



Operating Instructions

VLT[®] HVAC Drive FC 102 Low Harmonic Drive



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1 Introduction

1.1 Purpose of the Manual

The purpose of this manual is to provide information for the installation and operation of a VLT® HVAC Drive FC 102 Low Harmonic. The manual includes relevant safety information for installation and operation.

chapter 1 Introduction, chapter 2 Safety, chapter 3 Mechanical Installation, and Chapter 4 Electrical Installation introduce the unit functions and cover proper mechanical and electrical installation procedures. There are chapters on start-up and commissioning, applications and basic troubleshooting. *Chapter 8 Specifications* provides a quick reference for ratings and dimensions, as well as other operating specifications. This manual provides a basic knowledge of the unit and explains set-up and basic operation.

VLT® is a registered trademark.

1.2 Additional Resources

Other resources are available to understand advanced functions and programming.

- The *VLT® HVAC Drive FC 102 Programming Guide* provides greater detail on working with parameters and many application examples.
- The *VLT® HVAC Drive FC 102 Design Guide* provides detailed capabilities and functionality to design motor control systems.
- Supplemental publications and manuals are available from Danfoss. See vlt-drives.danfoss.com/Support/Technical-Documentation/ for listings.
- Optional equipment may change some of the procedures described. Reference the instructions supplied with those options for specific requirements. Contact the local Danfoss supplier or visit the Danfoss website: vlt-drives.danfoss.com/Support/Technical-Documentation/ for downloads or additional information.
- The *VLT® Active Filter AAF00x Instruction Manual* provides additional information about the filter portion of the low harmonic drive.

1.3 Product Overview

1.3.1 Intended Use

A frequency converter is an electronic motor controller that converts AC mains input into a variable AC waveform output. The frequency and voltage of the output are regulated to control the motor speed or torque. The frequency converter can vary the speed of the motor in response to system feedback, such as with position sensors on a conveyor belt. The frequency converter can also regulate the motor by responding to remote commands from external controllers.

The frequency converter:

- Monitors the system and motor status.
- Issues warnings or alarms for fault conditions.
- Starts and stops the motor.
- Optimises energy efficiency.

Operation and monitoring functions are available as status indications to an outside control system or serial communication network.

A low harmonic drive (LHD) is a single unit that combines the frequency converter with an advanced active filter (AAF) for harmonic mitigation. The frequency converter and filter are packaged together in an integrated system, but each functions independently. In this manual, there are separate specifications for the frequency converter and the filter. Since the frequency converter and filter are in the same enclosure, the unit is transported, installed, and operated as a single entity.

1.3.2 Working Principle

The low harmonic drive is a high-power frequency converter with an integrated active filter. An active filter is a device that actively monitors harmonic distortion levels and injects compensative harmonic current onto the line to cancel the harmonics.

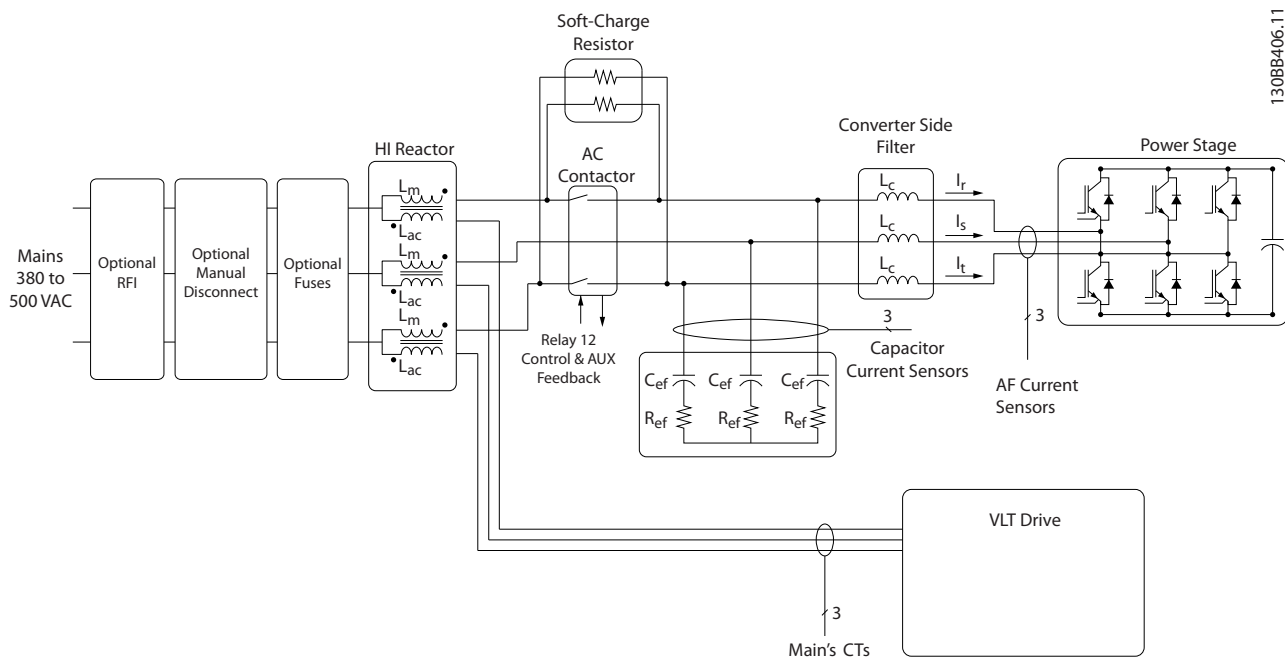
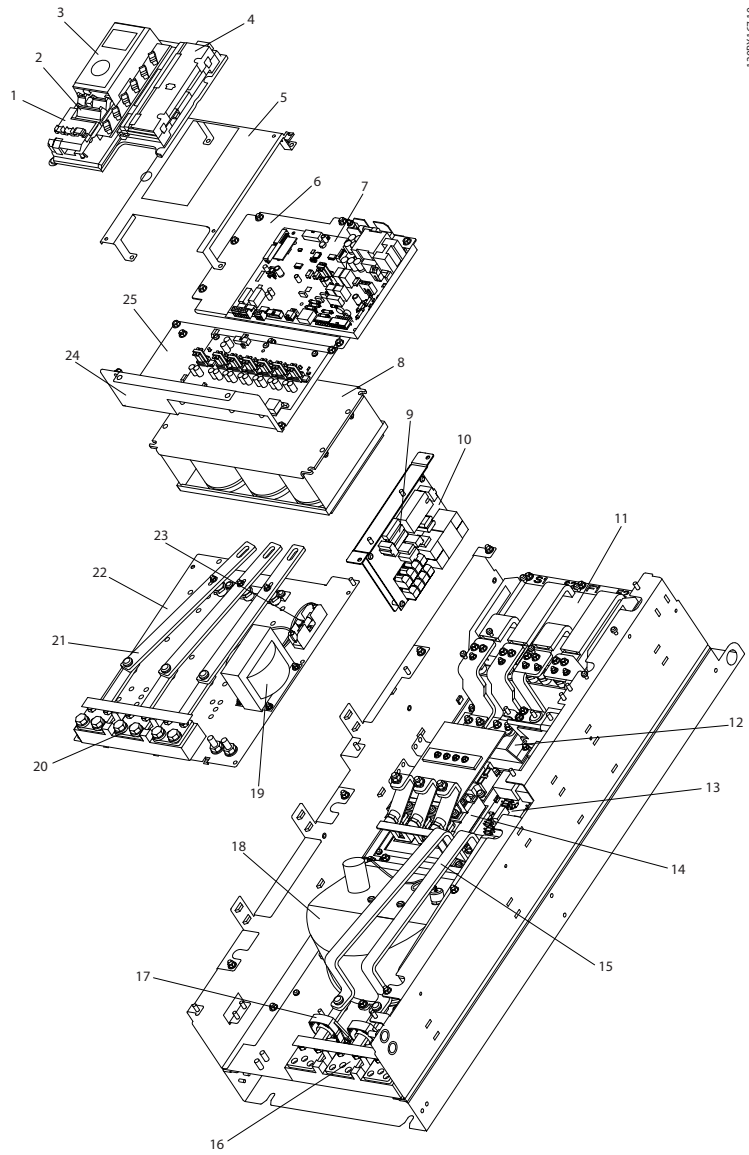


Figure 1.1 Basic Layout for the Low Harmonic Drive

Low harmonic drives are designed to draw an ideal sinusoidal current waveform from the supply grid with a power factor of 1. Where traditional non-linear load draws pulse-shaped currents, the low harmonic drive compensates that via the parallel filter path, lowering the stress on the supply grid. The low harmonic drive meets the highest harmonic standards with a THDi less than 5% at full load for <3% pre-distortion on a 3% unbalanced 3-phase grid.

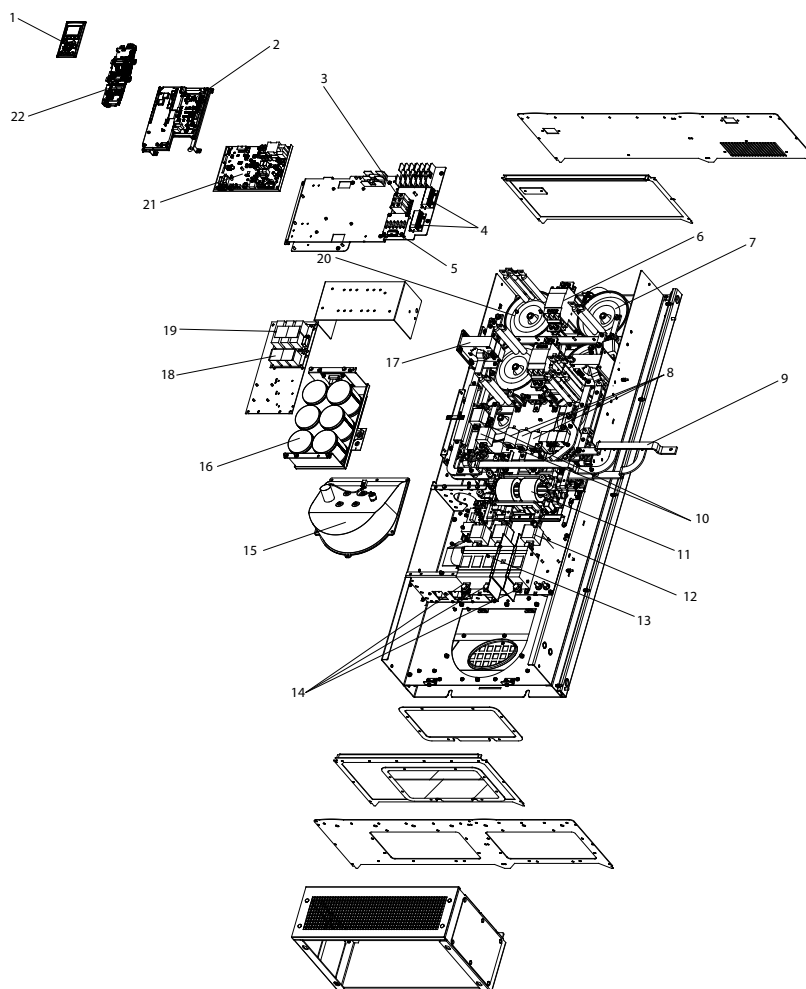
1.3.3 Exploded View Drawings



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1	Control card	14	SCR/diode module
2	Control input terminals	15	IGBT output bus bar
3	Local control panel (LCP)	16	Output motor terminals
4	Control card C option	17	Current sensor
5	Mounting bracket	18	Fan assembly
6	Power card mounting plate	19	Fan transformer
7	Power card	20	AC input terminals
8	Capacitor bank assembly	21	AC input bus bar
9	Soft-charge fuses	22	Input terminal mounting plate assembly
10	Soft-charge card	23	Fan fuse
11	DC inductor	24	Capacitor bank cover plate
12	Soft charge module	25	IGBT gate drive card
13	IGBT module		

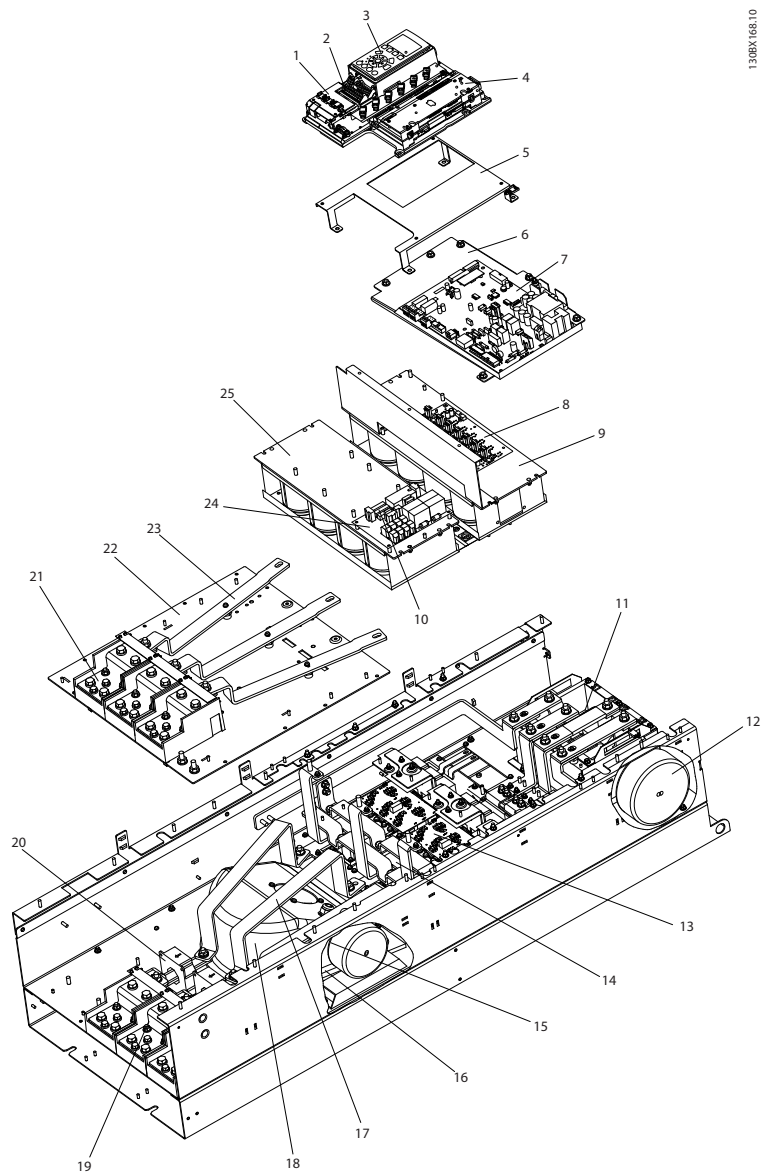
Figure 1.2 Frame Size D13 Drive Enclosure



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1	Local control panel (LCP)	13	Electrical fuses
2	Active filter card (AFC)	14	Line power disconnect
3	Metal oxide varistor (MOV)	15	Line Power Terminals
4	Soft-charge resistors	16	Heatsink fan
5	AC capacitors discharge board	17	DC capacitor bank
6	Line power contactor	18	Current transformer
7	LC inductor	19	RFI differential mode filter
8	AC capacitors	20	RFI common mode filter
9	Line power bus bars to drive input	21	HI inductor
10	IGBT fuses	22	Power card
11	RFI		

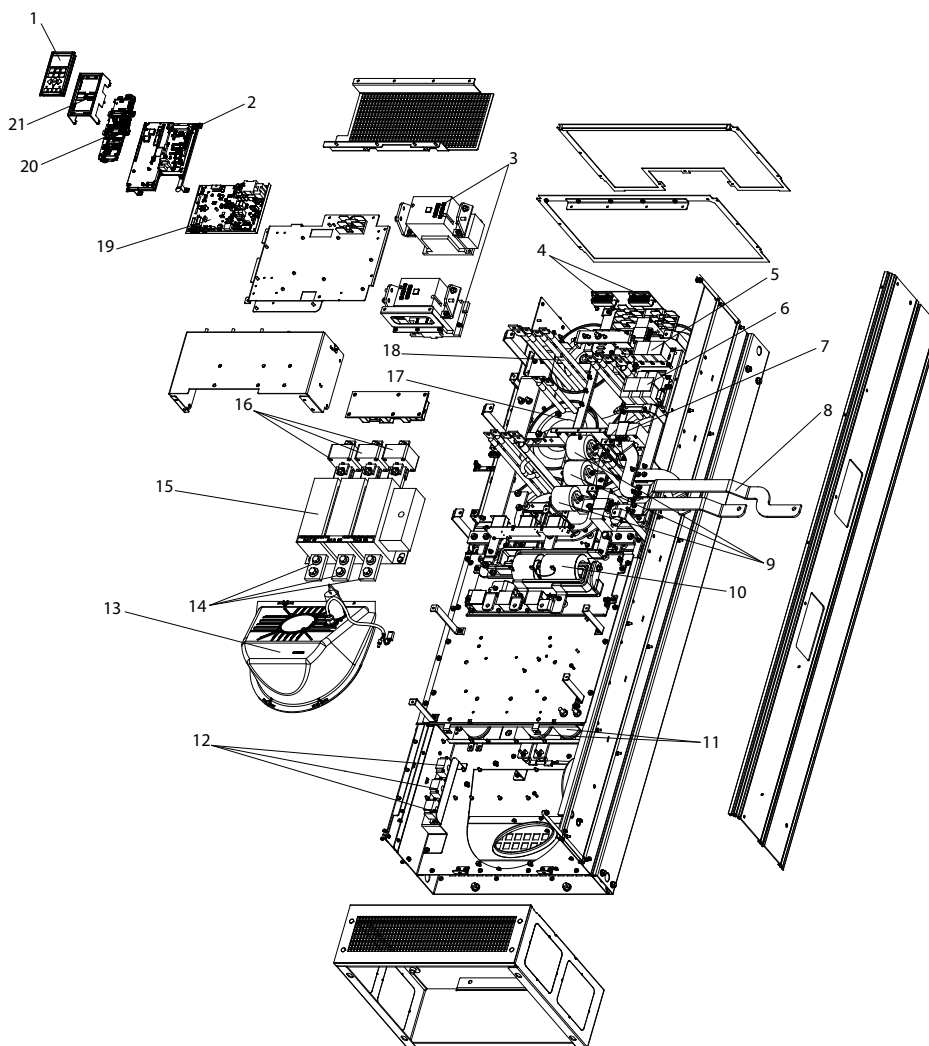
Figure 1.3 Frame Size D13 Filter Enclosure



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1	Control card	14	SCR and diode
2	Control input terminals	15	Fan inductor (not on all units)
3	Local control panel (LCP)	16	Soft-charge resistor assembly
4	Control card C option	17	IGBT output bus bar
5	Mounting bracket	18	Fan assembly
6	Power card mounting plate	19	Output motor terminals
7	Power card	20	Current sensor
8	IGBT gate drive card	21	Main AC power input terminals
9	Upper capacitor bank assembly	22	Input terminal mounting plate
10	Soft-charge fuses	23	AC input bus bar
11	DC inductor	24	Soft-charge card
12	Fan transformer	25	Lower capacitor bank assembly
13	IGBT module		

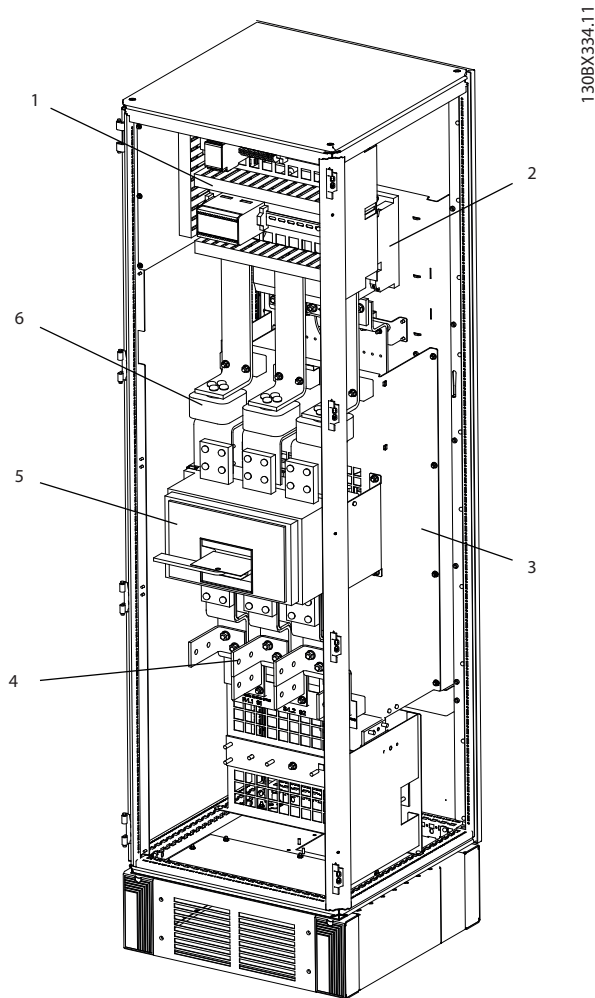
Figure 1.4 Frame Size E9 Drive Enclosure



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1	Local control panel (LCP)	12	AC capacitor current transducers
2	Active filter card (AFC)	13	Heatsink fan
3	Line power contactors	14	Line power terminals
4	Soft-charge resistors	15	Line power disconnect
5	RFI differential mode filter	16	Electrical fuses
6	RFI common mode filter	17	LC inductor
7	Current transformer (CT)	18	HI inductor
8	Line power bus bars to drive output	19	Power card
9	AC capacitors	20	Control card
10	RFI	21	LCP cradle
11	Lower DC capacitor bank		

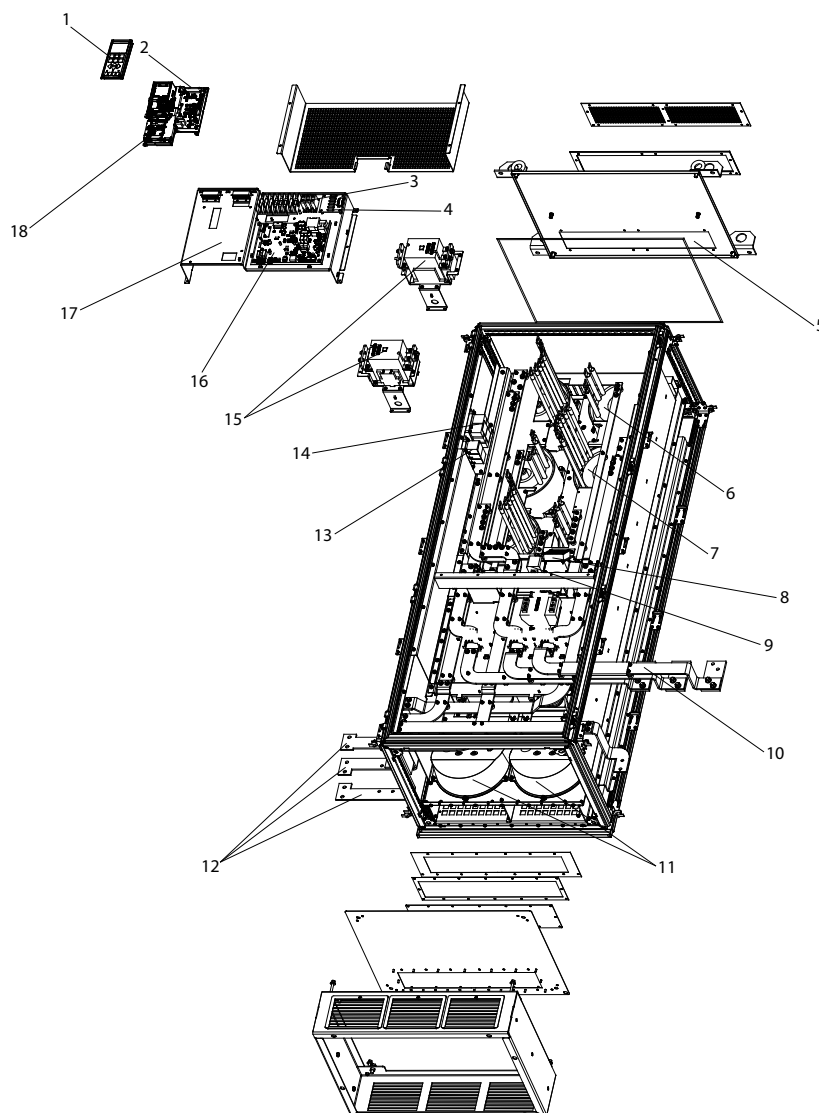
Figure 1.5 Frame Size E9 Filter Enclosure



1	Contactor	4	Circuit breaker or disconnect (if purchased)
2	RFI filter	5	AC line power/line fuses (if purchased)
3	Line power AC power input terminals		

Figure 1.6 Frame Size F18 Options Cabinet

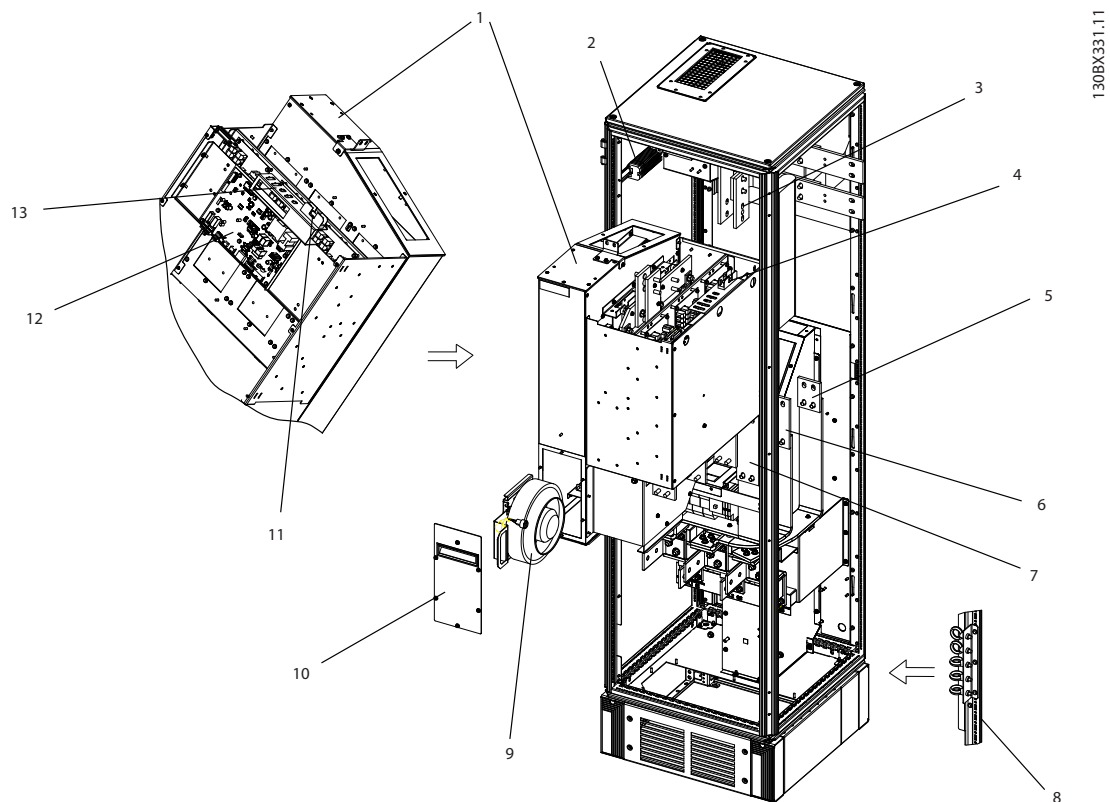
*The options cabinet is not optional for the LHD. The ancillary equipment is stored in the cabinet.



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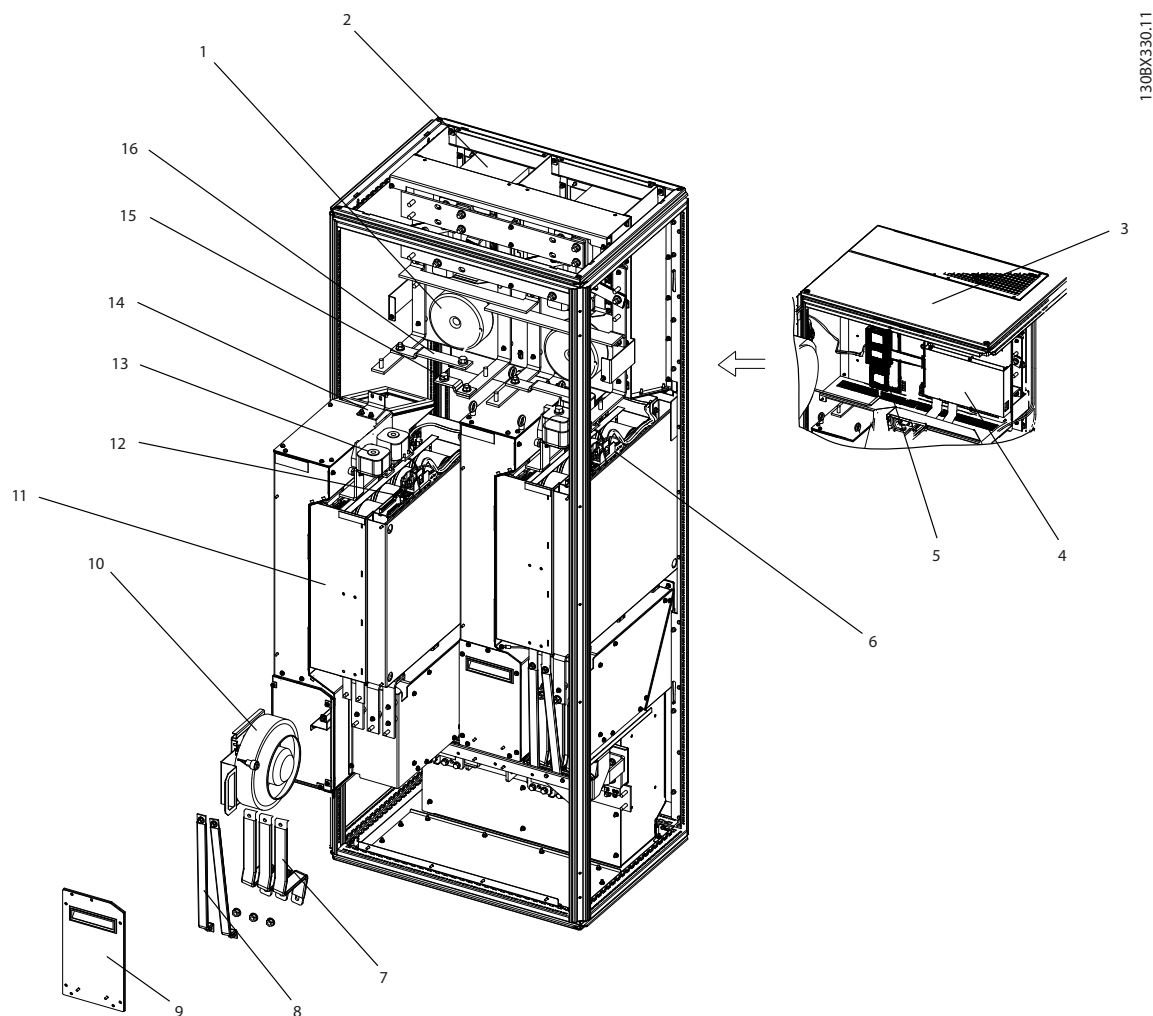
1	Local control panel (LCP)	10	Line power bus bars to drive input
2	Active filter card (AFC)	11	Heatsink fans
3	Soft-charge resistors	12	Line power terminals (R/L1, S/L2, T/L3) from options cabinet
4	Metal oxide varistor (MOV)	13	RFI differential mode filter
5	AC capacitors discharge board	14	RFI common mode filter
6	LC inductor	15	Line power contactor
7	HI inductor	16	Power card
8	Mixing fan	17	Control card
9	IGBT fuses	18	LCP cradle

Figure 1.7 Frame Size F18 Filter Cabinet



1	Rectifier module	7	Module lifting eye bolts (mounted on a vertical strut)
2	DC bus bar	8	Module heatsink fan
3	SMPS fuse	9	Fan door cover
4	(Optional) back AC fuse mounting bracket	10	SMPS fuse
5	(Optional) middle AC fuse mounting bracket	11	Power card
6	(Optional) front AC fuse mounting bracket	12	Panel connectors

Figure 1.8 Frame Size F18 Rectifier Cabinet



1	Fan transformer	9	Fan door cover
2	DC link inductor	10	Module heatsink fan
3	Top cover plate	11	Inverter module
4	MDCIC board	12	Panel connectors
5	Control card	13	DC fuse
6	SMPs fuse and fan fuse	14	Mounting bracket
7	Motor output bus bar	15	(+) DC bus bar
8	Brake output bus bar	16	(-) DC bus bar

Figure 1.9 Frame Size F18 Inverter Cabinet

1.4 Enclosure Sizes and Power Ratings

Enclosure size		D1n	D2n	E9	F18
Enclosure protection	IP	21/54	21/54	21/54	21/54
	NEMA	Type 1/Type 12	Type 1/Type 12	Type 1/Type 12	Type 1/Type 12
Frequency converter dimensions [mm/inch]	Height	1740/68.5	1740/68.5	2000.7/78.77	2278.4/89.70
	Width	915/36.02	1020/40.16	1200/47.24	2792/109.92
	Depth	380/14.96	380/14.96	493.5/19.43	605.8/23.85
Frequency converter weights [kg/lbs]	Maximum weight	353/777	413/910	676/1490	1900/4189
	Shipping weight	416/917	476/1050	840/1851	2345/5171

Table 1.1 Mechanical Dimensions, Enclosure Sizes D, E and F

1.5 Approvals and Certifications

1.5.1 Approvals

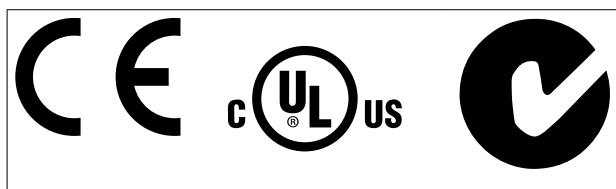


Table 1.2 Compliance Marks: CE, UL, and C-Tick

1.5.2 Compliance with ADN

For compliance with the European Agreement concerning International Carriage of Dangerous Goods by Inland Waterways (ADN), refer to *ADN-compliant Installation* in the *Design Guide*.

1.6 Harmonics Overview

1.6.1 Harmonics

Non-linear loads such as found with 6-pulse frequency converters do not draw current uniformly from the power line. This non-sinusoidal current has components which are multiples of the fundamental current frequency. These components are referred to as harmonics. It is important to control the total harmonic distortion on the mains supply. Although the harmonic currents do not directly affect electrical energy consumption, they generate heat in wiring and transformers and can impact other devices on the same power line.

1.6.2 Harmonic Analysis

Since harmonics increase heat losses, it is important to design systems with harmonics in mind to prevent overloading the transformer, inductors, and wiring.

When necessary, perform an analysis of the system harmonics to determine equipment effects.

A non-sinusoidal current is transformed with a Fourier series analysis into sine-wave currents at different frequencies, that is, different harmonic currents I_n with 50 Hz or 60 Hz as the fundamental frequency.

Abbreviation	Description
f_1	Fundamental frequency (50 Hz or 60 Hz)
I_1	Current at the fundamental frequency
U_1	Voltage at the fundamental frequency
I_n	Current at the nth harmonic frequency
U_n	Voltage at the nth harmonic frequency
n	Harmonic order

Table 1.3 Harmonics-related Abbreviations

	Fundamental current (I_1)	Harmonic current (I_n)		
		I_5	I_7	I_{11}
Current	I_1			
Frequency [Hz]	50	250	350	550

Table 1.4 Fundamental and Harmonic Currents

Current	Harmonic current				
	I_{RMS}	I_1	I_5	I_7	I_{11-49}
Input current	1.0	0.9	0.5	0.2	< 0.1

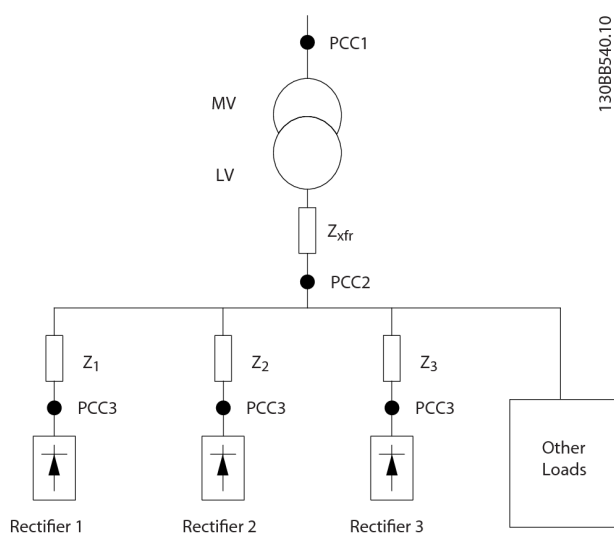
Table 1.5 Harmonic Currents Compared to the RMS Input Current

The voltage distortion on the mains supply voltage depends on the size of the harmonic currents multiplied by the mains impedance for the frequency in question. The total voltage distortion (THDi) is calculated based on the individual voltage harmonics using this formula:

$$THDi = \frac{\sqrt{U_{25}^2 + U_{27}^2 + \dots + U_{2n}^2}}{U}$$

1.6.3 Effect of Harmonics in a Power Distribution System

In Figure 1.10, a transformer is connected on the primary side to a point of common coupling PCC1, on the medium voltage supply. The transformer has an impedance Z_{xfr} and feeds a number of loads. The point of common coupling where all loads are connected is PCC2. Each load is connected through cables that have an impedance Z_1 , Z_2 , Z_3 .



PCC	Point of common coupling
MV	Medium voltage
LV	Low voltage
Z_{xfr}	Transformer impedance
$Z_{\#}$	Modeling resistance and inductance in the wiring

Figure 1.10 Small Distribution System

Harmonic currents drawn by non-linear loads cause distortion of the voltage because of the voltage drop on the impedances of the distribution system. Higher impedances result in higher levels of voltage distortion.

Current distortion relates to apparatus performance and it relates to the individual load. Voltage distortion relates to system performance. It is not possible to determine the voltage distortion in the PCC knowing only the harmonic performance of the load. To predict the distortion in the PCC, the configuration of the distribution system and relevant impedances must be known.

A commonly used term for describing the impedance of a grid is the short-circuit ratio R_{scc} . R_{scc} is defined as the ratio between the short circuit apparent power of the supply at the PCC (S_{sc}) and the rated apparent power of the load (S_{equ}).

$$R_{scc} = \frac{S_{sc}}{S_{equ}}$$

where $S_{sc} = \frac{U^2}{Z_{supply}}$ and $S_{equ} = U \times I_{equ}$

Negative effects of harmonics

- Harmonic currents contribute to system losses (in cabling, transformer).
- Harmonic voltage distortion causes disturbance to other loads and increase losses in other loads.

1.6.4 IEC Harmonic Standards

The mains voltage is rarely a uniform sinusoidal voltage with constant amplitude and frequency because loads that draw non-sinusoidal currents from the mains have non-linear characteristics.

Harmonics and voltage fluctuations are two forms of low-frequency mains interference. They have a different appearance at their origin than at any other point in the mains system when a load is connected. So, a range of influences must be determined collectively when assessing the effects of mains interference. These influences include the mains feed, structure, and loads.

Mains interference can cause the following:

Undervoltage warnings

- Incorrect voltage measurements due to distortion of the sinusoidal mains voltage.
- Cause incorrect power measurements because only RMS-true measuring takes harmonic content into account.

Higher functional losses

- Harmonics reduce the active power, apparent power, and reactive power.
- Distort electrical loads resulting in audible interference in other devices, or in worst case, even destruction.
- Shorten the lifetime of devices as a result of heating.

In most of Europe, the basis for the objective assessment of the quality of mains power is the Electromagnetic Compatibility of Devices Act (EMVG). Compliance with these regulations ensures that all devices and networks connected to electrical distribution systems fulfil their intended purpose without generating problems.

Standard	Definition
EN 61000-2-2, EN 61000-2-4, EN 50160	Define the mains voltage limits required for public and industrial power grids
EN 61000-3-2, 61000-3-12	Regulate mains interference generated by connected devices in lower current products
EN 50178	Monitors electronic equipment for use in power installations

Table 1.6 EN Design Standards for Mains Power Quality

There are 2 European standards that address harmonics in the frequency range from 0 Hz to 9 kHz:

EN 61000–2–2 (Compatibility Levels for Low-Frequency Conducted Disturbances and Signalling in Public Low-Voltage Power Supply Systems) states the requirements for compatibility levels for PCC (point of common coupling) of low-voltage AC systems on a public supply network. Limits are specified only for harmonic voltage and total harmonic distortion of the voltage. EN 61000–2–2 does not define limits for harmonic currents. In situations where the total harmonic distortion THD(V)=8%, PCC limits are identical to those limits specified in the EN 61000–2–4 Class 2.

EN 61000–2–4 (Compatibility Levels for Low-Frequency Conducted Disturbances and Signalling in Industrial Plants) states the requirements for compatibility levels in industrial and private networks. The standard further defines the following 3 classes of electromagnetic environments:

- Class 1 relates to compatibility levels that are less than the public supply network, which affects equipment sensitive to disturbances (lab equipment, some automation equipment, and certain protection devices).
- Class 2 relates to compatibility levels that are equal to the public supply network. The class applies to PCCs on the public supply network and to IPCs (internal points of coupling) on industrial or other private supply networks. Any equipment designed for operation on a public supply network is allowed in this class.

- Class 3 relates to compatibility levels greater than the public supply network. This class applies only to IPCs in industrial environments. Use this class where the following equipment is found:
 - Large converters
 - Welding machines
 - Large motors starting frequently
 - Loads that change quickly

Typically, a class cannot be defined ahead of time without taking into account the intended equipment and processes to be used in the environment. VLT® HVAC Drive FC 102 Low Harmonic observes the limits of Class 3 under typical supply system conditions ($R_{SC} > 10$ or $V_{k\text{ Line}} < 10\%$).

