Instruction Manual

VLT® 4000 VT

■ Contents

VLT 4000 VT

176FA141.12

Instruction Manual
Software version: 1.0x

This Instruction Manual can be used for all VLT 4000 VT, Adjustable Frequency Drives (AFD) with software version 1.0x. The software version number can be seen from parameter 624 *Software version no.*
cUL pending for VLT 4452-4652, 380-460 V

The voltage of the adjustable frequency drive is dangerous whenever the equipment is connected to line. Incorrect installation of the motor or the AFD 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 AFD must be disconnected from the line if repair work is to be carried out. Check that the line supply has been disconnected and that the necessary time has passed before removing motor and line plugs.
2. The [OFF/STOP] key on the control panel of the VLT AFD does not disconnect the equipment from line and is thusnot to be used as a safety switch.
3. Correct protective grounding 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 the National Electrical Code and local codes.
4. The ground leakage currents are higher than 3.5mA.
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. Note: The function is initialised at 1.0 x rated motor current and rated motor frequency *(see parameter 117, Motor thermal protection)*. In UL/cUL applications ETR provides Class 20, over-load protection in accordance with the NEC ® .
6. Do not remove the plugs for the motor and line supply while the VLT AFD is connected to line. Check that the line supply has been disconnected and that the necessary time has passed before removing motor and line 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 AFD has more voltage inputs than L1, L2, L3 when the DC-bus terminals or AUX 24 V option 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 AFD is connected to line. 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 AFD, or if a temporary overload or a fault in the supply line or the motor connection ceases.

Warning:

Touching the electrical parts may be fatal - even after the equipment has been disconnected from line.

Using VLT: wait at least 20 minutes for 200 and 400 V units
wait at least 30 minutes for 525-600 V units

Using VLT 4452-4652, 380-460 V: Wait at least 40 minutes!

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It is the responsibility of the user or the person installing the VLT to provide proper grounding, as well as motor overload and branch circuit protection according to the National Electrical Code (NEC ®) and local codes.

NOTE

Electrostatic Precaution; Electrostatic discharge (ESD). Many electronic components are sensitive to static electricity. Voltages so low that they cannot be felt, seen or heard, can reduce the life, affect performance, or completely destroy sensitive electronic components. When performing service, proper ESD equipment should be used to prevent possible damage from occurring.

The VLT Adjustable Frequency Drive contains dangerous voltages when connected to line voltage. After disconnecting from the line wait at least 20 minutes for 200 and 400 V units (VLT 4452-4652: Wait at least 40 minutes) and 30 minutes for 525-600 V units before touching any electrical components. Also make sure that other voltage inputs have been disconnected, such as external 24 VDC, load-sharing (linkage of DC intermediate circuit), as well as the motor connection for kinetic back-up. Only a competent electrician should carry out the electrical installation. Improper installation of the motor or the VLT may cause equipment failure, serious injury or death. Follow this manual and National Electrical Codes (NEC) and local safety codes.

■ Introduction to this Instruction Manual

This Instruction Manual is divided into four sections with information about VLT 4000 VT.

Introduction:	This section tells you the advantages you can obtain by using a VLT 4000 VT - such as AEO, Automatic Energy Optimization, and other variable torque relevant functions. This section also contains examples of applications as well as information about Danfoss.
Installation:	This section tells you how to carry out a mechanically correct installation of the VLT 4000 VT. Furthermore, a list is given of line 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 4000 VT. Also included is a guide to the Quick Setup menu, which allows you to get started on your application very quickly.
All about VLT 4000 VT:	This section gives information about status, warning and error messages from the VLT 4000 VT. Additionally, information is given on technical data, ser-vice, factory settings and special conditions.

NOTE
Indicates something to be noted by the reader.

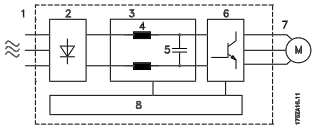
Indicates a general warning

Indicates a high-voltage warning

■ Control principle

An AFD rectifies AC voltage from line 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.

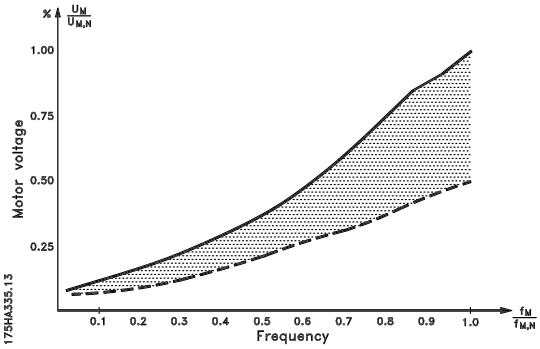


1. Line voltage
   3 x 200 - 240 V AC, 50 / 60 Hz
   3 x 380 - 460 V AC, 50 / 60 Hz
   3 x 525 - 600 V AC, 50 / 60 Hz.
2. Rectifier
   A three-phase rectifier bridge that rectifies AC current into DC current.
3. Intermediate circuit
   DC voltage = √2 x line voltage [V].
4. Intermediate circuit coils
   Even out the intermediate circuit voltage and reduce the harmonic current feedback to the line 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 line supply voltage.
8. Control card

■ 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 sol-ved by using a VLT 4000 VT with its integral Automatic Energy Optimization (AEO), which ensures optimum energy utilization. All VLT 4000 VT units feature this function as a factory setting, i.e. it is not necessary to adjust the AFD U/f ratio in order to obtain maximum energy savings. In other AFDs, the given load and voltage/frequency ratio (U/f) must be assessed to carry out correct setting of the AFD. Using Automatic Energy Optimization (AEO), you no longer need to calculate or assess the system characteristics of the installation, since Danfoss VLT 4000 VT 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 AFD 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 volume system
- Compensation in the oversynchronous working range
- Reduces acoustic motor noise

■ Serial communication

Serial communication allows monitoring, programming and controlling one or several units from a centrally placed computer.
All VLT 4000 VT units have a RS 485 port as standard.

■ 500-537 Serial communication

NOTE
Information on the use of RS 485 serial interface is not included in this manual. Please contact Danfoss and ask for information concerning serial communication.

■ Unpacking and ordering a VLT Adjustable Frequency Drive (AFD)

If you are in doubt as to which VLT AFD 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 4000 VT.

■ Type code ordering number string

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

VLT-4008-V-T4-CN1-ST-R0-DL-F00-A31-C0

This means that the AFD ordered is a VLT 4008 for three-phase line voltage of 380-460 V (**T4**) in Compact enclosure NEMA 1 (**CN1-ST**). The hardware variant is a standard unit without integral RFI filter, (R0). The AFD features a dis-play unit (**DL**) with no field bus option card (**F00**), and the 4 relay Card Option (**A31**) . Character no. 8 (**V**) indicates the application range of the unit: **V** = Industry dedicated (Variable Torque).

Hardware variants

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

Hardware variant

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

ST: Standard unit with or without control unit. Most of the types are with DC terminals, please see *DC bus connection* for exceptions.

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

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

PF: Standard unit with 24 V DC supply for back-up of control PCB and built-in main fuses. No DC terminals.

PS: Standard unit with 24 V DC supply for back-up of control PCB. No DC terminals.

PD: Standard unit with 24 V DC supply for back-up of control PCB, built-in main fuses and disconnect. No DC terminals.

Conformal Coating

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

200-240 V

Typecode	T2	C00	C20	CN1	C54	ST	R0	R1	R3
Position in string	9-10	11-13	11-13	11-13	11-13	14-15	16-17	16-17	16-17
4.0 kW/5.0 HP	4006		X	((X))	X	X	X		X
5.5 kW/7.5 HP	4008		X	((X))	X	X	X		X
7.5 kW/10 HP	4011		X	((X))	X	X	X		X
11 kW/15 HP	4016		X	((X))	X	X	X		X
15 kW/20 HP	4022		X	((X))	X	X	X		X
18.5 kW/25 HP	4027		X	((X))	X	X	X		X
22 kW/30 HP	4032		X	((X))	X	X	X		X
30 kW/40 HP	4042	X		X	X	X	X	X	
37 kW/50 HP	4052	X		X	X	X	X	X	
45 kW/60 HP	4062	X		X	X	X	X	X	

380-460 V

Typecode	T4	C00	C20	CN1	C54	ST	EX	DX	PS	PD	PF	R0	R1	R3
Position in string	9-10	11-13	11-13	11-13	11-13	14-15	14-15	14-15	14-15	14-15	14-15	16-17	16-17	16-17
4.0 kW/5.0 HP	4006		X	X	X	X						X		X
5.5 kW/7.5 HP	4008		X	X	X	X						X		X
7.5 kW/10 HP	4011		X	X	X	X						X	X	
11 kW/15 HP	4016		X	((X))	X	X						X		X
15 kW/20 HP	4022		X	((X))	X	X						X		X
18.5 kW/25 HP	4027		X	((X))	X	X						X		X
22 kW/30 HP	4032		X	((X))	X	X						X		X
30 kW/40 HP	4042		X	((X))	X	X						X		X
37 kW/50 HP	4052		X	((X))	X	X						X		X
45 kW/60 HP	4062		X	((X))	X	X						X		X
55 kW/75 HP	4072		X	((X))	X	X						X		X
75 kW/100 HP	4102		X	((X))	X	X						X		X
90 kW/125 HP	4122		X	((X))	X	X						X		X
110 kW/150 HP	4152	X		X	X	X	X	X	X	X	X	X	X	
132 kW/200 HP	4202	X		X	X	X	X	X	X	X	X	X	X	
160 kW/250 HP	4252	X		X	X	X	X	X	X	X	X	X	X	
200 kW/300 HP	4302	X		X	X	X	X	X	X	X	X	X	X	
250 kW/350 HP	4352	X		X	X	X	X	X	X	X	X	X	X	
315 kW/450 HP	4452	X		X	X	X	X	X	X	X	X	X	X	
355 kW/500 HP	4502	X		X	X	X	X	X	X	X	X	X	X	
400 kW/550 HP	4602	X		X	X	X	X	X	X	X	X	X	X	
450 kW/600 HP	4652	X		X	X	X	X	X	X	X	X	X	X	

(X): Compact Chassis (C00) enclosure not available with DX

((X)): Not with built-in RFI filter (R3)

Voltage

T2: 200-240 VAC

T4: 380-460 VAC

Enclosure

C00: Compact IP 00

C20: Compact IP 20

CN1: Compact NEMA 1

C54: Compact IP 54

Hardware variant

ST: Standard

EX: Extended with 24 V supply and DC terminals

DX: Extended with 24 V supply, DC terminals, disconnect and fuse

PS: Standard with 24 V supply

PD: Standard with 24 V supply, fuse and disconnect

PF: Standard with 24 V supply and fuse

RFI filter

R0: Without filter

R1: Class A1 filter

R3: Class A1 and B filter

525-600 V

Typecode	T6	C00	C20	CN1	ST	R0
Position in string	9-10	11-13	11-13	11-13	14-15	16-17
4.0 kW/5.0 HP	4006		X	X	X	X
5.5 kW/7.5 HP	4008		X	X	X	X
7.5 kW/10 HP	4011		X	X	X	X
11 kW/15 HP	4016			X	X	X
15 kW/20 HP	4022			X	X	X
18.5 kW/25 HP	4027			X	X	X
22 kW/30 HP	4032			X	X	X
30 kW/40 HP	4042			X	X	X
37 kW/50 HP	4052			X	X	X
45 kW/60 HP	4062			X	X	X
55 kW/75 HP	4072			X	X	X

T6: 525-600 VAC
C00: Compact IP 00
C20: Compact IP 20
CN1: Compact NEMA 1
ST: Standard
R0: Without filter

VLT 4102-4402, 525-600 V

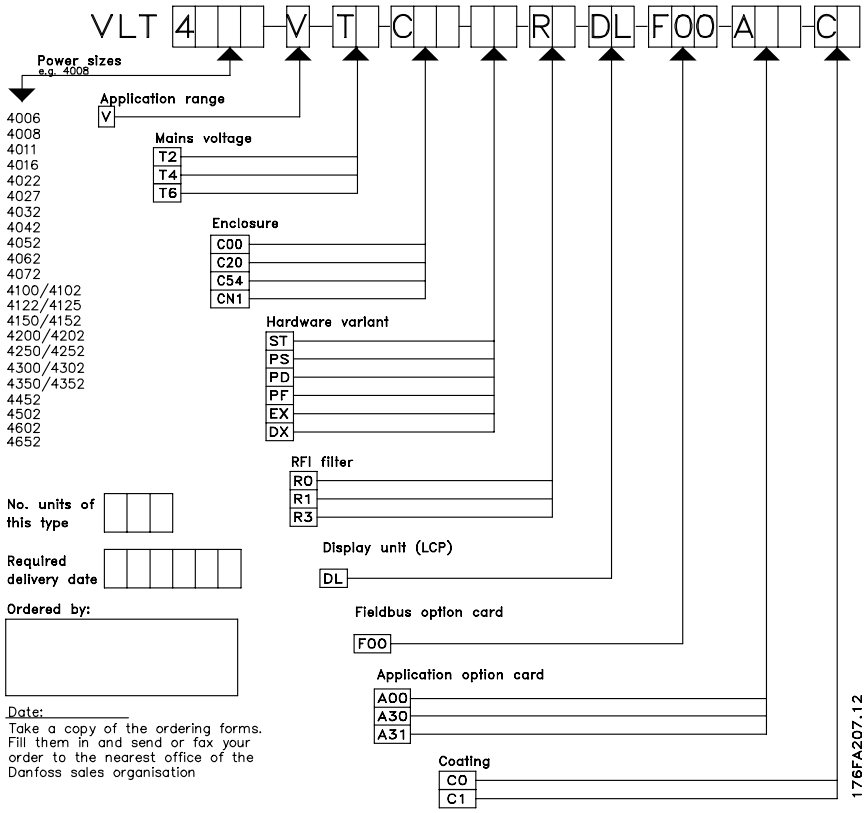
Typecode	T6	C00	CN1	C54	ST	EX	DX	PS	PD	PF	R0
Position in string	9-10	11-13	11-13	11-13	14-15	14-15	14-15	14-15	14-15	14-15	16-17
75 kW / 100 HP	4102	X	X	X	X	X	X	X	X	X	X
90 kW / 125 HP	4122	X	X	X	X	X	X	X	X	X	X
110 kW / 150 HP	4152	X	X	X	X	X	X	X	X	X	X
132 kW / 200 HP	4202	X	X	X	X	X	X	X	X	X	X
160 kW / 250 HP	4252	X	X	X	X	X	X	X	X	X	X
200 kW / 300 HP	4302	X	X	X	X	X	X	X	X	X	X
250 kW / 350 HP	4352	X	X	X	X	X	X	X	X	X	X
315 kW / 400HP	4402	X	X	X	X	X	X	X	X	X	X

Optional selections, 200-600 V

Application option	Position: 23-25
A00	No options
A30	Aux. relay option (1 relay)
A31	Relay card 4 relays
Coating	Position: 26-27
C0[1)]	No coating
C1	With coating

1) Not available for power sizes from 4450 to 4600

■ Ordering form VLT 4000 VT



■ General technical data

Line 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 voltage 525-600 V units	3 x 525/550/575/600 V ±10%
Supply frequency	48-62 Hz +/- 1%

Max. imbalance of supply voltage:

VLT 4006 - 4011 VT / 380 - 460 V and 525 - 600 V	±2.0% of rated supply voltage
VLT 4016 - 4062 VT / 380 - 460 V and VLT 4006 - 4032 VT / 200 - 240 V	±1.5% of rated supply voltage
VLT 4016 - 4072 VT / 525 - 600 V	±1.5% of rated supply voltage
VLT 4072 - 4652 VT / 380 - 460 V and VLT 4042 - 4062 VT / 200 - 240 V	±3.0% of rated supply voltage
VLT 4102 - 4402 VT / 525 - 600 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/2 min.
Max. short-circuit current	100.000 A

VLT output data (U, V, W):

Output voltage	0-100% of supply voltage
Output frequency:	
Output frequency 4006-4032, 200-240V	0-120 Hz, 0-1000 Hz
Output frequency 4042-4062, 200-240V	0-120 Hz, 0-450 Hz
Output frequency 4006-4062, 380-460V	0-120 Hz, 0-1000 Hz
Output frequency 4072-4652, 380-460V	0-120 Hz, 0-450 Hz
Output frequency 4006-4016, 525-600V	0-120 Hz, 0-1000 Hz
Output frequency 4022-4062, 525-600V	0-120 Hz, 0-450 Hz
Output frequency 4072, 525-600V	0-120 Hz, 0-450 Hz
Output frequency 4102-4352, 525-600V	0-132 Hz, 0-200 Hz
Output frequency 4402, 525-600V	0-132 Hz, 0-150 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 V
Rated motor voltage, 525-600 V units	525/550/575 V
Rated motor frequency	50/60 Hz
Switching on output	Unlimited
Ramp times	1 - 3600 sec.

Torque characteristics:

Starting torque	110% for 1 min.
Starting torque (parameter 110 *High break-away torque*)	Max. torque: 130% 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.
VLT 4006-4072 VT, 525-600 V, do not meet PELV requirements.

Control card, analog inputs:

No. of programmable analog voltage inputs/thermistor inputs 2
Terminal nos. 53, 54
Voltage level ..... 0 - 10 V DC (scalable)
Input resistance, R_i ..... approx. 10kΩ
No. of programmable analog 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 analog inputs are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.
VLT 4006-4072 VT, 525-600 V, do not meet PELV requirements.

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.
VLT 4006-4072 VT, 525-600 V, do not meet PELV requirements.

Control card, digital/pulse and analog outputs:

No. of programmable digital and analog outputs 2
Terminal nos. 42, 45
Voltage level at digital/pulse output ..... 0 - 24 V DC
Minimum load to frame (terminal 39) at digital/pulse output ..... 600 Ω

Frequency ranges (digital output used as pulse output) ..... 0-32 kHz
Current range at analog output ..... 0/4 - 20 mA
Maximum load to frame (terminal 39) at analog output ..... 500 Ω
Accuracy of analog output ..... Max. error: 1.5% of full scale
Resolution on analog output. ..... 8 bit
Reliable galvanic isolation: All digital and analog outputs are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.
VLT 4006-4072 VT, 525-600 V, do not meet PELV requirements.

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 analog outputs.

Control card, RS 485 serial communication :

Terminal nos. ..... 68 (TX+, RX+), 69 (TX-, RX-)
Reliable galvanic isolation: Full galvanic isolation (PELV).

Relay outputs:[1)]

No. of programmable relay outputs 2
Terminal nos., control card (resistive load only) ..... 4-5 (make)
Max. terminal load (AC1) on 4-5, control card ..... 50 V AC, 1 A, 50 VA
Max. terminal load (DC1 (IEC 947)) on 4-5, control card ..... 25 V DC, 2 A / 50 V DC, 1 A, 50 W
Max. terminal load (DC1) on 4-5, control card for UL/cUL applications ..... 30 V AC, 1 A / 42.5 V DC, 1A
Terminal nos., power card (resistive and inductive load) ..... 1-3 (break), 1-2 (make)
Max. terminal load (AC1) on 1-3, 1-2, power card ..... 250 V AC, 2 A, 500 VA
Max. terminal load (DC1 (IEC 947)) on 1-3, 1-2, power card ..... 25 V DC, 2 A / 50 V DC, 1A, 50 W
Min. terminal load (AC/DC) on 1-3, 1-2, power card ..... 24 V DC, 10 mA / 24 V AC, 100 mA

1) Rated values for up to 300,000 operations.
At inductive loads the number of operations are reduced by 50%, alternatively the current can be reduced by 50%, thus the 300,000 operations are maintained.

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, shielded cable ..... 500 feet
Max. motor cable length, unshielded cable ..... 1000 feet
Max. motor cable length, shielded cable VLT 4011 380-460 V ..... 330 feet
Max. motor cable length, shielded cable VLT 4011 525-600 V ..... 165 feet

Max. DC-bus cable length, shielded cable ..... 25 m from AFD to DC bar.
Max. loadsharing cable length, screened cable ..... 25 m from frequency converter to DC bar.
Max. cable cross-section to motor, see next section
Max. cross-section for control cables ..... 1.5 mm ^{2}/16 AWG
Max. cross-section for serial communication ..... 1.5 mm^2/16 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, 0 - 140% load ..... Max. error: ±2.0% of rated output current
Power kW, Power HP, 0 - 90% load ..... Max. error: ±5.0% of rated output power

Externals:

Enclosure ..... Chassis, NEMA 1, NEMA 12
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 Chassis/NEMA 1/NEMA 12 ..... Max. 45°C (24-hour average max. 40°C)
Ambient temperature NEMA 1/NEMA 12 VLT 4011 460 V ..... 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 ..... 3300 feet
see Derating for high air pressure

VLT 4000 VTprotection:

- Electronic motor thermal protection against overload.
- Temperature monitoring of heat-sink ensures that the VLT AFD cuts out if the temperature reaches 90°C for Chassis and NEMA 1. For NEMA 12, 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.

For the units mentioned below, the limits are as follows:

- VLT 4152, 380-460 V, cuts out at 75 °C and can be reset if the temperature is below 60 °C.
- VLT 4202, 380-460 V, cuts out at 80 °C and can be reset if the temperature has fallen below 60° C.
- VLT 4252, 380-460 V, cuts out at 95 °C and can be reset if the temperature has fallen below 65° C.
- VLT 4302, 380-460 V, cuts out at 95 °C and can be reset if the temperature has fallen below 65° C.
- VLT 4352, 380-460 V, cuts out at 105 °C and can be reset if the temperature has fallen below 75° C.
- VLT 4452-4652, 380-460 V, cuts out at 85° C and can be reset if the temperature has fallen below 60°.
- VLT 4102-4152, 525-600 V, cuts out at 75° C and can be reset if the temperature has fallen below 60° C.
- VLT 4202, 525-600 V, cuts out at 80° C and can be reset if the temperature has fallen below 60° C.
- VLT 4252-4402, 525-600 V, cuts out at 100° C and can be reset if the temperature has fallen below 70° C.

- The VLT AFD is protected against short-circuiting on motor terminals U, V, W.
- The VLT AFD is protected against ground fault on motor terminals U, V, W.
- Monitoring of the intermediate circuit voltage ensures that the VLT AFD cuts out if the intermediate circuit voltage gets too high or too low.
- If a motor phase is missing, the VLT AFD cuts out.
- If there is a line fault, the VLT AFD is able to carry out a controlled deramping.
- If a line phase is missing, the VLT AFD will cut out when a load is placed on the motor.

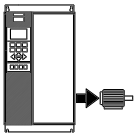
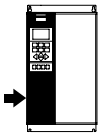
■ Line supply 3 x 200 - 240 V

According to international requirements	VLT type	4006	4008	4011
Output current	$I_{VLT,N}$ [A]	16.7	24.2	30.8
	$I_{VLT,\ MAX}$(60 s) [A]	18.4	26.6	33.9
Output (240 V)	$S_{VLT,N}$ [kVA]	6.9	10.1	12.8
Typical shaft output	$P_{VLT,N}$ [kW]	4.0	5.5	7.5
Typical shaft output	$P_{VLT,N}$ [HP]	5	7.5	10
Max. cable cross-section to motor,brake and DC-bus	[mm²]/[AWG] 2)	4/10	16/6	16/6
Max. input current	(200 V)(RMS) $I_{L,N}$ [A]	16.0	23.0	30.0
Max. cable cross-section power [mm²]/[AWG] 2)		4/10	16/6	16/6
Max. line-fuses	[A]/UL 1) [A]	50	50	50
Efficiency 3)		0.96		
Weight NEMA 1	[lbs]	51	51	51
Weight NEMA 12	[lbs]	77	77	84
Power loss at max. load. [W]	Total	194	194	545
Enclosure	VLT type	NEMA 1/NEMA 12		

According to international requirements	VLT type	4016	4022	4027	4032	4042	4052	4062
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] 2)	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 4)	90/250mcm 4)	120/300mcm 4)
Min. cable, cross-section, power [mm²]/[AWG] 2)		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] 2)	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 4)	90/250mcm 4)	120/300mcm 4)
Max. line-fuses	[A]/UL 1) [A]	60	80	125	125	150	200	250
Efficiency 3)		0.95						
Weight Chassis	[lbs]	-	-	-	-	180	180	180
Weight NEMA 1	[lbs]	46	60	60	96	202	202	202
Weight NEMA 12	[lbs]	76	98	100	110	208	208	208
Power loss at max. load.:	W	545	783	1042	1243	1089	1361	1613
Enclosure		NEMA 1, NEMA 12						

1. See section *Fuses*
2. American Wire Gauge
3. Measured using 100 ft. shielded motor cable at rated load and rated frequency.
4. Connection stud 1 x M8 / 2 x M8.

