■ Contents

176FA229.10

VLT 7000 Booster

Operating instructions
Software version: 30.00/0.00/1.x

These operating instructions can be used for all VLT 7000 Booster frequency converters with software version 30.00/0.00/1.0x.
The software version number can be seen from parameter 624.

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

■ Safety regulations

1. The frequency converter must be disconnected from mains if repair work is to be carried out. Check that the mains supply has been disconnected and that the necessary time has passed before removing motor and mains plugs.
2. The [OFF/STOP] key on the control panel of the frequency converter does not disconnect the equipment from mains and is thus not to be used as a safety switch.
3. Correct protective earthing of the equipment must be established, the user must be protected against supply voltage, and the motor must be protected against overload in accordance with applicable national and local regulations.
4. The earth leakage currents are higher than 3.5 mA.
5. Protection against motor overload is included in the factory setting. Parameter 117, *Motor thermal protection* default value is ETR trip 1.
   Note: The function is initialised at 1.0 x rated motor current and rated motor frequency (see parameter 117, *Motor thermal protection*).
6. Do not remove the plugs for the motor and mains supply while the frequency converter is connected to mains. Check that the mains supply has been disconnected and that the necessary time has passed before removing motor and mains plugs.
7. Please note that the frequency converter has more voltage inputs than L1, L2 and L3, when the DC-bus terminals are used.
   Check that all voltage inputs have been disconnected and that the necessary time has passed before repair work is commenced.

■ Warning against unintended start

1. The motor can be brought to a stop by means of digital commands, bus commands, references or a local stop, while the frequency converter is connected to mains.
   If personal safety considerations make it necessary to ensure that no unintended start occurs, these stop functions are not sufficient.
2. While parameters are being changed, the motor may start. Consequently, the stop key [OFF/STOP] must always be activated, following which data can be modified.
3. A motor that has been stopped may start if faults occur in the electronics of the frequency converter, or if a temporary overload or a fault in the supply mains or the motor connection ceases.

■ Use on isolated mains

See section *RFI Switch* regarding use on isolated mains.

Warning:

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

Using VLT 7002-7005, 380-460 V:	wait at least 4 minutes
Using VLT 7006-7072, 380-460 V:	wait at least 15 minutes

176FA230.10

■ Introduction to Operating Instructions

These Operating Instructions are a tool intended for persons who are to install, operate and program the VLT 7000 Booster.

These Operating Instructions are divided into four sections with information about VLT 7000 Booster.

Introduction to Booster:	This section tells you the advantages you can obtain by using a VLT 7000 Booster - such as AEO, Automatic Energy Optimization, RFI filters and other HVAC-relevant functions. This section also contains examples of application as well as information about Danfoss.
Installation:	This section tells you how to carry out mechanically correct installation of the VLT 7000 Booster. In addition, this section includes a description of how to ensure that the installation of your VLT 7000 Booster is EMC-correct. Furthermore, a list is given of mains and motor connections, together with a description of the control card terminals.
Programming:	This section describes the control unit and the software parameters for the VLT 7000 Booster. Also included is a guide to the Quick Setup menu, which allows you to get started on your application very quickly.
All about VLT 7000 Booster	This section gives information about status, warning and error messages from the VLT 7000 Booster. Additionally, information is given on technical data, service, factory settings and special conditions.

Indicates a general warning

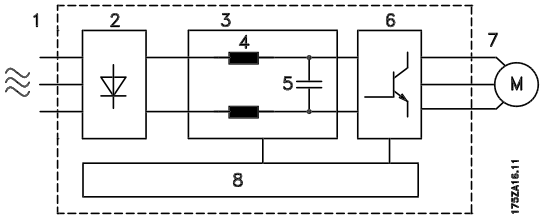
NB!:
Indicates something to be noted by the reader

Indicates a high-voltage warning

■ Control principle

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

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



1. Mains voltage
3 x 380 - 460 V AC, 50 / 60 Hz.

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

3. Intermediate circuit
DC voltage = 1.35 x mains voltage [V].

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

5. Intermediate circuit capacitors
Even out the intermediate circuit voltage.

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

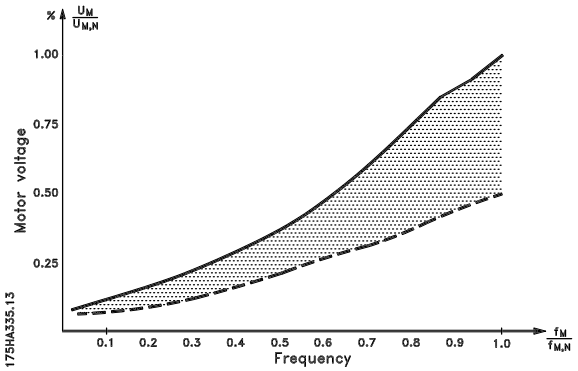
7. Motor voltage
Variable AC voltage, 0-100% of mains supply voltage.

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

■ AEO - Automatic Energy Optimization

Normally, the U/f characteristics have to be set on the basis of the expected load at different frequencies. However, knowing the load at a given frequency in an installation is often a problem. This problem can be solved by using a VLT 7000 Booster with its integral Automatic Energy Optimization (AEO), which ensures optimum energy utilization. All VLT 7000 Booster units feature this function as a factory setting, i.e. it is not necessary to adjust the frequency converter U/f ratio in order to obtain maximum energy savings. In other frequency converters, the given load and voltage/frequency ratio (U/f) must be assessed to carry out correct setting of the frequency converter. Using Automatic Energy Optimization (AEO), you no longer need to calculate or assess the system characteristics of the installation, since Danfoss VLT 7000 Booster 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 frequency converter will quickly adjust itself.

Advantages of the AEO function

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

■ PC software and serial communication

Danfoss offers various options for serial communication. Using serial communication, it is possible to monitor, program and control one or several frequency converters from a centrally located computer. All VLT 7000 Booster units have a RS 485 port and the FC protocol as standard.

Using the RS 485 port enables communication, e.g. with a PC. A Windows ™ program, called *MCT 10*, is available for this purpose. It can be used to monitor, program and control one or several VLT 7000 Booster units. For further information, contact Danfoss.

500-566 Serial communication

NB!:
Information on the use of RS-485 serial interface is not included in this manual.

■ Unpacking and ordering a VLT frequency converter

If you are in doubt as to which frequency converter you have received and which options it contains, use the following to find out.

■ Type code ordering number string

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

VLT-7008-B-T4-B20-R3-DL-F00-A33

This means that the frequency converter ordered is a VLT 7008 for three-phase mains voltage of 380-460 V (**T4**) in Bookstyle enclosure IP 20 (**B20**). The hardware variant is with integral RFI filter, classes A & B (**R3**). The frequency converter features a control unit (**DL**) without an option card (**F00**). Character no. 8 (**B**) indicates the application range of the unit: **B** = Booster.

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.

RFI filter

Bookstyle units always come *with* an integral RFI filter that complies with EN 55011-B with 20 m screened/armoured motor cable and EN 55011-A1 with 150 m screened/armoured motor cable. Units for a mains voltage of 380-460 V and a motor power of up to 7.5 kW (VLT 7011) are always supplied with an integral class A1 & B filter. Units for higher motor power can be ordered either with or without an RFI filter.

Control unit (keypad and display)

All types of units in the programme, can be ordered either with or without the control unit.

Conformal Coating

All types of units in the programme are available only with conformal coating of the PCB.

380-460 V

Typecode	T4	B20	C20	ST	R0	R3
Position in string	9-10	11-13	11-13	14-15	16-17	16-17
1.1 kW/1.5 HP	7002	X	X	X		X
1.5 kW/2.0 HP	7003	X	X	X		X
2.2 kW/3.0 HP	7004	X	X	X		X
3.0 kW/4.0 HP	7005	X	X	X		X
4.0 kW/5.0 HP	7006	X	X	X		X
5.5 kW/7.5 HP	7008	X	X	X		X
7.5 kW/10 HP	7011	X	X	X		X
11 kW/15 HP	7016		X	X	X	X
15 kW/20 HP	7022		X	X	X	X
18.5 kW/25 HP	7027		X	X	X	X
22 kW/30 HP	7032		X	X	X	X
30 kW/40 HP	7042		X	X	X	X
37 kW/50 HP	7052		X	X	X	X
45 kW/60 HP	7062		X	X	X	X
55 kW/75 HP	7072		X	X	X	X

Voltage

T4: 380-460 VAC

Enclosure

B20: Bookstyle IP 20

C20: Compact IP 20

Hardware variant

ST: Standard

RFI filter

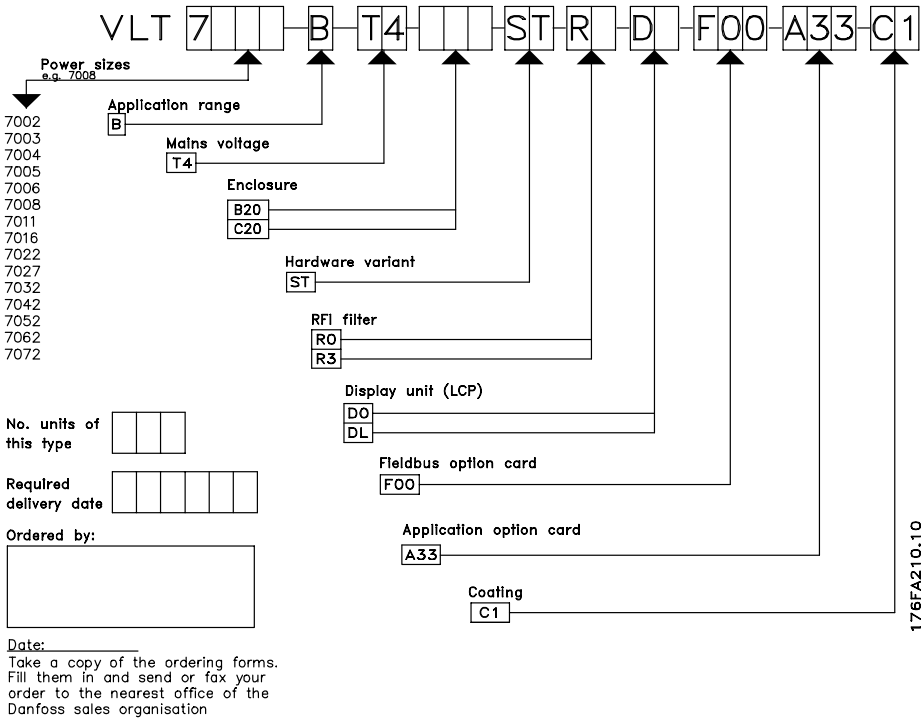
R0: Without filter

R3: Class A1 and B filter

Optional selections, 200-600 V

Display		Position: 18-19
D0	Without LCP	
DL	With LCP	

■ Ordering form



■ General technical data

Mains supply (L1, L2, L3):

Supply voltage 380-460 V units	3 x 380/400/415/440/460 V ±10%
Supply frequency	48-62 Hz ± 1%
Max. imbalance of supply voltage	± 3%
VLT 6002-6011, 380-460 V	±2.0% of rated supply voltage
VLT 6016-6072, 380-460 V	±1.5% of rated supply voltage
True Power factor (λ)	0.90 nominal at rated load
Displacement Power Factor (cos. φ)	near unity (>0.98)
No. of switches on supply input L1, L2, L3	approx. 1 time/2 min.
Max. short-circuit current	100.000 A

VLT output data (U, V, W):

Output voltage	0-100% of supply voltage
Output frequency 7002-7062, 380-460V	0-120 Hz, 0-1000 Hz
Output frequency 7072, 380-460V	0-120 Hz, 0-450 Hz
Rated motor voltage, 380-460 V units	380/400/415/440/460 V
Rated motor frequency	50/60 Hz
Switching on output	Unlimited
Ramp times	1 - 3600 sec.

Torque characteristics:

Starting torque	110% for 1 min.
Starting torque (parameter 110 *High break-away torque)*	Max. torque: 160% for 0.5 sec.
Acceleration torque	100%
Overload torque	110%

Control card, digital inputs:

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

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

Control card, analogue inputs

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

Basic galvanic isolation: All analogue inputs are galvanically isolated from the supply voltage and other high-voltage terminals.

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, logical '0'	< 5 V DC
Voltage level, logical '1'	>10 V DC
Maximum voltage on input	28 V DC
Input resistance, R_i	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

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

Control card, digital/pulse and analogue outputs:

No. of programmable digital and analogue outputs	2
Terminal nos.	42, 45
Voltage level at digital/pulse output	0 - 24 V DC
Minimum load to ground (terminal 39) at digital/pulse output	600 Ω
Frequency ranges (digital output used as pulse output)	0-32 kHz
Current range at analogue output	0/4 - 20 mA
Maximum load to ground (terminal 39) at analogue output	500 Ω
Accuracy of analogue output	Max. error: 1.5% of full scale
Resolution on analogue output.	8 bit

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

Control card, 24 V DC supply:

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

Basic galvanic isolation: The 24 V DC supply is galvanically isolated from the supply voltage, but has the same potential as the analogue outputs.

Control card, RS 485 serial communication:

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

Basic galvanic isolation.

Relay outputs:

No. of programmable relay outputs	2
Terminal nos., control card	4-5 (make)
Max. terminal load (AC) on 4-5, control card	50 V AC, 1 A, 60 VA
Max. terminal load (DC-1 (IEC 947)) on 4-5, control card	75 V DC, 1 A, 30 W
Terminal nos., power card and relay card	1-3 (break), 1-2 (make)

Max. terminal load (AC) on 1-3, 1-2 power card ..... 240 V AC, 2 A, 60 VA
Max. terminal load DC-1 (IEC 947) on 1-3, 1-2, power card and relay card ..... 50 V DC, 2 A
Min. terminal load on 1-3, 1-2, power card ..... 24 V DC, 10 mA, 24 V AC, 100 mA

Cable lengths and cross-sections:

Max. motor cable length, screened cable ..... 150 m
Max. motor cable length, unscreened cable ..... 300 m
Max. motor cable length, screened cable VLT 7011 380-460 V ..... 100 m
Max. DC-bus cable length, screened cable ..... 25 m from frequency converter to DC bar.
Max. cable cross-section to motor, see next section
Max. cross-section for control cables ..... 1.5 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, accuracy (open loop) ..... < 1500 rpm: max. error ± 7.5 rpm
>1500 rpm: max. error of 0.5% of actual speed
Process, accuracy (closed loop) ..... < 1500 rpm: max. error ± 1.5 rpm
>1500 rpm: max. error of 0.1% of actual speed
All control characteristics are based on a 4-pole asynchronous motor

Accuracy of display readout (parameters 009-012, *Display readout*):

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

Externals:

Enclosure ..... IP 20
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
Aggressive environment (IEC 721-3-3) ..... Coated class 3C3
Ambient temperature, 7002-7011 380-460 V, Bookstyle, IP 20 ..... Max. 45°C (24-hour average max. 40°C)
Ambient temperature, 7016-7072 380-460 V, IP 20 ..... Max. 40°C (24-hour average max. 35°C)
Min. ambient temperature in full operation ..... 0°C
Min. ambient temperature at reduced performance ..... -10°C
Temperature during storage/transport ..... -25 - +65/70°C
Max. altitude above sea level ..... 1000 m
EMC standards applied, Emission ..... EN 61000-6-3/4, EN 61800-3, EN 55011, EN 55014
EMC standards applied, Immunity ..... EN 50082-2, EN 61000-4-2, IEC 1000-4-3, EN 61000-4-4, EN 61000-4-5, ENV 50204, EN 61000-4-6, VDE 0160/1990.12

Relay outputs on the Cascade Card:

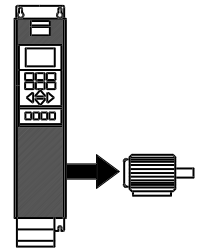
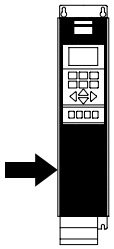
Relay 71-78: ..... Terminal 8 A-D and 71-78 make
Max. cross section: ..... 1,5 mm^2
Torque: ..... 0,22-0,25 Nm

VLT 7000 Boosterprotection

- Electronic motor thermal protection against overload.
- Temperature monitoring of heat-sink ensures that the frequency converter cuts out if the temperature reaches 90°C. An overtemperature can only be reset when the temperature of the heat-sink has fallen below 60°C.
- The frequency converter is protected against short-circuiting on motor terminals U, V, W.

- The frequency converter is protected against earth fault on motor terminals U, V, W.
- Monitoring of the intermediate circuit voltage ensures that the frequency converter cuts out if the intermediate circuit voltage gets too high or too low.
- If a motor phase is missing, the frequency converter cuts out.
- If there is a mains fault, the frequency converter is able to carry out a controlled decelleration.
- If a mains phase is missing, the frequency converter will cut out or autoderate when a load is placed on the motor.

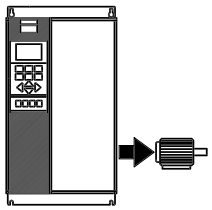
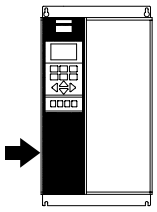
■ Technical data, mains supply 3 x 380-460V

According to international requirements		VLT type	7002	7003	7004	7005	7006	7008	7011
	Output current	$I_{VLT,N}$ [A] (380-440 V)	3.0	4.1	5.6	7.2	10.0	13.0	16.0
		$I_{VLT,\ MAX}$ (60 s) [A] (380-440 V)	3.3	4.5	6.2	7.9	11.0	14.3	17.6
		$I_{VLT,\ N}$ [A] (441-460 V)	3.0	3.4	4.8	6.3	8.2	11.0	14.0
		$I_{VLT,\ MAX}$ (60 s) [A] (441-460 V)	3.3	3.7	5.3	6.9	9.0	12.1	15.4
	Output power	$S_{VLT,N}$ [kVA] (400 V)	2.2	2.9	4.0	5.2	7.2	9.3	11.5
		$S_{VLT,N}$ [kVA] (460 V)	2.4	2.7	3.8	5.0	6.5	8.8	11.2
	Typical shaft output	$P_{VLT,N}$ [kW]	1.1	1.5	2.2	3.0	4.0	5.5	7.5
	Typical shaft output	$P_{VLT,N}$ [HP]	1.5	2	3	-	5	7.5	10
	Max. cable cross-section to motor	[mm^2]/[AWG][2) 4)]	4/10	4/10	4/10	4/10	4/10	4/10	4/10
	Max. input current	$I_{L,N}$ [A] (380 V)	2.8	3.8	5.3	7.0	9.1	12.2	15.0
	(RMS)	$I_{L,N}$ [A] (460 V)	2.5	3.4	4.8	6.0	8.3	10.6	14.0
	Max. cable cross-section power	[mm^2]/[AWG] [2) 4)]	4/10	4/10	4/10	4/10	4/10	4/10	4/10
	Max. pre-fuses	[-]/UL[1)][A]	16/6	16/10	16/10	16/15	25/20	25/25	35/30
	Mains contactor	[Danfoss type]	CI 6	CI 6	CI 6	CI 6	CI 6	CI 6	CI 6
	Efficiency[3)]		0.96	0.96	0.96	0.96	0.96	0.96	0.96
	Weight IP 20	[kg]	8	8	8.5	8.5	10.5	10.5	10.5
	Power loss at max. load. [W]	Total	67	92	110	139	198	250	295
	Enclosure	VLT type	IP 20						

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 that can be fitted on the terminals.

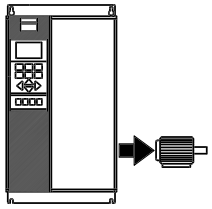
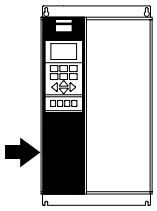
Always comply with national and local regulations on min. cable cross-section.

■ Technical data, mains supply 3x380-460V

According to international requirements		VLT type	7016	7022	7027	7032	7042
	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
		$I_{VLT,\ MAX}$ (60 s) [A] (441-460 V)	23.1	29.7	37.4	44.0	57.2
	Output power	$S_{VLT,N}$ [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, IP 20	[mm²]/[AWG][2) 4)]	16/6	16/6	16/6	35/2	35/2
	Min. cable cross-section to motor and DC-bus	[mm²]/[AWG][2) 4)]	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, IP 20	[mm²]/[AWG][2) 4)]	16/6	16/6	16/6	35/2	35/2
	Max. pre-fuses	[-]/UL[1)] [A]	63/40	63/40	63/50	63/60	80/80
	Mains contactor	[Danfoss type]	CI 9	CI 16	CI 16	CI 32	CI 32
	Efficiency at rated frequency		0.96	0.96	0.96	0.96	0.96
	Weight IP 20	[kg]	21	21	22	27	28
	Power loss at max. load.	[W]	419	559	655	768	1065
	Enclosure				IP 20		

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. 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.

■ Technical data, mains supply 3x380-460V

According to international requirements		VLT type	7052	7062	7072
	Output current	$I_{VLT,N}$ [A] (380-440 V)	73.0	90.0	106
		$I_{VLT, MAX}$ (60 s) [A] (380-440 V)	80.3	99.0	117
		$I_{VLT,N}$[A] (441-460 V)	65.0	77.0	106
		$I_{VLT, MAX}$ (60 s) [A] (441-460 V)	71.5	84.7	117
	Output power	$S_{VLT,N}$ [kVA] (400 V)	52.5	64.7	73.4
		$S_{VLT,N}$ [kVA] (460 V)	51.8	61.3	84.5
	Typical shaft output	$P_{VLT,N}$ [kW]	37	45	55
	Typical shaft output	$P_{VLT,N}$ [HP]	50	60	75
	Max. cable cross-section to motor and DC-bus, IP 20	[mm²]/[AWG][2) 4) 5)]	35/2	50/0	50/0
	Min. cable cross-section to motor and DC-bus	[mm²]/[AWG][2) 4)]	10/8	16/6	16/6
	Max. input current	$I_{L,N}$[A] (380 V)	72.0	89.0	104
	(RMS)	$I_{L,N}$[A] (460 V)	64.0	77.0	104
	Max. cable cross-section power, IP 20	[mm²]/[AWG][2) 4) 5)]	35/2	50/0	50/0
	Max. pre-fuses	[-]/UL[1)] [A]	100/100	125/125	150/150
	Mains contactor	[Danfoss type]	CI 37	CI 61	CI 85
	Efficiency at rated frequency		0.96	0.96	0.96
	Weight IP 20	[kg]	41	42	43
	Power loss at max. load.	[W]	1275	1571	1851
	Enclosure			IP 20	

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. 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. Aluminium cables with cross-section above 35 mm² must be connected by use of an Al-Cu connector.

■ Fuses

Non UL compliance

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

VLT 7002-7072	380-460 V	type gG

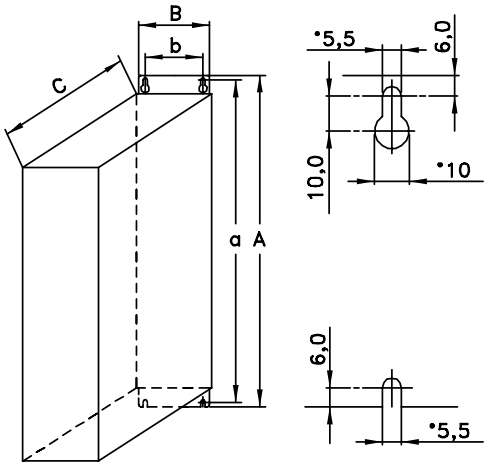
Not following the recommendation may result in unnecessary damage of the drive in case of malfunction. Fuses must be designed for protection in a circuit capable of supplying a maximum of 100000 A_{rms} (symmetrical), 500 V/600 V maximum.

■ Mechanical dimensions

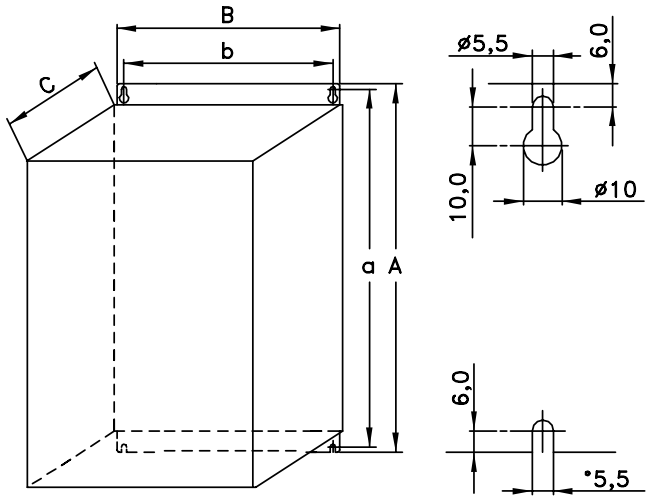
All the below listed measurements are in mm.

VLT type	A	B	C	a	b	aa/bb	Type
Bookstyle IP 20 380 - 460 V							
7002 - 7005	395	90	260	384	70	100	A
7006 - 7011	395	130	260	384	70	100	A
IP 20 380 - 460 V							
7002 - 7005	395	220	160	384	200	100	C
7006 - 7011	395	220	200	384	200	100	C
7016 - 7027	560	242	260	540	200	200	D
7032 - 7042	700	242	260	680	200	200	D
7052 - 7072	800	308	296	780	270	200	D

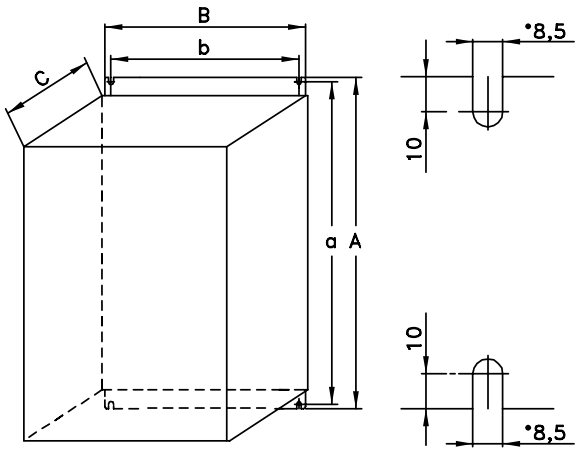
■ Mechanical dimensions



Type A, IP20



Type C, IP20



Type D, IP20

176FA214.10

■ 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.

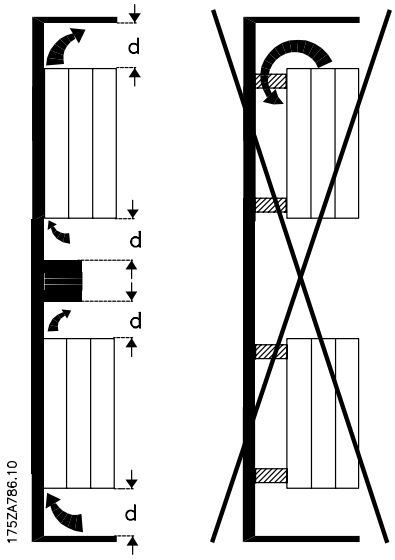
The frequency converter *must* be installed vertically.

The frequency converter is cooled by means of air circulation. For the unit to be able to release its cooling air, the *minimum* distance over and below the unit must be as shown in the illustration below.
To protect the unit from overheating, it must be ensured that the ambient temperature *does not rise above the max. temperature stated for the frequency converter* and that the 24-hour average temperature *is not exceeded* . The max. temperature and 24-hour average can be seen from the *General Technical Data*.
If the ambient temperature is in the range of 45°C -55° C, derating of the frequency converter will become relevant, see *Derating for ambient temperature*.
The service life of the frequency converter will be reduced if derating for ambient temperature is not taken into account.

■ Installation of VLT 7002-7072

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

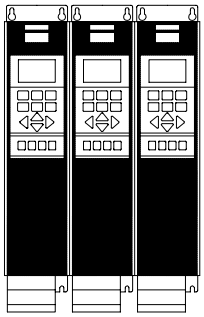
Cooling

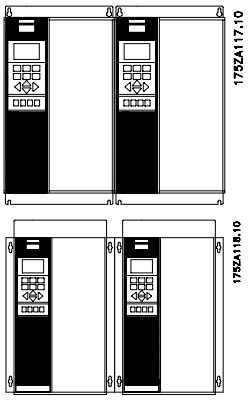


All Bookstyle and Compact units require a minimum space above and below the enclosure.

Side by side/flange by flange

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





	d [mm]	Comments
Bookstyle		
VLT 7002-7011, 380-460 V	100	Installation on a plane, vertical surface (no spacers)
Compact (all enclosure types)		
VLT 7002-7011, 380-460 V	100	Installation on a plane, vertical surface (no spacers)
VLT 7016-7072, 380-460 V	200	Installation on a plane, vertical surface (no spacers)

■ General information about electrical installation

■ High voltage warning

The voltage of the frequency converter is dangerous whenever the equipment is connected to mains. Incorrect installation of the motor or the frequency converter may cause damage to the equipment, serious personal injury or death. Consequently, the instructions in this Design Guide, as well as national and local safety regulations, must be complied with. Touching the electrical parts may be fatal - even after disconnection from mains: Using VLT 7002-7005, 380-460 V wait at least 4 minutes
Using VLT 7006-7072, 380-460 V wait at least 15 minutes

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

■ Earthing

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

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

Connect the different earth systems at the lowest possible conductor impedance. The lowest possible conductor impedance is obtained by keeping the conductor as short as possible and by using the greatest possible surface area. A flat conductor, for example, has a lower HF impedance than a round conductor for the same conductor cross-section C_{VESS}. If more than one device is installed in cabinets, the cabinet rear plate, which must be made of metal, should be used as a common earth reference plate. The metal cabinets of the different devices are mounted on the cabinet rear plate using the lowest possible HF impedance. This avoids having different HF voltages for the individual devices and avoids the risk of radio interference currents running in connection cables that may be used between the devices. The radio interference will have been reduced. In order to obtain a low HF impedance, use the fastening bolts of the devices as HF connection to the rear plate. It is necessary to remove insulating paint or similar from the fastening points.

■ Cables

Control cables and the filtered mains cable should be installed separate from the motor cables so as to avoid interference overcoupling. Normally, a distance of 20 cm will be sufficient, but it is recommended to keep the greatest possible distance wherever possible, especially where cables are installed in parallel over a substantial distance.
With respect to sensitive signal cables, such as telephone cables and data cables, the greatest possible distance is recommended with a minimum of 1 m per 5 m of power cable (mains and motor cable). It must be pointed out that the necessary distance depends on the sensitivity of the installation and the signal cables, and that therefore no precise values can be stated.
If cable jaws are used, sensitive signal cables are not to be placed in the same cable jaws as the motor cable or brake cable. If signal cables are to cross power cables, this should be done at an angle of 90 degrees. Remember that all interference-filled in- or outgoing cables to/from a cabinet should be screened/armoured or filtered.
See also *EMC-correct electrical installation.*

■ Screened/armoured cables

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

■ Extra protection with regard to indirect contact

ELCB relays, multiple protective earthing or earthing can be used as extra protection, provided that local safety regulations are complied with. In the case of an earth fault, a DC content may develop in the faulty current. Never use ELCB relays, type A, since such relays are not suitable for DC fault currents.
If ELCB relays are used, this must be:

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

■ RFI switch

Mains supply isolated from earth:

When the frequency converter is supplied from an isolated mains source (IT mains), the RFI switch must be closed (OFF). In the OFF position, the internal RFI capacitors (filter capacitors) between the chassis and the intermediate circuit are cut out so as to avoid damaging the intermediate circuit and to reduce the earth leakage currents (see IEC 1800-3). The position of the RFI switch can be seen from in *VLT 7000 enclosures*.

Please also refer to the application note *VLT on IT mains*, MN.90.CX.02.

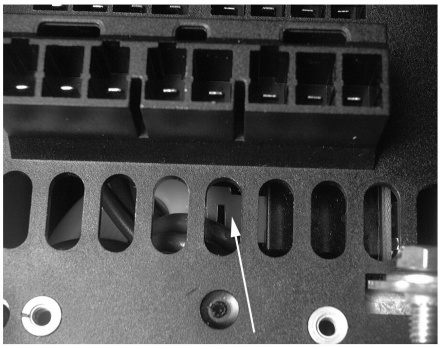
NB!:
When the RFI switch is set to OFF parameter 407 *Switching frequency max* is only allowed to be set to factory setting.

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

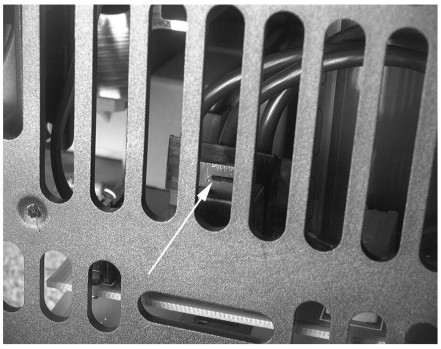
NB!:
The RFI switch disconnects the capacitors galvanically; however, transients higher than approx. 1,000 V will be bypassed by a spark gap.

