

Danfoss

Danfoss Graham



Installation, Operation and Maintenance Manual

VLT[®] 6000 Series Adjustable Frequency Drive



⚠️ WARNING

Equipment Hazard!

Rotating shafts and electrical equipment can be hazardous. Therefore, it is strongly recommended that all electrical work conform to National Electrical Code (NEC) and all local regulations. Installation, start-up and maintenance should be performed only by qualified personnel. Failure to follow the NEC or local regulations could result in death or serious injury.

Factory recommended procedures, included in this manual, should be followed. Always disconnect electrical power before working on the unit.

Although shaft couplings or belt drives are generally not furnished by the manufacturer, rotating shafts, couplings and belts must be protected with securely mounted metal guards that are of sufficient thickness to provide protection against flying particles such as keys, bolts and coupling parts. Even when the motor is stopped, it should be considered "alive" as long as its controller is energized. Automatic circuits may start the motor at any time. Keep hands away from the output shaft until the motor has completely stopped and power is disconnected from the controller.

Motor control equipment and electronic controls are connected to hazardous line voltages. When servicing drives and electronic controls, there will be exposed components at or above line potential. Extreme care should be taken to protect against shock. Stand on an insulating pad and make it a habit to use only one hand when checking components. Always work with another person in case of an emergency. Disconnect power whenever possible to check controls or to perform maintenance. Be sure equipment is properly grounded. Wear safety glasses whenever working on electric control or rotating equipment.

Safety Guidelines

1. The drive must be disconnected from the AC line before any service work is done.
2. The STOP/OFF key on the local control panel of the drive does not disconnect the equipment from the AC line and is 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. Ground currents are higher than 3 mA.

Warnings Against Unintended Start

1. While the drive is connected to the AC line, the motor can be brought to a stop by means of external switch closures, serial bus commands or references. 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. Be certain that no one is in the area of the motor or driven equipment when changing parameters.
3. A motor that has been stopped may start unexpectedly if faults occur in the electronics of the drive, or if an overload, a fault in the supply AC line or a fault in the motor connection or other fault clears.
4. If the LOCAL/HAND key is activated, the motor can only be brought to a stop by means of the STOP/OFF key or an external safety interlock.

Motor Overload Protection

NOTE

Person installing drive is responsible to provide proper grounding and branch circuit protection for incoming power and motor overload according to National Electrical Code (NEC) and local codes.

The electronic thermal relay (ETR) in UL listed VLTs provides Class 20 motor overload protection in accordance with the NEC in single motor applications when parameter 117 is set for ETR TRIP and parameter 105 is set for rated motor current.

⚠️ WARNING

Hazardous Voltage!

Touching electrical parts may be fatal, even after equipment has been disconnected from the AC input line. To be sure that capacitors have fully discharged, wait 14 minutes for 208 V and 480 V units and 30†minutes for 600 V units over 25 hp after power has been removed before touching any internal component. Failure to wait for capacitors to fully discharge before touching internal components could result in death or serious injury.

Never ignore warnings, cautions and notes in this manual. They are provided to alert anyone installing, operating, or maintaining this equipment to potential hazards or ineffective practices. Notes are used to call special attention to information which, if ignored or not clearly understood, in most cases will result in degraded or less than optimum equipment operation.

Become familiar with all warnings, cautions, and notes in this manual. These are important guidelines intended for your safety and for full utilization of the operational features of the equipment.

⚠WARNING	- Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
⚠CAUTION	- Indicates a potentially hazardous situation which, if not avoided, may result in injury. It may also be used to alert against unsafe practices.
CAUTION	- Indicates a situation which, if ignored, could result in substantial equipment or property damage.
NOTE	- Contains important information that, if not clearly understood or ignored, could result in degraded or less than optimum equipment operation.

Table of Contents

General	7
Clearances	7
Plenum Mounting	7
Grounding Plate	7
Shielded Wires	7
UL, C-UL, and CE Conformity	7
Drive Output Ratings	8
Input Fuses	9
Internal Drive Fuses	9
Locations of Conduit Entry, Terminal Blocks and Switches	10
Power Connections	14
Input Power Connection	14
Motor Wiring Connection	15
Grounding	15
Input Power Delay	15
Electronic Thermal Protection	15
External DC Bus Connection	15
High Voltage Form C Relay	15
Terminal Tightening Torque	16
Control Connections	19
Electrical Installation, Control Terminals	19
Drive Inputs and Outputs	19
Input Signals	19
Output Signals	20
Programming Control Terminals	20
Control Terminal Functions	20
Typical Control Connections	22
Electrical Installation, Control Wiring	23
DIP Switches 1 through 4	23
Ground Leakage Current	23
Galvanic Isolation	24
Extra Safety Protection	24
Electrical Noise	24
Application Control Connection Examples	25
Control Panel	26
Keys for Parameter Changes	26
Indicator Lamps	27
Local Control	27
Display Modes	27
Changing Data	29
Changing Numeric Values	29
Changing Functional Values	29
Changing Numeric Values in a List	29
Quick Menu	30
To Enter or Change Quick Menu Parameter Data	30
Example of Changing Parameter Data	30
Extended Menu	31
Manual Initialization of Parameters	31
Uploading Parameters	31
VLT 6000 Start-Up	32
Pre-installation Checks	32
Installation Checks	32
Setting Up Drive for Motor Start	32
Operational Tests — HAND	32

Operational Tests — AUTO	32
Final Adjustments	32
Programming	33
Description of Parameters	33
Setup Configuration and Parameters Copy	33
Operation and Display	
Parameters 000 through 017	33
Setup of User-defined Readout	34
Load and Motor	
Parameters 100 through 118	39
Procedure for Automatic Motor Adaptation:	41
DC Braking	43
Motor Thermal Protection	44
References and Limits	
Parameters 200 through 228	45
Reference Handling	46
Reference Type	49
Warning Functions	51
Inputs and Outputs	
Parameters 300 through 328	53
Analog Inputs	56
Analog/Digital Outputs	59
Relay Outputs	62
Application Functions	
Parameters 400 through 427	64
Sleep Mode	65
Feedback Signals in Open Loop	69
PID for Process Regulation	70
Feedback	70
Reference (Setpoint)	70
Inverse Regulation	70
Anti-windup	70
Start-up Conditions	70
Differentiator Gain Limit	71
Lowpass Filter	71
Optimization of the Process Regulator	71
PID Overview	71
Feedback Handling	71
Serial Communication for FC Protocol	76
Protocols	76
Packet Communication	76
Serial Communication	
Parameters 500 through 566	86
Programming Custom Display Text	91
Warning Words, Extended Status Word and Alarm Word	92
Service Functions	
Parameters 600 through 631	94
Relay Card Functions	
Parameters 700 through 711	99
Electrical Installation of the Relay Card	99
Status Messages	100
Warnings and Alarms	102
Warnings	103
Alarms	103
Factory Settings	108

SOFTWARE VERSION NOTICE: These operating instructions are used for all VLT 6000 Series drives with software version 2.XX and all prior versions. The software version number seen in parameter 624, *Software Version*.

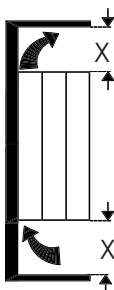
General

The specific installation instructions may vary depending upon the model of VLT 6000 Series being installed. When this occurs, the model can be identified by a "VLT Type 6XXX" number. This number can be found on the red nameplate on the outside left side of the drive enclosure, or the outside right side of a drive with an auxiliary enclosure.

The drive must always be installed vertically. To ensure that no injury or damage occurs, the drive must always be firmly attached to the wall or the floor before further installation work is carried out.

Clearances

The drive is cooled by air circulation. For proper cooling, the minimum distances above and below the unit must be maintained as shown in the table below. For units in an auxiliary enclosure with the drive mounted on a backpanel, the required clearances are measured from the top and bottom of the drive, not the backpanel.



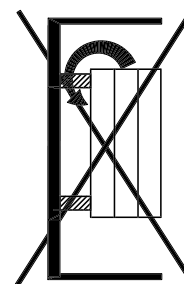
Drive Size	Top Clearance	Bottom Clearance
1 to 3 hp, 200-240 V 1 to 10 hp, 380-460, 550-600 V	4" (100mm)	4" (100mm)
5 to 30 hp, 200-240 V 15 to 75 hp, 380-460, 550-600 V	8" (200mm)	8" (200mm)
40 to 60 hp, 200-240 V 100 to 125 hp, 380-460, 550-600 V	9" (225mm)	9" (225mm)
150 to 300 hp, 380-460, 550-600 V	12" (300mm)	12" (300mm)
350 to 600 hp, 380-460 V	16" (400mm)	Floor mount

All drives can be mounted with no side clearance. Sufficient space must be provided in front of the drive for door swing on units with a hinged door. VLT drives 350 hp and above require 25 inches (605 mm) front space for access. In addition, sufficient room must be available for installation and service access. On units with an auxiliary enclosure, the auxiliary enclosure door will have a greater door swing than the drive. See the dimensional drawings of the auxiliary enclosure which are included with the drive.

Mount directly to the wall all drives without a backplate. This ensures that air flow is in contact with the heatsink all the way from the bottom of the drive. If this is not possible, a metal plate at least as large as the back of the drive may need to be firmly mounted to the back of the drive (see tables below). A backplate assembly is available from Danfoss.

Backplate Required NEMA 1		Backplate Required NEMA 12	
Drive Size	Power	Drive Size	Power
5 to 30 hp	200-240 V	1 to 30 hp	200-240 V
15 to 75 hp	380-460 V	1 to 75 hp	380-460 V
150 to 300 hp	380-460 V		
15 to 75 hp	550-600 V		
200 to 300 hp	550-600 V		

Drives without a backplate must be mounted directly to a solid wall with no spacers between the drive and the wall. Free-standing drives without a backplate require a backplate to be mounted.



Plenum Mounting

The drive is UL rated for plenum mounting as well as auxiliary panels that may be supplied with the drive. If the equipment is to be mounted in the plenum, allow sufficient access for servicing. All normal clearance, temperature, humidity limitations and local codes apply.

Grounding Plate

Drives up to 3 hp, 200 to 240 V, and up to 10 hp, 380 to 460 V and 550 to 600 V with a NEMA 1 enclosure have a plastic bottom cover with provision for conduit entry. To meet UL requirements, the metal grounding plate must be in place above the plastic bottom cover. The plate must be grounded to the chassis and the conduit grounded to the plate. If the grounding plate is not factory installed, it must be installed in the drives that have a plastic bottom panel to ensure proper grounding of the conduit to the enclosure. Connect the ground wire from the

This tab is located near the AC line terminal strip. Mount the bottom cover on the control unit.

Shielded Wires

Wires to control signals should be shielded to reduce radio frequency noise interference. When RFI is a concern, shielded cable should be used between the drive and the motor.

If unshielded control wires are used, control inputs are subject to signal disturbances. Such disturbances may affect drive operation. Extreme noise levels may disturb the microprocessor of the control card.

The shield of the control wires must be grounded at the cable clamp at the bottom of the drive, but the shield must continue with the cable all the way up to the control card. The shield is not to be connected to any of the terminals on the control card. For safety reasons, the insulation around the shield should only be removed where it is connected to the cable clamp. The insulation should be left on the shield between the clamp and the terminals.

Generally speaking, all conductors coming from a shielded control cable must be as short as possible. Long conductor ends attract noise. The shield must be connected to the chassis by means of the cable clamp. Long pigtailed on the shield reduce the effectiveness of the shield.

UL, C-UL, and CE Conformity

All 200-240 V and 380-460 V VLT 6000 adjustable frequency drives are CE marked. All drives and option packages are UL and C-UL listed.



Drive Output Ratings

208 Volt Input

VLT Type	Max. Nominal Output HP	Max. Drive Output Current
6002	1	4.6
6002	1½	6.6
6003	2	7.5
6004	3	10.6
6006	5	16.7
6008	7½	24.2
6011	10	30.8
6016	15	46.2
6022	20	59.4
6027	25	74.8
6032	30	88
6042	40	115
6052	50	143
6062	60	170

230 Volt Input

VLT Type	Max. Nominal Output HP	Max. Drive Output Current
6002	1	4.2
6002	1½	6.6
6003	2	7.5
6004	3	10.6
6006	5	16.7
6008	7½	24.2
6011	10	30.8
6016	15	46.2
6022	20	59.4
6027	25	74.8
6032	30	88
6042	40	104
6052	50	130
6062	60	154

460 Volt Input

VLT Type	Max. Nominal Output HP	Max. Drive Output Current
6002	1	2.1
6002	1½	3.0
6003	2	3.4
6004	3	4.8
6006	5	8.2
6008	7½	11.0
6011	10	14
6016	15	21
6022	20	27
6027	25	34
6032	30	40
6042	40	52
6052	50	65
6062	60	77
6072	75	106
6075	75	106
6100	100	130
6102	100	130
6122	125	160
6125	125	160
6150	150	190
6152	150	190
6172	200	240
6175	200	240
6222	250	302
6225	250	302
6272	300	361
6275	300	361
6350	350	443
6352	350	443
6400	450	540
6500	500	590
6550	600	678

380 Volt Input

VLT Type	Max. Nominal Output kW	Max. Drive Output Current
6002	1.1	3.0
6003	1.5	4.1
6004	2.2	5.6
6005	3	7.2
6006	4	10
6008	5.5	13
6011	7.5	16
6016	11	24
6022	15	32
6027	18.5	37.5
6032	22	44
6042	30	61
6052	37	73
6062	45	90
6075	55	106
6102	75	147
6122	90	177
6150	110	212
6152	110	212
6172	132	260
6175	132	260
6222	160	315
6225	160	315
6272	200	395
6275	200	368
6352	250	480
6400	315	600
6500	355	658
6550	400	745

600 Volt Input

VLT Type	Max. Nominal Output HP	Max. Drive Output Current
6002	1½	2.4
6003	2	2.7
6004	3	3.9
6005	4	4.9
6006	5	6.1
6008	7½	9
6011	10	11
6016	15	17
6022	20	22
6027	25	27
6032	30	32
6042	40	41
6052	50	52
6062	60	62
6072	75	77
6075	75	77
6100	100	99
6125	125	125
6150	150	144
6175	200	192
6225	250	242
6275	300	289

Input Fuses

CAUTION

Branch Circuit Fuses Required!

All drives must be protected with branch circuit fuses in accordance with the National Electrical Code. Failure to provide branch circuit fuses in accordance with the NEC may result in equipment or property damage.

To comply with UL508C, input fuses shown in the tables below must be installed in the power supply to drives which are 208 V above 30 hp, and 460 V and 600 V drives above 75 hp. The fuse ratings in the tables are the recommended maximum ratings.

Danfoss Graham recommends input fuses on all drives. If specified as a drive option, input fuses will be installed by Danfoss Graham in an enclosure external to the drive, which may include other optional features. If not supplied, they must be provided by the drive installer as part of installation.

NOTE

On input power, Ferraz-Shawmut fuses, type ATMR, Class CC, up to 30 A maximum, may be used on all VLT series drives.

200-240 V drives are suitable for use on a circuit capable of supplying a maximum of 100,000 A RMS (symmetrical), 250 V maximum.

380-460 V drives are suitable for use on a circuit capable of supplying a maximum of 100,000 A RMS (symmetrical), 500 V maximum.

550-600 V drives designed for protection in a circuit capable of supplying a maximum of 100,000 A RMS (symmetrical), 600 V maximum.

200 - 208 Volt Input

VLT Type	Maximum Fuse Rating (Amps)	Bussmann Type
6002	10	KTN-R or JJJ
6003	15	KTN-R or JJJ
6003	20	KTN-R or JJJ
6004	25	KTN-R or JJJ
6006	50	KTN-R or JJJ
6008	50	KTN-R or JJJ
6011	50	KTN-R or JJJ
6016	60	KTN-R or JJJ
6022	80	KTN-R or JJJ
6027	125	KTN-R or JJJ
6032	125	KTN-R or JJJ
6042	150	FWX or FWH
6052	200	FWX or FWH
6062	250	FWX or FWH

550 - 600 Volt Input

VLT Type	Maximum Fuse Rating (Amps)	Bussmann Type
6002	3	KTS-R or JJS
6003	4	KTS-R or JJS
6004	5	KTS-R or JJS
6005	6	KTS-R or JJS
6006	8	KTS-R or JJS
6008	10	KTS-R or JJS
6011	15	KTS-R or JJS
6016	20	KTS-R or JJS
6022	30	KTS-R or JJS
6027	35	KTS-R or JJS
6032	45	KTS-R or JJS
6042	60	KTS-R or JJS
6052	75	KTS-R or JJS
6062	90	KTS-R or JJS
6072	100	KTS-R or JJS
6075	100	KTS-R or JJS
6100	125	FWP
6125	175	FWP
6150	200	FWP
6175	250	FWP
6225	350	FWP
6275	400	FWP

Internal Drive Fuses

The table below specifies fuses used internally in the VLT 6000 series drives. Use the specified fuse or an exact replacement only.

200 – 240 VAC			
VLT Type	Soft Charge Fuse (3 phase)	Soft Charge Resistor Fuse (1 phase)	Power Card Fuse (1 phase)
6042	Littelfuse KLK-15	Littelfuse KLK-D-12	Bussmann KTK-5
6052	Littelfuse KLK-15	Littelfuse KLK-D-12	Bussmann KTK-5
6062	Littelfuse KLK-15	Littelfuse KLK-D-12	Bussmann KTK-5
380 – 460 VAC			
VLT Type	Soft Charge Fuse (3 phase)	Soft Charge Resistor Fuse (1 or 2 phase)	Power Card Fuse (1 phase)
6075	Littelfuse KLK-15	Littelfuse KLK-D-12 (2X)	Bussmann KTK-5
6100	Littelfuse KLK-15	Littelfuse KLK-D-12 (1X)	Bussmann KTK-5
6102	Littelfuse KLK-15	Littelfuse KLK-D-12 (1X)	Bussmann KTK-5
6122	Littelfuse KLK-15	Littelfuse KLK-D-12 (1X)	Bussmann KTK-5
6125	Littelfuse KLK-15	Littelfuse KLK-D-12 (1X)	Bussmann KTK-5
6150	Littelfuse KLK-30	Littelfuse KLK-D-12 (1X)	Bussmann KTK-5
6175	Littelfuse KLK-30	Littelfuse KLK-D-12 (2X)	Bussmann KTK-5
6225	Littelfuse KLK-30	Littelfuse KLK-D-12 (2X)	Bussmann KTK-5
6275	Littelfuse KLK-30	Littelfuse KLK-D-12 (2X)	Bussmann KTK-5
VLT Type	Soft Charge Fuse (3 phase)	Fan Fuse (1 phase)	Power Card/SMPS Fuse (1 phase)
6152	Bussmann FWH20A6F	Bussmann KTK-4	Bussmann KTK-4
6172	Bussmann FWH20A6F	Bussmann KTK-4	Bussmann KTK-4
6222	Bussmann FWH20A6F	Bussmann KTK-4	Bussmann KTK-4
6272	Bussmann FWH20A6F	Bussmann KTK-4	Bussmann KTK-4
6352	Bussmann FWH20A6F	Bussmann KTK-4	Bussmann KTK-4
VLT Type	Soft Charge Fuse (3 phase)	Line Snubber Fuse (3 phase)	Interface Board Fuse (1 phase)
6350	Littelfuse KLK-9	Littelfuse KLK-15	Bussmann KTK-5
6400	Littelfuse KLK-9	Littelfuse KLK-15	Bussmann KTK-5
6500	Littelfuse KLK-9	Littelfuse KLK-15	Bussmann KTK-5
6550	Littelfuse KLK-9	Littelfuse KLK-15	Bussmann KTK-5
550 – 600 VAC			
VLT Type	Soft Charge Fuse (3 phase)	Soft Charge Resistor Fuse (1 or 2 phase)	Power Card Fuse (1 phase)
6100	Littelfuse KLK-15	Littelfuse KLK-D-12 (1X)	Bussmann KTK-5
6125	Littelfuse KLK-15	Littelfuse KLK-D-12 (1X)	Bussmann KTK-5
6150	Littelfuse KLK-15	Littelfuse KLK-D-12 (1X)	Bussmann KTK-5
6175	Littelfuse KLK-30	Littelfuse KLK-D-12 (2X)	Bussmann KTK-5
6225	Littelfuse KLK-30	Littelfuse KLK-D-12 (2X)	Bussmann KTK-5
6275	Littelfuse KLK-30	Littelfuse KLK-D-12 (2X)	Bussmann KTK-5

380 - 460 Volt Input

VLT Type	Maximum Fuse Rating (Amps)	Bussmann Type
6002	6	KTS-R or JJS
6003	10	KTS-R or JJS
6004	10	KTS-R or JJS
6006	20	KTS-R or JJS
6008	25	KTS-R or JJS
6011	30	KTS-R or JJS
6016	40	KTS-R or JJS
6022	40	KTS-R or JJS
6027	50	KTS-R or JJS
6032	60	KTS-R or JJS
6042	80	KTS-R or JJS
6052	100	KTS-R or JJS
6062	125	KTS-R or JJS
6072	150	KTS-R or JJS
6075	150	KTS-R or JJS
6100	200	FWH
6102	225	FWH
6122	250	FWH
6125	250	FWH
6150	300	FWH
6152	300	FWH
6172	350	FWH
6175	350	FWH
6222	400	FWH
6225	400	FWH
6272	500	FWH
6275	500	FWH
6350	600	FWH
6352	600	FWH
6400	700	FWH
6500	800	FWH
6550	800	FWH

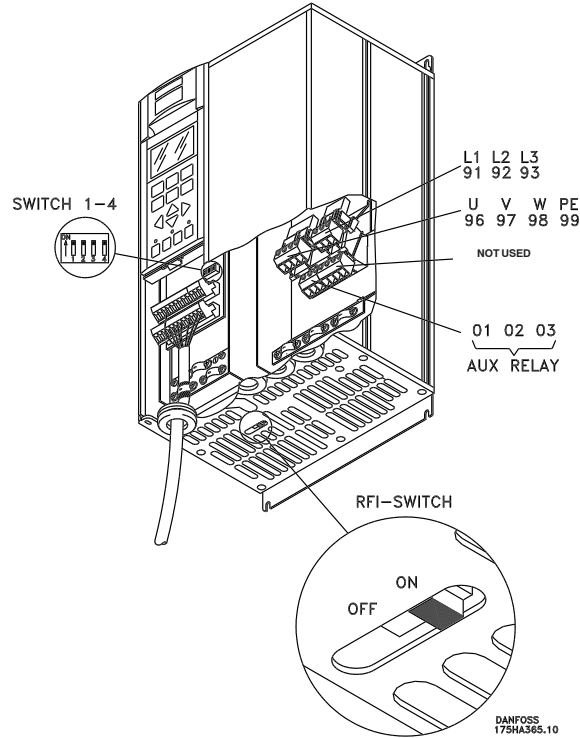


Locations of Conduit Entry, Terminal Blocks and Switches

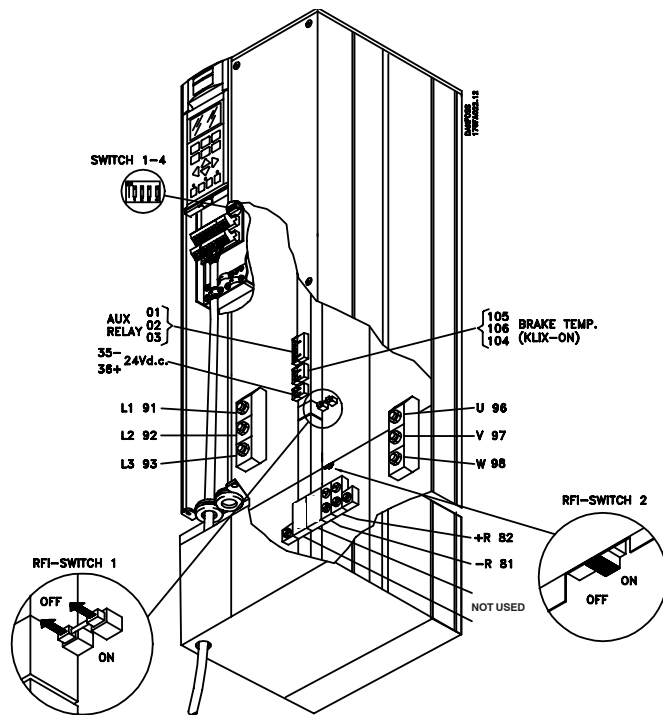
The following drawings illustrate the locations of the conduit entry, control terminal blocks, the auxiliary relay connections, input and output power terminal blocks, and the internal switches.

On drives with an auxiliary enclosure, some or all of the power connections at the drive will be factory made. Custom input and output terminals may be inside the auxiliary enclosure. See the drawings supplied with the drive for details on custom terminal blocks and conduit entry locations for the auxiliary enclosure.

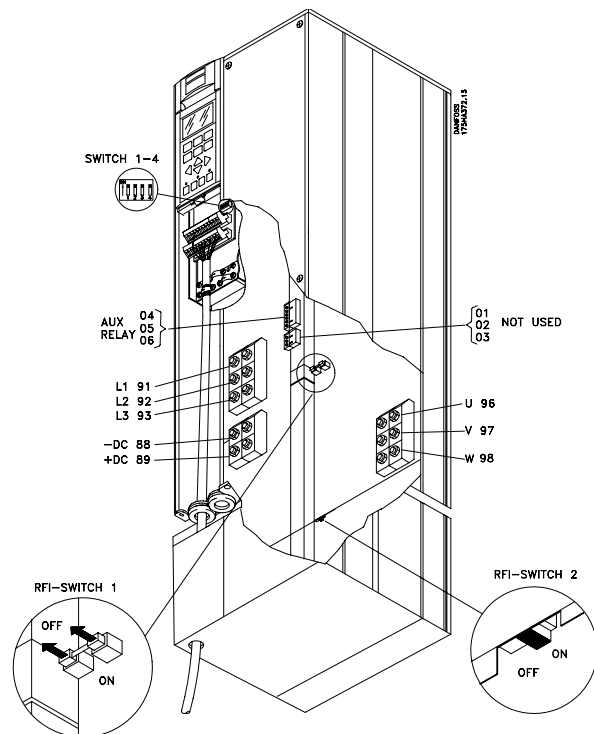
NEMA 1



VLT 6002-6004, 200 to 240 V
 VLT 6002-6011, 380 to 460 V
 VLT 6002-6011, 550 to 600 V



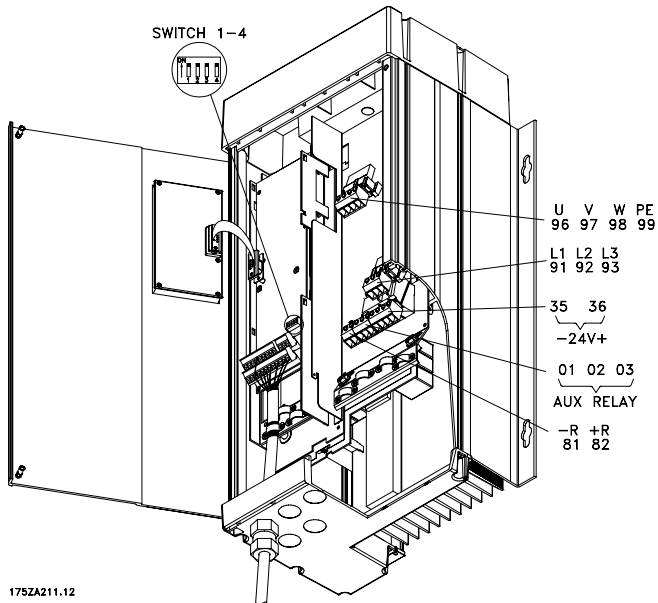
VLT 6006-6062, 200 to 240 V; VLT 6016, 6075, 6102, 6122 380 to 460 V;
 VLT 6100-6150, 550 to 600 V



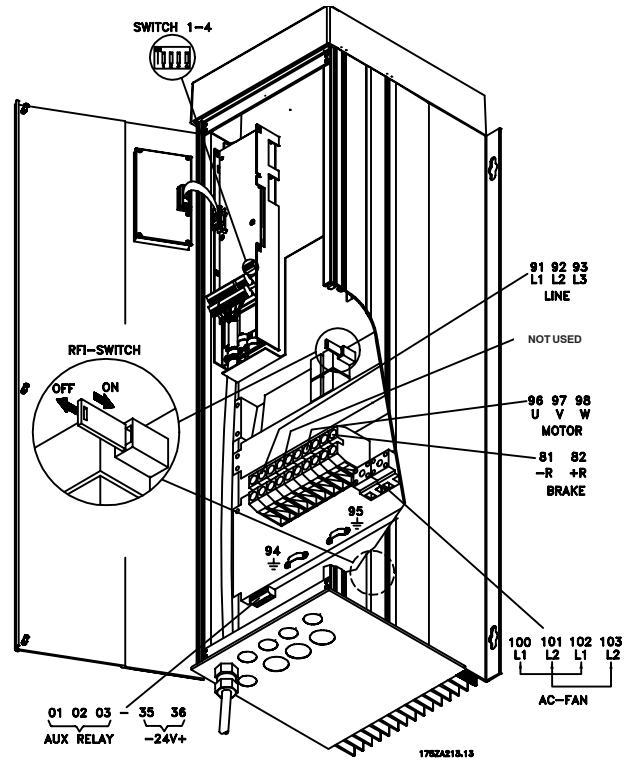
VLT 6100, 6125-6275, 380 to 460 V
 VLT 6175-6275, 550 to 600 V

Locations of Conduit Entry, Terminal Blocks and Switches (continued)

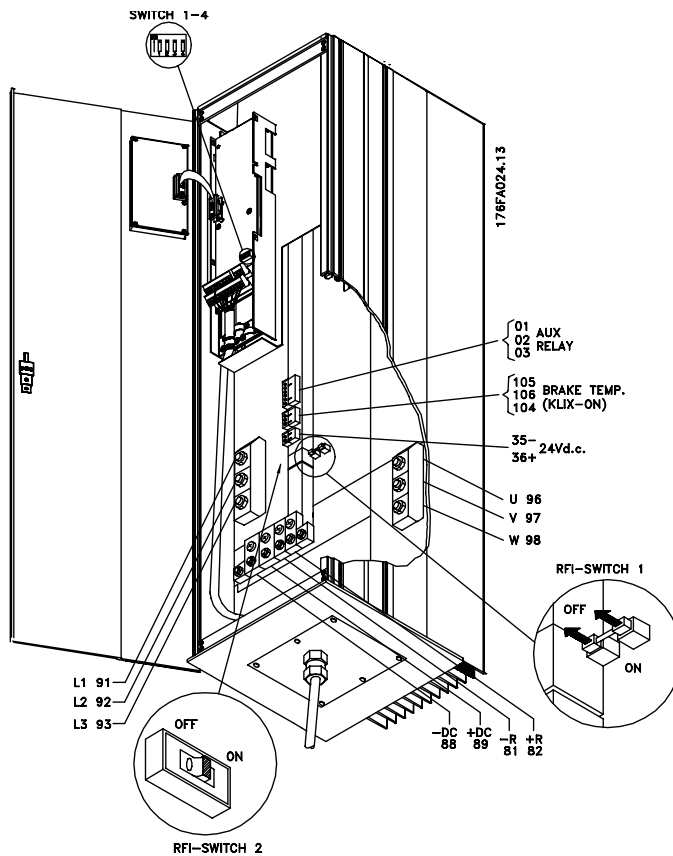
NEMA 12



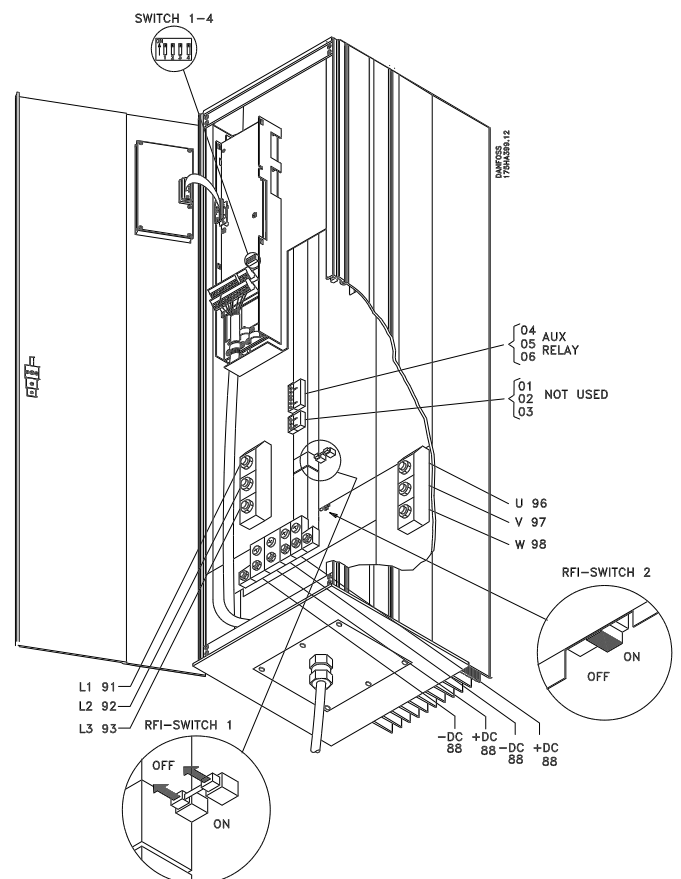
VLT 6002-6005, 200 to 240 V; VLT 6002-6011, 380 to 460 V



VLT 6006-6032, 200 to 240 V; VLT 6016-6072, 380 to 460 V



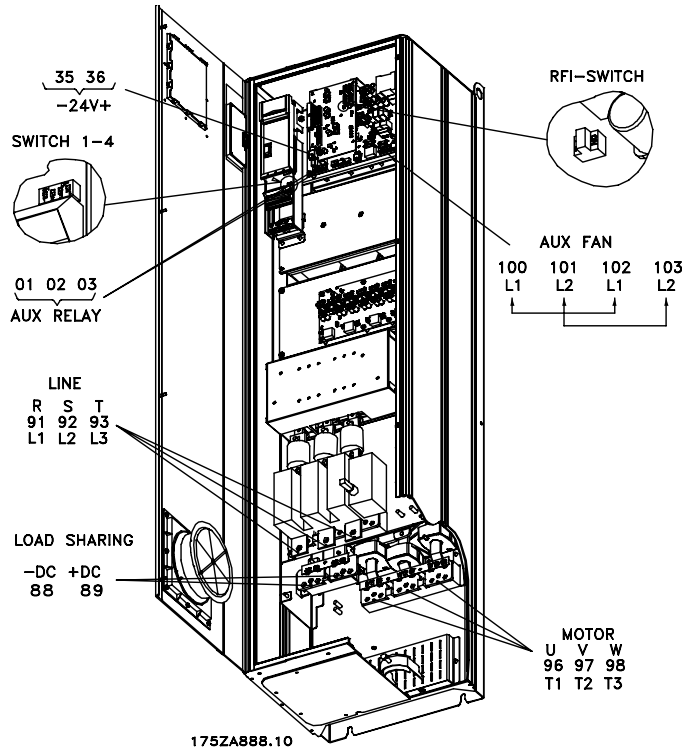
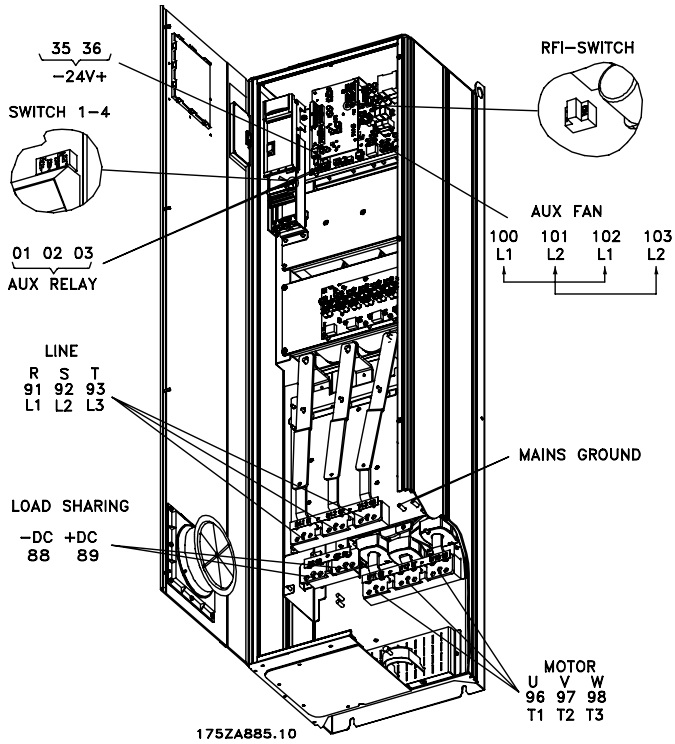
VLT 6042-6062, 200 to 240 V; VLT 6042-6062, 380 to 460 V



VLT 6072-6275, 380 to 460 V

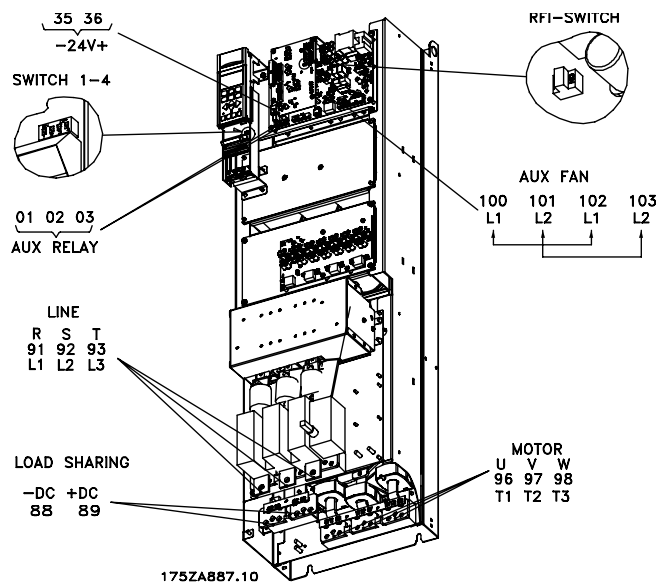
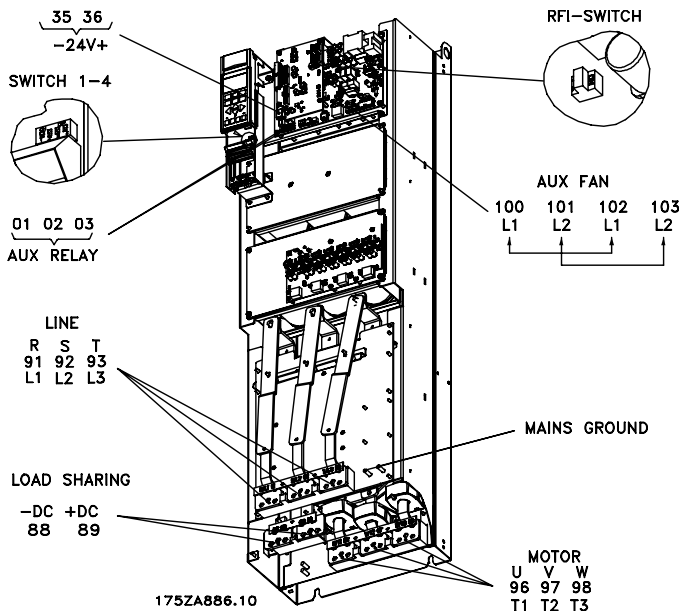
Locations of Conduit Entry, Terminal Blocks and Switches (continued)

NEMA 1 and NEMA 12



VLT 6152-6352, 380 to 460 V

VLT 6152-6352, 380 to 460 V (with disconnect and main fuse)

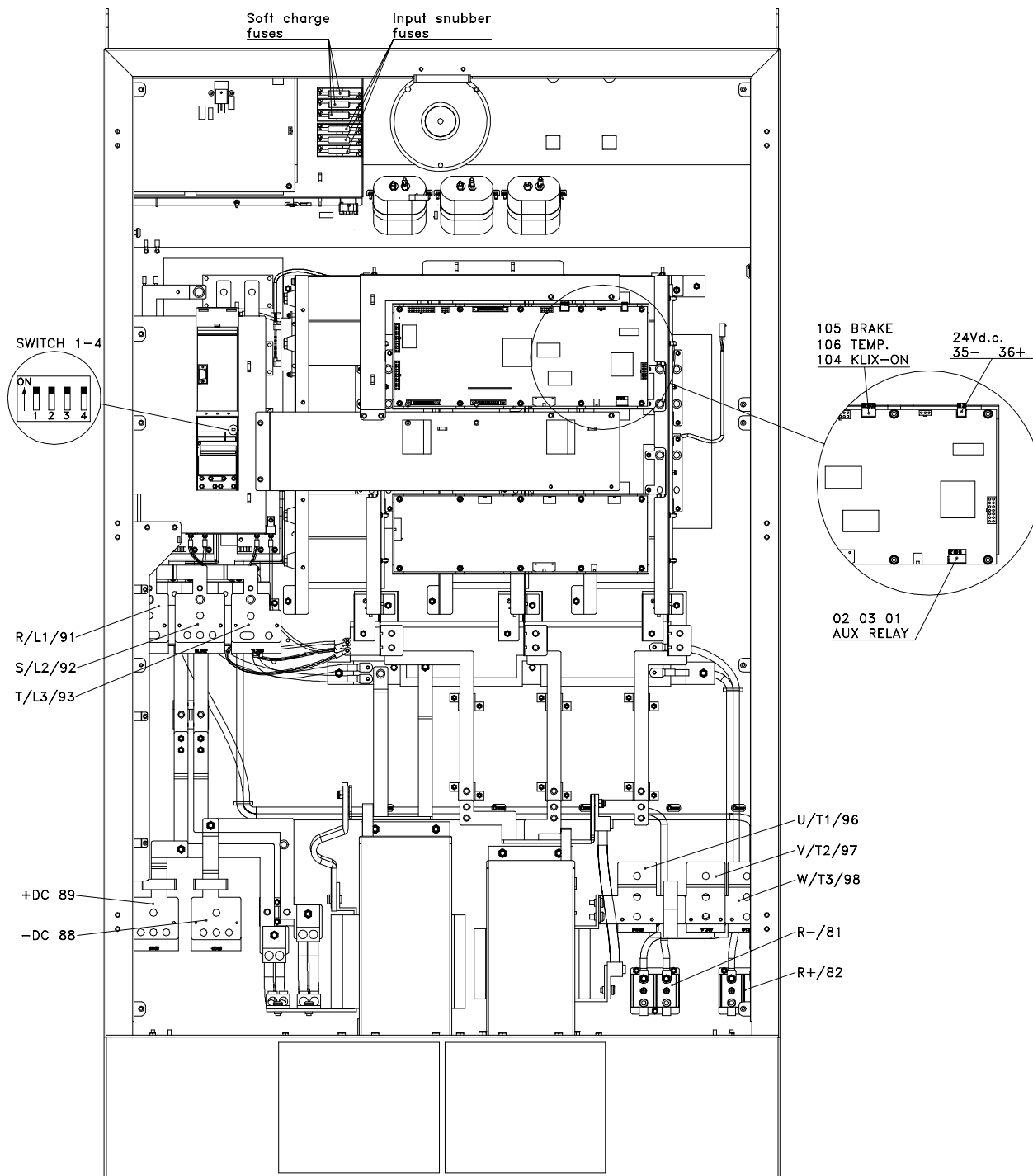


VLT 6152-6352, 380 to 460 V (chassis)

VLT 6152-6352, 380 to 460 V (chassis with disconnect and fuse)

Locations of Conduit Entry, Terminal Blocks and Switches (continued)

NEMA 1 and NEMA 12



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VLT 6400-6550, 380 to 460 V



Power Connections

1. Make all power connections with 75° C rated copper wiring.
2. Conduit entry must be from the bottom on all drives. Conduit entries are provided on smaller drives. For drives with auxiliary enclosures, refer to the dimensional drawings provided for conduit entry locations.
3. To meet UL requirements, install the metal grounding plate in all drives that have a plastic bottom. Install the grounding plate just above the plastic bottom. Ground the metal plate to the chassis and ground the conduit to the metal plate.
4. The conduit entries provide strain relief for the wires in drives mounted in NEMA 1 or NEMA 12 enclosures. With chassis mounted drives, the power and control wires must have strain relief supplied by the installer. Do not rely on the terminal blocks to provide strain relief.
5. Enclosures for larger drives and auxiliary enclosures are made of metal. To avoid getting metal chips into electronics, do not drill any holes after unit has been installed in a vertical position.

⚠WARNING Induced Voltage!

Run output motor cables from multiple drives separately. Induced voltage from output motor cables run together can charge equipment capacitors even with the equipment turned off and locked out. Failure to run output motor cables separately could result in death or serious injury.

NOTE

Run input power, motor wiring and control wiring in three separate metallic conduits or raceways for high frequency noise isolation. Failure to isolate power, motor and control wiring could result in less than optimum drive and associated equipment performance.

Input Power Connection

For drives with no auxiliary enclosure, connect input power to drive terminals L1, L2, and L3, (terminal numbers 91, 92, and 93). If an auxiliary enclosure is provided, input power connections are made in the auxiliary enclosure. Refer to the connection diagrams shipped with the drive.

Size wiring to the input current of the drive as shown in the tables below. Maximum AWG wire size is also provided. Local codes must be complied with for cable sizes.

Drive Input Current	Maximum AWG	Model
6	10	6002
7	10	6003
10	10	6004
16	10	6006
23	6	6008
30	6	6011
46	6	6016
59.2	2	6022
74.8	2	6027
88	0	6032
101	1/0	6042
126	3/0	6052
150	4/0	6062

208 VAC

Input Current/Wire Gage

Drive Input Current	Maximum AWG	Model
2.5	10	6002
3.4	10	6003
4.8	10	6004
8.3	10	6006
10.6	10	6008
14	10	6011
21	6	6016
27	6	6022
34	6	6027
41	6	6032
53	2	6042
64	2	6052
77	2	6062
103	1/0	6075
128	2/0	6100
128	3/0	6102
158	3/0	6122 / 6125
185	2x1/0	6150 / 6152
236	2x1/0	6172 / 6175
304	2x3/0	6222 / 6225
356	2x4/0	6272 / 6275
431	3x1/0	6350 / 6352
526	3x3/0	6400
581	3x3/0	6500
668	3x4/0	6550

460 VAC

Input Current/Wire Gage

Drive Input Current	Maximum AWG	Model
2.2	10	6002
2.5	10	6003
3.6	10	6004
4.6	10	6005
5.7	10	6006
8.4	10	6008
10.3	10	6011
16	6	6016
21	6	6022
25	6	6027
30	2	6032
38	2	6042
49	1/0	6052
58	1/0	6062
72	1/0	6072
92	4/0	6100
117	4/0	6125
134	4/0	6150
179	2 x 4/0	6175
226	2 x 4/0	6225
270	2 x 4/0	6275

600 VAC

Input Current/Wire Gage

CAUTION

Drive Failure!

Do not connect input power to drive output motor terminals. Connecting input power to motor terminals will result in drive failure when power is applied.

Motor Wiring Connection

For drives with no auxiliary enclosure, connect the motor to drive terminals U, V, and W (terminal numbers 96, 97, and 98). Terminal 99 is earth ground. If an auxiliary enclosure is provided, refer to the connection diagrams shipped with the drive. Ground the shield on the motor wire, if used, at both the drive and the motor.

⚠️WARNING

Grounding Hazard!

For operator safety, it is important to ground drive properly. Follow the grounding guidelines provided. Failure to follow grounding guidelines could result in death or serious injury.

Grounding

Ground the drive properly. Use a ground wire at least 7 AWG (10mm²). Connect the ground wire directly to a reliable earth ground. Do not use the conduit connecting to the drive as a replacement for a ground wire. Do not ground one drive to another in a “daisy chain” fashion.

Input Power Delay

To ensure that the input surge suppression circuitry performs correctly, a time delay between successive applications of input power must be observed.

The table below shows the minimum time that must be allowed between applications of input power.

Input voltage	380 V	415 V	460 V	600 V
Waiting time	48 sec	65 sec	89 sec	133 sec

Multiple Motors

The VLT 6000 can control several motors at once, all changing speed together. The sum of the nameplate currents of all the motors must not exceed the current rating of the drive.