■ Line supply 3 x 380 - 460 V

According to international requirements		VLT type	4006	4008	4011
	Output current	$I_{VLT,N}$ [A] (380-440 V)	10.0	13.0	16.0
		$I_{VLT,\ MAX}$(60 s) [A] (380-440 V)	11.0	14.3	17.6
		$I_{VLT,N}$ [A] (441-460 V)	8.2	11.0	14.0
		$I_{VLT,\ MAX}$ (60 s) [A] (441-460 V)	9.0	12.1	15.4
	Output	$S_{VLT,N}$ [kVA] (400 V)	7.2	9.3	11.5
		$S_{VLT,N}$ [kVA] (460 V)	6.5	8.8	11.2
	Typical shaft output	$P_{VLT,N}$ [kW]	4.0	5.5	7.5
	Typical shaft output	$P_{VLT,N}$ [HP]	5	7.5	10
	Max. cable cross-section to motor and DC-bus	[mm²]/[AWG] 2)	4/10	4/10	4/10
	Max. input current (RMS)	$I_{L,N}$[A] (380 V)	9.1	12.2	15.0
		$I_{L,N}$[A] (460 V)	8.3	10.6	14.0
	Max. cable cross-section, power	[mm²]/[AWG] 2)	4/10	4/10	4/10
	Max. line-fuses 1)	[A]/UL [A]	25/20	25/20	35/30
	Efficiency 3)		0.96		
	Weight NEMA 1	[lbs]	21	21	21
	Weight NEMA 12	[lbs]	28	28	28
	Power loss at max. load. [W]	Total	198	250	295
	Enclosure	VLT type	Compact NEMA 1/NEMA 12		

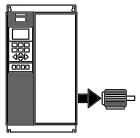
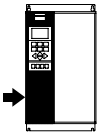
1 See section *Fuses*.

2 American Wire Gauge.

3 Measured using 100 feet shielded 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.

■ Line supply 3 x 380 - 460 V

According to international requirements		VLT type	4016	4022	4027	4032	4042
	Output current	$I_{VLT,N}$ [A] (380-440 V)	24.0	32.0	37.5	44.0	61.0
		$I_{VLT, MAX}$(60 s) [A] (380-440 V)	26.4	35.2	41.3	48.4	67.1
		$I_{VLT,N}$ [A] (441-460 V)	21.0	27.0	34.0	40.0	52.0
		$I_{VLT, MAX}$ (441-460 V)	23.1	29.7	37.4	44.0	57.2
	Output	$S_{VLT,N}$ [kVA] (400 V)	17.3	23.0	27.0	31.6	43.8
		$S_{VLT,N}$ [kVA] (460 V)	16.7	21.5	27.1	31.9	41.4
	Typical shaft output	$P_{VLT,N}$ [kW]	11	15	18.5	22	30
	Typical shaft output	$P_{VLT,N}$ [HP]	15	20	25	30	40
	Max. cable cross-section to motor and DC-bus	[mm²]/[AWG] 2)	16/6	16/6	16/6	16/6	35/2
	Min. cable. cross-section to motor and DC-bus 4)	[mm²]/[AWG] 2)	10/8	10/8	10/8	10/8	10/8
	Max. input current	$I_{L,N}$ [A] (380 V)	24.0	32.0	37.5	44.0	60.0
	(RMS)	$I_{L,N}$ [A] (460 V)	21.0	27.6	34.0	41.0	53.0
	Max. cable, cross-section, power	[mm²]/[AWG] 2)	16/6	16/6	16/6	16/6	35/2
	Max. line-fuses	[A]/UL 1) [A]	63/40	63/40	63/50	63/60	80/80
	Efficiency at rated frequency		0.96				
	Weight NEMA 1	[lbs]	21	46	46	60	60
	Weight NEMA 12	[lbs]	28	96	96	102	122
	Power loss at max. load.:	W	419	559	655	768	1065
	Enclosure		NEMA 1/NEMA 12				

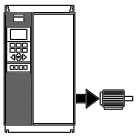
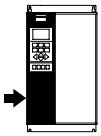
1. See section *Fuses*.

2. American Wire Gauge

3. Measured using 100 feet shielded motor cable at rated load and rated frequency.

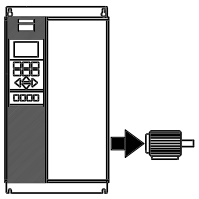
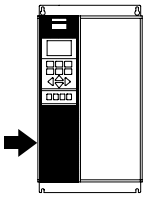
4. Min. cable cross-section is the smallest cable cross-section allowed to be fitted on the terminals. Always comply with national and local regulations on min. cable cross-section.

■ Line supply 3 x 380 - 460 V

According to international requirements		VLT type	4052	4062	4072	4102	4122
	Output current	$I_{VLT,N}$ [A] (380-440 V)	73.0	90.0	106	147	177
		$I_{VLT, MAX}$(60 s) [A] (380-440 V)	80.3	99.0	117	162	195
		$I_{VLT,N}$ [A] (441-460 V)	65.0	77.0	106	130	160
		$I_{VLT, MAX}$ (441-460 V)	71.5	84.7	117	143	176
	Output	$S_{VLT,N}$ [kVA] (400 V)	52.5	64.7	73.4	102	123
		$S_{VLT,N}$ [kVA] (460 V)	51.8	61.3	84.5	104	127
	Typical shaft output	$P_{VLT,N}$ [kW]	37	45	55	75	90
	Typical shaft output	$P_{VLT,N}$ [HP]	50	60	75	100	125
	Max. cable cross-section to motor and DC-bus	[mm²]/[AWG] 2)	35/2	50/0	50/0	120 /250 mcm5)	120 /250 mcm5)
	Min. cable. cross-section to motor and DC-bus 4)	[mm²]/[AWG] 2)	10/8	16/6	16/6	25/4	25/4
	Max. input current (RMS)	$I_{L,N}$ [A] (380 V)	72.0	89.0	104	145	174
		$I_{L,N}$ [A] (460 V)	64.0	77.0	104	128	158
	Max. cable, cross-section, power	[mm²]/[AWG] 2)	35/2	50/0		120 /250 mcm5)	120 /250 mcm5)
	Max. line-fuses	[A]/UL 1) [A]	100/100	125/125	150/150	225/225	250/250
	Efficiency at rated frequency		0.96	0.96	0.96	0.98	0.98
	Weight NEMA 1	[lbs]	96	96	106	119	119
	Weight NEMA 12	[lbs]	134	140	154	170	170
	Power loss at max. load.:	W	1275	1571	1851	<1400	<1600
	Enclosure				NEMA 1/NEMA 12		

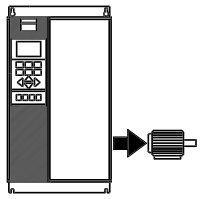
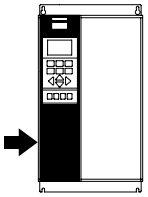
1. See section *Fuses*.
2. American Wire Gauge.
3. Measured using 100 feet shielded motor cable at rated load and rated frequency.
4. Min. cable cross-section is the smallest cable cross-section allowed to be fitted on the terminals. Always comply with national and local regulations on min. cable cross-section.
5. DC connection 95 mm²/AWG 3/0.

■ Line supply 3 x 380 - 460 V

According to international requirements		VLT type	4152	4202	4252	4302	4352
	Output current	$I_{VLT,N}$ [A] (380-440 V)	212	260	315	395	480
		$I_{VLT, MAX}$ (60 s) [A] (380-440 V)	233	286	347	435	528
		$I_{VLT,N}$ [A] (441-460 V)	190	240	302	361	443
		$I_{VLT, MAX}$ (60 s) [A] (441-460 V)	209	264	332	397	487
	Output power	$S_{VLT,N}$ [kVA] (400 V)	147	180	218	274	333
		$S_{VLT,N}$ [kVA] (460 V)	151	191	241	288	353
	Typical shaft output (400 V) $P_{VLT,N}$ [kW]		110	132	160	200	250
	Typical shaft output (460 V) $P_{VLT,N}$ [HP]		150	200	250	300	350
	Max. cable cross-section to motor and DC-bus [mm^2][2) 4) 5)]		2x70	2x70	2x185	2x185	2x185
	Max. cable cross-section to motor and DC-bus [AWG] [2) 4) 5)]		2x2/0	2x2/0	2x350 mcm	2x350 mcm	2x350 mcm
	Min. cable cross-section to motor and DC-bus [mm^2/AWG] [2) 4) 5)]		35/2	35/2	35/2	35/2	35/2
	Max. input current (RMS)	$I_{L,N}$[A] (380 V)	208	256	317	385	467
		$I_{L,N}$[A] (460 V)	185	236	304	356	431
	Max. cable cross-section to power [mm^2][2) 4) 5)]		2x70	2x70	2x185	2x185	2x185
	Max. cable cross-section to power [AWG][2) 4) 5)]		2x2/0	2x2/0	2x350 mcm	2x350 mcm	2x350 mcm
	Max. pre-fuses	[-]/UL[1)] [A]	300/300	350/350	450/400	500/500	630/600
	Weight Chassis	[lbs]	182	202	248	273	306
	Weight NEMA 1	[lbs]	213	231	277	302	335
	Weight NEMA 12	[lbs]	213	231	377	302	335
	Efficiency at rated frequency		0.98				
	Power loss at max. load.	[W]	2619	3309	4163	4977	6107
	Enclosure		Chassis/NEMA 1/NEMA 12				

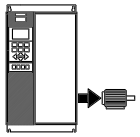
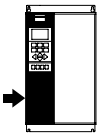
1. For type of fuse, see section *Fuses*.
2. American Wire Gauge.
3. Measured using 100 ft screened motor cables at rated load and rated frequency.
4. Min. cable cross-section is the smallest cable cross-section allowed to be fitted on the terminals. Max. cable cross section is the maximum possible cable cross section that can be fitted on the terminals.
Always comply with national and local regulations on min. cable cross-section.
5. Connection bolt 1 x M10 / 2 x M10 (mains and motor), connection bolt 1 x M8 / 2 x M8 (DC-bus).

■ Line supply 3 x 380 - 460 V

According to international requirements		VLT type	4452	4502	4605	4652
	Output current	$I_{VLT,N}$ [A] (380-440 V)	600	658	745	800
		$I_{VLT,MAX}$ (60 s) [A] (380-440 V)	660	724	820	880
		$I_{VLT,N}$ [A] (441-460 V)	540	590	678	730
		$I_{VLT,MAX}$ (60 s) [A] (441-460 V)	594	649	746	803
	Output power	$S_{VLT,N}$ [kVA] (400 V)	416	456	516	554
		$S_{VLT,N}$ [kVA] (460 V)	430	470	540	582
	Typical shaft output (380-440 V) $P_{VLT,N}$ [kW]		315	355	400	450
	Typical shaft output (441-460 V) $P_{VLT,N}$ [HP]		450	500	550/600	600
	Max. cable cross-section to motor and DC-bus [mm²] [4) 5)]		4 x 240	4 x 240	4 x 240	4 x 240
	Max. cable cross-section to motor and DC-bus [AWG] [2) 4) 5)]		4 x 500 mcm	4 x 500 mcm	4 x 500 mcm	4 x 500 mcm
	Max. input current (RMS)	$I_{L,MAX}$ [A] (380 V)	584	648	734	787
		$I_{L,MAX}$ [A] (460 V)	526	581	668	718
	Max. cable cross-section to power [mm²] [4) 5)]		4 x 240	4 x 240	4 x 240	4 x 240
	Max. cable cross-section to power [AWG] [2) 4) 5)]		4 x 500 mcm	4 x 500 mcm	4 x 500 mcm	4 x 500 mcm
	Max. pre-fuses (mains)	[-]/UL [A] [1)]	700/700	900/900	900/900	900/900
	Efficiency [3)]		0.98	0.98	0.98	0.98
	Mains contactor	[Danfoss type]	CI 300EL	-	-	-
	Weight IP 00	[kg]	221	234	236	277
	Weight IP 20	[kg]	263	270	272	313
	Weight IP 54	[kg]	263	270	272	313
	Power loss at max. load	[W]	7630	7701	8879	9428
	Enclosure			Chassis / NEMA 1 / NEMA 12		

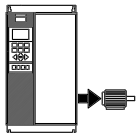
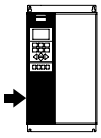
1. For type of fuse, see section *Fuses*.
2. American Wire Gauge.
3. Measured using 30 m screened motor cables at rated load and rated frequency.
4. Always comply with national and local regulations on min. cable cross-section. Max. cable cross section is the maximum possible cable cross section that can be fitted on the terminals.
5. Connection bolt power supply, motor and load sharing: M10 compression (lug), 2 x M8 (box lug)

■ Line Supply, 3 x 525 - 600 V

Output		VLT type	4006	4008	4011
	Output Current	$I_{VLT,N}$ [A] (550 V)	6.4	9.5	11.5
		$I_{VLT,MAX}$ (60 s) [A] (550 V)	7.0	10.5	12.7
		$I_{VLT,N}$ [A] (575 V)	6.1	9.0	11.0
		$I_{VLT,MAX}$ (60 s) [A] (575 V)	6.7	9.9	12.1
	Output	$S_{VLT,N}$ [kVA] (550 V)	6.1	9.0	11.0
		$S_{VLT,N}$ [kVA] (575 V)	6.1	9.0	11.0
	Typical shaft output	$P_{VLT,N}$ [kW]	4	5.5	7.5
	Typical shaft output	$P_{VLT,N}$ [HP]	5	7.5	10
	Max. copper cable cross-section to motor and loadsharing[4] [mm² /AWG][2]		4/10	4/10	4/10
Input					
	Rated Input Current	$I_{VLT,N}$ [A] (550 V)	6.2	9.2	11.2
		$I_{VLT,N}$ [A] (600 V)	5.7	8.4	10.3
	Max. copper cable cross-section power, NEMA 1[4] [mm² /AWG][2]		4 10	4 10	4 10
	Efficiency[3]		0.96	0.96	0.96
	Max. pre-fuses (mains)[1]	[-]/UL[1] [A]	8	10	15
	Weight IP20 / NEMA 1	[kg]	10.5	10.5	10.5
		[lbs]	23.1	23.1	23.1
	Estimated power loss at max. load	[W]	161	238	288
	Enclosure		IP 20 and NEMA 1		

1. See section *Fuses.*
2. American Wire Gauge (AWG).
3. Measured using 100 ft screened motor cables at rated load and rated frequency.

■ Line Supply, 3 x 525 - 600 V

Output		VLT type	4016	4022	4027	4032	4042	4052	4062	4072
	Output Current	$I_{VLT,N}$ [A] (550 V)	18	23	28	34	43	54	65	81
		$I_{VLT, MAX}$ (60 s) [A] (550 V)	20	25	31	37	47	59	72	89
		$I_{VLT, N}$ [A] (575 V)	17	22	27	32	41	52	62	77
		$I_{VLT, MAX}$ (60 s) [A] (575 V)	19	24	30	35	45	57	68	85
	Output	$S_{VLT,N}$ [kVA] (550 V)	17	22	27	32	41	51	62	77
		$S_{VLT,N}$ [kVA] (575 V)	17	22	27	32	41	52	62	77
	Typical shaft output	$P_{VLT,N}$ [kW]	11	15	18.5	22	30	37	45	55
	Typical shaft output	$P_{VLT,N}$ [HP]	15	20	25	30	40	50	60	75
	Max. copper cable cross-section to motor and loadsharing[4] [mm² /AWG][2]		16 6	16 6	16 6	35 2	35 2	50 1/0	50 1/0	50 1/0
	Min. cable cross-section to motor and loadsharing[3] [mm² /AWG][2]		0.5 20	0.5 20	0.5 20	10 8	10 8	16 6	16 6	16 6
Input										
	Rated Input Current	$I_{VLT,N}$ [A] (550 V)	18	22	27	33	42	53	63	79
		$I_{VLT, N}$ [A] (600 V)	16	21	25	30	38	49	58	72
	Max. copper cable cross-section power, NEMA 1[4] [mm² /AWG][2]		16 6	16 6	16 6	35 2	35 2	50 1/0	50 1/0	50 1/0
	Max. pre-fuses (mains)[1]	[-]/UL[1] [A]	20	30	35	45	60	75	90	100
	Efficiency		0.96							
	Weight IP20 / NEMA 1	[kg]	23	23	23	30	30	48	48	48
		[lbs]	51	51	51	66	66	106	106	106
	Estimated power loss at max. load	[W]	451	576	707	852	1077	1362	1628	2029
	Enclosure		NEMA 1							

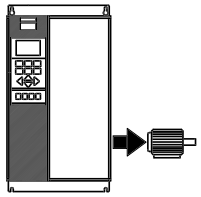
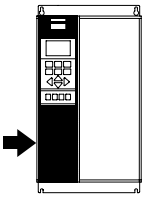
1. See section *Fuses*.

2. American Wire Gauge (AWG).

3. Min. cable cross-section is the smallest cable cross-section allowed to be fitted into the terminals to comply with IP 20. Always comply with national and local regulations on min. cable cross-section.

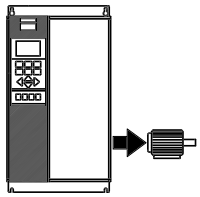
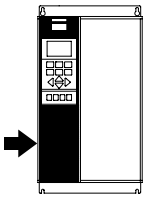
4. Aluminum cables with cross section above 35 mm²/AWG 2 must be connected by use of an Al-Cu connector.

■ Line Supply 3 x 525 - 600 V

According to international requirements		VLT type	4102	4122
	Output current	$I_{VLT,N}$ [A] (525-550 V)	113	137
		$I_{VLT,MAX}$ (60 s) [A] (525-550 V)	124	151
		$I_{VLT,N}$ [A] (551-600 V)	108	131
		$I_{VLT,MAX}$ (60 s) [A] (551-600 V)	119	144
	Output	$S_{VLT,N}$ [kVA] (550 V)	108	131
		$S_{VLT,N}$ [kVA] (575 V)	108	130
	Typical shaft output	[kW] (550 V)	75	90
		[HP] (575 V)	100	125
	Max. cable cross-section to motor	[mm²][4,5]	2 x 70	
		[AWG][2,4,5]	2 x 2/0	
	Max. cable cross-section to loadsharing and brake	[mm²][4,5]	2 x 70	
		[AWG][2,4,5]	2 x 2/0	
	Rated input current	$I_{L,N}$ [A] (550 V)	110	130
		$I_{L,N}$ [A] (575 V)	106	124
		$I_{L,N}$ [A] (690 V)	109	128
	Max. cable cross-section power supply	[mm²][4,5]	2 x 70	
		[AWG][2,4,5]	2 x 2/0	
	Min. cable cross-section to motor and power supply	[mm²][4,5]	35	
		[AWG][2,4,5]	2	
	Min. cable cross-section to brake and loadsharing	[mm²][4,5]	10	
		[AWG][2,4,5]	8	
	Max. pre-fuses (mains) [-]/UL	[A][1]	200	250
	Efficiency[3]		0.98	
	Power loss [W]	2262	2662	
	Weight	IP 00 [kg]	82	
	Weight	IP 21/Nema1 [kg]	96	
	Weight	IP 54/Nema12 [kg]	96	
	Enclosure	IP 00, IP 21/Nema 1 and IP 54/Nema12		

1. For type of fuse see section *Fuses*
2. American Wire Gauge.
3. Measured using 30 m screened motor cables at rated load and rated frequency.
4. Max. cable cross-section is the maximum possible cable cross-section allowed to be fitted on the terminals. Min. cable cross-section is the minimum allowed cross-section. Always comply with national and local regulations on min. cable cross-section.
5. Connection bolt 1 x M10 / 2 x M10 (mains and motor), connection bolt 1 x M8 / 2 x M8 (DC-bus).

■ Line Supply 3 x 525 - 600 V

According to international requirements		VLT type	4152	4202	4252	4302	4352	4402
	Output current	$I_{VLT,N}$ [A] (525-550 V)	162	201	253	303	360	418
		$I_{VLT, MAX}$ (60 s) [A] (525-550 V)	178	221	278	333	396	460
		$I_{VLT,N}$ [A] (551-600 V)	155	192	242	290	344	400
		$I_{VLT, MAX}$ (60 s) [A] (551-600 V)	171	211	266	319	378	440
	Output	$S_{VLT,N}$ [kVA] (550 V)	154	191	241	289	343	398
		$S_{VLT,N}$ [kVA] (575 V)	154	191	241	289	343	398
	Typical shaft output	[kW] (550 V)	110	132	160	200	250	315
		[HP] (575 V)	150	200	250	300	350	400
	Max. cable cross-section	[mm²][4,5]	2 x 70		2 x 185			
	to motor	[AWG][2,4,5]	2 x 2/0		2 x 350 mcm			
	Max. cable cross-section	[mm²][4,5]	2 x 70		2 x 185			
	to loadsharing and brake	[AWG][2,4,5]	2 x 2/0		2 x 350 mcm			
	Rated input current	$I_{L,N}$ [A] (550 V)	158	198	245	299	355	408
		$I_{L,N}$ [A] (575 V)	151	189	234	286	339	390
		$I_{L,N}$ [A] (690 V)	155	197	240	296	352	400
	Max. cable cross-section	[mm²][4,5]	2 x 70		2 x 185			
	power supply	[AWG][2,4,5]	2 x 2/0		2 x 350 mcm			
	Min. cable cross-section to	[mm²][4,5]	35					
	motor and power supply	[AWG][2,4,5]	2					
	Min. cable cross-section to	[mm²][4,5]	10					
	brake and loadsharing	[AWG][2,4,5]	8					
	Max. pre-fuses (mains)	[A][1]	315	350	350	400	500	550
	[-]/UL							
	Efficiency[3]		0,98					
	Power loss [W]		3114	3612	4293	5156	5821	6149
	Weight	IP 00 [kg]	82	91	112	123	138	151
	Weight	IP 21/Nema1 [kg]	96	104	125	136	151	165
	Weight	IP 54/Nema12 [kg]	96	104	125	136	151	165
	Enclosure	IP 00, IP 21/Nema 1 and IP 54/Nema12						

1. For type of fuse see section *Fuses*
2. American Wire Gauge.
3. Measured using 30 m screened motor cables at rated load and rated frequency.
4. Max. cable cross-section is the maximum possible cable cross-section allowed to be fitted on the terminals. Min. cable cross-section is the minimum allowed cross-section. Always comply with national and local regulations on min. cable cross-section.
5. Connection bolt 1 x M10 / 2 x M10 (mains and motor), connection bolt 1 x M8 / 2 x M8 (DC-bus).

■ Fuses

UL compliance

To comply with UL/cUL approvals, pre-fuses according to the table below must be used.

