MAKING MODERN LIVING POSSIBLE

Operating Instructions

VLT® HVAC Drive FC 102 Low Harmonic Drive

vlt-drives.danfoss.com

THE REAL DRIVE

ENGINEERING TOMORROW

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EU DECLARATION OF CONFORMITY

Danfoss A/S

Danfoss Drives A/S

declares under our sole responsibility that the

Product category: Frequency Converter
Type designation(s): FC-102XYYYZZ**********

Character X: N or P
Character YYY: K37, K75, 1K1, 1K5, 2K2, 3K0, 3K7, 4K0, 5K5, 7K5, 11K, 15K, 18K, 22K, 30K, 37K, 45K, 55K, 75K, 90K, 110, 132, 150, 160, 200, 250, 315, 355, 400, 450, 500, 560, 630, 710, 800, 900, 1M0, 1M2, 1M4
Character ZZ: T2, T4, T6, T7
* may be any number or letter indicating drive options which do not impact this DoC.
The meaning of the 39 characters in the type code string can be found in appendix 00729776.

Covered by this declaration is in conformity with the following directive(s), standard(s) or other normative document(s), provided that the product is used in accordance with our instructions.

Low Voltage Directive 2014/35/EU

EN61800-5-1:2007 + A1:2017	Adjustable speed electrical power drive systems – Part 5-1: Safety requirements – Electrical, thermal and energy.

EMC Directive 2014/30/EU

EN61800-3:2004 + A1:2012	Adjustable speed electrical power drive systems – Part 3: EMC requirements and specific test methods.

RoHS Directive 2011/65/EU including amendment 2015/863.

EN63000:2018	Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

Date: 2020.09.02 Place of issue:	Issued by	Date: 2020.09.02 Place of issue:	Approved by
Graasten, DK	**Signature:** **Name: Gert Kjær** **Title: Senior Director, GDE**	Graasten, DK	**Signature:** **Name: Michael Termansen** **Title: VP, PD Center Denmark**

Danfoss only vouches for the correctness of the English version of this declaration. In the event of the declaration being translated into any other language, the translator concerned shall be liable for the correctness of the translation

For products including available Safe Torque Off (STO) function according to unit typecode on the nameplate: **T or U at character 18 of the typecode.**

Machine Directive 2006/42/EC

EN/IEC 61800-5-2:2007 (Safe Stop function conforms with STO – Safe Torque Off, SIL 2 Capability)	Adjustable speed electrical power drive systems – Part 5-2: Safety requirements – Functional

Other standards considered:

EN ISO 13849-1:2015 (Safe Stop function, PL d (MTTFd=14000 years, DC=90%, Category 3)	Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design
EN/IEC 61508-1:2011, EN/IEC 61508-2:2011 (Safe Stop function, SIL 2 (PFH = 1E-10/h, 1E-8/h for specific variants, PFD = 1E-10, 1E-4 for specific variants, SFF>99%, HFT=0))	Functional safety of electrical/electronic/ programmable electronic safety-related systems Part 1: General requirements Part 2: Requirements for electrical/ electronic / programmable electronic safety-related systems
EN/IEC 62061:2005 + A1:2013 (Safe Stop function, SILCL 2)	Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems
EN/IEC 60204-1:2006 + A1:2009 (Stop Category 0)	Safety of machinery - Electrical equipment of machines - Part 1: General requirements

For products including ATEX option, it requires STO function in the products. The products can have the VLT PTC Thermistor Card MCB112 installed from factory **(2 at character 32 in the typecode)**, or it can be separately installed as an additional part.

2014/34/EU - Equipment for explosive atmospheres (ATEX)

Based on EU harmonized standard: EN 50495: 2010	Safety devices required for safe functioning of equipment with respect to explosion risks.

Notified Body:
PTB Physikalisch-Technische Bundesanstalt, Bundesallee 100, 38116 Braunschweig,
has assessed the conformity of the "ATEX certified motor thermal protection systems" of Danfoss FC VLT Drives with Safe Torque Off function and has issued the certificate PTB 14 ATEX 3009.

Contents

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 Drive. 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, and 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 AAF 006 Operating Instructions* provide 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.
- Optimizes 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 function 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.

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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.

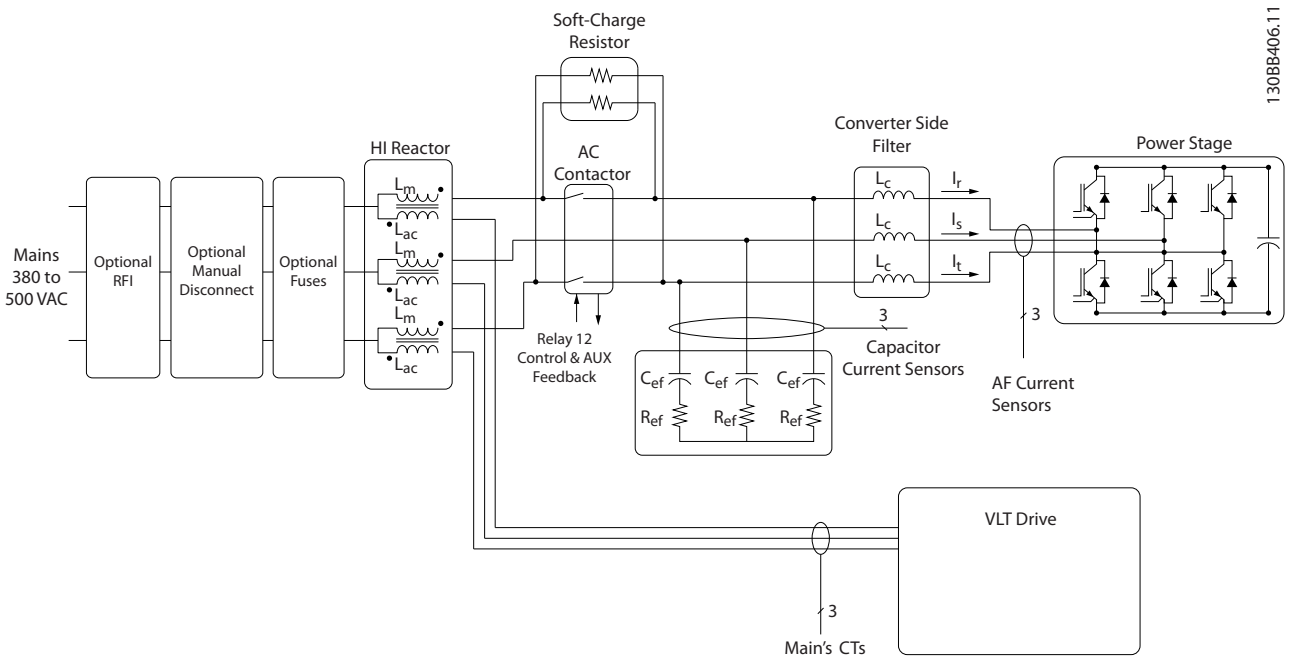

Illustration 1.1 Basic Layout for the Low Harmonic Drive

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.

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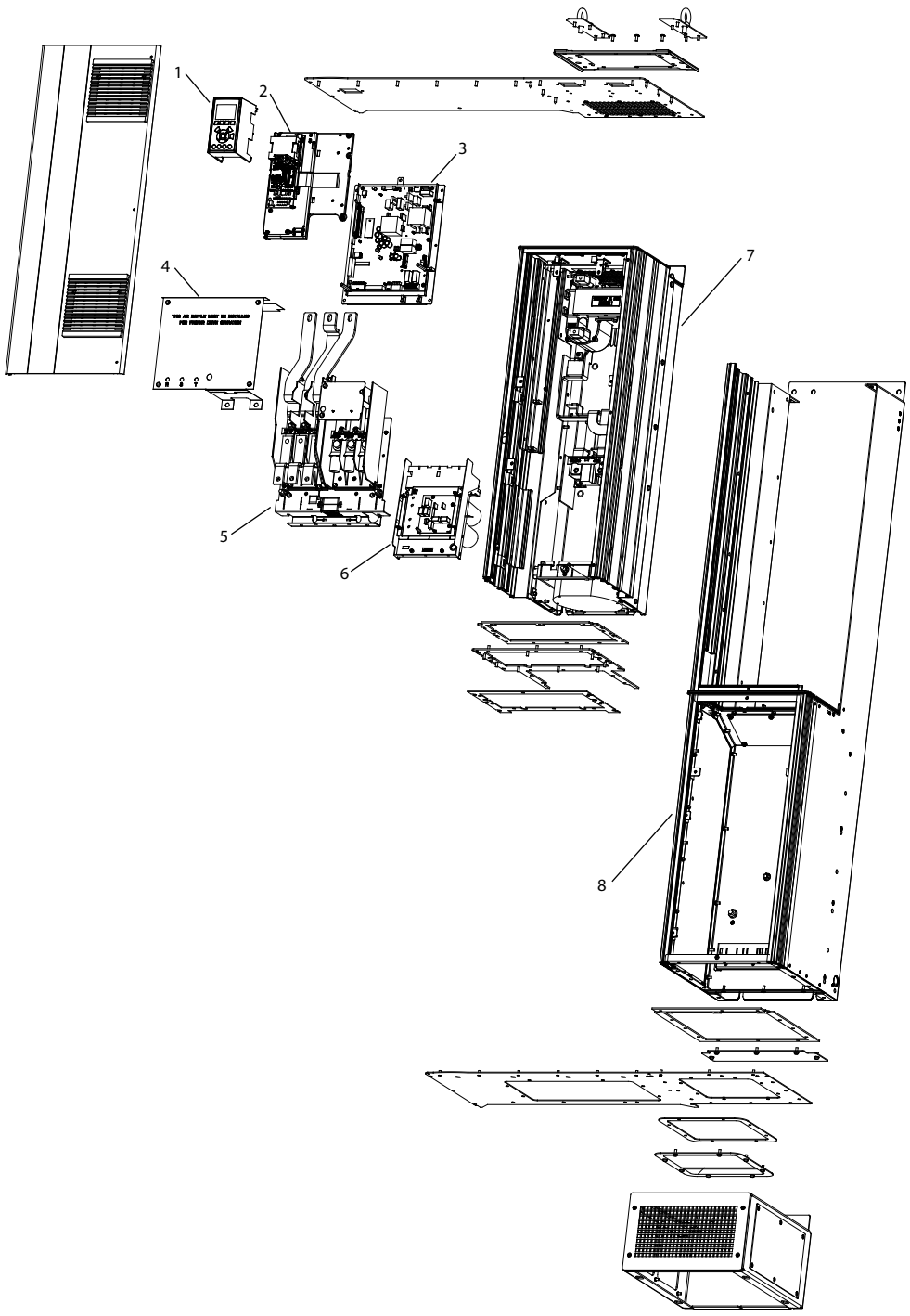
1.3.3 Exploded View Drawings



1	Local control panel (LCP)	5	Input/output terminal assembly
2	Control card assembly	6	Capacitor bank assembly
3	Power card assembly	7	D1/D2 assembly
4	Terminal cover sheet	8	EOC assembly

Illustration 1.2 Enclosure Size D1n/D2n, Frequency Converter Enclosure

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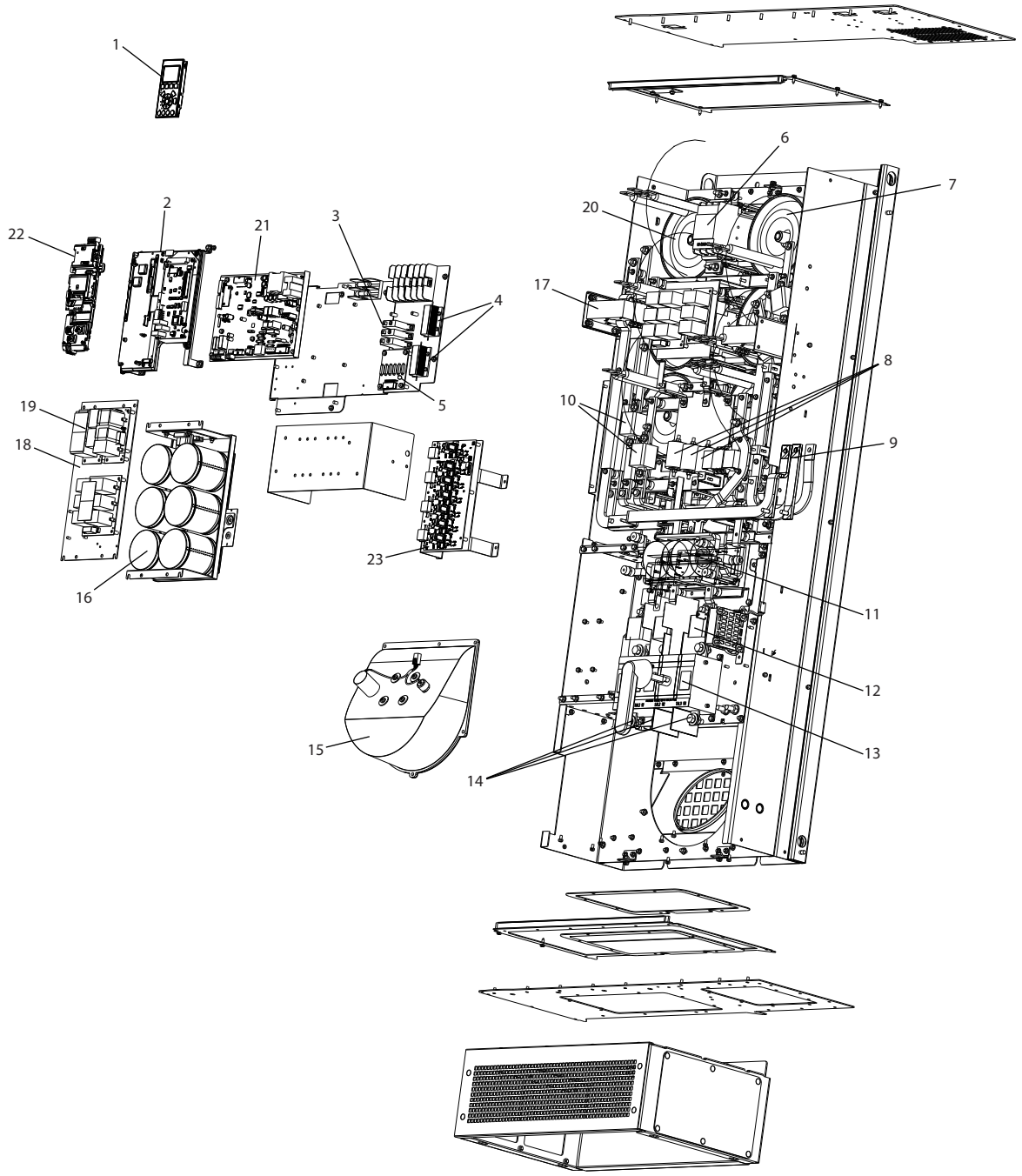
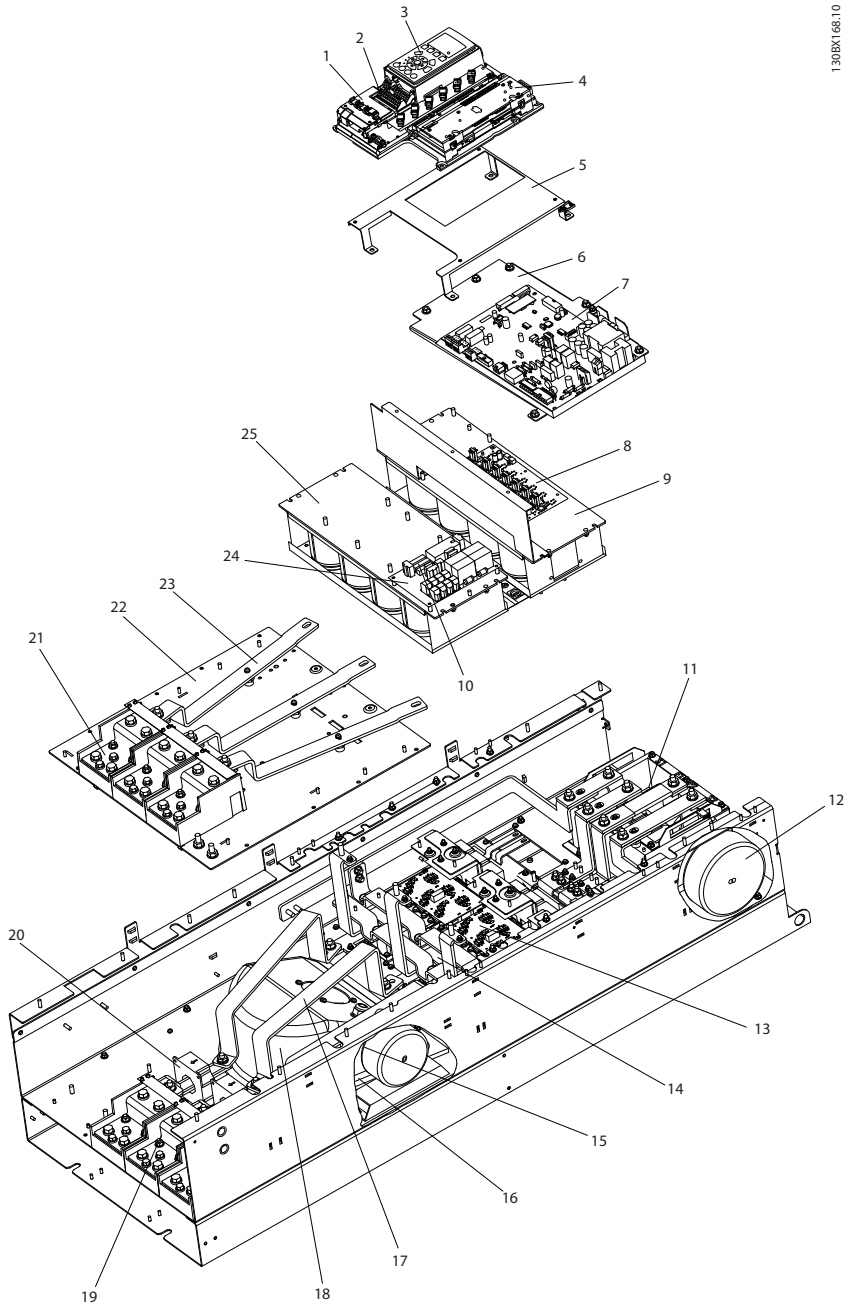


1	Local control panel (LCP)	13	Mains fuses
2	Active filter card (AFC)	14	Mains disconnect
3	Metal oxide varistor (MOV)	15	Mains terminals
4	Soft charge resistors	16	Heat sink fan
5	AC capacitors discharge board	17	DC capacitor bank
6	Mains contactor	18	Current transformer
7	LC inductor	19	RFI differential mode filter
8	AC capacitors	20	RFI common mode filter
9	Mains bus bar to frequency converter input	21	HI inductor
10	IGBT fuses	22	Power card
11	RFI filter	23	Gatedrive card
12	Fuses		

Illustration 1.3 Enclosure Size D1n/D2n, Filter Enclosure



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 gatedrive card	21	Mains 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		

Illustration 1.4 Enclosure Size E9, Frequency Converter Enclosure

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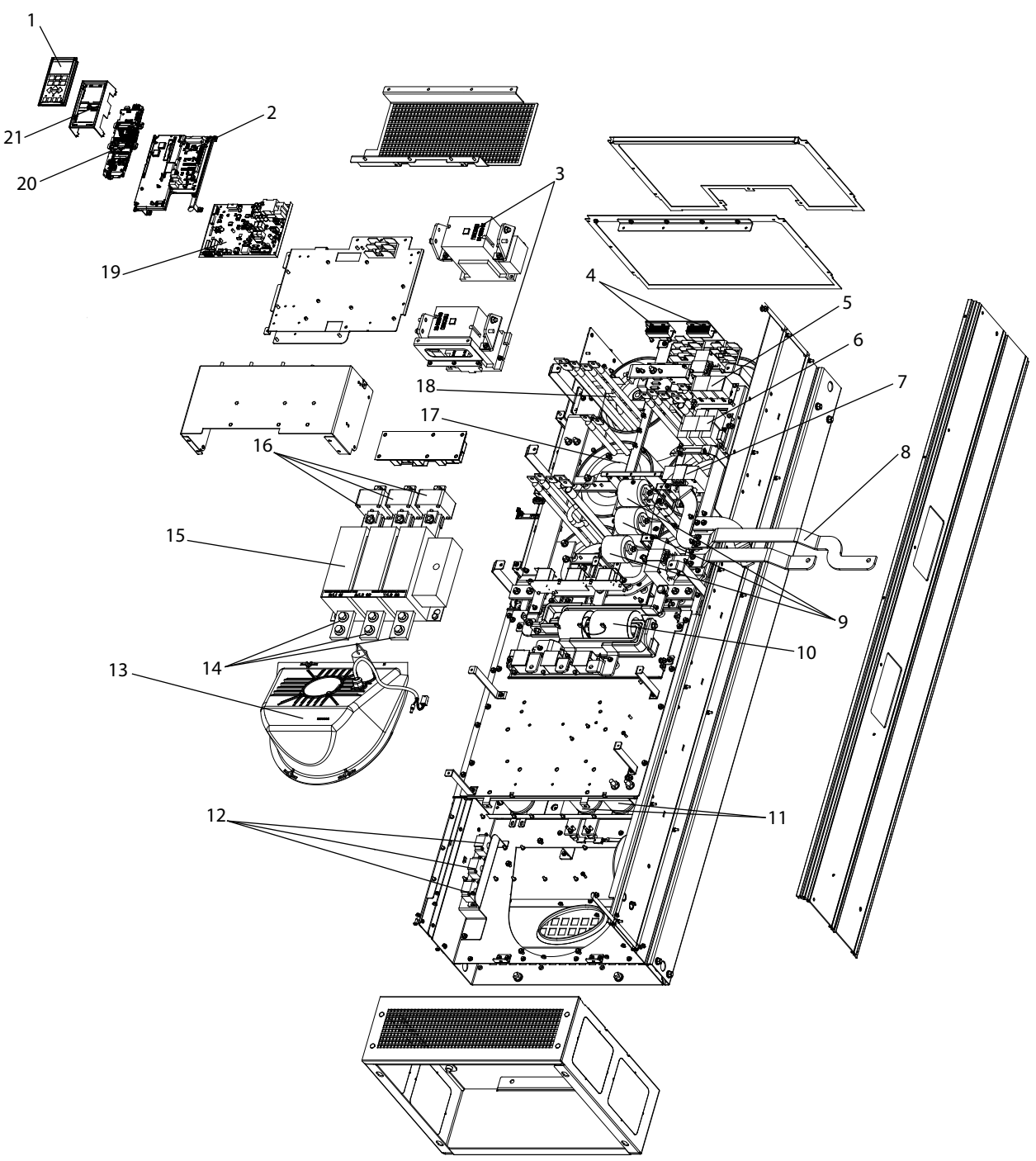
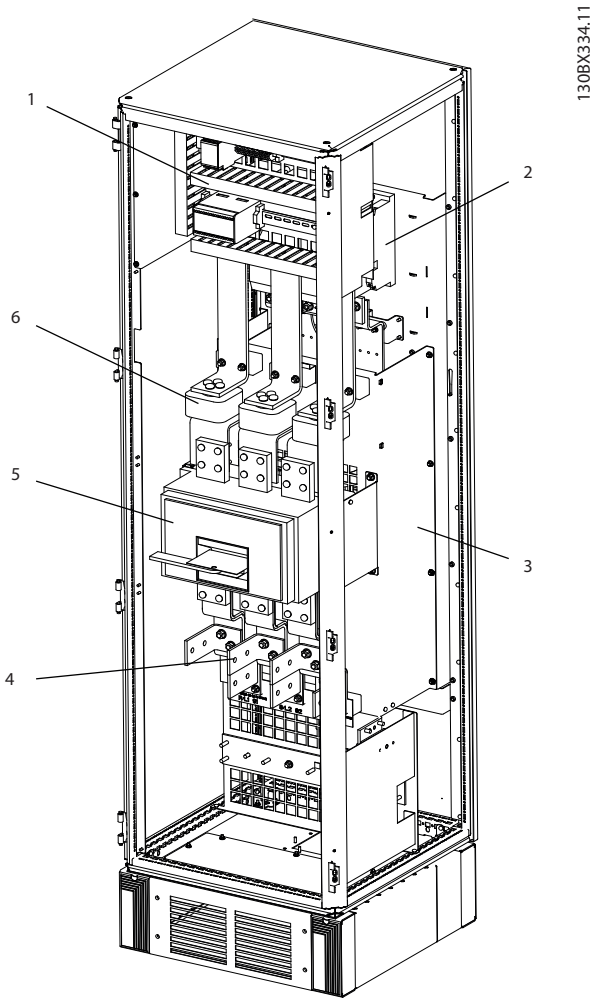


1	Local control panel (LCP)	12	AC capacitor current transducers
2	Active filter card (AFC)	13	Heat sink fan
3	Mains contactors	14	Mains terminals
4	Soft charge resistors	15	Mains disconnect
5	RFI differential mode filter	16	Mains fuses
6	RFI common mode filter	17	LC inductor
7	Current transformer (CT)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

Illustration 1.5 Enclosure Size E9, Filter Enclosure



1	Contactor	4	Circuit breaker or disconnect (if purchased)
2	RFI filter	5	AC mains/line fuses (if purchased)
3	Mains AC power input terminals	6	Mains disconnect

Illustration 1.6 Enclosure Size F18, Input Options Cabinet

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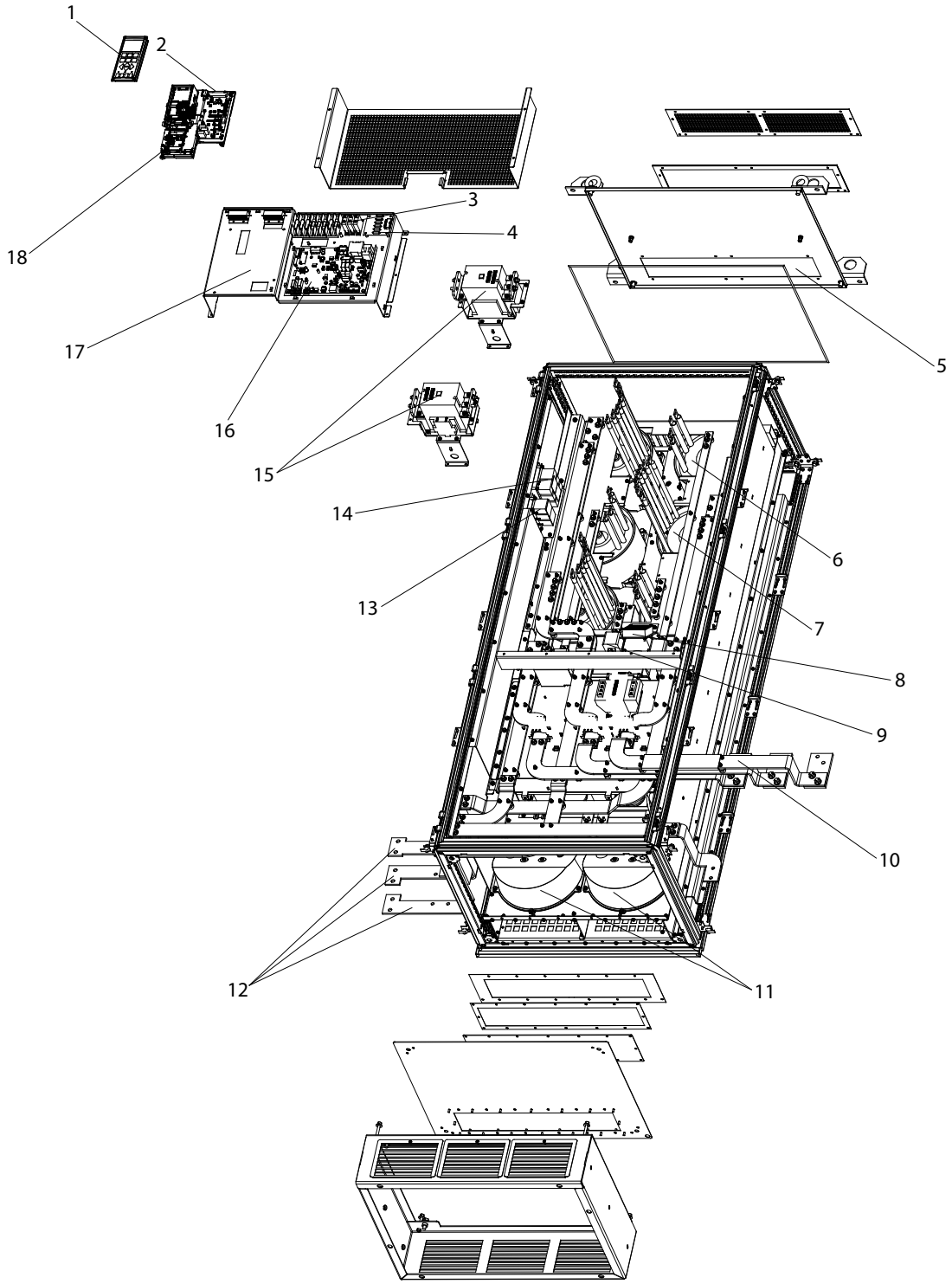
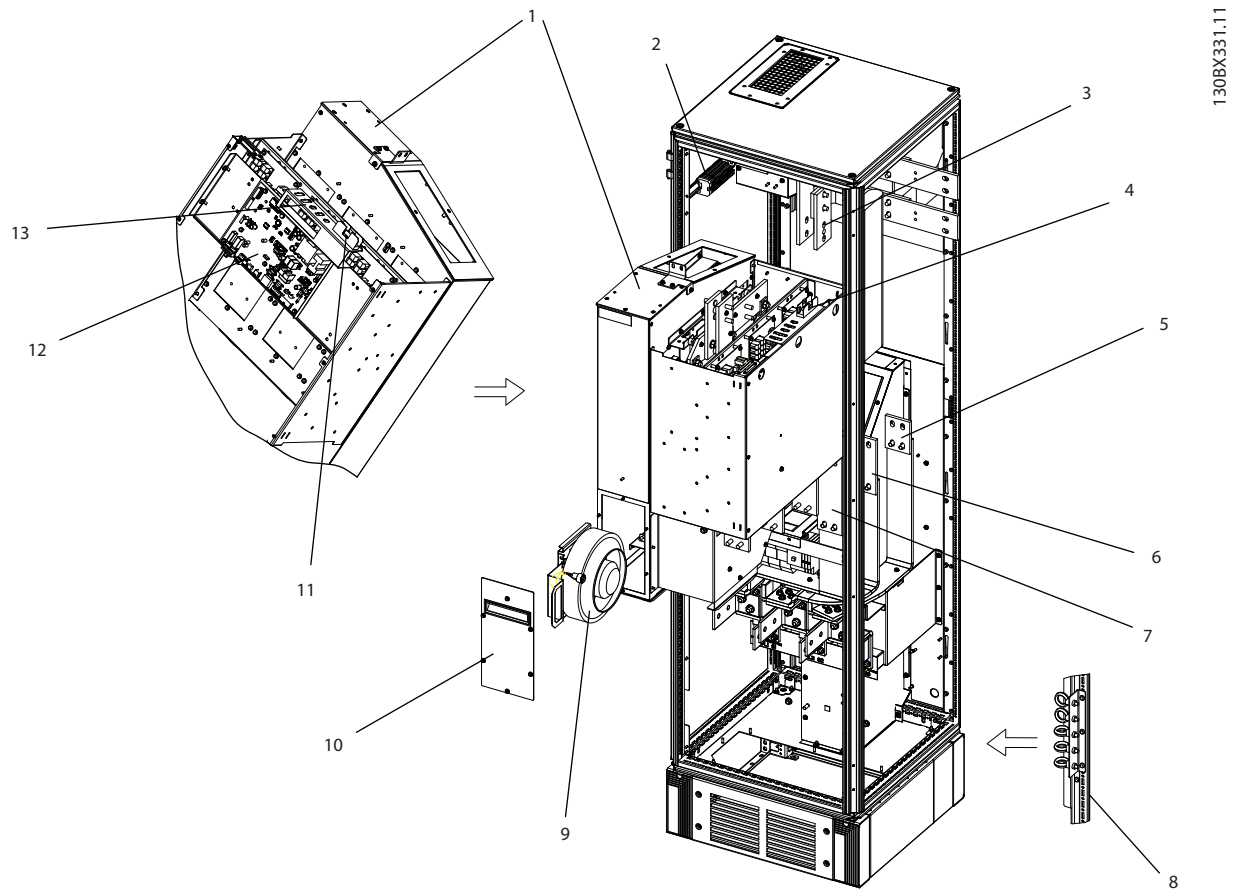