CAUTION

Motor Damage!

When multiple motors are used, the drive electronic thermal relay cannot be used to provide individual motor protection. A separate motor overload must be supplied for each motor. Failure to provide individual motor protection when multiple motors are used could result in motor or equipment damage.

If the multiple motors are of significantly different sizes, starting problems may occur. This is because the higher electrical resistance of smaller motors will require more start voltage than larger motors.

NOTE

Automatic†Motor Adaptation and Automatic Energy Optimization cannot be used for multiple motor installations.

Electronic Thermal Protection

The electronic thermal relay is UL approved for single motor thermal protection as long as the following is complied with:

1. Parameter 117, *Thermal Protection*, is set to ETR TRIP.
2. Parameter 105, *Motor Current*, is set for the full-load nameplate motor current. Multiple Motors

External DC Bus Connection

Terminals 88 and 89, an option on drives less than 125 hp, access the DC bus of the drive. They can provide DC backup power for the drive or connect to a 12-pulse input rectifier.

⚠️WARNING

Hazardous Voltage!

Terminals 88 and 89 will be at approximately 150% of line voltage and remain at high voltage for up to 30 minutes after power has been removed from the drive. To be sure that capacitors have fully discharged, wait 14 minutes for 208 V and 480 V units and 30†minutes for 600 V units after power has been removed before touching terminals 88 and 89. Failure to wait for capacitors to fully discharge before touching DC bus terminals could result in death or serious injury.

CAUTION

Equipment Damage!

Do not connect anything to terminals 88 and 89 without first consulting with Danfoss Graham. Failure consult with Danfoss Graham could result in motor or equipment damage.

High Voltage Form C Relay

The connections for the high-voltage relay are terminals 01, 02, 03. The high-voltage relay is programmed in parameter 323, *Relay Output 1*.

1+3 normally closed, 1+2 normally open

Max. 240 VAC, 2 Amp

Min. 24 VDC, 10 mA or

24 VAC, 100 mA

Max. wire gage: 10 AWG (4 mm²)

Terminal Torque: 5 in-lbs (0.5 - 0.6 Nm)



Terminal Tightening Torque

Tighten terminals connecting the drive input power, output to the motor(s) and ground to the values shown in the tables below. Drives with 200 to 240 volts of 88 amps and less, and drives with 380 to 600 volts of 90 amps and less, have removable terminal blocks with screws. Larger drives have fixed bolts. (See the drive nameplate for maximum drive output current.)

200 to 240 VAC Terminal Tightening Torque

Max. Drive Output Current	Torque in-lbs (Nm)
6.6	5 (0.6)
7.5	5 (0.6)
10.6	5 (0.6)
16.7	5 (0.6)
24.2	17 (1.8)
30.8	17 (1.8)
46.2	28 (3.0)
59.4	28 (3.0)
74.8	28 (3.0)
88	35 (4.0)
114	100 (11.3)
143	100 (11.3)
170	100 (11.3)

380 to 460 VAC Terminal Tightening Torque

Max. Drive Output Current	Torque in-lbs (Nm)	Max. Drive Output Current	Torque in-lbs (Nm)
to 10	5 (0.6)	147	100 (11.3)
16	5 (0.6)	177	100 (11.3)
24	17 (1.8)	212	100 (11.3)
32	17 (1.8)	260	100 (11.3)
37.5	17 (1.8)	315	100 (11.3)
44	28 (3.0)	368	100 (11.3)
61	28 (3.0)	487	372 (42.0)
73	28 (3.0)	594	372 (42.0)
90	28 (3.0)	649	372 (42.0)
106	100 (11.3)	746	372 (42.0)

550 to 600 VAC Terminal Tightening Torque

Max. Drive Output Current	Torque in-lbs (Nm)
to 11	5 (0.6)
27	17 (1.8)
41	28 (3.0)
77	35 (4.0)
144	100 (11.3)
289	100 (11.3)

All current ratings are in amps.

200 to 208 VAC Auxiliary Control Panel Tightening Torques

200-208 V Max Output	Overload Relay	In/Out Power Terminal	CTK Breaker	Main Disco Switch	Drive Disco Switch	MN/BYP Fuse BLK	Drive Fuse BLK	Ground Terminal
4.6 A	17 (1.9)	15 (1.7)	22 (2.5)	7 (.8)	7 (.8)	25 (2.8)	35 (4.0)	45 (5.1)
6.6 A	17 (1.9)	15 (1.7)	22 (2.5)	7 (.8)	7 (.8)	25 (2.8)	35 (4.0)	45 (5.1)
7.5 A	17 (1.9)	15 (1.7)	22 (2.5)	7 (.8)	7 (.8)	25 (2.8)	35 (4.0)	45 (5.1)
10.6 A	17 (1.9)	15 (1.7)	22 (2.5)	7 (.8)	7 (.8)	25 (2.8)	35 (4.0)	45 (5.1)
16.7 A	17 (1.9)	15 (1.7)	22 (2.5)	7 (.8)	7 (.8)	25 (2.8)	45 (5.1)	45 (5.1)
24.2 A	17 (1.9)	15 (1.7)	22 (2.5)	7 (.8)	7 (.8)	25 (2.8)	45 (5.1)	45 (5.1)
30.8 A	17 (1.9)	35 (4.0)	22 (2.5)	7 (.8)	7 (.8)	45 (5.1)	45 (5.1)	45 (5.1)
46 A	40 (4.5)	175 (19.8)	44 (5)	18 (2)	18 (2)	45 (5.1)	45 (5.1)	50 (5.6)
59.4 A	40 (4.5)	175 (19.8)	44 (5)	18 (2)	18 (2)	120 (13.6)	120 (13.6)	50 (5.6)
74.8 A	40 (4.5)	175 (19.8)	44 (5)	55 (6.2)	55 (6.2)	120 (13.6)	275 (30.1)	50 (5.6)
88 A	40 (4.5)	175 (19.8)	44 (5)	70 (7.9)	70 (7.9)	120 (13.6)	275 (30.1)	50 (5.6)
114 A	200 (22.6)	275 (30.1)	275 (30.1)	375 (42.4)	375 (42.4)	275 (31.1)	N/A	50 (5.6)
143 A	200 (22.6)	275 (30.1)	275 (30.1)	375 (42.4)	375 (42.4)	275 (31.1)	N/A	50 (5.6)
169 A	200 (22.6)	275 (30.1)	275 (30.1)	375 (42.4)	375 (42.4)	450 (50.8)	N/A	275 (30.1)

Current ratings are in amps. Torques are in in-lbs (Nm). All TB1 connections must be torqued to 8 in-lbs (0.9 Nm).

Terminal Tightening Torque (continued)

230 to 240 VAC Auxiliary Control Panel Tightening Torques

230-240 V Max Output	Overload Relay	In/Out Power Terminal	CTK Breaker	Main Disco Switch	Drive Disco Switch	MN/BYP Fuse BLK	Drive Fuse BLK	Ground Terminal
4.2 A	17 (1.9)	15 (1.7)	22 (2.5)	7 (.8)	7 (.8)	25 (2.8)	35 (4.0)	45 (5.1)
6.6 A	17 (1.9)	15 (1.7)	22 (2.5)	7 (.8)	7 (.8)	25 (2.8)	35 (4.0)	45 (5.1)
7.5 A	17 (1.9)	15 (1.7)	22 (2.5)	7 (.8)	7 (.8)	25 (2.8)	35 (4.0)	45 (5.1)
10.6 A	17 (1.9)	15 (1.7)	22 (2.5)	7 (.8)	7 (.8)	25 (2.8)	35 (4.0)	45 (5.1)
16.7 A	17 (1.9)	15 (1.7)	22 (2.5)	7 (.8)	7 (.8)	25 (2.8)	35 (4.0)	45 (5.1)
24.2 A	17 (1.9)	15 (1.7)	22 (2.5)	7 (.8)	7 (.8)	25 (2.8)	45 (5.1)	45 (5.1)
30.8 A	17 (1.9)	35 (4.0)	22 (2.5)	7 (.8)	7 (.8)	45 (5.1)	45 (5.1)	45 (5.1)
46.2 A	40 (4.5)	175 (19.8)	44 (5)	18 (2)	18 (2)	45 (5.1)	45 (5.1)	50 (5.6)
59.4 A	40 (4.5)	175 (19.8)	44 (5)	18 (2)	18 (2)	120 (13.6)	120 (13.6)	50 (5.6)
74.8 A	40 (4.5)	175 (19.8)	44 (5)	55 (6.2)	18 (2)	120 (13.6)	275 (30.1)	50 (5.6)
88 A	40 (4.5)	175 (19.8)	275 (30.1)	70 (7.9)	55 (6.2)	275 (31.1)	275 (30.1)	50 (5.6)
104 A	40 (4.5)	175 (19.8)	275 (30.1)	375 (42.4)	70 (7.9)	275 (31.1)	N/A	50 (5.6)
130 A	200 (22.6)	275 (30.1)	275 (30.1)	375 (42.4)	375 (42.4)	275 (31.1)	N/A	50 (5.6)
154 A	200 (22.6)	275 (30.1)	275 (30.1)	375 (42.4)	375 (42.4)	450 (50.8)	N/A	275 (30.1)

380 to 460 VAC Auxiliary Control Panel Tightening Torques

380-480 V Max Output	Overload Relay	In/Out Power Terminal	CTK Breaker	Main Disco Switch	Drive Disco Switch	MN/BYP Fuse BLK	Drive Fuse BLK	Ground Terminal
2.1 A	17 (1.9)	15 (1.7)	22 (2.5)	7 (.8)	7 (.8)	25 (2.8)	25 (2.8)	45 (5.1)
3.0 A	17 (1.9)	15 (1.7)	22 (2.5)	7 (.8)	7 (.8)	25 (2.8)	25 (2.8)	45 (5.1)
4.1 A	17 (1.9)	15 (1.7)	22 (2.5)	7 (.8)	7 (.8)	25 (2.8)	25 (2.8)	45 (5.1)
5.6 A	17 (1.9)	15 (1.7)	22 (2.5)	7 (.8)	7 (.8)	25 (2.8)	25 (2.8)	45 (5.1)
8.2 A	17 (1.9)	15 (1.7)	22 (2.5)	7 (.8)	7 (.8)	25 (2.8)	25 (2.8)	45 (5.1)
11.0 A	17 (1.9)	15 (1.7)	22 (2.5)	7 (.8)	7 (.8)	25 (2.8)	25 (2.8)	45 (5.1)
16 A	17 (1.9)	15 (1.7)	22 (2.5)	7 (.8)	7 (.8)	25 (2.8)	25 (2.8)	45 (5.1)
24 A	17 (1.9)	15 (1.7)	22 (2.5)	7 (.8)	7 (.8)	25 (2.8)	45 (5.1)	45 (5.1)
32 A	17 (1.9)	35 (4.0)	22 (2.5)	7 (.8)	7 (.8)	45 (5.1)	45 (5.1)	45 (5.1)
37.5 A	17 (1.9)	35 (4.0)	22 (2.5)	18 (2)	7 (.8)	45 (5.1)	45 (5.1)	45 (5.1)
44 A	40 (4.5)	35 (4.0)	22 (2.5)	18 (2)	18 (2)	45 (5.1)	45 (5.1)	50 (5.6)
61 A	40 (4.5)	175 (19.8)	44 (5)	18 (2)	18 (2)	45 (5.1)	120 (13.6)	50 (5.6)
73 A	40 (4.5)	175 (19.8)	44 (5)	55 (6.2)	18 (2)	120 (13.6)	120 (13.6)	50 (5.6)
90 A	40 (4.5)	175 (19.8)	44 (5)	70 (7.9)	55 (6.2)	120 (13.6)	275 (30.1)	50 (5.6)
106 A	40 (4.5)	175 (19.8)	275 (30.1)	375 (42.4)	70 (7.9)	275 (31.1)	N/A	50 (5.6)
147 A	200 (22.6)	275 (30.1)	275 (30.1)	375 (42.4)	375 (42.4)	275 (31.1)	N/A	50 (5.6)
177 A	200 (22.6)	275 (30.1)	275 (30.1)	375 (42.4)	375 (42.4)	275 (31.1)	N/A	275 (30.1)
212 A	200 (22.6)	275 (30.1)	275 (30.1)	375 (42.4)	375 (42.4)	450 (50.8)	500 (56.5)	275 (30.1)
260 A	200 (22.6)	375 (42.4)	275 (30.1)	500 (56.8)	500 (56.8)	450 (50.8)	500 (56.5)	275 (30.1)
315 A	375 (42.4)	375 (42.4)	275 (30.1)	500 (56.8)	500 (56.8)	450 (50.8)	275 (30.1)	275 (30.1)
368 A	375 (42.4)	375 (42.4)	275 (30.1)	500 (56.8)	500 (56.8)	375 (42.4)	375 (42.4)	275 (30.1)

Current ratings are in amps. Torques are in in-lbs (Nm). All TB1 connections must be torqued to 8 in-lbs (0.9 Nm).



Terminal Tightening Torque (continued)

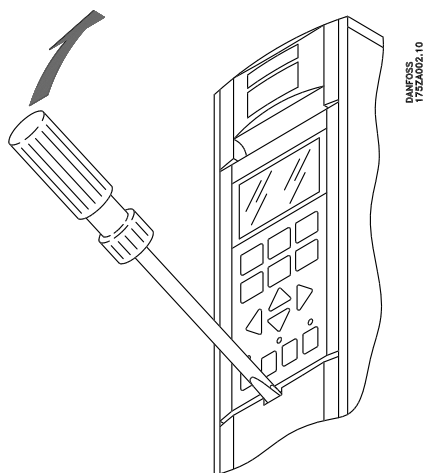
550 to 600 VAC Auxiliary Control Panel Tightening Torques

550-600 V Max Output	Overload Relay	In/Out Power Terminal	CTK Breaker	Main Disco Switch	Drive Disco Switch	MN/BYP Fuse BLK	Drive Fuse BLK	Ground Terminal
1.7 A	17 (1.9)	15 (1.7)	50 (5.6)	7 (.8)	7 (.8)	25 (2.8)	25 (2.8)	45 (5.1)
2.4 A	17 (1.9)	15 (1.7)	50 (5.6)	7 (.8)	7 (.8)	25 (2.8)	25 (2.8)	45 (5.1)
2.7 A	17 (1.9)	15 (1.7)	50 (5.6)	7 (.8)	7 (.8)	25 (2.8)	25 (2.8)	45 (5.1)
3.9 A	17 (1.9)	15 (1.7)	50 (5.6)	7 (.8)	7 (.8)	25 (2.8)	25 (2.8)	45 (5.1)
6.1 A	17 (1.9)	15 (1.7)	50 (5.6)	7 (.8)	7 (.8)	25 (2.8)	25 (2.8)	45 (5.1)
9.0 A	17 (1.9)	15 (1.7)	50 (5.6)	7 (.8)	7 (.8)	25 (2.8)	25 (2.8)	45 (5.1)
11.0 A	17 (1.9)	15 (1.7)	50 (5.6)	7 (.8)	7 (.8)	25 (2.8)	25 (2.8)	45 (5.1)
17 A	17 (1.9)	15 (1.7)	50 (5.6)	7 (.8)	7 (.8)	25 (2.8)	45 (5.1)	45 (5.1)
22 A	17 (1.9)	15 (1.7)	50 (5.6)	7 (.8)	7 (.8)	45 (5.1)	45 (5.1)	45 (5.1)
27 A	17 (1.9)	35 (4.0)	50 (5.6)	7 (.8)	7 (.8)	45 (5.1)	45 (5.1)	45 (5.1)
32 A	17 (1.9)	35 (4.0)	50 (5.6)	18 (2)	18 (2)	45 (5.1)	120 (13.6)	45 (5.1)
41 A	40 (4.5)	35 (4.0)	50 (5.6)	18 (2)	18 (2)	45 (5.1)	120 (13.6)	50 (5.6)
52 A	40 (4.5)	175 (19.8)	50 (5.6)	70 (7.9)	55 (6.2)	120 (13.6)	120 (13.6)	50 (5.6)
62 A	40 (4.5)	175 (19.8)	50 (5.6)	70 (7.9)	55 (6.2)	120 (13.6)	120 (13.6)	50 (5.6)
77 A	40 (4.5)	175 (19.8)	275 (30.1)	70 (7.9)	55 (6.2)	120 (13.6)	120 (13.6)	50 (5.6)
99 A	40 (4.5)	175 (19.8)	275 (30.1)	375 (42.4)	70 (7.9)	275 (31.1)	275 (30.1)	50 (5.6)
125 A	200 (22.6)	275 (30.1)	275 (30.1)	375 (42.4)	375 (42.4)	275 (31.1)	N/A	50 (5.6)
144 A	200 (22.6)	275 (30.1)	275 (30.1)	375 (42.4)	375 (42.4)	275 (31.1)	N/A	275 (30.1)
192 A	200 (22.6)	275 (30.1)	275 (30.1)	375 (42.4)	375 (42.4)	450 (50.8)	N/A	275 (30.1)
242 A	375 (42.4)	375 (42.4)	275 (30.1)	500 (56.8)	500 (56.8)	450 (50.8)	500 (56.5)	275 (30.1)
289 A	375 (42.4)	375 (42.4)	275 (30.1)	500 (56.8)	500 (56.8)	375 (42.4)	275 (30.1)	275 (30.1)

Current ratings are in amps. Torques are in in-lbs (Nm). All TB1 connections must be torqued to 8 in-lbs (0.9 Nm).

Control Connections

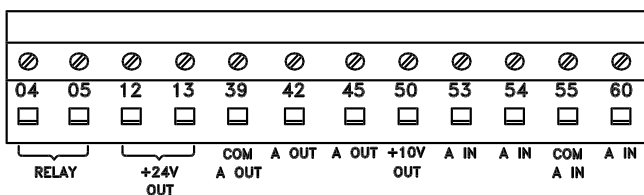
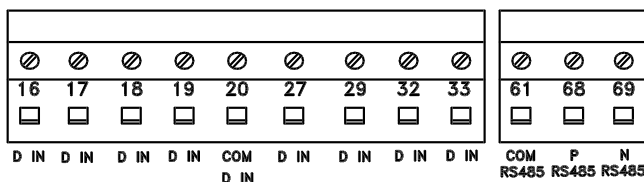
All terminals for the low voltage control wires are located under the protective cover below the keypad. Remove the cover with a screwdriver or other pointed object as shown below.



Electrical Installation, Control Terminals

Torque control terminals to 5 in-lbs (0.5-0.6 N-m)
Max. wire size: 16 AWG (1.5mm²)

The diagram below shows the location of the control terminals. The programming section of the manual covers the programmable terminals in greater depth.



DANFOSS
175HA379.10

Drive Inputs and Outputs

The drive operates by receiving control signals. Control input gets to the drive in three possible ways. One way is from input signals through the wiring connected to the drive control terminals. The drive control terminals are located below the LCP keypad.

Another control source is through serial communication from a serial bus. A serial communication protocol supplies commands and references to the drive and reads status and data from the drive. The serial bus connects to the drive through the RS-485 serial port. Use of serial communication may require installation of a corresponding option card.

A building management system, remote sensors, a speed command from associated equipment, or a PLC (programmable logic controller) are examples of possible remote drive controllers.

The third way for drive control input is through the keypad on the front of the drive when operating in local (hand) mode. These inputs include start, stop, reset, and speed reference.

Input Signals

The drive can receive two types of remote input signals: digital or analog. Digital inputs are wired to terminals 16, 17, 18, 19, 20 (common), 27, 29, 32, and 33. Analog inputs are wired to terminals 53, 54, and 55 (common), or terminal 60.

Analog signals can be either voltage (0 to +10 VDC) connected to terminals 53 and 54, or current (0 to 20 mA or 4 to 20 mA) connected to terminal 60. Analog signals can be varied like dialing a rheostat up and down. The drive can be programmed to increase or decrease output in relation to the amount of current or voltage. For example, a sensor may supply a variable current. The drive output, in turn, regulates the speed of the motor connected to the drive in response to that analog signal.

Digital signals are a simple binary 0 or 1 which, in effect, act as a switch. Digital signals are controlled by a 0 to 24 VDC signal. A voltage signal lower than 5 VDC is a logic 0. A voltage higher than 10 VDC is a logic 1. Zero is open, one is close. Digital inputs to the drive are switched commands such as start, stop, reverse, coast, reset, and so on. (Do not confuse these digital inputs with serial communication formats where digital bytes are grouped into communication words and protocols.)

The RS-485 serial communication connector is wired to terminals (+) 68 and (-) 69. Terminal 61 is common and may be used for terminating shields only when the control cable is run between VLT drives, not between drives and other devices.



Output Signals

The drive also produces output signals that are carried through either the RS-485 serial bus or terminals 42 and 45. Output terminals 42 and 45 operate in the same manner as the inputs. These terminals can be programmed for either a variable analog signal in mA or a digital signal (0 or 1) in 24 VDC. In addition, the terminals can provide a pulse reference of 0 to 32,000 pulses. Output analog signals generally report the drive frequency, current, torque and so on to an external controller or system. Digital outputs can be control signals used to open or close a damper, for example, or send a start or stop command to auxiliary equipment.

Additional terminals are 01, 02, and 03, which are a Form C relay output. Terminals 04 and 05 are a 1 A low voltage relay output.

Terminals 12 and 13 provide 24 VDC low voltage power, often used to supply power to the digital input terminals (16-33). Those terminals must be supplied with power from either terminal 12 or 13, or from a customer supplied external 24 VDC power source. Improperly connected control wiring can be the cause of a motor not operating or the drive not responding to a remote input.

Programming Control Terminals

Control terminals must be programmed. Each terminal has specific functions it is capable of performing and a numbered parameter associated with it. See the table below for associated parameter numbers. The setting selected in the parameter enables the function of the terminal.

It is important to confirm that the control terminal is programmed for the correct function. See *Control Panel* for details on operator interface and changing parameters.

In addition, the input terminal must be receiving a signal. Confirm that the control and power sources are wired to the terminal. Then check the signal.

Signals can be checked in two ways. Relay status can be selected in the display using the [DISPLAY MODE] key (see *Display Modes*), or a voltmeter may be used to check for voltage at the control terminal.

In summary, for proper drive functioning, the drive control terminals must be:

1. wired properly
2. programmed correctly for the intended function
3. powered
4. receiving a signal

Control Terminal Functions

The following is a description of the functions of the control terminals. Many of these terminals have multiple functions determined by parameter settings.

Terminal No.	Function
01, 02, 03	Form C relay output. Maximum 240 VAC, 2 A. Minimum 24 VDC, 10 mA or 24 VAC, 100 mA. (Location of Form C relay output varies with unit type. See connection diagram with unit for location.)
04, 05	30 VAC, 42.5 VDC, 1 A relay output can be used for indicating status and warnings.
12, 13	Voltage supply to digital inputs and external transducers. For the 24 VDC to be used for digital inputs, switch 4 on the control card must be closed, position "on." The maximum output current is 200 mA.
16 - 33	Digital inputs. R = 2 kohm. <5 V = logical "0", >10 V = logical "1". See parameters 300 through 307, <i>Digital Inputs</i> .
20	Common for digital inputs.
39	Common for analog and digital outputs.
42, 45	Analog and digital outputs for indicating frequency, reference, current and torque. The analog signal is 0 to 20 mA, or 4 to 20 mA at a maximum of 500 Ω. The digital signal is 24 VDC at a minimum of 600 Ω. See parameters 319-322, <i>Analog/digital Outputs</i> .
50	10 VDC, 17 mA maximum analog supply voltage to potentiometer and thermistor.
53, 54	0 to 10 VDC voltage input, R = 10 kΩ.
55	Common for analog inputs. This common is isolated from the common of all other power supplies. If, for example, the drive's 24 VDC power supply is used to power an external transducer which provides an analog input signal, terminal 55 must be wired to terminal 39.

Control Terminals and Associated Parameter

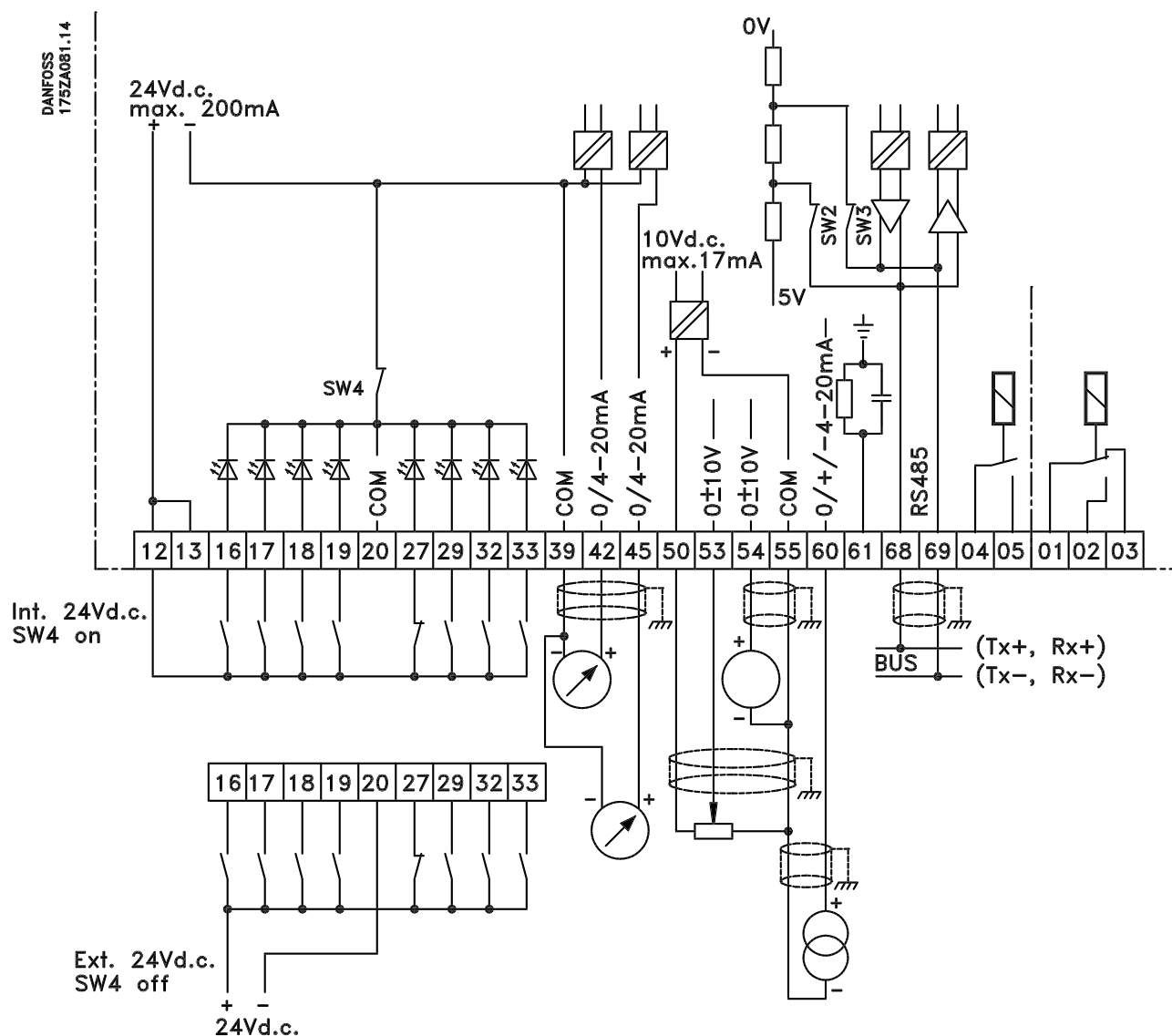
Term	16	17	18	19	27	29	32	33	53	54	60	42	45	1-3	4-5
Para	300	301	302	303	304	305	306	307	308	311	314	319	321	323	326

Control terminals must be programmed. Each terminal has specific functions it is capable of performing and a numbered parameter associated with it. The setting selected in the parameter enables the function of the terminal.

Control Terminal Functions (continued)

Terminal No.	Function
60	0 to 20 mA or 4 to 20 mA, analog current input, R = 188 Ω. See parameters 314 through 316.
61	Shield for serial communication.
68, 69	RS-485 interface and serial communication. When the drive is connected to an RS-485 serial communication bus, DIP switch settings on the control card may have to be reset. See <i>DIP Switches 1 through 4</i> in this manual.

Electronic Control Terminals



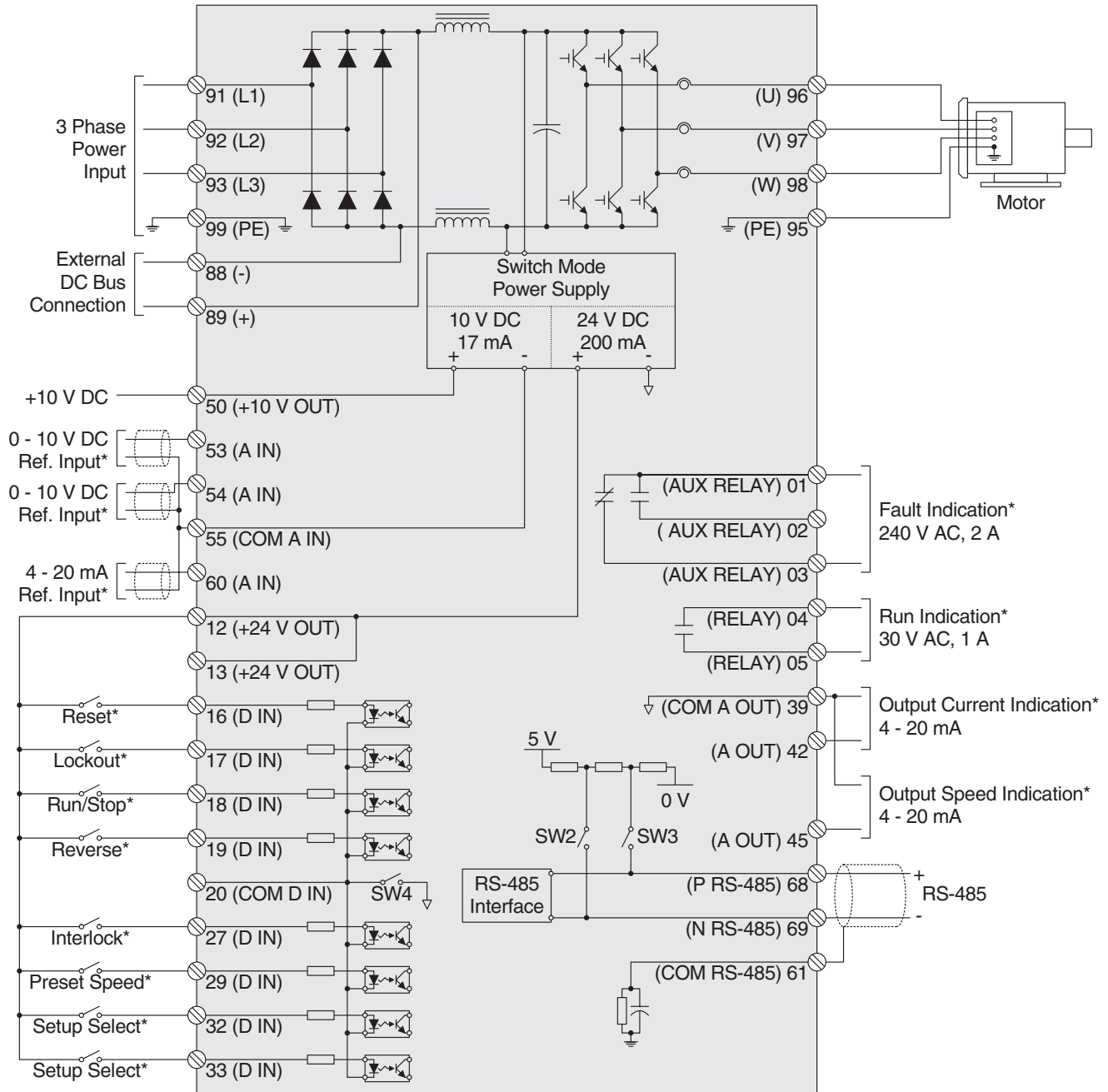
Electronic Control Terminals

Typical Control Connections

Shown below are typical interfaces between the VLT 6000 and other components in an HVAC system. The terminal numbers and the functions of the terminals are identical on all VLT 6000s. An optional relay card, not shown, can provide four additional Form C output relays. The RS-485 connections allow direct communication through

the drive's built-in serial communication: Johnson Controls Metasys® N2, Siemens System 600® FLN, Modbus RTU, or Danfoss FC® protocols. LonWorks® is available through an option card that fit into the back of the control card location. BACnet is also available in an auxiliary enclosure.

Typical* VLT 6000 Wiring



* The operation of all control inputs and outputs is programmable. Typical terminal functions are shown.

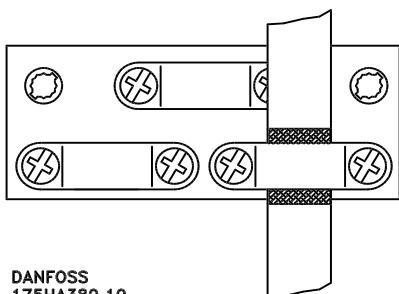
NOTE

Run input power, motor wiring and control wiring in three separate metallic conduits or raceways for high frequency noise isolation. Failure to isolate power, motor and control wiring could result in less than optimum drive and associated equipment performance.

Electrical Installation, Control Wiring

Torque: 5 - 6 in-lbs
Screw size: M3

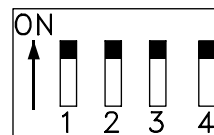
Shielded control wires are recommended. To reduce interference from electrical noise, ground the cable shield at a cable clamp, as shown below, at both ends. Connect the shield to the grounded clamp. Very long control wires may create 60 Hz interference. To resolve this, connect one end of the shield to earth with a 0.1 μ F capacitor, keeping the leads as short as possible. If interference persists, disconnect the grounded shield connection at the end opposite to the drive.



DIP Switches 1 through 4

DIP switches are located on the control card.

They are used for serial communication and the common of digital inputs 16 through 33. The switch positions shown are the factory settings.



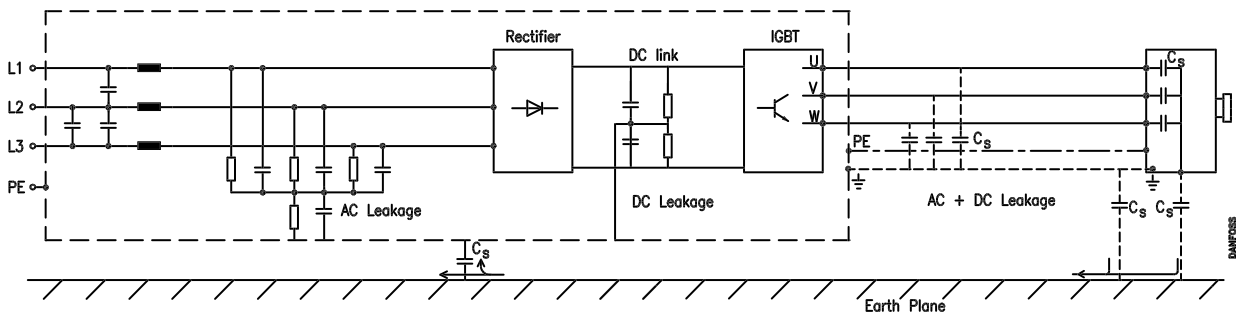
Switch 1 is not used.

Switches 2 and 3 are used for terminating serial communication. On the first and last drive in a multiple device network, or on the only drive of a single drive network, switches 2 and 3 must be ON (the default setting). On all other drives in a multiple device network, set switches 2 and 3 to OFF.

Switch 4 separates the common for the internal 24 VDC supply from the common of the external 24 VDC supply. Normally this switch is ON and the power supply is present at terminals 12 and 13. Set Switch 4 to the OFF position when an external 24 VDC supply is used.

Ground Leakage Current

It is normal for there to be some leakage current from the drive to earth ground. Paths of current leakage are shown on the drawing below. The leakage current will exceed 3.5 mA.



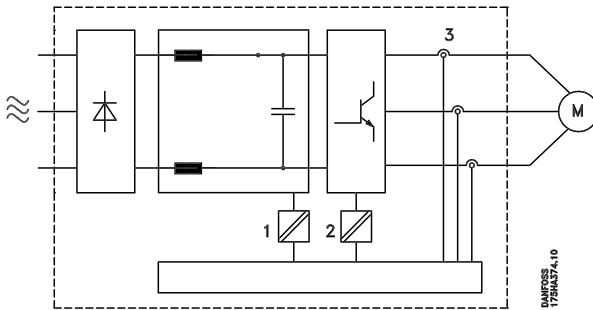
Paths of Normal Current Leakage to Ground

Galvanic Isolation

Galvanic isolation offers protection from electric shock. All control terminals of all VLT 6000 drives, and terminals 1 through 3 of the relay output, offer galvanic isolation. The galvanic isolation in the VLT 6000 conforms to the European standard EN 50178. (See figure below.)

The components that make up the galvanic isolation are:

1. Power supply, including signal isolation.
2. Gate drive for the IGBTs, the trigger transformers and opto-couplers.
3. The output current Hall effect transducers.



Galvanic Isolation

Extra Safety Protection

Residual Current Device (RCD) relays for ground fault protection, or multiple protective grounding, can be used as extra safety protection, provided that local safety regulations are complied with. In case of a grounding fault, the fault current may contain a DC component. If RCD relays, also known as Earth Leakage Circuit Breakers (ELCB), are used, they may be suitable for protection of 3-phase equipment with a bridge rectifier and for a brief current surge at power-up.

Since leakage current is greater than 3.5 mA, reinforced grounding must be provided if compliance with EN 50178 is required. The relays must be suitable to meet the following requirements:

- 1) protecting equipment with a DC content (Din VDE 0664) in the fault current (3-phase rectifier)
- 2) power-up with short pulse-shaped charging current to ground
- 3) high leakage currents

RCD fault relays type B comply with these requirements according to the norm IEC 755-2.

Electrical Noise

In general, electrical noise can be divided into two forms: wire-borne electromagnetic interference (EMI), and radiating radio frequency interference (RFI).

Using shielded motor cables reduces RFI but increases EMI. This is because shielded wires have a greater capacitance than unshielded wires. Unshielded input power connections to the drive generate more noise in the radio frequency range on the AC line. The shield reduces the radiated noise, but increases the low-frequency electromagnetic noise on the AC line. But, since the noise current is taken back to the unit through the shield, only a small electromagnetic field is generated from shielded motor wires.

With an EMI filter, the noise level on the AC line will be reduced to about the same level for shielded and unshielded wires alike.

Connect the motor wiring shield, if used, in the enclosure of the drive as well as at the motor. Use shield brackets to avoid "pigtail" shield ends. Even short "pigtails" increase the shield's impedance at higher frequencies, which reduces the shield's effect and increases the noise produced.

It is generally easier and less complicated to use unshielded motor wires than shielded cables. If unshielded wires are used, the RFI will be greater. But, since the strength of the radiated signal decreases with distance from the signal source, radiated noise is generally not a problem.

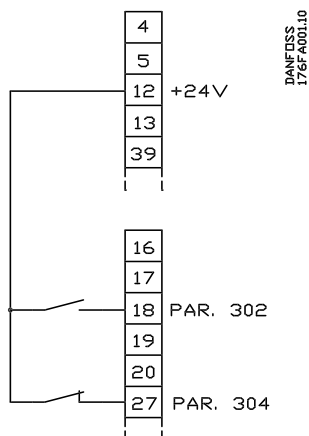
To reduce the noise level from the total system (drive + installation) make the motor wiring as short as possible.

Provide separate conduits, or raceways, for power, motor and control wiring to provide the greatest immunity from distortion.

Application Control Connection Examples

Two-wire Start/Stop

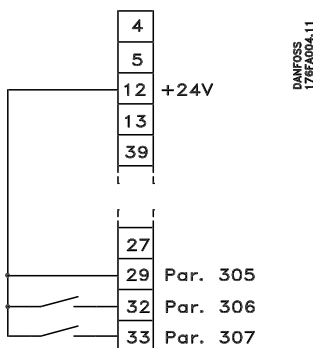
In Auto mode, closing the contact to terminal 18 will make the drive run. In any mode, opening the safety interlock contact to terminal 27 will stop the drive.



Set Parameter 302 to Start.
Set Parameter 304 to Safety Interlock.

Digital Speed Up/down

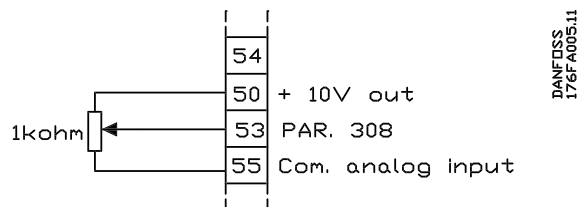
Closing the switch to terminal 32 will make the drive accelerate. Closing the switch to terminal 33 will make the drive decelerate.



Set Parameter 306 to Speed up.
Set Parameter 307 to Speed down.
Set Parameter 305 to Freeze reference.

Potentiometer Reference

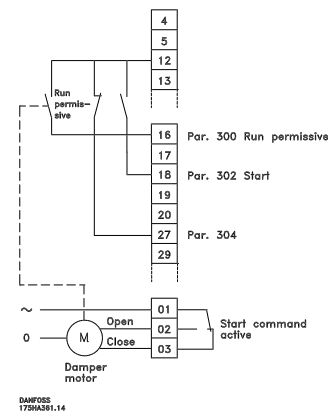
A manual potentiometer is used as a input reference for the drive.



Set Parameter 308, Terminal 53, Analog Input Voltage, to Reference.
Set Parameter 309, Terminal 53, Min. Scaling, to 0 V.
Set Parameter 310, Terminal 53, Max. Scaling, to 10 V.

Run Permissive

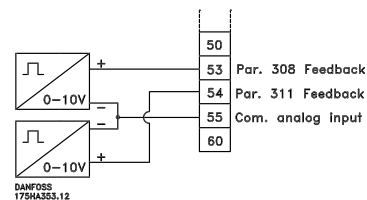
After receiving a run command, the drive will apply power to the damper motor and wait until it receives "permission" via the switch that is connected to terminal 16.



Set Parameter 300 to Run Permissive.
Set Parameter 302 to Start.
Set Parameter 304 to External Fault.
Set Parameter 323 to Start Signal Applied.

Two Feedback Signals

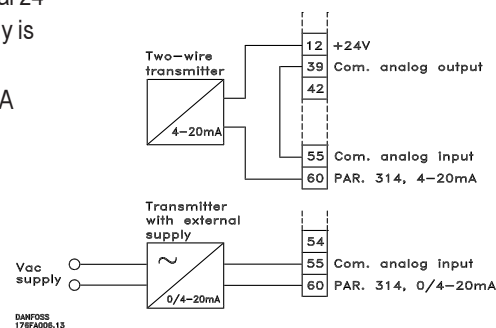
The drive processes two independent feedback signals during closed loop operation. It can respond to the sum, difference, average, minimum or maximum of these signals.



Set Parameter 308 to Feedback.
Set Parameter 311 to Feedback
Set Parameter 417 for the desired operation.

Transmitter Connection

The drive's internal 24 VDC power supply is used to power an external 4 to 20 mA transducer.



Set Parameter 314, Terminal 60, Analog Input Current, to correspond to the purpose of the 4 to 20 mA signal.
Set Parameter 315, Terminal 60, Min. Scaling, to 4 mA
Set Parameter 316, Terminal 60, Max. Scaling, to 20 mA.

Because the commons of the +24 VDC power supply and the input reference follower have separate circuit commons, it is necessary to connect a jumper between terminals 39 and 55.



Control Panel

The Local Control Panel (LCP), normally mounted on the front of the drive, is a complete interface for programming and operating the drive. The control panel can be removed from the drive and installed up to 10 feet (3 meters) from the drive by using a remote mounting kit.

The control panel has five functions:

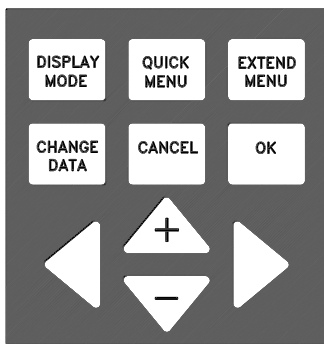
1. Display
2. Keys for changing the display
3. Keys for changing programming parameters
4. Indicator lamps
5. Keys for controlling drive operation

The LCP uses a four-line, alpha-numeric, back-lit, LCD display. The display can show four operating data values and three operating condition values continuously. During programming, all the information required for quick, effective parameter setup of the drive will be displayed. As a supplement to the display, there are three indicator lamps for power on (ON), warning (WARNING) and alarm (ALARM).

All drive parameters can be changed from the control panel, unless this ability has been locked out by setting parameter 016, *Lock for Data Change*, to Locked, or by a digital input to terminals 16 through 33. See the related parameters for more information.

Keys for Parameter Changes

The keys are divided into groups by function. The keys between the display and indicator lamps are used for parameter setup, selecting the display indication during normal operation and controlling the drive speed during local speed control operation. The keys below the indicator lamps are used for Start/Stop control and selection of the operating site.



DISPLAY MODE

The DISPLAY MODE key is used to change the mode of the display or to return to the Display Mode from either the Quick Menu or the Extend Menu mode.

QUICK MENU

The QUICK MENU key gives access to the parameters available for the Quick Menu setup. Parameters in this menu are the 12 most important setup parameters for the drive.

EXTEND MENU

The EXTEND MENU key gives access to all parameters.

CHANGE DATA

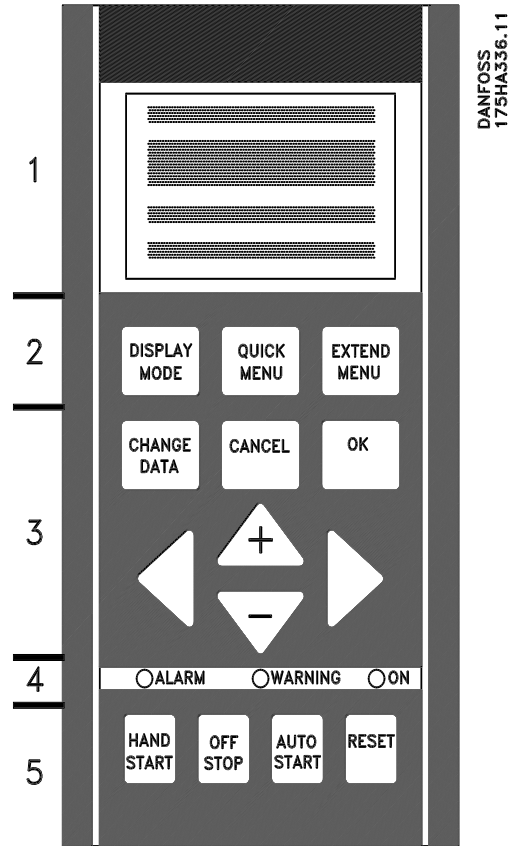
The CHANGE DATA key is used for changing the value of a parameter selected either in the Extend Menu or the Quick Menu mode. The desired parameter is first selected. Then the CHANGE DATA key is pressed to enable the editing of the parameter. The underline in the display will move under the parameter's value to show that it is being edited.

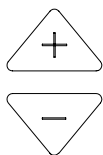
CANCEL

The CANCEL key is used if a change of the selected parameter is not to be carried out.

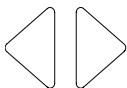
OK

The OK key is used for confirming a change of the parameter selected.





The [+] and [-] keys are used to scroll through parameters and to change the value of a chosen parameter. These keys are also used to change the local reference. In Display Mode, these keys are used to switch between readouts.



The ◀ and ▶ keys are used to select a parameter group and also to move the cursor to the desired digit when changing numerical values.

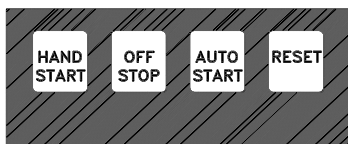
Indicator Lamps

At the bottom of the control panel is a red alarm LED, a yellow warning LED, and a green power on LED.



If certain threshold values are exceeded, the alarm and/or warning lamps will flash and text describing the alarm or warning condition will be displayed.

