MAKING MODERN LIVING POSSIBLE

Installation Manual

VLT® AutomationDrive FC 302 Low Harmonic Drive
132–630 kW

www.DanfossDrives.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-302XYYYZZ**************************

Character X: N or P
Character YYY: K25, K37, K55, 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
Character ZZ: T2, T5, 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

Date: 2020.09.15 **Place of issue:** Graasten, DK	**Issued by** **Signature:** **Name: Gert Kjær** **Title: Senior Director, GDE**	Date: 2020.09.15 **Place of issue:** Graasten, DK	**Approved by** **Signature:** **Name: Michael Termansen** **Title: VP, PD Center Denmark**

hazardous substances

For products including available Safe Torque Off (STO) function according to unit typecode on the nameplate: **X, B or R 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® Low Harmonic Drive. The manual includes relevant safety information for installation and operation. *chapter 2 Safety* and *chapter 1 Introduction* introduce the unit function and cover proper mechanical and electrical installation procedures. There are chapters on start-up and commissioning, applications and basic troubleshooting. *chapter 8 Specifications* provides a quick reference for ratings and dimensions, as well as other operating specifications. This manual provides a basic knowledge of the unit and explains set-up and basic operation.

1.2 Additional Resources

Other resources are available to understand advanced functions and programming.

- The *VLT® AutomationDrive FC 302 Instruction Manual* provides details on installation and operation of the adjustable frequency drive.
- The *VLT® AutomationDrive FC 302 Programming Guide* provides greater detail on working with parameters and many application examples.
- The *VLT® AutomationDrive FC 302 Design Guide* provides detailed capabilities and functionality to design motor control systems.
- Supplementary publications and manuals are available from Danfoss. See *www.danfoss.com/BusinessAreas/DrivesSolutions/Documentations/Technical+Documentation.htm* 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: *www.danfoss.com/BusinessAreas/DrivesSolutions/Documentations/Technical+Documentation.htm*for downloads or additional information.
- The *VLT® Active Filter AAF00x Instruction Manual* provides additional information about the filter portion of the low harmonic drive.

1.3 Product Overview

1.3.1 Intended Use

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

The frequency converter:

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

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

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

1.3.2 Working Principle

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

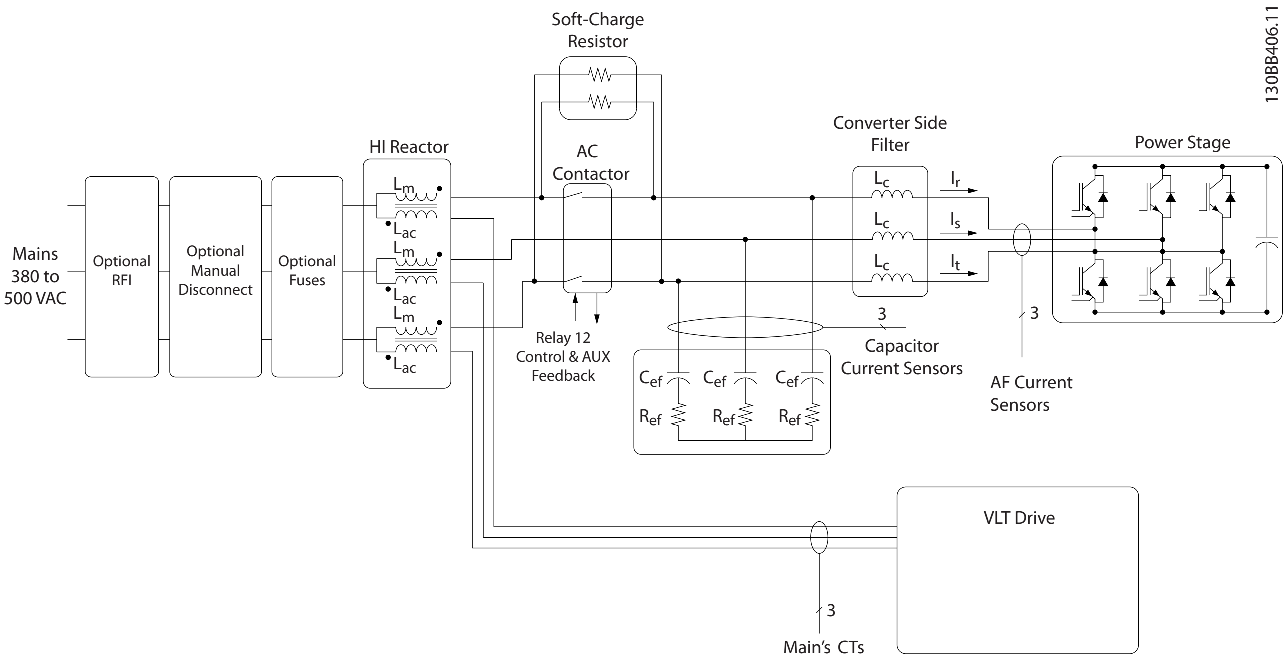
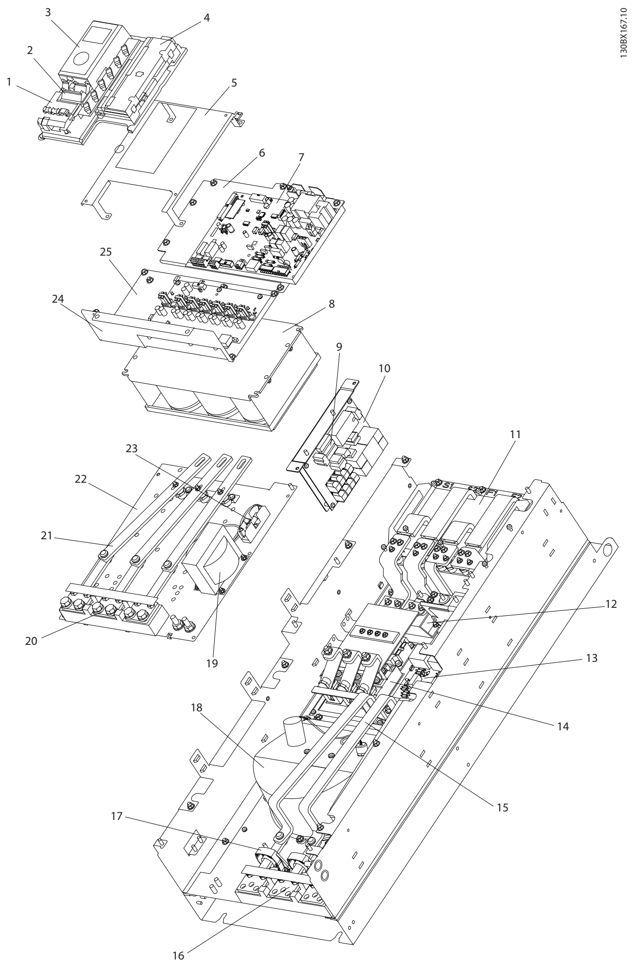


Figure 1.1 Basic Layout for the Low Harmonic Drive

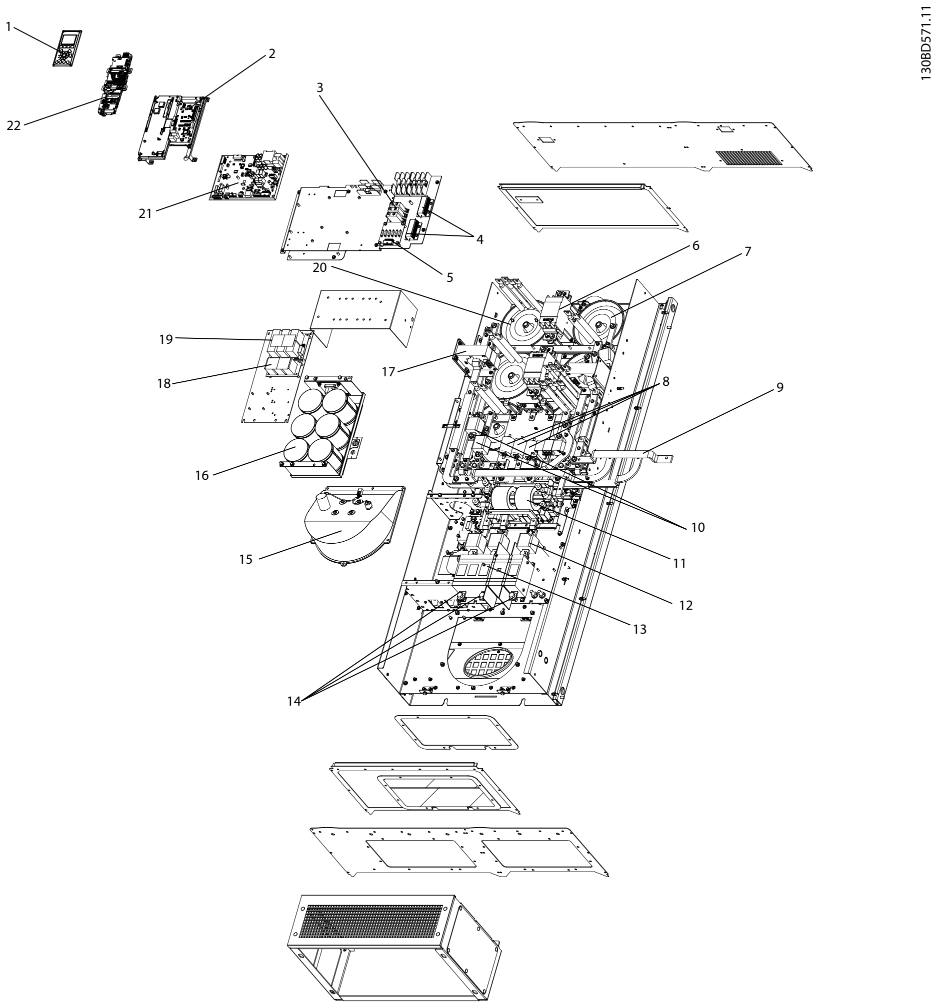
Low harmonic drives are designed to draw an ideal sinusoidal current waveform from the supply grid with a power factor of 1. Where traditional non-linear load draws pulse-shaped currents, the low harmonic drive compensates that via the parallel filter path, lowering the stress on the supply grid. The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

1.3.3 Exploded View Drawings



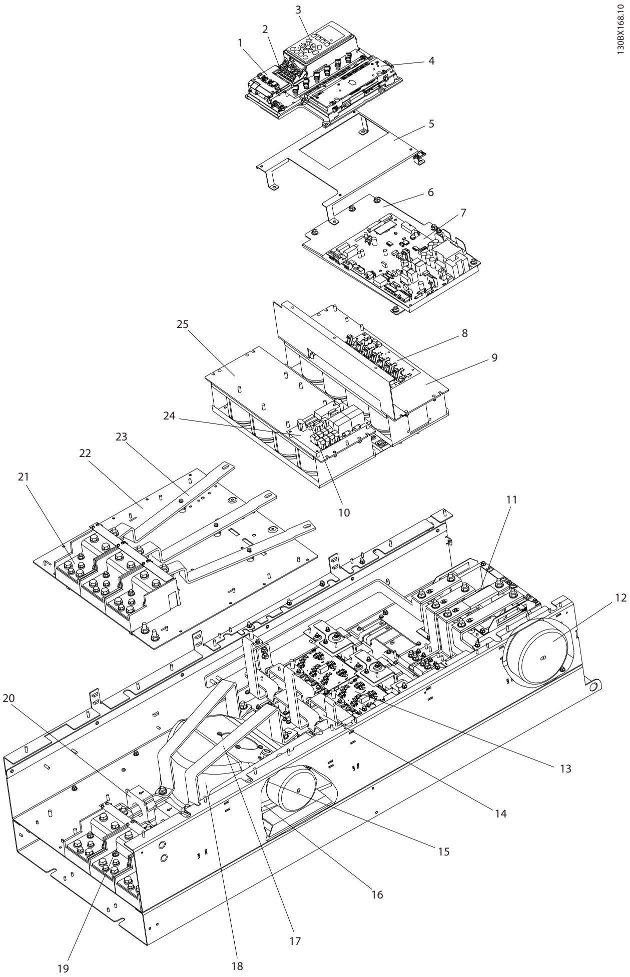
1	Control card	14	SCR/diode module
2	Control input terminals	15	IGBT output bus bar
3	Local control panel (LCP)	16	Output motor terminals
4	Control card C option	17	Current sensor
5	Mounting bracket	18	Fan assembly
6	Power card mounting plate	19	Fan transformer
7	Power card	20	AC input terminals
8	Capacitor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

Figure 1.2 Frame Size D13 Drive Enclosure



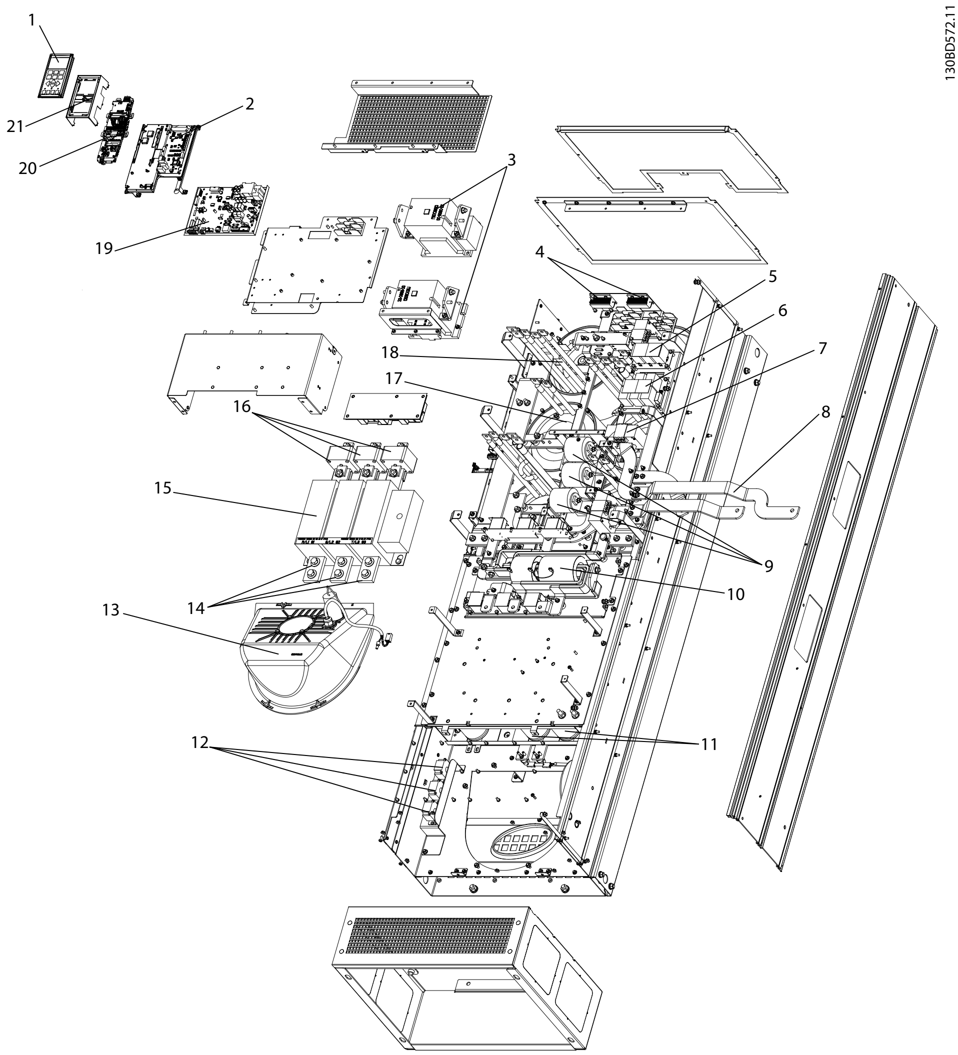
1	Local control panel (LCP)	13	Electrical fuses
2	Active filter card (AFC)	14	Line power disconnect
3	Metal oxide varistor (MOV)	15	Line Power Terminals
4	Soft-charge resistors	16	Heatsink fan
5	AC capacitors discharge board	17	DC capacitor bank
6	Line power contactor	18	Current transformer
7	LC inductor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

Figure 1.3 Frame Size D13 Filter Enclosure



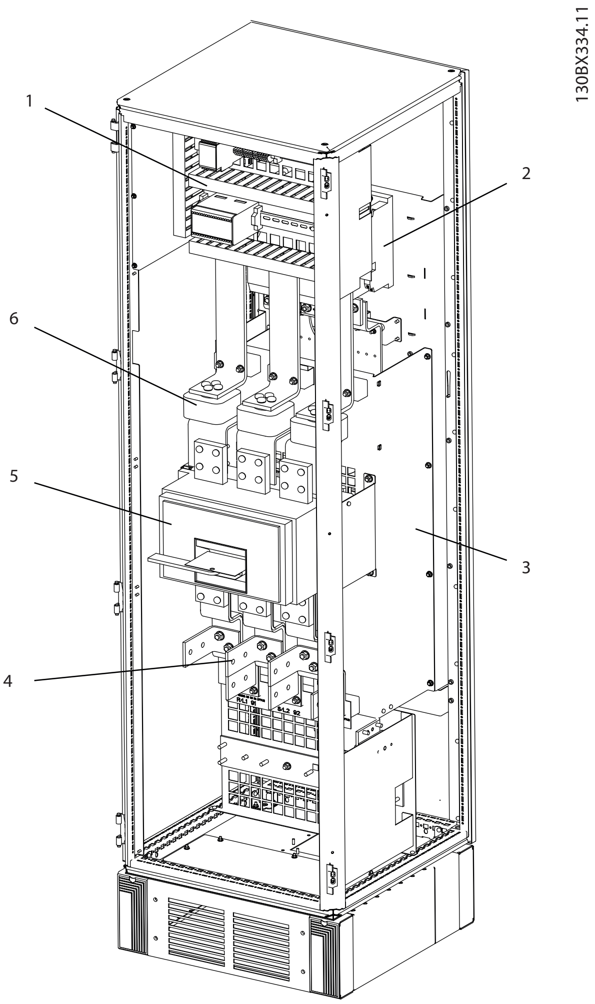
1	Control card	14	SCR and diode
2	Control input terminals	15	Fan inductor (not on all units)
3	Local control panel (LCP)	16	Soft-charge resistor assembly
4	Control card C option	17	IGBT output bus bar
5	Mounting bracket	18	Fan assembly
6	Power card mounting plate	19	Output motor terminals
7	Power card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

Figure 1.4 Frame Size E9 Drive Enclosure



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

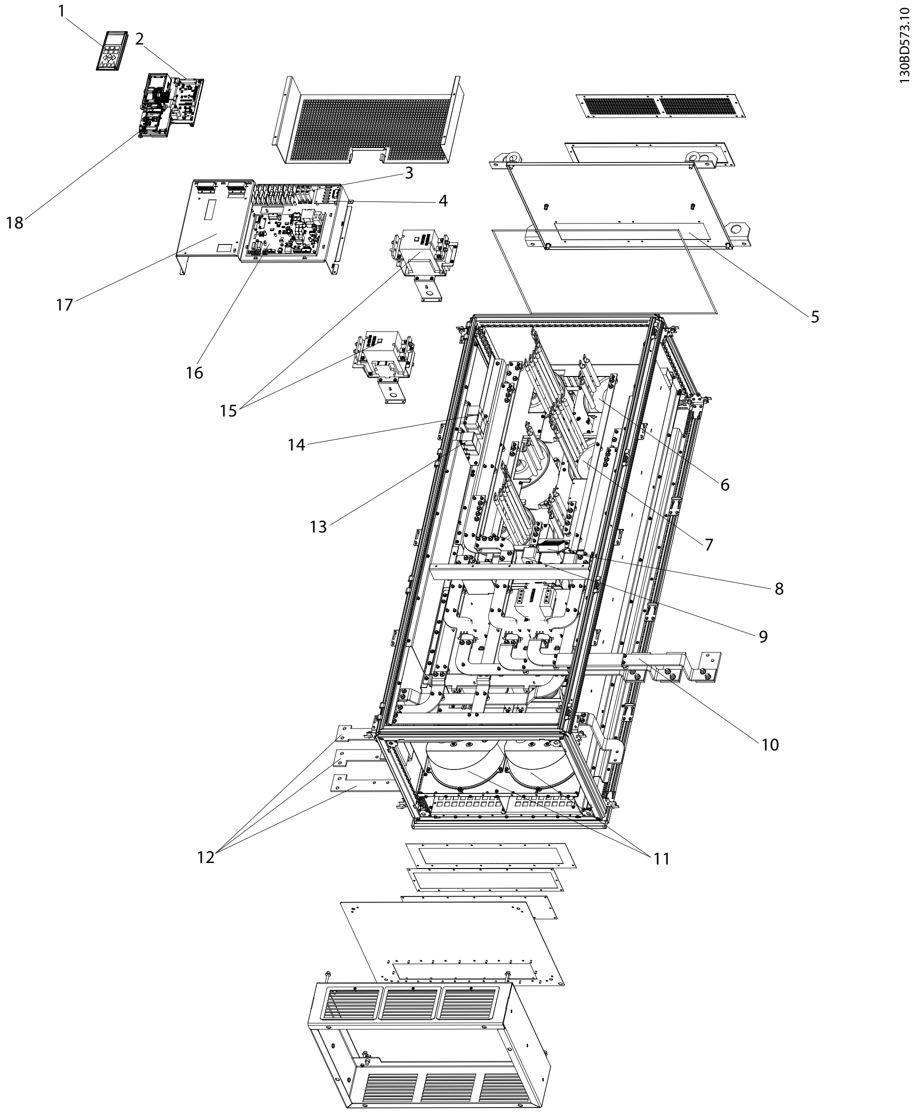
Figure 1.5 Frame Size E9 Filter Enclosure



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

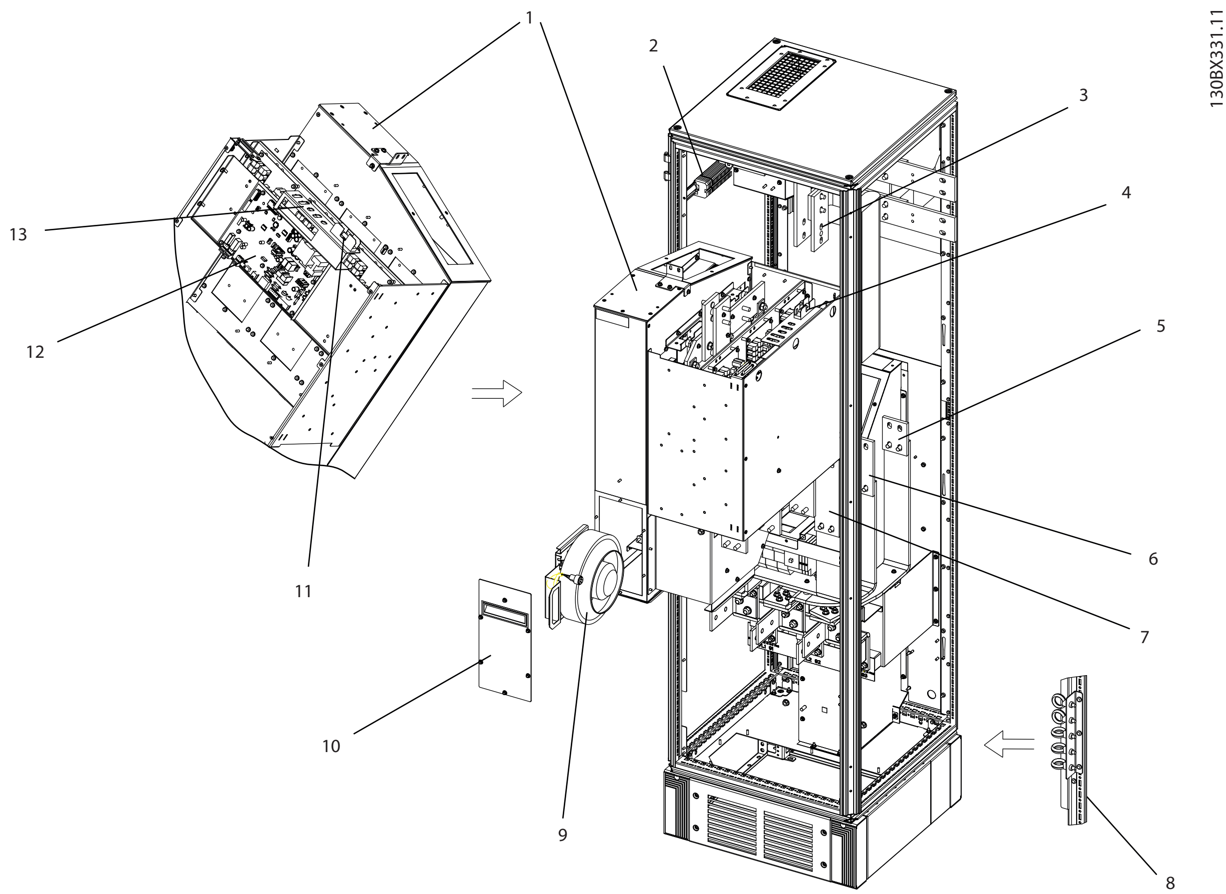
Figure 1.6 Frame Size F18 Options Cabinet

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



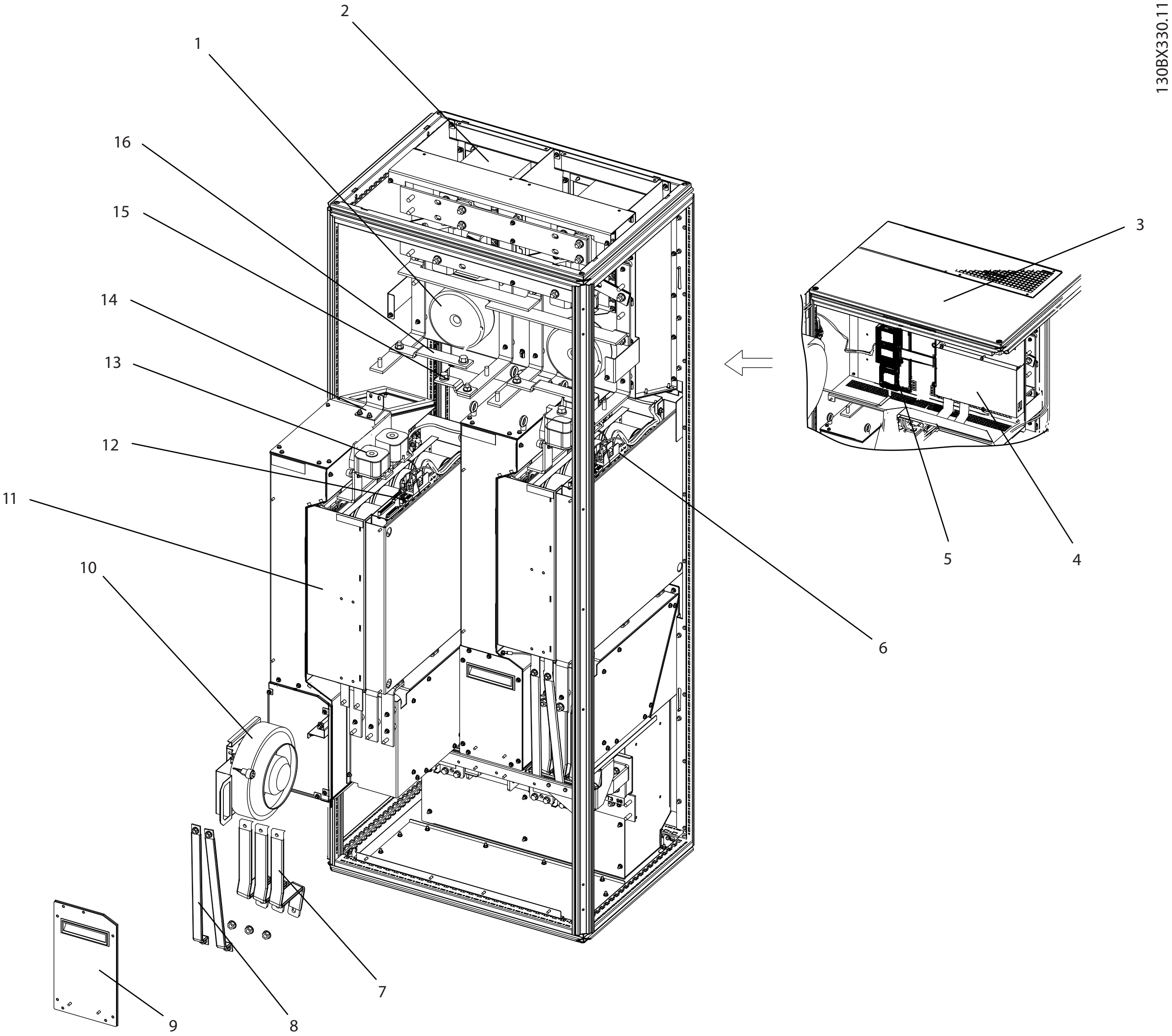
1	Local control panel (LCP)	10	Line power bus bars to drive input
2	Active filter card (AFC)	11	Heatsink fans
3	Soft-charge resistors	12	Line power terminals (R/L1, S/L2, T/L3) from options cabinet
4	Metal oxide varistor (MOV)	13	RFI differential mode filter
5	AC capacitors discharge board	14	RFI common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

Figure 1.7 Frame Size F18 Filter Cabinet



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

Figure 1.8 Frame Size F18 Rectifier Cabinet



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

Figure 1.9 Frame Size F18 Inverter Cabinet

1.4 Enclosure Sizes and Power Ratings

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

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

1.5 Approvals

1.5.1 Approvals

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

1.5.2 Compliance with ADN

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

1.6 Harmonics Overview

1.6.1 Harmonics

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

1.6.2 Harmonic Analysis

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

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

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

Abbreviation	Description
f_1	Fundamental frequency (50 Hz or 60 Hz)
I_1	Current at the fundamental frequency
U_1	Voltage at the fundamental frequency
I_n	Current at the 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_{11-49}
Input current	1.0	0.9	0.5	0.2	< 0.1

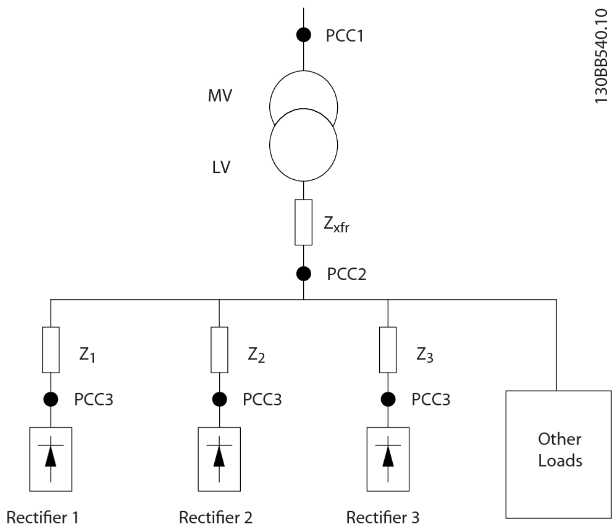
Table 1.5 Harmonic Currents Compared to the RMS Input Current

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

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

1.6.3 Effect of Harmonics in a Power Distribution System

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



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

Figure 1.10 Small Distribution System

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

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

A commonly used term for describing the impedance of a grid is the short-circuit ratio R_{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.

