Contents

Section 1
Section 2
Section 3
Section 4

Product Introduction

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 3502-3562 HVAC: wait 4 minutes
Using VLT 3542-3562 (230 V) HVAC: wait 14 minutes
Using VLT 3575-3800 HVAC: wait 14 minutes

Safety regulations

1. The frequency converter must be disconnected from mains if repair-work is to be carried out.
2. The "Stop/Reset" key on the operating 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 grounding of the equipment must be established, the user must be protected against supply voltage, and the motor must be protected against overload in accordance with applicable national and local regulations.
4. Earth currents are higher than 3 mA.

Warnings 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 stops are not sufficient.
2. During programming of parameters, the motor may start. Consequently, the "Stop/Reset" stop key 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, a fault in the supply mains or a fault in the motor connection ceases.
4. If the "Local/Hand" key is activated and the "Local" reference is modified, the motor can only be brought to a stop by means of the "Stop/Reset" key.

For the North American market

CAUTION: It is the responsibility of the user or person installing the drive to provide proper grounding and branch circuit protection for incoming power and motor overload according to National Electrical Codes (NEC) and local codes.

The Electronic Thermal Relay (ETR) in UL listed VLT´s provides class 20 motor overload protection in accordance with NEC in single motor applications, when parameter 315 is set for *"TRIP"* and parameter 107 is set for rated motor (nameplate) current.
Effective from software version 1.10.

Warning:

Touching the electrical parts may be fatal - even after the equipment has been disconnected from mains.
Using VLT 3502-3562 HVAC: wait 4 minutes
Using VLT 3542-3562 (230 V) HVAC: wait 14 minutes
Using VLT 3575-3800 HVAC: wait 14 minutes

■ Introduction to the manual for VLT 3500 HVAC

This manual is a tool for installation and programming the VLT 3500 HVAC frequency converters.

HVAC stands for Heating Ventilation Air-Conditioning.

This manual is valid for all VLT 3500 HVAC units with software version 3.0 and version 3.11.

The unit size and voltage is automatically identified when VLT 3500 HVAC is started up.

The following sizes of VLT 3500 HVAC are described in this manual:

VLT 3502-3562 HVAC and VLT 3575-3800 HVAC

The manual progresses step-by-step through the different routines required when installing and programming a VLT 3500 HVAC.

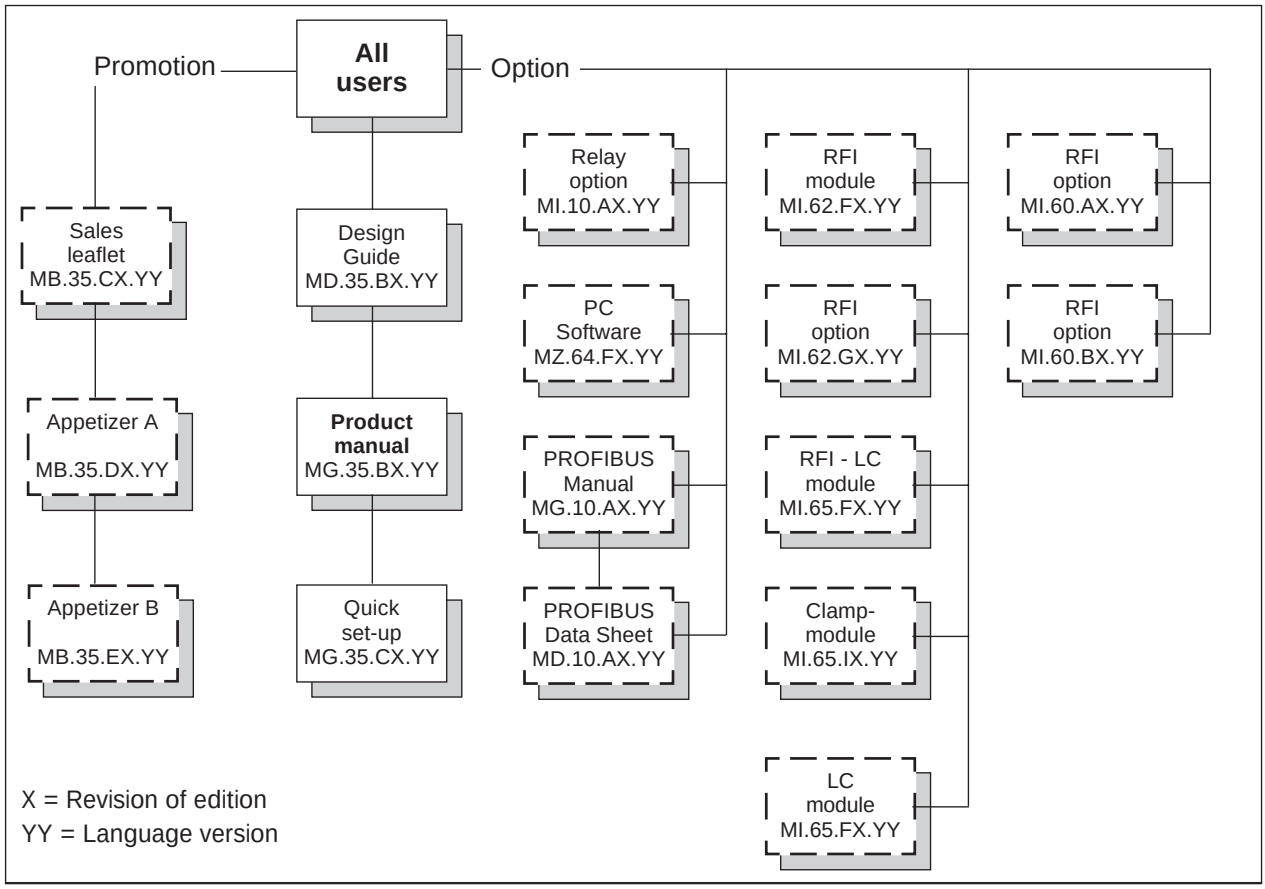
The manual forms part of the literature concept supplied with VLT 3500 HVAC.

When a VLT 3500 HVAC is supplied, it is accompanied by two documents: a Quick Set-up and a Manual.

Quick Set-up: is an Installation Guide which helps the great majority of users to get their VLT 3500 HVAC installed and started up very quickly.

The Manual: is for the user who has a greater need to utilize all the special functions offered by VLT 3500 HVAC. The Manual has largely the same contents as the Design Guide. However, it is structured as a set of operating instructions for use when starting up, operating and installing a VLT 3500 HVAC frequency converter in more complex systems.

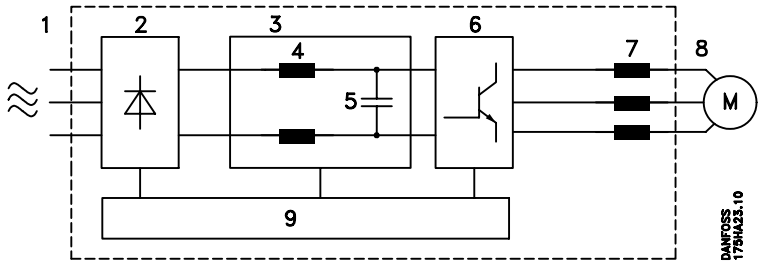
Design Guide is a tool to facilitate the sizing of systems in which VLT 3500 HVAC frequency converters are used.



■ Principle of the VLT 3500 HVAC

A frequency converter rectifies AC voltage from the mains supply into DC, and then modifies this into a variable AC voltage with variable amplitude and frequency.

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



1. Mains supply

3×200 / 220 / 230 V A.C., 50 / 60 Hz
3×380 / 400 / 415 V A.C., 50 / 60 Hz
3×440 / 460 / 500 V A.C., 50 / 60 Hz.

2. Rectifier

A three-phase rectifier bridge which rectifies AC into DC.

3. Intermediate circuit

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

4. Intermediate circuit coils

Even out intermediate circuit voltage and reduce mains supply interference from harmonic currents.

5. Intermediate circuit capacitor

Evens out the intermediate circuit voltage.

6. Inverter

Transforms DC voltage into variable AC voltage with variable frequency.

7. Motor coils

Advantages of motor coils:

- Long motor cables can be used.
- 100% protection against earthing and short-circuiting.
- Unlimited number of switchings on the frequency converter output.

8. Motor voltage

Variable AC current, 10-100% of the supply voltage.
Variable frequency: 0.5-120 Hz.
By regulating voltage and frequency (U/f characteristics) into a given ratio, the connected motor is enabled to supply the desired variable torque (VT) to the pump or fan.

9. Control card

This is where the computer is found that controls the inverter which generates the pulse pattern by which the DC voltage is transformed into variable AC voltage with variable frequency.

■ Selection of options and accessories

Danfoss offers a wide range of options and accessories for the VLT 3500 HVAC. For additional information please contact Danfoss.

NB!:
In order to obtain satisfactory operation of the frequency converter it is highly important to select the necessary options and accessories.

■ Mechanical and electrical installation

■ Installation related product data

■ Mains supply 3 x 200/220/230 V or 3 x 220/230/240 V

According to international VDE and UL/CSA requirements	VLT type	3502	3504	3508	3511	3516	3522	3532	3542	3552	3562
Output current	$I_{VLT,N}$ [A]	5.4	10.6	24.8	32.0	46.0	61.2	88.0	104.0	130.0	154.0
	$I_{VLT,MAX}$ (60 s) [A]	5.9	11.7	27.3	35.2	50.6	67.3	96.8	114.4	143.0	169.0
Output (at 230 V)	$S_{VLT,N}$ [kVA]	2.2	4.0	9.8	12.7	18.3	24.4	35.1	41.4	51.8	61.3
Typical shaft output	$P_{VLT,N}$ [kW]	1.1	2.2	5.5	7.5	11.0	15.0	22.0	30.0	37.0	45.0
Max. cable cross-section	[mm²]	2.5	2.5	16.0	16.0	16.0	35.0	50.0	70.0	70.0	70.0
Terminal torque	[Nm]	-	-	-	-	-	-	-	6	6	6
Max. motor cable length	[m]	300, with screened cables: 150 m $f_{SW} \leq 4.5$ kHz									
Rated motor voltage	$U_{M,N}$ [V]	200/220/230									
Rated motor frequency	$f_{M,N}$ [Hz]	50/60/87/100									
Max. input current	$I_{L,N}$ [A]	5.4	10.6	23.1	29.6	42.0	56.8	72.3	102.0	128.0	152.0
Max. cable cross-section	[mm²]	2.5	2.5	16.0	16.0	16.0	35.0	50.0	120.0	120.0	120.0
Terminal torque	[Nm]	-	-	-	-	-	-	-	31.1	31.1	31.1
Max. pre-fuses	[A]	16.0	25.0	40.0	50.0	60.0	80.0	125.0[1]	150.0[3]	150.0[3]	150.0[3]
Mains contactor[4]	[Danfoss type]	Cl 6	Cl 12	Cl 9	Cl 16	Cl 32	Cl 32	Cl37	Cl 85	Cl 85	Cl 85
	[AC value]	AC-3	AC-3	AC-1	AC-1	AC-1	AC-1	AC-1	AC-1	AC-1	AC-1
Supply voltage (VDE 0160)	[V]	3 x 200/220/230 ±10%							3 x 220/230/240 V $^{-15\%}_{+10\%}$		
Supply frequency	[Hz]	50/60									
Power factor / cos. φ_1		0.9/1.0									
Switching on input	times/min.	2									
Power loss at	Front	-	-	-	-	-	-	-	357	394	409
max. load.	Heat sink	-	-	-	-	-	-	-	588	712	884
[W]	Total	60	130	425	580	651	929	1350	945	1106	1293
Ambient temperature	[°C]	-10 → +40, operation at full load [2])									

[1]) Only semi-conductor fuses.

[2]) In the range -10 to 0°C, the equipment can start and run; however, the display values and certain operating characteristics will not fulfil the specifications.

[3]) Bussmann rapid type JJS integrated.

[4]) If mains contactors are used, the following Danfoss types are recommended:
Max. ambient temperature + 40°C

■ Mains supply 3 x 380/400/415 V

According to international VDE and UL/CSA requirements	VLT type	3502	3504	3505	3508	3511	3516	3522	3532	3542	3552	3562
Output current	$I_{VLT,N}$ [A]	2.8	5.6	7.3	13.0	16.0	24.0	31.9	44.2	61.2	73.2	88.3
	$I_{VLT,\ MAX}$ (60 s) [A]	3.1	6.2	8.0	14.3	17.6	26.4	35.2	48.4	67.1	80.3	96.8
Output (at 415 V)	$S_{VLT,N}$ [kVA]	2.0	4.0	5.2	9.3	11.5	17.2	22.9	31.8	44.0	52.6	63.5
Typical shaft output	$P_{VLT,N}$ [kW]	1.1	2.2	3.0	5.5	7.5	11.0	15.0	22.0	30.0	37.0	45.0
Max. cable cross-section	[mm²]	2.5	2.5	2.5	2.5	2.5	16.0	16.0	16.0	35.0	35.0	50.0
Max. motor cable length	[m]	300, with screened cables: 150 m [5]										
Rated motor voltage	$U_{M,N}$ [V]	380/400/415										
Rated motor frequency	$f_{M,N}$ [Hz]	50/60/87/100										
Max. input current	$I_{L,N}$ [A]	2.8	5.6	7.3	13.0	17.0	22.0	31.0	41.5	57.5	66.5	80.0
Max. cable cross-section	[mm²]	2.5	2.5	2.5	2.5	2.5	16.0	16.0	16.0	35.0	35.0	50.0
Max. pre-fuses	[A]	16	16	16	25	25	50	63	63	80	100 [1]	125 [1]
Mains contactor[4]	[Danfoss type]	Cl 6	Cl 6	Cl 9	Cl 5	Cl 6	Cl 9	Cl 16	Cl 32	Cl 32	Cl 37	Cl 45
	[AC value]	AC-3	AC-3	AC-3	AC-3	AC-1	AC-1	AC-1	AC-1	AC-1	AC-1	AC-1
Supply voltage	[V]	3 x 380/400/415 ±10% (VDE 0160)										
Supply frequency	[Hz]	50/60 Hz										
Power factor / cos. φ_1		0.9/1.0										
Switching on input	times/min.	2										
Power loss at max. load	[W]	60	100	130	280	300	425	580	880	1390	1875	2155
Ambient temperature	[°C]	-10→ +40 at full load [2]										

	VLT type	3575	3600	3625	3650	3700	3750	3800
Output current	$I_{VLT,N}$ [A]	105	139	168	205	243	302	368
	$I_{VLT,MAX}$ (60 s) [A]	116	153	185	226	267	332	405
Output (at 415 V)	$S_{VLT,N}$ [kVA]	75.5	99.9	121	147	175	217	265
Typical shaft output	$P_{VLT,N}$ [kW]	55	75	90	110	132	160	200
Max. cable cross-section	[mm²]	70	70	150	150	150	2 x 120	2 x 120
Terminal torque	[Nm]	6	6	10	10	10	6	6
Max. motor cable length	[m]	300						
Rated motor voltage	$U_{M,N}$ [V]	380/400/415/440/460/500						
Rated motor frequency	$f_{M,N}$ [Hz]	50/60/87/100						
Max. input current	$I_{L,N}$ [A]	103.3	138.4	167.2	201.7	241.9	293.3	366.3
	$I_{L,MAX}$ (60 s) [A]	116	153	185	226	267	332	405
Max. cable cross-section	[mm²]	120	120	2 x120	2 x120	2 x120	2 x 240	2 x 240
Terminal troque	[Nm]	31.1	31.1	31.1	31.1	31.1	42	42
Pre-fuses [3]	[A]	150	150	250	250	300	450	500
Mains contactor[4]	[Danfoss type]	Cl 85	Cl 85	Cl 140	Cl 140	Cl 140	-	-
	[AC value]	AC-1	AC-1	AC-1	AC-1	AC-1	-	-
Supply voltage (VDE 0160)	[V]	3 x 380/400/415/440/460/500 ±10%						
Supply frequency	[Hz]	50/60						
Power factor / cos. φ_1		0.9/1.0						
Switching on input	times/min.	1						
Power loss at max. load [W]	Front	529	713	910	1091	1503	1812	2209
	Heat sink	1074	1447	1847	2216	3051	3679	4485
Ambient temperature	[°C]	–10 → +40 at full load [2]						

[1] Only semi-conductor fuses

[2] In the range -10 to 0°C, the equipment can start and run; however, the display values and certain operating characteristics will not fulfil the specifications.

[3] Bussmann rapid type JJS integrated.

[4] If mains contactors are used, the following Danfoss types are recommended:
Max. ambient temperature +40°C

[5] VLT 3502-3505 fswitch > 4,5 kHz; max. 40 m motor cable.

■ Mains supply 3 x 440/460/500 V

According to international VDE and UL/CSA requirements	VLT type	3502	3504	3506	3508	3511	3516	3522	3532	3542	3552	3562
Output current	$I_{VLT,N}$ [A]	2.6	4.8	8.2	12.6	14.4	21.8	27.9	41.6	54.2	65.0	78.0
	$I_{VLT, Max}$ (60 s) [A]	2.9	5.3	9.0	13.9	15.9	24.0	30.7	45.8	59.6	71.5	85.8
Output (at 500 V)	$S_{VLT,N}$ [kVA]	2.3	4.1	7.1	10.9	12.4	18.9	24.2	36.0	46.9	56.3	67.5
Typical shaft output	$P_{VLT,N}$ [kW]	1.1	2.2	4.0	5.5	7.5	11.0	15.0	22.0	30.0	37.0	45.0
Max. cable cross-section	[mm²]	2.5	2.5	2.5	2.5	2.5	16.0	16.0	16.0	35.0	35.0	50.0
Max. motor cable length	[m]	300, with screened cables: 150 m $f_{SW} \leq 4.5$ kHz										
Rated motor voltage	$U_{M,N}$ [V]	440/460/500										
Rated motor frequency	$f_{M,N}$ [Hz]	50/60/87/100										
Max. input current	$I_{L,N}$ [A]	2.6	4.8	8.2	12.6	14.4	19.6	26.0	34.8	48.6	53.0	72.0
Max. cable cross-section	[mm²]	2.5	2.5	2.5	2.5	2.5	16.0	16.0	16.0	35.0	35.0	50.0
Max. pre-fuses	[A]	16	16	25	25	25	30	40	50	60	100 [1]	125 [1]
Mains contactor[4]	[Danfoss type]	Cl 6	Cl 6	Cl 9	Cl 12	Cl 15	Cl 6	Cl 16	Cl 16	Cl 32	Cl 32	Cl 37
	[AC value]	AC-3	AC-3	AC-3	AC-3	AC-3	AC-1	AC-1	AC-1	AC-1	AC-1	AC-1
Supply voltage	[V]	3 x 440/460/500 ±10% (VDE 0160)										
Supply frequency	[Hz]	50/60										
Power factor / cos. φ_1		0.9/1.0										
Switching on input	times/min.	2										
Power loss at max. load	VT [W]	60	130	160	200	393	281	369	880	1133	1440	1888
Ambient temperature	[°C]	–10 → +40 at full load [2]										

	VLT type	3575	3600	3625	3650	3700	3750	3800
Output current	$I_{VLT,N}$ [A]	96	124	156	180	240	302	361
	$I_{VLT,MAX}$ (60 s)[A]	106	136	172	198	264	332	397
Output (at 500 V)	$S_{VLT,N}$ [kVA]	83.1	107	135	156	208	262	313
Typical shaft output	$P_{VLT,N}$ [kW]	75	90	110	132	160	200	250
Max. cable cross-section	[mm²]	70	70	150	150	150	2 × 120	2 × 120
Terminal torque	[Nm]	6	6	10	10	10	6	6
Max. motor cable length	[m]	300						
Rated motor voltage	$U_{M,N}$ [V]	380/400/415/440/460/500						
Rated motor frequency	$f_{M,N}$ [Hz]	50/60/87/100						
Max. input current	$I_{L,N}$ [A]	94.4	123.4	155.3	177.1	238.9	307.6	359.3
	$I_{L,MAX}$ (60 s)[A]	106	136	172	198	264	332	397
Max. cable cross-section	[mm²]	120	120	2×120	2×120	2×120	2×240	2×240
Terminal torque	[Nm]	31.1	31.1	31.1	31.1	31.1	42	42
Pre-fuses [3]	[A]	150	150	250	250	300	450	500
Mains contactor[4]	[Danfoss type]	Cl 85	Cl 85	Cl 85	Cl 140	Cl 140	-	-
	[AC value]	AC-1	AC-1	AC-1	AC-1	AC-1	-	-
Supply voltage (VDE 0160)	[V]	3 × 380/400/415/440/460/500 ±10%						
Supply frequency	[Hz]	50/60						
Power factor / cos. φ_1		0.9/1.0						
Switching on input	times/min.	1						
Power loss at	Front	529	713	910	1091	1503	1812	2209
max. load [W]	Heat sink	1074	1447	1847	2216	3051	3679	4485
Ambient temperature	[°C]	-10 → +40 at full load [2]						

[1] Semi-conductor fuses

[2] In the range -10 to 0°C, the equipment can start and run; however, the display values and certain operating characteristics will not fulfil the specifications.

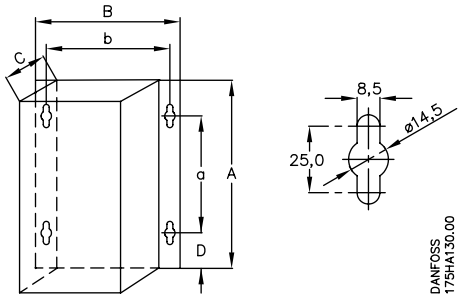
[3] Bussmann rapid type JJS integrated.

[4] If mains contactors are used, the following Danfoss types are recommended:
Max. ambient temperature +40°C

■ Cabinet sizes of VLT 3500 HV-AC

■ VLT 3502-3532 200 - 230 V

VLT Frequency converter type	Enclosure	A mm	B mm	C mm	D mm	a mm	b mm	Cabinet type
3502	IP 00	300	281	178	55	191	258	A
	IP 21	360	281	178	85	191	258	A
	IP 54	530	281	178	85	330	258	A
3504	IP 00	300	281	178	55	191	258	A
	IP 21	390	281	178	85	191	258	A
	IP 54	530	281	178	85	330	258	A
3508	IP 20	660	242	260	-	640	200	B
	IP 54	810	355	280	70	560	330	A
3511	IP 20	660	242	260	-	640	200	B
	IP 54	810	355	280	70	560	330	A
3516	IP 20	780	242	260	-	760	200	B
	IP 54	810	355	280	70	560	330	A
3522	IP 20	950	308	296	-	930	270	B
	IP 54	940	400	280	70	690	375	A
3532	IP 20	950	308	296	-	930	270	B
	IP 54	940	400	280	70	690	375	A

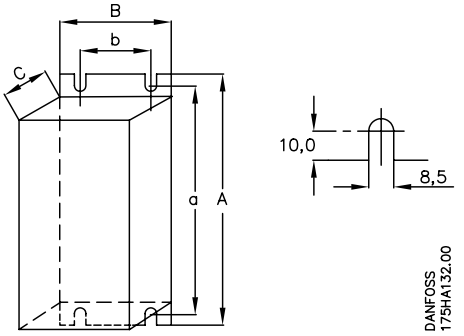


Type A cabinet

■ VLT 3502-3562 380 - 415/ 440 - 500 V

VLT Frequency converter type	Enclosure	A mm	B mm	C mm	D mm	a mm	b mm	Cabinet type
3502	IP 00	300	281	178	55	191	258	A
	IP 00 w. RFI*	440	281	178	55	330	258	A
	IP 21	360	281	178	85	191	258	A
	IP 21 w. RFI*	500	281	178	85	330	258	A
	IP 54	530	281	178	85	330	258	A
3504	IP 00	300	281	178	55	191	258	A
	IP 00 w. RFI*	440	281	178	55	330	258	A
	IP 21	360	281	178	85	191	258	A
	IP 21 w. RFI*	500	281	178	85	330	258	A
	IP 54	530	281	178	85	330	258	A
3505*	IP 00	300	281	178	55	191	258	A
	IP 00 w. RFI*	440	281	178	55	330	258	A
	IP 21	390	281	178	85	191	258	A
	IP 21 w. RFI*	530	281	178	85	330	258	A
	IP 54	530	281	178	85	330	258	A
3506**	IP 00	440	281	178	55	330	258	A
	IP 21	500	281	178	85	330	258	A
	IP 54	530	281	178	85	330	258	A
3508	IP 00	440	281	178	55	330	258	A
	IP 21	530	281	178	85	330	258	A
	IP 54	530	281	178	70	330	258	A
3511*	IP 00	500	281	178	55	330	258	A
	IP 21	530	281	178	85	330	258	A
	IP 54	530	281	178	70	330	258	A
3516	IP 20	660	242	260	-	640	200	B
	IP 54	810	355	280	70	560	330	A
3522	IP 20	660	242	260	-	640	200	B
	IP 54	810	355	280	70	560	330	A
3532	IP 20	780	242	260	-	760	200	B
	IP 54	810	355	280	70	560	330	A
3542	IP 20	950	308	296	-	930	270	B
	IP 54	940	400	280	70	690	375	A
3552	IP 20	950	308	296	-	930	270	B
	IP 54	940	400	280	70	690	375	A
3562	IP 20	950	308	296	-	930	270	B
	IP 54	940	400	280	70	690	375	A

* Only for 380 - 415 V
** Only for 440 - 500 V



Type B cabinet

■ VLT 3542 - 3562 230 V, 3575 - 3800 380 / 500 V

VLT Frequency converter type	Enclo-sure	A mm	B mm	C mm	a mm	b mm	D mm	Floor installation on base mm	Wall installation above/below mm	Floor installation on base left/right (mm)	Wall installation left/right (mm)	Cabinet type
3542-3562	IP 21	954 [1]	506 [3]	353	851	446	25	-	170	-	25 [5]	C
(230 V)	IP 54	954 [1]	506 [3]	376	851	446	25	-	170	-	25 [5]	C
3575-3600	IP 21	954 [1]	506 [3]	353	851	446	25	-	170	-	25 [5]	C
	IP 54	954 [1]	506 [3]	376	851	446	25	-	170	-	25 [5]	C
3625-3700	IP 21	1569 [1] 1696 [2]	513 [3]	394	1453	432	31	230	230	130	25 [5]	C
	IP 54	1569 [1] 1696 [2]	513 [3]	417	1453	432	31	230	230	130	25 [5]	C
3750-3800	IP 21	1877	513 [3]	508	[4]	[4]	[4]	260	-	130	25 [5]	C
	IP 54	1877	513 [3]	531	[4]	[4]	[4]	260	-	130	25 [5]	C

[1] with ring bolts

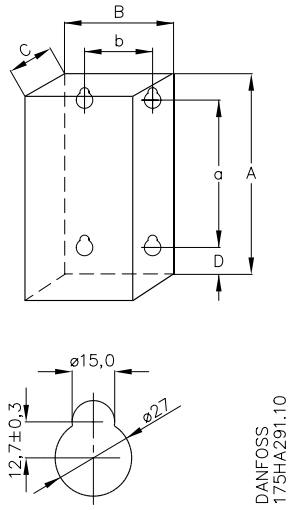
[2] with ring bolts and base

[3] with hinges

[4] to be placed on base

[5] only limited by the hinges on the sides.
Please note that the door opens to the left, while the option door opens to the right.

Type C cabinet



■ Mechanical installation

Warning

VLT 3500 HVAC must always be attached firmly to the wall or the floor before further installation work is carried out, so as to ensure that no injury or damage occurs. This rule must be complied with, especially with regard to the types of frequency converters that are top heavy.

■ EMC-correct installation

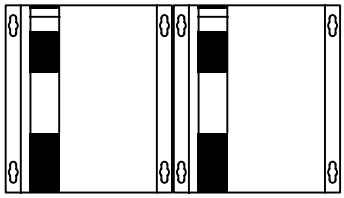
With respect to mechanical installation, reference is also made to chapter 2.6 on EMC-correct installation.

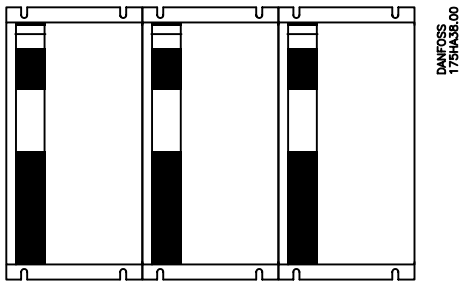
■ General aspects

VLT 3500 HVAC is cooled by means of air circulation. Consequently, the air needs to be able to move freely above and below the frequency converter.

■ VLT 3502-3562 HVAC

This series must be installed on a plane surface to ensure that the air flow is in contact with the heat sink all the way from the bottom of the converter. VLT 3500 HVAC has mounting holes in the side flanges. This means that two units can be installed flange to flange. Frequency converters without side flanges but with mounting holes at top and bottom (IP 20) can be installed without any free space on the sides.





VLT 3500 HVAC can be installed with the flanges side by side.

The enclosure of the frequency converter is made of steel. To avoid getting metal chips in the electronics, the drilling of holes for cables is only to be carried out after the unit has been installed in a vertical position.

■ VLT 3575-3700 and 3542-3562 HVAC

VLT 3575-3700, 380/500 V and VLT 3542-3562, 230 V, are supplied with a mounting bracket placed at the back of the converter. The mounting bracket also serves as an air duct for the heat sinks; the bracket must be mounted on the frequency converter before operation. The bracket does not need to be removed for installation purposes. However, it is possible to remove it temporarily by loosening the coupling bolts from the inside of the converter.

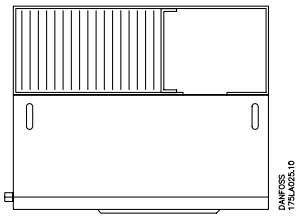
Remember to fasten the bracket again; otherwise there will be a great risk of a trip because of overheating. The 4 drip-shaped holes in the mounting bracket make it possible to fasten the attachment bolts to the wall or in the panel before hanging the unit.

The attachment bolts are accessible through the top and bottom of the bracket, since a need to adjust tension may arise later on.

VLT 3575-3600 HVAC, 380/500 V and VLT 3542-3562 HVAC, 230V, are intended for wall installation only.

VLT 3625-3700 HVAC is supplied for wall installation as standard, but can be mounted on a base.

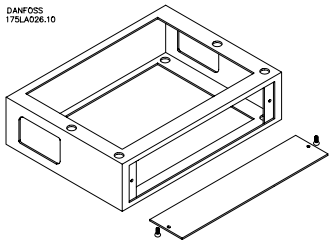
VLT 3750-3800 is intended for floor installation only, which is why the base is supplied as part of the frequency converter.



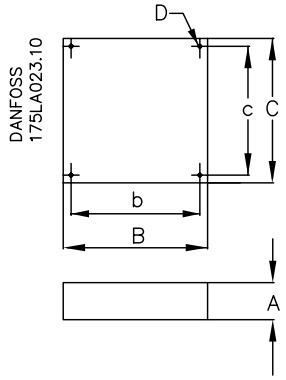
Drawing shows frequency converter seen from above.

