MAKING MODERN LIVING POSSIBLE

# Operating Instructions

# VLT® HVAC Drive FC 102

## 110-1400 kW




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VLT® THE REAL DRIVE

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1

# 1 How to Read these Operating Instructions

**VLT HVAC Drive**
**FC 100 Series**

**Software version: 4.1x**

This guide can be used with all FC 102 frequency converters with software version 4.1x or later. The actual software version number can be read from *15-43 Software Version*.

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Danfoss does not warrant that a software program produced according to the guidelines provided in this manual functions properly in every physical, hardware or software environment.

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- *VLT HVAC Drive Design Guide* entails all technical information about the frequency converter and customer design and applications.
- *VLT HVAC Drive Programming Guide* provides information on how to programme and includes complete parameter descriptions.
- *Application Note, Temperature Derating Guide*
- *MCT 10 Set-up Software Operating Instructions* enables the user to configure the frequency converter from a Windows™ based PC environment.
- Danfoss VLT® Energy Box software at *www.danfoss.com/BusinessAreas/DrivesSolutions* then choose PC Software Download
- *VLT HVAC Drive BACnet, Operating Instructions*
- *VLT HVAC Drive Metasys, Operating Instructions*
- *VLT HVAC Drive FLN, Operating Instructions*

Danfoss technical literature is available in print from local Danfoss Sales Offices or online at: *www.danfoss.com/BusinessAreas/DrivesSolutions/Documentations/Technical+Documentation.htm*

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.**

## 1.1.1 Abbreviations and Standards

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

**Table 1.1 Abbreviation and Standards Table**

# 2 Safety

2

## 2.1 Safety Note

**⚠WARNING**

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

**Safety Regulations**

1. The frequency converter must be disconnected from mains if repair work is to be carried out. Check that the mains supply has been disconnected and that the necessary time has passed before removing motor and mains plugs.
2. The [STOP/RESET] key on the control panel of the frequency converter does not disconnect the equipment from mains and is thus not to be used as a safety switch.
3. Correct protective earthing of the equipment must be established, the user must be protected against supply voltage, and the motor must be protected against overload in accordance with applicable national and local regulations.
4. The earth leakage currents are higher than 3.5 mA.
5. Protection against motor overload is set by *parameter 1-90 Motor Thermal Protection*. If this function is desired, set *parameter 1-90 Motor Thermal Protection* to data value *[4] ETR trip* (default value) or data value *[5] ETR warning*. Note: The function is initialised at 1.16 x rated motor current and rated motor frequency. For the North American market: The ETR functions provide class 20 motor overload protection in accordance with NEC.
6. Do not remove the plugs for the motor and mains supply while the frequency converter is connected to mains. Check that the mains supply has been disconnected and that the necessary time has passed before removing motor and mains plugs.
7. Note that the frequency converter has voltage inputs other than L1, L2 and L3, when load sharing (linking of DC intermediate circuit) and external 24 V DC have been installed. Check that all voltage inputs have been disconnected and that the necessary time has passed before commencing repair work.

***NOTICE***

**Installation at high altitude:**
**380 - 480 V: At altitudes above 3,000 m, contact Danfoss regarding PELV.**
**525 - 690 V: At altitudes above 2,000 m, contact Danfoss regarding PELV.**

**Warning against Unintended Start**

1. The motor can be stopped with digital commands, bus commands, references or a local stop, while the frequency converter is connected to mains. To avoid personal injury, these stop functions are not sufficient to ensure that no unintended start occurs.
2. While parameters are being changed, the motor may start. Consequently, always press [RESET]; following which data can be modified.
3. A motor that has been stopped may start if faults occur in the electronics of the frequency converter, or if a temporary overload or a fault in the supply mains or the motor connection ceases.

**⚠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 external 24 V DC, load sharing (linkage of DC intermediate circuit), as well as the motor connection for kinetic back-up.

### 2.1.1 General Warning

**⚠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, (linkage of DC intermediate circuit), as well as the motor connection for kinetic back-up.**
**Before touching any potentially live parts of the frequency converter, wait at least as follows: Be aware that there may be high voltage on the DC link even when the Control Card LEDs are turned off. A red LED is mounted on a circuit board inside the frequency converter to indicate the DC bus voltage. The red LED stays lit until the DC link is 50 V DC or lower.**

**⚠WARNING**

**Leakage Current**

**The earth leakage current from the frequency converter exceeds 3.5 mA. According to IEC 61800-5-1 a reinforced Protective Earth connection must be ensured by means of: a min. 10mm² Cu or 16mm² Al PE-wire or an addtional PE wire - with the same cable cross section as the Mains wiring - must be terminated separately.**

**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 MN.90.GX.02. Protective earthing of the frequency converter and the use of RCD's must always follow national and local regulations.**

## 2.1.2 Before Commencing Repair Work

1. Disconnect the frequency converter from mains.
2. Disconnect DC bus terminals 88 and 89.
3. Wait at least the time mentioned in *chapter 2.1.1 General Warning*.

## 2.1.3 Special Conditions

**Electrical ratings**

The rating indicated on the nameplate of the frequency converter is based on a typical 3-phase mains power supply, within the specified voltage, current and temperature range, which is expected to be used in most applications.

**The frequency converters also support other special applications, which affect the electrical ratings of the frequency converter. Special conditions which affect the electrical ratings might be:**

- Single phase applications
- High temperature applications which require derating of the electrical ratings
- Marine applications with more severe environmental conditions.

Consult the relevant clauses in these instructions and in the *Design Guide* for information about the electrical ratings.

**Installation requirements**

**The overall electrical safety of the frequency converter requires special installation considerations regarding:**

- Fuses and circuit breakers for over-current and short-circuit protection
- Selection of power cables (mains, motor, brake, loadsharing and relay)
- Grid configuration (IT,TN, grounded leg, etc.)
- Safety of low-voltage ports (PELV conditions)

Consult the relevant clauses in these instructions and in the *Design Guide* for information about the installation requirements.

**⚠WARNING**

**The frequency converter's DC link capacitors remain charged after power has been disconnected. To avoid an 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:**

| Voltage | Power size | **Min. Waiting Time** |
|---|---|---|
| 380 - 480 V | 110 - 250 kW | 20 minutes |
| | 315 - 1000 kW | 40 minutes |
| 525 - 690 V | 45 - 400 kW | 20 minutes |
| | 450- 1400 kW | 30 minutes |
| Be aware that there may be high voltage on the DC link even when the LEDs are turned off. | | |

**Table 2.1 Discharge Time**

## 2.1.4 Avoid Unintended Start

**⚠WARNING**

**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.**

- **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.**
- **Unless terminal 37 is turned off, an electronic fault, temporary overload, a fault in the mains supply, or lost motor connection may cause a stopped motor to start.**

## 2.1.5 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

### 2.1.6 IT Mains

**⚠WARNING**

**IT mains**

**Do not connect frequency converters with RFI-filters to mains supplies with a voltage between phase and earth of more than 440 V for 400 V converters and 760 V for 690 V converters.**

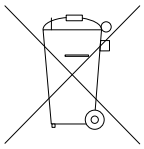
**For 400 V IT mains and delta earth (grounded leg), mains voltage may exceed 440 V between phase and earth.**

**For 690 V IT mains and delta earth (grounded leg), mains voltage may exceed 760 V between phase and earth.**

**Failure to follow recommendations could result in death or serious injury.**

*14-50 RFI Filter* can be used to disconnect the internal RFI capacitors from the RFI filter to ground.

### 2.1.7 Disposal Instruction



Equipment containing electrical components must 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.

# 3 Mechanical Installation



## 3.1 How to Get Started

This chapter covers mechanical and electrical installations to and from power terminals and control card terminals. Electrical installation of options is described in the relevant *Operating Instructions* and *Design Guide*.

The frequency converter is designed to achieve a quick and EMC-correct installation by following the steps described below.

**⚠WARNING**

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

**Mechanical Installation**

- Mechanical mounting

**Electrical Installation**

- Connection to Mains and Protecting Earth
- Motor connection and cables
- Fuses and circuit breakers
- Control terminals - cables

**Quick Setup**

- Local Control Panel, LCP
- Automatic Motor Adaptation, AMA
- Programming

Frame size is depending on enclosure type, power range and mains voltage.

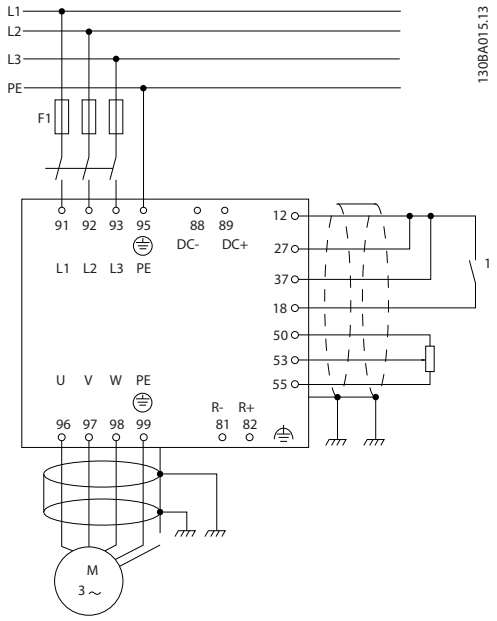



**Illustration 3.1 Diagram showing basic installation including mains, motor, start/stop key, and potentiometer for speed adjustment.**

## 3.2 Pre-installation

### 3.2.1 Planning the Installation Site

**⚠CAUTION**

**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

### 3.2.2 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.

### 3.2.3 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.

### 3.2.4 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.

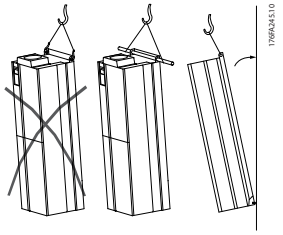


**Illustration 3.2 Recommended Lifting Method, Enclosure Types D and E**

**⚠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.**

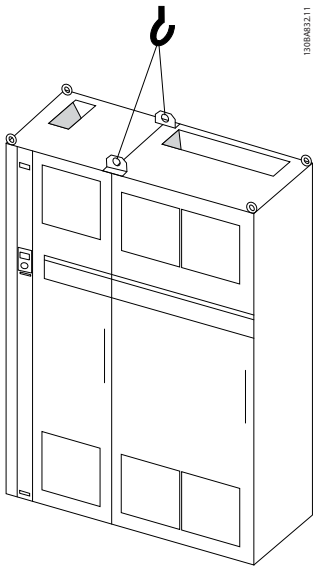


**Illustration 3.3 Recommended Lifting Method, Enclsoure Type F1 (460 V, 600 to 900 hp, 575/690 V, 900 to 1150 hp)**

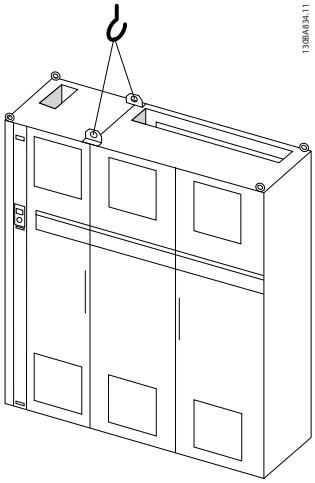


**Illustration 3.4 Recommended Lifting Method, Enclosure Type F2 (460 V, 1000 to 1200 hp, 575/690 V, 1250 to 1350 hp)**

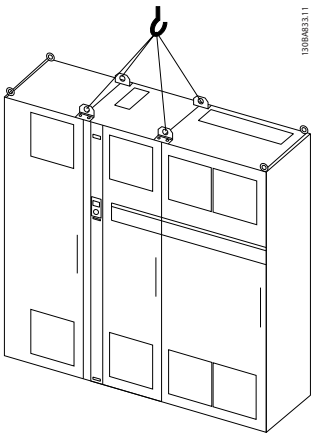



**Illustration 3.5 Recommended Lifting Method, Enclosure Type F3 (460 V, 600 to 900 hp, 575/690 V, 900 to 1150 hp)**

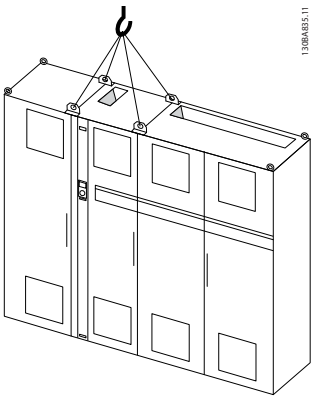



**Illustration 3.6 Recommended Lifting Method, Enclosure Type F4 (460 V, 1000 to 1200 hp, 575/690 V, 1250 to 1350 hp)**

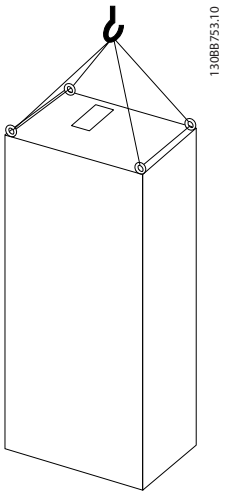



**Illustration 3.7 Recommended lifting method, Enclosure Type F8**

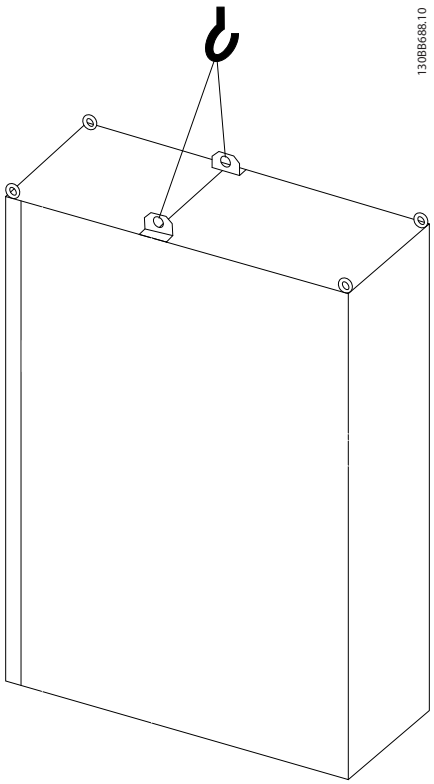



**Illustration 3.8 Recommended lifting method, Enclosure Type F9/F10**

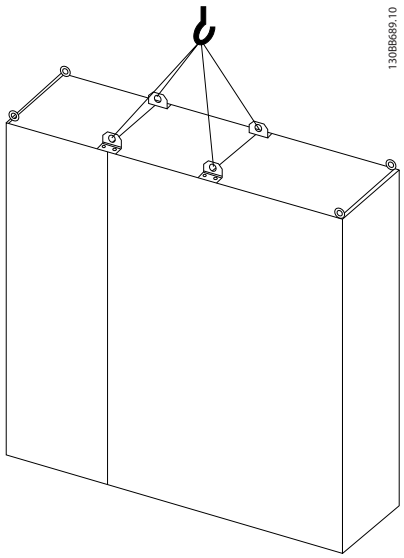


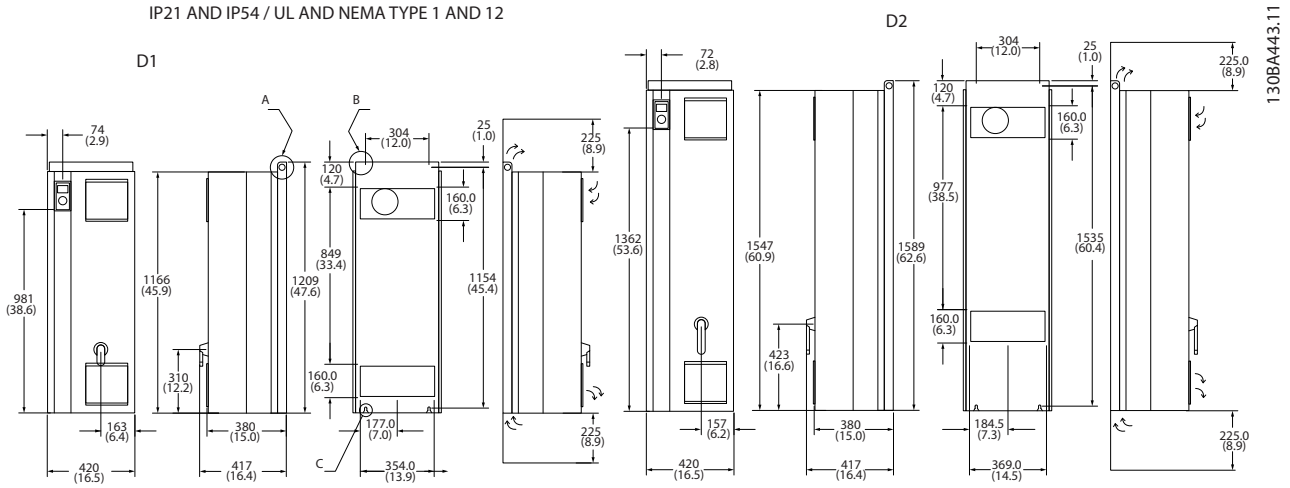

**Illustration 3.9 Recommended lifting method, Enclosure Type F11/F12/F13/F14**

***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.**

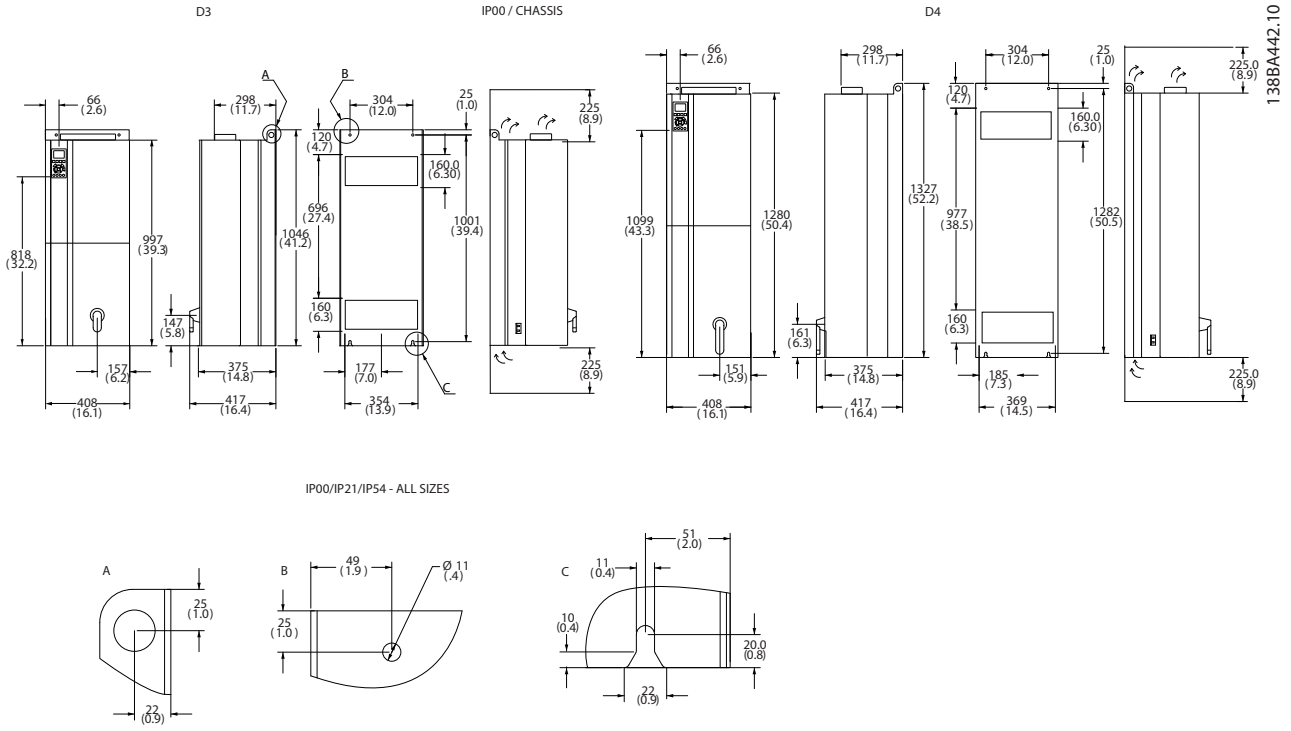


## 3.2.5 Mechanical Dimensions




* *Note airflow directions*

**Illustration 3.10**



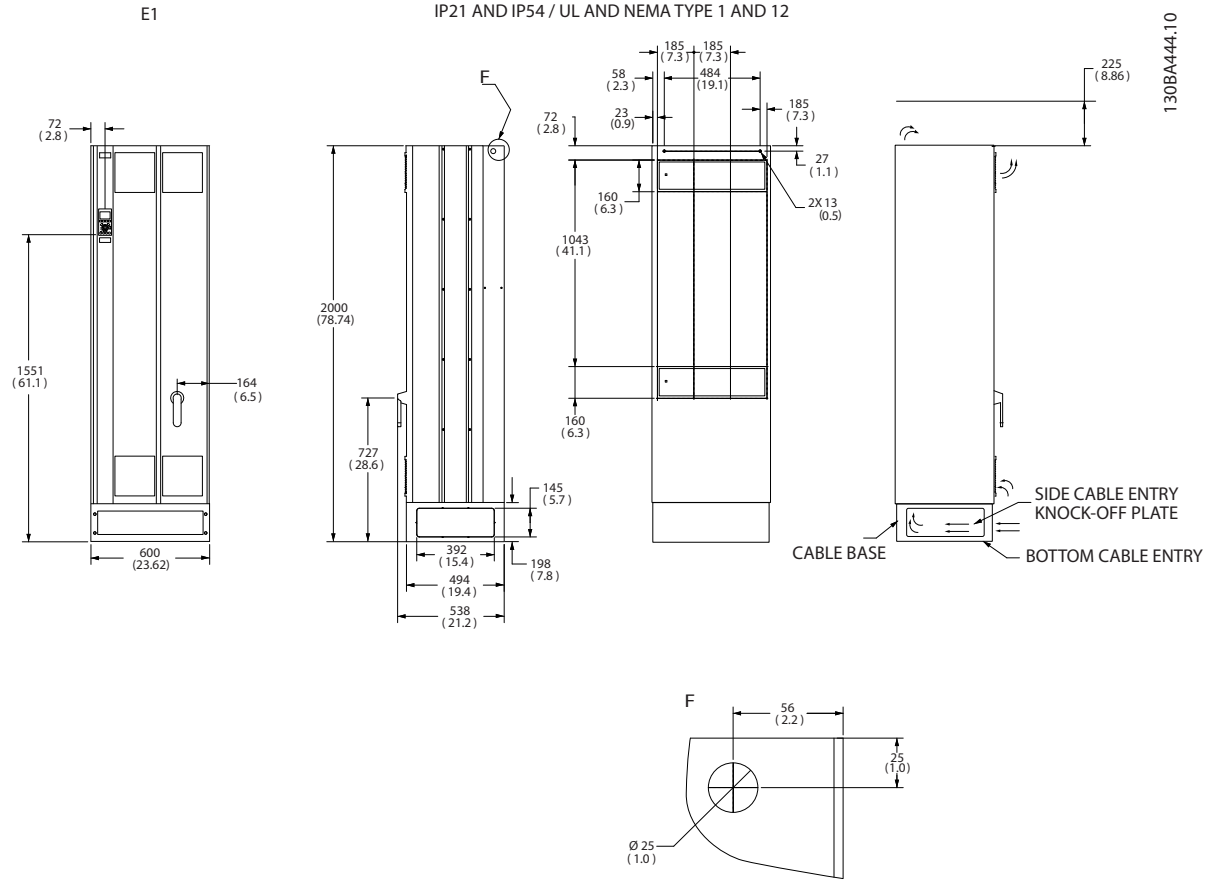




* *Note airflow directions*

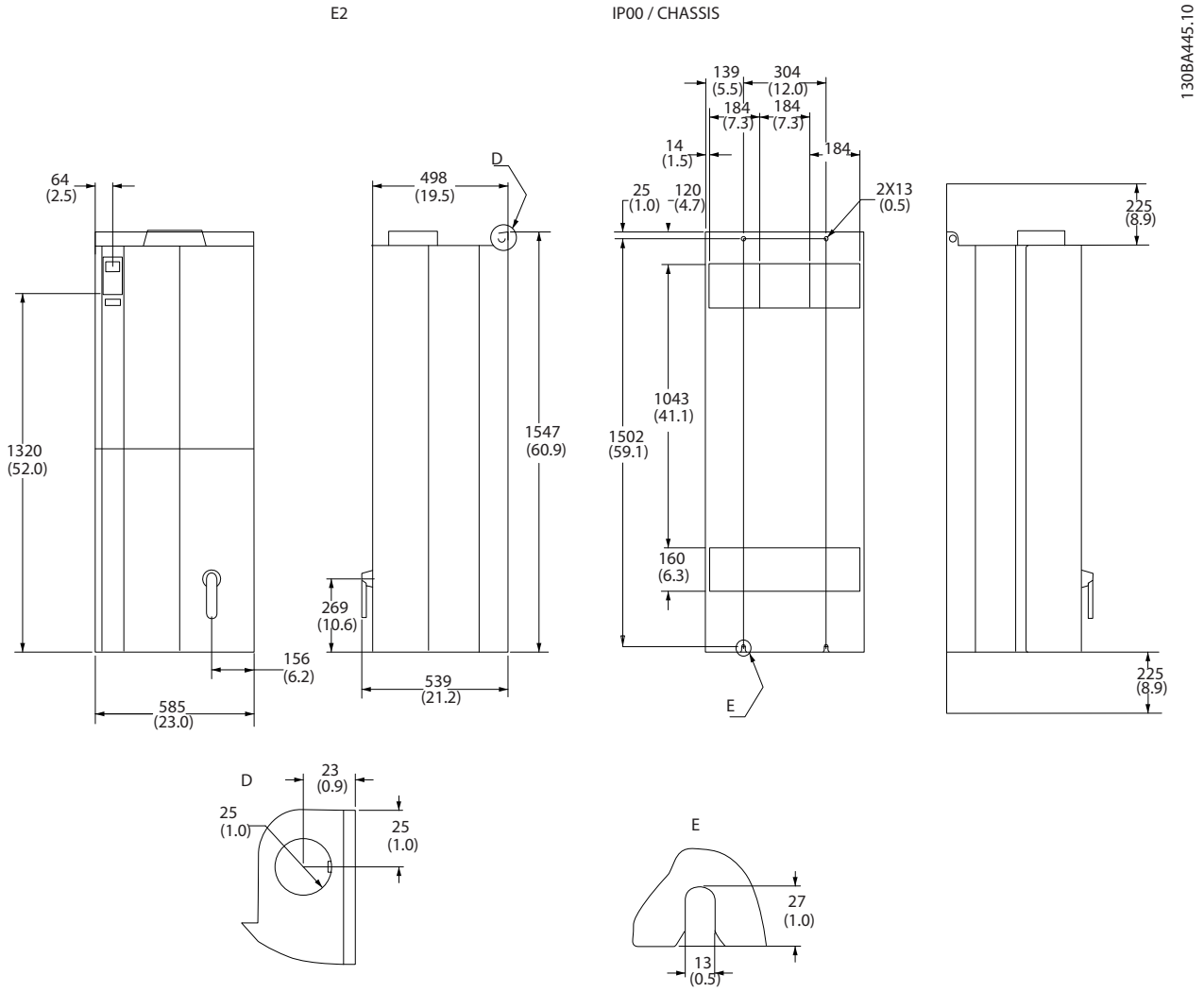
**Illustration 3.11**

3




* *Note airflow directions*

**Illustration 3.12**




* *Note airflow directions*

**Illustration 3.13**

3

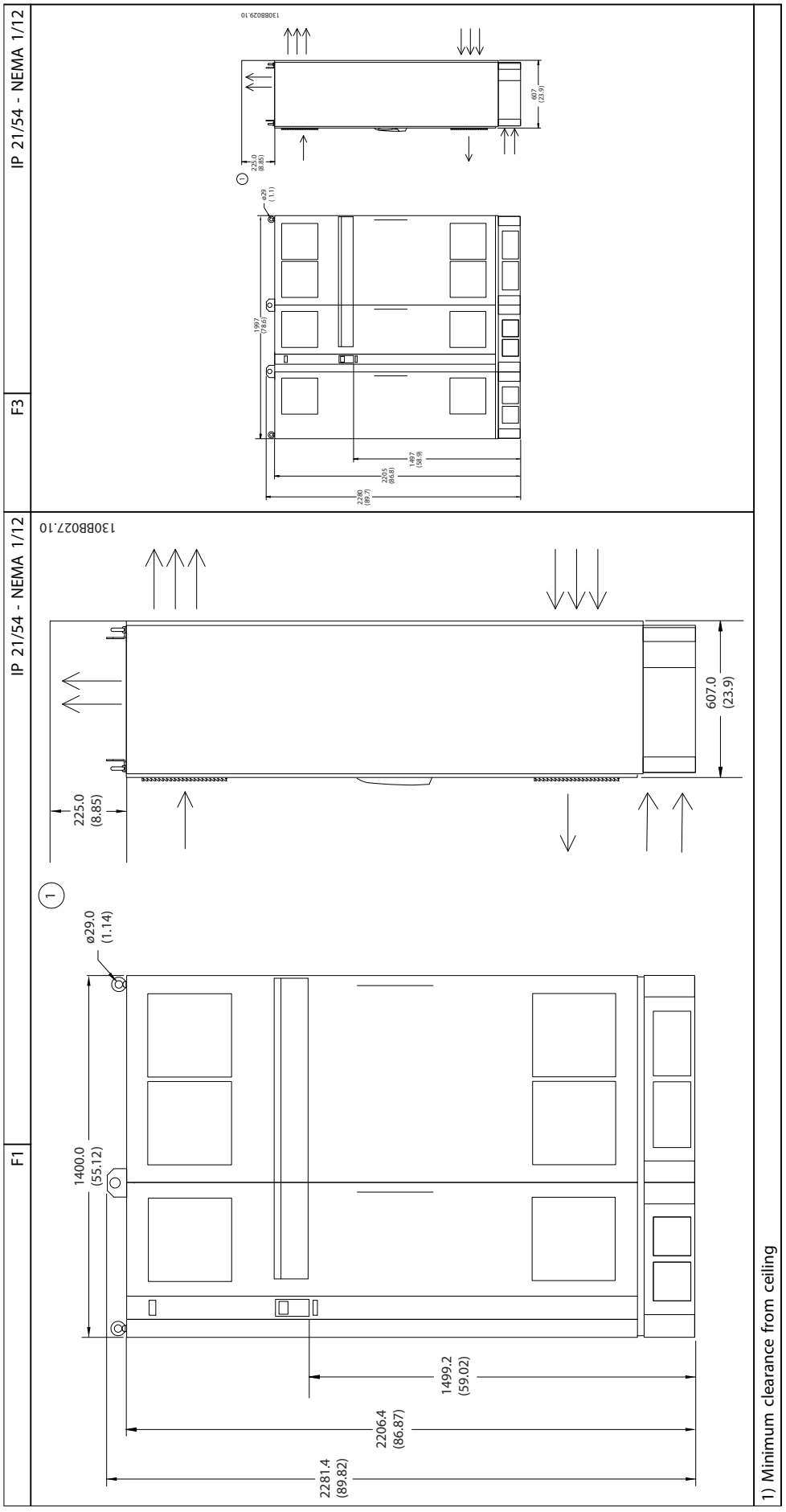

IP 21/54 - NEMA 1/12
F3
IP 21/54 - NEMA 1/12
F1
607.0 (23.9)
225.0 (8.85)
ø29.0 (1.14)
1400.0 (55.12)
1499.2 (59.02)
2206.4 (86.87)
2281.4 (89.82)
1) Minimum clearance from ceiling

**Table 3.1**

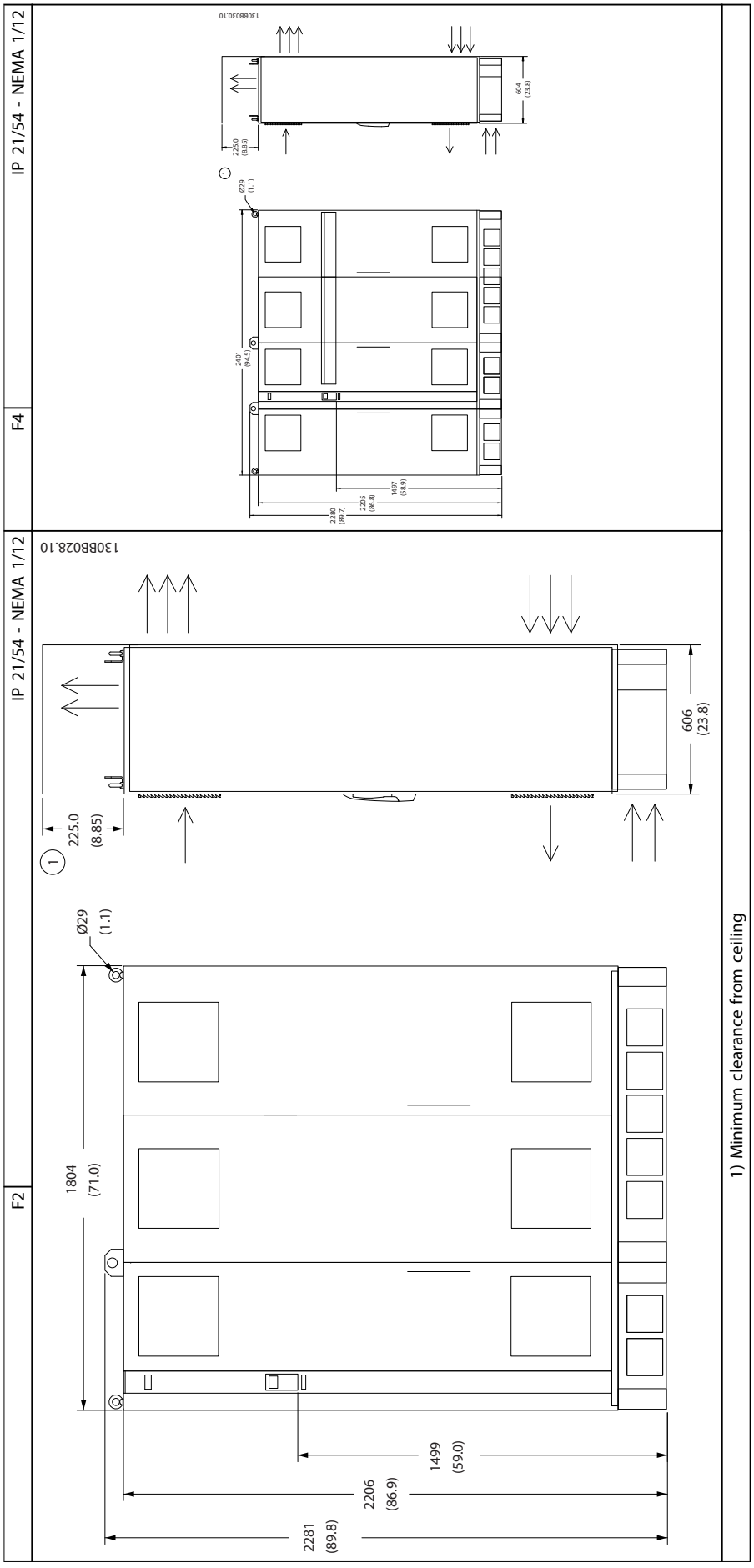

IP 21/54 - NEMA 1/12
F4
130BB030.10
604 (23.8)
225.0 (8.85)
1
Ø29 (1.1)
2401 (94.5)
1497 (58.9)
2205 (86.8)
2280 (89.7)
IP 21/54 - NEMA 1/12
F2
130BB028.10
606 (23.8)
225.0 (8.85)
1
Ø29 (1.1)
1804 (71.0)
1499 (59.0)
2206 (86.9)
2281 (89.8)
1) Minimum clearance from ceiling

**Table 3.2**

3

| Enclosure type Size | | D1 | | D2 | | D3 | D4 |
|---|---|---|---|---|---|---|---|
| | | 110-132 kW at 400 V (380-480 V) 45-160 kW at 690 V (525-690 V) | | 160-250 kW at 400 V (380-480 V) 200-400 kW at 690 V (525-690 V) | | 110-132 kW at 400 V (380-480 V) 45-160 kW at 690 V (525-690 V) | 160 - 250 kW at 400 V (380-480 V) 200-400 kW at 690 V (525-690 V) |
| IP NEMA | | 21 Type 1 | 54 Type 12 | 21 Type 1 | 54 Type 12 | 00 Chassis | 00 Chassis |
| Shipping dimensions [mm] | Height | 650 | 650 | 650 | 650 | 650 | 650 |
| | Width | 1730 | 1730 | 1730 | 1730 | 1220 | 1490 |
| | Depth | 570 | 570 | 570 | 570 | 570 | 570 |
| Frequency converter dimensions [mm] | Height | 1209 | 1209 | 1589 | 1589 | 104 | 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 3.3 Mechanical dimensions, Enclosure type D**

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

**Table 3.4 Mechanical dimensions, Enclosure Types E and F**

## 3.2.6 Rated Power

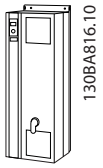
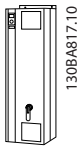
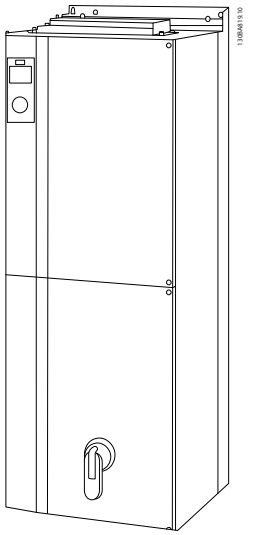
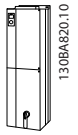
| Enclosure type | | D1 | D2 | D3 | D4 |
|---|---|---|---|---|---|
| | |   |   |   |   |
| Enclosure protection | IP | 21/54 | 21/54 | 00 | 00 |
| | NEMA | Type 1/Type 12 | Type 1/Type 12 | Chassis | Chassis |
| Normal overload rated power - 110% overload torque | | 110 - 132 kW at 400 V (380 - 480 V) 45 - 160 kW at 690 V (525-690 V) | 150 - 250 kW at 400 V (380 - 480 V) 200 - 400 kW at 690 V (525-690 V) | 110 - 132 kW at 400 V (380 - 480 V) 45 - 160 kW at 690 V (525-690 V) | 150 - 250 kW at 400 V (380 - 480 V) 200 - 400 kW at 690 V (525-690 V) |

**Table 3.5**

3

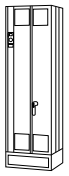
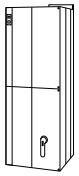
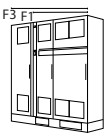
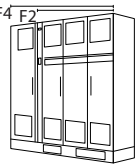
| Enclosure type | | E1 | E2 | F1/F3 | F2/F4 |
|---|---|---|---|---|---|
| | |  130BA818.10 |  130BA821.10 |  130BA959.10 |  130BB092.11 |
| Enclosure protection | IP | 21/54 | 00 | 21/54 | 21/54 |
| | NEMA | Type 1/Type 12 | Chassis | Type 1/Type 12 | Type 1/Type 12 |
| Normal overload rated power - 110% overload torque | | 315 - 450 kW at 400 V (380 - 480 V) 450 - 630 kW at 690 V (525-690 V) | 315 - 450 kW at 400 V (380 - 480 V) 450 - 630 kW at 690 V (525-690 V) | 500 - 710 kW at 400 V (380 - 480 V) 710 - 900 kW at 690 V (525-690 V) | 800 - 1000 kW at 400 V (380 - 480 V) 1000 - 1400 kW at 690 V (525-690 V) |

**Table 3.6**

***NOTICE***

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

## 3.3 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.

### 3.3.1 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.

## 3.3.2 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.

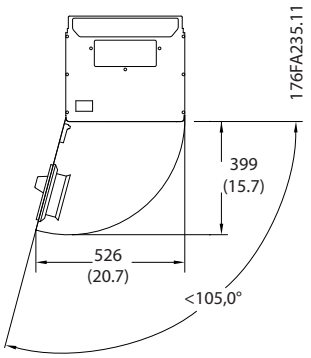



**Illustration 3.14 Space in Front of IP21/IP54 Rated Enclosure Types D1 and D2**

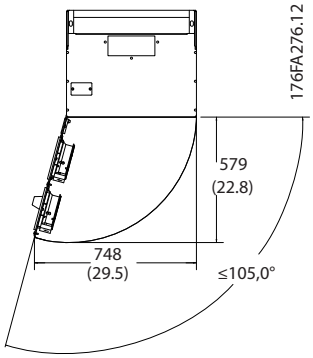



**Illustration 3.15 Space in Front of IP21/IP54 Rated Enclosure Type E1**

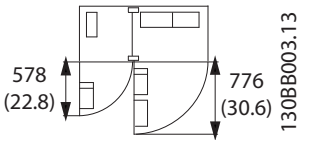



**Illustration 3.16 Space in Front of IP21/IP54 Rated Enclosure Type F1**

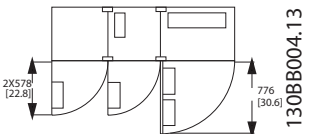



**Illustration 3.17 Space in Front of IP21/IP54 Rated Enclosure Type F3**

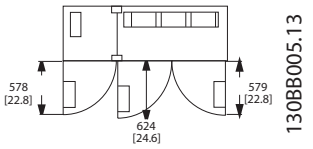



**Illustration 3.18 Space in Front of IP21/IP54 Rated Enclosure Type F2**

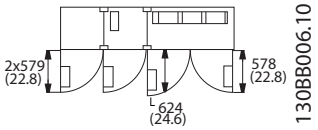



**Illustration 3.19 Space in Front of IP21/IP54 Rated Enclosure Type F4**

3

## 3.3.3 Terminal Locations - Enclosure Type D

Consider the following terminal positions when designing for cables access.