1	Local control panel (LCP)	10	Mains bus bars to frequency converter input
2	Active filter card (AFC)	11	Heat sink fans
3	Soft charge resistors	12	Mains terminals (R/L1, S/L2, T/L3) from options cabinet
4	Metal oxide varistor (MOV)	13	RFI differential mode filter
5	AC capacitors discharge board	14	RFI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

Illustration 1.7 Enclosure Size F18, Filter Cabinet



1	Rectifier module	8	Module heat sink fan
2	DC bus bar	9	Fan door cover
3	SMPS fuse	10	SMPS fuse
4	(Optional) back AC fuse mounting bracket	11	Power card
5	(Optional) middle AC fuse mounting bracket	12	Panel connectors
6	(Optional) front AC fuse mounting bracket	13	Control card
7	Module lifting eye bolts (mounted on a vertical strut)		

Illustration 1.8 Enclosure Size F18, Rectifier Cabinet

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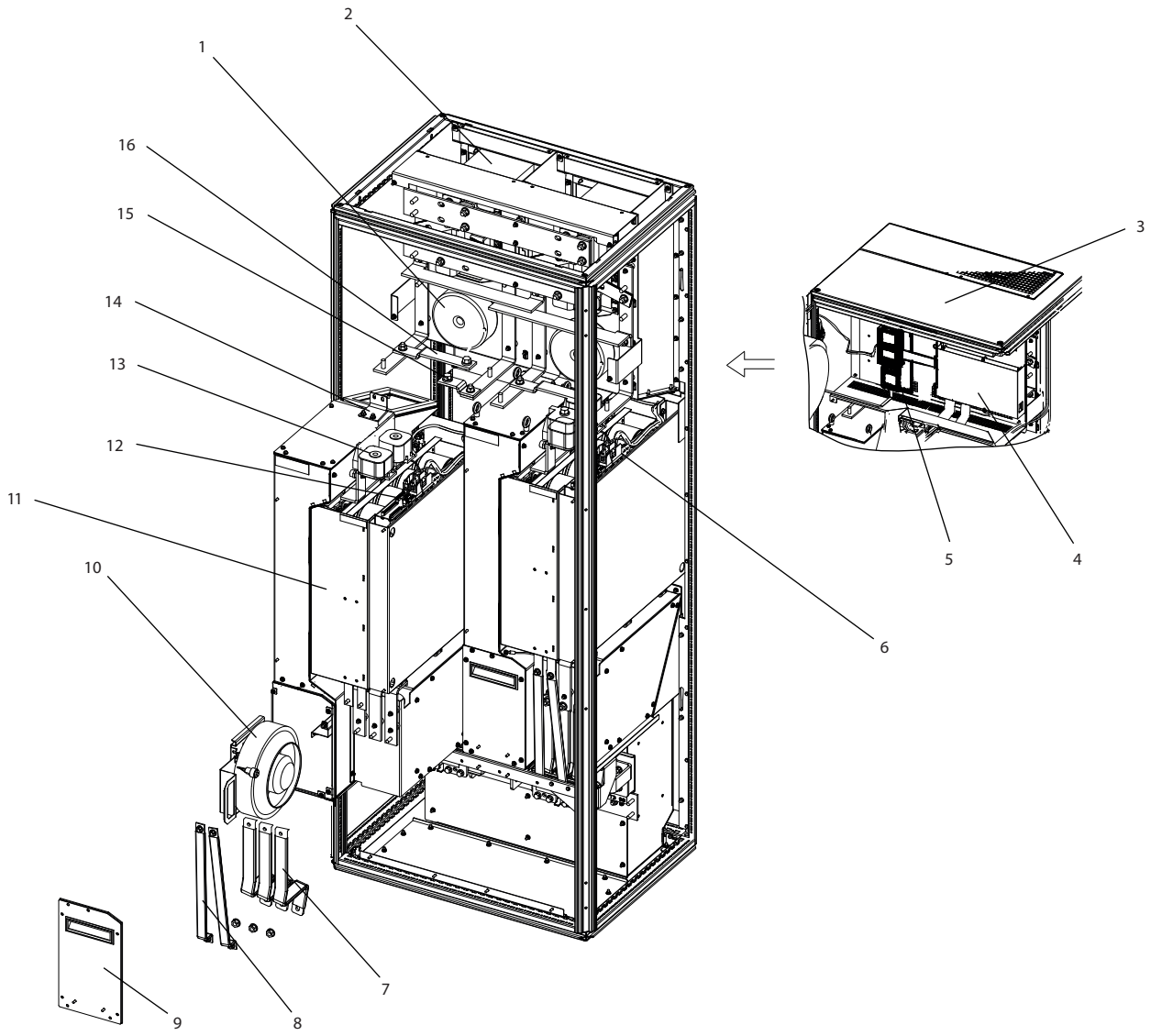

1	Fan transformer	9	Fan door cover
2	DC-link inductor	10	Module heat sink fan
3	Top cover plate	11	Inverter module
4	MDCIC board	12	Panel connectors
5	Control card	13	DC fuse
6	SMPS fuse and fan fuse	14	Mounting bracket
7	Motor output bus bar	15	(+) DC bus bar
8	Brake output bus bar	16	(-) DC bus bar

Illustration 1.9 Enclosure 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 (in)]	Height	1740 (69)	1740 (69)	2000.7 (79)	2278.4 (90)
	Width	915 (36)	1020 (40)	1200 (47)	2792 (110)
	Depth	380 (15)	380 (15)	493.5 (19)	605.8 (24)
Frequency converter weights [kg (lb)]	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

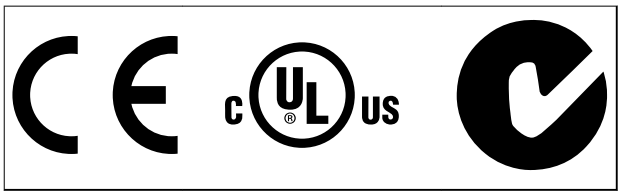

Table 1.2 Compliance Marks: CE, UL, and C-Tick

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*.

NOTICE

IMPOSED LIMITATIONS ON THE OUTPUT FREQUENCY

From software version 3.92, the output frequency of the frequency converter is limited to 590 Hz (due to export control regulations):.

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 n^{th} harmonic frequency
U_n	Voltage at the n^{th} harmonic frequency
n	Harmonic order

Table 1.3 Harmonics-related Abbreviations

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

Table 1.4 Fundamental and Harmonic Currents

Current	Harmonic current				
	I_{RMS}	I_1	I_5	I_7	$I_{11\text{-}49}$
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

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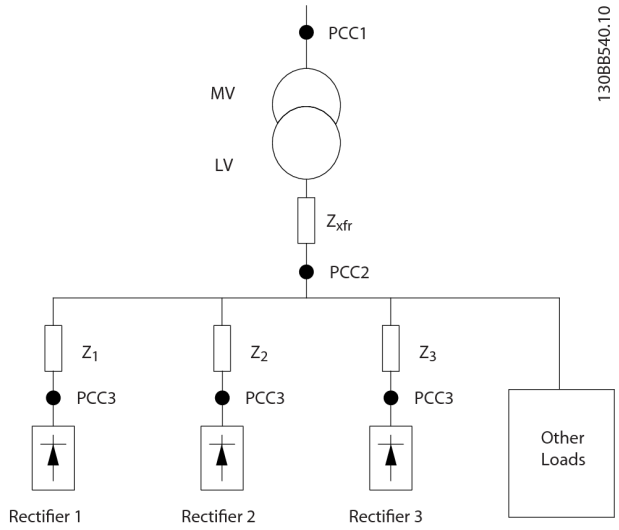
by the mains impedance for the frequency in question. The total voltage distortion (THDi) is calculated based on the individual voltage harmonics using this formula:

$$THDi = \frac{\sqrt{U25 + U27 + \ldots + U2n}}{U}$$

1.6.3 Effect of Harmonics in a Power Distribution System

In *Illustration 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 several 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

Illustration 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_{sce}. R_{sce} 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}).

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

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 and transformer).
- Harmonic voltage distortion causes disturbance to other loads and increases losses in other loads.

1.6.5 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.

Undervoltage warnings

Mains interference can cause the following:

- 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 fulfill 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 Signaling 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 Signaling in Industrial Plants) states the requirements for compatibility levels in industrial and private networks.

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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 Drive observes the limits of Class 3 under typical supply system conditions (R_{SC}>10 or $_{Vk\ Line}$<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)

1.6.6 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 utilizes 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}≥20.

I_{SC}/I_L (R_{SCE})	h<11	11≤h<17	17≤h<23	23≤h<35	35≤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 Drive complies with the following standards:

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

2 Safety

2

2.1 Safety Symbols

The following symbols are used in this document:

⚠WARNING

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

⚠CAUTION

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

NOTICE

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 authorized 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

⚠WARNING

HIGH VOLTAGE

Frequency converters contain high voltage when connected to AC mains input power. Qualified personnel only should perform installation, start up, and maintenance. Failure to perform installation, start up, and maintenance by qualified personnel could result in death or serious injury.

⚠WARNING

UNINTENDED START

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

⚠WARNING

DISCHARGE TIME

The frequency converter contains DC-link capacitors, which can remain charged even when the frequency converter is not powered. High voltage can be present even when the warning LED indicator lights are off. Failure to wait the specified time after power has been removed before performing service or repair work can result in death or serious injury.

- **Stop the motor.**
- **Disconnect AC mains and remote DC-link power supplies, including battery back-ups, UPS, and DC-link connections to other frequency converters.**
- **Disconnect or lock PM motor.**
- **Wait for the capacitors to discharge fully. The minimum duration of waiting time is specified in *Table 2.1*.**
- **Before performing any service or repair work, use an appropriate voltage measuring device to make sure that the capacitors are fully discharged.**

Voltage [V]	Power ranges for normal overload operation [kW/(hp)]	Minimum waiting time (minutes)
380–480	160–250 (250-350)	20
	315–710 (450-1000)	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 frequency converter, 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 frequency converter, 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 that each of the following are rated for the same voltage:
  - Mains (power)
  - Frequency converter
  - Motor
- Ensure that the output current rating is equal to or greater than the motor full load current for peak motor performance.
  - Motor size and frequency converter power must match for proper overload protection.
  - If the frequency converter rating is less than that of the motor, full motor output is impossible.

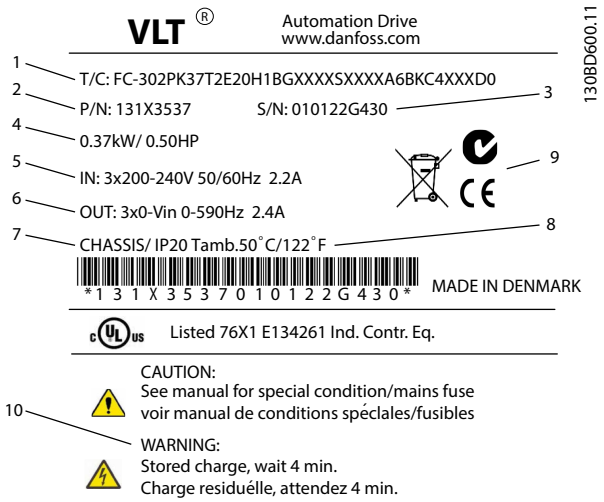
3.2 Unpacking

3.2.1 Items Supplied

3

Items supplied may vary according to product configuration.

- Make sure that the items supplied and the information on the nameplate correspond to the order confirmation.
- Check the packaging and the frequency converter 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	Code 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)

Illustration 3.1 Product Nameplate (Example)

NOTICE

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

3.3 Mounting

3.3.1 Cooling and Airflow

Cooling
Obtain cooling by taking air in through the plinth in the front and out of the top, 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. 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.

Airflow
Secure the necessary airflow over the heat sink. The flow rate is shown in *Table 3.1*.

Enclosure protection	Enclosure size	Door fan/top fan airflow Total airflow of multiple fans	Heat sink fan Total airflow for multiple fans
IP21/NEMA 1 IP54/NEMA 12	D1n	3 door fans, 442 m^3/h 2+1=2x170+102	2 heat sink fans, 1185 m^3/h (1+1=765+544)
	D2n	3 door fan, 544 m^3/h 2+1=2x170+204	2 heat sink fans, 1605 m^3/h (1+1=765+840)
	E9	4 door fans, 680 m^3/h (400 cfm) (2+2, 4x170=680)	2 heat sink fans, 2675 m^3/h (1574 cfm) (1+1, 1230+1445=2675)
	F18	6 door fans, 3150 m^3/h (1854 cfm) (6x525=3150)	5 heat sink fans, 4485 m^3/h (2639 cfm) 2+1+2, ((2x765)+(3x985)=4485)

Table 3.1 Heat Sink Air Flow

NOTICE

For the frequency converter section, the fan runs for the following reasons:

- **AMA.**
- **DC hold.**
- **Pre-mag.**
- **DC brake.**
- **60% of nominal current is exceeded.**
- **Specific heat sink temperature exceeded (power size dependent).**
- **Specific power card ambient temperature exceeded (power size dependent).**
- **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:

- **Active filter running.**
- **Active filter not running, but mains current exceeding the limit (power size dependent).**
- **Specific heat sink temperature exceeded (power size dependent).**
- **Specific power card ambient temperature exceeded (power size dependent).**
- **Specific control card ambient temperature exceeded.**

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

3

External ducts

If additional duct work is added externally to the Rittal cabinet, calculate the pressure drop in the ducting. Use *Illustration 3.2*, *Illustration 3.3*, and *Illustration 3.4* to derate the frequency converter according to the pressure drop.

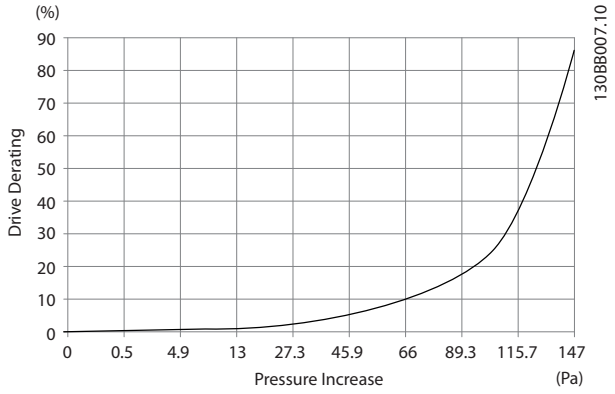


Illustration 3.2 D-Enclosure Derating vs. Pressure Change Frequency Converter Air Flow: 450 cfm (765 m³/h)

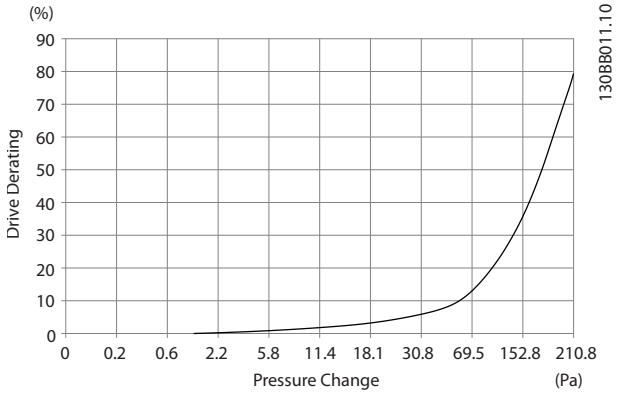


Illustration 3.3 E-Enclosure Derating vs. Pressure Change Frequency Converter Air Flow: 850 cfm (1445 m³/h)

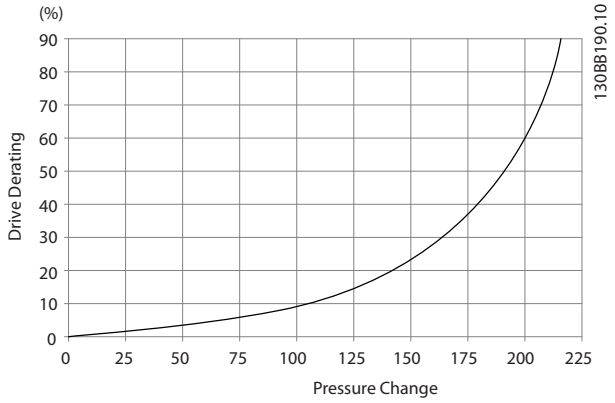
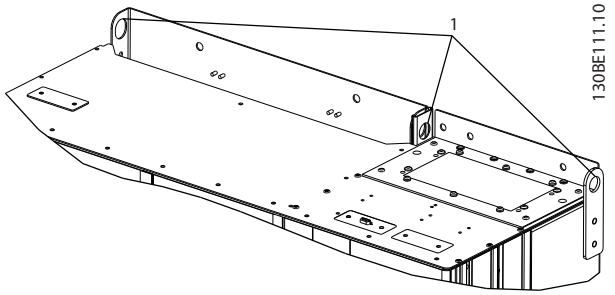


Illustration 3.4 F-Enclosure Derating vs. Pressure Change Frequency Converter Air Flow: 580 cfm (985 m³/h)

3.3.2 Lifting

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



1	Lifting holes

Illustration 3.5 Recommended Lifting Method, Enclosure Size D1n/D2n

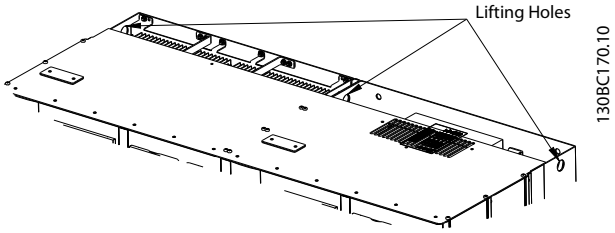
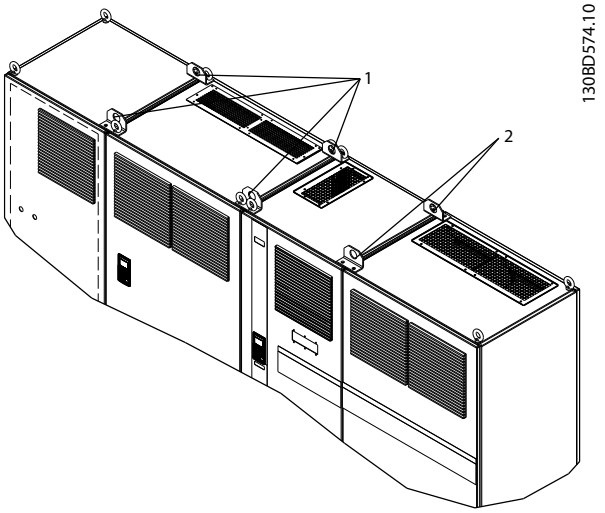


Illustration 3.6 Recommended Lifting Method, Enclosure Size E9

⚠WARNING

The lifting bar must be able to handle the weight of the frequency converter. See *chapter 8.2 Mechanical Dimensions* for the weight of the different enclosure sizes. Maximum diameter for the bar is 2.5 cm (1 in). The angle from the top of the frequency converter to the lifting cable should be 60° or greater.



1	Lifting holes for the filter
2	Lifting holes for the frequency converter

Illustration 3.7 Recommended Lifting Method, Enclosure Size F18

NOTICE

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

NOTICE

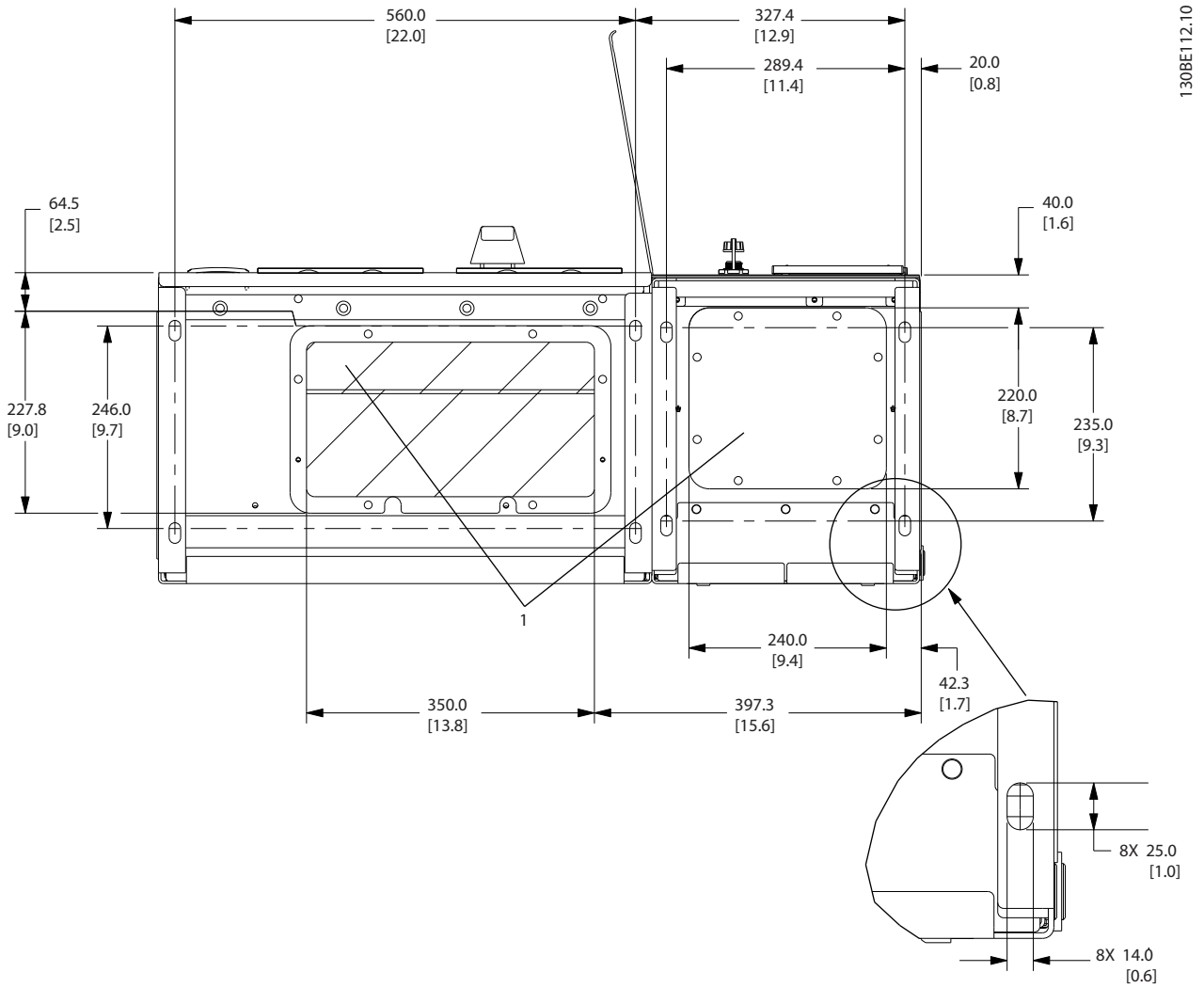
The F18 pedestal is packaged separately and included in the shipment. Mount the frequency converter on the pedestal in its final location. The pedestal allows proper airflow and cooling.

3.3.3 Cable Entry and Anchoring

Cables enter the unit through gland plate openings in the bottom. *Illustration 3.8*, *Illustration 3.9*, *Illustration 3.10*, and *Illustration 3.11* show gland entry locations and detailed views of anchoring hole dimensions.

