



Instruction Manual

VLT[®] HVAC Drive FC 102

315–1400 kW



Contents

| | |
|---|----------|
| 1 Introduction | 4 |
| 1.1 Purpose of the Manual | 4 |
| 1.2 Additional Resources | 5 |
| 1.3 Document and Software Version | 5 |
| 1.4 Approvals and Certifications | 5 |
| 2 Safety | 6 |
| 2.1 Safety Symbols | 6 |
| 2.2 Qualified Personnel | 6 |
| 2.3 Safety Precautions | 6 |
| 2.3.1 Safe Torque Off (STO) | 7 |
| 3 Mechanical Installation | 8 |
| 3.1 How to Get Started | 8 |
| 3.2 Pre-installation | 8 |
| 3.2.1 Planning the Installation Site | 8 |
| 3.2.2 Receiving the Adjustable Frequency Drive | 9 |
| 3.2.3 Transportation and Unpacking | 9 |
| 3.2.4 Lifting | 9 |
| 3.2.5 Mechanical Dimensions | 12 |
| 3.2.6 Rated Power | 16 |
| 3.3 Mechanical Installation | 17 |
| 3.3.1 Tools Needed | 17 |
| 3.3.2 General Considerations | 17 |
| 3.3.3 Terminal Locations - E Enclosures | 18 |
| 3.3.4 Terminal Locations - Enclosure type F | 24 |
| 3.3.5 Cooling and Airflow | 28 |
| 3.3.6 Gland/Conduit Entry - IP21 (NEMA 1) and IP54 (NEMA12) | 30 |
| 3.4 Field Installation of Options | 31 |
| 3.4.1 Installation of Duct Cooling Kit in Rittal Enclosures | 31 |
| 3.4.2 Installation of Top-only Duct Cooling Kit | 32 |
| 3.4.3 Installation of Top and Bottom Covers for Rittal Enclosures | 33 |
| 3.4.4 Installation of Top and Bottom Covers | 33 |
| 3.4.5 Outside Installation/NEMA 3R Kit for Rittal Enclosures | 34 |
| 3.4.6 Outside Installation/NEMA 3R Kit for Industrial Enclosures | 34 |
| 3.4.7 Installation of IP00 to IP20 Kits | 35 |
| 3.4.8 Installation of IP00 E2 Cable Clamp Bracket | 35 |
| 3.4.9 Installation of Line Power Shield for Adjustable Frequency Drives | 35 |

| | |
|---|-----------|
| 3.4.10 Enclosure Size F USB Extension Kit | 35 |
| 3.4.11 Installation of Input Plate Options | 36 |
| 3.4.12 Installation of E Load Share Option | 37 |
| 3.5 Enclosure Type F Panel Options | 37 |
| 3.5.1 Enclosure Type F Options | 37 |
| 4 Electrical Installation | 39 |
| 4.1 Electrical Installation | 39 |
| 4.1.1 Power Connections | 39 |
| 4.1.2 Grounding | 47 |
| 4.1.3 Extra Protection (RCD) | 47 |
| 4.1.4 RFI Switch | 47 |
| 4.1.5 Torque | 47 |
| 4.1.6 Shielded Cables | 48 |
| 4.1.7 Motor Cable | 48 |
| 4.1.8 Brake Cable for Adjustable Frequency Drives with Factory-installed Brake Chopper Option | 49 |
| 4.1.9 Brake Resistor Temperature Switch | 49 |
| 4.1.10 Load Sharing | 49 |
| 4.1.11 Shielding against Electrical Noise | 50 |
| 4.1.12 AC line input connections | 50 |
| 4.1.13 External Fan Supply | 50 |
| 4.1.14 Fuses | 50 |
| 4.1.15 Motor Insulation | 54 |
| 4.1.16 Motor Bearing Currents | 54 |
| 4.1.17 Control Cable Routing | 55 |
| 4.1.18 Access to Control Terminals | 56 |
| 4.1.19 Electrical Installation, Control Terminals | 56 |
| 4.1.20 Electrical Installation, Control Cables | 58 |
| 4.1.21 Switches S201, S202 and S801 | 61 |
| 4.2 Connection Examples | 61 |
| 4.2.1 Start/Stop | 61 |
| 4.2.2 Pulse Start/Stop | 62 |
| 4.3 Final Set-up and Test | 63 |
| 4.4 Additional Connections | 64 |
| 4.4.1 Mechanical Brake Control | 64 |
| 4.4.2 Parallel Connection of Motors | 64 |
| 4.4.3 Motor Thermal Protection | 65 |

| | |
|---|-----|
| 5 How to Operate the Adjustable Frequency Drive | 66 |
| 5.1 Operating with LCP | 66 |
| 5.1.1 Three Ways of Operating | 66 |
| 5.1.2 How to Operate the Graphical LCP (GLCP) | 66 |
| 5.2 Operating via Serial Communication | 70 |
| 5.2.1 RS-485 Bus Connection | 70 |
| 5.3 Operating via PC | 70 |
| 5.3.1 How to Connect a PC to the Adjustable Frequency Drive | 70 |
| 5.3.2 PC Software Tools | 70 |
| 5.3.3 Tips and Tricks | 71 |
| 5.3.4 Quick Transfer of Parameter Settings when Using GLCP | 72 |
| 5.3.5 Initialization to Default Settings | 72 |
| 6 How to Program | 74 |
| 6.1 Basic Programming | 74 |
| 6.1.1 Parameter Set-up | 74 |
| 6.1.2 Quick Menu Mode | 78 |
| 6.1.3 Function Set-ups | 82 |
| 6.1.4 5-1* Digital Inputs | 94 |
| 6.1.5 Main Menu Mode | 107 |
| 6.1.6 Parameter Selection | 107 |
| 6.1.7 Changing Data | 107 |
| 6.1.8 Changing a Text Value | 108 |
| 6.1.9 Changing a Group of Numeric Data Values | 108 |
| 6.1.10 Changing of Data Value, Step by Step | 108 |
| 6.1.11 Readout and Programming of Indexed Parameters | 108 |
| 6.2 Parameter Menu Structure | 108 |
| 7 General Specifications | 113 |
| 7.1 Motor Output and Motor Data | 113 |
| 7.2 Ambient Conditions | 113 |
| 7.3 Cable Specifications | 114 |
| 7.4 Control Input/Output and Control Data | 114 |
| 7.5 Electrical Data | 118 |
| 8 Warnings and Alarms | 123 |
| Index | 135 |

1 Introduction

1.1 Purpose of the Manual

This instruction manual provides information for safe installation and commissioning of the adjustable frequency drive.

This instruction manual is intended for use by qualified personnel.

Read and follow the instruction manual to use the adjustable frequency drive safely and professionally, and pay particular attention to the safety instructions and general warnings. Keep this instruction manual available with the adjustable frequency drive at all times.

VLT® is a registered trademark.

1.1.1 Intended Use

The adjustable frequency drive is an electronic motor controller intended for:

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

The adjustable frequency drive can also be used for motor protection.

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

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

NOTICE!

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

Foreseeable misuse

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

1.1.2 Abbreviations and Standards

| Abbreviations | Terms | SI units | I-P units |
|------------------|---|-----------------------|-----------------------|
| a | Acceleration | m/s ² | ft/s ² |
| AWG | American wire gauge | | |
| Auto Tune | Automatic motor tuning | | |
| °C | Celsius | | |
| I | Current | A | Amp |
| I _{LIM} | Current limit | | |
| IT line power | Line power supply with star point in transformer floating to ground | | |
| Joule | Energy | J=N·m | ft-lb, Btu |
| °F | Fahrenheit | | |
| FC | Adjustable frequency drive | | |
| 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 meters | | 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 Abbreviations and Standards

1.2 Additional Resources

- *VLT® HVAC Drive FC 102 Design Guide* holds all technical information about the adjustable frequency drive and customer design and applications.
- *VLT® HVAC Drive FC 102 Programming Guide* provides information on how to program and includes complete parameter descriptions.
- *Application Note, Temperature Derating Guide.*
- *MCT 10 Set-up Software Instruction Manual* enables the user to configure the adjustable frequency drive from a Windows™-based PC environment.
- Danfoss VLT® Energy Box software at www.danfoss.com/BusinessAreas/DrivesSolutions, then select PC Software Download.
- *VLT® HVAC Drive BACnet, Instruction Manual.*
- *VLT® HVAC Drive Metasys, Instruction Manual.*
- *VLT® HVAC Drive FLN, Instruction Manual.*

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

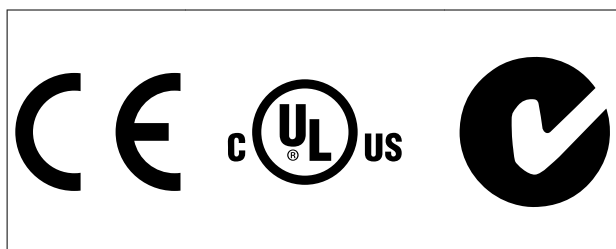
1.3 Document and Software Version

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

| Edition | Remarks | Software version |
|----------|-------------------|------------------|
| MG11F5xx | Replaces MG11F4xx | 4.1x |

Table 1.2 Document and Software Version

1.4 Approvals and Certifications



The adjustable frequency drive complies with UL508C thermal memory retention requirements. For more information, refer to the section Motor Thermal Protection in the product specific design guide.

NOTICE!

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

From software version 3.92, the output frequency of the adjustable frequency drive is limited to 590 Hz.

2

2 Safety

2.1 Safety Symbols

The following symbols are used in this document:

⚠ WARNING

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

⚠ CAUTION

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

NOTICE

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

2.2 Qualified Personnel

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

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

2.3 Safety Precautions

⚠ WARNING

HIGH VOLTAGE!

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

⚠ WARNING

UNINTENDED START!

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

⚠ WARNING

DISCHARGE TIME!

Adjustable frequency drives contain DC link capacitors that can remain charged even when the adjustable frequency drive is not powered. To avoid electrical hazards, disconnect AC line power, any permanent magnet type motors, and any remote DC link power supplies, including battery backups, UPS and DC link connections to other adjustable frequency drives. Wait for the capacitors to discharge completely before performing any service or repair work. The waiting time duration is listed in *Table 2.1*. Failure to wait for the specified period of time after power has been removed to do service or repair could result in death or serious injury.

| Voltage [V] | Power Size [kW (hp)] | Min. waiting time (min) |
|-------------|----------------------|-------------------------|
| 380–480 | 315–1000 (425–1350) | 40 |
| 525–690 | 450–1400 (600–1875) | 30 |

Be aware that there may be high voltage on the DC link even when the LEDs are turned off.

Table 2.1 Discharge Time

⚠ WARNING

LEAKAGE CURRENT HAZARD!

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

⚠ WARNING**EQUIPMENT HAZARD!**

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

⚠ WARNING**WINDMILLING!**

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

⚠ CAUTION**POTENTIAL HAZARD IN THE EVENT OF INTERNAL FAILURE!**

Risk of personal injury when the adjustable frequency drive is not properly closed. Before applying power, ensure all safety covers are in place and securely fastened.

2.3.1 Safe Torque Off (STO)

STO is an option. To run STO, additional wiring for the adjustable frequency drive is required. Refer to *VLT[®] Adjustable Frequency Drives Safe Torque Off Instruction Manual* for further information.

3 Mechanical Installation

3

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 *instruction manual* and *design guide*.

The adjustable frequency drive is designed to achieve a quick and EMC-compatible installation.

WARNING

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

Mechanical installation

- Mechanical mounting.

Electrical installation

- Connection to line and protective ground.
- Motor connection and cables.
- Fuses and circuit breakers.
- Control terminals - cables.

Quick Set-up

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

Enclosure size depends on enclosure type, power range and AC line voltage.

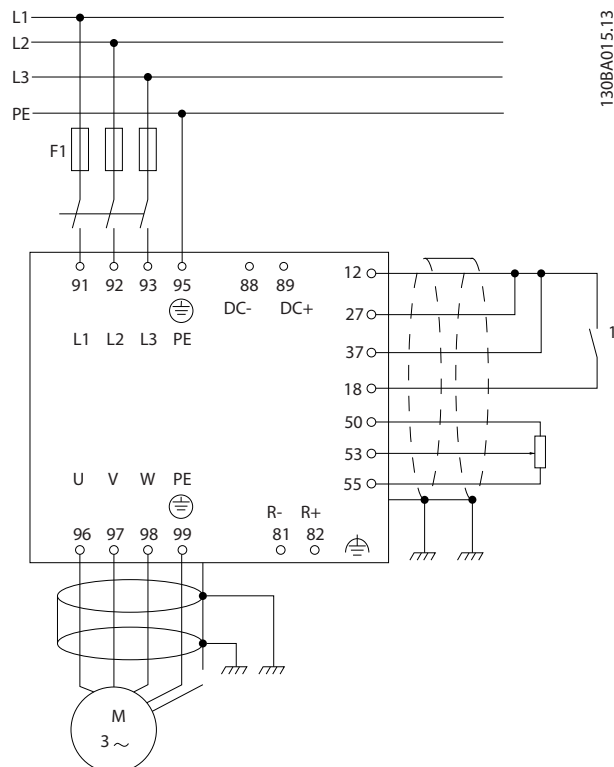


Figure 3.1 Diagram showing basic installation including line power, motor, start/stop key, and potentiometer for speed adjustment.

3.2 Pre-installation

3.2.1 Planning the Installation Site

CAUTION

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

Select the best possible operation site by considering the following (see details on the following pages, and the respective *design guides*):

- Ambient operating temperature.
- Installation method.
- How to cool the unit.
- Position of the adjustable frequency drive.
- Cable routing.

- Ensure that the power source supplies the correct voltage and necessary current.
- Ensure that the motor current rating is within the maximum current from the adjustable frequency drive.
- If the adjustable frequency drive is without built-in fuses, ensure that the external fuses are rated correctly.

3.2.2 Receiving the Adjustable Frequency Drive

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

3.2.3 Transportation and Unpacking

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

3.2.4 Lifting

Always lift the adjustable frequency drive using the dedicated lifting holes. For all E2 (IP00) enclosures, use a bar to avoid bending the lifting holes of the adjustable frequency drive.

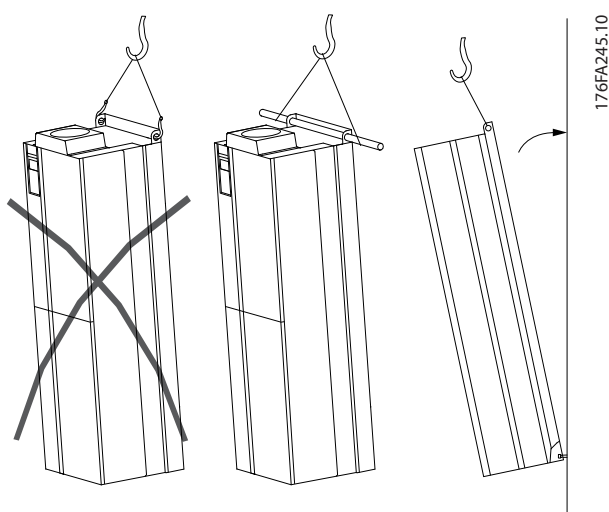


Figure 3.2 Recommended Lifting Method, Enclosure Size E

WARNING

The lifting bar must be able to handle the weight of the adjustable frequency drive. See *Table 3.3* for the weight of the different enclosure sizes. Maximum diameter for bar is 1 in [2.5 cm]. The angle from the top of the adjustable frequency drive to the lifting cable should be $\geq 60^\circ$.

NOTICE!

The plinth is provided in the same packaging as the adjustable frequency drive but is not attached to enclosure sizes F1-F4 during shipment. The plinth must allow airflow to the adjustable frequency drive 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 adjustable frequency drive to the lifting cable should be $\geq 60^\circ$. In addition to the lifting methods shown (*Figure 3.3* to *Figure 3.9*), a spreader bar is an acceptable way to lift the F enclosures.

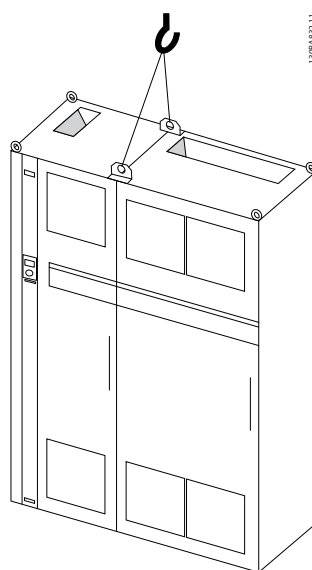


Figure 3.3 Recommended Lifting Method, Enclosure Size F1 (460 V, 600 to 900 hp, 575/690 V, 900 to 1150 hp)

3

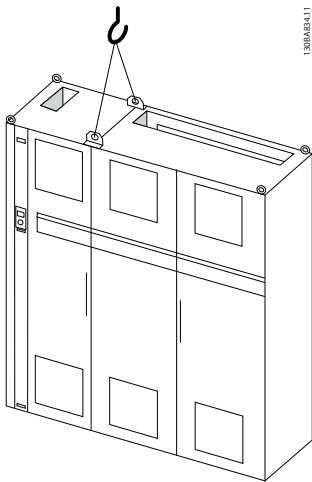


Figure 3.4 Recommended Lifting Method, Enclosure Size F2
(460 V, 1000 to 1200 hp, 575/690 V, 1250 to 1350 hp)

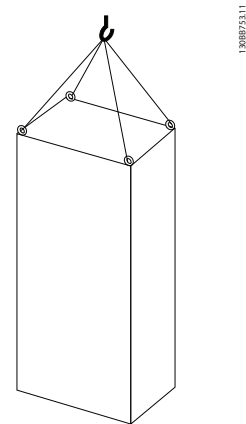


Figure 3.7 Recommended Lifting Method, Enclosure Type F8

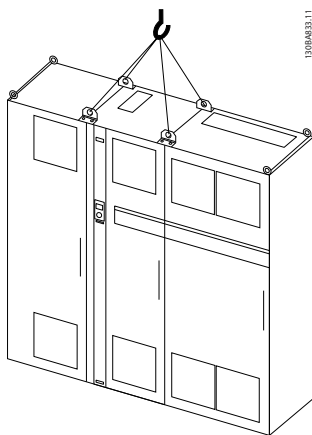


Figure 3.5 Recommended Lifting Method, Enclosure Size F3
(460 V, 600 to 900 hp, 575/690 V, 900 to 1150 hp)

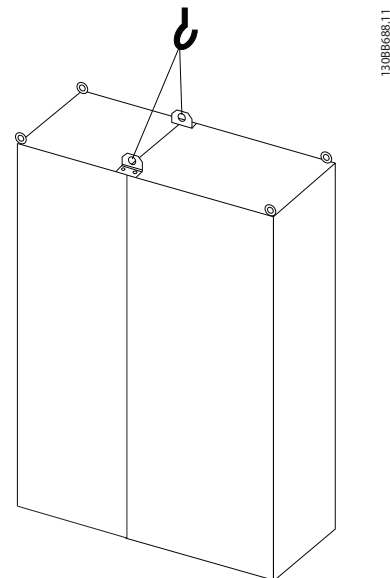


Figure 3.8 Recommended Lifting Method, Enclosure Size F9/F10

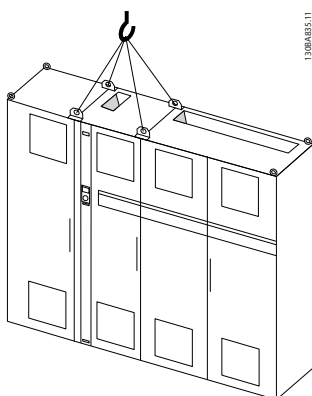


Figure 3.6 Recommended Lifting Method, Enclosure Size F4
(460 V, 1000 to 1200 hp, 575/690 V, 1250 to 1350 hp)

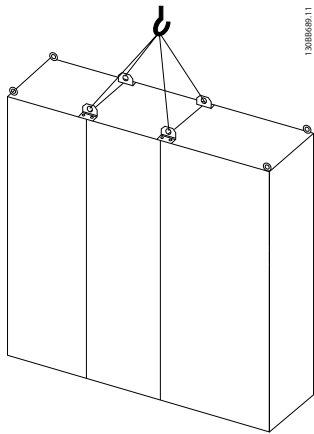


Figure 3.9 Recommended Lifting Method, Enclosure Size F11/F12/F13/F14

3.2.5 Mechanical Dimensions

3

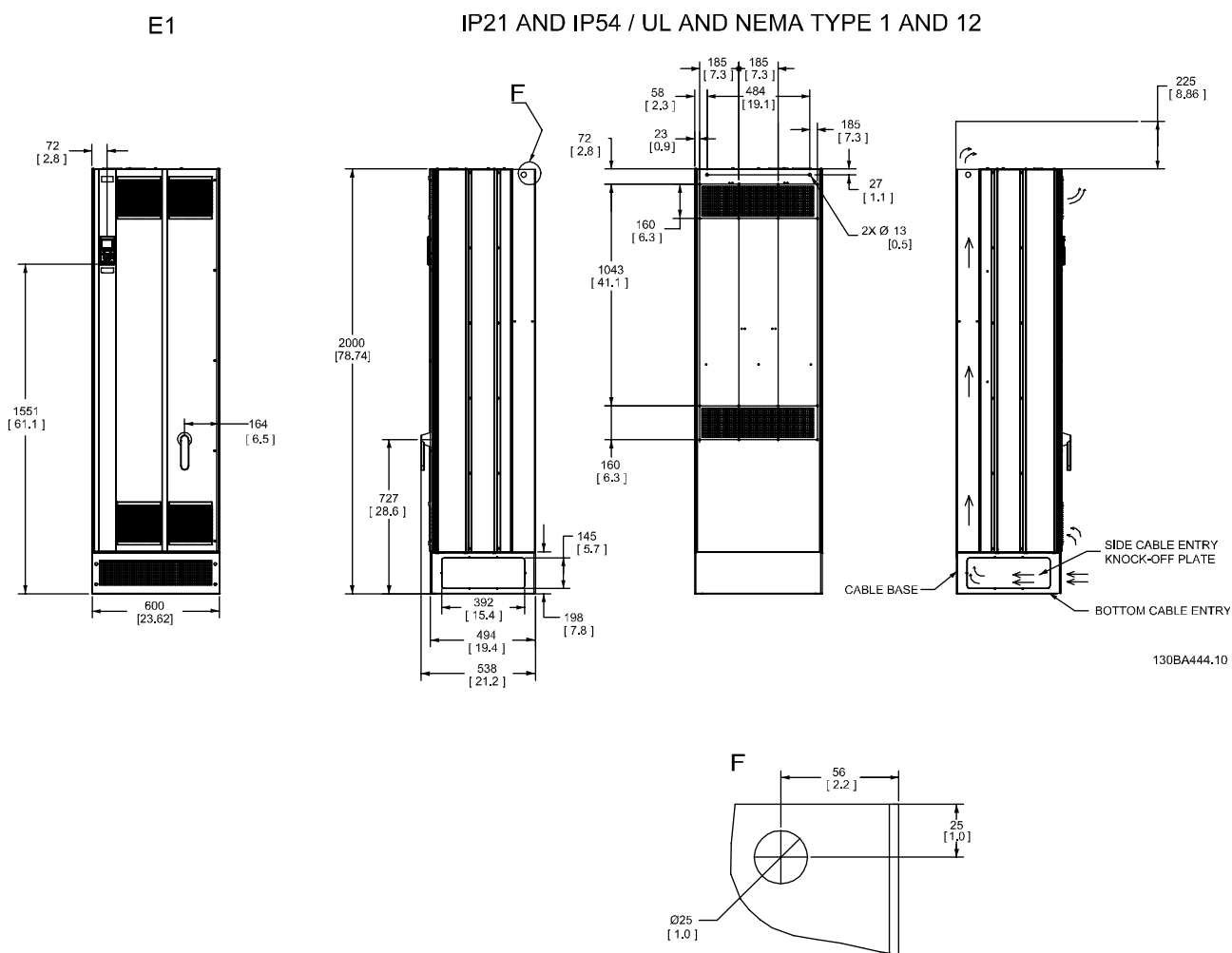
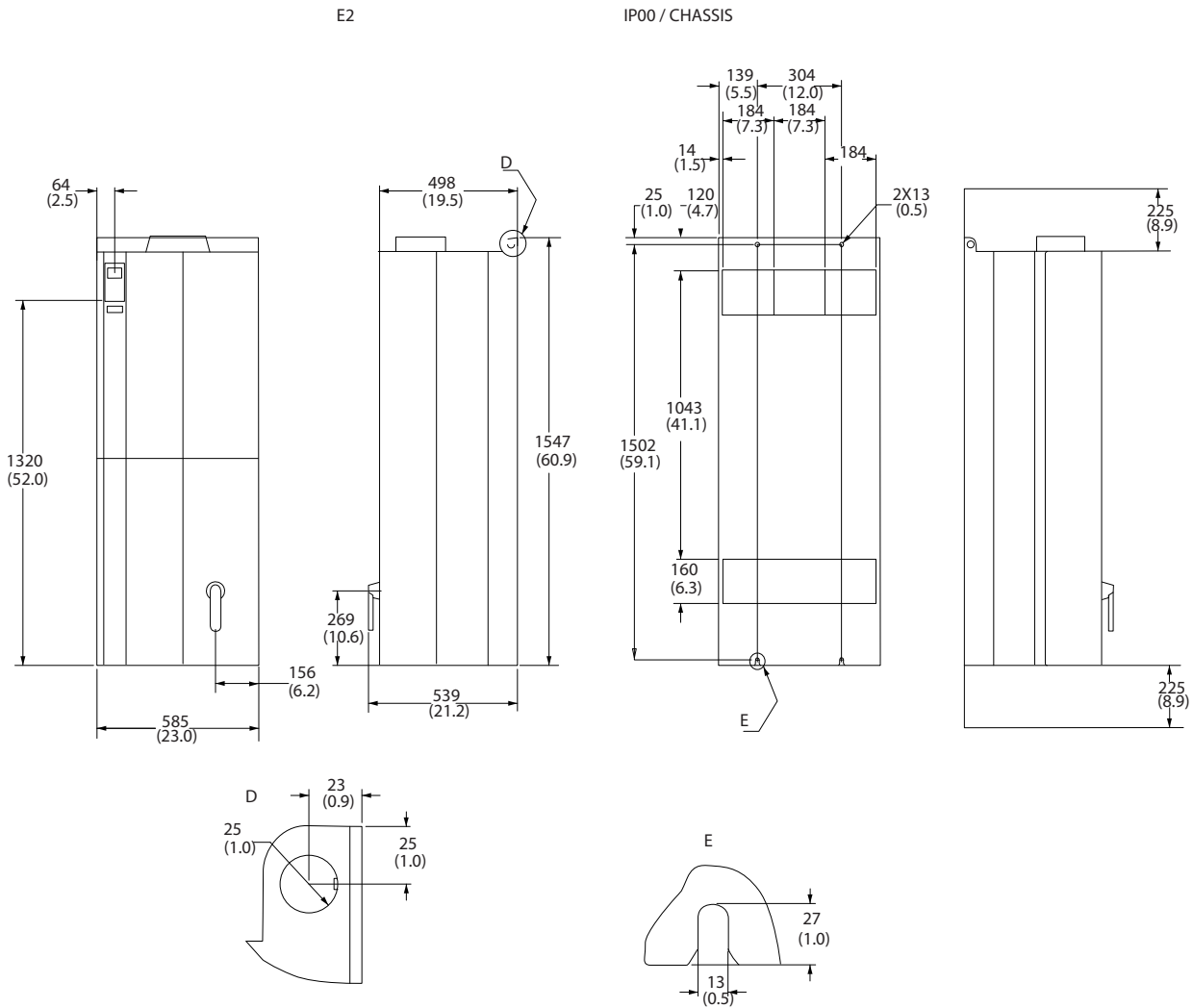


Figure 3.10 Dimensions, E1



* Note airflow directions

Figure 3.11 Dimensions, E2

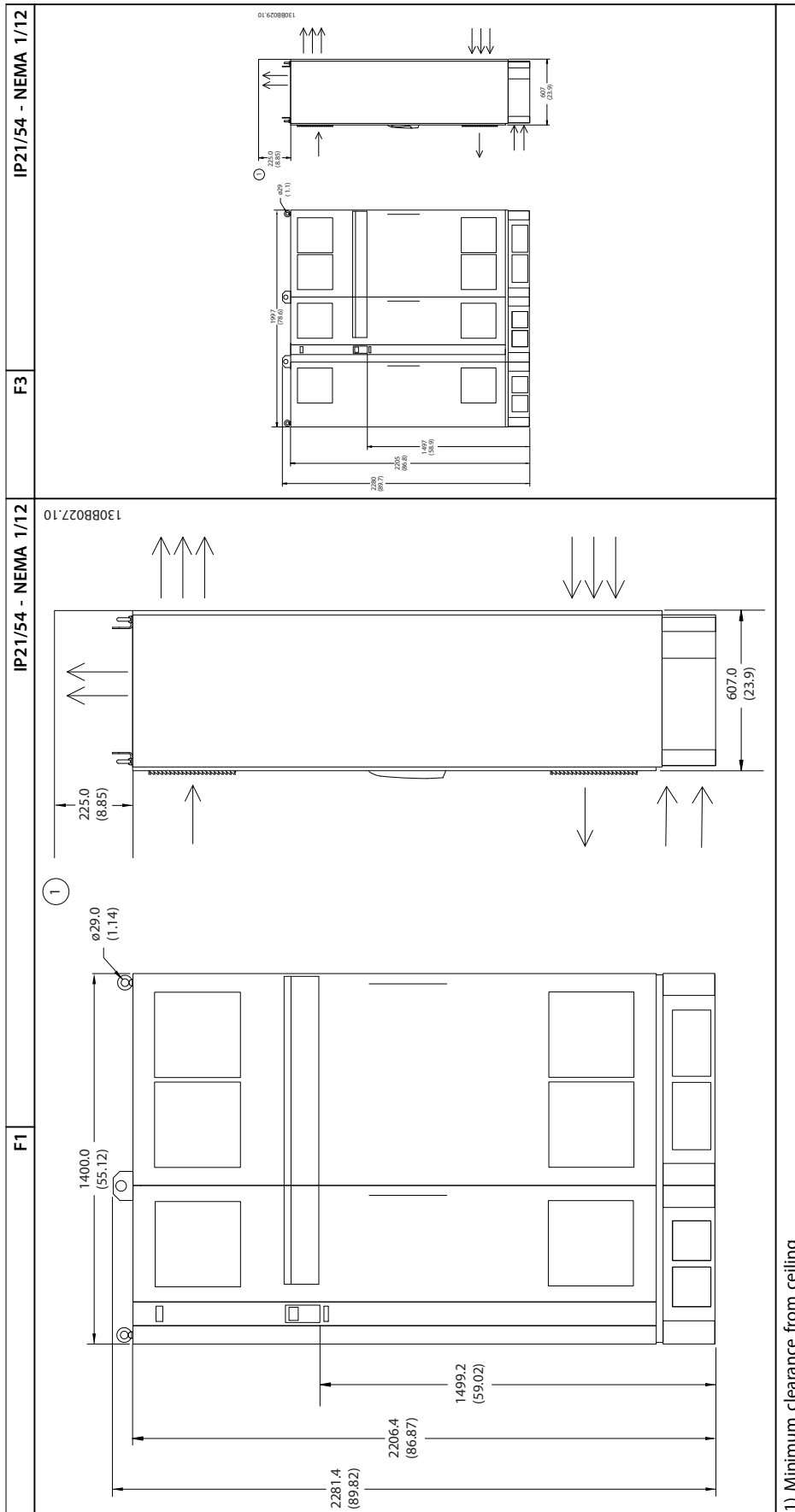


Table 3.1 Dimensions, F1 and F3

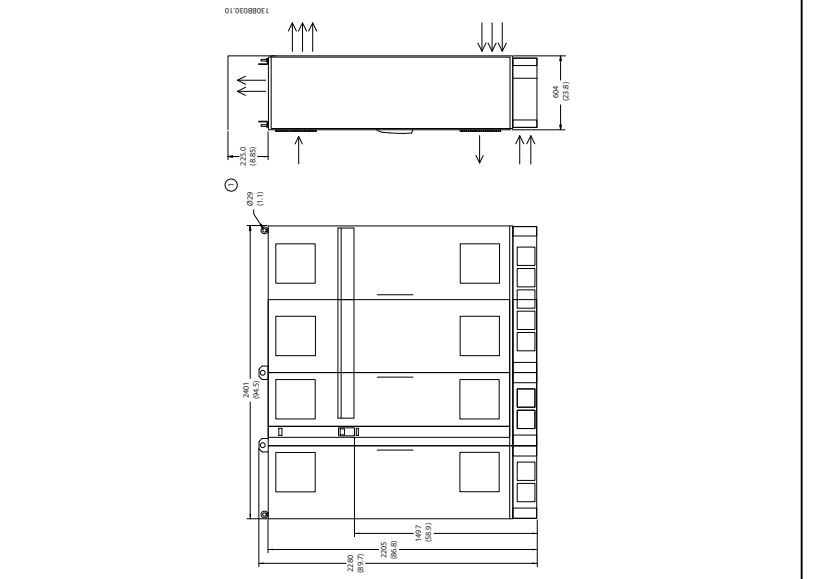
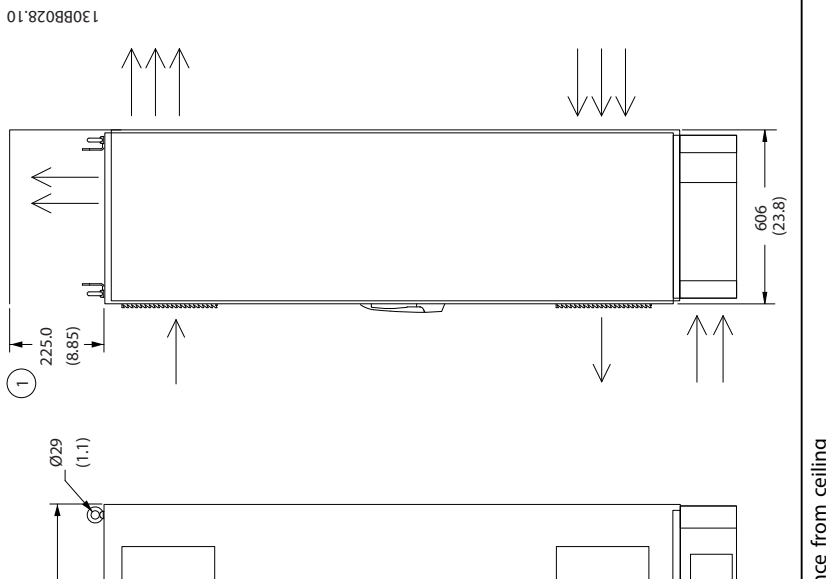
| IP21/54 - NEMA 1/12 | IP21/54 - NEMA 1/12 | IP21/54 - NEMA 1/12 |
|---|--|---|
| <p style="text-align: center;">F4</p>  | <p style="text-align: center;">F2</p>  | <p style="text-align: center;">F2</p> <p style="text-align: center;">1) Minimum clearance from ceiling</p> |

Table 3.2 Dimensions, F2 and F4

| Enclosure size size | | E1 | E2 | F1 | F2 | F3 | F4 |
|---|--------------------------------|--|--|---|---|---|---|
| | | 315–450 kW (425–600 hp) at 400 V (380–480 V) 450–630 kW (600–850 hp) at 690 V (525–690 V) | 315–450 kW (425–600 hp) at 400 V (380–480 V) 450–630 kW (600–850 hp) at 690 V (525–690 V) | 500–710 kW (650–950 hp) at 400 V (380–480 V) 710–900 kW (950–1200 hp) at 690 V (525–690 V) | 800–1000 kW (1075–1350 hp) at 400 V (380–480 V) 1000–1200 kW (1350–1600 hp) at 690 V (525–690 V) | 500–710 kW (650–950 hp) at 400 V (380–480 V) 710–900 kW (950–1200 hp) at 690 V (525–690 V) | 800–1000 kW (1075–1350 hp) at 400 V (380–480 V) 1000–1400 kW (1350–1875 hp) 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 (in)] | Height | 840 (33.1) | 831 (32.72) | 2324 (91.5) | 2324 (91.5) | 2324 (91.5) | 2324 (91.5) |
| | Width | 2197 (86.5) | 1705 (67.13) | 1569 (61.77) | 1962 (77.24) | 2159 (85) | 2559 (100.75) |
| | Depth | 736 (29) | 736 (29) | 1130 (44.5) | 1130 (44.5) | 1130 (44.5) | 1130 (44.5) |
| Adjustable frequency drive dimensions [mm (in)] | Height | 2000 (78.74) | 1547 (60.91) | 2204 (86.77) | 2204 (86.77) | 2204 (86.77) | 2204 (86.77) |
| | Width | 600 (23.62) | 585 (23.03) | 1400 (55.12) | 1800 (70.87) | 2000 (78.74) | 2400 (94.5) |
| | Depth | 494 (19.45) | 498 (19.61) | 606 (23.86) | 606 (23.86) | 606 (23.86) | 606 (23.86) |
| | Max. weight [kg (lb)] | 313 (690) | 277 (611) | 1004 (2214) | 1246 (2747) | 1299 (2864) | 1541 (3397.4) |

Table 3.3 Mechanical Dimensions, Enclosure Sizes E and F

3.2.6 Rated Power

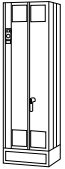

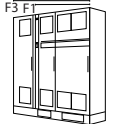
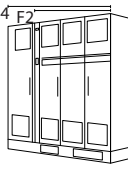
| Enclosure size | | E1 | E2 | F1/F3 | F2/F4 |
|---|------|--|--|---|---|
| | |  |  |  |  |
| Enclosure protection | IP | 21/54 | 00 | 21/54 | 21/54 |
| | NEMA | Type 1/Type 12 | Chassis | Type 1/Type 12 | Type 1/Type 12 |
| Normal overload rated power - 110% overload torque | | 315–450 kW (425–600 hp) at 400 V (380–480 V) 450–630 kW (600–850 hp) at 690 V (525–690 V) | 315–450 kW (425–600 hp) at 400 V (380–480 V) 450–630 kW (600–850 hp) at 690 V (525–690 V) | 500–710 kW (650–950 hp) at 400 V (380–480 V) 710–900 kW (950–1200 hp) at 690 V (525–690 V) | 800–1000 kW (1075–1350 hp) at 400 V (380–480 V) 1000–1400 kW (1350–1875 hp) at 690 V (525–690 V) |

Table 3.4 Rated Power, Enclosure Types E and F

NOTICE!