Local Control



Below the indicator lamps are keys which are used to determine the point of control. Each of these keys can be individually enabled or disabled using parameter 012 through 015. The Hand Start and Auto Start keys will also be disabled if any of the control terminals are programmed for either Remote Hand or Remote Auto.



The HAND START key is used if the drive is to be started from the control panel. Pressing HAND START will give a start command to the drive.

NOTE

If a minimum speed is set in parameter 201, Output Frequency, Low Limit, the motor will start and ramp up to this frequency when HAND START is pressed. If drive is running in Auto Mode when the HAND START key is pressed, drive control will switch to Hand Mode.



The OFF/STOP key is used for stopping the connected motor in either the Hand or Auto mode. Enable or disable via parameter 013. If this stop function is activated, the second line in the LCD display will flash.



AUTO START is used if the drive is to be started via the control terminals and/or serial communication. When a remote start signal is active, the drive will start if the AUTO START key has been pressed.

⚠ WARNING Unintended Start!

In Auto Mode, a start signal via digital inputs may cause drive to start at any time. The drive, motor, and any driven equipment must be in operational readiness. Failure to be in operational readiness in Auto Mode could result in death, serious injury, or equipment or property damage.



The RESET key is used for manually resetting the drive after a fault trip (alarm). In this case, the top line of the display will show TRIP (RESET). If the top line of the display shows TRIP (AUTO START), the drive will automatically restart. If the top line of the display shows TRIPLOCK (DISC. MAINS), input power to the drive must be removed before the trip can be reset.

Display Modes

In Auto operational mode, information is displayed in any of three programmable displays. Pressing the DISPLAY MODE key enters display mode and toggles between modes I and II. While in Display mode, the [+] and [-] keys scroll through all data display options. When in Mode II, holding down the DISPLAY MODE key enters Mode III which identifies the units on the top line that the display is showing. Mode IV is available only in local Hand operation and displays the local speed reference.

In normal operation, three data readouts can be shown on the first (top) line of the display. Parameters 008, 009 and 010 select the data displayed on the top line. One readout is available for the large display (line 2). Parameter 007, *Large Display Readout*, selects the data displayed on line 2. The list on the next page defines the operating data that can be selected for the display readouts.

During an alarm (fault trip), ALARM and the alarm number are shown on the large display. An explanation is given in line 3 or in lines 3 and 4. For a warning, WARN. and the warning number are shown with an explanation in line 3 and/or 4. Both alarms and warnings cause the display to flash.

Line 4 (bottom line), in normal operation, automatically displays the operating status of the drive.

The active setup number and an arrow indicating the direction of motor rotation is shown on the right side of the large display. Clockwise indicates forward and counterclockwise indicates reverse. The arrow body is removed if a stop command is given or if the output frequency falls below 0.01 Hz.

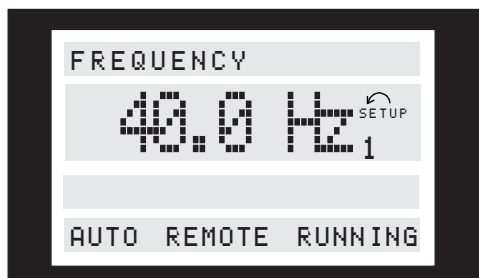
The table below gives the operating data options for the first and second lines of the display.

Data Item:	Unit:
Resulting reference, %	%
Resulting reference	unit chosen in par. 415
Frequency	Hz
% of maximum output frequency	%
Motor current	A
Power	kW
Power	HP
Output energy	kWh
Hours run	hours
User defined readout	unit chosen in par. 006
Setpoint 1	unit chosen in par. 415
Setpoint 2	unit chosen in par. 415
Feedback 1	unit chosen in par. 415
Feedback 2	unit chosen in par. 415
Feedback	unit chosen in par. 415
Motor voltage	V
DC link voltage	V
Thermal load on motor	%
Thermal load on VLT	%
Input status, digital input	binary code
Input status, analog terminal 53	V
Input status, analog terminal 54	V
Input status, analog terminal 60	mA
Relay status	binary code
Pulse reference	Hz
External reference	%
Heat sink temperature	°C

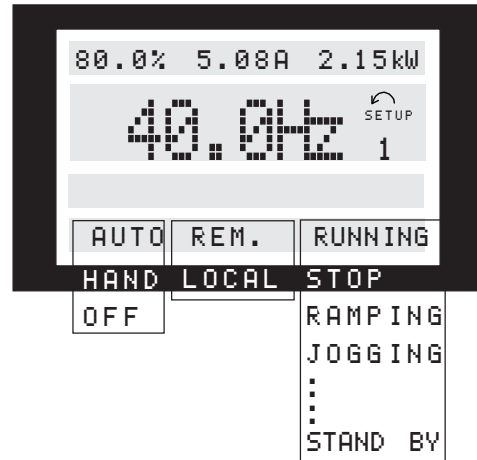
Display Mode I:

In Display mode I, the drive is in Auto mode with reference and control determined via the control terminals. Following is an example in which the drive is running in setup 1, in Auto mode, with a remote reference, and at an output frequency of 40 Hz.

The text in line 1, FREQUENCY, describes the meter shown in the large display. Line 2 (large display) shows the current output frequency (40.0 Hz), direction of rotation (reverse arrow), and active setup (1). Line 3 is blank. Line 4 is the status line and the information is automatically generated for display by the drive in response to its operation. It shows that the drive is in auto mode, with a remote reference, and that the motor is running.



Status line (Line 4): Additional automatic displays for the drive status line are shown below. See *Status Messages* section in this manual for additional information.



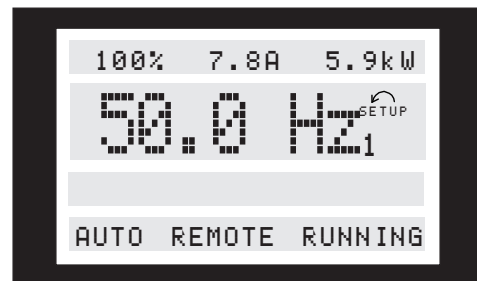
The left indicator on the status line displays the active control mode of the VLT drive. AUTO is displayed when control is via the control terminals. HAND indicates that control is local via the keys on the LCP. OFF indicates that the drive ignores all control commands and will not run.

The center part of the status line indicates the reference element that is active. REM. (Remote) means that reference from the control terminals is active, while LOCAL indicates that the reference is determined via the [+] and [-] keys on the control panel.

The last part of line 4 indicates the drive's operational status, for example: RUNNING, STOP, or RUN REQUEST, and so on.

Display Mode II:

This display mode shows three operating data values in the top line programmed via parameters 008, 009, and 010. Pressing the DISPLAY MODE key toggles between Display modes I and II.



Display Mode III:

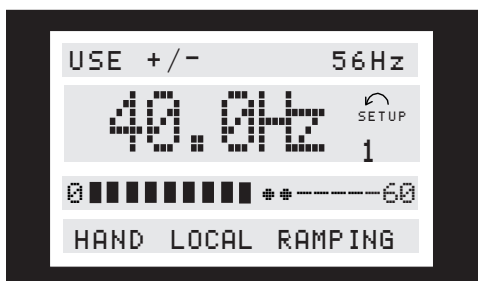
Press and hold the [DISPLAY MODE] key while in Mode II. Mode III is visible as long as the key is depressed. The top line changes to identify the data names and units displayed. Lines 2 and 4 are unchanged. When the key is released, the display returns to Mode II.



Display Mode IV:

This display mode is available when local reference is selected. In this display mode, the speed reference is increased or decreased via +/- keys.

The first line shows the present speed reference. The second line shows the present drive output frequency. The third line shows a bar graph of the relative value of the present drive output frequency in relation to the maximum frequency.



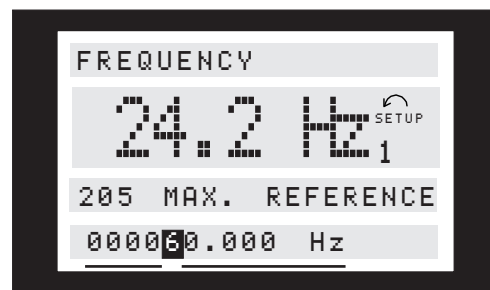
Changing Data

Regardless of whether a parameter has been selected under the Quick Menu or the Extend Menu, the procedure for changing data is the same. Pressing the CHANGE DATA key gives access to changing the selected parameter. Line 3 displays the parameter number and title. The underlined function or number flashing in line 4 on the display is subject to change.

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

Changing Numeric Values

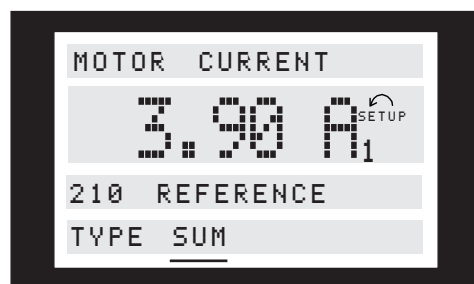
If the chosen parameter represents a number value, the flashing digit can be changed by means of the [+] and [-] keys. Position the cursor by using the [<] and [>] keys, then change the data value using the [+] and [-] keys.



The selected digit is indicated by a flashing cursor. The bottom display line gives the data value that will be entered (saved) by pressing the OK button. Use CANCEL to ignore the change.

Changing Functional Values

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



The functional value flashes until signing off by pressing the OK button. The functional value has then been selected. Use CANCEL to ignore the change.

Changing Numeric Values in a List

A few parameters offer numeric lists of values that can be selected from or changed. This means that if the numeric value is not listed, a value may be entered using the procedure for changing numeric values. This applies to parameter 102, *Motor power*, parameter 103, *Motor voltage*, and parameter 104, *Motor frequency*.

Quick Menu

The Quick Menu gives access to the 12 most important setup parameters of the drive. After programming the Quick Menu items, the drive will, in many cases, be ready for operation. The Quick Menu

parameters are described in the table below. A detailed description of the functions are given in the Programming section of this manual. The Quick Menu is activated by pressing the QUICK MENU key on the control panel.

Quick Menu Item Number	Parameter Name	Description
1	001 Language	Selects language used for all displays.
2	102 Motor Power	Sets output characteristics of drive based on kW (HP) of motor. See chart in parameter 102, <i>Motor Power</i> , to convert HP to kW.
3	103 Motor Voltage	Sets output characteristics of drive based on voltage of motor.
4	104 Motor Frequency	Sets output characteristics of drive based on nominal frequency of motor. This is typically equal to line frequency.
5	105 Motor Current	Sets output characteristics of drive based on full load current in amps (FLA) of motor. This sets overload protection for motor.
6	106 Motor Nominal Speed	Sets output characteristics of drive based on nominal full load speed of motor.
7	201 Minimum Frequency	Sets minimum controlled frequency at which motor will run.
8	202 Maximum Frequency	Sets maximum controlled frequency at which motor will run.
9	206 Ramp Up Time	Sets time to accelerate motor from 0 Hz to nominal motor frequency set in Quick Menu Item 4.
10	207 Ramp Down Time	Sets time to decelerate motor from nominal motor frequency set in Quick Menu Item 4 to 0 Hz.
11	323 Relay 1 Function	Sets function of high voltage Form C relay.
12	326 Relay 2 Function	Sets function of low voltage Form A relay.

To Enter or Change Quick Menu Parameter Data

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

1. Press Quick Menu key.
2. Use ◀ and ▶ keys to find parameter group to edit.
3. Use '+' and '-' keys to find parameter you chose to edit.
4. Press Change Data key.
5. Use '+' and '-' keys to select correct parameter setting. Or, to move to digits within a number, use ◀ and ▶ arrows. *Flashing cursor indicates digit selected to change.*
6. Press Cancel key to disregard change, or press OK key to accept change and enter new setting.

Example of Changing Parameter Data

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

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



NOTE

Programming additional parameter functions available through Extended Menu key is done in accordance with same procedure as described for Quick Menu functions.

Extended Menu

In some applications, the Quick Menu will not access all additional parameters necessary to set up the drive. To access all parameters, including Quick Menu items, use the Extended Menu. The Extended Menu is enabled by pressing the EXTEND. MENU key. The Programming section of this manual describes in detail all the parameters available through the Extended Menu.

Manual Initialization of Parameters

NOTE

Manual initialization using either procedure described below, or in parameter 620, will reset the drive to standard default parameters. Any special application programming performed at the factory, during start-up or thereafter, will be lost. As a backup, upload drive settings into the drive's local control panel (LCP) keypad as described in parameter 004, *LCP Copy*.

It is possible to reset parameters back to their original default values at once. To reset the drive parameters to their read only default values, first remove power from the drive. Then press and hold the DISPLAY MODE, the CHANGE DATA and the OK keys down simultaneously while reapplying power. Continue to hold down the three keys. Shortly after power is reapplied, the bottom line of the display will read "Initialized." After the display stops changing, release the keys. If "Initialized" did not appear, repeat the procedure.

These parameters are not reset by manual initialization:

Parameter 600	Operating hours
Parameter 601	Hours run
Parameter 602	kWh counter
Parameter 603	Number of power-ups
Parameter 604	Number of overtemperatures
Parameter 605	Number of overvoltages

Initialization can also be done using Parameter 620.

Uploading Parameters

At any time the present parameters may be copied to the local control panel (LCP). This may be useful when setting up multiple drives. It is also useful when it is desired to return to a previous set of parameters. See parameter 004, *LCP Copy*, for more information.

Manually initializing the drive using either the procedure described above or parameter 620, *Operating Mode*, does not change the values uploaded to the local control panel.



VLT 6000 Start-Up

Pre-installation Checks

1. Compare drive model number to what was ordered.
2. Ensure each of following are rated for same voltage:
 - Drive
 - Power line
 - Motor
3. Record following motor data:
 - Voltage
 - Frequency
 - Full load current
 - Full load speed
 - Power — convert HP to kW (See conversion table in parameter 102, *Motor Power*, in this manual.)
4. Ensure that rated drive current is equal to or greater than total full load current.
 - For multiple motor operations, add up full load current ratings of all motors.
 - Drive can be *at most* one size smaller than motor.
 - If drive rating is less than motor, full motor output cannot be achieved.
5. Check motor wiring:
 - Any disconnect between drive and motor should be interlocked to drive safety interlock circuit to avoid unwanted drive trips.
 - No power factor correction capacitors can be connected between drive and motor.
 - Two speed motors must be wired permanently for full speed.
 - Y-start, Δ -run motors must be wired permanently for run.

Installation Checks

1. Input fusing in power supply for all drives must be provided (see *Input Fuses* section in this manual).
2. Environmental concerns — for standard NEMA 1 drive:
 - Clean air supply
 - Dry air (max 95% relative humidity, non-condensing)
 - 14°F to 104°F ambient temperature operating range, or as rated
 - 3,300 foot maximum elevation with no derating
3. Mounting
 - Vertical
 - Drives with heat sink fins exposed in back of unit must be mounted against a solid surface (see *Clearances* section in this manual).
 - Keep any construction dirt out of drive.
4. Wiring
 - Wire drive in accordance with instructions and diagrams received with drive.
 - Separate conduits must be provided to drive for input power, output power, and control wiring.
 - Note that safety interlock and remote run/stop circuitry is 115 VAC for drives with bypasses.
 - Use knockouts or conduit entry plates. Avoid metal shavings in cabinet.

- Protect signal wires from noise.
- Ground each drive individually.
- Double check input and output power wiring for correct location.

Setting Up Drive for Motor Start

Enter motor nameplate data into drive through Quick Menu.

1. Parameter 101:
 - If one motor is connected to drive, set to AEO FUNCTION.
 - If more than one motor connected to drive, set to MULTIPLE MOTORS. (Parameter 108, MULTIPLE MOTOR STARTING VOLTAGE should be adjusted later to provide reliable starts and minimum starting current.)
2. Parameter 102, MOTOR POWER (in kW) (See conversion table in parameter 102, *Motor Power*, in this manual.)
3. Parameter 103, MOTOR VOLTAGE
4. Parameter 104, MOTOR FREQUENCY
5. Parameter 105, MOTOR CURRENT
6. Parameter 106, MOTOR SPEED
7. Parameter 107, (optional) select AUTOMATIC MOTOR ADAPTATION and run AMA in accordance with procedure in parameter 107, *Automatic Motor Adaptation*, in this manual.
8. Press HAND START key to initiate operation in local control.

Operational Tests, HAND Mode

1. Check motor rotation from drive. If incorrect, disconnect input power from drive and reverse two leads between drive and motor.
2. If a bypass is provided, check motor rotation in bypass mode. If incorrect, disconnect input power from drive and reverse two input power leads.
3. Accelerate motor quickly to full speed and verify operation.
4. Decelerate motor quickly to stop and verify operation.
5. Operate motor over entire speed range while closely checking for resonance.

Operational Tests, AUTO Mode

1. Ensure that drive follows run/stop and safety interlock commands from system.
2. Ensure drive follows speed reference, or feedback, from system.

Final Adjustments

1. Use parameters 216 through 220 to reject any resonant points.
2. Lock out keypad functions, as required.

General Troubleshooting

1. Display Messages:
 - AUTO START—Drive has tripped off and is in process of automatically restarting.
 - TRIP—Drive has tripped off. Press RESET to start.
 - TRIP LOCKED—Drive has tripped off. Remove and apply power before restarting with RESET.
2. Refer to *Warnings and Alarms* section in this manual.
3. Check tightness of all connections and wires for proper location.
4. Measure input signals.
5. Check drive input and output for balanced voltage and current.

Programming

EXTEND
MENU

Press the Extend Menu key to access all the drive parameters for programming data and selections.

Description of Parameters

Parameters are grouped by function. The groups are:

Operation and Display	Parameters 001 through 017
Load and Motor	Parameters 100 through 118
References and Limits	Parameters 200 through 228
Input and Outputs	Parameters 300 through 328
Application Functions	Parameters 400 through 427
Serial Communication	Parameters 500 through 566
Service Functions	Parameters 600 through 631
Relay Card Functions	Parameters 700 through 711

The numbers shown in the square brackets ([]) after the parameter values are used in serial communications to choose the parameter value from the list. They are not shown on the local control panel when programming the drive locally.

Setup Configuration and Parameters Copy

The VLT 6000 has four independent parameter setups that can be programmed. Each setup acts independently in controlling the drive. Example applications would be programming different setups for day/night or summer/winter operation. Any of the four setups can be used.

The setup is selected in parameter 002, *Active Setup*, for programming and operation. Setups are changed manually by switching between active setups in parameter 002. It is also possible to change setups through digital inputs or serial communication by selecting *Multi-setup* in parameter 002 and providing an external signal.

The number of the active setup selected is shown on the keypad display under *Setup* in the second line of the display.

A short cut to programming more than one setup is possible by using parameter 003, *Setup Copy*. This enables copying one setup to another setup. After copying parameter settings from one setup, just those parameters unique to the other setups need be changed.

All setups can be transferred from one VLT drive to another by using the VLT's removable keypad. Parameter 004, *LCP Copy*, allows this function. First, upload all parameter values to the keypad. The keypad can then be removed and plugged into another VLT drive where all parameter values can be downloaded. If motor or drive sizes differ, *Download Power-independent Parameters* can be selected in parameter 004 to omit downloading motor and current dependent data.

Operation and Display Parameters 000 through 017

This parameter group deals with the display, control keys and other general functions.

001 Language (Language)

Value:	
★ English (ENGLISH)	[0]
German (DEUTSCH)	[1]
French (FRANCAIS)	[2]
Danish (DANSK)	[3]
Spanish (ESPAÑOL)	[4]
Italian (ITALIANO)	[5]
Swedish (SVENSKA)	[6]
Dutch (NEDERLANDS)	[7]
Portuguese (PORTUGUESA)	[8]
Finnish (SUOMI)	[9]

Function:

This parameter determines the language to be used on the display.

Description of choice:

Select the display language.

002 Active Setup (ACTIVE SETUP)

Value:	
Factory Setup (FACTORY SETUP)	[0]
★ Setup 1 (SETUP 1)	[1]
Setup 2 (SETUP 2)	[2]
Setup 3 (SETUP 3)	[3]
Setup 4 (SETUP 4)	[4]
Multi-setup (MULTI SETUP)	[5]

Function:

This parameter defines the setup number that controls the drive.

All parameters can be programmed in four individual parameter setups, *Setup 1*, *Setup 2*, *Setup 3* and *Setup 4*.

There is also a pre-programmed, read-only setup, called *Factory Setup*.

Description of choice:

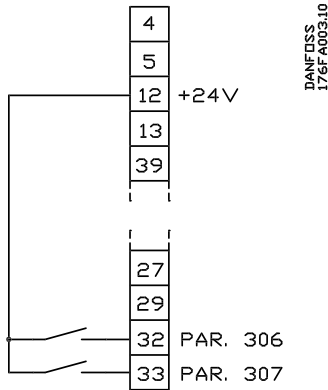
The *Factory Setup* contains the parameter values preset at the factory. This data can be used as a default setup to reset parameters to a known state.

Setups 1 through *4* are four individual setups that can be selected as required.

Multi-setup is used if remote switching between different setups is required. Terminals 16, 17, 29, 32, 33 and the serial communication port can be used for switching between setups.

★ Indicates factory default setting. Numbers in brackets [] represent selection as displayed on the serial bus.

Setup Change Connection Example



Selection of setup using terminals 32 and 33.
 See the descriptions of parameters 300 through 307.
 Parameter 306 = Selection of Setup, lsb
 Parameter 307 = Selection of Setup, msb
 Parameter 002 = Multi Setup

003 Copying of Setups	(Setup Copy)
Value:	
★ No copying (NO COPY)	[0]
Copy active Setup to Setup 1 (COPY TO SETUP 1)	[1]
Copy active Setup to Setup 2 (COPY TO SETUP 2)	[2]
Copy active Setup to Setup 3 (COPY TO SETUP 3)	[3]
Copy active Setup to Setup 4 (COPY TO SETUP 4)	[4]
Copy active Setup to all (COPY TO ALL)	[5]

Function:
 A copy is made from the active setup selected in parameter 002, *Active Setup*, to the setup or setups selected in parameter 003, *Copying of Setups*.

NOTE
Copying is only possible when drive is stopped.

Description of choice:
 The copying starts when the required copying function has been selected and the OK key has been pressed.

The display indicates when copying is in progress.

004 LCP Copy	(LCP COPY)
Value:	
★ No copying (NO COPY)	[0]
Upload all parameters (UPLOAD ALL PARAMET.)	[1]
Download all parameters (DOWNLOAD ALL PARAM.)	[2]
Download power-independent parameters (DOWNLOAD SIZE INDEP.)	[3]

Function:
 Parameter 004, *LCP Copy*, is used to copy all parameter setups to or from the Local Control Panel (LCP). This can be used to store a backup copy of all parameters in the LCP or to copy all setups from one drive to another.

Description of choice:
 Select *Upload All Parameters* if all parameter values are to be copied from the drive to the LCP.

Select *Download All Parameters* if all parameter values are to be copied from the LCP to the drive on which the control panel has been mounted.

Select *Download Power-independent Parameters* if only the power-independent parameters are to be downloaded. This allows the parameters from one drive to be easily copied to another drive of a different size. Settings in parameters 102, 103, 104, 105, 106, 215, 221, and 222 are not downloaded using this function.

NOTE
Copying is only possible when drive is stopped.

Setup of User-defined Readout
 Parameter 005, *Maximum Value of User-defined Readout*, and Parameter 006, *Unit for User-defined Readout*, allow users to design their own readout which can be seen if the *User-defined Readout* has been selected as one of the displayed meters. The range is set in parameter 005, *Maximum Value of User-defined Readout* and the unit is determined in parameter 006, *Unit for User-defined Readout*. The choice of unit determines whether the relationship between the output frequency and the readout is a linear, square or cubed. Units representing rates (RPM, CFM, GPM, etc.) are linear. Units representing pressure (PSI, in. wg., etc.) are square. Units representing power (HP, kW, etc.) are cubed.

★ Indicates factory default setting. Numbers in brackets [] represent selection as displayed on the serial bus.

005 Maximum Value of Custom Readout
(CUSTOM READOUT)
Value:

0.01 - 999,999.99 ★ 100.000

Function:

This parameter determines the value that the user defined meter will display when the drive's output frequency is the value set in parameter 202, *Output Frequency High*.

Description of choice:

Set the required value for maximum output frequency.

006 Custom Readout
(CUST. READ. UNIT)
Value:

	No unit	[0]	GPM	[21]
★	%	[1]	gal/s	[22]
	rpm	[2]	gal/min	[23]
	ppm	[3]	gal/h	[24]
	pulse/s	[4]	lb/s	[25]
	l/s	[5]	lb/min	[26]
	l/min	[6]	lb/h	[27]
	l/h	[7]	CFM	[28]
	kg/s	[8]	ft ³ /s	[29]
	kg/min	[9]	ft ³ /min	[30]
	kg/h	[10]	ft ³ /h	[31]
	m ³ /s	[11]	ft ³ /min	[32]
	m ³ /min	[12]	ft ³ /s	[33]
	m ³ /h	[13]	in wg ¹	[34]
	m/s	[14]	ft wg ¹	[35]
	mbar ¹	[15]	PSI ¹	[36]
	bar ¹	[16]	lb/in ¹	[37]
	Pa ¹	[17]	HP ²	[38]
	MPa ¹	[18]		
	MWG ¹	[19]		
	kW ²	[20]		

¹ Squared units (pressure)

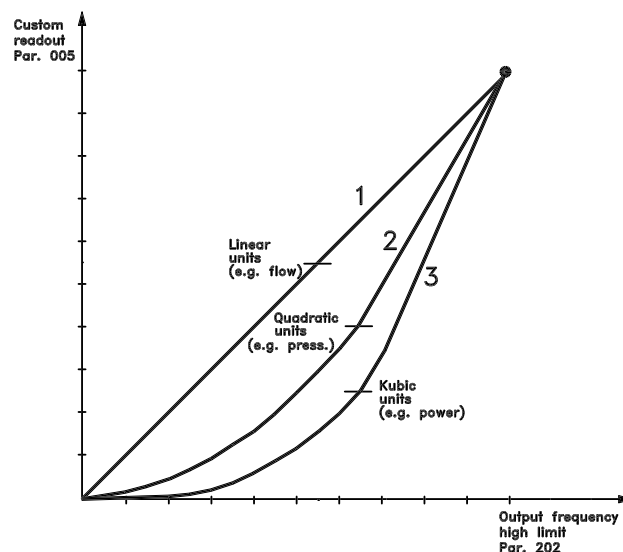
² Cubed units (power)

Function:

The value and the unit are shown in display mode whenever *Custom Readout* has been selected in one of parameters 007 through 010, *Display Readout*. If flow or speed units are selected, the relationship between readout and output frequency will be a linear one. If pressure units are selected, the ratio will be square. If power units are selected, the ratio will be cubed.

Description of choice:

Select the required unit for *Custom Readout*.


007 Large Readout (LARGE READOUT)
Value:

None	[0]
Reference [%] (REFERENCE [%])	[1]
Reference [unit] (REFERENCE [UNIT])	[2]
Frequency [Hz] (FREQUENCY [HZ])	[3]
★ Frequency [%] (FREQUENCY [%])	[4]
Motor current [A] (MOTOR CURRENT [A])	[5]
Power [kW] (POWER [KW])	[6]
Power [HP] (POWER [HP])	[7]
Output energy [kWh] (ENERGY [KWH])	[8]
Hours run [Hours] (HOURS RUN [h])	[9]
Custom readout [unit] (CUSTOM READ [UNITS])	[10]
Setpoint 1 [unit] (SETPOINT 1 [UNITS])	[11]
Setpoint 2 [unit] (SETPOINT 2 [UNITS])	[12]
Feedback 1 (FEEDBACK 1 [UNITS])	[13]
Feedback 2 (FEEDBACK 2 [UNITS])	[14]
Feedback [unit] (FEEDBACK [UNITS])	[15]
Motor voltage [V] (MOTOR VOLTAGE [V])	[16]
DC link voltage [V] (DC VOLTAGE [V])	[17]
Thermal motor load [%]	
(THERM.MOTOR LOAD [%])	[18]
Thermal drive load [%] (THERM.DRIVE LOAD [%])	[19]
Digital input [Binary code] (DIGITAL INPUT [BIN])	[20]
Analog input 53 [V] (ANALOG INPUT 53 [V])	[21]
Analog input 54 [V] (ANALOG INPUT 54 [V])	[22]
Analog input 60 [mA] (ANALOG 60 [mA])	[23]
Relay status [Binary code] (RELAY STATUS [BIN])	[24]
Pulse reference [Hz] (PULSE REFERENCE [Hz])	[25]
External reference [%] (EXT. REFERENCE [%])	[26]
Heat sink temp. [°C] (HEATSINK TEMP [°C])	[27]
Profibus fault [HEX] (COMM.OPTION WARN [HEX])	[28]
Free program array [text] (FREE PROG. ARRAY)	[29]
Status word (STATUS WORD [HEX])	[30]
Control word (CONTROL WORD [HEX])	[31]
Alarm word (ALARM WORD [HEX])	[32]

★ Indicates factory default setting. Numbers in brackets [] represent selection as displayed on the serial bus.

Function:

This parameter allows a choice of the data value to be shown in the large display when power is applied to the drive. In Display Mode, the + and - keys change this display when the drive is in operation.

Description of choice:

None can only be selected in parameters 008 through 010, *Small Readout*, but not in parameter 007, *Large Readout*.

Reference [%] gives the total of all references as a percentage of parameter 205, *Maximum Reference*.

Reference [unit] gives the total of all references. This is displayed in Hz in open loop. In closed loop, the reference unit is selected in parameter 415, *Process Units*.

Frequency [Hz] gives the output frequency of the drive.

Frequency [%] is the output frequency as a percentage of maximum output frequency in parameter 202, *Output Frequency High Limit*.

Motor current [A] is the average phase current of the motor.

Power [kW] is the actual power, in kW, delivered to the motor.

Power [HP] is the actual power, in HP, delivered to the motor.

Output energy [kWh] is the energy delivered by the motor since the latest reset was made using parameter 618, *Reset of kWh Counter*.

Hours run [hours] is the number of hours that the motor has run since the latest reset was made using parameter 619, *Reset of Hours Run Counter*.

Custom readout [-] is a user defined value, calculated on the basis of the present output frequency, as well as the scaling in parameter 005, *Maximum Value of User-Defined Readout*, and the unit in parameter 006, *Custom Readout*.

Setpoint 1 [unit] is the setpoint value programmed in parameter 418, Setpoint 1. The unit is selected in parameter 415, *Process Units*.

Setpoint 2 [unit] is the setpoint value programmed in parameter 419, Setpoint 2. The unit is selected in parameter 415, *Process Units*.

Feedback 1 [unit] is the value of the feedback signal applied to Terminal 53. The unit is selected in parameter 415, *Process Units*.

Feedback 2 [unit] is the value of the feedback signal applied to Terminal 54. The unit is selected in parameter 415, *Process Units*.

Feedback [unit] is the total feedback signal using the unit scaling selected in parameter 413, *Minimum Feedback*; parameter 414 *Maximum Feedback*; parameter 415, *Process Units*; and parameter 417, *2 Feedback Calc*.

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

DC link voltage [V] is the drive DC bus voltage.

Thermal load, motor [%] is the calculated thermal load of the motor. 100% is the cutout limit. See also parameter 117, *Motor Thermal Protection*.

Thermal drive load [%] is the calculated thermal load of the drive. 100% is the trip point.

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

Analog input 53 [V] is the voltage applied to terminal 53.

Analog input 54 [V] is the voltage applied to terminal 54.

Analog input 60 [mA] is the current applied to terminal 60.

Relay status [binary code] displays the open or closed position of relays 1 through 6 in binary code. Open is 0 and closed 1, read left to right (positions 7 and 8, displayed in parameter 007, are not used.)

Pulse reference [Hz] is the pulse frequency applied to terminal 17 or terminal 29.

External reference [%] is the sum of the external references as a percentage of parameter 205, *Maximum Reference*.

Heat sink temp. [°C] is the present heat sink temperature of the drive. The trip point is $90 \pm 5^\circ\text{C}$ for NEMA 1 units, $80 \pm 5^\circ\text{C}$ for NEMA 12.

Profibus fault [HEX] is enabled when the Profibus communication option is installed and the warnings in Profibus parameter 953 is active.

Free program array [text] displays the array of characters programmed in parameters 533, *Display Text Line 1* and 534, *Display Text Line 2* on lines 1 and 2 of the LCP.

Status word [HEX] displays the drive status word (see parameter 608, *Data Log*).

Control word [HEX] displays the drive control word (see parameter 609, *Data Log*).

Alarm word [HEX] displays the drive alarm word.

008 Small Readout 1 (SMALL READOUT 1)	
Value:	
★ Reference, %	[1]

Function:
This parameter selects the meter shown on the left display on line 1. Showing three different meters on line 1 is recommended when setting up the PID. This allows tracking how the process reacts to a change of reference.

Description of choice:
See parameter 007, *Large Readout*, for values that may be selected.

009 Small Readout 2 (SMALL READOUT 2)	
Value:	
★ Motor current [A]	[5]

Function:
This parameter selects the meter shown on the center display on line 1. Showing three different meters on line 1 is recommended when setting up the PID.

Description of choice:
See parameter 007, *Large Readout*, for values that may be selected.

010 Small Readout 3 (SMALL READOUT 3)	
Value:	
★ Power [HP]	[7]

Function:
This parameter selects the meter shown on the right display on line 1. Showing three different meters on line 1 is recommended when setting up the PID.

Description of choice:
See parameter 007, *Large Readout*, for values that may be selected.

011 Unit of Local Reference (UNIT OF LOC REF)	
Value:	
Hz (HZ)	[0]
★ % of output frequency range (%) (% OF FMAX)	[1]

Function:
This parameter sets the unit that will be displayed in Display Mode IV when the drive's speed is being controlled locally.

Description of choice:
Choose the desired unit for local reference.

012 Hand Start on LCP (HAND START BUTTON)	
Value:	
Disable (DISABLE)	[0]
★ Enable (ENABLE)	[1]

Function:
This parameter allows disabling the Hand/Start key on the keypad.

Description of choice:
If *Disable* is selected in this parameter, the Hand/Start key will be disabled.

013 OFF/STOP on LCP (STOP BUTTON)	
Value:	
Disable (DISABLE)	[0]
★ Enable (ENABLE)	[1]

Function:
This parameter allows disabling the Off/Stop key on the keypad.

Description of choice:
If *Disable* is selected in this parameter, the Off/Stop key will be disabled.

CAUTION

OFF/STOP Key Disabled!

If *Disable* is selected in parameter 013, the motor cannot be stopped by pressing the OFF/STOP key on the keypad. Use of the *Disable* option could result in injury or equipment or property damage.

★ Indicates factory default setting. Numbers in brackets [] represent selection as displayed on the serial bus.

014 Auto Start on LCP (AUTO START BTTN)

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

Function:

This parameter allows disabling the Auto/Start key on the keypad.

Description of choice:

If *Disable* is selected in this parameter, the Auto/Start key will be disabled.

015 Reset on LCP (RESET BUTTON)

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

Function:

This parameter allows disabling the Reset key on the keypad.

Description of choice:

If *Disable* is selected in this parameter, the Reset key will be inactive.

NOTE

Do not disable *Reset on LCP* unless a remote reset is available through digital inputs and parameters 300 through 307.

016 Lock for Data Change (DATA CHANGE LOCK)

Value:	
★ Not Locked (NOT LOCKED)	[0]
Locked (LOCKED)	[1]

Function:

This parameter allows locking out parameter changes at the local control panel.

Description of choice:

If *Locked* is selected, data modifications in the parameters cannot be made. Parameter changes will be possible through serial communication.

Parameters 007 through 010, *Display Readout* can be changed at the local control panel.

The local control panel can also be locked or unlocked by a digital input controlled by parameters 300 through 307.

017 Operating State at Power Up (POWER UP ACTION)

Value:	
★ Auto restart (AUTO RESTART)	[0]
OFF/STOP (OFF/STOP)	[1]

Function:

Selects auto or manual restart when power is reapplied after an outage occurs to a running drive.

Description of choice:

Auto restart is selected if the drive is to resume operation after a power outage.

OFF/STOP is selected if the drive is to remain stopped after a power outage. To restart, press the Hand/Start or Auto/Start key at the keypad. If HAND START or AUTO START are disabled by parameters 012 and 014, the motor will not be able to restart if *OFF STOP* is selected in parameter 017.

★ Indicates factory default setting. Numbers in brackets [] represent selection as displayed on the serial bus.

Load and Motor

Parameters 100 through 118

This parameter group controls output power and other output characteristics of the drive.

For correct operation, motor nameplate data must be entered into parameters 102 through 106 either through the Quick Menu or the Extended Menu. In addition, automatic motor adaptation, DC braking and motor thermal protection can be set by this parameter group.

100 Configuration (CONFIG. MODE)

Value:

★ Open loop (OPEN LOOP)	[0]
Closed loop (CLOSED LOOP)	[1]

Function:

This parameter is used for selecting closed loop or open loop operation.

Description of choice:

If *Open loop* is selected, speed control is changed directly by the speed reference signal. Any feedback signal applied to the drive will have no effect on the drive's speed.

If *Closed loop* is selected, the internal process regulator is available to accept feedback signal(s) to provide the desired speed regulation.

NOTE

It is important to set parameter 100, Configuration, properly when closed loop operation is required. When open loop is selected, parameters associated with setting up PID controller are not accessible.

101 Torque Characteristics (VT CHARACT)

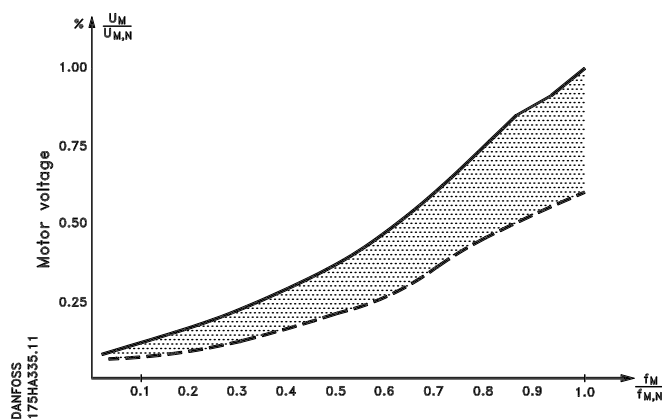
Value:

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

Function:

This parameter configures the drive for single or multiple motor operation.

The AEO function will automatically and continuously monitor the load and adjust the output voltage to maximize motor and drive efficiency and performance. After the motor reaches the set speed, the AEO function reduces the output voltage to the motor, if the load will allow. When the load is light, the voltage is reduced, as shown in the graph below. This lower voltage reduces motor heating and motor noise, and increases efficiency.



Description of choice:

Select *Automatic Energy Optimization (AEO)* for all single motor applications. When AEO has been selected, only one motor may be connected to the drive at a time.

Select *Parallel motors* when more than one motor is connected in parallel to the output. In this case, it is necessary to set a start voltage in parameter 108, *Start Voltage of Parallel Motors*.

NOTE

To optimize AEO for use with motors having more than 4 poles, see parameter 118, Motor Power Factor.

★ Indicates factory default setting. Numbers in brackets [] represent selection as displayed on the serial bus.

NOTE

It is very important that values set in parameters 102, *Motor Power*, through 106, *Rated Motor Speed*, correspond accurately to nameplate data of motor. Failure to enter motor nameplate data accurately could result in erratic or less than optimum equipment operation.

102 Motor Power		(MOTOR POWER)
Value:		
0.25 kW	(0.33 HP)	[25]
0.37 kW	(0.5 HP)	[37]
0.55 kW	(0.75 HP)	[55]
0.75 kW	(1 HP)	[75]
1.1 kW	(1.5 HP)	[110]
1.5 kW	(2 HP)	[150]
2.2 kW	(3 HP)	[220]
3 kW	--	[300]
4 kW	(5 HP)	[400]
5.5 kW	(7.5 HP)	[550]
7.5 kW	(10 HP)	[750]
11 kW	(15 HP)	[1100]
15 kW	(20 HP)	[1500]
18.5 kW	(25 HP)	[1850]
22 kW	(30 HP)	[2200]
30 kW	(40 HP)	[3000]
37 kW	(50 HP)	[3700]
45 kW	(60 HP)	[4500]
55 kW	(75 HP)	[5500]
75 kW	(100 HP)	[7500]
90 kW	(125 HP)	[9000]
110 kW	(150 HP)	[11000]
132 kW	(175 HP)	[13200]
160 kW	(200 HP)	[16000]
200 kW	(300 HP)	[20000]
250 kW	--	[25000]
300 kW	--	[30000]
315 kW	(350 HP)	[31500]
355 kW	(450 HP)	[35500]
400 kW	(500 HP)	[40000]
450 kW	(600 HP)	[50000]

★ Depends on the unit

Function:

Set the power value that corresponds to the nameplate power of the motor. The default setting is the full rating of the drive.

Description of choice:

Select a value that equals the nameplate data on the motor. It is also possible to set any power within the range of the drive.

103 Motor Voltage		(MOTOR VOLTAGE)
Value:		
200 V		[200]
208 V		[208]
220 V		[220]
230 V		[230]
240 V		[240]
380 V		[380]
400 V		[400]
415 V		[415]
440 V		[440]
480 V		[480]
480 V		[480]
500 V		[500]
575 V		[575]

★ Depends on the unit

Function:

Set the rated motor voltage.

Description of choice:

Select a value that equals the nameplate data on the motor. This may be less than the input voltage. It is also possible to set any voltage within the range of the drive.

104 Motor Frequency		(MOTOR FREQUENCY)
Value:		
50 Hz	(50 Hz)	[50]
★ 60 Hz	(60 Hz)	[60]

Function:

This is where the rated motor frequency is selected. This is usually the frequency of the power line.

Description of choice:

Select the desired value. It is also possible to set any frequency within the range of the drive.

105 Motor Current		(MOTOR CURRENT)
Value:		
0.01 to drive rating		★ Set based on motor nameplate.

Function:

The rated motor current in amps is used for setting output current and providing motor thermal protection. It is important to set the motor current to the full load current rating (FLA) of the motor.

Description of choice:

Set a value that equals the nameplate data on the motor.

NOTE

Failure to enter motor nameplate data accurately could result in erratic or less than optimum equipment operation. Also, changing values in parameter 102, *Motor Power*, or parameter 103, *Motor Voltage*, after motor current has been entered in parameter 105, may automatically change the value in parameter 105.

★ Indicates factory default setting. Numbers in brackets [] represent selection as displayed on the serial bus.

106 Rated Motor Speed (MOTOR NOM. SPEED)

Value:

100 through 60000

★ Depends on parameter 102, *Motor Power*

Function:

This is where the value is set that corresponds to the rated motor speed shown on the motor nameplate.

Description of choice:

Choose a value that corresponds to the motor nameplate data.

NOTE

Failure to enter motor nameplate data accurately could result in erratic or less than optimum equipment operation. Changing values in parameter 104, *Motor Frequency*, after rated motor speed has been entered in parameter 106, may automatically change the value in parameter 106.

107 Automatic Motor Adaptation, AMA (AUTO MOTOR ADAPT)

Value:

★ Optimization disable (NO AMA)	[0]
Automatic adaptation (RUN AMA)	[1]
Limited AMA (RUN LIMITED AMA)	[2]

Function:

Automatic Motor Adaptation (AMA) is an advanced procedure that measures electrical characteristics of the motor. This procedure does not cause the motor to run.

AMA optimizes the adjustment of the drive to the motor. This feature is particularly useful when the drive-to-motor cable length is long, and with nonstandard motors or high HP motors. Although it is not necessary to run AMA, it is highly recommended for optimum operation and increases the capability of the Automatic Energy Optimization function selectable in parameter 101, *Torque Characteristics*.

For the best adjustment of the drive, it is recommended to carry out AMA on a cold motor.

NOTE

Repeated AMA operation may lead to motor heating that could result in an increase of stator resistance. This can reduce test accuracy. Run AMA only on a cool motor.

If an output LC-filter has been connected between the drive and the motor, select *Limited AMA*. If the complete AMA procedure is desired, remove the LC-filter, run *Automatic Adaptation* (RUN AMA), and reinstall the filter.

NOTE

Some motors (such as motors with 6 or more poles) may be unable to run *Automatic Adaptation*. *Limited AMA* is a procedure which can be effective in such cases since results measure motor's stator and effects of cable length. Multiple motor applications cannot use AMA.

The following must be noted when either AMA function is used:

- Before running AMA, the correct nameplate data for the motor must be entered in parameters 102 through 106.
- Total automatic motor adaptation may take up to 10 minutes.
- Alarms and warnings will be shown in the display if faults occur during motor adaptation.
- AMA can only be carried out if the rated motor current of the motor is at least 35% of the rated output current of the drive.

Description of choice:

Select *Automatic Adaptation* if the drive is to carry out a complete automatic motor adaptation procedure.

Select *Limited AMA* if an LC-filter has been placed between the drive and the motor, for a motor with 6 or more poles, or if *Automatic Adaptation* was unsuccessful. Some drives may display *Automatic Adaptation with LC-filter* rather than *Limited AMA*. The functions are the same.

Procedure for Automatic Motor Adaptation:

1. Set motor parameters 102 through 106 according to motor nameplate data.
2. Connect 24 VDC from terminal 12, or from external source, to terminal 27.
3. Select either *Automatic Adaptation* or *Limited AMA* in parameter 107, *Automatic Motor Adaptation*.
4. Start drive by pressing Hand Start or connect terminal 18 (start) to terminal 12 and press Auto Start.

To stop automatic adaptation or limited AMA prior to completion:
Press OFF/STOP key.

After a normal sequence is complete, the display reads: AMA STOP
Press RESET key. Drive is now ready for operation.

NOTE

RESET key must be pressed after AMA is completed to save results to drive.

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

1. Check alarms section in this manual for possible causes of alarm.
2. Press RESET key to clear fault.

If there is a warning, the display reads: WARNING (39 through 42)

1. Check warnings section in this manual for possible causes of warning.
2. Press CHANGE DATA key and select *Continue* if AMA is to continue despite warning, or press OFF/STOP key to stop AMA.

★ Indicates factory default setting. Numbers in brackets [] represent selection as displayed on the serial bus.

108 Start Voltage of Parallel Motors (MULTIM.STARTVOLT)

Value:
0.0 through parameter 103 *Motor Voltage*
★ depends on par. 103 *Motor Voltage*

Function:
This parameter sets the voltage at 0 Hz for all drives with two or more motors connected in parallel.

The start voltage represents a supplementary voltage input to the motor. Increasing the start voltage will increase the starting torque. A start voltage is especially useful for small motors (<5 HP) as they have a higher stator resistance than larger motors.

This function is only active if *Parallel Motors* has been selected in parameter 101, *Torque Characteristics*.

Description of choice:
To set the start voltage, monitor the motor current while starting the load and choose the starting voltage that gives the lowest starting current. Start with a small value and increase only as required for reliable starting.

109 Resonance Dampening (RESONANCE DAMP.)

Value:
0 to 500 % ★ 100 %

Function:
High-frequency resonances in the motor can be eliminated by adjusting this parameter.

Description of choice:
Adjust the dampening percentage for smoothest high speed operation.

110 High Breakaway Torque (HIGH START TORQ.)

Value:
0.0 to 0.5 sec. ★ OFF

Function:
The drive is able to breakaway high friction loads. This high starting torque, approximately 1.6 x rated torque is available for up to 0.5 seconds. The current level is limited by the protective circuits of the drive. OFF corresponds to 0.0 sec.

Description of choice:
Set the time for which high starting torque is desired.

111 Start Delay (START DELAY)

Value:
0.0 to 120.0 sec. ★ 0.0 sec.

Function:
This parameter allows a delayed start of the drive after the conditions for start have been fulfilled. After the start delay time has elapsed, the drive will start and ramp up to the commanded speed.

Description of choice:
Set the desired time before the drive will start.

112 Motor Preheat (MOTOR PREHEAT)

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

Function:
The motor preheat function protects the motor from condensation by running a small DC current through the motor. Motor preheat is only active during stop when control voltage is applied to terminal 27.

Description of choice:
Select *Disable* if this function is not required. Select *Enable* to activate motor preheating. The amount of motor preheating is set in parameter 113.

