Danfoss

Operating Instructions
VLT® HVAC Drive FC 102
315-1400 kW

VLT®
THE REAL DRIVE

Contents

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1 Introduction

1.1 Purpose of the Manual

These operating instructions provide information for safe installation and commissioning of the frequency converter.

The operating instructions are intended for use by qualified personnel.
Read and follow the operating instructions to use the frequency converter safely and professionally, and pay particular attention to the safety instructions and general warnings. Keep these operating instructions available with the frequency converter at all times.

VLT® is a registered trademark.

1.1.1 Intended Use

The frequency converter is an electronic motor controller intended for:

- Regulation of motor speed in response to system feedback or to remote commands from external controllers. A power drive system consists of the frequency converter, the motor and equipment driven by the motor.

- System and motor status surveillance.

The frequency converter can also be used for motor protection.

Depending on configuration, the frequency converter can be used in stand-alone applications or form part of a larger appliance or installation.

The frequency converter is allowed for use in residential, industrial and commercial environments in accordance with local laws and standards.

NOTICE

In a residential environment this product can cause radio interference, in which case supplementary mitigation measures can be required.

Foreseeable misuse
Do not use the frequency converter in applications which are non-compliant with specified operating conditions and environments. Ensure compliance with the conditions specified in *chapter 7 General Specifications*.

1.1.2 Abbreviations and Standards

Abbreviations	Terms	SI units	I-P units
a	Acceleration	m/s^2	ft/s^2
AWG	American wire gauge		
Auto Tune	Automatic motor tuning		
°C	Celsius		
I	Current	A	Amp
I_{LIM}	Current limit		
IT mains	Mains supply with star point in transformer floating to ground		
Joule	Energy	J=N·m	ft-lb, Btu
°F	Fahrenheit		
FC	Frequency converter		
f	Frequency	Hz	Hz
kHz	Kilohertz	kHz	kHz
LCP	Local control panel		
mA	Milliampere		
ms	Millisecond		
min	Minute		
MCT	Motion Control Tool		
M-TYPE	Motor type dependent		
Nm	Newton metres		in-lbs
$I_{M,N}$	Nominal motor current		
$f_{M,N}$	Nominal motor frequency		
$P_{M,N}$	Nominal motor power		
$U_{M,N}$	Nominal motor voltage		
PELV	Protective extra low voltage		
Watt	Power	W	Btu/hr, hp
Pascal	Pressure	Pa = N/m²	psi, psf, ft of water
I_{INV}	Rated inverter output current		
RPM	Revolutions per minute		
s	Second		
SR	Size related		
T	Temperature	C	F
t	Time	s	s,hr
T_{LIM}	Torque limit		
U	Voltage	V	V

Table 1.1 Abbreviations and Standards

1

1.2 Additional Resources

- *VLT$^®$ HVAC Drive FC 102 Design Guide* holds all technical information about the frequency converter and customer design and applications.

- *VLT$^®$ HVAC Drive FC 102 Programming Guide* provides information on how to programme and includes complete parameter descriptions.

- *Application Note, Temperature Derating Guide.*

- *MCT 10 Set-up Software Operating Instructions* enables the user to configure the frequency converter from a Windows$^™$-based PC environment.

- Danfoss VLT$^®$ Energy Box software at *www.danfoss.com/BusinessAreas/DrivesSolutions*, then select PC Software Download.

- *VLT$^®$ HVAC Drive BACnet, Operating Instructions.*

- *VLT$^®$ HVAC Drive Metasys, Operating Instructions.*

- *VLT$^®$ HVAC Drive FLN, Operating Instructions.*

Danfoss technical literature is available in print from local Danfoss Sales Offices, or as electronic copies at: *www.danfoss.com/BusinessAreas/DrivesSolutions/Documen-tations/Technical+Documentation.htm*

1.3 Document and Software Version

This manual is regularly reviewed and updated. All suggestions for improvement are welcome. *Table 1.2* shows the document version and the corresponding software version.

Edition	Remarks	Software version
MG11F5xx	Replaces MG11F4xx	4.1x

Table 1.2 Document and Software Version

1.4 Approvals and Certifications
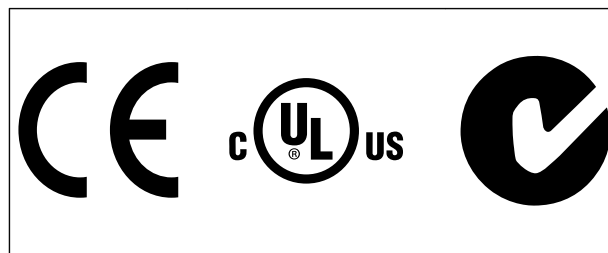
The frequency converter complies with UL508C thermal memory retention requirements. For more information, refer to the section *Motor Thermal Protection* in the product specific *design guide*.

NOTICE

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

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2 Safety

2.1 Safety Symbols

The following symbols are used in this document:

⚠WARNING

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

⚠CAUTION

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

NOTICE

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

2.2 Qualified Personnel

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

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

2.3 Safety Precautions

⚠WARNING

HIGH VOLTAGE!
Frequency converters contain high voltage when connected to AC mains input power. Installation, start-up, and maintenance must be performed by qualified personnel only. Failure to perform installation, start-up, and maintenance by qualified personnel could result in death or serious injury.

⚠WARNING

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

⚠WARNING

DISCHARGE TIME!
Frequency converters contain DC link capacitors that can remain charged even when the frequency converter is not powered. To avoid electrical hazards, disconnect AC mains, any permanent magnet type motors, and any remote DC link power supplies, including battery backups, UPS and DC link connections to other frequency converters. Wait for the capacitors to discharge completely before performing any service or repair work. The waiting time duration is listed in *Table 2.1*. 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 size [kW]	Min. waiting time (min)
380 - 480	315 - 1000	40
525 - 690	450 - 1400	30
Be aware that there may be high voltage on the DC link even when the LEDs are turned off.		

Table 2.1 Discharge Time

⚠WARNING

LEAKAGE CURRENT HAZARD!
Leakage currents are higher than 3.5 mA. It is the responsibility of the user or certified electrical installer to ensure correct grounding of the equipment. Failure to ground the frequency converter properly could result in death or serious injury.

2

⚠WARNING

EQUIPMENT HAZARD!
Rotating shafts and electrical equipment can be
hazardous. All electrical work must conform to national
and local electrical codes. Installation, start-up, and
maintenance are performed only by trained and
qualified personnel. Failure to follow these guidelines
could result in death or serious injury.

⚠WARNING

WINDMILLING!
Unintended rotation of permanent magnet motors
causes a risk of personal injury and equipment damage.
Ensure permanent magnet motors are blocked to
prevent unintended rotation.

⚠CAUTION

POTENTIAL HAZARD IN THE EVENT OF
INTERNAL FAILURE!
Risk of personal injury when the frequency converter is
not properly closed. Before applying power, ensure all
safety covers are in place and securely fastened.

2.3.1 Safe Torque Off (STO)

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

3 Mechanical Installation

3.1 How to Get Started

This chapter covers mechanical and electrical installations to and from power terminals and control card terminals. Electrical installation of options is described in the relevant *operating instructions* and *design guide*.

The frequency converter is designed to achieve a quick and EMC-correct installation.

⚠ WARNING

Read the safety instructions before installing the unit. Failure to follow recommendations could result in death or serious injury.

Mechanical installation
- Mechanical mounting.

Electrical installation
- Connection to mains and protective earth.
- Motor connection and cables.
- Fuses and circuit breakers.
- Control terminals - cables.

Quick Set-up
- Local Control Panel, LCP.
- Automatic Motor Adaptation, AMA.
- Programming.

Enclosure size depends on enclosure type, power range and mains voltage.
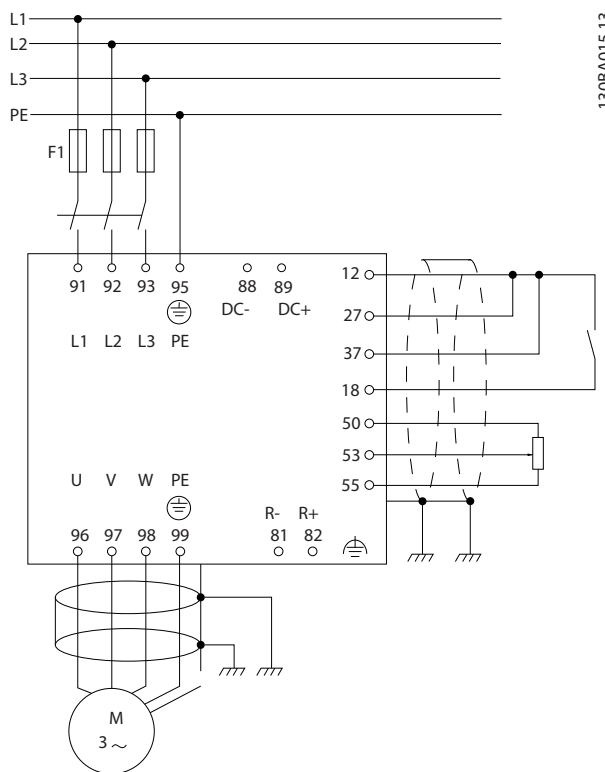
Illustration 3.1 Diagram showing basic installation including mains, motor, start/stop key, and potentiometer for speed adjustment.

3.2 Pre-installation

3.2.1 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 (see details on the following pages, and the respective *design guides*):
- 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.

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- If the frequency converter is without built-in fuses, ensure that the external fuses are rated correctly.

3.2.2 Receiving the Frequency Converter

When receiving the frequency converter, make sure that the packaging is intact. Also be aware of any damage that might have occurred to the unit during transport. In case damage has occurred, immediately contact the shipping company to claim the damage.

3.2.3 Transportation and Unpacking

Before unpacking the frequency converter, place the unit as close as possible to the final installation site. Remove the box and handle the frequency converter on the pallet, as long as possible.

3.2.4 Lifting

Always lift the frequency converter in the dedicated lifting eyes. For all E2 (IP00) enclosures, use a bar to avoid bending the lifting holes of the frequency converter.
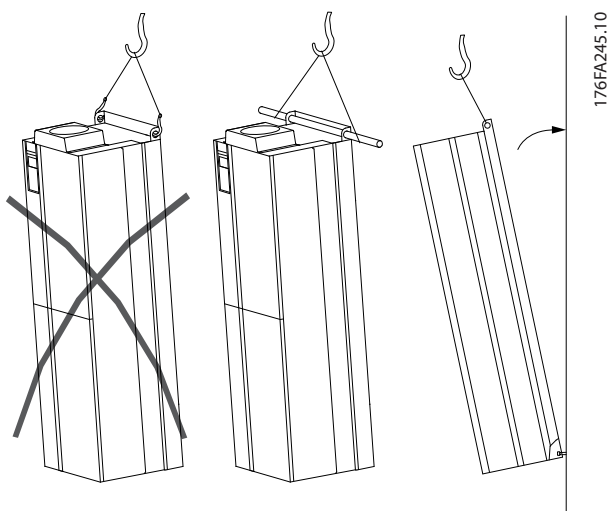
Illustration 3.2 Recommended Lifting Method, Enclosure Size E

⚠WARNING

The lifting bar must be able to handle the weight of the frequency converter. See *Table 3.3* for the weight of the different enclosure sizes. Maximum diameter for bar is 2.5 cm (1 inch). The angle from the top of the frequency converter to the lifting cable should be ≥60°.

NOTICE

The plinth is provided in the same packaging as the frequency converter but is not attached to enclosure sizes F1-F4 during shipment. The plinth must allow airflow to the frequency converter to provide proper cooling. The F enclosures should be positioned on top of the plinth in the final installation location. The angle from the top of the frequency converter to the lifting cable should be ≥60°.
In addition to the lifting methods shown (*Illustration 3.3* to *Illustration 3.9*), a spreader bar is an acceptable way to lift the F enclosures.
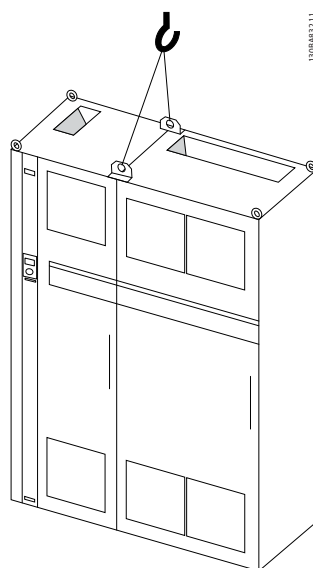
Illustration 3.3 Recommended Lifting Method, Enclosure Size F1 (460 V, 600 to 900 hp, 575/690 V, 900 to 1150 hp)
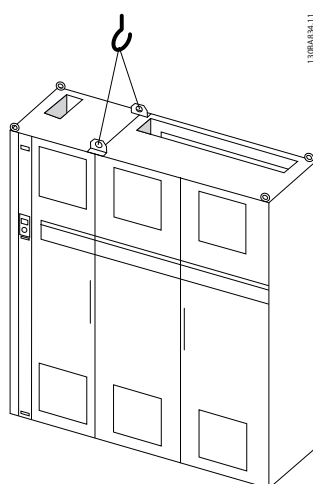
Illustration 3.4 Recommended Lifting Method, Enclosure Size F2 (460 V, 1000 to 1200 hp, 575/690 V, 1250 to 1350 hp)
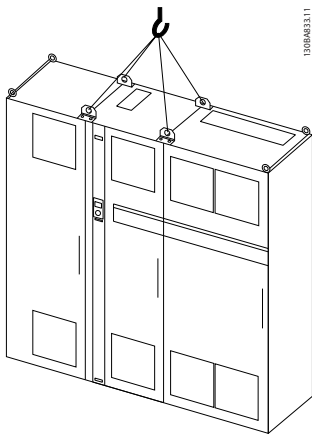
Illustration 3.5 Recommended Lifting Method, Enclosure Size F3 (460 V, 600 to 900 hp, 575/690 V, 900 to 1150 hp)
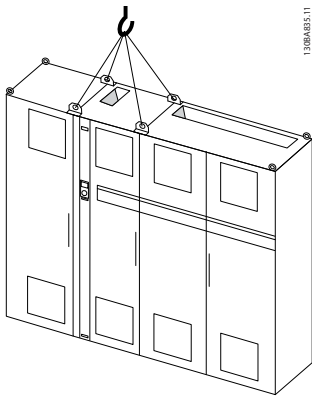
Illustration 3.6 Recommended Lifting Method, Enclosure Size F4 (460 V, 1000 to 1200 hp, 575/690 V, 1250 to 1350 hp)
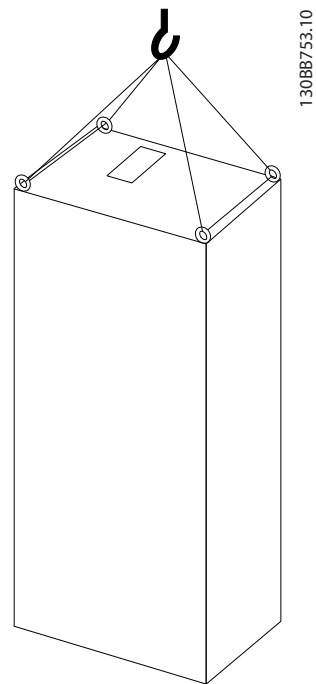
Illustration 3.7 Recommended Lifting Method, Enclosure Type F8
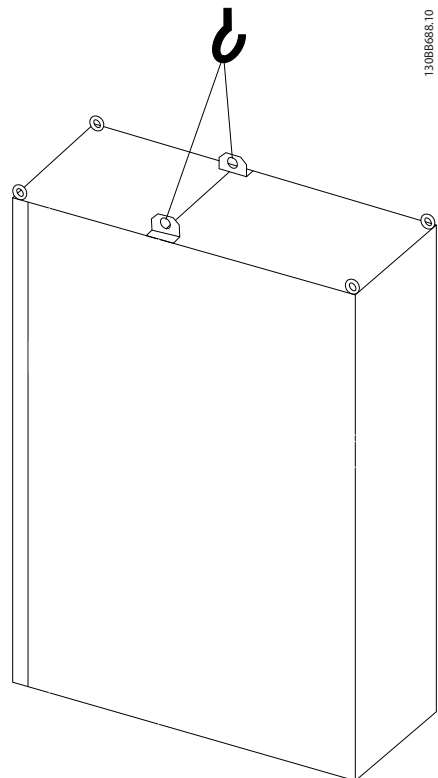
Illustration 3.8 Recommended Lifting Method, Enclosure Size F9/F10
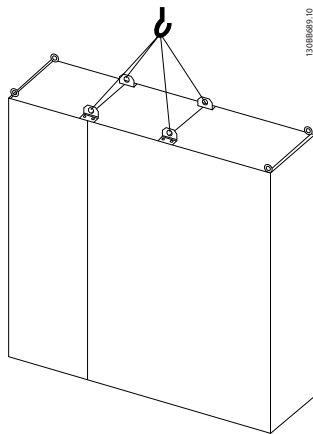
Illustration 3.9 Recommended Lifting Method, Enclosure Size F11/F12/F13/F14

3.2.5 Mechanical Dimensions
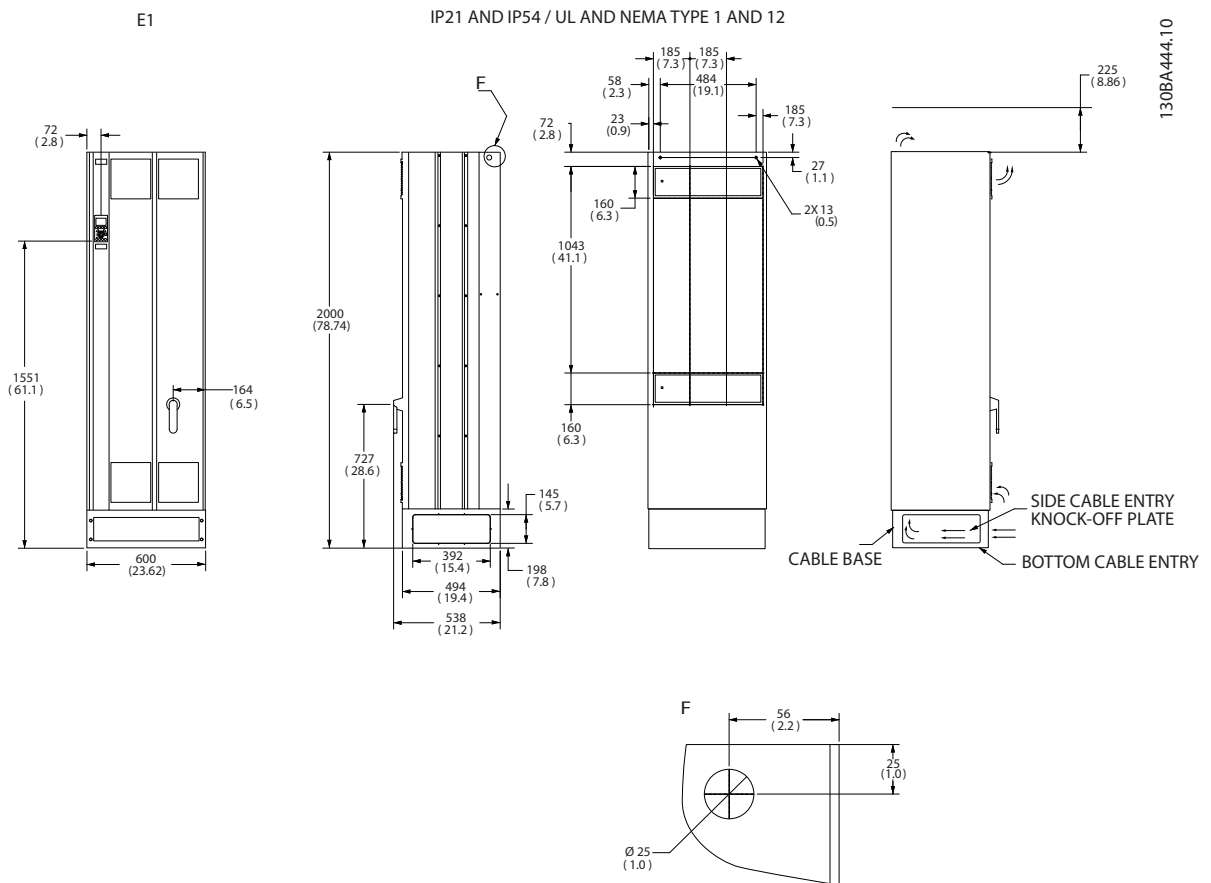
* Note airflow directions

Illustration 3.10 Dimensions, E1

3

E2

IP00 / CHASSIS

130BA445.10
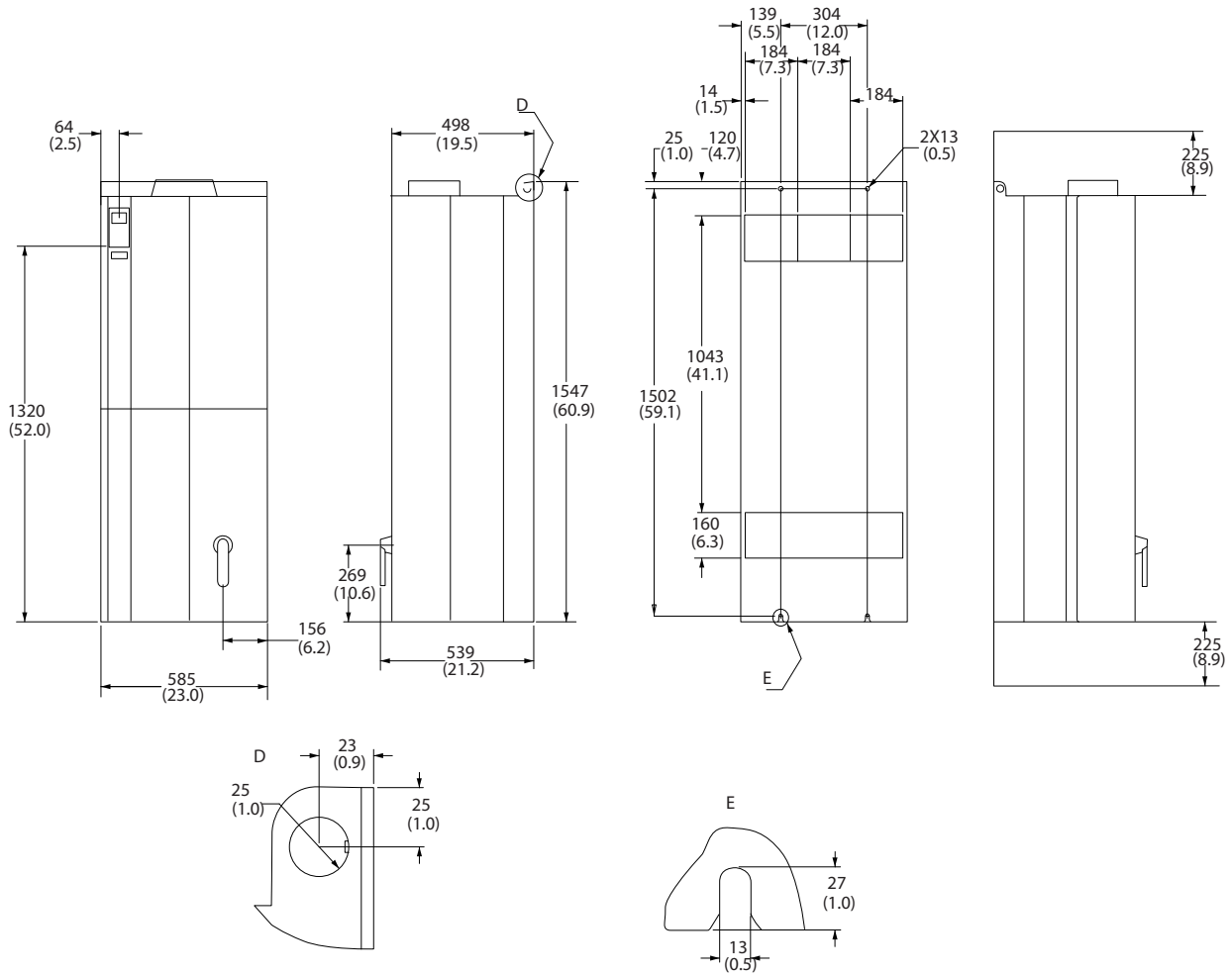
* *Note airflow directions*

Illustration 3.11 Dimensions, E2

1) Minimum clearance from ceiling
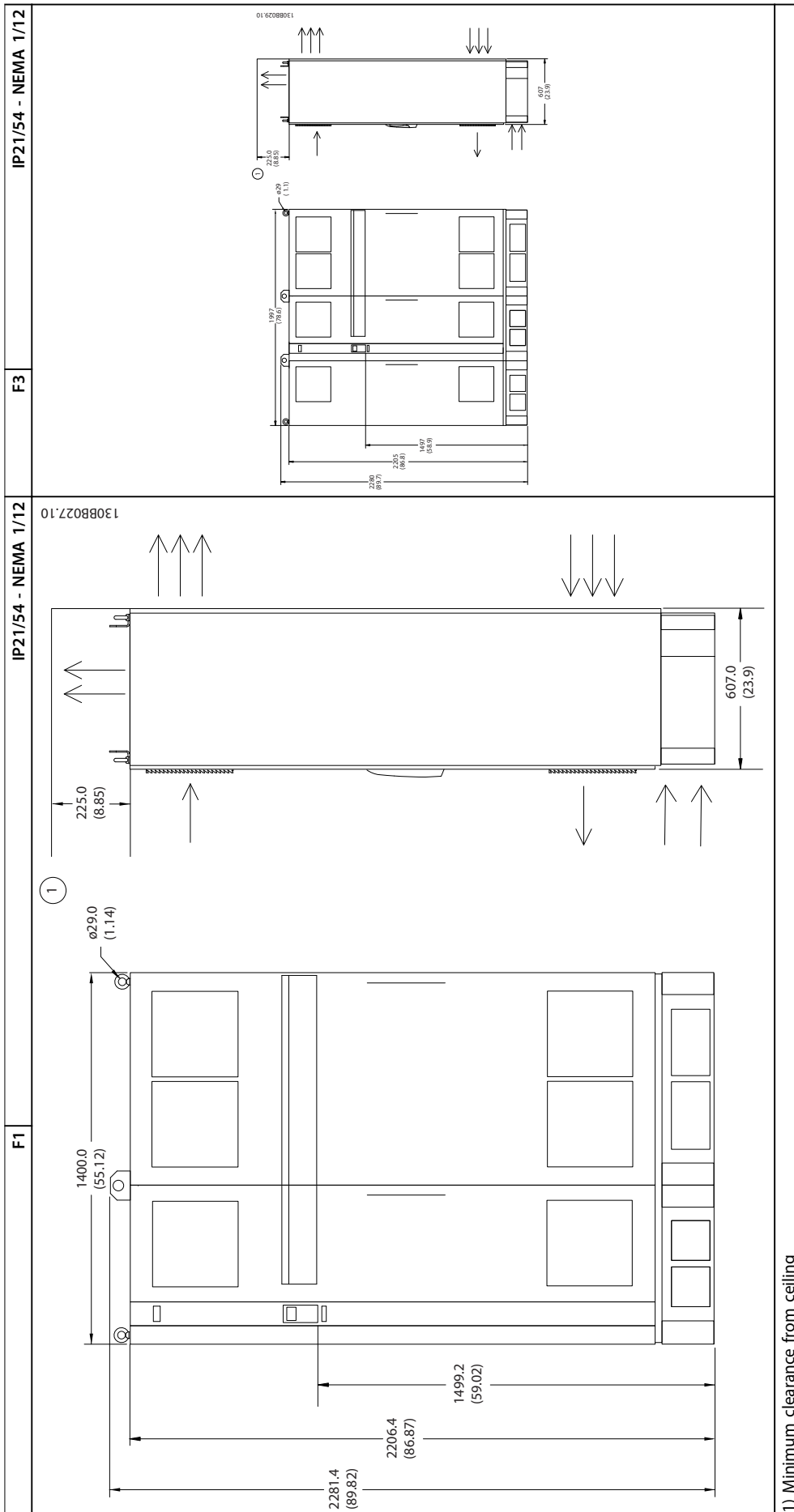
Table 3.1 Dimensions, F1 and F3

3

IP21/54 - NEMA 1/12

F4

604
(23.8)

225.0
(8.85)

Ø29
(1.1)

2401
(94.5)

1497
(58.9)

2205
(86.8)

2280
(89.7)

130BB030.10

IP21/54 - NEMA 1/12

130BB028.10

F2

606
(23.8)

225.0
(8.85)

Ø29
(1.1)

1804
(71.0)

1499
(59.0)

2206
(86.9)

2281
(89.8)

1) Minimum clearance from ceiling
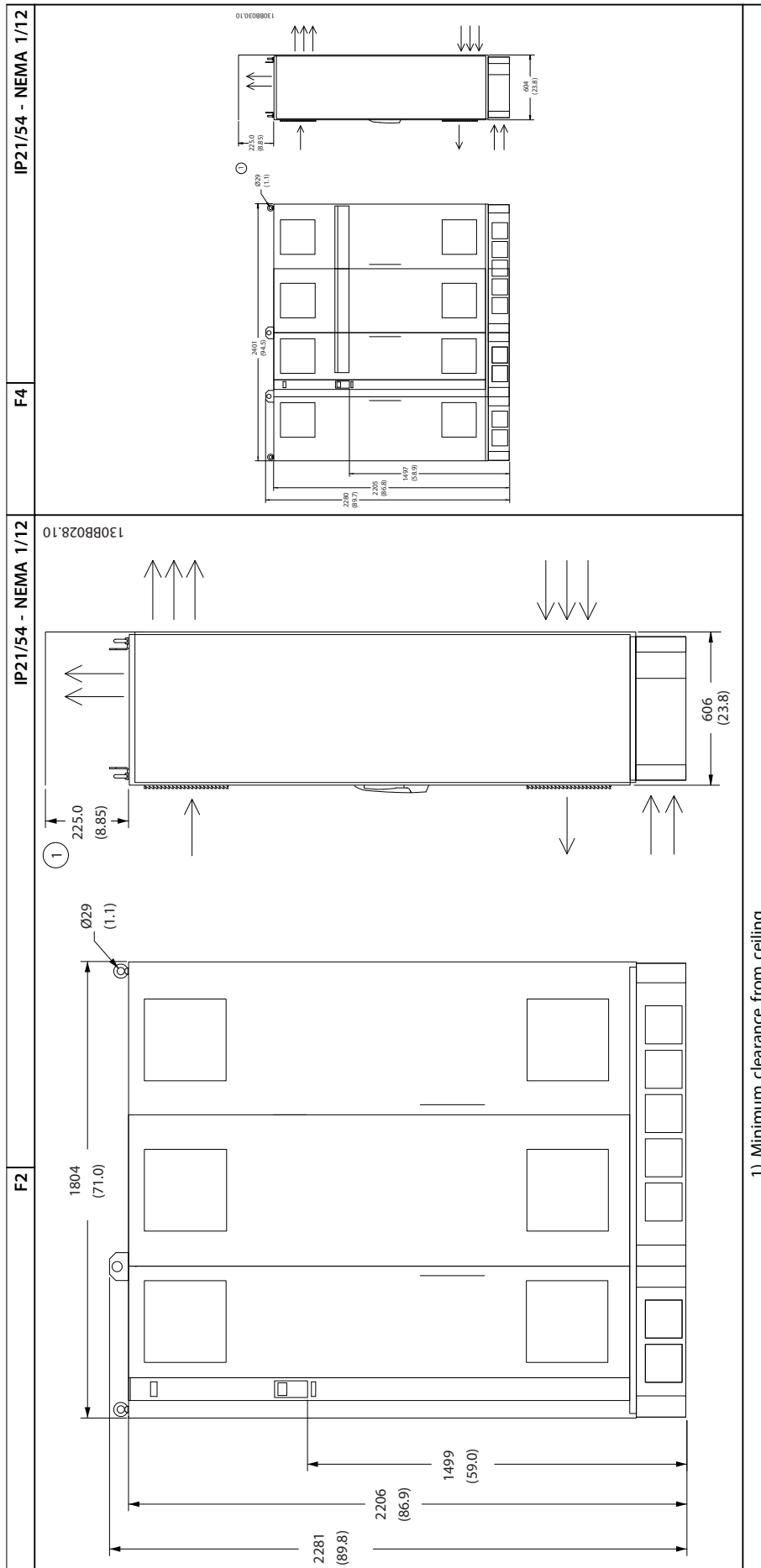
Table 3.2 Dimensions, F2 and F4

3

Enclosure size size		E1	E2	F1	F2	F3	F4
		315–450 kW at 400 V (380–480 V) 450–630 kW at 690 V (525–690 V)	315–450 kW at 400 V (380–480 V) 450–630 kW at 690 V (525–690 V)	500–710 kW at 400 V (380–480 V) 710–900 kW at 690 V (525–690 V)	800–1000 kW at 400 V (380–480 V) 1000–1200 kW at 690 V (525–690 V)	500–710 kW at 400 V (380–480 V) 710–900 kW at 690 V (525–690 V)	800–1000 kW at 400 V (380–480 V) 1000–1400 kW at 690 V (525–690 V)
IP		21, 54	00	21, 54	21, 54	21, 54	21, 54
NEMA		Type 1/Type 12	Chassis	Type 1/Type 12	Type 1/Type 12	Type 1/Type 12	Type 1/Type 12
Shipping dimensions [mm]	Height	840	831	2324	2324	2324	2324
	Width	2197	1705	1569	1962	2159	2559
	Depth	736	736	1130	1130	1130	1130
Frequency converter dimensions [mm]	Height	2000	1547	2204	2204	2204	2204
	Width	600	585	1400	1800	2000	2400
	Depth	494	498	606	606	606	606
	Max. weight [kg]	313	277	1004	1246	1299	1541

Table 3.3 Mechanical Dimensions, Enclosure Sizes E and F

3.2.6 Rated Power
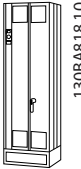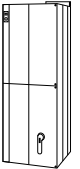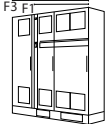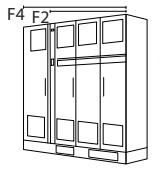
Enclosure size		E1	E2	F1/F3	F2/F4
Enclosure protection	IP	21/54	00	21/54	21/54
	NEMA	Type 1/Type 12	Chassis	Type 1/Type 12	Type 1/Type 12
Normal overload rated power - 110% overload torque		315–450 kW at 400 V (380–480 V) 450–630 kW at 690 V (525-690 V)	315–450 kW at 400 V (380–480 V) 450–630 kW at 690 V (525–690 V)	500–710 kW at 400 V (380–480 V) 710–900 kW at 690 V (525–690 V)	800–1000 kW at 400 V (380–480 V) 1000–1400 kW at 690 V (525–690 V)

Table 3.4 Rated Power, Enclosure Types E and F

NOTICE

The F enclosures are available in 4 different sizes, F1, F2, F3 and F4. The F1 and F2 consist of an inverter cabinet on the right and rectifier cabinet on the left. The F3 and F4 have an extra options cabinet left of the rectifier cabinet. The F3 is an F1 with an extra options cabinet. The F4 is an F2 with an extra options cabinet.

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3.3 Mechanical Installation

Prepare the mechanical installation of the frequency converter carefully to ensure a proper result and to avoid extra work during installation. To become familiar with the space demands, start taking a close look at the mechanical drawings at the end of this instruction.

3.3.1 Tools Needed

To perform the mechanical installation, the following tools are needed:

- Drill with 10 mm or 12 mm drill.

- Tape measure.

- Wrench with relevant metric sockets (7–17 mm).

- Extensions to wrench.

- Sheet metal punch for conduits or cable glands in IP21/Nema 1 and IP54 units

- Lifting bar to lift the unit (rod or tube max. Ø 5 mm (1 inch), able to lift minimum 400 kg (880 lbs).

- Crane or other lifting aid to place the frequency converter in position.

- Use a Torx T50 tool to install the E1 in IP21 and IP54 enclosure types.

3.3.2 General Considerations

Wire access
Ensure proper cable access, including necessary bending allowance. As the IP00 enclosure is open to the bottom, fix cables to the back panel of the enclosure where the frequency converter is mounted by using cable clamps.

> **⚠CAUTION**
>
> **All cable lugs/shoes must be mounted within the width of the terminal bus bar.**

Space
Ensure proper space above and below the frequency converter to allow airflow and cable access. In addition, consider space in front of the unit to enable opening of the panel door.
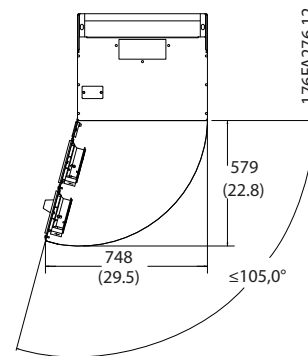
Illustration 3.12 Space in Front of IP21/IP54 Rated Enclosure Type E1
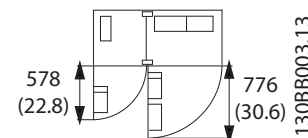
Illustration 3.13 Space in Front of IP21/IP54 Rated Enclosure Type F1
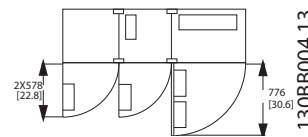
Illustration 3.14 Space in Front of IP21/IP54 Rated Enclosure Type F3
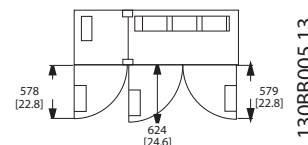
Illustration 3.15 Space in Front of IP21/IP54 Rated Enclosure Type F2
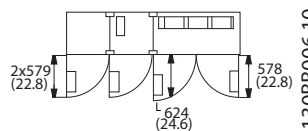
Illustration 3.16 Space in Front of IP21/IP54 Rated Enclosure Type F4

3.3.3 Terminal Locations - E Enclosures

Terminal locations - E1
Consider the following terminal positions when designing the cable access.
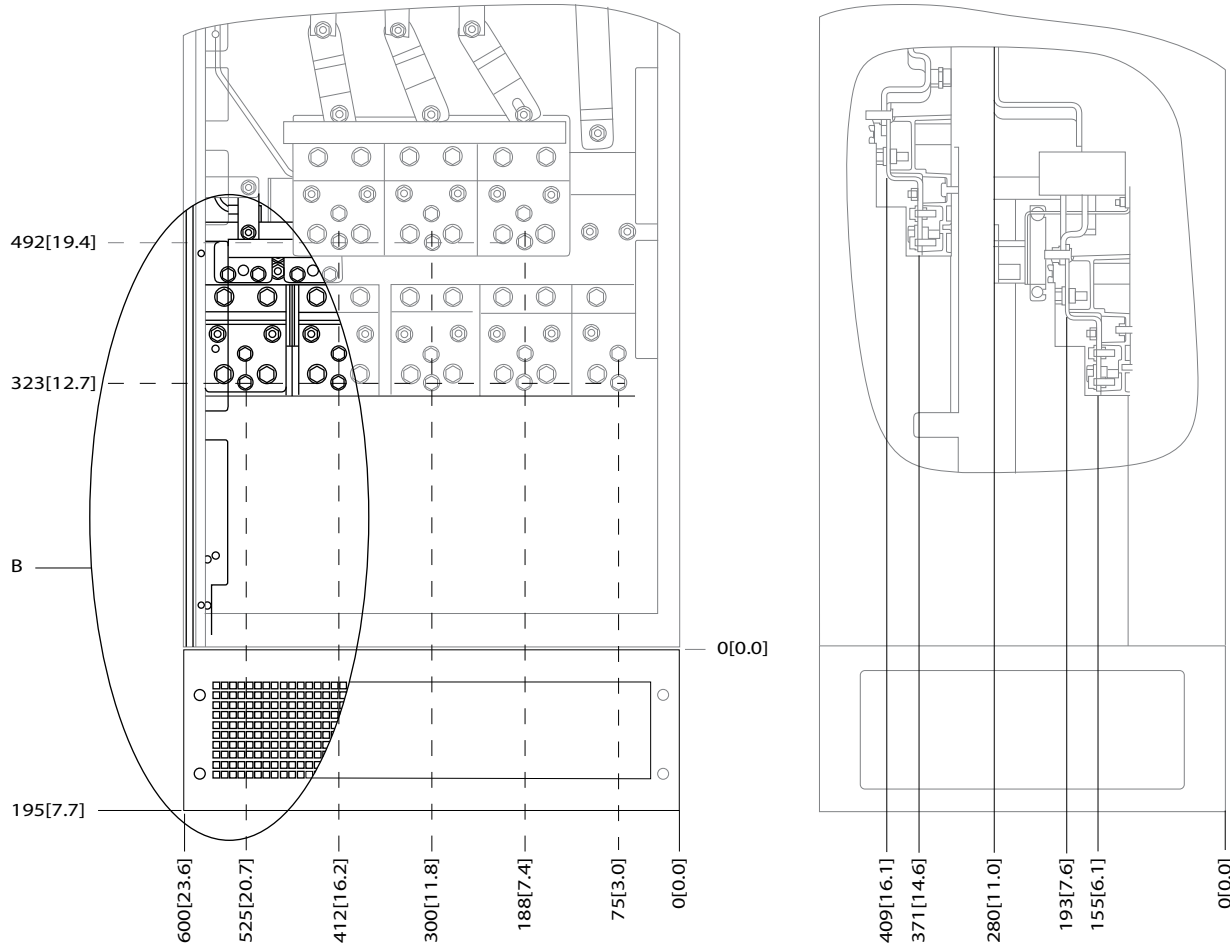
Illustration 3.17 IP21 (NEMA Type 1) and IP54 (NEMA Type 12) Enclosure Power Connection Positions

3

176FA272.10

453[17.8]

-R   81

19 Nm [14 FTa

0[0.0]

0[0.0]   55[2.2]   91[3.6]   139[5.5]   175[6.9]
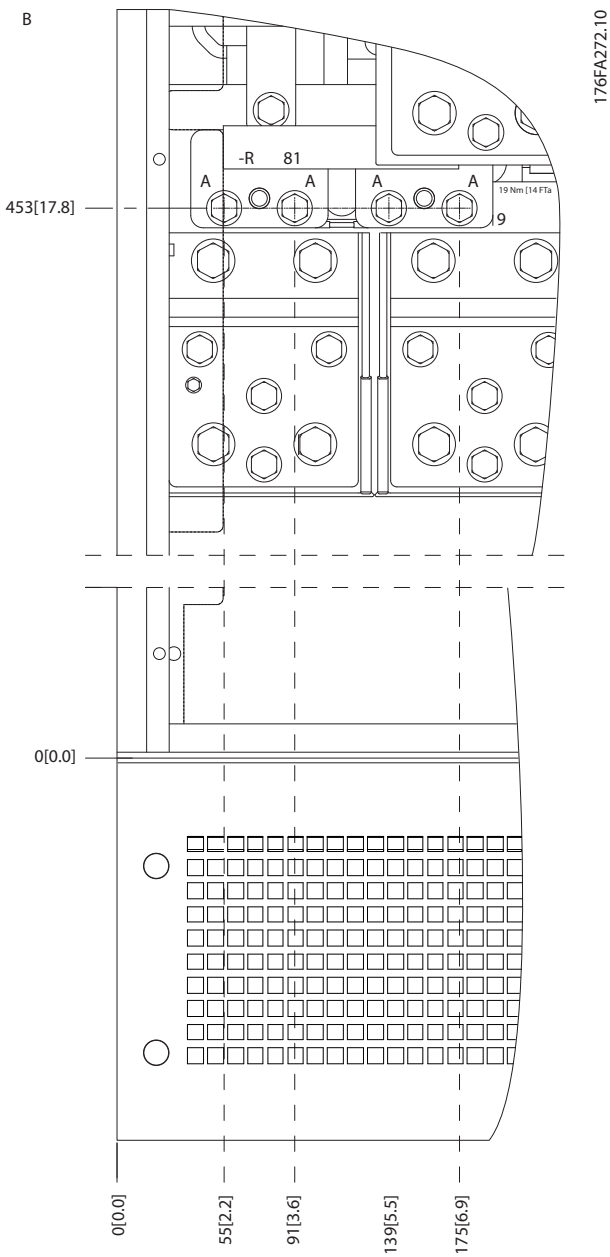
Illustration 3.18 IP21 (NEMA Type 1) and IP54 (NEMA Type 12)
Enclosure Power Connection Positions (Detail B)