Harmonic order (h)	Class 1 (V _h %)	Class 2 (V _h %)	Class 3 (V _h %)
5	3	6	8
7	3	5	7
11	3	3.5	5
13	3	3	4.5
17	2	2	4
17 < h ≤ 49	2.27 x (17/h) – 0.27	2.27 x (17/h) – 0.27	4.5 x (17/h) – 0.5

Table 1.7 Compatibility Levels for Harmonics

	Class 1	Class 2	Class 3
THD(V)	5%	8%	10%

Table 1.8 Compatibility Levels for the Total Harmonic Voltage Distortion THD(V)

1.6.5 IEEE Harmonic Standards

The IEEE 519 standard (Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems) provides specific limits for harmonic voltages and currents for individual components within the supply network. The standard also provides limits for the sum of all loads at the point of common coupling (PCC).

To determine permissible harmonic voltage levels, IEEE 519 uses a ratio between the supply short-circuit current and the maximum current of the individual load. For permissible harmonic voltage levels for individual loads, see *Table 1.9*. For permissible levels for all loads connected to the PCC, see *Table 1.10*.

I _{sc} /I _L (R _{SCE})	Permissible individual harmonic voltages	Typical areas
10	2.5–3%	Weak grid
20	2.0–2.5%	1–2 large loads
50	1.0–1.5%	A few high-output loads
100	0.5–1%	5–20 medium-output loads
1000	0.05–0.1%	Strong grid

Table 1.9 Permissible Voltage THD at the PCC for Each Individual Load

Voltage at the PCC	Permissible individual harmonic voltages	Permissible THD(V)
V _{Line} ≤ 69 kV	3%	5%

Table 1.10 Permissible Voltage THD at the PCC for all Loads

Limit harmonic currents to specified levels, as shown in *Table 1.11*. IEEE 519 utilises a ratio between the supply short-circuit current and the maximum current consumption at the PCC, averaged over 15 minutes or 30 minutes. In certain instances when dealing with harmonic limits containing low harmonic numbers, the IEEE 519 limits are lower than the 61000-2-4 limits. Low harmonic drives observe the total harmonic distortion as defined in IEEE 519 for all R_{sce} . Each individual harmonic current fulfills table 10-3 in IEEE 519 for $R_{sce} \geq 20$.

$I_{sc}/I_L (R_{sce})$	$h < 11$	$11 \leq h < 17$	$17 \leq h < 23$	$23 \leq h < 35$	$35 \leq h$	Total demand distortion TDD
< 20	4%	2.0%	1.5%	0.6%	0.3%	5%
$20 < 50$	7%	3.5%	2.5%	1.0%	0.5%	8%
$50 < 100$	10%	4.5%	4.0%	1.5%	0.7%	12%
$100 < 1000$	12%	5.5%	5.0%	2.0%	1.0%	15%
> 1000	15%	7.0%	6.0%	2.5%	1.4%	20%

Table 1.11 Permissible Harmonic Currents at the PCC

The VLT[®] HVAC Drive FC 102 Low Harmonic complies with the following standards:

- IEC61000-2-4
- IEC61000-3-4
- IEEE 519
- G5/4

2

2 Safety

2.1 Safety Symbols

The following symbols are used in this document:



Indicates a potentially hazardous situation which could result in death or serious injury.



Indicates a potentially hazardous situation which could result in minor or moderate injury. It may also be used to alert against unsafe practices.



Indicates important information, including situations that may result in damage to equipment or property.

2.2 Qualified Personnel

Correct and reliable transport, storage, installation, operation and maintenance are required for the safe operation of the frequency converter. Only qualified personnel are allowed to install or operate this equipment.

Qualified personnel is defined as trained staff, who are authorised to install, commission, and maintain equipment, systems and circuits in accordance with pertinent laws and regulations. Additionally, qualified personnel are familiar with the instructions and safety measures described in this document.

2.3 Safety Precautions



HIGH VOLTAGE

Adjustable frequency drives contain high voltage when connected to AC line input power. Qualified personnel only should perform installation, start-up, and maintenance. Failure to have qualified personnel perform installation, start-up, and maintenance could result in death or serious injury.



UNINTENDED START

When the adjustable frequency drive is connected to AC line power, the motor may start at any time. The adjustable frequency drive, motor, and any driven equipment must be in operational readiness. Failure to be in operational readiness when the adjustable frequency drive is connected to AC line power could result in death, serious injury, equipment, or property damage.



DISCHARGE TIME

Adjustable frequency drives contain DC link capacitors that can remain charged even when the adjustable frequency drive is not powered. To avoid electrical hazards, disconnect AC line power, any permanent magnet type motors, and any remote DC link power supplies, including battery backups, UPS and DC link connections to other adjustable frequency drives. Wait for the capacitors to fully discharge before performing any service or repair work. The wait time required is listed in the *Discharge Time* table. Failure to wait the specified time after power has been removed before doing service or repair could result in death or serious injury.

Voltage [V]	Power ranges for normal overload operation [kW]	Minimum waiting time (minutes)
380-480	160-250	20
	315-710	40

Table 2.1 Discharge Times

3 Mechanical Installation

3.1 Equipment Pre-Installation Checklist

3.1.1 Planning the Installation Site

CAUTION

It is important to plan the installation of the frequency converter. Neglecting to plan may result in extra work during and after installation.

Select the best possible operation site by considering the following:

- Ambient operating temperature.
- Installation method.
- How to cool the unit.
- Position of the frequency converter.
- Cable routing.
- Ensure that the power source supplies the correct voltage and necessary current.
- Ensure that the motor current rating is within the maximum current from the frequency converter.
- If the frequency converter is without built-in fuses, ensure that the external fuses are rated correctly.

3.1.2 Equipment Pre-Installation Checklist

- Before unpacking the adjustable frequency drive, examine the packaging for signs of damage. If the unit is damaged, refuse delivery and immediately contact the shipping company to claim the damage.
- Before unpacking the adjustable frequency drive, locate it as close as possible to the final installation site
- Compare the model number on the nameplate to what was ordered to verify the proper equipment
- Ensure each of the following are rated for the same voltage:
 - Line power
 - Adjustable frequency drive
 - Motor

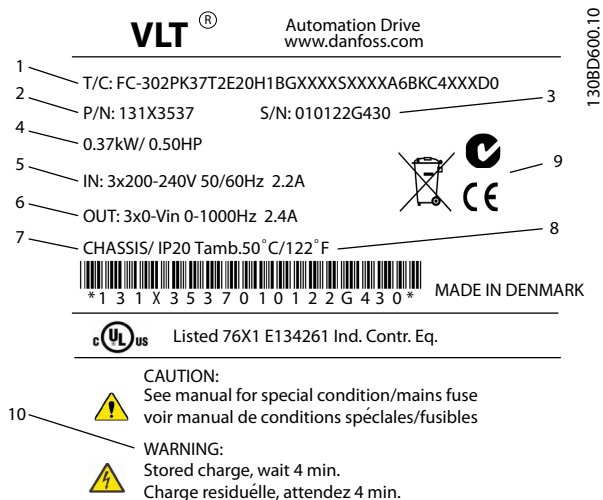
- Ensure the output current rating is equal to or greater than the motor full load current for peak motor performance.
 - Motor size and adjustable frequency drive power must match for proper overload protection.
 - If adjustable frequency drive rating is less than that of the motor, full motor output is impossible.

3.2 Unpacking

3.2.1 Items Supplied

Items supplied may vary according to product configuration.

- Make sure the items supplied and the information on the nameplate correspond to the order confirmation.
- Check the packaging and the adjustable frequency drive visually for damage caused by inappropriate handling during shipment. File any claim for damage with the carrier. Retain damaged parts for clarification.



1	Type code
2	Order number
3	Serial number
4	Power rating
5	Input voltage, frequency and current (at low/high voltages)
6	Output voltage, frequency and current (at low/high voltages)
7	Enclosure type and IP rating
8	Maximum ambient temperature
9	Certifications
10	Discharge time (Warning)

Figure 3.1 Product Nameplate (Example)

NOTICE!

Do not remove the nameplate from the adjustable frequency drive (loss of warranty).

3.3 Mounting

3.3.1 Cooling and Airflow

Cooling

Cooling can be obtained in different ways, by using the cooling ducts in the bottom and the top of the unit, by taking air in and out the back of the unit or by combining the cooling possibilities.

Back cooling

The backchannel air can also be ventilated in and out the back of a Rittal TS8 enclosure for frame size F18 LHD. This offers a solution where the backchannel could take air from outside the facility and return the heat losses outside the facility thus reducing air-conditioning requirements.

NOTICE!

A door fan is required on the enclosure to remove the heat losses not contained in the backchannel of the drive and any additional losses generated from other components installed inside the enclosure. The total required air flow must be calculated so that the appropriate fans can be selected. Some enclosure manufacturers offer software for performing the calculations (i.e., Rittal Therm software).

Airflow

The necessary airflow over the heatsink must be ensured. The flow rate is shown in Table 3.1.

Enclosure protection	Frame size	Door fan/top fan airflow Total airflow of multiple fans	Heatsink fan Total airflow for multiple fans
IP21/NEMA 1 IP54/NEMA 12	D13 (LHD120)	3 door fans, 510 m ³ /h (300 cfm) (2+1, 3x170=510)	2 heatsink fans, 1530 m ³ /h (900 cfm) (1+1, 2x765=1530)
	E9 P315-P400 (LHD210)	4 door fans, 680 m ³ /h (400 cfm) (2+2, 4x170=680)	2 heatsink fans, 2675 m ³ /h (1574 cfm) (1+1, 1230+1445=2675)
	F18 (LHD330)	6 door fans, 3150 m ³ /h (1854 cfm) (6x525=3150)	5 heatsink fans, 4485 m ³ /h (2639 cfm) 2+1+2, ((2x765)+(3x985)=4485)

Table 3.1 Heatsink Air Flow

NOTICE!

For the drive section, the fan runs for the following reasons:

1. AMA
2. DC Hold
3. Pre-Mag
4. DC Brake
5. 60% of nominal current is exceeded
6. Specific heatsink temperature exceeded (power size dependent)
7. Specific Power Card ambient temperature exceeded (power size-dependent)
8. Specific Control Card ambient temperature exceeded

Once the fan is started, it runs for minimum 10 minutes.

NOTICE!

For the active filter, the fan runs for the following reasons:

1. Active filter running
2. Active filter not running, but line power current exceeding limit (power size dependent)
3. Specific heatsink temperature exceeded (power size dependent)
4. Specific Power Card ambient temperature exceeded (power size-dependent)
5. Specific Control Card ambient temperature exceeded

Once the fan is started, it runs for minimum 10 minutes.

External ducts

If additional duct work is added externally to the Rittal cabinet, the pressure drop in the ducting must be calculated. Use the charts below to derate the adjustable frequency drive according to the pressure drop.

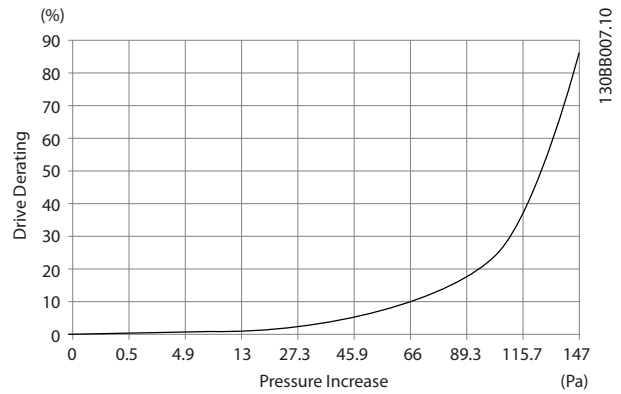


Figure 3.2 D-Frame Derating vs. Pressure Change Drive Air Flow: 450 cfm (765 m³/h)

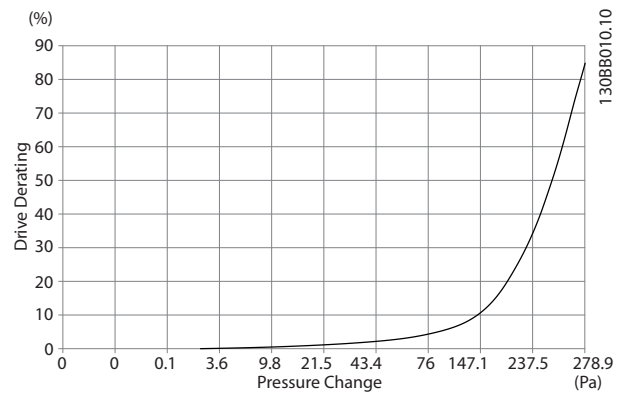


Figure 3.3 E-Frame Derating vs. Pressure Change (Small Fan), P315 Drive Air Flow: 650 cfm (1105 m³/h)

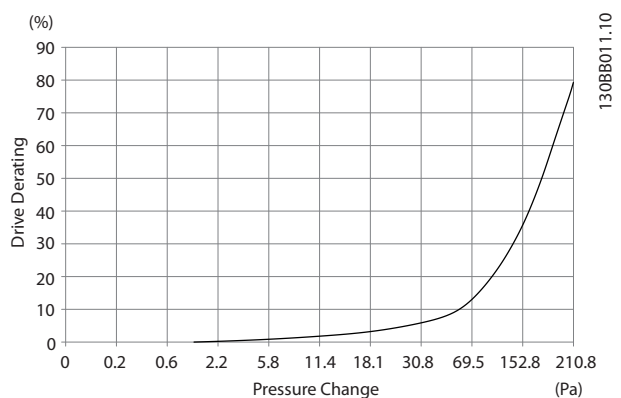


Figure 3.4 E-Frame Derating vs. Pressure Change (Large Fan) P355-P450 Drive Air Flow: 850 cfm (1445 m³/h)

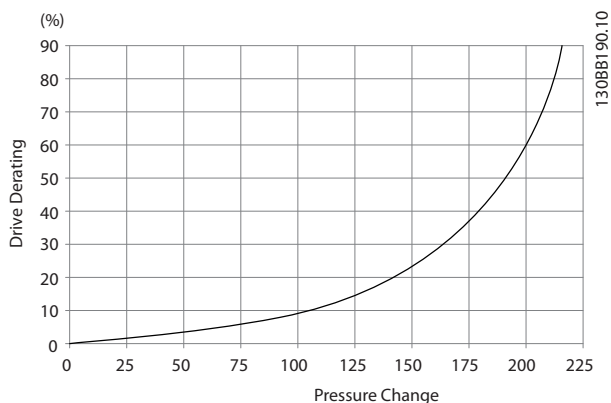
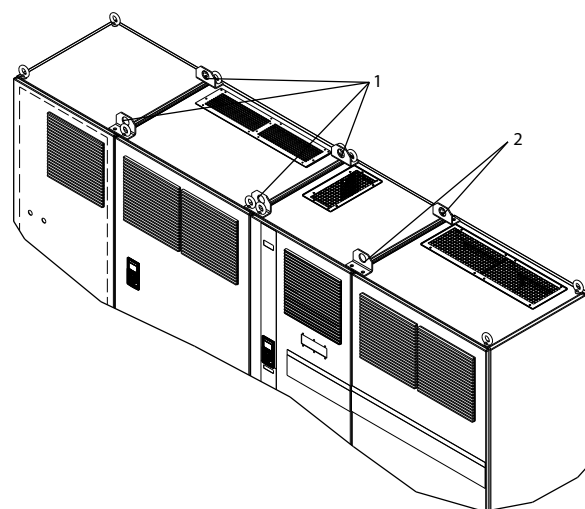


Figure 3.5 F-Frame Derating vs. Pressure Change Drive Air Flow: 580 cfm (985 m³/h)



1	Lifting holes for the filter
2	Lifting holes for the adjustable frequency drive

Figure 3.8 Recommended Lifting Method, Frame Size F18

3.3.2 Lifting

Lift the adjustable frequency drive using the dedicated lifting eyes. For all D-frames, use a bar to avoid bending the lifting holes of the adjustable frequency drive.

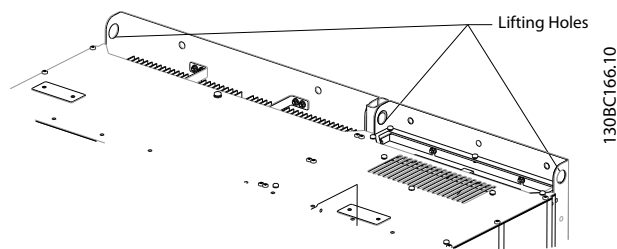


Figure 3.6 Recommended Lifting Method, Frame Size D13

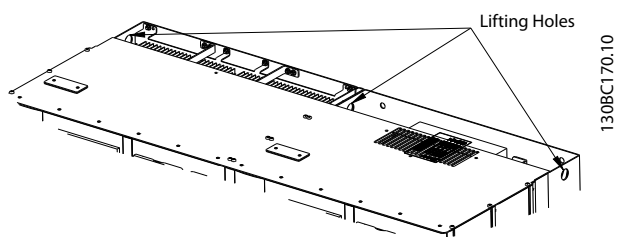


Figure 3.7 Recommended Lifting Method, Frame Size E9

NOTICE!

A spreader bar is also an acceptable way to lift the F-frame.

NOTICE!

The F18 pedestal is packaged separately and included in the shipment. Mount the adjustable frequency drive on the pedestal in its final location. The pedestal allows proper airflow and cooling.

WARNING

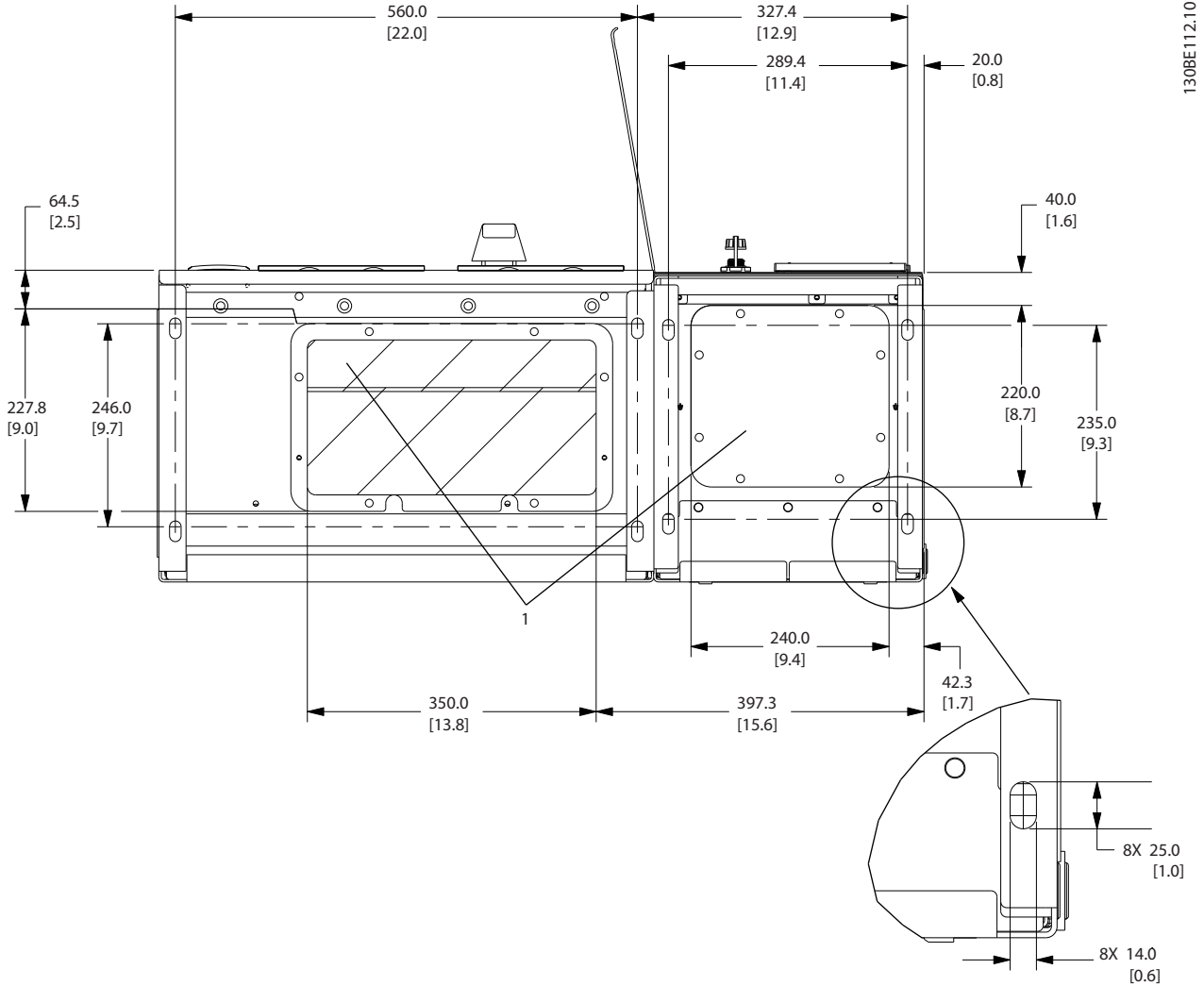
The lifting bar must be able to handle the weight of the adjustable frequency drive. See for the weight of the different frame sizes. Maximum diameter for bar is 1 in [2.5 cm]. The angle from the top of the adjustable frequency drive to the lifting cable should be 60° or greater.

3.3.3 Cable Entry and Anchoring

Cables enter the unit through gland plate openings in the bottom. *Figure 3.9, Figure 3.10, Figure 3.11, and Figure 3.12* show gland entry locations and detailed views of anchoring hole dimensions.

3

Bottom View, D1n/D2n



1	Cable entry locations
---	-----------------------

Figure 3.9 Cable Entry Diagram, Enclosure Size D1n

3

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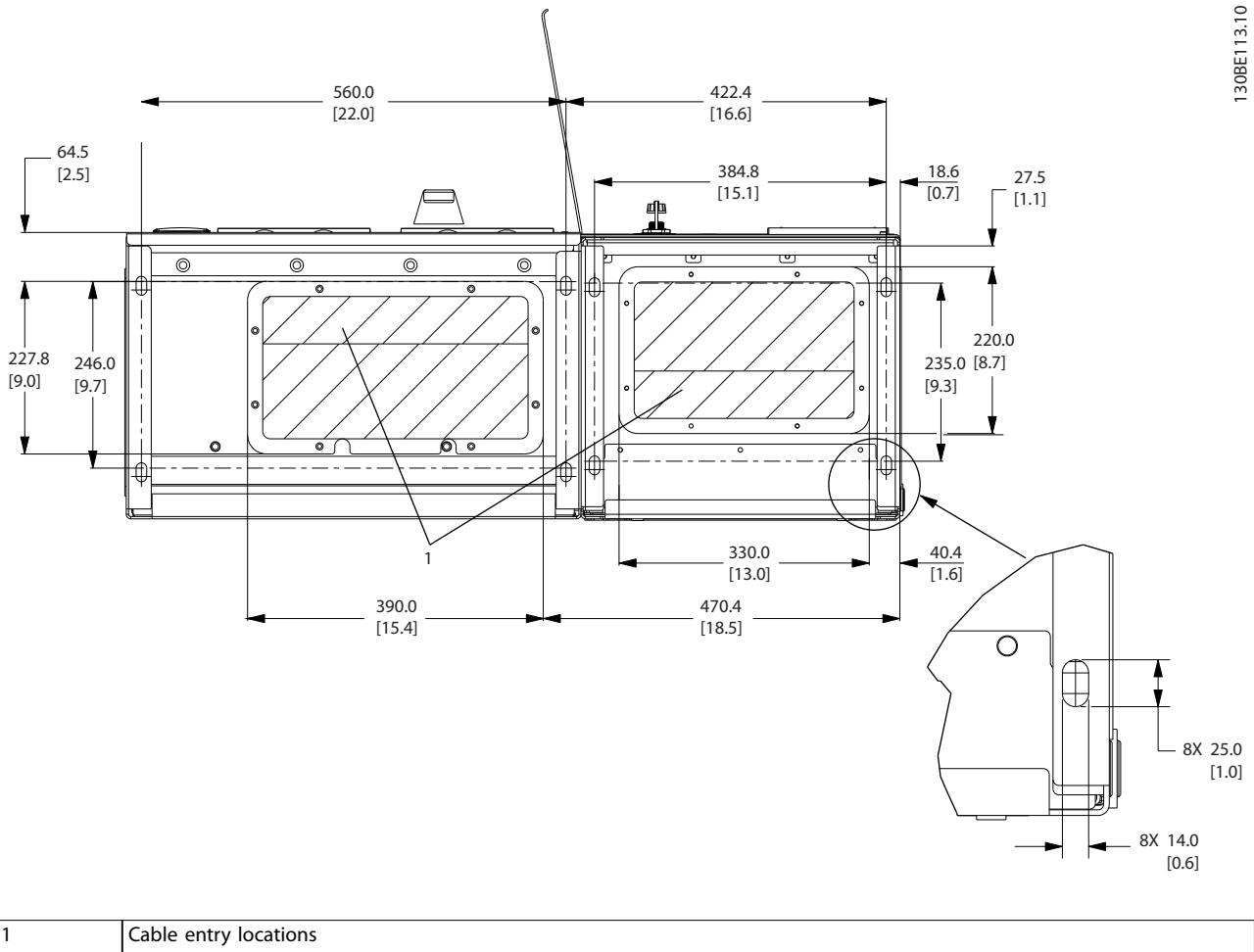
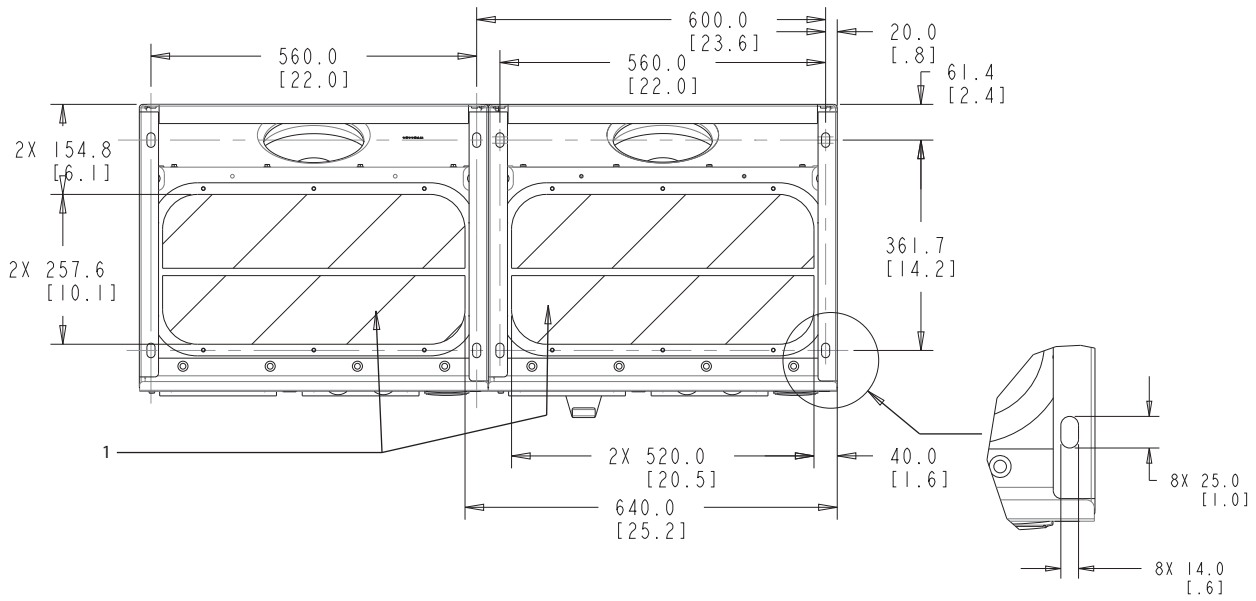


Figure 3.10 Cable Entry Diagram, Enclosure Size D2n

Bottom View, Enclosure Size E9



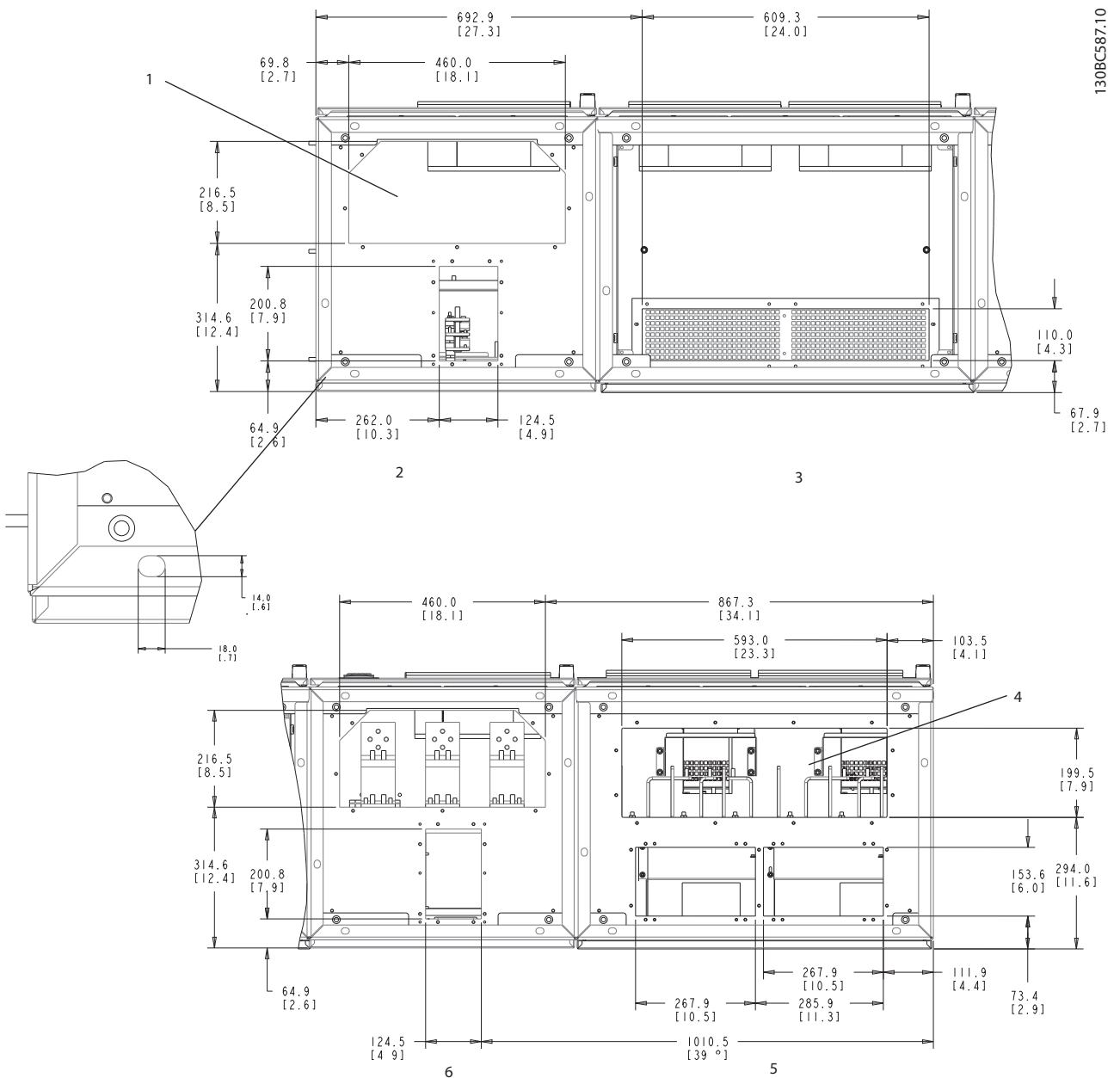
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1	Cable entry locations
---	-----------------------

Figure 3.11 Cable Entry Diagram, E9

Bottom View, F18



1	Mains cable entry	4	Motor cable entry
2	Option enclosure	5	Inverter enclosure
3	Filter enclosure	6	Rectifier enclosure

Figure 3.12 Cable Entry Diagram, F18

3.3.4 Terminal Locations - Frame Size D13

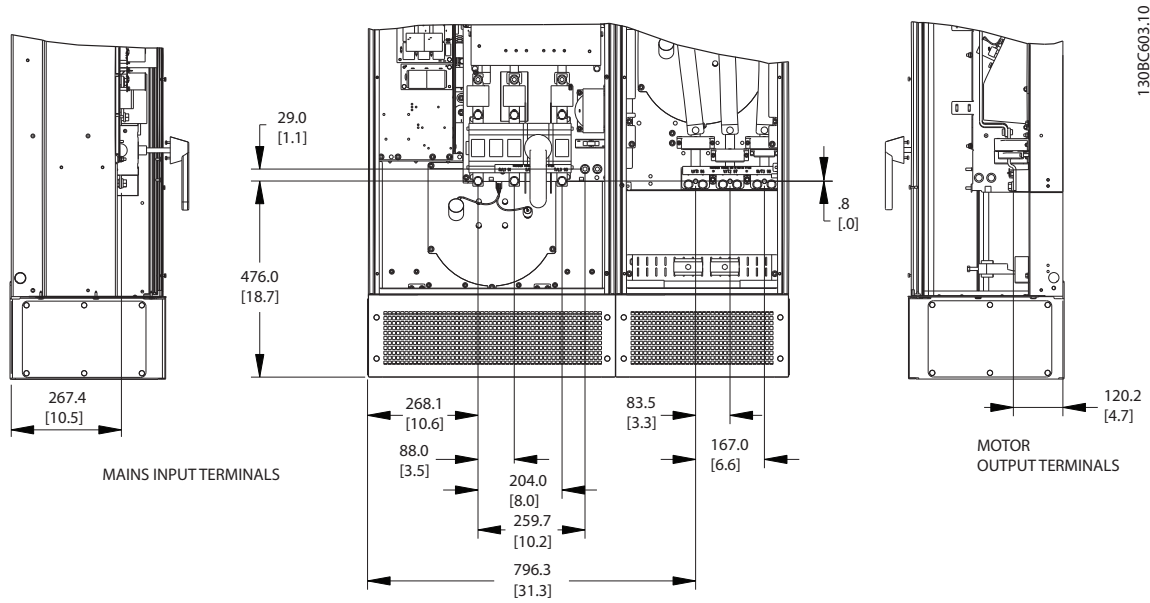


Figure 3.13 Frame Size D13 Terminal Locations

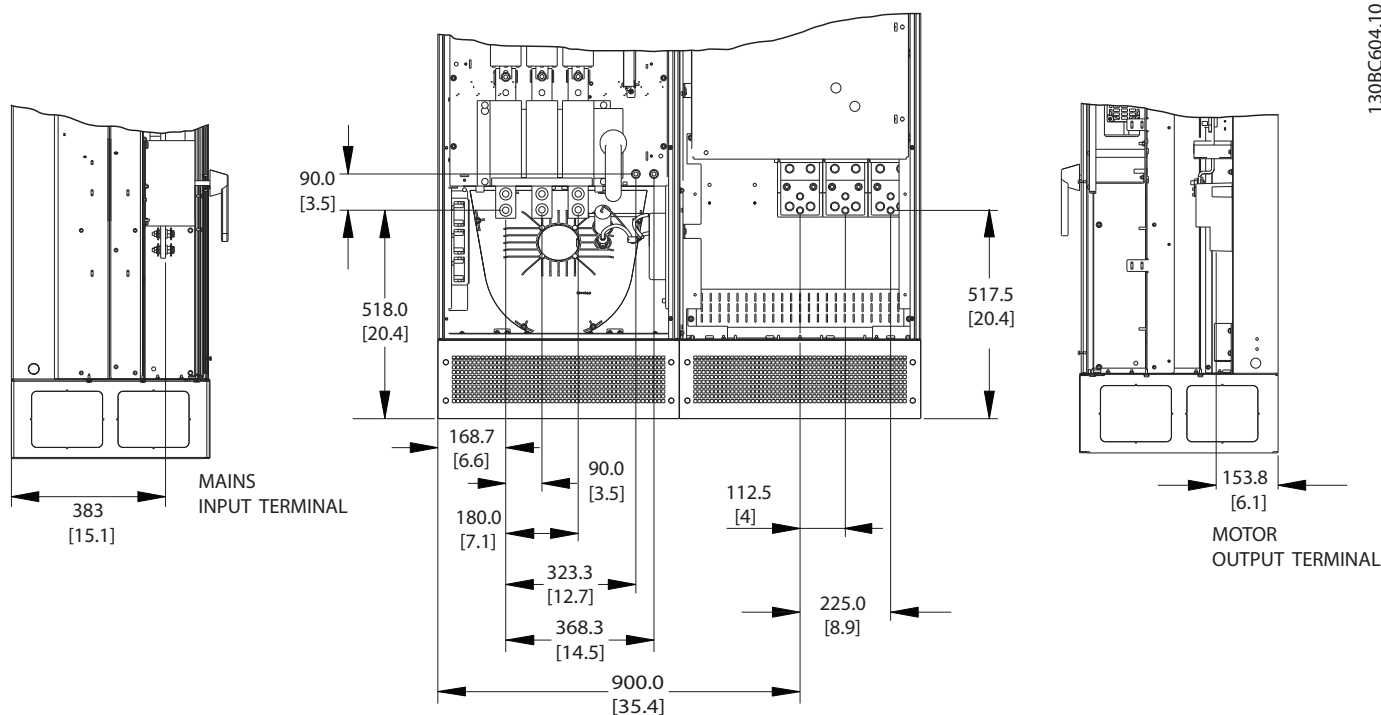
Allow for bend radius of heavy power cables.

NOTICE!

All D-frames are available with standard input terminals, fuse, or disconnect switch

3.3.5 Terminal Locations - Frame Size E9

3



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Figure 3.14 Frame Size E9 Terminal Locations

Allow for bend radius of heavy power cables.

NOTICE!

All E-frames are available with standard input terminals, fuse, or disconnect switch

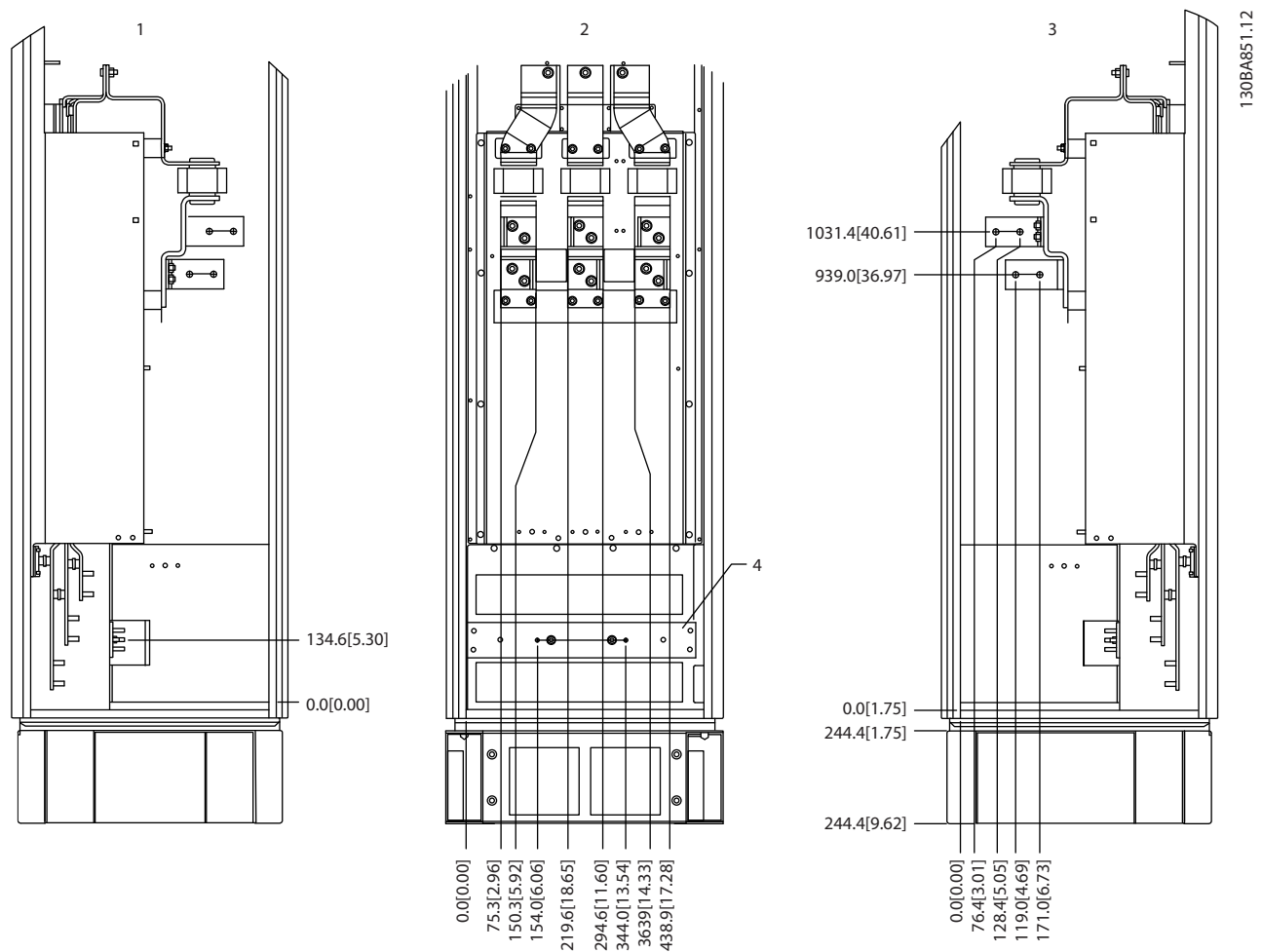
3.3.6 Terminal Locations for Enclosure Size F18

Consider the position of the terminals when designing the cable access.

F-frame units have 4 interlocked cabinets:

- Input options cabinet (not optional for LHD)
- Filter cabinet
- Rectifier cabinet
- Inverter cabinet

See *chapter 1.3.3 Exploded View Drawings* for exploded views of each cabinet. Mains inputs are located in the input option cabinet, which conducts power to the rectifier via interconnecting bus bars. Output from the unit is from the inverter cabinet. No connection terminals are located in the rectifier cabinet. Interconnecting bus bars are not shown.