The VLT 7000 Booster EMC performance will be reduced if the RFI switch is placed in the OFF position.

Mains supply connected to earth:
The RFI switch must be ON for all installations on earthed mains supplies.



Bookstyle IP 20
VLT 7002 - 7011 380 - 460 V



Compact IP 20
VLT 7002 - 7011 380 - 460 V

Compact IP 20
VLT 7016 - 7027 380 - 460 V

Compact IP 20
VLT 7032 - 7042 380 - 460 V

Compact IP 20
VLT 7052 - 7072 380 - 460 V

■ High voltage test

A high voltage test can be carried out by short-circuiting terminals U, V, W, L1, L2 and L3 and energizing by max. 2.5 kV DC for one second between this short-circuit and the chassis.

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

■ Heat emission from VLT 7000 Booster

The tables in *General technical data* show the power loss P_{Φ}(W) from VLT 7000 Booster. The maximum cooling air temperature $t_{IN\ MAX}$, is 40° at 100% load (of rated value).

■ Ventilation of integrated VLT 7000 Booster

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

1. Add up the values of P_{Φ} for all the frequency converters to be integrated in the same panel. The highest cooling air temperature (t_{IN}) present must be lower than $t_{IN,\ MAX}$ (40°C). The day/night average must be 5°C lower (VDE 160). The outlet temperature of the cooling air must not exceed: $t_{OUT,\ MAX}$ (45° C).
2. Calculate the permissible difference between the temperature of the cooling air (t_{IN}) and its outlet temperature (t_{OUT}): Δt = 45° C-t_{IN}.
3. Calculate the required quantity of air = $\frac{\sum P_{\varphi} \times 3.1}{\Delta t}$ m³/h insert Δt in Kelvin

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

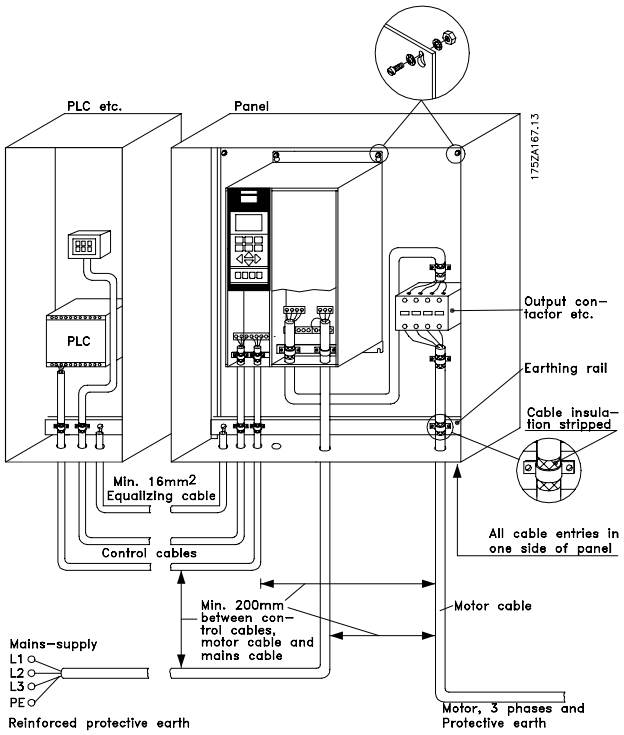
■ EMC-correct electrical installation

Following these guidelines is advised, where compliance with EN 61000-6-3/4, EN 55011 or EN 61800-3 *First environment* is required. If the installation is in EN 61800-3 *Second environment*, then it is acceptable to deviate from these guidelines. It is however not recommended.

Good engineering practice to ensure EMC-correct electrical installation:

- Use only braided screened/armoured motor cables and control cables.
  The screen should provide a minimum coverage of 80%.The screen material must be metal, not limited to but typically copper, aluminium, steel or lead. There are no special requirements for the mains cable.
- Installations using rigid metal conduits are not required to use screened cable, but the motor cable must be installed in conduit separate from the control and mains cables. Full connection of the conduit from the drive to the motor is required. The EMC performance of flexible conduits varies a lot and information from the manufacturer must be obtained.
- Connect the screen/armour/conduit to earth at both ends for motor cables and control cables. See also *Earthing of braided screened/ armoured control cables.*
- Avoid terminating the screen/armour with twisted ends (pigtails). Such a termination increases the high frequency impedance of the screen, which reduces its effectiveness at high frequencies. Use low impedance cable clamps or glands instead.
- Ensure good electrical contact between the mounting plate and the metal chassis of the frequency converter.
- Use starwashers and galvanically conductive installation plates to secure good electrical connections for IP 20 installations.
- Avoid using unscreened/unarmoured motor or control cables inside cabinets housing the drive(s), where possible.

The illustration shows an example of an EMC-correct electrical installation of an IP 20 frequency converter. The frequency converter has been fitted in an installation cabinet with an output contactor and connected to a PLC, which in this example is installed in a separate cabinet. Other ways of making the installation may have as good an EMC performance, provided the above guide- lines to engineering practice are followed. Please note that when unscreened cables and control wires are used, some emission requirements are not complied with, although the immunity requirements are fulfilled.
See the section *EMC test results* for further details.

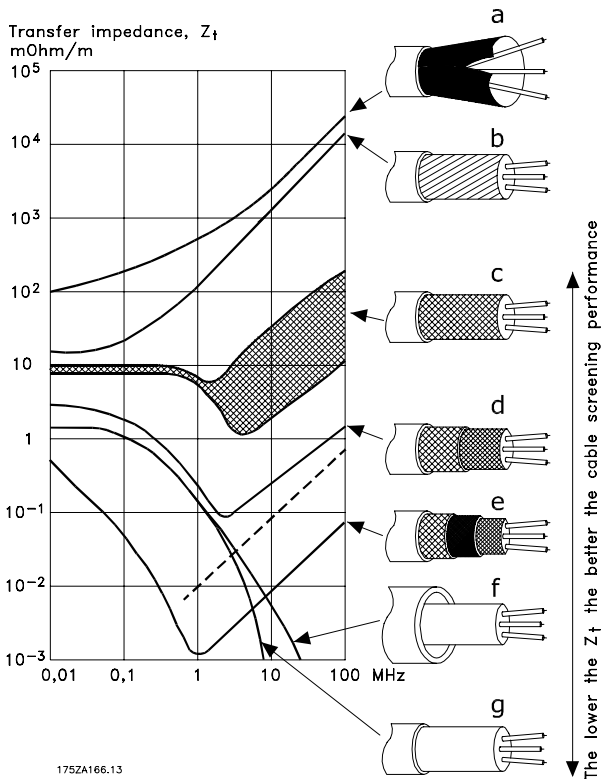

PLC etc.
Panel
175ZA167.13
PLC
Output con-
tactor etc.
Earthing rail
Cable insula-
tion stripped
Min. 16mm2
Equalizing cable
Control cables
All cable entries in
one side of panel
Min. 200mm
between con-
trol cables,
motor cable and
mains cable
Motor cable
Mains-supply
L1
L2
L3
PE
Reinforced protective earth
Motor, 3 phases and
Protective earth

■ Use of EMC-correct cables

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

The ability of a cable to reduce the in- and outgoing radiation of electric noise depends on the switching impedance (Z_T). The screen of a cable is normally designed to reduce the transfer of electric noise; however, a screen with a lower Z_T value is more effective than a screen with a higher Z_T.

Z_T is rarely stated by cable manufacturers, but it is often possible to estimate Z_T by assessing the physical design.



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

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

Aluminium-clad with copper wire.

Twisted copper wire or armoured steel wire cable.

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

Double-layer braided copper wire.

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

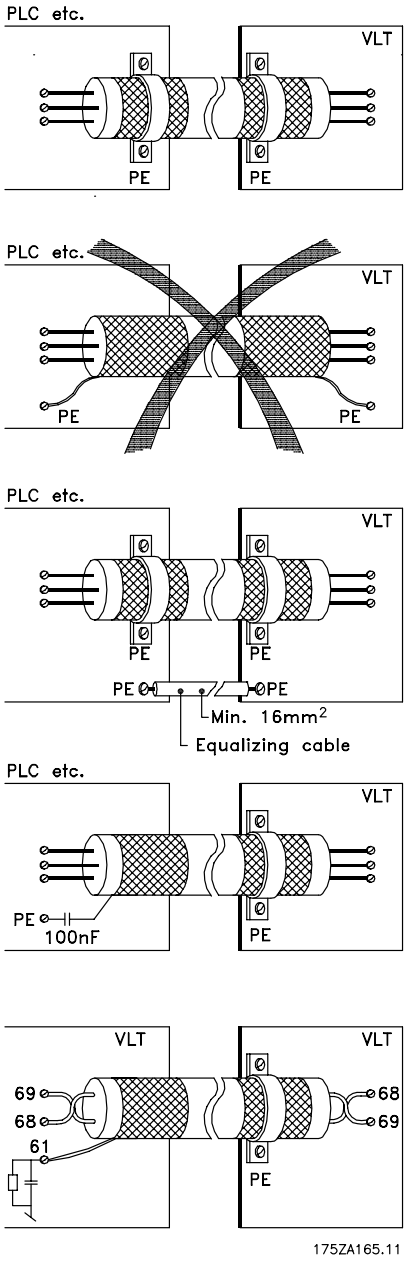
Cable that runs in copper tube or steel tube.

Lead cable with 1.1 mm wall thickness with full coverage.

■ Electrical installation - earthing of control cables

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

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



Correct earthing

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

Wrong earthing

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

Protection with respect to earth potential between PLC and VLT

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

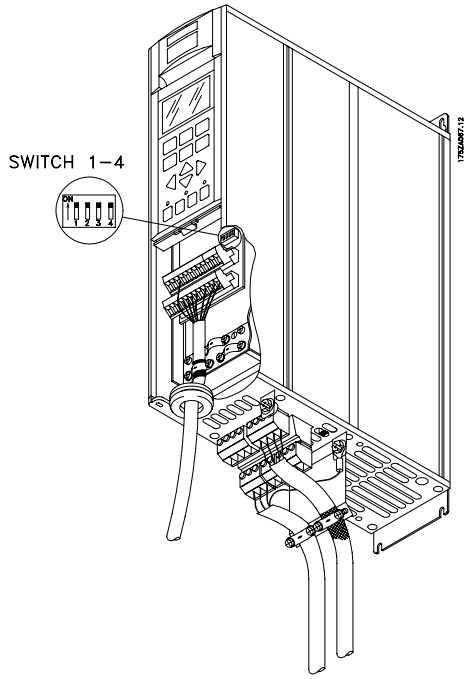
For 50/60 Hz earth loops

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

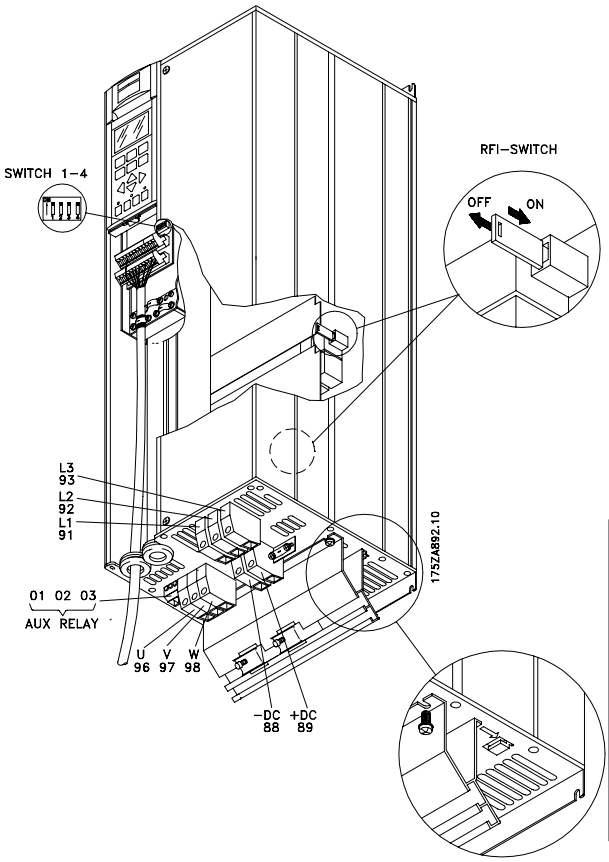
Cables for serial communication

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

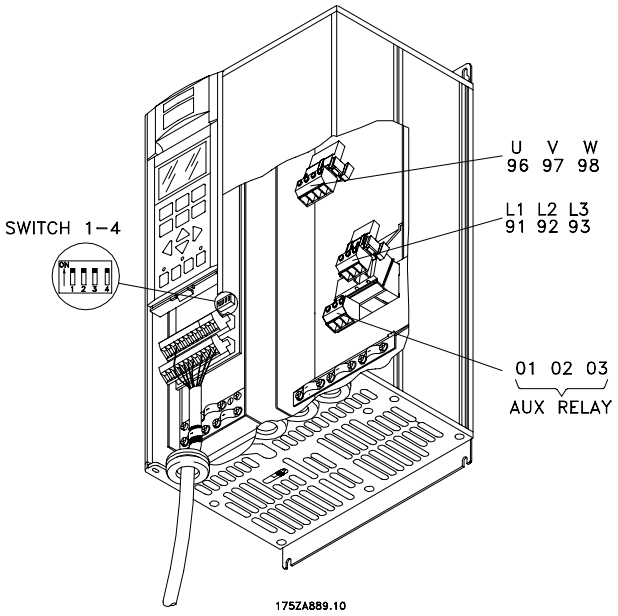
■ Electrical installation, enclosures



Bookstyle IP 20
VLT 7002-7011, 380-460 V



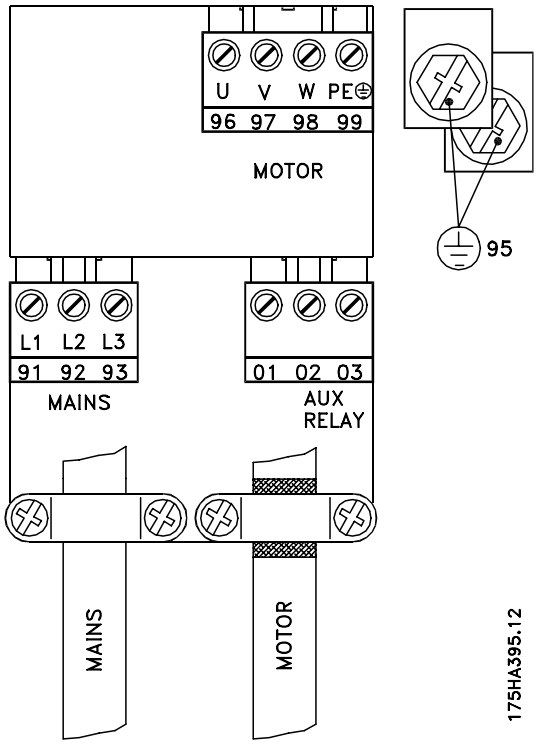
Compact IP 20
VLT 7016-7072, 380-460 V



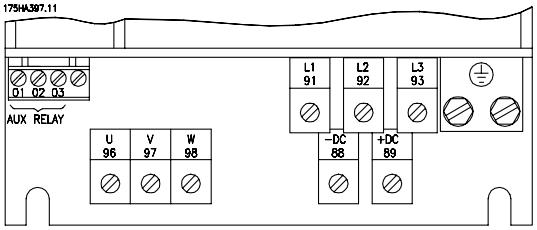
Compact IP 20
VLT 7002-7011, 380-460 V

Installation

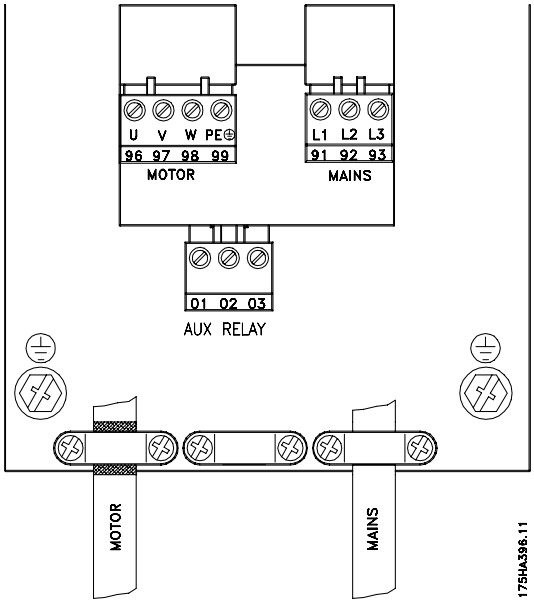
■ Electrical installation, power cables



Bookstyle IP 20
VLT 7002-7011, 380-460 V



IP 20
VLT 7016-7072, 380-460 V



Compact IP 20
VLT 7002-7011, 380-460 V

■ Tightening-up torque and screw sizes

The table shows the torque required when fitting terminals to the frequency converter. For VLT 7002-7072, 380-460 V the cables must be fastened with screws.
These figures apply to the following terminals:

Mains terminals (Nos.)	91, 92, 93 L1, L2, L3
Motor terminals (Nos.)	96, 97, 98 U, V, W
Earth terminal (Nos.)	94, 95, 99

VLT type 3 x 380-460 V	Tightening-up torque	Screw/bolt size	Allen key size
VLT 7002-7011	0.5-0.6 Nm	M3	
VLT 7016-7027	1.8 Nm (IP 20)	M4	
VLT 7032-7052	3.0 Nm (IP 20)	M5[3)]	4 mm
VLT 7062-7072	6.0 Nm	M6[3)]	5 mm

1. Loadsharing terminals 14 Nm/M6, 5 mm Allen key
3. Allen screws (hexagon)
4. Loadsharing terminals 9.5 Nm/M8 (bolt)

■ Mains connection

Mains must be connected to terminals
91, 92, 93 Mains voltage 3 x 380-460 V

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

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

■ Motor connection

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

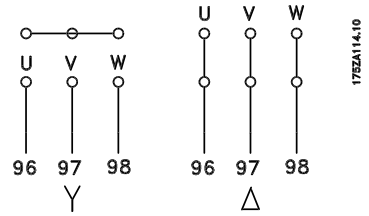
Nos.	
96. 97. 98 U, V, W	Motor voltage 0-100 % of mains voltage
No. 94/95/99	Earth connection

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

All types of three-phase asynchronous standard motors can be used with a VLT 7000 Booster unit.

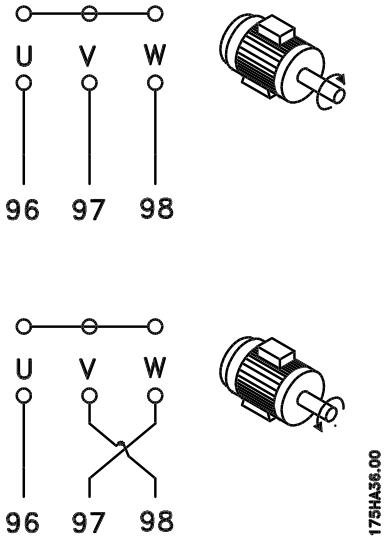
Small-size motors are normally star-connected. (220/380 V, △/Y). Large-size motors are delta-connected (380/660 V, △/Y). The correct connection and voltage can be read from the motor nameplate.

NB!:
In older motors without phase coil insulation, a LC filter should be fitted to the frequency converter output.



Installation

■ Direction of motor rotation



The factory setting is for clockwise rotation with the 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 motor rotation can be changed by switching two phases in the motor cable.

■ Motor cables

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

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

If the EMC specifications regarding emission are to be complied with, the motor cable must be screened, unless otherwise stated for the RFI filter in question. It is important to keep the motor cable as short as possible so as to reduce the noise level and leakage currents to a minimum.
The motor cable screen must be connected to the metal cabinet of the frequency converter and to the metal cabinet of the motor. The screen connections are to be made with the biggest possible surface (cable clamp). This is enabled by different installation devices in the differentT frequency converters. Mounting with twisted screen ends (pigtails) is to be avoided, since these spoil the screening effect at higher frequencies.

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

■ Motor thermal protection

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

■ Earth connection

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

■ 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.	88, 89

Contact Danfoss if you require further information.

DC bus connection is not available in VLT 7002-7011, 380-460 V

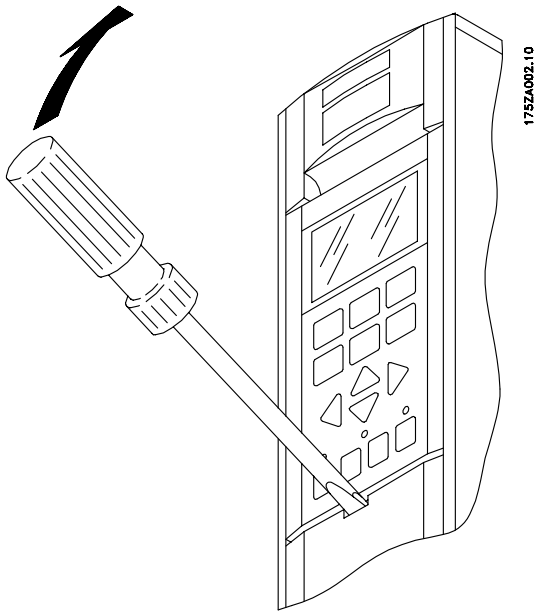
■ High-voltage relay

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, out-put.*

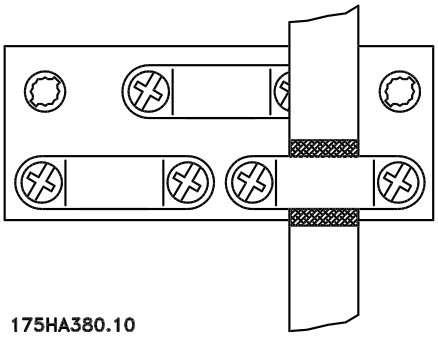
No. 1	Relay ouput 1 1+3 break, 1+2 make Max 240 V AC, 2 Amp Min. 24 V DC 10 mA or 24 V AC, 100 mA
Max Cross-section:	4 mm^2/10 AWG
Torque:	0.5-0.6 Nm
Screw size:	M3

■ Control card

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



■ Electrical installation, control cables



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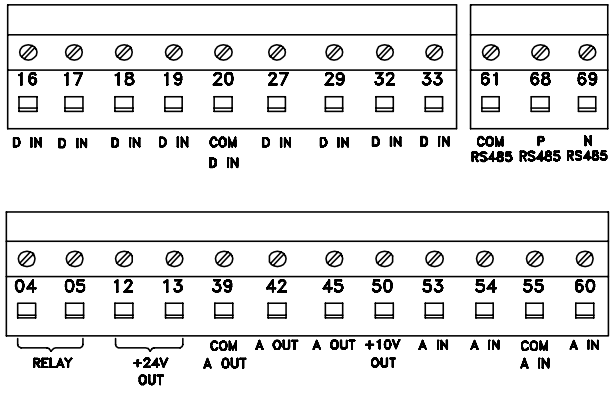
Torque: 0.5-0.6 Nm
Screw size: M3

Generally speaking, control cables must be screened/ armoured and the screen must be connected by means of a cable clamp at both ends to the metal cabinet of the unit (see *Earthing of screened/ armoured control cables*). Normally, the screen must also be connected to the body of the controlling unit (follow the instructions for installation given for the unit in question).
If very long control cables are used, 50/60 Hz earth loops may occur that will disturb the whole system. This problem can be solved by connecting one end of the screen to earth via a 100nF condenser (keeping leads short).

■ Electrical installation, control cables

Max. control cable cross section: 1.5 mm^2 /16 AWG
Torque: 0.5-0.6 Nm
Screw size: M3
See *Earthing of screened/armoured control cables* for correct termination of control cables.



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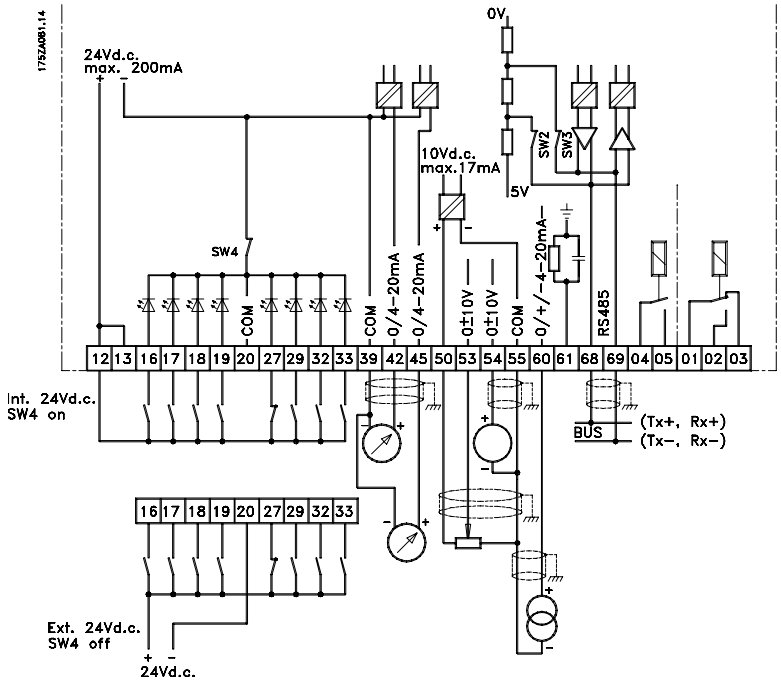
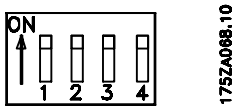
No.	Function
04, 05	Relay output 2 can be used for indicating status and warnings.
12, 13	Voltage supply to digital inputs. For the 24 V DC to be used for digital inputs, switch 4 on the control card must be closed, position "on".
16-33	Digital inputs. See parameters 300-307 *Digital inputs.*
20	Ground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



■ Switches 1-4

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



Switch 1 has no function.

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

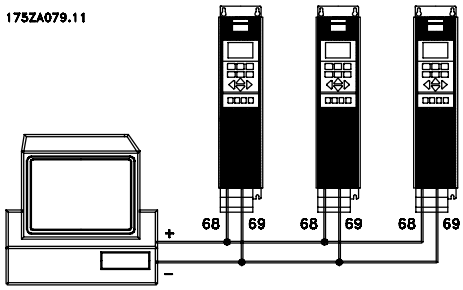
NB!:
When the frequency converter is the first or last device on the serial communication bus, switches 2 and 3 must be ON in that designated VLT. Any other VLTs on the serial communication bus must have switches 2 and 3 set to OFF.

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

■ Bus connection

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

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

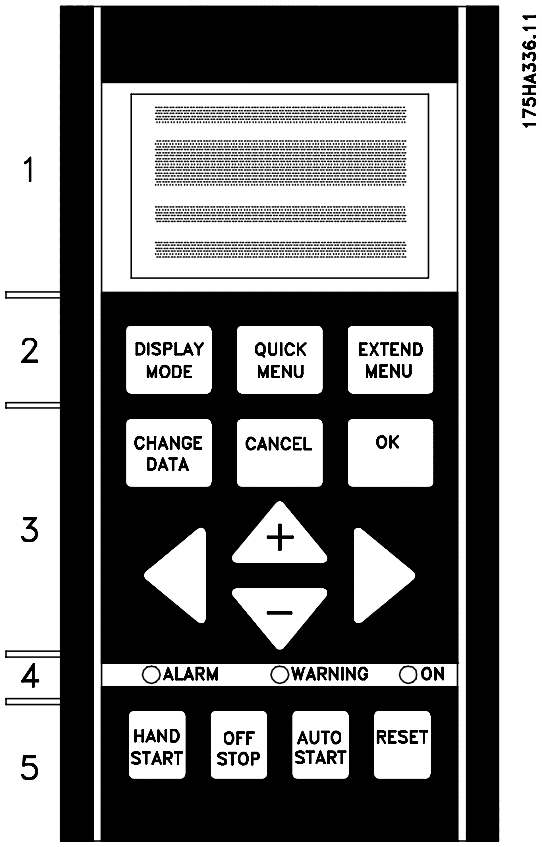


In order to avoid potential equalizing currents in the screen, the cable screen can be earthed via terminal 61, which is connected to the frame via an RC-link.

■ Control unit LCP

The front of the frequency converter features a control panel - LCP(Local Control Panel). This is a complete interface for operation and programming of the frequency converter.
The control panel is detachable and can - as an alternative - be installed up to 3 metres away from the frequency converter, e.g. on the front panel, by means of a mounting kit option.
The functions of the control panel can be divided into five groups:

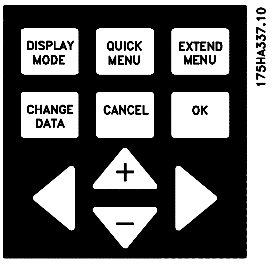
1. Display
2. Keys for changing display mode
3. Keys for changing program parameters
4. Indicator lamps
5. Keys for local operation



All data are indicated by means of a 4-line alphanumeric 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 frequency converter will be displayed.
As a supplement to the display, there are three indicator lamps for voltage (ON), warning (WARNING) and alarm (ALARM), respectively.
All frequency converter parameter Setups can be changed immediately via the control panel, unless this function has been programmed to be *Locked* [1] via parameter 016 *Lock for data change* or via a digital input, parameters 300-307 *Data change lock*.

■ 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

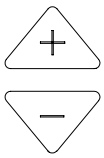
[CHANGE DATA] is used for changing a setting selected either in the Extend menu or the Quick menu mode.

CANCEL

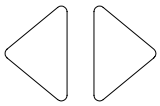
[CANCEL] is used if a change of the selec-ted parameter is not to be carried out.

OK

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



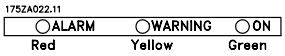
[+/-] is used for selecting parameters and for changing a chosen parameter. These keys are also used to change the local reference.
In addition, the keys are used in Display mode to switch between operation variable readouts.



[<>] 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.

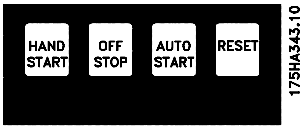


If certain threshold values are exceeded, the alarm and/ or warning lamp is activated, and a status or alarm text is displayed.

NB!:
The voltage indicator lamp is activated when the frequency converter receives voltage.

■ Local control

Underneath the indicator lamps are keys for local control.



HAND START

[HAND START] is used if the frequency converter is to be controlled via the control unit. The frequency converter will start the motor, since a start command is given by means of [HAND START].
On the control terminals, the following control signals will still be active when [HAND START] is activated:

- Hand start - Off stop - Auto start
- Safety Interlock
- Reset
- Coasting stop inverse
- Reversing
- Setup select lsb - Setup select msb
- Jog
- Run permissive
- Lock for data change
- Stop command from serial communication

NB!:
If parameter 201 *Output frequency low limit* f_{MIN} is set to an output frequency greater than 0 Hz, the motor will start and ramp up to this frequency when [HAND START] is activated.

OFF STOP

[OFF/STOP] is used for stopping the connected motor. Can be selected as Enable [1] or Disable [0] via parameter 013. If the stop function is activated, line 2 will flash.

AUTO START

[AUTO START] is used if the frequency converter is to be controlled via the control terminals and/or serial communication. When a start signal is active on the control terminals and/or the bus, the frequency converter will start.

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

RESET

[RESET] is used for resetting the frequency converter 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 frequency converter has an active reversing signal. The arrow body disappears if a stop command is given or if the output frequency falls below 0.01 Hz. The bottom line gives the status of the frequency converter.
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.

1st line

2nd line

3rd line

4th line

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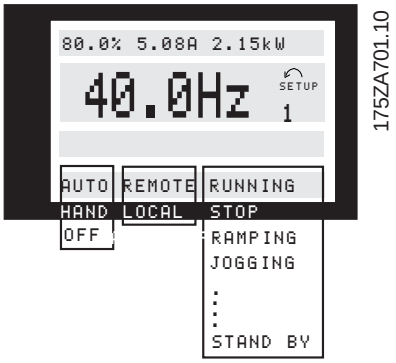
■ Display mode, cont.

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 read-out*.

- Status line (4th line):



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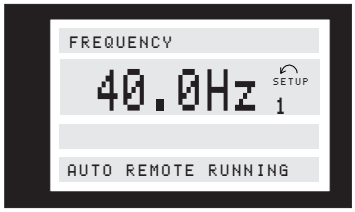
The left part of the status line indicates the control ele-ment of the frequency converter that is active. AUTO means that control is via the control terminals, while HAND indicates that control is via the local keys on the control unit.
OFF means that the frequency converter ignores all control commands and stops the motor.
The centre part of the status line indicates the refe-rence 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.

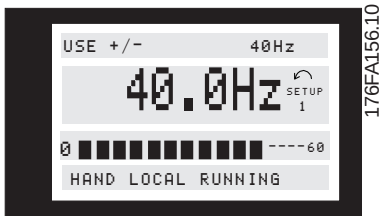
The last part of the status line indicates the current status, for example "Running", "Stop" or "Alarm".