3

176FA279.11
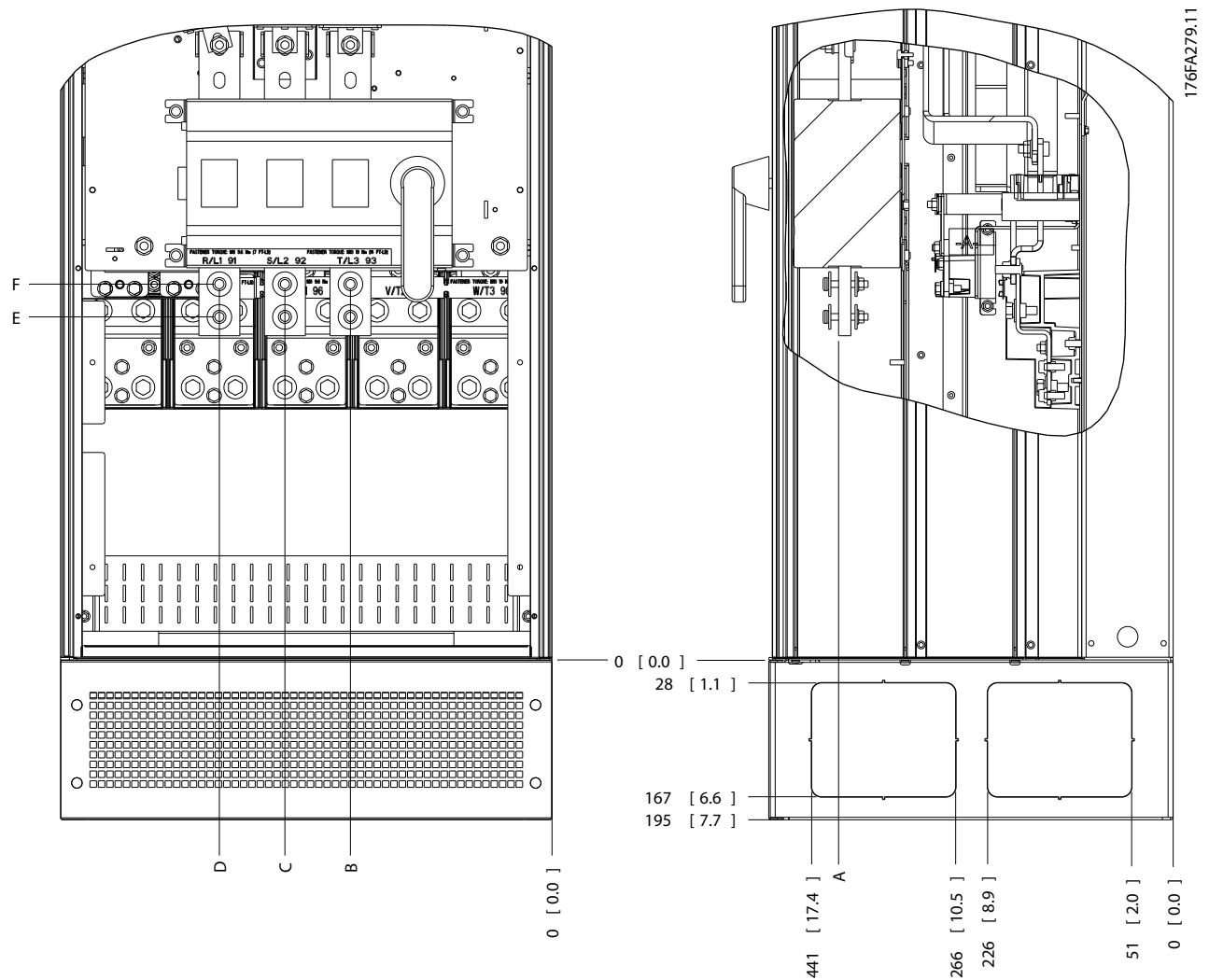
Illustration 3.19 IP21 (NEMA Type 1) and IP54 (NEMA Type 12) Enclosure Power Connection Position of Disconnect Switch

Enclosure size	Unit type	Dimensions [mm]/(inch)					
E1	IP54/IP21 UL and NEMA1/NEMA12						
	250/315 kW (400 V) and 355/450-500/630 kW (690 V)	396 (15.6)	267 (10.5)	332 (13.1)	397 (15.6)	528 (20.8)	N/A
	315/355-400/450 kW (400 V)	408 (16.1)	246 (9.7)	326 (12.8)	406 (16.0)	419 (16.5)	459 (18.1)

Table 3.5 Dimensions for Disconnect Terminal

3

Terminal locations - enclosure type E2

Take the following position of the terminals into consideration when designing the cable access.
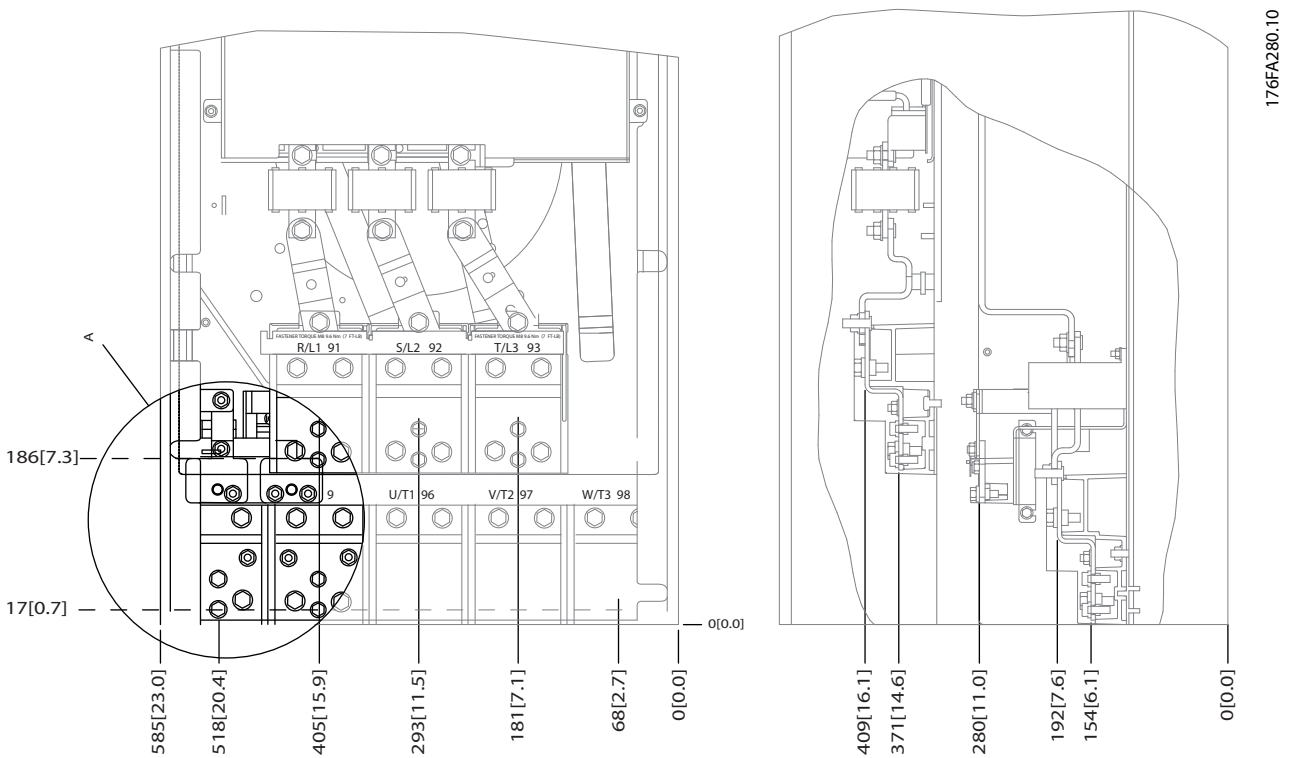
Illustration 3.20 IP00 Enclosure Power Connection Positions
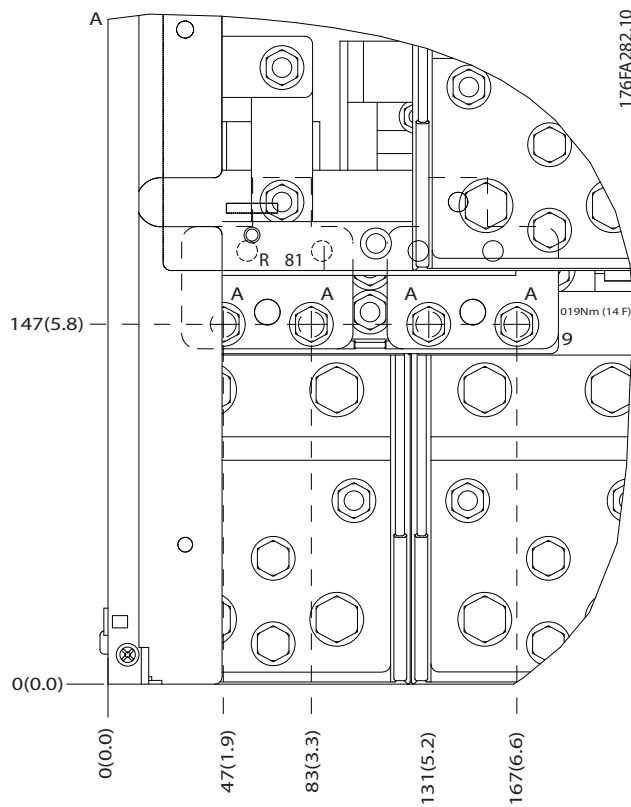
Illustration 3.21 IP00 Enclosure Power Connection Positions

3
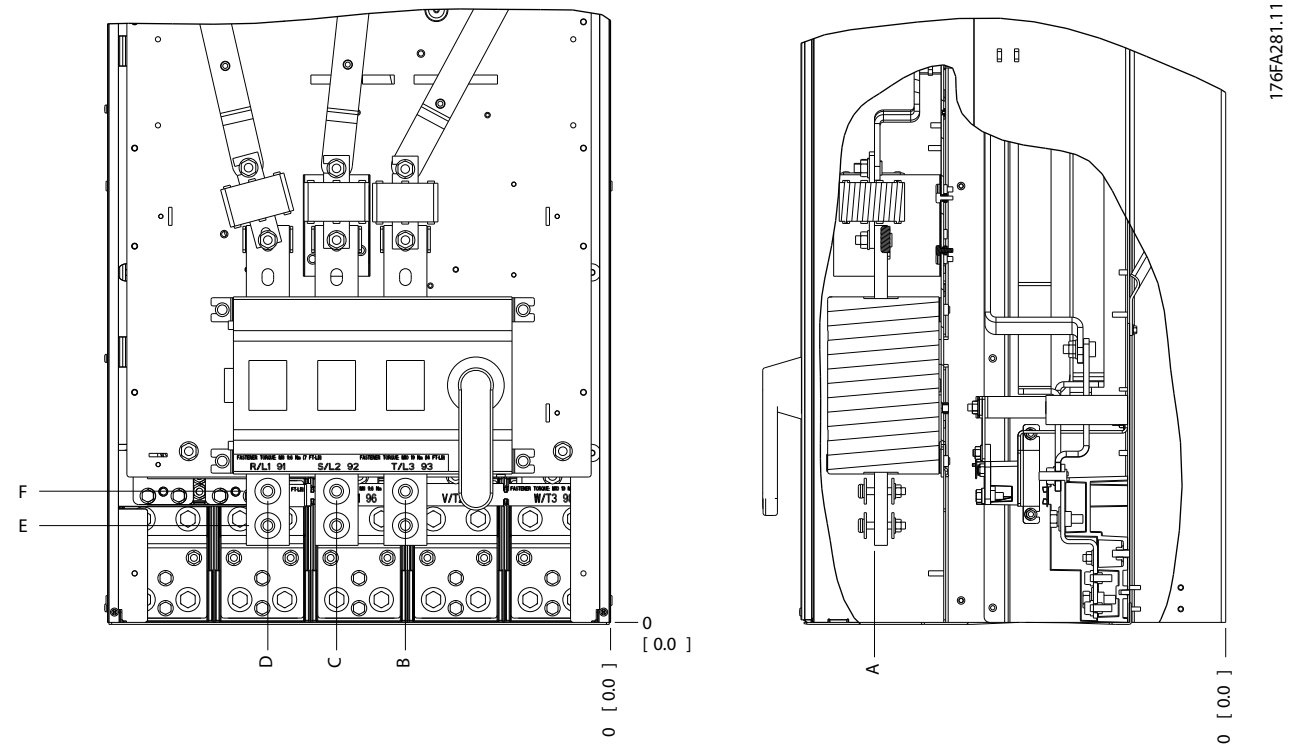
Illustration 3.22 IP00 Enclosure Power Connections Positions of Disconnect Switch

NOTICE

The power cables are heavy and difficult to bend. Consider the optimum position of the frequency converter for ensuring easy installation of the cables.
Each terminal allows use of up to 4 cables with cable lugs or use of standard box lug. Ground is connected to relevant termination point in the frequency converter.
If lugs are wider than 39 mm, install supplied barriers on the mains input side of the disconnect.
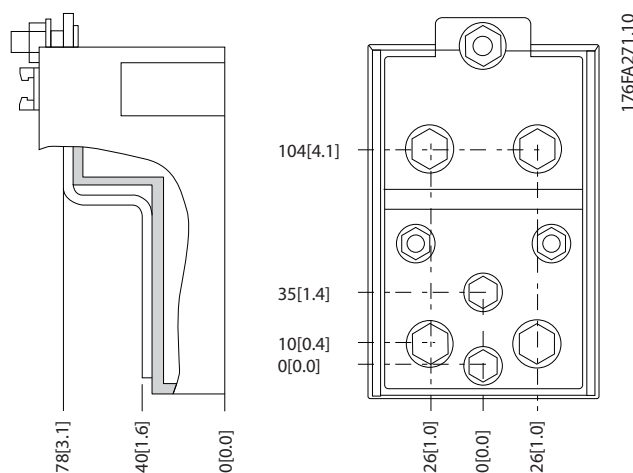
Illustration 3.23 Terminal in Detail

NOTICE

Power connections can be made to positions A or B.

Enclosure size	Unit type	Dimensions [mm]/(inch)					
	IP00/CHASSIS	A	B	C	D	E	F
E2	250/315 kW (400 V) and 355/450-500/630 kW (690 V)	396 (15.6)	268 (10.6)	333 (13.1)	398 (15.7)	221 (8.7)	N/A
	315/355-400/450 kW (400 V)	408 (16.1)	239 (9.4)	319 (12.5)	399 (15.7)	113 (4.4)	153 (6.0)

Table 3.6 Dimensions for Disconnect Terminal

3.3.4 Terminal Locations - Enclosure type F

NOTICE

The F enclosures are available in 4 different sizes, F1, F2, F3 and F4. The F1 and F2 consist of an inverter cabinet on the right and rectifier cabinet on the left. The F3 and F4 have an extra options cabinet left of the rectifier cabinet. The F3 is an F1 with an extra options cabinet. The F4 is an F2 with an extra options cabinet.

Terminal locations - enclosure types F1 and F3
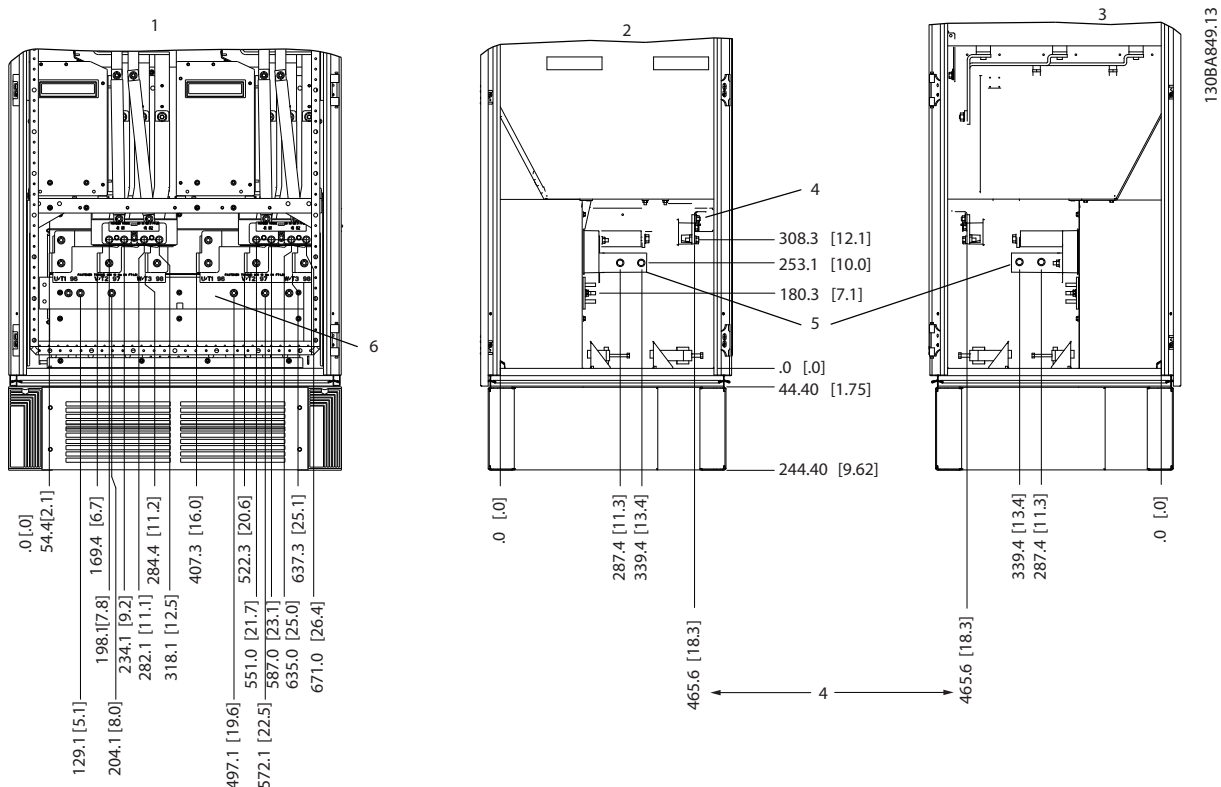
1	Ground bar
2	Motor terminals
3	Brake terminals

Illustration 3.24 Terminal Locations - Inverter Cabinet - F1 and F3 (Front, Left and Right Side View). The Gland Plate is 42 mm below .0 Level.

3
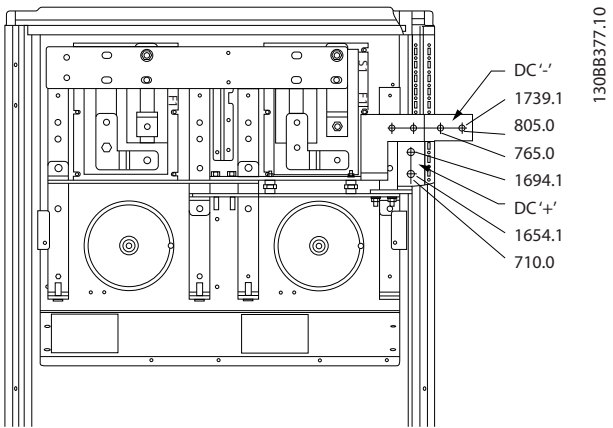
Illustration 3.25 Terminal Locations - Regen Terminals - F1 and F3

Terminal locations - enclosure types F2 and F4
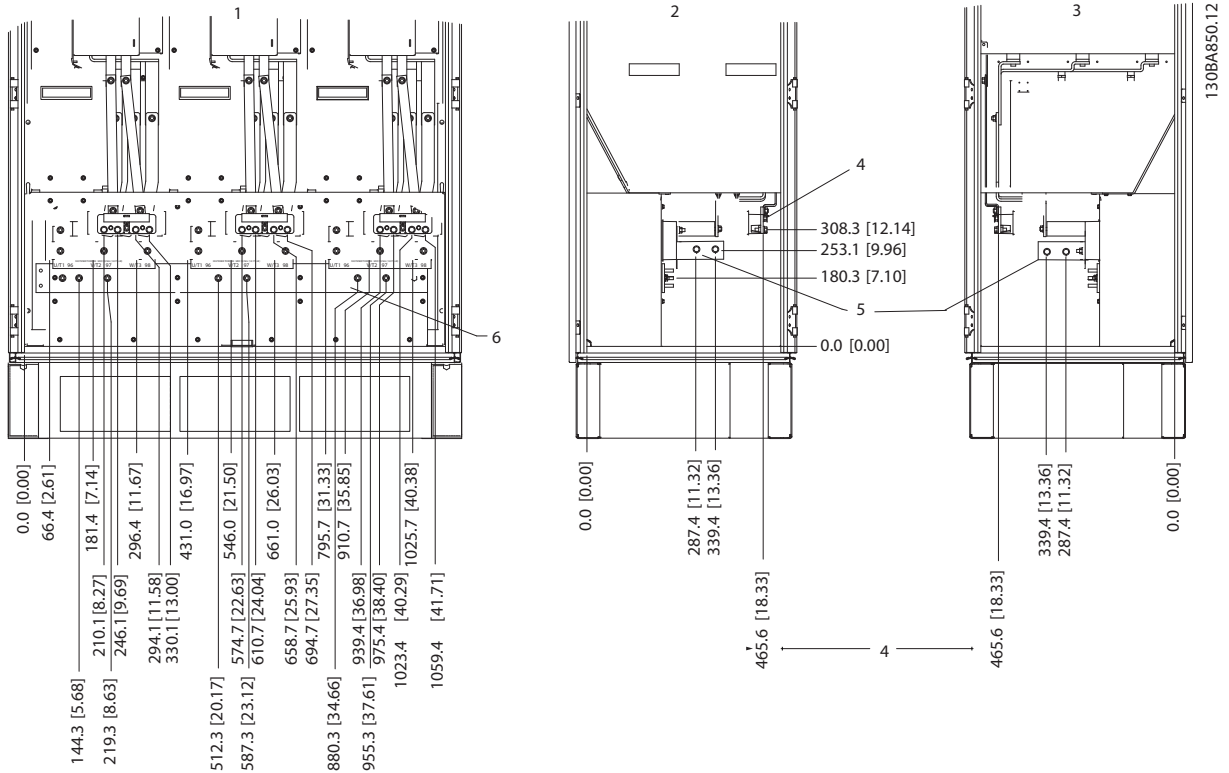
1	Ground bar

Illustration 3.26 Terminal Locations - Inverter Cabinet - F2 and F4 (Front, Left and Right Side View). The Gland Plate is 42 mm below .0 Level.

3
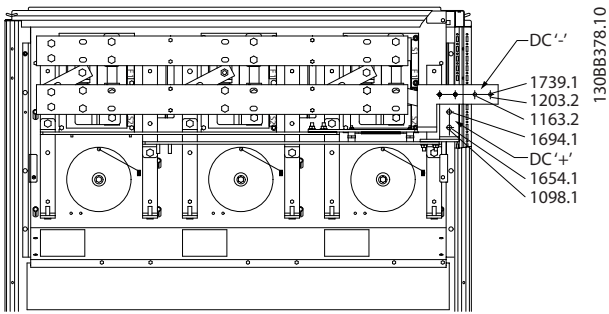
Illustration 3.27 Terminal Locations - Regen Terminals - F2 and F4

DC '-'
1739.1
1203.2
1163.2
1694.1
DC '+'
1654.1
1098.1

130BB378.10

Terminal locations - rectifier (F1, F2, F3 and F4)

130BA848.12

435.5 [17.15]
343.1 [13.51]
193.9 [7.64]
70.4 [2.77]
0.0 [0.00]

A
B

188.6 [7.42]
136.6 [5.38]
90.1 [3.55]
38.1 [1.50]
0.0 [0.00]

0.0 [0.0]
74.6 [2.9]
125.8 [4.95]
149.6 [5.89]
183.4 [7.22]
218.6 [8.61]
293.6 [11.56]
362.6 [14.28]
373.4 [14.70]
437.6 [17.23]
486.6 [19.16]

R/L1 91   S/L2 92   T/L3 93

LOAD SHARE LOCATION		
DIM	F1/F2	F3/F4
A	380.5 [14.98]	29.4 [1.16]
B	432.5 [17.03]	81.4 [3.20]
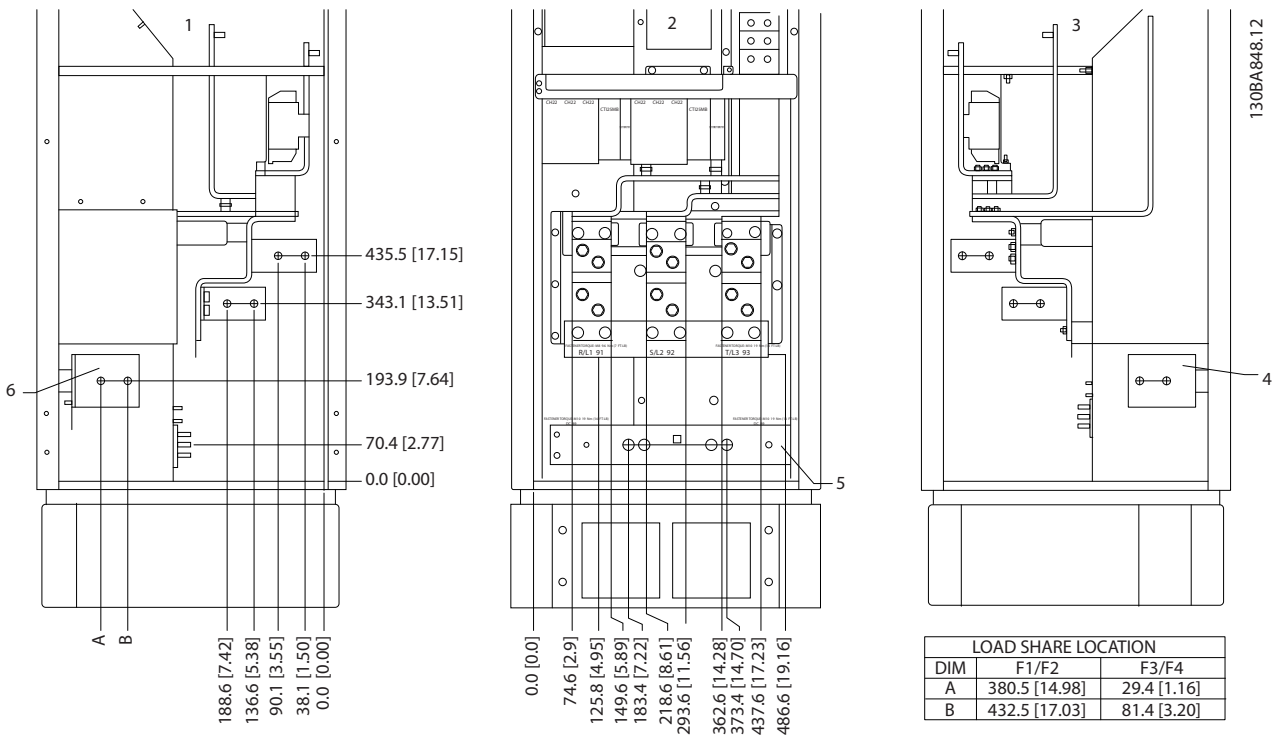
1	Load Share Terminal (-)
2	Ground Bar
3	Load Share Terminal (+)

Illustration 3.28 Terminal Locations - Rectifier (Left Side, Front and Right Side View). The Gland Plate is 42 mm below .0 Level.

24   MG11F502

Terminal locations - options cabinet (F3 and F4)
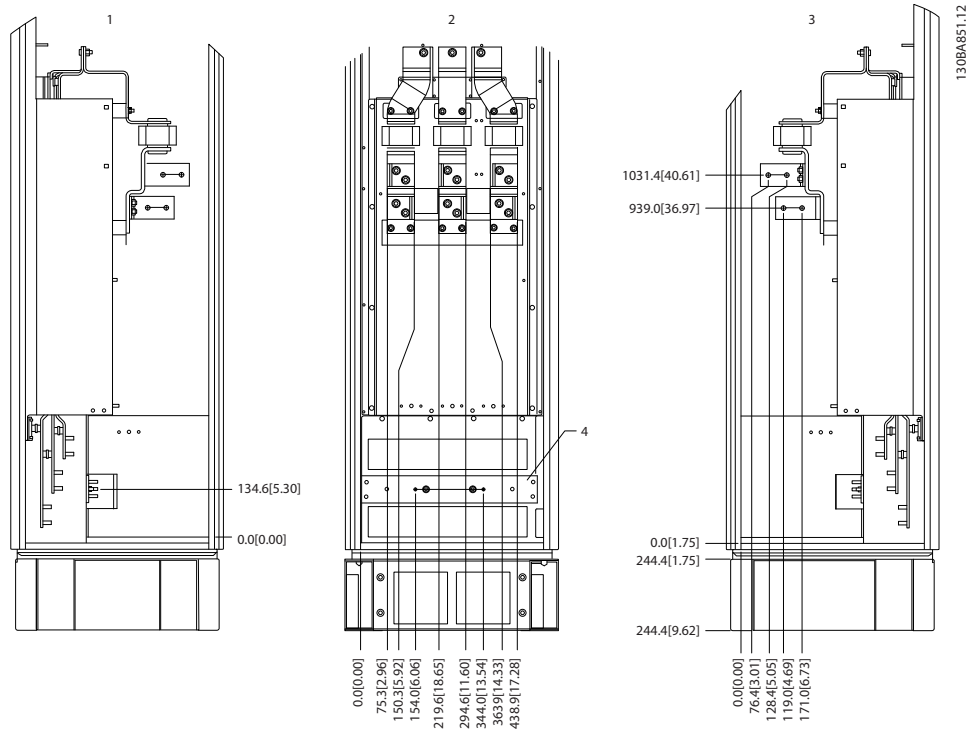
1	Ground bar

Illustration 3.29 Terminal Locations - Options Cabinet (Left Side, Front and Right Side View). The Gland Plate is 42 mm below .0 Level.

Terminal locations - options cabinet with circuit breaker/moulded case switch (F3 and F4)
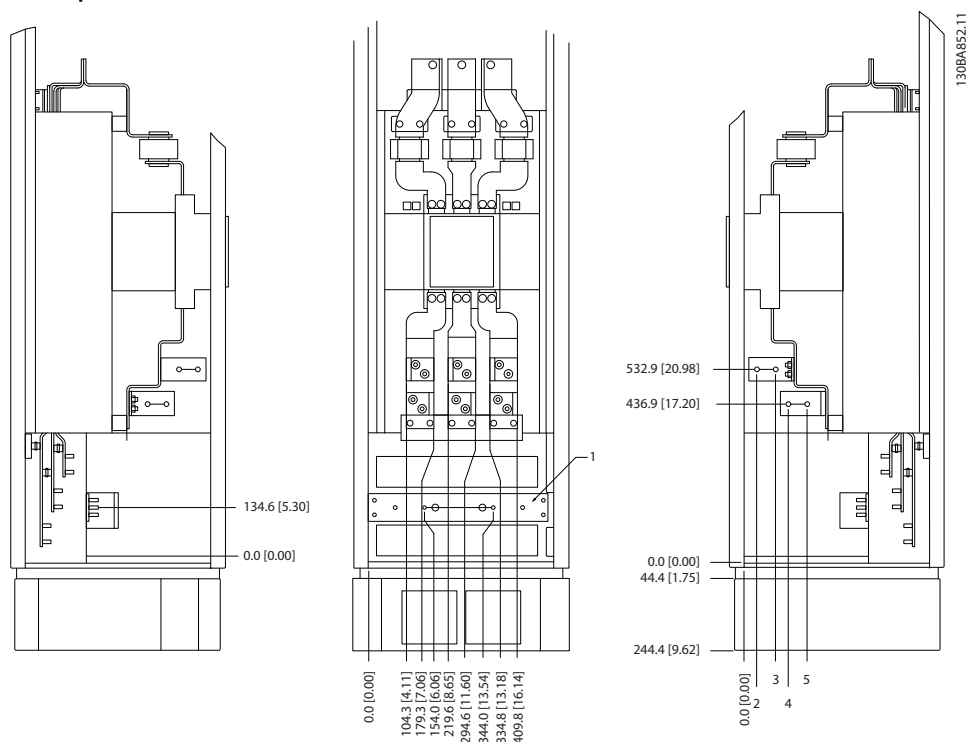
1	Ground bar

Illustration 3.30 Terminal Locations - Options Cabinet with Circuit Breaker/Moulded Case Switch (Left Side, Front and Right Side View). The Gland Plate is 42 mm below .0 Level.

Power size	2	3	4	5
500 kW (480 V), 710–800 kW (690 V)	34.9	86.9	122.2	174.2
560–1000 kW (480 V), 900–1400 kW (690 V)	46.3	98.3	119.0	171.0

Table 3.7 Dimensions for Terminal

3.3.5 Cooling and Airflow

Cooling

Cooling can be obtained in different ways:

- By using the cooling ducts at the bottom and top of the unit.

- By adding and removing air from the back of the unit.

- By combining the cooling possibilities.

Duct cooling

A dedicated option has been developed to optimise installation of IP00/chassis frequency converters in Rittal TS8 enclosures. The option uses the fan of the frequency converter for forced air cooling of the backchannel. Air that escapes from the top of enclosure could be ducted outside a facility. Then heat losses from the backchannel are not dissipated within the control room, reducing air-conditioning requirements of the facility.

See *chapter 3.4.1 Installation of Duct Cooling Kit in Rittal Enclosures*, for further information.

Back cooling

The backchannel air can also be ventilated in and out the back of a Rittal TS8 enclosure. Such back cooling 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.

⚠CAUTION

Install a door fan on the enclosure to remove the heat losses not contained in the backchannel of the frequency converter and any additional losses generated from other components installed inside the enclosure. Calculate the total required airflow to select the appropriate fans. Some enclosure manufacturers offer software for performing the calculations (Rittal Therm software). If the frequency converter is the only heat-generating component in the enclosure, the minimum airflow required at an ambient temperature of 45 °C for the E2 frequency converter is 782 m³/h (460 cfm).

Airflow

Provide sufficient airflow over the heat sink. The flow rate is shown in *Table 3.8*.

Enclosure protection rating	Enclosure size	Door fan/ top fan airflow	Heat sink fan
IP21/NEMA 1 IP54/NEMA 12	E1 P315T4, P450T7, P500T7	340 m³/h (200 cfm)	1105 m³/h (650 cfm)
	E1 P355-P450T4, P560-P630T7	340 m³/h (200 cfm)	1445 m³/h (850 cfm)
IP21/NEMA 1	F1, F2, F3 and F4	700 m³/h (412 cfm)*	985 m³/h (580 cfm)*
IP54/NEMA 12	F1, F2, F3 and F4	525 m³/h (309 cfm)*	985 m³/h (580 cfm)*
IP00/Chassis	E2 P315T4, P450T7, P500T7	255 m³/h (150 cfm)	1105 m³/h (650 cfm)
	E2 P355-P450T4, P560-P630T7	255 m³/h (150 cfm)	1445 m³/h (850 cfm)
* Airflow per fan. Enclosure type F contains multiple fans.			

Table 3.8 Heat Sink Airflow

NOTICE

The fan runs for the following reasons:

- **AMA.**
- **DC Hold.**
- **Pre-Mag.**
- **DC Brake.**
- **60% of nominal current is exceeded.**
- **Specific heat sink temperature is exceeded (power size dependent).**
- **Specific power card ambient temperature is exceeded (power size dependent).**
- **Specific control card ambient temperature is exceeded.**

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

External ducts

If extra duct work is added externally to the Rittal cabinet, calculate the pressure drop in the ducting. Use the following charts to derate the frequency converter according to the pressure drop.
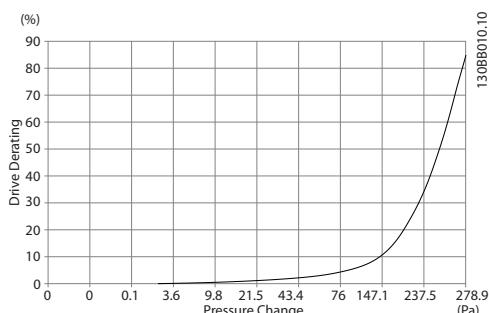
Illustration 3.31 E Enclosure Derating vs. Pressure Change (Small Fan), P315T4 and P450T7-P500T7
Frequency Converter Airflow: 650 cfm (1105 m³/h)
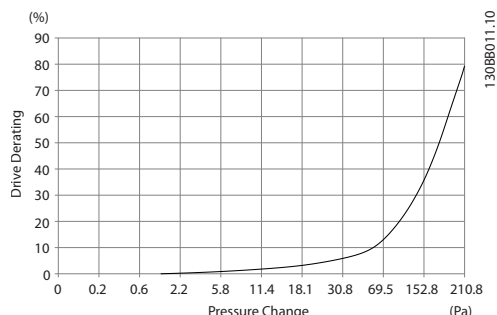
Illustration 3.32 E Enclosure Derating vs. Pressure Change (Large Fan), P355T4-P450T4 and P560T7-P630T7
Frequency Converter Airflow: 850 cfm (1445 m³/h)
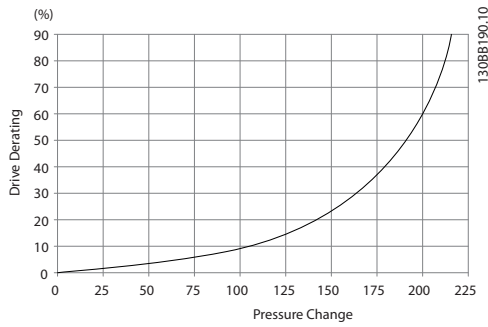
Illustration 3.33 F1, F2, F3, F4 Enclosures Derating vs. Pressure Change

Frequency Converter Airflow: 580 cfm (985 m³/h)

3.3.6 Gland/Conduit Entry - IP21 (NEMA 1) and IP54 (NEMA12)

Cables are connected through the gland plate from the bottom. Remove the plate and plan where to place the entry for the glands or conduits. Prepare holes in the marked area in *Illustration 3.35* to *Illustration 3.39*.

NOTICE

The gland plate must be fitted to the frequency converter to ensure the specified protection degree, as well as ensuring proper cooling of the unit. If the gland plate is not mounted, the frequency converter may trip on Alarm 69, Pwr. Card Temp
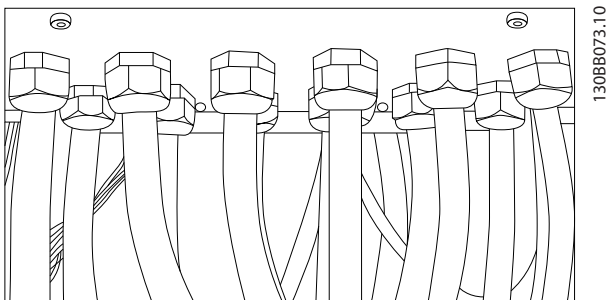
Illustration 3.34 Example of Proper Installation of Gland Plate

Cable entries viewed from the bottom of the frequency converter - 1) Mains side 2) Motor side
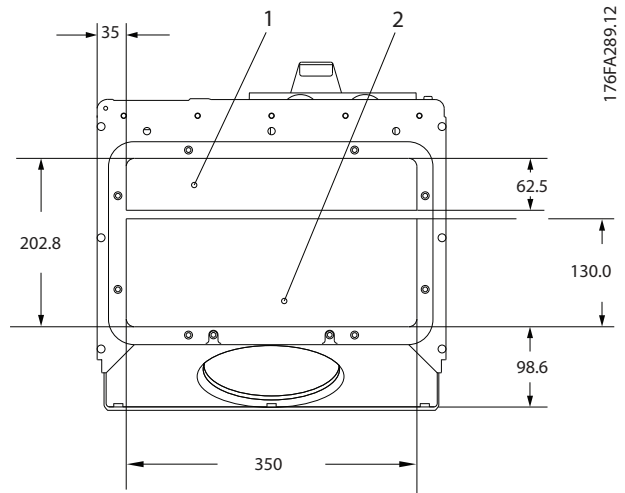
Illustration 3.35 Enclosure Size E1

Enclosure sizes F1-F4: Cable entries viewed from the bottom of the frequency converter - 1) Place conduits in marked areas
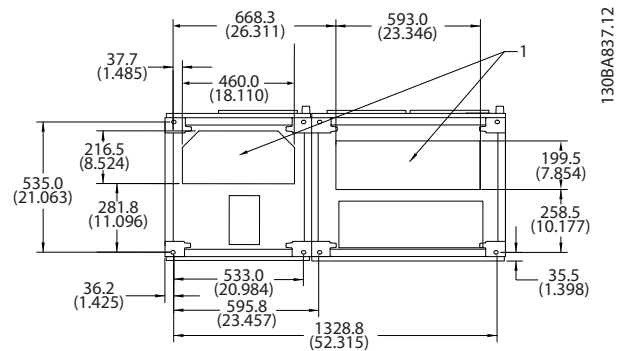
Illustration 3.36 Enclosure Size F1

3

3.4 Field Installation of Options

3.4.1 Installation of Duct Cooling Kit in Rittal Enclosures

This section deals with the installation of IP00/chassis enclosed frequency converters with duct work cooling kits in Rittal enclosures. In addition to the enclosure, a 200 mm base/plinth is required.
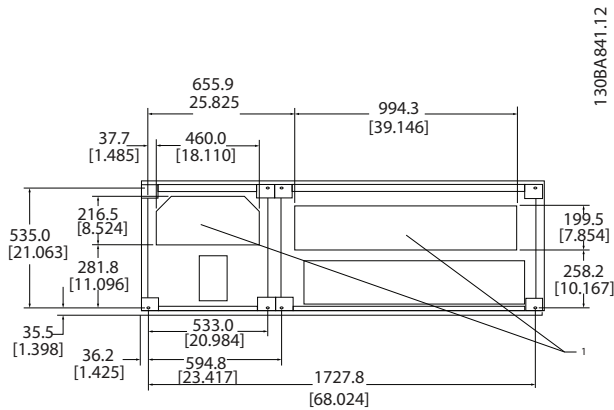
Illustration 3.37 Enclosure Size F2
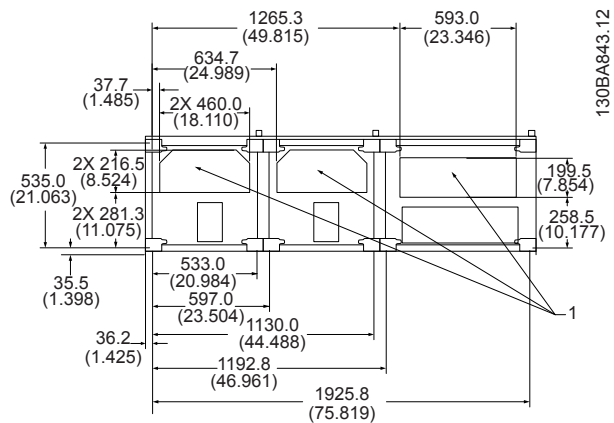
Illustration 3.38 Enclosure Size F3
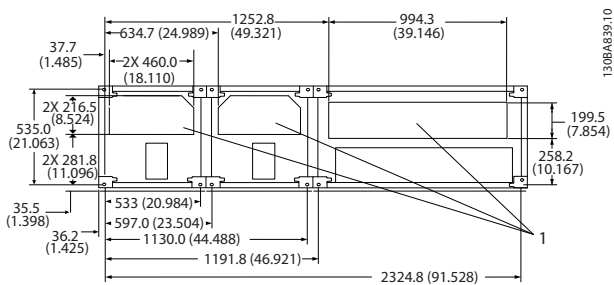
Illustration 3.39 Enclosure Size F4
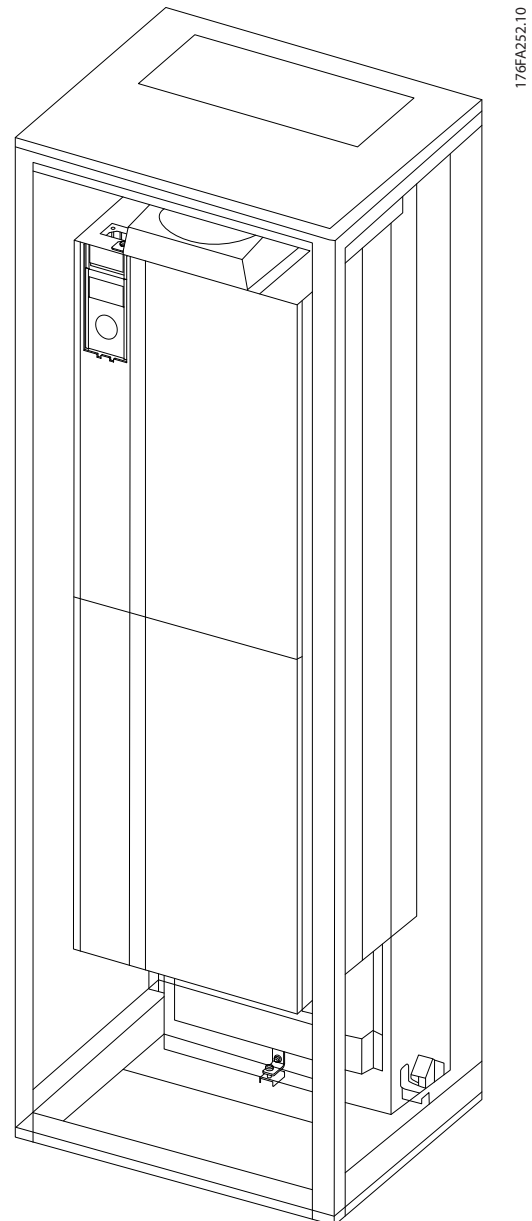
Illustration 3.40 Installation of IP00 in Rittal TS8 Enclosure.