■ Base VLT 3625-3800 HVAC

As an option to VLT 3625-3700 a base for floor installation can be supplied (ordering no.175L3047). VLT 3750-3800 is intended for floor installation only, which is why the base is supplied as part of the frequency converter. The base must be fastened to the floor by means of 4 bolts before installing the frequency converter. Unscrew the front plate of the base to fasten the converter through the 4 top holes in the base. See also the section on cooling.



The drawing shows the base and its dimensions.



VLT type	3625-3700	3750-3800
A [mm]	127	127
B [mm]	495	495
C [mm]	361	495
D [mm]	4 x 12.7	4 x 12.7
b [mm]	445	445
c [mm]	310	445

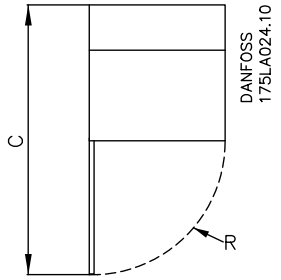
The bases for VLT 3500 HVAC and options have been updated to fit VLT 3625-3800 with its detachable bottom plate. Please note that the ventilation slits have been replaced by two apertures in the sides. If a base for the mounting cabinet and RFI in IP 54 enclosure are also used, make sure that the ventilation apertures match.
A base of the new design can be used with previous versions of VLT 3625-3800 HVAC; however, a base with the previous design must never be used for frequency converters with a detachable bottom plate.

■ Front door VLT 3542-3562 (230V), 3575-3800 HVAC

The front door for VLT 3542-3562 (230V) and 3575-3800 HVAC is hinged on the left-hand side.
The table below gives the door radius and the necessary distance from the mounting surface for the door to be able to open freely:

VLT type	3575*	3600	3625	3650	3700	3750	3800
C [mm]	846	846	894	894	894	1008	1008
R [mm]	505	505	513	513	513	513	513

* Dimensions for VLT 3575 also apply to VLT 3542-3562, 230 volts.



■ Heat emission from VLT 3500 HVAC

The table on page 5-7 show the power loss P_{ϕ}(W) from VLT 3500 HVAC. The maximum cooling air temperature $t_{IN, MAX}$ is 40° at 100% load (of rated value).

■ Ventilation of integrated VLT 3500 HVAC

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

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

   quantity of air = $\frac{\Sigma P_{\phi} \times 3.1}{\Delta t}$ 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.

■ Example

Total power loss and total quantity of air required at 100% load for eight VLT 3508 HVAC (380 volts) integrated in the same panel.

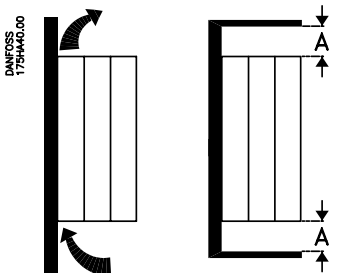
- The cooling air temperature (t_{IN}) = 40° C and the max. cooling air outlet temperature ($t_{OUT, MAX}$) = 45° C. P_{Φ} = 280 W and $t_{IN, MAX}$ = 40° C.

1. ΣP_{Φ} = 8xP_{Φ}(W) = $t_{IN, MAX}$ = 2240 W.
2. Δt = 45°C-t_{IN} = 45°C-40°C= 5°K.
3. Quantity of air (at 40°C) = $\frac{2240 \times 3.1}{5}$ = 1388 m³/h

Cooling

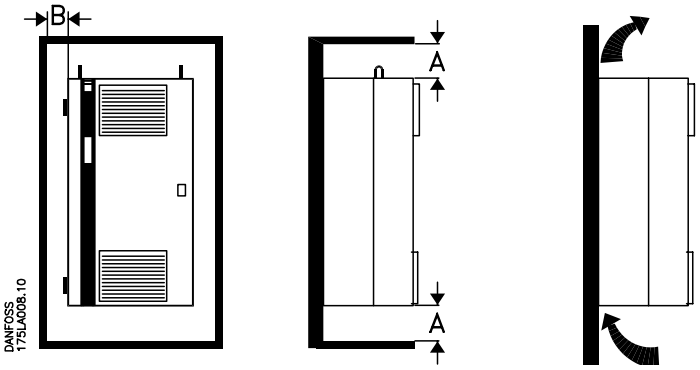
To enable the frequency converter to get rid of the cooling air, there must be a free air space above and below the unit.
The minimum distance of this air space depends on the frequency converter model and the enclosure.

For VLT type 3502-3562 HVAC the following applies:



Enclosure	A
IP 00	150 mm
IP 21	150 mm
IP 20	200 mm
IP 54	150 mm

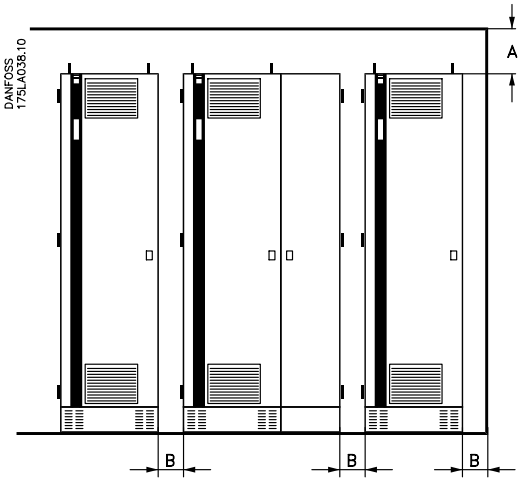
For VLT type 3575-3700 HVAC, 380/500 V and VLT type 3542-3562, 230 V, which are wall-mounted, the following applies:



Please note that the frequency converter can be installed without any free space to the sides; however, the hinges must be able to move freely;
(Distance B).

Model	B	(A) Top	A (Bottom)
3542-3562	25	170	170
3575-3600	25	170	170
3625-3700	25	230	230

For VLT type 3625-3800 HVAC installed on the floor the following applies:



Model	A	B
3625-3700	230	130
3750-3800	260	130

The sidewards distance to the next VLT 3500 HVAC must be 130 mm to allow the base to take in air at the side. VLT type 3575-3800 HVAC has a fan in the front door which cools down the internal components. A distance which allows free opening of the door is sufficient in front of the frequency converter.

See the section: Door radius VLT 3575-3800 HVAC.

■ Electrical installation

Warning:

The frequency converter voltage is dangerous when connected to mains and up to 14 minutes after the unit has been disconnected. Electrical installation is therefore only to be carried out by a qualified electrician.

Incorrect mounting of the motor or the frequency converter may result in damge to the equipment, serious personal injury or death. Consequently, the instructions of this Design Guide must be complied with, together with national and local safety regulations.

NB!:

It is the responsibility of the user or the electrician to ensure that protection against earthing is established in accordance with applicable national and local standards.

■ Pre-fuses

For VLT type 3502-3562 external pre-fuses must be installed in the power supply for the frequency converter.

Correct size and dimensioning can be seen from the section on technical data, pages 5-7.

For VLT type 3575-3800 HVAC, 380/500 V and VLT 3542-3562 HVAC, 230V, the pre-fuses are included in the mains connection of the frequency converter.

■ Extra protection

Earth fault voltage relays, protective multiple earthing or protective grounding can be used as extra protection. However, such an installation must comply with local health and safety standards.

An earth fault can introduce a DC current in the discharge current.

If FI relays are used, local regulations must be complied with.

The relays must be suitable for protecting 3-phase equipment with bridge rectifier and a short discharge on power-up.

■ General

The terminals for both the 3-phase mains supply and the motor are placed in the lower half of the enclosure of the frequency converter.

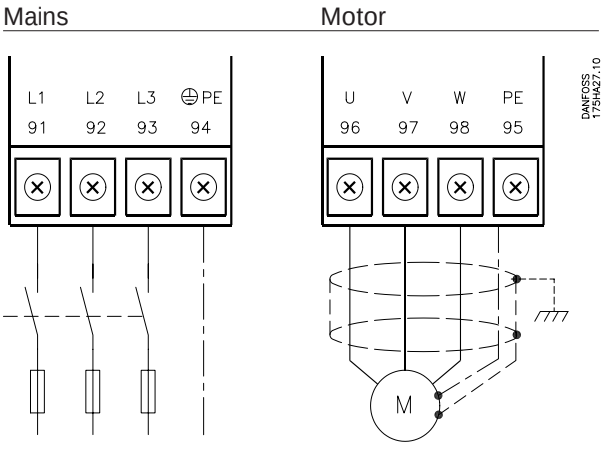
The motor cable screen is connected to both the frequency converter and the motor. The frequency converter has been tested using a given length of screened cable and a specific cross-section. If the cross-section is increased, the discharge capacity of the cable goes up and so does the discharge current. This means that the cable must be shortened correspondingly.

The electronic thermo relay (ETR) cannot be used if the motors operate in parallel. ETR has been UL approved for operating individual motors - when parameter 315 has been set to trip, parameter 311 has been set to 0 sec., and parameter 107 has been programmed to match the rated motor (nameplate) current.

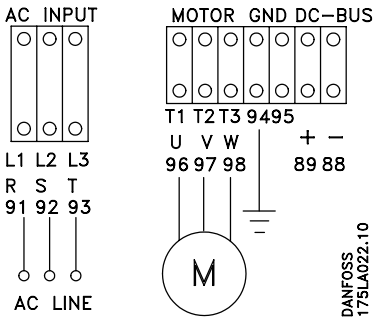
■ Mains and motor connection for VLT 3502-3562 HVAC, 200/380/500 V (not 3542-3562, 230 V)

The max. cable cross-section and the corresponding max. length and terminal size can be seen from the section on technical data, pages 5-7.

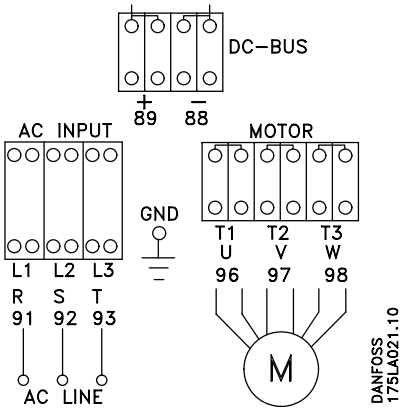
The mains supply and the motor are connected in accordance with the drawing below.



■ Mains and motor connection of VLT 3575-3600 HVAC and VLT 3542-3562 (230 V) HVAC



VLT 3575-3600,
VLT 3625-3700
VLT 3542-3562 (230)

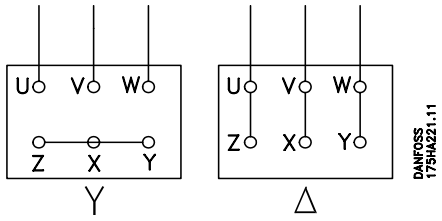


VLT 3750-3800

■ Motor connection

All types of three-phase asynchronous standard motors can be used together with VLT 3500 HVAC.

In general, smaller motors (220/380 V, Δ/ Y) are star-connected. Larger motors (380/660 V, Δ/ Y) are delta-connected.
The correct connection mode and voltage can be seen from the nameplate on the motor.

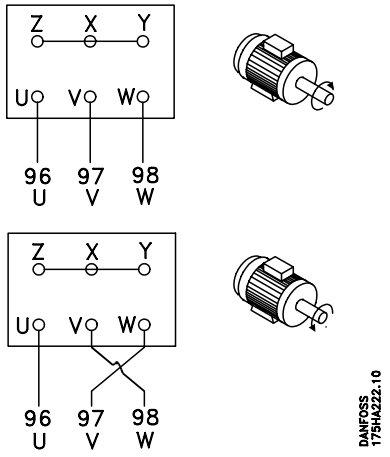


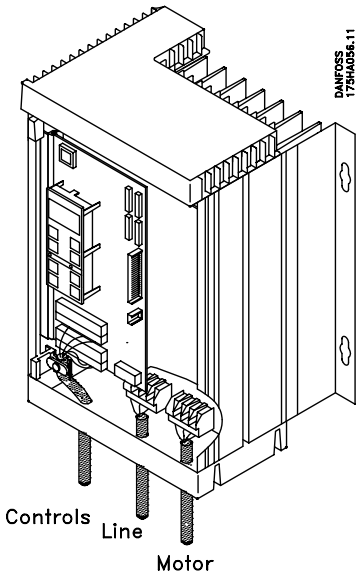
■ Direction of rotation

The factory setting gives clockwise rotation when the output on the VLT 3500 HVAC has been connected as follows:

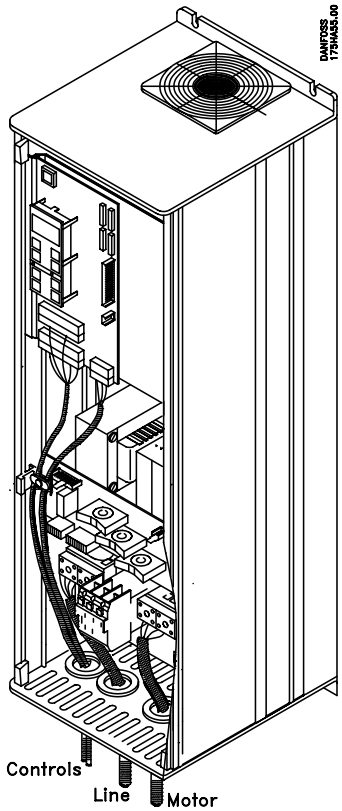
Terminal 96: connected to U
Terminal 97: connected to V
Terminal 98: connected to W

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

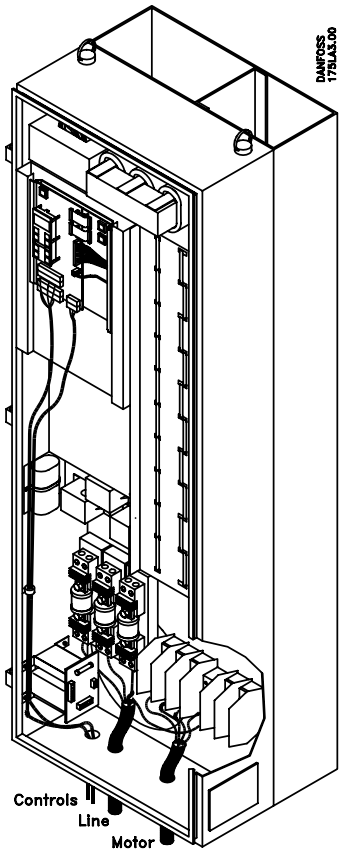




VLT type
3502 - 3511 HVAC, 380 V
3502 - 3504 HVAC, 200 V
3502 - 3511 HVAC, 380/500 V



VLT type
3516 - 3562 HVAC, 380/500 V
3508 - 3532 HVAC, 200 V



VLT type
3575 - 3800 HVAC, 380/500 V
3542 - 3562 HVAC, 230 V

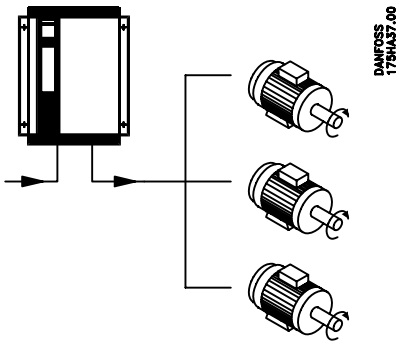
■ Parallel connection of motors

VLT 3500 HVAC can control several motors connected in parallel. If the motor speeds are to be different, motors of different rated speeds must be used. The speed of the motors changes simultaneously, which means that the ratio between the rated motor speeds is maintained over the whole range.

The total current consumption by the motors must not exceed the maximum rated output current ($I_{VLT,N}$) for VLT 3500 HVAC.

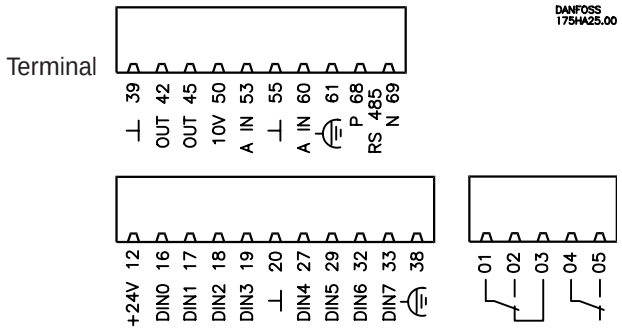
Problems may arise at the start and at low rpm values if the motor sizes deviate considerably. This is because small motors have a relatively high ohmic resistance in the stator, which is why they require a higher voltage during start and at low rpm values.

In systems with parallel motor operation, the internal, thermal protection cannot be used as motor protection of the individual motor, since the output current must be programmed to match the overall motor current. Consequently, additional motor protection is required, such as thermistors in every motor (or individual, thermal relays).



■ Connection of control card terminals

Below is a list of control card terminals on VLT 3500 HVAC. A description of the control signals and terminals is found at the bottom of this page.



Terminal 39:
Frame for analogue/digital outputs.

Terminals 42-45:
Analogue/digital outputs for indicating e.g. frequency, reference, current and torque (0-20 mA or 4-20 mA at max. 470 ohm)/indication of selected status, alarm or warning (24 V DC at min. 600 ohm). See parameters 407 and 408 on pages 67-68.

Terminal 50:
10 V DC, max. 17 mA. Supply voltage to the potentiometer and the thermistor.

Terminal 53:
0-10 V DC, R_i = 10 kohm. Analogue reference input, voltage.
See parameter 412 on page 69.

Terminal 55:
Frame for analogue reference inputs.

Terminal 60:
0/4-20 mA, R_i = 188 ohm. Analogue reference input, current.
See parameter 413, page 69.

Terminal 61:
Earth connection, via switch 04 (see page 172), to the screen for the communication cable.

Terminals 68-69:
RS 485 interface. Serial bus communication.

Terminal 12:
24 V DC, max. 140 mA. Supply voltage to digital inputs (DIN 0 -DIN 7).

Terminals 16-33:
0/24 V, R_i = 2 kohm. <5 V = logical "0", >10 V = logical "1".
Digital inputs. See parameters 400-406, pp 62-66.

Terminal 20:
Frame for digital inputs.

Terminal 38:
Earth connection to screen for control cables in units with no terminal brackets for the screen.

Terminals 01-03*):
Relay output. Max. 250 V AC, 2A. Min. 24 V DC, 10 mA or 24 V AC, 100 mA. See parameter 409, page 68.

Terminals 04-05*):
Relay outputs. Max. 250 V AC, 2A. Min. 24 V DC, 10 mA or 24 V AC, 100 mA. See parameter 410, page 69.

*) In UL versions: Max. 240 V AC, 2A.
NB: If a thermistor is used for motor protection, it must be wired from terminal 50 to terminal 16 (see description of choice in parameter 400).

■ What is CE-labelling ?

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

- **The machine directive (89/392/EEC)**
  All machines with critical, moving parts are covered by the machine directive which came into force on 1 January 1995. Since a frequency converter is largely electrical by function, it does not fall under the machine directive. However, if a frequency converter is supplied for use in a machine, we provide information about the safety aspects relating to the frequency converter. We do that by means of a manufacturer's declaration.

- **The low-voltage directive (73/23/EEC)**
  Frequency converters must be CE-labelled in accordance with the low-voltage directive, which will come into force on 1 January 1997.
  This directive applies to all electrical equipment and appliances used in the voltage range of 50-1000 VAC and 75-1500 VDC.

- **The EMC directive (89/336/EEC)**
  EMC is short for electromagnetic compatibility. The presence of electromagnetic compatibility means that the mutual interference between different components/appliances is so small that the functioning of the appliances is not affected. The EMC directive came into force on 1 January 1996. The directive distinguishes between components, appliances, systems and installations.

The EU "Guidelines on the Application of Council Directive 89/336/EEC" outline four typical situations of using a frequency converter. For each of these situations, explanations are offered as to whether the situation in question is covered by the EMC directive and must be CE-labelled.

1. The frequency converter is sold direct to the end-user. This applies for example if the frequency converter is sold to a DIY-market. The end-user is not an expert. He installs the frequency converter himself, e.g. for controlling a hobby machine or a domestic appliance. This frequency converter must be CE-labelled in accordance with the EMC directive.

2. The frequency converter is intended for use in a complete product. It is sold e.g. to a professional machine builder who has the technical knowledge it takes to install the frequency converter correctly. The frequency converter need not be CE-labelled in accordance with the EMC directive. Instead, the frequency converter manufacturer must provide detailed guidelines on how to carry out an EMC-correct installation.

3. The frequency converter is intended for use in an installation built up on the site of use by a professional. This could be e.g. a complete installation for manufacturing purposes or for the generation of heat/ventilation. The installation is planned and made by a professional installer. The complete system is not to be CE-labelled in accordance with the EMC directive. The system must comply with the basic requirements contained in the directive. This is ensured by using components, appliances and systems which are CE-labelled in accordance with the EMC directive.

4. The frequency converter is sold as part of a complete system, such as an air-conditioning system. The complete system must be CE-labelled in accordance with the EMC directive.

■ Danfoss VLT frequency converter and CE-labelling

CE-labelling is a positive feature when used for its original purpose, i.e. to facilitate trade within the EU and EFTA. However, CE-labelling may cover many different specifications. This means that it has to be checked what a given CE-label specifically covers. The specifications covered can in fact be widely different. That is why the CE-label can give installers a false feeling of security when using a frequency converter as a component in a system or an appliance.

We CE-label our VLT frequency converters in accordance with the low-voltage directive. This means that as long as the frequency converter is installed correctly, we guarantee that it complies with the low-voltage directive. We issue a declaration of conformity confirming that our CE-label complies with the low-voltage directive.

The CE-label also applies to the EMC directive on the condition that the EMC-correct installation and filtering instructions in the manual have been followed. On this basis a conformity declaration is issued in accordance with the EMC directive.

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

■ Compliance with EMC directive 89/336/EEC

In support of our claim that the VLT frequency converter complies with the protection requirements for emission and immunity under EMC directive 89/336/EEC, a Technical Construction File (TCF) has been prepared for each model.

Such a file defines the EMC requirements and the measurements made in accordance with harmonised EMC standards in a Power Drive System (PDS) that consists of a VLT frequency converter, a control cable and the controls (control box), motor cable and motor plus any options added. The Technical Construction File is prepared on this basis in cooperation with a duly authorised EMC laboratory (Competent Body).

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

As an aid to the installer, Danfoss has prepared EMC installation guidelines for the Power Drive System. The standards and testing levels stated for the Power Drive System are complied with, provided that the EMC-correct installation guidelines are applied.

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 c_{vess} sectional area.

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

The control cable and the filtered mains cable should be installed separately from the motor and brake cables to prevent interference coupling. 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-carrying in- or outgoing cables to/from a cabinet should be screened or filtered.

■ Screened 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.

■ EMC-correct installation

■ General aspects of radio noise

In general, electrical noise can be divided into two forms: the wire-borne noise and the radiated noise. Wire-borne noise occurs in the frequency range: 150 kHz-30 MHz. Radiated noise in the range 30 MHz-1 GHz radiates from the entire frequency converter system. Radiated electrical noise below 50 MHz is generated especially by the frequency converter, the motor and the motor cables.

As shown in the sketch below, the discharge capacity of the motor cable - together with a high du/dt from the motor voltage - generates noise.

The use of a screened motor cable increases the noise current I_1 (see fig. below). This is because screened cables have a greater discharge capacity than unscreened cables. If the noise current is not filtered, there will be more noise on the mains in the radio noise range below approx. 5 MHz. Since the noise current I_1 is taken back to the unit through the screen (I_3), only a small electromagnetic field will in principle be generated from the screened motor cable, see the figure below.

The screen reduces the radiated noise, but increases the low-frequency noise on the mains. With an RFI filter, the noise level on the mains will be reduced to about the same level for screened and unscreened cables alike.

The motor cable screen must be mounted on the enclosure of the frequency converter as well as the motor enclosure. The best way of doing this is by using screen brackets to avoid twisted screen ends.

Such twisting increases the screen impedance at higher frequencies, which reduces the screen effect and increases the noise current.

If a screened cable is used for PROFIBUS, control cable and signal interface, the screen must be mounted on the enclosure at both ends. In certain situations, however, it will be necessary to break the screen to avoid current loops.

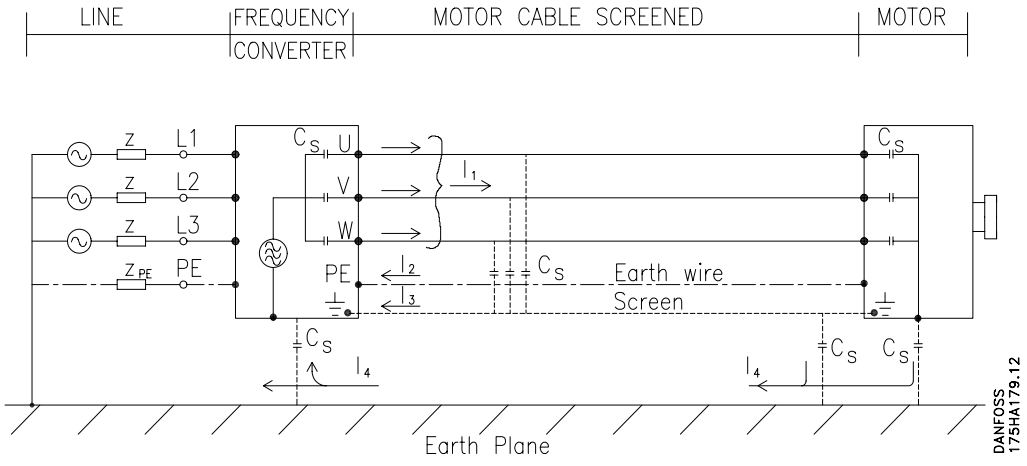
In those cases where the screen is to be connected to a mounting plate for VLT 3500 HVAC, the mounting plate must be made of metal, because the screen currents are to be taken back to the unit. It is also important to ensure good, electrical contact from the mounting plate through the mounting screws to the chassis of VLT 3500 HVAC.

With respect to installation, it is generally less complicated to use unscreened motor cables than screened ones. If unscreened cables are used, the EMC requirements are not met.

In order to reduce the noise level from the total system (frequency converter + installation) to the greatest possible extent, it is important to make the motor cables as short as possible.

Cables with a sensitive signal level are not to be placed together with motor cables.

Radio noise above 50 MHz (air-borne), in particular, will be disturbed by the control electronics.



■ EMC-correct installation instructions

Filtering

Electrical interference from the cable network - cable-borne as well as air-borne - can be prevented by using the correct filters. The filters or equivalent stated in the product programme must be installed, and when remounting, the filter installation instructions are to be observed.

VLT 3502-3562

All models are available with or without an integrated RFI filter. Also, RFI filters can be purchased as a separate module/option. See product range.

VLT 3575-3800 and 3542-3562 (230 V)

RFI filters are available in a separate IP54 enclosure or in an IP20 version for separate installation.
Special installation guidelines must be complied with.

Mechanical installation

VLT 3502 - VLT 3511, IP00/21 enclosure without integrated RFI filter must always be installed against a conductive rear plate.
Install the metal cabinet of the VLT frequency converter up against the rear plate. The rear plate must be electrically conductive and act as a common HF earth reference for the VLT frequency converter and the RFI/ module. The VLT frequency converter and the RFI/ module must be installed with the lowest possible HF impedance to the rear plate. This can best be done through the fastening bolts for the enclosure. Since the aluminium enclosure of the VLT 3500 HVAC is anodised and thus electrically insulating, toothed (serrated) washers should be used to penetrate the anodisation - or the anodised surface has to be removed. Remember also to remove any varnish or paint from the rear plate.

VLT 3502-11, IP00/21 enclosure with RFI filter
VLT 3502-11, IP54 enclosure and VLT 3616-62, IP20/IP54

These VLT 3500 HVAC can be installed on an electrically conductive or a non-conductive rear plate, since the RFI filter is integrated and the screen from control cables and motor cable can be terminated in the VLT frequency converter.
If an electrically conductive rear plate is used, the VLT frequency converter must be installed with the lowest possible HF impedance to the rear plate, and the instructions for installation must be complied with.

RFI filter/IP20 for VLT 3575-3800 and 3542-3562 (230 V)

- The filter should be installed on the same panel as the frequency converter. The panel must be electrically conductive. Both the frequency converter and the filter must have a good high-frequency connection to the panel.
- The filter should be connected as close as possible to the frequency converter input, the maximum distance being 1 metre.
- The mains filter should be earthed at both ends.
- Before mounting the filter on the panel, remove any surface treatment, etc.

NB!
The filter must be earthed before connection to mains.

RFI module IP54 for VLT 3575-3800 and 3542-3562 (230V)

1. Remove the access plate and the Philips screws in the right-hand side of the VLT 3500 HVAC (save the screws for the access plate for later use).
2. Place the IP54 RFI option on the right-hand side of the VLT 3500 HVAC.

Motor cable

In order to comply with the EMC specifications concerning emission and immunity, the motor cable must be screened unless otherwise stated for the mains filter in question. It is important to keep the motor cable as short as possible so as to reduce the interference level and the leakage currents to a minimum.

The motor cable screen should be connected to the metal cabinet of the frequency converter and to the metal cabinet of the motor. Screen connections should be made using as large a surface (cable clamp, cable union) as possible. This has been achieved by different installation devices in the different VLT frequency converters (see the instructions for installation, **pp.** 21-22, item D). Mounting with twisted screen ends (pigtails) should be avoided, since this reduces the screening effect at higher frequencies. The motor cable screen should basically not be broken and not be earthed between the motor and the drive. If it becomes necessary to break the screen to install a motor guard or motor relays, the screen should be continued past the relays at the lowest possible HF impedance.

■ **Control cables**

Control cables should be screened. The screen should be connected using a clamp to the VLT frequency converter chassis (see the instructions for installation, pp. 21-22, item C). Normally, the screen should also be connected to the PLC or similar of the controlling device (follow the instructions for use of the device in question).

In connection with very long control cables and analogue signals, 50 Hz ripple loops may occur in rare cases, depending on the installation. This is because of interference coupling from the mains supply cables. In this connection it can be necessary to break the screen or possible insert a 100 nF capacitor between screen and chassis.

■ **Cable for serial communication**

The cable for serial communication should be screened.