200-240 V

VLT	Bussmann	SIBA	Littel fuse	Ferraz-Shawmut
4006	KTN-R30	5017906-032	KLN-R30	ATM-R30 or A2K-30R
4008	KTN-R50	5012406-050	KLN-R50	A2K-50R
4011, 4016	KTN-R60	5014006-063	KLN-R60	A2K-60R
4022	KTN-R80	5014006-080	KLN-R80	A2K-80R
4027, 4032	KTN-R125	2028220-125	KLN-R125	A2K-125R
4042	FWX-150	2028220-150	L25S-150	A25X-150
4052	FWX-200	2028220-200	L25S-200	A25X-200
4062	FWX-250	2028220-250	L25S-250	A25X-250

380-460 V

	Bussmann	SIBA	Littel fuse	Ferraz-Shawmut
4006	KTS-R20	5017906-020	KLS-R20	ATM-R20 or A6K-20R
4008	KTS-R25	5017906-025	KLS-R25	ATM-R25 or A6K-25R
4011	KTS-R30	5012406-032	KLS-R30	ATM-R30 or A6K-30R
4016, 4022	KTS-R40	5014006-040	KLS-R40	A6K-40R
4027	KTS-R50	5014006-050	KLS-R50	A6K-50R
4032	KTS-R60	5014006-063	KLS-R60	A6K-60R
4042	KTS-R80	2028220-100	KLS-R80	A6K-80R
4052	KTS-R100	2028220-125	KLS-R100	A6K-100R
4062	KTS-R125	2028220-125	KLS-R125	A6K-125R
4072	KTS-R150	2028220-160	KLS-R150	A6K-150R
4102	FWH-220	2028220-200	L50S-225	A50-P225
4122	FWH-250	2028220-250	L50S-250	A50-P250
4152*	FWH-300/170M3017	2028220-315	L50S-300	A50-P300
4202*	FWH-350/170M3018	2028220-315	L50S-350	A50-P350
4252*	FWH-400/170M4012	206xx32-400	L50S-400	A50-P400
4302*	FWH-500/170M4014	206xx32-500	L50S-500	A50-P500
4352*	FWH-600/170M4016	206xx32-600	L50S-600	A50-P600
4452	170M4017			
4502	170M6013			
4602	170M6013			
4652	170M6013			

* Circuit Breakers manufactured by General Electric, Cat .No. SKHA36AT0800, with the rating plugs listed below can be used to meet UL requirement.

4152	rating plug No.	SRPK800 A 300
4202	rating plug No.	SRPK800 A 400
4252	rating plug No.	SRPK800 A 400
4302	rating plug No.	SRPK800 A 500
4352	rating plug No.	SRPK800 A 600

525-600 V

	Bussmann	SIBA	Littel fuse	Ferraz-Shawmut
4006	KTS-R8	5017906-008	KLS-R008	A6K-8R
4008	KTS-R10	5017906-010	KLS-R010	A6K-10R
4011	KTS-R15	5017906-016	KLS-R015	A6K-15R
4016	KTS-R20	5017906-020	KLS-R020	A6K-20R
4022	KTS-R30	5017906-030	KLS-R030	A6K-30R
4027	KTS-R35	5014006-040	KLS-R035	A6K-35R
4032	KTS-R45	5014006-050	KLS-R045	A6K-45R
4042	KTS-R60	5014006-063	KLS-R060	A6K-60R
4052	KTS-R75	5014006-080	KLS-R075	A6K-80R
4062	KTS-R90	5014006-100	KLS-R090	A6K-90R
4072	KTS-R100	5014006-100	KLS-R100	A6K-100R

525-600 V

	Bussmann	SIBA	FERRAZ-SHAWMUT
4102	170M3015	2061032,2	6.6URD30D08A0200
4122	170M3016	2061032,25	6.6URD30D08A0250
4152	170M3017	2061032,315	6.6URD30D08A0315
4202	170M3018	2061032,35	6.6URD30D08A0350
4252	170M4011	2061032,35	6.6URD30D08A0350
4302	170M4012	2061032,4	6.6URD30D08A0400
4352	170M4014	2061032,5	6.6URD30D08A0500
4402	170M5011	2062032,55	6.6URD32D08A550

KTS-fuses from Bussmann may substitute KTN for 240 V drives.
FWH-fuses from Bussmann may substitute FWX for 240 V drives.

KLSR fuses from LITTEL FUSE may substitute KLNR fuses for 240 V drives.
L50S fuses from LITTEL FUSE may substitute L50S fuses for 240 V drives.

A6KR fuses from FERRAZ SHAWMUT may substitute A2KR for 240 V drives.
A50X fuses from FERRAZ SHAWMUT may substitute A25X for 240 V drives.

Non UL compliance

If UL/cUL is not to be complied with, we recommend the above mentioned fuses or:

VLT 4006-4032	200-240 V	type gG
VLT 4042-4062	200-240 V	type gR
VLT 4006-4072	380-460 V	type gG
VLT 4102-4122	380-460 V	type gR
VLT 4152-4352	380-460 V	type gG
VLT 4450-4600	380-460 V	type gR
VLT 4006-4072	525-600 V	type gG

Not following the recommendation may result in unnecessary damage of the drive in case of malfunction. Fuses must be designed for protection in a circuit capable of supplying a maximum of 100000 A_{rms} (symmetrical), 500 V/600 V maximum.

■ Mechanical dimensions

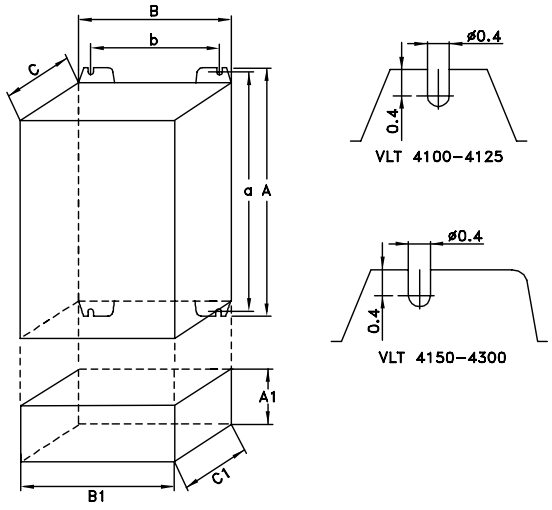
All measurements in inches.

VLT type	A	B	C	a	b	aa/bb [1]	Type
Chassis 200-240 V							
4042 - 4072	31.5	14.6	13.2	30.7	10.6	8.8	B
Chassis 380-460 V							
4152 - 4202	41.2	16.1	14.7	39.4	12.0	9	J
4252 - 4352	52.2	16.1	14.7	50.5	12.0	9	J
4452 - 4652	60.9	23.0	19.4[2]	59.1	12.0	8.9 (aa)	I
Chassis 525-600 V							
4102-4202	41.2	16.1	14.7[2]	39.4	12	8.9	J
4252-4402	52.2	16.1	14.7[2]	50.5	12	8.9	J
IP 20 525-600 V							
4006 - 4011	15.6	8.7	7.9	15.1	7.9	4.0	C
NEMA 1 200-240 V							
4006 - 4011	22.0	9.5	10.2	21.2	7.9	7.9	D
4016 - 4022	27.6	9.5	10.2	26.8	7.9	7.9	D
4027 - 4032	31.5	12.1	11.7	30.7	10.6	7.9	D
4042 - 4062	34.2	14.6	13.2	30.7	8.8	10.6	E
NEMA 1 380-460 V							
4006 - 4011	15.6	8.7	7.9	15.1	7.9	4.0	C
4016 - 4027	22.0	29.5	10.2	21.2	7.9	7.9	D
4032 - 4042	27.6	29.5	10.2	26.8	7.9	7.9	D
4052 - 4072	31.5	12.1	11.7	30.7	10.6	7.9	D
4102 - 4122	31.5	14.6	13.2	30.7	13.0	9	D
4152 - 4202	47.6	16.5	14.7[2]	45.4	12.0	9	J
4252 - 4352	62.5	16.5	14.7[2]	60.4	12.0	9	J
4452 - 4652	78.7	23.6	19.4[2]	-	-	8.9 (aa)	H
NEMA 1 525-600 V							
4006 - 4011	15.6	8.7	7.9	15.1	7.9	4.0	C
4016 - 4027	22.0	9.5	10.2	21.2	7.9	7.9	D
4032 - 4042	27.6	9.5	10.2	26.8	7.9	7.9	D
4052 - 4072	31.5	12.1	11.7	30.7	10.6	7.9	D
4102 - 4202	47.5	16.5	14.7[2]	45.4	12	8.9	J
4252 - 4402	62.5	16.5	14.7[2]	60.4	12	8.9	J

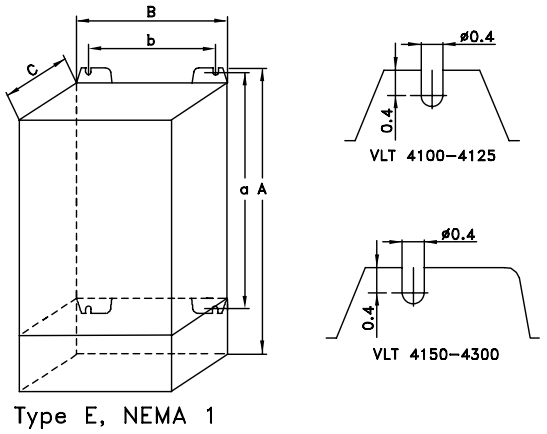
VLT type	A	B	C	D	a	b	aa/bb [1]	Type
NEMA 12 200-240 V								
4006 - 4011	31.9	14.0	11.0	2.8	22.0	13.0	7.9	F
4016 - 4032	37.0	15.7	11.0	2.8	27.2	14.8	7.9	F
4042 - 4062	36.9	19.5	16.6	-	32.7	14.7	8.8	G
NEMA 12 380-460 V								
4006 - 4011	20.9	11.1	7.7	3.3	13.0	10.1	4.0	F
4016 - 4032	31.9	14.0	11.0	2.8	22.0	13.0	7.9	F
4042 - 4072	37.0	15.7	11.0	2.8	27.2	14.8	7.9	F
4102 - 4122	37.0	15.8	14.2	2.76	27.2	14.8	9	F
4152 - 4202	47.6	16.5	14.7[2]	-	45.4	12.0	9	J
4252 - 4352	62.5	16.5	14.7[2]	-	60.4	12.0	9	J
4452 - 4652	78.7	23.6	19.4[2]	-	-	-	8.9 (aa)	H
Nema 12 525-600 V								
4102 - 4202	47.6	16.5	14.7[2]		45.4	12	8.9	J
4252 - 4402	62.5	16.5	14.7[2]		60.4	12	8.9	J

[1] aa: Min. air-space above enclosure to other parts.
bb: Min. air-space below enclosure to other parts.
[2] With disconnect, add 1.73 in.

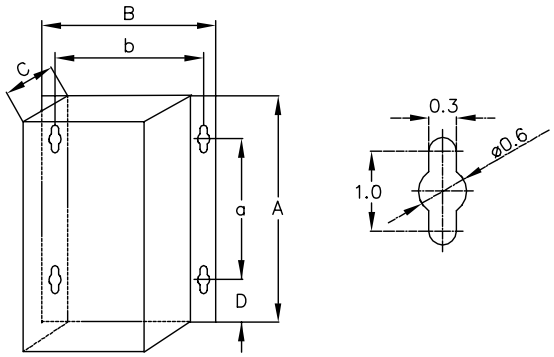
■ Mechanical dimensions



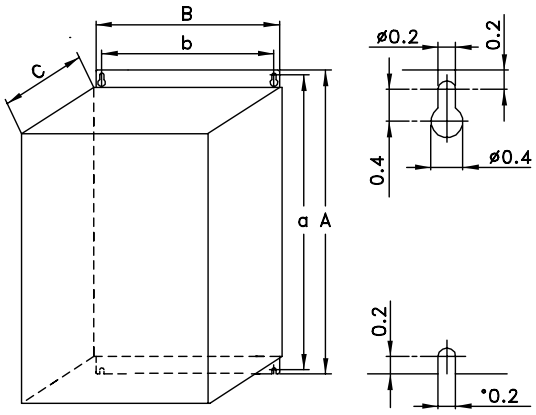
Type B, chassis
With option and enclosure NEMA 1



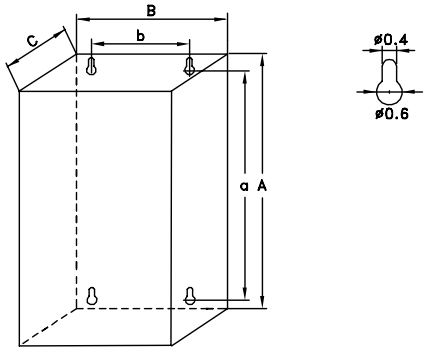
Type E, NEMA 1



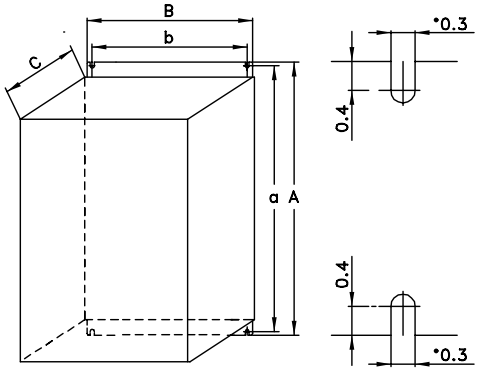
Type F, NEMA 12



Type C, NEMA 1



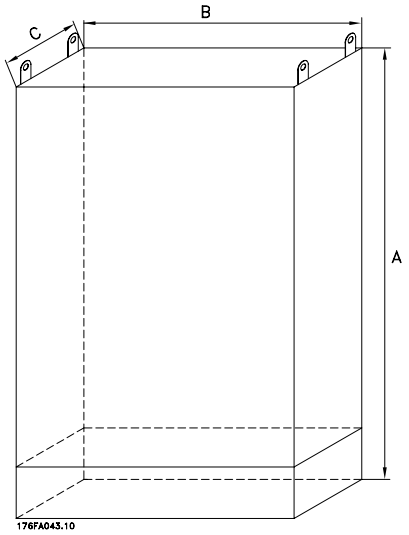
Type G, NEMA 12



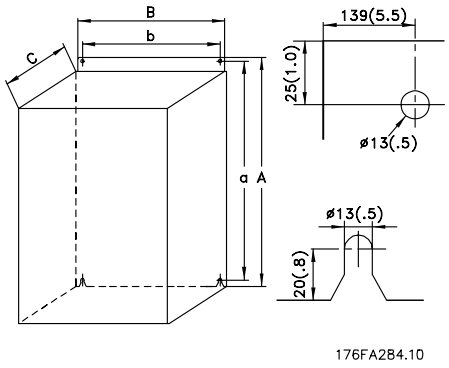
Type D, NEMA 1

176FA140.10

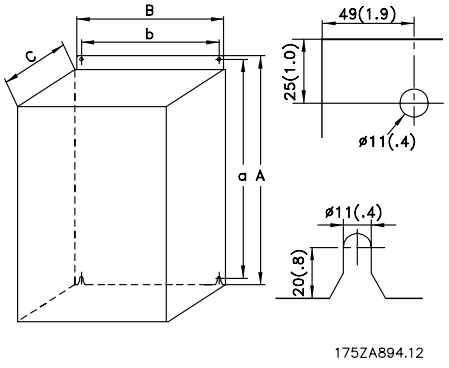
■ Mechanical dimensions (cont.)



Type H, Chassis, NEMA 1, NEMA 12



Type I, IP 00



Type J, Chassis, NEMA 1, NEMA 12

■ 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.

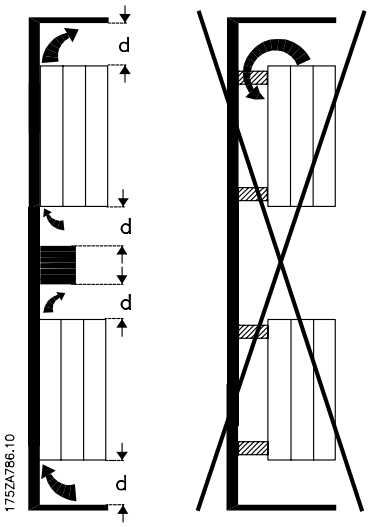
The VLT AFD *must* be installed vertically.

The VLT AFD 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 AFD* 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 AFD will become relevant, see *Derating for ambient temperature*.
The service life of the VLT AFD will be reduced if derating for ambient temperature is not taken into account.

■ Installation of VLT 4006-4352

All frequency converters must be installed in a way that ensures proper cooling.

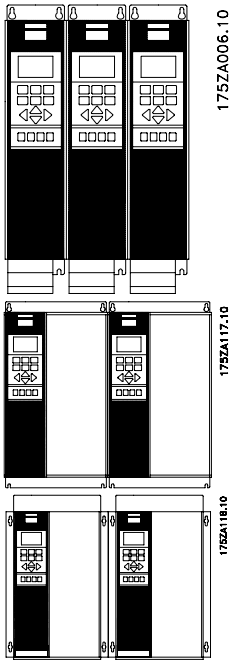
Cooling



All Bookstyle and Compact units require a minimum space above and below the enclosure.

Side by side/flange by flange

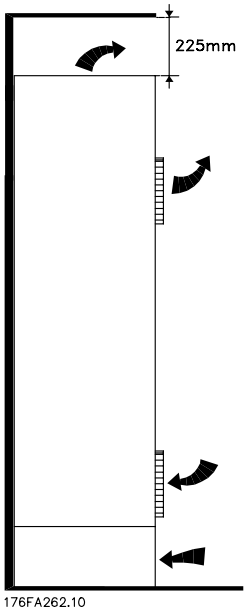
All frequency converters can be mounted side by side/flange by flange.



	d [mm]/in	Comments
Compact (all enclosure types)		
VLT 4006 - 4011, 380-460 V	100/4.0	Installation on a plane, vertical surface (no spacers)
VLT 4006 - 4011, 525-600 V	100/4.0	
VLT 4006 - 4032, 200-240 V	200/8.0	Installation on a plane, vertical surface (no spacers)
VLT 4016 - 4072, 380-460 V	200/8.0	
VLT 4102 - 4122, 380-460 V	225/9.0	
VLT 4016 - 4072, 525-600 V	200/8.0	
VLT 4042 - 4062, 200-240 V	225/9.0	Installation on a plane, vertical surface (no spacers) IP 54 filter mats must be changed when they are dirty.
VLT 4152 - 4352, 380-460 V	225/9.0	Installation on a plane, vertical surface (spacers can be used). IP 54 filter mats must be changed when they are dirty.
VLT 4102 - 4402, 525-600 V		
VLT 4452 - 4652, 380-460 V	225/9.0	IP 00 above and below enclosure IP 21/IP 54 only above enclosure

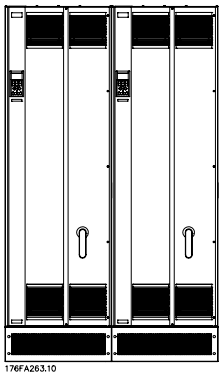
■ Installation of VLT 4452-4652 380-500 V Compact NEMA 1 and NEMA 12

Cooling



All units in the above-mentioned series require a minimum space of 9 inches above the enclosure and must be installed on a plane floor. This applies to both chassis, NEMA 1 and NEMA12 units. For accessing the VLT 4452-4652 VT it requires a minimum space of 22.8 inches in front of the VLT AFD.

Side-by-side



Compact chassis, NEMA 1, NEMA 12 All chassis, NEMA 1 and NEMA 12 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 AFD is dangerous whenever the equipment is connected to line. Incorrect installation of the motor or the AFD may cause damage to the equipment, serious personal injury or death.
Consequently, the instructions in this manual, as well as national and local safety regulations, must be complied with. Touching the electrical parts may be fatal - even after disconnection from line: using 200 and 400 V units, wait at least 20 minutes, 30 minutes for 600 V units.

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

■ Grounding

The following basic issues need to be considered when installing a AFD.

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

Connect the different ground 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 ground 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 ra-dio 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 line cable should be installed separate from the motor cables so as to avoid interference overcoupling. Normally, a distance of 8 inches 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 3 feet per 15 feet of power cable (line 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 shielded/armored or filtered.

■ Shielded/armored cables

The shield must be a low HF-impedance shield. This is ensured by using a braided shield of copper, aluminium or iron. Shield armor intended for mechanical protection, for example, is not suitable.

■ 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.

NOTE

The RFI switch must be closed (position ON) when high voltage tests are carried out . The line 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 4000 VT

The tables in *General technical data* show the power loss P_φ (W) from VLT 4000 VT. The maximum cooling air temperature $t_{IN, MAX}$ is 40° at 100% load (of rated value).

■ Ventilation of integrated VLT 4000 VT

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

1. Add up the values of P for all the AFDs 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.
   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}):
   Δ t= 45° C-t_{IN}.
3. Calculate the required

$$quantity\ of\ air = \frac{\sum P\varphi\ x\ 3.1}{\Delta t}\ m^3/h$$

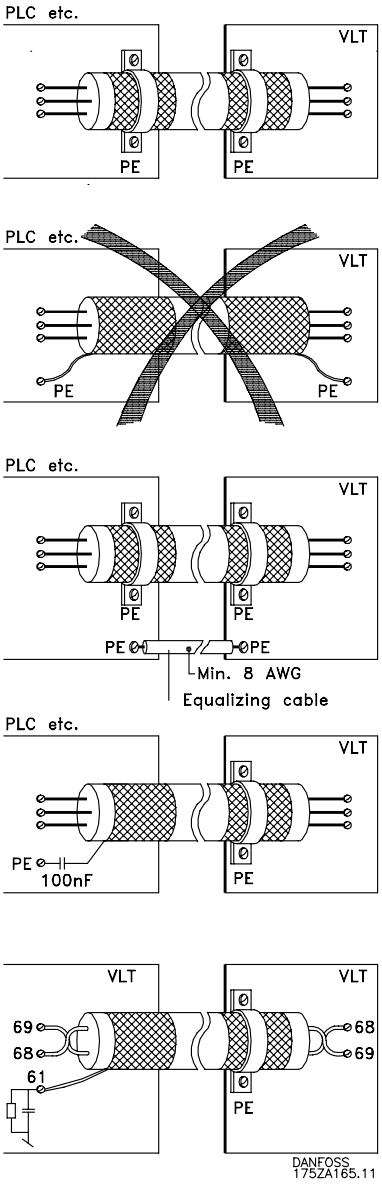
   Insert Δ t in Kelvin

The outlet from the ventilation must be placed above the highest-mounted AFD.
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.

■ Grounding of shielded/armored control cables

Generally speaking, control cables must be shielded/armored and the shield 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 grounding is carried out.



Correct grounding

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

Wrong grounding

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

Protection with respect to ground potential between PLC and VLT

If the ground potential between the VLT AFD 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: 8 AWG.