The minimum enclosure dimension is:

- E2 enclosure: Depth 600 mm and width 800 mm.

The maximum depth and width are as required by the installation. When using multiple frequency converters in 1 enclosure, mount each frequency converter on its own

3

back panel and support it along the mid-section of the panel. These duct work kits do not support the "in frame" mounting of the panel (see Rittal TS8 catalogue for details). The duct work cooling kits listed in *Table 3.9* are suitable for use only with IP00/Chassis frequency converters in Rittal TS8 IP20 and UL and NEMA 1 and IP54, and UL and NEMA 12 enclosures.

⚠CAUTION

For the E2 enclosures, it is important to mount the plate at the absolute rear of the Rittal enclosure due to the weight of the frequency converter.

⚠CAUTION

Install a door fan on the enclosure to remove the heat losses not contained in the backchannel of the frequency converter and any additional losses generated from other components installed inside the enclosure. Calculate the total required airflow to select the appropriate fans. Some enclosure manufacturers offer software for performing the calculations (Rittal Therm software). If the frequency converter is the only heat-generating component in the enclosure, the minimum airflow required at an ambient temperature of 45 °C for the E2 frequency converter is 782 m³/h (460 cfm).

Rittal TS-8 Enclosure	Enclosure size E2 part no.
1800 mm	Not possible
2000 mm	176F1850
2200 mm	176F0299

Table 3.9 Ordering Information

External ducts
If extra duct work is added externally to the Rittal cabinet, calculate the pressure drop in the ducting. See *chapter 3.3.5 Cooling and Airflow* for further information.

3.4.2 Installation of Top-only Duct Cooling Kit

This description is for the installation of the top section only of the backchannel cooling kits available for enclosure size E2. In addition to the enclosure, a 200 mm vented pedestal is required.
The minimum enclosure depth is 500 mm (600 mm for enclosure size E2) and the minimum enclosure width is 600 mm (800 mm for enclosure size E2). The maximum depth and width are as required by the installation. When using multiple frequency converters in 1 enclosure, mount each frequency converter on its own back panel and support it along the mid-section of the panel. The backchannel cooling kits are similar in construction for all enclosures. The E2 kit is mounted "in frame" for extra support of the frequency converter.

Using these kits as described removes 85% of the losses via the backchannel using the frequency converter's main heat sink fan. Remove the remaining 15% via the enclosure door.

NOTICE

See the *Top-only Back-Channel Cooling Kit Instruction, 175R1107,* for further information.

Ordering information

- Enclosure type E2: 176F1776

3.4.3 Installation of Top and Bottom Covers for Rittal Enclosures

The top and bottom covers, installed onto IP00 frequency converters, direct the heat sink cooling air in and out the back of the frequency converter. The kits are applicable to enclosure type E2, IP00. These kits are designed and tested to be used with IP00/Chassis frequency converters in Rittal TS8 enclosures.

Notes:
1. If external duct work is added to the exhaust path of the frequency converter, extra back pressure reduces the cooling of the frequency converter. Derate the frequency converter to accommodate the reduced cooling. First, calculate the pressure drop, then refer to *Illustration 3.31* to *Illustration 3.33*.

2. A door fan is required on the enclosure to remove the heat losses not contained in the backchannel of the frequency converter and any additional losses generated from other components installed inside the enclosure. Calculate the total required airflow to select the appropriate fans. Some enclosure manufacturers offer software for performing the calculations (Rittal Therm software).
   If the frequency converter is the only heat-generating component in the enclosure, the minimum airflow required at an ambient temperature of 45 °C for the enclosure size E2 frequency converter is 782 m³/h (460 cfm).

NOTICE

See the instruction for *Top and Bottom Covers - Rittal Enclosure, 177R0076,* for further information.

Ordering information

- Enclosure size E2: 176F1783

3.4.4 Installation of Top and Bottom Covers

Top and bottom covers can be installed on enclosure size E2. These kits direct the backchannel airflow in and out the back of the frequency converter instead of directing the airflow in at the bottom and out at the top of the frequency converter (when the frequency converters are being mounted directly on a wall or inside a welded enclosure).

Notes:

1. If external duct work is added to the exhaust path of the frequency converter, extra back pressure reduces the cooling of the frequency converter. Derate the frequency converter to accommodate the reduced cooling. Calculate the pressure drop, then refer to *Illustration 3.31* to *Illustration 3.33*.

2. A door fan is required on the enclosure to remove the heat losses not contained in the backchannel of the frequency converter and any additional losses generated from other components installed inside the enclosure. Calculate the total required airflow to select the appropriate fans. Some enclosure manufacturers offer software for performing the calculations (Rittal Therm software).
    If the frequency converter is the only heat-generating component in the enclosure, the minimum airflow required at an ambient temperature of 45 °C for the enclosure size E2 frequency converter is 782 m^3/h (460 cfm).

NOTICE

See the *Top and Bottom Covers Only Instruction, 175R1106,* for further information.

Ordering information

- Enclosure size E2: 176F1861

3.4.5 Outside Installation/NEMA 3R Kit for Rittal Enclosures
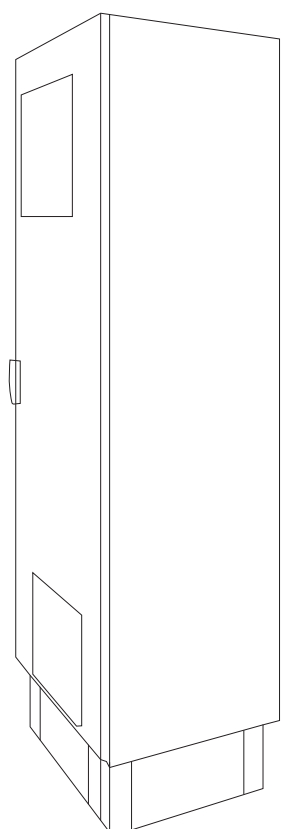
Illustration 3.41 Rittal Enclosure Size E2

This section is for the installation of NEMA 3R kits available for the frequency converter enclosure size E2. These kits are designed and tested to be used with IP00/Chassis versions of these enclosure sizes in Rittal TS8 NEMA 3R or NEMA 4 enclosures. The NEMA 3R enclosure is an outdoor enclosure that provides a degree of protection against rain and ice. The NEMA 4 enclosure is an outdoor enclosure that provides a greater degree of protection against weather and hosed water.
The minimum enclosure depth is 500 mm (600 mm for enclosure size E2) and the kit is designed for a 600 mm (800 mm for enclosure size E2) wide enclosure. Other enclosure widths are possible, however extra Rittal hardware is required. The maximum depth and width are as required by the installation.

3

NOTICE

Frequency converters in enclosure type E2 require no derating.

NOTICE

Install a door fan on the enclosure to remove the heat losses not contained in the backchannel of the frequency converter and any additional losses generated from other components installed inside the enclosure. Calculate the total required airflow to select the appropriate fans. Some enclosure manufacturers offer software for performing the calculations (Rittal Therm software). If the frequency converter is the only heat-generating component in the enclosure, the minimum airflow required at an ambient temperature of 45 °C for the E2 frequency converter is 782 m^3/h (460 cfm).

Ordering information

- Enclosure size E2: 176F1884

3.4.6 Outside Installation/NEMA 3R Kit for Industrial Enclosures

The kits are available for the enclosure size E2. These kits are designed and tested to be used with IP00/Chassis frequency converters in welded-box construction enclosures with an environmental rating of NEMA 3R or NEMA 4. The NEMA 3R enclosure is a dust-tight, rain-tight, ice-resistant, outdoor enclosure. The NEMA 4 enclosure is a dust-tight and water-tight enclosure.
This kit has been tested and complies with UL environmental rating Type 3R.

NOTICE

Enclosure size E2 frequency converters require no derating when installed in a NEMA 3R enclosure.

NOTICE

See the instruction for *Outside Installation/NEMA 3R Kit for Industrial Enclosures, 175R1068,* for further information.

Ordering information

- Enclosure size E2: 176F0298

3.4.7 Installation of IP00 to IP20 Kits

The kits can be installed on enclosure size E2 frequency converters (IP00).

⚠CAUTION

See the instruction for *Installation of IP20 Kits, 175R1108,* for further information.

Ordering information

- Enclosure size E2: 176F1884

3.4.8 Installation of IP00 E2 Cable Clamp Bracket

The motor cable clamp brackets can be installed on enclosure types E2 (IP00).

NOTICE

See the instruction for *Cable Clamp Bracket Kit, 175R1109,* for further information.

Ordering information

- Enclosure size E2: 176F1745

3.4.9 Installation of Mains Shield for Frequency Converters

This section describes the installation of a mains shield for the frequency converter series with enclosure size E1. It is not possible to install in the IP00/Chassis versions as they have included a metal cover as standard. These shields meet VBG-4 requirements.

Ordering information:

- Enclosure size E1: 176F1851

3

3.4.10 Enclosure Size F USB Extension Kit

A USB extension cable can be installed into the door of F-frame frequency converters.

Ordering information:

- 176F1784

3.4.11 Installation of Input Plate Options

This section describes the field installation of input option kits available for frequency converters in all E enclosures.
Do not attempt to remove RFI filters from input plates. Damage may occur to RFI filters if they are removed from the input plate.

NOTICE

2 different types of RFI filters are available, depending on the input plate combination and the RFI filters interchangeable. Field installable kits are, in certain cases, the same for all voltages.

NOTICE

For further information, see the *Instruction Sheet, 177R0091*.

	380–480 V 380-500 V	Fuses	Disconnect fuses	RFI	RFI fuses	RFI disconnect fuses
E1	FC 102/FC 202: 315 kW FC 302: 250 kW	176F0253	176F0255	176F0257	176F0258	176F0260
	FC 102/FC 202: 355–450 kW FC 302: 315–400 kW	176F0254	176F0256	176F0257	176F0259	176F0262

Table 3.10 Fuses, Enclosure Size E1 380-500 V

	525–690 V	Fuses	Disconnect fuses	RFI	RFI fuses	RFI disconnect fuses
E1	FC 102/FC 202: 450–500 kW FC 302: 355–400 kW	176F0253	176F0255	NA	NA	NA
	FC 102/FC 202: 560–630 kW FC 302: 500–560 kW	176F0254	176F0258	NA	NA	NA

Table 3.11 Fuses, Enclosure Size E1 525-690 V

NOTICE

For further information, see the Instruction *Installation of Field Installable Kits for VLT Drives*.

3.4.12 Installation of E Load Share Option

The load share option can be installed on enclosure size E2.

Ordering information

- Enclosure type E1/E2: 176F1843

3.5 Enclosure Type F Panel Options

3.5.1 Enclosure Type F Options

Space heaters and thermostat
Mounted on the cabinet interior of enclosure size F frequency converters, space heaters controlled via automatic thermostat help control humidity inside the enclosure. This control extends the lifetime of frequency converter components in damp environments. 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 enclosure size F frequency converters increases visibility during servicing and maintenance. The housing light includes a power outlet, which temporarily powers 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 and 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, and a 525–690 V frequency converter is set to the 690 V tap. This setting ensures that no overvoltage of secondary equipment occurs if the tap is not changed before power is applied. See *Table 3.12* to set the proper tap at terminal T1 located in the rectifier cabinet. For location in the frequency converter, see *Illustration 4.1*.

Input voltage range [V]	Tap to select
380–440	400 V
441–490	460 V
491–550	525 V
551–625	575 V
626–660	660 V
661–690	690 V

Table 3.12 Setting of Transformer Tap

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 labelled to the specifications of the NAMUR standard for frequency converter input and output terminals. This requires VLT PTC Thermistor Card MCB 112 and VLT Extended Relay Card MCB 113.

RCD (residual current device)
To monitor ground fault currents in grounded and high-resistance grounded systems (TN and TT systems in IEC terminology), use the core balance method. There is a pre-warning (50% of main alarm setpoint) and a main alarm setpoint. Associated with each setpoint is an SPDT alarm relay for external use. It requires an external "window-type" current transformer (supplied and installed by customer).

- Integrated into the frequency converter's safe-stop 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].

IRM (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. Associated with each setpoint is an SPDT alarm relay for external use.

NOTICE

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

- Integrated into the frequency converter's safe-stop circuit.

- LCD display of the ohmic value of the insulation resistance.

- Fault memory.

- [INFO], [TEST], and [RESET].

IEC emergency stop with Pilz safety relay
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 with the frequency converter's safe-stop circuit and the mains contactor located in the options cabinet.

STO + Pilz Relay
STO + Pilz Relay provides a solution for the "Emergency Stop" option without the contactor in F enclosure frequency converters.

Manual motor starters
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 start, and is off when the incoming power to the frequency converter is off. Up to 2

starters are allowed (one if a 30 A, fuse-protected circuit is ordered). The motor starters are integrated into the frequency converter's safe-stop 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 are provided from the load side of any supplied contactor, circuit breaker, or disconnect switch.

24 V DC power supply

- 5 A, 120 W, 24 V DC.

- Protected against output overcurrent, overload, short circuits, and overtemperature.

- For powering customer-supplied accessory devices such as sensors, PLC I/O, contactors, temperature probes, indicator lights, and/or other electronic hardware.

- Diagnostics include a dry DC-ok contact, a green DC-ok LED, and a red overload LED.

External temperature monitoring

External temperature monitoring, designed for monitoring temperatures of external system components, such as the motor windings and/or bearings. It includes 5 universal input modules. The modules are integrated into the frequency converter's safe-stop circuit and can be monitored via a fieldbus network (requires the purchase of a separate module/bus coupler).

Universal inputs (5)

Signal types:
- RTD inputs (including PT100), 3-wire or 4-wire.

- Thermocouple.

- Analog current or analog voltage.

Extra features:
- 1 universal output, configurable for analog voltage or analog current.

- 2 output relays (N.O.).

- Dual-line LC display and LED diagnostics.

- Sensor lead wire break, short circuit, and incorrect polarity detection.

- Interface set-up software.

4 Electrical Installation

4.1 Electrical Installation

4.1.1 Power Connections

Cabling and fusing

NOTICE

Cables in General

All cabling must comply with national and local regulations on cable cross-sections and ambient temperature. UL applications require 75 °C copper conductors. 75 °C and 90 °C copper conductors are thermally acceptable for the frequency converter to use in non-UL applications.

The power cable connections are located as shown in *Illustration 4.1*. Dimensioning of cable cross-section must be done in accordance with the current ratings and local legislation. See *chapter 7 General Specifications* for details.

If the frequency converter does not have built-in fuses, use the recommended fuses to protect it. See *chapter 4.1.15 Fuse Specifications* for recommended fuses. Always ensure that proper fusing is made according to local regulation.

The mains connection is fitted to the mains switch if this switch is included.
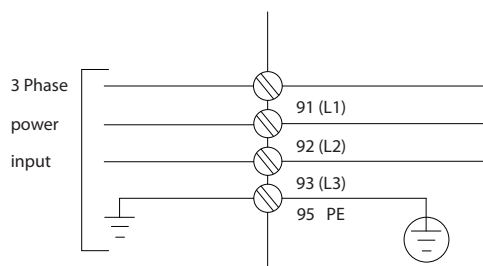
Illustration 4.1 Power Cable Connections

NOTICE

The motor cable must be screened/armoured. If an unscreened/unarmoured cable is used, some EMC requirements are not complied with. To comply with EMC emission specifications, use a screened/armoured motor cable. For more information, see *EMC specifications* in the product-related *design guide*.

See *chapter 7 General Specifications* for correct dimensioning of motor cable cross-section and length.

Screening of cables

Avoid installation with twisted screen ends (pigtails). They spoil the screening effect at higher frequencies. If it is necessary to break the screen to install a motor isolator or motor contactor, continue the screen at the lowest possible HF impedance.

Connect the motor cable screen to both the decoupling plate of the frequency converter and to the metal housing of the motor.

Make the screen connections with the largest possible surface area (cable clamp). These connections are made by using the supplied installation devices within the frequency converter.

Cable length and cross-section

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

Switching frequency

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

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

Table 4.1 Motor Terminals

1) Protected Ground Connection

NOTICE

In motors without phase insulation paper or other insulation reinforcement suitable for operation with voltage supply (such as a frequency converter), fit a sine-wave filter on the frequency converter output.
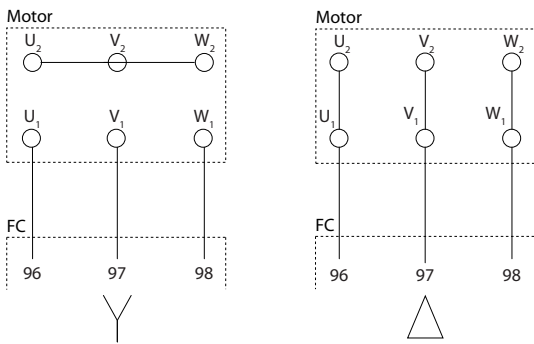
Illustration 4.2 Star/Delta Connections
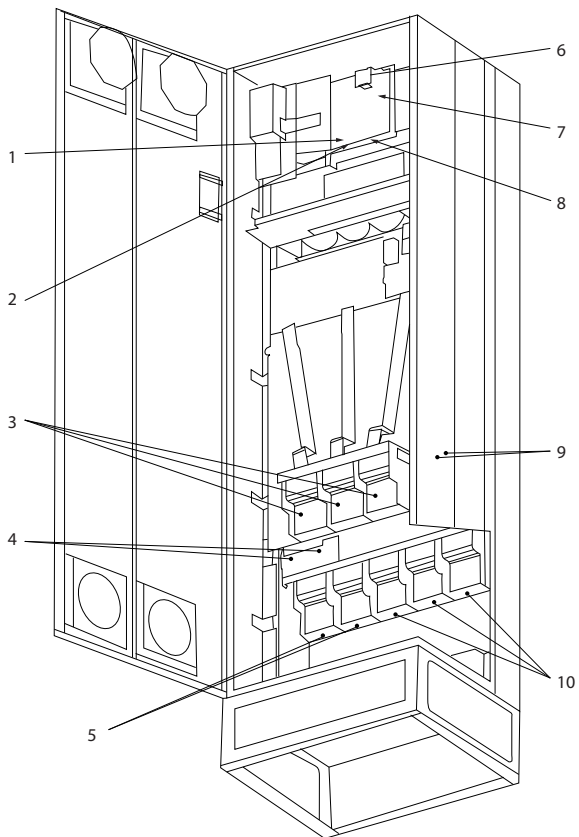
Illustration 4.3 Compact IP21 (NEMA 1) and IP54 (NEMA 12) Enclosure Type E1
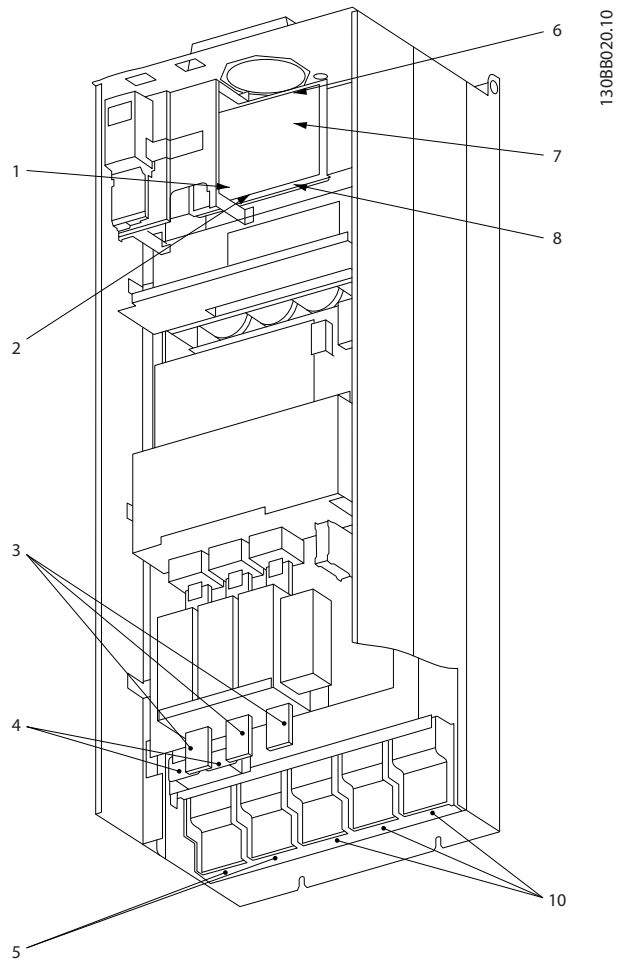
Illustration 4.4 Compact IP00 (Chassis) with Disconnect, Fuse and RFI Filter, Enclosure Type E2

1)	AUX relay					5)	Load sharing			
	01	02	03				-DC	+DC		
	04	05	06				88	89		
2)	Temp switch					6)	SMPS fuse (see *Table 4.18* for part number)			
	106	104	105			7)	Fan fuse (see *Table 4.19* for part number)			
3)	Mains					8)	AUX fan			
	R	S	T				100	101	102	103
	91	92	93				L1	L2	L1	L2
	L1	L2	L3			9)	Mains ground			
4)	Brake					10)	Motor			
	-R	+R					U	V	W	
	81	82					96	97	98	
							T1	T2	T3	

Table 4.2 Legend to *Illustration 4.3* and *Illustration 4.4*
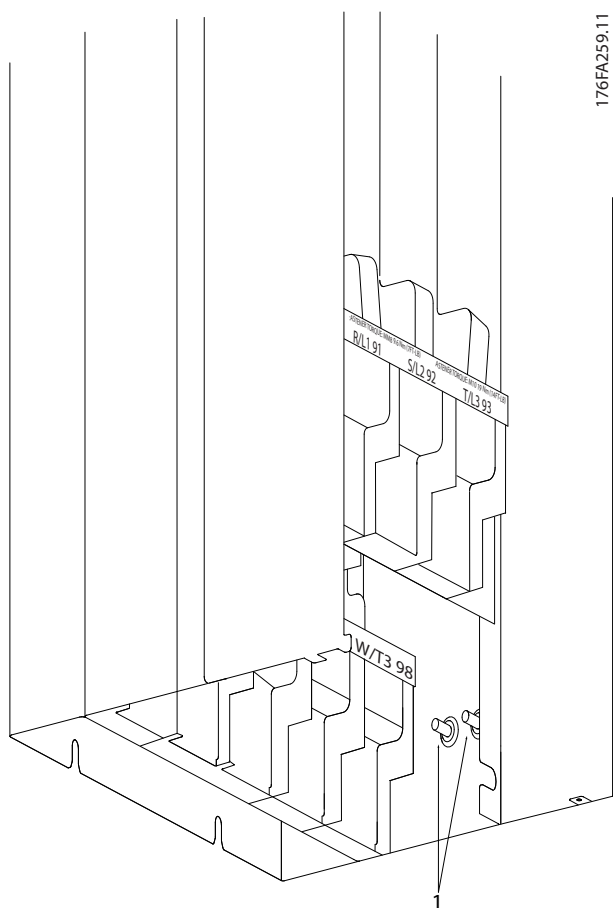
1	Ground terminals

Illustration 4.5 Position of Ground Terminals IP00, Enclosure Type E

130BA860.10
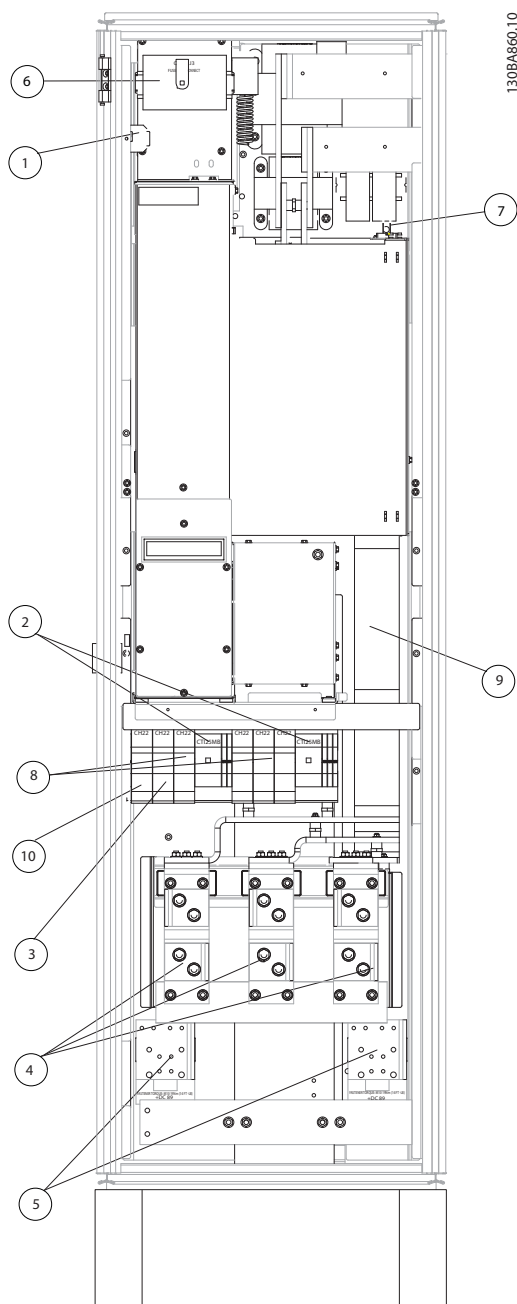
1)	24 V DC, 5 A		5)	Load sharing	
	T1 output taps			-DC +DC	
	Temp switch			88 89	
	106 104 105		6)	Control transformer fuses (2 or 4 pieces) (see *Table 4.22* for part numbers)	
2)	Manual motor starters		7)	SMPS fuse (see *Table 4.18* for part numbers)	
3)	30 A fuse-protected power terminals		8)	Manual motor controller fuses (3 or 6 pieces) (see *Table 4.20* for part numbers)	
4)	Mains		9)	Mains fuses, enclosure types F1 and F2 (3 pieces) (see *Table 4.12* to *Table 4.16* for part numbers)	
	R S T		10)	30 Amp fuse-protected power fuses	
	L1 L2 L3				

Illustration 4.6 Rectifier Cabinet, Enclosure Types F1, F2, F3 and F4

130BA861.11

1)	External temperature monitoring		6)	Motor		
2)	AUX relay			U	V	W
	01	02	03		96	97	98
	04	05	06		T1	T2	T3
3)	NAMUR		7)	NAMUR fuse (see *Table 4.23* for part numbers)		
4)	AUX fan		8)	Fan fuses (See *Table 4.19* for part numbers)		
	100	101	102	103	9)	SMPS fuses (See *Table 4.18* for part numbers)	
	L1	L2	L1	L2		
5)	Brake					
	-R	+R				
	81	82				

Illustration 4.7 Inverter Cabinet, Enclosure Types F1 and F3

130BA862.12

1)	External temperature monitoring		6)	Motor		
2)	AUX relay			U	V	W
	01 02 03			96	97	98
	04 05 06			T1	T2	T3
3)	NAMUR		7)	NAMUR fuse (see *Table 4.23* for part numbers)		
4)	AUX fan		8)	Fan fuses (see *Table 4.19* for part numbers)		
	100 101 102 103		9)	SMPS fuses (see *Table 4.18* for part numbers)		
	L1 L2 L1 L2					
5)	Brake					
	-R +R					
	81 82					

Illustration 4.8 Inverter Cabinet, Enclosure Types F2 and F4

4

130BA853.12
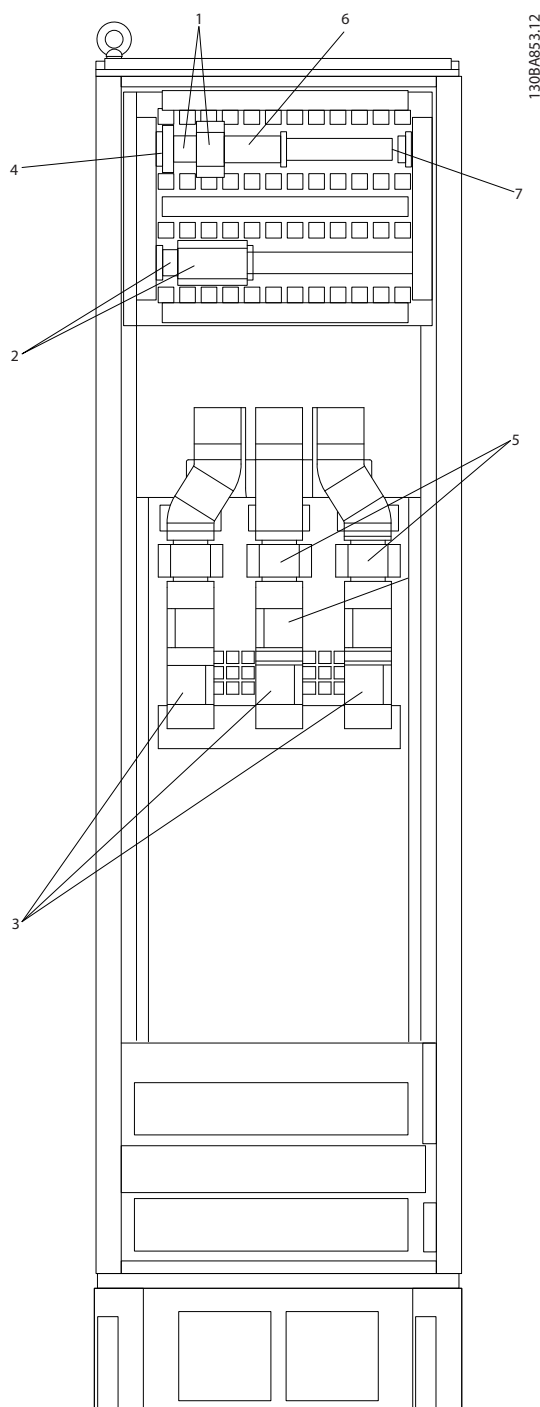
1)	Pilz relay terminal		4)	Safety relay coil fuse with PILZ relay (see *Table 4.24* for part numbers)
2)	RCD or IRM terminal			
3)	Mains		5)	Mains fuses, F3 and F4 (3 pieces) (see *Table 4.12* to *Table 4.16* for part numbers)
	R S T			
	91 92 93		6)	Contactor relay coil (230 VAC). N/C and N/O Aux contacts (customer supplied)
	L1 L2 L3		7)	Circuit breaker shunt trip control terminals (230 V AC or 230 V DC)

Illustration 4.9 Options Cabinet, Enclosure Types F3 and F4

4.1.2 Grounding

To obtain electromagnetic compatibility (EMC), consider the following during installation:

- Safety grounding: For safety reasons, ground the frequency converter appropriately due to its high leakage current. Apply 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. The lowest possible conductor impedance is obtained by keeping the conductor as short as possible and by using the greatest possible surface area.
The metal cabinets of the different devices are mounted on the cabinet rear plate using the lowest possible HF impedance. Different HF voltages are then avoided for the individual devices. Also the risk of radio interference currents running in connection cables that may be used between the devices is avoided. The radio interference has been reduced.
To obtain a low HF impedance, use the fastening bolts of the devices as HF connection to the rear plate. It is necessary to remove insulating paint or similar from the fastening points.

4.1.3 Extra Protection (RCD)

If local safety regulations are complied with, ELCB relays, multiple protective earthing, or grounding can be used as extra protection.

A ground fault may cause a DC component to develop in the fault current.

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

See also *Special Conditions* in the product relevant *design guide*.

4.1.4 RFI Switch

Mains supply isolated from ground
If the frequency converter is supplied from an isolated mains source (IT mains, floating delta and grounded delta) or TT/TN-S mains with grounded leg, turn off the RFI switch via *14-50 RFI Filter* on both the frequency converter and the filter. For further reference, see IEC 364-3.

Set *14-50 RFI Filter* to [ON]

- If optimum EMC performance is needed.

- Parallel motors are connected.

- The motor cable length is above 25 m.

In OFF, the internal RFI capacities (filter capacitors) between the enclosure and the intermediate circuit are cut off to avoid damage to the intermediate circuit and to reduce the ground capacity currents (according to IEC 61800-3).
Also refer to the Application Note *VLT on IT Mains*. It is important to use isolation monitors suited for power electronics (IEC 61557-8).

4.1.5 Torque

Tighten all electrical connections with the correct torque. Too low or too high torque results in a bad electrical connection. To ensure correct torque, use a torque wrench.
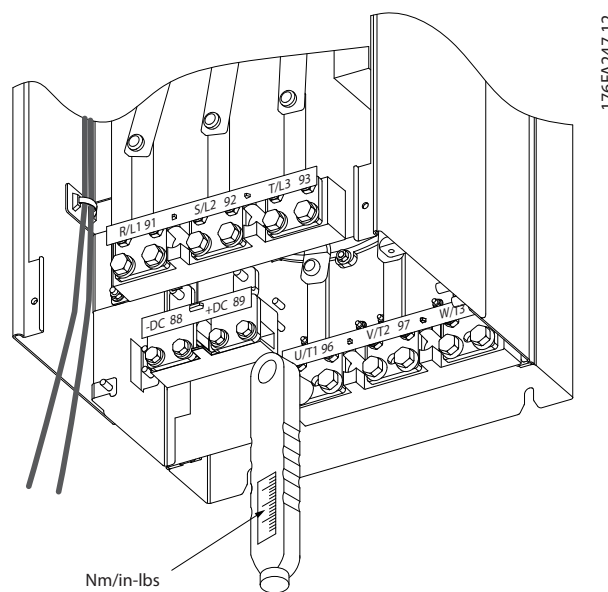
Illustration 4.10 Tighten Bolts with a Torque Wrench

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

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

Table 4.3 Torque for Terminals

4.1.6 Screened Cables

⚠WARNING

Danfoss recommends using screened cables between the LCL filter and the frequency converter. Unshielded cables can be used between the transformer and the LCL filter input side.

Make sure to connect screened and armoured cables properly to ensure high EMC immunity and low emissions.

The connection can be made using either cable glands or clamps.

- EMC cable glands: Available cable glands can be used to ensure optimum EMC connection.

- EMC cable clamp: Clamps allowing easy connection are supplied with the frequency converter.

4.1.7 Motor Cable

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

Terminal number	Function
96, 97, 98	Mains U/T1, V/T2, W/T3
99	Ground

Table 4.4 Mains Terminals

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

Table 4.5 Wiring for Motor Directions

The direction of rotation can be changed by switching 2 phases in the motor cable or by changing the setting of 4-10 Motor Speed Direction.

To perform motor rotation check, follow the steps in *parameter 1-28 Motor Rotation Check*.

F enclosure requirements
F1/F3 requirements
Attach an equal number of wires to both inverter module terminals. To obtain an equal number, motor phase cable quantities must be multiples of 2, resulting in 2, 4, 6, or 8 (1 cable is not allowed). The cables are required to be of equal length within 10% between the inverter module terminals and the first common point of a phase. The recommended common point is the motor terminals.

F2/F4 requirements: Attach an equal number of wires to both inverter module terminals. To obtain an equal number, motor phase cable quantities must be multiples of 3, resulting in 3, 6, 9, or 12 (1 or 2 cables are not allowed). The wires are required to be of equal length within 10% between the inverter module terminals and the first common point of a phase. The recommended common point is the motor terminals.

Output junction box requirements
The length, minimum 2.5 m, 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 for requirements and documentation, or use the top/bottom entry side enclosure option.

44   MG11F502

4.1.8 Brake Cable for Frequency Converters with Factory-installed Brake Chopper Option

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

Use a screened connection cable to the brake resistor. The maximum length from the frequency converter to the DC bar is limited to 25 m (82 ft).

Terminal number	Function
81, 82	Brake resistor terminals

Table 4.6 Brake Resistor Terminals

The connection cable to the brake resistor must be screened. Connect the screen to the conductive back plate on the frequency converter and to the metal cabinet of the brake resistor with cable clamps.
Size the brake cable cross-section to match the brake torque. See also the Instructions *Brake Resistor* and *Brake Resistors for Horizontal Applications* for further information regarding safe installation.

NOTICE

Depending on the supply voltage, voltages up to 1099 V DC may occur on the terminals.

F enclosure requirements
Connect the brake resistor to the brake terminals in each inverter module.

4.1.9 Brake Resistor Temperature Switch

Torque: 0.5–0.6 Nm (5 in-lbs)
Screw size: M3

This input can be used to monitor the temperature of an externally connected brake resistor. If the input between 104 and 106 is established, the frequency converter trips on *warning/alarm 27, Brake IGBT*. If the connection is closed between 104 and 105, the frequency converter trips on *warning/alarm 27, Brake IGBT*.
Install a Klixon switch that is normally closed. If this function is not used, short-circuit 106 and 104 together.
Normally closed: 104–106 (factory-installed jumper)
Normally open: 104–105

Terminal number	Function
106, 104, 105	Brake resistor temperature switch.

Table 4.7 Terminals for Brake Resister Temperature Switch

NOTICE

If the temperature of the brake resistor becomes too high and the thermal switch drops out, the frequency converter stops braking. The motor starts coasting.

4.1.10 Load Sharing

Terminal number	Function
88, 89	Load sharing

Table 4.8 Terminals for Load Sharing

The connection cable must be screened and the maximum length from the frequency converter to the DC bar is limited to 25 m (82 ft).
Load sharing enables linking of the DC intermediate circuits of several frequency converters.

⚠WARNING

Voltages up to 1099 V DC may occur on the terminals. Load sharing requires extra equipment and safety considerations. For further information, see the instructions *Load Sharing*.

⚠WARNING

Mains disconnect may not isolate the frequency converter due to DC link connection.

4.1.11 Shielding against Electrical Noise

To ensure best EMC performance, mount the EMC metal cover before mounting the mains power cable.

NOTICE

The EMC metal cover is only included in units with an RFI filter.

4
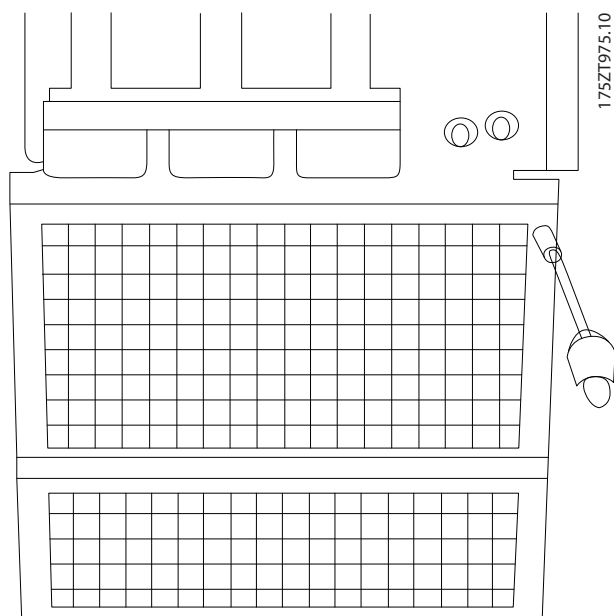
Illustration 4.11 Mounting of EMC Shield

4.1.12 Mains Connection

Connect mains to terminals 91, 92 and 93. Connect ground to the terminal to the right of terminal 93.

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

Table 4.9 Mains Terminals Connection

⚠CAUTION

Check the nameplate to ensure that the mains voltage of the frequency converter matches the power supply of the plant.

Ensure that the supply can supply the necessary current to the frequency converter.

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

4.1.13 External Fan Supply

If the frequency converter is supplied by DC, or if the fan must run independently of the power supply, apply an external power supply. The connection is made on the power card.

Terminal number	Function
100, 101	Auxiliary supply S, T
102, 103	Internal supply S, T

Table 4.10 External Fan Supply Terminals

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

4.1.14 Fuses

Use fuses and/or circuit breakers on the supply side as protection in case of component break-down inside the frequency converter (first fault).

NOTICE

Using fuses and/or circuit breakers is mandatory to ensure compliance with IEC 60364 for CE or NEC 2009 for UL.

⚠WARNING

Protect personnel and property against the consequence of component break-down internally in the frequency converter.

Branch circuit protection
To protect the installation against electrical and fire hazard, protect all branch circuits in an installation, switch gear, machines etc. 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 mentioned in this section to protect service personnel and property in case of component breakdown in the frequency converter.

Overcurrent protection

The frequency converter provides overload protection to limit threats to human life, property damage and to avoid fire hazard due to overheating of the cables. The frequency converter is equipped with an internal overcurrent protection (*4-18 Current Limit*) that can be used for upstream overload protection (UL applications excluded). Moreover, fuses or circuit breakers can be used to provide the overcurrent protection in the installation. Overcurrent protection must always be carried out according to national regulations.

The tables in this section list the recommended rated current. Recommended fuses are of the type gG for small to medium power sizes. For larger powers, aR fuses are recommended. Use circuit breakers that meet the national/

international regulations and that limit the energy into the frequency converter to an equal or lower level than the compliant circuit breakers.

If fuses/circuit breakers are selected according to recommendations, possible damage on the frequency converter is mainly limited to damage inside the unit.

Non-UL compliance

If UL/cUL is not to be complied with, use the following fuses to ensure compliance with EN50178:

P110-P250	380–480 V	type gG
P315-P450	380–480 V	type gR

Table 4.11 EN50178 Fuses

UL Compliance

380–480 V, Enclosure types E and F

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

Size/type	Bussmann PN*	Rating	Ferraz	Siba
P315	170M4017	700 A, 700 V	6.9URD31D08A0700	20 610 32.700
P355	170M6013	900 A, 700 V	6.9URD33D08A0900	20 630 32.900
P400	170M6013	900 A, 700 V	6.9URD33D08A0900	20 630 32.900
P450	170M6013	900 A, 700 V	6.9URD33D08A0900	20 630 32.900

Table 4.12 Enclosure Types E, Mains Fuses, 380–480 V

Size/type	Bussmann PN*	Rating	Siba	Internal Bussmann option
P500	170M7081	1600 A, 700 V	20 695 32.1600	170M7082
P560	170M7081	1600 A, 700 V	20 695 32.1600	170M7082
P630	170M7082	2000 A, 700 V	20 695 32.2000	170M7082
P710	170M7082	2000 A, 700 V	20 695 32.2000	170M7082
P800	170M7083	2500 A, 700 V	20 695 32.2500	170M7083
P1M0	170M7083	2500 A, 700 V	20 695 32.2500	170M7083

Table 4.13 Enclosure Types F, Mains Fuses, 380–480 V

Size/type	Bussmann PN*	Rating	Siba
P500	170M8611	1100 A, 1000 V	20 781 32.1000
P560	170M8611	1100 A, 1000 V	20 781 32.1000
P630	170M6467	1400 A, 700 V	20 681 32.1400
P710	170M6467	1400 A, 700 V	20 681 32.1400
P800	170M8611	1100 A, 1000 V	20 781 32.1000
P1M0	170M6467	1400 A, 700 V	20 681 32.1400

Table 4.14 Enclosure Type F, Inverter Module DC Link Fuses, 380-480 V

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

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

525–690 V, Enclosure types E and F

Size/type	Bussmann PN*	Rating	Ferraz	Siba
P450	170M4017	700 A, 700 V	6.9URD31D08A0700	20 610 32.700
P500	170M4017	700 A, 700 V	6.9URD31D08A0700	20 610 32.700
P560	170M6013	900 A, 700 V	6.9URD33D08A0900	20 630 32.900
P630	170M6013	900 A, 700 V	6.9URD33D08A0900	20 630 32.900

Table 4.15 Enclosure Type E, 525–690 V

Size/type	Bussmann PN*	Rating	Siba	Internal Bussmann option
P710	170M7081	1600 A, 700 V	20 695 32.1600	170M7082
P800	170M7081	1600 A, 700 V	20 695 32.1600	170M7082
P900	170M7081	1600 A, 700 V	20 695 32.1600	170M7082
P1M0	170M7081	1600 A, 700 V	20 695 32.1600	170M7082
P1M2	170M7082	2000 A, 700 V	20 695 32.2000	170M7082
P1M4	170M7083	2500 A, 700 V	20 695 32.2500	170M7083

Table 4.16 Enclosure Type Size F, Mains Fuses, 525–690 V

Size/type	Bussmann PN*	Rating	Siba
P710	170M8611	1100 A, 1000 V	20 781 32. 1000
P800	170M8611	1100 A, 1000 V	20 781 32. 1000
P900	170M8611	1100 A, 1000 V	20 781 32. 1000
P1M0	170M8611	1100 A, 1000 V	20 781 32. 1000
P1M2	170M8611	1100 A, 1000 V	20 781 32. 1000
P1M4	170M8611	1100 A, 1000 V	20 781 32.1000

Table 4.17 Enclosure Type F, Inverter Module DC Link Fuses, 525–690 V

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

Suitable for use on a circuit capable of delivering not more than 100,000 rms symmetrical A, 500/600/690 V maximum when protected by the above fuses.