■ Display mode I:

VLT 7000 Booster offers different display modes de-pending on the mode selected for the frequency converter. The figure on the next page shows the way to navigate between different display modes.
Below is a display mode, in which the frequency converter is in Auto mode with remote reference at an output frequency of 40 Hz.
In this display mode, reference and control are determined via the control terminals.
The text in line 1 gives the operating variable shown in line 2.

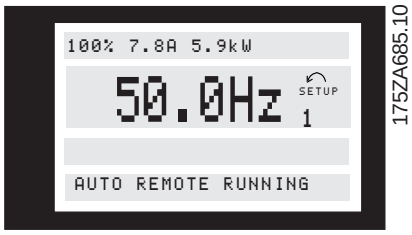


Line 2 gives the current output frequency and the active Setup.
Line 4 says that the frequency converter is in Auto mode with remote reference, and that the mo tor is running.



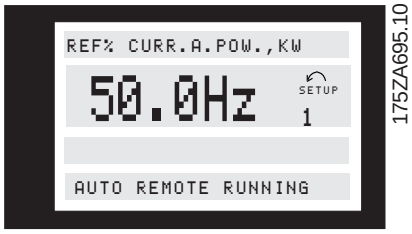
■ Display mode II:

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:

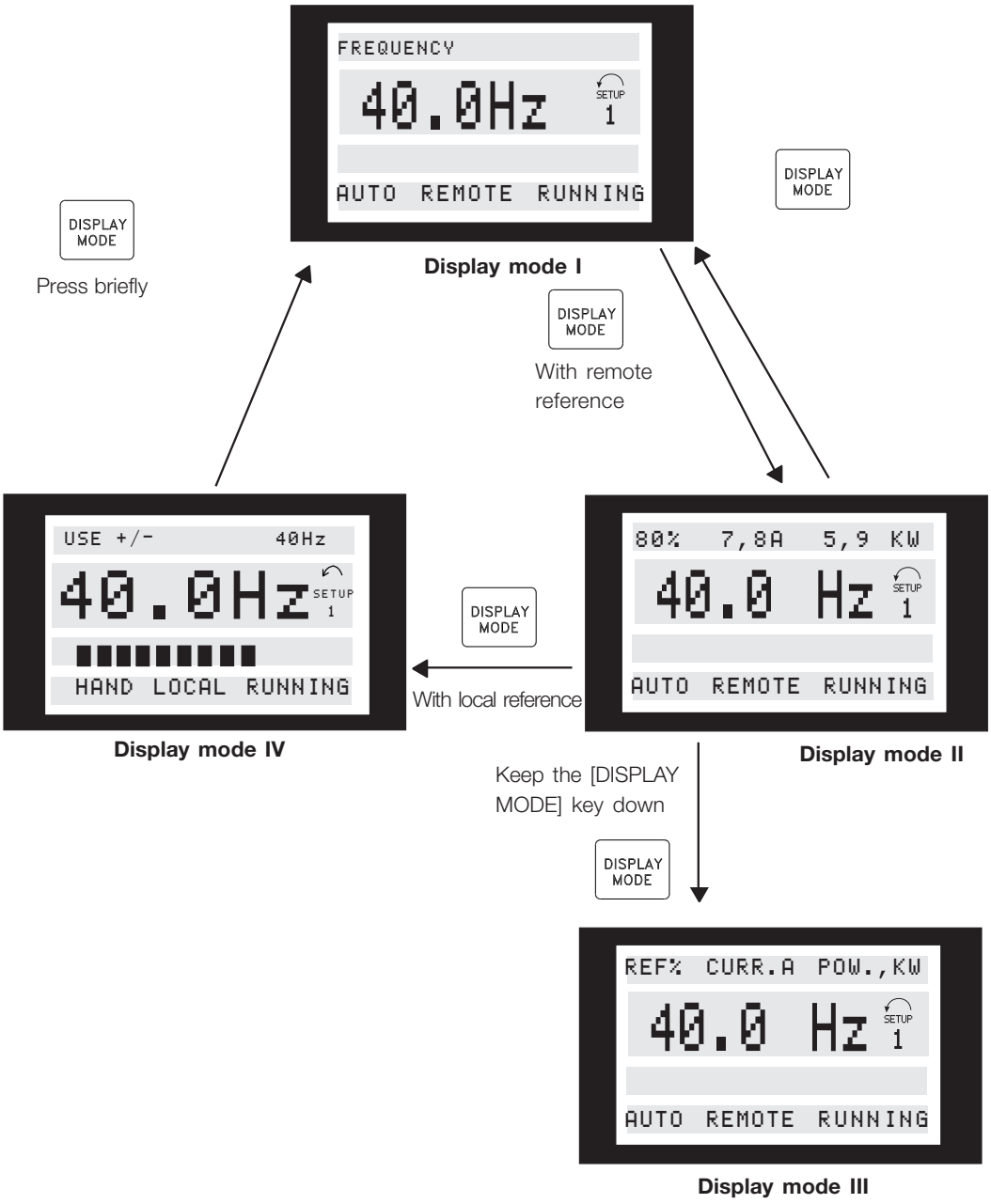
This display mode is active as long as the [DISPLAY MODE] key is kept depressed. In the first line, operating data names and units of operating data are displayed. In the second line, operating data 2 remains unchanged. When the key is released, the different operating data values are shown.



■ 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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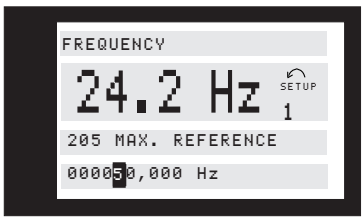
■ Changing data

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.

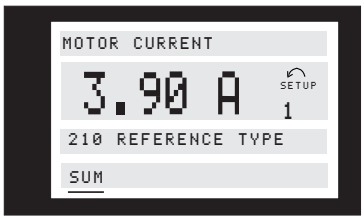
The procedure for changing data depends on whether the selected parameter represents a numerical data value or a functional value.

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 entered (saved) when signing off by pressing the [OK] button. Use [CANCEL] to cancel the change.

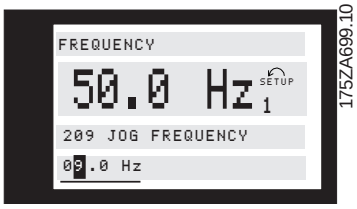
If the selected parameter is a functional value, the selected text value can be changed by means of the [+/-] keys.



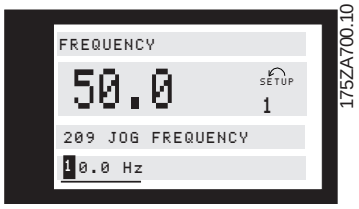
The functional value flashes until signing off by pressing the [OK] button. The functional value has now been selected. Use [CANCEL] to cancel the change.

■ Infinitely variable change of numeric data value

If the chosen parameter represents a numeric data value, a digit is first selected by means of the [<>] keys.



Then the chosen digit is changed infinitely 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 initialisation

Disconnect from mains and hold the [DISPLAY MODE] + [CHANGE DATA] + [OK] keys down while at the same time reconnecting the mains supply. Release the keys; the frequency converter has now been programmed for the factory setting.

The following parameters are not zeroed by means of manual initialisation:

Parameter	500, *Protocol*
	600, *Operating hours*
	601, *hours run*
	602, *kWh counter*
	603, *Number of power-ups*
	604, *Number of overtemperatures*
	605, *Number of overvoltages*

It is also possible to carry out initialisation via parameter 620 *Operating mode*.

■ Quick Menu

The QUICK MENU key gives access to 41 of the most important setup parameters of the drive. After programming, the drive will, in many cases, be ready for operation.

Quick Menu Number	Parameter number	Name	Units	Range	Factory Setting
1	102	Motor Power	KW/HP	1,1-55/1,5-75	kW
2	103	Motor Voltage	Volt	380-460	
3	104	Motor Frequency	Hz	50/60 Hz	50 Hz
4	105	Motor Current	Amps	0-Ivlt,max	-
5	106	Rated motor speed	RPM	1200 - f m,n x 60	-
6	201	Min. Frequency	Hz	0,0 - fmax	20 Hz
7	202	Max. Frequency	Hz	fmin - 120/1000	50 Hz
8	206	Ramp up time	seconds	1-60	See table below
9	207	Ramp down time	Seconds	1-60	See table below
10	415	Pressure unit			Bar
11	413	Minimum Feedback	Par. 415	999.999,999-FBmax	0.000
12	414	Maximum Feedback	Par. 415	FBmin - 999.999,999	100.000
13	227	Warning Low Feedback	Par. 415	999.999,999-FBhigh	-999.999.999
14	228	Warning High Feedback	Par. 415	FBlow - 999.999,999	999.999.999
15	204	Minimum reference	Par. 415	Min. feedback - Max. reference	0.000
16	205	Maximum reference	Par. 415	Min. reference - Max. feedback	50.000
17	700	Cascade mode		1-14	1
18	701	Pump Combination			DOM[1]
19	702	Staging bandwidth	%	0-100	5
20	703	SBW destage delay	Sec.	0-3000	10
21	704	SBW stage delay	Sec.	0-3000	10
22	705	Override bandwidth	%	0-100 (100=Off)	Off
23	706	Override timer	Sec.	0-300	10
24	707	Destage by timer	Sec.	0-301 (301=Off)	Off
25	708	Staging frequency	%	0-100% of f_{max}	90
26	709	Destaging frequency	%	0-100% of f_{max}	50
27	710	Delay before running on mains	ms	0-2000	500
28	711	Sleep/AUX timer	Sec.	0-300 (301 = Off)	DOM[2]
29	712	Sleep/AUX frequency	Hz	Par. 201 - Par. 713	20 Hz
30	713	Wakeup/disable AUX - frequency	Hz	Par. 712 - Par. 202	50 Hz
31	714	Boost setpoint	%	1-200% of Setpoint 1	100%
32	418	Setpoint 1 (H0)	Par. 415	Par. 413-Par. 414	0.000
33	419	Setpoint 2 (H1)	Par. 415	Par. 413-Par. 414	0.000
34	719	Pump enable	Indexed par.	0-1	1
35	720	Pump running hours	Hours	0,0-999.999,9	-
36	721	Setpoints	Par. 415	0,0-999.999,9	-
37	420	Normal/inverse control		Normal/inverse	Normal
38	422	PID start up frequency	Hz	f_{min} - f_{max}	0
39	427	PID Lowpass filter time	Sec.	0.01-10.00	0.2
40	423	PID Proportional Gain	Factor	0.00-10.00	0.3
41	424	PID Integrator time	Sec.	0.01-9999.00	Off

VLT Type	Ramp up time (par.206)	Ramp down time (par.207)
7002-7011	1 sec.	1 sec.
7016-7062	3 sec.	2 sec.
7072	5 sec.	3 sec.

1) Depending on Mode, please refer to par. 700.
2) Depending on Mode, with AUX pump: 150 sec., without AUX pump: OFF.

■ Parameter Data

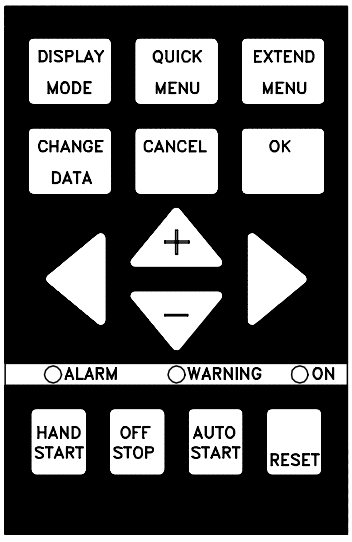
Enter or change parameter dataor settings in accordance with the following procedure.

1. Press Quick Menu key.
2. Use '+' and '-' keys to find parameter you choose to edit.
3. Press Change Data key.
4. Use '+' and '-' keys to select correct parameter setting. To move to a different digit within parameter, use < and > arrows. *Flashing cursor indicates digit selected to change.*
5. Press Cancel key to disregard change, or press OK key to accept change and enter new setting.

Example of Changing Parameter Data

Assume parameter 206, *Ramp Up Time,* is set at 60 seconds. Change the ramp up time to 100 seconds in accordance with the following procedure.

1. Press Quick Menu key.
2. Press '+' key until you reach Parameter 206, *Ramp Up Time.*
3. Press Change Data key.
4. Press < key twice – hundreds digit will flash.
5. Press '+' key once to change hundreds digit to '1.'
6. Press > key to change to tens digit.
7. Press '-' key until '6' counts down to '0' and setting for *Ramp Up Time* reads '100 s.'
8. Press OK key to enter new value into drive controller.



NB!:
Programming of extended parameters functions available through EXTENDED MENU key is done in accordance with same procedure as described for Quick Menu functions.

■ Programming

EXTEND MENU

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

■ 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]
Finnish (SUOMI)	[9]

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

The frequency converter 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 frequency converter to Multi-Setup to allow switching of Setups with the digital inputs or serial communication.
Setup shifts can be used in systems where, 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 frequency converter to another by moving the control panel. First all parameter values are copied to the control panel. This can then be moved to another frequency converter, where all parameter values can be copied from the control unit to the frequency converter.

002 Active Setup (ACTIVE SETUP)

Value:

Factory Setup (FACTORY SETUP)	[0]
✯Setup 1 (SETUP 1)	[1]

Function:

The choice in this parameter defines the Setup number you want to control the functions of the frequency converter. 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.

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

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 frequency converter to another by moving the control panel.

Description of choice:

Select *Upload all parameters* [1] if all parameter values are to be transmitted to the control panel.
Select *Download all parameters* [2] if all transmitted parameter values are to be copied to the frequency converter on which the control panel has been mounted.
Select *Download power-independent par*. [3] if only the power-independent parameters are to be downloaded. This is used if downloading to a frequency converter that has a different rated power than the one from where the parameter Setup originates.

NB!:
Uploading/Downloading can only be carried out in the Stop mode.

■ Setup of user-defined readout

Parameter 005 *Max. value of user-defined readout* and 006 *Unit for user-defined readout* allow users to design their own readout which can be seen if user-defined readout has been selected under display 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.

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

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:

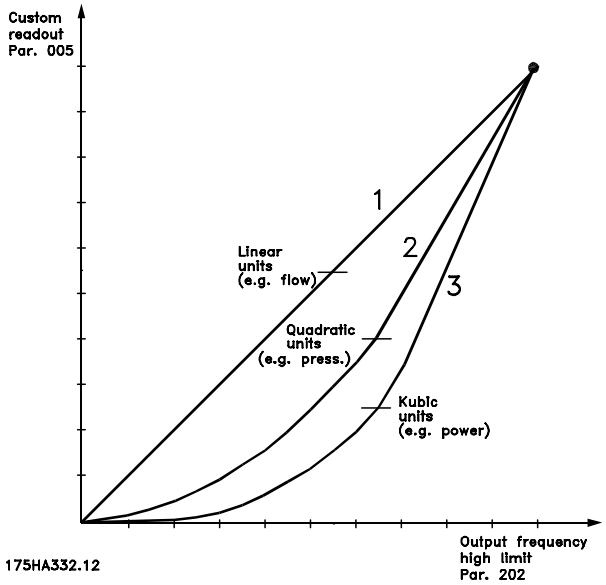
Set the required value for max. output frequency.

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, kW) 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] (OURS 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]

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

Feedback [unit] (FEEDBACK [UNITS])	[15]
Motor voltage [V] (MOTOR VOLTAGE [V])	[16]
DC link voltage [V] (DC VOLTAGE [V])	[17]
Thermal load, motor [%] (THERM.MOTOR LOAD [%])	[18]
Thermal load, VLT [%] (THERM.DRIVE LOAD [%])	[19]
Digital input [Binary code] (DIGITAL INPUT [BIN])	[20]
Analogue input 53 [V] (ANALOG INPUT 53 [V])	[21]
Analogue input 54 [V] (ANALOG INPUT 54 [V])	[22]
Analogue input 60 [mA] (ANALOG INPUT 60 [MA])	[23]
Relay status [binary code] (RELAY STATUS)	[24]
Pulse reference [Hz] (PULSE REFERENCE [HZ])	[25]
External reference [%] (EXT. REFERENCE [%])	[26]
Heat sink temp. [°C] (HEATSINK TEMP [°C])	[27]
Communication option card warning (COMM OPT WARN [HEX])	[28]
LCP display text (FREE PROG.ARRAY)	[29]
Status word (STATUS WORD [HEX])	[30]
Control word (CONTROL WORD [HEX])	[31]
Alarm word (ALARM WORD [HEX])	[32]

Function:

This parameter allows a choice of the data value to be shown in the display, line 2, when the frequency converter is turned on. The data values will also be included in the display mode scroll-list. Parameters 008-010 *Small display readout* allow a choice of another three data values, shown in line 1.
See the description of the *control unit.*

Description of choice:

No readout can only be selected in parameters 008-010 *Small display readout*.

Resulting reference [%] gives a percentage for the resulting reference in the range from *Minimum reference*, Ref_{MIN} to Maximum reference, Ref_{MAX} . See also *reference handling*.

Reference [unit] gives the resulting reference in Hz in *Open loop*. In *Closed loop*, the reference unit is selected in parameter 415 *Process units*.

Frequency [Hz] gives the output frequency from the frequency converter.

% of maximum output frequency [%] is the present output frequency as a percentage value of parameter 202 *Output frequency high limit,* f_{MAX}.

Motor current [A] states the phase current of the motor measured as effective value.

Power [kW] states the actual power consumed by the motor in kW.

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

Output energy [kWh] states the energy consumed by the motor since the latest reset was made in pa-rameter 618 *Reset of kWh* counter.

Hours run [Hours] states the number of hours that the motor has run since the latest reset in parameter 619 *Reset of hours-run counter*.

User -defined readout [-] is a user-defined value, calculated on the basis of the present output frequency and unit, as well as the scaling in parameter 005 *Max. value of user-defined readout.* Select unit in parameter 006 *Unit for user-defined readout.*

Setpoint 1 [unit] is the programmed setpoint value in parameter 418 *Setpoint 1*. The unit is decided in parameter 415 *Process units* . See also *Feedback handling*.

Setpoint 2 [unit] is the programmed setpoint value in parameter 419 *Setpoint 2*. The unit is decided in parameter 415 *Process units*.

Feedback 1 [unit] gives the signal value of the resulting feedback 1 (Term. 53). The unit is decided in parameter 415 *Process units*. See also *Feedback handling* .

Feedback 2 [unit] gives the signal value of the resulting feedback 2 (Term. 53). The unit is decided in parameter 415 *Process units*.

Feedback [unit] gives the resulting signal value using the unit/scaling selected in parameter 413 *Minimum feedback*, FB_{MIN}, 414 *Maximum feedback*, FB_{MAX} and 415 *Process units* .

Motor voltage [V] states the voltage supplied to the motor.

DC link voltage [V] states the intermediate circuit voltage in the frequency converter.

Thermal load, motor [%] states the calculated/ estimated thermal load on the motor. 100% is the cut-out limit. See also parameter 117 *Motor thermal protection*.

Thermal load, VLT [%] states the calculated/ estimated thermal load on the frequency converter. 100% is the cut-out limit.

Digital input [Binary code] states the signal status from the 8 digital inputs (16, 17, 18, 19, 27, 29, 32 and 33). Terminal 16 corresponds to the bit at the far left. '0' = no signal, '1' = connected signal.

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

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

Analogue input 60 [mA] states the voltage value on terminal 60.

Relay status [binary code] indicates the status of each relay. The left (most significant) bit indicates relay 1 followed by 2 and 6 through 9. A "1" indicates the relay is active, a "0" indicates inactive. Paramater 007 uses an 8-bit word with the last two positions

Programming

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

not used. Relays 6-9 are provided with the cascade controller and four relay option cards

Pulse reference [Hz] states a pulse frequency in Hz connected to terminal 17 or terminal 29.

External reference [%] gives the sum of the external references as a percentage (the sum of analogue/ pulse/serial communication) in the range from *Minimum reference*, Ref_{MIN} to *Maximum reference*, Ref_{MAX}.

Heat sink temp. [°C] states the present heat sink temperature of the frequency converter. The cut-out limit is 90 ± 5°C; cutting back in occurs at 60 ± 5°C.

Communication option card warning [Hex] gives a warning word if there is a fault on the communication bus. This is only active if communication options have been installed. Without communication options, 0 Hex is displayed.

LCP display text shows the text programmed in parameter 533 *Display text 1* and 534 *Display text 2* via LCP or the serial communication port.

LCP procedure for entering text

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

The available characters are:

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

'space' is the default value of parameter 533 & 534. To erase a character that has been entered, it must be replaced with 'space'.

Status word displays the actual drive status word (see parameter 608).

Control word displays the actual control word (see parameter 607).

Alarm word displays the actual alarm word.

---

008 Small display readout 1.1 (SMALL READOUT 1)

Value:

See parameter 007 *Large display readout*

★ Reference [Unit] [2]

Function:

This parameter enables a choice of the first of three data values to be shown on the display, line 1, position 1.

This is a useful function, i.a. when setting the PID regulator, in order to see how the process reacts to a change of reference.

For display read-outs, press the [DISPLAY MODE] button. Data option *LCP display text* [29] cannot be selected with *Small display readout* .

Description of choice:

There is a choice of 31 different data values, see parameter 007 *Large display readout*.

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

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*. Data option *LCP display text* [29] cannot be selected with *Small display readout* .

Description of choice:

There is a choice of 31 different data values, see parameter 007 *Large display readout.*

---

010 Small display readout 1.3 (SMALL READOUT 3)

Value:

Se parameter 007 *Large display readout*

✯Power [kW] [6]

Function:

See the functional description for parameter 008 *Small data readout.* Data option *LCP display text* [29] cannot be selected with *Small display readout* .

Description of choice:

There is a choice of 31 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.

NB!:
If *Disable* is selected, the motor cannot be stopped by means of the [OFF/STOP] key.

---

014 Auto start on LCP (AUTO START BTTN)

Value:

Disable (DISABLE) [0]

✯Enable (ENABLE) [1]

Function:

This parameter allows selection/deselection of the auto start key on the control panel.

Description of choice:

If *Disable* [0] is selected in this parameter, the [AUTO START] key will be inactive.

---

015 Reset on LCP (RESET BUTTON)

Value:

Disable (DISABLE) [0]

✯Enable (ENABLE) [1]

Function:

This parameter allows selection/deselection of the reset key on the control panel.

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

Description of choice:

If *Disable* [0] is selected in this parameter, the [RESET] key will be inactive.

NB!:
Only select *Disable* [0] if an external reset signal has been connected via the digital inputs.

---

016 Lock for data change
(DATA CHANGE LOCK)

Value:

✯Not locked (NOT LOCKED)	[0]
Locked (LOCKED)	[1]

Function:

This parameter allows the control panel to be "locked", which means that it is not possible to carry out data modifications via the control unit.

Description of choice:

If *Locked* [1] is selected, data modifications in the parameters cannot be made, although it will still be possible to carry out data modifications via the bus. Parameters 007-010 *Display readout* can be changed via the control panel.
It is also possible to lock for data modifications in these parameters by means of a digital input, see parameters 300-307 *Digital inputs*.

---

017 Operating state at power up, local control
(POWER UP ACTION)

Value:

✯Auto restart (AUTO RESTART)	[0]
OFF/Stop (OFF/STOP)	[1]

Function:

Setting of the desired operating mode when the mains voltage is reconnected.

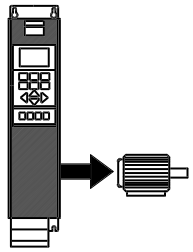
Description of choice:

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

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

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

■ Load and Motor 100-117



This parameter group allows the con-figuration of regulation parameters and the choice of torque characteristics to which the frequency converter is to be adapted.
The motor nameplate data must be set and automatic motor adaptation can be carried out. In addition, DC brake parameters can be set and the motor thermal protection can be activated.

■ Configuration

The selection of configuration and torque characteristics influences the parameters that can be seen in the display. If *Open loop* [0] is selected, all parameters relating to PID regulation will be hidden. Consequently, the user is only able to see the parameters that are of significance for a given application.

100 Configuration (CONFIG. MODE)

Value:

Closed loop (CLOSED LOOP) [1]

Function:

Only *closed loop* is available. *Open loop* is only possible in local reference or remote reference. See par. 203.

Description of choice:

The internal process regulator is activated to enable accurate regulation in relation to a given process signal. The reference (setpoint) and the process signal (feedback) can be set to a process unit as programmed in parameter 415 *Process units* . See *Feedback handling*.

101 Torque characteristics (VT CHARACT)

Value:

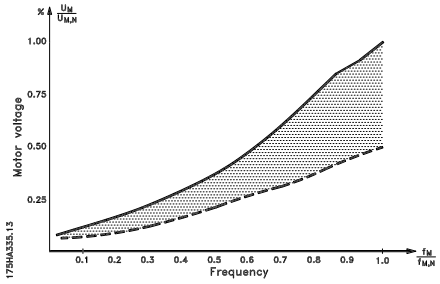
☆Automatic Energy Optimisation
(AEO FUNCTION) [0]
Parallel motors (MULTIPLE MOTORS) [1]

Function:

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

Description of choice:

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



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

Value:

0.25 kW (0.25 KW)	[25]
0.37 kW (0.37 KW)	[37]
0.55 kW (0.55 KW)	[55]
0.75 kW (0.75 KW)	[75]
1.1 kW (1.10 KW)	[110]
1.5 kW (1.50 KW)	[150]
2.2 kW (2.20 KW)	[220]
3 kW (3.00 KW)	[300]
4 kW (4.00 KW)	[400]
5,5 kW (5.50 KW)	[550]
7,5 kW (7.50 KW)	[750]
11 kW (11.00 KW)	[1100]
15 kW (15.00 KW)	[1500]
18.5 kW (18.50 KW)	[1850]
22 kW (22.00 KW)	[2200]
30 kW] (30.00 KW)	[3000]
37 kW (37.00 KW)	[3700]
45 kW (45.00 KW)	[4500]

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

55 kW (55.00 KW)	[5500]
75 kW (75.00 KW)	[7500]
90 kW (90.00 KW)	[9000]
110 kW] (110.00 KW)	[11000]
132 kW (132.00 KW)	[13200]
160 kW (160.00 KW)	[16000]
200 kW (200.00 KW)	[20000]
250 kW (250.00 KW)	[25000]
300 kW (300.00 KW)	[30000]
315 kW (315.00 KW)	[31500]
355 kW (355.00 KW)	[35500]
400 kW (400.00 KW)	[40000]
450 kW (450.00 KW)	[45000]
500 kW (500.00 KW)	[50000]

★Depends on the unit

Function:

This is where to select the kW value $P_{M,N}$ that corresponds to the rated power of the motor. At the works, a rated kW value $P_{M,N}$ has been selected that depends on the type of unit.

Description of choice:

Select a value that equals the nameplate data on the motor. There are 4 possible undersizes or 1 oversize in comparison with the factory setting. Also, alternatively it is possible to set the value for motor power as an infinitely variable value, see the procedure for *Infinitely variable change of numeric data value* .

---

103 Motor voltage, $U_{M,N}$ (MOTOR VOLTAGE)

Value:

200 V	[200]
208 V	[208]
220 V	[220]
230 V	[230]
240 V	[240]
380 V	[380]
400 V	[400]
415 V	[415]
440 V	[440]
460 V	[460]
480 V	[480]
500 V	[500]
550 V	[550]
575 V	[575]

★Depends on the unit

Function:

This is where the rated motor voltage $U_{M,N}$ is set for either star Y or delta Δ.

Description of choice:

Select a value that equals the nameplate data on the motor, regardless of the mains voltage of the frequency converter. 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*.

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

NB!:
Changing parameters 102, 103 or 104 will automatically reset parameters 105 and 106 to default values. If changes are made to parameters 102, 103 or 104, go back and reset parameters 105 and 106 to correct values.

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

Value:

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

Function:
This is where the rated motor frequency $f_{M,N}$ is selected.

Description of choice:
Select a value that equals the nameplate data on the motor. Furthermore, it is also possible to set the value for motor frequency infinitely variably in the 24-1000 Hz range.

105 Motor current, $I_{M,N}$ (MOTOR CURRENT) (MOTOR CURRENT)

Value:
0.01 - $I_{VLT,MAX}$ A ✯ Depends on the unit

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

Description of choice:
Set a value that equals the nameplate data on the motor.

NB!:
It is important to enter the correct value, since this forms part of the VVC + control feature.

106 Rated motor speed, $n_{M,N}$ (MOTOR NOM. SPEED)

Value:
1200 - $f_{M,N}$ x 60 (max. 60000 rpm)
✯Depends on parameter 102 *Motor power, $P_{M,N}$*

Function:
This is where the value is set that corresponds to the rated motor speed $n_{M,N}$, which can be seen from the nameplate data.

Description of choice:
Choose a value that corresponds to the motor nameplate data.

NB!:
It is important to set the correct value, since this forms part of the VVC + control feature. The max. value equals $f_{M,N}$ x 60.
$f_{M,N}$ is set in parameter 104 *Motor frequency, $f_{M,N}$*.

107 Automatic motor adaptation, AMA (AUTO MOTOR ADAPT)

Value:

✯Optimisation disable (NO AMA)	[0]
Automatic adaptation (RUN AMA)	[1]
Automatic adaptation with LC-filter (RUN AMA WITH LC-FILT)	[2]

Function:
Automatic motor adaptation is a test algorithm that measures the electrical motor parameters at motor standstill. This means that AMA itself does not supply any torque.
AMA is useful when commissioning systems, where the user wants to optimise the adjustment of the frequency converter to the motor applied. This feature is used in particular where the factory setting does not adequately cover the motor in question.
For the best adjustment of the frequency converter, it is recommended to carry out AMA on a cold motor.
It must be noted that repeated AMA runs may lead to a heating of the motor that will result in an increase of the stator resistance R_S. However, this is not normally critical.

NB!:
It is important to run AMA with any motors ≥55 kW/ 75 HP

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 frequency converter and the motor. If a total setting is required, the LC-filter can be removed and, after completion of the AMA, it can be reinstalled. In *Automatic optimisation with LC-filter* [2] there is no test of motor symmetry and

of whether all motor phases have been connected. The following must be noted when the AMA function is used:

- For AMA to be able to determine the motor parameters optimally, the correct nameplate data for the motor connected to the frequency converter must be entered in parameters 102 to 106.
- The duration of a total automatic motor adaptation varies from a few minutes to approx. 10 minutes for small motors, depending on the rating of the motor used (the time for a 7.5 kW motor, for example, is approx. 4 minutes).
- Alarms and warnings will be shown in the display if faults occur during motor adaptation.
- AMA can only be carried out if the rated motor current of the motor is min. 35% of the rated output current of the frequency converter.
- If automatic motor adaptation is to be discontinued, press the [OFF/STOP] key.

NB!:
AMA is not allowed on motors connected in parallel. AMA is only carried out on pump no. 1. After finalised AMA the system will start up immediately.

Description of choice:

Select *Automatic adaptation* [1] if the frequency converter is to carry out a complete automatic motor adaptation.
Select *Automatic adaptation with LC-filter* [2] if a LC-filter has been placed between the frequency converter and the motor.

Procedure for automatic motor adaptation:

1. Set the motor parameters in accordance with the motor nameplate data given in parameters 102-106 *Nameplate data.*
2. Connect 24 V DC (possibly from terminal 12) to terminal 27 on the control card.
3. Select Automatic adaptation [1] or Automatic adaptation with LC-filter [2] in parameter 107 *Automatic motor adaptation, AMA.*
4. Start up the frequency converter or connect terminal 18 (start) to 24 V DC (possibly from terminal 12).
5. After a normal sequence, the display reads: AMA STOP. After a reset, the frequency converter will be ready to start operation again.

If the automatic motor adaptation is to be stopped:

1. Press the [OFF/STOP] key.

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

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

Description of choice:

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

---

109 Resonance damping (RESONANCE DAMP.)

Value:

0 - 500 % ★ 100 %

Function:

High-frequency electric resonance problems between the frequency converter and the motor can be eliminated by adjusting the resonance damping.

Description of choice:

Adjust the damping percentage until the motor resonance has disappeared.

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

110 High break-away torque (HIGH START TORQ.)

Value:

0.0 (OFF) - 0.5 sec. ★ OFF

Function:

In order to secure a high starting torque, the maximum torque for max. 0.5 sec. is allowed. However, the current is limited by the protection limit of the frequency converter (inverter). 0 sec. corresponds to no high break-away torque.

Description of choice:

Set the necessary time in which a high starting torque is desired.

111 Start delay (START DELAY)

Value:

0.0 - 120.0 sec. ★ 0.0 sec.

Function:

This parameter enables a delay of the starting time after the conditions for start have been fulfilled. When the time has passed, the output frequency will start by ramping up to the reference.

Description of choice:

Set the desired time until acceleration is to begin.

112 Motor preheater (MOTOR PREHEAT)

Value:

★Disable (DISABLE) [0]
Enable (ENABLE) [1]

Function:

The motor preheater ensures that no condensate develops in the motor at stop. This function can also be used to evaporate condensed water in the motor. The motor preheater is only active during stop.

