MAKING MODERN LIVING POSSIBLE

Operating Instructions

VLT® AutomationDrive FC 302

90–1200 kW

www.danfoss.com/drives

VLT® THE REAL DRIVE

Contents

1

1 Introduction

1.1 How to Read these Operating Instructions

The frequency converter is designed to provide high shaft performance on electrical motors. Read this manual carefully for proper use. Incorrect handling of the frequency converter may cause improper operation of the frequency converter or related equipment, shorten lifetime or cause other troubles.

These Operating Instructions help starting, installing, programming, and troubleshooting the frequency converter.

Chapter 1 Introduction introduces the manual and informs you about the approvals, symbols, and abbreviations used in this literature.

Chapter 2 Safety Instructions and General Warning entails instructions on how to handle the frequency converter correctly.

Chapter 3 How to Install guides through mechanical and technical installation.

Chapter 4 How to Programme shows how to operate and programme the frequency converter via the LCP.

Chapter 5 General Specifications contains technical data about the frequency converter.

Chapter 6 Warnings and Alarms assists in solving problems that may occur when using the frequency converter.

Available literature

- The *VLT AutomationDrive 90-1200 kW Operating Instructions* provide the necessary information for getting the frequency converter up and running.
- The *VLT AutomationDrive FC 301/302 Design Guide* entails all technical information about the frequency converter and customer design and applications.
- The *VLT AutomationDrive Programming Guide* provides information on how to programme and includes complete parameter descriptions.
- The *VLT AutomationDrive Profibus Operating Instructions* provide the information required for controlling, monitoring and programming the frequency converter via a Profibus fieldbus.
- The *VLT AutomationDrive DeviceNet Operating Instructions* provide the information required for controlling, monitoring and programming the frequency converter via a DeviceNet fieldbus.

Danfoss technical literature is also available online at www.danfoss.com/drives.

1.1.1 Approvals

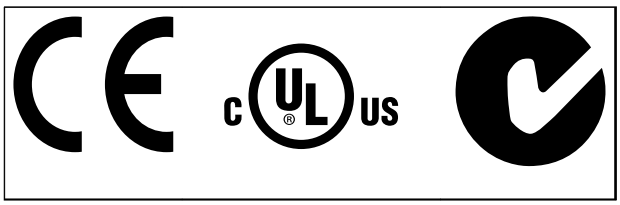


Table 1.1

The frequency converter complies with UL508C thermal memory retention requirements. For more information, refer to the section *Motor Thermal Protection* in the *Design Guide*.

NOTICE

Imposed limitations on the output frequency (due to export control regulations):

From software version 6.72 the output frequency of the frequency converter is limited to 590 Hz. Software versions 6x.xx also limit the maximum output frequency to 590 Hz, but these versions cannot be flashed, i.e. neither downgraded nor upgraded.

The following symbols are used in this document:

⚠WARNING

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

⚠CAUTION

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

NOTICE

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

Conventions

Numbered lists indicate procedures.

Bullet lists indicate other information and description of illustrations.

Italicised text indicates

- cross reference
- link
- footnote
- parameter name, parameter group name, parameter option

60° AVM	60° Asynchronous Vector Modulation
A	Ampere/AMP
AC	Alternating current
AD	Air discharge
AI	Analog Input
AMA	Automatic Motor Adaptation
AWG	American wire gauge
°C	Degrees Celsius
CD	Contant discharge
CM	Common mode
CT	Constand Torque
DC	Direct current
DI	Digital Input
DM	Differential mode
D-TYPE	Drive Dependent
EMC	Electro Magnetic Compatibility
ETR	Electronic Thermal Relay
f_{JOG}	Motor frequency when jog function is activated
f_M	Motor frequency
f_{MAX}	The maximum output frequency the frequency converter applies on its output
f_{MIN}	The minimum motor frequency from frequency converter
$f_{M,N}$	Nominal motor frequency
FC	Frequency converter
g	Gram
Hiperface®	Hiperface® is a registered trademark by Stegmann
hp	Horsepower
HTL	HTL encoder (10-30 V) pulses - High-voltage Transistor Logic
Hz	Hertz
I_{INV}	Rated Inverter Output Current
I_{LIM}	Current limit
$I_{M,N}$	Nominal motor current
$I_{VLT,MAX}$	The maximum output current
$I_{VLT,N}$	The rated output current supplied by the frequency converter
kHz	Kilohertz
LCP	Local Control Panel
lsb	Least significant bit
m	Meter
mA	Milliampere
MCM	Mille Circular Mil
MCT	Motion Control Tool
mH	Millihenry Inductance
min	Minute
ms	Millisecond
msb	Most significant bit
η_{VLT}	Efficiency of the frequency converter defined as ratio between power output and power input
nF	Nanofarad
NLCP	Numerical Local Control Panel
Nm	Newton Meters
n_s	Synchronous Motor Speed
On-line/Off-line Parameters	Changes to on-line parameters are activated immediately after the data value is changed.
$P_{br,cont.}$	Rated power of the brake resistor (average power during continuous braking)
PCB	Printed Circuit Board
PCD	Process Data
PELV	Protective Extra Low Voltage
P_m	Frequency converter nominal output power as HO
$P_{M,N}$	Nominal motor power
PM motor	Permanent Magnet motor
Process PID	The PID regulator maintains the desired speed, pressure, temperature, etc.
$R_{br,nom}$	The nominal resistor value that ensures a brake power on motor shaft of 150/160% for 1 minute
RCD	Residual Current Device
Regen	Regenerative terminals
R_{min}	Minimum permissible brake resistor value by frequency converter
RMS	Root Mean Square
RPM	Revolutions Per Minute
R_{rec}	Resistor value and resistance of the brake resistor
s	Second
SFAVM	Stator Flux oriented Asynchronous Vector Modulation
STW	Status Word
SMPS	Switch Mode Power Supply
THD	Total Harmonic Distortion
T_{LIM}	Torque limit
TTL	TTL encoder (5 V) pulses - Transistor Transistor Logic
$U_{M,N}$	Nominal motor voltage
V	Volts
VT	Variable Torque
VVC^{plus}	Voltage Vector Control

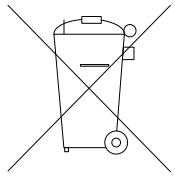
Table 1.2 Abbreviations

2 Safety Instructions and General Warning

2

2.1 Safety Regulations

2.1.1 Disposal Instruction



Equipment containing electrical components may not be disposed of together with domestic waste.
It must be separately collected with electrical and electronic waste according to local and currently valid legislation.

2.1.2 Caution

⚠WARNING

The frequency converter DC link capacitors remain charged after power has been disconnected. To avoid electrical shock hazard, disconnect the frequency converter from the mains before carrying out maintenance. Before doing service on the frequency converter wait at least the amount of time indicated below

380-500 V	90-200kW	20 minutes
	250-800kW	40 minutes
525-690V	37-315kW	20 minutes
	355-1200kW	30 minutes

Table 2.1 Discharge Time

2.1.3 Software Version

VLT AutomationDrive
Operating Instructions
Software version: 7.1x

These Operating Instructions can be used for all VLT AutomationDrive frequency converters with software version 7.1x.
The software version number can be seen from *15-43 Software Version*.

2.1.4 High Voltage

⚠WARNING

The voltage of the frequency converter is dangerous whenever the frequency converter is connected to mains. Incorrect installation or operation of the motor or frequency converter may cause damage to the equipment, serious personal injury or death. The instructions in this manual must consequently be observed, as well as applicable local and national rules and safety regulations.

⚠WARNING

Installation in high altitudes
380-500 V: At altitudes above 3,000 m, contact Danfoss regarding PELV.
525-690 V: At altitudes above 2,000 m, contact Danfoss regarding PELV.

2.1.5 Safety Instructions

- Make sure the frequency converter is properly connected to earth.
- Protect users against supply voltage.
- Protect the motor against overloading according to national and local regulations.
- Motor overload protection is not included in the default settings. To add this function, set *1-90 Motor Thermal Protection* to value *ETR trip* or *ETR warning*. For the North American market: ETR functions provide class 20 motor overload protection, in accordance with NEC.
- The earth leakage current exceeds 3.5 mA.
- The [Off] key is not a safety switch. It does not disconnect the frequency converter from mains.

2.1.6 General Warning

⚠WARNING

Touching the electrical parts may be fatal - even after the equipment has been disconnected from mains.
Also make sure that other voltage inputs have been disconnected, such as load-sharing (linkage of DC intermediate circuit), as well as the motor connection for kinetic back-up.
When using the frequency converter: wait at least 40 minutes.
Shorter time is allowed only if indicated on the nameplate for the specific unit.

⚠CAUTION

The earth leakage current from the frequency converter exceeds 3.5 mA. To ensure that the earth cable has a good mechanical connection to the earth connection (terminal 95), the cable cross section must be at least 10 mm² or 2 rated earth wires terminated separately. For proper earthing for EMC, see *chapter 3.5.2 Grounding*.
Residual Current Device
This product can cause a D.C. current in the protective conductor. Where a residual current device (RCD) is used for extra protection, only an RCD of Type B (time delayed) shall be used on the supply side of this product. See also *RCD Application Note MN90GX02* (x=version number).
Protective earthing of the frequency converter and the use of RCDs must always follow national and local regulations.

2.1.7 Before Commencing Repair Work

1. Disconnect the frequency converter from mains.
2. Disconnect DC bus terminals 88 and 89 from load share applications.
3. Wait for discharge of the DC-link. See period of time on the warning label.
4. Remove motor cable.

2.1.8 Avoid Unintended Start

While the frequency converter is connected to mains, the motor can be started/stopped using digital commands, bus commands, references or via the Local Control Panel (LCP):

- Disconnect the frequency converter from mains whenever personal safety considerations make it necessary to avoid unintended start.
- To avoid unintended start, always activate the [Off] key before changing parameters.
- An electronic fault, temporary overload, a fault in the mains supply, or lost motor connection may cause a stopped motor to start. The frequency converter with Safe Stop provides protection against unintended start, if the Safe Stop Terminal 37 is deactivated or disconnected.

2.1.9 Safe Torque Off (STO)

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

2.1.10 IT Mains

Parameter *14-50 RFI Filter* can be used to disconnect the internal RFI capacitors from the RFI filter to ground in the 380-500 V frequency converters. This reduces the RFI performance to A2 level. For the 525-690 V frequency converters, *14-50 RFI Filter* has no function. The RFI switch cannot be opened.

3 How to Install

3.1 Pre-installation

3.1.1 Planning the Installation Site

⚠CAUTION

Before performing the installation it is important to plan the installation of the frequency converter. Neglecting this 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 the power source supplies the correct voltage and necessary current
- Ensure that the motor current rating is within the maximum current from the frequency converter
- If the frequency converter is without built-in fuses, ensure that the external fuses are rated correctly.

3.1.2 Receiving the Frequency Converter

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

3.1.3 Transportation and Unpacking

Before unpacking the frequency converter it is recommended that it is located as close as possible to the final installation site.
Remove the box and handle the frequency converter on the pallet, as long as possible.

3.1.4 Lifting

Always lift the frequency converter in the dedicated lifting eyes. For all D and E2 (IP00) enclosures, use a bar to avoid bending the lifting holes of the frequency converter.

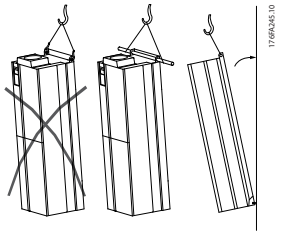


Illustration 3.1 Recommended Lifting Method, Enclosure Types D and E

⚠WARNING

The lifting bar must be able to handle the weight of the frequency converter. See *Mechanical Dimensions* for the weight of the different enclosure type. 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° or greater.

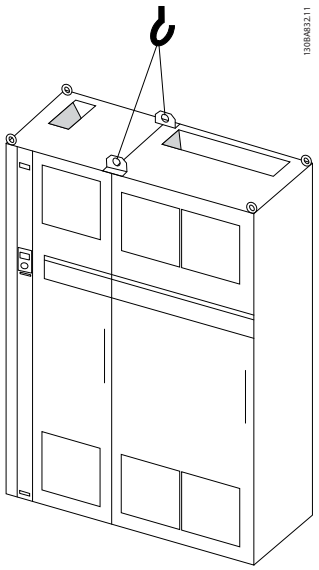


Illustration 3.2 Recommended Lifting Method, Enclsoure Type F1 (460 V, 600 to 900 HP, 575/690 V, 900 to 1150 HP)

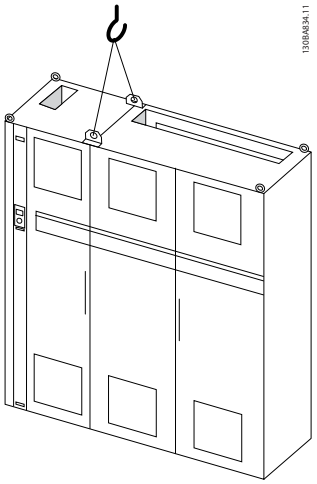


Illustration 3.3 Recommended Lifting Method, Enclosure Type F2 (460 V, 1000 to 1200 HP, 575/690 V, 1250 to 1350 HP)

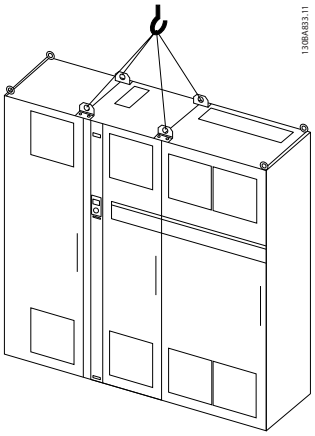


Illustration 3.4 Recommended Lifting Method, Enclosure Type F3 (460 V, 600 to 900 HP, 575/690 V, 900 to 1150 HP)

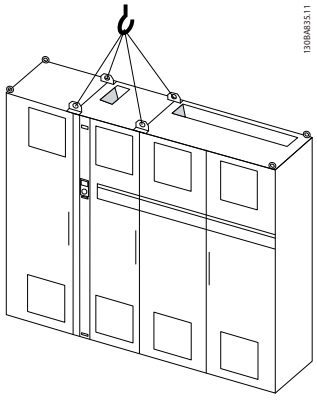


Illustration 3.5 Recommended Lifting Method, Enclosure Type F4 (460 V, 1000 to 1200 HP, 575/690 V, 1250 to 1350 HP)

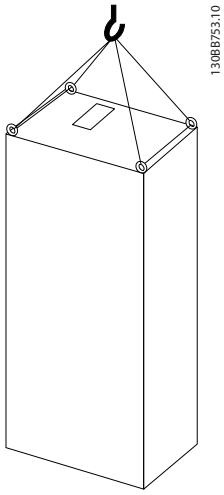


Illustration 3.6 Recommended lifting method, Enclosure Type F8

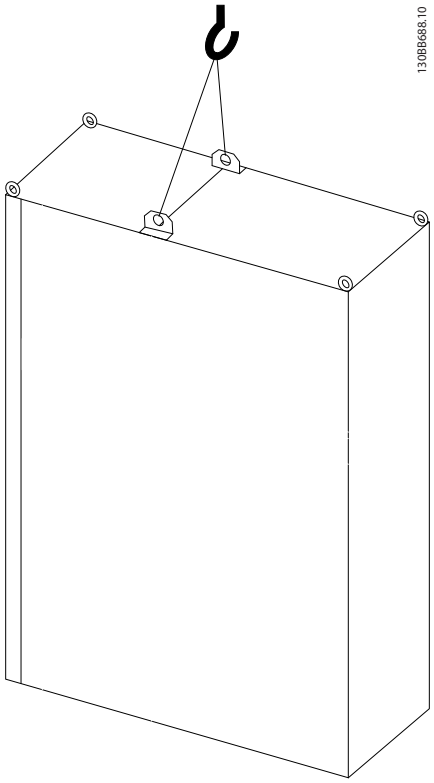


Illustration 3.7 Recommended lifting method, Enclosure Type F9/F10

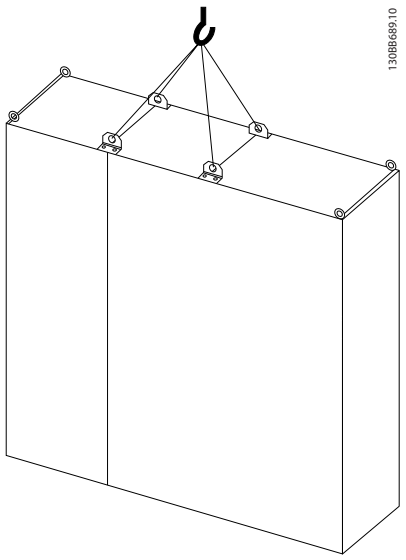
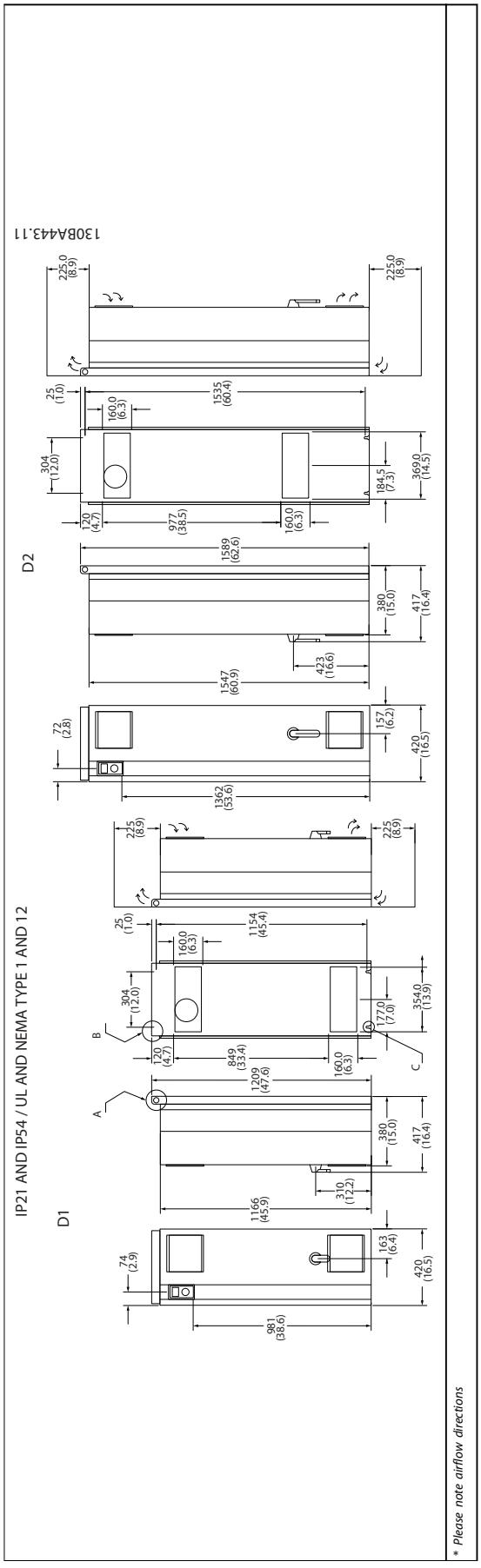


Illustration 3.8 Recommended lifting method, Enclosure Type F11/F12/F13/F14

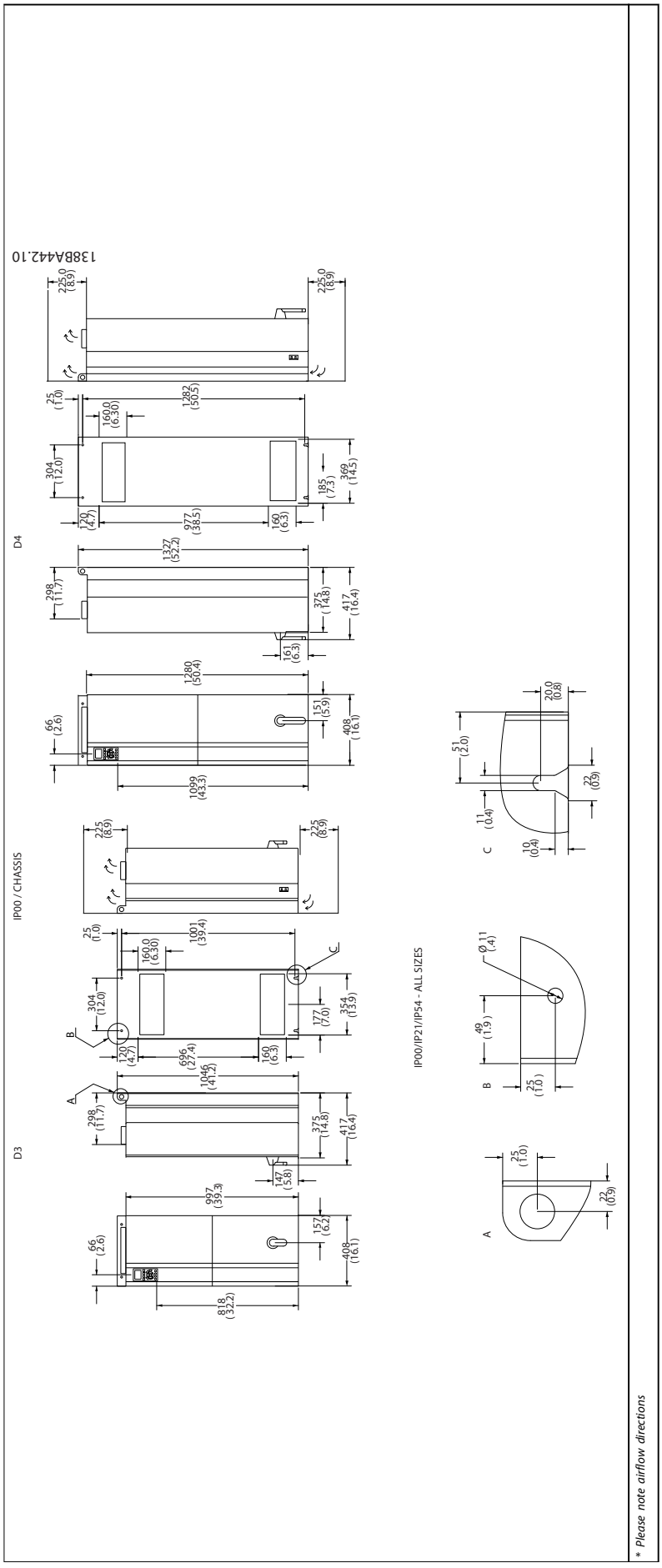
NOTICE

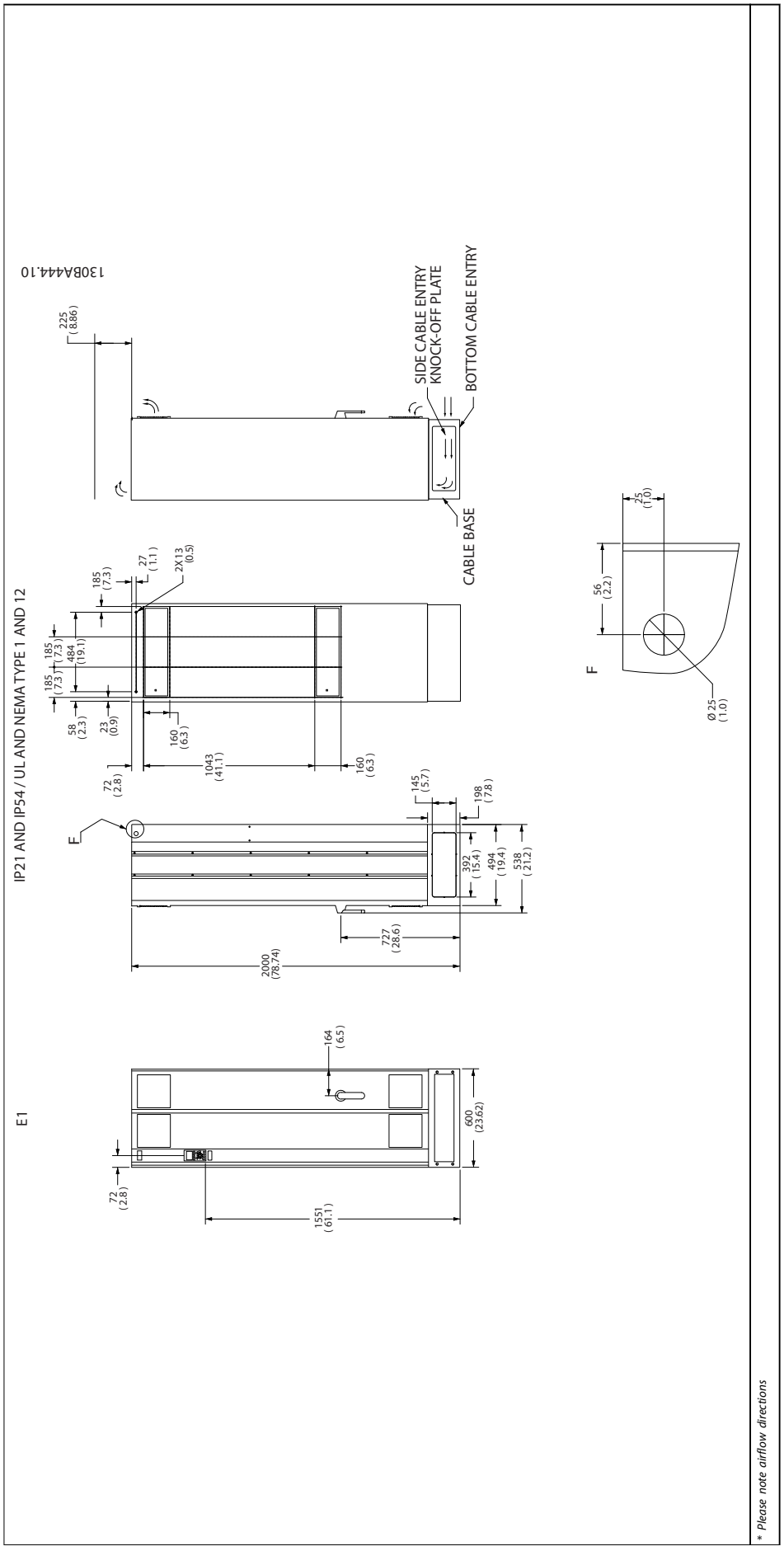
The plinth is provided in the same packaging as the frequency converter but is not attached to enclosure types F1-F4 during shipment. The plinth is required to allow airflow to the frequency converter to provide proper cooling. The F enclosures should be positioned on top of the plinth in the final installation location. The angle from the top of the frequency converter to the lifting cable should be 60° or greater.
In addition to the drawings above a spreader bar is an acceptable way to lift the F enclosures.

3.1.5 Mechanical Dimensions

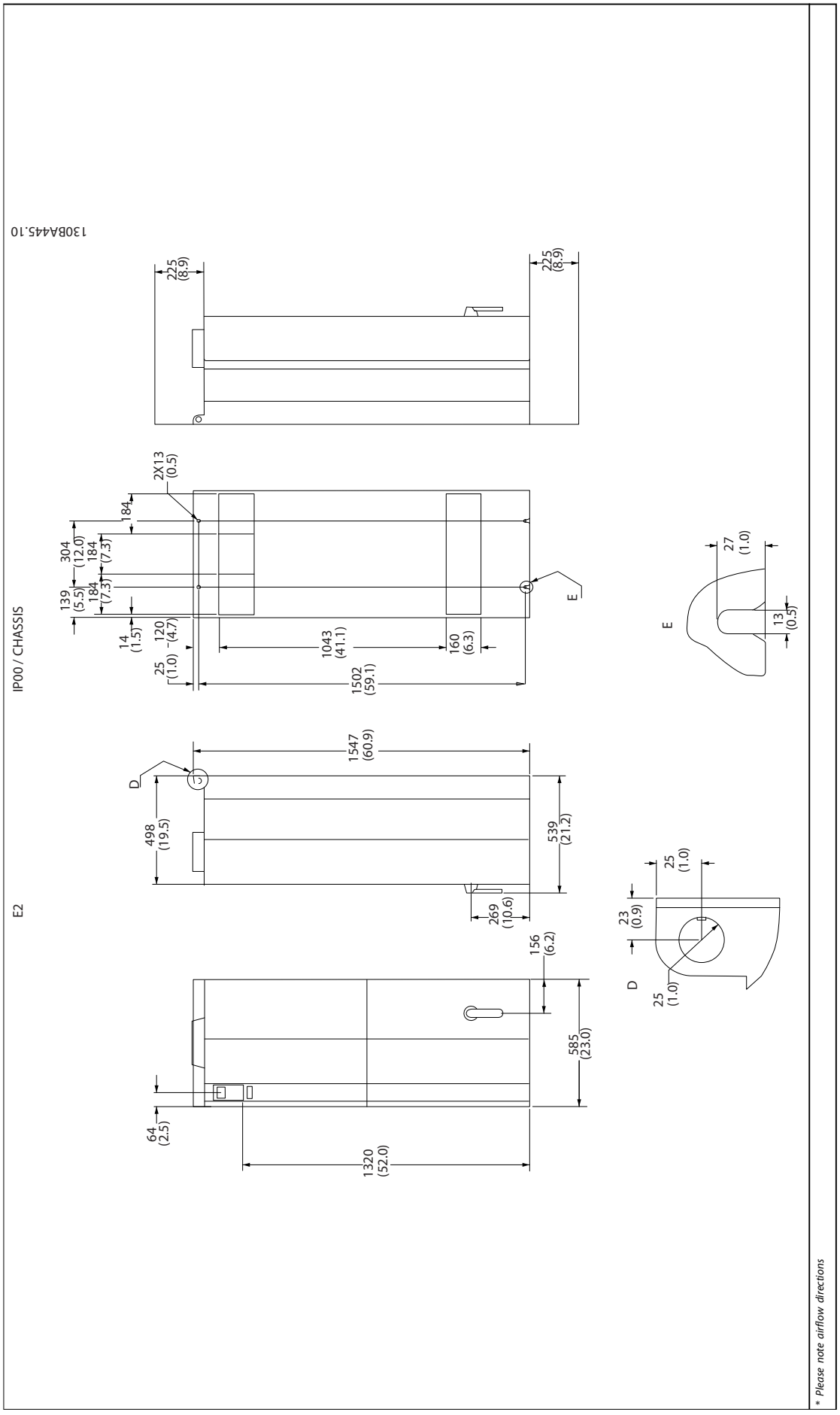


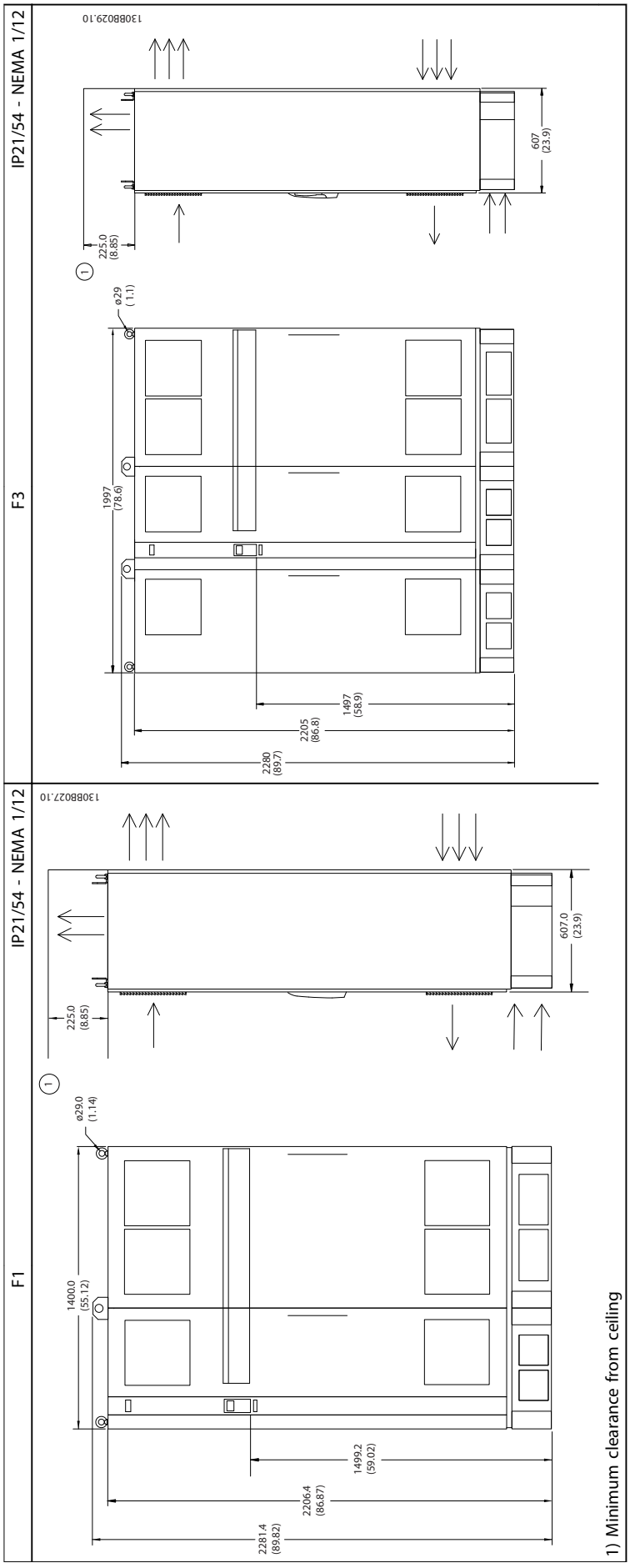
3


138BA442.10
D4
D3
IP00 / CHASSIS
IP00/IP21/IP54 - ALL SIZES
* Please note airflow directions

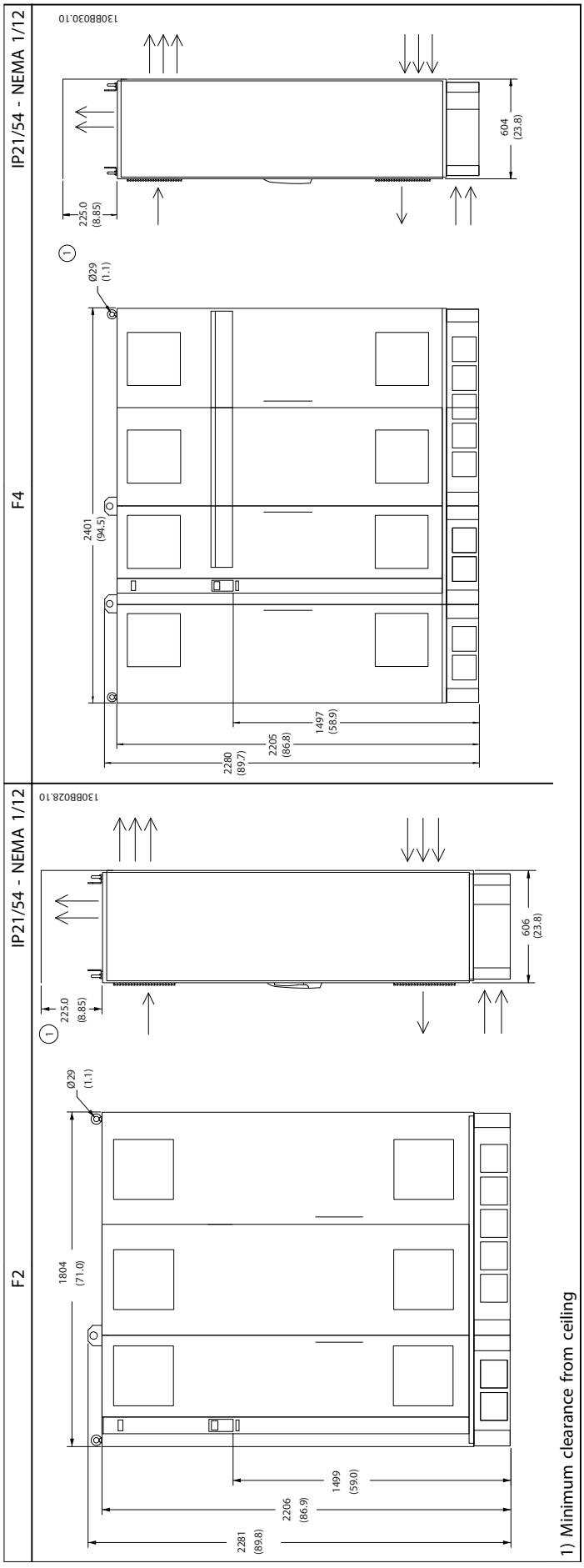

130BA444.10
IP21 AND IP54 / UL AND NEMA TYPE 1 AND 12
E1
F
SIDE CABLE ENTRY
KNOCK-OFF PLATE
BOTTOM CABLE ENTRY
CABLE BASE
225 (8.86)
185 (7.3)
27 (1.1)
2X13 (0.5)
484 (19.1)
58 (2.3)
23 (0.9)
160 (6.3)
1043 (41.1)
72 (2.8)
145 (5.7)
198 (7.8)
392 (15.4)
494 (19.4)
538 (21.2)
727 (28.6)
2000 (78.74)
164 (6.5)
600 (23.62)
1551 (61.1)
25 (1.0)
56 (2.2)
Ø 25 (1.0)
* Please note airflow directions