Supplementary fuses

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

Table 4.18 SMPS Fuse

Size/type	Bussmann PN*	Littelfuse	Rating
P315, 380–480 V	KTK-4		4 A, 600 V
P450-P500, 525–690 V	KTK-4		4 A, 600 V
P355-P1M0, 380–480 V		KLK-15	15A, 600 V
P560-P1M4, 525–690 V		KLK-15	15A, 600 V

Table 4.19 Fan Fuses

4

Size/type	[A]	Bussmann PN*	Rating [V]	Alternative fuses
P500-P1M0, 380–480 V	2.5–4.0	LPJ-6 SP or SPI	6 A, 600	Any listed Class J Dual Element, Time Delay, 6A
P710-P1M4, 525–690 V		LPJ-10 SP or SPI	10 A, 600	Any listed Class J Dual Element, Time Delay, 10 A
P500-P1M0, 380–480 V	4.0–6.3	LPJ-10 SP or SPI	10 A, 600	Any listed Class J Dual Element, Time Delay, 10 A
P710-P1M4, 525–690 V		LPJ-15 SP or SPI	15 A, 600	Any listed Class J Dual Element, Time Delay, 15 A
P500-P1M0, 380–480 V	6.3 - 10	LPJ-15 SP or SPI	15 A, 600	Any listed Class J Dual Element, Time Delay, 15 A
P710-P1M4, 525–690 V		LPJ-20 SP or SPI	20 A, 600	Any listed Class J Dual Element, Time Delay, 20A
P500-P1M0, 380–480 V	10–16	LPJ-25 SP or SPI	25 A, 600	Any listed Class J Dual Element, Time Delay, 25 A
P710-P1M4, 525–690 V		LPJ-20 SP or SPI	20 A, 600	Any listed Class J Dual Element, Time Delay, 20 A

Table 4.20 Manual Motor Controller Fuses

Enclosure size	Bussmann PN*	Rating	Alternative fuses
F	LPJ-30 SP or SPI	30 A, 600 V	Any listed Class J Dual Element, Time Delay, 30 A

Table 4.21 30 A Fuse-protected Terminal Fuse

Enclosure size	Bussmann PN*	Rating	Alternative fuses
F	LPJ-6 SP or SPI	6 A, 600 V	Any listed Class J Dual Element, Time Delay, 6 A

Table 4.22 Control Transformer Fuse

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

Table 4.23 NAMUR Fuse

Enclosure size	Bussmann PN*	Rating	Alternative fuses
F	LP-CC-6	6 A, 600 V	Any listed Class CC, 6 A

Table 4.24 Safety Relay Coil Fuse with PILZ Relay

Enclosure size	Power and voltage	Type
E1/E2	P315 380-480 V & P450-P630 525-690 V	ABB OT600U03
E1/E2	P355-P450 380-480 V	ABB OT800U03
F3	P500 380-480 V & P710-P800 525-690 V	Merlin Gerin NPJF36000S12AAYP
F3	P560-P710 380-480 V & P900 525-690 V	Merlin Gerin NRK36000S20AAYP
F4	P800-P1M0 380-480 V & P1M0-P1M4 525-690 V	Merlin Gerin NRK36000S20AAYP

Table 4.25 Mains Disconnectors Enclosure Sizes E and F

Enclosure size	Power and voltage	Type
F3	P500 380–480 V & P710-P800 525–690 V	Merlin Gerin NPJF36120U31AABSCYP
F3	P560-P710 380–480 V & P900 525–690 V	Merlin Gerin NRJF36200U31AABSCYP
F4	P800 380–480 V & P1M0-P1M4 525–690 V	Merlin Gerin NRJF36200U31AABSCYP
F4	P1M0 380–480 V	Merlin Gerin NRJF36250U31AABSCYP

Table 4.26 Circuit Breakers Enclosure Size F

Enclosure size	Power and voltage	Type
F3	P500-P560 380–480 V & P710-P900 525–690 V	Eaton XTCE650N22A
F3	P 630-P710 380–480 V	Eaton XTCEC14P22B
F4	P800-P1M0 380–480 V & P1M0-P1M4 525–690 V	Eaton XTCEC14P22B

Table 4.27 Mains Contactors Enclosure Size F

4.1.15 Motor Insulation

For motor cable lengths ≤ the maximum cable length listed in *chapter 7 General Specifications*, the recommended motor insulation ratings are in *Table 4.28*. The peak voltage can be up to twice the DC link voltage, 2.8 times the mains voltage, due to transmission line effects in the motor cable. If a motor has a lower insulation rating, use a dU/dt or sine wave filter.

Nominal mains voltage	Motor insulation
$U_N \leq 420$ V	Standard $U_{LL} = 1300$ V
420 V $< U_N \leq 500$ V	Reinforced $U_{LL} = 1600$ V
500 V $< U_N \leq 600$ V	Reinforced $U_{LL} = 1800$ V
600 V $< U_N \leq 690$ V	Reinforced $U_{LL} = 2000$ V

Table 4.28 Motor Insulation at Various Nominal Mains Voltages

4.1.16 Motor Bearing Currents

For motors with a rating of 110 kW or greater that operate via frequency converters, use NDE (Non-Drive End) insulated bearings to eliminate circulating bearing currents due to the physical size of the motor. To minimise DE (Drive End) bearing and shaft currents, proper grounding of the frequency converter, motor, driven machine, and motor to the driven machine is required. Although failure due to bearing currents is rare, if it occurs, use the following mitigation strategies.

Standard mitigation strategies:
- Use an insulated bearing.
- Apply rigorous installation procedures:
    - Ensure that the motor and load motor are aligned.
    - Strictly follow common EMC installation guidelines.

- Reinforce the PE so the high frequency impedance is lower in the PE than the input power leads.

- Provide a good high-frequency connection between the motor and the frequency converter by screened cable. The cable must have a 360° connection in the motor and frequency converter.

- Ensure that the impedance from frequency converter to building ground is lower than the grounding impedance of the machine. Make a direct ground connection between the motor and load motor.

- Apply conductive lubrication.

- Try to ensure that the mains voltage is balanced to ground. Balancing to ground can be difficult for IT, TT, TN-CS or grounded leg systems.

- Use an insulated bearing as recommended by the motor manufacturer.

NOTICE

Motors from reputable manufacturers typically have insulated bearings fitted as standard in motors of this size.
If none of these strategies work, consult the factory.
If necessary, after consulting 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.

4.1.17 Control Cable Routing

Tie down all control wires to the designated control cable routing as shown in *Illustration 4.21*. To ensure optimum electrical immunity, connect the screens properly.

Fieldbus connection
Connections are made to the relevant options on the control card. For details, see the relevant fieldbus instruction. Place the cable in the provided path inside the frequency converter and tie it down with other control wires (see *Illustration 4.12* and *Illustration 4.13*).
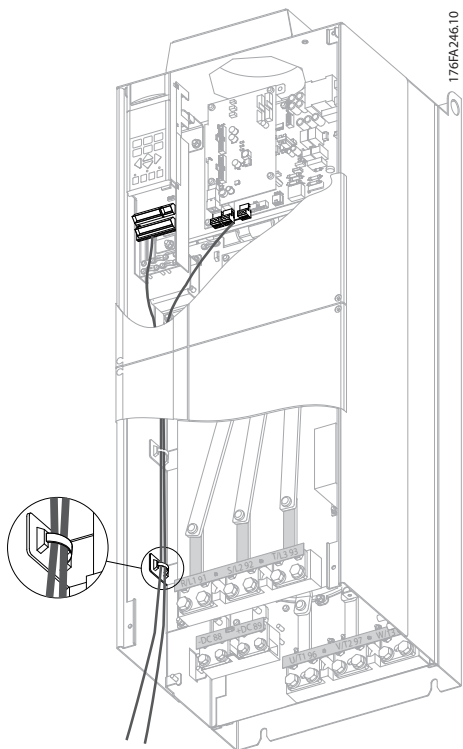
Illustration 4.12 Control Card Wiring Path for E1 and E2
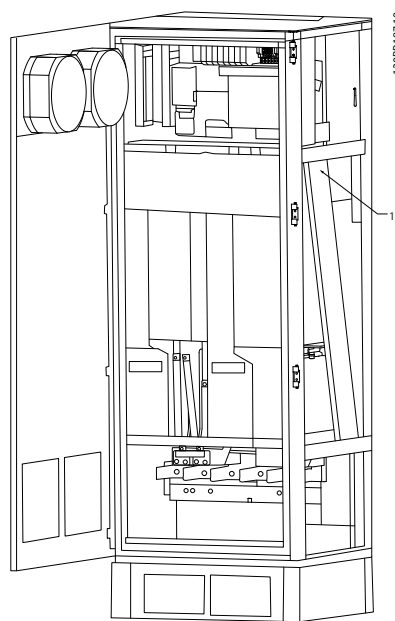
Illustration 4.13 Control Card Wiring Path for F1/F3. Control Card Wiring for the F2/F4 Use the Same Path

In the Chassis (IP00) and NEMA 1 units, it is also possible to connect the fieldbus from the top of the unit as shown in *Illustration 4.14* to *Illustration 4.16*. On the NEMA 1 unit a cover plate must be removed.
Kit number for fieldbus top connection: 176F1742.
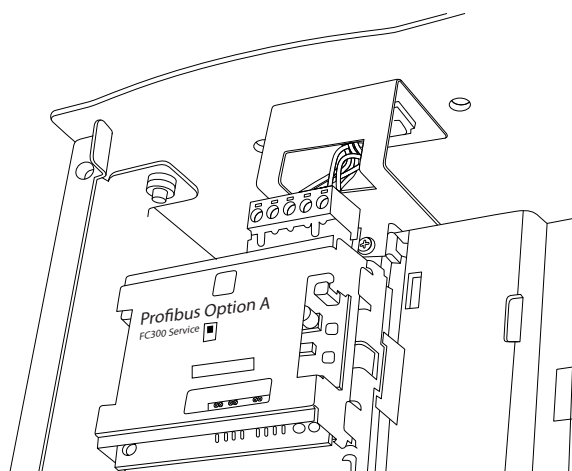
Illustration 4.14 Top Connection for Fieldbus.

4
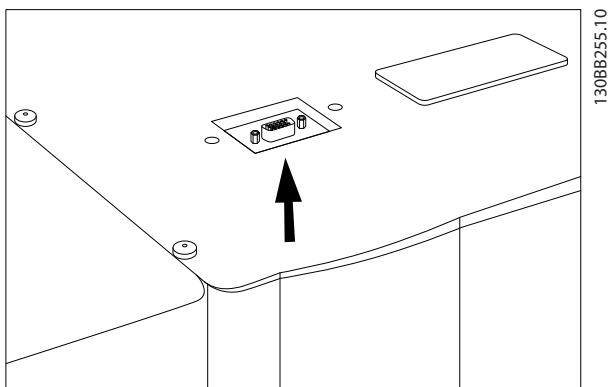
Illustration 4.15 Fieldbus Top Entry Kit, Installed
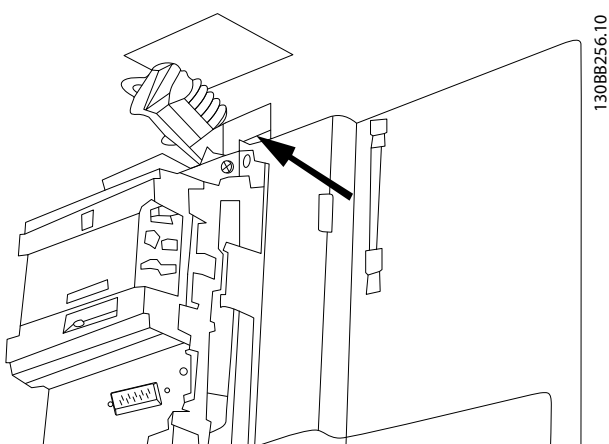
Illustration 4.16 Screen Termination/Strain Relief for Fieldbus Conductors

Installation of 24 V DC external supply
Torque: 0.5 - 0.6 Nm (5 in-lbs)
Screw size: M3

Terminal number	Function
35 (-), 36 (+)	24 V DC external supply

Table 4.29 Terminals for 24 V DC External Supply

24 V DC external supply can be used as low-voltage supply to the control card and any option cards installed. This enables full operation of the LCP (including parameter setting) without connection to mains. Note that a warning of low voltage is given when 24 V DC has been connected; however, there is no tripping.

⚠️WARNING

To ensure correct galvanic isolation (type PELV) on the control terminals of the frequency converter, use 24 V DC supply of type PELV.

4.1.18 Access to Control Terminals

All terminals to the control cables are located beneath the LCP. They are accessed by opening the door of the IP21/IP54 unit, or by removing the covers of the IP00 unit.

4.1.19 Electrical Installation, Control Terminals

To connect the cable to the terminal:
1. Strip off 9-10 mm of the insulation.

9 - 10 mm

(0.37 in)
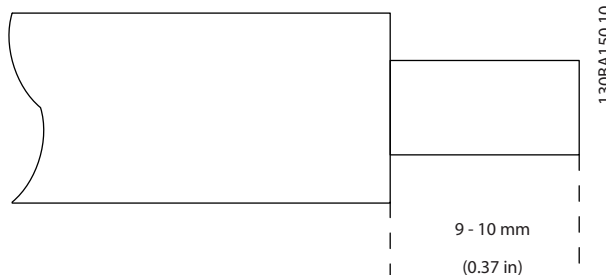
Illustration 4.17 Strip off Insulation

2. Insert a screwdriver[1] in the square hole.

3. Insert the cable in the adjacent circular hole.
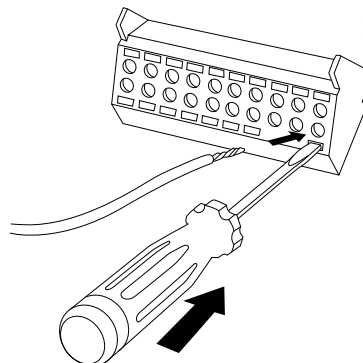
Illustration 4.18 Inserting Cable

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

1) Maximum 0.4 x 2.5 mm

To remove the cable from the terminal:
1. Insert a screwdriver[1] in the square hole.

2. Pull out the cable.

1) Max. 0.4 x 2.5 mm
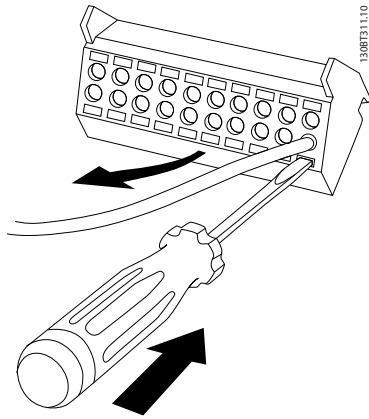
Illustration 4.19 Removing Cable
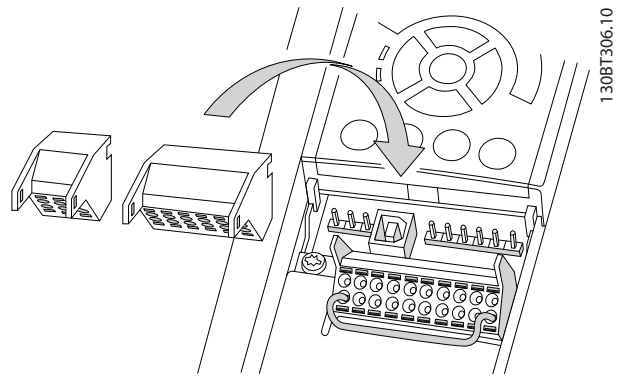
Illustration 4.20 Unplugging Control Terminals

4

Danfoss

4.1.20 Electrical Installation, Control Cables
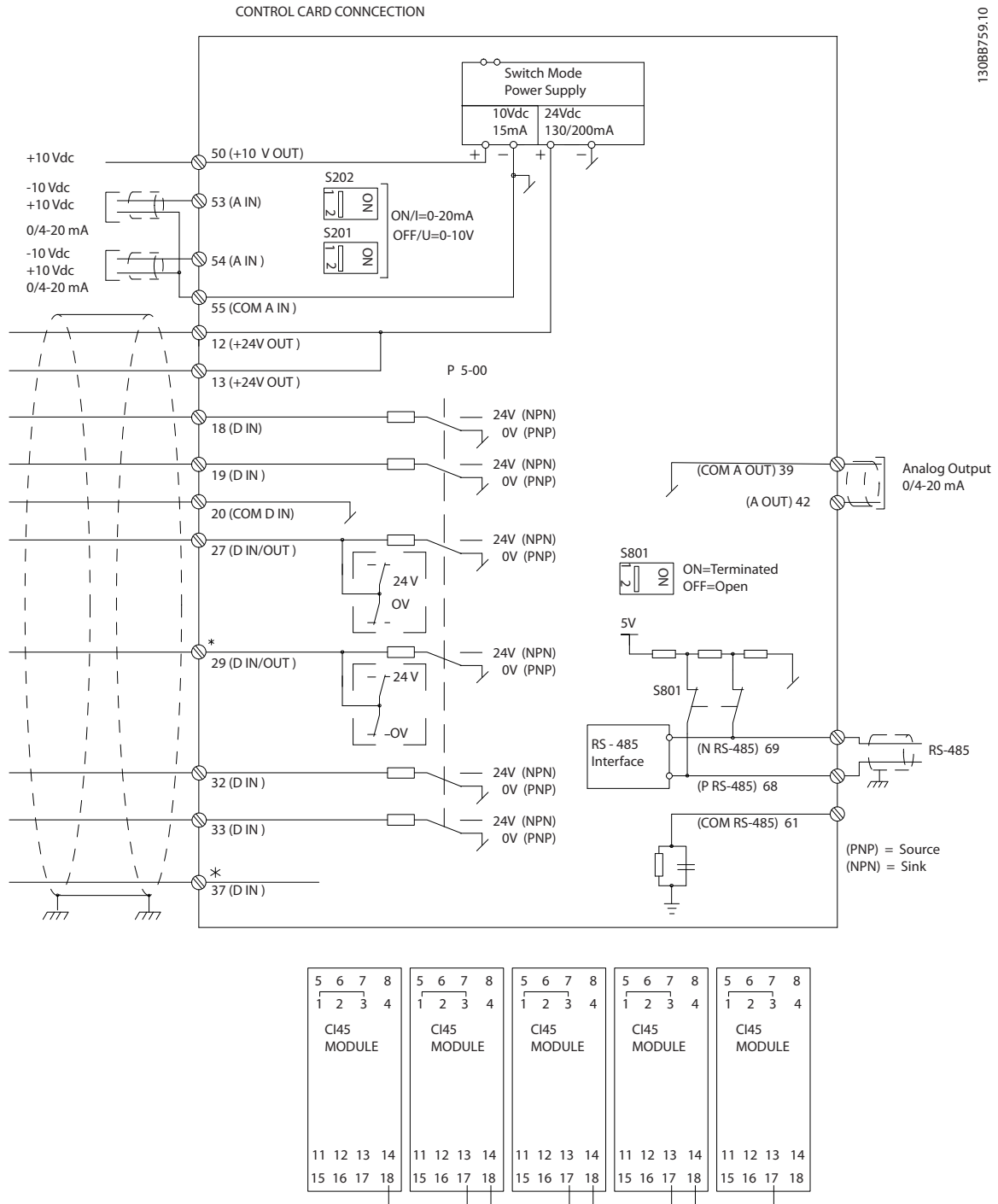
Illustration 4.21 Electrical Terminals Diagram

A=Analog, D=Digital
*Terminal 37 (optional) is used for STO. For STO installation instructions, refer to the *Safe Torque Off Operating Instructions for Danfoss VLT® Frequency Converters*.
**Do not connect cable screen.
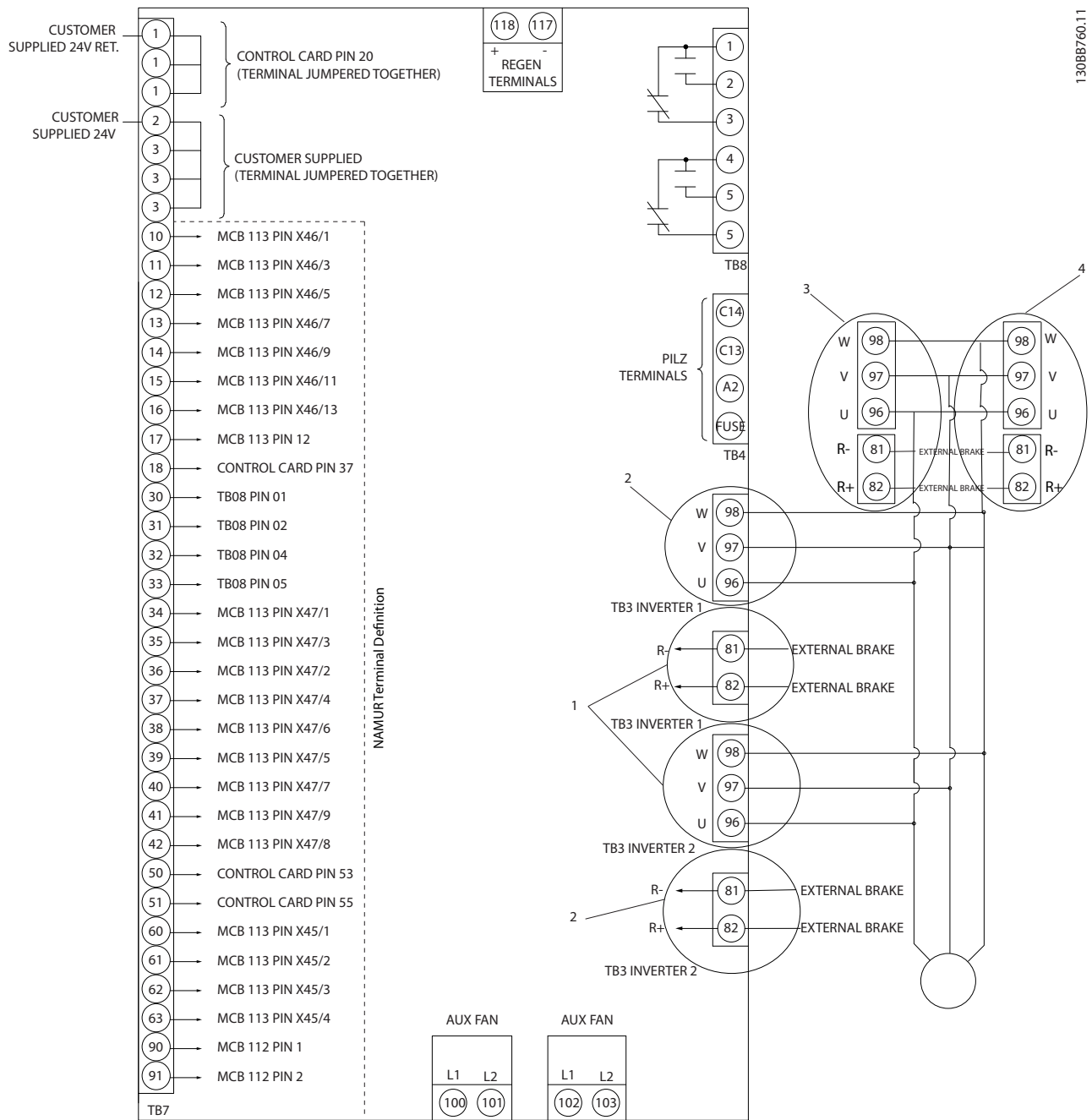
Illustration 4.22 Diagram showing all Electrical Terminals with NAMUR Option

Long control cables and analog signals may, in rare cases, and depending on installation, result in 50/60 Hz ground loops due to noise from mains supply cables.

If ground loops occur, it may be necessary to break the screen or insert a 100 nF capacitor between screen and enclosure.

Connect the digital and analog inputs and outputs separately to the frequency converter common inputs (terminal 20, 55, 39) to avoid ground currents from both groups to affect other groups. For example, switching on the digital input may disturb the analog input signal.

Input polarity of control terminals
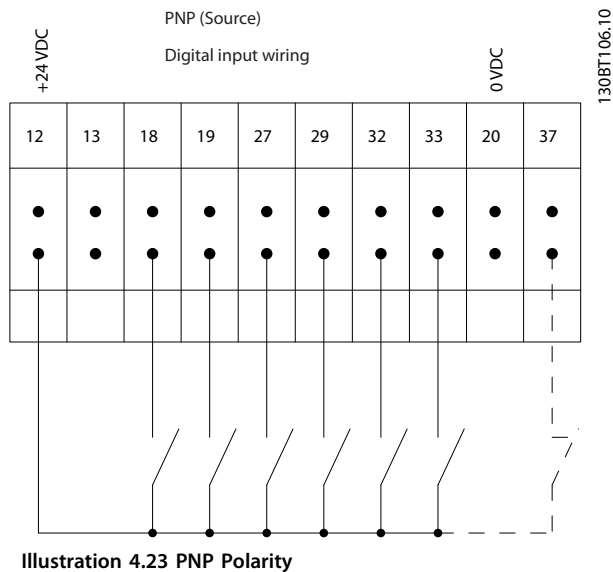
Illustration 4.23 PNP Polarity
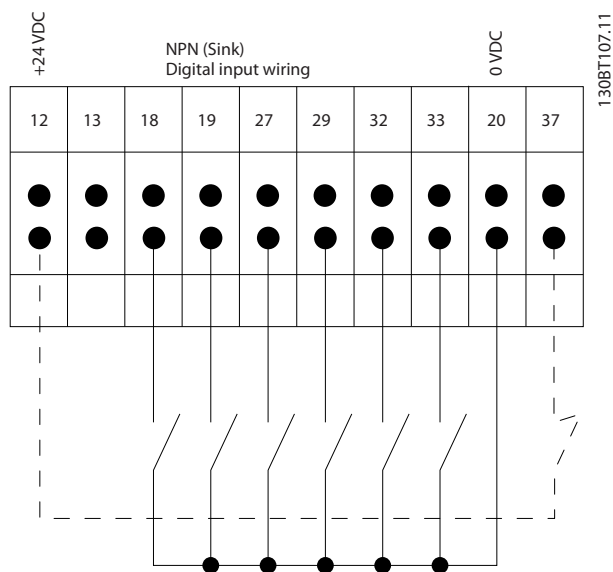
Illustration 4.24 NPN Polarity

NOTICE

Control cables must be screened/armoured.
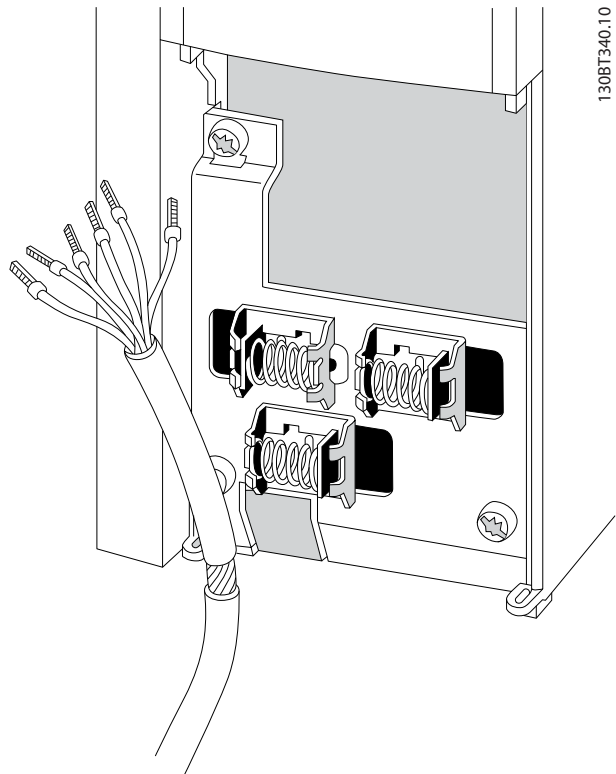
Illustration 4.25 Screened Control Cable

Connect the wires as described. To ensure optimum electrical immunity, connect the screens properly.

4.1.21 Switches S201, S202 and S801

Use switches S201 (A53) and S202 (A54) to configure the analog input terminals 53 and 54 as a current (0–20 mA) or a voltage (-10 V to +10 V).

Enable termination on the RS-485 port (terminals 68 and 69) via the switch S801 (BUS TER.).

See *Illustration 4.21*.

Default setting:
   S201 (A53) = OFF (voltage input)
   S202 (A54) = OFF (voltage input)
   S801 (Bus termination) = OFF

NOTICE

When changing the function of S201, S202, or S801, do not to use force during the switch over. Remove the LCP fixture (cradle) when operating the switches. Do not operate the switches when the frequency converter is powered.
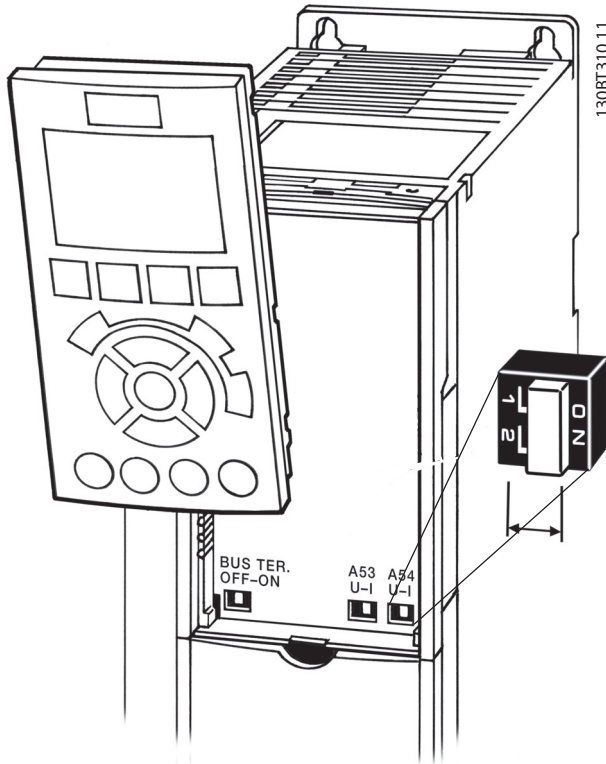
Illustration 4.26 Switch Location

4.2   Connection Examples

4.2.1 Start/Stop

Terminal 18 = *5-10 Terminal 18 Digital Input [8] Start*
Terminal 27 = *5-12 Terminal 27 Digital Input [0] No operation* (Default *coast inverse*)
Terminal 37 = STO
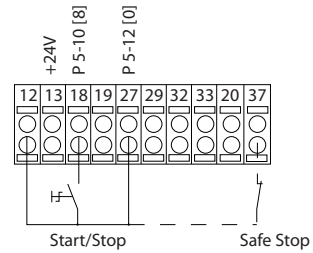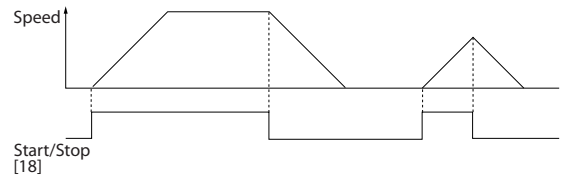
Illustration 4.27 Wiring Start/Stop

4

4.2.2 Pulse Start/Stop

Terminal 18 = *5-10 Terminal 18 Digital Input [9] Latched start*
Terminal 27= *5-12 Terminal 27 Digital Input [6] Stop inverse*
Terminal 37 = STO
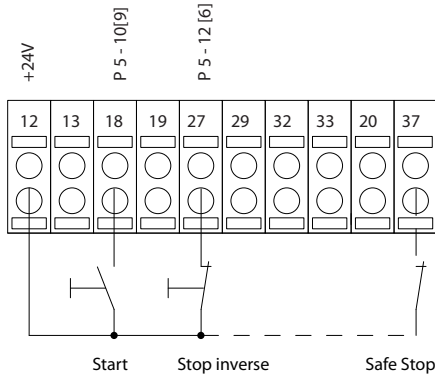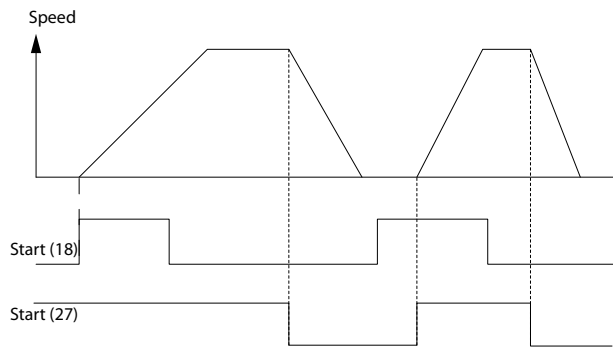
Illustration 4.28 Wiring Pulse Start/Stop

4.2.3 Speed Up/Down

Terminals 29/32 = Speed up/down

Terminal 18 = *5-10 Terminal 18 Digital Input [9] Start* (default)

Terminal 27 = *5-12 Terminal 27 Digital Input [19] Freeze reference*

Terminal 29 = *5-13 Terminal 29 Digital Input [21] Speed up*

Terminal 32 = *5-14 Terminal 32 Digital Input [22] Speed down*

NOTICE

Terminal 29 only in FC x02 (x = series type).
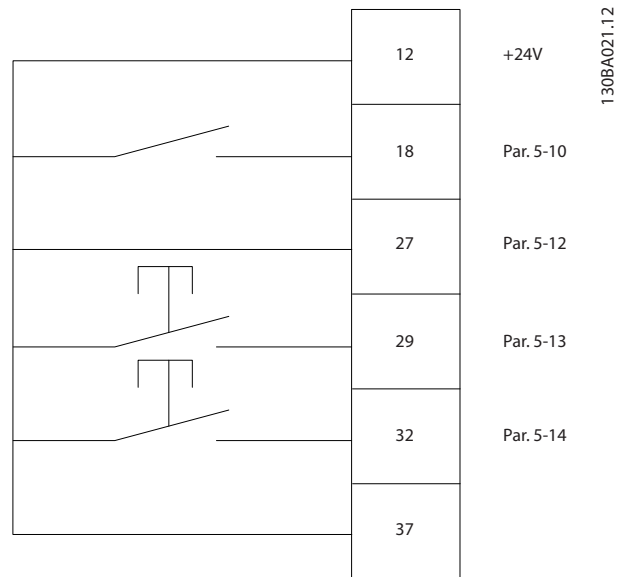
Illustration 4.29 Speed Up/Down

4.2.4 Potentiometer Reference

Voltage reference via a potentiometer

Reference Source 1 = *[1] Analog input 53* (default)

Terminal 53, Low Voltage = 0 V

Terminal 53, High Voltage = 10 V

Terminal 53, Low Ref./Feedback = 0 RPM

Terminal 53, High Ref./Feedback = 1500 RPM

Switch S201 = OFF (U)
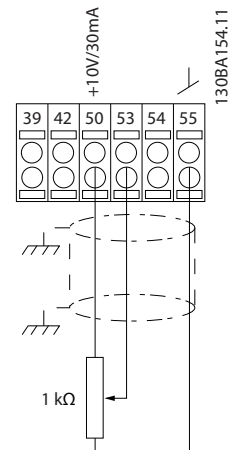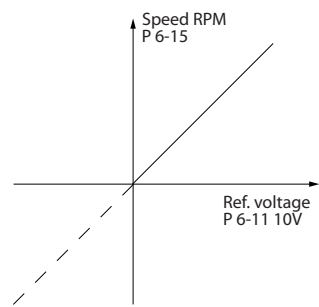
Illustration 4.30 Potentiometer Reference

4.3 Final Set-up and Test

To test the set-up and to ensure that the frequency converter is running, follow these steps.

Step 1. Locate the motor nameplate.

NOTICE

The motor is either star (Y) or delta connected (Δ). This information is on the motor nameplate.
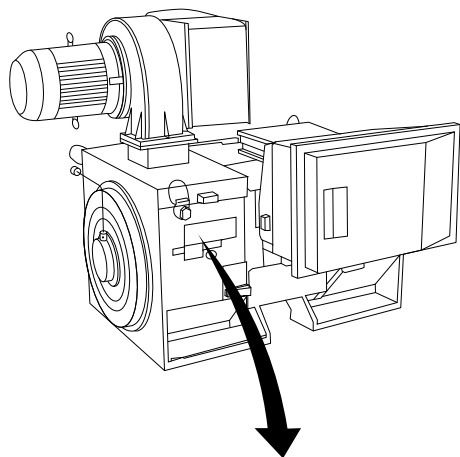
THREE PHASE INDUCTION MOTOR					
MOD MCV 315E	Nr.	135189 12 04		IL/IN 6.5	
kW 400		PRIMARY		SF 1.15	
HP 536	V 690	A 410.6	CONN Y	COS f 0.85	40
mm 1481	V	A	CONN	AMB 40	°C
Hz 50	V	A	CONN	ALT 1000	m
DESIGNN		SECONDARY		RISE 80	°C
DUTY S1	V	A	CONN	ENCLOSURE IP23	
INSUL I	EFFICIENCY %	95.8%	100%	95.8%	75%	WEIGHT 1.83 ton
⚠ CAUTION					

Illustration 4.31 Nameplate

Step 2. Enter the motor nameplate data in this parameter list.

To access this list, press [Quick Menu] then select *Q2 Quick Setup*.

1. *1-20 Motor Power [kW]*
    1-21 Motor Power [HP]

2. *1-22 Motor Voltage*

3. *1-23 Motor Frequency*

4. *1-24 Motor Current*

5. *1-25 Motor Nominal Speed*

Step 3. Activate the Automatic Motor Adaptation (AMA).

Performing an AMA ensures optimum performance. The AMA measures the values from the motor model equivalent diagram.

1. Connect terminal 37 to terminal 12 (if terminal 37 is available).

2. Connect terminal 27 to terminal 12 or set *5-12 Terminal 27 Digital Input* to *[0] No function*.

3. Activate the AMA *1-29 Automatic Motor Adaptation (AMA)*.

4. Select between complete or reduced AMA. If a sine wave filter is mounted, run only the reduced AMA, or remove the sine-wave filter during the AMA procedure.

5. Press [OK]. The display shows *Press [Hand On] to start*.

6. Press [Hand On]. A progress bar indicates if the AMA is in progress.

Stop the AMA during operation

1. Press [Off]. The frequency converter enters into alarm mode and the display shows that the user terminated the AMA.

Successful AMA

1. The display shows *Press [OK] to finish AMA*.

2. Press [OK] to exit the AMA state.

Unsuccessful AMA

1. The frequency converter enters into alarm mode. A description of the alarm can be found in .

2. *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. State the alarm number and description when contacting Danfoss service.

NOTICE

Incorrectly registered motor nameplate data, or a too big difference between the motor power size and the frequency converter power size often causes unsuccessful AMA.

Step 4. Set the speed limit and ramp time.

*   *3-02 Minimum Reference*

*   *3-03 Maximum Reference*

Step 5. Set up the desired limits for speed and ramp time.

*   *4-11 Motor Speed Low Limit [RPM]* or *4-12 Motor Speed Low Limit [Hz]*

*   *4-13 Motor Speed High Limit [RPM]* or *4-14 Motor Speed High Limit [Hz]*

*   *3-41 Ramp 1 Ramp Up Time*

*   *3-42 Ramp 1 Ramp Down Time*

4

4.4 Additional Connections

4.4.1 Mechanical Brake Control

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

- Control the brake using any relay output or digital output (terminal 27 or 29).

- Keep the output closed (voltage-free) as long as the frequency converter is unable to support the motor, for example 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 *2-20 Release Brake Current*.

- The brake is engaged when the output frequency is less than the frequency set in *2-21 Activate Brake Speed [RPM]* or *2-22 Activate Brake Speed [Hz]*, and only if the frequency converter carries out a stop command.

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

4.4.2 Parallel Connection of Motors

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

NOTICE

Installations with cables connected in a common joint as in *Illustration 4.32* are only recommended for short cable lengths.

NOTICE

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

NOTICE

The electronic thermal relay (ETR) of the frequency converter cannot be used as motor overload protection for the individual motor in systems with parallel-connected motors. Provide further motor overload protection, for example thermistors in each motor or individual thermal relays (circuit breakers are not suitable as protection).
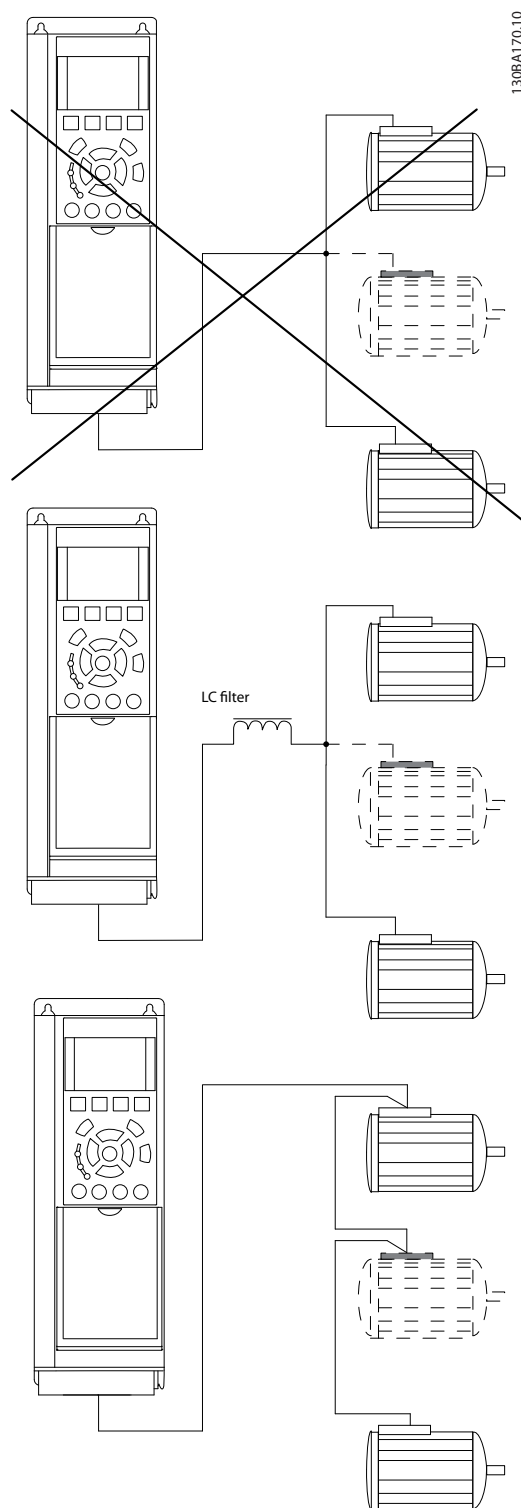
Illustration 4.32 Parallel Motor Connection

Problems may arise at start-up and at low RPM values if motor sizes are widely different because small motors' relatively high ohmic resistance in the stator calls for a higher voltage at start-up and at low RPM values.