1.6.4 IEC Harmonic Standards

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

Harmonics and voltage fluctuations are 2 forms of low-frequency mains interference. They have a different appearance at their origin than at any other point in the mains system when a load is connected. So, a range of influences must be determined collectively when assessing the effects of mains interference. These influences include the mains feed, structure, and loads.

Mains interference can cause the following:

Undervoltage warnings

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

Higher functional losses

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

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

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

Table 1.6 EN Design Standards for Mains Power Quality

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

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

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

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

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

Typically, a class cannot be defined ahead of time without taking into account the intended equipment and processes to be used in the environment. VLT® AutomationDrive FC 302 Low Harmonic Drive observes the limits of Class 3 under typical supply system conditions (R_{SC}>10 or $V_{k\ Line}$<10%).

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

Table 1.7 Compatibility Levels for Harmonics

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

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

1.6.5 IEEE Harmonic Standards

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

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

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

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

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

Table 1.10 Permissible Voltage THD at the PCC for all Loads

Limit harmonic currents to specified levels, as shown in *Table 1.11*. IEEE 519 utilises a ratio between the supply short-circuit current and the maximum current consumption at the PCC, averaged over 15 minutes or 30 minutes. In certain instances when dealing with harmonic limits containing low harmonic numbers, the IEEE 519 limits are lower than the 61000-2-4 limits. Low harmonic drives observe the total harmonic distortion as defined in IEEE 519 for all R_{sce}. Each individual harmonic current fulfills table 10–3 in IEEE 519 for R_{sce}≥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® AutomationDrive FC 302 Low Harmonic Drive complies with the following standards:

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

2 Safety

2.1 Safety

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

2.3 Safety Precautions

WARNING

HIGH VOLTAGE

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

WARNING

UNINTENDED START

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

WARNING

DISCHARGE TIME

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

Voltage [V]	Power range (hp [kW])	Minimum waiting time (min)
380–500	175–350 [132–250 kW]*	20
	425–850 [315–630 kW]	40

Table 2.1 Discharge Times

**Power ranges are for normal overload operation.*

3 Installation

3.1 Installation Site Checklist

3.1.1 Planning the Installation Site

CAUTION

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

Select the best possible operation site by considering the following:

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

3.1.2 Equipment Pre-Installation Checklist

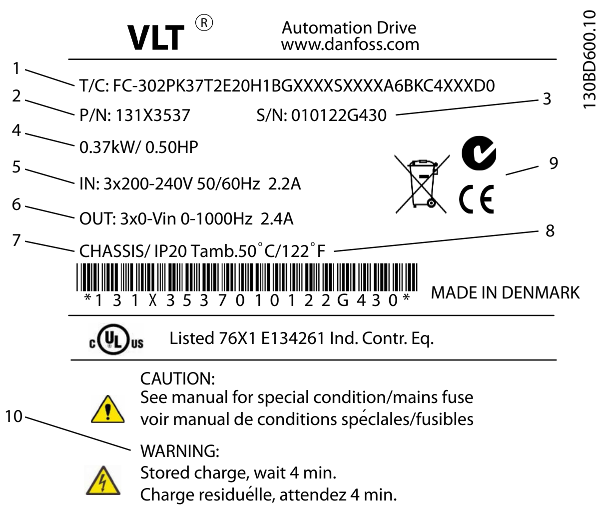
- Before unpacking the adjustable frequency drive, examine the packaging for signs of damage. If the unit is damaged, refuse delivery and immediately contact the shipping company to claim the damage.
- Before unpacking the adjustable frequency drive, locate it as close as possible to the final installation site
- Compare the model number on the nameplate to what was ordered to verify the proper equipment
- Ensure each of the following are rated for the same voltage:
  - Line power
  - Adjustable frequency drive
  - Motor
- Ensure the output current rating is equal to or greater than the motor full load current for peak motor performance.
- Motor size and adjustable frequency drive power must match for proper overload protection.
- If adjustable frequency drive rating is less than that of the motor, full motor output is impossible.

3.2 Electrical Installation

3.2.1 Items Supplied

Items supplied may vary according to product configuration.

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



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

Figure 3.1 Product Nameplate (Example)

NOTICE!

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

3.3 Mechanical Installation

3.3.1 Cooling and Airflow

Cooling

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

Back cooling

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

NOTICE!

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

Airflow

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

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

Table 3.1 Heatsink Air Flow

NOTICE!

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

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

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

NOTICE!

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

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

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

External ducts

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

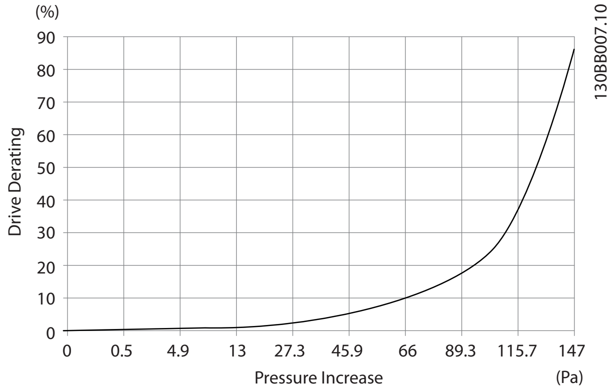


Figure 3.2 D-Frame Derating vs. Pressure Change Drive Air Flow: 450 cfm (765 m³/h)

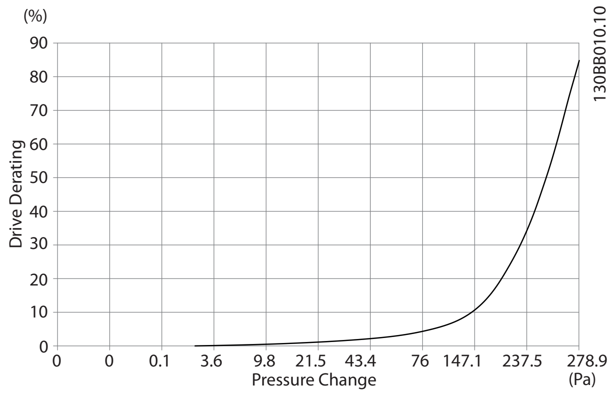


Figure 3.3 E-Frame Derating vs. Pressure Change (Small Fan), P315 Drive Air Flow: 650 cfm (1105 m³/h)

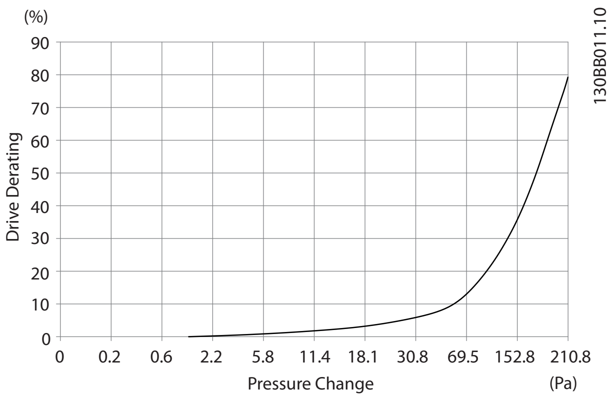


Figure 3.4 E-Frame Derating vs. Pressure Change (Large Fan) P355-P450 Drive Air Flow: 850 cfm (1445 m³/h)

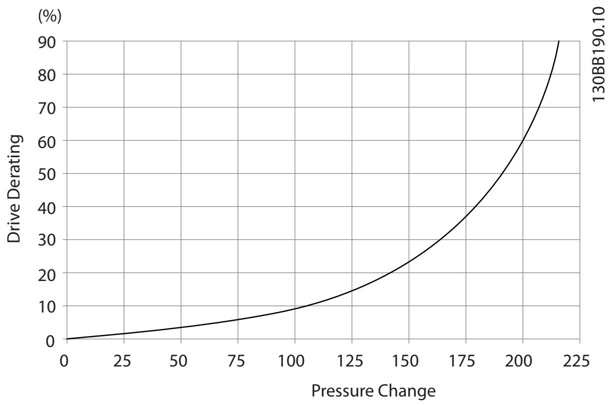


Figure 3.5 F-Frame Derating vs. Pressure Change Drive Air Flow: 580 cfm (985 m^3/h)

3.3.2 Lifting

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

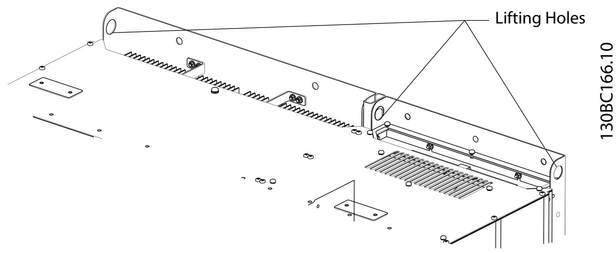


Figure 3.6 Recommended Lifting Method, Frame Size D13

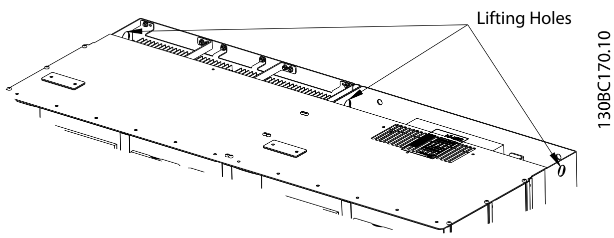
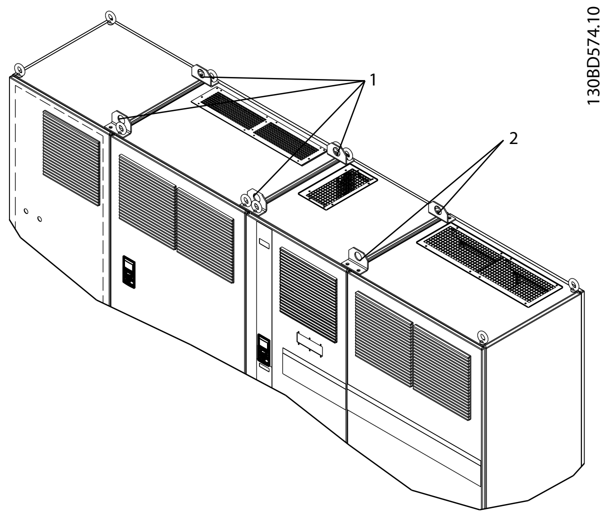


Figure 3.7 Recommended Lifting Method, Frame Size E9

WARNING

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



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

Figure 3.8 Recommended Lifting Method, Frame Size F18

NOTICE!

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

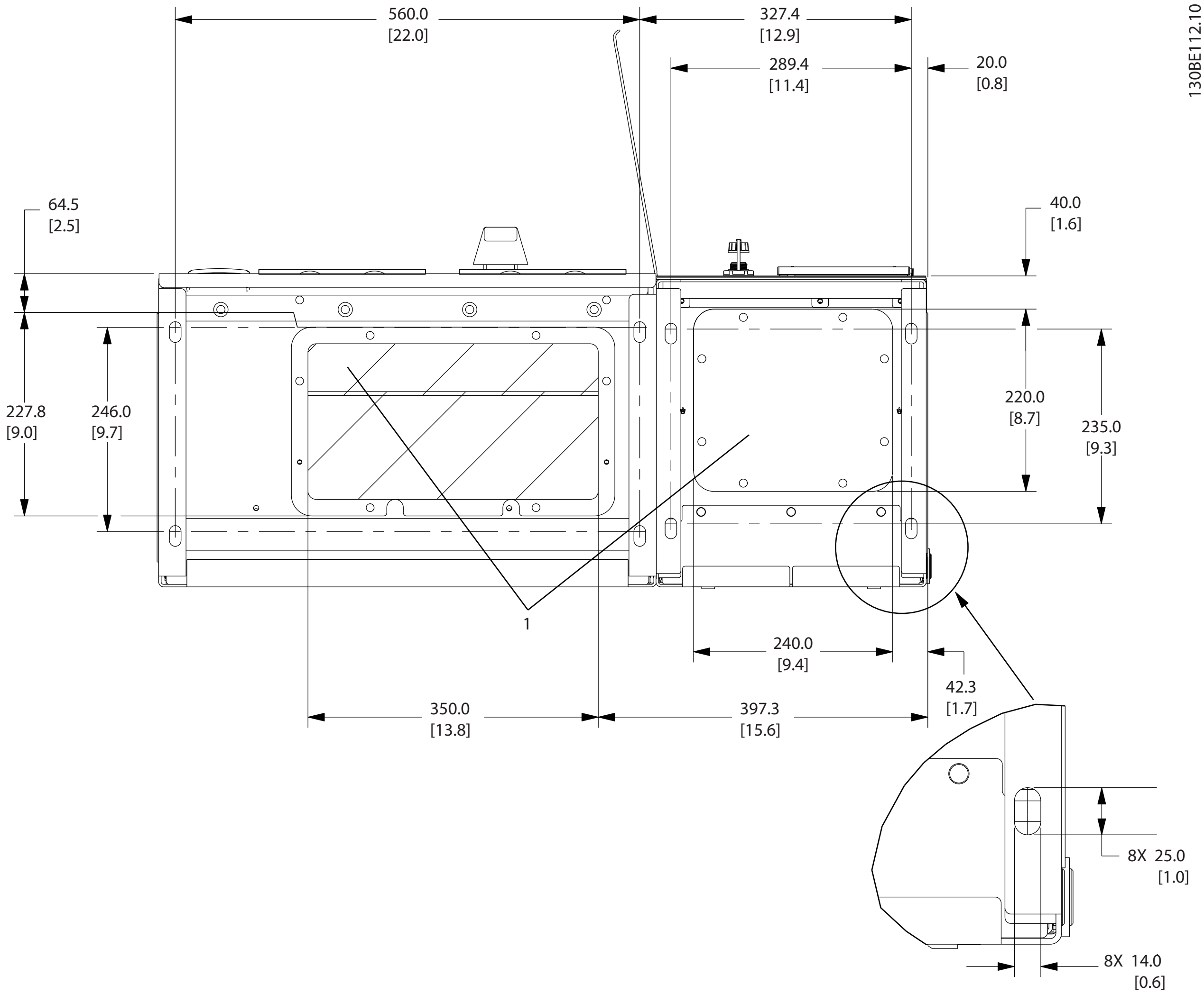
NOTICE!

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

3.3.3 Cable Entry and Anchoring

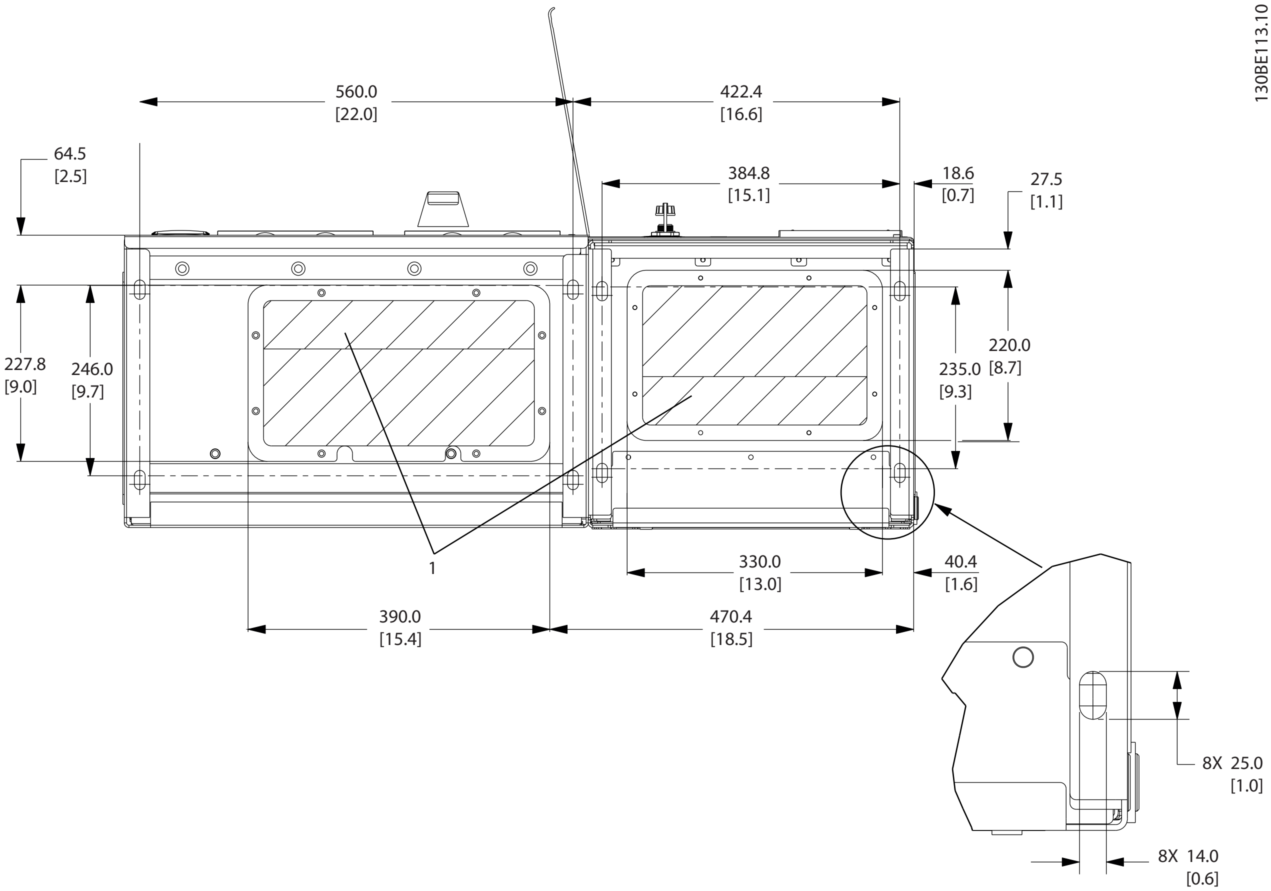
Cables enter the unit through gland plate openings in the bottom. *Figure 3.9*, *Figure 3.10*, *Figure 3.11*, and *Figure 3.12* show gland entry locations and detailed views of anchoring hole dimensions.

Bottom View, D1n/D2n



1	Cable entry locations

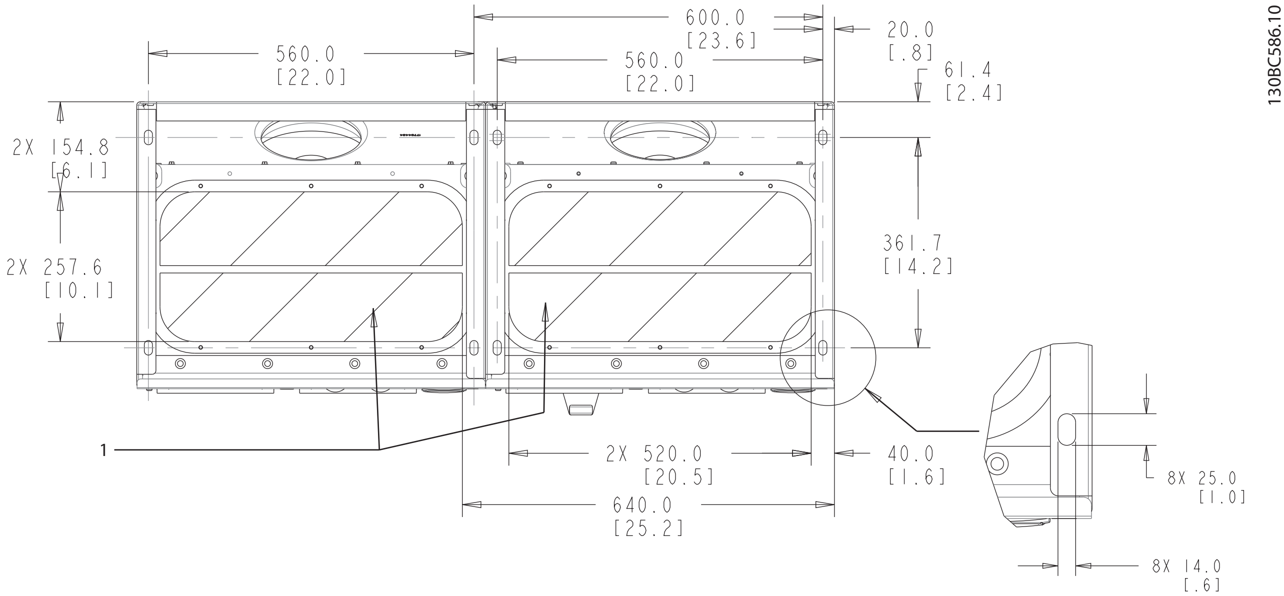
Figure 3.9 Cable Entry Diagram, Enclsoure Size D1n



1	Cable entry locations

Figure 3.10 Cable Entry Diagram, Enclsoure Size D2n

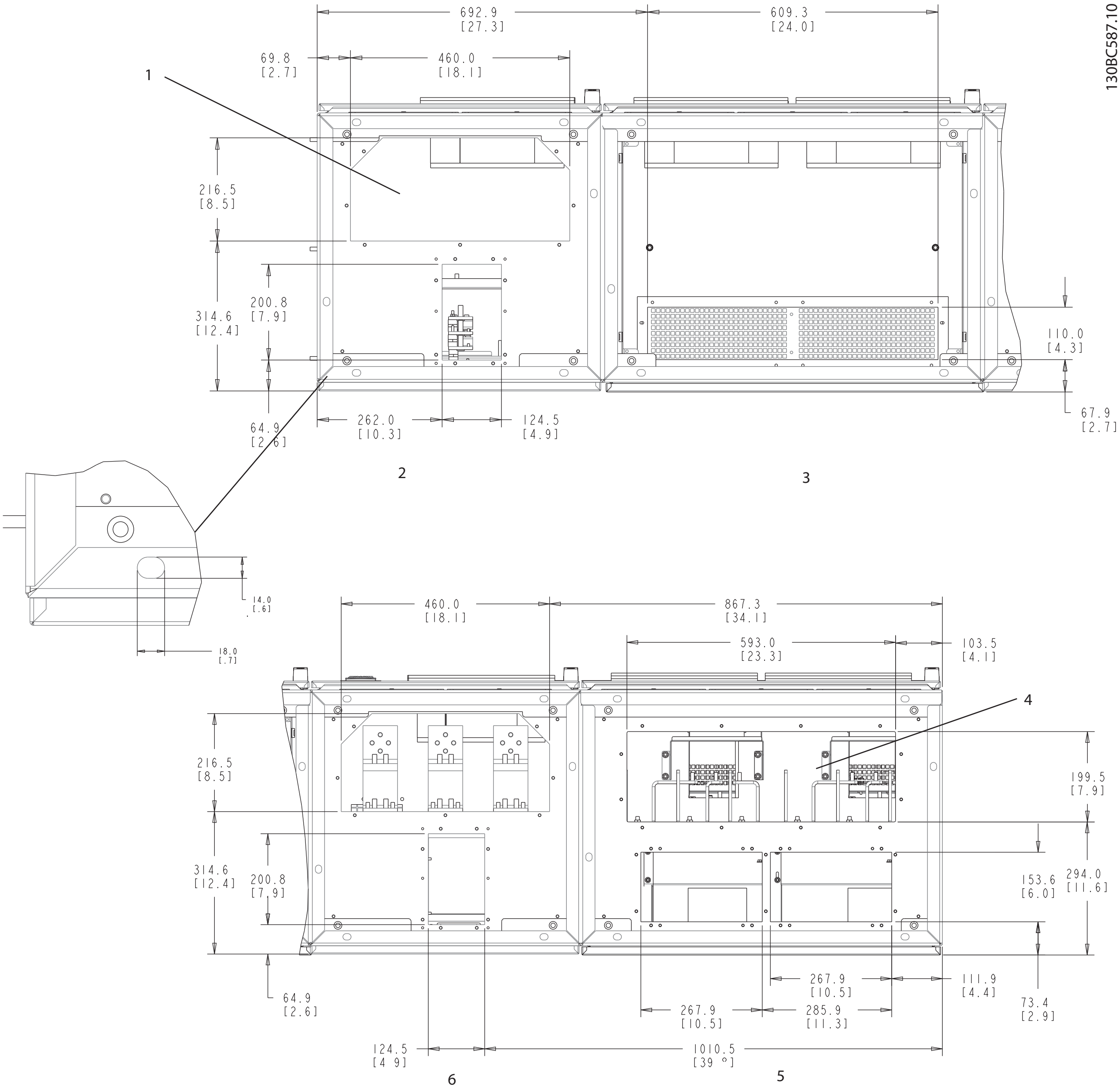
Bottom view, enclosure size E9



1	Cable entry locations

Figure 3.11 Cable Entry Diagram, E9

Bottom view, F18



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

Figure 3.12 Cable Entry Diagram, F18

3.3.4 Terminal Locations - Frame Size D13

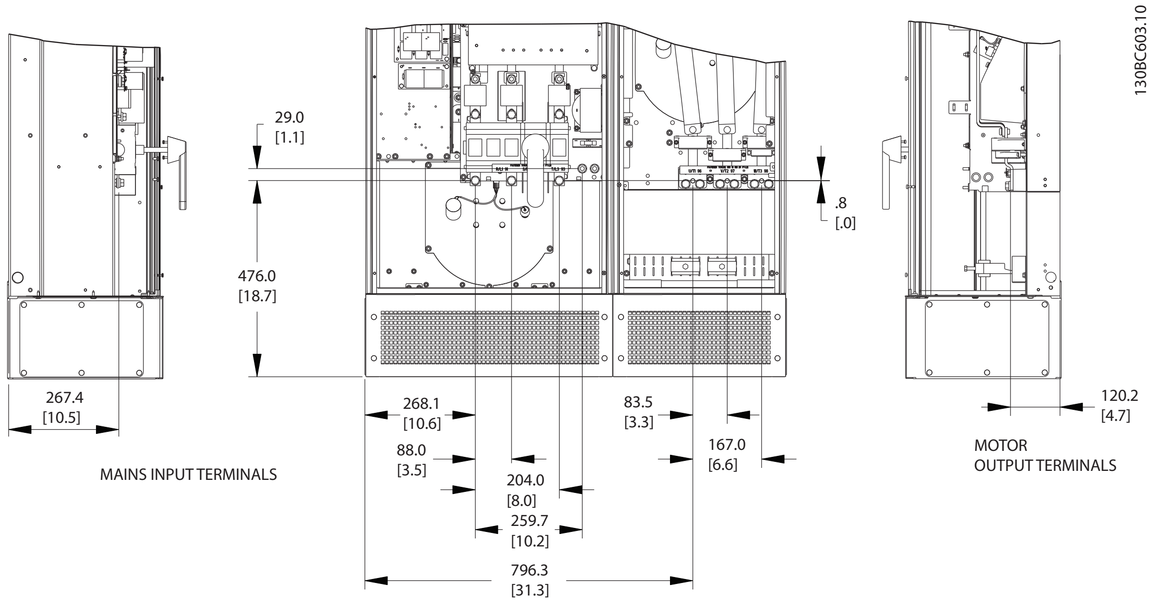


Figure 3.13 Frame Size D13 Terminal Locations

Allow for bend radius of heavy power cables.

NOTICE!