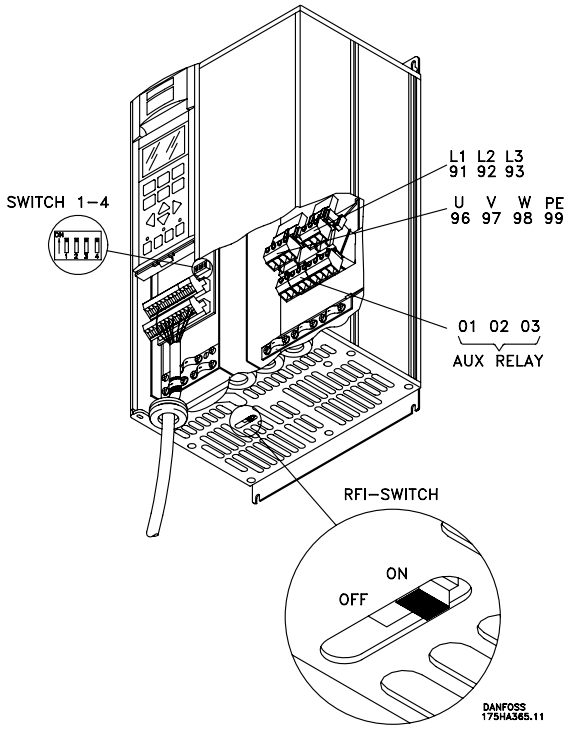
For 50/60 Hz ground loops

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

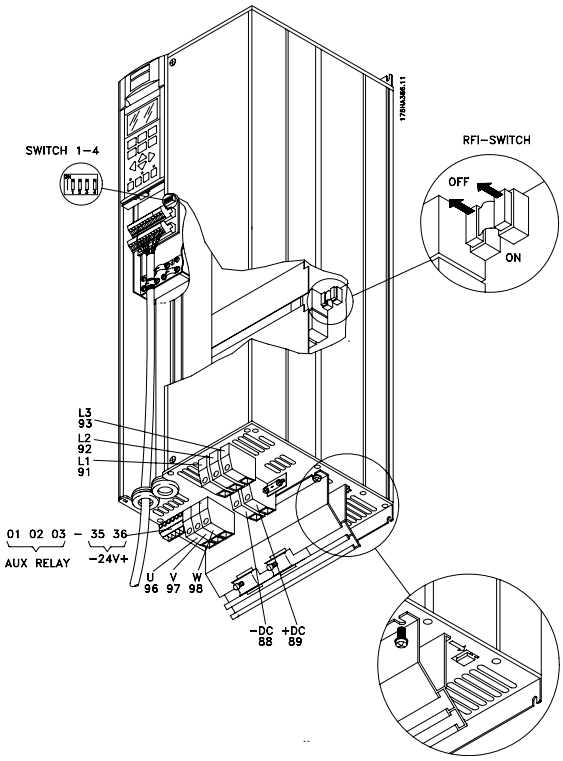
Cables for serial communication

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

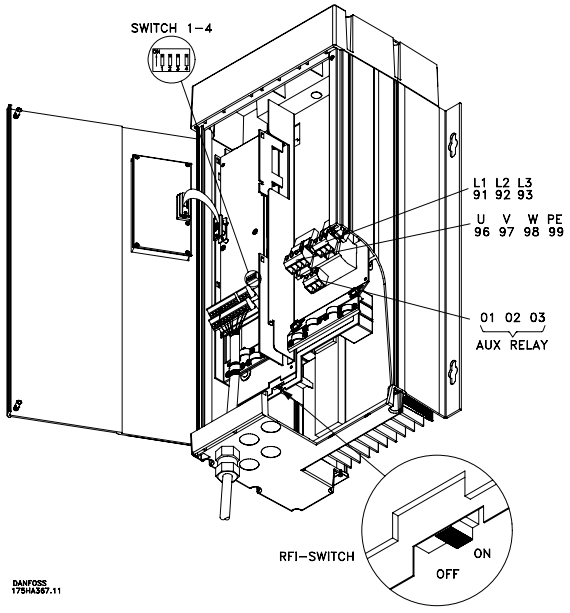
■ VLT 4000 VT enclosures



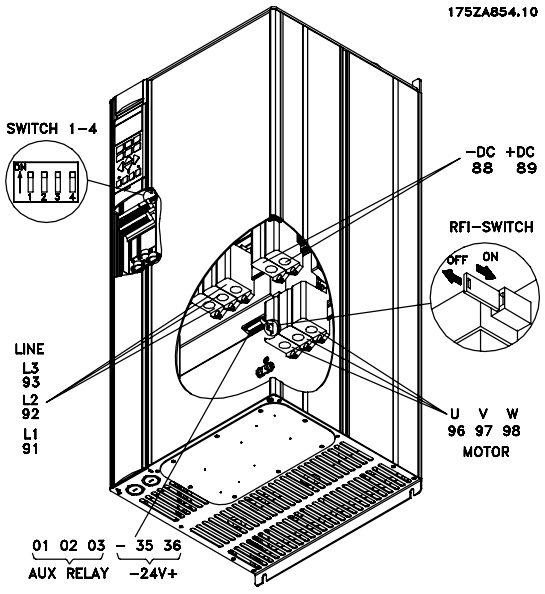
Chassis/IP20/NEMA 1
VLT 4006-4011, 380-460 V
VLT 4006-4011, 525-600 V



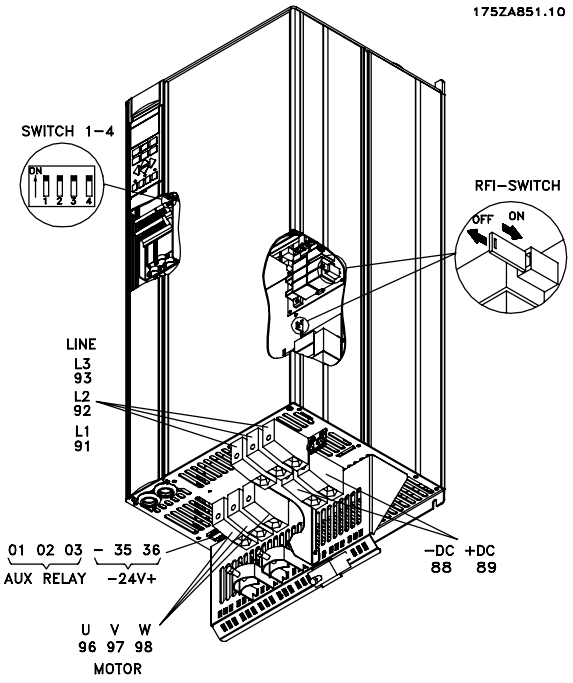
Chassis/NEMA 1
VLT 4006-4032, 200-240 V
VLT 4016-4072, 380-460 V
VLT 4016-4072, 525-600 V



NEMA 12
VLT 4006-4011, 380-460 V

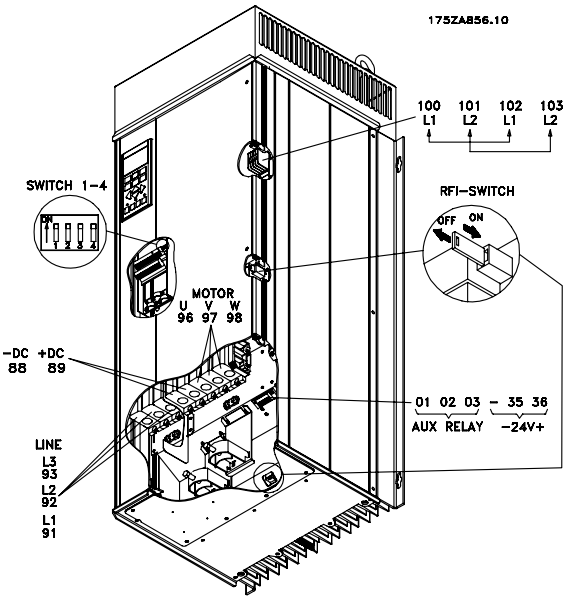


Compact NEMA 1
VLT 4102-4122, 380-460 V



Compact IP 20

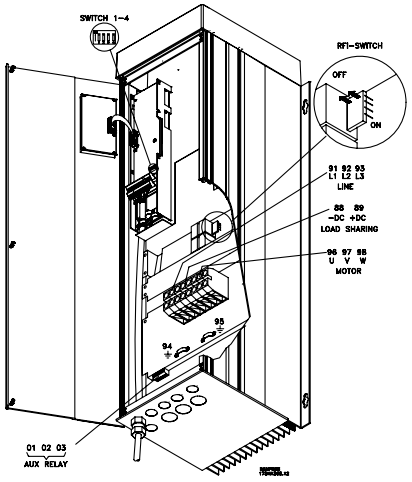
VLT 4102-4122, 380-460 V



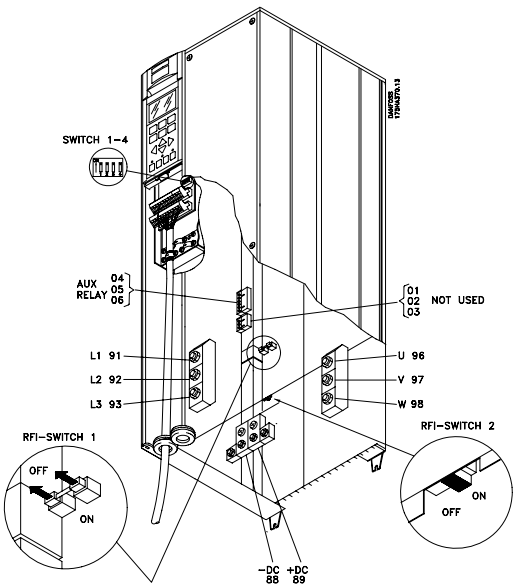
Compact NEMA 12

VLT 4102-4122, 380-460 V

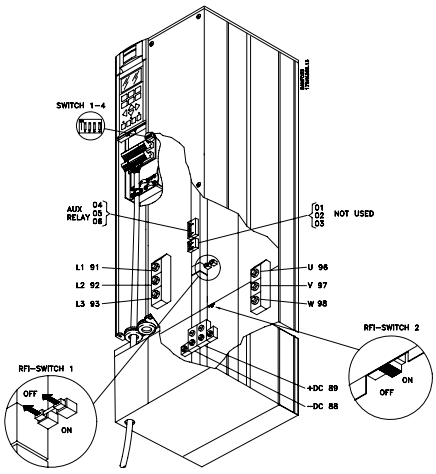
■ VLT 4000 VT enclosures



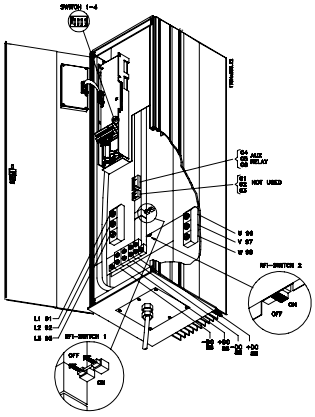
NEMA 12
VLT 4006-4032, 200-240 V Chassis
VLT 4016-4072, 380-460 V



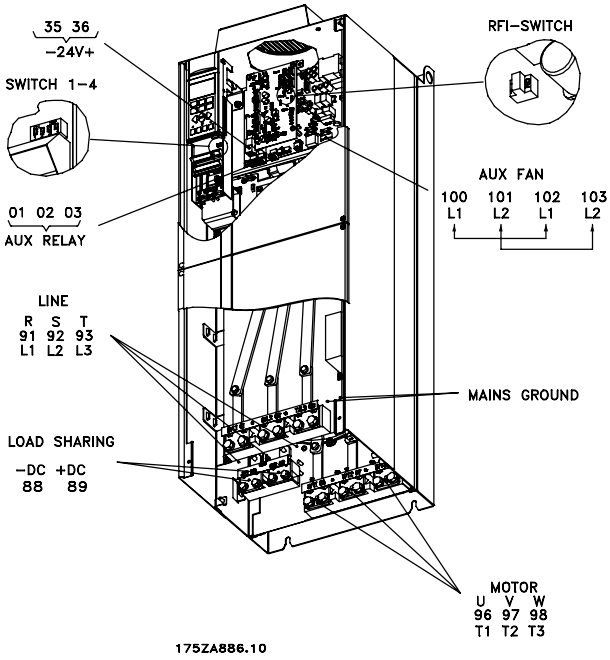
Chassis
VLT 4042-4062, 200-240 V



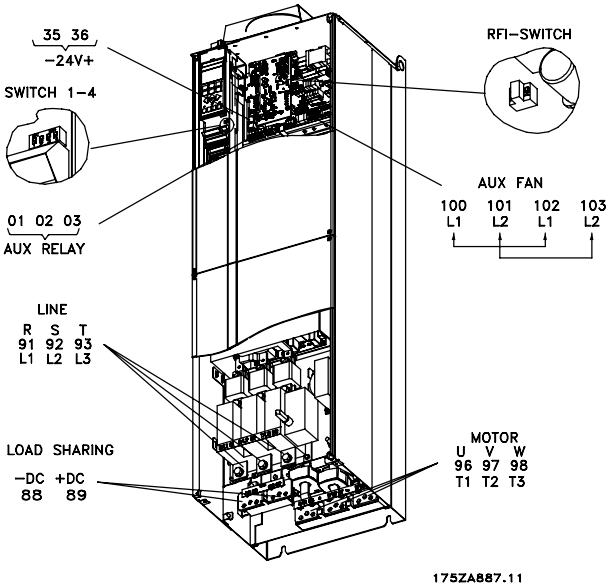
NEMA 1
VLT 4042-4062, 200-240 V



NEMA 12
VLT 4042-4062, 200-240 V

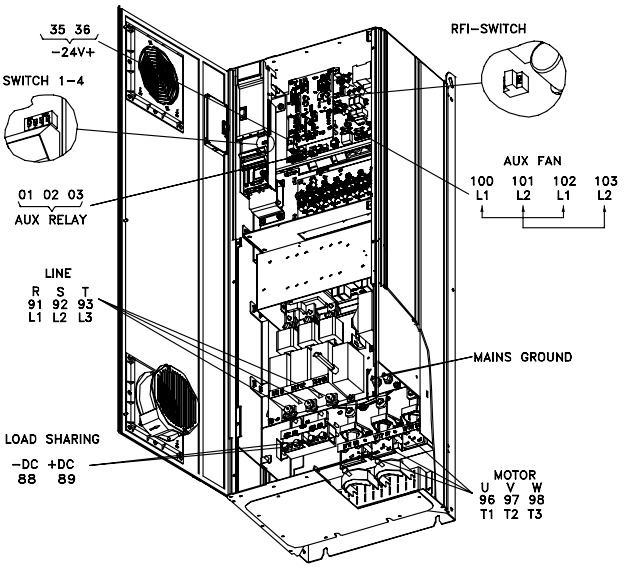


Chassis
VLT 4152-4202, 380-460 V
VLT 4102-4202, 525-600 V

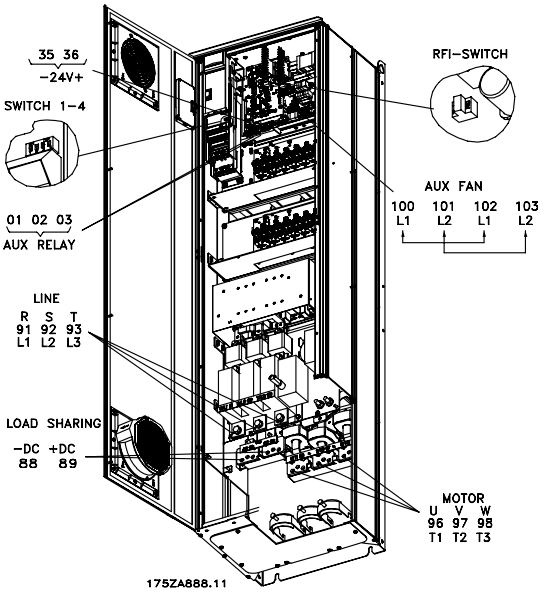


Chassis
Disconnect, fuse, RFI
VLT 4252-4352, 380-460 V

VLT 4252-4402, 525-600 V

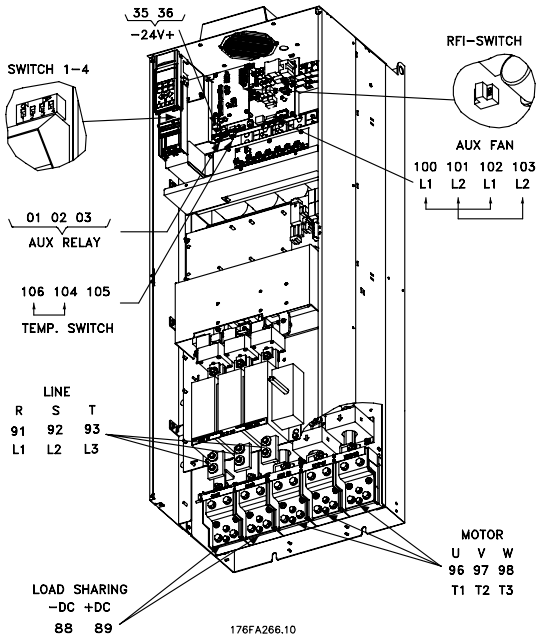


NEMA 1, NEMA 12
VLT 4152-4202, 380-460 V
VLT 4102-4202, 525-600 V

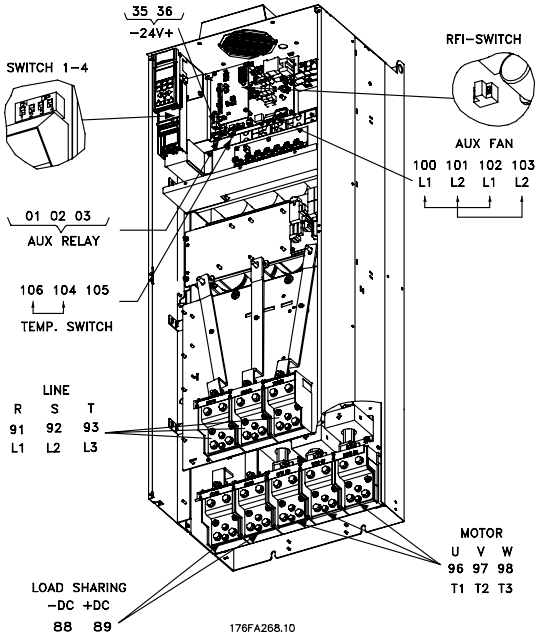


NEMA 1, NEMA 12
Disconnect, fuse, RFI
VLT 4252-4352, 380-460 V
VLT 4252-4402, 525-600 V

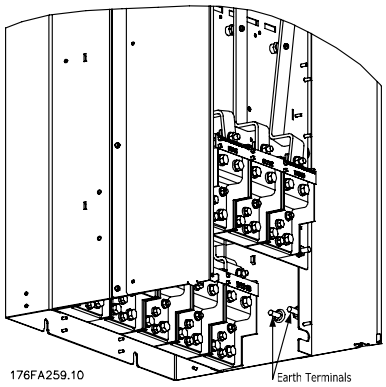
■ VLT 4000 VT enclosures



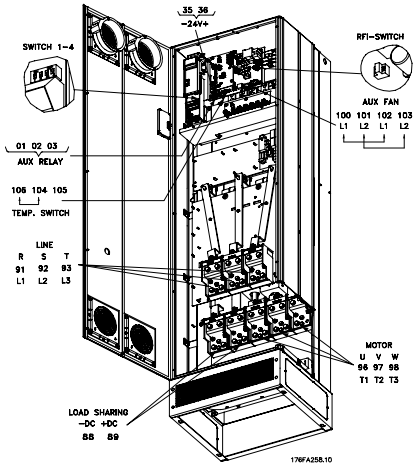
Compact chassis with disconnect and fuse
VLT 4452-4652 380-460 V



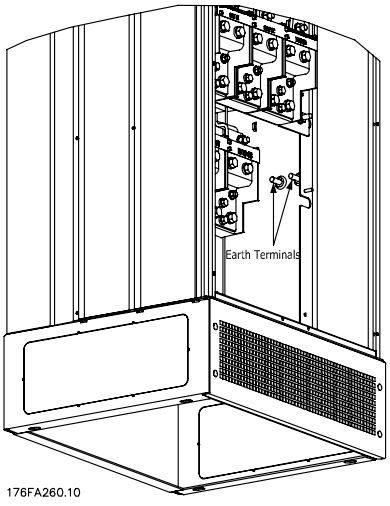
Compact chassis without disconnect and fuse
VLT 4452-4652 380-460 V



Position of earth terminals, chasssis

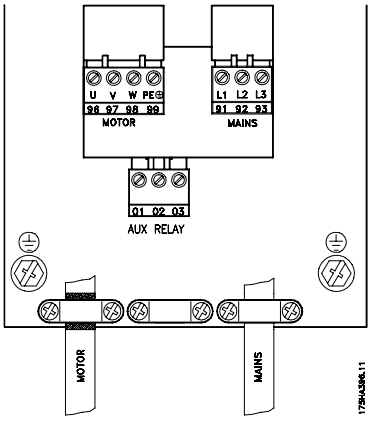


Compact NEMA 1 / NEMA 12 without disconnect and fuse
VLT 4452-4652 380-460 V

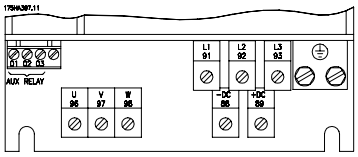


Position of earth terminals, NEMA 1 / NEMA 12

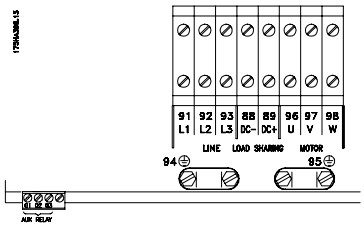
■ Electrical installation, power cables



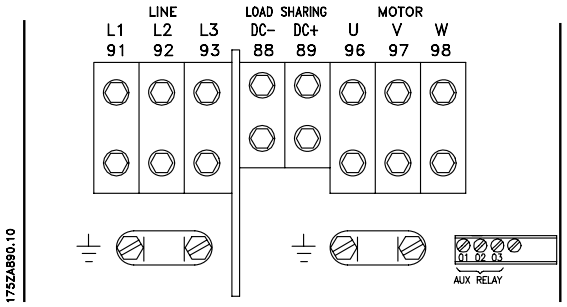
NEMA 1/NEMA 12
VLT 4006-4011, 380-460 V
VLT 4006-4011, 525-600 V



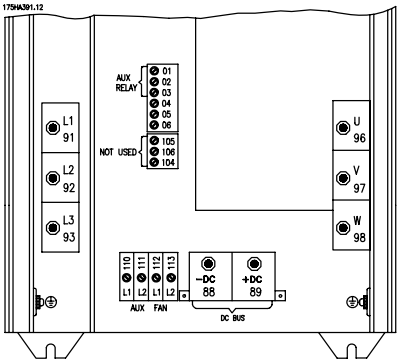
Chassis/NEMA 1
VLT 4006-4032, 200-240 V
VLT 4016-4122, 380-460 V
VLT 4016-4072, 525-600 V



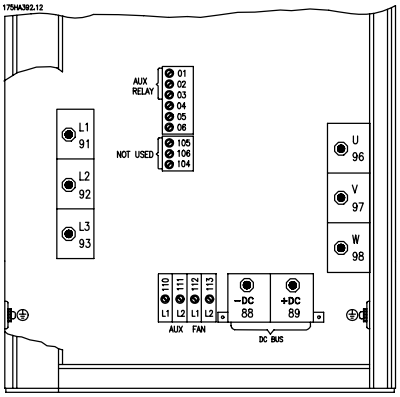
NEMA 12
VLT 4006-4032, 200-240 V
VLT 4016-4072, 380-460 V



Compact NEMA 12
VLT 4102-4122, 380-460 V



Chassis/NEMA 1
VLT 4042-4062, 200-240 V



NEMA 12 - VLT 4042-4062, 200-240 V

■ Tightening-up torque and screw sizes

The table shows the torque required when fitting terminals to the VLT AFD. For VLT 4006-4032, 200 -240 V, VLT 4006-4072, 380-460 V and 525-600 V the cables must be fastened with screws. For VLT 4042-4062, 200-240 V and for VLT 4100-4300 the cables must be fastened with bolts.
These figures apply to the following terminals:

Line terminals Nos 91, 92, 93 / L1, L2, L3

Motor terminals Nos 96, 97, 98 / U, V, W

Ground terminal No. 99

VLT type 3 x 200 - 240 V	Tightening-up torque	Screw/bolt size	Allen key size
VLT 4006-4011	16 in-lbs/1.8 Nm	M4	
VLT 4016-4027	26.6 in-lbs/3.0 Nm	M5[2]	4 mm
VLT 4032	53 in-lbs/6.0 Nm	M6[2]	5 mm
VLT 4042-4062	100 in-lbs/11.3 Nm	M8 (bolt)	

VLT type 3 x 380-460 V	Tightening-up torque	Screw/bolt size	Allen key size
VLT 4006-4011	5.3 in-lbs/0.5-0.6 Nm	M3	
VLT 4016-4027	16 in-lbs/1.8 Nm (IP 20)	M4	
VLT 4032-4052	26.6 in-lbs/3.0 Nm (IP 20)	M5[2]	4 mm
VLT 4062-4072	53 in-lbs/6.0 Nm	M6[2]	5 mm
VLT 4102-4122	133 in-lbs/15 Nm (IP 20)	M8[2]	6 mm
VLT 4152-4352	168 in-lbs/19 Nm[3]	M10 (bolt)	
VLT 4452-4652	168 in-lbs/19 Nm	M10 (compression lug)[4]	16 mm
	84 in-lbs/9.5 Nm	M8 (box lug)[4]	13 mm

VLT type 3 x 525-600 V	Tightening-up torque	Screw/bolt size	Allen key size
VLT 4006-4011	5.3 in-lbs/0.5-0.6 Nm	M3	
VLT 4016-4027	16 in-lbs/1.8 Nm	M4	
VLT 4032-4042	26.6 in-lbs/3.0 Nm[1]	M5[2]	4 mm
VLT 4052-4072	53 in-lbs/6.0 Nm	M6[2]	5 mm
VLT 4102-4402	168 in-lbs/19 Nm[3]	M10 (bolt)	

1. IP 54 units with RFI filter line terminals 53 in-lbs/6 Nm
2. Allen screws (hexagon)
3. Loadsharing terminals 84 in-lbs/M8 (bolt)
4. Hex wrench

■ Line connection

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

Nos. 91, 92, 93	Line voltage 3 x 200-240 V
L1, L2, L3	Line voltage 3 x 380-460 V
	Line voltage 3 x 525-600 V

NOTE
Check that the line voltage corresponds to the line voltage of the VLT AFD, which can be seen from the nameplate.