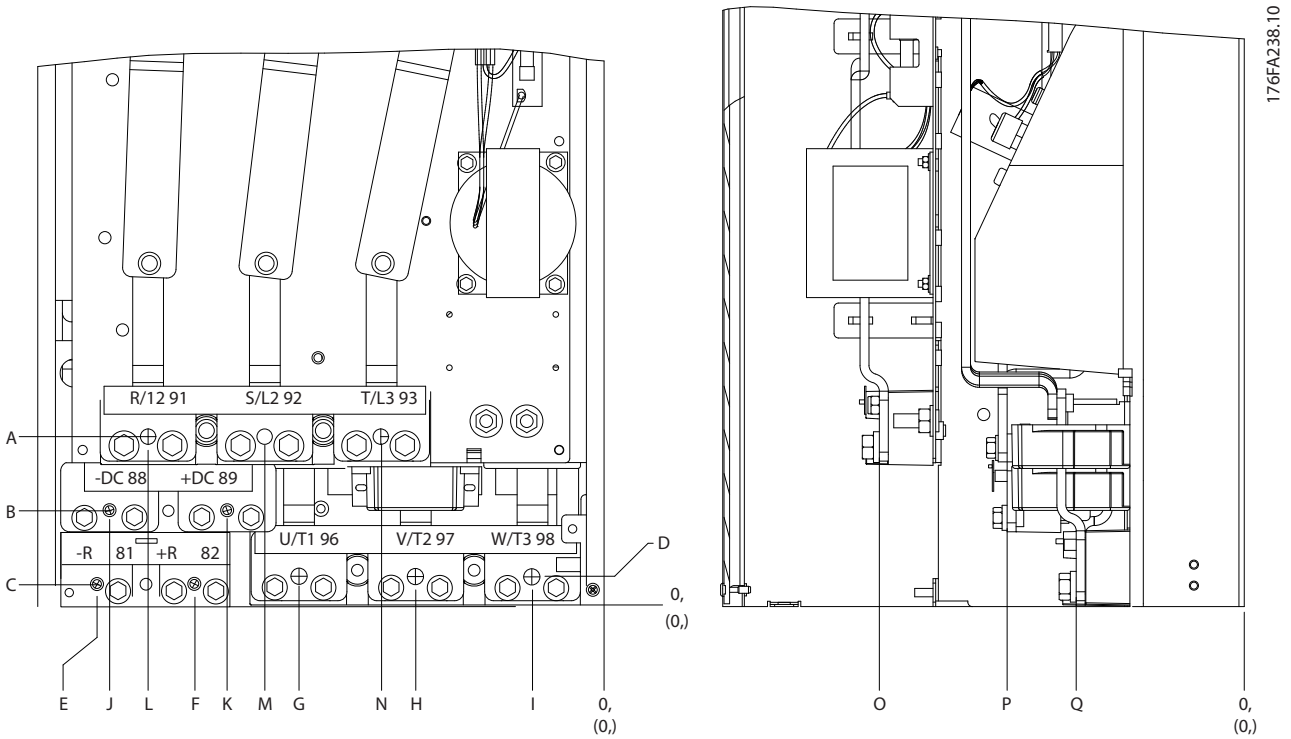



**Illustration 3.20 Position of Power Connections, Enclosure Types D3 and D4**

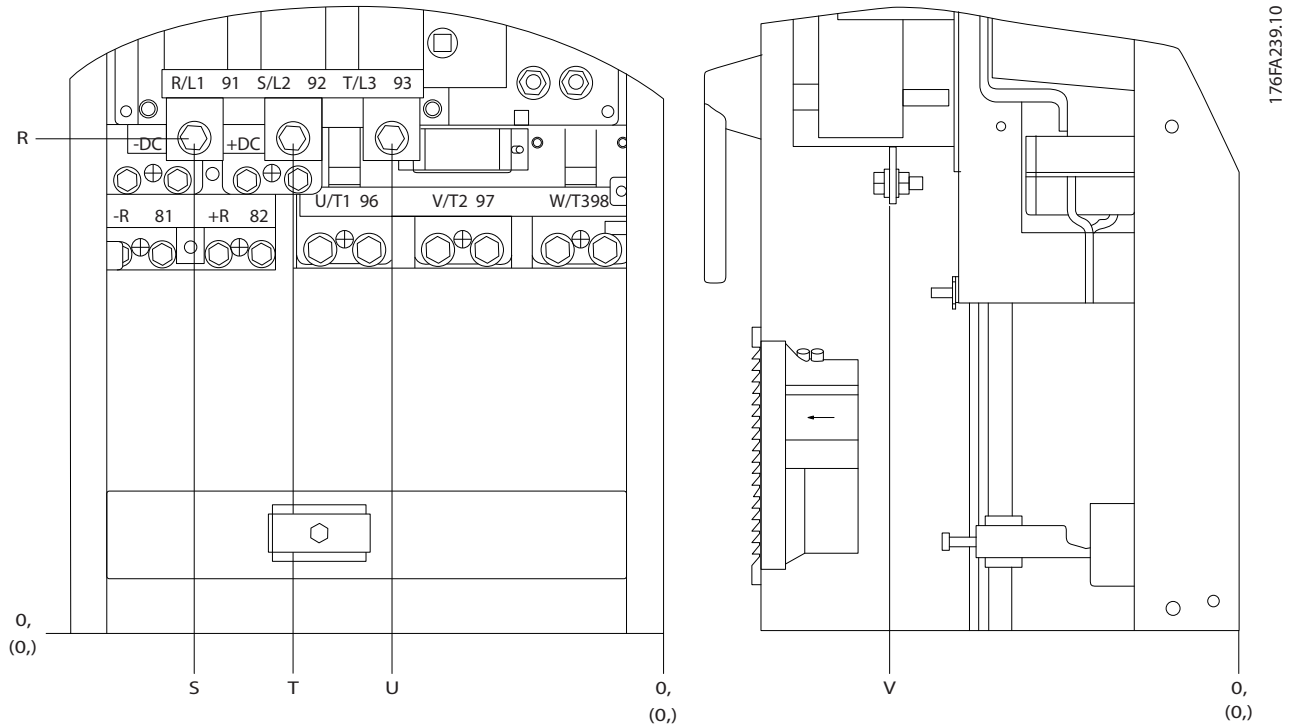



**Illustration 3.21 Position of Power Connections with Disconnect Switch, Enclosure Types D1 and D2**

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.

## NOTICE

**All D enclosures are available with standard input terminals or disconnect switch. All terminal dimensions can be found in *Table 3.7*.**



| | 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 3.7 Cable Positions Dimensions in mm (inch)**

## 3.3.4 Terminal Locations - E Enclosures

**Terminal Locations - E1**

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

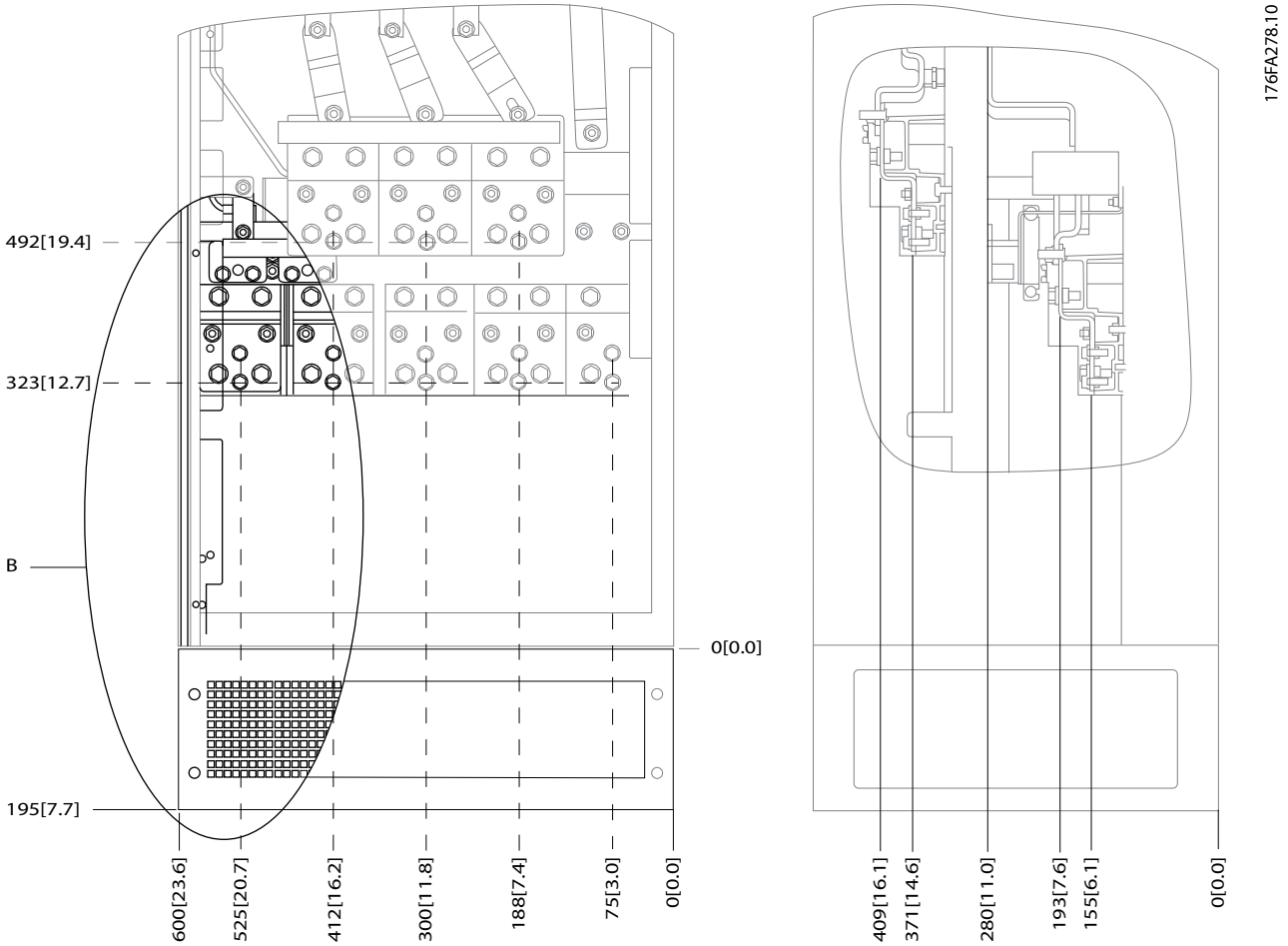



**Illustration 3.22 IP21 (NEMA Type 1) and IP54 (NEMA Type 12) Enclosure Power Connection Positions**

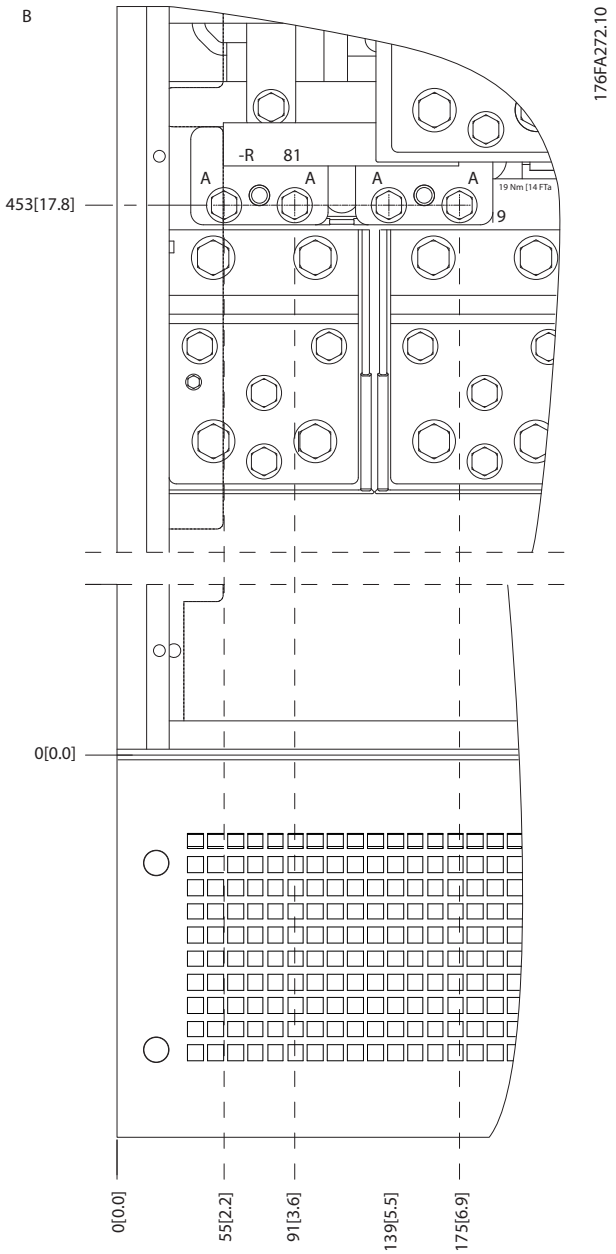



**Illustration 3.23 IP21 (NEMA type 1) and IP54 (NEMA type 12) Enclosure Power Connection Positions (Detail B)**

3

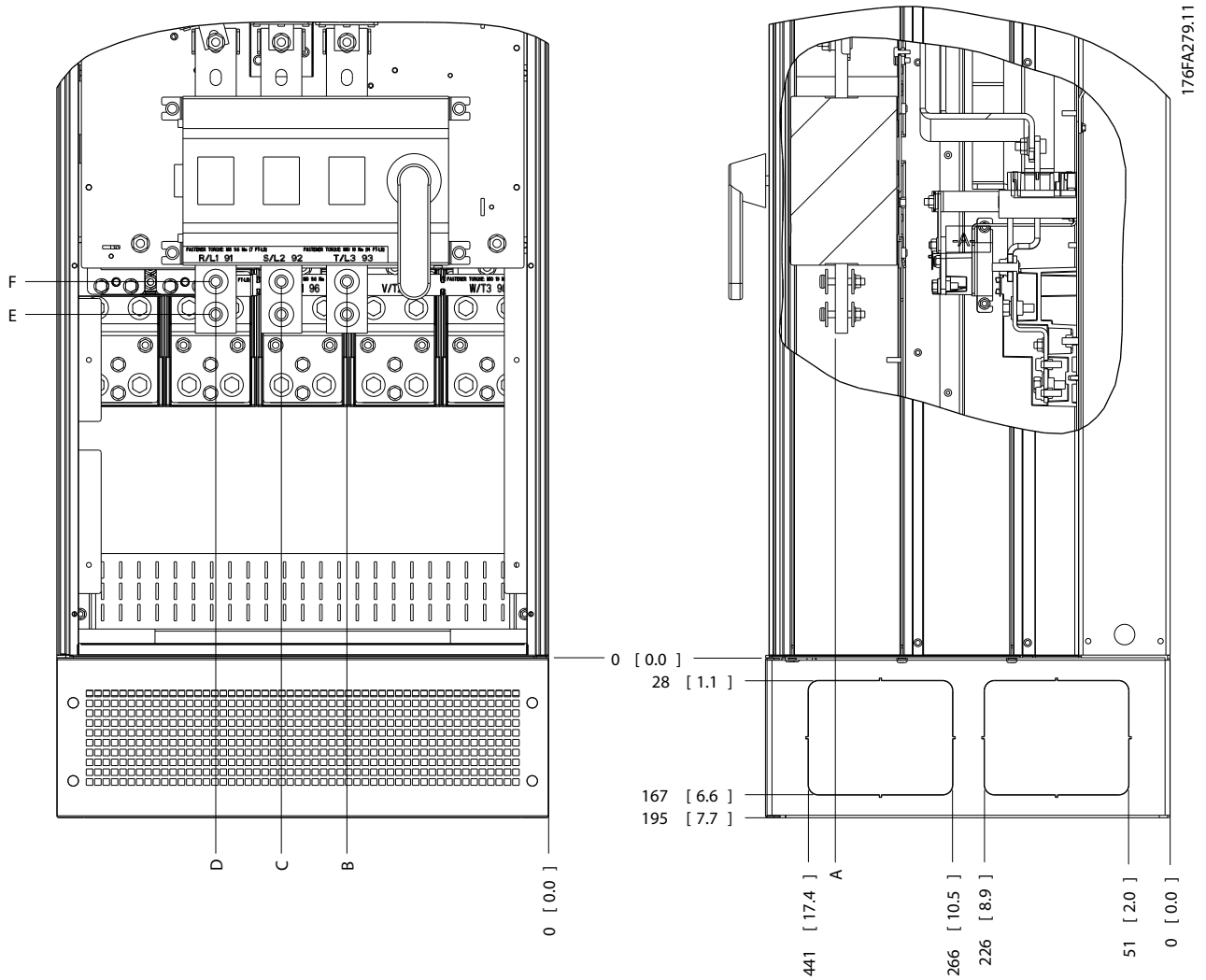



**Illustration 3.24 IP21 (NEMA type 1) and IP54 (NEMA type 12) Enclosure Power Connection Position of Disconnect Switch**

| 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 3.8 Dimensions for Disconnect Terminal**

**Terminal locations - enclosure type E2**

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

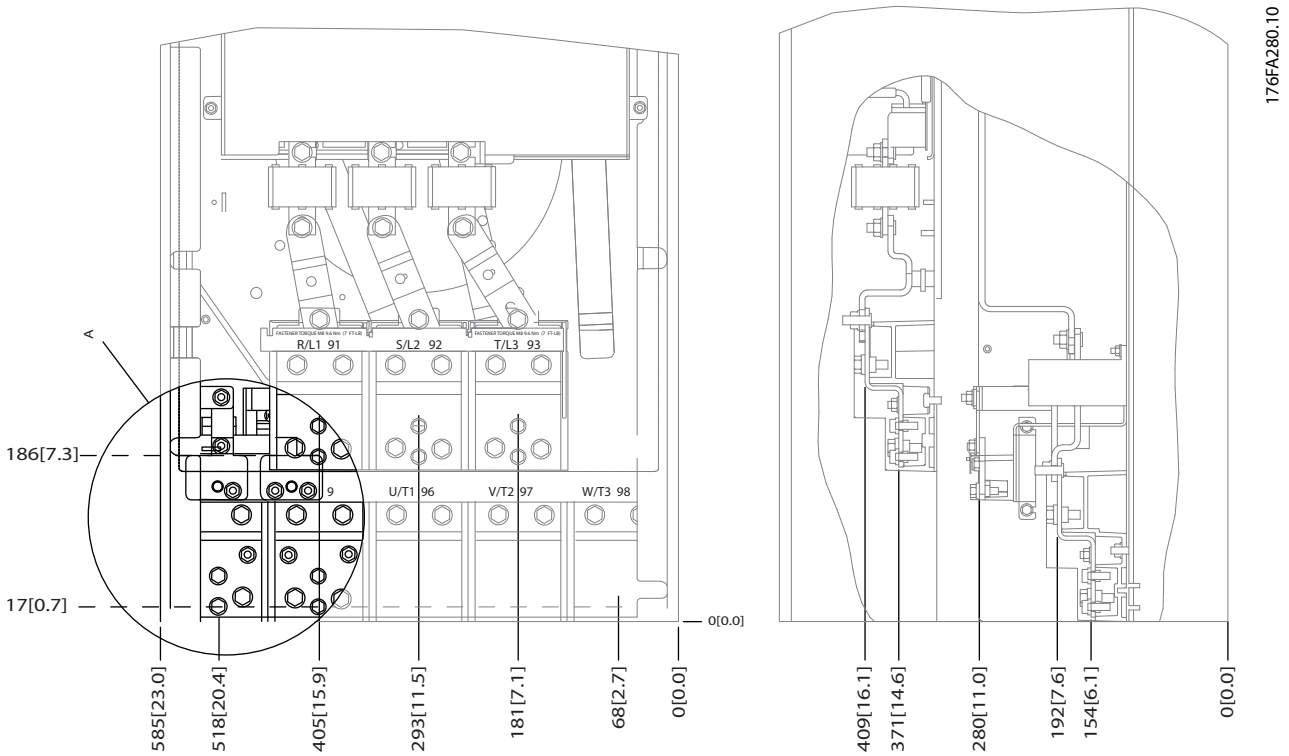



**Illustration 3.25 IP00 Enclosure Power Connection Positions**

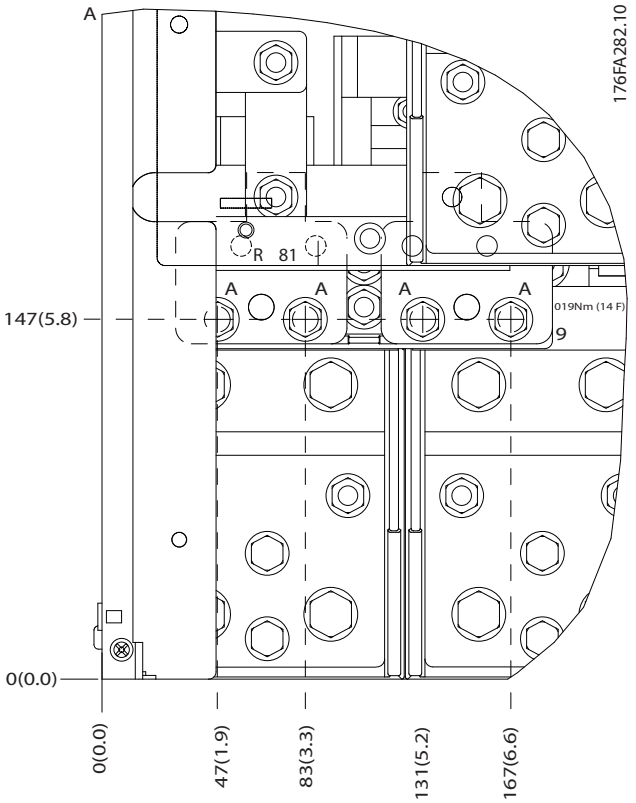



**Illustration 3.26 IP00 Enclosure Power Connection Positions**

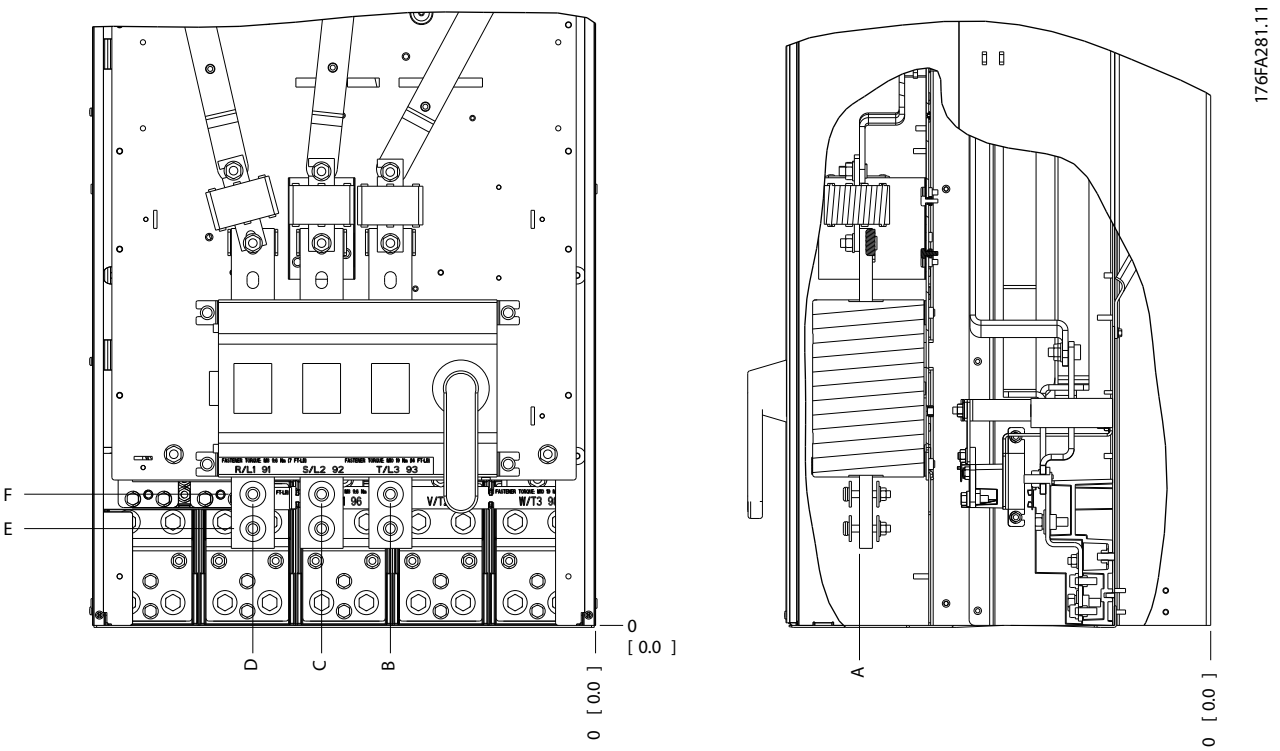



**Illustration 3.27 IP00 Enclosure Power Connections Positions of Disconnect Switch**

## *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.**

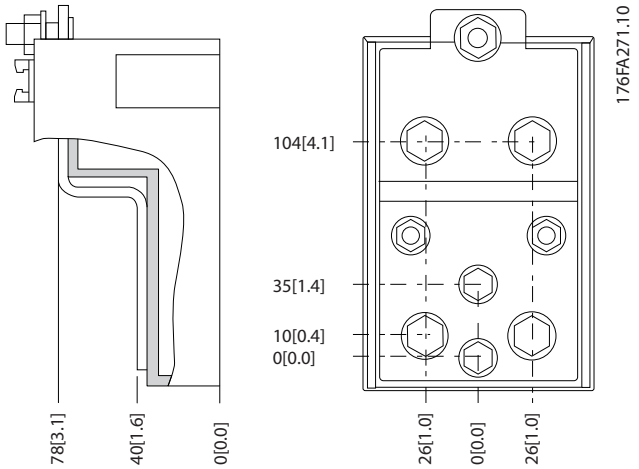



**Illustration 3.28 Terminal in Details**

***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 3.9 Dimensions for Disconnect Terminal**

## 3.3.5 Terminal Locations - Enclosure type F

***NOTICE***

**The F enclosures 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 - enclosure types F1 and F3**

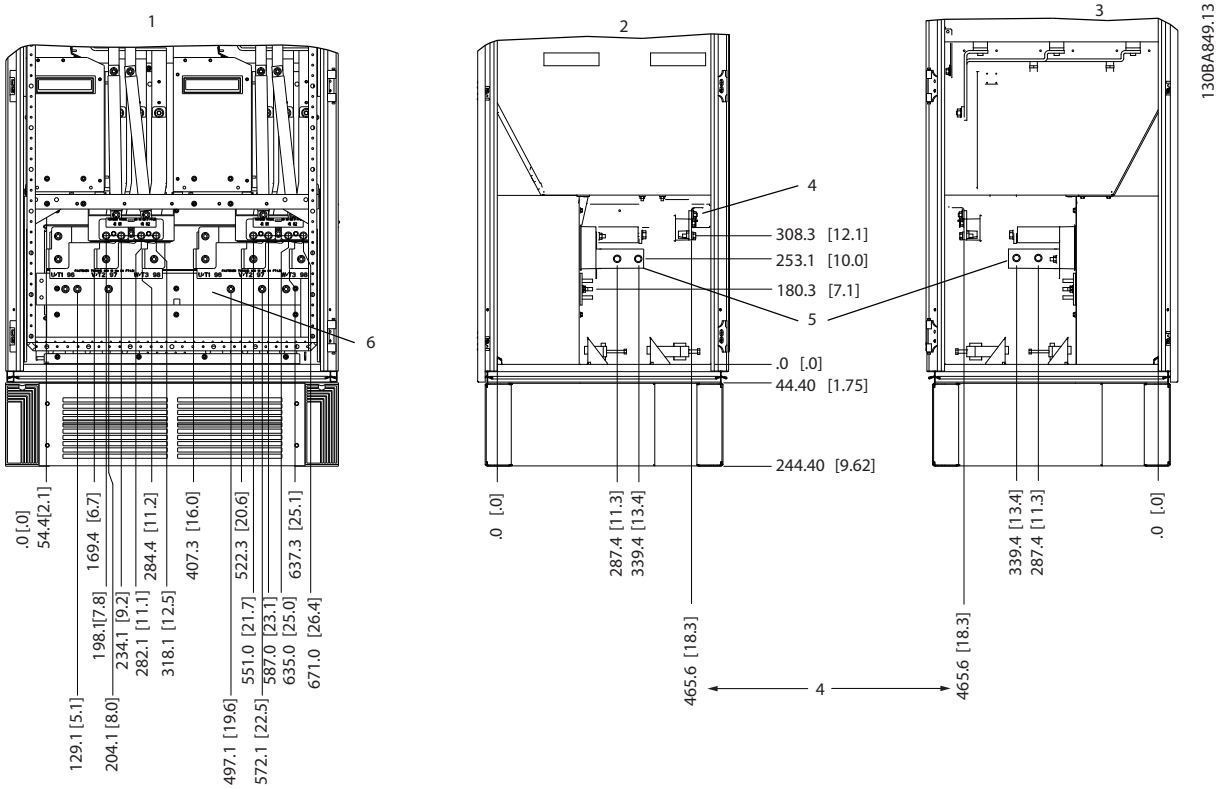



**Illustration 3.29 Terminal Locations - Inverter Cabinet - F1 and F3 (Front, Left and Right Side View). The Gland Plate is 42 mm below .0 Level.**

**1) Earth ground bar**

**2) Motor terminals**

**3) Brake terminals**

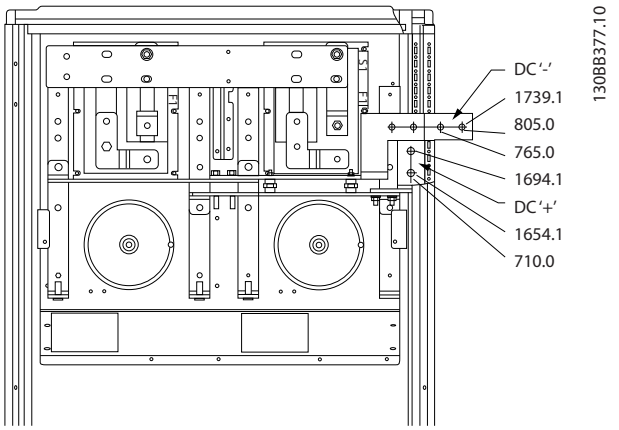



**Illustration 3.30 Terminal Locations - Regen Terminals - F1 and F3**

### Terminal locations - enclosure types F2 and F4

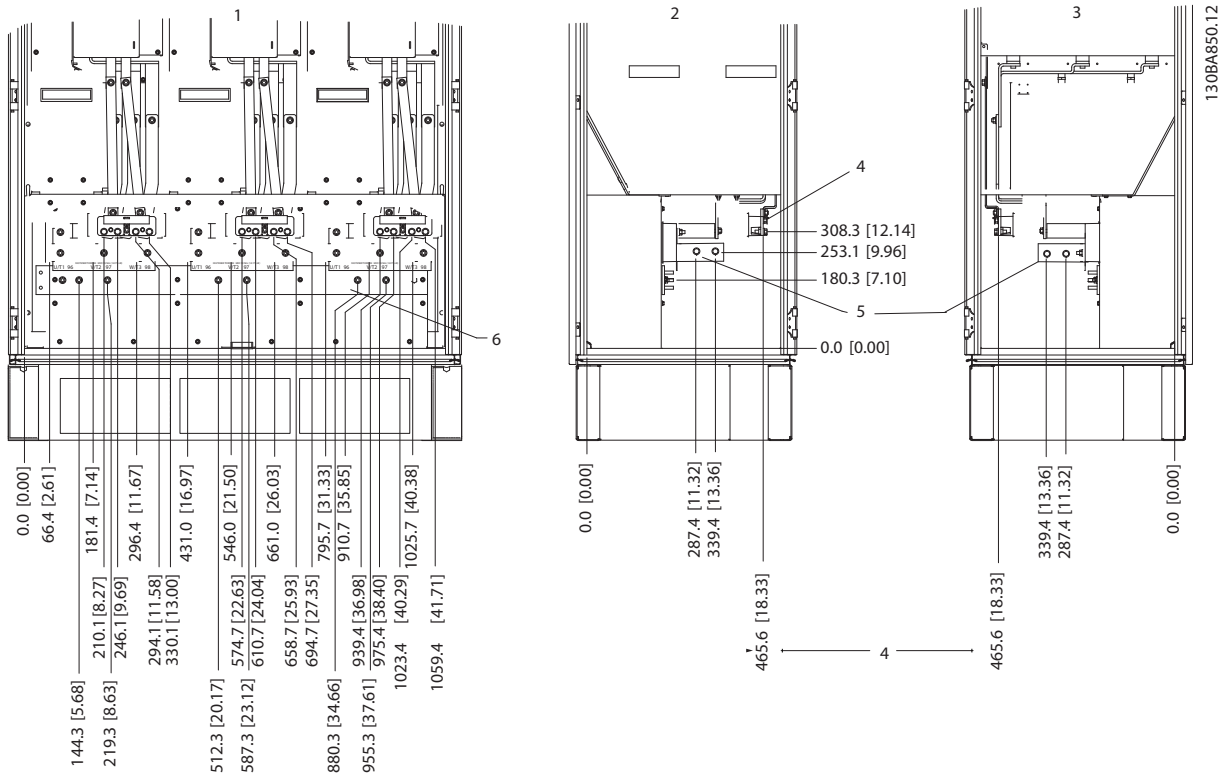



**Illustration 3.31 Terminal Locations - Inverter Cabinet - F2 and F4 (Front, Left and Right Side View). The Gland Plate is 42 mm below .0 Level.**

**1) Earth Ground Bar**

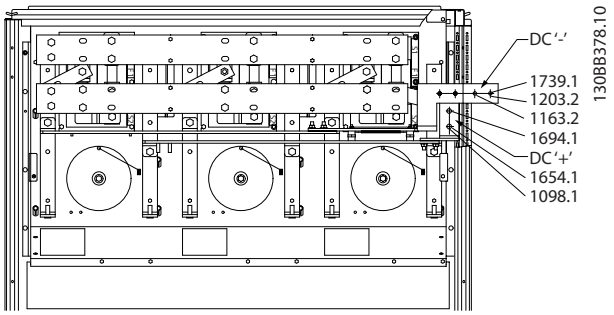
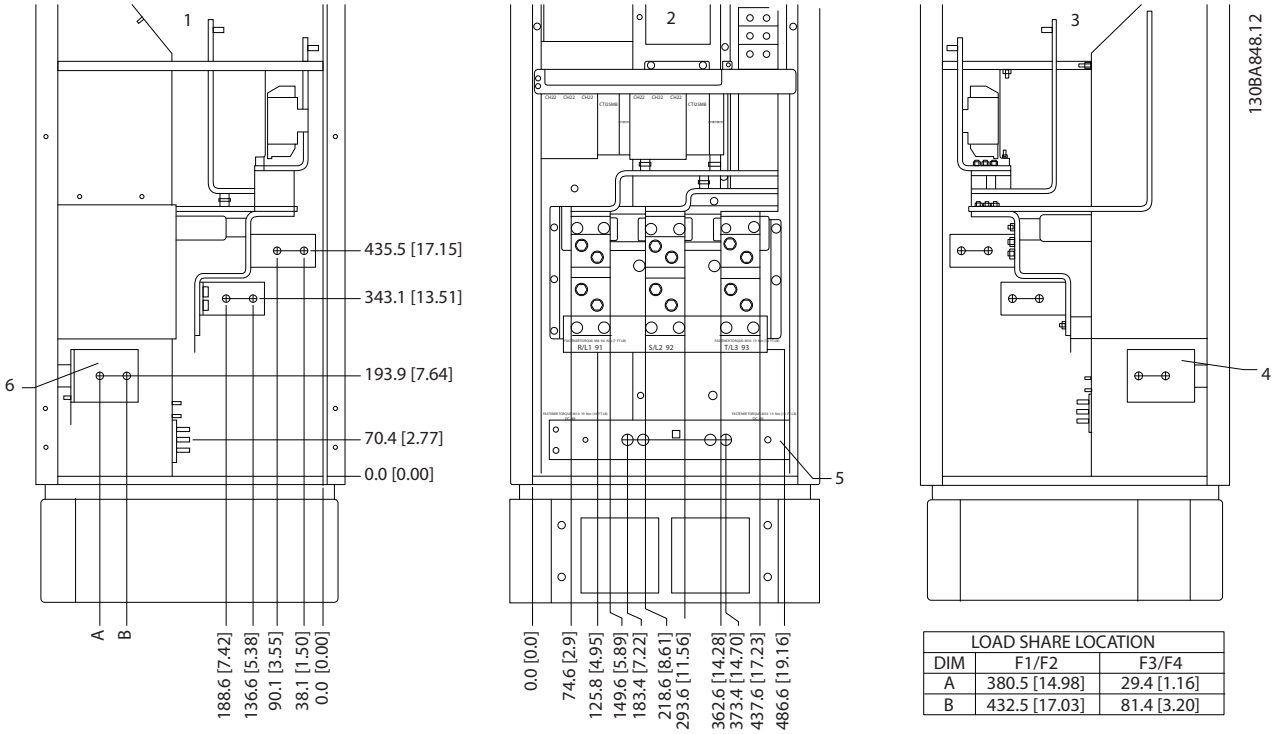