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

3.3.5 Terminal Locations - Frame Size E9

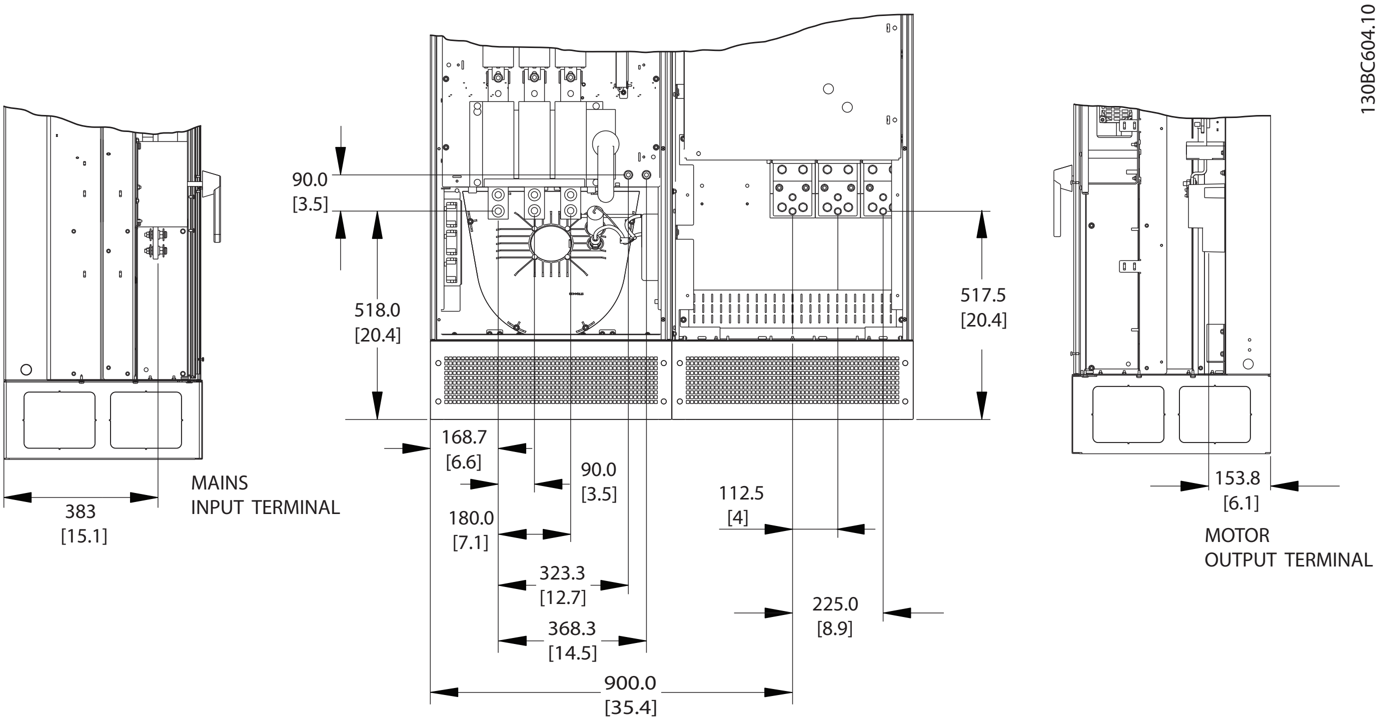


Figure 3.14 Frame Size E9 Terminal Locations

Allow for bend radius of heavy power cables.

NOTICE!

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

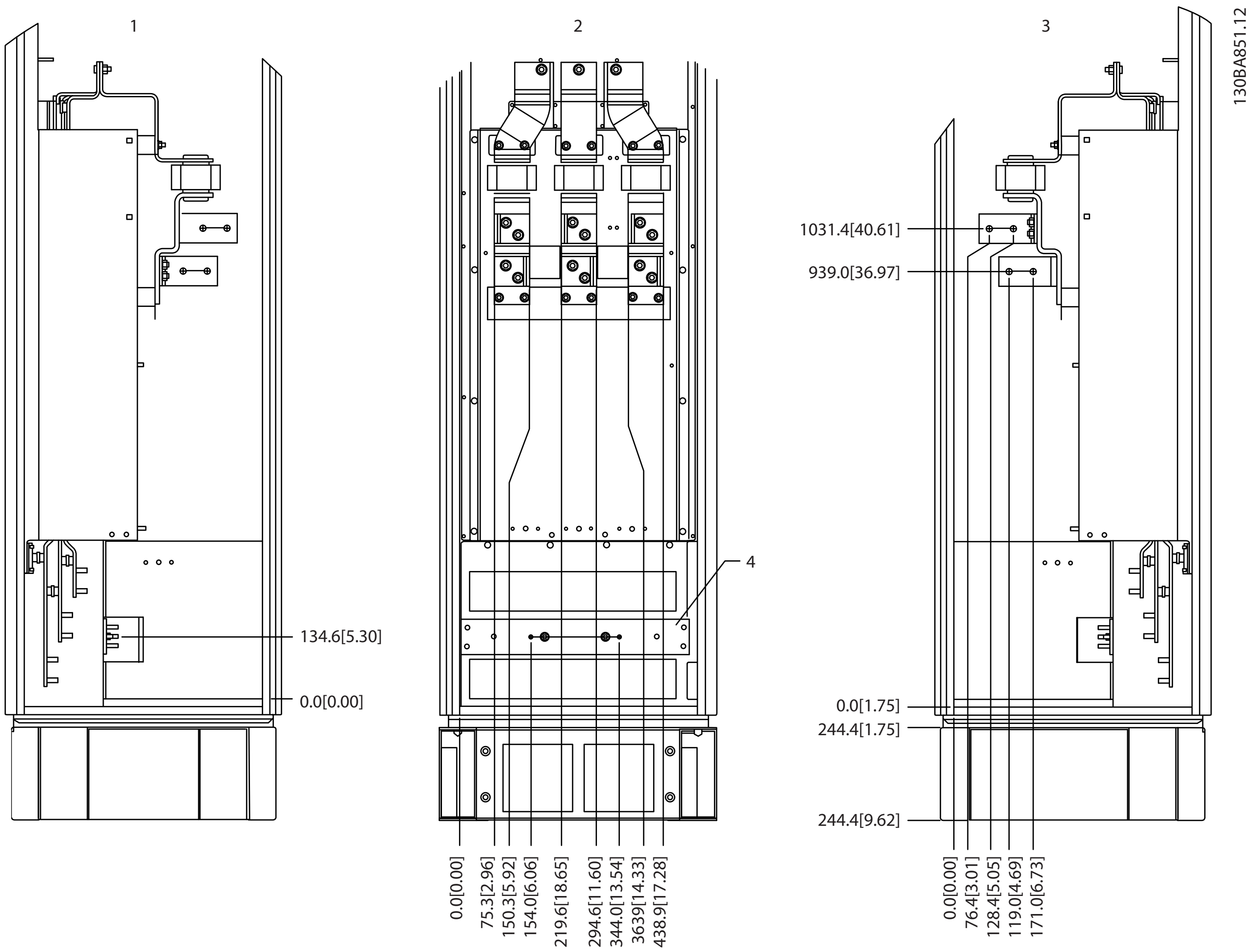
3.3.6 Terminal Locations for Enclsoure Size F18

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

F-frame units have 4 interlocked cabinets:

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

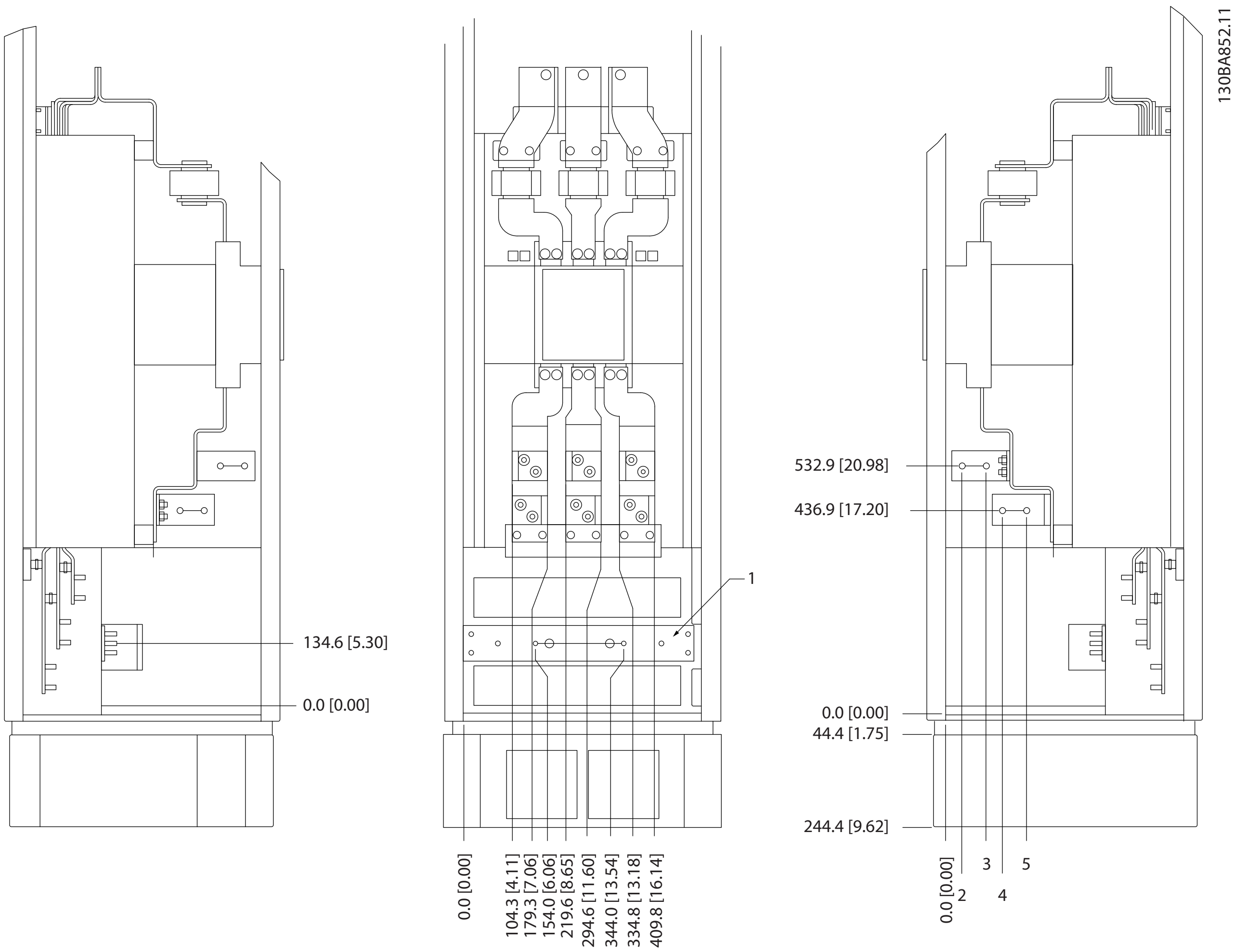
See *chapter 1.3.3 Exploded View Drawings* for exploded views of each cabinet. Mains inputs are located in the input option cabinet, which conducts power to the rectifier via interconnecting bus bars. Output from the unit is from the inverter cabinet. No connection terminals are located in the rectifier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



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

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

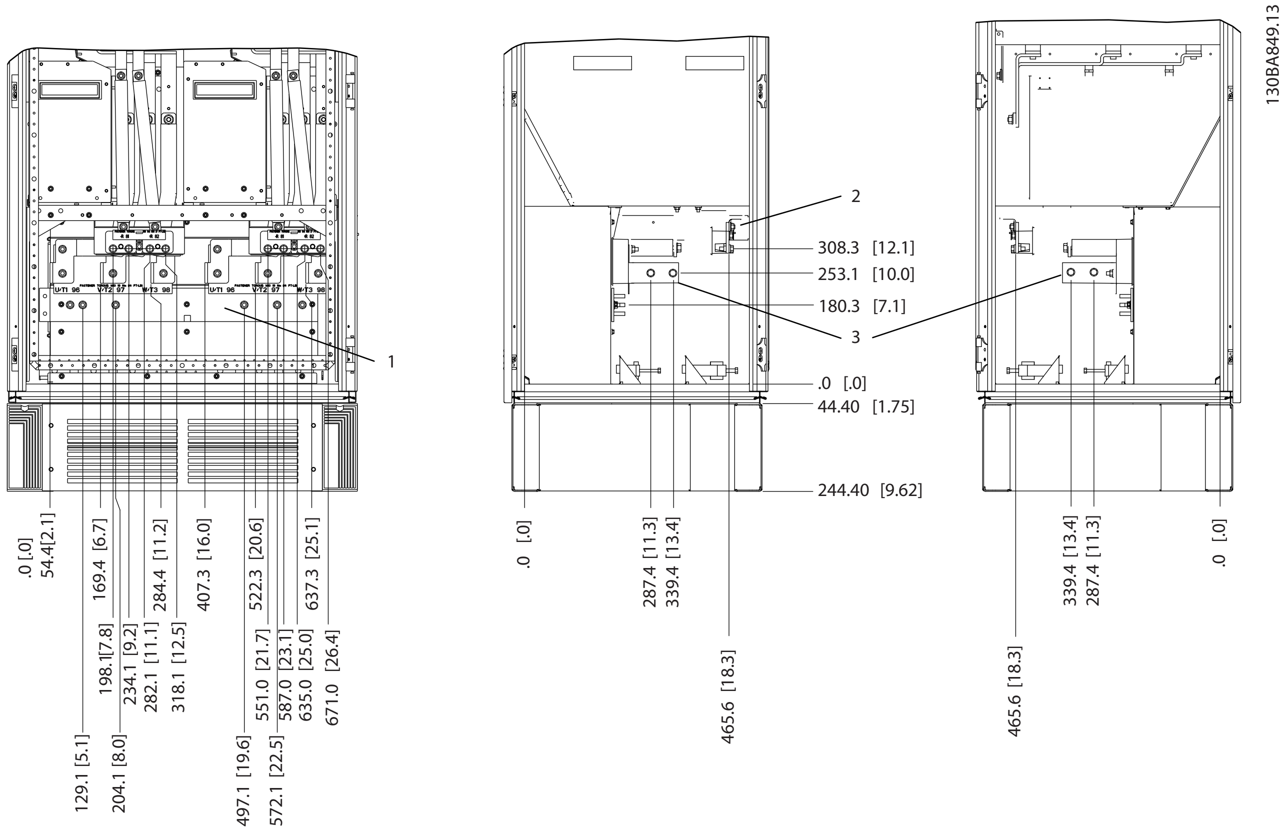
The gland plate is 42 mm below the 0 level. Shown are the left side view, front, and right.



	500 kW[1)](mm [in.])	560–710 kW[1)](mm [in.])
1	Ground bar	
2	34.9 [1.4]	46.3 [1.8]
3	86.9 [3.4]	98.3 [3.9]
4	122.2 [4.8]	119 [4.7]
5	174.2 [6.9]	171 [6.7]
1) Disconnect location and related dimensions vary with kilowatt rating.		

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

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



1	Front view
2	Left side view
3	Right side view

Figure 3.17 Inverter Cabinet, Enclosure Size F18

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

3.3.7 Torque

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

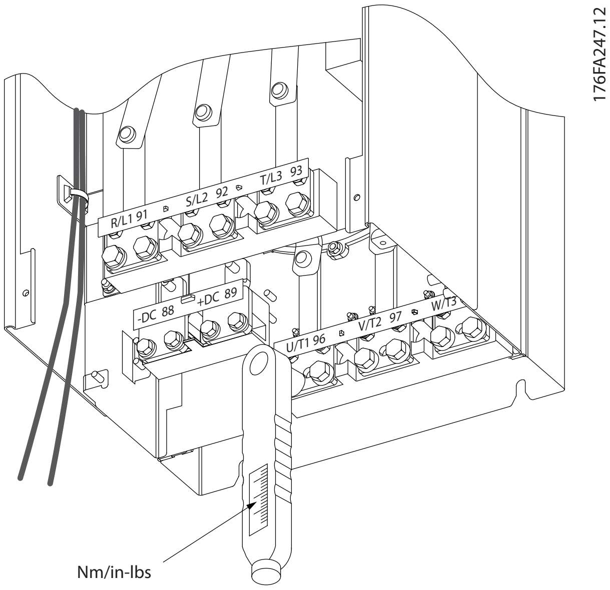


Figure 3.18 Use a Torque Wrench to Tighten the Bolts

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

Table 3.2 Torque for terminals

4 Electrical Installation

4.1 Safety Instructions

See *chapter 2 Safety* for general safety instructions.

⚠WARNING

INDUCED VOLTAGE

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

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

⚠CAUTION

SHOCK HAZARD

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

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

4.2 Electromagnetic Compatability (EMC)

To obtain an EMC-compliant installation, follow the instructions provided in *chapter 4.4 Grounding*, *chapter 4.3 Power Connections*, *chapter 4.8 Control Wiring*, and *chapter 4.6 Motor Connection*.

NOTICE!

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

Overcurrent protection

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

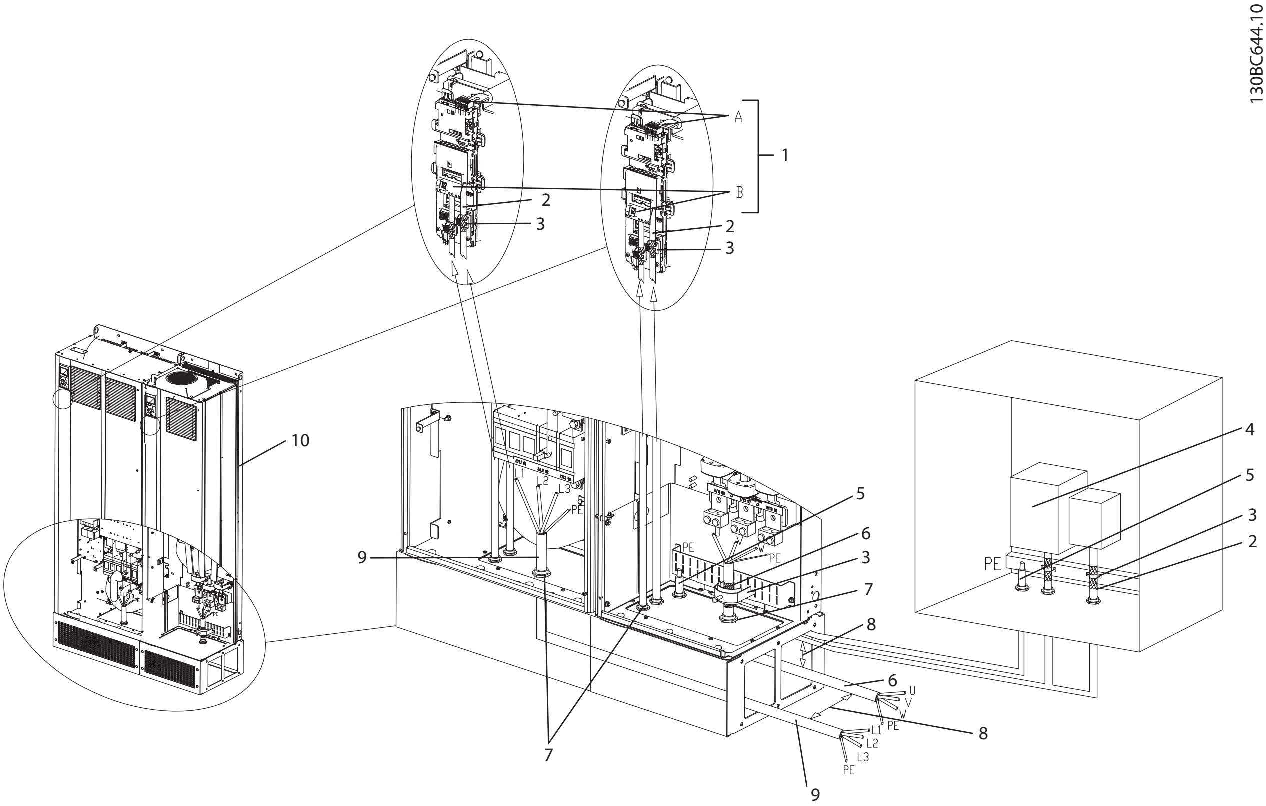
Wire type and ratings

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

See and *chapter 8.3 General Technical Data - Adjustable Frequency Drive* for recommended wire sizes and types.

4

4.2.1 EMC Interference



1	Customer control termination points–options A and B	6	Motor output cable, 3-phase and PE (not screened)
2	Screened control wiring	7	Cable gland
3	Cable clamp	8	Clearance, minimum 200 mm
4	Customer control input	9	Mains input cable, 3-phase and reinforce PE (not screened)
5	Potential equialisation wire [minimum 16 mm^2]	10	Low harmonic drive (LHD)

Figure 4.1 EMC-correct Installation

NOTICE!

EMC Interference

Use screened cables for motor and control wiring. Separate the LHD mains input cable, motor cable, and control wiring. Minimum 200 mm (7.9 in) clearance between power, motor, and control cables is required. Maximise this clearance to minimise EMC emissions. This reduces the risk of interference between the LHD and other electronic devices.

4.3 Power Connections

NOTICE!

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

The power cable connections are situated as shown in *Figure 4.2*. Dimension cable cross-section in accordance with the current ratings and local legislation. See *chapter 8.3.1 Cable lengths and cross-sections* for details.

To protect the adjustable frequency drive, use the recommended fuses if there are no built-in fuses. Fuse recommendations are provided in *chapter 8.4 Fuses*. Ensure that proper fusing is made according to local regulation.

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

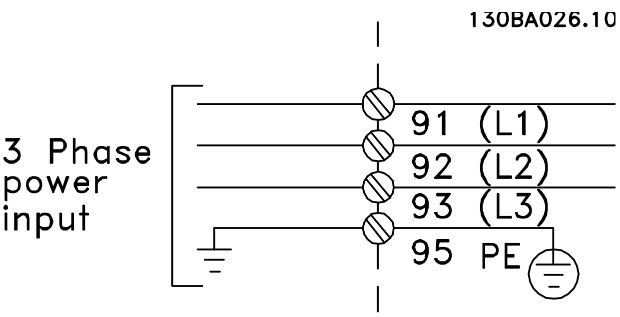


Figure 4.2 Power Cable Connections

NOTICE!

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

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

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

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

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

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

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

Term. no.	96	97	98	99	
	U	V	W	PE[1)]	Motor voltage 0–100% of AC line voltage. 3 wires out of motor
	U1	V1	W1	PE[1)]	Delta-connected
	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)] *Protected Ground Connection*

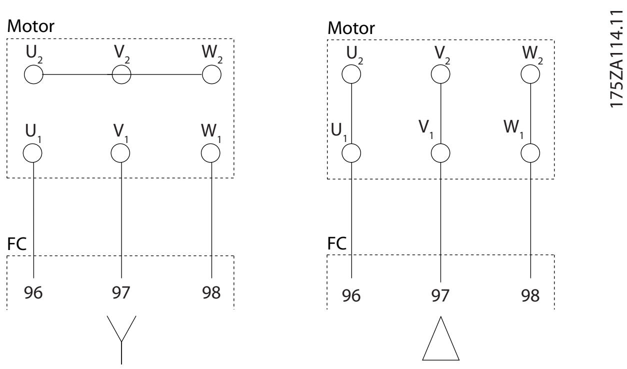


Figure 4.3 Y and Delta Terminal Configurations

4.4 Grounding

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

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

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

4.4.1 Leakage Current (>3.5 mA)

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

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

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

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

4.5 Input Options

4.5.1 Extra Protection (RCD)

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

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

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

4.5.2 RFI Switch

Line power supply isolated from ground
If the adjustable frequency drive is supplied from an isolated line power source or TT/TN-S line power with grounded leg, turn off the RFI switch via *parameter 14-50 RFI 1* on both adjustable frequency drive and the filter. For further reference, see IEC 364-3. When optimum EMC performance is needed, parallel motors are connected, or the motor cable length is above 82 ft [25 m], set *parameter 14-50 RFI 1* to [ON].
In OFF, the internal RFI capacitors (filter capacitors) between the chassis and the intermediate circuit are cut off to avoid damage to the intermediate circuit and reduce ground capacity currents (IEC 61800-3).
Refer to the application note *VLT on IT line power.* It is important to use isolation monitors that work together with power electronics (IEC 61557-8).

4.5.3 Shielded Cables

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

Connection can be made using either cable connectors or clamps:

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

4.6 Motor Connection

4.6.1 Motor Cable

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

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

Table 4.2 Terminal Functions

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

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

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

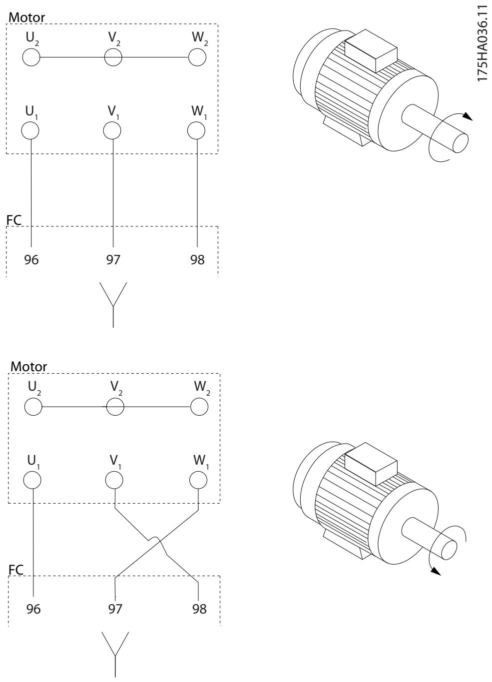


Figure 4.4 Motor Rotation Check

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

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

NOTICE!

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

4.6.2 Brake Cable

Adjustable frequency drives with factory installed brake chopper option

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

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

Terminal No.	Function
81, 82	Brake resistor terminals

Table 4.3 Terminal Functions

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

WARNING

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

F-frame requirements
The brake resistors must be connected to the brake terminals in each inverter module.

4.6.3 Motor Insulation

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

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

Table 4.4 Recommended Motor Insulation Ratings

4.6.4 Motor Bearing Currents

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

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

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

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

If found to be necessary and after consultation with Danfoss:

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

4.7 AC Mains Connection

4.7.1 AC line input connections

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

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

Table 4.5 Terminal Functions

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

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

4.7.2 External Fan Supply

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

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

Table 4.6 Terminal Functions

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

4.7.3 Power and Control Wiring for Non-shielded Cables

WARNING

Induced Voltage

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

CAUTION

Compromised Performance

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

- **power wiring**
- **motor wiring**
- **control wiring**

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

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

When shielded/armored cable is not used, at least three separate conduits are connected to the panel option (see *Figure 4.5*).

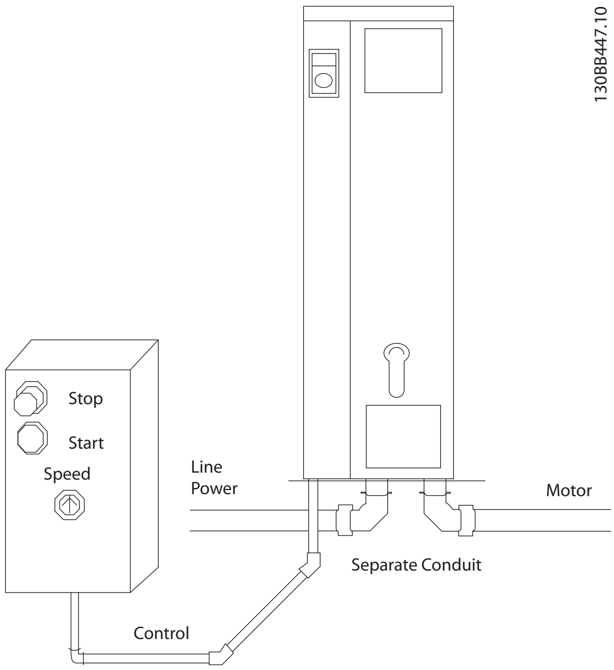


Figure 4.5 Proper Electrical Installation Using Conduit

4.7.4 Line Power Disconnects

Frame size	Power & Voltage	Type
D	P132–P200 380–500 V	OT400U12-9 or ABB OETL-NF400A
E	P250 380–500 V	ABB OETL-NF600A
E	P315–P400 380–500 V	ABB OETL-NF800A
F	P450 380–500 V	Merlin Gerin NPJF36000S12AAYP
F	P500–P630 380–500 V	Merlin Gerin NRK36000S20AAYP

Table 4.7 Recommended Line Power Disconnects

4.7.5 F-Frame Circuit Breakers

Frame size	Power & Voltage	Type
F	P450 380–500 V	Merlin Gerin NPJF36120U31AABSCYP
F	P500–P630 380–500 V	Merlin Gerin NRJF36200U31AABSCYP

Table 4.8 Recommended Circuit Breakers

4.7.6 F-Frame Line Power Contactors

Frame size	Power & Voltage	Type
F	P450–P500 380–500 V	Eaton XTCE650N22A
F	P560–P630 380–500 V	Eaton XTCEC14P22B

Table 4.9 Recommended Contactors

4.8 Control Wiring

4.8.1 Control Cable Routing

Tie down all control wires to the designated control cable routing as shown in *Figure 4.6*, *Figure 4.7*, and *Figure 4.8*. Remember to connect the shields in a proper way to ensure optimum electrical immunity.

Serial communication bus connection
Connections are made to the relevant options on the control card. For details, see the relevant serial communication bus instructions. The cable must be placed in the provided path inside the adjustable frequency drive and tied down together with other control wires (see *Figure 4.6* and *Figure 4.7*).