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

The voltage of the adjustable frequency drive is dangerous when the unit is connected to the AC line. Incorrect installation of the motor or the VLT adjustable frequency drive may lead to material damage, serious injury or death. Follow the instructions of this manual and comply to the National Electrical Code (NEC) and local codes and safety guidelines. DO NOT touch the electrical components of the VLT adjustable frequency drive for at least 30 minutes after the AC line has been disconnected.

NOTE
It is the responsability of the user or installer to ensure that proper grounding, branch circuit and motor overload protection is in accordance with the NEC and local safety codes.

NOTE
If UL/cUL is to be complied with, use copper wire with a temperature rating no less than 75° C.

■ Motor connection

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

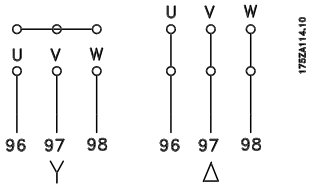
Nos. 96, 97, 98	Motor voltage 0-100% of
U, V, W	line voltage.
No. 99	Ground connection.

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

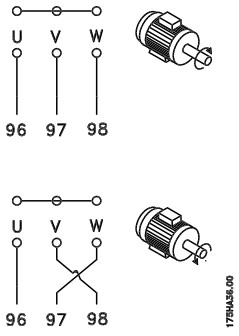
All types of three-phase asynchronous standard motors can be used with a VLT 4000 VT unit.

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

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



■ Direction of IEC motor rotation

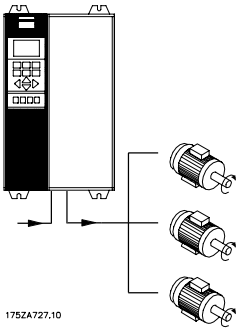


The factory setting is for clockwise rotationwith the VLT frequency transformer output connected as follows.

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 4000 VT is able to control several motors connected in parallel. If the motors are to have diffe-rent 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 AFD.

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 AFD cannot be used as motor protection for the individual motor. Consequently, additional motor protection is required, such as thermistors in ground motor (or individual thermal relays).

NOTE
Parameter 107 *Automatic Motor Adaptation, AMA* and *Automatic Energy Optimization, AEO* in parameter 101 *Torque characteristics* cannot be used 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.

NOTE
If an unshielded 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 shielded, 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 shield must be connected to the metal cabinet of the AFD and to the metal cabinet of the motor. The shield connections are to be made with the biggest possible surface (cable clamp). This is enabled by different installation devices in the different AFDs. Mounting with twisted shield ends (pigtails) is to be avoided, since these spoil the shielding effect at higher frequencies.
If it is necessary to break the shield to install a motor isolator or motor contactor, the shield must be continued at the lowest possible HF impedance.

■ Motor thermal protection

The electronic thermal relay in UL-approved AFD 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).

■ Ground connection

Since the leakage currents to ground may be higher than 3.5 mA, the AFD must always be grounded in accordance with applicable national and local regulations. In order to ensure good mechanical connection of the ground cable, its cable cross-section must be at least 8 AWG/10 mm^2. For added security, an RCD (Residual Current Device) may be installed. This ensures that the AFD 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.

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

■ DC bus connection

The DC bus terminal is used for DC back-up, with the intermediate circuit being supplied from an external DC source.

Terminal nos.	Nos. 88, 89

Contact Danfoss if you require further information.

■ High-voltage relay

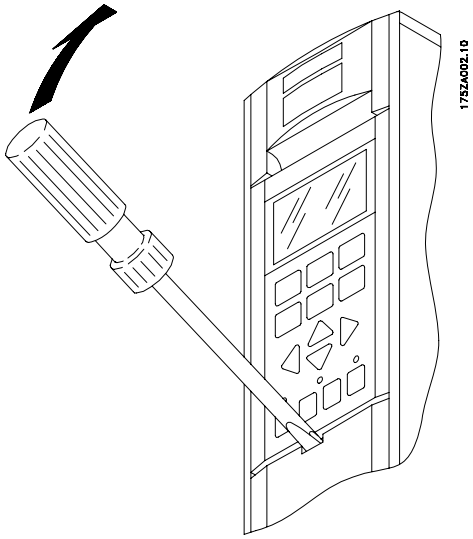
The cable for the high-voltage relay must be connected to terminals 01, 02, 03. The high-voltage relay is programmed in parameter 323, *Relay 1, output*.

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

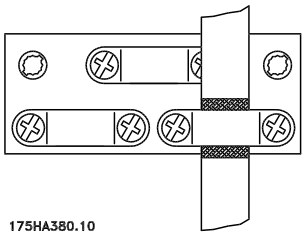
Max. cross-section:	4 mm^2 /10 AWG.
Torque:	4.5 - 5 In lb.
Screw size:	M3

■ Control card

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



■ Electrical installation, control cables



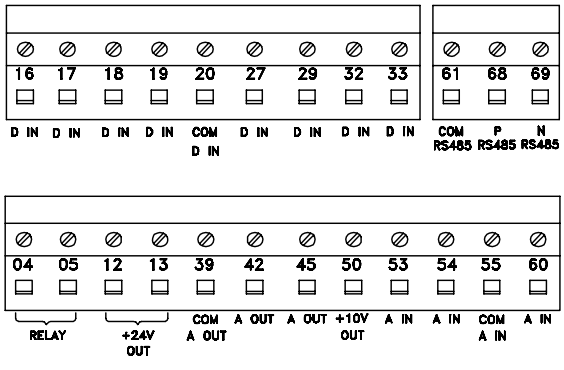
Torque: 4.5 - 5 In lb
Screw size: M3.

Generally speaking, control cables must be shielded/armored and the shield must be connected by means of a cable clamp at both ends to the metal cabinet of the unit (see *Grounding of shielded (armoured control cables)*.

Normally, the shield 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 ground loops may occur that will disturb the whole system. This problem can be solved by connecting one end of the shield to ground via a 100nF capacitor (keeping leads short).

■ Electrical installation,controlcables

Torque: 4.5 - 5 In lb
Screw size: M3
See *Grounding of shielded (armoured control cables* for correct termination of control cables.



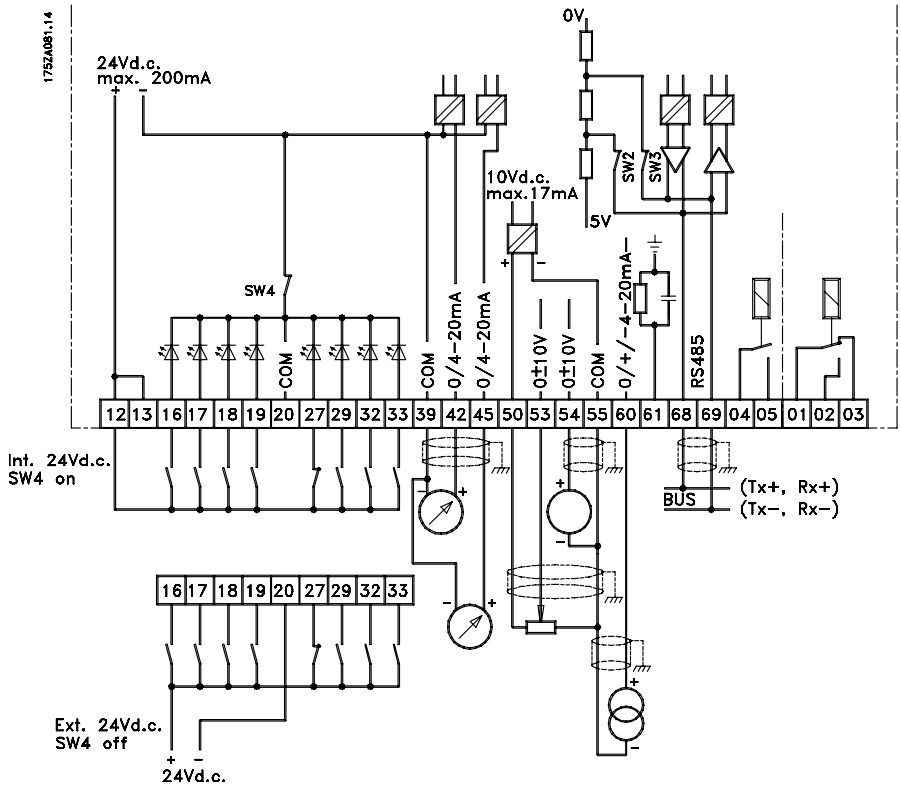
No.	Function
04, 05	Relay output 1 can be used for indicating status and warnings.
12, 13	Voltage supply to digital inputs. For the 24 V DC to be used for digital inputs, switch 4 on the control card must be closed, position "on".
16-33	Digital inputs. See parameters 300-307 *Digital inputs*.
20	Common for digital inputs.
39	Common for analog/digital outputs. Must be connnected to terminal 55 by means of a three-wire transmitter. See *Examples of connection*.
42, 45	Analog/digital outputs for indicating frequency, reference, current and torque. See parameters 319-322 *Analoge/digital outputs*.
50	Supply voltage to potentiometer and thermistor 10 V DC.
53, 54	Analog voltage input, 0 - 10 V DC.
55	Common for analog voltage inputs.
60	Analog current input 0/4-20 mA. See parameters 314-316 *Terminal 60*.
61	Termination of serial communication. See *Grounding of shielded (armoured control cables* . This terminal is not normally to be used.
68, 69	RS 485 interface, serial communication. Where the VLT AFD 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 AFD. On the remaining VLT AFD, 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 in-terface, serial communication. In the first and the last VLT AFD, switches 2 and 3 must be ON. In the other VLT AFD, 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.

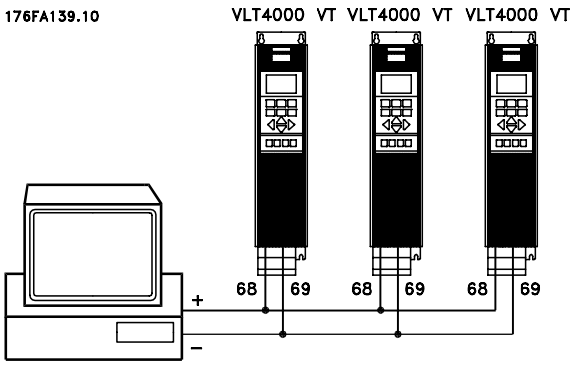
NOTE
Please note that when Switch 4 is in position "OFF", the external 24 V DC supply is galvanically isolated from the VLT AFD.



■ Bus connection

The serial bus connection in accordance with the RS 485 (2-conductor) norm is connected to terminals 68/69 of the AFD (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 AFD 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 grounded via termi-nal 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 4000 VT

The diagram below gives an example of a typical VLT 4000 VT installation.

The line 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 AFD.

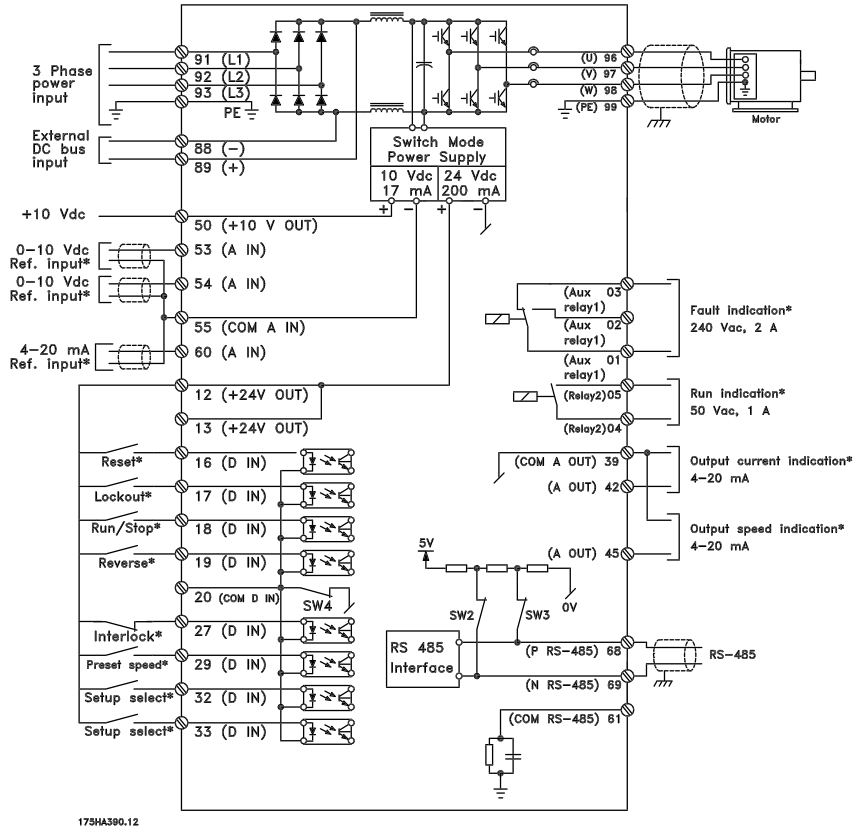
An external DC supply can be connected to terminals 88 and 89 (VLT 4006-4072, 200-240V and VLT 4016-4302, 460V, VLT 4016-4300, 600 V).

Analog 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 *Analog 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*.

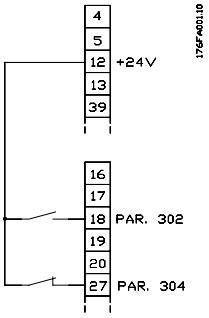
There are two analog/digital outputs (terminals 42 and 45), which can be programmed to show the present status or a process value, such as 0-f_{MAX}. Relay outputs 1 and 2 can be used for giving the present status or a warning.

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



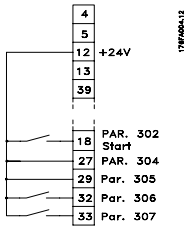
* These terminals can be programmed for other functions.

■ Single-pole start/stop



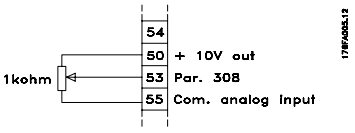
- Start/stop using terminal 18.
  Parameter 302 = *Start* [1]
- Quick-stop using terminal 27.
  Parameter 304 = *Coasting stop, inverse* [0]

■ Digital speed up/down



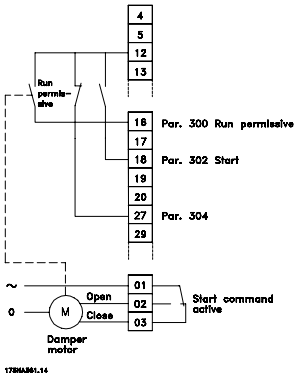
- Speed up and down using terminals 32 and 33.
  Parameter 306 = *Speed up* [7]
  Parameter 307 = *Speed down* [7]
  Parameter 305 = *Freeze reference* [2]

■ Potentiometer reference



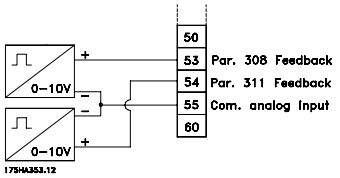
-Parameter 308 = *Reference* [1]
Parameter 309 = *Terminal 53, min. scaling*
Parameter 310 = *Terminal 53, max. scaling*

■ Run permissive



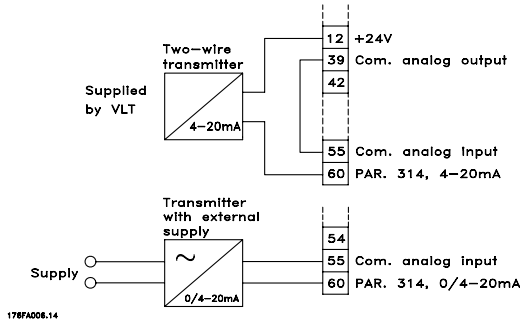
- Start permitted with terminal 16.
  Parameter 300 = *Run permissive* [8].
- Start/stop with terminal 18.
  Parameter 302 = *Start* [1].
- Quickstop with terminal 27.
  Parameter 304 = *Coasting stop, inverse* [0].
- Activated peripheral equip
  Parameter 323 = *Start command active* [13].

■ 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*

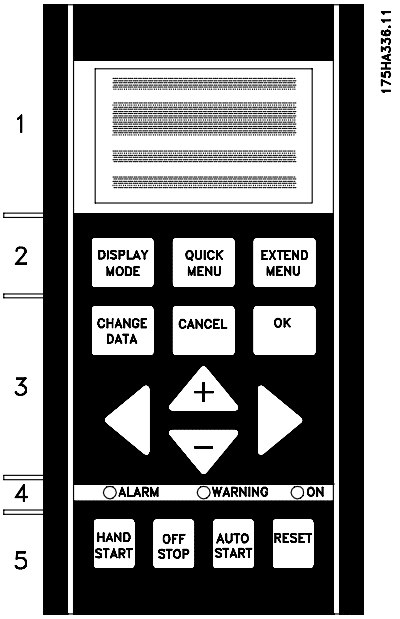
■ Control unit LCP

The front of the VLT AFD features a control panel -LCP (Local Control Panel). This is a complete inter-face for operation and programming of the VLT 4000 VT. The control panel is detachable and can - as an al-ternative - be installed up to 10 feet away from the VLT AFD, 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:

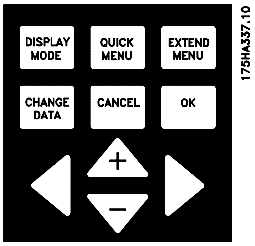
1. Display
2. Keys for changing display mode
3. Keys for changing program parameters
4. Indicator lamps
5. Keys for local operation.

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 AFD 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 AFD 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 MODE] 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 selec-ted parameter is not to be carried out.

OK

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

+ / −

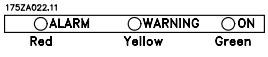
[+/-] is used for selecting parameters and for changing a chosen parameter. These keys are also used to change the local reference.
In addition, the keys are used in Display mode to switch between operation variable readouts.

◄ ►

[<>] 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.

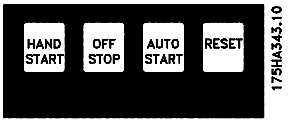


If certain threshold values are exceeded, the alarm and/ or warning lamp is activated, and a status or alarm text is displayed.

NOTE
The voltage indicator lamp is activated when the AFD receives voltage.

■ Local control

Underneath the indicator lamps are keys for local control.



HAND START

[HAND START] is used if the AFD is to be controlled via the control unit. The AFD 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

NOTE
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 AFD 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 AFD will start.

NOTE
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 AFD after an alarm (trip). Can be selected as *Enable* [1] or *Disable* [0] via parameter 015 *Reset on LCP*.
See also *List of warnings and alarms.*

■ 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 AFD 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 AFD. 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.

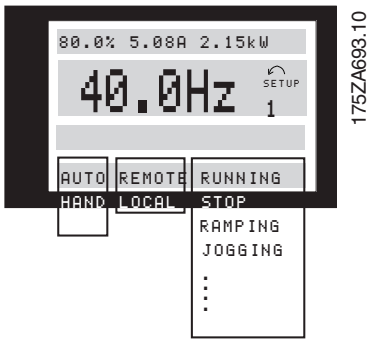
■ Display mode, cont.

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, analog terminal 53	[V]
Input status, analog terminal 54	[V]
Input status, analog 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:



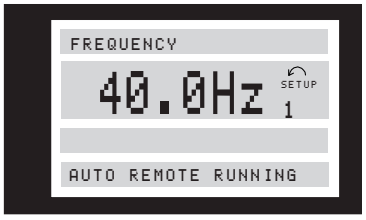
The left part of the status line indicates the control element of the VLT AFD that is active. AUTO means that control is via the control terminals, while HAND indicates that control is via the local keys on the control unit. OFF means that the VLT AFD ignores all control commands and stops the motor.

The center 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:

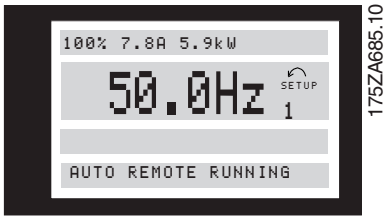
VLT 4000 VT offers different display modes de-pending on the mode selected for the VLT AFD. The figure on the next page shows the way to navigate between different display modes.
Below is a display mode, in which the VLT AFD is in Auto mode with remote reference at an output frequency of 40 Hz.
In this display mode, reference and control are deter-mined 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 AFD is in Auto mode with remote reference, and that the motor is running.

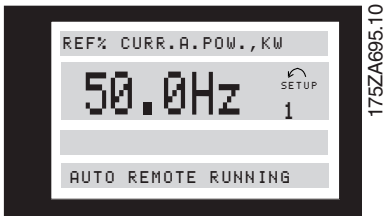
■ Display mode II:

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*.



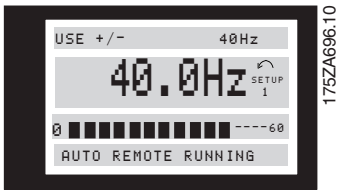
■ Display mode III:

This display mode is active 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.

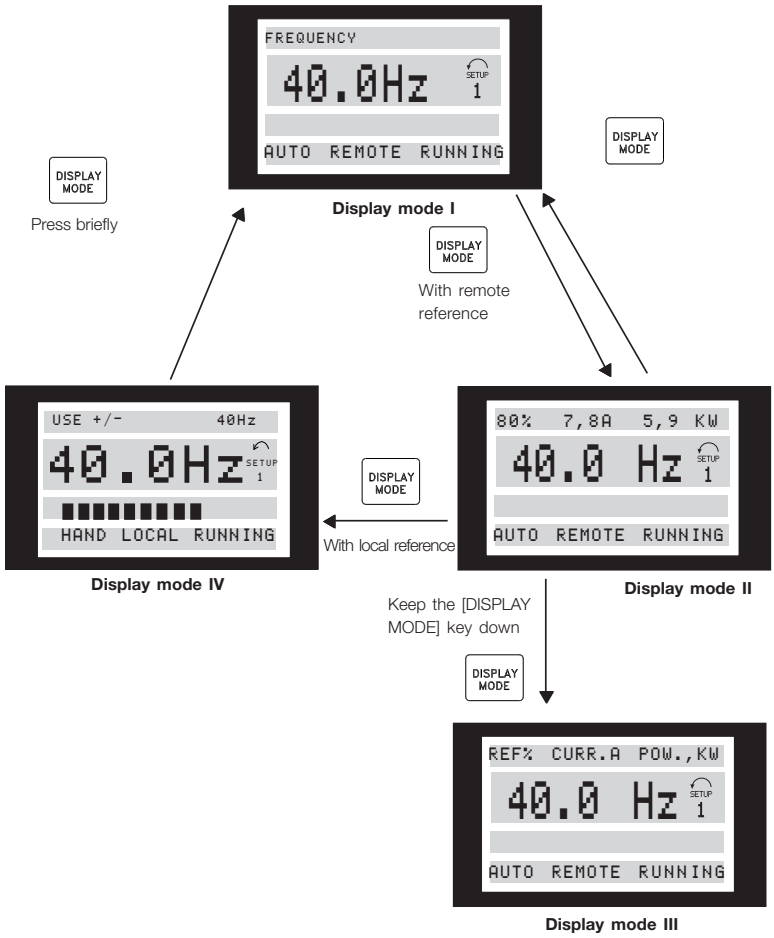


■ Display mode IV:

This display mode is only active 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



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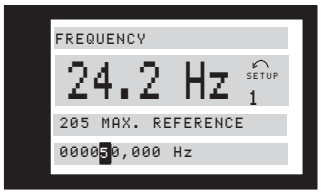
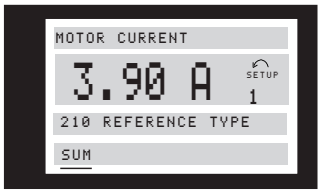
■ Changing data

Regardless of whether a parameter has been selected under the Quick menu or the Extended menu, the procedure for changing data is the same. Pressing the [CHANGE DATA] key allows change of the selected parameter, and 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 ente-red (saved) when signing off by pressing the [OK] button. Use [CANCEL] to cancel the change.