**Illustration 3.32 Terminal Locations - Regen Terminals - F2 and F4**



### 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 3.33 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 (+)**

3

### Terminal locations - Options Cabinet (F3 and F4)

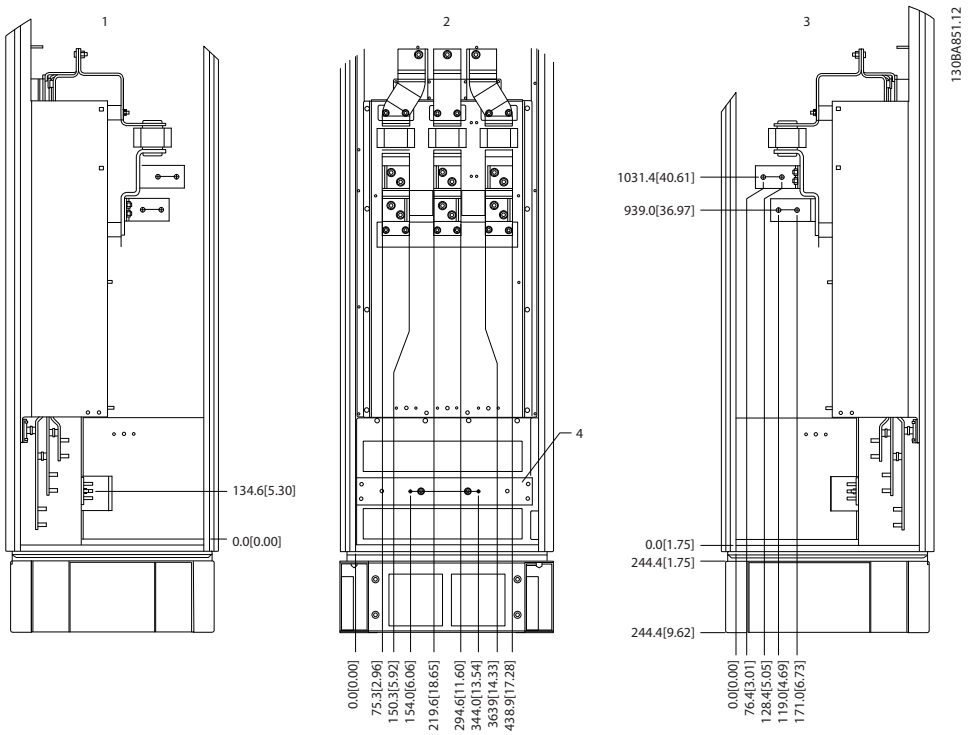



**Illustration 3.34 Terminal Locations - Options Cabinet (Left Side, Front and Right Side View). The Gland Plate is 42 mm below .0 Level.**

**1) Earth Ground Bar**

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

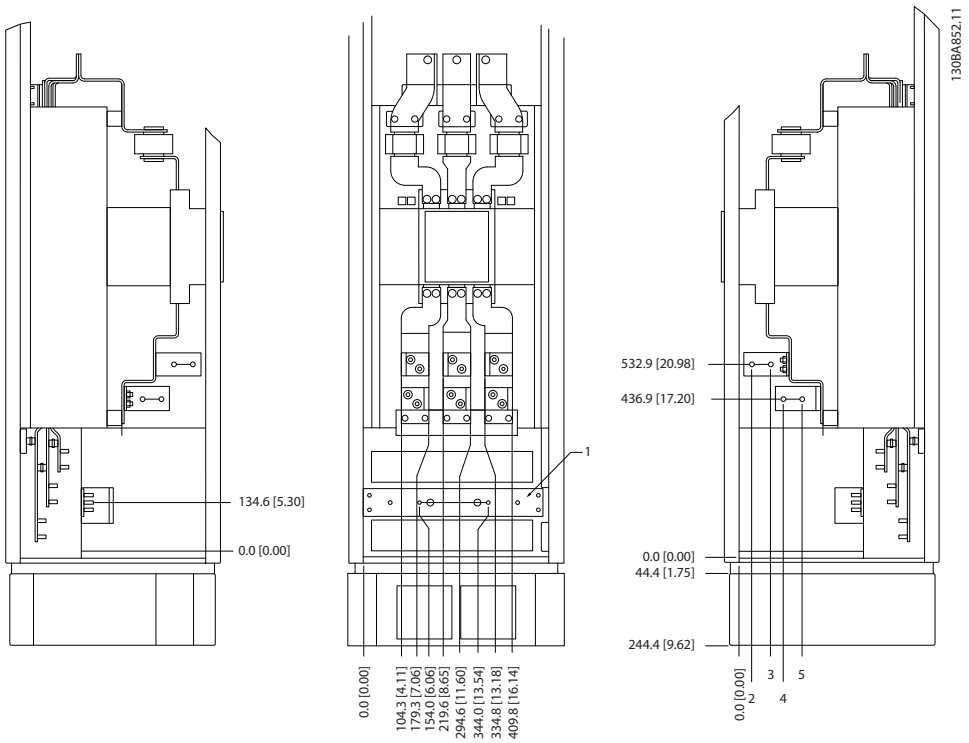



**Illustration 3.35 Terminal Locations - Options Cabinet with Circuit Breaker/Molded Case Switch (Left Side, Front and Right Side View). The Gland Plate is 42 mm below .0 Level.**
**1) Earth Ground Bar**

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

**Table 3.10 Dimensions for Terminal**

## 3.3.6 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 of 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.

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

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

3

## ⚠CAUTION

**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 in *Table 3.11*.

| Enclosure protection | Enclosure type | 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 P315T5, P450T7, P500T7 | 340 $m^3$/h (200 cfm) | 1105 $m^3$/h (650 cfm) |
| | E1 P355-P450T5, P560-P630T7 | 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 P315T5, P450T7, P500T7 | 255 $m^3$/h (150 cfm) | 1105 $m^3$/h (650 cfm) |
| | E2 P355-P450T5, P560-P630T7 | 255 $m^3$/h (150 cfm) | 1445 $m^3$/h (850 cfm) |
| * Airflow per fan. enclosure type F contain multiple fans. | | | |

**Table 3.11 Heat Sink Air Flow**

## *NOTICE*

**The fan runs for the following reasons:**

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

**Once the fan is started it will run 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.

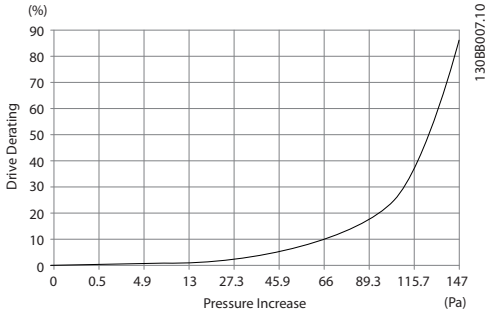



**Illustration 3.36 D Enclosure Derating vs. Pressure Change**
**Frequency converter air flow: 450 cfm (765 $m^3$/h)**

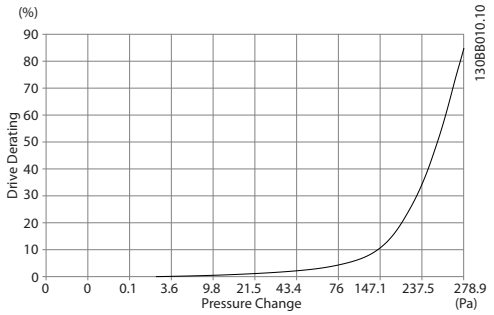



**Illustration 3.37 E Enclosure Derating vs. Pressure Change (Small Fan), P315T5 and P450T7-P500T7**
**Frequency converter air flow: 650 cfm (1105 $m^3$/h)**

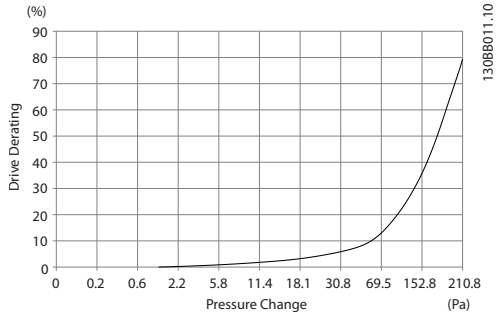



**Illustration 3.38 E Enclosure Derating vs. Pressure Change (Large Fan), P355T5-P450T5 and P560T7-P630T7**
**Frequency converter air flow: 850 cfm (1445 m³/h)**

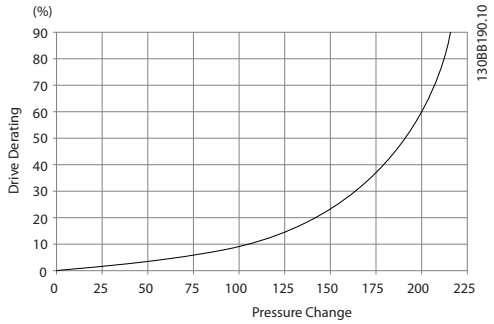



**Illustration 3.39 F1, F2, F3, F4 Enclosures Derating vs. Pressure Change**
**Frequency converter air flow: 580 cfm (985 m³/h)**

## 3.3.7 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.

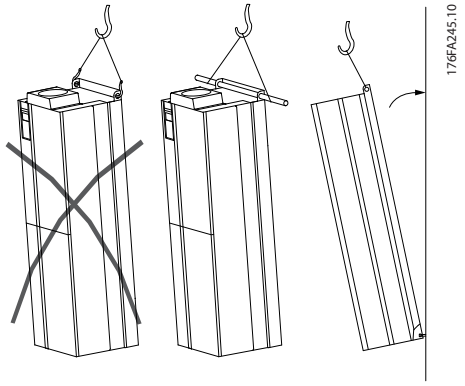



**Illustration 3.40 Lifting Method for Mounting Frequency Converter on Wall**

## 3.3.8 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**

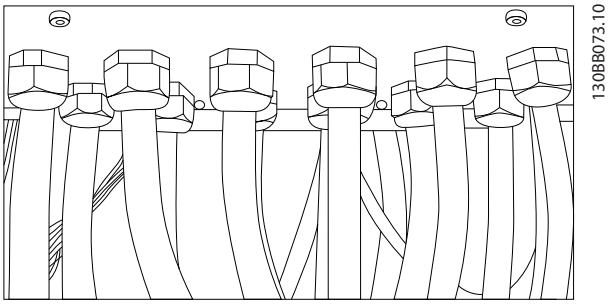



**Illustration 3.41 Example of Proper Installation of Gland Plate.**

3

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

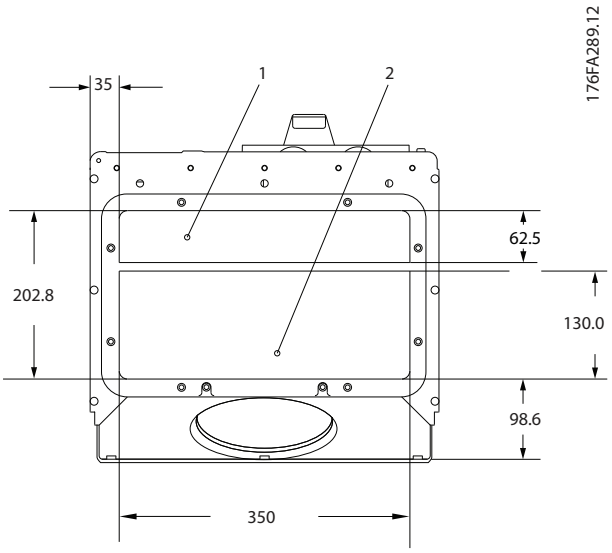



**Illustration 3.42 Enclosure Types D1 + D2**

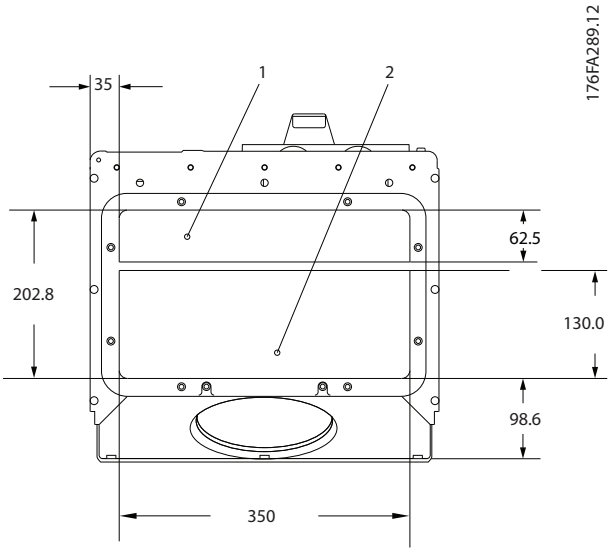



**Illustration 3.43 Enclosure Type E1**

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

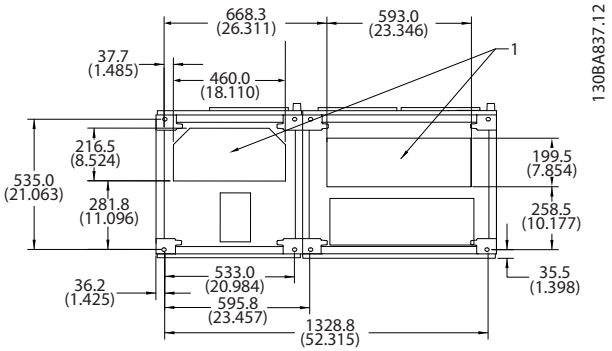



**Illustration 3.44 Enclosure Type F1**

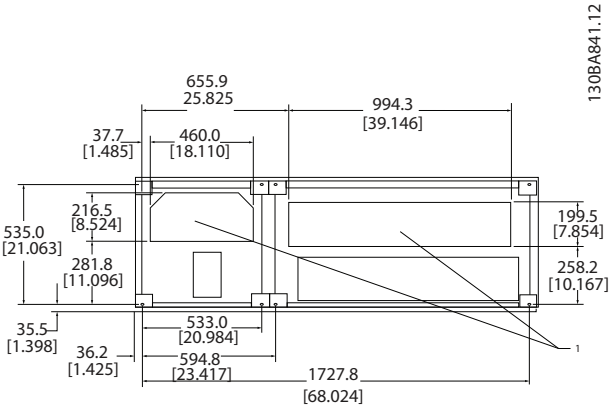



**Illustration 3.45 Enclosure Type F2**

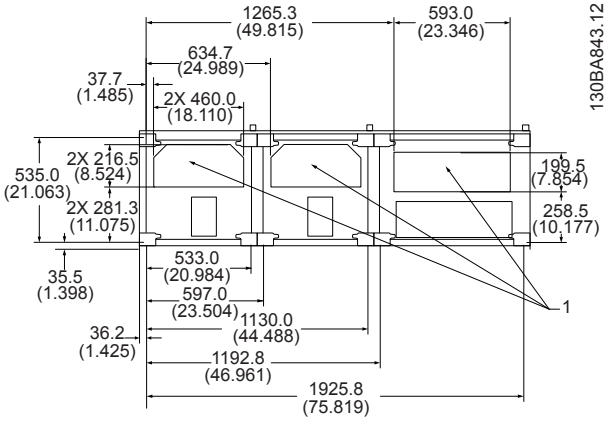



**Illustration 3.46 Enclosure Type F3**

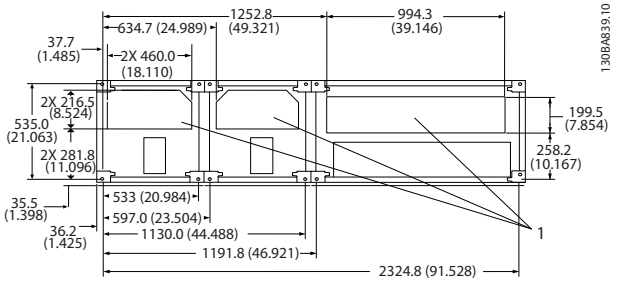



**Illustration 3.47 Enclosure Type F4**

## 3.3.9 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)

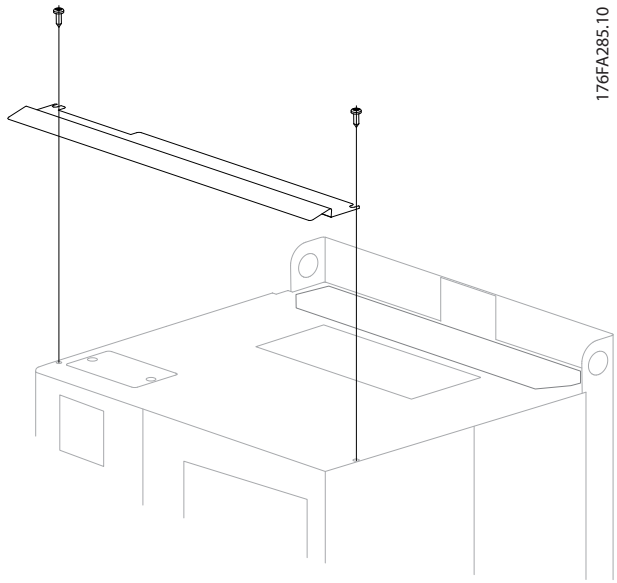



**Illustration 3.48 Drip Shield Installation.**

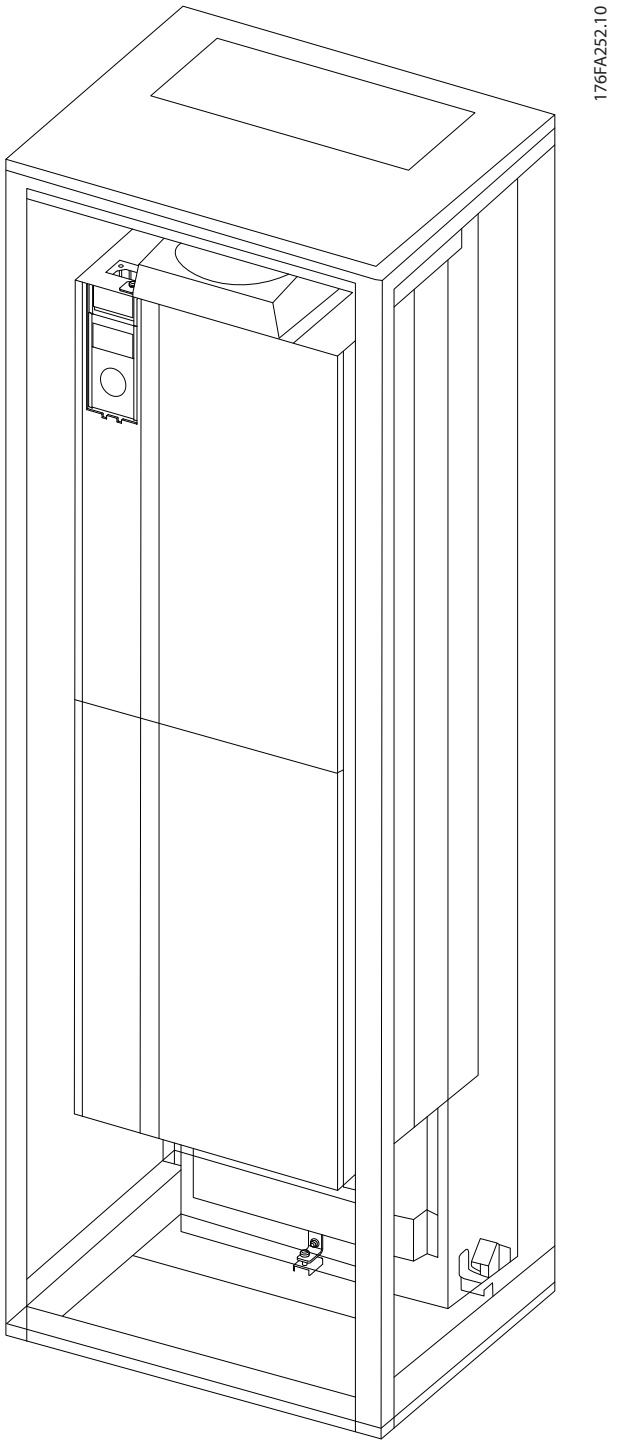



**Illustration 3.49 Installation of IP00 in Rittal TS8 Enclosure.**

## 3.4 Field Installation of Options

### 3.4.1 Installation of Duct Cooling Kit in Rittal Enclosures

This section deals with the installation of IP00/chassis enclosed frequency converters with duct work cooling kits in Rittal enclosures. In addition to the enclosure a 200 mm base/plinth is required.

**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 3.12* 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.

3

**⚠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 3.12 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 3.3.6 Cooling and Airflow* for further information.

### 3.4.2 Installation of Top-only Duct Cooling Kit

This description is for the installation of the top section only of the 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

### 3.4.3 Installation of Top and Bottom Covers for Rittal Enclosures

The top and bottom covers, installed onto IP00 frequency converters, direct the heat sink cooling air in and out the back of the frequency converter. The kits are applicable to 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

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

## 3.4.4 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

## 3.4.5 Outside Installation/NEMA 3R Kit for Rittal Enclosures

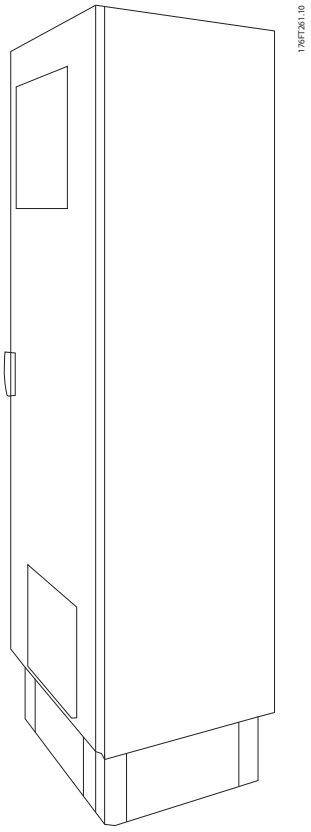



**Illustration 3.50**

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.**

### 3.4.6 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

### 3.4.7 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

### 3.4.8 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

### 3.4.9 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.

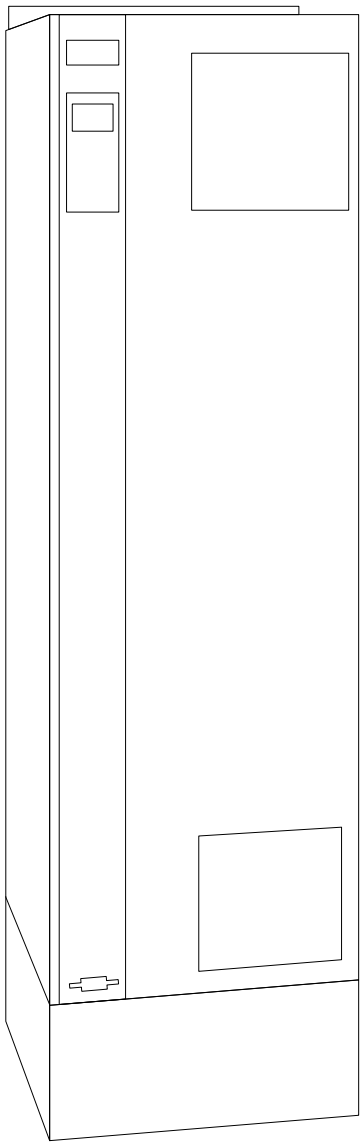



**Illustration 3.51 Frequency Converter on Pedestal**

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.

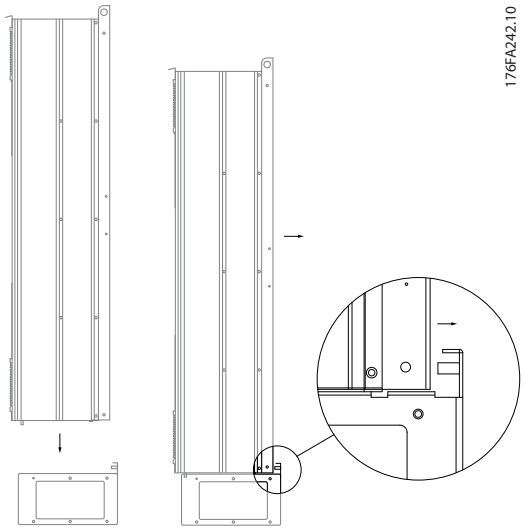



**Illustration 3.52 Mounting of Frequency Converter to Pedestal**

***NOTICE***

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

## 3.4.10 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***

### 3.4.11 F Frame USB Extension Kit

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

**Ordering number:**
176F1784

3

***NOTICE***

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

### 3.4.12 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<br>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<br>FC 302: 250 kW | 176F0253 | 176F0255 | 176F0257 | 176F0258 | 176F0260 |
| | FC 102/ FC 202: 355 - 450 kW<br>FC 302: 315 - 400 kW | 176F0254 | 176F0256 | 176F0257 | 176F0259 | 176F0262 |

**Table 3.13 Fuses**

| | 525 - 690 V | Fuses | Disconnect Fuses | RFI | RFI Fuses | RFI Disconnect Fuses |
|---|---|---|---|---|---|---|
| D1 | FC 102/ FC 202: 45-90 kW<br>FC 302: 37-75 kW | 175L8829 | 175L8828 | 175L8777 | NA | NA |
| | FC 102/ FC 202: 110-160 kW<br>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<br>FC 302: 355-400 kW | 176F0253 | 176F0255 | NA | NA | NA |
| | FC 102/ FC 202: 560-630 kW<br>FC 302: 500-560 kW | 176F0254 | 176F0258 | NA | NA | NA |

**Table 3.14**

***NOTICE***

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

### 3.4.13 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

## 3.5 Frame size F Panel Options

### 3.5.1 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

**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 3.15* to set the proper tap at terminal T1 located in the rectifier cabinet. For location in the frequency converter, see *Illustration 4.1*.

| Input Voltage Range [V] | Tap to Select |
|---|---|
| 380-440 | 400 V |
| 441-490 | 460 V |
| 491-550 | 525 V |
| 551-625 | 575 V |
| 626-660 | 660 V |
| 661-690 | 690 V |

**Table 3.15**

**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.

3

**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
- 2 output relays (N.O.)
- Dual-line LC display and LED diagnostics
- Sensor lead wire break, short-circuit, and incorrect polarity detection
- Interface setup software

# 4 Electrical Installation

## 4.1 Electrical Installation

### 4.1.1 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.

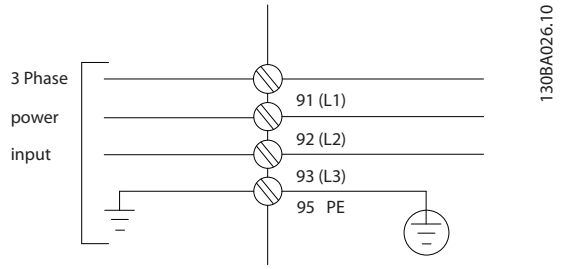



**Illustration 4.1 Power Cable Connections**

***NOTICE***

**The motor cable must be screened/armoured. If an unscreened/unarmoured cable is used, some EMC requirements are not complied with. 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*.

| 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 4.1**

*[1)]Protected Earth Connection*

4

***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.**

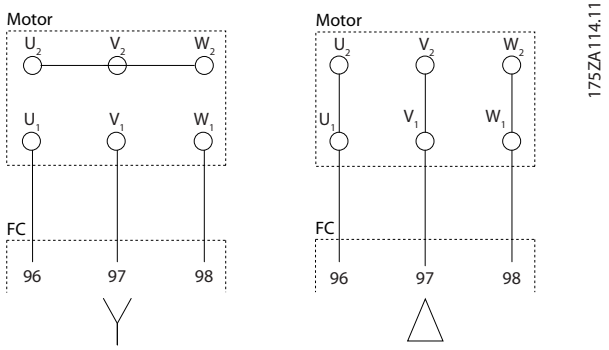



**Illustration 4.2 Star/Delta Connections**

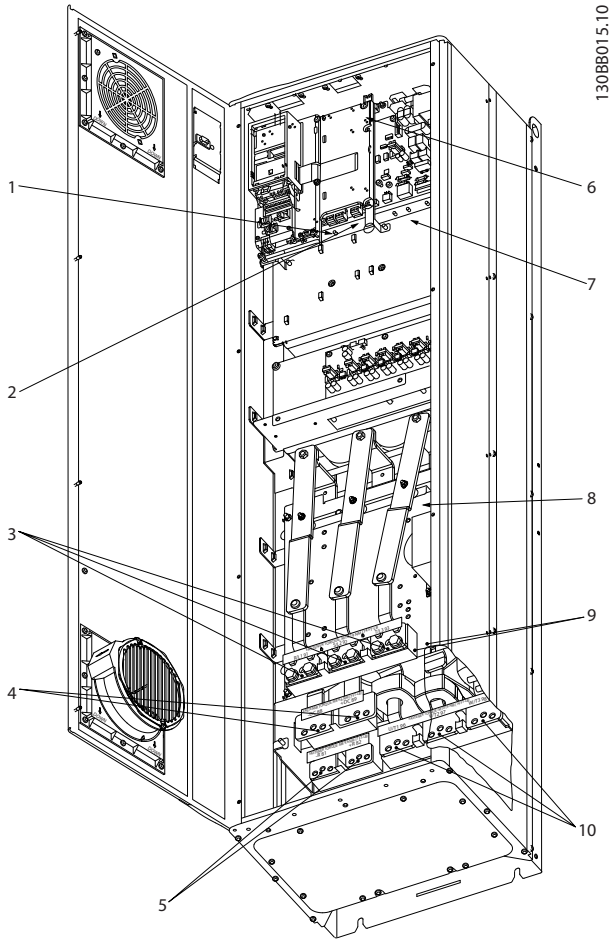



**Illustration 4.3 Compact IP21 (NEMA 1) and IP54 (NEMA 12), Enclosure Type D1**

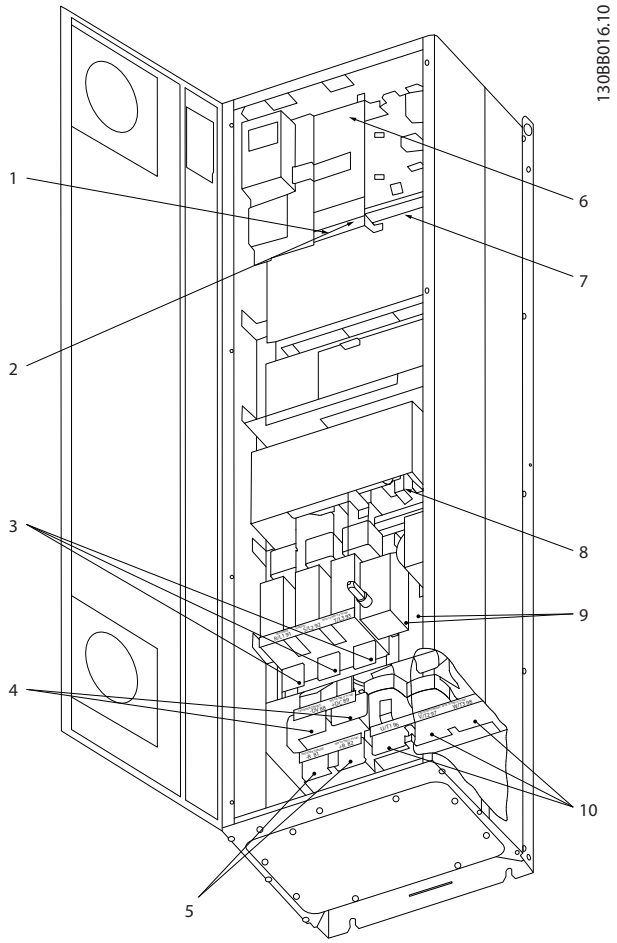



**Illustration 4.4 Compact IP21 (NEMA 1) and IP54 (NEMA 12) with Disconnect, Fuse and RFI Filter, Enclosure Type D2**

| | | | |
|---|---|---|---|
| 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 4.2 Legend to *Illustration 4.3* and *Illustration 4.4***

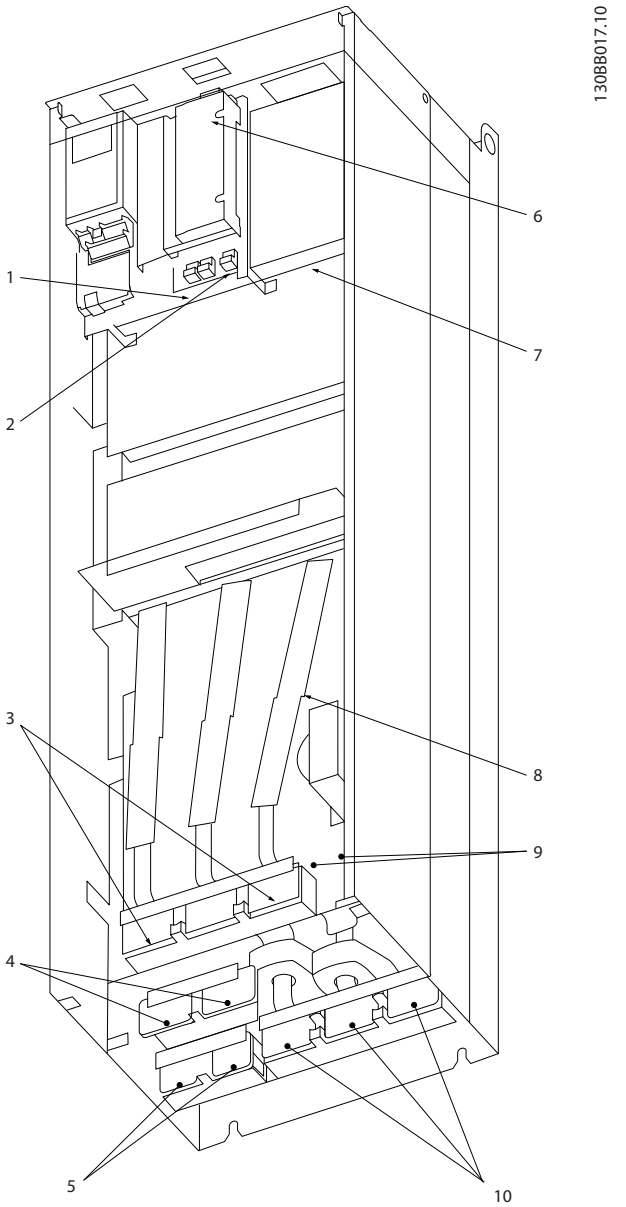



**Illustration 4.5 Compact IP00 (Chassis), Enclosure Type D3**

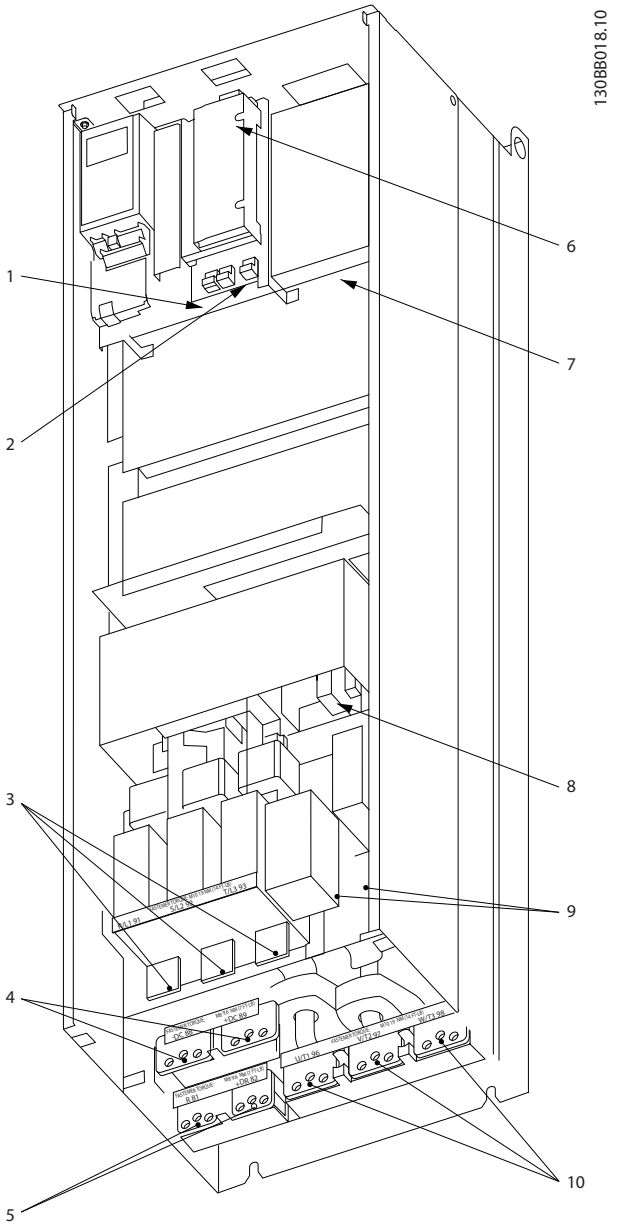



**Illustration 4.6 Compact IP00 (Chassis) with Disconnect, Fuse and RFI Filter, Enclosure Type D4**

| | | | | | |
|---|---|---|---|---|---|
| 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 4.3 Legend to *Illustration 4.5* and *Illustration 4.6***