4.4.3 Motor Thermal Protection

The electronic thermal relay in the frequency converter has received UL approval for single motor overload protection, when *1-90 Motor Thermal Protection* is set to *[4] ETR Trip* and *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 VLT PTC Thermistor Card MCB 112 option. This card provides ATEX certificate to protect motors in explosion hazardous areas, Zone 1/21 and Zone 2/22. When *1-90 Motor Thermal Protection* is set to *[20] ATEX ETR* and is combined with the use of MCB 112, it is possible to control an Ex-e motor in explosion hazardous areas. Consult the relevant *programming guide* for details on how to set up the frequency converter for safe operation of Ex-e motors.

4

5 How to Operate the Frequency Converter

5.1 Operating with LCP

5.1.1 Three Ways of Operating

The frequency converter can be operated in 3 ways:

- Graphical local control panel (GLCP).
- Numeric local control panel (NLCP).
- RS-485 serial communication or USB, both for PC connection.

If the frequency converter is fitted with fieldbus option, refer to the relevant documentation.

5.1.2 How to Operate Graphical LCP (GLCP)

The following instructions are valid for the GLCP (LCP 102).

The GLCP is divided into 4 functional groups:

1. Graphical display with status lines.

2. Menu keys and indicator lights (LEDs) - selecting mode, changing parameters and switching between display functions.

3. Navigation keys and indicator lights (LEDs).

4. Operation keys and indicator lights (LEDs).

Graphical display
The LCD display is backlit with a total of 6 alpha-numeric lines. All data is displayed on the LCP, which can show up to 5 operating variables while in [Status] mode.

Display lines:

a. **Status line**
   Status messages displaying icons and graphics.

b. **Line 1–2**
   Operator data lines displaying data and variables defined or selected by the user. Press [Status] to add one extra line.

c. **Status line**
   Status messages displaying text.
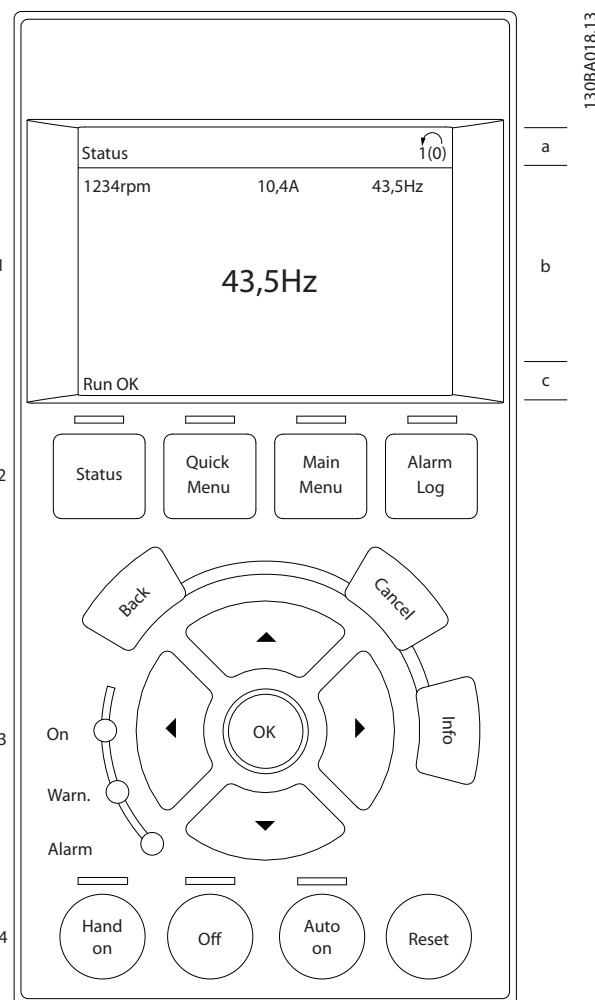
Illustration 5.1 LCP

The display is divided into 3 sections:
Top section
(a) shows the status when in status mode, or up to 2 variables when not in status mode, and in the case of Alarm/Warning.

The number of the active set-up (selected as the active set-up in *0-10 Active Set-up*) is shown. When programming in another set-up than the active set-up, the number of the set-up being programmed appears to the right in brackets.

Middle section
(b) shows up to 5 variables with related unit, regardless of status. In case of alarm/warning, the warning is shown instead of the variables.

Bottom section

(c) always shows the state of the frequency converter in status mode.

Press [Status] to toggle between 3 status readout displays. Operating variables with different formatting are shown in each status screen. See the examples below.

Several values or measurements can be linked to each of the displayed operating variables. The values/measurements to be displayed can be defined via *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* and *0-24 Display Line 3 Large*, which can be accessed via [Quick Menu], *Q3 Function Set-ups, Q3-1 General Settings, Q3-13 Display Settings*.

Each value/measurement readout parameter selected in *0-20 Display Line 1.1 Small* to *0-24 Display Line 3 Large* has its own scale and number of digits after a possible decimal point. Larger numeric values are displayed with few digits after the decimal point.
Ex.: Current readout
5.25 A; 15.2 A 105 A.

Status display I

This readout state is standard after start-up or initialisation. Press [INFO] to obtain information about the value/measurement linked to the displayed operating variables (1.1, 1.2, 1.3, 2, and 3).

See the operating variables shown in the display in *Illustration 5.2*. 1.1, 1.2 and 1.3 are shown in small size. 2 and 3 are shown in medium size.
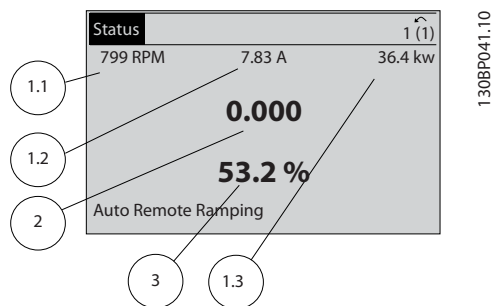
Illustration 5.2 Example of Status Display I

Status display II

See the operating variables (1.1, 1.2, 1.3, and 2) shown in the display in *Illustration 5.3*.
In the example, speed, motor current, motor power and frequency are selected as variables in the first and second lines.
1.1, 1.2 and 1.3 are shown in small size. 2 is shown in large size.
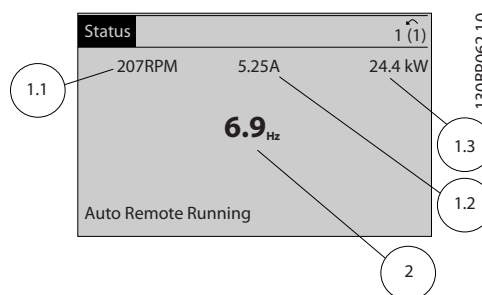
Illustration 5.3 Example of Status Display II

Status display III

This state displays the event and action of the smart logic control.
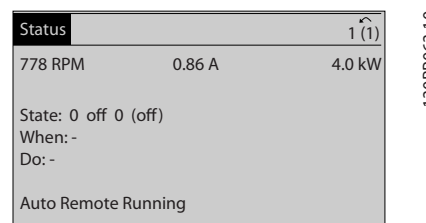
Illustration 5.4 Example of Status Display III

Display contrast adjustment

Press [status] and [▲] for darker display.
Press [status] and [▼] for brighter display.
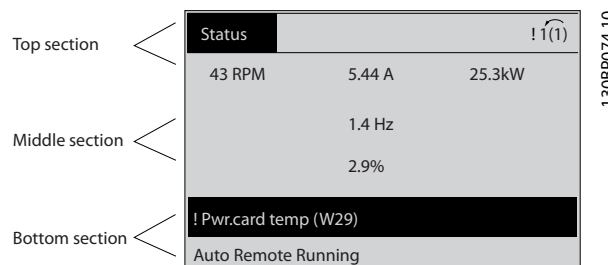
Illustration 5.5 Display Sections

Indicator lights (LEDs)

If certain threshold values are exceeded, the alarm and/or warning LED lights up. A status and alarm text appear in the display.
The On LED is activated when the frequency converter receives power from mains voltage, a DC bus terminal, or a 24 V external supply. At the same time, the backlight is on.

- Green LED/On: Control section is working.

- Yellow LED/Warn.: Indicates a warning.

- Flashing Red LED/Alarm: Indicates an alarm.

5
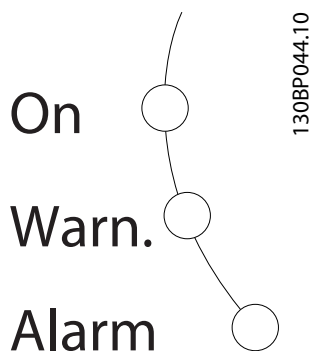
Illustration 5.6 Indicator Lights

GLCP keys
Menu keys
The menu keys are divided into functions. The keys below the display and indicator lights are used for parameter set-up, including selection of display indication during normal operation.

Illustration 5.7 Menu Keys

[Status]
[Status] indicates the status of the frequency converter and/or the motor. 3 different readouts can be selected by pressing the [Status] key:

- 5-line readouts

- 4-line readouts

- smart logic control

Press [Status] to select the display mode or for changing back to *Display* mode from either *Quick Menu* mode, *Main Menu* mode or *Alarm* mode. Also press [Status] to toggle single or double readout mode.

[Quick Menu]
[Quick Menu] allows quick set-up of the frequency converter. The most common HVAC functions can be programmed here.

 The Quick Menu consists of
- My personal menu

- Quick set-up

- Function set-up

- Changes made

- Loggings

The *Function Set-up* provides quick and easy access to all parameters required for most HVAC applications including:

- Most VAV and CAV supply and return fans.

- Cooling tower fans.

- Primary, secondary and condenser water pumps.

- Other pump, fan and compressor applications.

Among other features, it also includes parameters for selecting which variables to display in the LCP, digital preset speeds, scaling of analog references, closed loop single-zone and multi-zone applications, and specific functions related to fans, pumps and compressors.

The Quick Menu parameters can be accessed immediately unless a password has been created via *0-60 Main Menu Password*, *0-61 Access to Main Menu w/o Password*, *0-65 Personal Menu Password* or *0-66 Access to Personal Menu w/o Password*.
It is possible to switch directly between *Quick Menu* mode and *Main Menu* mode.

[Main Menu]
[Main Menu] is used for programming all parameters. The main menu parameters can be accessed immediately unless a password has been created via *0-60 Main Menu Password*, *0-61 Access to Main Menu w/o Password*, *0-65 Personal Menu Password*, or *0-66 Access to Personal Menu w/o Password*. For most HVAC applications, it is not necessary to access the main menu parameters. Instead, the *Quick Menu*, *Quick Set-up* and *Function Set-up* provide the simplest and quickest access to the most required parameters.
It is possible to switch directly between *Main Menu* mode and *Quick Menu* mode.
Parameter shortcut can be carried out by pressing [Main Menu] for 3 s. The parameter shortcut allows direct access to any parameter.

[Alarm Log]
[Alarm Log] displays an alarm list of the 10 most recent alarms (numbered A1-A10). To obtain more details about an alarm, press the navigation keys to manoeuvre to the alarm number and press [OK]. Information is displayed about the condition of the frequency converter before it enters the alarm mode.

The [Alarm Log] key on the LCP allows access to both alarm log and maintenance log.

[Back]
[Back] reverts to the previous step or layer in the navigation structure.

Illustration 5.8 Back Key

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[Cancel]

[Cancel] cancels the last change or command as long as the display has not been changed.

Illustration 5.9 Cancel Key

[Info]

[Info] displays information about a command, parameter, or function in any display window. [Info] provides detailed information when needed.
Exit Info mode by pressing either [Info], [Back], or [Cancel].

Illustration 5.10 Info Key

Navigation Keys

The 4 navigation keys are used to navigate between the different options available in the Quick Menu, Main Menu and Alarm Log. Press the keys to move the cursor.

[OK]

[OK] is used for selecting a parameter marked by the cursor and for enabling the change of a parameter.
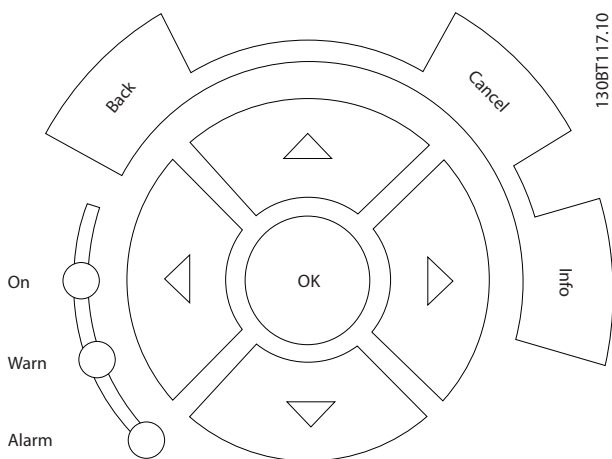
Illustration 5.11 Navigation Keys

Operation keys

Operation keys for local control are found at the bottom of the control panel.
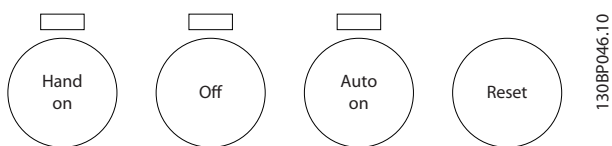
Illustration 5.12 Operation Keys

[Hand On]

[Hand On] enables control of the frequency converter via the GLCP. [Hand On] also starts the motor and allows entering the motor speed data with the navigation keys. The key can be selected as *[1] Enable* or *[0] Disable* via *0-40 [Hand on] Key on LCP*.
The following control signals are still active when [Hand On] is activated:

- [Hand On] - [Off] - [Auto On].
- Reset.
- Coasting stop inverse.
- Reversing.
- Set-up select lsb - Set-up select msb.
- Stop command from serial communication.
- Quick stop.
- DC brake.

NOTICE

External stop signals activated with control signals or a fieldbus override a start command via the LCP.

[Off]

[Off] stops the connected motor. The key can be selected as *[1] Enabled* or *[0] Disabled* via *0-41 [Off] Key on LCP*. If no external stop function is selected and the [Off] key is inactive, the motor can only be stopped by disconnecting the mains supply.

[Auto On]

[Auto On] enables the frequency converter to be controlled via the control terminals and/or serial communication. When a start signal is applied on the control terminals and/or the bus, the frequency converter starts. The key can be selected as *[1] Enabled* or *[0] Disabled* via *0-42 [Auto on] Key on LCP*.

NOTICE

An active HAND-OFF-AUTO signal via the digital inputs has higher priority than the control keys [Hand On] – [Auto On].

[Reset]

[Reset] is used for resetting the frequency converter after an alarm (trip). It can be selected as *[1] Enable* or *[0] Disable* via *0-43 [Reset] Key on LCP*.

The parameter shortcut can be carried out by holding down the [Main Menu] key for 3 s. The parameter shortcut allows direct access to any parameter.

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5.2 Operating via Serial Communication

5.2.1 RS-485 Bus Connection

One or more frequency converters can be connected to a controller (or master) using the RS-485 standard interface. Terminal 68 is connected to the P signal (TX+, RX+), while terminal 69 is connected to the N signal (TX-, RX-).

If more than one frequency converter is connected to a master, use parallel connections.
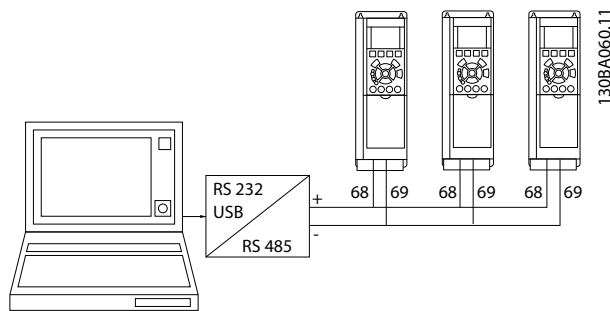
Illustration 5.13 Connection Example

To avoid potential equalising currents in the screen, ground the cable screen via terminal 61, which is connected to the frame via an RC link.

Bus termination
Terminate the RS-485 bus by a resistor network at both ends. If the frequency converter is the first or the last device in the RS-485 loop, set the switch S801 on the control card to ON.
For more information, see the paragraph *Switches S201, S202, and S801*.

5.3 Operating via PC

5.3.1 How to Connect a PC to the Frequency Converter

To control or program the frequency converter from a PC, install the PC-based configuration tool MCT 10 Set-up Software.
The PC is connected via a standard (host/device) USB cable, or via the RS-485 interface as shown in *chapter 5.2.1 RS-485 Bus Connection*.

NOTICE

The USB connection is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals. The USB connection is connected to protective earth. Use only an isolated laptop as PC connection to the USB connector on the frequency converter.
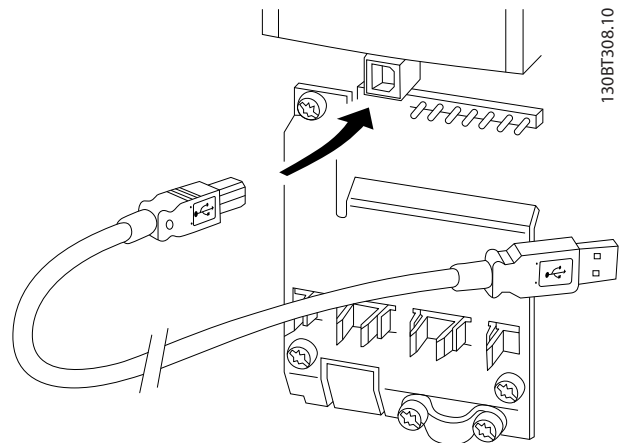
Illustration 5.14 USB Connection to Frequency Converter

5.3.2 PC Software Tools

PC-based MCT 10 Set-up Software
All frequency converters are equipped with a serial communication port. Danfoss provides a PC tool for communication between PC and frequency converter. Check the section in *chapter 1.2.1 Additional Resources* for detailed information on this tool.

MCT 10 Set-up Software
MCT 10 Set-up Software has been designed as an easy-to-use interactive tool for setting parameters in our frequency converters.
The MCT 10 Set-up Software is useful for:

- Planning a communication network off-line. MCT 10 Set-up Software contains a complete frequency converter database.

- Commissioning frequency converters online.

- Saving settings for all frequency converters.

- Replacing a frequency converter in a network.

- Simple and accurate documentation of frequency converter settings after commissioning.

- Expanding an existing network.

- Supporting future-developed frequency converters.

MCT 10 Set-up Software supports PROFIBUS DP-V1 via a master class 2 connection. It enables online reading/writing of parameters in a frequency converter via the PROFIBUS network. This network eliminates the need for an extra communication network.

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Save frequency converter settings:

1. Connect a PC to the unit via USB com port. (NOTE: Use a PC, which is isolated from the mains with the USB port. Failure to do so may damage the equipment.)

2. Open MCT 10 Set-up Software.

3. Select *Read from drive*.

4. Select *Save as*.

All parameters are now stored in the PC.

Load frequency converter settings:

1. Connect a PC to the frequency converter via USB com port.

2. Open MCT 10 Set-up Software.

3. Select *Open* – stored files are shown.

4. Open the appropriate file.

5. Select *Write to drive*.

All parameter settings are now transferred to the frequency converter.

A separate manual for MCT 10 Set-up Software is available at *www.Danfoss.com/BusinessAreas/DrivesSolutions/Software-download/DDPC+Software+Program.htm*.

The MCT 10 Set-up Software modules
The following modules are included in the software package.

	MCT Set-up 10 Software Setting parameters. Copy to and from frequency converters. Documentation and print of parameter settings, including diagrams.
	Ext. user interface Preventive Maintenance Schedule. Clock settings. Timed Action Programming. Smart Logic Controller Set-up.

Table 5.1 The MCT 10 Set-up Software Modules

Ordering number
Order the CD containing MCT 10 Set-up Software using code number 130B1000.

The software can be downloaded from the Danfoss internet site at *www.Danfoss.com/BusinessAreas/DrivesSo-lutions/Softwaredownload/DDPC+Software+Program.htm*

5.3.3 Tips and Tricks

*   For most HVAC applications, the *Quick Menu*, *Quick Set-up* and *Function Set-up* provide the simplest and quickest access to the most required parameters.

*   Whenever possible, performing an AMA ensures the best shaft performance.

*   Adjust display contrast by pressing [Status] and [▲] for darker display, or by pressing [Status] and [▼] for brighter display.

*   Under *Quick Menu* and *Changes Made*, all parameters which have been changed from factory settings are displayed.

*   Press and hold [Main Menu] key for 3 s to access to any parameter.

*   For service purposes, copy all parameters to the LCP. See *0-50 LCP Copy* for further information.

5.3.4 Quick Transfer of Parameter Settings when Using GLCP

Once the set-up of a frequency converter is complete, store (back up) the parameter settings in the GLCP or on a PC via MCT 10 Set-up Software.

⚠ **WARNING**

Stop the motor before performing any of these operations.

Data storage in the LCP:
1. Go to *0-50 LCP Copy*.

2. Press [OK].

3. Select *[1] All to LCP*.

4. Press [OK].

All parameter settings are now stored in the GLCP indicated by the progress bar. When 100% is reached, press [OK].

The GLCP can now be connected to another frequency converter and the parameter settings copied to this frequency converter.

Data transfer from the LCP to the frequency converter
1. Go to *0-50 LCP Copy*.

2. Press [OK].

3. Select *[2] All from LCP*.

4. Press [OK].

The parameter settings stored in the GLCP are now transferred to the frequency converter indicated by the progress bar. When 100% is reached, press [OK].

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5.3.5 Initialisation to Default Settings

There are 2 ways to initialise the frequency converter to default:

- Recommended initialisation

- Manual initialisation

Be aware that they have different impact according to the following description.

Recommended initialisation (via *14-22 Operation Mode*)

1.   Select *14-22 Operation Mode*.

2.   Press [OK].

3.   Select *[2] Initialisation* (for NLCP select "2").

4.   Press [OK].

5.   Remove power to unit and wait for the display to turn off.

6.   Reconnect power and the frequency converter is reset. Note that first start-up takes a few more seconds than normal.

7.   Press [Reset].

14-22 Operation Mode initialises all except:

- *14-50 RFI Filter*.

- *8-30 Protocol*.

- *8-31 Address*.

- *8-32 Baud Rate*.

- *8-35 Minimum Response Delay*.

- *8-36 Max Response Delay*.

- *8-37 Maximum Inter-Char Delay*.

- *15-00 Operating hours* to *15-05 Over Volt's*.

- *15-20 Historic Log: Event* to *15-22 Historic Log: Time*.

- *15-30 Alarm Log: Error Code* to *15-32 Alarm Log: Time*.

NOTICE

Parameters selected in *0-25 My Personal Menu* stay present with default factory setting.

Manual initialisation

NOTICE

When carrying out manual initialisation, serial communication, RFI filter settings and fault log settings are reset. Manual initialisation removes parameters selected in *0-25 My Personal Menu*.

1.   Disconnect from mains and wait until the display turns off.

2.   Press

    2a   [Status] - [Main Menu] - [OK] at the same time while powering up for the LCP 102, graphical LCP.

    2b   [Menu] while powering up for LCP 101, numerical LCP.

3.   Release the keys after 5 s.

4.   The frequency converter is now programmed according to default settings.

This parameter initialises all except:
15-00 Operating hours
15-03 Power Up's
15-04 Over Temp's
15-05 Over Volt's

6 How to Programme

6.1 Basic Programming

6.1.1 Parameter Set-Up

Group	Title	Function
0-**	Operation and Display	Parameters used to programme the fundamental functions of the frequency converter and the LCP including: • Selection of language. • Selection of which variables are displayed at each position in the display. As an example, static duct pressure or condenser water return temperature can be displayed with the setpoint in small digits in the top row and feedback in large digits in the centre of the display). • Enabling/disabling of the LCP keys. • Passwords for the LCP. • Upload and download of commissioned parameters to/from the LCP. • Setting the built-in clock.

1-**	Load/Motor	Parameters used to configure the frequency converter for the specific application and motor including:
		• Open or closed loop operation.
		• Type of application such as:
		    - Compressor
		    - Fan
		    - Centrifugal pump
		• Motor nameplate data.
		• Auto-tuning of the frequency converter to the motor for optimum performance.
		• Flying start (typically used in fan applications).
		• Thermal motor protection.

2-**	Brakes	Parameters used to configure brake functions of the frequency converter, which, although not common in many HVAC applications, can be useful in special fan applications. Parameters include: • DC brake. • Dynamic/resistor brake. • Overvoltage control (which provides automatic adjustment of the deceleration rate (auto-ramping) to avoid tripping when decelerating large inertia fans).
3-**	Reference/Ramps	Parameters used to program the following: • Minimum and maximum reference limits of speed (RPM/Hz) in open loop or in actual units when operating in closed loop). • Digital/preset references. • Jog speed. • Definition of the source of each reference (for example, to which analog input is the reference signal connected). • Ramp-up and ramp-down times. • Digital potentiometer settings.

Group	Title	Function
4-**	Limits/Warnings	Parameters used to program limits and warnings of operation including: • Allowable motor direction. • Minimum and maximum motor speeds. As an example, in pump applications the minimum speed is often set to approximately 30–40%. This speed ensures that pump seals are always adequately lubricated, avoid cavitation and ensure that adequate head is always produced to create flow). • Torque and current limits to protect the pump, fan or compressor driven by the motor. • Warnings for low/high current, speed, reference, and feedback. • Missing motor phase protection. • Speed bypass frequencies, including semi-automatic set-up of these frequencies (for example, to avoid resonance conditions on cooling tower and other fans).
5-**	Digital In/Out	Parameters used to programme the functions of all • digital inputs • digital outputs • relay outputs • pulse inputs • pulse outputs for terminals on the control card and all option cards.
6-**	Analog In/Out	Parameters used to programme the functions associated with all analog inputs and analog outputs for the control card terminals and general purpose I/O option (MCB 101). The parameters include: • Analog input live zero time-out function (which, for example, can be used to command a cooling tower fan to operate at full speed if the condenser water return sensor fails). • Scaling of the analog input signals (for example to match the analog input to the mA and pressure range of a static duct pressure sensor). • Filter time constant to filter out electrical noise on the analog signal, which sometimes occurs when long cables are installed. • Function and scaling of the analog outputs (for example to provide an analog output representing motor current or kW to an analog input of a DDC controller). • Configuring the analog outputs to be controlled by the BMS via a high-level interface (HLI) (for example to control a chilled water valve) including ability to define a default value of these outputs in the event of the HLI failing.
8-**	Communication and Options	Parameters used for configuring and monitoring functions associated with the serial communications/high-level interface to the frequency converter.
9-**	Profibus	Parameters only applicable when a PROFIBUS option is installed.
10-**	CAN Fieldbus	Parameters only applicable when a DeviceNet option is installed.
11-**	LonWorks	Parameters only applicable when a LonWorks option is installed.

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Group	Title	Function

13-**	Smart Logic Controller	Parameters used to configure the built-in smart logic controller (SLC). The SLC can be used for:
		● Simple functions such as:
		
		   ● Comparators (for example, if running above x Hz, activate output relay).
		
		   ● Timers (for example, when a start signal is applied, first activate output relay to open supply air damper and wait x seconds before ramping up).
		
		● Complex sequence of user-defined actions executed by the SLC when the associated user-defined event is evaluated as TRUE by the SLC. For example, initiate an economiser mode in a simple AHU cooling application control scheme where there is no BMS. For such an application, the SLC can monitor the outside air relative humidity. If the relative humidity is below a defined value, the supply air temperature setpoint could be automatically increased. With the frequency converter monitoring the outside air relative humidity and supply air temperature via its analog inputs, and controlling the chilled water valve via one of the extended PI(D) loops and an analog output, it would then modulate that valve to maintain a higher supply air temperature.
		
		The SLC can often replace the need for other external control equipment.

14-**	Special Functions	Parameters used to configure special functions of the frequency converter including: ● Setting of the switching frequency to reduce audible noise from the motor (sometimes required for fan applications). ● Kinetic back-up function (especially useful for critical applications in semi-conductor installations where performance under mains dip/mains loss is important). ● Mains imbalance protection. ● Automatic reset (to avoid the need for a manual reset of alarms). ● Energy-optimisation parameters. Normally, these parameters do not need changing. Fine-tuning of this automatic function ensures that the frequency converter and motor combination operate at their optimum efficiency. ● Autoderating functions enabling the frequency converter to continue operation at reduced performance under extreme operating conditions ensuring maximum up-time.
15-**	FC Information	Parameters providing operating data and other frequency converter information including: ● Operating and running hour counters. ● kWh counter; resetting of the running and kWh counters. ● Alarm/fault log (where the past 10 alarms are logged along with any associated value and time). ● Frequency converter and option card identification parameters, such as code number and software version.
16-**	Data Readouts	Read-only parameters which display the status/value of many operating variables that can be displayed on the LCP or viewed in this parameter group. These parameters can be useful during commissioning when interfacing with a BMS via a high-level interface.
18-**	Info & Readouts	Read-only parameters which display useful information for commissioning when interfacing with a BMS via a high-level interface. The information contains data such as: ● The last 10 preventive maintenance log items. ● Actions and time. ● The value of analog inputs and outputs on the analog I/O option card.

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Group	Title	Function
20-**	FC Closed Loop	Parameters used to configure the closed loop PI(D) controller, which controls the speed of the pump, fan or compressor in closed-loop mode including: • Defining where each of the 3 possible feedback signals come from (for example, which analog input or the BMS HLI). • Conversion factor for each of the feedback signals. An example could be a pressure signal used for indication of flow in an AHU or converting from pressure to temperature in a compressor application). • Engineering unit for the reference and feedback (for example, Pa, kPa, m Wg, in Wg, bar, m3/s, m3/h, °C, °F, etc). • The function (for example, sum, difference, average, minimum or maximum) used to calculate the resulting feedback for single-zone applications or the control philosophy for multi-zone applications. • Programming of the setpoints. • Manual tuning or auto-tuning of the PI(D) loop.
21-**	Extended Closed Loop	Parameters used to configure the 3 extended closed loop PI(D) controllers. The controllers can, for example, be used to control external actuators (for example, chilled water valve to maintain supply air temperature in a VAV system) including: • Engineering unit for the reference and feedback of each controller (for example, °C, °F). • Defining the range of the reference/setpoint for each controller. • Defining where each of the references/setpoints and feedback signals come from (for example, which analog input or the BMS HLI). • Programming of the setpoint, and manual tuning or auto-tuning of each of the PI(D) controllers.
22-**	Application Functions	Parameters used to monitor, protect and control pumps, fans and compressors, including: • No-flow detection and protection of pumps (including auto-setup of this function). • Dry-pump protection. • End-of-curve detection and protection of pumps. • Sleep mode (especially useful for cooling tower and booster pump sets). • Broken-belt detection (typically used for fan applications to detect no air flow instead of using a Δp switch installed across the fan). • Short-cycle protection of compressors and pump flow compensation of setpoint (especially useful for secondary chilled water pump applications where the Δp sensor has been installed close to the pump and not across the furthest most significant load(s) in the system. • Using this function can compensate for the sensor installation and help to realise the maximum energy savings).
23-**	Time Based Functions	Time-based parameters including: • Parameters used to initiate daily or weekly actions based on the built-in real-time clock. The actions could be change of setpoint for night set-back mode or start/stop of the pump/fan/compressor start/stop of an external equipment). • Preventive maintenance functions, which can be based on running or operating hour time intervals or on specific dates and times. • Energy log (especially useful in retrofit applications or where information of the actual historical load (kW) on the pump/fan/compressor is of interest). • Trending (useful in retrofit or other applications where there is an interest to log operating power, current, frequency or speed of the pump/fan/compressor for analysis and a payback counter.
24-**	Application Functions 2	Parameters used to set up fire mode and/or to control a bypass contactor/starter if designed into the system.

Group	Title	Function
25-**	Cascade Controller	Parameters used to configure and monitor the built-in pump cascade controller (typically used for pump booster sets).
26-**	Analog I/O Option MCB 109	Parameters used to configure the analog I/O option (MCB 109) including: • Definition of the analog input types (for example, voltage, Pt1000 or Ni1000). • Scaling and definition of the analog output functions and scaling.

Table 6.1 Parameter Groups

Parameter descriptions and selections are displayed on the graphic (GLCP) or numeric (NLCP) display. (See relevant section for details.) Access the parameters by pressing [Quick Menu] or [Main Menu] on the LCP. The *Quick Menu* is used primarily for commissioning the unit at start-up by providing the parameters necessary to start operation. The *Main Menu* provides access to all parameters for detailed application programming.

All digital input/output and analog input/output terminals are multifunctional. All terminals have factory default functions suitable for most HVAC applications but if other special functions are required, they must be programmed as explained in parameter group *5-** Digital In/out* or *6-** Analog In/out*.

6.1.2 Quick Menu Mode

Parameter data
The graphical display (GLCP) provides access to all parameters listed in the *Quick Menu*. The numeric display (NLCP) only provides access to the *Quick Set-up* parameters. To set parameters pressing [Quick Menu] - enter or change parameter data or settings in accordance with the following procedure:

1. Press [Quick Menu].
2. Press [▲] or [▼] to find the parameter to change.
3. Press [OK].
4. Press [▲] or [▼] to select the correct parameter setting.
5. Press [OK].
6. To move to a different digit within a parameter setting, use the [◄] and [►].
7. Highlighted area indicates digit selected for change.
8. Press [Cancel] to disregard change, or press [OK] to accept change and enter the new setting.

Example of changing parameter data
Assume *parameter 22-60 Broken Belt Function* is set to *[0] Off*. To monitor the fan-belt condition, non-broken or broken, follow this procedure:

1. Press [Quick Menu].
2. Press [▼] to select *Function Set-ups*.
3. Press [OK].
4. Press [▼] to select *Application Settings* .
5. Press [OK].
6. Press [OK] again for *Fan Functions*.
7. Press [OK] to select *Broken Belt Function*.
8. Press [▼], to select *[2] Trip*.

If a broken fan-belt is detected, the frequency converter trips.

Select *Q1 My Personal Menu* to display personal parameters
For example, an AHU or pump OEM may have pre-programmed personal parameters to be in *My Personal Menu* during factory commissioning to make on-site commissioning/fine-tuning simpler. These parameters are selected in *0-25 My Personal Menu*. Up to 20 different parameters can be programmed in this menu.

Select *Changes Made* to obtain information about:
- The last 10 changes. Press [▲] and [▼] to scroll between the last 10 changed parameters.
- The changes made since default setting.

Loggings
Loggings show information about the display line readouts. The information is shown as graphs. Only display parameters selected in *0-20 Display Line 1.1 Small* and *0-24 Display Line 3 Large* can be viewed. Up to 120 samples can be stored in the memory for later reference.

Quick Set-up

Efficient parameter set-up for HVAC applications
The parameters can easily be set up for most HVAC applications only by using the *Quick Set-up*.
After pressing [Quick Menu], the different options in the *Quick Menu* are listed. See also *Illustration 6.1* and *Table 6.3* to *Table 6.6*.

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Example of using the Quick Set-up

To set the ramp-down time to 100 s, follow this procedure:

1. Select *Quick Set-up*. *Parameter 0-01 Language* in Quick Set-up appears.

2. Press [▼] repeatedly until *parameter 3-42 Ramp 1 Ramp Down Time* appears with the default setting of 20 s.

3. Press [OK].

4. Press [◄] to highlight the third digit before the comma.

5. Change *0* to *1* by pressing [▲].

6. Press [►] to highlight the digit *2*.

7. Change *2* to *0* by pressing [▼].

8. Press [OK].

The new ramp-down time is now set to 100 s.
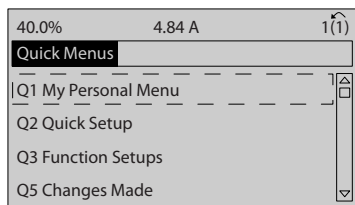
Illustration 6.1 Quick Menu View

Access the 18 most important set-up parameters of the frequency converter via *Quick Set-up*. After programming, the frequency converter is ready for operation. The 18 *Quick Set-up* parameters are shown in *Table 6.2*.

Parameter	[Units]
Parameter 0-01 Language	
Parameter 1-20 Motor Power [kW]	[kW]
Parameter 1-21 Motor Power [HP]	[Hp]
Parameter 1-22 Motor Voltage[1)	[V]
Parameter 1-23 Motor Frequency	[Hz]
Parameter 1-24 Motor Current	[A]
Parameter 1-25 Motor Nominal Speed	[RPM]
Parameter 1-28 Motor Rotation Check	[Hz]
Parameter 3-41 Ramp 1 Ramp Up Time	[s]
Parameter 3-42 Ramp 1 Ramp Down Time	[s]
Parameter 4-11 Motor Speed Low Limit [RPM]	[RPM]
Parameter 4-12 Motor Speed Low Limit [Hz][1)	[Hz]
Parameter 4-13 Motor Speed High Limit [RPM]	[RPM]
Parameter 4-14 Motor Speed High Limit [Hz][1)	[Hz]
3-19 Jog Speed [RPM]	[RPM]
Parameter 3-11 Jog Speed [Hz][1)	[Hz]
5-12 Terminal 27 Digital Input	
Parameter 5-40 Function Relay[2)	

Table 6.2 Quick Set-up Parameters

1) The information shown in the display depends on the selections made in 0-02 Motor Speed Unit and 0-03 Regional Settings. The

default settings of 0-02 Motor Speed Unit and 0-03 Regional Settings depend on which region of the world the frequency converter is supplied to but can be reprogrammed as required.

2) Parameter 5-40 Function Relay is an array. Select between [0] Relay1 or [1] Relay2. Standard setting is [0] Relay1 with the default option [9] Alarm.

For detailed information about settings and programming, see the *VLT® HVAC Drive FC 102 Programming Guide*.

NOTICE

If *[0] No Operation* **is selected in** *5-12 Terminal 27 Digital Input*, **no connection to +24 V on terminal 27 is necessary to enable start.**

If *[2] Coast Inverse* **(factory default value) is selected in** *5-12 Terminal 27 Digital Input*, **a connection to +24 V is necessary to enable start.**

0-01 Language		
Option:		**Function:**
		Defines display language. The frequency converter is delivered with 4 different language packages. English and German are included in all packages. English cannot be erased or manipulated.
[0] *	English	Part of language packages 1–4
[1]	Deutsch	Part of language packages 1–4
[2]	Francais	Part of language package 1
[3]	Dansk	Part of language package 1
[4]	Spanish	Part of language package 1
[5]	Italiano	Part of language package 1
[6]	Svenska	Part of language package 1
[7]	Nederlands	Part of language package 1
[10]	Chinese	Part of language package 2
[20]	Suomi	Part of language package 1
[22]	English US	Part of language package 4
[27]	Greek	Part of language package 4
[28]	Bras.port	Part of language package 4
[36]	Slovenian	Part of language package 3
[39]	Korean	Part of language package 2
[40]	Japanese	Part of language package 2
[41]	Turkish	Part of language package 4
[42]	Trad.Chinese	Part of language package 2
[43]	Bulgarian	Part of language package 3
[44]	Srpski	Part of language package 3
[45]	Romanian	Part of language package 3

0-01 Language

Option:		Function:
[46]	Magyar	Part of language package 3
[47]	Czech	Part of language package 3
[48]	Polski	Part of language package 4
[49]	Russian	Part of language package 3
[50]	Thai	Part of language package 2
[51]	Bahasa Indonesia	Part of language package 2
[52]	Hrvatski	Part of language package 3

1-20 Motor Power [kW]

Range:		Function:
Size related*	[0.09 - 3000.00 kW]	Enter the nominal motor power in kW according to the motor nameplate data. The default value corresponds to the nominal rated output of the unit. Depending on the selections made in *0-03 Regional Settings*, either *parameter 1-20 Motor Power [kW]* or *parameter 1-21 Motor Power [HP]* is made invisible.

1-21 Motor Power [HP]

Range:		Function:
Size related*	[0.09 - 3000.00 hp]	Enter the nominal motor power in hp according to the motor nameplate data. The default value corresponds to the nominal rated output of the unit. Depending on the selections made in *0-03 Regional Settings*, either *parameter 1-20 Motor Power [kW]* or *parameter 1-21 Motor Power [HP]* is made invisible.

1-22 Motor Voltage

Range:		Function:
Size related*	[10 - 1000 V]	Enter the nominal motor voltage according to the motor nameplate data. The default value corresponds to the nominal rated output of the frequency converter.

1-23 Motor Frequency

Range:		Function:
Size related*	[20 - 1000 Hz]	Select the motor frequency value from the motor nameplate data. For 87 Hz operation with 230/400 V motors, set the nameplate data for 230 V/50 Hz. Adapt *parameter 4-13 Motor Speed High Limit [RPM]* and *3-03 Maximum Reference* to the 87 Hz application.

1-24 Motor Current

Range:		Function:
Size related*	[0.10 - 10000.00 A]	Enter the nominal motor current value from the motor nameplate data. This data is used for calculating motor torque, thermal motor protection etc.

1-25 Motor Nominal Speed

Range:		Function:
Size related*	[100 - 60000 RPM]	Enter the nominal motor speed value from the motor nameplate data. This data is used for calculating automatic motor compensations.

1-28 Motor Rotation Check

Option:		Function:
		Following installation and connection of the motor, this function allows the correct motor rotation direction to be verified. Enabling this function overrides any bus commands or digital inputs, except external interlock and Safe Torque Off (STO) (if included).
[0] *	Off	Motor rotation check is not active.
[1]	Enabled	Motor rotation check is enabled.

⚠ WARNING

Remove mains power before disconnecting motor phase cables.

NOTICE

Once the motor rotation check is enabled the display shows: *Note! Motor may run in wrong direction*. Pressing [OK], [Back] or [Cancel] dismisses the message and displays a new message: "Press [Hand On] to start the motor. Press [Cancel] to abort". Pressing [Hand On] starts the motor at 5 Hz in forward direction and the display shows: "Motor is running. Check if motor rotation direction is correct. Press [Off] to stop the motor". Pressing [Off] stops the motor and resets *parameter 1-28 Motor Rotation Check*. If motor rotation direction is incorrect, interchange 2 motor phase cables.

3-11 Jog Speed [Hz]

Range:		Function:
Size related*	[0 - par. 4-14 Hz]	The jog speed is a fixed output speed at which the frequency converter is running when the jog function is activated. See also *3-80 Jog Ramp Time*.

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3-41 Ramp 1 Ramp Up Time		
Range:		**Function:**
Size related*	[1.00 - 3600 s]	Enter the ramp-up time, that is, the acceleration time from 0 RPM to *parameter 1-25 Motor Nominal Speed*. Select a ramp-up time such that the output current does not exceed the current limit in *4-18 Current Limit* during ramping. See ramp-down time in *parameter 3-42 Ramp 1 Ramp Down Time*.

$$par.3-41 = \frac{t_{acc} \times n_{nom}\,[par.1-25]}{ref\,[RPM]}[s]$$

3-42 Ramp 1 Ramp Down Time		
Range:		**Function:**
Size related*	[1.00 - 3600 s]	Enter the ramp-down time, that is, the deceleration time from *parameter 1-25 Motor Nominal Speed* to 0 RPM. Select a ramp-down time preventing overvoltage from arising in the inverter due to regenerative operation of the motor. The ramp-down time should also be long enough to prevent that the generated current exceeds the current limit set in *4-18 Current Limit*. See ramp-up time in *parameter 3-41 Ramp 1 Ramp Up Time*.

$$par.3-42 = \frac{t_{dec} \times n_{nom}\,[par.1-25]}{ref\,[RPM]}[s]$$

4-11 Motor Speed Low Limit [RPM]		
Range:		**Function:**
Size related*	[0 - par. 4-13 RPM]	Enter the minimum limit for motor speed in RPM. The motor speed low limit can be set to correspond to the manufacturer's recommended minimum motor speed. The motor speed low limit must not exceed the setting in *parameter 4-13 Motor Speed High Limit [RPM]*.

4-12 Motor Speed Low Limit [Hz]		
Range:		**Function:**
Size related*	[0 - par. 4-14 Hz]	Enter the minimum limit for motor speed in Hz. The motor speed low limit can be set to correspond to the minimum output frequency of the motor shaft. The speed low limit must not exceed the setting in *parameter 4-14 Motor Speed High Limit [Hz]*.

