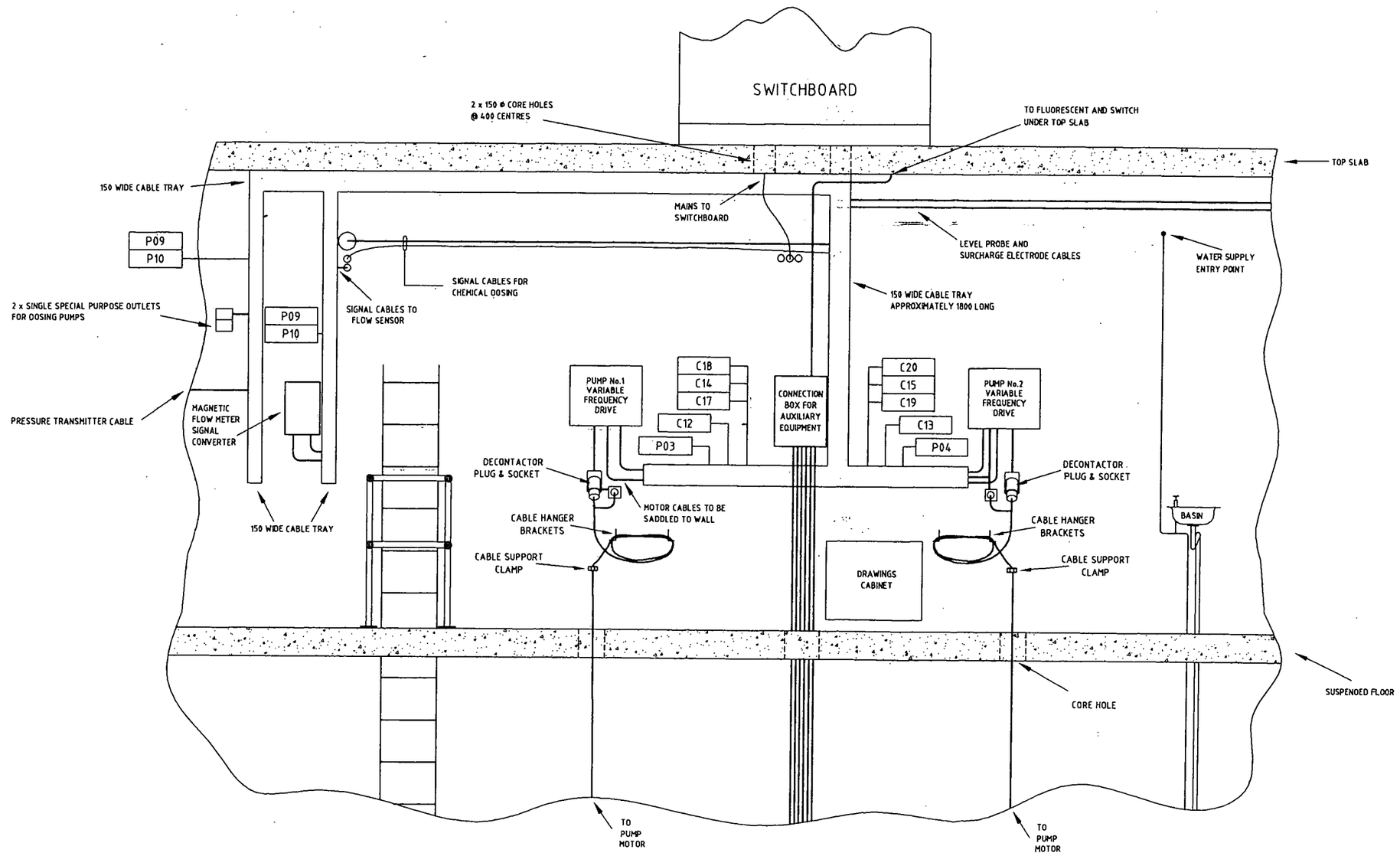
TITLE
R.T.U. CUBICLE
POWER SUPPLIES
CONNECTION DIAGRAM

SCALE NTS
N° 2 OF 2 SHEETS
DRAWING N° 486/5/7–HG011
AMEND. A



CENTENARY HIGHWAY PUMPING STATION
SP 19

1. THE ELEVATION HAS BEEN DRAWN TO AN APPROXIMATE SCALE ONLY. NO ALLOWANCE HAS BEEN MADE FOR THE CURVATURE OF THE WALLS.
2. CABLE NUMBERING PREFIXES:-
   'P' POWER AND EARTH (240V)
   'C' EXISTING CABLING OR NEW TO BE INSTALLED ON A PERMANENT BASIS.
   'D' TEMPORARY INTERCONNECTION BETWEEN R.T.U.'s.
   'X' COMMUNICATION CABLES - RADIO OR TELECOM.
3. THIS DRAWING HAS BEEN PRODUCED FROM DRAWING No:- 486/7/HG1T093E REV'N D.
4. ALL ITEMS IN THE AREAS DELINEATED BY REVISION CLOUDS ARE NEW MODIFICATIONS.



LEGEND

CONDUIT

DUCTING

SECTION A 092
SCALE:NTS

SUPERCEDES DRAWING No:- 486/7/HG1T093E REV'N D

AS CONSTRUCTED
PLOTTED [signature] DATE 8/00
CHECKED [signature] DATE 8/00

NO.	DATE	AMENDMENT	INITIALS
A	08/00	AS CONSTRUCTED ISSUE	
0	11/99	ORIGINAL ISSUE.	

