



Instruction Manual 12-Pulse High Power

VLT® AQUA Drive FC 200

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1 How to Read the Instruction Manual

1.1.1 Copyright, Limitation of Liability and Revision Rights

This publication contains information proprietary to Danfoss. By accepting and using this manual, the user agrees that the information contained herein will be used solely for operating equipment from Danfoss or equipment from other vendors provided that such equipment is intended for communication with Danfoss equipment over a serial communication link. This publication is protected under the copyright laws of Denmark and most other countries.

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

Although Danfoss has tested and reviewed the documentation within this manual, Danfoss makes no warranty or representation, neither expressed nor implied, with respect to this documentation, including its quality, performance, or fitness for a particular purpose.

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It has been assumed that all devices will be sitting behind a firewall that does packet filtering and the environment has well-implemented restrictions on the software that can run inside the firewall. All nodes are assumed to be "trusted" nodes.

1.1.2 Symbols

Symbols used in this manual

NOTE!

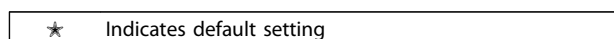
Indicates something to be noted by the reader.



Indicates a general warning.

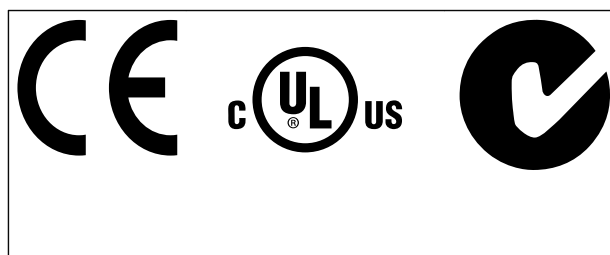


Indicates a high-voltage warning.



★ Indicates default setting

1.1.3 Approvals



1.1.4 Available literature for VLT® AQUA Drive FC 200

- VLT® AQUA Drive Instruction Manual MG.20.Mx.yy provides the necessary information for getting the drive up and running.
- VLT® AQUA Drive High Power Instruction Manual MG.20.Px.yy provides the necessary information for getting the HP drive up and running.
- VLT® AQUA Drive Design Guide MG.20.Nx.yy contains all the technical information about the drive and customer design and applications.
- VLT® AQUA Drive Programming Guide MN.20.Ox.yy provides information on how to program and includes complete parameter descriptions.
- VLT® AQUA Drive FC 200 Profibus MG.33.Cx.yy
- VLT® AQUA Drive FC 200 DeviceNet MG.33.Dx.yy
- Output Filters Design Guide MG.90.Nx.yy
- VLT® AQUA Drive FC 200 Cascade Controller MI.38.Cx.yy
- Application Note MN20A102: Submersible Pump Application

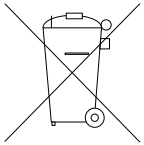
- Application Note MN20B102: Master/Follower Operation Application
 - Application Note MN20F102: Drive Closed-loop and Sleep Mode
 - Instruction MI.38.Bx.yy: Installation Instruction for Mounting Brackets Enclosure type A5, B1, B2, C1 and C2 IP21, IP55 or IP66
 - Instruction MI.90.Lx.yy: Analog I/O Option MCB109
 - Instruction MI.33.Hx.yy: Panel through mount kit
 x = Revision number
 yy = Language code
- Danfoss technical literature is also available online at www.danfoss.com/BusinessAreas/DrivesSolutions/Documentations/Technical+Documentation.htm.

1.1.5 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 | | |
| DCT | Drive Control Tool | | |
| Joule | Energy | J = N·m | ft-lb, Btu |
| °F | Fahrenheit | | |
| f | Frequency | Hz | Hz |
| kHz | Kilohertz | kHz | kHz |
| mA | Milliampere | | |
| ms | Millisecond | | |
| min | Minute | | |
| 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 | | |
| par. | Parameter | | |
| 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 Drive Output Current | | |
| RPM | Revolutions Per Minute | | |
| SR | Size Related | | |
| T | Temperature | C | F |
| t | Time | s | s, hr |
| T _{LIM} | Torque limit | | |
| U | Voltage | V | V |

Table 1.1 Abbreviation and Standards table

1.1.6 Disposal Instructions



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

2 Safety

Caution

The adjustable frequency drive DC link capacitors remain charged after power has been disconnected. To avoid the electrical shock hazard, disconnect the adjustable frequency drive from line power before carrying out maintenance. Before servicing the adjustable frequency drive, wait the minimum amount of time indicated below:

| | | |
|-----------|------------------------------|------------|
| 380- V | 425-1350 hp [315-1000 kW] | 40 minutes |
| 525-690 V | 535-1875 hp [400-1400 kW] | 30 minutes |

**VLT AQUA Drive
FC 200 Series**

Software version: 1.6x

This guide can be used with all adjustable frequency drives with software version 1.6x or later. The actual software version number can be read from *15-43 Software Version*.