3


130BA445.10
IP00 / CHASSIS
E2
225 (8.9)
225 (8.9)
2X13 (0.5)
184
304 (12.0)
184 (7.3)
184 (7.3)
139 (5.5)
14 (1.5)
120 (4.7)
25 (1.0)
1043 (41.1)
160 (6.3)
1502 (59.1)
E
27 (1.0)
13 (0.5)
1547 (60.9)
D
498 (19.5)
539 (21.2)
269 (10.6)
156 (6.2)
585 (23.0)
64 (2.5)
1320 (52.0)
25 (1.0)
23 (0.9)
25 (1.0)
* Please note airflow directions


IP21/54 - NEMA 1/12
F3
130BB029.10
607 (23.9)
225.0 (8.85)
1
ø29 (1.1)
1997 (78.6)
1497 (58.9)
2205 (86.8)
2280 (89.7)
IP21/54 - NEMA 1/12
F1
130BB027.10
607.0 (23.9)
225.0 (8.85)
1
ø29.0 (1.14)
1400.0 (55.12)
1499.2 (59.02)
2206.4 (86.87)
2281.4 (89.82)
1) Minimum clearance from ceiling

3


IP21/54 - NEMA 1/12
F4
130BB030.10
604 (23.8)
225.0 (8.85)
1
Ø29 (1.1)
2401 (94.5)
1497 (58.9)
2205 (86.8)
2280 (89.7)
IP21/54 - NEMA 1/12
F2
130BB028.10
606 (23.8)
225.0 (8.85)
1
Ø29 (1.1)
1804 (71.0)
1499 (59.0)
2206 (86.9)
2281 (89.8)
1) Minimum clearance from ceiling

Frame size		D1		D2		D3	D4
		90-110 kW (380-500 V) 37-132 kW (525-690 V)		132-200 kW (380-500 V) 160-315 kW (525-690 V)		90-110 kW (380-500 V) 37-132 kW (525-690 V)	132-200 kW (380-500 V) 160-315 kW (525-690 V)
IP NEMA		21 Type 1	54 Type 12	21 Type 1	54 Type 12	00 Chassis	00 Chassis
Shipping dimensions	Height	650	650	650	650	650	650
	Width	1730	1730	1730	1730	1220	1490
	Depth	570	570	570	570	570	570
Frequency converter dimensions	Height	1209	1209	1589	1589	1046	1327
	Width	420	420	420	420	408	408
	Depth	380	380	380	380	375	375
	Max weight [kg]	104	104	151	151	91	138

Table 3.1 Mechanical dimensions [mm], frame size D

Frame size		E1	E2	F1	F2	F3	F4
		250-400 kW (380-500 V) 355-560 kW (525-690 V)	250-400 kW (380-500 V) 355-560 kW (525-690 V)	450-630 kW (380-500 V) 630-800 kW (525-690 V)	710-800 kW (380-500 V) 900-1200 kW (525-690 V)	450-630 kW (380-500 V) 630-800 kW (525-690 V)	710-800 kW (380-500 V) 900-1200 kW (525-690 V)
IP NEMA		21, 54 Type 12	00 Chassis	21, 54 Type 12	21, 54 Type 12	21, 54 Type 12	21, 54 Type 12
Shipping dimensions	Height	840	831	2324	2324	2324	2324
	Width	2197	1705	1569	1962	2159	2559
	Depth	736	736	1130	1130	1130	1130
Frequency converter dimensions	Height	2000	1547	2204	2204	2204	2204
	Width	600	585	1400	1800	2000	2400
	Depth	494	498	606	606	606	606
	Max weight	313	277	1004	1246	1299	1541

Table 3.2 Mechanical dimensions [mm], frame sizes E and F

3

3.1.6 Rated Power

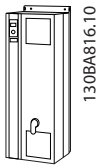
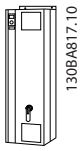
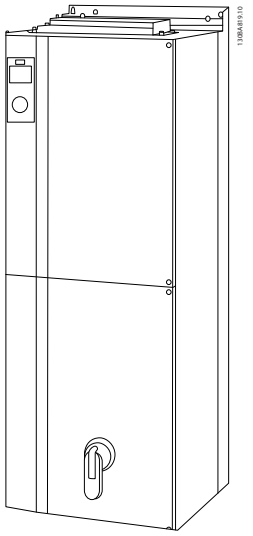
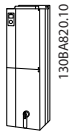
Frame size		D1	D2	D3	D4
					
Enclosure protection	IP	21/54	21/54	00	00
	NEMA	Type 1/Type 12	Type 1/Type 12	Chassis	Chassis
High overload rated power - 160% overload torque		90-110 kW at 400 V (380-500 V) 37-132 kW at 690 V (525-690 V)	132-200 kW at 400 V (380-500) 160-315 kW at 690 V (525-690 V)	90-110 kW at 400 V (380-500 V) 37-132 kW at 690 V (525-690 V)	132-200 kW at 400 V (380-500 V) 160-315 kW at 690 V (525-690 V)

Table 3.3 Rated Power, Enclosure Type D

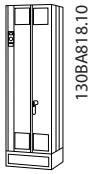
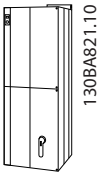
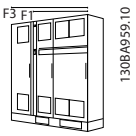
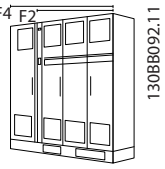
Frame size		E1	E2	F1/F3	F2/F4
					
Enclosure protection	IP	21/54	00	21/54	21/54
	NEMA	Type 1/Type 12	Chassis	Type 1/Type 12	Type 1/Type 12
High overload rated power - 160% overload torque		250-400 kW at 400 V (380-500 V) 355-560 kW at 690 V (525-690 V)	240-400 kW at 400 V (380-500 V) 355-560 kW at 690 V (525-690 V)	450-630 kW at 400 V (380-500 V) 630-800 kW at 690 V (525-690 V)	710-800 kW at 400 V (380-500 V) 900-1200 kW at 690 V (525-690 V)

Table 3.4 Rated Power, Enclosure Types E and F

NOTICE

The F enclsoures have 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 additional options cabinet left of the rectifier cabinet. The F3 is an F1 with an additional options cabinet. The F4 is an F2 with an additional options cabinet.

3.2 Mechanical Installation

Preparation of the mechanical installation of the frequency converter must be done carefully to ensure a proper result and to avoid additional work during installation. Start taking a close look at the mechanical drawings at the end of this instruction to become familiar with the space demands.

3.2.1 Tools Needed

To perform the mechanical installation the following tools are needed:

- Drill with 10 or 12 mm drill
- Tape measure
- Wrench with relevant metric sockets (7-17mm)
- 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
- A Torx T50 tool is needed to install the E1 in IP21 and IP54 enclosure types.

3.2.2 General Considerations

Wire access

Ensure that proper cable access is present including necessary bending allowance. As the IP00 enclosure is open to the bottom cables must be fixed to the back panel of the enclosure where the frequency converter is mounted, i.e. by using cable clamps.

⚠CAUTION

All cable lugs/shoes must mount 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 space in front of the unit must be considered to enable opening of the door of the panel.

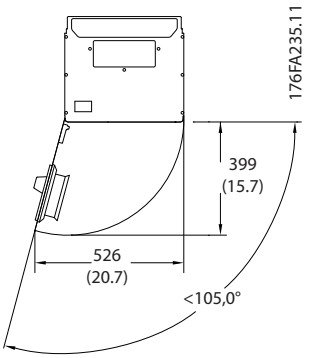


Illustration 3.9 Space in Front of IP21/IP54 Rated Enclosure Types D1 and D2

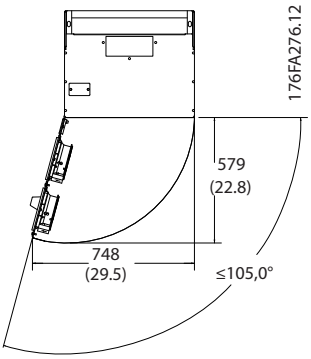


Illustration 3.10 Space in Front of IP21/IP54 Rated Enclosure Type E1

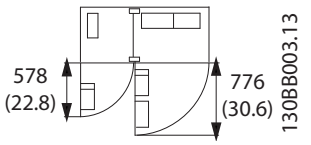


Illustration 3.11 Space in Front of IP21/IP54 Rated Enclosure Type F1

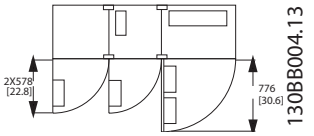


Illustration 3.12 Space in Front of IP21/IP54 Rated Enclosure Type F3

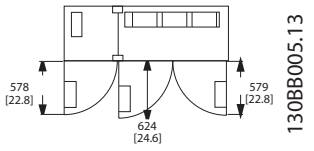


Illustration 3.13 Space in Front of IP21/IP54 Rated Enclosure Type F2

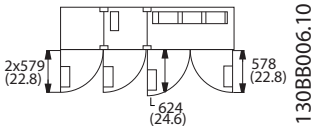


Illustration 3.14 Space in Front of IP21/IP54 Rated Enclosure Type F4

3

3.2.3 Terminal Locations - Enclosure Type D

Consider the following terminal positions when designing for cables access.

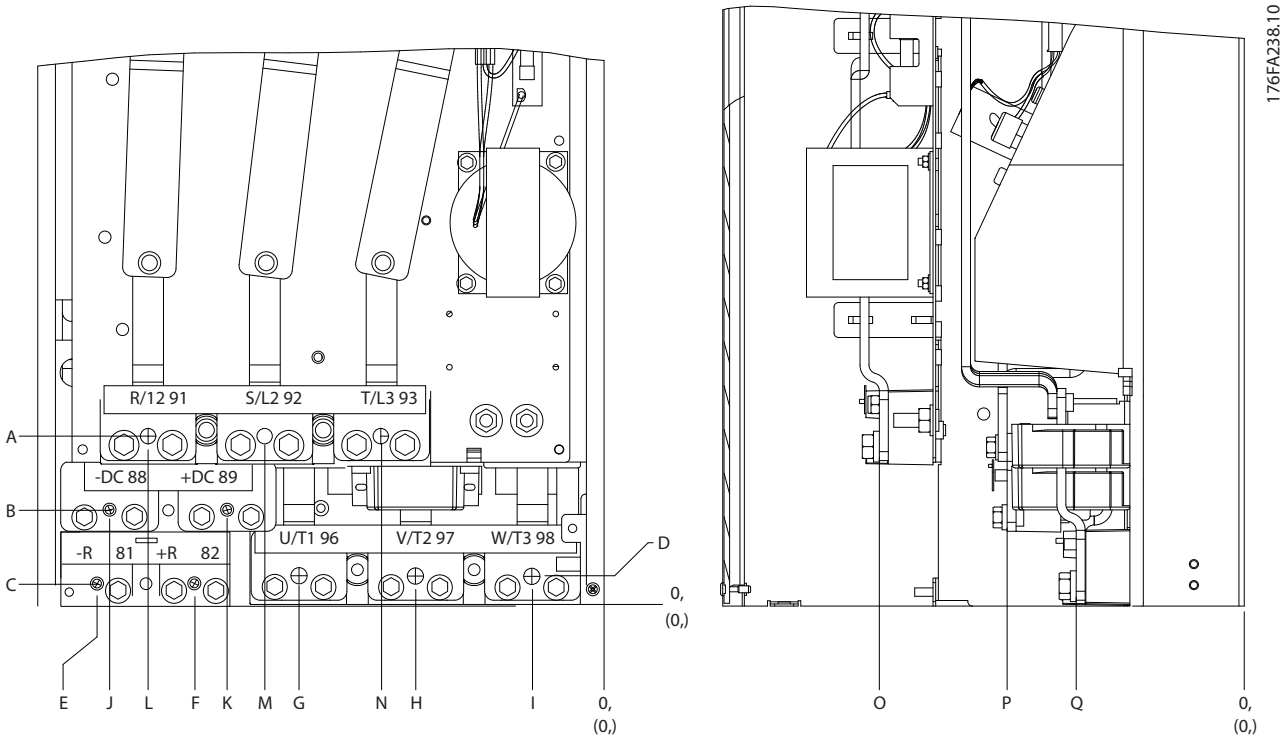


Illustration 3.15 Position of Power Connections, Enclosure Types D3 and D4

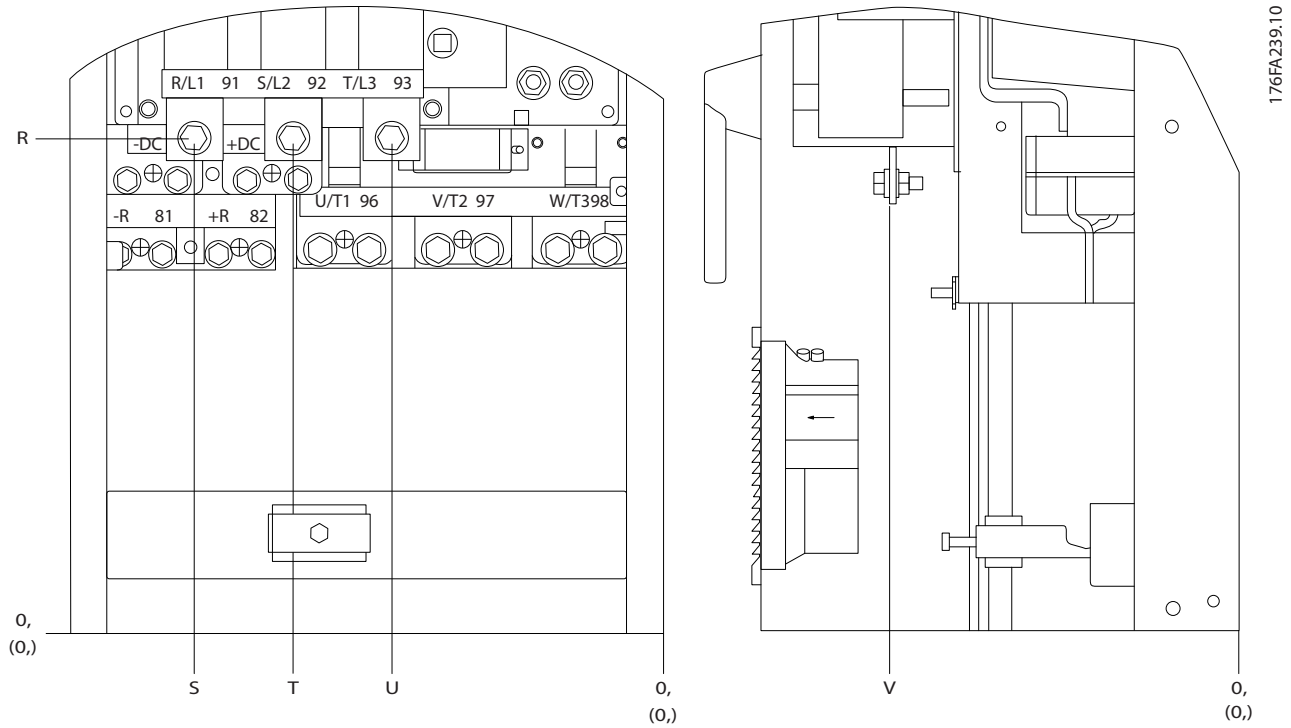


Illustration 3.16 Position of Power Connections with Disconnect Switch, Enclosure Types D1 and D2

Be aware that the power cables are heavy and hard to bend. Consider the optimum position of the frequency converter for ensuring easy installation of the cables.

3

NOTICE

All D enclosures are available with standard input terminals or disconnect switch. All terminal dimensions can be found in *Table 3.5*.

	IP21 (NEMA 1)/IP54 (NEMA 12)		IP00/Chassis	
	D1	D2	D3	D4
A	277 (10.9)	379 (14.9)	119 (4.7)	122 (4.8)
B	227 (8.9)	326 (12.8)	68 (2.7)	68 (2.7)
C	173 (6.8)	273 (10.8)	15 (0.6)	16 (0.6)
D	179 (7.0)	279 (11.0)	20.7 (0.8)	22 (0.8)
E	370 (14.6)	370 (14.6)	363 (14.3)	363 (14.3)
F	300 (11.8)	300 (11.8)	293 (11.5)	293 (11.5)
G	222 (8.7)	226 (8.9)	215 (8.4)	218 (8.6)
H	139 (5.4)	142 (5.6)	131 (5.2)	135 (5.3)
I	55 (2.2)	59 (2.3)	48 (1.9)	51 (2.0)
J	354 (13.9)	361 (14.2)	347 (13.6)	354 (13.9)
K	284 (11.2)	277 (10.9)	277 (10.9)	270 (10.6)
L	334 (13.1)	334 (13.1)	326 (12.8)	326 (12.8)
M	250 (9.8)	250 (9.8)	243 (9.6)	243 (9.6)
N	167 (6.6)	167 (6.6)	159 (6.3)	159 (6.3)
O	261 (10.3)	260 (10.3)	261 (10.3)	261 (10.3)
P	170 (6.7)	169 (6.7)	170 (6.7)	170 (6.7)
Q	120 (4.7)	120 (4.7)	120 (4.7)	120 (4.7)
R	256 (10.1)	350 (13.8)	98 (3.8)	93 (3.7)
S	308 (12.1)	332 (13.0)	301 (11.8)	324 (12.8)
T	252 (9.9)	262 (10.3)	245 (9.6)	255 (10.0)
U	196 (7.7)	192 (7.6)	189 (7.4)	185 (7.3)
V	260 (10.2)	273 (10.7)	260 (10.2)	273 (10.7)

Table 3.5 Cable Positions Dimensions in mm (inch)

3.2.4 Terminal Locations - E Enclosures

Terminal Locations - E1

Take the following position of the terminals into consideration when designing the cable access.

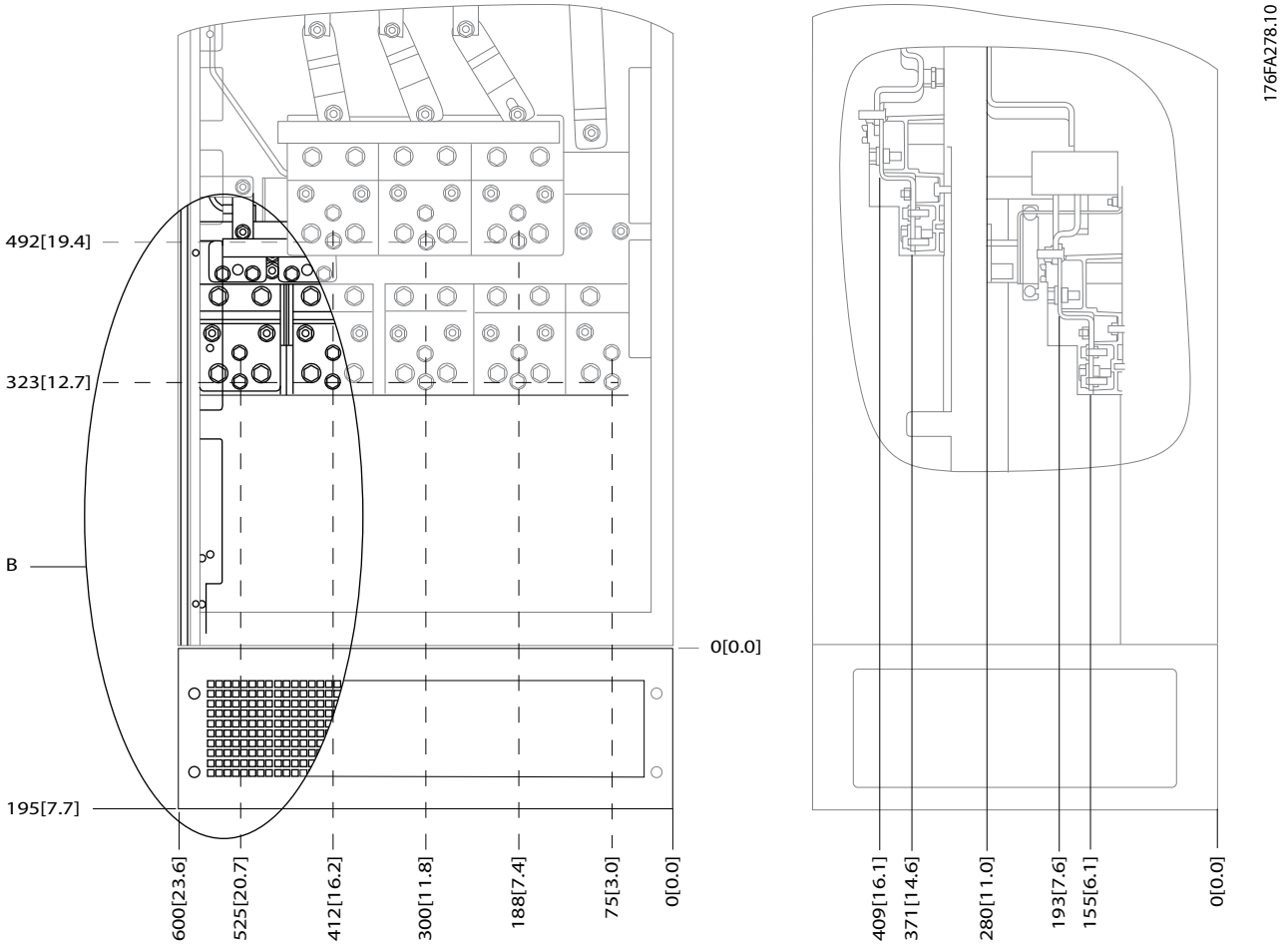


Illustration 3.17 IP21 (NEMA Type 1) and IP54 (NEMA Type 12) Enclosure Power Connection Positions

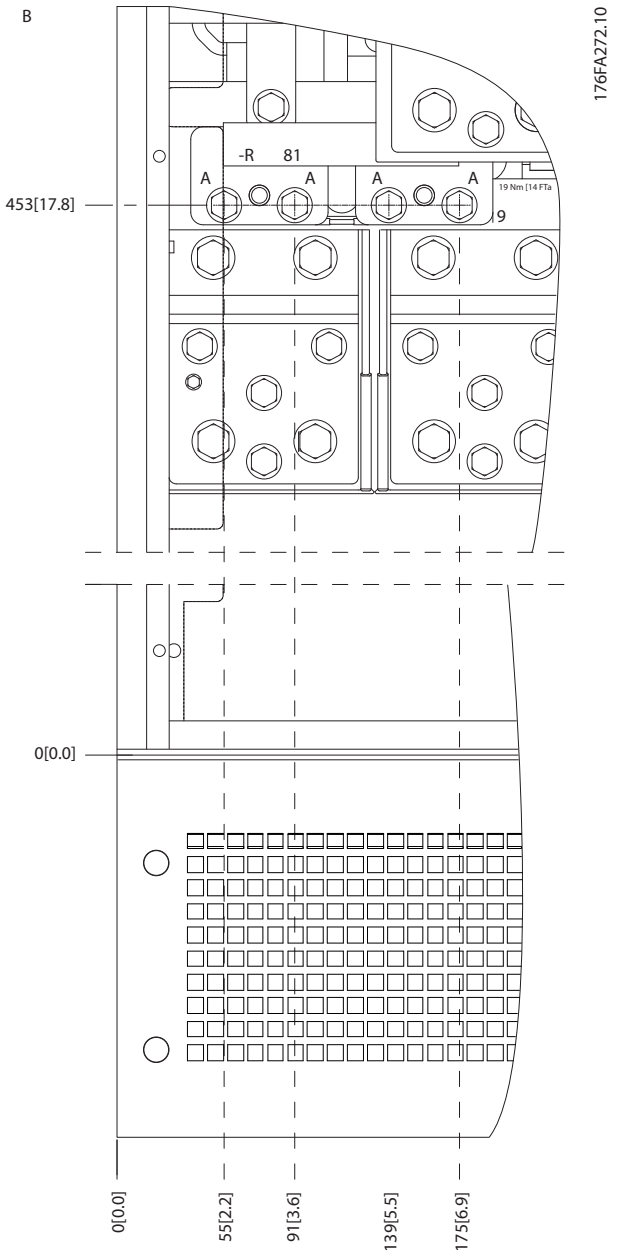


Illustration 3.18 IP21 (NEMA type 1) and IP54 (NEMA type 12) Enclosure Power Connection Positions (Detail B)

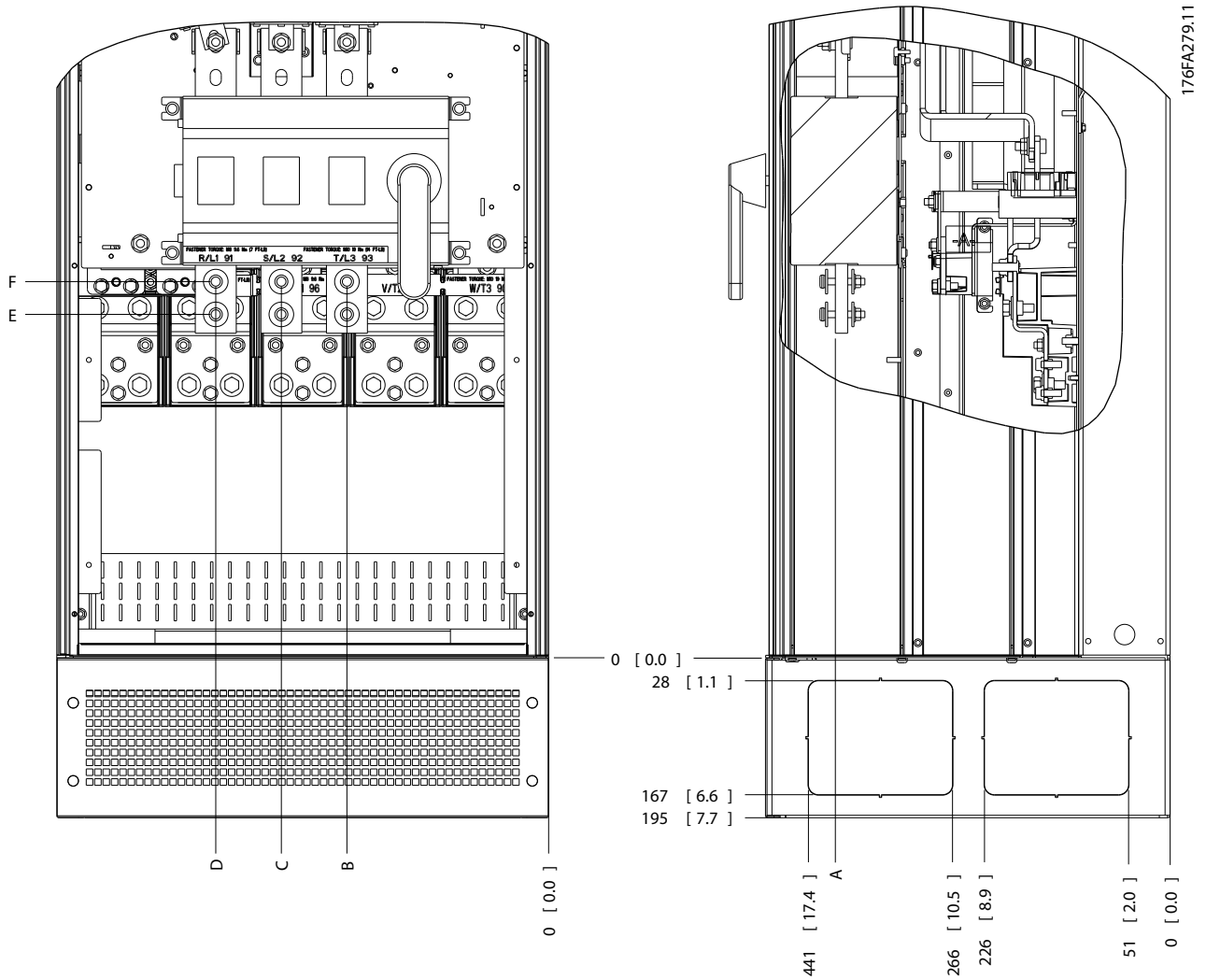


Illustration 3.19 IP21 (NEMA type 1) and IP54 (NEMA type 12) Enclosure Power Connection Position of Disconnect Switch

Enclosure types	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 3.6 Dimensions for Disconnect Terminal

3

Terminal locations - enclosure type E2

Take the following position of the terminals into consideration when designing the cable access.

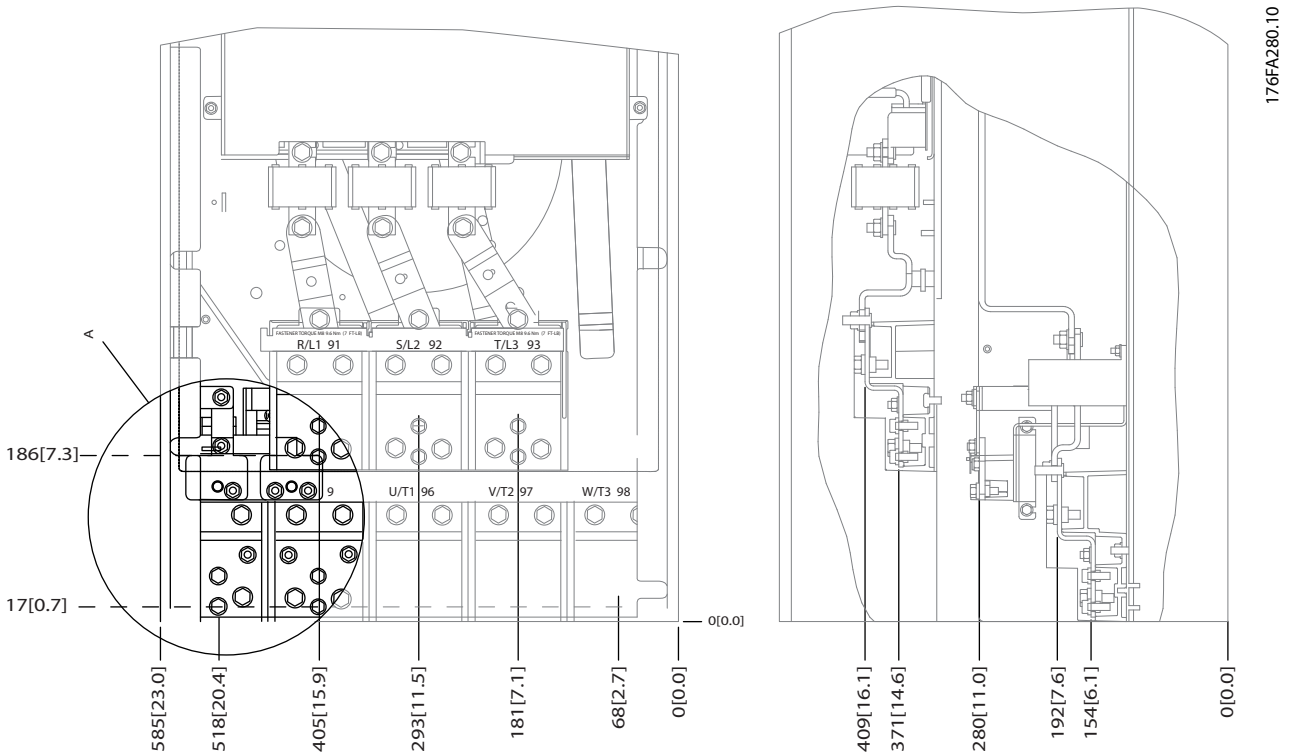


Illustration 3.20 IP00 Enclosure Power Connection Positions

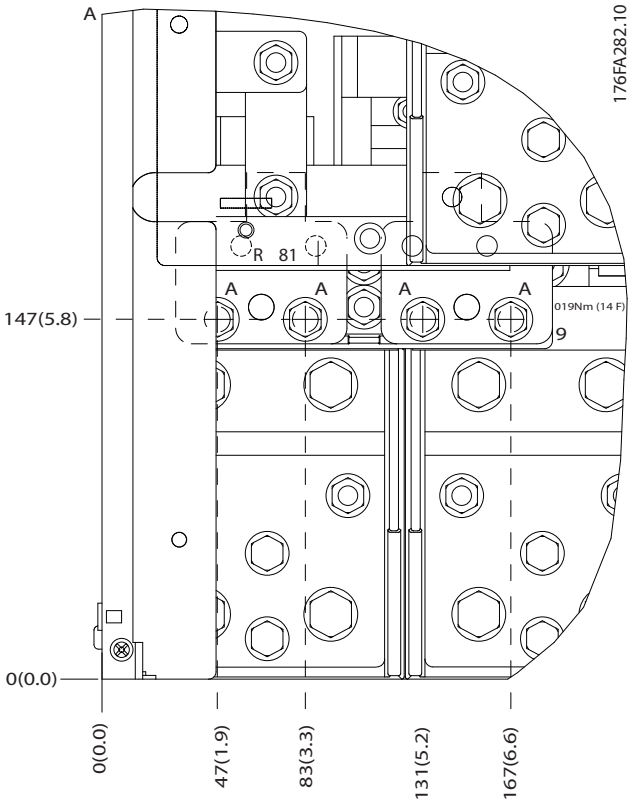


Illustration 3.21 IP00 Enclosure Power Connection Positions

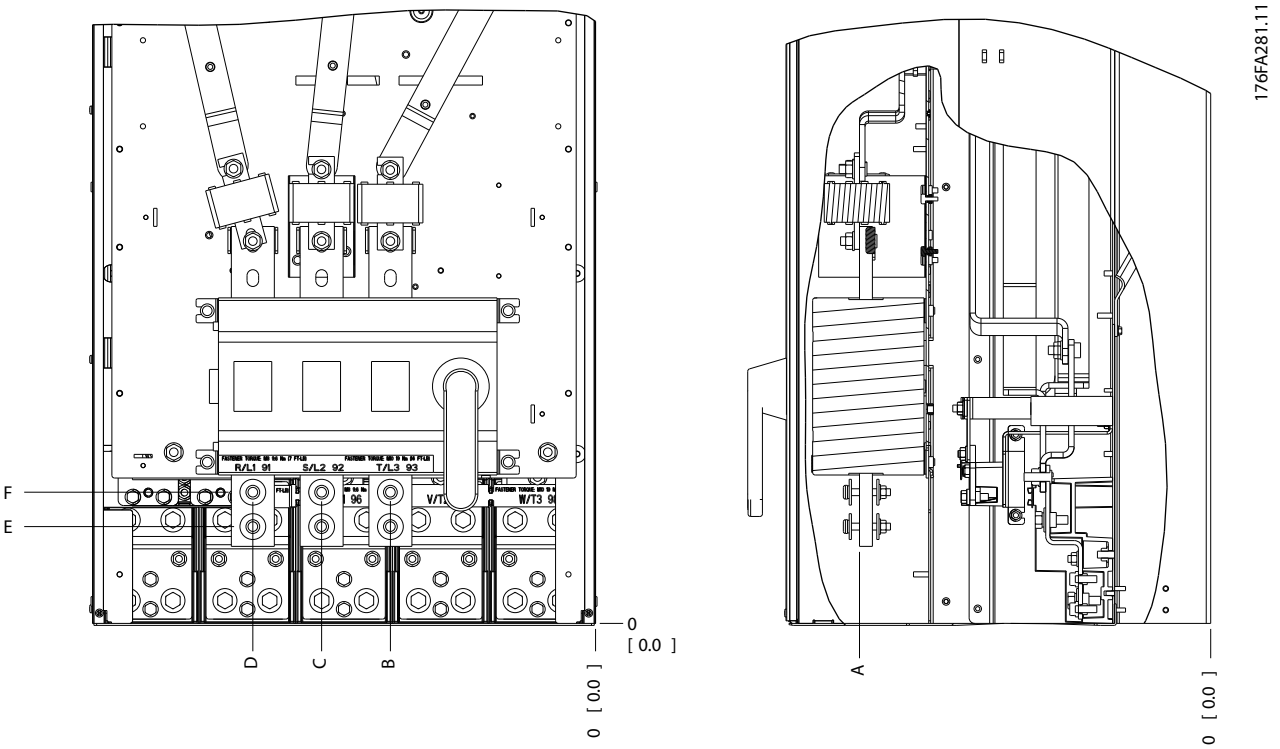


Illustration 3.22 IP00 Enclosure Power Connections Positions of Disconnect Switch

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. Earth 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.