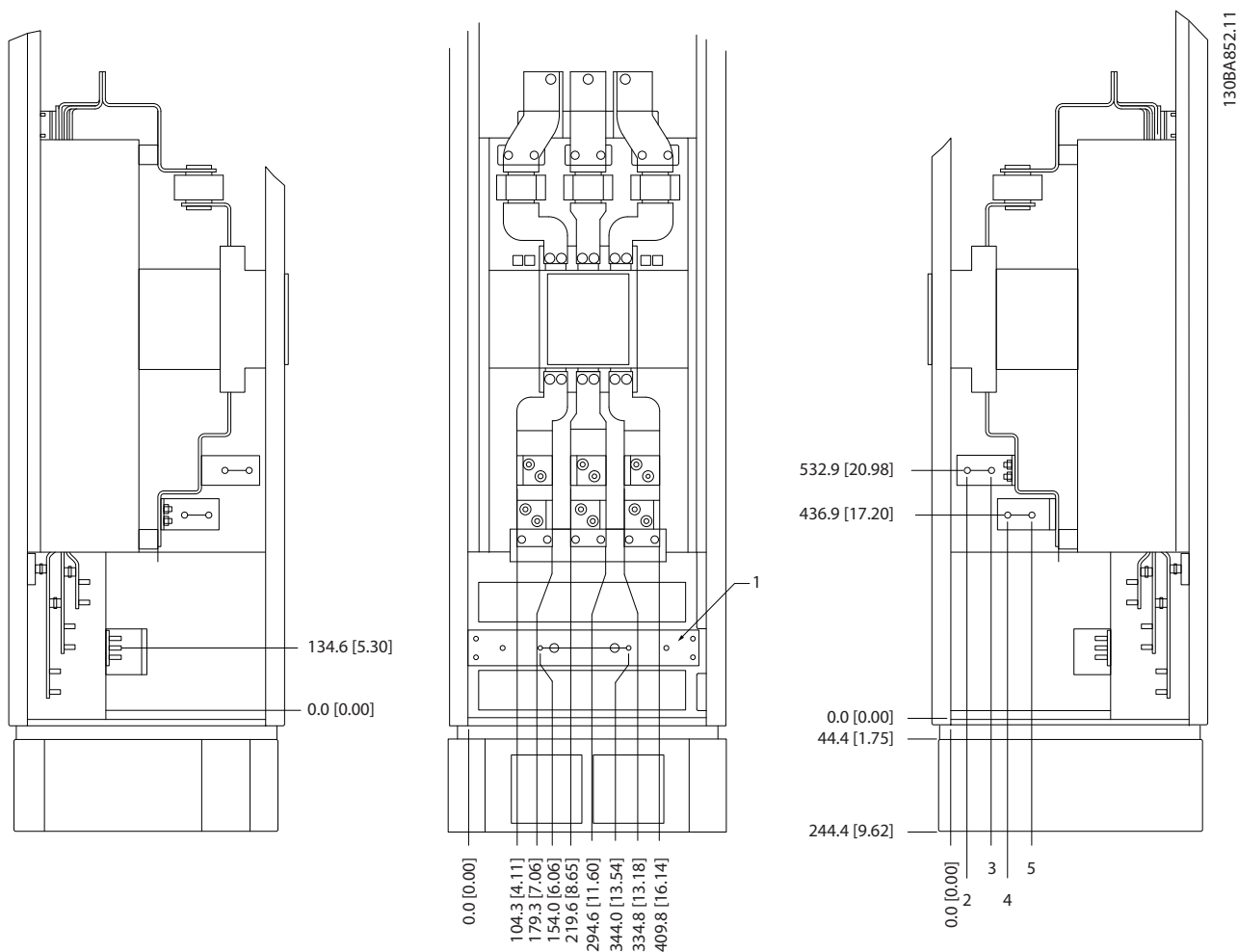


1	Right side cut-away	3	Left side cut-away
2	Front view	4	Ground bar

Figure 3.15 Input Option Cabinet, Enclosure Size F18 - Fuses Only

The gland plate is 42 mm below the 0 level. Shown are the left side view, front, and right.

3

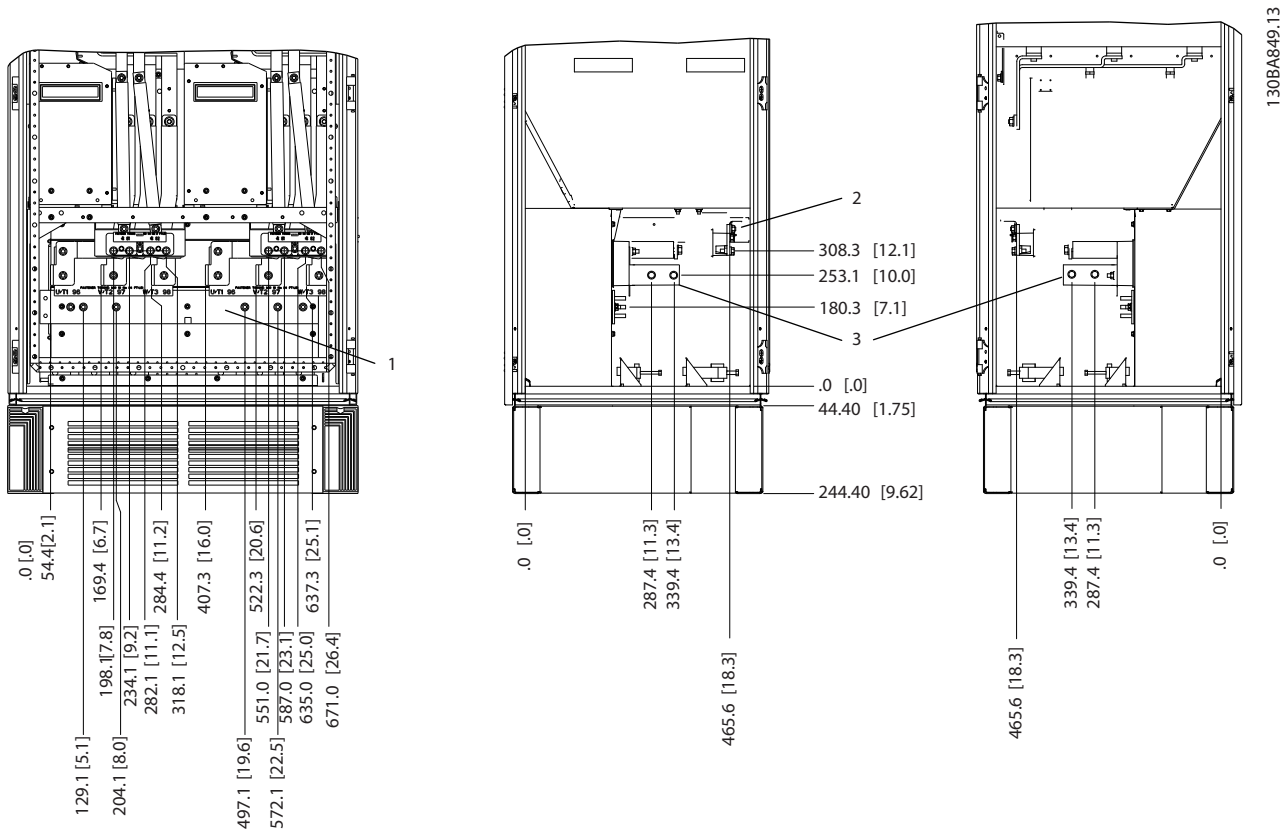


	500 kW ¹⁾ (mm [in.])	560-710 kW ¹⁾ (mm [in.])
1	Ground bar	
2	34.9 [1.4]	46.3 [1.8]
3	86.9 [3.4]	98.3 [3.9]
4	122.2 [4.8]	119 [4.7]
5	174.2 [6.9]	171 [6.7]

1) Disconnect location and related dimensions vary with kilowatt rating.

Figure 3.16 Input Option Cabinet with Circuit Breaker, Enclosure Size F18

The gland plate is 42 mm below the 0 level. Shown are the left side view, front, and right.



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3

1	Front view
2	Left side view
3	Right side view

Figure 3.17 Inverter Cabinet, Enclosure Size F18

The gland plate is 42 mm below the 0 level. Shown are the left side view, front, and right.

3.3.7 Torque

Correct torque is imperative for all electrical connections. Incorrect torque results in a bad electrical connection. Use a torque wrench to ensure correct torque.

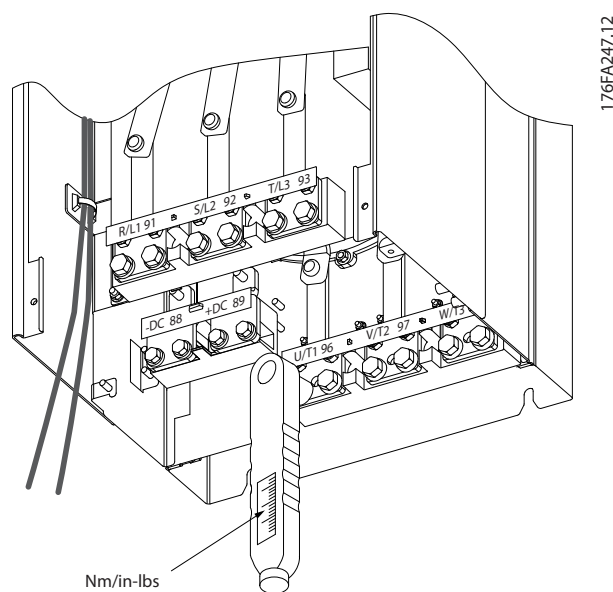


Figure 3.18 Use a Torque Wrench to Tighten the Bolts

Frame size	Terminal	Torque	Bolt size
D	Line power Motor	19–40 Nm (168–354 in-lbs)	M10
	Load sharing Brake	8.5–20.5 Nm (75–181 in-lbs)	M8
E	Line power Motor Load sharing	19–40 Nm (168–354 in-lbs)	M10
	Brake	8.5–20.5 Nm (75–181 in-lbs)	M8
F	Line power Motor	19–40 Nm (168–354 in-lbs)	M10
	Load sharing	19–40 Nm (168–354 in-lbs)	M10
	Brake	8.5–20.5 Nm (75–181 in-lbs)	M8
	Regen	8.5–20.5 Nm (75–181 in-lbs)	M8

Table 3.2 Torque for terminals

4 Electrical Installation

4.1 Safety Instructions

See *chapter 2 Safety* for general safety instructions.

⚠ WARNING

INDUCED VOLTAGE

Induced voltage from output motor cables that run together can charge equipment capacitors even with the equipment turned off and locked out. Failure to run output motor cables separately or use shielded cables or metal conduits could result in death or serious injury.

- run output motor cables separately, or
- use shielded cables or metal conduits

⚠ CAUTION

SHOCK HAZARD

The adjustable frequency drive can cause a DC current in the PE conductor. Failure to follow the recommendation below means the RCD may not provide the intended protection.

- When a residual current-operated protective device (RCD) is used for protection against electrical shock, only an RCD of Type B is permitted on the supply side.

NOTICE!

The adjustable frequency drive is supplied with Class 20 motor overload protection.

Overcurrent protection

- Additional protective equipment, such as short-circuit protection or motor thermal protection between adjustable frequency drive and motor, is required for applications with multiple motors.
- Input fusing is required to provide short circuit and overcurrent protection. If not factory-supplied, fuses must be provided by the installer. See maximum fuse ratings in *chapter 8.4 Fuses*.

Wire type and ratings

- All wiring must comply with local and national regulations regarding cross-section and ambient temperature requirements.
- Power connection wire recommendation: minimum 167°F [75°C] rated copper wire.

See *chapter 8.3 General Technical Data* and *chapter 8.1 Power-Dependent Specifications* for recommended wire sizes and types.

4.2 EMC Compliant Installation

To obtain an EMC-compliant installation, follow the instructions provided in *chapter 4.4 Grounding*, *chapter 4.6 Motor Connection*, and *chapter 4.8 Control Wiring*.

4.3 Power Connections

NOTICE!

Cables—General Information

All cabling must comply with national and local regulations on cable cross-sections and ambient temperature. UL applications require 167°F [75°C] copper conductors. For non-UL applications, 167°F and 194°F [75° and 90°C] copper conductors are thermally acceptable.

The power cable connections are situated as shown in *Figure 4.1*. Dimension cable cross-section in accordance with the current ratings and local legislation. See *chapter 8.3.1 Cable lengths and cross-sections* for details.

To protect the adjustable frequency drive, use the recommended fuses if there are no built-in fuses. Fuse recommendations are provided in . Ensure that proper fusing is made according to local regulation.

The AC line input connection is fitted to the line power switch if included.

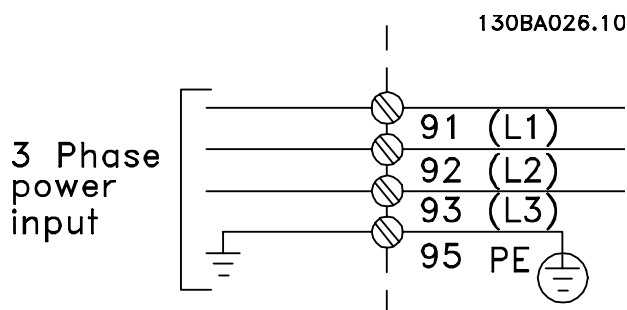


Figure 4.1 Power Cable Connections

NOTICE!

To comply with EMC emission specifications, shielded/ armored cables are recommended. If a non-shielded/ armored cable is used, see chapter 4.7.3 Power and Control Wiring for Non-shielded Cables.

4

See for correct dimensioning of motor cable cross-section and length.

Shielding of cables

Avoid installation with twisted shield ends (pigtailed). They spoil the shielding effect at higher frequencies. If breaking the shield is necessary to install a motor isolator or contactor, continue the shield at the lowest possible HF impedance.

Connect the motor cable shield to both the decoupling plate of the adjustable frequency drive and to the metal housing of the motor.

Make the shield connections with the largest possible surface area (cable clamp). Use the installation devices within the adjustable frequency drive.

Cable length and cross-section

The adjustable frequency drive has been EMC tested with a given length of cable. Keep the motor cable as short as possible to reduce the noise level and leakage currents.

Switching frequency

When adjustable frequency drives are used together with sine-wave filters to reduce the acoustic noise from a motor, the switching frequency must be set according to parameter 14-01 Switching Frequency.

Term. no.	96	97	98	99	
	U	V	W	PE ¹⁾	Motor voltage 0–100% of AC line voltage. 3 wires out of motor
	U1	V1	W1	PE ¹⁾	Delta-connected 6 wires out of motor
	W2	U2	V2		
	U1	V1	W1	PE ¹⁾	Star-connected U2, V2, W2 U2, V2, and W2 to be interconnected separately.

Table 4.1 Terminal Connections

¹⁾Protected Ground Connection

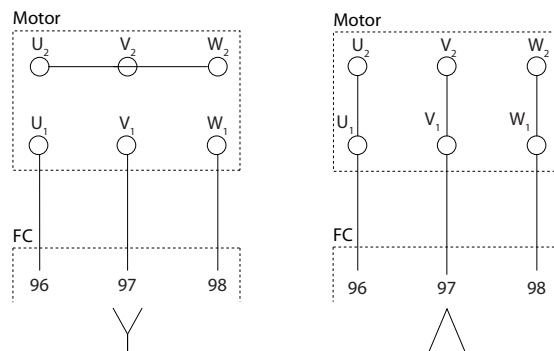


Figure 4.2 Y and Delta Terminal Configurations

4.4 Grounding

Note the following basic issues for electromagnetic compatibility (EMC) during installation:

- Safety grounding: The adjustable frequency drive has a high leakage current and must be grounded appropriately for safety reasons. Always follow local safety regulations.
- High-frequency grounding: Keep the ground wire connections as short as possible.

Connect the different ground systems at the lowest possible conductor impedance. Keep the conductor as short as possible and use the greatest possible surface area for the lowest possible conductor impedance. The metal cabinets of the different devices are mounted on the cabinet rear plate using the lowest possible HF impedance. Doing so avoids different HF voltages for individual devices and the risk of radio interference currents running in connection cables between the devices. The radio interference is reduced. To obtain a low HF impedance, use the fastening bolts of the devices as HF connection to the rear plate. Remove insulating paint or similar from the fastening points.

4.4.1 Leakage Current (>3.5 mA)

Follow national and local codes regarding protective earthing of equipment with a leakage current >3.5 mA. Frequency converter technology implies high frequency switching at high power. This generates a leakage current in the ground connection. A fault current in the frequency converter at the output power terminals might contain a DC component, which can charge the filter capacitors and cause a transient ground current. The earth leakage current depends on various system configurations including RFI filtering, screened motor cables, and frequency converter power.

EN/IEC61800-5-1 (Power Drive System Product Standard) requires special care if the leakage current exceeds 3.5 mA. Grounding must be reinforced in 1 of the following ways:

- Ground wire of at least 10 mm².
- 2 separate ground wires both complying with the dimensioning rules.

See EN 60364-5-54 § 543.7 for further information.

4.5 Input Options

4.5.1 Extra Protection (RCD)

ELCB relays, multiple protective grounding, or standard grounding provide extra protection, if local safety regulations are followed.

In the case of a ground fault, a DC component develops in the fault current.

If using ELCB relays, observe local regulations. Relays must be suitable for protection of 3-phase equipment with a bridge rectifier and for a brief discharge on power-up.

4.5.2 RFI Switch

Line power supply isolated from ground

If the adjustable frequency drive is supplied from an isolated line power source or TT/TN-S line power with grounded leg, turn off the RFI switch via *parameter 14-50 RFI 1* on both adjustable frequency drive and the filter. For further reference, see IEC 364-3. When optimum EMC performance is needed, parallel motors are connected, or the motor cable length is above 82 ft [25 m], set *parameter 14-50 RFI 1* to [ON].

In OFF, the internal RFI capacitors (filter capacitors) between the chassis and the intermediate circuit are cut off to avoid damage to the intermediate circuit and reduce ground capacity currents (IEC 61800-3).

Refer to the application note *VLT on IT line power*. It is important to use isolation monitors that work together with power electronics (IEC 61557-8).

4.5.3 Shielded Cables

It is important to connect shielded cables properly to ensure high EMC immunity and low emissions.

Connection can be made using either cable connectors or clamps:

- EMC cable connectors: generally available cable connectors can be used to ensure an optimum EMC connection.
- EMC cable clamp: Clamps allowing easy connection are supplied with the unit.

4.6 Motor Connection

4.6.1 Motor Cable

Connect the motor to terminals U/T1/96, V/T2/97, W/T3/98, on the far right of the unit. Ground to terminal 99. All types of 3-phase asynchronous standard motors can be used with an adjustable frequency drive. The factory setting is for clockwise rotation with the adjustable frequency drive output connected as follows:

Terminal No.	Function
96, 97, 98, 99	Line power U/T1, V/T2, W/T3 Ground

Table 4.2 Terminal Functions

- Terminal U/T1/96 connected to U-phase
- Terminal V/T2/97 connected to V-phase
- Terminal W/T3/98 connected to W-phase

The direction of rotation can be changed by switching two phases in the motor cable or by changing the setting of *parameter 4-10 Motor Speed Direction*.

Motor rotation check can be performed via *parameter 1-28 Motor Rotation Check* and following the steps shown in the display.

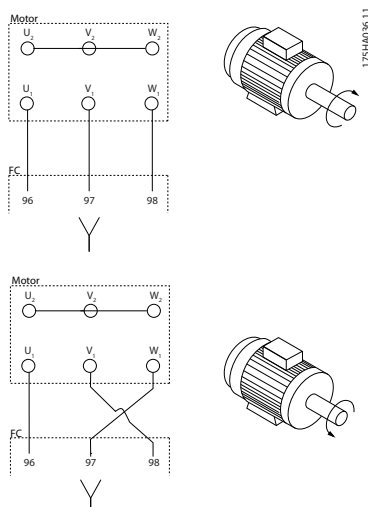


Figure 4.3 Motor Rotation Check

F-frame requirements

Use motor phase cables in quantities of 2, resulting in 2, 4, 6, or 8 to obtain an equal number of wires on both inverter module terminals. The cables are required to be equal length within 10% between the inverter module terminals and the first common point of a phase. The recommended common point is the motor terminals.

Output junction box requirements

The length, a minimum of 8 ft [2.5 m], and quantity of cables must be equal from each inverter module to the common terminal in the junction box.

NOTICE!

If a retrofit application requires an unequal number of wires per phase, consult the factory or use the top/bottom entry side cabinet option, instruction 177R0097.

4.6.2 Brake Cable

Adjustable frequency drives with factory installed brake chopper option

(Only standard with letter B in position 18 of type code).

The connection cable to the brake resistor must be shielded and the max. length from adjustable frequency drive to the DC bar is limited to 82 ft [25 m].

Terminal No.	Function
81, 82	Brake resistor terminals

Table 4.3 Terminal Functions

The connection cable to the brake resistor must be shielded. Connect the shield with cable clamps to the conductive backplate of the adjustable frequency drive and the metal cabinet of the brake resistor. Size the brake cable cross-section to match the brake torque. See also *Brake Instructions* for further information regarding safe installation.

WARNING

Note that voltages up to 790 V DC, depending on the supply voltage, are possible on the terminals.

F-frame requirements

The brake resistors must be connected to the brake terminals in each inverter module.

4.6.3 Motor Insulation

For motor cable lengths ≤ the maximum cable length, the motor insulation ratings listed in *Table 4.4* are recommended. The peak voltage can be twice the DC link voltage or 2.8 times AC line voltage, due to transmission line effects in the motor cable. If a motor has lower insulation rating, use a dU/dt or sine-wave filter.

Nominal AC Line Voltage	Motor Insulation
$U_N \leq 420 \text{ V}$	Standard $U_{LL} = 1,300 \text{ V}$
$420 \text{ V} < U_N \leq 500 \text{ V}$	Reinforced $U_{LL} = 1,600 \text{ V}$

Table 4.4 Recommended Motor Insulation Ratings

4.6.4 Motor Bearing Currents

Motors with a rating 110 kW or higher combined with adjustable frequency drives are best with NDE (Non-Drive End) insulated bearings to eliminate circulating bearing currents caused by motor size. To minimize DE (Drive End) bearing and shaft currents, proper grounding is required for:

- Adjustable frequency drive
- Motor
- Motor-driven machine
- Motor to the driven machine

Although failure due to bearing currents is infrequent, use the following strategies to reduce the likelihood:

- Use an insulated bearing
- Apply rigorous installation procedures
- Ensure that the motor and load motor are aligned
- Strictly follow the EMC Installation guideline
- Reinforce the PE so the high frequency impedance is lower in the PE than the input power leads.
- Provide a good high frequency connection between the motor and the adjustable frequency drive
- Ensure that the impedance from adjustable frequency drive to building ground is lower than the grounding impedance of the machine. Make a direct ground connection between the motor and load motor.
- Apply conductive lubrication
- Try to ensure that the line voltage is balanced to ground.
- Use an insulated bearing as recommended by the motor manufacturer (note: motors from reputable manufacturers typically have insulated bearings as standard in motors of this size).

If found to be necessary and after consultation with Danfoss:

- Lower the IGBT switching frequency
- Modify the inverter waveform, 60° AVM vs. SFAVM
- Install a shaft grounding system or use an isolating coupling between motor and load
- Use minimum speed settings, if possible.
- Use a dU/dt or sinus filter

4.7 AC Mains Connection

4.7.1 AC line input connections

Line power must be connected to terminals 91, 92 and 93 on the far left of the unit. Ground is connected to the terminal on the right of terminal 93.

Terminal No.	Function
91, 92, 93	Line power R/L1, S/L2, T/L3
94	Ground

Table 4.5 Terminal Functions

Ensure that the power supply can supply the necessary current to the adjustable frequency drive.

If the unit is without built-in fuses, ensure that the appropriate fuses have the correct current rating.

4.7.2 External Fan Supply

If the adjustable frequency drive is supplied by DC or the fan must run independently of the power supply, use an external power supply. Make the connection on the power card.

Terminal No.	Function
100, 101	Auxiliary supply S, T
102, 103	Internal supply S, T

Table 4.6 Terminal Functions

The connector on the power card provides the connection of line voltage for the cooling fans. The fans are connected from the factory to be supplied from a common AC line (jumpers between 100–102 and 101–103). If external power supply is needed, remove the jumpers and connect the supply to terminals 100 and 101. Protect with a 5 A. In UL applications, use a Littelfuse KLK-5 or equivalent.

4.7.3 Power and Control Wiring for Non-shielded Cables

⚠ WARNING

Induced Voltage

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

⚠ CAUTION

Compromised Performance

The adjustable frequency drive runs less efficiently if wiring is not isolated properly. To isolate high frequency noise, the following in separate metallic conduits:

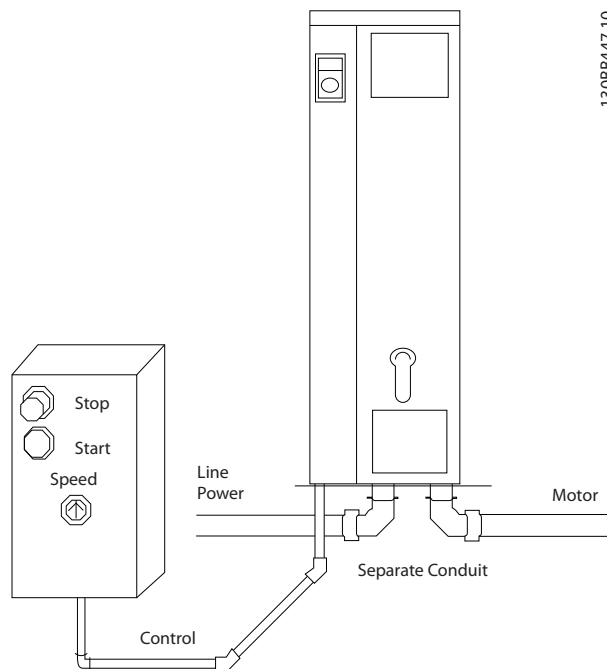
- power wiring
- motor wiring
- control wiring

Failure to isolate these connections could result in less than optimum controller and associated equipment performance.

4

Because the power wiring carries high frequency electrical pulses, it is important to run input power and motor power in separate conduit. If incoming power wiring is in the same conduit as motor wiring, these pulses can couple electrical noise back onto the power grid. Isolate control wiring from high-voltage power wiring.

When shielded/armored cable is not used, at least three separate conduits are connected to the panel option (see Figure 4.4).



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Figure 4.4 Proper Electrical Installation Using Conduit

4.7.4 Mains Disconnects

Frame size	Power & Voltage	Type
D	160-250 kw 380-480 V	OT400U12-9 or ABB OETL-NF400A
E	315 kW 380-480 V	ABB OETL-NF600A
E	355-450 kW 380-480 V	ABB OETL-NF800A
F	500 kW 380-480 V	Merlin Gerin NPJF36000S12AAYP
F	560-710 kW 380-480 V	Merlin Gerin NRK36000S20AAYP

Table 4.7 Recommended Mains Disconnects

4.7.5 F-Frame Circuit Breakers

Frame size	Power & Voltage	Type
F	500 kW 380-480 V	Merlin Gerin NPJF36120U31AABSCYP
F	560-710kW 380-480 V	Merlin Gerin NRJF36200U31AABSCYP

Table 4.8 Recommended Circuit Breakers

4.7.6 F-Frame Mains Contactors

Frame size	Power & Voltage	Type
F	500-560 kW 380-480 V	Eaton XTCE650N22A
F	630-710 kW 380-480 V	Eaton XTCEC14P22B

Table 4.9 Recommended Contactors

4.8 Control Wiring

4.8.1 Control Cable Routing

Tie down all control wires to the designated control cable routing as shown in *Figure 4.5*, *Figure 4.6*, and *Figure 4.7*. Remember to connect the shields in a proper way to ensure optimum electrical immunity.

Serial communication bus connection

Connections are made to the relevant options on the control card. For details, see the relevant serial communication bus instructions. The cable must be placed in the provided path inside the adjustable frequency drive and tied down together with other control wires (see *Figure 4.5* and *Figure 4.6*).

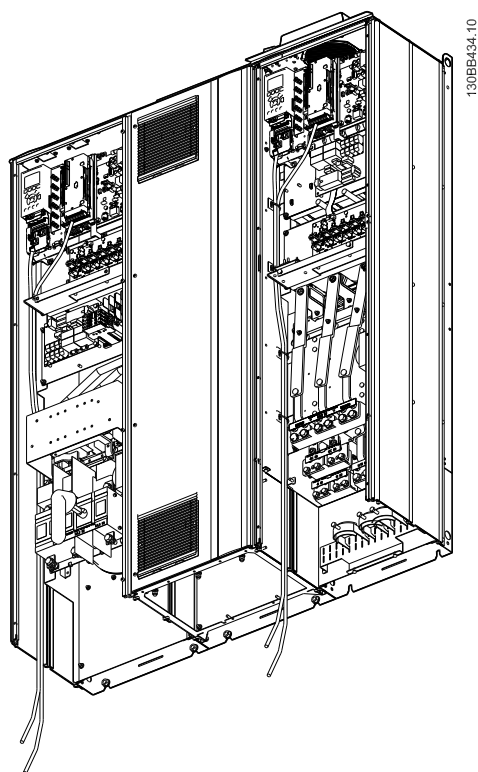


Figure 4.5 Control Card Wiring Path for Frame Size D13

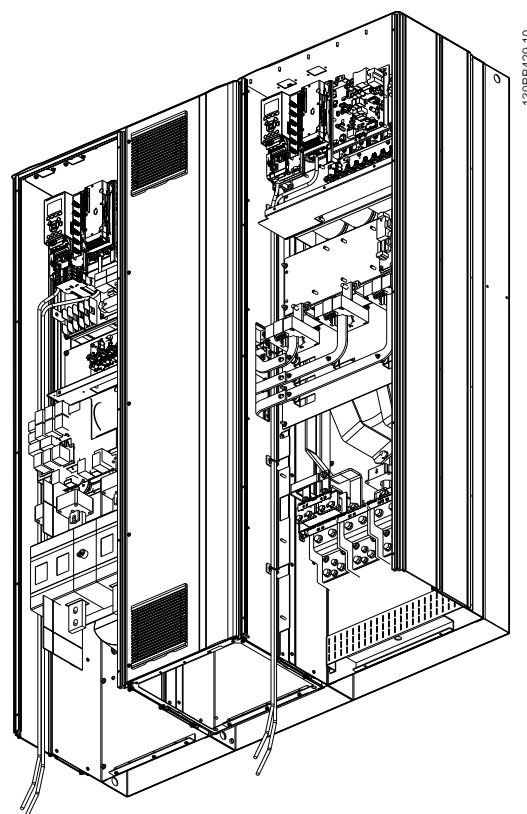
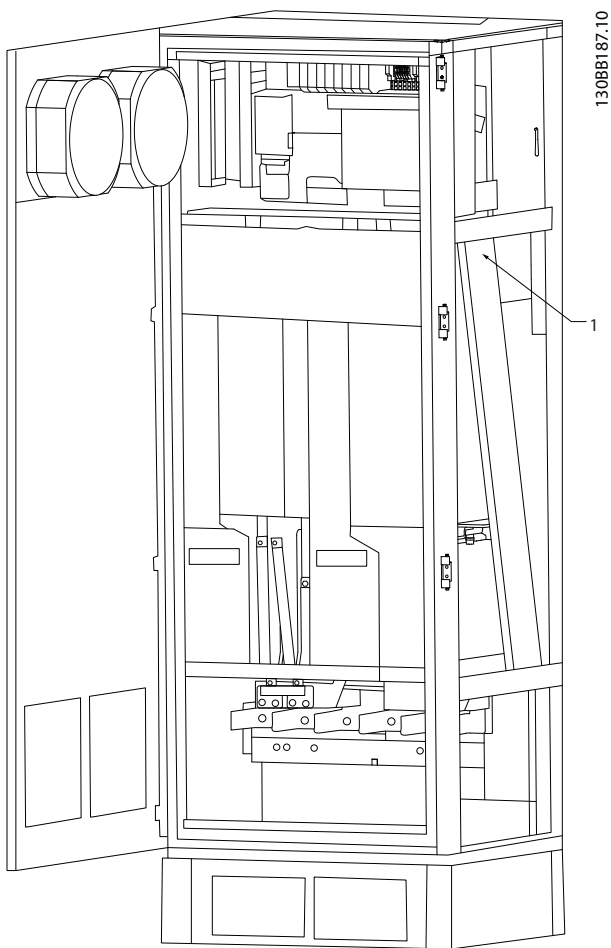


Figure 4.6 Control Card Wiring Path for Frame Size E9



1 Routing path for the control card wiring, inside the adjustable frequency drive enclosure.

Figure 4.7 Control Card Wiring Path for Frame Size F18

4.8.2 Access to Control Terminals

All terminals to the control cables are located beneath the LCP (both filter and adjustable frequency drive LCP). They are accessed by opening the door of the unit.

4.8.3 Electrical Installation, Control Terminals

To connect the cable to the terminal:

1. Strip insulation by about 0.35–0.4 in [9–10 mm] Electrical installationControl terminals

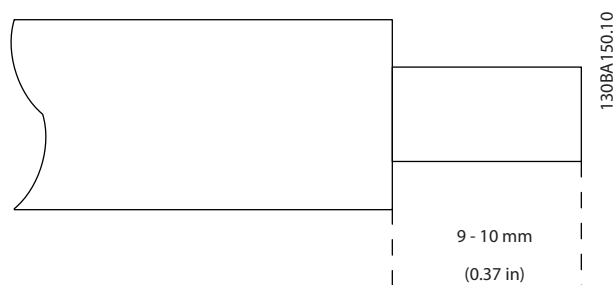


Figure 4.8 Length to Strip the Insulation

2. Insert a screwdriver (max. 0.016x0.1 in [0.4x2.5 mm]) in the square hole.
3. Insert the cable in the adjacent circular hole.

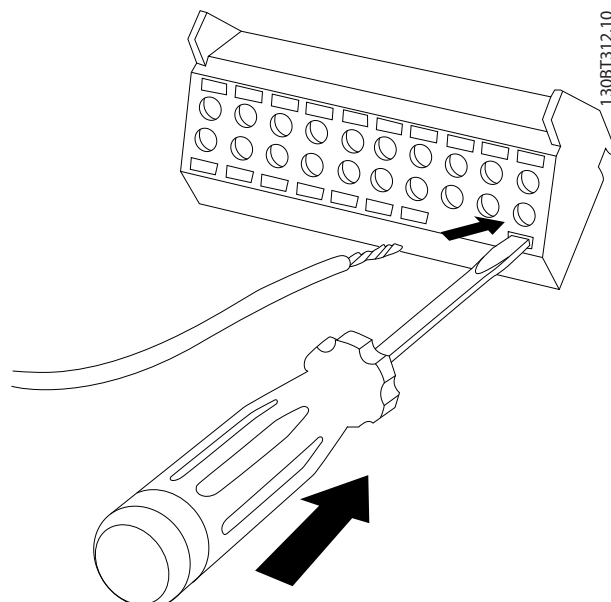


Figure 4.9 Inserting the Cable in the Terminal Block

4. Remove the screwdriver. The cable is now mounted in the terminal.

To remove the cable from the terminal:

1. Insert a screwdriver (max. 0.016x0.1 in [0.4x2.5 mm]) in the square hole.
2. Pull out the cable.

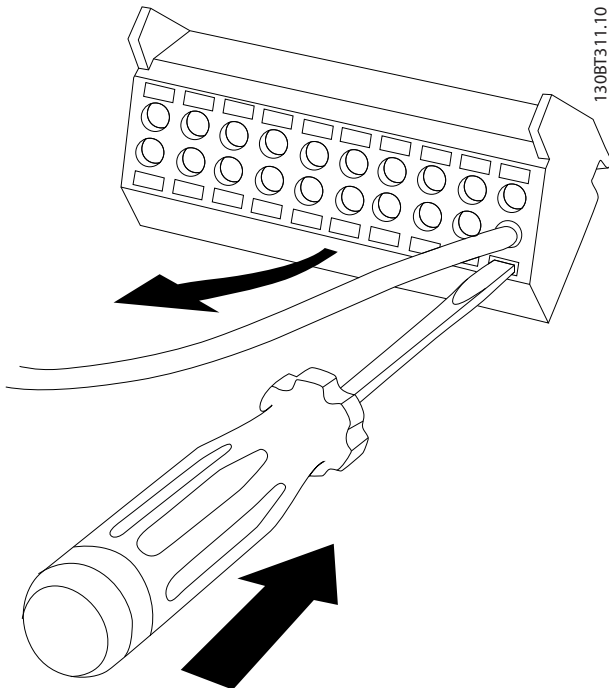


Figure 4.10 Removing the Screwdriver after Cable Insertion

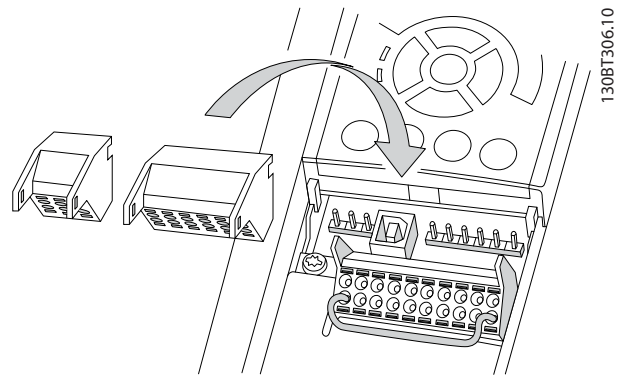


Figure 4.11 Control Terminal Locations

4.8.4 Electrical Installation, Control Cables

4

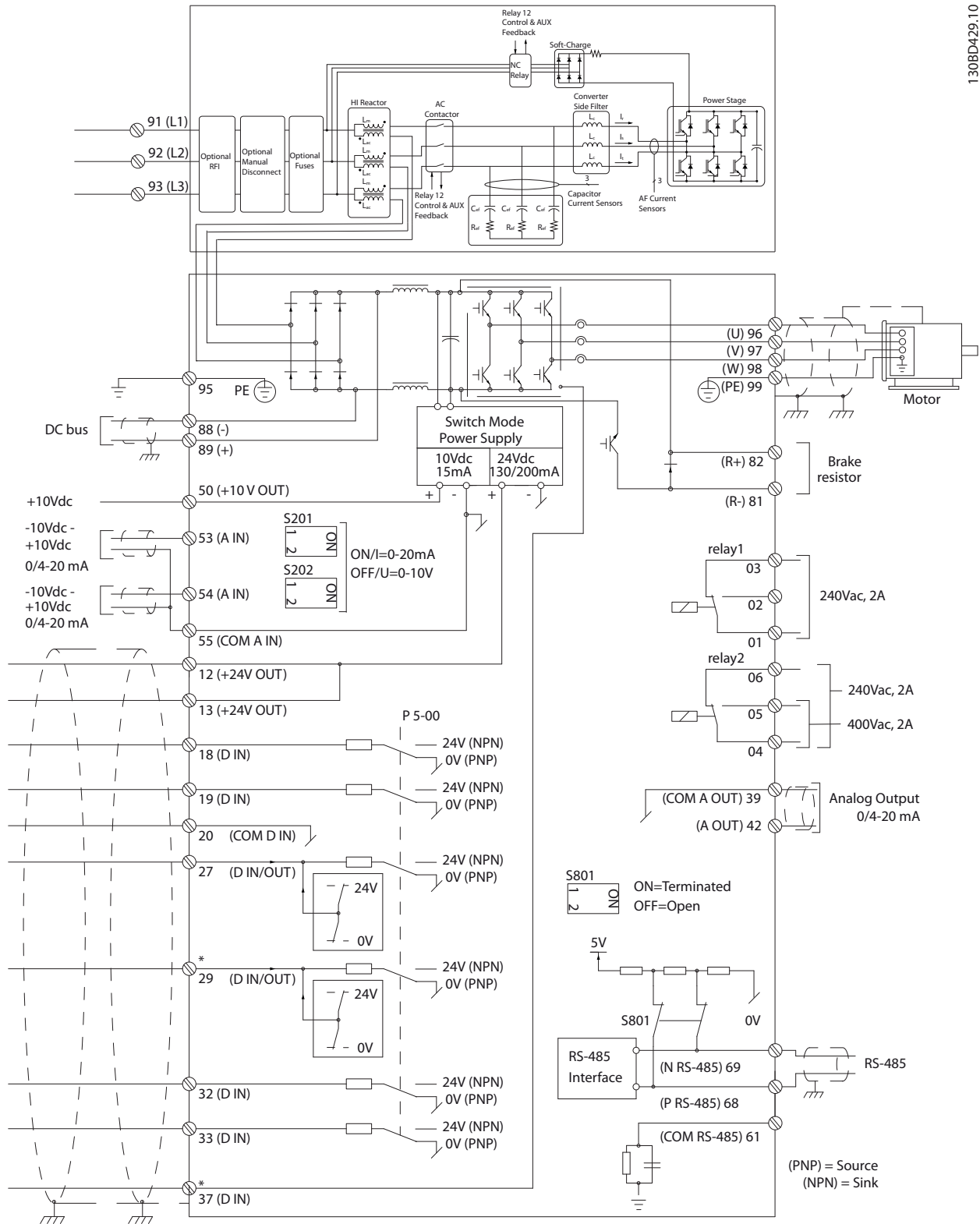


Figure 4.12 Terminal Diagram

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Long control cables and analog signals may result in 50/60 Hz ground loops due to noise from line power supply cables.

If ground loops occur, break the shield or insert a 100 nF capacitor between shield and chassis, if needed.

Connect the digital and analog inputs and outputs to the control cards of the units separately to avoid ground currents. These connections are on terminals 20, 55, and 39 for both the filter and adjustable frequency drive sections.