2.1.1 High Voltage

⚠ WARNING

The voltage of the adjustable frequency drive is dangerous whenever the adjustable frequency drive is connected to line power. Incorrect installation or operation of the motor or adjustable frequency drive may cause damage to the equipment, serious personal injury or death. The instructions in this manual must therefore be observed, in addition to applicable local and national rules and safety regulations.

⚠ WARNING

Installation at high altitudes
380-480V: At altitudes above 9,843 feet [3 km], please contact Danfoss regarding PELV.
525-690V: At altitudes above 6561 ft [2 km], please contact Danfoss regarding PELV.

2.1.2 Safety Instructions

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

2.1.3 General Warning

⚠ WARNING

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

CAUTION

Leakage Current

The ground leakage current from the adjustable frequency drive exceeds 3.5 mA. To ensure that the ground cable has a good mechanical connection to the ground connection (terminal 95), the cable cross-section must be at least 0.016 in² [10 mm²] or 2 rated ground wires terminated separately. For proper grounding for EMC, see section *Grounding* in the *How to Install* chapter.

Residual Current Device

The drive can cause DC current in the protective conductor. Where a residual current device (RCD) is used for extra protection, only an RCD of Type B (time delayed) shall be used on the supply side of this product. Protective grounding of the adjustable frequency drive and the use of RCDs must always follow national and local regulations.

2.1.4 Before Commencing Repair Work

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

2.1.5 Avoid Unintended Start

While the adjustable frequency drive is connected to line power, the motor can be started/stopped using digital commands, bus commands, references or via the keypad::

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

2.1.6 Safe Stop

The can perform the safety function *Safe Torque Off* (As defined by draft CD IEC 61800-5-2) or *Stop Category 0* (as defined in EN 60204-1).

It is designed and approved suitable for the requirements of Safety Category 3 in EN 954-1. This functionality is called Safe Stop. Prior to integration and use of Safe Stop in an installation, a thorough risk analysis on the installation must be carried out in order to determine whether the Safe Stop functionality and safety category are appropriate and sufficient. In order to install and use the Safe Stop function in accordance with the requirements of Safety Category 3 in EN 954-1, the related information and instructions of the Design Guide must be followed! The information and instructions of the Instruction Manual are not sufficient for a correct and safe use of the safe stop functionality!

2.1.7 Safe Stop Installation

To carry out an installation of a Category 0 Stop (EN60204) in conformity with Safety Category 3 (EN954-1), follow these instructions:

1. The bridge (jumper) between Terminal 37 and 24V DC must be removed. Cutting or breaking the jumper is not sufficient. Remove it entirely to avoid short-circuiting. See jumper on *Figure 2.1*.
2. Connect terminal 37 to 24 V DC by a short circuit-protected cable. The 24 V DC voltage supply must be interruptible by an EN954-1 category 3 circuit interrupt device. If the interrupt device and the are placed in the same installation panel, you can use an non-shielded cable instead of a shielded one.

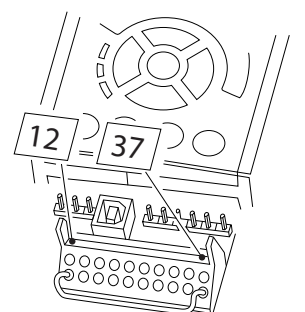


Figure 2.1 Bridge jumper between terminal 37 and 24 VDC

Figure 2.2 shows a Stopping Category 0 (EN 60204-1) with safety Category 3 (EN 954-1). The circuit interrupt is caused

by an opening door contact. The illustration also shows how to connect a non-safety related hardware coast.