Description of choice:

Select *Disable* [0] if this function is not required. Select *Enable* [1] to activate motor preheating. The DC current is set in parameter 113 *Motor preheater DC current*.

113 Motor preheater DC current (PREHEAT DC-CURR.)

Value:

0 - 100 % ★ 50 %

The maximum value depends on the rated motor current, parameter 105 *Motor current,* $I_{M,N}$.

Function:

The motor can be preheated at stop by means of a DC current to prevent moisture from entering the motor.

Description of choice:

The motor can be preheated by means of a DC current. At 0%, the function is inactive; at a value higher than 0%, a DC current will be supplied to the motor at stop (0 Hz). This function can also be used to generate a holding torque.

If too high a DC current is supplied for too long, the motor can be damaged.

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

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:

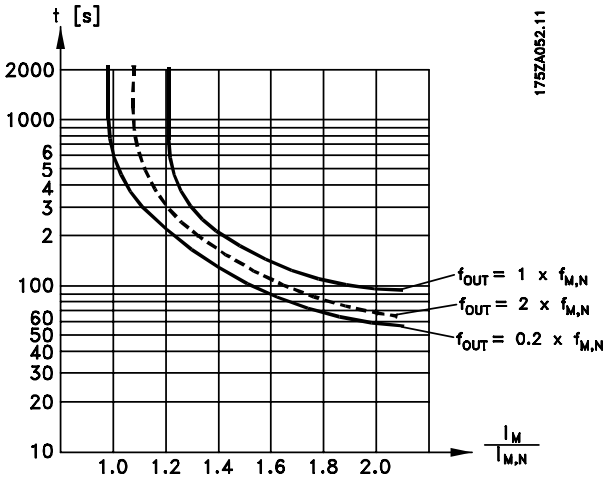
The frequency converter is able to monitor the motor temperature in two different ways:

- Via a thermistor sensor fitted to the motor. The thermistor is connected to one of the 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 frequency converter can also be programmed to give off a warning signal via one of the digital outputs.
Select *ETR Trip 1-4* if tripping is desired when the motor is overloaded according to the calculations.



118 Motor power factor (Cos ø) (MOTOR PWR FACT)

Value:

0.50 - 0.99	★ 0.75

Function:

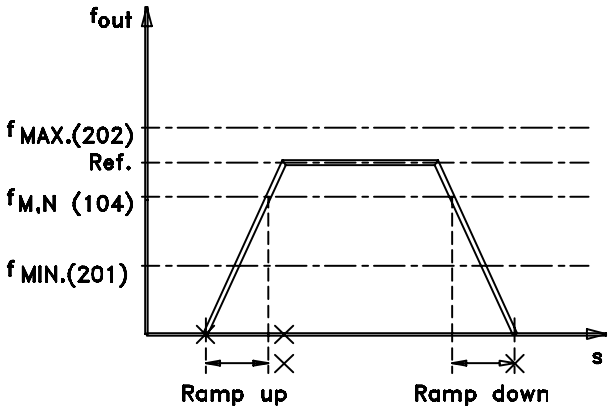
This parameter calibrates and optimizes the AEO function for motors of different power factor (Cos ø).

Description of choice:

Motors having > 4 poles have a lower power factor which would restrict or prevent use of the AEO function for energy savings. This parameter allows the user to calibrate the AEO function to the power factor of the motor so that AEO can be used with motors of 6, 8, and 12 poles as well as 4 and 2 poles.

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

■ References and Limits 200-228



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In this parameter group, the frequency and reference range of the frequency converter are established.
This parameter group also includes:

- Setting of ramp times
- Choice of four preset references
- Possibility of programming four bypass frequencies.
- Setting of maximum current to motor.
- Setting of warning limits for current, frequency, reference and feedback.

200 Output frequency range (FREQUENCY RANGE)

Value:

✯0 - 120 Hz (0 - 120 HZ)	[0]
0 - 1000 Hz (0 - 1000 HZ)	[1]

Function:

This is where to select the maximum output frequency range to be set in parameter 202 *Output frequency high limit*, f_{MAX}.

Description of choice:

Select the required output frequency range.

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

Value:

0.0 - f_{MAX}	✯ 20 HZ

Function:

This is where to select the minimum output frequency.

Description of choice:

A value from 0.0 Hz to the *Output frequency high limit, f_{MAX}* frequency set in parameter 202 can be selected.

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

Value:

f_{MIN} - 120/1000 Hz
(par. 200 *Output frequency range*) ✯ 50 Hz

Function:

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

NB!:
The output frequency of the frequency converter can never assume a value higher than 1/10 of the switching frequency (parameter 407 *Switching frequency*.

Description of choice:

A value from f_{MIN} to the choice made in parameter 200 *Output frequency* range can be selected.

Programming

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

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 frequency converter is in Hand or Auto mode.
The table shows which references are active when *Hand/Auto linked reference* [0], *Remote reference* [1] or *Local reference* [2] has been selected. The Hand mode or Auto mode can be selected via the control keys or via a digital input, parameters 300-307 *Digital inputs*.

Reference handling	Hand mode	Auto mode
Hand/Auto [0]	Local ref. active	Remote ref. active
Remote [1]	Remote ref. active	Remote ref. active
Local [2]	Local ref. active	Local ref. active

Description of choice:

If *Hand/Auto linked reference* [0] is chosen, the motor speed in Hand mode will be decided by the local reference, while in Auto mode it depends on remote references and any setpoints selected.
If *Remote reference* [1] is selected, the motor speed will depend on remote references, regardless of whether Hand mode or Auto mode has been chosen.
If *Local reference* [2] is selected, the motor speed will only depend on the local reference set via the control panel, regardless of whether Hand mode or Auto mode has been selected.

---

204 Minimum reference, Ref_{MIN} (MIN. REFERENCE)

Value:

-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. 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 is set in 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:

Par. 204 Ref $_{MIN}$
- par. 414 *Maximum feedback* ★ 50.000 Hz

Function:

The *Maximum reference* gives the maximum value that can be assumed by the sum of all references. 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 is set in 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*.

---

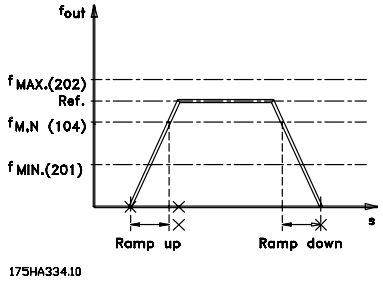
206 Ramp-up time (RAMP UP TIME)

Value:

1 - 60 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.

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

207 Ramp-down time
(RAMP DOWN TIME)

Value:

1 - 60 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 frequency converter does not trip during deceleration if the ramp-down time set is too short. If, during deceleration, the frequency converter registers that the intermediate circuit voltage is higher than the max. value (see *list of warnings and alarms*), the frequency converter automatically extends the ramp-down time.

NB!:
If the function is chosen as *Enable* [1], the ramp time may be considerably extended in relation to the time set in parameter 207 *Ramp-down time*.

Description of choice:

Program this function as *Enable* [1] if the frequency converter periodically trips during ramp-down. If a quick ramp-down time has been programmed that may lead to a trip under special conditions, the function can be set to *Enable* [1] to avoid trips.

209 Jog frequency
(JOG FREQUENCY)

Value:

Par. 201 *Output frequency Low limit* - par. 202 *Output frequency high limit* ★ 10.0 HZ

Function:

The jog frequency f_{JOG} is the fixed output frequency at which the frequency converter is running when the jog function is activated.
Jog can be activated via the digital inputs.

Description of choice:

Set the desired frequency.

215 Current limit, I_{LIM}
(CURRENT LIMIT)

Value:

0.1 - 1.1 x $I_{VLT,N}$ ✯ 1.1 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. Current limit should not be used for motor protection; parameter 117 is for motor protection. Current limit is for protection of the frequency converter. If the current limit is set within the range of 1.0-1.1 x $I_{VLT,N}$ (the rated output current of the frequency converter), the frequency converter can only handle a load intermittently, i.e. for short periods at a time. After the load has been higher than $I_{VLT,N}$, it must be ensured that for a period the load is lower than $I_{VLT,N}$. Please note that if the current limit is set to less than $I_{VLT,N}$, the acceleration torque will be reduced correspondingly. If the drive is in current limit and a stop command is initiated with the stop button on the LCP key pad, the drive output is immediately turned off and the motor will coast to a stop.

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. The frequencies to avoid can be programmed in parameters 217-220 *Frequency bypass* .
In this parameter (216 *Frequency bypass, bandwidth*), a definition can be given of a bandwidth around each of these frequencies.

Description of choice:

The bypass bandwidth is equal to the programmed bandwidth frequency. This bandwidth will be centered around each bypass frequency.

---

217 Frequency bypass 1
(BYPASS FREQ. 1)
218 Frequency bypass 2
(BYPASS FREQ. 2)
219 Frequency bypass 3
(BYPASS FREQ. 3)
220 Frequency bypass 4
(BYPASS FREQ. 4)

Value:

0 - 120/1000 HZ ✯ 120.0 Hz
The frequency range depends on the selection made in parameter 200 *Output frequency range*.

Function:

Some systems call for some output frequencies to be avoided because of mechanical resonance problems in the system.

Description of choice:

Enter the frequencies to be avoided.

---

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

Value:

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

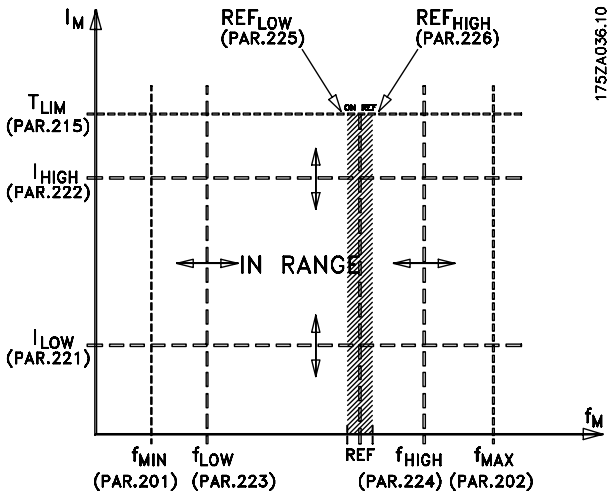
Function:

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 frequency converter will trip if parameter 409 *Function in case of no load* has been selected as *Trip* [0]. The warning functions in parameters 221-228 are not active during ramp-up after a start command, ramp-down after a stop command or while stopped. The warning functions are activated when the output frequency has reached the resulting reference. The signal outputs can be programmed to generate a warning signal via terminal 42 or 45 and via the relay outputs.

Description of choice:

The lower signal limit I_{LOW} must be programmed within the normal working range of the frequency converter.

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



222 Warning: High current, I_{HIGH} (WARN. HIGH CURR.)

Value:

Parameter 221 - $I_{VLT,MAX}$ ✯ $I_{VLT,MAX}$

Function:

If the motor current is above the limit, I_{HIGH}, programmed in this parameter, the display shows a flashing CURRENT HIGH.
The warning functions in parameters 221-228 are not active during ramp-up after a start command, ramp-down after a stop command or while stopped.
The warning functions are activated when the output frequency has reached the resulting reference.
The signal outputs can be programmed to generate a warning signal via terminal 42 or 45 and via the relay outputs.

Description of choice:

The upper signal limit of the motor frequency, f_{HIGH}, must be programmed within the normal working range of the frequency converter. See drawing at parameter 221 *Warning: Low current, I_{LOW}*.

223 Warning: Low frequency, f_{LOW} (WARN. LOW FREQ.)

Value:

0.0 - parameter 224 ✯ 0.0 Hz

Function:

If the output frequency is below the limit, f_{LOW}, programmed in this parameter, the display will show a flashing FREQUENCY LOW.
The warning functions in parameters 221-228 are not active during ramp-up after a start command, ramp-down after a stop command or while stopped.
The warning functions are activated when the output frequency has reached the 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 frequency converter. 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 resulting reference.
The signal outputs can be programmed to generate a warning signal via terminal 42 or 45 and via the relay outputs.

Description of choice:

The higher signal limit of the motor frequency, f_{HIGH}, must be programmed within the normal working range of the frequency converter. See drawing at pa-rameter 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,

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

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

---

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

Value:

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

Function:

If the resulting reference is above the limit, Ref_{HIGH}, programmed in this parameter, the display shows a flashing REFERENCE HIGH.
The warning functions in parameters 221-228 are not active during ramp-up after a start command, ramp-down after a stop command or while stopped. The warning functions are activated when the output frequency has reached the resulting reference.
The signal outputs can be programmed to generate a warning signal via terminal 42 or 45 and via the relay outputs.
The reference limits in parameter 226 Warning: *High reference, Ref_{HIGH}* , and in parameter 227 *Warning: Low reference, Ref_{LOW}* , are only active when remote reference has been selected.
In *Open loop* the unit for the reference is Hz, while in Closed loop the unit is programmed in parameter 415 *Process units* .

Description of choice:

The upper signal limit, Ref_{HIGH}, of the reference must be programmed within the normal working range of the frequency converter, provided parameter 100 Configuration has been programmed for *Open loop* [0]. In *Closed loop* [1] (parameter 100), Ref_{HIGH} must be within the reference range programmed in parameters 204 and 205.

---

227 Warning: Low feedback, FB_{LOW}
(WARN LOW FDBK)

Value:

-999,999.999 - FB_{HIGH} (parameter 228) ✯ -999.999,999

Function:

If the feedback signal is below the limit, FB_{LOW}, programmed in this parameter, the display will show a flashing FEEDBACK LOW.
The warning functions in parameters 221-228 are not active during ramp-up after a start command, ramp-down after a stop command or while stopped. The warning functions are activated when the output frequency has reached the 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.

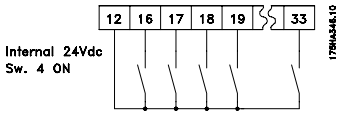
✯ = factory setting. () = display text [] = value for use in communication via serial communication port

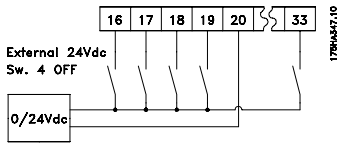
Description of choice:

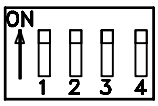
Set the required value within the feedback range (parameter 413 *Minimum feedback, FB_{MIN}*, and 414 *Maximum feedback, FB_{MAX}*).

■ Inputs and outputs 300-328

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







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Switch 4, which is located on the Dip switch control card, is used for separating the common potential of the internal 24 V DC supply from the common potential of the external 24 V DC supply.
See *Electrical installation*.
Please note that when Switch 4 is in the OFF position, the external 24 V DC supply is galvanically isolated from the frequency converter.

Digital inputs	Terminal no.	16	17	18	19	27	29	32	33
	parameter	300	301	302	303	304	305	306	307
Value:									
No function	(NO OPERATION)	[0]		[0]	[0]		[0]	[0]★	[0]★
Reset	(RESET)	[1]★					[1]	[1]	[1]
Coasting stop, inverse	(COAST INVERSE)					[0]★			
Start	(START)			[1]★					
Hand start	(HAND START)	[11]					[15]	[11]	[12]
System start	(SYSTEM START)		[20]						

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 frequency converter is not to react to signals transmitted to the terminal.

Reset the frequency converter after an alarm; however, trip locked alarms cannot be reset by cycling mains power supply. See table in *List of warnings and alarms* . Reset will occur on the rising edge of the signal.

Coasting stop, inverse is used to force the frequency converter to "release" the motor immediately (the output transistors are "turned off") to make it coast freely to stop. Logic '0' implements coasting to stop.

Start is selected if a start/stop command is required. Logic '1' = start, logic '0' = stop.

Hand start is selected if the frequency converter is to be controlled by means of an external hand/off or H-O-A switch. A logic '1' (Hand start active) will mean that the frequency converter starts the motor. A logic '0' means that the connected motor stops. The frequency converter will then be in OFF/STOP mode, unless there is an active *Auto start signal*. See also the description in *Local control*.

NB!:
An active *Hand* and *Auto* signal via the digital inputs will have higher priority than the [HAND START]-[AUTO START] control keys.

Please refer to section *Cascade Controller Settings* for further information on Start/Stop functionality.

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

■ Analogue inputs

Two analogue inputs for voltage signals (terminals 53 and 54) are provided for reference and feedback signals. Furthermore, an analogue input is available for current signal (terminal 60). A thermistor can be connected to voltage input 53 or 54.
The two analogue voltage inputs can be scaled in the range of 0-10 V DC; the current input in the range of 0-20 mA.

The table below gives the possibilities for programming the analogue inputs. Parameter 317 *Time out* and 318 *Function after time out* allow activation of a time-out function on all analogue inputs. If the signal value of the reference or feedback signal connected to one of the analogue input terminals drops to below 50% of the minimum scaling, a function will be activated after the time out determined in parameter 318, *Function after time out*.

Analogue inputs	terminal no.	53(voltage)	54(voltage)	60(current)
	parameter	308	311	314
Value:				
No operation	(NO OPERATION)	[0]	[0]★	[0]
Reference	(REFERENCE)	[1]★	[1]	[1]★
Feedback	(FEEDBACK)	[2]	[2]	[2]
Thermistor	(THERMISTOR)	[3]	[3]	

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

Function:

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

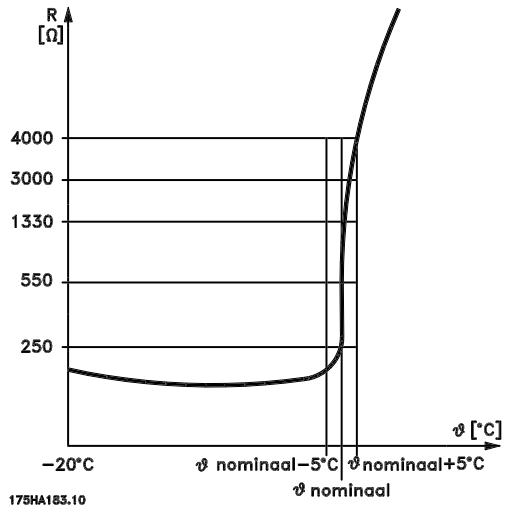
Description of choice:

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

Reference. Is selected to enable change of reference by means of an analogue reference signal.
If reference signals are connected to several inputs, these reference signals must be added up.

Feedback. If a feedback signal in connected, there is a choice of a voltage input (terminal 53 or 54) or a current input (terminal 60) as feedback.
In the case of zone regulation, feedback signals must be selected as voltage inputs (terminals 53 and 54). See *Feedback handling*.

Thermistor. Is selected if a thermistor integrated in the motor is to be able to stop the frequency converter in case of motor overtemperature.
The cut-out value is 3 kohm.
If a motor features a Klixon thermal switch instead, this can also be connected to the input. If motors run in parallel, the thermistors/thermal switches can be connected in series (total resistance < 3 kohm). Parameter 117 *Motor thermal protection* must be programmed for *Thermal warning* [1] or *Thermistor trip* [2], and the thermistor must be inserted between terminal 53 or 54 (analogue voltage input) and terminal 50 (+10 V supply).



Programming

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

309 Terminal 53, min. scaling
(AI 53 SCALE LOW)

Value:
0.0 - 10.0 V ★ 0.0 V

Function:
This parameter is used for setting the signal value that has to correspond to the minimum reference or the minimum feedback, parameter 204 *Minimum reference, Ref_{MIN}*/413 *Minimum feedback, FB_{MIN}*. See *Reference handling* or *Feedback handling*.

Description of choice:
Set the required voltage value.
For reasons of accuracy, voltage losses in long signal lines can be compensated for.
If the time-out function is to be applied (parameters 317 *Time out* and 318 *Function after time out*), the value must be set to > 1 V.

---

310 Terminal 53, max. scaling
(AI 53 SCALE HIGH)

Value:
0.0 - 10.0 V ★ 10.0 V

Function:
This parameter is used for setting the signal value that has to correspond to the maximum reference value or the maximum feedback, parameter 205 *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 205 *Maximum refe-rence, Ref_{MAX}/414 Maximum feedback, FB_{MAX}.* See *Reference handling* or *Feedback handling*.

Description of choice:
Set the required voltage value.
For reasons of accuracy, voltage losses in long signal lines can be compensated for.

---

314 Terminal 60, analogue input current
(AI [MA] 60 FUNCT.)

Value:
See description of parameter 308. ★ Reference

Function:
This parameter allows a choice between the different functions available for the input, terminal 60.

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

Scaling of the input signal is effected in parameter 315 *Terminal 60, min. scaling* and in parameter 316 *Terminal 60, max. scaling*.

Description of choice:

See description of parameter 308 *Terminal 53, analogue input voltage*.

---

315 Terminal 60, min. scaling
(AI 60 SCALE LOW)

Value:

0.0 - 20.0 mA ✯ 4.0 mA

Function:

This parameter determines the signal value that corresponds to the minimum reference or the minimum feedback, parameter 204 *Minimum reference, Ref_{MIN}*/413 *Minimum feedback, FB_{MIN}*. See *Reference handling* or *Feedback handling* .

Description of choice:

Set the required current value.
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 frequency converter can be:
- frozen at the present value [1]
- overruled to stop [2]
- overruled to jog frequency [3]
- overruled to max. output frequency [4]
- overruled to stop with subsequent trip [5].

Programming

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

■ Analogue/digital outputs

The two analogue/digital outputs (terminals 42 and 45) can be programmed to show the present status or a process value such as 0 - f_{MAX}. If the frequency converter is used as a digital output, it gives the present status by means of 0 or 24 V DC.

If the analogue output is used for giving a process value, there is a choice of three types of output signal:

0-20 mA, 4-20 mA or 0-32000 pulses (depending on the value set in parameter 322 *Terminal 45, output, pulse scaling*.

If the output is used as a voltage output (0-10 V), a pull-down resistor of 500 Ω should be fitted to terminal 39 (common for analogue/digital outputs). If the output is used as a current output, the resulting impedance of the connected equipment should not exceed 500 Ω.

Analogue/digital outputs	terminal no.	42	45
	parameter	319	321
No function (NO FUNCTION)		[0]	[0]
Drive ready (UN. READY)		[1]	[1]
Standby (STAND BY)		[2]	[2]
Running (RUNNING)		[3]	[3]
Running at ref. value (RUNNING AT REFERENCE)		[4]	[4]
Running, no warning (RUNNING NO WARNING)		[5]	[5]
Local reference active (DRIVE IN LOCAL REF.)		[6]	[6]
Remote references active (DRIVE IN REMOTE REF.)		[7]	[7]
Alarm (ALARM)		[8]	[8]
Alarm or warning (ALARM OR WARNING)		[9]	[9]
No alarm (NO ALARM)		[10]	[10]
Current limit (CURRENT LIMIT)		[11]	[11]
Safety interlock (SAFETY INTERLOCK)		[12]	[12]
Start command active (START SIGNAL APPLIED)		[13]	[13]
Reversing (RUNNING IN REVERSE)		[14]	[14]
Thermal warning (THERMAL WARNING)		[15]	[15]
Hand mode active (DRIVE IN HAND MODE)		[16]	[16]
Auto mode active (DRIVE IN AUTO MODE)		[17]	[17]
Sleep mode (SLEEP MODE)		[18]	[18]
Output frequency lower than f_{LOW} parameter 223 (F OUT < F LOW)		[19]	[19]
Output frequency higher than f_{HIGH} parameter 223 (F OUT > F HIGH)		[20]	[20]
Out of frequency range (FREQ. RANGE WARN.)		[21]	[21]
Output current lower than I_{LOW} parameter 221 (I OUT < I LOW)		[22]	[22]
Output current higher than I_{HIGH} parameter 222 (I OUT > I HIGH)		[23]	[23]
Out of current range (CURRENT RANGE WARN)		[24]	[24]
Out of feedback range (FEEDBACK RANGE WARN.)		[25]	[25]
Out of reference range (REFERENCE RANGE WARN)		[26]	[26]
Relay 123 (RELAY 123)		[27]	[27]
Mains imbalance (MAINS IMBALANCE)		[28]	[28]
Output frequency, 0 - f_{MAX} 0-20 mA (OUT. FREQ. 0-20 mA)		[29]	[29]✯
Output frequency, 0 - f_{MAX} 4-20 mA (OUT. FREQ. 4-20 mA)		[30]	[30]
Output frequency (pulse sequence), 0 - f_{MAX} 0-32000 p (OUT. FREQ. PULSE)		[31]	[31]
External reference, Ref_{MIN} - Ref_{MAX} 0-20 mA (EXT. REF. 0-20 mA)		[32]	[32]
External reference, Ref_{MIN} - Ref_{MAX} 4-20 mA (EXTERNAL REF. 4-20 mA)		[33]	[33]
External reference (pulse sequence), Ref_{MIN} - Ref_{MAX} 0-32000 p (EXTERNAL REF. PULSE)		[34]	[34]
Feedback, FB_{MIN} - FB_{MAX} 0-20 mA (FEEDBACK 0-20 mA)		[35]	[35]
Feedback, FB_{MIN} - FB_{MAX} 4-20 mA (FEEDBACK 4-20 mA)		[36]	[36]
Feedback (pulse sequence), FB_{MIN} - FB_{MAX} 0 - 32000 p (FEEDBACK PULSE)		[37]	[37]
Output current, 0 - I_{MAX} 0-20 mA (MOTOR CUR. 0- 20 mA)		[38]✯	[38]
Output current, 0 - I_{MAX} 4-20 mA (MOTOR CUR. 4- 20 mA)		[39]	[39]
Output current (pulse sequence), 0 - I_{MAX} 0 - 32000 p (MOTOR CUR. PULSE)		[40]	[40]
Output power, 0 - P_{NOM} 0-20 mA (MOTOR POWER 0-20 mA)		[41]	[41]
Output power, 0 - P_{NOM} 4-20 mA (MOTOR POWER 4-20 mA)		[42]	[42]
Output power (pulse sequence), 0 - P_{NOM} 0- 32000 p (MOTOR POWER PULSE)		[43]	[43]

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

Function:

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

Description of choice:

No function. Selected if the frequency converter is not to react to signals.

Drive ready. The frequency converter control card receives a supply voltage and the frequency con-verter is ready for operation.

Stand by. The frequency converter is ready for operation, but no start command has been given. No warning.

Running. A start command has been given.

Running at ref. value. Speed according to reference.

Running, no warning. A start command has been given. No warning.

Local reference active. The output is active when the motor is controlled by means of the local reference via the control unit.

Remote references active. The output is active when the frequency converter is controlled by means of the remote references.

Alarm. The output is activated by an alarm.

Alarm or warning. The output is activated by an alarm or a warning.

No alarm. The output is active when there is no alarm.

Current limit. The output current is greater than the value programmed in parameter 215 *Current limit* I_{LIM}.

Safety interlock. The output is active when terminal 27 is a logic '1' and *Safety interlock* has been selected on the input.

Start command active. Is active when there is a start command or the output frequency is above 0.1 Hz.

Reversing. There is 24 V DC on the output when the motor rotates anti-clockwise. When the motor rotates clockwise, the value is 0 V DC.

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

Hand mode active. The output is active when the frequency converter is in Hand mode.

Auto mode active. The output is active when the frequency converter is in Auto mode.

Sleep mode. Active when the frequency conver-ter 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}.

Outout frequency higher than f_{high}. The output frequency is higher than the value set in parameter 224 *Warning: High frequency,* f_{HIGH} .

Out of frequency range. The output frequency is outside the frequency range programmed in parameter 223 *Warning: Low frequency,* f_{LOW} and 224 *Warning: High frequency,* f_{HIGH}.

Output current lower than I_{LOW}. The output current is lower than the value set in parameter 221 *Warning: Low current,* I_{LOW}.

Output current higher than I_{HIGH}. The output current is higher than the value set in parameter 222 *Warning: High current,* I_{HIGH}.

Out of current range. The output current is outside the range programmed in parameter 221 *Warning: Low current,* I_{LOW} and 222 *Warning, High current,* I_{HIGH}.

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

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

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

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

0-f_{MAX} 0-20 mA and

0-f_{MAX} 4-20 mA and

0-f_{MAX} 0-32000 p which generates an output sig-nal proportional to the output frequency in the interval 0 - f_{MAX} (parameter 202 *Output frequency, high limit,* f_{MAX}).

Programming

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

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$_{MAX}$ ***4-20 mA*** 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$_{NOM}$ ***0-32000p***, 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:

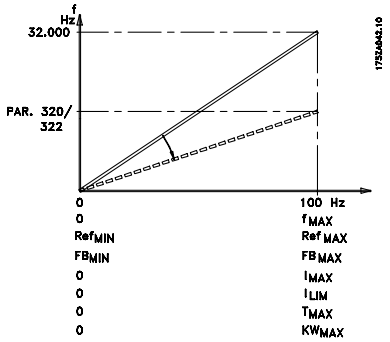
1 - 32000 Hz ✯ 5000 Hz

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.

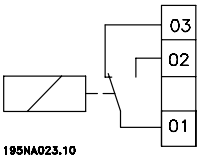
Description of choice:

Set the desired value.

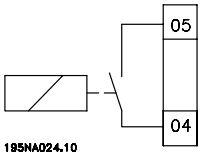
✯ = factory setting. () = display text [] = value for use in communication via serial communication port

■ Relay outputs

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



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



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

Relay outputs	Relay no.	1	2
	parameter	323	326
Value:			
No function (NO FUNCTION)		[0]	[0]
Ready signal (READY)		[1]	[1]
Standby (STAND BY)		[2]	[2]
Running (RUNNING)		[3]	[3]✯
Running at ref. value (RUNNING AT REFERENCE)		[4]	[4]
Running, no warning (RUNNING NO WARNING)		[5]	[5]
Local reference active (DRIVE IN LOCAL REF)		[6]	[6]
Remote references active (DRIVE IN REMOTE REF.)		[7]	[7]
Alarm (ALARM)		[8]✯	[8]
Alarm or warning (ALARM OR WARNING)		[9]	[9]
No alarm (NO ALARM)		[10]	[10]
Current limit (CURRENT LIMIT)		[11]	[11]
Safety interlock (SAFETY INTERLOCK)		[12]	[12]
Start command active (START SIGNAL APPLIED)		[13]	[13]
Reversing (RUNNING IN REVERSE)		[14]	[14]
Thermal warning (THERMAL WARNING)		[15]	[15]
Hand mode active (DRIVE IN HAND MODE)		[16]	[16]
Auto mode active (DRIVE IN AUTO MODE)		[17]	[17]
Sleep mode (SLEEP MODE)		[18]	[18]
Output frequency lower than f_{LOW} parameter 223 (F OUT < F LOW)		[19]	[19]
Output frequency higher than f_{HIGH} parameter 224 (F OUT > F HIGH)		[20]	[20]
Out of frequency range (FREQ RANGE WARN.)		[21]	[21]
Output current lower than $_{LOW}$ 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]
Aux Pump Control (CONTROL AUXILIARY PUMP)		[30]	[30]

Function:

Description of choice:

See description of [0] - [28] in *Analogue/digital outputs.*

Control word bit 11/12, relay 1 and relay 2 can be activated via the serial communication. Bit 11 activates relay 1 and bit 12 activates relay 2.

If the parameter 556 *Bus time interval function* becomes active, relay 1 and relay 2 will become cut off if they are activated via the *serial communication*.

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

323 Relay 1, output function
(RELAY1 FUNCTION)

Function:

This output activates a relay switch. Relay switch 01 can be used for 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. ✯ 0 sec.

Function:

This parameter makes it possible to delay the cut-out time of relay 01 (terminals 1-2).

Description of choice:

Enter the desired value.

326 Relay 2, output function
(RELAY2 FUNCTION)

Value:

See functions of relay 2 on previous page.

Function:

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

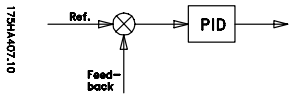
Function:

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



In this parameter group, the special functions the frequency converter are set up, e.g. PID regulation,
setting of the feedback range and the Setup of the Sleep mode function.

Additionally, this parameter group includes:

- Reset function.
- Flying start.
- Option of interference reduction method.
- Setup of any function upon loss of load, e.g.because of a damaged V-belt.
- Setting of switching frequency.
- Selection of process units.

The motor may start without warning.

400 Reset function (RESET FUNCTIO)

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 frequency converter is to be reset and restarted automatically. In addition, there is a choice of the number of times the unit is to attempt a restart. The time between each reset attempt is set in parameter 401, *Automatic restart time*.

Description of choice:

If Manual reset [0] is selected, resetting must be effected via the "Reset" key or via a digital input. If the frequency converter is to carry out an automatic reset and restart after a trip, select data value [1]-[9].

401 Automatic restart time (AUTORESTART TIME)

Value:

0 - 600 sec. ★ 10 sec.

Function:

This parameter allows setting of the time from tripping until the automatic reset function begins. It is assumed that automatic reset has been selected in parameter 400 *Reset* function.

Description of choice:

Set the desired time.

---

407 Switching frequency (SWITCHING FREQ.)

Value:

Depends on the size of the unit.