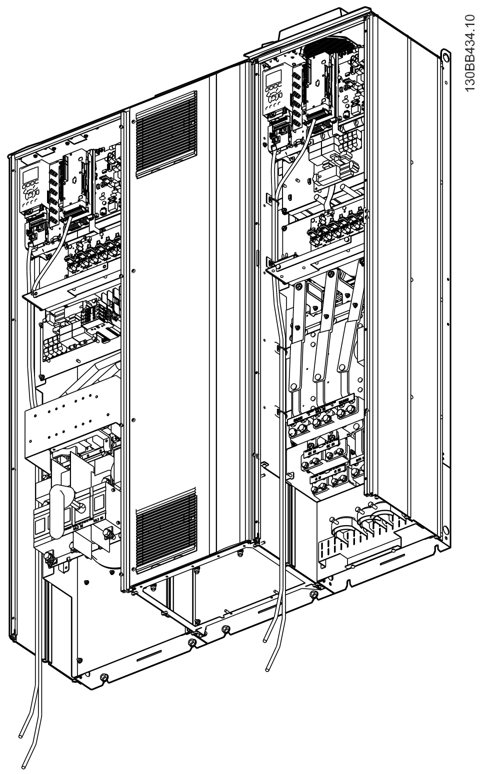


Figure 4.6 Control Card Wiring Path for Frame Size D13

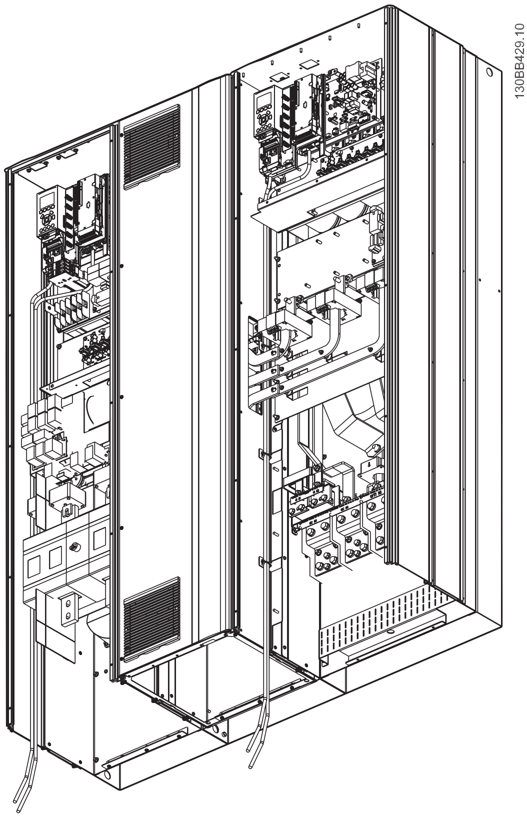
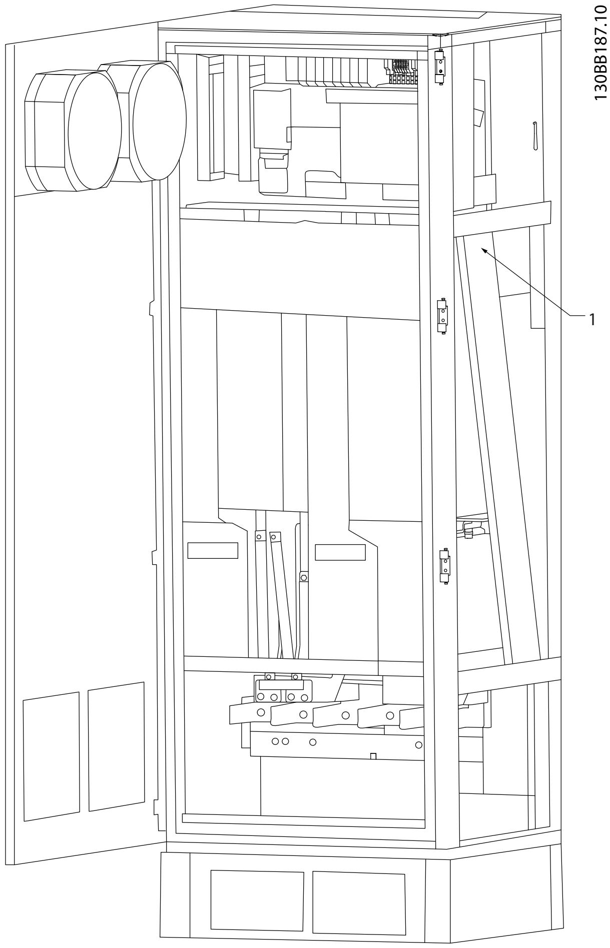


Figure 4.7 Control Card Wiring Path for Frame Size E9



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

Figure 4.8 Control Card Wiring Path for Frame Size F18

4.8.2 Access to Control Terminals

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

4.8.3 Electrical Installation, Control Terminals

To connect the cable to the terminal:

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

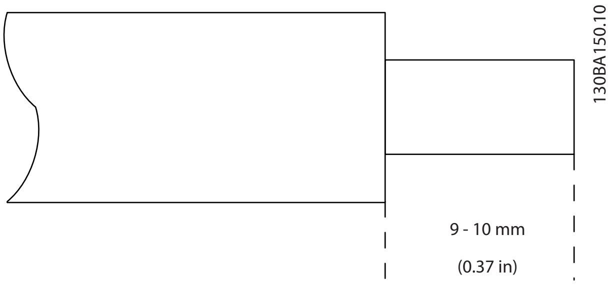


Figure 4.9 Length to Strip the Insulation

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

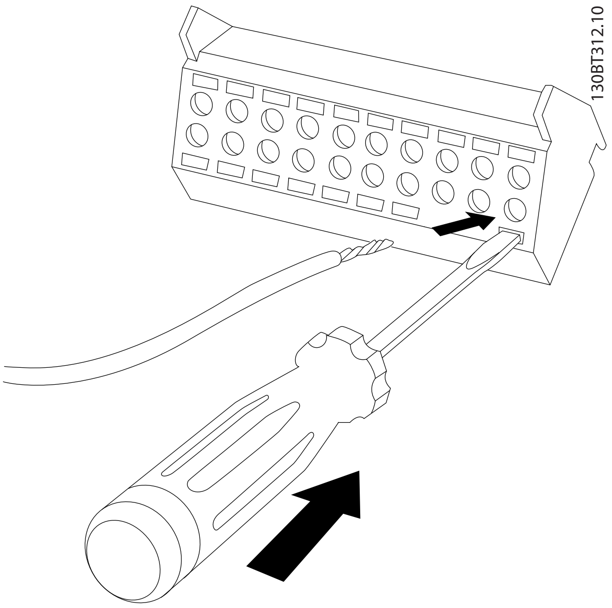


Figure 4.10 Inserting the Cable in the Terminal Block

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

To remove the cable from the terminal:

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

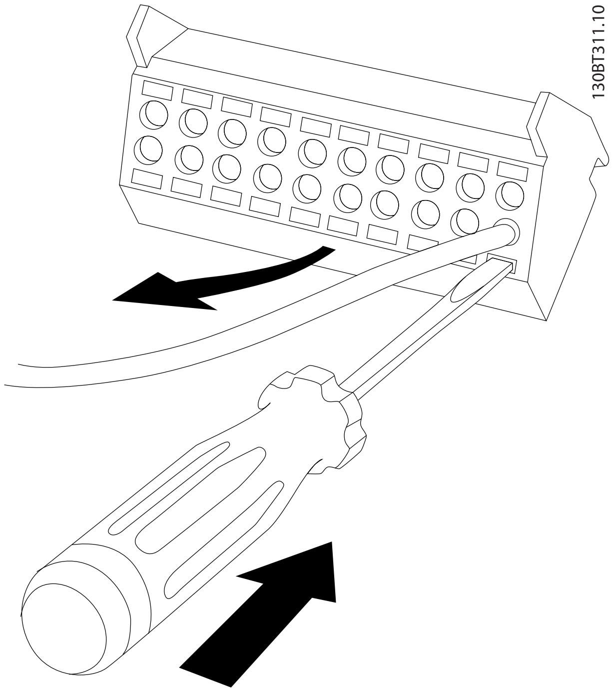


Figure 4.11 Removing the Screwdriver after Cable Insertion

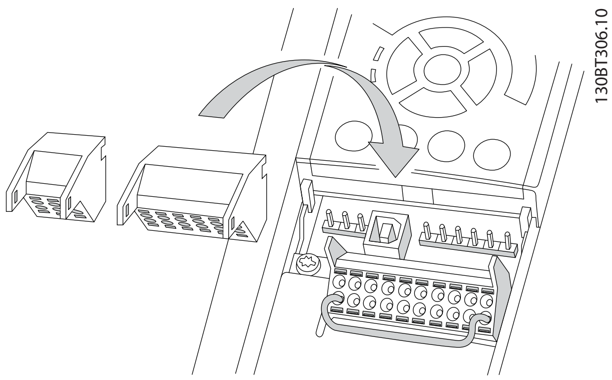


Figure 4.12 Control Terminal Locations

4.8.4 Electrical Installation, Control Cables

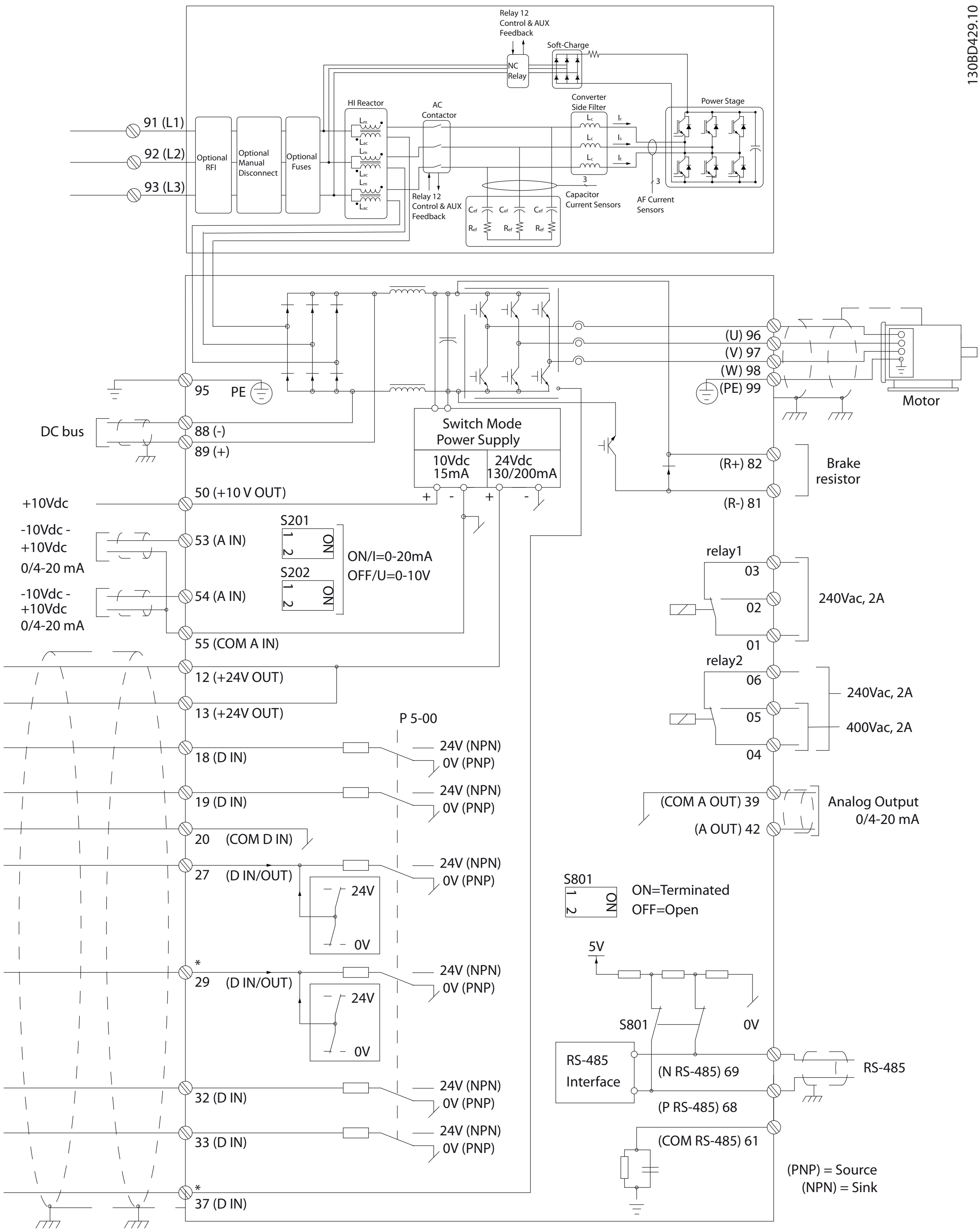


Figure 4.13 Terminal Diagram

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

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

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

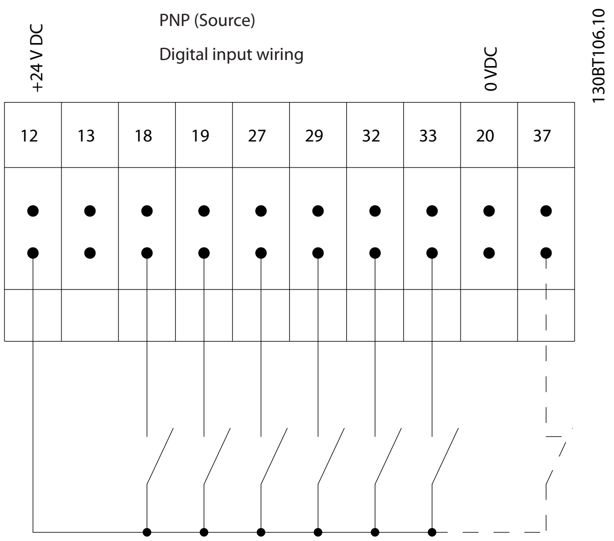


Figure 4.14 Input Polarity of Control Terminals, PNP

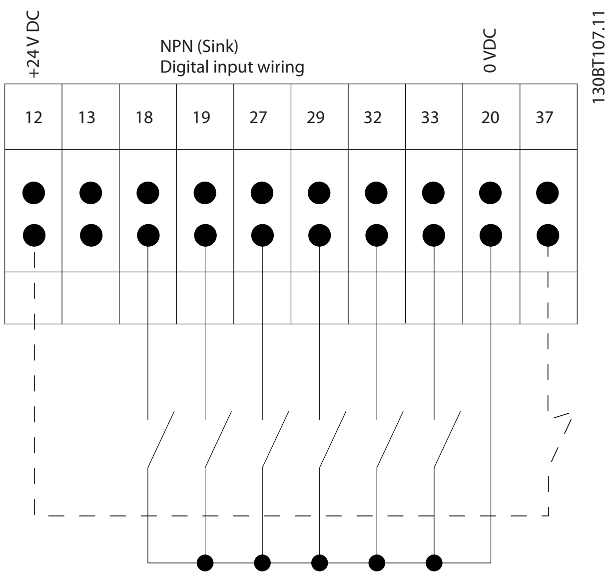


Figure 4.15 Input Polarity of Control Terminals, NPN

NOTICE!

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

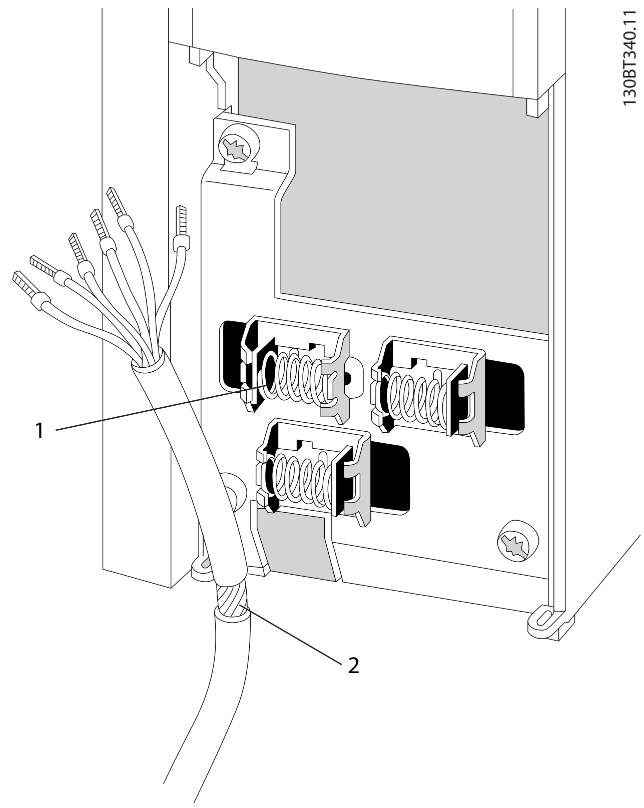


Figure 4.16 Connecting Shielded Cables

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

4.8.5 Safe Torque Off (STO)

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

4.9 Additional Connections

4.9.1 Serial Communication

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

NOTICE!

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

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

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

Table 4.10 Cable Recommendations

4.9.2 Mechanical Brake Control

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

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

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

4.9.3 Parallel Connection of Motors

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

NOTICE!

Installations with cables connected in a common joint as in *Figure 4.17*, is only recommended for short cable lengths.

NOTICE!

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

NOTICE!

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

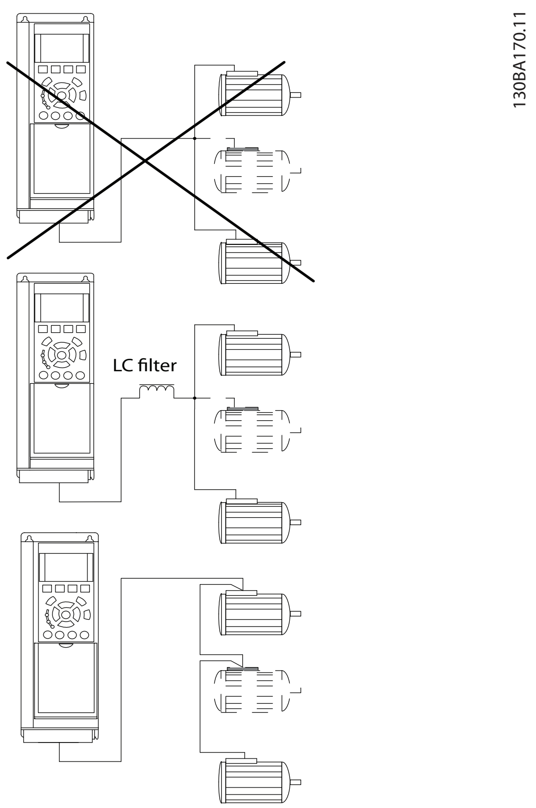


Figure 4.17 Installations with Cables Connected in a Common Joint

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

4.9.4 Motor Thermal Protection

The electronic thermal relay in the adjustable frequency drive has received UL-approval for single motor protection, when *parameter 1-90 Motor Thermal Protection* is set for *ETR Trip* and *parameter 1-24 Motor Current* is set to the rated motor current (see motor nameplate).
For thermal motor protection, it is also possible to use the MCB 112 PTC thermistor card option. This card provides ATEX certification to protect motors in explosion hazardous areas, Zone 1/21 and Zone 2/22. When *parameter 1-90 Motor Thermal Protection* is set to *[20] ATEX ETR* and MCB 112 are combined. It is possible to control an Ex-e motor in explosion hazardous areas. Consult the programming guide for details on how to set up the adjustable frequency drive for safe operation of Ex-e motors.

4.9.5 Voltage/Current Input Selection (Switches)

The analog mains terminals 53 and 54 allow setting of input signal to voltage (0–10 V) or current (0/4–20 mA). See *Figure 4.13* and for the location of the control terminals within the low harmonic drive.

Default parameter settings:

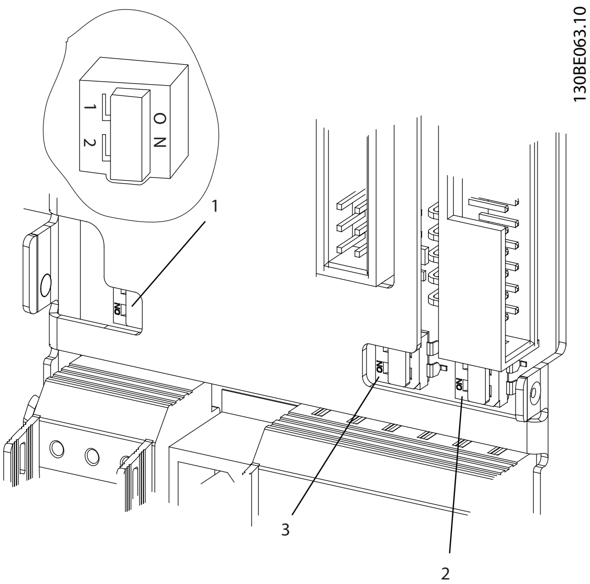
- Terminal 53: Speed reference signal in open loop (see *parameter 16-61 Terminal 53 Switch Setting*).
- Terminal 54: Feedback signal in closed loop (see *parameter 16-63 Terminal 54 Switch Setting*).

NOTICE!

REMOVE POWER

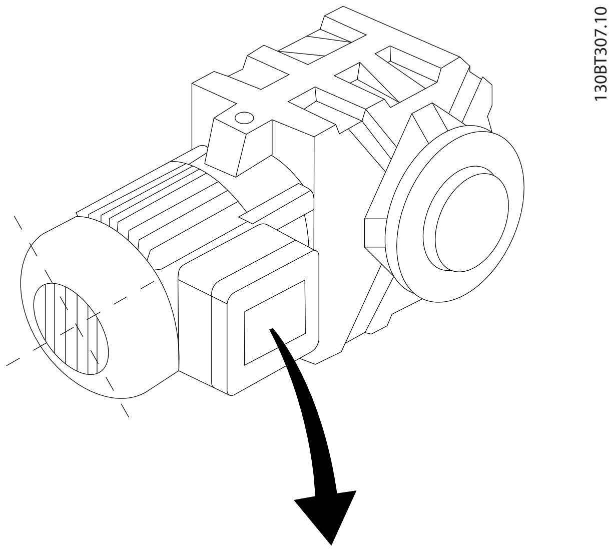
Remove power to the low harmonic drive before changing switch positions.

1. Remove the LCP (see *Figure 4.18*).
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

Figure 4.18 Bus Termination Switch, A53, and A54 Switch Locations



BAUER D-7 3734 ESLINGEN				
3~ MOTOR NR. 1827421 2003				
S/E005A9				
	1,5	KW		
n_2 31,5	/MIN.	400	Y	V
n_1 1400	/MIN.		50	Hz
cos 0,80			3,6	A
1,7L				
B	IP 65	H1/1A		

Figure 4.19 Motor Name Plate

4.10 Final Set-up and Test

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

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

1.	*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

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. A description of the alarm can be found in *chapter 7 Status Messages*.
- 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 organised and labeled to the specifications of the NAMUR standard for frequency converters input and output terminals. This requires VLT® PTC Thermistor Card MCB 112 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 set-point) and a main alarm set-point. Associated with each set-point is an SPDT alarm relay for external use. Requires an external window-type current transformer (supplied and installed by the customer).

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

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

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

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

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

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

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

30 A, fuse-protected terminals

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

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

5

5 Start-up and Functional Testing

5.1 Safety Instructions

See *chapter 2 Safety* for general safety instructions.

⚠WARNING

HIGH VOLTAGE

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

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

Before applying power:

1. Close the cover properly.
2. Check that all cable connectors are firmly tightened.
3. Ensure that input power to the unit is OFF and locked out. Do not rely on the adjustable frequency drive disconnect switches for input power isolation.
4. Verify that there is no voltage on input terminals L1 (91), L2 (92), and L3 (93), phase-to-phase, and phase-to-ground.
5. Verify that there is no voltage on output terminals 96 (U), 97 (V), and 98 (W), phase-to-phase, and phase-to-ground.
6. Confirm continuity of the motor by measuring Ω values on U-V (96-97), V-W (97-98), and W-U (98-96).
7. Check for proper grounding of the adjustable frequency drive as well as the motor.
8. Inspect the adjustable frequency drive for loose connections on the terminals.
9. Confirm that the supply voltage matches the voltage of the adjustable frequency drive and the motor.

5.1.1 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 adjustable frequency drive or output side to the motor. Ensure that they are ready for full speed operation. • Check function and installation of any sensors used for feedback to the adjustable frequency drive. • Remove power factor correction caps on motors, if present	

Cable routing	• 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, if necessary. • The use of shielded cable or twisted pair is recommended. Ensure that the shield is terminated correctly.	
Cooling clearance	• Make sure that the top and bottom clearance is adequate to ensure proper airflow for cooling.	

Inspect for	Description	☑
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 chassis to the building ground. • Check for good ground connections that are tight and free of oxidation. • Grounding to conduit or mounting the back panel to a metal surface is not a suitable ground.	
Input and output power wiring	• Check for loose connections. • Check that motor and line power are in separate conduits or separated shielded cables.	
Panel interior	• Make sure 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 to the Equipment

⚠WARNING

HIGH VOLTAGE!

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

⚠WARNING

UNINTENDED START!

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

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

NOTICE!

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

5.3 Local Control Panel Operation

5.3.1 Local Control Panel

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

The LCP has several functions:

- Control speed of frequency converter when in local mode.
- Start and stop in local mode.
- Display operational data, status, warnings, and alarms.
- Programme frequency converter and active filter functions.

- Manually reset the frequency converter or active filter after a fault when auto-reset is inactive.

NOTICE!

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

5.3.2 LCP Layout

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

A. Display area

B. Display menu keys

C. Navigation keys and indicator lights (LEDs)

D. Operation keys and reset

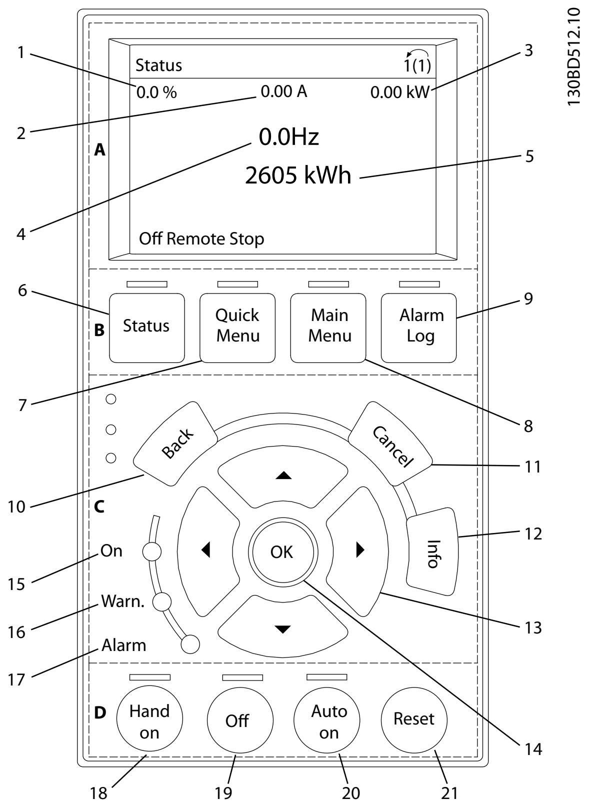


Figure 5.1 Local Control Panel (LCP)

A. Display area

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

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

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

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

B. Display menu keys

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

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

Table 5.3 Legend to *Figure 5.1*, Display Menu Keys

C. Navigation keys and indicator lights (LEDs)

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

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

Table 5.4 Legend to *Figure 5.1*, Navigation Keys

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

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

D. Operation keys and reset
Operation keys are located at the bottom of the LCP.

Callout	Key	Function
18	Hand On	Starts the frequency converter in local control. • 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 *Figure 5.1*, Operation Keys and Reset

NOTICE!

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

5.3.3 Parameter Settings

Establishing the correct programming for applications often requires setting functions in several related parameters.

Programming data are stored internally in the adjustable frequency drive.

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

5.3.4 Uploading/Downloading Data to/from the LCP

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

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

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

5

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

5.3.6 Restoring Default Settings

NOTICE!

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

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

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

Recommended initialisation procedure, via *parameter 14-22 Operation Mode*

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

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

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

Manual initialisation procedure

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

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

Manual initialisation does not reset the following frequency converter information:

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

5.4 Basic Operational Programming

5.4.1 VLT® Low Harmonic Drive Programming

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

Detailed programming information for the frequency converter portion can be found in the relevant *programming guide*. Detailed programming information for the filter can be found in the *VLT® Active Filter AAF 006 Operating Instructions*.
The remaining sections in this chapter apply to the frequency converter side. The active filter of the low harmonic drives is pre-configured for optimal performance and must only be turned on by pressing its [Hand On] key after the frequency converter side is commissioned.

5.4.2 Commissioning with SmartStart

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

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

NOTICE!

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

5.4.3 Commissioning via [Main Menu]

Recommended parameter settings are intended for start-up and check-out purposes. Application settings may vary.

Enter data with power ON, but before operating the adjustable frequency drive.

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

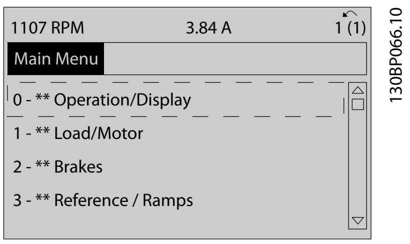


Figure 5.2 Main Menu

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

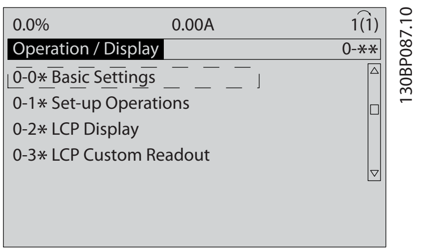


Figure 5.3 Operation/Display

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

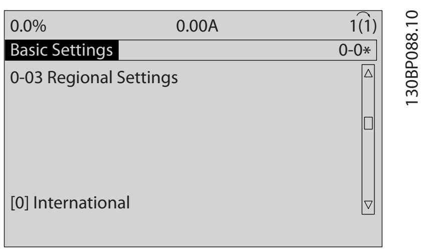


Figure 5.4 Basic Settings

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

5.4.4 Asynchronous Motor Set-up

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

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

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

1. *Parameter 1-30 Stator Resistance (Rs)*.
2. *Parameter 1-31 Rotor Resistance (Rr)*.
3. *Parameter 1-33 Stator Leakage Reactance (X1)*.