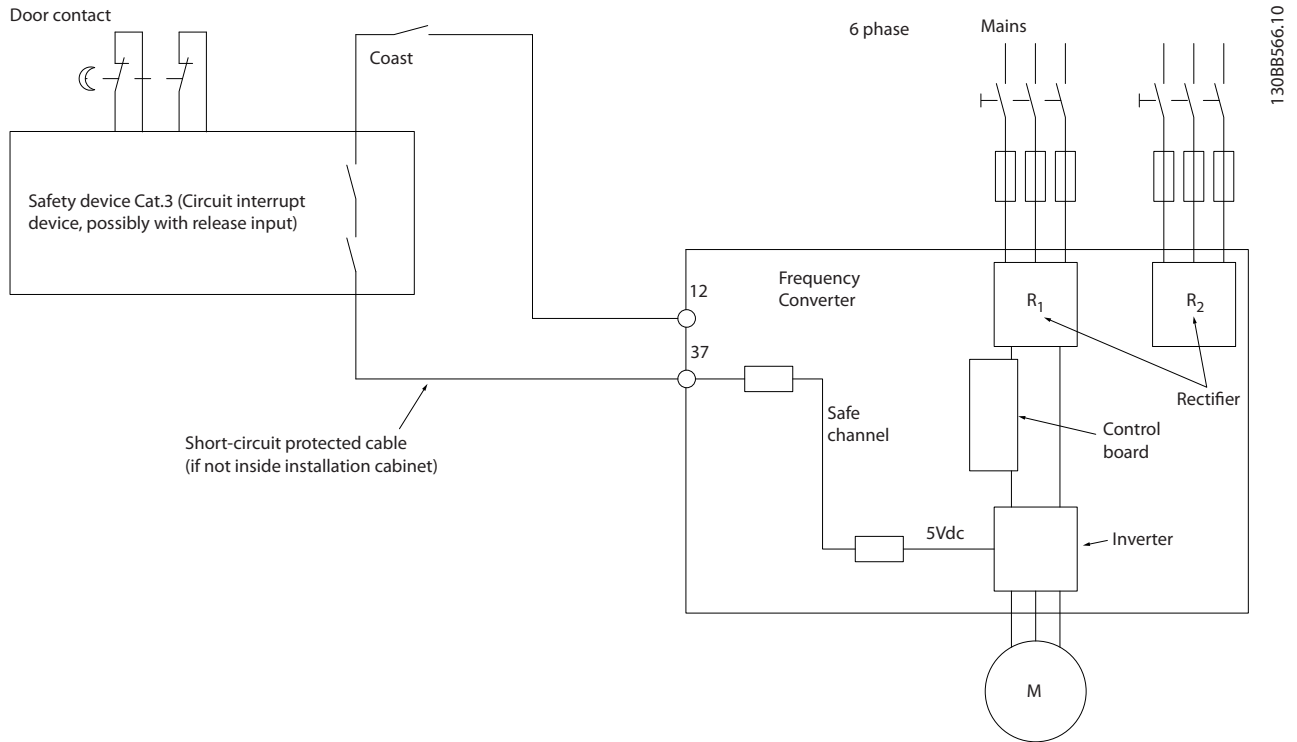


Figure 2.2 Essential aspects of an installation to achieve a Stopping Category 0 (EN 60204-1) with safety Category 3 (EN 954-1).

2.1.8 IT Line Power

14-50 RFI 1 can be used to disable the factory installed A1/B1 RFI filter option. If this is done, it will reduce the RFI performance to A2 level. For the 525–690V adjustable frequency drives, 14-50 RFI 1 is not available as there is no A1/B1 Factory Installed RFI Filter option.

3 Mechanical Installation

3.1 Pre-installation

3.1.1 Planning the Installation Site

NOTE!

Before performing the installation, it is important to plan the installation of the adjustable frequency drive. Neglecting this may result in extra work during and after installation.

Select the best possible operation site by considering the following (see details on the following pages and in the respective Design Guides):

- Ambient operating temperature
- Installation method
- How to cool the unit
- Position of the adjustable frequency drive.
- Cable routing
- Ensure the power source supplies the correct voltage and necessary current.
- Ensure that the motor current rating is within the maximum current from the adjustable frequency drive.
- Ensure that the drive is properly protected per local regulations.

3.1.2 Receiving the Adjustable Frequency Drive

When receiving the adjustable frequency drive, make sure that the packaging is intact, and look for any damage that might have occurred to the unit during transport. If damage has occurred, immediately contact the shipping company to make a damage claim.

3.1.3 Transportation and Unpacking

Before unpacking the adjustable frequency drive, it is recommended to unload it 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.

3.1.4 Lifting

Always lift the adjustable frequency drive using the dedicated lifting holes. For all 4X unit size and 52 unit size (IP00) Units, use a bar to avoid bending the lifting holes of the adjustable frequency drive.