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

3.3 Mechanical Installation

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

3.3.1 Tools Needed

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

- Drill with 10 mm or 12 mm (0.4 or 0.5 in) drill
- Tape measure.
- Wrench with relevant metric sockets (7–17 mm (0.28–0.67 in))
- Extensions to wrench.
- Sheet metal punch for conduits or cable connectors in IP21/Nema 1 and IP54 units
- Lifting bar to lift the unit (rod or tube max. \varnothing 5 mm (1 inch), able to lift minimum 400 kg (880 lbs).
- Crane or other lifting aid to place the adjustable frequency drive in position.
- Use a Torx T50 tool to install the E1 in IP21 and IP54 enclosure types.

3.3.2 General Considerations

Wire access

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

CAUTION

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

Space

Ensure proper space above and below the adjustable frequency drive to allow airflow and cable access. In addition, consider space in front of the unit to enable opening of the panel door.

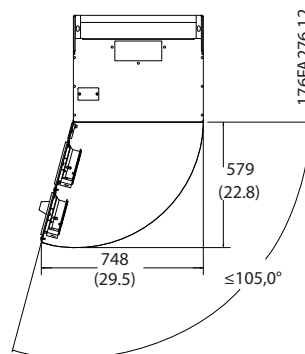


Figure 3.12 Space in Front of IP21/IP54 Rated Enclosure Type E1

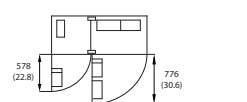


Figure 3.13 Space in Front of IP21/IP54 Rated Enclosure Type F1

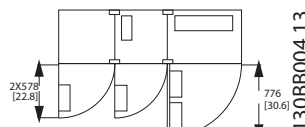


Figure 3.14 Space in Front of IP21/IP54 Rated Enclosure Type F3

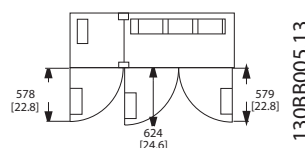


Figure 3.15 Space in Front of IP21/IP54 Rated Enclosure Type F2

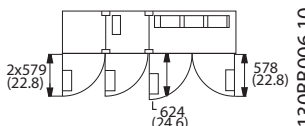
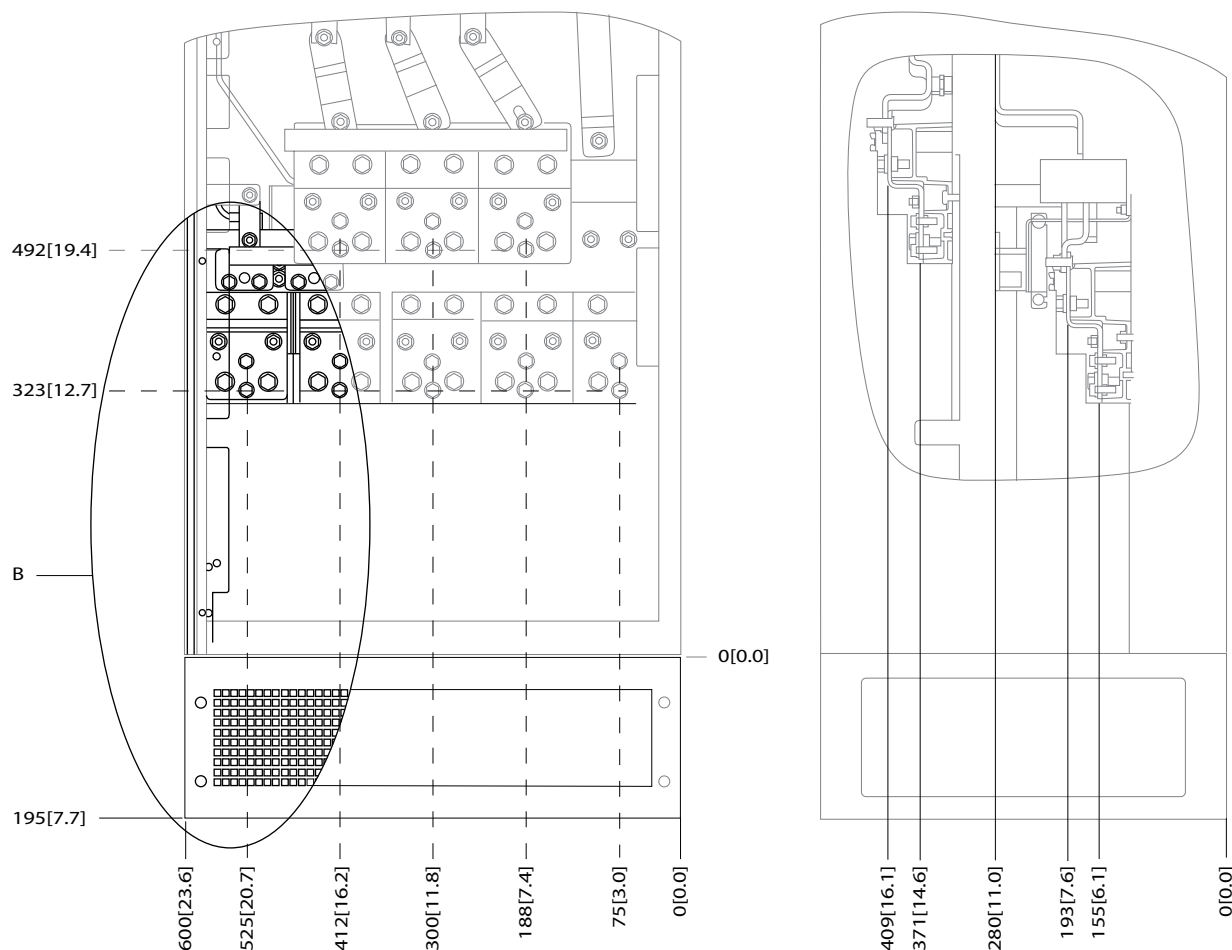


Figure 3.16 Space in Front of IP21/IP54 Rated Enclosure Type F4

3.3.3 Terminal Locations - E Enclosures

Terminal locations - E1

Consider the following terminal positions when designing the cable access.



176FA278.10

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

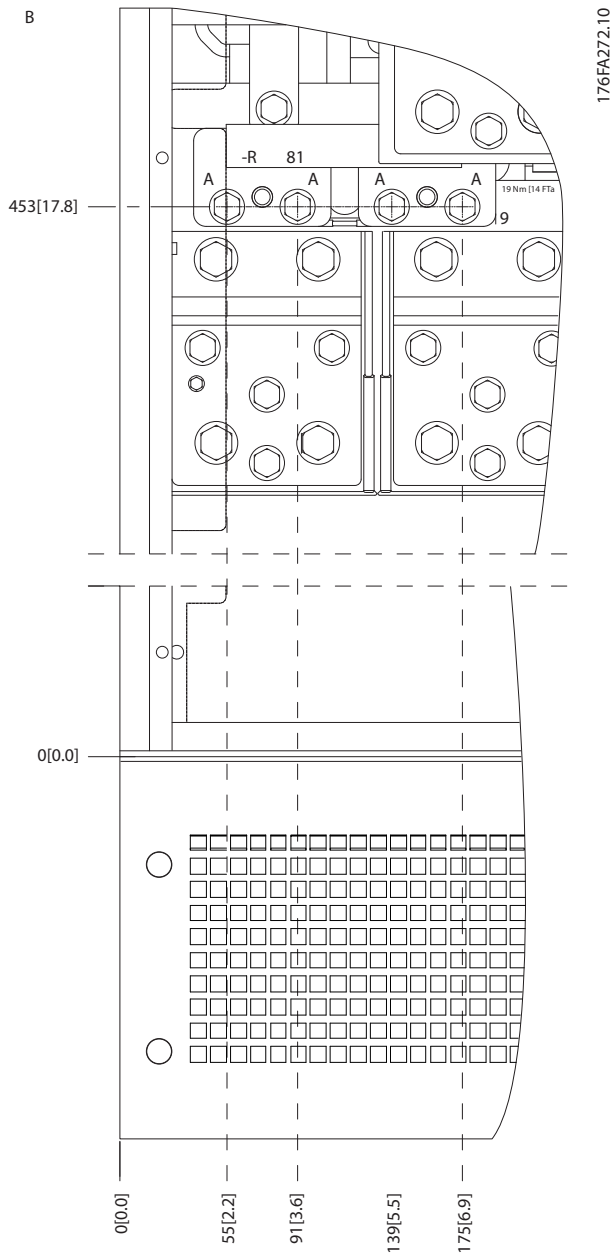


Figure 3.18 IP21 (NEMA Type 1) and IP54 (NEMA Type 12)
Enclosure Power Connection Positions (Detail B)

3

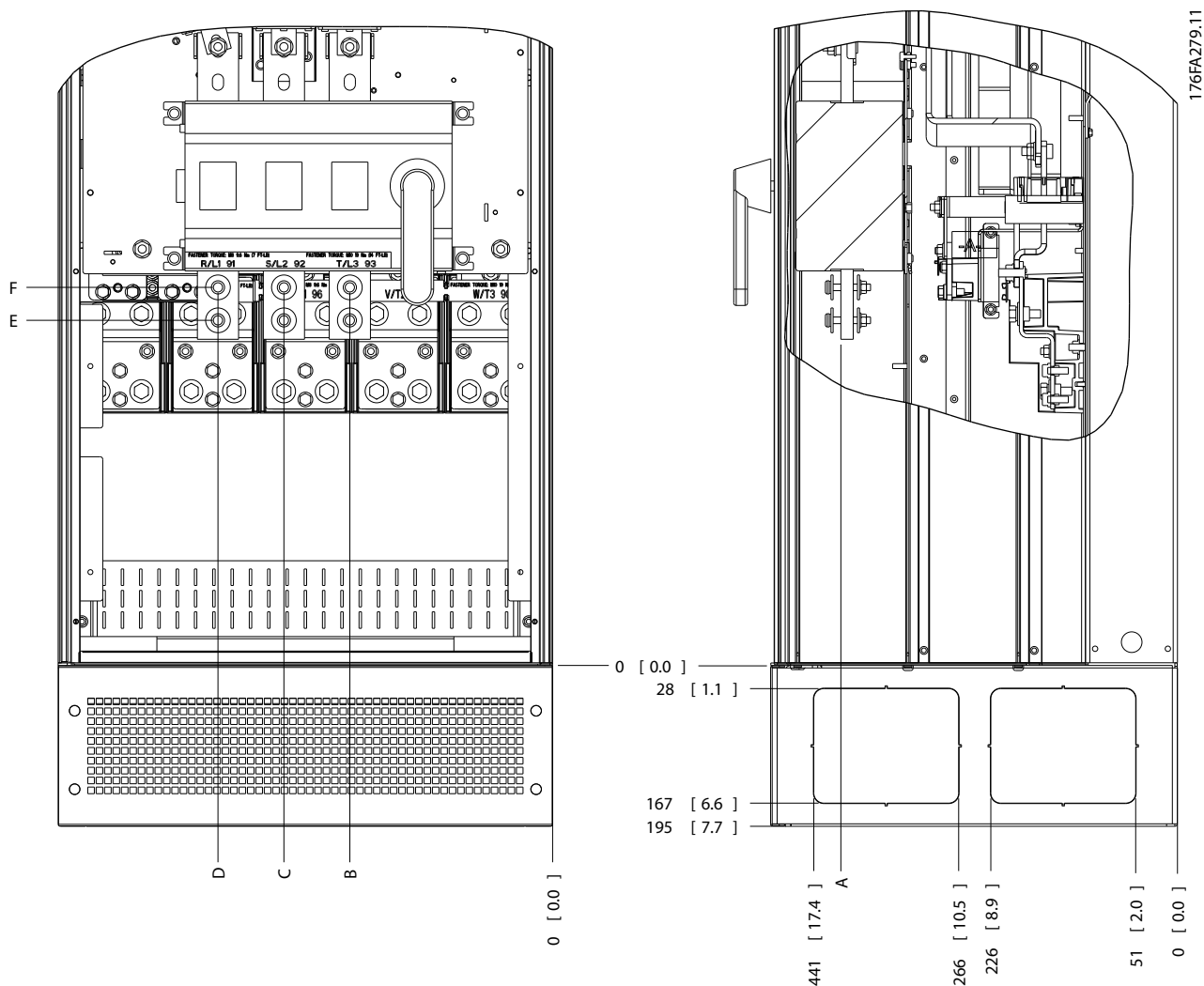


Figure 3.19 IP21 (NEMA Type 1) and IP54 (NEMA Type 12) Enclosure Power Connection Position of Disconnect Switch

| Enclosure size | Unit type | Dimensions [mm]/(inch) | | | | | |
|----------------|--|------------------------|------------|------------|------------|------------|------------|
| E1 | IP54/IP21 UL and NEMA1/NEMA12 250/315 kW (350/425 hp) (400 V) and 355/450–500/630 kW (475/600–650/850 hp) (690 V) | 396 (15.6) | 267 (10.5) | 332 (13.1) | 397 (15.6) | 528 (20.8) | N/A |
| | 315/355–400/450 kW (425/475–550/600 hp) (400 V) | 408 (16.1) | 246 (9.7) | 326 (12.8) | 406 (16.0) | 419 (16.5) | 459 (18.1) |

Table 3.5 Dimensions for Disconnect Terminal

Terminal locations - enclosure type E2

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

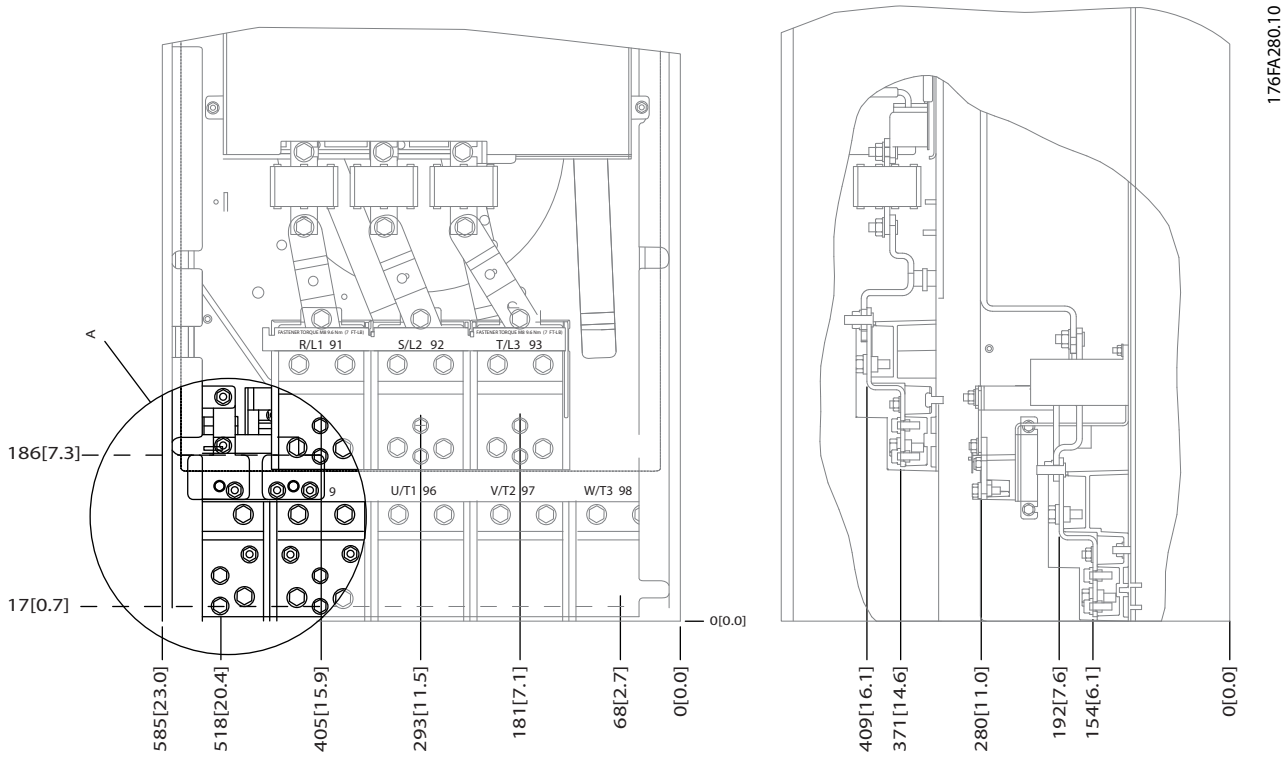


Figure 3.20 IP00 Enclosure Power Connection Positions

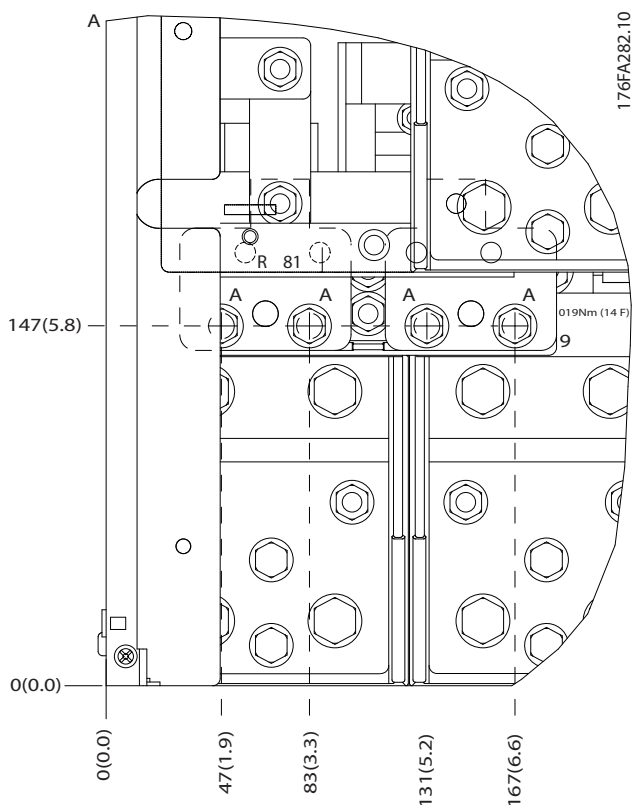


Figure 3.21 IP00 Enclosure Power Connection Positions

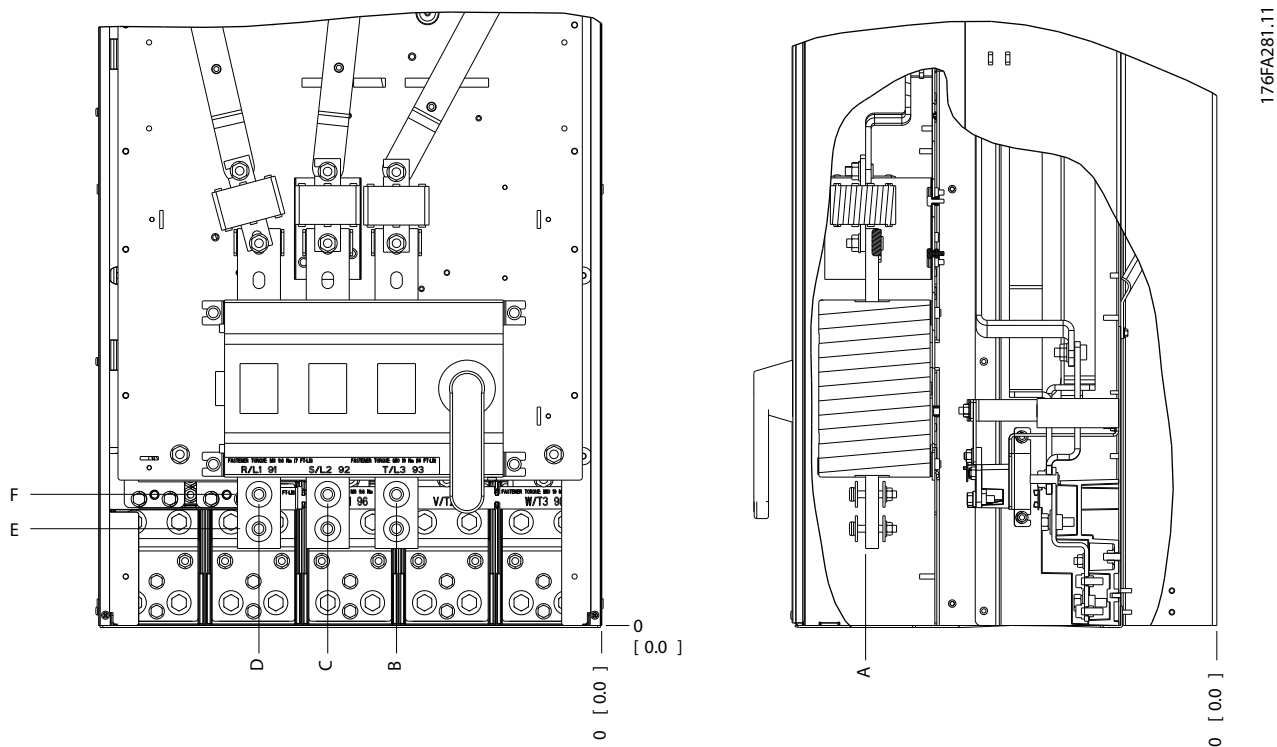


Figure 3.22 IP00 Enclosure Power Connections Positions of Disconnect Switch

NOTICE!

The power cables are heavy and difficult to bend. Give thought to the optimum position of the adjustable frequency drive for ensuring easy installation of the cables.

Each terminal allows use of up to four cables with cable lugs or use of standard box lug. Ground is connected to relevant termination point in the adjustable frequency drive.

If lugs are wider than 39 mm (1.54 in), install supplied barriers on the line power input side of the disconnect.

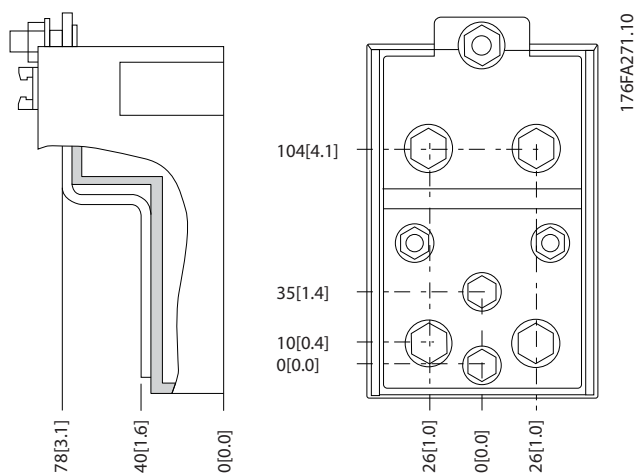


Figure 3.23 Terminal in Detail

NOTICE!

Power connections can be made to positions A or B.

| Enclosure size | Unit type | Dimensions [mm]/(inch) | | | | | |
|----------------|---|------------------------|------------|------------|------------|-----------|-----------|
| | | A | B | C | D | E | F |
| E2 | IP00/CHASSIS | | | | | | |
| | 250/315 kW (350/425 hp) (400 V) and 355/450–500/630 kW (475/600–650/850 hp) (690 V) | 396 (15.6) | 268 (10.6) | 333 (13.1) | 398 (15.7) | 221 (8.7) | N/A |
| | 315/355–400/450 kW (425/475–550/600 hp) (400 V) | 408 (16.1) | 239 (9.4) | 319 (12.5) | 399 (15.7) | 113 (4.4) | 153 (6.0) |

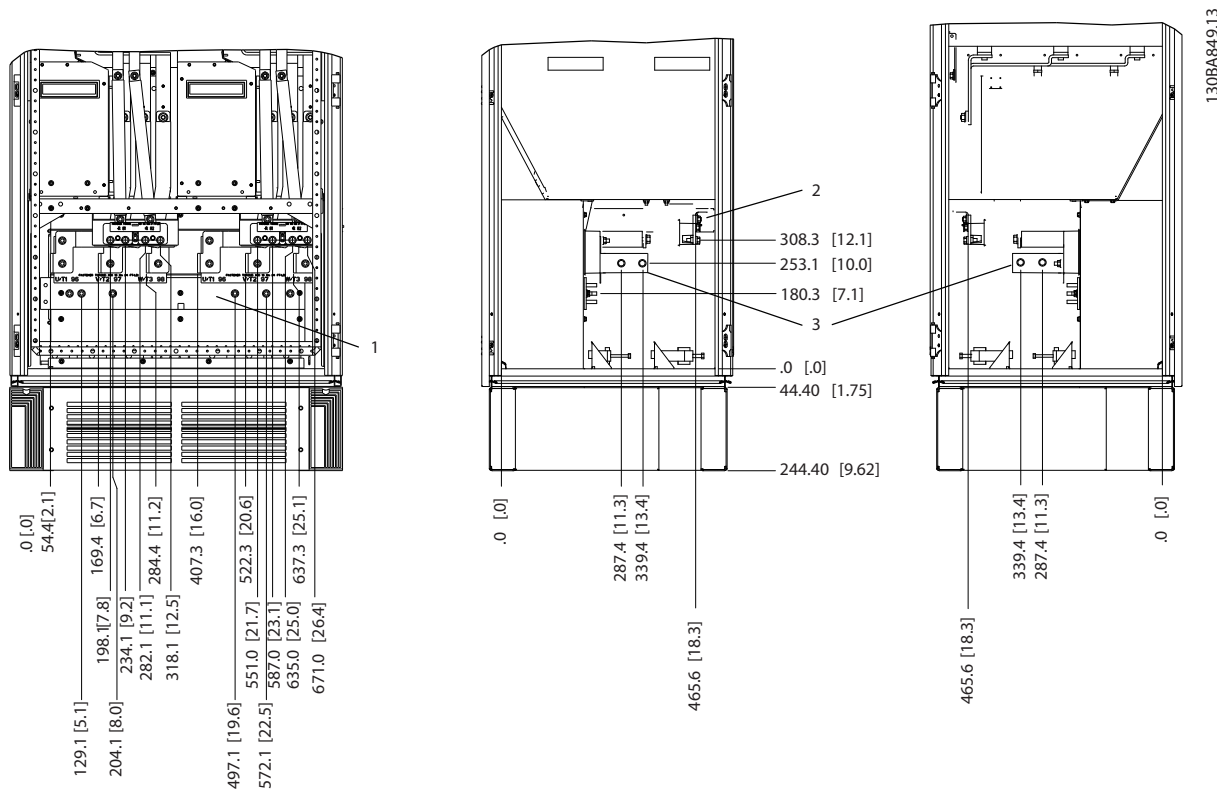
Table 3.6 Dimensions for Disconnect Terminal

3.3.4 Terminal Locations - Enclosure type F

NOTICE!

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

Terminal locations - enclosure types F1 and F3



| | |
|---|-----------------|
| 1 | Ground bar |
| 2 | Motor terminals |
| 3 | Brake terminals |

Figure 3.24 Terminal Locations - Inverter Cabinet - F1 and F3 (Front, Left and Right Side View). The Connector Plate is 42 mm (1.65 in) below .0 level.

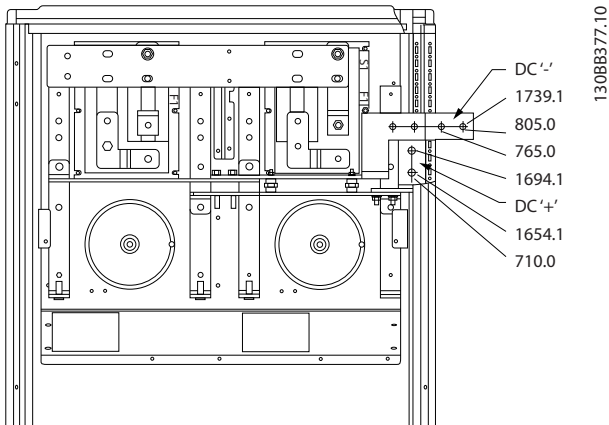
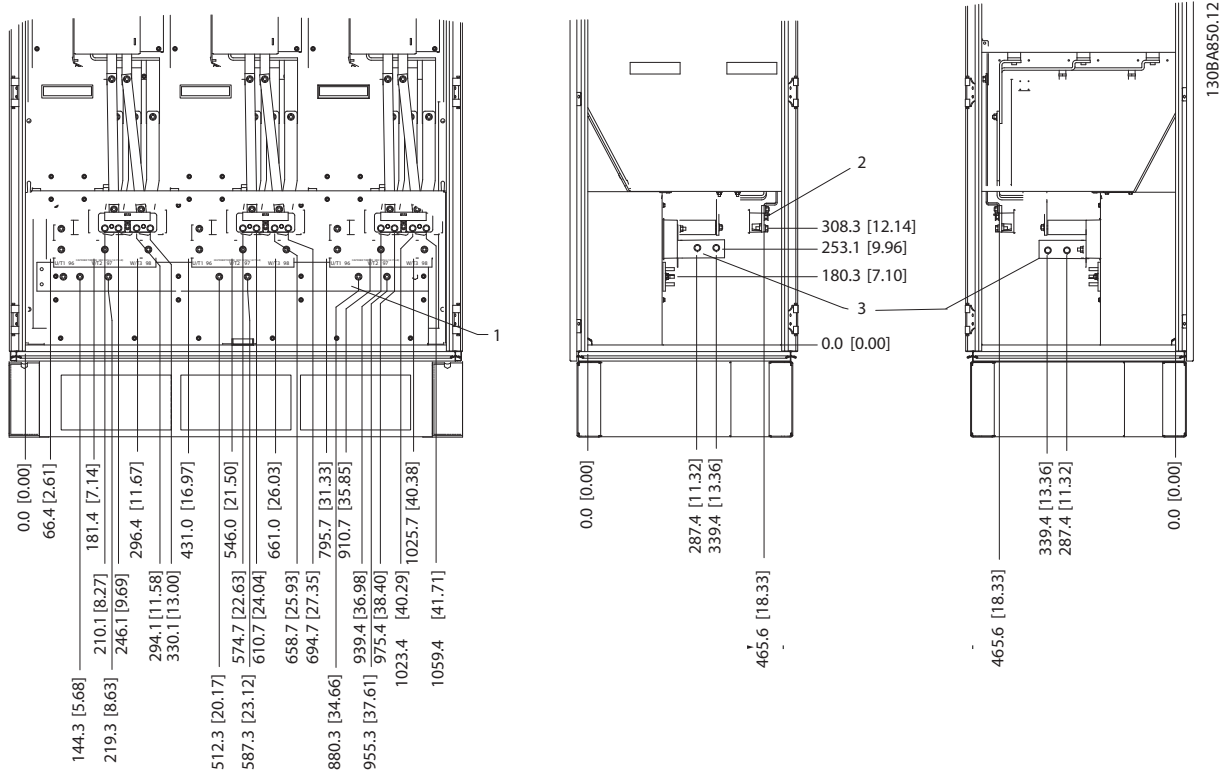


Figure 3.25 Terminal Locations - Regen Terminals - F1 and F3

Terminal locations - enclosure types F2 and F4



| | |
|---|------------|
| 1 | Ground bar |
|---|------------|

Figure 3.26 Terminal Locations - Inverter Cabinet - F2 and F4 (Front, Left and Right Side View). The Connector Plate is 42 mm (1.65 in) below .0 level.

3

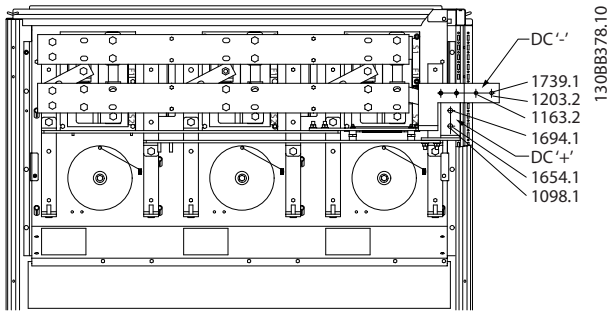
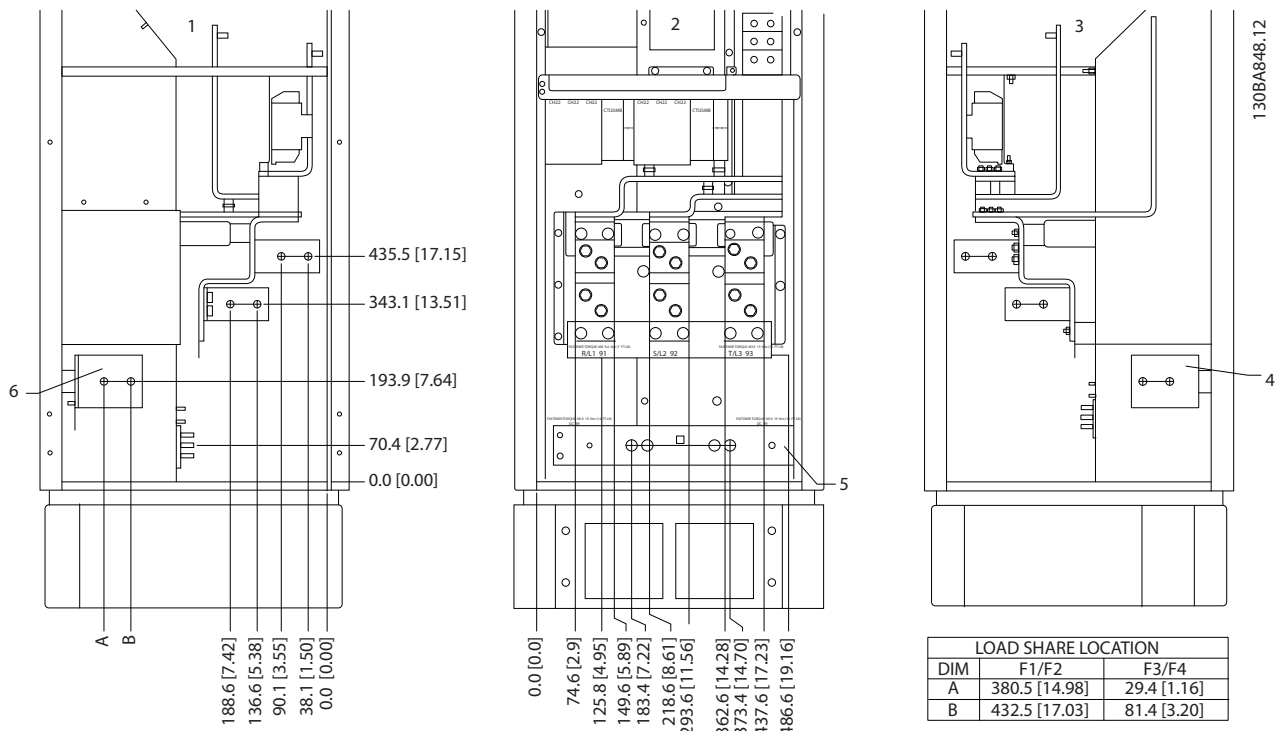


Figure 3.27 Terminal Locations - Regen Terminals - F2 and F4

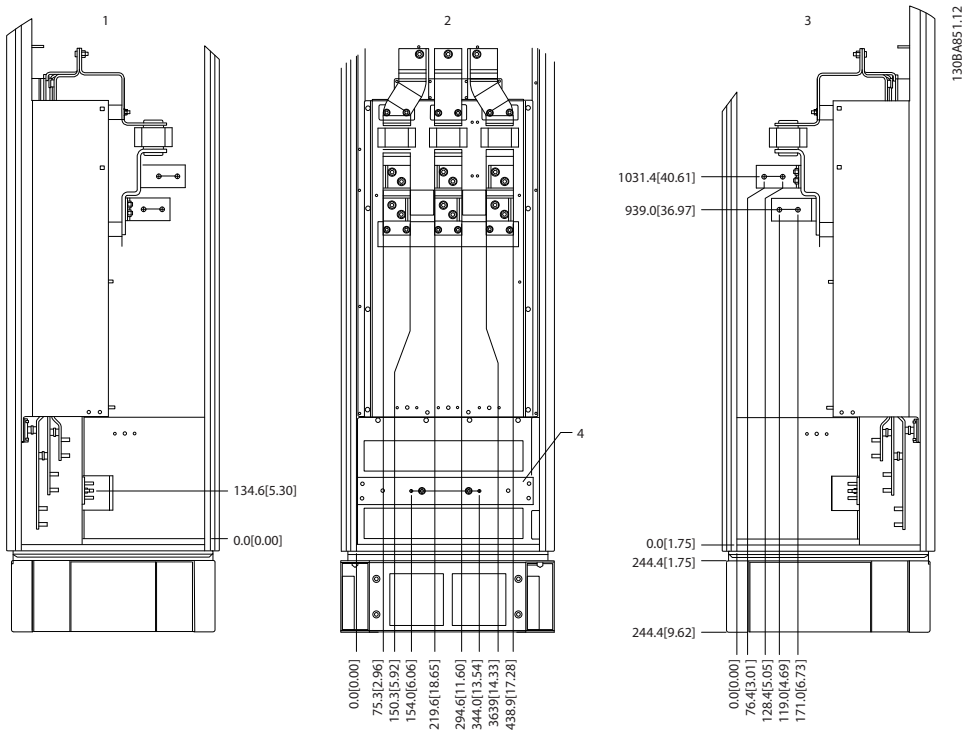
Terminal locations - rectifier (F1, F2, F3 and F4)



| | |
|---|-------------------------|
| 1 | Load Share Terminal (-) |
| 2 | Ground Bar |
| 3 | Load Share Terminal (+) |

Figure 3.28 Terminal Locations - Rectifier (Left Side, Front and Right Side View). The Connector Plate is 42 mm (1.65 in) below .0 level.

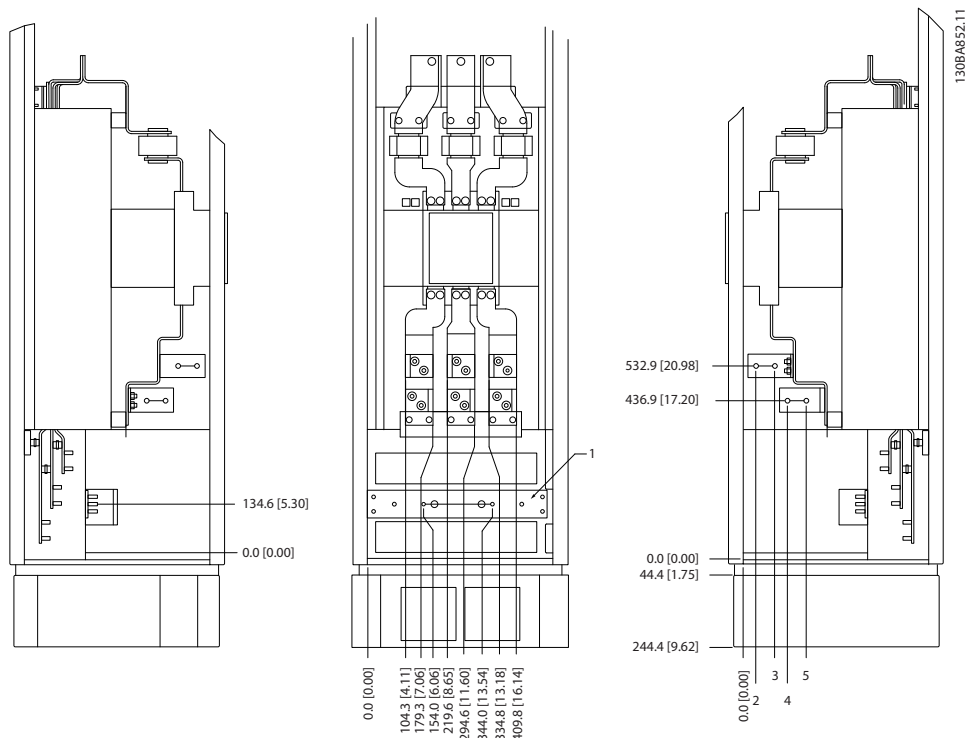
Terminal locations - options cabinet (F3 and F4)



| | |
|---|------------|
| 1 | Ground bar |
|---|------------|

Figure 3.29 Terminal Locations - Options Cabinet (Left Side, Front and Right Side View). The Connector Plate is 42 mm (1.65 in) below .0 level.