Function:

The preset value determines the switching frequency of the inverter, provided *Fixed switching frequency* [1] has been selected in parameter 408 *Interference reduction method*. If the switching frequency is changed, this may help to minimise possible acoustic noise from the motor.

NB!:
The output frequency of the frequency converter can never assume a value higher than 1/10 of the switching frequency.

Description of choice:

When the motor is running, the switching frequency is adjusted in parameter 407 *Switching frequency*, until the frequency has been achieved at which the motor is as quiet as possible.

NB!:
Switching frequencies higher than 4.5 kHz implement automatic derating of the maximum output of the frequency converter. 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 frequency converter. This is done by monitoring the load.
Fixed switching frequency [1] makes it possible to set a fixed high/low switching frequency. This can generate the best result, as the switching frequency can be set to lie outside the motor interference or in a less irritating area. The switching frequency is adjusted in parameter 407 *Switching frequency. LC-filter fitted* [2] is to be used if an LC-filter is fitted between the frequency converter and the motor, as the frequency converter will otherwise not be able to protect the LC-filter.

---

409 Function in case of no load (FUNCT. LOW CURR.)

Value:

Trip (TRIP)	[0]
★Warning (WARNING)	[1]

Function:

This parameter can be used e.g. for monitoring the V-belt of a fan to make sure it has not snapped. This function is activated when the output current goes below parameter 221 *Warning: Low current*.

Description of choice:

In the case of a *Trip* [1], the frequency converter will stop the motor.
If *Warning* [2] is selected, the frequency converter will give a warning if the output current drops below the threshold value in parameter 221 *Warning: Low current,* I_{LOW}.

---

410 Function at mains failure (MAINS FAILURE)

Value:

★Trip (TRIP)	[0]
Autoderate & warning (AUTODERATE & WARNING)	[1]
Warning (WARNING)	[2]

Function:

Select the function which is to be activated if the mains imbalance becomes too high or if a phase is missing.

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

Description of choice:

At *Trip* [0] the frequency converter will stop the motor within a few seconds (depending on drive size).
If *Autoderate & warning* [1] is selected, the drive will export a warning and reduce the output current to 30 % of $I_{VLT,N}$ to maintain operation.
At *Warning* [2] only a warning will be exported when a mains failure occurs, but in severe cases, other extreme conditions might result in a trip.

NB!:
If *Warning* has been selected, the life expectancy of the drive will be reduced when the mains failure persists.

---

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 frequency converter is exposed to an overtemperature condition.

Description of choice:

At *Trip* [0] the frequency converter will stop the motor and export an alarm.
At *Autoderate & warning* [1] the frequency converter will first reduce the switching frequency to minimize internal losses. If the overtemperature condition persists, the frequency converter 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) .	✯ 60 sec

Function:

When the frequency converter registers that the output current has reached the current limit I_{LIM} (parameter 215 *Current limit*) and stays there for the duration selected, a cut-out will be performed.

Description of choice:

Select for how long the frequency converter is to 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 7000 Booster 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.

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)

Value:

mbar	[15]
✯bar	[16]

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

Pa	[17]
kPa	[18]
mVS	[19]
PSI	[36]
lb/in ^{2}	[37]

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 con-dition (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 feed-back 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 7000 Booster units has been optimised for use in HVAC applications. This means that a number of specialised functions are available in VLT 7000 Booster units.
Formerly, it was necessary to get a BMS (Building Management System) to handle these special functions by installing extra I/O modules and by programming the system.
Using the VLT 7000 Booster, there is no need for extra modules to be installed. For example, only one required reference/setpoint and the handling of feedback need to be programmed.
There is in-built a option for connecting two feedback signals to the system, making two-zone regulation possible.
Correction for voltage losses in long signal cables can be carried out when using a transmitter with a voltage output. This is done in parameter group 300 *Min./ Max. scaling.*

Feedback

The feedback signal must be connected to a terminal on the frequency converter. Use the list below to decide which terminal to use and which parameters to program.

Feedback type	Terminal	Parameters
Pulse	33	307
Voltage	53, 54	308, 309, 310 or 311, 312, 313, 314
Current	60	315, 316
Bus feedback 1	68+69	535
Bus feedback 2	68+69	536

Please note that the feedback value in parameter 535/ 536 *Bus feedback* 1 and 2 can only be set via serial communication (not via the control unit).

Furthermore, the *minimum* and *maximum feedback* (parameters 413 and 414) must be set to a value in the process unit that corresponds to the minimum and maximum scaling value for signals connected to the terminal. The process unit is selected in parameter 415 *Process units*.

Reference

In parameter 205 *Maximum reference, Ref_{MAX}*, a maximum reference that scales the sum of all references, i.e. the resulting reference, can be set. The *minimum reference* in parameter 204 indicates the smallest value that the resulting reference can assume. The reference range cannot exceed the feedback range. If *Preset references* are required, set these in parameters 211 to 214 *Preset reference*. See *Reference type*. See also *Reference handling*.
If a current signal is used as a feedback signal, voltage can be used as analogue reference. Use the list below to decide which terminal to use and which parameters to program.

Reference type	Terminal	Parameters
Pulse	17 or 29	301 or 305
Voltage	53 or 54	308, 309, 310 or 311, 312, 313
Current	60	314, 315, 316
Preset reference	214	211, 212, 213,
Setpoints		418, 419
Bus reference	68+69	

Please note that the bus reference can only be set via serial communication.

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

■ PID for process regulation, cont.

Inverse regulation

Normal regulation means that the motor speed increases when the reference/setpoint is higher than the feedback signal. If there is a need for inverse regulation, in which the speed is reduced when the feedback signal is lower than the reference/setpoint, Inverse must be programmed in parameter 420 *PID normal/inverse control*.

Anti Windup

The process regulator is factory preset with an active anti-windup function. This function ensures that when either a frequency limit, current limit or voltage limit 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 the process, the controller of which is not possible means of a speed change. This function can be disabled in parameter 421 *PID anti windup*.

Start-up conditions

In some applications, optimum setting of the process regulator will mean that it takes an excessive time for the required process state to be reached. In such applications it might be an advantage to fix an output frequency to which the frequency converter is to bring the motor before the process regulator is activated. This is done by programming a *PID start-up frequency* in parameter 422.

Differentiator gain limit

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

Lowpass filter

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

Optimisation of the process regulator

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

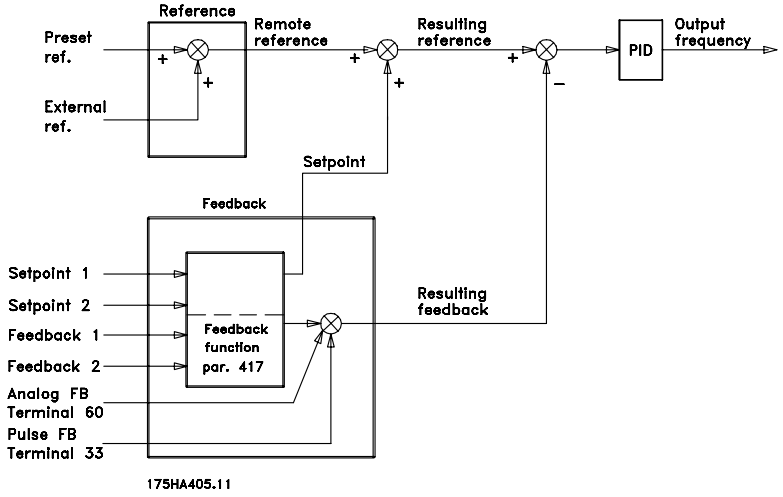
1. Start the motor.
2. Set parameter 423 *PID proportional gain* to 0.3 and increase it until the process shows that the feedback signal is unstable. Then reduce the value until the feedback signal has stabilised. Now lower the proportional gain by 40-60%.
3. Set parameter 424 *PID integration time* to 20 s and reduce the value until the process shows that the feedback signal is unstable. Increase the inte-gration time until the feedback signal stabilises, followed by an increase of 15-50%.
4. Parameter 425 *PID differentiation time* is only used in very fast-acting systems. The typical value is 1/4 of the value set in parameter 424 *PID Integration time*. The differentiator should only be used when the setting of the proportional gain and the integra-tion time have been fully optimised.

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

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

■ 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 frequency converter 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

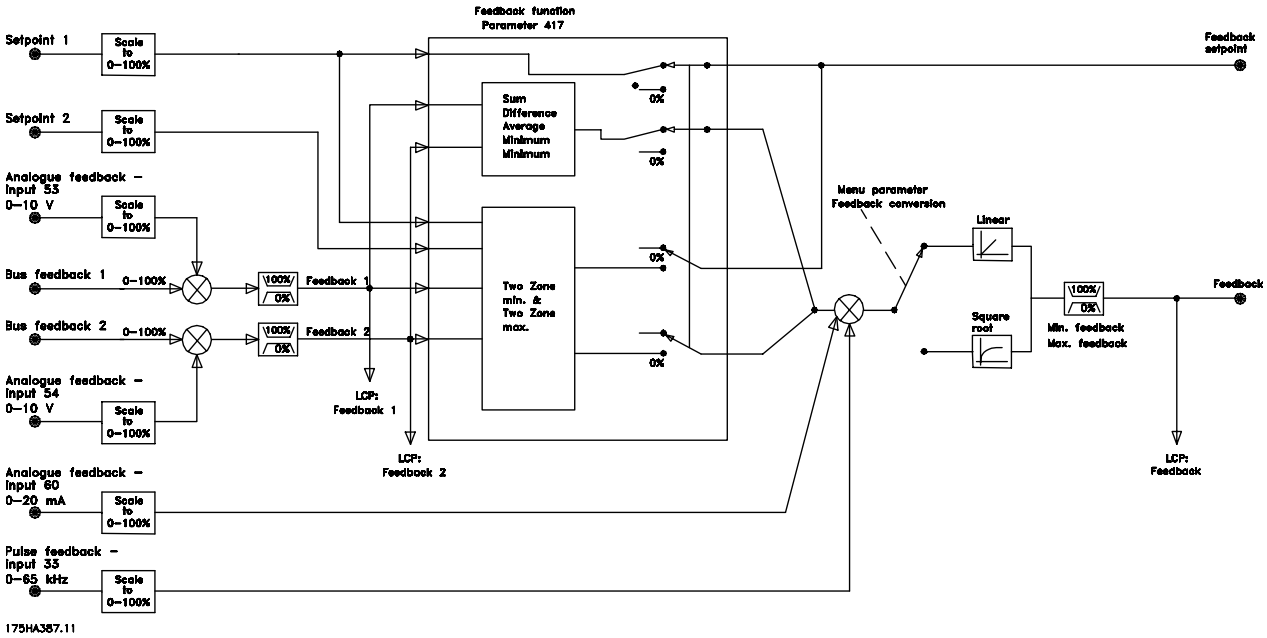
If only 1 setpoint and 1 feedback signal are used, parameter 418 *Setpoint 1* will be added to the remote reference. The sum of the remote reference and *Setpoint 1* becomes the resulting reference, which will then be compared with the feedback signal.

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*.

Programming

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



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.

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 frequency converter translates the feedback signal to a square root value.

417 Feedback function (2 FEEDBACK, CALC.)

Value:

Minimum (MINIMUM)	[0]
Maximum (MAXIMUM)	[1]
Sum (SUM)	[2]
Difference (DIFFERENCE)	[3]
Average (AVERAGE)	[4]
Feedback 1 only (FEEDBACK 1 ONLY)	[7]
Feedback 2 only (FEEDBACK 2 ONLY)	[8]
✯Virtual Control Curve (VIRTUAL CTR CURVE)	[9]

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 frequency converter will compare *feedback 1* with *feedback 2* and regulate on the basis of the lower feedback value.
Feedback 1 = Sum of parameter 535 *Bus feedback 1* and the feedback signal value of terminal 53. *Feedback 2* = Sum of parameter 536 *Bus feedback* 2 and the feedback signal value of terminal 54.

If *Maximum* [1] is selected, the frequency converter will compare *feedback 1* with*feedback 2* and regulate on the basis of the higher feedback value.
If *Sum* [2] is selected, the frequency converter will total *feedback 1* with *feedback 2*. Please note that the remote reference will be added to *Setpoint 1*.
If *Difference [3*] is selected, the frequency converter will subtract *feedback 1* from *feedback 2*.
If *Average* [4] is selected, the frequency converter will calculate the average of *feedback 1* and *feedback 2*. Please note that the remote reference will be added to the *Setpoint 1*.

If *Feedback 1 only* [7] is selected, terminal 53 is read as the feedback signal and terminal 54 ignored. Feedback 1 is compared to Setpoint 1 for drive control.

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

If *Feedback 2 only* [8] is selected, terminal 54 is read as the feedback signal and terminal 53 ignored. Feedback 2 is compared to Setpoint 2 for drive control.

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 frequency converter is to reduce the output frequency in case the feedback signal increases, select *Normal* [0].
If the frequency converter is to increase the output frequency in case the feedback signal increases, select *Inverse* [1].

421 PID anti windup (PID ANTI WINDUP)

Value:

Off (DISABLE)	[0]
✯On (ENABLE)	[1]

Function:

It is possible to choose whether the process regulator is to continue regulating on a deviation even if it is not possible to increase/reduce the output frequency.
Used in *Closed loop* [1] (parameter 100).

Description of choice:

The factory setting is *On* [1], which means that the integration link is adjusted to the actual output frequency if either the current limit, the voltage limit or the max./min. frequency has been reached. The process regulator will not be engaged again, until either the deviation is zero or its prefix has changed.
Select *Off* [0] if the integrator is to continue integrating to the deviation even if it is not possible to remove the deviation by regulation.

NB!:
If *Off* [0] is selected, it will mean that when the deviation changes its prefix, the integrator will first have to integrate down from the level obtained as a result of the former error, before any change to the output frequency occurs.

422 PID start-up frequency (PID START VALUE)

Value:

f_{MIN}-f_{MAX} (parameter 201 and 202)	✯ 0 Hz

Function:

When the start signal comes, the frequency converter will react in the form of *Open loop* [0] following the ramp. Only when the programmed start frequency has been obtained, will it change over to *Closed loop* [1]. In addition, it is possible to set a frequency that corresponds to the speed at which the process normally runs, which will enable the required process conditions to be reached sooner.
Used in *Closed loop* [1] (parameter 100).

Description of choice:

Set the required start frequency.

NB!:
If the frequency converter is running at the current limit before the desired start frequency is obtained, the process regulator will not be activated. For the regulator to be activated anyway, the start frequency must be lowered to the required output frequency. This can be done during operation.

NB!:
PID start frequency is always applied in clockwise direction.

423 PID proportional gain (PID PROP. GAIN)

Value:

0.00 - 10.00	✯ 2.0

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.

NB!:
Some value other than OFF must be set or the PID will not function correctly.

---

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

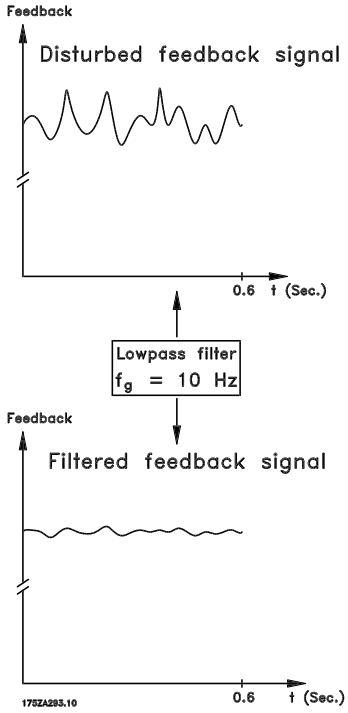
Function:

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 $(10/(2 \times \pi)) = 1.6$ 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.

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



483 Dynamic DC link compensation (DC LINK COMP.)

Value:

Off	[0]
✯On	[1]

Function:

The frequency converter includes a feature, which ensures that the output voltage is independent of any voltage fluctuation in the DC link, e.g. caused by fast fluctuation in the mains supply voltage. The benefit is a very steady torque on motor shaft (low torque ripple) under most mains conditions.

Description of choice:

In some cases this dynamic compensation can cause resonance's in the DC link and should then be disabled. Typical cases are where a line choke or a passive harmonic filter (e.g. filters AHF005/010) is mounted in the mains supply to the frequency converter to suppress harmonics. Can also occur on mains with low short circuit ratio.

500 - 566 Serial communication

Value:

All information concerning the use of RS 485 serial interface is not included in this manual. Please contact Danfoss for further information.

Please note that only the FC protocol is available in the VLT 7000 Booster.

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

■ Service functions 600-631

This parameter group contains functions such as operating data, data log and fault log.

It also has information on the nameplate data of the frequency converter.
These service functions are very useful in connection with operating and fault analysis in an installation.

600-605 Operating data

Value:

Parameter no.	Description Operating data:	Display text	Unit	Range
600	Operating hours	(OPERATING HOURS)	Hours	0 - 130,000.0
601	Hours run	(RUNNING HOURS)	Hours	0 - 130,000.0
602	kWh counter	(KWH COUNTER)	kWh	-
603	No. of cut-ins	(POWER UP'S)	Nos.	0 - 9999
604	No. of overtemps.	(OVER TEMP'S)	Nos.	0 - 9999
605	No. of overvoltages	(OVER VOLT'S)	Nos.	0 - 9999

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 frequency converter has been in operation. The value is saved every hour and when the power supply to the unit is cut off. This value cannot be reset.

Parameter 601 *Hours run:*
Gives the number of hours in which the motor has been in operation since being reset in parameter 619 *Reset of hours-run counter*. The value is saved every hour and when the power supply to the unit is cut off.

Parameter 602 *kWh counter:*
Gives the output power of the frequency converter. The calculation is based on the mean value in kWh over one hour. This value can be reset using parameter 618 *Reset of kWh counter* .

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

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

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

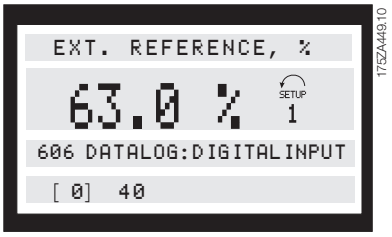
606 - 614 Data log

Value:

Parameter no.	Description Data log:	Display text	Unit	Range
606	Digital input	(LOG: DIGITAL INP)	Decimal	0 - 255
607	Control word	(LOG: BUS COMMAND)	Decimal	0 - 65535
608	Status word	(LOG: BUS STAT WD)	Decimal	0 - 65535
609	Reference	(LOG: REFERENCE)	%	0 - 100
610	Feedback	(LOG: FEEDBACK)	Par. 414	-999,999.999 - 999,999.999
611	Output frequency	(LOG: MOTOR FREQ.)	Hz	0.0 - 999.9
612	Output voltage	(LOG: MOTOR VOLT)	Volt	50 - 1000
613	Output current	(LOG: MOTOR CURR.)	Amp	0.0 - 999.9
614	DC link voltage	(LOG: DC LINK VOLT)	Volt	0.0 - 999.9

Function:

With these parameters, it is possible to see up to 20 saved values (data logs) - [1] being the most recent and [20] the oldest log. When a start command has been given, a new entry to the data log is made every 160 ms. If there is a trip or if the motor has stopped, the 20 latest data log entries will be saved and the values will be visible in the display. This is useful, 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 frequency converter. The control word read can only be changed via serial communication.
The control work is read as a decimal number which is to be converted into hex.

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.

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

615 Fault log: Error code
(F. LOG: ERROR CODE)

Value:

[Index 1-10] Error Code: 0 - 99

Function:

This parameter makes it possible to see the reason why a trip (cut-out of the frequency converter) occurs. 10 [1-10] log values are stored.
The lowest log number [1] contains the latest/most recently saved data value; the highest log number [10] contains the oldest data value.
If there is a trip on the frequency converter, 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 frequency converter is reset. This parameter cannot be selected via the serial port, RS 485.

NB!:
When the [OK] key has been activated, the reset has been carried out.

---

619 Reset of hours-run counter
(RESET RUN. HOUR)

Value:

✯No reset (DO NOT RESET)	[0]
Reset (RESET COUNTER)	[1]

Function:

Reset to zero of parameter 601 *Hours-run*.

Description of choice:

If Reset [1] has been selected and when the [OK] key is pressed, parameter 601 *Hours-run* is reset. This parameter cannot be selected via the serial port, RS 485.

NB!:
When the [OK] key has been activated, the reset has been carried out.

---

620 Operating mode
(OPERATION MODE)

Value:

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

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

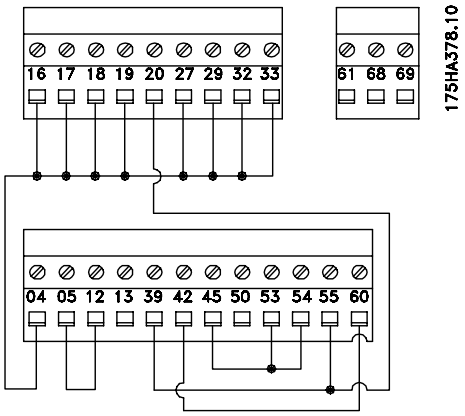
Function:

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 sig-nal on the control card and its functions - without the motor shaft running.
Control card [2] is selected if control of the analogue and digital inputs, analogue and digital outputs, relay outputs and the control voltage of +10 V is desired.
A test connector with internal connections is required for this test.
The test connector for the *Control card* [2] is set up as follows:

connect 4-16-17-18-19-27-29-32-33;
connect 5-12;
connect 39-20-55;
connect 42 - 60;
connect 45-53-54.



Use the following procedure for the control card test:
1. Select *Control card test*.
2. Cut off the mains supply and wait for the light in the display to go out.
3. Insert the test plug (see preceding column).
4. Connect to mains.
5. The frequency converter expects the [OK] key to be pressed (the test cannot be run without LCP).
6. The frequency converter automatically tests the control card.
7. Remove the test connector and press the [OK] key when the frequency converter displays "TEST COMPLETED".
8. Parameter 620 *Operating mode* is automatically set to *Normal function*.

If the control card test fails, the frequency conver-ter 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 615-6171 *Fault log*.

Procedure for initialisation:

1. Select *Initialisation*.
2. Press the [OK] key.
3. Cut off the mains supply and wait for the light in the display to go out.
4. Connect to mains.
5. Initialisation of all parameters will be carried out in all Setups with the exception of parameters 500 *Address*, 501 *Baud rate*, 600-605 *Operating data* and 615-617 *Fault log*.

Manual initialisation is another option. (See *Manual initialisation*).

621 - 631 Nameplate

Value:

Parameter No.	Description Nameplate	Display text
621	Unit type	(DRIVE TYPE)
622	Power component	(POWER SECTION)
623	VLT ordering no.	(ORDERING NO)
624	Software version no.	(SOFTWARE VERSION)
625	LCP identification no.	(LCP ID NO.)
626	Database identification no.	(PARAM DB ID)
627	Power component identification no.	(POWER UNIT DB ID)
628	Application option type	(APPLIC. OPTION)
629	Application option ordering no.	(APPLIC. ORDER NO)
630	Communication option type	(COM. OPTION)
631	Communication option ordering no.	(COM. ORDER NO)

Function:

The main data for the unit can be read from parameters 621 to 631 *Nameplate* via the display or the serial communication port.

Description of choice:

Parameter 621 *Nameplate: Unit type:* VLT type gives the unit size and mains voltage. Example: VLT 6008 380-460 V.

Parameter 622 *Nameplate: Power component:* This gives the type of power card fitted to the frequency converter. Example: STANDARD.

Parameter 623 *Nameplate: VLT ordering no.:* This gives the ordering number for the VLT type in question. Example: 1757805.

Parameter 624 *Nameplate: Software version no.*: This gives the present software version number of the unit. Example: V 1.00.

Parameter 625 *Nameplate: LCP identification no.:* This gives the identification number of the LCP of the unit. Example: ID 1.42 2 kB.

Parameter 626 *Nameplate: Database identification no.*: This gives the identification number of the software's database. Example: ID 1.14.

Parameter 627 *Nameplate: Power component: identification no.:* This gives the identification number of the database of the unit. Example: ID 1.15.

Parameter 628 *Nameplate: Application option type:* This gives the type of application options fitted with the frequency converter.

Parameter 629 *Application option Nameplate: ordering no.:* This gives the ordering number for the application op-tion.

Parameter 630 *Nameplate: Communication option type:* This gives the type of communication options fitted with theT frequency converter.

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

■ Cascade Controller Settings

■ Operation modes

The following table gives an overview of the 14 available modes in the VLT 7000 Booster. Below the table a description of the different terms is given.

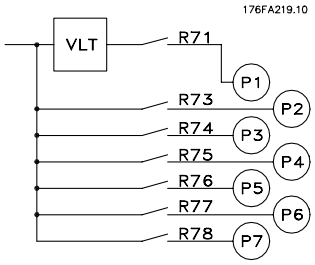
Mode No	Control type	AUX pump available?	Staging and destaging order	Default value for digital input on terminal 18 (DI 18)	No. of pumps incl. AUX pump
1	Fixed lead pump control	No	FILO	DI 18: (NO OPERATION)	2 - 7
2		No	FILO	DI 18: (START)	2 - 7
3		No	LRHIMRHO	DI 18: (NO OPERATION)	2 - 7
4		No	LRHIMRHO	DI 18: (START)	2 - 7
5		Yes - R78	FILO	DI 18: (NO OPERATION)	2 - 7
6		Yes - R78	FILO	DI 18: (START)	2 - 7
7		Yes - R78	LRHIMRHO	DI 18: (NO OPERATION)	2 - 7
8		Yes - R78	LRHIMRHO	DI 18: (START)	2 - 7
9	Alternating lead pump control	No	LRHIMRHO	DI 18: (NO OPERATION)	2 - 4
10		No	LRHIMRHO	DI 18: (START)	2 - 4
11		Yes - R78	LRHIMRHO	DI 18: (NO OPERATION)	2 - 4
12		Yes - R78	LRHIMRHO	DI 18: (START)	2 - 4
13		Yes - CCR	LRHIMRHO	DI 18: (NO OPERATION)	2 - 5
14		Yes - CCR	LRHIMRHO	DI 18: (START)	2 - 5

■ Mode no

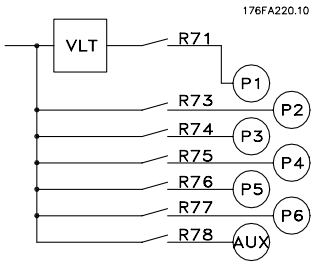
The mode no is the mode number which is to be selected in the VLT menu, please refer to parameter settings.

■ Fixed lead pump control (mode 1-8)

When choosing this control type, the VLT will be fixed to one pump (pump no. 1) - the lead pump, and the remaining pumps (the lag pumps) will be operated ON/OFF. Up to 7 pumps can be connected.



Mode 1-4

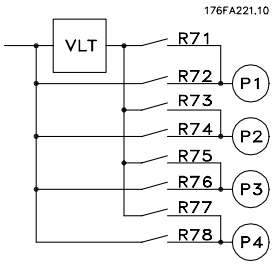


Mode 5-8

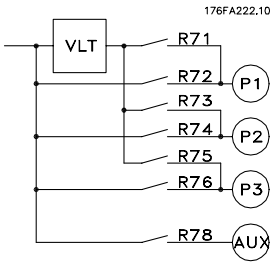
P1, P2, P3,... are the pump numbers, that can also be seen in the display of the VLT. R71, R72,.... are the relays switching on and off the different pumps. Please notice that the relay numbers are not unique, as some of the terminals on the VLT 7000 Cascade Controller Card have the same numbers. The relay numbers are only used to describe the functionality in the manual. The relay numbers are not used in the display or in the wiring diagrams.

■ Alternating lead pump control (Mode 9-14)

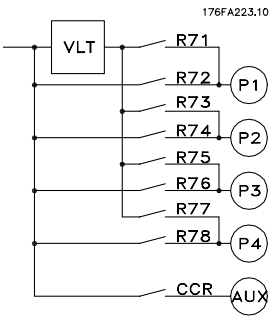
This control type makes it possible to circle the VLT between all the pumps in the system. Whenever more pump capacity is needed, the VLT will switch the lead pump to mains, and start up a new pump. Consequently there will not be a fixed lead pump in this control type.



Mode 9-10



Mode 11-12



Mode 13-14

As to pumps and relays, the same applies as described above.

Please observe: If the pressure demand never exceeds one pumps capacity, there will no changing of the lead pump, as this only happens during staging.

■ AUX pump

At low flow demand, it can be an advantage to switch on a small pump, instead of running the lead pump at low speed. This pump is called an auxiliary pump (AUX pump). As can be seen in the scheme above, the AUX pump can be controlled by a relay on the cascade controller card (Relay R78) or by the control card relay (CCR).

■ **Staging and destaging order**

Here the staging and destaging order of the pumps is chosen. Staging means switching on an additional pump in order maintain pressure. Destaging means swithing off a pump in order to maintain pressure.

Please notice: In modes with higher capacity pumps (200% or 300%) adding capacity doesn't necessarily mean switching on an additional pump. Nevertheless the term "pump" is being used no matter how the capacity of the system will be increased or decreased.

■ **FILO: First in, last out**

If a pump is to be added, the order is as follows:

P1 > P2 > P3 > P4 > P5 > P6 > P7

This means, that the pump, which is not running and has the lowest number, will be staged. If a pump is to be removed, the destaging order is as follows:

P7 > P6 > P5 > P4 > P3 > P2 > P1

This means, that the pump, which is running and has the highest number, will be destaged.

■ **LRHIMRHO: Least-running-hours-in, most running-hours out**

The advantage of this type, is the averaging of pump running hours. Every pump in the system, will have a timer in the VLT to count the running hours. This is used to select the right pump when staging and destaging, so that all pumps are equally worn. Please notice, that in modes 3,4 and 7,8 there is a fixed lead pump, which will always be running at demand.

If a pump is to be staged, the order is as follows:
Among the pumps that are not running, the one with the least running hours is staged.

If apump is to be destaged, the order is as follows:
Among the pumps that are running, the one with highest number of running hours will be destaged.

The lead pump will not be destaged, even if it should have the highest number.

■ **Default value for digital input on terminal 18 (DI18)**

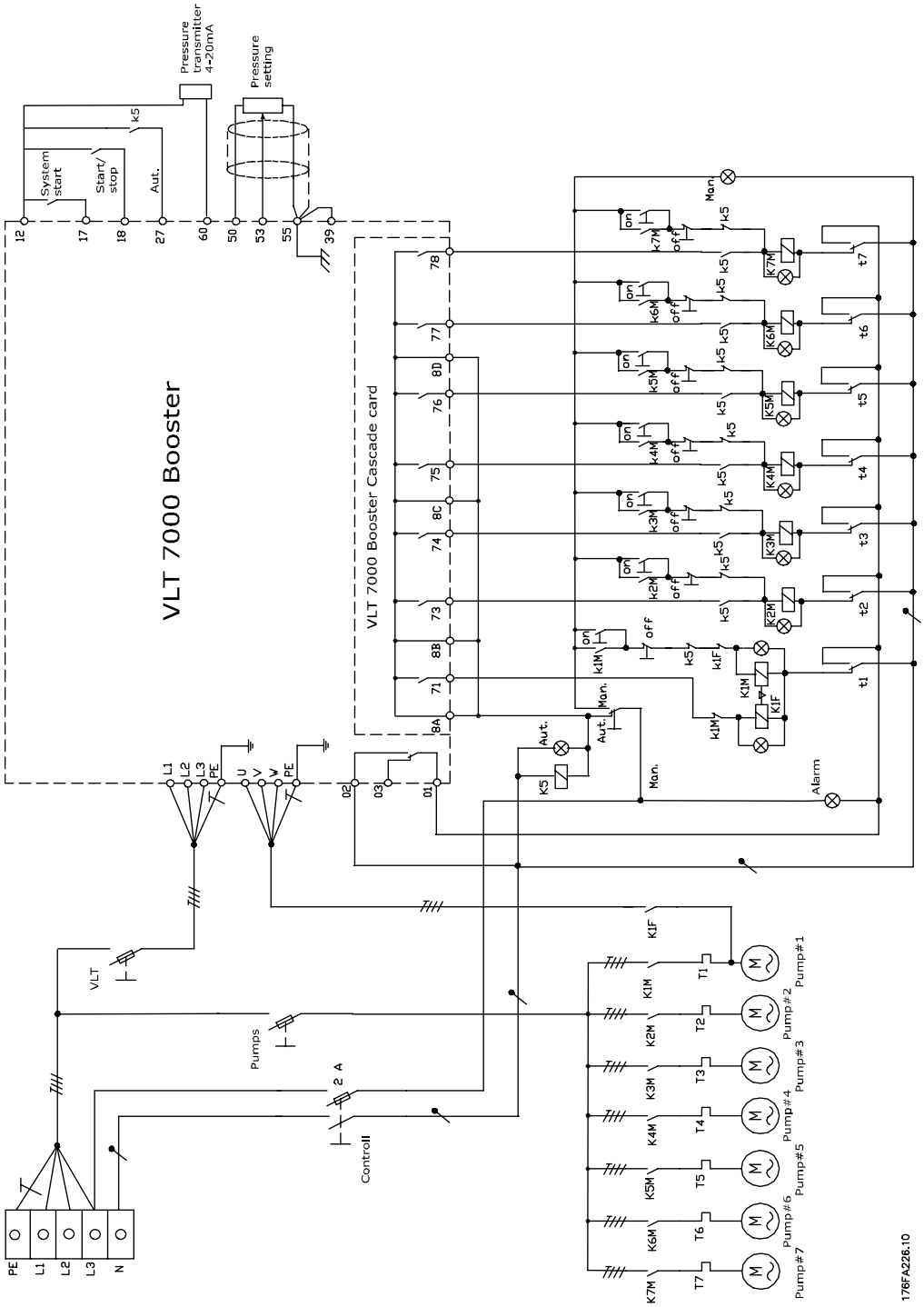
A digital input (high) on terminal 18, will either have (NO OPERATION) as default, which means nothing will happen, or have (START) as default. This start command will only start the lead pump. Please refer to Start and stop functionality for further explanation.