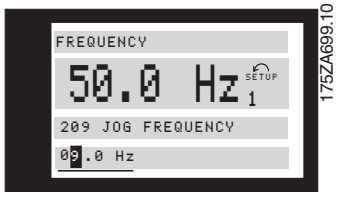
If the selected parameter is a functional value, the selected text value can be changed by means of the [+/-] keys.



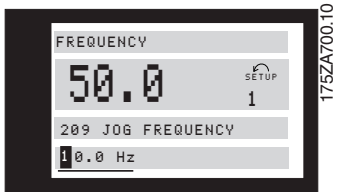
The functional value flashes until signing off by pressing the [OK] button. The functional value has now been selected. Use [CANCEL] to cancel the change.

■ 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 by means of the [+/-] keys:



The chosen digit flashes. 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 initialization

Disconnect from line and hold the [DISPLAY/STATUS] + [CHANGE DATA] + [OK] keys down while at the same time reconnecting the line supply.
Release the keys; the AFD has now been programmed for the factory setting.

The following parameters are not reset by means of manual initialization:

parameter
- 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 initialization 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.

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.

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.

Parameter Data

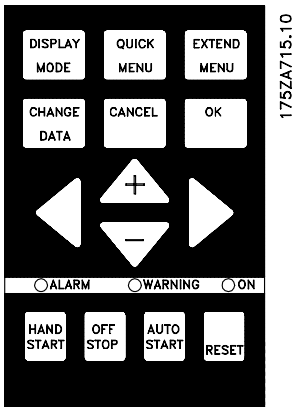
Enter or change parameter data or settings in accordance with the following procedure.

1. Press Quick Menu key.
2. Use '+' and '-' keys to find parameter you chose 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 left and right 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 left arrow twice – hundreds digit will flash.
5. Press '+' key once to change hundreds digit to '1.'
6. Press right arrow 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.



NOTE

Programming of extended parameters functions available through Extended Menu key is done in accordance with the same procedure as described for Quick Menu functions.

■ Programming

EXTEND MENU

Using the [EXTEND MENU] key, it is possible to have access to all the parameters for the AFD.

■ Operation and Display 001 - 017

This parameter group allows to set up parameters such as 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 4000 VT 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 AFD to Multi-Setup to allow switching of Setups with the digital inputs or serial communication. Setup shifts can be used in systems where, 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 AFD 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 AFD, where all parameter values can be copied from the control unit to the VLT AFD.

---

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]

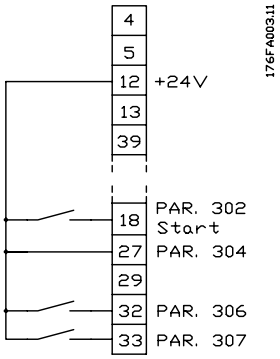
Function:

The choice in this parameter defines the Setup number you want to control the functions of the AFD. 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 common 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 002 =*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*.

NOTE
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 AFD 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 AFD 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 AFD that has a different rated power than the one from where the parameter Setup originates.

NOTE
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 readout. The range is set in parameter 005 *Max. value of user-defined readou*t 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:

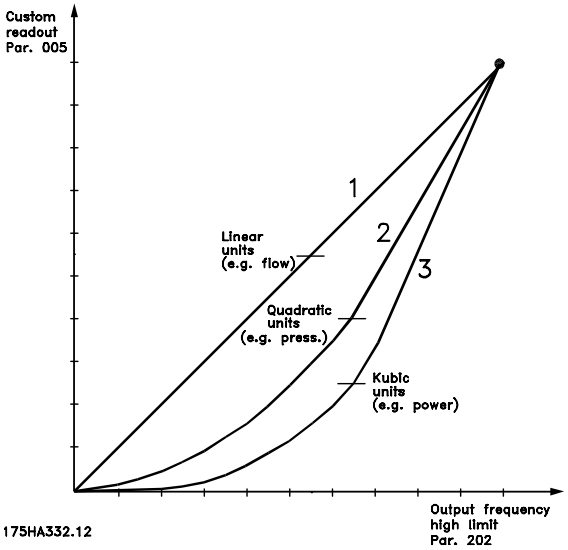
Set the required value for max. output frequency.

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

★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 (HP, 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]
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]
Analog input 53 [V] (ANALOG INPUT 53 [V])	[21]
Analog input 54 [V] (ANALOG INPUT 54 [V])	[22]
Analog 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 AFD 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 AFD.

% 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 [HP] states the actual power consumed by the motor in HP.

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 states the intermediate circuit voltage in the VLT AFD.

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 AFD. 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.

Analog input 53 [V] states the voltage value on terminal 53.

Analog input 54 [V] states the voltage value on terminal 54.

Analog input 60 [mA] states the voltage value on terminal 60.
Pulse reference [Hz] P 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 analog/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 AFD. 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, when setting the PID regu-lator to see how the process reacts to a change of reference. For display read-outs, press the [DISPLAY/STATUS] button. Data option *LCP display text* [27] cannot be selected with small display readout.

Description of choice:
There is a choice of 26 different data values, see parameter 007 *Large display readout* .

---

009 Small display readout 1.2
(SMALL READOUT 2)

Value:
See parameter 007 *Large display readout*
★Motorcurrent [A] [5]

Function:
See the functional description for parameter 008 *Small display readout*.

Description of choice:
There is a choice of 26 different data values, see parameter 007 *Large display readout* .

---

010 Small display readout 1.3
(SMALL READOUT 3)

Value:
See parameter 007 *Large display readout*
★Power [HP] [6]

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* .

---

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.

---

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.

NOTE
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.

NOTE
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 line voltage is reconnected.

Description of choice:

Auto restart [0] is selected if the AFD is to start up in the same start/stop condition as immediately before power to the AFD is cut off.
OFF/Stop [1] is selected if the AFD is to remain stopped when the line voltage is connected, until a start command is active. To restart, activate the key [HAND START] or [AUTO START] by using the control panel .

NOTE

If [HAND START] or [AUTO START] cannot be activated by the keys on the control panel (see parameter 012/014 *Hand/Auto start on LCP)* the motor will not be able to restart if *OFF/Stop* [1] is selected. If Handstart or Autostart has been programmed for activation via the digital inputs, the motor will not be able to restart if *OFF/Stop* [1] is selected.

■ Load and motor 100-117

This parameter group allows the configuration of regulation parameters and the choice of torque characteristics to which the VLT AFD 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 AFD 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:

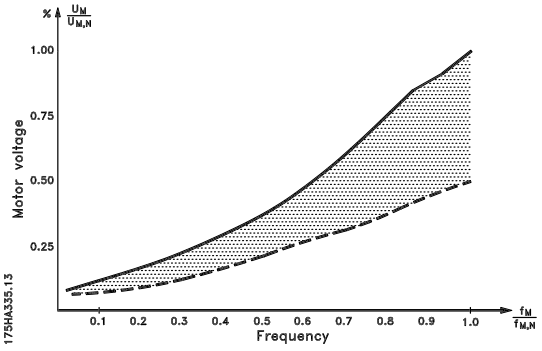
★Automatic Energy Optimization (AEO FUNCTION)	[0]
Parallel motors (MULTIPLE MOTORS)	[1]

Function:

This parameter allows a choice of whether the VLT AFD has one or several motors connected to it.

Description of choice:

If *Automatic Energy Optimization* [0] has been selected, only one motor may be connected to the VLT AFD. The AEO function ensures that the motor obtains its maximum efficiency and minimizes motor interference. Select *Parallel motors* [1] if more than one motor is connected to the output in parallel. See the description un-der parameter 108 *Start voltage of parallel motors* regarding the setting of parallel motor start voltages.



NOTE

It is important that the values set in parameters 102-106 *Nameplate data* correspond to the nameplate data of the motor with respect to either star coupling Y or delta coupling Δ.

102 Motor power, $P_{M,N}$M,N (MOTOR POWER)

Value:

0.25 HP (0.25 KW)	[25]
0.5 HP (0.37 KW)	[37]
0.75 HP (0.55 KW)	[55]
1 HP (0.75 KW)	[75]
1.5 HP (1.10 KW)	[110]
2 HP (1.50 KW)	[150]
3 HP (2.20 KW)	[220]

4 HP (3.00 KW)	[300]
5 HP (4.00 KW)	[400]
7.5 HP (5.50 KW)	[550]
10 HP (7.50 KW)	[750]
15 HP (11.00 KW)	[1100]
20 HP (15.00 KW)	[1500]
25 HP (18.50 KW)	[1850]
30 HP (22.00 KW)	[2200]
40 HP (30.00 KW)	[3000]
50 HP (37.00 KW)	[3700]
60 HP (45.00 KW)	[4500]
75 HP (55.00 KW)	[5500]
100 HP (75.00 KW)	[7500]
125 HP (90.00 KW)	[9000]
150 HP (110.00 KW)	[11000]
200 HP (132.00 KW)	[13200]
250 HP (160.00 KW)	[16000]
300 HP (200.00 KW)	[20000]
350 HP (250.00 KW)	[25000]
400 HP (300.00 KW)	[30000]
450 HP (315.00 KW)	[31500]
500 HP (355.00 KW)	[35500]
600 HP (400.00 KW)	[40000]

★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 of the motor power infinitely variable value, see the procedure for *infinetely 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]
550 V	[550*]
575 V	[575*]

★Depends on the unit
* (Must be manually programmed.)

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 line voltage of the VLT AFD. Furthermore, alternatively it is possible to set the value of the motor voltage infinitely variably.
Also refer to the procedure for *infinitely variable change of numeric data value*.

---

104 Motor frequency, $f_{M,N}$ (MOTOR FREQUENCY)

Value:

50 Hz (50 HZ)	[50]
★60 Hz (60 HZ)	[60]

Function:

Select the rated motor frequency $f_{M,N}$.

Description of choice:

Select a value that equals the nameplate data on the motor.
It is also possible to set the value for motor frequency infinitely variable 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 AFD calculations 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.

NOTE
It is important to enter the correct value, since this forms part of the V V C PLUS 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 sets the value that corresponds to the rated motor speed $n_{M,N}$, from the nameplate data.

Description of choice:

Choose a value that corresponds to the motor nameplate data.

NOTE
It is important to set the correct value, since this forms part of the V V C PLUS 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 AFD to the motor applied. This feature is used where the factory setting does not match requirements of the motor.

For the best adjustment of the VLT AFD, 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 AFD 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 AFD 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 HP 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 out-put current of the VLT AFD.
- If automatic motor adaptation is to be discontinued, press the [OFF/STOP] key.

NOTE
AMA is not allowed on motors connected in parallel.

Description of choice:

Select *Automatic adaptation* [1] if the VLT AFD 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 AFD 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 AFD or connect terminal 18 (start) to 24 V DC (possibly from terminal 12).

If the automatic motor adaptation is to be stopped:

1. Press the [OFF/STOP] key.

After a normal sequence, the display reads: AMA STOP

1. The VLT AFD is now ready for operation.

If there is a fault, the display reads: ALARM 22

1. Press the [Reset] key.
2. Check for possible causes of the fault in accor-dance 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 HP) connected in parallel, as they have a higher stator resistance than motors above 5.5 HP. This function is only active if *Parallel motors* [1] has been selected in parameter 101 *Torque characteristics* .

Description of choice:

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

---

109 Resonance damping
(RESONANCE DAMP.)

Value:

0 - 500 % ★ 100 %

Function:

High-frequency electric resonance problems between the AFD 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 AFD. 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). 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.

■ 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.

NOTE
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:

$0 - \frac{I_{VLT,MAX}}{I_{M,N}} \; x \; 100 \; [\%]$ ★ 50 %
The maximum value depends on the rated motor current. If the DC braking current is active, the AFD 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 a braking current for too long.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.

---

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:

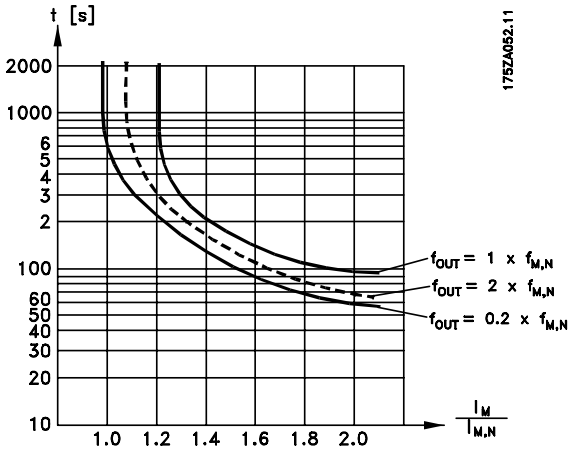
The AFD is able to monitor the motor temperature in two different ways:

- Via a thermistor sensor fitted to the motor. The thermistor is connected to one of the analog 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 AFD 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 mo-tor is overloaded according to the calculations.

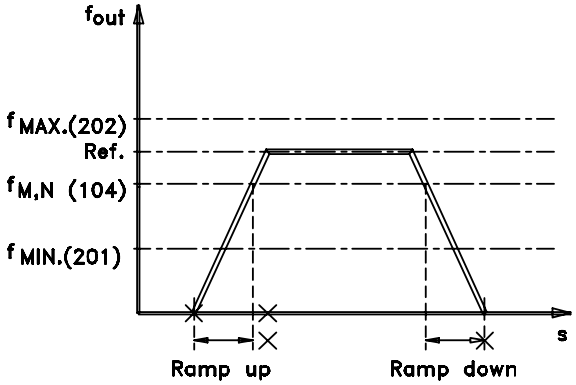


NOTE
In UL / cUL applications ETR provides class 20 motor overload profection in accordance with National Electrical Code.

Programming

■ References and limits 200-228

■ References and Limits 200-208



175HA334.10

In this parameter group, the frequency and reference range of the AFD 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*) ★ 60 Hz

Function:

In this parameter, a maximum output frequency can be selected that corresponds to the highest speed at which the motor can be.

NOTE
The output frequency of the VLT AFD 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.

■ 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 analog 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.

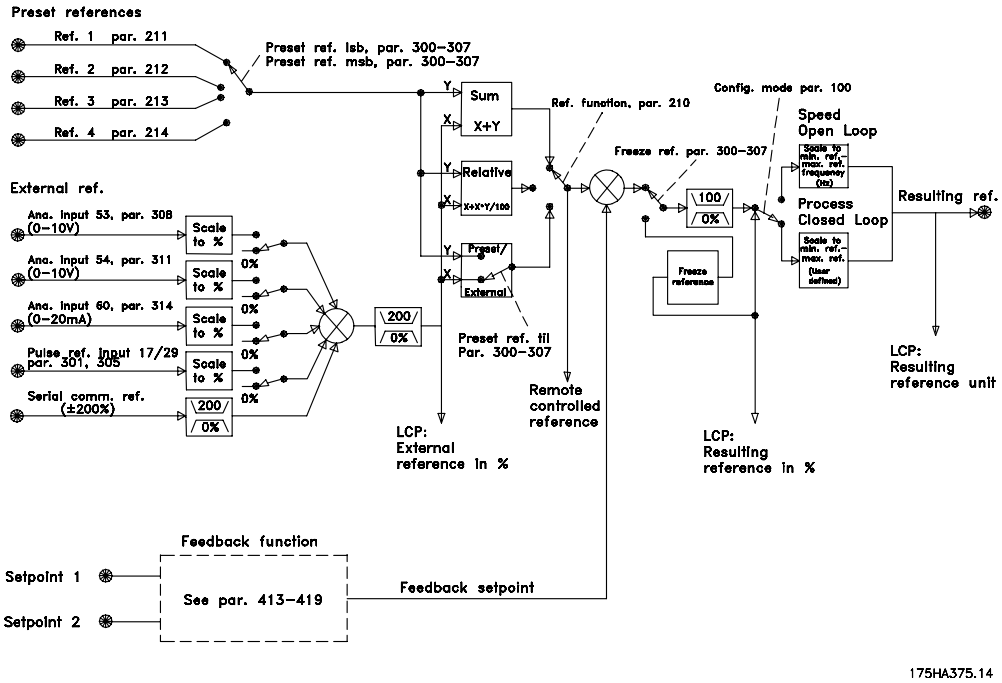
The sum of the external references can be shown in the display as a percentage of the range from *Minimum reference, Ref $_{MIN}$* to *Maximum reference, Ref $_{MAX}$*. Select *External reference*, % [25] in parameters 007-010 *Display readout* if a readout is required.

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}.*

NOTE
If the local reference is active, the VLT AFD 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*.



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 determines the location of the active reference. If *Hand/Auto linked reference* [0] is selected, the resulting reference will depend on whether the AFD 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 ★ 60 Hz
Parameter 100 *Configuration* = *Closed loop* [1]
Par. 204 *Ref $_{MIN}$*
- par. 414 *Maximum feedback* ★ 60 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*).

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*.

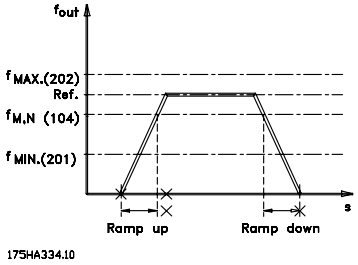
206 Ramp-up time
(RAMP UP TIME)

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 AFD does not trip during deceleration if the ramp-down time set is too short. If, during deceleration, the AFD registers that the intermediate circuit voltage is higher than the max. value (see *list of warnings and alarms*), the AFD automatically extends the ramp-down time.

NOTE

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 AFD 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 AFD is running when the jog function is activated.
Jog can be activated via the digital inputs.

Description of choice:

Set the desired frequency.

■ 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, analog 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 analog input voltage of 4 V, the resulting reference will be as follows:

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

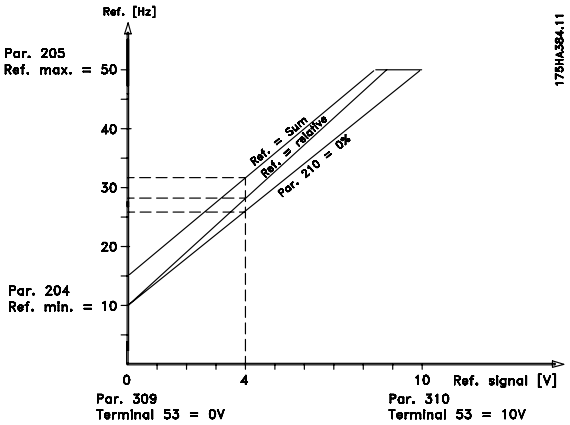
Par. 204 *Minimum reference*	= 10.0 Hz
Reference contribution at 4 V	= 16.0 Hz
Par. 211 ***Preset reference***	= 6.0 Hz
Resulting reference	= 32.0 Hz

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 analog 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 analog references, pulse references and any references from serial communication.

NOTE
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.

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. lsb	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 AFD), the AFD 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*.

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

Value:

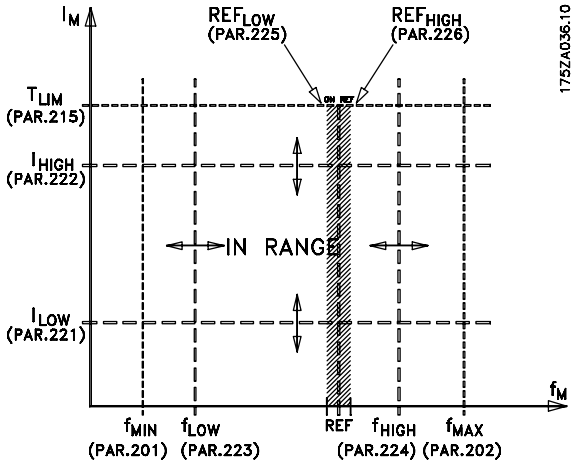
0.0 - par. 222 *Warning: High current* I_{HIGH}, ★ 0.0A

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 AFD 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 AFD.



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 AFD. 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 selected 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 AFD. See drawing at parameter 221*Warning: Low current,* I_{LOW}.

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 selected 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 AFD. 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 selected 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 225 *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 AFD, provided parameter 100 *Configuration* has been programmed for *Open loop* [0]. In *Closed loop* [1] (parameter 100), Ref_{LOW} must be within the reference range programmed in parameters 204 and 205.

---

226 Warning: High reference, REF_{HIGH} (WARN. HIGH REF.)

Value:

REF_{Low} (par. 225)
- 999,999.999 ★ - 999,999.999

Function:

If the resulting reference lies under the limit, Ref_{HIGH}, programmed in this parameter, the display shows a flashing REFERENCE HIGH.
The warning functions in parameters 221-228 are not active during ramp-up after a start command, ramp-down after a stop command or while stop-ped. The warning functions are activated when the output frequency has reached the selected 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 225 *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 AFD, 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 selected 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

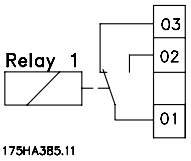
Function:

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 selected 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.

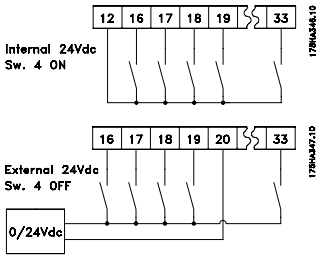
Description of choice:

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 AFD are defined.
The digital inputs (terminals 16, 17, 18, 19, 27, 29, 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 AFD.

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 INVERS)					[1]			
Start	(START)			★[1]					
Reversing	(REVERSE)				★[1]				
Reverse and start	(START INVERSE)				[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]

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 AFD is not to react to signals transmitted to the terminal.

Reset resets the VLT AFD after an alarm; however, not all alarms can be reset (trip locked) cycling line 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 Freeze AFD 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 foractivating 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 ro-tation; it does not activate the start function. It can not be used in *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 line failure.

Freeze output freezes the present output frequency (in Hz). The frozen output frequency can now only be changed by *Speed up* or *Speed down*.

NOTE
If Freeze output is active, the VLT AFD cannot be stopped via terminal 18. The VLT AFD can only be stopped when terminal 27 or terminal 19 has been programmed for *DC braking, inverse*.

Selection of Setup, lsb or ***Selection of Setup, msb*** enables a choice of one of the four Setups. However, this assumes that parameter 002 *Active Setup* has been set at *Multi Setup* [5].

	Setup, msb	Setup, lsb
Setup 1	0	0
Setup 2	0	1
Setup 3	1	0
Setup 4	1	1

Preset reference, on is used for switching between remote reference and preset reference. This assumes that *Remote/preset* [2] has been selected in parameter 210 *Reference type*. Logic "0" = remote references active; logic "1" = one of the four preset references is active in accordance with the table on the next page.

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 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 mini-mum 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 AFD has stopped. In addition, the frozen reference will be rememberd in case of a line 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.

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 AFD 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 AFD 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 AFD starts the motor. A logic "0" means that the connected motor stops. The VLT AFD will then be in OFF/STOP mode, unless there is an active *Auto start signal*. See also the description in *Local control*.

NOTE
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 AFD is to be controlled via an external auto/off or H-O-A switch. A logic '1' will place the VLT AFD 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 AFD will then be in OFF/STOP mode. See also the description in *Local control*.

■ Analog inputs

Two analog inputs for voltage signals (terminals 53 and 54) are provided for reference and feedback signals. Furthermore, an analog input is available for a current signal (terminal 60). A thermistor can be connected to voltage input 53 or 54. The two analog 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 analoge inputs.
Parameter 317 *Time out* and 318 *Function after time out* allow activation of a time-out function on all analoge inputs. If the signal value of the reference or feedback signal connected to one of the analoge in-put 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*.

Analog 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, analog input voltage (AI [V] 53 FUNCT.)

Function:

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

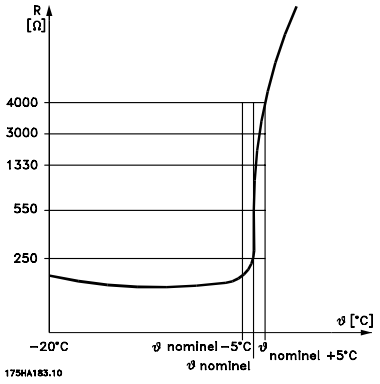
Description of choice:

No operation Is selected if the AFD is not to react to signals connected to the terminal.