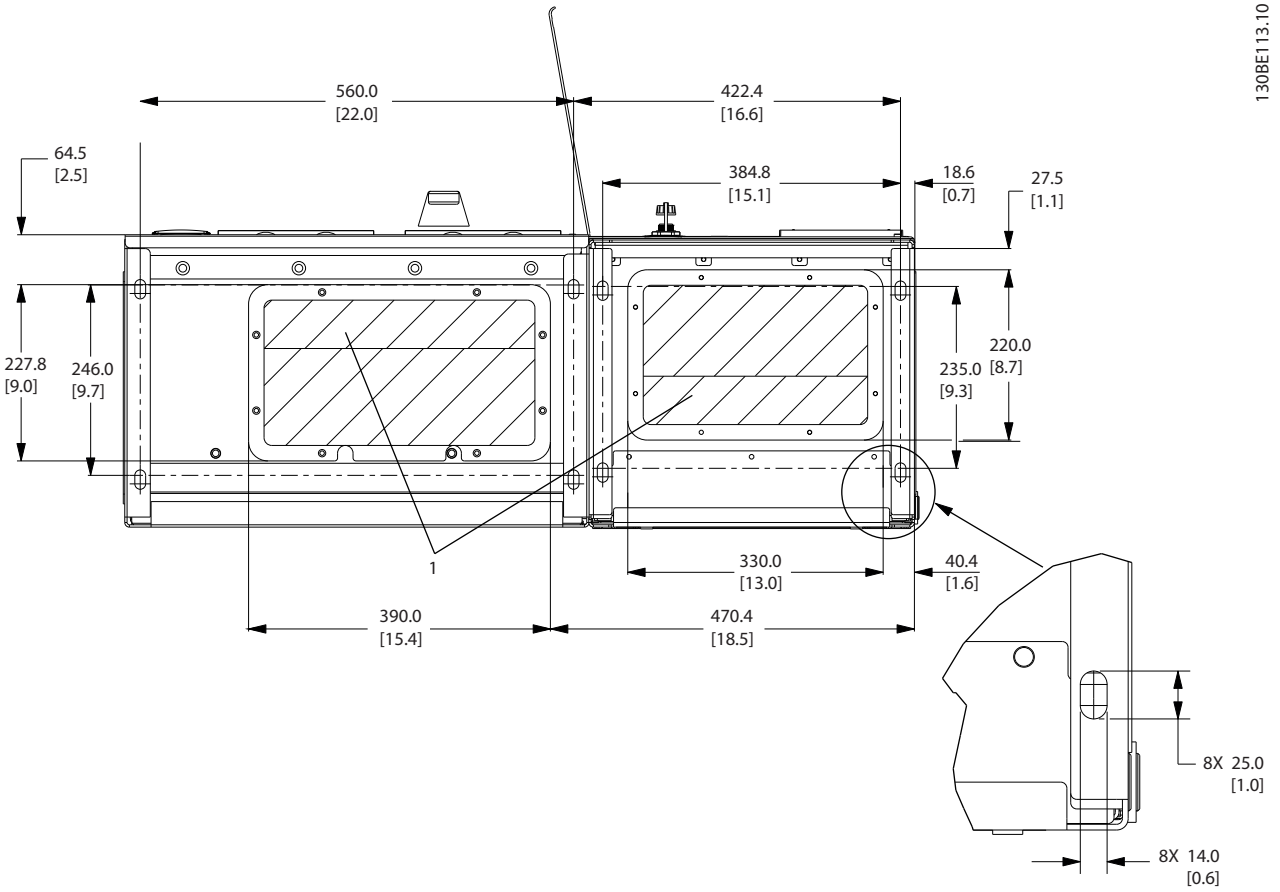
3

Bottom view, D1n/D2n



1	Cable entry locations

Illustration 3.8 Cable Entry Diagram, Enclosure Size D1n

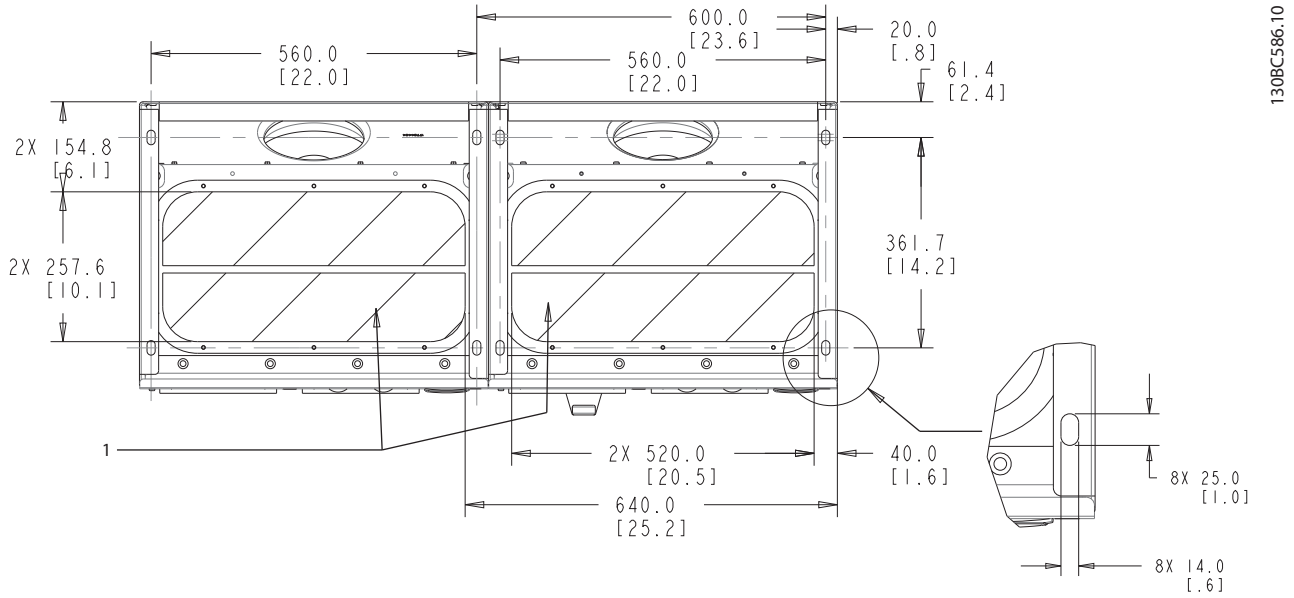


1	Cable entry locations

Illustration 3.9 Cable Entry Diagram, Enclosure Size D2n

3

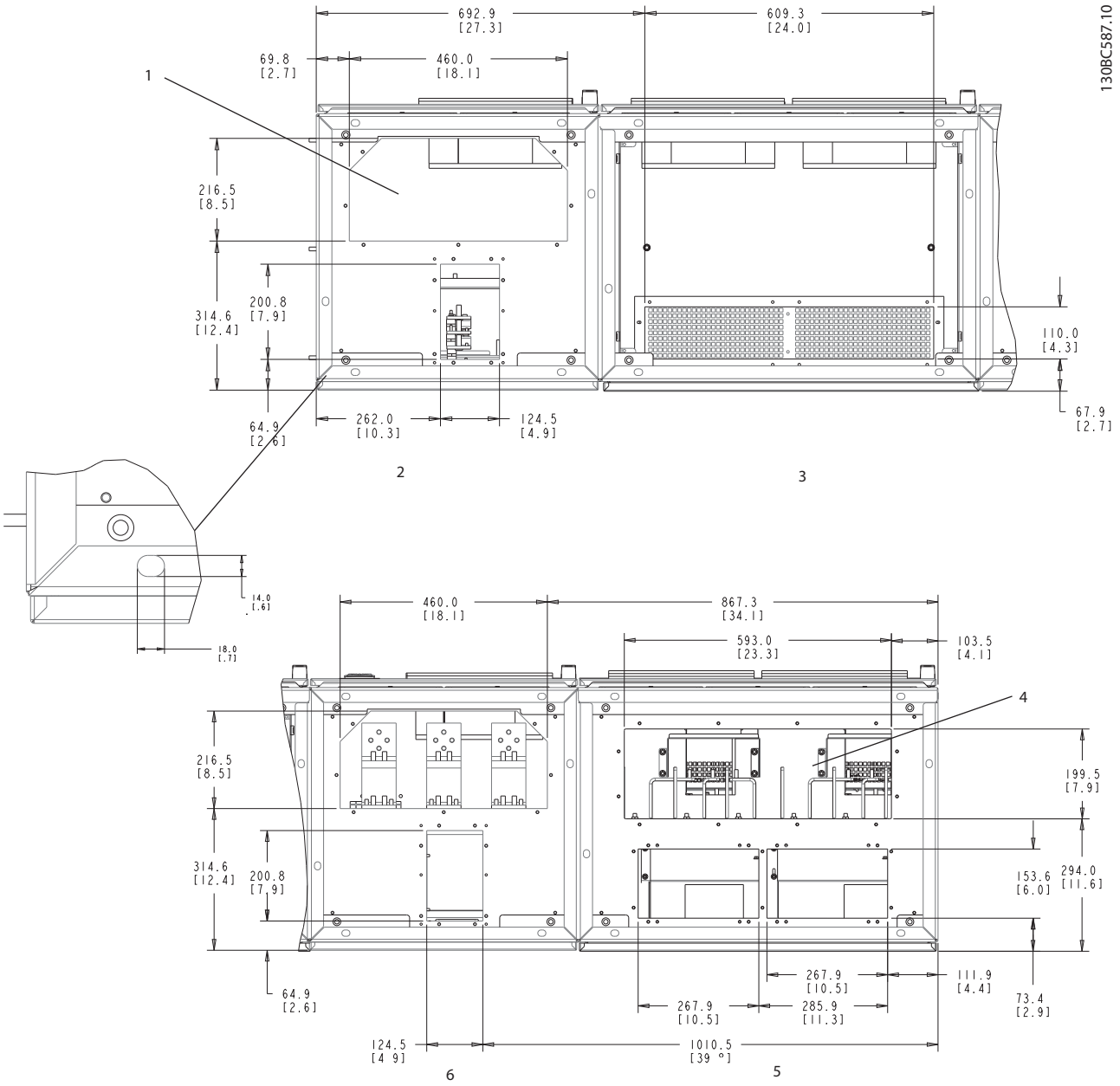
Bottom view, enclosure size E9



1	Cable entry locations

Illustration 3.10 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

Illustration 3.11 Cable Entry Diagram, F18

3

3.3.4 Terminal Locations for Enclosure Size D1n/D2n

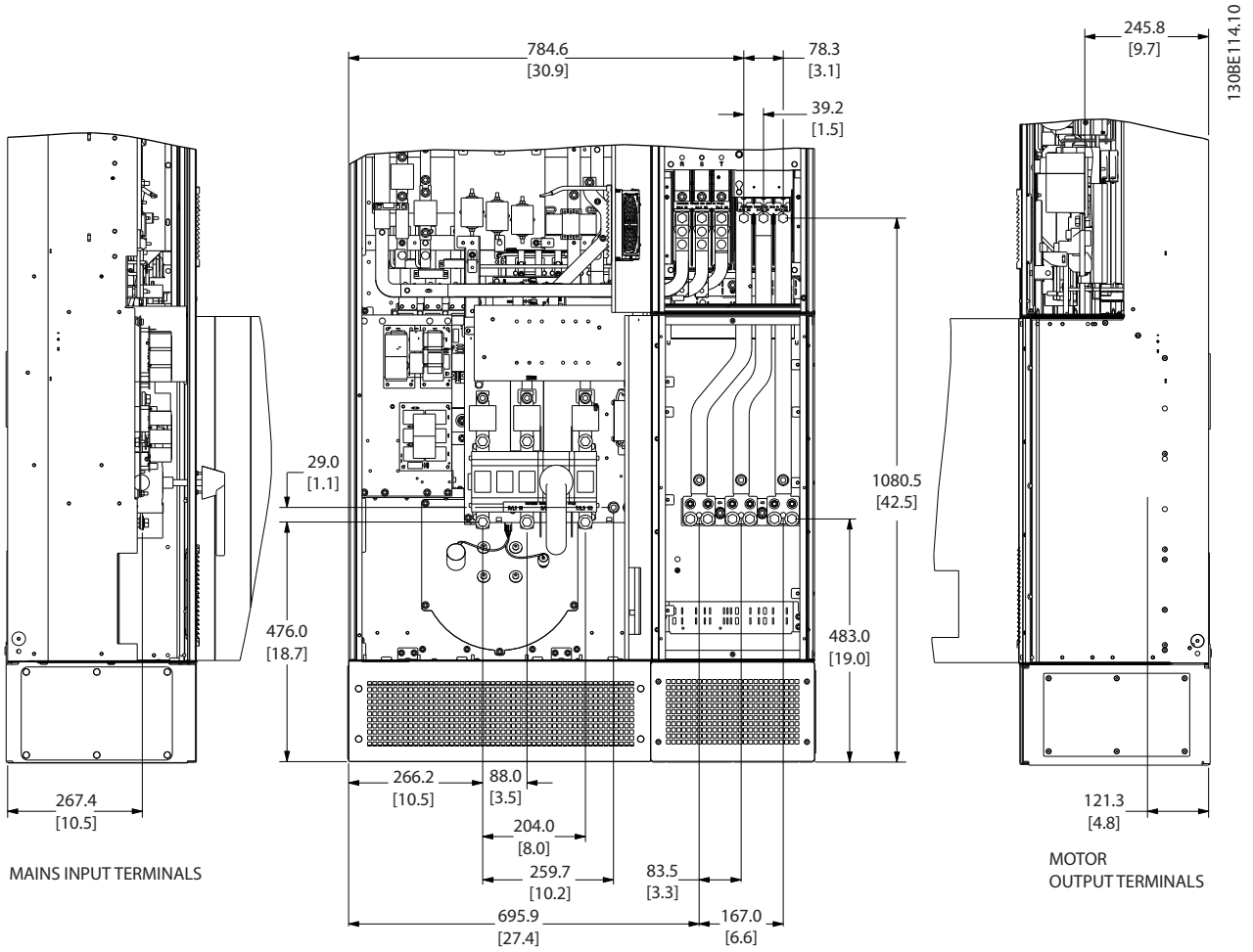


Illustration 3.12 Terminal Locations, Enclosure Size D1n

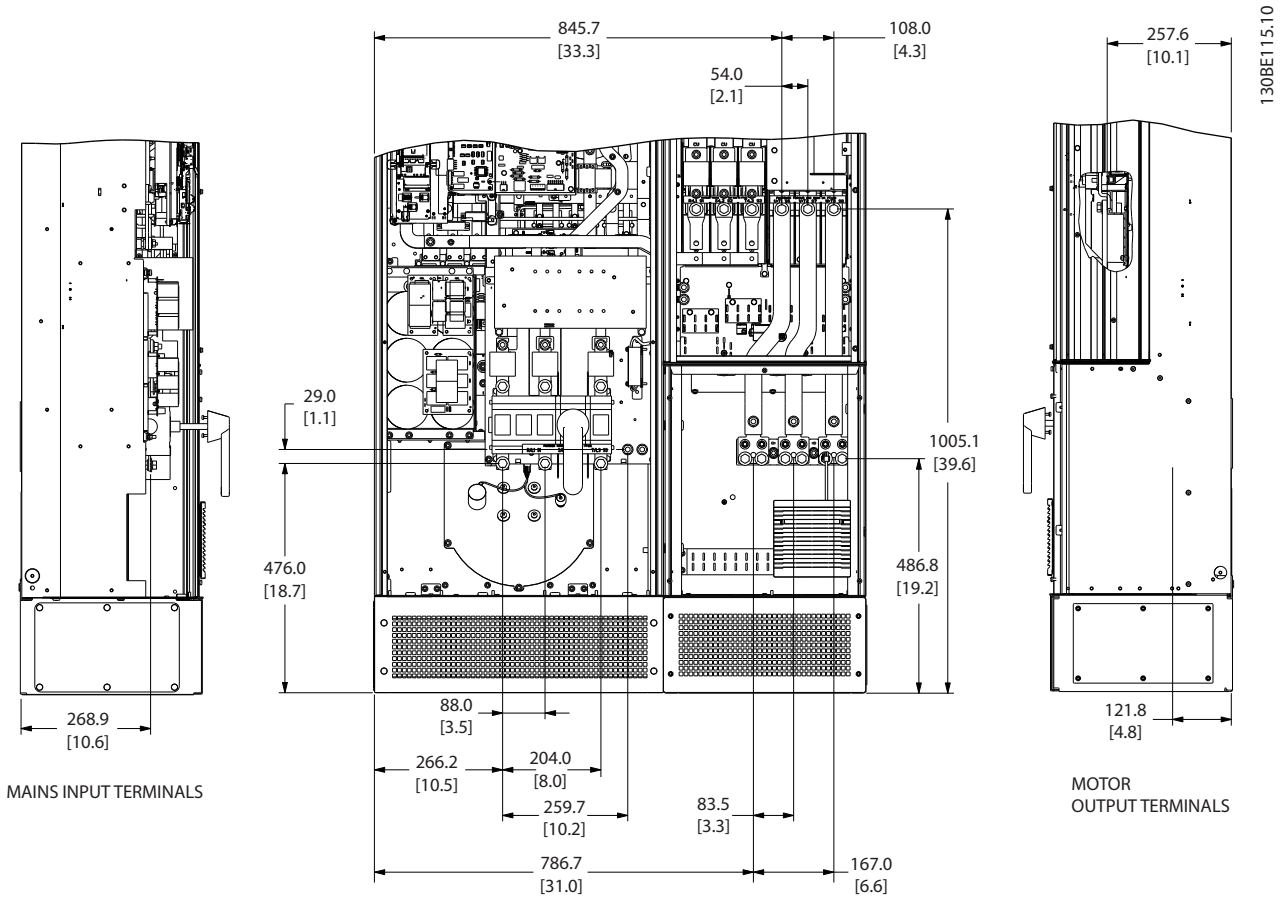


Illustration 3.13 Terminal Locations, Enclosure Size D2n

Allow for bend radius of heavy power cables.

NOTICE

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

3

3.3.5 Terminal Locations for Enclosure Size E9

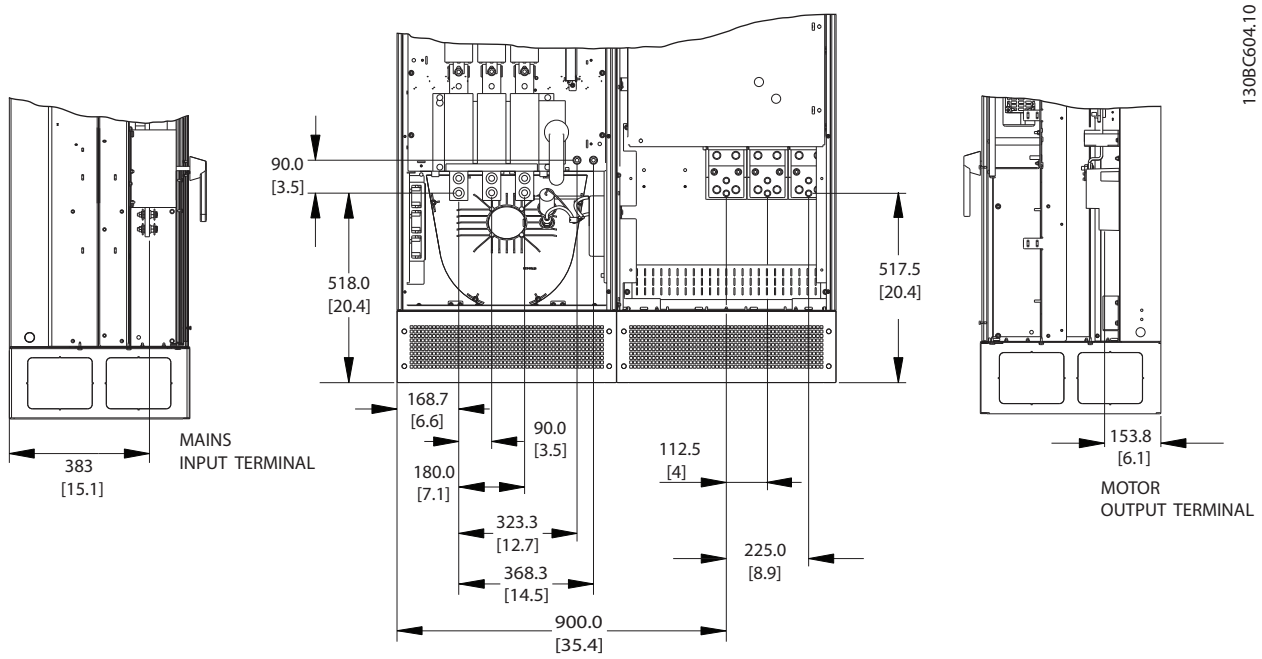


Illustration 3.14 Terminal Locations, Enclosure Size E9

Allow for bend radius of heavy power cables.

NOTICE

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

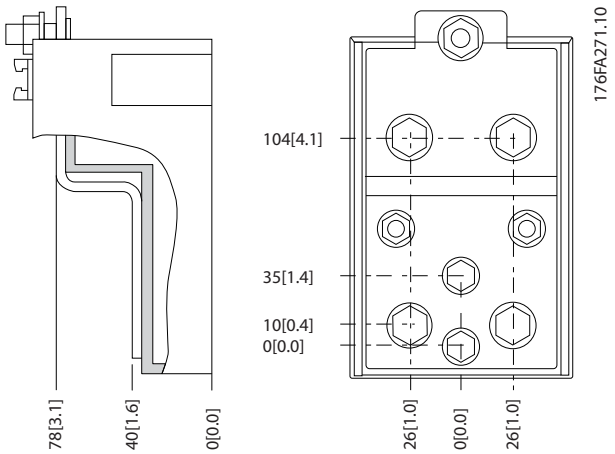


Illustration 3.15 Close-up Terminal Diagrams

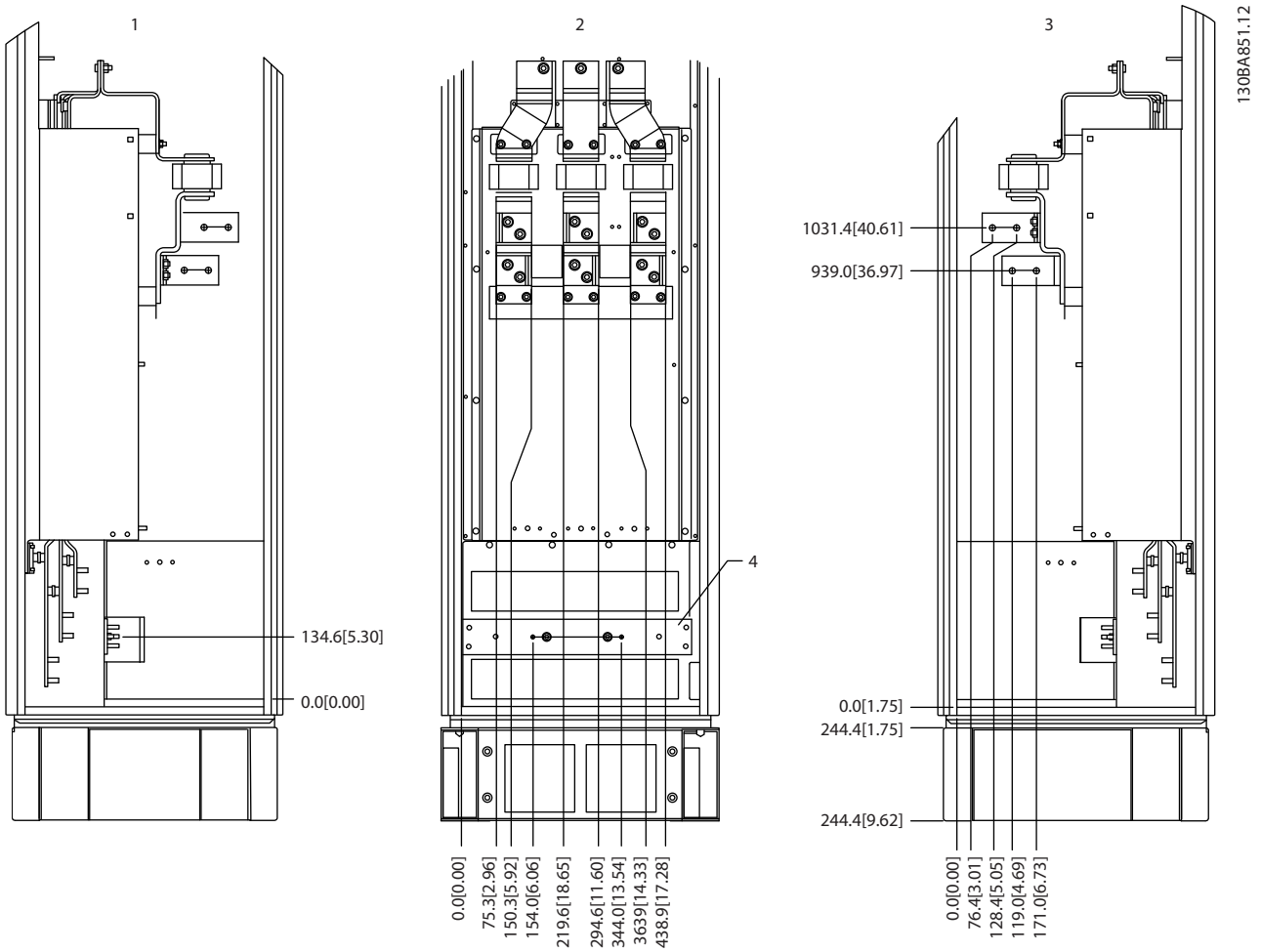
3.3.6 Terminal Locations for Enclosure Size F18

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

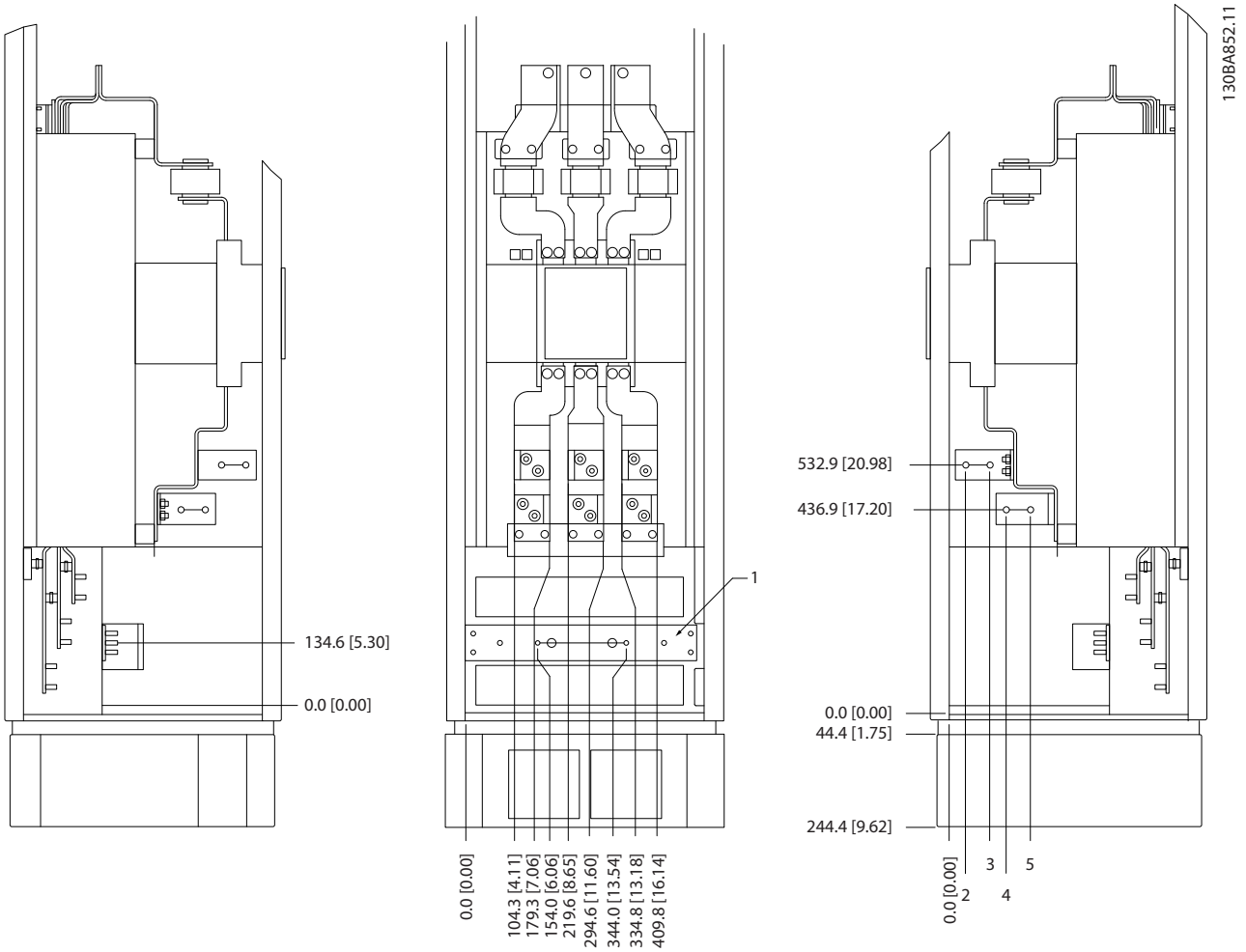
See *chapter 1.3.3 Exploded View Drawings* for exploded views of each cabinet. Mains inputs are located in the input option cabinet, which conducts power to the rectifier via interconnecting bus bars. Output from the unit is from the inverter cabinet. No connection terminals are located in the rectifier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



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

Illustration 3.16 Input Option Cabinet, Enclosure Size F18 - Fuses Only

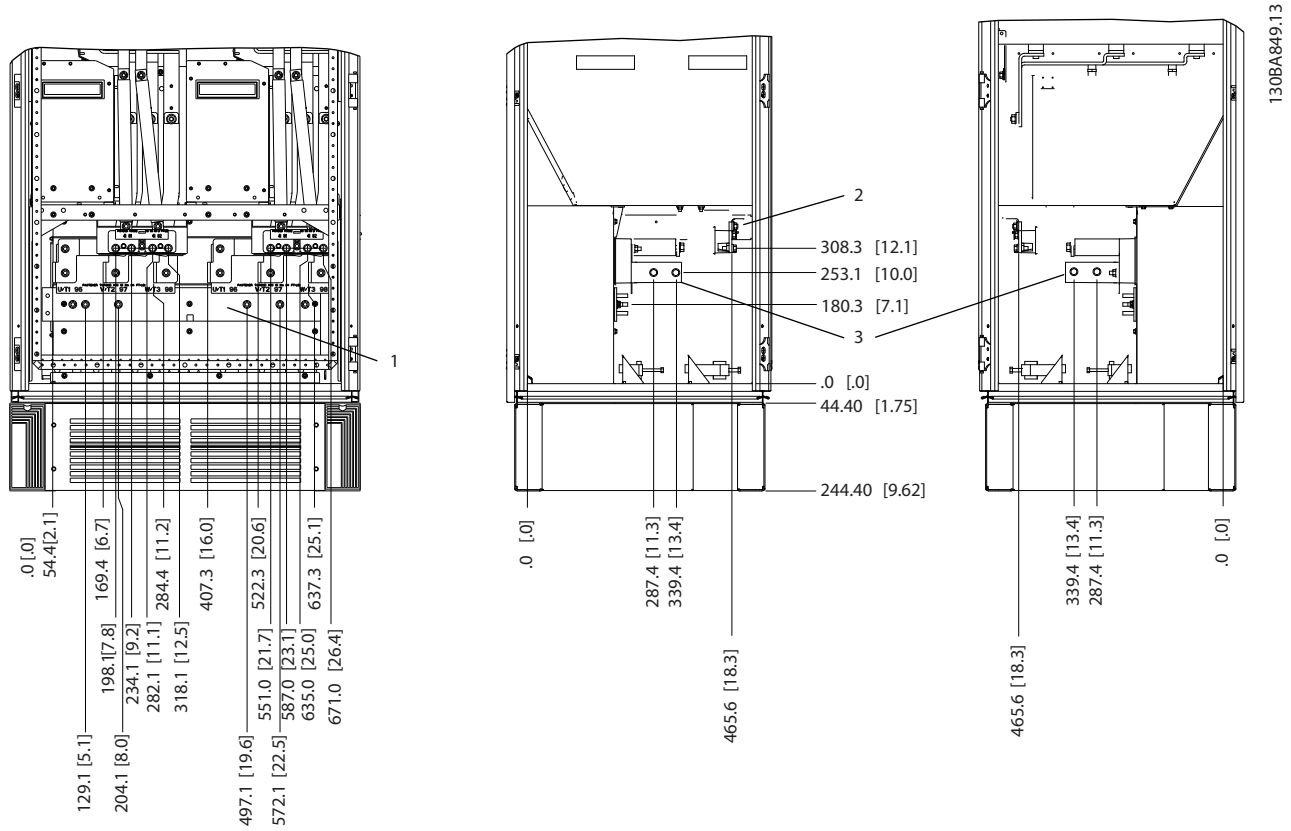
The gland plate is 42 mm below the 0 level. Shown are the left side view, front, and right.



	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 kW rating.		

Illustration 3.17 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.



1	Front view
2	Left side view
3	Right side view

Illustration 3.18 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. The correct values are listed in *Table 3.2*. Incorrect torque results in a bad electrical connection. Use a torque wrench to ensure correct torque.

Enclosure size	Terminal	Torque [Nm] (in-lbs)	Bolt size
D	Mains Motor	19–40 (168–354)	M10
	Regen Brake	8.5–20.5 (75–181)	M8
E	Mains Motor Regen	19–40 (168–354)	M10
	Brake	8.5–20.5 (75–181)	M8
F	Mains Motor	19–40 (168–354)	M10
	Brake	8.5–20.5 (75–181)	M8
	Regen	8.5–20.5 (75–181)	M8

Table 3.2 Torque for Terminals

4 Electrical Installation

4.1 Safety Instructions

See *chapter 2 Safety* for general safety instructions.

4

⚠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 to use shielded cables could result in death or serious injury.

- **Run output motor cables separately, or**
- **Use shielded cables.**

⚠CAUTION

SHOCK HAZARD

The frequency converter can cause a DC current in the PE conductor. Failure to follow the recommendation may lead to the RCD not providing 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.**

Overcurrent protection

- Extra protective equipment, such as short-circuit protection or motor thermal protection between frequency converter and motor, is required for applications with multiple motors.
- Input fusing is required to provide short circuit and overcurrent protection. If not factory-supplied, the installer must provide fuses. 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 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 4.3 Power Connections*, *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 75 °C copper conductors. For non-UL applications, 75 and 90 °C copper conductors are thermally acceptable.

The power cable connections are located as shown in *Illustration 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.

For protection of the frequency converter, use the recommended fuses if there are no built-in fuses. Fuse recommendations are provided in *chapter 8.4 Fuses*. Ensure that proper fusing is made according to local regulation.

If included, the mains connection is fitted to the mains switch.

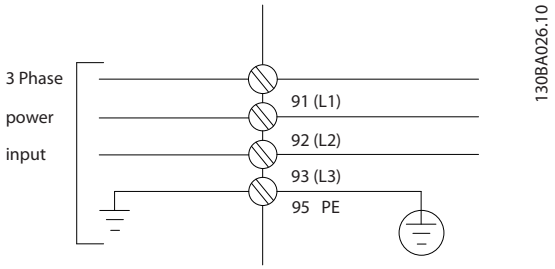


Illustration 4.1 Power Cable Connections

NOTICE

To comply with EMC emission specifications, screened/armoured cables are recommended. If an unscreened/unarmoured cable is used, see *chapter 4.7.3 Power and Control Wiring for Unscreened Cables*.

See *chapter 8 Specifications* for correct dimensioning of motor cable cross-section and length.

Screening of cables

Avoid installation with twisted shield ends (pigtails). They spoil the screening 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 screen to both the decoupling plate of the frequency converter 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 frequency converter.

Cable length and cross-section
The frequency converter has been EMC-tested with a given cable length. To reduce the noise level and leakage currents, keep the motor cable as short as possible.

Switching frequency
When frequency converters are used with sine-wave filters to reduce the acoustic noise from a motor, set the switching frequency according to *parameter 14-01 Switching Frequency*.

Terminal number	96	97	98	99	
	U	V	W	PE[1)]	Motor voltage 0–100% of mains voltage. 3 wires out of motor
	U1	V1	W1	PE[1)]	Delta-connected
	W2	U2	V2		6 wires out of motor
	U1	V1	W1	PE[1)]	Star-connected U2, V2, W2 U2, V2, and W2 to be interconnected separately.

Table 4.1 Terminal Connections

1) Protective earth connection

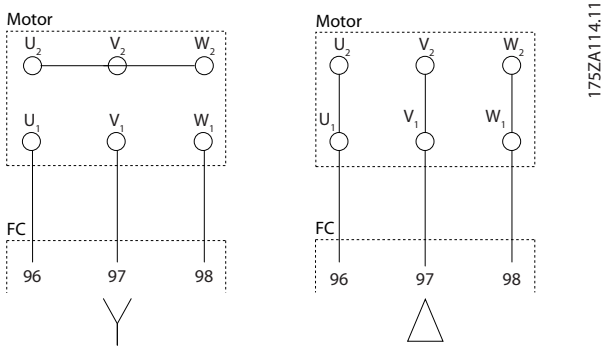


Illustration 4.2 Y and Delta Terminal Configurations

4.4 Grounding

⚠WARNING

GROUNDING HAZARD!

For operator safety, it is important to ground the frequency converter properly in accordance with national and local electrical codes and instructions contained within this document. Do not use conduit connected to the frequency converter as a replacement for proper grounding. Ground currents are higher than 3.5 mA. Failure to ground the frequency converter properly could result in death or serious injury.

NOTICE

It is the responsibility of the user or certified electrical installer to ensure correct grounding of the equipment in accordance with national and local electrical codes and standards.