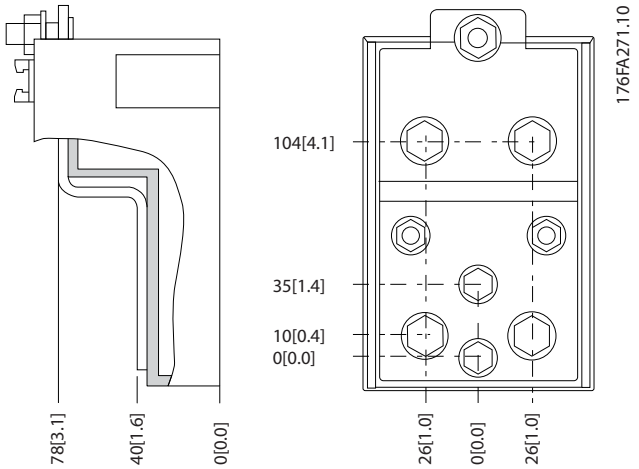


Illustration 3.23 Terminal in Details

3

NOTICE

Power connections can be made to positions A or B

Enclosure type	Unit type	Dimensions [mm]/(inch)					
	IPOO/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 3.7 Dimensions for Disconnect Terminal

3.2.5 Terminal Locations - Frame size F

NOTICE

The F frames have 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 additional options cabinet left of the rectifier cabinet. The F3 is an F1 with an additional options cabinet. The F4 is an F2 with an additional options cabinet.

Terminal locations - Frame size F1 and F3

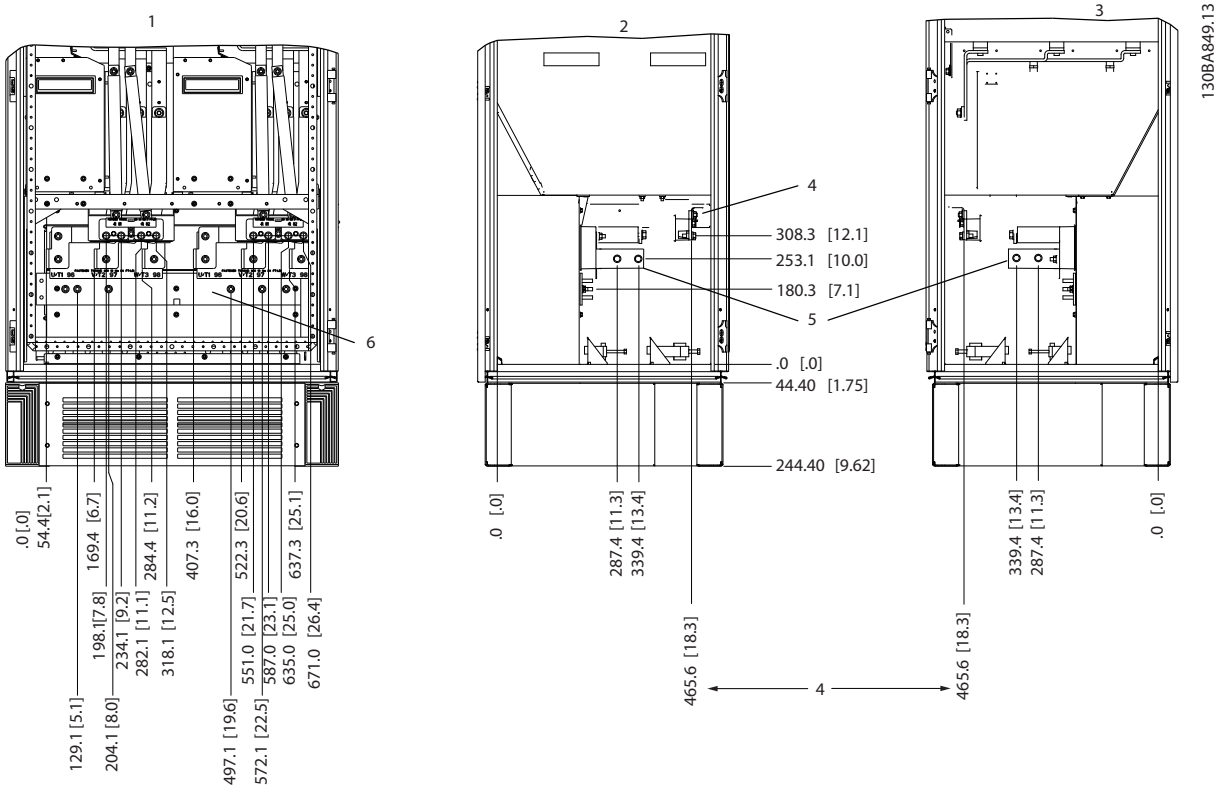


Illustration 3.24 Terminal locations - Inverter Cabinet - F1 and F3 (front, left and right side view). The gland plate is 42 mm below .0 level.

1) Earth ground bar

2) Motor terminals

3) Brake terminals

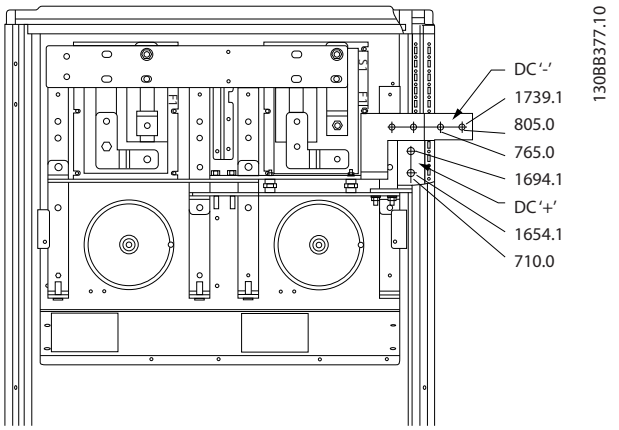


Illustration 3.25 Terminal Locations - Regen Terminals - F1 and F3

Terminal locations - Frame size F2 and F4

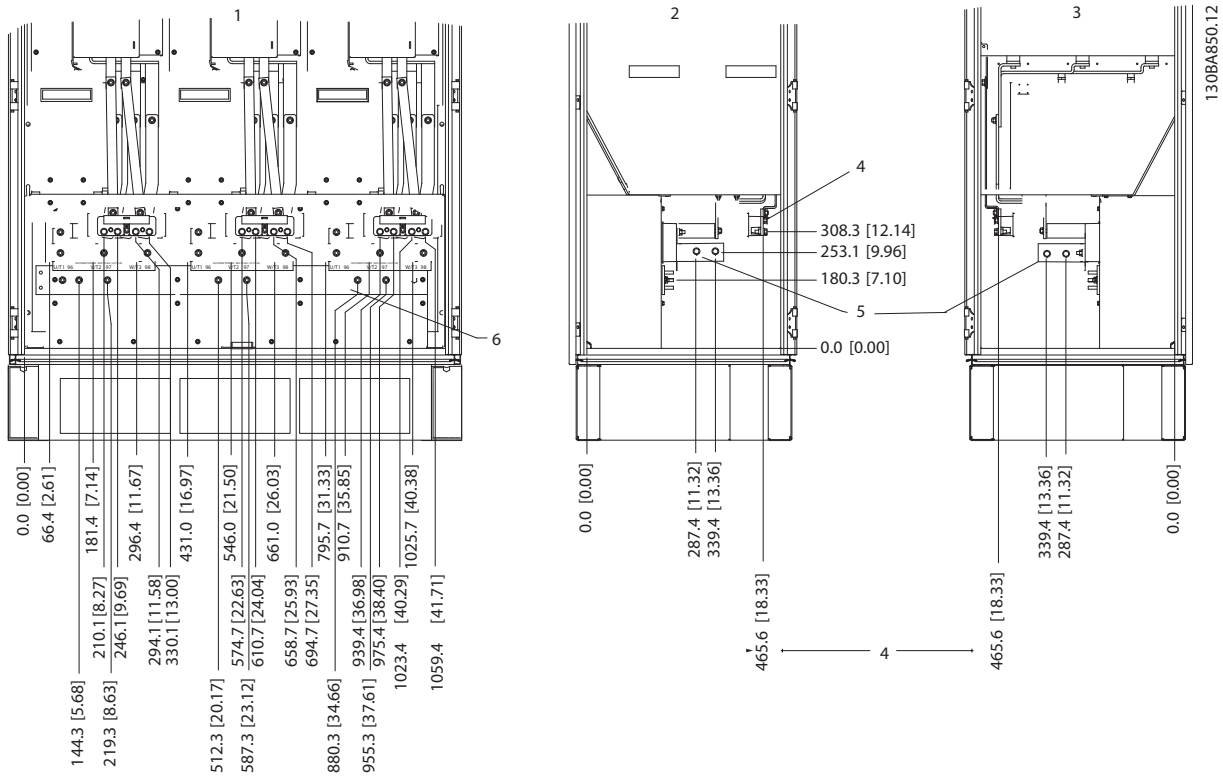


Illustration 3.26 Terminal locations - Inverter Cabinet - F2 and F4 (front, left and right side view). The gland plate is 42 mm below .0 level.

1) Earth ground bar

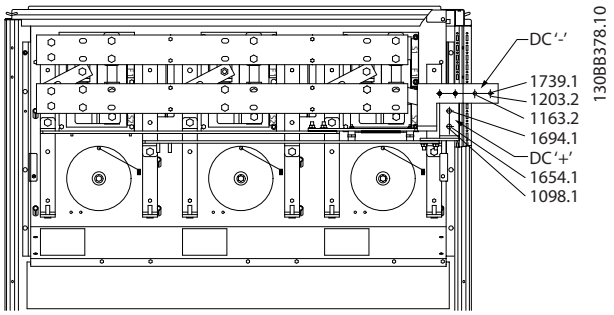
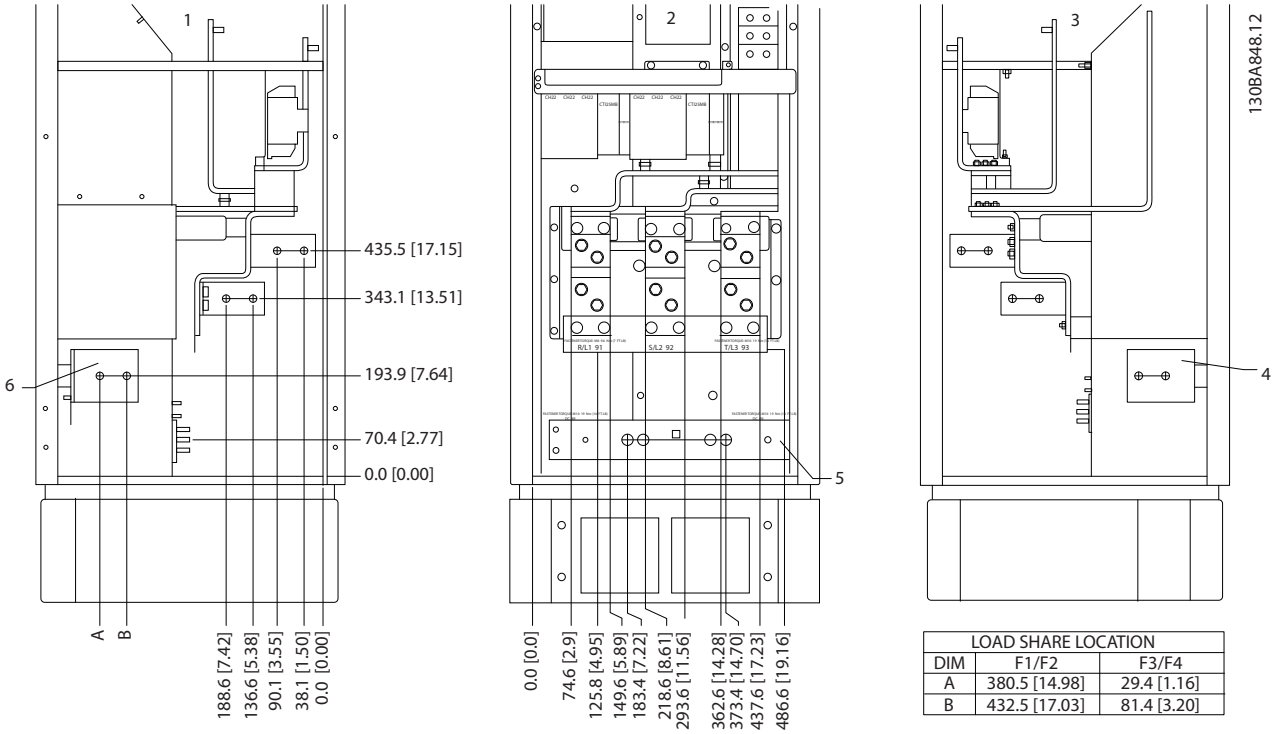


Illustration 3.27 Terminal Locations - Regen Terminals - F2 and F4

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



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]

Illustration 3.28 Terminal locations - Rectifier (Left side, front and right side view). The gland plate is 42 mm below .0 level.

1) Loadshare Terminal (-)

2) Earth ground bar

3) Loadshare Terminal (+)

Terminal locations - Options Cabinet (F3 and F4)

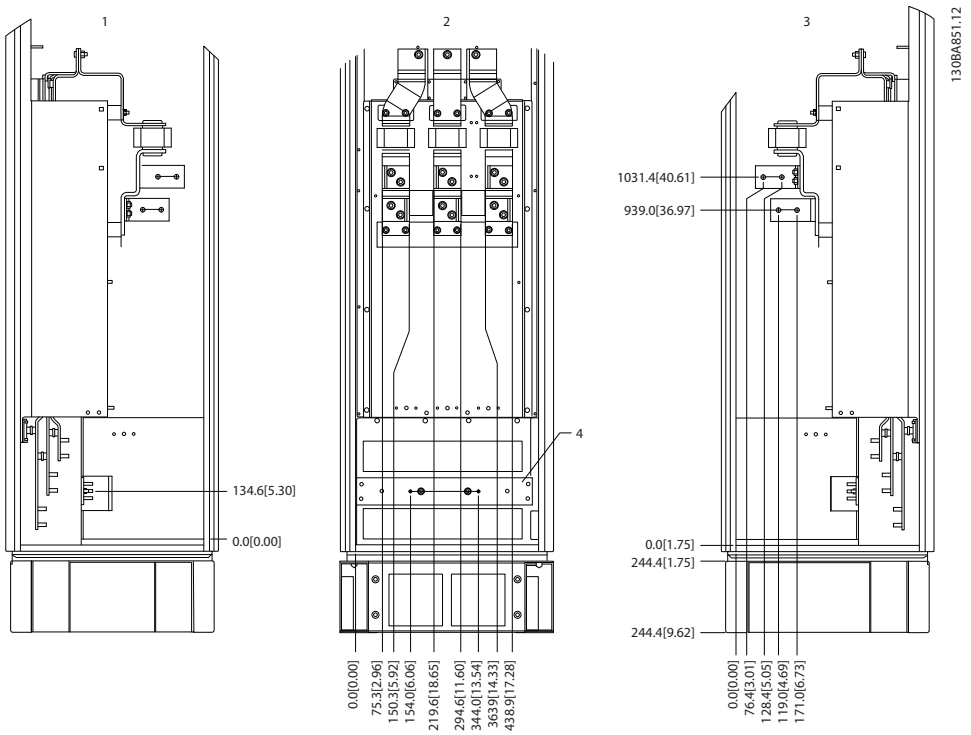


Illustration 3.29 Terminal locations - Options Cabinet (Left side, front and right side view). The gland plate is 42 mm below .0 level.
1) Earth ground bar

Terminal locations - Options Cabinet with circuit breaker/ molded case switch (F3 and F4)

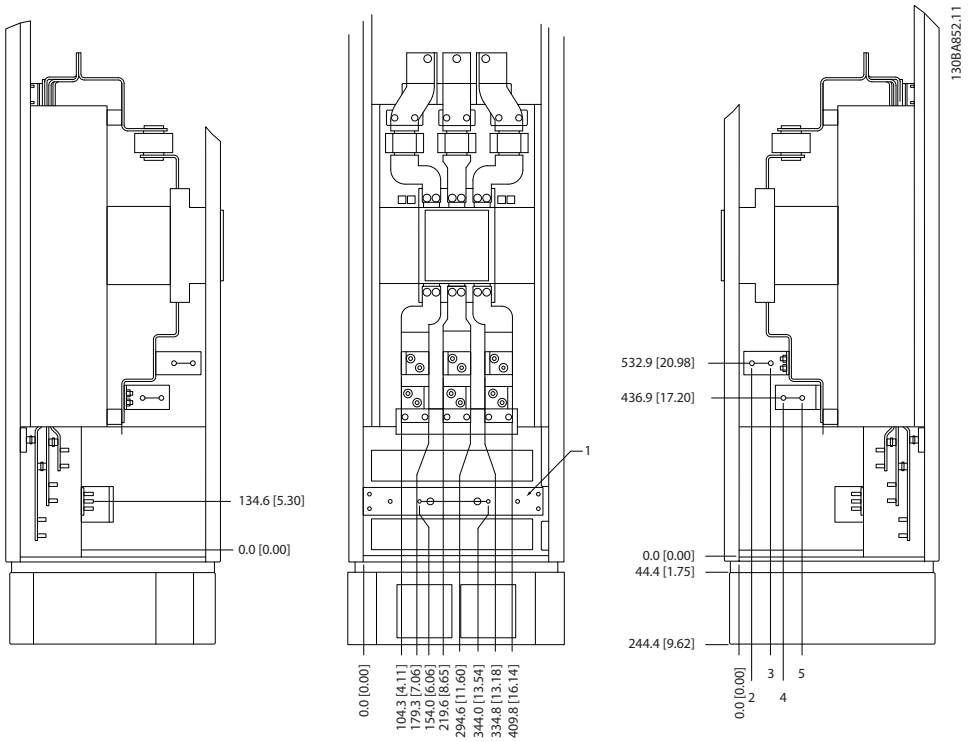


Illustration 3.30 Terminal locations - Options Cabinet with circuit breaker/ molded case switch (Left side, front and right side view). The gland plate is 42 mm below .0 level.
1) Earth ground bar

Power size	2	3	4	5
450 kW (480 V), 630-710 kW (690 V)	34.9	86.9	122.2	174.2
500-800 kW (480 V), 800-1000 kW (690 V)	46.3	98.3	119.0	171.0

Table 3.8 Dimension for Terminal

3

3.2.6 Cooling and Airflow

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

Duct cooling
A dedicated option has been developed to optimize installation of IP00/chassis frequency converters in Rittal TS8 enclosures utilizing the fan of the frequency converter for forced air cooling of the backchannel. The air out the top of the enclosure could but ducted outside a facility so the heat loses from the backchannel are not dissipated within the control room reducing air-conditioning requirements of the facility.
Please see *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. This offers a solution where the backchannel could take air from outside the facility and return the heat loses outside the facility thus reducing air-conditioning requirements.

NOTICE

A door fan(s) 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. The total required air flow must be calculated so that the appropriate fans can be selected. Some enclosure manufacturers offer software for performing the calculations (i.e. Rittal Therm software). 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 D3 and D4 frequency converters is 391 m^3/h (230 cfm). The minimum airflow required at an ambient temperature of 45 °C for the E2 frequency converter is 782 m^3/h (460 cfm).

Airflow
The necessary airflow over the heat sink must be secured. The flow rate is shown below.

Enclosure protection	Frame size	Door fan(s)/Top fan airflow	Heat sink fan(s)
IP21/NEMA 1 IP54/NEMA 12	D1 and D2	170 m^3/h (100 cfm)	765 m^3/h (450 cfm)
	E1 P250T5, P355T7, P400T7	340 m^3/h (200 cfm)	1105 m^3/h (650 cfm)
	E1P315-P400T5, P500-P560T7	340 m^3/h (200 cfm)	1445 m^3/h (850 cfm)
IP21/NEMA 1	F1, F2, F3 and F4	700 m^3/h (412 cfm)*	985 m^3/h (580 cfm)*
IP54/NEMA 12	F1, F2, F3 and F4	525 m^3/h (309 cfm)*	985 m^3/h (580 cfm)*
IP00/Chassis	D3 and D4	255 m^3/h (150 cfm)	765 m^3/h (450 cfm)
	E2 P250T5, P355T7, P400T7	255 m^3/h (150 cfm)	1105 m^3/h (650 cfm)
	E2 P315-P400T5, P500-P560T7	255 m^3/h (150 cfm)	1445 m^3/h (850 cfm)
* Airflow per fan. Frame size F contain multiple fans.			

Table 3.9 Heat sink Air Flow

NOTICE

The fan runs for the following reasons:

- **AMA**
- **DC Hold**
- **Pre-Mag**
- **DC Brake**
- **60% of nominal current is exceeded**
- **Specific heatsink temperature exceeded (power size dependent).**
- **Specific Power Card ambient temperature exceeded (power size dependent)**
- **Specific Control Card ambient temperature exceeded**

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

External ducts

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

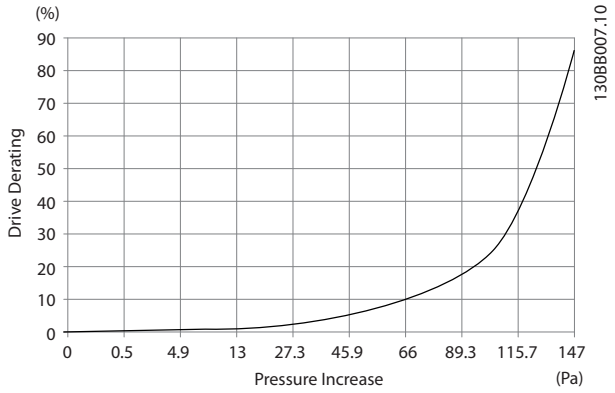


Illustration 3.31 D frame Derating vs. Pressure Change
Drive air flow: 450 cfm (765 m³/h)

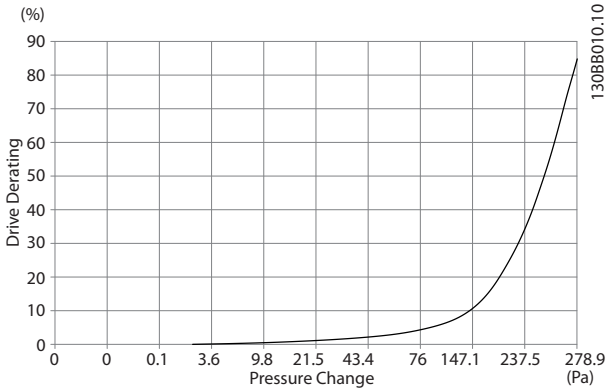


Illustration 3.32 E frame Derating vs. Pressure Change (Small Fan), P250T5 and P355T7-P400T7
Drive air flow: 650 cfm (1105 m³/h)

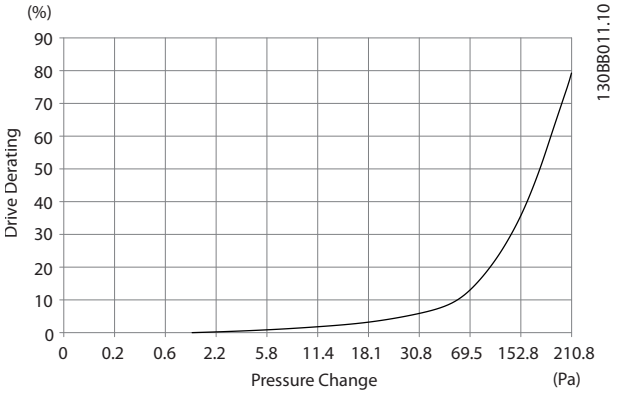


Illustration 3.33 E frame Derating vs. Pressure Change (Large Fan), P315T5-P400T5 and P500T7-P560T7
Drive air flow: 850 cfm (1445 m³/h)

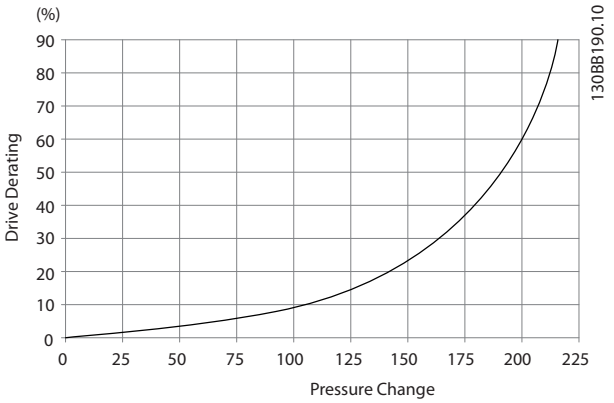


Illustration 3.34 F1, F2, F3, F4 frame Derating vs. Pressure Change
Drive air flow: 580 cfm (985 m³/h)

3

3.2.7 Installation on the Wall - IP21 (NEMA 1) and IP54 (NEMA 12) Units

This only applies to enclosure types D1 and D2. It must be considered where to install the unit.

Take the relevant points into consideration before selecting the final installation site:

- Free space for cooling
- Access to open the door
- Cable entry from the bottom

Mark the mounting holes carefully using the mounting template on the wall and drill the holes as indicated. Ensure proper distance to the floor and the ceiling for cooling. A minimum of 225 mm (8.9 inch) below the frequency converter is needed. Mount the bolts at the bottom and lift the frequency converter up on the bolts. Tilt the frequency converter against the wall and mount the upper bolts. Tighten all 4 bolts to secure the frequency converter against the wall.

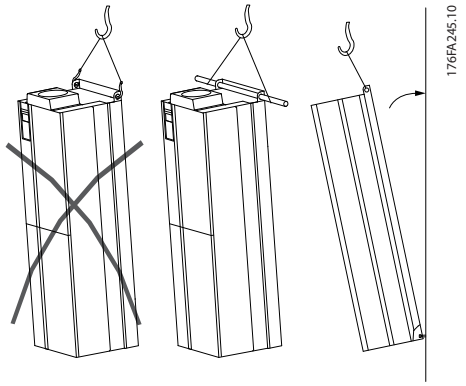


Illustration 3.35 Lifting Method for Mounting Frequency Converter on Wall

3.2.8 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 on the drawing.

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

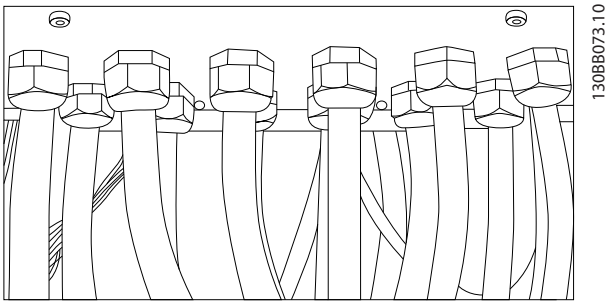


Illustration 3.36 Example of Proper Installation of Gland Plate.

Cable entries viewed from the bottom of the frequency converter - 1) Mains side 2) Motor side

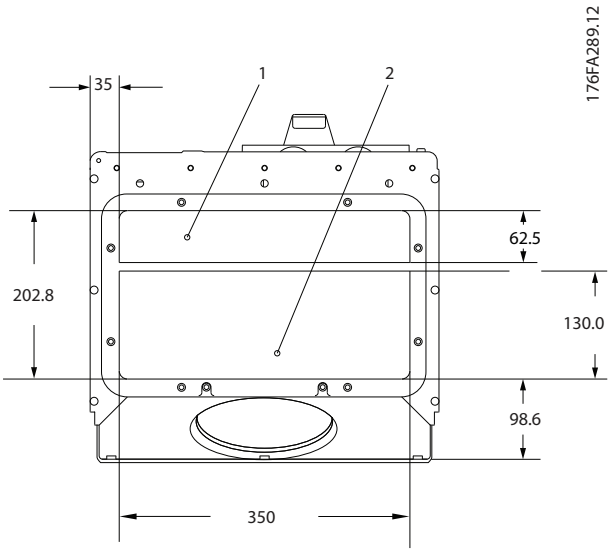


Illustration 3.37 Enclosure Types D1 + D2

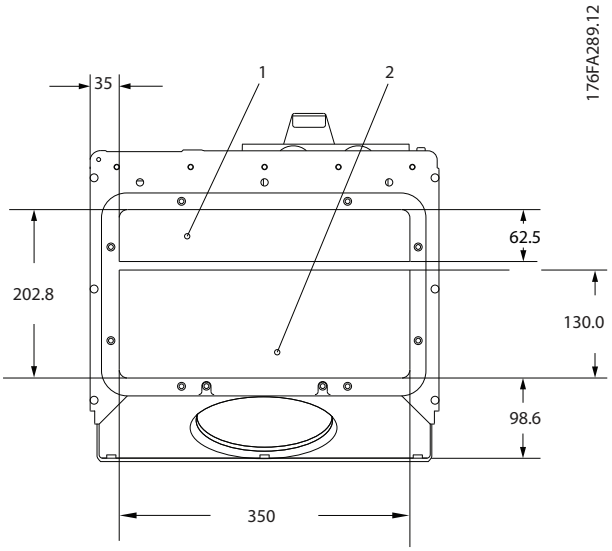


Illustration 3.38 Enclosure Type E1

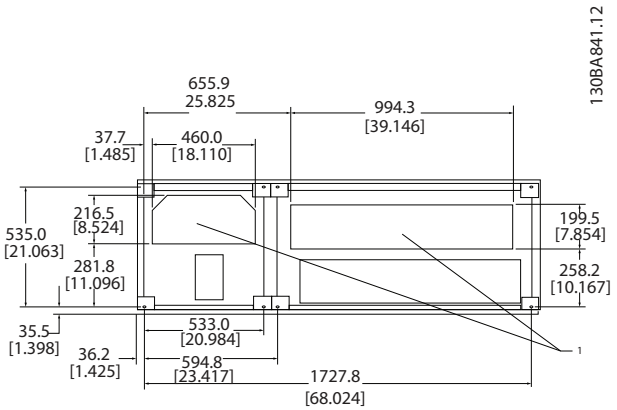


Illustration 3.40 Enclosure Type F2

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

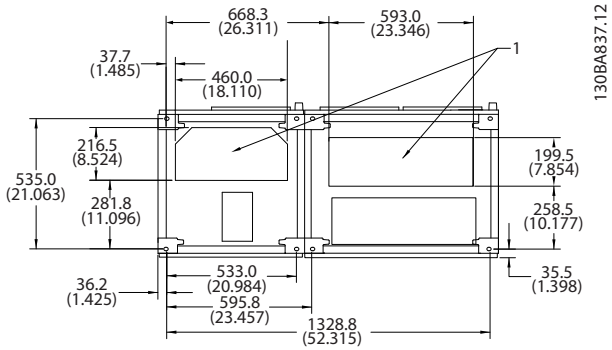


Illustration 3.39 Enclosure Type F1

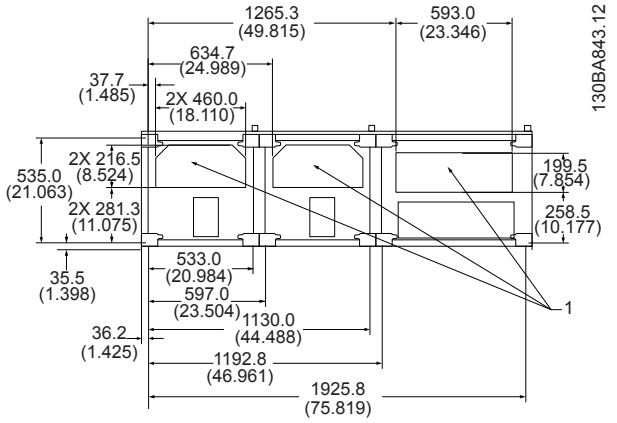


Illustration 3.41 Enclosure Type F3

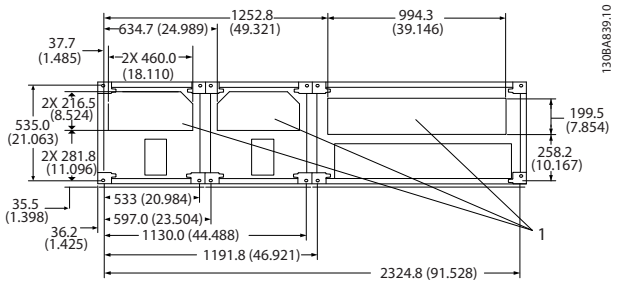


Illustration 3.42 Enclosure Type F4

3

3.2.9 IP21 Drip Shield Installation (Enclosure Types D1 and D2)

To comply with the IP21 rating, a separate drip shield is to be installed as explained below:

- Remove the 2 front screws
- Insert the drip shield and replace screws
- Tighten the screws to 5.6 Nm (50 in-lbs)

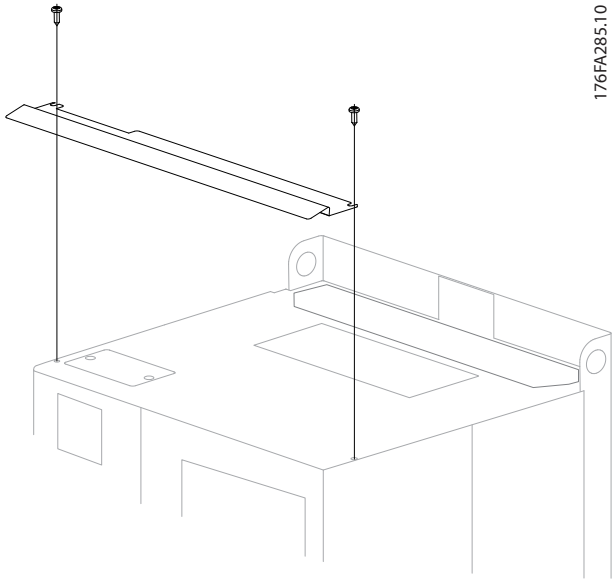


Illustration 3.43 Drip Shield Installation.