■ **No. of pumps, excl. AUX pump**

The minimum and maximum number of pumps that can be controlled by the different modes.

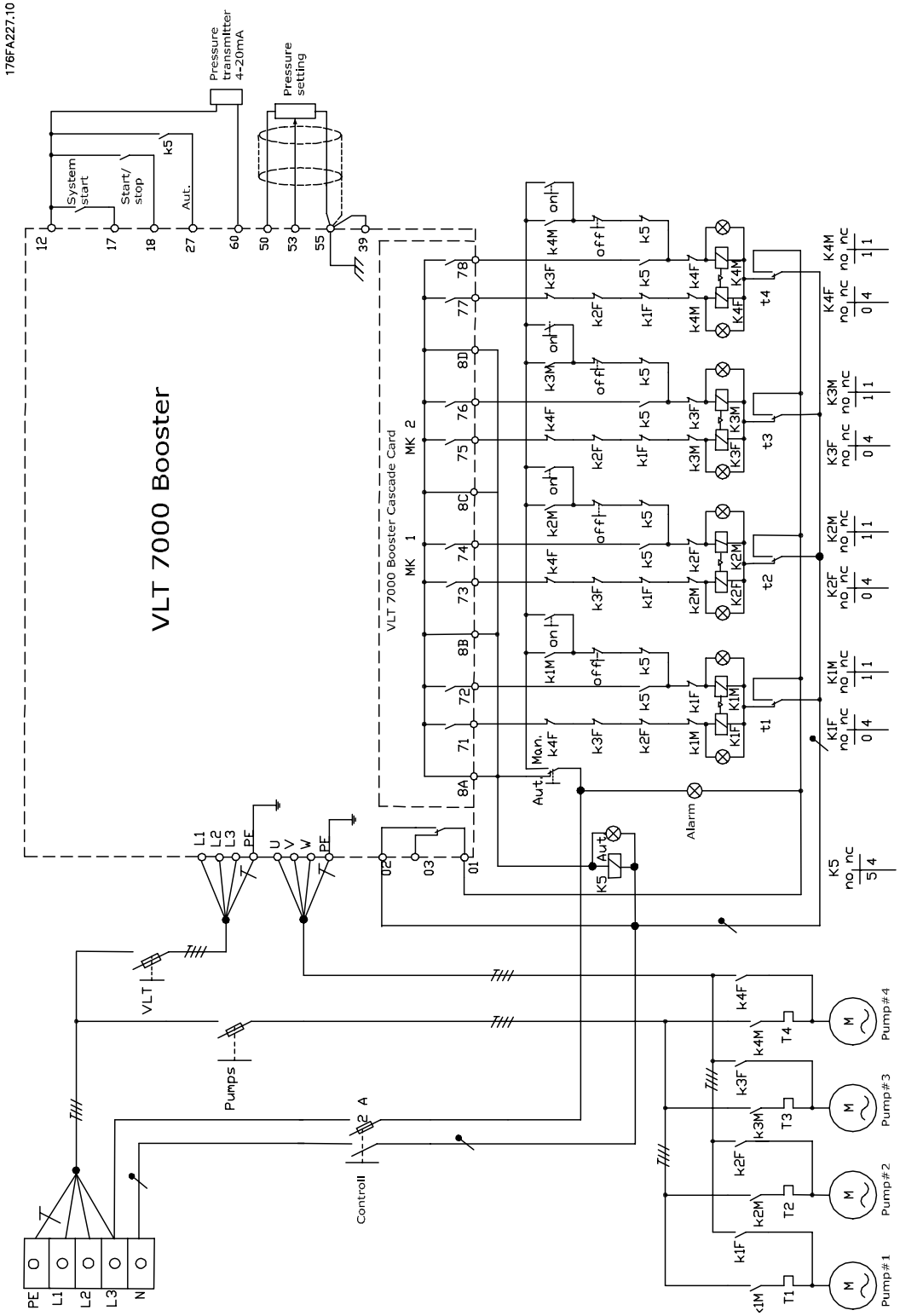
■ Wiring diagram mode 1-8

Please notice, that the DI18 functionality (terminal 18) depends on the mode selection. The diagram is specifically made for modes 2, 4, 6 and 8.



■ Wiring diagram modes 9-14

Please notice, that the DI18 functionality (terminal 18) depends on the mode selection. The diagram is specifically made for modes 10, 12 and 14.



■ Parameter settings

At the end of the Manual you will find an overview of the parameters. Parameters 700-708 always have to be set no matter what operating mode is selected in parameter 700.

■ Quick menu 17 Par. 700 Cascade Mode

Par. 700 Cascade Mode
(CASCADE MODE)

Value:

1-14 ✯ Mode no. 1

Function:

The cascade mode is chosen. Please refer to the overview table for further explanation of the different modes.

Description of choice:

Select mode number.

■ Quick menu 18 Par. 701 Pump combination

Par. 701 Pump combination
(PUMP COMBINATION)

Value:

Fixed lead pump control ✯ R73@100%
Alternating lead pump control ✯ 2 PUMPS: R71-R74@100%

Function:

The combinations of pumps and their rated capacities are selected in this parameter. In standard mode, additional pumps can be either 100%, 200% or 300% capacity relative to the lead pump. In Alternating lead pump control only 100% capacity pumps can be used.

Description of choice:

Select the pump combination and capacities from the choices offered. Selections #1-10 are only for Fixed lead pump control and #11-13 for Alternating lead pump control.

#	Display option	100% Capacity	200% Capacity	300%Capacity
1	R73 @100% R74 @200%	1 pump controlled by relay R73	1 pump controlled by relay R74	
2	R73 100% R74,75 200%	1 pump controlled by relay R73	2 pumps controlled by relay R74, R75	
3	R73,74 100% R75 300%	2 pumps controlled by relay R73, R74		1 pump controlled by relay R75
4	R73,74 100 75,76 300	2 pumps controlled by relay R73, R74		2 pump controlled by relay R75, R76
5	R73 @100%	1 pump controlled by relay R73		
6	R73, R74 @100%	2 pumps controlled by relay R73, R74		
7	R73-R75 @100%	3 pumps controlled by relay R73, R74, R75		
8	R73-R76 @100%	4 pumps controlled by relay R73, R74, R75, R76		
9	R73-R77 @100%	5 pumps controlled by relay R73, R74, R75, R76, R77		
10	R73-R78 @100%	6 pumps controlled by relay R73, R74, R75, R76, R77, R78		
11	2 PUMPS:R71-R74 100%	2 pumps controlled by relay R71, R72, R73, R74		
12	3 PUMPS:R71-R76 100%	3 pumps controlled by relay R71, R72, R73, R74, R75, R76		
13	4 PUMPS:R71-R78 100	4 pumps controlled by relay R71, R72, R73, R74, R75, R76, R77, R78		

The lead pump is always a 100% capacity pump and is always part of the system. The lead pump is not mentioned in the table, for the choices (# 1-10) related to Fixed lead pump control.

■ **Quick menu 19 Par. 702 Staging bandwidth %**

Par. 702 Staging bandwidth %

(STAGING BANDW%)

Value:

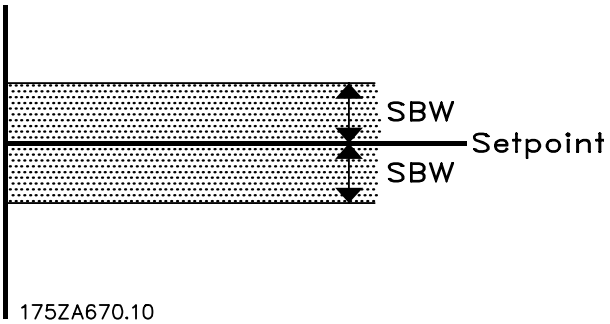
1 - 100% (100% = Off) ✯ 5%

Function:

In cascade control systems, to avoid frequent switching of fixed speed pumps, the desired system pressure is typically kept within a bandwidth rather than at a constant level. The Staging bandwidth (SBW) is programmed as a percentage of the setpoint (desired pressure). For example, if the setpoint is 5 bar and the SBW set at 10%, a system pressure between 4.5 and 5.5 bar is tolerated. No staging or destaging will occur within this bandwidth.

Description of choice:

Set the staging bandwidth percentage to accommodate system pressure fluctuation.



■ **Quick menu 20 Par. 703 SBW Destage delay**

Par. 703 SBW Destage delay

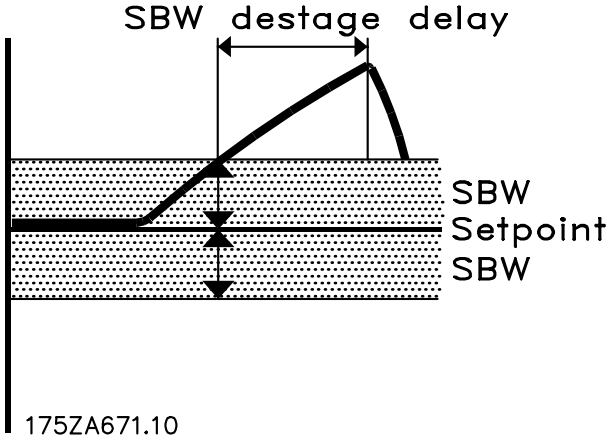
(SBW DESTAG DELAY)

Value:

0 - 3000 sec. ✯ 10 sec.

Function:

Immediate destaging of a fixed speed pump is not desirable when a momentary pressure increase in the system that exceeds the Staging bandwidth (SBW) occur. Destaging is delayed by the length of time programmed, and happens only when min. frequency is reached. If the pressure decreases to within the SBW before the timer has elapsed, the timer is reset.



Description of choice:

Set the SBW destage delay. A delay time of 10 seconds (factory setting) is sufficient in most systems. When encountering frequent staging, increase the delay time.

■ **Quick menu 21 Par. 704 SBW Stage delay**

Par. 704 SBW Stage delay

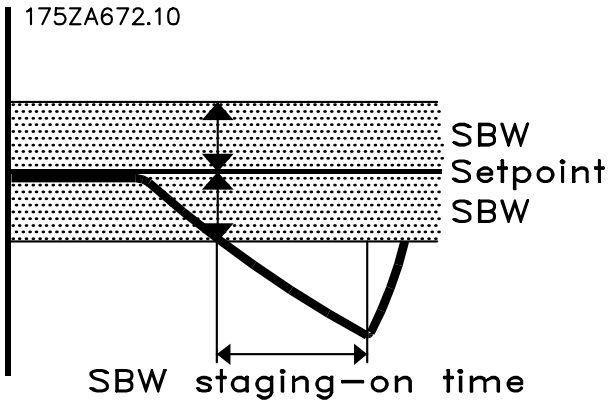
(SBW STAGE DELAY)

Value:

0 - 3000 sec. ✯ 10 sec.

Function:

Immediate staging of a fixed speed pump is not desirable when a momentary pressure drop in the system that exceeds the Staging bandwidth (SBW) occur. Staging on is delayed by the length of time programmed and happens only when the speed is at max. frequency. If the pressure increases to within the SBW before the timer has elapsed, the timer is reset.



Description of choice:

Set the SBW stage delay. A delay time of 10 seconds (factory setting) is sufficient in most systems. When encountering frequent staging, increase the delay.

■ **Quick menu 22 Par. 705 Override bandwidth**

Par. 705 Override bandwidth

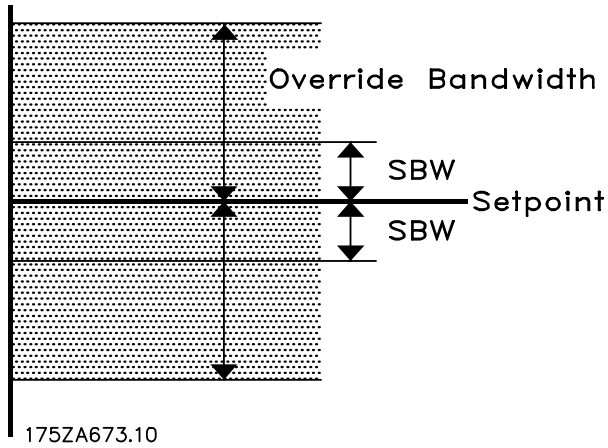
(OVERRIDE BANDW.%)

Value:

2 - 100% (100 = Off) ✯ 100% = Off

Function:

When a large and quick change in the system demand (such as a sudden water demand), the system pressure rapidly changes and an immediate staging or destaging of a fixed speed pump becomes necessary to match the requirement. The Override bandwidth (OBW) is programmed to override the staging/destaging timer for immediate response. The Override bandwidth is a percentage of the setpoint and defines the feedback (pressure) at which the timers (set in parameters 703, 704) are overridden. For example, if the setpoint is 5 bar and the override is set to 20%, the low limit is 4 bar and the high limit 6 bar.



Description of choice:

The OBW must always be programmed to a higher value than the staging bandwidth (SBW) set in

parameter 702. Setting the OBW too close to the SBW could defeat the purpose with frequent staging at momentary pressure changes. Setting the OBW too high might lead to unacceptably high or low pressure in the system while the SBW timers are running. The value can be optimized with increased familiarity with the system. See parameter 706, Override Bandwidth Timer.

Commissioning the Cascade Controller:
To avoid unintended staging during the commissioning phase and fine tuning of the controller, initially leave the OBW at the factory setting of 100%. When the fine tuning is completed, the OBW should be set to the desired value. A good initial value may be 10%.

■ Quick menu 23 Par. 706 Override Bandwidth timer

Par. 706 Override Bandwidth timer
(OVERRIDE TIMER)

Value:

0 - 300 sec. ✯ 10%

Function:

Staging a fixed speed pump creates a momentary pressure peak in the system, which might exceed the Override bandwidth (OBW). It is not desirable to destage a pump in response to a staging pressure peak. The Override bandwidth timer can be programmed to prevent staging or destaging until the system pressure has stabilized and normal control established.

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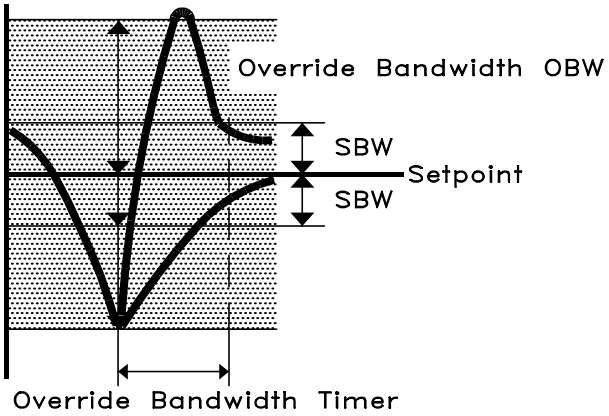


Description of choice:

Set the timer to a value that allows the system to stabilize after staging. The 10 second factory setting is appropriate in most applications. In highly dynamic systems, a shorter time might be desirable.

■ Quick menu 24 Par. 707 Destage by timer

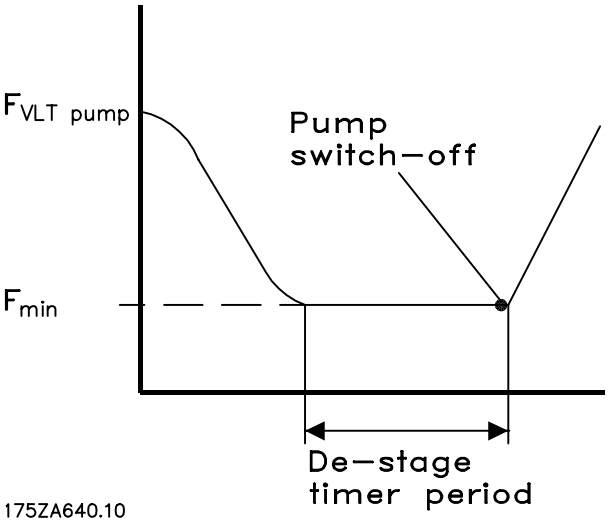
Par. 707 Destage by timer
(DESTAGE BY TIMER)

Value:

0 - 300 sec. (301 = Off) ✯ OFF

Function:

The timer starts when the adjustable speed pump is running at minimum speed with one or more constant speed pumps in operation and system requirements satisfied. In this situation, the lead pump contributes little to the system. When the programmed value of the timer expires, a fixed speed pump is destaged and the lead pump accelerated to maintain system requirement. This saves energy and avoids dead head water circulation within the lead pump.



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Description of choice:

Set the destage timer interval. When sleep mode is activated, ensure the interval is set lower or equal to the value of the sleep mode timer (parameter 711).

NB!:
Sleep mode activates when the adjustable speed pump is the only pump running. To turn off the destage timer, turn off sleep mode first. Set parameter 711, Sleep Mode to OFF, then parameter 707, Destage by Timer to OFF

■ Staging and destaging of fixed speed pumps

The parameters 708-709 are only to be set, when mode 1-8 is selected.

■ Quick menu 25 Par. 708 Staging frequency

Par. 708 Staging frequency

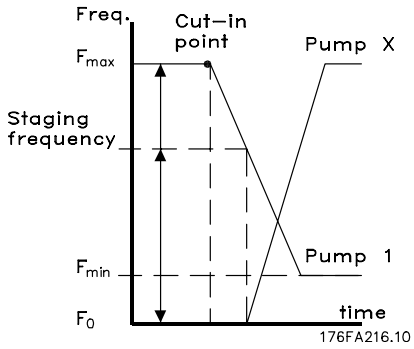
(STAGING FREQ)

Value:

0 - 100% of F_{max} ✯ 90%

Function:

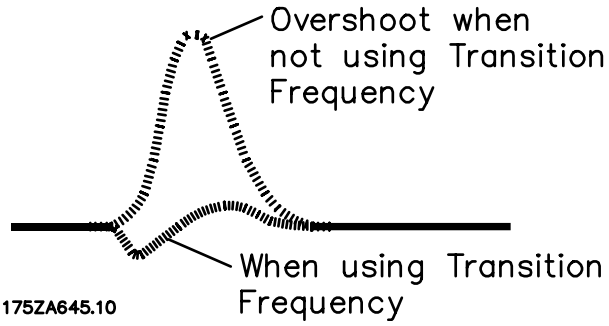
The adjustable speed pump typically runs at maximum speed when staging on an additional fixed speed pump to match the system demand. The instant effect of the fixed speed pump (Pump X in the figure) creates a momentary over-pressurization until the lead pump (Pump 1 in the figure) decelerates. This is undesirable in most situations. To avoid this, the drive can be programmed to decelerate to a Staging frequency before starting the fixed speed pump. The Cut-in point shows the start of the destaging process, which is determined by the Staging bandwidth and Override bandwidth, par. 702-707.



NB!:
Ensure that the staging frequency is set within the Minimum and Maximum frequency set in parameters 201 and 202.

Description of choice:

Adjust the Staging frequency to the best compromise to prevent momentary pressure overshoot and a pressure drop during transition. A very low value for the Staging frequency might cause the check valve at the discharge of the lead pump to close during the transition, which could add pressure in the system. Ensure that the Staging frequency setting allows the check valve to remain open.



■ Quick menu 26 Par. 709 Destaging frequency

Par. 709 Destaging frequency

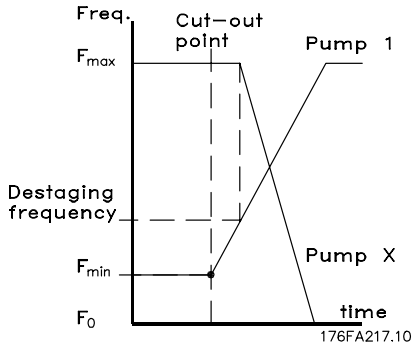
(DESTAGING FREQ)

Value:

0 - 100% of F_{max} ✯ 50%

Function:

The opposite process occurs during destaging. The lead pump (pump 1 in the figure) typically runs at minimum speed when destaging occurs. Turning off a fixed speed pump (pump X in the figure) creates a momentary pressure drop until the lead pump decelerates. To avoid this, the drive will accelerate to a Destaging frequency before turning off the fixed speed pump.



Description of choice:

Adjust the Destaging frequency to the best compromise to prevent momentary pressure drop and over-pressurization during transition. A very low value for the destaging frequency might cause the check valve at the discharge of the lead pump to close during the transition, which could add pressure in the system. Ensure that the Destaging frequency setting allows the check valve to remain open.

■ Staging and destaging of pumps in mode 9-14

Parameter 710 is only to be set, when operating mode 9-14 is selected.

The adjustable speed pump typically runs at maximum speed when staging on an additional fixed speed pump to match the system demand. When staging on another pump, the VLT will coast and after a time delay set i par. 710, the pump will be switched to mains. The VLT will finally bring the next pump in line up in speed.

■ Quick menu 27 Par. 710 Delay before running on mains

Par. 710 Delay before running on mains

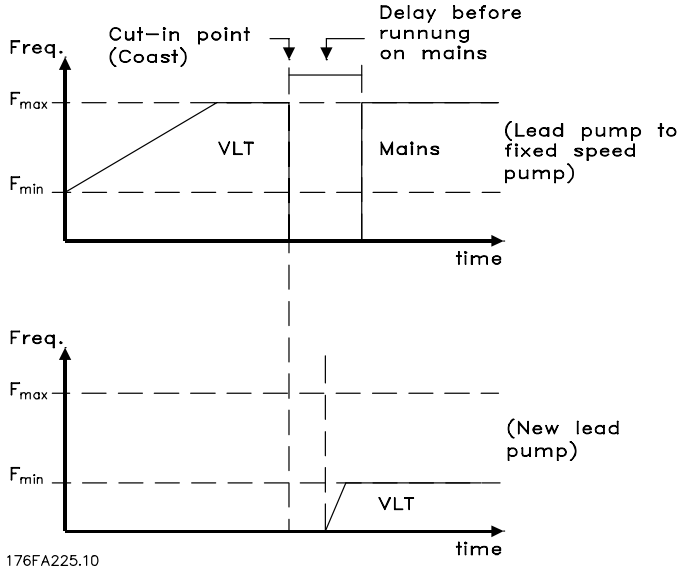
(DELAY BEF. MAINS)

Value:

100 ms - 2000 ms ✯ 500 ms

Function:

Time delay to ensure sufficient de-magnetisation of the motor before switching it to mains.



Description of choice:

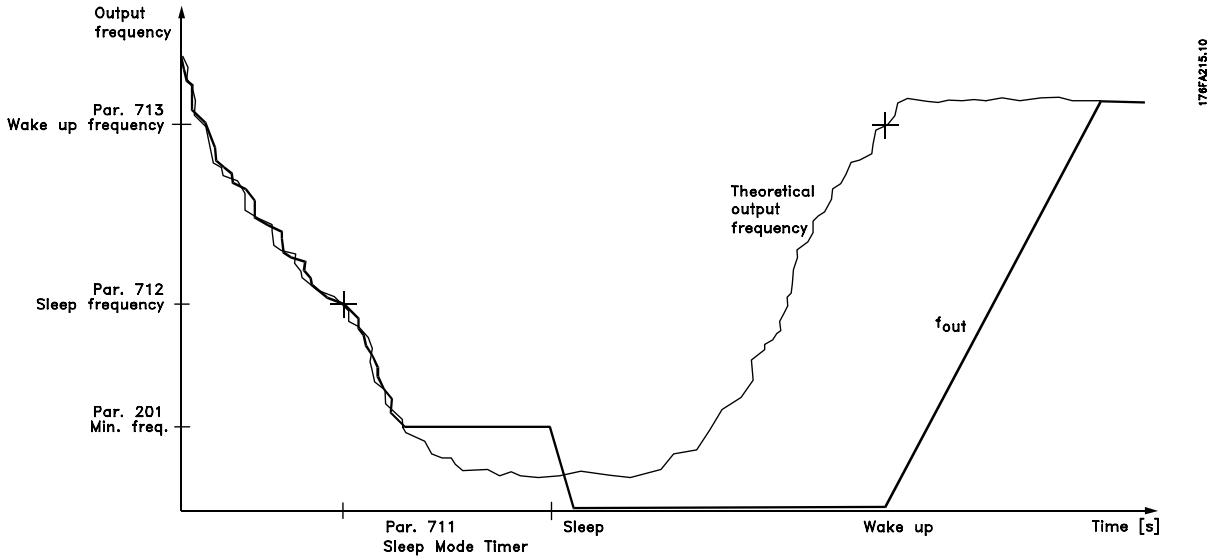
Set the delay before running on mains.

NB!:
The destaging of a pump in any of the modes 9-14 is done in the same way as for modes 1-8, please refer to quick menu 26 parameter 709.

■ Auxiliary pump/sleep mode

As can be seen in the section *Operation Modes*, there is a possibility for using an AUX pump. The control of the auxiliary pump is done with the sleep-mode functionality. This basically means, that if a mode without AUX pump is selected, the sleep-mode function will turn off the lead pump if flow demand gets low.

If a mode with AUX pump is selected the sleep-mode function will turn on the auxiliary pump and turn off the lead pump if flow demand gets low.



■ Quick menu 28 Par. 711 Sleep/AUX timer

Par. 711 Sleep/AUX timer
(SLEEP/AUX TIMER)

Value:

0 - 300 sec. (301 sec. = OFF)
With AUX pump ✯ 150 sec.
Without AUX pump ✯ OFF

Function:

In this parameter the Sleep mode/AUX pump functionality is activitated. The timer starts when the theoretical output frequency drops below the frequency set in parameter 712 Sleep frequency. When the time set in the timer has expired, the lead pump will ramp to stop via parameter 207 Ramp down time. The lead pump will restart, when the theoretical output frequency exceeds the frequency in parameter 713 Wake up frequency.

The theoretical output frequency can be monitored in the LCP. Please refer to par. 007, where the readout can be set to *PID output*.

Description of choice:

Select OFF if the function is not wanted. Set the threshold value that is to activate Sleep mode after the output frequency has fallen below parameter 712 Sleep frequency.

■ Quick menu 29 Par. 712 Sleep/AUX frequency

Par. 712 Sleep/AUX frequency
(SLEEP/AUX FREQ)

Value:

Par. 201 F_{MIN} - par. 713 Wake up frequency ✯ 20 Hz

Function:

When the output frequency falls below the preset value, the timer will start the time count set in parameter 711 Sleep/AUX timer. The present output frequency will follow the theoretical output frequency until fmin is reached.

Description of choice:

Set the required frequency.

■ **Quick Menu 30 Par. 713 Wake up/disable aux - frequency**

Par. 713 Wake up/disable aux - frequency
(WAKEUP/DIS.AUX F)

Value:

Par. 712 Sleep frequency - par. 202 F_{max} ✯ 50 Hz

Function:

When the theoretical output frequency exceeds the preset value, the lead pump restarts, thereby switching of the AUX pump if a such is being used.

Description of choice:

Set the required frequency.

■ **Quick Menu 31 Par. 714 Boost setpoint**

Par. 714 Boost setpoint
(BOOST SETPOINT)

Value:

0 - 200% ✯ 100% of setpoint

Function:

In systems with constant pressure control, it is advantageous to increase the pressure in the system before the lead pump stops. This helps to avoid frequent starting and stopping, e.g. in the case of leaks in the water supply system.

Description of choice:

Set the required Boost setpoint as a percentage of the resulting reference under normal operation. 100% corresponds to the reference without boost (supplement).

■ Virtual control curve

The purpose of the Virtual Control Curve is to compensate for additional friction loss in the pipe work with increasing flow rate. When a stage is added to the system, the actual set-point (head) is increased. When a stage is removed from the system, the set-point is decreased.

The system automatically calculates virtual set-points for each stage number. The setpoints 1 and 2 (par. 418 and 419) defines the lowest and the highest virtual set-points. The number of stages available, due to pump combination, is part of the calculation, that defines the virtual set-points.

When the system is running, the number of stages running determines which virtual set-points to use. The virtual set-points develop quadratic. See the following example.

■ Example

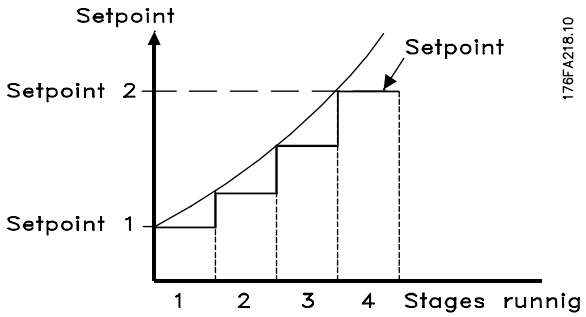
If the system consists of 4 100% pumps totally, 4 stages are available. Setpoint 1 is set to 50 hPa and setpoint 2 is 80 hPa.

If 1 stage is running, the setpoint is 50 hPa.
If 2 stages are running, the setpoint is 56 hPa.
If 3 stages are running, the setpoint is 66 hPa.
If 4 stages are running, the setpoint is 80 hPa.

The calculated virtual setpoints can be read from parameter 725.

The virtual control curve is set as default in par. 417 *Feedback function*.

Please refer to par. 417 if another feedback function is desired.



■ Quick Menu 32 Par. 418 setpoint 1

Par. 418 Setpoint 1

(SETPOINT 1)

Value:

Par. 413 Feedback Min.
- Par. 414 Feedback Max. ✯ 0.000

Function:

The default feedback process is used when a pressure feedback signal is measured at the discharge of the pumps. The cascade controller uses the feedback to estimate the setpoint required at various rates of flow. All other reference signals are ignored. Setpoint 1 is the minimum pressure required when the system is running with only the lead pump running at full speed.

Description of choice:

Set setpoint 1.

■ Quick Menu 33 Par. 419 setpoint 2

Par. 419 Setpoint 2

(SETPOINT 2)

Value:

Par. 413 Feedback Min.
- Par. 414 Feedback Max ✯ 0.000

Function:

The default feedback process is used when a pressure feedback signal is measured at the discharge of the pumps. The cascade controller uses the feedback to estimate the setpoint required at various rates of flow. All other reference signals are ignored. Setpoint 2 is the maximum pressure required when the system is running with all pumps at full capacity. A theoretical value calculates pressure loss in the system under maximum load. The controller adjusts the loading based upon the number of pumps in operation.

Description of choice:

Set setpoint 2.

■ Start and stop functionality

Two overall types of start/stop functions are provided by the cascade controller option, one type quickly stops all pumps while the other stages off the pumps in a sequence, allowing for a controlled pressure stop.

Do not use these functions as emergency stops. Some functions do not turn off all pumps!

The Start and Stop functions are described in the table below and are valid for all modes available. In a sequenced stop, there is a one ramp-down time delay between each destaging of the pumps.

Type	Terminal and parameter	Description
System stop and start via LCP	STOP/OFF key AUTO/START key	The lead pump decelerates to a stop and all constant speed pumps are stopped at a time.
Start of lead pump via LCP	HAND/START key	Only the lead pump is running. If more pumps are running, they are destaged with a controlled stop.
System start and stop	Terminal 17 - parameter 301 - (SYSTEM START)	At digital input low, the lead pump decelerates to a stop, and then provides sequenced stop for all constant speed pumps.
Stop and start of lead-pump only	Terminal 18 - parameter 302 - (START)	At digital input low, the lead pump decelerates to a stop. The constant speed pumps continue to operate normally controlled by the cascade controller in the VLT.
Fast system stop	Terminal 27 - parameter 304 - (COAST INVERSE)	At digital input low, the constant speed pumps stop immediately. The lead pump coasts to a stop.

When only the lead pump is stopped, the cascade controller will try to maintain the pressure in the system, by staging and destaging the remaining pumps.

NB!:
Should the drive trip for any reason, the cascade controller can continue operation with the remaining pumps. Only at live zero where Parameter 318 Live zero functionality is set to (STOP) or (STOP AND TRIP) or at Warning 8 (DC UNDERVOLTAGE), all pumps will stop.

It is also possible to stop every single pump in the system manually e.g. for service. Please read below.

NB!:
Please note that par. 719 and 720 are indexed parameters.