- Follow all local and national electrical codes to ground electrical equipment properly.
- Establish proper protective earthing for equipment with ground currents higher than 3.5 mA, see *chapter 4.4.1 Leakage Current (>3.5 mA)*.
- A dedicated ground wire is required for input power, motor power, and control wiring.
- Use the clamps provided with the equipment for proper ground connections.
- Do not ground one frequency converter to another in a “daisy chain” fashion.
- Keep the ground wire connections as short as possible.
- Using high-strand wire to reduce electrical noise is recommended.
- Follow motor manufacturer wiring requirements.

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 ground leakage current depends on various system configurations including RFI filtering, shielded 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 mm^2 (8 AWG).
- 2 separate ground wires both complying with the dimensioning rules.

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

4

4.5 Input Options

4.5.1 Extra Protection (RCD)

ELCB relays, multiple protective earthing, 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

Mains supply isolated from ground
If the frequency converter is supplied from an isolated mains source or TT/TN-S mains with grounded leg, turn off the RFI switch via *parameter 14-50 RFI Filter* on both frequency converter 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 25 m, set *parameter 14-50 RFI Filter* to [ON].
In OFF, the internal RFI capacitors (filter capacitors) between the enclosure and the DC link are cut off to avoid damage to the DC link and reduce ground capacity currents (IEC 61800-3).
Refer to the application note *VLT on IT mains.* 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 glands or clamps:

- EMC cable glands: Generally available cable glands 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 a frequency converter. The factory setting is for clockwise rotation with the frequency converter output connected as follows:

Terminal number	Function
96, 97, 98	Mains U/T1, V/T2, W/T3
99	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 2 phases in the motor cable or by changing the setting of *parameter 4-10 Motor Speed Direction*.

To check motor rotation, select *parameter 1-28 Motor Rotation Check* and follow the steps on the display.

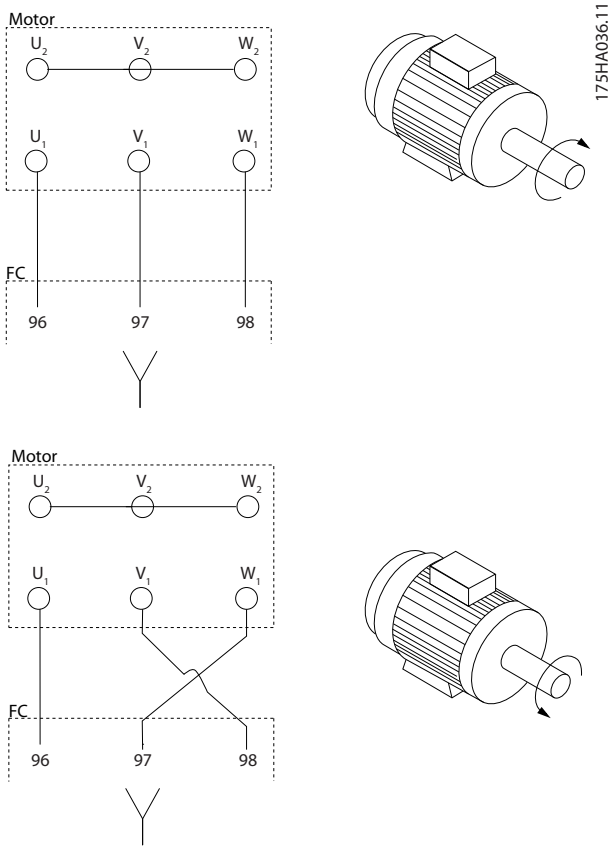


Illustration 4.3 Motor Rotation Check

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 of 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, minimum 2.5 m (8 ft), 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.

4.6.2 Brake Cable

Frequency converters with factory installed brake chopper option.

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

The connection cable to the brake resistor must be shielded, and the maximum length from frequency converter to the DC bar is limited to 25 m (82 ft).

Terminal number	Function
81, 82	Brake resistor terminals

Table 4.3 Terminal Functions

Connect the shield with cable clamps to the conductive backplate of the frequency converter and the metal cabinet of the brake resistor.
Size the brake cable cross-section to match the brake torque.

⚠WARNING

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

F-frame requirements
Connect the brake resistors 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 mains 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 mains voltage	Motor insulation
$U_N \leq 420$ V	Standard U_{LL}=1300 V
420 V<$U_N \leq 500$ V	Reinforced U_{LL}=1600 V

Table 4.4 Recommended Motor Insulation Ratings

4.6.4 Motor Bearing Currents

Motors with a rating of 110 kW or higher combined with frequency converters 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:

- The frequency converter.
- The 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 frequency converter.
- Ensure that the impedance from frequency converter 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.
- Balance the mains voltage to ground.
- Use an insulated bearing as recommended by the motor manufacturer.

NOTICE

Motors from reputable manufacturers typically have insulated bearings as standard in motors of this size.

If 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 sine-wave filter.

4.7 AC Mains Connection

4.7.1 Mains Connection

Connect mains 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 number	Function
91, 92, 93	Mains R/L1, S/L2, T/L3
94	Ground

Table 4.5 Terminal Functions

Ensure sufficient current supply to the frequency converter.

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

4.7.2 External Fan Supply

NOTICE

Applicable for E and F enclosures only.

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

Terminal number	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 mains 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 supply is needed, remove the jumpers and connect the supply to terminals 100 and 101. Protect with a 5 A fuse. In UL applications, use a Littelfuse KLK-5 or equivalent.

4.7.3 Power and Control Wiring for Unscreened 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 frequency converters separately. Failure to run output cables separately could result in death or serious injury.

⚠CAUTION

COMPROMISED PERFORMANCE

The frequency converter runs less efficiently if wiring is not isolated properly.

To isolate high frequency noise, place 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.

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. See *Illustration 4.4*. When screened/armoured cable is not used, at least 3 separate conduits are connected to the panel options cabinet.

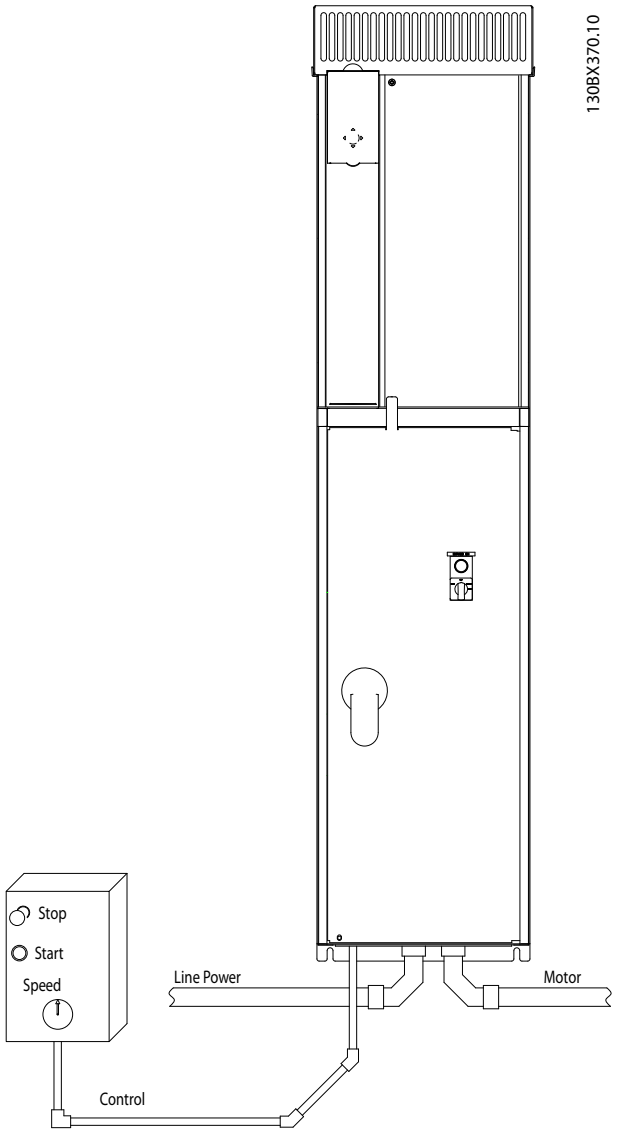


Illustration 4.4 Example of Proper Electrical Installation Using Conduit

4.7.4 Mains Disconnects

Enclosure size	Power/Voltage	Type
D	160–250 kW (250-350 hp) /380–480 V	OT400U12-9 or ABB OETL-NF400A
E	315 kW (450 hp) /380–480 V	ABB OETL-NF600A
E	355–450 kW (500-600 hp) /380–480 V	ABB OETL-NF800A
F	500 kW (650 hp) /380–480 V	Merlin Gerin NPJF36000S12AAYP
F	560–710 kW (750-1000 hp) /380–480 V	Merlin Gerin NRK36000S20AAYP

Table 4.7 Recommended Mains Disconnects

4.7.5 F-Frame Circuit Breakers

Enclosure size	Power/Voltage	Type
F	500 kW (650 hp) /380–480 V	Merlin Gerin NPJF36120U31AABSCYP
F	560–710 kW (750-1000 hp) /380–480 V	Merlin Gerin NRJF36200U31AABSCYP

Table 4.8 Recommended Circuit Breakers

4.7.6 F-Frame Mains Contactors

Enclosure size	Power/Voltage	Type
F	500–560 kW (650-750 hp)/380–480 V	Eaton XTCE650N22A
F	630–710 kW (900-1000 hp) /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 *Illustration 4.5*, *Illustration 4.6*, *Illustration 4.7*, and *Illustration 4.8*. Remember to connect the shields in a proper way to ensure optimum electrical immunity.

Fieldbus connection
Connections are made to the relevant options on the control card. For details, see the relevant fieldbus instruction. The cable must either be entered through the access point in the top or be placed in the provided path inside the frequency converter and tied down with other control wires (see *Illustration 4.5*, *Illustration 4.6*, and *Illustration 4.7*).

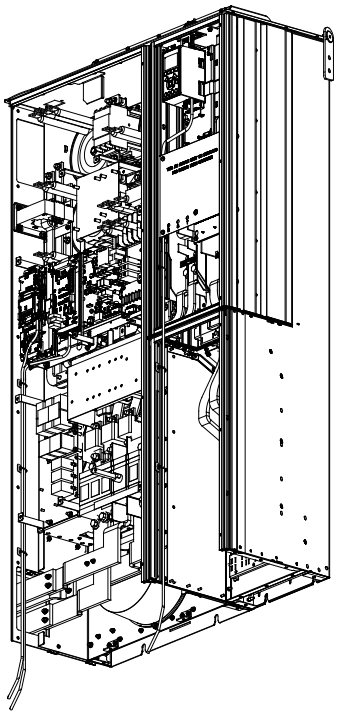


Illustration 4.5 Control Card Wiring Path for Enclosure Size D1n

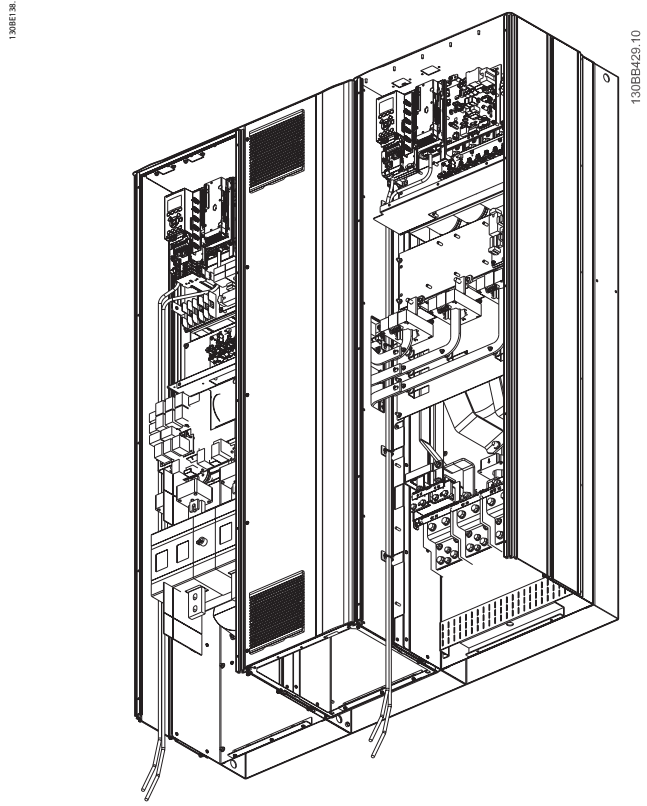


Illustration 4.7 Control Card Wiring Path for Enclosure Size E9

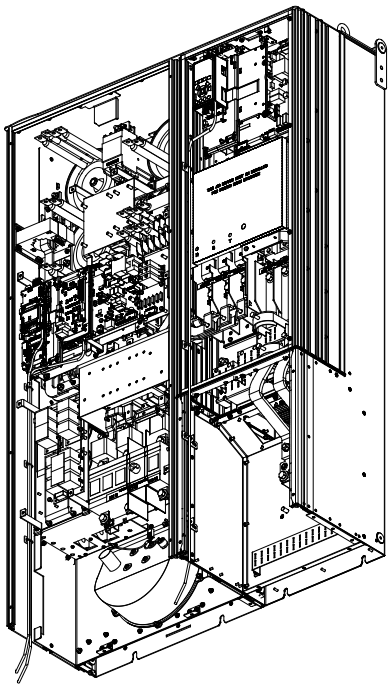
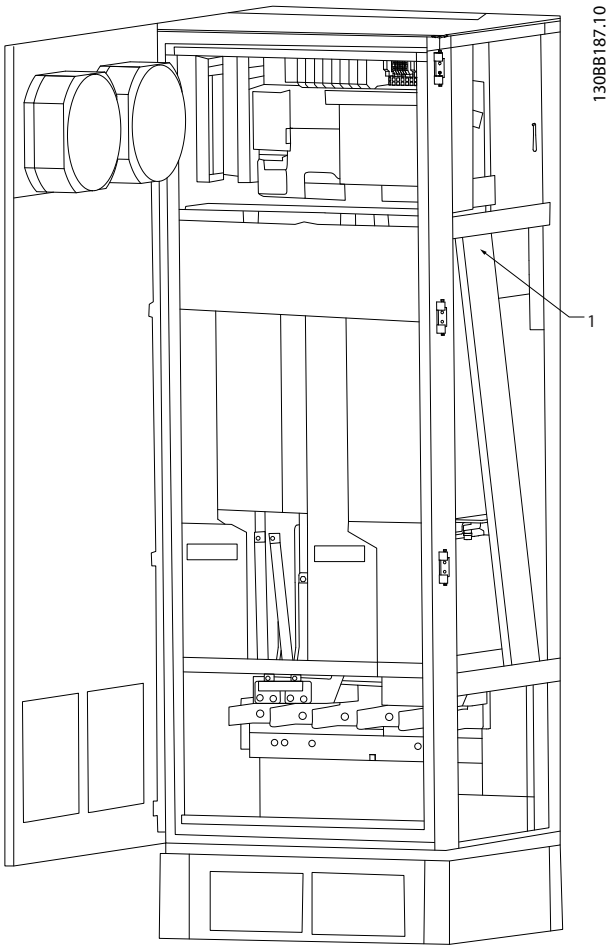


Illustration 4.6 Control Card Wiring Path for Enclosure Size D2n



1	Routing path for the control card wiring inside the frequency converter enclosure.

Illustration 4.8 Control Card Wiring Path for Enclosure Size F18

4.8.2 Access to Control Terminals

All terminals for the control cables are located beneath the LCP (both filter and frequency converter LCPs). 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 9–10 mm (0.5 in).

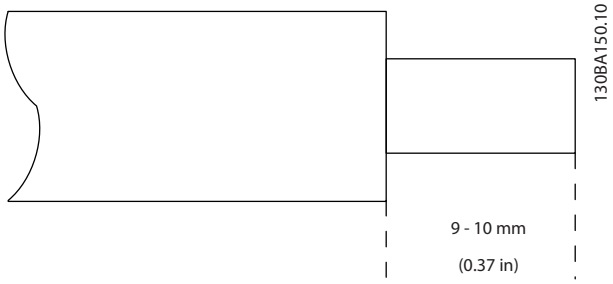


Illustration 4.9 Length to Strip the Insulation

2. Insert a screwdriver (maximum 0.4 x 2.5 mm (0.016 x 0.1 in)) in the square hole.
3. Insert the cable in the adjacent circular hole.

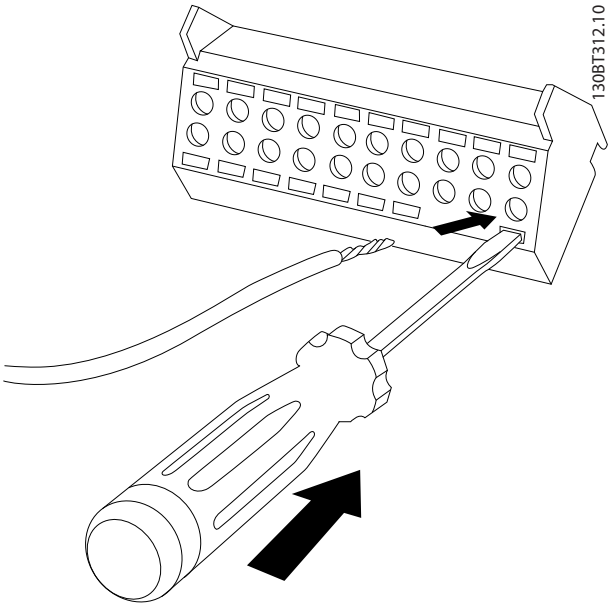


Illustration 4.10 Inserting the Cable in the Terminal Block

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

To remove the cable from the terminal:

1. Insert a screwdriver (maximum 0.4 x 2.5 mm (0.016 x 0.1 in)) in the square hole.
2. Pull out the cable.

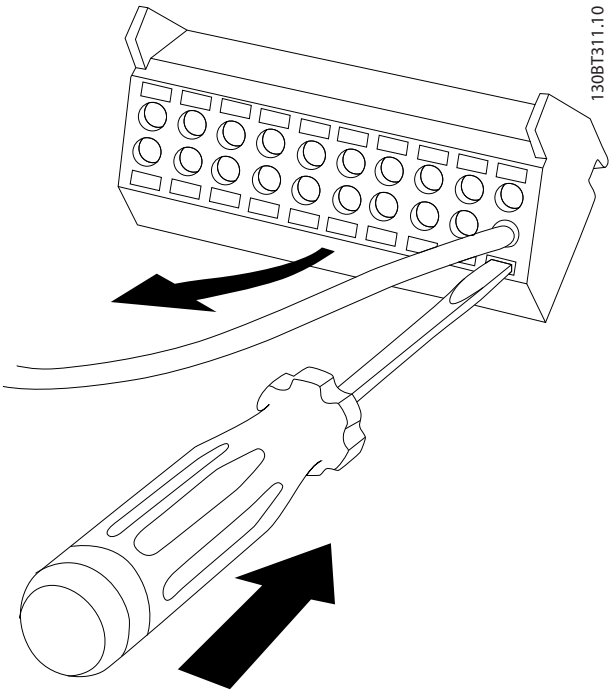


Illustration 4.11 Removing the Screwdriver after Cable Insertion

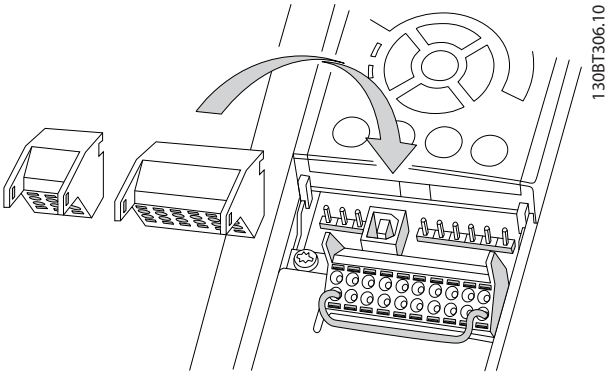


Illustration 4.12 Control Terminal Locations

4.8.4 Electrical Installation, Control Cables

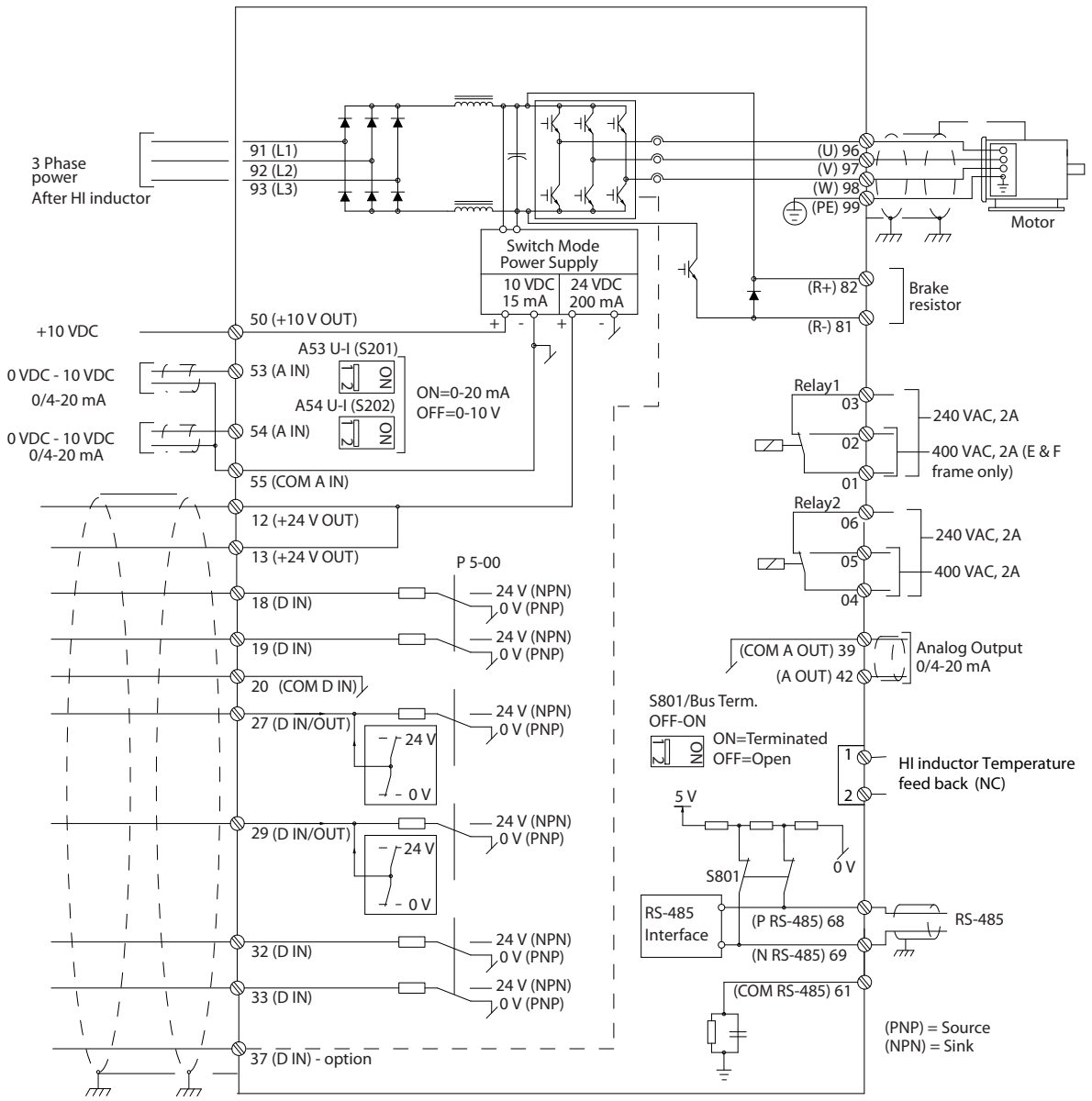


Illustration 4.13 Terminal Diagram for the Frequency Converter Side

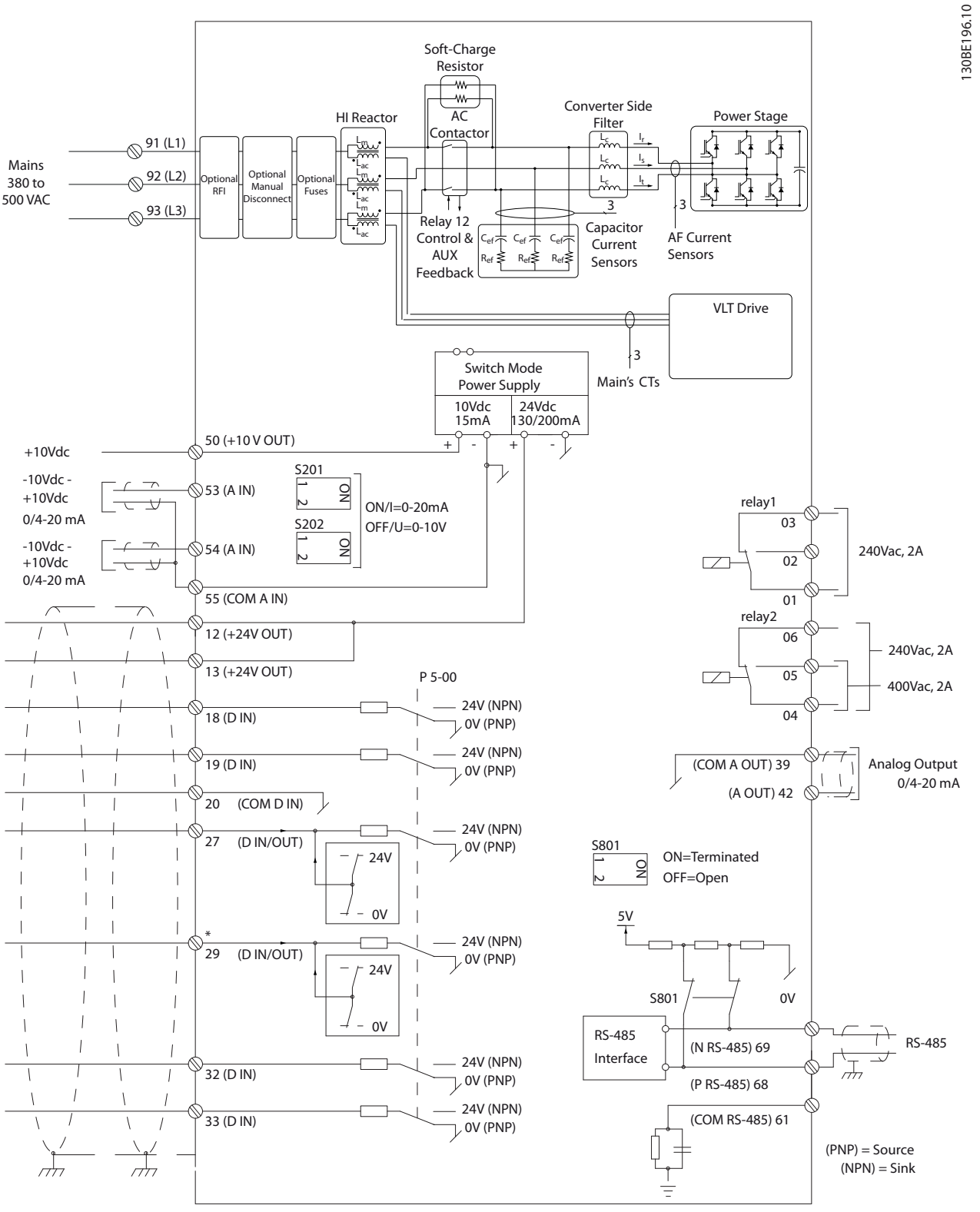


Illustration 4.14 Terminal Diagram for the Filter Side

4.8.5 Safe Torque Off (STO)

To run STO, extra 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

4

RS485 is a 2-wire bus interface compatible with multi-drop network topology, that is 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 1 network segment. Repeaters divide networks.

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 frequency converters 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 gland. 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 frequency converters, always use shielded motor cable.

Cable	Shielded twisted pair (STP)
Impedance	120 Ω
Cable length [m]	Maximum 1200 (including drop lines) Maximum 500 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 frequency converter is unable to support the motor, due to the load being too heavy, for example.
- 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 frequency converter completes a stop command.

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

4.9.3 Parallel Connection of Motors

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

NOTICE

Installations with cables connected in a common joint as in *Illustration 4.15* are 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 frequency converter cannot be used as motor overload protection for the individual motor in systems with parallel-connected motors. Provide further motor overload protection with thermistors in each motor or individual thermal relays. Circuit breakers are not suitable as protection.

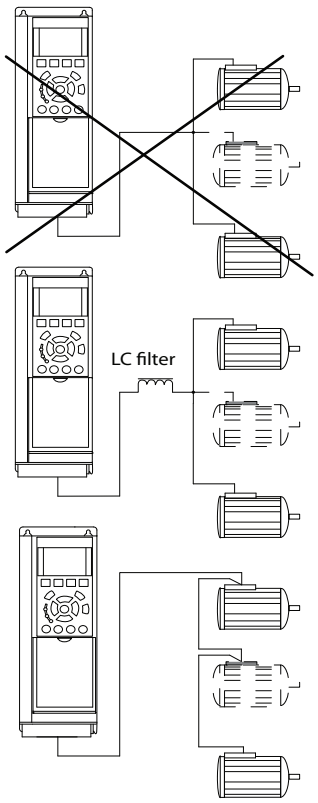


Illustration 4.15 Installations with Cables Connected in a Common Joint

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 frequency converter has received UL-approval for single motor overload protection, when *parameter 1-90 Motor Thermal Protection* is set for *[4] ETR Trip 1* and *parameter 1-24 Motor Current* is set to the rated motor current (see motor nameplate).

For the North American market: The ETR functions provide class 20 motor overload protection in accordance with NEC.

For motor thermal protection, it is also possible to use the VLT® PTC Thermistor Card MCB 112. 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 frequency converter 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 *Illustration 4.13* and *Illustration 4.14* for the location of the control terminals within the low harmonic drive.

Default parameter settings:

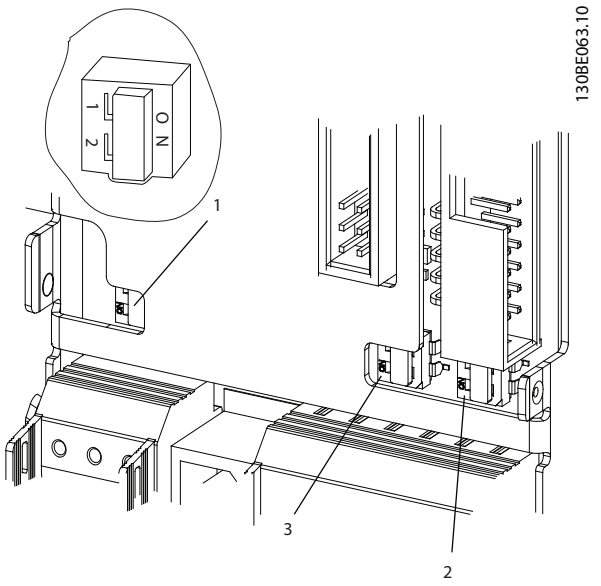
- Terminal 53: Speed reference signal in open loop (see *parameter 16-61 Terminal 53 Switch Setting*).
- Terminal 54: Feedback signal in closed loop (see *parameter 16-63 Terminal 54 Switch Setting*).