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4. *Parameter 1-34 Rotor Leakage Reactance (X2).*
5. *Parameter 1-35 Main Reactance (Xh).*
6. *Parameter 1-36 Iron Loss Resistance (Rfe).*

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

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

See *Table 5.7* for application-related recommendations.

Application	Settings
Low-inertia applications	Keep calculated values.
High-inertia applications	*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 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 adjustable frequency drive tripping.

Table 5.7 Recommendations for Flux Applications

5.4.5 Permanent Magnet Motor Set-up

NOTICE!

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

Initial Programming Steps

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

Programming motor data
After selecting PM motor in *Parameter 1-10 Motor Construction*, the PM motor-related parameters in parameter groups *1-2* Motor Data*, *1-3* Addl. Motor Data* and *1-4** are active.
The necessary data can be found on the motor nameplate and in the motor data sheet.
Program the following parameters in the listed order

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

line-line value by 2 to achieve the line to common (starpoint) value.
It is also possible to measure the value with an ohmmeter, which takes the resistance of the cable into account. Divide the measured value by 2 and enter the result.

6. *Parameter 1-37 d-axis Inductance (Ld)*
Enter line to common direct axis inductance of the PM motor.
If only line-line data are available, divide the line-line value by 2 to achieve the line-common (starpoint) value.
It is also possible to measure the value with an inductance meter, which takes the inductance of the cable into account. Divide the measured value by 2 and enter the result.

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

Test motor operation

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

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

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

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

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

Table 5.8 Recommendations for Different Applications

If the motor starts oscillating at a certain speed, increase *parameter 1-14 Damping Gain*. Increase the value in small steps. Depending on the motor, a good value for this parameter can be 10% or 100% higher than the default value.

Starting torque can be adjusted in *parameter 1-66 Min. Current at Low Speed*. 100% provides nominal torque as starting torque.

5.4.6 Automatic Energy Optimization (AEO)

NOTICE!

AEO is not relevant for permanent magnet motors.

AEO is a procedure which minimizes voltage to the motor, thereby reducing energy consumption, heat, and noise.

To activate AEO, set *parameter 1-03 Torque Characteristics* to *[2] Auto Energy Optim. CT* or *[3] Auto Energy Optim. VT*.

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5.4.7 Automatic Motor Adaptation (AMA)

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

- The adjustable frequency drive builds a mathematical model of the motor for regulating output motor current. The procedure also tests the input phase balance of electrical power. It compares the motor characteristics with the entered nameplate data.
- The motor shaft does not turn and no harm is done to the motor while running the AMA.
- Some motors may be unable to run the complete version of the test. In that case, select *[2] Enable reduced AMA*.
- If an output filter is connected to the motor, select *[2] Enable reduced AMA*.
- If warnings or alarms occur, see *chapter 7 Status Messages*.
- Run this procedure on a cold motor for best results.

To run AMA

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

5.5 Checking Motor Rotation

NOTICE!

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

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

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

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

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

NOTICE!

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

5.6 Local Control Test

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

In the event of acceleration or deceleration problems, see *chapter 7.5 Troubleshooting*. See *chapter 7.3 Warnings and Alarm Definitions - Adjustable Frequency Drive* for resetting the adjustable frequency drive 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 Warnings and Alarm Definitions - Adjustable Frequency Drive* or *chapter 7.4 Warning and Alarm Definitions - Filter (Left LCP)*.

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.

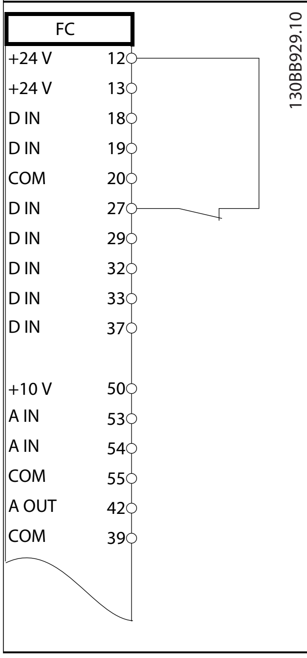
NOTICE!

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

6.2 Application Examples

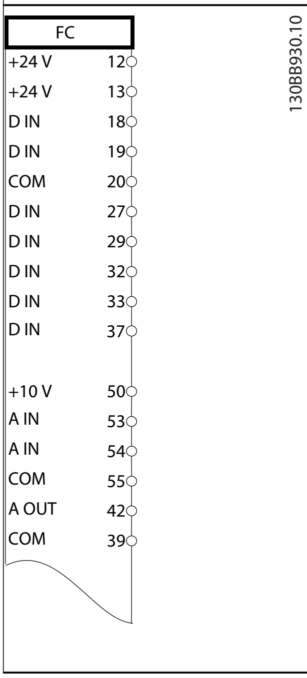
CAUTION

Thermistors must use reinforced or double insulation to meet PELV insulation requirements.



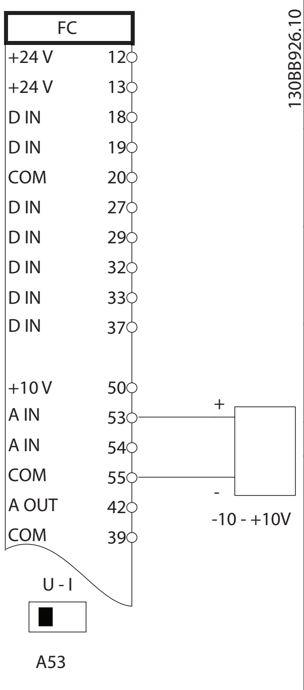
Parameters	
Function	**Setting**
parameter 1-29 Automatic Motor Adaptation (AMA)	[1] Enable complete AMA
parameter 5-12 Terminal 27 Digital Input	[2]* Coast inverse
*=Default Value	
Notes/comments: Parameter group *1–2* Motor Data* must be set according to motor	

Table 6.1 AMA with T27 Connected



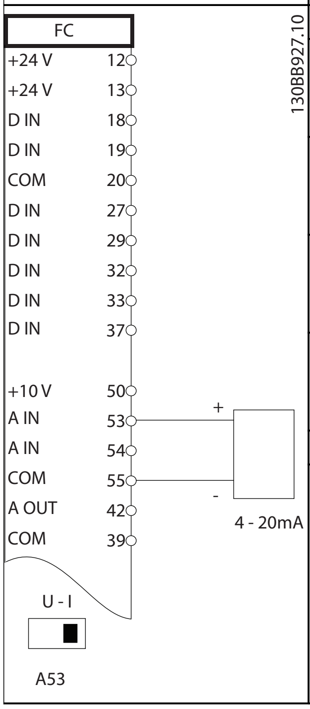
Parameters	
Function	**Setting**
parameter 1-29 Automatic Motor Adaptation (AMA)	[1] Enable complete AMA
parameter 5-12 Terminal 27 Digital Input	[0] No operation
*=Default Value	
Notes/comments: Parameter group *1–2* Motor Data* must be set according to motor	

Table 6.2 AMA without T27 Connected



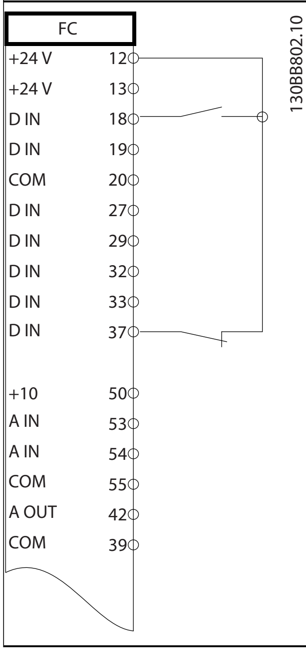
	Parameters	
	Function	Setting
	parameter 6-10 Terminal 53 Low Voltage	0.07 V*
	parameter 6-11 Terminal 53 High Voltage	10 V*
	parameter 6-14 Terminal 53 Low Ref./Feedb. Value	0 RPM
	parameter 6-15 Terminal 53 High Ref./Feedb. Value	1,500 RPM
	*=Default Value	
	Notes/comments:	

Table 6.3 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 RPM
	parameter 6-15 Terminal 53 High Ref./Feedb. Value	1,500 RPM
	*=Default Value	
	Notes/comments:	

Table 6.4 Analog Speed Reference (Current)



	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 Digital Input	[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.	

Table 6.5 Start/Stop Command with Safe Torque Off

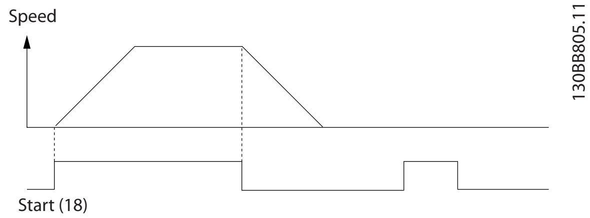
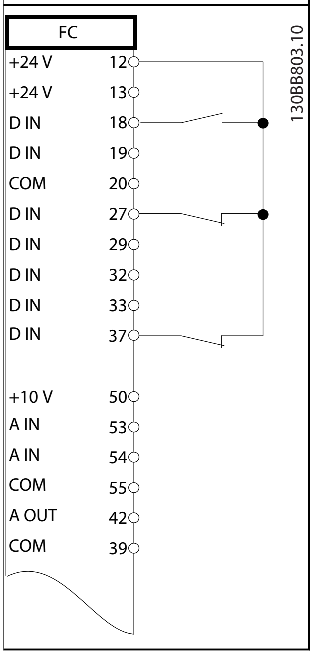


Figure 6.1 Start/Stop with Safe Torque Off



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.	

Table 6.6 Pulse Start/Stop

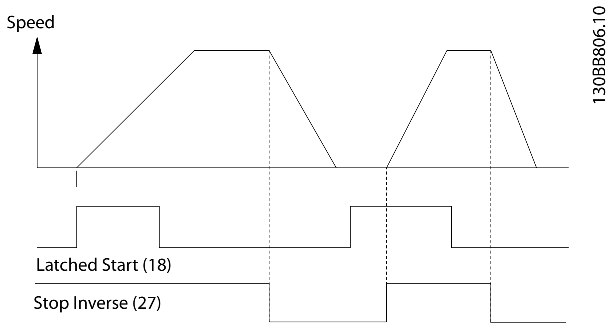
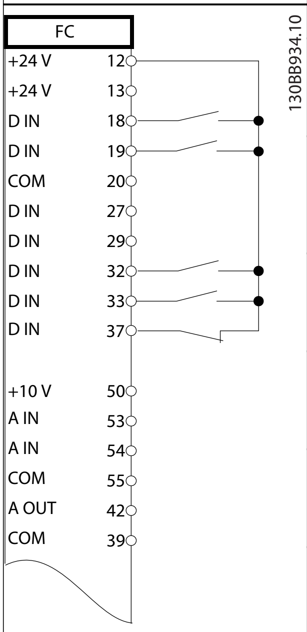


Figure 6.2 Latched Start/Stop Inverse



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

Table 6.7 Start/Stop with Reversing and Four Preset Speeds

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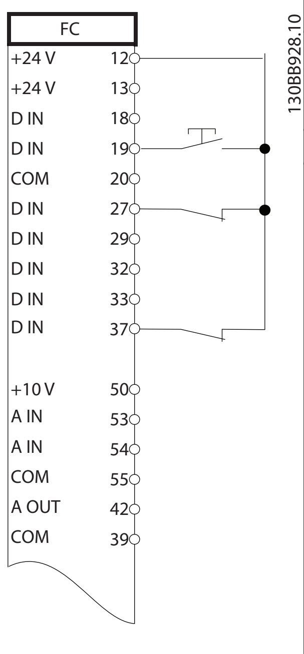
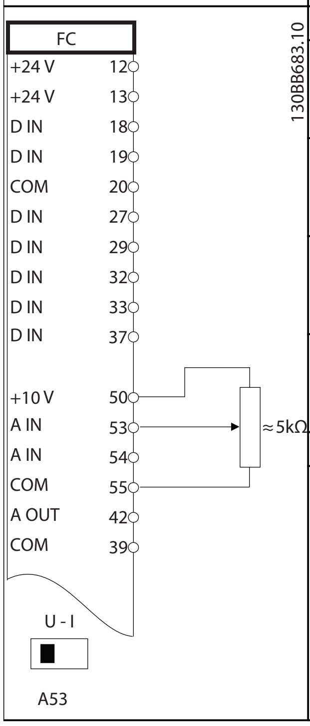


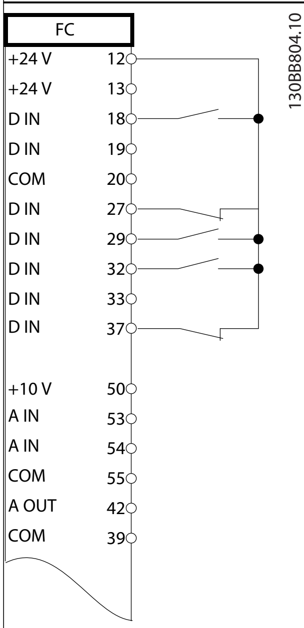
Parameters	
Function	**Setting**
parameter 5-11 Terminal 19 Digital Input	[1] Reset
*=Default Value	
Notes/comments:	

Table 6.8 External Alarm Reset



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 RPM
parameter 6-15 Terminal 53 High Ref./Feedb. Value	1,500 RPM
*=Default Value	
Notes/comments:	

Table 6.9 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] Slow
*=Default Value	
Notes/comments:	

Table 6.10 Speed Up/Down

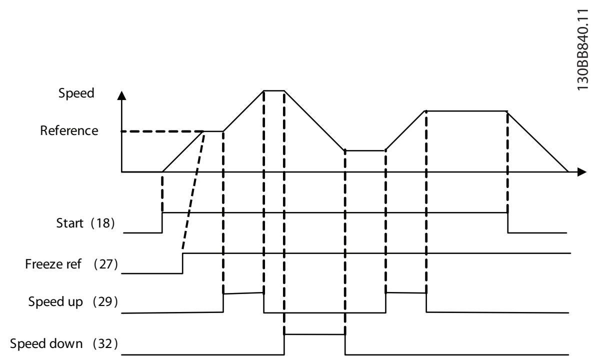
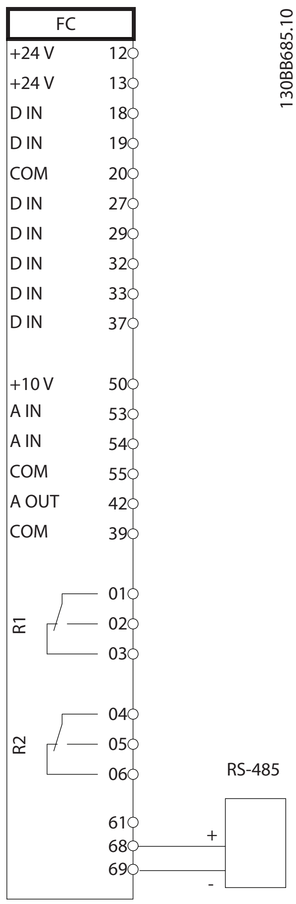


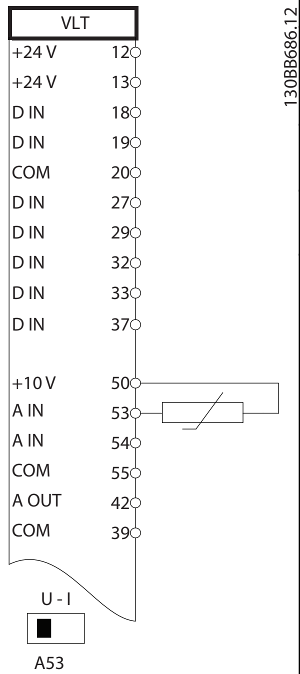
Figure 6.3 Speed Up/Down



Parameters	
Function	**Setting**
Parameter 8-30 Protocol	FC*
Parameter 8-31 Address	1*
Parameter 8-32 Baud Rate	9,600*
*=Default Value	

Notes/comments:
Select protocol, address, and Baud rate in the parameters mentioned above.

Table 6.11 RS-485 Network Connection



Parameters	
Function	**Setting**
Parameter 1-90 Motor Thermal Protection	[2] Thermistor trip
Parameter 1-93 T hermistor Source	[1] Analog input 53
*=Default Value	

Notes/comments:
If only a warning is desired, set *parameter 1-90 Motor Thermal Protection* to *[1] Thermistor warning*.

Table 6.12 Motor Thermistor

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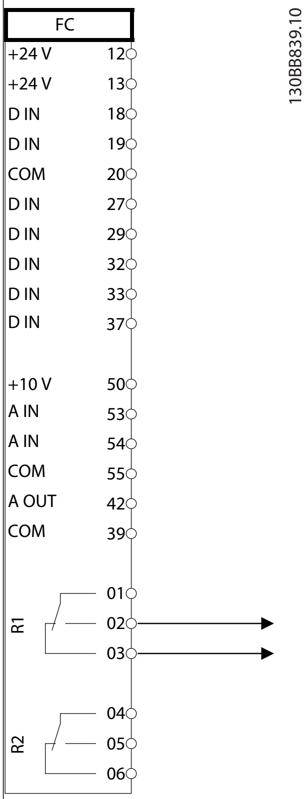
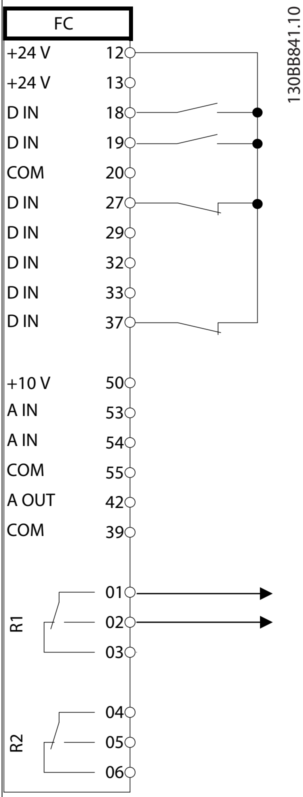


Parameters	
Function	**Setting**
Parameter 4-30 Motor Feedback Loss Function	[1] Warning
Parameter 4-31 Motor Feedback Speed Error	100 RPM
parameter 4-32 Motor Feedback Loss Timeout	5 s
parameter 7-00 Speed PID Feedback Source	[2] MCB 102
parameter 17-11 Resolution (PPR)	1024*
parameter 13-00 SL Controller Mode	[1] On
parameter 13-01 Start Event	[19] Warning
parameter 13-02 Stop Event	[44] Reset key
parameter 13-10 Comparator Operand	[21] Warning no.
parameter 13-11 Comparator Operator	[1] ≈*
parameter 13-12 Comparator Value	90
parameter 13-51 SL Controller Event	[22] Comparator 0
parameter 13-52 SL Controller Action	[32] Set digital out A low
parameter 5-40 Function Relay	[80] SL digital output A
*=Default Value	
Notes/comments: If the limit in the feedback monitor is exceeded, Warning 90 is issued. The SLC monitors Warning 90 and in the case that Warning 90 becomes TRUE, then relay 1 is triggered. External equipment may indicate that service is required. If the feedback error goes below the limit again within 5 s, the adjustable frequency drive continues and the warning disappears. But relay 1 is still triggered until [Reset] on the LCP.	

Table 6.13 Using SLC to Set a Relay



Parameters

Function	Setting
parameter 1-00 Configuration Mode	[0] Speed open-loop
parameter 1-01 Motor Control Principle	[1] VVC^{+}
parameter 5-40 Function Relay	[32] Mech. brake ctrl.
Parameter 5-10 Terminal 18 Digital Input	[8] Start*
parameter 5-11 Terminal 19 Digital Input	[11] Start reversing
parameter 1-71 Start Delay	0.2
parameter 1-72 Start Function	[5] VVC^{+}/ FLUX Clockwise
parameter 1-76 Start Current	$I_{m,n}$
parameter 2-20 Release Brake Current	App. dependent
parameter 2-21 Activate Brake Speed [RPM]	Half of nominal slip of the motor
*=Default Value	
Notes/comments:	

Table 6.14 Mechanical Brake Control (Open-loop)

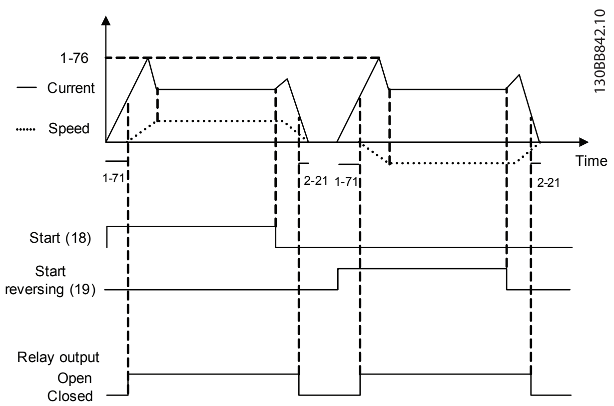
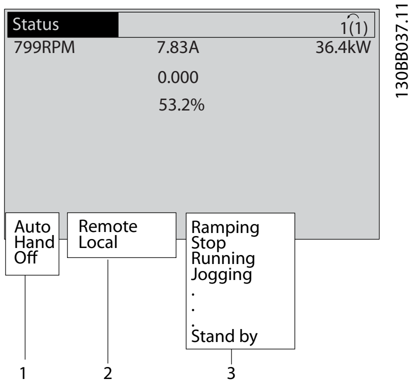


Figure 6.4 Mechanical Brake Control (Open-loop)

7 Status Messages

7.1 Status Display

When the frequency converter is in *Status* mode, status messages are generated automatically and appear in the bottom line of the display (see *Figure 7.1*). Refer to the *VLT® AutomationDrive FC 302 Programming Guide* for detailed descriptions of the displayed status messages.



1	Operation mode
2	Reference site
3	Operation status

Figure 7.1 Status Display

7.2 Warning and Alarm Types

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

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

Investigate as indicated in the alarm or warning.

7.2.1 Warnings

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

7.2.2 Alarm Trip

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

A trip can be reset in any of 4 ways:

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

7.2.3 Alarm Trip-lock

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

7.3 Warnings and Alarm Definitions - Adjustable Frequency Drive

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

WARNING 1, 10 Volts low
The control card voltage is <10 V from terminal 50. Remove some of the load from terminal 50, as the 10 V supply is overloaded. Maximum 15 mA or minimum 590 Ω.

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

Troubleshooting

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

WARNING/ALARM 2, Live zero error
This warning or alarm only appears if programmed in *parameter 6-01 Live Zero Timeout Function*. The signal on one of the analog inputs is less than 50% of the minimum value programmed for that input. Broken wiring or a faulty device sending the signal can cause this condition.

Troubleshooting

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

WARNING/ALARM 3, No motor
No motor has been connected to the output of the adjustable frequency drive.

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

Troubleshooting

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

WARNING 5, DC link voltage high
The intermediate circuit voltage (DC) is higher than the high-voltage warning limit. The limit is dependent on the adjustable frequency drive voltage rating. The unit is still active.

WARNING 6, DC link voltage low
The intermediate circuit voltage (DC) is lower than the low-voltage warning limit. The limit is dependent on the adjustable frequency drive voltage rating. The unit is still active.

WARNING/ALARM 7, DC overvoltage
If the intermediate circuit voltage exceeds the limit, the adjustable frequency drive trips after a time.

Troubleshooting

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

WARNING/ALARM 8, DC undervoltage
If the DC link voltage drops below the undervoltage limit, the adjustable frequency drive checks if a 24 V DC backup supply is connected. If no 24 V DC backup supply is connected, the adjustable frequency drive trips after a fixed time delay. The time delay varies with unit size.

Troubleshooting

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

WARNING/ALARM 9, Inverter overload
The adjustable frequency drive has run with more than 100% overload for too long and is about to cut out. The counter for electronic thermal inverter protection issues a warning at 98% and trips at 100%, while giving an alarm. The adjustable frequency drive cannot be reset until the counter is below 90%.

Troubleshooting

- Compare the output current shown on the LCP with the adjustable frequency drive rated current.
- Compare the output current shown on the LCP with the measured motor current.

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- Display the thermal drive load on the LCP and monitor the value. When running above the adjustable frequency drive continuous current rating, the counter increases. When running below the adjustable frequency drive continuous current rating, the counter decreases.

WARNING/ALARM 10, Motor overload temperature
According to the electronic thermal protection (ETR), the motor is too hot. Select whether the adjustable frequency drive issues a warning or an alarm when the counter reaches 100% in *parameter 1-90 Motor Thermal Protection*. The fault occurs when the motor runs with more than 100% overload for too long.

Troubleshooting

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

WARNING/ALARM 11, Motor thermistor overtemp
The thermistor may be disconnected. Select whether the adjustable frequency drive issues a warning or an alarm in *parameter 1-90 Motor Thermal Protection*.

Troubleshooting

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

WARNING/ALARM 12, Torque limit
The torque has exceeded the value in *parameter 4-16 Torque Limit Motor Mode* or the value in *parameter 4-17 Torque Limit Generator Mode*. *Parameter 14-25 Trip Delay at Torque Limit* can change this warning from a warning-only condition to a warning followed by an alarm.

Troubleshooting

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

WARNING/ALARM 13, Overcurrent
The inverter peak current limit (approximately 200% of the rated current) is exceeded. The warning lasts approximately 1.5 s, then the adjustable frequency drive trips and issues an alarm. Shock loading or quick acceleration with high-inertia loads can cause this fault. If the acceleration during ramp-up is quick, the fault can also appear after kinetic backup. If extended mechanical brake control is selected, a trip can be reset externally.

Troubleshooting

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

ALARM 14, Ground fault
There are current from the output phases to ground, either in the cable between the adjustable frequency drive and the motor or in the motor itself.

Troubleshooting

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

ALARM 15, Hardware mismatch
A fitted option is not operational with the present control board hardware or software.

Record the value of the following parameters and contact Danfoss:

- *Parameter 15-40 FC Type*
- *Parameter 15-41 Power Section*
- *Parameter 15-42 Voltage*
- *Parameter 15-43 Software Version*
- *Parameter 15-45 Actual Typecode String*
- *Parameter 15-49 SW ID Control Card*
- *Parameter 15-50 SW ID Power Card*
- *Parameter 15-60 Option Mounted*
- *Parameter 15-61 Option SW Version* (for each option slot)

ALARM 16, Short circuit
There is short-circuiting in the motor or motor wiring.

Troubleshooting

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

WARNING/ALARM 17, Control word timeout
There is no communication to the adjustable frequency drive.
The warning is only active when *parameter 8-04 Control Timeout Function* is not set to *[0] Off*.
If *parameter 8-04 Control Timeout Function* is set to *[2] Stop* and *[26] Trip*, a warning appears and the adjustable frequency drive ramps down until it trips then displays an alarm.

Troubleshooting:

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

WARNING/ALARM 22, Hoist mechanical brake
Report value shows what kind it is.
0 = The torque reference was not reached before timeout (*parameter 2-27 Torque Ramp Up Time*).
1 = Expected brake feedback not received before timeout (*parameter 2-23 Activate Brake Delay*, *parameter 2-25 Brake Release Time*).

WARNING 23, Internal fan fault
The fan warning function is an extra protective function that checks if the fan is running/mounted. The fan warning can be disabled in *parameter 14-53 Fan Monitor ([0] Disabled)*.

Troubleshooting

- Check fan resistance.
- Check soft charge fuses.

WARNING 24, External fan fault
The fan warning function is an extra protective function that checks if the fan is running/mounted. The fan warning can be disabled in *parameter 14-53 Fan Monitor ([0] Disabled)*.

Troubleshooting

- Check fan resistance.
- Check soft charge fuses.

WARNING 25, Brake resistor short circuit
The brake resistor is monitored during operation. If a short circuit occurs, the brake function is disabled and the warning appears. The adjustable frequency drive is still operational but without the brake function.

Troubleshooting

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

WARNING/ALARM 26, Brake resistor power limit
The power transmitted to the brake resistor is calculated as a mean value over the last 120 s of run time. The calculation is based on the intermediate circuit voltage and the brake resistance value set in *parameter 2-16 AC Brake Max. Current*. The warning is active when the dissipated braking energy is higher than 90% of the brake resistance power. If *[2] Trip* is selected in *parameter 2-13 Brake Power Monitoring*, the adjustable frequency drive trips when the dissipated braking energy reaches 100%.

⚠WARNING

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

WARNING/ALARM 27, Brake chopper fault
This alarm/warning could occur if the brake resistor overheats. Terminals 104 and 106 are available as brake resistors Klixon inputs.

NOTICE!

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

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WARNING/ALARM 28, Brake check failed
The brake resistor is not connected or not working. Check *parameter 2-15 Brake Check*.

ALARM 29, Heatsink temp
The maximum temperature of the heatsink has been exceeded. The temperature fault resets when the temperature falls below a defined heatsink temperature. The trip and reset points are different based on the adjustable frequency drive power size.

Troubleshooting
Check for the following conditions.

- Ambient temperature too high.
- Motor cables too long.
- Incorrect airflow clearance above and below the adjustable frequency drive
- Blocked airflow around the adjustable frequency drive.
- Damaged heatsink fan.
- Dirty heatsink.

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

Troubleshooting

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

ALARM 30, Motor phase U missing
Motor phase U between the adjustable frequency drive and the motor is missing.

Troubleshooting

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

ALARM 31, Motor phase V missing
Motor phase V between the adjustable frequency drive and the motor is missing.