Terminal locations - options cabinet with circuit breaker/molded case switch (F3 and F4)



| | |
|---|------------|
| 1 | Ground bar |
|---|------------|

Figure 3.30 Terminal Locations - Options Cabinet with Circuit Breaker/Molded Case Switch (Left Side, Front and Right Side View). The Connector Plate is 42 mm (1.65 in) below .0 level.

| Power size | 2 | 3 | 4 | 5 |
|---|------|------|-------|-------|
| 500 kW (650 hp) (480 V), 710–800 kW (950–1075 hp) (690 V) | 34.9 | 86.9 | 122.2 | 174.2 |
| 560–1000 kW (750–1350 hp) (480 V), 900–1400 kW (1200–1875 hp) (690 V) | 46.3 | 98.3 | 119.0 | 171.0 |

Table 3.7 Dimensions for Terminal

3.3.5 Cooling and Airflow

Cooling

Cooling can be obtained in different ways:

- By using the cooling ducts at the bottom and top of the unit.
- By adding and removing air from the back of the unit.
- By combining the cooling possibilities.

Duct cooling

A dedicated option has been developed to optimize installation of IP00/chassis adjustable frequency drives in Rittal TS8 enclosures. The option uses the fan of the adjustable frequency drive for forced air cooling of the backchannel.

Air that escapes from the top of enclosure could be ducted outside a facility. Then heat losses from the backchannel are not dissipated within the control room, reducing air-conditioning requirements of the facility.

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

Back cooling

The backchannel air can also be vented in and out the back of a Rittal TS8 enclosure. Such back cooling offers a solution where the backchannel could take air from outside the facility and return the heat losses outside the facility, thus reducing air-conditioning requirements.

CAUTION

Install a door fan on the enclosure to remove the heat losses not contained in the backchannel of the adjustable frequency drive and any additional losses generated from other components installed inside the enclosure. Calculate the total required airflow to select the appropriate fans. Some enclosure manufacturers offer software for performing the calculations (Rittal Therm software). If the adjustable frequency drive is the only heat-generating component in the enclosure, the minimum airflow required at an ambient temperature of 45 °C (113 °F) for the E2 adjustable frequency drive is 782 m³/h (460 cfm).

Airflow

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

| Enclosure protection rating | Enclosure size | Door fan/top fan airflow | Heatsink fan |
|-----------------------------|-----------------------------|----------------------------------|----------------------------------|
| IP21/NEMA 1 IP54/NEMA 12 | E1 P315T4, P450T7, P500T7 | 340 m ³ /h (200 cfm) | 1105 m ³ /h (650 cfm) |
| | E1 P355-P450T4, 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 | E2 P315T4, P450T7, P500T7 | 255 m ³ /h (150 cfm) | 1105 m ³ /h (650 cfm) |
| | E2 P355-P450T4, P560-P630T7 | 255 m ³ /h (150 cfm) | 1445 m ³ /h (850 cfm) |

* Airflow per fan. Enclosure type F contains multiple fans.

Table 3.8 Heatsink Airflow

NOTICE

The fan runs for the following reasons:

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

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

External ducts

If extra duct work is added externally to the Rittal cabinet, calculate the pressure drop in the ducting. Use the following charts to derate the adjustable frequency drive according to the pressure drop.

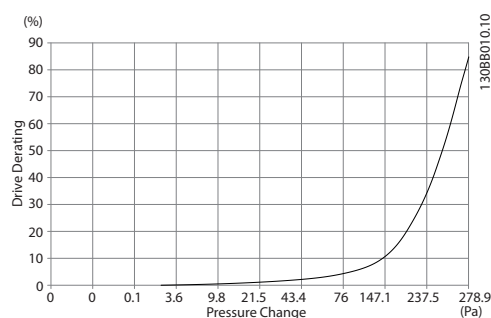


Figure 3.31 E Enclosure Derating vs. Pressure Change (Small Fan), P315T4 and P450T7-P500T7
Adjustable Frequency Drive Airflow: 650 cfm (1105 m³/h)

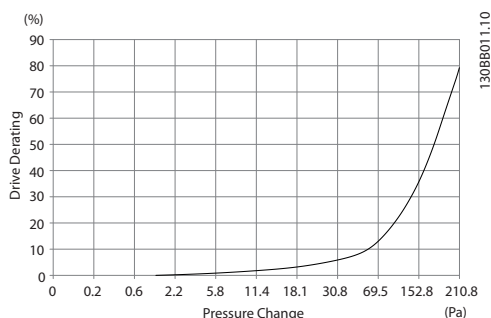


Figure 3.32 E Enclosure Derating vs. Pressure Change (Large Fan), P355T4-P450T4 and P560T7-P630T7
Adjustable Frequency Drive Airflow: 850 cfm (1445 m³/h)

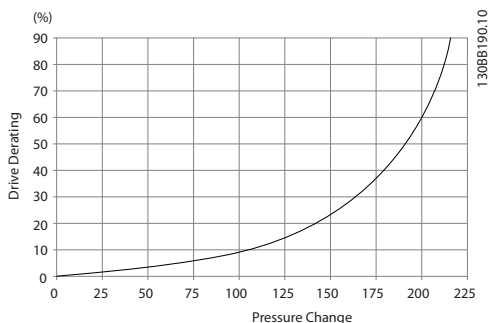


Figure 3.33 F1, F2, F3, F4 Enclosures Derating vs. Pressure Change
Adjustable Frequency Drive Airflow: 580 cfm (985 m³/h)

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

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

NOTICE!

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

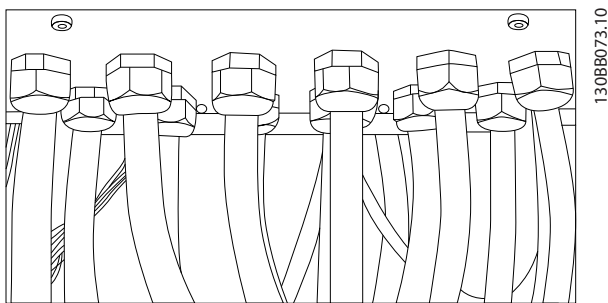


Figure 3.34 Example of Proper Installation of Gland Plate

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

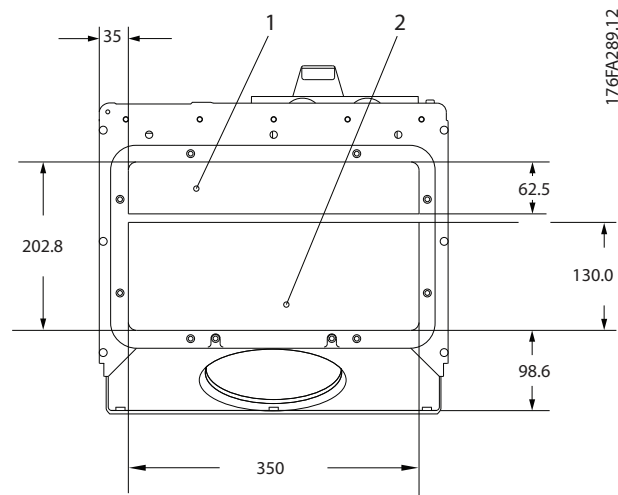


Figure 3.35 Enclosure Size E1

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

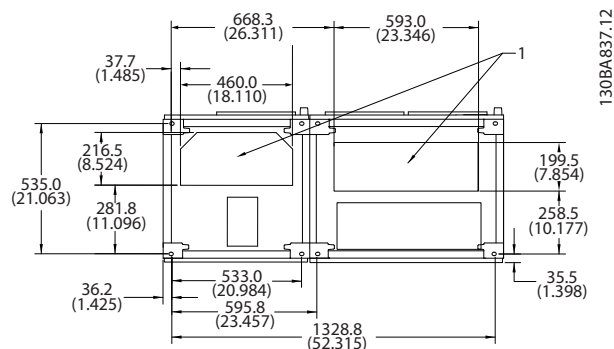


Figure 3.36 Enclosure Size F1

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 adjustable frequency drives with duct work cooling kits in Rittal enclosures. In addition to the enclosure, a 200 mm (8 in) base/plinth is required.

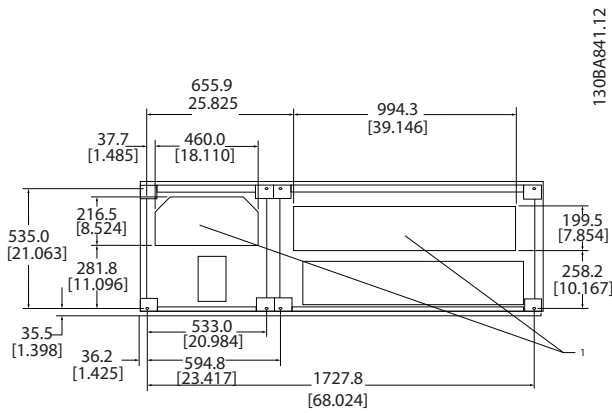


Figure 3.37 Enclosure Size F2

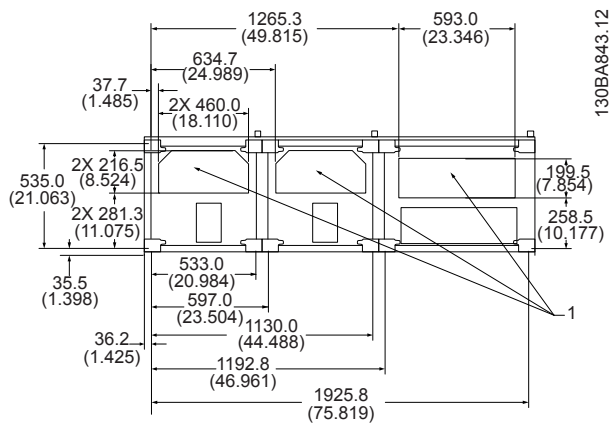


Figure 3.38 Enclosure Size F3

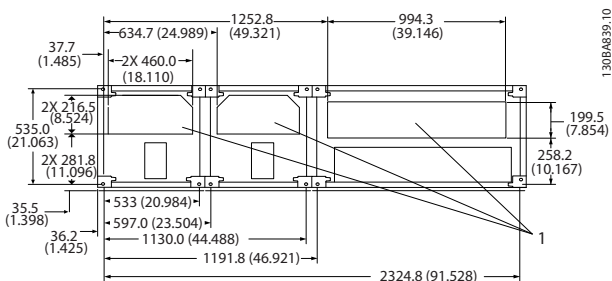


Figure 3.39 Enclosure Size F4

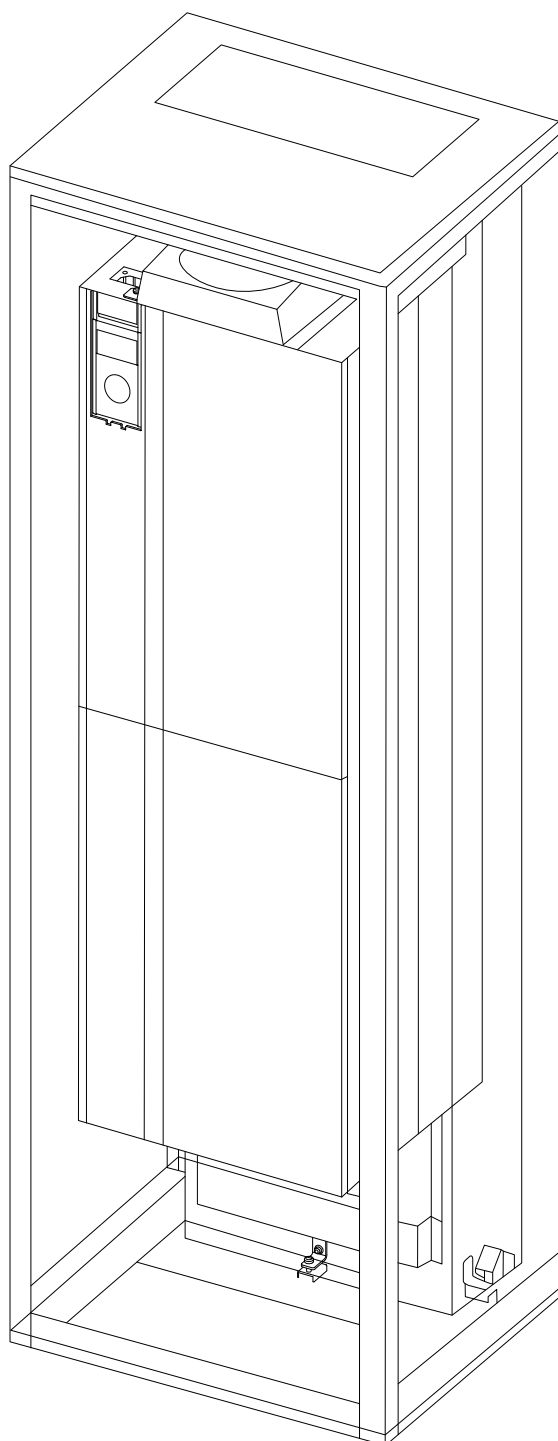


Figure 3.40 Installation of IP00 in Rittal TS8 Enclosure.

The minimum enclosure dimension is:

- E2 enclosure Unit Size 52: Depth 600 mm (23.6 in) and width 800 mm (31.5 in).

The maximum depth and width are as required for the installation. When using multiple adjustable frequency

drives in 1 enclosure, mount each adjustable frequency drive on its own back panel and support it along the mid-section of the panel. These duct work kits do not support the “in frame” mounting of the panel (see Rittal TS8 catalog for details). The duct work cooling kits listed in *Table 3.9* are suitable for use only with IP00/Chassis adjustable frequency drives in Rittal TS8 IP20 and UL and NEMA 1 and IP54, and UL and NEMA 12 enclosures.

CAUTION

For the E2 enclosures Unit Size 52, it is important to mount the plate at the absolute rear of the Rittal enclosure due to the weight of the adjustable frequency drive.

CAUTION

Install a door fan on the enclosure to remove the heat losses not contained in the backchannel of the adjustable frequency drive and any additional losses generated from other components installed inside the enclosure. Calculate the total required airflow to select the appropriate fans. Some enclosure manufacturers offer software for performing the calculations (Rittal Therm software). If the adjustable frequency drive is the only heat-generating component in the enclosure, the minimum airflow required at an ambient temperature of 45 °C (113 °F) for the E2 adjustable frequency drive is 782 m³/h (460 cfm).

| Rittal TS-8 Enclosure | Enclosure size E2 part no. |
|-----------------------|----------------------------|
| 1800 mm (70.9 in) | Not possible |
| 2000 mm (78.74 in) | 176F1850 |
| 2200 mm (86.6 in) | 176F0299 |

Table 3.9 Ordering Information

External ducts

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

3.4.2 Installation of Top-only Duct Cooling Kit

This description is for the installation of the top section only of the backchannel cooling kits available for enclosure size E2. In addition to the enclosure, a 200 mm (8 in) vented pedestal is required.

The minimum enclosure depth is 500 mm (19.7 in) (600 mm (23.6 in) for enclosure size E2) and the minimum enclosure width is 600 mm (23.6 in) (800 mm (31.5 in) for enclosure size E2). The maximum depth and width are as

required for the installation. When using multiple adjustable frequency drives in 1 enclosure, mount each adjustable frequency drive on its own back panel and support it along the mid-section of the panel. The backchannel cooling kits are similar in construction for all enclosures. The E2 kit is mounted "in frame" for extra support of the adjustable frequency drive. Using these kits as described removes 85% of the losses via the backchannel using the adjustable frequency drive's main heatsink fan. Remove the remaining 15% via the enclosure door.

NOTICE!

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

Ordering information

- Enclosure type E2: 176F1776

3.4.3 Installation of Top and Bottom Covers for Rittal Enclosures

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

Notes:

1. If external duct work is added to the exhaust path of the adjustable frequency drive, extra back pressure reduces the cooling of the adjustable frequency drive. Derate the adjustable frequency drive to accommodate the reduced cooling. First, calculate the pressure drop, then refer to *Figure 3.31* to *Figure 3.33*.
2. A door fan is required on the enclosure to remove the heat losses not contained in the backchannel of the adjustable frequency drive and any additional losses generated from other components installed inside the enclosure. Calculate the total required airflow to select the appropriate fans. Some enclosure manufacturers offer software for performing the calculations (Rittal Therm software).
If the frequency converter is the only heat-generating component in the enclosure, the minimum airflow required at an ambient temperature of 45 °C (113 °F) for the enclosure size E2 adjustable frequency drive is 782 m³/h (460 cfm).

NOTICE!

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

Ordering information

- Enclosure size E2: 176F1783

3.4.4 Installation of Top and Bottom Covers

Top and bottom covers can be installed on enclosure size E2. These kits direct the backchannel airflow in and out the back of the adjustable frequency drive instead of directing the airflow in at the bottom and out at the top of the adjustable frequency drive (when the adjustable frequency drives 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 adjustable frequency drive, extra back pressure reduces the cooling of the adjustable frequency drive. Derate the adjustable frequency drive to accommodate the reduced cooling. Calculate the pressure drop, then refer to *Figure 3.31* to *Figure 3.33*.
2. A door fan is required on the enclosure to remove the heat losses not contained in the backchannel of the adjustable frequency drive and any additional losses generated from other components installed inside the enclosure. Calculate the total required airflow to select the appropriate fans. Some enclosure manufacturers offer software for performing the calculations (Rittal Therm software).
If the frequency converter is the only heat-generating component in the enclosure, the minimum airflow required at an ambient temperature of 45 °C (113 °F) for the enclosure size E2 adjustable frequency drive is 782 m³/h (460 cfm).

NOTICE!

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

Ordering information

- Enclosure size E2: 176F1861

3.4.5 Outside Installation/NEMA 3R Kit for Rittal Enclosures

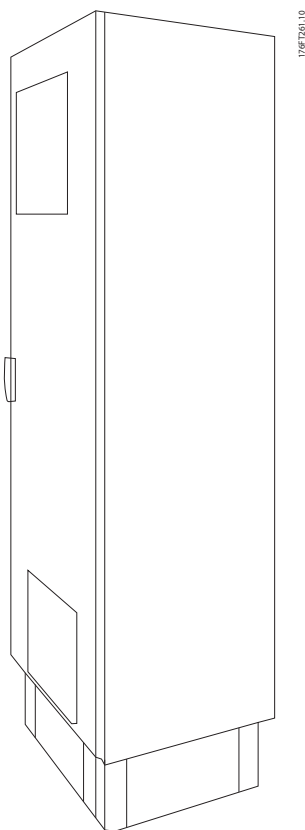


Figure 3.41 Rittal Enclosure Size E2

This section is for the installation of NEMA 3R kits available for the adjustable frequency drive enclosure size E2. These kits are designed and tested to be used with IP00/Chassis versions of these enclosure sizes in Rittal TS8 NEMA 3R or NEMA 4 enclosures. The NEMA 3R enclosure is an outdoor enclosure that provides a degree of protection against rain and ice. The NEMA 4 enclosure is an outdoor enclosure that provides a greater degree of protection against weather and hosed water.

The minimum enclosure depth is 500 mm (19.7 in) (600 mm (23.6 in) for enclosure size E2) and the kit is designed for a 600 mm (23.6 in) (800 mm (31.5 in) for enclosure size E2) wide enclosure. Other enclosure widths are possible; however, extra Rittal hardware is required. The maximum depth and width are as required for the installation.

NOTICE!

Adjustable frequency drives in enclosure type E2 require no derating.

NOTICE!

Install a door fan on the enclosure to remove the heat losses not contained in the backchannel of the adjustable frequency drive and any additional losses generated from other components installed inside the enclosure. Calculate the total required airflow to select the appropriate fans. Some enclosure manufacturers offer software for performing the calculations (Rittal Therm software). If the adjustable frequency drive is the only heat-generating component in the enclosure, the minimum airflow required at an ambient temperature of 45 °C (113 °F) for the E2 adjustable frequency drive is 782 m³/h (460 cfm).

Ordering information

- Enclosure size E2: 176F1884

3.4.6 Outside Installation/NEMA 3R Kit for Industrial Enclosures

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

This kit has been tested and complies with UL environmental rating Type 3R.

NOTICE!

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

NOTICE!

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

Ordering information

- Enclosure size E2: 176F0298

3.4.7 Installation of IP00 to IP20 Kits

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

CAUTION

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

Ordering information

- Enclosure size E2: 176F1884

3.4.8 Installation of IP00 E2 Cable Clamp Bracket

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

NOTICE!

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

Ordering information

- Enclosure size E2: 176F1745

3.4.9 Installation of Line Power Shield for Adjustable Frequency Drives

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

Ordering information:

- Enclosure size E1: 176F1851

3.4.10 Enclosure Size F USB Extension Kit

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

Ordering information:

- 176F1784

NOTICE!

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

3.4.11 Installation of Input Plate Options

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

NOTICE!

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

| | 380–480 V 380–500 V | Fuses | Disconnect fuses | RFI | RFI fuses | RFI disconnect fuses |
|----|---|----------|------------------|----------|-----------|----------------------|
| E1 | FC 102/FC 202: 315 kW (430 hp) FC 302: 250 kW (350 hp) | 176F0253 | 176F0255 | 176F0257 | 176F0258 | 176F0260 |
| | FC 102/FC 202: 355–450 kW (475–600 hp) FC 302: 315–400 kW (425–550 hp) | 176F0254 | 176F0256 | 176F0257 | 176F0259 | 176F0262 |

Table 3.10 Fuses, Enclosure Size E1 380–500 V

| | 525–690 V | Fuses | Disconnect fuses | RFI | RFI fuses | RFI disconnect fuses |
|----|---|----------|------------------|-----|-----------|----------------------|
| E1 | FC 102/FC 202: 450–500 kW (600–650 hp) FC 302: 355–400 kW (475–550 hp) | 176F0253 | 176F0255 | NA | NA | NA |
| | FC 102/FC 202: 560–630 kW (750–850 hp) FC 302: 500–560 kW (650–750 hp) | 176F0254 | 176F0258 | NA | NA | NA |

Table 3.11 Fuses, Enclosure Size E1 525–690 V

NOTICE!

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

3.4.12 Installation of E Load Share Option

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

Ordering information

- Enclosure type E1/E2: 176F1843

3.5 Enclosure Type F Panel Options

3.5.1 Enclosure Type F Options

Space heaters and thermostat

Mounted on the cabinet interior of enclosure size F adjustable frequency drives, space heaters controlled via automatic thermostat help control humidity inside the enclosure. This control extends the lifetime of adjustable frequency drive components in damp environments. The thermostat default settings turn on the heaters at 10 °C (50 °F) and turn them off at 15.6 °C (60 °F).

Cabinet light with power outlet

A light mounted on the cabinet interior of enclosure size F adjustable frequency drives increases visibility during servicing and maintenance. The housing light includes a power outlet, which temporarily powers 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 set-up

If the cabinet light and outlet and/or the space heaters and thermostat are installed, transformer T1 requires its taps to be set to the proper input voltage. A 380–480/500 V adjustable frequency drive is initially set to the 525 V tap, and a 525–690 V adjustable frequency drive is set to the 690 V tap. This setting ensures that no overvoltage of secondary equipment occurs if the tap is not changed before power is applied. See *Table 3.12* to set the proper tap at terminal T1 located in the rectifier cabinet. For location in the adjustable frequency drive, see *Figure 4.1*.

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

Table 3.12 Setting of Transformer Tap

NAMUR terminals

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

RCD (residual current device)

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

- Integrated into the adjustable frequency drive’s safe-stop circuit.
- IEC 60755 Type B device monitors AC, pulsed DC, and pure DC ground fault currents.
- LED bar graph indicator of the ground fault current level from 10–100% of the setpoint.
- Fault memory.
- [TEST/RESET].

IRM (insulation resistance monitor)

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

NOTICE!

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

- Integrated into the adjustable frequency drive’s safe-stop circuit.
- LCD display of the ohmic value of the insulation resistance.
- Fault memory.
- [INFO], [TEST], and [RESET].

IEC emergency stop with Pilz safety relay

IEC emergency stop with Pilz safety relay includes a redundant 4-wire emergency-stop push-button mounted on the front of the enclosure and a Pilz relay that monitors it with the adjustable frequency drive’s safe-stop circuit and the line power contactor located in the options cabinet.

STO + Pilz Relay

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

Manual motor starters

Manual motor starters provide 3-phase power for electric blowers often required for larger motors. Power for the starters is provided from the load side of any supplied contactor, circuit breaker, or disconnect switch. Power is fused before each motor start, and is off when the incoming power to the adjustable frequency drive is off. Up to two starters are allowed (one if a 30 A, fuse-protected circuit is ordered). The motor starters are integrated into the adjustable frequency drive'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 AC line voltage for powering auxiliary customer equipment.
- Not available if two manual motor starters are selected.
- Terminals are off when the incoming power to the adjustable frequency drive is off.
- Power for the fused protected terminals are provided from the load side of any supplied contactor, circuit breaker, or disconnect switch.

24 V DC power supply

- 5 A, 120 W, 24 V DC.
- Protected against output overcurrent, overload, short circuits, and overtemperature.
- For powering customer-supplied accessory devices such as sensors, PLC I/O, contactors, temperature probes, indicator lights, and/or other electronic hardware.
- Diagnostics include a dry DC-ok contact, a green DC-ok LED, and a red overload LED.

External temperature monitoring

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

Universal inputs (5)

Signal types:

- RTD inputs (including PT100), 3-wire or 4-wire.
- Thermocouple.
- Analog current or analog voltage.

Extra features:

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

4 Electrical Installation

4.1 Electrical Installation

4.1.1 Power Connections

Cabling and fusing

NOTICE!

Cables in General

All cabling must comply with national and local regulations on cable cross-sections and ambient temperature. UL applications require 75 °C (167 °F) copper conductors. 75 °C (167 °F) and 90 °C (194 °F) copper conductors are thermally acceptable for the adjustable frequency drive to use in non-UL applications.

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

If the adjustable frequency drive does not have built-in fuses, use the recommended fuses to protect it. See chapter 4.1.15 Fuse Specifications for recommended fuses. Always ensure that proper fusing is done according to local regulations.

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

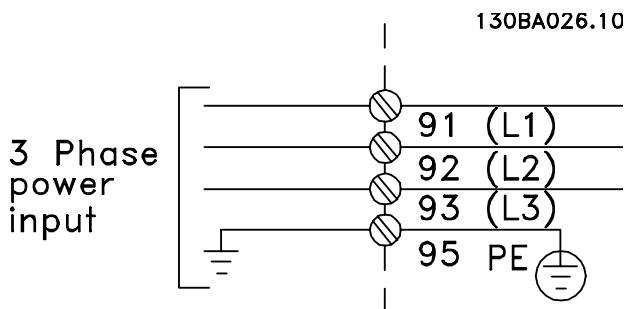


Figure 4.1 Power Cable Connections

NOTICE!

The motor cable must be shielded/armored. If a non-shielded/unarmored cable is used, some EMC requirements are not complied with. To comply with EMC emission specifications, use a shielded/armored motor cable. For more information, see EMC specifications in the product-related design guide.

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

Shielding of cables

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

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

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

Cable length and cross-section

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

Switching frequency

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

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

Table 4.1 Motor Terminals

1) Protected Ground Connection

NOTICE!

In motors without phase insulation paper or other insulation reinforcement suitable for operation with voltage supply (such as a adjustable frequency drive), fit a sine-wave filter on the adjustable frequency drive output.

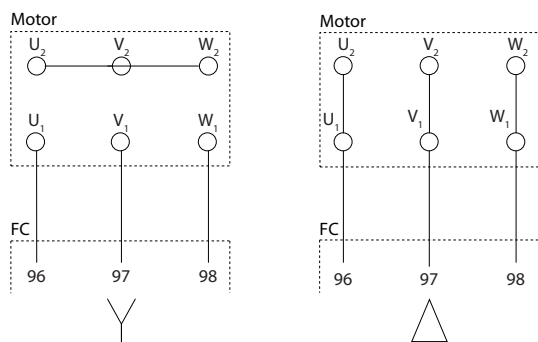


Figure 4.2 Star/Delta Connections

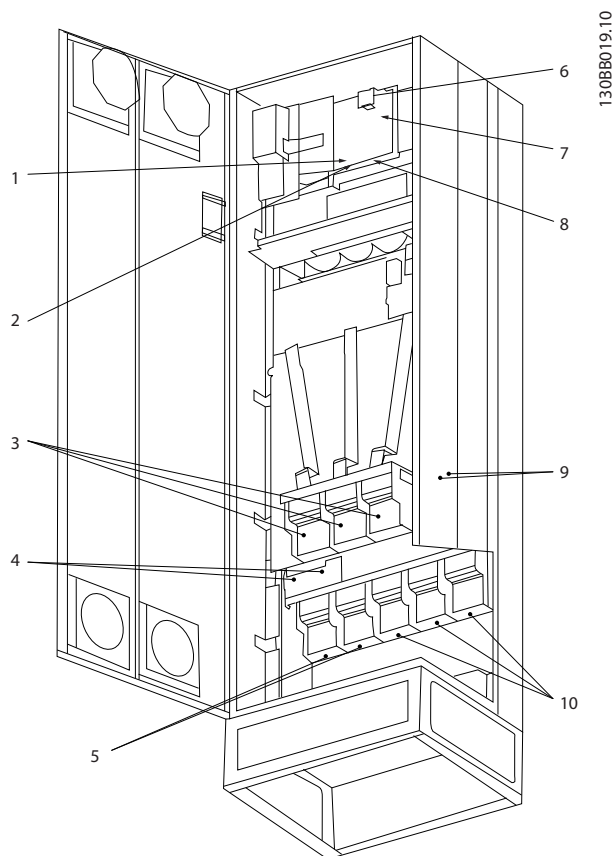


Figure 4.3 Compact IP21 (NEMA 1) and IP54 (NEMA 12) Enclosure Type E1

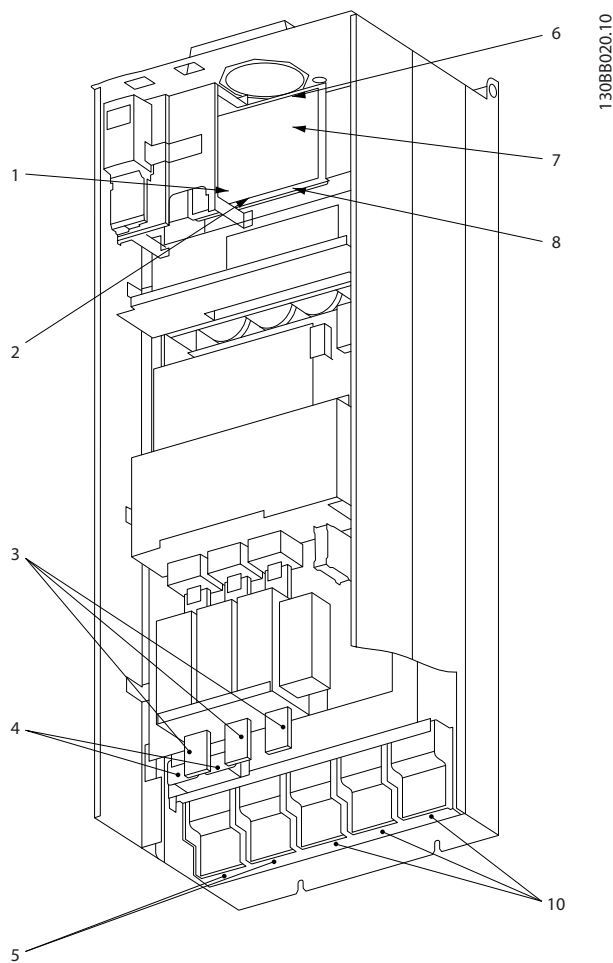
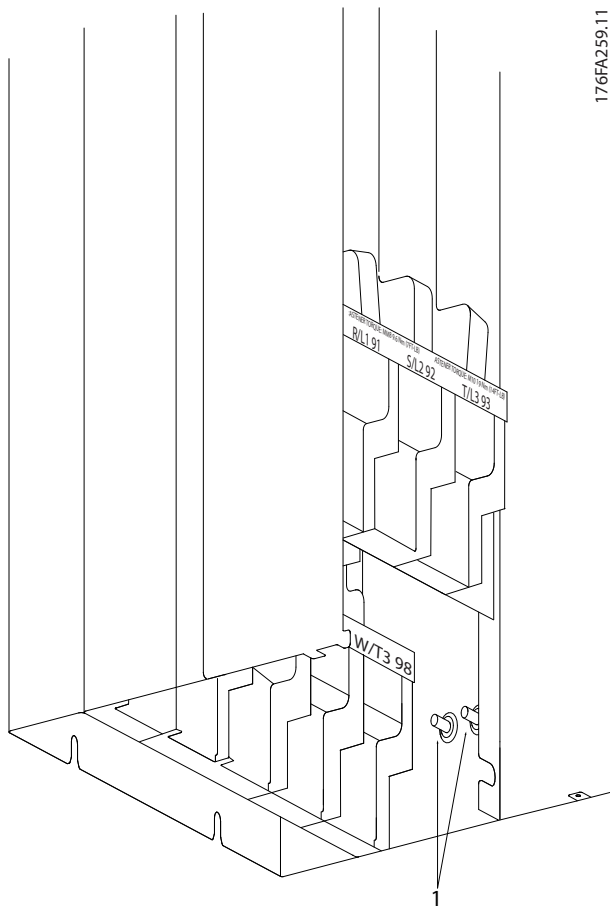


Figure 4.4 Compact IP00 (Chassis) with Disconnect, Fuse and RFI Filter, Enclosure Type E2

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

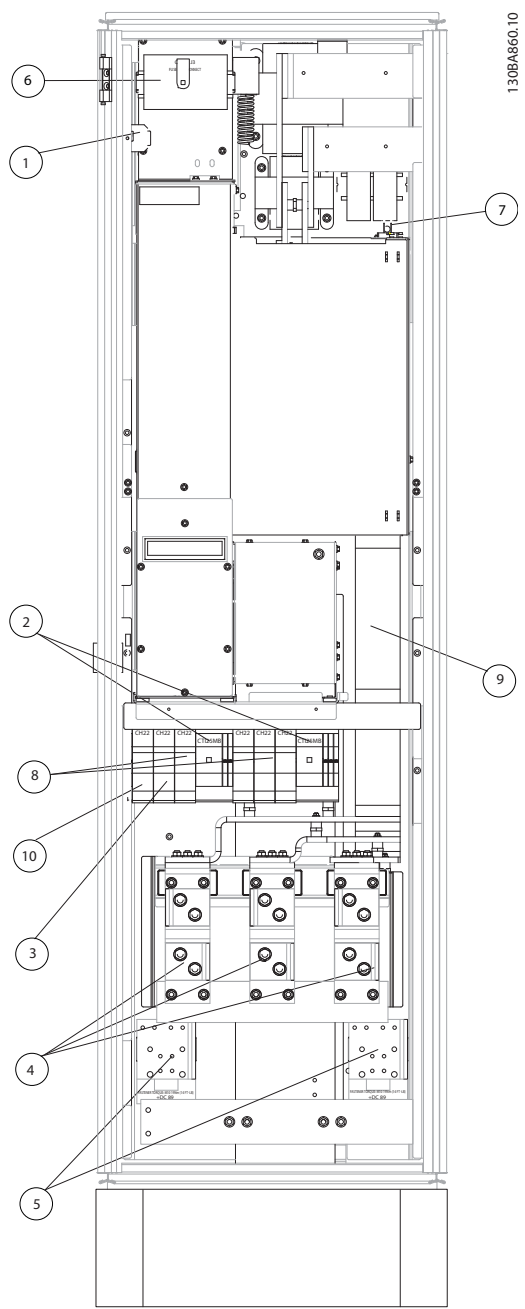
Table 4.2 Legend to Figure 4.3 and Figure 4.4

4



| | |
|---|------------------|
| 1 | Ground terminals |
|---|------------------|

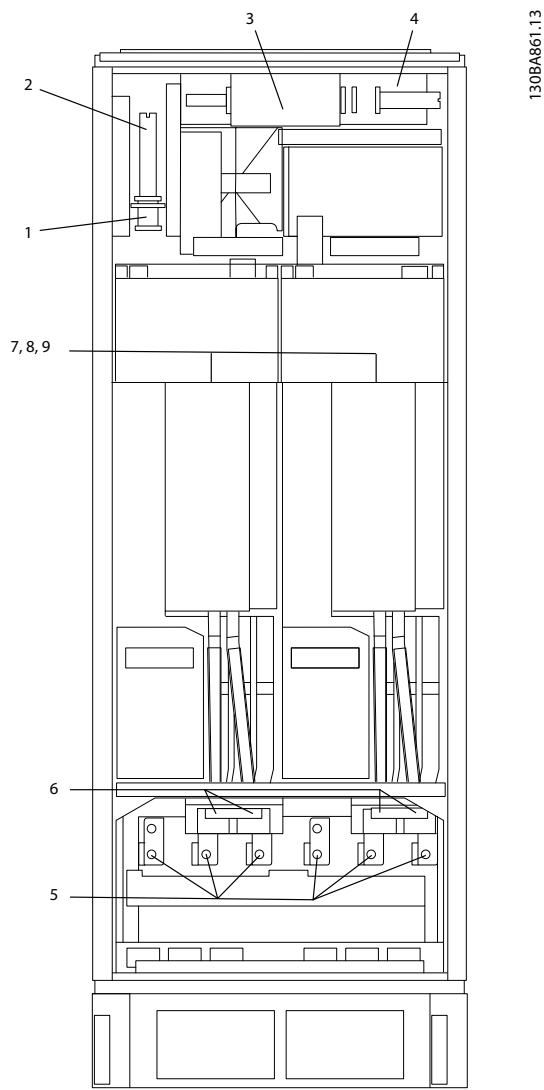
Figure 4.5 Position of Ground Terminals IP00, Enclosure Type E