CAUTION

Motor Damage!

Be sure to check settings in parameter 113 if parameter 112, *Motor Preheat*, is enabled. Do not apply any more current than required. Excessive current or preheating time may damage the motor.

113 Motor Preheat DC Current (PREHEAT DC-CURR.)

Value:
0 to 100 % ★ 50 %

The maximum value depends on the rated motor current.

Function:
The motor can be preheated when stopped by applying DC current to it. A holding torque can also be provided.

Description of choice:
The motor can be preheated by means of a DC current. At 0%, the function is inactive; at a value higher than 0%, a DC current will be supplied to the motor whenever it is stopped. A windmilling fan can be held by providing a holding torque by using this parameter.

★ Indicates factory default setting. Numbers in brackets [] represent selection as displayed on the serial bus.

DC Braking

Applying DC current to the motor will brake the motor. Parameter 114, *DC Braking Current*, sets the DC braking current as a percentage of the rated motor current. Parameter 115, *DC Braking Time*, sets the amount of time that the DC current will be applied. Parameter 116, *DC Brake Cut-in Frequency*, sets the frequency at which DC braking begins when the motor decelerates during a stop.

If terminal 19 or 27 (parameters 303 or 304 *Digital Input*) has been programmed to *DC Braking Inverse* and shifts from logic '1' to logic '0', the DC braking will be activated immediately.

When the start signal on terminal 18 changes from logic '1' to logic '0', the DC braking will be activated when the output frequency becomes lower than the brake cut-in frequency.

If a DC brake current is set in parameter 114, the drive's switching frequency will be limited to 4 kHz during the braking.

CAUTION

Motor Damage!

A high braking current supplied for a long time will overheat the motor. Use only the DC braking current and time required. Excessive braking current may damage the motor.

Also, do not use DC braking function if inertia of driven load is more than 20 times inertia of motor. Excessive load inertia may damage the motor.

114 DC Braking Current (DC BRAKE CURRENT)

Value:

0 to 100% ★ 50 %

The maximum value depends on the rated motor current.

Function:

This parameter is used for setting the DC braking current that is applied:

1. When the DC brake frequency set in parameter 116 *DC Brake Cut-in Frequency* has been reached during a stop.
2. When DC brake inverse is active via terminal 19 or 27, or via the serial bus.

The DC braking current will be active for the duration of the DC braking time set in parameter 115 *DC Braking Time*.

Description of choice:

To be set as a percentage value of the rated motor current set in parameter 105 *Motor Current*.

100% DC braking current corresponds to the value set in parameter 105.

NOTE

Most HVAC applications do not require braking or holding. It is suggested that parameter 114 remain set at 0 unless braking or holding torque is required.

115 DC Braking Time (DC BRAKE TIME)

Value:

0.0 to 60.0 sec. ★ 10.0 sec.

Function:

This parameter sets the time that the DC braking is active.

Description of choice:

Set the desired time.

116 DC Brake Cut-in Frequency (DC BRAKE CUT-IN)

Value:

0.0 (OFF) to setting of parameter 202 ★ OFF

Function:

This parameter is used for setting the frequency at which DC braking begins after a stop command is issued.

Description of choice:

Set the desired frequency for braking to begin upon deceleration.

★ Indicates factory default setting. Numbers in brackets [] represent selection as displayed on the serial bus.

117 Motor Thermal Protection

(MOT. THERM PROTEC)

Value:

No protection (NO PROTECTION)	[0]
Thermistor warning (THERMISTOR WARNING)	[1]
Thermistor trip (THERMISTOR FAULT)	[2]
ETR Warning 1 (ETR WARNING 1)	[3]
★ ETR Trip 1 (ETR TRIP 1)	[4]
ETR Warning 2 (ETR WARNING 2)	[5]
ETR Trip 2 (ETR TRIP 2)	[6]
ETR Warning 3 (ETR WARNING 3)	[7]
ETR Trip 3 (ETR TRIP 3)	[8]
ETR Warning 4 (ETR WARNING 4)	[9]
ETR Trip 4 (ETR TRIP 4)	[10]

Function:

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

By a thermistor installed in the motor. The thermistor is connected to one of the analog input terminals (53 or 54).

Calculation of the thermal load by the Electronic Thermal Relay (ETR) is based on current, frequency and time. This is compared with the rated motor current and the rated motor frequency. The calculations take into account the reduced cooling of the motor at low speeds.

ETR Trip 1 through 4 and ETR Warning 1 through 4 correspond to the four drive setups. This enables the use of the ETR function to protect up to four different motors if a different setup is used for each different motor.

NOTE

If multiple setups are used, be sure to program complete motor data (parameters 102 through 106) and parameter 117 in each setup.

Description of choice:

Select *No protection* if no warning or trip is desired when the motor is overheated.

Select *Thermistor warning* if a warning is desired when the motor thermistor reaches its trip point.

Select *Thermistor trip* if a fault is desired when the motor thermistor reaches its trip point.

Select *ETR Warning 1 through 4*, if a warning is desired when the motor is overheated according to the ETR calculations.

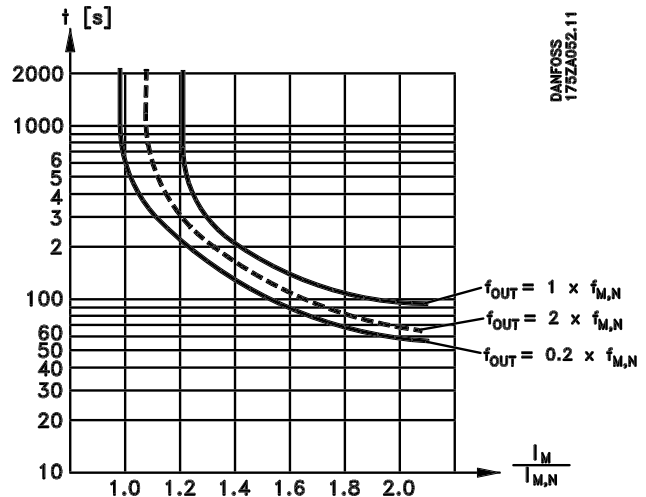
The drive can also be programmed to give off a warning signal through one of the digital outputs.

Select *ETR Trip 1 through 4* if a fault is desired when the motor is overheated according to the ETR calculations.

★ Indicates factory default setting. Numbers in brackets [] represent selection as displayed on the serial bus.

Motor Thermal Protection

The motor temperature is calculated on the basis of motor current, output frequency and time. The graph shows the amount of time that the drive can provide a current level to the motor at the rated motor frequency, 20% of rated motor frequency and 200% of rated motor frequency.



118 Motor Power Factor (Cos φ)

(MOTOR PWR FACT)

Value:

0.50 - 0.99

★ 0.75

Function:

Automatic Energy Optimization (AEO) (see parameter 101, *Torque Characteristics*) can be calibrated to work with motors with greater than 4 poles. Motors with 6, 8, and 12 poles have a lower power factor which restricts the energy saving capability of AEO. Calibrating AEO can optimize this function. The full load power factor will either be on the motor nameplate or available from the motor manufacturer.

Description of choice:

Enter the full load power factor value.

References and Limits Parameters 200 through 228

In this parameter group, the frequencies and references of the drive are set.

This parameter group includes:

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

200 Output Frequency Range (FREQUENCY RANGE)

Value:

- ★ 0 to 120 Hz (0 - 120 HZ) [0]
- 0 to 1000 Hz (0 - 1000 HZ) [1]

Function:

Choose one of two maximum output frequency ranges.

Description of choice:

Select the output frequency range that includes the highest output frequency required for normal operation.

NOTE

HVAC applications seldom require output frequency greater than 120 Hz. Check with Danfoss Graham, motor manufacturer, or manufacturer of driven equipment before selecting 0 - 1000 Hz range.

201 Output Frequency Low Limit (MIN. FREQUENCY)

Value:

- 0.0 to parameter 202 ★ 0.0 Hz

Function:

Set the minimum speed at which the motor is to run.

Description of choice:

A value from 0.0 Hz to the *Output Frequency High Limit* frequency set in parameter 202 can be selected. The drive will not be able to run continuously at an output frequency below this value in any mode.

NOTE

For fan applications, factory setting of parameter 201 is 6 Hz. For pump applications, factory setting for parameter 201 is 18 Hz.

202 Output Frequency High Limit (MAX. FREQUENCY)

Value:

- Parameter 201 to parameter 200 ★ 60 Hz

Function:

Set the highest speed at which the motor is to run.

NOTE

Output frequency of drive can never assume value higher than 1/10th of switching frequency. See parameter 407, *Switching Frequency*.

Description of choice:

Set a value between the low frequency limit, set in parameter 201, and the frequency range limit, set in parameter 200. The drive will not be able to run continuously at an output frequency above this value in any mode.

NOTE

HVAC applications seldom require output frequency greater than 60 Hz. Check with Danfoss Graham, motor manufacturer, or manufacturer of driven equipment before selecting a maximum frequency greater than 60 Hz.

★ Indicates factory default setting. Numbers in brackets [] represent selection as displayed on the serial bus.

Reference Handling

Reference handling is shown in the block diagram at the bottom of this page. The block diagram shows how a change in a parameter can effect the resulting reference.

Parameters 203 to 205, *Reference Handling, Minimum and Maximum Reference*, and parameter 210, *Reference Type*, define the way reference handling is carried out. These parameters are active both in closed loop and open loop operation.

In closed loop operation, the resulting reference is affected by parameters 418 and 419, *Setpoint 1 and 2*, as well as by remote references.

Remote references can be:

- 1) external references, including analog inputs 53, 54 and 60; pulse references through terminals 17 or 29 and references from serial communication
- 2) preset references

The resulting reference can be shown in the display as a percentage or as a selected unit of measure. The sum of the external references can be displayed in a percentage of the range between *Minimum Reference* to *Maximum Reference*. Select *External Reference, [%]* or the desired unit in parameters 007 through 010, *Display Readout*, to display the reference value.

It is possible to have both internal preset references and external references at the same time. In parameter 210, *Reference Type*, a choice is made of how the preset references are to be combined with the external references.

An independent local reference exists, where the resulting reference is set by means of the [+] and [-] keys. In all cases, the output frequency range is limited by parameter 201, *Output Frequency Low Limit*, and parameter 202, *Output Frequency High Limit*.

NOTE

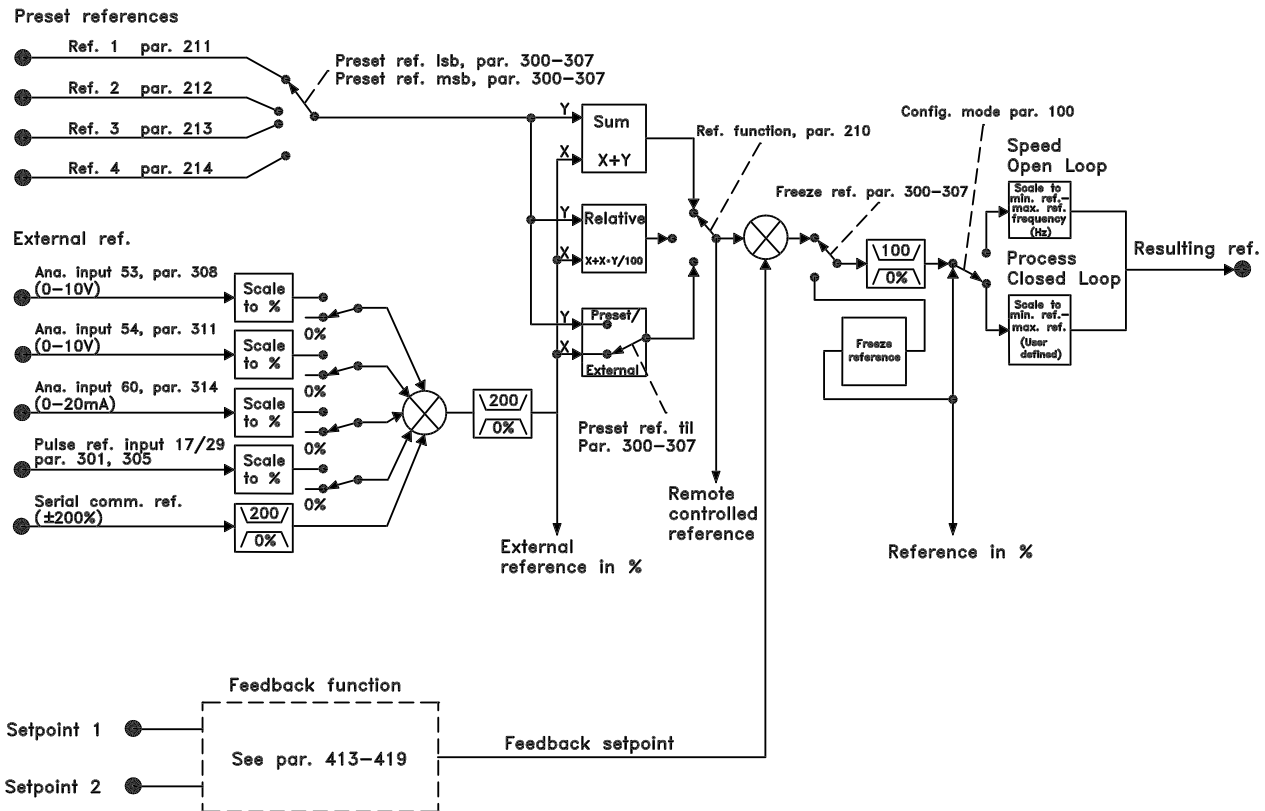
If local reference is active, drive is always in Open Loop, regardless of choice made in parameter 100, Configuration.

The unit of the local reference can be set either as Hz or as a percentage of the output frequency range. The unit is selected in parameter 011, *Unit of Local Reference*.

203 Reference Handling (REFERENCE SITE)

Value:

★ Hand/Auto linked reference (LINKED TO HAND/AUTO)	[0]
Local reference (LOCAL)	[1]
Remote controlled reference (REMOTE)	[2]



Reference Handling Block Diagram

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★ Indicates factory default setting. Numbers in brackets [] represent selection as displayed on the serial bus.

Function:

This parameter chooses the active resulting reference. If *Hand/Auto linked reference* is selected, the resulting reference will depend on whether the drive is in Hand or Auto mode.

The table below shows which reference is active when *Hand/Auto linked reference*, *Remote reference* or *Local reference* has been selected. The Hand mode or Auto mode can be selected via the keypad or by a digital input set in parameters 300 through 307 *Digital Inputs*.

Reference Handling	Hand Mode	Auto Mode
Hand/Auto	Local ref. active	Remote ref. active
Remote	Remote ref. active	Remote ref. active
Local	Local ref. active	Local ref. active

Description of choice:

If *Hand/Auto linked reference* is chosen, the motor speed in Hand mode will be set by the local reference, while in Auto mode it is set by the remote references and any setpoints selected.

If *Remote reference* is selected, the motor speed will depend on remote references and any setpoints selected, regardless of whether Hand mode or Auto mode has been chosen.

If *Local reference* is selected, the motor speed will only depend on the local reference set via the control panel, regardless of whether Hand mode or Auto mode has been selected.

204 Minimum Reference (MIN. REFERENCE)

Value:

If parameter 100, *Configuration = Open loop*, 0.000Hz to parameter 205, *Maximum Reference*. ★ 0.000 Hz

If parameter 100 *Configuration = Closed loop*, parameter 413, *Minimum Feedback*, to parameter 205, *Maximum Reference*. ★ 0.000 Hz

Function:

The *Minimum Reference* sets the minimum value of the sum of all references. If *Closed loop* has been selected in parameter 100, *Configuration*, the minimum reference is limited by parameter 413, *Minimum Feedback*.

Minimum reference is ignored when the local reference is active. In this case, minimum reference is determined by parameter 201, *Minimum Frequency*.

NOTE

For fan applications, factory setting of parameter 204 is 6 Hz. For pump applications, factory setting for parameter 204 is 18 Hz.

The unit for the reference can be seen from the following table:

	Unit
Parameter 100 <i>Configuration = Open loop</i>	Hz
Parameter 100 <i>Configuration = Closed loop</i>	Par. 415

Description of choice:

Minimum Reference is the lowest reference value that can be set for the drive.

205 Maximum Reference (MAX. REFERENCE)

Value:

If parameter 100, *Configuration = Open loop*, parameter 204, *Minimum Reference*, to 1000.000 Hz ★60.000 Hz

If parameter 100, *Configuration = Closed loop*, parameter 204, *Minimum Reference*, to parameter 414, *Maximum Feedback*. ★60.000 Hz

Function:

The *Maximum Reference* sets the maximum value of the sum of all references. If *Closed loop* has been selected in parameter 100, *Configuration*, the maximum reference cannot be set above parameter 414, *Maximum Feedback*. The *Maximum Reference* is ignored when the local reference is active.

The reference unit can be determined from the following table:

	Unit
Parameter 100 <i>Configuration = Open loop</i>	Hz
Parameter 100 <i>Configuration = Closed loop</i>	Par. 415

Description of choice:

Maximum reference is the highest reference value that can be set for the drive.

★ Indicates factory default setting. Numbers in brackets [] represent selection as displayed on the serial bus.

206 Ramp Up Time (RAMP UP TIME)

Value:

1 to 3600 seconds ★ Depends on the unit

Function:

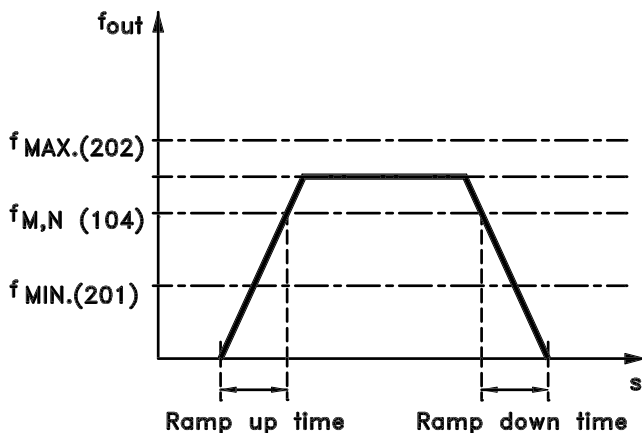
The ramp up time is the acceleration time from 0 Hz to the rated motor frequency set in parameter 104. It is assumed that the output current does not reach the current limit set in parameter 215. This determines the maximum acceleration rate for all modes of operation.

Description of choice:

Program the desired accel time. Too long of a ramp up time can cause sluggish drive operation. Too short of a ramp up time can cause the drive to go into current limit during acceleration or cause unacceptable torque pulses in the controlled system.

NOTE

For fan applications, factory setting of parameter 206 is 60 seconds. For pump applications, factory setting for parameter 206 is 10 seconds.



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207 Ramp Down Time (RAMP DOWN TIME)

Value:

1 to 3600 seconds ★ Depends on the unit

Function:

The ramp-down time is the deceleration time from the rated motor frequency set in parameter 104, *Motor Frequency*, to 0 Hz. This ramp-down time may be automatically extended to prevent an overvoltage trip if the load regenerates to the drive. This determines the maximum deceleration rate for all modes of operation.

Description of choice:

Program the desired decel time. Too long of a ramp down time can cause sluggish operation. Too short of a ramp down time can cause the drive to trip off due to high DC bus voltage or cause unacceptable torque pulses in the controlled system.

NOTE

Factory setting of parameter 207 for fan applications, is 60 seconds. For pump applications, factory setting for parameter 207 is 10 seconds.

208 Automatic Ramp Down (AUTO RAMPING)

Value:

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

Function:

This function ensures that the drive does not trip during deceleration if the decel time set is too short. If, during deceleration, the DC bus voltage increases to the maximum value permitted, the drive automatically extends the ramp-down time.

NOTE

If auto ramp down is enabled, ramp time could be considerably longer than time set in parameter 207, *Ramp Down Time*.

Description of choice:

Program this function as *Enable* to avoid trips caused by too rapid a deceleration.

209 Jog Frequency (JOG FREQUENCY)

Value:

Parameter 201, *Output Frequency Low Limit*, to parameter 202
Output Frequency High Limit ★ 10.0 Hz

Function:

The jog frequency is the fixed output frequency at which the drive is running when the jog function is activated.

Jog can be activated via the digital inputs.

Description of choice:

Set the desired frequency.

★ Indicates factory default setting. Numbers in brackets [] represent selection as displayed on the serial bus.

Reference Type

The example below shows how the resulting reference is calculated when Preset references are used together with Sum and Relative references set in parameter 210, *Reference Type*. A formula for calculating the resulting reference is given under Calculation of Resulting Reference. See the drawing under Reference Handling.

Example:

The following parameters have been set:

Parameter 204 <i>Minimum Reference</i> :	10 Hz
Parameter 205 <i>Maximum Reference</i> :	60 Hz
Parameter 211 <i>Preset Reference</i> :	15%
Parameter 308 <i>Terminal 53, Analog Input</i> :	Reference
Parameter 309 <i>Terminal 53, Min. Scaling</i> :	0 V
Parameter 310 <i>Terminal 53, Max. Scaling</i> :	10 V

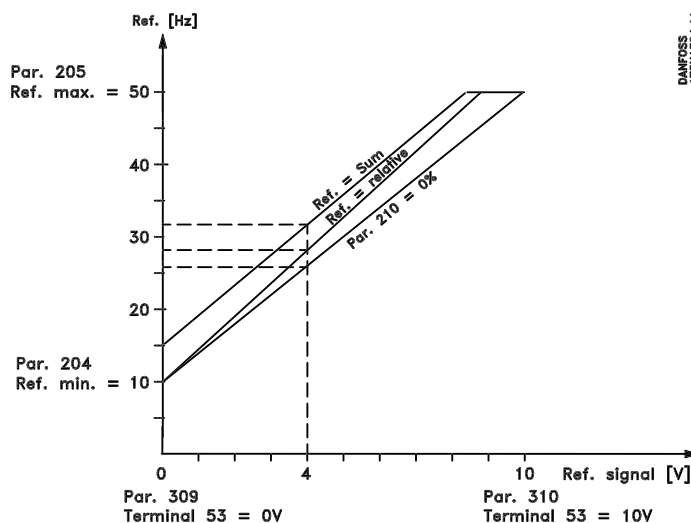
When parameter 210 *Reference Type* is set to Sum, one of the adjusted *Preset References*, parameters 211 through 214, will be added to the external references as a percentage of the reference range. If terminal 53 has an analog input voltage of 4 V, the resulting reference will be:

Parameter 210 <i>Reference type = Sum</i>	
Parameter 204 <i>Minimum Reference</i>	= 10.0 Hz
Reference contribution at 4 V	= 16.0 Hz
Parameter 211 <i>Preset Reference</i>	= <u>6.0 Hz</u>
Resulting reference	= 32.0 Hz

If parameter 210 *Reference Type* is set to *Relative*, one of the adjusted *Preset References* parameters 211 through 214 will be totaled as a percentage of the sum of the present external references. If terminal 53 has an analog input voltage of 4 V, the resulting reference will be:

Parameter 210 <i>Reference type = Relative</i>	
Parameter 204 <i>Minimum Reference</i>	= 10.0 Hz
Reference contribution at 4 V	= 16.0 Hz
Parameter 211 <i>Preset Reference</i>	= <u>2.4 Hz</u>
Resulting reference	= 28.4 Hz

The graph in the next column shows the resulting reference while the external reference changes from 0 to 10 V. Parameter 210, *Reference Type* has been programmed for *Sum* and *Relative*. Parameter 211, *Preset Reference 1*, is programmed for 0%.



210 Reference Type	(REF. FUNCTION)
Value:	
Sum (SUM)	[0]
Relative (RELATIVE)	[1]
★ External/preset (EXTERNAL/PRESET)	[2]

Function:

It is possible to define how the preset references are added to the other references. For this purpose, *Sum* or *Relative* is used. It is also possible, by using the *External/Preset* function, to select between the external references and a preset reference.

Description of choice:

If *Sum* is selected, one of the preset references (parameters 211 through 214, *Preset Reference*) is added to the other external references as a percentage of the reference range (minimum reference through maximum reference).

If *Relative* is selected, one of the adjusted preset references (parameters 211 through 214, *Preset Reference*) is added as a percentage of the total external reference.

If *External/Preset* is selected, it is possible to shift between the external references and the preset references using terminals 16, 17, 29, 32 or 33 (parameters 300, 301, 305, 306 or 307, *Digital Inputs*). Preset references are a percentage value of the reference range. External reference is the sum of the analog references, pulse references and any references from serial communication.

NOTE

If *Sum* or *Relative* is selected, one of preset references is always active. If preset references are not used, set value to 0%.

NOTE

See *Calculation of Resulting Reference* section in this manual for mathematic formula to calculate references.

★ Indicates factory default setting. Numbers in brackets [] represent selection as displayed on the serial bus.

211	Preset Reference 1	(PRESET REF. 1)
212	Preset Reference 2	(PRESET REF. 2)
213	Preset Reference 3	(PRESET REF. 3)
214	Preset Reference 4	(PRESET REF. 4)

Value:
 -100.00 % to +100.00 % ★ 0.00%
 of the reference range or external reference

Function:
 Four different preset references can be programmed in parameters 211 to 214, *Preset Reference*. The preset reference is stated as a percentage of the reference range or as a percentage of the other external references, depending upon the choice made in parameter 210, *Reference Type*.

The choice of preset references is made by activating terminals 16, 17, 29, 32 or 33, as shown in the table below.

Terminal 17/29/33 preset reference msb	Terminal 16/29/32 preset reference lsb	
0	0	Preset reference 1
0	1	Preset reference 2
1	0	Preset reference 3
1	1	Preset reference 4

Description of choice:
 Set the required preset reference(s) that is/are to be used.

215	Current Limit	(CURRENT LIMIT)
Value:		
0.1 to 1.1 x rated current		★ rated current

Function:
 This is where the maximum output current is set. If the motor attempts to draw more than this amount of current, the drive will reduce its output frequency until the current is less than or equal to the current limit value.

The factory setting corresponds to the rated output current. If the current limit is to be used as motor protection, the rated motor current must be set. If the current limit is set within the range of 1.0 to 1.1 times the rated output current of the drive, the drive can only handle current greater than its rated output intermittently. After the load has been higher than rated output current limit, it must be reduced to a level that is lower than the rated current of the drive for a period of time.

Note that if the current limit is set to less than the maximum value of the drive, acceleration torque is reduced correspondingly.

Description of choice:

Set the required maximum output current.

NOTE

When drive is in current limit and a stop command is issued by pressing the STOP key on LCP keypad, drive output is immediately cut off and motor will coast-to-stop.

216	Frequency Bypass, Bandwidth	(FREQUENCY BYPASS B.W.)
------------	------------------------------------	--------------------------------

Value:
 0 (OFF) to 100 Hz ★ DISABLED

Function:
 Mechanical resonance in the driven system sometimes makes it desirable to avoid operation at critical speeds.

These output frequencies can be programmed in parameters 217 through 220.

In this parameter, *Frequency Bypass, Bandwidth*, the width of the frequency to be bypassed is defined.

Description of choice:

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

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

Value:
 0 to 120 or 1000 Hz ★ 120.0 Hz

The frequency range depends on the selection made in parameter 200, *Output Frequency Range*.

Function:
 Some systems require that some output frequencies be avoided because of mechanical resonance problems in the system.

Description of choice:

Enter the frequencies to be avoided.

See also parameter 216, *Frequency Bypass, Bandwidth*.

★ Indicates factory default setting. Numbers in brackets [] represent selection as displayed on the serial bus.

Warning Functions

The warning functions in parameters 221 through 228 are not active during ramp-up after a Start command, ramp down after a Stop command, or while stopped. The warning functions are activated when the output frequency has reached the resulting reference.

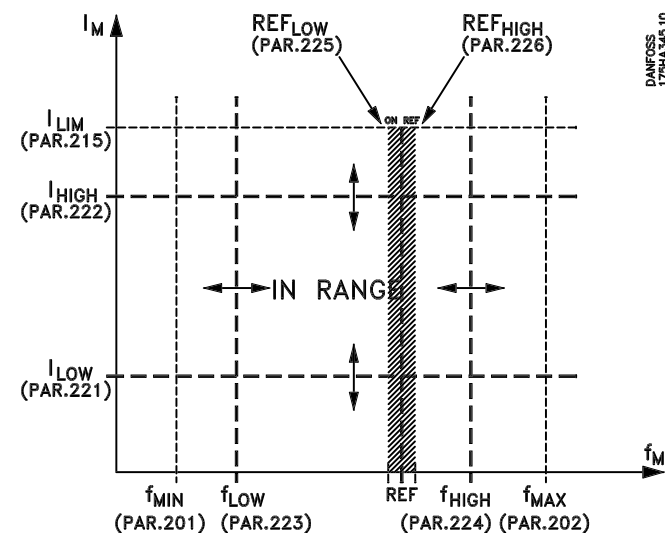
The signal outputs can be programmed to generate a warning signal via terminal 42 or 45 and via the relay outputs.

The reference limits in parameter 226, *Warning: High Reference* and parameter 227, *Warning: Low Reference* are only active when remote reference has been selected.

221	Warning: Low Current	(WARN. LOW CURR)
Value:		
0.0 to parameter 222	<i>Warning: High current</i>	★ 0.0 A

Function:
When the motor current is below the limit programmed in this parameter, the display shows a flashing CURRENT LOW, provided *Warning* has been selected in parameter 409, *Function in Case of No Load*. The drive will trip if parameter 409 has been selected as *Trip*. This can be used to indicate when a belt between the motor and the driven load is broken.

Description of choice:
The lower signal limit must be programmed within the normal working range of the drive.



★ Indicates factory default setting. Numbers in brackets [] represent selection as displayed on the serial bus.

222	Warning: High Current	(WARN. HIGH CURR)
Value:		
Parameter 221 to 1.1 x rated current		★ 1.1 x rated current

Function:
If the motor current is above the limit programmed in this parameter, the display shows a flashing CURRENT HIGH.

Description of choice:
The upper signal limit of the motor frequency must be programmed within the normal working range of the drive. See the drawing at parameter 221, *Warning: Low Current*.

223	Warning: Low Frequency	(WARN. LOW FREQ)
Value:		
0.0 to parameter 224		★ 0.0 Hz

Function:
If the output frequency is below the limit programmed in this parameter, the display will show a flashing F OUT < FLOW.

Description of choice:
The lower signal limit of the motor frequency must be programmed within the normal working range of the drive. See drawing at parameter 221 *Warning: Low current*.

224	Warning: High Frequency	(WARN. HIGH FREQ.)
Value:		
Par. 200 Output frequency range = 0 to 120 Hz	parameter 223 - 120 Hz	★ 120.0 Hz
Par. 200 Output frequency range = 0 to 1000 Hz	parameter 223 - 1000 Hz	★ 120.0 Hz

Function:
If the output frequency is above the limit programmed in this parameter, the display will show a flashing F OUT > F HIGH

Description of choice:
The higher signal limit of the motor frequency must be programmed within the normal working range of the drive. See the drawing at parameter 221, *Warning: Low Current*.

**225 Warning: Low Reference
(WARN. LOW REF)**

Value:
-999,999.999 - *High Reference* (par. 226) ★ -999,999.999 Hz

Function:

When the total remote reference is less than the limit programmed in this parameter, the display shows a flashing REF. < REF. LOW

The reference limits in parameter 226, *Warning: High Reference* and parameter 225, *Warning: Low Reference* are only active when remote reference has been selected.

In *Open Loop*, the unit for the reference is Hz, while in *Closed Loop* the unit is programmed in parameter 415, *Process Units*.

Description of choice:

When parameter 100, *Configuration*, has been programmed for *Open Loop*, the lower signal limit of the reference must be programmed within the normal working range of the drive. If parameter 100 is programmed as *Closed Loop*, Low Reference must be within the reference range programmed in parameters 204 and 205.

**226 Warning: High Reference
(WARN. HIGH REF)**

Value:
Reference Low (par. 225) to 999,999.999 ★ 999,999.999 Hz

Function:

If the resulting reference is below the limit programmed in this parameter, the display flashes REF. > REF. HIGH.,

The reference limits in parameter 226 *Warning: High Reference* and parameter 225 *Warning: Low Reference* are only active when remote reference has been selected.

In *Open Loop*, the unit for the reference is Hz, while in *Closed Loop* the unit is programmed in parameter 415, *Process Units*.

Description of choice:

The high reference warning must be programmed within the normal working range of the drive, provided parameter 100 *Configuration* has been programmed for *Open Loop*. If parameter 100 has been programmed for *Closed Loop*, Reference High must be within the reference range programmed in parameters 204 and 205.

**227 Warning: Low Feedback
(WARN. LOW FDBK)**

Value:
-999,999.999 to High Feedback (parameter 228)
★ -999,999.999

Function:

If the feedback signal is below the limit of Low Feedback programmed in this parameter, the display will flash FEEDBACK < FOB LOW.

The unit for feedback is programmed in parameter 415, *Process Units*.

Description of choice:

Set the desired value within the feedback range, parameter 413, *Minimum Feedback*, and parameter 414, *Maximum Feedback*.

**228 Warning: High Feedback
(WARN. HIGH FDBK)**

Value:
Low Feedback (parameter 227) to 999,999.999
★ 999,999.999

Function:

If the feedback signal is above the limit programmed in this parameter, the display will show a flashing FEEDBACK > FOB HIGH.

The unit for feedback is programmed in parameter 415, *Process Units*.

Description of choice:

Set the required value within the feedback range, parameter 413, *Minimum Feedback*, and parameter 414, *Maximum Feedback*.

★ Indicates factory default setting. Numbers in brackets [] represent selection as displayed on the serial bus.

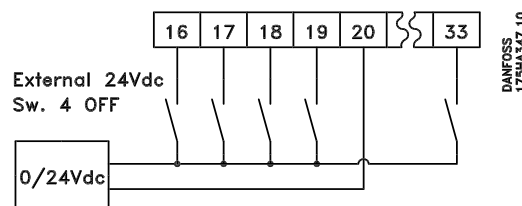
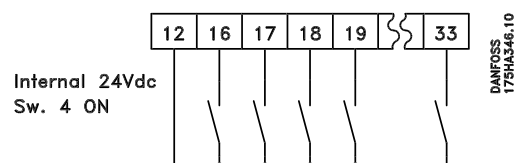
Inputs and Outputs Parameters 300 through 328

In this parameter group, the functions of the drive input and output terminals are defined. The digital inputs are through terminals 16, 17, 18, 19, 27, 32 and 33. Inputs are programmed by parameters 300 through 307. The table below shows the functions available for input.

Digital inputs require a signal of 0 or 24 VDC. A signal lower than 5 VDC is a logic '0', while a signal higher than 10 VDC is a logic '1'.

The terminals for the digital inputs can be connected to the internal 24 VDC supply through terminals 12 and 13, or an external 24 VDC supply can be connected.

The drawings at the right show one setup using the internal 24 VDC supply and one setup using an external 24 VDC supply.



Switch 4 is used for separating the common potential of the internal 24 VDC supply from the common potential of an external 24 VDC supply. Switch 4 is the DIP switch on the far right of the group of DIP switches located on the lower right of the control card, just above the control terminals.



When Switch 4 is in the OFF position, the external 24 VDC supply is galvanically isolated from the drive.

Digital Inputs	Terminal Number:	16	17	18	19	27	29	32	33
	Parameter:	300	301	302	303	304	305	306	307
Value:									
No function	(NO OPERATION)	[0]	★[0]	[0]	[0]		[0]	★[0]	★[0]
Reset	(RESET)	★[1]	[1]				[1]	[1]	[1]
Coasting stop, inverse	(COAST INVERSE)					[0]			
Reset and coasting stop, inverse	(RESET & COAST INVERSE)					[1]			
Start	(START)			★[1]					
Reversing	(REVERSE)				★[1]				
Reversing and start	(START REVERSE)				[2]				
DC-braking, inverse	(DC BRAKE INVERSE)				[3]	[2]			
Safety interlock	(SAFETY INTERLOCK)					★[3]			
Freeze reference	(FREEZE REFERENCE)	[2]	[2]				[2]	[2]	[2]
Freeze output	(FREEZE OUTPUT)	[3]	[3]				[3]	[3]	[3]
Selection of Setup, lsb	(SETUP SELECT LSB)	[4]					[4]	[4]	
Selection of Setup, msb	(SETUP SELECT MSB)		[4]				[5]		[4]
Preset reference, on	(PRESET REF. ON)	[5]	[5]				[6]	[5]	[5]
Preset reference, lsb	(PRESET REF. LSB)	[6]					[7]	[6]	
Preset reference, msb	(PRESET REF. MSB)		[6]				[8]		[6]
Speed down	(SPEED DOWN)		[7]				[9]		[7]
Speed up	(SPEED UP)	[7]					[10]	[7]	
Start enabled	(RUN PERMISSIVE)	[8]	[8]				[11]	[8]	[8]
Jog	(JOG)	[9]	[9]				★[12]	[9]	[9]
Data change lock	(PROGRAMMING LOCK)	[10]	[10]				[13]	[10]	[10]
Pulse reference	(PULSE REFERENCE)		[11]				[14]		
Pulse feedback	(PULSE FEEDBACK)								[11]
Hand start	(HAND START)	[11]	[12]				[15]	[11]	[12]
Auto start	(AUTOSTART)	[12]	[13]				[16]	[12]	[13]

★ Indicates factory default setting. Numbers in brackets [] represent selection as displayed on the serial bus.

Function:

In parameters 300 through 307, *Digital Inputs*, the functions of terminals 16 through 33 are selected.

These options are shown in the table on the previous page.

Description of choice:

No Function is selected if the drive is not to react to signals transmitted to the terminal.

Reset allows reset of the drive after a resettable fault. Not all faults can be reset without removing and reapplying the input power. Faults that require the removal of input power are called trip lock faults. See *Warnings and Alarms*.

Coasting Stop, Inverse is used to release the motor immediately by turning off the output transistors. The motor will coast freely to a stop. Inverse indicates a closed terminal sends the stop signal. Logic '0' implements coasting to a stop.

Reset and Coasting Stop, Inverse is used for activating coasting stop at the same time as reset. Inverse indicates a closed terminal sends the stop signal. Logic '0' implements coasting stop and reset.

DC Braking, Inverse is used for stopping the motor by energizing it with a DC voltage for a given time, as set by parameters 114 and 115. Inverse indicates a closed terminal sends the braking signal. Logic '0' implements DC braking. See the DC braking parameters.

Safety Interlock is the same as *Coasting Stop, Inverse*, except *Safety Interlock* generates an alarm message on the display when terminal 27 is logic '0'. The alarm message will also be active through digital outputs 42 and 45 and relay outputs 1 and 2, if programmed for *Safety Interlock*.

Start is selected for a remote Start/Stop command. Logic '1' = Start. Logic '0' = Stop.

Reversing is used for changing the direction of rotation of the motor. Logic '0' is for forward. Logic '1' is for reverse. The drive can be safely reversed while it is driving the motor. The reversing signal only changes the direction of rotation, it does not activate the start function. It is not active in *Closed Loop* mode.

Reversing and Start is used for Start/Stop and reversing using the same signal. A start signal through terminal 18 starts the drive in the forward direction. If both terminal 18 and a reversing and start terminal are given a logic '1' at the same time, the drive will not start. It is not active in *Closed Loop*.

Freeze Reference freezes the present reference. The frozen reference can only be changed by means of *Speed Up* or *Speed Down*. The frozen reference is saved after a stop command and when power is removed.

Freeze Output freezes the present output frequency. The frozen output frequency can now only be changed by means of *Speed Up* or *Speed Down*.

NOTE

If Freeze Output is active, the drive cannot be stopped via terminal 18.

To stop the drive when *Freeze Output* is active, one of the four methods listed below must be used.

1. Turn off the *Freeze Output* function and perform a normal stop.
2. Press the keypad Off/Stop key.
3. Remove the control voltage to terminal 27.
4. If terminal 19 is programmed in parameter 303 for *DC Brake Inverse*, remove the control voltage to it.

Selection of Setup, Lsb* and **Selection of Setup, Msb**** enables digital selection of the four possible setups. To enable this, parameter 002 *Active Setup* must be set to *Multi Setup*.

	Setup, Msb	Setup, Lsb
Setup 1	0	0
Setup 2	0	1
Setup 3	1	0
Setup 4	1	1

*Lsb - Least significant bit. **Msb - Most significant bit.

Preset Reference, on is used for switching between remote controlled reference and preset reference. This assumes that *Remote/preset* has been selected in parameter 210, *Reference Type*. Logic '0' = remote controlled references active; logic '1' = one of the four preset references is active in accordance with the table below.

Preset Reference, Lsb and **Preset reference, Msb** enables a choice of one of the four preset references, in accordance with the table below.

	Preset ref. msb	Preset ref. lsb
Preset ref. 1	0	0
Preset ref. 2	0	1
Preset ref. 3	1	0
Preset ref. 4	1	1

Speed Up and Speed Down are selected if digital control of the up/down speed is desired. This function is only active if *Freeze Reference* or *Freeze Output* has been selected.

As long as there is a logic '1' on the terminal selected for *Speed Up*, the reference or the output frequency will increase by the *Ramp-up Time* set in parameter 206.

As long as there is a logic '1' on the terminal selected for *Speed Down*, the reference or the output frequency will decrease by the *Ramp-down Time* set in parameter 207.

Pulses (logic '1' minimum high for 3 ms and a minimum pause of 3 ms) will lead to a change of speed of 0.1% (reference) or 0.1 Hz (output frequency).

Example:

	Terminal (16)	Terminal (17)	Freeze ref./ Freeze output
No speed change	0	0	1
Speed down	0	1	1
Speed up	1	0	1
Speed down	1	1	1

The speed reference frozen through the control panel can be changed even if the drive has stopped. In addition, the frozen reference will be retained in memory after power interruption.

Run Permissive. *Run Permissive* is used to require a second "run permission" signal in addition to the normal run command, either in Hand or Auto mode. When a run command alone is given, the display will show RUN REQ., but the drive will not start. The drive can also indicate that a run has been requested through one of the transistorized or relay outputs. When, in addition to the run command, a logic '1' is applied to the *Run Permissive* terminal, the drive will run. If more than one terminal is programmed for *Run Permissive*, a logic '1' at any of these terminals will allow the drive to run.

Jog is used to start the drive and run it at the frequency set in parameter 209, *Jog Frequency*. Jog is active in both Hand and Auto mode.

Jog is not active if a stop command has been given through the keypad or terminal 27.

Data change lock is selected if changes to parameters are not to be made via the control panel. It is possible to change parameters through the serial bus.

Pulse reference is selected if the frequency of a pulse train is to be used as a reference signal. 0 Hz corresponds to parameter 204, *Minimum Reference*. The frequency set in parameter 327, *Pulse Reference, Maximum Frequency* corresponds to parameter 205 *Maximum Reference*.

Pulse feedback is selected if the frequency of a pulse train is to be used as a feedback signal. Parameter 328, *Pulse Feedback, Maximum Frequency* is the pulse frequency that corresponds to maximum feedback.

Hand start is selected if an external signal is used to switch the drive to Hand mode. A logic '1' (*Hand Start* active) will start the motor. A logic '0' will stop the motor. The drive will then be in OFF/STOP mode, unless there is an active *Auto Start* signal from an external source. Programming one of the digital inputs for *Hand Start* will disable the LCP Hand Start and Auto Start keys.

WARNING

Unintended Start!

With *Hand Start* active, digital inputs may cause drive to start at any time. The drive, motor, and any driven equipment must be in operational readiness. Failure to be in operational readiness with *Hand Start* active could result in death, serious injury, or equipment or property damage.

Auto start is selected if an external signal is sent to switch the drive to Auto mode. When a start signal is active on the control terminals or the serial communication port, the drive will start the motor. If *Auto Start* and *Hand Start* are active at the same time on the control terminals, *Auto Start* will have the higher priority. If *Auto Start* and *Hand Start* are not active, the motor will stop and the drive will then be in the OFF/STOP mode. Programming one of the digital inputs for *Auto Start* will disable the LCP Hand Start and Auto Start keys.

Analog Inputs

Two analog inputs for voltage signals, terminals 53 and 54, and an analog input for current, terminal 60, are provided for reference and feedback signals. A thermistor can be connected to the voltage inputs, terminals 53 or 54.

The two analog voltage inputs can be scaled over the range of 0 to 10 V DC. The current input can be scaled over the range of 0 to 20 mA.

The table below shows the possible analog input programming.

Parameter 317, *Time Out*, and Parameter 318, *Function After Time Out*, allow activation of a time-out function on all analog inputs. If the signal value of the reference or feedback signal connected to one of the analog input terminals drops below 50% of the minimum scaling, the function set in parameter 318, *Function After Time Out*, will be activated after the time-out set in parameter 317.

308 Terminal 53, Analog Input Voltage (AI [V] 53 FUNCT.)

Function:

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

Description of choice:

No operation. Selected if the drive is not to react to signals connected to the terminal.

Reference. Selected to enable change of reference by means of an analog reference signal. If reference signals are connected to several inputs, these reference signals will be summed.

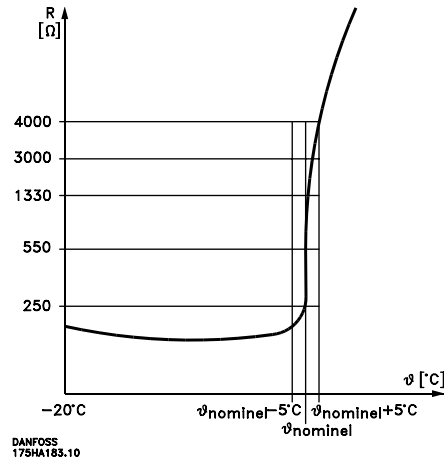
Feedback. If a feedback signal is connected, a voltage input may be connected to either terminal 53 or 54, or a current input connected to terminal 60. If a two zone PID control is used, the feedback signals must be voltage inputs and applied to terminals 53 and 54. See *Feedback Handling*.

Thermistor. Selected if a thermistor in the motor stops the drive in case of motor overtemperature. The cutout value is 3 kohm. A Klixon thermal switch may also be connected to this input. If parallel sensors are used, the thermistors/thermal switches can be connected in series. The drive will shut down when the total resistance exceeds 3 kohms.

NOTE

When a thermistor is mounted in motor wiring, a breakdown of insulation between thermistor and motor can feed high voltage back to drive control terminals. To comply with protective extra-low voltage (PELV) grounding requirements, if applicable, thermistor must be mounted externally.

Parameter 117, *Motor Thermal Protection*, must be programmed for *Thermal Warning* or *Thermistor Trip*, and the thermistor must be inserted between terminal 53 or 54, *analog voltage input*, and terminal 50, 10 V supply.



Analog Inputs	Terminal Number	53	54	60
	Parameter	308	311	314
Value:				
No operation	(NO OPERATION)	★[0]	★[0]	[0]
Reference	(REFERENCE)	[1]	[1]	★[1]
Feedback	(FEEDBACK)	[2]	[2]	[2]
Thermistor	(THERMISTOR)	[3]	[3]	

★ Indicates factory default setting. Numbers in brackets [] represent selection as displayed on the serial bus.

309 Terminal 53, Minimum Scaling
(AI 53 SCALE LOW)
Value:
0.0 to 10.0 V ★ 0.0 V

Function:
 This parameter is used for setting the signal value that corresponds to the minimum reference or the minimum feedback, parameter 204, *Minimum Reference*, or parameter 413, *Minimum Feedback*. See *Reference Handling* or *Feedback Handling*.

Description of choice:
 Set the required voltage value. For reasons of accuracy, voltage losses in long signal lines should be compensated for. If the time out functions in parameter 317, *Time Out*, and parameter 318, *Function After Time Out*, are to be used, the value must be set to > 1 V.

310 Terminal 53, Maximum Scaling
(AI 53 SCALE HIGH)
Value:
0.0 to 10.0 V ★ 10.0 V

Function:
 This parameter is used to set the signal value that corresponds to the maximum reference value or the maximum feedback, parameter 205, *Maximum Reference*, or parameter 414, *Maximum Feedback*. See *Reference Handling* or *Feedback Handling*.

Description of choice:
 Set the required voltage value.

 For reasons of accuracy, voltage losses in long signal lines should be compensated for.

311 Terminal 54, Analog Input Voltage
(AI [V] 54 FUNCT.)
Value:
See the description of parameter 308. ★ No operation

Function:
 This parameter selects the function of terminal 54.