Troubleshooting

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

ALARM 32, Motor phase W missing
Motor phase W between the adjustable frequency drive and the motor is missing.

Troubleshooting

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

ALARM 33, Inrush fault
Too many power-ups have occurred within a short time period.

Troubleshooting

- Let the unit cool to operating temperature.

WARNING/ALARM 34, Fieldbus communication fault
The serial communication bus on the communication option card is not working.

WARNING/ALARM 36, Mains failure
This warning/alarm is only active if the supply voltage to the adjustable frequency drive is lost and *parameter 14-10 Mains Failure* is not set to option *[0] No Function*. Check the fuses to the adjustable frequency drive and line power supply to the unit.

ALARM 38, Internal fault
When an internal fault occurs, a code number defined in *Table 7.1* is displayed.

Troubleshooting

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

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

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

No.	Text
1317	Option SW in slot C0 is not supported (not allowed)
1318	Option SW in slot C1 is not supported (not allowed)
1379	Option A did not respond when calculating platform version
1380	Option B did not respond when calculating platform version
1381	Option C0 did not respond when calculating platform version.
1382	Option C1 did not respond when calculating platform version.
1536	An exception in the application-oriented control is registered. Debug information written in LCP.
1792	DSP Watch Dog is active. Debugging of power part data, motor-oriented control data not transferred correctly.
2049	Power data restarted
2064–2072	H081x: Option in slot x has restarted
2080–2088	H082x: Option in slot x has issued a power-up wait
2096–2104	H983x: Option in slot x has issued a legal power-up wait
2304	Could not read any data from power EEPROM
2305	Missing SW version from power unit
2314	Missing power unit data from power unit
2315	Missing SW version from power unit
2316	Missing lo_statepage from power unit
2324	Power card configuration is determined to be incorrect at power-up
2325	A power card has stopped communicating while line power is applied
2326	Power card configuration is determined to be incorrect after the delay for power cards to register.
2327	Too many power card locations have been registered as present.
2330	Power size information between the power cards does not match.
2561	No communication from DSP to ATACD
2562	No communication from ATACD to DSP (state running)
2816	Stack overflow control board module
2817	Scheduler slow tasks
2818	Fast tasks
2819	Parameter thread
2820	LCP stack overflow
2821	Serial port overflow
2822	USB port overflow
2836	cfListMempool too small
3072–5122	Parameter value is outside its limits
5123	Option in slot A: Hardware incompatible with control board hardware
5124	Option in slot B: Hardware incompatible with control board hardware.
5125	Option in slot C0: Hardware incompatible with control board hardware.
5126	Option in slot C1: Hardware incompatible with control board hardware.
5376–6231	Out of memory

Table 7.1 Internal Fault, Code Numbers

ALARM 39, Heatsink sensor
No feedback from the heatsink temperature sensor.

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

WARNING 40, Overload of digital output terminal 27
Check the load connected to terminal 27 or remove the short-circuit connection. Check *parameter 5-00 Digital I/O Mode* and *parameter 5-01 Terminal 27 Mode*.

WARNING 41, Overload of digital output terminal 29
Check the load connected to terminal 29 or remove the short-circuit connection. Check *parameter 5-00 Digital I/O Mode* and *parameter 5-02 Terminal 29 Mode*.

WARNING 42, Overload of digital output on X30/6 or overload of digital output on X30/7
For X30/6, check the load connected to X30/6 or remove the short-circuit connection. Check *parameter 5-32 Term X30/6 Digi Out (MCB 101)*.

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

ALARM 45, Ground fault 2
Ground fault.

Troubleshooting

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

ALARM 46, Power card supply
The supply on the power card is out of range.

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

WARNING 47, 24 V supply low
The 24 V DC is measured on the control card. This alarm appears when the detected voltage of terminal 12 is <18 V.

Troubleshooting

- Check for a defective control card.

WARNING 48, 1.8 V supply low
The 1.8 V DC supply used on the control card is outside of the allowable limits. The power supply is measured on the control card. Check for a defective control card. If an option card is present, check for overvoltage.

WARNING 49, Speed limit
When the speed is outside of the specified range in *parameter 4-11 Motor Speed Low Limit [RPM]* and *parameter 4-13 Motor Speed High Limit [RPM]*, the adjustable frequency drive shows a warning. When the speed is below the specified limit in *parameter 1-86 Trip Speed Low [RPM]* (except when starting or stopping), the adjustable frequency drive trips.

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

ALARM 51, AMA check U_{nom} and I_{nom}
The settings for motor voltage, motor current and motor power are wrong. Check the settings in *parameters 1-20* to *1-25*.

ALARM 52, AMA low I_{nom}
The motor current is too low. Check the settings in *parameter 4-18 Current Limit*.

ALARM 53, AMA motor too big
The motor is too big for the AMA to operate.

ALARM 54, AMA motor too small
The motor is too small for the AMA to operate.

ALARM 55, AMA parameter out of range
The parameter values of the motor are outside of the acceptable range. AMA cannot run.

ALARM 56, AMA interrupted by user
The user has interrupted AMA.

ALARM 57, AMA internal fault
Try to restart AMA again a number of times until the AMA is carried out.

NOTICE!

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

ALARM 58, AMA Internal fault
Contact the Danfoss supplier.

WARNING 59, Current limit
The current is higher than the value in *parameter 4-18 Current Limit*. Ensure that motor data in *parameters 1–20* to *1–25* are set correctly. Increase the current limit if necessary. Ensure that the system can operate safely at a higher limit.

WARNING 60, External interlock
External interlock has been activated. To resume normal operation, apply 24 V DC to the terminal programmed for external interlock and reset the adjustable frequency drive (via serial communication, digital I/O, or by pressing [Reset]).

WARNING/ALARM 61, Tracking error
An error between calculated motor speed and speed measurement from feedback device. The function warning/alarm/disable is set in *parameter 4-30 Motor Feedback Loss Function*. Accepted error setting in *parameter 4-31 Motor Feedback Speed Error* and the allowed time the error occur setting in *parameter 4-32 Motor Feedback Loss Timeout*. During a commissioning procedure, the function could be effective.

WARNING 62, Output frequency at maximum limit
The output frequency is higher than the value set in *parameter 4-19 Max Output Frequency*.

ALARM 63, Mechanical brake low
The actual motor current has not exceeded the release brake current within the start delay time window.

ALARM 64, Voltage Limit
The load and speed combination demands a motor voltage higher than the actual DC link voltage.

WARNING/ALARM 65, Control card overtemperature
The cut-out temperature of the control card is 176°F [80°C].

Troubleshooting

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

WARNING 66, Heatsink temperature low
The adjustable frequency drive is too cold to operate. This warning is based on the temperature sensor in the IGBT module.
Increase the ambient temperature of the unit. Also, a trickle amount of current can be supplied to the adjustable frequency drive whenever the motor is stopped by setting *parameter 2-00 DC Hold/Preheat Current* at 5% and *parameter 1-80 Function at Stop*

Troubleshooting

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

ALARM 67, Option module configuration has changed

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

ALARM 68, Safe Stop activated

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

ALARM 69, Power card temperature

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

Troubleshooting

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

ALARM 70, Illegal FC configuration

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

ALARM 71, PTC 1 Safe Torque Off

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

ALARM 72, Dangerous failure

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

WARNING 73, Safe Stop auto restart

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

WARNING 76, Power unit set-up

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

Troubleshooting

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

WARNING 77, Reduced power mode

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

ALARM 79, Illegal power section configuration

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

ALARM 80, Drive initialized to default value

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

ALARM 81, CSIV corrupt

CSIV file has syntax errors.

ALARM 82, CSIV parameter error

CSIV failed to initialize a parameter.

ALARM 85, Dang fail PB

Profibus/Profisafe error.

WARNING/ALARM 104, Mixing fan fault

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

Troubleshooting

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

ALARM 243, Brake IGBT

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

1 = left most inverter module.

2 = middle inverter module in F12 or F3 frame sizes.

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

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

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

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

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4 = far right inverter module in F14 frame size.

5 = rectifier module.

6 = right rectifier module in F14 frame size.

ALARM 244, Heatsink temperature
This alarm is only for F-frame adjustable frequency drives. It is equivalent to Alarm 29. The report value in the alarm log indicates which power module generated the alarm.

1 = left most inverter module.

2 = middle inverter module in F12 or F3 frame sizes.

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

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

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

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

4 = far right inverter module in F14 frame size.

5 = rectifier module.

6 = right rectifier module in F14 frame size.

ALARM 245, Heatsink sensor
This alarm is only for F-frame adjustable frequency drives. It is equivalent to Alarm 39. The report value in the alarm log indicates which power module generated the alarm.

1 = left most inverter module.

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

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

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

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

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

4 = far right inverter module in F14 frame size.

5 = rectifier module.

6 = right rectifier module in F14 frame size.

ALARM 246, Power card supply
This alarm is only for F-frame adjustable frequency drive. It is equivalent to Alarm 46. The report value in the alarm log indicates which power module generated the alarm.

1 = left most inverter module.

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

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

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

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

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

4 = far right inverter module in F14 frame size.

5 = rectifier module.

6 = right rectifier module in F14 frame size.

ALARM 247, Power card temperature
This alarm is only for F-frame adjustable frequency drives. It is equivalent to Alarm 69. The report value in the alarm log indicates which power module generated the alarm.

1 = left most inverter module.

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

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

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

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

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

4 = far right inverter module in F14 frame size.

5 = rectifier module.

6 = right rectifier module in F14 frame size.

ALARM 248, Illegal power section configuration
This alarm is only for F-frame adjustable frequency drives. It is equivalent to Alarm 79. The report value in the alarm log indicates which power module generated the alarm:

1 = left most inverter module.

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

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

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

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

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

4 = far right inverter module in F14 frame size.

5 = rectifier module.

6 = right rectifier module in F14 frame size.

WARNING 250, New spare part
A component in the adjustable frequency drive has been replaced.

Troubleshooting

- Reset the adjustable frequency drive for normal operation.

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

Troubleshooting

- Reset to remove the warning and resume normal operation.

7.4 Warning and Alarm Definitions - Filter (Left LCP)

NOTICE!

This section covers warnings and alarms on the filter side LCP. For warning and alarms for the adjustable frequency drive, see *chapter 7.3 Warnings and Alarm Definitions - Adjustable Frequency Drive*

A warning or an alarm is signaled by the relevant LED on the front of the filter and indicated by a code on the display. A warning remains active until its cause is no longer present. Under certain circumstances, operation of the unit may still be continued. Warning messages may be critical, but are not necessarily so.
In the event of an alarm, the unit will have tripped. Alarms must be reset to restart operation once their cause has been rectified.

This may be done in four ways:

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

NOTICE!

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

If an alarm cannot be reset, the reason may be that its cause has not been rectified, or the alarm is trip-locked (see also *Table 7.2*). Alarms that are trip-locked offer additional protection, meaning that the line power supply must be switched off before the alarm can be reset. After being switched back on, the unit is no longer blocked and may be reset as described above once the cause has been rectified.

Alarms that are not trip-locked can also be reset using the automatic reset function in *parameter 14-20 Reset Mode* (Warning: automatic wake-up is possible). If a warning and alarm is marked against a code in *Table 7.2*, either a warning occurs before an alarm, or it can be specified whether it is a warning or an alarm that is to be displayed for a given fault.

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

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

Table 7.2 Alarm/Warning Code List

A trip is the action when an alarm has appeared. The trip coasts the motor and can be reset by pressing [Reset] or make a reset by a digital input (parameter group *5-1* Digital Inputs [1] Reset*). The original event that caused an alarm cannot damage the adjustable frequency drive or cause dangerous conditions. A trip lock is an action that occurs in conjunction with an alarm, which may cause damage to the adjustable frequency drive or connected parts. A trip lock situation can only be reset by power cycling.

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

Table 7.3 LED Indicator Lights

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

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

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

7.4.1 Fault Messages - Active Filter

WARNING 1, 10 volts low
The control card voltage is below 10 V from terminal 50. Remove some of the load from terminal 50, as the 10 V supply is overloaded. Max. 15 mA or minimum 590 Ω.
Fault messages - active filter

WARNING/ALARM 2, Live zero error
The signal on terminal 53 or 54 is less than 50% of the value set in parameters 6-10, 6-12, 6-20 or 6-22.

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

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

WARNING 6, DC link voltage low
The intermediate circuit voltage (DC) is below the undervoltage limit of the control system. The unit is still active.

WARNING/ALARM 7, DC overvoltage
If the intermediate circuit voltage exceeds the limit, the unit trips.

WARNING/ALARM 8, DC undervoltage
If the intermediate circuit voltage (DC) drops below the under voltage limit, the filter checks if a 24 V backup supply is connected. If not, the unit trips. Make sure the AC line voltage matches the nameplate specification.

WARNING/ALARM 13, Overcurrent
the unit current limit has been exceeded.

ALARM 14, Ground fault
The sum current of the IGBT CTs does not equal zero. Check if the resistance of any phase to ground has a low value. Check both before and after line power contactor. Ensure IGBT current transducers, connection cables, and connectors are ok.

ALARM 15, Incomp. Hardware
A mounted option is incompatible with the present control card SW/HW.

ALARM 16, Short-circuit
There is a short-circuit in the output. Turn off the unit and correct the error.

WARNING/ALARM 17, Control word timeout
There is no communication to the unit.
The warning is only active when *parameter 8-04 Control Timeout Function* is not set to off.
Possible correction: Increase *parameter 8-03 Control Timeout Time*. Change *parameter 8-04 Control Timeout Function*

WARNING 23, Internal fan fault
Internal fans have failed due to defect hardware or fans not mounted.

WARNING 24, External fan fault
External fans have failed due to defect hardware or fans not mounted.

ALARM 29, Heatsink temp
The maximum temperature of the heatsink has been exceeded. The temperature fault is not reset until the temperature falls below a defined heatsink temperature.

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

WARNING/ALARM 34, Fieldbus communication fault
The serial communication bus on the communication option card is not working.

WARNING/ALARM 35, Option Fault:
Contact Danfoss or supplier.

ALARM 38, Internal fault
Contact Danfoss or supplier.

ALARM 39, Heatsink sensor
No feedback from the heatsink temperature sensor.

WARNING 40, Overload of Digital Output Terminal 27
Check the load connected to terminal 27 or remove short-circuit connection.

WARNING 41, Overload of Digital Output Terminal 29
Check the load connected to terminal 29 or remove short-circuit connection.

WARNING 43, Ext. Supply (option)
The external 24 V DC supply voltage on the option is not valid.

ALARM 46, Power card supply
The supply on the power card is out of range.

WARNING 47, 24 V supply low
Contact Danfoss or supplier.

WARNING 48, 1.8 V supply low
Contact Danfoss or supplier.

WARNING/ALARM/TRIP 65, Control card overtemperature
Control card overtemperature: The cutout temperature of the control card is 176°F [80°C].

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

Troubleshooting:

The heatsink temperature measured as 32°F [0°C] could indicate that the temperature sensor is defective, causing the fan speed to increase to the maximum. If the sensor wire between the IGBT and the gate drive card is 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 activated
Safe Torque Off has been activated. To resume normal operation, apply 24 V DC to terminal 37, then send a reset signal (via bus, digital I/O, or by pressing [Reset]). See *parameter 5-19 Terminal 37 Digital Input*.

ALARM 69, Power card temperature
The temperature sensor on the power card is either too hot or too cold.

ALARM 70, Illegal FC Configuration
Actual combination of control board and power board is illegal.

WARNING 73, Safe Torque Off auto restart
Safe stopped. Note that with automatic restart enabled, the motor can start when the fault is cleared.

ALARM 79, Illegal power section configuration
The scaling card is the incorrect part number or not installed. Also MK102 connector on the power card could not be installed.

ALARM 80, Unit initialized to default value
Parameter settings are initialized to default settings after a manual reset.

ALARM 244, Heatsink temperature
Report value indicates source of alarm (from left):
1-4 inverter
5-8 rectifier

ALARM 245, Heatsink sensor
No feedback from the heatsink sensor. Report value indicates source of alarm (from left):
1-4 inverter
5-8 rectifier

ALARM 246, Power card supply
The supply on the power card is out of range. Report value indicates source of alarm (from left):
1-4 inverter
5-8 rectifier

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

ALARM 248, Illegal power section configuration
Power size configuration fault on the power card. Report value indicates source of alarm (from left):
1-4 inverter
5-8 rectifier

ALARM 250, New spare part
The power or switch mode power supply has been exchanged. The filter type code must be restored in the EEPROM. Select the correct type code in *parameter 14-23 Typecode Setting* according to the label on the unit. Remember to select 'Save to EEPROM' to complete.

ALARM 251, New type code
The filter has a new type code.

ALARM 300, Mains Cont. Fault
The feedback from the line power contactor did not match the expected value within the allowed time frame. Contact Danfoss or supplier.

ALARM 301, SC Cont. Fault
The feedback from the soft charge contactor did not match the expected value within the allowed time frame. Contact Danfoss or supplier.

ALARM 302, Cap. Overcurrent
Excessive current was detected through the AC capacitors. Contact Danfoss or supplier.

ALARM 303, Cap. Ground Fault
A ground fault was detected through the AC capacitor currents. Contact Danfoss or supplier.

ALARM 304, DC Overcurrent
Excessive current through the DC link capacitor bank was detected. Contact Danfoss or supplier.

ALARM 305, Line Power Freq. Limit
The line power frequency was outside the limits. Verify that the line power frequency is within product specification.

ALARM 306, Compensation Limit
The needed compensation current exceeds unit capability. Unit is running at full compensation.

ALARM 308, Resistor temp
Excessive resistor heatsink temperature detected.

ALARM 309, Mains Earth Fault
A ground fault was detected in the line power currents. Check the line power for shorts and leakage current.

ALARM 310, RTDC Buffer Full
Contact Danfoss or supplier.

ALARM 311, Switch. Freq. Limit
The average switching frequency of the unit exceeded the limit. Verify that *parameter 300-10 Active Filter Nominal Voltage* and *parameter 300-22 CT Nominal Voltage* are set correctly. If so, contact Danfoss or supplier.

ALARM 312, CT Range
Current transformer measurement limitation was detected. Verify that the CTs used are an appropriate ratio.

ALARM 314, Auto CT Interrupt
Auto CT detection has been interrupted.

ALARM 315, Auto CT Error
An error was detected while performing auto CT detection. Contact Danfoss or supplier.

WARNING 316, CT Location Error
The auto CT function could not determine the correct locations of the CTs.

WARNING 317, CT Polarity Error
The auto CT function could not determine the correct polarity of the CTs.

WARNING 318, CT Ratio Error
The auto CT function could not determine the correct primary rating of the CTs.

7.5 Troubleshooting

Symptom	Possible cause	Test	Solution
Display dark/No function	Missing input power	See *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 to 55	Wire the terminals properly
	Wrong LCP (LCP from VLT® 2800 or 5000/6000/8000/ FCD or FCM)		Use only LCP 101 (P/N 130B1124) or LCP 102 (P/N 130B1107)
	Wrong contrast setting		Press [Status] + [▲]/[▼] to adjust the contrast
	Display (LCP) is defective	Test using a different LCP	Replace the faulty LCP or connection cable
	Internal voltage supply fault or SMPS is defective		Contact supplier
Intermittent display	Overloaded power supply (SMPS) due to improper control wiring or a fault within the adjustable frequency drive	To rule out a problem in the control wiring, disconnect all control wiring by removing the terminal blocks.	If the display stays lit, then the problem is in the control wiring. Check the wiring for shorts or incorrect connections. If the display continues to cut out, follow the procedure for display dark.

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Symptom	Possible cause	Test	Solution
Motor not running	Service switch open or missing motor connection	Check if the motor is connected and the connection is not interrupted (by a service switch or other device).	Connect the motor and check the service switch.
	No line power with 24 V DC option card	If the display is functioning but no output, check that line power is applied to the adjustable frequency drive.	Apply line power to run the unit.
	LCP Stop	Check if [Off] has been pressed	Press [Auto On] or [Hand On] (depending on operation mode) to run the motor
	Missing start signal (Standby)	Check *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 *5-12 Coast inv*. for correct setting for terminal 27 (use default setting).	Apply 24 V on terminal 27 or program this terminal to *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* in this manual
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]* and *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 Limits*.	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 overmagnetization	Check for incorrect motor settings in all motor parameters	Check motor settings in parameter groups *1-2* Motor Data, 1-3* Addl. Motor Data*, and *1-5* Load Indep. Setting.*

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

Table 7.5 Troubleshooting

8 Specifications

8.1 Power-Dependent Specifications

8.1.1 Line Power Supply 3x380–480 V AC

	P132		P160		P200	
Normal Overload =110% current for 60 s	**HO**	**NO**	**HO**	**NO**	**HO**	**NO**
Typical shaft output at 400 V [kW]	132	160	160	200	200	250
Typical shaft output at 460 V [hp]	200	250	250	300	300	350
Typical shaft output at 480 V [kW]	160	200	200	250	250	315
Enclosure IP21/54	D13					
Output current						
Continuous (at 400 V) [A]	260	315	315	395	395	480
Intermittent (60 s overload) (at 400 V) [A]	390	347	473	435	593	528
Continuous (at 460/480 V) [A]	240	302	302	361	361	443
Intermittent (60 s overload) (at 460/480 V) [A]	360	332	453	397	542	487
Continuous kVA (at 400 V) [kVA]	180	218	218	274	274	333
Continuous kVA (at 460 V) [kVA]	191	241	241	288	288	353
Continuous kVA (at 480 V) [kVA]	208	262	262	313	313	384
Max. Input current						
Continuous (at 400 V) [A]	251	304	304	381	381	463
Continuous (at 460/480 V) [A]	231	291	291	348	348	427
Max. pre-fuses[1)] [A]	400		500		630	
Max. cable size						
Motor (mm²/AWG[2)])	2x185 (2x300 mcm)					
Line power (mm²/AWG[2)])						
Load sharing (mm²/AWG[2)])						
Brake (mm²/AWG[2)])						
Total LHD loss 400 V AC [kW]	7621	8868	8594	10527	10003	11751
Total backchannel loss 400 V AC [kW]	6136	7318	7067	8903	8398	10033
Total filter loss 400 V AC [kW]	4505	4954	4954	5714	5714	6234
Total LHD loss 460 V AC [kW]	7687	9059	8799	10192	9714	11706
Total backchannel loss 460 V AC [kW]	5819	7123	6883	8209	7747	9635
Total filter loss 460 V AC [kW]	4801	5279	5279	5819	5819	6681
Weight, enclosure IP21, IP54 (lbs [kg])	838 [380]				896 [406]	
Efficiency[4)]	0.96					
Output frequency [Hz]	0–800					
Heatsink overtemp. trip (°F [°C])	221 [105]					
Power card ambient trip (°F [°C])	185 [85]					
*High overload = 160% torque during 60 s; Normal overload = 110% torque during 60 s						

Table 8.1 Line Power Supply 3x380–480 V AC

	P250		P315		P355		P400	
Normal Overload =110% current for 60 s	**HO**	**NO**	**HO**	**NO**	**HO**	**NO**	**HO**	**NO**
Typical shaft output at 400 V [kW]	250	315	315	355	355	400	400	450
Typical shaft output at 460 V [hp]	350	450	450	500	500	600	550	600
Typical shaft output at 480 V [kW]	315	355	355	400	400	500	500	530
Enclosure IP21/54	E9							
Output current								
Continuous (at 400 V) [A]	480	600	600	658	658	745	695	800
Intermittent (60 s overload) (at 400 V) [A]	720	660	900	724	987	820	1043	880
Continuous (at 460/480 V) [A]	443	540	540	590	590	678	678	730
Intermittent (60 s overload) (at 460/480 V) [A]	665	594	810	649	885	746	1017	803
Continuous kVA (at 400 V) [kVA]	333	416	416	456	456	516	482	554
Continuous kVA (at 460 V) [kVA]	353	430	430	470	470	540	540	582
Continuous kVA (at 480 V) [kVA]	384	468	468	511	511	587	587	632
Max. Input current								
Continuous (at 400 V) [A]	472	590	590	647	647	733	684	787
Continuous (at 460/480 V) [A]	436	531	531	580	580	667	667	718
Max. pre-fuses[1)] [A]	700		900					
Max. cable size								
Motor (mm^2/AWG[2)])	4x240 (4x500 mcm)							
Line power (mm^2/AWG[2)])								
Load sharing (mm^2/AWG[2)])								
Brake (mm^2/AWG[2)])	2x185 (2x350 mcm)							
Total LHD loss 400 V AC [kW]	11587	14051	14140	15320	15286	17180	16036	18447
Total backchannel loss 400 V AC [kW]	9011	11301	10563	11648	11650	13396	12348	14570
Total filter loss 400 V AC [kW]	6528	7346	7346	7788	7788	8503	8060	8974
Total LHD loss 460 V AC [kW]	10962	12936	13124	14083	13998	15852	15847	16962
Total backchannel loss 460 V AC [kW]	8432	10277	9636	10522	10466	12184	12186	13214
Total filter loss 460 V AC [kW]	6316	7066	7006	7359	7326	8033	8033	8435
Weight, enclosure IP21, IP54 (lbs [kg])	1314 [596]		1374 [623]		1425 [646]			
Efficiency[4)]	0.96							
Output frequency [Hz]	0–600							
Heatsink overtemp. trip (°F [°C])	221 [105]							
Power card ambient trip (°F [°C])	85							
*High overload = 160% torque during 60 s; Normal overload = 110% torque during 60 s								

Table 8.2 Line Power Supply 3x380–480 V AC

	P450		P500		P560		P630	
Normal Overload =110% current for 60 s	**HO**	**NO**	**HO**	**NO**	**HO**	**NO**	**HO**	**NO**
Typical shaft output at 400 V [kW]	450	500	500	560	560	630	630	710
Typical shaft output at 460 V [hp]	600	650	650	750	750	900	900	1000
Typical shaft output at 480 V [kW]	530	560	560	630	630	710	710	800
Enclosure IP21/54	F18							
Output current								
Continuous (at 400 V) [A]	800	880	880	990	990	1120	1120	1260
Intermittent (60 s overload) (at 400 V) [A]	1200	968	1320	1089	1485	1232	1680	1386
Continuous (at 460/480 V) [A]	730	780	780	890	890	1050	1050	1160
Intermittent (60 s overload) (at 460/480 V) [A]	1095	858	1170	979	1335	1155	1575	1276
Continuous kVA (at 400 V) [kVA]	554	610	610	686	686	776	776	873
Continuous kVA (at 460 V) [kVA]	582	621	621	709	709	837	837	924
Continuous kVA (at 480 V) [kVA]	632	675	675	771	771	909	909	1005
Max. Input current								
Continuous (at 400 V) [A]	779	857	857	964	964	1090	1090	1227
Continuous (at 460/480 V) [A]	711	759	759	867	867	1022	1022	1129
Max. pre-fuses[1)] [A]	1600				2000			
Max. cable size								
Motor (mm^2/AWG[2)])	8 x 150 (8 x 300 mcm)							
Line power (mm^2/AWG[2)])	8 x 240 (8 x 500 mcm)							
Brake (mm^2/AWG[2)])	4 x 185 (4 x 350 mcm)							
Total LHD loss 400 V AC [kW]	20077	21909	21851	24592	23320	26640	26559	30519
Total backchannel loss 400 V AC [kW]	16242	17767	17714	19984	18965	21728	21654	24936
Total filter loss 400 V AC [kW]	11047	11747	11705	12771	12670	14128	14068	15845
Total LHD loss 460 V AC [kW]	18855	19896	19842	22353	21260	25030	25015	27989
Total backchannel loss 460 V AC [kW]	15260	16131	16083	18175	17286	20428	20417	22897
Total filter loss 460 V AC [kW]	10643	11020	10983	11929	11846	13435	13434	14776
Weight, enclosure IP21, IP54 (lbs [kg])	2009							
Efficiency[4)]	0.96							
Output frequency [Hz]	0–600							
Heatsink overtemp. trip (°F [°C])	221 [105]							
Power card ambient trip (°F [°C])	185 [85]							
*High overload = 160% torque during 60 s; Normal overload = 110% torque during 60 s								

Table 8.3 Line Power Supply 3x380–480 V AC

1) For type of fuse, see *chapter 8.4.1 Fuses*.

2) American wire gauge.

3) Measured using 16.5 ft. [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 variances in voltage and cable conditions). Values are based on a typical motor efficiency (IE2/IE3 border line). Motors with lower efficiency will also add to the power loss in the adjustable frequency drive and vice-versa. If the switching frequency is increased to the default setting, the power losses may rise significantly. LCP and typical control card power consumptions are included. Further options and customer load may add up to 30 W to the losses. (Though typical only 4 W extra for a fully loaded control card, or options for slot A or slot B, each). Although measurements are made with state-of-the-art equipment, some measurement inaccuracy must be allowed for (±5%).

8.1.2 Derating for Temperature

The frequency converter automatically derates the switching frequency, switching type, or output current under certain load or ambient conditions as described in the following. *Figure 8.1* to *Figure 8.8* show the derating curve for SFAWM and 60 AVM switching modes.