Reference Is selected to enable change of reference by means of an analog 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 AFD in case of motor overtemperature. The cut-out value is 3 kohm. If a motor features a 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 (analoge voltage input) and termi-nal 50 (+10 V supply).



A motor thermistor connected to terminals 53/54 must be double isolated to obtain PELV.

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 *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.

---

311 Terminal 54, analog 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 done 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 204 *Minimum reference, Ref_{MIN}*/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, analog 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 done 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.
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 AFD 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].

■ Analog/digital outputs

The two analog/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 AFD is used as a digital output, it gives the present status by means of 0 or 24 V DC. If the analoge output is used for giving a process value, there is a choice of three types of output signals: 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 analog/digital outputs). If the output is used as a current output, the resulting impedance of the connected equipment should not exceed 500 Ω.

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]

Function:

This output can act both as a digital or an analog output. If used as a digital output (data value [0]-[59]), a 0/24 V DC signal is transmitted; if used as an ana-loge output, either a 0-20 mA signal, a 4-20 mA sig-nal or a pulse sequence of 0-32000 pulses is transmitted.

Description of choice:

No function. Selected if the VLT AFD is not to react to signals.

Drive ready. The VLT AFD control card receives a supply voltage and the AFD is ready for operation.

Stand by. The VLT AFD 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 AFD 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 ILIM.

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 counter-clockwise. When the mo-tor rotates clockwise, the value is 0 V DC.

Thermal warning. The temperature limit in either the motor, the VLT AFD or a thermistor connected to an analogue input has been exceeded.

Hand mode active. The output is active when the VLT AFD is in Hand mode.

Auto mode active. The output is active when the VLT AFD is in Auto mode.

Sleep mode. Active when the VLT AFD 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 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}*.

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 line imbalance or when a phase is missing in the line supply. Check the line voltage to the VLT AFD.

0-f_{MAX} ⇒0-20 mA and
0-f_{MAX} ⇒4-20 mA and
0-f_{MAX}⇒0-32000 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} ⇒0-20 mA and
External Ref_{MIN} - Ref_{MAX} ⇒4-20 mA and
External Ref_{MIN} - Ref_{MAX} ⇒ 0-32000 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} ⇒ 0-20 mA and
FB_{MIN}-FB_{MAX} ⇒ 4-20mA and
FB_{MIN}-FB_{MAX} ⇒ 0-32000 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 - $I_{VLT,MAX}$ ⇒0-20 mA and
0 - $I_{VLT,MAX}$ ⇒ 4-20 mA and
0 - $I_{VLT,MAX}$ ⇒ 0-32000 p, an output signal proportional to the output current in the interval 0 - $I_{VLT,MAX}$ is obtained.

0 - p_{NOM} ⇒0-20 mA and
0 - p_{NOM} ⇒4-20 mA and
0 - p_{NOM} ⇒0-32000 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:

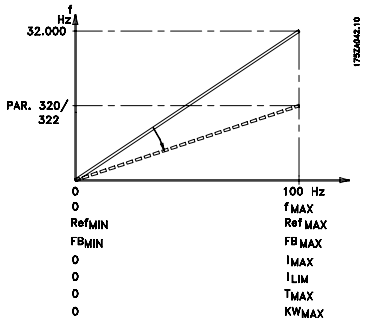
1 - 32000 Hz ★ 5000 Hz

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 analog output. When used as a digital output (data value [0]-[26]) it generates a 24 V (max. 40 mA) signal. For the analog 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:

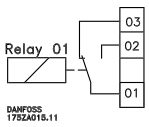
This parameter allows scaling of the pulse output signal.

Description of choice:

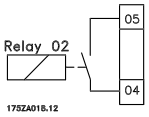
Set the desired value.

■ Relay outputs

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 line 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	terminal 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]

Function:

Description of choice:

See description of [0] - [28] in *Analog/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.

323 Relay 1, output function
(RELAY1 FUNCTION)

Function:

This output activates a relay switch. Relay switch 01 can be used for indicating 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. ★ 2 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 indicating 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

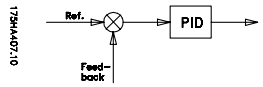
Function:

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



Includes this parameter group, the special functions of the VLT AFD 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 AFD 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 AFD 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 - 1800 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 AFD to "catch" a spinning motor, which - e.g. because of a line failure - is no longer controlled by the AFD. This function is activated whenever a start command is active.
For the VLT AFD 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 AFD is to be able to "catch" and control a spinning motor. Select *DC brake and start* [2] if the VLT AFD is to brake the motor with DC braking, and then restart the motor. It is assumed that parameters 114-116 *DC braking* are enabled. In the case of a substantial "windmilling" effect (spinning motor), the AFD will not "catch" a spinning motor unless *DC brake and start* has been selected.

■ Sleep mode

Sleep mode makes it possible to stop the motor when it is running at low speed, similar to a no load situation. If consumption in the system goes back up, the AFD will start the motor and supply the power required.

NOTE
Energy can be saved with this function, since the motor is only in operation when the system needs it.

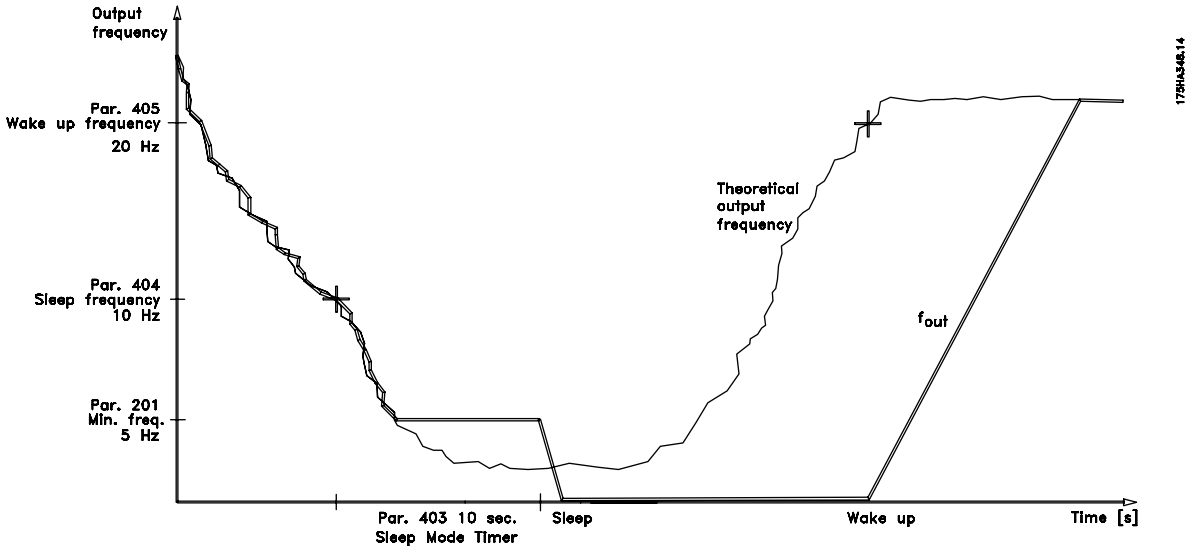
Sleep mode is not active if *Local reference* or *Jog* has been selected
The function is active in both *Open loop* and *Closed loop*.

In parameter 403 *Sleep mode timer*, the Sleep mode is activated. In parameter 403 *Sleep mode timer*, a timer is set that determines how long the output frequency can be lower than the frequency set in parameter 404 *Sleep frequency*. When the timer runs out, the AFD 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 AFD 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 AFD 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 AFD stops the motor. This extends the time during which the AFD 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 AFD stops the motor, parameter 406 *Boost setpoint* is set to 125%. Parameter 406 *Boost setpoint* is only active in *Closed loop*.

NOTE
In highly dynamic pumping processes, it is recommended to switch off the *Flying Start* function (parameter 402).



403 Sleep mode timer
(SLEEP MODE TIMER)

Value:

0 - 300 sec.(OFF) ★ OFF

Function:

This parameter enables the AFD 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 AFD will turn off the motor. The AFD 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 AFD restarts the motor.

Description of choice:

Set the required frequency.

---

406 Boost setpoint
(BOOST SETPOINT)

Value:

1 - 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 AFD stops the motor. This extends the time during which the AFD 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.

There is a fixed boost time-out on 30 sec. in case the boost setpoint cannot be reached.

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.

NOTE
The output frequency of the AFD 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.

NOTE
Switching frequencies higher than 4.5 kHz implement automatic derating of the maximum output of the AFD. See *Derating of high switching frequency*.

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 AFD. 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 reduce acoustic noise in the motor. 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 AFD and the motor, as the AFD 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 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 AFD will stop the motor.

If *Warning* [2] is selected, the VLT AFD will give a warning if the output current drops below the threshold value in parameter 221 *Warning: Low current,* I_{LOW}.

Parameter 410 and 411:

NOTE
Par. 410 and 411 are not available for VLT 4042-4062 200-240 V, and VLT 4100-4600 380-460 V.

410 Function at line 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 line imbalance becomes too high or if a phase is missing.

Description of choice:

At *Trip* [0] the AFD 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 line failure occurs, but in severe cases, other extreme conditions might result in a trip.

NOTE
If *Warning* has been selected, the life expectancy of the drive will be reduced when the line failure persists.

NOTE
At phase loss the cooling fans of NEMA 12 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 AFD is exposed to an overtemperature condition.

Description of choice:

At *Trip* [0] the AFD will stop the motor and export an alarm.
At *Autoderate & warning* [1] the AFD will first reduce the switching frequency to minimize internal losses. If the overtemperature condition persists, the AFD will reduce the output current until the heat sink temperature stabilizes. When the function is active, a warning will be exported.

---

412 Trip delay overcurrent, I_{LIM} ()
(OVERLOAD DELAY)

Value:

0 - 60 sec. (61=OFF) ★ 61 sec. (OFF)

Function:

When the AFD 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 AFD 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 4000 VT 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 *Analog 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 *Analoge inputs*).

---

415 Units relating to closed loop

(REF. / FDBK. UNIT)

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]
mWG	[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.

■ 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 4000 VT units have been optimised for use in water applications. This means that a number of specialised functions are available in VLT 4000 VT units.
Using the VLT 4000 VT, 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 a built in option for connecting two feed-back signals to the system.

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 AFD. 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, volt-age can be used as analog 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.

NOTE
Terminals that are not in use may preferably be set to *No function* [0].

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 exces-sive 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 AFD is to bring the motor before the process regulator is activated. This is done by programming a*PID start-up frequency* in parameter 422.

Differentiator gain limit
If there are very quick variations in a given application with respect to the reference/setpoint signal or the feedback signal, the deviation between reference/ setpoint and the actual process state will quickly change. The differentiator may thus become too dominant. This is because it reacts to the deviation between the reference/setpoint and the actual process state. The quicker the deviation changes, the stronger the resulting differentiator frequency contribution. The differentiator frequency contribution can thus be limited to allow the setting of a reasonable differentiation time for slow changes and a suitable frequency contribution for quick changes. This is done in parameter 426, *PID Differentiator gain limit*.

Lowpass filter
If there are ripple currents/voltages on the feedback signal, these can be dampened by means of a built-in lowpass filter. Set a suitable lowpass filter time constant. This time constant represents the limit frequency of the ripples occurring on the feedback signal.
If the lowpass filter has been set to 0.1s, the limit frequency will be 10 RAD/sec., corresponding to (10/ $2 \times \pi$) = 1.6 Hz. This means that all currents/voltages that vary by more than 1.6 oscillations per second will be removed by the filter.
In other words, regulation will only be carried out on a feedback signal that varies by a frequency of less than 1.6 Hz. Choose a suitable time constant in parameter 427, *PID Lowpass filter time*.

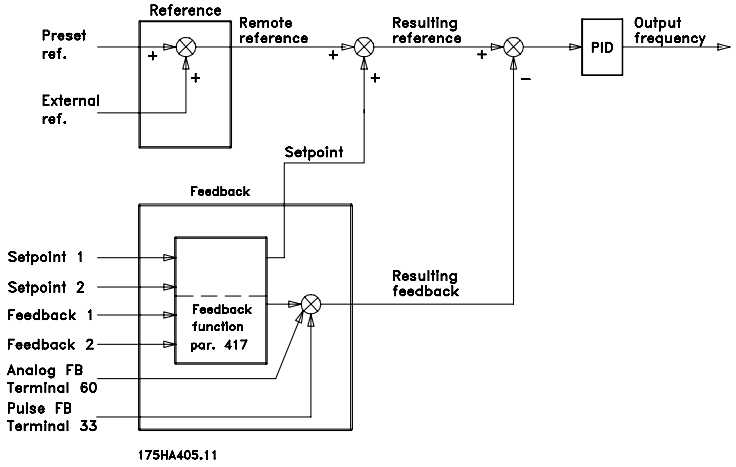
Optimisation of the process regulator
The basic settings have now been made; all that remains to be done is to optimize the proportional gain, the integration time and the differentiation time (parameters 423, 424 and 425). In most processes, this can be done by following the guidelines given below.

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 stabilizes, 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 optimized.

NOTE
If necessary, start/stop can be activated a number of times in order to provoke an unstable feedback signal.

■ 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 4000 VT 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 set-point/ 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

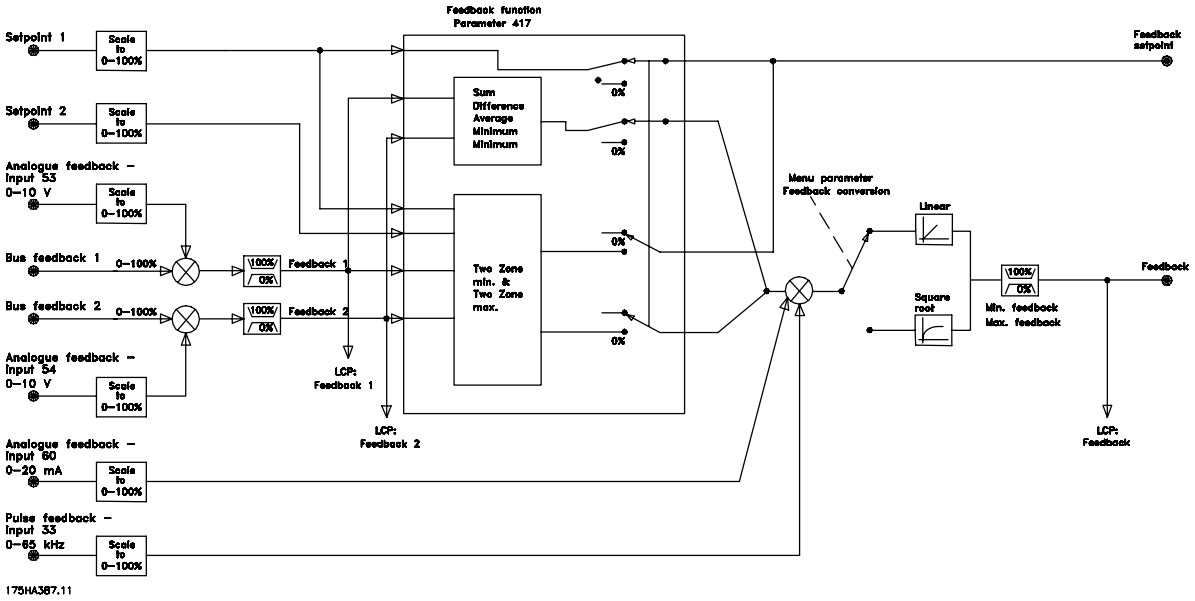
If only 1 setpoint and 1 feedback signal are used, parameter 418 *Setpoint 1* will be added to the remote reference. The sum of the remote reference and *Setpoint 1* becomes the resulting reference, which will then be compared with the feedback signal.

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.



416 Feedback conversion (FEEDBACK CONV)

Value:

★Linear (LINEAR)	[0]
Square root (SQUARE ROOT)	[1]

Function:

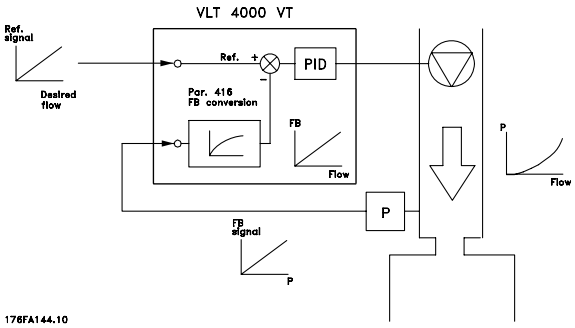
In this parameter, a function is selected which converts a connected feedback signal from the process to a feedback value that equals the square root of the connected signal.

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 of choice:

If *Linear* [0] is selected, the feedback signal and the feedback value will be proportional. If *Square root* [1] is selected, the VLT AFD translates the feedback signal to a squared feedback value.



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 AFD 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 AFD will compare *feedback 1* with *feedback 2* and regulate on the basis of the higher feedback value.
If Sum [2] is selected, the VLT AFD 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 AFD will subtract *feedback 1* from *feedback 2*.
If *Average* [4] is selected, the VLT AFD 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 AFD will calculate the difference between *Setpoint 1* and *feedback 1* as well as *Setpoint 2* and *feedback 2*. After this calculation, the VLT AFD 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 AFD will calculate the difference between *Setpoint 1* and *feedback 1* as well as *Setpoint 2* and *feedback 2*. After the calculation, the VLT AFD 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 AFD is to reduce the output frequency in case the feedback signal increases, select *Normal* [0].
If the AFD 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.

NOTE
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 AFD 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.

NOTE
If the AFD 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.

NOTE
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.

---

427 PID lowpass filter time (PID FILTER TIME)

Value:

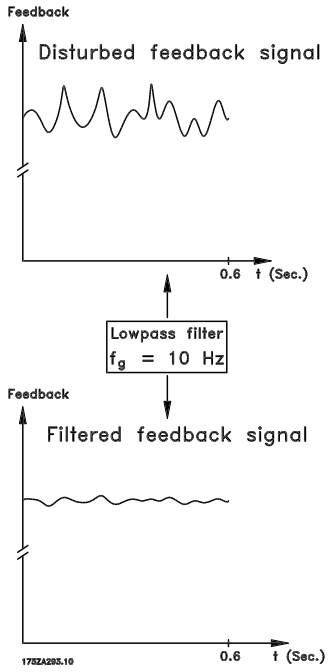
0.01 - 10.00 ★ 0.01

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 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.



■ 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 AFD. 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

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 AFD 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 AFD. 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*.

Parameter 603 *No. of cut-ins:*
Gives the number of cut-ins of supply voltage to the AFD.

Parameter 604 *No. of overtemps:*
Gives the number of overtemperature errors on the heat-sink of the AFD.

Parameter 605 *No. of overvoltages:*
Gives the number of overvoltages on the intermediate circuit voltage of the AFD. The count is only taken when Alarm 7 *Overvoltage* is active.

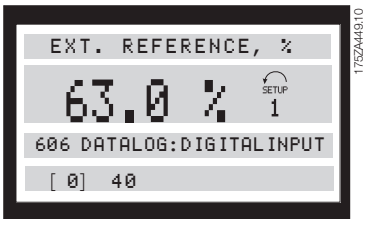
606 - 614 Data log

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, 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 AFD. 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.

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.

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.

---

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 AFD) 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 4000 VT, 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 initialization. (See *Manual initialization*).

---

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 initialization. (See *Manual initialization*).

---

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 initialization. (*See Manual initialization*).

---

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 AFD is reset. This parameter cannot be selected via the serial port, RS 485.

NOTE
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.

NOTE
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:

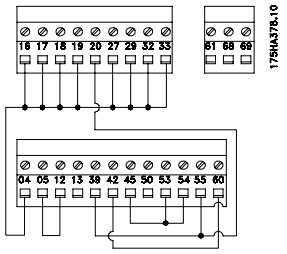
In addition to its normal function, this parameter can be used for two different tests.
Furthermore, it is possible to reset to the default factory settings for all Setups, except parameters 500 *Address*, 501 *Baud rate*, 600-605 *Operating data* and 615-617 *Fault log*.

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 analog and digital inputs, analog 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 line supply and wait for the light in the display to go out.
3. Insert the test plug (see preceding column).
4. Connect to line.
5. The VLT AFD expects the [OK] key to be pressed (the test cannot be run without LCP).
6. The VLT AFD automatically tests the control card.
7. Remove the test connector and press the [OK] key when the VLT AFD displays "TEST COMPLETED".
8. Parameter 620 *Operating mode* is automatically set to Normal function.

If the control card test fails, the VLT AFD 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 line supply and wait for the light in the display to go out.
4. Connect to line.
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 initialization*).

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 line voltage. Example: VLT 4008 380-460 V.

Parameter 622 *Nameplate: Power component:*
This gives the type of power card fitted to the VLT AFD. 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 Nameplate: 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 AFD.

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 AFD.

Parameter 631 *Nameplate: Communication option ordering no.:*
This gives the ordering number for the communication option.

NOTE
Parameters 700-711 for the relay card are only activated if a relay option card is installed in the VLT 4000 VT.

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.

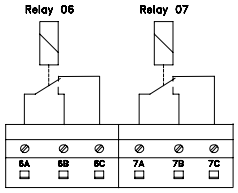
Function:
This parameter is used to delay the cut-out time of relays 6/7/8/9 (terminals 1-2).

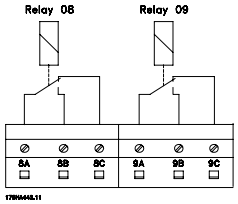
Description of choice:
Enter the required value.

■ Electrical installation of the relay card

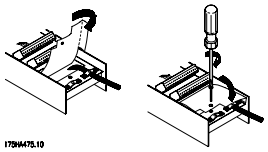
The relays are connected as shown below.

Relay 6-9:
A-B make, A-C break
Max. 240 V AC, 2 Amp.
Max. cross-section: 1.5 mm ^{2} (AWG 28-16)
Torque: 0.22 - 0.25 Nm / 4.5 - 5 In lb
Screw size: M2





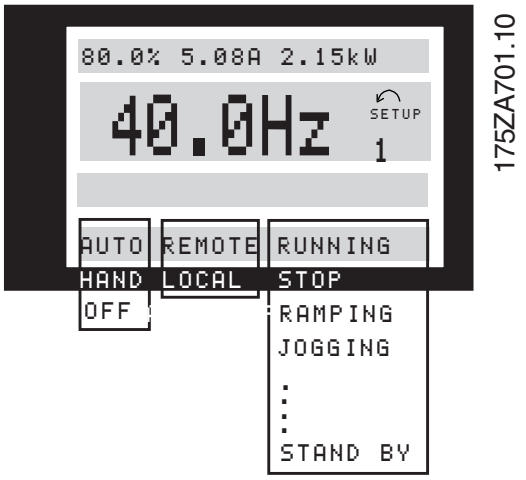
To achieve double isolation, the plastic foil must be mounted as shown in the drawing below.



Programming

■ 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 AFD.
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 AFD 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 AFD is in Hand mode, i.e. control is carried out via the control keys. See *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-up/down* is enabled, i.e. the AFD 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.

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 AFD is now ready for operation after the *Reset* signal has been enabled. Please note that the motor will start after the AFD has received the *Reset* signal.

Stand by (STANDBY)
The AFD 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 AFD is ready for operation, but terminal 27 is a logic "0" and/or a *Coasting command* has been received via the serial communication.

Not ready (NOT READY)
The AFD 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 AFD is out of operation.
The cause may be noise on the line, 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 AFD. After Trip locked, the line supply must be cut and the fault must be corrected. Reconnect the line supply and reset the VLT AFD 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

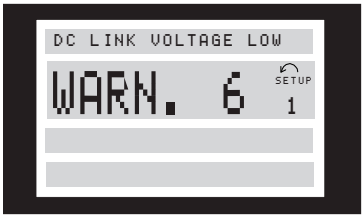
   In addition, an automatic reset may be selected in parameter 400 *Reset function.*

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 AFD alarm and warning will flash. If the fault is removed, only the alarm will flash. After a reset, the VLT AFD 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	X
4	Mains imbalance (MAINS IMBALANCE)	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	
14	Ground fault (GROUND 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	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	HBFB communication fault (HBFB 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

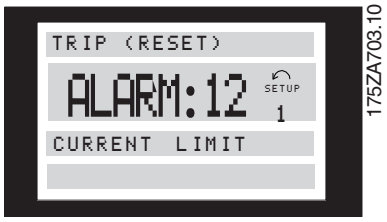
■ Warnings

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.