3.3 Field Installation of Options

3.3.1 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.

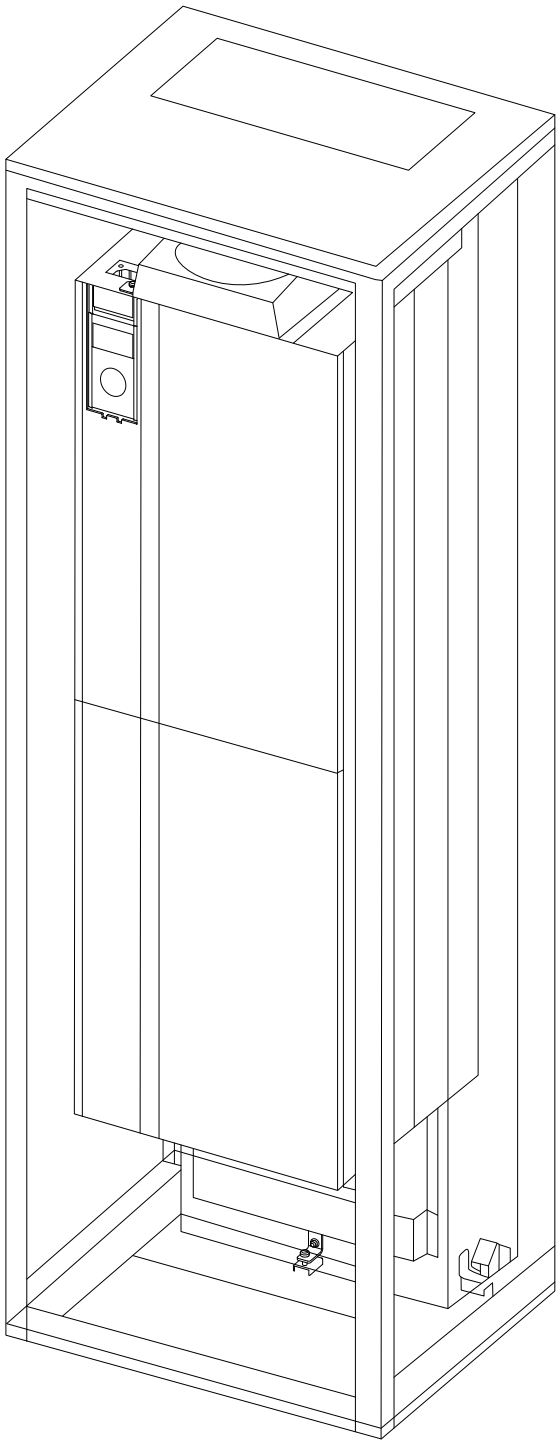


Illustration 3.44 Installation of IP00 in Rittal TS8 Enclosure.

The minimum enclosure dimension is:

- D3 and D4 enclosures: Depth 500 mm and width 600 mm.
- 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 one enclosure, it is recommended that each frequency converter is mounted on its own back panel and

supported 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 3.10* are suitable for use only with IP00/Chassis frequency converters in Rittal TS8 IP 20 and UL and NEMA 1 and IP 54 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

A doorfan(s) 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. The total required airflow must be calculated so that the appropriate fans can be selected. Some enclosure manufacturers offer software for performing the calculations (i.e. Rittal Therm software). 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 D3 and D4 frequency converters is 391 m^3/h (230 cfm). The minimum airflow required at an ambient temperature of 45 °C for the E2 frequency converter is 782 m^3/h (460 cfm).

Rittal TS-8 Enclosure	Enclosure type D3 Kit Part No.	Enclosure type D4 Kit Part No.	Enclosure type E2 Part No.
1800 mm	176F1824	176F1823	Not possible
2000 mm	176F1826	176F1825	176F1850
2200 mm			176F0299

Table 3.10 Ordering Information

NOTICE

See the instruction *Duct Work Cooling Kit Instruction for Frames D3, D4 and E2* for further information.

External ducts
If additional duct work is added externally to the Rittal cabinet the pressure drop in the ducting must be calculated. See *chapter 3.2.6 Cooling and Airflow* for further information.

3.3.2 Installation of Top-only Duct Cooling Kit

This description is for the installation of the top section only of the back-channel cooling kits available for frame sizes D3, D4 and E2. In addition to the enclosure a 200 mm vented pedestal is required.
The minimum enclosure depth is 500 mm (600 mm for E2 frame) and the minimum enclosure width is 600 mm (800 mm for E2 frame). The maximum depth and width are as required by the installation. When using multiple frequency converters in one enclosure mount each frequency converter on its own back panel and support along the mid-section of the panel. The back-channel cooling kits are very similar in construction for all frames. The D3 and D443 and 44 kits do not support "in frame" mounting of the frequency converters. The E2 kit is mounted "in frame" for additional support of the frequency converter.
Using these kits as described removes 85% of the losses via the back channel using the frequency converter's main heat sink fan. The remaining 15% must be removed via the door of the enclosure.

NOTICE

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

Ordering information
Frame size D3 and D4: 176F1775
Frame size E2: 176F1776

3.3.3 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 IP00 frequency converterframes D3, D4 and E2. 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, additional back pressure reduces the cooling of the frequency converter. The frequency converter must be derated to accommodate the reduced cooling. First, the pressure drop must be calculated, then refer to the derating tables located earlier in this section.
2. A doorfan(s) is required on the enclosure to remove the heat losses not contained in the backchannel of the frequency converter and any

3

additional losses generated from other components installed inside the enclosure. The total required airflow must be calculated so that the appropriate fans can be selected. Some enclosure manufacturers offer software for performing the calculations (i.e. Rittal Therm software).
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 D3 and D4 frame frequency converter is 391 m^3/h (230 cfm). The minimum airflow required at an ambient temperature of 45 °C for the E2 frame frequency converter is 782 m^3/h (460 cfm).

NOTICE

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

Ordering information
Frame size D3: 176F1781
Frame size D4: 176F1782
Frame size E2: 176F1783

3.3.4 Installation of Top and Bottom Covers

Top and bottom covers can be installed on frame sizes D3, D4 and E2. These kits are designed to be used to direct the back-channel airflow in and out the back of the frequency converter as opposed to in the bottom and out 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, additional back pressure reduces the cooling of the frequency converter. The frequency converter must be derated to accommodate the reduced cooling. First, the pressure drop must be calculated, then refer to the derating tables located earlier in this section.
2. A doorfan(s) 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. The total required airflow must be calculated so that the appropriate fans can be selected. Some enclosure manufacturers offer software for performing the calculations (i.e. Rittal Therm software).
   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 D3 and D4 frame frequency converters is 391 m^3/h (230 cfm). The minimum airflow required at an ambient temperature of 45 °C for the E2 frame frequency converter is 782 m^3/h (460 cfm).

NOTICE

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

Ordering information
Frame size D3 and D4: 176F1862
Frame size E2: 176F1861

3.3.5 Outside Installation/NEMA 3R Kit for Rittal Enclosures

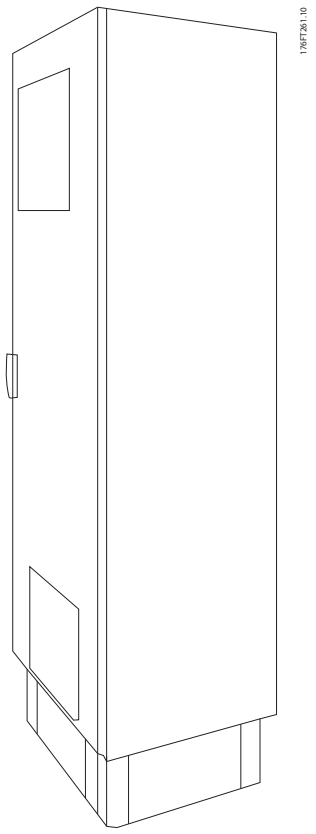


Illustration 3.45

This section is for the installation of NEMA 3R kits available for the frequency converter enclosure types D3, D4 and E2. These kits are designed and tested to be used with IP00/ Chassis versions of these enclosure types 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 type E2) and the kit is designed for a 600 mm (800 mm for enclosure type E2) wide enclosure. Other enclosure widths are possible, however additional Rittal hardware is required. The maximum depth and width are as required by the installation.

NOTICE

The current rating of frequency converters in enclosure types D3 and D4 are de-rated by 3%, when adding the NEMA 3R kit. Frequency converters in enclosure type E2 require no derating.

NOTICE

A doorfan(s) 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. The total required airflow must be calculated so that the appropriate fans can be selected. Some enclosure manufacturers offer software for performing the calculations (i.e. Rittal Therm software). 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 D3 and D4 frequency converters is 391 m^3/h (230 cfm). 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 type D3: 176F4600
Enclosure type D4: 176F4601
Enclosure type E2: 176F1852

NOTICE

See the instructions *Installation of NEMA 3R Kit for IP00 Frames D3, D4 & E2* for further information.

3.3.6 Outside Installation/NEMA 3R Kit of Industrial Enclosures

The kits are available for the frame sizes D3, D4 and 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.

Note: The current rating of D3 and D4 frame frequency converters are de-rated by 3% when installed in a NEMA-3R enclosure. E2 frame frequency converters require no de-rating when installed in a NEMA-3R enclosure.

NOTICE

See the instruction for *Outside Installation/NEMA 3R kit of industrial enclosures, 175R1068,* for further information.

Ordering information
Frame size D3: 176F0296
Frame size D4: 176F0295
Frame size E2: 176F0298

3.3.7 Installation of IP00 to IP20 Kits

The kits can be installed on frame sizes D3, D4, and E2 (IP00).

⚠CAUTION

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

Ordering information
Frame size D3/D4: 176F1779
Frame size E2: 176FXXXX

3.3.8 Installation of IP00s D3, D4, & E2 Cable Clamp Bracket

The motor cable clamp brackets can be installed on frame sizes D3 and D4 (IP00).

NOTICE

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

Ordering information
Frame size D3: 176F1774
Frame size D4: 176F1746
Frame size E2: 176F1745

3.3.9 Installation on Pedestal

This section describes the installation of a pedestal unit available for the frequency converters enclosure types D1 and D2. This is a 200 mm high pedestal that allows these enclosure types to be floor mounted. The front of the pedestal has openings for input air to the power components.

The frequency converter gland plate must be installed to provide adequate cooling air to the control components of

the frequency converter via the door fan and to maintain the IP21/NEMA 1 or IP54/NEMA 12 degrees of enclosure protections.

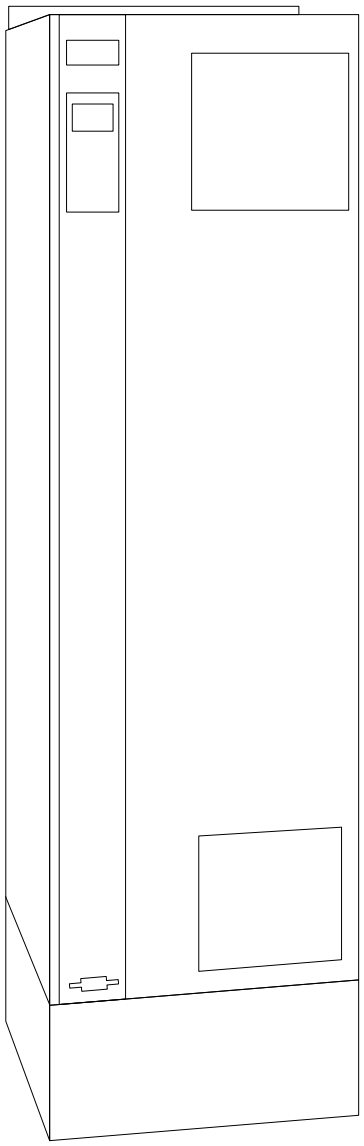


Illustration 3.46 Frequency Converter on Pedestal

There is one pedestal that fits both enclosure types D1 and D2. Its ordering number is 176F1827. The pedestal is standard for enclosure type E1.

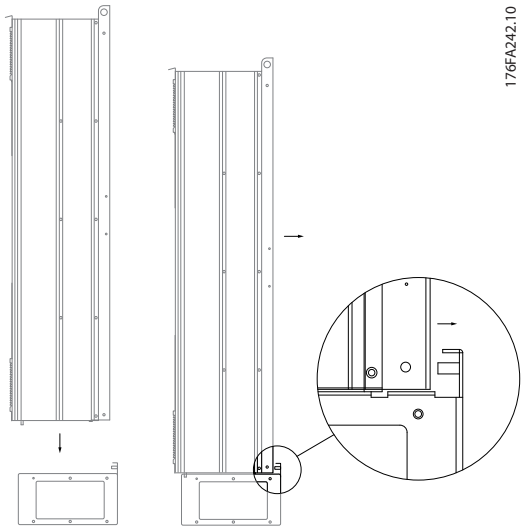


Illustration 3.47 Mounting of Frequency Converter to Pedestal

NOTICE

See the *Pedestal Kit Instruction Manual*, for further information.

3.3.10 Installation of Mains Shield for Frequency Converters

This section is for the installation of a mains shield for the frequency converter series with enclosure types D1, D2 and E1. It is not possible to install in the IP00/Chassis versions as these have included as standard a metal cover. These shields satisfy VBG-4 requirements.

Ordering numbers:
Enclosure types D1 and D2: 176F0799
Enclosure type E1: 176F1851

NOTICE

For further information, see the Instruction Sheet, *175R5923*

3.3.11 Installation of Input Plate Options

This section is for the field installation of input option kits available for frequency converters in all enclosure types D and E.
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

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

	380-480 V 380-500 V	Fuses	Disconnect Fuses	RFI	RFI Fuses	RFI Disconnect Fuses
D1	All D1 power sizes	176F8442	176F8450	176F8444	176F8448	176F8446
D2	All D2 power sizes	176F8443	176F8441	176F8445	176F8449	176F8447
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 3.11 Fuses

	525 - 690 V	Fuses	Disconnect Fuses	RFI	RFI Fuses	RFI Disconnect Fuses
D1	FC 102/ FC 202: 45-90 kW FC 302: 37-75 kW	175L8829	175L8828	175L8777	NA	NA
	FC 102/ FC 202: 110-160 kW FC 302: 90-132 kW	175L8442	175L8445	175L8777	NA	NA
D2	All D2power sizes	175L8827	175L8826	175L8825	NA	NA
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 3.12

NOTICE

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

3.3.12 Installation of D or E Loadshare Option

The loadshare option can be installed on frame sizes D1, D2, D3, D4, E1 and E2.

NOTICE

See the *Loadshare Terminal Kit Instructions, 175R5637 (D frames) or 177R1114 (E frames),* for further information.

Ordering information
Frame size D1/D3: 176F8456
Frame size D2/D4: 176F8455
Frame size E1/E2: 176F1843

3.4 F Enclosure Panel Options

3.4.1 Enclsoure Type F Options

Space Heaters and Thermostat
Mounted on the cabinet interior of enclosure type F frequency converters, space heaters controlled via automatic thermostat help control humidity inside the enclosure, extending 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 type F frequency converters increase visibility during servicing and maintenance. The housing the light includes a power outlet for temporarily powering tools or other devices, available in two voltages:

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

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Transformer Tap Setup
If the cabinet light & outlet and/or the space heaters & thermostat are installed Transformer T1 requires it taps to be set to the proper input voltage. A 380-480/500 V frequency converter is set initially to the 525 V tap and a 525-690 V frequency converter is set to the 690 V tap to insure no overvoltage of secondary equipment occurs if the tap is not changed before power is applied. See *Table 3.13* to set the proper tap at terminal T1 located in the rectifier cabinet. For location in the frequency converter, see *Illustration 3.48*.

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 3.13

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

RCD (Residual Current Device)
Uses the core balance method to monitor ground fault currents in grounded and high-resistance grounded systems (TN and TT systems in IEC terminology). There is a pre-warning (50% of main alarm set-point) and a main alarm set-point. Associated with each set-point is an SPDT alarm relay for external use. Requires an external “window-type” current transformer (supplied and installed by 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 set-point
- Fault memory
- [TEST/RESET]

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 set-point for the insulation level. Associated with each set-point is an SPDT alarm relay for external use. Note: only one 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
Includes a redundant 4-wire emergency-stop push-button mounted on the front of the enclosure and a Pilz relay that monitors it in conjunction with the frequency converter’s safe-stop circuit and the mains contactor located in the options cabinet.

Safe Stop + Pilz Relay
Provides a solution for the "Emergency Stop" option without the contactor in F-Enclosure frequency converters.

Manual Motor Starters
Provides 3-phase power for electric blowers often required for larger motors. Power for the starters is provided from the load side of any supplied contactor, circuit breaker, or disconnect switch. Power is fused before each motor starter, and is off when the incoming power to the frequency converter is off. Up to 2 starters are allowed (one if a 30 A, fuse-protected circuit is ordered). 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 will be 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 over-current, overload, short circuits, and over-temperature
- 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
Designed for monitoring temperatures of external system components, such as the motor windings and/or bearings. Includes five 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

Additional features:

- One universal output, configurable for analog voltage or analog current
- Two output relays (N.O.)
- Dual-line LC display and LED diagnostics
- Sensor lead wire break, short-circuit, and incorrect polarity detection
- Interface setup software

3.5 Electrical Installation

3.5.1 Power Connections

Cabling and Fusing

NOTICE

Cables 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 and 90 °C copper conductors are thermally acceptable for the frequency converter to use in non UL applications.

The power cable connections are situated as shown below. Dimensioning of cable cross section must be done in accordance with the current ratings and local legislation. See the *Specifications section* for details.

For protection of the frequency converter, the recommended fuses must be used or the unit must be with built-in fuses. Recommended fuses can be seen in the tables of the fuse section. Always ensure that proper fusing is made according to local regulation.

The mains connection is fitted to the mains switch if this is included.

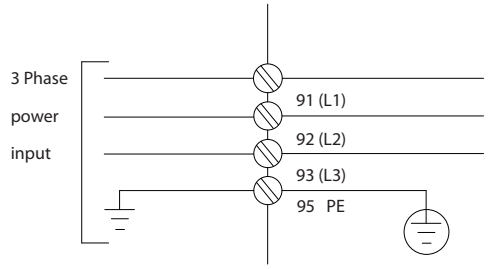


Illustration 3.48 Power Cable Connections

NOTICE

The motor cable must be screened/armoured. If an unscreened/unarmoured cable is used, some EMC requirements are not complied with. Use a screened/armoured motor cable to comply with EMC emission specifications. For more information, see *EMC specifications* in the *Design Guide*.

See section *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, the screen must be continued at the lowest possible HF impedance.

Connect the motor cable screen to both the de-coupling 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). This is done 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 length of cable. 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, the switching frequency must be set according to the instruction in *14-01 Switching Frequency*.

3

Term. no.	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 3.14

1) Protected Earth 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 output of the frequency converter.

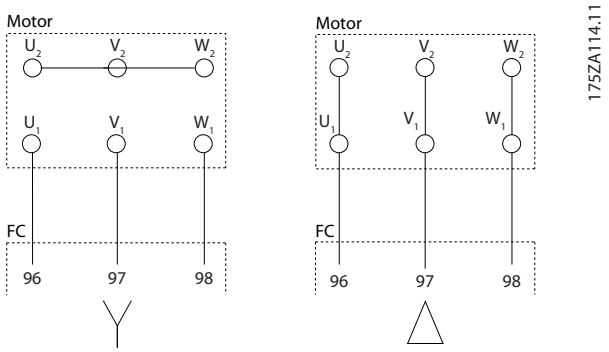


Illustration 3.49 Star/Delta Connections

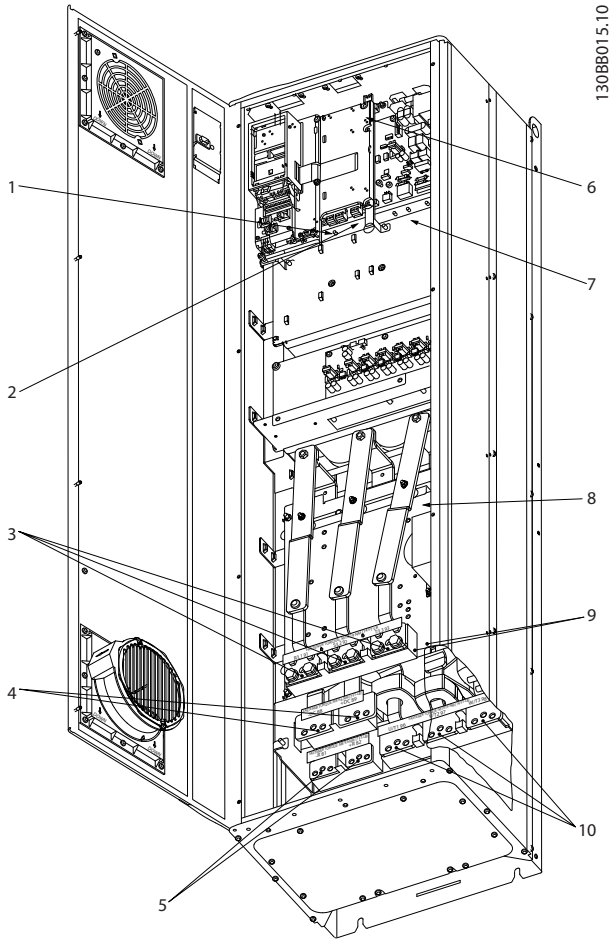


Illustration 3.50 Compact IP21 (NEMA 1) and IP54 (NEMA 12), Enclosure Type D1

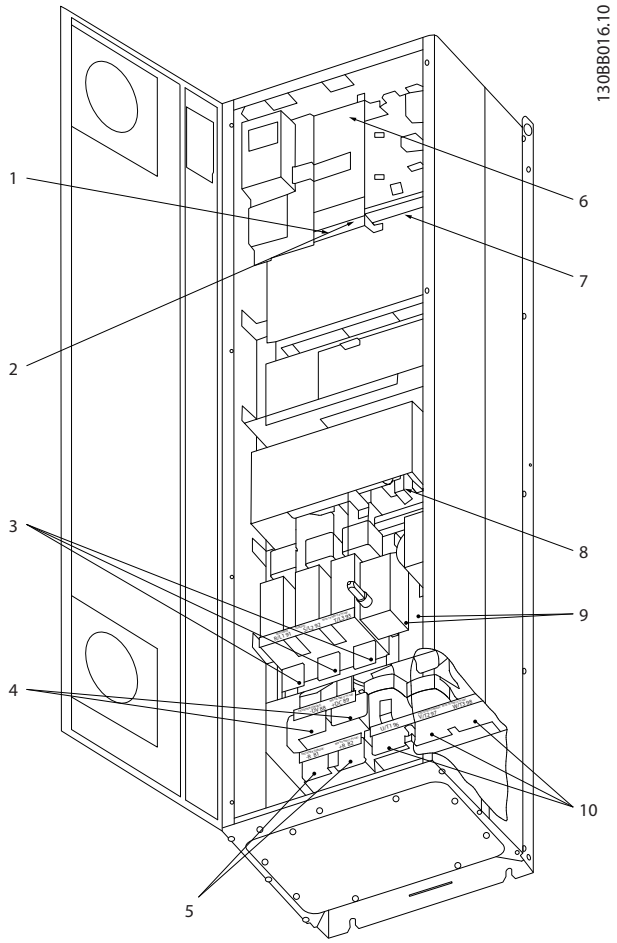


Illustration 3.51 Compact IP21 (NEMA 1) and IP54 (NEMA 12) with Disconnect, Fuse and RFI Filter, Enclosure Type D2

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

Table 3.15 Legend to *Illustration 3.50* and *Illustration 3.51*

3

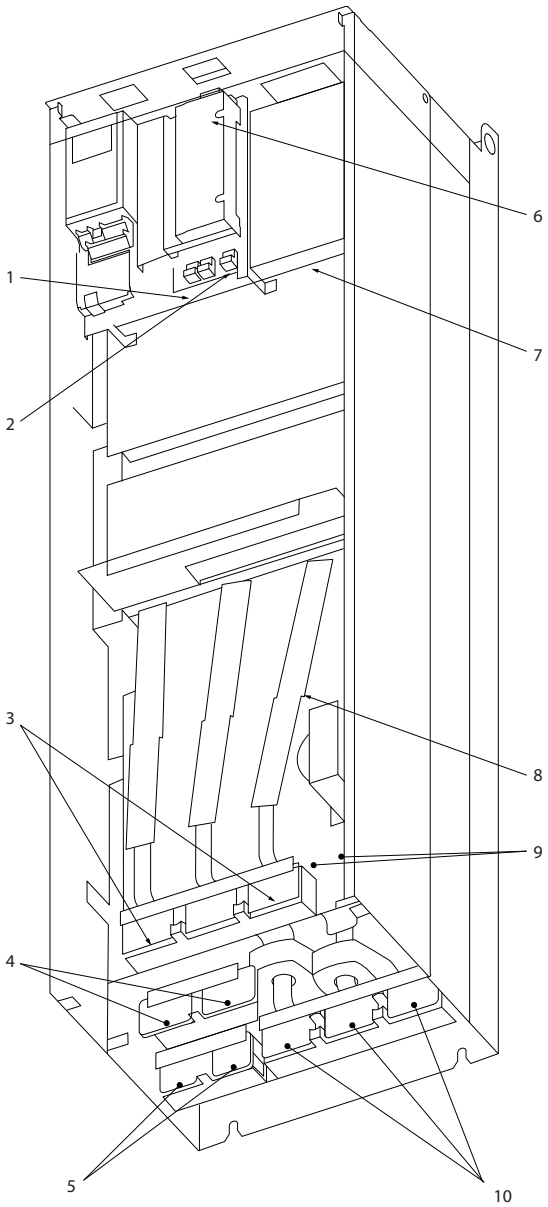


Illustration 3.52 Compact IP00 (Chassis), Enclosure Type D3

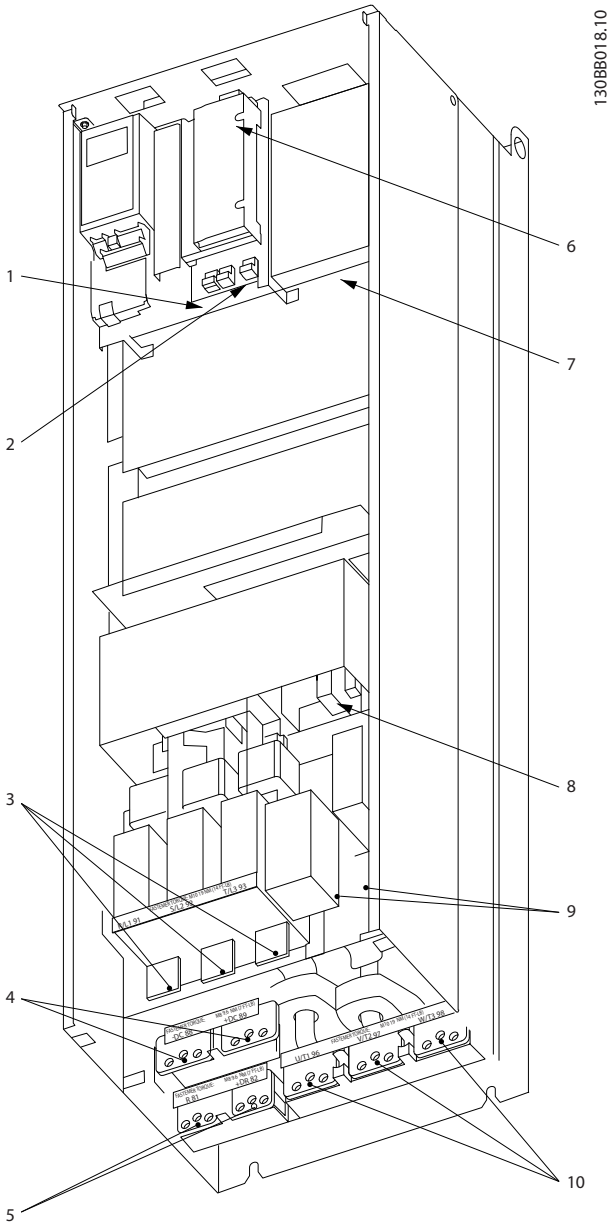


Illustration 3.53 Compact IP00 (Chassis) with Disconnect, Fuse and RFI Filter, Enclosure Type D4

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

Table 3.16 Legend to *Illustration 3.52* and *Illustration 3.53*

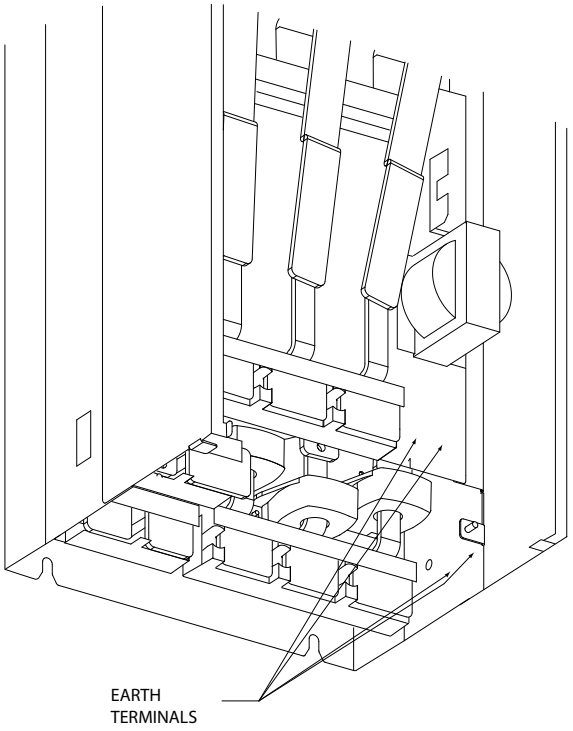


Illustration 3.54 Position of Earth Terminals IP00, Enclosure Type D

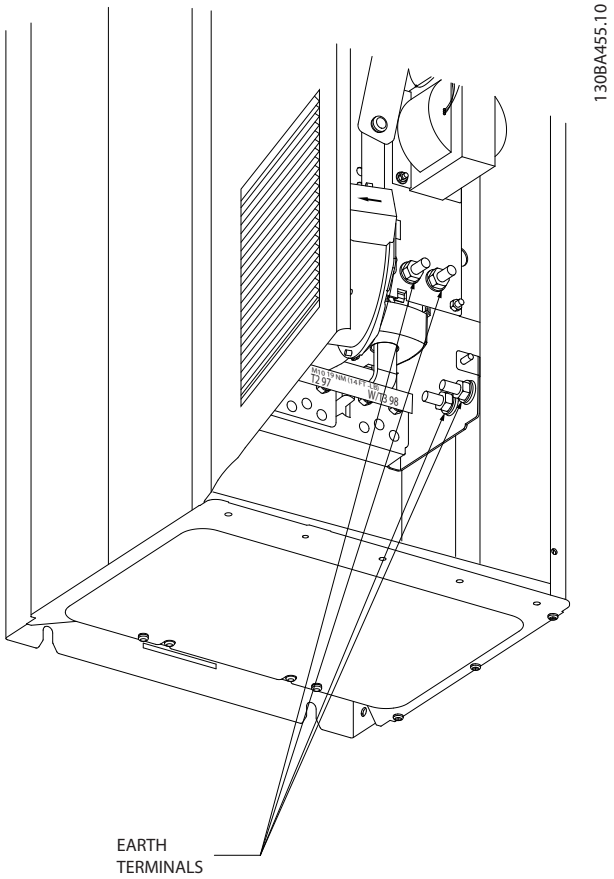


Illustration 3.55 Position of Earth Terminals IP21 (NEMA type 1) and IP54 (NEMA type 12)

NOTICE

D2 and D4 shown as examples. D1 and D3 are equivalent.