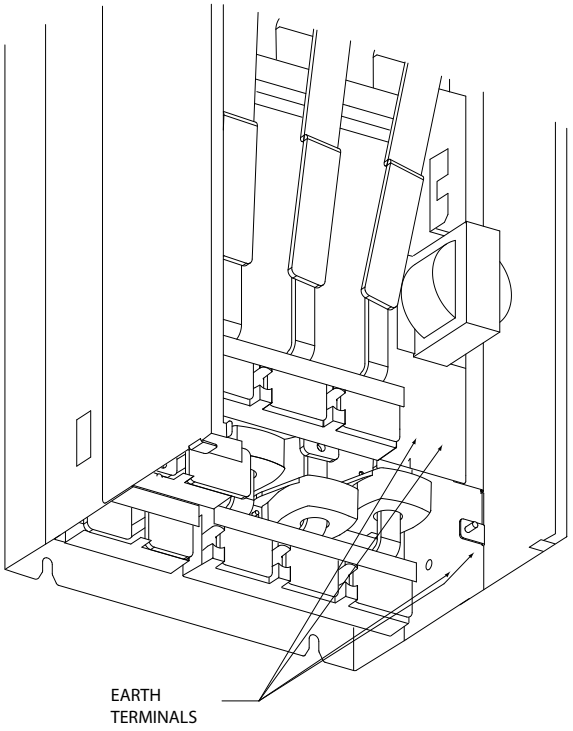



**Illustration 4.7 Position of Earth Terminals IP00, Enclosure Type D**

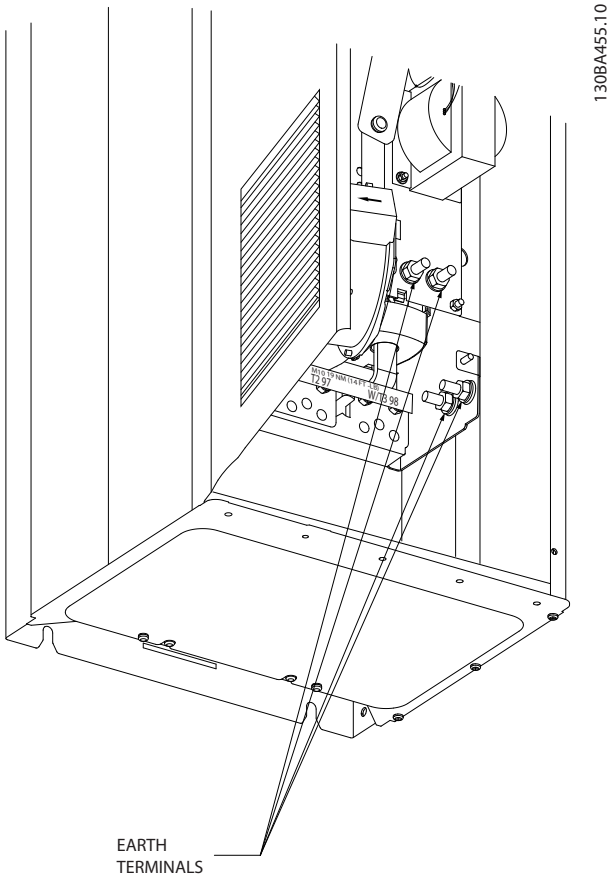



**Illustration 4.8 Position of Earth Terminals IP21 (NEMA type 1) and IP54 (NEMA type 12)**

***NOTICE***

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

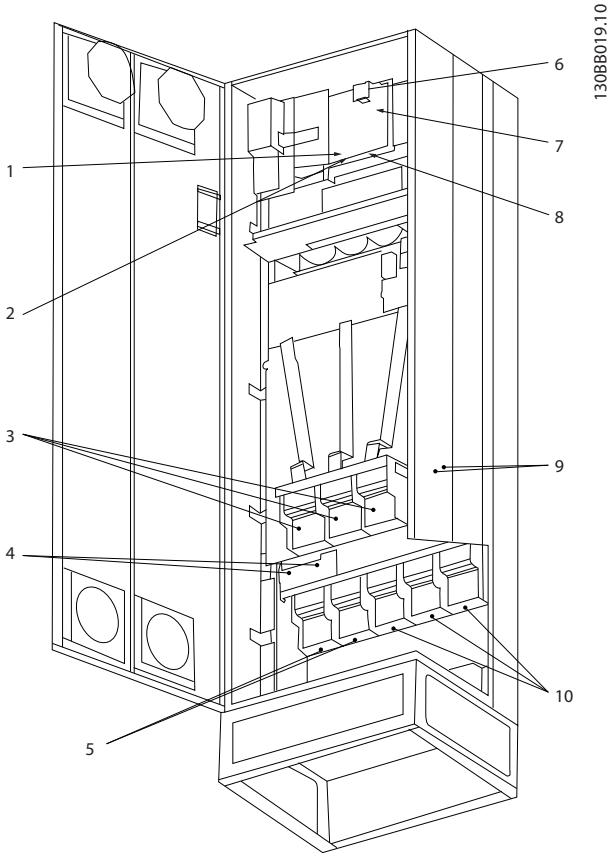



**Illustration 4.9 Compact IP21 (NEMA 1) and IP54 (NEMA 12) Enclosure Type E1**

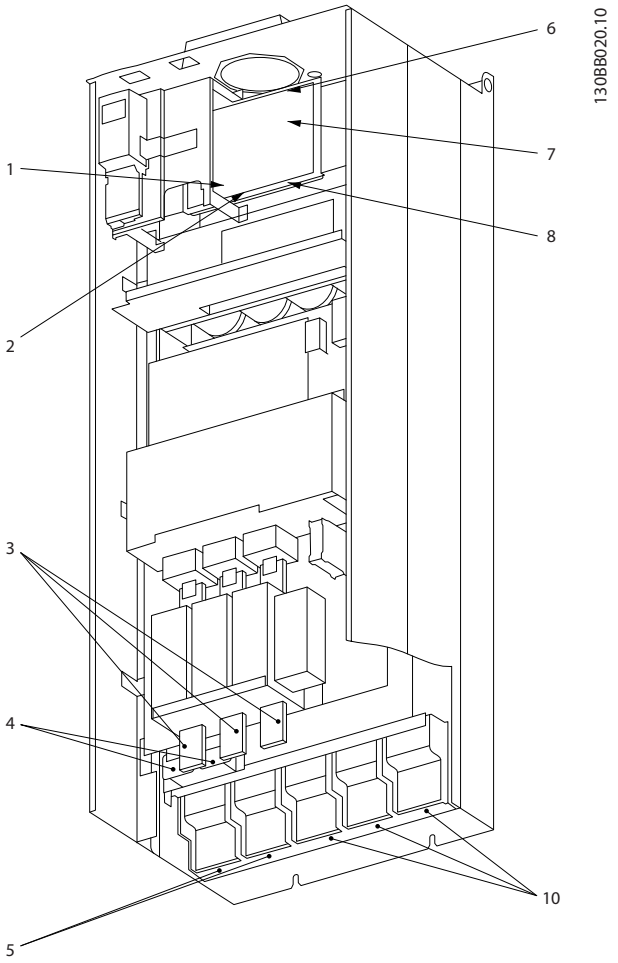



**Illustration 4.10 Compact IP00 (Chassis) with Disconnect, Fuse and RFI Filter, Enclosure Type E2**

| | | | |
|---|---|---|---|
| 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 4.4 Legend to *Illustration 4.9* and *Illustration 4.10***

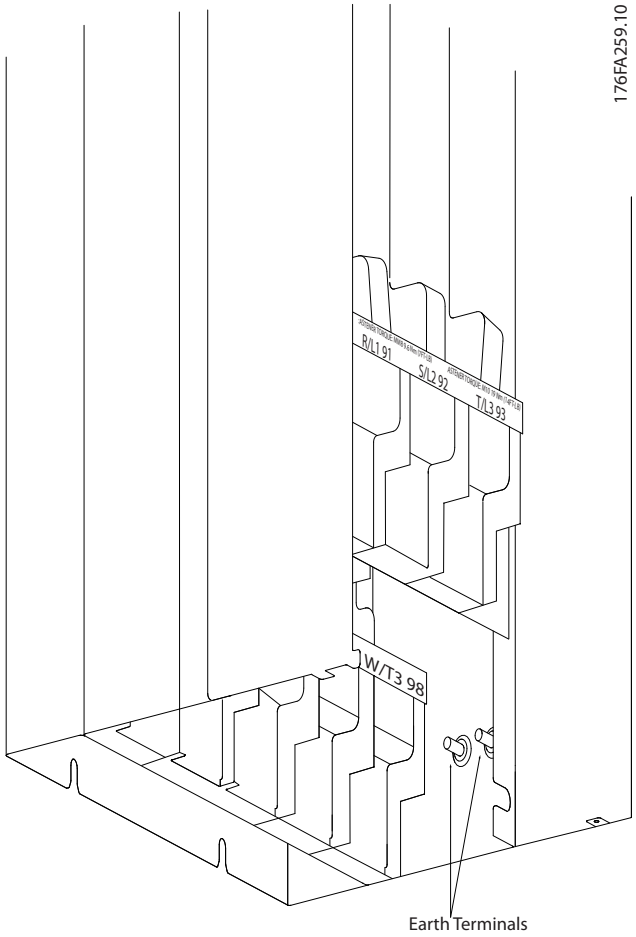
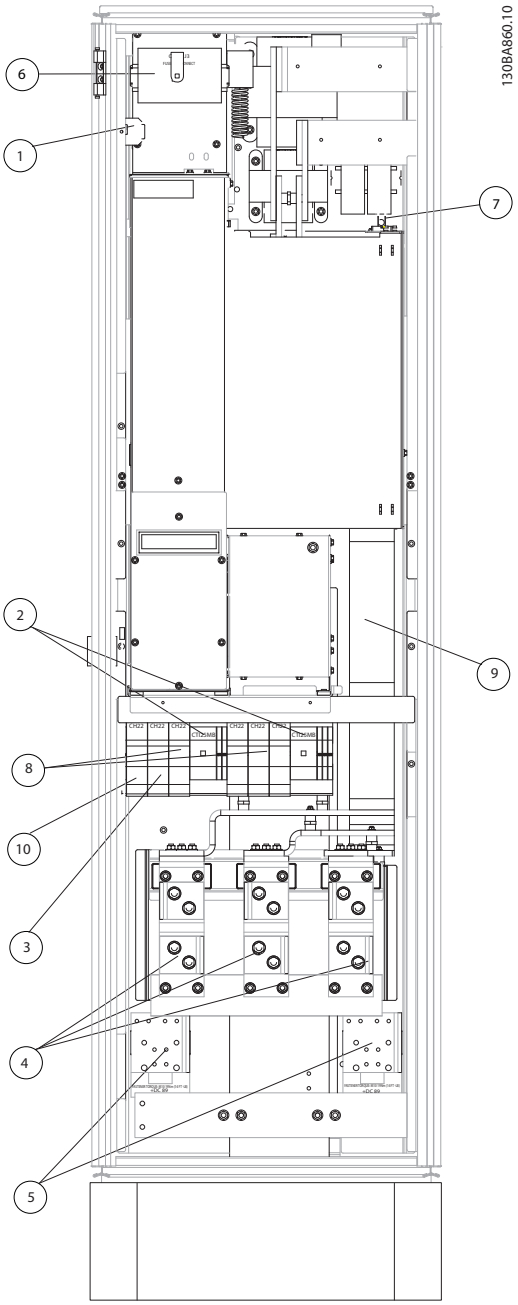
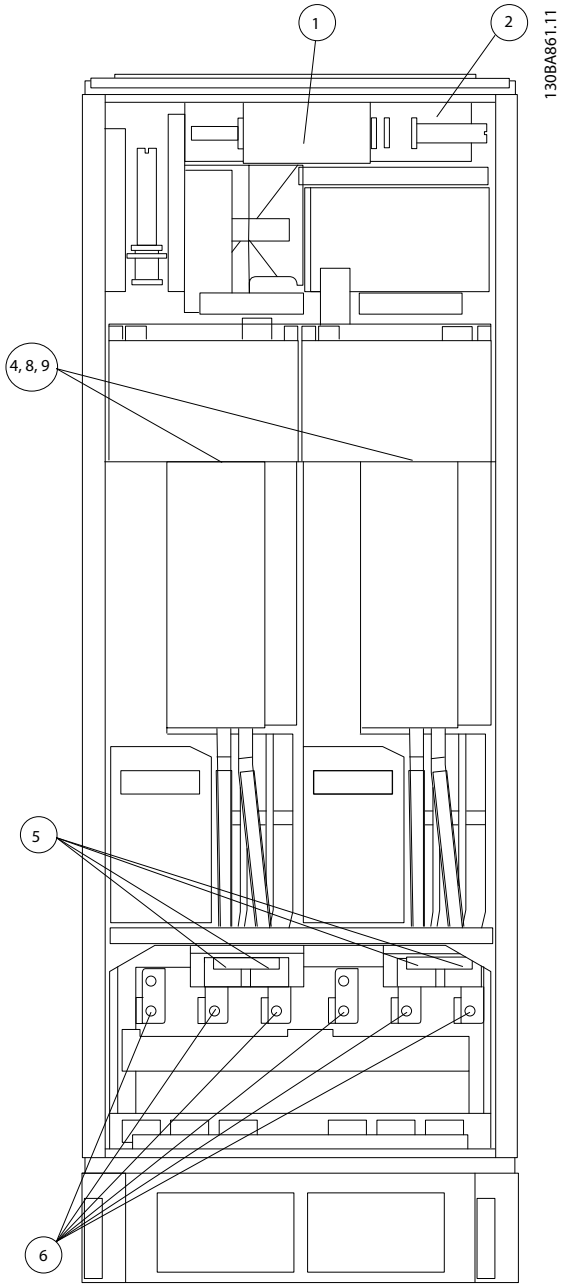



**Illustration 4.11 Position of Earth Terminals IP00, Enclosure Type E**



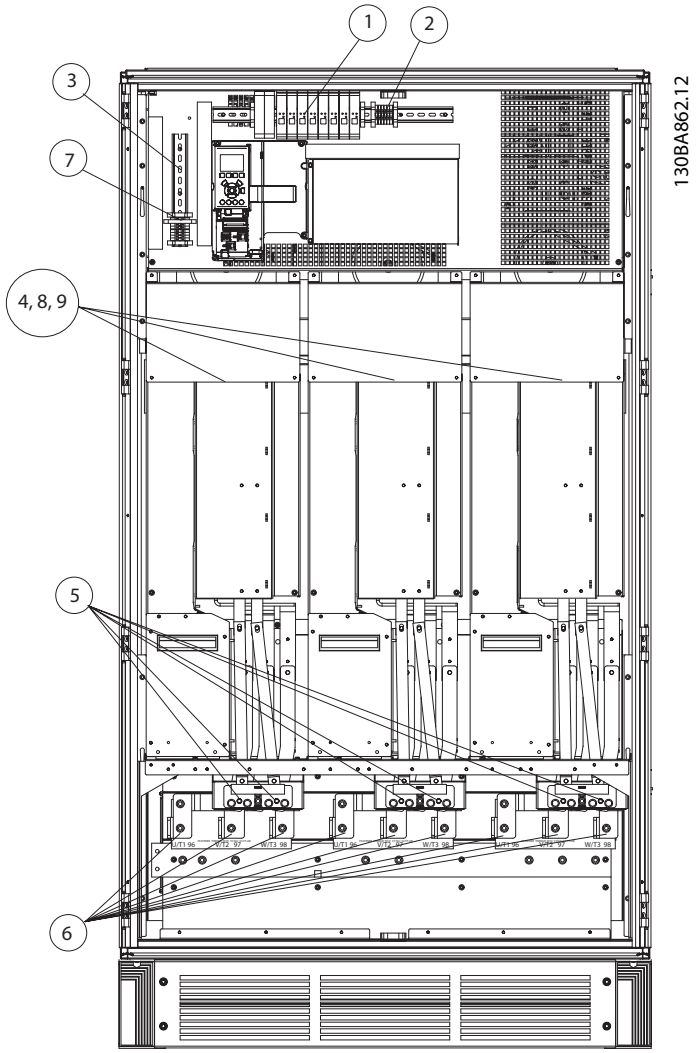

| | | | |
|---|---|---|---|
| 1) | 24 V DC, 5 A | 5) | Loadsharing |
| | T1 Output Taps | | -DC +DC |
| | Temp Switch | | 88 89 |
| | 106 104 105 | 6) | Control Transformer Fuses (2 or 4 pieces). See fuse tables for part numbers |
| 2) | Manual Motor Starters | 7) | SMPS Fuse. See fuse tables for part 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 4.12 Rectifier Cabinet, Enclosure Types F1, F2, F3 and F4**



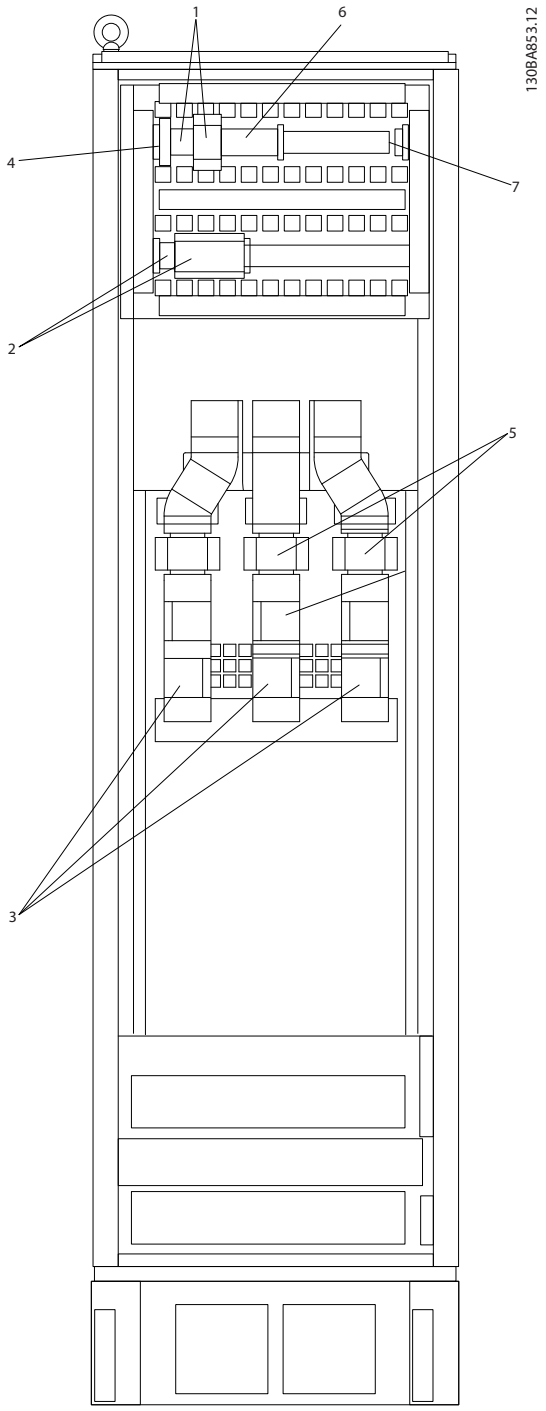

| | | | |
|---|---|---|---|
| 1) | External Temperature Monitoring | 6) | Motor |
| 2) | AUX Relay | | U V W |
| | 01 02 03 | | 96 97 98 |
| | 04 05 06 | | T1 T2 T3 |
| 3) | NAMUR | 7) | NAMUR Fuse. See fuse tables for part numbers |
| 4) | AUX Fan | 8) | Fan Fuses. See fuse tables for part numbers |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

**Illustration 4.13 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 4.14 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 4.15 Options Cabinet, Enclosure Types F3 and F4**

4

## 4.1.2 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.

## 4.1.3 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*.

## 4.1.4 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).

## 4.1.5 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.

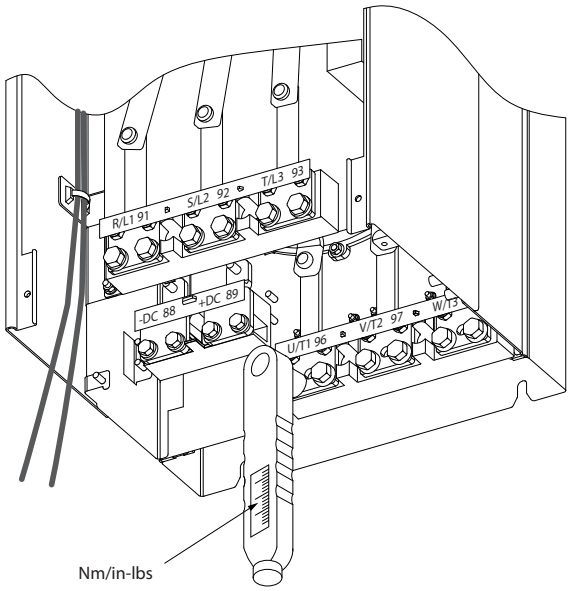



**Illustration 4.16 Tightening Bolts with a Torque Wrench**

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

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

**Table 4.5 Torque for Terminals**

## 4.1.6 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.

## 4.1.7 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<br>Earth |

**Table 4.6 Mains Terminals**

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

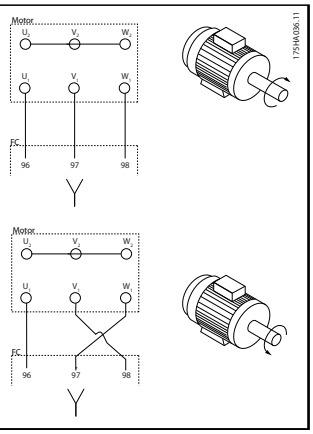



**Table 4.7**

*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 *parameter 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.**

### 4.1.8 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 4.8 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.

### 4.1.9 Brake Resistor Temperature Switch

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

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

| Terminal No. | Function |
|---|---|
| 106, 104, 105 | Brake resistor temperature switch. |

**Table 4.9 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.**

### 4.1.10 Load Sharing

| Terminal No. | Function |
|---|---|
| 88, 89 | Loadsharing |

**Table 4.10 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.**

### 4.1.11 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.**

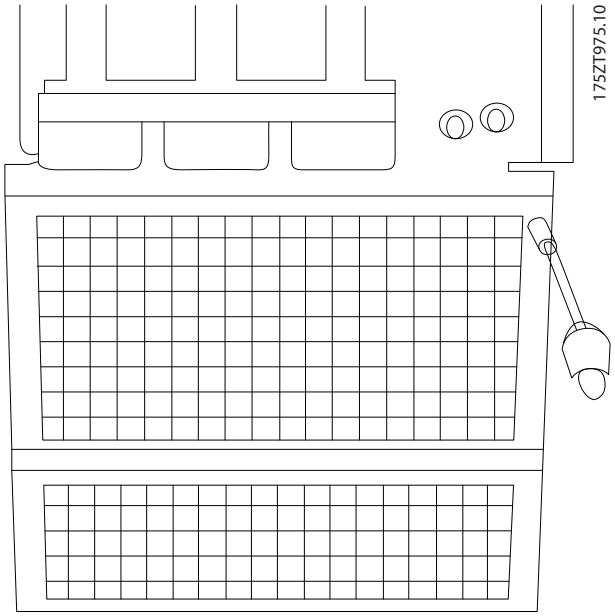



**Illustration 4.17 Mounting of EMC Shield.**

## 4.1.12 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 4.11 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.

## 4.1.13 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 4.12 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.

## 4.1.14 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, use the following fuses to ensure compliance with EN50178:

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

**Table 4.13 EN50178 Fuses**

4

**UL Compliance**

**380-480 V, Enclosure types D, E and F**

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

| Size/ Type | Bussmann E1958 JFHR2** | Bussmann E4273 T/JDDZ** | SIBA E180276 JFHR2 | LittelFuse E71611 JFHR2** | Ferraz-Shawmut E60314 JFHR2** | Bussmann E4274 H/JDDZ** | Bussmann E125085 JFHR2* | Internal Option Bussmann |
|---|---|---|---|---|---|---|---|---|
| P110 | FWH-300 | JJS-300 | 2061032.315 | L50S-300 | A50-P300 | NOS-300 | 170M3017 | 170M3018 |
| P132 | FWH-350 | JJS-350 | 2061032.35 | L50S-350 | A50-P350 | NOS-350 | 170M3018 | 170M3018 |
| P160 | FWH-400 | JJS-400 | 2061032.40 | L50S-400 | A50-P400 | NOS-400 | 170M4012 | 170M4016 |
| P200 | FWH-500 | JJS-500 | 2061032.50 | L50S-500 | A50-P500 | NOS-500 | 170M4014 | 170M4016 |
| P250 | FWH-600 | JJS-600 | 2062032.63 | L50S-600 | A50-P600 | NOS-600 | 170M4016 | 170M4016 |

**Table 4.14 Enclosure Types D, Line Fuses, 380-480 V**

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

**Table 4.15 Enclosure Types E, Line Fuses, 380-480 V**

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

**Table 4.16 Enclosure Types F, Line Fuses, 380-480 V**

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

**Table 4.17 Enclosure Type F, Inverter Module DC Link Fuses, 380-480 V**

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

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

### 525-690 V, Enclosure Types D, E and F

| Size/ Type | Buss-mann E1250 85 JFHR2 | [A] | SIBA E1802 76 JFHR2 | Ferraz-Shawmut E76491 JFHR2 | Internal Option Bussmann |
|---|---|---|---|---|---|
| P45K | 170M 3013 | 125 | 20610 32.125 | 6.6URD30D08 A0125 | 170M3015 |
| P55K | 170M 3014 | 160 | 20610 32.16 | 6.6URD30D08 A0160 | 170M3015 |
| P75K | 170M 3015 | 200 | 20610 32.2 | 6.6URD30D08 A0200 | 170M3015 |
| P90K | 170M 3015 | 200 | 20610 32.2 | 6.6URD30D08 A0200 | 170M3015 |
| P110 | 170M 3016 | 250 | 20610 32.25 | 6.6URD30D08 A0250 | 170M3018 |
| P132 | 170M 3017 | 315 | 20610 32.315 | 6.6URD30D08 A0315 | 170M3018 |
| P160 | 170M 3018 | 350 | 20610 32.35 | 6.6URD30D08 A0350 | 170M3018 |
| P200 | 170M 4011 | 350 | 20610 32.35 | 6.6URD30D08 A0350 | 170M5011 |
| P250 | 170M 4012 | 400 | 20610 32.4 | 6.6URD30D08 A0400 | 170M5011 |
| P315 | 170M 4014 | 500 | 20610 32.5 | 6.6URD30D08 A0500 | 170M5011 |
| P400 | 170M 5011 | 550 | 20620 32.55 | 6.6URD32D08 A550 | 170M5011 |

**Table 4.18 Enclosure Types D, E and F 525-690 V**

| Size/ Type | Bussmann PN* | Rating | Ferraz | Siba |
|---|---|---|---|---|
| P450 | 170M4017 | 700 A, 700 V | 6.9URD31 D08A070 0 | 20 610 32.700 |
| P500 | 170M4017 | 700 A, 700 V | 6.9URD31 D08A070 0 | 20 610 32.700 |
| P560 | 170M6013 | 900 A, 700 V | 6.9URD33 D08A090 0 | 20 630 32.900 |
| P630 | 170M6013 | 900 A, 700 V | 6.9URD33 D08A090 0 | 20 630 32.900 |

**Table 4.19 Enclosure Type E, 525-690 V**

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

**Table 4.20 Enclosure Type Size F, Line Fuses, 525-690 V**

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

**Table 4.21 Enclosure Type F, Inverter Module DC Link Fuses, 525-690 V**

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

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

### Supplementary fuses

| Enclosure Type | Bussmann PN* | Rating |
|---|---|---|
| D, E and F | KTK-4 | 4 A, 600 V |

**Table 4.22 SMPS Fuse**

| Size/Type | Bussmann PN* | LittelFuse | Rating |
|---|---|---|---|
| P110-P315, 380-480 V | KTK-4 | | 4 A, 600 V |
| P45K-P500, 525-690 V | KTK-4 | | 4 A, 600 V |
| P355-P1M0, 380-480 V | | KLK-15 | 15A, 600 V |
| P560-P1M4, 525-690 V | | KLK-15 | 15A, 600 V |

**Table 4.23 Fan Fuses**

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

**Table 4.24 Manual Motor Controller Fuses**

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

**Table 4.25 30 A Fuse Protected Terminal Fuse**

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

**Table 4.26 Control Transformer Fuse**

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

**Table 4.27 NAMUR Fuse**

| Enclosure Type | Bussmann PN* | Rating | Alternative Fuses |
|---|---|---|---|
| F | LP-CC-6 | 6 A, 600 V | Any listed Class CC, 6 A |

**Table 4.28 Safety Relay Coil Fuse with PILS Relay**

## 4.1.15 Mains Disconnectors

| Enclosure Type | Power & Voltage | Type |
|---|---|---|
| D1/D3 | P110-P132 380-480 V & P110-P160 525-690 V | ABB OETL-NF200A or OT200U12-91 |
| D2/D4 | P160-P250 380-480 V & P200-P400 525-690 V | ABB OETL-NF400A or OT400U12-91 |
| E1/E2 | P315 380-480 V & P450-P630 525-690 V | ABB OT600U03 |
| E1/E2 | P355-P450 380-480 V | ABB OT800U03 |
| F3 | P500 380-480 V & P710-P800 525-690 V | Merlin Gerin NPJF36000S12AAYP |
| F3 | P560-P710 380-480 V & P900 525-690 V | Merlin Gerin NRK36000S20AAYP |
| F4 | P800-P1M0 380-480 V & P1M0-P1M4 525-690 V | Merlin Gerin NRK36000S20AAYP |

**Table 4.29**

## 4.1.16 F Enclosure Circuit Breakers

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

**Table 4.30**

## 4.1.17 F Enclosure Mains Contactors

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

**Table 4.31**

## 4.1.18 Motor Insulation

For motor cable lengths ≤ the maximum cable length listed in *chapter 7 General Specifications*, the recommended motor insulation ratings are in *Table 4.32*. The peak voltage can be up to twice the DC link voltage, 2.8 times the mains voltage, due to transmission line effects in the motor cable. If a motor has a lower insulation rating, use a dU/dt or sine wave filter.

| Nominal Mains Voltage | Motor Insulation |
|---|---|
| $U_N \leq 420$ V | Standard $U_{LL} = 1300$ V |
| 420 V < $U_N \leq 500$ V | Reinforced $U_{LL} = 1600$ V |
| 500 V < $U_N \leq 600$ V | Reinforced $U_{LL} = 1800$ V |
| 600 V < $U_N \leq 690$ V | Reinforced $U_{LL} = 2000$ V |

**Table 4.32 Motor Insulation at Various Nominal Mains Voltages**

## 4.1.19 Motor Bearing Currents

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

**Standard mitigation strategies**

- Use an insulated bearing
- Apply rigorous installation procedures
  - Ensure the motor and load motor are aligned
  - Strictly follow the EMC Installation guideline
  - Reinforce the PE so the high frequency impedance is lower in the PE than the input power leads
  - Provide a good high frequency connection between the motor and the frequency converter by screened cable, which has a 360° connection in the motor and frequency converter
  - Ensure that the impedance from frequency converter to building ground is lower than the grounding impedance of the machine. Make a direct earth connection between the motor and load motor
- Apply conductive lubrication
- Try to ensure that the line voltage is balanced to ground. This can be difficult for IT, TT, TN-CS or Grounded leg systems
- Use an insulated bearing as recommended by the motor manufacturer

***NOTICE***

**Motors from reputable manufacturers typically have these fitted as standard in motors of this size.**
If none of these strategies works, consult the factory.
If necessary after consulting Danfoss:

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

## 4.1.20 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).

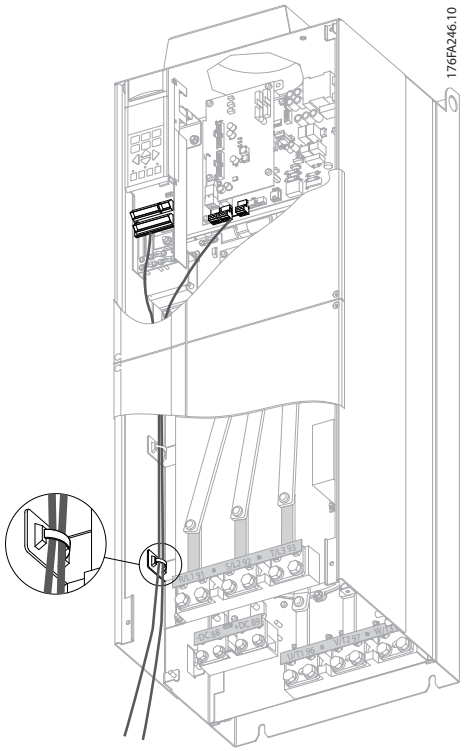



**Illustration 4.18 Control Card Wiring Path for the D3. Control Card Wiring for the D1, D2, D4, E1 and E2 use the same Path**

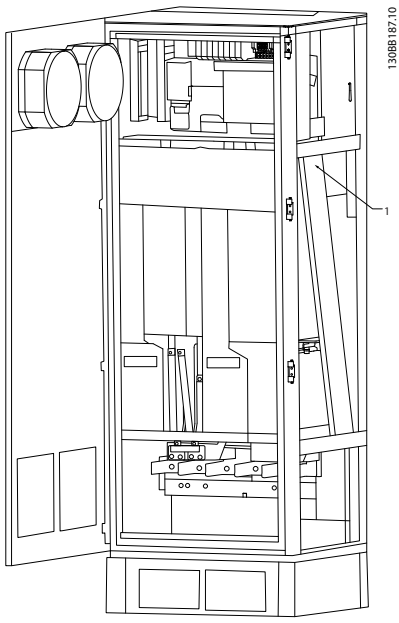



**Illustration 4.19 Control Card Wiring Path for the F1/F3. Control Card Wiring for the F2/F4 use the same Path**

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

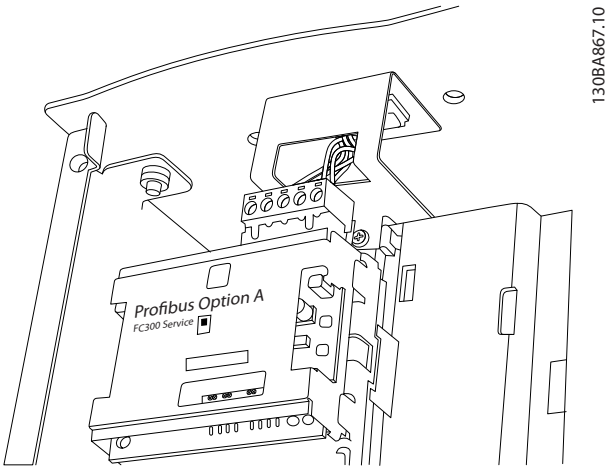



**Illustration 4.20 Top Connection for Fieldbus.**

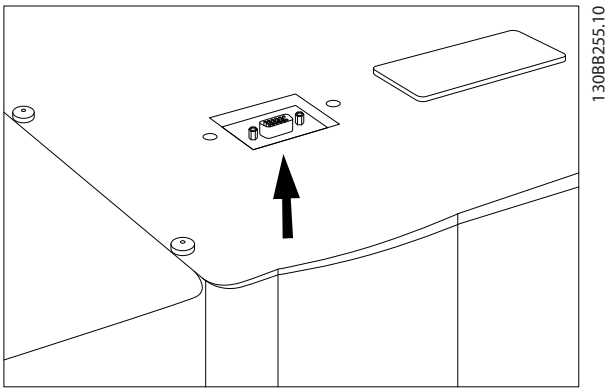



**Illustration 4.21**

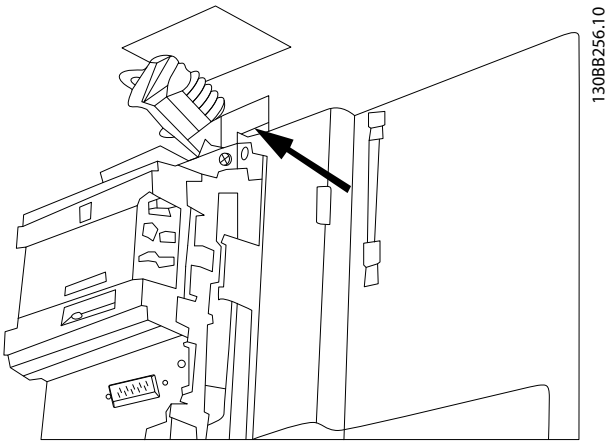



**Illustration 4.22**

**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 4.33 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.**

## 4.1.21 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.

## 4.1.22 Electrical Installation, Control Terminals

**To connect the cable to the terminal**

1. Strip insulation by about 9-10 mm

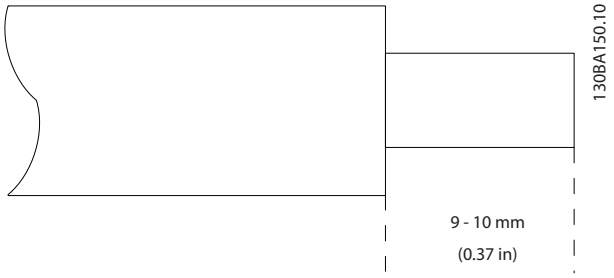



**Illustration 4.23 Stripping of Insulation**

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

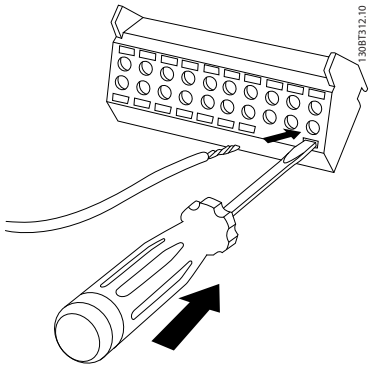



**Illustration 4.24**

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.