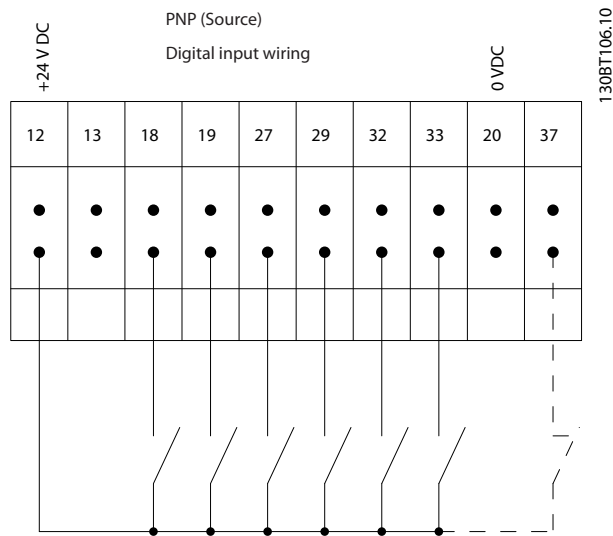


Figure 4.13 Input Polarity of Control Terminals, PNP

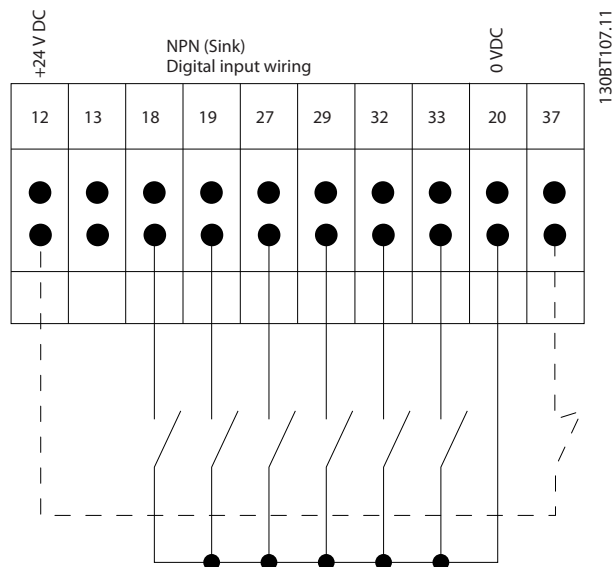


Figure 4.14 Input Polarity of Control Terminals, NPN

NOTICE!

To comply with EMC emission specifications, shielded/armored cables are recommended. If using non-shielded/armored cable, see chapter 4.7.3 Power and Control Wiring for Non-shielded Cables. If using non-shielded control cables, use ferrite cores to improve EMC performance.

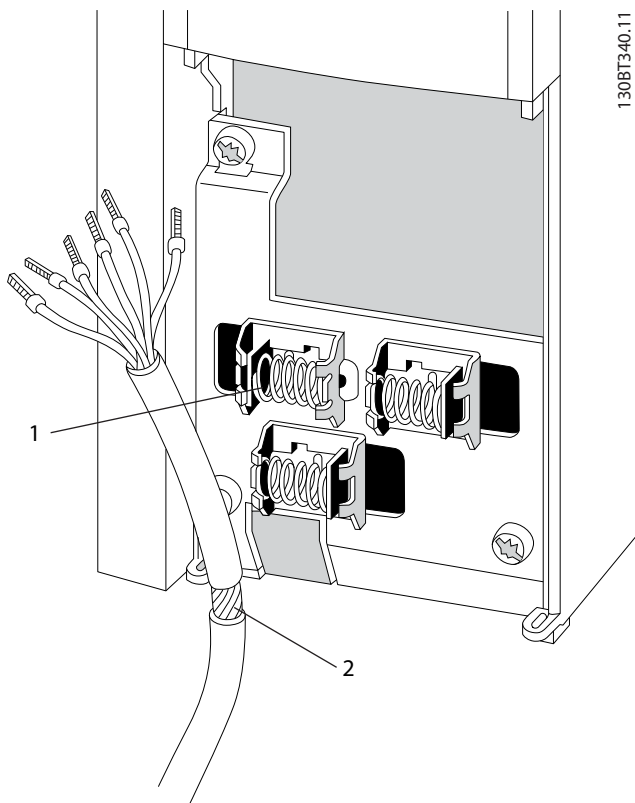


Figure 4.15 Connecting Shielded Cables

Connect the shields in a proper way to ensure optimum electrical immunity.

4.8.5 Safe Torque Off (STO)

To run STO, additional wiring for the frequency converter is required. Refer to VLT® Frequency Converters Safe Torque Off Operating Instructions for further information.

4.9 Additional Connections

4.9.1 Serial Communication

RS-485 is a 2-wire bus interface compatible with multi-drop network topology, i.e., nodes can be connected as a bus, or via drop cables from a common trunk line. A total of 32 nodes can be connected to one network segment. Repeaters divide network

4

NOTICE!

Each repeater functions as a node within the segment in which it is installed. Each node connected within a given network must have a unique node address across all segments.

Terminate each segment at both ends using either the termination switch (S801) of the adjustable frequency drives or a biased termination resistor network. Always use shielded twisted pair (STP) cable for bus cabling, and always follow good common installation practice. Low-impedance ground connection of the shield at every node is important, including at high frequencies. Thus, connect a large surface of the shield to ground, for example, with a cable clamp or a conductive cable connector. It may be necessary to apply potential-equalizing cables to maintain the same ground potential throughout the network - particularly in installations with long cables.

To prevent impedance mismatch, always use the same type of cable throughout the entire network. When connecting a motor to the adjustable frequency drives, always use shielded motor cable.

Cable	Shielded twisted pair (STP)
Impedance	120 Ω
Cable length	Max. 4000 ft [1200 m] (including drop lines) Max. 1,650 ft [500 m] station-to-station

Table 4.10 Cable Recommendations

4.9.2 Mechanical Brake Control

In hoisting/lowering applications, it is necessary to be able to control an electro-mechanical brake:

- Control the brake using any relay output or digital output (terminal 27 or 29).
- Keep the output closed (voltage-free) as long as the adjustable frequency drive is unable to 'support' the motor, e.g., due to the load being too heavy.
- Select [32] *Mechanical brake control* in parameter group 5-4* *Relays* for applications with an electro-mechanical brake.
- The brake is released when the motor current exceeds the preset value in *parameter 2-20 Release Brake Current*.
- The brake engages when the output frequency is less than the frequency set in *parameter 2-21 Activate Brake Speed [RPM]* or *parameter 2-22 Activate Brake Speed [Hz]*, only if

the adjustable frequency drive completes a stop command.

If the adjustable frequency drive is in alarm mode or in an overvoltage situation, the mechanical brake immediately cuts in.

4.9.3 Parallel Connection of Motors

The adjustable frequency drive can control several motors connected in parallel. The total current consumption of the motors must not exceed the rated output current $I_{M,N}$ for the adjustable frequency drive.

NOTICE!

Installations with cables connected in a common joint as in *Figure 4.16*, is only recommended for short cable lengths.

NOTICE!

When motors are connected in parallel, *parameter 1-29 Automatic Motor Adaptation (AMA)* cannot be used.

NOTICE!

The electronic thermal relay (ETR) of the adjustable frequency drive cannot be used as motor protection for the individual motor of systems with motors connected in parallel. Provide further motor protection with thermistors in each motor or individual thermal relays. Circuit breakers are not suitable as protection.

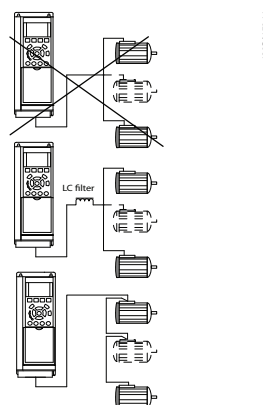


Figure 4.16 Installations with Cables Connected in a Common Joint

Problems are possible at start and at low RPM values if motor sizes vary widely. The relatively high ohmic resistance in the stator of small motors calls for a higher voltage at start and at low RPM values.

4.9.4 Motor Thermal Protection

The electronic thermal relay in the adjustable frequency drive has received UL-approval for single motor protection, when *parameter 1-90 Motor Thermal Protection* is set for *ETR Trip* and *parameter 1-24 Motor Current* is set to the rated motor current (see motor nameplate).

For thermal motor protection, it is also possible to use the MCB 112 PTC thermistor card option. This card provides ATEX certification to protect motors in explosion hazardous areas, Zone 1/21 and Zone 2/22. When *parameter 1-90 Motor Thermal Protection* is set to [20] ATEX ETR and MCB 112 are combined. It is possible to control an Ex-e motor in explosion hazardous areas. Consult the programming guide for details on how to set up the adjustable frequency drive for safe operation of Ex-e motors.

4.9.5 Voltage/Current Input Selection (Switches)

The analog mains terminals 53 and 54 allow setting of input signal to voltage (0–10 V) or current (0/4–20 mA). See *Figure 4.12* and for the location of the control terminals within the low harmonic drive.

Default parameter settings:

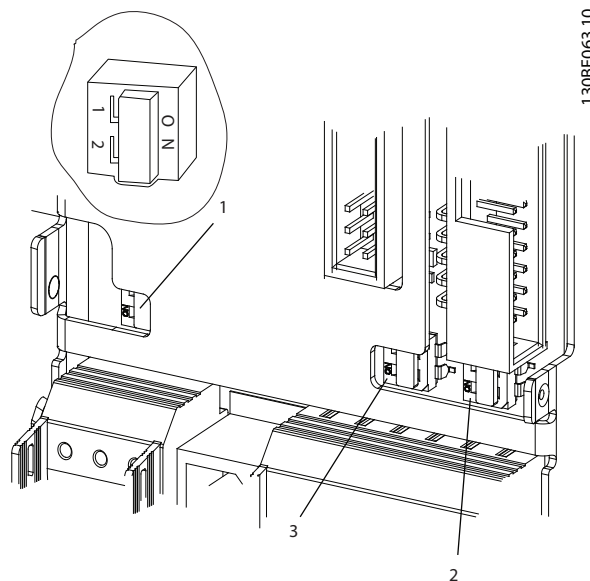
- Terminal 53: Speed reference signal in open loop (see *parameter 16-61 Terminal 53 Switch Setting*).
- Terminal 54: Feedback signal in closed loop (see *parameter 16-63 Terminal 54 Switch Setting*).

NOTICE!

REMOVE POWER

Remove power to the low harmonic drive before changing switch positions.

1. Remove the LCP (see *Figure 4.17*).
2. Remove any optional equipment covering the switches.
3. Set switches A53 and A54 to select the signal type. U selects voltage, I selects current.



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1	Bus termination switch
2	A54 switch
3	A53 switch

Figure 4.17 Bus Termination Switch, A53, and A54 Switch Locations

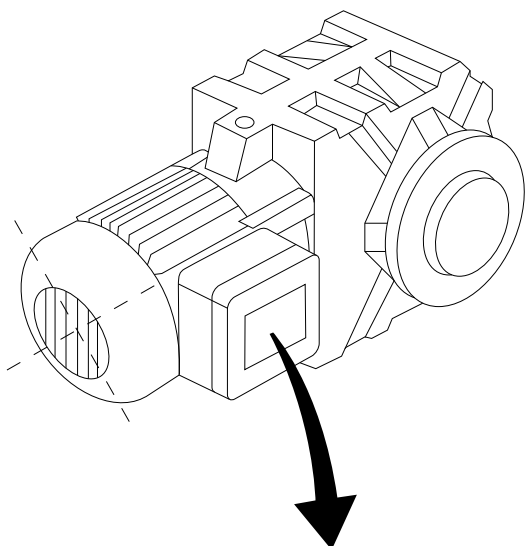
4.10 Final Set-up and Test

Before operating the frequency converter, perform a final test of the installation:

1. Locate the motor name plate to find out whether the motor is star- (Y) or delta- connected (Δ).
2. Enter the motor name plate data in the parameter list. Access the list by pressing the [Quick Menu] key and selecting Q2 Quick Set-up. See *Table 4.11*.

1.	<i>Parameter 1-20 Motor Power [kW]</i> <i>Parameter 1-21 Motor Power [HP]</i>
2.	<i>Parameter 1-22 Motor Voltage</i>
3.	<i>Parameter 1-23 Motor Frequency</i>
4.	<i>Parameter 1-24 Motor Current</i>
5.	<i>Parameter 1-25 Motor Nominal Speed</i>

Table 4.11 Quick Set-up Parameters



BAUER D-7 3734 ESLINGEN				
3~ MOTOR NR. 1827421 2003				
S/E005A9				
	1,5	KW		
n ₂	31,5	/MIN.	400	Y V
n ₁	1400	/MIN.	50	Hz
cos	0,80		3,6	A
1,7L				
B	IP 65		H1/1A	

Figure 4.18 Motor Name Plate

3. Perform an automatic motor adaptation (AMA) to ensure optimum performance.
 - 3a Connect terminal 27 to terminal 12 or set *parameter 5-12 Terminal 27 Digital Input* to [0] No operation.
 - 3b Activate the AMA in *parameter 1-29 Automatic Motor Adaptation (AMA)*.
 - 3c Select either complete or reduced AMA. If an LC filter is mounted, run only the reduced AMA, or remove the LC filter during the AMA procedure.
 - 3d Press [OK]. The display shows *Press [Hand On] to start*.
 - 3e Press [Hand On]. A progress bar indicates whether the AMA is in progress.

- 3f Press [Off] - the frequency converter enters into alarm mode and the display shows that the user terminated AMA.

Stop the AMA during operation

Successful AMA

- The display shows *Press [OK] to finish AMA*.
- Press [OK] to exit the AMA state.

Unsuccessful AMA

- The frequency converter enters into alarm mode. A description of the alarm can be found in *chapter 7 Diagnostics and Troubleshooting*.
- Report value in the alarm log shows the last measuring sequence carried out by the AMA before the frequency converter entered alarm mode. This number, along with the description of the alarm, helps with troubleshooting. Mention the number and alarm description when contacting Danfoss service personnel.

Unsuccessful AMA is the result of incorrectly registered motor nameplate data or too large a difference between the motor power size and the frequency converter power size.

Set up the desired limits for speed and ramp time

Minimum Reference	<i>Parameter 3-02 Minimum Reference</i>
Maximum Reference	<i>Parameter 3-03 Maximum Reference</i>

Table 4.12 Reference Parameters

Motor Speed Low Limit	<i>Parameter 4-11 Motor Speed Low Limit [RPM] or parameter 4-12 Motor Speed Low Limit [Hz]</i>
Motor Speed High Limit	<i>Parameter 4-13 Motor Speed High Limit [RPM] or parameter 4-14 Motor Speed High Limit [Hz]</i>

Table 4.13 Speed Limits

Ramp-up Time 1 [s]	<i>Parameter 3-41 Ramp 1 Ramp-up Time</i>
Ramp-down Time 1 [s]	<i>Parameter 3-42 Ramp 1 Ramp-down Time</i>

Table 4.14 Ramp Times

4.11 F-frame Options

Space heaters and thermostat

There are space heaters mounted on the cabinet interior of F-frame frequency converters. These heaters are controlled by an automatic thermostat and help control humidity inside the enclosure. The thermostat default settings turn on the heaters at 10 °C (50 °F) and turn them off at 15.6 °C (60 °F).

Cabinet light with power outlet

A light mounted on the cabinet interior of F-frame frequency converters increases visibility during servicing and maintenance. The housing includes a power outlet for temporarily powering tools or other devices, available in 2 voltages:

- 230 V, 50 Hz, 2.5 A, CE/ENEC
- 120 V, 60 Hz, 5 A, UL/cUL

Transformer tap set-up

If the cabinet light, outlet, and/or the space heaters, and thermostat are installed, transformer T1 requires its taps to be set to the proper input voltage. A 380–480/500 V frequency converter is initially set to the 525 V tap, to ensure that no overvoltage of secondary equipment occurs if the tap is not changed before applying power. See *Table 4.15* to set the proper tap at terminal T1 located in the rectifier cabinet.

Input voltage range [V]	Tap to select [V]
380–440	400
441–500	460

Table 4.15 Transformer Tap Set-up

NAMUR terminals

NAMUR is an international association of automation technology users in the process industries, primarily chemical and pharmaceutical industries in Germany. Selecting this option, provides terminals organised and labeled to the specifications of the NAMUR standard for frequency converters input and output terminals. This requires VLT® PTC Thermistor Card MCB 112 VLT® and Extended Relay Card MCB 113.

RCD (residual current device)

Uses the core balance method to monitor ground fault currents in grounded and high-resistance grounded systems (TN and TT systems in IEC terminology). There is a pre-warning (50% of main alarm set-point) and a main alarm set-point. Associated with each set-point is an SPDT alarm relay for external use. Requires an external window-type current transformer (supplied and installed by the customer).

- Integrated into the frequency converter safe torque off circuit.
- IEC 60755 Type B device monitors AC, pulsed DC, and pure DC ground fault currents.
- LED bar graph indicator of the ground fault current level from 10–100% of the setpoint.
- Fault memory.
- TEST/RESET key.

Insulation resistance monitor (IRM)

Monitors the insulation resistance in ungrounded systems (IT systems in IEC terminology) between the system phase conductors and ground. There is an ohmic pre-warning and a main alarm setpoint for the insulation level. An SPDT alarm relay for external use is associated with each setpoint.

NOTICE!

Only 1 insulation resistance monitor can be connected to each ungrounded (IT) system.

- Integrated into the frequency converter Safe Torque Off circuit.
- LCD display of the ohmic value of the insulation resistance.
- Fault memory.
- INFO, TEST, and RESET keys.

IEC emergency stop with Pilz safety relay

Includes a redundant 4-wire emergency-stop push button mounted on the front of the enclosure and a Pilz relay that monitors it in conjunction with the frequency converter STO (Safe Torque Off) circuit and the mains contactor located in the options cabinet.

Manual motor starters

Provide 3-phase power for electric blowers often required for larger motors. Power for the starters is provided from the load side of any supplied contactor, circuit breaker, or disconnect switch. Power is fused before each motor starter, and is off when the incoming power to the frequency converters is off. Up to 2 starters are allowed (1 if a 30 A, fuse-protected circuit is ordered), and are integrated into the frequency converter STO circuit.

Unit features include:

- Operation switch (on/off).
- Short-circuit and overload protection with test function.
- Manual reset function.

30 A, fuse-protected terminals

- 3-phase power matching incoming mains voltage for powering auxiliary customer equipment.
- Not available if 2 manual motor starters are selected.
- Terminals are off when the incoming power to the frequency converter is off.
- Power for the fused protected terminals is provided from the load side of any supplied contactor, circuit breaker, or disconnect switch.

In applications where the motor is used as a brake, energy is generated in the motor and sent back into the frequency converter. If the energy cannot be transported back to the motor, it increases the voltage in the frequency converter DC line. In applications with frequent braking and/or high inertia loads, this increase may lead to an overvoltage trip in the frequency converter and finally a shut down. Brake resistors are used to dissipate the excess energy resulting from the regenerative braking. The resistor is selected based on its ohmic value, its power dissipation rate and its physical size. Danfoss offers a wide variety of different resistors that are specifically designed for Danfoss frequency converters.

5 Commissioning

5.1 Safety Instructions

See *chapter 2 Safety* for general safety instructions.

⚠ WARNING

HIGH VOLTAGE

Adjustable frequency drives contain high voltage when connected to AC line input power. Failure to perform installation, start-up, and maintenance by qualified personnel could result in death or serious injury.

- Installation, start-up, and maintenance must be performed by qualified personnel only.

Before applying power:

1. Close the cover properly.
2. Check that all cable connectors are firmly tightened.
3. Ensure that input power to the unit is OFF and locked out. Do not rely on the adjustable

frequency drive disconnect switches for input power isolation.

4. Verify that there is no voltage on input terminals L1 (91), L2 (92), and L3 (93), phase-to-phase and phase-to-ground.
5. Verify that there is no voltage on output terminals 96 (U), 97 (V), and 98 (W), phase-to-phase and phase-to-ground.
6. Confirm continuity of the motor by measuring Ω values on U-V (96-97), V-W (97-98), and W-U (98-96).
7. Check for proper grounding of the adjustable frequency drive as well as the motor.
8. Inspect the adjustable frequency drive for loose connections on the terminals.
9. Confirm that the supply voltage matches the voltage of the adjustable frequency drive and the motor.

5

CAUTION

Before applying power to the unit, inspect the entire installation as detailed in *Table 5.1*. Check mark those items when completed.

Inspect for	Description	<input checked="" type="checkbox"/>
Auxiliary equipment	<ul style="list-style-type: none"> • Look for auxiliary equipment, switches, disconnects, or input fuses/circuit breakers on the input power side of the adjustable frequency drive or output side to the motor. Ensure that they are ready for full speed operation. • Check function and installation of any sensors used for feedback to the adjustable frequency drive. • Remove power factor correction caps on motors, if present 	
Cable routing	<ul style="list-style-type: none"> • Use separate metallic conduits for each of the following: <ul style="list-style-type: none"> • input power • motor wiring • control wiring 	
Control wiring	<ul style="list-style-type: none"> • Check for broken or damaged wires and loose connections. • Check that control wiring is isolated from power and motor wiring for noise immunity. • Check the voltage source of the signals, if necessary. • The use of shielded cable or twisted pair is recommended. Ensure that the shield is terminated correctly. 	
Cooling clearance	<ul style="list-style-type: none"> • Make sure that the top and bottom clearance is adequate to ensure proper airflow for cooling. 	
EMC considerations	<ul style="list-style-type: none"> • Check for proper installation regarding electromagnetic compatibility. 	

Inspect for	Description	☑
Environmental considerations	<ul style="list-style-type: none"> See equipment label for the maximum ambient operating temperature limits. Humidity levels must be 5–95% non-condensing 	
Fusing and circuit breakers	<ul style="list-style-type: none"> Check for proper fusing or circuit breakers. Check that all fuses are inserted firmly and in operational condition and that all circuit breakers are in the open position. 	
Grounding	<ul style="list-style-type: none"> The unit requires a ground wire from its chassis to the building ground. Check for good ground connections that are tight and free of oxidation. Grounding to conduit or mounting the back panel to a metal surface is not a suitable ground. 	
Input and output power wiring	<ul style="list-style-type: none"> Check for loose connections. Check that motor and line power are in separate conduits or separated shielded cables. 	
Panel interior	<ul style="list-style-type: none"> Make sure that the unit interior is free of debris and corrosion 	
Switches	<ul style="list-style-type: none"> Ensure that all switch and disconnect settings are in the proper positions. 	
Vibration	<ul style="list-style-type: none"> Check that the unit is mounted solidly or that shock mounts are used, as necessary. Check for an unusual amount of vibration. 	

Table 5.1 Start-up Checklist

5.2 Applying Power

⚠ WARNING

HIGH VOLTAGE!

Adjustable frequency drives contain high voltage when connected to AC line power. Installation, start-up and maintenance should be performed by qualified personnel only. Failure to comply could result in death or serious injury.

⚠ WARNING

UNINTENDED START!

When the adjustable frequency drive is connected to AC line power, the motor may start at any time. The adjustable frequency drive, motor, and any driven equipment must be in operational readiness. Failure to comply could result in death, serious injury, equipment, or property damage.

1. Confirm that the input voltage is balanced within 3%. If not, correct input voltage imbalance before proceeding.
2. Ensure that optional equipment wiring (if present) matches the installation application.
3. Ensure that all operator devices are off. Panel doors should be closed or cover mounted.
4. Apply power to the unit. Do not start the adjustable frequency drive at this time. For units

with a disconnect switch, turn the switch on to apply power.

NOTICE!

If the status line at the bottom of the LCP reads **AUTO REMOTE COASTING** or *Alarm 60 External Interlock* is displayed, this indicates that the unit is ready to operate but is missing an input signal on terminal 27.

5.3 Local Control Panel Operation

5.3.1 Local Control Panel

The local control panel (LCP) is the combined display and keypad on the front of the unit. The low harmonic drive includes 2 LCPs: 1 to control the frequency converter side and 1 to control the filter side.

The LCP has several user functions:

- Control speed of frequency converter when in local mode.
- Start and stop in local mode.
- Display operational data, status, warnings, and alarms.
- Programme frequency converter and active filter functions.
- Manually reset the frequency converter or active filter after a fault when auto-reset is inactive.

NOTICE!

For commissioning via PC, install the MCT 10 Set-up Software. The software is available for download (basic version) or for ordering (advanced version, order number 130B1000). For more information and downloads, see www.danfoss.com/BusinessAreas/DrivesSolutions/Software+MCT10/MCT10+Downloads.htm.

5.3.2 LCP Layout

The LCP is divided into 4 functional groups (see Figure 5.1).

- A. Display area
- B. Display menu keys
- C. Navigation keys and indicator lights (LEDs)
- D. Operation keys and reset

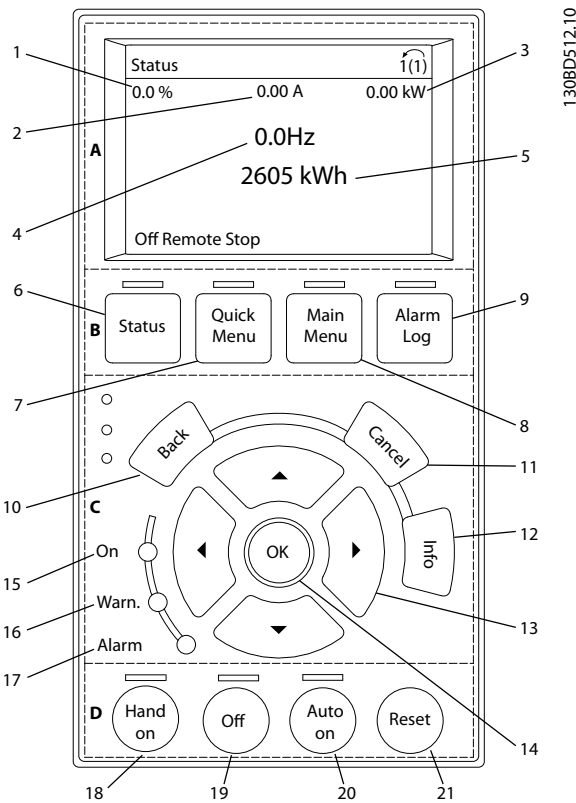


Figure 5.1 Local Control Panel (LCP)

A. Display area

The display area is activated when the frequency converter receives power from mains voltage, a DC bus terminal, or an external 24 V DC supply.

The information displayed on the LCP can be customised for user application. Select options in the *Quick Menu Q3-13 Display Settings*.

Callout	Display	Parameter number	Default setting
1	1.1	0-20	Reference %
2	1.2	0-21	Motor current
3	1.3	0-22	Power [kW]
4	2	0-23	Frequency
5	3	0-24	kWh counter

Table 5.2 Legend to Figure 5.1, Display Area (Frequency Converter Side)

B. Display menu keys

Menu keys are used for menu access for parameter set-up, toggling through status display modes during normal operation, and viewing fault log data.

Callout	Key	Function
6	Status	Shows operational information.
7	Quick Menu	Allows access to programming parameters for initial set-up instructions and many detailed application instructions.
8	Main Menu	Allows access to all programming parameters.
9	Alarm Log	Displays a list of current warnings, the last 10 alarms, and the maintenance log.

Table 5.3 Legend to Figure 5.1, Display Menu Keys

C. Navigation keys and indicator lights (LEDs)

Navigation keys are used for programming functions and moving the display cursor. The navigation keys also provide speed control in local (hand) operation. There are also 3 frequency converter status indicator lights in this area.

Callout	Key	Function
10	Back	Reverts to the previous step or list in the menu structure.
11	Cancel	Cancels the last change or command as long as the display mode has not changed.
12	Info	Press for a definition of the function being displayed.
13	Navigation keys	Press to move between items in the menu.
14	OK	Press to access parameter groups or to enable an option.

Table 5.4 Legend to Figure 5.1, Navigation Keys

Callout	Indicator	Light	Function
15	ON	Green	The ON light activates when the frequency converter receives power from mains voltage, a DC bus terminal, or an external 24 V supply.
16	WARN	Yellow	When a warning is issued, the yellow WARN light comes on and text appears in the display area identifying the problem.
17	ALARM	Red	A fault condition causes the red alarm light to flash and an alarm text is displayed.

Table 5.5 Legend to Figure 5.1, Indicator Lights (LEDs)

D. Operation keys and reset

Operation keys are located at the bottom of the LCP.

Callout	Key	Function
18	Hand On	Starts the frequency converter in local control. <ul style="list-style-type: none"> An external stop signal by control input or serial communication overrides the local hand on.
19	Off	Stops the operation but does not remove power to the frequency converter.
20	Auto On	Puts the system in remote operational mode. <ul style="list-style-type: none"> Responds to an external start command by control terminals or serial communication.
21	Reset	Resets the frequency converter or active filter manually after a fault has been cleared.

Table 5.6 Legend to Figure 5.1, Operation Keys and Reset

NOTICE!

The display contrast can be adjusted by pressing [Status] and [▲]/[▼] keys.

5.3.3 Parameter Settings

Establishing the correct programming for applications often requires setting functions in several related parameters. Details for parameters are provided in *chapter 9 Appendix A - Parameters*.

Programming data is stored internally in the adjustable frequency drive.

- For backup, upload data into the LCP memory.
- To download data to another adjustable frequency drive, connect the LCP to that unit and download the stored settings.
- Restoring factory default settings does not change data stored in the LCP memory.

5.3.4 Uploading/Downloading Data to/from the LCP

- Press [Off] to stop operation before uploading or downloading data.
- Press [Main Menu] *parameter 0-50 LCP Copy* and press [OK].
- Select [1] *All to LCP* to upload data to the LCP or select [2] *All from LCP* to download data from the LCP.
- Press [OK]. A progress bar shows the uploading or downloading progress.
- Press [Hand On] or [Auto On] to return to normal operation.

5.3.5 Changing Parameter Settings

Parameter settings can be accessed and changed from the *Quick Menu* or from the *Main Menu*. The *Quick Menu* only gives access to a limited number of parameters.

- Press [Quick Menu] or [Main Menu] on the LCP.
- Press [▲] [▼] to browse through the parameter groups, press [OK] to select a parameter group.
- Press [▲] [▼] to browse through the parameters, press [OK] to select a parameter.
- Press [▲] [▼] to change the value of a parameter setting.
- Press [◀] [▶] to shift digit when a decimal parameter is in the editing state.
- Press [OK] to accept the change.
- Press either [Back] twice to enter *Status*, or press [Main Menu] once to enter the *Main Menu*.

View changes

Quick Menu Q5 - Changes Made lists all parameters changed from default settings.

- The list only shows parameters, which have been changed in the current edit set-up.
- Parameters, which have been reset to default values, are not listed.

- The message *Empty* indicates that no parameters have been changed.

5.3.6 Restoring Default Settings

NOTICE!

Risk of losing programming and monitoring records by restoration of default settings. To provide a back-up, upload data to the LCP before initialisation.

Restoring the default parameter settings is done by initialisation of the frequency converter. Initialisation is carried out through *parameter 14-22 Operation Mode* (recommended) or manually.

- Initialisation using *parameter 14-22 Operation Mode* does not reset frequency converter settings, such as operating hours, serial communication selections, personal menu settings, fault log, alarm log, and other monitoring functions.
- Manual initialisation erases all motor, programming, localisation, and monitoring data and restores factory default settings.

Recommended initialisation procedure, via parameter 14-22 Operation Mode

1. Press [Main Menu] twice to access parameters.
2. Scroll to *parameter 14-22 Operation Mode* and press [OK].
3. Scroll to [2] *Initialisation* and press [OK].
4. Remove power to the unit and wait for the display to turn off.
5. Apply power to the unit.

Default parameter settings are restored during start-up. This may take slightly longer than normal.

6. Alarm 80 is displayed.
7. Press [Reset] to return to operation mode.

Manual initialisation procedure

1. Remove power to the unit and wait for the display to turn off.
2. Press and hold [Status], [Main Menu], and [OK] at the same time while applying power to the unit (approximately 5 s or until audible click and fan starts).

Factory default parameter settings are restored during start-up. This may take slightly longer than normal.

Manual initialisation does not reset the following frequency converter information:

- *Parameter 15-00 Operating hours*
- *Parameter 15-03 Power-ups*
- *Parameter 15-04 Over Temps*
- *Parameter 15-05 Over Volts*

5.4 Basic Programming

5.4.1 VLT® Low Harmonic Drive Programming

The low harmonic drive includes 2 LCPs: 1 to control the frequency converter side and 1 to control the filter side. Because of this unique design, the detailed parameter information for the product is found in 2 places.

Detailed programming information for the frequency converter portion can be found in the relevant *programming guide*. Detailed programming information for the filter can be found in the *VLT® Active Filter AAF 006 Operating Instructions*.

The remaining sections in this chapter apply to the frequency converter side. The active filter of the low harmonic drives is pre-configured for optimal performance and must only be turned on by pressing its [Hand On] key after the frequency converter side is commissioned.

5.4.2 Commissioning with SmartStart

The SmartStart wizard enables fast configuration of basic motor and application parameters.

- SmartStart starts automatically at first power-up or after initialization of the adjustable frequency drive.
- Follow the on-screen instructions to complete the commissioning of the adjustable frequency drive. Always reactivate SmartStart by selecting *Quick Menu Q4 - SmartStart*.
- For commissioning without use of the SmartStart wizard, refer to *chapter 5.4.3 Commissioning via [Main Menu]* or the programming guide.

NOTICE!

Motor data is required for the SmartStart set-up. The required data is normally available on the motor nameplate.

5.4.3 Commissioning via [Main Menu]

Recommended parameter settings are intended for start-up and check-out purposes. Application settings may vary. Enter data with power ON, but before operating the adjustable frequency drive.

1. Press [Main Menu] on the LCP.
2. Press the navigation keys to scroll to parameter group 0-** Operation/Display and press [OK].

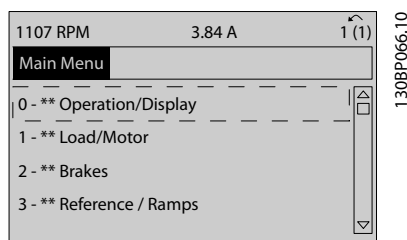


Figure 5.2 Main Menu

3. Press the navigation keys to scroll to parameter group 0-0* Basic Settings and press [OK].

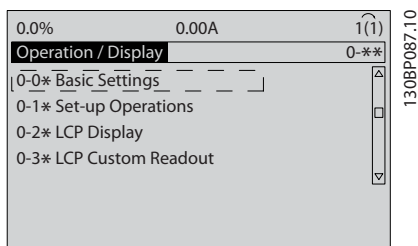


Figure 5.3 Operation/Display

4. Press the navigation keys to scroll to parameter 0-03 Regional Settings and press [OK].

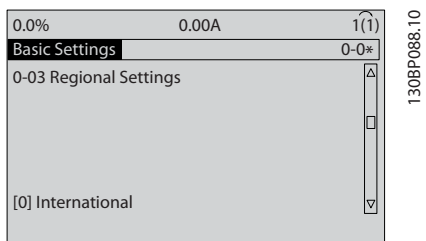


Figure 5.4 Basic Settings

5. Press the navigation keys to select [0] International or [1] North America as appropriate and press [OK]. (This changes the default settings for a number of basic parameters).
6. Press [Main Menu] on the LCP.

7. Press the navigation keys to scroll to parameter 0-01 Language.
8. Select the language and press [OK].
9. If a jumper wire is in place between control terminals 12 and 27, leave parameter 5-12 Terminal 27 Digital Input at factory default. Otherwise, select No Operation in parameter 5-12 Terminal 27 Digital Input. For adjustable frequency drives with an optional bypass, no jumper wire is required between control terminals 12 and 27.
10. Make the application specific settings in the following parameters:
 - 10a Parameter 3-02 Minimum Reference
 - 10b Parameter 3-03 Maximum Reference
 - 10c Parameter 3-41 Ramp 1 Ramp-up Time
 - 10d Parameter 3-42 Ramp 1 Ramp-down Time
 - 10e Parameter 3-13 Reference Site. Linked to Hand/Auto Local Remote.

5.4.4 Asynchronous Motor Set-up

Enter the following motor data. The information can be found on the motor nameplate.

1. Parameter 1-20 Motor Power [kW] or parameter 1-21 Motor Power [HP].
2. Parameter 1-22 Motor Voltage.
3. Parameter 1-23 Motor Frequency.
4. Parameter 1-24 Motor Current.
5. Parameter 1-25 Motor Nominal Speed.

When running in flux mode, or for optimum performance in VVC⁺ mode, extra motor data is required to set up the following parameters. The data can be found in the motor datasheet (this data is typically not available on the motor nameplate). Run a complete AMA using parameter 1-29 Automatic Motor Adaptation (AMA) [1] Enable Complete AMA or enter the parameters manually. Parameter 1-36 Iron Loss Resistance (Rfe) is always entered manually.

1. Parameter 1-30 Stator Resistance (Rs).
2. Parameter 1-31 Rotor Resistance (Rr).
3. Parameter 1-33 Stator Leakage Reactance (X1).
4. Parameter 1-34 Rotor Leakage Reactance (X2).
5. Parameter 1-35 Main Reactance (Xh).

6. *Parameter 1-36 Iron Loss Resistance (Rfe).*

Application-specific adjustment when running VVC⁺

VVC⁺ is the most robust control mode. In most situations, it provides optimum performance without further adjustments. Run a complete AMA for best performance.

Application-specific adjustment when running Flux

Flux mode is the preferred control mode for optimum shaft performance in dynamic applications. Perform an AMA since this control mode requires precise motor data. Depending on the application, further adjustments may be required.

See *Table 5.7* for application-related recommendations.

Application	Settings
Low-inertia applications	Keep calculated values.
High-inertia applications	<i>Parameter 1-66 Min. Current at Low Speed.</i> Increase current to a value between default and maximum depending on the application. Set ramp times matching the application. Too fast ramp up causes an overcurrent or overtorque. Too fast ramp-down causes an overvoltage trip.
High load at low speed	<i>Parameter 1-66 Min. Current at Low Speed.</i> Increase current to a value between default and maximum depending on the application.
No-load application	Adjust <i>parameter 1-18 Min. Current at No Load</i> to achieve smoother motor operation by reducing torque ripple and vibration.

Application	Settings
Flux sensorless only	Adjust <i>parameter 1-53 Model Shift Frequency</i> . Example 1: If the motor oscillates at 5 Hz and dynamics performance is required at 15 Hz, set <i>parameter 1-53 Model Shift Frequency</i> to 10 Hz. Example 2: If the application involves dynamic load changes at low speed, reduce <i>parameter 1-53 Model Shift Frequency</i> . Observe the motor behavior to make sure that the model shift frequency is not reduced too much. Symptoms of inappropriate model shift frequency are motor oscillations or adjustable frequency drive tripping.

Table 5.7 Recommendations for Flux Applications

5.4.5 Permanent Magnet Motor Set-up

NOTICE!

Only use permanent magnet (PM) motor with fans and pumps.

Initial Programming Steps

1. Activate PM motor operation
Parameter 1-10 Motor Construction, select (1) PM, non-salient SPM
2. Set *parameter 0-02 Motor Speed Unit* to [0] RPM

Programming motor data

After selecting PM motor in *Parameter 1-10 Motor Construction*, the PM motor-related parameters in parameter groups 1-2* *Motor Data*, 1-3* *Addl. Motor Data* and 1-4* are active.

The necessary data can be found on the motor nameplate and in the motor data sheet.

Program the following parameters in the listed order

1. *Parameter 1-24 Motor Current*
2. *Parameter 1-26 Motor Cont. Rated Torque*
3. *Parameter 1-25 Motor Nominal Speed*
4. *Parameter 1-39 Motor Poles*
5. *Parameter 1-30 Stator Resistance (Rs)*
Enter line to common stator winding resistance (Rs). If only line-line data are available, divide the line-line value by 2 to achieve the line to common (starpoint) value.

It is also possible to measure the value with an ohmmeter, which takes the resistance of the cable into account. Divide the measured value by 2 and enter the result.

6. *Parameter 1-37 d-axis Inductance (Ld)*

Enter line to common direct axis inductance of the PM motor.

If only line-line data are available, divide the line-line value by 2 to achieve the line-common (starpoint) value.

It is also possible to measure the value with an inductance meter, which takes the inductance of the cable into account. Divide the measured value by 2 and enter the result.

7. *Parameter 1-40 Back EMF at 1000 RPM*

Enter line-to-line back EMF of PM Motor at 1000 RPM mechanical speed (RMS value). Back EMF is the voltage generated by a PM motor when no drive is connected and the shaft is turned externally. Back EMF is normally specified for nominal motor speed or for 1,000 RPM measured between two lines. If the value is not available for a motor speed of 1000 RPM, calculate the correct value as follows: If back EMF is, e.g., 320 V at 1800 RPM, it can be calculated at 1000 RPM as follows: Back EMF = (Voltage / RPM)*1000 = (320/1800)*1000 = 178. This is the value that must be programmed for *parameter 1-40 Back EMF at 1000 RPM*.

Test motor operation

1. Start the motor at low speed (100 to 200 RPM). If the motor does not turn, check installation, general programming and motor data.
2. Check if start function in *parameter 1-70 PM Start Mode* fits the application requirements.

Rotor detection

This function is the recommended choice for applications where the motor starts from standstill, e.g., pumps or conveyors. On some motors, an acoustic sound is heard when the impulse is sent out. This does not harm the motor.

Parking

This function is the recommended choice for applications where the motor is rotating at slow speed, e.g., windmilling in fan applications. *parameter 2-06 Parking Current* and *parameter 2-07 Parking Time* can be adjusted. Increase the factory setting of these parameters for applications with high inertia.

Start the motor at nominal speed. If the application does not run well, check the VVC+ PM settings. Recommendations for different applications can be seen in *Table 5.7*.

Application	Settings
Low inertia applications $I_{Load}/I_{Motor} < 5$	<i>Parameter 1-17 Voltage filter time const.</i> to be increased by factor 5 to 10 <i>parameter 1-14 Damping Gain</i> should be reduced <i>parameter 1-66 Min. Current at Low Speed</i> should be reduced (<100%)
Low inertia applications $50 > I_{Load}/I_{Motor} > 5$	Keep calculated values
High inertia applications $I_{Load}/I_{Motor} > 50$	<i>Parameter 1-14 Damping Gain</i> , <i>parameter 1-15 Low Speed Filter Time Const.</i> and <i>parameter 1-16 High Speed Filter Time Const.</i> should be increased
High load at low speed <30% (rated speed)	<i>Parameter 1-17 Voltage filter time const.</i> should be increased <i>parameter 1-66 Min. Current at Low Speed</i> should be increased (>100% for a prolonged time can overheat the motor)

Table 5.8 Recommendations for Different Applications

If the motor starts oscillating at a certain speed, increase *parameter 1-14 Damping Gain*. Increase the value in small steps. Depending on the motor, a good value for this parameter can be 10% or 100% higher than the default value. Starting torque can be adjusted in *parameter 1-66 Min. Current at Low Speed*. 100% provides nominal torque as starting torque.

5.4.6 Automatic Energy Optimization (AEO)

NOTICE!

AEO is not relevant for permanent magnet motors.

AEO is a procedure which minimizes voltage to the motor, thereby reducing energy consumption, heat, and noise. To activate AEO, set *parameter 1-03 Torque Characteristics* to [2] *Auto Energy Optim. CT* or [3] *Auto Energy Optim. VT*

5.4.7 Automatic Motor Adaptation (AMA)

AMA is a procedure which optimizes compatibility between the adjustable frequency drive and the motor.