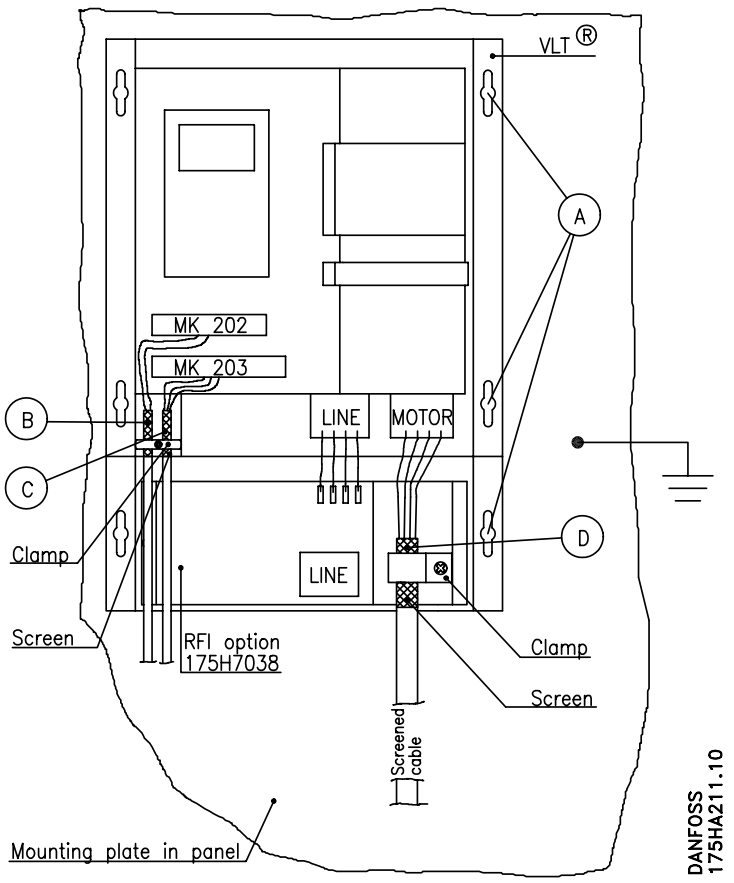
The screen should be installed using a clamp on the VLT frequency converter (see the instructions for installation, **pp.** 21-22, item B).

With regard to cable specifications and instructions for installation in general, reference is made to the PROFIBUS product manual.

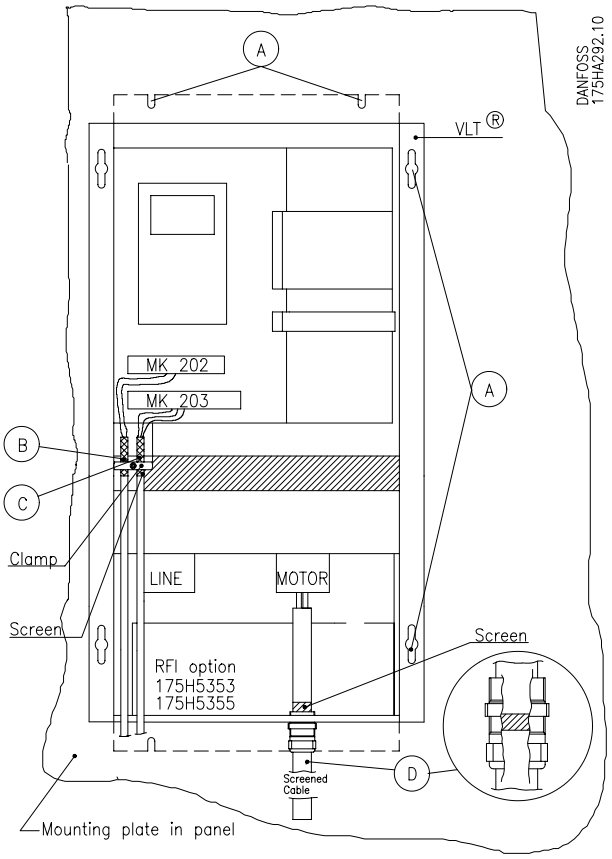
■ **Equalising currents**

Efforts should be made to avoid possible equalising currents that may occur when the control cable screen is connected to the chassis (earthed) at both ends. Equalising currents occur because of voltage differences between the VLT frequency converter chassis and the chassis of the controlling device. They can be avoided by making a tight fit with the cabinet chassis rear plate, thereby ensuring that any equalising currents will run via the chassis rear plates and their joints, not via the cable screens.

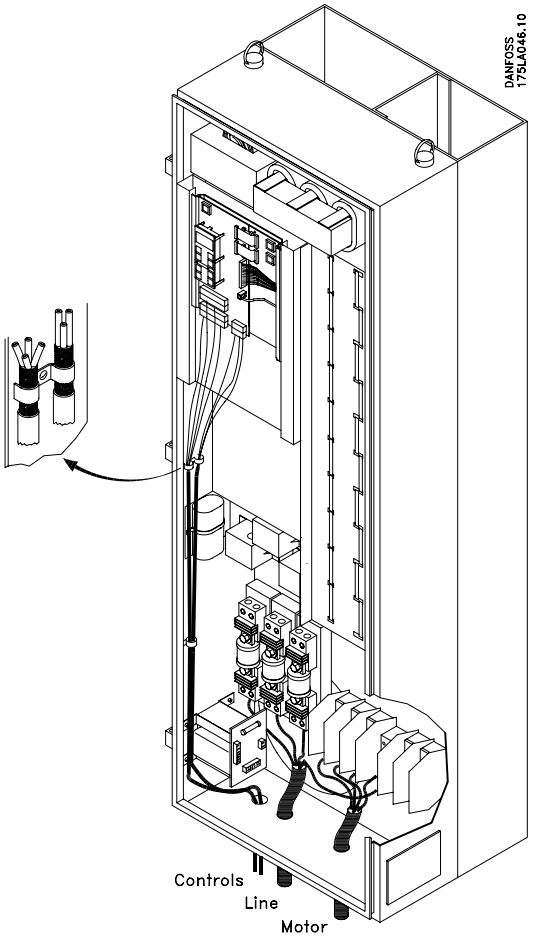
VLT 3502-3511



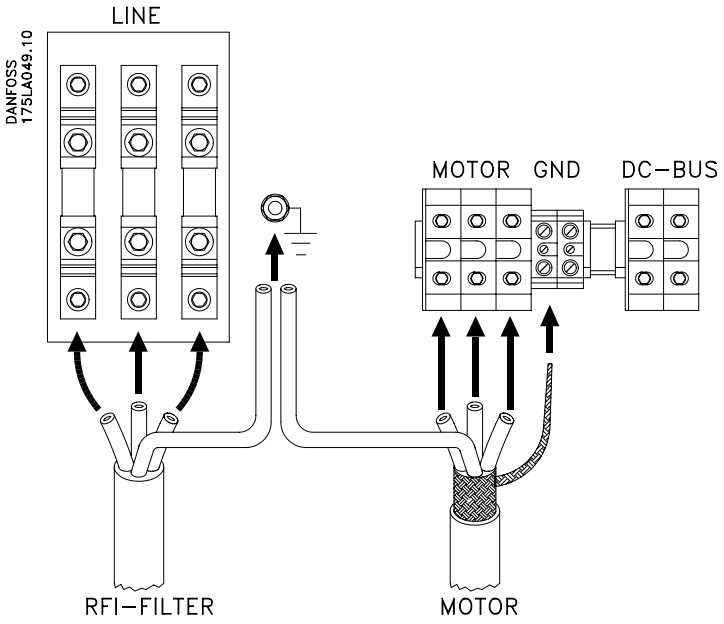
VLT 3516-3562



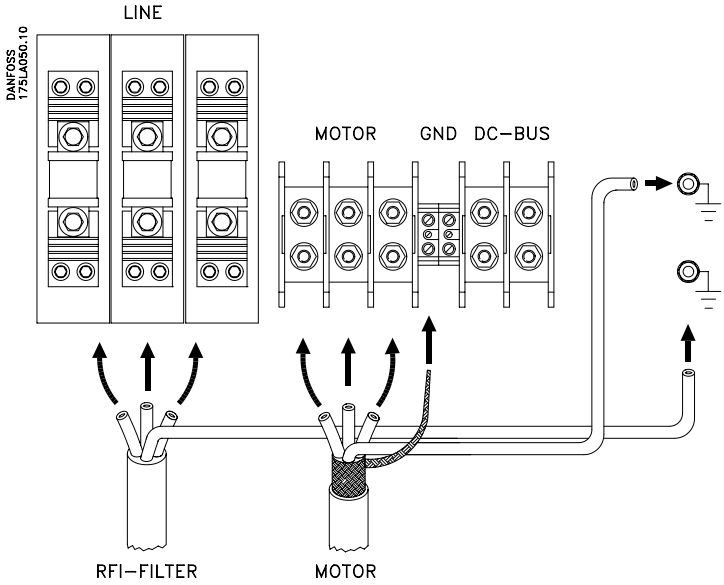
VLT 3575-3800 and
VLT 3542-3562, 230 V



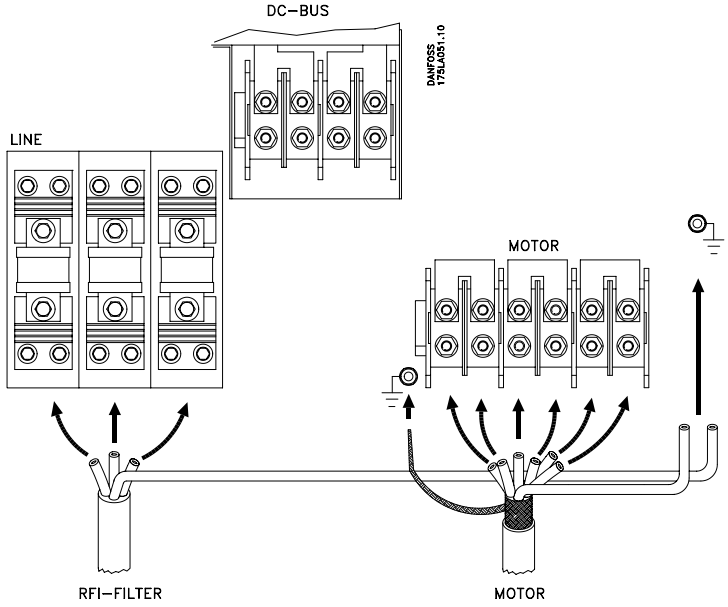
VLT 3542-3562, 230V.
VLT 3575-3600, 400/500V.



VLT 3625-3700



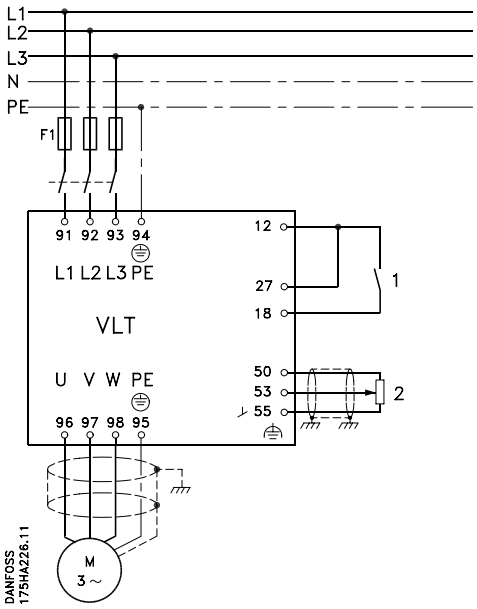
VLT 3750-3800



■ Installation examples

■ Example 1:

A fan is to be speed-controlled at between 0 and 50 Hz. A potentiometer 0-10 V is used as control signal.



NB!:
Screen for control cables must be connected as described in the chapter on EMC-correct installation.

All settings are based on factory settings; however, motor data settings (parameters 104, 105 and 107) (or the Quick Set-up menu items 1, 2 and 3) are to be adjusted to the motor connected.

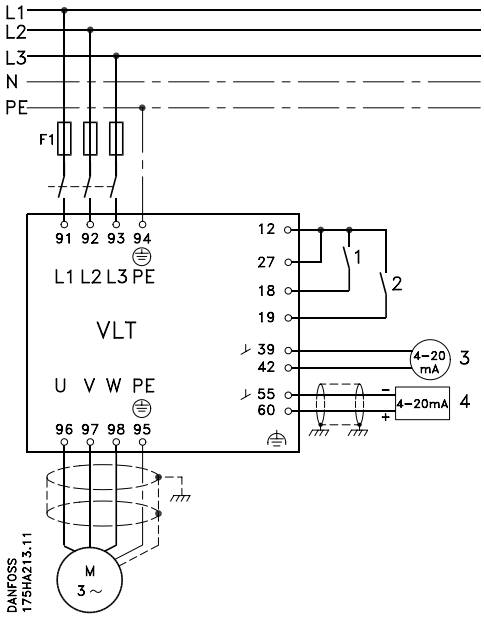
1 = Start/Stop
2 = 1 K Ω potentiometer

■ **Example 2:**

In a ventilating system an option of reversing the fan in the case of fire is desired, so that flue gases can be removed or fresh air blown in.

The control signal used is 4-20 mA, corresponding to 0-100% motor speed, typically 0-50 Hz.

Information is desired on the output frequency, i.e. an expression of the motor speed. The analogue output 4-20 mA is used. 4 mA corresponds to 0 Hz and 20 mA corresponds to the max. output frequency, normally 50 Hz.



NB!:
Screen for control cables must be connected as described in the chapter on EMC-correct installation.

All settings are based on factory settings; however, motor data settings (parameters 104, 105 and 107) (or the Quick Set-up menu items 1, 2 and 3) are to be adjusted to the motor connected.

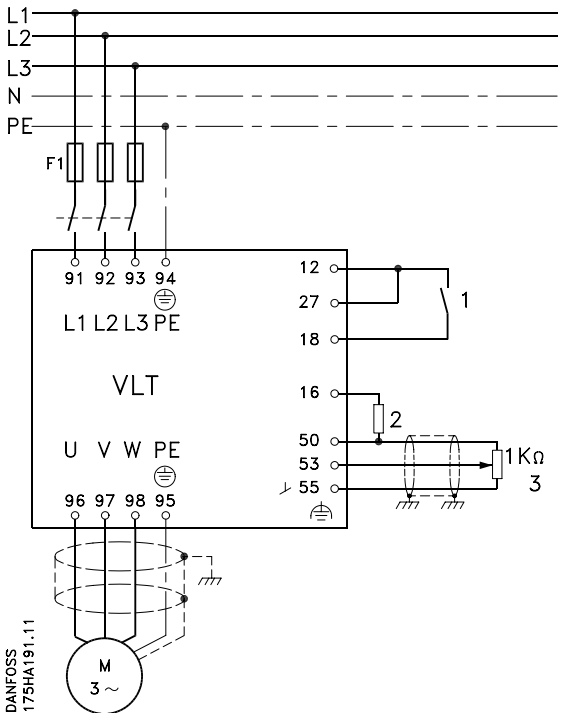
1 = Start/Stop
2 = Reversing
3 = 4-20 mA
4 = 4-20 mA

The following must be programmed:

Function	Parameter no.	Parameter value	Data value no.
0-f_{MAX}	407	f_{MAX} = 4-20 mA	[20]
Reference	413	4-20 mA	[2]

■ **Example 3:**

A fan is to be controlled manually by means of a potentiometer 0-10 V, corresponding to 0-50 Hz.
A thermistor is installed in the motor to obtain optimum motor protection. Connection is established to VLT 3500 HVAC.



NB!:
Screen for control cables must be connected as described in the chapter on EMC-correct installation.

All settings are based on factory settings; however, motor data settings (parameters 104, 105 and 107) (or the Quick Set-up menu items 1, 2 and 3) are to be adjusted to the motor connected.

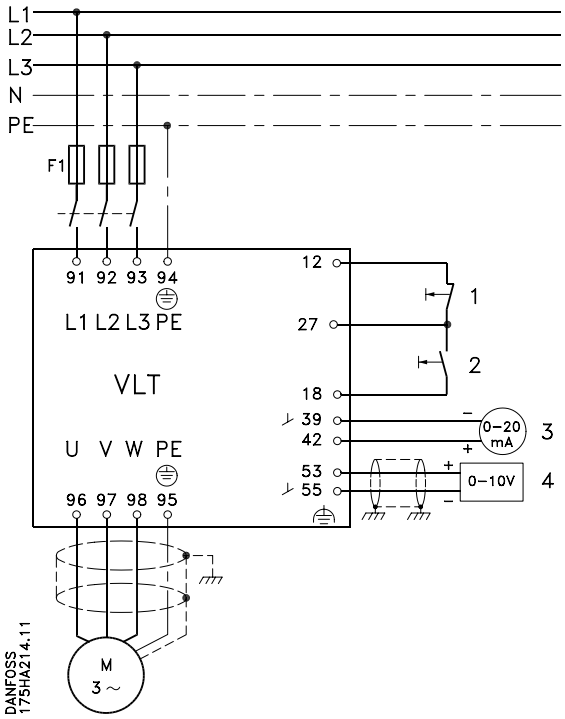
1 = Start/Stop
2 = Thermistor
3 = 1 kΩ Potentiometer

The following must be programmed:

Function	Parameter no.	Parameter value	Data value no.
Thermistor on terminal 16	400	THERMISTOR	[4]

■ **Example 4:**

A pump is to be controlled by means of a 0-10 V control signal, corresponding to 0-50 Hz.
"Start/Stop" is to be in the form of a 3-wire.
"Start/Stop".
It is required to obtain information about the output current via the anolog output. 0-20 mA corresponds to zero to max. output current.



NB!:
Screen for control cables must be connected as described in the chapter on EMC-correct installation.

All settings are based on factory settings; however, motor data settings (parameters 104, 105 and 107) (or the Quick Set-up menu items 1, 2 and 3) are to be adjusted to the motor connected.

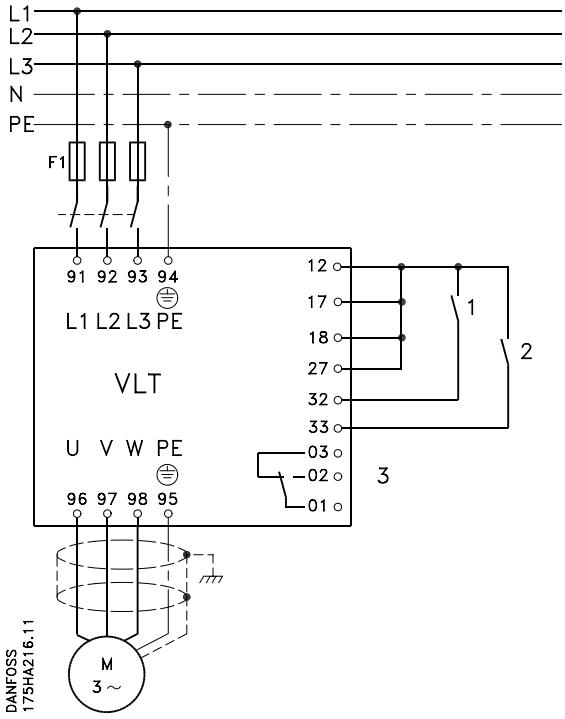
1 = Stop
2 = Start
3 = 0-20 mA output signal (0-I_{MAX})
4 = 0-10 V control signal (0-100% speed)

The following must be programmed:

Function	Parameter no.	Parameter value	Data value no.
STOP	404	STOP	[4]
START	402	LATCH START	[1]
0-I_{MAX}	407	I_{MAX} 0-20 mA	[25]
Reference	412	0-10 V DC	[1]

■ **Example 5:**

The output frequency of the frequency converter and thus the motor speed are to be controlled by means of digital signals, e.g. from a PLC or using push-buttons. Whenever the output frequency is outside the 10-45 Hz range, the relay output must be activated.



NB!:
Screen for control cables must be connected as described in the chapter on EMC-correct installation.

All settings are based on factory settings; however, motor data settings (parameters 104, 105 and 107) (or the Quick Set-up menu items 1, 2 and 3) are to be adjusted to the motor connected.

1 = Speed up
2 = Speed down
3 = Relay is activated when the output frequency is outside the 10-45 Hz range, i.e. connection 02-01.

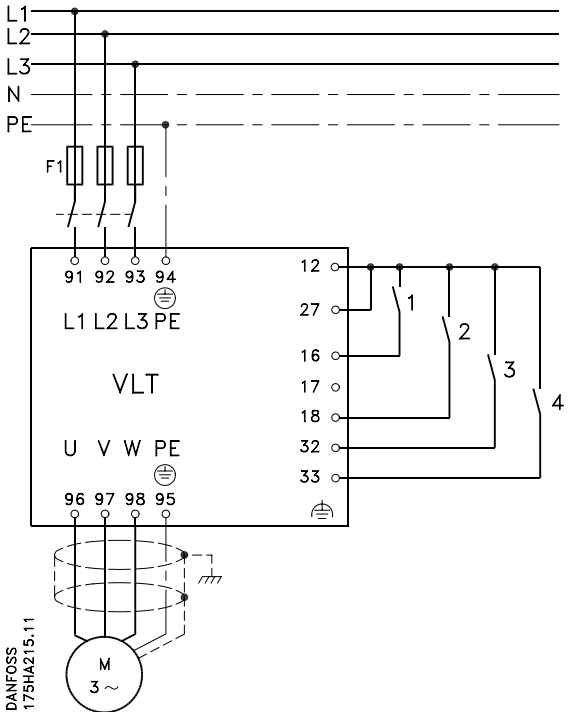
The following must be programmed:

Function	Parameter no.	Parameter value	Data value no.
Speed up and down	401	FREEZE REF.	[2]
Speed up and down	406	SPEED UP/DOWN	[1]
Frequency warning on relay	409	OUT FREQ RGE	[11]
Frequency too low	210	10 Hz	
Frequency too high	211	45 Hz	

■ **Example 6:**

A ventilation system is to be run at 6 fixed speeds, depending on the time of the day or night.
Max. speed is 60 Hz.

1. Speed 6 Hz (10%)
2. Speed 12 Hz (20%)
3. Speed 18 Hz (30%)
4. Speed 24 Hz (40%)
5. Speed 42 Hz (70%)
6. Speed 60 Hz (100%)



NB!:
Screen for control cables must be connected as described in the chapter on EMC-correct installation.

All settings are based on factory settings; however, motor data settings (parameters 104, 105 and 107) (or the Quick Set-up menu items 1, 2 and 3) are to be adjusted to the motor connected.

1 = Set-up choice
2 = Start/stop
3 = Digital reference choice
4 = Digital reference choice

The following must be programmed:

Function	Parameter no.	Parameter-value	Data value no.
Choice of set-up	001	MULTISETUP	[5]
Choice of set-up	400	SETUP SELECT	[3]
Digital reference choice	406	DIGITAL REF.	[0]
Set-up 1			
Max. frequency	202	60 Hz	
Digital reference 1	205	10%	
Digital reference 2	206	20%	
Digital reference 3	207	30%	
Digital reference 4	208	40%	
Set-up 2			
Max. frequency	202	60 Hz	
Digital reference 1	205	70%	
Digital reference 2	205	100%	

How to activate different speeds

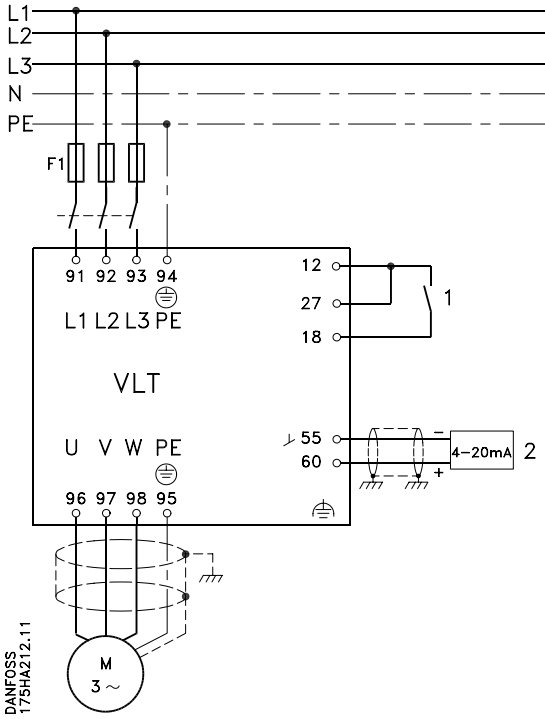
Terminal			Set-up		Digital reference			
33	32	16	1	2	1	2	3	4
0	0	0	X	0	10%	0	0	0
0	1	0	X	0	0	20%	0	0
1	0	0	X	0	0	0	30%	0
1	1	0	X	0	0	0	0	40%
0	0	1	0	X	70%	0	0	0
0	1	1	0	X	0	100%	0	0

"1" means that 24 V DC is connected to the terminal.

■ **Example 7:**

In a pump system, a constant pressure of 5 bar is to be maintained. The integrated PID regulator in VLT 3500 HVAC is used. Normal regulation is desired, in which the speed is reduced when the pressure increases and vice versa, i.e. that the speed goes up when the pressure drops.

The transmitter used is a 4-20 mA, 0-10 bar type. Since a pressure of 5 bar is required, this corresponds to 50% of the working range of the transmitter, which in turn corresponds to the setpoint programmed as internal setpoint in VLT 3500 HVAC. (Digital reference = 50%). The min. speed must be 10 Hz and the max. speed 50 Hz.



NB!:
Screen for control cables must be connected as described in the chapter on EMC-correct installation.

All settings are based on factory settings; however, motor data settings (parameters 104, 105 and 107) (or the Quick Set-up menu items 1, 2 and 3) are to be adjusted to the motor connected.

1 = Start/Stop
2 = Feedback pressure transmitter 4-20 mA, 0-10 bar

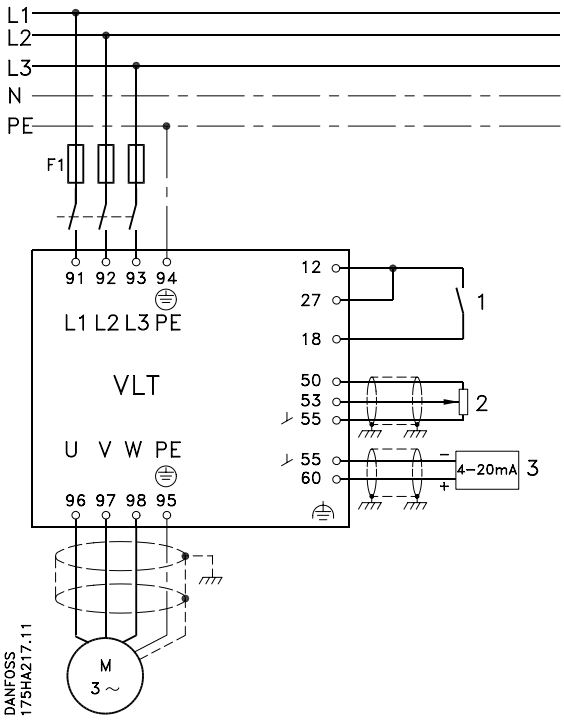
The following must be programmed:

Function	Parameter no.	Parameter value	Data value no.
Activation of PID-regulator	101	CLOSED LOOP	[2]
Internal setpoint	205	50%	
Feedback type	114	CURRENT	[1]
Current signal	413	4-20 mA	[2]
Min. speed	201	10 Hz	
Max. speed	202	50 Hz	
Regulator range	120	Application-dependent	
Proportional gain	121	Application-dependent	
Integration time	122	Application-dependent	
Ref. independent of minimum speed	411	Prop w/min	[1]

■ **Example 8:**

In a ventilation system the temperature is to be adjustable by means of a 0-10 V potentiometer.
The selected temperature must be kept constant, and the internal PID regulator is to be used. The regulation required is of the inversed type; this means that when the temperature goes up, the fan speed increases so that more air is supplied.

When the temperature drops, the speed goes down. The transmitter used is a temperature sensor with a working range of 0-50°C 4-20 mA. In order to carry out inverse regulation, VLT 3500 HVAC is programmed to convert the temperature transmitter signal (4-20 mA) to 20-4 mA.
The min./max. speed is 10/50 Hz.



NB!:
Screen for control cables must be connected as described in the chapter on EMC-correct installation.

All settings are based on factory settings; however, motor data settings (parameters 104, 105 and 107) (or the Quick Set-up menu items 1, 2 and 3) are to be adjusted to the motor connected.

1 = Start/Stop
2 = Temperature reference 0-50° C, 0-10 V
3 = Temperature transmitter 0-50° C, 4-20 mA

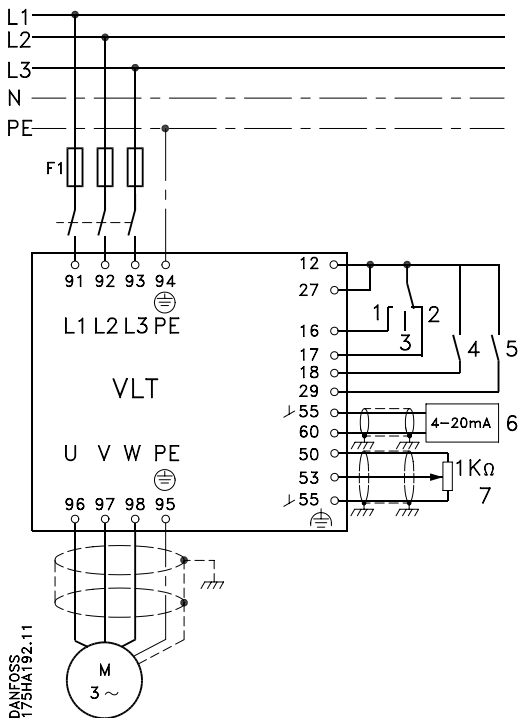
The following must be programmed:

Function:	Parameter no.	Parameter value	Data value no.
Activation of PID-regulator	101	CLOSED LOOP	[2]
Feedback type	114	CURRENT	[1]
Current signal	413	20-4 mA	[4]
Min. speed	201	10 Hz	
Max. speed	202	50 Hz	
Regulator range	120	Application-dependent	
Proportional gain	121	Application-dependent	
Integration time	122	Application-dependent	
Ref. independent of minimum speed	411	Prop w/min	[1]

■ **Example 9:**

In a ventilation system where there is no access to VLT 3500 HVAC, external switching between hand operation "Hand" and remote operation "Auto" on the frequency converter is required.

A 3-point switch is used that allows a choice between "Hand-Off-Auto". The "Hand" reference is a 0-10 V signal on a potentiometer. When VLT 3500 HVAC runs in the Auto mode, the frequency converter is controlled using a 4-20 mA reference.



NB!:
Screen for control cables must be connected as described in the chapter on EMC-correct installation.

All settings are based on factory settings; however, motor data settings (parameters 104, 105 and 107) (or the Quick Set-up menu items 1, 2 and 3) are to be adjusted to the motor connected.

1 = Activation of Hand Mode
2 = Activation of Auto Mode
3 = Stop
4 = Start Auto Mode
5 = Pulse Start Hand Mode
6 = Auto Mode reference, 4-20 mA
7 = Hand Mode reference, 0-10 V/1 KΩ

The following must be programmed:

Function:	Parameter no.	Parameter value	Data value no.
H-O-A position	003	EXT. HOA	[2]
Activation of Hand	400	EXT. HOA HAND	[5]
Activation of Auto	401	EXT. HOA AUTO	[7]
Pulse Start Hand	405	LATCH ST. HAND	[4]
Hand reference	420	VOLTAGE	[0]
Auto reference	413	4-20 mA	[2]

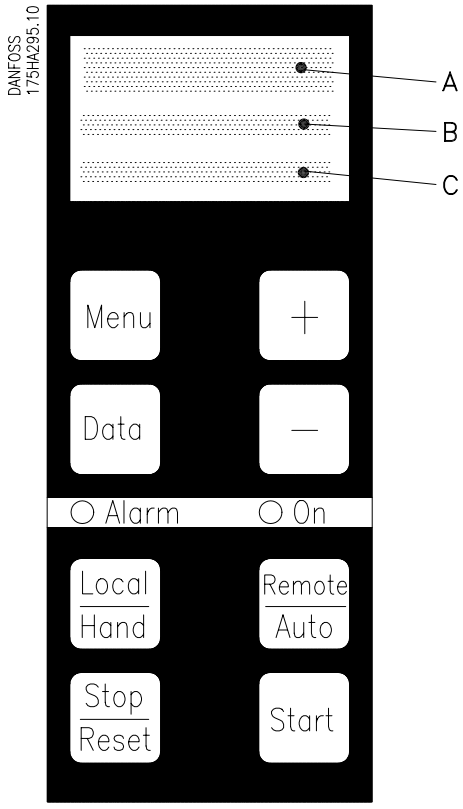
■ Operation and programming

■ Control panel

In order to programme and locally control the frequency converter, use the control panel at the front of the frequency converter.