DIRECTOR OF P.D. & P.S. — DATE
ENGINEER IN CHARGE R. BOWRING 21/12/99 DATE
SUPERVISING ENGINEER NOTE 3 R.P.E.Q. NO. DATE

	NAME	DATE
DESIGN	NOTE 3 R.J.	21-12-99
DRAWN	NOTE 3	21-12-99
CHECKED		

Brisbane City

JOB FILE			
ACAD FILE	57HG012	SHEET SIZE	A1
SURVEY No.		FIELD BOOK	
SURVEYED		A.H. DATUM	

Brisbane Water

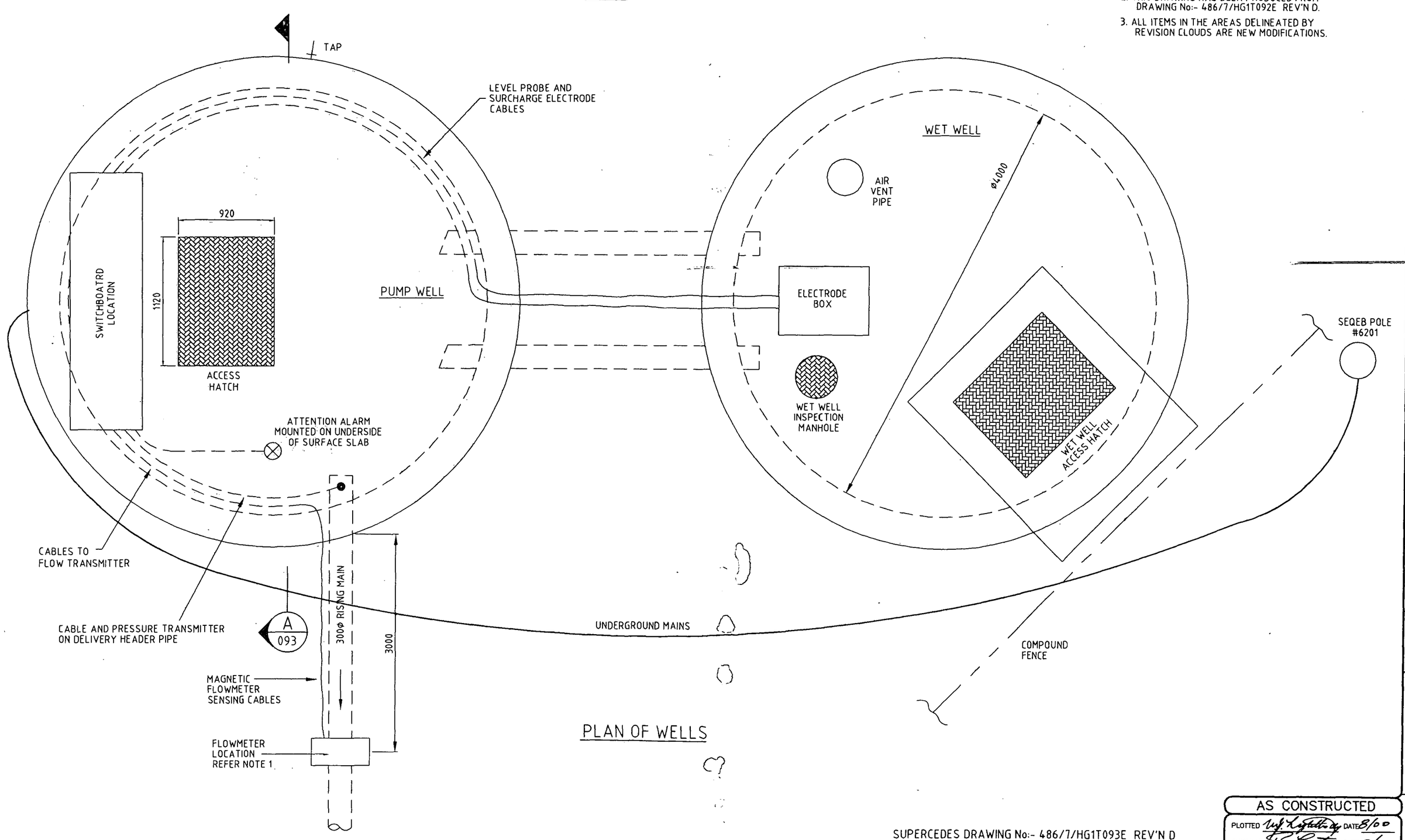
PROJECT: CENTENARY HIGHWAY SEWAGE PUMP STATION SP19

TITLE: DRY WELL ELECTRICAL EQUIPMENT GENERAL ARRANGEMENT

SCALE NTS | N° 1 OF 1 SHEETS
DRAWING N° 486/5/7-HG012 | AMEND. A

CENTENARY HIGHWAY PUMPING STATION
SP 19

1. REMOVE THE EXISTING ULTRASONIC FLOWMETER AND INSTALL NEW A.B.B. MAGMASTER MAGNETIC FLOWMETER. REF DWG:- 486/5/7-HG005.
2. THIS DRAWING HAS BEEN PRODUCED FROM DRAWING No:- 486/7/HG1T092E REV'N D.