NOTICE

REMOVE POWER

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

1. Remove the LCP (see *Illustration 4.16*).
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.



1	Bus termination switch
2	A54 switch
3	A53 switch

Illustration 4.16 Bus Termination Switch, A53, and A54 Switch Locations

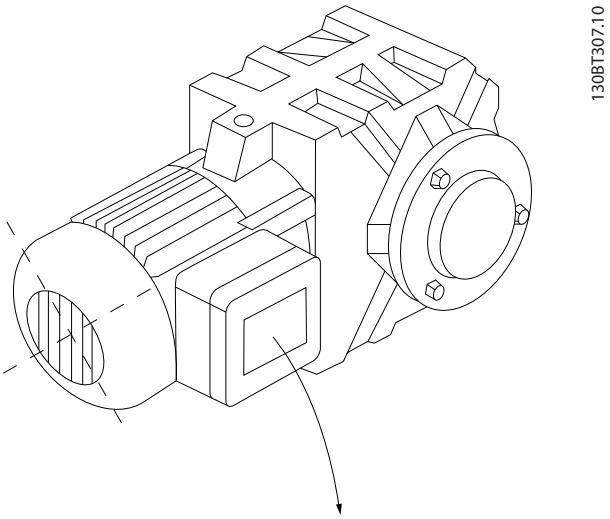
4.10 Final Set-up and Test

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

1. Locate the motor nameplate to find out whether the motor is star- (Y) or delta- connected (Δ).
2. Enter the motor nameplate 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.	*Parameter 1-20 Motor Power [kW]* *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*

Table 4.11 Quick Set-up Parameters



BAUER D-7 3734 ESLINGEN				
3~ MOTOR NR. 1827421 2003				
S/E005A9				
	1,5	KW		
n2 31,5	/min.	400	Y	V
n1 1400	/min.		50	Hz
COS θ 0,80			3,6	A
1,7L				
B	IP 65	H1/1A		

Illustration 4.17 Motor Nameplate

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 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. Find a description of the alarm 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	*Parameter 3-02 Minimum Reference*
Maximum reference	*Parameter 3-03 Maximum Reference*

Table 4.12 Reference Parameters

Motor speed low limit	*Parameter 4-11 Motor Speed Low Limit [RPM]* or *parameter 4-12 Motor Speed Low Limit [Hz]*
Motor speed high limit	*Parameter 4-13 Motor Speed High Limit [RPM]* or *parameter 4-14 Motor Speed High Limit [Hz]*

Table 4.13 Speed Limits

Ramp-up time 1 [s]	*Parameter 3-41 Ramp 1 Ramp Up Time*
Ramp-down time 1 [s]	*Parameter 3-42 Ramp 1 Ramp Down Time*

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 organized and labeled to the specifications of the NAMUR standard for frequency converters input and output terminals. This requires VLT® PTC Thermistor Card MCB 112 and VLT® 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 setpoint) and a main alarm setpoint. Associated with each setpoint 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 shutdown. 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 designed for Danfoss frequency converters.

5 Commissioning

5.1 Safety Instructions

See *chapter 2 Safety* for general safety instructions.

⚠WARNING

HIGH VOLTAGE

Frequency converters contain high voltage when connected to AC mains 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 glands are firmly tightened.
3. Ensure that input power to the unit is off and locked out. Do not rely on the frequency converter 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 frequency converter and the motor.
8. Inspect the frequency converter for loose connections on the terminals.
9. Confirm that the supply voltage matches the voltage of the frequency converter and the motor.

5.1.1 Pre-start

⚠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	☑
Auxiliary equipment	• Look for auxiliary equipment, switches, disconnects, or input fuses/circuit breakers on the input power side of the frequency converter 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 frequency converter. • Remove power factor correction capacitors on motors, if present.	
Cable routing	• Use separate metallic conduits for each of the following: - Input power - Motor wiring - Control wiring	
Control wiring	• 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. • Use shielded or twisted-pair cable. Ensure that the shield is terminated correctly.	
Cooling clearance	• Measure that top and bottom clearance is adequate to ensure proper air flow for cooling.	
EMC considerations	• Check for proper installation regarding electromagnetic compatibility.	
Environmental considerations	• See equipment label for the maximum ambient operating temperature limits. • Humidity levels must be 5–95%, non-condensing.	
Fusing and circuit breakers	• 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	• The unit requires a ground wire from its enclosure 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 sufficient.	
Input and output power wiring	• Check for loose connections. • Check that motor and mains are in separate conduit or separated shielded cables.	
Panel interior	• Inspect that the unit interior is free of debris and corrosion.	
Switches	• Ensure that all switch and disconnect settings are in the proper positions.	
Vibration	• 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!

Frequency converters contain high voltage when connected to AC mains. 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 frequency converter is connected to AC mains, the motor may start at any time. The frequency converter, 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 frequency converter 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 showed, 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 functions:

- Control speed of frequency converter when in local mode.
- Start and stop in local mode.
- Display operational data, status, warnings, and alarms.
- Program 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, code 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 *Illustration 5.1*).

A. Display area

B. Display menu keys

C. Navigation keys and indicator lights (LEDs)

D. Operation keys and reset

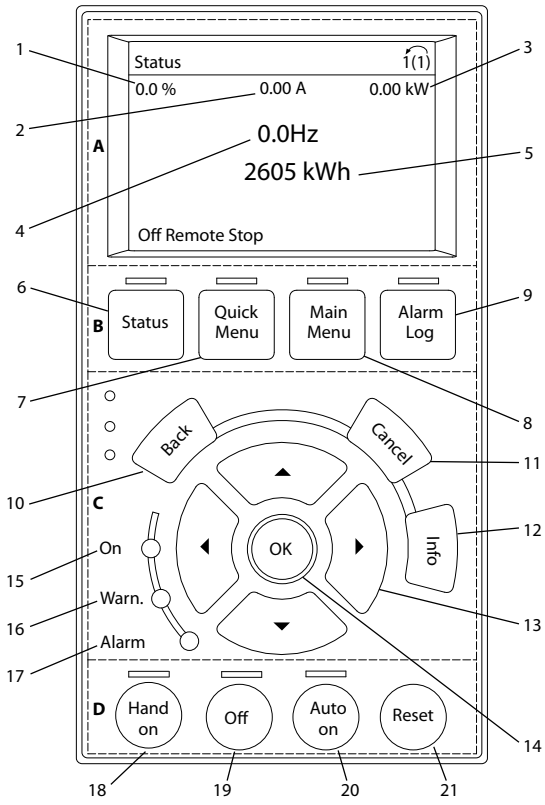


Illustration 5.1 Local Control Panel (LCP)

A. Display area

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

The information shown on the LCP can be customized 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 *Illustration 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	Shows a list of current warnings, the last 10 alarms, and the maintenance log.

Table 5.3 Legend to *Illustration 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 shown.
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 *Illustration 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 a 24 V external 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 shown.

Table 5.5 Legend to *Illustration 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. • 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. • 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 *Illustration 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 frequency converter.

- For back-up, upload data into the LCP memory.
- To download data to another frequency converter, 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

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

5.3.5 Changing Parameter Settings

Access and change parameter settings from the *Quick Menu* or from the *Main Menu*. The *Quick Menu* only gives access to a limited number of parameters.

1. Press [Quick Menu] or [Main Menu] on the LCP.
2. Press [▲] [▼] to browse through the parameter groups, press [OK] to select a parameter group.
3. Press [▲] [▼] to browse through the parameters, press [OK] to select a parameter.
4. Press [▲] [▼] to change the value of a parameter setting.
5. Press [◄] [►] to shift digit when a decimal parameter is in the editing state.
6. Press [OK] to accept the change.
7. 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 are changed in the current edit set-up.
- Parameters, which were reset to default values, are not listed.
- The message *Empty* indicates that no parameters are 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 initialization.

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

- Initialization 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 initialization erases all motor, programming, localization, and monitoring data, and restores factory default settings.

Recommended initialization 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 shown.
7. Press [Reset] to return to operation mode.

Manual initialization 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 initialization does not reset the following frequency converter information:

- *Parameter 15-00 Operating hours*
- *Parameter 15-03 Power Up's*
- *Parameter 15-04 Over Temp's*
- *Parameter 15-05 Over Volt's*

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 frequency converter.
- Follow the on-screen instructions to complete the commissioning of the frequency converter. 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 frequency converter.

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

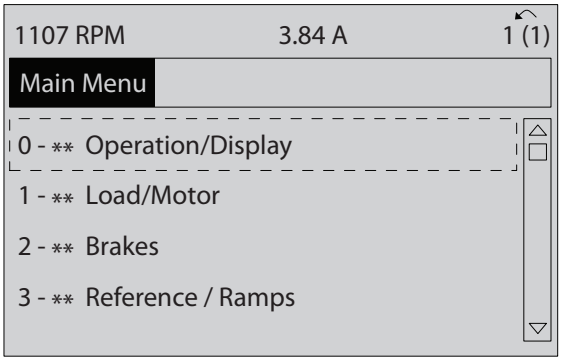


Illustration 5.2 Main Menu

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

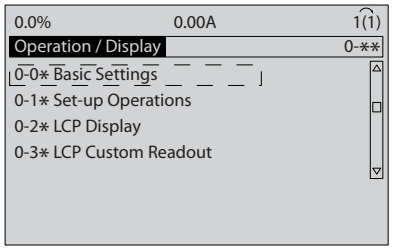


Illustration 5.3 Operation/Display

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

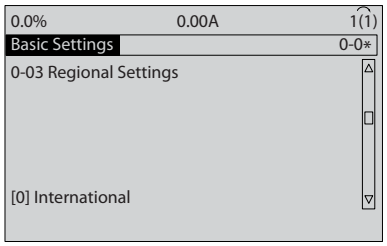


Illustration 5.4 Basic Settings

5. Press the navigation keys to select *[0] International* or *[1] North America* as appropriate and press [OK]. (This changes the default settings for several 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 *[0] No Operation* in *parameter 5-12 Terminal 27 Digital Input*.

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. Find the information 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 control principle, or for optimum performance in VVC$^+$ mode, extra motor data is required to set up the following parameters. Find the data in the motor datasheet (this data is typically not available on the motor nameplate). Run a complete automatic motor adaptation (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 control principle is the preferred control principle 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	*Parameter 1-66 Min. Current at Low Speed*. 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	*Parameter 1-66 Min. Current at Low Speed*. Increase current to a value between default and maximum depending on the application.
No-load application	Adjust *parameter 1-18 Min. Current at No Load* to achieve smoother motor operation by reducing torque ripple and vibration.
Flux Sensorless control principle only	Adjust *parameter 1-53 Model Shift Frequency*. Example 1: If the motor oscillates at 5 Hz, and dynamics performance is required at 15 Hz, set *parameter 1-53 Model Shift Frequency* to 10 Hz. Example 2: If the application involves dynamic load changes at low speed, reduce *parameter 1-53 Model Shift Frequency*. 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 frequency converter 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 in *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* Adv. Motor Data*, and *1-4** are active.
Find the necessary data on the motor nameplate and in the motor datasheet.

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 (R_s). If only line-line data are available, divide the line-line value with 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 with 2 to achieve the line-common (starpoint) value.
   It is also possible to measure the value with an inductancemeter, 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-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 frequency converter is connected and the shaft is turned externally. Back EMF is normally specified for nominal motor speed or for 1000 RPM measured between 2 lines. If the value is not available for a motor speed of 1000 RPM, calculate the correct value as follows: If back EMF is for example 320 V at 1800 RPM, it can be calculated at 1000 RPM as follows: Back EMF = (Voltage/RPM)x1000 = (320/1800)x1000 = 178. Program this value for *parameter 1-40 Back EMF at 1000 RPM*.

Test motor operation

1. Start the motor at low speed (100–200 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, for example pumps or conveyors. On some motors, a 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 for example 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. *Table 5.7* shows recommendations in different applications.

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

Table 5.8 Recommendations in 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.

Adjust starting torque 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, as a result of that 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 frequency converter and the motor.

- The frequency converter 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 frequency converter, 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 frequency converter and wait for power to discharge. Reverse the connection of any 2 of the 3 motor wires on the motor or frequency converter side of the connection.

5.6 Local-control Test

1. Press [Hand On] to provide a local start command to the frequency converter.
2. Accelerate the frequency converter 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 frequency converter after a trip.

5.7 System Start-up

The procedure in this section requires 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

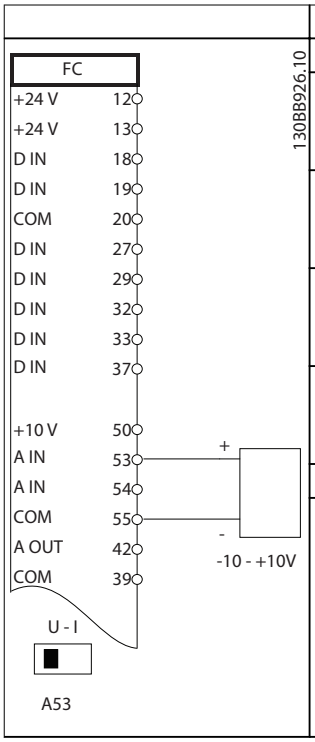
When using the optional STO feature, a jumper wire may be required between terminal 12 (or 13) and terminal 37 for the frequency converter to operate with factory default programming values.

NOTICE

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

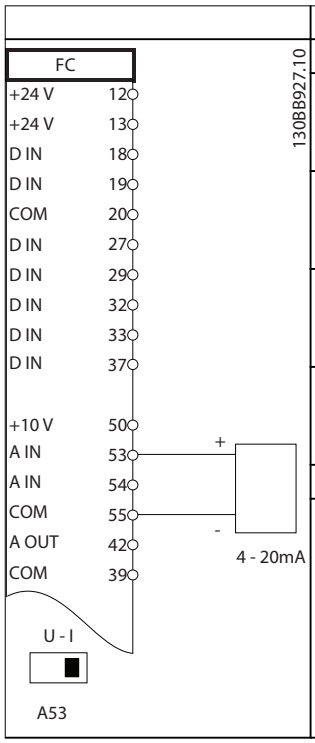
6.2 Application Examples

6.2.1 Speed



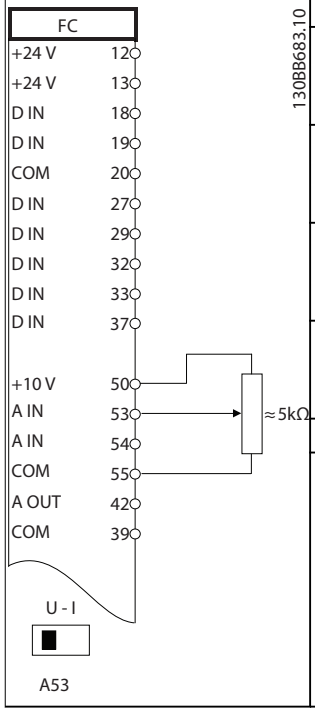
	Parameters	
	Function	**Setting**
	Parameter 6-10 Terminal 53 Low Voltage	0.07 V*
	Parameter 6-11 Terminal 53 High Voltage	10 V*
	Parameter 6-14 Terminal 53 Low Ref./Feedb. Value	0 Hz
	Parameter 6-15 Terminal 53 High Ref./Feedb. Value	50 Hz
	* = Default value	
	Notes/comments: D IN 37 is an option.	

Table 6.1 Analog Speed Reference (Voltage)



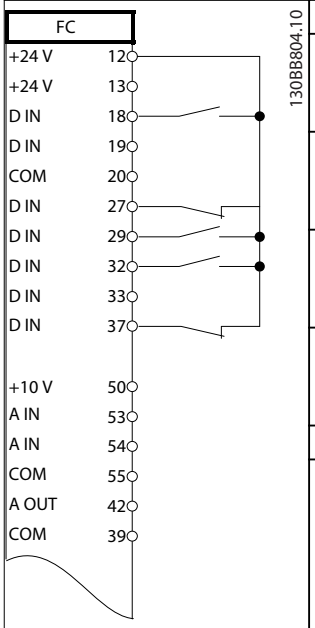
	Parameters	
	Function	**Setting**
	Parameter 6-12 Terminal 53 Low Current	4 mA*
	Parameter 6-13 Terminal 53 High Current	20 mA*
	Parameter 6-14 Terminal 53 Low Ref./Feedb. Value	0 Hz
	Parameter 6-15 Terminal 53 High Ref./Feedb. Value	50 Hz
	* = Default value	
	Notes/comments: D IN 37 is an option.	

Table 6.2 Analog Speed Reference (Current)



	Parameters	
	Function	**Setting**
	Parameter 6-10 Terminal 53 Low Voltage	0.07 V*
	Parameter 6-11 Terminal 53 High Voltage	10 V*
	Parameter 6-14 Terminal 53 Low Ref./Feedb. Value	0 Hz
	Parameter 6-15 Terminal 53 High Ref./Feedb. Value	1500 Hz
	* = Default value	
	Notes/comments: D IN 37 is an option.	

Table 6.3 Speed Reference (Using a Manual Potentiometer)



	Parameters	
	Function	**Setting**
	Parameter 5-10 Terminal 18 Digital Input	*[8] Start**
	Parameter 5-12 Terminal 27 Digital Input	*[19] Freeze Reference*
	Parameter 5-13 Terminal 29 Digital Input	*[21] Speed Up*
	Parameter 5-14 Terminal 32 Digital Input	*[22] Speed Down*
	* = Default value	
	Notes/comments: D IN 37 is an option.	

Table 6.4 Speed Up/Speed Down

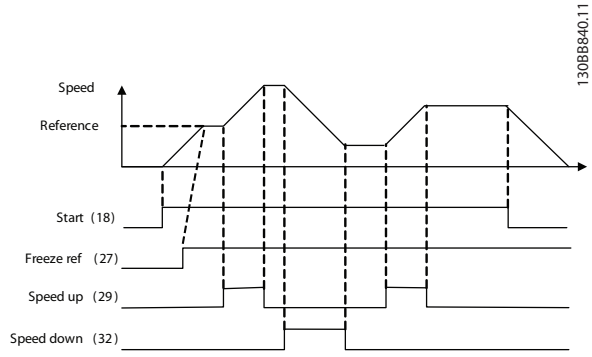
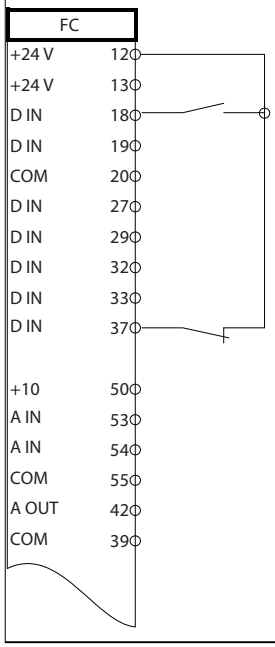


Illustration 6.1 Speed Up/Speed Down

6.2.2 Start/Stop



	Parameters	
	Function	**Setting**
	Parameter 5-10 Terminal 18 Digital Input	*[8] Start*
	Parameter 5-12 Terminal 27 Digital Input	*[0] No operation*
	Parameter 5-19 Terminal 37 Safe Stop	*[1] Safe Stop Alarm*
	* = Default value	
	Notes/comments: If *parameter 5-12 Terminal 27 Digital Input* is set to *[0] No operation*, a jumper wire to terminal 27 is not needed. D IN 37 is an option.	

Table 6.5 Start/Stop Command with Safe Torque Off Option

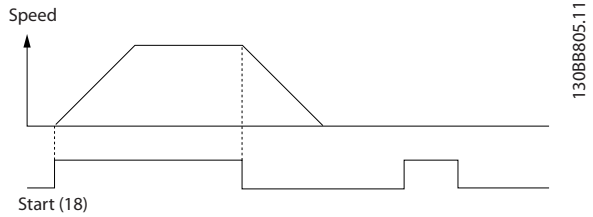
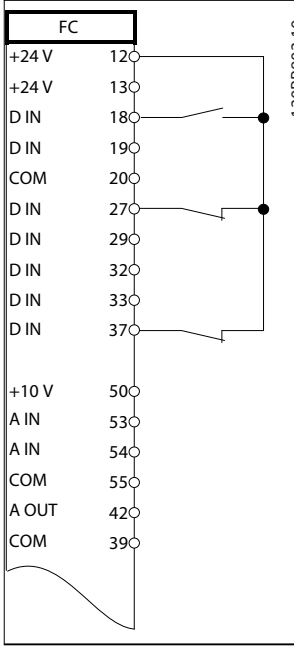


Illustration 6.2 Start/Stop Command with Safe Torque Off

6



Parameters	
Function	**Setting**
Parameter 5-10 Terminal 18 Digital Input	*[9] Latched Start*
Parameter 5-12 Terminal 27 Digital Input	*[6] Stop Inverse*
* = Default value	
Notes/comments: If *parameter 5-12 Terminal 27 Digital Input* is set to *[0] No operation*, a jumper wire to terminal 27 is not needed. D IN 37 is an option.	

Table 6.6 Pulse Start/Stop

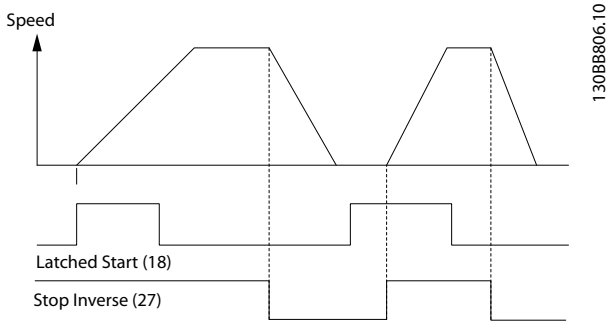
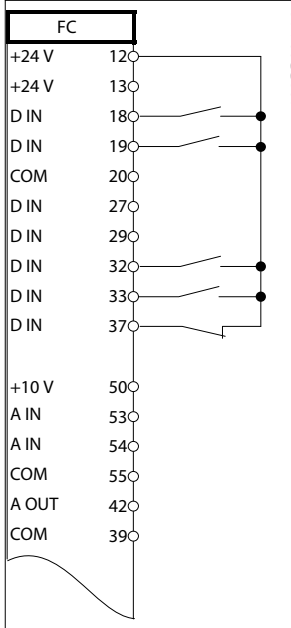


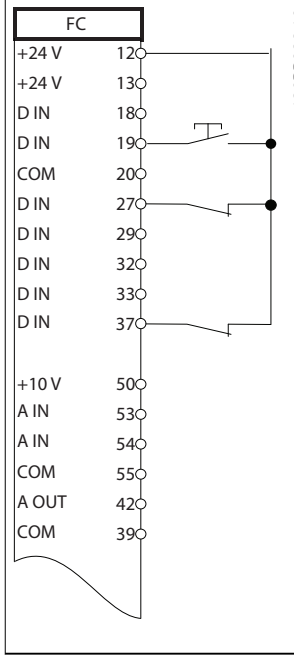
Illustration 6.3 Latched Start/Stop Inverse



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 reference 0	25%
Preset reference 1	50%
Preset reference 2	75%
Preset reference 3	100%
* = Default value	
Notes/comments: D IN 37 is an option.	

Table 6.7 Start/Stop with Reversing and 4 Preset Speeds

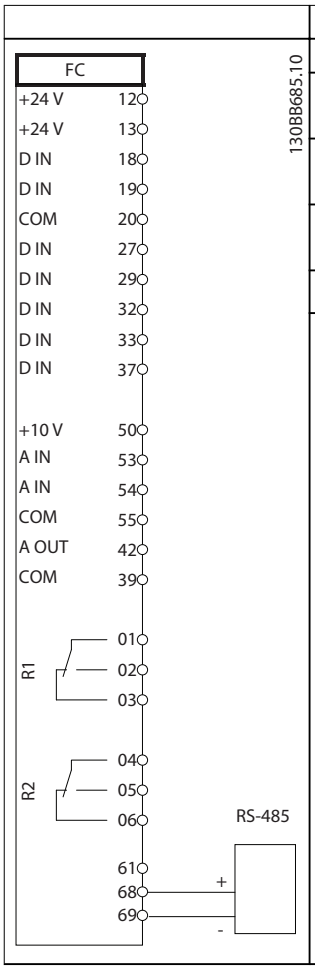
6.2.3 External Alarm Reset



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	
	Function	**Setting**
	Parameter 8-30 Protocol	FC*
	Parameter 8-31 Address	1*
	Parameter 8-32 Baud Rate	9600*
	* = Default value	
	Notes/comments: Select protocol, address, and baud rate in the above-mentioned parameters. D IN 37 is an option.	

Table 6.9 RS485 Network Connection

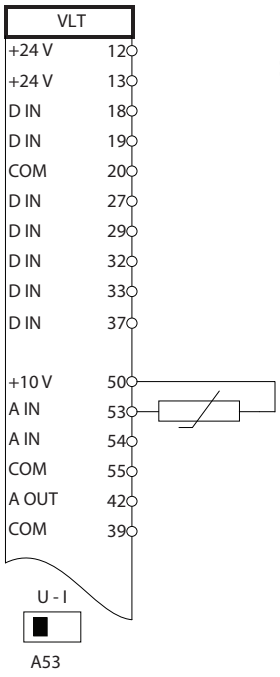
6.2.5 Motor Thermistor

⚠WARNING

THERMISTOR INSULATION

Risk of personal injury or equipment damage.

- **Use only thermistors with reinforced or double insulation to meet PELV insulation requirements.**



	Parameters	
	Function	**Setting**
	Parameter 1-90 Motor Thermal Protection	*[2] Thermistor trip*
	Parameter 1-93 Thermistor Source	*[1] Analog input 53*
	* = Default Value	
	Notes/comments: If only a warning is required, set *parameter 1-90 Motor Thermal Protection* to *[1] Thermistor warning*. D IN 37 is an option.	

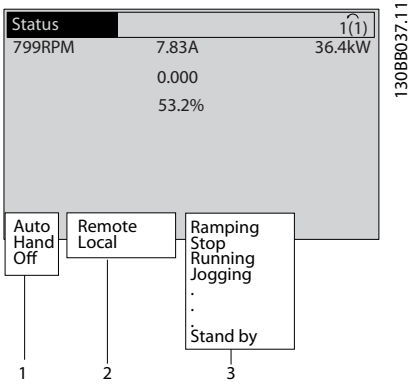
Table 6.10 Motor Thermistor

6

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 *Illustration 7.1*). Refer to the *VLT® HVAC Drive FC 102 Programming Guide* for detailed descriptions of the shown status messages.



1	Operating mode
2	Reference site
3	Operation status

Illustration 7.1 Status Display

7.2 Warning and Alarm Types

The frequency converter monitors the condition of its input power, output, and motor factors, and other system performance indicators. A warning or alarm does not necessarily indicate a problem internally in the frequency converter.

Often, 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 frequency converter 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 restart operation.

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 less than 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 1 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 connections on all analog mains terminals.
  - Control card terminals 53 and 54 for signals, terminal 55 common.
  - VLT® General Purpose I/O MCB 101 terminals 11 and 12 for signals, terminal 10 common.
  - VLT® Analog I/O Option MCB 109 terminals 1, 3, and 5 for signals, terminals 2, 4, and 6 common.
- Check that the frequency converter programming and switch settings match the analog signal type.
- Perform an input terminal signal test.

WARNING/ALARM 3, No motor
No motor is connected to the output of the frequency converter.

WARNING/ALARM 4, Mains phase loss
A phase is missing on the supply side, or the mains voltage imbalance is too high. This message also appears for a fault in the input rectifier. Options are programmed in *parameter 14-12 Function at Mains Imbalance*.

Troubleshooting

- Check the supply voltage and supply currents to the frequency converter.

WARNING 5, DC link voltage high
The DC-link voltage (DC) is higher than the high-voltage warning limit. The limit depends on the frequency converter voltage rating. The unit is still active.

WARNING 6, DC link voltage low
The DC-link voltage (DC) is lower than the low voltage warning limit. The limit depends on the frequency converter voltage rating. The unit is still active.

WARNING/ALARM 7, DC overvoltage
If the DC-link voltage exceeds the limit, the frequency converter trips after a certain 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 back-up (*parameter 14-10 Mains Failure*).

WARNING/ALARM 8, DC under voltage
If the DC-link voltage drops below the undervoltage limit, the frequency converter checks for 24 V DC back-up supply. If no 24 V DC back-up supply is connected, the frequency converter trips after a fixed time delay. The time delay varies with unit size.

Troubleshooting

- Check that the supply voltage matches the frequency converter voltage.
- Perform an input voltage test.
- Perform a soft-charge circuit test.

WARNING/ALARM 9, Inverter overload
The frequency converter 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% with an alarm. The frequency converter cannot be reset until the counter is below 90%.

Troubleshooting

- Compare the output current shown on the LCP with the frequency converter rated current.
- Compare the output current shown on the LCP with the measured motor current.
- Show the thermal frequency converter load on the LCP and monitor the value. When running above the frequency converter continuous current rating, the counter increases. When running below the frequency converter 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 frequency converter issues a warning or an alarm when the counter is >90% if *parameter 1-90 Motor Thermal Protection* is set to warning options, or whether the frequency converter trips when the counter reaches 100% if *parameter 1-90 Motor Thermal Protection* is set to trip options. 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 frequency converter

to the motor more accurately and reduces thermal loading.

WARNING/ALARM 11, Motor thermistor overtemp
The thermistor may be disconnected. Select whether the frequency converter 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 *parameter 1-93 Thermistor Resource* is set to 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 of *parameter 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, Over current
The inverter peak current limit (approximately 200% of the rated current) is exceeded. The warning lasts approximately 1.5 s, then the frequency converter 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 back-up. 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.
- Check that the motor size matches the frequency converter.
- Check that the motor data is correct in *parameters 1-20* to *1-25*.

ALARM 14, Earth (ground) fault
There is current from the output phases to ground, either in the cable between the frequency converter and the motor, or in the motor itself.

Troubleshooting

- Remove the power to the frequency converter 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 a 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 frequency converter and repair the short circuit.

WARNING/ALARM 17, Control word timeout
There is no communication with the frequency converter. The warning is only active when *parameter 8-04 Control Word Timeout Function* is not set to *[0] Off*.

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

Troubleshooting

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

WARNING/ALARM 22, Hoist mechanical brake

The value of this warning/alarm shows the type of warning/alarm.
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 the fan resistance.
- Check the 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 the fan resistance.
- Check the 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 frequency converter is still operational, but without the brake function.

Troubleshooting

- Remove the power to the frequency converter and replace the brake resistor (refer to *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 DC-link voltage and the brake resistance value set in *parameter 2-16 AC brake Max. Current*. The warning is active when the dissipated braking is >90% of the brake resistance power. If *[2] Trip* is selected in *parameter 2-13 Brake Power Monitoring*, the frequency converter trips when the dissipated braking power 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.

Troubleshooting

- Check *parameter 2-15 Brake Check*.

ALARM 29, Heat Sink temp

The maximum temperature of the heat sink has been exceeded. The temperature fault resets when the temperature falls below a defined heat sink temperature. The trip and reset points vary based on the frequency converter power size.

Troubleshooting

Check for the following conditions:

- Ambient temperature too high.
- Motor cables too long.
- Incorrect airflow clearance above and below the frequency converter.
- Blocked airflow around the frequency converter.
- Damaged heat sink fan.
- Dirty heat sink.

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

Troubleshooting

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

ALARM 30, Motor phase U missing

Motor phase U between the frequency converter and the motor is missing.

Troubleshooting

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

ALARM 31, Motor phase V missing

Motor phase V between the frequency converter and the motor is missing.

Troubleshooting

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

ALARM 32, Motor phase W missing

Motor phase W between the frequency converter and the motor is missing.