The control panel serves a dual purpose:
- Local operation
- Programming

The control panel consists of:
- a display, which establishes a dialogue between the user and the frequency converter,
- some keys, which each have one or several functions (described later on in this chapter),
- two light diodes, which indicate:
  green (On): VLT 3500 HVAC is connected to supply mains
  red (Alarm): in case of an alarm.



■ Description of the display

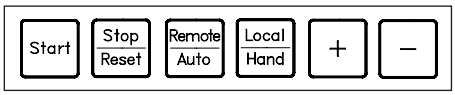
The display is designed to be lit whenever the frequency converter is connected to supply mains.

The display consists of 3 lines:

Line A	large print, 7 characters.
Lines B and C	small print, 14 characters.

■ Keys for local operation

The following keys are available on the frequency converter for local operation:



Start — This key is used for starting up VLT 3500 HVAC.

Local Hand — This key is used exclusively for local control of the frequency converter via the operating panel. When the key is activated, the operating panel display will show an image indicating that the frequency converter is in Local Mode. The key can be de-activated in parameter 010, see page 41.

\+ — These keys are used for changing the motor frequency in Local mode.

—

Image of Local Mode

Stop Reset — This key is used to stop the connected motor. If stop is activated, the top line in the display will start to flash. The key on the operating panel of the frequency converter does not turn off the mains supply and is thus not to be used as a safety switch.
The key is also used for resetting VLT 3500 HVAC after a trip occurence.
Furthermore, the Speed bar in Local Mode will change from filled-in squares, which is the speed, to unfilled squares in Stop Mode, which is the reference.
The local reference can also be seen in the bottom right-hand corner of the display (also in Stop Mode).

Remote Auto — This key is used to switch (back from local operation) to remote control (Remote Mode), in which control is effected via the control terminals of the frequency converter.

■ Keys for programming and control

The following buttons are available on the control panel of the frequency converter for the purpose of programming and control:

[Menu] This key is used for switching from Display Mode to Quick Set-up Mode.
If "Menu" is pressed once more, the system reverts to Display Mode.
The key is also used for switching from Data Mode to Menu Mode.

[Data] This key is used for switching from Menu Mode to Data Mode or Display Mode.
The key is also used for moving the cursor between the decimal points of the data values.
The programme automatically leaves Data Mode after 20 seconds if no operation is registered.
If the "Data" key is pressed once, it is possible to revert to Data Mode to program the parameter that was left after 20 seconds.

[+] [−] These keys are used for scrolling through the different Menu Modes and their parameters and for choosing a specific parameter value or for scrolling parameter data.

■ Combinations of control panel keys

[Menu] [Data] If these keys are pressed simultaneously, the system switches to Display Mode from any other Mode.

[Menu] [+] If these keys are pressed simultaneously, the system switches to Extended Menu from any Mode.

[Menu] [−] If these keys are pressed simultaneously, the system switches to the Quick Set-up Menu from any Mode.

[Menu] [+] [Menu] [−] The combination of "Menu" with the "+" and "-" keys must be activated simultaneously to avoid unwanted leaps to other Modes.

■ External H-O-A

(Hand-Off-Auto)

[Local / Hand] [Remote / Auto] The functions "Local"/"Hand" and "Remote"/"Auto" can be moved from the operating panel of the frequency converter to act as an external control option, where there is no direct physical access to the frequency converter, see example 9, page 32.
Via the control terminals of the frequency converter it is possible to activate "Hand", which gives the option of controlling the frequency converter manually by means of a control signal.
Subsequently, it is possible to switch back to "Auto", which is the normal remote operating mode, in which a general control system regulates the reference.

Hand-Off-Auto
“Hand-Off-Auto” is a function description taken over from the American market.

Hand
"Hand" is a function that focuses on manual operation.

Off
Off means that the inverter of the frequency converter has stopped.

Auto
"Auto" is a function in which operation is effected normally, i.e. via the control terminals of the frequency converter.

NB!:
The motor must be stopped by pressing "Stop/Reset" before the data values of certain parameters are changed.

■ Display Mode

In normal operation, VLT 3500 HVAC starts up in the Display Mode, in which there is an option of choosing between different read-outs. VLT 3500 HVAC comes with a factory-set Display Mode that allows a choice of the following display read-outs by means of the "+" and "-" keys:

Standard Display

1. Frequency Hz
2. Feedback
3. Current
4. Power kW
5. Energy kWh
6. Motor voltage V
7. Reference %

In parameter 606, see page 137, it is possible to choose between 2 different read-outs: Standard Display and Extended Display.

Extended Display

1. Reference %
2. Frequency Hz
3. Display/Feedback %
4. Current A
5. Torque %
6. Power kW
7. Power HP
8. Energy kWh
9. Motor voltage V
10. DC voltage V
11. Thermal motor load %
12. Thermal inverter load %

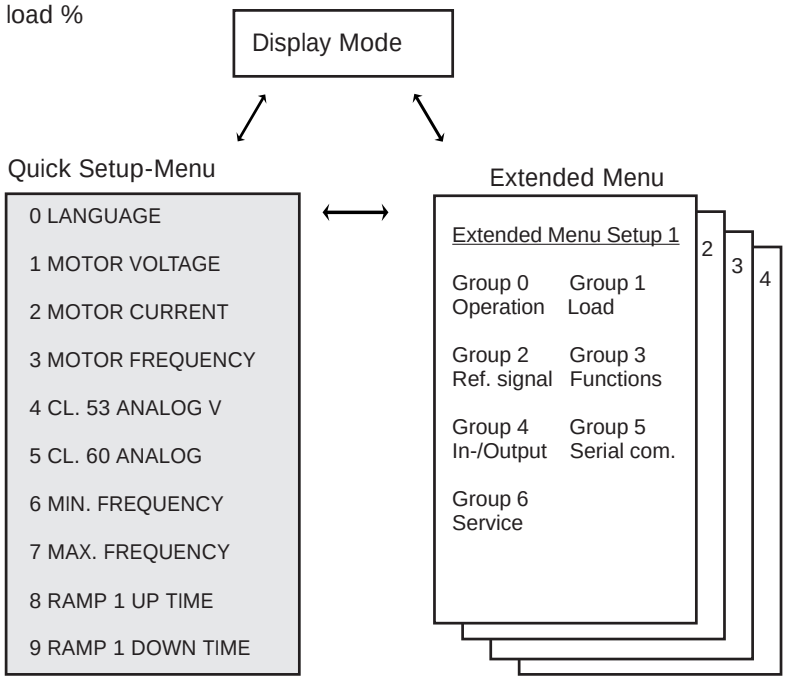
In parameter 605, see page 74, it is possible to programme a different display layout, in which 2 different read-outs can be defined at the same time.
Using the PID regulator, for example, it is possible to read out the reference (setpoint) and the feedback signal at the same time.

■ General software structure

Programming is carried out by changing the data values in the parameters that have been grouped in a menu, from which the most important parameters have been transferred to the Quick Set-up Menu (overall menu).
There are 2 different menus:

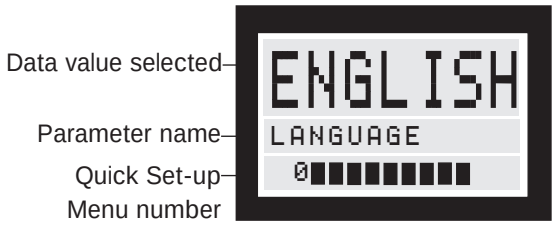
1. Quick Set-up Menu
2. Extended Menu

Parameters that are included in the Quick Set-up Menu are also included in the Extended Menu.
If a parameter in the Quick Set-up Menu is changed, it is automatically changed in the Extended Menu as well.
Certain parameters can be programmed for several set-ups, which means that application-dependent programming can be carried out.
Via the control inputs, the different set-ups can be selected.
As an example, one set-up may have no PID regulation, while another set-up has PID regulation.

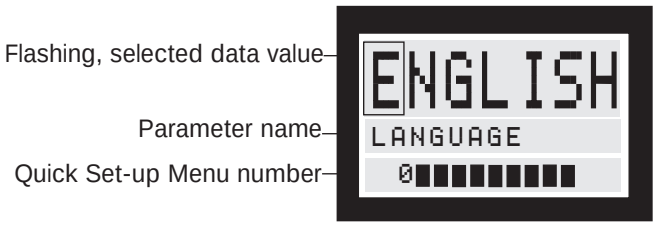


■ Display Mode

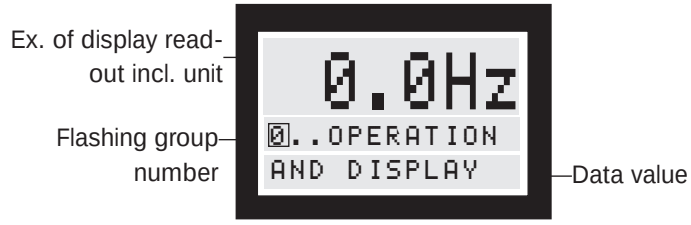
■ Quick Set-up Menu



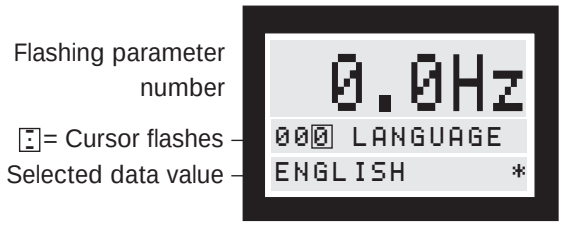
■ Quick Set-up Data Mode



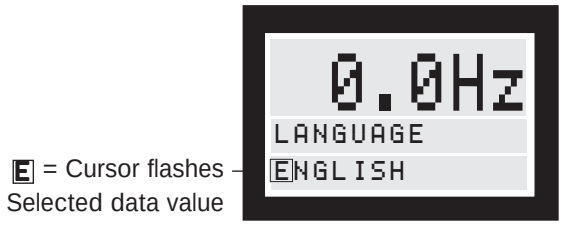
■ Extended Menu



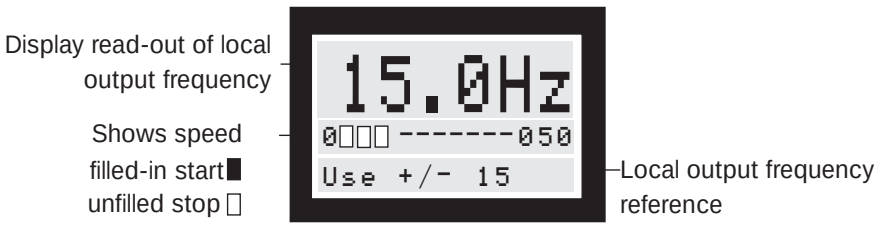
■ Extended Parameter Mode



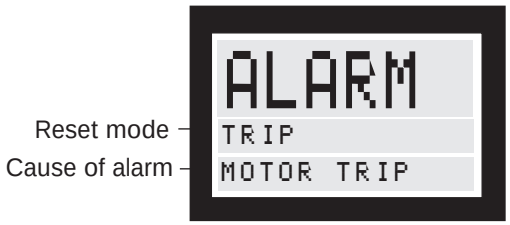
■ Extended Data Mode



■ Local/Hand Mode



■ Alarm Mode



NB!:
If the display reads TRIP, the frequency converter will have stopped. It is necessary to press the "Reset" key to restart VLT 3500 HVAC.

If the display reads LOCKED, the mains supply to VLT 3500 HVAC must be cut out and cut back in. Then press the "Reset" key to restart VLT 3500 HVAC.

■ Initialisation

Initialisation is used when wanting to go back to a known starting point (the factory setting).
This need arises if the software version is changed, or if the parameters have been changed so much that the starting point is no longer known, or if the unit starts acts unpredictably and cannot be reset in the normal way.
Initialisation is effected basically in two ways: Manual initialisation and initialisation via parameter 604.

■ Manual initialisation

Cut out the mains voltage and hold down the "Menu", "Data" and "Local Hand" keys while cutting the mains voltage back in. Release the keys when the 3rd line on the display reads INIT EEPROM.
When INIT EEPROM is no longer displayed in the 3rd line, the factory setting has been programmed into the unit.

This method is used:

When introducing another software version.
Manual setting means:

- First-time set-up of communication parameters to ensure factory setting (these parameters are set from the operating panel of the unit):

  Standard
  (RS 485) 500 Address
  501 Baud Rate

  Profibus 820 Baud Rate
  821 FMS/DP select
  822 Station Delay
  904 PPO Write
  918 Station Address

- Reset of operating data such as kWh and total number of running hours (parameter 600), as well as alarm memory (parameter 602).

- Initialisation of all other parameters, as described under initialisation via parameter 604.

■ Initialisation via parameter 604

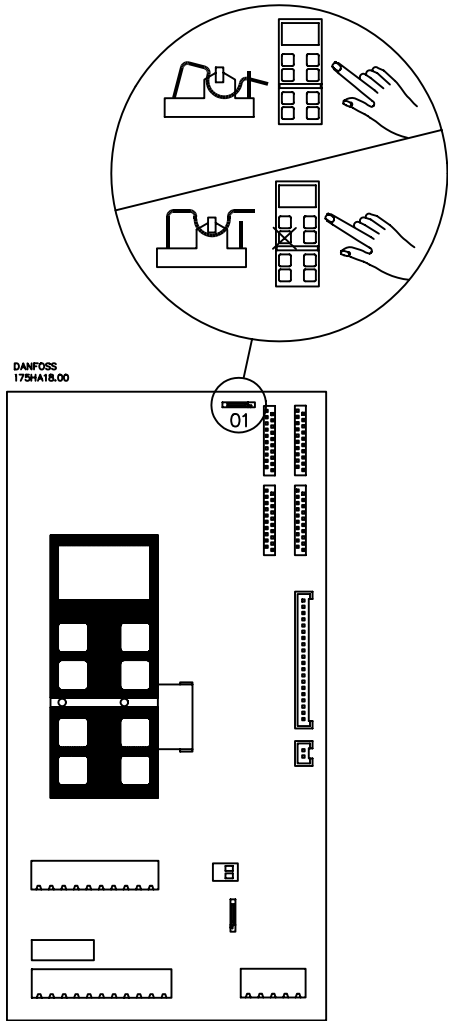
This method is used:

- When initialising all parameters to the factory setting, except:

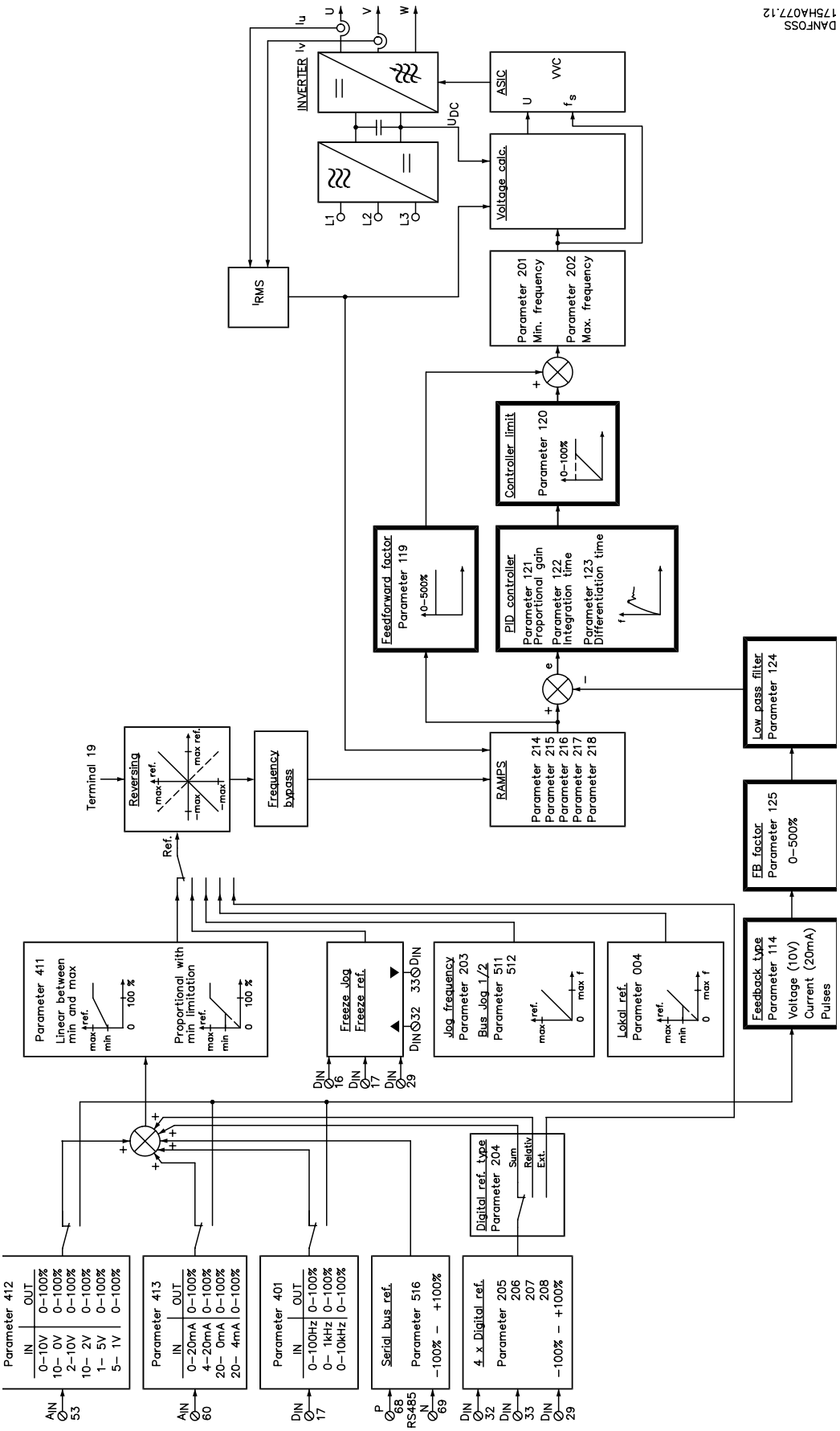
Communication parameters (parameters 500 and 501) and the stated Profibus parameters if this option has been installed.
Operating data (parameter 600)
Alarm memory (parameter 602)
NB! If factory setting of data is only wanted in a single set-up, the *Pre-programme* can be selected in parameter 001.
In parameter 002, copying from this setting to the selected set-up is carried out.

■ "Lock" switch

Unwanted programming can be avoided by opening the switch pin 01 on the control card.
When the switch pin is open, the programming function of the operating panel is locked.
If Local Mode is active, the local reference can still be changed.



■ Parameter overview



■ Programming

■ Operation and display, group 0..

This group comprises parameters that concern display read-outs, local operation and the handling of set-ups.

000 Language (LANGUAGE)

Value:

★	English (ENGLISH)	[0]
	German (DEUTSCH)	[1]
	French (FRANCAIS)	[2]
	Danish (DANSK)	[3]
	Spanish (ESPANOL)	[4]
	Italian (ITALIANO)	[5]

Function:

The choice in this parameter defines the language of the display.

Description of choice:

There is a choice of *English, German, French, Danish, Spanish* and *Italian.*

---

001 Set-up choice, operation (SETUP OPERATIO)

Value:

	Pre-programmed (FACTORY SET)	[0]
★	Setup 1 (SETUP 1)	[1]
	Setup 2 (SETUP 2)	[2]
	Setup 3 (SETUP 3)	[3]
	Setup 4 (SETUP 4)	[4]
	Multisetup (MULTI SETUP)	[5]

Example:

Setup	Terminal 17	Terminal 16
1	0	0
2	0	1
3	1	0
4	1	1

Function:

The choice in this parameter defines the set-up number you want to control VLT 3500 HVAC. The parameters that can be changed are stated on page 85-86. If more set-ups are required, up to four different ones can be selected. If you want to remote-control the choice between the different set-ups, this can be done from terminals 16/17 or 32/33, as well as via the serial port (RS 485).

Description of choice:

The pre-programme [0] contains the data set at the factory. Can be used as data source if the other set-ups are to be returned to a known state. The language used is English.

It is not possible to change data when this set-up has been chosen, but via parameter 002 it is possible to copy to one or several set-ups.

Set-ups 1-4 [1]-[4] are four individual set-ups for use as desired. Changes can be made to the currently active set-up; such changes have an immediate effect on the functioning of the unit. However, certain parameters require a Stop Mode before being changed.

Multi set-up [5] is used if remote control of more than one set-up is required. Terminal 16/17 (par. 400/401), terminal 32/33 (par. 406) or the serial bus can be used for switching between set-ups.

---

002 Copy of set-ups (MENU SET COPY)

Value:

★	No copying (DO NOT COPY)	[0]
	Copy to 1 from # (COPY TO 1 FROM)	[1]
	Copy to 2 from # (COPY TO 2 FROM)	[2]
	Copy to 3 from # (COPY TO 3 FROM)	[3]
	Copy to 4 from # (COPY TO 4 FROM)	[4]
	Copy to ALL from # (COPY ALL FROM)	[5]

Function:

A menu set-up can be copied to one of the other set-ups or to all the other set-ups simultaneously, although not to set-up [0].

Copying is only enabled in Stop Mode.

Description of choice:

The copying starts when you have entered the desired copying function and Data Mode is left by pressing the "Menu" key, or left automatically after 20 seconds.

Line 3 in the display flashes while copying is in progress. The display indicates the destination set-up and the source set-up. It is always the active set-up that is being copied from (chosen in parameter 001), or the set-up chosen via terminals 16/17 or 32/33). When copying has been completed, the data value shifts automatically to *No copying* [0].

★ = factory setting. Text in ( ) = display text. Figures in [ ] are used when communicating with the bus.

003 Local/remote control (LOCAL / REMOTE)

Value:

★	Use keypad (KEYPAD HOA)	[0]
	Use keypad w/ext. stop (LOC/EXT STOP)	[1]
	Extern H-O-A [EXT H-O-A]	[2]

Function:

There is a choice of three different Local/remote control modes for controlling VLT 3500 HVAC: *Use keypad, use keypad w/external stop and External H-O-A. External H-O-A* is used in cases where externally from the frequency converter a control feature is to be used which allows switching between "Hand" (manual operation) and "Auto" (control via general control system).
If *External H-O-A* is chosen, the "Local Hand" key cannot be used directly on the control panel of the frequency converter.

Description of choice:

If *Use keypad* [0] is selected, the speed can be controlled directly on the control panel of the frequency converter by activating the "Local/Hand" key. The "Stop" key is active on the control panel of the frequency converter, unless it has been disregarded in parameter 007. When shifting between "Local/Hand" and "Remote/Auto", a possible local speed reference will not be saved.
If *Use keypad w/ext. stop* [1] is selected, the frequency converter can be stopped by breaking the connection between terminal 12 (24 V DC) and terminal 27 (Q-stop). Terminal 27 (Q-stop) must be programmed for *Coast stop* [0] or *Reset and Coast stop* [3] in parameter 404.
If *External H-O-A* [2] is selected, shifting is possible between "Hand" (manual operation) and "Auto" (control from general control system) via the control terminals of the frequency converter, as programmed in parameters 400-403. "Latch Start Hand" is programmed in parameter 403 or 405. The reference type for "Hand" control is selected in parameter 420.

004 Local reference (LOCAL SPEED)

Value:

0.00 - f_{MAX}

Function:

A Local reference can be programmed in parameter 004. If the programmed Local reference is to be active, the "Local/Hand" key must have been activated. When shifting between "Local/Hand" and "Remote/Auto", the local speed reference will be retained.

Description of choice:

The speed can be set directly in Hz. The set value is saved after 20 seconds. The setting is saved and is also active after a mains drop-out.
In this parameter Data Mode is not left automatically.
The Local reference cannot be controlled via RS 485.
Data changes in parameter 004 are blocked if parameter 010 is programmed as DISABLE.

The motor may start without warning if parameter 014 is changed to Auto restart [0].

005 User read-out (VALUE AT MAX)

Value:

	1-9999	★ 100

Function:

By choosing the DISPLAY/FEEDBACK function in Display Mode, a user read-out can be obtained which is a scaling of the reference sum if "Open loop" has been selected in parameter 101.
The unit to be used can be chosen in parameter 117.

Description of choice:

The programmed value will be displayed when the output frequency is equal to f_{MAX} (parameter 202).

006 Local reset (LOCAL RESET)

Value:

	Not possible (DISABLE)	[0]
★	Possible (ENABLE)	[1]

007 Local stop (LOCAL STOP)

Value:

	Not possible (DISABLE)	[0]
★	Possible (ENABLE)	[1]

008 Local/Hand (KEY LOCAL/HAND)

Value:

	Not possible (DISABLE)	[0]
★	Possible (ENABLE)	[1]

★ = factory setting. Text in ( ) = display text. Figures in [ ] are used when communicating with the bus.

009 Remote/Auto (KEY REMOTE/AUTO)

Value:

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

Function:

In parameters 006, 007, 008 and 009 it is possible to select/remove the function in question from the keyboard.

Description of choice:

If *disable* [0] is selected in parameters 006, 007, 008 and 009, the function in question cannot be used from the keyboard.

---

010 Local speed selection (LOC REFERENCE)

Value:

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

Function:

The possibility of changing the local speed reference via parameter 004 can be selected/removed.

Description of choice:

If *disable* [0] is selected in parameter 010, the local speed reference cannot be changed via parameter 004.

---

011 Reset of kWh (ENERGY COUNTER)

Value:

★ No reset (NO RESET)
Reset (RESET)

Function:

Zeroing of kW energy counter.

Description of choice:

Reset is initiated when RESET has been selected and the Data Mode is exited. Cannot be selected via the serial bus, RS 485.
NB! When RESET has been selected, zeroing has been completed.

---

012 Reset of hours run (HOUR COUNTER)

Value:

★ No reset (NO RESET)
Reset (RESET)

Function:

Zeroing of hours run (see also parameter 600). This counter of hours of operation is activated when VLT 3500 HVAC receives its start signal.

Description of choice:

Reset starts when Data Mode is exited. Cannot be chosen via the serial bus, RS 485.

---

014 Power Up Mode (POWERUP MODE)

Value:

Auto restart in local operation, use saved ref. (AUTO RESTART) [0]
★ Stopped in local operation, use saved ref. (LOC=STOP) [1]
Stopped in local operation, set ref. to 0 (LOC=STP+REF=0) [2]

Function:

When the "Local/Hand" key has been activated and the frequency converter is running with Local speed reference, or if FREEZE REFERENCE is used, it is possible to programme the state in which the frequency converter is to start up when the mains supply is cut back in.

Description of choice:

Auto restart in local operation, use saved ref. [0] is selected if the unit is to start up with the local speed reference that was in force when the mains supply was cut out.
Stopped in local operation, use saved ref. [1] is selected if the unit is to remain stopped when the mains supply is connected until the "Start" key is activated. After the start command, the saved, local speed reference is used.
Stopped in local operation, set ref. to 0 [2] is selected if the unit is to remain stopped when the mains supply is connected. Local Reference (par. 004) and Freeze Reference (par. 400, 401 or 405) are zeroed.
If remote control is used together with a Freeze Reference function when cutting out the mains supply, Freeze Reference will be zeroed when the mains supply is cut back in.
Consequently, the speed needs to be reset using the Speed up function (e.g. par. 406).

NB!:
In remote-controlled operation, the restart function is always an "Auto Restart". If the unit is to remain stopped after connection to mains, select Pulse Start in par. 402. However, it is a condition in this connection that the start function is not activated.

★ = factory setting. Text in ( ) = display text. Figures in [ ] are used when communicating with the bus.

015 Set-up choice, Programming

(SETUP PROGRAM.)

Value:

Pre-programmed	(FACTORY SET)	[0]
Setup 1	(SETUP 1)	[1]
Setup 2	(SETUP 2)	[2]
Setup 3	(SETUP 3)	[3]
Setup 4	(SETUP 4)	[4]
★ Set-up=Parameter 001	(SETUP=P001)	[5]

Function

It is possible to choose the menu set-up that is to be programmed (whose data are to be changed) during operation.

The 4 menu set-ups can be programmed independently of the set-up in which VLT 3500 HVAC is running (selected in parameter 001). This concerns programming via the keyboard and the serial bus (RS 485).

Description of choice:

Pre-programmed [0] contains the factory-set data and can be used as a source for data. The language is always English. It is not possible to change data with this set-up selected.

Set-ups 1-4 [1]-[4] are 4 individual set-ups which can be used as desired. They can be programmed independently of the set-up currently used.

Setup = Parameter 001 [5] is the pre-selected value normally used. This function can be removed if access to programming other set-ups than the one applied is required during operation.

NB!:
If data is changed in the set-up being used, these changes have immediate effect on the functioning of the unit. This applies to both parameters 001 and 015.

★ = factory setting. Text in ( ) = display text. Figures in [ ] are used when communicating with the bus.

Load and motor, group 1..

This group of parameters has been reserved for the adjustments necessary to adapt VLT 3500 HVAC to the application and motor.

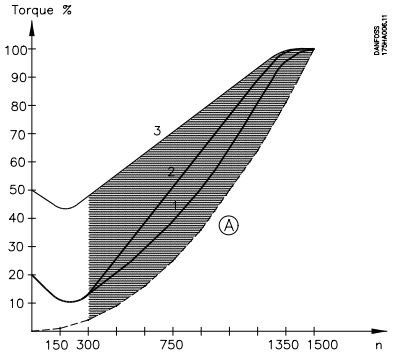
100 Load (LOAD TYPE)	
Value:	
Variable torque low (VT MODE-LOW)	[0]
Variable torque medium (VT MODE-MED)	[1]
Variable torque high (VT MODE-HIGH)	[2]
Variable torque low with constant torque start (VT LOW W/CT)	[3]
Variable torque, medium, with constant torque start (VT LOW MED W/CT)	[4]
Variable torque, high, with constant torque start (VT HIGH W/CT)	[5]
No operation (NO OPERATION)	[6]
No operation (NO OPERATION)	[7]
No operation (NO OPERATION)	[8]
Variable torque with AEO function and constant torque start (ENERGY CT.ST)	[9]
★ Variable torque, low, with AEO (ENERGY VT.L)	[10]
Variable torque, medium, with AEO (ENERGY VT.M)	[11]
Variable torque, high, with AEO (ENERGY VT.H)	[12]

Function:

The adjustment of VLT 3500 HVAC's U/f characteristic to the load characteristic from centrifugal pumps or fans.