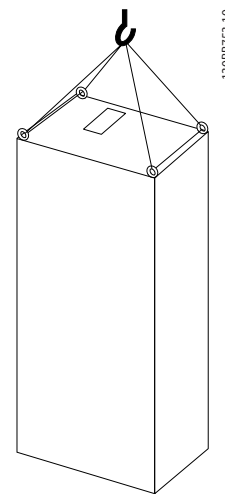
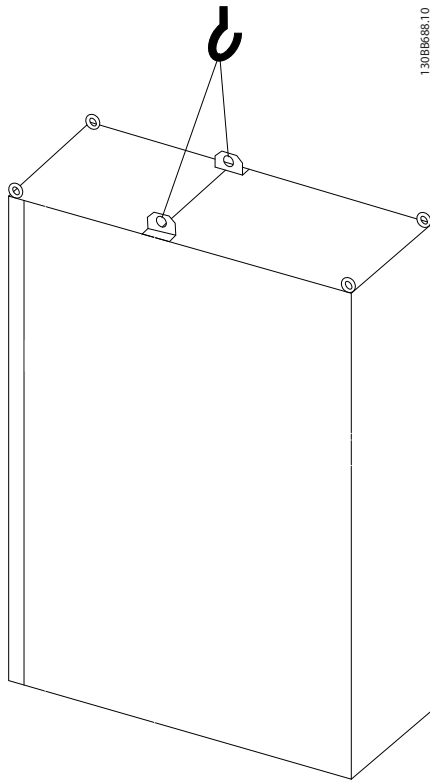


Figure 3.1 Recommended lifting method, Unit Size .

3



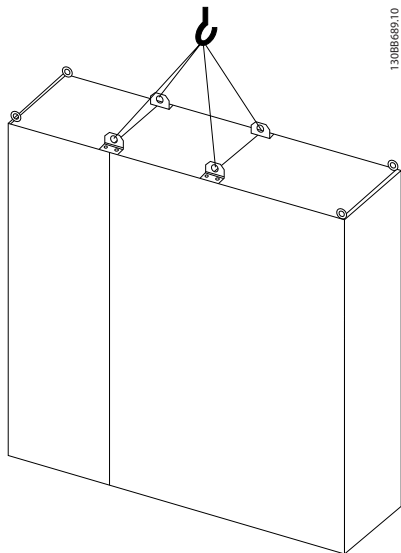
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NOTE!

Note the plinth is provided in the same packaging as the adjustable frequency drive but is not attached during shipment. The plinth is required to allow airflow to the drive to provide proper cooling. The unit sizes 6X should be positioned on top of the plinth in the final installation location. The angle from the top of the drive to the lifting cable should be 140°F [60°C] or greater.

In addition to the drawings above a spreader bar is an acceptable way to lift the unit sizes 6X.

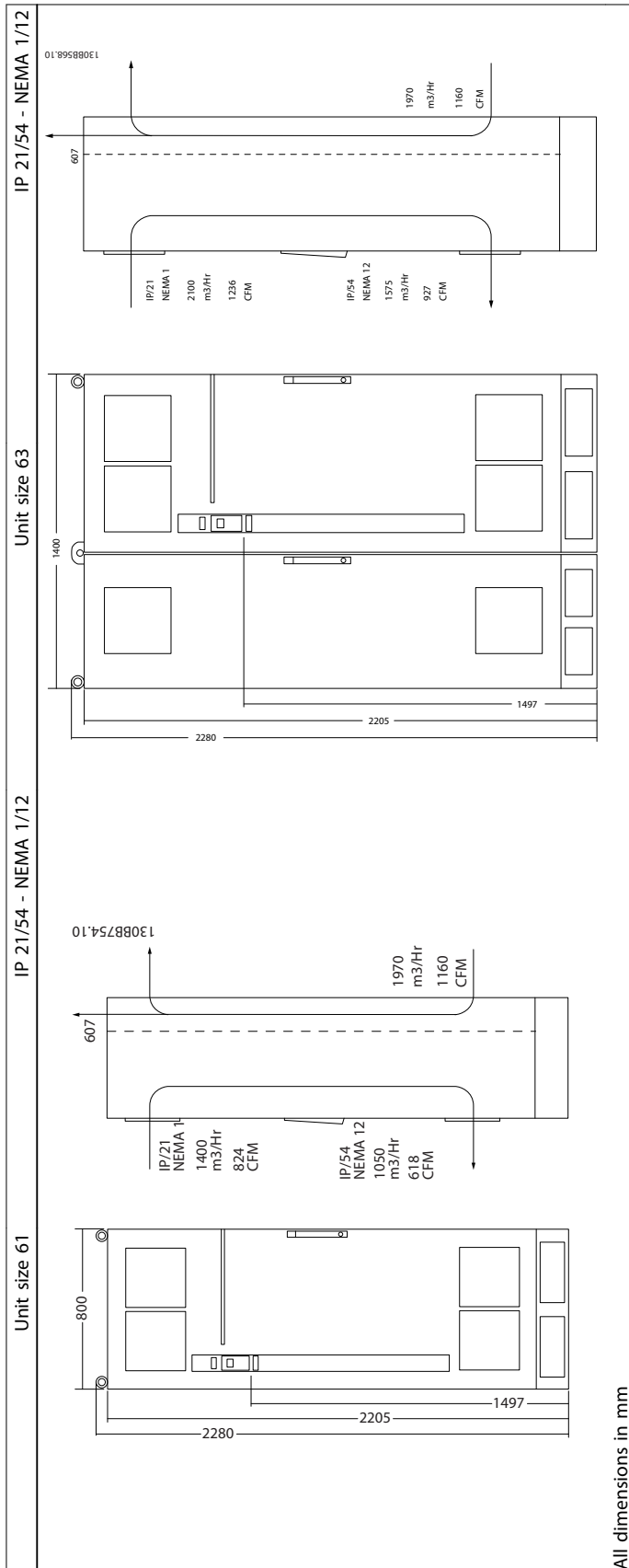
Figure 3.2 Recommended lifting method, Unit Size 63 (460V, 600–900 HP, 575/600V, 900–1150 HP).