Troubleshooting

- Remove the power from the frequency converter 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 fieldbus 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 frequency converter is lost and *parameter 14-10 Mains Failure* is not set to *[0] No Function*.

Troubleshooting

- Check the fuses to the frequency converter and mains supply to the unit.

ALARM 38, Internal fault

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

Troubleshooting

- Cycle the 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.

Number	Text
0	The serial port cannot be initialized. Contact the Danfoss supplier or Danfoss Service.
256–258	The power EEPROM data is defective or too old.
512	The 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 in progress.
517	The write command is under timeout.
518	Failure in the EEPROM.
519	Missing or invalid barcode data in EEPROM.
783	Parameter value outside of minimum/maximum limits.
1024–1279	A CAN telegram 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	The option software in slot A is too old.
1300	The option software in slot B is too old.
1301	The option software in slot C0 is too old.
1302	The option software in slot C1 is too old.
1315	The option software in slot A is not supported (not allowed).
1316	The option software in slot B is not supported (not allowed).
1317	The option software in slot C0 is not supported (not allowed).
1318	The option software in slot C1 is not supported (not allowed).
1379	Option A did not respond when calculating the platform version.
1380	Option B did not respond when calculating the platform version.
1381	Option C0 did not respond when calculating the platform version.
1382	Option C1 did not respond when calculating the platform version.
1536	An exception in the application-oriented control is registered. The debug information is written on the LCP.
1792	DSP watchdog 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 the power EEPROM.
2305	Missing software version from the power unit.
2314	Missing power unit data from the power unit.
2315	Missing software version from the power unit.
2316	Missing lo_statepage from the power unit.
2324	The power card configuration is determined to be incorrect at power-up.
2325	A power card has stopped communicating while mains power is applied.

Number	Text
2326	The 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	The 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 is too small.
3072–5122	The parameter value is outside its limits.
5123	Option in slot A: Hardware incompatible with the control board hardware.
5124	Option in slot B: Hardware incompatible with the control board hardware.
5125	Option in slot C0: Hardware incompatible with the control board hardware.
5126	Option in slot C1: Hardware incompatible with the control board hardware.
5376–6231	Out of memory.

Table 7.1 Internal Fault, Code Numbers

ALARM 39, Heat sink sensor
No feedback from the heat sink 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 gatedrive card, or the ribbon cable between the power card and gatedrive 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. Also 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 terminal X30/6, check the load connected to terminal X30/6 or remove the short circuit connection. Also check *parameter 5-32 Term X30/6 Digi Out (MCB 101)* (VLT® General Purpose I/O MCB 101).

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

ALARM 45, Earth 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 3 power supplies generated by the switch mode power supply (SMPS) on the power card: 24 V, 5 V, and ±18 V. When powered with 24 V DC with the MCB 107, only the 24 V and 5 V supplies are monitored. When powered with 3-phase mains voltage, all 3 supplies are monitored.

WARNING 47, 24 V supply low
The supply on the power card is out of range.

There are 3 supplies generated by the switch mode supply (SMPS) on the power card:
- 24 V.
- 5 V.
- ±18 V.

Troubleshooting
- Check for a defective power 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 supply is measured on the control card.

Troubleshooting
- Check for a defective control card.
- If an option card is present, check for overvoltage.

WARNING 49, Speed limit
The warning is shown 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]*. When the speed is below the specified limit in *parameter 1-86 Trip Speed Low [RPM]* (except when starting or stopping), the frequency converter trips.

ALARM 50, AMA calibration failed
Contact the Danfoss supplier or Danfoss service department.

ALARM 51, AMA check U_{nom} and I_{nom}
The settings for motor voltage, motor current, and motor power are wrong.

Troubleshooting
- Check the settings in *parameters 1-20* to *1-25*.

ALARM 52, AMA low I_{nom}
The motor current is too low.

Troubleshooting

- Check the settings in *parameter 1-24 Motor Current*.

ALARM 53, AMA motor too big
The motor is too large 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
AMA cannot run because the parameter values of the motor are outside of the acceptable range.

ALARM 56, AMA interrupted by user
The AMA is manually interrupted.

ALARM 57, AMA internal fault
Continue to restart the AMA, until the AMA is carried out.

7

NOTICE

Repeated runs may heat the motor to a level where the resistance R_s and R_r are increased. Usually, 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* is 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 frequency converter (via serial communication, digital I/O, or by pressing [Reset]).

WARNING/ALARM 61, Tracking error
An error has occurred between the calculated motor speed and the speed measurement from the 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 over temperature
The cut-out temperature of the control card is 85 °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, Heat sink temperature low
The frequency converter 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 frequency converter 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 heat sink temperature measured as 0 °C could indicate that the temperature sensor is defective, causing the fan speed to increase to the maximum. This warning results if the sensor wire between the IGBT and the gatedrive card is disconnected. 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
STO 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.
- Check that the filters for the door fans are not blocked.
- Check that the gland plate is properly installed on IP21/IP54 (NEMA 1/12) frequency converters.

ALARM 70, Illegal FC configuration
The control card and power card are incompatible. To check compatibility, contact the Danfoss supplier with the type code from the unit nameplate and the part numbers of the cards.

ALARM 71, PTC 1 Safe Torque Off
STO has been activated from the VLT® PTC Thermistor Card MCB 112 (motor too warm). Normal operation can resume when the VLT® PTC Thermistor Card MCB 112 applies 24 V DC to terminal 37 (when the motor temperature is acceptable) and when the digital input from the VLT® PTC Thermistor Card MCB 112 is deactivated. When that

happens, a reset signal is sent (via Bus, Digital I/O, or by pressing [Reset]).

NOTICE

If automatic restart is enabled, the motor could start when the fault is cleared.

ALARM 72, Dangerous failure
STO with trip lock. Unexpected signal levels on safe torque off and digital input from the VLT® PTC Thermistor Card MCB 112.

WARNING 73, Safe Stop auto restart
STO activated. With automatic restart enabled, the motor can start when the fault is cleared.

WARNING 76, Power unit setup
The required number of power units does not match the detected number of active power units.

This warning occurs when replacing a module for an F-size enclosure if the power-specific data in the module power card does not match the rest of the frequency converter.

Troubleshooting

- Confirm that the spare part and its power card are the correct part number.

WARNING 77, Reduced power mode
The frequency converter is operating in reduced power mode (less than the allowed number of inverter sections). This warning is generated on power cycle when the frequency converter 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 initialised 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 frequency converter to determine if the warning/alarm returns.

ALARM 243, Brake IGBT
This alarm is only for enclosure size F frequency converters. 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 enclosure sizes F12 or F13.

2 = Right inverter module in enclosure sizes F10 or F11.

2 = Second frequency converter from the left inverter module in enclosure size F14.

3 = Right inverter module in enclosure sizes F12 or F13.

3 = Third from the left inverter module in enclosure size F14 or F15.

4 = Far right inverter module in enclosure size F14.

5 = Rectifier module.

6 = Right rectifier module in enclosure size F14 or F15.

ALARM 244, Heat Sink temperature
This alarm is only for enclosure type F frequency converters. 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 enclosure size F12 or F13.

2 = Right inverter module in enclosure size F10 or F11.

2 = Second frequency converter from the left inverter module in enclosure size F14 or F15.

3 = Right inverter module in enclosure sizes F12 or F13.

3 = Third from the left inverter module in enclosure size F14 or F15.

4 = Far right inverter module in enclosure sizes F14 or F15.

5 = Rectifier module.

6 = Right rectifier module in enclosure sizes F14 or F15.

ALARM 245, Heat Sink sensor
This alarm is only for enclosure size F frequency converters. 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 enclosure sizes F12 or F13.

2 = Right inverter module in enclosure sizes F10 or F11.

2 = Second frequency converter from the left inverter module in enclosure size F14 or F15.

3 = Right inverter module in enclosure sizes F12 or F13.

3 = Third from the left inverter module in enclosure size F14 or F15.

4 = Far right inverter module in enclosure size F14 or F15.

5 = Rectifier module.

6 = Right rectifier module in enclosure size F14 or F15.

The 12-pulse frequency converter may generate this warning/alarm when one of the disconnects or circuit breakers is opened while the unit is on.

ALARM 246, Power card supply
This alarm is only for enclosure size F frequency converters. 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 enclosure sizes F12 or F13.

2 = Right inverter module in enclosure sizes F10 or F11.

2 = Second frequency converter from the left inverter module in enclosure size F14 or F15.

3 = Right inverter module in enclosure sizes F12 or F13.

3 = Third from the left inverter module in enclosure size F14 or F15.

4 = Far right inverter module in enclosure size F14 or F15.

5 = Rectifier module.

6 = Right rectifier module in enclosure size F14 or F15.

ALARM 247, Power card temperature
This alarm is only for enclosure size F frequency converters. 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 enclosure sizes F12 or F13.

2 = Right inverter module in enclosure sizes F10 or F11.

2 = Second frequency converter from the left inverter module in enclosure size F14 or F15.

3 = Right inverter module in enclosure sizes F12 or F13.

3 = Third from the left inverter module in enclosure size F14 or F15.

4 = Far right inverter module in enclosure size F14 or F15.

5 = Rectifier module.

6 = Right rectifier module in enclosure size F14 or F15.

ALARM 248, Illegal power section configuration
This alarm is only for enclosure size F frequency converters. 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 enclosure sizes F12 or F13.

2 = Right inverter module in enclosure sizes F10 or F11.

2 = Second frequency converter from the left inverter module in enclosure size F14 or F15.

3 = Right inverter module in enclosure sizes F12 or F13.

3 = Third from the left inverter module in enclosure sizes F14 or F15.

4 = Far right inverter module in enclosure sizes F14 or F15.

5 = Rectifier module.

6 = Right rectifier module in enclosure size F14 or F15.

WARNING 250, New spare part
The power or switch mode supply has been exchanged. Restore the frequency converter type code in the EEPROM. Select the correct type code in *parameter 14-23 Typecode Setting* according to the label on the frequency converter. Remember to select Save to EEPROM at the end.

WARNING 251, New typecode
The power card or other components are replaced and the type code has changed.

7.4 Warnings and Alarm Definitions - Active Filter

NOTICE

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

Number	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 over voltage	X	X		
8	DC under voltage	X	X		
13	Over current	X	X	X	
14	Earth fault	X	X	X	
15	Hardware mismatch		X	X	
16	Short circuit		X	X	
17	Control word timeout	(X)	(X)		8-04
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 over-temperature	X	X	X	
66	Heat sink temperature low	X			
67	Option configuration has changed		X		
68	Safe torque off activated		X		
69	Pwr. card temp		X	X	
70	Illegal FC configuration			X	
72	Dangerous failure			X	
73	Safe torque off auto restart				
76	Power unit setup	X			
79	Illegal PS config		X	X	
80	Unit initialised to default value		X		
250	New spare part			X	
251	New type code		X	X	
300	Mains cont. fault	X			
301	SC cont. fault	X			
302	Cap. over current	X	X		
303	Cap. earth fault	X	X		
304	DC over current	X	X		
305	Mains freq. limit		X		
306	Compensation Limit				
308	Resistor temp	X		X	
309	Mains earth fault	X	X		
311	Switch. freq. limit		X		

Number	Description	Warning	Alarm/Trip	Alarm/Trip Lock	Parameter Reference
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 disables the active filter and can be reset by pressing [Reset] or resetting via a digital input (parameter group *5-1* Digital Inputs [1] Reset*). The original event that caused an alarm cannot damage the active filter or cause dangerous conditions. A trip lock is an action when an alarm occurs, which may cause damage to active filter or connected parts. A trip lock situation can only be reset by a power cycling.

Warning	Yellow
Alarm	Flashing red
Trip locked	Yellow and red

Table 7.3 LED Indicator Lights

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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	Heat sink temp	Heat sink 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	Over current	Over current	Reserved
6	00000040	64	SC cont. fault	Reserved	Reserved
7	00000080	128	Cap. over current	Cap. over current	Reserved
8	00000100	256	Cap. earth fault	Cap. earth fault	Reserved
9	00000200	512	Inverter overld.	Inverter overld.	Reserved
10	00000400	1024	DC under volt	DC under volt	Reserved
11	00000800	2048	DC over volt	DC over volt	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 over current	DC over current	Password Protection
19	00080000	524288	Resistor temp	Resistor temp	Reserved
20	00100000	1048576	Mains earth fault	Mains earth 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 initialised	Unit initialised	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 fieldbus 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 for 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. Maximum 15 mA or minimum 590 Ω.

WARNING/ALARM 2, Live zero error
The signal on terminal 53 or 54 is less than 50% of the value set in:

- *Parameter 6-10 Terminal 53 Low Voltage*.
- *Parameter 6-12 Terminal 53 Low Current*.
- *Parameter 6-20 Terminal 54 Low Voltage*.
- *Parameter 6-22 Terminal 54 Low Current*.

WARNING 4, Mains phase loss
A phase is missing on the supply side, or the mains voltage imbalance is too high.

WARNING 5, DC-link voltage high
The DC-link voltage (DC) is higher than the high-voltage warning limit. The unit is still active.

WARNING 6, DC-link voltage low
The DC-link voltage (DC) is below the low-voltage warning limit. The unit is still active.

WARNING/ALARM 7, DC overvoltage
If the DC-link voltage exceeds the limit, the unit trips.

WARNING/ALARM 8, DC under voltage
If the DC-link voltage (DC) drops below the undervoltage limit, the filter checks if a 24 V back-up supply is connected. If not, the filter trips. Check that the mains 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 0. Check if the resistance of any phase-to-ground has a low value. Check both before and after mains contactor. Ensure that 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 time-out
There is no communication to the unit.
The warning is only active when *parameter 8-04 Control Word Timeout Function* is not set to off.
Possible correction: Increase *parameter 8-03 Control Word Timeout Time*. Change *parameter 8-04 Control Word 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 defective hardware or fans not mounted.

ALARM 29, Heat sink temp
The maximum temperature of the heat sink has been exceeded. The temperature fault is not reset until the temperature drops below a defined heat sink temperature.

ALARM 33, Inrush fault
Check whether a 24 V external DC supply has been connected.

WARNING/ALARM 34, Fieldbus communication fault
The fieldbus 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, Heat sink sensor
No feedback from the heat sink 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.

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 cut-out temperature of the control card is 80 °C.

WARNING 66, Heat sink temperature low
This warning is based on the temperature sensor in the IGBT module.

Troubleshooting
The heat sink temperature measured as 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.

ALARM 68, Safe Torque Off (STO) activated
Safe Torque Off (STO) 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 Safe Stop*.

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.

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 initialised to default value
Parameter settings are initialised to default settings after a manual reset.

ALARM 247, Power card temperature
Power card overtemperature. A report value indicates the source of the alarm (from left):
1–4 inverter.
5–8 rectifier.

ALARM 250, New spare part
The power or switch mode supply has been exchanged. Restore the filter type code 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 mains 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, Mains freq. limit
The mains frequency was outside the limits. Verify that the mains frequency is within product specification.

ALARM 306, Compensation limit
The needed compensation current exceeds unit capability. The unit runs at full compensation.

ALARM 308, Resistor temp
Excessive resistor heat sink temperature detected.

ALARM 309, Mains ground fault
A ground fault was detected in the mains currents. Check the mains 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 *Table 5.1*.	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 50–55.	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 frequency converter.	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.
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 mains power with 24 V DC option card.	If the display is functioning but no output, check that mains power is applied to the frequency converter.	Apply mains 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 *parameter 5-10 Terminal 18 Digital Input* for correct setting for terminal 18 (use default setting).	Apply a valid start signal to start the motor.
	Motor coast signal active (Coasting).	Check *parameter 5-12 Terminal 27 Digital Input*. for correct setting for terminal 27 (use default setting).	Apply 24 V on terminal 27 or program this terminal to *[0] No operation*.
	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 *parameter 3-13 Reference Site*. Set preset reference active in parameter group *3-1* References*. Check for correct wiring. Check scaling of terminals. Check reference signal.
Motor running in wrong direction	Motor rotation limit.	Check that *parameter 4-10 Motor Speed Direction* is programmed correctly.	Program correct settings.
	Active reversing signal.	Check if a reversing command is programmed for the terminal in parameter group *5-1* Digital inputs*.	Deactivate reversing signal.
	Wrong motor phase connection.		See *chapter 4.6.1 Motor Cable*.

Symptom	Possible cause	Test	Solution
Motor is not reaching maximum speed	Frequency limits set wrong.	Check output limits in: • *Parameter 4-13 Motor Speed High Limit [RPM].* • *Parameter 4-14 Motor Speed High Limit [Hz].* • *Parameter 4-19 Max Output Frequency.*	Program correct limits.
	Reference input signal not scaled correctly.	Check reference input signal scaling in *6-0* Analog I/O Mode* and parameter group *3-1* References.* Reference limits in parameter group *3-0* Reference Limit.*	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 *1-6* Load Depen. Setting*. For closed-loop operation, check settings in parameter group *20-0* Feedback*.
Motor runs rough	Possible overmagnetisation.	Check for incorrect motor settings in all motor parameters.	Check motor settings in parameter groups *1-2* Motor Data, 1-3* Adv Motor Data*, and *1-5* Load Indep. Setting.*
Motor does 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* DC Brake* and *3-0* Reference Limits*.
Open power fuses or circuit breaker trip	Phase-to-phase shortcircuit.	Motor or panel has a short phase-to-phase. Check motor and panel phase for short circuits.	Eliminate any short circuits detected.
	Motor overload.	Motor is overloaded for the application.	Perform start-up test and verify that the 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-startup check for loose connections.	Tighten loose connections.
Mains current imbalance greater than 3%	Problem with mains power (See *Alarm 4 Mains phase loss* description).	Rotate input power leads into the frequency converter 1 position: A to B, B to C, C to A.	If imbalanced leg follows the wire, it is a power problem. Check mains power supply.
	Problem with the frequency converter.	Rotate input power leads into the frequency converter 1 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 1 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 frequency converters.	Rotate output motor leads 1 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.

Symptom	Possible cause	Test	Solution
Acoustic noise or vibration (for example a fan blade is making noise or vibrations at certain frequencies)	Resonances, for example in the motor/fan system.	Bypass critical frequencies by using parameters in parameter group *4-6* Speed Bypass*.	Check if noise and/or vibration have been reduced to an acceptable limit.
		Turn off overmodulation in *parameter 14-03 Overmodulation*.	
		Change switching pattern and frequency in parameter group 14-0* Inverter Switching.	
		Increase resonance dampening in *parameter 1-64 Resonance Dampening*.	

Table 7.5 Troubleshooting

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8 Specifications

8.1 Power-Dependent Specifications

8.1.1 Mains Supply 3x380–480 V AC

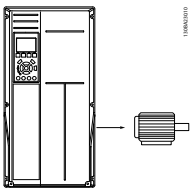
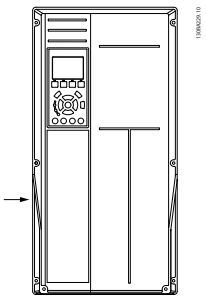
Mains Supply 3x380–480 V AC				
		N160	N200	N250
Normal overload =110% current for 60 s*		NO	NO	NO
	Typical shaft output at 400 V [kW]	160	200	250
	Typical shaft output at 460 V [hp]	250	300	350
	Typical shaft output at 480 V [kW]	200	250	315
	Enclosure protection rating IP21/Nema Type 1	D1n	D2n	D2n
	Enclosure protection rating IP54/NEMA Type 12	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 [mm² (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 [W]	8725	9831	11371
	Total back channel loss 400 V AC [W]	7554	8580	10020
	Total filter loss 400 V AC [W]	4954	5714	6234
	Total LHD loss 460 V AC [W]	8906	9046	10626
	Total back channel loss 460 V AC [W]	7343	7374	8948
	Total filter loss 460 V AC [W]	4063	4187	4822
	Weight [kg/(lb)]	352 (776)	413 (910)	413 (910)
	Efficiency[4)]	0.96		
	Acoustic noise	85dBa		
	Output frequency	0–590 Hz		
	Heat sink overtemperature trip	105 °C (221 ° F)		
	Power card ambient trip	85 °C (185 °F)		
* High overload = 150% current for 60 s, normal overload = 110% current for 60 s.				

Table 8.1 D-frame Ratings

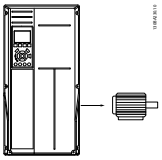
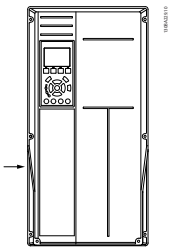
Mains supply 3x380–480 V AC					
		P315	P355	P400	P450
Normal overload =110% current for 60 s*		NO	NO	NO	NO
	Typical shaft output at 400 V [kW]	315	355	400	450
	Typical shaft output at 460 V [hp]	450	500	600	600
	Typical shaft output at 480 V [kW]	355	400	500	530
	Enclosure protection rating IP21/NEMA Type 1	E9	E9	E9	E9
	Enclosure protection rating IP54/NEMA Type 12	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 [mm² (AWG[2)])]	4x240 (4x500 mcm)	4x240 (4x500 mcm)	4x240 (4x500 mcm)	4x240 (4x500 mcm)
	Maximum cable size, brake [mm² (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 [W]	14051	15320	17180	18447
	Total back channel loss 400 V AC [W]	11301	11648	13396	14570
	Total filter loss 400 V AC [W]	7346	7788	8503	8974
	Total LHD loss 460 V AC [W]	12936	14083	15852	16962
	Total back channel loss 460 V AC [W]	10277	10522	12184	13214
	Total filter loss 460 V AC [W]	7066	7359	8033	8435
	Weight [kg/(lb)]	596 (1314)	623 (1373)	646 (1424)	646 (1424)
	Efficiency[4)]	0.96			
	Acoustic noise	72dBa			
	Output frequency	0–590 Hz			
	Heat sink overtemperate trip	105 °C (221 ° F)			
	Power card ambient trip	85 °C (185 ° F)			
* High overload = 160% current for 60 s, normal overload = 110% current for 60 s.					

Table 8.2 E-frame Ratings

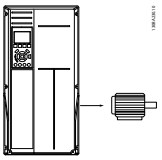
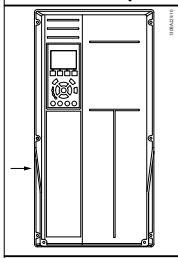
Mains supply 3x380–480 V AC					
		P500	P560	P630	P710
Normal overload =110% current for 60 s*		NO	NO	NO	NO
	Typical shaft output at 400 V [kW]	500	560	630	710
	Typical shaft output at 460 V [hp]	650	750	900	1000
	Typical shaft output at 480 V [kW]	560	630	710	800
	Enclosure protection rating IP21/ NEMA Type 1 IP54/NEMA Type 12	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 [mm² (AWG[2)])]	8x150 (8x300 mcm)			
	Maximum cable size, mains F1/F2 [mm² (AWG[2)])]	8x240 (8x500 mcm)			
	Maximum cable size, mains F3/F4 [mm² (AWG[2)])]	8x456 (8x900 mcm)			
	Maximum cable size, load sharing [mm² (AWG[2)])]	4x120 (4x250 mcm)			
	Maximum cable size, brake [mm² (AWG[2)])	4x185 (4x350 mcm)			
	Maximum. external mains fuses [A][1)]	1600		2000	
	Total LHD loss 400 V AC [W]	21909	24592	26640	30519
	Total back channel loss 400 V AC [W]	17767	19984	21728	24936
	Total filter loss 400 V AC [W]	11747	12771	14128	15845
	Total LHD loss 460 V AC [W]	19896	22353	25030	27989
	Total back channel loss 460 V AC [W]	16131	18175	20428	22897
	Total filter loss 460 V AC [W]	11020	11929	13435	14776
	Maximum panel options losses	400			
	Weight [kg/(lb)]	2009 (4429)			
	Weight frequency converter section [kg/(lb)]	1004 (2213)			
	Weight filter section [kg/(lb]	1005 (2216)			
	Efficiency[4)]	0.96			
	Acoustic noise	69dBa			
	Output frequency	0–590 Hz			
	Heat sink overtemperate trip	105 °C (221 ° F)			
	Power card ambient trip	85 °C (185 ° F)			
* 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 shielded 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. Applies for dimensioning of frequency converter cooling. If the switching frequency is higher than the default setting, the power losses may increase. LCP and typical control card power consumptions are included. For power loss data according to EN 50598-2, refer to www.danfoss.com/vltenergyefficiency.
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%).
Efficiency measured at nominal current. For energy efficiency class, see *chapter 8.3 General Technical Data*. For part load losses, see www.danfoss.com/vltenergyefficiency.

8.1.2 Derating for Temperature

8

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

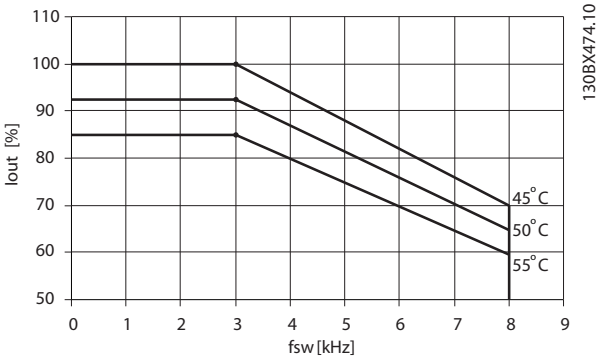


Illustration 8.1 Derating Enclosure Size D, N160 to N250 380–480 V (T5) Normal Overload 110%, 60 AVM

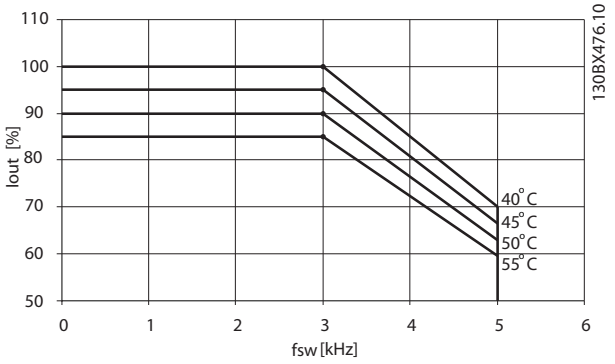


Illustration 8.2 Derating Enclosure Size D, N160 to N250 380–480 V (T5) Normal Overload 110%, SFAVM

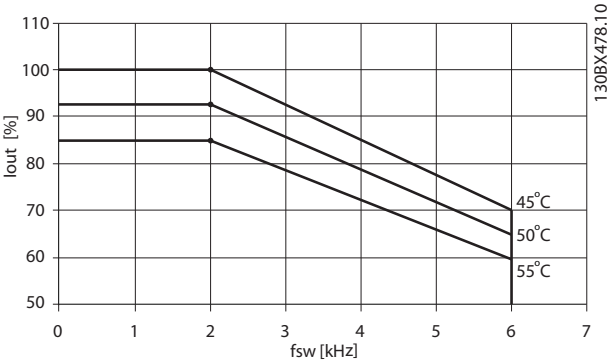


Illustration 8.3 Derating Enclosure Sizes E and F, P315 to P710 380–480 V (T5) Normal Overload 110%, 60 AVM

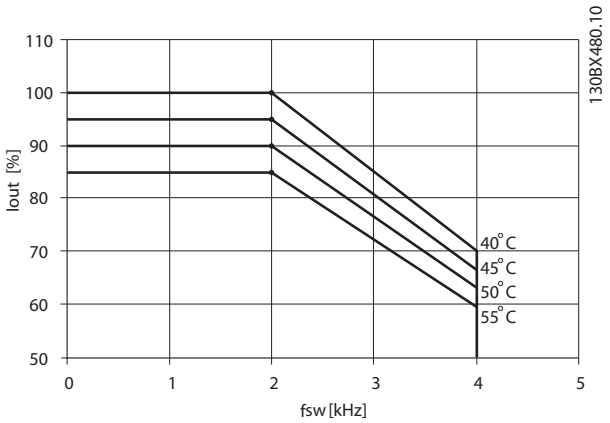


Illustration 8.4 Derating Enclosure Sizes E and F, P315 to P710 380–480 V (T5) Normal Overload 110%, SFAVM