3

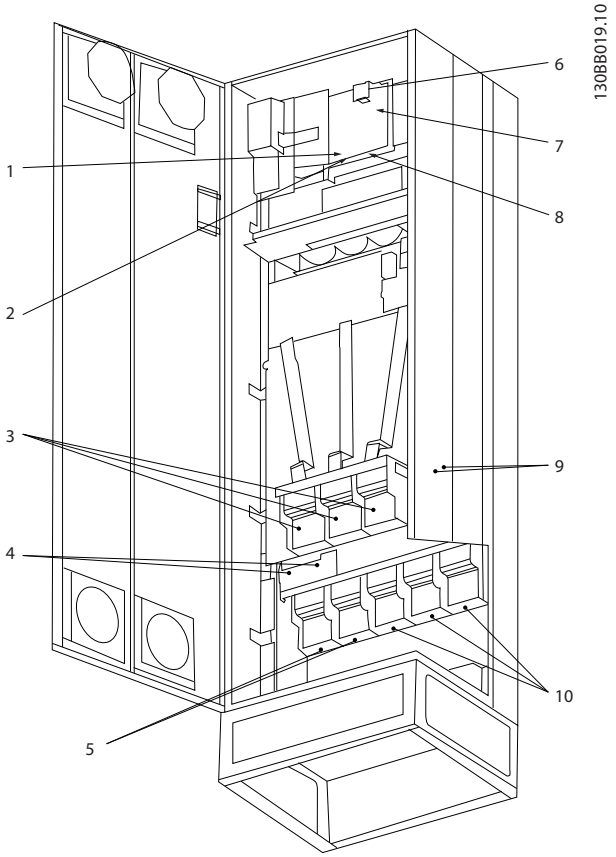


Illustration 3.56 Compact IP21 (NEMA 1) and IP54 (NEMA 12) Enclosure Type E1

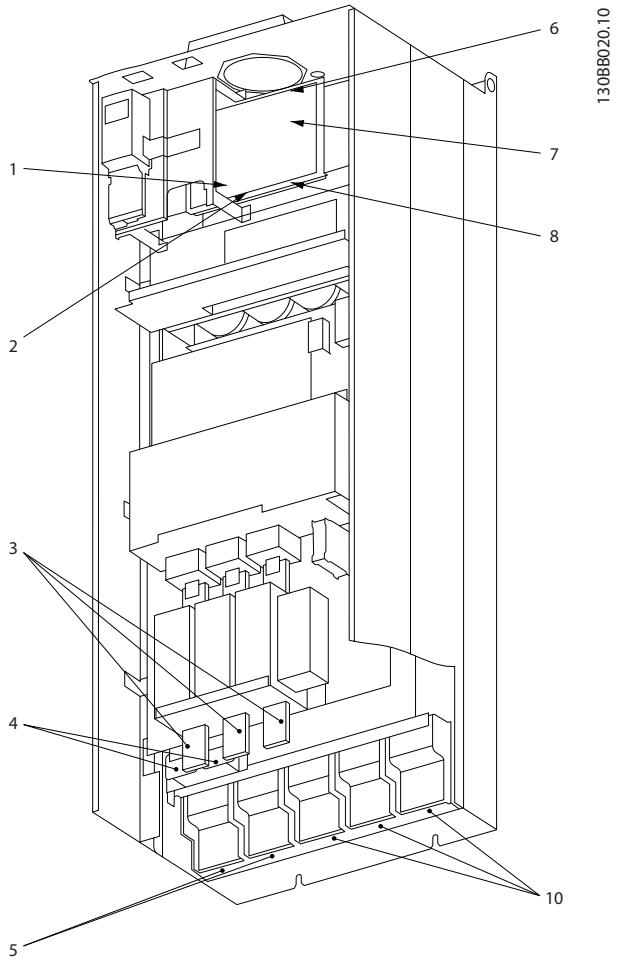


Illustration 3.57 Compact IP00 (Chassis) with Disconnect, Fuse and RFI Filter, Enclosure Type E2

1)	AUX Relay	5)	Load sharing
	01 02 03		-DC +DC
	04 05 06		88 89
2)	Temp Switch	6)	SMPS Fuse (see fuse tables for part number)
	106 104 105	7)	Fan Fuse (see fuse tables 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 3.17 Legend to *Illustration 3.56* and *Illustration 3.57*

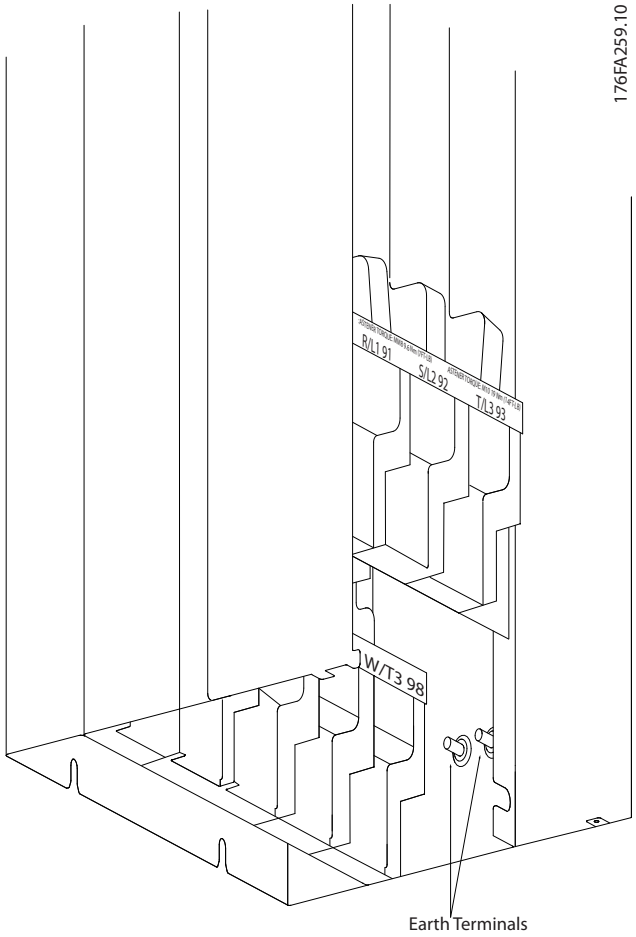
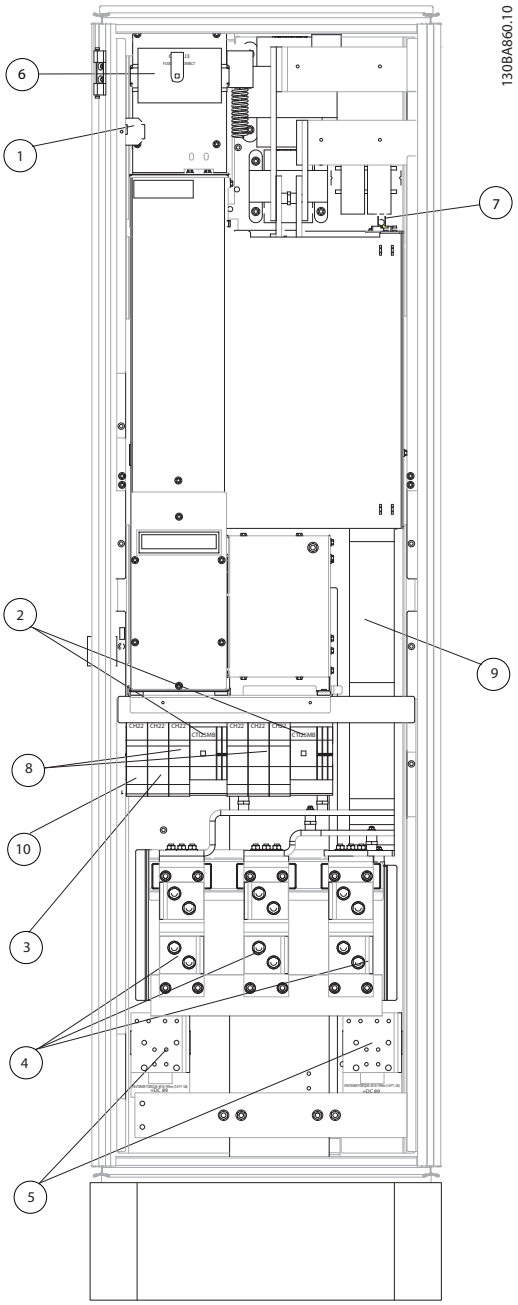


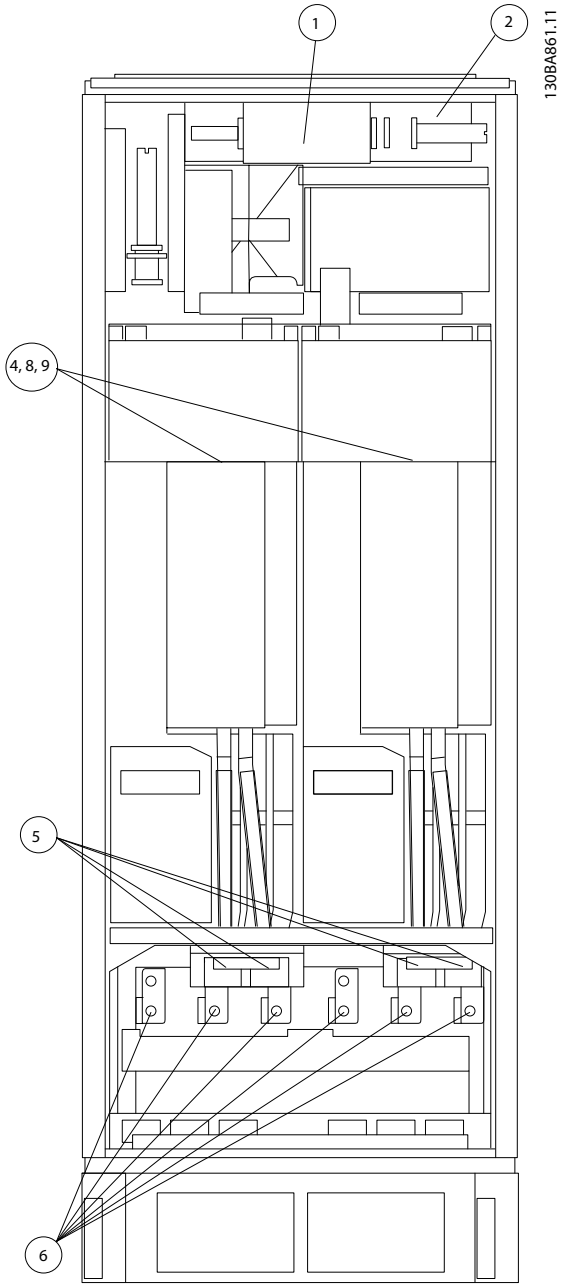
Illustration 3.58 Position of Earth Terminals IP00, Enclosure Type E

3



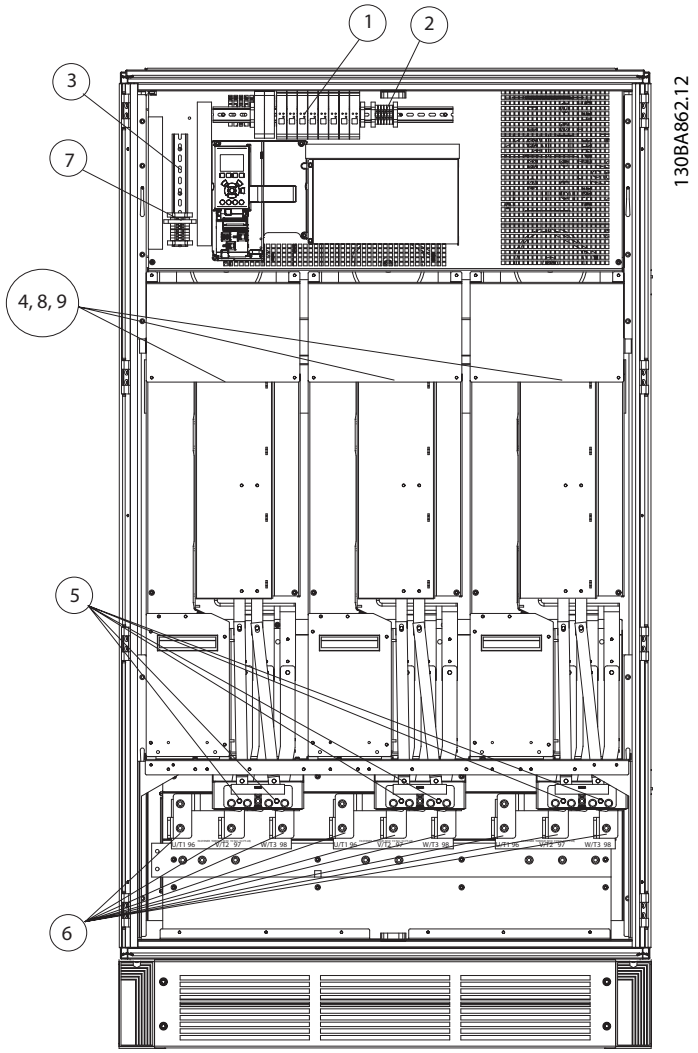
1)	24 V DC, 5 A	5)	Loadsharing
	T1 Output Taps		-DC +DC
	Temp Switch		88 89
	106 104 105	6)	Control Transformer Fuses (2 or 4 pieces). See fuse tables for part numbers
2)	Manual Motor Starters	7)	SMPS Fuse. See fuse tables for part numbers
3)	30 A Fuse Protected Power Terminals	8)	Manual Motor Controller fuses (3 or 6 pieces). See fuse tables for part numbers
4)	Mains	9)	Line Fuses, enclosure types F1 and F2 (3 pieces). See fuse tables for part numbers
	R S T	10)	30 Amp Fuse Protected Power fuses
	L1 L2 L3		

Illustration 3.59 Rectifier Cabinet, Enclosure Types F1, F2, F3 and F4



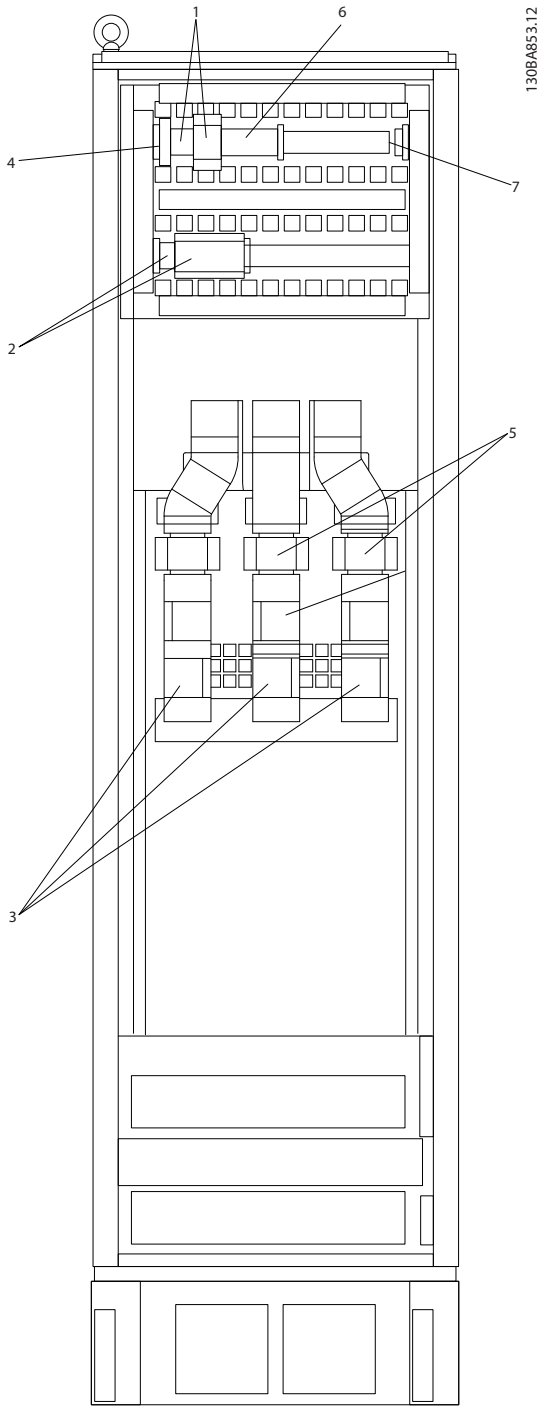
1)	External Temperature Monitoring	6)	Motor
2)	AUX Relay		U V W
	01 02 03		96 97 98
	04 05 06		T1 T2 T3
3)	NAMUR	7)	NAMUR Fuse. See fuse tables for part numbers
4)	AUX Fan	8)	Fan Fuses. See fuse tables for part numbers
	100 101 102 103	9)	SMPS Fuses. See fuse tables for part numbers
	L1 L2 L1 L2		
5)	Brake		
	-R +R		
	81 82		

Illustration 3.60 Inverter Cabinet, Enclosure Types F1 and F3



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 fuse tables for part numbers
4)	AUX Fan	8)	Fan Fuses. See fuse tables for part numbers
	100 101 102 103	9)	SMPS Fuses. See fuse tables for part numbers
	L1 L2 L1 L2		
5)	Brake		
	-R +R		
	81 82		

Illustration 3.61 Inverter Cabinet, Enclosure Types F2 and F4



1)	Pilz Relay Terminal	4)	Safety Relay Coil Fuse with PILZ Relay
2)	RCD or IRM Terminal		See fuse tables for part numbers
3)	Mains	5)	Line Fuses, F3 and F4 (3 pieces)
	R S T		See fuse tables for part numbers
	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 3.62 Options Cabinet, Enclosure Types F3 and F4

3

3.5.2 Grounding

The following basic issues need to be considered when installing a frequency converter, so as to obtain electro-magnetic compatibility (EMC).

- Safety grounding: The frequency converter has a high leakage current and must be grounded appropriately for safety reasons. 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. This avoids having different HF voltages for the individual devices and avoids the risk of radio interference currents running in connection cables that may be used between the devices. 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.

3.5.3 Extra Protection (RCD)

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

In case of an ground fault, a DC component may develop in the fault current.

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

See also *Special Conditions* in the *Design Guide*.

3.5.4 RFI Switch

Mains supply isolated from earth
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, the RFI switch is recommended to be turned off (OFF) via *14-50 RFI Filter* on the frequency converter and *14-50 RFI Filter* on the filter. For further reference, see IEC 364-3. In case optimum EMC performance is needed, parallel motors are connected or the motor cable length is above 25 m, it is recommended to set *14-50 RFI Filter* to [ON].

In OFF, the internal RFI capacities (filter capacitors) between the chassis and the intermediate circuit are cut off to avoid damage to the intermediate circuit and to reduce the earth capacity currents (according to IEC 61800-3).
Also refer to the application note *VLT on IT Mains* It is important to use isolation monitors that are capable for use together with power electronics (IEC 61557-8).

3.5.5 Torque

When tightening all electrical connections it is very important to tighten with the correct torque. Too low or too high torque results in a bad electrical connection. Use a torque wrench to ensure correct torque.

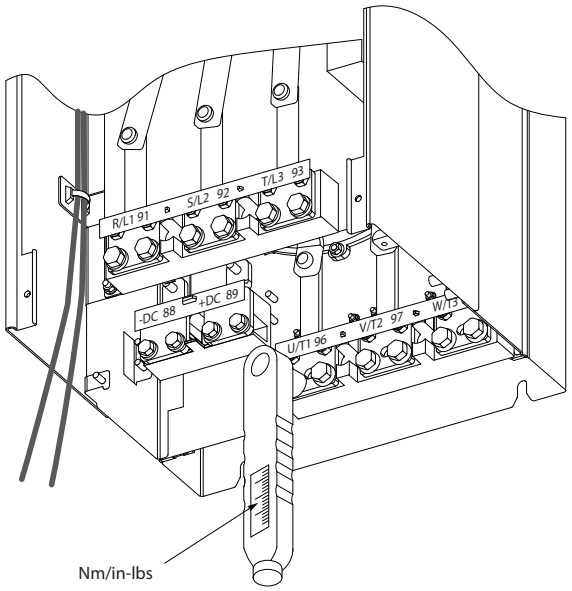


Illustration 3.63 Tightening Bolts with a Torque Wrench

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

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

Table 3.18 Torque for Terminals

3.5.6 Shielded Cables

⚠WARNING

Danfoss recommends to use shielded cables between the LCL filter and the AFE unit. Unshielded cables can be between transformer and LCL filter input side.

It is important that shielded and armoured cables are connected in a proper way to ensure the high EMC immunity and low emissions.

The connection can be made using either cable glands or clamps

- EMC cable glands: Generally available cable glands can be used to ensure an optimum EMC connection.
- EMC cable clamp: Clamps allowing easy connection are supplied with the frequency converter.

3.5.7 Motor Cable

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

Terminal No.	Function
96, 97, 98, 99	Mains U/T1, V/T2, W/T3 Earth

Table 3.19 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

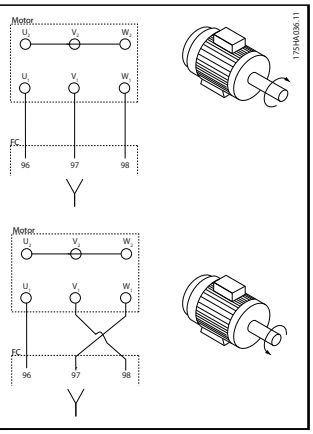


Table 3.20

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.

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

F enclosure requirements

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

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

Output junction box requirements: The length, 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 unequal amount of wires per phase, consult the factory for requirements and documentation or use the top/bottom entry side cabinet option.

3

3.5.8 Brake Cable for Frequency Converters with Factory Installed Brake Chopper Option

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

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

Terminal No.	Function
81, 82	Brake resistor terminals

Table 3.21 Terminals for Brake Resistor

The connection cable to the brake resistor must be screened. Connect the screen with cable clamps to the conductive back plate at the frequency converter and to the metal cabinet of the brake resistor.
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.

⚠WARNING

Note that voltages up to 1099 V DC, depending on the supply voltage, may occur on the terminals.

F enclosure requirements
The brake resistor(s) must be connected to the brake terminals in each inverter module.

3.5.9 Load Sharing

Terminal No.	Function
88, 89	Loadsharing

Table 3.22 Terminals for Load Sharing

The connection cable must be screened and the max. 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 calls for extra equipment and safety considerations. For further information, see the instuctions *Load Sharing*.

⚠WARNING

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

3.5.10 Shielding against Electrical Noise

Before mounting the mains power cable, mount the EMC metal cover to ensure best EMC performance.

NOTICE

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

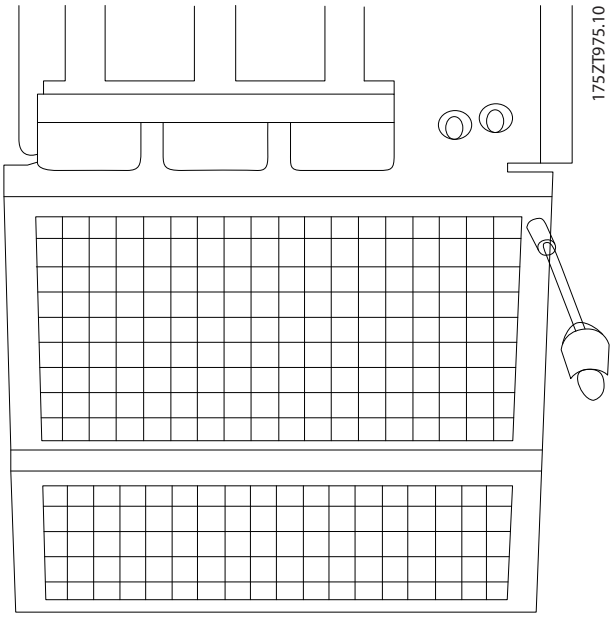


Illustration 3.64 Mounting of EMC Shield.

3.5.11 Mains Connection

Mains must be connected to terminals 91, 92 and 93. Earth is connected to the terminal to the right of terminal 93.

Terminal No.	Function
91, 92, 93	Mains R/L1, S/L2, T/L3
94	Earth

Table 3.23 Mains Terminals Connection

⚠CAUTION

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

Ensure that the power 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.

3.5.12 External Fan Supply

In case the frequency converter is supplied by DC or if the fan must run independently of the power supply, an external power supply can be applied. The connection is made on the power card.

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

Table 3.24 External Fan Supply Terminals

The connector located on the power card provides the connection of line 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.

3.5.13 Fuses

It is recommended to 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

This is mandatory to ensure compliance with IEC 60364 for CE or NEC 2009 for UL.

⚠WARNING

Personnel and property must be protected against the consequence of component break-down internally in the frequency converter.

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

NOTICE

The recommendations given do not cover branch circuit protection for UL.

Short-circuit protection:
Danfoss recommends using the fuses/circuit breakers mentioned below to protect service personnel and property in case of component break-down in the frequency converter.

Non UL compliance
If UL/cUL is not to be complied with, Danfoss recommends using the following fuses, which ensure compliance with EN50178:
In case of malfunction, not following the recommendation may result in unnecessary damage to the frequency converter.

P90 - P200	380 - 500 V	type gG
P250 - P400	380 - 500 V	type gR

Table 3.25 Recommended EN 50178 Fuses

3

UL compliance

Enclosure	FC 300 power	Recommended fuse size	Recommended max. fuse	Recommended circuit breaker	Max trip level
Size	[kW]			Moeller	[A]
A1	0.25-1.5	gG-10	gG-25	PKZM0-16	16
A2	0.25-2.2	gG-10 (0.25-1.5) gG-16 (2.2)	gG-25	PKZM0-25	25
A3	3.0-3.7	gG-16 (3) gG-20 (3.7)	gG-32	PKZM0-25	25
B3	5.5	gG-25	gG-63	PKZM4-50	50
B4	7.5-15	gG-32 (7.5) gG-50 (11) gG-63 (15)	gG-125	NZMB1-A100	100
C3	18.5-22	gG-80 (18.5) aR-125 (22)	gG-150 (18.5) aR-160 (22)	NZMB2-A200	150
C4	30-37	aR-160 (30) aR-200 (37)	aR-200 (30) aR-250 (37)	NZMB2-A250	250
A4	0.25-2.2	gG-10 (0.25-1.5) gG-16 (2.2)	gG-32	PKZM0-25	25
A5	0.25-3.7	gG-10 (0.25-1.5) gG-16 (2.2-3) gG-20 (3.7)	gG-32	PKZM0-25	25
B1	5.5-7.5	gG-25 (5.5) gG-32 (7.5)	gG-80	PKZM4-63	63
B2	11	gG-50	gG-100	NZMB1-A100	100
C1	15-22	gG-63 (15) gG-80 (18.5) gG-100 (22)	gG-160 (15-18.5) aR-160 (22)	NZMB2-A200	160
C2	30-37	aR-160 (30) aR-200 (37)	aR-200 (30) aR-250 (37)	NZMB2-A250	250

Table 3.26 200-240 V, Frame Sizes A, B, and C

Enclosure	FC 300 power	Recommended fuse size	Recommended Max. fuse	Recommended circuit breaker	Max trip level
Size	[kW]			Moeller	[A]
A1	0.37-1.5	gG-10	gG-25	PKZM0-16	16
A2	0.37-4.0	gG-10 (0.37-3) gG-16 (4)	gG-25	PKZM0-25	25
A3	5.5-7.5	gG-16	gG-32	PKZM0-25	25
B3	11-15	gG-40	gG-63	PKZM4-50	50
B4	18.5-30	gG-50 (18.5) gG-63 (22) gG-80 (30)	gG-125	NZMB1-A100	100
C3	37-45	gG-100 (37) gG-160 (45)	gG-150 (37) gG-160 (45)	NZMB2-A200	150
C4	55-75	aR-200 (55) aR-250 (75)	aR-250	NZMB2-A250	250
A4	0.37-4	gG-10 (0.37-3) gG-16 (4)	gG-32	PKZM0-25	25
A5	0.37-7.5	gG-10 (0.37-3) gG-16 (4-7.5)	gG-32	PKZM0-25	25
B1	11-15	gG-40	gG-80	PKZM4-63	63
B2	18.5-22	gG-50 (18.5) gG-63 (22)	gG-100	NZMB1-A100	100
C1	30-45	gG-80 (30) gG-100 (37) gG-160 (45)	gG-160	NZMB2-A200	160
C2	55-75	aR-200 (55) aR-250 (75)	aR-250	NZMB2-A250	250
D	90-200	gG-300 (90) gG-350 (110) gG-400 (132) gG-500 (160) gG-630 (200)	gG-300 (90) gG-350 (110) gG-400 (132) gG-500 (160) gG-630 (200)	-	-
E	250-400	aR-700 (250) aR-900 (315-400)	aR-700 (250) aR-900 (315-400)	-	-
F	450-800	aR-1600 (450-500) aR-2000 (560-630) aR-2500 (710-800)	aR-1600 (450-500) aR-2000 (560-630) aR-2500 (710-800)	-	-

Table 3.27 380-500 V, Frame Sizes A, B, C, D, E, and F

Enclosure	FC 300 power	Recommended fuse size	Recommended Max. fuse	Recommended circuit breaker	Max trip level
Size	[kW]			Moeller	[A]
A2	0-75-4.0	gG-10	gG-25	PKZM0-25	25
A3	5.5-7.5	gG-10 (5.5) gG-16 (7.5)	gG-32	PKZM0-25	25
B3	11-15	gG-25 (11) gG-32 (15)	gG-63	PKZM4-50	50
B4	18.5-30	gG-40 (18.5) gG-50 (22) gG-63 (30)	gG-125	NZMB1-A100	100
C3	37-45	gG-63 (37) gG-100 (45)	gG-150	NZMB2-A200	150
C4	55-75	aR-160 (55) aR-200 (75)	aR-250	NZMB2-A250	250
A5	0.75-7.5	gG-10 (0.75-5.5) gG-16 (7.5)	gG-32	PKZM0-25	25
B1	11-18	gG-25 (11) gG-32 (15) gG-40 (18.5)	gG-80	PKZM4-63	63
B2	22-30	gG-50 (22) gG-63 (30)	gG-100	NZMB1-A100	100
C1	37-55	gG-63 (37) gG-100 (45) aR-160 (55)	gG-160 (37-45) aR-250 (55)	NZMB2-A200	160
C2	75	aR-200 (75)	aR-250	NZMB2-A250	250

Table 3.28 525-600 V, Frame Sizes A, B, and C

Enclosure	Power [kW]	Recommended fuse size	Recommended Max. fuse	Recommended circuit breaker Moeller	Max trip level [A]
A3	1.1-7.5	gG-6 (3) gG-10 (2) gG-16 (2)	gG-25		
B2	22-30	gG-25 (11) gG-32 (15) gG-32 (18) gG-40 (22)	gG-63	-	-
C2	75-90	gG-63 (30) gG-63 (37) gG-80 (45) gG-100 (55) gG-125 (75)	gG-80 (30) gG-100 (37) gG-125 (45) gG-160 (55-75)	-	-
C3	44-55	gG-80 gG-100	gG-100 gG-125		
D	-	gG-125 (37) gG-160 (45) gG-200 (55-75) aR-250 (90) aR-315 (110) aR-350 (132-160) aR-400 (200) aR-500 (250) aR-550 (315)	gG-125 (37) gG-160 (45) gG-200 (55-75) aR-250 (90) aR-315 (110) aR-350 (132-160) aR-400 (200) aR-500 (250) aR-550 (315)	-	-
E	-	aR-700 (355-400) aR-900 (500-560)	aR-700 (355-400) aR-900 (500-560)	-	-
F	-	aR-1600 (630-900) aR-2000 (1000) aR-2500 (1200)	aR-1600 (630-900) aR-2000 (1000) aR-2500 (1200)	-	-

Table 3.29 525-690 V, Frame Sizes A, B, C, D, E and F

UL Compliance

Fuses or circuit breakers are mandatory to comply with NEC 2009. Danfoss recommends using a selection of the following.

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 drive Short Circuit Current Rating (SCCR) is 100,000 A_{rms}.

3

	Recommended max. fuse					
FC 300 Power	**Bussmann**	**Bussmann**	**Bussmann**	**Bussmann**	**Bussmann**	**Bussmann**
[kW]	Type RK1 [1)]	Type J	Type T	Type CC	Type CC	Type CC
0.25-0.37	KTN-R-05	JKS-05	JJN-05	FNQ-R-5	KTK-R-5	LP-CC-5
0.55-1.1	KTN-R-10	JKS-10	JJN-10	FNQ-R-10	KTK-R-10	LP-CC-10
1.5	KTN-R-15	JKS-15	JJN-15	FNQ-R-15	KTK-R-15	LP-CC-15
2.2	KTN-R-20	JKS-20	JJN-20	FNQ-R-20	KTK-R-20	LP-CC-20
3.0	KTN-R-25	JKS-25	JJN-25	FNQ-R-25	KTK-R-25	LP-CC-25
3.7	KTN-R-30	JKS-30	JJN-30	FNQ-R-30	KTK-R-30	LP-CC-30
5.5	KTN-R-50	KS-50	JJN-50	-	-	-
7.5	KTN-R-60	JKS-60	JJN-60	-	-	-
11	KTN-R-80	JKS-80	JJN-80	-	-	-
15-18.5	KTN-R-125	JKS-125	JJN-125	-	-	-
22	KTN-R-150	JKS-150	JJN-150	-	-	-
30	KTN-R-200	JKS-200	JJN-200	-	-	-
37	KTN-R-250	JKS-250	JJN-250	-	-	-

Table 3.30 200-240 V, Frame Sizes A, B, and C

	Recommended max. fuse			
FC 300 Power	**SIBA**	**Littel fuse**	**Ferraz-Shawmut**	**Ferraz-Shawmut**
[kW]	Type RK1	Type RK1	Type CC	Type RK1[3)]
0.25-0.37	5017906-005	KLN-R-05	ATM-R-05	A2K-05-R
0.55-1.1	5017906-010	KLN-R-10	ATM-R-10	A2K-10-R
1.5	5017906-016	KLN-R-15	ATM-R-15	A2K-15-R
2.2	5017906-020	KLN-R-20	ATM-R-20	A2K-20-R
3.0	5017906-025	KLN-R-25	ATM-R-25	A2K-25-R
3.7	5012406-032	KLN-R-30	ATM-R-30	A2K-30-R
5.5	5014006-050	KLN-R-50	-	A2K-50-R
7.5	5014006-063	KLN-R-60	-	A2K-60-R
11	5014006-080	KLN-R-80	-	A2K-80-R
15-18.5	2028220-125	KLN-R-125	-	A2K-125-R
22	2028220-150	KLN-R-150	-	A2K-150-R
30	2028220-200	KLN-R-200	-	A2K-200-R
37	2028220-250	KLN-R-250	-	A2K-250-R

Table 3.31 200-240 V, Frame Sizes A, B, and C

	Recommended max. fuse			
FC 300 Power	Bussmann	Littel fuse	Ferraz-Shawmut	Ferraz-Shawmut
[kW]	Type JFHR2[2)]	JFHR2	JFHR2[4)]	J
0.25-0.37	FWX-5	-	-	HSJ-6
0.55-1.1	FWX-10	-	-	HSJ-10
1.5	FWX-15	-	-	HSJ-15
2.2	FWX-20	-	-	HSJ-20
3.0	FWX-25	-	-	HSJ-25
3.7	FWX-30	-	-	HSJ-30
5.5	FWX-50	-	-	HSJ-50
7.5	FWX-60	-	-	HSJ-60
11	FWX-80	-	-	HSJ-80
15-18.5	FWX-125	-	-	HSJ-125
22	FWX-150	L25S-150	A25X-150	HSJ-150
30	FWX-200	L25S-200	A25X-200	HSJ-200
37	FWX-250	L25S-250	A25X-250	HSJ-250

Table 3.32 200-240 V, Frame Sizes A, B, and C

1) KTS-fuses from Bussmann may substitute KTN for 240 V frequency converters.

2) FWH-fuses from Bussmann may substitute FWX for 240 V frequency converters.

3) A6KR fuses from FERRAZ SHAWMUT may substitute A2KR for 240 V frequency converters.

4) A50X fuses from FERRAZ SHAWMUT may substitute A25X for 240 V frequency converters.

	Recommended max. fuse					
FC 300 Power	Bussmann	Bussmann	Bussmann	Bussmann	Bussmann	Bussmann
[kW]	Type RK1	Type J	Type T	Type CC	Type CC	Type CC
0.37-1.1	KTS-R-6	JKS-6	JJS-6	FNQ-R-6	KTK-R-6	LP-CC-6
1.5-2.2	KTS-R-10	JKS-10	JJS-10	FNQ-R-10	KTK-R-10	LP-CC-10
3	KTS-R-15	JKS-15	JJS-15	FNQ-R-15	KTK-R-15	LP-CC-15
4	KTS-R-20	JKS-20	JJS-20	FNQ-R-20	KTK-R-20	LP-CC-20
5.5	KTS-R-25	JKS-25	JJS-25	FNQ-R-25	KTK-R-25	LP-CC-25
7.5	KTS-R-30	JKS-30	JJS-30	FNQ-R-30	KTK-R-30	LP-CC-30
11	KTS-R-40	JKS-40	JJS-40	-	-	-
15	KTS-R-50	JKS-50	JJS-50	-	-	-
18	KTS-R-60	JKS-60	JJS-60	-	-	-
22	KTS-R-80	JKS-80	JJS-80	-	-	-
30	KTS-R-100	JKS-100	JJS-100	-	-	-
37	KTS-R-125	JKS-125	JJS-125	-	-	-
45	KTS-R-150	JKS-150	JJS-150	-	-	-
55	KTS-R-200	JKS-200	JJS-200	-	-	-
75	KTS-R-250	JKS-250	JJS-250	-	-	-

Table 3.33 380-500 V, Frame Sizes A, B, and C

	Recommended max. fuse			
FC 302 Power	SIBA	Littel fuse	Ferraz-Shawmut	Ferraz-Shawmut
[kW]	Type RK1	Type RK1	Type CC	Type RK1
0.37-1.1	5017906-006	KLS-R-6	ATM-R-6	A6K-6-R
1.5-2.2	5017906-010	KLS-R-10	ATM-R-10	A6K-10-R
3	5017906-016	KLS-R-15	ATM-R-15	A6K-15-R
4	5017906-020	KLS-R-20	ATM-R-20	A6K-20-R
5.5	5017906-025	KLS-R-25	ATM-R-25	A6K-25-R
7.5	5012406-032	KLS-R-30	ATM-R-30	A6K-30-R
11	5014006-040	KLS-R-40	-	A6K-40-R
15	5014006-050	KLS-R-50	-	A6K-50-R
18	5014006-063	KLS-R-60	-	A6K-60-R
22	2028220-100	KLS-R-80	-	A6K-80-R
30	2028220-125	KLS-R-100	-	A6K-100-R
37	2028220-125	KLS-R-125	-	A6K-125-R
45	2028220-160	KLS-R-150	-	A6K-150-R
55	2028220-200	KLS-R-200	-	A6K-200-R
75	2028220-250	KLS-R-250	-	A6K-250-R

Table 3.34 380-500 V, Frame Sizes A, B, and C

	Recommended max. fuse			
FC 302 Power	**Bussmann**	**Ferraz- Shawmut**	**Ferraz- Shawmut**	**Littel fuse**
[kW]	JFHR2	J	JFHR2[1)]	JFHR2
0.37-1.1	FWH-6	HSJ-6	-	-
1.5-2.2	FWH-10	HSJ-10	-	-
3	FWH-15	HSJ-15	-	-
4	FWH-20	HSJ-20	-	-
5.5	FWH-25	HSJ-25	-	-
7.5	FWH-30	HSJ-30	-	-
11	FWH-40	HSJ-40	-	-
15	FWH-50	HSJ-50	-	-
18	FWH-60	HSJ-60	-	-
22	FWH-80	HSJ-80	-	-
30	FWH-100	HSJ-100	-	-
37	FWH-125	HSJ-125	-	-
45	FWH-150	HSJ-150	-	-
55	FWH-200	HSJ-200	A50-P-225	L50-S-225
75	FWH-250	HSJ-250	A50-P-250	L50-S-250

Table 3.35 380-500 V, Frame Sizes A, B, and C

1) Ferraz-Shawmut A50QS fuses may substitute for A50P fuses.