- The adjustable frequency drive builds a mathematical model of the motor for regulating output motor current. The procedure also tests the input phase balance of electrical power. It

compares the motor characteristics with the entered nameplate data.

- The motor shaft does not turn and no harm is done to the motor while running the AMA.
- Some motors may be unable to run the complete version of the test. In that case, select [2] *Enable reduced AMA*.
- If an output filter is connected to the motor, select [2] *Enable reduced AMA*.
- If warnings or alarms occur, see *chapter 7 Diagnostics and Troubleshooting*.
- Run this procedure on a cold motor for best results.

To run AMA

1. Press [Main Menu] to access parameters.
2. Scroll to parameter group 1-** *Load and Motor* and press [OK].
3. Scroll to parameter group 1-2* *Motor Data* and press [OK].
4. Scroll to parameter 1-29 *Automatic Motor Adaptation (AMA)* and press [OK].
5. Select [1] *Enable complete AMA* and press [OK].
6. Follow the on-screen instructions.
7. The test runs automatically and indicates when it is complete.
8. The advanced motor data is entered in parameter group 1-3* *Adv. Motor Data*.

5.5 Checking Motor Rotation

NOTICE!

Risk of damage to pumps/compressors caused by motor running in wrong direction. Before running the adjustable frequency drive, check the motor rotation.

The motor runs briefly at 5 Hz or the minimum frequency set in *parameter 4-12 Motor Speed Low Limit [Hz]*.

1. Press [Main Menu].
2. Scroll to *parameter 1-28 Motor Rotation Check* and press [OK].
3. Scroll to [1] *Enable*.

The following text appears: *Note! Motor may run in wrong direction.*

4. Press [OK].
5. Follow the on-screen instructions.

NOTICE!

To change the direction of rotation, remove power to the adjustable frequency drive and wait for power to discharge. Reverse the connection of any two of the three motor wires on the motor or adjustable frequency drive side of the connection.

5.6 Local-control Test

1. Press [Hand On] to provide a local start command to the adjustable frequency drive.
2. Accelerate the adjustable frequency drive by pressing [▲] to full speed. Moving the cursor left of the decimal point provides quicker input changes.
3. Note any acceleration problems.
4. Press [Off]. Note any deceleration problems.

In the event of acceleration or deceleration problems, see *chapter 7.5 Troubleshooting*. See *chapter 7.4 Warnings and Alarm Definitions - Active Filter* for resetting the adjustable frequency drive after a trip.

5.7 System Start-up

The procedure in this section requires user-wiring and application programming to be completed. The following procedure is recommended after application set-up is completed.

1. Press [Auto On].
2. Apply an external run command.
3. Adjust the speed reference throughout the speed range.
4. Remove the external run command.
5. Check the sound and vibration levels of the motor to ensure that the system is working as intended.

If warnings or alarms occur, see *chapter 7.3 Warning and Alarm Definitions for Frequency Converter* or *chapter 7.4 Warnings and Alarm Definitions - Active Filter*.

6 Application Examples

6.1 Introduction

The examples in this section are intended as a quick reference for common applications.

- Parameter settings are the regional default values unless otherwise indicated (selected in *parameter 0-03 Regional Settings*).
- Parameters associated with the terminals and their settings are shown next to the drawings.
- Required switch settings for analog terminals A53 or A54 are also shown.

NOTICE!

When using the optional STO feature, a jumper wire may be required between terminal 12 (or 13) and terminal 37 for the frequency converter to operate with factory default programming values.

NOTICE!

The following examples refer only to the frequency converter control card (right LCP), *not* the filter.

6.2 Application Examples

6.2.1 Speed

		Parameters		
		Function	Setting	
	FC			
	+24 V	12	Parameter 6-10	0.07 V*
	+24 V	13	Terminal 53	
	D IN	18	Low Voltage	
	D IN	19	Parameter 6-11	10 V*
	COM	20	Terminal 53	
	D IN	27	High Voltage	
	D IN	29	Parameter 6-14	0 RPM
	D IN	32	Terminal 53	
	D IN	33	Low Ref./Feedb.	
	D IN	37	Value	
	+10 V	50	Parameter 6-15	1500 RPM
A IN	53	Terminal 53		
A IN	54	High Ref./		
COM	55	Feedb. Value		
A OUT	42	* = Default Value		
COM	39	Notes/comments:		
		D IN 37 is an option.		

Table 6.1 Analog Speed Reference (Voltage)

		Parameters	
FC		Function	Setting
+24 V	12	Parameter 6-12	4 mA*
+24 V	13	Terminal 53	
D IN	18	Low Current	
D IN	19	Parameter 6-13	20 mA*
COM	20	Terminal 53	
D IN	27	High Current	
D IN	29	Parameter 6-14	0 RPM
D IN	32	Terminal 53	
D IN	33	Low Ref./Feedb. Value	
D IN	37	Parameter 6-15	1500 RPM
+10 V	50	Terminal 53	
A IN	53	High Ref./Feedb. Value	
A IN	54		
COM	55		
A OUT	42		
COM	39		
		* = Default Value Notes/comments: D IN 37 is an option.	

Table 6.2 Analog Speed Reference (Current)

		Parameters	
FC		Function	Setting
+24 V	12	Parameter 5-10	[8] Start*
+24 V	13	Terminal 18	
D IN	18	Digital Input	
D IN	19	Parameter 5-12	[19] Freeze Reference
COM	20	Terminal 27	
D IN	27	Digital Input	
D IN	29	parameter 5-13	[21] Speed Up
D IN	32	Terminal 29	
D IN	33	Digital Input	
D IN	37	parameter 5-14	[22] Slow
+10 V	50	Terminal 32	
A IN	53	Digital Input	
A IN	54		
COM	55		
A OUT	42		
COM	39		
		* = Default Value Notes/comments: D IN 37 is an option.	

Table 6.4 Speed Up/Down

		Parameters	
FC		Function	Setting
+24 V	12	Parameter 6-10	0.07 V*
+24 V	13	Terminal 53	
D IN	18	Low Voltage	
D IN	19	Parameter 6-11	10 V*
COM	20	Terminal 53	
D IN	27	High Voltage	
D IN	29	Parameter 6-14	0 RPM
D IN	32	Terminal 53	
D IN	33	Low Ref./Feedb. Value	
D IN	37	Parameter 6-15	1500 RPM
+10 V	50	Terminal 53	
A IN	53	High Ref./Feedb. Value	
A IN	54		
COM	55		
A OUT	42		
COM	39		
		* = Default Value Notes/comments: D IN 37 is an option.	

Table 6.3 Speed Reference (using a Manual Potentiometer)

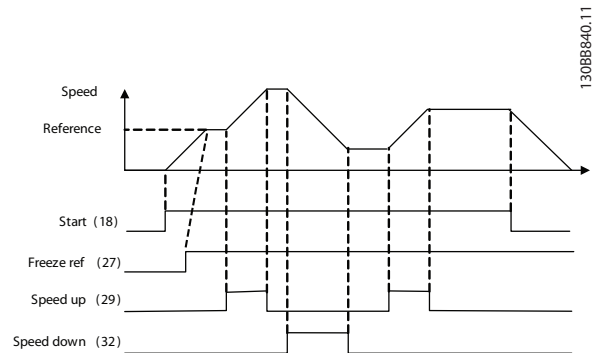


Figure 6.1 Speed Up/Down

6.2.2 Start/Stop

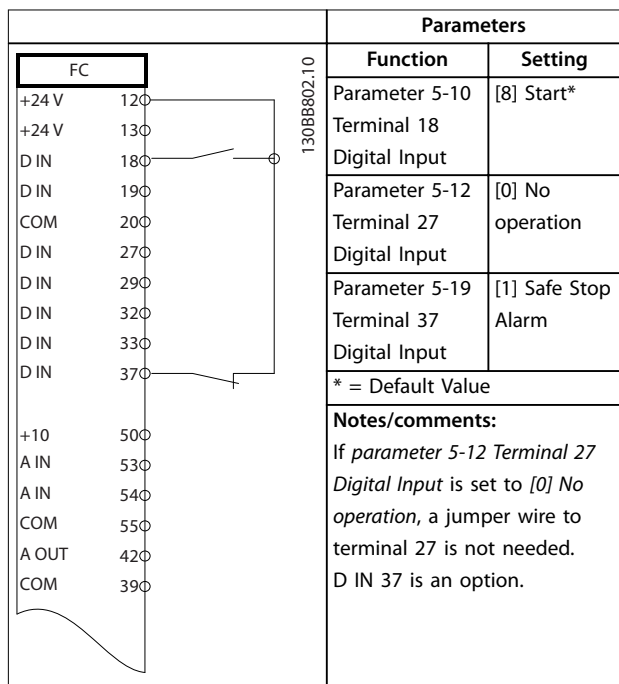


Table 6.5 Start/Stop Command with Safe Stop Option

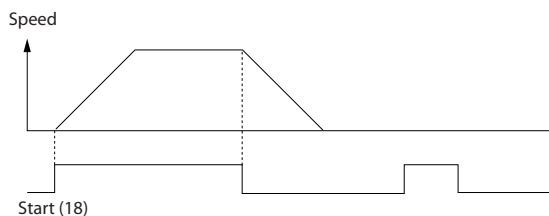


Figure 6.2 Start/Stop Command with Safe Stop

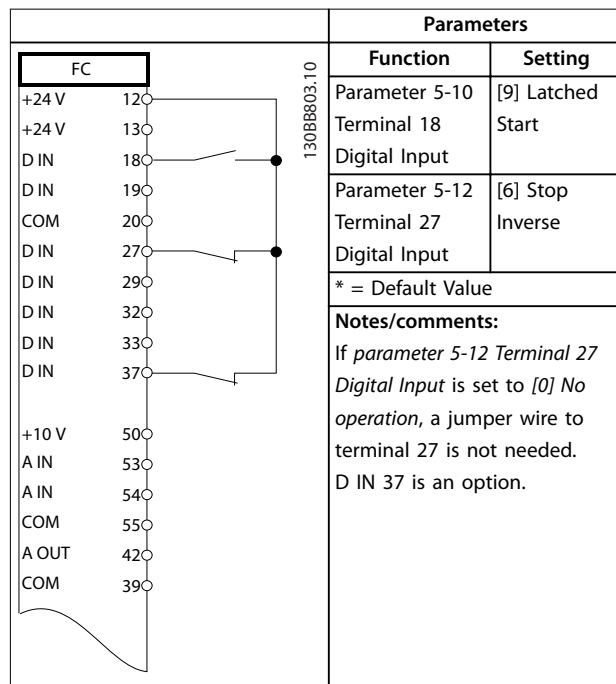


Table 6.6 Pulse Start/Stop

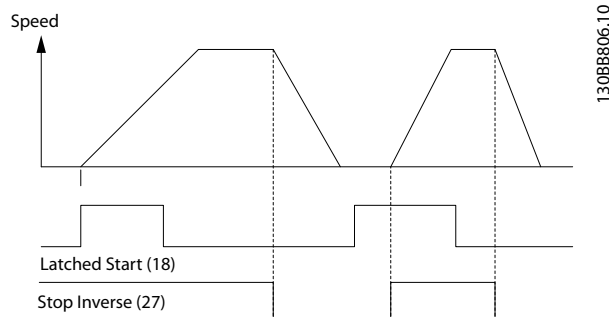


Figure 6.3 Latched Start/Stop Inverse

		Parameters	
		Function	Setting
		Parameter 5-10 Terminal 18 Digital Input	[8] Start
		Parameter 5-11 Terminal 19 Digital Input	[10] Reversing *
		Parameter 5-12 Terminal 27 Digital Input	[0] No operation
		Parameter 5-14 Terminal 32 Digital Input	[16] Preset ref bit 0
		Parameter 5-15 Terminal 33 Digital Input	[17] Preset ref bit 1
		Parameter 3-10 Preset Reference	
		Preset ref. 0	25%
		Preset ref. 1	50%
		Preset ref. 2	75%
		Preset ref. 3	100%
		* = Default Value	
		Notes/comments: D IN 37 is an option.	

Table 6.7 Start/Stop with Reversing and Four Preset Speeds

6.2.3 External Alarm Reset

		Parameters	
		Function	Setting
		Parameter 5-11 Terminal 19 Digital Input	[1] Reset
		* = Default Value	
		Notes/comments: D IN 37 is an option.	

Table 6.8 External Alarm Reset

6.2.4 RS485

		Parameters	
FC		Function	Setting
+24 V	120	Parameter 8-30	
+24 V	130	Protocol	FC*
D IN	180	Parameter 8-31	1*
D IN	190	Address	
COM	200	Parameter 8-32	9600*
D IN	270	Baud Rate	
D IN	290	* = Default value	
D IN	320	Notes/comments:	
D IN	330	Select protocol, address and Baud rate in the parameters mentioned above.	
D IN	370	D IN 37 is an option.	
+10 V	500		
A IN	530		
A IN	540		
COM	550		
A OUT	420		
COM	390		

Table 6.9 RS485 Network Connection

6.2.5 Motor Thermistor

		Parameters	
VLT		Function	Setting
+24 V	120	Parameter 1-90	[2]
+24 V	130	Motor Thermal Protection	Thermistor trip
D IN	180	Parameter 1-93 T	[1] Analog
D IN	190	hermistor Source	input 53
COM	200	* = Default Value	
D IN	270	Notes/comments:	
D IN	290	If only a warning is desired, parameter 1-90 Motor Thermal Protection should be set to [1] Thermistor warning.	
D IN	320	D IN 37 is an option.	
D IN	330		
D IN	370		
+10 V	500		
A IN	530		
A IN	540		
COM	550		
A OUT	420		
COM	390		

Table 6.10 Motor Thermistor

7 Diagnostics and Troubleshooting

7.1 Status Messages

When the frequency converter is in *Status* mode, status messages are generated automatically and appear in the bottom line of the display (see *Figure 7.1*). Refer to the *VLT® HVAC Drive FC 102 Programming Guide* for detailed descriptions of the displayed status messages.

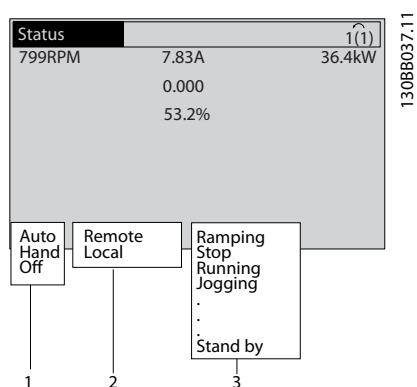


Figure 7.1 Status Display

7.2 Warning and Alarm Types

The adjustable frequency drive monitors the condition of its input power, output, and motor factors as well as other system performance indicators. A warning or alarm does not necessarily indicate a problem internal to the adjustable frequency drive itself. In many cases, it indicates failure conditions from:

- input voltage
- motor load
- motor temperature
- external signals
- other areas monitored by internal logic

Investigate as indicated in the alarm or warning.

7.2.1 Warnings

A warning is issued when an alarm condition is impending or when an abnormal operating condition is present and may result in the adjustable frequency drive issuing an

alarm. A warning clears by itself when the abnormal condition is removed.

7.2.2 Alarm Trip

An alarm is issued when the frequency converter is tripped, that is, the frequency converter suspends operation to prevent frequency converter or system damage. The motor coasts to a stop, if the alarm trip is on the frequency converter side. The frequency converter logic continues to operate and monitors the frequency converter status. After the fault condition is remedied, reset the frequency converter. It is then ready to start operation again.

A trip can be reset in any of 4 ways:

- Press [Reset] on the LCP.
- Digital reset input command.
- Serial communication reset input command.
- Auto reset.

7.2.3 Alarm Trip-lock

An alarm that causes the frequency converter to trip-lock requires that input power is cycled. If the alarm trip is on the frequency converter side, The motor coasts to a stop. The frequency converter logic continues to operate and monitors the frequency converter status. Remove input power to the frequency converter and correct the cause of the fault, then restore power. This action puts the frequency converter into a trip condition as described in *chapter 7.2.2 Alarm Trip* and may be reset in any of the 4 ways.

7.3 Warning and Alarm Definitions for Frequency Converter

The following warning/alarm information defines each warning/alarm condition, provides the probable cause for the condition, and details a remedy or troubleshooting procedure.

WARNING 1, 10 Volts low

The control card voltage is <10 V from terminal 50. Remove some of the load from terminal 50, as the 10 V supply is overloaded. Maximum 15 mA or minimum 590 Ω.

A short circuit in a connected potentiometer or incorrect wiring of the potentiometer can cause this condition.

Troubleshooting

- Remove the wiring from terminal 50. If the warning clears, the problem is with the wiring. If the warning does not clear, replace the control card.

WARNING/ALARM 2, Live zero error

This warning or alarm only appears if programmed in *parameter 6-01 Live Zero Timeout Function*. The signal on one of the analog inputs is less than 50% of the minimum value programmed for that input. Broken wiring or a faulty device sending the signal can cause this condition.

Troubleshooting

- Check the connections on all the analog input terminals.
 - Control card terminals 53 and 54 for signals, terminal 55 common.
 - MCB 101 terminals 11 and 12 for signals, terminal 10 common.
 - MCB 109 terminals 1, 3, 5 for signals, terminals 2, 4, 6 common.
- Check that the adjustable frequency drive programming and switch settings match the analog signal type.
- Perform an input terminal signal test.

WARNING/ALARM 3, No motor

No motor has been connected to the output of the adjustable frequency drive.

WARNING/ALARM 4, Mains phase loss

A phase is missing on the supply side, or the line voltage imbalance is too high. This message also appears for a fault in the input rectifier on the adjustable frequency drive. Options are programmed in *parameter 14-12 Function at Mains Imbalance*.

Troubleshooting

- Check the supply voltage and supply currents to the adjustable frequency drive.

WARNING 5, DC link voltage high

The intermediate circuit voltage (DC) is higher than the high-voltage warning limit. The limit is dependent on the adjustable frequency drive voltage rating. The unit is still active.

WARNING 6, DC link voltage low

The intermediate circuit voltage (DC) is lower than the low-voltage warning limit. The limit is dependent on the adjustable frequency drive voltage rating. The unit is still active.

WARNING/ALARM 7, DC overvoltage

If the intermediate circuit voltage exceeds the limit, the adjustable frequency drive trips after a time.

Troubleshooting

- Connect a brake resistor.
- Extend the ramp time.
- Change the ramp type.
- Activate the functions in *parameter 2-10 Brake Function*.
- Increase *parameter 14-26 Trip Delay at Inverter Fault*.
- If the alarm/warning occurs during a power sag, use kinetic backup (*parameter 14-10 Mains Failure*).

WARNING/ALARM 8, DC undervoltage

If the DC link voltage drops below the undervoltage limit, the adjustable frequency drive checks if a 24 V DC backup supply is connected. If no 24 V DC backup supply is connected, the adjustable frequency drive trips after a fixed time delay. The time delay varies with unit size.

Troubleshooting

- Make sure that the supply voltage matches the adjustable frequency drive voltage.
- Perform an input voltage test.
- Perform a soft charge circuit test.

WARNING/ALARM 9, Inverter overload

The adjustable frequency drive has run with more than 100% overload for too long and is about to cut out. The counter for electronic thermal inverter protection issues a warning at 98% and trips at 100%, while giving an alarm. The adjustable frequency drive cannot be reset until the counter is below 90%.

Troubleshooting

- Compare the output current shown on the LCP with the adjustable frequency drive rated current.
- Compare the output current shown on the LCP with the measured motor current.
- Display the thermal drive load on the LCP and monitor the value. When running above the adjustable frequency drive continuous current rating, the counter increases. When running below the adjustable frequency drive continuous current rating, the counter decreases.

WARNING/ALARM 10, Motor overload temperature

According to the electronic thermal protection (ETR), the motor is too hot. Select whether the adjustable frequency drive issues a warning or an alarm when the counter reaches 100% in *parameter 1-90 Motor Thermal Protection*. The fault occurs when the motor runs with more than 100% overload for too long.

Troubleshooting

- Check for motor overheating.
- Check if the motor is mechanically overloaded.
- Check that the motor current set in *parameter 1-24 Motor Current* is correct.
- Ensure that the motor data in *parameters 1-20 to 1-25* are set correctly.
- If an external fan is in use, check that it is selected in *parameter 1-91 Motor External Fan*.
- Running AMA in *parameter 1-29 Automatic Motor Adaptation (AMA)* tunes the adjustable frequency drive to the motor more accurately and reduces thermal loading.

WARNING/ALARM 11, Motor thermistor overtemp

The thermistor may be disconnected. Select whether the adjustable frequency drive issues a warning or an alarm in *parameter 1-90 Motor Thermal Protection*.

Troubleshooting

- Check for motor overheating.
- Check if the motor is mechanically overloaded.
- Check that the thermistor is connected correctly between either terminal 53 or 54 (analog voltage input) and terminal 50 (+10 V supply). Also check that the terminal switch for 53 or 54 is set for voltage. Check that 1-93 Thermistor Source selects terminal 53 or 54.
- When using digital inputs 18 or 19, check that the thermistor is connected correctly between either terminal 18 or 19 (digital input PNP only) and terminal 50.
- If a KTY sensor is used, check for correct connection between terminals 54 and 55
- If using a thermal switch or thermistor, check that the programming in *1-93 Thermistor Resource* matches sensor wiring.
- If using a KTY Sensor, check the programming of *parameter 1-95 KTY Sensor Type*, *parameter 1-96 KTY Thermistor Resource* and *parameter 1-97 KTY Threshold level* match sensor wiring.

WARNING/ALARM 12, Torque limit

The torque has exceeded the value in *parameter 4-16 Torque Limit Motor Mode* or the value in *parameter 4-17 Torque Limit Generator Mode*. *Parameter 14-25 Trip Delay at Torque Limit* can change this warning from a warning-only condition to a warning followed by an alarm.

Troubleshooting

- If the motor torque limit is exceeded during ramp-up, extend the ramp-up time.
- If the generator torque limit is exceeded during ramp-down, extend the ramp-down time.
- If torque limit occurs while running, increase the torque limit. Make sure that the system can operate safely at a higher torque.
- Check the application for excessive current draw on the motor.

WARNING/ALARM 13, Overcurrent

The inverter peak current limit (approximately 200% of the rated current) is exceeded. The warning lasts approximately 1.5 s, then the adjustable frequency drive trips and issues an alarm. Shock loading or quick acceleration with high-inertia loads can cause this fault. If the acceleration during ramp-up is quick, the fault can also appear after kinetic backup.

If extended mechanical brake control is selected, a trip can be reset externally.

Troubleshooting

- Remove the power and check if the motor shaft can be turned.
- Make sure that the motor size matches the adjustable frequency drive.
- Check that the motor data is correct in *parameters 1-20 to 1-25*.

ALARM 14, Ground fault

There are current from the output phases to ground, either in the cable between the adjustable frequency drive and the motor or in the motor itself.

Troubleshooting

- Remove power to the adjustable frequency drive and repair the ground fault.
- Check for ground faults in the motor by measuring the resistance to the ground of the motor cables and the motor with a megohmmeter.
- Perform current sensor test.

ALARM 15, Hardware mismatch

A fitted option is not operational with the present control board hardware or software.

Record the value of the following parameters and contact Danfoss:

- *Parameter 15-40 FC Type*
- *Parameter 15-41 Power Section*
- *Parameter 15-42 Voltage*
- *Parameter 15-43 Software Version*

- *Parameter 15-45 Actual Typecode String*
- *Parameter 15-49 SW ID Control Card*
- *Parameter 15-50 SW ID Power Card*
- *Parameter 15-60 Option Mounted*
- *Parameter 15-61 Option SW Version (for each option slot)*

ALARM 16, Short circuit

There is short-circuiting in the motor or motor wiring.

Troubleshooting

- Remove the power to the adjustable frequency drive and repair the short circuit.

WARNING/ALARM 17, Control word timeout

There is no communication to the adjustable frequency drive.

The warning is only active when *parameter 8-04 Control Timeout Function* is not set to [0] Off.

If *parameter 8-04 Control Timeout Function* is set to [2] Stop and [26] Trip, a warning appears and the adjustable frequency drive ramps down until it trips then displays an alarm.

Troubleshooting:

- Check connections on the serial communication cable.
- Increase *parameter 8-03 Control Timeout Time*
- Check the operation of the communication equipment.
- Verify a proper installation based on EMC requirements.

WARNING/ALARM 22, Hoist mechanical brake

Report value shows what kind it is.

0 = The torque reference was not reached before timeout (*parameter 2-27 Torque Ramp Up Time*).

1 = Expected brake feedback not received before timeout (*parameter 2-23 Activate Brake Delay, parameter 2-25 Brake Release Time*).

WARNING 23, Internal fan fault

The fan warning function is an extra protective function that checks if the fan is running/mounted. The fan warning can be disabled in *parameter 14-53 Fan Monitor ([0] Disabled)*.

Troubleshooting

- Check fan resistance.
- Check soft charge fuses.

WARNING 24, External fan fault

The fan warning function is an extra protective function that checks if the fan is running/mounted. The fan warning can be disabled in *parameter 14-53 Fan Monitor ([0] Disabled)*.

Troubleshooting

- Check fan resistance.
- Check soft charge fuses.

WARNING 25, Brake resistor short circuit

The brake resistor is monitored during operation. If a short circuit occurs, the brake function is disabled and the warning appears. The adjustable frequency drive is still operational but without the brake function.

Troubleshooting

- Remove the power to the adjustable frequency drive and replace the brake resistor (see *parameter 2-15 Brake Check*).

WARNING/ALARM 26, Brake resistor power limit

The power transmitted to the brake resistor is calculated as a mean value over the last 120 s of run time. The calculation is based on the intermediate circuit voltage and the brake resistance value set in *parameter 2-16 AC Brake Max. Current*. The warning is active when the dissipated braking energy is higher than 90% of the brake resistance power. If [2] Trip is selected in *parameter 2-13 Brake Power Monitoring*, the adjustable frequency drive trips when the dissipated braking energy reaches 100%.

⚠ WARNING

If the brake transistor is short-circuited, there is a risk of substantial power being transmitted to the brake resistor.

WARNING/ALARM 27, Brake chopper fault

This alarm/warning could occur if the brake resistor overheats. Terminals 104 and 106 are available as brake resistors Klixon inputs.

NOTICE!

This signal feedback is used by LHD to monitor the temperature of the HI inductor. This fault indicates that Klixon opened on the HI inductor at the active filter side.

WARNING/ALARM 28, Brake check failed

The brake resistor is not connected or not working. Check *parameter 2-15 Brake Check*.

ALARM 29, Heatsink temp

The maximum temperature of the heatsink has been exceeded. The temperature fault resets when the temperature falls below a defined heatsink temperature. The trip and reset points are different based on the adjustable frequency drive power size.

Troubleshooting

Check for the following conditions.

- Ambient temperature too high.
- Motor cables too long.

- Incorrect airflow clearance above and below the adjustable frequency drive
- Blocked airflow around the adjustable frequency drive.
- Damaged heatsink fan.
- Dirty heatsink.

For the D, E, and F enclosures, this alarm is based on the temperature measured by the heatsink sensor mounted inside the IGBT modules. For the F enclosures, the thermal sensor in the rectifier module can also cause this alarm.

Troubleshooting

- Check fan resistance.
- Check soft charge fuses.
- IGBT thermal sensor.

ALARM 30, Motor phase U missing

Motor phase U between the adjustable frequency drive and the motor is missing.

Troubleshooting

- Remove the power from the adjustable frequency drive and check motor phase U.

ALARM 31, Motor phase V missing

Motor phase V between the adjustable frequency drive and the motor is missing.

Troubleshooting

- Remove the power from the adjustable frequency drive and check motor phase V.

ALARM 32, Motor phase W missing

Motor phase W between the adjustable frequency drive and the motor is missing.

Troubleshooting

- Remove the power from the adjustable frequency drive and check motor phase W.

ALARM 33, Inrush fault

Too many power-ups have occurred within a short time period.

Troubleshooting

- Let the unit cool to operating temperature.

WARNING/ALARM 34, Fieldbus communication fault

The serial communication bus on the communication option card is not working.

WARNING/ALARM 36, Mains failure

This warning/alarm is only active if the supply voltage to the adjustable frequency drive is lost and *parameter 14-10 Mains Failure* is not set to option [0] *No Function*. Check the fuses to the adjustable frequency drive and line power supply to the unit.

ALARM 38, Internal fault

When an internal fault occurs, a code number defined in *Table 7.1* is displayed.

Troubleshooting

- Cycle power
- Check that the option is properly installed
- Check for loose or missing wiring

It may be necessary to contact Danfoss service or the supplier. Note the code number for further troubleshooting directions.

No.	Text
0	Serial port cannot be initialized. Contact your Danfoss supplier or Danfoss Service Department.
256–258	Power EEPROM data is defective or too old
512	Control board EEPROM data is defective or too old.
513	Communication timeout reading EEPROM data
514	Communication timeout reading EEPROM data
515	Application-oriented control cannot recognize the EEPROM data.
516	Cannot write to the EEPROM because a write command is on progress.
517	Write command is under timeout
518	Failure in the EEPROM
519	Missing or invalid barcode data in EEPROM
783	Parameter value outside of min/max limits
1024–1279	A CAN message that has to be sent could not be sent.
1281	Digital signal processor flash timeout
1282	Power micro software version mismatch
1283	Power EEPROM data version mismatch
1284	Cannot read digital signal processor software version
1299	Option SW in slot A is too old
1300	Option SW in slot B is too old
1301	Option SW in slot C0 is too old
1302	Option SW in slot C1 is too old
1315	Option SW in slot A is not supported (not allowed)
1316	Option SW in slot B is not supported (not allowed)
1317	Option SW in slot C0 is not supported (not allowed)
1318	Option SW in slot C1 is not supported (not allowed)
1379	Option A did not respond when calculating platform version
1380	Option B did not respond when calculating platform version
1381	Option C0 did not respond when calculating platform version.
1382	Option C1 did not respond when calculating platform version.

No.	Text
1536	An exception in the application-oriented control is registered. Debug information written in LCP.
1792	DSP Watch Dog is active. Debugging of power part data, motor-oriented control data not transferred correctly.
2049	Power data restarted
2064–2072	H081x: Option in slot x has restarted
2080–2088	H082x: Option in slot x has issued a power-up wait
2096–2104	H983x: Option in slot x has issued a legal power-up wait
2304	Could not read any data from power EEPROM
2305	Missing SW version from power unit
2314	Missing power unit data from power unit
2315	Missing SW version from power unit
2316	Missing lo_statepage from power unit
2324	Power card configuration is determined to be incorrect at power-up
2325	A power card has stopped communicating while line power is applied
2326	Power card configuration is determined to be incorrect after the delay for power cards to register.
2327	Too many power card locations have been registered as present.
2330	Power size information between the power cards does not match.
2561	No communication from DSP to ATACD
2562	No communication from ATACD to DSP (state running)
2816	Stack overflow control board module
2817	Scheduler slow tasks
2818	Fast tasks
2819	Parameter thread
2820	LCP stack overflow
2821	Serial port overflow
2822	USB port overflow
2836	cflistMempool too small
3072–5122	Parameter value is outside its limits
5123	Option in slot A: Hardware incompatible with control board hardware
5124	Option in slot B: Hardware incompatible with control board hardware.
5125	Option in slot C0: Hardware incompatible with control board hardware.
5126	Option in slot C1: Hardware incompatible with control board hardware.
5376–6231	Out of memory

Table 7.1 Internal Fault, Code Numbers

ALARM 39, Heatsink sensor

No feedback from the heatsink temperature sensor.

The signal from the IGBT thermal sensor is not available on the power card. The problem could be on the power card, on the gate drive card, or the ribbon cable between the power card and gate drive card.

WARNING 40, Overload of digital output terminal 27

Check the load connected to terminal 27 or remove the short-circuit connection. Check *parameter 5-00 Digital I/O Mode* and *parameter 5-01 Terminal 27 Mode*.

WARNING 41, Overload of digital output terminal 29

Check the load connected to terminal 29 or remove the short-circuit connection. Check *parameter 5-00 Digital I/O Mode* and *parameter 5-02 Terminal 29 Mode*.

WARNING 42, Overload of digital output on X30/6 or overload of digital output on X30/7

For X30/6, check the load connected to X30/6 or remove the short-circuit connection. Check *parameter 5-32 Term X30/6 Digi Out (MCB 101)*.

For X30/7, check the load connected to X30/7 or remove the short-circuit connection. Check *parameter 5-33 Term X30/7 Digi Out (MCB 101)*.

ALARM 45, Ground fault 2

Ground fault.

Troubleshooting

- Check for proper grounding and loose connections.
- Check for proper wire size.
- Check the motor cables for short circuits or leakage currents.

ALARM 46, Power card supply

The supply on the power card is out of range.

There are three power supplies generated by the switch mode power supply (SMPS) on the power card: 24 V, 5 V, ±18 V. When powered with 24 V DC with the MCB 107 option, only the 24 V and 5 V supplies are monitored. When powered with three phase AC line voltage, all three supplies are monitored.

WARNING 47, 24 V supply low

The 24 V DC is measured on the control card. This alarm appears when the detected voltage of terminal 12 is <18 V.

Troubleshooting

- Check for a defective control card.

WARNING 48, 1.8 V supply low

The 1.8 V DC supply used on the control card is outside of the allowable limits. The power supply is measured on the control card. Check for a defective control card. If an option card is present, check for overvoltage.

WARNING 49, Speed limit

When the speed is outside of the specified range in *parameter 4-11 Motor Speed Low Limit [RPM]* and *parameter 4-13 Motor Speed High Limit [RPM]*, the adjustable frequency drive shows a warning. When the speed is below the specified limit in *parameter 1-86 Trip Speed Low [RPM]* (except when starting or stopping), the adjustable frequency drive trips.

ALARM 50, AMA calibration failed

Contact the Danfoss supplier or Danfoss Service.

ALARM 51, AMA check U_{nom} and I_{nom}

The settings for motor voltage, motor current and motor power are wrong. Check the settings in *parameters 1-20 to 1-25*.

ALARM 52, AMA low I_{nom}

The motor current is too low. Check the settings in *parameter 4-18 Current Limit*.

ALARM 53, AMA motor too big

The motor is too big for the AMA to operate.

ALARM 54, AMA motor too small

The motor is too small for the AMA to operate.

ALARM 55, AMA parameter out of range

The parameter values of the motor are outside of the acceptable range. AMA cannot run.

ALARM 56, AMA interrupted by user

The user has interrupted AMA.

ALARM 57, AMA internal fault

Try to restart AMA again a number of times until the AMA is carried out.

NOTICE!

Repeated runs may heat the motor to a level where the resistance R_s and R_r are increased. In most cases, however, this behavior is not critical.

ALARM 58, AMA Internal fault

Contact the Danfoss supplier.

WARNING 59, Current limit

The current is higher than the value in *parameter 4-18 Current Limit*. Ensure that motor data in *parameters 1-20 to 1-25* are set correctly. Increase the current limit if necessary. Ensure that the system can operate safely at a higher limit.

WARNING 60, External interlock

External interlock has been activated. To resume normal operation, apply 24 V DC to the terminal programmed for external interlock and reset the adjustable frequency drive (via serial communication, digital I/O, or by pressing [Reset]).

WARNING/ALARM 61, Tracking error

An error between calculated motor speed and speed measurement from feedback device. The function warning/ alarm/disable is set in *parameter 4-30 Motor Feedback Loss Function*. Accepted error setting in *parameter 4-31 Motor Feedback Speed Error* and the allowed time the error occur setting in *parameter 4-32 Motor Feedback Loss Timeout*. During a commissioning procedure, the function could be effective.

WARNING 62, Output frequency at maximum limit

The output frequency is higher than the value set in *parameter 4-19 Max Output Frequency*.

ALARM 63, Mechanical brake low

The actual motor current has not exceeded the release brake current within the start delay time window.

ALARM 64, Voltage Limit

The load and speed combination demands a motor voltage higher than the actual DC link voltage.

WARNING/ALARM 65, Control card overtemperature

The cut-out temperature of the control card is 176°F [80°C].

Troubleshooting

- Check that the ambient operating temperature is within the limits.
- Check for clogged filters.
- Check the fan operation.
- Check the control card.

WARNING 66, Heatsink temperature low

The adjustable frequency drive is too cold to operate. This warning is based on the temperature sensor in the IGBT module.

Increase the ambient temperature of the unit. Also, a trickle amount of current can be supplied to the adjustable frequency drive whenever the motor is stopped by setting *parameter 2-00 DC Hold/Preheat Current* at 5% and *parameter 1-80 Function at Stop*

Troubleshooting

The heatsink temperature measured as 32°F [0°C] could indicate that the temperature sensor is defective, causing the fan speed to increase to the maximum. If the sensor wire between the IGBT and the gate drive card is disconnected, this warning would result. Also, check the IGBT thermal sensor.

ALARM 67, Option module configuration has changed

One or more options have either been added or removed since the last power-down. Check that the configuration change is intentional and reset the unit.

ALARM 68, Safe Stop activated

Safe Torque Off has been activated. To resume normal operation, apply 24 V DC to terminal 37, then send a reset signal (via bus, digital I/O, or by pressing [Reset]).

ALARM 69, Power card temperature

The temperature sensor on the power card is either too hot or too cold.

Troubleshooting

- Check the operation of the door fans.
- Make sure that the filters for the door fans are not blocked.
- Check that the connector plate is properly installed on IP21/IP 54 (NEMA 1/12) adjustable frequency drives.

ALARM 70, Illegal FC configuration

The control card and power card are incompatible. To check compatibility, contact the Danfoss supplier with the type code of the unit from the nameplate and the part numbers of the cards.

ALARM 71, PTC 1 Safe Torque Off

Safe torque has been activated from the MCB 112 PTC Thermistor Card (motor too warm). Normal operation can resume when the MCB 112 applies 24 V DC to T-37 (when the motor temperature is acceptable) and when the digital input from the MCB 112 is deactivated. When that happens, a reset signal must be sent (via Bus, Digital I/O, or by pressing [Reset]). Note that if automatic restart is enabled, the motor could start when the fault is cleared.

ALARM 72, Dangerous failure

Safe Torque Off with trip lock. Unexpected signal levels on safe stop and digital input from the MCB 112 PTC thermistor card.

WARNING 73, Safe Stop auto restart

Safe stopped. With automatic restart enabled, the motor can start when the fault is cleared.

WARNING 76, Power unit set-up

The required number of power units does not match the detected number of active power units.

Troubleshooting

When replacing an F-frame module, this warning occurs, if the power-specific data in the module power card does not match the rest of the adjustable frequency drive. Confirm that the spare part and its power card are the correct part number.

WARNING 77, Reduced power mode

The adjustable frequency drive is operating in reduced power mode (less than the allowed number of inverter sections). This warning is generated on power cycle when the adjustable frequency drive is set to run with fewer inverters and remains on.

ALARM 79, Illegal power section configuration

The scaling card has an incorrect part number or is not installed. The MK102 connector on the power card could not be installed.

ALARM 80, Drive initialized to default value

Parameter settings are initialized to default settings after a manual reset. To clear the alarm, reset the unit.

ALARM 81, CSIV corrupt

CSIV file has syntax errors.

ALARM 82, CSIV parameter error

CSIV failed to initialize a parameter.

ALARM 85, Dang fail PB

Profibus/Profisafe error.

WARNING/ALARM 104, Mixing fan fault

The fan is not operating. The fan monitor checks that the fan is spinning at power-up or whenever the mixing fan is turned on. The mixing fan fault can be configured as a warning or an alarm trip in *parameter 14-53 Fan Monitor*.

Troubleshooting

- Cycle power to the adjustable frequency drive to determine if the warning/alarm returns.

ALARM 243, Brake IGBT

This alarm is only for F-frame adjustable frequency drives. It is equivalent to Alarm 27. The report value in the alarm log indicates which power module generated the alarm:

- 1 = left most inverter module.
- 2 = middle inverter module in F12 or F3 frame sizes.
- 2 = right inverter module in F10 or F11 frame sizes.
- 2 = second adjustable frequency drive from the left inverter module in F14 frame size.
- 3 = right inverter module in F12 or F13 frame sizes.
- 3 = third from the left inverter module in F14 frame size.
- 4 = far right inverter module in F14 frame size.
- 5 = rectifier module.
- 6 = right rectifier module in F14 frame size.

ALARM 244, Heatsink temperature

This alarm is only for F-frame adjustable frequency drives. It is equivalent to Alarm 29. The report value in the alarm log indicates which power module generated the alarm.

- 1 = left most inverter module.
- 2 = middle inverter module in F12 or F3 frame sizes.
- 2 = right inverter module in F10 or F11 frame sizes.
- 2 = second adjustable frequency drive from the left inverter module in F14 frame size.

3 = right inverter module in F12 or F13 frame sizes.

3 = third from the left inverter module in F14 frame size.

4 = far right inverter module in F14 frame size.

5 = rectifier module.

6 = right rectifier module in F14 frame size.

ALARM 245, Heatsink sensor

This alarm is only for F-frame adjustable frequency drives. It is equivalent to Alarm 39. The report value in the alarm log indicates which power module generated the alarm.

1 = left most inverter module.

2 = middle inverter module in F12 or F13 frame sizes.

2 = right inverter module in F10 or F11 frame sizes.

2 = second adjustable frequency drive from the left inverter module in F14 frame size.

3 = right inverter module in F12 or F13 frame sizes.

3 = third from the left inverter module in F14 frame size.

4 = far right inverter module in F14 frame size.

5 = rectifier module.

6 = right rectifier module in F14 frame size.

ALARM 246, Power card supply

This alarm is only for F-frame adjustable frequency drive. It is equivalent to Alarm 46. The report value in the alarm log indicates which power module generated the alarm.

1 = left most inverter module.

2 = middle inverter module in F12 or F13 frame sizes.

2 = right inverter module in F10 or F11 frame sizes.

2 = second adjustable frequency drive from the left inverter module in F14 frame size.

3 = right inverter module in F12 or F13 frame sizes.

3 = third from the left inverter module in F14 frame size.

4 = far right inverter module in F14 frame size.

5 = rectifier module.

6 = right rectifier module in F14 frame size.

ALARM 247, Power card temperature

This alarm is only for F-frame adjustable frequency drives. It is equivalent to Alarm 69. The report value in the alarm log indicates which power module generated the alarm.

1 = left most inverter module.

2 = middle inverter module in F12 or F13 frame sizes.