8.2 Mechanical Dimensions

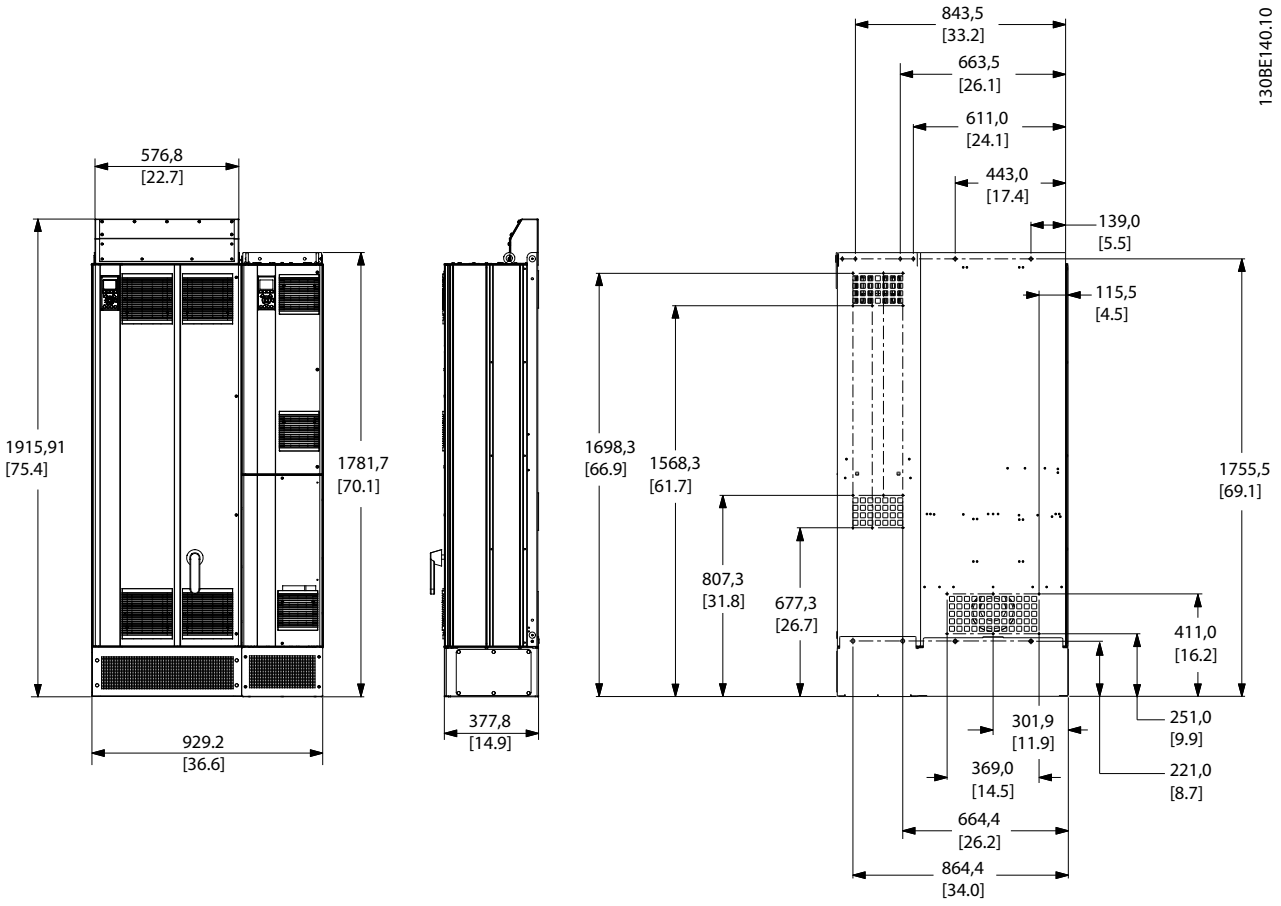


Illustration 8.5 Enclosure Size D1n

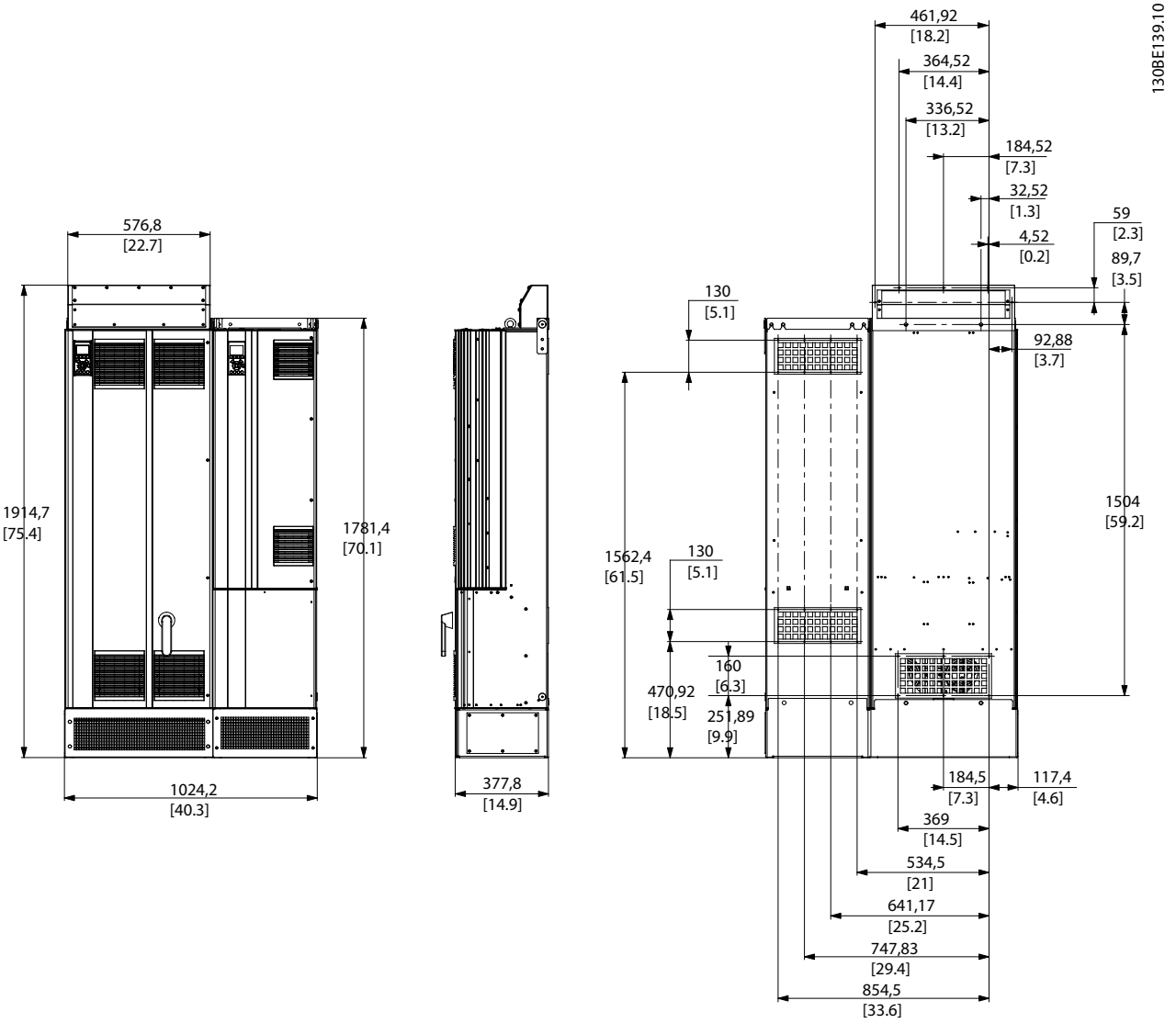


Illustration 8.6 Enclosure Size D2n

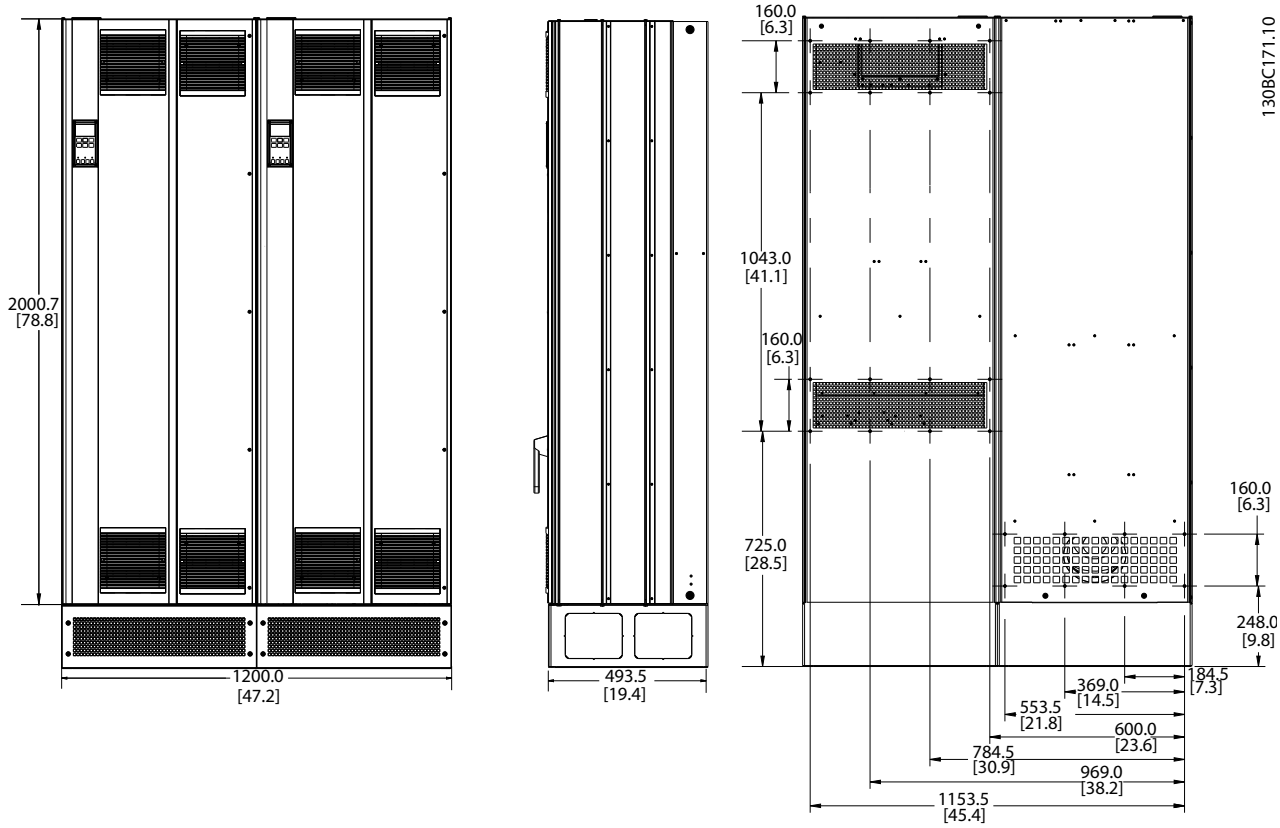


Illustration 8.7 Enclosure Size E9

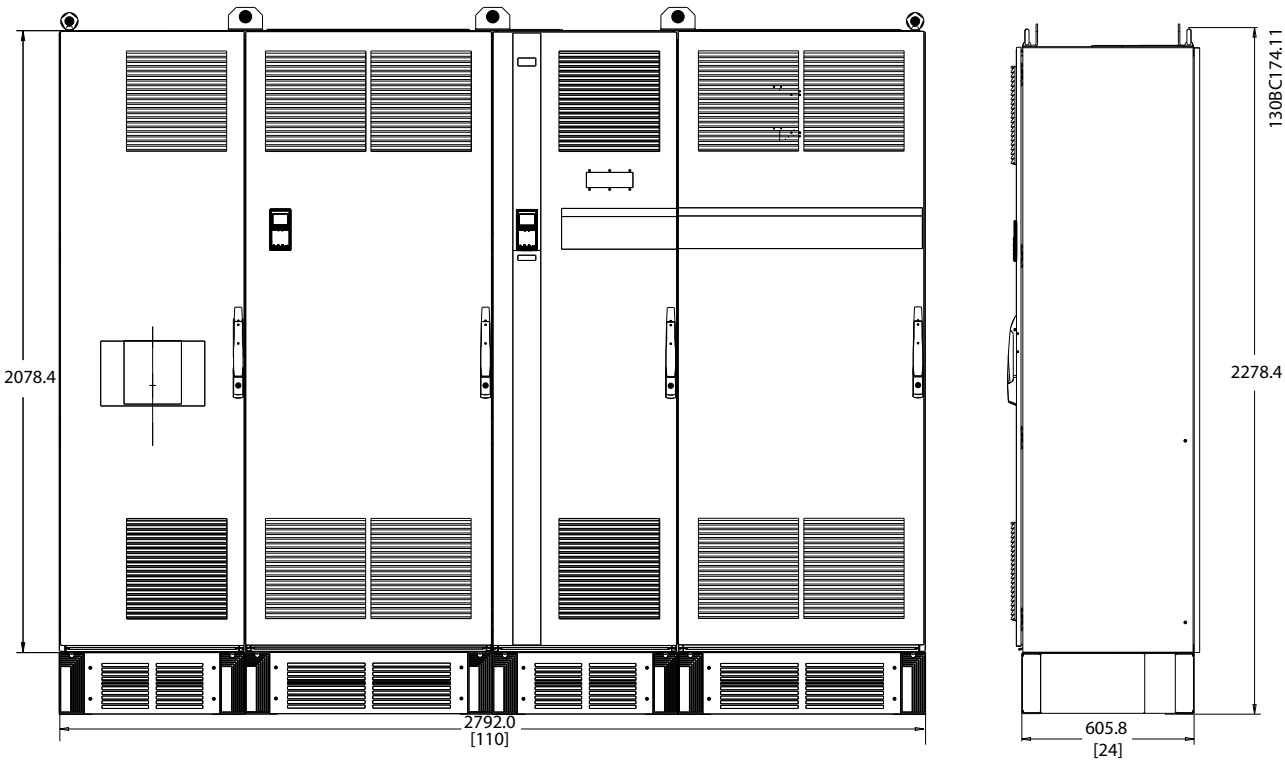


Illustration 8.8 Enclosure Size F18, Front, and Side View

8.3 General Technical Data

Mains supply (L1, L2, L3)	
Supply voltage	380–480 V +5%

Mains voltage low/mains drop-out:
During low mains voltage or mains drop-out, the frequency converter continues until the DC-link 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 mains voltage lower than 10% below the lowest rated supply voltage.

Supply frequency	50/60 Hz ±5%
Maximum imbalance temporary between mains phases	3.0% of rated supply voltage
True power factor (λ)	>0.98 nominal at rated load
Displacement power factor (cosφ) near unity	(>0.98)
THDi	<5%
Switching on input supply L1, L2, L3 (power-ups)	maximum once/2 minutes
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 100000 RMS symmetrical Amperes, 480/690 V maximum.

Motor output (U, V, W)	
Output voltage	0–100% of supply voltage
Output frequency	0–590 Hz[1)]
Switching on output	Unlimited
Ramp times	0.01–3600 s

1) Voltage and power dependent

Torque characteristics	
Starting torque (constant torque)	maximum 150% for 60 s[1)]
Starting torque	maximum 180% up to 0.5 s[1)]
Overload torque (constant torque)	maximum 150% for 60 s[1)]

1) Percentage relates to nominal torque of the unit.

Cable lengths and cross-sections	
Maximum motor cable length, screened/armoured	150 m (500 ft)
Maximum motor cable length, unscreened/unarmoured	300 m (1000 ft)
Maximum cross-section to motor, mains, load sharing, and brake[1)]	
Maximum cross-section to control terminals, rigid wire	1.5 mm^2 (16 AWG) (2x0.75 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 (24 AWG)

1) See chapter 8.1.1 Mains Supply 3x380–480 V AC for more information

Digital inputs	
Programmable digital inputs	4 (6) on frequency converter and 2 (4) on active filter
Terminal number	18, 19, 27[1)], 29[1)], 32, and 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	approximately 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 on frequency converter
Terminal number	53 and 54
Modes	Voltage or current
Mode select	Switch S201 and switch S202, switch A53 and A54
Voltage mode	Switch S201/switch S202 = OFF (U), switch A53 and A54
Voltage level	0–10 V (scaleable)
Input resistance, R_i	Approximately 10 kΩ
Maximum voltage	± 20 V
Current mode	Switch S201/switch S202 = ON (I), switch A53 and A54
Current level	0/4–20 mA (scaleable)
Input resistance, R_i	approximately 200 Ω
Maximum current	30 mA
Resolution for analog inputs	10 bit (+ sign)
Accuracy of analog inputs	Maximum error 0.5% of full scale
Bandwidth	100 Hz (D-frame), 200 Hz

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

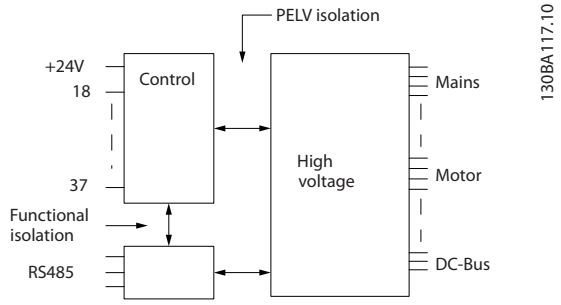


Illustration 8.9 PELV Isolation of Analog Inputs

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

Analog output	
Number of programmable analog outputs	1 on both frequency converter and active filter
Terminal number	42
Current range at analog output	0/4–20 mA
Maximum resistor load to common at analog output	500 Ω
Accuracy on analog output	Maximum 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, RS485 serial communication	
Terminal number	68 (P,TX+, RX+) and 69 (N,TX-, RX-)
Terminal number 61	Common for terminals 68 and 69

The RS485 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 on both frequency converter and active filter
Terminal number	27 and 29[1)]
Voltage level at digital/frequency output	0–24 V
Maximum output current (sink or source)	40 mA
Maximum load at frequency output	1 kΩ
Maximum 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	Maximum error: 0.1% of full scale
Resolution of frequency outputs	12 bit

1) Terminals 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)
Maximum 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.

8

Relay outputs	
Programmable relay outputs	2 on frequency converter only
Relay 01 terminal number (D-frame)	1–3 (break), 1–2 (make)
Maximum terminal load (AC-1)[1)] on 1–2 (NO) (Resistive load)[2)3)]	400 V AC, 2 A
Maximum terminal load (AC-15)[1)] on 1–2 (NO) (Inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1)[1)] on 1–2 (NO) (Resistive load)	80 V DC, 2 A
Maximum terminal load (DC-13)[1)] on 1–2 (NO) (Inductive load)	24 V DC, 0.1 A
Maximum terminal load (AC-1)[1)] on 1–3 (NC) (Resistive load)	240 V AC, 2 A
Maximum terminal load (AC-15)[1)] on 1–3 (NC) (Inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1)[1)] on 1–3 (NC) (Resistive load)	50 V DC, 2 A
Maximum terminal load (DC-13)[1)] on 1–3 (NC) (Inductive load)	24 V DC, 0.1 A
Minimum terminal load on 1–3 (NC), 1–2 (NO)	24 V DC 10 mA, 24 V AC 2 mA
Environment according to EN 60664-1	overvoltage category III/pollution degree 2
Relay 01 terminal number (E-frame and F-frame)	1–3 (break), 1–2 (make)
Maximum terminal load (AC-1)[1)] on 1–3 (NC), 1–2 (NO) (resistive load)	240 V AC, 2A
Maximum terminal load (AC-15)[1)] (inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1)[1)] on 1–2 (NO), 1–3 (NC) (resistive load)	60 V DC, 1 A
Maximum terminal load (DC-13)[1)] (inductive load)	24 V DC, 0.1 A
Relay 02 terminal number	4–6 (break), 4–5 (make)
Maximum terminal load (AC-1)[1)] on 4–5 (NO) (resistive load)[2)3)]	400 V AC, 2 A
Maximum terminal load (AC-15)[1)] on 4–5 (NO) (inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1)[1)] on 4–5 (NO) (resistive load)	80 V DC, 2 A
Maximum terminal load (DC-13)[1)] on 4–5 (NO) (inductive load)	24 V DC, 0.1 A
Maximum terminal load (AC-1)[1)] on 4–6 (NC) (resistive load)	240 V AC, 2 A
Maximum terminal load (AC-15)[1)] on 4–6 (NC) (inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1)[1)] on 4–6 (NC) (resistive load)	50 V DC, 2 A
Maximum terminal load (DC-13)[1)] on 4–6 (NC) (inductive load)	24 V DC, 0.1 A
Minimum 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, and 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 protection rating, enclosure sizes D and E	IP21, IP54
Enclosure protection rating, enclosure 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_2S test	class kD
Test method according to IEC 60068-2-43 H_2S (10 days)	
Ambient temperature (at 60 AVM switching mode)	
- with derating	maximum 55 °C (131 °F)
- with full output power, typical IE2 motors (see *chapter 8.1.2 Derating for Temperature*	maximum 50 °C (122 °F)
- at full continuous FC output current	maximum 45 °C (113 °F)
Minimum ambient temperature during full-scale operation	0 °C (32 °F)
Minimum ambient temperature at reduced performance	-10 °C (14 °F)
Temperature during storage/transport	-25 to +65/70 °C (-13 to 149/158 °F)
Maximum altitude above sea level without derating	1000 m (3300 ft)
Maximum altitude above sea level with derating	3000 m (10000 ft)

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
EMC standards, immunity	EN 61800-3, EN 61000-6-1/2, 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	1 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 protective earth. Use only an isolated laptop/PC as connection to the USB connector on the frequency converter or an isolated USB cable/converter.

Protection and features:

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

Power Ranges (LHD with AF)	
Response time	<0.5 ms
Settling time - reactive current control	<40 ms
Settling time - harmonic current control (filtering)	<20 ms
Overshoot - reactive current control	<20%
Overshoot - harmonic current control	<10%

Grid conditions	
Supply voltage	380–480 V, -10% to +5%

Mains voltage low/mains drop-out:
During low mains voltage or a mains drop-out, the filter continues until the DC-link voltage drops below the minimum stop level, which corresponds to 15% below the filter lowest rated supply voltage. Full compensation cannot be expected at mains voltage lower than 10% below the filter lowest rated supply voltage. If mains 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 main voltages exceed 580 V.

Supply frequency	50/60 Hz ±5%
Maximum imbalance temporary between mains phases where mitigation performance is kept high.	3.0% of rated supply voltage Filter mitigates at higher mains imbalance but harmonic mitigation performance is reduced
Maximum THDv pre-distortion	10% with kept mitigation performance Reduced performance for higher pre-distortion levels

Harmonic mitigation performance	
	Best performance <4%
THDi	Depending on filter vs. distortion ratio.
Individual harmonic mitigation ability:	Current maximum RMS [% of rated RMS current]
2^{nd}	10%
4^{th}	10%
5^{th}	70%
7^{th}	50%
8^{th}	10%
10^{th}	5%
11^{th}	32%
13^{th}	28%
14^{th}	4%
16^{th}	4%
17^{th}	20%
19^{th}	18%
20^{th}	3%
22^{nd}	3%
23^{rd}	16%
25^{th}	14%
Total current of harmonics	90%

The filter is performance tested to the 40^{th} order

Reactive current compensation	
Cos phi	Lagging and leading, depending on parameter settings
Cos phi	Controllable 1.0 to 0.5 lagging
Reactive current, % of filter current rating	100%

Generic specifications	
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%

8.3.1 Derating for Altitude

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

Below 1000 m (3300 ft) altitude, no derating is necessary, but above 1000 m (3300 ft), derate the ambient temperature (T_{AMB}) or maximum output current (I_{out}) in accordance with *Illustration 8.10*.

An alternative is to lower the ambient temperature at high altitudes and as a result of that ensure 100% output current at high altitudes. As an example of how to read the graph, the situation at 2000 m (6600 ft) is elaborated. At a temperature of 45 °C (113 °F) ($T_{AMB, MAX}$ - 3.3 K), 91% of the rated output current is available. At a temperature of 41.7 °C (107 °F), 100% of the rated output current is available.

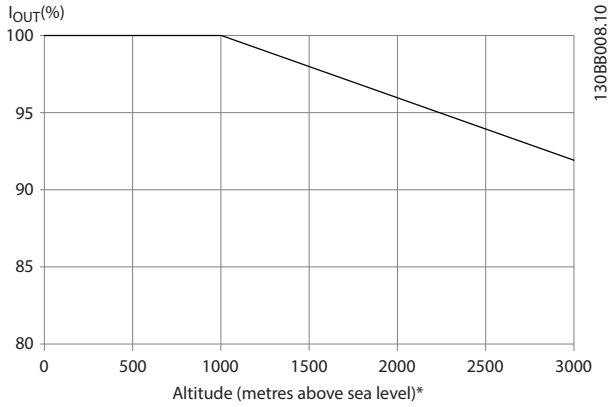


Illustration 8.10 Altitude Derating

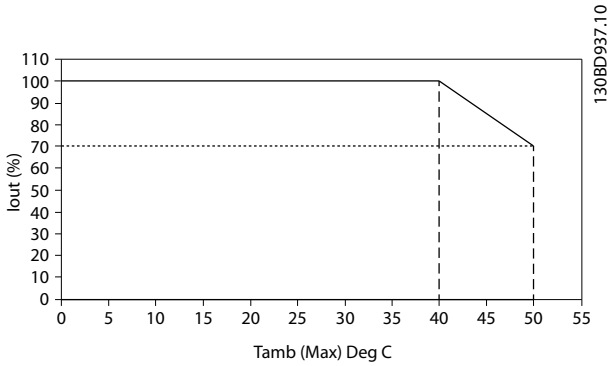


Illustration 8.11 Input/Output vs. Maximum Ambient Temperature

8.4 Fuses

Danfoss recommends using fuses and/or circuit breakers on the supply side as protection if there is component break-down inside the frequency converter (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, and so on, 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 if there is component break-down in the frequency converter.

8.4.1 Non-UL compliance

Non-UL compliance
If UL/cUL is not to be complied with, Danfoss recommends using the fuses in *Table 8.4*, which ensure compliance with EN 50178:

N160–N250	380–500 V	Type gG
P315–P450	380–500 V	Type gR

Table 8.4 Recommended Fuses for non-UL Applications

8.4.2 Fuse Tables

UL Compliance

380–480 V, enclosure sizes D, E, and F
The fuses below are suitable for use on a circuit capable of delivering 100000 Arms (symmetrical). With the proper fusing, the frequency converter short circuit current rating (SCCR) is 100000 Arms.

Size/Type	Bussmann	Littelfuse	Littelfuse PN	Bussmann PN	Siba PN	Ferraz Shawmut Europ	Ferraz Shawmut NA	Ferraz Shawmut PN
160 kW	170M4012	LA50QS400-4	L50S-400	FWH-400A	20 610 31.400	6,9URD31D08A0400	A070URD31KI0400	A50QS400-4
200 kW	170M4015	LA50QS500-4	L50S-500	FWH-500A	20 610 31.550	6,9URD31D08A0550	A070URD31KI0550	A50QS500-4
250 kW	170M5012	LA50QS600-4	L50S-600	FWH-600A	20 610 31.630	6,9URD31D08A0630	A070URD31KI0630	A50QS600-4

Table 8.5 Enclosure size D, Mains Fuses, 380–480 V

Size/Type	Bussmann PN[1)]	Rating	Ferraz	Siba
315 kW	170M4017	700 A, 700 V	6.9URD33D08A0700	20 630 32.700
355 kW	170M6013	900 A, 700 V	6.9URD33D08A0900	20 630 32.900
400 kW	170M6013	900 A, 700 V	6.9URD33D08A0900	20 630 32.900
450 kW	170M6013	900 A, 700 V	6.9URD33D08A0900	20 630 32.900

Table 8.6 Enclosure size E, Mains Fuses, 380–480 V

Size/Type	Bussmann PN[1)]	Rating	Siba	Internal Bussmann option
500 kW	170M7081	1600 A, 700 V	20 695 32.1600	170M7082
560 kW	170M7081	1600 A, 700 V	20 695 32.1600	170M7082
630 kW	170M7082	2000 A, 700 V	20 695 32.2000	170M7082
710 kW	170M7082	2000 A, 700 V	20 695 32.2000	170M7082

Table 8.7 Enclosure size F, Mains Fuses, 380–480 V

Size/Type	Bussmann PN[1)]	Rating	Siba
500 kW	170M8611	1100 A, 1000 V	20 781 32.1000
560 kW	170M8611	1100 A, 1000 V	20 781 32.1000
630 kW	170M6467	1400 A, 700 V	20 681 32.1400
710 kW	170M6467	1400 A, 700 V	20 681 32.1400

Table 8.8 Enclosure Size F, Inverter Module DC-link Fuses, 380–480 V

1) 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.

8.4.3 Supplementary Fuses

Supplementary fuses

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

Table 8.9 SMPS Fuse

Size/Type	Bussmann PN	Littelfuse	Rating
355–710 kW, 380–480 V, 380–500 V		KLK-15	15 A, 600 V

Table 8.10 Fan Fuses

Size/Type		Bussmann PN	Rating	Alternative fuses
500–710 kW, 380–480 V	2.5–4.0 A	LPJ-6 SP or SPI	6 A, 600 V	Any listed class J dual element, time delay, 6A
500–710 kW, 380–480 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
500–710 kW, 380–480 V	6.3–10 A	LPJ-15 SP or SPI	15 A, 600 V	Any listed class J dual element, time delay, 15 A
500–710 kW, 380–480 V	10–16 A	LPJ-25 SP or SPI	25 A, 600 V	Any listed class J dual element, time delay, 25 A

Table 8.11 Manual Motor Controller Fuses

Enclosure size	Bussmann PN[1)]	Rating	Alternative fuses
F	LPJ-30 SP or SPI	30 A, 600 V	Any listed Class J dual element, time delay, 30 A

Table 8.12 30 A Fuse Protected Terminal Fuse

Enclosure size	Bussmann PN[1)]	Rating	Alternative fuses
F	LPJ-6 SP or SPI	6 A, 600 V	Any listed class J dual element, time delay, 6 A

Table 8.13 Control Transformer Fuse

Enclosure size	Bussmann PN[1)]	Rating
F	GMC-800MA	800 mA, 250 V

Table 8.14 NAMUR Fuse

Enclosure size	Bussmann PN[1)]	Rating	Alternative fuses
F	LP-CC-6	6 A, 600 V	Any listed class CC, 6 A

Table 8.15 Safety Relay Coil Fuse with PILS Relay

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

Table 8.16 Mains Fuses (Power Card)

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

Table 8.17 Transformer Fuse (Mains Contactor)

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

Table 8.18 Soft Charge Fuses

1) 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.