 The input signal is scaled by parameter 312, *Terminal 54, Minimum Scaling*, and by parameter 313, *Terminal 54, Maximum Scaling*.

Description of choice:
 See description of parameter 308.

 For reasons of accuracy, voltage losses in long signal lines should be compensated for.

312 Terminal 54, Minimum Scaling
(AI 54 SCALE LOW)
Value:
0.0 to 10.0 V ★ 0.0 V

Function:
 This parameter is used to set the signal value that corresponds to the minimum reference value or the minimum feedback, parameter 204, *Minimum Reference*, and parameter 413, *Minimum Feedback*. See *Reference Handling* or *Feedback Handling*.

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

 If the time out function is to be applied, parameter 317, *Time Out*, and parameter 318, *Function After Time Out*, the value must be set to > 1 V.

313 Terminal 54, Maximum Scaling
(AI 54 SCALE HIGH)
Value:
0.0 to 10.0 V ★ 10.0 V

Function:
 This parameter is used to set the signal value that corresponds to the maximum reference value or the maximum feedback, parameter 205, *Maximum Reference*, or parameter 414, *Maximum Feedback*. See *Reference Handling* or *Feedback Handling*.

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

314 Terminal 60, Analog Input Current
(AI [mA] 60 FUNCT.)
Value:
See description of parameter 308. ★ Reference

Function:
 This parameter selects the function of terminal 60.

 Scaling of the input signal is set by parameter 315, *Terminal 60, Minimum Scaling*, and by parameter 316, *Terminal 60, Maximum Scaling*.

Description of choice:
 See description of parameter 308, *Terminal 53, Analog Input Voltage*.

★ Indicates factory default setting. Numbers in brackets [] represent selection as displayed on the serial bus.

315 Terminal 60, Minimum Scaling (AI 60 SCALE LOW)

Value:
0.0 to 20.0 mA ★ 4.0 mA

Function:

This parameter determines the signal value that corresponds to the minimum reference or the minimum feedback, parameter 204 *Minimum Reference*, parameter 413, *Minimum Feedback*. See *Reference Handling* or *Feedback Handling*.

Description of choice:

Set the required current value.

If the time-out function is to be used, parameter 317, *Time Out*, and parameter 318, *Function After Time Out*, the value must be set to > 2 mA.

316 Terminal 60, Maximum Scaling (AI 60 SCALE HIGH)

Value:
0.0 to 20.0 mA ★ 20.0 mA

Function:

This parameter determines the signal value that corresponds to the maximum reference or maximum feedback, parameter 205, *Maximum Reference Value*, or parameter 414, *Maximum Feedback*. See *Reference Handling* or *Feedback Handling*.

Description of choice:

Set the desired current value.

317 Time Out (LIVE ZERO TIME)

Value:
1 to 99 sec. ★ 10 sec.

Function:

If the signal value of the reference or feedback signal connected to one of the input terminals 53, 54 or 60 drops to below 50% of the minimum scaling for a longer period than the Live Zero time, the function selected in parameter 318, *Function After Time Out*, will be activated.

This function will only be active if, in parameter 309 or 312, a value has been selected for *Terminals 53 and 54, Minimum Scaling*, that exceeds 1 V, or if, in parameter 315, *Terminal 60, Minimum Scaling*, a value has been selected that exceeds 2 mA.

Description of choice:

Set the desired time.

318 Function After Time Out (LIVE ZERO FUNCT.)

Value:

★ Off (NO FUNCTION)	[0]
Freeze output frequency (FREEZE OUTPUT FREQ.)	[1]
Stop (STOP)	[2]
Jog (JOG FREQUENCY)	[3]
Max. output frequency (MAX FREQUENCY)	[4]
Stop and trip (STOP AND TRIP)	[5]

Function:

This is where to select the function to be activated after the end of the time-out period, parameter 317, *Time Out*.

If a time-out function occurs at the same time as a bus time-out function, parameter 510, *Bus Time Interval Function*, the time-out function in parameter 318 will be activated.

Description of choice:

The output frequency of the drive can:

- go to minimum (NO FUNCTION)
- be frozen at the present value (FREEZE OUTPUT FREQUENCY)
- stop (STOP)
- run at the jog frequency set in parameter 209 (JOG FREQUENCY)
- run at the maximum frequency set in parameter 202 (MAX. FREQUENCY)
- stop and send an alarm (STOP AND TRIP)

★ Indicates factory default setting. Numbers in brackets [] represent selection as displayed on the serial bus.

Analog/Digital Outputs

The two analog/digital outputs available through terminals 42 and 45 can be programmed to show a status or an analog value such as frequency. The status signal is a 24 VDC output.

For the analog output, there is a choice of three types of output signal: 0 to 20 mA, 4 to 20 mA or 0 to 32000 pulses. The pulse rate is set by parameter 322, *Terminal 45, Output, Pulse Scaling*.

See the Electrical Installation, Control Terminals section of this manual for the ratings of these outputs.

Analog/Digital Outputs	Terminal Number:	42	45
	Parameter:	319	321
Value:			
No function (NO FUNCTION)		[0]	[0]
Drive ready (READY)		[1]	[1]
Standby (ENABLED & NO WARNING)		[2]	[2]
Running (RUNNING)		[3]	[3]
Running at ref. value (RUNNING AT REFERENCE)		[4]	[4]
Running, no warning (RUNNING NO WARNING)		[5]	[5]
Local reference active (DRIVE IN LOCAL REF.)		[6]	[6]
Remote controlled references active (DRIVE IN REMOTE REF.)		[7]	[7]
Alarm (ALARM)		[8]	[8]
Alarm or warning (ALARM OR WARNING)		[9]	[9]
No alarm (NO ALARM)		[10]	[10]
Current limit (CURRENT LIMIT)		[11]	[11]
Safety interlock (SAFETY INTERLOCK)		[12]	[12]
Start command active (START SIGNAL APPLIED)		[13]	[13]
Reversing (RUNNING IN REVERSE)		[14]	[14]
Thermal warning (THERMAL WARNING)		[15]	[15]
Hand mode active (DRIVE IN HAND MODE)		[16]	[16]
Auto mode active (DRIVE IN AUTO MODE)		[17]	[17]
Sleep mode (SLEEP MODE)		[18]	[18]
Output frequency lower than parameter 223 (F OUT < F LOW)		[19]	[19]
Output frequency higher than parameter 223 (F OUT > F HIGH)		[20]	[20]
Out of frequency range (FREQ. RANGE WARN.)		[21]	[21]
Output current lower than low current, parameter 221 (I OUT < I LOW)		[22]	[22]
Output current higher than high current, parameter 222 (I OUT > I HIGH)		[23]	[23]
Out of current range (CURRENT RANGE WARN)		[24]	[24]
Out of feedback range (FEEDBACK RANGE WARN.)		[25]	[25]
Out of reference range (REFERENCE RANGE WARN)		[26]	[26]
Relay 123 (RELAY 123)		[27]	[27]
Input phase loss (MAINS PHASE LOSS)		[28]	[28]
Output frequency, (OUT. FREQ. 0-20 mA)		[29]	[29]
Output frequency, (OUT. FREQ. 4-20 mA)		[30]	★ [30]
Output frequency (pulses), (OUT. FREQ. PULSE)		[31]	[31]
External reference, (EXT. REF. 0-20 mA)		[32]	[32]
External reference, (EXTERNAL REF. 4-20 mA)		[33]	[33]
External reference (pulses), (EXTERNAL REF. PULSE)		[34]	[34]
Feedback, (FEEDBACK 0-20 mA)		[35]	[35]
Feedback, (FEEDBACK 4-20 mA)		[36]	[36]
Feedback (pulses), (FEEDBACK PULSE)		[37]	[37]
Output current, 0-20 mA (MOTOR CUR. 0-20mA)		[38]	[38]
Output current, 4-20 mA (MOTOR CUR. 4-20mA)		★ [39]	[39]
Output current (pulses) (MOTOR CUR PULSE)		[40]	[40]
Output power, 0-20 mA (MOTOR POWER 0-20mA)		[41]	[41]
Output power, 4-20 mA (MOTOR POWER 4-20mA)		[42]	[42]
Output power (pulses) (MOTOR POWER PULSE)		[43]	[43]
Controlled by serial bus: 0-20 mA (BUS CONTROL 0-20MA)		[44]	[44]
Controlled by serial bus: 0-24 mA (BUS CONTROL 0-24MA)		[45]	[45]
Controlled by serial bus: pulses (BUS CONTROL PULSE)		[46]	[46]

★ Indicates factory default setting. Numbers in brackets [] represent selection as displayed on the serial bus.

Function:

These outputs can act both as digital and analog outputs. If used as a digital output, a 0 or 24 VDC signal is transmitted. If used as an analog output, either a 0 to 20 mA signal, a 4 to 20 mA signal, or a pulse sequence with a frequency of 0 to up to 32,000 Hz is transmitted.

Description of choice:

No function. Selected if this output is always to remain off.

Drive ready. The drive's control card receives a supply voltage and the drive is ready for operation.

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

Running. The drive is running or the drive is in the sleep mode.

Running at ref. value. The drive is at the speed commanded by the reference.

Running, no warning. The drive is running and there are no warnings.

Local reference active. The motor's speed is being controlled by the local reference through the keypad. This output will also be on if the drive is set up for local speed control but the jog function has been activated.

Remote references active. The motor's speed is being controlled by a remote reference or a preset speed.

Alarm. The drive has been stopped by an alarm.

Alarm or warning. An alarm or a warning exists in the drive.

No alarm. The drive has no alarm.

Current limit. The output current is greater than or equal to the value programmed in parameter 215, *Current Limit*. The speed of the drive is being limited to keep the current from increasing.

Safety interlock. Terminal 27 has been programmed for *Safety Interlock* in parameter 304, and no control voltage has been applied to it.

Start command active. The drive is either running or it has received a run command. This is commonly used in conjunction with the drive's run permissive control.

Reversing. The drive is running in the reverse direction.

Thermal warning. The temperature limit of either the motor, the drive, or a thermistor connected to an analog input has been exceeded.

Hand mode active. The drive is operating in the Hand run/stop mode.

Auto mode active. The drive is operating in the Auto run/stop mode.

Sleep mode. The drive is stopped because of Sleep Mode.

Output frequency lower than low frequency warning level. The output frequency is lower than the value set in parameter 223, *Warning: Low Frequency*.

Output frequency higher than high frequency warning level. The output frequency is higher than the value set in parameter 224, *Warning: High Frequency*.

Out of frequency range. The output frequency is outside the frequency range programmed in parameter 223, *Warning: Low Frequency*, and 224, *Warning: High Frequency*.

Output current lower than low current warning level. The output current is lower than the value set in parameter 221, *Warning: Low Current*. This can be used to indicate a broken belt.

Output current higher than high current warning level. The output current is higher than the value set in parameter 222, *Warning: High Current*.

Out of current range. The output current is outside the range programmed in parameter 221, *Warning: Low Current*, and parameter 222, *Warning: High Current*.

Out of feedback range. The feedback signal is outside the range programmed in parameter 227 *Warning: Low Feedback*, and 228 *Warning: High feedback*.

Out of reference range. The reference is outside the range programmed in parameter 225, *Warning: Low Reference*, and parameter 226, *Warning: High Reference*.

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

Input phase loss. An incoming power phase is missing.

Output frequency: 0 to 20 mA, 4 to 20 mA, and pulses. An output signal proportional to the output frequency in the range from 0 to *Output Frequency, High Limit*, set by parameter 202. Maximum pulse frequency is determined in parameters 320, *Terminal 42, Output Pulse Scaling*, and 322, *Terminal 45, Output Pulse Scaling*.

External reference: 0 to 20 mA, 4 to 20 mA, and pulses. An output signal proportional to the resulting reference value in the range from *Minimum Reference* to *Maximum Reference*, set by parameters 204 and 205. Maximum pulse frequency is determined in parameters 320, *Terminal 42, Output Pulse Scaling*, and 322, *Terminal 45, Output Pulse Scaling*.

Feedback Minimum to Feedback Maximum: 0 to 20 mA, 4 to 20 mA, and pulses. An output signal proportional to the reference value in the range from *Minimum Feedback* to *Maximum Feedback*, set by parameters 413 and 414. Maximum pulse frequency is determined in parameters 320, *Terminal 42, Output Pulse Scaling*, and 322, *Terminal 45, Output Pulse Scaling*.

Output Current: to 20 mA, 4 to 20 mA, and pulses. An output signal proportional to the output current in the range from 0 to the maximum drive output current. Maximum pulse frequency is determined in parameters 320, *Terminal 42, Output Pulse Scaling*, and 322, *Terminal 45, Output Pulse Scaling*.

Output power: 0 to 20 mA, 4 to 20 mA, and pulses. Generates an output signal proportional to the present output power. 20 mA corresponds to the value set by parameter 102, *Motor Power*. Maximum pulse frequency is determined in parameters 320, *Terminal 42, Output Pulse Scaling*, and 322, *Terminal 45, Output Pulse Scaling*.

Bus Control: 0 to 20 mA, 4 to 20 mA, and pulses. Generates a proportional output signal provided over a serial communication bus. The serial bus value for output terminal 42 is written to parameter 364 and the serial bus value for output terminal 45 is written to parameter 365. Maximum pulse frequency is determined in parameters 320, *Terminal 42, Output Pulse Scaling*, and 322, *Terminal 45, Output Pulse Scaling*.

319 Terminal 42, Output (AO 42 FUNCTION)

Value: ★ MOTOR CUR. 4-20 mA
See the description of analog/digital outputs.

Function:
This output can function both as a digital and an analog output. When used as a digital output, it generates a 24 V (max. 40 mA) signal. For the analog outputs, there is a choice of 0 to 20 mA, 4 to 20 mA or a pulse sequence.

Description of choice:
See the description of analog/digital outputs.

320 Terminal 42, Output Pulse Scaling (AO 42 PULS SCALE)

Value: 1 to 32000 Hz ★ 5000 Hz

Function:
This parameter allows scaling of the pulse output signal.

Description of choice:
Set the desired value for the maximum pulse frequency.

321 Terminal 45, Output (AO 45 FUNCTION)

Value: ★ OUT. FREQ. 4 - 20 mA
See the description of analog/digital outputs.

Function:
This output can function both as a digital and an analog output. When used as a digital output, it generates a 24 V (max. 40 mA) signal. For the analog outputs, there is a choice of 0 to 20 mA, 4 to 20 mA or a pulse sequence.

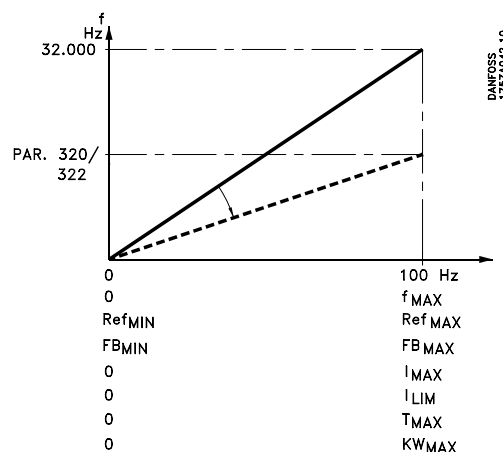
Description of choice:
See the description of analog/digital outputs.

322 Terminal 45, Output Pulse Scaling (AO 45 PULS SCALE)

Value: 1 to 32000 Hz ★ 5000 Hz

Function:
This parameter allows scaling of the pulse output signal.

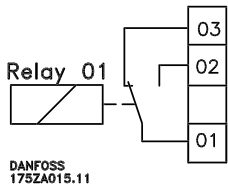
Description of choice:
Set the desired value for the maximum pulse frequency.



Pulse Scaling

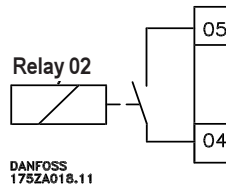
★ Indicates factory default setting. Numbers in brackets [] represent selection as displayed on the serial bus.

Relay Outputs



Relay 1:
1 - 3 normally closed, 1 - 2 normally open
Maximum: 240 VAC/DC, 2 A
Minimum: 24 VAC, 100 mA;
24 VDC, 10 mA

The high voltage relay connections are located near the input power and motor terminals.



Relay 2:
4 - 5 normally open
Maximum: 30 VAC, 1 A,
42.5 VDC, 1 A

The low voltage relay terminals are located on the control wiring terminal strips.

Relay outputs	Relay Number:	1	2
	Parameter:	323	326
Value:			
No function (NO FUNCTION)		[0]	[0]
Drive ready (READY)		[1]	[1]
Waiting for start (ENABLED & NO WARNING)		[2]	[2]
Running (RUNNING)		[3]	★ [3]
Running at reference value (RUNNING AT REFERENCE)		[4]	[4]
Running, no warning (RUNNING NO WARNING)		[5]	[5]
Local reference active (DRIVE IN LOCAL REF)		[6]	[6]
Remote controlled references active (DRIVE IN REMOTE REF.)		[7]	[7]
Alarm (ALARM)		[8]	[8]
Alarm or warning (ALARM OR WARNING)		[9]	[9]
No alarm (NO ALARM)		★ [10]	[10]
Current limit (CURRENT LIMIT)		[11]	[11]
Safety interlock (SAFETY INTERLOCK)		[12]	[12]
Start command active (START SIGNAL APPLIED)		[13]	[13]
Running in reverse (RUNNING IN REVERSE)		[14]	[14]
Thermal warning (THERMAL WARNING)		[15]	[15]
Hand mode active (DRIVE IN HAND MODE)		[16]	[16]
Auto mode active (DRIVE IN AUTO MODE)		[17]	[17]
Sleep mode active (SLEEP MODE)		[18]	[18]
Output frequency lower than low frequency, parameter 223 (F OUT < F LOW)		[19]	[19]
Output frequency higher than high frequency, parameter 224 (F OUT > F HIGH)		[20]	[20]
Out of frequency range (FREQ RANGE WARN.)		[21]	[21]
Output current lower than low current, parameter 221 (I OUT < I LOW)		[22]	[22]
Output current higher than high current, parameter 222 (I OUT > I HIGH)		[23]	[23]
Out of current range (CURRENT RANGE WARN.)		[24]	[24]
Out of feedback range (FEEDBACK RANGE WARN.)		[25]	[25]
Out of reference range (REFERENCE RANGE WARN.)		[26]	[26]
Relay 123 (RELAY 123)		[27]	[27]
Input phase loss (MAINS PHASE LOSS)		[28]	[28]
Control word bit 11/12 (CONTROL WORD 11/12)		[29]	[29]

Function:

Relay outputs 1 and 2 can be used to give the present status or a warning. See the description of options in Analog/Digital Outputs.

Control word bit 11/12 [29]. Relay 1 and relay 2 can be activated through serial communication. Bit 11 activates relay 1 and bit 12 activates relay 2.

If parameter 556, *Bus Time Interval Function*, becomes active, relay 1 and relay 2 will cut out if they are activated through serial communication.

Description of choice:

Select the output relay function.

★ Indicates factory default setting. Numbers in brackets [] represent selection as displayed on the serial bus.

**323 Relay 1, Output Function
(RELAY1 FUNCTION)**

Function:

★ NO ALARM

Relay 1 is a form C relay that can be used for status indications and warnings. The relay is activated when the programmed condition occurs.

Time delays for relay 1 are programmed in parameter 324, *Relay 1, ON Delay*, and parameter 325, *Relay 1, OFF Delay*.

Description of choice:

See data choice and connections under Relay Outputs.

**324 Relay 1, ON Delay
(RELAY1 ON DELAY)**

Value:

0 to 600 sec.

★ 0 sec.

Function:

This parameter determines the time delay before the relay activates.

Description of choice:

Enter the desired value.

**325 Relay 1, OFF Delay
(RELAY1 OFF DELAY)**

Value:

0 to 600 sec.

★ 2 sec.

Function:

This parameter determines the time delay before the relay deactivates.

Description of choice:

Enter the desired value.

**326 Relay 2, Output Function
(RELAY2 FUNCTION)**

Value:

See the functions of relay 1.

★ RUNNING

Function:

Relay 2 is a form A relay that can be used for status indications and warnings. The relay is activated when the programmed condition occurs.

Description of choice:

See data choice and connections under Relay Outputs.

**327 Pulse Reference, Maximum Frequency
(PULSE REF. MAX)**

Value:

100 to 65,000 Hz at terminal 29

★ 5,000 Hz

100 to 5,000 Hz at terminal 17

Function:

This parameter is used to set the pulse value that corresponds to the maximum reference, parameter 205, *Maximum Reference*.

The pulse reference signal can be connected to terminal 17 or 29.

Description of choice:

Set the required maximum pulse reference.

**328 Pulse Feedback, Maximum Frequency
(PULSE FDBK MAX.)**

Value:

100 to 65,000 Hz at terminal 33

★ 25,000 Hz

Function:

This parameter is used to set the pulse value that corresponds to the maximum feedback value. The pulse feedback signal is connected to terminal 33.

Description of choice:

Set the desired feedback value.

★ Indicates factory default setting. Numbers in brackets [] represent selection as displayed on the serial bus.

Application Functions Parameters 400 through 427

Special functions of the drive are set up in this parameter group. This includes the proportional, integral, derivative controller (PID) and setting the sleep mode function.

Additionally, this parameter group includes:

- Reset function
- Flying start
- Interference reduction
- Loss of load
- Carrier frequency
- Selection of process units

400 Reset Function (RESET FUNCTION)	
Value:	
Manual reset (MANUAL RESET)	[0]
Automatic reset x 1 (AUTOMATIC X 1)	[1]
Automatic reset x 2 (AUTOMATIC X 2)	[2]
Automatic reset x 3 (AUTOMATIC X 3)	[3]
Automatic reset x 4 (AUTOMATIC X 4)	[4]
Automatic reset x 5 (AUTOMATIC X 5)	[5]
Automatic reset x 10 (AUTOMATIC X 10)	[6]
Automatic reset x 15 (AUTOMATIC X 15)	[7]
Automatic reset x 20 (AUTOMATIC X 20)	[8]
★ Infinite automatic reset (INFINITE AUTOMATIC)	[9]

Function:
This parameter allows a choice of manual or automatic reset after a fault trip. There is also a choice of the number of times the unit will attempt to restart. The time between each attempt is set in parameter 401, *Automatic Restart Time*.

Description of choice:
If *Manual Reset* is selected, the Reset key must be pressed or a digital input given to reset the drive.

If auto reset after a fault trip is desired, select one of the Automatic reset choices.

WARNING Unintended Start!

With any automatic reset active, digital inputs may cause drive to start at any time. The drive, motor, and any driven equipment must be in operational readiness. Failure to be in operational readiness with automatic reset active could result in death, serious injury, or equipment or property damage.

401 Automatic Restart Time (AUTORESTART TIME)	
Value:	
0 to 600 seconds	★ 10 sec.
Function:	
This parameter sets the automatic reset time delay until each reset is attempted. One of the automatic resets must be selected in parameter 400, <i>Reset Function</i> .	

Description of choice:
Set the desired time before each restart attempt.

CAUTION Motor Rotation!

When parameter 402, *Flying Start*, is enabled, motor may turn forward and reverse a few revolutions even with motor stopped. In highly dynamic pumping processes, it is recommended to disable *Flying Start* function. Using *Flying Start* in highly dynamic pumping processes could result in injury or equipment or property damage.

402 Flying Start (FLYING START)	
Value:	
★ Disable (DISABLE)	[0]
Enable (ENABLE)	[1]
DC brake and start (DC BRAKE AND START)	[3]

Function:
This function makes it possible for the drive to 'catch' a rotating motor when the drive is started. The drive will sense the speed of rotation and direction of rotation of the motor and synchronize with it.

This function is active whenever a start command is present.

For the drive to catch the spinning motor, the motor speed must be lower than the maximum frequency set in parameter 202.

Description of choice:
Select *Disable* if this function is not required.
Select *Enable* if the drive is to 'catch' and control a rotating motor.

Select *DC brake and start* if the drive is to brake the motor by means of the DC brake first, and then start. Ensure that parameters 114 through 116, *DC Braking*, are set appropriately. Select *DC brake and start* if the motor may be externally driven at a significant speed in the reverse direction.

NOTE

For fan applications, factory setting for *Flying Start* is Enable. For pump applications, factory setting for *Flying Start* is Disable.

★ Indicates factory default setting. Numbers in brackets [] represent selection as displayed on the serial bus.

Sleep Mode

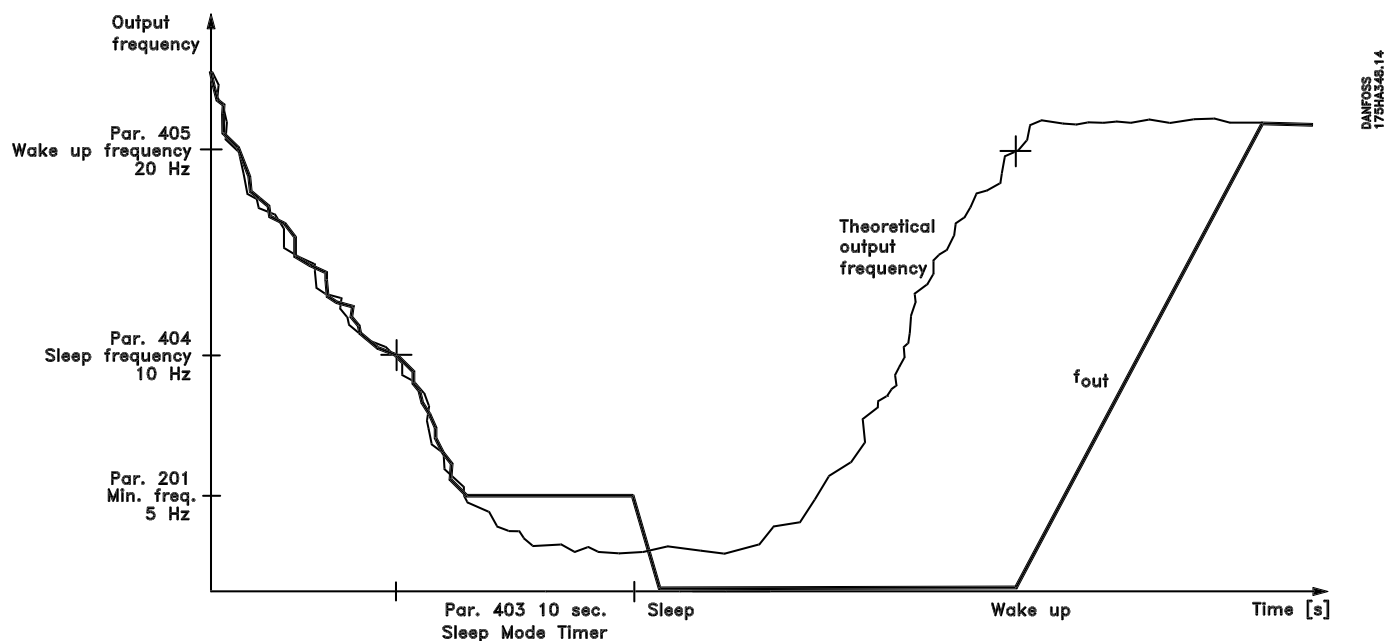
Sleep mode makes it possible to stop the drive when the system demand drops below a preset level. When the demand increases to a higher preset level, the drive will restart. A significant amount of energy can be saved using sleep mode. Unlike a set-back time clock, the drive is always available to run when the demand reaches the preset “wake up” level. Sleep mode operates in both *Open Loop* and *Closed Loop*.

Activate sleep mode in parameter 403, *Sleep Mode Timer*. In this parameter, set how long the output frequency must be lower than the sleep frequency set in parameter 404, *Sleep Frequency*, before sleep mode activates. After the set time, the drive will ramp down the motor to a stop, as controlled by parameter 207, *Ramp Down Time*. If the output frequency needed to meet the system demand rises above the sleep frequency during the timed period, the drive will simply ramp up to the demanded frequency.

When the sleep mode timer expires and the drive is stopped in sleep mode, a theoretical output frequency is calculated based upon the reference signal. When the theoretical output frequency rises above the frequency set in parameter 405, *Wake-up Frequency*, the drive will restart the motor and ramp up to the commanded reference.

For closed loop operation, it may be useful to “over satisfy” the system before putting the drive into sleep mode. The boost setpoint parameter provides for this. After the sleep mode timer expires, the drive will reset the set point based on the value in parameter 406, *Boost Setpoint*. Once this new setpoint is satisfied, the drive enters sleep mode. A setting of 100% in parameter 406, *Boost Setpoint*, indicates no setpoint boost. Boost setpoint is only active in *Closed Loop*, selected in parameter 100, *Configuration*.

Sleep mode is not active if *Local Reference* is selected in parameter 203, *Reference Handling*, or if the *Jog* function activates via digital inputs.



Sleep Mode Frequency Response

⚠ WARNING

Unintended Start!

In Sleep Mode, a start signal via digital inputs may cause drive to start at any time. The drive, motor, and any driven equipment must be in operational readiness. Failure to be in operational readiness in Sleep Mode could result in death, serious injury, or equipment or property damage.

403 Sleep Mode Timer (SLEEP MODE TIMER)

Value:

0 to 300 seconds (OFF) ★ OFF

Function:

This parameter enables the drive to stop the motor if the load on the system is minimal. The timer starts when the output frequency drops below the frequency set in parameter 404, *Sleep Frequency*. When the time set has passed, the drive will stop. The drive will restart when the theoretical output frequency exceeds the frequency set in parameter 405, *Wake-up Frequency*.

Description of choice:

Select OFF if this function is not wanted.

Set the amount of time that the drive must run at or below the sleep frequency before it stops and “goes to sleep.”

404 Sleep Frequency (SLEEP FREQUENCY)

Value:

0.0 to parameter 405, *Wake-up Frequency* ★ 0.0 Hz

Function:

When the output frequency falls below this set value, the timer set in parameter 403, *Sleep Mode Timer*, will start. The drive’s speed will follow the reference signal until the timer times out.

Description of choice:

Choose the output frequency at which the drive will activate the sleep mode timer. It is generally best to set SLEEP FREQUENCY equal to the minimum frequency set in parameter 201, *Output Frequency Low Limit* and parameter 204, *Minimum Reference*. This is because the sleep mode isn’t active until after the drive output frequency equals the sleep frequency. If the sleep frequency is less than the minimums, the sleep mode cannot activate.

405 Wake-up Frequency (WAKEUP FREQUENCY)

Value:

Parameter 404 to parameter 202, *Maximum Frequency* ★ 60 Hz

Function:

When the theoretical output frequency exceeds the preset value, the drive restarts the motor.

Description of choice:

Set the required frequency.

406 Boost Setpoint (BOOST SETPOINT)

Value:

0 to 200 % ★ 100 % of setpoint

Function:

This function can only be used if *Closed Loop* has been selected in parameter 100, *Configuration*.

In some systems, it may advantageous to increase the set point of the system before the drive stops the motor. This extends the time that the drive will be stopped and reduces cycling of the motor.

Description of choice:

Set the required *Boost Setpoint* as a percentage of the resulting reference under normal operation. 100% corresponds to the boost.

★ Indicates factory default setting. Numbers in brackets [] represent selection as displayed on the serial bus.

407 Switching Frequency (SWITCHING FREQ.)

Value:

Depends on the current rating of the unit.

Function:

The value of this parameter determines the maximum switching frequency of the inverter. If *Fixed Switching Frequency* has been selected in parameter 408, *Interference Reduction Method*, this will be the fixed inverter switching frequency. Changing the switching frequency may reduce audible noise from the motor. The output frequency of the drive can never be a greater than 1/10 of the switching frequency.

Description of choice:

When the motor is running, the switching frequency may be adjusted by parameter 407, *Switching Frequency*, until the sound level is as low as possible.

Switching frequencies higher than 4.5 kHz will result in automatic derating of the maximum continuous output current of the drive. The derate is linear from 4.5 kHz to the maximum switching frequency of the drive. At maximum switching frequency, the continuous output current from the drive will be limited to 60% of the rated current. To avoid possible problems at high load when using a high switching frequency, it may be desirable to select Automatic Switching Frequency Modulation in parameter 408, below.

NOTE

Switching frequencies higher than 4.5 kHz automatically derate maximum continuous output of drive.

408 Interference Reduction Method (NOISE REDUCTION)

Value:

- ★ ASFM (ASFM) [0]
- Fixed switching freq. (FIXED SWITCHING FREQ.) [1]
- LC filter fitted (LC-FILTER CONNECTED) [2]

Function:

Used to select different methods for reducing the amount of audible noise from the motor.

Description of choice:

ASFM (Automatic Switching Frequency Modulation) uses the maximum switching frequency possible while providing the output required by the load. The load is automatically monitored and the switching frequency set accordingly. The maximum switching frequency is set in parameter 407, *Switching Frequency*.

Fixed Switching Frequency makes it possible to set a fixed switching frequency. The switching frequency is set in parameter 407, *Switching Frequency*.

LC-filter fitted is to be used if an LC filter is installed between the drive and the motor. This prevents excessive heating of the LC filter.

409 Function in Case of No Load (FUNCT. LOW CURR.)

Value:

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

Function:

This parameter can be used for monitoring the V-belt of a fan or other power transmission component to make sure it has not broken. This function is activated when the output current goes below the current level set in parameter 221, *Warning: Low Current*. This function is not active during a start until the drive has reached the speed reference. It is also not active while the drive is stopped or while it is decelerating to a stop.

Description of choice:

In the case of a *Trip*, the drive will stop the motor if the output current drops below the value set in parameter 221.

If *Warning* is selected, the drive will give a warning if the output current drops below the value set in parameter 221.

★ Indicates factory default setting. Numbers in brackets [] represent selection as displayed on the serial bus.



410 Function at Input Phase Loss (MAINS IMBALANCE)

Value:

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

Function:

This determines the action of the drive when one of the incoming power phases is lost. Some action is required to control the level of ripple voltage on the DC bus to avoid damage to the DC bus capacitors. Drive display will show MAINS PHASE LOSS.

Description of choice:

At *Trip*, the drive stops the motor within a few seconds (depending on drive size).

If *Autoderate & Warning* is selected, the drive will export a warning and reduce the output current to 30% of maximum current to maintain operation.

CAUTION

Input Phase Loss!

If *Warning* is selected, life expectancy of the drive could be reduced if input phase loss persists. Select *Warning* only when input phase loss is known to be temporary.

At *Warning*, only a warning will be exported when an input phase loss occurs, but in severe cases, other extreme conditions might result in a trip.

For drives with software version 2.0 or later, select *Autoderate & Warning*. Set parameter 412, *Trip Delay Overcurrent*, to OFF.

CAUTION

Overheating Hazard!

At phase loss, the cooling fan of NEMA 12 drives cannot be powered. To avoid overheating, an external power supply can be connected. Contact Danfoss Graham for further information. Failure to provide fan cooling may result in equipment damage.

411 Function at Drive Overtemperature (FUNCT. OVERTEMP)

Value:

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

Function:

Select the function to be activated when the drive is exposed to an overtemperature condition.

Description of choice:

At *Trip*, the drive stops the motor and exports an alarm.

At *Autoderate & Warning*, the drive first reduces the switching frequency to minimize internal loss. If the overtemperature condition persists, the drive reduces the output current until the heat sink temperature stabilizes. A warning is issued when the function is active.

For drives with software version 2.0 or later, select *Autoderate & Warning*. Set parameter 412, *Trip Delay Overcurrent*, to OFF.

412 Trip Delay Overcurrent (OVERLOAD DELAY)

Value:

OFF or 0 to 60 sec.	★ 60 sec.
---------------------	-----------

Function:

When the output current has reached the current limit set in parameter 215, *Current Limit*, and remains there for the time selected in this parameter, the drive will trip.

Description of choice:

Select how long the drive will run in current limit before it trips.

★ Indicates factory default setting. Numbers in brackets [] represent selection as displayed on the serial bus.

Feedback Signals in Open Loop

In some drives, feedback signals and feedback parameters are only used in closed loop operation. In the VLT 6000, the feedback signals are also active in open loop operation. Although they don't effect the speed of the drive, they can be displayed on the drive's meters.

Parameters 227 and 228 can set high and low limits for the feedback signals, which can activate warnings.

For open or closed loop operation, the feedback signal is scaled in parameters 413 and 414 *Minimum* and *Maximum Feedback*, and the unit displayed is chosen in parameter 415, *Process Units*.

413 Minimum Feedback (MIN. FEEDBACK)

Value:

-999,999.999 to *Maximum Feedback*, Parameter 414 ★ 0.000

Function:

Parameters 413 *Minimum Feedback* and 414 *Maximum Feedback*, are used to scale the feedback signal.

Description of choice:

Set the value to be shown on the display when the feedback signal is at its minimum value.

414 Maximum Feedback (MAX. FEEDBACK)

Value:

Minimum Feedback to 999,999.999 ★ 100.000

Function:

See the description of parameter 413, *Minimum Feedback*.

Description of choice:

Set the value to be shown on the display when the feedback signal is at its maximum value.

415 Units Relating to Closed Loop (REF. / FDBK. UNIT)

Value:

	No unit	[0]	°C	[21]
★	%	[1]	GPM	[22]
	rpm	[2]	gal/s	[23]
	ppm	[3]	gal/min	[24]
	pulse/s	[4]	gal/h	[25]
	l/s	[5]	lb/s	[26]
	l/min	[6]	lb/min	[27]
	l/h	[7]	lb/h	[28]
	kg/s	[8]	CFM	[29]
	kg/min	[9]	ft ³ /s	[30]
	kg/h	[10]	ft ³ /min	[31]
	m ³ /s	[11]	ft ³ /h	[32]
	m ³ /min	[12]	ft/s	[33]
	m ³ /h	[13]	in wg	[34]
	m/s	[14]	ft wg	[35]
	mbar	[15]	PSI	[36]
	bar	[16]	lb/in ²	[37]
	Pa	[17]	HP	[38]
	kPa	[18]	°F	[39]
	m wg	[19]		
	kW	[20]		

Function:

Selects the unit shown on the feedback display.

The selected unit is used if *Reference [unit]* or *Feedback [unit]* has been selected in one of the parameters 007 through 010, as well as in the Display Mode. It will be the unit for *Minimum/Maximum Feedback*. In *Closed Loop*, the unit is also used as the unit for *Minimum/Maximum Reference* and *Minimum/Maximum Feedback*, as well as *Setpoint 1* and *Setpoint 2*.

Description of choice:

Select the unit for the reference/feedback signal.

★ Indicates factory default setting. Numbers in brackets [] represent selection as displayed on the serial bus.



PID for Process Regulation

The built-in proportional, integral, derivative (PID) controller in the drive maintains a constant condition (pressure, temperature, flow, etc.) in the system. It adjusts motor speed based upon a reference and/or setpoint and the feedback signal. The PID controller is activated by setting parameter 100, *Configuration*, to *Closed loop*.

A transmitter supplies the PID controller with a feedback signal from the process to indicate its current state. The type of feedback signal in use depends upon the type of process.

This means that deviations that occur between the reference/setpoint and the actual process state are sensed. Such deviations are compensated for by the PID regulator by adjusting the output frequency as required by the difference (or error) between the reference/setpoint and the feedback signal.

The PID controller in the drive has been designed for use in HVAC applications and to perform a number of specialized functions. Previously, it was necessary for a building management system to handle these special functions by installing extra modules to program the system.

With the VLT 6000, there is no need for extra modules to be installed. Only the reference and/or setpoint and a selected feedback signal need to be programmed. An advanced feature of the VLT 6000 is the drive's ability to accept two feedback signals, making two-zone regulation possible.

Voltage drop in long control cables can be compensated for by using the scaling parameters for the analog inputs.

Feedback

The feedback signal must be connected to the drive according to the table below, depending on the type of feedback signal and the settings of the associated parameters listed.

Feedback type	Terminal	Parameters
Pulse	33	307
Voltage	53 or 54	308, 309, 310 or 311, 312, 313
Current	60	314, 315, 316
Bus feedback 1*	68 and 69	537
Bus feedback 2*	68 and 69	538

*The bus feedbacks can only be set by serial communication.

If two analog feedback signals are to be used, they both must be voltage signals.

The *Minimum Feedback* and *Maximum Feedback*, parameters 413 and 414, must be set for the feedback signals. The type of process unit for the signals is selected in parameter 415, *Process Units*.

Reference (Setpoint)

In parameter 205, *Maximum Reference*, the maximum value of the sum of all reference signals is set.

The *Minimum Reference*, set in parameter 204, indicates the smallest value that the resulting reference can assume.

The reference range cannot exceed the feedback range.

If multiple *Preset References* are required, use multiple setups or set them in parameters 211 to 214 *Preset Reference*. See *Reference Handling*.

If a current signal is used as a feedback signal, voltage can be used as an analog reference. Use the table below to decide which terminal to use and which parameters to program.

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

* The bus reference can only be set by serial communication.

Terminals that are not used should be set to *No function*.

Inverse Regulation

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

Anti-windup

The process controller is factory set with an active anti-windup function. This function ensures that when either a frequency limit or a current limit is reached, the integrator will be reset to zero. If the frequency limit or current limit is cleared, the integrator will turn on again. This function can be disabled in parameter 421, *PID Anti-windup*.

Start-up Conditions

In some applications, the optimum setting of the process regulator takes a long time to reach. In such cases, a start-up frequency can be entered in parameter 422, *PID Start-up Frequency*. The drive will ramp directly to this frequency before PID control begins. This avoids control by deviation between the reference/setpoint and the actual state of the process during acceleration. It also avoids overshoot of the process requirement during acceleration due to lag in the feedback signal.

Differentiator Gain Limit

The differentiation control reacts to the rate of change of the error between the setpoint and the feedback signal. This is seldom needed for HVAC applications. If the differentiation function becomes too dominant, the differentiation factor can be limited. This is done in parameter 426, *PID Differentiator Gain Limit*.

Lowpass Filter

Noise on the feedback signal can be reduced by using the built-in lowpass filter. Set a suitable lowpass filter time constant. This time constant determines the cutoff frequency of the filter.

If the lowpass filter has been set to 0.1s, the cut-off frequency will be 10 RAD/sec., corresponding to $(10/2 \times \pi) = 1.6$ Hz. This means that any noise on the feedback signal whose frequency is greater than 1.6 Hz will be filtered out. Choose a suitable time constant in parameter 427, *PID Lowpass Filter Time*.

Optimization of the Process Regulator

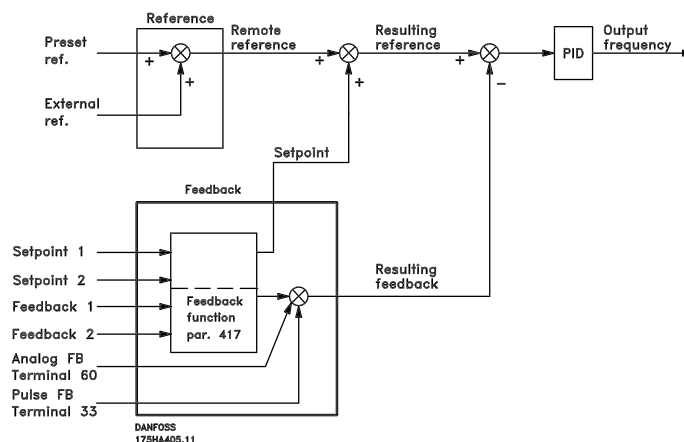
The basic settings have now been made; all that remains to be done is to optimize the proportional gain, the integration time and, if needed, the differentiation time. These are set by parameters 423, 424 and 425. In most processes, this can be done by following the guidelines below.

1. Start the motor.
2. Set parameter 423, *PID Proportional Gain*, to 0.3 and increase it until the feedback signal becomes unstable. Then reduce the value until the feedback signal has stabilized. Now lower the proportional gain by about half (40% to 60%).
3. Set parameter 424, *PID Integration Time*, to 20 seconds and reduce the value until the feedback signal becomes unstable. Increase the integration time until the feedback signal stabilizes. Now increase the integration time from 15% to 50%.
4. Parameter 425, *PID Differentiation Time*, is only used in very fast-acting systems and should be left off for most HVAC applications. When it is used, the typical value is 1/4th the value set in parameter 424, *PID Integration Time*. The differentiator should only be used when the setting of the proportional gain and the integration time have been fully optimized.

Starting and stopping the drive will produce the necessary error signal in the process to set the PID.

PID Overview

The block diagram below shows reference and setpoint in relation to the feedback signal.



As can be seen, the remote reference is added to Setpoint 1 or Setpoint 2. The setpoint that is active depends on the value of parameter 417, *Feedback Function*.

Feedback Handling

Handling of the feedback signal(s) can be seen from the block diagram on the next page. The block diagram shows how and by which parameters the feedback handling is affected.

Feedback signals can be voltage, current, pulse and bus feedback signals. In two zone feedback systems, both feedback signals must be voltage signals (terminals 53 and 54). Please note that *Feedback 1* consists of bus feedback 1, (parameter 537) added to the feedback signal value of terminal 53. *Feedback 2* consists of bus feedback 2, (parameter 538) added to the feedback signal value of terminal 54.

In addition, the drive has an internal calculator capable of converting a pressure signal into a "linear flow" feedback signal. This function is activated in parameter 416, *Feedback Conversion*.

The parameters for feedback handling are active both in closed and open loop modes. In open loop, the feedback signal can be displayed on one of the drive's meters and the drive can produce warnings if the feedback signal is beyond the range set in parameters 227, *Warning: Low Feedback* and 228, *Warning: High Feedback*.

Feedback Handling (continued)

During closed loop operation, there are three ways to use the PID controller and setpoint and feedback signals:

- 1 setpoint and 1 feedback
- 1 setpoint and 2 feedbacks
- 2 setpoints and 2 feedbacks

1 Setpoint and 1 Feedback

In HVAC applications it is often possible to place a pressure or temperature sensor at the farthest significant load and measure actual pressure or temperature in the system. In these cases, the drive's PID controller can respond to system changes, as programmed. When only one setpoint and one feedback signal are used, the drive responds to the feedback signal to match the programmed setpoint in parameter 418, *Setpoint 1*. (If a remote reference is used, it will be added to the setpoint.)

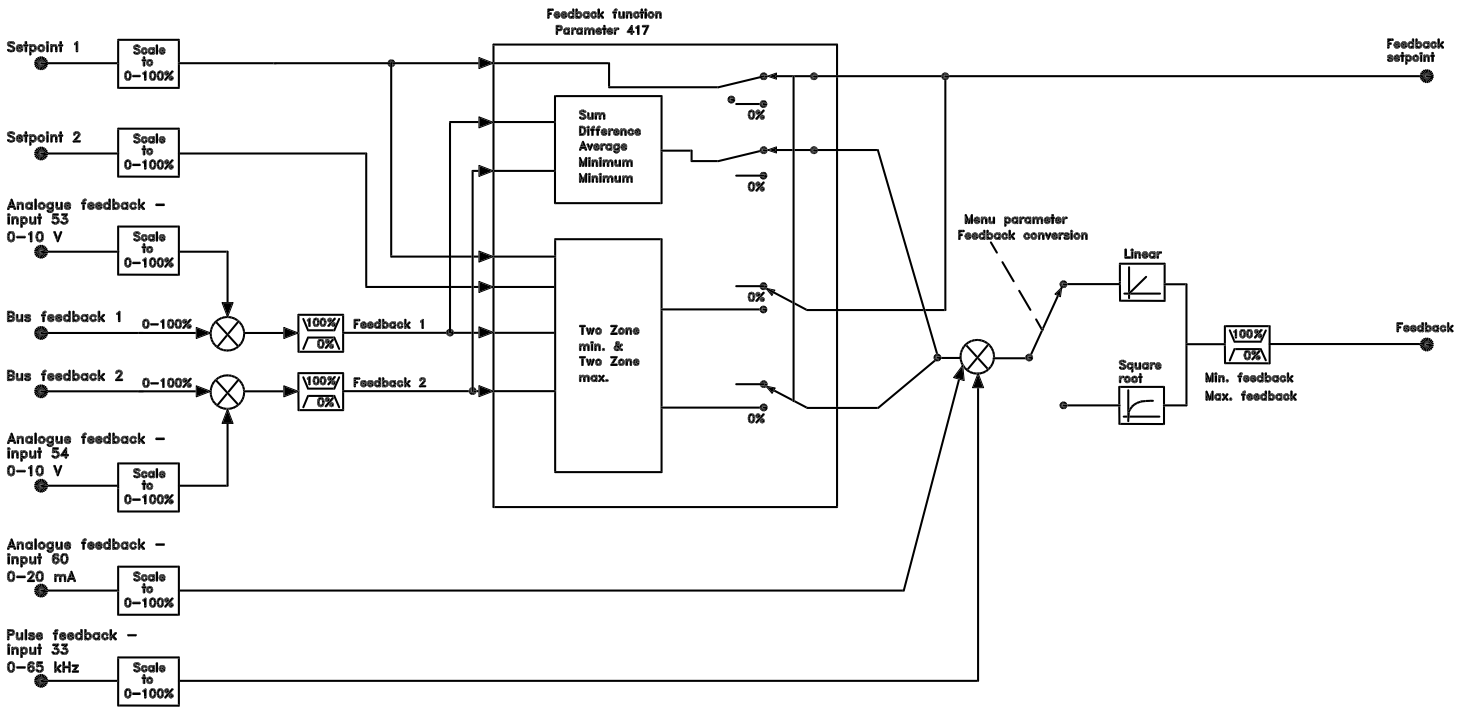
1 Setpoint and 2 Feedbacks

Depending on the feedback function selected in parameter 417, *Feedback Function*, the two feedback signals will be compared to the setpoint. A description of the individual feedback functions is given in parameter 417. As above, parameter 418, *Setpoint 1*, will be added to the remote reference, if a remote reference is used.