With the factory setting [10], the AEO function (Automatic Energy Optimizing) is active. This means that the frequency converter automatically adjusts the voltage to the current load from the pump or fan motor, which ensures optimum efficiency and optimally reduced motor noise. The AEO function is active from 20% of f_{MAX} (parameter 202).

NB!:
Where parallel motors are to be installed, it is not advisable to use the AEO function.



Area where the AEO- function will typically be active

1. VT low

2. VT medium

3. VT high

A. Theoretically square torque curve for centrifugal pumps and fans.

Description of choice:

Variable torque (VT) low [0], *medium* [1] *or high* [2] is chosen if the load is square (centrifugal pumps, fans). The choice of torque characteristic should be made taking into account the need for trouble-free operation, minimum energy consumption and the lowest possible acoustic noise level. *Variable torque (VT) low* [3], *medium* [4] *or high* [5] *with constant torque (CT) start* is selected if there is a need for a greater break-away torque than that obtainable with the three first-mentioned characteristics.

The curve for constant torque is followed, until the set reference is reached; from that point onwards the characteristic chosen for variable torque is followed. *Variable torque with AEO function and constant torque start* [9] is selected if the variable torque characteristic is unknown and there is a need for a high break-away torque.

Variable torque low [10], *medium* [11] *and high* [12] with AEO is selected where, in the start-up situation, a load characteristic has to be followed which corresponds to variable torque low, medium and high up to 20% of f_{MAX}, parameter 202.

The AEO function is now active; it adjusts the voltage to the optimum load characteristic, which provides optimum efficiency and optimally low motor noise. There is only one AEO-curve available for VLT 3575-3800 and 3542-3562, 230 V. Even if [10], [11] or [12] is programmed the device uses the AEO VT LOW curve.

101 Speed Control (SPEED CONTROL)

Value:

★ Open loop (OPEN LOOP) [0]
Closed loop (CLOSED LOOP) [2]

Function:

It is possible to choose two different kinds of speed control: *Open loop* and *closed loop*.

Description of choice:

Open loop [0] is chosen if an external control without process feedback is desired. *Closed loop* [2] is chosen to use the integrated PID controller of the VLT 3500 HVAC. A detailed description is shown on page 47.

102 Setting of current limit (SET CUR. LIMIT)

Value:

★ Pre-programmed value (PROGRAM.VALUE) [0]
Voltage signal (10 V DC SIGNAL) [1]
Current signal (20 mA SIGNAL) [2]

Function:

Speed can be controlled by means of the current limit, which allows indirect control of the torque.
The current limit can be set in parameter 209, or by means of a current or voltage signal in parameter 412 or parameter 413.

Description of choice:

Pre-programmed value [0] is chosen if a fixed, set limit for the current is desired. This current limit is selected in parameter 209.
Voltage signal [1] is selected if the current limit is to be adjustable during operation by means of a control signal of e.g. 0-10 V on analogue input 53 (parameter 412). In this context, 0 V corresponds to 0% current and 10 V corresponds to the value in parameter 209.
Current signal [2] is chosen e.g. to be 0-20 mA on analogue input 60 (parameter 413). Here, 0 mA corresponds to 0% current limit, and 20 mA corresponds to the value of parameter 209.

NB!:
The starting conditions (terminals 18 and 27) must be present together with a speed reference (possibly digital ref. parameters 205-208) for current limit control to be applicable.

If the above-mentioned conditions are fulfilled when the unit is turned on, the motor may rotate for up to 5 seconds, even if the current limit setting is 0.

103 Motor power (MOTOR POWER)

Value:

Depends on unit
Under size 2 [0]
Under size 1 [1]
★ Rated size [2]

Function:

This parameter allows a choice of the kW value that best matches the rated motor power.
At the factory, a rated kW value has been chosen. kW values depend on the type of unit.

Description of choice:

Check the rated motor power in kW on the motor nameplate and select the setting that best matches the motor size. If this value deviates substantially from the setting options, choose the nearest lower or higher value.

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

Value:

Only 200-230 V units
★ 200 V [0]
220 V [1]
230 V [2]
Only 380-415 V units
★ 380 V [3]
400 V [4]
415 V [5]
Only 440-500 V units
440 V [6]
★ 460 V [7]
500 V [8]

Function:

The rated voltage that matches the motor (nameplate) can be selected.

Description of choice:

Parameters 107 and 109 are changed automatically. All values can be addressed via the bus.
It is possible to choose 440 V motor voltage on a 400 V unit. This facility can be used to obtain a better optimized motor voltage, e.g. by using a 440 V motor on 415 V mains supply. If VLT 3575-3800 has been set at the factory to 500 V, this means that the lowest motor voltage that can be selected is 440 V. In parameter 650 the same VLT type can be chosen, but for 400 V mains supply.

★ = factory setting. Text in ( ) = display text. Figures in [ ] are used when communicating with the bus.

105 Motor frequency (f_N)(MOTOR FREQ)

Value:

50 Hz (50 Hz)	[0]
60 Hz (60 Hz)	[1]
87 Hz (87 Hz)	[2]
100 Hz (100 Hz)	[3]

★ Depends on unit

Function:

The frequency that corresponds to the rated motor frequency (nameplate) is chosen.

Description of choice:

If a motor for 220/230 V is connected to a 380/415 V frequency converter, the standard value (50 Hz) must be changed to 87 Hz to obtain 220/230 V at 50 Hz. Parameters 107 and 109 are changed automatically.

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

Value:

I_Φ - $I_{VLT,MAX}$

Function:

The rated current of the motor forms part of VLT 3500 HVAC's calculation of torque and thermal motor protection.

Description of choice:

The rated motor current, in ampere, which can be seen from the motor nameplate, must be keyed in. I_Φ is the magnetising current of the motor and depends on the motor size.

109 Start voltage (START VOLTAGE)

Value:

0.0 - ($U_{M,N}$ + 10%)

Function:

When *Constant torque start* (CT) has been chosen in parameter 100, the start voltage can be adjusted. By increasing the start voltage, a high start torque can be obtained. Small motors (<1.0 kW) normally require a high start voltage. By connecting the motors in parallel, the start voltage can be used to increase the start torque. The programmed value is not changed in the case of varying load.

Description of choice:

This value is selected taking into consideration that the motor must be able to start with the desired torque:

1. Select a value that enables starting with the given load.
2. Reduce this value, until starting up with the given load is just possible.
   $U_{M,N}$ = rated motor voltage.

If the use of start voltage is exaggerated, this can lead to over-magnetisation and overheating of the motor; the frequency converter may cut out. So be careful when using the start voltage.

■ How to use the PID controller

The PID controller integrated in the VLT® frequency converter comprises a feed forward function and a traditional PID controller.

The feed forward function

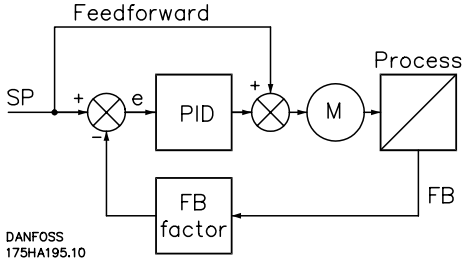
The feed forward function transmits the desired setpoint past the PID controller. Any changes of the setpoint will therefore directly affect the motor speed.

The PID controller

The PID controller maintains a constant process output (pressure, temperature, flow etc.). The PID controller adjusts the motor speed on the basis of the setpoint and the feedback signal.
The feedback signal is a transmitter's feedback indication from the process, showing whether the desired setpoint is being reached. The feedback signal varies as the load of the process changes.
An error (e) occurs, which is then regulated by the PID controller by adding or subtracting from the feedforward signal.
The band width determines how much the PID controller must add to or subtract from the feedforward signal. The band width will thus ensure that the controller keeps close to the setpoint.
The bandwith can only be reduced if there is a correlation between the feedback and the motor speed.

The setpoint is given as a percentage of the range between the minimum and maximum feedback signal.

The feedback signal can be adjusted to that of the actual transmitter. If the transmitter is a pressure transmitter with a range from 0-10 bar, this can be set as the feedback range to be displayed, but as standard it is set in percentage of the chosen voltage, current or pulse signal.



Normal or inverse control

The control is called normal, if the motor frequency is reduced, when the feedback signal goes up, and increased when the feedback signal goes down.
The control is called inverse, if the motor frequency increases/decreases with the increase/decrease of the feedback signal.

■ Programming the PID controller

Activating the PID controller

Set parameter 101 to CLOSED LOOP to choose PID control. The PID controller is activated, when the P, I and D have been programmed .

The transmitter

Which connection terminal in the VLT® frequency converter is to be used for the transmitter will depend on the transmitter type. Connect the transmitter (feedback signal) as follows and set the parameter according to the transmitter signal data.
Then programme parameter 114 feedback signal.

The reference

If for example a current transmitter is used as feedback signal and an external adjustment of the reference (setpoint) is required parameter 412 must be set for 0-10 VDC and the potentiometer must be connected to terminal 53.
It can be seen from the table, that the reference signal cannot be of the same type as the feedback signal.
The reference (setpoint) can also be set internally. This can be done in parameters 205-208, digital reference 1 - 4.
Par. 405 must be set for digital reference and terminal 29 must be connected to terminal 12.
A selection between the digital references can be made on terminal 32/33 if parameter 406 is programmed for speed select.
If an internal reference is used terminals 17, 53 and 60 should be set for no operation (terminal 17 = Freeze reference) if not used for the feedback signal or other purposes.

The reference with minimum frequency

To select a reference independently of minimum frequency setting, change parameter 411 to PROPORTIONAL. If the minimum frequency as a percentage of f_{max} is larger than the reference the minimum frequency will function as minimum reference.
This will call for an adjustment of the feedback factor (par. 125), as shown in the formulae below.

Ramp times

The ramp times are set in parameter 215-216 according to the application, but only on start and stop. On start and stop the PID controller will regulate internally on ramp time, but the actual ramp time on the motor may be shorter or longer, than the programmed value.

Feedback factor

Parameter 125 makes it possible to scale the feedback signal to adapt to the desired setpoint.
The formulae shown below must be modified if a scaling for the transmitter is needed as well.

It can be optimized for min. frequency as follows:

$$100 \times \frac{\text{Min. freq.}}{\text{Max. freq.}} \ (\%) < \text{reference } (\%)$$

$$\Rightarrow \text{parameter } 125 = 100\%$$

$$100 \times \frac{\text{Min. freq.}}{\text{Max. freq.}} \ (\%) > \text{reference } (\%)$$

$$\Rightarrow \text{new reference} = \frac{f_{max}(\%) - f_{min}(\%)}{2} + f_{min}(\%)$$

$$\Rightarrow \text{parameter } 125 = \frac{\text{new reference } (\%)}{\text{old reference } (\%)} \times 100\%$$

PID optimization

Parameters 121, 122 and 123 are set to factory settings, see page 86.

1. Start the frequency converter.
2. Set parameter 121 (proportional gain) for 0,3 sec. and increase the value, until the feedback signal (FB) oscillates constantly. Reduce the value until the oscillations stop. Carry out further reduction (0.4-0.6 times).
3. Set parameter 122 (integration time) for 20 sec. and reduce the value, until the feedback signal (FB) oscillates again. Increase the value until the oscillations stop. Subsequently, increase again (1.15-1.5 times).
4. Parameter 123 (differentiation time) is only used in fast reacting systems. The typical value is the integration time divided by 4.
   Not used in HV-AC applications and only to be used if the integrator is fully optimized.
5. Reduce the control range if necessary (parameter 120) to reduce overshooting.

There must however be correlation between the feed back and the motorspeed.

Note:
Activate start/stop repeatedly if necessary to generate oscillations.

■ Regulating accuracy

PID (closed loop)	±0.1%	5-50 Hz: (-140 - +140% load change)
Open loop (digital)	±0.01%	0,5-120 Hz (frequency stability)
	±0.05%	Frequency resolution (digital)

114 Feedback-signal (FEEDBACKSIGNAL)

Value:

	Voltage input (VOLTAGE)	[0]
★	Current input (CURRENT)	[1]
	Pulse input (PULSES)	[2]

Function:

This parameter allows a choice of process feedback type by using the *Closed loop*, which is selected in parameter 101.

Description of choice:

If the internal PID regulator is used, one of the inputs on terminal 17 (parameter 401), terminal 53 (parameter 412) or terminal 60 (parameter 413) is to be used for the feedback signal.
By choosing one of these, the same type is disabled as a reference signal.

---

115 Display value at min. feedback (FB)
(DIS VLU@MIN FB)

Value:

0 - 9999 ★ 0

Function:

Parameters 115 and 116 are used to scale a display read-out which is proportional to a feedback transmitter signal.
The value is displayed if feedback has been selected in Display Mode.

Description of choice:

If a transmitter, for example, has a range of 6-10 bar, 6 can be programmed in parameter 115 and 10 in parameter 116. In parameter 117 the unit of bar can be chosen [4].

---

116 Display value at max. feedback (FB)
(DIS VLU@MAX FB)

Value:

0 - 9999 ★ 100

Function & Description of choice:

See function under parameter 115.

---

117 Display unit (DISPLAY UNIT)

Value:

★	% (standard)	[0]	°F	[21]
	°C	[1]	PPM	[22]
	PPM	[2]	in wg	[23]
	Pa	[3]	bar	[24]
	bar	[4]	RPM	[25]
	RPM	[5]	gal/s	[26]
	l/s.	[6]	ft^3/s	[27]
	m^3/s.	[7]	gal/min.	[28]
	l/min.	[8]	ft^3/min.	[29]
	m^3/min.	[9]	gal/h	[30]
	l/h	[10]	ft^3/h	[31]
	m^3/h	[11]	lb/s	[32]
	kg/s.	[12]	lb/min.	[33]
	kg/min.	[13]	lb/h	[34]
	kg/h	[14]	t/min.	[35]
	t/h	[15]	ft	[36]
	m	[16]	lb ft	[37]
	Nm	[17]	ft/s	[38]
	m/s.	[18]	ft/min.	[39]
	m/min.	[19]	mVs	[40]
		[20]	lb/in^2	[41]

Function:

Choose between different units that are to be shown in the Display Mode together with the feedback value. Scaling of the display read-out is carried out in parameters 115 and 116.

Description of choice:

See description of choice under parameter 115.

---

119 FF factor (FEED FWD FACTR)

Value:

0 - 500% ★ 100%

Function:

This parameter is used in conjunction with PID regulation. The FF function makes a large or small proportion of the reference signal (setpoint) bypass the PID regulator, which means that the PID regulator only affects part of the control signal. Any change of the setpoint will thus affect the motor rpm directly. The FF factor ensures a high level of dynamism when the setpoint is to be changed and guarantees a smaller overshoot value.

Description of choice:

The feedforward factor is selected if the desired reference signal (setpoint) does not lead to the right start frequency. The feedforward function determines the start frequency proportional to the setpoint.

★ = factory setting. Text in ( ) = display text. Figures in [ ] are used when communicating with the bus.

120 Control range (CONTRL RANGE)

Value:

0 - 100% ★ 100%

Function:

The regulator range (bandwidth) limits the output from the PID regulator as a % of f_{MAX}.

Description of choice:

A desired % value of f_{MAX} can be selected. If the regulator range is reduced, speed variations will become smaller during initial adjustment.

121 Proportional gain (PROPRT/L GAIN)

Value:

OFF - 10.00 ★ 0.01

Function:

The proportional gain indicates how much the error (the deviation between the feedback signal and the setpoint) must be amplified.

Description of choice:

Fast regulation is obtained at a high amplification, but if the amplification is too high, the process may become unstable and cause overshooting.

122 Integral time (INTEGRAL TIME)

Value:

0.01 - 9999 secs. (OFF) ★ OFF

Function:

The integral time determines how long the PID regulator takes to correct the fault. The integral time results in a delay of the signal, and thus has a damping effect.

Description of choice:

Fast regulation is achieved by a short integral time. However, this time may be too short, which can make the process unstable. When the integral time is long, regulation becomes slow. *Off* means that the function is inactive.

123 Differential time (DIFFERENTIAL TIME)

Value:

OFF - 10.00 secs. ★ OFF

Function:

Fast control is obtained by a short differentiation time. However, this time can be too short, which makes the process unstable.
When the differentiation time is 0 sec., the D-function is not active.

Description of choice:

In typical pump and fan systems, the differentiation time is not used.

124 Lowpass filter (LOWPASS FILTER)

Value:

0.0 - 10.00 secs. ★ 0.0 sec.

Function:

The feedback signal is damp by means of a lowpass filter with a time constant (τ) of 0-10 secs.
0 sec. means not-activated.

Description of choice:

If a time constant (τ) is programmed to be 0.1 sec., the cut-off frequency for the lowpass filter will be 1/0.1 = 10 Hz. The PID regulator will thus regulate a feedback signal which varies by a frequency of less than 10 Hz. If the feedback signal varies by a higher frequency than 10 Hz, the PID regulator will not react.

125 Feedback factor (FEEDBACK FACTR)

Value:

0 - 500% ★ 100%

Function:

The feedback factor is used if the transmitter cannot be selected optimally for the scale range of the setpoint.

Description of choice:

A value can be programmed which scales the feedback signal to fit the desired setpoint. If 50% is used as setpoint, for example, and the feedback signal is only 25%, parameter 125 enables programming of 200%, which means that the feedback signal is recorded as 50% (25% x 200% = 50%).

★ = factory setting. Text in ( ) = display text. Figures in [ ] are used when communicating with the bus.

■ References and limits, group 2..

VLT 3500 HVAC distinguishes between different types of references.

NB!:
The analogue reference type is programmed in group 4. Unused references are set at 0, or switched out (parameters 205-208, 412-413).

201 Minimum frequency (f_{MIN}) (MIN FREQUENCY)

Value:

0.0 - f_{MAX} ★ 0.0 Hz

Function:

In this parameter a minimum frequency limit can be chosen that corresponds to the minimum speed at which the motor is to run.
The minimum frequency can never be higher than the maximum frequency, f_{MAX}.

Description of choice:

A value from 0.0 Hz to the max. frequency (f_{MAX}) selected in parameter 202 can be chosen.

202 Maximum frequency (f_{MAX}) (MAX FREQUENCY)

Value:

f_{MIN} - 120 Hz ★ depending on the unit

Function:

In this parameter a maximum frequency can be chosen that corresponds to the maximum speed at which the motor is to run.

Description of choice:

A value from f_{MIN} to 120 Hz can be chosen.

203 Jog frequency (JOG FREQUENCY)

Value:

0.0 - 120 Hz ★10 Hz

Function:

The jog frequency is the fixed output frequency at which the frequency converter runs when the Jog function is activated.
See also a description of parameter 511.

Description of choice:

The jog frequency can be selected to be lower than f_{MIN} (parameter 201) and higher than f_{MAX} (parameter 202); however, the upper output frequency is limited by the f_{MAX} that has been set (parameter 202).

204 Digital reference type (DIG. REF. TYPE)

Value:

★	Sum (SUM)	[0]
	Relative (RELATIVE)	[1]
	External on/off function (EXT. ON/OFF)	[2]

Function:

It is possible to define how the internal digital references are to be added to the other references. There is a choice of *Sum* and *Relative*. Using the *External on/off function*, it is possible to choose whether there is to be a shift between control using other references or the internal digital references.

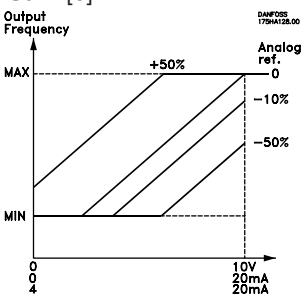
Description of choice:

If *Sum* [0] is selected, one of the digital references is summed (parameters 205-208) as a % of f_{MAX} with the other references.

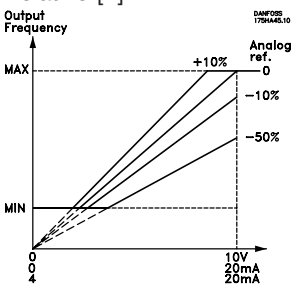
If *Relative* [1] is selected, one of the digital references (parameters 205-208) is summed as a % of the other references.

If *External on/off* [2] is selected, switching can be carried out via terminal 29 (parameter 405) between the other references and one of the digital references.

Sum [0]



Relative [1]



NB!:
The sign only determines the direction of rotation if external on/off has been selected. Reversing via terminal 19 has no function.

Other references - this is the sum of the analogue, the pulse and the bus references.

★ = factory setting. Text in ( ) = display text. Figures in [ ] are used when communicating with the bus.

205 Digital reference 1 (REF. 1 DIGITAL)

Value:

-100.00% - +100.00% of $f_{MAX.}$/analogue reference ★ 0 %

206 Digital reference 2 (REF. 2 DIGITAL)

Value:

-100.00% - +100.00% of $f_{MAX.}$/analogue reference ★ 0 %

207 Digital reference 3 (REF. 3 DIGITAL)

Value:

-100.00% - +100.00% of $f_{MAX.}$/analogue reference ★ 0 %

208 Digital reference 4 (REF. 4 DIGITAL)

Value:

-100.00% - +100.00% of $f_{MAX.}$/analogue reference ★ 0 %

Function (parameter 205-208):

Four different, internal, digital references can be programmed in parameters 205-208.
The internal digital references are stated as a percentage of the value f_{MAX} (parameter 202). If a f_{MIN} (parameter 201) has been programmed, the internal, digital reference as a percentage is calculated from the difference between f_{MAX} and f_{MIN}, and subsequently added to f_{MIN}.

Description of choice (parameters 205-208):

The desired, internal, digital reference is programmed as a percentage of f_{MAX} (parameter 202).
Via terminals 32 and 33 (parameter 406) it is possible to choose between the four internal, digital references - see the table below.

Terminal 33	Terminal 32	
0	0	Digital ref. 1
0	1	Digital ref. 2
1	0	Digital ref. 3
1	1	Digital ref. 4

NB!:
The sign determines the direction of rotation, if external on/off has been selected in parameter 204.

209 Current limit (f_{LIM}) (CURRENT LIMIT)

Value:

0.0 - $I_{VLT,MAX}$ ★ depending on the unit

Function:

Here VLT 3500 HVAC's greatest permissible output current can be set. If the current limit is exceeded, the output frequency is regulated downwards, until the current falls to below the current limit. The output frequency is not regulated upwards to the reference set, until the current has fallen to below the current limit.

Description of choice:

The value set at the factory corresponds to the rated output current. If the current limit is to be used as motor protection, the rated motor current must be programmed.
In parameter 310 the length of time can be programmed that VLT 3500 HVAC is to run at the current limit before cutting out.
The load range between 100 and 110% can be programmed and is only intended for intermittent operation. That is why the unit can only perform 110% for 60 seconds.
The intermittent operating time is extended when the load falls below 110% and becomes unlimited at 100%.

210 Warning: Low frequency (LO FREQ. WARN)

Value:

0.0 - 120 Hz ★ 0.0 Hz

Function:

In this parameter the lower warning limit f_{LOW} of the output frequency can be set for VLT 3500 HVAC's normal operating range, see page ??.

Description of choice:

If the output frequency falls below the set warning limit f_{LOW}, the display says LO FREQ. WARN.
The signal outputs can be programmed to give a warning signal (see parameters 407-410).

★ = factory setting. Text in ( ) = display text. Figures in [ ] are used when communicating with the bus.

211 Warning: High frequency (HI FREQ. WARN)

Value:

0.0 - 120 Hz + 10% ★ 132 Hz

Function:

In this parameter the upper warning limit f_{HIGH} of the output frequency can be set for VLT 3500 HVAC's normal operating range.

Description of choice:

If the output frequency increases above the set warning limit f_{HIGH}, the display says HI FREQ. WARN.
The signal outputs can be programmed to give a warning signal (see parameters 407-410).

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

Value:

0.0 - $I_{VLT,MAX}$ ★ 0.0 A

Function:

If the motor current lies below the I_{LOW} programmed, the display reads LO CURR. WARN.
The signal outputs can be programmed to give a warning signal (see parameters 407-410).

Description of choice:

The lower warning limit I_{LOW} of the motor current is programmed within the normal operating range of the frequency converter.

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

Value:

0.0 - $I_{VLT,MAX}$ ★ $I_{VLT,MAX}$

Function:

If the motor current lies above the I_{HIGH} programmed, the display reads HI CURR. WARN.
The signal outputs can be programmed to give a warning signal (see parameters 407-410).

Description of choice:

The upper warning limit I_{HIGH} of the motor current is programmed within the normal operating range of the frequency converter.

214 Ramp type (RAMP TYPE)

Value:

★ Linear (LINEAR)	[0]
Sine shape (S CURVE 1)	[1]
Sine² shape (S CURVE 2)	[2]
Sine³ shape (S CURVE 3)	[3]

Function:

There is a choice of 4 types of ramps. The sine shapes ensure a softer start and stop of acceleration and deceleration.

Description of choice:

Choose the desired ramp type, depending on how start/stop is desired to be.

215 Ramp-up time (RAMP UP TIME)

Value:

0.00 - 3600 secs. ★ depends on unit

Function:

The ramp-up time is the acceleration time from 0 Hz to the rated motor frequency, provided that the output current is not higher than the current limit (parameter 209).

Description of choice:

The desired ramp-up time is programmed.

216 Ramp-down time (RAMP DOWN TIME)

Value:

0.00 - 3600 secs. ★ depends on unit

Function:

The ramp-down time is the deceleration time to 0 Hz from the rated motor frequency, provided that no overvoltage arises in the inverter because of regenerative operation of the motor.

Description of choice:

The desired ramp-down time is programmed.

★ = factory setting. Text in ( ) = display text. Figures in [ ] are used when communicating with the bus.

217 Alternative ramp-up time (ALT. UP RAMP)

Value:

0.00 - 3600 secs. ★ depends on unit

Function:

This alternative ramp time is activated when the jog function is activated via terminal 29 (parameter 405) or RS 485; no other start signal must have been given (e.g. terminal 18 (parameter 402)).

Description of choice:

The desired alternative ramp-up time is programmed.

218 Alternative ramp-down time (ALT. DOWN RAMP)

Value:

0.00 - 3600 secs. ★ depends on unit

Function:

This alternative ramp time is activated when a quick-stop is used via terminal 27, parameter 404 or via the serial bus (RS 485).

Description of choice:

The desired alternative ramp-down time is programmed.

219 Frequency bypass 1 (FREQ 1 BYPASS)

Value:

0 - 120 Hz ★ 120 Hz

220 Frequency bypass 2 (FREQ 2 BYPASS)

Value:

0 - 120 Hz ★ 120 Hz

221 Frequency bypass 3 (FREQ 3 BYPASS)

Value:

0 - 120 Hz ★ 120 Hz

222 Frequency bypass 4 (FREQ 4 BYPASS)

Value:

0 - 120 Hz ★ 120 Hz

Description of parameter 219 - 222 see parameter 223.

223 Frequency bypass bandwidth (BYPASS B.WIDTH)

Value:

0 - 100% ★ 0 %

Function: (Parameter 219-223)

Some systems require that certain output frequencies are avoided which lead to resonance problems in the installation.

In parameters 219-222 these output frequencies can be programmed to be bypassed (frequency bypass).

In parameter 223, a bandwidth on either side of these frequencies can be defined.

Description of choice: (Parameter 219-223)

Enter the frequencies to be avoided and the bandwidth as a percentage of the keyed-in frequencies. The bypass band is the bypass frequency +/- the bandwidth selected.

224 Carrier frequency (CARRIER FREQ.)

Value:

2.0 - 14.0 kHz ★ 4.5 kHz

Function:

The set value determines the carrier frequency of the inverter. Changing the switching frequency will minimise any acoustic noise from the motor. Certain types may not operate at a higher switching frequency than 4.5 kHz (VLT 3575-3800 and VLT 3542- 3562 (230 V)).

Description of choice:

When the motor is running, the switching frequency is adjusted in parameter 224 to find the switching frequency at which the noise from the motor is reduced to the greatest possible extent.

NB!:
Switching frequencies higher than 4.5 kHz lead to automatic derating.

★ = factory setting. Text in ( ) = display text. Figures in [ ] are used when communicating with the bus.

225 Output frequency dependent carrier frequency (VAR.CARR.FREQ.)

Value, VLT 3502-62 **(Version 3.0)**

★ OFF (DISABLE) [0]
ON (ENABLE) [1]

Value, VLT 3542-62 (230 V) and 3575-3800 **(Ver. 3.11)**

OFF (DISABLED) [0]
High switching frequency at low speed (HI.CAR.FREQ.LO) [1]
★ Low switching frequency at low speed (LO.CAR.FREQ.LO) [2]

Function:

The output frequency dependent switching frequency means that the switching frequency changes with changes in the output frequency. However, the maximum switching frequency is determined by parameter 224.

Description of choice, **version 3.0:**

The output frequency dependent switching frequency can be activated, i.e. On (ENABLED) or not activated, i.e. Off (DISABLED).
This function gives a high switching frequency at low speed. In the range from 0-50% of the nominal output frequency, the switching frequency = data for par. 224. From 50-100% of the nominal output frequency the switching frequency is reduced to 4.5 kHz. The function helps to reduce acoustic motor interference. When an output frequency dependent switching frequency is used (ASFM), there is typically no derating. See chapter on optimally low motor interference.

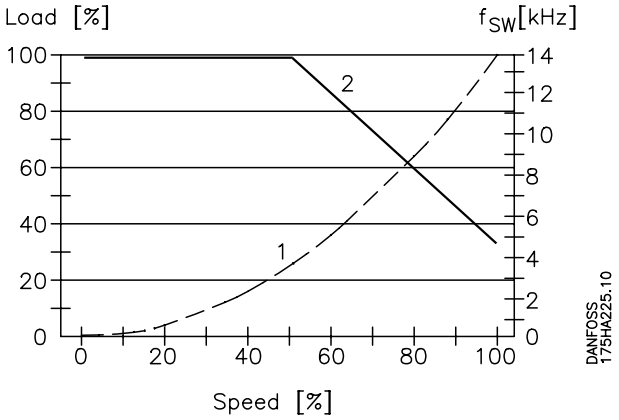
Description of choice, **version 3.11:**

VLT 3542-3562 (230 V) and VLT 3575-3800:
It can be chosen that the output frequency dependent switching frequency is not activated, i.e. Off (DISABLED). The output dependent switching frequency will result in a permanent switching frequency if Off is selected.

The option of High switching frequency at low speed is not available (has no function) on these units.

If Low switching frequency at low speed is selected, the switching frequency will start at 1.1 kHz at a low output frequency and current. From 8 Hz the switching frequency increases to 4.5 kHz. This function imporves the stability of the motor.

NB!:
If the VLT has a LC filter, the output frequency dependent switching frequency must be set at



232 Idle running current (CURR.MIN VALUE)

Value:

0-I_{LIM} ★ Depends on unit

Function:

This is where the minimum motor current value (idle running current) is programmed.
As soon as the value drops below the preset value and the maximum output frequency is reached, a signal can be activated by means of a relay.
This function can be used e.g. for monitoring whether the V- belt has broken.
I_{LIM} is the current limit programmed in parameter 209.