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

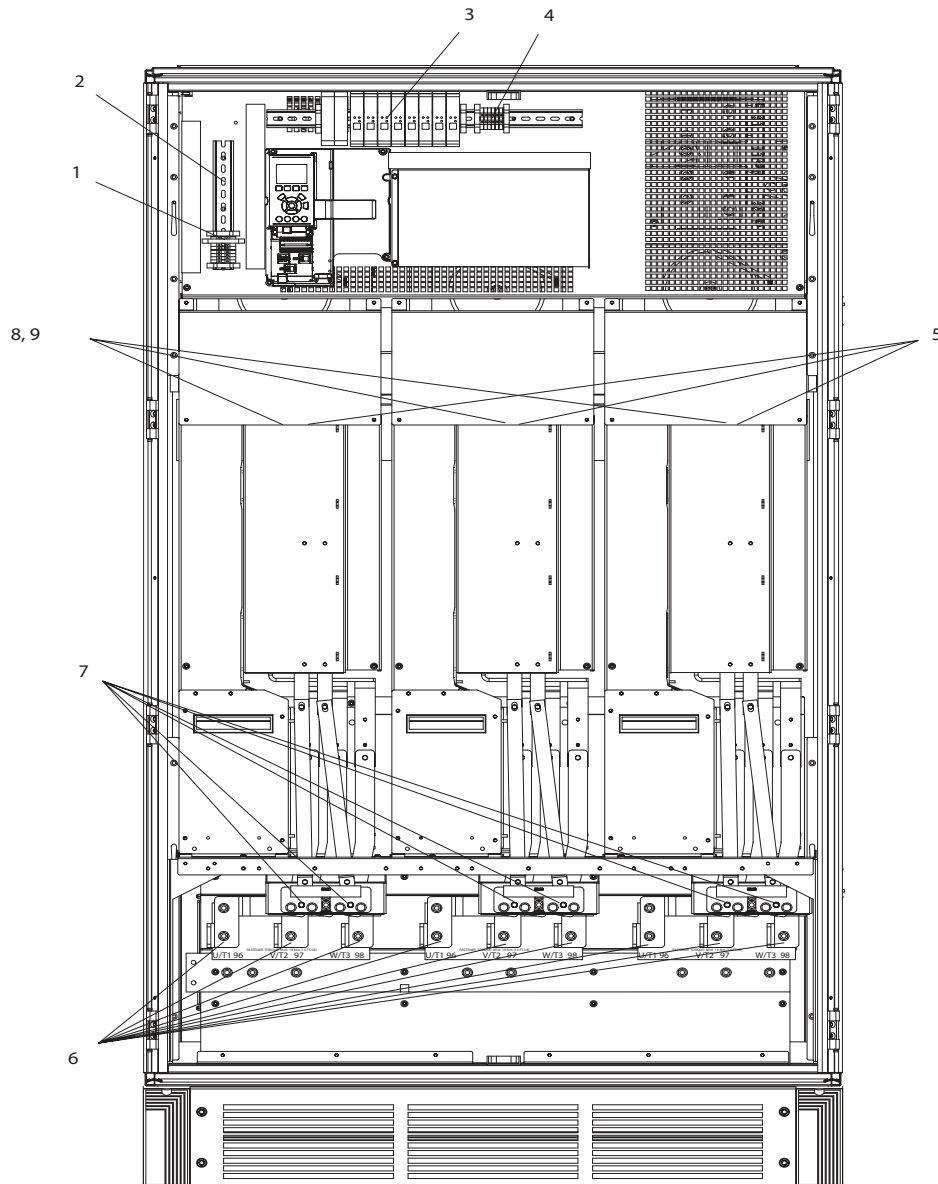
Figure 4.6 Rectifier Cabinet, Enclosure Types F1, F2, F3 and F4

4



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

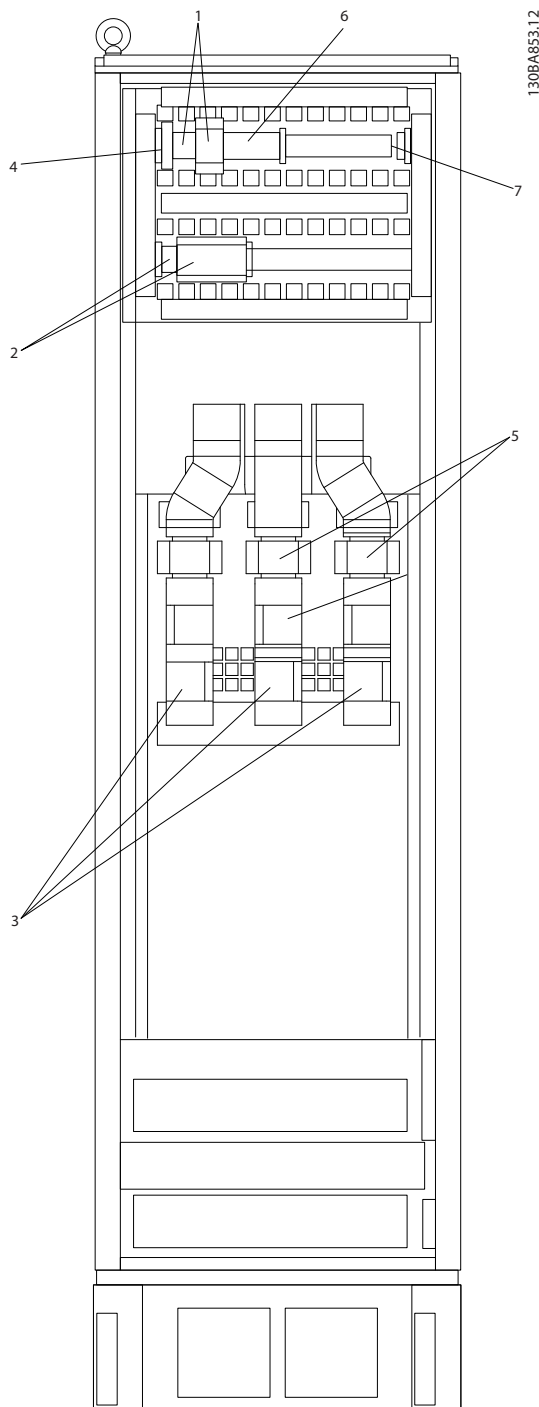
Figure 4.7 Inverter Cabinet, Enclosure Types F1 and F3



| | | | |
|----|---------------------------------|----|--|
| 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 Table 4.23 for part numbers) |
| 4) | AUX fan | 8) | Fan fuses (see Table 4.19 for part numbers) |
| | 100 101 102 103 | 9) | SMPS fuses (see Table 4.18 for part numbers) |
| | L1 L2 L1 L2 | | |
| 5) | Brake | | |
| | -R +R | | |
| | 81 82 | | |

Figure 4.8 Inverter Cabinet, Enclosure Types F2 and F4

4



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

Figure 4.9 Options Cabinet, Enclosure Types F3 and F4

4.1.2 Grounding

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

- Safety grounding: For safety reasons, ground the adjustable frequency drive appropriately due to its high leakage current. Always follow local safety regulations.
- High-frequency grounding: Keep the ground wire connections as short as possible.

Connect the different ground systems at the lowest possible conductor impedance. The lowest possible conductor impedance is obtained by keeping the conductor as short as possible and by using the greatest possible surface area.

The metal cabinets of the different devices are mounted on the cabinet rear plate using the lowest possible HF impedance. Different HF voltages are then avoided for the individual devices. Also the risk of radio interference currents running in connection cables that may be used between the devices is avoided. The radio interference has been reduced.

To obtain a low HF impedance, use the fastening bolts of the devices as HF connection to the rear plate. It is necessary to remove insulating paint and the like from the fastening points.

4.1.3 Extra Protection (RCD)

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

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

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

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

4.1.4 RFI Switch

Line power supply isolated from ground

If the adjustable frequency drive is supplied from an isolated line power source (IT line power, floating delta and grounded delta) or TT/TN-S line power with grounded leg, turn off the RFI switch via *parameter 14-50 RFI 1* on both

the adjustable frequency drive and the filter. For further reference, see IEC 364-3.

Set *parameter 14-50 RFI 1* to [ON]

- If optimum EMC performance is needed.
- Parallel motors are connected.
- The motor cable length is above 25 m (82 ft).

In OFF, the internal RFI capacities (filter capacitors) between the enclosure and the intermediate circuit are cut off to avoid damage to the intermediate circuit and to reduce the ground capacity currents (according to IEC 61800-3).

Also refer to the Application Note *VLT on IT Line Power*. It is important to use isolation monitors suited for power electronics (IEC 61557-8).

4.1.5 Torque

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

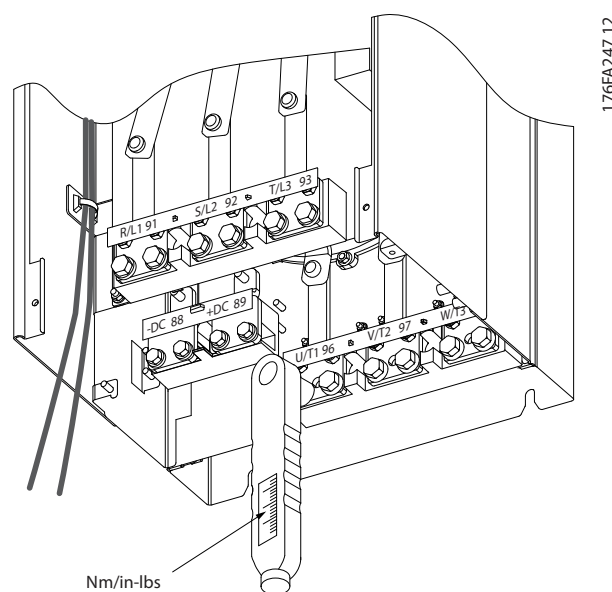


Figure 4.10 Tighten Bolts with a Torque Wrench

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

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

Table 4.3 Torque for Terminals

4.1.6 Shielded Cables

WARNING

Danfoss recommends using shielded cables between the LCL filter and the adjustable frequency drive. Non-shielded cables can be used between the transformer and the LCL filter input side.

Make sure to connect shielded and armored cables properly to ensure high EMC immunity and low emissions.

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

- EMC cable connectors: Available cable connectors can be used to ensure optimum EMC connection.
- EMC cable clamp: Clamps allowing for easy connection are supplied with the adjustable frequency drive.

4.1.7 Motor Cable

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

| Terminal number | Function |
|-----------------|-----------------------------|
| 96, 97, 98 | Line power U/T1, V/T2, W/T3 |
| 99 | Ground |

Table 4.4 Line Power Terminals

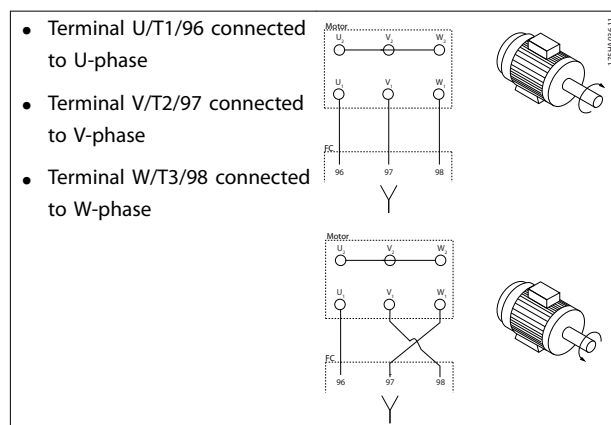


Table 4.5 Wiring for Motor Directions

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

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

F enclosure requirements

F1/F3 requirements

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

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

Output junction box requirements

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

NOTICE!

If a retrofit application requires an unequal number of wires per phase, consult the factory for requirements and documentation, or use the top/bottom entry side enclosure option.

4.1.8 Brake Cable for Adjustable Frequency Drives with Factory-installed Brake Chopper Option

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

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

| Terminal number | Function |
|-----------------|--------------------------|
| 81, 82 | Brake resistor terminals |

Table 4.6 Brake Resistor Terminals

The connection cable to the brake resistor must be shielded. Connect the shield to the conductive backplate on the adjustable frequency drive and to the metal cabinet of the brake resistor with cable clamps.

Size the brake cable cross-section to match the brake torque. See also the Instructions *Brake Resistor* and *Brake Resistors for Horizontal Applications* for further information regarding safe installation.

NOTICE!

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

F enclosure requirements

Connect the brake resistor to the brake terminals in each inverter module.

4.1.9 Brake Resistor Temperature Switch

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

This input can be used to monitor the temperature of an externally connected brake resistor. If the input between 104 and 106 is established, the adjustable frequency drive trips on *warning/alarm 27, Brake IGBT*. If the connection is closed between 104 and 105, the adjustable frequency drive trips on *warning/alarm 27, Brake IGBT*.

Install a Klixon switch that is normally closed. If this function is not used, short-circuit 106 and 104 together.
Normally closed: 104–106 (factory-installed jumper)
Normally open: 104–105

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

Table 4.7 Terminals for Brake Resistor Temperature Switch

NOTICE!

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

4.1.10 Load Sharing

| Terminal number | Function |
|-----------------|--------------|
| 88, 89 | Load sharing |

Table 4.8 Terminals for Load Sharing

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

Load sharing enables the linking of the DC intermediate circuits of several adjustable frequency drives.

WARNING

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

WARNING

Line power disconnect may not isolate the adjustable frequency drive due to DC link connection.

4.1.11 Shielding against Electrical Noise

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

NOTICE!

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

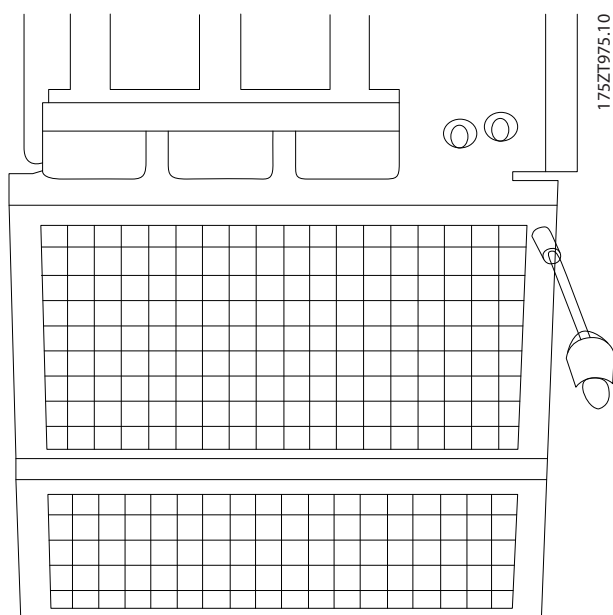


Figure 4.11 Mounting of EMC Shield

4.1.12 AC line input connections

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

| Terminal number | Function |
|-----------------|-----------------------------|
| 91, 92, 93 | Line power R/L1, S/L2, T/L3 |
| 94 | Ground |

Table 4.9 Line Terminals Connection

CAUTION

Check the nameplate to ensure that the AC line voltage of the adjustable frequency drive matches the power supply of the plant.

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

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

4.1.13 External Fan Supply

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

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

Table 4.10 External Fan Supply Terminals

The connector on the power card provides the connection of 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 an external supply is needed, the jumpers are removed and the supply is connected to terminals 100 and 101. Use a 5 A fuse for protection. In UL applications, use a Littelfuse KLK-5 or equivalent.

4.1.14 Fuses

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

NOTICE!

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

WARNING

Protect personnel and property against the consequence of component breakdown internally in the adjustable frequency drive.

Branch circuit protection

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

NOTICE!

The recommendations do not cover branch circuit protection for UL.

Short-circuit protection

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

Overcurrent protection

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

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

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

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

Non-UL compliance

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

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

Table 4.11 EN50178 Fuses

UL Compliance

380–480 V, Enclosure types E and F

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

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

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

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

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

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

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

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

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

525–690 V, Enclosure types E and F

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

Table 4.15 Enclosure Type E, 525–690 V

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

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

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

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

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

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

Supplementary fuses

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

Table 4.18 SMPS Fuse

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

Table 4.19 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, 6 A |
| 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, 20 A |
| P500-P1M0, 380–480 V | 10–16 | LPJ-25 SP or SPI | 25 A, 600 | Any listed Class J Dual Element, Time Delay, 25 A |
| P710-P1M4, 525–690 V | | LPJ-20 SP or SPI | 20 A, 600 | Any listed Class J Dual Element, Time Delay, 20 A |

Table 4.20 Manual Motor Controller Fuses

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

Table 4.21 30 A Fuse-protected Terminal Fuse

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

Table 4.22 Control Transformer Fuse

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

Table 4.23 NAMUR Fuse

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

Table 4.24 Safety Relay Coil Fuse with PILZ Relay

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

Table 4.25 Line Power Disconnectors Enclosure Sizes E and F

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

Table 4.26 Circuit Breakers Enclosure Size F

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

Table 4.27 Line Power Contactors Enclosure Size F

4.1.15 Motor Insulation

For motor cable lengths \leq the maximum cable length listed in *chapter 7 General Specifications*, the recommended motor insulation ratings are in *Table 4.28*. The peak voltage can be up to twice the DC link voltage, 2.8 times the AC line 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 AC line voltage | Motor insulation |
|----------------------------|------------------------------|
| $U_N \leq 420$ V | Standard $U_{LL} = 1300$ V |
| 420 V < $U_N \leq 500$ V | Reinforced $U_{LL} = 1600$ V |
| 500 V < $U_N \leq 600$ V | Reinforced $U_{LL} = 1800$ V |
| 600 V < $U_N \leq 690$ V | Reinforced $U_{LL} = 2000$ V |

Table 4.28 Motor Insulation at Various Nominal AC Line Voltages

4.1.16 Motor Bearing Currents

For motors with a rating of 110 kW (150 hp) or greater that operate via adjustable frequency drives, use NDE (Non-Drive End) insulated bearings to eliminate circulating bearing currents due to the physical size of the motor. To minimize DE (Drive End) bearing and shaft currents proper grounding of the adjustable frequency drive, motor, driven machine, and motor to the driven machine is required.

Although failure due to bearing currents is rare, if it occurs, use the following mitigation strategies.

Standard mitigation strategies:

- Use an insulated bearing.
- Apply rigorous installation procedures:
 - Ensure that the motor and load motor are aligned.
 - Strictly follow common EMC installation guidelines.
 - Reinforce the PE so the high frequency impedance is lower in the PE than the input power leads.
 - Provide a good high frequency connection between the motor and the adjustable frequency drive by shielded cable. The cable must have a 360° connection in the motor and adjustable frequency drive.
 - Ensure that the impedance from adjustable frequency drive to building ground is lower than the grounding impedance of the machine. Make a direct ground connection between the motor and load motor.
- Apply conductive lubrication.

- Try to ensure that the AC line voltage is balanced to ground. Balancing to ground can be difficult for IT, TT, TN-CS or grounded leg systems.
- Use an insulated bearing as recommended by the motor manufacturer.

NOTICE!

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

If none of these strategies work, consult the factory.

If necessary, after consulting Danfoss:

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

4.1.17 Control Cable Routing

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

Serial communication bus connection

Connections are made to the relevant options on the control card. For details, see the relevant serial communication bus instructions. Place the cable in the provided path inside the adjustable frequency drive and tie it down with other control wires (see *Figure 4.12* and *Figure 4.13*).

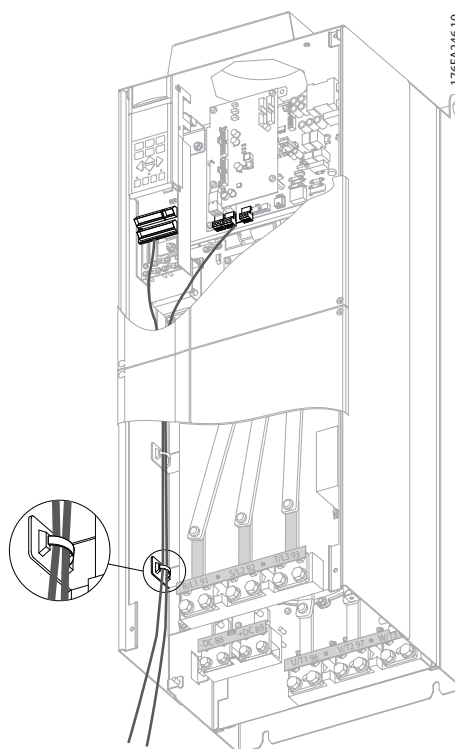


Figure 4.12 Control Card Wiring Path for E1 and E2

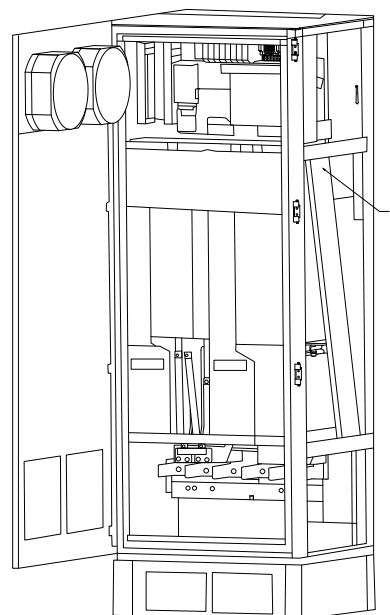
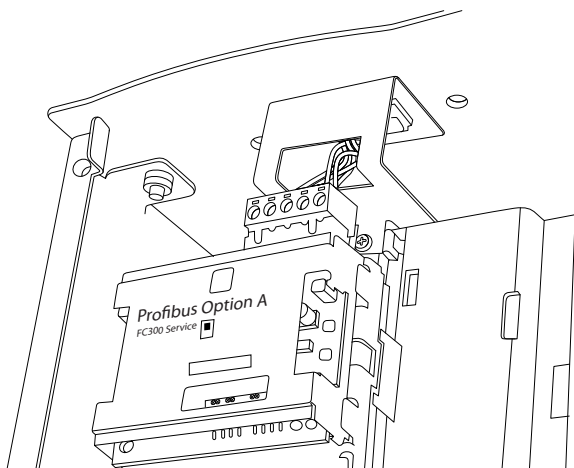


Figure 4.13 Control Card Wiring Path for F1/F3. Control Card Wiring for the F2/F4 Use the Same Path

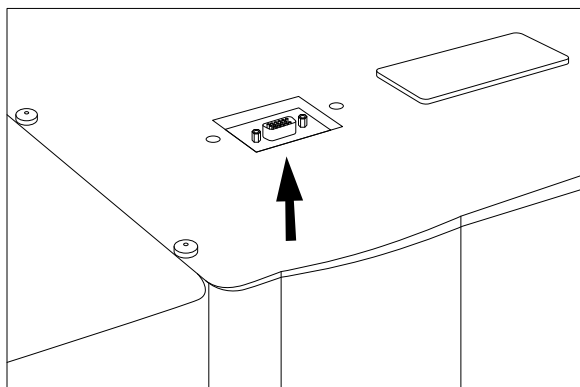
In the Chassis (IP00) and NEMA 1 units, it is also possible to connect the serial communication bus from the top of the unit as shown in *Figure 4.14* to *Figure 4.16*. On the NEMA 1 unit a cover plate must be removed.

Kit number for serial communication bus top connection: 176F1742.



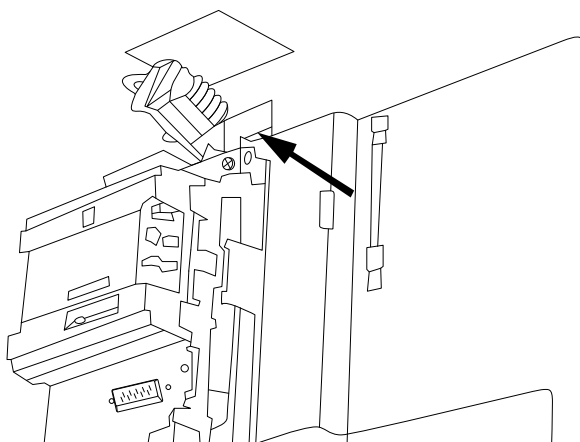
130BA867.10

Figure 4.14 Top Connection for Serial Communication Bus.



130BB255.10

Figure 4.15 Serial Communication Bus Top Entry Kit, Installed



130BB256.10

Figure 4.16 Shield Termination/Strain Relief for Serial Communication Bus Conductors

Installation of 24 V DC external supply

Torque: 0.5–0.6 Nm (5 in-lbs)

Screw size: M3

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

Table 4.29 Terminals for 24 V DC External Supply

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

⚠ WARNING

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

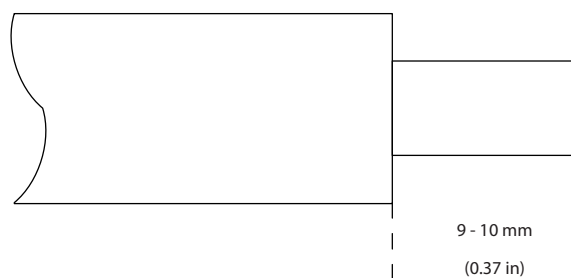
4.1.18 Access to Control Terminals

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

4.1.19 Electrical Installation, Control Terminals

To connect the cable to the terminal:

1. Strip off 9–10 mm (0.34–0.39 in) of the insulation.



130BA150.10

Figure 4.17 Strip off Insulation

2. Insert a screwdriver¹⁾ in the square hole.
3. Insert the cable in the adjacent circular hole.

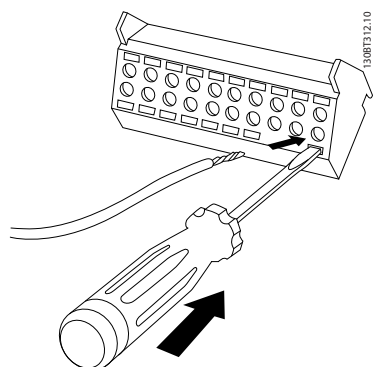


Figure 4.18 Inserting Cable

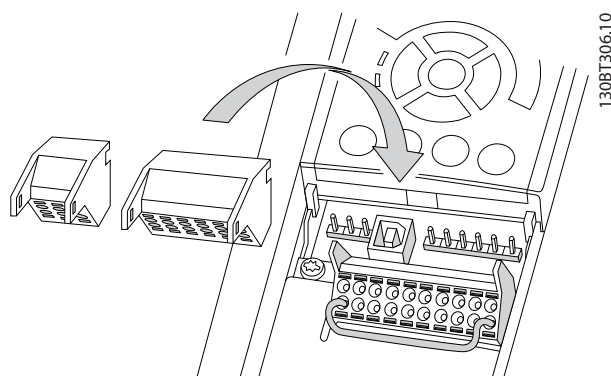


Figure 4.20 Unplugging Control Terminals

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

1) Maximum 0.4 x 2.5 mm

To remove the cable from the terminal:

1. Insert a screwdriver¹⁾ in the square hole.
2. Pull out the cable.

1) Max. 0.4 x 2.5 mm

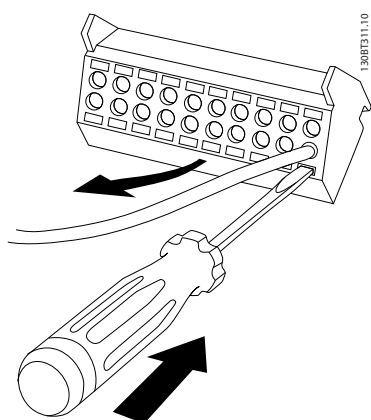


Figure 4.19 Removing Cable

4.1.20 Electrical Installation, Control Cables

4

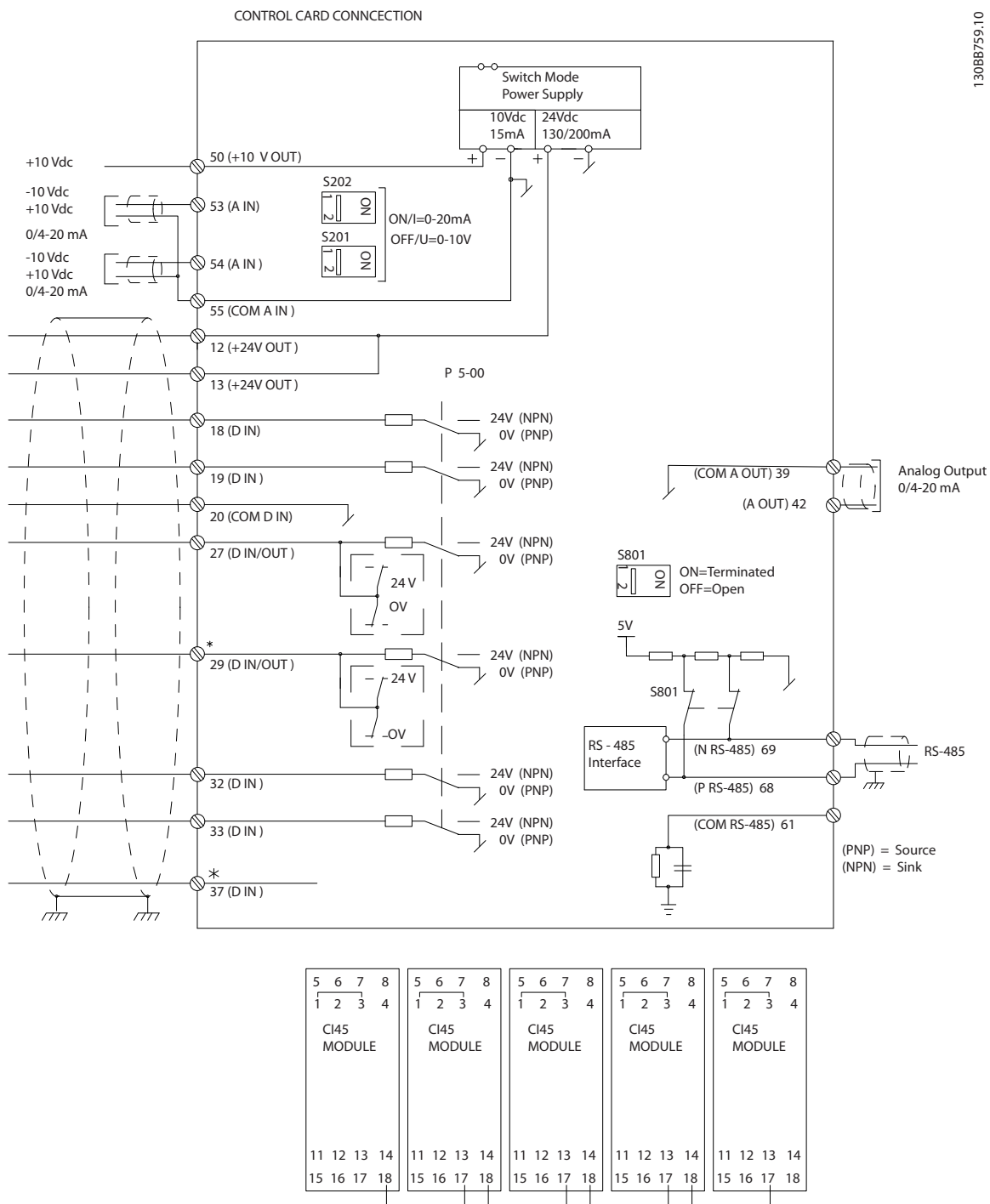


Figure 4.21 Electrical Terminals Diagram

A=Analog, D=Digital

*Terminal 37 (optional) is used for STO. For STO installation instructions, refer to the *Safe Torque Off Instruction Manual for Danfoss VLT® Adjustable Frequency Drives*.

**Do not connect cable shield.

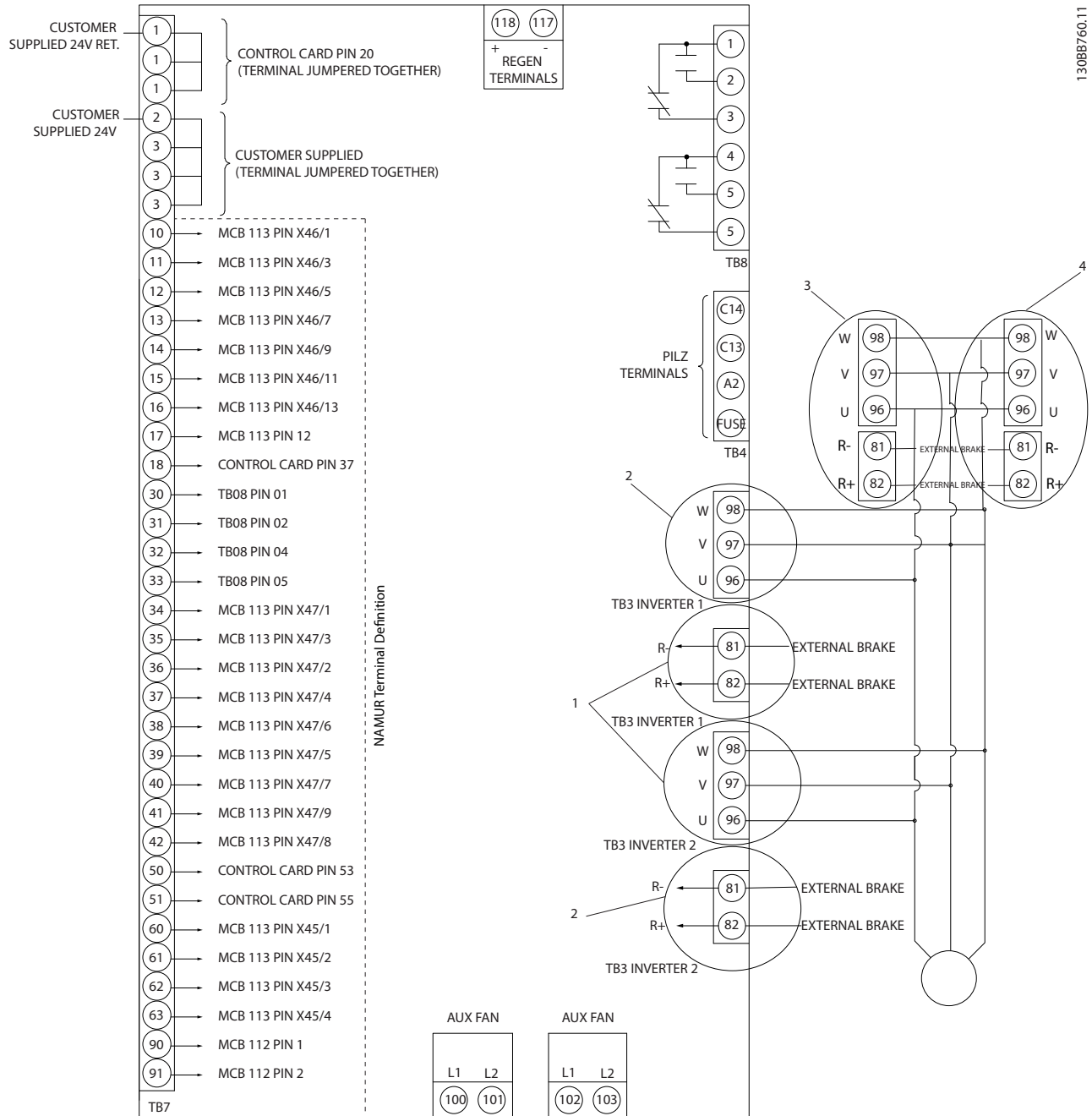


Figure 4.22 Diagram showing all Electrical Terminals with NAMUR Option

4

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 line power supply cables.

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

Connect the digital and analog inputs and outputs separately to the adjustable frequency drive 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

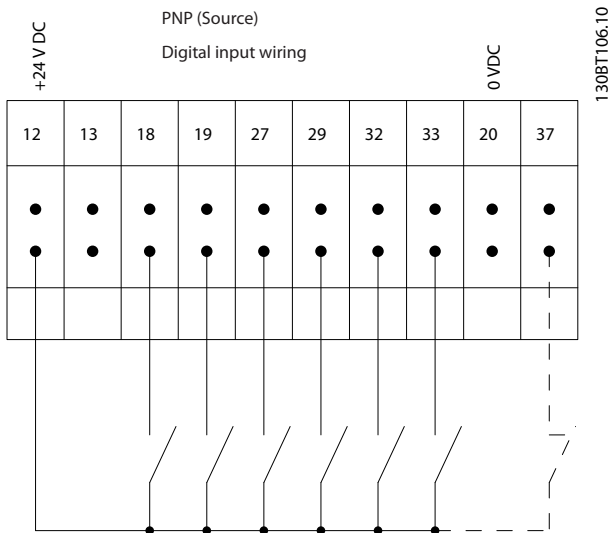


Figure 4.23 PNP Polarity

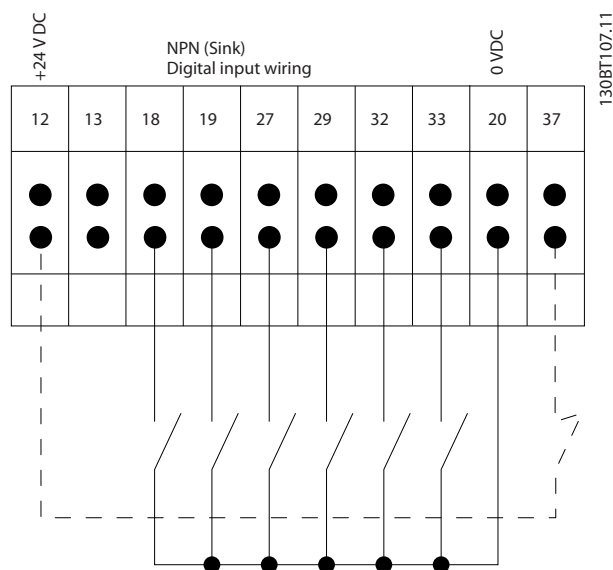


Figure 4.24 NPN Polarity

NOTICE!

Control cables must be shielded/armored.

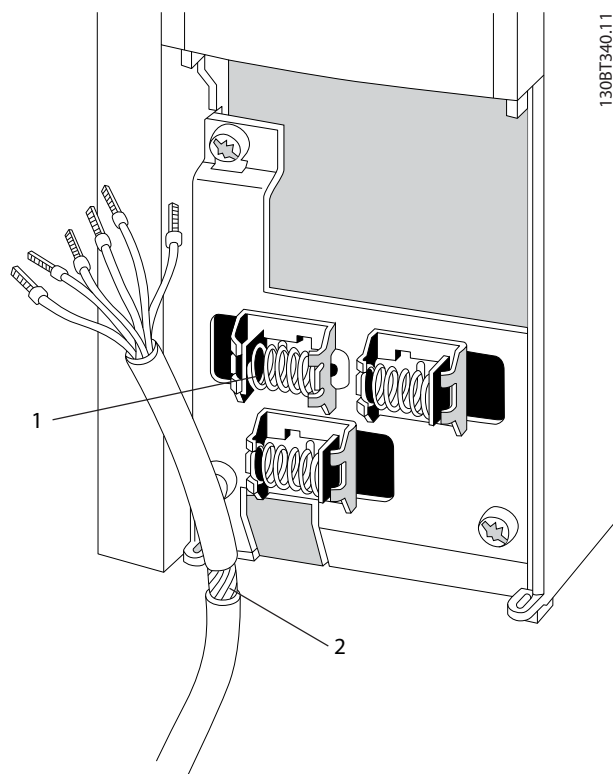


Figure 4.25 Shielded Control Cable

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

4.1.21 Switches S201, S202 and S801

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

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

See Figure 4.21.