■ Quick Menu 34 Par. 719 Pump enable

Par. 719 Pump enable
(PUMP ENABLE)

Value:

0
1 ✯ 1

Function:

If a pump is to be removed from the system due to repairs or service this can be done by disabling the specific pump. The system will continue without any interruption, and the pressure will be controlled as good as possible by the remaining pumps. Disabling a pump will lead to an immediate destaging of the pump, and it will not be staged on until it is enabled again.

Please note, that the lead pump cannot be disabled. It is not possible to disable pumps in pump combination 1-4 (par. 701).

1: Enable
0: Disable

Description of choice:

Disable the pump or pumps that needs to be taken out of operation. Please be aware that removing pumps can make it impossible for the remaining pumps to keep up the system pressure at the desired level.

■ Quick Menu 35 Par. 720 Pump running hours

Par. 720 Pump running hours

(PUMP RUN. HOURS)

Value:

0.0 hours - 999999.9 hours

Function:

As described in the beginning of this document, it is possible to choose modes, where staging and destaging is determined by the running hours of the pumps (LRHIMRHO). In this parameter it is possible to adjust the recorded running hours.

Please note, that the AUX pump will be no. 8 in the display of the LCP, even if it is pump no. 7 in the system.

Description of choice:

Adjust the running hours of the pumps.

■ Feedback transmitter wiring

Terminal 12 and 13 of the VLT provide access to a 24 VDC, 200 mA power supply. This can be used to power remote transmitters, so an external power supply is generally not needed. The diagrams below show how to wire two- and three-wire transmitters.

Single 4 - 20 mA feedback transmitter connection (default setting)

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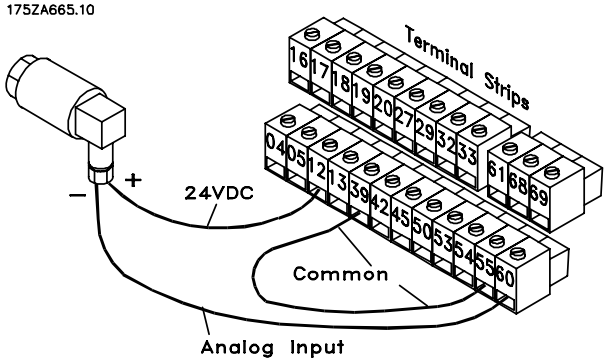

Programming:

Parameter Number	Parameter Description	Parameter Value
415	Ref./FDBK UNIT	Process unit
413	MIN. FEEDBACK	Transmitter low limit
414	MAX. FEEDBACK	Transmitter high limit
308	AI [V] 53 FUNCT.	NO OPERATION
311	AI [V] 54 FUNCT.	NO OPERATION
314	AI [mA] 60 FUNCT.	FEEDBACK
315	AI 60 SCALE LOW	4 mA
316	AI 60 SCALE HIGH	20 mA

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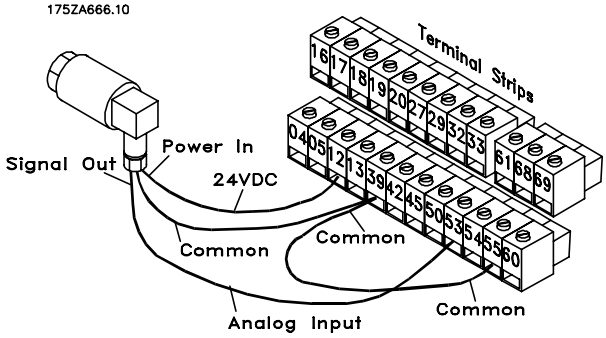
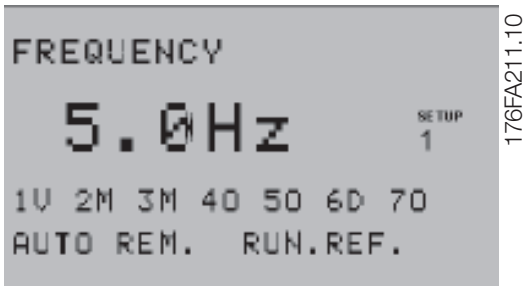


Programming:

Parameter Number	Parameter Description	Parameter Value
415	Ref./FDBK UNIT	Process unit
413	MIN. FEEDBACK	Transmitter low limit
414	MAX. FEEDBACK	Transmitter high limit
308	AI [V] 53 FUNCT.	FEEDBACK
309	AI 53 SCALE LOW	0 V
310	AI 53 SCALE HIGH	10 V
314	AI [mA] 60 FUNCT	NO FUNCTION

In the display line 3 in the LCP the user is given information on which pumps are running and which one is the lead pump.

If the system contains more than 4 pumps the status is like in the below example which shows a system with fixed lead pump containing 7 pumps in total. That means 1-7 indicates the pump numbers.



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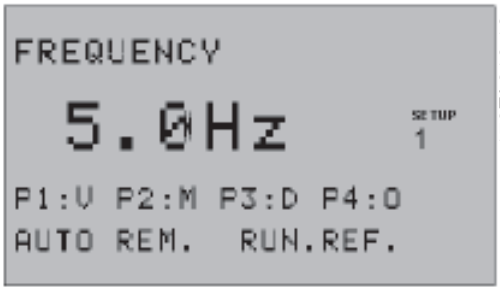
When up to 4 pumps are available, the pump number is also shown:



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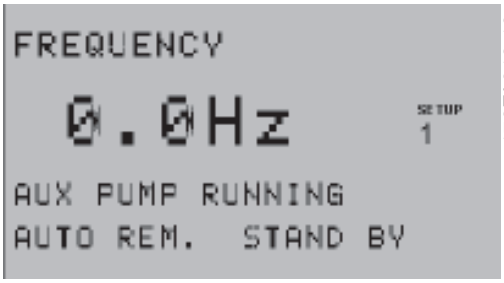
The letters shown after the pump numbers have the following meaning:

- V: Lead pump (running on VLT)
- M: Running on mains
- O: Off
- D: Disabled (Parameter 719 Pump enable)

When running with AUX pump, the status will be given as shown below.



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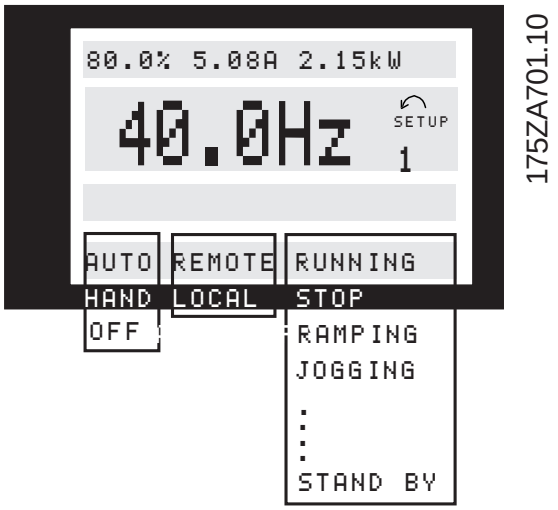
■ Status messages

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 frequency converter.
The centre part of the status line indicates the active reference.
The last part of the status line gives the present status, e.g. "Running", "Stop" or "Stand by".



Auto mode (AUTO)
The frequency converter is in Auto mode, i.e. control is carried out via the control terminals and/or serial communication. See also *Auto start.*

Hand mode (HAND)
The frequency converter 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 frequency converter is trying to avoid a trip from overvoltage by increasing its output frequency.

Sleep Boost (SLEEP .BST)
The boost function in parameter 406 *Boost setpoint* is enabled. This function is only possible in *Closed loop* operation.

Sleep mode (SLEEP)
The energy saving function in parameter 403 *Sleep mode timer* is enabled. This means that at present the motor has stopped, but that it will restart automatically when required.

Start delay (START DEL)
A start delay time has been programmed i parameter 111 *Start delay*. When the delay has passed, the output frequency will start by ramping up to the reference.

Run request (RUN REQ.)
A start command has been given, but the motor will be stopped until a Run permissive signal is received via a digital input.

Jogging (JOG)
Jog has been enabled via a digital input or via serial communication.

Jog request (JOG REQ.)
A JOG command has been given, but the motor will remain stopped until a *Run permissive* signal is received via a digital input.

Freeze output (FRZ.OUT.)
Freeze output has been enabled via a digital input.

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

Stand by (STANDBY)
The frequency converter is able to start the motor when a start command is received.

Stop (STOP)
The motor has been stopped via a stop signal from a digital input, [OFF/STOP]-buttom or serial communication.

DC stop (DC STOP)
The DC brake in parameter 114-116 has been enabled.

DRIVE ready (UN. READY)
The frequency converter is ready for operation, but terminal 27 is a logic "0" and/or a *Coasting command* has been received via the serial communication.

Not ready (NOT READY)
The frequency converter is not ready for operation, because of a trip or because OFF1, OFF2 or OFF3 is a logic '0'.

Start disabled (START IN.)
This status will only be displayed if, in parameter 599 *Statemachine, Profidrive* [1] has been selected and OFF2 or OFF3 is a logic '0'.

Exceptions XXXX (EXCEPTIONS XXXX)
The microprocessor of the control card has stopped and the frequency converter is out of operation. The cause may be noise on the mains, motor or control cables, leading to a stop of the control card microprocessor.
Check for EMC-correct connection of these cables.

■ List of warnings and alarms

The table gives the different warnings and alarms and indicates whether the fault locks the frequency converter. After Trip locked, the mains supply must be cut and the fault must be corrected. Reconnect the mains supply and reset the frequency converter before being ready. A Trip can be reset manually in three ways

1. Via the control key [RESET]
2. Via a digital input
3. Via serial communication In addition, an automatic reset may be selected in parameter 400 *Reset function.*

Wherever a cross is placed under both Warning and Alarm, this can mean that a warning precedes the alarm. It can also mean that it is possible to program whether a given fault is to result in a warning or an alarm. This is possible, e.g. in parameter 117 *Motor thermal protection*. After a trip, the motor will be coasting and on the frequency converter alarm and warning will flash. If the fault is removed, only the alarm will flash. After a reset, the frequency converter will be ready to start operation again.

No.	Description	Warning	Alarm	Trip locked
1	10 Volts low (10 VOLT LOW)	x		
2	Live zero fault (LIVE ZERO ERROR)	x	x	
4	Mains imbalance (MAINS IMBALANCE)	x	x	x
5	Voltage warning high (DC LINK VOLTAGE HIGH)	x		
6	Voltage warning low (DC LINK VOLTAGE LOW)	x		
7	Overvoltage (DC LINK OVERVOLT)	x	x	
8	Undervoltage (DC LINK UNDERVOLT)	x	x	
9	Inverter overloaded (INVERTER TIME)	x	x	
10	Motor overloaded (MOTOR TIME)	x	x	
11	Motor thermistor (MOTOR THERMISTOR)	x	x	
12	Current limit (CURRENT LIMIT)	x	x	
13	Overcurrent (OVERCURRENT)	x	x	x
14	Earth fault (EARTH FAULT)		x	x
15	Switch mode fault (SWITCH MODE FAULT)		x	x
16	Short-circuit (CURR.SHORT CIRCUIT)		x	x
17	Serial communication timeout (STD BUSTIMEOUT)	x	x	
18	HPFB bus timeout (HPFB TIMEOUT)	x	x	
19	Fault in EEprom on power card (EE ERROR POWER)	x		
20	Fault in EEprom on control card (EE ERROR CONTROL)	x		
22	Auto-optimisation not OK (AMA FAULT)		x	
29	Heat-sink temperature too high (HEAT SINK OVERTEMP.)		x	
30	Motor phase U missing (MISSING MOT.PHASE U)		x	
31	Motor phase V missing (MISSING MOT.PHASE V)		x	
32	Motor phase W missing (MISSING MOT.PHASE W)		x	
34	HPFB communication fault (HPFB COMM. FAULT)	x	x	
37	Inverter fault (GATE DRIVE FAULT)		x	x
39	Check parameters 104 and 106 (CHECK P.104 & P.106)	x		
40	Check parameters 103 and 105 (CHECK P.103 & P.106)	x		
41	Motor too big (MOTOR TOO BIG)	x		
42	Motor too small (MOTOR TOO SMALL)	x		
60	Safety stop (EXTERNAL FAULT)		x	
61	Output frequency low (FOUT < FLOW)	x		
62	Output frequency high (FOUT > FHIGH)	x		
63	Output current low (I MOTOR < I LOW)	x	x	
64	Output current high (I MOTOR > I HIGH)	x		
65	Feedback low (FEEDBACK < FDB LOW)	x		
66	Feedback high (FEEDBACK > FDB HIGH)	x		
67	Reference low (REF. < REF. LOW)	x		
68	Reference high (REF. > REF. HIGH)	x		
69	Temperature auto derate (TEMP.AUTO DERATE)	x		
99	Unknown fault (UNKNOWN ALARM)		x	x

■ Warnings

A warning will flash in line 2, while an explanation is given in line 1.

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■ 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.

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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 .

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 frequency converter.

WARNING 5
Voltage warning high (DC LINK VOLTAGE HIGH)
The intermediate circuit voltage (DC) is higher than *Voltage warning high*, see table below. The controls of the frequency converter are still enabled.

WARNING 6
Voltage warning low (DC LINK VOLTAGE LOW)
The intermediate circuit voltage (DC) is lower than *Voltage warning low*, see table below. The controls of the frequency converter are still enabled.

WARNING/ALARM 7
Overvoltage (DC LINK OVERVOLT)
If the intermediate circuit voltage (DC) is higher than the *Overvoltage limit* of the inverter (see table below), the frequency converter will trip after a fixed period. The length of this period depends on the unit.

Alarm/warning limits:

VLT 7000 Booster	3 x 380 - 460 V [VDC]
Undervoltage	402
Voltage warning low	423
Voltage warning high	762
Overvoltage	798

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

Warnings and alarms, cont.

WARNING/ALARM 8
Undervoltage (DC LINK UNDERVOLT)
If the intermediate circuit voltage (DC) drops below the *undervoltage limit* of the inverter, the frequency converter will trip after a fixed period, the length of the period depending on the unit.
Furthermore, the voltage will be stated in the display.
Check whether the supply voltage matches the frequency converter, see *Technical data*.

WARNING/ALARM 9
Inverter overload (INVERTER TIME)
The electronic, thermal inverter protection reports that the frequency converter is about to cut out because of an overload (too high current for too long). The counter for electronic, thermal inverter protection gives a warning at 98% and trips at 100%, while giving an alarm. The frequency converter cannot be reset until the counter is below 90%.
The fault is that the frequency converter is overloaded by more than 100% for too long.

WARNING/ALARM 10
Motor overtemperature (MOTOR TIME)
According to the electronic thermal protection (ETR), the motor is too hot. Parameter 117 *Motor thermal protection* allows a choice of whether the frequency converter is to give a warning or an alarm when the *Motor thermal projection* reaches 100%. The fault is that the motor is overloaded by more than 100% of the preset, rated motor current for too long.
Check that the motor parameters 102-106 have been set correctly.

WARNING/ALARM 11
Motor thermistor (MOTOR THERMISTOR)
The thermistor or the thermistor connection has been disconnected. Parameter 117 *Motor thermal protection* allows a choice of whether the frequency converter is to give a warning or an alarm. Check that the thermistor has been correctly connected between terminal 53 or 54 (analogue voltage input) and terminal 50 (+ 10 V supply).

WARNING/ALARM 12
Current limit (CURRENT LIMIT)
The current is higher than the value in parameter 215 *Current limit* I_{LIM} and the frequency converter trips after the time set in parameter 412 *Trip delay overcurrent* , I_{LIM} has passed.

WARNING/ALARM 13
Overcurrent (OVER CURRENT)
The inverter peak current limit (approx. 200% of the rated current) has been exceeded. The warning will last approx. 1-2 seconds, following which the frequency converter will trip and give off an alarm. Turn off the frequency converter and check whether the motor shaft can be turned and whether the motor size matches the frequency converter.

ALARM: 14
Earth fault (EARTH FAULT)
There is a discharge from the output phases to earth, either in the cable between the frequency converter and the motor or in the motor itself. Turn off the frequency converter and remove the earth fault.

ALARM: 15
Switch mode fault (SWITCH MODE FAULT)
Fault in the switch mode power supply (internal ± 15 V supply).
Contact your Danfoss supplier.

ALARM: 16
Short-circuiting (CURR. SHORT CIRCUIT)
There is short-circuiting on the motor terminals or in the motor itself. Cut off the mains supply to the frequency converter and remove the short-circuit.

WARNING/ALARM 17
Serial communication timeout (STD BUSTIMEOUT)
There is no serial communication with the frequency converter.
This warning will only be enabled if parameter 556 *Bus time interval function* has been set to a value different from OFF.
If parameter 556 *Bus time interval function* has been set to *Stop and trip* [5], the frequency converter will first give off an alarm, then ramp down and finally trip while giving off an alarm. It is possible to increase parameter 555 *Bus time interva* l.

Warnings and alarms, cont.

WARNING/ALARM 18
HPFB bus timeout (HPFB TIMEOUT)
There is no serial communication with the communication option card of the frequency converter. The warning will only be enabled if parameter 804 *Bus time interval function* has been set to anything but OFF. If parameter 804 *Bus time interval function* has been set to *Stop and trip*, the frequency converter will first give off an alarm, then ramp down and finally trip while giving off an alarm.
Parameter 803 *Bus time interval* could possibly be increased.

WARNING 19
Fault in the EEprom on the power card
(EE ERROR POWER) There is a fault on the power card EEPROM. The frequency converter will continue to function, but is likely to fail at the next power-up. Contact your Danfoss supplier.

WARNING 20
Fault in the EEprom on the control card
(EE ERROR CONTROL) There is a fault in the EEPROM on the control card. The frequency converter will continue to function, but is likely to fail at the next power-up. Contact your Danfoss supplier.

ALARM: 22
Auto-optimisation not OK
(AMA FAULT) A fault has been found during automatic motor adaptation. The text shown in the display indicates a fault message.

NB!:
AMA can only be carried out if there are no alarms during tuning.

CHECK 103, 105 [0]
Parameter 103 or 105 has a wrong setting. Correct the setting and start AMA all over.

LOW P.105 [1]
The motor is too small for AMA to be carried out. If AMA is to be enabled, the rated motor current (para-meter 105) must be higher than 35% of the rated out-put current of the frequency converter.

ASYMMETRICAL IMPEDANCE [2]
AMA has detected an asymmetrical impedance in the motor connected to the system. The motor could be defective.

MOTOR TOO BIG [3]
The motor connected to the system is too big for AMA to be carried out. The setting in parameter 102 does not match the motor used.

MOTOR TOO SMALL [4]
The motor connected to the system is too small for AMA to be carried out. The setting in parameter 102 does not match the motor used.

TIME OUT [5]
AMA fails because of noisy measuring signals. Try to start AMA all over a number of times, until AMA is carried out. Please note that repeated AMA runs may heat the motor to a level where the stator resistance R_S is increased. In most cases, however, this is not critical.

INTERRUPTED BY USER [6]
AMA has been interrupted by the user.

INTERNAL FAULT [7]
An internal fault has occurred in the frequency converter. Contact your Danfoss supplier.

LIMIT VALUE FAULT [8]
The parameter values found for the motor are outside the acceptable range within which the frequency converter is able to work.

MOTOR ROTATES [9]
The motor shaft rotates. Make sure that the load is not able to make the motor shaft rotate. Then start AMA all over.

Warnings and alarms, cont.

ALARM 29
Heat sink temperature too high
(HEAT SINK OVER TEMP.):
If the enclosure is IP 00, IP 20 or NEMA 1, the cut-out temperature of the heat-sink is 90°C. If IP 54 is used, the cut-out temperature is 80°C.
The tolerance is ± 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 frequency converter and motor is missing.
Turn off the frequency converter and check motor phase U.

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

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

WARNING/ALARM: 34
HPFB communication fault
(HPFB COMM. FAULT)
The serial communication on the communication option card is not working.

ALARM: 37
Inverter fault (GATE DRIVE FAULT):
IGBT or the power card is defective. Contact your Danfoss supplier.

Auto-optimisation warnings 39-42
Automatic motor adaptation has stopped, since some parameters have probably been set wrongly, or the motor used in too big/small for AMA to be carried out. A choice must thus be made by pressing [CHANGE DATA] and choosing 'Continue' + [OK] or 'Stop' + [OK]. If parameters need to be changed, select 'Stop'; start up AMA all over.

WARNING: 39
CHECK PAR. 104, 106
Parameters 104 *Motor frequency* $f_{M,N}$, or 106 *Rated motor speed* $n_{M,N}$, have probably not been set correctly. Check the setting and select 'Continue' or [STOP].

WARNING: 40
CHECK PAR. 103, 105
Parameter 103 *Motor voltage,* $U_{M,N}$ or 105 *Motor current,* $I_{M,N}$ has not been set correctly. Correct the setting and restart AMA.

WARNING: 41
MOTOR TOO BIG (MOTOR TOO BIG)
The motor used is probably too big for AMA to be carried out. The setting in parameter 102 *Motor power,* $P_{M,N}$ may not match the motor. Check the motor and choose 'Continue' or [STOP].

WARNING: 42
MOTOR TOO SMALL (MOTOR TOO SMALL)
The motor used is probably too small for AMA to be carried out. The setting in parameter 102 *Motor power,* $P_{M,N}$ may not match the motor. Check the motor and select 'Continue' or [STOP].

ALARM: 60
Safety stop (EXTERNAL FAULT)
Terminal 27 (parameter 304 Digital inputs) has been programmed for a *Safety interlock* [3] and is a logic '0'.

WARNING: 61
Output frequency low (FOUT < FLOW)
The output frequency is lower than parameter 223 *Warning: Low frequency,* f_{LOW}.

WARNING: 62
Output frequency high (FOUT > FHIGH)
The output frequency is higher than parameter 224 *Warning: High frequency,* f_{HIGH}.

WARNING/ALARM: 63
Output current low (I MOTOR < I LOW)
The output current is lower than parameter 221 *Warning: Low current,* I_{LOW}. Select the required function in parameter 409 *Function in case of no load*.

WARNING: 64
Output current high (I MOTOR > I HIGH)
The output current is higher than parameter 222 *Warning: High current,* I_{HIGH}.

WARNING: 65
Feedback low (FEEDBACK < FDB LOW)
The resulting feedback value is lower than parameter 227 *Warning: Low feedback,* FB_{LOW}.

WARNING: 66
Feedback high (FEEDBACK > FDB HIGH)
The resulting feedback value is higher than parameter 228 *Warning: High feedback,* FB_{HIGH}.

WARNING: 67
Remote reference low (REF. < REF LOW)
The remote reference is lower than parameter 225 *Warning: Low reference,* RE_{FLOW}.

WARNING: 68
Remote reference high (REF. > REF HIGH)
The remote reference is higher than parameter 226 *Warning: High reference,* REF_{HIGH}.

WARNING: 69
Temperature auto derate (TEMP.AUTO DERATE)
The heat sink temperature has exceeded the maximum value and the auto derating function (par. 411) is active. *Warning: Temp. Auto derate.*

WARNING: 99
Unknown fault (UNKNOWN ALARM)
An unknown fault has occurred which the software is not able to handle.
Contact your Danfoss supplier.

■ Aggressive environments

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

The frequency converter should not therefore be installed in environments with airborne liquids, particles or gases capable of affecting and damaging the electronic components. Failure to take the necessary protective measures increases the risk of stoppages, thus reducing the life of the frequency converter.

Liquids can be carried through the air and condense in the frequency converter. In addition to this, liquids may cause corrosion of components and metal parts. Steam, oil and salt water may cause corrosion of components and metal parts.
In such environments, equipment with enclosure rating IP 54 is recommended.

Airborne particles such as dust particles may cause mechanical, electrical or thermal failure in the frequency converter.
A typical indicator of excessive levels of airborne particles is dust particles around the frequency converter fan.
In very dusty environments, equipment with enclosure rating IP 54 or a cabinet for IP 00/20 equipment is recommended.

In environments with high temperatures and humidity, corrosive gases such as sulphur, nitrogen and chlorine compounds will cause chemical processes on the frequency converter components. Such chemical reactions will rapidly affect and damage the electronic components.

In such environments, it is recommended that equipment is mounted in a cabinet with fresh air ventilation, keeping aggressive gases away from the frequency converter.

NB!:
Mounting frequency converters in aggressive environments will increase the risk of stop-pages and furthermore considerably reduce the life of the converter.

Before the installation of the frequency converter, the ambient air should be checked for liquids, particles and gases. This may be done by observing existing installations in this environment. Typical indicators of

harmful airborne liquids are water or oil on metal parts, or corrosion of metal parts.
Excessive dust particle levels are often found on installation cabinets and existing electrical installations.
One indicator of aggressive airborne gases is blackening of copper rails and cable ends on existing installations.

■ Calculation of resulting reference

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

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

External reference can be calculated as follows:

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

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

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

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

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

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

■ Earth leakage current

Earth leakage current is primarily caused by the capacitance between motor phases and the motor cable screen. When an RFI filter is used, this contributes additional leakage current, as the filter circuit is connected to earth through capacitors. See drawing on the following page.
The size of the leakage current to the ground depends on the following factors, in order of priority:

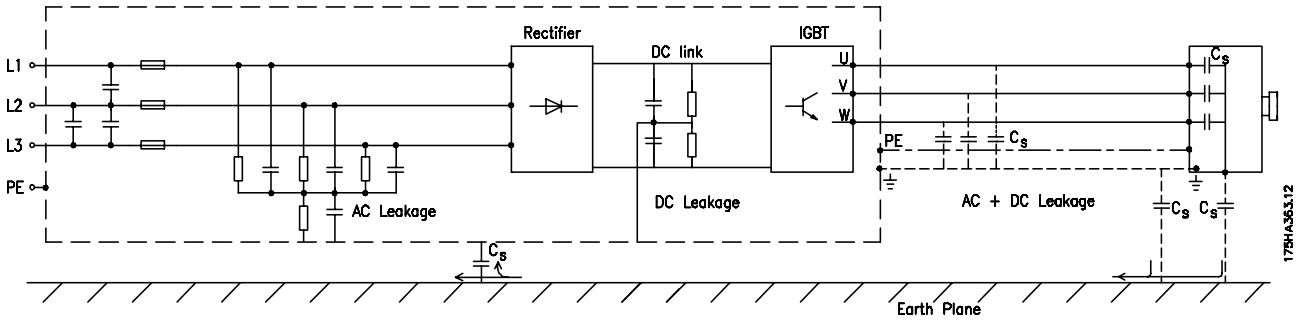
1. Length of motor cable
2. Motor cable with or without screen
3. Switching frequency
4. RFI filter used or not
5. Motor grounded on site or not.

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

NB!:
Since the leakage current is > 3.5 mA, rein-forced earthing must be established, which is required if EN 50178 is to be complied with.
Never use ELCB relays (type A) that are not suitable for DC fault currents from three-phase rectifier loads.

If ELCB relays are used, they must be:

- Suitable for protecting equipment with a direct current content (DC) in the fault current (3-phase bridge rectifier)
- Suitable for power-up with short pulse-shaped charging current to earth
- Suitable for a high leakage current (300 mA).



■ Extreme running conditions

Short circuit
VLT 7000 Booster is protected against short circuits by means of current measurement in each of the three motor phases. A short circuit between two output phases will cause an overcurrent in the inverter. However, each transistor of the inverter will be turned off individually when the short circuit current exceeds the permitted value.

After a few microseconds the driver card turns off the inverter and the frequency converter will display a fault code, although depending on impedance and motor frequency.

Earth fault
The inverter cuts out within a few micorseconds in case of an earth fault on a motor phase, although depending on impedance and motor frequency.

Switching on the output
Switching on the output between the motor and the frequency converter is fully permitted. It is not possible to damage VLT 7000 Booster in any way by switching on the output. However, fault messages may appear.

Motor-generated overvoltage
The voltage in the intermediate circuit is increased when the motor acts as a generator. This occurs in two cases:

1. The load drives the motor (at constant output frequency from the frequency converter), i.e. the load generates energy.
2. During deceleration ("ramp-down") if the moment of inertia is high, the load is low and the ramp-down time is too short for the energy to be dissipated as a loss in the frequency converter, the motor and the installation.

The control unit attempts to correct the ramp if possible. The inverter turns off to protect the transistors and the intermediate circuit capacitors when a certain voltage level is reached.

Mains drop-out
During a mains drop-out, VLT 7000 Booster continues until the intermediate circuit voltage drops below the minimum stop level, which is typically 15% below VLT 7000 Booster's lowest rated supply voltage.

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

Static overload
When VLT 7000 Booster 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 frequency converter cut out after approx. 1.5 sec.

Operation within the current limit can be limited in time (0-60 s) in parameter 412 *Trip delay overcurrent, I_{LIM}*.

■ Peak voltage on motor

When a transistor in the inverter is opened, the voltage across the motor increases by a dV/dt ratio that depends on:

- the motor cable (type, cross-section, length screened/armoured or unscreened/unarmoured)
- inductance

The natural induction causes an overshot U_{PEAK} in the motor voltage before it stabilises itself at a level which depends on the voltage in the intermediate circuit. The rise time and the peak voltage U_{PEAK} affect the service life of the motor. If the peak voltage is too high, motors without phase coil insulation are the ones that will primarily be affected. If the motor cable is short (a few meters), the rise time and peak voltage are lower. If the motor cable is long (100 m), the rise time and peak voltage will increase.

If very small motors are used without phase coil insulation, it is recommended to fit a LC filter after the frequency converter. Typical values for the rise time and peak voltage U_{PEAK} measured on the motor terminals between two phases:

VLT 7002-7011 400 V

Cable length	Mains voltage	Rise time	Peak voltage
50 metres	380 V	0.3 µsec.	850 V
50 metres	460 V	0.4 µsec.	950 V
150 metres	380 V	1.2 µsec.	1000 V
150 metres	460 V	1.3 µsec.	1300 V

VLT 7016-7072 400 V

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

■ Switching on the input

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

The table states the waiting time between cut-ins.

Mains voltage	380 V	415 V	460 V
Waiting time	48 s	65 s	89 s

■ Acoustic noise

The acoustic interference from the frequency converter comes from two sources:
1. DC intermediate circuit coils
2. Integral fan.

Below are the typical values measured at a distance of 1 m from the unit at full load and are nominal maximum values:

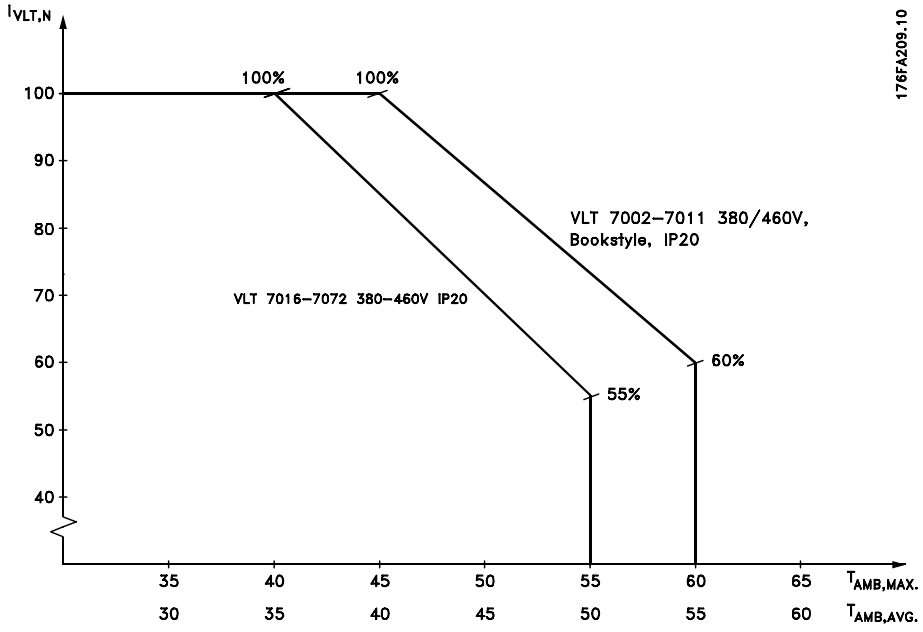
VLT 7002-7011 380-460 V
IP 20 units: 50 dB(A)

VLT 7016-7072 380-460 V
IP 20 units: 61 dB(A)

■ Derating for ambient temperature

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

If VLT 7000 Booster is operated at temperatures above 45 ºC, a derating of the continuous output current is necessary.