	Recommended max. fuse					
FC 302 Power	**Bussmann**	**Bussmann**	**Bussmann**	**Bussmann**	**Bussmann**	**Bussmann**
[kW]	Type RK1	Type J	Type T	Type CC	Type CC	Type CC
0.75-1.1	KTS-R-5	JKS-5	JJS-6	FNQ-R-5	KTK-R-5	LP-CC-5
1.5-2.2	KTS-R-10	JKS-10	JJS-10	FNQ-R-10	KTK-R-10	LP-CC-10
3	KTS-R15	JKS-15	JJS-15	FNQ-R-15	KTK-R-15	LP-CC-15
4	KTS-R20	JKS-20	JJS-20	FNQ-R-20	KTK-R-20	LP-CC-20
5.5	KTS-R-25	JKS-25	JJS-25	FNQ-R-25	KTK-R-25	LP-CC-25
7.5	KTS-R-30	JKS-30	JJS-30	FNQ-R-30	KTK-R-30	LP-CC-30
11	KTS-R-35	JKS-35	JJS-35	-	-	-
15	KTS-R-45	JKS-45	JJS-45	-	-	-
18	KTS-R-50	JKS-50	JJS-50	-	-	-
22	KTS-R-60	JKS-60	JJS-60	-	-	-
30	KTS-R-80	JKS-80	JJS-80	-	-	-
37	KTS-R-100	JKS-100	JJS-100	-	-	-
45	KTS-R-125	JKS-125	JJS-125	-	-	-
55	KTS-R-150	JKS-150	JJS-150	-	-	-
75	KTS-R-175	JKS-175	JJS-175	-	-	-

Table 3.36 525-600 V, Frame Sizes A, B, and C

	Recommended max. fuse			
FC 302 Power	SIBA	Littel fuse	Ferraz-Shawmut	Ferraz-Shawmut
[kW]	Type RK1	Type RK1	Type RK1	J
0.75-1.1	5017906-005	KLS-R-005	A6K-5-R	HSJ-6
1.5-2.2	5017906-010	KLS-R-010	A6K-10-R	HSJ-10
3	5017906-016	KLS-R-015	A6K-15-R	HSJ-15
4	5017906-020	KLS-R-020	A6K-20-R	HSJ-20
5.5	5017906-025	KLS-R-025	A6K-25-R	HSJ-25
7.5	5017906-030	KLS-R-030	A6K-30-R	HSJ-30
11	5014006-040	KLS-R-035	A6K-35-R	HSJ-35
15	5014006-050	KLS-R-045	A6K-45-R	HSJ-45
18	5014006-050	KLS-R-050	A6K-50-R	HSJ-50
22	5014006-063	KLS-R-060	A6K-60-R	HSJ-60
30	5014006-080	KLS-R-075	A6K-80-R	HSJ-80
37	5014006-100	KLS-R-100	A6K-100-R	HSJ-100
45	2028220-125	KLS-R-125	A6K-125-R	HSJ-125
55	2028220-150	KLS-R-150	A6K-150-R	HSJ-150
75	2028220-200	KLS-R-175	A6K-175-R	HSJ-175

Table 3.37 525-600 V, Frame Sizes A, B, and C

[1] 170M fuses shown from Bussmann 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.

	Recommended max. fuse					
Power	**Bussmann**	**Bussmann**	**Bussmann**	**Bussmann**	**Bussmann**	**Bussmann**
[kW]	Type RK1	Type J	Type T	Type CC	Type CC	Type CC
1.1	KTS-R-5	JKS-5	JJS-6	FNQ-R-5	KTK-R-5	LP-CC-5
1.5-2.2	KTS-R-10	JKS-10	JJS-10	FNQ-R-10	KTK-R-10	LP-CC-10
3	KTS-R15	JKS-15	JJS-15	FNQ-R-15	KTK-R-15	LP-CC-15
4	KTS-R20	JKS-20	JJS-20	FNQ-R-20	KTK-R-20	LP-CC-20
5.5	KTS-R-25	JKS-25	JJS-25	FNQ-R-25	KTK-R-25	LP-CC-25
7.5	KTS-R-30	JKS-30	JJS-30	FNQ-R-30	KTK-R-30	LP-CC-30
11	KTS-R-35	JKS-35	JJS-35	-	-	-
15	KTS-R-45	JKS-45	JJS-45	-	-	-
18	KTS-R-50	JKS-50	JJS-50	-	-	-
22	KTS-R-60	JKS-60	JJS-60	-	-	-
30	KTS-R-80	JKS-80	JJS-80	-	-	-
37	KTS-R-100	JKS-100	JJS-100	-	-	-
45	KTS-R-125	JKS-125	JJS-125	-	-	-
55	KTS-R-150	JKS-150	JJS-150	-	-	-
75	KTS-R-175	JKS-175	JJS-175	-	-	-

Table 3.38 525-690V, Frame Sizes A, B, and C

	Recommended max. fuse							
FC 302 [kW] Power	**Max. prefuse**	**Bussmann E52273 RK1/JDDZ**	**Bussmann E4273 J/JDDZ**	**Bussmann E4273 T/JDDZ**	**SIBA E180276 RK1/JDDZ**	**LittelFuse E81895 RK1/JDDZ**	**Ferraz-Shawmut E163267/E2137 RK1/JDDZ**	**Ferraz-Shawmut E2137 J/HSJ**
11	30 A	KTS-R-30	JKS-30	JKJS-30	5017906-030	KLS-R-030	A6K-30-R	HST-30
15-18.5	45 A	KTS-R-45	JKS-45	JJS-45	5014006-050	KLS-R-045	A6K-45-R	HST-45
22	60 A	KTS-R-60	JKS-60	JJS-60	5014006-063	KLS-R-060	A6K-60-R	HST-60
30	80 A	KTS-R-80	JKS-80	JJS-80	5014006-080	KLS-R-075	A6K-80-R	HST-80
37	90 A	KTS-R-90	JKS-90	JJS-90	5014006-100	KLS-R-090	A6K-90-R	HST-90
45	100 A	KTS-R-100	JKS-100	JJS-100	5014006-100	KLS-R-100	A6K-100-R	HST-100
55	125 A	KTS-R-125	JKS-125	JJS-125	2028220-125	KLS-150	A6K-125-R	HST-125
75	150 A	KTS-R-150	JKS-150	JJS-150	2028220-150	KLS-175	A6K-150-R	HST-150
* UL compliance only 525-600V								

Table 3.39 525-690 V*, Frame Sizes B and C

Supplementary fuses

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

Table 3.40 SMPS Fuse

Size/Type	Bussmann PN*	LittelFuse	Rating
P90K-P250, 380-500 V	KTK-4		4 A, 600 V
P37K-P400, 525-690 V	KTK-4		4 A, 600 V
P315-P800, 380-500 V		KLK-15	15A, 600 V
P500-P1M2, 525-690 V		KLK-15	15A, 600 V

Table 3.41 Fan Fuses

3

	Size/Type	Bussmann PN*	Rating	Alternative Fuses
2.5-4.0 A Fuse	P450-P800, 380-500 V	LPJ-6 SP or SPI	6 A, 600V	Any listed Class J Dual Element, Time Delay, 6 A
	P630-P1M2, 525-690 V	LPJ-10 SP or SPI	10 A, 600V	Any listed Class J Dual Element, Time Delay, 10 A
4.0-6.3 A Fuse	P450-P800, 380-500 V	LPJ-10 SP or SPI	10 A, 600V	Any listed Class J Dual Element, Time Delay, 10 A
	P630-P1M2, 525-690 V	LPJ-15 SP or SPI	15 A, 600V	Any listed Class J Dual Element, Time Delay, 15 A
6.3 - 10 A Fuse	P450-P800600HP-1200HP, 380-500 V	LPJ-15 SP or SPI	15 A, 600V	Any listed Class J Dual Element, Time Delay, 15 A
	P630-P1M2, 525-690 V	LPJ-20 SP or SPI	20 A, 600V	Any listed Class J Dual Element, Time Delay, 20A
10 - 16 A Fuse	P450-P800, 380-500 V	LPJ-25 SP or SPI	25 A, 600V	Any listed Class J Dual Element, Time Delay, 25 A
	P630-P1M2, 525-690 V	LPJ-20 SP or SPI	20 A, 600V	Any listed Class J Dual Element, Time Delay, 20 A

Table 3.42 Manual Motor Controller Fuses

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

Table 3.43 30 A Fuse Protected Terminal Fuse

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

Table 3.44 Control Transformer Fuse

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

Table 3.45 NAMUR Fuse

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

Table 3.46 Safety Relay Coil Fuse with PILZ Relay

3.5.14 Mains Disconnectors - Frame Size D, E and F

Frame size	Power	Type
380-500 V		
D1/D3	P90K-P110	ABB OT200U12-91
D2/D4	P132-P200	ABB OT400U12-91
E1/E2	P250	ABB OT600U03
E1/E2	P315-P400	ABB OT800U03
F3	P450	Merlin Gerin NPJF36000S12AAYP
F3	P500-P630	Merlin Gerin NRKF36000S20AAYP
F4	P710-P800	Merlin Gerin NRKF36000S20AAYP
525-690 V		
D1/D3	P90K-P132	ABB OT200U12-91
D2/D4	P160-P315	ABB OT400U12-91
E1/E2	P355-P560	ABB OETL-NF600A
F3	P630-P710	Merlin Gerin NPJF36000S12AAYP
F3	P800	Merlin Gerin NRKF36000S20AAYP
F4	P900-P1M2	Merlin Gerin NRKF36000S20AAYP

Table 3.47 Mains Disconnector Types

3.5.15 F-Frame Circuit Breakers

Frame size	Power & voltage	Type	Default breaker settings	
			Trip level [A]	Time [s]
F3	P450 380-500 V & P630-P710 525-690 V	Merlin Gerin NPJF36120U31AABSCYP	1200	0.5
F3	P500-P630 380-500 V & P800 525-690 V	Merlin Gerin NRJF36200U31AABSCYP	2000	0.5
F4	P710 380-500 V & P900-P1M2 525-690 V	Merlin Gerin NRJF36200U31AABSCYP	2000	0.5
F4	P800 380-500 V	Merlin Gerin NRJF36250U31AABSCYP	2500	0.5

Table 3.48 Circuit Breakers Types

3.5.16 F-Frame Mains Contactors

Frame size	Power & voltage	Type
F3	P450-P500 380-500 V & P630-P800 525-690 V	Eaton XTCE650N22A
F3	P560 380-500 V	Eaton XTCE820N22A
F3	P630380-500 V	Eaton XTCEC14P22B
F4	P900 525-690 V	Eaton XTCE820N22A
F4	P710-P800 380-500 V & P1M2 525-690 V	Eaton XTCEC14P22B

Table 3.49 Mains Contactor Types

⚠WARNING

Customer supplied 230 V supply required for Mains Contactors.

3

3.5.17 Motor Insulation

For motor cable lengths ≤ the maximum cable length listed in , the recommended motor insulation ratings are in *Table 3.50*. 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 3.50 Motor Insulation at Various Nominal Mains Voltages

3.5.18 Motor Bearing Currents

All motors installed with FC 302 90 kW or higher power drives should have NDE (Non-Drive End) insulated bearings installed to eliminate circulating bearing currents. To minimize DE (Drive End) bearing and shaft currents proper grounding of the drive, motor, driven machine, and motor to the driven machine is required.

Standard Mitigation Strategies:

1. Use an insulated bearing
2. Apply rigorous installation procedures
   - 2a Ensure the motor and load motor are aligned
   - 2b Strictly follow the EMC Installation guideline
   - 2c Reinforce the PE so the high frequency impedance is lower in the PE than the input power leads
   - 2d Provide a good high frequency connection between the motor and the frequency converter for instance by screened cable which has a 360° connection in the motor and the frequency converter
   - 2e Make sure that the impedance from frequency converter to building ground is lower that the grounding impedance of the machine. This can be difficult for pumps
   - 2f Make a direct earth connection between the motor and load motor
3. Lower the IGBT switching frequency
4. Modify the inverter waveform, 60° AVM vs. SFAVM
5. Install a shaft grounding system or use an isolating coupling
6. Apply conductive lubrication
7. Use minimum speed settings if possible
8. Try to ensure the line voltage is balanced to ground. This can be difficult for IT, TT, TN-CS or Grounded leg systems
9. Use a dU/dt or sinus filter

3.5.19 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 No.	Function
106, 104, 105	Brake resistor temperature switch.

Table 3.51 Terminals for Brake Resister Temperature Switch

NOTICE

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

3.5.20 Control Cable Routing

Tie down all control wires to the designated control cable routing as shown in the picture. Remember to connect the shields in a proper way to ensure optimum electrical immunity.

Fieldbus connection
Connections are made to the relevant options on the control card. For details, see the relevant fieldbus instruction. The cable must be placed in the provided path inside the frequency converter and tied down with other control wires (see illustrations).

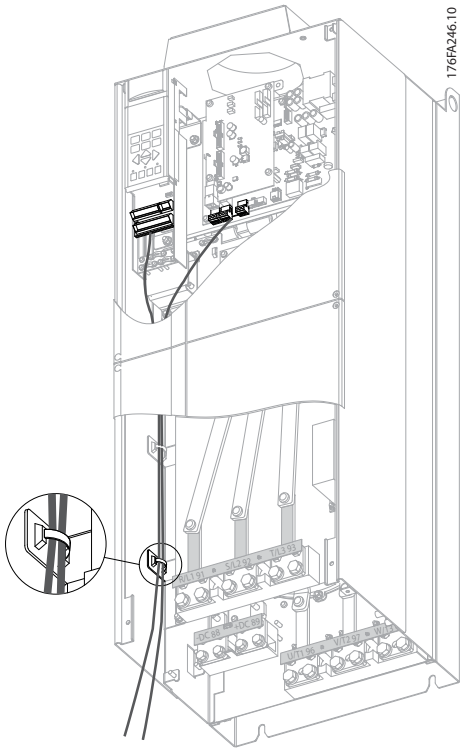


Illustration 3.65 Control Card Wiring Path for the D3. Control Card Wiring for the D1, D2, D4, E1 and E2 use the same Path

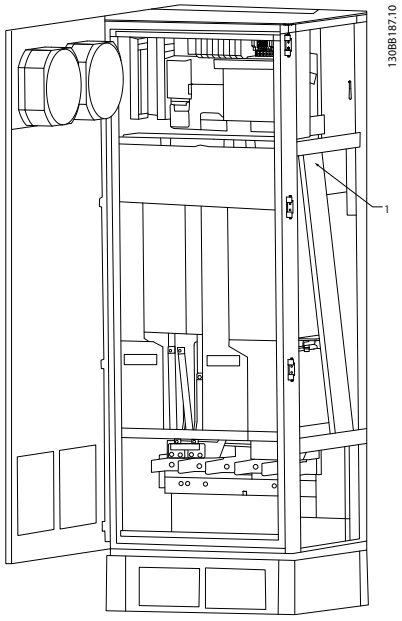


Illustration 3.66 Control Card Wiring Path for the F1/F3. Control Card Wiring for the F2/F4 use the same Path

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 the following pictures. On the NEMA 1 unit a cover plate must be removed.
Kit number for fieldbus top connection: 176F1742

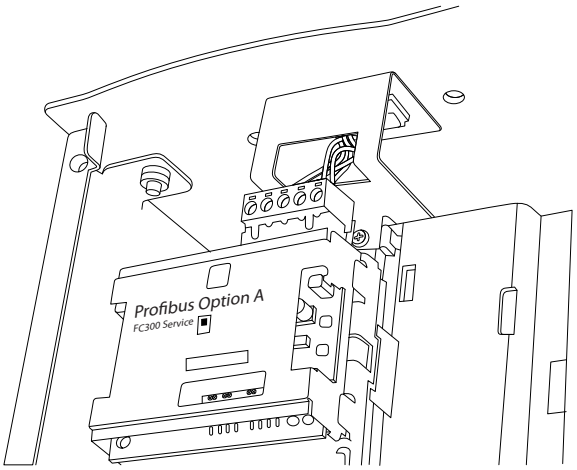


Illustration 3.67 Top Connection for Fieldbus.

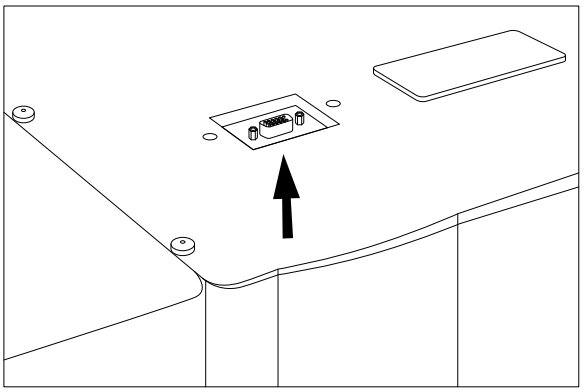


Illustration 3.68

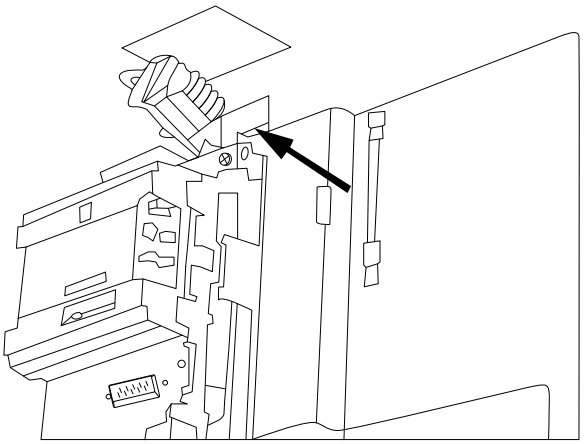


Illustration 3.69

3

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

No.	Function
35 (-), 36 (+)	24 V external DC supply

Table 3.52 Terminals for 24 V External DC 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

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

3.5.21 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 version or removing the covers of the IP00 version.

3.5.22 Electrical Installation, Control Terminals

To connect the cable to the terminal

1. Strip insulation by about 9-10 mm

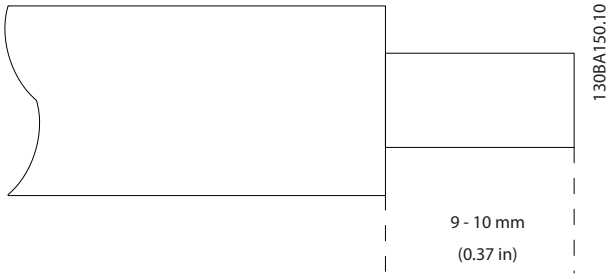


Illustration 3.70 Stripping of Insulation

2. Insert a screwdriver[1)] in the square hole.
3. Insert the cable in the adjacent circular hole.

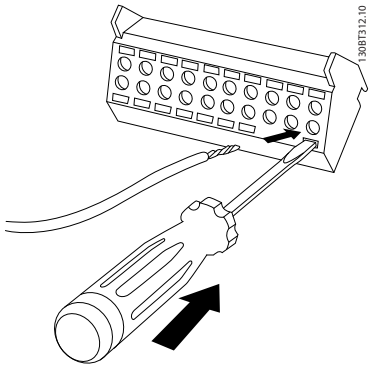


Illustration 3.71

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

To remove the cable from the terminal

1. Insert a screw driver[1)] in the square hole.
2. Pull out the cable.

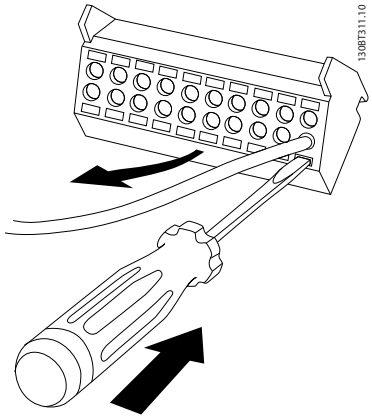


Illustration 3.72

[1)] Max. 0.4 x 2.5 mm

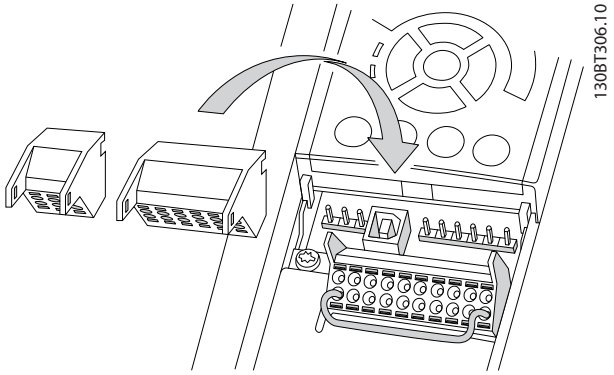


Illustration 3.73

3.5.23 Electrical Installation, Control Cables

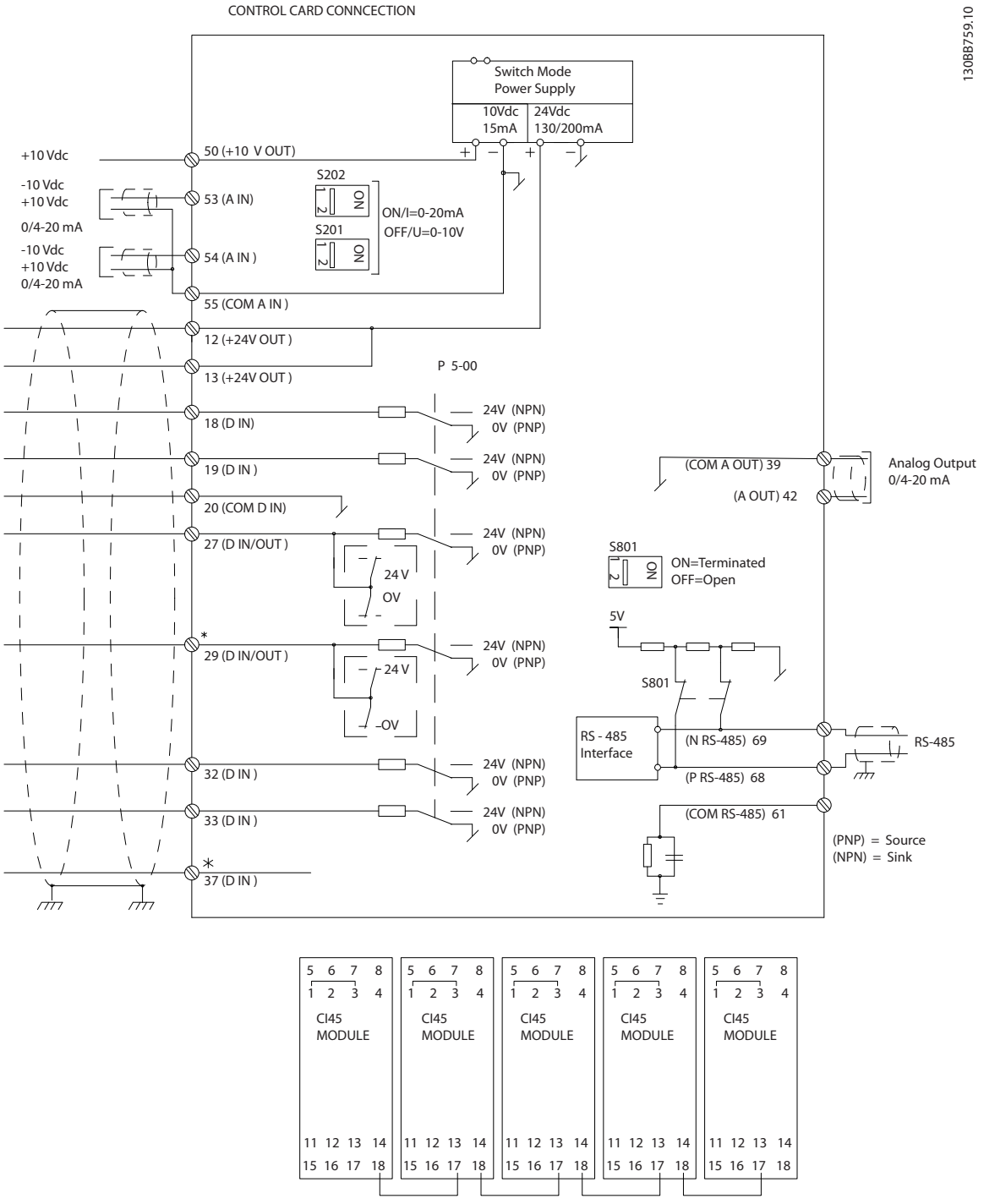


Illustration 3.74

A=Analog, D=Digital

*Terminal 37 (optional) is used for Safe Torque Off. For Safe Torque Off installation instructions, refer to the *Safe Torque Off Operating Instructions for Danfoss VLT® Frequency Converters*. Terminal 37 is not included in FC 301 (except enclosure type A1). Relay 2 and terminal 29 have no function in FC 301.

**Do not connect cable screen.

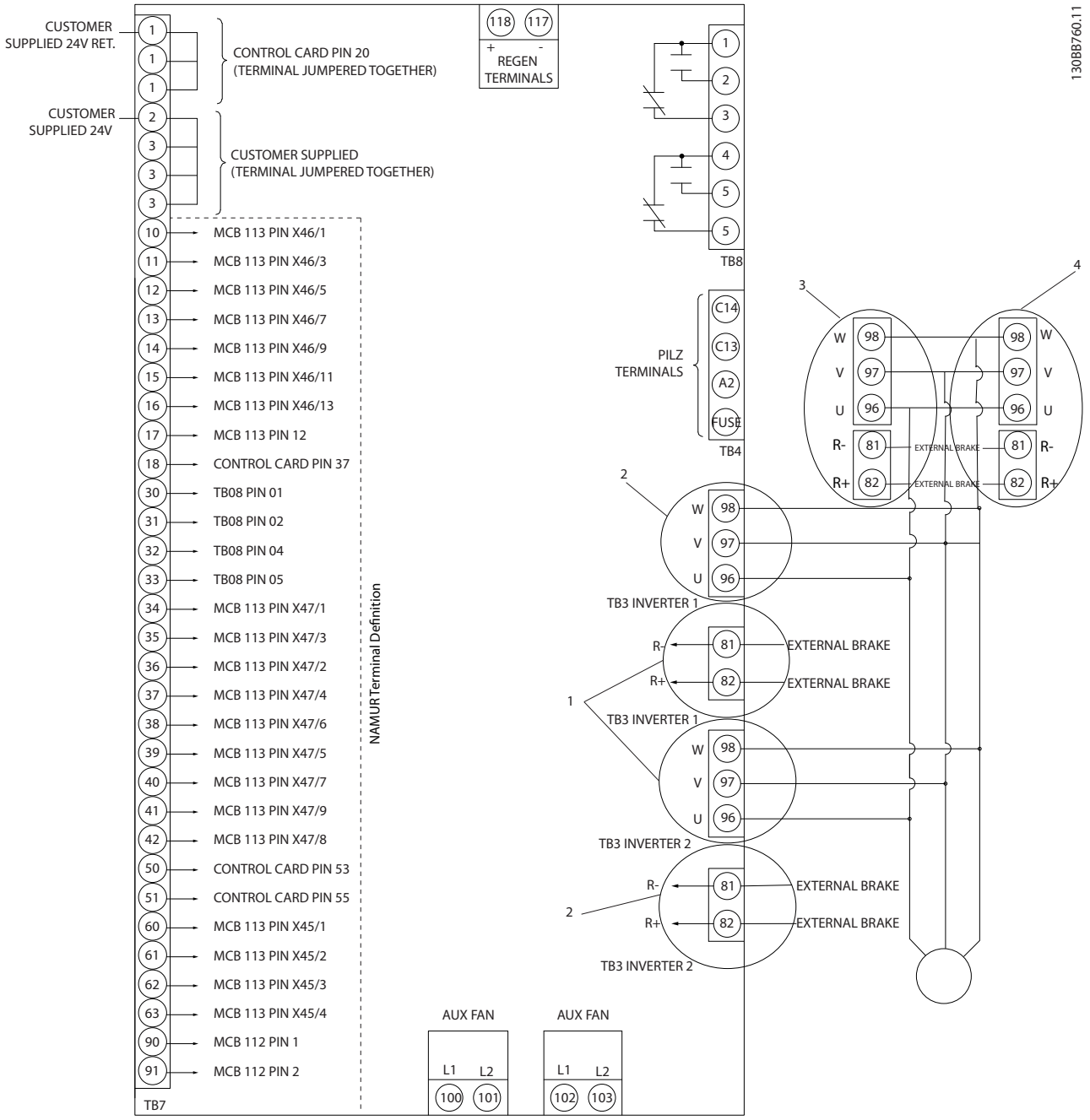


Illustration 3.75 Diagram Showing all Electrical Terminals with NAMUR Option shown in Dotted Line Box

Very 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 this occurs, it may be necessary to break the screen or insert a 100 nF capacitor between screen and chassis.

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

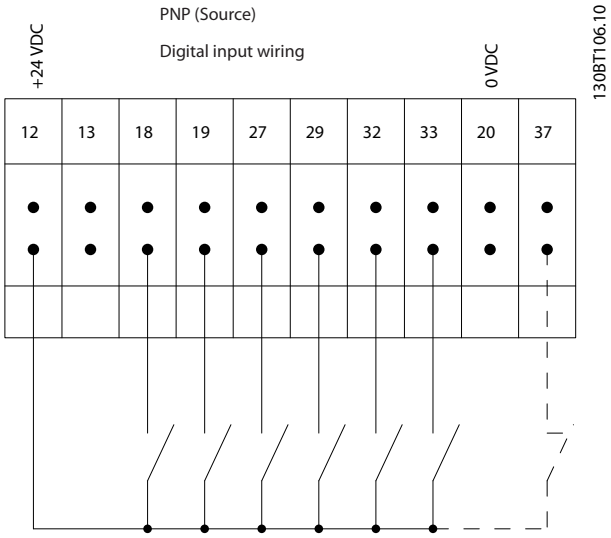


Illustration 3.76

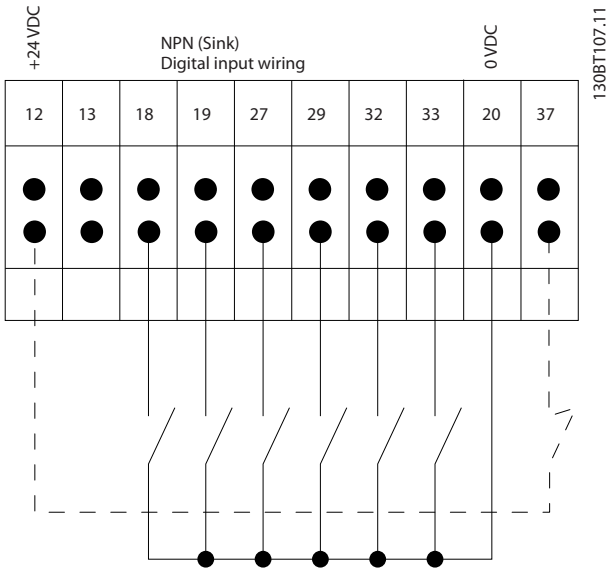


Illustration 3.77

NOTICE

Control cables must be screened/armoured.

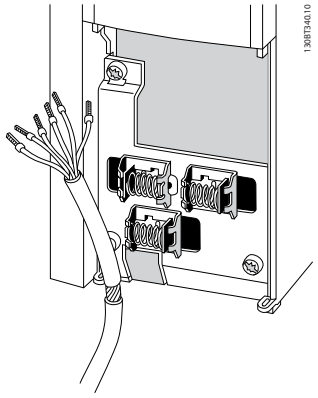


Illustration 3.78

Connect the wires as described in the product related *Operating Instructions*. Remember to connect the shields in a proper way to ensure optimum electrical immunity.

3.5.24 Switches S201, S202, and S801

Switches S201 (A53) and S202 (A54) are used to select a current (0-20 mA) or a voltage (-10 to +10 V) configuration of the analog input terminals 53 and 54.

Switch S801 (BUS TER.) can be used to enable termination on the RS-485 port (terminals 68 and 69).

See *Illustration 3.74*.

Default setting:

S201 (A53) = OFF (voltage input)

S202 (A54) = OFF (voltage input)

S801 (Bus termination) = OFF

3

NOTICE

When changing the function of S201, S202 or S801 be careful not to use force for the switch over. It is recommended to remove the LCP fixture (cradle) when operating the switches. The switches must not be operated with power on the frequency converter.

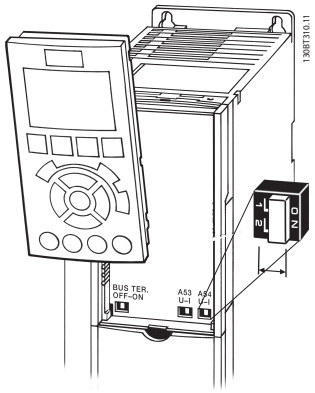


Illustration 3.79

3.6 Connection Examples

3.6.1 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 = Safe Torque Off

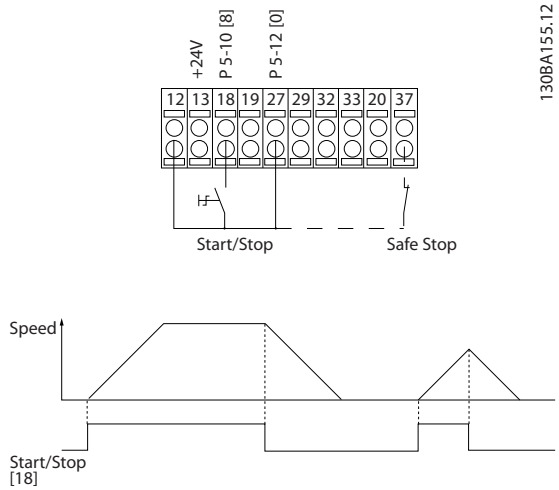


Illustration 3.80

3.6.2 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 = Safe Torque Off

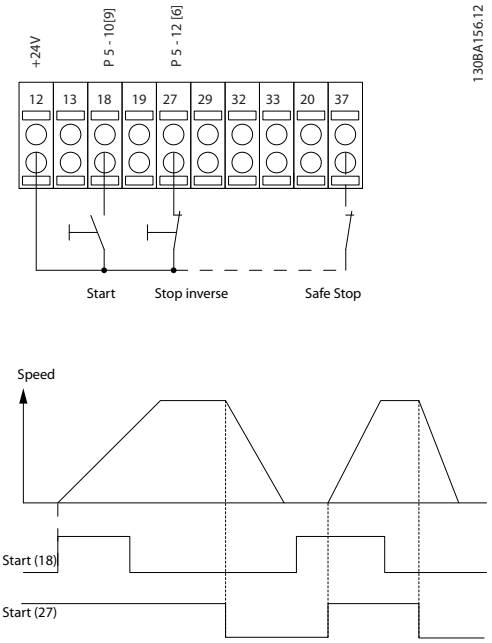


Illustration 3.81

3.6.3 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).