Default setting:

S201 (A53) = OFF (voltage input)

S202 (A54) = OFF (voltage input)

S801 (Bus termination) = OFF

NOTICE!

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

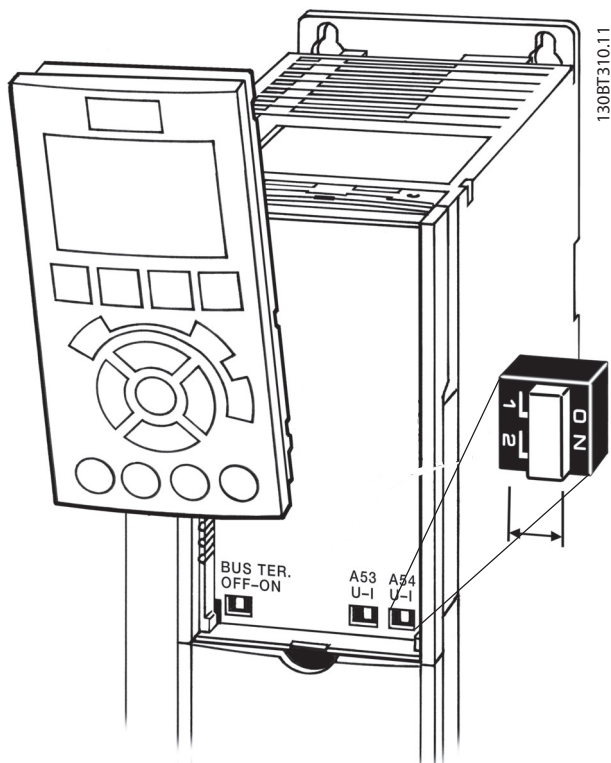


Figure 4.26 Switch Location

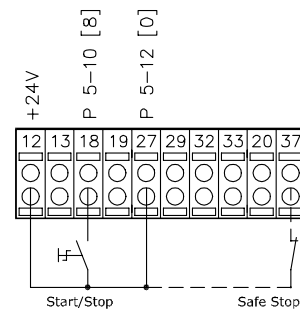
4.2 Connection Examples

4.2.1 Start/Stop

Terminal 18 = parameter 5-10 Terminal 18 Digital Input [8] Start

Terminal 27 = parameter 5-12 Terminal 27 Digital Input [0] No operation (Default coast inverse)

Terminal 37 = STO



130BA155.12

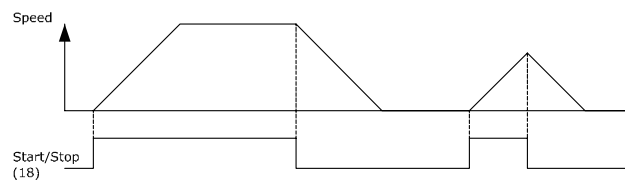


Figure 4.27 Wiring Start/Stop

4.2.2 Pulse Start/Stop

Terminal 18 = parameter 5-10 Terminal 18 Digital Input [9] Latched start
 Terminal 27 = parameter 5-12 Terminal 27 Digital Input [6] Stop inverse
 Terminal 37 = STO

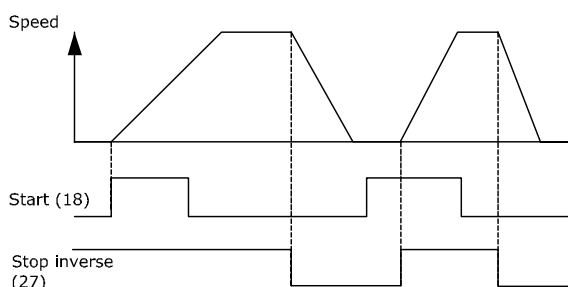
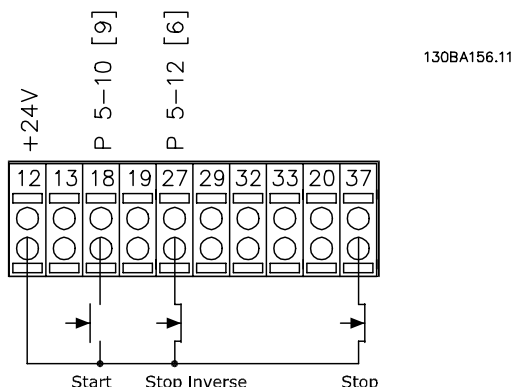


Figure 4.28 Wiring Pulse Start/Stop

4.2.3 Speed Up/Down

Terminals 29/32 = Speed up/down

Terminal 18 = parameter 5-10 Terminal 18 Digital Input [9] Start (default)
 Terminal 27 = parameter 5-12 Terminal 27 Digital Input [19] Freeze reference
 Terminal 29 = parameter 5-13 Terminal 29 Digital Input [21] Speed up
 Terminal 32 = parameter 5-14 Terminal 32 Digital Input [22] Slow

NOTICE

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

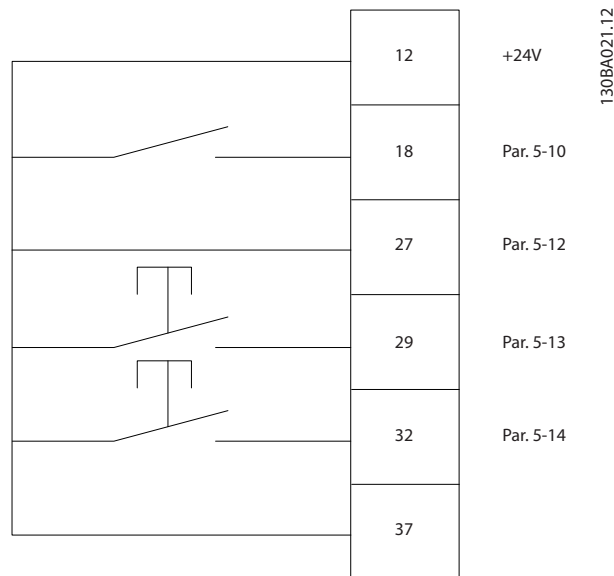


Figure 4.29 Speed Up/Down

4.2.4 Potentiometer Reference

Voltage reference via a potentiometer

Reference Source 1 = [1] Analog input 53 (default)
 Terminal 53, Low Voltage = 0 V
 Terminal 53, High Voltage = 10 V
 Terminal 53, Low Ref./Feedback = 0 RPM
 Terminal 53, High Ref./Feedback = 1500 RPM
 Switch S201 = OFF (U)

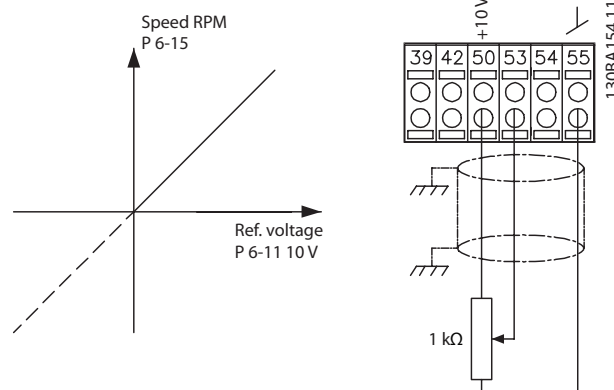


Figure 4.30 Potentiometer Reference

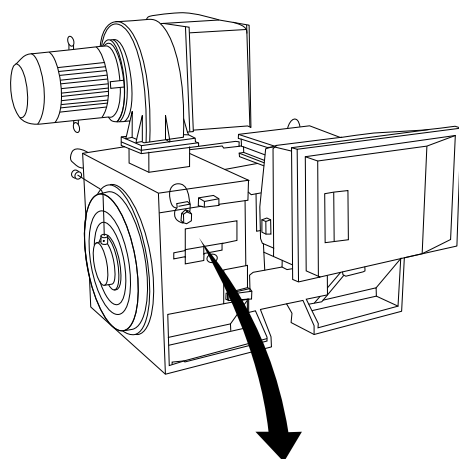
4.3 Final Set-up and Test

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

Step 1. Locate the motor nameplate.

NOTICE!

The motor is either star (Y) or delta connected (Δ). This information is on the motor nameplate.



1308A767.10

| 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 ϕ 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 | | | | | |

Figure 4.31 Nameplate

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

To access this list, press [Quick Menu], then select Q2 Quick Set-up "Quick".

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

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 parameter 5-12 Terminal 27 Digital Input to [0] No function.
3. Activate the AMA parameter 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 adjustable frequency drive enters into alarm mode and the display shows that the user terminated the AMA.

Successful AMA

1. The display shows *Press [OK] to finish AMA*.
2. Press [OK] to exit the AMA state.

Unsuccessful AMA

1. The adjustable frequency drive enters into alarm mode. A description of the alarm can be found in .
2. *Report Value* in the [Alarm Log] shows the last measuring sequence carried out by the AMA before the adjustable frequency drive entered alarm mode. This number along with the description of the alarm helps with troubleshooting. State the alarm number and description when contacting Danfoss service.

NOTICE!

Incorrectly registered motor nameplate data, or a difference between the motor power size and the adjustable frequency drive power size that is too large often causes unsuccessful AMA.

Step 4. Set the speed limit and ramp time.

- Parameter 3-02 Minimum Reference
- Parameter 3-03 Maximum Reference

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

- Parameter 4-11 Motor Speed Low Limit [RPM] or parameter 4-12 Motor Speed Low Limit [Hz]
- Parameter 4-13 Motor Speed High Limit [RPM] or parameter 4-14 Motor Speed High Limit [Hz]
- Parameter 3-41 Ramp 1 Ramp-up Time
- Parameter 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 adjustable frequency drive 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 parameter 2-20 Release Brake Current.
- The brake is engaged when the output frequency is less than the frequency set in parameter 2-21 Activate Brake Speed [RPM] or parameter 2-22 Activate Brake Speed [Hz], and only if the adjustable frequency drive carries out a stop command.

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

4.4.2 Parallel Connection of Motors

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

NOTICE!

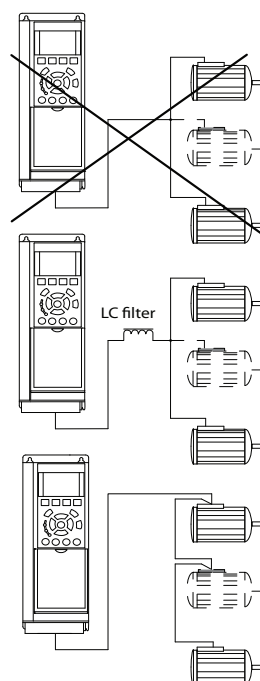
Installations with cables connected in a common joint as in Figure 4.32 are only recommended for short cable lengths.

NOTICE!

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

NOTICE!

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



130BA170.11

Figure 4.32 Parallel Motor Connection

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

4.4.3 Motor Thermal Protection

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

For thermal motor protection, it is also possible to use the VLT PTC Thermistor Card MCB 112 option. This card provides an ATEX certificate to protect motors in explosion hazard areas, Zone 1/21 and Zone 2/22. When *parameter 1-90 Motor Thermal Protection* is set to [20] *ATEX ETR* and is combined with the use of MCB 112, it is possible to control an Ex-e motor in explosion hazardous areas. Consult the relevant *programming guide* for details on how to set up the adjustable frequency drive for safe operation of Ex-e motors.

5 How to Operate the Adjustable Frequency Drive

5.1 Operating with LCP

5.1.1 Three Ways of Operating

The adjustable frequency drive can be operated in 3 ways:

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

If the adjustable frequency drive is fitted with serial communication option option, refer to the relevant documentation.

5.1.2 How to Operate the 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 LEDs (LEDs).
4. Operation keys and LEDs.

Graphical display

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

Display lines:

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

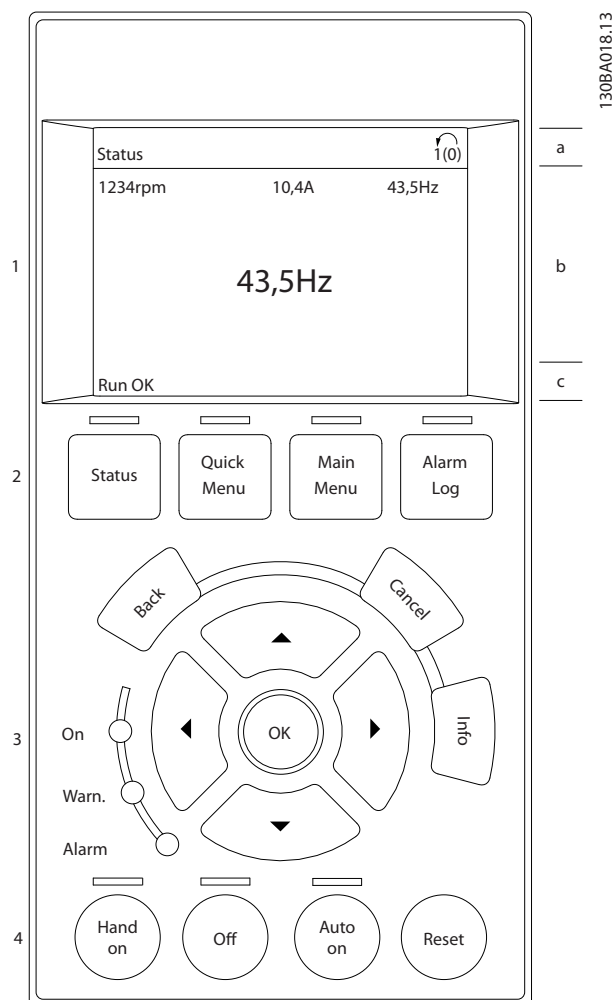


Figure 5.1 LCP

The display is divided into three sections:

Top section

(a) shows the status when in status mode, or up to two 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 *parameter 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 five variables with related unit, regardless of status. In the event of an alarm/warning, the warning is shown instead of the variables.

Bottom section

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

Press [Status] to toggle between three status readout displays.

Operating variables with different formatting are shown in each status screen. See the examples below.

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

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

Ex.: Current readout
5.25 A; 15.2 A 105 A.

Status display I

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

See the operating variables shown in the display in *Figure 5.2*. 1.1, 1.2 and 1.3 are shown in small size. 2 and 3 are shown in medium size.

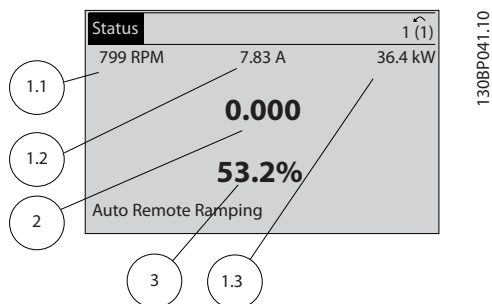


Figure 5.2 Example of Status Display I

Status display II

See the operating variables (1.1, 1.2, 1.3, and 2) shown in the display in *Figure 5.3*.

In the example, speed, motor current, motor power and frequency are selected as variables in the first and second lines.

1.1, 1.2 and 1.3 are shown in small size. 2 is shown in large size.

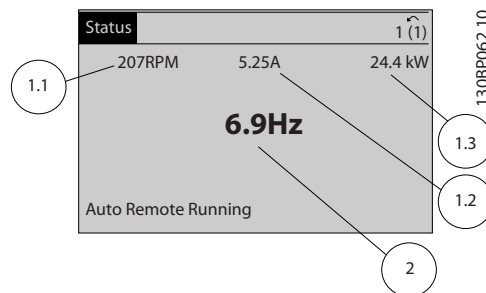


Figure 5.3 Example of Status Display II

Status display III

This state displays the event and action of the smart logic control.

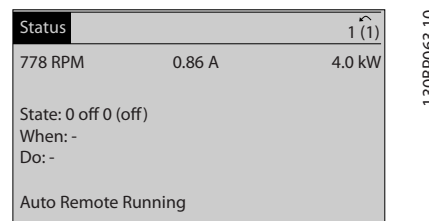


Figure 5.4 Example of Status Display III

Display contrast adjustment

Press [status] and [▲] for darker display.
Press [status] and [▼] for brighter display.

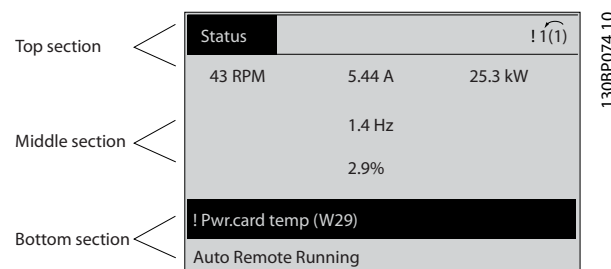


Figure 5.5 Display Sections

LEDs

If certain threshold values are exceeded, the alarm and/or warning LED lights up. A status and alarm text appear in the display.

The On LED is activated when the adjustable frequency drive receives power from AC line voltage, a DC bus terminal, or a 24 V external supply. At the same time, the backlight is on.

- Green LED/On: Control section is working.
- Yellow LED/Warn.: Indicates a warning.

- Flashing Red LED/Alarm: Indicates an alarm.

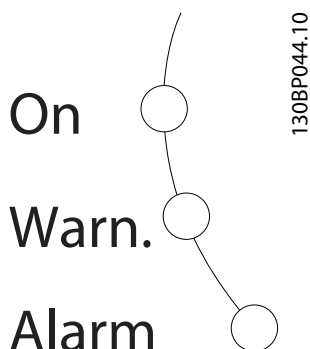


Figure 5.6 LEDs

GLCP keys

Menu keys

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



Figure 5.7 Menu Keys

[Status]

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

- 5-line readouts
- 4-line readouts
- smart logic control

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

[Quick Menu]

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

The Quick Menu consists of

- My personal menu
- Quick set-up
- Function Set-up
- Changes made
- Loggings

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

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

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

The Quick Menu parameters can be accessed immediately unless a password has been created via *parameter 0-60 Main Menu Password*, *parameter 0-61 Access to Main Menu w/o Password*, *parameter 0-65 Personal Menu Password* or *parameter 0-66 Access to Personal Menu w/o Password*.

It is possible to switch directly between *Quick Menu* mode and *Main Menu* mode.

[Main Menu]

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

It is possible to switch directly between *Main Menu* mode and *Quick Menu* mode.

Parameter shortcut can be carried out by pressing [Main Menu] for 3 s. The parameter shortcut allows direct access to any parameter.

[Alarm Log]

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

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

[Back]

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



Figure 5.8 Back Key

[Cancel]

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



Figure 5.9 Cancel Key

[Info]

[Info] displays information about a command, parameter, or function in any display window. [Info] provides detailed information when needed.

Exit Info mode by pressing either [Info], [Back], or [Cancel].



Figure 5.10 Info Key

Navigation Keys

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

[OK]

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

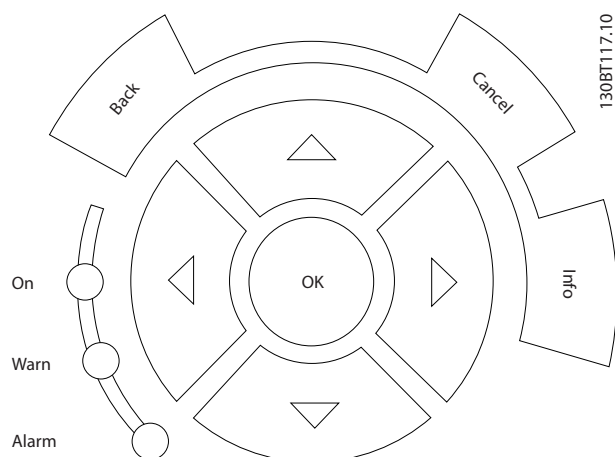


Figure 5.11 Navigation Keys

Operation keys

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

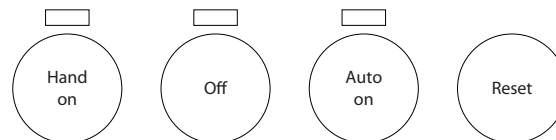


Figure 5.12 Operation Keys

[Hand On]

[Hand On] enables control of the adjustable frequency drive via the GLCP. [Hand On] also starts the motor and allows entering the motor speed data with the navigation keys. The key can be selected as [1] Enable or [0] Disable via parameter 0-40 [Hand on] Key on LCP.

The following control signals are still active when [Hand On] is activated:

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

NOTICE!

External stop signals activated with control signals or a serial communication bus override a start command via the LCP.

[Off]

[Off] stops the connected motor. The key can be selected as [1] Enabled or [0] Disabled via parameter 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 line power supply.

[Auto On]

[Auto On] enables the adjustable frequency drive 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 adjustable frequency drive starts. The key can be selected as [1] Enabled or [0] Disabled via parameter 0-42 [Auto on] Key on LCP.

NOTICE!

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

[Reset]

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

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

5.2 Operating via Serial Communication

5.2.1 RS-485 Bus Connection

One or more adjustable frequency drives can be connected to a controller (or master) using the standard RS-485 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 adjustable frequency drive is connected to a master, use parallel connections.

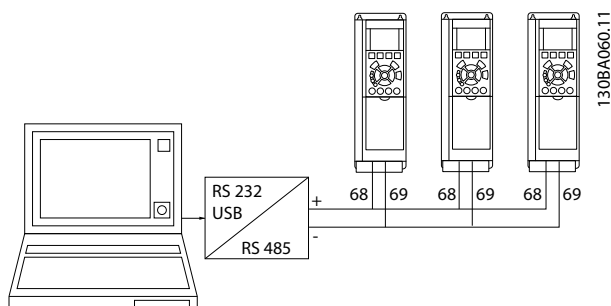


Figure 5.13 Connection Example

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

Bus termination

Terminate the RS-485 bus by a resistor network at both ends. If the adjustable frequency drive is the first or the last device in the RS-485 loop, set the switch S801 on the control card to ON.

For more information, see the paragraph *Switches S201, S202, and S801*.

5.3 Operating via PC

5.3.1 How to Connect a PC to the Adjustable Frequency Drive

To control or program the adjustable frequency drive from a PC, install the PC-based configuration tool MCT 10 Set-up Software.

The PC is connected via a standard (host/device) USB cable, or via the RS-485 interface as shown in chapter 5.2.1 RS-485 Bus Connection.

NOTICE!

The USB connection is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals. The USB connection is connected to protective ground. Use only an isolated laptop as PC connection to the USB connector on the adjustable frequency drive.

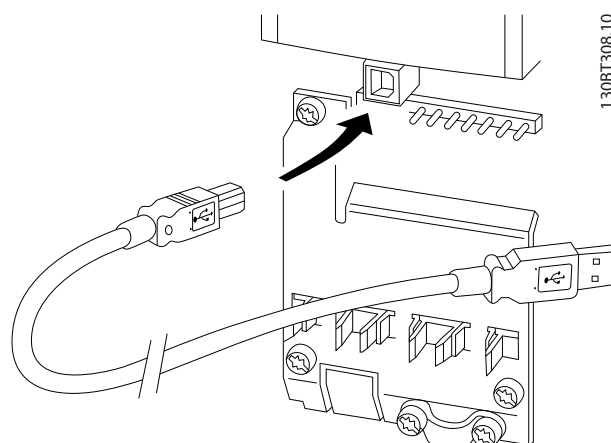


Figure 5.14 USB Connection to Adjustable Frequency Drive

5.3.2 PC Software Tools

PC-based MCT 10 Set-up Software

All adjustable frequency drives are equipped with a serial communication port. Danfoss provides a PC tool for communication between PC and adjustable frequency drive. Check the section in chapter 1.2.1 *Additional Resources* for detailed information on this tool.

MCT 10 Set-up Software

MCT 10 Set-up Software has been designed as an easy-to-use interactive tool for setting parameters in our adjustable frequency drives.

The MCT 10 Set-up Software is useful for:

- Planning a communication network off-line. MCT 10 Set-up Software contains a complete adjustable frequency drive database.
- Commissioning adjustable frequency drives online.
- Saving settings for all adjustable frequency drives.
- Replacing an adjustable frequency drive in a network.
- Simple and accurate documentation of adjustable frequency drive settings after commissioning.
- Expanding an existing network.
- Supporting future-developed adjustable frequency drives.

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

Save adjustable frequency drive settings:

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

All parameters are now stored on the PC.

Load adjustable frequency drive settings:

1. Connect a PC to the adjustable frequency drive 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 adjustable frequency drive.

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

The MCT 10 Set-up Software modules

The following modules are included in the software package.

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

Table 5.1 The MCT 10 Set-up Software Modules

Ordering number

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

The software can be downloaded from the Danfoss internet site at www.Danfoss.com/BusinessAreas/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* provide the simplest and quickest access to the most required parameters.
- Whenever possible, performing an AMA ensures the best shaft performance.
- Adjust display contrast by pressing [Status] and [▲] for darker display, or by pressing [Status] and [▼] for brighter display.
- Under *Quick Menu* and *Changes Made*, all parameters which have been changed from factory settings are displayed.
- Press and hold [Main Menu] key for 3 s to access to any parameter.
- For service purposes, copy all parameters to the LCP. See *parameter 0-50 LCP Copy* for further information.

5.3.4 Quick Transfer of Parameter Settings when Using GLCP

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

⚠ WARNING

Stop the motor before performing any of these operations.

Data storage in the LCP:

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

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

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

Data transfer from the LCP to the adjustable frequency drive

1. Go to *parameter 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 adjustable frequency drive, as indicated by the progress bar. When 100% is reached, press [OK].

5.3.5 Initialization to Default Settings

There are two ways to initialize the adjustable frequency drive to default:

- Recommended initialization
- Manual initialization

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

Recommended initialization (via *parameter 14-22 Operation Mode*)

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

Parameter 14-22 Operation Mode initializes all except:

- *Parameter 14-50 RFI 1*.
- *Parameter 8-30 Protocol*.
- *Parameter 8-31 Address*.
- *Parameter 8-32 Baud Rate*.
- *Parameter 8-35 Minimum Response Delay*.
- *Parameter 8-36 Max Response Delay*.
- *Parameter 8-37 Maximum Inter-Char Delay*.
- *Parameter 15-00 Operating hours to parameter 15-05 Over Volts*.
- *Parameter 15-20 Historic Log: Event to parameter 15-22 Historic Log: Time*.
- *Parameter 15-30 Alarm Log: Error Code to parameter 15-32 Alarm Log: Time*.

NOTICE!

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

Manual initialization

NOTICE!

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

1. Disconnect from the line power and wait until the display turns off.
2. Press
 - 2a [Status] - [Main Menu] - [OK] at the same time while powering up for the LCP 102, graphical LCP.
 - 2b [Menu] while powering up for LCP 101, numerical LCP.
3. Release the keys after 5 s.
4. The adjustable frequency drive is now programmed according to default settings.

This parameter initializes all except:

Parameter 15-00 Operating hours

Parameter 15-03 Power-ups

Parameter 15-04 Over Temps

Parameter 15-05 Over Volts

6 How to Program

6.1 Basic Programming

6.1.1 Parameter Set-up

6

| Group | Title | Function |
|-------|-----------------------|--|
| 0-** | Operation and Display | Parameters used to program the fundamental functions of the adjustable frequency drive and the LCP including: <ul style="list-style-type: none"> • Selection of language. • Selection of which variables are displayed at each position in the display. As an example, static duct pressure or condenser water return temperature can be displayed with the setpoint in small digits in the top row and feedback in large digits in the center of the display). • Enabling/disabling of the LCP keys. • Passwords for the LCP. • Upload and download of commissioned parameters to/from the LCP. • Setting the built-in clock. |
| 1-** | Load/Motor | Parameters used to configure the adjustable frequency drive for the specific application and motor including: <ul style="list-style-type: none"> • Open or closed-loop operation. • Type of application such as: <ul style="list-style-type: none"> - Compressor - Fan - Centrifugal pump • Motor nameplate data. • Auto-tuning of the adjustable frequency drive to the motor for optimum performance. • Flying start (typically used in fan applications). • Thermal motor protection. |
| 2-** | Brakes | Parameters used to configure brake functions of the adjustable frequency drive, which, although not common in many HVAC applications, can be useful in special fan applications. Parameters include: <ul style="list-style-type: none"> • DC brake. • Dynamic/resistor brake. • Overvoltage control (which provides automatic adjustment of the deceleration rate (auto-ramping) to avoid tripping when decelerating large inertia fans). |

| Group | Title | Function |
|-------|---------------------------|---|
| 3-** | Reference/Ramps | Parameters used to program the following: <ul style="list-style-type: none"> • Minimum and maximum reference limits of speed (RPM/Hz) in open-loop or in actual units when operating in closed-loop. • Digital/preset references. • Jog speed. • Definition of the source of each reference (for example, to which analog input is the reference signal connected). • Ramp-up and ramp-down times. • Digital potentiometer settings. |
| 4-** | Limits/Warnings | Parameters used to program limits and warnings of operation including: <ul style="list-style-type: none"> • Allowable motor direction. • Minimum and maximum motor speeds. As an example, in pump applications the minimum speed is often set to approximately 30–40%. This speed ensures that pump seals are always adequately lubricated, avoid cavitation and ensure that adequate head is always produced to create flow). • Torque and current limits to protect the pump, fan or compressor driven by the motor. • Warnings for low/high current, speed, reference, and feedback. • Missing motor phase protection. • Speed bypass frequencies, including semi-automatic set-up of these frequencies (for example, to avoid resonance conditions on cooling tower and other fans). |
| 5-** | Digital In/Out | Parameters used to programme the functions of all <ul style="list-style-type: none"> • digital inputs • digital outputs • relay outputs • pulse inputs • pulse outputs for terminals on the control card and all option cards. |
| 6-** | Analog In/Out | Parameters used to program the functions associated with all analog inputs and analog outputs for the control card terminals and general purpose I/O option (MCB 101). The parameters include: <ul style="list-style-type: none"> • 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). • Scaling of the analog input signals (for example, to match the analog input to the mA and pressure range of a static duct pressure sensor). • Filter time constant to filter out electrical noise on the analog signal, which sometimes occurs when long cables are installed. • Function and scaling of the analog outputs (for example, to provide an analog output representing motor current or kW to an analog input of a DDC controller). • Configuring the analog outputs to be controlled by the BMS via a high-level interface (HLI) (for example to control a chilled water valve) including ability to define a default value of these outputs in the event of the HLI failing. |
| 8-** | Communication and Options | Parameters used for configuring and monitoring functions associated with the serial communications/high-level interface to the adjustable frequency drive. |
| 9-** | Profibus | Parameters only applicable when a PROFIBUS option is installed. |
| 10-** | CAN Fieldbus | Parameters only applicable when a DeviceNet option is installed. |

| Group | Title | Function |
|-------|------------------------|--|
| 11-** | LonWorks | Parameters only applicable when a LonWorks option is installed. |
| 13-** | Smart Logic Controller | <p>Parameters used to configure the built-in smart logic controller (SLC). The SLC can be used for:</p> <ul style="list-style-type: none"> • Simple functions such as: <ul style="list-style-type: none"> • Comparators (for example, if running above x Hz, activate output relay). • Timers (for example, when a start signal is applied, first activate output relay to open supply air damper and wait x seconds before ramping up). • Complex sequence of user-defined actions executed by the SLC when the associated user-defined event is evaluated as TRUE by the SLC. For example, initiate an economizer mode in a simple AHU cooling application control scheme where there is no BMS. For such an application, the SLC can monitor the outside air relative humidity. If the relative humidity is below a defined value, the supply air temperature setpoint could be automatically increased. With the adjustable frequency drive 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. <p>The SLC can often replace the need for other external control equipment.</p> |
| 14-** | Special Functions | <p>Parameters used to configure special functions of the adjustable frequency drive including:</p> <ul style="list-style-type: none"> • Setting of the switching frequency to reduce audible noise from the motor (sometimes required for fan applications). • Kinetic backup function (especially useful for critical applications in semi-conductor installations where performance under line power dip/line power loss is important). • Line imbalance protection. • Automatic reset (to avoid the need for a manual reset of alarms). • Energy-optimization parameters. Normally, these parameters do not need changing. Fine-tuning of this automatic function ensures that the adjustable frequency drive and motor combination operate at their optimum efficiency. • Autoderating functions enabling the adjustable frequency drive to continue operation at reduced performance under extreme operating conditions ensuring maximum up-time. |
| 15-** | FC Information | <p>Parameters providing operating data and other adjustable frequency drive information including:</p> <ul style="list-style-type: none"> • Operating and running hour counters. • kWh counter; resetting of the running and kWh counters. • Alarm/fault log (where the past 10 alarms are logged along with any associated value and time). • Adjustable frequency drive and option card identification parameters, such as code number and software version. |
| 16-** | Data Readouts | <p>Read-only parameters which display the status/value of many operating variables that can be displayed on the LCP or viewed in this parameter group. These parameters can be useful during commissioning when interfacing with a BMS via a high-level interface.</p> |
| 18-** | Info & Readouts | <p>Read-only parameters which display useful information for commissioning when interfacing with a BMS via a high-level interface. The information contains data such as:</p> <ul style="list-style-type: none"> • The last 10 preventive maintenance log items. • Actions and time. • The value of analog inputs and outputs on the analog I/O option card. |

| Group | Title | Function |
|-------|-----------------------|---|
| 20-** | FC Closed-loop | <p>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:</p> <ul style="list-style-type: none"> Defining where each of the three possible feedback signals come from (for example, which analog input or the BMS HLI). Conversion factor for each of the feedback signals. An example could be a pressure signal used for indication of flow in an AHU or converting from pressure to temperature in a compressor application). Engineering unit for the reference and feedback (for example, Pa, kPa, m Wg, in Wg, bar, m3/s, m3/h, °C, °F, etc). The function (for example, sum, difference, average, minimum or maximum) used to calculate the resulting feedback for single-zone applications or the control philosophy for multi-zone applications. Programming of the setpoints. Manual tuning or auto-tuning of the PI(D) loop. |
| 21-** | Extended Closed-loop | <p>Parameters used to configure the three extended closed-loop PI(D) controllers. The controllers can, for example, be used to control external servos (for example, chilled water valve to maintain supply air temperature in a VAV system) including:</p> <ul style="list-style-type: none"> Engineering unit for the reference and feedback of each controller (for example, °C, °F). Defining the range of the reference/setpoint for each controller. Defining where each of the references/setpoints and feedback signals come from (for example, which analog input or the BMS HLI). Programming of the setpoint, and manual tuning or auto-tuning of each of the PI(D) controllers. |
| 22-** | Application Functions | <p>Parameters used to monitor, protect and control pumps, fans and compressors, including:</p> <ul style="list-style-type: none"> No-flow detection and protection of pumps (including auto-setup of this function). Dry-pump protection. End-of-curve detection and protection of pumps. Sleep mode (especially useful for cooling tower and booster pump sets). Broken-belt detection (typically used for fan applications to detect no air flow instead of using a Δp switch installed across the fan). Short-cycle protection of compressors and pump flow compensation of setpoint (especially useful for secondary chilled water pump applications where the Δp sensor has been installed close to the pump and not across the furthest most significant load(s) in the system). Using this function can compensate for the sensor installation and help to realize the maximum energy savings). |
| 23-** | Time-based Functions | <p>Time-based parameters including:</p> <ul style="list-style-type: none"> Parameters used to initiate daily or weekly actions based on the built-in real time clock. The actions could be change of setpoint for night set-back mode or start/stop of the pump/fan/compressor start/stop of an external equipment). Preventive maintenance functions, which can be based on running or operating hour time intervals or on specific dates and times. Energy log (especially useful in retrofit applications or where information of the actual historical load (kW) on the pump/fan/compressor is of interest). Trending (useful in retrofit or other applications where there is an interest to log operating power, current, frequency or speed of the pump/fan/compressor for analysis and a payback counter). |

| Group | Title | Function |
|-------|---------------------------|--|
| 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). |
| 26-** | Analog I/O Option MCB 109 | Parameters used to configure the analog I/O option (MCB 109) including: <ul style="list-style-type: none"> • Definition of the analog input types (for example, voltage, Pt1000 or Ni1000). • Scaling and definition of the analog output functions and scaling. |

Table 6.1 Parameter Groups

6

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

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

6.1.2 Quick Menu Mode

Parameter data

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

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

Example of changing parameter data

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

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

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

Select Q1 My Personal Menu to display personal parameters

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

Select Changes Made to obtain information about:

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

Loggings

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

Quick Set-up

Efficient parameter set-up for HVAC applications

The parameters can easily be set up for most HVAC applications only by using the *Quick Set-up*.

After pressing [Quick Menu], the different options in the Quick Menu are listed. See also Figure 6.1 and Table 6.3 to Table 6.6.

Example of using the Quick Set-up

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

1. Select *Quick Set-up*. *Parameter 0-01 Language* in Quick Set-up appears.
2. Press [▼] repeatedly until *parameter 3-42 Ramp 1 Ramp-down Time* appears with the default setting of 20 s.
3. Press [OK].
4. Press [◀] to highlight the third digit before the comma.
5. Change 0 to 1 by pressing [▲].
6. Press [▶] to highlight the digit 2.
7. Change 2 to 0 by pressing [▼].
8. Press [OK].

The new ramp-down time is now set to 100 s.



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Figure 6.1 Quick Menu View

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

| Parameter | [Units] |
|--|---------|
| Parameter 0-01 Language | |
| Parameter 1-20 Motor Power [kW] | [kW] |
| Parameter 1-21 Motor Power [HP] | [hp] |
| Parameter 1-22 Motor Voltage ¹⁾ | [V] |
| Parameter 1-23 Motor Frequency | [Hz] |
| Parameter 1-24 Motor Current | [A] |
| Parameter 1-25 Motor Nominal Speed | [RPM] |
| Parameter 1-28 Motor Rotation Check | [Hz] |

| Parameter | [Units] |
|--|---------|
| Parameter 3-41 Ramp 1 Ramp-up Time | [s] |
| Parameter 3-42 Ramp 1 Ramp-down Time | [s] |
| Parameter 4-11 Motor Speed Low Limit [RPM] | [RPM] |
| Parameter 4-12 Motor Speed Low Limit [Hz] ¹⁾ | [Hz] |
| Parameter 4-13 Motor Speed High Limit [RPM] | [RPM] |
| Parameter 4-14 Motor Speed High Limit [Hz] ¹⁾ | [Hz] |
| Parameter 3-19 Jog Speed [RPM] | [RPM] |
| Parameter 3-11 Jog Speed [Hz] ¹⁾ | [Hz] |
| Parameter 5-12 Terminal 27 Digital Input | |
| Parameter 5-40 Function Relay ²⁾ | |

Table 6.2 Quick Set-up Parameters

- 1) The information shown in the display depends on the selections made in parameter 0-02 Motor Speed Unit and parameter 0-03 Regional Settings. The default settings of parameter 0-02 Motor Speed Unit and parameter 0-03 Regional Settings depend on which region of the world the adjustable frequency drive is supplied to but can be reprogrammed as required.
- 2) Parameter 5-40 Function Relay is an array. Select between [0] Relay1 or [1] Relay2. Standard setting is [0] Relay1 with the default option [9] Alarm.