4-13 Motor Speed High Limit [RPM]		
Range:		**Function:**
Size related*	[par. 4-11 - 60000 RPM]	***NOTICE*** **Any changes in *parameter 4-13 Motor Speed High Limit [RPM]* reset the value in *parameter 4-53 Warning Speed High* to the value set in *parameter 4-13 Motor Speed High Limit [RPM]*.** ***NOTICE*** **Max. output frequency cannot exceed 10% of the inverter switching frequency (*parameter 14-01 Switching Frequency*).** Enter the maximum limit for motor speed in RPM. The motor speed high limit can be set to correspond to the manufacturer's maximum rated motor. The motor speed high limit must exceed the setting in *parameter 4-11 Motor Speed Low Limit [RPM]*. The parameter name appears as either *parameter 4-11 Motor Speed Low Limit [RPM]* or *parameter 4-12 Motor Speed Low Limit [Hz]*, depending on: • The settings of other parameters in the *Main Menu*. • Default settings based on geographical location.

4-14 Motor Speed High Limit [Hz]		
Range:		**Function:**
Size related*	[par. 4-12 - par. 4-19 Hz]	Enter the maximum limit for motor speed in Hz. *Parameter 4-14 Motor Speed High Limit [Hz]* can match the manufacturer's recommended maximum motor speed. The motor speed high limit must exceed the value in *parameter 4-12 Motor Speed Low Limit [Hz]*. The output frequency must not exceed 10% of the switching frequency (*parameter 14-01 Switching Frequency*).

6.1.3 Function Set-ups

The *Function Set-up* provides quick and easy access to all parameters required for most HVAC applications including:

- Most VAV and CAV supply and return fans.
- Cooling tower fans.
- Primary pumps.
- Secondary pumps.
- Condenser water pumps.
- Other pump, fan and compressor applications.

How to access *Function Set-up* - example

1. Turn on the frequency converter (yellow LED lights).
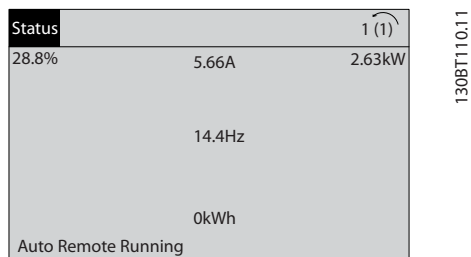
Illustration 6.2 Frequency Converter Turned on

2. Press [Quick Menus].
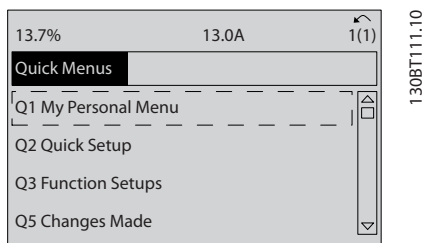
Illustration 6.3 Quick Menu Selected

3. Press [▲] and [▼] to scroll down to *Function Set-ups*. Press [OK].
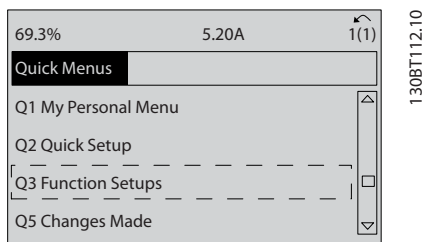
Illustration 6.4 Scrolling to Function Set-up

4. *Function Set-ups* options appear. Select Q3-1 *General Settings*. Press [OK].
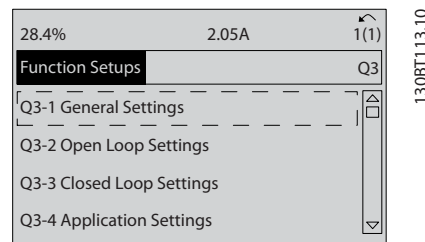
Illustration 6.5 Function Set-ups Options

5. Press [▲] and [▼] to scroll down to *Q3-11 Analog Outputs*. Press [OK].
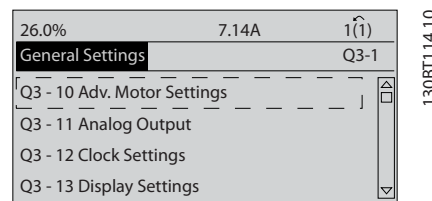
Illustration 6.6 General Settings Options

6. Select *parameter 6-50 Terminal 42 Output*. Press [OK].
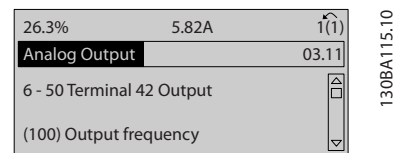
Illustration 6.7 *Parameter 6-50 Terminal 42 Output* Selected

7. Press [▲] and [▼] to select between the different options. Press [OK].
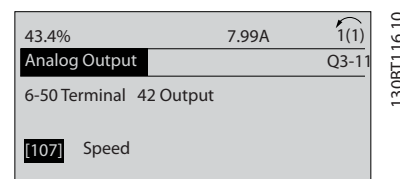
Illustration 6.8 Setting a Parameter

Function Set-ups parameters

The *Function Set-ups* parameters are grouped in the following way:

Q3-10 Adv. motor settings	Q3-11 Analog output	Q3-12 Clock settings	Q3-13 Display settings
Parameter 1-90 Motor Thermal Protection	Parameter 6-50 Terminal 42 Output	0-70 Date and Time	0-20 Display Line 1.1 Small
Parameter 1-93 Thermistor Source	Parameter 6-51 Terminal 42 Output Min Scale	0-71 Date Format	0-21 Display Line 1.2 Small
Parameter 1-29 Automatic Motor Adaptation (AMA)	Parameter 6-52 Terminal 42 Output Max Scale	0-72 Time Format	0-22 Display Line 1.3 Small
Parameter 14-01 Switching Frequency		0-74 DST/Summertime	0-23 Display Line 2 Large
Parameter 4-53 Warning Speed High		0-76 DST/Summertime Start	0-24 Display Line 3 Large
		0-77 DST/Summertime End	0-37 Display Text 1
			0-38 Display Text 2
			0-39 Display Text 3

Table 6.3 Q3-1 General Settings

Q3-20 Digital reference	Q3-21 Analog reference
Parameter 3-02 Minimum Reference	Parameter 3-02 Minimum Reference
3-03 Maximum Reference	3-03 Maximum Reference
Parameter 3-10 Preset Reference	Parameter 6-10 Terminal 53 Low Voltage
5-13 Terminal 29 Digital Input	Parameter 6-11 Terminal 53 High Voltage
5-14 Terminal 32 Digital Input	6-12 Terminal 53 Low Current
5-15 Terminal 33 Digital Input	6-13 Terminal 53 High Current
	Parameter 6-14 Terminal 53 Low Ref./Feedb. Value
	Parameter 6-15 Terminal 53 High Ref./Feedb. Value

Table 6.4 Q3-2 Open-loop Settings

Q3-30 Single zone int. setpoint	Q3-31 Single zone ext. setpoint	Q3-32 Multi zone/adv
Parameter 1-00 Configuration Mode	Parameter 1-00 Configuration Mode	Parameter 1-00 Configuration Mode
20-12 Reference/Feedback Unit	20-12 Reference/Feedback Unit	Parameter 3-15 Reference 1 Source
20-13 Minimum Reference/Feedb.	20-13 Minimum Reference/Feedb.	Parameter 3-16 Reference 2 Source
20-14 Maximum Reference/Feedb.	20-14 Maximum Reference/Feedb.	Parameter 20-00 Feedback 1 Source
6-22 Terminal 54 Low Current	Parameter 6-10 Terminal 53 Low Voltage	Parameter 20-01 Feedback 1 Conversion
Parameter 6-24 Terminal 54 Low Ref./Feedb. Value	Parameter 6-11 Terminal 53 High Voltage	20-02 Feedback 1 Source Unit
Parameter 6-25 Terminal 54 High Ref./Feedb. Value	6-12 Terminal 53 Low Current	Parameter 20-03 Feedback 2 Source
Parameter 6-26 Terminal 54 Filter Time Constant	6-13 Terminal 53 High Current	Parameter 20-04 Feedback 2 Conversion
Parameter 6-27 Terminal 54 Live Zero	Parameter 6-14 Terminal 53 Low Ref./Feedb. Value	20-05 Feedback 2 Source Unit
Parameter 6-00 Live Zero Timeout Time	Parameter 6-15 Terminal 53 High Ref./Feedb. Value	Parameter 20-06 Feedback 3 Source
Parameter 6-01 Live Zero Timeout Function	6-22 Terminal 54 Low Current	Parameter 20-07 Feedback 3 Conversion
Parameter 20-21 Setpoint 1	Parameter 6-24 Terminal 54 Low Ref./Feedb. Value	20-08 Feedback 3 Source Unit
Parameter 20-81 PID Normal/ Inverse Control	Parameter 6-25 Terminal 54 High Ref./Feedb. Value	20-12 Reference/Feedback Unit
20-82 PID Start Speed [RPM]	Parameter 6-26 Terminal 54 Filter Time Constant	20-13 Minimum Reference/Feedb.
20-83 PID Start Speed [Hz]	Parameter 6-27 Terminal 54 Live Zero	20-14 Maximum Reference/Feedb.

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Q3-30 Single zone int. setpoint	Q3-31 Single zone ext. setpoint	Q3-32 Multi zone/adv
Parameter 20-93 PID Proportional Gain	*Parameter 6-00 Live Zero Timeout Time*	*Parameter 6-10 Terminal 53 Low Voltage*
Parameter 20-94 PID Integral Time	*Parameter 6-01 Live Zero Timeout Function*	*Parameter 6-11 Terminal 53 High Voltage*
20-70 Closed Loop Type	*Parameter 20-81 PID Normal/ Inverse Control*	*6-12 Terminal 53 Low Current*
20-71 PID Performance	*20-82 PID Start Speed [RPM]*	*6-13 Terminal 53 High Current*
20-72 PID Output Change	*20-83 PID Start Speed [Hz]*	*Parameter 6-14 Terminal 53 Low Ref./Feedb. Value*
20-73 Minimum Feedback Level	*Parameter 20-93 PID Proportional Gain*	*Parameter 6-15 Terminal 53 High Ref./Feedb. Value*
20-74 Maximum Feedback Level	*Parameter 20-94 PID Integral Time*	*Parameter 6-16 Terminal 53 Filter Time Constant*
20-79 PID Autotuning	*20-70 Closed Loop Type*	*Parameter 6-17 Terminal 53 Live Zero*
	20-71 PID Performance	*Parameter 6-20 Terminal 54 Low Voltage*
	20-72 PID Output Change	*Parameter 6-21 Terminal 54 High Voltage*
	20-73 Minimum Feedback Level	*6-22 Terminal 54 Low Current*
	20-74 Maximum Feedback Level	*6-23 Terminal 54 High Current*
	20-79 PID Autotuning	*Parameter 6-24 Terminal 54 Low Ref./Feedb. Value*
		Parameter 6-25 Terminal 54 High Ref./Feedb. Value
		Parameter 6-26 Terminal 54 Filter Time Constant
		Parameter 6-27 Terminal 54 Live Zero
		Parameter 6-00 Live Zero Timeout Time
		Parameter 6-01 Live Zero Timeout Function
		Parameter 4-56 Warning Feedback Low
		Parameter 4-57 Warning Feedback High
		Parameter 20-20 Feedback Function
		Parameter 20-21 Setpoint 1
		Parameter 20-22 Setpoint 2
		Parameter 20-81 PID Normal/ Inverse Control
		20-82 PID Start Speed [RPM]
		20-83 PID Start Speed [Hz]
		Parameter 20-93 PID Proportional Gain
		Parameter 20-94 PID Integral Time
		20-70 Closed Loop Type
		20-71 PID Performance
		20-72 PID Output Change
		20-73 Minimum Feedback Level
		20-74 Maximum Feedback Level
		20-79 PID Autotuning

Table 6.5 Q3-3 Closed-loop Settings

MG11F502   79

Q3-40 Fan functions	Q3-41 Pump functions	Q3-42 Compressor functions
Parameter 22-60 Broken Belt Function	*22-20 Low Power Auto Set-up*	*Parameter 1-03 Torque Characteristics*
Parameter 22-61 Broken Belt Torque	*Parameter 22-21 Low Power Detection*	*Parameter 1-71 Start Delay*
Parameter 22-62 Broken Belt Delay	*Parameter 22-22 Low Speed Detection*	*Parameter 22-75 Short Cycle Protection*
Parameter 4-64 Semi-Auto Bypass Set-up	*Parameter 22-23 No-Flow Function*	*Parameter 22-76 Interval between Starts*
Parameter 1-03 Torque Characteristics	*Parameter 22-24 No-Flow Delay*	*Parameter 22-77 Minimum Run Time*
Parameter 22-22 Low Speed Detection	*Parameter 22-40 Minimum Run Time*	*Parameter 5-01 Terminal 27 Mode*
Parameter 22-23 No-Flow Function	*Parameter 22-41 Minimum Sleep Time*	*Parameter 5-02 Terminal 29 Mode*
Parameter 22-24 No-Flow Delay	*Parameter 22-42 Wake-up Speed [RPM]*	*5-12 Terminal 27 Digital Input*
Parameter 22-40 Minimum Run Time	*22-43 Wake-up Speed [Hz]*	*5-13 Terminal 29 Digital Input*
Parameter 22-41 Minimum Sleep Time	*22-44 Wake-up Ref./FB Difference*	*Parameter 5-40 Function Relay*
Parameter 22-42 Wake-up Speed [RPM]	*22-45 Setpoint Boost*	*Parameter 1-73 Flying Start*
22-43 Wake-up Speed [Hz]	*22-46 Maximum Boost Time*	*1-86 Trip Speed Low [RPM]*
22-44 Wake-up Ref./FB Difference	*Parameter 22-26 Dry Pump Function*	*1-87 Trip Speed Low [Hz]*
22-45 Setpoint Boost	*22-27 Dry Pump Delay*	
22-46 Maximum Boost Time	*22-80 Flow Compensation*	
Parameter 2-10 Brake Function	*22-81 Square-linear Curve Approximation*	
2-16 AC brake Max. Current	*22-82 Work Point Calculation*	
Parameter 2-17 Over-voltage Control	*22-83 Speed at No-Flow [RPM]*	
Parameter 1-73 Flying Start	*22-84 Speed at No-Flow [Hz]*	
Parameter 1-71 Start Delay	*22-85 Speed at Design Point [RPM]*	
Parameter 1-80 Function at Stop	*22-86 Speed at Design Point [Hz]*	
Parameter 2-00 DC Hold/Preheat Current	*22-87 Pressure at No-Flow Speed*	
Parameter 4-10 Motor Speed Direction	*22-88 Pressure at Rated Speed*	
	22-89 Flow at Design Point	
	22-90 Flow at Rated Speed	
	Parameter 1-03 Torque Characteristics	
	Parameter 1-73 Flying Start	

Table 6.6 Q3-4 Application Settings

1-00 Configuration Mode		
Option:	**Function:**	
	NOTICE **This parameter cannot be adjusted while the motor is running.**	
[0]	Open Loop	Motor speed is determined by applying a speed reference or by setting desired speed when in *Hand mode*. Open loop is also used if the frequency converter is of a closed loop control system based on an external PID controller providing a speed reference signal as output.
[3]	Closed Loop	Motor speed is determined by a reference from the built-in PID controller varying the motor speed as of a closed-loop control process (for example, constant pressure or flow). Configure the PID controller in parameter group *20-** Feedback* or via the *Function Set-ups* accessed by pressing [Quick Menus].

NOTICE

When set for closed loop, the commands reversing and start reversing do not reverse the motor direction.

1-03 Torque Characteristics		
Option:	**Function:**	
[0]	Compressor torque	For speed control of screw and scroll compressors. Provides a voltage which is optimised for a constant torque load characteristic of the motor in the entire range down to 10 Hz.
[1]	Variable torque	For speed control of centrifugal pumps and fans. Also to be used when controlling more than 1 motor from the same frequency converter (for example, multiple condenser fans or cooling tower fans). Provides a voltage which is optimised for a squared torque load characteristic of the motor.
[2]	Auto Energy Optim. CT	For optimum energy-efficient speed control of screw and scroll compressors. Provides a voltage which is optimised for a constant torque load characteristic of the motor in the entire range down to 15 Hz. In addition, the

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1-03 Torque Characteristics		
Option:	**Function:**	
		AEO feature adapts the voltage exactly to the current load situation, thereby reducing energy consumption and audible noise from the motor. To obtain optimum performance, set the motor power factor cos phi correctly. This value is set in *14-43 Motor Cosphi*. The parameter has a default value which is automatically adjusted when the motor data is programmed. These settings ensure optimum motor voltage. If the motor power factor cos phi requires tuning, an AMA function can be carried out using *parameter 1-29 Automatic Motor Adaptation (AMA)*. It is rarely necessary to adjust the motor power factor parameter manually.
[3] *	Auto Energy Optim. VT	For optimum energy-efficient speed control of centrifugal pumps and fans. Provides a voltage optimised for a squared torque load characteristic of the motor. In addition, the AEO feature adapts the voltage exactly to the current load situation, thereby reducing energy consumption and audible noise from the motor. To obtain optimum performance, set the motor power factor cos phi correctly. This value is set in *14-43 Motor Cosphi*. The parameter has a default value and is automatically adjusted when the motor data is programmed. These settings ensure optimum motor voltage. If the motor power factor cos phi requires tuning, an AMA function can be carried out using *parameter 1-29 Automatic Motor Adaptation (AMA)*. It is rarely necessary to adjust the motor power factor parameter manually.

NOTICE

Parameter 1-03 Torque Characteristics **has no effect when** *1-10 Motor Construction=[1] PM, non-salient SPM.*

NOTICE

For pumps or fan applications where the viscosity or density can vary significantly, or where excessive flow can occur, select *[2] Auto Energy Optim. CT.*

1-29 Automatic Motor Adaptation (AMA)		
Option:	**Function:**	
		NOTICE **This parameter cannot be adjusted while the motor is running.** The AMA function optimises dynamic motor performance by automatically optimising the

1-29 Automatic Motor Adaptation (AMA)		
Option:	**Function:**	
		advanced motor parameters (*1-30 Stator Resistance (Rs)* to *1-35 Main Reactance (Xh)*) at motor standstill.
[0] *	Off	No function.
[1]	Enable Complete AMA	Performs AMA of the stator resistance R_S, the rotor resistance R_r, the stator leakage reactance X_1, the rotor leakage reactance X_2 and the main reactance X_h.
[2]	Enable Reduced AMA	Performs a reduced AMA of the stator resistance R_s in the system only. Select this option if an LC filter is used between the frequency converter and the motor.

NOTICE

Parameter 1-29 Automatic Motor Adaptation (AMA) **has no effect when** *1-10 Motor Construction=[1] PM, non-salient SPM.*

Activate the AMA function by pressing [Hand On] after selecting *[1] Enable complete AMA* or *[2] Enable reduced AMA*. See also the section *Automatic Motor Adaptation* in the *design guide*. After a normal sequence, the display reads: *Press [OK] to finish AMA*. After pressing [OK], the frequency converter is ready for operation.

NOTICE

- **For the best adaptation of the frequency converter, run AMA on a cold motor.**
- **AMA cannot be performed while the motor is running.**

NOTICE

Avoid generating external torque during AMA.

NOTICE

If one of the settings in parameter group *1-2* Motor Data* **is changed,** *1-30 Stator Resistance (Rs)* **to** *1-39 Motor Poles* **return to default settings.**

NOTICE

Only run complete AMA without filter, and only run reduced AMA with filter.

See section: *Application Examples > Automatic Motor Adaptation* in the *design guide*.

1-71 Start Delay		
Range:		**Function:**
00 s*	[0 - 120 s]	When the frequency converter receives the start command, it delays motor start for the time specified in this parameter. The function selected in *parameter 1-80 Function at Stop* is active in the delay period.

1-73 Flying Start		
Option:		**Function:**
		This function enables catching a motor which is spinning freely due to a mains drop-out.
		When *parameter 1-73 Flying Start* is enabled, *parameter 1-71 Start Delay* has no function. Search direction for flying start is linked to the setting in *parameter 4-10 Motor Speed Direction*. *[0] Clockwise*: Flying start searches in clockwise direction. If not successful, a DC brake is activated. *[2] Both Directions*: The flying start first makes a search in the direction determined by the last reference (direction). If the speed is not found, it makes a search in the other direction. If not successful, a DC brake is activated in the time set in *2-02 DC Braking Time*. Start then takes place from 0 Hz.
[0]	Disabled	Select *[0] Disable* if this function is not required.
[1]	Enabled	Select *[1] Enable* to enable the frequency converter to catch and control a spinning motor. The parameter is always set to *[1] Enable* when *1-10 Motor Construction*=[1] PM non-salient. Important related parameters: • *1-58 Flystart Test Pulses Current* • *1-59 Flystart Test Pulses Frequency* • *1-70 PM Start Mode* • *2-06 Parking Current* • *2-07 Parking Time* • *2-03 DC Brake Cut In Speed [RPM]* • *2-04 DC Brake Cut In Speed [Hz]* • *2-06 Parking Current* • *2-07 Parking Time*

The flying-start function used for PM motors is based on an initial speed estimation. The speed is always estimated as the first thing after an active start signal is given. Based on the setting of *1-70 PM Start Mode* the following happens:

1-70 PM Start Mode=[0] Rotor Detection:
If the speed estimate appears as greater than 0 Hz, the frequency converter catches the motor at that speed and resumes normal operation. Otherwise, the frequency converter estimates the rotor position and start normal operation from there.

1-70 PM Start Mode=[1] Parking:
A speed estimate lower than the setting in *1-59 Flystart Test Pulses Frequency* engages the parking function (see *2-06 Parking Current* and *2-07 Parking Time*). Otherwise, the frequency converter catches the motor at that speed and resumes normal operation. Refer to the description of *1-70 PM Start Mode* for recommended settings.

Current limitations of the flying-start principle used for PM motors:

• The speed range is up to 100% nominal speed or the field weakening speed (whichever is lowest).

• PMSM with high back EMF (>300 VLL(rms)) and high winding inductance (>10 mH) needs more time for reducing short-circuit current to 0 and may be susceptible to error in estimation.

• Current testing limited to a speed range up to 300 Hz. For certain units, the limit is 250 Hz; all 200-240 V units up to and including 2.2 kW and all 380-480 V units up to and including 4 kW.

• Prepared for salient pole machine (IPMSM) but not yet verified on those types of machine.

• For high-inertia applications (that is, where the load inertia is more than 30 times larger than the motor inertia), use a brake resistor to avoid overvoltage trip during high-speed engagement of the flying-start function.

1-80 Function at Stop		
Option:		**Function:**
		Select the frequency converter function after a stop command or after the speed is ramped down to the settings in *1-81 Min Speed for Function at Stop [RPM]*. Available selections depend on *1-10 Motor Construction*: [0] Asynchronous: [0] Coast [1] DC hold [2] Motor check, warning [6] Motor check, alarm [1] PM non-salient: [0] Coast
[0] *	Coast	Leaves motor in free mode.
[1]	DC Hold/ Motor Preheat	Energises motor with a DC hold current (see *parameter 2-00 DC Hold/Preheat Current*).
[2]	Motor check, warning	Issues a warning if the motor is not connected.
[6]	Motor check, alarm	Issues an alarm if the motor is not connected.

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1-90 Motor Thermal Protection		
Option:		**Function:**
		The frequency converter determines the motor temperature for motor overload protection in 2 different ways: • Via a thermistor sensor connected to one of the analog or digital inputs (*parameter 1-93 Thermistor Source*). • Via calculation (ETR=electronic thermal relay) of the thermal load, based on the actual load and time. The calculated thermal load is compared with the rated motor current $I_{M,N}$ and the rated motor frequency $f_{M,N}$. The calculations estimate the need for a lower load at lower speed due to less cooling from the fan incorporated in the motor.
[0]	No protection	If the motor is continuously overloaded, and no warning or trip of frequency converter is wanted.
[1]	Thermistor warning	Activates a warning when the connected thermistor in the motor reacts in the event of motor overtemperature.
[2]	Thermistor trip	Stops (trips) the frequency converter when the connected thermistor in the motor reacts in the event of motor overtemperature.
[3]	ETR warning 1	
[4]	ETR trip 1	
[5]	ETR warning 2	
[6]	ETR trip 2	
[7]	ETR warning 3	
[8]	ETR trip 3	
[9]	ETR warning 4	
[10]	ETR trip 4	

ETR functions 1-4 calculate the load when the set-up where they were selected is active. For example ETR-3 starts calculating when set-up 3 is selected. For the North American market: The ETR functions provide class 20 motor overload protection in accordance with NEC.
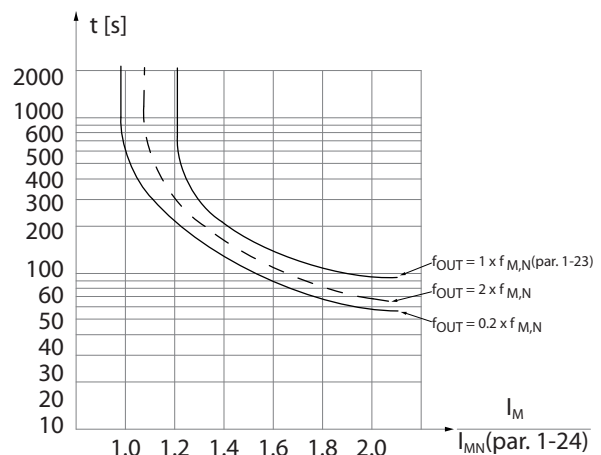
Illustration 6.9 Thermal Motor Protection

⚠ WARNING

To maintain PELV, all connections made to the control terminals must be PELV, for example, thermistor must be reinforced/double insulated.

NOTICE

Danfoss recommends using 24 V DC as thermistor supply voltage.

NOTICE

The ETR timer function does not work when *1-10 Motor Construction=[1] PM, non-salient SPM*.

NOTICE

For correct operation of the ETR function, the setting in *parameter 1-03 Torque Characteristics* must fit the application (see description of *parameter 1-03 Torque Characteristics*).

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1-93 Thermistor Source	
Option:	Function:
	NOTICE **This parameter cannot be adjusted while the motor is running.** **NOTICE** **Set digital input to _[0] PNP - Active at 24 V_ in _5-00 Digital I/O Mode_.** Select the input to which the thermistor (PTC sensor) should be connected. An analog input option _[1] Analog Input 53_ or _[2] Analog Input 54_ cannot be selected if the analog input is already in use as a reference source (selected in _parameter 3-15 Reference 1 Source, parameter 3-16 Reference 2 Source_ or _3-17 Reference 3 Source_). When using VLT PTC thermistor card MCB 112, _[0] None_ must always be selected.
[0] *	None
[1]	Analog Input 53
[2]	Analog Input 54
[3]	Digital input 18
[4]	Digital input 19
[5]	Digital input 32
[6]	Digital input 33

2-00 DC Hold/Preheat Current		
Range:		Function:
50 %*	[0 - 160 %]	Enter a value for holding current as a percentage of the rated motor current $I_{M,N}$ set in _parameter 1-24 Motor Current_. 100% DC hold current corresponds to $I_{M,N}$. This parameter holds the motor (holding torque) or preheats the motor. This parameter is active if _[1] DC hold/Motor Preheat_ is selected in _parameter 1-80 Function at Stop_.

NOTICE

Parameter 2-00 DC Hold/Preheat Current **has no effect when _1-10 Motor Construction=[1] PM, non-salient SPM_.**

NOTICE

The maximum value depends on the rated motor current.
Avoid 100% current for too long. It may damage the motor.

2-10 Brake Function		
Option:		Function:
		Available selections depend on _1-10 Motor Construction_: [0] Asynchron: _[0] Off_ _[1] Resistor brake_ _[2] AC brake_ [1] PM non-salient: _[0] Off_ _[1] Resistor brake_
[0]	Off	No brake resistor installed.
[1]	Resistor brake	Brake resistor incorporated in the system, for dissipation of surplus brake energy as heat. Connecting a brake resistor allows a higher DC-link voltage during braking (generating operation). The resistor brake function is only active in frequency converters with an integral dynamic brake.
[2]	AC brake	AC brake only works in compressor torque mode in _parameter 1-03 Torque Characteristics_.

2-17 Over-voltage Control		
Option:		Function:
		NOTICE _Parameter 2-17 Over-voltage Control_ **has no effect when _1-10 Motor Construction=[1] PM, non-salient SPM_.** **NOTICE** **The ramp time is automatically adjusted to avoid tripping of the frequency converter.**
[0]	Disabled	No OVC required.
[2] *	Enabled	Activates OVC.

3-02 Minimum Reference

Range:		Function:
Size related*	[-999999.999 - par. 3-03 ReferenceFeed-backUnit]	Enter the minimum reference. The minimum reference is the lowest value obtainable by summing all references. The minimum reference value and unit match the configuration made in *parameter 1-00 Configuration Mode* and *20-12 Reference/Feedback Unit*. **NOTICE** **This parameter is used in open loop only.**

3-04 Reference Function

Option:		Function:
[0]	Sum	Sums both external and preset reference sources.
[1]	External/ Preset	Use either the preset or the external reference source. Shift between external and preset via a command on a digital input.

3-10 Preset Reference

Array [8]

Range:		Function:
0 %*	[-100 - 100 %]	Enter up to 8 different preset references (0-7) in this parameter, using array programming. The preset reference is stated as a percentage of the value Ref$_{MAX}$ (*3-03 Maximum Reference*, for closed loop see *20-14 Maximum Reference/ Feedb.*). When using preset references, select Preset ref. bit 0/1/2 [16], [17] or [18] for the corresponding digital inputs in parameter group *5-1* Digital Inputs*.
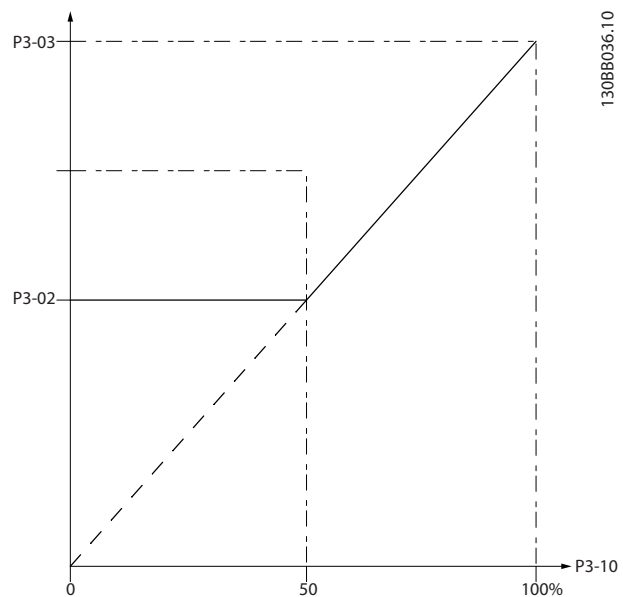
Illustration 6.10 Preset Reference
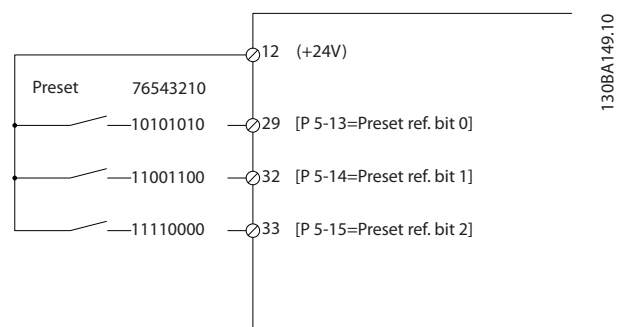
Illustration 6.11 Preset Reference Scheme

3-15 Reference 1 Source

Option:		Function:
		NOTICE **This parameter cannot be adjusted while the motor is running.** Select the reference input to be used for the first reference signal. *Parameter 3-15 Reference 1 Source*, *parameter 3-16 Reference 2 Source* and *3-17 Reference 3 Source* define up to 3 different reference signals. The sum of these reference signals defines the actual reference.
[0]	No function	
[1] *	Analog Input 53	
[2]	Analog Input 54	
[7]	Pulse input 29	
[8]	Pulse input 33	

3-15 Reference 1 Source	
Option:	**Function:**
[20]	Digital pot.meter
[21]	Analog input X30/11
[22]	Analog input X30/12
[23]	Analog Input X42/1
[24]	Analog Input X42/3
[25]	Analog Input X42/5
[29]	Analog Input X48/2
[30]	Ext. Closed Loop 1
[31]	Ext. Closed Loop 2
[32]	Ext. Closed Loop 3

3-16 Reference 2 Source		
Option:		**Function:**
		NOTICE **This parameter cannot be adjusted while the motor is running.** Select the reference input to be used for the second reference signal. *Parameter 3-15 Reference 1 Source, parameter 3-16 Reference 2 Source* and *3-17 Reference 3 Source* define up to 3 different reference signals. The sum of these reference signals defines the actual reference.
[0]	No function	
[1]	Analog Input 53	
[2]	Analog Input 54	
[7]	Pulse input 29	
[8]	Pulse input 33	
[20] *	Digital pot.meter	
[21]	Analog input X30/11	
[22]	Analog input X30/12	
[23]	Analog Input X42/1	
[24]	Analog Input X42/3	
[25]	Analog Input X42/5	
[29]	Analog Input X48/2	
[30]	Ext. Closed Loop 1	
[31]	Ext. Closed Loop 2	
[32]	Ext. Closed Loop 3	

4-10 Motor Speed Direction		
Option:		**Function:**
		Selects the motor speed direction required. Use this parameter to prevent unwanted reversing.
[0]	Clockwise	Only operation in clockwise direction is allowed.
[2] *	Both directions	Operation in both clockwise and counter-clockwise direction is allowed.

NOTICE

The setting in *parameter 4-10 Motor Speed Direction* has impact on the flying start in *parameter 1-73 Flying Start*.

4-53 Warning Speed High		
Range:		**Function:**
Size related*	[par. 4-52 - par. 4-13 RPM]	*NOTICE* **Any changes in *parameter 4-13 Motor Speed High Limit [RPM]* reset the value in *parameter 4-53 Warning Speed High* to the value in *parameter 4-13 Motor Speed High Limit [RPM]*.** **If a different value is needed in *parameter 4-53 Warning Speed High*, it must be set after programming *parameter 4-13 Motor Speed High Limit [RPM]*** Enter the n_{HIGH} value. When the motor speed exceeds this limit (n_{HIGH}), the display reads SPEED HIGH. The signal outputs can be programmed to produce a status signal on terminal 27 or 29 and on relay output 01 or 02. Programme the upper signal limit of the motor speed, n_{HIGH}, within the normal working range of the frequency converter.

4-56 Warning Feedback Low		
Range:		**Function:**
-999999.999 ProcessCtrlUnit*	[-999999.999 - par. 4-57 ProcessCtrlUnit]	Enter the lower feedback limit. When the feedback drops below this limit, the display reads $Feedb_{Low}$. The signal outputs can be programmed to produce a status signal on terminal 27 or 29 and on relay output 01 or 02.

4-57 Warning Feedback High		
Range:		**Function:**
999999.999 ProcessCtrlUnit*	[par. 4-56 - 999999.999 ProcessCtrlUnit]	Enter the upper feedback limit. When the feedback exceeds this limit, the display reads $Feedb_{High}$. The signal outputs can be programmed to produce a status signal on terminal 27 or 29 and on relay output 01 or 02.

6

4-64 Semi-Auto Bypass Set-up		
Option:	**Function:**	
[0] *	Off	No function.
[1]	Enabled	Starts the semi-automatic bypass set-up and continues with the procedure described above.

5-01 Terminal 27 Mode		
Option:	**Function:**	
		NOTICE This parameter cannot be adjusted while the unit is running.
[0] *	Input	Defines terminal 27 as a digital input.
[1]	Output	Defines terminal 27 as a digital output.

5-02 Terminal 29 Mode		
Option:	**Function:**	
		NOTICE This parameter cannot be adjusted while the motor is running.
[0] *	Input	Defines terminal 29 as a digital input.
[1]	Output	Defines terminal 29 as a digital output.

6.1.4 5-1* Digital Inputs

Parameters for configuring the input functions for the input terminals.
The digital inputs are used for selecting various functions in the frequency converter. All digital inputs can be set to the following functions:

Digital input function	Select	Terminal
No operation	[0]	All *terminal 19, 32, 33
Reset	[1]	All
Coast inverse	[2]	27
Coast and reset inverse	[3]	All
DC brake inverse	[5]	All
Stop inverse	[6]	All
External interlock	[7]	All
Start	[8]	All *terminal 18
Latched start	[9]	All
Reversing	[10]	All
Start reversing	[11]	All
Jog	[14]	All *terminal 29
Preset reference on	[15]	All
Preset ref bit 0	[16]	All
Preset ref bit 1	[17]	All
Preset ref bit 2	[18]	All
Freeze reference	[19]	All
Freeze output	[20]	All

Digital input function	Select	Terminal
Speed up	[21]	All
Speed down	[22]	All
Set-up select bit 0	[23]	All
Set-up select bit 1	[24]	All
Pulse input	[32]	Terminal 29, 33
Ramp bit 0	[34]	All
Mains failure inverse	[36]	All
Fire mode	[37]	All
Run permissive	[52]	All
Hand start	[53]	All
Auto start	[54]	All
DigiPot increase	[55]	All
DigiPot decrease	[56]	All
DigiPot clear	[57]	All
Counter A (up)	[60]	29, 33
Counter A (down)	[61]	29, 33
Reset counter A	[62]	All
Counter B (up)	[63]	29, 33
Counter B (down)	[64]	29, 33
Reset counter B	[65]	All
Sleep mode	[66]	All
Reset maintenance word	[78]	All
PTC card 1	[80]	All
Lead pump start	[120]	All
Lead pump alternation	[121]	All
Pump 1 interlock	[130]	All
Pump 2 interlock	[131]	All
Pump 3 interlock	[132]	All

5-12 Terminal 27 Digital Input

The parameter contains all options and functions listed in parameter group *5-1* Digital Inputs* except for option *[32] Pulse input*.

5-13 Terminal 29 Digital Input

The parameter contains all options and functions listed in parameter group *5-1* Digital Inputs*.

5-14 Terminal 32 Digital Input

The parameter contains all options and functions listed in parameter group *5-1* Digital Inputs* except for option *[32] Pulse input*.

5-15 Terminal 33 Digital Input

The parameter contains all options and functions listed in parameter group *5-1* Digital Inputs*.

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6

5-40 Function Relay		
Array [8]		
(Relay 1 [0], Relay 2 [1]		
Option MCB 105: Relay 7 [6], Relay 8 [7] and Relay 9 [8]).		
Select options to define the function of the relays.		
The selection of each mechanical relay is realised in an array parameter.		
Option:		**Function:**
[0]	No operation	
[1]	Control Ready	
[2]	Drive ready	
[3]	Drive rdy/rem ctrl	
[4]	Standby / no warning	
[5]	Running	Default setting for relay 2.
[6]	Running / no warning	
[8]	Run on ref/no warn	
[9]	Alarm	Default setting for relay 1.
[10]	Alarm or warning	
[11]	At torque limit	
[12]	Out of current range	
[13]	Below current, low	
[14]	Above current, high	
[15]	Out of speed range	
[16]	Below speed, low	
[17]	Above speed, high	
[18]	Out of feedb. range	
[19]	Below feedback, low	
[20]	Above feedback, high	
[21]	Thermal warning	
[25]	Reverse	
[26]	Bus OK	
[27]	Torque limit & stop	
[28]	Brake, no brake war	
[29]	Brake ready, no fault	
[30]	Brake fault (IGBT)	
[33]	Safe stop active	
[35]	External Interlock	
[36]	Control word bit 11	
[37]	Control word bit 12	
[40]	Out of ref range	
[41]	Below reference, low	
[42]	Above ref, high	
[45]	Bus ctrl.	
[46]	Bus ctrl, 1 if timeout	
[47]	Bus ctrl, 0 if timeout	
[60]	Comparator 0	
[61]	Comparator 1	
[62]	Comparator 2	
[63]	Comparator 3	
[64]	Comparator 4	
[65]	Comparator 5	
[70]	Logic rule 0	

5-40 Function Relay		
Array [8]		
(Relay 1 [0], Relay 2 [1]		
Option MCB 105: Relay 7 [6], Relay 8 [7] and Relay 9 [8]).		
Select options to define the function of the relays.		
The selection of each mechanical relay is realised in an array parameter.		
Option:		**Function:**
[71]	Logic rule 1	
[72]	Logic rule 2	
[73]	Logic rule 3	
[74]	Logic rule 4	
[75]	Logic rule 5	
[80]	SL digital output A	
[81]	SL digital output B	
[82]	SL digital output C	
[83]	SL digital output D	
[84]	SL digital output E	
[85]	SL digital output F	
[160]	No alarm	
[161]	Running reverse	
[165]	Local ref active	
[166]	Remote ref active	
[167]	Start command activ	
[168]	Hand / Off	
[169]	Auto mode	
[180]	Clock Fault	
[181]	Prev. Maintenance	
[188]	AHF Capacitor Connect	
[189]	External Fan Control	
[190]	No-Flow	
[191]	Dry Pump	
[192]	End Of Curve	
[193]	Sleep Mode	
[194]	Broken Belt	
[195]	Bypass Valve Control	
[196]	Fire Mode	
[197]	Fire Mode was Act.	
[198]	Drive Bypass	
[211]	Cascade Pump 1	
[212]	Cascade Pump 2	
[213]	Cascade Pump 3	

6-00 Live Zero Timeout Time		
Range:		**Function:**
10 s*	[1 - 99 s]	Enter the live zero timeout time period. Live zero timeout time is active for analog inputs, that is, terminal 53 or terminal 54, used as reference or feedback sources. If the reference signal value associated with the selected current input drops below 50% of the value set in *parameter 6-10 Terminal 53 Low Voltage*, *6-12 Terminal 53 Low Current*, *parameter 6-20 Terminal 54 Low Voltage* or *6-22 Terminal 54 Low Current* for a time period longer than the time set in *parameter 6-00 Live Zero Timeout Time*, the function selected in *parameter 6-01 Live Zero Timeout Function* is activated.

6-01 Live Zero Timeout Function		
Option:		**Function:**
		Select the time out function. The function set in *parameter 6-01 Live Zero Timeout Function* is activated if the input signal on terminal 53 or 54 is below 50% of the value in *parameter 6-10 Terminal 53 Low Voltage*, *6-12 Terminal 53 Low Current*, *parameter 6-20 Terminal 54 Low Voltage* or *6-22 Terminal 54 Low Current* for a time period defined in *parameter 6-00 Live Zero Timeout Time*. If several time outs occur simultaneously, the frequency converter prioritises the time out functions as follows
		1. *Parameter 6-01 Live Zero Timeout Function*
		2. *8-04 Control Timeout Function*
		The output frequency of the frequency converter can be:
		• [1] frozen at the present value
		• [2] overruled to stop
		• [3] overruled to jog speed
		• [4] overruled to max. speed
		• [5] overruled to stop with subsequent trip
[0] *	Off	
[1]	Freeze output	
[2]	Stop	
[3]	Jogging	
[4]	Max. speed	
[5]	Stop and trip	

Illustration 6.12 Live Zero Conditions

6-10 Terminal 53 Low Voltage		
Range:		**Function:**
0.07 V*	[0 - par. 6-11 V]	Enter the low-voltage value. This analog input scaling value should correspond to the low reference/feedback value set in *parameter 6-14 Terminal 53 Low Ref./Feedb. Value*.

6-11 Terminal 53 High Voltage		
Range:		**Function:**
10 V*	[par. 6-10 - 10 V]	Enter the high-voltage value. This analog input scaling value should correspond to the high reference/feedback value set in *parameter 6-15 Terminal 53 High Ref./Feedb. Value*.

6-14 Terminal 53 Low Ref./Feedb. Value		
Range:		**Function:**
0*	[-999999.999 - 999999.999]	Enter the analog input scaling value that corresponds to the low voltage/low current set in *parameter 6-10 Terminal 53 Low Voltage* and *6-12 Terminal 53 Low Current*.

6-15 Terminal 53 High Ref./Feedb. Value		
Range:		**Function:**
Size related*	[-999999.999 - 999999.999]	Enter the analog input scaling value that corresponds to the high voltage/high current value set in *parameter 6-11 Terminal 53 High Voltage* and *6-13 Terminal 53 High Current*.