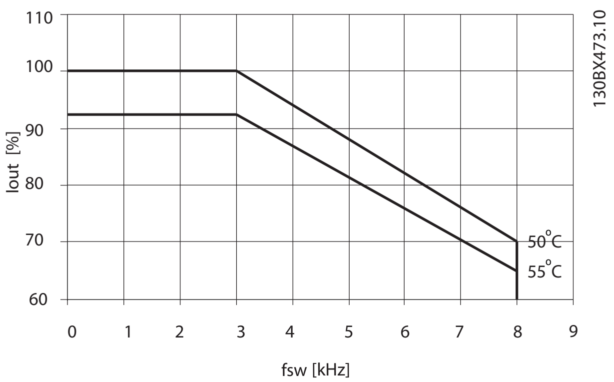

Figure 8.1 Derating Enclosure Size D, N132 to N200 380–480 V (T5) High overload 150%, 60 AVM

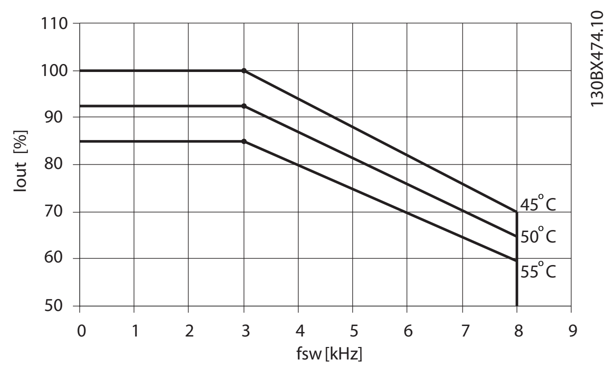

Figure 8.2 Derating Enclosure Size D, N132 to N200 380–480 V (T5) Normal Overload 110%, 60 AVM

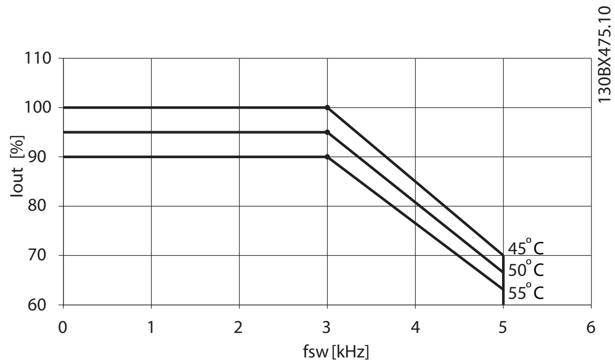

Figure 8.3 Derating Enclosure Size D, N132 to N200 380–480 V (T5) High overload 150%, SFAVM

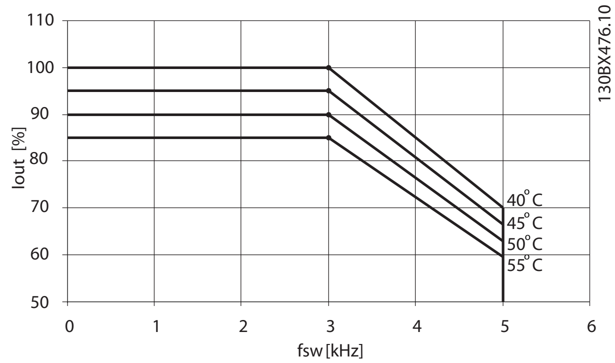

Figure 8.4 Derating Enclosure Size D, N132 to N200 380–480 V (T5) Normal Overload 110%, SFAVM

8

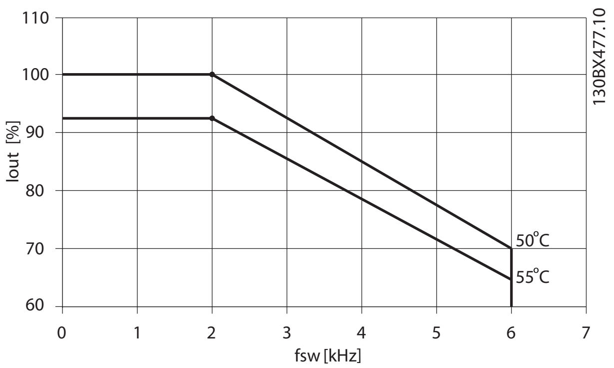

Figure 8.5 Derating Enclosure Sizes E and F, P250 to P630 380–480 V (T5) High overload 150%, 60 AVM

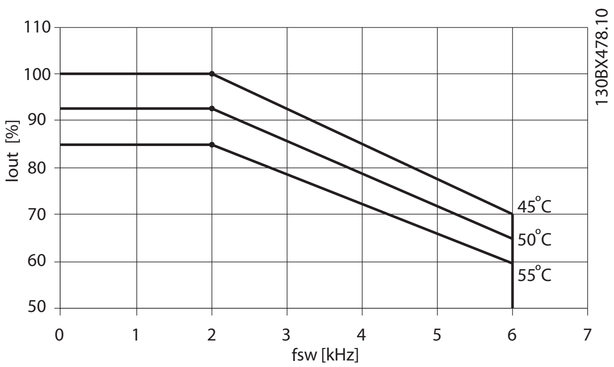

Figure 8.6 Derating Enclosure Sizes E and F, P250 to P630 380–480 V (T5) Normal Overload 110%, 60 AVM

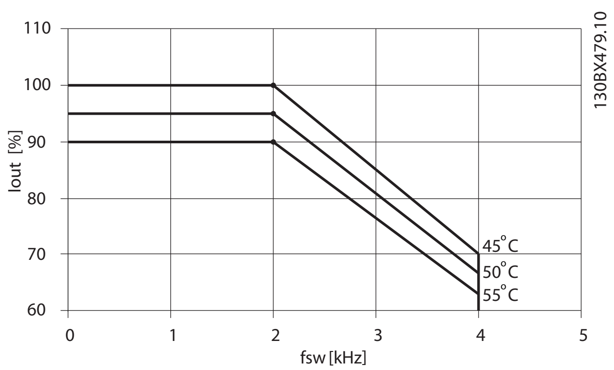

Figure 8.7 Derating Enclosure Sizes E and F, P250 to P630 380–480 V (T5) High overload 150%, SFAVM

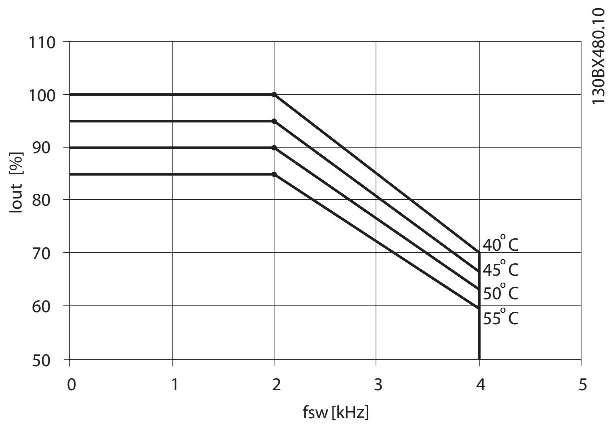

Figure 8.8 Derating Enclosure Sizes E and F, P250 to P630 380–480 V (T5) Normal Overload 110%, SFAVM

8.2 Mechanical Dimensions

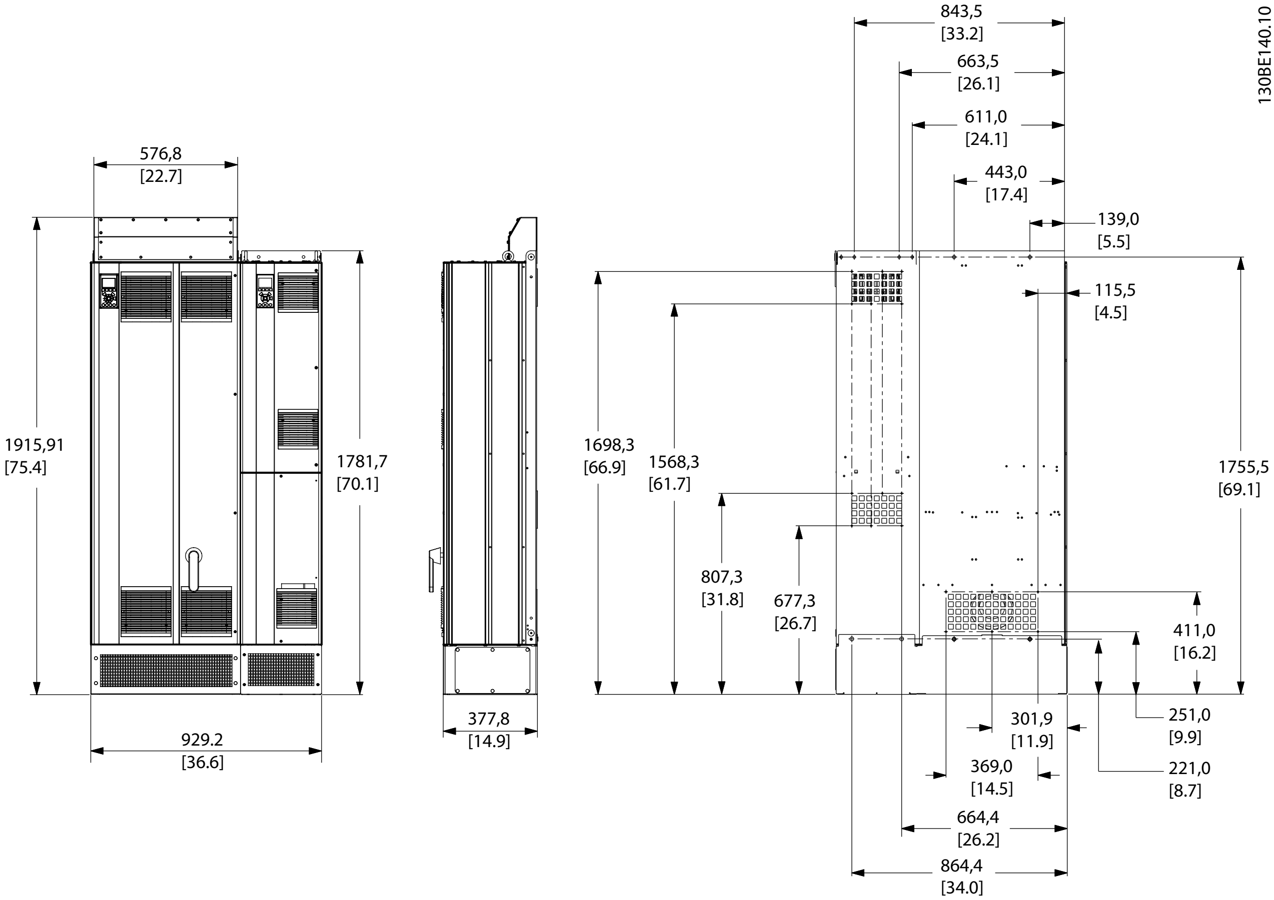

Figure 8.9 Enclosure Size D1n

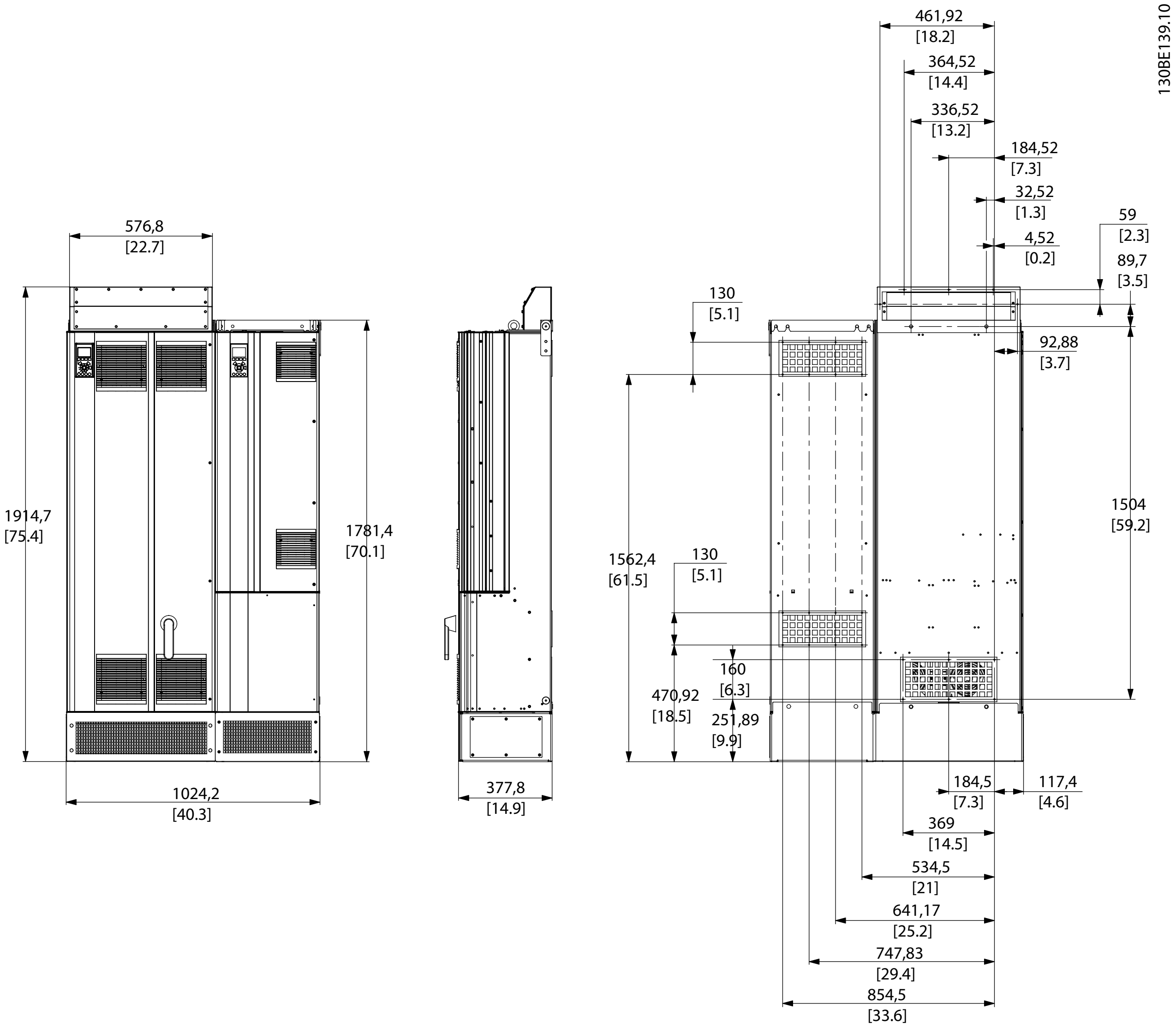

Figure 8.10 Enclosure Size D2n

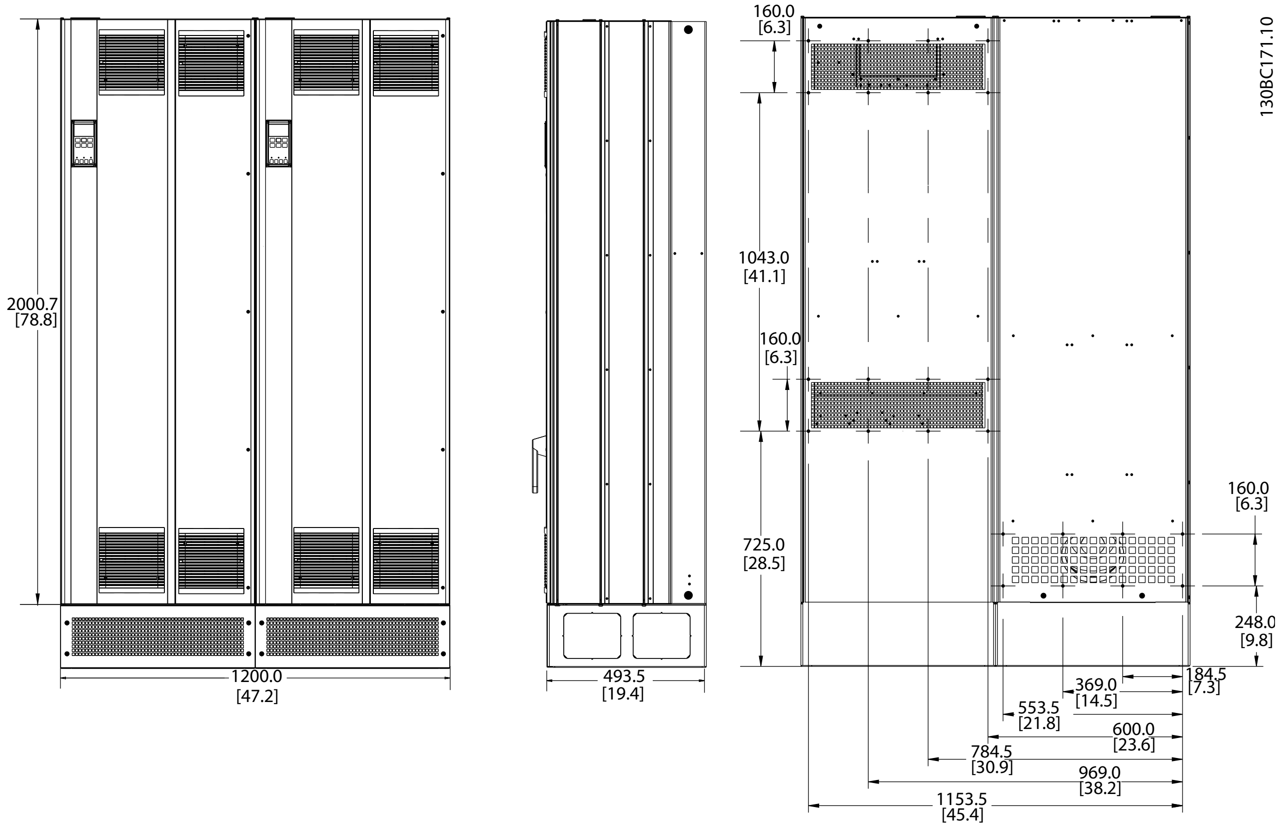

Figure 8.11 Enclosure Size E9

8

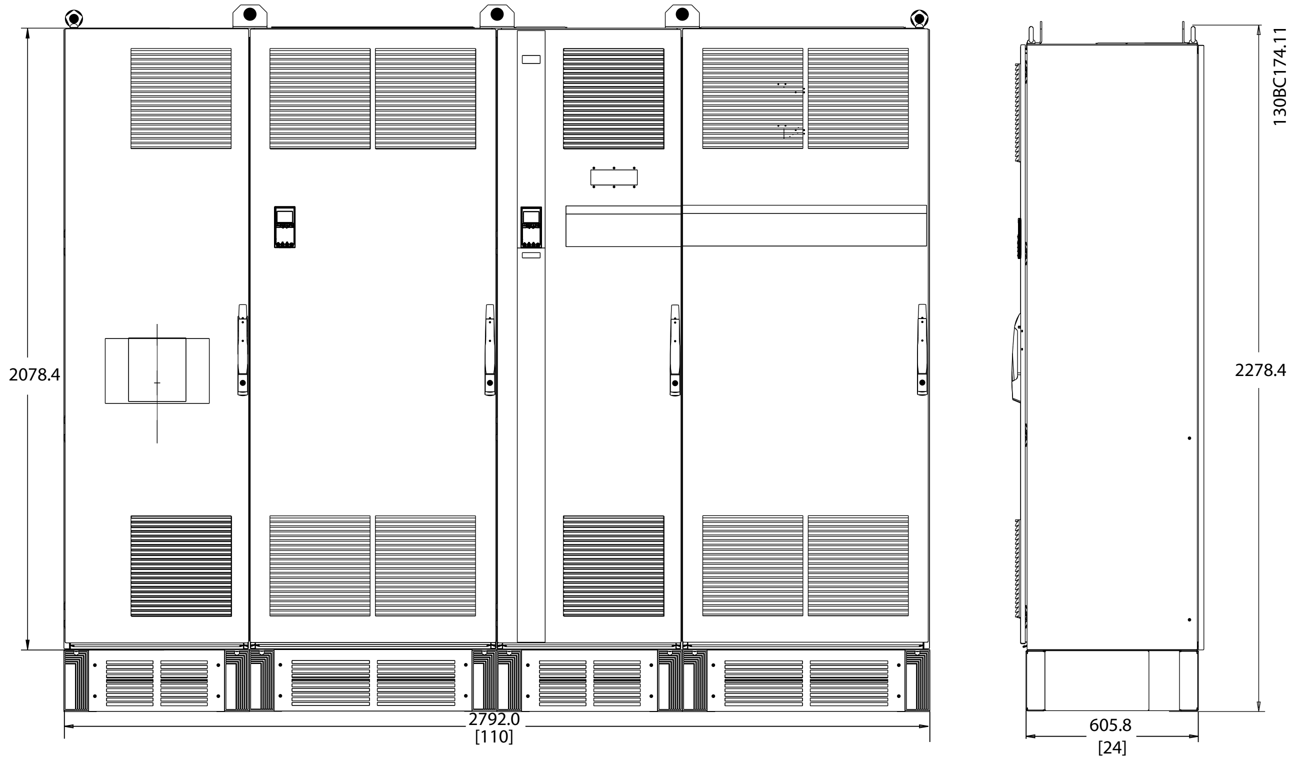

Figure 8.12 Enclosure Size F18, Front and Side View

8.3 General Technical Data - Adjustable Frequency Drive

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

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

Supply frequency	50/60 Hz ±5%
Max. temporary imbalance between line phases	3.0% of rated supply voltage
True power factor (λ)	> 0.98 nominal at rated load
Displacement power factor (cosφ) near unity	(> 0.98)
THiD	< 5%
Switching on input supply L1, L2, L3 (power-ups)	maximum once/2 min.
Environment according to EN60664-1	Overvoltage category III/pollution degree 2

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

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

* Voltage and power dependent

Torque characteristics	
Starting torque (constant torque)	maximum 160% for 1 m.*
Starting torque	maximum 180% up to 0.5 s*
Overload torque (constant torque)	maximum 160% for 1 m.*

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

Cable lengths and cross-sections	
Max. motor cable length, shielded/armored	500 ft [150 m]
Max. motor cable length, non-shielded/unarmored	1,000 ft [300 m]
Max. cross-section to motor, line power, load sharing, and brake *	
Maximum cross-section to control terminals, rigid wire	1.5 mm^2/16 AWG (2 x 0.75 mm^2)
Maximum cross-section to control terminals, flexible cable	1 mm^2/18 AWG
Maximum cross-section to control terminals, cable with enclosed core	0.5 mm^2/20 AWG
Minimum cross-section to control terminals	0.25 mm^2/4 AWG

** See chapter 8.1.1 Line Power Supply 3x380–480 V AC for more information*

Digital inputs	
Programmable digital inputs	4 (6)
Terminal number	18, 19, 27 [1)], 29 [1)], 32, 33,
Logic	PNP or NPN
Voltage level	0–24 V DC
Voltage level, logic'0' PNP	< 5 V DC
Voltage level, logic'1' PNP	> 10 V DC
Voltage level, logic '0' NPN	> 19 V DC
Voltage level, logic '1' NPN	< 14 V DC
Maximum voltage on input	28 V DC
Input resistance, R_i	approx. 4 kΩ

All digital inputs are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.
1) Terminals 27 and 29 can also be programmed as output.

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

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

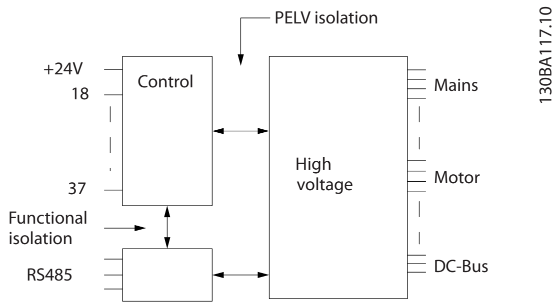

Figure 8.13

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

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

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

Control card, RS-485 serial communication

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

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

Digital output

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

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

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

Control card, 24 V DC output

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

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

Relay outputs

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

1) IEC 60947 parts 4 and 5
The relay contacts are galvanically isolated from the rest of the circuit by reinforced isolation (PELV).
2) Overvoltage Category II
3) UL applications 300 V AC 2 A

Control characteristics

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

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

Surroundings

Enclosure, frame size D and E	IP21, IP54
Enclosure, frame size F	IP21, IP54
Vibration test	0.7 g
Relative humidity	5–95% IEC 721-3-3; Class 3K3 (non-condensing) during operation
Aggressive environment (IEC 60068-2-43) H_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	max. 131°F [55°C][1)]
- with full output power, typical EFF2 motors (see)	max. 122°F [50°C][1)]
- at full continuous FC output current	max. 113°F [45°C][1)]

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

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

For more information on derating, consult the design guide

EMC standards, emission	EN 61800-3, EN 61000-6-3/4, EN 55011, IEC 61800-3
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	5 ms

Control card, USB serial communication

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

NOTICE!

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

Protection and Features:

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

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

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

Table 8.4 Power Ranges (LHD with AF)

Grid conditions

Supply voltage	380–480 V

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

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

Harmonic mitigation performance

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

The filter is performance tested to the 40th order

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

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

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

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

All digital inputs are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.
**) Terminals 27 and 29 can also be programmed as output.*

Control card, RS-485 serial communication	
Terminal number	68 (P, TX+, RX+), 69 (N, TX-, RX-)
Terminal number 61	Common for terminals 68 and 69

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

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

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

Control card, 24 V DC output	
Terminal number	13
Max. load	200 mA

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

Surroundings

Enclosure	IP21, IP54
Vibration test	1.0 g
Relative humidity	5%–95% IEC 721-3-3; class 3K3 (non-condensing) during operation
Aggressive environment (IEC 60068-2-43) H_2S test	class kD
Test method according to IEC 60068-2-43 H_2S (10 days)	
Ambient temperature	
- with derating	max. NA °F [°C]
- with full output current (short temperature overload)	max. 113°F [45°C]
- at full continuous output current (24 hours)	max. 104°F [40°C]
Minimum ambient temperature during full-scale operation	32°F [0°C]
Minimum ambient temperature at reduced performance	14°F [-10°C]
Temperature during storage/transport	+13° to 158°F [-25° to +70°C]
Maximum altitude above sea level without derating	3300 ft [1000 m]
Maximum altitude above sea level with derating	10,000 ft [3000 m]
EMC standards, Emission	EN 61800-3, EN 61000-6-3/4, EN 55011, IEC 61800-3
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	5 ms

Control card, USB serial communication

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

Generic specifications

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

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

Protection and features

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

8.3.1 Derating for Altitude

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

Below 3,300 ft [1000 m] altitude no derating is necessary but above 3,300 ft [1000 m] the ambient temperature (T_{AMB}) or max. output current (I_{out}) should be derated in accordance with *Figure 8.14*.

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

Altitude Derating

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

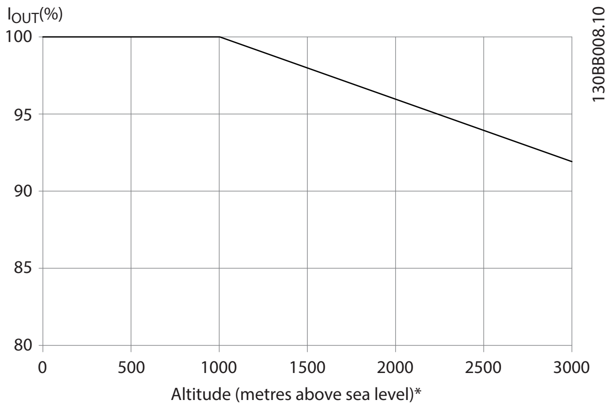

Figure 8.14 Altitude Derating

8.4 Fuses

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

NOTICE!

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

Branch Circuit Protection

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

NOTICE!

The recommendations do not cover branch circuit protection for UL.

Short-circuit protection

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

8.4.1 Non- UL compliance

Non- UL compliance

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

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

Table 8.5 Recommended Fuses for non-UL Applications

8.4.2 Fuse Tables

UL Compliance

380-480 V, enclosure sizes D, E, and F

The fuses below are suitable for use on a circuit capable of delivering 100,000 Arms (symmetrical). With the proper fusing, the frequency converter short circuit current rating (SCCR) is 100000 Arms.

Size/Type [kW]	Bussmann	LittelFuse	LittelFuse PN	Bussmann PN	Siba PN	Ferraz/Shawmut Europ	Ferraz-Shawmut NA	Ferraz-Shawmut PN
132	170M4012	LA50QS400-4	L50S-400	FWH-400A	20 610 31.400	6,9URD31D08A0400	A070URD31KI0400	A50QS400-4
160	170M4015	LA50QS500-4	L50S-500	FWH-500A	20 610 31.550	6,9URD31D08A0550	A070URD31KI0550	A50QS500-4
200	170M5012	LA50QS600-4	L50S-600	FWH-600A	20 610 31.630	6,9URD31D08A0630	A070URD31KI0630	A50QS600-4

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

Size/Type [kW]	Bussmann PN[1)]	Rating	Ferraz	Siba
250	170M4017	700 A, 700 V	6.9URD33D08A0700	20 630 32.700
315	170M6013	900 A, 700 V	6.9URD33D08A0900	20 630 32.900
355	170M6013	900 A, 700 V	6.9URD33D08A0900	20 630 32.900
400	170M6013	900 A, 700 V	6.9URD33D08A0900	20 630 32.900

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

Size/Type [kW]	Bussmann PN[1)]	Rating	Siba	Internal Bussmann option
450	170M7081	1600 A, 700 V	20 695 32.1600	170M7082
500	170M7081	1600 A, 700 V	20 695 32.1600	170M7082
560	170M7082	2000 A, 700 V	20 695 32.2000	170M7082
630	170M7082	2000 A, 700 V	20 695 32.2000	170M7082

Table 8.8 Enclosure size F, Mains Fuses, 380–480 V

Size/Type [kW]	Bussmann PN[1)]	Rating	Siba
450	170M8611	1100 A, 1000 V	20 781 32.1000
500	170M8611	1100 A, 1000 V	20 781 32.1000
560	170M6467	1400 A, 700 V	20 681 32.1400
630	170M6467	1400 A, 700 V	20 681 32.1400

Table 8.9 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.