2 = right inverter module in F10 or F11 frame sizes.

2 = second adjustable frequency drive from the left inverter module in F14 frame size.

3 = right inverter module in F12 or F13 frame sizes.

3 = third from the left inverter module in F14 frame size.

4 = far right inverter module in F14 frame size.

5 = rectifier module.

6 = right rectifier module in F14 frame size.

ALARM 248, Illegal power section configuration

This alarm is only for F-frame adjustable frequency drives. It is equivalent to Alarm 79. The report value in the alarm log indicates which power module generated the alarm:

1 = left most inverter module.

2 = middle inverter module in F12 or F13 frame sizes.

2 = right inverter module in F10 or F11 frame sizes.

2 = second adjustable frequency drive from the left inverter module in F14 frame size.

3 = right inverter module in F12 or F13 frame sizes.

3 = third from the left inverter module in F14 frame size.

4 = far right inverter module in F14 frame size.

5 = rectifier module.

6 = right rectifier module in F14 frame size.

WARNING 250, New spare part

A component in the adjustable frequency drive has been replaced.

Troubleshooting

- Reset the adjustable frequency drive for normal operation.

WARNING 251, New typecode

The power card or other components have been replaced and the type code has been changed.

Troubleshooting

- Reset to remove the warning and resume normal operation.

7.4 Warnings and Alarm Definitions - Active Filter

NOTICE!

This section covers warnings and alarms on the filter side LCP. For warning and alarms for the adjustable frequency drive, see

A warning or an alarm is signaled by the relevant LED on the front of the filter and indicated by a code on the display.

A warning remains active until its cause is no longer present. Under certain circumstances, operation of the unit may still be continued. Warning messages may be critical, but are not necessarily so.

In the event of an alarm, the unit will have tripped. Alarms must be reset to restart operation once their cause has been rectified.

This may be done in four ways:

1. By pressing [Reset].
2. Via a digital input with the "Reset" function.
3. Via serial communication/optional serial communication bus.
4. By resetting automatically using the [Auto Reset] function.

NOTICE!

After a manual reset pressing [Reset], press [Auto On] or [Hand On] to restart the unit.

If an alarm cannot be reset, the reason may be that its cause has not been rectified, or the alarm is trip-locked (see also *Table 7.2*).

Alarms that are trip-locked offer additional protection, meaning that the line power supply must be switched off before the alarm can be reset. After being switched back on, the unit is no longer blocked and may be reset as described above once the cause has been rectified.

Alarms that are not trip-locked can also be reset using the automatic reset function in *parameter 14-20 Reset Mode* (Warning: automatic wake-up is possible).

If a warning and alarm is marked against a code in *Table 7.2*, either a warning occurs before an alarm, or it can be specified whether it is a warning or an alarm that is to be displayed for a given fault.

No.	Description	Warning	Alarm/Trip	Alarm/Trip Lock	Parameter Reference
1	10 Volts low	X			
2	Live zero error	(X)	(X)		6-01
4	Mains phase loss	X			
5	DC link voltage high	X			
6	DC link voltage low	X			
7	DC overvoltage	X	X		
8	DC undervoltage	X	X		
13	Overcurrent	X	X	X	
14	Ground fault	X	X	X	
15	Hardware mismatch		X	X	
16	Short-circuit		X	X	
17	Control word timeout	(X)	(X)		8-04

No.	Description	Warning	Alarm/Trip	Alarm/Trip Lock	Parameter Reference
23	Internal fan fault	X			
24	External fan fault	X			14-53
29	Heatsink temp	X	X	X	
33	Inrush fault		X	X	
34	Fieldbus fault	X	X		
35	Option fault	X	X		
38	Internal fault				
39	Heatsink sensor		X	X	
40	Overload of digital output terminal 27	(X)			5-00, 5-01
41	Overload of digital output terminal 29	(X)			5-00, 5-02
46	Pwr. card supply		X	X	
47	24 V supply low	X	X	X	
48	1.8 V supply low		X	X	
65	Control board overtemperature	X	X	X	
66	Heatsink temperature low	X			
67	Option configuration has changed		X		
68	Safe torque off activated		X ¹⁾		
69	Pwr. card temp		X	X	
70	Illegal FC configuration			X	
72	Dang. failure			X ¹⁾	
73	Safe torque off auto restart				
76	Power unit set-up	X			
79	Illegal PS config		X	X	
80	Unit initialized to default value		X		
244	Heatsink temp	X	X	X	
245	Heatsink sensor		X	X	
246	Pwr.card supply		X	X	
247	Pwr.card temp		X	X	
248	Illegal PS config		X	X	
250	New spare part			X	
251	New type code		X	X	
300	Mains cont. fault	X			
301	SC cont. fault	X			
302	Cap. overcurrent	X	X		
303	Cap. ground fault	X	X		
304	DC overcurrent	X	X		
305	Mains freq. limit		X		
308	Resistor temp	X		X	
309	Power ground fault	X	X		
311	Switch. freq. limit		X		
312	CT range		X		
314	Auto CT interrupt		X		
315	Auto CT error		X		
316	CT location error	X			
317	CT polarity error	X			
318	CT ratio error	X			

Table 7.2 Alarm/Warning Code List

A trip is the action when an alarm has appeared. The trip coasts the motor and can be reset by pressing [Reset] or make a reset by a digital input (parameter group 5-1* *Digital Inputs [1] Reset*). The original event that caused an alarm cannot

damage the adjustable frequency drive or cause dangerous conditions. A trip lock is an action that occurs in conjunction with an alarm, which may cause damage to the adjustable frequency drive or connected parts. A trip lock situation can only be reset by power cycling.

LED indication	
Warning	yellow
Alarm	flashing red
Trip locked	yellow and red

Table 7.3 LED Indicator Lights

Alarm Word and Extended Status Word					
Bit	Hex	Dec	Alarm Word	Warning Word	Extended Status Word
0	00000001	1	Mains cont. fault	Reserved	Reserved
1	00000002	2	Heatsink temp	Heatsink temp	Auto CT running
2	00000004	4	Ground fault	Ground fault	Reserved
3	00000008	8	Ctrl.card temp	Ctrl.card temp	Reserved
4	00000010	16	Ctrl. word TO	Ctrl. word TO	Reserved
5	00000020	32	Overcurrent	Overcurrent	Reserved
6	00000040	64	SC cont. fault	Reserved	Reserved
7	00000080	128	Cap. overcurrent	Cap. overcurrent	Reserved
8	00000100	256	Cap. ground fault	Cap. ground fault	Reserved
9	00000200	512	Inverter overld.	Inverter overld.	Reserved
10	00000400	1024	DC under volt	DC under volt	Reserved
11	00000800	2048	DC overvolt	DC overvolt	Reserved
12	00001000	4096	Short-circuit	DC voltage low	Reserved
13	00002000	8192	Inrush fault	DC voltage high	Reserved
14	00004000	16384	Mains ph. loss	Mains ph. loss	Reserved
15	00008000	32768	Auto CT error	Reserved	Reserved
16	00010000	65536	Reserved	Reserved	Reserved
17	00020000	131072	Internal fault	10 V low	Password Time Lock
18	00040000	262144	DC overcurrent	DC overcurrent	Password Protection
19	00080000	524288	Resistor temp	Resistor temp	Reserved
20	00100000	1048576	Power ground fault	Power ground fault	Reserved
21	00200000	2097152	Switch. freq. limit	Reserved	Reserved
22	00400000	4194304	Fieldbus fault	Fieldbus fault	Reserved
23	00800000	8388608	24 V supply low	24 V supply low	Reserved
24	01000000	16777216	CT range	Reserved	Reserved
25	02000000	33554432	1.8 V supply low	Reserved	Reserved
26	04000000	67108864	Reserved	Low temp	Reserved
27	08000000	134217728	Auto CT interrupt	Reserved	Reserved
28	10000000	268435456	Option change	Reserved	Reserved
29	20000000	536870912	Unit initialized	Unit initialized	Reserved
30	40000000	1073741824	Safe torque off	Safe torque off	Reserved
31	80000000	2147483648	Mains freq. limit	Extended status word	Reserved

Table 7.4 Description of Alarm Word, Warning Word and Extended Status Word

The alarm words, warning words and extended status words can be read out via serial bus or optional serial communication bus for diagnosis. See also *parameter 16-90 Alarm Word*, *parameter 16-92 Warning Word* and *parameter 16-94 Ext. Status Word*. "Reserved" means that the bit is not guaranteed to be any particular value. Reserved bits should not be used for any purpose.

7.4.1 Fault Messages - Active Filter

WARNING 1, 10 volts low

The control card voltage is below 10 V from terminal 50. Remove some of the load from terminal 50, as the 10 V supply is overloaded. Max. 15 mA or minimum 590 Ω. Fault messages - active filter

WARNING/ALARM 2, Live zero error

The signal on terminal 53 or 54 is less than 50% of the value set in parameters 6-10, 6-12, 6-20 or 6-22.

WARNING 4, Mains phase loss

A phase is missing on the supply side, or the line voltage imbalance is too high.

WARNING 5, DC link voltage high

The intermediate circuit voltage (DC) is higher than the high voltage warning limit. The unit is still active.

WARNING 6, DC link voltage low

The intermediate circuit voltage (DC) is below the undervoltage limit of the control system. The unit is still active.

WARNING/ALARM 7, DC overvoltage

If the intermediate circuit voltage exceeds the limit, the unit trips.

WARNING/ALARM 8, DC undervoltage

If the intermediate circuit voltage (DC) drops below the under voltage limit, the filter checks if a 24 V backup supply is connected. If not, the unit trips. Make sure the AC line voltage matches the nameplate specification.

WARNING/ALARM 13, Overcurrent

the unit current limit has been exceeded.

ALARM 14, Ground fault

The sum current of the IGBT CTs does not equal zero. Check if the resistance of any phase to ground has a low value. Check both before and after line power contactor. Ensure IGBT current transducers, connection cables, and connectors are ok.

ALARM 15, Incomp. Hardware

A mounted option is incompatible with the present control card SW/HW.

ALARM 16, Short-circuit

There is a short-circuit in the output. Turn off the unit and correct the error.

WARNING/ALARM 17, Control word timeout

There is no communication to the unit.

The warning is only active when *parameter 8-04 Control Timeout Function* is not set to off.

Possible correction: Increase *parameter 8-03 Control Timeout Time*. Change *parameter 8-04 Control Timeout Function*

WARNING 23, Internal fan fault

Internal fans have failed due to defect hardware or fans not mounted.

WARNING 24, External fan fault

External fans have failed due to defect hardware or fans not mounted.

ALARM 29, Heatsink temp

The maximum temperature of the heatsink has been exceeded. The temperature fault is not reset until the temperature falls below a defined heatsink temperature.

ALARM 33, Inrush fault

Check whether a 24 V external DC supply has been connected.

WARNING/ALARM 34, Fieldbus communication fault

The serial communication bus on the communication option card is not working.

WARNING/ALARM 35, Option Fault:

Contact Danfoss or supplier.

ALARM 38, Internal fault

Contact Danfoss or supplier.

ALARM 39, Heatsink sensor

No feedback from the heatsink temperature sensor.

WARNING 40, Overload of Digital Output Terminal 27

Check the load connected to terminal 27 or remove short-circuit connection.

WARNING 41, Overload of Digital Output Terminal 29

Check the load connected to terminal 29 or remove short-circuit connection.

WARNING 43, Ext. Supply (option)

The external 24 V DC supply voltage on the option is not valid.

ALARM 46, Power card supply

The supply on the power card is out of range.

WARNING 47, 24 V supply low

Contact Danfoss or supplier.

WARNING 48, 1.8 V supply low

Contact Danfoss or supplier.

WARNING/ALARM/TRIP 65, Control card overtemperature

Control card overtemperature: The cutout temperature of the control card is 176°F [80°C].

WARNING 66, Heatsink temperature low

This warning is based on the temperature sensor in the IGBT module.

Troubleshooting:

The heatsink temperature measured as 32°F [0°C] could indicate that the temperature sensor is defective, causing the fan speed to increase to the maximum. If the sensor wire between the IGBT and the gate drive card is discon-

nected, this warning would result. Also, check the IGBT thermal sensor.

ALARM 67, Option module configuration has changed

One or more options have either been added or removed since the last power-down.

ALARM 68, Safe Torque Off activated

Safe Torque Off has been activated. To resume normal operation, apply 24 V DC to terminal 37, then send a reset signal (via bus, digital I/O, or by pressing [Reset]). See *parameter 5-19 Terminal 37 Digital Input*.

ALARM 69, Power card temperature

The temperature sensor on the power card is either too hot or too cold.

ALARM 70, Illegal FC Configuration

Actual combination of control board and power board is illegal.

WARNING 73, Safe Torque Off auto restart

Safe stopped. Note that with automatic restart enabled, the motor can start when the fault is cleared.

ALARM 79, Illegal power section configuration

The scaling card is the incorrect part number or not installed. Also MK102 connector on the power card could not be installed.

ALARM 80, Unit initialized to default value

Parameter settings are initialized to default settings after a manual reset.

ALARM 244, Heatsink temperature

Report value indicates source of alarm (from left):

1-4 inverter

5-8 rectifier

ALARM 245, Heatsink sensor

No feedback from the heatsink sensor. Report value indicates source of alarm (from left):

1-4 inverter

5-8 rectifier

ALARM 246, Power card supply

The supply on the power card is out of range. Report value indicates source of alarm (from left):

1-4 inverter

5-8 rectifier

ALARM 247, Power card temperature

Power card overtemperature. Report value indicates source of alarm (from left):

1-4 inverter

5-8 rectifier

ALARM 248, Illegal power section configuration

Power size configuration fault on the power card. Report value indicates source of alarm (from left):

1-4 inverter

5-8 rectifier

ALARM 250, New spare part

The power or switch mode power supply has been exchanged. The filter type code must be restored in the EEPROM. Select the correct type code in *parameter 14-23 Typecode Setting* according to the label on the unit. Remember to select 'Save to EEPROM' to complete.

ALARM 251, New type code

The filter has a new type code.

ALARM 300, Mains Cont. Fault

The feedback from the line power contactor did not match the expected value within the allowed time frame. Contact Danfoss or supplier.

ALARM 301, SC Cont. Fault

The feedback from the soft charge contactor did not match the expected value within the allowed time frame. Contact Danfoss or supplier.

ALARM 302, Cap. Overcurrent

Excessive current was detected through the AC capacitors. Contact Danfoss or supplier.

ALARM 303, Cap. Ground Fault

A ground fault was detected through the AC capacitor currents. Contact Danfoss or supplier.

ALARM 304, DC Overcurrent

Excessive current through the DC link capacitor bank was detected. Contact Danfoss or supplier.

ALARM 305, Line Power Freq. Limit

The line power frequency was outside the limits. Verify that the line power frequency is within product specification.

ALARM 306, Compensation Limit

The needed compensation current exceeds unit capability. Unit is running at full compensation.

ALARM 308, Resistor temp

Excessive resistor heatsink temperature detected.

ALARM 309, Mains Earth Fault

A ground fault was detected in the line power currents. Check the line power for shorts and leakage current.

ALARM 310, RTDC Buffer Full

Contact Danfoss or supplier.

ALARM 311, Switch. Freq. Limit

The average switching frequency of the unit exceeded the limit. Verify that *parameter 300-10 Active Filter Nominal Voltage* and *parameter 300-22 CT Nominal Voltage* are set correctly. If so, contact Danfoss or supplier.

ALARM 312, CT Range

Current transformer measurement limitation was detected. Verify that the CTs used are an appropriate ratio.

ALARM 314, Auto CT Interrupt

Auto CT detection has been interrupted.

ALARM 315, Auto CT Error

An error was detected while performing auto CT detection. Contact Danfoss or supplier.

WARNING 316, CT Location Error

The auto CT function could not determine the correct locations of the CTs.

WARNING 317, CT Polarity Error

The auto CT function could not determine the correct polarity of the CTs.

WARNING 318, CT Ratio Error

The auto CT function could not determine the correct primary rating of the CTs.

7.5 Troubleshooting

Symptom	Possible cause	Test	Solution
Display dark/No function	Missing input power	See <i>Table 5.1</i>	Check the input power source
	Missing or open fuses or circuit breaker tripped	See open fuses and tripped circuit breaker in this table for possible causes	Follow the recommendations provided
	No power to the LCP	Check the LCP cable for proper connection or damage	Replace the faulty LCP or connection cable
	Shortcut on control voltage (terminal 12 or 50) or at control terminals	Check the 24 V control voltage supply for terminals 12/13 to 20-39 or 10 V supply for terminals 50 to 55	Wire the terminals properly
	Wrong LCP (LCP from VLT [®] 2800 or 5000/6000/8000/ FCD or FCM)		Use only LCP 101 (P/N 130B1124) or LCP 102 (P/N 130B1107)
	Wrong contrast setting		Press [Status] + [▲]/[▼] to adjust the contrast
	Display (LCP) is defective	Test using a different LCP	Replace the faulty LCP or connection cable
	Internal voltage supply fault or SMPS is defective		Contact supplier
Intermittent display	Overloaded power supply (SMPS) due to improper control wiring or a fault within the adjustable frequency drive	To rule out a problem in the control wiring, disconnect all control wiring by removing the terminal blocks.	If the display stays lit, then the problem is in the control wiring. Check the wiring for shorts or incorrect connections. If the display continues to cut out, follow the procedure for display dark.

Symptom	Possible cause	Test	Solution
Motor not running	Service switch open or missing motor connection	Check if the motor is connected and the connection is not interrupted (by a service switch or other device).	Connect the motor and check the service switch.
	No line power with 24 V DC option card	If the display is functioning but no output, check that line power is applied to the adjustable frequency drive.	Apply line power to run the unit.
	LCP Stop	Check if [Off] has been pressed	Press [Auto On] or [Hand On] (depending on operation mode) to run the motor
	Missing start signal (Standby)	Check <i>parameter 5-10 Terminal 18 Digital Input</i> for correct setting for terminal 18 (use default setting)	Apply a valid start signal to start the motor
	Motor coast signal active (Coasting)	Check <i>5-12 Coast inv.</i> for correct setting for terminal 27 (use default setting).	Apply 24 V on terminal 27 or program this terminal to <i>no operation</i>
	Wrong reference signal source	Check reference signal: Local, remote or bus reference? Preset reference active? Terminal connection correct? Scaling of terminals correct? Reference signal available?	Program correct settings. Check <i>parameter 3-13 Reference Site</i> . Set preset reference active in parameter group <i>3-1* References</i> . Check for correct wiring. Check scaling of terminals. Check reference signal.
Motor running in wrong direction	Motor rotation limit	Check that <i>parameter 4-10 Motor Speed Direction</i> is programmed correctly.	Program correct settings
	Active reversing signal	Check if a reversing command is programmed for the terminal in parameter group <i>5-1* Digital inputs</i> .	Deactivate reversing signal
	Wrong motor phase connection		See <i>chapter 4.6.1 Motor Cable</i> in this manual
Motor is not reaching maximum speed	Frequency limits set wrong	Check output limits in <i>parameter 4-13 Motor Speed High Limit [RPM]</i> , <i>parameter 4-14 Motor Speed High Limit [Hz]</i> and <i>parameter 4-19 Max Output Frequency</i> .	Program correct limits
	Reference input signal not scaled correctly	Check reference input signal scaling in <i>6-0* Analog I/O Mode</i> and parameter group <i>3-1* References</i> . Reference limits in parameter group <i>3-0* Reference Limits</i> .	Program correct settings
Motor speed unstable	Possible incorrect parameter settings	Check the settings of all motor parameters, including all motor compensation settings. For closed-loop operation, check PID settings.	Check settings in parameter group <i>1-6* Load Depen. Setting</i> . For closed-loop operation, check settings in parameter group <i>20-0* Feedback</i> .
Motor runs rough	Possible overmagnetization	Check for incorrect motor settings in all motor parameters	Check motor settings in parameter groups <i>1-2* Motor Data</i> , <i>1-3* Addl. Motor Data</i> , and <i>1-5* Load Indep. Setting</i> .

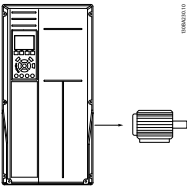
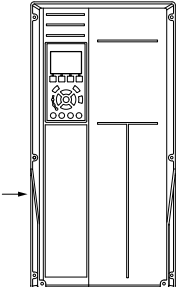
Symptom	Possible cause	Test	Solution
Motor will not brake	Possible incorrect settings in the brake parameters. Possible too short ramp-down times.	Check brake parameters. Check ramp time settings.	Check parameter group 2-0* <i>DC Brake</i> and 3-0* <i>Reference Limits</i> .
Open power fuses or circuit breaker trip	Phase-to-phase short	Motor or panel has a short phase-to-phase. Check motor and panel phase for shorts	Eliminate any shorts detected
	Motor overload	Motor is overloaded for the application	Perform start-up test and verify motor current is within specifications. If motor current is exceeding nameplate full load current, motor may run only with reduced load. Review the specifications for the application.
	Loose connections	Perform pre-start-up check for loose connections	Tighten loose connections
Line power current imbalance greater than 3%	Problem with line power (See <i>Alarm 4 Mains phase loss</i> description)	Rotate input power leads into the adjustable frequency drive one position: A to B, B to C, C to A.	If imbalanced leg follows the wire, it is a power problem. Check line power supply.
	Problem with the adjustable frequency drive	Rotate input power leads into the adjustable frequency drive one position: A to B, B to C, C to A.	If imbalance leg stays on same input terminal, it is a problem with the unit. Contact the supplier.
Motor current imbalance greater than 3%	Problem with motor or motor wiring	Rotate output motor leads one position: U to V, V to W, W to U.	If imbalanced leg follows the wire, the problem is in the motor or motor wiring. Check motor and motor wiring.
	Problem with the adjustable frequency drives	Rotate output motor leads one position: U to V, V to W, W to U.	If imbalance leg stays on same output terminal, it is a problem with the unit. Contact the supplier.
Acoustic noise or vibration (e.g., a fan blade is making noise or vibrations at certain frequencies)	Resonances, e.g., in the motor/fan system	Bypass critical frequencies by using parameters in parameter group 4-6* <i>Speed Bypass</i>	Check if noise and/or vibration have been reduced to an acceptable limit
		Turn off overmodulation in parameter 14-03 <i>Overmodulation</i>	
		Change switching pattern and frequency in parameter group 14-0* <i>Inverter Switching</i>	
		Increase Resonance Dampening in parameter 1-64 <i>Resonance Damping</i>	

Table 7.5 Troubleshooting

8 Specifications

8.1 Power-Dependent Specifications

8.1.1 Mains Supply 3x380–480 V AC

Mains Supply 3x380–480 VAC					
		N160	N200	N250	
Normal overload =110% current for 60 s*		NO	NO	NO	
	Typical shaft output at 400 V [kW]	160	200	250	
	Typical shaft output at 460 V [HP]	250	300	350	
	Typical shaft output at 480 V [kW]	200	250	315	
	Enclosure protection rating IP21	D1n	D2n	D2n	
	Enclosure protection rating IP54	D1n	D2n	D2n	
	Output current				
	Continuous (at 400 V) [A]	315	395	480	
	Intermittent (60 s overload) (at 400 V) [A]	347	435	528	
	Continuous (at 460/480 V) [A]	302	361	443	
	Intermittent (60 s overload) (at 460/480 V) [A]	332	397	487	
Continuous KVA (at 400 V) [KVA]	218	274	333		
Continuous KVA (at 460 V) [KVA]	241	288	353		
Continuous KVA (at 480 V) [KVA]	262	313	384		
Maximum input current					
	Continuous (at 400 V) [A]	304	381	463	
	Continuous (at 460/480 V) [A]	291	348	427	
	Maximum cable size, mains motor, brake, and load share [mm ² (AWG ²)]	Motor, brake and load share: 2x95 (2x3/0) Mains: 2x185 (2x350)	2x185 (2x350 mcm)	2x185 (2x350 mcm)	
	Maximum external mains fuses [A] ¹⁾	400	550	630	
	Total LHD loss 400 V AC [kW]	8725	9831	11371	
	Total back channel loss 400 V AC [kW]	7554	8580	10020	
	Total filter loss 400 V AC [kW]	4954	5714	6234	
	Total LHD loss 460 V AC [kW]	8906	9046	10626	
	Total back channel loss 460 V AC [kW]	7343	7374	8948	
	Total filter loss 460 V AC [kW]	4063	4187	4822	
Weight, enclosure protection rating IP21, IP54 [kg]	352	413	413		
Efficiency ⁴⁾	0.96				
Acoustic noise	85dBa				

Mains Supply 3x380–480 VAC				
		N160	N200	N250
Normal overload =110% current for 60 s*		NO	NO	NO
	Output frequency	0–590 Hz		
	Heat sink overtemperature trip	105° C	105 °C	105 °C
	Power card ambient trip	85 °C		

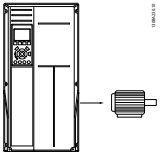
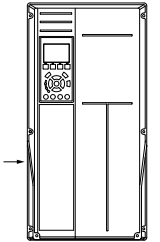
* High overload = 150% current for 60 s, normal overload = 110% current for 60 s.

Table 8.1 D-frame Ratings

Mains supply 3x380–480 V AC					
		P315	P355	P400	P450
Normal overload =110% current for 60 s*		NO	NO	NO	NO
	Typical shaft output at 400 V [kW]	315	355	400	450
	Typical shaft output at 460 V [HP]	450	500	600	600
	Typical shaft output at 480 V [kW]	355	400	500	530
	Enclosure protection rating IP21	E9	E9	E9	E9
	Enclosure protection rating IP54	E9	E9	E9	E9
Output current					
	Continuous (at 400 V) [A]	600	658	745	800
	Intermittent (60 s overload) (at 400 V) [A]	660	724	820	880
	Continuous (at 460/480 V) [A]	540	590	678	730
	Intermittent (60 s overload) (at 460/480 V) [A]	594	649	746	803
	Continuous KVA (at 400 V) [KVA]	416	456	516	554
	Continuous KVA (at 460 V) [KVA]	430	470	540	582
	Continuous KVA (at 480 V) [KVA]	468	511	587	632
Maximum input current					
	Continuous (at 400 V) [A]	590	647	733	787
	Continuous (at 460/480 V) [A]	531	580	667	718
	Maximum cable size, mains, motor, and load share [mm ² (AWG ²)]	4x240 (4x500 mcm)	4x240 (4x500 mcm)	4x240 (4x500 mcm)	4x240 (4x500 mcm)
	Maximum cable size, brake [mm ² (AWG ²)]	2x185 (2x350 mcm)	2x185 (2x350 mcm)	2x185 (2x350 mcm)	2x185 (2x350 mcm)
	Maximum external mains fuses [A] ¹⁾	700	900	900	900
	Total LHD loss 400 V AC [kW]	14051	15320	17180	18447
	Total back channel loss 400 V AC [kW]	11301	11648	13396	14570
	Total filter loss 400 V AC [kW]	7346	7788	8503	8974
	Total LHD loss 460 V AC [kW]	12936	14083	15852	16962
	Total back channel loss 460 V AC [kW]	10277	10522	12184	13214
	Total filter loss 460 V AC [kW]	7066	7359	8033	8435
	Weight, enclosure protection rating IP21, IP54 [kg]	596	623	646	646
	Efficiency ⁴⁾	0.96			
Acoustic noise	72dBa				
Output frequency	0–600 Hz				
Heat sink overtemperature trip	105 °C				
Power card ambient trip	85 °C				

* High overload = 160% current for 60 s, normal overload = 110% current for 60 s.

Table 8.2 E-frame Ratings

Mains supply 3x380–480 V AC						
		P500	P560	P630	P710	
Normal overload =110% current for 60 s*		NO	NO	NO	NO	
	Typical shaft output at 400 V [kW]	500	560	630	710	
	Typical shaft output at 460 V [HP]	650	750	900	1000	
	Typical shaft output at 480 V [kW]	560	630	710	800	
	Enclosure protection rating IP21, 54	F18	F18	F18	F18	
Output current						
	Continuous (at 400 V) [A]	880	990	1120	1260	
	Intermittent (60 s overload) (at 400 V) [A]	968	1089	1232	1386	
	Continuous (at 460/480 V) [A]	780	890	1050	1160	
	Intermittent (60 s overload) (at 460/480 V) [A]	858	979	1155	1276	
	Continuous KVA (at 400 V) [KVA]	610	686	776	873	
	Continuous KVA (at 460 V) [KVA]	621	709	837	924	
	Continuous KVA (at 480 V) [KVA]	675	771	909	1005	
	Maximum input current					
		Continuous (at 400 V) [A]	857	964	1090	1227
		Continuous (at 460/480 V) [A]	759	867	1022	1129
Maximum cable size, motor [mm ² (AWG ²)]		8x150 (8x300 mcm)				
Maximum cable size, mains F1/F2 [mm ² (AWG ²)]		8x240 (8x500 mcm)				
Maximum cable size, mains F3/F4 [mm ² (AWG ²)]		8x456 (8x900 mcm)				
Maximum cable size, loadsharing [mm ² (AWG ²)]		4x120 (4x250 mcm)				
Maximum cable size, brake [mm ² (AWG ²)]		4x185 (4x350 mcm)				
Maximum. external mains fuses [A] ¹⁾		1600		2000		
Total LHD loss 400 V AC [kW]		21909	24592	26640	30519	
Total back channel loss 400 V AC [kW]		17767	19984	21728	24936	
Total filter loss 400 V AC [kW]	11747	12771	14128	15845		
Total LHD loss 460 V AC [kW]	19896	22353	25030	27989		
Total back channel loss 460 V AC [kW]	16131	18175	20428	22897		
Total filter loss 460 V AC [kW]	11020	11929	13435	14776		
Maximum panel options losses	400					
Weight, enclosure protection ratings IP21, IP54 [kg]	2009					
Weight frequency converter section [kg]	1004					
Weight filter section [kg]	1005					
Efficiency ⁴⁾	0.96					
Acoustic noise	69dBa					
Output frequency	0–600 Hz					
Heat sink overtemperature trip	105 °C					
Power card ambient trip	85 °C					

* High overload = 160% current for 60 s, normal overload = 110% current for 60 s.

Table 8.3 F-frame Ratings

- 1) For type of fuse see *chapter 8.4.1 Fuses*.
- 2) American Wire Gauge.
- 3) Measured using 5 m screened motor cables at rated load and rated frequency.
- 4) The typical power loss is at nominal load conditions and expected to be within +/-15% (tolerance relates to variety in voltage and cable conditions). Values are based on a typical motor efficiency (eff2/eff3 border line). Motors with lower efficiency also add to the power loss in the frequency converter and opposite. If the switching frequency is increased come to the default setting, the power losses may rise significantly. LCP and typical control card power consumptions are included. Further options and customer load may add up to 30 W to the losses (though typical only 4 W extra for a fully loaded control card, or options for slot A or slot B, each). Although measurements are made with state-of-the-art equipment, some measurement inaccuracy must be allowed for (+/-5%).

8.1.2 Derating for Temperature

The frequency converter automatically derates the switching frequency, switching type, or output current under certain load or ambient conditions as described in the following. *Figure 8.1, Figure 8.2, Figure 8.3, and Figure 8.4* show the derating curve for SFAWM and 60 AVM switching modes.

8

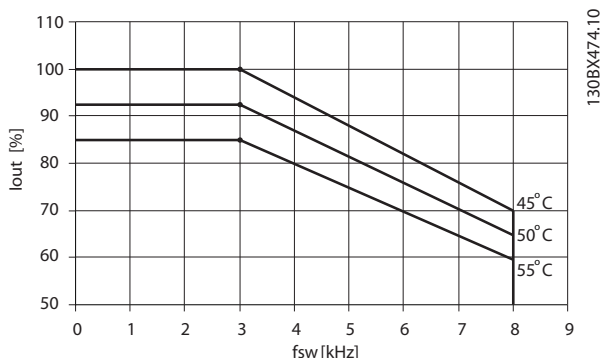


Figure 8.1 Derating Enclosure Size D, N160 to N250 380-480 V (T5) Normal Overload 110%, 60 AVM

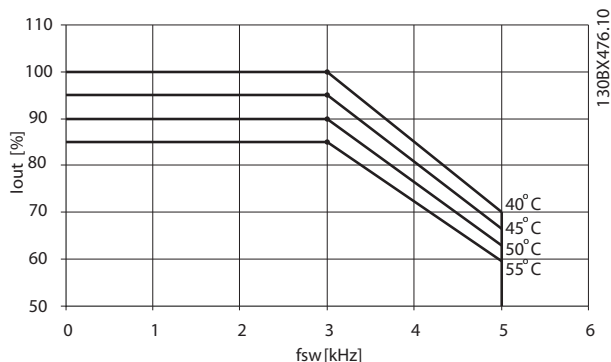


Figure 8.2 Derating Enclosure Size D, N160 to N250 380-480 V (T5) Normal Overload 110%, SFAWM

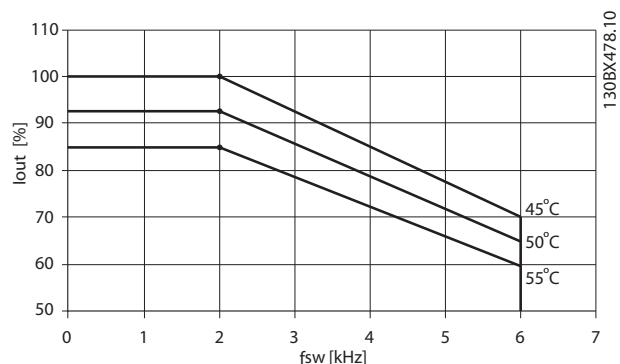


Figure 8.3 Derating Enclosure Sizes E and F, P315 to P710 380-480 V (T5) Normal Overload 110%, 60 AVM

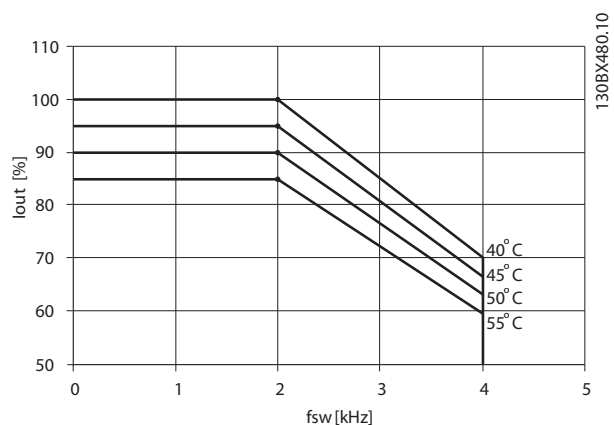


Figure 8.4 Derating Enclosure Sizes E and F, P315 to P710 380-480 V (T5) Normal Overload 110%, SFAWM