6-16 Terminal 53 Filter Time Constant

Range:		Function:
0.001 s*	[0.001 - 10 s]	**NOTICE** **This parameter cannot be adjusted while the motor is running.** Enter the filter time constant. This constant is a first-order digital low-pass filter time for suppressing electrical noise in terminal 53. A high value improves dampening, but also increases the delay through the filter.

6-17 Terminal 53 Live Zero

Option:		Function:
		Disables the live zero monitoring, for example if the analog outputs are used as part of a decentral I/O system (i.e. if these are used to feed a Building Management System with data, and not as part of any control functions related to the frequency converter).
[0]	Disabled	
[1] *	Enabled	

6-20 Terminal 54 Low Voltage

Range:		Function:
0.07 V*	[0 - par. 6-21 V]	Enter the low-voltage value. This analog input scaling value should correspond to the low reference/feedback value, set in *parameter 6-24 Terminal 54 Low Ref./Feedb. Value*.

6-21 Terminal 54 High Voltage

Range:		Function:
10 V*	[par. 6-20 - 10 V]	Enter the high-voltage value. This analog input scaling value should correspond to the high reference/feedback value set in *parameter 6-25 Terminal 54 High Ref./Feedb. Value*.

6-24 Terminal 54 Low Ref./Feedb. Value

Range:		Function:
0*	[-999999.999 - 999999.999]	Enter the analog input scaling value that corresponds to the low voltage/low current value set in *parameter 6-20 Terminal 54 Low Voltage* and *6-22 Terminal 54 Low Current*.

6-25 Terminal 54 High Ref./Feedb. Value

Range:		Function:
100*	[-999999.999 - 999999.999]	Enter the analog input scaling value that corresponds to the high voltage/high current value set in *parameter 6-21 Terminal 54 High Voltage* and *6-23 Terminal 54 High Current*.

6-26 Terminal 54 Filter Time Constant

Range:		Function:
0.001 s*	[0.001 - 10 s]	**NOTICE** **This parameter cannot be adjusted while the motor is running.** Enter the filter time constant. This is a first-order digital low-pass filter time constant for suppressing electrical noise in terminal 54. A high time constant value improves dampening but also increases the time delay through the filter.

6-27 Terminal 54 Live Zero

Option:		Function:
		Disables the live zero monitoring, for example if the analog outputs are used as part of a decentral I/O system (i.e. if these are used to feed a Building Management System with data, and not as part of any control functions related to the frequency converter).
[0]	Disabled	
[1] *	Enabled	

6-50 Terminal 42 Output

Option:		Function:
		Select the function of terminal 42 as an analog current output. A motor current of 20 mA corresponds to I_{max}.
[0]	No operation	
[100]	Output freq. 0-100	0–100 Hz, (0–20 mA)
[101]	Reference Min-Max	Minimum reference - Maximum reference, (0–20 mA)
[102]	Feedback +-200%	-200% to +200% of *20-14 Maximum Reference/Feedb.*, (0–20 mA)
[103]	Motor cur. 0-Imax	0 - Inverter Max. Current (*16-37 Inv. Max. Current*), (0-20 mA)
[104]	Torque 0-Tlim	0 - Torque limit (*4-16 Torque Limit Motor Mode*), (0-20 mA)
[105]	Torque 0-Tnom	0 - Motor rated torque, (0-20 mA)
[106]	Power 0-Pnom	0 - Motor rated power, (0-20 mA)

6-50 Terminal 42 Output

Option:		Function:
[107]	Speed 0-HighLim	0 - Speed High Limit (*parameter 4-13 Motor Speed High Limit [RPM]* and *parameter 4-14 Motor Speed High Limit [Hz]*), (0-20 mA)
[113]	Ext. Closed Loop 1	0-100%, (0-20 mA)
[114]	Ext. Closed Loop 2	0-100%, (0-20 mA)
[115]	Ext. Closed Loop 3	0-100%, (0-20 mA)
[130]	Out frq 0-100 4-20mA	0-100 Hz
[131]	Reference 4-20mA	Minimum Reference - Maximum Reference
[132]	Feedback 4-20mA	-200% to +200% of *20-14 Maximum Reference/Feedb.*
[133]	Motor cur. 4-20mA	0 - Inverter Max. Current (*16-37 Inv. Max. Current*)
[134]	Torq.0-lim 4-20 mA	0 - Torque limit (*4-16 Torque Limit Motor Mode*)
[135]	Torq.0-nom 4-20mA	0 - Motor rated torque
[136]	Power 4-20mA	0 - Motor rated power
[137]	Speed 4-20mA	0 - Speed High Limit (*parameter 4-13 Motor Speed High Limit [RPM]* and *parameter 4-14 Motor Speed High Limit [Hz]*)
[139]	Bus ctrl.	0–100%, (0–20 mA)
[140]	Bus ctrl. 4-20 mA	0–100%
[141]	Bus ctrl t.o.	0–100%, (0–20 mA)
[142]	Bus ctrl t.o. 4-20mA	0–100%
[143]	Ext. CL 1 4-20mA	0–100%
[144]	Ext. CL 2 4-20mA	0–100%
[145]	Ext. CL 3 4-20mA	0–100%

NOTICE

Values for setting the minimum reference are found in open loop *parameter 3-02 Minimum Reference* and for closed loop *20-13 Minimum Reference/Feedb.* - values for maximum reference for open loop are found in *3-03 Maximum Reference* and for closed loop *20-14 Maximum Reference/Feedb.*

6-51 Terminal 42 Output Min Scale

Range:		Function:
0 %*	[0 - 200 %]	Scale for the minimum output (0 mA or 4 mA) of the analog signal at terminal 42.

6-51 Terminal 42 Output Min Scale

Range:		Function:
		Set the value to be the percentage of the full range of the variable selected in *parameter 6-50 Terminal 42 Output*.

6-52 Terminal 42 Output Max Scale

Range:		Function:
100 %*	[0 - 200 %]	Scale for the maximum output (20 mA) of the analog signal at terminal 42. Set the value to be the percentage of the full range of the variable selected in *parameter 6-50 Terminal 42 Output*. **Illustration 6.13 Output Current vs Reference Variable** It is possible to obtain a value lower than 20 mA at full scale by programming values >100% by using a formula as follows:

$20\ mA / desired\ maximum\ current \times 100\%$

$i.e.\ 10 mA: \frac{20\ mA}{10\ mA} \times 100\% = 200\%$

Example 1:
Variable value=OUTPUT FREQUENCY, range=0-100 Hz
Range needed for output=0-50 Hz.
Output signal 0 mA or 4 mA is needed at 0 Hz (0% of range) - set *parameter 6-51 Terminal 42 Output Min Scale* to 0%.
Output signal 20 mA is needed at 50 Hz (50% of range) - set *parameter 6-52 Terminal 42 Output Max Scale* to 50%.
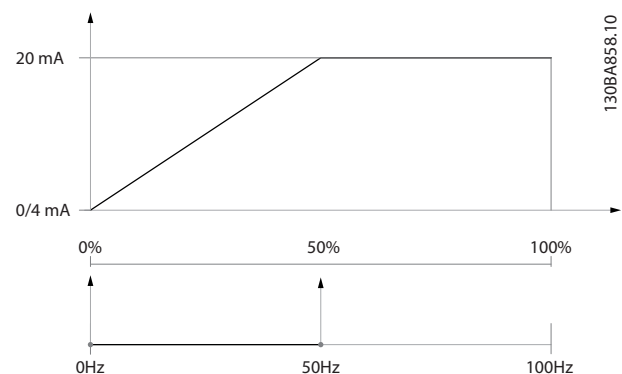
Illustration 6.14 Example 1

Example 2:

Variable=FEEDBACK, range=-200% to +200%

Range needed for output=0-100%.

Output signal 0 mA or 4 mA is needed at 0% (50% of range) - set *parameter 6-51 Terminal 42 Output Min Scale* to 50%.

Output signal 20 mA is needed at 100% (75% of range) - set *parameter 6-52 Terminal 42 Output Max Scale* to 75%.
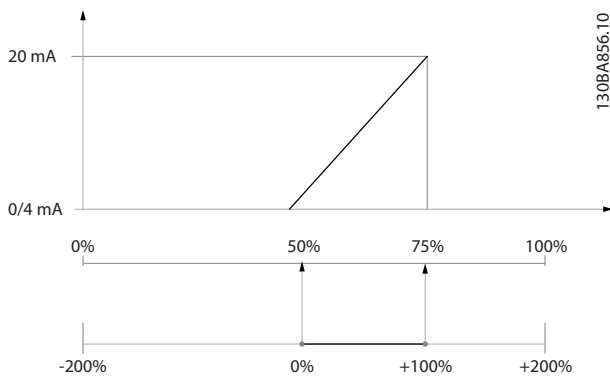
Illustration 6.15 Example 2

Example 3:

Variable value=REFERENCE, range=Minimum ref - maximum ref.

Range needed for output=Minimum ref (0%) - Maximum ref (100%), 0-10 mA

Output signal 0 mA or 4 mA is needed at minimum ref - set *parameter 6-51 Terminal 42 Output Min Scale* to 0%.

Output signal 10 mA is needed at maximum ref (100% of range) - set *parameter 6-52 Terminal 42 Output Max Scale* to 200%.

(20 mA/10 mA x 100%=200%).
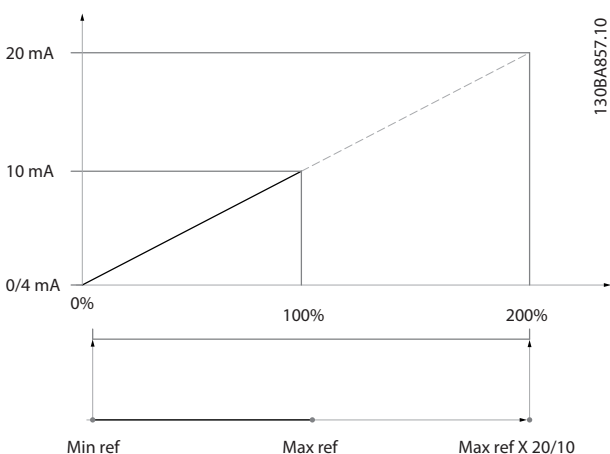
Illustration 6.16 Example 3

14-01 Switching Frequency		
Option:	**Function:**	
		Select the inverter switching frequency. Changing the switching frequency can help reduce acoustic noise from the motor.
		NOTICE
		The output frequency value of the frequency converter must never exceed 1/10 of the switching frequency. When the motor is running, adjust the switching frequency in *parameter 14-01 Switching Frequency* until the motor is as noiseless as possible. See also *14-00 Switching Pattern* and the section *Derating* in the relevant design guide.
[0]	1.0 kHz	
[1]	1.5 kHz	
[2]	2.0 kHz	
[3]	2.5 kHz	
[4]	3.0 kHz	
[5]	3.5 kHz	
[6]	4.0 kHz	
[7]	5.0 kHz	
[8]	6.0 kHz	
[9]	7.0 kHz	
[10]	8.0 kHz	
[11]	10.0 kHz	
[12]	12.0kHz	
[13]	14.0 kHz	
[14]	16.0kHz	

20-00 Feedback 1 Source		
Option:	**Function:**	
		Up to 3 different feedback signals can be used to provide the feedback signal for the frequency converter's PID controller. This parameter defines which input is used as the source of the first feedback signal. Analog input X30/11 and analog input X30/12 refer to inputs on the optional general purpose I/O board.
[0]	No function	
[1]	Analog Input 53	
[2] *	Analog Input 54	
[3]	Pulse input 29	
[4]	Pulse input 33	
[7]	Analog Input X30/11	
[8]	Analog Input X30/12	
[9]	Analog Input X42/1	
[10]	Analog Input X42/3	
[11]	Analog Input X42/5	

20-00 Feedback 1 Source		
Option:		**Function:**
[15]	Analog Input X48/2	
[100]	Bus Feedback 1	
[101]	Bus Feedback 2	
[102]	Bus feedback 3	
[104]	Sensorless Flow	Requires set-up by MCT 10 Set-up Software with sensorless-specific plug-in.
[105]	Sensorless Pressure	Requires set-up by MCT 10 Set-up Software with sensorless-specific plug-in.

NOTICE

If a feedback is not used, set its source to *[0] No Function*. *Parameter 20-20 Feedback Function* determines how the PID controller uses the 3 possible feedbacks.

20-01 Feedback 1 Conversion		
Option:		**Function:**
		This parameter allows a conversion function to be applied to feedback 1.
[0] *	Linear	No effect on the feedback.
[1]	Square root	Commonly used when a pressure sensor is used to provide flow feedback (($flow \propto \sqrt{pressure}$)).
[2]	Pressure to temperature	Used in compressor applications to provide temperature feedback using a pressure sensor. The temperature of the refrigerant is calculated using the following formula: $Temperature = \frac{A2}{(ln(Pe+1)-A1)} - A3$, where A1, A2 and A3 are refrigerant-specific constants. Select the refrigerant in *20-30 Refrigerant*. *Parameter 20-21 Setpoint 1* through *20-23 Setpoint 3* allow the values of A1, A2 and A3 to be entered for a refrigerant that is not listed in *20-30 Refrigerant*.
[3]	Pressure to flow	Used in applications for controlling the air flow in a duct. A dynamic pressure measurement (pitot tube) represents the feedback signal. $Flow = Duct\ Area \times \sqrt{Dynamic\ Pressure} \times Air\ Density\ Factor$ See also *20-34 Duct 1 Area [m2]* through *20-38 Air Density Factor [%]* for setting of duct area and air density.
[4]	Velocity to flow	Used in applications for controlling the air flow in a duct. An air velocity measurement represents the feedback signal. $Flow = Duct\ Area \times Air\ Velocity$

20-01 Feedback 1 Conversion		
Option:		**Function:**
		See also *20-34 Duct 1 Area [m2]* through *20-37 Duct 2 Area [in2]* for setting of duct area.

20-03 Feedback 2 Source		
Option:		**Function:**
		See *parameter 20-00 Feedback 1 Source* for details.
[0] *	No function	
[1]	Analog Input 53	
[2]	Analog Input 54	
[3]	Pulse input 29	
[4]	Pulse input 33	
[7]	Analog Input X30/11	
[8]	Analog Input X30/12	
[9]	Analog Input X42/1	
[10]	Analog Input X42/3	
[11]	Analog Input X42/5	
[15]	Analog Input X48/2	
[100]	Bus Feedback 1	
[101]	Bus Feedback 2	
[102]	Bus feedback 3	
[104]	Sensorless Flow	
[105]	Sensorless Pressure	

20-04 Feedback 2 Conversion		
Option:		**Function:**
		See *parameter 20-01 Feedback 1 Conversion* for details.
[0] *	Linear	
[1]	Square root	
[2]	Pressure to temperature	
[3]	Pressure to flow	
[4]	Velocity to flow	

20-06 Feedback 3 Source		
Option:		**Function:**
		See *parameter 20-00 Feedback 1 Source* for details.
[0] *	No function	
[1]	Analog Input 53	
[2]	Analog Input 54	
[3]	Pulse input 29	
[4]	Pulse input 33	
[7]	Analog Input X30/11	
[8]	Analog Input X30/12	
[9]	Analog Input X42/1	
[10]	Analog Input X42/3	
[11]	Analog Input X42/5	
[15]	Analog Input X48/2	
[100]	Bus Feedback 1	
[101]	Bus Feedback 2	

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20-06 Feedback 3 Source	
Option:	**Function:**
[102] Bus feedback 3	
[104] Sensorless Flow	
[105] Sensorless Pressure	

20-07 Feedback 3 Conversion	
Option:	**Function:**
	See *parameter 20-01 Feedback 1 Conversion* for details.
[0] * Linear	
[1] Square root	
[2] Pressure to temperature	
[3] Pressure to flow	
[4] Velocity to flow	

20-20 Feedback Function		
Option:		**Function:**
		This parameter determines how the 3 possible feedbacks are used to control the output frequency of the frequency converter.
[0]	Sum	Sets up the PID controller to use the sum of feedback 1, feedback 2 and feedback 3 as the feedback. **NOTICE** **Set any unused feedbacks to *[0] No Function* in *parameter 20-00 Feedback 1 Source*, *parameter 20-03 Feedback 2 Source*, or *parameter 20-06 Feedback 3 Source*.** The sum of setpoint 1 and any other references that are enabled (see *parameter group 3-1* References*) are used as the PID controller's setpoint reference.
[1]	Difference	Sets up the PID controller to use the difference between feedback 1 and feedback 2 as the feedback. Feedback 3 is not used with this selection. Only setpoint 1 is used. The sum of setpoint 1 and any other references that are enabled (see *parameter group 3-1* References*) are used as the PID controller's setpoint reference.
[2]	Average	Sets up the PID Controller to use the average of feedback 1, feedback 2 and feedback 3 as the feedback.

20-20 Feedback Function		
Option:		**Function:**
		NOTICE **Set any unused feedbacks to *[0] No Function* in *parameter 20-00 Feedback 1 Source*, *parameter 20-03 Feedback 2 Source*, or *parameter 20-06 Feedback 3 Source*. The sum of setpoint 1 and any other references that are enabled (see *parameter group 3-1* References*) are used as the PID controller's setpoint reference.**
[3] *	Minimum	Sets up the PID controller to compare feedback 1, feedback 2 and feedback 3 and uses the lowest value as the feedback. **NOTICE** **Set any unused feedbacks to *[0] No Function* in *parameter 20-00 Feedback 1 Source*, *parameter 20-03 Feedback 2 Source*, or *parameter 20-06 Feedback 3 Source*. Only setpoint 1 is used. The sum of setpoint 1 and any other references that are enabled (see *parameter group 3-1* References*) are used as the PID controller's setpoint reference.**
[4]	Maximum	Sets up the PID controller to compare feedback 1, feedback 2 and feedback 3 and use the highest value as the feedback. **NOTICE** **Set any unused feedbacks to *[0] No Function* in *parameter 20-00 Feedback 1 Source*, *parameter 20-03 Feedback 2 Source*, or *parameter 20-06 Feedback 3 Source*.** Only setpoint 1 is used. The sum of setpoint 1 and any other references that are enabled (see *parameter group 3-1* References*) are used as the PID controller's setpoint reference.
[5]	Multi Setpoint Min	Sets up the PID controller to calculate the difference between feedback 1 and setpoint 1, feedback 2 and setpoint 2, and feedback 3 and setpoint 3. It uses the feedback/setpoint pair in which the feedback is the farthest below its corresponding setpoint reference. If all feedback signals are above their corresponding setpoints, the PID controller uses the feedback/setpoint pair with the least difference between the 2.

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20-20 Feedback Function		
Option:		**Function:**
		NOTICE **If only 2 feedback signals are used, set the non-used feedback to** *[0] No Function* **in** *parameter 20-00 Feedback 1 Source,* *parameter 20-03 Feedback 2 Source,* **or** *parameter 20-06 Feedback 3 Source.* **Note that each setpoint reference is the sum of its respective parameter value (***parameter 20-21 Setpoint 1,* *parameter 20-22 Setpoint 2* **and** *20-23 Setpoint 3***) and any other references that are enabled (see** *parameter group 3-1* References***).**
[6]	Multi Setpoint Max	Sets up the PID controller to calculate the difference between feedback 1 and setpoint 1, feedback 2 and setpoint 2, and feedback 3 and setpoint 3. It uses the feedback/setpoint pair in which the feedback is farthest above its corresponding setpoint reference. If all feedback signals are below their corresponding setpoints, the PID controller uses the feedback/setpoint pair with the least difference between the 2. **NOTICE** **If only 2 feedback signals are used, set the non-used feedback to** *[0] No Function* **in** *parameter 20-00 Feedback 1 Source,* *parameter 20-03 Feedback 2 Source,* **or** *parameter 20-06 Feedback 3 Source.* **Note that each setpoint reference is the sum of its respective parameter value (***parameter 20-21 Setpoint 1,* *parameter 20-22 Setpoint 2* **and** *20-23 Setpoint 3***) and any other references that are enabled (see** *parameter group 3-1* References***).**

NOTICE

Set any unused feedback to *[0] No function* **in** *Parameter 20-00 Feedback 1 Source,* *parameter 20-03 Feedback 2 Source,* **or** *parameter 20-06 Feedback 3 Source.*

The PID controller uses the feedback resulting from the function selected in *parameter 20-20 Feedback Function* to control the output frequency of the frequency converter. This feedback can also:

- Be shown on the frequency converter's display.
- Be used to control a frequency converter's analog output.
- Be transmitted over various serial communication protocols.

The frequency converter can be configured to handle multi-zone applications. 2 different multi-zone applications are supported:

- Multi-zone, single setpoint
- Multi-zone, multi-setpoint

Examples 1 and 2 illustrate the difference between the 2:

Example 1 – Multi-zone, single setpoint
In an office building, a VAV (variable air volume) VLT® HVAC Drive system must ensure a minimum pressure at selected VAV boxes. Due to the varying pressure losses in each duct, the pressure at each VAV box cannot be assumed to be the same. The minimum pressure required is the same for all VAV boxes. This control method can be set up by setting *parameter 20-20 Feedback Function* to *[3] Minimum*, and entering the desired pressure in *parameter 20-21 Setpoint 1*. If any feedback is below the setpoint, the PID controller increases the fan speed. If all feedbacks are above the setpoint, the PID controller decreases the fan speed.

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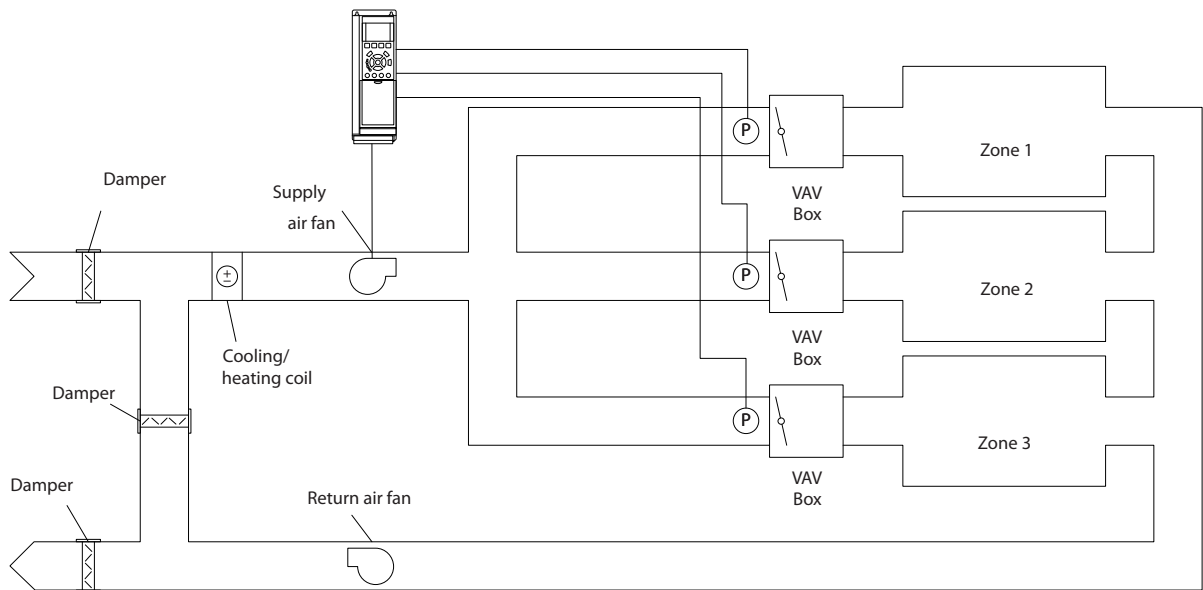
Illustration 6.17 Example, Multi-zone, Single Setpoint

Example 2 – Multi-zone, multi-setpoint
The previous example illustrates the use of multi-zone, multi-setpoint control. If the zones require different pressures for each VAV box, each setpoint may be specified in *parameter 20-21 Setpoint 1*, *parameter 20-22 Setpoint 2* and *20-23 Setpoint 3*. By selecting *[5] Multi-setpoint minimum* in *parameter 20-20 Feedback Function*, the PID controller increases the fan speed if any one of the feedbacks is below its setpoint. If all feedbacks are above their individual setpoints, the PID controller decreases the fan speed.

20-21 Setpoint 1		
Range:		**Function:**
0 ProcessCtrlUnit*	[-999999.999 - 999999.999 ProcessCtrlUnit]	Setpoint 1 is used in closed-loop mode to enter a setpoint reference that is used by the frequency converter's PID controller. See the description of *parameter 20-20 Feedback Function*.
		NOTICE
		The setpoint reference entered here is added to any other references that are enabled (see parameter group 3-1* References).

20-22 Setpoint 2		
Range:		**Function:**
0 ProcessCtrlUnit*	[-999999.999 - 999999.999 ProcessCtrlUnit]	Setpoint 2 is used in closed-loop mode to enter a setpoint reference that may be used by the frequency converter's PID controller. See the description of *parameter 20-20 Feedback Function*.
		NOTICE
		The setpoint reference entered here is added to any other references that are enabled (see parameter group 3-1* References).

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20-81 PID Normal/ Inverse Control		
Option:		**Function:**
[0] *	Normal	The frequency converter's output frequency decreases when the feedback is greater than the setpoint reference. This behaviour is common for pressure-controlled supply fan and pump applications.
[1]	Inverse	The frequency converter's output frequency increases when the feedback is greater than the setpoint reference. This behaviour is common for temperature-controlled cooling applications, such as cooling towers.

20-93 PID Proportional Gain		
Range:		**Function:**
0.50*	[0 - 10]	*NOTICE* **Always set the desired value for *20-14 Maximum Reference/Feedb.* before setting the values for the PID controller in parameter group *20-9* PID Controller*.** The proportional gain indicates the number of times the error between the setpoint and the feedback signal is to be applied.

If (Error x Gain) jumps with a value equal to what is set in *20-14 Maximum Reference/Feedb.*, the PID controller tries to change the output speed equal to what is set in *parameter 4-13 Motor Speed High Limit [RPM]/ parameter 4-14 Motor Speed High Limit [Hz]*. However, the output speed is limited by this setting.
The proportional band (error causing output to change from 0-100%) can be calculated with the formula:

$$\left(\frac{1}{\textit{Proportional Gain}}\right) \times (\textit{Max Reference})$$

20-94 PID Integral Time		
Range:		**Function:**
20 s*	[0.01 - 10000 s]	The integrator accumulates a contribution to the output from the PID controller as long as there is a deviation between the reference/ setpoint and feedback signals. The contribution is proportional to the size of the deviation. This ensures that the deviation (error) approaches zero. Quick response on any deviation is obtained when the integral time is set to a low value. Setting it too low, however, may cause the control to become unstable. The value set is the time needed for the integrator to add the same contribution as the proportional for a certain deviation. If the value is set to 10000, the controller acts as a pure proportional controller with a P-band based on the value set in *parameter 20-93 PID*

20-94 PID Integral Time		
Range:		**Function:**
		Proportional Gain. When no deviation is present, the output from the proportional controller is 0.

22-21 Low Power Detection		
Option:		**Function:**
[0] *	Disabled	
[1]	Enabled	Carry out the low-power detection commissioning to set the parameters in parameter group *22-3* No-Flow Power Tuning* for proper operation.

22-22 Low Speed Detection		
Option:		**Function:**
[0] *	Disabled	
[1]	Enabled	Detects when the motor operates with a speed as set in *parameter 4-11 Motor Speed Low Limit [RPM]* or *parameter 4-12 Motor Speed Low Limit [Hz]*.

22-23 No-Flow Function		
Common actions for low-power detection and low-speed detection (individual selections not possible).		
Option:		**Function:**
[0] *	Off	
[1]	Sleep Mode	The frequency converter enters sleep mode and stops when a no-flow condition is detected. See parameter group *22-4* Sleep Mode* for programming options for sleep mode.
[2]	Warning	The frequency converter continues to run, but activates a no-flow warning [W92]. A digital output or a serial communication bus can communicate a warning to other equipment.
[3]	Alarm	The frequency converter stops running and activates a no-flow alarm [A 92]. A frequency converter digital output or a serial communication bus can communicate an alarm to other equipment.

NOTICE

Do not set *14-20 Reset Mode*, to *[13] Infinite auto reset*, when *parameter 22-23 No-Flow Function* is set to *[3] Alarm*. Doing so causes the frequency converter to continuously cycle between running and stopping when a no-flow condition is detected.

NOTICE

Disable the automatic bypass function of the bypass if:

- **The frequency converter is equipped with a constant-speed bypass with an automatic bypass function starting the bypass if the frequency converter experiences a persistent alarm condition, and**

- *[3] Alarm* **is selected as the no-flow function.**

22-24 No-Flow Delay		
Range:		**Function:**
10 s*	[1 - 600 s]	Set the time that low power/low speed must stay detected to activate signal for actions. If detection disappears before the timer runs out, the timer is reset.

22-26 Dry Pump Function		
Select desired action for dry pump operation.		
Option:		**Function:**
[0] *	Off	
[1]	Warning	The frequency converter continues to run, but activates a dry pump warning [W93]. A frequency converter digital output or a serial communication bus can communicate a warning to other equipment.
[2]	Alarm	The frequency converter stops running and activates a dry pump alarm [A93]. A frequency converter digital output or a serial communication bus can communicate an alarm to other equipment.
[3]	Man. Reset Alarm	The frequency converter stops running and activates a dry pump alarm [A93]. A frequency converter digital output or a serial communication bus can communicate an alarm to other equipment.

NOTICE

To use dry pump detection:

1. **Enable *low-power detection* in *parameter 22-21 Low Power Detection*.**

2. **Commission *low-power detection* using either parameter group *22-3* No-flow Power Tuning No Flow Power Tuning*, or *22-20 Low Power Auto Set-up*.**

NOTICE

Do not set *14-20 Reset Mode* to *[13] Infinite auto reset*, when *parameter 22-26 Dry Pump Function* is set to *[2] Alarm*. Doing so causes the frequency converter to continuously cycle between running and stopping when a dry pump condition is detected.

NOTICE

For frequency converters with constant-speed bypass

If an automatic bypass function starts the bypass at persistent alarm conditions, disable the bypass's automatic bypass function, if *[2] Alarm* or *[3] Man. Reset Alarm* is selected as the dry-pump function.

22-40 Minimum Run Time		
Range:		**Function:**
10 s*	[0 - 600 s]	Set the desired minimum running time for the motor after a start command (digital input or bus) before entering sleep mode.

22-41 Minimum Sleep Time		
Range:		**Function:**
10 s*	[0 - 600 s]	Set the desired minimum time for staying in sleep mode. This setting overrides any wake-up conditions.

22-42 Wake-up Speed [RPM]		
Range:		**Function:**
Size related*	[par. 4-11 - par. 4-13 RPM]	To be used if *0-02 Motor Speed Unit* has been set for RPM (parameter not visible if Hz is selected). Only to be used if *parameter 1-00 Configuration Mode* is set for open loop and an external controller applies speed reference. Set the reference speed at which the sleep mode should be cancelled.

22-60 Broken Belt Function		
Selects the action to be performed if the broken-belt condition is detected		
Option:		**Function:**
[0] *	Off	
[1]	Warning	The frequency converter continues to run, but activates a broken-belt warning [W95]. A frequency converter digital output or a serial communication bus can communicate a warning to other equipment.
[2]	Trip	The frequency converter stops running and activates a broken-belt alarm [A 95]. A frequency converter digital output or a serial communication bus can communicate an alarm to other equipment.

NOTICE

Do not set *14-20 Reset Mode*, to *[13] Infinite auto reset*, when *parameter 22-60 Broken Belt Function* is set to *[2] Trip*. Doing so causes the frequency converter to continuously cycle between running and stopping when a broken-belt condition is detected.

NOTICE

For frequency converters with constant-speed bypass

If an automatic bypass function starts the bypass at persistent alarm conditions, disable the bypass's automatic bypass function, if *[2] Alarm* or *[3] Man. Reset Alarm* is selected as the dry-pump function.

22-61 Broken Belt Torque		
Range:		**Function:**
10 %*	[0 - 100 %]	Sets the broken belt torque as a percentage of the rated motor torque.

22-62 Broken Belt Delay		
Range:		**Function:**
10 s	[0 - 600 s]	Sets the time for which the broken-belt conditions must be active before carrying out the action selected in *parameter 22-60 Broken Belt Function*.

22-75 Short Cycle Protection		
Option:		**Function:**
[0] *	Disabled	Timer set in *parameter 22-76 Interval between Starts* is disabled.
[1]	Enabled	Timer set in *parameter 22-76 Interval between Starts* is enabled.

22-76 Interval between Starts		
Range:		**Function:**
Size related*	[par. 22-77 - 3600 s]	Sets the time desired as minimum time between 2 starts. Any normal start command (start/jog/freeze) is disregarded until the timer has expired.

22-77 Minimum Run Time		
Range:		**Function:**
0 s*	[0 - par. 22-76 s]	**NOTICE** **Does not work in cascade mode.** Sets the time desired as minimum run time after a normal start command (start/jog/freeze). Any normal stop command is disregarded until the set time has expired. The timer starts counting following a normal start command (start/jog/freeze). A coast (inverse) or an external interlock command overrides the timer.

6.1.5 Main Menu Mode

Both the GLCP and NLCP provide access to the *Main Menu mode*. Select the *Main Menu mode* by pressing [Main Menu]. *Illustration 6.18* shows the resulting readout, which appears on the display of the GLCP.
Lines 2 to 5 on the display show a list of parameter groups which can be selected by toggling [▲] and [▼].
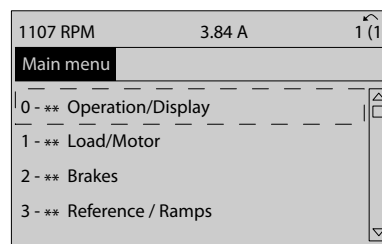
Illustration 6.18 Display Example

Each parameter has a name and a number, which remain the same regardless of the programming mode. In the *Main Menu mode*, the parameters are divided into groups. The first digit of the parameter number (from the left) indicates the parameter group number.

All parameters can be changed in the *Main Menu*. The configuration of the unit (*parameter 1-00 Configuration Mode*) determines other parameters available for programming. For example, selecting closed loop enables more parameters related to closed-loop operation. Option cards added to the unit enable more parameters associated with the option device.

6.1.6 Parameter Selection

In the *Main Menu mode*, the parameters are divided into groups. Press the navigation keys to select a parameter group.
The following parameter groups are accessible:

Group no.	Parameter group
0-**	Operation/Display
1-**	Load/Motor
2-**	Brakes
3-**	References/Ramps
4-**	Limits/Warnings
5-**	Digital In/Out
6-**	Analog In/Out
8-**	Comm. and Options
9-**	Profibus
10-**	CAN Fieldbus
11-**	LonWorks
12-**	Ethernet
13-**	Smart Logic

Group no.	Parameter group
14-**	Special Functions
15-**	FC Information
16-**	Data Readouts
18-**	Data Readouts 2
20-**	FC Closed Loop
21-**	Ext. Closed Loop
22-**	Application Functions
23-**	Time Actions
24-**	Appl. Functions 2
25-**	Cascade Controller
26-**	Analog I/O Option MCB 109
30-**	Special Features
31-**	Bypass Option
35-**	Sensor Input Option

Table 6.7 Parameter Groups

After selecting a parameter group, select a parameter with the navigation keys.
The middle section on the GLCP display shows the parameter number and name as well as the selected parameter value.
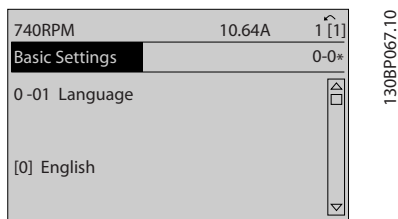
Illustration 6.19 Display Example

6.1.7 Changing Data

1. Press [Quick Menu] or [Main Menu].

2. Press [▲] and [▼] to find the parameter group to edit.

3. Press [OK].

4. Press [▲] and [▼] to find the parameter to edit.

5. Press [OK].

6. Press [▲] and [▼] to select correct parameter setting. Or, to move to digits within a number, press keys. cursor indicates digit selected to change. [▲] increases the value, [▼] decreases the value.

7. Press [Cancel] to disregard change, or press [OK] to accept change and enter new setting.

6.1.8 Changing a Text Value

If the selected parameter is a text value, change the text value with the [▲]/[▼] keys.
[▲] increases the value, and [▼] decreases the value. Place the cursor on the value to be saved and press [OK].
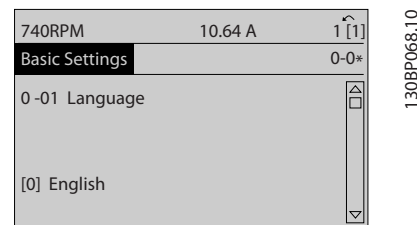
Illustration 6.20 Display Example

6.1.9 Changing a Group of Numeric Data Values

If the selected parameter represents a numeric data value, change the selected data value with the [◄] and [►] keys as well as the up/down [▲] [▼] keys. Press [◄] and [►] to move the cursor horizontally.
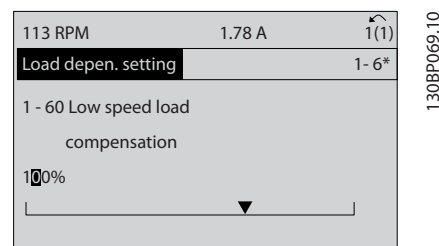
Illustration 6.21 Display Example

Press [▲] and [▼] to change the data value. [▲] increases the data value, and [▼] decreases the data value. Place the cursor on the value to be saved and press [OK].
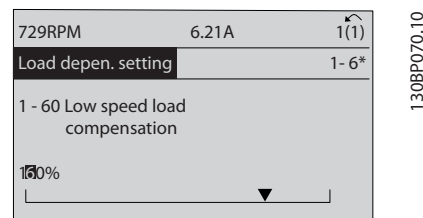
Illustration 6.22 Display Example

6.1.10 Changing of Data Value, Step by Step

Certain parameters can be changed step by step or infinitely variably. This applies to *parameter 1-20 Motor Power [kW]*, *parameter 1-22 Motor Voltage* and *parameter 1-23 Motor Frequency*.
The parameters are changed both as a group of numeric data values and as numeric data values infinitely variably.

6.1.11 Readout and Programming of Indexed Parameters

Parameters are indexed when placed in a rolling stack. *15-30 Alarm Log: Error Code* to *15-32 Alarm Log: Time* contain a fault log which can be read out. Select a parameter, press [OK], and use [▲] and [▼] to scroll through the value log.

Use *parameter 3-10 Preset Reference* as another example: Select the parameter, press [OK], and use [▲] and [▼] to scroll through the indexed values. To change the parameter value, select the indexed value and press [OK]. Change the value by [▲] and [▼]. Press [OK] to accept the new setting. Press [Cancel] to abort. Press [Back] to leave the parameter.

6.2 Parameter Menu Structure

6

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No.	Description
0-**	**Operation/Display**
0-0*	**Basic Settings**
0-01	Language
0-02	Motor Speed Unit
0-03	Regional Settings
0-04	Operating State at Power-up
0-05	Local Mode Unit
0-1*	**Set-up Operations**
0-10	Active Set-up
0-11	Programming Set-up
0-12	This Set-up Linked to
0-13	Readout: Linked Set-ups
0-14	Readout: Prog. Set-ups/Channel
0-2*	**LCP Display**
0-20	Display Line 1.1 Small
0-21	Display Line 1.2 Small
0-22	Display Line 1.3 Small
0-23	Display Line 2 Large
0-24	Display Line 3 Large
0-25	My Personal Menu
0-3*	**LCP Custom Readout**
0-30	Custom Readout Unit
0-31	Custom Readout Min Value
0-32	Custom Readout Max Value
0-37	Display Text 1
0-38	Display Text 2
0-39	Display Text 3
0-4*	**LCP Keypad**
0-40	[Hand on] Key on LCP
0-41	[Off] Key on LCP
0-42	[Auto on] Key on LCP
0-43	[Reset] Key on LCP
0-44	[Off/Reset] Key on LCP
0-45	[Drive Bypass] Key on LCP
0-5*	**Copy/Save**
0-50	LCP Copy
0-51	Set-up Copy
0-6*	**Password**
0-60	Main Menu Password
0-61	Access to Main Menu w/o Password
0-65	Personal Menu Password
0-66	Access to Personal Menu w/o Password
0-67	Bus Access Password
0-7*	**Clock Settings**
0-70	Date and Time
0-71	Date Format
0-72	Time Format
0-74	DST/Summertime
0-76	DST/Summertime Start
0-77	DST/Summertime End
0-79	Clock Fault
0-81	Working Days
0-82	Additional Working Days
0-83	Additional Non-Working Days
0-89	Date and Time Readout
1-**	**Load and Motor**
1-0*	**General Settings**
1-00	Configuration Mode
1-03	Torque Characteristics
1-06	Clockwise Direction
1-1*	**Motor Selection**
1-10	Motor Construction
1-1*	**VVC+ PM**
1-14	Damping Gain
1-15	Low Speed Filter Time Const.
1-16	High Speed Filter Time Const.
1-17	Voltage filter time const.
1-2*	**Motor Data**
1-20	Motor Power [kW]
1-21	Motor Power [hp]
1-22	Motor Voltage
1-23	Motor Frequency
1-24	Motor Current
1-25	Motor Nominal Speed
1-26	Motor Cont. Rated Torque
1-28	Motor Rotation Check
1-29	Automatic Motor Adaptation (AMA)
1-3*	**Adv. Motor Data**
1-30	Stator Resistance (Rs)
1-31	Rotor Resistance (Rr)
1-35	Main Reactance (Xh)
1-36	Iron Loss Resistance (Rfe)
1-37	d-axis Inductance (Ld)
1-39	Motor Poles
1-40	Back EMF at 1000 RPM
1-46	Position Detection Gain
1-5*	**Load Indep. Setting**
1-50	Motor Magnetisation at Zero Speed
1-51	Min Speed Normal Magnetising [RPM]
1-52	Min Speed Normal Magnetising [Hz]
1-58	Flystart Test Pulses Current
1-59	Flystart Test Pulses Frequency
1-6*	**Load Depen. Setting**
1-60	Low Speed Load Compensation
1-61	High Speed Load Compensation
1-62	Slip Compensation
1-63	Slip Compensation Time Constant
1-64	Resonance Dampening
1-65	Resonance Dampening Time Constant
1-66	Min. Current at Low Speed
1-7*	**Start Adjustments**
1-70	PM Start Mode
1-71	Start Delay
1-72	Start Function
1-73	Flying Start
1-77	Compressor Start Max Speed [RPM]
1-78	Compressor Start Max Speed [Hz]
1-79	Compressor Start Max Time to Trip
1-8*	**Stop Adjustments**
1-80	Function at Stop
1-81	Min Speed for Function at Stop [RPM]
1-82	Min Speed for Function at Stop [Hz]
1-86	Trip Speed Low [RPM]
1-87	Trip Speed Low [Hz]
1-9*	**Motor Temperature**
1-90	Motor Thermal Protection
1-91	Motor External Fan
1-93	Thermistor Source
2-**	**Brakes**
2-0*	**DC Brake**
2-00	DC Hold/Preheat Current
2-01	DC Brake Current
2-02	DC Braking Time
2-03	DC Brake Cut In Speed [RPM]
2-04	DC Brake Cut In Speed [Hz]
2-06	Parking Current
2-07	Parking Time
2-1*	**Brake Energy Funct.**
2-10	Brake Function
2-11	Brake Resistor (ohm)
2-12	Brake Power Limit (kW)
2-13	Brake Power Monitoring
2-15	Brake Check
2-16	AC brake Max. Current
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25-91 Manual Alternation
26-** Analog I/O Option
26-0* Analog I/O Mode
26-00 Terminal X42/1 Mode
26-01 Terminal X42/3 Mode
26-02 Terminal X42/5 Mode
26-1* Analog Input X42/1
26-10 Terminal X42/1 Low Voltage
26-11 Terminal X42/1 High Voltage
26-14 Term. X42/1 Low Ref./Feedb. Value
26-15 Term. X42/1 High Ref./Feedb. Value
26-16 Term. X42/1 Filter Time Constant
26-17 Term. X42/1 Live Zero
26-2* Analog Input X42/3
26-20 Terminal X42/3 Low Voltage
26-21 Terminal X42/3 High Voltage
26-24 Term. X42/3 Low Ref./Feedb. Value
26-25 Term. X42/3 High Ref./Feedb. Value
26-26 Term. X42/3 Filter Time Constant
26-27 Term. X42/3 Live Zero
26-3* Analog Input X42/5
26-30 Terminal X42/5 Low Voltage
26-31 Terminal X42/5 High Voltage
26-34 Term. X42/5 Low Ref./Feedb. Value
26-35 Term. X42/5 High Ref./Feedb. Value
26-36 Term. X42/5 Filter Time Constant
26-37 Term. X42/5 Live Zero
26-4* Analog Out X42/7
26-40 Terminal X42/7 Output
26-41 Terminal X42/7 Min. Scale
26-42 Terminal X42/7 Max. Scale
26-43 Terminal X42/7 Bus Control
26-44 Terminal X42/7 Timeout Preset
26-5* Analog Out X42/9
26-50 Terminal X42/9 Output
26-51 Terminal X42/9 Min. Scale
26-52 Terminal X42/9 Max. Scale
26-53 Terminal X42/9 Bus Control
26-54 Terminal X42/9 Timeout Preset
26-6* Analog Out X42/11
26-60 Terminal X42/11 Output
26-61 Terminal X42/11 Min. Scale
26-62 Terminal X42/11 Max. Scale
26-63 Terminal X42/11 Bus Control
26-64 Terminal X42/11 Timeout Preset
30-** Special Features
30-2* Adv. Start Adjust
30-22 Locked Rotor Detection
30-23 Locked Rotor Detection Time [s]
31-** Bypass Option
31-00 Bypass Mode
31-01 Bypass Start Time Delay
31-02 Bypass Trip Time Delay
31-03 Test Mode Activation
31-10 Bypass Status Word
31-11 Bypass Running Hours
31-19 Remote Bypass Activation
35-** Sensor Input Option
35-0* Temp. Input Mode

35-00 Term. X48/4 Temperature Unit
35-01 Term. X48/4 Input Type
35-02 Term. X48/7 Temperature Unit
35-03 Term. X48/7 Input Type
35-04 Term. X48/10 Temperature Unit
35-05 Term. X48/10 Input Type
35-06 Temperature Sensor Alarm Function
35-1* Temp. Input X48/4
35-14 Term. X48/4 Filter Time Constant
35-15 Term. X48/4 Temp. Monitor
35-16 Term. X48/4 Low Temp. Limit
35-17 Term. X48/4 High Temp. Limit
35-2* Temp. Input X48/7
35-24 Term. X48/7 Filter Time Constant
35-25 Term. X48/7 Temp. Monitor
35-26 Term. X48/7 Low Temp. Limit
35-27 Term. X48/7 High Temp. Limit
35-3* Temp. Input X48/10
35-34 Term. X48/10 Filter Time Constant
35-35 Term. X48/10 Temp. Monitor
35-36 Term. X48/10 Low Temp. Limit
35-37 Term. X48/10 High Temp. Limit
35-4* Analog Input X48/2
35-42 Term. X48/2 Low Current
35-43 Term. X48/2 High Current
35-44 Term. X48/2 Low Ref./Feedb. Value
35-45 Term. X48/2 High Ref./Feedb. Value
35-46 Term. X48/2 Filter Time Constant
35-47 Term. X48/2 Live Zero

7 General Specifications

Mains supply (L1, L2, L3)	
Supply voltage	380–480 V ±10%
Supply voltage	525–690 V ±10%

Mains voltage low/mains drop-out:

During low mains voltage or a mains drop-out, the frequency converter continues until the intermediate circuit voltage drops below the minimum stop level. The stop level normally corresponds to 15% below the frequency converter's lowest rated supply voltage. Power-up and full torque cannot be expected at mains voltage lower than 10% below the frequency converter's lowest rated supply voltage.