2 Setpoints and 2 Feedbacks

Whenever two critical zones do not have the same setpoint value, two feedback with two setpoint control is required. Many pumping systems require the monitoring and control of two loads that differ in size and pressure drop. Or this can be effective when controlling different temperature zones in cooling or heating applications. Parameter 418, *Setpoint 1*, is the setpoint for zone 1. Feedback for zone 1 is the feedback signal at terminal 53. Parameter 419, *Setpoint 2*, is the setpoint for zone 2 and terminal 54 for feedback 2. Bus Feedback 1 and 2 (parameters 535 and 536) are added to their respective feedback signals, when serial bus data is added to the zone control.

Parameter 417, *Feedback Function*, selects whether the drive will attempt to have both feedback signals meet the minimum (2 zone min.) or maximum (2 zone max.) to their respective setpoints.



Feedback Handling Block Diagram

416 Feedback Conversion (FEEDBACK CONV.)

Value:

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

Function:

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

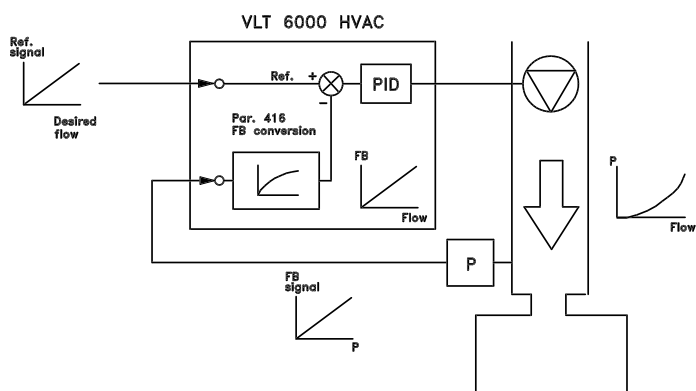
This can be used where regulation of a flow is required and the feedback is from a pressure sensor (flow is proportional to the square root of pressure). This conversion makes it possible to set the reference in such a way that there is a linear connection between the reference and the flow required. See diagram below.

Feedback conversion should not be used if two-zone regulation has been selected in parameter 417, *Feedback Function*.

Description:

If *Linear* is selected, the feedback signal and the feedback value will be proportional.

If *Square root* is selected, the drive first takes the square root of the feedback signal.



417 Feedback Function (2 FEEDBACK, CALC.)

Value:

- Minimum (MINIMUM) [0]
- ★ Maximum (MAXIMUM) [1]
- Sum (SUM) [2]
- Difference (DIFFERENCE) [3]
- Average (AVERAGE) [4]
- Two-zone minimum (2 ZONE MIN) [5]
- Two-zone maximum (2 ZONE MAX) [6]
- Feedback 1 only (FEEDBACK 1 ONLY) [7]
- Feedback 2 only (FEEDBACK 2 ONLY) [8]

Function:

This parameter determines the calculation method for two feedback signals. Terminals 53 and 54 are both read in selections [0] through [6]. In each case, if only one feedback signal is received, a zero value will be calculated for the inactive terminal. To read feedback from only one of the two terminals, use *Feedback 1 Only* (terminal 53) or *Feedback 2 Only* (terminal 54) to exclude the inactive terminal.

Feedback 1 = Sum of parameter 535, *Bus Feedback 1*, (if present) and the feedback signal value of terminal 53.

Feedback 2 = Sum of parameter 536, *Bus Feedback 2*, (if present) and the feedback signal value of terminal 54.

Description of choice:

If *Minimum* is selected, the drive will compare *Feedback 1* with *Feedback 2* and regulate on the basis of the lower feedback value.

If *Maximum* is selected, the drive will compare *Feedback 1* with *Feedback 2* and regulate on the basis of the higher feedback value.

If *Sum* is selected, the drive will total *Feedback 1* with *Feedback 2*.

If *Difference* is selected, the drive will subtract *Feedback 1* from *Feedback 2*.

If *Average* is selected, the drive will calculate the average of *Feedback 1* and *Feedback 2*.

If 2-zone *Minimum* is selected, the drive will calculate the difference between *Setpoint 1* and *Feedback 1* as well as *Setpoint 2* and *Feedback 2*. The drive will regulate its output speed based on the larger difference. A positive difference, (a setpoint higher than the feedback), is always larger than a negative difference.

If 2-zone *Maximum* is selected, the drive will calculate the difference between *Setpoint 1* and *Feedback 1* as well as *Setpoint 2* and *Feedback 2*. After the calculation, the drive will use the smaller difference. A negative difference (a setpoint lower than the feedback) is always smaller than a positive difference.

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

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

NOTE

Value of parameter 418, *Setpoint 1*, is added to any remote reference when *Minimum*, *Maximum*, *Sum*, *Difference* or *Average* is selected.

★ Indicates factory default setting. Numbers in brackets [] represent selection as displayed on the serial bus.

418 Setpoint 1 (SETPOINT 1)

Value:
Feedback Minimum to Feedback Maximum ★ 0.000

Function:

Setpoint 1 is used to provide the setpoint reference for PID control with one feedback signal. It is also used for the setpoint for zone one in two-setpoint PID control. External and preset references may be added to its value.

In open loop, Setpoint 1 should be set to 0 to prevent parameter 417, Feedback Function, from affecting the reference.

See description of parameter 417, Feedback Function.

Description of choice:

Set the desired value within the programmed minimum and maximum. The process unit is selected in parameter 415, Process Units.

419 Setpoint 2 (SETPOINT 2)

Value:
Feedback minimum to Feedback maximum ★ 0.000

Function:

Setpoint 2 is used to provide the setpoint reference for zone two in two-zone PID. In open loop, Setpoint 2 should be set to 0, to prevent parameter 417, Feedback Function, from affecting the reference.

See description of parameter 417.

Description of choice:

Set the required value. The process unit is selected in parameter 415, Process Units.

420 PID Normal/Inverse Control (PID NOR/INV. CTRL)

Value:
★ Normal (NORMAL) [0]
Inverse (INVERSE) [1]

Function:

This determines how the drive's PID controller responds to an error between the setpoint and feedback.

Used in Closed Loop, (parameter 100).

Description of choice:

Select *normal* when the drive is to reduce the output frequency as the feedback signal increases.

Select *inverse* when the drive is to increase the output frequency as the feedback signal increases.

421 PID Anti-windup (PID ANTI WINDUP)

Value:
Off (DISABLE) [0]
★ On (ENABLE) [1]

Function:

It is possible to choose whether the PID controller integrator is to continue to sum the error signal when it is not possible to increase or decrease the output frequency to correct the error.

Used in Closed Loop, parameter 100.

Description of choice:

The factory setting is *On*, which means that the error integrator is cleared if either the current limit, the voltage limit or the maximum or minimum frequency has been reached. The integrator will not function again until regulation is possible. Select *Off* if the integrator is to continue integrating even if it is not possible to correct the error.

422 PID Start-up Frequency (PID START VALUE)

Value:
Minimum frequency to maximum frequency (set by parameters 201 and 202) ★ 0 Hz

Function:

Each time the drive is given a start command, the start-up frequency is the speed the drive accelerates to before PID control is activated. The drive will follow the acceleration ramp when a start signal is received as if in open loop. When the programmed start-up frequency is reached, it will change to closed loop operation.

Used in Closed Loop, parameter 100.

Description of choice:

Set the required start frequency. For software versions prior to 2.0, do not set this frequency between 0.1 and 7.7 Hz.

NOTE

If drive is running in current limit before desired start frequency is obtained, PID control will not be activated. To avoid this, start frequency must be low enough to ensure drive does not go into current limit. This can be done during operation.

★ Indicates factory default setting. Numbers in brackets [] represent selection as displayed on the serial bus.

423 PID Proportional Gain
(PID PROP. GAIN)
Value:
0.00 to 10.00 ★ 0.30

Function:
The proportional gain determines how fast the system responds to a change in feedback.

Used in *Closed Loop*, parameter 100.

Description of choice:
Quick regulation is obtained by a high gain, but, if the gain is too high, the process may become unstable. See Optimization of the Process Regulator for information on proper adjustment.

424 PID Integral Time
(PID INTEGR.TIME)
Value:
0.01 to 9999.00 sec. (OFF) ★ OFF

Function:
The integrator adds the error signal over time and uses this to correct the speed of the drive.

The integral time is the time needed by the integrator to have the same effect as the proportional gain.

Used in *Closed Loop* parameter 100.

Description of choice:
Fast regulation is obtained by setting a short integration time. However, if this time is too short, the process will overcorrect and become unstable. See Optimization of the Process Regulator for information on proper adjustment.

425 PID Differentiation Time
(PID DIFF. TIME)
Value:
0.00 (OFF) to 10.00 sec. ★ OFF

Function:
The differentiator responds to the rate of change of the error signal.

The quicker the error changes, the greater the response from the differentiator.

Used in *Closed Loop*, parameter 100.

Description of choice:
Fast regulation can be obtained by means of a long differentiation time. If this time is too long, the process may overshoot. The differentiator is generally set of OFF in HVAC applications. See Optimization of the Process Regulator for information on proper adjustment.

426 PID Differentiator Gain Limit
(PID DIFF. GAIN)
Value:
5.0 to 50.0 ★ 5.0

Function:
When the differentiator is used, fast changes in the error can sometimes cause unstable operation. In these cases it may be useful to limit the contribution of the differentiator.

Used in *Closed Loop*, parameter 100.

Description of choice:
A lower limit will improve stability, but will reduce the effect of the differential.

427 PID Lowpass Filter Time
(PID FILTER TIME)
Value:
0.01 to 10.00 ★ 0.01

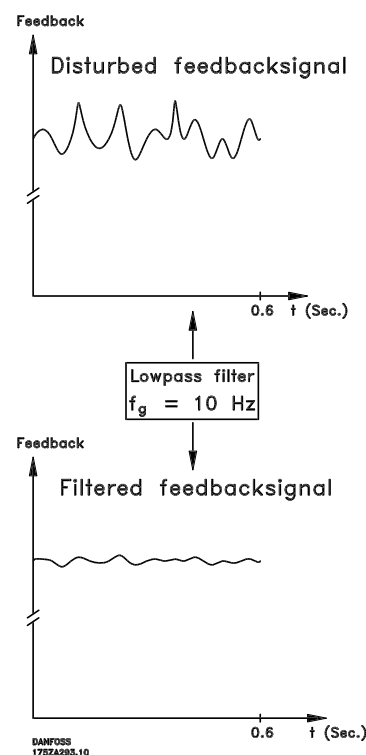
Function:
Noise on the feedback signal can be reduced by the lowpass filter.

Used in *Closed Loop*, parameter 100.

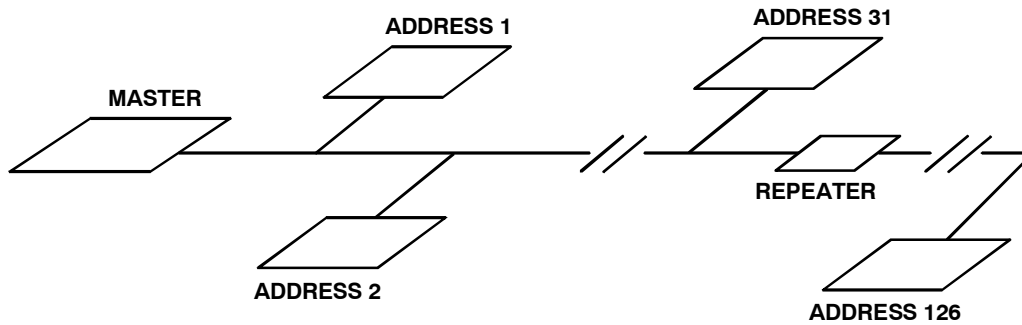
Description of choice:
Select the desired time constant (t).

The cut off frequency equals $\frac{1}{2\pi t}$. For example, if a time constant of 0.1 s is programmed, the cut off frequency for the lowpass filter will be $\frac{1}{[2\pi (.1)]} = 1.6$ Hz.

The PID controller will then only respond to changes in the feedback signal whose frequency is less than 1.6 Hz.



★ Indicates factory default setting. Numbers in brackets [] represent selection as displayed on the serial bus.



Protocols

All VLT 6000 drives have an RS-485 port which allows controlling the drive by one of four different serial communication protocols. The protocols, which can be selected in parameter 500, *Protocol*, are:

- Johnson Controls Metasys N2®
- Siemens FLN®
- Modbus RTU
- Danfoss FC protocol

Metasys N2 is a registered trademark of Johnson Controls.

FLN is a registered trademark of Siemens.

If Danfoss FC protocol is to be selected, set parameter 500, *Protocol* to *FC protocol*.

For further information on operating the drive through N2, FLN, or Modbus RTU communication, request the related operator's manual from Danfoss Graham.

Packet Communication

Control and Reply Packets

The packet communication in a master/slave system is controlled by the master. The drives are the slaves. A maximum of 31 VLT 6000 drives can be connected to one master unless a repeater is used. If a repeater is used, a maximum of 126 drives can be connected to one master.

The master continuously sends packets addressed to the slaves and awaits reply packets from them. The response time of the slaves is a maximum of 50 ms.

Only a slave that has received a faultless packet addressed to that slave will respond by sending a reply packet.

Broadcast

When a master sends a packet to all slaves connected to the bus at the same time, it is called a broadcast. In broadcast communication, if the packet has been correctly received, the slaves do not send reply packets to the master.

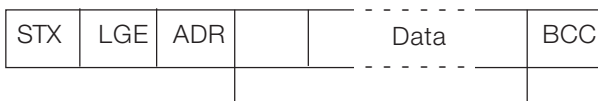
Contents of a Character (byte)

Each transferred character begins with a start bit. Subsequently, eight data-bits are transferred, corresponding to one byte. Each character is sent with a parity bit to produce even parity (i.e., an even number of binary 1's in the eight data-bits and the parity bit combined). A character ends with a stop bit and therefore consists of a total of eleven bits.

Start bit	0	1	2	3	4	5	6	7	Even Parity	Stop Bit
-----------	---	---	---	---	---	---	---	---	-------------	----------

Packet Buildup with FC Protocol

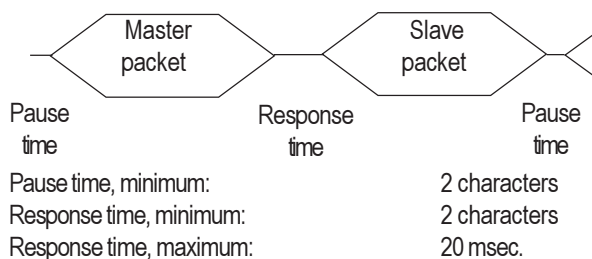
Each packet begins with a start character (STX) = 02 Hex, followed by a byte that gives the packet length (LGE) and a byte that gives the drive address (ADR). Next a number of data bytes is sent. The size of the packet is variable, depending upon the packet type. The packet ends with a data control byte (BCC).



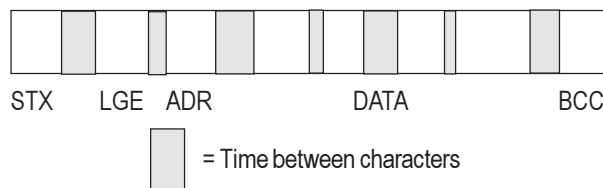
Packet Times

The speed of communication between a master and a slave depends on the baud rate. The baud rate of the drive must be the same as the baud rate of the master. Select the baud rate of the drive in parameter 502, *Baud Rate*.

After a reply packet from the slave, there must be a minimum pause of two characters (22 bits) before the master is able to send another packet. At a baud rate of 9600 baud, there must be a minimum pause of 2.3 msec. After the master has completed the packet, the response time of the slave back to the master is a maximum 20 msec., with a minimum pause of two characters.



The time between individual characters in a packet is not to exceed two characters, and the packet must be completed within 1.5 times the rated packet time. If the baud rate is 9600 and the packet length is 16 characters, the packet must be completed within 27.5 msec.



Packet Length (LGE)

The packet length is the number of data bytes plus address byte ADR plus data control byte BCC.

Packets with four data bytes have a length of:
 $LGE = 4 + 1 + 1 = 6$ bytes

Packets with twelve data bytes have a length of:
 $LGE = 12 + 1 + 1 = 14$ bytes

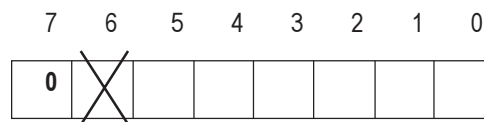
Packets that contain text have a length of 10+n bytes. Ten is the fixed characters, while 'n' is variable, depending on the length of the text.

Drive Address (ADR)

Two different address formats are used in which the address range of the drive is either from 1 through 31 or from 1 through 126.

1. Address format 1-31

The byte for this address range has the following profile:



Bit 7 = 0 (address format 1 through 31 active)

Bit 6 is not used

Bit 5 = 1: Broadcast, address bits (0 through 4), not used

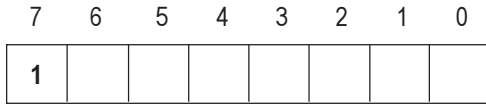
Bit 5 = 0: No Broadcast

Bit 0 through 4 = Drive address 1 through 31



1. Address format 1 through 126

The byte for the 1 through 126 address range has the following profile:



Bit 7 = 1 (address format 1 through 126 active)

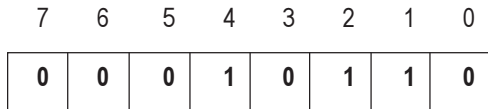
Bit 0 through 6 = Drive address 1 through 126

Bit 0 through 6 = 0 Broadcast

The slave sends the address byte back to the master in the reply packet in unchanged form.

Example:

A packet is sent to drive address 22 using address format 1 through 31:



Data Control Byte (BCC)

The data control byte can be explained by means of an example:
Before the first byte of the packet is received, the calculated check sum (BCS) is 0.



After the first byte (02H) has been received:

BCS = BCC EXOR "first byte"
(EXOR = exclusive-or gate)
BCS = 00000000
EXOR

"first byte" = 00000010 (02H)
BCC = 00000010

Each additional, subsequent byte is gated with BCS EXOR and results in a new BCC, such as:

BCS = 00000010
EXOR

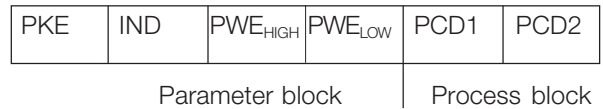
"second byte" = 11010110 (D6H)
BCC = 11010100

Data Character (byte)

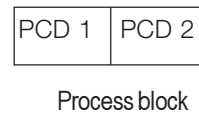
The buildup of data blocks depends on the type of packet. There are three types of packets. The packet type applies to both control packets (master→slave) and reply packets (slave→master).

The three types of packets are the following:

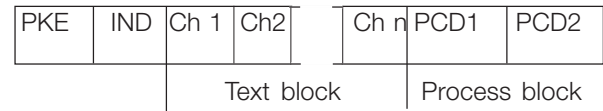
1. Parameter block, used for transferring parameters between master and slave. The data block has 12 bytes (6 words) and also contains the process block.



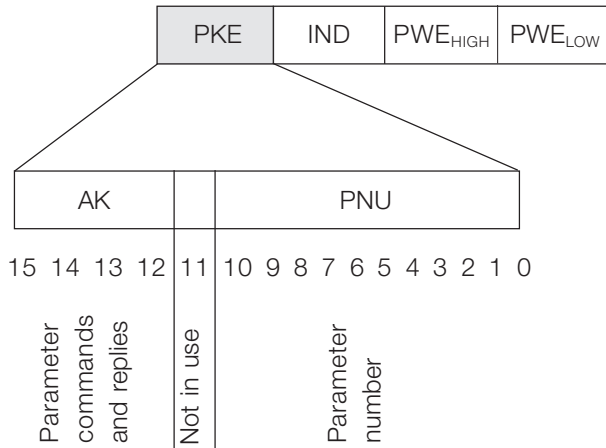
2. Process block, built up as a data block with four bytes (two words), covering:
 - Control word and reference value (from master to slave)
 - Status word and present output frequency (from slave to master).



3. Text block, used for reading or writing texts via the data block.



1. Parameter Bytes



Parameter commands and replies (AK)
 Bits no. 12-15 are used for transferring parameter commands from master to slave and the slave's processed reply back to the master.

Parameter Commands Master→Slave:

Bit no.

15	14	13	12	Parameter command
0	0	0	0	No command
0	0	0	1	Read parameter value
0	0	1	0	Write parameter value in RAM (word)
0	0	1	1	Write parameter value in RAM (double word)
1	1	0	1	Write parameter value in RAM and EEPROM (double word)
1	1	1	0	Write parameter value in RAM and EEPROM (word)
1	1	1	1	Read/write text

Reply slave→master:

Bit no.

15	14	13	12	Reply
0	0	0	0	No reply
0	0	0	1	Parameter value transferred (word)
0	0	1	0	Parameter value transferred (double word)
0	1	1	1	Command cannot be executed
1	1	1	1	Text transferred

If the command cannot be carried out, the slave will send this reply (0111) *Command cannot be executed* and give the following error message in the parameter value (PWE):

(reply 0111)	Error message
0	The parameter number used does not exist
1	There is no write access to the parameter called
2	The data value exceeds the parameter limits
3	The used sub-index does not exist
4	The parameter is not of the array type
5	The data type does not match the parameter called
17	Data change in the parameter called is not possible in the present mode of the drive. Some parameters can only be changed when the motor has stopped
130	There is no bus access to the parameter called
131	Data change is not possible because factory setup has been selected

Parameter Number (PNU)

Bits numbered 0-10 are used for transmitting parameter numbers. The function of a given parameter can be seen from the parameter description in the programming section.

Index



Index is used together with the parameter number for read/write access to parameters with an index, such as parameter 615, *Error Code*.

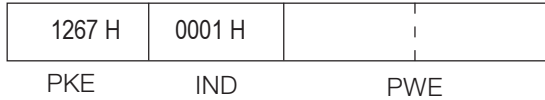
Index has 2 bytes - a lowbyte and a highbyte. However, only the lowbyte is used. See the example on the following page.

Example - Index:

The first error code (index [1]) in parameter 615, *Error code*, must be read.

PKE = 1267 Hex (read parameter 615, *Error Code*).

IND = 0001 Hex - Index no. 1.



The drive will respond in the parameter value (PWE) block by means of an error code with a value from 1 through 99. See *List of Warnings and Alarms* to identify the error code.

Parameter Value (PWE)



The parameter value block consists of 2 words (4 bytes). Its value depends on the command given (AK). If the master inquires about a parameter value, the PWE block contains no value.

If a parameter value is to be changed by the master (write), the new value is entered in the PWE block and sent to the slave.

If the slave responds to a parameter requirement (read command), the present parameter value is transferred in the PWE block and returned to the master.

If a parameter does not contain a numerical value, but several data selection options, for example parameter 001, *Language*, where [0] is *English* and [4] is *Spanish*, the data value is selected by writing the value in the PWE block. See the example on the following page.

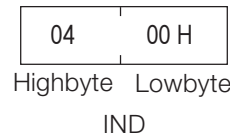
Through serial communication, it is only possible to read parameters with data type 9 (text string). In VLT 6000 drives, parameters 621 through 631, *Nameplate Data* are data type 9. For example, it is possible in parameter 621, *Unit Type*, to read the unit size and input voltage range.

When a text string is transferred (read), the packet length is variable, since the texts have different lengths. The packet length is stated in the 2nd byte of the packet, called LGE.

In order to read a text via the PWE block, the parameter command (AK) must be set to 'F' Hex.

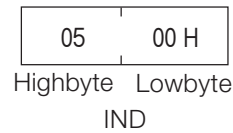
The index character is used to indicate whether the command in question is a read or write command.

For a read command, the index must have the following format:



The drive has two parameters for which a text can be written. These are parameters 533 and 534, *Display Text*. See the description in the parameter section of this manual. In order to write a text via the PWE block, the parameter command (AK) must be set to 'F' Hex.

For a write command, the index must have the following format:



The following data types are supported by the drive:

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

Unsigned means there is no sign included in the packet.

Example - Write a parameter value:

Parameter 202, *Output Frequency, High Limit*, is to be changed to 100 Hz. This value must be remembered after a power failure, so it is written in EEPROM.

PKE = E0CA Hex - Write to parameter 202, *Output Frequency, High Limit*

IND = 0000 Hex

PWE_{HIGH} = 0000 Hex

PWE_{LOW} = 03E8 Hex - Data value 1000, corresponding to 100 Hz, see *Conversion*.

E0CA H	0000 H	0000 H	03E8 H
PKE	IND	PWE _{HIGH}	PWE _{LOW}

The reply from the slave to the master will be:

10CA H	0000 H	0000 H	03E8 H
PKE	IND	PWE _{HIGH}	PWE _{LOW}

Example - Choice of a Data Value:

kW is to be selected in parameter 415, *Process Units*. This value must be remembered after a power failure, so it is written in EEPROM.

PKE = E19F Hex - Write to parameter 415, *Process Units*

IND = 0000 Hex

PWE_{HIGH} = 0000 Hex

PWE_{LOW} = 0014 Hex - Choose data choice *kW* [20]

E19F H	0000 H	0000 H	0014 H
PKE	IND	PWE _{HIGH}	PWE _{LOW}

The reply from the slave to the master will be:

119F H	0000 H	0000 H	0014 H
PKE	IND	PWE _{HIGH}	PWE _{LOW}

Example - Read a parameter value:

The value in parameter 206, *Ramp Up Time*, is required. The master sends the following inquiry:

PKE = 10CE Hex - read parameter 206, *Ramp Up Time*

IND = 0000 Hex

PWE_{HIGH} = 0000 Hex

PWE_{LOW} = 0000 Hex

10CE H	0000 H	0000 H	0000 H
PKE	IND	PWE _{HIGH}	PWE _{LOW}

If the value in parameter 206, *Ramp Up Time*, is 10 seconds, the reply from the slave to the master will be as follows:

10CE H	0000 H	0000 H	000A H
PKE	IND	PWE _{HIGH}	PWE _{LOW}

Conversion

The different attributes for each parameter can be seen in the section on factory settings.

Since a parameter value can only be transferred as a whole number, a conversion factor must be used to transfer decimals.

Example:

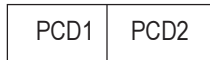
Parameter 201: *Minimum Frequency*, conversion factor 0.1. If parameter 201 is to be set to 10 Hz, a value of 100 must be transferred, since a conversion factor of 0.1 means that the transferred value will be multiplied by 0.1. A value of 100 will, therefore, be understood as 10.0.

Index	Factor
74	3.6
2	100.0
1	10.0
0	1.0
-1	0.1
-2	0.01
-3	0.001
-4	0.0001

Conversion Table

Process word

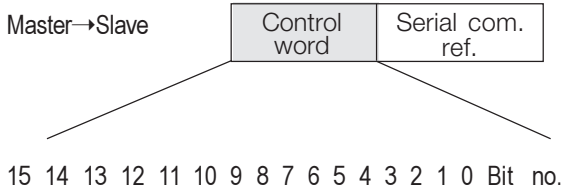
The process word block is divided into two blocks each of 16 bits, which always come in the sequence stated.



	PCD1	PCD2
Control packet (master→slave)	Control word	Reference value
Reply packet (slave→master)	Status word	Given output frequency

Control Word per FC Protocol

The control word is used for transmitting commands from a master (PC) to a slave (drive).



Bit 00/01:

Bits 00 and 01 are used for choosing between the four pre-programmed references parameters 211 through 214, *Preset Reference*, as shown in the table below.

Preset Reference	Parameter	Bit 01	Bit 00
1	211	0	0
2	212	0	1
3	213	1	0
4	214	1	1

Bit	Bit = 0	Bit = 1
00		Preset ref. lsb
01		Preset ref. msb
02	DC braking	
03	Coasting stop	
04	Quick stop	
05	Freeze output frequency	
06	Ramp stop	Start
07		Reset
08		Jog
09	No function	No function
10	Data not valid	Data valid
11		Activate relay 1
12		Activate relay 2
13		Choice of setup lsb
14		Choice of setup msb
15		Reversing

NOTE

Parameter 508, *Choice of Preset Reference*, is used to choose how bits 00/01 are to be gated with the corresponding functions of the digital inputs.

Bit 02, DC BRAKE:

Bit 02 = 0 enables DC braking. Set braking current and duration in parameter 114, *DC Braking Current*, and in parameter 115, *DC Braking Time*.

NOTE

Parameter 504, *DC Brake*, is used for selecting how bit 02 is to be gated with the corresponding function of terminal 27.

Bit 03, Coasting Stop:

Bit 03 = 0 means that the drive will coast to a stop.
 Bit 03 = 1 means that the drive is able to start the motor, provided the other conditions for starting are fulfilled.

NOTE

In parameter 503, *Coasting Stop*, the choice is made of how bit 03 is to be gated with the corresponding function of terminal 27.

Bit 04, Quick Stop:

Bit 04 = 0 leads to a stop in which the motor speed is ramped down to a stop as set in parameter 207, *Ramp Down Time*.

Bit 05, Freeze Output Frequency:

Bit 05 = 0 means that the given output frequency is frozen. The frozen output frequency can now only be changed with the digital inputs programmed for *Speed Up* and *Speed Down*.

NOTE

If *Freeze Output* is active, drive cannot be stopped via Bit 06, *Start*, or through terminal 18. Drive can only be stopped in following ways:

- Bit 03, *Coasting Stop*
- Terminal 27
- Bit 02, *DC Braking*
- Terminal 19 programmed for *DC Braking*

Bit 06, Ramp Stop/Start:

Bit 06 = 0 leads to a stop in which the motor speed is ramped down to stop through parameter 207, *Ramp Down Time*.
 Bit 06 = 1 means that the drive is able to start the motor, provided the other conditions for starting are fulfilled.

NOTE

Parameter 505, *Start*, determines how bit 06, *Ramp Stop/Start*, is gated and corresponding function of terminal 18.

Bit 07, Reset:

Bit 07 = 0 leads to no reset.
 Bit 07 = 1 means that a trip is reset.
 Reset is activated on the leading edge of the signal, at the time the signal changes from logic 0 to logic 1.

Bit 08, Jog:

Bit 08 = 1 means that the output frequency is determined by parameter 209, *Jog Frequency*.

Bit 09, No function:

Bit 09 has no function.

Bit 10, Data Not Valid/Data Valid:

Used for telling the drive whether the control is to be used or ignored.
 Bit 10 = 0 means that the control word is ignored.
 Bit 10 = 1 means that the control word is used. This function is relevant because the control word is always contained in the packet, regardless of the type of packet used. Therefore it is possible to disconnect the control word if it is not to be used in connection with updating or reading of parameters.

Bit 11, Relay 1:

Bit 11 = 0 Relay 1 is not activated.
 Bit 11 = 1 Relay 1 is activated, provided *Control Word Bits 11/12* has been selected in parameter 323, *Relay Outputs*.

Bit 12, Relay 2:

Bit 12 = 0 Relay 2 is not activated.
 Bit 12 = 1 Relay 2 is activated, provided *Control Word Bits 11/12* has been selected in parameter 326, *Relay Outputs*.

NOTE

If time-out period set in parameter 556, *Bus Time Interval Function*, is exceeded, relays 1 and 2 will have voltage removed if activated via serial communication.

Bits 13/14, Choice of Setup:

Bits 13 and 14 are used to choose among the four menu setups in accordance with the following table:

Setup	Bit 14	Bit 13
1	0	0
2	0	1
3	1	0
4	1	1

This function is only possible if *Multi-setup* has been selected in parameter 004.

NOTE

In parameter 507, *Choice of Setup*, a choice is made of how bits 13/14 are gated with corresponding function of digital inputs.

Bit 15, No function/reversing:

Bit 15 = 0 leads to no reversing
 Bit 15 = 1 leads to reversing
 In the factory setting, reversing has been selected as digital in parameter 506, *Reversing*. Bit 15 will only allow reversing, if *bus or logic* or has been selected, or *logic and* has been selected and a signal is present at terminal 19.

Status Word per FC Protocol

The status word is used to inform the master (e.g., a PC) of the condition of the slave (drive).

Slave → Master



15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 Bit no.

Bit	Bit = 0	Bit = 1
00	Trip	Control ready
01		Drive ready
02		Standby
03	No trip	Trip
04	Not in use	
05	Not in use	
06	Not in use	
07	No warning	Warning
08	Speed reference	Speed = reference
09	Local operation	Serial comm. control
10	Out of frequency range	
11		Running
12	No function	No function
13		Voltage warning high/low
14		Current limit
15		Thermal warning

Bit 00, Control Ready:

Bit 00 = 1 The drive is ready for operation.

Bit 00 = 0 The drive has tripped.

Bit 01, Drive Ready:

Bit 01 = 1 The drive is ready for operation, but terminal 27 is a logic 0 and/or a coasting command has been received via serial communication.

Bit 02, Standby:

Bit 02 = 1 The drive is able to start the motor when a start command is given.

Bit 03, No Trip/Trip:

Bit 03 = 0 means that the drive is not in an error state.

Bit 03 = 1 means that the drive has tripped and needs a reset signal in order for operation to be resumed.

Bit 04, Not in use:

Bit 04 is not used in the status word.

Bit 05, Not in use:

Bit 05 is not used in the status word.

Bit 06, Not in use:

Bit 06 is not used in the status word.

Bit 07, No warning/warning:

Bit 07 = 0 means there is no warning.

Bit 07 = 1 means a warning has occurred.

Bit 08, Speed ≠ Reference/Speed = Reference:

Bit 08 = 0 means that the motor is running, but that the present speed is different from the preset speed reference. This may be the case when the speed is being ramped up or down after a start or stop command.

Bit 08 = 1 means that the present motor speed equals the preset speed reference.

Bit 09, Local Operation/Serial Communication Control:

Bit 09 = 0 means that OFF/STOP has been activated on the control unit, or that the drive is in Hand mode. It is not possible to control the drive through serial communication.

Bit 09 = 1 means that it is possible to control the drive through serial communication.

Bit 10, Out of Frequency Range:

Bit 10 = 0 if the output frequency is outside the range established by the values in parameter 201, *Output Frequency Low Limit*, and parameter 202, *Output Frequency High Limit*.

Bit 10 = 1 means that the output frequency is within the limits of those parameters.

Bit 11, Not Running/Running:

Bit 11 = 0 means that there is no output from the drive.

Bit 11 = 1 means that the drive has a start signal, or that the output frequency is greater than 0 Hz.

Bit 12, No Function:

Bit 12 has no function.

Bit 13, Voltage Warning High/Low:

Bit 13 = 0 means that there is no voltage warning.

Bit 13 = 1 means that the DC voltage of the drive intermediate circuit is too low or too high.

Bit 14, Current Limit:

Bit 14 = 0 means that the output current is less than or equal to the value in parameter 215, *Current Limit*.

Bit 14 = 1 means that the output current is higher than the value in parameter 215, *Current Limit*, and the drive will trip after the time set in parameter 412, *Trip Delay Overcurrent*, has passed if the output current is not reduced.

Bit 15, Thermal Warning:

Bit 15 = 0 means there is no thermal warning.

Bit 15 = 1 means that the temperature limit has been exceeded either in the motor, in the drive or from a thermistor connected to an analog input.

Serial Communication Reference

Master→Slave



15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 Bit no.

The serial communication reference is transmitted to the drive in the form of a 16-bit word. The value is transmitted as whole numbers 0 through ± 32767 ($\pm 200\%$).
16384 (4000 Hex) corresponds to 100 %.

The serial communication reference has the following format:

0 through 16384 (4000 Hex) - 0 through 100% (parameter 204, *Minimum Reference* - Par. 205, *Maximum Reference*).

It is possible to change the direction of rotation through the serial reference. This is done by converting the binary reference value to 2's complement. See example in next column.

Example - Control word and serial communication reference:

The drive must receive a start command, and the reference is to be set to 50% (2000 Hex) of the reference range.

Control word = 047F Hex. Start command
Reference = 2000 Hex. 50 % reference



Control word Reference

The drive is to receive a start command, and the reference is to be set to -50% (-2000 Hex) of the reference range.

The reference value is first converted to the first complement; then 1 binary is added to get 2's complement:

2000 Hex = 0010 0000 0000 0000 binary
1' complement = 1101 1111 1111 1111 binary
+ 1 binary
2' complement = 1110 0000 0000 0000 binary

Control word = 047F Hex. Start command
Reference = E000 Hex. -50 % reference



Control word Reference

Present Output Frequency

Slave→Master



15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 Bit no.

The value of the output frequency of the drive at any given time is transmitted as a 16-bit word. The value is transmitted in the form of whole numbers 0 through ± 32767 ($\pm 200\%$).

16384 (4000 Hex) corresponds to 100%.

The output frequency has the following format:

0 through 16384 (4000 Hex) @ 0 to 100% (Parameter 201, *Output Frequency Low limit* - Parameter 202, *Output Frequency High Limit*).

Example - Status Word and Present Output Frequency:

The master receives a status message from the drive that the present output frequency is 50% of the output frequency range.

Parameter 201, *Output Frequency Low Limit* = 0 Hz

Parameter 202, *Output Frequency High Limit* = 60 Hz

Status word = 0F03 Hex. Status message

Output frequency = 2000 Hex. 50% of the frequency range, corresponding to 30 Hz.



Status word Output frequency

Serial Communication

Parameters 500 through 566

This parameter group sets up the drive for serial communication.

There is a choice of three protocols: FC (VLT protocol), Johnson Controls Metasys N2, Siemens FLN, and Modbus RTU. In order to use serial communication to control the drive, address and baud rate must always be set. In addition to controlling the drive, operational data from the drive including reference, feedback, motor temperature and others can be read through serial communication.

500 Protocol (PROTOCOL)	
Value:	
★ FC protocol (FC PROTOCOL)	[0]
Metasys N2 (METASYS N2)	[1]
Siemens FLN (FLN)	[2]
Modbus RTU (MODBUS)	[3]

Function:
There is a choice of three different protocols.

Description of choice:
Select the required control word protocol.

501 Address (ADDRESS)	
Value:	
Parameter 500 Protocol = FC protocol 0 through 126	★1
Parameter 500 Protocol = Metasys N2 1 through 255	1
Parameter 500 Protocol = FLN 0 through 98	1
Parameter 500 Protocol = Modbus RTU 0 through 247	1

Function:
In this parameter it is possible to allocate an address in a serial communication network to each drive.

Description of choice:
The individual drive must be given a unique address. If the number of drives exceeds 31, a repeater must be used. Parameter 501, Address, cannot be chosen via serial communication but is set via the keypad.

502 Baud Rate (BAUDRATE)	
Value:	
300 Baud (300 BAUD)	[0]
600 Baud (600 BAUD)	[1]
1200 Baud (1200 BAUD)	[2]
2400 Baud (2400 BAUD)	[3]
4800 Baud (4800 BAUD)	[4]
★ 9600 Baud (9600 BAUD)	[5]

Function:
In this parameter, the speed at which data is transmitted via serial communication is programmed. Baud rate is defined as the number of bits transmitted per second.

★ Indicates factory default setting. Numbers in brackets [] represent selection as displayed on the serial bus.

Description of choice:

The transmission speed of the drive must be set at a value that corresponds to the transmission speed of the master. Parameter 502, *Baud Rate*, cannot be selected through serial communication; it must be set by the keypad. The data transmission time itself, which is determined by the baud rate selected, is only part of the total communication time.

503 Coasting Stop (COASTING)	
Value:	
Digital input (DIGITAL INPUT)	[0]
Serial communication (SERIAL PORT)	[1]
Logic and (LOGIC AND)	[2]
★ Logic or (LOGIC OR)	[3]

Function:
In parameters 503 through 508, a choice can be made to control the drive via the digital inputs and/or by serial communication.

If *Digital input* is selected, the command can only be carried out through digital input.

If *Serial communication* is selected, the command can only be carried out through serial communication.

If *Logic and* is selected, the command must be by both serial communication and a digital input.

If *Logic or* is selected, the command can be made by either digital or serial communication.

Description of choice:

The tables below show whether the motor is running or coasting when *Digital Input*, *Serial Communication*, *Logic and* or *Logic or* has been selected.

NOTE

Terminal 27 and bit 03 of control word are active when logic 0 is selected.

Digital Input			Serial Communication		
Term. 27	Serial Comm.	Function	Term. 27	Serial Comm.	Function
0	0	Coasting	0	0	Coasting
0	1	Coasting	0	1	Motor run
1	0	Motor run	1	0	Coasting
1	1	Motor run	1	1	Motor run

Logic and			Logic or		
Term. 27	Serial Comm.	Function	Term. 27	Serial Comm.	Function
0	0	Coasting	0	0	Coasting
0	1	Motor run	0	1	Coasting
1	0	Motor run	1	0	Coasting
1	1	Motor run	1	1	Motor run

504 DC Brake
(DC BRAKE)

Value:

Digital input (DIGITAL INPUT)	[0]
Serial communication (SERIAL PORT)	[1]
Logic and (LOGIC AND)	[2]
★ Logic or (LOGIC OR)	[3]

Function:

See the functional description under parameter 503, *Coasting Stop*.

Description of choice:

The table below shows when the motor is running and is DC-braking when *Digital input*, *Serial communication*, *Logic and* or *Logic or* has been selected.

NOTE

DC braking inverse, through terminals 19 and 27, and bit 03 of the control word, is active when logic 0 is selected.

<i>Digital Input</i>			<i>Serial Communication</i>		
Term. 19/27	Serial Comm.	Function	Term. 19/27	Serial Comm.	Function
0	0	DC brake	0	0	DC brake
0	1	DC brake	0	1	Motor run
1	0	Motor run	1	0	DC brake
1	1	Motor run	1	1	Motor run

<i>Logic and</i>			<i>Logic or</i>		
Term. 19/27	Serial Comm.	Function	Term. 19/27	Serial Comm.	Function
0	0	DC brake	0	0	DC brake
0	1	Motor run	0	1	DC brake
1	0	Motor run	1	0	DC brake
1	1	Motor run	1	1	Motor run

505 Start
(START)

Value:

Digital input (DIGITAL INPUT)	[0]
Serial communication (SERIAL PORT)	[1]
Logic and (LOGIC AND)	[2]
★ Logic or (LOGIC OR)	[3]

Function:

See the functional description under parameter 503, *Coasting Stop*.

Description of choice:

The table below shows when the motor has stopped and gives the situations in which the drive has a start command when *Digital input*, *Serial communication*, *Logic and* or *Logic or* has been selected.

<i>Digital Input</i>			<i>Serial Communication</i>		
Term. 18	Serial Comm.	Function	Term. 18	Serial Comm.	Function
0	0	Stop	0	0	Stop
0	1	Stop	0	1	Start
1	0	Start	1	0	Stop
1	1	Start	1	1	Stop

<i>Logic and</i>			<i>Logic or</i>		
Term. 18	Serial Comm.	Function	Term. 18	Serial Comm.	Function
0	0	Stop	0	0	Stop
0	1	Stop	0	1	Start
1	0	Stop	1	0	Start
1	1	Start	1	1	Start

★ Indicates factory default setting. Numbers in brackets [] represent selection as displayed on the serial bus.

506 Reversing (REVERSING)

Value:

★ Digital input (DIGITAL INPUT)	[0]
Serial communication (SERIAL PORT)	[1]
Logic and (LOGIC AND)	[2]
Logic or (LOGIC OR)	[3]

Function:
See the functional description under parameter, 503 *Coasting Stop*.

Description of choice:
The table below shows when the motor is running forward and reverse when *Digital input*, *Serial communication*, *Logic and* or *Logic or* has been selected.

<i>Digital Input</i>			<i>Serial Communication</i>		
Term. 19	Serial Comm.	Function	Term. 19	Serial Comm.	Function
0	0	Forward	0	0	Forward
0	1	Forward	0	1	Forward
1	0	Reverse	1	0	Forward
1	1	Reverse	1	1	Reverse

<i>Logic and</i>			<i>Logic or</i>		
Term. 19	Serial Comm.	Function	Term. 19	Serial Comm.	Function
0	0	Forward	0	0	Forward
0	1	Forward	0	1	Reverse
1	0	Forward	1	0	Reverse
1	1	Start	1	1	Reverse

507 Selection of Setup (SELECTING OF SETUP)

508 Selection of Preset Reference (SELECTING OF SPEED)

Value:

Digital input (DIGITAL INPUT)	[0]
Serial communication (SERIAL PORT)	[1]
Logic and (LOGIC AND)	[2]
★ Logic or (LOGIC OR)	[3]

Function:
See the functional description for parameters 507 and 508 under parameter 503, *Coasting Stop*.

Description of choice:
The table below shows the Setup (parameter 002 *Active Setup*) that has been selected via *Digital input*, *Serial communication*, *Logic and* or *Logic or*. The table also shows the preset reference (parameters 211 through 214, *Preset reference*) that has been selected via *Digital input*, *Serial communication*, *Logic and* or *Logic or*.

<i>Digital Input</i>				
Bus Msb	Bus Lsb	Setup/Preset Msb	Setup/Preset Lsb	Setup No. Preset Ref. No.
0	0	0	0	1
0	0	0	1	2
0	0	1	0	3
0	0	1	1	4
0	1	0	0	1
0	1	0	1	2
0	1	1	0	3
0	1	1	1	4
1	0	0	0	1
1	0	0	1	2
1	0	1	0	3
1	0	1	1	3
1	1	0	0	1
1	1	0	1	2
1	1	1	0	3
1	1	1	1	4

<i>Serial Communication</i>				
Bus Msb	Bus Lsb	Setup/Preset Msb	Setup/Preset Lsb	Setup No. Preset Ref. No.
0	0	0	0	1
0	0	0	1	1
0	0	1	0	1
0	0	1	1	1
0	1	0	0	2
0	1	0	1	2
0	1	1	0	2
0	1	1	1	2
1	0	0	0	3
1	0	0	1	3
1	0	1	0	3
1	0	1	1	3
1	1	0	0	4
1	1	0	1	4
1	1	1	0	4
1	1	1	1	4

<i>Logic and</i>				
Bus Msb	Bus Lsb	Setup/Preset Msb	Setup/Preset Lsb	Setup No. Preset Ref. No.
0	0	0	0	1
0	0	0	1	1
0	0	1	0	1
0	0	1	1	1
0	1	0	0	1
0	1	0	1	2
0	1	1	0	1
0	1	1	1	2
1	0	0	0	1
1	0	0	1	1
1	0	1	0	3
1	0	1	1	3
1	1	0	0	1
1	1	0	1	2
1	1	1	0	3
1	1	1	1	4

★ Indicates factory default setting. Numbers in brackets [] represent selection as displayed on the serial bus.