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

NOTICE!

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

| 0-01 Language | | |
|---------------|------------|--|
| Option: | Function: | |
| | | Defines display language. The adjustable frequency drive is delivered with four 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 |

| 0-01 Language | | |
|---------------|------------------|----------------------------|
| Option: | Function: | |
| [10] | Chinese | Part of language package 2 |
| [20] | Suomi | Part of language package 1 |
| [22] | English US | Part of language package 4 |
| [27] | Greek | Part of language package 4 |
| [28] | Bras.port | Part of language package 4 |
| [36] | Slovenian | Part of language package 3 |
| [39] | Korean | Part of language package 2 |
| [40] | Japanese | Part of language package 2 |
| [41] | Turkish | Part of language package 4 |
| [42] | Trad.Chinese | Part of language package 2 |
| [43] | Bulgarian | Part of language package 3 |
| [44] | Srpski | Part of language package 3 |
| [45] | Romanian | Part of language package 3 |
| [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 |

NOTICE!

Parameter 1-20 Motor Power [kW], parameter 1-21 Motor Power [HP], parameter 1-22 Motor Voltage and parameter 1-23 Motor Frequency will not have effect when parameter 1-10 Motor Construction = [1] PM, non-salient SPM.

| 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 parameter 0-03 Regional Settings, either parameter 1-20 Motor Power [kW] or parameter 1-21 Motor Power [HP] is made invisible. | |

| 1-20 Motor Power [kW] | | |
|-----------------------|-----------|---|
| Range: | Function: | |
| | | NOTICE! This parameter cannot be adjusted while the motor is running. |

| 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 parameter 0-03 Regional Settings, either parameter 1-20 Motor Power [kW] or parameter 1-21 Motor Power [HP] is made invisible. | |
| | | NOTICE! This parameter cannot be adjusted while the motor is running. |

| 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. | |
| | | NOTICE! This parameter cannot be adjusted while the motor is running. |

| 1-23 Motor Frequency | | |
|-------------------------------|---|--|
| Range: | Function: | |
| Size related* [20 - 1000 Hz] | Select the motor frequency value from the motor nameplate data. For 87 Hz operation with 230/400 V motors, set the nameplate data for 230 V/50 Hz. Adapt parameter 4-13 Motor Speed High Limit [RPM] and parameter 3-03 Maximum Reference to the 87 Hz application. | |

NOTICE!

This parameter cannot be adjusted while the motor is running.

| 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. |

NOTICE!

This parameter cannot be adjusted while the motor is running.

| 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. |

NOTICE!

This parameter cannot be adjusted while the motor is running.

| 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: "Please Note! Motor may run in wrong direction". Pressing [OK], [Back] or [Cancel] will dismiss the message and display a new message: "Press [Hand On] to start the motor. Press [Cancel] to abort". Pressing [Hand On] starts the motor at 5 Hz in the forward direction; 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, two motor phase cables should be interchanged.

⚠ WARNING

Line power must be removed 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 adjustable frequency drive is running when the jog function is activated. See also <i>parameter 3-80 Jog Ramp Time</i> . |

| 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 <i>parameter 1-25 Motor Nominal Speed</i> . Choose a ramp-up time such that the output current does not exceed the current limit in <i>parameter 4-18 Current Limit</i> during ramping. See ramp-down time in <i>parameter 3-42 Ramp 1 Ramp-down Time</i> . |

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

| 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 <i>parameter 1-25 Motor Nominal Speed</i> to 0 RPM. Choose a ramp-down time such that no overvoltage arises in the inverter due to regenerative operation of the motor, and such that the generated current does not exceed the current limit set in <i>parameter 4-18 Current Limit</i> . See ramp-up time in <i>parameter 3-41 Ramp 1 Ramp-up Time</i> . |

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

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

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

| 4-13 Motor Speed High Limit [RPM] | | |
|-----------------------------------|--------------------------|--|
| Range: | Function: | |
| Size related* | [par. 4-11 - 60000 RPM] | <p>NOTICE!</p> <p>Any changes in <i>parameter 4-13 Motor Speed High Limit [RPM]</i> reset the value in <i>parameter 4-53 Warning Speed High</i> to the value set in <i>parameter 4-13 Motor Speed High Limit [RPM]</i>.</p> <p>NOTICE!</p> <p>Max. output frequency cannot exceed 10% of the inverter switching frequency (<i>parameter 14-01 Switching Frequency</i>).</p> <p>Enter the maximum limit for motor speed in RPM. The motor speed high limit can be set to correspond to the manufacturer's maximum rated motor. The motor speed high limit must exceed the setting in <i>parameter 4-11 Motor Speed Low Limit [RPM]</i>. The parameter name appears as either <i>parameter 4-11 Motor Speed Low Limit [RPM]</i> or <i>parameter 4-12 Motor Speed Low Limit [Hz]</i>, depending on:</p> <ul style="list-style-type: none"> The settings of other parameters in the <i>Main Menu</i>. Default settings based on geographical location. |

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

6.1.3 Function Set-ups

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

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

How to access *Function Set-up* - example

1. Turn on the adjustable frequency drive (yellow LED lights).

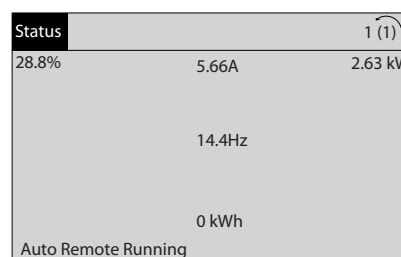


Figure 6.2 Adjustable Frequency Drive Turned on

2. Press [Quick Menus].

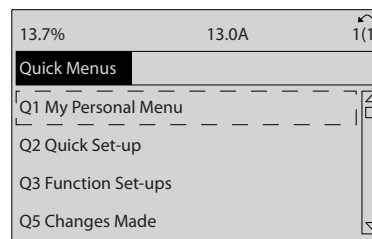


Figure 6.3 Quick Menu Selected

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

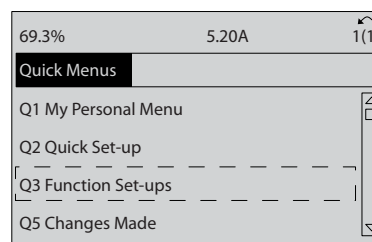
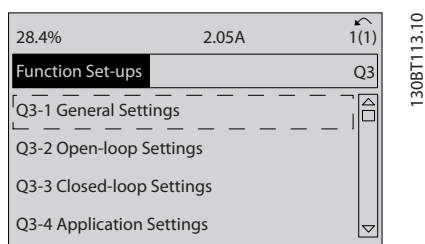


Figure 6.4 Scrolling to Function Set-up

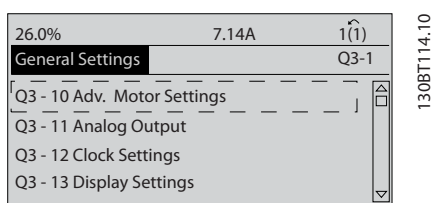
- Function Set-ups options appear. Select Q3-1 General Settings. Press [OK].



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Figure 6.5 Function Set-ups Options

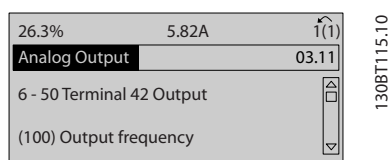
- Press [▲] and [▼] to scroll down to Q3-11 Analog Outputs. Press [OK].



130BT114.10

Figure 6.6 General Settings Options

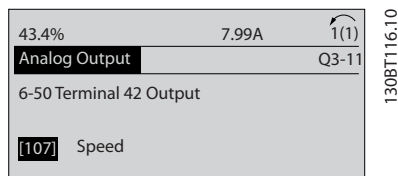
- Select parameter 6-50 Terminal 42 Output. Press [OK].



130BT115.10

Figure 6.7 Parameter 6-50 Terminal 42 Output Selected

- Press [▲] and [▼] to select between the different options. Press [OK].



130BT116.10

Figure 6.8 Setting a Parameter

Function Set-up 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 | Parameter 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 | Parameter 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 | Parameter 0-22 Display Line 1.3 Small |
| Parameter 14-01 Switching Frequency | | Parameter 0-74 DST/Summertime | Parameter 0-23 Display Line 2 Large |
| Parameter 4-53 Warning Speed High | | Parameter 0-76 DST/Summertime Start | Parameter 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 |
| Parameter 3-03 Maximum Reference | Parameter 3-03 Maximum Reference |
| Parameter 3-10 Preset Reference | Parameter 6-10 Terminal 53 Low Voltage |
| Parameter 5-13 Terminal 29 Digital Input | Parameter 6-11 Terminal 53 High Voltage |
| Parameter 5-14 Terminal 32 Digital Input | Parameter 6-12 Terminal 53 Low Current |
| Parameter 5-15 Terminal 33 Digital Input | Parameter 6-13 Terminal 53 High Current |
| | Parameter 6-14 Terminal 53 Low Ref./Feedb. Value |
| | Parameter 6-15 Terminal 53 High Ref./Feedb. Value |

Table 6.4 Q3-2 Open-loop Settings

| Q3-30 Single zone int. setpoint | Q3-31 Single zone ext. setpoint | Q3-32 Multi zone/adv |
|---|---|--|
| Parameter 1-00 Configuration Mode | Parameter 1-00 Configuration Mode | Parameter 1-00 Configuration Mode |
| Parameter 20-12 Reference/Feedback Unit | Parameter 20-12 Reference/Feedback Unit | Parameter 3-15 Reference 1 Source |
| Parameter 20-13 Minimum Reference/Feedb. | Parameter 20-13 Minimum Reference/Feedb. | Parameter 3-16 Reference 2 Source |
| Parameter 20-14 Maximum Reference/Feedb. | Parameter 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 | Parameter 20-02 Feedback 1 Source Unit |
| Parameter 6-25 Terminal 54 High Ref./Feedb. Value | Parameter 6-12 Terminal 53 Low Current | Parameter 20-03 Feedback 2 Source |
| Parameter 6-26 Terminal 54 Filter Time Constant | Parameter 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 | Parameter 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 | Parameter 20-08 Feedback 3 Source Unit |

| Q3-30 Single zone int. setpoint | Q3-31 Single zone ext. setpoint | Q3-32 Multi zone/adv |
|---|---|---|
| Parameter 20-81 PID Normal/ Inverse Control | Parameter 6-25 Terminal 54 High Ref./Feedb. Value | Parameter 20-12 Reference/Feedback Unit |
| Parameter 20-82 PID Start Speed [RPM] | Parameter 6-26 Terminal 54 Filter Time Constant | Parameter 20-13 Minimum Reference/Feedb. Value |
| Parameter 20-83 PID Start Speed [Hz] | Parameter 6-27 Terminal 54 Live Zero | Parameter 20-14 Maximum Reference/Feedb. Value |
| 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 |
| Parameter 20-70 Closed-loop Type | Parameter 20-81 PID Normal/ Inverse Control | Parameter 6-12 Terminal 53 Low Current |
| Parameter 20-71 PID Performance | Parameter 20-82 PID Start Speed [RPM] | Parameter 6-13 Terminal 53 High Current |
| Parameter 20-72 PID Output Change | Parameter 20-83 PID Start Speed [Hz] | Parameter 6-14 Terminal 53 Low Ref./Feedb. Value |
| Parameter 20-73 Minimum Feedback Level | Parameter 20-93 PID Proportional Gain | Parameter 6-15 Terminal 53 High Ref./Feedb. Value |
| Parameter 20-74 Maximum Feedback Level | Parameter 20-94 PID Integral Time | Parameter 6-16 Terminal 53 Filter Time Constant |
| Parameter 20-79 PID Autotuning | Parameter 20-70 Closed-loop Type | Parameter 6-17 Terminal 53 Live Zero |
| | Parameter 20-71 PID Performance | Parameter 6-20 Terminal 54 Low Voltage |
| | Parameter 20-72 PID Output Change | Parameter 6-21 Terminal 54 High Voltage |
| | Parameter 20-73 Minimum Feedback Level | Parameter 6-22 Terminal 54 Low Current |
| | Parameter 20-74 Maximum Feedback Level | Parameter 6-23 Terminal 54 High Current |
| | Parameter 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 |
| | | Parameter 20-82 PID Start Speed [RPM] |
| | | Parameter 20-83 PID Start Speed [Hz] |
| | | Parameter 20-93 PID Proportional Gain |
| | | Parameter 20-94 PID Integral Time |
| | | Parameter 20-70 Closed-loop Type |
| | | Parameter 20-71 PID Performance |
| | | Parameter 20-72 PID Output Change |
| | | Parameter 20-73 Minimum Feedback Level |
| | | Parameter 20-74 Maximum Feedback Level |
| | | Parameter 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 | Parameter 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] | Parameter 5-12 Terminal 27 Digital Input |
| Parameter 22-40 Minimum Run Time | Parameter 22-43 Wake-up Speed [Hz] | Parameter 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] | Parameter 22-45 Setpoint Boost | Parameter 1-73 Flying Start |
| Parameter 22-43 Wake-up Speed [Hz] | Parameter 22-46 Maximum Boost Time | Parameter 1-86 Trip Speed Low [RPM] |
| Parameter 22-44 Wake-up Ref./FB Difference | Parameter 22-26 Dry Pump Function | Parameter 1-87 Trip Speed Low [Hz] |
| Parameter 22-45 Setpoint Boost | Parameter 22-27 Dry Pump Delay | |
| Parameter 22-46 Maximum Boost Time | Parameter 22-80 Flow Compensation | |
| Parameter 2-10 Brake Function | Parameter 22-81 Square-linear Curve Approximation | |
| Parameter 2-16 AC Brake Max. Current | Parameter 22-82 Work Point Calculation | |
| Parameter 2-17 Over-voltage Control | Parameter 22-83 Speed at No-Flow [RPM] | |
| Parameter 1-73 Flying Start | Parameter 22-84 Speed at No-Flow [Hz] | |
| Parameter 1-71 Start Delay | Parameter 22-85 Speed at Design Point [RPM] | |
| Parameter 1-80 Function at Stop | Parameter 22-86 Speed at Design Point [Hz] | |
| Parameter 2-00 DC Hold/Preheat Current | Parameter 22-87 Pressure at No-Flow Speed | |
| Parameter 4-10 Motor Speed Direction | Parameter 22-88 Pressure at Rated Speed | |
| | Parameter 22-89 Flow at Design Point | |
| | Parameter 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: |
| [0] Open-loop | Motor speed is determined by applying a speed reference or by setting desired speed when in Hand mode. Open-loop is also used if the adjustable frequency drive is part 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 part of a closed-loop control process (e.g., constant pressure or flow). The PID controller must be configured in parameter group 20-** or via the Function Set-ups accessed by pressing [Quick Menus]. |

NOTICE!

This parameter cannot be adjusted while the motor is running.

NOTICE!

When set for Closed-loop, the commands Reversing and Start Reversing will not reverse the direction of the motor.

| 1-03 Torque Characteristics | | |
|-----------------------------|-------------------------|--|
| Option: | Function: | |
| [0] | Compressor torque | <i>Compressor</i> [0]: 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 | <i>Variable Torque</i> [1]: For speed control of centrifugal pumps and fans. Also to be used when controlling more than one motor from the same (e.g., multiple condenser fans or cooling tower fans). Provides a voltage which is optimized for a squared torque load characteristic of the motor. |
| [2] | Auto Energy Optim. CT | <i>Auto Energy Optimization Compressor</i> [2]: For optimum energy efficient speed control of screw and scroll compressors. Provides a voltage that is optimized for a constant torque load characteristic of the motor in the entire range down to 15 Hz. In addition, the AEO feature will adapt the voltage exactly to the current load situation, thereby reducing energy consumption and audible noise from the motor. To obtain optimal performance, the motor power factor cos phi must be set correctly. This value is set in <i>parameter 14-43 Motor Cos-Phi</i> . The parameter has a default value which is automatically adjusted when the motor data is programmed. These settings will typically ensure optimum motor voltage but if the motor power factor cos phi requires tuning, an AMA function can be carried out using <i>parameter 1-29 Automatic Motor Adaptation (AMA)</i> . It is very rarely necessary to adjust the motor power factor parameter manually. |
| [3] | Auto Energy Optim. VT * | <i>Auto Energy Optimization VT</i> [3]: For optimum energy efficient speed control of centrifugal pumps and fans. Provides a voltage which is optimized for a squared torque load characteristic of the motor but in addition the AEO feature will adapt the voltage exactly to the current load situation, thereby reducing energy consumption and audible noise from the motor. To obtain optimal performance, the motor power factor cos phi must be set correctly. This value is set in <i>parameter 14-43 Motor Cos-Phi</i> . The parameter has a default value and is automatically adjusted when the motor data is programmed. These settings will typically ensure optimum motor voltage but if the motor power factor cos phi requires tuning, |

| 1-03 Torque Characteristics | | |
|-----------------------------|-----------|--|
| Option: | Function: | |
| | | an AMA function can be carried out using <i>parameter 1-29 Automatic Motor Adaptation (AMA)</i> . It is very rarely necessary to adjust the motor power factor parameter manually. |

NOTICE!

Parameter 1-03 Torque Characteristics will not have effect when *parameter 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 to pipe breakage can occur, it is recommended to select Auto Energy Optim. CT.

| 1-29 Automatic Motor Adaptation (AMA) | | |
|---------------------------------------|---------------------|--|
| Option: | Function: | |
| | | The AMA function optimizes dynamic motor performance by automatically optimizing the advanced motor <i>parameter 1-30 Stator Resistance (Rs)</i> to <i>parameter 1-35 Main Reactance (Xh)</i> while the motor is stationary. |
| [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 adjustable frequency drive and the motor. |

NOTICE!

Parameter 1-29 Automatic Motor Adaptation (AMA) will not have effect when *parameter 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 will read: "Press [OK] to finish AMA". After pressing the [OK] key, the adjustable frequency drive is ready for operation.

NOTICE!

- For the best adaptation of the adjustable frequency drive, 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, *parameter 1-30 Stator Resistance (Rs)* to *parameter 1-39 Motor Poles*, the advanced motor parameters, will return to default setting. This parameter cannot be adjusted while the motor is running.

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] | The function selected in <i>parameter 1-80 Function at Stop</i> is active in the delay period. Enter the time delay required before commencing acceleration. |

| 1-73 Flying Start | |
|-------------------|-----------|
| Option: | Function: |
| [0] | Disabled |
| [1] | Enabled |

This function makes it possible to catch a motor that is spinning freely due to a line drop-out.

When *parameter 1-73 Flying Start* is enabled, *parameter 1-71 Start Delay* has no function. Search direction for Flying Start is linked to the setting in *parameter 4-10 Motor Speed Direction*.

[0] Clockwise: Flying Start search in clockwise direction. If not successful, a DC brake is carried out.

[2] Both Directions: The Flying Start will first make a search in the direction determined by the last reference (direction). If unable to find the speed, it will search in the other direction. If not successful, a DC brake will be activated in the time set in *parameter 2-02 DC Braking Time*. Start will then take place from 0 Hz.

| 1-73 Flying Start | |
|-------------------|-----------|
| Option: | Function: |
| [0] | Disabled |
| [1] | Enabled |

Select [0] *Disable* if this function is not required

Select [1] *Enable* to enable the adjustable frequency drive to "catch" and control a spinning motor.

The parameter is always set to [1] Enable when *parameter 1-10 Motor Construction* = [1] PM non-salient.

Important related parameters:

- *parameter 1-58 Flystart Test Pulses Current*
- *parameter 1-59 Flystart Test Pulses Frequency*
- *parameter 1-70 PM Start Mode*
- *parameter 2-06 Parking Current*
- *parameter 2-07 Parking Time*
- *parameter 2-03 DC Brake Cut-in Speed [RPM]*
- *parameter 2-04 DC Brake Cut-in Speed [Hz]*
- *parameter 2-06 Parking Current*
- *parameter 2-07 Parking Time*

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

parameter 1-70 PM Start Mode = [0] *Rotor Detection*:
If the speed estimate comes out as greater than 0 Hz, the adjustable frequency drive will catch the motor at that speed and resume normal operation. Otherwise, the adjustable frequency drive will estimate the rotor position and start normal operation from there.

parameter 1-70 PM Start Mode = [1] *Parking*:
If the speed estimate comes out lower than the setting in *parameter 1-59 Flystart Test Pulses Frequency*, then the Parking function will be engaged (see *parameter 2-06 Parking Current* and *parameter 2-07 Parking Time*). Otherwise, the adjustable frequency drive will catch the motor at that speed and resume normal operation. Refer to description of *parameter 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 200–240V units up to and including 3 HP [2.2 kW] and all 380–480V units up to and including 5.4 HP [4 kW].
- Current testing limited to a machine power size up to 30 HP [22 kW].
- Prepared 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 recommended to avoid overvoltage trip during high speed engagement of the Flystart function.

| 1-80 Function at Stop | | |
|-----------------------|------------------------|---|
| Option: | Function: | |
| | | Select the adjustable frequency drive function after a stop command or after the speed is ramped down to the settings in <i>parameter 1-81 Min Speed for Function at Stop [RPM]</i> . Available selections depend on <i>parameter 1-10 Motor Construction</i> : [0] Asynchron: <ul style="list-style-type: none"> [0] coast [1] DC hold [2] Motor check, warning [6] Motor check, alarm [1] PM non-salient: <ul style="list-style-type: none"> [0] coast |
| [0] * | Coast | Leaves motor in free mode. |
| [1] | DC Hold/ Motor Preheat | Energizes motor with a DC holding current (see <i>parameter 2-00 DC Hold/Preheat Current</i>). |
| [2] | Motor check, warn. | 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 adjustable frequency drive determines the motor temperature for motor protection in two different ways: <ul style="list-style-type: none"> • Via a thermistor sensor connected to one of the analog or digital inputs (<i>parameter 1-93 Thermistor Source</i>). • Via calculation (ETR = Electronic Thermal Relay) of the thermal load, based on the actual load and time. The calculated thermal load is compared with the rated motor current $I_{M,N}$ and the rated motor frequency $f_{M,N}$. The calculations estimate the need for a lower load at lower speed due to less cooling from the fan incorporated in the motor. |
| [0] | No protection | If the motor is continuously overloaded and no warning or trip of adjustable frequency drive is wanted. |
| [1] | Thermistor warning | Activates a warning when the connected thermistor in the motor reacts in the event of motor overtemperature. |
| [2] | Thermistor trip | Stops (trips) the adjustable frequency drive when the connected thermistor in the motor reacts in the event of motor overtemperature. |
| [3] | ETR warning 1 | |
| [4] | ETR trip 1 | |
| [5] | ETR warning 2 | |
| [6] | ETR trip 2 | |
| [7] | ETR warning 3 | |
| [8] | ETR trip 3 | |
| [9] | ETR warning 4 | |
| [10] | ETR trip 4 | |

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

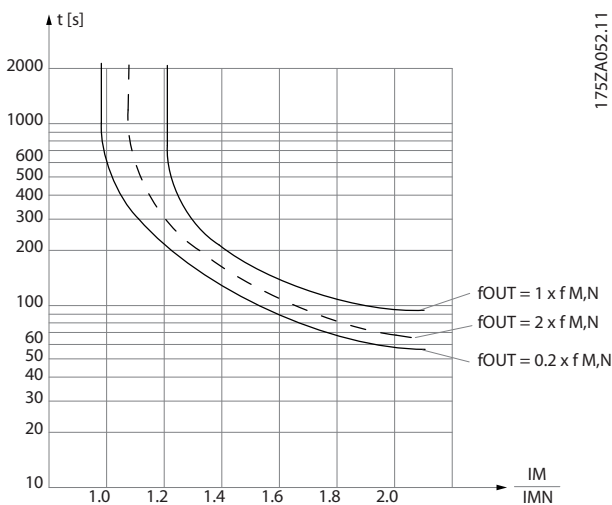


Figure 6.9

WARNING

In order 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 *parameter 1-10 Motor Construction* = [1] PM, non-salient SPM.

NOTICE!

For correct operation of ETR function, 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: | |
| | | Select the input to which the thermistor (PTC sensor) should be connected. An analog input option [1] or [2] cannot be selected if the analog input is already in use as a reference source (selected in <i>parameter 3-15 Reference 1 Source</i> , <i>parameter 3-16 Reference 2 Source</i> or <i>parameter 3-17 Reference 3 Source</i>). When using MCB 112, choice [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!

This parameter cannot be adjusted while the motor is running.

NOTICE!

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

| 2-00 DC Hold/Preheat Current | | |
|------------------------------|--------------|--|
| Range: | Function: | |
| 50 %* | [0 - 160 %] | |

NOTICE!

Parameter 2-00 DC Hold/Preheat Current will not have effect when *parameter 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 <i>parameter 1-10 Motor Construction</i> : [0] Asynchron: [0] off [1] Resistor brake [2] AS brake [1] PM non-salient: [0] off [1] Resistor brake | |
| [0] | Off | No brake resistor installed. |
| [1] | Resistor brake | Brake resistor incorporated in the system, for dissipation of surplus braking 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 adjustable frequency drives with an integral dynamic brake. |
| [2] | AC brake | AC Brake will only work in Compressor Torque mode in <i>parameter 1-03 Torque Characteristics</i> . |

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

NOTICE!

Parameter 2-17 Over-voltage Control will not have effect when *parameter 1-10 Motor Construction* = [1] PM, non-salient SPM.

NOTICE!

The ramp time is automatically adjusted to avoid tripping of the adjustable frequency drive.

| 3-02 Minimum Reference | | |
|---|---|--|
| Range: | Function: | |
| Size related* | [-999999.999 - par. 3-03 ReferenceFeedbackUnit] | 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 <i>parameter 1-00 Configuration Mode</i> and <i>parameter 20-12 Reference/Feedback Unit</i> , respectively. |
| NOTICE! This parameter is used in open-loop only. | | |

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

| 3-10 Preset Reference | | |
|-----------------------|----------------|--|
| Array [8] | Function: | |
| 0 %* | [-100 - 100 %] | |

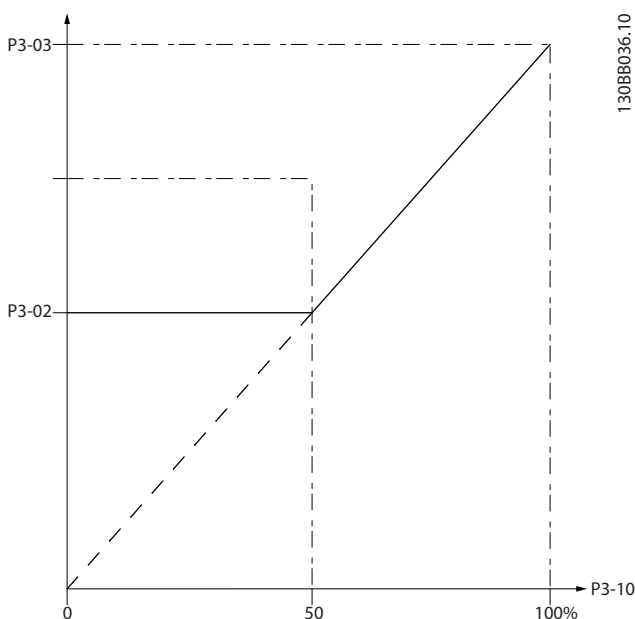


Figure 6.10

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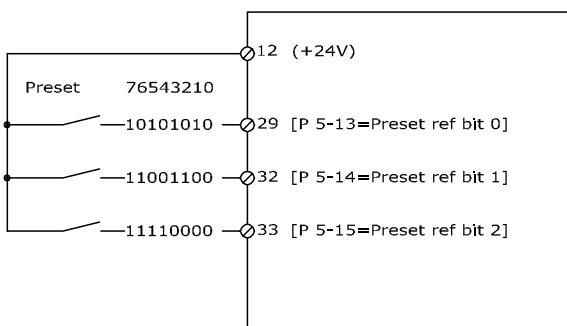


Figure 6.11

6

| 3-15 Reference 1 Source | |
|-------------------------|---|
| Option: | Function: |
| | Select the reference input to be used for the first reference signal. <i>Parameter 3-15 Reference 1 Source, parameter 3-16 Reference 2 Source and parameter 3-17 Reference 3 Source</i> define up to three 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.

| 3-16 Reference 2 Source | |
|-------------------------|--|
| Option: | Function: |
| | Select the reference input to be used for the second reference signal. <i>parameter 3-15 Reference 1 Source, parameter 3-16 Reference 2 Source and parameter 3-17 Reference 3 Source</i> define up to three 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 counter-clockwise direction is allowed. |

NOTICE!

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

| 4-53 Warning Speed High | | |
|---|-----------|--|
| Range: | Function: | |
| Size related* 4-52 - par. 4-13 RPM] | [par. | <p>NOTICE!</p> <p>Any changes in <i>parameter 4-13 Motor Speed High Limit [RPM]</i> reset the value in <i>parameter 4-53 Warning Speed High</i> to the value in <i>parameter 4-13 Motor Speed High Limit [RPM]</i>.</p> <p>If a different value is needed in <i>parameter 4-53 Warning Speed High</i>, it must be set after programming <i>parameter 4-13 Motor Speed High Limit [RPM]</i></p> <p>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. Program the upper signal limit of the motor speed, n_{HIGH}, within the normal working range of the adjustable frequency drive.</p> |

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

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

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

| 5-01 Terminal 27 Mode | | |
|-----------------------|--|---|
| Option: | Function: | |
| | | <p>NOTICE!</p> <p>This parameter cannot be adjusted while the unit is running.</p> |
| [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: | |
| [0] * Input | Defines terminal 29 as a digital input. | |
| [1] Output | Defines terminal 29 as a digital output. | |

NOTICE!

This parameter cannot be adjusted while the motor is running.

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 adjustable frequency drive. 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 |
| Slow | [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 |

| Digital input function | Select | Terminal |
|------------------------|--------|----------|
| Lead pump alternation | [121] | All |
| Pump 1 interlock | [130] | All |
| Pump 2 interlock | [131] | All |
| Pump 3 interlock | [132] | All |

5-12 Terminal 27 Digital Input

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

5-13 Terminal 29 Digital Input

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

5-14 Terminal 32 Digital Input

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

5-15 Terminal 33 Digital Input

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

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 realized in an array parameter.

| Option: | Function: |
|---------|----------------------|
| [0] | No operation |
| [1] | Control ready |
| [2] | Drive ready |
| [3] | Drive rdy/rem ctrl |
| [4] | Standby / no warning |
| [5] | Running |
| [6] | Running / no warning |
| [8] | Run on ref/no warn |
| [9] | Alarm |
| [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 |

| 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 realized in an array parameter. | | |
| Option: | Function: | |
| [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 | |
| [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 | |

| 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 realized in an array parameter. | | |
| Option: | Function: | |
| [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 <i>parameter 6-10 Terminal 53 Low Voltage</i> , <i>parameter 6-12 Terminal 53 Low Current</i> , <i>parameter 6-20 Terminal 54 Low Voltage</i> or <i>parameter 6-22 Terminal 54 Low Current</i> for a time period longer than the time set in <i>parameter 6-00 Live Zero Timeout Time</i> , the function selected in <i>parameter 6-01 Live Zero Timeout Function</i> will be activated. | |

| 6-01 Live Zero Timeout Function | |
|---------------------------------|---|
| Option: | Function: |
| | <p>Select the Timeout function. The function set in <i>parameter 6-01 Live Zero Timeout Function</i> will be activated if the input signal on terminal 53 or 54 is below 50% of the value in <i>parameter 6-10 Terminal 53 Low Voltage</i>, <i>parameter 6-12 Terminal 53 Low Current</i>, <i>parameter 6-20 Terminal 54 Low Voltage</i> or <i>parameter 6-22 Terminal 54 Low Current</i> for a time period defined in <i>parameter 6-00 Live Zero Timeout Time</i>. If several timeouts occur simultaneously, the adjustable frequency drive prioritizes the timeout functions as follows</p> <ol style="list-style-type: none"> 1. <i>Parameter 6-01 Live Zero Timeout Function</i> 2. <i>Parameter 8-04 Control Timeout Function</i> <p>The output frequency of the adjustable frequency drive can be:</p> <ul style="list-style-type: none"> • [1] frozen at the present value • [2] overruled to stop • [3] overruled to jog speed • [4] overruled to max. speed • [5] overruled to stop with subsequent trip |
| [0] * | Off |
| [1] | Freeze output |
| [2] | Stop |
| [3] | Jogging |
| [4] | Max. speed |
| [5] | Stop and trip |

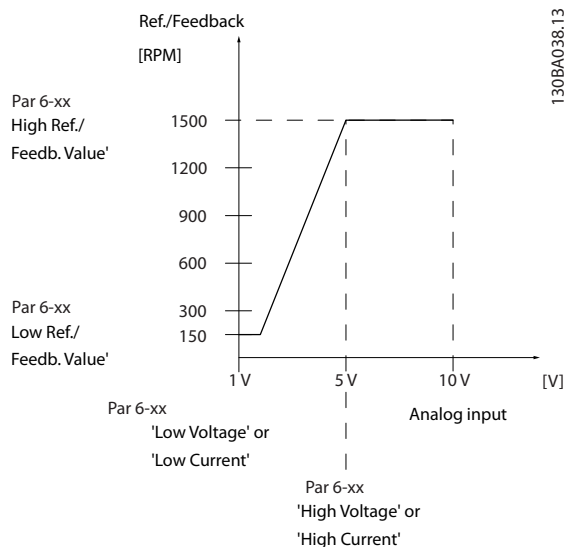


Figure 6.12

| 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 <i>parameter 6-14 Terminal 53 Low Ref./Feedb. Value</i> . | |

| 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 <i>parameter 6-15 Terminal 53 High Ref./Feedb. Value</i> . | |

| 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 <i>parameter 6-10 Terminal 53 Low Voltage</i> and <i>parameter 6-12 Terminal 53 Low Current</i> . | |

| 6-15 Terminal 53 High Ref./Feedb. Value | | |
|---|-----------|--|
| Range: | Function: | |
| Size related* [-999999.999 - 999999.999] | | |

| 6-16 Terminal 53 Filter Time Constant | | |
|---------------------------------------|---|--|
| Range: | Function: | |
| 0.001 s* [0.001 - 10 s] | <p>NOTICE!</p> <p>This parameter cannot be adjusted while the motor is running.</p> <p>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.</p> | |

| 6-17 Terminal 53 Live Zero | | |
|----------------------------|--|--|
| Option: | Function: | |
| | This parameter makes it possible to disable the Live Zero monitoring. For example, this is to be used if the analog outputs are used as part of a de-central I/O system (e.g., when not used as part of any adjustable frequency drive related control functions, but for 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 <i>parameter 6-24 Terminal 54 Low Ref./Feedb. Value.</i> | |

| 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 <i>parameter 6-25 Terminal 54 High Ref./Feedb. Value.</i> | |

| 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 <i>parameter 6-20 Terminal 54 Low Voltage</i> and <i>parameter 6-22 Terminal 54 Low Current.</i> | |

| 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 <i>parameter 6-21 Terminal 54 High Voltage</i> and <i>parameter 6-23 Terminal 54 High Current.</i> | |

| 6-26 Terminal 54 Filter Time Constant | | |
|---------------------------------------|---|--|
| Range: | Function: | |
| 0.001 s* [0.001 - 10 s] | <p>NOTICE!</p> <p>This parameter cannot be adjusted while the motor is running.</p> <p>Enter the time constant. This is a first-order digital low pass filter time constant for suppressing electrical noise in terminal 54. A high time constant value improves dampening but also increases the time delay through the filter.</p> | |

| 6-27 Terminal 54 Live Zero | | |
|----------------------------|---|--|
| Option: | Function: | |
| | This parameter makes it possible to disable the Live Zero monitoring. For example, this to be used if the analog outputs are used as part of a de-central I/O system (e.g., when used not as part of any adjustable frequency drive related control functions, but for 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 <i>parameter 20-14 Maximum Reference/Feedb.</i> , (0-20 mA) |
| [103] | Motor cur. 0- I_{max} | 0 - Inverter Max. Current (<i>parameter 16-37 Inv. Max. Current</i>), (0-20 mA) |

| 6-50 Terminal 42 Output | | |
|----------------------------|--|--|
| Option: | Function: | |
| [104] Torque 0-Tlim | 0 - Torque limit (<i>parameter 4-16 Torque Limit Motor Mode</i>), (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 (<i>parameter 4-13 Motor Speed High Limit [RPM]</i> and <i>parameter 4-14 Motor Speed High Limit [Hz]</i>), (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 fr 0-100 4-20 | 0–100 Hz | |
| [131] Reference 4-20mA | Minimum Reference - Maximum Reference | |
| [132] Feedback 4-20mA | -200% to +200% of <i>parameter 20-14 Maximum Reference/Feedb.</i> | |
| [133] Motor cur. 4-20mA | 0 - Inverter Max. Current (<i>parameter 16-37 Inv. Max. Current</i>) | |
| [134] Torq.0-lim 4-20mA | 0 - Torque limit (<i>parameter 4-16 Torque Limit Motor Mode</i>) | |
| [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 4-20 mA | 0–100% | |
| [144] Ext. CL 2 4-20 mA | 0–100% | |
| [145] Ext. CL 3 4-20 mA | 0–100% | |

NOTICE!

Values for setting the minimum reference are found in open-loop *parameter 3-02 Minimum Reference* and for closed-loop *parameter 20-13 Minimum Reference/Feedb.* - values for maximum reference for open-loop are found in *parameter 3-03 Maximum Reference* and for closed-loop *parameter 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 <i>parameter 6-50 Terminal 42 Output</i> . | |

| 6-52 Terminal 42 Output Max Scale | | |
|-----------------------------------|-------------|--|
| Range: | Function: | |
| 100 %* | [0 - 200 %] | |

$20 \text{ mA} / \text{desired maximum current} \times 100 \%$

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

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%

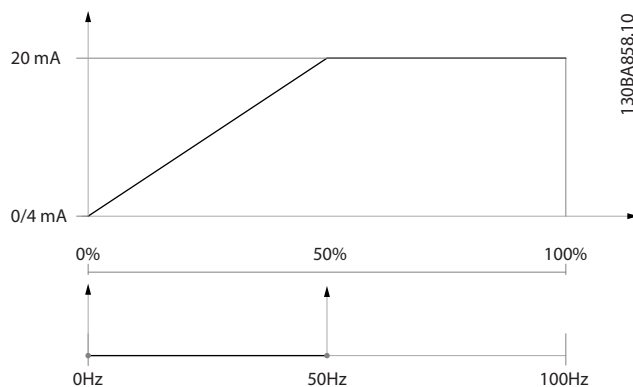


Figure 6.14

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%

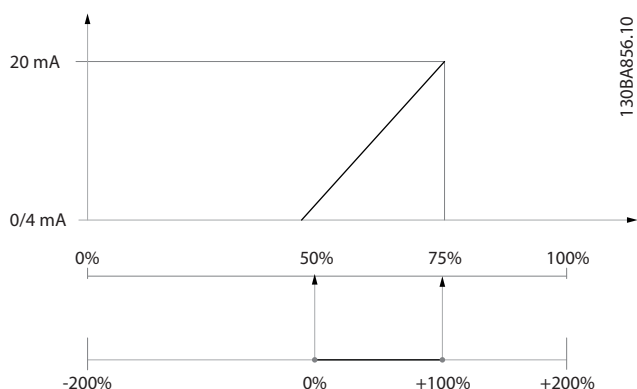


Figure 6.15

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%).