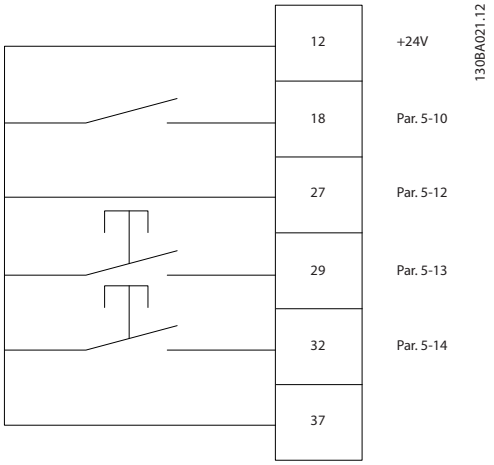


Illustration 3.82 Speed Up/Down

3.6.4 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)

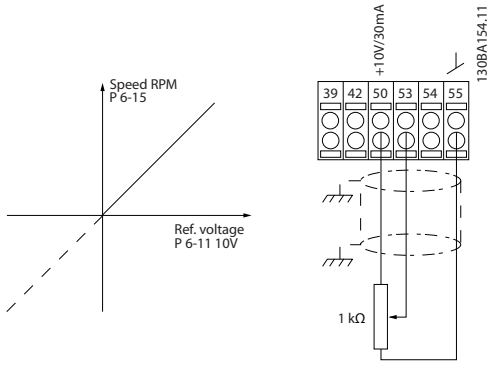


Illustration 3.83 Potentiometer Reference

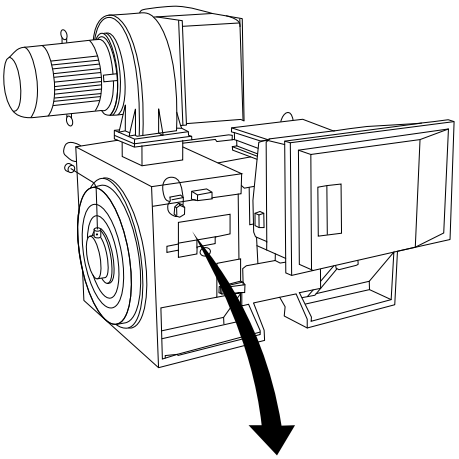
3.7 Final Set-Up and Test

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

Step 1. Locate the motor name plate

NOTICE

The motor is either star- (Y) or delta- connected (Δ). This information is located on the motor name plate data.



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 3.84

Step 2. Enter the motor name plate data in this parameter list.

To access this list first press [Quick Menu] then select "Q2 Quick Setup".

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

Table 3.53

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 AMA was terminated by the user.

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 *chapter 6 Warnings and Alarms*.
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 assists in troubleshooting. If contacting Danfoss for service, make sure to mention number and alarm description.

NOTICE

Unsuccessful AMA is often caused by incorrectly registered motor name plate data or a too big difference between the motor power size and the frequency converter power size.

Step 4. Set speed limit and ramp time

Parameter 3-02 Minimum Reference

Parameter 3-03 Maximum Reference

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]*

Parameter 3-41 Ramp 1 Ramp Up Time

Parameter 3-42 Ramp 1 Ramp Down Time

3.8 Additional Connections

3.8.1 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.

3.8.2 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 3.85*, is 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 protection for the individual motor in systems with parallel-connected motors. Provide further motor protection by e.g. thermistors in each motor or individual thermal relays (circuit breakers are not suitable as protection).

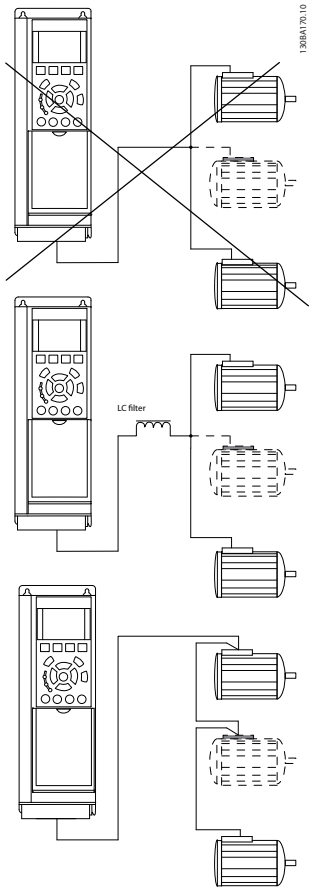


Illustration 3.85

Problems may arise at start 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 and at low RPM values.

3.8.3 Motor Thermal Protection

The electronic thermal relay in the frequency converter has received UL-approval for single motor protection, when *1-90 Motor Thermal Protection*is set for *ETR Trip* and *1-24 Motor Current* is set to the rated motor current (see motor name plate).
For thermal motor protection it is also possible to use the MCB 112 PTC Thermistor Card 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* is combined with the use of MCB 112, it is possible to control an Ex-e motor in explosion hazardous areas. Consult the programming guide for details on how to set up the frequency converter for safe operation of Ex-e motors.

4 How to Programme

4.1 The Graphical and Numerical LCP

The easiest programming of the frequency converter is performed by the graphical LCP (LCP 102). Consult the frequency converter *Design Guide*, when using the Numeric Local Control Panel (LCP 101).

The control panel is divided into 4 functional groups:

1. Graphical display with Status lines.
2. Menu keys and indicator lights - changing parameters and switching between display functions.
3. Navigation keys and indicator lights (LEDs).
4. Operation keys and indicator lights (LEDs).

All data is displayed in a graphical LCP display, which can show up to 5 items of operating data while displaying [Status].

Display lines:

a. **Status line:** Status messages displaying icons and graphic.

b. **Line 1-2:** Operator data lines displaying data defined or selected by the user. By pressing [Status], up to one extra line can be added.

c. **Status line:** Status messages displaying text.

NOTICE

If some operation is delaying the start-up, the LCP displays the INITIALISING message until it is ready. Adding or removing options may delay the start-up.

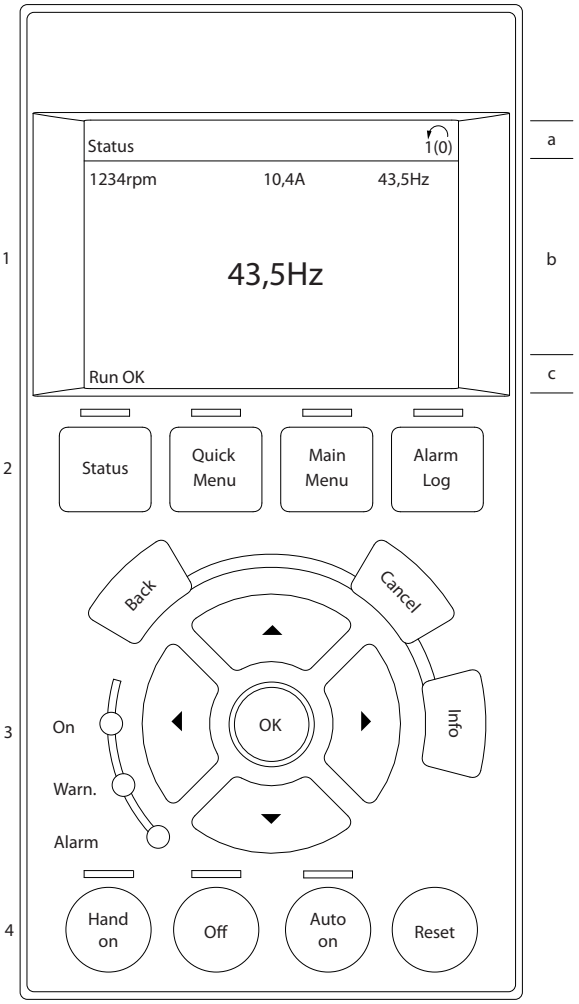


Illustration 4.1 Control Panel (LCP)

4.1.1 How to Programme on the Numerical Local Control Panel

The following instructions are valid for the numerical LCP (LCP 101):

The control panel is divided into 4 functional groups:

1. Numerical display.
2. Menu keys and indicator lights - changing parameters and switching between display functions.
3. Navigation keys and indicator lights (LEDs).
4. Operation keys and indicator lights (LEDs).

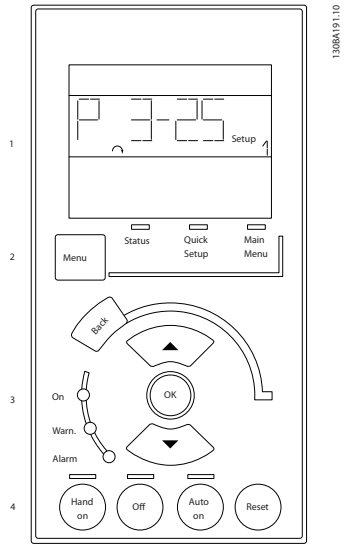


Illustration 4.2

4.1.2 Initial Commissioning

The easiest way of carrying out the initial commissioning is by pressing [Quick Menu] and following the quick set-up procedure using LCP 102 (read *Table 4.1* from left to right). The example applies to open loop applications.

Press				
Quick Menu	↓	Q2 Quick Menu	OK	↓
Parameter 0-01 Language	OK	Set language	↓	
Parameter 1-20 Motor Power [kW]	OK	Set Motor nameplate power	↓	
1-22 Motor Voltage	OK	Set Nameplate voltage	↓	
Parameter 1-23 Motor Frequency	OK	Set Nameplate frequency	↓	
1-24 Motor Current	OK	Set Nameplate current	↓	
1-25 Motor Nominal Speed	OK	Set Nameplate speed in RPM	↓	
5-12 Terminal 27 Digital Input	OK	If terminal default is *Coast inverse* it is possible to change this setting to *No function*. No connection to terminal 27 is then needed for running AMA	↓	
1-29 Automatic Motor Adaptation (AMA)	OK	Set desired AMA function. Enable complete AMA is recommended	↓	
Parameter 3-02 Minimum Reference	OK	Set the minimum speed of the motor shaft	↓	
Parameter 3-03 Maximum Reference	OK	Set the maximum speed of the motor shaft	↓	
Parameter 3-41 Ramp 1 Ramp Up Time	OK	Set the ramping up time with reference to synchronous motor speed, n_s	↓ ↓	
Parameter 3-42 Ramp 1 Ramp Down Time	OK	Set the ramping down time with reference to synchronous motor speed, n_s	↓	
3-13 Reference Site	OK	Set the site from where the reference must work	↓	

Table 4.1 Quick Set-up Procedure

Another easy way of commissioning the frequency converter is by using the Smart Application Setup (SAS), which can also be found under the Quick Menu. Follow the indications on the successive screens for setting up the applications listed.

[Info] can be used throughout the SAS to see help information for various selections, settings, and messages. The following 3 applications are included:

- Mechanical Brake
- Conveyor
- Pump/Fan

The following 4 field-busses can be selected:

- Profibus
- Profinet
- DeviceNet
- EthernetIP

NOTICE

The start conditions are ignored while in the wizard.

NOTICE

The Smart Set-up runs automatically on the first power-up of the frequency converter or after a reset to factory settings. If no action is taken, the SAS screen automatically disappears after 10 min.

4.2 Quick Setup

0-01 Language		
Option:		**Function:**
		Defines the language to be used in the display. 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

0-01 Language		
Option:		**Function:**
[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
[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]	***NOTICE*** **This parameter cannot be adjusted while the motor is running.** 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. This parameter is visible in LCP if *0-03 Regional Settings* is *[0] International*. ***NOTICE*** **4 sizes down, 1 size up from nominal unit rating.**

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 unit.

4

1-23 Motor Frequency		
Range:		**Function:**
Size related*	[20 - 1000 Hz]	Min - Max motor frequency: 20-1000 Hz. Select the motor frequency value from the motor nameplate data. If a value different from 50 Hz or 60 Hz is selected, adapt the load independent settings in *1-50 Motor Magnetisation at Zero Speed* to *1-53 Model Shift Frequency*. For 87 Hz operation with 230/400 V motors, set the nameplate data for 230 V/50 Hz. To run at 87 Hz, adapt *4-13 Motor Speed High Limit [RPM]* and *parameter 3-03 Maximum Reference*.

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, motor thermal 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.

5-12 Terminal 27 Digital Input		
Option:		**Function:**
[2] *	Coast inverse	Functions are described under parameter group *5-1* Digital Inputs*

1-29 Automatic Motor Adaptation (AMA)		
Option:		**Function:**
		The AMA function optimises dynamic motor performance by automatically optimising the advanced motor parameters (*1-30 Stator Resistance (Rs)* to *1-35 Main Reactance (Xh)*) at motor standstill. Activate the AMA function by pressing [Hand on] after selecting *[1] Enable complete AMA* or *[2] Enable reduced AMA*. See also *chapter 3.7.1 Final Set-Up and Test*. After a normal sequence, the display reads: "Press [OK] to finish AMA". After pressing [OK], the frequency converter is ready for operation. This parameter cannot be adjusted while the motor is running.
[0] *	OFF	
[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. **FC 301:** The complete AMA does not include X_h measurement for FC 301. Instead, the X_h value is determined from the motor database. *1-35 Main Reactance (Xh)* may be adjusted to obtain optimal start performance.
[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.

1-29 Automatic Motor Adaptation (AMA)		
Option:		**Function:**
		X_1, the rotor leakage reactance X_2 and the main reactance X_h. **FC 301:** The complete AMA does not include X_h measurement for FC 301. Instead, the X_h value is determined from the motor database. *1-35 Main Reactance (Xh)* may be adjusted to obtain optimal start performance.
[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.

Note:

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

NOTICE

It is important to set motor parameter group 1-2* correctly, since these form part of the AMA algorithm. An AMA must be performed to achieve optimum dynamic motor performance. It may take up to 10 min, depending on the power rating of the motor.

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 setting.

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. Minimum reference is active only when *3-00 Reference Range* is set to *[0] Min.- Max.* The minimum reference unit matches: • The configuration of *1-00 Configuration Mode*:

3-02 Minimum Reference		
Range:		**Function:**
		for *[1] Speed closed loop*, RPM; for *[2] Torque*, Nm. • The unit selected in *3-01 Reference/Feedback Unit*.

3-03 Maximum Reference		
Range:		**Function:**
Size related*	[par. 3-02 - 999999.999 ReferenceFeedbackUnit]	Enter the Maximum Reference. The Maximum Reference is the highest value obtainable by summing all references. **The Maximum Reference unit matches:** • The choice of configuration in *1-00 Configuration Mode*: for *[1] Speed closed loop*, RPM; for *[2] Torque*, Nm. • The unit selected in *3-00 Reference Range*.

3-41 Ramp 1 Ramp Up Time		
Range:		**Function:**
Size related*	[0.01 - 3600 s]	Enter the ramp-up time, i.e. the acceleration time from 0 RPM to the synchronous motor speed n_S. Select a ramp-up time such that the output current does not exceed the current limit in *4-18 Current Limit* during ramping. The value 0.00 corresponds to 0.01 s in speed mode. See ramp-down time in *parameter 3-42 Ramp 1 Ramp Down Time*. $Par.\ 3-41 = \frac{tacc\ [s]\ x\ ns\ [RPM]}{ref\ [RPM]}$

3-42 Ramp 1 Ramp Down Time		
Range:		**Function:**
Size related*	[0.01 - 3600 s]	Enter the ramp-down time, that is, the deceleration time from the synchronous motor speed n_s to 0 RPM. Select a ramp-down time such that no overvoltage arises in the inverter due to regenerative operation of the motor, and such that the generated current does not exceed the current limit set in *4-18 Current Limit*. The value 0.00 corresponds to 0.01 s in speed mode. See ramp-up time in *parameter 3-41 Ramp 1 Ramp Up Time*. $Par.\ 3-42 = \frac{tdec\ [s]\ x\ ns\ [RPM]}{ref\ [RPM]}$

4.3 Parameter Menu Structure

4

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5-26	Terminal X46/13 Digital Input
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5-31	Terminal 29 Digital Output
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5-41	On Delay, Relay
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5-51	Term. 29 High Frequency
5-52	Term. 29 Low Ref./Feedb. Value
5-53	Term. 29 High Ref./Feedb. Value
5-54	Pulse Filter Time Constant #29
5-55	Term. 33 Low Frequency
5-56	Term. 33 High Frequency
5-57	Term. 33 Low Ref./Feedb. Value
5-58	Term. 33 High Ref./Feedb. Value
5-59	Pulse Filter Time Constant #33
5-6*	**Pulse Output**
5-60	Terminal 27 Pulse Output Variable
5-62	Pulse Output Max Freq #27
5-63	Terminal 29 Pulse Output Variable
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5-66	Terminal X30/6 Pulse Output Variable
5-68	Pulse Output Max Freq #X30/6
5-7*	**24V Encoder Input**
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5-71	Term 32/33 Encoder Direction
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5-9*	**Bus Controlled**
5-90	Digital & Relay Bus Control
5-93	Pulse Out #27 Bus Control
5-94	Pulse Out #27 Timeout Preset
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5-98	Pulse Out #X30/6 Timeout Preset
6-**	**Analog In/Out**
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6-16	Terminal 53 Filter Time Constant
6-2*	**Analog Input 2**
6-20	Terminal 54 Low Voltage
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6-23	Terminal 54 High Current
6-24	Terminal 54 Low Ref./Feedb. Value
6-25	Terminal 54 High Ref./Feedb. Value
6-26	Terminal 54 Filter Time Constant
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6-30	Terminal X30/11 Low Voltage
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6-4*	**Analog Input 4**
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6-44	Term. X30/12 Low Ref./Feedb. Value
6-45	Term. X30/12 High Ref./Feedb. Value
6-46	Term. X30/12 Filter Time Constant
6-5*	**Analog Output 1**
6-50	Terminal 42 Output
6-51	Terminal 42 Output Min Scale
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6-54	Terminal 42 Output Timeout Preset
6-55	Analog Output Filter
6-6*	**Analog Output 2**
6-60	Terminal X30/8 Output
6-61	Terminal X30/8 Min. Scale
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6-7*	**Analog Output 3**
6-70	Terminal X45/1 Output
6-71	Terminal X45/1 Min. Scale
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6-80	Terminal X45/3 Output
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7-02	Speed PID Proportional Gain
7-03	Speed PID Integral Time
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7-06	Speed PID Lowpass Filter Time
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7-08	Speed PID Feed Forward Factor
7-09	Speed PID Error Correction w/ Ramp
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7-20	Process CL Feedback 1 Resource
7-22	Process CL Feedback 2 Resource
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7-30	Process PID Normal/ Inverse Control
7-31	Process PID Anti Windup
7-32	Process PID Start Speed
7-33	Process PID Proportional Gain
7-34	Process PID Integral Time
7-35	Process PID Differentiation Time
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7-39	On Reference Bandwidth
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7-43	Process PID Gain Scale at Min. Ref.
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7-46	Process PID Feed Fwd Normal/ Inv. Ctrl.
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7-5*	**Adv. Process PID II**
7-50	Process PID Extended PID
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32-30 Incremental Signal Type
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32-32 Absolute Protocol
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32-35 Absolute Encoder Data Length
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5 General Specifications

5

Mains supply (L1, L2, L3):	
Supply voltage	380-500 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 converters continues until the intermediate circuit voltage drops below the minimum stop level, which corresponds typically to 15% below the drive'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%
Max. imbalance temporary between mains phases	3.0 % of rated supply voltage
True Power Factor (λ)	≥ 0.9 nominal at rated load
Displacement Power Factor (cos ϕ) near unity	(> 0.98)
Switching on input supply L1, L2, L3 (power-ups)	maximum 1 time/2 min.
Environment according to EN60664-1	over-voltage category III/pollution degree 2

The unit is suitable for use on a circuit capable of delivering not more than 100.000 RMS symmetrical Amperes, 500/600/690 V maximum.

Motor output (U, V, W)	
Output voltage	0 - 100% of supply voltage
Output frequency	0 - 800* Hz
Switching on output	Unlimited
Ramp times	0.01 - 3600 s

** Voltage and power dependent*

Torque characteristics	
Starting torque (constant torque)	maximum 160% for 60 s[1)] once in 10 min.
Starting/overload torque (variable torque)	maximum 110% up to 0.5 s[1)] once in 10 min.
Torque rise time in FLUX (for 5 kHz fsw)	1 ms
Torque rise time in VVC^{plus} (independent of fsw)	10 ms

1) Percentage relates to the nominal torque.

2) The torque response time depends on application and load but as a general rule, the torque step from 0 to reference is 4-5 x torque rise time.

Digital inputs	
Programmable digital inputs	4 (6)
Terminal number	18, 19, 27[1)], 29, 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[2)]	> 19 V DC
Voltage level, logic '1' NPN[2)]	< 14 V DC
Maximum voltage on input	28 V DC
Pulse frequency range	0 - 110 kHz
(Duty cycle) Min. pulse width	4.5 ms
Input resistance, R_i	approx.4 kΩ

Safe stop Terminal 37[3] (Terminal 37 is fixed PNP logic)	
Voltage level	0 - 24 V DC
Voltage level, logic'0' PNP	< 4 V DC
Voltage level, logic'1' PNP	>20 V DC
Nominal input current at 24 V	50 mA rms
Nominal input current at 20 V	60 mA rms
Input capacitance	400 nF

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.

[2] Except safe stop input Terminal 37.

[3] See chapter 2.1.9 Safe Torque Off (STO) for further information about terminal 37 and Safe Stop..

Analog inputs	
Number of analog inputs	2
Terminal number	53, 54
Modes	Voltage or current
Mode select	Switch S201 and switch S202
Voltage mode	Switch S201/switch S202 = OFF (U)
Voltage level	-10 to +10 V (scaleable)
Input resistance, R_i	approx. 10 kΩ
Max. voltage	± 20 V
Current mode	Switch S201/switch S202 = ON (I)
Current level	0/4 to 20 mA (scaleable)
Input resistance, R_i	approx. 200 Ω
Max. current	30 mA
Resolution for analog inputs	10 bit (+ sign)
Accuracy of analog inputs	Max. error 0.5% of full scale
Bandwidth	100 Hz

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

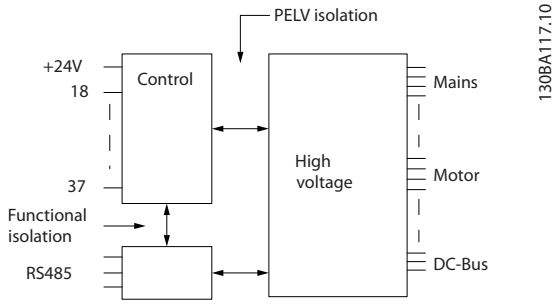

Illustration 5.1

Pulse/encoder inputs	
Programmable pulse/encoder inputs	2/1
Terminal number pulse/encoder	29[1], 33[2] / 32[3], 33[3]
Max. frequency at terminal 29, 32, 33	110 kHz (Push-pull driven)
Max. frequency at terminal 29, 32, 33	5 kHz (open collector)
Min. frequency at terminal 29, 32, 33	4 Hz
Voltage level	see section on Digital input
Maximum voltage on input	28 V DC
Input resistance, R_i	approx. 4 kΩ
Pulse input accuracy (0.1-1 kHz)	Max. error: 0.1% of full scale
Encoder input accuracy (1-11 kHz)	Max. error: 0.05 % of full scale

The pulse and encoder inputs (terminals 29, 32, 33) are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

[1] FC 302 only

[2] Pulse inputs are 29 and 33

[3] Encoder inputs: 32 = A, and 33 = B

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

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

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

Analog output	
Number of programmable analog outputs	1
Terminal number	42
Current range at analog output	0/4 to 20 mA
Max. load GND - analog output less than	500 Ω
Accuracy on analog output	Max. error: 0.5% of full scale
Resolution on analog output	12 bit

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

Control card, 24 V DC output	
Terminal number	12, 13
Output voltage	24 V +1, -3V
Max. load	200 mA

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

Control card, 10 V DC output	
Terminal number	±50
Output voltage	10.5 V ±0.5 V
Max. load	15 mA

The 10 V DC supply 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).

Control card, USB serial communication:	
USB standard	1.1 (Full speed)
USB plug	USB type B plug

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 ground connection is not galvanically isolated from protection earth. Use only an isolated laptop as PC connection to the USB connector on the frequency converter.

Relay outputs	
Programmable relay outputs	2
Relay 01 Terminal number	1-3 (break), 1-2 (make)
Max. terminal load (AC-1)[1)] on 1-3 (NC), 1-2 (NO) (Resistive load)	240 V AC, 2 A
Max. terminal load (AC-15)[1)] (Inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Max. terminal load (DC-1)[1)] on 1-2 (NO), 1-3 (NC) (Resistive load)	60 V DC, 1 A
Max. terminal load (DC-13)[1)] (Inductive load)	24 V DC, 0.1 A
Relay 02 (FC 302 only) Terminal number	4-6 (break), 4-5 (make)
Max. terminal load (AC-1)[1)] on 4-5 (NO) (Resistive load)	400 V AC, 2 A
Max. terminal load (AC-15)[1)] on 4-5 (NO) (Inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Max. terminal load (DC-1)[1)] on 4-5 (NO) (Resistive load)	80 V DC, 2 A
Max. terminal load (DC-13)[1)] on 4-5 (NO) (Inductive load)	24 V DC, 0.1 A
Max. terminal load (AC-1)[1)] on 4-6 (NC) (Resistive load)	240 V AC, 2 A
Max. terminal load (AC-15)[1)] on 4-6 (NC) (Inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Max. terminal load (DC-1)[1)] on 4-6 (NC) (Resistive load)	50 V DC, 2 A
Max. terminal load (DC-13)[1)] on 4-6 (NC) (Inductive load)	24 V DC, 0.1 A
Min. terminal load on 1-3 (NC), 1-2 (NO), 4-6 (NC), 4-5 (NO)	24 V DC 10 mA, 24 V AC 20 mA
Environment according to EN 60664-1	overvoltage category III/pollution degree 2

1) IEC 60947 part 4 and 5
The relay contacts are galvanically isolated from the rest of the circuit by reinforced isolation (PELV).

Cable lengths and cross sections	
Max. motor cable length, screened/armoured	150 m
Max. motor cable length, unscreened/unarmoured	300 m
Maximum cross section to control terminals, flexible/ rigid wire without cable end sleeves	1.5 mm^2/16 AWG
Maximum cross section to control terminals, flexible wire with cable end sleeves	1 mm^2/18 AWG
Maximum cross section to control terminals, flexible wire with cable end sleeves with collar	0.5 mm^2/20 AWG
Minimum cross section to control terminals	0.25 mm^2/24 AWG

Control card performance	
Scan interval	1 ms

Control characteristics	
Resolution of output frequency at 0-590 Hz	±0.003 Hz
Repeat accuracy of Precise start/stop (terminals 18, 19)	≤±0.1 ms
System response time (terminals 18, 19, 27, 29, 32, 33)	≤ 2 ms
Speed control range (open loop)	1:100 of synchronous speed
Speed control range (closed loop)	1:1000 of synchronous speed
Speed accuracy (open loop)	30-4000 RPM: error ±8 RPM
Speed accuracy (closed loop), depending on resolution of feedback device	0-6000 RPM: error ±0.15 RPM
Torque control accuracy (speed feedback)	max error ±5% of rated torque

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

Surroundings	
Enclosure, frame size D and E	IP 00/ Chassis, IP 21/ Type 1, IP 54/ Type 12
Enclosure, frame size F	IP 21/ Type 1, IP 54/ Type 12
Vibration test	0.7 g
Max. relative humidity	5% - 95%(IEC 721-3-3; Class 3K3 (non-condensing) during operation
Aggressive environment (IEC 60068-2-43	class H_25
Ambient temperature (with SFAVM switching mode)	
- with derating	Max. 55 °C[1)]
- at full continuous drive output current	Max. 45 °C[1)]

1) For more information on derating, see 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 - +65/70 °C
Maximum altitude above sea level without derating	1000 m

Derating for high altitude, see special conditions in the Design Guide

EMC standards, Emission	EN 61800-3, EN 61000-6-3/4, EN 55011
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

See section on special conditions in the Design Guide.

Protection and Features

- Electronic thermal motor protection against overload.
- Temperature monitoring of the heatsink ensures that the frequency converter trips if the temperature reaches a predefined level. An overload temperature cannot be reset until the temperature of the heatsink is below the values stated in the tables on the following pages (Guideline - these temperatures may vary for different power sizes, frame 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).
- Monitoring of the intermediate circuit voltage ensures that the frequency converter trips if the intermediate circuit voltage is too low or too high.
- The frequency converter constantly checks for critical levels of internal temperature, load current, high voltage on the intermediate circuit and low motor speeds. As a response to a critical level, the frequency converter can adjust the switching frequency and/ or change the switching pattern to ensure the performance of the frequency converter.

Mains Supply 3 x 380 - 500 V AC										
FC 302	P90K		P110		P132		P160		P200	
High/ Normal Load*	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
Typical Shaft output at 400 V [kW]	90	110	110	132	132	160	160	200	200	250
Typical Shaft output at 460 V [hp]	125	150	150	200	200	250	250	300	300	350
Typical Shaft output at 500 V [kW]	110	132	132	160	160	200	200	250	250	315
Enclosure IP21	D1		D1		D2		D2		D2	
Enclosure IP54	D1		D1		D2		D2		D2	
Enclosure IP00	D3		D3		D4		D4		D4	
Output current										
Continuous (at 400 V) [A]	177	212	212	260	260	315	315	395	395	480
Intermittent (60 s overload) (at 400 V) [A]	266	233	318	286	390	347	473	435	593	528
Continuous (at 460/500 V) [A]	160	190	190	240	240	302	302	361	361	443
Intermittent (60 s overload) (at 460/500 V) [A]	240	209	285	264	360	332	453	397	542	487
Continuous kVA (at 400 V) [kVA]	123	147	147	180	180	218	218	274	274	333
Continuous kVA (at 460 V) [kVA]	127	151	151	191	191	241	241	288	288	353
Continuous kVA (at 500 V) [kVA]	139	165	165	208	208	262	262	313	313	384
Max. input current										
Continuous (at 400 V) [A]	171	204	204	251	251	304	304	381	381	463
Continuous (at 460/500 V) [A]	154	183	183	231	231	291	291	348	348	427
Max. cable size, mains motor, brake and load share [mm² (AWG[2)])]	2 x 70 (2 x 2/0)		2 x 70 (2 x 2/0)		2 x 150 (2 x 300 mcm)		2 x 150 (2 x 300 mcm)		2 x 150 (2 x 300 mcm)	
Max. external mains fuses [A] [1]	300		350		400		500		630	
Estimated power loss at 400 V [W] [4)]	2369	2907	2634	3357	3117	3914	3640	4812	4288	5517
Estimated power loss at 460 V [W]	2162	2599	2350	3078	2886	3781	3629	4535	3624	5025
Weight, enclosure IP21, IP54 [kg]	96		104		125		136		151	
Weight, enclosure IP00 [kg]	82		91		112		123		138	
Efficiency[4)]	0.98									
Output frequency	0 - 800 Hz									
Heatsink overtemp. trip	90 °C		110 °C		110 °C		110 °C		110 °C	
Power card ambient trip	75 °C									
* High overload = 160% torque during 60 s, Normal overload = 110% torque during 60 s										

Table 5.1

5

Mains Supply 3 x 380 - 500 V AC								
FC 302	P250		P315		P355		P400	
High/ Normal Load*	HO	NO	HO	NO	HO	NO	HO	NO
Typical Shaft output at 400 V [kW]	250	315	315	355	355	400	400	450
Typical Shaft output at 460 V [hp]	350	450	450	500	500	600	550	600
Typical Shaft output at 500 V [kW]	315	355	355	400	400	500	500	530
Enclosure IP21	E1		E1		E1		E1	
Enclosure IP54	E1		E1		E1		E1	
Enclosure IP00	E2		E2		E2		E2	
Output current								
Continuous (at 400 V) [A]	480	600	600	658	658	745	695	800
Intermittent (60 sec overload) (at 400 V) [A]	720	660	900	724	987	820	1043	880
Continuous (at 460/500 V) [A]	443	540	540	590	590	678	678	730
Intermittent (60 s overload) (at 460/500 V) [A]	665	594	810	649	885	746	1017	803
Continuous kVA (at 400 V) [kVA]	333	416	416	456	456	516	482	554
Continuous kVA (at 460 V) [kVA]	353	430	430	470	470	540	540	582
Continuous kVA (at 500 V) [kVA]	384	468	468	511	511	587	587	632
Max. input current								
Continuous (at 400 V) [A]	472	590	590	647	647	733	684	787
Continuous (at 460/500 V) [A]	436	531	531	580	580	667	667	718
Max. cable size, mains, motor and load share [mm² (AWG[2)])]	4x240 (4x500 mcm)		4x240 (4x500 mcm)		4x240 (4x500 mcm)		4x240 (4x500 mcm)	
Max. 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)	
Max. external mains fuses [A] [1]	700		900		900		900	
Estimated power loss at 400 V [W] [4)]	5059	6705	6794	7532	7498	8677	7976	9473
Estimated power loss at 460 V [W]	4822	6082	6345	6953	6944	8089	8085	7814
Weight, enclosure IP21, IP54 [kg]	263		270		272		313	
Weight, enclosure IP00 [kg]	221		234		236		277	
Efficiency[4)]	0.98							
Output frequency	0 - 600 Hz							
Heatsink overtemp. trip	110 °C							
Power card ambient trip	75 °C							
* High overload = 160% torque during 60 s, Normal overload = 110% torque during 60 s								

Table 5.2

Mains Supply 3 x 380 - 500 V AC												
FC 302	P450		P500		P560		P630		P710		P800	
High/ Normal Load*	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
Typical Shaft output at 400 V [kW]	450	500	500	560	560	630	630	710	710	800	800	1000
Typical Shaft output at 460 V [hp]	600	650	650	750	750	900	900	1000	1000	1200	1200	1350
Typical Shaft output at 500 V [kW]	530	560	560	630	630	710	710	800	800	1000	1000	1100
Enclosure 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]	800	880	880	990	990	1120	1120	1260	1260	1460	1460	1720
Intermittent (60 s overload) (at 400 V) [A]	1200	968	1320	1089	1485	1232	1680	1386	1890	1606	2190	1892
Continuous (at 460/500 V) [A]	730	780	780	890	890	1050	1050	1160	1160	1380	1380	1530
Intermittent (60 s overload) (at 460/500 V) [A]	1095	858	1170	979	1335	1155	1575	1276	1740	1518	2070	1683
Continuous kVA (at 400 V) [kVA]	554	610	610	686	686	776	776	873	873	1012	1012	1192
Continuous kVA (at 460 V) [kVA]	582	621	621	709	709	837	837	924	924	1100	1100	1219
Continuous kVA (at 500 V) [kVA]	632	675	675	771	771	909	909	1005	1005	1195	1195	1325
Max. input current												
Continuous (at 400 V) [A]	779	857	857	964	964	1090	1090	1227	1227	1422	1422	1675
Continuous (at 460/ 500 V) [A]	711	759	759	867	867	1022	1022	1129	1129	1344	1344	1490
Max. cable size,motor [mm² (AWG[2)])]	8x150 (8x300 mcm)								12x150 (12x300 mcm)			
Max. cable size,mains F1/F2 [mm² (AWG[2)])]	8x240 (8x500 mcm)											
Max. cable size,mains F3/F4 [mm² (AWG[2)])]	8x456 (8x900 mcm)											
Max. cable size, loadsharing [mm² (AWG[2)])]	4x120 (4x250 mcm)											
Max. cable size, brake [mm² (AWG[2)])	4x185 (4x350 mcm)								6x185 (6x350 mcm)			
Max. external mains fuses [A] [1]	1600				2000				2500			
Estimated power loss, 400 V [W] [4)]	9031	10162	10146	11822	10649	12512	12490	14674	14244	17293	15466	19278
Estimated power loss, 460 V [W]	8212	8876	8860	10424	9414	11595	11581	13213	13005	16229	14556	16624
F3/F4 max. added losses A1 RFI, CB or Disconnect, & contactor F3/F4	893	963	951	1054	978	1093	1092	1230	2067	2280	2236	2541
Max. panel options losses	400											
Weight,enclosure IP21/IP54 [kg]	1004/1299		1004/1299		1004/1299		1004/1299		1246/1541		1246 1541	
Weight Rectifier Module [kg]	102		102		102		102		136		136	
Weight Inverter Module [kg]	102		102		102		136		102		102	
Efficiency[4)]	0.98											
Output frequency	0-600 Hz											
Heatsink overtemp. trip	95 °C											
Power card ambient trip	75 °C											
* High overload = 160% torque during 60 s, Normal overload = 110% torque during 60 s												

Table 5.3

5

Mains Supply 525-690 V AC										
FC 302	P37K		P45K		P55K		P75K		P90K	
High/ Normal Load*	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
Typical Shaft output at 550 V [kW]	30	37	37	45	45	55	55	75	75	90
Typical Shaft output at 575 V [hp]	40	50	50	60	60	75	75	100	100	125
Typical Shaft output at 690 V [kW]	37	45	45	55	55	75	75	90	90	110
Enclosure IP21	D1		D1		D1		D1		D1	
Enclosure IP54	D1		D1		D1		D1		D1	
Enclosure IP00	D3		D3		D3		D3		D3	
Output current										
Continuous (at 550 V) [A]	48	56	56	76	76	90	90	113	113	137
Intermittent (60 s overload) (at 550 V) [A]	77	62	90	84	122	99	135	124	170	151
Continuous (at 575/690 V) [A]	46	54	54	73	73	86	86	108	108	131
Intermittent (60 s overload) (at 575/690 V) [A]	74	59	86	80	117	95	129	119	162	144
Continuous KVA (at 550 V) [KVA]	46	53	53	72	72	86	86	108	108	131
Continuous KVA (at 575 V) [KVA]	46	54	54	73	73	86	86	108	108	130
Continuous KVA (at 690 V) [KVA]	55	65	65	87	87	103	103	129	129	157
Max. input current										
Continuous (at 550 V) [A]	53	60	60	77	77	89	89	110	110	130
Continuous (at 575 V) [A]	51	58	58	74	74	85	85	106	106	124
Continuous (at 690 V) [A]	50	58	58	77	77	87	87	109	109	128
Max. cable size, mains, motor, load share and brake [mm^2 (AWG)]	2x70 (2x2/0)									
Max. external mains fuses [A] [1]	125		160		200		200		250	
Estimated power loss at 600 V [W] [4]	1299	1398	1459	1645	1643	1827	1350	1599	1597	1891
Estimated power loss at 690 V [W] [4]	1002	1071	1071	1251	1251	1392	1392	1648	1650	1951
Weight, enclosure IP21, IP54 [kg]	96									
Weight, enclosure IP00 [kg]	82									
Efficiency[4]	0.97		0.97		0.98		0.98		0.98	
Output frequency	0 - 600Hz									
Heatsink overtemp. trip	90°C									
Power card ambient trip	75°C									
* High overload = 160% torque during 60 s., Normal overload = 110% torque during 60 s.										