Description of choice:

The relay is activated (parameter 409) [17] and (parameter 410) [17] when the motor current drops below the set idle running value and the maximum output frequency is reached.

★ = factory setting. Text in ( ) = display text. Figures in [ ] are used when communicating with the bus.

■ Start/stop functions and timers, group 3..

This parameter group includes special start/stop functions, e.g. how to catch a spinning motor. It is also possible to programme a timer for the relay outputs.

301 Start frequency (START FREQ)

Value:

0.0 - 10 Hz ★ 0.0 Hz

Function:

It is possible to define an output frequency at which the motor is to start.

Description of choice:

Programme the start frequency at which the motor is to start.

---

302 Delayed start (START DELAY)

Value:

0.0 - 1 sec. ★ 0.0 sec.

Function:

VLT 3500 HVAC starts at the start frequency (parameter 301) and begins to ramp up when the start delay has ended.

Description of choice:

Programme the desired time delay before VLT 3500 HVAC starts to ramp up.

---

303 High starting torque (HI START TORQ.)

Value:

0.0 - 1 sec. ★ 0.0 sec.

Function:

A high starting torque means that a current approx. 2 x the current limit of parameter 209 is permitted. However, the current is limited by the protection limit of the inverter.

Description of choice:

Insert the time required to give as high a starting torque as desired.

---

304 Mains failure (POWER FAIL)

Value:

★	Uncontrolled stop (NORM PWR DWN)	[0]
	Ramp down 1 (RAMP DOWN)	[1]
	Ramp down 2 (ALT. RAMP DOWN)	[2]

Function:

Select one of the 3 ramp-down functions to extend the overrun time in case of mains failure. The effect will depend on the load and the mains voltage before the failure.

Description of choice:

Uncontrolled stop [0]:
The motor continues to run at the selected speed until the controls cut out.

Ramp down 1 [1]:
The motor begins to ramp down immediately (parameter 216) until the controls cut out.

Ramp down 2 [2]:
The motor begins to ramp down immediately (parameter 218). If the ramp-down time is short, a regenerative effect may keep up the DC voltage, which means that it takes longer before the controls cut out.

---

305 Cutting in on rotating motor (FLYING START)

Value:

★	Disable (NO FLY START)	[0]
	OK - same direction (SAME DIRECT)	[1]
	OK - both directions (BOTH DIRECT)	[2]
	Stop before start (CD-BRAKE @STAR)	[3]

Function:

This parameter is used when VLT 3500 HVAC cuts in on a rotating motor (e.g. after a power failure).

Description of choice:

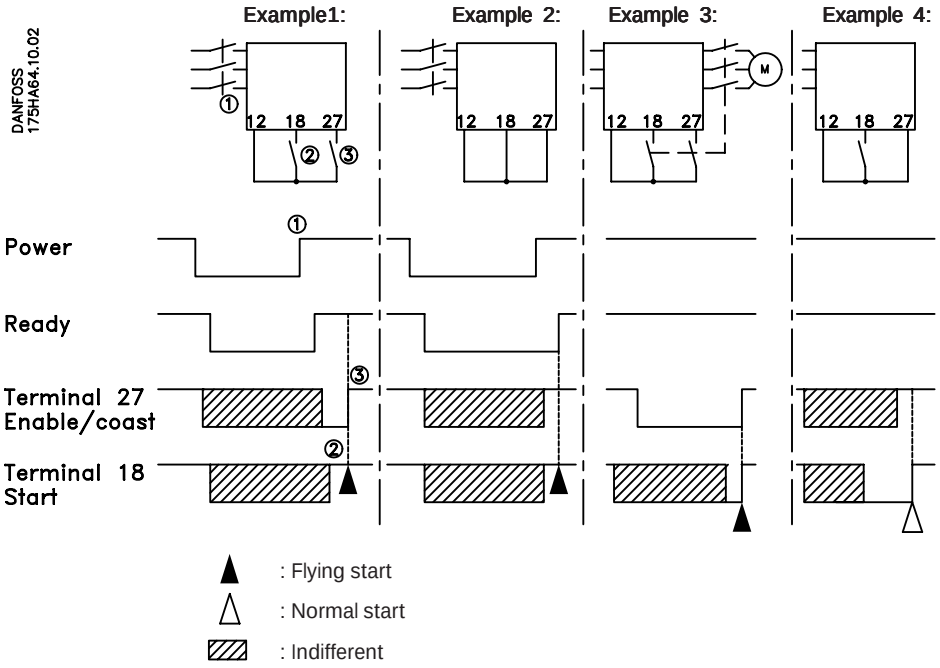
OK - same direction [1]:
Chosen if the motor is only able to rotate in the same direction when cutting in.

OK - both directions [2]:
Chosen if the motor is able to rotate in both directions when cutting in.

Stop before start [3]:
Chosen if the motor is to be stopped by means of DC-braking, before the motor is ramped up to the desired speed. The DC braking time is to be set in parameter 306.
The selected function is activated in accordance with the diagram on next page.

★ = factory setting. Text in ( ) = display text. Figures in [ ] are used when communicating with the bus.

When the function Coupling to rotating motor has been selected



306 DC-braking time (DC-BRAKE TIME)

Value:

0.0 - 3600 secs. ★ 0.0 sec.

307 DC-brake cut-in frequency (DC BRK ON FREQ)

Value:

0.0 - 120 Hz ★ 1.0 Hz.

308 DC-brake voltage (DC-BRK VOLTAGE)

Value:

0 - 50 V ★ Depends on unit

Function:

If the stator of an asynchronous motor is supplied with a DC current, a braking torque will arise.
The braking torque depends on the selected DC brake voltage (par. 308).

Description of choice:

Select the duration of the energized DC voltage (par. 306). Pay attention to the motor power.
Select the output frequency at which DC braking is to start on ramp-down to stop (par. 307).

If the value is too high, the motor can be damaged because of overheating.
Parameters 306 and 307 must be different from 0 to activate the DC braking.
DC braking can also be activated via terminal 27 (parameter 404).

NB!:
If VLT 3575-3800 and 3542-62 are used, there is no braking just after the connection to mains.

★ = factory setting. Text in ( ) = display text. Figures in [ ] are used when communicating with the bus.

309 Reset function (RESET MODE)

Value:

★	Manual reset (MANUAL)	[0]
	Automatic reset (AUTOMATIC X 1)	[1]
	Automatic reset (AUTOMATIC X 2)	[2]
	Automatic reset (AUTOMATIC X 3)	[3]
	Automatic reset (AUTOMATIC X 4)	[4]
	Automatic reset (AUTOMATIC X 5)	[5]
	Automatic reset (AUTOMATIC X 6)	[6]
	Automatic reset (AUTOMATIC X 7)	[7]
	Automatic reset (AUTOMATIC X 8)	[8]
	Automatic reset (AUTOMATIC X 9)	[9]
	Automatic reset (AUTOMATIC X 10)	[10]
	Start disabled (START INHIBIT)	[11]

Function:

VLT 3500 HVAC can be programmed for automatic resetting. Automatic resetting 1-10 times within 20 minutes can be selected. The time between each reset is chosen in parameter 312.

Description of choice:

Manual reset [0] can be opted out of via RS 485, terminal 16, or from the operating panel.
Automatic reset [1]: The number of resets, between 1 and 10, can be selected. If resetting fails, the frequency converter enters the TRIP Lock mode, which can only be reset after cutting out the main suppy.
Start not possible [11] disables restart after tripping. *Start not possible* [11] only works in connection with serial communication, since restart is only possible via the bus. *Start not possible* [11] enables the use of the status table as in Profibus, when the control word is ON1, ON2 or ON3. The status table is found in Profibus literature MG.10.AX.0X.

The motor may start without warning.

310 Trip delay at current limit (TRIP DLY@C.LIM)

Value:

0 - 60 secs. (OFF) ★ OFF

Function:

When the frequency converter registers that the output current has exceeded the current limit I_{LIM} (parameter 209) for the set time, cutting out is then effected.

Description of choice:

Select how long the frequency converter is going to be able to run at the current limit I_{LIM} before tripping. 60 secs. = OFF means that the time is infinite.

311 Trip delay at inverter fault (TRIP DLY@FAULT)

Value:

0 - 35 secs. ★ Depends on unit

Function:

When the frequency converter registers an over- or undervoltage for the set time, cutting out is then effected.

Description of choice:

Select how long the frequency converter is to be able to run at over- or undervoltage before tripping.

NB!:
If this value is reduced from the factory setting, the unit may report a fault when the mains supply comes on (undervoltage).

312 Maximum automatic restart time (AUTO RESTART T)

Value:

0 - 10 secs. ★ 5 secs.

Function:

The time from tripping until automatic reset can be set if this option has been selected in parameter 309.

Description of choice:

The time between tripping and automatic reset is selected.

313 Motor check (MOTOR CHECK)

Value:

★	Off (OFF)	[0]
	On (ON)	[1]

Function:

VLT 3500 HVAC is able to check whether a motor has been connected.

Description of choice:

If *On* [1] has been selected, check that a motor has been connected when there is 24 V on terminal 27 and no start command has been given (START, START.REV or JOG). If no motor has been connected, NO MOTOR is displayed.
This function is not available in VLT 3575-3800 HVAC and VLT 3542-3562 HVAC (230 V), from software version 3.11 onwards.

★ = factory setting. Text in ( ) = display text. Figures in [ ] are used when communicating with the bus.

314 Motor pre-heat (MOTOR PRE-HEAT)

Value:

★	Off (OFF)	[0]
	On (ON)	[1]

Function:

The pre-heat function can be activated to counteract moisture in the motor.

Description of choice:

If *On* [1] has been selected, the motor is pre-heated by means of direct current (approx. half the start voltage) when there is 24 V on terminal 27 and no start command has been given (START, START.REV or JOG).

This function is not available in VLT 3575-3800 HVAC and VLT 3542-3562 HVAC (230 V), from software version 3.11 onwards.

315 Motor thermal protection (MOTOR THERMAL)

Value:

	Off (PROTECT-OFF)	[0]
	Warning 1 (WARNING 1)	[1]
★	Trip 1 (TRIP 1)	[2]
	Warning 2 (WARNING 2)	[3]
	Trip 2 (TRIP 2)	[4]
	Warning 3 (WARNING 3)	[5]
	Trip 3 (TRIP 3)	[6]
	Warning 4 (WARNING 4)	[7]
	Trip 4 (TRIP 4)	[8]

Function:

The frequency converter calculates whether the motor temperature may exceed the permissible limits. The calculation is based on 1.16 x rated motor current (set in parameter 107).

Four separate calculations are possible. One calculation can be chosen for each set-up, or the same calculation can be used in several set-ups.

Warning 1 and Trip 1 refer to motor settings in set-up 1. Also for warnings 2-4 and trips 2-4 reference is made to set-up numbers.

With the options above, it is possible to monitor the same motor in several set-ups, or up to four different motors can be monitored.

Description of choice:

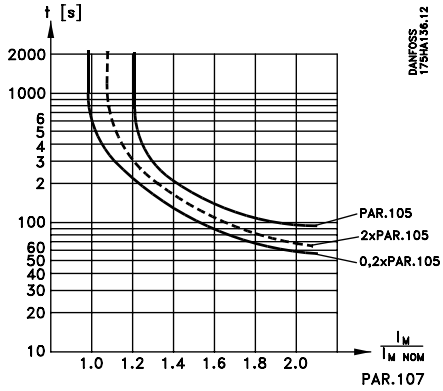
Select *Off* (OFF) if no warning or trip is required.

Only select *Warning* if a warning is to come up on the display when a motor is overloaded.

The frequency converter can also be programmed to ensure that a warning signal is given via the signal outputs (parameters 407- 410).

Select *Trip* if tripping is required when the motor is overloaded.

The frequency converter can also be programmed to give an alarm signal via the signal outputs (parameters 407-410).



316 Relay ON delay (RELAY ON DELAY)

Value:

0.00 - 10.00 secs. ★ 0.00 sec.

Function:

Relay output 01, which is connected to terminals 01-02-03 (parameter 409) can be programmed for relay on/off delay.

Description of choice:

The setting in parameters 316 and 317 effects the relay on/off delay for relay output 01, which has outputs on terminals 01-02-03.

317 Relay OFF delay (RELAY OFF DELAY)

Value:

0.00 - 10.00 secs. ★ 0.00 sec.

Function:

See function under parameter 316.

Description of choice:

See description of choice under parameter 316.

★ = factory setting. Text in ( ) = display text. Figures in [ ] are used when communicating with the bus.

■ Inputs and outputs, group 4..

Group 4 is used to programme a set-up of the connection terminals other than the standard set-up. See the layout of digital input signals below.

The analogue output signals and the relays can be used for different types of indication. See parameters 407-410. For layout of digital input signals see following cross reference.

■ Digital inputs

Cross reference for terminals/parameter functions (see also pages 60-69)

Terminal 16 / Par.400	★ Reset	Stop *)	Freeze ref.	Set-up select	Thermistor **)	Extern H-O-A Hand	
Terminal 17 / Par.401	Reset	Stop *)	★ Freeze ref.		Pulse 100 Hz	Pulse 1kHz	Pulse 10 kHz	Ex H-O-A Auto
Terminal 18 / Par.402	★ Start	Latch start	No operation	Extern H-O-A Auto			
Terminal 19 / Par.403	★ Reversing	Start rev.	No operation	Extern H-O-A Hand	Pulse Start Hand		
Terminal 27 / Par.404	★ Mtr. coast *)	Q-stop *)	DC-brake *)	Reset and coast *)	Stop *)		
Terminal 29 / Par.405	★ Jog	Jog freeze	Freeze ref.	Digital ref.	Ramp select	Pulse Start Hand	
Terminal 32 / Par.406 Terminal 33 / Par.406	Speed select	Speed up Speed down	Set-up select	★ 4 Set-up ext.			

★ = Factory setting

*) Must be carried out with the break-before-make contact function (NC), since this function is activated at 0 V on the input

**) To be connected to terminal 50 (10 V DC) and terminal 16 (parameter 400), with choice of thermistor function

■ Hand-Off-Auto, H-O-A

In the section on Local Operation using the operating panel of the frequency converter it is possible to choose where the H-O-A function is to be active. See example 9, page 32.

Hand

"Hand" is a function in which manual control has first priority.

Off

"Off" is a function in which the inverter of the frequency converter has stopped.

Auto

"Auto" is a function in which normal operation is effected via the control terminals of the frequency converter or the RS 485 port.

Where is the H-O-A function to be active?

In parameter 003 it is possible to choose between 3 different ways of implementing the H-O-A function:

1. H-O-A via the operating panel of the frequency converter.
2. H-O-A via the operating panel with external stop.
3. External H-O-A.

H-O-A desired externally from VLT 3500 HVAC

Via the digital inputs, it is possible to choose between "Hand" or "Auto" Mode.

The "Hand" mode is activated when one of the digital input terminals 16 (parameter 400) or 19 (parameter 403) is programmed for External H-O-A Hand, and 24 V DC is connected (terminal 12).

The "Auto" mode is activated when one of the digital input terminals 17 (parameter 401) or 18 (parameter 402) is programmed for External H-O-A Auto, and 24 V DC is connected (terminal 12).

If no terminals are activated using 24 V DC (terminal 12), the output frequency of the frequency converter will follow the ramp down to 0 Hz.

External H-O-A reference

In parameter 420 it is possible to choose the reference to be used in the External Hand Mode.

There is a choice of 3 options:

1. Voltage reference V
2. Current reference mA
3. Digital speed up/down

Start signal for External Hand Mode

When "Hand" Mode is activated via terminal 16 (parameter 400) or 19 (parameter 403), it is necessary to give the frequency converter a start signal to start up the inverter.

Terminal 29 or 19 can be programmed to Pulse start Hand. If 24 V DC is connected to terminal 29 or 19 for min. 20 milliseconds, the inverter starts and the frequency converter supplies the motor with a frequency determined by the reference.

When the 24 V DC signal is removed from terminal 16 or 19, the frequency converter stays in "Hand" Mode, but the inverter stops.

Auto Mode

When "Auto" Mode is activated via terminal 17 (parameter 401) or 18 (parameter 402), the frequency converter will be controlled by means of normal remote operation.

400 Terminal 16 input (INPUT 16)

Value:

★	Reset (RESET)	[0]
	Stop (STOP)	[1]
	Freeze reference (FREEZE REF.)	[2]
	Selection of set-up (SETUP SELECT)	[3]
	Thermistor (THERMISTOR)	[4]
	External H-O-A Hand (EXT. HOA HAND)	[5]

Function:

Used for choosing between different possible functions of terminal 16.

Description of choice:

Reset [0]:
With 24 V DC from terminal 12 connected to terminal 16, the frequency converter can be reset after tripping. Refer to the section on reset messages.

Stop [1]:
The stop function is activated by removing 24 V DC from terminal 12 to terminal 16. This means that terminal 16 must be on for the motor to be able to run. A stop will be effected in accordance with the ramp time selected in parameter 216. The function is normally used together with pulse start on terminal 18 (parameter 402). A pulse which breaks the connection from terminal 12 to terminal 16 for min. 20 msec. will effect a stop function.

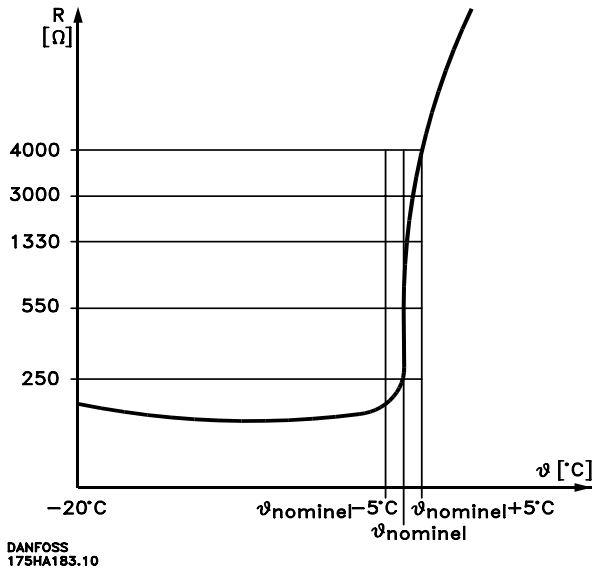
Freeze reference [2]:
Selected if terminals 32/33 (parameter 406) are to be used for digital control of speed up/down (motor potentiometer). 24 V DC from terminal 12 to terminal 16 will freeze the existing reference, and the speed can be changed by means of terminals 32/33 (parameter 406 = speed up/down).

Choice of set-up [3]:
If *Multi set-up* [5] has been selected in parameter 001, terminal 16 allows a choice of Set-up 1 ("0") and Set-up 2 ("1"). If more than 2 set-ups are required, both terminals 16 and 17 (parameter 401) must be used for choosing the set-up.

Set-up	Terminal 17	Terminal 16
1	0	0
2	0	1
3	1	0
4	1	1

Thermistor [4]:
Selected if the thermistor that may be integrated in the motor is to be able to stop the frequency converter if the motor is overheated. The tripping value is ≥ 3 kΩ

Typical characteristics of a thermistor



★ = factory setting. Text in ( ) = display text. Figures in [ ] are used when communicating with the bus.

400 Terminal 16 input (INPUT 16) continued

The thermistor is to be connected between terminal 50 (+10 V) and terminal 16. When the resistance of the thermistor exceeds 3 kΩ, the frequency converter will trip and the following message will be displayed:

ALARM
TRIP
MOTOR TRIP

If a motor features a Klixon thermal switch rather than a thermistor, this switch can also be used for this input. If motors are running in parallel, thermistors can be connected in series, their number depending on the ohmic value of the thermistor in warm running condition.

NB!:
If Thermistor is selected in parameter 400 without a thermistor being connected, the frequency converter will go into the Alarm Mode. To exit from this mode, hold down the "stop/reset" key while changing the data values by means of the "+"/"-" keys.

External H-O-A Hand [5]:
Selected if the H-O-A function is to be used externally from the frequency converter for switching between hand-operation (Hand) and normal remote control (Auto). By energizing 24 V DC from terminal 12 to terminal 16, the hand-operation mode is activated and adjustment of the output frequency - by the reference chosen as external hand-operation reference in parameter 420 - is enabled.
The inverter of the frequency converter does not start until a Pulse Start Hand is given via terminal 19 or terminal 29.

401 Terminal 17 input (INPUT 17)

Value:

	Reset (RESET)	[0]
	Stop (STOP)	[1]
★	Freeze reference (FREEZE REF.)	[2]
	Selection of set-up (SETUP SELECT)	[3]
	Pulse input 100 Hz (PULSES 100 Hz)	[4]
	Pulse input 1 kHz (PULSES 1 KHz)	[5]
	Pulse input 10 kHz (PULSES 10 KHz)	[6]
	External H-O-A Auto (EXT. HOA AUTO)	[7]

Function:

Used for choosing between different possible functions of terminal 17.

Description of choice:

Reset, stop, freeze reference and choice of set-up as terminal 16.
Pulses:
Terminal 17 can be used for pulse signals in the ranges: 0-100 Hz, 0-1 kHz and 0-10 kHz. The pulse signal can be used as a speed reference in normal operation and as either setpoint or feedback signal for operation in "closed loop" (PID regulator); see also parameter 101 if required. Pulse emitters with a PNP signal can be used between terminals 12 and 17. Earth connection to terminal 20.
External H-O-A Auto [7]:
Selected if the H-O-A function is to be used externally from the frequency converter for switching between hand-operation (Hand) and normal remote control (Auto). By energizing 24 V DC from terminal 12 to terminal 17, the normal remote control mode is activated and normal control via the control terminals of the frequency converter is enabled.

★ = factory setting. Text in ( ) = display text. Figures in [ ] are used when communicating with the bus.

402 Terminal 18 start (INPUT 18)

Value:

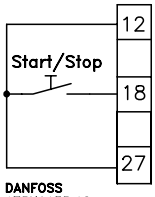
★	Start (START)	[0]
	Latch start (LATCH START)	[1]
	No operation (NO OPERATION)	[2]
	External H-O-A Auto (EXT. HOA AUTO)	[3]

Function:

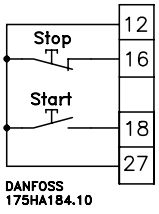
Used for choosing between different possible functions of terminal 18. Start and stop will be effected in accordance with the ramp times selected in parameters 215 and 216.

Description of choice:

Start [0]:
Selected if a start/stop function is desired. Logic "1" = start, logic "0" = stop.



Latch start [1]:
Chosen if a start and stop function is desired for 2 different inputs (can be used together with terminal 16, 17 or 27).
A 24 V DC pulse from terminal 12 ("1" for min. 20 msec.) on terminal 18 will start the motor.
A pulse where 24 V DC from terminal 12 is removed ("0" for min. 20 msec.) from terminal 16, 17 or 27 will stop the motor.



No operation [2]:
Selected if the frequency converter is not to react to signals coming to terminal 18.
If serial communication is used, the input status can be read and used by the master.

External H-O-A Auto [3]:
Selected if the H-O-A function is to be used externally from the frequency converter for switching between hand-operation (Hand) and the normal remote control (Auto). By energizing 24 V DC from terminal 12 to terminal 17, the normal remote control mode is activated, and normal control via the control terminals of the frequency converter is possible.

403 Terminal 19 reversing (INPUT 19)

Value:

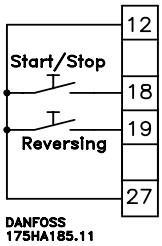
★	Reversing (REVERSING)	[0]
	Start reversing (START REV)	[1]
	No operation (NO OPERATION)	[2]
	External H-O-A Hand (EXT. HOA HAND)	[3]
	Latch start Hand (LATCH ST.HAND)	[4]

Function:

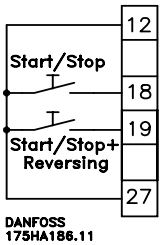
This parameter (terminal 19) is used i.a. for changing the direction of rotation of the motor.

Description of choice:

Reversing [0]:
Chosen if an option is to be available to change the direction of rotation of the motor. No signal on terminal 19 will give normal rotation.
24 V DC from terminal 12 on terminal 19 leads to reversing.
The motor is only able to start if together with a signal on terminal 19 a start command is given (e.g. on terminal 18).



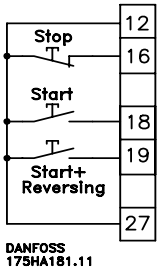
Start with reversing [1], parameter 402, *Start* [0]:
Selected if start and reversing are to be activated at the same input.



★ = factory setting. Text in ( ) = display text. Figures in [ ] are used when communicating with the bus.

403 Terminal 19 rev. (INPUT 19) continued

Start with reversing [1] and parameter *402 Latch Start* [1]:
If a latch start has been selected in par. 402, latch start with reversing will be set automatically.



NB!:
If 24 V DC is supplied from terminal 12 to effect a start command (logic "1") to terminals 18 and 19 at the same time, the motor will stop.

No operation [2]:
As parameter 402.

External H-O-A Hand [3]:
Selected if the H-O-A function is to be used externally from the frequency converter to switch between hand-operation (Hand) and the normal remote control (Auto). By providing 24 V DC from terminal 12 to terminal 16, the hand-operation mode is activated and the output frequency can be adjusted by the reference selected as external hand-operation reference in parameter 420.

Latch start Hand [4]:
Selected for starting the inverter when the frequency converter is in the hand-operation mode, "Hand". When 24 V DC is supplied from 12 to terminal 19 for min. 20 msec., the start will be activated.

404 Terminal 27 stop (INPUT 27)

Value:

★	Motor coasting stop (MTR. COAST)	[0]
	Quick-stop (Q-STOP)	[1]
	DC braking (DC-BRAKE)	[2]
	Reset and motor coasting stop (RST&COAST)	[3]
	Stop (STOP)	[4]

Function:

Used for choosing between different possible functions of terminal 27.

NB!:
The motor is only able to run if 24 V DC is supplied from terminal 12 to terminal 27 (logic "1"). However, this feature can be disregarded by using serial communication or Local Mode.

Description of choice:

Motor coasting stop [0]:
Chosen if the frequency converter is to "release" the motor and the motor runs freely until stopping. When the connection from terminal 12, 24 V DC, to terminal 27 is broken, motor coasting stop is effected.

Quick-stop [1]:
Selected if the motor is to be stopped in accordance with the alternative ramp time set in parameter 218. When the connection from terminal 12, 24 V DC, to terminal 27 is broken, this leads to a quick-stop.

DC braking [2]:
Selected if the motor is to be stopped by energizing it with a DC voltage for a certain time - as chosen in parameters 306 and 308. This function is only active when the value in parameters 306 and 308 are other than 0. When the connection from terminal 12, 24 V DC, to terminal 27 is broken, this leads to DC braking.

Reset and coasting stop [3]:
Selected if coasting stop is to be activated (see under coasting stop at the top of the description) and a reset applied (see description of reset in parameters 400, 401) at the same time. When the connection from terminal 12, 24 V DC, to terminal 27 is broken, this leads to Reset and Coasting Stop.

Stop [4]:
Chosen if it is desired to stop the frequency converter (see description of stop in parameters 400, 401). When the connection from terminal 12, 24 V DC, to terminal 27 is broken, this leads to a Stop.

★ = factory setting. Text in ( ) = display text. Figures in [ ] are used when communicating with the bus.

405 Terminal 29 input (INPUT 29)

Value:

★	Jogging (JOG)	[0]
	Freeze jogging reference (JOG FREEZE)	[1]
	Freeze reference (FREEZE REF)	[2]
	Digital reference (DIGITAL REF)	[3]
	Ramp selection (RAMP SELECT)	[4]
	Latch start Hand (LATCH ST.HAND)	[5]

Function:

Used to choose between the possible functions of terminal 29.

Description of choice:

Jogging [0]:
Selected if the output frequency is to be set at the value pre-programmed in parameter 203. There is no need for a separate start command to activate jogging.

Freeze jogging reference [1]:
Selected if terminals 32/33 (parameter 406) are to be used for digital control of speed up/down, with the jogging speed as the point of reference. 24 V DC from terminal 12 supplied to terminal 29 will freeze the jogging reference; the speed can be changed by means of terminals 32/33 (parameter 406 = speed up/down).

Freeze reference [2]:
Selected if terminals 32/33 (parameter 406) are to be used for digital control of speed up/down (motor potentiometer). 24 V DC (from terminal 12) supplied to terminal 29, will freeze the existing reference; the speed can be changed by means of terminals 32/33 (parameter 406 = speed up/down).

Digital reference [3]:
Selected if there is to be a choice between one of the digital references (parameters 205-208) or other references (analogue voltage (parameter 412), analogue current (parameter 413), pulses (parameter 401), bus references (parameter 516)).
Digital reference [3] is only active if *external on/off* has been selected in parameter 204. When the digital reference has been activated, the direction of rotation is determined exclusively by the reference sign.

Choice of ramp [4]:
Different ramp times can be selected by means of terminal 29:
24 V DC (from terminal 12) removed from terminal 29 (logic 0) leads to activation of *Ramp 1* (par. 215/216).
24 V DC (from terminal 12) supplied to terminal 29 (logic 1) leads to activation of *Ramp 2* (par. 217/218).
The selected ramp up/down times apply to start/stop via terminal 18 (19 - if programmed) and also apply if the reference is changed.
Selection of *Quick-stop* [1] via terminal 27 automatically activates ramp down-time 2 (parameter 218).

Latch start Hand [5]:
Selected for starting the inverter when the frequency converter is in hand-operation mode, "Hand". If 24 V DC is supplied from terminal 12 to terminal 29 for min. 20 msecs., start is activated.

★ = factory setting. Text in ( ) = display text. Figures in [ ] are used when communicating with the bus.

406 Terminals 32/33 input (INPUT 32/33)

Value:

	Choice of digital reference (SPEED SELECT)	[0]
	Speed up/down (SPEED UP/DOWN)	[1]
	Choice of set-up (SETUP SELECT)	[2]
★	4 set-ups, extended (4 SETUP EXT.)	[3]

Function:

Used for choosing between the possible functions of terminals 32/33.

Description of choice:

Selection of digital reference [0]:
Selected if up to 4 different, pre-programmed, digital speed
references are to be chosen, using a binary code in accordance with the table below:

Digital reference	Terminal 33	Terminal 32
1 (parameter 205)	0	0
2 (parameter 206)	0	1
3 (parameter 207)	1	0
4 (parameter 208)	1	1

Speed up/down [1]:
Selected if digital control of the speed up/down is desired (motor potentiometer). This function is only active if Freeze reference/Freeze jogging reference has been selected in parameter 400, 401 or 405, and if the corresponding terminal 16, 17 or 29 is supplied with 24 V DC from terminal 12.
As long as terminal 32 receives 24 V DC from terminal 12, the output frequency will increase up to f_{MAX} (parameter 202).
As long as terminal 33 receives 24 V DC from terminal 12, the output frequency will decrease down to f_{MIN} (parameter 201). Terminal 33 is the default terminal.