8.5 General Torque Tightening Values

For fastening hardware described in this manual, use the torque values in *Table 8.19*. 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 8.19 Torque Values

8

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-** Operation/Display**
  - **0-0* Basic Settings**
    - 0-01 Language
    - 0-02 Motor Speed Unit
    - 0-03 Regional Settings
    - 0-04 Operating State at Power-up
    - 0-05 Local Mode Unit
  - **0-1* Set-up Operations**
    - 0-10 Active Set-up
    - 0-11 Programming Set-up
    - 0-12 This Set-up Linked to
    - 0-13 Readout: Linked Set-ups
    - 0-14 Readout: Prog. Set-ups/Channel
  - **0-2* LCP Display**
    - 0-20 Display Line 1.1 Small
    - 0-21 Display Line 1.2 Small
    - 0-22 Display Line 1.3 Small
    - 0-23 Display Line 2 Large
    - 0-24 Display Line 3 Large
    - 0-25 My Personal Menu
  - **0-3* LCP Custom Readout**
    - 0-30 Custom Readout Unit
    - 0-31 Custom Readout Min Value
    - 0-32 Custom Readout Max Value
    - 0-37 Display Text 1
    - 0-38 Display Text 2
    - 0-39 Display Text 3
  - **0-4* LCP Keypad**
    - 0-40 [Hand on] Key on LCP
    - 0-41 [Off] Key on LCP
    - 0-42 [Auto on] Key on LCP
    - 0-43 [Reset] Key on LCP
    - 0-44 [Off/Reset] Key on LCP
    - 0-45 [Drive Bypass] Key on LCP
  - **0-5* Copy/Save**
    - 0-50 LCP Copy
    - 0-51 Set-up Copy
  - **0-6* Password**
    - 0-60 Main Menu Password
    - 0-61 Access to Main Menu w/o Password
    - 0-65 Personal Menu Password
    - 0-66 Access to Personal Menu w/o Password
    - 0-67 Bus Access Password
  - **0-7* Clock Settings**
    - 0-70 Date and Time
    - 0-71 Date Format
    - 0-72 Time Format
    - 0-74 DST/Summertime
    - 0-76 DST/Summertime Start
    - 0-77 DST/Summertime End
    - 0-79 Clock Fault
    - 0-81 Working Days
    - 0-82 Additional Working Days
    - 0-83 Additional Non-Working Days
    - 0-89 Date and Time Readout
- **1-** Load and Motor**
  - **1-0* General Settings**
    - 1-00 Configuration Mode
    - 1-03 Torque Characteristics
    - 1-06 Clockwise Direction
  - **1-1* Motor Selection**
    - 1-10 Motor Construction
  - **1-1* VVC+ PM**
    - 1-14 Damping Gain
    - 1-15 Low Speed Filter Time Const.
    - 1-16 High Speed Filter Time Const.
    - 1-17 Voltage filter time const.
  - **1-2* Motor Data**
    - 1-20 Motor Power [kW]
    - 1-21 Motor Power [hp]
    - 1-22 Motor Voltage
    - 1-23 Motor Frequency
    - 1-24 Motor Current
    - 1-25 Motor Nominal Speed
    - 1-26 Motor Cont. Rated Torque
    - 1-28 Motor Rotation Check
    - 1-29 Automatic Motor Adaptation (AMA)
  - **1-3* Adv. Motor Data**
    - 1-30 Stator Resistance (Rs)
    - 1-31 Rotor Resistance (Rr)
    - 1-35 Main Reactance (Xh)
    - 1-36 Iron Loss Resistance (Rfe)
    - 1-37 d-axis Inductance (Ld)
    - 1-39 Motor Poles
    - 1-40 Back EMF at 1000 RPM
    - 1-46 Position Detection Gain
  - **1-5* Load Indep. Setting**
    - 1-50 Motor Magnetisation at Zero Speed
    - 1-51 Min Speed Normal Magnetising [RPM]
    - 1-52 Min Speed Normal Magnetising [Hz]
    - 1-58 Flystart Test Pulses Current
    - 1-59 Flystart Test Pulses Frequency
  - **1-6* Load Depen. Setting**
    - 1-60 Low Speed Load Compensation
    - 1-61 High Speed Load Compensation
    - 1-62 Slip Compensation
    - 1-63 Slip Compensation Time Constant
    - 1-64 Resonance Dampening
    - 1-65 Resonance Dampening Time Constant
    - 1-66 Min. Current at Low Speed
  - **1-7* Start Adjustments**
    - 1-70 PM Start Mode
    - 1-71 Start Delay
    - 1-72 Start Function
    - 1-73 Flying Start
    - 1-77 Compressor Start Max Speed [RPM]
    - 1-78 Compressor Start Max Speed [Hz]
    - 1-79 Compressor Start Max Time to Trip
  - **1-8* Stop Adjustments**
    - 1-80 Function at Stop
    - 1-81 Min Speed for Function at Stop [RPM]
    - 1-82 Min Speed for Function at Stop [Hz]
    - 1-86 Trip Speed Low [RPM]
    - 1-87 Trip Speed Low [Hz]
  - **1-9* Motor Temperature**
    - 1-90 Motor Thermal Protection
    - 1-91 Motor External Fan
    - 1-93 Thermistor Source
- **2-** Brakes**
  - **2-0* DC Brake**
    - 2-00 DC Hold/Preheat Current
    - 2-01 DC Brake Current
    - 2-02 DC Braking Time
    - 2-03 DC Brake Cut In Speed [RPM]
    - 2-04 DC Brake Cut In Speed [Hz]
    - 2-06 Parking Current
    - 2-07 Parking Time
  - **2-1* Brake Energy Funct.**
    - 2-10 Brake Function
    - 2-11 Brake Resistor (ohm)
    - 2-12 Brake Power Limit (kW)
    - 2-13 Brake Power Monitoring
    - 2-15 Brake Check
    - 2-16 AC brake Max. Current
    - 2-17 Over-voltage Control
- **3-** Reference/Ramps**
  - **3-0* Reference Limits**
    - 3-02 Minimum Reference
    - 3-03 Maximum Reference
    - 3-04 Reference Function
  - **3-1* References**
    - 3-10 Preset Reference
    - 3-11 Jog Speed [Hz]
    - 3-13 Reference Site
    - 3-14 Preset Relative Reference
    - 3-15 Reference 1 Source
    - 3-16 Reference 2 Source
    - 3-17 Reference 3 Source
    - 3-19 Jog Speed [RPM]
  - **3-4* Ramp 1**
    - 3-41 Ramp 1 Ramp Up Time
    - 3-42 Ramp 1 Ramp Down Time
  - **3-5* Ramp 2**
    - 3-51 Ramp 2 Ramp Up Time
    - 3-52 Ramp 2 Ramp Down Time
  - **3-8* Other Ramps**
    - 3-80 Jog Ramp Time
    - 3-81 Quick Stop Ramp Time
    - 3-82 Starting Ramp Up Time
  - **3-9* Digital Pot.Meter**
    - 3-90 Step Size
    - 3-91 Ramp Time
    - 3-92 Power Restore
    - 3-93 Maximum Limit
    - 3-94 Minimum Limit
    - 3-95 Ramp Delay
- **4-** Limits/Warnings**
  - **4-1* Motor Limits**
    - 4-10 Motor Speed Direction
    - 4-11 Motor Speed Low Limit [RPM]
    - 4-12 Motor Speed Low Limit [Hz]
    - 4-13 Motor Speed High Limit [RPM]
    - 4-14 Motor Speed High Limit [Hz]
    - 4-16 Torque Limit Motor Mode
    - 4-17 Torque Limit Generator Mode
    - 4-18 Current Limit
    - 4-19 Max Output Frequency
  - **4-5* Adj. Warnings**
    - 4-50 Warning Current Low
    - 4-51 Warning Current High
    - 4-52 Warning Speed Low
    - 4-53 Warning Speed High
    - 4-54 Warning Reference Low
    - 4-55 Warning Reference High
    - 4-56 Warning Feedback Low
    - 4-57 Warning Feedback High
    - 4-58 Missing Motor Phase Function
  - **4-6* Speed Bypass**
    - 4-60 Bypass Speed From [RPM]
    - 4-61 Bypass Speed From [Hz]
    - 4-62 Bypass Speed To [RPM]
    - 4-63 Bypass Speed To [Hz]
    - 4-64 Semi-Auto Bypass Set-up
- **5-** Digital In/Out**
  - **5-0* Digital I/O mode**
    - 5-00 Digital I/O mode
    - 5-01 Terminal 27 Mode
    - 5-02 Terminal 29 Mode
  - **5-1* Digital Inputs**
    - 5-10 Terminal 18 Digital Input
    - 5-11 Terminal 19 Digital Input
    - 5-12 Terminal 27 Digital Input
    - 5-13 Terminal 29 Digital Input
    - 5-14 Terminal 32 Digital Input
    - 5-15 Terminal 33 Digital Input
    - 5-16 Terminal X30/2 Digital Input
    - 5-17 Terminal X30/3 Digital Input
    - 5-18 Terminal X30/4 Digital Input
    - 5-19 Terminal 37 Safe Stop
  - **5-3* Digital Outputs**
    - 5-30 Terminal 27 Digital Output
    - 5-31 Terminal 29 Digital Output
    - 5-32 Term X30/6 Digi Out (MCB 101)
    - 5-33 Term X30/7 Digi Out (MCB 101)
  - **5-4* Relays**
    - 5-40 Function Relay
    - 5-41 On Delay, Relay
    - 5-42 Off Delay, Relay
  - **5-5* Pulse Input**
    - 5-50 Term. 29 Low Frequency
    - 5-51 Term. 29 High Frequency
    - 5-52 Term. 29 Low Ref./Feedb. Value
    - 5-53 Term. 29 High Ref./Feedb. Value
    - 5-54 Pulse Filter Time Constant #29
    - 5-55 Term. 33 Low Frequency
    - 5-56 Term. 33 High Frequency
    - 5-57 Term. 33 Low Ref./Feedb. Value
    - 5-58 Term. 33 High Ref./Feedb. Value
    - 5-59 Pulse Filter Time Constant #33
  - **5-6* Pulse Output**
    - 5-60 Terminal 27 Pulse Output Variable
    - 5-62 Pulse Output Max Freq #27
    - 5-63 Terminal 29 Pulse Output Variable
    - 5-65 Pulse Output Max Freq #29
    - 5-66 Terminal X30/6 Pulse Output Variable
    - 5-68 Pulse Output Max Freq #X30/6
  - **5-8* I/O Options**
    - 5-80 AHF Cap Reconnect Delay
  - **5-9* Bus Controlled**
    - 5-90 Digital & Relay Bus Control
    - 5-93 Pulse Out #27 Bus Control
    - 5-94 Pulse Out #27 Timeout Preset
    - 5-95 Pulse Out #29 Bus Control
    - 5-96 Pulse Out #29 Timeout Preset
    - 5-97 Pulse Out #X30/6 Bus Control
    - 5-98 Pulse Out #X30/6 Timeout Preset
- **6-** Analog In/Out**
  - **6-0* Analog I/O Mode**
    - 6-00 Live Zero Timeout Time
    - 6-01 Live Zero Timeout Function
    - 6-02 Fire Mode Live Zero Timeout Function
  - **6-1* Analog Input 53**
    - 6-10 Terminal 53 Low Voltage
    - 6-11 Terminal 53 High Voltage
    - 6-12 Terminal 53 Low Current
    - 6-13 Terminal 53 High Current
    - 6-14 Terminal 53 Low Ref./Feedb. Value
    - 6-15 Terminal 53 High Ref./Feedb. Value
    - 6-16 Terminal 53 Filter Time Constant
    - 6-17 Terminal 53 Live Zero
  - **6-2* Analog Input 54**
    - 6-20 Terminal 54 Low Voltage
    - 6-21 Terminal 54 High Voltage
    - 6-22 Terminal 54 Low Current
    - 6-23 Terminal 54 High Current
    - 6-24 Terminal 54 Low Ref./Feedb. Value
    - 6-25 Terminal 54 High Ref./Feedb. Value
    - 6-26 Terminal 54 Filter Time Constant
    - 6-27 Terminal 54 Live Zero
  - **6-3* Analog Input X30/11**
    - 6-30 Terminal X30/11 Low Voltage
    - 6-31 Terminal X30/11 High Voltage
    - 6-34 Term. X30/11 Low Ref./Feedb. Value
    - 6-35 Term. X30/11 High Ref./Feedb. Value
    - 6-36 Term. X30/11 Filter Time Constant
    - 6-37 Term. X30/11 Live Zero
  - **6-4* Analog Input X30/12**
    - 6-40 Terminal X30/12 Low Voltage
    - 6-41 Terminal X30/12 High Voltage
    - 6-44 Term. X30/12 Low Ref./Feedb. Value
    - 6-45 Term. X30/12 High Ref./Feedb. Value
    - 6-46 Term. X30/12 Filter Time Constant
    - 6-47 Term. X30/12 Live Zero
  - **6-5* Analog Output 42**
    - 6-50 Terminal 42 Output
    - 6-51 Terminal 42 Output Min Scale
    - 6-52 Terminal 42 Output Max Scale
    - 6-53 Terminal 42 Output Bus Control
    - 6-54 Terminal 42 Output Timeout Preset
    - 6-55 Analog Output Filter
  - **6-6* Analog Output X30/8**
    - 6-60 Terminal X30/8 Output
    - 6-61 Terminal X30/8 Min. Scale
    - 6-62 Terminal X30/8 Max. Scale
    - 6-63 Terminal X30/8 Output Bus Control

6-64 Terminal X30/8 Output Timeout Preset
8- Comm. and Options**
8-0* General Settings
8-01 Control Site
8-02 Control Source
8-03 Control Timeout Time
8-04 Control Timeout Function
8-05 End-of-Timeout Function
8-06 Reset Control Timeout
8-07 Diagnosis Trigger
8-08 Readout Filtering
8-09 Communication Charset
8-1* Control Settings
8-10 Control Profile
8-13 Configurable Status Word STW
8-3* FC Port Settings
8-30 Protocol
8-31 Address
8-32 Baud Rate
8-33 Parity/Stop Bits
8-34 Estimated cycle time
8-35 Minimum Response Delay
8-36 Maximum Response Delay
8-37 Maximum Inter-Char Delay
8-4* FC MC protocol set
8-40 Telegram Selection
8-42 PCD Write Configuration
8-43 PCD Read Configuration
8-5* Digital/Bus
8-50 Coasting Select
8-52 DC Brake Select
8-53 Start Select
8-54 Reversing Select
8-55 Set-up Select
8-56 Preset Reference Select
8-7* BACnet
8-70 BACnet Device Instance
8-72 MS/TP Max Masters
8-73 MS/TP Max Info Frames
8-74 "I-Am" Service
8-75 Initialisation Password
8-8* FC Port Diagnostics
8-80 Bus Message Count
8-81 Bus Error Count
8-82 Slave Messages Rcvd
8-83 Slave Error Count
8-84 Slave Messages Sent
8-85 Slave Timeout Errors
8-89 Diagnostics Count
8-9* Bus Jog/Feedback
8-90 Bus Jog 1 Speed
8-91 Bus Jog 2 Speed
8-94 Bus Feedback 1
8-95 Bus Feedback 2
8-96 Bus Feedback 3
9- Profibus**
9-00 Setpoint
9-07 Actual Value
9-15 PCD Write Configuration
9-16 PCD Read Configuration
9-18 Node Address
9-22 Telegram Selection
9-23 Parameters for Signals
9-27 Parameter Edit
9-28 Process Control
9-44 Fault Message Counter
9-45 Fault Code
9-47 Fault Number
9-52 Fault Situation Counter
9-53 Profibus Warning Word
9-63 Actual Baud Rate
9-64 Device Identification
9-65 Profile Number
9-67 Control Word 1
9-68 Status Word 1
9-71 Profibus Save Data Values
9-72 ProfibusDriveReset
9-75 DO Identification
9-80 Defined Parameters (1)
9-81 Defined Parameters (2)
9-82 Defined Parameters (3)
9-83 Defined Parameters (4)
9-84 Defined Parameters (5)
9-90 Changed Parameters (1)
9-91 Changed Parameters (2)
9-92 Changed Parameters (3)
9-93 Changed Parameters (4)
9-94 Changed Parameters (5)
9-99 Profibus Revision Counter
11- LonWorks**
11-0* LonWorks ID
11-00 Neuron ID
11-1* LON Functions
11-10 Drive Profile
11-15 LON Warning Word
11-17 XIF Revision
11-18 LonWorks Revision
11-2* LON Param. Access
11-21 Store Data Values
12- Ethernet**
12-0* IP Settings
12-00 IP Address Assignment
12-01 IP Address
12-02 Subnet Mask
12-03 Default Gateway
12-04 DHCP Server
12-05 Lease Expires
12-06 Name Servers
12-07 Domain Name
12-08 Host Name
12-09 Physical Address
12-1* Ethernet Link Parameters
12-10 Link Status
12-11 Link Duration
12-12 Auto Negotiation
12-13 Link Speed
12-14 Link Duplex
12-2* Process Data
12-20 Control Instance
12-21 Process Data Config Write
12-22 Process Data Config Read
12-27 Primary Master
12-28 Store Data Values
12-29 Store Always
12-3* Ethernet/IP
12-30 Warning Parameter
12-31 Net Reference
12-32 Net Control
12-33 CIP Revision
12-34 CIP Product Code
12-35 EDS Parameter
12-37 COS Inhibit Timer
12-38 COS Filter
12-4* Modbus TCP
12-40 Status Parameter
12-41 Slave Message Count
12-42 Slave Exception Message Count
12-8* Other Ethernet Services
12-80 FTP Server
12-81 HTTP Server
12-82 SMTP Service
12-89 Transparent Socket Channel Port
12-9* Advanced Ethernet Services
12-90 Cable Diagnostic
12-91 Auto Crossover
12-92 IGMP Snooping
12-93 Cable Error Length
12-94 Broadcast Storm Protection
12-95 Broadcast Storm Filter
12-96 Port Config
12-98 Interface Counters
12-99 Media Counters
13- Smart Logic**
13-0* SLC Settings
13-00 SL Controller Mode
13-01 Start Event
13-02 Stop Event
13-03 Reset SLC
13-1* Comparators
13-10 Comparator Operand
13-11 Comparator Operator
13-12 Comparator Value
13-2* Timers
13-20 SL Controller Timer
13-4* Logic Rules
13-40 Logic Rule Boolean 1
13-41 Logic Rule Operator 1
13-42 Logic Rule Boolean 2
13-43 Logic Rule Operator 2
13-44 Logic Rule Boolean 3
13-5* States
13-51 SL Controller Event
13-52 SL Controller Action
14- Special Functions**
14-0* Inverter Switching
14-00 Switching Pattern
14-01 Switching Frequency
14-03 Overmodulation
14-04 PWM Random
14-1* Mains On/Off
14-10 Mains Failure
14-11 Mains Voltage at Mains Fault
14-12 Function at Mains Imbalance
14-2* Reset Functions
14-20 Reset Mode
14-21 Automatic Restart Time
14-22 Operation Mode
14-23 Typecode Setting
14-25 Trip Delay at Torque Limit
14-26 Trip Delay at Inverter Fault
14-28 Production Settings
14-29 Service Code
14-3* Current Limit Ctrl.
14-30 Current Lim Ctrl, Proportional Gain
14-31 Current Lim Ctrl, Integration Time
14-32 Current Lim Ctrl, Filter Time
14-4* Energy Optimising
14-40 VT Level
14-41 AEO Minimum Magnetisation
14-42 Minimum AEO Frequency
14-43 Motor Cosphi
14-5* Environment
14-50 RFI Filter
14-51 DC Link Compensation
14-52 Fan Control
14-53 Fan Monitor
14-55 Output Filter
14-59 Actual Number of Inverter Units
14-6* Auto Derate
14-60 Function at Overtemperature
14-61 Function at Inverter Overload
14-62 Inv. Overload Derate Current
14-9* Fault Settings
14-90 Fault Level
15- Drive Information**
15-0* Operating Data
15-00 Operating Hours
15-01 Running Hours
15-02 kWh Counter
15-03 Power Up's
15-04 Over Temp's
15-05 Over Volt's
15-06 Reset kWh Counter
15-07 Reset Running Hours Counter
15-08 Number of Starts
15-1* Data Log Settings
15-10 Logging Source
15-11 Logging Interval
15-12 Trigger Event
15-13 Logging Mode
15-14 Samples Before Trigger
15-2* Historic Log
15-20 Historic Log: Event
15-21 Historic Log: Value
15-22 Historic Log: Time
15-23 Historic log: Date and Time
15-3* Alarm Log
15-30 Alarm Log: Error Code
15-31 Alarm Log: Value
15-32 Alarm Log: Time
15-33 Alarm Log: Date and Time
15-4* Drive Identification
15-40 FC Type
15-41 Power Section
15-42 Voltage
15-43 Software Version
15-44 Ordered Typecode String
15-45 Actual Typecode String
15-46 Frequency Converter Ordering No
15-47 Power Card Ordering No
15-48 LCP D No
15-49 SW ID Control Card
15-50 SW ID Power Card
15-51 Frequency Converter Serial Number
15-53 Power Card Serial Number
15-55 Vendor URL
15-56 Vendor Name
15-59 CSIV Filename
15-6* Option Ident
15-60 Option Mounted
15-61 Option SW Version
15-62 Option Ordering No
15-63 Option Serial No
15-70 Option in Slot A
15-71 Slot A Option SW Version
15-72 Option in Slot B
15-73 Slot B Option SW Version
15-8* Operating Data II
15-80 Fan Running Hours
15-81 Preset Fan Running Hours
15-9* Parameter Info
15-92 Defined Parameters
15-93 Modified Parameters
15-98 Drive Identification
15-99 Parameter Metadata
16- Data Readouts**
16-0* General Status
16-00 Control Word
16-01 Reference [Unit]
16-02 Reference [%]
16-03 Status Word
16-05 Main Actual Value [%]
16-09 Custom Readout
16-1* Motor Status
16-10 Power [kW]
16-11 Power [hp]
16-12 Motor Voltage
16-13 Frequency
16-14 Motor current
16-15 Frequency [%]
16-16 Torque [Nm]
16-17 Speed [RPM]
16-18 Motor Thermal
16-20 Motor Angle
16-22 Torque [%]

16-26 Power Filtered [kW]
16-27 Power Filtered [hp]
16-3* Drive Status
16-30 DC Link Voltage
16-32 Brake Energy /s
16-33 Brake Energy /2 min
16-34 Heatsink Temp.
16-35 Inverter Thermal
16-36 Inv. Nom. Current
16-37 Inv. Max. Current
16-38 SL Controller State
16-39 Control Card Temp.
16-40 Logging Buffer Full
16-41 Logging Buffer Full
16-43 Timed Actions Status
16-49 Current Fault Source
16-5* Ref. & Feedb.
16-50 External Reference
16-52 Feedback [Unit]
16-53 Digi Pot Reference
16-54 Feedback 1 [Unit]
16-55 Feedback 2 [Unit]
16-56 Feedback 3 [Unit]
16-58 PID Output [%]
16-6* Inputs & Outputs
16-60 Digital Input
16-61 Terminal 53 Switch Setting
16-62 Analog Input 53
16-63 Terminal 54 Switch Setting
16-64 Analog Input 54
16-65 Analog Output 42 [mA]
16-66 Digital Output [bin]
16-67 Pulse Input #29 [Hz]
16-68 Pulse Input #33 [Hz]
16-69 Pulse Output #27 [Hz]
16-70 Pulse Output #29 [Hz]
16-71 Relay Output [bin]
16-72 Counter A
16-73 Counter B
16-75 Analog In X30/11
16-76 Analog In X30/12
16-77 Analog Out X30/8 [mA]
16-8* Fieldbus & FC Port
16-80 Fieldbus CTW 1
16-82 Fieldbus REF 1
16-84 Comm. Option STW
16-85 FC Port CTW 1
16-86 FC Port REF 1
16-9* Diagnosis Readouts
16-90 Alarm Word
16-91 Alarm Word 2
16-92 Warning Word
16-93 Warning Word 2
16-94 Ext. Status Word
16-95 Ext. Status Word 2
16-96 Maintenance Word
18- Info & Readouts**
18-0* Maintenance Log
18-00 Maintenance Log: Item
18-01 Maintenance Log: Action
18-02 Maintenance Log: Time
18-03 Maintenance Log: Date and Time
18-1* Fire Mode Log
18-10 Fire Mode Log: Event
18-11 Fire Mode Log: Time
18-12 Fire Mode Log: Date and Time
18-3* Inputs & Outputs
18-30 Analog Input X42/1
18-31 Analog Input X42/3
18-32 Analog Input X42/5
18-33 Analog Out X42/7 [V]
18-34 Analog Out X42/9 [V]
18-35 Analog Out X42/11 [V]
18-36 Analog Input X48/2 [mA]
18-37 Temp. Input X48/4
18-38 Temp. Input X48/7
18-39 Temp. Input X48/10
18-5* Ref. & Feedb.
18-50 Sensorless Readout [unit]
20- Drive Closed Loop**
20-0* Feedback
20-00 Feedback 1 Source
20-01 Feedback 1 Conversion
20-02 Feedback 1 Source Unit
20-03 Feedback 2 Source
20-04 Feedback 2 Conversion
20-05 Feedback 2 Source Unit
20-06 Feedback 3 Source
20-07 Feedback 3 Conversion
20-08 Feedback 3 Source Unit
20-12 Reference/Feedback Unit
20-13 Minimum Reference/Feedb.
20-14 Maximum Reference/Feedb.
20-2* Feedback/Setpoint
20-20 Feedback Function
20-21 Setpoint 1
20-22 Setpoint 2
20-23 Setpoint 3
20-3* Feedb. Adv. Conv.
20-30 Refrigerant
20-31 User-defined Refrigerant A1
20-32 User-defined Refrigerant A2
20-33 User-defined Refrigerant A3
20-34 Duct 1 Area [m2]
20-35 Duct 1 Area [in2]
20-36 Duct 2 Area [m2]
20-37 Duct 2 Area [in2]
20-38 Air Density Factor [%]
20-6* Sensorless
20-60 Sensorless Unit
20-69 Sensorless Information
20-7* PID Autotuning
20-70 Closed Loop Type
20-71 PID Performance
20-72 PID Output Change
20-73 Minimum Feedback Level
20-74 Maximum Feedback Level
20-79 PID Autotuning
20-8* PID Basic Settings
20-81 PID Normal/Inverse Control
20-82 PID Start Speed [RPM]
20-83 PID Start Speed [Hz]
20-84 On Reference Bandwidth
20-9* PID Controller
20-91 PID Anti Windup
20-93 PID Proportional Gain
20-94 PID Integral Time
20-95 PID Differentiation Time
20-96 PID Diff. Gain Limit
21- Ext. Closed Loop**
21-0* Ext. CL Autotuning
21-00 Closed Loop Type
21-01 PID Performance
21-02 PID Output Change
21-03 Minimum Feedback Level
21-04 Maximum Feedback Level
21-09 PID Autotuning
21-1* Ext. CL 1 Ref./Fb.
21-10 Ext. 1 Ref./Feedback Unit
21-11 Ext. 1 Minimum Reference
21-12 Ext. 1 Maximum Reference
21-13 Ext. 1 Reference Source
21-14 Ext. 1 Feedback Source
21-15 Ext. 1 Setpoint
21-17 Ext. 1 Reference [Unit]
21-18 Ext. 1 Feedback [Unit]
21-19 Ext. 1 Output [%]
21-2* Ext. CL 1 PID
21-20 Ext. 1 Normal/Inverse Control
21-21 Ext. 1 Proportional Gain
21-22 Ext. 1 Integral Time
21-23 Ext. 1 Differentation Time
21-24 Ext. 1 Dif. Gain Limit
21-3* Ext. CL 2 Ref./Fb.
21-30 Ext. 2 Ref./Feedback Unit
21-31 Ext. 2 Minimum Reference
21-32 Ext. 2 Maximum Reference
21-33 Ext. 2 Reference Source
21-34 Ext. 2 Feedback Source
21-35 Ext. 2 Setpoint
21-37 Ext. 2 Reference [Unit]
21-38 Ext. 2 Feedback [Unit]
21-39 Ext. 2 Output [%]
21-4* Ext. CL 2 PID
21-40 Ext. 2 Normal/Inverse Control
21-41 Ext. 2 Proportional Gain
21-42 Ext. 2 Integral Time
21-43 Ext. 2 Differentation Time
21-44 Ext. 2 Dif. Gain Limit
21-5* Ext. CL 3 Ref./Fb.
21-50 Ext. 3 Ref./Feedback Unit
21-51 Ext. 3 Minimum Reference
21-52 Ext. 3 Maximum Reference
21-53 Ext. 3 Reference Source
21-54 Ext. 3 Feedback Source
21-55 Ext. 3 Setpoint
21-57 Ext. 3 Reference [Unit]
21-58 Ext. 3 Feedback [Unit]
21-59 Ext. 3 Output [%]
21-6* Ext. CL 3 PID
21-60 Ext. 3 Normal/Inverse Control
21-61 Ext. 3 Proportional Gain
21-62 Ext. 3 Integral Time
21-63 Ext. 3 Differentation Time
21-64 Ext. 3 Dif. Gain Limit
22- Appl. Functions**
22-0* Miscellaneous
22-00 External Interlock Delay
22-01 Power Filter Time
22-2* No-Flow Detection
22-20 Low Power Auto Set-up
22-21 Low Power Detection
22-22 Low Speed Detection
22-23 No-Flow Function
22-24 No-Flow Delay
22-26 Dry Pump Function
22-27 Dry Pump Delay
22-3* No-Flow Power Tuning
22-30 No-Flow Power
22-31 Power Correction Factor
22-32 Low Speed [RPM]
22-33 Low Speed [Hz]
22-34 Low Speed Power [kW]
22-35 Low Speed Power [hp]
22-36 High Speed [RPM]
22-37 High Speed [Hz]
22-38 High Speed Power [kW]
22-39 High Speed Power [hp]
22-4* Sleep Mode
22-40 Minimum Run Time
22-41 Minimum Sleep Time
22-42 Wake-up Speed [RPM]
22-43 Wake-up Speed [Hz]
22-44 Wake-up Ref./FB Difference
22-45 Setpoint Boost
22-46 Maximum Boost Time
22-5* End of Curve
22-50 End of Curve Function
22-51 End of Curve Delay
22-6* Broken Belt Detection
22-60 Broken Belt Function
22-61 Broken Belt Torque
22-62 Broken Belt Delay
22-7* Short Cycle Protection
22-75 Short Cycle Protection
22-76 Interval between Starts
22-77 Minimum Run Time
22-78 Minimum Run Time Override
22-79 Minimum Run Time Override Value
22-8* Flow Compensation
22-80 Flow Compensation
22-81 Square-linear Curve Approximation
22-82 Work Point Calculation
22-83 Speed at No-Flow [RPM]
22-84 Speed at No-Flow [Hz]
22-85 Speed at Design Point [RPM]
22-86 Speed at Design Point [Hz]
22-87 Pressure at No-Flow Speed
22-88 Pressure at Rated Speed
22-89 Flow at Design Point
22-90 Flow at Rated Speed
23- Time-based Functions**
23-0* Timed Actions
23-00 ON Time
23-01 ON Action
23-02 OFF Time
23-03 OFF Action
23-04 Occurrence
23-0* Timed Actions Settings
23-08 Timed Actions Mode
23-09 Timed Actions Reactivation
23-1* Maintenance
23-10 Maintenance Item
23-11 Maintenance Action
23-12 Maintenance Time Base
23-13 Maintenance Time Interval
23-14 Maintenance Date and Time
23-1* Maintenance Reset
23-15 Reset Maintenance Word
23-16 Maintenance Text
23-5* Energy Log
23-50 Energy Log Resolution
23-51 Period Start
23-53 Energy Log
23-54 Reset Energy Log
23-6* Trending
23-60 Trend Variable
23-61 Continuous Bin Data
23-62 Timed Bin Data
23-63 Timed Period Start
23-64 Timed Period Stop
23-65 Minimum Bin Value
23-66 Reset Continuous Bin Data
23-67 Reset Timed Bin Data
23-8* Payback Counter
23-80 Power Reference Factor
23-81 Energy Cost
23-82 Investment
23-83 Energy Savings
23-84 Cost Savings
24- Appl. Functions 2**
24-0* Fire Mode
24-00 Fire Mode Function
24-01 Fire Mode Configuration
24-02 Fire Mode Unit
24-03 Fire Mode Min Reference
24-04 Fire Mode Max Reference
24-05 Fire Mode Preset Reference
24-06 Fire Mode Reference Source
24-07 Fire Mode Feedback Source
24-09 Fire Mode Alarm Handling
24-1* Drive Bypass
24-10 Drive Bypass Function
24-11 Drive Bypass Delay Time

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

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 4 set-ups, (1 single parameter can have 4 different data values).
1 set-up: Data value is 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 with 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	3600000	3600	60	1/60	1000000	100000	10000	1000	100	10	1	0.1	0.01	0.001	0.0001	0.00001	0.000001

Table 9.1 Conversion Index

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	Normalised value 2 bytes	N2
35	Bit sequence of 16 boolean variables	V2
54	Time difference without date	TimD

Table 9.2 Data Type and Description

9.3.2 0-** Operation/Display

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* LCP 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* LCP Keypad						
0-40	[Hand on] key on LCP	[1] Enabled	All set-ups	TRUE	-	Uint8
0-41	[Off] key on LCP	[1] Enabled	All set-ups	TRUE	-	Uint8
0-42	[Auto on] key on LCP	[1] Enabled	All set-ups	TRUE	-	Uint8
0-43	[Reset] key on LCP	[1] Enabled	All set-ups	TRUE	-	Uint8
0-5* Copy/Save						
0-50	LCP 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 without 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 without password	[0] Full access	1 set-up	TRUE	-	Uint8

9.3.3 5-** Digital In/Out

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
5-16	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 8-** Comm. and Options

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 liter-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 14-** Special Functions

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 15-** FC Information

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 up's	0 N/A	All set-ups	FALSE	0	Uint32
15-04	Over temp's	0 N/A	All set-ups	FALSE	0	Uint16
15-05	Over volt's	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 number	0 N/A	All set-ups	FALSE	0	VisStr[8]
15-47	Power card ordering number	0 N/A	All set-ups	FALSE	0	VisStr[8]
15-48	LCP ID number	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]

Par. No. #	Parameter description	Default value	4-set-up	Change during operation	Conversion index	Type
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 number	0 N/A	All set-ups	FALSE	0	VisStr[8]
15-63	Option serial number	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 16-** Data Readouts

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.	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.	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* Fieldbus & FC Port						
16-80	Fieldbus CTW 1	0 N/A	All set-ups	FALSE	0	V2
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

9.3.8 300-** AF Settings

NOTICE

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

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
300-08	Lagging reactive current	[0] Disabled	All set-ups			
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	Cosphi 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	Number 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] Mains current	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

9.3.9 301-** AF Readouts

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	Cosphi	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* Mains Status						
301-20	Mains current [A]	0 A	All set-ups	TRUE	0	Int32
301-21	Mains frequency	0 Hz	All set-ups	TRUE	0	Uint8
301-22	Fund. mains 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.

Italicized text indicates:

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

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