Table 5.4

Mains Supply 525-690 V AC								
FC 302	P110		P132		P160		P200	
High/ Normal Load*	HO	NO	HO	NO	HO	NO	HO	NO
Typical Shaft output at 550 V [kW]	90	110	110	132	132	160	160	200
Typical Shaft output at 575 V [hp]	125	150	150	200	200	250	250	300
Typical Shaft output at 690 V [kW]	110	132	132	160	160	200	200	250
Enclosure IP21	D1		D1		D2		D2	
Enclosure IP54	D1		D1		D2		D2	
Enclosure IP00	D3		D3		D4		D4	
Output current								
Continuous (at 550 V) [A]	137	162	162	201	201	253	253	303
Intermittent (60 s overload) (at 550 V) [A]	206	178	243	221	302	278	380	333
Continuous (at 575/690 V) [A]	131	155	155	192	192	242	242	290
Intermittent (60 s overload) (at 575/690 V) [A]	197	171	233	211	288	266	363	319
Continuous KVA (at 550 V) [KVA]	131	154	154	191	191	241	241	289
Continuous KVA (at 575 V) [KVA]	130	154	154	191	191	241	241	289
Continuous KVA (at 690 V) [KVA]	157	185	185	229	229	289	289	347
Max. input current								
Continuous (at 550 V) [A]	130	158	158	198	198	245	245	299
Continuous (at 575 V) [A]	124	151	151	189	189	234	234	286
Continuous (at 690 V) [A]	128	155	155	197	197	240	240	296
Max. cable size, mains motor, load share and brake [mm^2 (AWG)]	2 x 70 (2 x 2/0)		2 x 70 (2 x 2/0)		2 x 150 (2 x 300 mcm)		2 x 150 (2 x 300 mcm)	
Max. external mains fuses [A] [1]	315		350		350		400	
Estimated power loss at 600 V [W] [4]	1890	2230	2101	2617	2491	3197	3063	3757
Estimated power loss at 690 V [W] [4]	1953	2303	2185	2707	2606	3320	3192	3899
Weight, Enclosure IP21, IP54 [kg]	96		104		125		136	
Weight, Enclosure IP00 [kg]	82		91		112		123	
Efficiency[4]	0.98							
Output frequency	0 - 600 Hz							
Heatsink overtemp. trip	90°C		110°C		110°C		110°C	
Power card ambient trip	75°C							
* High overload = 160% torque during 60 s., Normal overload = 110% torque during 60 s.								

Table 5.5

Mains Supply 525-690 V AC						
FC 302	P250		P315		P355	
High/ Normal Load*	HO	NO	HO	NO	HO	NO
Typical Shaft output at 550 V [kW]	200	250	250	315	315	355
Typical Shaft output at 575 V [hp]	300	350	350	400	400	450
Typical Shaft output at 690 V [kW]	250	315	315	400	355	450
Enclosure IP21	D2		D2		E1	
Enclosure IP54	D2		D2		E1	
Enclosure IP00	D4		D4		E2	
Output current						
Continuous (at 550 V) [A]	303	360	360	418	395	470
Intermittent (60 sec overload) (at 550 V) [A]	455	396	540	460	593	517
Continuous (at 575/690 V) [A]	290	344	344	400	380	450
Intermittent (60 s overload) (at 575/ 690 V) [A]	435	378	516	440	570	495
Continuous KVA (at 550 V) [KVA]	289	343	343	398	376	448
Continuous KVA (at 575 V) [KVA]	289	343	343	398	378	448
Continuous KVA (at 690 V) [KVA]	347	411	411	478	454	538
Max. input current						
Continuous (at 550 V) [A]	299	355	355	408	381	453
Continuous (at 575 V) [A]	286	339	339	390	366	434
Continuous (at 690 V) [A]	296	352	352	400	366	434
Max. cable size, mains, motor and load share [mm^2 (AWG)]	2 x 150 (2 x 300 mcm)		2 x 150 (2 x 300 mcm)		4 x 240 (4 x 500 mcm)	
Max. cable size, brake [mm^2 (AWG)]	2 x 150 (2 x 300 mcm)		2 x 150 (2 x 300 mcm)		2 x 185 (2 x 350 mcm)	
Max. external mains fuses [A] [1]	500		550		700	
Estimated power loss at 600 V [W] [4]	3552	4307	3971	4756	4130	4974
Estimated power loss at 690 V [W] [4]	3704	4485	4103	4924	4240	5128
Weight, enclosure IP21, IP54 [kg]	151		165		263	
Weight, enclosure IP00 [kg]	138		151		221	
Efficiency[4]	0.98					
Output frequency	0 - 600Hz		0 - 500Hz		0 - 500Hz	
Heatsink overtemp. trip	110°C		110°C		110°C	
Power card ambient trip	75°C		75°C		75°C	
* High overload = 160% torque during 60 s, Normal overload = 110% torque during 60 s.						

Table 5.6

Mains Supply 525-690 V AC						
FC 302	P400		P500		P560	
High/ Normal Load*	HO	NO	HO	NO	HO	NO
Typical Shaft output at 550 V [kW]	315	400	400	450	450	500
Typical Shaft output at 575 V [hp]	400	500	500	600	600	650
Typical Shaft output at 690 V [kW]	400	500	500	560	560	630
Enclosure IP21	E1		E1		E1	
Enclosure IP54	E1		E1		E1	
Enclosure IP00	E2		E2		E2	
Output current						
Continuous (at 550 V) [A]	429	523	523	596	596	630
Intermittent (60 sec overload) (at 550 V) [A]	644	575	785	656	894	693
Continuous (at 575/690 V) [A]	410	500	500	570	570	630
Intermittent (60 s overload) (at 575/690 V) [A]	615	550	750	627	855	693
Continuous KVA (at 550 V) [KVA]	409	498	498	568	568	600
Continuous KVA (at 575 V) [KVA]	408	498	498	568	568	627
Continuous KVA (at 690 V) [KVA]	490	598	598	681	681	753
Max. input current						
Continuous (at 550 V) [A]	413	504	504	574	574	607
Continuous (at 575 V) [A]	395	482	482	549	549	607
Continuous (at 690 V) [A]	395	482	482	549	549	607
Max. cable size, mains, motor and load share [mm^2 (AWG)]	4x240 (4x500 mcm)		4x240 (4x500 mcm)		4x240 (4x500 mcm)	
Max. cable size, brake [mm^2 (AWG)]	2 x 185 (2 x 350 mcm)		2 x 185 (2 x 350 mcm)		2 x 185 (2 x 350 mcm)	
Max. external mains fuses [A] [1]	700		900		900	
Estimated power loss at 600 V [W] [4]	4478	5623	6153	7018	7007	7793
Estimated power loss at 690 V [W] [4]	4605	5794	6328	7221	7201	8017
Weight, enclosure IP21, IP54 [kg]	263		272		313	
Weight, enclosure IP00 [kg]	221		236		277	
Efficiency[4]	0.98					
Output frequency	0 - 500Hz					
Heatsink overtemp. trip	110°C					
Power card ambient trip	75°C					
* High overload = 160% torque during 60 s., Normal overload = 110% torque during 60 s.						

Table 5.7

5

Mains Supply 525-690 V AC						
FC 302	P630		P710		P800	
High/ Normal Load*	HO	NO	HO	NO	HO	NO
Typical Shaft output at 550 V [kW]	500	560	560	670	670	750
Typical Shaft output at 575 V [hp]	650	750	750	950	950	1050
Typical Shaft output at 690 V [kW]	630	710	710	800	800	900
Enclosure IP21, 54 without/ with options cabinet	F1/ F3		F1/ F3		F1/ F3	
Output current						
Continuous (at 550 V) [A]	659	763	763	889	889	988
Intermittent (60 sec overload) (at 550 V) [A]	989	839	1145	978	1334	1087
Continuous (at 575/690 V) [A]	630	730	730	850	850	945
Intermittent (60 sec overload) (at 575/690 V) [A]	945	803	1095	935	1275	1040
Continuous KVA (at 550 V) [KVA]	628	727	727	847	847	941
Continuous KVA (at 575 V) [KVA]	627	727	727	847	847	941
Continuous KVA (at 690 V) [KVA]	753	872	872	1016	1016	1129
Max. input current						
Continuous (at 550 V) [A]	642	743	743	866	866	962
Continuous (at 575 V) [A]	613	711	711	828	828	920
Continuous (at 690 V) [A]	613	711	711	828	828	920
Max. cable size, motor [mm^2 (AWG[2)])]	8x150 (8x300 mcm)					
Max. cable size,mains F1 [mm^2 (AWG[2)])]	8x240 (8x500 mcm)					
Max. cable size,mains F3 [mm^2 (AWG[2)])]	8x456 (8x900 mcm)					
Max. cable size, loadsharing [mm^2 (AWG[2)])]	4x120 (4x250 mcm)					
Max. cable size, brake [mm^2 (AWG[2)])	4x185 (4x350 mcm)					
Max. external mains fuses [A] [1]	1600					
Estimated power loss, 600 V [W] [4)]	7586	8933	8683	10310	10298	11692
Estimated power loss, 690 V [W] [4)]	7826	9212	8983	10659	10646	12080
F3/F4 Max added losses CB or Disconnect & Contactor	342	427	419	532	519	615
Max panel options losses	400					
Weight, enclosure IP21, IP54 [kg]	1004/ 1299		1004/ 1299		1004/ 1299	
Weight, Rectifier Module [kg]	102		102		102	
Weight, Inverter Module [kg]	102		102		136	
Efficiency[4)]	0.98					
Output frequency	0-500 Hz					
Heatsink overtemp. trip	95 °C		105 °C		95 °C	
Power card ambient trip	75 °C					
* High overload = 160% torque during 60 s., Normal overload = 110% torque during 60 s.						

Table 5.8

Mains Supply 525-690 V AC						
FC 302	P900		P1M0		P1M2	
High/ Normal Load*	HO	NO	HO	NO	HO	NO
Typical Shaft output at 550 V [kW]	750	850	850	1000	1000	1100
Typical Shaft output at 575 V [hp]	1050	1150	1150	1350	1350	1550
Typical Shaft output at 690 V [kW]	900	1000	1000	1200	1200	1400
Enclosure IP21, IP54 without/with options cabinet	F2/ F4		F2/ F4		F2/ F4	
Output current						
Continuous (at 550 V) [A]	988	1108	1108	1317	1317	1479
Intermittent (60 s overload) (at 550 V) [A]	1482	1219	1662	1449	1976	1627
Continuous (at 575/690 V) [A]	945	1060	1060	1260	1260	1415
Intermittent (60 s overload) (at 575/690 V) [A]	1418	1166	1590	1386	1890	1557
Continuous KVA (at 550 V) [KVA]	941	1056	1056	1255	1255	1409
Continuous KVA (at 575 V) [KVA]	941	1056	1056	1255	1255	1409
Continuous KVA (at 690 V) [KVA]	1129	1267	1267	1506	1506	1691
Max. input current						
Continuous (at 550 V) [A]	962	1079	1079	1282	1282	1440
Continuous (at 575 V) [A]	920	1032	1032	1227	1227	1378
Continuous (at 690 V) [A]	920	1032	1032	1227	1227	1378
Max. cable size, motor [mm^2 (AWG[2)])]	12x150 (12x300 mcm)					
Max. cable size,mains F2 [mm^2 (AWG[2)])]	8x240 (8x500 mcm)					
Max. cable size,mains F4 [mm^2 (AWG[2)])]	8x456 (8x900 mcm)					
Max. cable size, loadsharing [mm^2 (AWG[2)])]	4x120 (4x250 mcm)					
Max. cable size, brake [mm^2 (AWG[2)])	6x185 (6x350 mcm)					
Max. external mains fuses [A] [1]	1600		2000		2500	
Estimated power loss, 600V [W] [4)]	11329	12909	12570	15358	15258	17602
Estimated power loss, 690V [W] [4)]	11681	13305	12997	15865	15763	18173
F3/F4 Max added losses CB or Disconnect & Contactor	556	665	634	863	861	1044
Max panel options losses	400					
Weight, enclosure IP21, IP54 [kg]	1246/ 1541		1246/ 1541		1280/1575	
Weight, Rectifier Module [kg]	136		136		136	
Weight, Inverter Module [kg]	102		102		136	
Efficiency[4)]	0.98					
Output frequency	0-500Hz					
Heatsink overtemp. trip	105°C		105°C		95°C	
Power card ambient trip	75°C					
* High overload = 160% torque during 60 s., Normal overload = 110% torque during 60 s.						

Table 5.9

1) For type of fuse see *chapter 3.5.13 Fuses*.

2) American Wire Gauge.

3) Measured using 5 m screened motor cables at rated load and rated frequency.

4) The typical power loss is at nominal load conditions and expected to be within +/-15% (tolerence relates to variety in voltage and cable conditions).
Values are based on a typical motor efficiency (eff2/eff3 border line). Motors with lower efficiency will also add to the power loss in the frequency converter and opposite.
If the switching frequency is increased compared to the default setting, the power losses may rise significantly.
LCP and typical control card power consumptions are included. Further options and customer load may add up to 30 W to the losses. (Though typical only 4 W extra for a fully loaded control card, or options for slot A or slot B, each).
Although measurements are made with state of the art equipment, some measurement inaccuracy must be allowed for (+/-5%).

6 Warnings and Alarms

6.1 Status Messages

6.1.1 Warnings/Alarm Messages

A warning or an alarm is signalled by the relevant LED on the front of the frequency converter and indicated by a code on the display.

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

An alarm trips the frequency converter. Reset alarms to restart operation once their cause has been rectified.

This may be done in three ways

- By pressing [Reset].
- Via a digital input with the "Reset" function.
- Via serial communication/optional fieldbus.

NOTICE

After a manual reset pressing [Reset], [Auto On] must be pressed 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 6.1*).

Alarms that are trip-locked offer additional 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 above 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!)

If a warning and alarm is marked against a code in *Table 6.1*, this means that either a warning occurs before an alarm, or else that it is possible to specify whether it is a warning or an alarm that is to be displayed for a given fault.

This is possible, for instance, in *1-90 Motor Thermal Protection*. After an alarm or trip, the motor carries on coasting, and the alarm and warning flash. Once the problem has been rectified, only the alarm continues flashing until the frequency converter is reset.

NOTICE

No missing motor phase detection (no 30-32) and no stall detection is active when *1-10 Motor Construction* is set to *[1] PM non salient SPM*.

No.	Description	Warning	Alarm/Trip	Alarm/Trip Lock	Parameter Reference
1	10 Volts low	X			
2	Live zero error	(X)	(X)		6-01 Live Zero Timeout Function
3	No motor	(X)			1-80 Function at Stop
4	Mains phase loss	(X)	(X)	(X)	14-12 Function at Mains Imbalance
5	DC link voltage high	X			
6	DC link voltage low	X			
7	DC over-voltage	X	X		
8	DC under voltage	X	X		
9	Inverter overloaded	X	X		
10	Motor ETR over temperature	(X)	(X)		1-90 Motor Thermal Protection
11	Motor thermistor over temperature	(X)	(X)		1-90 Motor Thermal Protection
12	Torque limit	X	X		
13	Over Current	X	X	X	

No.	Description	Warning	Alarm/Trip	Alarm/Trip Lock	Parameter Reference
14	Earth Fault	X	X	X	
15	Hardware mismatch		X	X	
16	Short Circuit		X	X	
17	Control word time-out	(X)	(X)		8-04 Control Word Timeout Function
18	Start Failed		X		1-77 Compressor Start Max Speed [RPM] and 1-79 Compressor Start Max Time to Trip
20	Temp. Input Error				
21	Param Error				
22	Hoist Mech. Brake	(X)	(X)		Parameter group 2-2*
23	Internal Fans	X			
24	External Fans	X			
25	Brake resistor short-circuited	X			
26	Brake resistor power limit	(X)	(X)		2-13 Brake Power Monitoring
27	Brake chopper short-circuited	X	X		
28	Brake check	(X)	(X)		2-15 Brake Check
29	Heatsink temp	X	X	X	
30	Motor phase U missing	(X)	(X)	(X)	4-58 Missing Motor Phase Function
31	Motor phase V missing	(X)	(X)	(X)	4-58 Missing Motor Phase Function
32	Motor phase W missing	(X)	(X)	(X)	4-58 Missing Motor Phase Function
33	Inrush Fault		X	X	
34	Fieldbus communication fault	X	X		
35	Option Fault				
36	Mains failure	X	X		
37	Phase imbalance		X		
38	Internal Fault		X	X	
39	Heatsink sensor		X	X	
40	Overload of Digital Output Terminal 27	(X)			5-00 Digital I/O Mode, 5-01 Terminal 27 Mode
41	Overload of Digital Output Terminal 29	(X)			5-00 Digital I/O Mode, 5-02 Terminal 29 Mode
42	Ovrld X30/6-7	(X)			
43	Ext. Supply (option)				
45	Earth Fault 2	X	X	X	
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		1-86 Trip Speed Low [RPM]
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		

No.	Description	Warning	Alarm/Trip	Alarm/Trip Lock	Parameter Reference
57	AMA time-out		X		
58	AMA internal fault	X	X		
59	Current limit	X			
60	External Interlock	X	X		
61	Feedback Error	(X)	(X)		4-30 Motor Feedback Loss Function
62	Output Frequency at Maximum Limit	X			
63	Mechanical Brake Low		(X)		2-20 Release Brake Current
64	Voltage Limit	X			
65	Control Board Over-temperature	X	X	X	
66	Heat sink Temperature Low	X			
67	Option Configuration has Changed		X		
68	Safe Stop	(X)	(X)[1)]		5-19 Terminal 37 Safe Stop
69	Pwr. Card Temp		X	X	
70	Illegal FC configuration			X	
71	PTC 1 Safe Stop				
72	Dangerous failure				
73	Safe Stop Auto Restart	(X)	(X)		5-19 Terminal 37 Safe Stop
74	PTC Thermistor			X	
75	Illegal Profile Sel.		X		
76	Power Unit Setup	X			
77	Reduced power mode	X			14-59 Actual Number of Inverter Units
78	Tracking Error	(X)	(X)		4-34 Tracking Error Function
79	Illegal PS config		X	X	
80	Drive Initialized to Default Value		X		
81	CSIV corrupt		X		
82	CSIV parameter error		X		
83	Illegal Option Combination			X	
84	No Safety Option		X		
88	Option Detection			X	
89	Mechanical Brake Sliding	X			
90	Feedback Monitor	(X)	(X)		17-61 Feedback Signal Monitoring
91	Analog input 54 wrong settings			X	S202
163	ATEX ETR cur.lim.warning	X			
164	ATEX ETR cur.lim.alarm		X		
165	ATEX ETR freq.lim.warning	X			
166	ATEX ETR freq.lim.alarm		X		
250	New spare parts			X	
251	New Type Code		X	X	

Table 6.1 Alarm/Warning Code List

(X) Dependent on parameter

1) Can not 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 make a reset by a digital input (parameter group *5-1* Digital Inputs* [1]). The origin 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.

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

Table 6.2

Bit	Hex	Dec	Alarm Word	Alarm Word 2	Warning Word	Warning Word 2	Extended Status Word
Alarm Word Extended Status Word							
0	00000001	1	Brake Check (A28)	ServiceTrip, Read/ Write	Brake Check (W28)	reserved	Ramping
1	00000002	2	Heatsink temp. (A29)	ServiceTrip, (reserved)	Heatsink temp. (W29)	reserved	AMA Running
2	00000004	4	Earth Fault (A14)	ServiceTrip, Typecode/ Sparepart	Earth Fault (W14)	reserved	Start CW/CCW start_possible is active, when the DI selections [12] OR [13] are active and the requested direction matches the reference sign
3	00000008	8	Ctrl.Card Temp (A65)	ServiceTrip, (reserved)	Ctrl.Card Temp (W65)	reserved	Slow Down slow down command active, e.g. via CTW bit 11 or DI
4	00000010	16	Ctrl. Word TO (A17)	ServiceTrip, (reserved)	Ctrl. Word TO (W17)		Catch Up catch up command active, e.g. via CTW bit 12 or DI
5	00000020	32	Over Current (A13)	reserved	Over Current (W13)	reserved	Feedback High feedback > 4-57
6	00000040	64	Torque Limit (A12)	reserved	Torque Limit (W12)	reserved	Feedback Low feedback < 4-56
7	00000080	128	Motor Th Over (A11)	reserved	Motor Th Over (W11)	reserved	Output Current High current > 4-51
8	00000100	256	Motor ETR Over (A10)	reserved	Motor ETR Over (W10)	reserved	Output Current Low current < 4-50
9	00000200	512	Inverter Overld. (A9)	reserved	Inverter Overld (W9)	reserved	Output Freq High speed > 4-53
10	00000400	1024	DC under Volt (A8)	reserved	DC under Volt (W8)		Output Freq Low speed < 4-52
11	00000800	2048	DC over Volt (A7)	reserved	DC over Volt (W7)		Brake Check OK brake test NOT ok
12	00001000	4096	Short Circuit (A16)	reserved	DC Voltage Low (W6)	reserved	Braking Max BrakePower > BrakePowerLimit (2-12)
13	00002000	8192	Inrush Fault (A33)	reserved	DC Voltage High (W5)		Braking
14	00004000	16384	Mains ph. Loss (A4)	reserved	Mains ph. Loss (W4)		Out of Speed Range
15	00008000	32768	AMA Not OK	reserved	No Motor (W3)		OVC Active
16	00010000	65536	Live Zero Error (A2)	reserved	Live Zero Error (W2)		AC Brake

Bit	Hex	Dec	Alarm Word	Alarm Word 2	Warning Word	Warning Word 2	Extended Status Word
17	00020000	131072	Internal Fault (A38)	KTY error	10V Low (W1)	KTY Warn	Password Timelock number of allowed password trials exceeded - timelock active
18	00040000	262144	Brake Overload (A26)	Fans error	Brake Overload (W26)	Fans Warn	Password Protection 0-61 = ALL_NO_ACCESS OR BUS_NO_ACCESS OR BUS_READONLY
19	00080000	524288	U phase Loss (A30)	ECB error	Brake Resistor (W25)	ECB Warn	Reference High reference > 4-55
20	00100000	1048576	V phase Loss (A31)	reserved	Brake IGBT (W27)	reserved	Reference Low reference < 4-54
21	00200000	2097152	W phase Loss (A32)	reserved	Speed Limit (W49)	reserved	Local Reference reference site = REMOTE -> auto on pressed & active
22	00400000	4194304	Fieldbus Fault (A34)	reserved	Fieldbus Fault (W34)	reserved	Protection Mode
23	00800000	8388608	24 V Supply Low (A47)	reserved	24V Supply Low (W47)	reserved	Unused
24	01000000	16777216	Mains Failure (A36)	reserved	Mains Failure (W36)	reserved	Unused
25	02000000	33554432	1.8V Supply Low (A48)	reserved	Current Limit (W59)	reserved	Unused
26	04000000	67108864	Brake Resistor (A25)	reserved	Low Temp (W66)	reserved	Unused
27	08000000	134217728	Brake IGBT (A27)	reserved	Voltage Limit (W64)	reserved	Unused
28	10000000	268435456	Option Change (A67)	reserved	Encoder loss (W90)	reserved	Unused
29	20000000	536870912	Drive Initialized(A80)	Feedback Fault (A61, A90)	Feedback Fault (W61, W90)		Unused
30	40000000	1073741824	Safe Stop (A68)	PTC 1 Safe Stop (A71)	Safe Stop (W68)	PTC 1 Safe Stop (W71)	Unused
31	80000000	2147483648	Mech. brake low (A63)	Dangerous Failure (A72)	Extended Status Word		Unused

Table 6.3 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 diagnose. See also *16-94 Ext. Status Word*.

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

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

This condition can be caused by a short in a connected potentiometer or improper wiring of the potentiometer.

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 by the user in *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 faulty device sending the signal can cause 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 Input Terminal Signal Test

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 for a fault in the input rectifier on the frequency converter. Options are programmed at *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 is dependent 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 is dependent 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 a time.

Troubleshooting

- Connect a brake resistor
- Extend the ramp time
- Change the ramp type
- Activate the functions in *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 under voltage 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 input voltage test.
- Perform 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 gives a warning at 98% and trips at 100%, while giving an alarm. The frequency converter *cannot* be reset until the counter is below 90%.
The fault is that the frequency converter is overloaded by more than 100% for too long.

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 gives a warning or an alarm when the counter reaches 100% in *1-90 Motor Thermal Protection*. The fault occurs when the motor is overloaded by more than 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 that Motor data in parameters 1-20 through 1-25 are set correctly
- If an external fan is in use, check in *1-91 Motor External Fan* that it is selected
- Running AMA in *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 gives a warning or an alarm in *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 *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 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. This fault may be caused by shock loading or fast acceleration with high inertia loads. If extended mechanical brake control is selected, 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 to the frequency converter and repair the earth fault
- Check for earth 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 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 to 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 OFF.

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

Troubleshooting:

- Check 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

WARNING 22, Hoist mechanical brake
The report value shows what kind it is.
0 = The torque reference was not reached before time-out.
1 = There was no brake feedback before the time-out.

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 enclosures, the regulated voltage to the fan is monitored.

Troubleshooting

- Check fan resistance
- Check soft charge fuses

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

For D, E and F enclosures, 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 to 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

There is a risk of substantial power being transmitted to the brake resistor if the brake transistor is short-circuited.

WARNING/ALARM 27, Brake chopper fault
The brake transistor is monitored during operation and 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 to the frequency converter and remove the brake resistor.

This alarm/warning could also occur should the brake resistor overheat. Terminals 104 and 106 are available as brake resistors Klixon inuputs, 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 for 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 the D, E and F enclosures, this alarm is based on the temperature measured by the heat sink sensor mounted inside the IGBT modules. For the F enclosures, this alarm can also be caused by the thermal sensor in the rectifier module.

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.

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.

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, communication fault
The fieldbus on the communication option card is not working.

WARNING/ALARM 36, Mains failure
This warning/alarm is only active if the supply voltage to the frequency converter is lost and *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 the *Table 6.4* is displayed.

Troubleshooting

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

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

No.	Text
0	Serial port cannot be initialised. Contact the Danfoss supplier or Danfoss Service Department.
256-258	Power EEPROM data is defective or too old.
512	Control board EEPROM data is defective or too old.
513	Communication time out reading EEPROM data.
514	Communication time out reading EEPROM data.
515	Application oriented control cannot recognize the EEPROM data.
516	Cannot write to the EEPROM because a write command is on progress.
517	Write command is under time out.
518	Failure in the EEPROM.
519	Missing or invalid barcode data in EEPROM.
783	Parameter value outside of min/max limits.
1024-1279	A centelegram that has to be sent couldn't be sent.
1281	Digital signal processor flash timeout.
1282	Power micro software version mismatch.
1283	Power EEPROM data version mismatch.
1284	Cannot read digital signal processor software version.
1299	Option SW in slot A is too old.
1300	Option SW in slot B is too old.
1301	Option SW in slot C0 is too old.
1302	Option SW in slot C1 is too old.
1315	Option SW in slot A is not supported (not allowed).
1316	Option SW in slot B is not supported (not allowed).
1317	Option SW in slot C0 is not supported (not allowed).
1318	Option SW in slot C1 is not supported (not allowed).
1379	Option A did not respond when calculating platform version.
1380	Option B did not respond when calculating platform version.
1381	Option C0 did not respond when calculating platform version.
1382	Option C1 did not respond when calculating platform version.
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 powerup-wait.
2096-2104	H983x: option in slot x has issued a legal powerup-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	Missint 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).

No.	Text
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 6.4 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 short-circuit connection. Check *5-00 Digital I/O Mode* and *5-01 Terminal 27 Mode*.

WARNING 41, Overload of digital output terminal 29
Check the load connected to terminal 29 or remove short-circuit connection. Check *5-00 Digital I/O Mode* and *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 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 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 *4-11 Motor Speed Low Limit [RPM]* and *4-13 Motor Speed High Limit [RPM]*, the frequency converter shows 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 Department.

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 again 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, apply 24 V DC to the terminal programmed for external interlock and reset the frequency converter (via serial communication, digital I/O, or by pressing [Reset]).

WARNING 61, Tracking error
An error has been detected between the calculated motor speed and the speed measurement from the feedback device. The function for Warning/Alarm/ Disable is set in *4-30 Motor Feedback Loss Function*, error setting in *4-31 Motor Feedback Speed Error*, and the allowed error time in *4-32 Motor Feedback Loss Timeout*. During a commissioning procedure the function may be effective.

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 *2-00 DC Hold/Preheat Current* at 5% and *1-80 Function at Stop*

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

ALARM 67, Option module configuration has changed
One or more options have either been added or removed since the last power-down. Check that the configuration change is intentional and reset the unit.

ALARM 68, Safe stop activated
Safe stop has been activated. To resume normal operation, apply 24 V DC to terminal 37, then send a reset signal (via Bus, Digital I/O, or by pressing [Reset]).

ALARM 69, Power card 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. Contact the supplier with the type code of the unit from the nameplate and the part numbers of the cards to check compatibility.

WARNING/ALARM 71, PTC 1 safe stop
Safe Stop has been activated from the MCB 112 PTC thermistor card (motor too warm). Normal operation can be resumed when the MCB 112 applies 24 V DC to T-37 again (when the motor temperature reaches an acceptable level) and when the digital input from the MCB 112 is deactivated. When this happens, a reset signal is sent (via serial communication, digital I/O, or by pressing reset button on LCP). Note that if automatic restart is enabled, the motor may start when the fault is cleared.

ALARM 72, Dangerous failure
Safe Stop with Trip Lock. Unexpected signal levels on safe stop and digital input from the PTC thermistor card.

WARNING 73, Safe stop auto restart
Safe stopped. With automatic restart enabled, the motor may start when the fault is cleared.

WARNING 76, Power unit setup
The required number of power units does not match the detected number of active power units. When replacing an F-frame module, this occurs if the power specific data in the module power card does not match the rest of the frequency converter.

Troubleshooting
- Confirm 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 (i.e. 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 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. Reset the unit to clear the alarm.

ALARM 81, CSIV corrupt
CSIV file has syntax errors.

ALARM 82, CSIV parameter error
CSIV failed to initialise a parameter.

ALARM 85, Dang fail PB:
Profibus/Profisafe Error.

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 243, Brake IGBT
This alarm is only for F Frame frequency converters. It is equivalent to Alarm 27. The report value in the alarm log indicates which power module generated the alarm:

1 = left most inverter module.

2 = middle inverter module in 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, Heatsink temperature
This alarm is only for F Frame frequency converters. It is equivalent to Alarm 29. The report value in the alarm log indicates which power module generated the alarm:

1 = left most inverter module.

2 = middle inverter module in 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, Heatsink sensor
This alarm is only for F Frame frequency converters. It is equivalent to Alarm 39. The report value in the alarm log indicates which power module generated the alarm:

1 = left most inverter module.

2 = middle inverter module in 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 F Frame frequency converters. It is equivalent to Alarm 46. The report value in the alarm log indicates which power module generated the alarm:

1 = left most inverter module.

2 = middle inverter module in 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 F Frame frequency converter. It is equivalent to Alarm 69. The report value in the alarm log indicates which power module generated the alarm:

1 = left most inverter module.

2 = middle inverter module in 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 F Frame frequency converters. It is equivalent to Alarm 79. The report value in the alarm log indicates which power module generated the alarm:

1 = left most inverter module.

2 = middle inverter module in 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. Reset the frequency converter for normal operation.

WARNING 251, New typecode
The power card or other components have been replaced and the typecode changed. Reset to remove the warning and resume normal operation.

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