8.2 Mechanical Dimensions

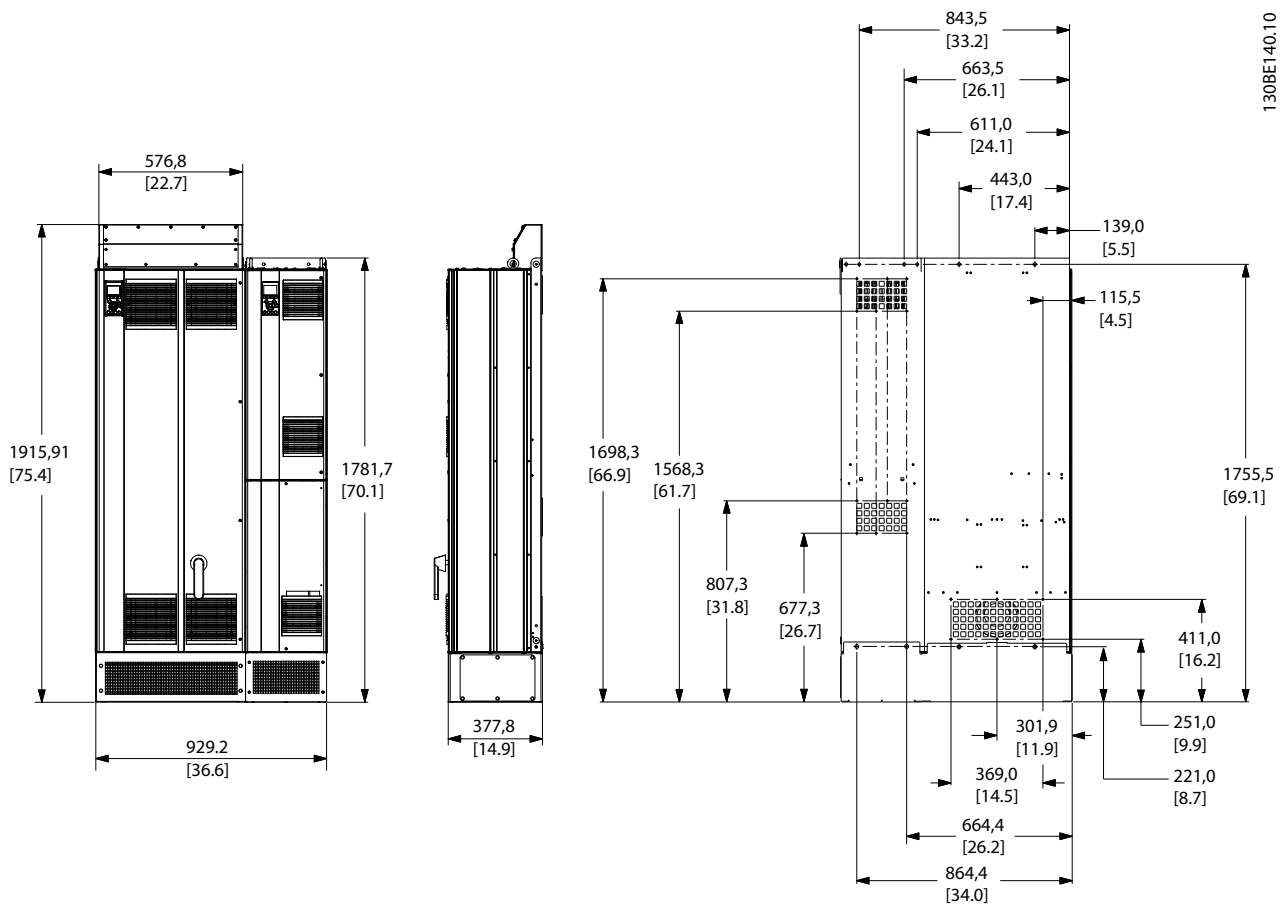


Figure 8.5 Enclosure Size D1n

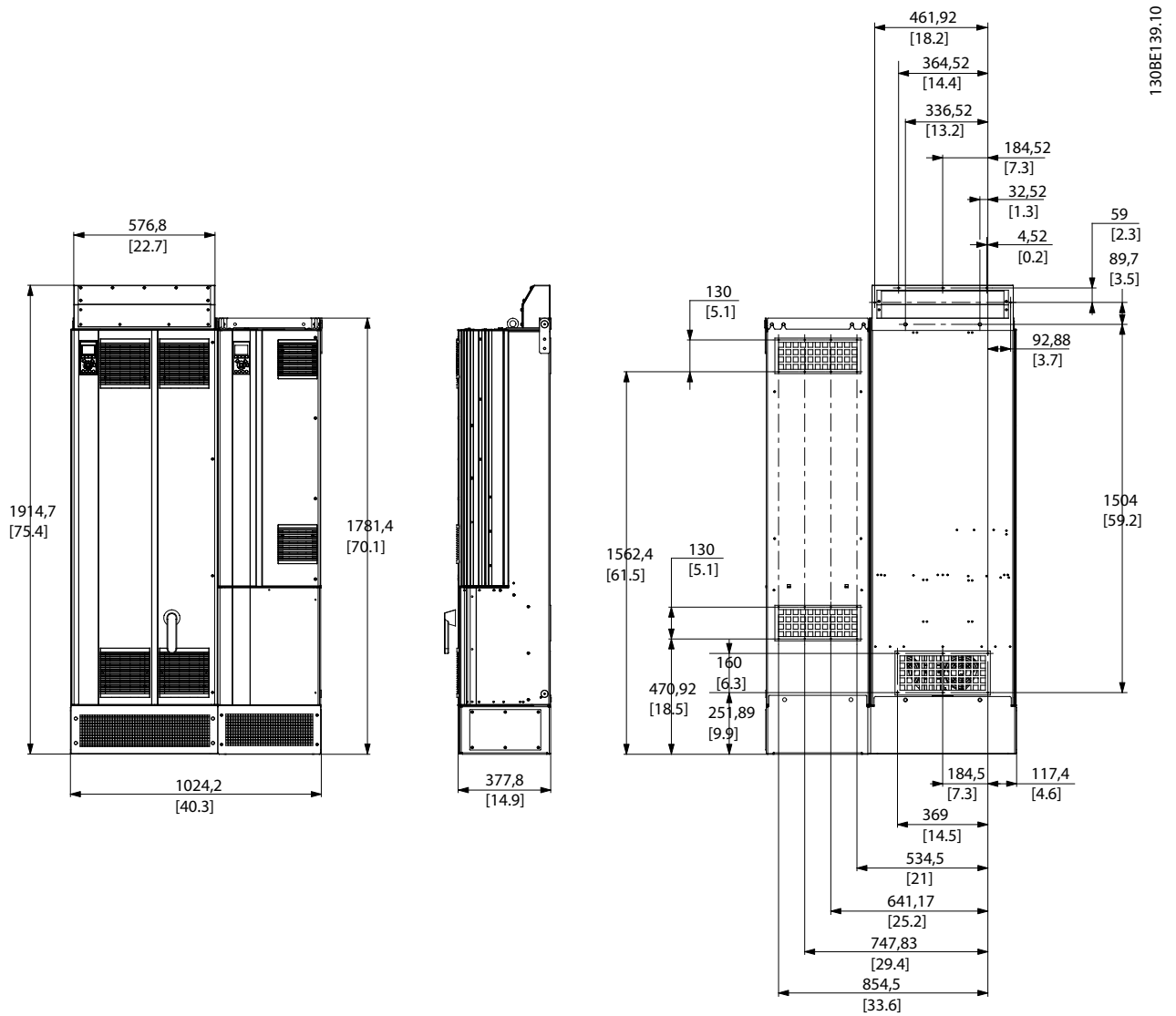


Figure 8.6 Enclosure Size D2n

8

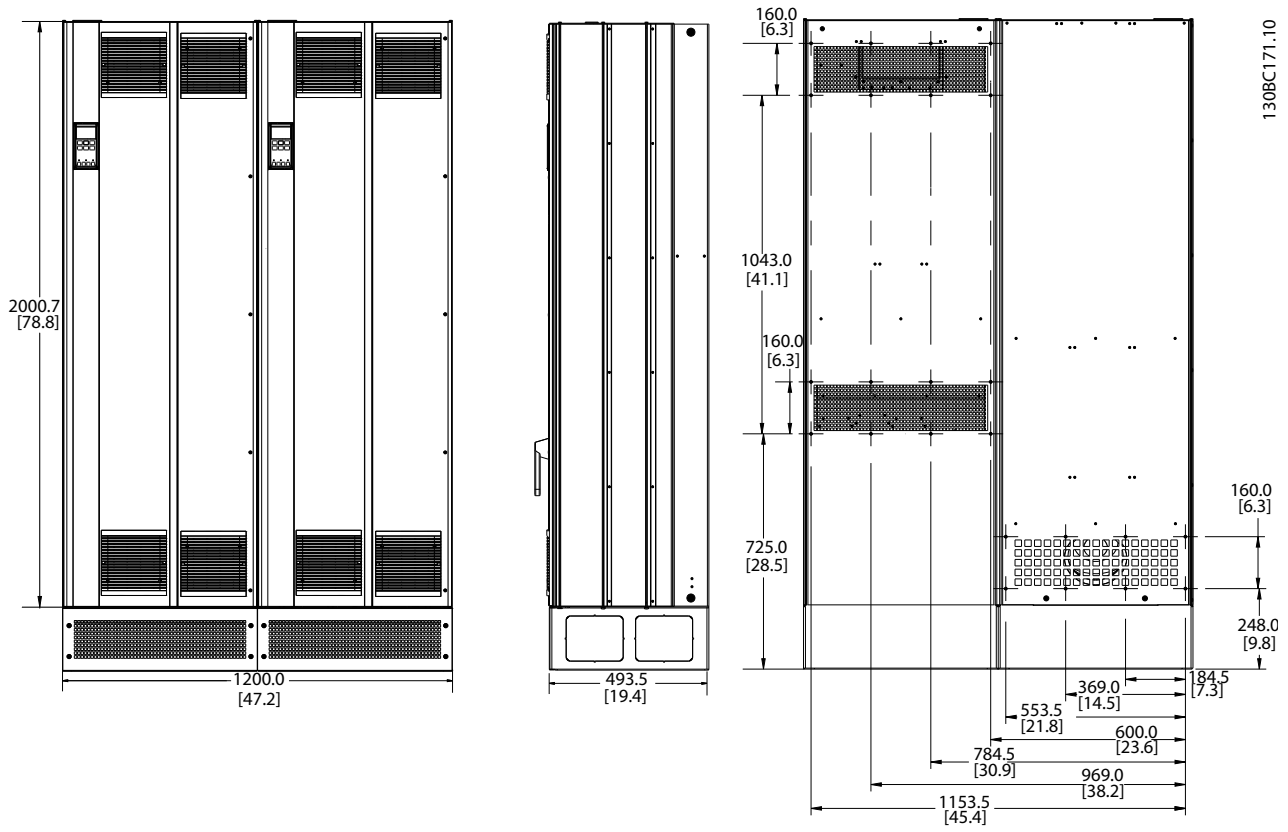


Figure 8.7 Enclosure Size E9

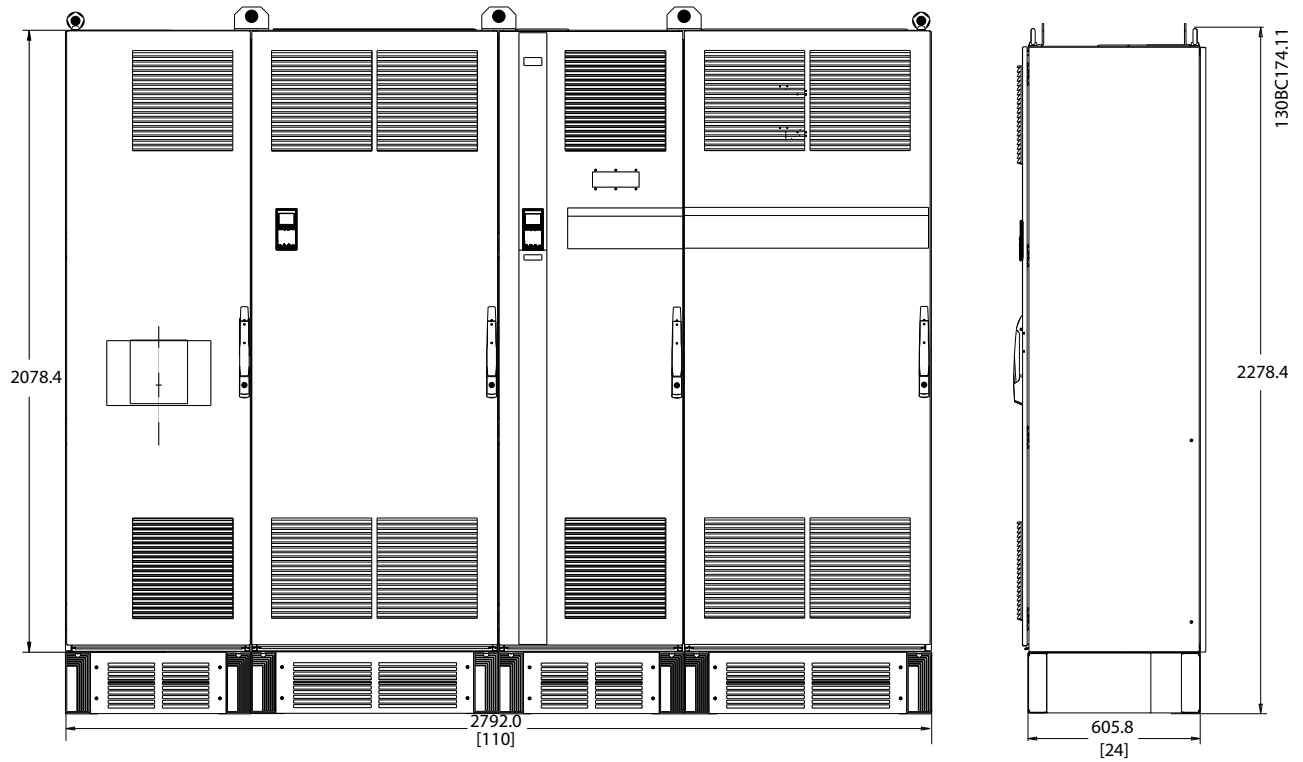


Figure 8.8 Enclosure Size F18, Front and Side View

8.3 General Technical Data

Line power supply (L1, L2, L3)

Supply voltage 380–480 V +5%

AC line voltage low/line drop-out:

During low AC line voltage or line drop-out, the adjustable frequency drive continues until the intermediate circuit voltage drops below the minimum stop level, corresponding to 15% below the lowest rated supply voltage. Power-up and full torque cannot be expected at AC line voltage lower than 10% below the lowest rated supply voltage.

Supply frequency 50/60 Hz ±5%

Max. temporary imbalance between line phases 3.0% of rated supply voltage

True power factor (λ) > 0.98 nominal at rated load

Displacement power factor ($\cos\phi$) near unity (> 0.98)

THiD < 5%

Switching on input supply L1, L2, L3 (power-ups) maximum once/2 min.

Environment according to EN60664-1 Overvoltage category III/pollution degree 2

The unit is suitable for use on a circuit capable of delivering not more than 100,000 RMS symmetrical Amperes, 480/690 V maximum.

Motor output (U, V, W)

Output voltage 0–100% of supply voltage

Output frequency 0–590* Hz

Switching on output Unlimited

Ramp times 0.01–3600 s

* Voltage and power dependent

Torque characteristics

Starting torque (constant torque) maximum 160% for 1 m.*

Starting torque maximum 180% up to 0.5 s*

Overload torque (constant torque) maximum 160% for 1 m.*

**Percentage relates to nominal torque of the unit.*

Cable lengths and cross-sections

Max. motor cable length, shielded/armored 500 ft [150 m]

Max. motor cable length, non-shielded/unarmored 1,000 ft [300 m]

Max. cross-section to motor, line power, load sharing, and brake *

Maximum cross-section to control terminals, rigid wire 1.5 mm²/16 AWG (2 x 0.75 mm²)

Maximum cross-section to control terminals, flexible cable 1 mm²/18 AWG

Maximum cross-section to control terminals, cable with enclosed core 0.5 mm²/20 AWG

Minimum cross-section to control terminals 0.25 mm²/4 AWG

** See for more information*

Digital inputs

Programmable digital inputs 4 (6)

Terminal number 18, 19, 27¹⁾, 29¹⁾, 32, 33,

Logic PNP or NPN

Voltage level 0–24 V DC

Voltage level, logic '0' PNP < 5 V DC

Voltage level, logic '1' PNP > 10 V DC

Voltage level, logic '0' NPN > 19 V DC

Voltage level, logic '1' NPN < 14 V DC

Maximum voltage on input 28 V DC

Input resistance, R_i approx. 4 kΩ

All digital inputs are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

1) Terminals 27 and 29 can also be programmed as output.

Analog inputs

Number of analog inputs	2
Terminal number	53, 54
Modes	Voltage or current
Mode select	Switch S201 and switch S202
Voltage mode	Switch S201/switch S202 = OFF (U)
Voltage level	0 to + 10 V (scaleable)
Input resistance, R_i	approx. 10 k Ω
Max. voltage	\pm 20 V
Current mode	Switch S201/switch S202 = ON (I)
Current level	0/4 to 20 mA (scaleable)
Input resistance, R_i	approx. 200 Ω
Max. current	30 mA
Resolution for analog inputs	10 bit (+ sign)
Accuracy of analog inputs	Max. error 0.5% of full scale
Bandwidth	200 Hz

The analog inputs are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

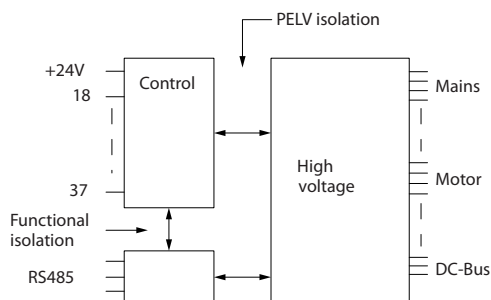


Figure 8.9

Pulse inputs

Programmable pulse inputs	2
Terminal number pulse	29, 33
Max. frequency at terminal, 29, 33	110 kHz (push-pull driven)
Max. frequency at terminal, 29, 33	5 kHz (open collector)
Min. frequency at terminal 29, 33	4 Hz
Voltage level	see chapter 8.3.1 Digital inputs
Maximum voltage on input	28 V DC
Input resistance, R_i	approx. 4 k Ω
Pulse input accuracy (0.1–1 kHz)	Max. error: 0.1% of full scale

Analog output

Number of programmable analog outputs	1
Terminal number	42
Current range at analog output	0/4–20 mA
Max. resistor load to common at analog output	500 Ω
Accuracy on analog output	Max. error: 0.8% of full scale
Resolution on analog output	8 bit

The analog output is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

Control card, RS-485 serial communication

Terminal number	68 (P,TX+, RX+), 69 (N,TX-, RX-)
Terminal number 61	Common for terminals 68 and 69

The RS-485 serial communication circuit is functionally seated from other central circuits and galvanically isolated from the supply voltage (PELV).

Digital output

Programmable digital/pulse outputs	2
Terminal number	27, 29 ¹⁾
Voltage level at digital/frequency output	0–24 V
Max. output current (sink or source)	40 mA
Max. load at frequency output	1 kΩ
Max. capacitive load at frequency output	10 nF
Minimum output frequency at frequency output	0 Hz
Maximum output frequency at frequency output	32 kHz
Accuracy of frequency output	Max. error: 0.1% of full scale
Resolution of frequency outputs	12 bit

1) Terminal 27 and 29 can also be programmed as input.

The digital output is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

Control card, 24 V DC output

Terminal number	13
Output voltage	24 V (+1, -3 V)
Max. load	200 mA

The 24 V DC supply is galvanically isolated from the supply voltage (PELV), but has the same potential as the analog and digital inputs and outputs.

Relay outputs

Programmable relay outputs	2
Relay 01 Terminal number	1-3 (break), 1-2 (make)
Max. terminal load (AC-1) ¹⁾ on 1-3 (NC), 1-2 (NO) (resistive load)	240 V AC, 2 A
Max. terminal load (AC-15) ¹⁾ (inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Max. terminal load (DC-1) ¹⁾ on 1-2 (NO), 1-3 (NC) (resistive load)	60 V DC, 1 A
Max. terminal load (DC-13) ¹⁾ (inductive load)	24 V DC, 0.1 A
Relay 02 Terminal number	4-6 (break), 4-5 (make)
Max. terminal load (AC-1) ¹⁾ on 4-5 (NO) (resistive load) ²⁾³⁾	400 V AC, 2 A
Max. terminal load (AC-15) ¹⁾ on 4-5 (NO) (inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Max. terminal load (DC-1) ¹⁾ on 4-5 (NO) (resistive load)	80 V DC, 2 A
Max. terminal load (DC-13) ¹⁾ on 4-5 (NO) (inductive load)	24 V DC, 0.1 A
Max. terminal load (AC-1) ¹⁾ on 4-6 (NC) (resistive load)	240 V AC, 2 A
Max. terminal load (AC-15) ¹⁾ on 4-6 (NC) (inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Max. terminal load (DC-1) ¹⁾ on 4-6 (NC) (resistive load)	50 V DC, 2 A
Max. terminal load (DC-13) ¹⁾ on 4-6 (NC) (inductive load)	24 V DC, 0.1 A
Min. terminal load on 1-3 (NC), 1-2 (NO), 4-6 (NC), 4-5 (NO)	24 V DC 10 mA, 24 V AC 20 mA
Environment according to EN 60664-1	Overvoltage category III/pollution degree 2

1) IEC 60947 parts 4 and 5

The relay contacts are galvanically isolated from the rest of the circuit by reinforced isolation (PELV).

2) Overvoltage Category II

3) UL applications 300 V AC 2 A

Control characteristics

Resolution of output frequency at 0–1000 Hz	±0.003 Hz
System response time (terminals 18, 19, 27, 29, 32, 33)	≤ 2 ms
Speed control range (open-loop)	1:100 of synchronous speed
Speed accuracy (open-loop)	30–4000 RPM: Maximum error of ±8 RPM

All control characteristics are based on a 4-pole asynchronous motor

Surroundings

Enclosure, frame size D and E	IP21, IP54
Enclosure, frame size F	IP21, IP54
Vibration test	0.7 g
Relative humidity	5–95% IEC 721-3-3; Class 3K3 (non-condensing) during operation
Aggressive environment (IEC 60068-2-43) H ₂ S test	class kD
Test method according to IEC 60068-2-43 H ₂ S (10 days)	
Ambient temperature (at 60 AVM switching mode)	
- with derating	max. 131°F [55°C] ¹⁾
- with full output power, typical EFF2 motors (see)	max. 122°F [50°C] ¹⁾
- at full continuous FC output current	max. 113°F [45°C] ¹⁾

¹⁾ For more information on derating, consult the design guide

Minimum ambient temperature during full-scale operation	32°F [0°C]
Minimum ambient temperature at reduced performance	14°F [-10°C]
Temperature during storage/transport	-13°–+149°/158°F [-25°–+65°/70°C]
Maximum altitude above sea level without derating	3300 ft [1,000 m]
Maximum altitude above sea level with derating	10,000 ft [3000 m]

For more information on derating, consult the design guide

EMC standards, emission	EN 61800-3, EN 61000-6-3/4, EN 55011, IEC 61800-3 EN 61800-3, EN 61000-6-1/2,
EMC standards, immunity	EN 61000-4-2, EN 61000-4-3, EN 61000-4-4, EN 61000-4-5, EN 61000-4-6
Control card performance	
Scan interval	5 ms

Control card, USB serial communication

USB standard	1.1 (full speed)
USB plug	USB type B device plug

NOTICE!

Connection to PC is carried out via a standard host/device USB cable.

The USB connection is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

The USB connection is not galvanically isolated from ground protection. Use only isolated laptop/PC as connection to the USB connector on the adjustable frequency drive or an isolated USB cable/drive.

Protection and Features:

- Electronic thermal motor protection against overload.
- Temperature monitoring of the heatsink ensures that the adjustable frequency drive trips if the temperature reaches a predefined level. An overload temperature cannot be reset until the temperature of the heatsink is below the allowed values.
- The adjustable frequency drive is protected against short-circuits on motor terminals U, V, W.
- If a line phase is missing, the adjustable frequency drive trips or issues a warning (depending on the load).
- Monitoring of the intermediate circuit voltage ensures that the adjustable frequency drive trips if the intermediate circuit voltage is too low or too high.

- The adjustable frequency drive is protected against ground faults on motor terminals U, V, W.

Frame size	D13	E9	F18	
Voltage [V]	380–480	380–480	380–480	
Current, RMS [A]	120	210	330	Nominal value
Peak current [A]	340	595	935	Amplitude value of the current
Response time [ms]	<0.5			
Settling time - reactive current control [ms]	<40			
Settling time - harmonic current control (filtering) [ms]	<20			
Overshoot - reactive current control [%]	<20			
Overshoot - harmonic current control [%]	<10			

Table 8.4 Power Ranges (LHD with AF)

Grid conditions

Supply voltage 380–480 V

AC line voltage low/line drop-out:

During low AC line voltage or a line drop-out, the filter continues until the intermediate circuit voltage drops below the minimum stop level, which corresponds to 15% below the filter lowest rated supply voltage. Full compensation cannot be expected at AC line voltage lower than 10% below the filter lowest rated supply voltage. If AC line voltage exceeds the filter highest rated voltage, the filter continues to work but harmonic mitigation performance is reduced. The filter does not cut out until AC line voltages exceed 580 V.

Supply frequency 50/60 Hz ±5%

Max. imbalance temporary between line phases where mitigation performance is kept high. Filter mitigates at higher line imbalance but harmonic mitigation performance is reduced

3.0% of rated supply voltage
10% with kept mitigation performance

Max THDv pre-distortion Reduced performance for higher pre-distortion levels

Harmonic mitigation performance

Best performance <4%

THiD Depending on filter vs. distortion ratio.

Individual harmonic mitigation ability: Current maximum RMS [% of rated RMS current]

2nd	10%
4th	10%
5th	70%
7th	50%
8th	10%
10th	5%
11th	32%
13th	28%
14th	4%
16th	4%
17th	20%
19th	18%
20th	3%
22nd	3%
23rd	16%
25th	14%
Total current of harmonics	90%

The filter is performance tested to the 40th order

Reactive current compensation

Cos phi	Controllable 1.0 to 0.5 lagging
Reactive current, % of filter current rating	100%

Cable lengths and cross-sections

Max grid cable length (direct internal connection to drive)	Unlimited (determined by voltage drop)
Maximum cross-section to control terminals, rigid wire	1.5 mm ² /16 AWG (2 x 0.75 mm ²)
Maximum cross-section to control terminals, flexible cable	1 mm ² /18 AWG
Maximum cross-section to control terminals, cable with enclosed core	0.5 mm ² /20 AWG
Minimum cross-section to control terminals	0.25 mm ² /4 AWG

CT terminals specification

CT number	3 (one for each phase)
The AAF burden equals	2 mΩ
Secondary current rating	1 A or 5 A (hardware set-up)
Accuracy	Class 0.5 or better

Digital inputs

Programmable digital inputs	2 (4)
Terminal number	18, 19, 27*, 29*
Logic	PNP or NPN
Voltage level	0–24 V DC
Voltage level, logic '0' PNP	< 5 V DC
Voltage level, logic '1' PNP	> 10 V DC
Voltage level, logic '0' NPN	> 19 V DC
Voltage level, logic '1' NPN	< 14 V DC
Maximum voltage on input	28 V DC
Input resistance, R _i	approx. 4 kΩ

All digital inputs are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

**) Terminals 27 and 29 can also be programmed as output.*

Control card, RS-485 serial communication

Terminal number	68 (P, TX+, RX+), 69 (N, TX-, RX-)
Terminal number 61	Common for terminals 68 and 69

The RS-485 serial communication circuit is functionally separated from other central circuits and galvanically isolated from the supply voltage (PELV).

Digital output

Programmable digital/pulse outputs	2
Terminal number	27, 29 ¹⁾
Voltage level at digital/frequency output	0–24 V
Max. output current (sink or source)	40 mA

1) Terminal 27 and 29 can also be programmed as input.

Control card, 24 V DC output

Terminal number	13
Max. load	200 mA

The 24 V DC supply is galvanically isolated from the supply voltage (PELV), but has the same potential as the analog and digital inputs and outputs.

Surroundings

Enclosure	IP21, IP54
Vibration test	1.0 g
Relative humidity	5%–95% IEC 721-3-3; class 3K3 (non-condensing) during operation
Aggressive environment (IEC 60068-2-43) H ₂ S test	class kD
Test method according to IEC 60068-2-43 H ₂ S (10 days)	
Ambient temperature	
- with derating	max. NA °F [°C]
- with full output current (short temperature overload)	max. 113°F [45°C]
- at full continuous output current (24 hours)	max. 104°F [40°C]
Minimum ambient temperature during full-scale operation	32°F [0°C]
Minimum ambient temperature at reduced performance	14°F [-10°C]
Temperature during storage/transport	+13° to 158°F [-25° to +70°C]
Maximum altitude above sea level without derating	3300 ft [1000 m]
Maximum altitude above sea level with derating	10,000 ft [3000 m]
EMC standards, Emission	EN 61800-3, EN 61000-6-3/4, EN 55011, IEC 61800-3 EN 61800-3, EN 61000-6-1/2,
EMC standards, Immunity	EN 61000-4-2, EN 61000-4-3, EN 61000-4-4, EN 61000-4-5, EN 61000-4-6

Control card performance

Scan interval	5 ms
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Control card, USB serial communication

USB standard	1.1 (full speed)
USB plug	USB type B "device" plug

Generic specifications

Maximum parallel filters	4 on same CT set
Filter efficiency	97%
Typical average switching frequency	3.0–4.5 kHz
Response time (reactive and harmonic)	< 0.5 ms
Settling time - reactive current control	< 20 ms
Settling time - harmonic current control	< 20 ms
Overshoot – reactive current control	<10%
Overshoot – Harmonic current control	<10%

Connection to PC is carried out via a standard host/device USB cable. The USB connection is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals. The USB connection is not galvanically isolated from ground protection. Use only isolated laptop/PC as connection to the USB connector on the unit or an isolated USB cable/driver.

Protection and features

- Temperature monitoring of the heatsink ensures that the active filter trips if the temperature reaches a predefined level. An overload temperature cannot be reset until the temperature of the heatsink is below the acceptable values.
- If a line phase is missing, the active filter trips.
- The active filter has a short circuit protection current rate of 100 kA if properly fused
- Monitoring of the intermediate circuit voltage ensures that the filter trips if the intermediate circuit voltage is too low or too high.
- The active filter monitors the line power current as well as internal currents to ensure that current levels do not reach critical levels. If current exceeds a critical level, the filter trips.

The cooling capability of air is decreased at a lower air pressure.

Below 3,300 ft [1000 m] altitude no derating is necessary but above 3,300 ft [1000 m] the ambient temperature (T_{AMB}) or max. output current (I_{out}) should be derated in accordance with *Figure 8.10*.

An alternative is to lower the ambient temperature at high altitudes and thereby ensure 100% output current at high altitudes. As an example of how to read the graph, the situation at 6,600 ft [2 km] is elaborated. At a temperature of 113°F [45°C] ($T_{AMB, MAX} - 3.3 K$), 91% of the rated output current is available. At a temperature of 107°F [41.7°C], 100% of the rated output current is available.

Altitude Derating

Derating of output current versus altitude at $T_{AMB, MAX}$ for frame sizes D, E and F.

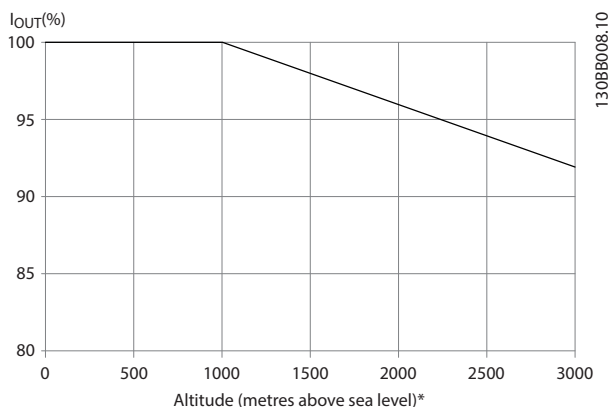


Figure 8.10 Altitude Derating

8.4 Fuses

Danfoss recommends using fuses and/or circuit breakers on the supply side as protection in case of component break-down inside the adjustable frequency drive (first fault).

NOTICE!

Using fuses and/or circuit breakers ensures compliance with IEC 60364 for CE or NEC 2009 for UL.

Branch Circuit Protection

To protect the installation against electrical and fire hazard, all branch circuits in an installation, switch gear, machines, etc., must be protected against short-circuit and overcurrent according to national/international regulations.

NOTICE!

The recommendations do not cover branch circuit protection for UL.

Short-circuit protection

Danfoss recommends using the fuses/circuit breakers in *chapter 8.4.2 Fuse Tables* to protect service personnel and property in case of component breakdown in the adjustable frequency drive.

8.4.1 Non- UL compliance

Non- UL compliance

If UL/cUL is not to be complied with, Danfoss recommends using the following fuses, which ensures compliance with EN50178:

P132-P200	380-500 V	type gG
P250-P400	380-500 V	type gR

Table 8.5 Recommended Fuses for non-UL Applications

8.4.2 Fuse Tables

UL Compliance Fuse tables

380–480 V, frame sizes D, E and F

The fuses below are suitable for use on a circuit capable of delivering 100,000 Arms (symmetrical), 240 V, or 480 V, or 500 V, or 600 V depending on the adjustable frequency drive voltage rating. With the proper fusing the adjustable frequency drive Short Circuit Current Rating (SCCR) is 100,000 Arms.

Size/ Type	Bussmann E1958 JFHR2**	Bussmann E4273 T/JDDZ**	SIBA E180276 JFHR2	Littelfuse E71611 JFHR2**	Ferraz- Shawmut E60314 JFHR2**	Bussmann E4274 H/JDDZ**	Bussmann E125085 JFHR2*	Internal Option Bussmann
P132	FWH- 400	JJS- 400	2061032.40	L50S-400	A50-P400	NOS- 400	170M4012	170M4016
P160	FWH- 500	JJS- 500	2061032.50	L50S-500	A50-P500	NOS- 500	170M4014	170M4016
P200	FWH- 600	JJS- 600	2062032.63	L50S-600	A50-P600	NOS- 600	170M4016	170M4016

Table 8.6 Frame size D, Line Fuses, 380–480 V

Size/Type	Bussmann PN*	Rating	Ferraz	Siba
P250	170M4017	700 A, 700 V	6.9URD33D08A0700	20 630 32.700
P315	170M6013	900 A, 700 V	6.9URD33D08A0900	20 630 32.900
P355	170M6013	900 A, 700 V	6.9URD33D08A0900	20 630 32.900
P400	170M6013	900 A, 700 V	6.9URD33D08A0900	20 630 32.900

Table 8.7 Frame size E, Line Fuses, 380–480 V

Size/Type	Bussmann PN*	Rating	Siba	Internal Bussmann Option
P450	170M7081	1600 A, 700 V	20 695 32.1600	170M7082
P500	170M7081	1600 A, 700 V	20 695 32.1600	170M7082
P560	170M7082	2000 A, 700 V	20 695 32.2000	170M7082
P630	170M7082	2000 A, 700 V	20 695 32.2000	170M7082

Table 8.8 Frame size F, Line Fuses, 380–480 V

Size/Type	Bussmann PN*	Rating	Siba
P450	170M8611	1100 A, 1000 V	20 781 32.1000
P500	170M8611	1100 A, 1000 V	20 781 32.1000
P560	170M6467	1400 A, 700 V	20 681 32.1400
P630	170M6467	1400 A, 700 V	20 681 32.1400

Table 8.9 Frame Size F, Inverter Module DC Link Fuses, 380–480 V

*170M fuses from Bussmann shown use the -/80 visual indicator; -TN/80 Type T, -/110 or TN/110 Type T indicator fuses of the same size and amperage may be substituted for external use

**Any minimum 500 V UL listed fuse with associated current rating may be used to meet UL requirements.

8.4.3 Supplementary Fuses - High Power

Supplementary fuses

Frame size	Bussmann PN	Rating
D, E and F	KTK-4	4 A, 600 V

Table 8.10 SMPS Fuse

Size/Type	Bussmann PN	Littelfuse	Rating
P132–P250, 380–500 V	KTK-4		4 A, 600 V
P315–P630, 380–500 V		KLK-15	15 A, 600 V

Table 8.11 Fan Fuses

Size/Type		Bussmann PN	Rating	Alternative Fuses
P450–P630, 380–500 V	2.5–4.0 A	LPJ-6 SP or SPI	6 A, 600 V	Any listed class J dual element, time delay, 6A
P450–P630, 380–500 V	4.0–6.3 A	LPJ-10 SP or SPI	10 A, 600 V	Any listed class J dual element, time delay, 10 A
P450–P630, 380–500 V	6.3–10 A	LPJ-15 SP or SPI	15 A, 600 V	Any listed class J dual element, time delay, 15 A
P450–P630, 380–500 V	10–16 A	LPJ-25 SP or SPI	25 A, 600 V	Any listed class J dual element, time delay, 25 A

Table 8.12 Manual Motor Controller Fuses

Frame size	Bussmann PN*	Rating	Alternative Fuses
F	LPJ-30 SP or SPI	30 A, 600 V	Any listed Class J dual element, time delay, 30 A

Table 8.13 30 A Fuse Protected Terminal Fuse

Frame size	Bussmann PN*	Rating	Alternative Fuses
F	LPJ-6 SP or SPI	6 A, 600 V	Any listed class J dual element, time delay, 6 A

Table 8.14 Control Transformer Fuse

Frame size	Bussmann PN*	Rating
F	GMC-800MA	800 mA, 250 V

Table 8.15 NAMUR Fuse

Frame size	Bussmann PN*	Rating	Alternative Fuses
F	LP-CC-6	6 A, 600 V	Any listed class CC, 6 A

Table 8.16 Safety Relay Coil Fuse with PILS Relay

Frame size	Littelfuse PN	Rating
D, E, F	KLK-15	15 A, 600 V

Table 8.17 Electrical Fuses (Power Card)

Frame size	Bussmann PN	Rating
D, E, F	FNQ-R-3	3 A, 600 V

Table 8.18 Transformer Fuse (Line Contactor)

Frame size	Bussmann PN	Rating
D, E, F	FNQ-R-1	1 A, 600 V

Table 8.19 Soft Charge Fuses

8.5 General Torque Tightening Values

For fastening hardware described in this manual, use the torque values in *Table 8.20*. These values are not intended for fastening IGBTs. See the instructions included with those replacement parts for correct values.

Shaft Size	Driver Size Torx/Hex [mm]	Torque [Nm]	Torque [in-lbs]
M4	T-20/7	1.0	10
M5	T-25/8	2.3	20
M6	T-30/10	4.0	35
M8	T-40/13	9.6	85
M10	T-50/17	19.2	170
M12	18/19	19	170

Table 8.20 Torque Values

9 Appendix A - Parameters

9.1 Description of Parameters

9.1.1 Main Menu

The main menu includes all available parameters in the frequency converter. All parameters are grouped by name indicating the function of the parameter group. All parameters are listed by name and number in this manual.

9.2 Frequency Converter Parameter Lists

0-0*	Operation/Display	Torque Characteristics	1-9*	Motor Temperature	4-16	Torque Limit Motor Mode	5-63	Terminal 29 Pulse Output Variable
0-0*	Basic Settings	Clockwise Direction	1-90	Motor Thermal Protection	4-17	Torque Limit Generator Mode	5-65	Pulse Output Max Freq #29
0-01	Language	Motor Selection	1-91	Motor External Fan	4-18	Current Limit	5-66	Terminal X30/6 Pulse Output Variable
0-02	Motor Speed Unit	Motor Construction	1-93	Thermistor Source	4-19	Max Output Frequency	5-68	Pulse Output Max Freq #X30/6
0-03	Regional Settings	VVC+ PM	2-*	Brakes	4-5*	Adj. Warnings	5-8*	I/O Options
0-04	Operating State at Power-up	Damping Gain	2-0*	DC Brake	4-50	Warning Current Low	5-80	AHF Cap Reconnect Delay
0-05	Local Mode Unit	Low Speed Filter Time Const.	2-00	DC Hold/Preheat Current	4-51	Warning Current High	5-9*	Bus Controlled
0-1*	Set-up Operations	High Speed Filter Time Const.	2-01	DC Brake Current	4-52	Warning Speed Low	5-90	Digital & Relay Bus Control
0-10	Active Set-up	Voltage Filter Time Const.	2-02	DC Braking Time	4-53	Warning Speed High	5-93	Pulse Out #27 Bus Control
0-11	Programming Set-up	Motor Data	2-03	DC Brake Cut-in Speed [RPM]	4-54	Warning Reference Low	5-94	Pulse Out #27 Timeout Preset
0-12	This Set-up Linked to	Motor Power [kW]	2-04	DC Brake Cut-in Speed [Hz]	4-55	Warning Reference High	5-95	Pulse Out #29 Bus Control
0-13	Readout: Linked Set-ups	Motor Power [hp]	2-06	Parking Current	4-56	Warning Feedback Low	5-96	Pulse Out #29 Timeout Preset
0-14	Readout: Prog. Set-ups/Channel	Motor Voltage	2-07	Parking Time	4-57	Warning Feedback High	5-97	Pulse Out #X30/6 Bus Control
0-2*	LCP Display	Motor Frequency	2-1*	Brake Energy Funct.	4-58	Missing Motor Phase Function	5-98	Pulse Out #X30/6 Timeout Preset
0-20	Display Line 1.1 Small	Motor Current	2-10	Brake Function	4-6*	Speed Bypass	6-*	Analog In/Out
0-21	Display Line 1.2 Small	Motor Nominal Speed	2-11	Brake Resistor (ohm)	4-60	Bypass Speed From [RPM]	6-0*	Analog I/O Mode
0-22	Display Line 1.3 Small	Motor Cont. Rated Torque	2-12	Brake Power Limit [kW]	4-61	Bypass Speed From [Hz]	6-00	Live Zero Timeout Time
0-23	Display Line 2 Large	Motor Rotation Check	2-13	Brake Power Monitoring	4-62	Bypass Speed To [RPM]	6-01	Live Zero Timeout Function
0-24	Display Line 3 Large	Automatic Motor Adaptation (AMA)	2-15	Brake Check	4-63	Bypass Speed To [Hz]	6-02	Fire Mode Live Zero Timeout Function
0-25	My Personal Menu	Adv. Motor Data	2-16	AC brake Max. Current	4-64	Semi-Auto Bypass Set-up	6-1*	Analog Input 53
0-3*	LCP Custom Readout	Stator Resistance (Rs)	2-17	Overvoltage Control	5-*	Digital In/Out	6-1*	Analog Input 53
0-30	Custom Readout Unit	Rotor Resistance (Rr)	3-*	Reference/Ramps	5-0*	Digital I/O mode	6-10	Terminal 53 Low Voltage
0-31	Custom Readout Min Value	Main Reactance (Xh)	3-0*	Reference Limits	5-00	Digital I/O mode	6-11	Terminal 53 High Voltage
0-32	Custom Readout Max Value	Iron Loss Resistance (Rfe)	3-02	Minimum Reference	5-01	Terminal 27 Mode	6-12	Terminal 53 Low Current
0-37	Display Text 1	d-axis Inductance (Ld)	3-03	Maximum Reference	5-02	Terminal 29 Mode	6-13	Terminal 53 High Current
0-38	Display Text 2	Motor Poles	3-04	Reference Function	5-1*	Digital inputs	6-14	Terminal 53 Low Ref./Feedb. Value
0-39	Display Text 3	Back EMF at 1000 RPM	3-1*	References	5-10	Terminal 18 Digital Input	6-15	Terminal 53 High Ref./Feedb. Value
0-4*	LCP keypad	Position Detection Gain	3-10	Preset Reference	5-11	Terminal 19 Digital Input	6-16	Terminal 53 Filter Time Constant
0-40	[Hand on] Key on LCP	Load Indep. Setting	3-11	Jog Speed [Hz]	5-12	Terminal 27 Digital Input	6-17	Terminal 53 Live Zero
0-41	[Off] Key on LCP	Motor Magnetization at Zero Speed	3-13	Reference Site	5-13	Terminal 29 Digital Input	6-2*	Analog Input 54
0-42	[Auto on] Key on LCP	Min Speed Normal Magnetizing [RPM]	3-14	Preset Relative Reference	5-14	Terminal 32 Digital Input	6-20	Terminal 54 Low Voltage
0-43	[Reset] Key on LCP	Min Speed Normal Magnetizing [Hz]	3-15	Reference 1 Source	5-15	Terminal 33 Digital Input	6-21	Terminal 54 High Voltage
0-44	[Off/Reset] Key on LCP	Min Speed Normal Magnetizing [Hz]	3-16	Reference 2 Source	5-16	Terminal X30/2 Digital Input	6-22	Terminal 54 Low Current
0-45	[Drive Bypass] Key on LCP	Flystart Test Pulses Current	3-17	Reference 3 Source	5-17	Terminal X30/3 Digital Input	6-23	Terminal 54 High Current
0-5*	Copy/Save	Flystart Test Pulses Frequency	3-19	Jog Speed [RPM]	5-18	Terminal X30/4 Digital Input	6-24	Terminal 54 Low Ref./Feedb. Value
0-50	LCP Copy	Load Depen. Setting	3-4*	Ramp 1	5-19	Terminal 37 Safe Stop	6-25	Terminal 54 High Ref./Feedb. Value
0-51	Set-up Copy	Low Speed Load Compensation	3-41	Ramp 1 Ramp-up Time	5-3*	Digital Outputs	6-26	Terminal 54 Filter Time Constant
0-6*	Password	High Speed Load Compensation	3-42	Ramp 1 Ramp-down Time	5-30	Terminal 27 Digital Output	6-27	Terminal 54 Live Zero
0-60	Main Menu Password	Slip Compensation	3-5*	Ramp 2	5-31	Terminal 29 Digital Output	6-3*	Analog Input X30/11
0-61	Access to Main Menu w/o Password	Resonance Dampening Time Constant	3-51	Ramp 2 Ramp-up Time	5-32	Term X30/6 Digi Out (MCB 101)	6-30	Terminal X30/11 Low Voltage
0-65	Personal Menu Password	Resonance Dampening Time	3-52	Ramp 2 Ramp-down Time	5-33	Term X30/7 Digi Out (MCB 101)	6-31	Terminal X30/11 High Voltage
0-66	Access to Personal Menu w/o Password	Constant	3-8*	Other Ramps	5-4*	Relays	6-34	Term. X30/11 High Ref./Feedb. Value
0-67	Bus Access Password	Min. Current at Low Speed	3-80	Jog Ramp Time	5-40	Function Relay	6-35	Term. X30/11 High Ref./Feedb. Value
0-7*	Clock Settings	Start Adjustments	3-81	Quick Stop Ramp Time	5-41	On Delay, Relay	6-36	Term. X30/11 Filter Time Constant
0-70	Date and Time	PM Start Mode	3-82	Starting Ramp-up Time	5-42	Off Delay, Relay	6-37	Term. X30/11 Live Zero
0-71	Date Format	Start Delay	3-90	Step Size	5-50	Term. 29 Low Frequency	6-40	Terminal X30/12 Low Voltage
0-72	Time Format	Start Function	3-91	Ramp Time	5-51	Term. 29 High Frequency	6-41	Terminal X30/12 High Voltage
0-74	DST/Summertime	Flying Start	3-92	Power Restore	5-52	Term. 29 Low Ref./Feedb. Value	6-44	Term. X30/12 Low Ref./Feedb. Value
0-76	DST/Summertime Start	Compressor Start Max Speed [RPM]	3-93	Maximum Limit	5-53	Term. 29 High Ref./Feedb. Value	6-45	Term. X30/12 High Ref./Feedb. Value
0-77	DST/Summertime End	Compressor Start Max Speed [Hz]	3-94	Minimum Limit	5-54	Pulse Filter Time Constant #29	6-46	Term. X30/12 Filter Time Constant
0-79	Clock Fault	Compressor Start Max Time to Trip	3-95	Ramp Delay	5-55	Term. 33 Low Frequency	6-47	Term. X30/12 Live Zero
0-81	Working Days	Stop Adjustments	4-*	Limits/Warnings	5-56	Term. 33 High Frequency	6-5*	Analog Output 42
0-82	Additional Working Days	Function at Stop	4-1*	Motor Limits	5-57	Term. 33 Low Ref./Feedb. Value	6-50	Terminal 42 Output
0-83	Additional Non-Working Days	Min Speed for Function at Stop [RPM]	4-10	Motor Speed Direction	5-58	Term. 33 High Ref./Feedb. Value	6-51	Terminal 42 Output Min Scale
0-89	Date and Time Readout	Min Speed for Function at Stop [Hz]	4-11	Motor Speed Low Limit [RPM]	5-59	Pulse Filter Time Constant #33	6-52	Terminal 42 Output Max Scale
1-0*	Load and Motor	Trip Speed Low [RPM]	4-12	Motor Speed Low Limit [Hz]	5-6*	Pulse Output	6-53	Terminal 42 Output Bus Control
1-00	Configuration Mode	Trip Speed Low [Hz]	4-13	Motor Speed High Limit [RPM]	5-60	Terminal 27 Pulse Output Variable	6-54	Terminal 42 Output Timeout Preset
			4-14	Motor Speed High Limit [Hz]	5-62	Pulse Output Max Freq #27	6-55	Analog Output Filter