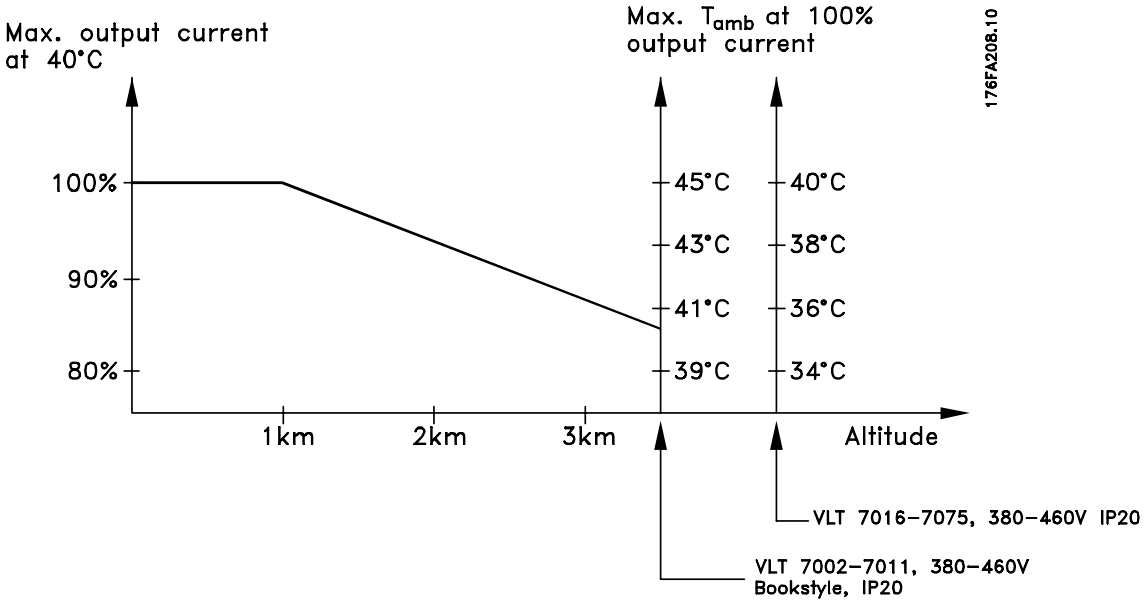


■ Derating for air pressure

Below 1000 m altitude no derating is necessary.

Above 1000 m the ambient temperature (T_{AMB}) or max. output current ($I_{VLT,MAX}$) must be derated in accordance with the diagram below:

1. Derating of output current versus altitude at T_{AMB} = 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 7000 Booster frequency converter, it is not necessary to reduce the output current at low speed because the load characterstic of the centrifugal pumps/fans, automatically ensures the necessary reduction.

■ Derating for long motor cables or cables with larger cross-section

VLT 7000 Booster has been tested using 300 m unscreened/unarmoured cable and 150 m screened/armoured cable.

VLT 7000 Booster has been designed to work using a motor cable with a rated cross-section. If a cable with a larger cross-section is to be used, it is recommended to reduce the output current by 5% for every step the cross-section is increased. (Increased cable cross-section leads to increased capacity to earth, and thus an increased earth leakage current).

■ Derating for high switching frequency

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

VLT 7000 Booster has a pulse pattern in which it is possible to set the switching frequency from 3.0- 10.0/14.0 kHz.

The frequency converter will automatically derate the rated output current $I_{VLT,N,}$ when the switching frequency exceeds 4.5 kHz.

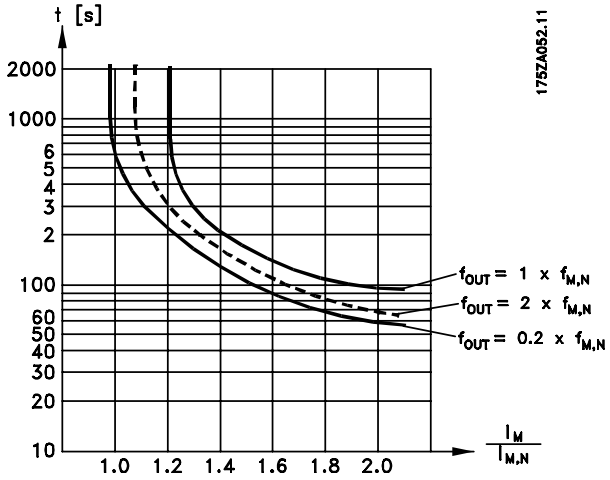
In both cases, the reduction is carried out linearly, down to 60% of $I_{VLT,N}$.

The table gives the min., max. and factory-set switching frequencies for VLT 7000 Booster units.

Switching frequency [kHz]	Min.	Max.	Fact.
VLT 7002-7011, 460 V	3.0	10.0	4.5
VLT 7016-7062, 460 V	3.0	14.0	4.5
VLT 7072, 460 V	3.0	4.5	4.5

■ Motor thermal protection

The motor temperature is calculated on the basis of motor current, output frequency and time. See parameter 117, *Motor thermal protection.*



■ Vibration and shock

VLT 7000 Booster 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

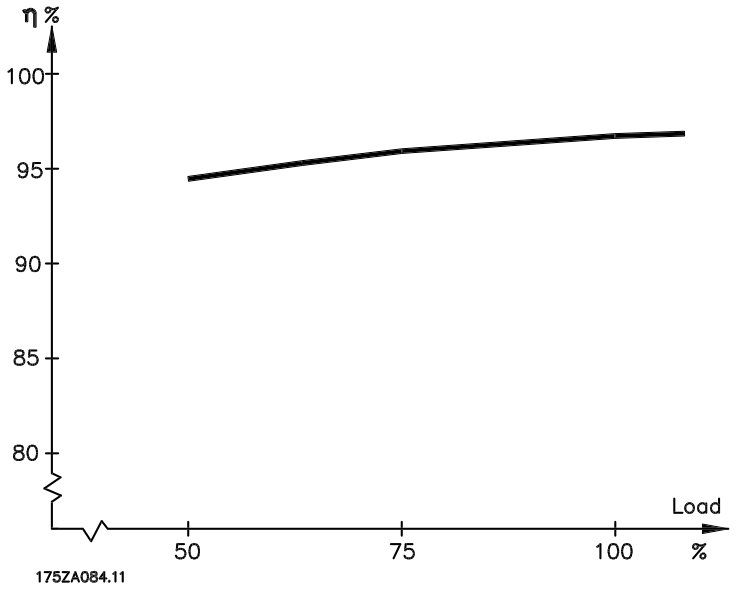
VLT 7000 Booster complies with requirements that correspond to conditions when the unit is mounted on the walls and floors of production premises, as well as in panels bolted to walls or floors.

■ Air humidity

VLT 7000 Booster 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 7000 Booster (η_{VLT})

The load on the frequency converter has little effect on its efficiency. In general, the efficiency is the same at the rated motor frequency $f_{M,N}$, regardless of whether the motor supplies 100% of the rated shaft torque or only 75%, i.e. in case of part loads.

The efficiency declines a little when the switching frequency is set to a value of above 4 kHz (parameter 407 *Switching frequency*). The rate of efficiency will also be slightly reduced if the mains voltage is 460 V, or if the motor cable is longer than 30 m.

Efficiency of the motor (η_{MOTOR})

The efficiency of a motor connected to the frequency converter depends on the sine shape of the current. In general, the efficiency is just as good as with mains operation. The efficiency of the motor depends on the type of motor.

In the range of 75-100% of the rated torque, the efficiency of the motor is practically constant, both when it is controlled by the frequency converter and when it runs directly on mains.

In small motors, the influence from the U/f characteristic on efficiency is marginal; however, in motors from 11 kW and up, the advantages are significant.

In general, the switching frequency does not affect the efficiency of small motors. Motors from 11 kW and up have their efficiency improved (1-2%). This is because the sine shape of the motor current is almost perfect at high switching frequency.

Efficiency of the system (η_{SYSTEM})

To calculate the system efficiency, the efficiency of VLT 7000 Booster (VLT) is multiplied by the efficiency of the motor (MOTOR):

$\eta_{SYSTEM} = \eta_{VLT} \times \eta_{MOTOR}$

Based on the graph outlined above, it is possible to calculate the system efficiency at different speeds.

■ Mains supply interference/harmonics

A frequency converter takes up a non-sinusoidal current from mains, which increases the input current I_{RMS}. A non-sinusoidal current can be transformed by means of a Fourier analysis and split up into sine wave currents with different frequencies, i.e. different harmonic currents I_N with 50 Hz as the basic frequency:

Harmonic currents	I_1	I_5	I_7
Hz	50 Hz	250 Hz	350 Hz

The harmonics do not affect the power consumption directly, but increase the heat losses in the installation (transformer, cables). Consequently, in plants with a rather high percentage of rectifier load, it is important to maintain harmonic currents at a low level to avoid overload of the transformer and high temperature in the cables.

Harmonic currents compared to the RMS input current:

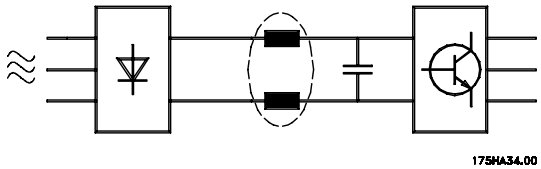
	Input current
I_{RMS}	1.0
I_1	0.9
I_5	0.4
I_7	0.3
I_{11-49}	<0.1

To ensure low, harmonic currents, VLT 7000 Booster has intermediate circuit coils as standard. This normally reduces the input current I_{RMS} by 40%, down to 40-45% ThiD.

In some cases, there is a need for further suppression (e.g. retrofit with frequency converters). For this purpose Danfoss can offer two acvanced harmonic filters AHF05 and AHF10, bringing the harmonic current down to around 5% and 10% respectively. For further details, see the operating instructions MG.80.BX.YY. For calculation of harmonic, Danfoss offers the software tool MCT31.

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 7000 Booster has been designed in accordance with the following standards:

- IEC 1000-3-2
- IEEE 519-1992
- IEC 22G/WG4
- EN 50178
- VDE 160, 5.3.1.1.2



The voltage distortion on the mains supply depends on the size of the harmonic currents multiplied by the mains impedance for the frequency in question. The total voltage distortion THD is calculated on the basis of the individual voltage harmonics using the following formula:

$$THD\% = \frac{\sqrt{U_5^2 + U_7^2 + ...U_N^2}}{U_1} \qquad (U_N\% \; of \; U)$$

■ Power factor

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

The power factor for 3-phase control

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

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

The power factor indicates the extent to which the frequency converter imposes a load on the mains supply. The lower the power factor, the higher the I_{RMS} for the same kW performance.

In addition, a high power factor indicates that the different harmonic currents are low.

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

EMC test results (Emission, Immunity)

The following test results have been obtained using a system with a frequency converter (with options if relevant), a screened control cable, a control box with potentiometer, as well as a motor and motor cable.

VLT 7002- 7011/ 380- 460V	Emission					
	Environment	Industrial environment		Housing, trades and light industries		
	Basic standard	EN 55011 Class A1		EN 55011 Class B		EN 61800- 3
Setup	Motor cable	Conducted 150 kHz- 30 MHz	Radiated 30 MHz- 1 GHz	Conducted 150 kHz- 30 MHz	Radiated 30 MHz- 1 GHz	Conducted/ radiated 150 kHz- 30 MHz
VLT 7000 Booster with RFI filter option	300 m unscreened/ unarmoured	Yes 1)	No	No	No	Yes/ No
	50 m br. screened/ armoured (Bookstyle 20m)	Yes	Yes	Yes	No	Yes/ Yes
	150m br. screened/ armoured	Yes	Yes	No	No	Yes/ Yes
VLT 7000 Booster with RFI- filter (+ LC- module)	300 m unscreened/ unarmoured	Yes	No	No	No	Yes/ No
	50 m br. screened/ armoured	Yes	Yes	Yes	No	Yes/ Yes
	150m br. screened/ armoured	Yes	Yes	No	No	Yes/ Yes

VLT 7016- 7072 / 380- 460 V	Emission				
	Environment	Industrial environment		Housing, trades and light industries	
	Basic standard	EN 55011 Class A1		EN 55011 Class B	
Setup	Motor cable	Conducted 150 kHz- 30 MHz	Radiated 30 MHz- 1 GHz	Conducted 150 kHz- 30 MHz	Radiated 30 MHz- 1 GHz
VLT 7000 Booster w/ o RFI filter option	300 unscreened/ unarmoured	No	No	No	No
	150 m br. screened/ armoured	No	Yes	No	No
VLT 7000 Booster with RFI- module	300 m unscreened / unarmoured	Yes 1)	No	No	No
	50 m br. screened/ armoured	Yes	Yes	Yes	No
	150 m br. screened/ armoured	Yes	Yes	No	No

1) Depending on installation conditions

In order to minimise the conducted noise to the mains supply and the radiated noise from the frequency converter system, the motor cables should be as short as possible and the screen ends should be made in accordance with the section on electrical installation.

■ EMC Immunity

In order to confirm immunity against interference from electrical phenomena, the following immunity test has been made on a system consisting of a frequency converter (with options, if relevant), a screened/armoured control cable and control box with potentiometer, motor cable and motor.

The tests were made in accordance with the following basic standards:

EN 61000-4-2 (IEC 1000-4-2): Electrostatic discharges (ESD)
Simulation of electrostatic discharges from human beings.

EN 61000-4-3 (IEC 1000-4-3): Incoming electromagnetic field radiation, amplitude modulated
Simulation of the effects of radar and radio communication equipment as well as mobile communications equipment.

EN 61000-4-4 (IEC 1000-4-4): Burst transients
Simulation of interference brought about by switching with a contactor, relays or similar devices.

EN 61000-4-5 (IEC 1000-4-5): Surge transients
Simulation of transients brought about e.g. by lightning that strikes near installations.

ENV 50204: Incoming electromagnetic field, pulse modulated
Simulation of the impact from GSM telephones.

ENV 61000-4-6: Cable-borne HF
Simulation of the effect of radio transmission equipment connected to supply cables.

VDE 0160 class W2 test pulse: Mains transients
Simulation of high-energy transients brought about by main fuse breakage, switching of power factor-correction capacitors, etc.

■ Immunity, continued

VLT 7002-7072 380-460 V

Basic standard	Burst IEC 1000-4-4	Surge IEC 1000-4-5		ESD 1000-4-2	Radiated electro-magnetic field IEC 1000-4-3	Mains distortion VDE 0160	RF common mode voltage ENV 50141	Radiated radio freq.elect.field ENV 50140
Acceptance criterion	B	B		B	A		A	A
Port connection	CM	DM	CM	-	-	CM	CM	
Line	OK	OK	-	-	-	OK	OK	-
Motor	OK	-	-	-	-	-	OK	-
Control lines	OK	-	OK	-	-	-	OK	-
Signal Interface<3 m	OK	-	-	-	-	-	-	-
Enclosure	-	-	-	OK	OK	-	-	OK
Load sharing	OK	-	-	-	-	-	OK	-
Standard bus	OK	-	OK	-	-	-	OK	-
Basic specifications				-	-	-		-
Line	4 kV/5kHz/DCN	2 kV/2Ω	4 kV/12Ω	-	-	2,3 x U_N [2)]	10 V_{RMS}	-
Motor	4 kV/5kHz/CCC	-	-	-	-	-	10 V_{RMS}	-
Control lines	2 kV/5kHz/CCC	-	2 kV/2Ω [1)]	-	-	-	10 V_{RMS}	-
Signal interface<3 m	1 kV/5kHz/CCC	-	-	-	-	-	10 V_{RMS}	-
Enclosure	-	-	-	8 kV AD 6 kV CD	10 V/m	-	-	-
Load sharing	4 kV/5kHz/CCC	-	-	-	-	-	10 V_{RMS}	-
Standard bus	2 kV/5kHz/CCC	-	4 kV/2 [1)]	-	-	-	10 V_{RMS}	-

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

■ Definitions

Definitions are given in alphabetical order.

Analogue inputs:
The analogue inputs can be used for controlling various functions of the frequency converter.
There are two types of analogue inputs:
Current input, 0-20 mA
Voltage input, 0-10 V DC.

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

Analogue outputs:
There are two analogue outputs, which are able to supply a signal of 0-20 mA, 4-20 mA or a digital signal.

Automatic motor adjustment, AMA:
Automatic motor adjustment algorithm, which determines the electrical parameters for the connected motor, at standstill.

AWG:
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 frequency converter.

Digital outputs:
There are four digital outputs, two of which activate a relay switch. The outputs are able to supply a 24 V DC (max. 40 mA) signal.

f_{JOG}
The output frequency from the VLT frequency conver-ter transmitted to the motor when the jog function is activated (via digital terminals or serial communication).

f_M
The output frequency from the frequency converter transmitted to the motor.

$f_{M,N}$
The rated motor frequency (nameplate data).

f_{MAX}
Maximum output frequency transmitted to the motor.

f_{MIN}
Minimum output frequency transmitted to the motor.

I_M
The current transmitted to the motor.

$I_{M,N}$
The rated motor current (nameplate data).

Initializing:
If initializing is carried out (see parameter 620 *Operating mode*), the frequency converter returns to the factory setting.

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

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

LCP:
The control panel, which makes up a complete interface for control and programming of VLT 7000 Booster. The control panel is detachable and may, as an alter-native, be installed up to 3 metres away from the frequency converter, i.e. in a front panel, by means of the installation kit option.

LSB:
Least significant bit.
Used in serial communication.

MCM:

Stands for Mille Circular Mil, an American measuring unit for cable cross-section.

MSB:
Most significant bit.
Used in serial communication.

$\eta_{M,N}$
The rated motor speed (nameplate data).

η_{VLT}
The efficiency of the frequency converter is defined as the ratio between the power output and the power input.

On-line/off-line parameters:
On-line parameters are activated immediately after the data value is changed. Off-line parameters are not activated until OK has been entered on the control unit.

PID:
The PID regulator maintains the desired speed (pressure, temperature, etc.) by adjusting the output frequency to match the varying load.

$P_{M,N}$
The rated power delivered by the motor (nameplate data).

Preset ref.
A permanently defined reference, which can be set from -100% to +100% of the reference range. There are four preset references, which can be selected via the digital terminals.

Ref_{MAX}
The maximum value which the reference signal may have. Set in parameter 205 *Maximum reference, Ref_{MAX}*.

Ref_{MIN}
The smallest value which the reference signal may have. Set in parameter 204 *Minimum reference, Ref_{MIN}*.

Setup:
There are four Setups, in which it is possible to save parameter settings. It is possible to change between the four parameter Setups and to edit one Setup, while another Setup is active.

Start-disable command:
A stop command that belongs to group 1 of the control commands - see this group.

Stop command:
See Control commands.

Thermistor:
A temperature-dependent resistor placed where the temperature is to be monitored (VLT or motor).

Trip:
A state which occurs in different situations, e.g. if the frequency converter is subjected to an over-temperature. A trip can be cancelled by pressing reset or, in some cases, automatically.

Trip locked:
Trip locked is a state which occurs in different situations, e.g. if the frequency converter is subject to an over-temperature. A locked trip can be cancelled by cutting off mains and restarting the frequency converter.

U_M
The voltage transmitted to the motor.

$U_{M,N}$
The rated motor voltage (nameplate data).

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

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

■ Factory settings

PNU #	Parameter description	Factory setting	Range	Changes during operation	4-Setup	Conversion index	Data type
001	Language	English		Yes	No	0	5
002	Active Setup	Setup 1		Yes	No	0	5
004	LCP copy	No copying		No	No	0	5
005	Max value of user-defined readout	100.00	0-999.999,99	Yes	Yes	-2	4
006	Unit for user-defined readout	No unit		Yes	Yes	0	5
007	Big display readout	Frequency, Hz		Yes	Yes	0	5
008	Small display readout 1.1	Reference. Unit		Yes	Yes	0	5
009	Small display readout 1.2	Motor current, A		Yes	Yes	0	5
010	Small display readout 1.3	Power, kW		Yes	Yes	0	5
011	Unit of local reference	Hz		Yes	Yes	0	5
012	Hand start on LCP	Enable		Yes	Yes	0	5
013	OFF/STOP on LCP	Enable		Yes	Yes	0	5
014	Auto start on LCP	Enable		Yes	Yes	0	5
015	Reset on LCP	Enable		Yes	Yes	0	5
016	Lock for data change	Not locked		Yes	Yes	0	5
017	Operating state at power-up, local control	Auto restart		Yes	Yes	0	5

PNU #	Parameter description	Factory setting	Range	Changes during operation	4-Setup	Conversion index	Data type
100	**Configuration**	Closed loop		No	Yes	0	5
101	**Torque characteristics**	Automatic Energy Optimisation		No	Yes	0	5
102	**Motor power, $P_{M,N}$**	Depends on the unit	0.25-500 kW	No	Yes	1	6
103	**Motor voltage, $U_{M,N}$**	Depends on the unit	200-575 V	No	Yes	0	6
104	**Motor frequency, $f_{M,N}$**	50 Hz	24-1000 Hz	No	Yes	0	6
105	**Motor current, $I_{M,N}$**	Depends on the unit	0.01-$I_{VLT,MAX}$	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 break-away torque**	OFF	0.0 - 0.5 sec.	Yes	Yes	-1	5
111	**Start delay**	0.0 sec.	0.0 - 120.0 sec.	Yes	Yes	-1	6
112	**Motor preheater**	Disable		Yes	Yes	0	5
113	**Motor preheater DC current**	50 %	0 - 100 %	Yes	Yes	0	6
117	**Motor thermal proctection**	ETR Trip 1		Yes	Yes	0	5
118	**Motor power factor**	0.75	0.50 - 0.99	No	Yes	-2	6

PNU #	Parameter description	Factory setting	Range	Changes during operation	4-Setup	Conversion index	Data type
200	**Output frequency range**	0 - 120 Hz	0 - 1000 Hz	No	Yes	0	5
201	**Output frequency low limit, f_{MIN}**	0.0 Hz	0.0 - f_{MAX}	Yes	Yes	-1	6
202	**Output frequency high limit, f_{MAX}**	50 Hz	f_{MIN} - par. 200	Yes	Yes	-1	6
203	**Reference site**	Hand/Auto linked reference		Yes	Yes	0	5
204	**Minimum reference, Ref_{MIN}**	0.000	0.000-par. 100	Yes	Yes	-3	4
205	**Maximum reference, Ref_{MAX}**	50.000	par. 100-999.999,999	Yes	Yes	-3	4
206	**Ramp-up time**	Depends on the unit	1 - 3600	Yes	Yes	0	7
207	**Ramp-down time**	Depends on the unit	1 - 3600	Yes	Yes	0	7
208	**Automatic ramp-up/down**	Enable		Yes	Yes	0	5
209	**Jog frequency**	10.0 Hz	0.0 - par. 100	Yes	Yes	-1	6
215	**Current limit, I_{LIM}**	1.0 x $I_{VLT,N[A]}$	0,1-1,1 x $I_{VLT,N[A]}$	Yes	Yes	-1	6
216	**Frequency bypass, bandwidth**	0 Hz	0 - 100 Hz	Yes	Yes	0	6
217	**Frequency bypass 1**	120 Hz	0.0 - par.200	Yes	Yes	-1	6
218	**Frequency bypass 2**	120 Hz	0.0 - par.200	Yes	Yes	-1	6
219	**Frequency bypass 3**	120 Hz	0.0 - par.200	Yes	Yes	-1	6
220	**Frequency bypass 4**	120 Hz	0.0 - par.200	Yes	Yes	-1	6
221	**Warning: Low current, I_{LOW}**	0.0 A	0.0 - par.222	Yes	Yes	-1	6
222	**Warning: High current, I_{HIGH}**	$I_{VLT,MAX}$	Par.221 - $I_{VLT,MAX}$	Yes	Yes	-1	6
223	**Warning: Low frequency, f_{LOW}**	0.0 Hz	0.0 - par.224	Yes	Yes	-1	6
224	**Warning: High frequency, f_{HIGH}**	120.0 Hz	Par.223 - par.200/202	Yes	Yes	-1	6
225	**Warning: Low reference, Ref_{LOW}**	-999,999.999	-999,999.999 - par.226	Yes	Yes	-3	4
226	**Warning: High reference, Ref_{HIGH}**	999,999.999	Par.225 - 999,999.999	Yes	Yes	-3	4
227	**Warning: Low feedback, FB_{LOW}**	-999,999.999	-999,999.999 - par.228	Yes	Yes	-3	4
228	**Warning: High feedback, FB_{HIGH}**	999,999.999	Par. 227 - 999,999.999	Yes	Yes	-3	4

Changes during operation:
"Yes" means that the parameter can be changed, while the frequency converter is in operation. "No" means that the frequency converter must be stopped before a change can be made.

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

Conversion index:
This number refers to a conversion figure to be used when writing or reading by means of a frequency converter.

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

PNU #	Parameter description	Factory setting	Range	Changes during operation	4-Setup	Conversion index	Data type
300	**Terminal 16, Digital input**	Reset		Yes	Yes	0	5
301	**Terminal 17, Digital input**	Freeze output		Yes	Yes	0	5
302	**Terminal 18, Digital input**	Start		Yes	Yes	0	5
303	**Terminal 19, Digital input**	Reversing		Yes	Yes	0	5
304	**Terminal 27, Digital input**	Coasting stop, inverse		Yes	Yes	0	5
305	**Terminal 29, Digital input**	Jog		Yes	Yes	0	5
306	**Terminal 32, Digital input**	No operation		Yes	Yes	0	5
307	**Terminal 33, Digital input**	No operation		Yes	Yes	0	5
308	**Terminal 53, analogue input voltage**	Reference		Yes	Yes	0	5
309	**Terminal 53, min. scaling**	0.0 V	0.0 - 10.0 V	Yes	Yes	-1	5
310	**Terminal 53, max. scaling**	10.0 V	0.0 - 10.0 V	Yes	Yes	-1	5
311	**Terminal 54, analogue input voltage**	No operation		Yes	Yes	0	5
312	**Terminal 54, min. scaling**	0.0 V	0.0 - 10.0 V	Yes	Yes	-1	5
313	**Terminal 54, max. scaling**	10.0 V	0.0 - 10.0 V	Yes	Yes	-1	5
314	**Terminal 60, analogue input current**	Reference		Yes	Yes	0	5
315	**Terminal 60, min. scaling**	4.0 mA	0.0 - 20.0 mA	Yes	Yes	-4	5
316	**Terminal 60, max. scaling**	20.0 mA	0.0 - 20.0 mA	Yes	Yes	-4	5
317	**Time out**	10 sec.	1 - 99 sec.	Yes	Yes	0	5
318	**Function after time out**	Off		Yes	Yes	0	5
319	**Terminal 42, output**	0 - I_{MAX} 0-20 mA		Yes	Yes	0	5
320	**Terminal 42, output, pulse scaling**	5000 Hz	1 - 32000 Hz	Yes	Yes	0	6
321	**Terminal 45, output**	0 - f_{MAX} 0-20 mA		Yes	Yes	0	5
322	**Terminal 45, output, pulse scaling**	5000 Hz	1 - 32000 Hz	Yes	Yes	0	6
323	**Relay 1, output function**	Alarm		Yes	Yes	0	5
324	**Relay 01, ON delay**	0.00 sec.	0 - 600 sec.	Yes	Yes	0	6
325	**Relay 01, OFF delay**	0.00 sec.	0 - 600 sec.	Yes	Yes	0	6
326	**Relay 2, output function**	Running		Yes	Yes	0	5
327	**Pulse reference, max. frequency**	5000 Hz	Depends on input terminal	Yes	Yes	0	6
328	**Pulse feedback, max. frequency**	25000 Hz	0 - 65000 Hz	Yes	Yes	0	6

Changes during operation:
"Yes" means that the parameter can be changed, while the frequency converter is in operation. "No" means that the frequency converter must be stopped before a change can be made.

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

Conversion index:
This number refers to a conversion figure to be used when writing or reading by means of a frequency converter.

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

PNU #	Parameter description	Factory setting	Range	Changes during operation	4-Setup	Conversion index	Data type
400	**Reset function**	Manual reset		Yes	Yes	0	5
401	**Automatic restart time**	10 sec.	0 -600 sec.	Yes	Yes	0	6
407	**Switching frequency**	Depends on the unit	3.0 - 14.0 kHz	Yes	Yes	2	5
408	**Interference reduction method**	ASFM		Yes	Yes	0	5
409	**Function in case of no load**	Warning		Yes	Yes	0	5
410	**Function at mains failure**	Trip		Yes	Yes	0	5
411	**Function at overtemperature**	Trip		Yes	Yes	0	5
412	**Trip delay overcurrent, 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	0	5
422	**PID start-up frequency**	0 Hz	F_{MIN}- F_{MAX}			-1	6
423	**PID proportional gain**	0.01	0.0-10.00	Yes	Yes	-2	6
424	**PID integration time**	Off	0.01-9999.00 s.(off)	Yes	Yes	-2	7
425	**PID differentiation time**	Off	0.0 (Off) - 10.00 sec.	Yes	Yes	-2	6
426	**PID differentiator gain limit**	5.0	5.0 - 50.0	Yes	Yes	-1	6
427	**PID lowpass filter time**	0.01	0.01 - 10.00	Yes	Yes	-2	6
483	**Dynamic DC Link Compensation**	On		No	No	0	5

PNU #	Parameter description	Factory setting	Range	Changes during operation	4-Setup	Conversion index	Data type
500	Protocol	FC protocol		Yes	Yes	0	5
501	Address	1	Depends on par. 500	Yes	No	0	6
502	Baudrate	9600 Baud		Yes	No	0	5
503	Coasting	Logic or		Yes	Yes	0	5
504	DC-brake	Logic or		Yes	Yes	0	5
505	Start	Logic or		Yes	Yes	0	5
506	Direction of rotation	Logic or		Yes	Yes	0	5
507	Selection of Setup	Logic or		Yes	Yes	0	5
508	Selection of preset reference	Logic or		Yes	Yes	0	5
509	Data read-out: Reference %			No	No	-1	3
510	Data read-out: Reference unit			No	No	-3	4
511	Data read-out: Feedback			No	No	-3	4
512	Data read-out: Frequency			No	No	-1	6
513	User defined read-out			No	No	-2	7
514	Data read-out: Current			No	No	-2	7
515	Data read-out: Power, kW			No	No	1	7
516	Data read-out: Power, HP			No	No	-2	7
517	Data read-out: Motor voltage			No	No	-1	6
518	Data read-out: DC link voltage			No	No	0	6
519	Data read-out: Motor temp.			No	No	0	5
520	Data read-out: VLT temp.			No	No	0	5
521	Data read-out: Digital input			No	No	0	5
522	Data read-out: Terminal 53, analogue input			No	No	-1	3
523	Data read-out: Terminal 54, analogue input			No	No	-1	3
524	Data read-out: Terminal 60, analogue input			No	No	-4	3
525	Data read-out: Pulse reference			No	No	-1	7
526	Data read-out: External reference %			No	No	-1	3
527	Data read-out: Status word, hex			No	No	0	6
528	Data read-out: Heat sink temperature			No	No	0	5
529	Data read-out: Alarm word, hex			No	No	0	7
530	Data read-out: Control word, hex			No	No	0	6
531	Data read-out: Warning word, hex			No	No	0	7
532	Data read-out: Extended status word, hex			No	No	0	7
533	Display text 1			No	No	0	9
534	Display text 2			No	No	0	9
535	Busfeedback 1			No	No	0	3
536	Busfeedback 2			No	No	0	3
537	Data read-out: Relay status			No	No	0	5
555	Bus time interval	1 sec.	1 - 99 sec.	Yes	Yes	0	5
556	Bus time interval function	OFF		Yes	Yes	0	5

PNU #	Parameter description	Factory setting	Range	Changes during operation	4-Setup	Conversion index	Data type
600	Operating data: Operating hours			No	No	74	7
601	Operating data: Hours run			No	No	74	7
602	Operating data: kWh counter			No	No	3	7
603	Operating data: Number of cut-ins			No	No	0	6
604	Operating data: Number of overtemps			No	No	0	6
605	Operating data: Number of overvoltages			No	No	0	6
606	Data log: Digital input			No	No	0	5
607	Data log: Control word			No	No	0	6
608	Data log: Status word			No	No	0	6
609	Data log: Reference			No	No	-1	3
610	Data log: Feedback			No	No	-3	4
611	Data log: Output frequency			No	No	-1	3
612	Data log: Output voltage			No	No	-1	6
613	Data log: Output current			No	No	-2	3
614	Data log: DC link voltage			No	No	0	6
615	Fault log: Error code			No	No	0	5
616	Fault log: Time			No	No	0	7
617	Fault log: Value			No	No	0	3
618	Reset of kWh counter	No reset		Yes	No	0	5
619	Reset of hours-run counter	No reset		Yes	No	0	5
620	Operating mode	Normal function		Yes	No	0	5
621	Nameplate: Unit type			No	No	0	9
622	Nameplate: Power component			No	No	0	9
623	Nameplate: VLT ordering no.			No	No	0	9
624	Nameplate: Software version no.			No	No	0	9
625	Nameplate: LCP identification no.			No	No	0	9
626	Nameplate: Database identification no.			No	No	-2	9
627	Nameplate: Power component identification no.			No	No	0	9
628	Nameplate: Application option type			No	No	0	9
629	Nameplate: Application option ordering no.			No	No	0	9
630	Nameplate: Communication option type			No	No	0	9
631	Nameplate: Communication option ordering no.			No	No	0	9

Changes during operation:
"Yes" means that the parameter can be changed, while the frequency converter is in operation. "No" means that the frequency converter must be stopped before a change can be made.

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

Conversion index:
This number refers to a conversion figure to be used when writing or reading by means of a frequency converter.

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

V

W