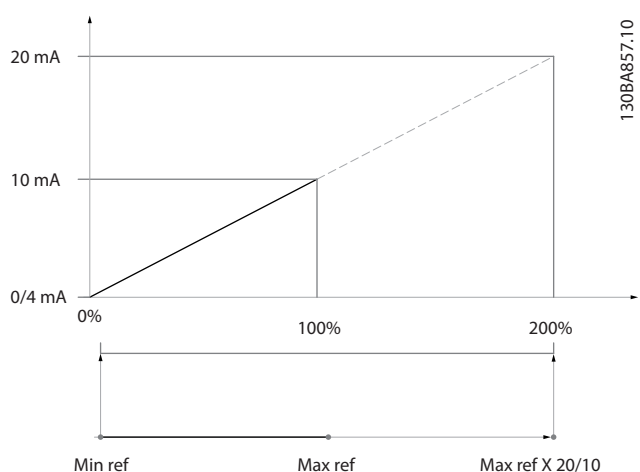


Figure 6.16

14-01 Switching Frequency

| Option: | Function: |
|---------|---|
| | Select the inverter switching frequency. Changing the switching frequency can help reduce acoustic noise from the motor. NOTICE! The output frequency value of the adjustable frequency drive 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 parameter 14-00 Switching Pattern and the section Derating in the relevant design guide. |
| [0] | 1.0 kHz |
| [1] | 1.5 kHz |
| [2] | 2.0 kHz |
| [3] | 2.5 kHz |
| [4] | 3.0 kHz |
| [5] | 3.5 kHz |
| [6] | 4.0 kHz |
| [7] | 5.0 kHz |
| [8] | 6.0 kHz |
| [9] | 7.0 kHz |
| [10] | 8.0 kHz |
| [11] | 10.0 kHz |
| [12] | 12.0 kHz |
| [13] | 14.0 kHz |
| [14] | 16.0 kHz |

20-00 Feedback 1 Source

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

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

NOTICE!

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

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

| 20-01 Feedback 1 Conversion | | |
|-----------------------------|------------------|--|
| Option: | Function: | |
| | | See also parameter 20-34 Duct 1 Area [m2] through parameter 20-38 Air Density Factor [%] for setting of duct area and air density. |
| [4] | Velocity to flow | Used in applications for controlling the air flow in a duct. An air velocity measurement represents the feedback signal. $Flow = Duct\ Area \times Air\ Velocity$ See also parameter 20-34 Duct 1 Area [m2] through parameter 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 <i>parameter 20-00 Feedback 1 Source</i> 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 <i>parameter 20-01 Feedback 1 Conversion</i> 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 adjustable frequency drive. |
| [0] | Sum | <p>Sets up the PID controller to use the sum of feedback 1, feedback 2 and feedback 3 as the feedback.</p> <p>NOTICE!</p> <p>Set any unused feedbacks to [0] No Function in <i>parameter 20-00 Feedback 1 Source</i>, <i>parameter 20-03 Feedback 2 Source</i>, or <i>parameter 20-06 Feedback 3 Source</i>.</p> <p>The sum of setpoint 1 and any other references that are enabled (see <i>parameter group 3-1* References</i>) are used as the PID controller's setpoint reference.</p> |

| 20-20 Feedback Function | | |
|-------------------------|------------|--|
| Option: | Function: | |
| [1] | Difference | <p>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 <i>parameter group 3-1* References</i>) are used as the PID controller's setpoint reference.</p> |
| [2] | Average | <p>Sets up the PID Controller to use the average of feedback 1, feedback 2 and feedback 3 as the feedback.</p> <p>NOTICE!</p> <p>Set any unused feedbacks to [0] No Function in <i>parameter 20-00 Feedback 1 Source</i>, <i>parameter 20-03 Feedback 2 Source</i>, or <i>parameter 20-06 Feedback 3 Source</i>. The sum of setpoint 1 and any other references that are enabled (see <i>parameter group 3-1* References</i>) are used as the PID controller's setpoint reference.</p> |
| [3] | Minimum * | <p>Sets up the PID controller to compare feedback 1, feedback 2 and feedback 3 and uses the lowest value as the feedback.</p> <p>NOTICE!</p> <p>Set any unused feedbacks to [0] No Function in <i>parameter 20-00 Feedback 1 Source</i>, <i>parameter 20-03 Feedback 2 Source</i>, or <i>parameter 20-06 Feedback 3 Source</i>. Only setpoint 1 is used. The sum of setpoint 1 and any other references that are enabled (see <i>parameter group 3-1* References</i>) are used as the PID controller's setpoint reference.</p> |
| [4] | Maximum | <p>Sets up the PID controller to compare feedback 1, feedback 2 and feedback 3 and use the highest value as the feedback.</p> <p>NOTICE!</p> <p>Set any unused feedbacks to [0] No Function in <i>parameter 20-00 Feedback 1 Source</i>, <i>parameter 20-03 Feedback 2 Source</i>, or <i>parameter 20-06 Feedback 3 Source</i>.</p> <p>Only setpoint 1 is used. The sum of setpoint 1 and any other references that are enabled (see <i>parameter group 3-1* References</i>) are used as the PID controller's setpoint reference.</p> |

| 20-20 Feedback Function | | |
|---------------------------------|--|--|
| Option: | Function: | |
| [5] Multi Setpoint Min | Sets up the PID controller to calculate the difference between feedback 1 and setpoint 1, feedback 2 and setpoint 2, and feedback 3 and setpoint 3. It uses the feedback/setpoint pair in which the feedback is the farthest below its corresponding setpoint reference. If all feedback signals are above their corresponding setpoints, the PID controller uses the feedback/setpoint pair with the least difference between the two. | |
| | <p>NOTICE!</p> <p>If only two feedback signals are used, set the non-used feedback to [0] No Function in <i>parameter 20-00 Feedback 1 Source</i>, <i>parameter 20-03 Feedback 2 Source</i>, or <i>parameter 20-06 Feedback 3 Source</i>. Note that each setpoint reference is the sum of its respective parameter value (<i>parameter 20-21 Setpoint 1</i>, <i>parameter 20-22 Setpoint 2</i> and <i>parameter 20-23 Setpoint 3</i>) and any other references that are enabled (see <i>parameter group 3-1* References</i>).</p> | |
| [6] Multi Setpoint Max | Sets up the PID controller to calculate the difference between feedback 1 and setpoint 1, feedback 2 and setpoint 2, and feedback 3 and setpoint 3. It uses the feedback/setpoint pair in which the feedback is farthest above its corresponding setpoint reference. If all feedback signals are below their corresponding setpoints, the PID controller uses the feedback/setpoint pair with the least difference between the two. | |
| | <p>NOTICE!</p> <p>If only two feedback signals are used, set the non-used feedback to [0] No Function in <i>parameter 20-00 Feedback 1 Source</i>, <i>parameter 20-03 Feedback 2 Source</i>, or <i>parameter 20-06 Feedback 3 Source</i>. Note that each setpoint reference is the sum of its respective parameter value (<i>parameter 20-21 Setpoint 1</i>, <i>parameter 20-22 Setpoint 2</i> and <i>parameter 20-23 Setpoint 3</i>) and any other references that are enabled (see <i>parameter group 3-1* References</i>).</p> | |

NOTICE!

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

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

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

The adjustable frequency drive can be configured to handle multi-zone applications. Two different multi-zone applications are supported:

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

Examples 1 and 2 illustrate the difference between the two:

Example 1 – Multi-zone, single setpoint

In an office building, a VAV (variable air volume) VLT® HVAC Drive system must ensure a minimum pressure at selected VAV boxes. Due to the varying pressure losses in each duct, the pressure at each VAV box cannot be

assumed to be the same. The minimum pressure required is the same for all VAV boxes. This control method can be set up by setting *parameter 20-20 Feedback Function* to [3] *Minimum*, and entering the desired pressure in *parameter 20-21 Setpoint 1*. If any feedback is below the setpoint, the PID controller increases the fan speed. If all feedbacks are above the setpoint, the PID controller decreases the fan speed.

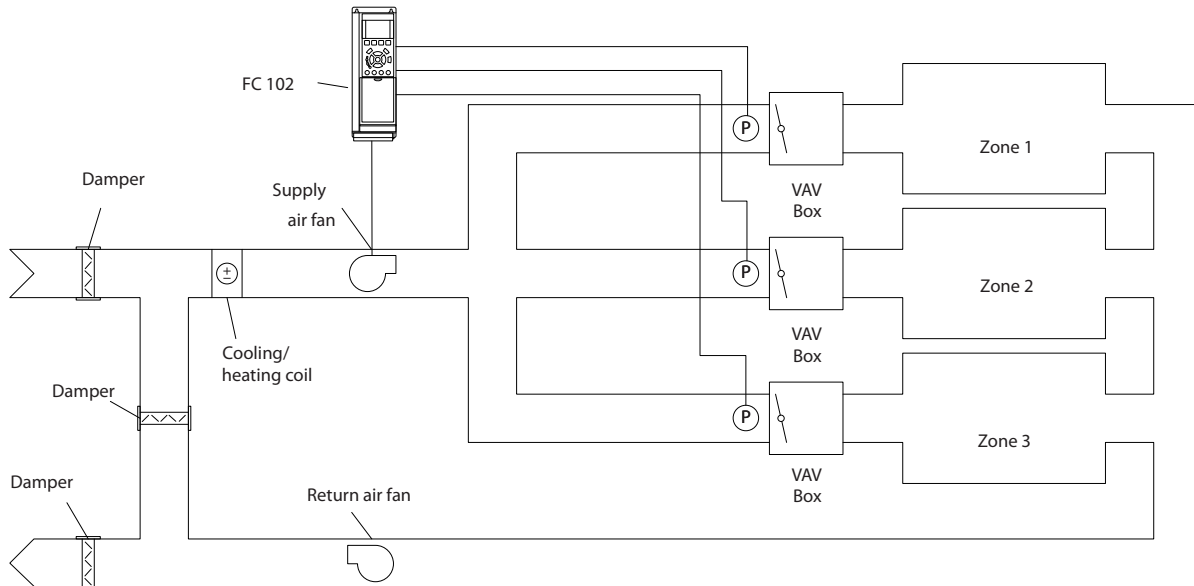


Figure 6.17 Example, Multi-zone, Single Setpoint

Example 2 – Multi-zone, multi-setpoint

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

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

| 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 adjustable frequency drive's PID controller. See the description of <i>parameter 20-20 Feedback Function</i> . NOTICE! The setpoint reference entered here is added to any other references that are enabled (see <i>parameter group 3-1* References</i>). |

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

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

If (Error x Gain) jumps with a value equal to what is set in *parameter 20-14 Maximum Reference/Feedb.*, the PID controller tries to change the output speed equal to what is set in *parameter 4-13 Motor Speed High Limit [RPM]/ parameter 4-14 Motor Speed High Limit [Hz]*. However, the output speed is limited by this setting.

The proportional band (error causing output to change from 0–100%) can be calculated with the formula:

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

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

| 22-21 Low Power Detection | | |
|---------------------------|----------|--|
| Option: | | Function: |
| [0] * | Disabled | |
| [1] | Enabled | Carry out the low-power detection commissioning to set the parameters in parameter group 22-3* <i>No-Flow Power Tuning</i> 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 <i>parameter 4-11 Motor Speed Low Limit [RPM]</i> or <i>parameter 4-12 Motor Speed Low Limit [Hz]</i> . |

| 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 adjustable frequency drive enters sleep mode and stops when a no-flow condition is detected. See parameter group 22-4* <i>Sleep Mode</i> for programming options for sleep mode. |
| [2] | Warning | The adjustable frequency drive 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 adjustable frequency drive stops running and activates a no-flow alarm [A 92]. An adjustable frequency drive digital output or a serial communication bus can communicate an alarm to other equipment. |

NOTICE!

Do not set *parameter 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 adjustable frequency drive to continuously cycle between running and stopping when a no-flow condition is detected.

NOTICE!

Disable the automatic bypass function of the bypass if:

- The adjustable frequency drive is equipped with a constant-speed bypass with an automatic bypass function starting the bypass if the adjustable frequency drive experiences a persistent alarm condition, and
- [3] Alarm is selected as the no-flow function.

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

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

NOTICE!

To use dry pump detection:

1. Enable *low-power detection* in *parameter 22-21 Low Power Detection*.
2. Commission *low-power detection* using either *parameter group 22-3* No-flow Power Tuning No-Flow Power Tuning*, or *parameter 22-20 Low Power Auto Set-up*.

NOTICE!

Do not set *parameter 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 adjustable frequency drive to continuously cycle between running and stopping when a dry pump condition is detected.

NOTICE!

For adjustable frequency drives with constant-speed bypass

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

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

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

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

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

NOTICE!

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

NOTICE!

For adjustable frequency drives with constant-speed bypass

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

| 22-61 Broken Belt Torque | | |
|--------------------------|-------------|--|
| Range: | Function: | |
| 10 %* | [0 - 100 %] | |

| 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 <i>parameter 22-60 Broken Belt Function</i> . |

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

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

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

6.1.5 Main Menu Mode

Both the GLCP and NLCP provide access to the *Main Menu mode*. Select the *Main Menu mode* by pressing [Main Menu]. *Figure 6.18* shows the resulting readout which appears on the display of the GLCP.

Lines 2 to 5 on the display show a list of parameter groups which can be selected by toggling [▲] and [▼].

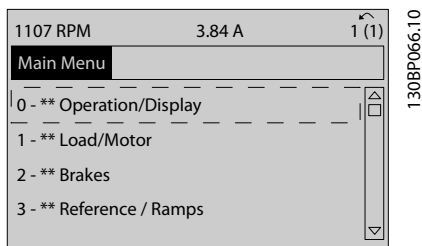


Figure 6.18 Display Example

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

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

6.1.6 Parameter Selection

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

The following parameter groups are accessible:

| Group # | 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 |

| Group # | Parameter group |
|---------|---------------------------|
| 11-** | LonWorks |
| 12-** | Ethernet |
| 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 |
| 24-** | Appl. Functions 2 |
| 25-** | Cascade Controller |
| 26-** | Analog I/O Option MCB 109 |
| 30-** | Special Features |
| 31-** | Bypass Option |
| 35-** | Sensor Input Option |

Table 6.7 Parameter Groups

After selecting a parameter group, select a parameter with the navigation keys.

The middle section on the GLCP display shows the parameter number and name, as well as the selected parameter value.

The middle section of the keypad display shows the parameters. Press [OK] to select the parameters; the display now shows the selected parameter's value.

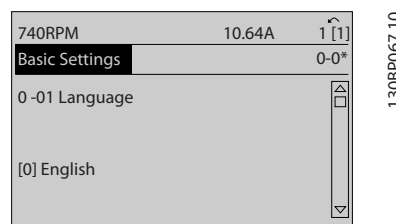


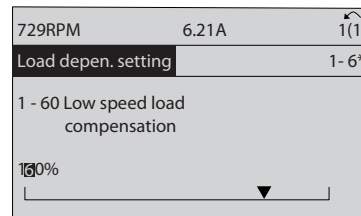
Figure 6.19 Display Example

6.1.7 Changing Data

1. Press [Quick Menu] or [Main Menu].
2. Press [▲] and [▼] to find the parameter group to edit.
3. Press [OK].
4. Press [▲] and [▼] to find the parameter to edit.
5. Press [OK].

6. Press [▲] and [▼] to select correct parameter setting. Or, to move to digits within a number, press keys. cursor indicates digit selected to change. [▲] increases the value, [▼] decreases the value.
7. Press [Cancel] to disregard change, or press [OK] to accept change and enter new setting.

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].



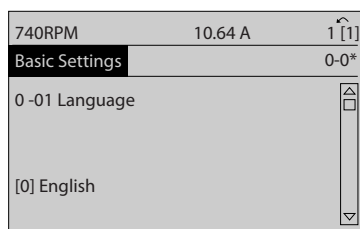
130BP070.10

Figure 6.22 Display Example

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].

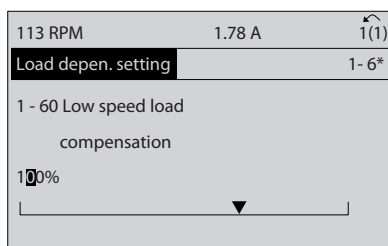


130BP068.10

Figure 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.



130BP069.10

Figure 6.21 Display Example

6.1.10 Changing of Data Value, Step by Step

Certain parameters can be changed step-by-step or by an infinite number of variables. 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 using an infinite number of variables.

6.1.11 Readout and Programming of Indexed Parameters

Parameters are indexed when placed in a rolling stack. *Parameter 15-30 Alarm Log: Error Code* to *parameter 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

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

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

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

| | | | | | |
|--------------|-----------------------------|-------------|------------------------------------|--------------|------------------------------------|
| 24-05 | Fire Mode Preset Reference | 24-05 | Lead Pump | 31-02 | Bypass Trip Time Delay |
| 24-06 | Fire Mode Reference Source | 25-82 | Relay Status | 31-03 | Test Mode Activation |
| 24-07 | Fire Mode Feedback Source | 25-83 | Pump ON Time | 31-10 | Bypass Status Word |
| 24-09 | Fire Mode Alarm Handling | 25-84 | Relay ON Time | 31-11 | Bypass Running Hours |
| 24-11* | Drive Bypass | 25-85 | Reset Relay Counters | 31-19 | Remote Bypass Activation |
| 24-10 | Drive Bypass Function | 25-86 | Service | 35-0* | Sensor Input Option |
| 24-11 | Drive Bypass Delay Time | 25-90 | Pump Interlock | 35-0* | Temp. Input Mode |
| 24-9* | Multi-Motor Funct. | 25-91 | Manual Alternation | 35-00 | Term. X48/4 Temperature Unit |
| 24-90 | Missing Motor Function | 26-0* | Analog I/O Option | 35-01 | Term. X48/4 Input Type |
| 24-91 | Missing Motor Coefficient 1 | 26-00 | Analog I/O Mode | 35-02 | Term. X48/7 Temperature Unit |
| 24-92 | Missing Motor Coefficient 2 | 26-00 | Terminal X42/1 Mode | 35-03 | Term. X48/7 Input Type |
| 24-93 | Missing Motor Coefficient 3 | 26-01 | Terminal X42/3 Mode | 35-04 | Term. X48/10 Temperature Unit |
| 24-94 | Missing Motor Coefficient 4 | 26-02 | Terminal X42/5 Mode | 35-05 | Term. X48/10 Input Type |
| 24-95 | Locked Rotor Function | 26-1* | Analog Input X42/1 | 35-06 | Temperature Sensor Alarm Function |
| 24-96 | Locked Rotor Coefficient 1 | 26-10 | Terminal X42/1 Low Voltage | 35-1* | Temp. Input X48/4 |
| 24-97 | Locked Rotor Coefficient 2 | 26-11 | Terminal X42/1 High Voltage | 35-14 | Term. X48/4 Filter Time Constant |
| 24-98 | Locked Rotor Coefficient 3 | 26-14 | Term. X42/1 Low Ref./Feedb. Value | 35-15 | Term. X48/4 Temp. Monitor |
| 24-99 | Locked Rotor Coefficient 4 | 26-15 | Term. X42/1 High Ref./Feedb. Value | 35-16 | Term. X48/4 Low Temp. Limit |
| 25-0* | Cascade Controller | 26-16 | Term. X42/1 Filter Time Constant | 35-17 | Term. X48/4 High Temp. Limit |
| 25-00 | Cascade Controller | 26-17 | Term. X42/1 Live Zero | 35-2* | Temp. Input X48/7 |
| 25-02 | Motor Start | 26-2* | Analog Input X42/3 | 35-24 | Term. X48/7 Filter Time Constant |
| 25-04 | Pump Cycling | 26-20 | Terminal X42/3 Low Voltage | 35-25 | Term. X48/7 Temp. Monitor |
| 25-05 | Fixed Lead Pump | 26-21 | Terminal X42/3 High Voltage | 35-26 | Term. X48/7 Low Temp. Limit |
| 25-06 | Number of Pumps | 26-24 | Term. X42/3 Low Ref./Feedb. Value | 35-27 | Term. X48/7 High Temp. Limit |
| 25-2* | Bandwidth Settings | 26-25 | Term. X42/3 High Ref./Feedb. Value | 35-3* | Temp. Input X48/10 |
| 25-20 | Staging Bandwidth | 26-26 | Term. X42/3 Filter Time Constant | 35-34 | Term. X48/10 Filter Time Constant |
| 25-21 | Override Bandwidth | 26-27 | Term. X42/3 Live Zero | 35-35 | Term. X48/10 Temp. Monitor |
| 25-22 | Fixed Speed Bandwidth | 26-3* | Analog Input X42/5 | 35-36 | Term. X48/10 Low Temp. Limit |
| 25-23 | SBW Staging Delay | 26-30 | Terminal X42/5 Low Voltage | 35-37 | Term. X48/10 High Temp. Limit |
| 25-24 | SBW Staging Delay | 26-31 | Terminal X42/5 High Voltage | 35-4* | Analog Input X48/2 |
| 25-25 | OBW Time | 26-34 | Term. X42/5 Low Ref./Feedb. Value | 35-42 | Term. X48/2 Low Current |
| 25-26 | Stage At No-Flow | 26-35 | Term. X42/5 High Ref./Feedb. Value | 35-43 | Term. X48/2 High Current |
| 25-27 | Stage Function | 26-36 | Term. X42/5 Filter Time Constant | 35-44 | Term. X48/2 Low Ref./Feedb. Value |
| 25-28 | Stage Function Time | 26-37 | Analog Out X42/7 | 35-45 | Term. X48/2 High Ref./Feedb. Value |
| 25-29 | Destage Function | 26-40 | Terminal X42/7 Output | 35-46 | Term. X48/2 Filter Time Constant |
| 25-30 | Destage Function Time | 26-41 | Terminal X42/7 Min. Scale | 35-47 | Term. X48/2 Live Zero |
| 25-4* | Staging Settings | 26-42 | Terminal X42/7 Max. Scale | | |
| 25-40 | Ramp-down Delay | 26-43 | Terminal X42/7 Bus Control | | |
| 25-41 | Ramp-up Delay | 26-44 | Terminal X42/7 Timeout Preset | | |
| 25-42 | Staging Threshold | 26-5* | Analog Out X42/9 | | |
| 25-43 | Destaging Threshold | 26-50 | Terminal X42/9 Output | | |
| 25-44 | Staging Speed [RPM] | 26-51 | Terminal X42/9 Min. Scale | | |
| 25-45 | Staging Speed [Hz] | 26-52 | Terminal X42/9 Max. Scale | | |
| 25-46 | Destaging Speed [RPM] | 26-53 | Terminal X42/9 Bus Control | | |
| 25-47 | Destaging Speed [Hz] | 26-54 | Terminal X42/9 Timeout Preset | | |
| 25-5* | Alternation Settings | 26-6* | Analog Out X42/11 | | |
| 25-50 | Lead Pump Alternation | 26-60 | Terminal X42/11 Output | | |
| 25-51 | Alternation Event | 26-61 | Terminal X42/11 Min. Scale | | |
| 25-52 | Alternation Time Interval | 26-62 | Terminal X42/11 Max. Scale | | |
| 25-53 | Alternation Timer Value | 26-63 | Terminal X42/11 Bus Control | | |
| 25-54 | Alternation Predefined Time | 26-64 | Terminal X42/11 Timeout Preset | | |
| 25-55 | Alternate if Load < 50% | 30-* | Special Features | | |
| 25-56 | Staging Mode at Alternation | 30-2* | Adv. Start Adjust | | |
| 25-58 | Run Next Pump Delay | 30-22 | Locked Rotor Detection | | |
| 25-59 | Run-on Line Delay | 30-23 | Locked Rotor Detection Time [s] | | |
| 25-8* | Status | 31-* | Bypass Option | | |
| 25-80 | Cascade Status | 31-00 | Bypass Mode | | |
| 25-81 | Pump Status | 31-01 | Bypass Start Time Delay | | |

7 General Specifications

Line power supply (L1, L2, L3)

| | |
|----------------|----------------------|
| Supply voltage | 380–480 V $\pm 10\%$ |
| Supply voltage | 525–690 V $\pm 10\%$ |

AC line voltage low/line drop-out:

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

| | |
|---|---|
| Supply frequency | 50/60 Hz $\pm 5\%$ |
| Maximum imbalance temporary between line power phases | 3.0% of rated supply voltage |
| True power factor (λ) | ≥ 0.9 nominal at rated load |
| Displacement power factor ($\cos\phi$) near unity | (> 0.98) |
| Switching on input supply L1, L2, L3 (power-ups) | maximum once/2 min. |
| Environment according to EN60664-1 | Overvoltage category III/pollution degree 2 |

The unit is suitable for use on a circuit capable of delivering not more than 100000 RMS symmetrical Amperes, 480/690 V maximum.

7.1 Motor Output and Motor Data

Motor output (U, V, W)

| | |
|---------------------|--------------------------|
| Output voltage | 0–100% of supply voltage |
| Output frequency | 0–590 ¹⁾ Hz |
| Switching on output | unlimited |
| Ramp times | 1–3600 s |

1) Voltage and power-dependent.

Torque characteristics

| | |
|-----------------------------------|--|
| Starting torque (constant torque) | maximum 110% for 1 min. ¹⁾ |
| Starting torque | maximum 135% up to 0.5 s ¹⁾ |
| Overload torque (constant torque) | maximum 110% for 1 min. ¹⁾ |

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

7.2 Ambient Conditions

Surroundings

| | |
|--|---|
| Enclosure size E | IP00, IP21, IP54 |
| Enclosure size F | IP21, IP54 |
| Vibration test | 1 g |
| Relative humidity | 5%–95% IEC 721-3-3; Class 3K3 (non-condensing) during operation |
| Aggressive environment (IEC 721-3-3), coated | 3C3 |
| Test method according to IEC 60068-2-43 H2S | 10 days |
| Ambient temperature (at 60 AVM switching mode) | |
| - with derating | maximum 55 °C (131 °F) ¹⁾ |
| - with full output power, typical EFF2 motors | maximum 50 °C (122 °F) ¹⁾ |
| - at full continuous adjustable frequency drive output current | maximum 45 °C (113 °F) ¹⁾ |

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

| | |
|---|--------------|
| Minimum ambient temperature during full-scale operation | 0 °C (32 °F) |
|---|--------------|

| | |
|--|---|
| Minimum ambient temperature at reduced performance | -10 °C (14 °F) |
| Temperature during storage/transport | -25 to +65/70 °C (-13 °F to + 149/158 °F) |
| Maximum altitude above sea level without derating | 1000 m (3300 ft) |
| Maximum altitude above sea level with derating | 3000 m (10,000 ft) |

For more information on derating for high altitude, see the section on special conditions in the design guide.

| | |
|---------------------------------------|--|
| EMC standards, Emission | EN 61800-3, EN 61000-6-3/4, EN 55011, IEC 61800-3 EN 61800-3, EN 61000-6-1/2, |
| EMC standards, Immunity | EN 61000-4-2, EN 61000-4-3, EN 61000-4-4, EN 61000-4-5, EN 61000-4-6 |
| Energy efficiency class ²⁾ | IE2 |

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

2) Determined according to EN50598-2 at:

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

7

7.3 Cable Specifications

Cable lengths and cross-sections

| | |
|--|---|
| Maximum motor cable length, shielded/armored | 150 m (500 ft) |
| Maximum motor cable length, non-shielded/unarmored | 300 m (1000 ft) |
| Maximum cross-section to motor, line power, load sharing and brake ¹⁾ | |
| Maximum cross-section to control terminals, rigid wire | 1.5 mm ² /16 AWG (2 x 0.75 mm ²) |
| Maximum cross-section to control terminals, flexible cable | 1 mm ² /18 AWG |
| Maximum cross-section to control terminals, cable with enclosed core | 0.5 mm ² /20 AWG |
| Minimum cross-section to control terminals | 0.25 mm ² (AWG 3/4) |

1) See chapter 7.5 Electrical Data for more information.

7.4 Control Input/Output and Control Data

Digital inputs

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

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

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

Analog inputs

| | |
|-------------------------|----------------------------|
| Number of analog inputs | 2 |
| Terminal number | 53, 54 |
| Modes | voltage or current |
| Mode select | switches S201 and S202 |
| Voltage mode | switch S201/S202 = OFF (U) |
| Voltage level | 0–10 V (scaleable) |

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

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

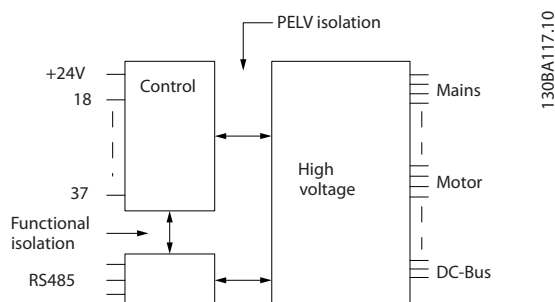


Figure 7.1 PELV Isolation of Analog Inputs

Pulse inputs

| | |
|--------------------------------------|----------------------------------|
| Programmable pulse inputs | 2 |
| Terminal number pulse | 29, 33 |
| Maximum frequency at terminal 29, 33 | 110 kHz (push-pull driven) |
| Maximum frequency at terminal 29, 33 | 5 kHz (open collector) |
| Minimum frequency at terminal 29, 33 | 4 Hz |
| Voltage level | see <i>Digital inputs</i> |
| Maximum voltage on input | 28 V DC |
| Input resistance, R_i | approx. 4 k Ω |
| Pulse input accuracy (0.1–1 kHz) | maximum error 0.1% of full scale |

Analog output

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

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

Control card, RS-485 serial communication

| | |
|--------------------|--------------------------------|
| Terminal number | 68 (PTX+, RX+), 69 (NTX-, 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 |
| Maximum output current (sink or source) | 40 mA |

| | |
|--|----------------------------------|
| Maximum load at frequency output | 1 kΩ |
| Maximum capacitive load at frequency output | 10 nF |
| Minimum output frequency at frequency output | 0 Hz |
| Maximum output frequency at frequency output | 32 kHz |
| Accuracy of frequency output | maximum error 0.1% of full scale |
| Resolution of frequency outputs | 12 bit |

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

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

Control card, 24 V DC output

| | |
|-----------------|--------|
| Terminal number | 12, 13 |
| 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

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 NOT galvanically isolated from protective ground. Use only isolated laptop/PC as connection to the USB connector on the adjustable frequency drive or an isolated USB cable/drive.

Protection and features

- Electronic thermal motor protection against overload.
- If the temperature reaches a predefined level, temperature monitoring of the heatsink ensures that the adjustable frequency drive trips. An overload temperature cannot be reset until the temperature of the heatsink is below the values stated in *Table 7.1* to *Table 7.4* (Guideline - these temperatures may vary for different power sizes, enclosure sizes, enclosure ratings, etc.).
- The adjustable frequency drive is protected against short-circuits on motor terminals U, V, W.
- If a line phase is missing, the adjustable frequency drive trips or issues a warning (depending on the load).
- If the intermediate circuit voltage is too low or too high, monitoring of the intermediate circuit voltage ensures that the adjustable frequency drive trips.
- The adjustable frequency drive is protected against ground faults on motor terminals U, V, W.

7.5 Electrical Data

| Line Power Supply 3 x 380–480 V AC | | | | |
|--|--------------------------|--------------------------|--------------------------|--------------------------|
| | P315 | P355 | P400 | P450 |
| Typical shaft output at 400 V [kW] | 315 | 355 | 400 | 450 |
| Typical shaft output at 460 V [hp] | 450 | 500 | 600 | 600 |
| Enclosure protection rating IP21 | E1 | E1 | E1 | E1 |
| Enclosure protection rating IP54 | E1 | E1 | E1 | E1 |
| Enclosure protection rating IP00 | E2 | E2 | E2 | E2 |
| Output current | | | | |
| Continuous (at 400 V) [A] | 600 | 658 | 745 | 800 |
| Intermittent (60 s overload) (at 400 V) [A] | 660 | 724 | 820 | 880 |
| Continuous (at 460/480 V) [A] | 540 | 590 | 678 | 730 |
| Intermittent (60 s overload) (at 460/480 V) [A] | 594 | 649 | 746 | 803 |
| Continuous KVA (at 400 V) [KVA] | 416 | 456 | 516 | 554 |
| Continuous KVA (at 460 V) [KVA] | 430 | 470 | 540 | 582 |
| Maximum input current | | | | |
| Continuous (at 400 V) [A] | 590 | 647 | 733 | 787 |
| Continuous (at 460/480 V) [A] | 531 | 580 | 667 | 718 |
| Maximum cable size, line power, motor and load share [mm ² (AWG ²)] | 4 x 240 (4 x 500 mcm) | 4 x 240 (4 x 500 mcm) | 4 x 240 (4 x 500 mcm) | 4 x 240 (4 x 500 mcm) |
| Maximum cable size, brake [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) |
| Maximum external pre-fuses [A] ¹⁾ | 700 | 800 | 900 | 900 |
| Estimated power loss at rated max. load [W] ³⁾ , 400 V | 6790 | 7701 | 8677 | 9473 |
| Estimated power loss at rated maximum load [W] ³⁾ , 460 V | 6082 | 6953 | 7819 | 8527 |
| Weight, enclosure protection rating IP21, IP54 [kg (lb)] | 263 (580) | 270 (595.5) | 272 (600) | 313 (690) |
| Weight, enclosure protection rating IP00 [kg (lb)] | 221 (487.3) | 234 (516) | 236 (520.3) | 277 (611) |
| Efficiency ⁴⁾ | 0.98 | | | |
| Output frequency | 0–590 Hz | | | |
| Heatsink overtemperature trip | 110 °C (230 °F) | | | |
| Power card ambient trip | 75 °C (167 °F) | | | 85 °C (185 °F) |

Table 7.1 Line Power Supply 3 x 380–480 V AC

| Line Power Supply 3 x 380–480 V AC | | | | | | |
|---|---------------------------|-------|-------|----------------------------|-------------|-------|
| | P500 | P560 | P630 | P710 | P800 | P1M0 |
| Typical shaft output at 400 V [kW] | 500 | 560 | 630 | 710 | 800 | 1000 |
| Typical shaft output at 460 V [hp] | 650 | 750 | 900 | 1000 | 1200 | 1350 |
| Enclosure protection rating IP21, IP54 without/with options cabinet | F1/F3 | F1/F3 | F1/F3 | F1/F3 | F2/F4 | F2/F4 |
| Output current | | | | | | |
| Continuous (at 400 V) [A] | 880 | 990 | 1120 | 1260 | 1460 | 1720 |
| Intermittent (60 s overload) (at 400 V) [A] | 968 | 1089 | 1232 | 1386 | 1606 | 1892 |
| Continuous (at 460/480 V) [A] | 780 | 890 | 1050 | 1160 | 1380 | 1530 |
| Intermittent (60 s overload) (at 460/480 V) [A] | 858 | 979 | 1155 | 1276 | 1518 | 1683 |
| Continuous KVA (at 400 V) [KVA] | 610 | 686 | 776 | 873 | 1012 | 1192 |
| Continuous KVA (at 460 V) [KVA] | 621 | 709 | 837 | 924 | 1100 | 1219 |
| Maximum input current | | | | | | |
| Continuous (at 400 V) [A] | 857 | 964 | 1090 | 1227 | 1422 | 1675 |
| Continuous (at 460/480 V) [A] | 759 | 867 | 1022 | 1129 | 1344 | 1490 |
| Maximum cable size, motor [mm ² (AWG ²)] | 8 x 150 (8 x 300 mcm) | | | 12 x 150 (12 x 300 mcm) | | |
| Maximum cable size, line power F1/F2 [mm ² (AWG ²)] | 8 x 240 (8 x 500 mcm) | | | | | |
| Maximum cable size, line power F3/F4 [mm ² (AWG ²)] | 8 x 456 (8 x 900 mcm) | | | | | |
| Maximum cable size, load sharing [mm ² (AWG ²)] | 4 x 120 (4 x 250 mcm) | | | | | |
| Maximum cable size, brake [mm ² (AWG ²)] | 4 x 185 (4 x 350 mcm) | | | 6 x 185 (6 x 350 mcm) | | |
| Maximum external pre-fuses [A] ¹⁾ | 1600 | | 2000 | | 2500 | |
| Estimated power loss at rated maximum load [W] ³⁾ , 400 V, F1 & F2 | 10162 | 11822 | 12512 | 14674 | 17293 | 19278 |
| Estimated power loss at rated maximum load [W] ³⁾ , 460 V, F1 & F2 | 8876 | 10424 | 11595 | 13213 | 16229 | 16624 |
| Maximum added losses of A1 RFI, circuit breaker or disconnect, & contactor, F3 & F4 | 963 | 1054 | 1093 | 1230 | 2280 | 2541 |
| Maximum panel options losses | 400 | | | | | |
| Weight, enclosure protection rating IP21, IP54 [kg (lb)] | 1017/1318 (2242.1/2905.7) | | | 1260/1561 (2778/3441.5) | | |
| Weight rectifier module [kg (lb)] | 102 (224.9) | | | | 136 (300) | |
| Weight inverter module [kg (lb)] | 102 (224.9) | | | 136 (300) | 102 (224.9) | |
| Efficiency ⁴⁾ | 0.98 | | | | | |
| Output frequency | 0–590 Hz | | | | | |
| Heatsink overtemperature trip | 95 °C (203 °F) | | | | | |
| Power card ambient trip | 85 °C (185 °F) | | | | | |