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8.4.3 Supplementary Fuses

Supplementary fuses

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

Table 8.10 SMPS Fuse

Size/Type	Bussmann PN	LittelFuse	Rating
315–630 kW, 380–500 V		KLK-15	15 A, 600 V

Table 8.11 Fan Fuses

Size/Type		Bussmann PN	Rating	Alternative fuses
450–630 kW, 380–500 V	2.5–4.0 A	LPJ-6 SP or SPI	6 A, 600 V	Any listed class J dual element, time delay, 6A
450–630 kW, 380–500 V	4.0–6.3 A	LPJ-10 SP or SPI	10 A, 600 V	Any listed class J dual element, time delay, 10 A
450–630 kW, 380–500 V	6.3–10 A	LPJ-15 SP or SPI	15 A, 600 V	Any listed class J dual element, time delay, 15 A
450–630 kW, 380–500 V	10–16 A	LPJ-25 SP or SPI	25 A, 600 V	Any listed class J dual element, time delay, 25 A

Table 8.12 Manual Motor Controller Fuses

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 8.13 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 8.14 Control Transformer Fuse

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

Table 8.15 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 8.16 Safety Relay Coil Fuse with PILS Relay

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

Table 8.17 Mains Fuses (Power Card)

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

Table 8.18 Transformer Fuse (Mains Contactor)

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

Table 8.19 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 8.20*. These values are not intended for fastening IGBTs. See the instructions included with those replacement parts for correct values.

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

Table 8.20 Torque Values

9 Appendix A - Parameters

9.1 Description of Parameters

9.1.1 Main Menu

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

9.2 Frequency Converter Parameter Lists

0-**	**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 (Hand)
0-09	Performance Monitor
0-1*	**Set-up Operations**
0-10	Active Set-up
0-11	Edit Set-up
0-12	This Set-up Linked to
0-13	Readout: Linked Set-ups
0-14	Readout: Edit Set-ups / Channel
0-15	Readout: Actual set-up
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	Unit for User-defined Readout
0-31	Min Value of User-defined Readout
0-32	Max Value of User-defined Readout
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	Quick Menu Password
0-66	Access to Quick Menu w/o Password
0-67	Bus Password Access
0-68	Safety Parameters Password
0-69	Password Protection of Safety Parameters
1-**	**Load and Motor**
1-0*	**General Settings**
1-00	Configuration Mode
1-01	Motor Control Principle
1-02	Flux Motor Feedback Source
1-03	Torque Characteristics
1-04	Overload Mode
1-05	Local Mode Configuration
1-06	Clockwise Direction
1-07	Motor Angle Offset Adjust
1-1*	**Special Settings**
1-10	Motor Construction
1-11	Motor Model
1-14	Damping Gain
1-15	Low Speed Filter Time Const.
1-16	High Speed Filter Time Const.
1-17	Voltage Filter Time Const.
1-18	Min. Current at No Load
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
1-29	Automatic Motor Adaptation (AMA)
1-3*	**Adv. Motor Data**
1-30	Stator Resistance (Rs)
1-31	Rotor Resistance (Rr)
1-33	Stator Leakage Reactance (X1)
1-34	Rotor Leakage Reactance (X2)
1-35	Main Reactance (Xh)
1-36	Iron Loss Resistance (Rfe)
1-37	d-axis Inductance (Ld)
1-38	q-axis Inductance (Lq)
1-39	Motor Poles
1-40	Back EMF at 1,000 RPM
1-41	Motor Angle Offset
1-44	d-axis Inductance Sat. (LdSat)
1-45	q-axis Inductance Sat. (LqSat)
1-46	Position Detection Gain
1-47	Torque Calibration
1-48	Inductance Sat. Point
1-5*	**Load Indep. Setting**
1-50	Motor Magnetization at Zero Speed
1-51	Min Speed Normal Magnetizing [RPM]
1-52	Min Speed Normal Magnetizing [Hz]
1-53	Model Shift Frequency
1-54	Voltage reduction in field weakening
1-55	U/f Characteristic - U
1-56	U/f Characteristic - F
1-58	Flying Start Test Pulses Current
1-59	Flying Start 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 Damping
1-65	Resonance Damping Time Constant
1-66	Min. Current at Low Speed
1-67	Load Type
1-68	Motor Inertia
1-69	System Inertia
1-7*	**Start Adjustments**
1-70	PM Start Mode
1-71	Start Delay
1-72	Start Function
1-73	Flying Start
1-74	Start Speed [RPM]
1-75	Start Speed [Hz]
1-76	Start Current
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]
1-83	Precise Stop Function
1-84	Precise Stop Counter Value
1-85	Precise Stop Speed Compensation Delay
1-9*	**Motor Temperature**
1-90	Motor Thermal Protection
1-91	Motor External Fan
1-93	Thermistor Resource
1-94	ATEX ETR cur.lim. speed reduction
1-95	KTY Sensor Type
1-96	KTY Thermistor Resource
1-97	KTY Threshold level
1-98	ATEX ETR interpol. points freq.
1-99	ATEX ETR interpol points current
2-**	**Brakes**
2-0*	**DC Brake**
2-00	DC Hold 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]
2-05	Maximum Reference
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
2-18	Brake Check Condition
2-19	Over-voltage Gain
2-2*	**Mechanical Brake**
2-20	Release Brake Current
2-21	Activate Brake Speed [RPM]
2-22	Activate Brake Speed [Hz]
2-23	Activate Brake Delay
2-24	Stop Delay
2-25	Brake Release Time
2-26	Torque Ref
2-27	Torque Ramp-up Time
2-28	Gain Boost Factor
2-29	Torque Ramp-down Time
2-3*	**Adv. Mech Brake**
2-30	Position P Start Proportional Gain
2-31	Speed PID Start Proportional Gain
2-32	Speed PID Start Integral Time
2-33	Speed PID Start Lowpass Filter Time
3-**	**Reference / Ramps**
3-0*	**Reference Limits**
3-00	Reference Range
3-01	Reference/Feedback Unit
3-02	Minimum Reference
3-03	Maximum Reference
3-04	Reference Function
3-1*	**References**
3-10	Preset Reference
3-11	Jog Speed [Hz]
3-12	Catch up/slow-down value
3-13	Reference Site
3-14	Preset Relative Reference
3-15	Reference Resource 1
3-16	Reference Resource 2
3-17	Reference Resource 3
3-18	Relative Scaling Reference Resource
3-19	Jog Speed [RPM]
3-4*	**Ramp 1**
3-40	Ramp 1 Type
3-41	Ramp 1 Ramp-up Time
3-42	Ramp 1 Ramp-down Time
3-45	Ramp 1 S-ramp Ratio at Accel. Start
3-46	Ramp 1 S-ramp Ratio at Accel. End
3-47	Ramp 1 S-ramp Ratio at Decel. Start
3-48	Ramp 1 S-ramp Ratio at Decel. End
3-5*	**Ramp 2**
3-50	Ramp 2 Type
3-51	Ramp 2 Ramp-up Time
3-52	Ramp 2 Ramp-down Time
3-55	Ramp 2 S-ramp Ratio at Accel. Start
3-56	Ramp 2 S-ramp Ratio at Accel. End
3-57	Ramp 2 S-ramp Ratio at Decel. Start
3-58	Ramp 2 S-ramp Ratio at Decel. End
3-6*	**Ramp 3**
3-60	Ramp 3 Type
3-61	Ramp 3 Ramp-up Time
3-62	Ramp 3 Ramp-down Time
3-65	Ramp 3 S-ramp Ratio at Accel. Start
3-66	Ramp 3 S-ramp Ratio at Accel. End
3-67	Ramp 3 S-ramp Ratio at Decel. Start
3-68	Ramp 3 S-ramp Ratio at Decel. End
3-7*	**Ramp 4**
3-70	Ramp 4 Type
3-71	Ramp 4 Ramp-up Time
3-72	Ramp 4 Ramp-down Time
3-75	Ramp 4 S-ramp Ratio at Accel. Start
3-76	Ramp 4 S-ramp Ratio at Accel. End
3-77	Ramp 4 S-ramp Ratio at Decel. Start
3-78	Ramp 4 S-ramp Ratio at Decel. End
3-8*	**Other Ramps**
3-80	Jog Ramp Time
3-81	Quick Stop Ramp Time
3-82	Quick Stop Ramp Type
3-83	Quick Stop S-ramp Ratio at Decel. Start
3-84	Quick Stop S-ramp Ratio at Decel. End
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
4-2*	**Limit Factors**
4-20	Torque Limit Factor Source
4-21	Speed Limit Factor Source
4-23	Brake Check Limit Factor Source
4-24	Brake Check Limit Factor
4-3*	**Motor Speed Mon.**
4-30	Motor Feedback Loss Function
4-31	Motor Feedback Speed Error
4-32	Motor Feedback Loss Timeout
4-34	Tracking Error Function
4-35	Tracking Error
4-36	Tracking Error Timeout
4-37	Tracking Error Ramping
4-38	Tracking Error Ramping Timeout
4-39	Tracking Error After Ramping Timeout
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]
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

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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
5-20 Terminal X46/1 Digital Input
5-21 Terminal X46/3 Digital Input
5-22 Terminal X46/5 Digital Input
5-23 Terminal X46/7 Digital Input
5-24 Terminal X46/9 Digital Input
5-25 Terminal X46/11 Digital Input
5-26 Terminal X46/13 Digital Input
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
5-7* 24 V Encoder Input
5-70 Term 32/33 Pulses Per Revolution
5-71 Term 32/33 Encoder Direction
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
6-1* Analog Input 1
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
6-2* Analog Input 2
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
6-3* Analog Input 3
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
6-4* Analog Input 4
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
6-5* Analog Output 1
6-50 Terminal 42 Output
6-51 Terminal 42 Output Min Scale
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42-85	Active Safe Func.
42-86	Safe Option Info
42-88	Supported Customization File Version
42-89	Customization File Version
42-9*	**Special**
42-90	Restart Safe Option
99-*	**Devel support**
99-0*	**DSP Debug**
99-00	DAC 1 selection
99-01	DAC 2 selection
99-02	DAC 3 selection
99-03	DAC 4 selection
99-04	DAC 1 scale
99-05	DAC 2 scale
99-06	DAC 3 scale
99-07	DAC 4 scale
99-08	Test param 1
99-09	Test param 2
99-10	DAC Option Slot
99-1*	**Hardware Control**
99-11	RFI 2
99-12	Fan
99-1*	**Software Readouts**
99-13	Idle time
99-14	Paramdb requests in queue
99-15	Secondary Timer at Inverter Fault
99-16	No. of Current Sensors
99-17	tCon1 time
99-18	tCon2 time
99-19	Time Optimize Measure
99-2*	**Heatsink Readouts**
99-20	HS Temp. (PC1)
99-21	HS Temp. (PC2)
99-22	HS Temp. (PC3)
99-23	HS Temp. (PC4)
99-24	HS Temp. (PC5)
99-25	HS Temp. (PC6)
99-26	HS Temp. (PC7)
99-27	HS Temp. (PC8)
99-3*	**Performance Readouts**
99-34	Perf FastThread AOC
99-35	Perf SlowThread AOC
99-36	Perf IdleThread AOC
99-37	Perf SystemIdleThread AOC
99-38	Perf CPU usage AOC (%)
99-39	Performance IntervalCounter
99-4*	**Software Control**
99-40	StartupWizardState
99-41	Performance Measurements
99-5*	**PC Debug**
99-50	PC Debug Selection
99-51	PC Debug 0
99-52	PC Debug 1
99-53	PC Debug 2
99-54	PC Debug 3
99-55	PC Debug 4
99-56	Fan 1 Feedback
99-57	Fan 2 Feedback
99-58	PC Auxiliary Temp
99-59	Power Card Temp.
99-8*	**RTDC**
99-80	tCon1 Selection
99-81	tCon2 Selection
99-82	Trig Compare Selection
99-83	Trig Compare Operator
99-84	Trig Compare Operand
99-85	Trig Start
99-86	Pre-trigger
99-9*	**Internal Values**
99-90	Options present
99-91	Motor Power Internal
99-92	Motor Voltage Internal
99-93	Motor Frequency Internal
600-**	**PROFIsafe**
600-22	PROFIdrive/safe Tel. Selected
600-44	Fault Message Counter
600-47	Fault Number
600-52	Fault Situation Counter
601-**	**PROFIdrive 2**
601-22	PROFIdrive Safety Channel Tel. No.

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9.3 Active Filter Parameter Lists

9.3.1 Default settings

<u>Changes during operation:</u>
"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.

<u>4 set-up:</u>
'All set-up': the parameter can be set individually in each of the four set-ups, i.e., one single parameter can have four different data values.
'1 set-up': the data value will be the same in all set-ups.

<u>SR:</u>
Size related

<u>N/A:</u>
No default value available.

<u>Conversion index:</u>
This number refers to a conversion figure used when writing or reading using an active filter.

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

Table 9.1 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	Normalized value 2 bytes	N2
35	Bit sequence of 16 Boolean variables	V2
54	Time difference w/o date	TimD

Table 9.2 Data Type and Description

9.3.2 Operation/Display 0-**

Par. No. #	Parameter description	Default value	4-set-up	FC 302 only	Change during operation	Conver-sion index	Type
0-0* Basic Settings							
0-01	Language	[0] English	1 set-up		TRUE	-	Uint8
0-04	Operating State at Power-up (Hand)	[1] Forced stop	All set-ups		TRUE	-	Uint8
0-1* Set-up Operations							
0-10	Active Set-up	[1] Set-up 1	1 set-up		TRUE	-	Uint8
0-11	Edit Set-up	[1] Set-up 1	All set-ups		TRUE	-	Uint8
0-12	This Set-up Linked to	[0] Not linked	All set-ups		FALSE	-	Uint8
0-13	Readout: Linked Set-ups	0 N/A	All set-ups		FALSE	0	Uint16
0-14	Readout: Edit Set-ups / Channel	0 N/A	All set-ups		TRUE	0	Int32
0-2* Display							
0-20	Display Line 1.1 Small	30112	All set-ups		TRUE	-	Uint16
0-21	Display Line 1.2 Small	30110	All set-ups		TRUE	-	Uint16
0-22	Display Line 1.3 Small	30120	All set-ups		TRUE	-	Uint16
0-23	Display Line 2 Large	30100	All set-ups		TRUE	-	Uint16
0-24	Display Line 3 Large	30121	All set-ups		TRUE	-	Uint16
0-25	My Personal Menu	ExpressionLimit	1 set-up		TRUE	0	Uint16
0-4* Keypad							
0-40	[Hand on] Key on	[1] Enabled	All set-ups		TRUE	-	Uint8
0-41	[Off] Key on	[1] Enabled	All set-ups		TRUE	-	Uint8
0-42	[Auto on] Key on	[1] Enabled	All set-ups		TRUE	-	Uint8
0-43	[Reset] Key on	[1] Enabled	All set-ups		TRUE	-	Uint8
0-5* Copy/Save							
0-50	Copy	[0] No copy	All set-ups		FALSE	-	Uint8
0-51	Set-up Copy	[0] No copy	All set-ups		FALSE	-	Uint8
0-6* Password							
0-60	Main Menu Password	100 N/A	1 set-up		TRUE	0	Int16
0-61	Access to Main Menu w/o Password	[0] Full access	1 set-up		TRUE	-	Uint8
0-65	Quick Menu Password	200 N/A	1 set-up		TRUE	0	Int16
0-66	Access to Quick Menu w/o Password	[0] Full access	1 set-up		TRUE	-	Uint8

9.3.3 Digital In/Out 5-**

Par. No. #	Parameter description	Default value	4-set-up	FC 302 only	Change during operation	Conver-sion 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	x	TRUE	-	Uint8
5-1* Digital Inputs							
5-10	Terminal 18 Digital Input	[8] Start	All set-ups		TRUE	-	Uint8
5-11	Terminal 19 Digital Input	[0] No operation	All set-ups		TRUE	-	Uint8
5-12	Terminal 27 Digital Input	[0] No operation	All set-ups		TRUE	-	Uint8
5-13	Terminal 29 Digital Input	[0] No operation	All set-ups		TRUE	-	Uint8
5-14	Terminal 32 Digital Input	[90] AC Contactor	All set-ups		TRUE	-	Uint8
5-15	Terminal 33 Digital Input	[91] DC Contactor	All set-ups		TRUE	-	Uint8
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	x	TRUE	-	Uint8
5-4* Relays							
5-40	Function Relay	[0] No operation	All set-ups		TRUE	-	Uint8
5-41	On Delay, Relay	0.30 s	All set-ups		TRUE	-2	Uint16
5-42	Off Delay, Relay	0.30 s	All set-ups		TRUE	-2	Uint16

9.3.4 Comm. and Options 8-**

Par. No. #	Parameter description	Default value	4-set-up	FC 302 only	Change during operation	Conver-sion index	Type
8-0* General Settings							
8-01	Control Site	[0] Digital and ctrl.word	All set-ups		TRUE	-	Uint8
8-02	Control Word Source	null	All set-ups		TRUE	-	Uint8
8-03	Control Word Timeout Time	1.0 s	1 set-up		TRUE	-1	Uint32
8-04	Control Word Timeout Function	[0] Off	1 set-up		TRUE	-	Uint8
8-05	End-of-Timeout Function	[1] Resume set-up	1 set-up		TRUE	-	Uint8
8-06	Reset Control Word Timeout	[0] Do not reset	All set-ups		TRUE	-	Uint8
8-3* FC Port Settings							
8-30	Protocol	[1] FC MC	1 set-up		TRUE	-	Uint8
8-31	Address	2 N/A	1 set-up		TRUE	0	Uint8
8-32	FC Port Baud Rate	[2] 9600 Baud	1 set-up		TRUE	-	Uint8
8-35	Minimum Response Delay	10 ms	All set-ups		TRUE	-3	Uint16
8-36	Max Response Delay	5000 ms	1 set-up		TRUE	-3	Uint16
8-37	Max Inter-Char Delay	25 ms	1 set-up		TRUE	-3	Uint16
8-5* Digital/Bus							
8-53	Start Select	[3] Logic OR	All set-ups		TRUE	-	Uint8
8-55	Set-up Select	[3] Logic OR	All set-ups		TRUE	-	Uint8

9.3.5 Special Functions 14-**

Par. No. #	Parameter description	Default value	4-set-up	FC 302 only	Change during operation	Conver-sion index	Type
14-2* Trip Reset							
14-20	Reset Mode	[0] Manual reset	All set-ups		TRUE	-	Uint8
14-21	Automatic Restart Time	10 s	All set-ups		TRUE	0	Uint16
14-22	Operation Mode	[0] Normal operation	All set-ups		TRUE	-	Uint8
14-23	Typecode Setting	null	2 set-ups		FALSE	-	Uint8
14-28	Production Settings	[0] No action	All set-ups		TRUE	-	Uint8
14-29	Service Code	0 N/A	All set-ups		TRUE	0	Int32
14-5* Environment							
14-50	RFI filter	[1] On	1 set-up		FALSE	-	Uint8
14-53	Fan Monitor	[1] Warning	All set-ups		TRUE	-	Uint8
14-54	Bus Partner	1 N/A	2 set-ups		TRUE	0	Uint16

9.3.6 Adj. Freq. Drive Information 15-**

Par. No. #	Parameter description	Default value	4-set-up	FC 302 only	Change during operation	Conver-sion index	Type
15-0* Operating Data							
15-00	Operating Hours	0 h	All set-ups		FALSE	74	Uint32
15-01	Running Hours	0 h	All set-ups		FALSE	74	Uint32
15-03	Power-ups	0 N/A	All set-ups		FALSE	0	Uint32
15-04	Over Temps	0 N/A	All set-ups		FALSE	0	Uint16
15-05	Over Volts	0 N/A	All set-ups		FALSE	0	Uint16
15-07	Reset Running Hours Counter	[0] Do not reset	All set-ups		TRUE	-	Uint8
15-1* Data Log Settings							
15-10	Logging Source	0	2 set-ups		TRUE	-	Uint16
15-11	Logging Interval	ExpressionLimit	2 set-ups		TRUE	-3	TimD
15-12	Trigger Event	[0] False	1 set-up		TRUE	-	Uint8
15-13	Logging Mode	[0] Log always	2 set-ups		TRUE	-	Uint8
15-14	Samples Before Trigger	50 N/A	2 set-ups		TRUE	0	Uint8
15-2* Historic Log							
15-20	Historic Log: Event	0 N/A	All set-ups		FALSE	0	Uint8
15-21	Historic Log: Value	0 N/A	All set-ups		FALSE	0	Uint32
15-22	Historic Log: Time	0 ms	All set-ups		FALSE	-3	Uint32
15-3* Fault Log							
15-30	Fault Log: Error Code	0 N/A	All set-ups		FALSE	0	Uint16
15-31	Fault Log: Value	0 N/A	All set-ups		FALSE	0	Int16
15-32	Fault Log: Time	0 s	All set-ups		FALSE	0	Uint32
15-4* Unit Identification							
15-40	FC Type	0 N/A	All set-ups		FALSE	0	VisStr[6]
15-41	Power Section	0 N/A	All set-ups		FALSE	0	VisStr[20]
15-42	Voltage	0 N/A	All set-ups		FALSE	0	VisStr[20]
15-43	Software Version	0 N/A	All set-ups		FALSE	0	VisStr[5]
15-44	Ordered Typecode String	0 N/A	All set-ups		FALSE	0	VisStr[40]
15-45	Actual Typecode String	0 N/A	All set-ups		FALSE	0	VisStr[40]
15-46	Unit Ordering No	0 N/A	All set-ups		FALSE	0	VisStr[8]
15-47	Power Card Ordering No	0 N/A	All set-ups		FALSE	0	VisStr[8]
15-48	ID No	0 N/A	All set-ups		FALSE	0	VisStr[20]
15-49	SW ID Control Card	0 N/A	All set-ups		FALSE	0	VisStr[20]
15-50	SW ID Power Card	0 N/A	All set-ups		FALSE	0	VisStr[20]
15-51	Unit Serial Number	0 N/A	All set-ups		FALSE	0	VisStr[10]
15-53	Power Card Serial Number	0 N/A	All set-ups		FALSE	0	VisStr[19]
15-6* Option Ident							
15-60	Option Mounted	0 N/A	All set-ups		FALSE	0	VisStr[30]
15-61	Option SW Version	0 N/A	All set-ups		FALSE	0	VisStr[20]
15-62	Option Ordering No	0 N/A	All set-ups		FALSE	0	VisStr[8]
15-63	Option Serial No	0 N/A	All set-ups		FALSE	0	VisStr[18]
15-70	Option in Slot A	0 N/A	All set-ups		FALSE	0	VisStr[30]
15-71	Slot A Option SW Version	0 N/A	All set-ups		FALSE	0	VisStr[20]
15-72	Option in Slot B	0 N/A	All set-ups		FALSE	0	VisStr[30]
15-73	Slot B Option SW Version	0 N/A	All set-ups		FALSE	0	VisStr[20]
15-74	Option in Slot C0	0 N/A	All set-ups		FALSE	0	VisStr[30]
15-75	Slot C0 Option SW Version	0 N/A	All set-ups		FALSE	0	VisStr[20]

Par. No. #	Parameter description	Default value	4-set-up	FC 302 only	Change during operation	Conver-sion index	Type
15-76	Option in Slot C1	0 N/A	All set-ups		FALSE	0	VisStr[30]
15-77	Slot C1 Option SW Version	0 N/A	All set-ups		FALSE	0	VisStr[20]
15-9* Parameter Info							
15-92	Defined Parameters	0 N/A	All set-ups		FALSE	0	Uint16
15-93	Modified Parameters	0 N/A	All set-ups		FALSE	0	Uint16
15-98	Unit Identification	0 N/A	All set-ups		FALSE	0	VisStr[40]
15-99	Parameter Metadata	0 N/A	All set-ups		FALSE	0	Uint16

9.3.7 Data Readouts 16-**

Par. No. #	Parameter description	Default value	4-set-up	FC 302 only	Change during operation	Conver-sion index	Type
16-0* General Status							
16-00	Control Word	0 N/A	All set-ups		FALSE	0	V2
16-03	Status Word	0 N/A	All set-ups		FALSE	0	V2
16-3* AF Status							
16-30	DC Link Voltage	0 V	All set-ups		FALSE	0	Uint16
16-34	Heatsink Temp.	32°F [0°C]	All set-ups		FALSE	100	Uint8
16-35	Inverter Thermal	0%	All set-ups		FALSE	0	Uint8
16-36	Inv. Nom. Current	ExpressionLimit	All set-ups		FALSE	-2	Uint32
16-37	Inv. Max. Current	ExpressionLimit	All set-ups		FALSE	-2	Uint32
16-39	Control Card Temp.	32°F [0°C]	All set-ups		FALSE	100	Uint8
16-40	Logging Buffer Full	[0] No	All set-ups		TRUE	-	Uint8
16-49	Current Fault Source	0 N/A	All set-ups		TRUE	0	Uint8
16-6* Inputs & Outputs							
16-60	Digital Input	0 N/A	All set-ups		FALSE	0	Uint16
16-66	Digital Output [bin]	0 N/A	All set-ups		FALSE	0	Int16
16-71	Relay Output [bin]	0 N/A	All set-ups		FALSE	0	Int16
16-8* & FC Port							
16-80	CTW 1	0 N/A	All set-ups		FALSE	0	V2
16-84	Comm. Option STW	0 N/A	All set-ups		FALSE	0	V2
16-85	FC Port CTW 1	0 N/A	All set-ups		FALSE	0	V2
16-9* Diagnosis Readouts							
16-90	Alarm Word	0 N/A	All set-ups		FALSE	0	Uint32
16-91	Alarm Word 2	0 N/A	All set-ups		FALSE	0	Uint32
16-92	Warning Word	0 N/A	All set-ups		FALSE	0	Uint32
16-93	Warning Word 2	0 N/A	All set-ups		FALSE	0	Uint32
16-94	Ext. Status Word	0 N/A	All set-ups		FALSE	0	Uint32

9.3.8 AF Settings 300-**

NOTICE!

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

Par. No. #	Parameter description	Default value	4-set-up	FC 302 only	Change during operation	Conver-sion index	Type
300-0* General Settings							
300-00	Harmonic Cancellation Mode	[0] Overall	All set-ups		TRUE	-	Uint8
300-01	Compensation Priority	[0] Harmonics	All set-ups		TRUE	-	Uint8
300-1* Network Settings							
300-10	Active Filter Nominal Voltage	ExpressionLimit	2 set-ups		FALSE	0	Uint32
300-2* CT Settings							
300-20	CT Primary Rating	ExpressionLimit	2 set-ups		FALSE	0	Uint32
300-22	CT Nominal Voltage	342 V	2 set-ups		FALSE	0	Uint32
300-24	CT Sequence	[0] L1, L2, L3	2 set-ups		FALSE	-	Uint8
300-25	CT Polarity	[0] Normal	2 set-ups		FALSE	-	Uint8
300-26	CT Placement	[1] Load Current	2 set-ups		FALSE	-	Uint8
300-29	Start Auto CT Detection	[0] Off	All set-ups		FALSE	-	Uint8
300-3* Compensation							
300-30	Compensation Points	0.0 A	All set-ups		TRUE	-1	Uint32
300-35	Cos-phi Reference	0.500 N/A	All set-ups		TRUE	-3	Uint16
300-4* Paralleling							
300-40	Master Follower Selection	[2] Not Paralleled	2 set-ups		FALSE	-	Uint8
300-41	Follower ID	1 N/A	2 set-ups		FALSE	0	Uint32
300-42	Num. of Follower AFs	1 N/A	2 set-ups		FALSE	0	Uint32
300-5* Sleep Mode							
300-50	Enable Sleep Mode	null	2 set-ups		TRUE	-	Uint8
300-51	Sleep Mode Trig Source	[0] Line power	All set-ups		TRUE	-	Uint8
300-52	Sleep Mode Wake-up Trigger	ExpressionLimit	All set-ups		TRUE	0	Uint32
300-53	Sleep Mode Sleep Trigger	80%	All set-ups		TRUE	0	Uint32

9.3.9 AF Readouts 301-**

Par. No. #	Parameter description	Default value	4-set-up	FC 302 only	Change during operation	Conver-sion index	Type
301-0* Output Currents							
301-00	Output Current [A]	0.00 A	All set-ups		TRUE	-2	Int32
301-01	Output Current [%]	0.0%	All set-ups		TRUE	-1	Int32
301-1* Unit Performance							
301-10	THD of Current [%]	0.0%	All set-ups		TRUE	-1	Uint16
301-11	Estimated THD of Voltage [%]	0.0%	All set-ups				Uint16
301-12	Power Factor	0.00 N/A	All set-ups		TRUE	-2	Uint16
301-13	Cos-phi	0.00 N/A	All set-ups		TRUE	-2	Int16
301-14	Leftover Currents	0.0 A	All set-ups		TRUE	-1	Uint32
301-2* Line Power Status							
301-20	Line Power Current [A]	0 A	All set-ups		TRUE	0	Int32
301-21	Line Power Frequency	0 Hz	All set-ups		TRUE	0	Uint8
301-22	Fund. Line Power Current [A]	0 A	All set-ups		TRUE	0	Int32

10 Appendix B

10.1 Abbreviations and Conventions

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

Table 10.1 Abbreviations

Conventions
Numbered lists indicate procedures.
Bullet lists indicate other information and description of illustrations.
Italicised text indicates:

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

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