■ Warnings and alarms

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 AFD.

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 AFD 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 AFD 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 AFD will trip after a fixed period. The length of this period depends on the unit.

Alarm/warning limits:

VLT 4000 VT	3 x 200 - 240 V [VDC]	3 x 380 - 460 V [VDC]	3 x 525 - 600 V [VDC]	3 x 525 - 600 V 1) [VDC]
Undervoltage	211	402	557	553
Voltage warning low	222	423	585	585
Voltage warning high	384	769	943	1084
Overvoltage	425	855	975	1020

1) VLT 4102-4402.

The voltages stated are the intermediate circuit voltage of the VLT AFD with a tolerance of ± 5 %. The corresponding line voltage is the intermediate circuit voltage divided by √2.

WARNING/ALARM 8
Undervoltage (DC LINK UNDERVOLT)
If the intermediate circuit voltage (DC) drops below the *undervoltage limit* of the inverter, the VLT AFD 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 AFD, see *Technical data*.

WARNING/ALARM 9
Inverter overload (INVERTER TIME)
The electronic, thermal inverter protection reports that the AFD is about to cut out because of an over-load (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 AFD cannot be reset until the counter is below 90%.
The fault is that the VLT AFD 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 AFD 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 AFD is to give a warning or an alarm. Check that the thermistor has been correctly connected between terminal 53 or 54 (analog 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 AFD 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 AFD will trip and give off an alarm.
Turn off the VLT AFD and check whether the motor shaft can be turned and whether the motor size matches the VLT AFD.

ALARM: 14
Ground fault (GROUND FAULT)
There is a discharge from the output phases to ground, either in the cable between the AFD and the motor or in the motor itself.
Turn off the VLT AFD and remove the ground 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 line supply to the VLT AFD and remove the short-circuit.

WARNING/ALARM 17
Serial communication timeout (STD BUSTIMEOUT)
There is no serial communication with the VLT AFD. 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 AFD 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.*

WARNING/ALARM 18
HPFB bus timeout (HPFB TIMEOUT)
There is no serial communication with the commu-nication option card of the VLT AFD.
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 AFD 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 AFD 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 AFD 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 AFD.

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 RS 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 AFD. Contact your Danfoss supplier.

LIMIT VALUE FAULT [8]
The parameter values found for the motor are out-side the acceptable range within which the VLT AFD 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.

ALARM 29
Heat sink temperature too high (HEAT SINK OVER TEMP.):
If the enclosure is Chassis or NEMA 1, the cut-out temperature of the heat-sink is 90°C. If NEMA 12 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 AFD and motor is missing. Turn off the VLT AFD and check motor phase U.

ALARM: 31
Motor phase V missing (MISSING MOT.PHASE V):
Motor phase V between VLT AFD and motor is missing. Turn off the VLT AFD and check motor phase V.

ALARM: 32
Motor phase W missing (MISSING MOT.PHASE U):
Motor phase W between VLT AFD and motor is missing. Turn off the VLT AFD 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.

■ Special conditions

■ Aggressive environments

In common with all electronic equipment, a VLT AFD contains a large number of mechanical and electronic components, all of which are vulnerable to environmental effects to some extent.

The VLT AFD should not therefore be installed in environments with airborn liquids, particles or gasses capable of affecting and damaging the elec-tronic components. Failure to take the necessary protective measures increases the risk of stoppages, thus reducing the life of the VLT AFD.

Liquids can be carried through the air and condense in the VLT AFD. 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 NEMA 12 is recommended.

Airborne particles such as dust particles may cause mechanical, electrical or thermal failure in the VLT AFD. A typical indicator of excessive levels of airborne particles is dust particles around the VLT AFD fan. In very dusty environments, equipment with enclosure rating NEMA 12 or a cabinet for Chassis/ NEMA 1 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 AFD 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 ventila-tion, keeping aggressive gases away from the VLT AFD.

NOTE
Mounting VLT AFD in aggressive environments will increase the risk of stoppages and furthermore considerably reduce the life of the drive.

Before the installation of the VLT AFD, the ambient air should be checked for liquids, particles and gasses. 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 installa-tion cabinets and existing electrical installations. One indicator of aggressive airborn gasses is blackening of copper rails and cable ends on existing installations.

■ Calculation of resulting reference

The calculation made below gives the resulting reference when parameter 210 *Reference type* is programmed for *Sum* [0] and *Relative* [1], respectively.

External reference is the sum of references from terminals 53, 54, 60 and serial communication. The sum of these can never exceed parameter 205 *Max. reference.* External reference can be calculated as follows:

$$\text{Ext. ref.} = \frac{\text{(Par. 205 Max. ref. - Par. 204 Min. ref.) x Ana. signal Te r m. 53 [V]}}{\text{Par. 310 Term. 53 Max. scaling - Par. 309 Term. 53 Min. scaling}} + \frac{\text{(Par. 205 Max. ref. - Par. 204 Min. ref.) x Ana. signal Term. 54 [V]}}{\text{Par. 313 Term. 54 Max. scaling - Par. 312 Term. 54 Min. scaling}} +$$

$$\frac{\text{(Par. 205 Max. ref. - Par. 204 Min. ref.) x Par. 314 Term. 60 [mA]}}{\text{Par. 316 Term. 60 Max. scaling - Par. 315 Term. 60 Min. scaling}} + \frac{\text{serial com. reference x (Par. 205 Max. ref. - Par. 204 Min. ref.)}}{\text{16384 (4000 Hex)}}$$

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

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

(only in closed loop)

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

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

■ 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.

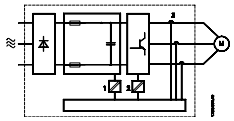
In VLT 4000 VT all control terminals as well as terminals 1-3 (AUX relay) are supplied from or in connection with extra low voltage (PELV).

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).

NOTE
525-600 V (VLT 4002-4072) units do not meet PELV requirements.



Galvanic isolation

■ Ground leakage current

Ground leakage current is primarily caused by the capacitance between motor phases and the motor cable shield. 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 shield
3. Switching frequency
4. RFI filter used or not
5. Motor grounded on site or not

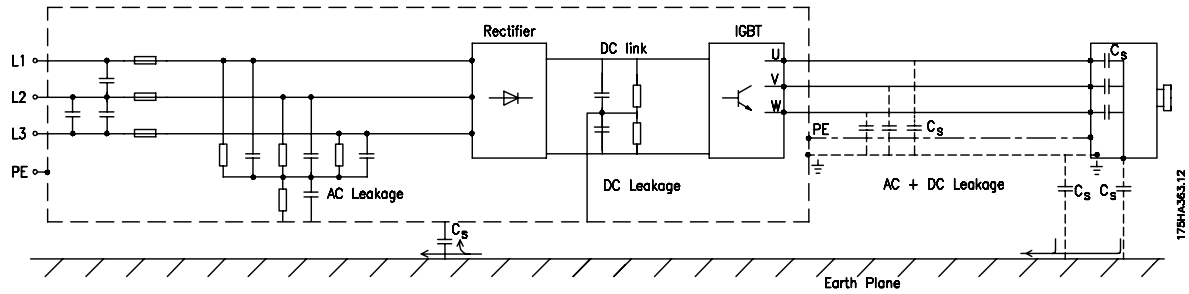
The leakage current is of importance to safety during handling/operation of the AFD if (by mistake) the AFD has not been grounded.

NOTE
RCD

Since the leakage current is > 3.5 mA, reinforced grounding 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 ground
- Suitable for a high leakage current (300 mA)



Leakage currents to ground

■ Extreme running conditions

Short circuit

VLT 4000 VT 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 AFD will display a fault code, although depending on impedance and motor frequency.

Ground fault

The inverter cuts out within 100 ms in case of an ground 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 AFD is fully permitted. It is not possible to damage VLT 4000 VT 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 AFD), 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 AFD, 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.

Line drop-out

During a line drop-out, VLT 4000 VT continues until the intermediate circuit voltage drops below the minimum stop level, which is typically 15% below VLT 4000 VT's lowest rated supply voltage.

The time before the inverter stops depends on the line voltage before the drop-out and on the motor load.

Static overload

When VLT 4000 VT 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 AFD 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 shielded/armored or unshielded/unarmored)
- 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 feet), the rise time and peak voltage are lower. If the motor cable is long (333 feet), 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 AFD.

Typical values for the rise time and peak voltage U_{PEAK} measured on the motor terminals between two phases:

VLT 4006 200 V, VLT 4006-4011 400 V

Cable length	Line voltage	Rise time	Peak voltage
165 feet	380 V	0.3 µsec.	850 V
165 feet	460 V	0.4 µsec.	950 V
495 feet	380 V	1.2 µsec.	1000 V
495 feet	460 V	1.3 µsec.	1300 V

VLT 4008-4027 200 V, VLT 4016-4122 400 V

Cable length	Line voltage	Rise time	Peak voltage
165 feet	380 V	0.1 µsec.	900 V
495 feet	380 V	0.2 µsec.	1000 V

VLT 4152-4352 380-460 V

Cable length	Line voltage	Rise time	Peak voltage
100 feet	460 V	0.2 µsec.	1148 V

VLT 4042-4062 200-240V

Cable length	Line voltage	Rise time	Peak voltage
44 feet	460 V	670 V/µsec.	815 V
66 feet	460 V	620 V/µsec.	915 V

VLT 4452 - 4652 380-460V

Cable length	Line voltage	Rise time	Peak voltage
96 feet	500 V	0.71 µsec.	1165 V
96 feet	400 V	0.61 µsec.	1360 V

VLT 4006-4011 525-600 V

Cable length	Line voltage	Rise time	Peak voltage
115 feet	600 V	0.36 µsec.	1360 V

VLT 4016-4072 525-600 V

Cable length	Line voltage	Rise time	Peak voltage
15 feet	575 V	0.38 µsec.	1430 V

VLT 4102-4402 525-600 V

Cable length	Line voltage	Rise time	Peak voltage
75 feet	575 V	0.45 µsec.	1159 V

■ Switching on the input

Switching on the input depends on the line voltage in question.

The table below states the waiting time between cut-ins.

Line voltage	380 V	415 V	460 V	600 V
Waiting time	48 s	65 s	89 s	120 s

■ Acoustic noise

The acoustic interference from the AFD comes from two sources:

1. DC intermediate circuit coils
2. Integral fan.

Below are the typical values measured at a distance of 3 feet from the unit at full load:

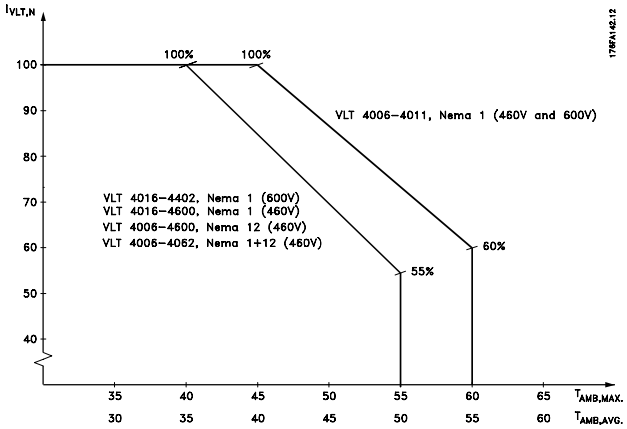
VLT 4006 200 V, VLT 4006-4011 400 V	
NEMA 1 units:	50 dB(A)
NEMA 12 units:	62 dB(A)
VLT 4008-4027 200 V, VLT 4016-4122 400 V	
NEMA 1 units:	61 dB(A)
NEMA 12 units:	66 dB(A)
VLT 4042-4062 200-240 V	
NEMA 1 units:	70 dB(A)
NEMA 12 units:	65 dB(A)
VLT 4152-4352 380-460 V	
NEMA 1 units:	74 dB(A)
NEMA 12 units:	74 dB(A)
VLT 4452 380-460 V	
All enclosure types:	80 dB(A)
VLT 4502-4652380-460 V	
All enclosure types:	100 dB(A)
VLT 4006-4011 525-600 V	
IP20/NEMA 1 units:	62 dB
VLT 4016-4072 525-600 V	
IP20/NEMA 1 units:	66 dB
VLT 4102-4402 525-600 V	
IP00/IP20/NEMA 1/NEMA 12 units:	74 dB

All units are measured 1 meter from the unit at full load.

■ Derating for ambient temperature

The ambient temperature ($T_{AMB,MAX}$) is the maximum temperature allowed. The average ($T_{AMB,MAX}$) measured over 24 hours must be at least 5ºC lower.

If VLT 4000 VT is operated at temperatures above 45 ºC, a derating of the continuous output current is necessary.



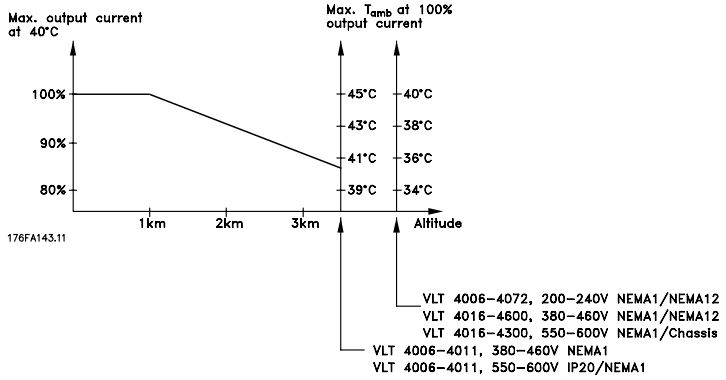
The current of VLT 4152-4652, 380-460 V and VLT 4102-4402, 525-600 V, is to be derated 1%/ºC above 40ºC.

■ Derating for air pressure

Below 3300 feet altitude no derating is necessary.

Above 3300 feet the ambient temperature (T_{AMB}) or max. output current ($I_{VLT,MAX}$) must be derated in accordance with the diagram below:

1. Derating of output current versus altitude at T_{AMB} = 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 4000 VT AFD, 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 4000 VT has been tested using 1000 feet unshielded/unarmoured cable and 4950 feet shielded/armored cable.

VLT 4000 VT 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 recom-mended to reduce the output current by 5% for every step the cross-section is increased. (Increased cable cross-section leads to increased capacity to ground, and thus an increased ground leakage current).

■ Derating for high switching frequency

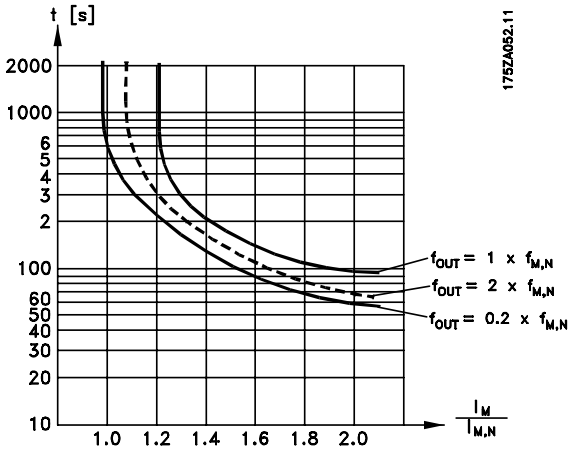
A higher switching frequency (to be set in parameter 407 *Switching frequency)* leads to higher losses in the electronics of the VLT AFD.

VLT 4000 VT has a pulse pattern in which it is possible to set the switching frequency from 3.0- 10.0/14.0 kHz. The VLT AFD 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 4000 VT units.

Switching frequency [kHz]	Min.	Max.	Fact.
VLT 4006-4032, 200 V	3.0	14.0	4.5
VLT 4042-4062, 200 V	3.0	4.5	4.5
VLT 4006-4011, 460 V	3.0	10.0	4.5
VLT 4016-4062, 460 V	3.0	14.0	4.5
VLT 4072-4352, 460 V	3.0	4.5	4.5
VLT 4452-4652, 460 V	1.5	3.0	3.0
VLT 4006-4011, 600 V	4.5	7.0	4.5
VLT 4016-4032, 600 V	3.0	14.0	4.5
VLT 4042-4062, 600 V	3.0	10.0	4.5
VLT 4072, 600 V	3.0	4.5	4.5
VLT 4102-4352, 600 V	1.5	2.0	2.0
VLT 4402, 600 V	1.5	1.5	1.5

■ 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 4000 VT 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

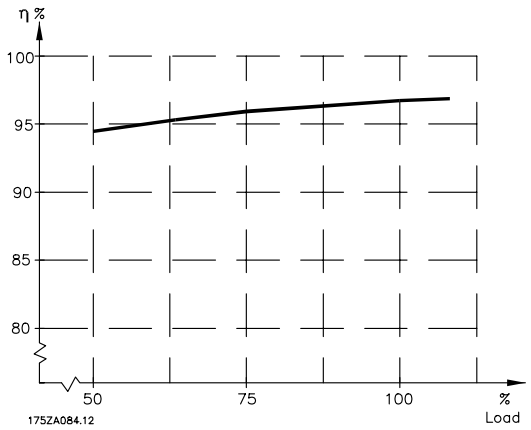
VLT 4000 VT complies with requirements that correspond to conditions when the unit is mounted on the walls and floors of production premises, as well as in panels bolted to walls or floors.

■ Air humidity

VLT 4000 VT 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 4000 VT(η_{VLT})
The load on the AFD 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 line voltage is 460 V, or if the motor cable is longer than 100 feet.

Efficiency of the motor (η_{MOTOR})
The efficiency of a motorconnected to the AFD depends on the sine shape of the current. In gene-ral, the efficiency is just as good as with line 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 AFD and when it runs directly on line.

In small motors, the influence from the U/f characteristic on efficiency is marginal; however, in motors from 15 HP and up, the advantages are significant.

In general, the switching frequency does not affect the efficiency of small motors. Motors from 15 HP 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 4000 VT (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.

■ Line supply interference/harmonics

An AFD takes up a non-sinusoidal current from line, which increases the input current IRMS. 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.

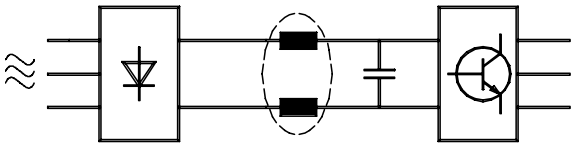
Harmonic currents compared to the RMS input current:

	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 4000 VT 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 4000 VT 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



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The voltage distortion on the line supply depends on the size of the harmonic currents multiplied by the line 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:

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

■ Power factor

The power factor is the relation between I_1 and I_{RMS}.

The power factor for 3-phase control

$$= \frac{\sqrt{3} \text{ x } U \text{x } I_1 \text{ x} \cos \varphi_1}{\sqrt{3} \text{ x } U \text{ x } I_{RMS}}$$

$$\text{Power factor} = \frac{I_1 \text{ x} \cos \varphi_1}{I_{RMS}} = \frac{I_1}{I_{RMS}} \qquad \text{since} \cos\varphi = 1$$

The power factor indicates the extent to which the AFD imposes a load on the line supply.
The lower the power factor, the higher the I_{RMS} for the same HP performance.
In addition, a high power factor indicates that the different harmonic currents are low.

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

■ Definitions

Definitions are given in alphabetical order.

Analog inputs:
The analog inputs can be used for controlling various functions of the VLT AFD. There are two types of analoge inputs:
Current input, 0-20 mA
Voltage input, 0-10 V DC.

Analog ref.
A signal transmitted to input 53, 54 or 60.
Can be voltage or current.

Analog outputs:
There are two analog 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 AFD.

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 AFD transmitted to the motor when the jog function is activated (via digital terminals or serial communication).

f_M
The output frequency from the VLT AFD 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:
Ifinitializing is carried out (see parameter 620 *Operating mode*), the VLT AFD returns to the factory setting.

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

$I_{VLT,N}$
The rated output current supplied by the VLT AFD.

LCP:
The control panel, which makes up a complete interface for control and programming of VLT 4000 VT. The control panel is detachable and may, as an alterna-tive, be installed up to 10 feet away from the VLT AFD, 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 AFD 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 (press-ure, temperature, etc.) by adjusting the output fre-quency 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 AFD 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 AFD is subject to an overtemperature. A locked trip can be cancelled by cutting off line and restarting the VLT AFD.

U_M
The voltage transmitted to the motor.

U_M,
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	Con-version index	Data type
001	**Language**	English		Yes	No	0	5
002	**Active Setup**	Setup 1		Yes	No	0	5
003	**Copying of Setup**	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, % of max.		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, HP		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	5 - 600 HP	No	Yes	1	6
103	**Motor voltage, $U_{M,N}$**	Depends on the unit	208/460/575 V	No	Yes	0	6
104	**Motor frequence, $f_{M,N}$**	60 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**	ETR trip 1		Yes	Yes	0	5

■ Factory settings

PNU #	Parameter description	Factory setting	Range	Changes during operation	4-setup	Con-version 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 , f_{MAX}**	60 Hz	f_{MIN} - par. 200	Yes	Yes	-1	6
203	**Reference site**	Hand/Auto linked reference		Yes	Yes	0	5
204	**Minimum Ref ence, Ref_{MIN}**	0.000	0.000-par. 100	Yes	Yes	-3	4
205	**Maximum Ref ence, Ref_{MAX}**	60 Hz	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**	External/Preset		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}[A]	0,1-1,1 x I_{VLT},[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: Higth 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}**	0.0 Hz	-999,999.999 - par. 226	Yes	Yes	-3	4
226	**Warning: Low reference $High_{HIGH}$**	50.0 Hz	Par. 225 - 999,999.999	Yes	Yes	-3	4
227	**Warning: Low feedback FB_{LOW}**	0.000	-999,999.999 - par. 228	Yes	Yes	-3	4
228	**Warning: High feedback FB_{HIGH}**	100.000	Par. 227 - 999,999.999	Yes	Yes	-3	4

Changes during operation:
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4-Setup:
"Yes" means that the parameter can be programmed individually in each of the four setups, i.e. the same parameter can have four different data values. "No" means that the data value will be the same in all four setups.

Conversion index:
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Conversion index	Conversion factor
74	0.1
2	100
1	10
0	1
-1	0.1
-2	0.01
-3	0.001
-4	0.0001

Data type:
Data type shows the type and length of the telegram.

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

■ 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**	No operation		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**	Safety interlock		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, analog input voltage**	No operation		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, analog 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, analog input voltage**	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} ⇒4-20 mA		Yes	Yes	0	5
320	**Terminal 42, output pulse scaling**			Yes	Yes	0	6
321	**Terminal 42, output**	0 - f_{MAX} ⇒0-20 mA		Yes	Yes	0	5
322	**Terminal 45, output, pulse scaling**	5000 Hz	1 - 32000 Hz	Yes Yes	Yes Yes	0	6
323	**Relay 1, output function**	No 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**	2.00 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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■ Factory settings

PNU #	Parameter description	Parameter	Factory setting during operation	Changes	4-setup	Conversion index	Data type
400	**Reset function**	Automatic x 20		Yes	Yes	0	5
401	**Automatic restart time**	10 sec.	0 - 600 sec.	Yes	Yes	0	6
402	**Flying start**	Enable		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**	60 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 method eduction**	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 overcurr ent, 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**	Maximum		Yes	Yes	0	5
418	**Setpoint 1**	0.000	FB_{MIN} - FB_{MAX}	Yes	Yes	-3	4
419	**Setpoint 2**	0.000	FB_{MIN} - FB_{MAX}	Yes	Yes	-3	4
420	**PID normal/inverse control**	Normal		Yes	Yes	0	5
421	**PID anti windup**	On		Yes	Yes	-1	6
422	**PID start-up frequency**	0 Hz	f_{MIN} - f_{MAX}	Yes	Yes	-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	Con-version 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	1	7
603	**Operating data: No. of cut-ins**			No	No	0	6
604	**Operating data: No. of overtemps**			No	No	0	6
606	**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	5
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: r 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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