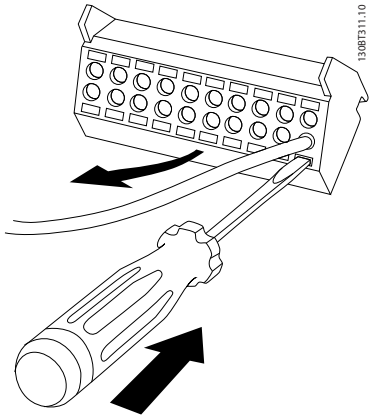



**Illustration 4.25**

[1)] Max. 0.4 x 2.5 mm

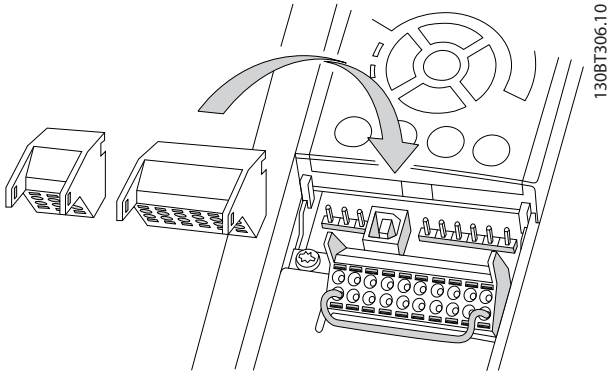



**Illustration 4.26**

## 4.1.23 Electrical Installation, Control Cables

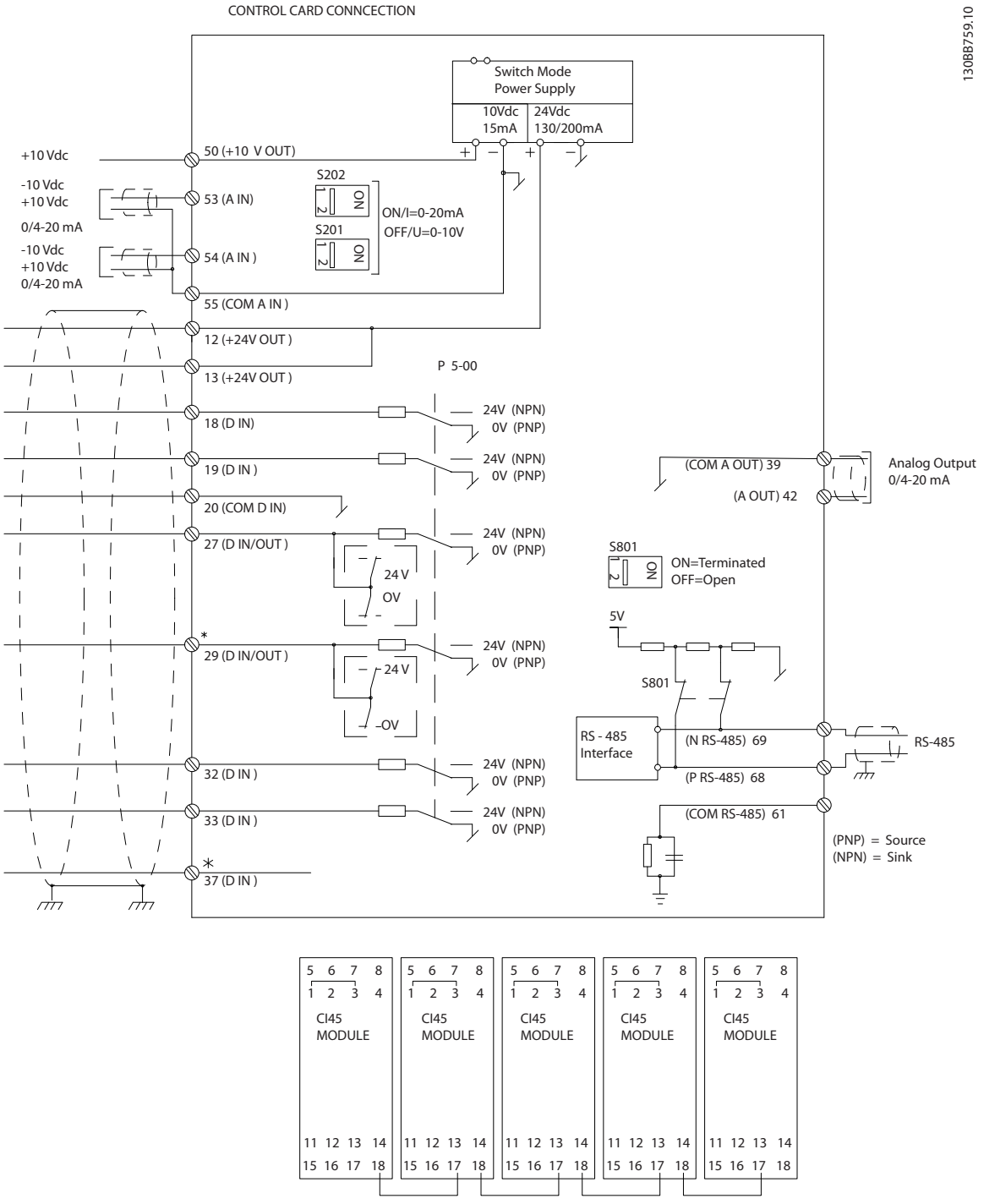



**Illustration 4.27**

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*.

**Do not connect cable screen.

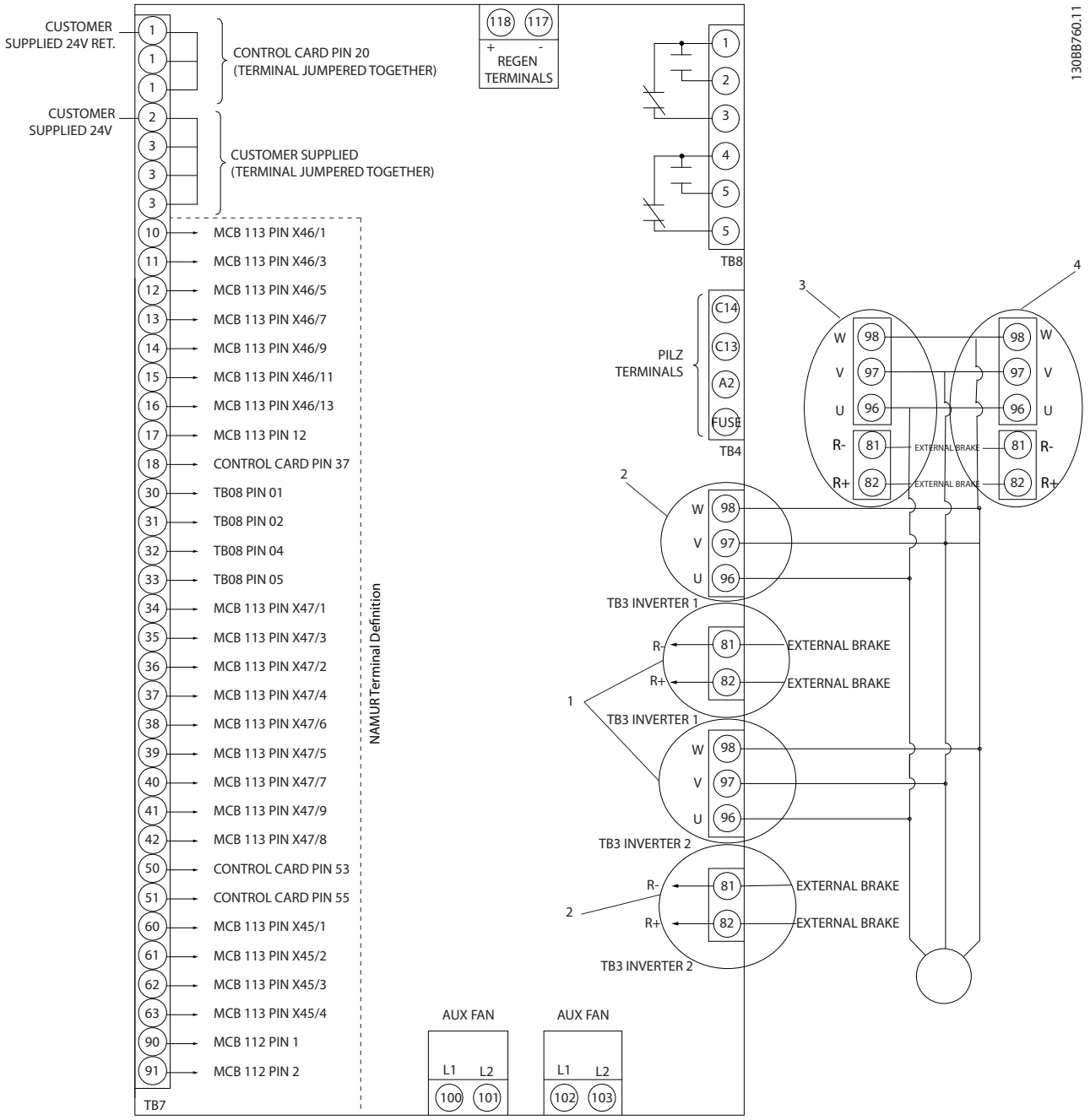



**Illustration 4.28 Diagram Showing all Electrical Terminals with NAMUR Option shown in Dotted Line Box**

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**

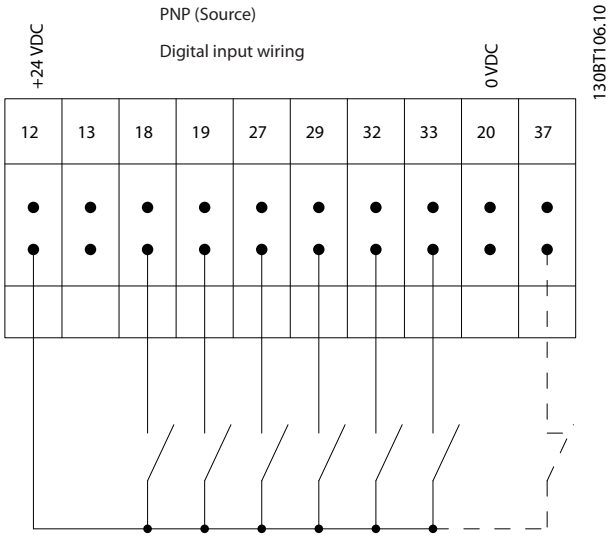



**Illustration 4.29**

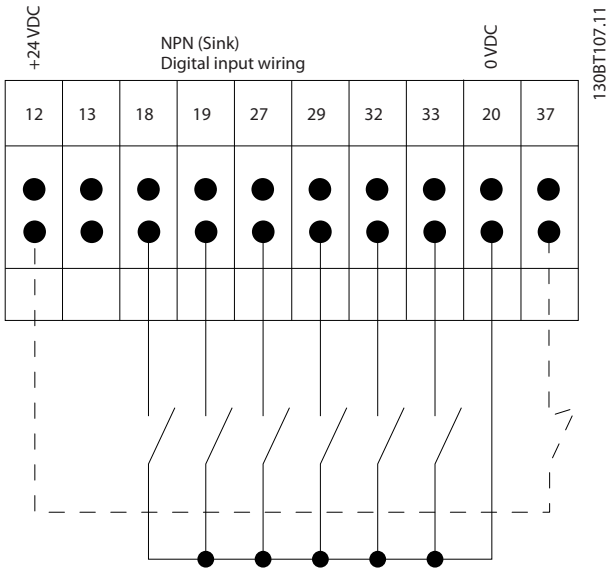



**Illustration 4.30**

***NOTICE***

**Control cables must be screened/armoured.**

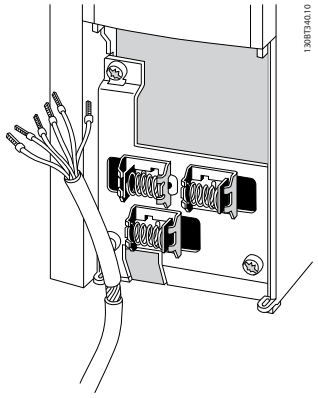



**Illustration 4.31**

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.

## 4.1.24 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 4.27*.

**Default setting:**

S201 (A53) = OFF (voltage input)

S202 (A54) = OFF (voltage input)

S801 (Bus termination) = OFF

***NOTICE***

**When changing the function of S201, S202 or S801 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.**

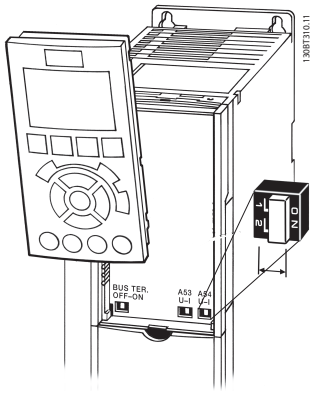



**Illustration 4.32**

## 4.2 Connection Examples

### 4.2.1 Start/Stop

Terminal 18 = *5-10 Terminal 18 Digital Input [8] Start*
Terminal 27 = *5-12 Terminal 27 Digital Input [0] No operation* (Default *coast inverse*)
Terminal 37 = Safe Torque Off

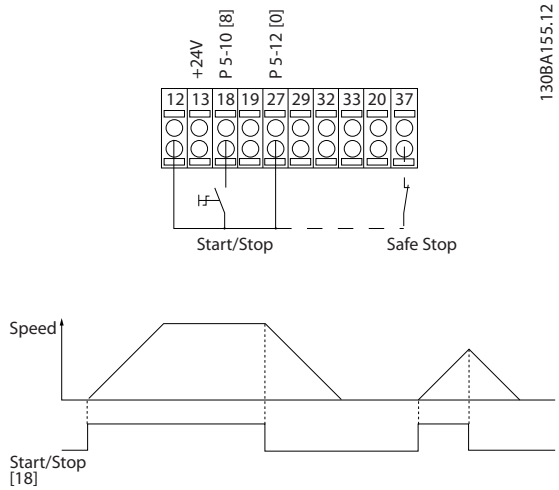



**Illustration 4.33**

### 4.2.2 Pulse Start/Stop

Terminal 18 = *5-10 Terminal 18 Digital Input [9] Latched start*
Terminal 27= *5-12 Terminal 27 Digital Input [6] Stop inverse*
Terminal 37 = Safe Torque Off

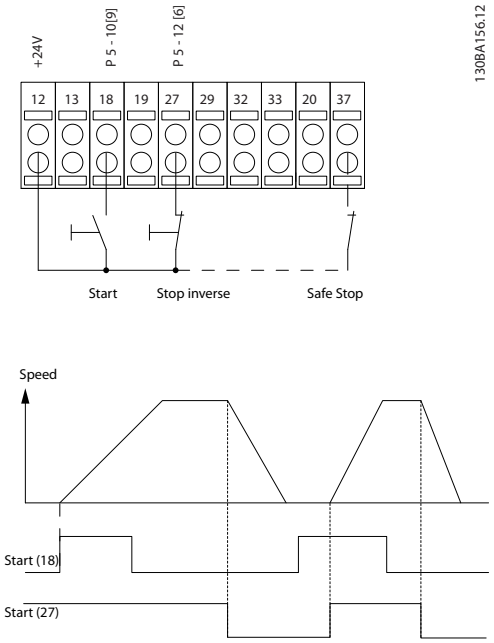



**Illustration 4.34**

### 4.2.3 Speed Up/Down

**Terminals 29/32 = Speed up/down**

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

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

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

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

***NOTICE***

**Terminal 29 only in FC x02 (x=series type).**

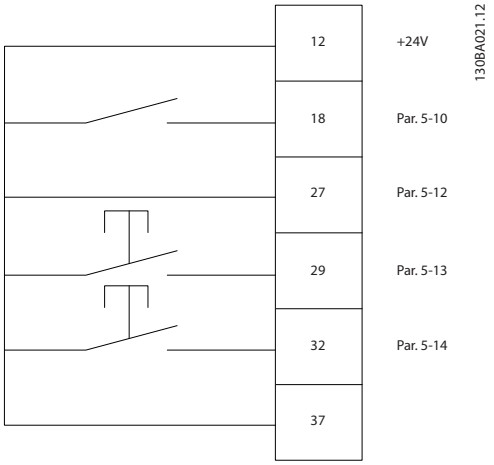



**Illustration 4.35 Speed Up/Down**

## 4.2.4 Potentiometer Reference

**Voltage reference via a potentiometer**

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

Terminal 53, Low Voltage = 0 V

Terminal 53, High Voltage = 10 V

Terminal 53, Low Ref./Feedback = 0 RPM

Terminal 53, High Ref./Feedback = 1500 RPM

Switch S201 = OFF (U)

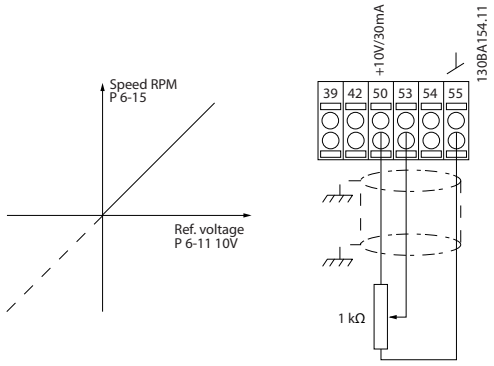



**Illustration 4.36 Potentiometer Reference**

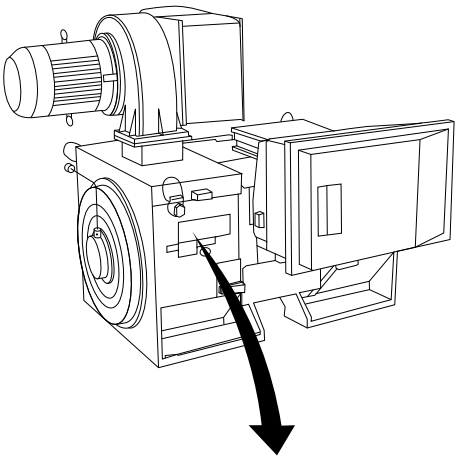
## 4.3 Final Set-up and Test

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 4.37**

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

**Table 4.34**

**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 8 Troubleshooting*.
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**

*3-02 Minimum Reference*

*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]*

*3-41 Ramp 1 Ramp Up Time*

*3-42 Ramp 1 Ramp Down Time*

## 4.4 Additional Connections

### 4.4.1 Mechanical Brake Control

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

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

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

### 4.4.2 Parallel Connection of Motors

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

**NOTICE**

**Installations with cables connected in a common joint as in *Illustration 4.38*, 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).**

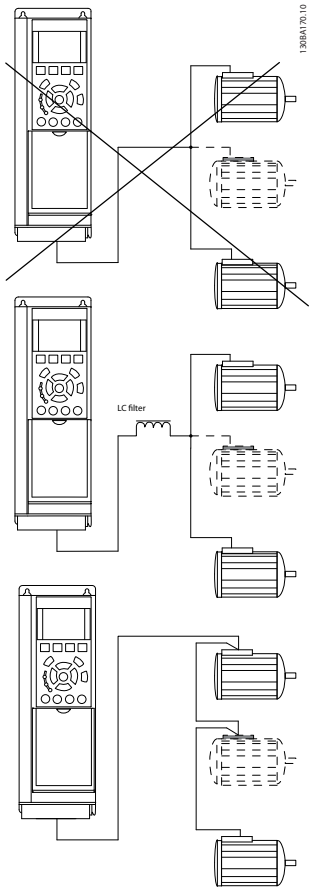



**Illustration 4.38**

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.

## 4.4.3 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.

# 5 How to Operate the Frequency Converter

## 5.1 Operating with LCP

### 5.1.1 3 Ways of Operating

**The frequency converter can be operated in 3 ways:**

1. Graphical Local Control Panel (GLCP)
2. Numeric Local Control Panel (NLCP)
3. RS-485 serial communication or USB, both for PC connection

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

### 5.1.2 How to Operate Graphical LCP (GLCP)

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

The GLCP is divided into four functional groups

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

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

**Display lines**

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

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

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

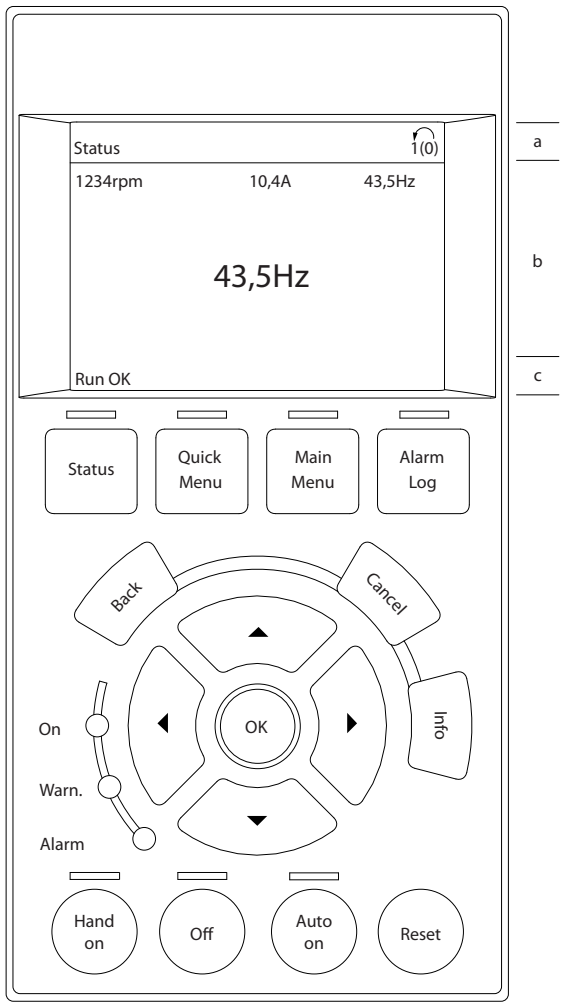



**Illustration 5.1 Keypad**

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

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

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

**Bottom section**
(c) always shows the state of the frequency converter in Status mode.

5

It is possible to toggle between 3 status read-out displays by pressing the [Status] key.
Operating variables with different formatting are shown in each status screen - see below.

Several values or measurements can be linked to each of the displayed operating variables. The values/ measurements to be displayed can be defined via *0-20 Display Line 1.1 Small*, *0-21 Display Line 1.2 Small*, *0-22 Display Line 1.3 Small*, *0-23 Display Line 2 Large* and *0-24 Display Line 3 Large*, which can be accessed via [QUICK MENU], *Q3 Function Setups*, *Q3-1 General Settings*, *Q3-13 Display Settings*.

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

**Status display I**
This read-out state is standard after start-up or initialisation.
Use [INFO] to obtain information about the value/ measurement linked to the displayed operating variables (1.1, 1.2, 1.3, 2, and 3).
See the operating variables shown in the display in this illustration. 1.1, 1.2 and 1.3 are shown in small size. 2 and 3 are shown in medium size.

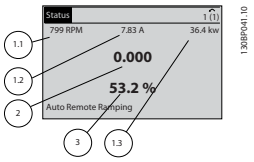



**Illustration 5.2**

**Status display II**
See the operating variables (1.1, 1.2, 1.3, and 2) shown in the display in this illustration.
In the example, Speed, Motor current, Motor power and Frequency are selected as variables in the first and second lines.
1.1, 1.2 and 1.3 are shown in small size. 2 is shown in large size.

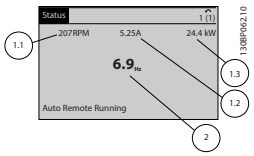



**Illustration 5.3**

**Status display III**
This state displays the event and action of the Smart Logic Control.

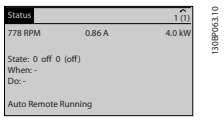



**Illustration 5.4**

**Display Contrast Adjustment**
Press [status] and [▲] for darker display
Press [status] and [▼] for brighter display

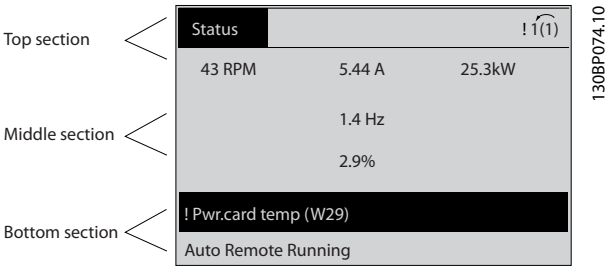



**Illustration 5.5**

**Indicator lights (LEDs)**
If certain threshold values are exceeded, the alarm and/or warning LED lights up. A status and alarm text appear on the control panel.
The On LED is activated when the frequency converter receives power from mains voltage, a DC bus terminal, or an external 24 V supply. At the same time, the back light is on.

- Green LED/On: Control section is working.
- Yellow LED/Warn.: Indicates a warning.
- Flashing Red LED/Alarm: Indicates an alarm.

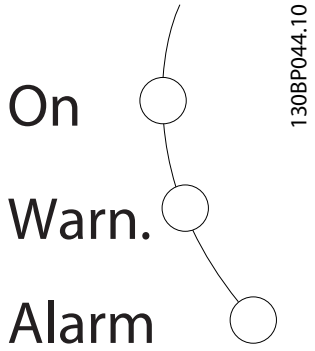



**Illustration 5.6**

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

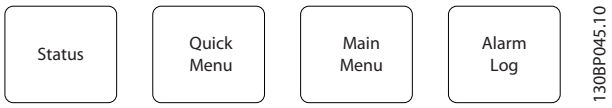



**Illustration 5.7 Menu Keys**

**[Status]**
indicates the status of the frequency converter and/or the motor. 3 different readouts can be selected by pressing the [Status] key:
5 line readouts, 4 line readouts or Smart Logic Control.
Use [Status] for selecting the mode of display or for changing back to Display mode from either the Quick Menu mode, the Main Menu mode or Alarm mode. Also use the [Status] key to toggle single or double read-out mode.

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

**The [Quick Menu] consists of**

- My Personal Menu
- Quick Set-up
- Function Set-up
- Changes Made
- Loggings

The Function Set-up provides quick and easy access to all parameters required for most HVAC applications including most VAV and CAV supply and return fans, cooling tower fans, primary, secondary and condenser water pumps and other pump, fan and compressor applications. Amongst other features it also includes parameters for selecting which variables to display on the LCP, digital preset speeds, scaling of analog references, closed loop single zone and multi-zone applications and specific functions related to fans, pumps and compressors.

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

**[Main Menu]**
is used for programming all parameters. The Main Menu parameters can be accessed immediately unless a password has been created via *0-60 Main Menu Password*, *0-61 Access to Main Menu w/o Password*, *0-65 Personal Menu Password* or *0-66 Access to Personal Menu w/o Password*. For most HVAC applications it is not necessary to access the Main Menu parameters but instead the Quick Menu, Quick Set-up and Function Set-up provides the simplest and quickest access to the typical required parameters.

It is possible to switch directly between Main Menu mode and Quick Menu mode.
Parameter shortcut can be carried out by pressing down the **[Main Menu]** key for 3 seconds. The parameter shortcut allows direct access to any parameter.

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

The Alarm log key on the LCP allows access to both Alarm log and Maintenance log.

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


**Illustration 5.8**

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


**Illustration 5.9**

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


**Illustration 5.10**

**Navigation Keys**
The 4 navigation keys are used to navigate between the different choices available in [Quick Menu], [Main Menu] and [Alarm Log]. Press the keys to move the cursor.

**[OK]**
is used for selecting a parameter marked by the cursor and for enabling the change of a parameter.

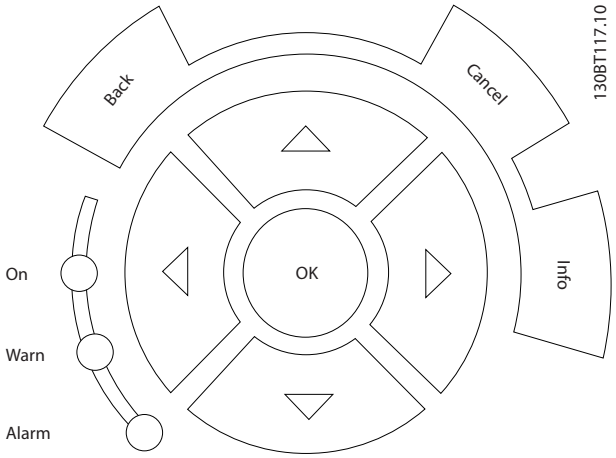



**Illustration 5.11**

**Operation Keys**
for local control are found at the bottom of the control panel.

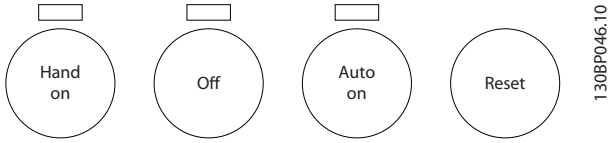



**Illustration 5.12 Operation Keys**

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

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

***NOTICE***

**External stop signals activated by means of control signals or a serial bus overrides a start command via the LCP.**

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

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

***NOTICE***

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

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

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

## 5.2 Operating via Serial Communication

### 5.2.1 RS-485 Bus Connection

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

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

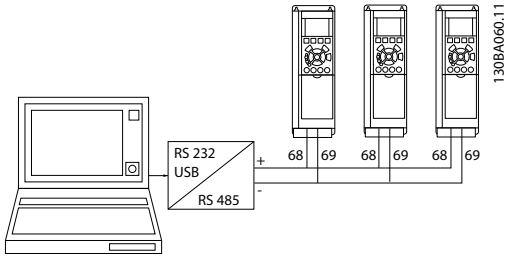



**Illustration 5.13 Connection Example.**

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

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

## 5.3 Operating via PC

### 5.3.1 How to Connect a PC to the Frequency Converter

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

***NOTICE***

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

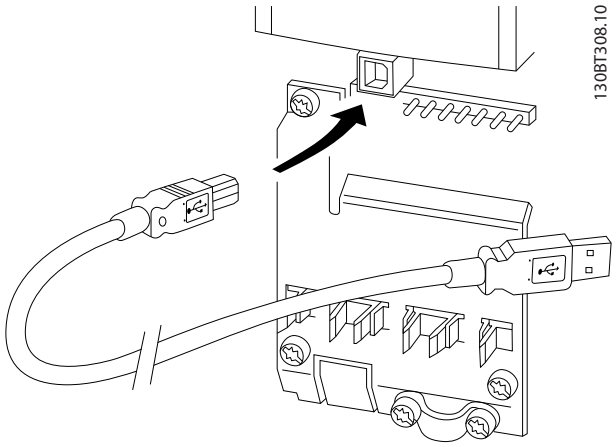



**Illustration 5.14 USB Connection to Frequency Converter**

### 5.3.2 PC Software Tools

**PC-based MCT 10 Set-up Software**
All Frequency converters are equipped with a serial communication port. Danfoss provides a PC tool for communication between PC and frequency converter, PC-based Configuration Tool MCT 10. Check the section on *Available Literature* for detailed information on this tool.

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

- Planning a communication network off-line. MCT 10 Set-up Software contains a complete frequency converter database.
- Commissioning frequency converters on line.
- Saving settings for all frequency converters.
- Replacing a frequency converter in a network.
- Simple and accurate documentation of frequency converter settings after commissioning.
- Expanding an existing network.
- Future developed frequency converters are supported.

MCT 10 Set-up Software supports Profibus DP-V1 via a Master class 2 connection. It makes it possible to on line read/write parameters in a frequency converter via the Profibus network. This eliminates the need for an extra communication network.

**Save frequency converter settings:**

1. Connect a PC to the unit via USB com port. (NOTE: Use a PC, which is isolated from the mains, in conjunction with the USB port. Failure to do so may damage equipment.).
2. Open MCT 10 Set-up Software.
3. Select *Read from drive*.
4. Select *Save as*.

All parameters are now stored in the PC.

**Load frequency converter settings:**

1. Connect a PC to the frequency converter via USB com port.
2. Open MCT 10 Set-up Software.
3. Select *Open* – stored files are shown.
4. Open the appropriate file.
5. Select *Write to drive*.

All parameter settings are now transferred to the frequency converter.

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

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

| | |
|---|---|
|  | **MCT Set-up 10 Software**<br>Setting parameters<br>Copy to and from frequency converters<br>Documentation and print out of parameter settings incl. diagrams |
| | **Ext. user interface**<br>Preventive Maintenance Schedule<br>Clock settings<br>Timed Action Programming<br>Smart Logic Controller Set-up |

**Table 5.1**

5

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

The software can be downloaded from the Danfoss internet site www.Danfoss.com/BusinessAreas/DrivesSolutions/Softwaredownload/DDPC+Software+Program.htm

### 5.3.3 Tips and Tricks

- For most HVAC applications the Quick Menu, Quick Set-up and Function Set-up provides the simplest and quickest access to all the typical parameters required
- Whenever possible, performing an AMA, ensures best shaft performance
- Contrast of the display can be adjusted by pressing [Status] and [▲] for darker display or by pressing [Status] and [▼] for brighter display
- Under [Quick Menu] and [Changes Made] all parameters that have been changed from factory settings are displayed
- Press and hold [Main Menu] key for 3 seconds for access to any parameter
- For service purposes it is recommended to copy all parameters to the LCP, see *0-50 LCP Copy* for further information

### 5.3.4 Quick Transfer of Parameter Settings when Using GLCP

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

**⚠WARNING**

**Stop the motor before performing any of these operations.**

**Data storage in LCP**

1. Go to *0-50 LCP Copy*.
2. Press [OK].
3. Select *[1] All to LCP*.
4. Press [OK].

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

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

**Data transfer from LCP to Frequency converter**

1. Go to *0-50 LCP Copy*.
2. Press [OK].
3. Select *[2] All from LCP*.
4. Press [OK]

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

### 5.3.5 Initialisation to Default Settings

There are 2 ways to initialise the frequency converter to default: Recommended initialisation and manual initialisation.
Be aware that they have different impact according to the below description.

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

1. Select *14-22 Operation Mode*.
2. Press [OK].
3. Select *[2] Initialisation* (for NLCP select "2").
4. Press [OK].
5. Remove power to unit and wait for display to turn off.
6. Reconnect power and the frequency converter is reset. Note that first start-up takes a few more seconds.
7. Press [Reset]

*14-22 Operation Mode* initialises all except:
*14-50 RFI Filter*
*8-30 Protocol*
*8-31 Address*
*8-32 Baud Rate*
*8-35 Minimum Response Delay*
*8-36 Max Response Delay*
*8-37 Maximum Inter-Char Delay*
*15-00 Operating hours* to *15-05 Over Volt's*

*15-20 Historic Log: Event* to *15-22 Historic Log: Time*
*15-30 Alarm Log: Error Code* to *15-32 Alarm Log: Time*

## NOTICE

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

**Manual initialisation**

## NOTICE

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

1. Disconnect from mains and wait until the display turns off.
2. Press
   - 2a [Status] - [Main Menu] - [OK] at the same time while power up for Graphical LCP (GLCP).
   - 2b [Menu] while power up for LCP 101, Numerical Display.
3. Release the keys after 5 s.
4. The frequency converter is now programmed according to default settings.

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

# 6 How to Programme

## 6.1 Basic Programming

### 6.1.1 Parameter Set-Up

| Group | Title | Function |
|---|---|---|
| 0** | Operation and Display | Parameters used to program the fundamental functions of the frequency converter and the LCP including:<br>• Selection of language<br>• Selection of which variables are displayed at each position in the display (e.g. static duct pressure or condenser water return temperature can be displayed with the setpoint in small digits in the top row and feedback in large digits in the centre of the dispay)<br>• Enabling/disabling of the LCP keys<br>• Passwords for the LCP<br>• Upload and download of commissioned parameters to/from the LCP<br>• Setting the built-in clock |
| 1** | Load/Motor | Parameters used to configure the frequency converter for the specific application and motor including:<br>• Open or closed loop operation<br>• Type of application such as compressor, fan or centrifugal pump<br>• Motor nameplate data<br>• Auto-tuning of the frequency converter to the motor for optimum performance<br>• Flying start (typically used for fan applications)<br>• Motor thermal protection |
| 2** | Brakes | Parameters used to configure braking functions of the frequency converter which although not common in many HVAC applications, can be useful on special fan applications. Parameters including:<br>• DC braking<br>• Dymamic/resistor braking<br>• Over voltage control (which provides automatic adjustment of the deceleration rate (auto-ramping) to avoid tripping when decelerating large inertia fans) |
| 3** | Reference/Ramps | Parameters used to program the<br>• minimum and maximum reference limits of speed (RPM/Hz) in open loop or in actual units when operating in closed loop)<br>• digital/preset references<br>• jog speed<br>• definition of the source of each reference (e.g. which analog input the reference signal is connected to)<br>• ramp up and down times<br>• digital potentiometer settings |

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

| Group | Title | Function |
|---|---|---|
| 13** | Smart Logic Controller | Parameters used to configure the built-in Smart Logic Controller (SLC). The SLC can be used for<br>• simple functions such as<br>- comparators (e.g. if running above x Hz, activate output relay)<br>- timers (e.g. when a start signal is applied, first activate output relay to open supply air damper and wait x seconds before ramping up)<br>• complex sequence of user-defined actions executed by the SLC when the associated user-defined event is evaluated as TRUE by the SLC. (For example, initiate an economiser mode in a simple AHU cooling application control scheme where there is no BMS. For such an application the SLC can monitor the outside air relative humidity and if it is below a defined value, the supply air temperature setpoint could be automatically increased. With the frequency converter monitoring the outside air relative humidity and supply air temperature via its analog inputs, and controlling the chilled water valve via one of the extended PI(D) loops and an analog output, it would then modulate that valve to maintain a higher supply air temperature).<br>The SLC can often replace the need for other external control equipment. |
| 14** | Special Functions | Parameters used to configure special functions of the frequency converter including:<br>• Setting of the switching frequency to reduce audible noise from the motor (sometimes required for fan applications)<br>• Kinetic back-up function (especially useful for critical applications in semi-conductor installations where performance under mains dip/mains loss is important)<br>• Mains imbalance protection<br>• Automatic reset (to avoid the need for a manual reset of Alarms)<br>• Energy optimisation parameters (which typically do not need changing but enable fine tuning of this automatic function (if necessary) ensuring the frequency converter and motor combination operate at their optimum efficiency at full and partial load conditions)<br>• Auto-derating functions (which enable the frequency converter to continue operation at reduced performance under extreme operating conditions ensuring maximum up time) |
| 15** | FC Information | Parameters providing operating data and other frequency converter information including:<br>• Operating and running hour counters<br>• kWh counter; resetting of the running and kWh counters<br>• Alarm/fault log (where the past 10 alarms are logged along with any associated value and time)<br>• Frequency converter and option card indentification parameters such as code number and software version |
| 16** | Data Readouts | Read only parameters which display the status/value of many operating variables which can be displayed on the LCP or viewed in this parameter group. These parameters can be particularly useful during commissioning when interfacing with a BMS via a high level interface. |
| 18** | Info & Readouts | Read only parameters which display the last 10 prevantative maintenance log items, actions and time and the value of analog inputs and outputs on the Analog I/O option card which can be particularly useful during commissioning when interfacing with a BMS via a high level interface. |

| Group | Title | Function |
|---|---|---|
| 20** | FC Closed Loop | Parameters used to configure the closed loop PI(D) controller which controls the speed of the pump, fan or compressor in closed loop mode including:<br>• Defining where each of the 3 possible feedback signals come from (e.g. which analog input or the BMS HLI)<br>• Conversion factor for each of the feedback signals (e.g. where a pressure signal is used for indication of flow in an AHU or converting from pressure to temperature in a compressor application)<br>• Engineering unit for the reference and feedback (e.g. Pa, kPa, m Wg, in Wg, bar, m3/s, m3/h, °C, °F etc)<br>• The function (e.g. sum, difference, average, minimum or maximum) used to calculate the resulting feedback for single zone applications or the control philosophy for multi-zone applications<br>• Programming of the setpoint(s)<br>• Manual or auto-tuning of the PI(D) loop |
| 21** | Extended Closed Loop | Parameters used to configure the 3 extended closed loop PI(D) controllers which for example can be used to control external actuators (e.g. chilled water valve to maintain supply air temperature in a VAV system) including:<br>• Engineering unit for the reference and feedback of each controller (e.g. °C, °F etc)<br>• Defining the range of the reference/setpoint for each controller<br>• Defining where each of the references/setpoints and feedback signals come from (e.g. which analog input or the BMS HLI); programming of the setpoint and manual or auto-tuning of the each of the PI(D) controllers |
| 22** | Application Functions | Parameters used to monitor, protect and control pumps, fans and compressors including:<br>• No flow detection and protection of pumps (including auto-setup of this function); dry pump protection<br>• End of curve detection and protection of pumps<br>• Sleep mode (especially useful for cooling tower and booster pump sets)<br>• Broken belt detection (typically used for fan applications to detect no air flow instead of using a Δp switch installed across the fan)<br>• Short cycle protection of compressors and pump flow compensation of setpoint (especially useful for secondary chilled water pump applications where the Δp sensor has been installed close to the pump and not across the furthest most significant load(s) in the system. Using this function can compensate for the sensor installation and help to realise the maximum energy savings). |
| 23** | Time Based Functions | Time based parameters including:<br>• Parameters used to initiate daily or weekly actions based on the built-in real time clock (e.g. change of setpoint for night set back mode or start/stop of the pump/fan/compressor start/stop of a external equipment)<br>• Preventive maintenance functions which can be based on running or operating hour time intervals or on specific dates and times<br>• Energy log (especially useful in retrofit applications or where information of the actual historical load (kW) on the pump/fan/compressor is of interest)<br>• Trending (especially useful in retrofit or other applications where there is an interest to log operating power, current, frequency or speed of the pump/fan/compressor for analysis and a payback counter |
| 24** | Application Functions 2 | Parameters used to set-up Fire Mode and/or to control a bypass contactor/starter if designed into the system. |
| 25** | Cascade Controller | Parameters used to configure and monitor the built-in pump cascade controller (typically used for pump booster sets). |

| Group | Title | Function |
|---|---|---|
| 26** | Analog I/O Option MCB 109 | Parameters used to configure the Analog I/O option (MCB 109) including:<br>• Definition of the analog input types (e.g. voltage, Pt1000 or Ni1000)<br>• Scaling and definition of the analog output functions and scaling. |

**Table 6.1 Parameter Groups**

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



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

## 6.1.2 Quick Menu Mode

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

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

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

1. Press [Quick Menu]
2. Select Function Setups with [▼].
3. Press [OK].
4. Select Application Settings with [▼] .
5. Press [OK].
6. Press [OK] again for Fan Functions..
7. Select Broken Belt Function by pressing [OK].
8. With [▼], select *[2] Trip*.