Logic or				
Bus Msb	Bus Lsb	Setup/Preset Msb	Setup/Preset Lsb	Setup No. Preset Ref. No.
0	0	0	0	1
0	0	0	1	2
0	0	1	0	3
0	0	1	1	4
0	1	0	0	2
0	1	0	1	4
0	1	1	0	2
0	1	1	1	3
1	0	0	0	3
1	0	0	1	4
1	0	1	0	3
1	0	1	1	4
1	1	0	0	4
1	1	0	1	4
1	1	1	0	4
1	1	1	1	4

509 through 532, 537
Data Read-out
Value:

Parameter No.	Description	Display Text	Unit	Updating Interval
509	Reference %	(REFERENCE %)	%	80 msec.
510	Reference [unit]	(REFERENCE [UNIT])	Hz, rpm	80 msec.
511	Feedback [unit]	(FEEDBACK)	Par. 415	80 msec.
512	Frequency [Hz]	(FREQUENCY)	Hz	80 msec.
513	User-defined readout	(CUSTOM READOUT)	Hz x scaling	80 msec.
514	Motor current [A]	(CURRENT)	Amp	80 msec.
515	Power [kW]	(POWER KW)	kW	80 msec.
516	Power [HP]	(POWER HP)	HP	80 msec.
517	Motor voltage [V]	(MOTOR VOLT)	VAC	80 msec.
518	DC link voltage [V]	(DC LINK VOLTAGE)	VDC	80 msec.
519	Thermal load, motor [%]	(MOTOR TEMPERATURE)	%	80 msec.
520	Thermal load, VLT [%]	(VLT TEMPERATURE)	%	80 msec.
521	Digital input	(DIGITAL INPUT)	Binary	80 msec.
522	Terminal 53, analog input [V]	(TERMINAL 53, ANALOG INPUT)	Volt	20 msec.
523	Terminal 54, analog input [V]	(TERMINAL 54, ANALOG INPUT)	Volt	20 msec.
524	Terminal 60, analog input [mA]	(TERMINAL 60, ANALOG INPUT)	mA	20 msec.
525	Pulse reference [Hz]	(PULSE REFERENCE)	Hz	20 msec.
526	External reference [%]	(EXTERNAL REFERENCE)	%	20 msec.
527	Status word	(STATUS WORD HEX)	Hex	20 msec.
528	Heat sink temperature [°C]	(HEAT SINK TEMP.)	°C	1.2 sec.
529	Alarm word	(ALARM WORD, HEX)	Hex	20 msec.
530	Control word	(VLT CONTROL WORD, HEX)	Hex	2 msec.
531	Warning word	(WARNING WORD)	Hex	20 msec.
532	Extended status word	(STATUS WORD)	Hex	20 msec.
*****	*****	*****	*****	*****
537	Relay status	(RELAY STATUS)	Binary	20 msec.

Function:

These parameters are read-only through the serial communication port. To display drive functions on the drive display, see parameters 007 through 010, *Display Readout*.

Description of choice:

Reference [%], parameter 509 gives a percentage for the resulting reference in the range from *Minimum Reference* to *Maximum Reference*. See also Reference Handling.

Reference [unit], parameter 510 gives the resulting reference by means of the unit Hz in *Open Loop*, parameter 100. In *Closed Loop*, the reference unit is selected in parameter 415, *Units with Closed Loop*.

Feedback [unit], parameter 511, gives the resulting feedback value by means of the unit/scaling selected in parameters 413, 414 and 415. See also Feedback Handling.

Frequency [Hz], parameter 512, gives the output frequency of the drive.

User Defined Read Out, parameter 513, gives a user defined value calculated on the basis of the present output frequency and unit, as well as the scaling in selected in parameter 005, *Maximum Value of User Defined Read Out*. The unit is selected in parameter 006, *Unit for User Defined Read Out*.

Motor Current [A], parameter 514, gives the motor current in A.

Power [kW], parameter 515, gives the present power provided to the motor in kW.

Power [HP], parameter 516, gives the present power provided to the motor in HP.

Motor Voltage [V], parameter 517, gives the voltage fed to the motor.

DC Link Voltage [V], parameter 518, gives the intermediate circuit voltage of the drive.

Thermal Load, Motor [%], parameter 519, gives the calculated/estimated thermal load on the motor. 100% is the trip point. See also parameter 117, *Motor Thermal Protection*.

Thermal Protection, VLT [%], parameter 520, gives the calculated/estimated thermal load on the drive. 100% is the trip point.

Digital Input, parameter 521, gives the signal status of the 8 inputs (16, 17, 18, 19, 27, 29, 32 and 33). Input 16 corresponds to the bit to the extreme left. 0 = no signal, 1 = signal connected.

Terminal 53, Analog Input [V], parameter 522, gives the voltage value of the signal on terminal 53.

Terminal 54, Analog Input [V], parameter 523, gives the voltage value of the signal on terminal 54.

Terminal 60, Analog Input [mA], parameter 524, gives the current value of the signal on terminal 60.

Pulse Reference [Hz], parameter 525, gives a pulse frequency in Hz connected to one of the terminals 17 and 29.

External Reference [%], parameter 526, gives the sum of external references as a percentage (sum of analog/pulse/serial communication) in the range from *minimum reference* to *maximum reference*.

Status Word, parameter 527, gives the present status word of the drive in hex.

Heat Sink Temperature [°C], parameter 528, gives the present heat sink temperature of the drive.

Alarm Word, parameter 529, gives a hex code for the alarm on the drive.

Control Word, parameter 530, gives the present control word of the drive in hex.

Warning Word, parameter 531, indicates in hex warnings from the drive.

Extended Status Word, parameter 532, indicates in hex code whether there is a warning from the drive.

Relay Status, parameter 537, indicates in binary code the status of relays 1 through 6.

533 Display Text Line 1

(DISPL. TEXT LINE 1)

Value:

Max. 20 characters ★ OFF

Function:

Text up to 20 characters may be displayed on line 1 (top line) of the LCP display. Parameter 007, *Large Readout*, must be set for *Free Program Array*. Line 1 custom text is only visible in auto mode.

Description of choice:

See *Programming Custom Display Text*.

534 Display Text Line 2

(DISPL. TEXT LINE 2)

Value:

Max. 8 characters ★ OFF

Function:

Text up to 8 characters may be displayed on line 2 (large text display) of the LCP display. Parameter 007, *Large Readout*, must be set for *Free Program Array*. Line 2 custom text is visible in display modes I and II (see *Display Modes*).

Description of choice:

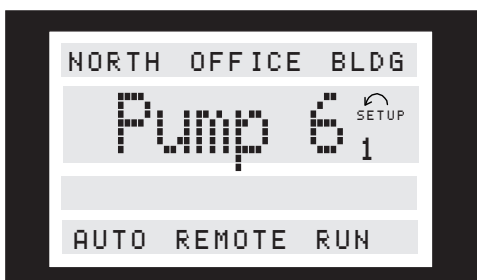
See *Programming Custom Display Text*.

★ Indicates factory default setting. Numbers in brackets [] represent selection as displayed on the serial bus.

Programming Custom Display Text

Enter custom text in lines 1 (top line) or 2 (large display) of the LCP keypad display in accordance with the following procedure.

1. Select parameter 533, *Display Text Line 1* or 534, *Display Text Line 2*.
2. Press CHANGE DATA key on keypad.
3. Use left or right arrows on keypad to position cursor.
4. Use [+] or [-] arrows to scroll through character options.
5. Press [OK] key to accept changes or [CANCEL] key to cancel.
6. Select *Free Program Array* in parameter 007, *Large read-out*, to activate custom text readout.



The available characters are:

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z Æ Ø Å Ä Ö Ü
É Ì Ù è . / - () 0 1 2 3 4 5 6 7 8 9 "space"

To erase a character that has been entered, replace it with "space."

535	Bus Feedback 1	(BUS FEEDBACK1)
Value:		
	0 through 16384 decimal (0 through 4000 Hex)	★ 0

Function:
Via the serial communication port, this parameter allows writing of a bus feedback value which will then form part of the feedback handling. *Bus Feedback 1* will be added to any feedback value registered on terminal 53.

Description of choice:
Write the required bus feedback value via serial communication.

536	Bus Feedback 2	(BUS FEEDBACK2)
Value:		
	0 through 16384 decimal (0 through 4000 Hex)	★ 0

Function:
Via serial communication, a bus feedback value can be written in this parameter that will become part of the feedback handling system. *Bus Feedback 2* will be added to any feedback value on terminal 54.

Description of choice:
Write the required bus feedback value via the serial communication.

537	Relay Status	(RELAY STATUS)
Value:		
	binary (0 = open, 1 = closed)	★ 0

Description of choice:
See *Data Read-out* for parameters 509 through 532, 537 on previous page for relay status description.

NOTE
Parameters 555, *Bus Time Interval*, and 556, *Bus Time Interval Function*, are only active when *FC Protocol* has been selected in parameter 500, *Protocol*.

555	Bus Time Interval	(BUS TIME INTERVAL)
Value:		
	1 to 99 sec.	★ 60 sec.

Function:
In this parameter, the maximum time allowed between the receipt of two packets in a row is set. If this time is exceeded, the serial communication is assumed to have stopped and the choice made in parameter 556, *Bus Time Interval Function*, will be carried out.

Description of choice:
Set the required time.

556	Bus Time Interval Function	(BUS TIME INTERVAL FUNCTION)
Value:		
★	Off (NO FUNCTION)	[0]
	Freeze output (FREEZE OUTPUT)	[1]
	Stop (STOP)	[2]
	Jogging (JOG FREQUENCY)	[3]
	Max. output frequency (MAX FREQUENCY)	[4]
	Stop and trip (STOP AND TRIP)	[5]

Function:
In this parameter, the required reaction from the drive is selected when the time set in parameter 555, *Bus Time Interval*, has been exceeded.

Description of choice:
The output frequency of the drive can be frozen at the present value, frozen as selected in parameter 211, *Preset Reference 1*, frozen as selected in parameter 202, *Maximum Output Frequency*, or stop and show a fault.

★ Indicates factory default setting. Numbers in brackets [] represent selection as displayed on the serial bus.

**560 N2 override release time
(N2 OVER.REL.TIME)**

Value:

1 - 65533 sec. ★ OFF

Function

The maximum time is set between the receipt of two N2 messages. If the time is exceeded, serial communication is assumed stopped. All N2 points which are overridden will be released in the following order:

1. Analog outputs
2. Binary outputs
3. Internal floating points
4. Internal integer points
5. Internal byte points

N2 point addresses are released in numerical order beginning with 1 (or 0).

Description of choice:

Set the required time.

**565 FLN bus time interval
(FLN TIME INTER.)**

Value:

1 - 65534 sec. ★ 60 sec.

Function

The maximum time is set between the receipt of two FLN messages. If the time is exceeded, serial communication is assumed stopped and the required reaction is set in parameter 566, *FLN Bus Time Interval Function*.

Description of choice:

Set the required time.

**566 FLN bus time interval function
(FLN TIME FUNCT.)**

Value:

- ★ Off (NO FUNCTION) [0]
- Freeze output (FREEZE OUTPUT) [1]
- Stop (STOP) [2]
- Jogging (JOG FREQUENCY) [3]
- Max. output frequency (MAX.SPEED) [4]
- Stop and trip (STOP AND TRIP) [5]

Function

The required reaction from the adjustable frequency drive is selected when the time set in parameter 565, *FLN Bus Time Interval*, has been exceeded.

Description of choice:

The output frequency of the adjustable frequency drive can be frozen at the present value at any given time, frozen at parameter 211, *Preset Reference 1*, frozen at parameter 202, *Max. Output Frequency*, or stop output and show a fault.

Warning Words, Extended Status Word and Alarm Word

Warning Word, Extended Status Word and Alarm Word are shown in hex format on the display. If there is more than one warning or alarm, the sum of the warnings or alarms will be shown.

The descriptions of the Extended Status Words, Warning Words and Alarm Words can be read out via the serial bus in parameter 531, *Warning Word*; 532, *Extended Status Word*; and 529, *Alarm Word*.

Hex Code	Extended Status Word (Parameter 532)
00000001	Autoramping
00000002	Start delay
00000004	Sleep boost active
00000008	Sleep mode active
00000010	Automatic motor adaptation completed
00000020	Automatic motor adaptation running
00000040	Reverse start (not for VLT 6000)
00000080	Normal ramping
00000100	Reversing
00000200	At reference
00000400	Running
00000800	Local reference = 0, Remote = 1
00001000	OFF = 1
00002000	Hand = 1, Auto = 0
00004000	Run request
00008000	No run permission
00010000	Freeze output frequency
00020000	Freeze output blocked
00040000	Jogging
00080000	No jog permission
00100000	Stand by
00200000	Stopped
00400000	DC braking stop
00800000	Drive ready
01000000	Relay 123 active (Profibus only)
02000000	Drive ready
04000000	Control ready
08000000	Start prevented
10000000	Profibus OFF3 active
20000000	Profibus OFF2 active
40000000	Profibus OFF1 active
80000000	Reserved

★ Indicates factory default setting. Numbers in brackets [] represent selection as displayed on the serial bus.

Hex Code	Warning Word (Parameter 531)
00000001	Reference high
00000002	Control card fault
00000004	Power card fault
00000008	HPFB bus timeout
00000010	RS-485 timeout
00000020	Overcurrent
00000040	Current limit
00000080	Motor thermistor
00000100	Motor overtemperature
00000200	Inverter overtemperature
00000400	Undervoltage
00000800	Overvoltage
00001000	Voltage warning low
00002000	Voltage warning high
00004000	Input phase fault
00008000	Live zero fault
00010000	Under 10 Volt (terminal 50)
00020000	Reference low
00040000	Feedback high
00080000	Feedback low
00100000	Output current high
00200000	Out of frequency range66666
00400000	Profibus communication fault
00800000	Output current low
01000000	Output frequency high
02000000	Output frequency low
04000000	AMA - motor too small
08000000	AMA - motor too big
10000000	AMA - check par. 102, 103, or 105
20000000	AMA - check par. 102, 104, or 106
40000000	Reserved
80000000	Reserved

Hex Code	Alarm Word (Parameter 529)
00000001	Unknown fault
00000002	Trip locked
00000004	AMA fault
00000008	HPFB fault
00000010	RS-485 timeout
00000020	Short circuit
00000040	SMPS fault
00000080	Ground fault
00000100	Overcurrent
00000200	Current limit
00000400	Motor thermistor
00000800	Motor thermal
00001000	Inverter thermal
00002000	Undervoltage
00004000	Overvoltage
00008000	Input phase loss
00010000	Live zero fault
00020000	Heat sink overtemperature
00040000	Motor phase W missing
00080000	Motor phase V missing
00100000	Motor phase U missing
00200000	Profibus communication fault
00400000	Inverter fault
00800000	Output current low
01000000	External fault
02000000	Reserved
04000000	Reserved
08000000	Reserved
10000000	Reserved



**Service Functions
Parameters 600 through 631**

600-605 Operating Data Value:

Value:

Parameter	Description	Display	Unit	Range
Number	Operating Data:	Text		
600	Operating Hours	(OPERATING HOURS)	Hours	0 through 130,000
601	Hours Run	(RUNNING HOURS)	Hours	0 through 130,000
602	kWh Counter	(KWH COUNTER)	kWh	-
603	Number of Power-ups	(POWER UPS)	Occurrences	0 through 9999
604	Number of Overtemp Trips	(OVER TEMPS)	Occurrences	0 through 9999
605	Number of Overvoltage Trips	(OVER VOLTS)	Occurrences	0 through 9999

This parameter group contains functions useful for troubleshooting the drive including operating data, data log and fault log.

It also has information on the nameplate data of the drive.

Function:

These parameters can be read out through the serial communication port as well as on the control panel display.

Description of choice:

Parameter 600, Operating Hours

Shows the number of hours the drive has had power applied. The value is saved every hour and when the power is removed. This value cannot be reset.

Parameter 601, Hours Run

Shows the number of hours the drive has powered the motor. This parameter can be reset in parameter 619, *Reset of Hours Run Counter*. The value is saved every hour and when the power is removed.

Parameter 602, kWh Counter

Shows the output power of the drive. The calculation is based on the mean value in kWh over one hour. This value can be reset using parameter 618, *Reset of kWh Counter*.

Parameter 603, Number of Power Ups

Shows the number of times power has been applied to the drive.

Parameter 604, Number of Overtemperature Trips

Shows the number of overtemperature trips from the heatsink temperature sensor on the drive.

Parameter 605, Number of Overvoltage Trips

Shows the number of overvoltage trips from the sensor of DC link voltage of the drive. The count is only taken when Alarm 7 *Overvoltage* is activated.

606 - 614 Data Log

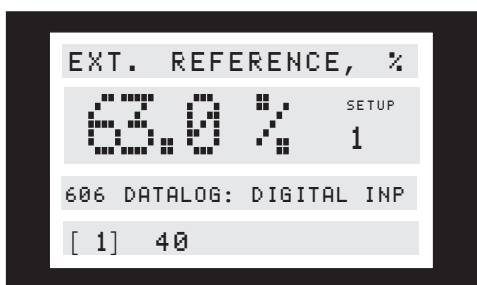
Value:

Parameter no.	Description	Display Text	Unit	Range
606	Digital Input	(LOG: DIGITAL INP)	Decimal	0 through 255
607	Control Word	(LOG: BUS COMMAND)	Decimal	0 through 65535
608	Status Word	(LOG: BUS STAT WD)	Decimal	0 through 65535
609	Reference	(LOG: REFERENCE)	%	0 through 100
610	Feedback	(LOG: FEEDBACK)	Par. 414	-999,999.999 through 999,999.999
611	Output Frequency	(LOG: MOTOR FREQ.)	Hz	0.0 through 999.9
612	Output Voltage	(LOG: MOTOR VOLT)	Volt	50 through 1000
613	Output Current	(LOG: MOTOR CURR.)	Amp	0.0 through 999.9
614	DC Link Voltage	(LOG: DC LINK VOLT)	Volt	0.0 through 999.9

Function:

With these parameters, it is possible to see up to twenty saved values, or data logs. Data log [1] is the most recent and [20] the oldest log. When a start command has been given, a new entry to the data log is made every 160 ms. If there is a trip or if the drive is stopped, the 20 latest data log entries will be saved and the values will be visible in the display. This is useful to view the operation of the drive just before a trip. These values will be lost if power is removed from the drive.

The drawing below shows a display. The data log number is shown in the square brackets at the left of the fourth line of the display.



Data logs [1] through [20] can be read by first pressing CHANGE DATA, followed by the + and - keys to change data log numbers.

Parameters 606 through 614, *Data Log*, can also be read out via the serial communication port.

Description of choice:

Parameter 606 Data Log: Digital Input:

This is where the latest log data is shown in decimal code, representing the status of the digital inputs. Translated into binary code, terminal 16 corresponds to the bit to the extreme left and to decimal code 128. Terminal 33 corresponds to the bit to the extreme right and to decimal code 1.

The table can be used for converting a decimal number into a binary code. For example, digital 40 corresponds to binary 00101000. The nearest smaller decimal number is 32, corresponding to a signal on terminal 18. $40-32 = 8$, corresponds to the signal on terminal 27.

Terminal	16	17	18	19	27	29	32	33
Decimal number	128	64	32	16	8	4	2	1

Parameter 607 Data Log: Control Word:

This is where the latest log data is given in decimal code for the control word of the drive. The control word can only be changed via serial communication. The control word is read as a decimal number which is to be converted into hex. See the control word profile under the section *Serial communications*.

Parameter 608, Data Log: Status Word:

This gives the latest log data in decimal code for the status word. The status word is read as a decimal number which is to be converted into hex. See the status word profile under the section *Serial communication*.

Parameter 609, Data Log: Reference:

This gives the latest log data for the resulting reference.

Parameter 610, Data Log: Feedback:

This gives the latest log data for the feedback signal.

Parameter 611, Data Log: Output Frequency:

This gives the latest log data for the output frequency.

Parameter 612, Data Log: Output Voltage:

This gives the latest log data for the output voltage.

Parameter 613, Data Log: Output Current:

This gives the latest log data for the output current.

Parameter 614, Data Log: DC Link Voltage:

This gives the latest log data for the intermediate circuit voltage.

615	Fault Log: Error Code
(F. LOG: ERROR CODE)	
Value:	
[Index 1-10]	Error Code: 0 - 99

Function:
This parameter makes it possible to see the reason why a fault trip occurs. Ten log values, indicated as [1] through [10] are stored.

The lowest log number [1] contains the most recently saved data value; the highest log number [10] contains the oldest data value.

If there is a fault trip, it is possible to see its cause, the time and possibly the values or output current or output voltage. See the section on Warnings and Alarms for a table explaining the error codes.

Description of choice:
The fault log is only reset after manual initialization.

616	Fault Log: Time
(F. LOG: TIME)	
Value:	
[Index 1-10]	Hours: 0 - 130,000.0

Function:
This parameter makes it possible to see the total number of hours run in connection with the 10 most recent fault trips. Ten log values, indicated as [1] through [10] are stored.

The lowest log number [1] contains the most recently saved data value; the highest log number [10] contains the oldest data value.

Description of choice:
The fault log is only reset after manual initialization.

617	Fault Log: Value
(F. LOG: VALUE)	
Value:	
[Index 1 - 10]	Value: 0 - 9999

Function:
This parameter makes it possible to see the value at which a fault trip occurred. The unit of the value depends on the alarm active in parameter 615, *Fault Log: Error Code*.

Description of choice:
The fault log is only reset after manual initialization.

618	Reset of kWh Counter
(RESET KWH COUNT)	
Value:	
★ No reset (DO NOT RESET)	[0]
Reset (RESET COUNTER)	[1]

Function:
Reset to zero of parameter 602, *kWh Counter*.

Description of choice:
If *Reset* has been selected and the OK key is pressed, the kWh counter of the drive is reset.

619	Reset of Hours Run Counter
(RESET RUN. HOUR)	
Value:	
★ No reset (DO NOT RESET)	[0]
Reset (RESET COUNTER)	[1]

Function:
Reset to zero of parameter 601, *Hours Run*.

Description of choice:
If *Reset* has been selected and the OK key is pressed, parameter 601 *Hours-run* is reset to zero.

620	Operating Mode
(OPERATION MODE)	
Value:	
★ Normal function (NORMAL OPERATION)	[0]
Function with deactivated inverter (OPER. W/INVERT.DISAB)	[1]
Control card test (CONTROL CARD TEST)	[2]
Initialization (INITIALIZE)	[3]

Function:
In addition to its normal function, this parameter can be used for two different tests.

It is possible to reset to the default factory settings for all Setups, except parameters 500, *Address*; 501 *Baud Rate*; 600-605, *Operating Data*; and 615-617, *Fault Log*.

Description of choice:
Normal function is used for normal operation of the motor.

Function with deactivated inverter is selected to operate the control card using its control signals without running the motor.

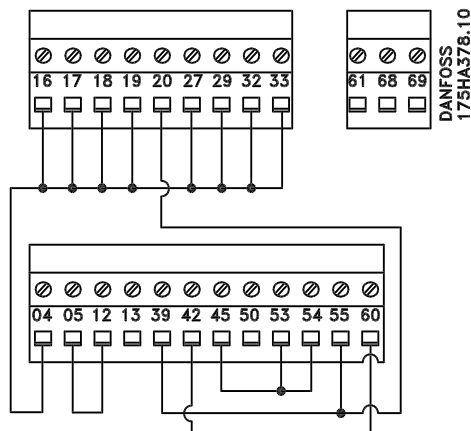
Control card test is used to test the analog and digital inputs, analog and digital outputs, relay output and the power supplies of the control card.

★ Indicates factory default setting. Numbers in brackets [] represent selection as displayed on the serial bus.

A test connector with the connections shown below is required for this test.

Set test connector set up as follows:

1. Connect 4, 16, 17, 18, 19, 27, 29, 32 and 33.
2. Connect 5 and 12.
3. Connect 39, 20 and 55.
4. Connect 42 and 60.
5. Connect 45, 53 and 54.



Test the control card in accordance with the following procedure:

1. Select *Control Card Test*.
2. Remove input power and wait for light in display to go out.
3. Insert test connector described above.
4. Reconnect input power.
5. Press OK key. (Test cannot run without control panel in place.)
6. Drive automatically tests control card.
7. Remove test connector and press OK key when drive displays "TEST COMPLETED."
8. Parameter 620, *Operating Mode*, is automatically set to *Normal Function*.

If the control card test fails, the drive will display "TEST FAILED."
Replace the control card.

Initialization is selected to reset the drive to its factory default settings without resetting parameters 501 *Address*, 502 *Baud Rate*; 600-605, *Operating Data*; and 615-617, *Fault Log*.

NOTE

Choosing *Initialization* resets drive to standard default values. Any special application programming performed at the factory, during start-up, or thereafter, will be lost. As a backup, upload drive settings into the drive's local control panel (LCP) keypad as described in parameter 004, *LCP Copy*.

Initialization the drive to factory default settings in accordance with the following procedures:

1. Select *Initialization*.
2. Press OK key.
3. Remove input power and wait for light in display to go out.
4. Connect input power.
5. Initialization of all parameters will be carried out in all Setups with exception of parameters 501, *Address*; 502, *Baud Rate*; 600-605, *Operating Data*; and 615-617, *Fault Log*.

621 - 631 Nameplate

Value:

Parameter	Description	Display text
Number	Nameplate:	
621	Unit Type	(DRIVE TYPE)
622	Power Component	(POWER SECTION)
623	VLT Ordering No.	(ORDERING NO)
624	Software Version No.	(SOFTWARE VERSION)
625	Control Panel Identification No.	(LCP ID NO.)
626	Database Identification No.	(PARAM DB ID)
627	Power Component Identification No.	(POWER UNIT DB ID)
628	Application Option Type	(APPLIC. OPTION)
629	Application Option Ordering No.	(APPLIC. ORDER NO)
630	Communication Option Type	(COM. OPTION)
631	Communication Option Ordering No.	(COM. ORDER NO)

Function:

Identification information for the drive can be read from parameters 621 through 631, *Nameplate* via the display or the serial communication port.

Description of choice:

Parameter 621, Nameplate: Unit Type:

VLT type gives the unit size and input voltage. See Cross Reference - Model Number to VLT Type to convert this do the drive's model number.

Parameter 622, Nameplate: Power Component:

This gives the type of power card installed in the drive.

Parameter 623, Nameplate: VLT Ordering Number:

This gives the ordering number for the specific drive. Because this number does not specify any special options or programming that was provided with the drive, it is better to refer to the serial number printed on the Danfoss Graham nameplate when contacting the factory about the drive.

Parameter 624, Nameplate: Software Version Number:

This gives the present software version number of the drive.

Parameter 625, Nameplate: LCP Identification Number:

This gives the identification number of the keypad (LCP) of the unit.

Parameter 626, Nameplate: Database identification Number:

This gives the identification number of the software's database.

Parameter 627, Nameplate: Power Component Identification Number:

This gives the identification number of the database of the drive.

Parameter 628, Nameplate: Application Option Type:

This gives the type of application options fitted to the basic drive.

Parameter 629, Nameplate: Application Option Ordering Number:

This gives the ordering number for the application option of the basic drive. Because this number does not specify any special options or programming that was provided with the drive, it is better to refer to the serial number printed on the Danfoss Graham nameplate when contacting the factory about the drive.

Parameter 630, Nameplate: Communication Option Type:

This gives the type of communication option card installed in the drive, if any.

Parameter 631, Nameplate: Communication Option Ordering Number:

This gives the ordering number for the communication option.

Relay Card Functions Parameters 700 through 711

Parameters 700 through 711 are only activated if a relay option card is installed in the drive. A relay card can be field installed in the drive if desired.

Activation/deactivation can be programmed in parameters 701, 704, 707 and 710, *Relay 6, 7, 8 and 9, ON Delay*; and parameters 702, 705, 708 and 711 *Relay 6, 7, 8 and 9, OFF Delay*.

700	Relay 6, Function	(RELAY6 FUNCTION)
703	Relay 7, Function	(RELAY7 FUNCTION)
706	Relay 8, Function	(RELAY8 FUNCTION)
709	Relay 9, Function	(RELAY9 FUNCTION)

Function:

This output activates a relay.

Relay outputs 6, 7, 8 and 9 can be used for showing status and warnings. The relay is activated when the conditions for the relevant data values have been fulfilled. Because these have the same possible functions as relay 1, see the description under parameter 323.

701	Relay 6, ON Delay	(RELAY6 ON DELAY)
704	Relay 7, ON Delay	(RELAY7 ON DELAY)
707	Relay 8, ON Delay	(RELAY8 ON DELAY)
710	Relay 9, ON Delay	(RELAY9 ON DELAY)

Value:

0 to 600 sec.

★ 0 sec.

Function:

This parameter allows a delay of the activation of relays 6, 7, 8 and 9 (terminals 1, and 2).

Description of choice:

Enter the desired value.

702	Relay 6, OFF Delay	(RELAY6 OFF DELAY)
705	Relay 7, OFF Delay	(RELAY7 OFF DELAY)
708	Relay 8, OFF Delay	(RELAY8 OFF DELAY)
711	Relay 9, OFF Delay	(RELAY9 OFF DELAY)

Value:

0 to 600 sec.

★ 0 sec.

Function:

This parameter is used to delay the deactivation time of relays 6, 7, 8 and 9 (terminals 1 and 2).

Description of choice:

Enter the desired value.

This parameter allows a delay of the activation of relays 6, 7, 8 and 9 (terminals 1, and 2).

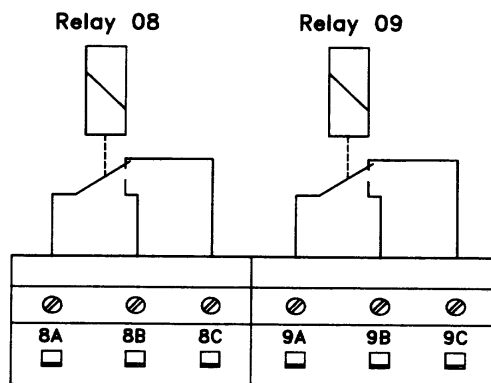
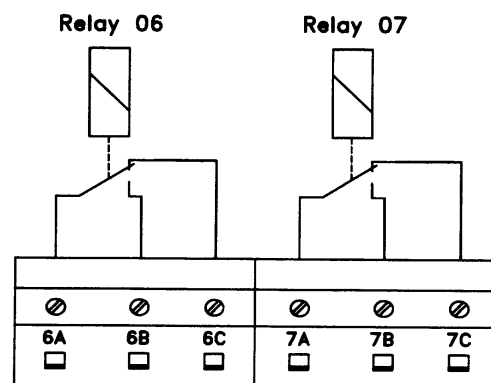
Electrical Installation of the Relay Card

The relays are connected as shown below.

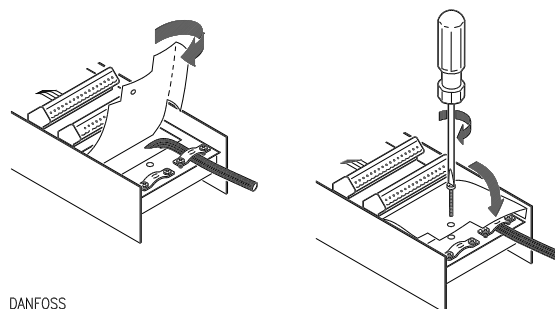
Relay 6-9

A-B make, A-C break

Max. 240 VAC, 2 Amp



To achieve double isolation, mount the plastic foil as shown below.



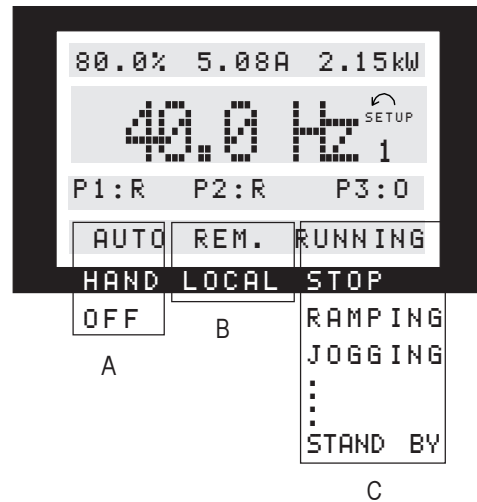
DANFOSS
175HA475.10

★ Indicates factory default setting. Numbers in brackets [] represent selection as displayed on the serial bus.

Status Messages

Status messages are generated automatically and appear in the fourth (bottom) line of the display as shown.

- A. The first part of the status line indicates the CONTROL POINT of the drive.
- B. The center part of the status line indicates the REFERENCE LOCATION.
- C. The last part of the status line gives the present DRIVE STATUS.



The table below defines the status message display words.

DISPLAY WORD	DESCRIPTION
CONTROL POINT	
AUTO	The drive is in Auto mode, which means that Run/Stop control is carried out via the control terminals and/or serial communication.
HAND	The drive is in Hand mode, which means that Run/Stop control is carried out via the keys on the keypad
OFF	OFF/STOP is activated either by means of the keypad, or by the digital inputs <i>Hand Start</i> and <i>Auto Start</i> , both being a logic '0.'
REFERENCE LOCATION	
REM.	If REMOTE has been selected, the reference is set via the control terminals or via serial communication.
LOCAL	If LOCAL has been selected, the reference is set via the [+] and [-] keys on the keypad.
DRIVE STATUS	
RUNNING	The motor speed now corresponds to the resulting reference.
RAMPING	The output frequency is changing.
AUTO RAMP	Parameter 208, <i>Automatic Ramp</i> , is enabled. The drive is attempting to avoid a trip from overvoltage by extending its decel ramp time.
SLEEP.BST	The boost function in parameter 406, <i>Boost Setpoint</i> , is enabled. This function can only be enabled in <i>Closed Loop</i> operation.
SLEEP	<p>⚠WARNING Unintended Start! When in <i>Sleep</i> mode, motor may restart at any time without warning. The drive, motor, and any driven equipment must be in operational readiness. Failure to be in operational readiness could result in death, serious injury, or equipment and property damage.</p> <p>The energy saving function in parameter 403, <i>Sleep Mode Timer</i>, is enabled. This status message shows that at present the motor has been stopped by sleep mode. It can restart automatically.</p>
START DEL	<p>⚠WARNING Unintended Start! When in <i>Start Delay</i> mode, motor may restart at any time without warning. The drive, motor, and any driven equipment must be in operational readiness. Failure to be in operational readiness could result in death, serious injury, or equipment and property damage.</p> <p>A start delay time has been programmed in parameter 111, <i>Start Delay</i>. When the delay has passed, the drive will start and ramp up to the reference frequency.</p>

DISPLAY WORD	DESCRIPTION
RUN REQ.	<p>⚠WARNING Unintended Start! When in <i>Run Request</i> mode, motor may restart at any time without warning. The drive, motor, and any driven equipment must be in operational readiness. Failure to be in operational readiness could result in death, serious injury, or equipment and property damage.</p> <p>A start command has been given, but the motor will not be started until a <i>Run Permission</i> signal is received via a digital input.</p>
JOG	Jog has been enabled via a digital input or via serial communication.
JOG REQ.	<p>⚠WARNING Unintended Start! When in <i>Jog</i> mode, motor may restart at any time without warning. The drive, motor, and any driven equipment must be in operational readiness. Failure to be in operational readiness could result in death, serious injury, or equipment and property damage.</p> <p>A start command has been given, but the motor will remain stopped until a <i>Run Permission</i> signal is received via a digital input.</p>
FRZ.OUT	The output frequency has been frozen.
FRZ.REQ	<p>⚠WARNING Unintended Start! When in <i>Freeze Request</i> mode, motor may restart at any time without warning. The drive, motor, and any driven equipment must be in operational readiness. Failure to be in operational readiness could result in death, serious injury, or equipment and property damage.</p> <p>A start command has been given, but the motor will remain stopped until a <i>Run Permission</i> signal is received via a digital input.</p>
START F/R	<i>Reversing and start</i> on terminal 19, parameter 303, <i>Digital Inputs</i> , and <i>Start</i> on terminal 18, parameter 302, <i>Digital Inputs</i> , are enabled at the same time. The motor will remain stopped until one of the signals becomes a logic '0.'
AMA RUN	Automatic motor adaptation has been enabled in parameter 107, <i>Automatic Motor Adaptation, AMA</i> .
AMA STOP	Automatic motor adaptation has been completed. The drive is now ready for operation after the <i>Reset</i> signal has been given. Note that the motor will start after the drive has received the <i>Reset</i> signal.
STANDBY	The drive is able to start the motor when a start command is received.
STOP	The motor has been stopped via a stop signal from <i>serial communication</i> .
DC STOP	The DC brake has been enabled in parameters 114 through 116.
UN.READY	The drive is ready for operation, but terminal 27 is a logic '0' and/or a <i>Coasting Command</i> has been received via the <i>serial communication</i> .
CTR.READY	This status is only active when a Profibus option card is installed.
NOT READY	The drive is not ready for operation, because of a trip or because OFF1, OFF2 or OFF3 is a logic '0.'
START IN.	This status will only be displayed if, in parameter 599, <i>Profidrive</i> [1] has been selected and OFF2 or OFF3 is a logic '0.'
XXXX	The microprocessor of the control has stopped and the drive is not operating. The cause may be noise on the power line, motor leads or control wires.



Warnings and Alarms

The table below lists the drive fault messages and indicates whether a warning, alarm, or trip-lock occurs. Wherever an “X” is placed under both warning and alarm, this means that a warning precedes the alarm. An alarm always precedes, or simultaneously accompanies, a trip-lock.

A trip causes the drive to suspend operation by cutting off power to the motor. A trip-lock requires that input power to the drive must be removed, the cause of the fault corrected, and the input power restored in order to reset the drive.

A trip can be reset in any one of the following ways:

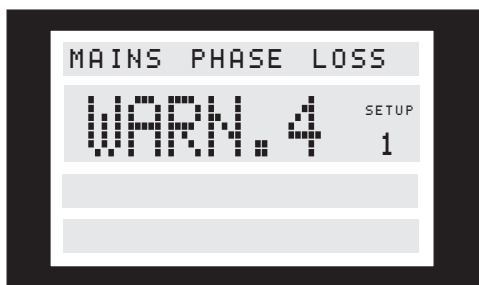
- 1) Manual reset by pressing the RESET key on the keypad
- 2) A digital input through a digital input terminal
- 3) Serial communication command
- 4) Automatic reset

Automatic or manual reset may be selected in parameter 400, *Reset Function*. Auto reset will not restore a trip-lock. The number of reset attempts may be selected or infinite, which allows continuous attempts. A timer between attempts can be set in parameter 401.

No.	Description	Warning	Alarm	Trip Locked
1	Under 10 Volts (10 VOLT LOW)	X		
2	Live zero fault (LIVE ZERO ERROR)	X	X	
4	Mains phase imbalance (MAINS IMBALANCE)	X	X	X
5	Voltage warning high (DC LINK VOLTAGE HIGH)	X		
6	Voltage warning low (DC LINK VOLTAGE LOW)	X		
7	Overvoltage (DC LINK OVERVOLT)	X	X	
8	Undervoltage (DC LINK UNDERVOLT)	X	X	
9	Inverter overloaded (INVERTER TIME)	X	X	
10	Motor overloaded (MOTOR TIME)	X	X	
11	Motor thermistor (MOTOR THERMISTOR)	X	X	
12	Current limit (CURRENT LIMIT)	X	X	
13	Overcurrent (OVERCURRENT)		X	X
14	Ground fault (EARTH FAULT)		X	X
15	Switch mode fault (SWITCH MODE FAULT)		X	X
16	Short circuit (CURR.SHORT CIRCUIT)		X	X
17	Serial communication timeout (STD BUSTIMEOUT)	X	X	
18	HP field bus timeout (HPFB TIMEOUT)	X	X	
19	Fault in EEPROM on power card (EE ERROR POWER)	X		
20	Fault in EEPROM on control card (EE ERROR CONTROL)	X		
22	Auto motor adaptation fault (AMA FAULT)		X	
29	Heat-sink temperature too high (HEAT SINK OVERTEMP.)		X	X
30	Motor phase U missing (MISSING MOT.PHASE U)		X	
31	Motor phase V missing (MISSING MOT.PHASE V)		X	
32	Motor phase W missing (MISSING MOT.PHASE W)		X	
34	HPFB communication fault (HPFB COMM. FAULT)	X	X	
35	Out of frequency range (OUT FREQ RNG/ROT LIM)	X		
37	Inverter fault (GATE DRIVE FAULT)		X	X
39	Check parameters 104 and 106 (CHECK P.104 & P.106)	X		
40	Check parameters 103 and 105 (CHECK P.103 & P.106)	X		
41	Motor too large (MOTOR TOO BIG)	X		
42	Motor too small (MOTOR TOO SMALL)	X		
60	Safety stop (EXTERNAL FAULT)		X	
61	Output frequency low (FOUT < FLOW)	X		
62	Output frequency high (FOUT > FHIGH)	X		
63	Output current low (I MOTOR < I LOW)	X	X	
64	Output current high (I MOTOR > I HIGH)	X		
65	Feedback low (FEEDBACK < FDB LOW)	X		
66	Feedback high (FEEDBACK > FDB HIGH)	X		
67	Reference low (REF. < REF. LOW)	X		
68	Reference high (REF. > REF. HIGH)	X		
69	Temperature auto derate (TEMP.AUTO DERATE)	X		
99	Unknown fault (UNKNOWN ALARM)		X	X

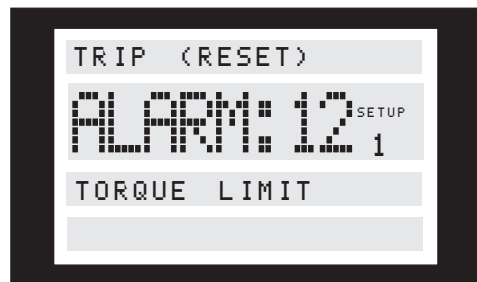
Warnings

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



Alarms

If an alarm is given, the present alarm number will be shown in line 2. Lines 1 and 3 of the display will offer an explanation.



WARNING 1 10 VOLT LOW

The 10 V voltage from terminal 50 on the control card is below 10 V.

Remove some of the load from terminal 50, as the 10 volts supply is overloaded. Maximum load is 17 mA, minimum resistance is 590 Ω.

WARNING/ALARM 2 LIVE ZERO ERROR

The current or voltage signal on terminal 53, 54 or 60 is below 50% of the value preset in parameters 309, 312 and 315 *Terminal, Minimum Scaling*.

WARNING/ALARM 4 MAINS IMBALANCE

Phase missing on the input power. Check the supply voltage to the drive.

WARNING 5 DC LINK VOLTAGE HIGH

The intermediate DC circuit voltage is higher than *Voltage Warning High*, see table below. The drive is still controlling the motor.

WARNING 6 DC LINK VOLTAGE LOW

The intermediate DC circuit voltage is lower than *Voltage Warning Low*, see table below. The drive is still controlling the motor.

WARNING/ALARM 7 DC LINK OVERVOLT

If the intermediate circuit voltage (DC) is higher than the *Overvoltage Limit* of the drive (see table below), the drive will trip after a fixed period. The length of this period depends upon the unit.

WARNING/ALARM 8 Undervoltage (DC LINK UNDERVOLT)

If the intermediate circuit voltage (DC) drops below the *Undervoltage Limit* of the inverter, the drive will trip after a fixed period. The length of the period depends upon the unit.

The voltage will be stated in the display. Check whether the supply voltage matches the drive rating.

WARNING/ALARM 9 INVERTER TIME

The electronic thermal inverter protection reports that the drive is about to trip because of an overload. The counter for electronic thermal inverter protection gives a warning at 98% and trips at 100% showing an alarm. The drive cannot be reset until the counter drops below 90%. Activate ASFM (Automatic Switching Frequency Modulation) in parameter 408, *Interference Reduction Method*, or reduce the carrier frequency in parameter 407, *Switching Frequency*.

Alarm/Warning Limits:

Drive	208 to 230 volt		380 to 480 volt		550 to 600 volt	
	VDC	VAC	VDC	VAC	VDC	VAC
Undervoltage alarm	211	151	402	289	557	413
Voltage warning, low	222	159	423	304	613	443
Voltage warning, high	384	276	777	530	943	667
Overvoltage alarm	425	305	798	550	975	689



**WARNING/ALARM 10
MOTOR TIME**

According to the electronic thermal protection, the motor is overheated. Parameter 117, *Motor Thermal Protection*, allows a choice of whether the drive is to give a warning or an alarm when the *Motor Thermal Projection* reaches 100%. The fault is that the motor is overloaded to more than 100% of the preset rated motor current for too long. Check that the motor parameters 102 through 106 have been set correctly.

**WARNING/ALARM 11
MOTOR THERMISTOR**

The thermistor or the thermistor connection has been disconnected. Parameter 117, *Motor Thermal Protection*, allows a choice of whether the drive is to give a warning or an alarm. Check that the thermistor has been correctly connected between terminal 53 or 54 (analog voltage input) and terminal 50 (+10 V supply).

**WARNING/ALARM 12
CURRENT LIMIT**

The current is higher than the value in parameter 215, *Current Limit*, and the drive trips after the time set in parameter 412, *Trip Delay Overcurrent*, has passed. Run AMA on a cold motor in parameter 107, *Automatic Motor Adaptation*.

**WARNING/ALARM 13
OVER CURRENT**

The inverter peak current limit, approximately 200% of the rated current, has been exceeded. The warning will last approximately 1 or 2 seconds, and then the drive will trip and signal an alarm.

Turn off the drive and check for free rotation of the motor shaft and other causes of the overload. Run AMA on a cold motor in parameter 107, *Automatic Motor Adaptation*.

**ALARM 14
EARTH FAULT**

There is current leakage from the output phases to ground, either in the leads between the drive and the motor or in the motor itself.

Remove power to the drive and correct the ground fault.

**ALARM 15
SWITCH MODE FAULT**

Fault in the switch mode power supply (internal ± 15 V supply).

Contact the Danfoss Graham service department.

**ALARM 16
CURR. SHORT CIRCUIT**

There is a short circuit in the output from the drive.

Remove power to the drive and correct the short circuit.

**WARNING/ALARM 17
STD BUSTIMEOUT**

There is no serial communication with the drive.

This warning will only be enabled if parameter 556, *Bus Time Interval Function*, has been set to a value different from OFF.

If parameter 556, *Bus Time Interval Function*, has been set to *Stop and Trip* [5], the drive will first give off an alarm, then ramp down and finally trip while giving an alarm. It is possible to increase parameter 555, *Bus Time Interval*.

**WARNING/ALARM 18
HPFB TIMEOUT**

There is no serial communication with the communication option card in the drive.

The warning will only be enabled if parameter 804, *Bus Time Interval Function*, has been set to anything but OFF. If parameter 804, *Bus Time Interval Function*, has been set to *Stop and Trip*, the drive will first give an alarm, then ramp down and finally trip while giving an alarm.

Parameter 803, *Bus Time Interval* could possibly be increased. Parameter 803 is only available when a communication option card is installed in the drive.

**WARNING 19
EE ERROR POWER**

There is a fault on the power card EEPROM. The drive will continue to function, but is likely to fail at the next power-up. Contact the Danfoss Graham service department.

**WARNING 20
EE ERROR CONTROL**

There is a fault in the EEPROM on the control card. The drive will continue to function, but is likely to fail at the next power-up. Contact the Danfoss Graham service department.

ALARM 22

AMA FAULT

A fault has been found during automatic motor adaptation (AMA). The text shown in the display indicates a fault message.

AMA can only be carried out if there are no alarms during the AMA process.

CHECK 103, 105

Parameter 103 or 105 has a wrong setting. Correct the setting and repeat AMA.

LOW P 105

The motor is too small for AMA to be carried out. If AMA is to be enabled, the rated motor current, parameter 105, must be higher than 35% of the rated output current of the drive.

ASYMMETRICAL IMPEDANCE

AMA has detected an asymmetrical impedance in the motor connected to the system. The motor could be defective.

MOTOR TOO BIG

The motor connected to the system is too big for AMA to be carried out. The setting in parameter 102 does not match the motor used.

MOTOR TOO SMALL

The motor connected to the system is too small for AMA to be carried out. The setting in parameter 102 does not match the motor used.

TIME OUT

AMA fails because of noisy measuring signals. Retry until AMA is successfully completed. Please note that repeated AMA runs may heat the motor to a level where the stator resistance is increased.

INTERRUPTED BY USER

AMA has been interrupted by the user.