	Terminal 33	Terminal 32
No reference change	0	0
Increase reference	0	1
Reduce reference	1	0
Reduce reference	1	1

A pulse where 24 V DC from terminal 12 is supplied to terminal 32/33 (logic "1" with a duration of between 20 msec. and 500 msec.) will lead to a change of speed of 0.1 Hz at the output.
Logic "1" for more than 500 msec. will make the output frequency change in relation to the set ramps (parameters 215 and 216).

The digital speed reference can be adjusted even if the unit has stopped (does not apply to motor coasting stop, quick-stop or DC-braking on terminal 27). The speed reference is remembered after a mains cut-out if it was constant for at least 15 sec. (see also parameter 014).

Choice of set-up [2]:
If *multi set-up* has been selected in parameter 001, there is a choice between *set-up 1*, *set-up 2*, *set-up 3* and *set-up 4* in accordance with the table below:

Set-up	Terminal 33	Terminal 32
1	0	0
2	0	1
3	1	0
4	1	1

4 set-ups, extended [3]:
Selected if the same function is desired on terminal 32/33 as on the first generation of the VLT 3000 range, with extended control card and with 4 set-up functions. If freeze reference is not selected in parameter 400, 401 or 405, the following set-ups are available:

Set-up	Terminal 32	Terminal 33
1	0	0
2	0	1
3	1	0
4	1	1

If, however, the reference is frozen in either parameter 400, 401 or 405, it will be possible to choose between two functions by means of terminal 16, 17 or 29. Terminal 16, 17 or 29 without any voltage connected (logic "0").

Set-up	Terminal 32	Terminal 33
1	0	0
2	0	1
3	1	0
4	1	1

Terminal 16, 17 or 29 receiving 24 V DC from terminal 12 (logic "1").

	Terminal 33	Terminal 32
Freeze reference (summed)	0	0
Increase reference	0	1
Reduce reference	1	0
Reduce reference	1	1

★ = factory setting. Text in ( ) = display text. Figures in [ ] are used when communicating with the bus.

407 Terminal 42 output (OUTPUT 42)

Value:

	Control ready (CONTROL READY)			[0]
	Unit ready (UNIT READY)			[1]
	Ready - remote control (UNT RDY RCTL)			[2]
	Enabled (ENABLED noWR)			[3]
	Running (RUNNING)			[4]
	Running, no warning (RUNNING noWR)			[5]
	Running in range, no warning (RUNinRANGE)			[6]
	Speed = reference, no warning (RUN@REF noWR)			[7]
	Alarm (ALARM)			[8]
	Alarm or warning (ALARM or WARN)			[9]
	Current limit (CURRENT LIMIT)			[10]
	Out of frequency range (OUT FREQ RGE)			[11]
	Warning of F low (LO FREQ. WARN)			[12]
	Warning of F high (HI FREQ. WARN)			[13]
	Out of current range (OUT CURR RGE)			[14]
	Warning of I low (LO CURR. WARN)			[15]
	Warning of I high (HI CURR. WARN)			[16]
	0 - 100 Hz	0-20 mA	(100 Hz 0-20 mA)	[17]
	0 - 100 Hz	4-20 mA	(100 Hz 4-20 mA)	[18]
	0 - f_{MAX}	0-20 mA	(Fmax 0-20 mA)	[19]
	0 - f_{MAX}	4-20 mA	(Fmax 4-20 mA)	[20]
	REF_{MIN} - REF_{MAX}	0-20 mA	(REFmax 0-20 mA)	[21]
	REF_{MIN} - REF_{MAX}	4-20 mA	(REFmax 4-20 mA)	[22]
	FB_{MIN} - FB_{MAX}	0-20 mA	(FBmax 0-20 mA)	[23]
	FB_{MIN} - FB_{MAX}	4-20 mA	(FBmax 4-20 mA)	[24]
★	0 - I_{MAX}	0-20 mA	(CURmax 0-20 mA)	[25]
	0 - I_{MAX}	4-20 mA	(CURmax 4-20 mA)	[26]
	0 - I_{LIM}	0-20 mA	(CURlim 0-20 mA)	[27]
	0 - I_{LIM}	4-20 mA	(CURlim 4-20 mA)	[28]
	0 - kW_{MAX}	0-20 mA	(PWRlim 0-20 mA)	[29]
	0 - kW_{MAX}	4-20 mA	(PWRlim 4-20 mA)	[30]

Function:

At signal output 42 and 45, three types of signals can be chosen terminals: 24 V, (max. 40 mA), 0-20 mA or 4-20 mA.

The 24 V signal is used to indicate the status and warnings selected; 0-20 mA and 4-20 mA are used for analogue read-outs on terminal 42.

Description of choice:

[0] VLT is ready for use.

[1] VLT is ready for use.

[2] VLT is set for remote control and is ready for use.

[3] VLT ready, no warning.

[4] VLT running (output frequency > 0.5 Hz or start signal).

[5] VLT running (output frequency > 0.5 Hz or start signal), no warning.

[6] VLT runs within the programmed warning frequency and/or current range, no warning.

[7] VLT output frequency corresponds to the reference, no warning.

[8] Output activated due to alarm.

[9] Output activated due to alarm or warning.

[10] Current limit in parameter 209 has been exceeded.

[11] The motor is running out of the frequency range programmed in parameters 210-211.

[12] The motor is running below the frequency programmed in parameter 210.

[13] The motor is running above the frequency programmed in parameter 211.

[14] The motor is running out of the current range programmed in parameters 212-213.

[15] The motor current is below the current programmed in parameter 212.

[16] The motor current is above the current programmed in parameter 213.

[17] 0-100 Hz is used for reading the given output
[18] frequency, regardless of the frequency set in parameter 202 (f_{MAX}).

[19] 0-f_{MAX} is used for reading the given output
[20] frequency, where f_{MAX} is stated in parameter 202.

[21] REF_{MIN}-REF_{MAX} states the output signal range,
[22] corresponding to the sum of analogue and pulse input ranges in parameters 401, 412 and 413, as well as the bus reference (parameter 516).

[23] FB_{MIN}-FB_{MAX} states the output signal range,
[24] corresponding to the range of the feedback signal selected in parameters 401, 412 or 413.

[25] 0-I_{MAX} indicates the output signal range from 0
[26] to I_N x 1.1.

[27] 0-I_{LIM} indicates the output signal range from 0
[28] to the current limit I_{LIM} programmed in parameter 209.

[29] 0-kW_{MAX} states the output signal range from
[30] 0 to $P_{VLT,N}$
$P_{VLT,N}$ is the motor size programmed in parameter 103.

★ = factory setting. Text in ( ) = display text. Figures in [ ] are used when communicating with the bus.

408 Terminal 45 output (OUTPUT 45)

Value:

	Control ready (CONTROL READY)			[0]
	Unit ready (UNIT READY)			[1]
	Ready - remote control (UNT RDY RCTL)			[2]
	Enabled (ENABLED noWR)			[3]
	Running (RUNNING)			[4]
	Running, no warning (RUNNING noWR)			[5]
	Running in range, no warning (RUNinRANGE)			[6]
	Speed = reference, no warning (RUN@REF noWR)			[7]
	Alarm (ALARM)			[8]
	Alarm or warning (ALARM or WARN)			[9]
	Current limit (CURRENT LIMIT)			[10]
	Out of frequency range (OUT FREQ RGE)			[11]
	Warning of F low (LO FREQ. WARN)			[12]
	Warning of F high (HI FREQ. WARN)			[13]
	Out of current range (OUT CURR RGE)			[14]
	Warning of I low (LO CURR. WARN)			[15]
	Warning of I high (HI CURR. WARN)			[16]
	0 - 100 Hz	0-20 mA	(100 Hz 0-20 mA)	[17]
	0 - 100 Hz	4-20 mA	(100 Hz 4-20 mA)	[18]
★	0 - f_{MAX}	0-20 mA	(Fmax 0-20 mA)	[19]
	0 - f_{MAX}	4-20 mA	(Fmax 4-20 mA)	[20]
	REF_{MIN} - REF_{MAX}	0-20 mA	(REFmax 0-20 mA)	[21]
	REF_{MIN} - REF_{MAX}	4-20 mA	(REFmax 4-20 mA)	[22]
	FB_{MIN} - FB_{MAX}	0-20 mA	(FBmax 0-20 mA)	[23]
	FB_{MIN} - FB_{MAX}	4-20 mA	(FBmax 4-20 mA)	[24]
	0 - I_{MAX}	0-20 mA	(CURmax 0-20 mA)	[25]
	0 - I_{MAX}	4-20 mA	(CURmax 4-20 mA)	[26]
	0 - I_{LIM}	0-20 mA	(CURlim 0-20 mA)	[27]
	0 - I_{LIM}	4-20 mA	(CURlim 4-20 mA)	[28]
	0 - kW_{MAX}	0-20 mA	(PWRlim 0-20 mA)	[29]
	0 - kW_{MAX}	4-20 mA	(PWRlim 4-20 mA)	[30]

Function:

See function under parameter 407.

Description of choice:

See description of choice under parameter 407.

409 Terminal 01 relay output (RELAY 01)

Value:

	Control ready (CONTROL READY)	[0]
	Unit ready (UNIT READY)	[1]
	Ready - remote control (UNT RDY RCTL)	[2]
	Enabled (ENABLED noWR)	[3]
	Running (RUNNING)	[4]
	Running, no warning (RUNNING noWR)	[5]
	Running in range, no warning (RUNinRANGE)	[6]
	Speed = reference, no warning (RUN@REF noWR)	[7]
★	Alarm (ALARM)	[8]
	Alarm or warning (ALARM or WARN)	[9]
	Current limit (CURRENT LIMIT)	[10]
	Out of frequency range (OUT FREQ RGE)	[11]
	Warning of F low (LO FREQ. WARN)	[12]
	Warning of F high (HI FREQ. WARN)	[13]
	Out of current range (OUT CURR RGE)	[14]
	Warning of I low (LO CURR. WARN)	[15]
	Warning of I high (HI CURR. WARN)	[16]
	Motor thermal overload (MOT.THERM.WARN)	[17]
	Ready and no motor thermal overload (READY+MOT.OK)	[18]
	Ready and remote control (RDY+MOT+REM)	[19]
	Ready and no over-/undervoltage (RDY+DC V OK)	[20]
	Idle running current (NO LOAD CURR)	[21]

Function:

Relay output 01 and relay output 04 can be used for indicating status and warnings. The relay is activated when the conditions for the different data values are fulfilled. Activation/de-activation can be delayed using parameters 316 and 317.

When relay output 01 is not active, there is a connection between terminals 01 and 03, but no connection between terminals 01/03 and terminal 02 (switch contact).

Description of choice:

[0]-[16]: See explanations under parameter 407.

[17] Motor thermal overload: The electronic motor thermal overload indicates that the motor is overheated.

[18] Ready and no motor thermal overload: VLT is ready and the electronic motor protection indicates that there is no thermal overload.

[19] Ready and remote control: VLT is ready and is in remote control mode (Auto).

[20] Ready and no under-/overvoltage: VLT is ready and the intermediate circuit voltage is OK.

[21] Idle running current must be programmed (par. 332), since the relay uses this information to indicate e.g. whether the V-belt has broken.

★ = factory setting. Text in ( ) = display text. Figures in [ ] are used when communicating with the bus.

410 Terminal 04 relay output (RELAY 04)

Value:

	Control ready (CONTROL READY)	[0]
	Unit ready (UNIT READY)	[1]
	Ready - remote control (UNT RDY RCTL)	[2]
	Enabled (ENABLED noWR)	[3]
★	Running (RUNNING)	[4]
	Running, no warning (RUNNING noWR)	[5]
	Running in range, no warning (RUNinRANGE)	[6]
	Speed = reference, no warning (RUN@REF noWR)	[7]
	Alarm (ALARM)	[8]
	Alarm or warning (ALARM or WARN)	[9]
	Current limit (CURRENT LIMIT)	[10]
	Out of frequency range (OUT FREQ RGE)	[11]
	Warning of F low (LO FREQ. WARN)	[12]
	Warning of F high (HI FREQ. WARN)	[13]
	Out of current range (OUT CURR RGE)	[14]
	Warning of I low (LO CURR. WARN)	[15]
	Warning of I high (HI CURR. WARN)	[16]
	Motor thermal overload (MOT.THERM.WARN)	[17]
	Ready and no motor thermal overload (READY+MOT.OK)	[18]
	Ready and remote control (RDY+MOT+REM)	[19]
	Ready and no over-/undervoltage (RDY+DC V OK)	[20]
	Idle running current (NO LOAD CURR)	[21]

Function:

Relay outputs 01 and 04 can be used for indicating status and warnings.
The relay is activated when the conditions for the different data values are fulfilled. When relay 04 is activated, there is a connection between terminals 4 and 5 (make contact).

Description of choice:

[0]-[16]: See explanations under parameter 407.
[17]-[21]: See explanations under parameter 409.

---

411 Analogue reference type (ANALOG REFTYPE)

Value:

★	Linear between min. and max. (LINEAR)	[0]
	Proportional to lower limit (PROP W/MIN.)	[1]

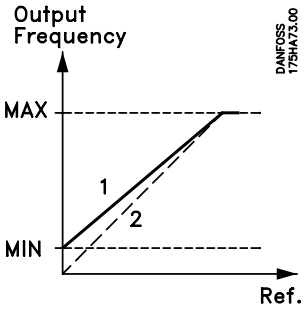
Function:

It is possible to select how the output frequency is to depend on the analogue reference signal.

Description of choice:

Used for deciding how the frequency converter is to follow an analogue reference signal, see graph on page 93.

Analogue reference type
(parameter 411)



1. Linear between min. and max. Data [0]
2 . Proportional to reference with min. and max. limits. Data [1]

412 Terminal 53 Analogue input voltage (INPUT #53 ANA.)

Value:

	No operation (NO OPERATION)	[0]
★	0-10 V (0-10 V DC)	[1]
	10-0 V (10-0 V DC)	[2]
	2-10 V (2-10 V DC)	[3]
	10-2 V (10-2 V DC)	[4]
	1-5 V (1-5 V DC)	[5]
	5-1 V (5-1 V DC)	[6]

★ = factory setting. Text in ( ) = display text. Figures in [ ] are used when communicating with the bus.

413 Terminal 60 Analogue input current
(INPUT #60 ANA.)

Value:

	No operation (NO OPERATION)	[0]
★	0-20 mA (0-20 mA)	[1]
	4-20 mA (4-20 mA)	[2]
	20-0 mA (20-0 mA)	[3]
	20-4 mA (20-4 mA)	[4]

Function (parameters 412 and 413):

There is a choice of different types of references.

Description of choice (parameters 412 and 413):

Enter the type of analogue input signals to terminals 53 and 60. Choose between voltage and current, and whether the signals are to be normal or inverted. If both inputs are used for reference signals, the total reference signal is the sum of those two signals.
If a PID regulator is used without latched input being used, terminal 17 (parameter 401), one of the inputs must be used for the feedback signal.
If current control is used (par. 102), one of the inputs must be used for setting a current limit. The choice of these options prevents the use of the same type of reference signal.

NB!:
If terminal 53 and/or 60 is not used, "no ope ration" should be chosen in the respective parameters 412 or 413, so a reference fault does not occur.

414 Time interval (TIME OUT)

Value:

0 - 99 secs. ★100 = OFF

Function:

See parameter 415.

415 Time interval function (TIME OUT ACT.)

Value:

★	Freeze (FREEZE)	[0]
	Stop (STOP)	[1]
	Jogging (JOG)	[2]
	Max. speed (MAX)	[3]

Function: (parameters 414 and 415):

If one of the "live zero" signals (e.g. 4-20 mA) has been selected and the reference is less than 2 mA, a warning (Ref. fault) shown in the display and a desired operating state occurs after expiry of the time interval chosen in parameter 414.

Description of choice: (parameters 414 and 415):

The desired operating mode is selected in parameter 415. The reference of the frequency converter can be frozen at the given value, or it can regulate to stop, the jogging frequency set in parameter 203, or the maximum frequency set in parameter 202.
This function is not active for local speed reference (par. 004), or when closed loop has been selected (par. 101).

420 Reference type to H-O-A (EXT.HOA REF.)

Value:

★	Voltage	[0]
	Current 60	[1]
	Speed up/down (SPEED UP/DOWN)	[2]

Function:

When an external H-O-A is selected in parameter 003, a reference for hand-operation (Hand) must be selected; this reference cannot be of the same type that is used for remote control (Auto), see example 9 on page 32.

Description of choice:

If *Voltage* [0] is selected, an analogue voltage reference is used which is programmed in parameter 412 (terminal 53).
If *Current 60* [1] is selected, an analogue current reference is used which is programmed in parameter 413 (terminal 60).
If *Speed up/down* [2] is selected, digital speed up/down is used which is programmed in parameter 406.

All information about how to use the RS 485 serial interface is not included in this manual. Please contact Danfoss for a Design Guide.

★ = factory setting. Text in ( ) = display text. Figures in [ ] are used when communicating with the bus.

■ Service and diagnostics, group 6..

In group 6.., different operating data can be recorded that may be used in connection with service and diagnostics. Also, this group contains information about the identity of the unit and the software version used.

600 Operation data (OPERATION DATA)

Value:

★ 0 Total number of operating hours (TOT.HRS xxxx) *)
1 Running hours (RUN.HRS xxxx)*)
2 kWh (ENERGY xxxx)
3 No. of cut-ins (POW-UPS xxxx)
4 No. of overheatings (OV.TEMP xxxx)
5 No. of overvoltages (OV.VOLT xxxx)

Function:

[Index 000.00-005.00]
Display of the most important operation data.

Description of choice:

Display range:
Total number of operating hours/Running hours/kWh is 0.0 - 99999 (below 10000, with 1 decimal).

Number of cut-ins/Number of overheatings/Number of overvoltages is 0 - 99999.

Serial communication:
Total number of operating hours/Running hours/kWh is registered in the form of floating decimal point values.

No. of cut-ins/Number Overheatings/Number Overvoltages, registered as whole numbers.

Total number of operating hours/Running hours/kWh is automatically reset after manual initialisation.

NB!:
The data stated are saved every 8 hours. kWh can be reset via parameter 011.

Running hours can be reset via parameter 012.

Number of cut-ins/Number of overheatings/Number of overvoltages are saved as they occur.

601 Data log (DATALOG)

		0	1	2	3	4	-	-19
Digital inputs	(DIG.IN)	[0]						
Control word	(CONTRL)	[1]						
Status word	(STATUS)	[2]						
Reference %	(REF. %)	[3]						
Frequency out	(F-OUT)	[4]						
Phase current	(IPHASE)	[5]						
DC voltage	(UDC)	[6]						

Function:

[Index 000.00 - 019.06]
Logging of data for the last few seconds of operation, before stop or trip.

Description of choice:

Digital inputs are stated in hex code (0-FF).
Control words are stated as a hex code (0-FFFF) for bus operation RS 485.
Status words are stated as a hex code (0-FFFF) for bus operation RS 485.
Reference is the control signal in percent (0-100%).
Frequency out is the output frequency of the unit in Hz (0.0 - 999.9).
Phase current is an output current in A (0.0 - 999.9).
Direct voltage indicates the voltage of the intermediate circuit in [V DC] (0-999).

20 log values are stated (0-19).
The lowest number (0) contains the most recent/last data value saved; the highest log number (19) contains the oldest data value.
Data values log every 160 msec. as long as the start signal is active.
The data log contains the 20 last log values (approx. 3.2 sec.) before a stop signal is given (start not active), or a trip occurs.
It is possible to scroll through the log values. The data log is reset during start up (when the mains supply is restored).

★ = factory setting. Text in ( ) = display text. Figures in [ ] are used when communicating with the bus.

602 Alarm store (ALARM MEMORY)

	0	1	2	3	4	-	-	7
Fault code	[0]							
Time	[1]							
Value	[2]							

Function:

[Index 000.00 - 007.02]. Storage of data in connection with tripping.

Description of choice:

The fault code gives the cause of a trip occurrence in the form of a digit code from 1 to 15:

Fault code	Alarm
1	Alarm
2	Overvoltage
3	Undervoltage
4	Overcurrent
5	Ground fault
6	Overtemperature
7	Inverter overloaded
8	Motor overloaded
9	Current limit
10	Trip locked
11	Control card or option card fault
13	Auto-optimisation fault
14	Fault in direct current supply
15	Thermistor input activated, se parameter 400/terminal 16

Time indicates the total number of operating hours after which the trip occurred. Display range 0.0 - 999.9.

Value indicates e.g. at what voltage or current the trip occurred. Display range 0.0 - 999.9.

Serial communication - the fault code is returned in the form of a whole number. Time and value are registered in the form of floating decimal point values. 8 log values are indicated (0-7).

The lowest log number (0) contains the most recent/ last data value saved, with the highest log number (7) containing the earliest data value.

An alarm can only be represented once. The fault log is reset after manual initialisation. Regardless of the log set being studied at any given time, the display automatically switches to log no. 0 if another trip occurs.

603 Nameplate (NAMEPLATE)

Value:

★ 0 Type (VLT3xxx)

1 Unit voltage (xxx V)

2 Software type

Process	[1]
HVAC	[2]
Profibus Proc	[3]
Profibus HVAC	[4]
Syncron Opt	[5]
Modbus+ Proc	[6]
Modbus HVAC	[7]

3 Software version (vx.x)

Function:

The key data for the unit can be read from the display or the bus (RS 485).

Description of choice:

Type indicates the size of unit and the basic functions involved.

Unit voltage indicates the voltage for which the unit was built or set (par. 650).

Software type indicates whether the software used is a standard product or specially developed.

Software version indicates the version number.

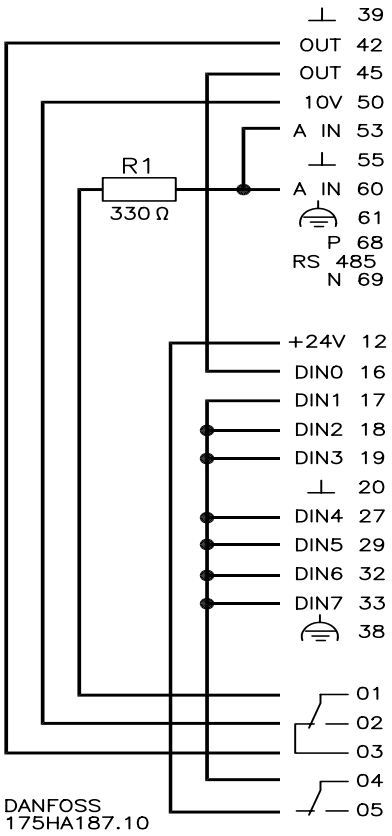
★ = factory setting. Text in ( ) = display text. Figures in [ ] are used when communicating with the bus.

604 Operation mode (OPERATION MODE)

Value:

★	Normal operation (RUN NORMAL)	[0]
	Operation with de-activated inverter (RUN INV DISABL)	[1]
	Control card test (CTRL CARD TEST)	[2]
	Initialisation (INITIALIZE)	[3]

Test connector



Function:

In addition to its normal function, this parameter can be used for 2 different tests.
Furthermore, manual initialisation of all parameters can be carried out (except for par. 501, par. 600 and par. 602).

Description of choice:

Normal operation [0] is used for normal running of the motor for the application chosen.
Operation with de-activated inverter [1] is selected if monitoring is required of the influence that the control signal has on the control card and its functions without the inverter driving the motor.

Control card test [2] is selected if monitoring is required of the control card analogue and digital inputs as well as its analogue, digital and relay outputs, and control voltage of +10 V. This test requires the use of a test connector with internal wiring connections.

Proceed as follows:

1) Press the stop key.
2) Insert the test connector in the plug.
3) Choose control card test from parameter 604.
4) Cut out mains and wait for the light in the display to go out.
5) Cut mains back in.
6) Press the start key.

The test will now go through three steps, each of which gives an OK or fault message, depending on the result. If a fault message appears, the control card must be replaced.
Initialisation [3] is selected if factory setting of the unit is required without resetting of parameters 500, 501, 600 and 602.

Procedure:

1) Select initialisation.
2) Press the "Menu" key.
3) Cut out mains and wait for the light in the display to go out.
4) Cut mains back in.

★ = factory setting. Text in ( ) = display text. Figures in [ ] are used when communicating with the bus.

605 Personal display select (DISPLAY SELECT)

Value:

★	Standard display (STANDARD DISP.)	[0]
	Reference % (REFERENCE %)	[1]
	Frequency Hz (FREQUENCY Hz)	[2]
	Feedback unit (FEEDBK 'UNIT')	[3]
	Current A (CURRENT A)	[4]
	Torque % (TORQUE %)	[5]
	Power kW (POWER kW)	[6]
	HP power (POWER HP)	[7]
	Energy kWh (ENERGY kWh)	[8]
	Output voltage V (OUTPUT VOLT.V)	[9]
	DC voltage (DC BUS V)	[10]
	VLT therm % (ETR (VLT) %)	[11]
	Motor therm % (ETR (MOT) %)	[12]
	Running hours (RUN HOURS)	[13]
	Input status "binary code" (DIGITAL INPUT)	[14]

Function:

The display can show two different readouts at the same time. The second readout is shown in line 2 on the display.

Description of choice:

Standard display [0] is chosen if normal reading is desired, e.g. of the frequency in Hz in line 1, while stating "frequency" in line 2 and the operating mode in line 3.

Personal display select. The other data values are selected if a different operating value is to be displayed in line 2, thereby making it possible to have e.g. the mentioned frequency in line 1 and current in line 2 at the same time. There are 14 different data values to choose from.

NB!:
If both lines are to be visible at the same time, the display must be in Display Mode.

606 Display Mode (DISPLAY MODE)

Value:

★	Standard display (QUICK DISPLAY)	[0]
	Extended display (EXT. DISPLAY)	[1]

Function:

Choose between two different Display Modes, see page 34.

650 VLT type (VLT TYPE)

Function:

Used for indicating the unit in which the control card is placed, in cases where the control card is not able to determine this itself. Or used for choosing the voltage range in multi-voltage units whose factory setting varies from that required.

Description of choice:

This parameter is used for choosing the right VLT type/size/voltage for VLT 3575-3800, which are multi-voltage units. If the factory-set voltage does not correspond to the voltage of the application for which the unit is intended, proceed as follows:

1) Select the desired VLT type/size/voltage.
2) Select parameter 604, data value initialisation.
3) Cut out mains and wait for the light in the display to go out.
4) Cut mains back in.

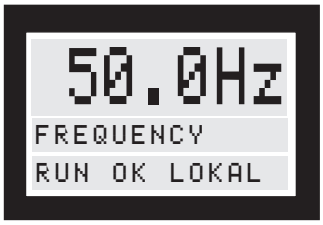
NB!:
When starting up it must be checked that the display shows the new data selected.

★ = factory setting. Text in ( ) = display text. Figures in [ ] are used when communicating with the bus.

■ Diagnosis and service

■ Status messages

Status messages appear in the 3rd line of the display - see example below:



Local stop (ENAB STP LOC.):
"Local" or "Local with external stop" has been selected in parameter 003. The "Local/Hand" key on the frequency converter operating panel is activated and "Stop" on the keyboard is activated, too.

VLT ready, local (UNIT RDY LOC.):
"Local" or "Local with external stop" has been selected in parameter 003. The "Local/Hand" key on the frequency converter operating panel is activated and "Coasting stop" in parameter 404; there is 0 V on terminal 27.

Local operation OK (RUN OK LOCAL):
"Local" or "Local with external stop" has been selected in parameter 003. The "Local/Hand" key on the frequency converter operating panel is activated and the frequency converter is running at the set speed reference (parameter 004).

Local ramp operation (RAMP LOCAL):
"Local" or "Local with external stop" has been selected in parameter 003. The "Local/Hand" key on the frequency converter operating panel is activated and the output frequency is varying in accordance with the set ramping times.

Stop (ENAB STOP.):
Remote Control Mode ("Remote/Auto") is active and the frequency converter has been stopped via the keyboard or the control terminals.

VLT ready (UNIT READY.):
Remote Control Mode ("Remote/Auto") is active and "Coasting stop" has been selected in parameter 404; there is 0 V on terminal 27.

Operation OK (RUN OK.):
Remote Control Mode ("Remote/Auto") is active and the frequency converter is running at the speed reference.

Jogging (JOGGING.):
Remote Control Mode ("Remote/Auto") is active and "Jogging" has been selected in parameter 405; at the same time there is 24 V on terminal 29.

Ramping (RAMPING):
Remote Control Mode ("Remote/Auto") is active and the output frequency is varying with the set ramping times.

Freeze reference (FREEEZE.):
Remote Control Mode ("Remote/Auto") is active and freeze reference has been selected in parameter 400, 401 or 405; at the same time, the respective input (16, 17 or 29) is active.

Off 2 (OFF 2):
Bit 01 of the control word is "0".

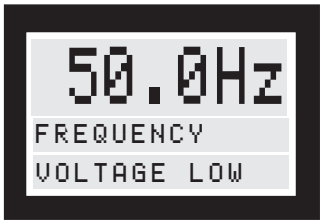
Off 3 (OFF 3):
Bit 02 of the control word is "0".

Start disabled (START INHIB.):
Bit 06 of the status word is "1".

Reference locked (HOLD.):
Bit 05 of the control word is "0".

■ Warnings

Warnings appear in line 3 of the display - see example below:



Voltage warning, low (VOLTAGE LOW):
The intermediate circuit voltage (DC) is below the warning limit of the control card, see table page 77. The inverter is still active.

Voltage warning, high (VOLTAGE HIGH):
The intermediate circuit voltage (DC) is above the warning limit of the control card, see table page 77. The inverter is still active.

Undervoltage (UNDER VOLTAGE):
The intermediate circuit voltage is below the undervoltage limit of the inverter, see table page 77. The inverter has stopped and a trip will occur when the delay time selected in parameter 311 has passed.

Overvoltage (OVER VOLTAGE):
The intermediate circuit voltage is above the overvoltage limit of the inverter, see table page 77. The inverter has stopped and a trip will occur when the delay time selected in parameter 311 has passed.

Current limit (CURRENT LIMIT):
The motor current is higher than the value stated in parameter 209.

Overcurrent (OVER CURRENT):
The peak current limit of the inverter (approx. 250% of the rated current) has been exceeded; after 7-11 secs. a trip will occur.

Reference fault (REF FAULT):
There is a fault on an analogue input signal (terminal 53 or 60), when a signal type with "live zero" has been chosen (4-20 mA, 1-5 V or 2-10 V). The warning is activated when the signal level is less than half the zero level (4 mA, 1 V or 2 V).

No motor (NO MOTOR):
The motor check function (par. 313) detects that a motor has not been connected to the frequency converter output.

Frequency warning, low (LO FREQ WARN):
The output frequency is lower than the value selected in parameter 210.

Frequency warning, high (HI FREQ WARN):
The output frequency is higher than the value selected in parameter 211.

Current warning, low (LO CURR WARN):
The output current is lower than the value selected in parameter 212.

Current warning, high (HI CURR WARN):
The output current is higher than the value selected in parameter 213.

Motor overloaded (MOTOR TIME):
According to the electronic thermal motor protection, the motor is too hot. This warning only comes up if "warning" has been selected in parameter 315.