3. ALL ITEMS IN THE AREAS DELINEATED BY REVISION CLOUDS ARE NEW MODIFICATIONS.



PLAN OF WELLS

SUPERCEDES DRAWING No:- 486/7/HG1T093E REV'N D

AS CONSTRUCTED
PLOTTED DATE 8/00
CHECKED DATE 8/00

NO.	DATE	AMENDMENT	INITIALS
A	08/99	AS CONSTRUCTED ISSUE.	
D	01/99	ORIGINAL ISSUE.	RFW

DIRECTOR OF P.D. & P.S. — DATE
ENGINEER IN CHARGE R. BOWRING 21/12/99 — DATE
SUPERVISING ENGINEER NOTE 2 R.P.E.Q. NO. — DATE

	NAME	DATE
DESIGN	NOTE 2 R.J.	21-12-99
DRAWN	NOTE 2	21-12-99
CHECKED		

Brisbane City

JOB FILE			
ACAD FILE	57HG013	SHEET SIZE	A1
SURVEY No.		FIELD BOOK	
SURVEYED		A.H. DATUM	

Brisbane Water

PROJECT: CENTENARY HIGHWAY SEWAGE PUMP STATION SP19

TITLE: DRY & WET WELL PLAN ELECTRICAL EQUIPMENT GENERAL ARRANGEMENT

SCALE NTS | N° 1 OF 1 SHEETS

DRAWING N° 486/5/7-HG013 | AMEND. A