INTERNAL FAULT

An internal fault has occurred in the drive. Contact Danfoss Graham service department.

LIMIT VALUE FAULT

The parameter values found for the motor are outside the acceptable range within which the drive is able to work.

MOTOR ROTATES

The motor shaft is rotating. Make sure that the load is not able to make the motor shaft rotate while the AMA is being performed. Then start AMA all over.

ALARM 29

HEAT SINK OVER TEMP.

The heatsink temperature became too high. For NEMA 1 drives, the limit is 90°C. For NEMA 12 drives, the limit is 80°C. The tolerance is $\pm 5^\circ\text{C}$. The fault cannot be reset until the temperature of the heatsink has fallen below 60°C.

The fault could be due to the following:

- Ambient temperature too high
- Air obstructed
- Cooling fan(s) not operating
- Motor leads too long
- Too high a switching frequency

ALARM 30

MISSING MOT.PHASE U

Motor phase U, as indicated by the letters on the output terminal block, is missing or has a high impedance.

Remove power to the drive and check motor phase U.

ALARM 31

MISSING MOT.PHASE V

Motor phase V, as indicated by the letters on the output terminal block is missing or has a high impedance.

Remove power to the drive and check motor phase V.

ALARM 32

MISSING MOT.PHASE W

Motor phase W, as indicated by the letters on the output terminal block is missing or has a high impedance.

Remove power to the drive and check motor phase W.

WARNING/ALARM 34

HPFB COMM. FAULT

The serial communication on the communication option card is not working.

WARNING 35

OUT FREQ RNG/ROT LIM

This warning will occur if the output frequency has reached its *Output Frequency Low Limit*, parameter 201, or *Output Frequency High Limit*, parameter 202. If the drive is in *Closed Loop*, parameter 100, the warning will show in the display.



**ALARM 37
GATE DRIVE FAULT**

An output IGBT or the power card is defective. Contact the Danfoss Graham service department.

Auto Optimization Warnings 39 through 42

Automatic motor adaptation has stopped, because some parameters have probably been improperly set, or the motor used is too large or small for AMA to be carried out.

A choice must be made by pressing CHANGE DATA and choosing 'Continue' + OK or 'Stop' + OK.

If parameters need to be changed, select 'Stop', change the parameters and run AMA again.

**WARNING 39
CHECK PAR. 104, 106**

Parameters 104, *Motor Frequency*, or 106, *Rated Motor Speed*, have probably not been set correctly. Correct the setting and run AMA again.

**WARNING 40
CHECK PAR. 103, 105**

Parameter 103 *Motor Voltage*, or 105 *Motor Current*, has not been set correctly. Correct the setting and run AMA again.

**WARNING 41
MOTOR TOO BIG**

The motor used is probably too large for AMA to be carried out. The setting in parameter 102 *Motor Power*, may not match the motor. Check the motor and select 'Continue' or [STOP].

**WARNING 42
MOTOR TOO SMALL**

The motor used is probably too small for AMA to be carried out. The setting in parameter 102 *Motor Power*, may not match the motor. Check the motor and select 'Continue' or [STOP].

**ALARM 60
EXTERNAL FAULT**

Terminal 27, parameter 304, *Digital Inputs*, has been programmed for a *Safety Interlock* and is a logic '0'.

**WARNING 61
FOUT < FLOW**

The output frequency is lower than parameter 223, *Warning: Low Frequency*.

**WARNING 62
FOUT > FHIGH**

The output frequency is higher than parameter 224, *Warning: High Frequency*.

**WARNING/ALARM 63
I MOTOR < I LOW**

The output current is lower than parameter 221, *Warning: Low Current*. Select the required function in parameter 409, *Function in Case of No Load*.

**WARNING 64
I MOTOR > I HIGH**

The output current is higher than parameter 222, *Warning: High Current*.

**WARNING 65
FEEDBACK < FDB LOW**

The resulting feedback value is lower than parameter 227, *Warning: Low Feedback*.

**WARNING 66
FEEDBACK > FDB HIGH**

The resulting feedback value is higher than parameter 228, *Warning: High Feedback*.

**WARNING 67
REF. < REF LOW**

The remote controlled reference is lower than parameter 225, *Warning: Low Reference*.

**WARNING 68
REF. > REF HIGH**

The remote controlled reference is higher than parameter 226, *Warning: High Reference*.

**WARNING 69
TEMP.AUTO DERATE**

The heat sink temperature has exceeded the maximum value and the auto derating function in parameter 411, *Function at Over Temp*, is active.

**WARNING 99
UNKNOWN ALARM**

An unknown fault has occurred which the software is not able to handle. Contact Danfoss Graham service department.

Calculation of Resulting Reference

The calculation made below gives the resulting reference when parameter 210, *Reference Type*, is programmed for *Sum* and *Relative*, respectively. In *Open Loop*, parameters 418 and 419, *Setpoints 1* and *2*, should be set to 0. If they are not set to 0, parameter 417, *Feedback Function*, will affect the reference.

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

External reference can be calculated as follows:

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

Parameter 210, *Reference Type*, is programmed = *Sum*

$$\text{Res. ref.} = \frac{(\text{Par. 205 Max. ref.} - \text{Par. 204 Min. ref.}) \times \text{Par. 211-214 Preset ref.}}{100} + \text{External ref.} + \text{Par. 204 Min. ref.} + \text{Feedback setpoint}$$

Parameter 210, *Reference Type*, is programmed = *Relative*

$$\text{Res. ref.} = \frac{\text{External reference} \times \text{Par. 211-214 Preset ref.}}{100} + \text{Par. 204 Min. ref.} + \text{Feedback setpoint}$$



Factory Settings

Changes During Operation:

“Yes” means that the parameter can be changed while the drive is in operation. “No” means that the drive must be stopped before a change can be made.

4-Setup:

“Yes” means that the parameter can be programmed individually in each of the four setups. The same parameter can have four different data values. “No” means that the data value will be the same in all four setups.

Conversion Index:

This number refers to a conversion figure to be used when writing or reading to or from the drive by means of serial communication.

Since a parameter value can only be transferred as a whole number, a conversion factor must be used to transfer decimals.

Example:

Parameter 201: *Minimum Frequency*, conversion factor -1 (0.1). If parameter 201 is to be set to 10 Hz, a value of 100 must be transferred, since a conversion factor of -1 means that the transferred value will be multiplied by 0.1. A value of 100 will, therefore, be understood as 10.0.

Data type:

Data type shows the type and length of the packet.

0.. Operation and Display

#	Parameter Description	Factory Setting	Range	Changes During Operation	4-Setup	Conversion Index	Data Type
001	Language	ENGLISH		Yes	No	0	5
002	Active Setup	SETUP 1		Yes	No	0	5
003	Copying of Setups	NO COPY		No	No	0	5
004	LCP Copy	NO COPY		No	No	0	5
005	Max Value of User-defined Readout	100.000	0 - 999.999,999	Yes	Yes	-2	4
006	Unit for User-defined Readout	%		Yes	Yes	0	5
007	Big Display Readout	FREQUENCY, %		Yes	Yes	0	5
008	Small Display Readout 1.1	REFERENCE, %		Yes	Yes	0	5
009	Small Display Readout 1.2	MOTOR CURRENT, A		Yes	Yes	0	5
010	Small Display Readout 1.3	POWER, HP		Yes	Yes	0	5
011	Unit of Local Reference	% OF F MAX		Yes	Yes	0	5
012	Hand Start on LCP	ENABLE		Yes	Yes	0	5
013	OFF/STOP on LCP	ENABLE		Yes	Yes	0	5
014	Auto Start on LCP	ENABLE		Yes	Yes	0	5
015	Reset on LCP	ENABLE		Yes	Yes	0	5
016	Lock for Data Change	NOT LOCKED		Yes	Yes	0	5
017	Operating State at Power-up	AUTO RESTART		Yes	Yes	0	5

Conversion Index	Conversion Factor
74	3.6
2	100.0
1	10.0
0	1.0
-1	0.1
-2	0.01
-3	0.001
-4	0.0001

Conversion Index Factors

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

Data Type Descriptions

NOTE

Installation of Cascade Controller Option Card in VLT 6000 series drives will change some default parameter settings. See Cascade Controller Manual for details.

1.. Load and Motor

#	Parameter Description	Factory Setting	Range	Changes During Operation	4-Setup	Conversion Index	Data Type
100	Configuration	OPEN LOOP		No	Yes	0	5
101	Torque Characteristics	AEO FUNCTION		No	Yes	0	5
102	Motor Power	Depends on the unit	0.25 - 500 kW	No	Yes	-2	6
103	Motor Voltage	Depends on the unit	200 - 575 V	No	Yes	0	6
104	Motor Frequency	60 Hz	24 - 1000 Hz	No	Yes	0	6
105	Motor Current	Depends on the unit	0.01 - I	No	Yes	-2	7
106	Rated Motor Speed	Depends on par. 102 Motor power	100 - 60000 rpm	No	Yes	0	6
107	Automatic Motor Adaptation, AMA	NO AMA		No	No	0	5
108	Start Voltage of Parallel Motors	Depends on par. 103	0.0 - par. 103	Yes	Yes	-1	6
109	Resonance Dampening	100%	0 - 500 %	Yes	Yes	0	6
110	High Breakaway Torque	OFF	0.0 - 0.5 sec.	Yes	Yes	-1	5
111	Start Delay	000.0 s	0.0 - 120.0 sec.	Yes	Yes	-1	6
112	Motor Preheater	DISABLE		Yes	Yes	0	5
113	Motor Preheater DC Current	50%	0 - 100 %	Yes	Yes	0	6
114	DC Braking Current	50%	0 - 100 %	Yes	Yes	0	6
115	DC Braking Time	10.0 s	0.0 - 60.0 sec.	Yes	Yes	-1	6
116	DC Brake Cut-in Frequency	OFF	0.0 - par. 202	Yes	Yes	-1	6
117	Motor Thermal Protection	ETR TRIP 1		Yes	Yes	0	5
118	Motor Power Factor (Cos ϕ)	0.75	0.50 - 0.99	No	Yes	-2	3

2.. References and Limits

#	Parameter Description	Factory Setting	Range	Changes during operation	4-Setup	Conversion Index	Data Type
200	Output Frequency Range	0 - 120 Hz	0 - 1000 Hz	No	Yes	0	5
201	Output Frequency Low Limit	Fans=6 Hz, Pumps=18 Hz	0.0 - par. 202	Yes	Yes	-1	6
202	Output Frequency High Limit	60 Hz	par. 201 - par. 200	Yes	Yes	-1	6
203	Reference Handling	LINKED TO HAND/AUTO		Yes	Yes	0	5
204	Minimum Reference	Fans=6 Hz, Pumps=18 Hz	0.000-Ref _{MAX}	Yes	Yes	-3	4
205	Maximum Reference	000060.000 Hz	Ref _{MIN} -999.999,999	Yes	Yes	-3	4
206	Ramp-up Time	Fans=60 sec., Pumps=10 sec.	1 - 3600 sec.	Yes	Yes	0	7
207	Ramp-down Time	Fans=60 sec., Pumps=10 sec.	1 - 3600 sec.	Yes	Yes	0	7
208	Automatic Ramp-up/down	ENABLE		Yes	Yes	0	5
209	Jog Frequency	10.0 Hz	par. 201 - par. 202	Yes	Yes	-1	6
210	Reference Type	EXTERNAL PRESET		Yes	Yes	0	5
211	Preset Reference 1	0.00%	-100.00 - 100.00 %	Yes	Yes	-2	3
212	Preset Reference 2	0.00 %	-100.00 - 100.00 %	Yes	Yes	-2	3
213	Preset Reference 3	0.00 %	-100.00 - 100.00 %	Yes	Yes	-2	3
214	Preset Reference 4	0.00 %	-100,00 - 100,00 %	Yes	Yes	-2	3
215	Current Limit	Depends on the unit	0 - I [A]	Yes	Yes	-1	6
216	Frequency Bypass Bandwidth	DISABLED	0 - 120 Hz	Yes	Yes	0	6
217	Frequency Bypass 1	120.0 Hz	0.0 - par. 200	Yes	Yes	-1	6
218	Frequency Bypass 2	120.0 Hz	0.0 - par. 200	Yes	Yes	-1	6
219	Frequency Bypass 3	120.0 Hz	0.0 - par. 200	Yes	Yes	-1	6
220	Frequency Bypass 4	120.0 Hz	0.0 - par. 200	Yes	Yes	-1	6
221	Warning: Low Current	0.0 A	0.0 - par. 222	Yes	Yes	-1	6
222	Warning: High Current, I	I [A]	Par. 221 - I [A]	Yes	Yes	-1	6
223	Warning: Low Frequency	0.0 Hz	0.0 - par. 224	Yes	Yes	-1	6
224	Warning: High Frequency	120.0 Hz	Par. 223 - par. 200/202	Yes	Yes	-1	6
225	Warning: Low Reference	-999,999.999 Hz	-999,999.999 - par. 226	Yes	Yes	-3	4
226	Warning: High Reference	999,999.999 Hz	Par. 225 - 999,999.999	Yes	Yes	-3	4
227	Warning: Low Feedback	-999,999.999 Hz	-999,999.999 - par. 228	Yes	Yes	-3	4
228	Warning: High Feedback	999,999.999 Hz	Par. 227 - 999,999.999	Yes	Yes	-3	4



3.. Inputs and Outputs

#	Parameter Description	Factory Setting	Range	Changes During Operation	4-Setup	Conversion Index	Data Type
300	Terminal 16 Digital Input	RESET		Yes	Yes	0	5
301	Terminal 17 Digital Input	NO OPERATION		Yes	Yes	0	5
302	Terminal 18 Digital Input	START		Yes	Yes	0	5
303	Terminal 19 Digital Input	REVERSING		Yes	Yes	0	5
304	Terminal 27 Digital Input	SAFETY INTERLOCK		Yes	Yes	0	5
305	Terminal 29 Digital Input	JOG		Yes	Yes	0	5
306	Terminal 32 Digital Input	NO OPERATION		Yes	Yes	0	5
307	Terminal 33 Digital Input	NO OPERATION		Yes	Yes	0	5
308	Terminal 53, Analog Input Voltage	NO OPERATION		Yes	Yes	0	5
309	Terminal 53, Min. Scaling	0.0 V	0.0 - 10.0 V	Yes	Yes	-1	5
310	Terminal 53, Max. Scaling	10.0 V	0.0 - 10.0 V	Yes	Yes	-1	5
311	Terminal 54, Analog Input Voltage	NO OPERATION		Yes	Yes	0	5
312	Terminal 54, Min. Scaling	0.0 V	0.0 - 10.0 V	Yes	Yes	-1	5
313	Terminal 54, Max. Scaling	10.0 V	0.0 - 10.0 V	Yes	Yes	-1	5
314	Terminal 60, Analog Input Current	REFERENCE		Yes	Yes	0	5
315	Terminal 60, Min. Scaling	4.0 mA	0.0 - 20.0 mA	Yes	Yes	-4	5
316	Terminal 60, Max. Scaling	20.0 mA	0.0 - 20.0 mA	Yes	Yes	-4	5
317	Live Zero Time	10 sec.	1 - 99 sec.	Yes	Yes	0	5
318	Function After Time Out	NO FUNCTION		Yes	Yes	0	5
319	Terminal 42, Output	MOTOR CURRENT	4 - 20 mA	Yes	Yes	0	5
320	Terminal 42, Output, Pulse Scaling	5000 Hz	1 - 32000 Hz	Yes	Yes	0	6
321	Terminal 45, Output	OUT. FREQ.	4 - 20 mA	Yes	Yes	0	5
322	Terminal 45, Output, Pulse Scaling	5000 Hz	1 - 32000 Hz	Yes	Yes	0	6
323	Relay 1, Output Function	NO ALARM		Yes	Yes	0	5
324	Relay 01, ON Delay	0 sec.	0 - 600 sec.	Yes	Yes	0	6
325	Relay 01, OFF Delay	2 sec.	0 - 600 sec.	Yes	Yes	0	6
326	Relay 2, Output Function	RUNNING		Yes	Yes	0	5
327	Pulse Reference, Max. Frequency	5000 Hz	Depends on input terminal	Yes	Yes	0	6
328	Pulse Feedback, Max. Freq.	25000 Hz	0 - 65000 Hz	Yes	Yes	0	6
*364	Analog Output 42 Control	0%	0 - 100%	---	---	-1	3
*365	Analog Output 45 Control	0%	0 - 100%	---	---	-1	3

*Only accessible through serial communications

4.. Application Functions

#	Parameter Description	Factory Setting	Range	Changes During Operation	4-Setup	Conversion Index	Data Type
400	Reset Function	INFINITE AUTOMATIC		Yes	Yes	0	5
401	Automatic Restart Time	10 sec.	0 - 600 sec.	Yes	Yes	0	6
402	Flying Start	Fans=ENABLE, Pumps=DISABLE		Yes	Yes	-1	5
403	Sleep Mode Timer	OFF	0 - 300 sec.	Yes	Yes	0	6
404	Sleep Frequency	0 Hz	Min freq - Par. 405	Yes	Yes	-1	6
405	Wake up Frequency	60 Hz	Par. 404 - max freq	Yes	Yes	-1	6
406	Boost Setpoint	100%	0 - 200 %	Yes	Yes	0	6
407	Switching Frequency	Depends on the unit	3.0 - 14.0 kHz	Yes	Yes	2	5
408	Interference Reduction Method	ASFM		Yes	Yes	0	5
409	Function in Case of No Load	WARNING		Yes	Yes	0	5
410	Function at Phase Loss	TRIP		Yes	Yes	0	5
411	Function at Over Temp	TRIP		Yes	Yes	0	5
412	Trip Delay Overcurrent	60 sec.	0 - 60 sec.	Yes	Yes	0	5
413	Minimum Feedback	0.000	-999,999.999 - FB _{MIN}	Yes	Yes	-3	4
414	Maximum Feedback	100.000	FB _{MIN} - 999,999.999	Yes	Yes	-3	4
415	Units Relating to Closed Loop	%		Yes	Yes	-1	5
416	Feedback Conversion	LINEAR		Yes	Yes	0	5
417	Feedback Calculation	MAXIMUM		Yes	Yes	0	5
418	Setpoint 1	0.000	Min to max fdbk.	Yes	Yes	-3	4
419	Setpoint 2	0.000	Min to max fdbk.	Yes	Yes	-3	4
420	PID Normal/Inverse Control	NORMAL		Yes	Yes	0	5
421	PID Anti Windup	ENABLE		Yes	Yes	0	5
422	PID Start-up Frequency	0 Hz	Min. to max. freq.	Yes	Yes	-1	6
423	PID Proportional Gain	0.30	0.00 - 10.00	Yes	Yes	-2	6
424	PID Integral Time	OFF	0.01 - 9999.00 s. (Off)	Yes	Yes	-2	7
425	PID Differentiation Time	OFF	0.0 (Off) - 10.00 sec.	Yes	Yes	-2	6
426	PID Differentiation Gain Limit	5.0	5.0 - 50.0	Yes	Yes	-1	6
427	PID Lowpass Filter Time	0.01	0.01 - 10.00	Yes	Yes	-2	6



5.. Serial Communication

#	Parameter Description	Factory Setting	Range	Changes during operation	4-Setup	Conversion Index	Data Type
500	Protocol	FC		Yes	Yes	0	5
501	Address	001	Depends on par. 500	Yes	No	0	5
502	Baudrate	9600 BAUD		Yes	No	0	5
503	Coasting	LOGIC OR		Yes	Yes	0	5
504	DC-brake	LOGIC OR		Yes	Yes	0	5
505	Start	LOGIC OR		Yes	Yes	0	5
506	Reversing	DIGITAL INPUT		Yes	Yes	0	5
507	Selection of Setup	LOGIC OR		Yes	Yes	0	5
508	Selection of Preset Reference	LOGIC OR		Yes	Yes	0	5
*509	Data Read-out:	REFERENCE %		---	---	-1	3
*510	Data Read-out:	REFERENCE UNIT		---	---	-3	4
*511	Data Read-out:	FEEDBACK		---	---	-3	4
*512	Data Read-out:	FREQUENCY		---	---	-1	6
*513	Data Read-out:	User Defined Read-out		---	---	-2	7
*514	Data Read-out:	CURRENT		---	---	-2	7
*515	Data Read-out:	POWER, kW		---	---	1	7
*516	Data Read-out:	POWER, HP		---	---	-2	7
*517	Data Read-out:	MOTOR VOLTAGE		---	---	-1	6
*518	Data Read-out:	DC LINK VOLTAGE		---	---	0	6
*519	Data Read-out:	MOTOR TEMP.		---	---	0	5
*520	Data Read-out:	DRIVE TEMP.		---	---	0	5
*521	Data Read-out:	DIGITAL INPUT		---	---	0	5
*522	Data Read-out:	TERMINAL 53, ANALOG INPUT		---	---	-1	3
*523	Data Read-out:	TERMINAL 54, ANALOG INPUT		---	---	-1	3
*524	Data Read-out:	TERMINAL 60, ANALOG INPUT		---	---	-1	3
*525	Data Read-out:	PULSE REFERENCE		---	---	-1	7
*526	Data Read-out:	EXTERNAL REFERENCE %		---	---	-1	3
*527	Data Read-out:	STATUS WORD, HEX		---	---	0	6
*528	Data Read-out:	HEAT SINK TEMP.		---	---	0	5
*529	Data Read-out:	ALARM WORD, HEX		---	---	0	7
*530	Data Read-out:	CONTROL WORD, HEX		---	---	0	6
*531	Data Read-out:	WARNING WORD, HEX		---	---	0	7
*532	Data Read-out:	EXTENDED STATUS WORD, HEX		---	---	0	7
533	Display Text Line 1			No	No	0	9
534	Display Text Line 2			No	No	0	9
535	Bus Feedback 1	00000		Yes	No	0	3
536	Bus Feedback 2	00000		Yes	No	0	3
537	Data Read-out:	RELAY STATUS		No	No	0	5
555	Bus Time Interval	60 sec.	1 to 99 sec.	Yes	Yes	0	5
556	Bus Time Interval Function	NO FUNCTION		Yes	Yes	0	5
560	N2 Override Release Time	OFF	1 to 65534 sec.	Yes	Yes	0	5
565	FLN Bus Time Interval	60 sec.	1 to 65534 sec.	Yes	Yes	0	5
566	FLN Bus Time Interval Function	OFF		Yes	Yes	0	5

*Only accessible through serial communications

6.. Service Functions

#	Parameter Description	Factory Setting	Changes During Operation	4-Setup	Conversion Index	Data Type
600	Operating Data:	OPERATING HOURS	No	No	-1	7
601	Operating Data:	HOURS RUN	No	No	-1	7
602	Operating Data:	kWh COUNTER	No	No	-1	7
603	Operating Data:	NO. OF POWER UPS	No	No	0	6
604	Operating Data:	NO. OF OVERTEMPS	No	No	0	6
605	Operating Data:	NO. OF OVERVOLTAGES	No	No	0	6
606	Data Log:	DIGITAL INPUT	No	No	0	5
607	Data Log:	BUS COMMAND	No	No	0	6
608	Data Log:	BUS STATUS WORD	No	No	0	6
609	Data Log:	REFERENCE	No	No	-1	3
610	Data Log:	FEEDBACK	No	No	-3	4
611	Data Log:	OUTPUT FREQUENCY	No	No	-1	-3
612	Data Log:	OUTPUT VOLTAGE	No	No	-1	6
613	Data Log:	OUTPUT CURRENT	No	No	-2	3
614	Data Log:	DC LINK VOLTAGE	No	No	0	6
615	Fault Log:	ERROR CODE	No	No	0	5
616	Fault Log:	TIME	No	No	0	7
617	Fault Log:	VALUE	No	No	0	3
618	Reset of kWh Counter	DO NOT RESET	Yes	No	0	5
619	Reset of Hours Run Counter	DO NOT RESET	Yes	No	0	5
620	Operating Mode	NORMAL OPERATION	Yes	No	0	5
621	Nameplate:	UNIT TYPE	No	No	0	9
622	Nameplate:	POWER COMPONENT	No	No	0	9
623	Nameplate:	DRIVE ORDERING NO.	No	No	0	9
624	Nameplate:	SOFTWARE VERSION NO.	No	No	0	9
625	Nameplate:	LCP IDENTIFICATION NO.	No	No	0	9
626	Nameplate:	DATABASE IDENTIFICATION NO.	No	No	-2	9
627	Nameplate:	POWER COMPONENT IDENTIFICATION NO.	No	No	0	9
628	Nameplate:	APPLICATION OPTION TYPE	No	No	0	9
629	Nameplate:	APPLICATION OPTION ORDERING NO.	No	No	0	9
630	Nameplate:	COMMUNICATION OPTION TYPE	No	No	0	9
631	Nameplate:	COMMUNICATION OPTION ORDERING NO.	No	No	0	9

7.. Option Card (for the four relay option card)

#	Parameter Description	Factory Setting	Range	Changes During Operation	4-Setup	Conversion Index	Data Type
700	Relay 6, Output Function	Running		Yes	Yes	0	5
701	Relay 6, On Delay	000 sec.	0 to 600 sec.	Yes	Yes	0	6
702	Relay 6, Off Delay	000 sec.	0 to 600 sec.	Yes	Yes	0	6
703	Relay 7, Output Function	NO FUNCTION		Yes	Yes	0	5
704	Relay 7, On Delay	000 sec.	0 to 600 sec.	Yes	Yes	0	6
705	Relay 7, Off Delay	000 sec.	0 to 600 sec.	Yes	Yes	0	6
706	Relay 8, Output Function	NO FUNCTION		Yes	Yes	0	5
707	Relay 8, On Delay	000 sec.	0 to 600 sec.	Yes	Yes	0	6
708	Relay 8, Off Delay	000 sec.	0 to 600 sec.	Yes	Yes	0	6
709	Relay 9, Output Function	NO FUNCTION		Yes	Yes	0	5
710	Relay 9, On Delay	000 sec.	0 to 600 sec.	Yes	Yes	0	6
711	Relay 9, Off Delay	000 sec.	0 to 600 sec.	Yes	Yes	0	6

Index

A

activation	99
address	77
AEO FUNCTION	39
AI [ma] 60 FUNCT.	57
AI [v] 53 FUNCT.	56
AI [v] 54 FUNCT.	57
AI 53 SCALE HIGH	57
AI 53 SCALE LOW	57
AI 54 SCALE HIGH	57
AI 54 SCALE LOW	57
AI 60 SCALE HIGH	58
AI 60 SCALE LOW	58
ALARM	26
alarm lamp	27
alarm word	92
ALARM WORD, HEX	89
alarms	103
AMA STOP	41
ANALOG 60 [mA]	35
analog input 53 [V]	35
analog input 54 [V]	35
analog inputs	56
analog output	59
anti-windup	70
AO 42 PULS SCALE	61
AO 45 FUNCTION	61
AO 45 PULS SCALE	61
APPLIC. OPTION	98
APPLIC. ORDER NO	98
application functions	33, 64
ASFM	67
ASYMMETRICAL IMPEDANCE	105
AUTO MOTOR ADAPT	41
AUTO RAMPING	48
auto reset	64
auto restart	38
auto restart time	64
auto start	27, 55
AUTO START BTTN	38
AUTO START key	27
automatic energy optimization	15, 39
automatic motor adaptation	15, 41
automatic reset	64
automatic switching frequency modulation	67
auxiliary enclosure	10
auxiliary relay	10

B

bandwidth, bypass	50
BAUDRATE	86
blocks, terminal	10, 11, 12, 13
boost setpoint	66
bus, DC	15

BUS FEEDBACK 2	91
BUS FEEDBACK 1	91
BUS TIME INTERVAL	91
BUS TIME INTERVAL FUNCTION	91, 92
bypass bandwidth	50
BYPASS FREQ. 1	50
BYPASS FREQ. 2	50
BYPASS FREQ. 3	50
BYPASS FREQ. 4	50
bypass frequencies	45
byte, data control	78

C

cable, shielded control	7
calculation of resulting reference	107
CANCEL key	26
card, relay option	99
carrier frequency	64
catch a rotating motor	64
CHANGE DATA key	26
CHECK 103, 105	105
CHECK PAR. 103, 105	106
CHECK PAR. 104, 106	106
clearance, side	7
clearances	7
closed loop	39, 47
COASTING	86
coasting stop, inverse	54
COM. OPTION	98
COM. ORDER NO	98
communication, serial	23, 76
conduit entry	10, 11, 12, 13, 14
CONFIG. MODE	39
connection examples	25
connections, control	19
connections, motor	15
connections, power	14
connector, test	97
control connections	19
control, differentiation	71
control panel	26
control terminals	19
control word	82
controller	70
controller, PID	70
conversion factor	82, 108
conversion, feedback	73
COPY TO SETUP 1	34
COPY TO SETUP 2	34
COPY TO SETUP 3	34
COPY TO SETUP 4	34
CURRENT	89
current	45
CURRENT HIGH	51

CURRENT LIMIT	50	EXT. REFERENCE [%]	35
CURRENT LOW	51	EXTEND MENU	26
current, output	50	extend menu key	33
CUST. READ. UNIT	35	extended status word	92
CUSTOM READOUT	35, 89	EXTERNAL REFERENCE	89
D		F	
Danfoss FC protocol	76	F. LOG: ERROR CODE	96
DATA CHANGE LOCK	38	F. LOG: TIME	96
data change lock	55	F. LOG: VALUE	96
data control byte	78	factory settings	108
data, log	95	factory setup	33
DC BRAKE	87	FC protocol	86
DC BRAKE CURRENT	43	FEEDBACK	89
DC BRAKE CUT-IN	43	feedback	45
DC brake cut-in frequency	43	FEEDBACK 1 [UNITS]	35
DC BRAKE TIME	43	FEEDBACK 2 [UNITS]	35
DC braking current	43	feedback [units]	35
DC braking, inverse	54	FEEDBACK CONV.	73
DC braking time	43	feedback conversion	73
DC bus	15	FEEDBACK HIGH	52
DC LINK VOLTAGE	89	FEEDBACK LOW	52
DC VOLTAGE [V]	35	feedback signal	70, 71
deactivation time	99	feedback signals	69
derivative	70	filter, EMI	24
differentiation control	71	filter, LC	41
differentiation time	75	filter, lowpass	71, 75
differentiator	75	final adjustments	32
DIGITAL INPUT	89	fixed switching frequency	67
DIGITAL INPUT [BIN]	35	FLA	40
digital inputs	20, 53	FLN	76
DIP switches	23	flow	73
DISABLE	37	flying start	64
display, LCD	26	freeze output	54
display modes	26, 27	freeze reference	54
DISPLAY TEXT ARRAY 1	90	frequencies, bypass	45
DISPLAY TEXT ARRAY 2	90	FREQUENCY	89
disturbances, signal	7	FREQUENCY [%]	35
download	34	FREQUENCY [HZ]	35
DOWNLOAD ALL PARAM.	34	frequency, bypass bandwidth	50
DOWNLOAD SIZE INDEP.	34	frequency, carrier	64
drive type	98	frequency, fixed switching	67
E		FREQUENCY LOW	51
electrical noise	24	frequency, present output	85
electronic thermal protection	15	FREQUENCY RANGE	45
electronic thermal relay	2, 15	frequency, switching	67
EMI	24	full load current rating	40
EMI filter	24	FUNCT. LOW CURR.	67
ENABLE	37	fuses, input	9
enclosure, auxiliary	10	fuses, internal drive	9
ENERGY [UNIT]	35	G	
entry, conduit	10, 11, 12, 13, 14	galvanic isolation	24
error code	80	ground leakage current	24
ETR	44	ground terminals	16
examples, connection	25	grounding	15
		grounding plate	7



H

hand start	27, 55
HAND START BTTN	37
HEATSINK TEMP	35, 89
high breakaway torque	42
HIGH START TORQ.	42
high-voltage relay	15
HOURS RUN	35

I

initialization	31
initialization, manual	31, 97
input fuses	9
inputs and outputs	33, 53
inputs, digital	20, 53
installation checks	32
integral	70
integrator	75
interference reduction	64
INTERNAL FAULT	105
INTERRUPTED BY USER	105
inverse regulation	70

J

jog	55
JOG FREQUENCY	48
Johnson Controls Metasys N2	76, 86

K

key, extend menu	33
kWh COUNTER	94

L

lamp, alarm	27
lamp, warning	27
language	30
LARGE READOUT	35
LC filter	41
LCD display	26
LCP copy	34
LCP ID NO.	98
LED, power on	27
LIMIT VALUE FAULT	105
LIVE ZERO FUNCT.	58
LIVE ZERO TIME	58
load and motor	33, 39
load, loss of	64
lock for data change	26
LOCKED	38
log data	95
log, digital input	95
LOG: BUS COMMAND	95
LOG: BUS STAT WD	95
LOG: DC LINK VOLT	95

LOG: FEEDBACK	95
LOG: MOTOR CURR.	95
LOG: MOTOR FREQ.	95
LOG: MOTOR VOLT	95
LOG: REFERENCE	95
loss of load	64
LOW P 105	105
lowpass filter	71, 75

M

manual initialization	31, 97
manual reset	64
MAX. FEEDBACK	69
MAX. FREQUENCY	45
MAX. REFERENCE	47
messages, status	100
metal grounding plate	14
Metasys N2	86
meters	27
MIN. FEEDBACK	69
MIN. FREQUENCY	45
MIN. REFERENCE	47
minimum frequency	30
MOT. THERM PROTEC	44
motor connections	15
MOTOR CURRENT	40
motor current	30
MOTOR CURRENT [A]	35
MOTOR FREQUENCY	40
motor frequency	30
MOTOR NOM. SPEED	41
motor nominal speed	30
MOTOR POWER	40
motor power	30
MOTOR PREHEAT	42
motor preheat	42
motor preheat DC current	42
MOTOR ROTATES	105
MOTOR TEMPERATURE	89
motor temperature	44
motor thermal protection	44
MOTOR TOO BIG	105
MOTOR TOO SMALL	105
MOTOR VOLT	89
MOTOR VOLTAGE	40
motor voltage	30, 35
motor wiring	15
motors, multiple	15
MULTI SETUP	33
multi-setup	33
MULTIM.START VOLT	42
MULTIPLE MOTORS	39
multiple motors	15

N

N2	76
----------	----

nameplate	98	103 Motor Voltage	40
National Electrical Code	2	104 Motor Frequency	40
NEC	2	105 Motor Current	40
NEMA 1	7	106 Rated Motor Speed	41
NEMA 12	11, 12	107 Automatic Motor Adaptation	41
NO AMA	41	107 Automatic Motor Adaptation, AMA	41
NO COPY	34	108 Start Voltage of Parallel Motors	42
noise, electrical	24	109 Resonance Dampening	42
noise, radio frequency	7	110 High Breakaway Torque	42
NOISE REDUCTION	67	111 Start Delay	42
NOT LOCKED	38	112 Motor Preheat	42
O		113 Motor Preheat DC Current	42
OFF/START key	27, 37	114 DC Braking Current	43
OFF/STOP	38	115 DC Braking Time	43
OK	26	116 DC Brake Cut-in Frequency	43
ON	26	117 Motor Thermal Protection	44
OPEN LOOP	39	118 Motor Power Factor (Cos)	44
open loop	39, 47	200 Output Frequency Range	45
OPERATING HOURS	94	201 Output Frequency Low Limit	45
operation and display	33	202 Output Frequency High Limit	45
OPERATION MODE	96	203 Reference Handling	46
operational tests — AUTO	32	204 Minimum Reference	47
operational tests — HAND	32	205 Maximum Reference	47
ORDERING NO	98	206 Ramp Up Time	48
output current	50	207 Ramp Down Time	48
output frequency high limit	45	208 Automatic Ramp Up/Down	48
output frequency low limit	45	209 Jog Frequency	48
output frequency range	45	210 Reference Type	49
output signal	59	211 Preset Reference 1	50
OVER TEMPS	94	212 Preset Reference 2	50
OVER VOLTS	94	213 Preset Reference 3	50
OVERLOADDELAY	68	214 Preset Reference 4	50
P		215 Current Limit	50
parallel motors	39, 42	216 Frequency Bypass, Bandwidth	50
PARAM DB ID	98	217 Frequency Bypass 1	50
Parameters		218 Frequency Bypass 2	50
002 Active Setup	33	219 Frequency Bypass 3	50
003 Copying of Setups	34	220 Frequency Bypass 4	50
004 LCP Copy	34	221 Warning: Low Current	51
005 Maximum Value of User-defined Readout	35	222 Warning: High Current	51
006 Unit for User Defined Readout	35	223 Warning: Low Frequency	51
007 Large Display Readout	35	224 Warning: High Frequency	51
008 Small Display Readout 1.1	37	225 Warning: Low Reference	52
009 Small Display Readout 1.2	37	226 Warning: High Reference	52
010 Small Display Readout 1.3	37	227 Warning: Low Feedback	52
011 Unit of Local Reference	37	228 Warning: High Feedback	52
012 Hand Start on LCP	37	308 Terminal 53	56
013 OFF/STOP on LCP (STOP BUTTON)	37	309 Terminal 53	57
014 Auto Start on LCP	38	309 Terminal 53, Minimum Scaling	57
016 Lock for Data Change	38	310 Terminal 53, Maximum Scaling	57
017 Operating State at Power up, Local	38	311 Terminal 54, Analog Input Voltage	57
100 Configuration	39	312 Terminal 54, Minimum Scaling	57
101 Torque Characteristics	39	313 Terminal 54, Maximum Scaling	57
102 Motor Power	40	314 Terminal 60, Analog Input Current	57
		315 Terminal 60, Minimum Scaling	58
		316 Terminal 60, Maximum Scaling	58
		317 Time Out	58

318 Function After Time Out	58	522 Terminal 53, analog input [V]	89
320 Terminal 42, Output, Pulse Scaling	61	523 Terminal 54, analog input [V]	89
321 Terminal 45, Output	61	524 Terminal 60, analog input [mA]	89
322 Terminal 45, Output, Pulse Scaling	61	525 Pulse reference [Hz]	89
323 Relay 1, Output Function	63	526 External reference [%]	89
324 Relay 01, ON Delay	63	527 Status word	89
325 Relay 01, OFF Delay	63	528 Heat sink temperature [°C]	89
326 Relay 2, Output Function	63	529 Alarm word	89
327 Pulse Reference, Maximum Frequency	63	530 Control word	89
328 Pulse Feedback, Maximum Frequency	63	531 Warning word	89
400 Reset Function	64	532 Extended status word	89
401 Automatic Restart Time	64	533 Display Text 1	90
402 Flying Start	64	534 Display Text 2	90
403 Sleep Mode Timer	66	536 Bus Feedback 2	91
404 Sleep Frequency	66	555 Bus Time Interval	91
406 Boost Setpoint	66	556 Bus Time Interval Function	91, 92
407 Switching Frequency	67	600 Operating Hours	94
408 Interference Reduction Method	67	601 Hours Run	94
409 Function in Case of No Load	67	602 kWh Counter	94
410 Function at Input Phase Loss	68	603 No. of Power-ups	94
412 Trip Delay Overcurrent	68	604 No. of Overtemp Trips	94
413 Minimum Feedback	69	605 No. of Overvoltage Trips	94
414 Maximum Feedback	69	606 Digital Input	95
415 Units Relating to Closed Loop	69	607 Control Word	95
416 Feedback Conversion	73	608 Status Word	95
418 Setpoint 1	74	609 Reference	95
419 Setpoint 2	74	610 Feedback	95
420 PID Normal/Inverse Control	74	611 Output Frequency	95
421 PID Anti-windup	74	612 Output Voltage	95
422 PID Start-up Frequency	74	613 Output Current	95
423 PID Proportional Gain	75	614 DC Link Voltage	95
424 PID Start-up Frequency	75	615 Fault Log: Error Code	96
425 PID Differentiation Time	75	616 Fault Log: Time	96
426 PID Differentiator Gain Limit	75	617 Fault Log: Value	96
427 PID Lowpass Filter Time	75	618 Reset of kWh Counter	96
500 Protocol	86	619 Reset of Hours Run Counter	96
502 Baudrate	86	620 Operating Mode	96
503 Coasting Stop	86	621 - 631 Nameplate	98
504 DC Brake	87	621 Unit Type	98
505 Start	87	622 Power Component	98
506 Reversing	88	623 VLT Ordering No.	98
507 Selection of Setup	88	624 Software Version No.	98
508 Selection of Preset Reference	88	625 Control Panel Identification No.	98
509 Resulting reference	89	626 Database Identification No.	98
509 through 532 Data Read-Out	89	627 Power Component Identification No.	98
510 Resulting reference [unit]	89	628 Application Option Type	98
511 Feedback [unit]	89	629 Application Option Ordering No.	98
512 Frequency [Hz]	89	630 Communication Option Type	98
513 User-defined readout	89	631 Communication Option Ordering No.	98
514 Motor current [A]	89	700 Relay 3, Function	99
515 Power [kW]	89	701 Relay 3, ON Delay	99
516 Power [HP]	89	702 Relay 3, OFF Delay	99
517 Motor voltage [V]	89	703 Relay 4, Function	99
518 DC link voltage [V]	89	704 Relay 4, ON Delay	99
519 Thermal load, motor [%]	89	705 Relay 4, OFF Delay	99
520 Thermal load, VLT [%]	89	706 Relay 5, Function	99
521 Digital input	89	707 Relay 5, ON Delay	99

708 Relay 5, OFF Delay	99
709 Relay 6, Function	99
710 Relay 6, ON Delay	99
711 Relay 6, OFF Delay	99
Parameters, other references	
Parameter 004	34
Parameter 005	34
Parameter 006	34
Parameter 105	15
Parameter 117	15
Parameter 200 through 228	45
Parameter 300 through 328	53
Parameter 400 through 427	64
parameters, uploading	31
PID	70
PID NOR/INV. CTRL	74
PID ANTI WINDUP	74
PID controller	70
PID DIFF. GAIN	75
PID DIFF. TIME	75
PID FILTER TIME	75
PID INTEGR.TIME	75
PID PROP. GAIN	75
PID START VALUE	74
plate, metal grounding	14
potentiometer reference	25
POWER [HP]	35
POWER [KW]	35
POWER HP	89
power, input	14
POWER KW	89
power on LED	27
POWER SECTION	98
POWER UNIT DB ID	98
POWER UPS	94
pre-installation checks	32
PREHEAT DC-CURR.	42
present output frequency	85
PRESET REF. 1	50
PRESET REF. 2	50
PRESET REF. 3	50
PRESET REF. 4	50
preset reference	54
process units	64
process word	82
proportional	70
PROTOCOL	86
protocols	76
PULSE FDBK MAX.	63
pulse feedback	55
PULSE REF. MAX	63
PULSE REFERENCE	89
pulse reference	55
PULSE REFERENCE [Hz]	35

Q

quick menu	26, 30
------------------	--------

R

radio frequency noise	7
RAMP DOWN TIME	48
ramp down time	30
ramp times	45
RAMP UP TIME	48
ramp up time	30
rating, full load current	40
REF. / FDBK. UNIT	69
REF. FUNCTION	49
reference	56
REFERENCE %	89
REFERENCE [%]	35
REFERENCE [UNIT]	89
reference handling	46
REFERENCE HIGH	52
REFERENCE LOW	52
REFERENCE SITE	46
reference type	49
references	45
references and limits	33, 45
regulation, inverse	70
Relay 1	62
Relay 1 function	30
Relay 2	62
Relay 2 function	30
relay, auxiliary	10
relay, electronic thermal	15
relay, form C	20
relay, high-voltage	15
relay option card	99
relay outputs	62
RELAY1 FUNCTION	63
RELAY1 OFF DELAY	63
RELAY1 ON DELAY	63
RELAY2 FUNCTION	63
RELAY3 FUNCTION	99
RELAY3 OFF DELAY	99
RELAY3 ON DELAY	99
RELAY4 FUNCTION	99
RELAY4 OFF DELAY	99
RELAY4 ON DELAY	99
RELAY5 FUNCTION	99
RELAY5 OFF DELAY	99
RELAY5 ON DELAY	99
RELAY6 FUNCTION	99
RELAY6 OFF DELAY	99
RELAY6 ON DELAY	99
relief, strain	14
remote, auto	27
remote, hand	27
reset	54

reset and coasting stop, inverse	54
reset, auto	64
RESET FUNCTION	64
reset function	64
RESET key	27, 38
RESET kWh COUNT	96
reset, manual	64
RESET RUN. HOUR	96
RESONANCE DAMP.	42
resonance dampening	42
resulting reference	46
REVERSING	88
reversing	54
reversing and start	54
RFI	7, 24
RS-485	21
RUN AMA	41
run permissive	25, 55
RUNNING HOURS	94

S

safety interlock	54
SELECTING OF SETUP	88
SELECTING OF SPEED	88
serial communication	23, 33, 76
service functions	33
Setpoint 1	74
Setpoint 1 [units]	35
Setpoint 2	74
Setpoint 2 [units]	35
setting up drive	32
setup	54
SETUP 1	33
SETUP 2	33
SETUP 3	33
SETUP 4	33
setup, factory	33
shield	7
shielded wires	7
Siemens FLN	76, 86
signal disturbances	7
signal, feedback	70
signal, output	59
SLEEP FREQUENCY	66
sleep mode	65
SLEEP MODE TIMER	66
SMALL READOUT 1	37
SMALL READOUT 2	37
SMALL READOUT 3	37
SOFTWARE VERSION	98
sound level	67
speed up and speed down	54
START	87
start	54
start bit	77
start character	77

START DELAY	42
start delay	42
start, flying	64
start voltage of parallel motors	42
start-up	32
start-up frequency	70
status line	100
status messages	100
STATUS WORD	89
status word	84
STATUS WORD HEX	89
strain relief	14
switch, Klixon thermal	56
switches	10, 11, 12, 13
switches, DIP	23
SWITCHING FREQ.	67
switching frequency	67

T

telegram	77
TERMINAL 53, ANALOG INPUT	89
TERMINAL 54, ANALOG INPUT	89
TERMINAL 60, ANALOG INPUT	89
terminal blocks	10, 11, 12, 13
terminals, control	19
terminals, ground	16
test connector	97
THERM.DRIVE LOAD [%]	35
THERM.MOTOR LOAD [%]	35
thermistor	44, 56
time, differentiation	75
TIME OUT	105
torque, tightening	16
transmitter connection	25
troubleshooting, general	32
two wire start/stop	25
two zone inputs	25

U

UL, C-UL, and CE conformity	7
UNIT OF LOC REF	37
units, selection of	64
upload	34
UPLOAD ALL PARAMET.	34
uploading parameters	31
user defined readout	34

V

VLT CONTROL WORD, HEX	89
VLT TEMPERATURE	89
VLT Type	7, 71, 97
VT CHARACT	39

W

WARNING	26	WARNING 6	103
Warning Functions		WARNING/ALARM 10	104
Warning: High Current	51	WARNING/ALARM 11	104
Warning: High Feedback	52	WARNING/ALARM 12	104
Warning: High Frequency	51	WARNING/ALARM 13	104
Warning: High Reference	52	WARNING/ALARM 17	104
Warning: Low Current	51	WARNING/ALARM 18	104
Warning: Low Feedback	52	WARNING/ALARM 2	103
Warning: Low Frequency	51	WARNING/ALARM 4	103
Warning: Low Reference	52	WARNING/ALARM 7	103
waming functions	51	WARNING/ALARM 8	103
warning lamp	27	WARNING/ALARM 9	103
warning word	89, 92	WARNING/ALARM: 34	105
warnings	103	WARNING/ALARM: 63	106
Warnings and Alarms	102	WARNING: 35	105
ALARM: 14	104	WARNING: 39	106
ALARM: 15	104	WARNING: 40	106
ALARM: 16	104	WARNING: 41	106
ALARM: 22	41, 105	WARNING: 42	106
ALARM: 29	105	WARNING: 61	106
ALARM: 30	105	WARNING: 62	106
ALARM: 31	105	WARNING: 64	106
ALARM: 32	105	WARNING: 65	106
ALARM: 37	105	WARNING: 66	106
ALARM: 60	106	WARNING: 67	106
WARNING 1	103	WARNING: 68	106
WARNING 19	104	WARNING: 69	106
WARNING 20	104	WARNING: 99	106
WARNING 5	103	wires, shielded	7



NOTES



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