Table 7.2 Line Power Supply 3 x 380–480 V AC

| Line Power Supply 3 x 525–690 V AC | | | | |
|--|-------------------|-------------------|-------------------|-------------------|
| | P450 | P500 | P560 | P630 |
| Typical shaft output at 550 V [kW] | 355 | 400 | 450 | 500 |
| Typical shaft output at 575 V [hp] | 450 | 500 | 600 | 650 |
| Typical shaft output at 690 V [kW] | 450 | 500 | 560 | 630 |
| Enclosure protection rating IP21 | E1 | E1 | E1 | E1 |
| Enclosure protection rating IP54 | E1 | E1 | E1 | E1 |
| Enclosure protection rating IP00 | E2 | E2 | E2 | E2 |
| Output current | | | | |
| Continuous (at 550 V) [A] | 470 | 523 | 596 | 630 |
| Intermittent (60 s overload) (at 550 V) [A] | 517 | 575 | 656 | 693 |
| Continuous (at 575/690 V) [A] | 450 | 500 | 570 | 630 |
| Intermittent (60 s overload) (at 575/690 V) [A] | 495 | 550 | 627 | 693 |
| Continuous KVA (at 550 V) [KVA] | 448 | 498 | 568 | 600 |
| Continuous KVA (at 575 V) [KVA] | 448 | 498 | 568 | 627 |
| Continuous KVA (at 690 V) [KVA] | 538 | 598 | 681 | 753 |
| Maximum input current | | | | |
| Continuous (at 550 V) [A] | 453 | 504 | 574 | 607 |
| Continuous (at 575 V) [A] | 434 | 482 | 549 | 607 |
| Continuous (at 690 V) [A] | 434 | 482 | 549 | 607 |
| Maximum cable size, line power, motor and load share [mm ² (AWG)] | 2x240 (2x500 mcm) | 4x240 (4x500 mcm) | 4x240 (4x500 mcm) | 4x240 (4x500 mcm) |
| Maximum cable size, brake [mm ² (AWG)] | 2x185 (2x350 mcm) | 2x185 (2x350 mcm) | 2x185 (2x350 mcm) | 2x185 (2x350 mcm) |
| Maximum external pre-fuses [A] ¹⁾ | 700 | 700 | 900 | 900 |
| Estimated power loss at rated maximum load [W] ³⁾ , 600 V | 5323 | 6010 | 7395 | 8209 |
| Estimated power loss at rated maximum load [W] ³⁾ , 690 V | 5529 | 6239 | 7653 | 8495 |
| Weight, enclosure protection ratings IP21, IP54 [kg (lb)] | 263 (580) | 263 (580) | 272 (600) | 313 (690) |
| Weight, enclosure protection rating IP00 [kg (lb)] | 221 (487.3) | 221 (487.3) | 236 (520.3) | 277 (611) |
| Efficiency ⁴⁾ | 0.98 | | | |
| Output frequency | 0–525 Hz | | | |
| Heatsink overtemperature trip | 110 °C (230 °F) | 95 °C (203 °F) | | 110 °C (230 °F) |
| Power card ambient trip | 85 °C (185 °F) | | | |

Table 7.3 Line Power Supply 3 x 525–690 V AC

| Line Power Supply 3 x 525–690 V AC | | | | | | |
|---|------------------------------|------------------------------|------------------------------|----------------------------|----------------------------|----------------------------|
| | P710 | P800 | P900 | P1M0 | P1M2 | P1M4 |
| Typical shaft output at 550 V [kW] | 560 | 670 | 750 | 850 | 1000 | 1100 |
| Typical shaft output at 575 V [hp] | 750 | 950 | 1050 | 1150 | 1350 | 1550 |
| Typical shaft output at 690 V [kW] | 710 | 800 | 900 | 1000 | 1200 | 1400 |
| Enclosure protection ratings IP21, IP54 without/with options cabinet | F1/F3 | F1/F3 | F1/F3 | F2/F4 | F2/F4 | F2/F4 |
| Output current | | | | | | |
| Continuous (at 550 V) [A] | 763 | 889 | 988 | 1108 | 1317 | 1479 |
| Intermittent (60 s overload, at 550 V) [A] | 839 | 978 | 1087 | 1219 | 1449 | 1627 |
| Continuous (at 575/690 V) [A] | 730 | 850 | 945 | 1060 | 1260 | 1415 |
| Intermittent (60 s overload, at 575/690 V) [A] | 803 | 935 | 1040 | 1166 | 1386 | 1557 |
| Continuous KVA (at 550 V) [KVA] | 727 | 847 | 941 | 1056 | 1255 | 1409 |
| Continuous KVA (at 575 V) [KVA] | 727 | 847 | 941 | 1056 | 1255 | 1409 |
| Continuous KVA (at 690 V) [KVA] | 872 | 1016 | 1129 | 1267 | 1506 | 1691 |
| Maximum input current | | | | | | |
| Continuous (at 550 V) [A] | 743 | 866 | 962 | 1079 | 1282 | 1440 |
| Continuous (at 575 V) [A] | 711 | 828 | 920 | 1032 | 1227 | 1378 |
| Continuous (at 690 V) [A] | 711 | 828 | 920 | 1032 | 1227 | 1378 |
| Maximum cable size, motor [mm ² (AWG ²)] | 8x150 (8x300 mcm) | | | 12x150 (12x300 mcm) | | |
| Maximum cable size, line power F1/F2 [mm ² (AWG ²)] | 8x240 (8x500 mcm) | | | | | |
| Maximum cable size, line power F3/F4 [mm ² (AWG ²)] | 8x456 (8x900 mcm) | | | | | |
| Maximum cable size, load sharing [mm ² (AWG ²)] | 4x120 (4x250 mcm) | | | | | |
| Maximum cable size, brake [mm ² (AWG ²)] | 4x185 (4x350 mcm) | | | 6x185 (6x350 mcm) | | |
| Maximum external pre-fuses [A] ¹⁾ | 1600 | | | | 2000 | 2500 |
| Estimated power loss at rated maximum load [W] ³⁾ , 600 V, F1 & F2 | 9500 | 10872 | 12316 | 13731 | 16190 | 18536 |
| Estimated power loss at rated maximum load [W] ³⁾ , 690 V, F1 & F2 | 9863 | 11304 | 12798 | 14250 | 16821 | 19247 |
| Maximum added losses of circuit breaker or disconnect & contactor, F3 & F4 | 427 | 532 | 615 | 665 | 863 | 1044 |
| Maximum panel options losses | 400 | | | | | |
| Weight, enclosure protection ratings IP21, IP54 [kg (lb)] | 1004/1299 (2213.5/2863.8) | 1004/1299 (2213.5/2863.8) | 1004/1299 (2213.5/2863.8) | 1246/1541 (2747/3397.4) | 1246/1541 (2747/3397.4) | 1280/1575 (2822/3472.3) |
| Weight, rectifier module [kg (lb)] | 102 (224.9) | 102 (224.9) | 102 (224.9) | 136 (300) | 136 (300) | 136 (300) |
| Weight, inverter module [kg (lb)] | 102 (224.9) | 102 (224.9) | 136 (300) | 102 (224.9) | 102 (224.9) | 136 (300) |
| Efficiency ⁴⁾ | 0.98 | | | | | |
| Output frequency | 0–500 Hz | | | | | |
| Heatsink overtemperature trip | 95 °C (203 °F) | 105 °C (221 °F) | 95 °C (203 °F) | 95 °C (203 °F) | 105 °C (221 °F) | 95 °C (203 °F) |
| Power card ambient trip | 85 °C (185 °F) | | | | | |

Table 7.4 Line Power Supply 3 x 525–690 V AC

- 1) For type of fuse, see *chapter 4.1.14 Fuses*.
- 2) American wire gauge.

- 3) Applies for dimensioning of adjustable frequency drive cooling. If the switching frequency is higher than the default setting, the power losses may increase. LCP and typical control card power consumptions are included. For power loss data according to EN 50598-2, refer to www.danfoss.com/vltenergyefficiency.
- 4) Efficiency measured at nominal current. For energy efficiency class, see *chapter 7.2 Ambient Conditions*. For part load losses, see www.danfoss.com/vltenergyefficiency.

8 Warnings and Alarms

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

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

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

Reset can be done in four ways:

- Pressing [Reset] on the LCP.
- Via a digital input with the *Reset* function.
- Via serial communication/optional serial communication bus.
- By resetting automatically using the *Auto Reset* function (default).

NOTICE!

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

If an alarm cannot be reset, the reason may be that its cause has not been rectified, or the alarm is trip-locked (see also *Table 8.1*).

CAUTION

Alarms that are trip-locked offer extra protection, meaning that the line power supply must be switched off before the alarm can be reset. After being switched back on, the adjustable frequency drive is no longer blocked and may be reset as described previously once the cause has been rectified.

Alarms that are not trip-locked can also be reset using the automatic reset function in *parameter 14-20 Reset Mode* (Warning: Automatic wake-up is possible!) *Table 8.1* specifies whether a warning occurs before an alarm, or whether to display a warning or an alarm for a given fault.

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

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

| No. | Description | Warning | Alarm/trip | Alarm/trip lock | Parameter reference |
|-----|--|---------|-----------------|-----------------|---------------------|
| 27 | Brake chopper short-circuited | X | X | | |
| 28 | Brake check | (X) | (X) | | 2-15 |
| 29 | Drive overtemperature | 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 | Heatsink sensor | | X | X | |
| 40 | Overload of digital output terminal 27 | (X) | | | 5-00, 5-01 |
| 41 | Overload of digital output terminal 29 | (X) | | | 5-00, 5-02 |
| 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 overtemperature | X | X | X | |
| 66 | Heatsink 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 set-up | X | | | |
| 79 | Illegal PS config | | X | X | |
| 80 | Drive initialized to default value | | X | | |
| 91 | Analog input 54 wrong settings | | | X | |
| 92 | No-Flow | X | X | | 22-2* |
| 93 | Dry pump | X | X | | 22-2* |
| 94 | End of curve | X | X | | 22-5* |
| 95 | Broken belt | X | X | | 22-6* |

| No. | Description | Warning | Alarm/trip | Alarm/trip lock | Parameter reference |
|-----|------------------------|---------|------------|-----------------|---------------------|
| 96 | Start delayed | X | | | 22-7* |
| 97 | Stop delayed | X | | | 22-7* |
| 98 | Clock fault | X | | | 0-7* |
| 201 | Fire M was active | | | | |
| 202 | Fire M limits exceeded | | | | |
| 203 | Missing motor | | | | |
| 204 | Locked rotor | | | | |
| 243 | Brake IGBT | X | X | | |
| 244 | Heatsink temp | X | X | X | |
| 245 | Heatsink sensor | | X | X | |
| 246 | Pwr.card supply | | X | X | |
| 247 | Pwr.card temp | | X | X | |
| 248 | Illegal PS config | | X | X | |
| 250 | New spare parts | | | X | |
| 251 | New type code | | X | X | |

Table 8.1 Alarm/Warning Code List

(X) *Dependent on parameter.*

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

A trip is the action when an alarm has appeared. The trip coasts the motor and can be reset by pressing [Reset] or by using the *Reset* function via a digital input (parameter group 5-1* *Digital Inputs* [1]). The original event that caused an alarm cannot damage the adjustable frequency drive or cause dangerous conditions. A trip lock is an

action when an alarm occurs, which may damage the adjustable frequency drive or connected parts. A trip lock situation can only be reset by power cycling.

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

Table 8.2 LED Indication

| Alarm Word and Extended Status Word | | | | | |
|-------------------------------------|----------|---------|---------------------|---------------------|----------------------|
| Bit | Hex | Dec | Alarm Word | Warning Word | Extended Status Word |
| 0 | 00000001 | 1 | Brake Check | Brake Check | Ramping |
| 1 | 00000002 | 2 | Pwr. Card Temp | Pwr. Card Temp | AMA Running |
| 2 | 00000004 | 4 | Ground Fault | Ground 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 | Overcurrent | Overcurrent | 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 undervolt | DC undervolt | Output Freq Low |
| 11 | 00000800 | 2048 | DC overvolt | DC overvolt | Brake Check OK |
| 12 | 00001000 | 4096 | Short circuit | DC Voltage Low | Braking Max |
| 13 | 00002000 | 8192 | Soft-charge fault | DC Voltage High | Braking |
| 14 | 00004000 | 16384 | Line power ph. Loss | Line power 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 | 10 V 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 | |

| Alarm Word and Extended Status Word | | | | | |
|-------------------------------------|----------|------------|--------------------------------|--------------------------------|----------------------|
| Bit | Hex | Dec | Alarm Word | Warning Word | Extended Status Word |
| 22 | 00400000 | 4194304 | Serial communication bus fault | Serial communication bus fault | |
| 23 | 00800000 | 8388608 | 24 V Supply Low | 24 V Supply Low | |
| 24 | 01000000 | 16777216 | Line failure | Line failure | |
| 25 | 02000000 | 33554432 | 1.8 V 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
8

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

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

WARNING 1, 10 Volts low

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

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

Troubleshooting

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

WARNING/ALARM 2, Live zero error

This warning or alarm only appears if programmed in *parameter 6-01 Live Zero Timeout Function*. The signal on one of the analog inputs is less than 50% of the minimum value programmed for that input. Broken wiring or signals being sent by a faulty device causes this condition.

Troubleshooting

- Check connections on all the analog input terminals. Control card terminals 53 and 54 for signals, terminal 55 common. MCB 101 terminals 11 and 12 for signals, terminal 10 common. MCB

109 terminals 1, 3, 5 for signals, terminals 2, 4, 6 common.

- Check that the adjustable frequency drive programming and switch settings match the analog signal type.
- Perform an input terminal signal test.

WARNING 3, No motor

No motor has been connected to the output of the adjustable frequency drive.

WARNING/ALARM 4, Mains phase loss

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

Troubleshooting

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

WARNING 5, DC link voltage high

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

WARNING 6, DC link voltage low

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

WARNING/ALARM 7, DC overvoltage

If the intermediate circuit voltage exceeds the limit, the adjustable frequency drive trips after some time.

Troubleshooting

- Connect a brake resistor.
- Extend the ramp time.
- Change the ramp type.

- Activate the functions in *parameter 2-10 Brake Function*.
- Increase *parameter 14-26 Trip Delay at Inverter Fault*.

WARNING/ALARM 8, DC undervoltage

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

Troubleshooting

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

WARNING/ALARM 9, Inverter overload

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

Troubleshooting

- Compare the output current shown on the LCP with the adjustable frequency drive rated current.
- Compare the output current shown on the LCP with measured motor current.
- Display the thermal drive load on the LCP and monitor the value. When running above the adjustable frequency drive continuous current rating, the counter should increase. When running below the adjustable frequency drive 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 adjustable frequency drive issues a warning or an alarm when the counter reaches 100% in *parameter 1-90 Motor Thermal Protection*. The fault occurs when the motor overload exceeds 100% for too long.

Troubleshooting

- Check for motor overheating.
- Check if the motor is mechanically overloaded.
- Check that the motor current set in *parameter 1-24 Motor Current* is correct.
- Ensure the motor data in parameters *1-20* through *1-25* is set correctly.

- If an external fan is used, check that it is selected in *parameter 1-91 Motor External Fan*.
- Running AMA in *parameter 1-29 Automatic Motor Adaptation (AMA)* tunes the adjustable frequency drive to the motor more accurately and reduces thermal loading.

WARNING/ALARM 11, Motor thermistor overtemp

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

Troubleshooting

- Check for motor overheating.
- Check if the motor is mechanically overloaded.
- Check that the thermistor is connected correctly between either terminal 53 or 54 (analog voltage input) and terminal 50 (+10 V supply) 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 in *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 *parameter 4-16 Torque Limit Motor Mode* or the value in *parameter 4-17 Torque Limit Generator Mode*. *Parameter 14-25 Trip Delay at Torque Limit* can change this from a warning-only condition to a warning followed by an alarm.

Troubleshooting

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

WARNING/ALARM 13, Overcurrent

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

Troubleshooting

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

ALARM 14, Ground fault

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

Troubleshooting

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

ALARM 15, Hardware mismatch

A fitted option is not operational with the present control board hardware or software.

Record the value of the following parameters and contact the local Danfoss supplier:

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

ALARM 16, Short circuit

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

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

WARNING/ALARM 17, Control word timeout

There is no communication to the adjustable frequency drive.

The warning is only active when *parameter 8-04 Control Word Timeout Function* is NOT set to [0] Off.

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

Troubleshooting

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

ALARM 18, Start failed

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

WARNING 23, Internal fan fault

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

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

Troubleshooting

- Check fan resistance.
- Check soft charge fuses.

WARNING 24, External fan fault

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

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

Troubleshooting

- Check fan resistance.
- Check soft charge fuses.

WARNING 25, Brake resistor short circuit

The brake resistor is monitored during operation. If a short circuit occurs, the brake function is disabled and the warning appears. The adjustable frequency drive is still operational but without the brake function. Remove power from the adjustable frequency drive and replace the brake resistor (see *parameter 2-15 Brake Check*).

WARNING/ALARM 26, Brake resistor power limit

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

WARNING/ALARM 27, Brake chopper fault

The brake transistor is monitored during operation. If a short circuit occurs, the brake function is disabled and a warning is issued. The adjustable frequency drive is still operational, but since the brake transistor has short-circuited, substantial power is transmitted to the brake resistor, even if it is inactive.

Remove power from the adjustable frequency drive and remove the brake resistor.

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

WARNING/ALARM 28, Brake check failed

The brake resistor is not connected or not working. Check *parameter 2-15 Brake Check*.

ALARM 29, Heatsink temp

The maximum temperature of the heatsink has been exceeded. The temperature fault does not reset until the temperature drops below a defined heatsink temperature. The trip and reset points are different based on the adjustable frequency drive power size.

Troubleshooting

Check the following conditions:

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

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

Troubleshooting

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

ALARM 30, Motor phase U missing

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

Troubleshooting

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

ALARM 31, Motor phase V missing

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

Troubleshooting

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

ALARM 32, Motor phase W missing

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

Troubleshooting

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

ALARM 33, Inrush fault

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

WARNING/ALARM 34, Serial communication bus communication fault

The serial communication bus on the communication option card is not working.

WARNING/ALARM 35, Out of frequency range

This warning is active if the output frequency has reached the high limit (set in *parameter 4-53 Warning Speed High*) or low limit (set in *parameter 4-52 Warning Speed Low*). In [3] Closed-loop (*parameter 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 adjustable frequency drive is lost and *parameter 14-10 Mains Failure* is NOT set to [0] No Function.

Troubleshooting

- Check the fuses to the adjustable frequency drive and line power supply to the unit.

ALARM 38, Internal fault

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

Troubleshooting

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

Contact the Danfoss supplier or Danfoss service, if necessary. Note the code number for further troubleshooting directions.

| No. | Text |
|-----------|--|
| 0 | Serial port cannot be initialized. Contact the Danfoss supplier or Danfoss Service. |
| 256–258 | Power EEPROM data is defective or too old. |
| 512 | Control board EEPROM data is defective or too old. |
| 513 | Communication timeout reading EEPROM data. |
| 514 | Communication timeout reading EEPROM data. |
| 515 | Application-oriented control cannot recognize the EEPROM data. |
| 516 | Cannot write to the EEPROM because a write command is in progress. |
| 517 | Write command is under timeout. |
| 518 | Failure in the EEPROM. |
| 519 | Missing or invalid barcode data in EEPROM. |
| 783 | Parameter value outside of min/max limits. |
| 1024–1279 | Sending a CAN message failed. |
| 1281 | Digital signal processor flash timeout. |
| 1282 | Power micro software version mismatch. |
| 1283 | Power EEPROM data version mismatch. |
| 1284 | Cannot read digital signal processor software version. |
| 1299 | Option SW in slot A is too old. |
| 1300 | Option SW in slot B is too old. |
| 1301 | Option SW in slot C0 is too old. |
| 1302 | Option SW in slot C1 is too old. |
| 1315 | Option SW in slot A is not supported (not allowed). |
| 1316 | Option SW in slot B is not supported (not allowed). |
| 1317 | Option SW in slot C0 is not supported (not allowed). |
| 1318 | Option SW in slot C1 is not supported (not allowed). |
| 1379 | Option A did not respond when calculating platform version. |
| 1380 | Option B did not respond when calculating platform version. |
| 1381 | Option C0 did not respond when calculating platform version. |
| 1382 | Option C1 did not respond when calculating platform version. |
| 1536 | An exception in the application-oriented control is registered. Debug information written in LCP. |
| 1792 | DSP watchdog is active. Debugging of power part data, motor-oriented control data not transferred correctly. |
| 2049 | Power data restarted. |
| 2064–2072 | H081x: option in slot x has restarted. |
| 2080–2088 | H082x: option in slot x has issued a power-up wait. |
| 2096–2104 | H983x: option in slot x has issued a legal power-up wait. |
| 2304 | Could not read any data from power EEPROM. |
| 2305 | Missing SW version from power unit. |

| No. | Text |
|-----------|---|
| 2314 | Missing power unit data from power unit. |
| 2315 | Missing SW version from power unit. |
| 2316 | Missing lo_statepage from power unit. |
| 2324 | Power card configuration is determined to be incorrect at power-up. |
| 2325 | A power card has stopped communicating while line power is applied. |
| 2326 | Power card configuration is determined to be incorrect after the delay for power cards to register. |
| 2327 | Too many power card locations have been registered as present. |
| 2330 | Power size information between the power cards does not match. |
| 2561 | No communication from DSP to ATACD. |
| 2562 | No communication from ATACD to DSP (state running). |
| 2816 | Stack overflow control board module. |
| 2817 | Scheduler slow tasks. |
| 2818 | Fast tasks. |
| 2819 | Parameter thread. |
| 2820 | LCP stack overflow. |
| 2821 | Serial port overflow. |
| 2822 | USB port overflow. |
| 2836 | cfListMempool too small. |
| 3072–5122 | Parameter value is outside its limits. |
| 5123 | Option in slot A: Hardware incompatible with control board hardware. |
| 5124 | Option in slot B: Hardware incompatible with control board hardware. |
| 5125 | Option in slot C0: Hardware incompatible with control board hardware. |
| 5126 | Option in slot C1: Hardware incompatible with control board hardware. |
| 5376–6231 | Out of memory. |

Table 8.4 Code Numbers for Internal Faults

ALARM 39, Heatsink sensor

No feedback from the heatsink temperature sensor.

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

WARNING 40, Overload of digital output terminal 27

Check the load connected to terminal 27 or remove the short-circuit connection. Check *parameter 5-00 Digital I/O Mode* and *parameter 5-01 Terminal 27 Mode*.

WARNING 41, Overload of digital output terminal 29

Check the load connected to terminal 29 or remove the short-circuit connection. Check *parameter 5-00 Digital I/O Mode* and *parameter 5-02 Terminal 29 Mode*.

WARNING 42, Overload of digital output on X30/6 or overload of digital output on X30/7

For X30/6, check the load connected to X30/6 or remove the short-circuit connection. Check *parameter 5-32 Term X30/6 Digi Out (MCB 101)*.

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

ALARM 46, Power card supply

The supply on the power card is out of range.

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

WARNING 47, 24 V supply low

The 24 V DC supply is measured on the control card. The external 24 V DC backup power supply may be overloaded; otherwise, contact the Danfoss supplier.

WARNING 48, 1.8 V supply low

The 1.8 V DC supply used on the control card is outside of the allowable limits. The power supply is measured on the control card. Check for a defective control card. If an option card is present, check for 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 adjustable frequency drive displays a warning. When the speed is below the specified limit in *parameter 1-86 Trip Speed Low [RPM]* (except when starting or stopping) the adjustable frequency drive trips.

ALARM 50, AMA calibration failed

Contact the Danfoss supplier or Danfoss Service.

ALARM 51, AMA check U_{nom} and I_{nom}

The settings for motor voltage, motor current, and motor power are wrong. Check the settings in parameters 1-20 to 1-25.

ALARM 52, AMA low I_{nom}

The motor current is too low. Check the settings.

ALARM 53, AMA motor too big

The motor is too big for the AMA to operate.

ALARM 54, AMA motor too small

The motor is too small for the AMA to operate.

ALARM 55, AMA parameter out of range

The parameter values of the motor are outside of the acceptable range. AMA does not run.

ALARM 56, AMA interrupted by user

The user has interrupted the AMA.

ALARM 57, AMA internal fault

Try to restart AMA a number of times until the AMA is carried out. Note that repeated runs may heat the motor to a level where the resistance R_s and R_r are increased. In most cases, however, this is not critical.

ALARM 58, AMA Internal fault

Contact the Danfoss supplier.

WARNING 59, Current limit

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

WARNING 60, External interlock

External interlock has been activated. To resume normal operation:

1. Apply 24 V DC to the terminal programmed for external interlock.
2. Reset the adjustable frequency drive via
 - 2a serial communication
 - 2b digital I/O
 - 2c by pressing [Reset]

WARNING 62, Output frequency at maximum limit

The output frequency is higher than the value set in *parameter 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 overtemperature

The control card has reached its trip temperature of 80 °C (176 °F).

WARNING 66, Heatsink temperature low

The adjustable frequency drive is too cold to operate. This warning is based on the temperature sensor in the IGBT module.

Increase the ambient temperature of the unit. Also, a trickle amount of current can be supplied to the adjustable frequency drive whenever the motor is stopped by setting *parameter 2-00 DC Hold/Preheat Current* at 5% and *parameter 1-80 Function at Stop*.

Troubleshooting

- Check the temperature sensor.
- Check the sensor wire between the IGBT and the gate drive card.

ALARM 67, Option module configuration has changed

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

ALARM 68, Safe stop activated

STO has been activated.

Troubleshooting

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

ALARM 69, Power card temperaturePower card temperature

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

Troubleshooting

- Check the operation of the door fans.
- Make sure that the filters for the door fans are not blocked.
- Check that the connector plate is properly installed on IP21/IP54 (NEMA 1/12) adjustable frequency drives.

ALARM 70, Illegal FC configuration

The control card and power card are incompatible.

Troubleshooting

- Contact the supplier with the type code of the unit from the nameplate and the part numbers of the cards to check compatibility.

ALARM 72, Dangerous failure

Safe stop with trip lock. Unexpected signal levels on safe stop and digital input from the VLT® PTC Thermistor Card MCB 112.

WARNING 73, Safe stop auto restart

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

WARNING 76, Power unit set-up

The required number of power units do not match the detected number of active power units. When replacing an enclosure size F module, this occurs if the power-specific data in the module power card does not match the rest of the adjustable frequency drive.

Troubleshooting

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

WARNING 77, Reduced power mode

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

ALARM 79, Illegal power section configuration

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

ALARM 80, Drive initialized to default value

Parameter settings are initialized to default settings after a manual reset.

Troubleshooting

- Reset the unit to clear the alarm.

ALARM 91, Analog input 54 wrong settings

Switch S202 has to be set in position OFF (voltage input) when a KTY sensor is connected to analog input terminal 54.

ALARM 92, No-Flow

A no-flow condition has been detected in the system. *Parameter 22-23 No-Flow Function* is set for alarm.

Troubleshooting

- Troubleshoot the system and reset the adjustable frequency drive after the fault has been cleared.

ALARM 93, Dry pump

A no-flow condition in the system with the adjustable frequency drive operating at high speed may indicate a dry pump. *Parameter 22-26 Dry Pump Function* is set for alarm.

Troubleshooting

- Troubleshoot the system and reset the adjustable frequency drive after the fault has been cleared.

ALARM 94, End of curve

The feedback is lower than the setpoint. This may indicate leakage in the system. *Parameter 22-50 End of Curve Function* is set for alarm.

Troubleshooting

- Troubleshoot the system and reset the adjustable frequency drive after the fault has been cleared.

ALARM 95, Broken belt

Torque is below the torque level set for no load, indicating a broken belt. *Parameter 22-60 Broken Belt Function* is set for alarm.

Troubleshooting

- Troubleshoot the system and reset the adjustable frequency drive after the fault has been cleared.

ALARM 96, Start delayed

Motor start has been delayed due to short-cycle protection. *Parameter 22-76 Interval between Starts* is enabled.

Troubleshooting

- Troubleshoot the system and reset the adjustable frequency drive after the fault has been cleared.

WARNING 97, Stop delayed

Stopping the motor has been delayed due to short cycle protection. *Parameter 22-76 Interval between Starts* is enabled.

Troubleshooting

- Troubleshoot the system and reset the adjustable frequency drive 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 that the adjustable frequency drive has entered fire mode. Cycle power to the unit to remove the warning. See the fire mode data in the alarm log.

WARNING 202, Fire mode limits exceeded

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

WARNING 203, Missing motor

With an adjustable frequency drive operating multi-motors, an underload condition was detected. This could indicate a missing motor. Inspect the system for proper operation.

WARNING 204, Locked rotor

With an adjustable frequency drive operating multi-motors, an overload condition was detected. This could indicate a locked rotor. Inspect the motor for proper operation.

ALARM 243, Brake IGBT

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

- 1 = inverter module to the far left.
- 2 = middle inverter module in F2 or F4 adjustable frequency drive.
- 2 = right inverter module in F1 or F3 adjustable frequency drive.
- 3 = right inverter module in F2 or F4 adjustable frequency drive.
- 5 = rectifier module.

ALARM 244, Heatsink temperature

This alarm is only for enclosure size F adjustable frequency drives. It is equivalent to Alarm 29. The report value in the alarm log indicates which power module generated the alarm:

- 1 = inverter module to the far left.
- 2 = middle inverter module in F2 or F4 adjustable frequency drive.
- 2 = right inverter module in F1 or F3 adjustable frequency drive.
- 3 = right inverter module in F2 or F4 adjustable frequency drive.
- 5 = rectifier module.

ALARM 245, Heatsink sensor

This alarm is only for enclosure size F adjustable frequency drives. It is equivalent to Alarm 39. The report value in the alarm log indicates which power module generated the alarm:

- 1 = inverter module to the far left.
- 2 = middle inverter module in F2 or F4 adjustable frequency drive.
- 2 = right inverter module in F1 or F3 adjustable frequency drive.
- 3 = right inverter module in F2 or F4 adjustable frequency drive.
- 5 = rectifier module.

ALARM 246, Power card supply

This alarm is only for enclosure size F adjustable frequency drives. It is equivalent to Alarm 46. The report value in the alarm log indicates which power module generated the alarm:

- 1 = inverter module to the far left.
- 2 = middle inverter module in F2 or F4 adjustable frequency drive.
- 2 = right inverter module in F1 or F3 adjustable frequency drive.
- 3 = right inverter module in F2 or F4 adjustable frequency drive.
- 5 = rectifier module.

ALARM 247, Power card temperature

This alarm is only for enclosure size F adjustable frequency drive. It is equivalent to Alarm 69. The report value in the alarm log indicates which power module generated the alarm:

- 1 = inverter module to the far left.
- 2 = middle inverter module in F2 or F4 adjustable frequency drive.
- 2 = right inverter module in F1 or F3 adjustable frequency drive.
- 3 = right inverter module in F2 or F4 adjustable frequency drive.
- 5 = rectifier module.

ALARM 248, Illegal power section configuration

This alarm is only for enclosure size F adjustable frequency drives. It is equivalent to Alarm 79. The report value in the alarm log indicates which power module generated the alarm:

- 1 = inverter module to the far left.
- 2 = middle inverter module in F2 or F4 adjustable frequency drive.
- 2 = right inverter module in F1 or F3 adjustable frequency drive.
- 3 = right inverter module in F2 or F4 adjustable frequency drive.
- 5 = rectifier module.

WARNING 250, New spare part

A component in the adjustable frequency drive has been replaced. To resume normal operation, reset the adjustable frequency drive.

WARNING 251, New typecode

The power card or other components have been replaced and the type code changed.

Troubleshooting

- Reset to remove the warning and resume normal operation.

Index

A

Abbreviations and standards..... 4

AC line input connections..... 50

Acceleration time..... 81

Access to control terminal..... 56

Airflow..... 29

Alarm log..... 133

Alarm/warning code list..... 125

Alarms and warnings..... 123

AMA..... 63, 71, 127, 131

Analog input..... 114, 126

Analog output..... 115

Analog signal..... 126

Auto Energy Optimization Compressor..... 87

Auto Energy Optimization VT..... 87

Automatic motor adaptation (AMA)..... 63

B

Back cooling..... 28

Brake
 cable..... 49
 control, mechanical..... 64

Brake resistor temperature switch..... 49

Braking..... 129

Branch circuit protection..... 50

C

Cable length..... 114

Cable length and cross-section..... 39, 114

Cabling..... 39

Changes made..... 78

Changing a group of numeric data values..... 108

Changing a text value..... 108

Changing data..... 107

Changing of data value..... 108

Changing parameter data..... 78

Closed-loop..... 129

Coast inverse..... 79

Coasting..... 69

Communication option..... 129

Control cable..... 58, 60

Control card..... 126

Control Card performance..... 117

Control card, 10 V DC output..... 116

Control Card, 24 V DC output..... 116

Control card, RS-485 serial communication..... 115

Control card, USB serial communication..... 117

Control characteristics..... 116

Control terminal..... 56

Cooling..... 28, 89

Cross-section..... 114

Current
 level..... 115
 mode..... 115
 range..... 115

Current rating..... 127

D

DC link..... 126

Default setting..... 72

Digital input..... 127

Digital inputs..... 114

Digital output..... 115

Discharge time..... 6

Dry pump function..... 105

Duct cooling..... 28

Duct work cooling kits..... 31

E

ELCB relay..... 47

Electrical installation..... 56, 58

Enclosure type F option..... 37

Energy efficiency class..... 114, 122

Example of changing parameter data..... 78

External controllers..... 4

External fan supply..... 50

External temperature monitoring..... 38

F

Feedback..... 130, 132

Function set-up..... 82

Fuse..... 50, 129

Fuse specification..... 51

Fusing..... 39

G

General considerations..... 17

| | | | |
|---|------------|--|--|
| Gland/conduit entry, IP21 (NEMA 1) and IP54 (NEMA12)..... | 30 | | |
| GLCP..... | 72 | | |
| Graphical display..... | 66 | | |
| Grounding..... | 47 | | |
| H | | | |
| High voltage..... | 6 | | |
| How to connect a PC to the adjustable frequency drive..... | 70 | | |
| I | | | |
| IEC emergency stop with Pilz safety relay..... | 37 | | |
| IGBT..... | 55 | | |
| Indexed parameter..... | 108 | | |
| Indicator lights (LED)..... | 67 | | |
| Initialization..... | 72 | | |
| Input polarity of control terminal..... | 60 | | |
| Input terminal..... | 126 | | |
| Installation of 24 V DC external supply..... | 56 | | |
| Installation of input plate option..... | 36 | | |
| Installation of line power shield for adjustable frequency drive..... | 35 | | |
| Installation, duct cooling kit in Rittal..... | 31 | | |
| Intended use..... | 4 | | |
| IRM (insulation resistance monitor)..... | 37 | | |
| IT line power..... | 47 | | |
| K | | | |
| Keypad..... | 0 | | |
| L | | | |
| Language package..... | 79 | | |
| LCP..... | 71 | | |
| LCP 102..... | 66 | | |
| Leakage current..... | 6 | | |
| LED..... | 66 | | |
| Lifting..... | 9 | | |
| Line power supply (L1, L2, L3)..... | 113 | | |
| Line power supply 3 x 525–690 V AC..... | 120 | | |
| Literature..... | 5 | | |
| Load sharing..... | 49 | | |
| Logging..... | 78 | | |
| Low speed detection..... | 104 | | |
| Low-power detection..... | 104 | | |
| M | | | |
| Main Menu..... | 78 | | |
| Main Menu Mode..... | 68, 107 | | |
| Main reactance..... | 87 | | |
| Manual motor starters..... | 38 | | |
| Mechanical brake control..... | 64 | | |
| Mechanical dimensions..... | 12, 16 | | |
| Mechanical installation..... | 17 | | |
| Motor | | | |
| nameplate..... | 63 | | |
| thermal protection..... | 65 | | |
| Motor cable..... | 48 | | |
| Motor current..... | 131 | | |
| Motor data..... | 127, 131 | | |
| Motor insulation..... | 54 | | |
| Motor output..... | 113 | | |
| Motor power..... | 131 | | |
| Motor protection..... | 4, 89, 117 | | |
| Motor status..... | 4 | | |
| N | | | |
| NAMUR..... | 37 | | |
| No operation..... | 79 | | |
| Non-UL compliance..... | 51 | | |
| O | | | |
| Operate graphical LCP (GLCP), how to..... | 66 | | |
| Ordering..... | 32 | | |
| Output current..... | 127 | | |
| Output performance (U, V, W)..... | 113 | | |
| Outside installation/NEMA 3R kit for Rittal..... | 34 | | |
| P | | | |
| Parallel connection of motors..... | 64 | | |
| Parameter data..... | 78 | | |
| Parameter menu structure..... | 109 | | |
| Parameter selection..... | 107 | | |
| Parameter set-up..... | 74 | | |
| PC software tools..... | 70 | | |
| PELV..... | 115, 116 | | |
| Phase loss..... | 126 | | |
| Pilz relay..... | 38 | | |
| Planning, installation site..... | 8 | | |

| | | | |
|---|----------|--|---------|
| Potentiometer reference..... | 62 | System feedback..... | 4 |
| Power connections..... | 39 | | |
| Profibus DP-V1..... | 71 | T | |
| Programming..... | 126 | Terminal 54..... | 132 |
| Protection and features..... | 117 | Terminal location..... | 18 |
| Pulse input..... | 115 | Thermal protection..... | 5 |
| Pulse start/stop..... | 62 | Thermistor..... | 89, 127 |
| | | Three means of operation..... | 66 |
| Q | | Torque..... | 47 |
| Qualified personnel..... | 6 | Torque characteristic..... | 113 |
| Quick Menu..... | 78 | Torque for terminals..... | 48 |
| Quick Menu mode..... | 68, 78 | | |
| Quick transfer of parameter settings when using GLCP..... | 72 | U | |
| | | Unintended start..... | 6 |
| R | | Unpacking..... | 9 |
| RCD (residual current device)..... | 37 | | |
| Receiving, adjustable frequency drive..... | 9 | V | |
| Relay Outputs..... | 116 | Voltage imbalance..... | 126 |
| Remote commands..... | 4 | Voltage level..... | 114 |
| Reset..... | 127, 132 | Voltage reference via a potentiometer..... | 62 |
| RFI Switch..... | 47 | | |
| RS-485 bus connection..... | 70 | W | |
| | | Windmilling..... | 7 |
| S | | Wire access..... | 17 |
| Safe Torque Off..... | 7 | | |
| Serial communication..... | 117 | | |
| Serial communication bus connection..... | 55 | | |
| Shielded cable..... | 48 | | |
| Shielded/armored..... | 60 | | |
| Shielding of cables..... | 39 | | |
| Short circuit..... | 128 | | |
| Sine-wave filter..... | 39 | | |
| Space..... | 17 | | |
| Space heater and thermostat..... | 37 | | |
| Speed up/down..... | 62 | | |
| Start/stop..... | 61 | | |
| Stator leakage reactance..... | 87 | | |
| Status..... | 68 | | |
| Status messages..... | 66 | | |
| STO..... | 7, 38 | | |
| Supply voltage..... | 129 | | |
| Surrounding..... | 113 | | |
| Switches S201, S202 and S801..... | 61 | | |
| Switching frequency..... | 39 | | |



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