Inverter overloaded (INVERT TIME):
According to the electronic inverter protection, the frequency converter is close to tripping because of overload (too high current for too long a time). The counter for electronic inverter protection has readed98% (100% results in a trip).

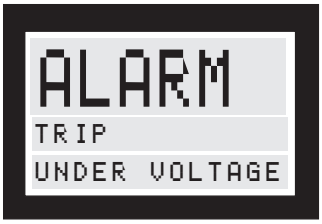
24 V fault (NO 24 VOLT):
The 24 V voltage supply from the power unit to the control card is not present.

EEPROM fault (EEPROM ERROR):
EEPROM fault. Data changes are not saved when the mains supply is cut out.

Lost motor (STALLING):

■ Reset messages

Reset messages appear in the 2nd line of the display and alarm messages appear in the 3rd line of the display - see the example below:



Automatic restart (RESTART):
When "automatic reset" has been selected as the reset function, the message indicates that VLT 3500 HVAC is trying to restart automatically after having tripped. The time delay before the restart depends on parameter 312.

Trip (TRIP):
VLT 3500 HVAC has tripped and manual reseting is required. Manual resetting can be carried out by means of the reset key on the keyboard, a digal input (terminal 16, 17 or 27) or bit 07 of the control word (RS 485).

Trip locked (TRIP LOCKED):
VLT 3500 HVAC has tripped and resetting is only possible if the mains supply is cut out. Having cut the mains supply back in, manual resetting is required.

■ Alarm messages

Undervoltage (UNDER VOLTAGE):
Error code 3
The intermediate circuit voltage is below the undervoltage limit of the inverter.

Overvoltage (OVER VOLTAGE):
Error code 2
The intermediate circuit voltage is above the overvoltage limit of the inverter.

Current limit (CURRENT LIMIT):
Error code 9
The motor current has exceeded the value of parameter 209 for a longer time than that permitted in parameter 310.

Overcurrent (OVER CURRENT):
Error code 4
The peak current limit of the inverter (approx. 250% of the rated current) has been exceeded for more than 7-11 secs. (Trip locked).

Ground fault (GROUND FAULT):
Error code 5
There is a discharge from the output phases to ground, either in the cable between the frequency converter and the motor, or from inside the motor. (Trip locked).

Overtemperature (OVER TEMP):
Error code 6
An excessive temperature has been measured internally in VLT 3500 HVAC. A cooling-down period is required before resetting is possible. (Trip locked).

Inverter overloaded (OVERLOAD):
Error code 7
The electronic thermal inverter protection reports that VLT 3500 HVAC has tripped because of overload (too high current for too long). The counter for electronic thermal inverter protection has reached 100%.

Motor overloaded (MOTOR TRIP):
Error codes 8 and 15
According to the electronic thermal motor protection, the motor is too hot. The alarm only comes up if "trip" has been selected in parameter 315. See also parameter 400.

Inverter fault (INVERT FAULT):
Error code 1
There is a fault in the power side of VLT 3500 HVAC. Please contact DANFOSS.

Voltage limits:

VLT 3500 range	3x200/230 V [VDC]	3x380/415 V [VDC]	3x440/500 V [VDC]	VLT 3575-3800 [VDC]
Undervoltage	210	400	460	470
Voltage warning, low	235	440	510	480
Voltage warning, high	370	665	800	790
Overvoltage	410	730	880	850

The voltage is the intermediate circuit voltage of the frequency converter. The corresponding mains voltage is the intermediate circuit voltage divided by √2.

■ Fault messages

- If an inactive key is pressed:
  KEY DISABLED
  This indicates that either factory setting has been selected (parmeter 001).
  Parameter 001 must be changed to set-up 1-4.
  Or the key in question has been blocked (parameters 006-009).
- If an attempt is made to change data that can only be changed when the frequency converter has stopped: **ONLY IN STOP.**
- If an attempt is made to change data with an open LOCK switch: **LOCK OPEN.**
- If an attempt is made to change data outside the permissible range: **LIMIT.**

■ Start-up test:

VLT 3500 HVAC carries out a self-test of the control card when the mains supply is cut in. The following message may appear:

The reason for this fault message is a fault on the control card or an option card, if used. Contact DANFOSS.

Warning:

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

Using VLT 3502-3562 HVAC: wait 4 minutes

Using VLT 3542-3562 (230 V) HVAC: wait 14 minutes

Using VLT 3575-3800 HVAC: wait 14 minutes

Fault messages

Inverter fault

The power section of VLT 3500 HVAC is defective.

Overvoltage

The voltage of the intermediate circuit (DC voltage) is too high. Possible reasons: mains voltage too high, transients on the mains voltage, or regenerative motor operation.

Note: When VLT 3500 HVAC stops via ramps, energy from the motor is returned to the frequency converter (regenerative operation), which charges the intermediate circuit.

- If the fault message is given when the speed is ramped down, the ramp-down time can be increased.

If the fault message arises in other situations, the problem is probably in the mains supply.

Undervoltage

The voltage of the intermediate circuit of the frequency converter (DC current) is too low. Possible reasons: Mains voltage too low or a fault on the charging circuit/rectifier of the frequency converter.

- Check whether the mains voltage is in order.

Overcurrent

The upper limit of the rectifier peak current is reached, possibly because of a short-circuiting of the frequency converter output.

- Check that there is no short-circuiting at the motor or in the motor cable.

Ground fault

A ground fault on VLT 3500 HVAC's output. Another possibility is that the motor cable is too long.

- Check under technical data to find out how long the cable must be. Check whether motor and motor cable have been grounded correctly.

Critical temperature

The temperature inside VLT 3500 HVAC is too high. Possible causes: Ambient temperature too high (max. 40/45°C), the heat sink ribs of the frequency converter have been covered, or the fan is out of order.

- Reduce the ambient temperature by increasing the amount of ventilation. Clear/clean the heat sinks. Replace the fan if faulty.

Overload

The electronic VLT 3500 HVAC protection is active. This means that the motor has consumed more than 110% of the rated current of the frequency converter for too long.

- Reduce the motor load. If this is not possible, the application may require a larger frequency converter.

Motor trip

The electronic motor protection is active. This means that the current consumed by the motor at low speed has been too high for too long.

- The motor has been loaded excessively at low speed. If the load cannot be changed, the motor has to be replaced by a bigger version, or extra cooling must be provided for the existing motor. Subsequently, the electronic motor protection can be de-activated in parameter 315.

NB!:

Electrostatic discharges

Important! Many electronic components are sensitive to static electricity. Even voltages so low that they cannot be felt, seen or heard, may impair components or damage them completely.

Discharge of static electricity can have the following unpleasant consequence: the service life of components is reduced.

■ Earth leakage current

Earth leakage current is primarily caused by the capacitance between the conductor 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.

The size of the leakage current to the ground depends on the following factors:

- Length of motor cable
- Switching frequency
- RFI filter used or not
- Motor grounded on site or not
- Motor cable w/ or w/o screen

The leakage current is of importance regarding safety during handling/operation of the frequency converter if an earth connection has not been established.

NB!:
Never operate the frequency converter without an effective earth connection complying with local regulations for high leakage current (>3.5 mA). Never use HFI relays. That is not allowed because of the rectifier load.

If FI relays are used, they must be

- Suitable for protecting equipment with direct current in the discharge current (3-phase bridge rectifier)
- Suitable for power-up with pulsing, short discharge
- Suitable for a high discharge current

■ Extreme running conditions

Short circuit

VLT 3500 HVAC is protected against short circuit by means of current measurement in each of the three motor phases. A short circuit between two output phases will cause an overcurrent in the inverter. However, each transistor of the inverter will be turned off individually when the short circuit current exceeds the permitted value.

After 5-10 seconds the driver card turns off the inverter and the frequency converter will display a fault code.

Earth fault

In case of an earth fault in a motor phase, the inverter is turned off within 5-10 ms.

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 3500 HVAC in any way by switching on the output. However, fault messages may appear.

Motor-generated overvoltage

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

1. The load drives the motor (at constant output frequency from the frequency converter), i.e. the load generates energy.
2. During deceleration ("ramp-down") if the moment of inertia is high, the load is low and/or the ramp-down time is short.

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 3500 HVAC continues until the intermediate circuit voltage drops below the minimum stop level, which is typically 15% below VLT 3500 HVAC's lowest rated supply voltage.

The time before the inverter stops depends on the mains voltage before the drop-out and on the motor load. Ride-through and/or flying start can be programmed.

Static overload

When VLT 3500 HVAC is overloaded (the current limit I_{LIM} is reached), the controls will reduce the output frequency in an attempt to reduce the load. If the reduction of the output frequency does not reduce the load, a trip is activated when the output frequency has fallen below 0.5 Hz.

Operation in the current limit can be limited in time (0-60 s) by adjusting parameter 310.

■ du/dt and peak voltage on motor

When a transistor in the inverter is activated, the voltage applied to the motor will rise by the du/dt ratio determined by

- the motor cable (type, cross-section, length, screened/unscreened)
- inductors

The self-inductance will cause an overshoot U_{PEAK} for the motor voltage before it stabilizes at a level determined by the voltage in the intermediate circuit. Both the du/dt ratio and the peak voltage U_{PEAK} influence the lifetime of the motor. Too high values will primarily affect motors without phase coil insulation. If the motor cable is short (a few metres), the du/dt ratio will be quite high, but the peak voltage quite low. If the motor cable is long (100 m), du/dt will decrease and U_{PEAK} will increase.
To ensure a long service life of the motor, VLT 3500 HVAC features as standard built-in motor coils which ensure a low value for the du/dt ratio, even with very short motor cables.

If very small motors are used without phase coil insulation, it is recommended to mount a clamp filter or an LC filter after the frequency converter.
Clamp filter, ordering no. 175H5147 (fits all units in VLT type 3502-3562).
Typical values for the du/dt ratio and the peak voltage U_{PEAK} measured on the terminals of the frequency converter between two phases (30 m screened motor cable).

VLT type 3502 - 3562:

- **du/dt** ~ 200 - 300 V/µs
- **U_{PEAK}**~ 800 - 1100 V

VLT type 3575 - 3800:

- **du/dt** ~ 2000 - 2100 V/µs
- **U_{PEAK}**~ 900 - 950 V measured with a 20 m unscreened cable

• 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 in accordance with VDE 160 5.2.1.1.
If VLT 3500 HVAC is operated at temperatures above 40 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 :

1) Derating of output current versus altitude at T_{AMB} = max. 40°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 3500 HVAC frequency converter, it is not necessary to reduce the output current at low speed because of the load type characteristic of the centrifugal pumps/fans.

• Derating for installing long motor cables or cables with larger cross-section

VLT 3502-3800 HVAC has been tested using 300 m unscreened cable and 150 m screened cable (for 3502-3505 this only applies to $f_{SWITCH} \leq 4.5$ kHz. For $f_{SWITCH} > 4.5$ kHz, max. is 40 m).

VLT 3500 HVAC has been designed to work using a motor cable with a rated cross-section. If a cable with a larger cross-section is to be used, it is recommended to reduce the output current by 5% for every step the cross-section is increased.
(Increased cable cross-section leads to increased capacitance to earth, and thus an increased earth leakage current).

• Derating for high switching frequency

This only applies to VLT 3502-62, since the max. switching frequency is 4.5 kHz in VLT 3575-3800. Higher switching frequencies (par. 224) lead to greater losses and greater heat formation in the transistors and motor coils of the frequency converter. Consequently, the frequency converter automatically derates the maximum permitted constant output current $I_{VLT,N}$ whenever the switching frequency exceeds 4.5 kHz. The reduction is carried out as a linear reduction down to 60% at 14 kHz .
If the ASFM function (Adjustable Switching Frequency Modulation) is applied (parameter 225) it is not necessary to derate, since the variable torque characteristic provides automatic derating.

■ Immunity

In order to document immunity towards interference from electrical phenomena that are coupled in, the following immunity test has been made on a system consisting of a VLT frequency converter (with options, if relevant), a screened control cable and control box with potentiometer, motor cable and motor.

Fault criteria and test were in accordance with **EN50082-2** and **IEC 22G/21/CDV**.

The tests were made using the following standards:

- *IEC 1000-4-2 (IEC 801-2/1991):* **Electrostatic discharges (ESD)**
  Simulation of electrostatic discharges from human beings.

- *IEC 1000-4-3 (IEC 801-3):* **Incoming electromagnetic field radiation**
  Simulation of the effects of radar and radio communication equipment as well as mobile communications equipment.

- *IEC 1000-4-4 (IEC 801-4):* **Burst transients**
  Simulation of interference brought about by coupling with a contactor, relays or similar devices.

- *IEC 1000-4-5:* **Surge transients**
  Simulation of transients brought about e.g. by lightning that strikes near installations.

- *ENV50141:* **Cable-borne HF**
  Simulation of the effect of radio transmission equipment coupled to connection cables.

- *VDE0160 class W2 test pulse:* **Mains transients**
  Simulation of high-energy transients brought about by main fuse breakage, coupling with phase-compensation batteries, etc.

VLT 3502 - 3511 380-500V, VLT 3502- 3504 200V

Basic standard	Burst IEC 1000-4-4	Surge IEC 1000-4-5		ESD IEC 1000-4-2	Radiated electro-magn. field IEC 1000-4-3	Mains distortion VDE 0160	RF common mode voltage ENV 50141
Acceptance criterion	B	B		B	A		A
Port connection	CM	DM	CM		DM	CM	DM
Line	OK	OK	OK	-	-	OK	OK
Motor	OK	-	-	-	-	-	-
Control lines	OK	-	OK	-	-	-	OK
PROFIBUS option	OK	-	-	-	-	-	-
Signal interface < 3 m	OK	-	-	-	-	-	-
Enclosure	-	-	-	OK	OK	-	-

DM: Differential mode
CM: Common mode

Basic specifications							
Line	2 kV/5Hz/DCN	2 kV/2 Ω	4kV/12 Ω	-	-	**2,3 x $\hat{U}_N$	3 V
Motor	2 kV/5Hz/CCC	-	-	-	-	-	-
Control lines	2 kV/5Hz/CCC	-	2kV/40 Ω*	-	-	-	3V
PROFIBUS option	2 kV/5Hz/CCC	-	-	-	-	-	-
Signal interface < 3 m	1 kV/5Hz/CCC	-	-	-	-	-	-
Enclosure	-	-	-	8 kV AD 6 kV AC	10 V/m	-	-

Acceptance criteria according to: IEC 22G/21/CDV, EN50082-2, 175R0740

CCC: Capacitive clamp coupling
DNC: Direct coupling network
* Injection on cable shield
** 2.3 x $\hat{U}_N$ max. test pulse e.g. 1350 V_{peak} at 415 V

VLT 3516 - 3562 380-500 V, VLT 3508 - 3532 200 V

Basic standard	Burst IEC 1000-4-4	Surge IEC 1000-4-5		ESD IEC 1000-4-2	Radiated electro-magn. field IEC 1000-4-3	Mains distortion VDE 0160	Radiated Radio freq. elect. field ENV 50140	RF common mode voltage ENV 50141
Acceptance criterion	B	B		B	A		A	A
Port connection	CM	DM	CM			DM		CM
Line	OK	OK	OK	-	-	OK	-	OK
Motor	OK	-	-	-	-	-	-	
Control lines	OK	-	OK	-	-	-	-	OK
PROFIBUS option	OK	-	-	-	-	-	-	-
Signal interface < 3 m	OK	-	-	-	-	-	-	-
Enclosure	-	-	-	OK	OK	-	OK	-

DM: Differential mode
CM: Common mode

Basic specifications								
Line	2 kV/5Hz/DCN	2 kV/2 Ω		4kV/12 Ω	-	-	**2,3 x $\hat{U}_N$	-	3 V
Motor	2 kV/5Hz/CCC	-	-		-	-	-	-	-
Control lines	2 kV/5Hz/CCC	-	2 kV/40 Ω*		-	-	-	-	3V
PROFIBUS option	2 kV/5Hz/CCC	-	-		-	-	-	-	-
Signal interface < 3 m	1 kV/5Hz/CCC	-	-		-	-	-	-	-
Enclosure	-	-	-	8 kV AD 6 kV AC	10 V/m	-	10 V/m	-	

Acceptance criteria according to: IEC 22G/21/CDV, EN50082-2, 175R0740

CCC: Capacitive clamp coupling
DNC: Direct coupling network
* Injection on cable shield
** 2.3 x $\hat{U}_N$ max. test pulse e.g. 1350 V_{peak} at 415 V

VLT 3575 - 3800 380-500 V, VLT 3542-3562 230 V

Basic standard	Burst IEC 1000-4-4	Surge IEC 1000-4-5		ESD IEC 1000-4-2	Radiated electro-magn. field IEC 1000-4-3	Mains distortion VDE 0160
Acceptance criterion	B	B		B	A	
Port connection	CM	DM	CM		DM	CM
Line	OK	OK	OK	-	-	OK
Motor	OK	-	-	-	-	-
Control lines	OK	-	OK	-	-	-
PROFIBUS option	OK	-	-	-	-	-
Signal interface < 3 m	OK	-	-	-	-	-
Enclosure	-	-	-	OK	OK	-

DM: Differential mode
CM: Common mode

Basic specifications						
Line	2 kV/5Hz/DCN	2 kV/2 Ω	4kV/12 Ω	-	-	**2,3 x $\hat{U}_N$
Motor	2 kV/5Hz/CCC	-	-	-	-	-
Control lines	2 kV/5Hz/CCC	-	2 kV/40 Ω*	-	-	-
PROFIBUS option	2 kV/5Hz/CCC	-	-	-	-	-
Signal interface < 3 m	1 kV/5Hz/CCC	-	-	-	-	-
Enclosure	-	-	-	8 kV AD 6 kV AC	10 V/m	-

Acceptance criteria according to: IEC 22G/21/CDV, EN50082-2, 175R0740

CCC: Capacitive clamp coupling
DNC: Direct coupling network
* Injection on cable shield
** 2.3 x $\hat{U}_N$ max. test pulse e.g. 1350 V_{peak} at 415 V

■ Emission:

Subsequent test results have been obtained using a system with a VLT® frequency converter (with options, if relevant), a screened control cable and control box with potentiometer, screened motor cable and motor.

Standard	Switching frequency	VLT type		VLT		
		3502-3511 3502-3504	380-500 V 200 V	3516-3562 3508-3532		
EN55014	4.5 kHz 14 kHz	yes [1] yes [1]		ye ye	1 1	1
EN55011 Class A Gr.1	4.5 kHz 14 kHz	yes [1, 2] yes [1]		ye ye	1 1	1
EN55011 Class B Gr.1	4.5 kHz 14 kHz	yes [1, 3] yes [1, 3]		ye ye	1, 3 1, 3	1, 3

[1] Using the RFI option/module

[2] Without the RFI option/module the cable borne part of EN55011 class A gr. 1 (150kHz-30MHz) is complied with.

[3] Radiated emission (30MHz-1GHz) in accordance with EN55011 class A group 1.

With the purpose of minimising the cable-borne interference to the mains supply and the radiated interference from the frequency converter system, the motor cables should be kept as short as possible. According to experience, most installations represent only a slight risk of any interference from radiation.

■ 200/220/230 V

Parameter	3502	3504	3508	3511	3516	3522	3532	3542	3552	3562
103 Motor power	1.1	2.2	5.5	7.5	11	15	22	30	37	45
104 Motor voltage	200	200	200	200	200	200	200	230	230	230
105 Motor frequency	50	50	50	50	50	50	50	60	60	60
107 Motor current	6.0	10.0	25.0	32.0	46.0	57.2	79.2	104.0	130	158.0
109 Start voltage	22.2	19.3	19.5	19.4	19.4	19.5	19.4	21.9	22.2	22.0
202 Max. frequency	50	50	50	50	50	50	50	60	60	60
209 Current limit	5.4	10.6	24.8	32.0	46.0	61.2	88.0	104.0	130.0	154.0
215 Ramp 1 up time	5	5	15	15	15	15	15	45	45	45
216 Ramp 1 down time	5	5	15	15	15	15	15	45	45	45
217 Ramp 2 up time	5	5	15	15	15	15	15	45	45	45
218 Ramp 2 down time	5	5	15	15	15	15	15	45	45	45
232 Idle running current	2.8	5.1	9.7	11.0	15.8	23.8	21.6	29.8	41.1	41.5
308 DC brake voltage	18	19	14	11	10	10	8	0	0	0
311 Trip delay inverter	2	2	6	6	6	6	6	0	0	0

■ 380/400/415 V

Parameter	3502	3504	3505	3508	3511	3516	3522	3532	3542	3552	3562	3575	3600	3625	3650	3700	3750	3800
103 Motor power	1.1	2.2	3.0	5.5	7.5	11	15	22	30	37	45	55	75	90	110	132	160	200
104 Motor voltage	380	380	380	380	380	380	380	380	380	380	380	380	380	380	380	380	380	380
105 Motor frequency	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
107 Motor current	2.8	5.3	6.9	12.2	15.8	22.8	31.1	42.8	59.3	72.0	86.2	106.3	134.1	166.8	197.8	230.0	272.4	345.0
109 Start voltage	39.1	36.8	36.3	35.4	35.2	35.0	34.9	34.9	36.8	36.2	36.8	36.7	36.7	36.7	36.7	36.7	36.7	36.7
202 Max. frequency	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
209 Current limit	2.8	5.6	7.3	13.0	16.0	24.0	31.9	44.2	61.2	73.2	88.3	105.0	139.0	168.0	205.0	243.0	302.0	368.0
215 Ramp 1 up time	5	5	5	5	15	15	15	30	30	30	30	45	45	45	45	45	45	45
216 Ramp 1 down time	5	5	5	5	15	15	15	30	30	30	30	45	45	45	45	45	45	45
217 Ramp 2 up time	5	5	5	5	15	15	15	30	30	30	30	45	45	45	45	45	45	45
218 Ramp 2 down time	5	5	5	5	15	15	15	30	30	30	30	45	45	45	45	45	45	45
232 Idle running current	1.8	2.6	3.7	5.1	5.9	9.5	11.2	14.5	22	22	30.8	38.1	44.2	59.0	66.4	74.6	85.4	105.2
308 DC brake voltage	27	28	25	14	13	11	12	11	21	20	20	0	0	0	0	0	0	0
311 Trip delay inverter	2	2	2	2	9	9	9	12	12	12	12	0	0	0	0	0	0	0

■ 440/460/500 V

Parameter	3502	3504	3506	3508	3511	3516	3522	3532	3542	3552	3562	3575	3600	3625	3650	3700	3750	3800
103 Motor power	1.1	2.2	4	5.5	7.5	11	15	22	30	37	45	75	90	110	132	160	200	250
104 Motor voltage	460	460	460	460	460	460	460	460	460	460	460	460	460	460	460	460	460	460
105 Motor frequency	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
107 Motor current	2.5	4.8	7.6	10	13.7	20.0	25.0	35.5	48.5	61.8	74.9	110.8	137.8	163.4	190.0	225.0	285.0	360.0
109 Start voltage	48.6	45.8	45.2	45	44.9	44.7	44.3	43.8	44.6	44.5	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0
202 Max. frequency	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
209 Current limit	2.6	4.8	8.2	12.6	14.4	21.8	27.9	41.6	54.2	65.0	78.0	96.0	124.0	156.0	180.0	240.0	302.0	361.0
215 Ramp 1 up time	5	5	5	30	30	30	30	30	30	30	30	45	45	45	45	45	45	45
216 Ramp 1 down time	5	5	5	30	30	30	30	30	30	30	30	45	45	45	45	45	45	45
217 Ramp 2 up time	5	5	5	30	30	30	30	30	30	30	30	45	45	45	45	45	45	45
218 Ramp 2 down time	5	5	5	30	30	30	30	30	30	30	30	45	45	45	45	45	45	45
232 Idle running current	2.0	3.7	4.4	5.3	6.6	10.2	11.7	12.2	17.8	22.9	23.7	36.4	48.7	54.8	61.6	70.4	86.9	104.5
308 DC brake voltage	24	23	16	11	11	9	9	9	9	9	9	0	0	0	0	0	0	0
311 Trip delay inverter	2	5	7	7	7	7	7	8	8	12	12	0	0	0	0	0	0	0

■ **Operation and display**

000	LANGUAGE	English
001	SETUP OPERATIO	Setup 1
002	MENU SET COPY #)	Do not copy
003	HAND-O-AUTO	Keypad auto
004	LOCAL SPEED	
005	VALUE AT MAX	100
006	LOCAL RESET	Enable
007	LOCAL STOP	Enable
008	KEY LOCAL/HAND	Enable
009	KEY REMOT/AUTO	Enable
010	LOC REFERENCE	Enable
011	ENERGY COUNTER	No reset
012	HOUR COUNTER	No reset
014	POWERUP MODE	Loc=stop
015	SETUP PROGRAM.	Setup=P001

■ **Load and motor**

100	LOAD TYPE 4)	Energy VT.L
101	SPEED CONTROL 4) #)	Open loop
102	SET CUR. LIMIT	Program. value
103	MOTOR POWER 4) #)	Depending on unit
104	MOTOR VOLTAGE 4) #)	Depending on unit
105	MOTOR FREQ 4) #)	Depending on unit
107	MOTOR CURRENT 4)	Depending on unit
109	START VOLTAGE 4)	Depending on unit
114	FEEDBACK TYPE	Current
115	DIS VLU@min FB	0
116	DIS VLU@max FB	100 %
117	DISPLAY UNIT	%
119	FEED FWD FACTR 4)	100%
120	CONTRL RANGE 4)	100%
121	PROPRT/L GAIN 4)	0.01
122	INTEGRAL TIME 4)	Off
123	DIFFERENTL TIME 4)	Off
124	LOWPASS FILTER 4)	0.0 sec.
125	FEEDBACK FACTR 4)	100%

■ **References and limits**

201	MIN. FREQUENCY 4)	0.0
202	MAX. FREQUENCY 4)	Depending on unit
203	JOG FREQUENCY 4)	10 Hz
204	DIG. REF. TYPE 4)	Sum
205	REF. 1 DIGITAL 4)	0
206	REF. 2 DIGITAL 4)	0
207	REF. 3 DIGITAL 4)	0
208	REF. 4 DIGITAL 4)	0
209	CURRENT LIMIT 4)	Depending on unit
210	LO FREQ. WARN 4)	0.0 Hz
211	HI FREQ. WARN 4)	132 Hz
212	LO CURR. WARN 4)	0.0
213	HI CURR. WARN 4)	$I_{VLT,MAX}$
214	RAMP TYPE 4)	Linear
215	RAMP UP TIME 4)	Depending on unit
216	RAMP DOWN TIME 4)	Depending on unit
217	ALT. UP RAMP 4)	Depending on unit
218	ALT DOWN RAMP 4)	Depending on unit
219	FREQ. 1 BYPASS 4)	120 Hz
220	FREQ. 2 BYPASS 4)	120 Hz
221	FREQ. 3 BYPASS 4)	120 Hz
222	FREQ. 4 BYPASS 4)	120 Hz
223	BYPASS B.WIDTH 4)	0%
224	CARRIER FREQ. 4)	4.5 kHz
225	VAR. CARR. FREQ. 4)	Disable *)
232	NO LOAD CURR. 4)	Depending on unit

4) Available in all 4 setups.

#) Can only be changed in Stop Mode (motor stopped)

*) For VLT 3542-3562 (230 V) and VLT 3575-3800 LOW SWFQ.LOW

■ Functions and timers

301	START FREQ. [4]	0.0
302	START DELAY [4]	0.0
303	HI START TORQ [4]	0.0
304	POWER FAIL	NORM PWR DWN
305	FLYING START [4]	No flying start
306	DC-BRAKE TIME [4]	0 sec.
307	DC-BRK ON FREQ. [4]	1.0 Hz
308	DC-BRK VOLTAGE [4]	Depending on unit
309	RESET MODE	Manual
310	TRIP DLY@ C.LIM	Off
311	TRIP DLY@ FAULT	Depending on unit
312	AUTO RESTART T	5 sec.
313	MOTOR CHECK [4]	Off
314	MOTOR PRE-HEAT [4]	Off
315	MOTOR THERMAL [4]	Trip 1
316	RELAY ON DELAY	0.00
317	RELAY OFF DELAY	0.00

■ Inputs and outputs

400	INPUT 16	Reset
401	INPUT 17	Freeze ref.
402	INPUT 18	Start
403	INPUT 19	Reversing
404	INPUT 27	Mtr. coast
405	INPUT 29	Jog
406	INPUT 32/33	4 Setup ext.
407	OUTPUT 42 [4]	0-Imax 0-20 mA
408	OUTPUT 45 [4]	0-fmax 0-20 mA
409	RELAY 01 [4]	Alarm
410	RELAY 04 [4]	Running
411	ANALOG REFTYPE	Linear
412	INPUT #53 ANA. [4]	0-10 Volt
413	INPUT #60 ANA. [4]	0-20 mA
414	TIME OUT	Off
415	TIME OUT ACT	Freeze
420	EXT. HOA REF.	Voltage # 53

■ Serial data interface

500	ADDRESS [#]	1
501	BAUD RATE [#]	9600
502	DATA READOUT	Reference %
503	COAST	Logic or
504	Q-STOP	Logic or
505	DC-BRAKE	Logic or
506	START	Logic or
507	DIRECTION	Digital
508	RESET	Logic or
509	SETUP SELECT	Logic or
510	SPEED SELECT	Logic or
511	BUS JOG 1	10
512	BUS JOG 2	10
513	CATCH UP / SLOW DN	0
514	BUS BIT 4	Q stop
515	BUS BIT 11 /12	Catch↑/Slow↓
516	BUS REFERENCE	0
517	STORE DATA	Off

■ Service and diagnostics

600	OPERATION DATA	Tot.hours
601	DATALOG	
602	ALARM MEMORY	
603	NAMEPLATE	Depending on unit
604	OPERATION MODE	Run normal
605	DISPLAY SELECT	Standard disp
606	DISPLAY MODE	Quick display
650	VLT TYPE	Dependning on unit

[4] Available in all 4 setups.

[#] Can only be changed in Stop Mode (motor stopped)

Company: _____ Mr.: _____ Application: _____ Data: _____

VLT-Type: _____ SW Version: _____ Menu: _____

Parameter number	Set value
000	
001	
002	
003	
004	
005	
006	
007	
008	
009	
010	
011	
012	
014	
015	
100	
101	
102	
103	
104	
105	
106	
107	
108	
109	
110	

Parameter number	Set value
111	
112	
113	
114	
115	
116	
117	
119	
120	
121	
122	
123	
124	
125	
201	
202	
203	
204	
205	
206	
207	
208	
209	
210	
211	
212	

Parameter number	Set value
213	
214	
215	
216	
217	
218	
219	
220	
221	
222	
223	
224	
225	
230	
231	
232	
233	
300	
301	
302	
303	
304	
305	
306	
307	
308	
309	

Parameter number	Set value
310	
311	
312	
313	
314	
315	
316	
317	
400	
401	
402	
403	
404	
405	
406	
407	
408	
409	
410	
411	
412	
413	
414	
415	
420	
605	
606	