6-6*	Analog Output X30/8	8-95	Bus Feedback 2	12-10	Link Status	13-51	SL Controller Event	15-14	Samples Before Trigger
6-61	Terminal X30/8 Output	8-96	Bus Feedback 3	12-11	Link Duration	13-52	SL Controller Action	15-2*	Historic Log
6-62	Terminal X30/8 Min. Scale	9-9*	Profibus	12-12	Auto Negotiation	14-1*	Special Functions	15-20	Historic Log: Event
6-63	Terminal X30/8 Max. Scale	9-00	Setpoint	12-13	Link Speed	14-0*	Inverter Switching	15-21	Historic Log: Value
6-64	Terminal X30/8 Output Bus Control	9-05	Actual Value	12-14	Link Duplex	14-00	Switching Pattern	15-22	Historic Log: Time
	Terminal X30/8 Output Bus Control Preset	9-17	PCD Write Configuration	12-2*	Process Data	14-01	Switching Frequency	15-23	Historic log: Date and Time
		9-16	PCD Read Configuration	12-20	Control Instance	14-03	Overmodulation	15-3*	Alarm Log
		9-18	Node Address	12-21	Process Data Config Write	14-04	PWM Random	15-30	Alarm Log: Error Code
		9-22	Message Selection	12-22	Process Data Config Read	14-1*	Mains On/Off	15-31	Alarm Log: Value
		9-23	Parameters for Signals	12-27	Primary Master	14-10	Line failure	15-32	Alarm Log: Time
		9-27	Parameter Edit	12-28	Store Data Values	14-11	Mains Voltage at Mains Fault	15-33	Alarm Log: Date and Time
		9-28	Process Control	12-29	Store Always	14-12	Function at Mains Imbalance	15-4*	Drive Identification
		9-44	Fault Message Counter	12-3*	Ethernet/IP	14-2*	Reset Functions	15-40	FC Type
		9-45	Fault Code	12-30	Warning Parameter	14-20	Reset Mode	15-41	Power Section
		9-47	Fault Number	12-31	Net Reference	14-21	Automatic Restart Time	15-42	Voltage
		9-52	Fault Situation Counter	12-32	Net Control	14-22	Operation Mode	15-43	Software Version
		9-53	Profibus Warning Word	12-33	CIP Revision	14-23	Typecode Setting	15-44	Ordered Typecode String
		9-63	Actual Baud Rate	12-34	CIP Product Code	14-25	Trip Delay at Torque Limit	15-45	Actual Typecode String
		9-64	Device Identification	12-35	EDS Parameter	14-26	Trip Delay at Inverter Fault	15-46	Adjustable Frequency Drive Ordering Number
		9-65	Profile Number	12-37	COS Inhibit Timer	14-28	Production Settings		
		9-67	Control Word 1	12-38	COS Filter	14-29	Service Code	15-47	Power Card Ordering No.
		9-68	Status Word 1	12-4*	Modbus TCP	14-3*	Current Limit Ctrl.	15-48	LCP D No
		9-71	Profibus Save Data Values	12-40	Status Parameter	14-30	Current Lim Ctrl, Proportional Gain	15-49	SW ID Control Card
		9-72	ProfibusDriveReset	12-41	Slave Message Count	14-31	Current Lim Ctrl, Integration Time	15-50	SW ID Power Card
		9-75	DO Identification	12-42	Slave Exception Message Count	14-32	Current Lim Ctrl, Filter Time	15-51	Adjustable Frequency Drive Serial Number
		9-80	Defined Parameters (1)	12-8*	Other Ethernet Services	14-4*	Energy Optimizing		
		9-81	Defined Parameters (2)	12-80	FTP Server	14-40	VT Level	15-53	Power Card Serial Number
		9-82	Defined Parameters (3)	12-81	HTTP Server	14-41	AEO Minimum Magnetization	15-55	Vendor URL
		9-83	Defined Parameters (4)	12-82	SMP Service	14-42	Minimum AEO Frequency	15-56	Vendor Name
		9-84	Defined Parameters (5)	12-89	Transparent Socket Channel Port	14-43	Motor Cos Phi	15-59	CSV Filename
		9-90	Changed Parameters (1)	12-9*	Advanced Ethernet Services	14-5*	Environment	15-6*	Option Ident
		9-91	Changed Parameters (2)	12-90	Cable Diagnostic	14-50	RFI Filter	15-60	Option Mounted
		9-92	Changed Parameters (3)	12-91	Auto Crossover	14-51	DC Link Compensation	15-61	Option SW Version
		9-93	Changed Parameters (4)	12-92	IGMP Snooping	14-52	Fan Control	15-62	Option Ordering No
		9-94	Changed Parameters (5)	12-93	Cable Error Length	14-53	Fan Monitor	15-63	Option Serial No
		9-99	Profibus Revision Counter	12-94	Broadcast Storm Protection	14-55	Output Filter	15-70	Option in Slot A
		11-1*	LonWorks	12-95	Broadcast Storm Filter	14-56*	Auto Derate	15-71	Slot A Option SW Version
		11-0*	LonWorks ID	12-96	Port Config	14-60	Function at Overtemperature	15-72	Option in Slot B
		11-0*	Neuron ID	12-99	Interface Counters	14-61	Function at Inverter Overload	15-8*	Operating Data II
		11-10	Drive Profile	12-99	Media Counters	14-62	Inv. Overload Derate Current	15-80	Fan Running Hours
		11-15	LON Warning Word	13-3*	Smart Logic	14-9*	Fault Settings	15-9*	Parameter Info
		11-17	XIF Revision	13-0*	SLC Settings	14-90	Fault Level	15-92	Defined Parameters
		11-18	LonWorks Revision	13-01	Start Event	15-0*	Operating Data	15-93	Modified Parameters
		11-2*	LON Param. Access	13-02	Stop Event	15-00	Operating Hours	15-98	Drive Identification
		11-21	Store Data Values	13-03	Reset SLC	15-01	Running Hours	15-99	Parameter Metadata
		12-2*	Ethernet	13-1*	Comparators	15-02	kWh Counter	16-0*	Data Readouts
		12-0*	IP Settings	13-10	Comparator Operand	15-03	Power-ups	16-00	General Status
		12-00	IP Address Assignment	13-11	Comparator Operator	15-04	Overtemps	16-01	Control Word
		12-01	IP Address	13-12	Comparator Value	15-05	Overvolts	16-02	Reference [Unit]
		12-02	Subnet Mask	13-20	SL Controller Timer	15-06	Reset kWh Counter	16-03	Reference [%]
		12-03	Default Gateway	13-4*	Logic Rules	15-07	Reset Running Hours Counter	16-03	Status Word
		12-04	DHCP Server	13-40	Logic Rule Boolean 1	15-08	Number of Starts	16-05	Main Actual Value [%]
		12-05	Lease Expires	13-41	Logic Rule Operator 1	15-1*	Data Log Settings	16-09	Custom Readout
		12-06	Name Servers	13-42	Logic Rule Boolean 2	15-10	Logging Source	16-1*	Motor Status
		12-07	Domain Name	13-43	Logic Rule Operator 2	15-11	Logging Interval	16-10	Power [kW]
		12-08	Host Name	13-44	Logic Rule Operator 3	15-12	Trigger Event	16-11	Power [hp]
		12-09	Physical Address	13-5*	States	15-13	Logging Mode	16-12	Motor Voltage
		12-1*	Ethernet Link Parameters						

16-13	Frequency	16-92	Warning Word	20-69	Sensorless Information	21-5*	Ext. CL 3 Ref/Fb.	22-79	Minimum Run Time Override Value
16-14	Motor current	16-93	Warning Word 2	20-70*	PID Autotuning	21-50	Ext. 3 Ref/Feedback Unit	22-8*	Flow Compensation
16-15	Frequency [%]	16-94	Ext. Status Word	20-70	Closed-loop Type	21-51	Ext. 3 Minimum Reference	22-80*	Flow Compensation
16-16	Torque [Nm]	16-95	Ext. Status Word 2	20-71	PID Performance	21-52	Ext. 3 Maximum Reference	22-81	Square-linear Curve Approximation
16-17	Speed [RPM]	16-96	Maintenance Word	20-72	PID Output Change	21-53	Ext. 3 Reference Source	22-82	Work Point Calculation
16-18	Motor Thermal	18-1*	Info & Readouts	20-73	Minimum Feedback Level	21-54	Ext. 3 Feedback Source	22-83	Speed at No-Flow [RPM]
16-20	Motor Angle	18-0*	Maintenance Log	20-74	Maximum Feedback Level	21-55	Ext. 3 Setpoint	22-84	Speed at No-Flow [Hz]
16-22	Torque [%]	18-00	Maintenance Log: Item	20-79	PID Autotuning	21-57	Ext. 3 Reference [Unit]	22-85	Speed at Design Point [RPM]
16-26	Power Filtered [kW]	18-01	Maintenance Log: Action	20-8*	PID Basic Settings	21-58	Ext. 3 Feedback [Unit]	22-86	Speed at Design Point [Hz]
16-27	Power Filtered [hp]	18-02	Maintenance Log: Time	20-81	PID Normal/Inverse Control	21-59	Ext. 3 Output [%]	22-87	Pressure at No-Flow Speed
16-30*	Drive Status	18-03	Maintenance Log: Date and Time	20-82	PID Start Speed [RPM]	21-60	Ext. CL 3 PID	22-88	Pressure at Rated Speed
16-33	DC Link Voltage	18-1*	Fire Mode Log	20-83	PID Start Speed [Hz]	21-60	Ext. 3 Normal/Inverse Control	22-89	Flow at Design Point
16-32	Brake Energy /s	18-10	Fire Mode Log: Event	20-84	On Reference Bandwidth	21-61	Ext. 3 Proportional Gain	22-90	Flow at Rated Speed
16-33	Brake Energy /2 min	18-11	Fire Mode Log: Time	20-84	On Reference Bandwidth	21-62	Ext. 3 Integral Time	23-0*	Time-based Functions
16-34	Heatsink Temp.	18-12	Fire Mode Log: Date and Time	20-9*	PID Controller	21-63	Ext. 3 Differentiation Time	23-0*	Timed Actions
16-35	Inverter Thermal	18-3*	Inputs & Outputs	20-91	PID Anti Windup	21-64	Ext. 3 Dif. Gain Limit	23-00	ON Time
16-36	Inv. Nom. Current	18-30	Analog Input X42/1	20-93	PID Proportional Gain	22-0*	Miscellaneous	23-01	ON Action
16-37	Inv. Max. Current	18-31	Analog Input X42/3	20-94	PID Integral Time	22-00	External Interlock Delay	23-02	OFF Time
16-38	SL Controller State	18-32	Analog Input X42/5	20-95	PID Differentiation Time	22-01	Power Filter Time	23-03	OFF Action
16-39	Control Card Temp.	18-33	Analog Out X42/7 [V]	20-96	PID Diff. Gain Limit	22-01	No-Flow Detection	23-04	Occurrence
16-40	Logging Buffer Full	18-34	Analog Out X42/9 [V]	21-0*	Ext. CL Autotuning	22-2*	No-Flow Detection	23-0*	Timed Actions Settings
16-41	Logging Buffer Full	18-35	Analog Out X42/11 [V]	21-00	Closed-loop Type	22-20	Low Power Auto Set-up	23-08	Timed Actions Mode
16-43	Timed Actions Status	18-36	Analog Input X48/2 [mA]	21-01	PID Performance	22-21	Low Power Detection	23-09	Timed Actions Reactivation
16-49	Current Fault Source	18-37	Temp. Input X48/4	21-02	PID Output Change	22-22	Low Speed Detection	23-1*	Maintenance
16-5*	Ref. & Feeds.	18-38	Temp. Input X48/7	21-03	Minimum Feedback Level	22-23	No-Flow Item	23-10	Maintenance Item
16-50	External Reference	18-39	Temp. Input X48/10	21-04	Maximum Feedback Level	22-24	No-Flow Delay	23-11	Maintenance Action
16-52	Feedback [Unit]	18-5*	Ref. & Feeds.	21-09	PID Autotuning	22-26	Dry Pump Function	23-12	Maintenance Time Base
16-53	Digi Pot Reference	18-50	Sensorless Readout [unit]	21-1*	Ext. CL 1 Ref/Fb.	22-27	Dry Pump Delay	23-13	Maintenance Time Interval
16-54	Feedback 1 [Unit]	20-*	Drive Closed-loop	21-10	Ext. 1 Ref/Feedback Unit	22-27	ON Action	23-14	Maintenance Date and Time
16-55	Feedback 2 [Unit]	20-00	Feedback	21-11	Ext. 1 Minimum Reference	22-30	No-Flow Power	23-1*	Maintenance Reset
16-56	Feedback 3 [Unit]	20-00	Feedback 1 Source	21-12	Ext. 1 Maximum Reference	22-30	No-Flow Power	23-15	Reset Maintenance Word
16-58	PID Output [%]	20-01	Feedback 1 Conversion	21-13	Ext. 1 Reference Source	22-31	Power Correction Factor	23-16	Maintenance Text
16-6*	Inputs & Outputs	20-02	Feedback 2 Source Unit	21-14	Ext. 1 Feedback Source	22-32	Low Speed [RPM]	23-5*	Energy Log
16-60	Digital Input	20-03	Feedback 2 Source	21-15	Ext. 1 Setpoint	22-33	Low Speed [Hz]	23-50	Energy Log Resolution
16-61	Terminal 53 Switch Setting	20-04	Feedback 2 Conversion	21-17	Ext. 1 Reference [Unit]	22-35	Low Speed Power [hp]	23-51	Period Start
16-62	Terminal Input 53	20-05	Feedback 2 Source Unit	21-18	Ext. 1 Feedback [Unit]	22-36	High Speed [RPM]	23-53	Energy Log
16-63	Terminal 54 Switch Setting	20-06	Feedback 3 Source	21-19	Ext. 1 Output [%]	22-37	High Speed [Hz]	23-54	Reset Energy Log
16-64	Analog Input 54	20-07	Feedback 3 Conversion	21-2*	Ext. CL 1 PID	22-38	High Speed Power [kW]	23-6*	Trending
16-65	Analog Output 42 [mA]	20-08	Feedback 3 Source Unit	21-20	Ext. 1 Normal/Inverse Control	22-39	High Speed Power [hp]	23-60	Trend Variable
16-66	Digital Output [bin]	20-12	Reference/Feedback Unit	21-21	Ext. 1 Proportional Gain	22-4*	Sleep Mode	23-61	Continuous Bin Data
16-67	Pulse Input #29 [Hz]	20-13	Minimum Reference/Feedb.	21-22	Ext. 1 Integral Time	22-40	Minimum Run Time	23-62	Timed Bin Data
16-68	Pulse Input #33 [Hz]	20-14	Maximum Reference/Feedb.	21-23	Ext. 1 Differentiation Time	22-41	Minimum Sleep Time	23-63	Timed Period Start
16-69	Pulse Output #29 [Hz]	20-2*	Feedback/Setpoint	21-23	Ext. 1 Differentiation Time	22-42	Wake-up Speed [RPM]	23-64	Timed Period Stop
16-70	Pulse Output #29 [Hz]	20-20	Feedback Function	21-24	Ext. 1 Dif. Gain Limit	22-43	Wake-up Speed [Hz]	23-65	Minimum Bin Value
16-71	Relay Output [bin]	20-21	Setpoint 1	21-30	Ext. 2 Ref/Feedback Unit	22-44	Wake-up Ref/FB Difference	23-66	Reset Continuous Bin Data
16-72	Counter A	20-22	Setpoint 2	21-31	Ext. 2 Minimum Reference	22-45	Setpoint Boost	23-67	Reset Timed Bin Data
16-73	Counter B	20-23	Setpoint 3	21-32	Ext. 2 Maximum Reference	22-46	Maximum Boost Time	23-8*	Payback Counter
16-75	Analog In X30/11	20-3*	Feedb. Adv. Conv.	21-33	Ext. 2 Reference Source	22-5*	End of Curve	23-80	Power Reference Factor
16-76	Analog In X30/12	20-30	Refrigerant	21-34	Ext. 2 Feedback Source	22-50	End of Curve Function	23-81	Energy Cost
16-77	Analog Out X30/8 [mA]	20-31	User-defined Refrigerant A1	21-35	Ext. 2 Setpoint	22-51	End of Curve Delay	23-82	Investment
16-80*	Fieldbus & FC Port	20-32	User-defined Refrigerant A2	21-37	Ext. 2 Reference [Unit]	22-6*	Broken Belt Detection	23-83	Energy Savings
16-80	Fieldbus CTW 1	20-33	User-defined Refrigerant A3	21-38	Ext. 2 Feedback [Unit]	22-60	Broken Belt Function	23-84	Cost Savings
16-82	Fieldbus REF 1	20-34	Duct 1 Area [m2]	21-39	Ext. 2 Output [%]	22-61	Broken Belt Torque	24-*	Appl. Functions 2
16-84	Comm. Option STW	20-35	Duct 2 Area [m2]	21-40	Ext. CL 2 PID	22-62	Broken Belt Torque	24-0*	Fire Mode
16-85	FC Port CTW 1	20-36	Duct 1 Area [m2]	21-40	Ext. 2 Normal/Inverse Control	22-7*	Short Cycle Protection	24-00	Fire Mode Function
16-86	FC Port REF 1	20-37	Duct 2 Area [m2]	21-41	Ext. 2 Proportional Gain	22-75	Short Cycle Protection	24-01	Fire Mode Configuration
16-90*	Diagnosis Readouts	20-38	Air Density Factor [%]	21-42	Ext. 2 Integral Time	22-76	Interval between Starts	24-02	Fire Mode Unit
16-91	Alarm Word 2	20-60	Sensorless Unit	21-43	Ext. 2 Differentiation Time	22-77	Minimum Run Time	24-03	Fire Mode Min Reference
				21-44	Ext. 2 Dif. Gain Limit	22-78	Minimum Run Time Override	24-04	Fire Mode Max Reference

24-05	Fire Mode Preset Reference	25-82	Lead Pump	31-02	Bypass Trip Time Delay
24-06	Fire Mode Reference Source	25-83	Relay Status	31-03	Test Mode Activation
24-07	Fire Mode Feedback Source	25-84	Pump ON Time	31-10	Bypass Status Word
24-09	Fire Mode Alarm Handling	25-85	Relay ON Time	31-11	Bypass Running Hours
24-10	Drive Bypass	25-86	Reset Relay Counters	31-19	Remote Bypass Activation
24-11	Drive Bypass Function	25-9*	Service	35-2*	Sensor Input Option
24-11	Drive Bypass Delay Time	25-90	Pump Interlock	35-0*	Temp. Input Mode
24-90	Multi-Motor Funct.	25-91	Manual Alternation	35-00	Term. X48/4 Temperature Unit
24-91	Missing Motor Coefficient 1	26-0*	Analog I/O Option	35-01	Term. X48/4 Input Type
24-92	Missing Motor Coefficient 2	26-00	Terminal X42/1 Mode	35-02	Term. X48/7 Temperature Unit
24-93	Missing Motor Coefficient 3	26-01	Terminal X42/3 Mode	35-03	Term. X48/7 Input Type
24-94	Missing Motor Coefficient 4	26-02	Terminal X42/5 Mode	35-04	Term. X48/10 Temperature Unit
24-95	Locked Rotor Function	26-1*	Analog Input X42/1	35-05	Term. X48/10 Input Type
24-96	Locked Rotor Coefficient 1	26-10	Terminal X42/1 Low Voltage	35-06	Temperature Sensor Alarm Function
24-97	Locked Rotor Coefficient 2	26-11	Terminal X42/1 High Voltage	35-1*	Temp. Input X48/4
24-98	Locked Rotor Coefficient 3	26-14	Term. X42/1 Low Ref./Feedb. Value	35-14	Term. X48/4 Filter Time Constant
24-99	Locked Rotor Coefficient 4	26-15	Term. X42/1 High Ref./Feedb. Value	35-15	Term. X48/4 Temp. Monitor
25-2*	Cascade Controller	26-16	Term. X42/1 Filter Time Constant	35-16	Term. X48/4 Low Temp. Limit
25-0*	System Settings	26-17	Term. X42/1 Live Zero	35-17	Term. X48/4 High Temp. Limit
25-00	Cascade Controller	26-2*	Analog Input X42/3	35-2*	Temp. Input X48/7
25-02	Motor Start	26-20	Terminal X42/3 Low Voltage	35-24	Term. X48/7 Filter Time Constant
25-04	Pump Cycling	26-21	Terminal X42/3 High Voltage	35-25	Term. X48/7 Temp. Monitor
25-05	Fixed Lead Pump	26-24	Term. X42/3 Low Ref./Feedb. Value	35-26	Term. X48/7 Low Temp. Limit
25-06	Number of Pumps	26-25	Term. X42/3 High Ref./Feedb. Value	35-27	Term. X48/7 High Temp. Limit
25-2*	Bandwidth Settings	26-26	Term. X42/3 Filter Time Constant	35-3*	Temp. Input X48/10
25-20	Staging Bandwidth	26-27	Term. X42/3 Live Zero	35-34	Term. X48/10 Filter Time Constant
25-21	Override Bandwidth	26-3*	Analog Input X42/5	35-35	Term. X48/10 Temp. Monitor
25-22	Fixed Speed Bandwidth	26-30	Terminal X42/5 Low Voltage	35-36	Term. X48/10 Low Temp. Limit
25-23	SBW Staging Delay	26-31	Terminal X42/5 High Voltage	35-37	Term. X48/10 High Temp. Limit
25-24	SBW Staging Delay	26-34	Term. X42/5 Low Ref./Feedb. Value	35-4*	Analog Input X48/2
25-25	OBW Time	26-35	Term. X42/5 High Ref./Feedb. Value	35-42	Term. X48/2 Low Current
25-26	Destage At No-Flow	26-36	Term. X42/5 Filter Time Constant	35-43	Term. X48/2 High Current
25-27	Stage Function	26-37	Term. X42/5 Live Zero	35-44	Term. X48/2 Low Ref./Feedb. Value
25-28	Stage Function Time	26-4*	Analog Out X42/7	35-45	Term. X48/2 High Ref./Feedb. Value
25-29	Destage Function	26-40	Terminal X42/7 Output	35-46	Term. X48/2 Filter Time Constant
25-30	Destage Function Time	26-41	Terminal X42/7 Min. Scale	35-47	Term. X48/2 Live Zero
25-4*	Staging Settings	26-42	Terminal X42/7 Max. Scale		
25-40	Ramp-down Delay	26-43	Terminal X42/7 Bus Control		
25-41	Ramp-up Delay	26-44	Terminal X42/7 Timeout Preset		
25-42	Staging Threshold	26-5*	Analog Out X42/9		
25-43	Destaging Threshold	26-50	Terminal X42/9 Output		
25-44	Staging Speed [RPM]	26-51	Terminal X42/9 Min. Scale		
25-45	Staging Speed [Hz]	26-52	Terminal X42/9 Max. Scale		
25-46	Destaging Speed [RPM]	26-53	Terminal X42/9 Bus Control		
25-47	Destaging Speed [Hz]	26-54	Terminal X42/9 Timeout Preset		
25-5*	Alternation Settings	26-6*	Analog Out X42/11		
25-50	Lead Pump Alternation	26-60	Terminal X42/11 Output		
25-51	Alternation Event	26-61	Terminal X42/11 Min. Scale		
25-52	Alternation Time Interval	26-62	Terminal X42/11 Max. Scale		
25-53	Alternation Timer Value	26-63	Terminal X42/11 Bus Control		
25-54	Alternation Predefined Time	26-64	Terminal X42/11 Timeout Preset		
25-55	Alternate if Load < 50%	30-2*	Special Features		
25-56	Staging Mode at Alternation	30-2*	Adv. Start Adjust		
25-58	Run Next Pump Delay	30-22	Locked Rotor Detection		
25-59	Run-on Line Delay	30-23	Locked Rotor Detection Time [s]		
25-8*	Status	31-0*	Bypass Option		
25-80	Cascade Status	31-00	Bypass Mode		
25-81	Pump Status	31-01	Bypass Start Time Delay		

9.3 Active Filter Parameter Lists

9.3.1 Default settings

Changes during operation:

"TRUE" means that the parameter can be changed while the active filter is in operation and "FALSE" means that the unit must be stopped before a change can be made.

4 set-up:

'All set-up': the parameter can be set individually in each of the four set-ups, i.e., one single parameter can have four different data values.

'1 set-up': the data value will be the same in all set-ups.

SR:

Size related.

N/A:

No default value available.

Conversion index:

This number refers to a conversion figure used when writing or reading using an active filter.

Conv. index	100	75	74	70	67	6	5	4	3	2	1	0	-1	-2	-3	-4	-5	-6
Conv. factor	1	3,600,000	3,600	60	1/60	1,000,000	100,000	10,000	1,000	100	10	1	0.1	0.01	0.001	0.0001	0.00001	0.000001

Table 9.1

Data type	Description	Type
2	Integer 8	Int8
3	Integer 16	Int16
4	Integer 32	Int32
5	Unsigned 8	UInt8
6	Unsigned 16	UInt16
7	Unsigned 32	UInt32
9	Visible String	VisStr
33	Normalized value 2 bytes	N2
35	Bit sequence of 16 Boolean variables	V2
54	Time difference w/o date	TimD

Table 9.2

9.3.2 Operation/Display 0-**

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conversion index	Type
0-0* Basic Settings						
0-01	Language	[0] English	1 set-up	TRUE	-	Uint8
0-04	Operating State at Power-up (Hand)	[1] Forced stop	All set-ups	TRUE	-	Uint8
0-1* Set-up Operations						
0-10	Active Set-up	[1] Set-up 1	1 set-up	TRUE	-	Uint8
0-11	Edit Set-up	[1] Set-up 1	All set-ups	TRUE	-	Uint8
0-12	This Set-up Linked to	[0] Not linked	All set-ups	FALSE	-	Uint8
0-13	Readout: Linked Set-ups	0 N/A	All set-ups	FALSE	0	Uint16
0-14	Readout: Edit Set-ups / Channel	0 N/A	All set-ups	TRUE	0	Int32
0-2* Display						
0-20	Display Line 1.1 Small	30112	All set-ups	TRUE	-	Uint16
0-21	Display Line 1.2 Small	30110	All set-ups	TRUE	-	Uint16
0-22	Display Line 1.3 Small	30120	All set-ups	TRUE	-	Uint16
0-23	Display Line 2 Large	30100	All set-ups	TRUE	-	Uint16
0-24	Display Line 3 Large	30121	All set-ups	TRUE	-	Uint16
0-25	My Personal Menu	ExpressionLimit	1 set-up	TRUE	0	Uint16
0-4* Keypad						
0-40	[Hand on] Key on	[1] Enabled	All set-ups	TRUE	-	Uint8
0-41	[Off] Key on	[1] Enabled	All set-ups	TRUE	-	Uint8
0-42	[Auto on] Key on	[1] Enabled	All set-ups	TRUE	-	Uint8
0-43	[Reset] Key on	[1] Enabled	All set-ups	TRUE	-	Uint8
0-5* Copy/Save						
0-50	Copy	[0] No copy	All set-ups	FALSE	-	Uint8
0-51	Set-up Copy	[0] No copy	All set-ups	FALSE	-	Uint8
0-6* Password						
0-60	Main Menu Password	100 N/A	1 set-up	TRUE	0	Int16
0-61	Access to Main Menu w/o Password	[0] Full access	1 set-up	TRUE	-	Uint8
0-65	Quick Menu Password	200 N/A	1 set-up	TRUE	0	Int16
0-66	Access to Quick Menu w/o Password	[0] Full access	1 set-up	TRUE	-	Uint8

9.3.3 Digital In/Out 5-**

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conversion index	Type
5-0* Digital I/O mode						
5-00	Digital I/O Mode	[0] PNP	All set-ups	FALSE	-	Uint8
5-01	Terminal 27 Mode	[0] Input	All set-ups	TRUE	-	Uint8
5-02	Terminal 29 Mode	[0] Input	All set-ups	TRUE	-	Uint8
5-1* Digital Inputs						
5-10	Terminal 18 Digital Input	[8] Start	All set-ups	TRUE	-	Uint8
5-11	Terminal 19 Digital Input	[0] No operation	All set-ups	TRUE	-	Uint8
5-12	Terminal 27 Digital Input	[0] No operation	All set-ups	TRUE	-	Uint8
5-13	Terminal 29 Digital Input	[0] No operation	All set-ups	TRUE	-	Uint8
5-14	Terminal 32 Digital Input	[90] AC Contactor	All set-ups	TRUE	-	Uint8
5-15	Terminal 33 Digital Input	[91] DC Contactor	All set-ups	TRUE	-	Uint8

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conversion index	Type
5-16	Terminal X30/2 Digital Input	[0] No operation	All set-ups	TRUE	-	Uint8
5-17	Terminal X30/3 Digital Input	[0] No operation	All set-ups	TRUE	-	Uint8
5-18	Terminal X30/4 Digital Input	[0] No operation	All set-ups	TRUE	-	Uint8
5-19	Terminal 37 Safe Stop	[1] Safe Stop Alarm	1 set-up	TRUE	-	Uint8
5-3* Digital Outputs						
5-30	Terminal 27 Digital Output	[0] No operation	All set-ups	TRUE	-	Uint8
5-31	Terminal 29 Digital Output	[0] No operation	All set-ups	TRUE	-	Uint8
5-4* Relays						
5-40	Function Relay	[0] No operation	All set-ups	TRUE	-	Uint8
5-41	On Delay, Relay	0.30 s	All set-ups	TRUE	-2	Uint16
5-42	Off Delay, Relay	0.30 s	All set-ups	TRUE	-2	Uint16

9.3.4 Comm. and Options 8-**

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conversion index	Type
8-0* General Settings						
8-01	Control Site	[0] Digital and ctrl.word	All set-ups	TRUE	-	Uint8
8-02	Control Word Source	null	All set-ups	TRUE	-	Uint8
8-03	Control Word Timeout Time	1.0 s	1 set-up	TRUE	-1	Uint32
8-04	Control Word Timeout Function	[0] Off	1 set-up	TRUE	-	Uint8
8-05	End-of-Timeout Function	[1] Resume set-up	1 set-up	TRUE	-	Uint8
8-06	Reset Control Word Timeout	[0] Do not reset	All set-ups	TRUE	-	Uint8
8-3* FC Port Settings						
8-30	Protocol	[1] FC MC	1 set-up	TRUE	-	Uint8
8-31	Address	2 N/A	1 set-up	TRUE	0	Uint8
8-32	FC Port Baud Rate	[2] 9600 Baud	1 set-up	TRUE	-	Uint8
8-35	Minimum Response Delay	10 ms	All set-ups	TRUE	-3	Uint16
8-36	Max Response Delay	5000 ms	1 set-up	TRUE	-3	Uint16
8-37	Max Inter-Char Delay	25 ms	1 set-up	TRUE	-3	Uint16
8-5* Digital/Bus						
8-53	Start Select	[3] Logic OR	All set-ups	TRUE	-	Uint8
8-55	Set-up Select	[3] Logic OR	All set-ups	TRUE	-	Uint8

9.3.5 Special Functions 14-**

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conversion index	Type
14-2* Trip Reset						
14-20	Reset Mode	[0] Manual reset	All set-ups	TRUE	-	Uint8
14-21	Automatic Restart Time	10 s	All set-ups	TRUE	0	Uint16
14-22	Operation Mode	[0] Normal operation	All set-ups	TRUE	-	Uint8
14-23	Typecode Setting	null	2 set-ups	FALSE	-	Uint8
14-28	Production Settings	[0] No action	All set-ups	TRUE	-	Uint8
14-29	Service Code	0 N/A	All set-ups	TRUE	0	Int32
14-5* Environment						
14-50	RFI filter	[1] On	1 set-up	FALSE	-	Uint8
14-53	Fan Monitor	[1] Warning	All set-ups	TRUE	-	Uint8
14-54	Bus Partner	1 N/A	2 set-ups	TRUE	0	Uint16

9.3.6 Adj. Freq. Drive Information 15-**

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conversion index	Type
15-0* Operating Data						
15-00	Operating Hours	0 h	All set-ups	FALSE	74	Uint32
15-01	Running Hours	0 h	All set-ups	FALSE	74	Uint32
15-03	Power-ups	0 N/A	All set-ups	FALSE	0	Uint32
15-04	Over Temps	0 N/A	All set-ups	FALSE	0	Uint16
15-05	Over Volts	0 N/A	All set-ups	FALSE	0	Uint16
15-07	Reset Running Hours Counter	[0] Do not reset	All set-ups	TRUE	-	Uint8
15-1* Data Log Settings						
15-10	Logging Source	0	2 set-ups	TRUE	-	Uint16
15-11	Logging Interval	ExpressionLimit	2 set-ups	TRUE	-3	TimD
15-12	Trigger Event	[0] False	1 set-up	TRUE	-	Uint8
15-13	Logging Mode	[0] Log always	2 set-ups	TRUE	-	Uint8
15-14	Samples Before Trigger	50 N/A	2 set-ups	TRUE	0	Uint8
15-2* Historic Log						
15-20	Historic Log: Event	0 N/A	All set-ups	FALSE	0	Uint8
15-21	Historic Log: Value	0 N/A	All set-ups	FALSE	0	Uint32
15-22	Historic Log: Time	0 ms	All set-ups	FALSE	-3	Uint32
15-3* Fault Log						
15-30	Fault Log: Error Code	0 N/A	All set-ups	FALSE	0	Uint16
15-31	Fault Log: Value	0 N/A	All set-ups	FALSE	0	Int16
15-32	Fault Log: Time	0 s	All set-ups	FALSE	0	Uint32
15-4* Unit Identification						
15-40	FC Type	0 N/A	All set-ups	FALSE	0	VisStr[6]
15-41	Power Section	0 N/A	All set-ups	FALSE	0	VisStr[20]
15-42	Voltage	0 N/A	All set-ups	FALSE	0	VisStr[20]
15-43	Software Version	0 N/A	All set-ups	FALSE	0	VisStr[5]
15-44	Ordered Typecode String	0 N/A	All set-ups	FALSE	0	VisStr[40]
15-45	Actual Typecode String	0 N/A	All set-ups	FALSE	0	VisStr[40]
15-46	Unit Ordering No	0 N/A	All set-ups	FALSE	0	VisStr[8]

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conversion index	Type
15-47	Power Card Ordering No	0 N/A	All set-ups	FALSE	0	VisStr[8]
15-48	ID No	0 N/A	All set-ups	FALSE	0	VisStr[20]
15-49	SW ID Control Card	0 N/A	All set-ups	FALSE	0	VisStr[20]
15-50	SW ID Power Card	0 N/A	All set-ups	FALSE	0	VisStr[20]
15-51	Unit Serial Number	0 N/A	All set-ups	FALSE	0	VisStr[10]
15-53	Power Card Serial Number	0 N/A	All set-ups	FALSE	0	VisStr[19]
15-6* Option Ident						
15-60	Option Mounted	0 N/A	All set-ups	FALSE	0	VisStr[30]
15-61	Option SW Version	0 N/A	All set-ups	FALSE	0	VisStr[20]
15-62	Option Ordering No	0 N/A	All set-ups	FALSE	0	VisStr[8]
15-63	Option Serial No	0 N/A	All set-ups	FALSE	0	VisStr[18]
15-70	Option in Slot A	0 N/A	All set-ups	FALSE	0	VisStr[30]
15-71	Slot A Option SW Version	0 N/A	All set-ups	FALSE	0	VisStr[20]
15-72	Option in Slot B	0 N/A	All set-ups	FALSE	0	VisStr[30]
15-73	Slot B Option SW Version	0 N/A	All set-ups	FALSE	0	VisStr[20]
15-74	Option in Slot C0	0 N/A	All set-ups	FALSE	0	VisStr[30]
15-75	Slot C0 Option SW Version	0 N/A	All set-ups	FALSE	0	VisStr[20]
15-76	Option in Slot C1	0 N/A	All set-ups	FALSE	0	VisStr[30]
15-77	Slot C1 Option SW Version	0 N/A	All set-ups	FALSE	0	VisStr[20]
15-9* Parameter Info						
15-92	Defined Parameters	0 N/A	All set-ups	FALSE	0	Uint16
15-93	Modified Parameters	0 N/A	All set-ups	FALSE	0	Uint16
15-98	Unit Identification	0 N/A	All set-ups	FALSE	0	VisStr[40]
15-99	Parameter Metadata	0 N/A	All set-ups	FALSE	0	Uint16

9.3.7 Data Readouts 16-**

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conversion index	Type
16-0* General Status						
16-00	Control Word	0 N/A	All set-ups	FALSE	0	V2
16-03	Status Word	0 N/A	All set-ups	FALSE	0	V2
16-3* AF Status						
16-30	DC Link Voltage	0 V	All set-ups	FALSE	0	Uint16
16-34	Heatsink Temp.	32°F [0°C]	All set-ups	FALSE	100	Uint8
16-35	Inverter Thermal	0%	All set-ups	FALSE	0	Uint8
16-36	Inv. Nom. Current	ExpressionLimit	All set-ups	FALSE	-2	Uint32
16-37	Inv. Max. Current	ExpressionLimit	All set-ups	FALSE	-2	Uint32
16-39	Control Card Temp.	32°F [0°C]	All set-ups	FALSE	100	Uint8
16-40	Logging Buffer Full	[0] No	All set-ups	TRUE	-	Uint8
16-49	Current Fault Source	0 N/A	All set-ups	TRUE	0	Uint8
16-6* Inputs & Outputs						
16-60	Digital Input	0 N/A	All set-ups	FALSE	0	Uint16
16-66	Digital Output [bin]	0 N/A	All set-ups	FALSE	0	Int16
16-71	Relay Output [bin]	0 N/A	All set-ups	FALSE	0	Int16
16-8* & FC Port						
16-80	CTW 1	0 N/A	All set-ups	FALSE	0	V2

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conversion index	Type
16-84	Comm. Option STW	0 N/A	All set-ups	FALSE	0	V2
16-85	FC Port CTW 1	0 N/A	All set-ups	FALSE	0	V2
16-9* Diagnosis Readouts						
16-90	Alarm Word	0 N/A	All set-ups	FALSE	0	Uint32
16-91	Alarm Word 2	0 N/A	All set-ups	FALSE	0	Uint32
16-92	Warning Word	0 N/A	All set-ups	FALSE	0	Uint32
16-93	Warning Word 2	0 N/A	All set-ups	FALSE	0	Uint32
16-94	Ext. Status Word	0 N/A	All set-ups	FALSE	0	Uint32

9.3.8 AF Settings 300-**

NOTICE!

Except for *parameter 300-10 Active Filter Nominal Voltage*, it is not recommended to change the settings in this par. group for the Low Harmonic Drive

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conversion index	Type
300-0* General Settings						
300-00	Harmonic Cancellation Mode	[0] Overall	All set-ups	TRUE	-	Uint8
300-01	Compensation Priority	[0] Harmonics	All set-ups	TRUE	-	Uint8
300-1* Network Settings						
300-10	Active Filter Nominal Voltage	ExpressionLimit	2 set-ups	FALSE	0	Uint32
300-2* CT Settings						
300-20	CT Primary Rating	ExpressionLimit	2 set-ups	FALSE	0	Uint32
300-22	CT Nominal Voltage	342 V	2 set-ups	FALSE	0	Uint32
300-24	CT Sequence	[0] L1, L2, L3	2 set-ups	FALSE	-	Uint8
300-25	CT Polarity	[0] Normal	2 set-ups	FALSE	-	Uint8
300-26	CT Placement	[1] Load Current	2 set-ups	FALSE	-	Uint8
300-29	Start Auto CT Detection	[0] Off	All set-ups	FALSE	-	Uint8
300-3* Compensation						
300-30	Compensation Points	0.0 A	All set-ups	TRUE	-1	Uint32
300-35	Cos-phi Reference	0.500 N/A	All set-ups	TRUE	-3	Uint16
300-4* Paralleling						
300-40	Master Follower Selection	[2] Not Paralleled	2 set-ups	FALSE	-	Uint8
300-41	Follower ID	1 N/A	2 set-ups	FALSE	0	Uint32
300-42	Num. of Follower AFs	1 N/A	2 set-ups	FALSE	0	Uint32
300-5* Sleep Mode						
300-50	Enable Sleep Mode	null	2 set-ups	TRUE	-	Uint8
300-51	Sleep Mode Trig Source	[0] Line power	All set-ups	TRUE	-	Uint8
300-52	Sleep Mode Wake-up Trigger	ExpressionLimit	All set-ups	TRUE	0	Uint32
300-53	Sleep Mode Sleep Trigger	80%	All set-ups	TRUE	0	Uint32

9.3.9 AF Readouts 301-**

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conversion index	Type
301-0* Output Currents						
301-00	Output Current [A]	0.00 A	All set-ups	TRUE	-2	Int32
301-01	Output Current [%]	0.0%	All set-ups	TRUE	-1	Int32
301-1* Unit Performance						
301-10	THD of Current [%]	0.0%	All set-ups	TRUE	-1	UInt16
301-11	Estimated THD of Voltage [%]	0.0%	All set-ups			UInt16
301-12	Power Factor	0.00 N/A	All set-ups	TRUE	-2	UInt16
301-13	Cos-phi	0.00 N/A	All set-ups	TRUE	-2	Int16
301-14	Leftover Currents	0.0 A	All set-ups	TRUE	-1	UInt32
301-2* Line Power Status						
301-20	Line Power Current [A]	0 A	All set-ups	TRUE	0	Int32
301-21	Line Power Frequency	0 Hz	All set-ups	TRUE	0	UInt8
301-22	Fund. Line Power Current [A]	0 A	All set-ups	TRUE	0	Int32

10 Appendix B

10.1 Abbreviations and Conventions

AC	Alternating current
AEO	Automatic energy optimization
AMA	Automatic motor adaptation
AWG	American wire gauge
°C	Degrees celsius
DC	Direct current
EMC	Electromagnetic compatibility
ETR	Electronic thermal relay
$f_{M,N}$	Nominal motor frequency
FC	Frequency converter
I_{LIM}	Current limit
I_{INV}	Rated inverter output current
$I_{M,N}$	Nominal motor current
$I_{VLT,MAX}$	The maximum output current
$I_{VLT,N}$	The rated output current supplied by the frequency converter
IP	Ingress protection
LCP	Local control panel
N.A.	Not applicable
$P_{M,N}$	Nominal motor power
PCB	Printed circuit board
PE	Protective earth
PELV	Protective extra low voltage
Regen	Regenerative terminals
RPM	Revolutions per minute
T_{LIM}	Torque limit
$U_{M,N}$	Nominal motor voltage

Table 10.1 Abbreviations

Conventions

Numbered lists indicate procedures.

Bullet lists indicate other information and description of illustrations.

Italicised text indicates:

- Cross-reference.
- Link.
- Footnote.
- Parameter name, parameter group name, parameter option.

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