Supply frequency	50/60 Hz ±5%
Maximum imbalance temporary between mains phases	3.0% of rated supply voltage
True power factor (λ)	≥0.9 nominal at rated load
Displacement power factor (cosφ) near unity	(> 0.98)
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 100000 RMS symmetrical Amperes, 480/690 V maximum.

7.1 Motor Output and Motor Data

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

1) Voltage and power-dependent.

Torque characteristics	
Starting torque (constant torque)	maximum 110% for 1 min.[1]
Starting torque	maximum 135% up to 0.5 s[1]
Overload torque (constant torque)	maximum 110% for 1 min.[1]

1) Percentage relates to the frequency converter's nominal torque.

7.2 Ambient Conditions

Surroundings	
Enclosure size E	IP00, IP21, IP54
Enclosure size F	IP21, IP54
Vibration test	1 g
Relative humidity	5% - 95% (IEC 721-3-3; Class 3K3 (non-condensing) during operation
Aggressive environment (IEC 721-3-3), coated	3C3
Test method according to IEC 60068-2-43 H2S	10 days
Ambient temperature (at 60 AVM switching mode)	
- with derating	maximum 55 °C[1]
- with full output power, typical EFF2 motors	maximum 50 °C[1]
- at full continuous frequency converter output current	maximum 45 °C[1]

1) For more information on derating, see the section on special conditions in the design guide.

Minimum ambient temperature during full-scale operation	0 °C
Minimum ambient temperature at reduced performance	-10 °C
Temperature during storage/transport	-25 to +65/70 °C
Maximum altitude above sea level without derating	1000 m
Maximum altitude above sea level with derating	3000 m

For more information on derating for high altitude, see the section on special conditions in 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
Energy efficiency class[2]	IE2

For more information, see the section on special conditions in the design guide.

2) Determined according to EN50598-2 at:

- *Rated load*
- *90% rated frequency*
- *Switching frequency factory setting*
- *Switching pattern factory setting*

7.3 Cable Specifications

Cable lengths and cross-sections

Maximum motor cable length, screened/armoured	150 m
Maximum motor cable length, unscreened/unarmoured	300 m
Maximum cross-section to motor, mains, load sharing and brake[1]	
Maximum cross-section to control terminals, rigid wire	1.5 mm^2/16 AWG (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

1) See chapter 7.5 Electrical Data for more information.

7.4 Control Input/Ouput and Control Data

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	switches S201 and S202
Voltage mode	switch S201/S202 = OFF (U)
Voltage level	0-10 V (scaleable)
Input resistance, R$_i$	approx. 10 kΩ

Maximum voltage	±20 V
Current mode	switch S201/S202=On (I)
Current level	0/4-20 mA (scaleable)
Input resistance, R_i	approx. 200 Ω
Maximum current	30 mA
Resolution for analog inputs	10 bit (+ sign)
Accuracy of analog inputs	maximum error 0.5% of full scale
Bandwidth	200 Hz

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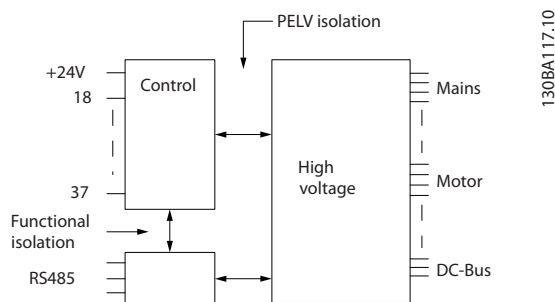

Illustration 7.1 PELV Isolation of Analog Inputs

Pulse inputs

Programmable pulse inputs	2
Terminal number pulse	29, 33
Maximum frequency at terminal 29, 33	110 kHz (push-pull driven)
Maximum frequency at terminal 29, 33	5 kHz (open collector)
Minimum frequency at terminal 29, 33	4 Hz
Voltage level	see *Digital inputs*
Maximum voltage on input	28 V DC
Input resistance, R_i	approx. 4 kΩ
Pulse input accuracy (0.1–1 kHz)	maximum 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
Maximum resistor load to common at analog output	500 Ω
Accuracy on analog output	maximum error 0.8% of full scale
Resolution on analog output	8 bit

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

Control card, 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
Maximum output current (sink or source)	40 mA
Maximum load at frequency output	1 kΩ
Maximum capacitive load at frequency output	10 nF
Minimum output frequency at frequency output	0 Hz

Maximum output frequency at frequency output	32 kHz
Accuracy of frequency output	maximum error 0.1% of full scale
Resolution of frequency outputs	12 bit

1) 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	12, 13
Maximum load	200 mA

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

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

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

Control card, 10 V DC output	
Terminal number	50
Output voltage	10.5 V ±0.5 V
Maximum load	25 mA

The 10 V DC supply is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

Control characteristics	
Resolution of output frequency at 0–590 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.

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

7

⚠CAUTION

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

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

The USB connection is NOT galvanically isolated from protective earth. Use only isolated laptop/PC as connection to the USB connector on the frequency converter or an isolated USB cable/converter.

Protection and features

- Electronic thermal motor protection against overload.

- If the temperature reaches a predefined level, temperature monitoring of the heat sink ensures that the frequency converter trips. An overload temperature cannot be reset until the temperature of the heat sink is below the values stated in *Table 7.1* to *Table 7.4* (Guideline - these temperatures may vary for different power sizes, enclosure sizes, enclosure ratings etc.).

- The frequency converter is protected against short circuits on motor terminals U, V, W.

- If a mains phase is missing, the frequency converter trips or issues a warning (depending on the load).

- If the intermediate circuit voltage is too low or too high, monitoring of the intermediate circuit voltage ensures that the frequency converter trips.

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

7

7.5 Electrical Data

Mains Supply 3 x 380-480 V AC				
	P315	**P355**	**P400**	**P450**
Typical shaft output at 400 V [kW]	315	355	400	450
Typical shaft output at 460 V [hp]	450	500	600	600
Enclosure protection rating IP21	E1	E1	E1	E1
Enclosure protection rating IP54	E1	E1	E1	E1
Enclosure protection rating IP00	E2	E2	E2	E2
Output current				
Continuous (at 400 V) [A]	600	658	745	800
Intermittent (60 s overload) (at 400 V) [A]	660	724	820	880
Continuous (at 460/480 V) [A]	540	590	678	730
Intermittent (60 s overload) (at 460/480 V) [A]	594	649	746	803
Continuous KVA (at 400 V) [KVA]	416	456	516	554
Continuous KVA (at 460 V) [KVA]	430	470	540	582
Maximum input current				
Continuous (at 400 V) [A]	590	647	733	787
Continuous (at 460/480 V) [A]	531	580	667	718
Maximum cable size, mains, motor and load share [mm² (AWG[2])]	4 x 240 (4 x 500 mcm)	4 x 240 (4 x 500 mcm)	4 x 240 (4 x 500 mcm)	4 x 240 (4 x 500 mcm)
Maximum cable size, brake [mm² (AWG[2])]	2 x 185 (2 x 350 mcm)	2 x 185 (2 x 350 mcm)	2 x 185 (2 x 350 mcm)	2 x 185 (2 x 350 mcm)
Maximum external pre-fuses [A][1]	700	800	900	900
Estimated power loss at rated max. load [W][3], 400 V	6790	7701	8677	9473
Estimated power loss at rated maximum load [W][3], 460 V	6082	6953	7819	8527
Weight, enclosure protection rating IP21, IP54 [kg]	263	270	272	313
Weight, enclosure protection rating IP00 [kg]	221	234	236	277
Efficiency[4]	0.98			
Output frequency	0-590 Hz			
Heat sink overtemperature trip	110 °C			
Power card ambient trip	75°C			85 °C

Table 7.1 Mains Supply 3 x 380-480 V AC

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Mains Supply 3 x 380-480 V AC						
	P500	**P560**	**P630**	**P710**	**P800**	**P1M0**
Typical shaft output at 400 V [kW]	500	560	630	710	800	1000
Typical shaft output at 460 V [hp]	650	750	900	1000	1200	1350
Enclosure protection rating IP21, IP54 without/with options cabinet	F1/F3	F1/F3	F1/F3	F1/F3	F2/F4	F2/F4
Output current						
Continuous (at 400 V) [A]	880	990	1120	1260	1460	1720
Intermittent (60 s overload) (at 400 V) [A]	968	1089	1232	1386	1606	1892
Continuous (at 460/480 V) [A]	780	890	1050	1160	1380	1530
Intermittent (60 s overload) (at 460/480 V) [A]	858	979	1155	1276	1518	1683
Continuous KVA (at 400 V) [KVA]	610	686	776	873	1012	1192
Continuous KVA (at 460 V) [KVA]	621	709	837	924	1100	1219
Maximum input current						
Continuous (at 400 V) [A]	857	964	1090	1227	1422	1675
Continuous (at 460/480 V) [A]	759	867	1022	1129	1344	1490
Maximum cable size, motor [mm² (AWG[2])]	8 x 150 (8 x 300 mcm)				12 x 150 (12 x 300 mcm)	
Maximum cable size, mains F1/F2 [mm² (AWG[2])]	8 x 240 (8 x 500 mcm)					
Maximum cable size, mains F3/F4 [mm² (AWG[2])]	8 x 456 (8 x 900 mcm)					
Maximum cable size, loadsharing [mm² (AWG[2])]	4 x 120 (4 x 250 mcm)					
Maximum cable size, brake [mm² (AWG[2])]	4 x 185 (4 x 350 mcm)				6 x 185 (6 x 350 mcm)	
Maximum external pre-fuses [A][1]	1600		2000		2500	
Estimated power loss at rated maximum load [W][3], 400 V, F1 & F2	10162	11822	12512	14674	17293	19278
Estimated power loss at rated maximum load [W][3], 460 V, F1 & F2	8876	10424	11595	13213	16229	16624
Maximum added losses of A1 RFI, circuit breaker or disconnect, & contactor, F3 & F4	963	1054	1093	1230	2280	2541
Maximum panel options losses	400					
Weight, enclosure protection rating IP21, IP54 [kg]	1017/1318				1260/1561	
Weight rectifier module [kg]	102				136	
Weight inverter module [kg]		102		136	102	
Efficiency[4]	0.98					
Output frequency	0-590 Hz					
Heat sink overtemperature trip	95 °C					
Power card ambient trip	85 °C					

Table 7.2 Mains Supply 3 x 380-480 V AC

Mains Supply 3 x 525-690 V AC				
	P450	**P500**	**P560**	**P630**
Typical shaft output at 550 V [kW]	355	400	450	500
Typical shaft output at 575 V [hp]	450	500	600	650
Typical shaft output at 690 V [kW]	450	500	560	630
Enclosure protection rating IP21	E1	E1	E1	E1
Enclosure protection rating IP54	E1	E1	E1	E1
Enclosure protection rating IP00	E2	E2	E2	E2
Output current				
Continuous (at 550 V) [A]	470	523	596	630
Intermittent (60 s overload) (at 550 V) [A]	517	575	656	693
Continuous (at 575/ 690 V) [A]	450	500	570	630
Intermittent (60 s overload) (at 575/ 690 V) [A]	495	550	627	693
Continuous KVA (at 550 V) [KVA]	448	498	568	600
Continuous KVA (at 575 V) [KVA]	448	498	568	627
Continuous KVA (at 690 V) [KVA]	538	598	681	753
Maximum input current				
Continuous (at 550 V) [A]	453	504	574	607
Continuous (at 575 V) [A]	434	482	549	607
Continuous (at 690 V) [A]	434	482	549	607
Maximum cable size, mains, motor and load share [mm^2 (AWG)]	2x240 (2x500 mcm)	4x240 (4x500 mcm)	4x240 (4x500 mcm)	4x240 (4x500 mcm)
Maximum cable size, brake [mm^2 (AWG)]	2x185 (2x350 mcm)	2x185 (2x350 mcm)	2x185 (2x350 mcm)	2x185 (2x350 mcm)
Maximum external pre-fuses [A][1]	700	700	900	900
Estimated power loss at rated maximum load [W][3], 600 V	5323	6010	7395	8209
Estimated power loss at rated maximum load [W][3], 690 V	5529	6239	7653	8495
Weight, enclosure protection ratings IP21, IP54 [kg]	263	263	272	313
Weight, enclosure protection rating IP00 [kg]	221	221	236	277
Efficiency[4]	0.98			
Output frequency	0-525 Hz			
Heat sink overtemperature trip	110 °C	95 °C		110 °C
Power card ambient trip	85 °C			

Table 7.3 Mains Supply 3 x 525-690 V AC

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Mains Supply 3 x 525-690 V AC						
	P710	P800	P900	P1M0	P1M2	P1M4
Typical shaft output at 550 V [kW]	560	670	750	850	1000	1100
Typical shaft output at 575 V [hp]	750	950	1050	1150	1350	1550
Typical shaft output at 690 V [kW]	710	800	900	1000	1200	1400
Enclosure protection ratings IP21, IP54 without/with options cabinet	F1/F3	F1/F3	F1/F3	F2/F4	F2/F4	F2/F4
Output current						
Continuous (at 550 V) [A]	763	889	988	1108	1317	1479
Intermittent (60 s overload, at 550 V) [A]	839	978	1087	1219	1449	1627
Continuous (at 575/690 V) [A]	730	850	945	1060	1260	1415
Intermittent (60 s overload, at 575/690 V) [A]	803	935	1040	1166	1386	1557
Continuous KVA (at 550 V) [KVA]	727	847	941	1056	1255	1409
Continuous KVA (at 575 V) [KVA]	727	847	941	1056	1255	1409
Continuous KVA (at 690 V) [KVA]	872	1016	1129	1267	1506	1691
Maximum input current						
Continuous (at 550 V) [A]	743	866	962	1079	1282	1440
Continuous (at 575 V) [A]	711	828	920	1032	1227	1378
Continuous (at 690 V) [A]	711	828	920	1032	1227	1378
Maximum cable size, motor [mm² (AWG[2])]	8x150 (8x300 mcm)			12x150 (12x300 mcm)		
Maximum cable size, mains F1/F2 [mm² (AWG[2])]	8x240 (8x500 mcm)					
Maximum cable size, mains F3/F4 [mm² (AWG[2])]	8x456 (8x900 mcm)					
Maximum cable size, loadsharing [mm² (AWG[2])]	4x120 (4x250 mcm)					
Maximum cable size, brake [mm² (AWG[2])]	4x185 (4x350 mcm)			6x185 (6x350 mcm)		
Maximum external pre-fuses [A][1]	1600				2000	2500
Estimated power loss at rated maximum load [W][3], 600 V, F1 & F2	9500	10872	12316	13731	16190	18536
Estimated power loss at rated maximum load [W][3], 690 V, F1 & F2	9863	11304	12798	14250	16821	19247
Maximum added losses of circuit breaker or disconnect & contactor, F3 & F4	427	532	615	665	863	1044
Maximum panel options losses	400					
Weight, enclosure protection ratings IP21, IP54 [kg]	1004/1299	1004/1299	1004/1299	1246/1541	1246/1541	1280/1575
Weight, rectifier module [kg]	102	102	102	136	136	136
Weight, inverter module [kg]	102	102	136	102	102	136
Efficiency[4]	0.98					
Output frequency	0-500 Hz					
Heat sink overtemperature trip	95 °C	105 °C	95 °C	95 °C	105 °C	95 °C
Power card ambient trip	85 °C					

Table 7.4 Mains Supply 3 x 525-690 V AC

1) For type of fuse see *chapter 4.1.14 Fuses*.

2) American wire gauge.

3) Applies for dimensioning of frequency converter cooling. If the switching frequency is higher than the default setting, the power losses may increase. LCP and typical control card power consumptions are included. For power loss data according to EN 50598-2, refer to *www.danfoss.com/vltenergyefficiency*.

4) Efficiency measured at nominal current. For energy efficiency class see *chapter 7.2 Ambient Conditions*. For part load losses see *www.danfoss.com/vltenergyefficiency*.

7

8 Warnings and Alarms

LEDs on the front of the frequency converter indicate if a warning or an alarm has occurred. For each warning and alarm there is a specific code, which is shown on the display.

A warning remains active until its cause is no longer present. Under certain circumstances operation of the motor may still continue. Warning messages may in some cases be critical.

If an alarm occurs, the frequency converter trips. To restart operation, reset alarms once their causes have been rectified.

 Reset can be done in 4 ways:
- Pressing [Reset] on the LCP.
- Via a digital input with the *Reset* function.
- Via serial communication/optional fieldbus.
- By resetting automatically using the *Auto Reset* function (default).

NOTICE

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

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 8.1*).

⚠CAUTION

Alarms that are trip-locked offer extra protection, meaning that the mains supply must be switched off before the alarm can be reset. After being switched back on, the frequency converter is no longer blocked and may be reset as described previously once the cause has been rectified.
Alarms that are not trip-locked can also be reset using the automatic reset function in *14-20 Reset Mode* (Warning: Automatic wake-up is possible!)
Table 8.1 specifies whether a warning occurs before an alarm, or whether to display a warning or an alarm for a given fault.
This is possible, for instance, in *parameter 1-90 Motor Thermal Protection*. After an alarm or trip, the motor carries on coasting, and the alarm and warning flash on the frequency converter. Once the problem has been rectified, only the alarm continues flashing.

No.	Description	Warning	Alarm/trip	Alarm/trip lock	Parameter reference
1	10 volts low	X			
2	Live zero error	(X)	(X)		6-01
3	No motor	(X)			1-80
4	Mains phase loss	(X)	(X)	(X)	14-12
5	DC link voltage high	X			
6	DC link voltage low	X			
7	DC overvoltage	X	X		
8	DC undervoltage	X	X		
9	Inverter overloaded	X	X		
10	Motor ETR overtemperature	(X)	(X)		1-90
11	Motor thermistor overtemperature	(X)	(X)		1-90
12	Torque limit	X	X		
13	Overcurrent	X	X	X	
14	Earth fault	X	X	X	
15	Hardware mismatch		X	X	
16	Short circuit		X	X	
17	Control word timeout	(X)	(X)		8-04
23	Internal fan fault	X			
24	External fan fault	X			14-53
25	Brake resistor short-circuited	X			
26	Brake resistor power limit	(X)	(X)		2-13
27	Brake chopper short-circuited	X	X		
28	Brake check	(X)	(X)		2-15
29	Drive overtemperature	X	X	X	

No.	Description	Warning	Alarm/trip	Alarm/trip lock	Parameter reference
30	Motor phase U missing	(X)	(X)	(X)	4-58
31	Motor phase V missing	(X)	(X)	(X)	4-58
32	Motor phase W missing	(X)	(X)	(X)	4-58
33	Inrush fault		X	X	
34	Fieldbus communication fault	X	X		
35	Out of frequency range	X	X		
36	Mains failure	X	X		
37	Phase imbalance	X	X		
38	Internal fault		X	X	
39	Heat sink sensor		X	X	
40	Overload of digital output terminal 27	(X)			5-00, 5-01
41	Overload of digital output terminal 29	(X)			5-00, 5-02
42	Overload of digital outpu on X30/6	(X)			5-32
42	Overload of digital output on X30/7	(X)			5-33
46	Pwr. card supply		X	X	
47	24 V supply low	X	X	X	
48	1.8 V supply low		X	X	
49	Speed limit	X	(X)		1-86
50	AMA calibration failed		X		
51	AMA check U_{nom} and I_{nom}		X		
52	AMA low I_{nom}		X		
53	AMA motor too big		X		
54	AMA motor too small		X		
55	AMA parameter out of range		X		
56	AMA interrupted by user		X		
57	AMA timeout		X		
58	AMA internal fault	X	X		
59	Current limit	X			
60	External interlock	X			
62	Output frequency at maximum limit	X			
64	Voltage limit	X			
65	Control board over temperature	X	X	X	
66	Heat sink temperature low	X			
67	Option configuration has changed		X		
69	Pwr. card temp		X	X	
70	Illegal FC configuration			X	
71	PTC 1 safe stop	X	X[1]		
72	Dangerous failure			X[1]	
73	Safe stop auto restart				
76	Power unit setup	X			
79	Illegal PS config		X	X	
80	Drive initialized to default value		X		
91	Analog input 54 wrong settings			X	
92	No flow	X	X		22-2*
93	Dry pump	X	X		22-2*
94	End of curve	X	X		22-5*
95	Broken belt	X	X		22-6*
96	Start delayed	X			22-7*
97	Stop delayed	X			22-7*
98	Clock fault	X			0-7*
201	Fire M was active				
202	Fire M limits exceeded				
203	Missing motor				

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No.	Description	Warning	Alarm/trip	Alarm/trip lock	Parameter reference
204	Locked rotor				
243	Brake IGBT	X	X		
244	Heat sink temp	X	X	X	
245	Heat sink sensor		X	X	
246	Pwr.card supply		X	X	
247	Pwr.card temp		X	X	
248	Illegal PS config		X	X	
250	New spare parts			X	
251	New type code		X	X	

Table 8.1 Alarm/Warning Code List

(X) Dependent on parameter.

1) Cannot be auto reset via 14-20 Reset Mode.

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

Warning	yellow
Alarm	flashing red
Trip locked	yellow and red

Table 8.2 LED Indication

Alarm Word and Extended Status Word					
Bit	Hex	Dec	Alarm Word	Warning Word	Extended Status Word
0	00000001	1	Brake Check	Brake Check	Ramping
1	00000002	2	Pwr. Card Temp	Pwr. Card Temp	AMA Running
2	00000004	4	Earth Fault	Earth Fault	Start CW/CCW
3	00000008	8	Ctrl.Card Temp	Ctrl.Card Temp	Slow Down
4	00000010	16	Ctrl. Word TO	Ctrl. Word TO	Catch Up
5	00000020	32	Over Current	Over Current	Feedback High
6	00000040	64	Torque Limit	Torque Limit	Feedback Low
7	00000080	128	Motor Th Over	Motor Th Over	Output Current High
8	00000100	256	Motor ETR Over	Motor ETR Over	Output Current Low
9	00000200	512	Inverter Overld.	Inverter Overld.	Output Freq High
10	00000400	1024	DC under Volt	DC under Volt	Output Freq Low
11	00000800	2048	DC over Volt	DC over Volt	Brake Check OK
12	00001000	4096	Short Circuit	DC Voltage Low	Braking Max
13	00002000	8192	Inrush Fault	DC Voltage High	Braking
14	00004000	16384	Mains ph. Loss	Mains ph. Loss	Out of Speed Range
15	00008000	32768	AMA Not OK	No Motor	OVC Active
16	00010000	65536	Live Zero Error	Live Zero Error	
17	00020000	131072	Internal Fault	10V Low	
18	00040000	262144	Brake Overload	Brake Overload	
19	00080000	524288	U phase Loss	Brake Resistor	
20	00100000	1048576	V phase Loss	Brake IGBT	
21	00200000	2097152	W phase Loss	Speed Limit	
22	00400000	4194304	Fieldbus Fault	Fieldbus Fault	
23	00800000	8388608	24V Supply Low	24V Supply Low	
24	01000000	16777216	Mains Failure	Mains Failure	
25	02000000	33554432	1.8V Supply Low	Current Limit	
26	04000000	67108864	Brake Resistor	Low Temp	
27	08000000	134217728	Brake IGBT	Voltage Limit	
28	10000000	268435456	Option Change	Unused	
29	20000000	536870912	Drive Initialized	Unused	
30	40000000	1073741824	Safe Stop	Unused	

Table 8.3 Description of Alarm Word, Warning Word and Extended Status Word

The alarm words, warning words and extended status words can be read out via serial bus or optional fieldbus for diagnosis. See also *16-90 Alarm Word*, *16-92 Warning Word* and *16-94 Ext. Status Word*.

The warning/alarm information in this chapter 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 from terminal 50 is <10 V. Remove some of the load from terminal 50, as the 10 V supply is overloaded. Max. 15 mA or minimum 590 Ω.

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

Troubleshooting
- Remove the wiring from terminal 50.
- If the warning clears, the problem is with the customer 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 signals being sent by a faulty device causes this condition.

Troubleshooting
- Check 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 frequency converter programming and switch settings match the analog signal type.
- Perform an input terminal signal test.

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WARNING 3, No motor
No motor has been connected to the output of the frequency converter.

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

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

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

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

WARNING/ALARM 7, DC overvoltage
If the intermediate circuit voltage exceeds the limit, the frequency converter trips after some time.

Troubleshooting
- Connect a brake resistor.

- Extend the ramp time.

- Change the ramp type.

- Activate the functions in *parameter 2-10 Brake Function*.

- Increase *14-26 Trip Delay at Inverter Fault*.

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

Troubleshooting
- Check that the supply voltage matches the frequency converter voltage.

- Perform an input voltage test.

- Perform a soft charge circuit test.

WARNING/ALARM 9, Inverter overload
The frequency converter is about to cut out because of an overload (too high current for too long). The counter for electronic thermal inverter protection issues a warning at 98% and trips at 100%, while issuing an alarm. The frequency converter *cannot* be reset until the counter is below 90%.

Troubleshooting
- Compare the output current shown on the LCP with the frequency converter rated current.

- Compare the output current shown on the LCP with measured motor current.

- Display the thermal drive load on the LCP and monitor the value. When running above the frequency converter continuous current rating, the counter should increase. When running below the frequency converter continuous current rating, the counter should decrease.

WARNING/ALARM 10, Motor overload temperature
According to the electronic thermal protection (ETR), the motor is too hot. Select whether the frequency converter issues a warning or an alarm when the counter reaches 100% in *parameter 1-90 Motor Thermal Protection*. The fault occurs when the motor overload exceeds 100% 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 the motor data in parameters *1-20* through *1-25* is set correctly.

- If an external fan is used, check that it is selected in *1-91 Motor External Fan*.

- Running AMA in *parameter 1-29 Automatic Motor Adaptation (AMA)* tunes the frequency converter to the motor more accurately and reduces thermal loading.

WARNING/ALARM 11, Motor thermistor over temp
The thermistor might be disconnected. Select whether the frequency converter issues a warning or an alarm in *parameter 1-90 Motor Thermal Protection*.

Troubleshooting
- Check for motor overheating.

- Check if the motor is mechanically overloaded.

- Check that the thermistor is connected correctly between either terminal 53 or 54 (analog voltage input) and terminal 50 (+10 V supply) and that the terminal switch for 53 or 54 is set for voltage. Check *parameter 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 *1-95 KTY Sensor Type, 1-96 KTY Thermistor Resource*, and *1-97 KTY Threshold level* match sensor wiring.

WARNING/ALARM 12, Torque limit

The torque has exceeded the value in *4-16 Torque Limit Motor Mode* or the value in *4-17 Torque Limit Generator Mode*. *14-25 Trip Delay at Torque Limit* can change this 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, possibly increase the torque limit. Be sure that the system can operate safely at a higher torque.

- Check the application for excessive current draw on the motor.

WARNING/ALARM 13, Over current

The inverter peak current limit (approximately 200% of the rated current) is exceeded. The warning lasts about 1.5 s, then the frequency converter trips and issues an alarm. Shock loading or fast acceleration with high-inertia loads can cause this fault. If extended mechanical brake control is selected, the trip can be reset externally.

Troubleshooting

- Remove power and check if the motor shaft can be turned.

- Check that the motor size matches the frequency converter.

- Check parameters *1-20* to *1-25* for correct motor data.

ALARM 14, Earth (ground) fault

There is current from the output phases to ground, either in the cable between the frequency converter and the motor or in the motor itself.

Troubleshooting

- Remove power from the frequency converter and repair the ground fault.

- Check for ground faults in the motor by measuring the resistance to ground of the motor leads 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 the local Danfoss supplier:

- *15-40 FC Type*.

- *15-41 Power Section*.

- *15-42 Voltage*.

- *15-43 Software Version*.

- *15-45 Actual Typecode String*.

- *15-49 SW ID Control Card*.

- *15-50 SW ID Power Card*.

- *15-60 Option Mounted*.

- *15-61 Option SW Version* (for each option slot).

ALARM 16, Short circuit

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

- Remove power from the frequency converter and repair the short circuit.

WARNING/ALARM 17, Control word timeout

There is no communication to the frequency converter. The warning is only active when *8-04 Control Word Timeout Function* is NOT set to *[0] Off*.

If *8-04 Control Word Timeout Function* is set to *[5] Stop and trip*, a warning appears and the frequency converter ramps down until it trips, then it displays an alarm.

Troubleshooting

- Check the connections on the serial communication cable.

- Increase *8-03 Control Word Timeout Time*.

- Check the operation of the communication equipment.

- Verify a proper installation based on EMC requirements.

ALARM 18, Start failed

The speed has not been able to exceed *1-77 Compressor Start Max Speed [RPM]* during start within the allowed time (set in *1-79 Compressor Start Max Time to Trip*.) A blocked motor may cause this alarm.

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 *14-53 Fan Monitor* (*[0] Disabled*).

For D, E and F enclosure sizes, the regulated voltage to the fan is monitored.

Troubleshooting

- Check fan resistance.

- Check soft charge fuses.

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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 *14-53 Fan Monitor* (*[0] Disabled*).

For D, E and F enclosure sizes, the regulated voltage to the fan is monitored.

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 frequency converter is still operational but without the brake function. Remove power from the frequency converter and replace the brake resistor (see *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 *2-16 AC brake Max. Current*. The warning is active when the dissipated braking is higher than 90% of the brake resistance power. If *[2] Trip* is selected in *2-13 Brake Power Monitoring*, the frequency converter trips when the dissipated braking power reaches 100%.

WARNING/ALARM 27, Brake chopper fault
The brake transistor is monitored during operation. If a short circuit occurs, the brake function is disabled and a warning is issued. The frequency converter is still operational, but since the brake transistor has short-circuited, substantial power is transmitted to the brake resistor, even if it is inactive.
Remove power from the frequency converter and remove the brake resistor.

This alarm/warning could also occur if the brake resistor overheats. Terminals 104 and 106 are available as brake resistor Klixon inputs, see *Brake Resistor Temperature Switch* in the *Design Guide*.

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

ALARM 29, Heat sink temp
The maximum temperature of the heat sink has been exceeded. The temperature fault does not reset until the temperature drops below a defined heat sink temperature. The trip and reset points are different based on the frequency converter power size.

Troubleshooting
Check the following conditions:
- Ambient temperature too high.
- Motor cable too long.

- Incorrect airflow clearance above and below the frequency converter.
- Blocked airflow around the frequency converter.
- Damaged heat sink fan.
- Dirty heat sink.

For D, E and F enclosure sizes, this alarm is based on the temperature measured by the heat sink sensor mounted inside the IGBT modules. For 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 frequency converter and the motor is missing.

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

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

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

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

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

ALARM 33, Inrush fault
Too many power-ups have occurred within a short time period. Let the unit cool to operating temperature.

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

WARNING/ALARM 35, Out of frequency range
This warning is active if the output frequency has reached the high limit (set in *4-53 Warning Speed High*) or low limit (set in *4-52 Warning Speed Low*). In *[3] Closed Loop* (*1-00 Configuration Mode*), this warning is displayed.

WARNING/ALARM 36, Mains failure
This warning/alarm is only active if the supply voltage to the frequency converter is lost and *14-10 Mains Failure* is NOT set to *[0] No Function*.

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

ALARM 38, Internal fault

When an internal fault occurs, a code number defined in *Table 8.4* is displayed.

Troubleshooting

- Cycle power.

- Check that the option is properly installed.

- Check for loose or missing wiring.

Contact the Danfoss supplier or Danfoss service if necessary. Note the code number for further trouble-shooting directions.

No.	Text
0	Serial port cannot be initialised. Contact the Danfoss supplier or Danfoss Service.
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 recognise the EEPROM data.
516	Cannot write to the EEPROM because a write command is in 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	Sending a CAN telegram failed.
1281	Digital signal processor flash timeout.
1282	Power micro software version mismatch.
1283	Power EEPROM data version mismatch.
1284	Cannot read digital signal processor software version.
1299	Option SW in slot A is too old.
1300	Option SW in slot B is too old.
1301	Option SW in slot C0 is too old.
1302	Option SW in slot C1 is too old.
1315	Option SW in slot A is not supported (not allowed).
1316	Option SW in slot B is not supported (not allowed).
1317	Option SW in slot C0 is not supported (not allowed).
1318	Option SW in slot C1 is not supported (not allowed).
1379	Option A did not respond when calculating platform version.
1380	Option B did not respond when calculating platform version.
1381	Option C0 did not respond when calculating platform version.
1382	Option C1 did not respond when calculating platform version.

No.	Text
1536	An exception in the application-oriented control is registered. Debug information written in LCP.
1792	DSP watchdog is active. Debugging of power part data, motor-oriented control data not transferred correctly.
2049	Power data restarted.
2064–2072	H081x: option in slot x has restarted.
2080–2088	H082x: option in slot x has issued a power-up wait.
2096–2104	H983x: option in slot x has issued a legal power-up wait.
2304	Could not read any data from 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 main 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 8.4 Code Numbers for Internal Faults

ALARM 39, Heat sink sensor

No feedback from the heat sink temperature sensor.

The signal from the IGBT thermal sensor is not available on the power card. The problem could be on the power card,

on the 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 *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 *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 *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 *5-33 Term X30/7 Digi Out (MCB 101)*.

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

There are 3 power supplies generated by the switch mode power supply (SMPS) on the power card: 24 V, 5 V, ±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 3-phase mains voltage, all 3 supplies are monitored.

WARNING 47, 24V supply low
The 24 V DC supply is measured on the control card. The external 24 V DC back-up power supply may be overloaded, otherwise contact the Danfoss supplier.

WARNING 48, 1.8V 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 an overvoltage condition.

WARNING 49, Speed limit
When the speed is not within the specified range in *parameter 4-11 Motor Speed Low Limit [RPM]* and *parameter 4-13 Motor Speed High Limit [RPM]*, the frequency converter displays a warning. When the speed is below the specified limit in *1-86 Trip Speed Low [RPM]* (except when starting or stopping) the frequency converter trips.

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

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.

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 does not run.

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

ALARM 57, AMA internal fault
Try to restart AMA a number of times, until the AMA is carried out. Note that repeated runs may heat the motor to a level where the resistance R$_s$ and R$_r$ are increased. In most cases, however, this is not critical.

ALARM 58, AMA Internal fault
Contact the Danfoss supplier.

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

WARNING 60, External interlock
External interlock has been activated. To resume normal operation:

1.   Apply 24 V DC to the terminal programmed for external interlock.

2.   Reset the frequency converter via

     2a   serial communication

     2b   digital I/O

     2c   by pressing [Reset]

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

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

WARNING/ALARM 65, Control card over temperature
The control card has reached its trip temperature of 80 °C.

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

Troubleshooting
   •   Check the temperature sensor.

   •   Check the sensor wire between the IGBT and the gate drive card.

ALARM 67, Option module configuration has changed
One or more options have either been added or removed since the last power-down. Check that the configuration change is intentional and reset the unit.

ALARM 68, Safe stop activated
STO has been activated.

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

 Troubleshooting
- Check the operation of the door fans.
- Check that the filters for the door fans are not blocked.
- Check that the gland plate is properly installed on IP21/IP54 (NEMA 1/12) frequency converters.

ALARM 70, Illegal FC configuration
The control card and power card are incompatible.

 Troubleshooting
- Contact the supplier with the type code of the unit from the nameplate and the part numbers of the cards to check compatibility.

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

WARNING 73, Safe stop auto restart
Safe stop. With automatic restart enabled, the motor may start when the fault is cleared.

WARNING 76, Power unit setup
The required number of power units do not match the detected number of active power units. When replacing an enclosure size F module, this occurs if the power-specific data in the module power card does not match the rest of the frequency converter.

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

WARNING 77, Reduced power mode
This warning indicates that the frequency converter is operating in reduced power mode (that is, less than the allowed number of inverter sections). This warning is generated on power cycle when the frequency converter is set to run with fewer inverters and remains on.

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

ALARM 80, Drive initialised to default value
Parameter settings are initialised to default settings after a manual reset.

 Troubleshooting
- Reset the unit to clear the alarm.

ALARM 91, Analog input 54 wrong settings
Switch S202 has to be set in position OFF (voltage input) when a KTY sensor is connected to analog input terminal 54.

ALARM 92, No flow
A no-flow condition has been detected in the system. *Parameter 22-23 No-Flow Function* is set for alarm.

 Troubleshooting
- Troubleshoot the system and reset the frequency converter after the fault has been cleared.

ALARM 93, Dry pump
A no-flow condition in the system with the frequency converter operating at high speed may indicate a dry pump. *Parameter 22-26 Dry Pump Function* is set for alarm.

 Troubleshooting
- Troubleshoot the system and reset the frequency converter after the fault has been cleared.

ALARM 94, End of curve
The feedback is lower than the setpoint. This may indicate leakage in the system. *22-50 End of Curve Function* is set for alarm.

 Troubleshooting
- Troubleshoot the system and reset the frequency converter after the fault has been cleared.

ALARM 95, Broken belt
Torque is below the torque level set for no load, indicating a broken belt. *Parameter 22-60 Broken Belt Function* is set for alarm.

 Troubleshooting
- Troubleshoot the system and reset the frequency converter after the fault has been cleared.

ALARM 96, Start delayed
Motor start has been delayed due to short-cycle protection. *Parameter 22-76 Interval between Starts* is enabled.

 Troubleshooting
- Troubleshoot the system and reset the frequency converter after the fault has been cleared.

WARNING 97, Stop delayed
Stopping the motor has been delayed due to short cycle protection. *Parameter 22-76 Interval between Starts* is enabled.

 Troubleshooting
- Troubleshoot the system and reset the frequency converter after the fault has been cleared.

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WARNING 98, Clock fault
Time is not set or the RTC clock has failed. Reset the clock in *0-70 Date and Time*.

WARNING 201, Fire mode was active
This indicates that the frequency converter has entered fire mode. Cycle power to the unit to remove the warning. See the fire mode data in the alarm log.

WARNING 202, Fire mode limits exceeded
While operating in fire mode one or more alarm conditions have been ignored which would normally trip the unit. Operating in this condition voids unit warranty. Cycle power to the unit to remove the warning. See the fire mode data in the alarm log.

WARNING 203, Missing motor
With a frequency converter operating multi-motors, an underload condition was detected. This could indicate a missing motor. Inspect the system for proper operation.

WARNING 204, Locked rotor
With a frequency converter operating multi-motors, an overload condition was detected. This could indicate a locked rotor. Inspect the motor for proper operation.

ALARM 243, Brake IGBT
This alarm is only for enclosure size F frequency converters. It is equivalent to Alarm 27. The report value in the alarm log indicates which power module generated the alarm:

> 1 = inverter module to the far left.

> 2 = middle inverter module in F2 or F4 frequency converter.

> 2 = right inverter module in F1 or F3 frequency converter.

> 3 = right inverter module in F2 or F4 frequency converter.

> 5 = rectifier module.

ALARM 244, Heat sink temperature
This alarm is only for enclosure size F frequency converters. It is equivalent to Alarm 29. The report value in the alarm log indicates which power module generated the alarm:

> 1 = inverter module to the far left.

> 2 = middle inverter module in F2 or F4 frequency converter.

> 2 = right inverter module in F1 or F3 frequency converter.

> 3 = right inverter module in F2 or F4 frequency converter.

> 5 = rectifier module.

ALARM 245, Heat sink sensor
This alarm is only for enclosure size F frequency converters. It is equivalent to Alarm 39. The report value in the alarm log indicates which power module generated the alarm:

> 1 = inverter module to the far left.

> 2 = middle inverter module in F2 or F4 frequency converter.

> 2 = right inverter module in F1 or F3 frequency converter.

> 3 = right inverter module in F2 or F4 frequency converter.

> 5 = rectifier module.

ALARM 246, Power card supply
This alarm is only for enclosure size F frequency converters. It is equivalent to Alarm 46. The report value in the alarm log indicates which power module generated the alarm:

> 1 = inverter module to the far left.

> 2 = middle inverter module in F2 or F4 frequency converter.

> 2 = right inverter module in F1 or F3 frequency converter.

> 3 = right inverter module in F2 or F4 frequency converter.

> 5 = rectifier module.

ALARM 247, Power card temperature
This alarm is only for enclosure size F frequency converter. It is equivalent to Alarm 69. The report value in the alarm log indicates which power module generated the alarm:

> 1 = inverter module to the far left.

> 2 = middle inverter module in F2 or F4 frequency converter.

> 2 = right inverter module in F1 or F3 frequency converter.

> 3 = right inverter module in F2 or F4 frequency converter.

> 5 = rectifier module.

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

> 1 = inverter module to the far left.

> 2 = middle inverter module in F2 or F4 frequency converter.

> 2 = right inverter module in F1 or F3 frequency converter.

> 3 = right inverter module in F2 or F4 frequency converter.

> 5 = rectifier module.

WARNING 250, New spare part
A component in the frequency converter has been replaced. To resume normal operation, reset the frequency converter.

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

 Troubleshooting
- • Reset to remove the warning and resume normal operation.

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