The frequency converter now trips if a broken fan-belt is detected.

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

**Select [Changes Made] to get information about**

- The last 10 changes. Use [▲] and [▼] to scroll between the last 10 changed parameters.
- The changes made since default setting.

**[Loggings]**
shows information about the display line read-outs. The information is shown as graphs.
Only display parameters selected in *0-20 Display Line 1.1 Small* and *0-24 Display Line 3 Large* can be viewed. It is possible to store up to 120 samples in the memory for later reference.

**Quick Setup**

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

**Example of using the Quick Setup option**
To set the ramp down time to 100 s:

1. Select [Quick Setup]. *parameter 0-01 Language* in Quick Setup appears.
2. Press [▼] repeatedly until *parameter 3-42 Ramp 1 Ramp Down Time* appears with the default setting of 20 s.
3. Press [OK].

4. Press [◄] to highlight the 3rd digit before the comma.
5. Change '0' to '1' by pressing [▲].
6. Press [►] to highlight the digit '2'.
7. Change '2' to '0' by pressing [▼].
8. Press [OK].

The new ramp-down time is now set to 100 s.
It is recommended to do the set-up in the order listed.

## NOTICE

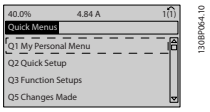



**Illustration 6.1 Quick Menu View**

The Quick Setup menu gives access to the 18 most important setup parameters of the frequency converter. After programming, the frequency converter is ready for operation. The 18 Quick Set-up parameters are shown in *Table 6.2*.

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

**Table 6.2 Quick Setup Parameters**

**The display showing depends on choices made in 0-02 Motor Speed Unit and 0-03 Regional Settings. The default settings of 0-02 Motor Speed Unit and 0-03 Regional Settings depend on which region of the world the frequency converter is supplied to but can be re-programmed as required.*
*** Parameter 5-40 Function Relay is an array. Select between [0] Relay1 or [1] Relay2 . Standard setting is [0] Relay1 with the default choice [9] Alarm.*

For a detailed information about settings and programming, see the *VLT HVAC Drive Programming Guide*

## NOTICE

**If *[0] No Operation* is selected in *5-12 Terminal 27 Digital Input*, no connection to +24 V on terminal 27 is necessary to enable start.**
**If [2] Coast Inverse (factory default value) is selected in *5-12 Terminal 27 Digital Input*, a connection to +24 V is necessary to enable start.**

| 0-01 Language | | |
|---|---|---|
| **Option:** | | **Function:** |
| | | Defines 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 |
| [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 |

| 0-01 Language | | |
|---|---|---|
| **Option:** | | **Function:** |
| [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] | Enter the nominal motor power in kW according to the motor nameplate data. The default value corresponds to the nominal rated output of the unit. Depending on the choices made in *0-03 Regional Settings*, either *parameter 1-20 Motor Power [kW]* or *parameter 1-21 Motor Power [HP]* is made invisible. |

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

| 1-22 Motor Voltage | | |
|---|---|---|
| **Range:** | | **Function:** |
| Size related* | [ 10 - 1000 V] | Enter the nominal motor voltage according to the motor nameplate data. The default value corresponds to the nominal rated output of the unit. |

| 1-23 Motor Frequency | | |
|---|---|---|
| **Range:** | | **Function:** |
| Size related* | [20 - 1000 Hz] | Select the motor frequency value from the motor nameplate data. For 87 Hz operation with 230/400 V motors, set the nameplate data for 230 V/50 Hz. Adapt *parameter 4-13 Motor Speed High Limit [RPM]* |

| 1-23 Motor Frequency | | |
|---|---|---|
| **Range:** | | **Function:** |
| | | and *3-03 Maximum Reference* to the 87 Hz application. |

| 1-24 Motor Current | | |
|---|---|---|
| **Range:** | | **Function:** |
| Size related* | [ 0.10 - 10000.00 A] | Enter the nominal motor current value from the motor nameplate data. This data is used for calculating motor torque, 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. |

| 1-28 Motor Rotation Check | | |
|---|---|---|
| **Option:** | | **Function:** |
| | | Following installation and connection of the motor, this function allows the correct motor rotation direction to be verified. Enabling this function overrides any bus commands or digital inputs, except External Interlock and Safe Stop (if included). |
| [0] * | Off | Motor Rotation Check is not active. |
| [1] | Enabled | Motor Rotation Check is enabled. |

***NOTICE***

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

**⚠WARNING**

**Remove mains power before disconnecting motor phase cables.**

| 3-11 Jog Speed [Hz] | | |
|---|---|---|
| **Range:** | | **Function:** |
| Size related* | [ 0 - par. 4-14 Hz] | The jog speed is a fixed output speed at which the frequency converter is running when the jog function is activated. See also *3-80 Jog Ramp Time*. |

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

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

| 3-42 Ramp 1 Ramp Down Time | | |
|---|---|---|
| **Range:** | | **Function:** |
| Size related* | [ 1.00 - 3600 s] | Enter the ramp-down time, i.e. the deceleration time from *parameter 1-25 Motor Nominal Speed* to 0 RPM. Select a ramp-down time such that no over-voltage 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*. See ramp-up time in *parameter 3-41 Ramp 1 Ramp Up Time*. |

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

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

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

| 4-13 Motor Speed High Limit [RPM] | | |
|---|---|---|
| **Range:** | | **Function:** |
| Size related* | [ par. 4-11 - 60000 RPM] | Enter the maximum limit for motor speed. The motor speed high limit can be set to correspond to the manufacturer's maximum rated motor. The motor speed high limit must exceed the setting in *parameter 4-11 Motor Speed Low Limit [RPM]*. Only *parameter 4-11 Motor Speed Low Limit [RPM]* or *parameter 4-12 Motor Speed Low Limit [Hz]* is displayed depending on other parameters in the Main Menu and depending on default settings dependant on global location. |

***NOTICE***

**Max. output frequency cannot exceed 10% of the inverter switching frequency (*parameter 14-01 Switching Frequency*).**

***NOTICE***

**Any changes in *parameter 4-13 Motor Speed High Limit [RPM]* reset the value in *parameter 4-53 Warning Speed High* to the same value as set in *parameter 4-13 Motor Speed High Limit [RPM]*.**

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

***NOTICE***

**Max. output frequency cannot exceed 10% of the inverter switching frequency (*parameter 14-01 Switching Frequency*).**

6

## 6.1.3 Function Set-ups

The Function Set-up provides quick and easy access to all parameters required for most HVAC applications including most VAV and CAV supply and return fans, cooling tower fans, primary, secondary and condenser water pumps and other pump, fan and compressor applications.

**How to access Function Set-up - example**

1. Turn on the frequency converter (yellow LED lights).

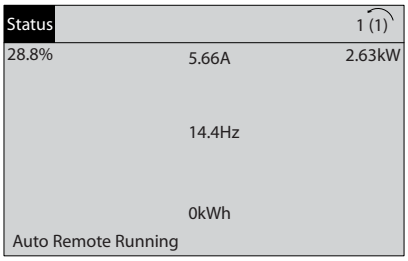



**Illustration 6.2**

2. Press [Quick Menus] (Quick Menus choices appear).

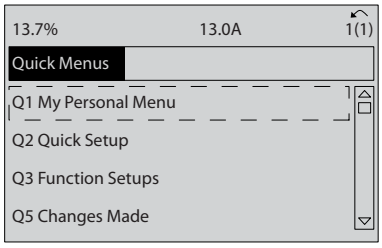



**Illustration 6.3**

3. Press [▲] and [▼] to scroll down to Function set-ups. Press [OK].

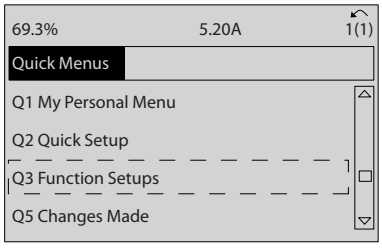



**Illustration 6.4**

4. Function set-ups choices appear. Select Q3-1 *General Settings*. Press [OK].

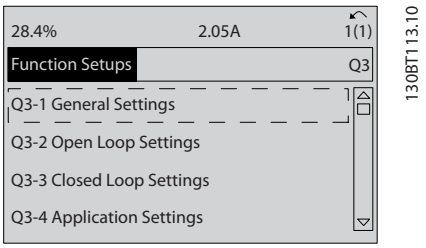



**Illustration 6.5**

5. Press [▲] and [▼] to scroll down to i.e. Q3-11 *Analog Outputs*. Press [OK].

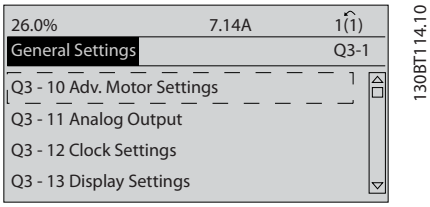



**Illustration 6.6**

6. Selectparameter 6-50 Terminal 42 Output. Press [OK].

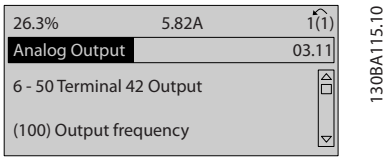



**Illustration 6.7**

7. Use [▲] and [▼] to select between the different choices. Press [OK].

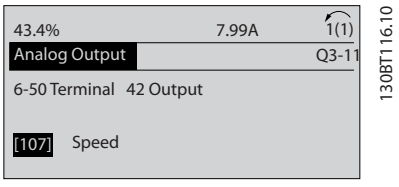



**Illustration 6.8**

**Function Set-ups parameters**

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

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

**Table 6.3 Q3-1 General Settings**

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

**Table 6.4 Q3-2 Open Loop Settings**

| Q3-30 Single Zone Int. Set Point | Q3-31 Single Zone Ext. Set Point | Q3-32 Multi Zone / Adv |
|---|---|---|
| Parameter 1-00 Configuration Mode | Parameter 1-00 Configuration Mode | Parameter 1-00 Configuration Mode |
| 20-12 Reference/Feedback Unit | 20-12 Reference/Feedback Unit | Parameter 3-15 Reference 1 Source |
| 20-13 Minimum Reference/Feedb. | 20-13 Minimum Reference/Feedb. | Parameter 3-16 Reference 2 Source |
| 20-14 Maximum Reference/Feedb. | 20-14 Maximum Reference/Feedb. | Parameter 20-00 Feedback 1 Source |
| Parameter 6-22 Terminal 54 Low Current | Parameter 6-10 Terminal 53 Low Voltage | Parameter 20-01 Feedback 1 Conversion |
| Parameter 6-24 Terminal 54 Low Ref./Feedb. Value | Parameter 6-11 Terminal 53 High Voltage | 20-02 Feedback 1 Source Unit |
| Parameter 6-25 Terminal 54 High Ref./ Feedb. Value | 6-12 Terminal 53 Low Current | Parameter 20-03 Feedback 2 Source |
| Parameter 6-26 Terminal 54 Filter Time Constant | 6-13 Terminal 53 High Current | Parameter 20-04 Feedback 2 Conversion |
| Parameter 6-27 Terminal 54 Live Zero | Parameter 6-14 Terminal 53 Low Ref./Feedb. Value | 20-05 Feedback 2 Source Unit |
| Parameter 6-00 Live Zero Timeout Time | Parameter 6-15 Terminal 53 High Ref./ Feedb. Value | Parameter 20-06 Feedback 3 Source |
| Parameter 6-01 Live Zero Timeout Function | Parameter 6-22 Terminal 54 Low Current | Parameter 20-07 Feedback 3 Conversion |
| Parameter 20-21 Setpoint 1 | Parameter 6-24 Terminal 54 Low Ref./Feedb. Value | 20-08 Feedback 3 Source Unit |
| Parameter 20-81 PID Normal/ Inverse Control | Parameter 6-25 Terminal 54 High Ref./ Feedb. Value | 20-12 Reference/Feedback Unit |

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

**Table 6.5 Q3-3 Closed Loop Settings**

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

**Table 6.6 Q3-4 Application Settings**

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

***NOTICE***

**When set for Closed Loop, the commands Reversing and Start Reversing do not reverse the direction of the motor.**

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

| 1-03 Torque Characteristics | | |
|---|---|---|
| **Option:** | | **Function:** |
| | | voltage which is optimised for a constant torque load characteristic of the motor in the entire range down to 15 Hz but in addition the AEO feature adapts the voltage exactly to the current load situation, thereby reducing energy consumption and audible noise from the motor. To obtain optimum performance, set the motor power factor cos phi correctly. This value is set in *14-43 Motor Cosphi*. The parameter has a default value which is automatically adjusted when the motor data is programmed. These settings typically ensure optimum motor voltage, but if the motor power factor cos phi requires tuning, an AMA function can be carried out using *parameter 1-29 Automatic Motor Adaptation (AMA)*. It is rarely necessary to adjust the motor power factor parameter manually. |
| [3] * | Auto Energy Optim. VT | For optimum energy efficient speed control of centrifugal pumps and fans. Provides a voltage optimised for a squared torque load characteristic of the motor, but in addition the AEO feature adapts the voltage exactly to the current load situation, thereby reducing energy consumption and audible noise from the motor. To obtain optimum performance, set the motor power factor cos phi correctly. This value is set in *14-43 Motor Cosphi*. The parameter has a default value and is automatically adjusted when the motor data is programmed. These settings typically ensure optimum motor voltage, but if the motor power factor cos phi requires tuning, an AMA function can be carried out using *parameter 1-29 Automatic Motor Adaptation (AMA)*. It is rarely necessary to adjust the motor power factor parameter manually. |

**NOTICE**

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

**NOTICE**

**For pumps or fan applications where the viscosity or density can vary significantly or where excessive flow e.g. due pipe breakage, can occur, it is recommended to select Auto Energy Optim. CT**

| 1-29 Automatic Motor Adaptation (AMA) | | |
|---|---|---|
| **Option:** | | **Function:** |
| | | **NOTICE**<br>**This parameter cannot be adjusted while the motor is running.** |
| [0] * | Off | No function |
| [1] | Enable Complete AMA | Performs AMA of the stator resistance $R_S$, the rotor resistance $R_r$, the stator leakage reactance $X_1$, the rotor leakage reactance $X_2$ and the main reactance $X_h$. |
| [2] | Enable Reduced AMA | Performs a reduced AMA of the stator resistance $R_s$ in the system only. Select this option if an LC filter is used between the frequency converter and the motor. |

**NOTICE**

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

Activate the AMA function by pressing [Hand on] after selecting [1] or [2]. See also the item *Automatic Motor Adaptation* in the *Design Guide*. After a normal sequence, the display reads: *Press [OK] to finish AMA*. After pressing [OK], the frequency converter is ready for operation.

**NOTICE**

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

**NOTICE**

**Avoid generating external torque during AMA.**

**NOTICE**

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

**NOTICE**

**Full AMA should be run without filter only while reduced AMA should be run with filter.**

See section: *Application Examples* > *Automatic Motor Adaptation* in the *Design Guide*.

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

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

The flystart function used for PM motors is based on an initial speed estimation. The speed is always estimated as the first thing after an active start signal is given. Based on the setting of *1-70 PM Start Mode* the following happens:
*1-70 PM Start Mode = [0] Rotor Detection*:
If the speed estimate comes out as greater than 0 Hz, the frequency converter catches the motor at that speed and resume normal operation. Otherwise, the frequency converter estimates the rotor position and start normal operation from there.

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

Current limitations of the flystart principle used for PM motors:

- The speed range is up to 100% nominal speed or the field weakening speed (which ever is lowest).
- PMSM with high back EMF (>300 VLL(rms)) and high winding inductance(>10 mH) needed more time for reducing short circuit current to zero and may be susceptible to error in estimation.
- Current testing limited to a speed range up to 300 Hz. For certain units the limit is 250 Hz; all 200-240 V units up to and including 2.2 kW and all 380-480 V units up to and including 4 kW.
- Current testing limited to a machine power size up to 22 kW.
- Pred for salient pole machine (IPMSM) but not yet verified on those types of machine.
- For high-inertia applications (i.e. where the load inertia is more than 30 times larger than the motor inertia) a brake resistor is recomended to avoid overvoltage trip during high speed engagement of the flystart function.

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

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

| 1-90 Motor Thermal Protection | | |
|---|---|---|
| **Option:** | | **Function:** |
| [2] | Thermistor trip | Stops (trips) the frequency converter when the connected thermistor in the motor reacts in the event of motor over-temperature. |
| [3] | ETR warning 1 | |
| [4] | ETR trip 1 | |
| [5] | ETR warning 2 | |
| [6] | ETR trip 2 | |
| [7] | ETR warning 3 | |
| [8] | ETR trip 3 | |
| [9] | ETR warning 4 | |
| [10] | ETR trip 4 | |

ETR (Electronic Thermal Relay) functions 1-4 calculates the load when the set-up where they were selected is active. For example ETR-3 starts calculating when set-up 3 is selected. For the North American market: The ETR functions provide class 20 motor overload protection in accordance with NEC.

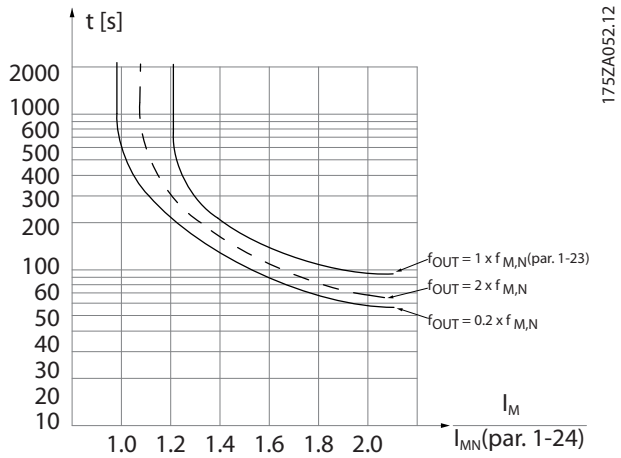



**Illustration 6.9**

**⚠WARNING**

**To maintain PELV, all connections made to the control terminals must be PELV, e.g. thermistor must be reinforced/double insulated**

***NOTICE***

**Danfoss recommends using 24 V DC as thermistor supply voltage.**

**NOTICE**

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

**NOTICE**

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

| 1-93 Thermistor Source | | |
|---|---|---|
| **Option:** | | **Function:** |
| | | **NOTICE**<br>**This parameter cannot be adjusted while the motor is running.**<br>Select the input to which the thermistor (PTC sensor) should be connected. An analog input option *[1] Analog Input 53* or *[2] Analog Input 54* cannot be selected if the analog input is already in use as a reference source (selected in *parameter 3-15 Reference 1 Source*, *parameter 3-16 Reference 2 Source* or *3-17 Reference 3 Source*).<br>When using MCB 112, *[0] None* must always be selected. |
| [0] * | None | |
| [1] | Analog Input 53 | |
| [2] | Analog Input 54 | |
| [3] | Digital input 18 | |
| [4] | Digital input 19 | |
| [5] | Digital input 32 | |
| [6] | Digital input 33 | |

**NOTICE**

**Digital input should be set to *[0] PNP - Active at 24 V* in *5-00 Digital I/O Mode*.**

| 2-00 DC Hold/Preheat Current | | |
|---|---|---|
| **Range:** | | **Function:** |
| 50 %* | [ 0 - 160 %] | Enter a value for holding current as a percentage of the rated motor current $I_{M,N}$ set in *parameter 1-24 Motor Current*. 100% DC holding current corresponds to $I_{M,N}$.<br>This parameter holds the motor (holding torque) or pre-heats the motor. |

| 2-00 DC Hold/Preheat Current | | |
|---|---|---|
| **Range:** | | **Function:** |
| | | This parameter is active if *[1] DC hold/Motor Preheat* is selected in *parameter 1-80 Function at Stop*. |

**NOTICE**

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

**NOTICE**

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

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

| 2-17 Over-voltage Control | | |
|---|---|---|
| **Option:** | | **Function:** |
| [0] | Disabled | No OVC required. |
| [2] * | Enabled | Activates OVC. |

**NOTICE**

***Parameter 2-17 Over-voltage Control* has no effect when *1-10 Motor Construction* = [1] PM, non salient SPM.**

**NOTICE**

**The ramp time is automatically adjusted to avoid tripping of the frequency converter.**

| 3-02 Minimum Reference | | |
|---|---|---|
| **Range:** | | **Function:** |
| Size related* | [ -999999.999 - par. 3-03 ReferenceFeed-backUnit] | Enter the Minimum Reference. The Minimum Reference is the lowest value obtainable by summing all references. The Minimum Reference value and unit matches the configuration choice made in *parameter 1-00 Configuration Mode* and *20-12 Reference/Feedback Unit*, respectively.<br>***NOTICE***<br>**This parameter is used in open loop only.** |

| 3-04 Reference Function | | |
|---|---|---|
| **Option:** | | **Function:** |
| [0] | Sum | Sums both external and preset reference sources. |
| [1] | External/ Preset | Use either the preset or the external reference source.<br>Shift between external and preset via a command on a digital input. |

| 3-10 Preset Reference | | |
|---|---|---|
| Array [8] | | |
| **Range:** | | **Function:** |
| 0 %* | [-100 - 100 %] | Enter up to eight different preset references (0-7) in this parameter, using array programming. The preset reference is stated as a percentage of the value $Ref_{MAX}$ (*3-03 Maximum Reference*, for closed loop see *20-14 Maximum Reference/Feedb.*). When using preset references, select Preset ref. bit 0/1/2 [16], [17] or [18] for the corresponding digital inputs in parameter group *5-1* Digital Inputs*. |

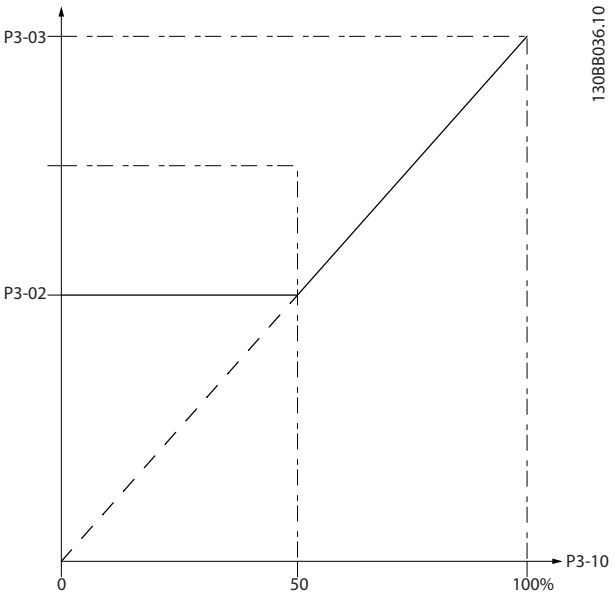



**Illustration 6.10**

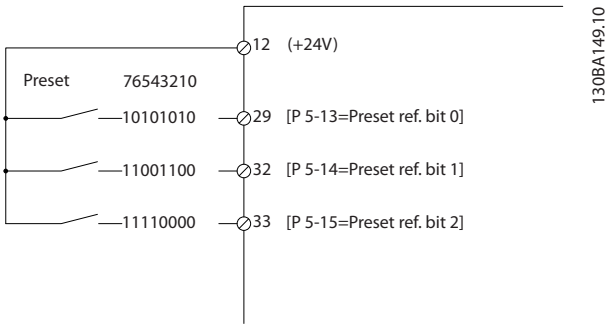



**Illustration 6.11**

| 3-15 Reference 1 Source | | |
|---|---|---|
| **Option:** | | **Function:** |
| | | Select the reference input to be used for the first reference signal. *Parameter 3-15 Reference 1 Source*, *parameter 3-16 Reference 2 Source* and *3-17 Reference 3 Source* define up to 3 different reference signals. The sum of these reference signals defines the actual reference. |
| [0] | No function | |
| [1] * | Analog Input 53 | |
| [2] | Analog Input 54 | |
| [7] | Pulse input 29 | |
| [8] | Pulse input 33 | |
| [20] | Digital pot.meter | |
| [21] | Analog input X30/11 | |
| [22] | Analog input X30/12 | |
| [23] | Analog Input X42/1 | |
| [24] | Analog Input X42/3 | |

| 3-15 Reference 1 Source | | |
|---|---|---|
| **Option:** | | **Function:** |
| [25] | Analog Input X42/5 | |
| [29] | Analog Input X48/2 | |
| [30] | Ext. Closed Loop 1 | |
| [31] | Ext. Closed Loop 2 | |
| [32] | Ext. Closed Loop 3 | |

**NOTICE**

**This parameter cannot be adjusted while the motor is running.**

| 3-16 Reference 2 Source | | |
|---|---|---|
| **Option:** | | **Function:** |
| | | Select the reference input to be used for the second reference signal. *parameter 3-15 Reference 1 Source*, *parameter 3-16 Reference 2 Source* and *3-17 Reference 3 Source* define up to 3 different reference signals. The sum of these reference signals defines the actual reference. |
| [0] | No function | |
| [1] | Analog Input 53 | |
| [2] | Analog Input 54 | |
| [7] | Pulse input 29 | |
| [8] | Pulse input 33 | |
| [20] * | Digital pot.meter | |
| [21] | Analog input X30/11 | |
| [22] | Analog input X30/12 | |
| [23] | Analog Input X42/1 | |
| [24] | Analog Input X42/3 | |
| [25] | Analog Input X42/5 | |
| [29] | Analog Input X48/2 | |
| [30] | Ext. Closed Loop 1 | |
| [31] | Ext. Closed Loop 2 | |
| [32] | Ext. Closed Loop 3 | |

**NOTICE**

**This parameter cannot be adjusted while the motor is running.**

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

**NOTICE**

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

| 4-53 Warning Speed High | | |
|---|---|---|
| **Range:** | | **Function:** |
| Size related* | [par. 4-52 - par. 4-13 RPM] | Enter the $n_{HIGH}$ value. When the motor speed exceeds this limit ($n_{HIGH}$), the display reads SPEED HIGH. The signal outputs can be programmed to produce a status signal on terminal 27 or 29 and on relay output 01 or 02. Programme the upper signal limit of the motor speed, $n_{HIGH}$, within the normal working range of the frequency converter. |

**NOTICE**

**Any changes in *parameter 4-13 Motor Speed High Limit [RPM]* reset the value in *parameter 4-53 Warning Speed High* to the same value as set in *parameter 4-13 Motor Speed High Limit [RPM]*.**
**If a different value is needed in *parameter 4-53 Warning Speed High*, it must be set after programming of *parameter 4-13 Motor Speed High Limit [RPM]***

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

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

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

6

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

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

## 6.1.4 5-1* Digital Inputs

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

| Digital input function | Select | Terminal |
|---|---|---|
| No operation | [0] | All *terminal 19, 32, 33 |
| Reset | [1] | All |
| Coast inverse | [2] | 27 |
| Coast and reset inverse | [3] | All |
| DC-brake inverse | [5] | All |
| Stop inverse | [6] | All |
| External interlock | [7] | All |
| Start | [8] | All *terminal 18 |
| Latched start | [9] | All |
| Reversing | [10] | All |
| Start reversing | [11] | All |
| Jog | [14] | All *terminal 29 |
| Preset reference on | [15] | All |
| Preset ref bit 0 | [16] | All |
| Preset ref bit 1 | [17] | All |
| Preset ref bit 2 | [18] | All |
| Freeze reference | [19] | All |
| Freeze output | [20] | All |
| Speed up | [21] | All |
| Speed down | [22] | All |
| Set-up select bit 0 | [23] | All |
| Set-up select bit 1 | [24] | All |
| Pulse input | [32] | terminal 29, 33 |
| Ramp bit 0 | [34] | All |
| Mains failure inverse | [36] | All |
| Fire mode | [37] | All |
| Run Permissive | [52] | All |
| Hand start | [53] | All |
| Auto start | [54] | All |
| DigiPot Increase | [55] | All |
| DigiPot Decrease | [56] | All |
| DigiPot Clear | [57] | All |
| Counter A (up) | [60] | 29, 33 |
| Counter A (down) | [61] | 29, 33 |
| Reset Counter A | [62] | All |
| Counter B (up) | [63] | 29, 33 |
| Counter B (down) | [64] | 29, 33 |
| Reset Counter B | [65] | All |
| Sleep Mode | [66] | All |
| Reset Maintenance Word | [78] | All |
| PTC Card 1 | [80] | All |
| Lead Pump Start | [120] | All |
| Lead Pump Alternation | [121] | All |
| Pump 1 Interlock | [130] | All |
| Pump 2 Interlock | [131] | All |
| Pump 3 Interlock | [132] | All |

**Table 6.7**

**5-12 Terminal 27 Digital Input**

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

**5-13 Terminal 29 Digital Input**

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

**5-14 Terminal 32 Digital Input**

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

**5-15 Terminal 33 Digital Input**

The parameter contains all options and functions listed in parameter group .

**5-40 Function Relay**

Array [8]
(Relay 1 [0], Relay 2 [1]
Option MCB 105: Relay 7 [6], Relay 8 [7] and Relay 9 [8]).
Select options to define the function of the relays.
The selection of each mechanical relay is realised in an array parameter.

| **Option:** | | **Function:** |
|---|---|---|
| [0] | No operation | |
| [1] | Control Ready | |
| [2] | Drive ready | |
| [3] | Drive rdy/rem ctrl | |
| [4] | Standby / no warning | |

**5-40 Function Relay**

Array [8]
(Relay 1 [0], Relay 2 [1]
Option MCB 105: Relay 7 [6], Relay 8 [7] and Relay 9 [8]).
Select options to define the function of the relays.
The selection of each mechanical relay is realised in an array parameter.

| Option: | | Function: |
|---|---|---|
| [5] | Running | Default setting for relay 2. |
| [6] | Running / no warning | |
| [8] | Run on ref/no warn | |
| [9] | Alarm | Default setting for relay 1. |
| [10] | Alarm or warning | |
| [11] | At torque limit | |
| [12] | Out of current range | |
| [13] | Below current, low | |
| [14] | Above current, high | |
| [15] | Out of speed range | |
| [16] | Below speed, low | |
| [17] | Above speed, high | |
| [18] | Out of feedb. range | |
| [19] | Below feedback, low | |
| [20] | Above feedback, high | |
| [21] | Thermal warning | |
| [25] | Reverse | |
| [26] | Bus OK | |
| [27] | Torque limit & stop | |
| [28] | Brake, no brake war | |
| [29] | Brake ready, no fault | |
| [30] | Brake fault (IGBT) | |
| [33] | Safe stop active | |
| [35] | External Interlock | |
| [36] | Control word bit 11 | |
| [37] | Control word bit 12 | |
| [40] | Out of ref range | |
| [41] | Below reference, low | |
| [42] | Above ref, high | |
| [45] | Bus ctrl. | |
| [46] | Bus ctrl, 1 if timeout | |
| [47] | Bus ctrl, 0 if timeout | |
| [60] | Comparator 0 | |
| [61] | Comparator 1 | |
| [62] | Comparator 2 | |
| [63] | Comparator 3 | |
| [64] | Comparator 4 | |
| [65] | Comparator 5 | |
| [70] | Logic rule 0 | |
| [71] | Logic rule 1 | |
| [72] | Logic rule 2 | |
| [73] | Logic rule 3 | |
| [74] | Logic rule 4 | |
| [75] | Logic rule 5 | |

**5-40 Function Relay**

Array [8]
(Relay 1 [0], Relay 2 [1]
Option MCB 105: Relay 7 [6], Relay 8 [7] and Relay 9 [8]).
Select options to define the function of the relays.
The selection of each mechanical relay is realised in an array parameter.

| Option: | | Function: |
|---|---|---|
| [80] | SL digital output A | |
| [81] | SL digital output B | |
| [82] | SL digital output C | |
| [83] | SL digital output D | |
| [84] | SL digital output E | |
| [85] | SL digital output F | |
| [160] | No alarm | |
| [161] | Running reverse | |
| [165] | Local ref active | |
| [166] | Remote ref active | |
| [167] | Start command activ | |
| [168] | Hand / Off | |
| [169] | Auto mode | |
| [180] | Clock Fault | |
| [181] | Prev. Maintenance | |
| [188] | AHF Capacitor Connect | |
| [189] | External Fan Control | |
| [190] | No-Flow | |
| [191] | Dry Pump | |
| [192] | End Of Curve | |
| [193] | Sleep Mode | |
| [194] | Broken Belt | |
| [195] | Bypass Valve Control | |
| [196] | Fire Mode | |
| [197] | Fire Mode was Act. | |
| [198] | Drive Bypass | |
| [211] | Cascade Pump 1 | |
| [212] | Cascade Pump 2 | |
| [213] | Cascade Pump 3 | |

**6-00 Live Zero Timeout Time**

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

6

6

### 6-01 Live Zero Timeout Function

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

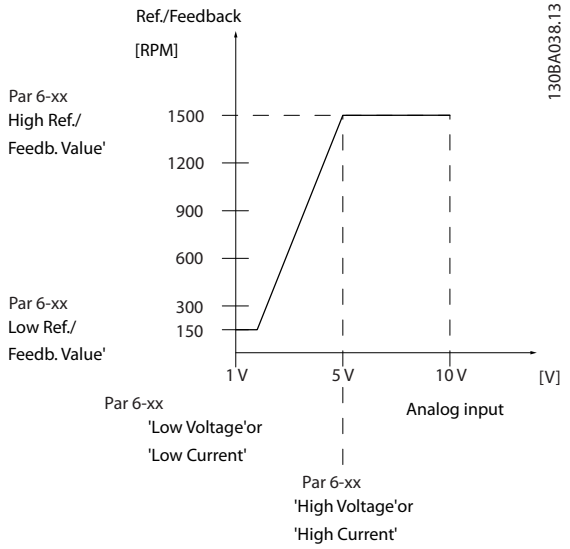



**Illustration 6.12**

### 6-10 Terminal 53 Low Voltage

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

### 6-11 Terminal 53 High Voltage

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

### 6-14 Terminal 53 Low Ref./Feedb. Value

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

### 6-15 Terminal 53 High Ref./Feedb. Value

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

### 6-16 Terminal 53 Filter Time Constant

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

### 6-17 Terminal 53 Live Zero

| Option: | | Function: |
|---|---|---|
| | | This parameter makes it possible to disable the Live Zero monitoring. E.g. to be used if the analog outputs are used as of a de-central I/O system (e.g. when not as of any frequency converter related control functions, but feeding a Building Management system with data). |
| [0] | Disabled | |
| [1] * | Enabled | |

### 6-20 Terminal 54 Low Voltage

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

### 6-21 Terminal 54 High Voltage

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

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

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

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

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

### 6-26 Terminal 54 Filter Time Constant

| Range: | | Function: |
|---|---|---|
| 0.001 s* | [0.001 - 10 s] | ***NOTICE***<br>**This parameter cannot be adjusted while the motor is running.**<br><br>Enter the time constant. This is a first-order digital low pass filter time constant for suppressing electrical noise in terminal |

### 6-26 Terminal 54 Filter Time Constant

| Range: | | Function: |
|---|---|---|
| | | 54. A high time constant value improves dampening but also increases the time delay through the filter. |

### 6-27 Terminal 54 Live Zero

| Option: | | Function: |
|---|---|---|
| | | This parameter makes it possible to disable the Live Zero monitoring. E.g. to be used if the analog outputs are used as of a de-central I/O system (e.g. when not as of any frequency converter related control functions, but feeding a Building Management System with data). |
| [0] | Disabled | |
| [1] * | Enabled | |

### 6-50 Terminal 42 Output

| Option: | | Function: |
|---|---|---|
| | | Select the function of Terminal 42 as an analog current output. A motor current of 20 mA corresponds to $I_{max}$. |
| [0] | No operation | |
| [100] | Output freq. 0-100 | 0-100 Hz, (0-20 mA) |
| [101] | Reference Min-Max | Minimum reference - Maximum reference, (0-20 mA) |
| [102] | Feedback +-200% | -200% to +200% of *20-14 Maximum Reference/Feedb.*, (0-20 mA) |
| [103] | Motor cur. 0-Imax | 0 - Inverter Max. Current (*16-37 Inv. Max. Current*), (0-20 mA) |
| [104] | Torque 0-Tlim | 0 - Torque limit (*4-16 Torque Limit Motor Mode*), (0-20 mA) |
| [105] | Torque 0-Tnom | 0 - Motor rated torque, (0-20 mA) |
| [106] | Power 0-Pnom | 0 - Motor rated power, (0-20 mA) |
| [107] | Speed 0-HighLim | 0 - Speed High Limit (*parameter 4-13 Motor Speed High Limit [RPM]* and *parameter 4-14 Motor Speed High Limit [Hz]*), (0-20 mA) |
| [113] | Ext. Closed Loop 1 | 0-100%, (0-20 mA) |
| [114] | Ext. Closed Loop 2 | 0-100%, (0-20 mA) |
| [115] | Ext. Closed Loop 3 | 0-100%, (0-20 mA) |
| [130] | Out frq 0-100 4-20mA | 0-100 Hz |
| [131] | Reference 4-20mA | Minimum Reference - Maximum Reference |
| [132] | Feedback 4-20mA | -200% to +200% of *20-14 Maximum Reference/Feedb.* |

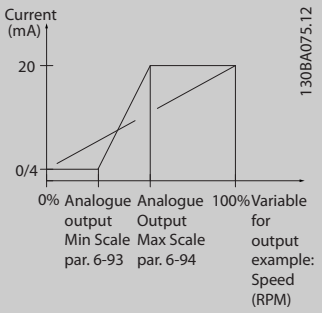
| 6-50 Terminal 42 Output | | |
|---|---|---|
| **Option:** | | **Function:** |
| [133] | Motor cur. 4-20mA | 0 - Inverter Max. Current (*16-37 Inv. Max. Current*) |
| [134] | Torq.0-lim 4-20 mA | 0 - Torque limit (*4-16 Torque Limit Motor Mode*) |
| [135] | Torq.0-nom 4-20mA | 0 - Motor rated torque |
| [136] | Power 4-20mA | 0 - Motor rated power |
| [137] | Speed 4-20mA | 0 - Speed High Limit (4-13 and 4-14) |
| [139] | Bus ctrl. | 0-100%, (0-20 mA) |
| [140] | Bus ctrl. 4-20 mA | 0-100% |
| [141] | Bus ctrl t.o. | 0-100%, (0-20 mA) |
| [142] | Bus ctrl t.o. 4-20mA | 0-100% |
| [143] | Ext. CL 1 4-20mA | 0-100% |
| [144] | Ext. CL 2 4-20mA | 0-100% |
| [145] | Ext. CL 3 4-20mA | 0-100% |

***NOTICE***

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

| 6-51 Terminal 42 Output Min Scale | | |
|---|---|---|
| **Range:** | | **Function:** |
| 0 %* | [0 - 200 %] | Scale for the minimum output (0 or 4 mA) of the analog signal at terminal 42. Set the value to be the percentage of the full range of the variable selected in *parameter 6-50 Terminal 42 Output*. |

| 6-52 Terminal 42 Output Max Scale | | |
|---|---|---|
| **Range:** | | **Function:** |
| 100 %* | [0 - 200 %] | Scale for the maximum output (20mA) of the analog signal at terminal 42. Set the value to be the percentage of the full range of the variable selected in *parameter 6-50 Terminal 42 Output*. |

| 6-52 Terminal 42 Output Max Scale | | |
|---|---|---|
| **Range:** | | **Function:** |
| | |  **Illustration 6.13** It is possible to get a value lower than 20mA at full scale by programming values >100% by using a formula as follows: |

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

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

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

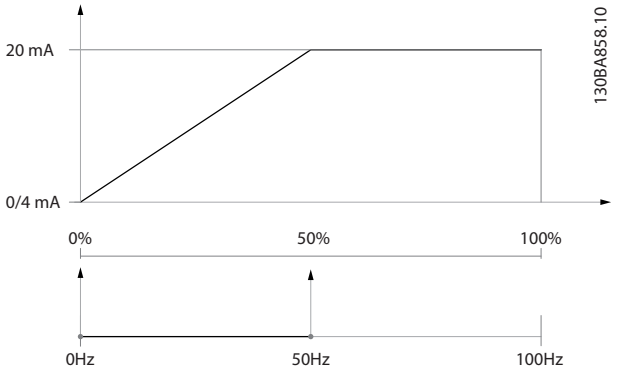



**Illustration 6.14**

**Example 2:**
Variable= FEEDBACK, range= -200% to +200%
Range needed for output= 0-100%
Output signal 0 or 4 mA is needed at 0% (50% of range) - set *parameter 6-51 Terminal 42 Output Min Scale* to 50%
Output signal 20 mA is needed at 100% (75% of range) - set *parameter 6-52 Terminal 42 Output Max Scale* to 75%

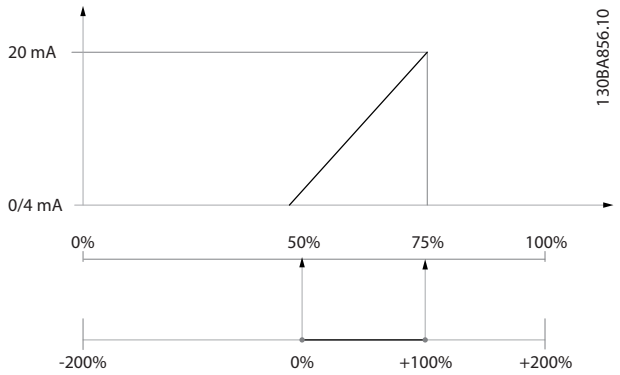



**Illustration 6.15**

**Example 3:**
Variable value= REFERENCE, range= Min ref - Max ref
Range needed for output= Min ref (0%) - Max ref (100%), 0-10 mA
Output signal 0 or 4 mA is needed at Min ref - set *parameter 6-51 Terminal 42 Output Min Scale* to 0%
Output signal 10 mA is needed at Max ref (100% of range) - set *parameter 6-52 Terminal 42 Output Max Scale* to 200% (20 mA/10 mA x 100%=200%).

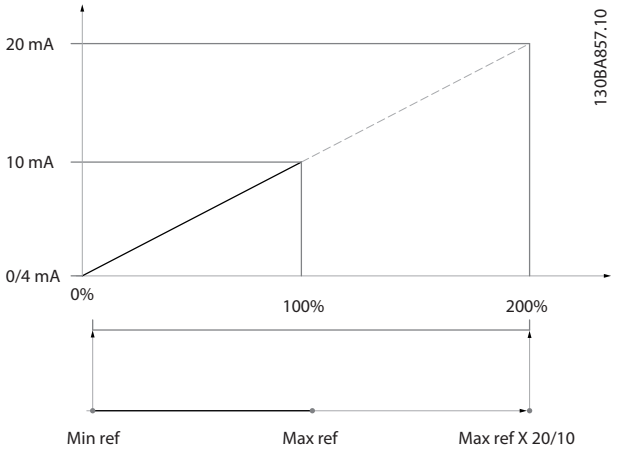



**Illustration 6.16**

| 14-01 Switching Frequency | | |
|---|---|---|
| **Option:** | | **Function:** |
| | | Select the inverter switching frequency. Changing the switching frequency can help to reduce acoustic noise from the motor. |

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

| 20-00 Feedback 1 Source | | |
|---|---|---|
| **Option:** | | **Function:** |
| | | Up to three different feedback signals can be used to provide the feedback signal for the frequency converter's PID Controller.<br>This parameter defines which input will be used as the source of the first feedback signal.<br>Analog input X30/11 and Analog input X30/12 refer to inputs on the optional General Purpose I/O board. |
| [0] | No function | |
| [1] | Analog Input 53 | |
| [2] * | Analog Input 54 | |
| [3] | Pulse input 29 | |
| [4] | Pulse input 33 | |
| [7] | Analog Input X30/11 | |
| [8] | Analog Input X30/12 | |
| [9] | Analog Input X42/1 | |
| [10] | Analog Input X42/3 | |
| [11] | Analog Input X42/5 | |
| [15] | Analog Input X48/2 | |
| [100] | Bus Feedback 1 | |
| [101] | Bus Feedback 2 | |
| [102] | Bus feedback 3 | |

| 20-00 Feedback 1 Source | | |
|---|---|---|
| **Option:** | | **Function:** |
| [104] | Sensorless Flow | Requires set up by MCT 10 Set-up Software with sensorless specific plug in. |
| [105] | Sensorless Pressure | Requires set up by MCT 10 Set-up Software with sensorless specific plug in. |

***NOTICE***

**If a feedback is not used, its source must be set to *[0] No Function*. *Parameter 20-20 Feedback Function* determines how the three possible feedbacks will be used by the PID Controller.**

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| 20-01 Feedback 1 Conversion | | |
|---|---|---|
| **Option:** | | **Function:** |
| | | This parameter allows a conversion function to be applied to Feedback 1. |
| [0] * | Linear | No effect on the feedback. |
| [1] | Square root | Commonly used when a pressure sensor is used to provide flow feedback ($(flow \propto \sqrt{pressure})$). |
| [2] | Pressure to temperature | Used in compressor applications to provide temperature feedback using a pressure sensor. The temperature of the refrigerant is calculated using the following formula: $Temperature = \frac{A2}{(ln(Pe+1)-A1)} - A3$, where A1, A2 and A3 are refrigerant-specific constants. The refrigerant must be selected in *20-30 Refrigerant*. *Parameter 20-21 Setpoint 1* through *20-23 Setpoint 3* allow the values of A1, A2 and A3 to be entered for a refrigerant that is not listed in *20-30 Refrigerant*. |
| [3] | Pressure to flow | Used in applications where the air flow in a duct is to be controlled. The feedback signal is represented by a dynamic pressure measurement (pitot tube). $Flow = Duct\ Area \times \sqrt{Dynamic\ Pressure} \times Air\ Density\ Factor$ See also *20-34 Duct 1 Area [m2]* through *20-38 Air Density Factor [%]* for setting of duct area and air density. |
| [4] | Velocity to flow | Used in applications where the air flow in a duct is to be controlled. The feedback signal is represented by an air velocity measurement. $Flow = Duct\ Area \times Air\ Velocity$ See also *20-34 Duct 1 Area [m2]* through *20-37 Duct 2 Area [in2]* for setting of duct area. |

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

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

| 20-06 Feedback 3 Source | | |
|---|---|---|
| **Option:** | | **Function:** |
| | | See *parameter 20-00 Feedback 1 Source* for details. |
| [0] * | No function | |
| [1] | Analog Input 53 | |
| [2] | Analog Input 54 | |
| [3] | Pulse input 29 | |
| [4] | Pulse input 33 | |
| [7] | Analog Input X30/11 | |
| [8] | Analog Input X30/12 | |
| [9] | Analog Input X42/1 | |
| [10] | Analog Input X42/3 | |
| [11] | Analog Input X42/5 | |
| [15] | Analog Input X48/2 | |
| [100] | Bus Feedback 1 | |
| [101] | Bus Feedback 2 | |
| [102] | Bus feedback 3 | |
| [104] | Sensorless Flow | |
| [105] | Sensorless Pressure | |

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

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

| 20-20 Feedback Function | | |
|---|---|---|
| **Option:** | | **Function:** |
| | | ***NOTICE***<br>**Any unused feedbacks must be set to *No Function* in *parameter 20-00 Feedback 1 Source*, *parameter 20-03 Feedback 2 Source*, or *parameter 20-06 Feedback 3 Source*. Only setpoint 1 is used. The sum of Setpoint 1 and any other references that are enabled (see *parameter group 3-1* References*) are used as the PID Controller's setpoint reference.** |
| [4] | Maximum | Sets up the PID Controller to com Feedback 1, Feedback 2 and Feedback 3 and use the highest value as the feedback.<br>***NOTICE***<br>**Any unused feedbacks must be set to *No Function* in *parameter 20-00 Feedback 1 Source*, *parameter 20-03 Feedback 2 Source*, or *parameter 20-06 Feedback 3 Source*.**<br>Only Setpoint 1 is used. The sum of Setpoint 1 and any other references that are enabled (see *parameter group 3-1* Referencdes*) are used as the PID Controller's setpoint reference. |
| [5] | Multi Setpoint Min | Sets up the PID Controller to calculate the difference between Feedback 1 and Setpoint 1, Feedback 2 and Setpoint 2, and Feedback 3 and Setpoint 3. It uses the feedback/setpoint pair in which the feedback is the farthest below its corresponding setpoint reference. If all feedback signals are above their corresponding setpoints, the PID Controller uses the feedback/setpoint pair in which the difference between the feedback and setpoint is the least.<br>***NOTICE***<br>**If only 2 feedback signals are used, the feedback that is not to be used must be set to *[0] No Function* in *parameter 20-00 Feedback 1 Source*, *parameter 20-03 Feedback 2 Source* or *parameter 20-06 Feedback 3 Source*. Note that each setpoint reference is the sum of its respective parameter value (*parameter 20-21 Setpoint 1*, *parameter 20-22 Setpoint 2* and *20-23 Setpoint 3*) and any other references that are enabled (see *parameter group 3-1* References*).** |

6

| 20-20 Feedback Function | | |
|---|---|---|
| **Option:** | | **Function:** |
| [6] | Multi Setpoint Max | Sets up the PID Controller to calculate the difference between Feedback 1 and Setpoint 1, Feedback 2 and Setpoint 2, and Feedback 3 and Setpoint 3. It uses the feedback/setpoint pair in which the feedback is farthest above its corresponding setpoint reference. If all feedback signals are below their corresponding setpoints, the PID Controller uses the feedback/setpoint pair in which the difference between the feedback and the setpoint reference is the least.<br>***NOTICE***<br>**If only 2 feedback signals are used, the feedback that is not to be used must be set to *[0] No Function* in *parameter 20-00 Feedback 1 Source*, *parameter 20-03 Feedback 2 Source* or *parameter 20-06 Feedback 3 Source*. Note that each setpoint reference will be the sum of its respective parameter value (*parameter 20-21 Setpoint 1*, *parameter 20-22 Setpoint 2* and *20-23 Setpoint 3*) and any other references that are enabled (see *parameter group 3-1* References*).** |

***NOTICE***

**Any unused feedback must be set to *[0] No function* in its Feedback Source parameter: *Parameter 20-00 Feedback 1 Source*, *parameter 20-03 Feedback 2 Source* or *parameter 20-06 Feedback 3 Source*.**

The feedback resulting from the function selected in *parameter 20-20 Feedback Function* is used by the PID Controller to control the output frequency of the frequency converter. This feedback can also be shown on the frequency converter's display, be used to control a frequency converter's analog output, and be transmitted over various serial communication protocols.

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

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

The difference between the 2 is illustrated by the following examples:

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

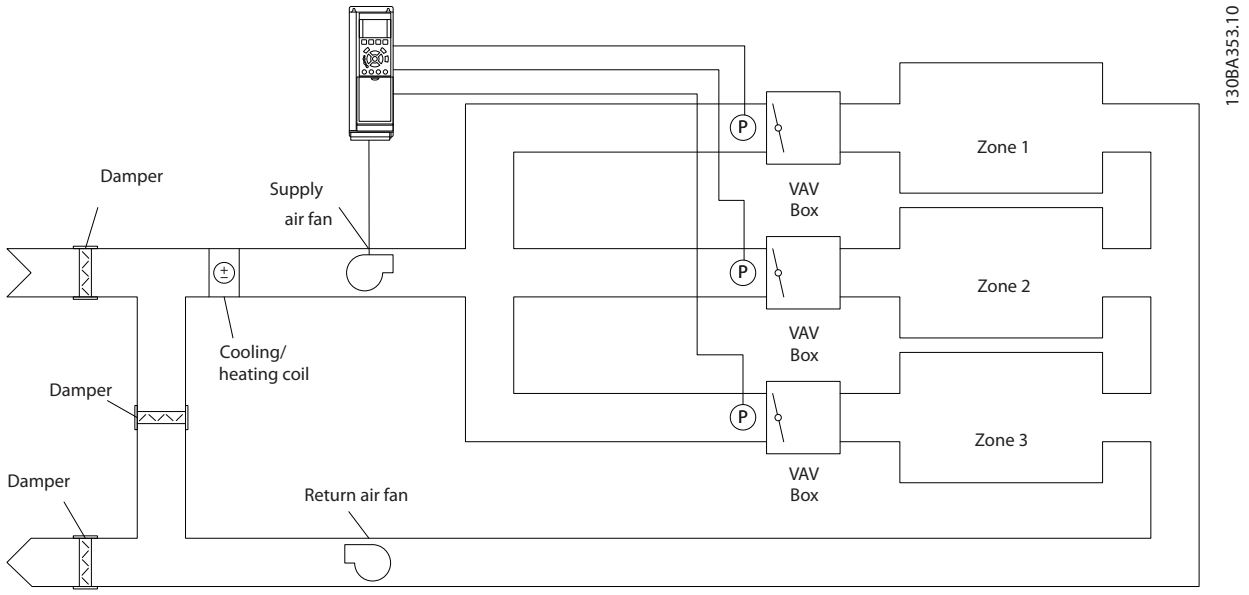


**Illustration 6.17**

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

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

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

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

| 20-93 PID Proportional Gain | | |
|---|---|---|
| **Range:** | | **Function:** |
| 0.50* | [0 - 10 ] | The proportional gain indicates the number of times the error between the set point and the feedback signal is to be applied. |

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

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

**NOTICE**

**Always set the desired for *20-14 Maximum Reference/ Feedb.* before setting the values for the PID controller in parameter group *20-9* PID Controller*.**

| 20-94 PID Integral Time | | |
|---|---|---|
| **Range:** | | **Function:** |
| 20 s* | [0.01 - 10000 s] | Over time, the integrator accumulates a contribution to the output from the PID controller as long as there is a deviation between the Reference/Setpoint and feedback signals. The contribution is proportional to the size of the deviation. This ensures that the deviation (error) approaches zero. Quick response on any deviation is obtained when the integral time is set to a low value. Setting it too low, however, may cause the control to become unstable. The value set, is the time needed for the integrator to add the same contribution as the proportional for a certain deviation. If the value is set to 10,000, the controller acts as a pure proportional controller with a P-band based on the value set in *parameter 20-93 PID Proportional Gain*. When no deviation is present, the output from the proportional controller is 0. |

| 22-21 Low Power Detection | | |
|---|---|---|
| **Option:** | | **Function:** |
| [0] * | Disabled | |
| [1] | Enabled | The Low Power Detection commissioning must be carried out to set the parameters in parameter group *22-3* No-Flow Power Tuning* for proper operation. |

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

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

**NOTICE**

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

**NOTICE**

**If the frequency converter is equipped with a constant speed bypass with an automatic bypass function that starts the bypass if the frequency converter experiences a persistent alarm condition, be sure to disable the bypass's automatic bypass function, if *[3] Alarm* is selected as the No-Flow Function.**

| 22-24 No-Flow Delay | | |
|---|---|---|
| **Range:** | | **Function:** |
| 10 s* | [1 - 600 s] | Set the time Low Power/Low Speed must stay detected to activate signal for actions. If detection disappears before run out of the timer, the timer is reset. |

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

**NOTICE**

***Low Power Detection* must be Enabled (*parameter 22-21 Low Power Detection*) and commissioned (using either parameter group *22-3* No-flow Power Tuning No Flow Power Tuning*, or *22-20 Low Power Auto Set-up*) to use Dry Pump Detection.**

**NOTICE**

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

**NOTICE**

**If the frequency converter is equipped with a constant speed bypass with an automatic bypass function that starts the bypass if the frequency converter experiences a persistent alarm condition, be sure to disable the bypass's automatic bypass function, if *[2] Alarm* or *[3] Man. Reset Alarm* is selected as the Dry Pump Function.**

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

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

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

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

## NOTICE

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

## NOTICE

**If the frequency converter is equipped with a constant speed bypass with an automatic bypass function that starts the bypass if the frequency converter experiences a persistent alarm condition, be sure to disable the bypass's automatic bypass function, if *[2] Trip* is selected as the Broken Belt Function.**

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

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

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

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

| 22-77 Minimum Run Time | | |
|---|---|---|
| **Range:** | | **Function:** |
| 0 s* | [ 0 - par. 22-76 s] | Sets the time desired as minimum run time after a normal start command (start/jog/freeze). Any normal stop command is disregarded until the set time has expired. The timer starts counting following a normal start command (start/jog/freeze).<br>The timer is overridden by a coast (inverse) or an external interlock command. |

## NOTICE

**Does not work in cascade mode.**

## 6.1.5 Main Menu Mode

Both the GLCP and NLCP provide access to the main menu mode. Select the Main Menu mode by pressing the [Main Menu] key. *Illustration 6.18* shows the resulting read-out, which appears on the display of the GLCP.
Lines 2 through 5 on the display show a list of parameter groups which can be selected by toggling the up and down keys.

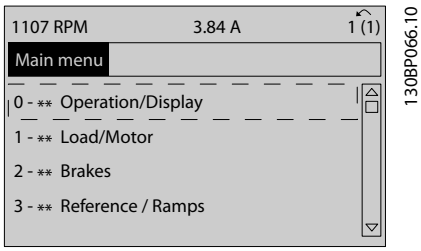


**Illustration 6.18 Display Example**

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

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

## 6.1.6 Parameter Selection

In the Main Menu mode, the parameters are divided into groups. Select a parameter group by means of the navigation keys.
The following parameter groups are accessible:

| Group no. | Parameter group |
|---|---|
| 0-** | Operation/Display |
| 1-** | Load/Motor |
| 2-** | Brakes |
| 3-** | References/Ramps |
| 4-** | Limits/Warnings |
| 5-** | Digital In/Out |
| 6-** | Analog In/Out |
| 8-** | Comm. and Options |
| 9-** | Profibus |
| 10-** | CAN Fieldbus |
| 11-** | LonWorks |
| 13-** | Smart Logic |
| 14-** | Special Functions |
| 15-** | FC Information |
| 16-** | Data Readouts |
| 18-** | Data Readouts 2 |
| 20-** | FC Closed Loop |
| 21-** | Ext. Closed Loop |
| 22-** | Application Functions |
| 23-** | Time Actions |
| 25-** | Cascade Controller |
| 26-** | Analog I/O Option MCB 109 |
| 27-** | Cascade CTL Option |
| 29-** | Water Application Functions |
| 31-** | Bypass Option |

**Table 6.8 Parameter Groups**

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

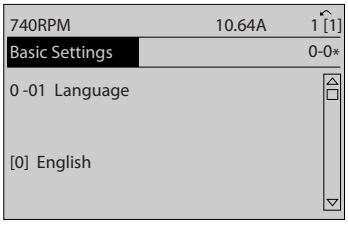


**Illustration 6.19 Display Example**

## 6.1.7 Changing Data

1. Press [Quick Menu] or [Main Menu] key.
2. Press [▲] and [▼] to find parameter group to edit.
3. Press [OK] key.
4. Press [▲] and [▼] to find parameter to edit.
5. Press [OK] key.
6. Press [▲] and [▼] to select correct parameter setting. Or, to move to digits within a number, press keys. Cursor indicates digit selected to change. [▲] increases the value, [▼] decreases the value.
7. Press [Cancel] to disregard change, or press [OK] to accept change and enter new setting.

### 6.1.8 Changing a Text Value

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

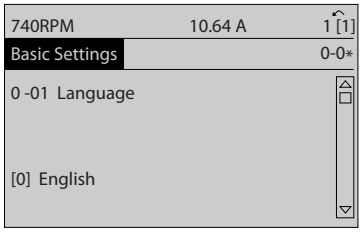


**Illustration 6.20 Display Example**

### 6.1.9 Changing a Group of Numeric Data Values

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

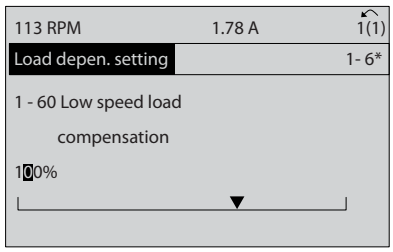


**Illustration 6.21 Display Example**

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

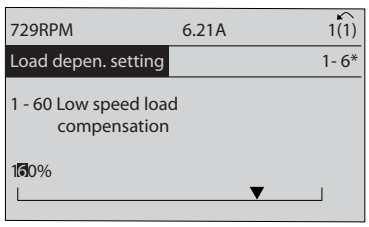


**Illustration 6.22 Display Example**

### 6.1.10 Changing of Data Value, Step-by-Step

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

### 6.1.11 Read-out and Programming of Indexed Parameters

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

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

## 6.2 Parameter Menu Structure

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

6-63 Terminal X30/8 Output Bus Control
6-64 Terminal X30/8 Output Timeout Preset
**8-** Comm. and Options**
**8-0* General Settings**
8-01 Control Site
8-02 Control Source
8-03 Control Timeout Time
8-04 Control Timeout Function
8-05 End-of-Timeout Function
8-06 Reset Control Timeout
8-07 Diagnosis Trigger
8-08 Readout Filtering
8-09 Communication Charset
**8-1* Control Settings**
8-10 Control Profile
8-13 Configurable Status Word STW
**8-3* FC Port Settings**
8-30 Protocol
8-31 Address
8-32 Baud Rate
8-33 Parity / Stop Bits
8-34 Estimated cycle time
8-35 Minimum Response Delay
8-36 Maximum Response Delay
8-37 Maximum Inter-Char Delay
8-39 Protocol Firmware version
**8-4* FC MC protocol set**
8-40 Telegram Selection
8-42 PCD Write Configuration
8-43 PCD Read Configuration
**8-5* Digital/Bus**
8-50 Coasting Select
8-52 DC Brake Select
8-53 Start Select
8-54 Reversing Select
8-55 Set-up Select
8-56 Preset Reference Select
**8-7* BACnet**
8-70 BACnet Device Instance
8-72 MS/TP Max Masters
8-73 MS/TP Max Info Frames
8-74 "I-Am" Service
8-75 Initialisation Password
**8-8* FC Port Diagnostics**
8-80 Bus Message Count
8-81 Bus Error Count
8-82 Slave Messages Rcvd
8-83 Slave Error Count
8-84 Slave Messages Sent
8-85 Slave Timeout Errors
8-89 Diagnostics Count
**8-9* Bus Jog / Feedback**
8-90 Bus Jog 1 Speed
8-91 Bus Jog 2 Speed
8-94 Bus Feedback 1
8-95 Bus Feedback 2
8-96 Bus Feedback 3
**9-** PROFIdrive**
9-00 Setpoint
9-07 Actual Value
9-15 PCD Write Configuration
9-16 PCD Read Configuration
9-18 Node Address
9-22 Telegram Selection
9-23 Parameters for Signals
9-27 Parameter Edit
9-28 Process Control
9-44 Fault Message Counter
9-45 Fault Code
9-47 Fault Number
9-52 Fault Situation Counter
9-53 Profibus Warning Word
9-63 Actual Baud Rate
9-64 Device Identification
9-65 Profile Number
9-67 Control Word 1
9-68 Status Word 1
9-70 Programming Set-up
9-71 Profibus Save Data Values
9-72 ProfibusDriveReset
9-75 DO Identification
9-80 Defined Parameters (1)
9-81 Defined Parameters (2)
9-82 Defined Parameters (3)
9-83 Defined Parameters (4)
9-84 Defined Parameters (5)
9-90 Changed Parameters (1)
9-91 Changed Parameters (2)
9-92 Changed Parameters (3)
9-93 Changed Parameters (4)
9-94 Changed Parameters (5)
9-99 Profibus Revision Counter
**10-** CAN Fieldbus**
**10-0* Common Settings**
10-00 CAN Protocol
10-01 Baud Rate Select
10-02 MAC ID
10-05 Readout Transmit Error Counter
10-06 Readout Receive Error Counter
10-07 Readout Bus Off Counter
**10-1* DeviceNet**
10-10 Process Data Type Selection
10-11 Process Data Config Write
10-12 Process Data Config Read
10-13 Warning Parameter
10-14 Net Reference
10-15 Net Control
**10-2* COS Filters**
10-20 COS Filter 1
10-21 COS Filter 2
10-22 COS Filter 3
10-23 COS Filter 4
**10-3* Parameter Access**
10-30 Array Index
10-31 Store Data Values
10-32 Devicenet Revision
10-33 Store Always
10-34 DeviceNet Product Code
10-39 Devicenet F Parameters
**11-** LonWorks**
**11-0* LonWorks ID**
11-00 Neuron ID
**11-1* LON Functions**
11-10 Drive Profile
11-15 LON Warning Word
11-17 XIF Revision
11-18 LonWorks Revision
**11-2* LON Param. Access**
11-21 Store Data Values
**12-** Ethernet**
**12-0* IP Settings**
12-00 IP Address Assignment
12-01 IP Address
12-02 Subnet Mask
12-03 Default Gateway
12-04 DHCP Server
12-05 Lease Expires
12-06 Name Servers
12-07 Domain Name
12-08 Host Name
12-09 Physical Address
**12-1* Ethernet Link Parameters**
12-10 Link Status
12-11 Link Duration
12-12 Auto Negotiation
12-13 Link Speed
12-14 Link Duplex
**12-2* Process Data**
12-20 Control Instance
12-21 Process Data Config Write
12-22 Process Data Config Read
12-27 Primary Master
12-28 Store Data Values
12-29 Store Always
**12-3* EtherNet/IP**
12-30 Warning Parameter
12-31 Net Reference
12-32 Net Control
12-33 CIP Revision
12-34 CIP Product Code
12-35 EDS Parameter
12-37 COS Inhibit Timer
12-38 COS Filter
**12-4* Modbus TCP**
12-40 Status Parameter
12-41 Slave Message Count
12-42 Slave Exception Message Count
**12-8* Other Ethernet Services**
12-80 FTP Server
12-81 HTTP Server
12-82 SMTP Service
12-89 Transparent Socket Channel Port
**12-9* Advanced Ethernet Services**
12-90 Cable Diagnostic
12-91 Auto Cross Over
12-92 IGMP Snooping
12-93 Cable Error Length
12-94 Broadcast Storm Protection
12-95 Broadcast Storm Filter
12-96 Port Config
12-98 Interface Counters
12-99 Media Counters
**13-** Smart Logic**
**13-0* SLC Settings**
13-00 SL Controller Mode
13-01 Start Event
13-02 Stop Event
13-03 Reset SLC
**13-1* Comparators**
13-10 Comparator Operand
13-11 Comparator Operator
13-12 Comparator Value
**13-2* Timers**
13-20 SL Controller Timer
**13-4* Logic Rules**
13-40 Logic Rule Boolean 1
13-41 Logic Rule Operator 1
13-42 Logic Rule Boolean 2
13-43 Logic Rule Operator 2
13-44 Logic Rule Boolean 3
**13-5* States**
13-51 SL Controller Event
13-52 SL Controller Action
**14-** Special Functions**
**14-0* Inverter Switching**
14-00 Switching Pattern
14-01 Switching Frequency
14-03 Overmodulation
14-04 PWM Random
**14-1* Mains On/Off**
14-10 Mains Failure
14-11 Mains Voltage at Mains Fault
14-12 Function at Mains Imbalance
**14-2* Reset Functions**
14-20 Reset Mode
14-21 Automatic Restart Time
14-22 Operation Mode
14-23 Typecode Setting
14-25 Trip Delay at Torque Limit
14-26 Trip Delay at Inverter Fault
14-28 Production Settings
14-29 Service Code
**14-3* Current Limit Ctrl.**
14-30 Current Lim Ctrl, Proportional Gain
14-31 Current Lim Ctrl, Integration Time
14-32 Current Lim Ctrl, Filter Time
**14-4* Energy Optimising**
14-40 VT Level
14-41 AEO Minimum Magnetisation
14-42 Minimum AEO Frequency
14-43 Motor Cosphi
**14-5* Environment**
14-50 RFI Filter
14-51 DC Link Compensation
14-52 Fan Control
14-53 Fan Monitor
14-55 Output Filter
14-59 Actual Number of Inverter Units
**14-6* Auto Derate**
14-60 Function at Over Temperature
14-61 Function at Inverter Overload
14-62 Inv. Overload Derate Current
**14-9* Fault Settings**
14-90 Fault Level
**15-** Drive Information**
**15-0* Operating Data**
15-00 Operating hours
15-01 Running Hours
15-02 kWh Counter
15-03 Power Up's
15-04 Over Temp's
15-05 Over Volt's
15-06 Reset kWh Counter
15-07 Reset Running Hours Counter
15-08 Number of Starts
**15-1* Data Log Settings**
15-10 Logging Source
15-11 Logging Interval
15-12 Trigger Event
15-13 Logging Mode
15-14 Samples Before Trigger
**15-2* Historic Log**
15-20 Historic Log: Event
15-21 Historic Log: Value
15-22 Historic Log: Time
15-23 Historic log: Date and Time
**15-3* Alarm Log**
15-30 Alarm Log: Error Code
15-31 Alarm Log: Value
15-32 Alarm Log: Time
15-33 Alarm Log: Date and Time
**15-4* Drive Identification**
15-40 FC Type
15-41 Power Section
15-42 Voltage
15-43 Software Version
15-44 Ordered Typecode String
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| **25-0*** | **System Settings** |
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| **25-2*** | **Bandwidth Settings** |
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| 25-23 | SBW Staging Delay |
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| 25-42 | Staging Threshold |
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| 25-44 | Staging Speed [RPM] |
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| 25-51 | Alternation Event |
| 25-52 | Alternation Time Interval |
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| 25-81 | Pump Status |
| 25-82 | Lead Pump |
| 25-83 | Relay Status |
| 25-84 | Pump ON Time |
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| **26-**** | **Analog I/O Option** |
| **26-0*** | **Analog I/O Mode** |
| 26-00 | Terminal X42/1 Mode |
| 26-01 | Terminal X42/3 Mode |
| 26-02 | Terminal X42/5 Mode |
| **26-1*** | **Analog Input X42/1** |
| 26-10 | Terminal X42/1 Low Voltage |
| 26-11 | Terminal X42/1 High Voltage |
| 26-14 | Term. X42/1 Low Ref./Feedb. Value |
| 26-15 | Term. X42/1 High Ref./Feedb. Value |
| 26-16 | Term. X42/1 Filter Time Constant |
| 26-17 | Term. X42/1 Live Zero |
| **26-2*** | **Analog Input X42/3** |
| 26-20 | Terminal X42/3 Low Voltage |
| 26-21 | Terminal X42/3 High Voltage |
| 26-24 | Term. X42/3 Low Ref./Feedb. Value |
| 26-25 | Term. X42/3 High Ref./Feedb. Value |
| 26-26 | Term. X42/3 Filter Time Constant |
| 26-27 | Term. X42/3 Live Zero |
| **26-3*** | **Analog Input X42/5** |
| 26-30 | Terminal X42/5 Low Voltage |
| 26-31 | Terminal X42/5 High Voltage |
| 26-34 | Term. X42/5 Low Ref./Feedb. Value |
| 26-35 | Term. X42/5 High Ref./Feedb. Value |
| 26-36 | Term. X42/5 Filter Time Constant |
| 26-37 | Term. X42/5 Live Zero |
| **26-4*** | **Analog Out X42/7** |
| 26-40 | Terminal X42/7 Output |
| 26-41 | Terminal X42/7 Min. Scale |
| 26-42 | Terminal X42/7 Max. Scale |
| 26-43 | Terminal X42/7 Bus Control |
| 26-44 | Terminal X42/7 Timeout Preset |
| **26-5*** | **Analog Out X42/9** |
| 26-50 | Terminal X42/9 Output |
| 26-51 | Terminal X42/9 Min. Scale |
| 26-52 | Terminal X42/9 Max. Scale |
| 26-53 | Terminal X42/9 Bus Control |
| 26-54 | Terminal X42/9 Timeout Preset |
| **26-6*** | **Analog Out X42/11** |
| 26-60 | Terminal X42/11 Output |
| 26-61 | Terminal X42/11 Min. Scale |
| 26-62 | Terminal X42/11 Max. Scale |
| 26-63 | Terminal X42/11 Bus Control |
| 26-64 | Terminal X42/11 Timeout Preset |
| **30-**** | **Special Features** |
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| 30-22 | Locked Rotor Detection |
| 30-23 | Locked Rotor Detection Time [s] |
| **31-**** | **Bypass Option** |
| 31-00 | Bypass Mode |
| 31-01 | Bypass Start Time Delay |
| 31-02 | Bypass Trip Time Delay |
| 31-03 | Test Mode Activation |
| 31-10 | Bypass Status Word |
| 31-11 | Bypass Running Hours |
| 31-19 | Remote Bypass Activation |
| **35-**** | **Sensor Input Option** |
| **35-0*** | **Temp. Input Mode** |
| 35-00 | Term. X48/4 Temperature Unit |
| 35-01 | Term. X48/4 Input Type |
| 35-02 | Term. X48/7 Temperature Unit |
| 35-03 | Term. X48/7 Input Type |
| 35-04 | Term. X48/10 Temperature Unit |
| 35-05 | Term. X48/10 Input Type |
| 35-06 | Temperature Sensor Alarm Function |
| **35-1*** | **Temp. Input X48/4** |
| 35-14 | Term. X48/4 Filter Time Constant |
| 35-15 | Term. X48/4 Temp. Monitor |
| 35-16 | Term. X48/4 Low Temp. Limit |
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| **35-2*** | **Temp. Input X48/7** |
| 35-24 | Term. X48/7 Filter Time Constant |
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| 35-26 | Term. X48/7 Low Temp. Limit |
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| 35-34 | Term. X48/10 Filter Time Constant |
| 35-35 | Term. X48/10 Temp. Monitor |
| 35-36 | Term. X48/10 Low Temp. Limit |
| 35-37 | Term. X48/10 High Temp. Limit |
| **35-4*** | **Analog Input X48/2** |
| 35-42 | Term. X48/2 Low Current |
| 35-43 | Term. X48/2 High Current |
| 35-44 | Term. X48/2 Low Ref./Feedb. Value |
| 35-45 | Term. X48/2 High Ref./Feedb. Value |
| 35-46 | Term. X48/2 Filter Time Constant |
| 35-47 | Term. X48/2 Live Zero |
| **99-*** | **Devel support** |
| **99-0*** | **DSP Debug** |
| 99-00 | DAC 1 selection |
| 99-01 | DAC 2 selection |
| 99-02 | DAC 3 selection |
| 99-03 | DAC 4 selection |
| 99-04 | DAC 1 scale |
| 99-05 | DAC 2 scale |
| 99-06 | DAC 3 scale |
| 99-07 | DAC 4 scale |
| 99-08 | Test param 1 |
| 99-09 | Test param 2 |
| 99-10 | DAC Option Slot |
| **99-1*** | **Hardware Control** |
| 99-11 | RFI 2 |
| 99-12 | Fan |
| **99-1*** | **Software Readouts** |
| 99-13 | Idle time |
| 99-14 | Paramdb requests in queue |
| 99-15 | Secondary Timer at Inverter Fault |
| 99-16 | No of Current Sensors |
| **99-2*** | **Heatsink Readouts** |
| 99-20 | HS Temp. (PC1) |
| 99-21 | HS Temp. (PC2) |
| 99-22 | HS Temp. (PC3) |
| 99-23 | HS Temp. (PC4) |
| 99-24 | HS Temp. (PC5) |
| 99-25 | HS Temp. (PC6) |
| 99-26 | HS Temp. (PC7) |
| 99-27 | HS Temp. (PC8) |
| **99-2*** | **Platform Readouts** |
| 99-29 | Platform Version |
| **99-4*** | **Software Control** |
| 99-40 | StartupWizardState |
| **99-5*** | **PC Debug** |
| 99-50 | PC Debug Selection |
| 99-51 | PC Debug 0 |
| 99-52 | PC Debug 1 |
| 99-53 | PC Debug 2 |
| 99-54 | PC Debug 3 |
| 99-55 | PC Debug 4 |
| 99-56 | Fan 1 Feedback |
| 99-57 | Fan 2 Feedback |
| 99-58 | PC Auxiliary Temp |
| 99-59 | Power Card Temp. |
| **99-9*** | **Internal Values** |
| 99-90 | Options present |
| 99-91 | Motor Power Internal |
| 99-92 | Motor Voltage Internal |
| 99-93 | Motor Frequency Internal |
| 99-94 | Imbalance derate [%] |
| 99-95 | Temperature derate [%] |
| 99-96 | Overload derate [%] |

# 7 General Specifications

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

*Mains voltage low/mains drop-out:*
*During low mains voltage or a mains drop-out, the FC continues until the intermediate circuit voltage drops below the minimum stop level, which corresponds typically to 15% below the FC's lowest rated supply voltage. Power-up and full torque cannot be expected at mains voltage lower than 10% below the FC'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 (cosφ) near unity | (> 0.98) |
| Switching on input supply L1, L2, L3 (power-ups) | maximum once/2 min. |
| Environment according to EN60664-1 | overvoltage category III/pollution degree 2 |

*The unit is suitable for use on a circuit capable of delivering not more than 100.000 RMS symmetrical Amperes, 480/690 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 | 1-3600 s |

** Voltage and power dependent*

| Torque characteristics | |
|---|---|
| Starting torque (Constant torque) | maximum 110% for 1 min.* |
| Starting torque | maximum 135% up to 0.5 s* |
| Overload torque (Constant torque) | maximum 110% for 1 min.* |

**Percentage relates to the frequency converter's nominal torque.*

| Cable lengths and cross sections | |
|---|---|
| Max. motor cable length, screened/armoured | 150 m |
| Max. motor cable length, unscreened/unarmoured | 300 m |
| Max. cross section to motor, mains, load sharing and brake * | |
| Maximum cross section to control terminals, rigid wire | 1.5 mm²/16 AWG (2x0.75 mm²) |
| Maximum cross section to control terminals, flexible cable | 1 mm²/18 AWG |
| Maximum cross section to control terminals, cable with enclosed core | 0.5 mm²/20 AWG |
| Minimum cross section to control terminals | 0.25 mm² |

** See chapter 7.1 Electrical Data for more information!*

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

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

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

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

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

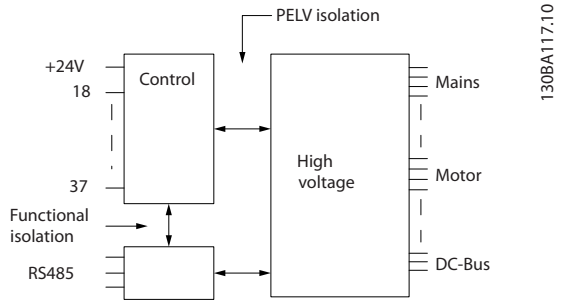


**Illustration 7.1 PELV Isolation of Analog Inputs**

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

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

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

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

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

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

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

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

| Control card, 24 V DC output | |
|---|---|
| Terminal number | 12, 13 |
| Max. load | 200 mA |

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

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

*1) IEC 60947 parts 4 and 5*

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

*2) Overvoltage Category II*

*3) UL applications 300 V AC 2 A*

| Control card, 10 V DC output | |
|---|---|
| Terminal number | 50 |
| Output voltage | 10.5 V ±0.5 V |
| Max. load | 25 mA |

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

| Control characteristics | |
|---|---|
| Resolution of output frequency at 0-590 Hz | ±0.003 Hz |
| System response time (terminals 18, 19, 27, 29, 32, 33) | ≤ 2 ms |
| Speed control range (open loop) | 1:100 of synchronous speed |

| | |
|---|---|
| Speed accuracy (open loop) | 30-4000 RPM: Maximum error of ±8 RPM |

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

| Surroundings | |
|---|---|
| Enclosure, frame size D and E | IP00, IP21, IP54 |
| Enclosure, frame size F | IP21, IP54 |
| Vibration test | 0.7 g |
| Relative humidity | 5% - 95% (IEC 721-3-3; Class 3K3 (non-condensing) during operation |
| Aggressive environment (IEC 60068-2-43) $H_2S$ test | class kD |
| Test method according to IEC 60068-2-43 $H_2S$ (10 days) | |
| Ambient temperature (at 60 AVM switching mode) | |
| - with derating | max. 55 °C[1)] |
| - with full output power, typical EFF2 motors | max. 50 °C[1)] |
| - at full continuous FC output current | max. 45 °C[1)] |

*[1)] For more information on derating see the Design Guide, section on Special Conditions.*

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

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

| | |
|---|---|
| EMC standards, Emission | EN 61800-3, EN 61000-6-3/4, EN 55011, IEC 61800-3 |
| EMC standards, Immunity | EN 61800-3, EN 61000-6-1/2, EN 61000-4-2, EN 61000-4-3, EN 61000-4-4, EN 61000-4-5, EN 61000-4-6 |

*See section on special conditions in the Design Guide!*

| Control card performance | |
|---|---|
| Scan interval | 5 ms |
| Control card, USB serial communication | |
| USB standard | 1.1 (Full speed) |
| USB plug | USB type B “device” plug |

**⚠CAUTION**

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

**Protection and Features**

- Electronic thermal motor protection against overload.
- Temperature monitoring of the heat sink ensures that the frequency converter trips if the temperature reaches a predefined level. An overload temperature cannot be reset until the temperature of the heat sink is below the 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 is protected against earth faults on motor terminals U, V, W.

## 7.1 Electrical Data

| Mains Supply 3x380-480 V AC | | | | | |
|---|---|---|---|---|---|
| | **P110** | **P132** | **P160** | **P200** | **P250** |
| Typical Shaft output at 400 V [kW] | 110 | 132 | 160 | 200 | 250 |
| Typical Shaft output at 460 V [hp] | 150 | 200 | 250 | 300 | 350 |
| 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] | 212 | 260 | 315 | 395 | 480 |
| Intermittent (60 s overload) (at 400 V) [A] | 233 | 286 | 347 | 435 | 528 |
| Continuous (at 460/480 V) [A] | 190 | 240 | 302 | 361 | 443 |
| Intermittent (60 s overload) (at 460/480 V) [A] | 209 | 264 | 332 | 397 | 487 |
| Continuous KVA (at 400 V) [KVA] | 147 | 180 | 218 | 274 | 333 |
| Continuous KVA (at 460 V) [KVA] | 151 | 191 | 241 | 288 | 353 |
| **Max. input current** | | | | | |
| Continuous (at 400 V) [A] | 204 | 251 | 304 | 381 | 463 |
| Continuous (at 460/480 V) [A] | 183 | 231 | 291 | 348 | 427 |
| Max. cable size, mains motor, brake and load share [$mm^2$ (AWG[2)])] | 2x70 (2x2/0) | 2x70 (2x2/0) | 2x150 (2x300 mcm) | 2x150 (2x300 mcm) | 2x150 (2x300 mcm) |
| Max. external pre-fuses [A] [1] | 300 | 350 | 400 | 500 | 630 |
| Estimated power loss at rated max. load [W] [4)], 400 V | 3234 | 3782 | 4213 | 5119 | 5893 |
| Estimated power loss at rated max. load [W] [4)], 460 V | 2947 | 3665 | 4063 | 4652 | 5634 |
| 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 | | | | |
| Heat sink overtemp. trip | 90 °C | 110°C | 110°C | 110 °C | 110°C |
| Power card ambient trip | 60 °C | | | | |

**Table 7.1**

| Mains Supply 3x380-480 V AC | | | | |
|---|---|---|---|---|
| | **P315** | **P355** | **P400** | **P450** |
| Typical Shaft output at 400 V [kW] | 315 | 355 | 400 | 450 |
| Typical Shaft output at 460 V [HP] | 450 | 500 | 600 | 600 |
| Enclosure IP21 | E1 | E1 | E1 | E1 |
| EnclosureIP54 | E1 | E1 | E1 | E1 |
| Enclosure IP00 | E2 | E2 | E2 | E2 |
| **Output current** | | | | |
| Continuous (at 400 V) [A] | 600 | 658 | 745 | 800 |
| Intermittent (60 sec overload) (at 400 V) [A] | 660 | 724 | 820 | 880 |
| Continuous (at 460/ 480 V) [A] | 540 | 590 | 678 | 730 |
| Intermittent (60 sec overload) (at 460/ 480 V) [A] | 594 | 649 | 746 | 803 |
| Continuous KVA (at 400 V) [KVA] | 416 | 456 | 516 | 554 |
| Continuous KVA (at 460 V) [KVA] | 430 | 470 | 540 | 582 |
| **Max. input current** | | | | |
| Continuous (at 400 V ) [A] | 590 | 647 | 733 | 787 |
| Continuous (at 460/ 480 V) [A] | 531 | 580 | 667 | 718 |
| Max. cable size, mains, motor and load share [$mm^2$ (AWG[2)])] | 4x240 (4x500 mcm) | 4x240 (4x500 mcm) | 4x240 (4x500 mcm) | 4x240 (4x500 mcm) |
| Max. cable size, brake [$mm^2$ (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 pre-fuses [A] [1] | 700 | 900 | 900 | 900 |
| Estimated power loss at rated max. load [W] [4) ], 400 V | 6790 | 7701 | 8879 | 9670 |
| Estimated power loss at rated max. load [W] [4) ], 460 V | 6082 | 6953 | 8089 | 8803 |
| Weight, enclosure IP21, IP 54 [kg] | 263 | 270 | 272 | 313 |
| Weight, enclosure IP00 [kg] | 221 | 234 | 236 | 277 |
| Efficiency[4)] | 0.98 | | | |
| Output frequency | 0 - 600 Hz | | | |
| Heat sink overtemp. trip | 110°C | | | |
| Power card ambient trip | 68 °C | | | |

**Table 7.2**

| Mains Supply 3x380-480 V AC | | | | | | |
|---|---|---|---|---|---|---|
| | **P500** | **P560** | **P630** | **P710** | **P800** | **P1M0** |
| Typical Shaft output at 400 V [kW] | 500 | 560 | 630 | 710 | 800 | 1000 |
| Typical Shaft output at 460 V [HP] | 650 | 750 | 900 | 1000 | 1200 | 1350 |
| Enclosure IP21, 54 without/ with options cabinet | F1/F3 | F1/F3 | F1/F3 | F1/F3 | F2/F4 | F2/F4 |
| **Output current** | | | | | | |
| Continuous (at 400 V) [A] | 880 | 990 | 1120 | 1260 | 1460 | 1720 |
| Intermittent (60 sec overload) (at 400 V) [A] | 968 | 1089 | 1232 | 1386 | 1606 | 1892 |
| Continuous (at 460/ 480 V) [A] | 780 | 890 | 1050 | 1160 | 1380 | 1530 |
| Intermittent (60 sec overload) (at 460/ 480 V) [A] | 858 | 979 | 1155 | 1276 | 1518 | 1683 |
| Continuous KVA (at 400 V) [KVA] | 610 | 686 | 776 | 873 | 1012 | 1192 |
| Continuous KVA (at 460 V) [KVA] | 621 | 709 | 837 | 924 | 1100 | 1219 |
| **Max. input current** | | | | | | |
| Continuous (at 400 V ) [A] | 857 | 964 | 1090 | 1227 | 1422 | 1675 |
| Continuous (at 460/ 480 V) [A] | 759 | 867 | 1022 | 1129 | 1344 | 1490 |
| Max. cable size,motor [$mm^2$ (AWG[2)])] | 8x150 (8x300 mcm) | | | | 12x150 (12x300 mcm) | |
| Max. cable size,mains F1/F2 [$mm^2$ (AWG[2)])] | 8x240 (8x500 mcm) | | | | | |
| Max. cable size,mains F3/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)]) | 4x185 (4x350 mcm) | | | | 6x185 (6x350 mcm) | |
| Max. external pre-fuses [A] [1] | 1600 | | 2000 | | 2500 | |
| Est. power loss at rated max. load [W][4)] , 400 V, F1 & F2 | 10647 | 12338 | 13201 | 15436 | 18084 | 20358 |
| Est. power loss at rated max. load [W] [4)] , 460 V, F1 & F2 | 9414 | 11006 | 12353 | 14041 | 17137 | 17752 |
| Max added losses of A1 RFI, Circuit Breaker or Disconnect, & Contactor, F3 & F4 | 963 | 1054 | 1093 | 1230 | 2280 | 2541 |
| Max Panel Options Losses | 400 | | | | | |
| Weight, enclosure IP21, IP 54 [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 | | | | | |
| Heat sink overtemp. trip | 95 °C | | | | | |
| Power card ambient trip | 68 °C | | | | | |

**Table 7.3**

| Mains Supply 3x525-690 V AC | | | | | |
|---|---|---|---|---|---|
| | **P45K** | **P55K** | **P75K** | **P90K** | **P110** |
| Typical Shaft output at 550 V [kW] | 37 | 45 | 55 | 75 | 90 |
| Typical Shaft output at 575 V [HP] | 50 | 60 | 75 | 100 | 125 |
| Typical Shaft output at 690 V [kW] | 45 | 55 | 75 | 90 | 110 |
| Enclosure IP21 | D1 | D1 | D1 | D1 | D1 |
| Enclosure IP54 | D1 | D1 | D1 | D1 | D1 |
| Enclosure IP00 | D2 | D2 | D2 | D2 | D2 |
| **Output current** | | | | | |
| Continuous (at 3 x 525-550 V) [A] | 56 | 76 | 90 | 113 | 137 |
| Intermittent (60 sec overload) (at 550 V) [A] | 62 | 84 | 99 | 124 | 151 |
| Continuous (at 3 x 551-690 V) [A] | 54 | 73 | 86 | 108 | 131 |
| Intermittent (60 sec overload) (at 575/ 690 V) [A] | 59 | 80 | 95 | 119 | 144 |
| Continuous KVA (at 550 V) [KVA] | 53 | 72 | 86 | 108 | 131 |
| Continuous KVA (at 575 V) [KVA] | 54 | 73 | 86 | 108 | 130 |
| Continuous KVA (at 690 V) [KVA] | 65 | 87 | 103 | 129 | 157 |
| **Max. input current** | | | | | |
| Continuous (at 550 V ) [A] | 60 | 77 | 89 | 110 | 130 |
| Continuous (at 575 V ) [A] | 58 | 74 | 85 | 106 | 124 |
| Continuous (at 690 V ) [A] | 58 | 77 | 87 | 109 | 128 |
| Max. cable size, mains, motor, load share and brake [$mm^2$ (AWG)] | 2x70 (2x2/0) | | | | |
| Max. external pre-fuses [A] [1)] | 125 | 160 | 200 | 200 | 250 |
| Estimated power loss at rated max. load [W] [4)] , 600 V | 1398 | 1645 | 1827 | 2157 | 2533 |
| Estimated power loss at rated max. load [W] [4)] , 690 V | 1458 | 1717 | 1913 | 2262 | 2662 |
| Weight, enclosure IP21, IP 54 [kg] | 96 | | | | |
| Weight, enclosure IP00 [kg] | 82 | | | | |
| Efficiency[4)] | 0.97 | 0.97 | 0.98 | 0.98 | 0.98 |
| Output frequency | 0 - 600 Hz | | | | |
| Heat sink overtemp. trip | 85 °C | | | | |
| Power card ambient trip | 60 °C | | | | |

**Table 7.4**

| Mains Supply 3x525-690 V AC | | | | |
|---|---|---|---|---|
| | **P132** | **P160** | **P200** | **P250** |
| Typical Shaft output at 550 V [kW] | 110 | 132 | 160 | 200 |
| Typical Shaft output at 575 V [HP] | 150 | 200 | 250 | 300 |
| Typical Shaft output at 690 V [kW] | 132 | 160 | 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] | 162 | 201 | 253 | 303 |
| Intermittent (60 sec overload) (at 550 V) [A] | 178 | 221 | 278 | 333 |
| Continuous (at 575/ 690 V) [A] | 155 | 192 | 242 | 290 |
| Intermittent (60 sec overload) (at 575/ 690 V) [A] | 171 | 211 | 266 | 319 |
| Continuous KVA (at 550 V) [KVA] | 154 | 191 | 241 | 289 |
| Continuous KVA (at 575 V) [KVA] | 154 | 191 | 241 | 289 |
| Continuous KVA (at 690 V) [KVA] | 185 | 229 | 289 | 347 |
| **Max. input current** | | | | |
| Continuous (at 550 V ) [A] | 158 | 198 | 245 | 299 |
| Continuous (at 575 V) [A] | 151 | 189 | 234 | 286 |
| Continuous (at 690 V) [A] | 155 | 197 | 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 pre-fuses [A] [1] | 315 | 350 | 350 | 400 |
| Estimated power loss at rated max. load [W] [4] , 600 V | 2963 | 3430 | 4051 | 4867 |
| Estimated power loss at rated max. load [W] [4] , 690 V | 3430 | 3612 | 4292 | 5156 |
| Weight, Enclosure IP21, IP 54 [kg] | 96 | 104 | 125 | 136 |
| Weight, Enclosure IP00 [kg] | 82 | 91 | 112 | 123 |
| Efficiency[4] | 0.98 | | | |
| Output frequency | 0 - 600 Hz | | | |
| Heat sink overtemp. trip | 90 °C | 110°C | 110 °C | 110 °C |
| Power card ambient trip | 60 °C | | | |

**Table 7.5**

| Mains Supply 3x525-690 V AC | | | |
|---|---|---|---|
| | **P315** | **P400** | **P450** |
| Typical Shaft output at 550 V [kW] | 250 | 315 | 355 |
| Typical Shaft output at 575 V [HP] | 350 | 400 | 450 |
| Typical Shaft output at 690 V [kW] | 315 | 400 | 450 |
| Enclosure IP21 | D2 | D2 | E1 |
| Enclosure IP54 | D2 | D2 | E1 |
| Enclosure IP00 | D4 | D4 | E2 |
| **Output current** | | | |
| Continuous (at 550 V) [A] | 360 | 418 | 470 |
| Intermittent (60 sec overload) (at 550 V) [A] | 396 | 460 | 517 |
| Continuous (at 575/ 690 V) [A] | 344 | 400 | 450 |
| Intermittent (60 sec overload) (at 575/ 690 V) [A] | 378 | 440 | 495 |
| Continuous KVA (at 550 V) [KVA] | 343 | 398 | 448 |
| Continuous KVA (at 575 V) [KVA] | 343 | 398 | 448 |
| Continuous KVA (at 690 V) [KVA] | 411 | 478 | 538 |
| **Max. input current** | | | |
| Continuous (at 550 V ) [A] | 355 | 408 | 453 |
| Continuous (at 575 V) [A] | 339 | 390 | 434 |
| Continuous (at 690 V) [A] | 352 | 400 | 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 pre-fuses [A] [1] | 500 | 550 | 700 |
| Estimated power loss at rated max. load [W] [4] , 600 V | 5493 | 5852 | 6132 |
| Estimated power loss at rated max. load [W] [4] , 690 V | 5821 | 6149 | 6440 |
| Weight, enclosure IP21, IP 54 [kg] | 151 | 165 | 263 |
| Weight, enclosure IP00 [kg] | 138 | 151 | 221 |
| Efficiency[4] | 0.98 | | |
| Output frequency | 0 - 600 Hz | 0 - 500 Hz | 0 - 500 Hz |
| Heat sink overtemp. trip | 110 °C | 110 °C | 110 °C |
| Power card ambient trip | 60 °C | 60 °C | 68 °C |

**Table 7.6**

| Mains Supply 3x525-690 V AC | | | |
|---|---|---|---|
| | **P500** | **P560** | **P630** |
| Typical Shaft output at 550 V [kW] | 400 | 450 | 500 |
| Typical Shaft output at 575 V [HP] | 500 | 600 | 650 |
| Typical Shaft output at 690 V [kW] | 500 | 560 | 630 |
| Enclosure IP21 | E1 | E1 | E1 |
| Enclosure IP54 | E1 | E1 | E1 |
| Enclosure IP00 | E2 | E2 | E2 |
| **Output current** | | | |
| Continuous (at 550 V) [A] | 523 | 596 | 630 |
| Intermittent (60 sec overload) (at 550 V) [A] | 575 | 656 | 693 |
| Continuous (at 575/ 690 V) [A] | 500 | 570 | 630 |
| Intermittent (60 sec overload) (at 575/ 690 V) [A] | 550 | 627 | 693 |
| Continuous KVA (at 550 V) [KVA] | 498 | 568 | 600 |
| Continuous KVA (at 575 V) [KVA] | 498 | 568 | 627 |
| Continuous KVA (at 690 V) [KVA] | 598 | 681 | 753 |
| **Max. input current** | | | |
| Continuous (at 550 V ) [A] | 504 | 574 | 607 |
| Continuous (at 575 V) [A] | 482 | 549 | 607 |
| Continuous (at 690 V) [A] | 482 | 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 pre-fuses [A] [1] | 700 | 900 | 900 |
| Estimated power loss at rated max. load [W] [4] , 600 V | 6903 | 8343 | 9244 |
| Estimated power loss at rated max. load [W] [4] , 690 V | 7249 | 8727 | 9673 |
| Weight, enclosure IP21, IP 54 [kg] | 263 | 272 | 313 |
| Weight, enclosure IP00 [kg] | 221 | 236 | 277 |
| Efficiency[4] | 0.98 | | |
| Output frequency | 0 - 500 Hz | | |
| Heat sink overtemp. trip | 110 °C | | |
| Power card ambient trip | 68 °C | | |

**Table 7.7**

| Mains Supply 3x525-690 V AC | | | | | | |
|---|---|---|---|---|---|---|
| | P710 | P800 | P900 | P1M0 | P1M2 | P1M4 |
| Typical Shaft output at 550 V [kW] | 560 | 670 | 750 | 850 | 1000 | 1100 |
| Typical Shaft output at 575 V [HP] | 750 | 950 | 1050 | 1150 | 1350 | 1550 |
| Typical Shaft output at 690 V [kW] | 710 | 800 | 900 | 1000 | 1200 | 1400 |
| Enclosure IP21, 54 without/with options cabinet | F1/ F3 | F1/ F3 | F1/ F3 | F2/F4 | F2/ F4 | F2/F4 |
| **Output current** | | | | | | |
| Continuous (at 550 V) [A] | 763 | 889 | 988 | 1108 | 1317 | 1479 |
| Intermittent (60 s overload, at 550 V) [A] | 839 | 978 | 1087 | 1219 | 1449 | 1627 |
| Continuous (at 575/ 690 V) [A] | 730 | 850 | 945 | 1060 | 1260 | 1415 |
| Intermittent (60 s overload, at 575/690 V) [A] | 803 | 935 | 1040 | 1166 | 1386 | 1557 |
| Continuous KVA (at 550 V) [KVA] | 727 | 847 | 941 | 1056 | 1255 | 1409 |
| Continuous KVA (at 575 V) [KVA] | 727 | 847 | 941 | 1056 | 1255 | 1409 |
| Continuous KVA (at 690 V) [KVA] | 872 | 1016 | 1129 | 1267 | 1506 | 1691 |
| **Max. input current** | | | | | | |
| Continuous (at 550 V ) [A] | 743 | 866 | 962 | 1079 | 1282 | 1440 |
| Continuous (at 575 V) [A] | 711 | 828 | 920 | 1032 | 1227 | 1378 |
| Continuous (at 690 V) [A] | 711 | 828 | 920 | 1032 | 1227 | 1378 |
| Max. cable size,motor [$mm^2$ (AWG[2)])] | 8x150 (8x300 mcm) | | | 12x150 (12x300 mcm) | | |
| Max. cable size,mains F1/F2 [$mm^2$ (AWG[2)])] | 8x240 (8x500 mcm) | | | | | |
| Max. cable size,mains F3/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)]) | 4x185 (4x350 mcm) | | | 6x185 (6x350 mcm) | | |
| Max. external pre-fuses [A] [1)] | 1600 | | | | 2000 | 2500 |
| Est. power loss at rated max. load [W] [4)], 600 V, F1 & F2 | 10771 | 12272 | 13835 | 15592 | 18281 | 20825 |
| Est. power loss at rated max. load [W] [4)], 690 V, F1 & F2 | 11315 | 12903 | 14533 | 16375 | 19207 | 21857 |
| Max added losses of Circuit Breaker or Disconnect & Contactor, F3 & F4 | 427 | 532 | 615 | 665 | 863 | 1044 |
| Max Panel Options Losses | 400 | | | | | |
| Weight,enclosure IP21, IP 54 [kg] | 1004/1299 | 1004/1299 | 1004/1299 | 1246/1541 | 1246/1541 | 1280/1575 |
| Weight, Rectifier Module [kg] | 102 | 102 | 102 | 136 | 136 | 136 |
| Weight, Inverter Module [kg] | 102 | 102 | 136 | 102 | 102 | 136 |
| Efficiency[4)] | 0.98 | | | | | |
| Output frequency | 0-500 Hz | | | | | |
| Heat sink overtemp. trip | 95 °C | | | | | |
| Power card amb. trip | 68 °C | | | | | |

**Table 7.8**

1) For type of fuse see section *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 also adds to the power loss in the frequency converter and opposite. If the switching frequency is increased comed to the default setting, the power losses may rise significantly. LCP and typical control card power consumptions are included. Further options and customer load may add up to 30 W to the losses. (Though typical only 4 W extra for a fully loaded control card, or options for slot A or slot B, each). Although measurements are made with state of the art equipment, some measurement inaccuracy must be allowed for (+/-5%).

# 8 Warnings and Alarms

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.

If an alarm occurs, the frequency converter trips. Alarms must be reset to restart operation once their cause has been rectified.

**This may be done in 4 ways:**

1. Pressing [Reset] on the LCP
2. Via a digital input with the "Reset" function
3. Via serial communication/optional fieldbus
4. By resetting automatically using the [Auto Reset] function (default)

***NOTICE***

**After a manual reset pressing [Reset], the [Auto On] or [Hand 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 8.1*).

**⚠CAUTION**

**Alarms that are trip-locked offer additional protection, means 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 the table on the following page, this means that either a warning occurs before an alarm, or it can be specified whether it is a warning or an alarm that is to be displayed for a given fault.**
**This is possible, for instance, in *parameter 1-90 Motor Thermal Protection*. After an alarm or trip, the motor carries on coasting, and the alarm and warning flash on the frequency converter. Once the problem has been rectified, only the alarm continues flashing.**

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| No. | Description | Warning | Alarm/ Trip | Alarm/Trip Lock | Parameter Reference |
|---|---|---|---|---|---|
| 1 | 10 Volts low | X | | | |
| 2 | Live zero error | (X) | (X) | | 6-01 |
| 3 | No motor | (X) | | | 1-80 |
| 4 | Mains phase loss | (X) | (X) | (X) | 14-12 |
| 5 | DC link voltage high | X | | | |
| 6 | DC link voltage low | X | | | |
| 7 | DC over voltage | X | X | | |
| 8 | DC under voltage | X | X | | |
| 9 | Inverter overloaded | X | X | | |
| 10 | Motor ETR over temperature | (X) | (X) | | 1-90 |
| 11 | Motor thermistor over temperature | (X) | (X) | | 1-90 |
| 12 | Torque limit | X | X | | |
| 13 | Over Current | X | X | X | |
| 14 | Earth fault | X | X | X | |
| 15 | Hardware mismatch | | X | X | |
| 16 | Short Circuit | | X | X | |
| 17 | Control word timeout | (X) | (X) | | 8-04 |
| 23 | Internal Fan Fault | X | | | |
| 24 | External Fan Fault | X | | | 14-53 |
| 25 | Brake resistor short-circuited | X | | | |

| No. | Description | Warning | Alarm/ Trip | Alarm/Trip Lock | Parameter Reference |
|---|---|---|---|---|---|
| 26 | Brake resistor power limit | (X) | (X) | | 2-13 |
| 27 | Brake chopper short-circuited | X | X | | |
| 28 | Brake check | (X) | (X) | | 2-15 |
| 29 | Drive over temperature | X | X | X | |
| 30 | Motor phase U missing | (X) | (X) | (X) | 4-58 |
| 31 | Motor phase V missing | (X) | (X) | (X) | 4-58 |
| 32 | Motor phase W missing | (X) | (X) | (X) | 4-58 |
| 33 | Inrush fault | | X | X | |
| 34 | Fieldbus communication fault | X | X | | |
| 35 | Out of frequency range | X | X | | |
| 36 | Mains failure | X | X | | |
| 37 | Phase Imbalance | X | X | | |
| 38 | Internal fault | | X | X | |
| 39 | Heat sink sensor | | X | X | |
| 40 | Overload of Digital Output Terminal 27 | (X) | | | 5-00, 5-01 |
| 41 | Overload of Digital Output Terminal 29 | (X) | | | 5-00, 5-02 |
| 42 | Overload of Digital Output On X30/6 | (X) | | | 5-32 |
| 42 | Overload of Digital Output On X30/7 | (X) | | | 5-33 |
| 46 | Pwr. card supply | | X | X | |
| 47 | 24 V supply low | X | X | X | |
| 48 | 1.8 V supply low | | X | X | |
| 49 | Speed limit | X | (X) | | 1-86 |
| 50 | AMA calibration failed | | X | | |
| 51 | AMA check $U_{nom}$ and $I_{nom}$ | | X | | |
| 52 | AMA low $I_{nom}$ | | X | | |
| 53 | AMA motor too big | | X | | |
| 54 | AMA motor too small | | X | | |
| 55 | AMA Parameter out of range | | X | | |
| 56 | AMA interrupted by user | | X | | |
| 57 | AMA timeout | | X | | |
| 58 | AMA internal fault | X | X | | |
| 59 | Current limit | X | | | |
| 60 | External Interlock | X | | | |
| 62 | Output Frequency at Maximum Limit | X | | | |
| 64 | Voltage Limit | X | | | |
| 65 | Control Board Over-temperature | X | X | X | |
| 66 | Heat sink Temperature Low | X | | | |
| 67 | Option Configuration has Changed | | X | | |
| 69 | Pwr. Card Temp | | X | X | |
| 70 | Illegal FC configuration | | | X | |
| 71 | PTC 1 Safe Stop | X | X[1)] | | |
| 72 | Dangerous Failure | | | X[1)] | |
| 73 | Safe Stop Auto Restart | | | | |
| 76 | Power Unit Setup | X | | | |
| 79 | Illegal PS config | | X | X | |
| 80 | Drive Initialized to Default Value | | X | | |
| 91 | Analog input 54 wrong settings | | | X | |
| 92 | NoFlow | X | X | | 22-2* |
| 93 | Dry Pump | X | X | | 22-2* |
| 94 | End of Curve | X | X | | 22-5* |
| 95 | Broken Belt | X | X | | 22-6* |
| 96 | Start Delayed | X | | | 22-7* |

| No. | Description | Warning | Alarm/ Trip | Alarm/Trip Lock | Parameter Reference |
|---|---|---|---|---|---|
| 97 | Stop Delayed | X | | | 22-7* |
| 98 | Clock Fault | X | | | 0-7* |
| 201 | Fire M was Active | | | | |
| 202 | Fire M Limits Exceeded | | | | |
| 203 | Missing Motor | | | | |
| 204 | Locked Rotor | | | | |
| 243 | Brake IGBT | X | X | | |
| 244 | Heat sink temp | X | X | X | |
| 245 | Heat sink sensor | | X | X | |
| 246 | Pwr.card supply | | X | X | |
| 247 | Pwr.card temp | | X | X | |
| 248 | Illegal PS config | | X | X | |
| 250 | New spare parts | | | X | |
| 251 | New Type Code | | X | X | |

**Table 8.1 Alarm/Warning Code List**

*(X) Dependent on parameter*

*1) Can not be Auto reset via 14-20 Reset Mode*

A trip is the action when an alarm has appeared. The trip will coast 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 original event that caused an alarm cannot damage the frequency converter or cause dangerous conditions. A trip lock is an action when an alarm occurs, which may cause damage to frequency converter or connected parts. A Trip Lock situation can only be reset by a power cycling.

| | |
|---|---|
| Warning | yellow |
| Alarm | flashing red |
| Trip locked | yellow and red |

**Table 8.2 LED Indication**

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

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

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

The warning/alarm information 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 *parameter 6-01 Live Zero Timeout Function*. The signal on one of the analog inputs is less than 50% of the minimum value programmed for that input. Broken wiring or 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 *parameter 2-10 Brake Function*
- Increase *14-26 Trip Delay at Inverter Fault*

**WARNING/ALARM 8, DC under voltage**
If the intermediate circuit voltage (DC link) drops below the 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 *parameter 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 *parameter 1-29 Automatic Motor Adaptation (AMA)* tunes the frequency converter to the motor more accurately and reduces thermal loading

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

**Troubleshooting**

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

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

**Troubleshooting**

- If the motor torque limit is exceeded during ramp up, extend the ramp up time
- If the generator torque limit is exceeded during ramp down, extend the ramp down time
- If torque limit occurs while running, possibly increase the torque limit. Be sure 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

**ALARM 18, Start failed**
The speed has not been able to exceed *1-77 Compressor Start Max Speed [RPM]* during start within the allowed time. (set in *1-79 Compressor Start Max Time to Trip*). This may be caused by a blocked motor.

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

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

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

**Troubleshooting**

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

**ALARM 38, Internal fault**
When an internal fault occurs, a code number defined in the *Table 8.4* is displayed.

**Troubleshooting**

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

Contact the Danfoss supplier or 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. |

| No. | Text |
|---|---|
| 2326 | Power card configuration is determined to be incorrect after the delay for power cards to register. |
| 2327 | Too many power card locations have been registered as present. |
| 2330 | Power size information between the power cards does not match. |
| 2561 | No communication from DSP to ATACD. |
| 2562 | No communication from ATACD to DSP (state running). |
| 2816 | Stack overflow control board module. |
| 2817 | Scheduler slow tasks. |
| 2818 | Fast tasks. |
| 2819 | Parameter thread. |
| 2820 | LCP stack overflow. |
| 2821 | Serial port overflow. |
| 2822 | USB port overflow. |
| 2836 | cfListMempool too small. |
| 3072-5122 | Parameter value is outside its limits. |
| 5123 | Option in slot A: Hardware incompatible with control board hardware. |
| 5124 | Option in slot B: Hardware incompatible with Control board hardware. |
| 5125 | Option in slot C0: Hardware incompatible with control board hardware. |
| 5126 | Option in slot C1: Hardware incompatible with control board hardware. |
| 5376-6231 | Out of memory. |

**Table 8.4 Code Numbers for Internal Faults**

**ALARM 39, Heat sink sensor**
No feedback from the heat sink temperature sensor.

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

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

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

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

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

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

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

**WARNING 47, 24V supply low**
The 24 V DC 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 *parameter 4-11 Motor Speed Low Limit [RPM]* and *parameter 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.

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

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

**WARNING/ALARM 65, Control card over temperature**
The control card has reached its trip temperature of 80 °C.

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

**Troubleshooting**
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.

**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 91, Analog input 54 wrong settings**
Switch S202 has to be set in position OFF (voltage input) when a KTY sensor is connected to analog input terminal 54.

**ALARM 92, No flow**
A no-flow condition has been detected in the system. *parameter 22-23 No-Flow Function* is set for alarm. Troubleshoot the system and reset the frequency converter after the fault has been cleared.

**ALARM 93, Dry pump**
A no-flow condition in the system with the frequency converter operating at high speed may indicate a dry pump. *parameter 22-26 Dry Pump Function* is set for alarm. Troubleshoot the system and reset the frequency converter after the fault has been cleared.

**ALARM 94, End of curve**
Feedback is lower than the set point. This may indicate leakage in the system. *22-50 End of Curve Function* is set for alarm. Troubleshoot the system and reset the frequency converter after the fault has been cleared.

**ALARM 95, Broken belt**
Torque is below the torque level set for no load, indicating a broken belt. *parameter 22-60 Broken Belt Function* is set for alarm. Troubleshoot the system and reset the frequency converter after the fault has been cleared.

**ALARM 96, Start delayed**
Motor start has been delayed due to short-cycle protection. *parameter 22-76 Interval between Starts* is enabled. Troubleshoot the system and reset the frequency converter after the fault has been cleared.

**WARNING 97, Stop delayed**
Stopping the motor has been delayed due to short cycle protection. *parameter 22-76 Interval between Starts* is enabled. Troubleshoot the system and reset the frequency converter after the fault has been cleared.

**WARNING 98, Clock fault**
Time is not set or the RTC clock has failed. Reset the clock in *parameter 0-70 Date and Time*.

**WARNING 201, Fire mode was active**
This indicates the frequency converter had entered fire mode. Cycle power to the unit to remove the warning. See the fire mode data in the alarm log.

**WARNING 202, Fire mode limits exceeded**
While operating in fire mode one or more alarm conditions have been ignored which would normally trip the unit. Operating in this condition voids unit warranty. Cycle power to the unit to remove the warning. See the fire mode data in the alarm log.

**WARNING 203, Missing motor**
With a frequency converter operating multi-motors, an under-load condition was detected. This could indicate a missing motor. Inspect the system for proper operation.

**WARNING 204, Locked rotor**
With a frequency converter operating multi-motors, an overload condition was detected. This could indicate a locked rotor. Inspect the motor for proper operation.

**ALARM 243, Brake IGBT**
This alarm is only for 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.

8

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