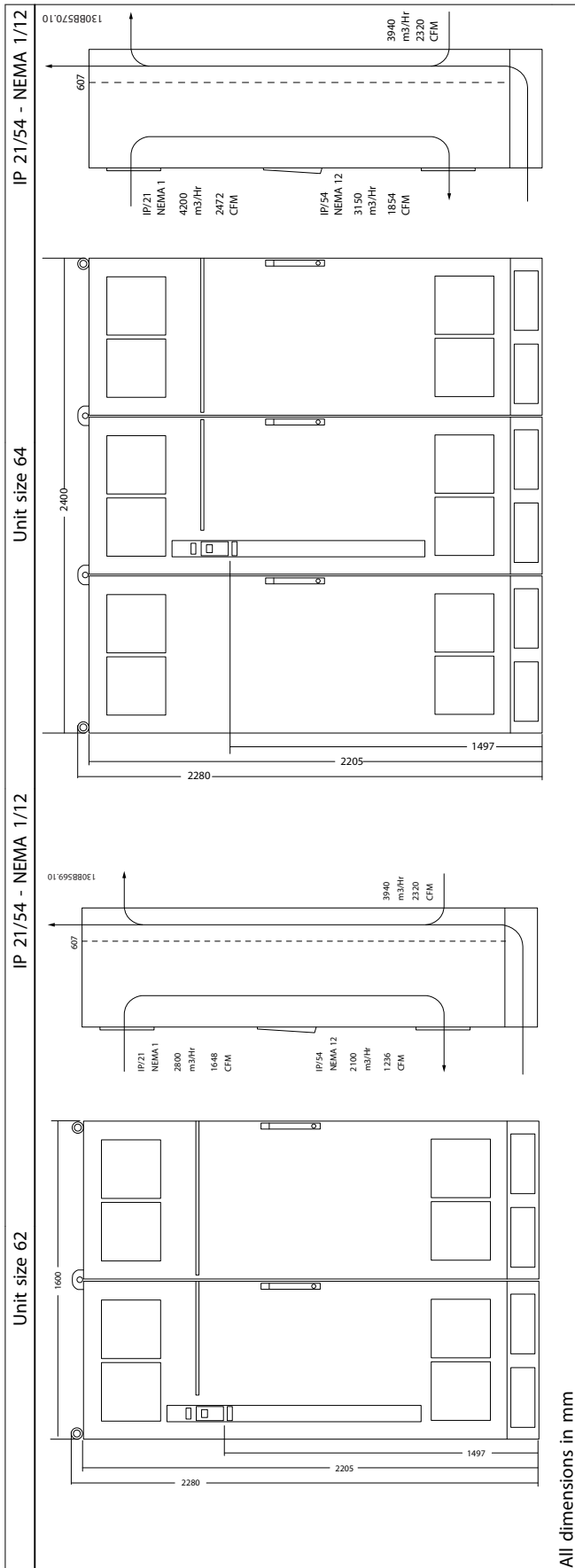


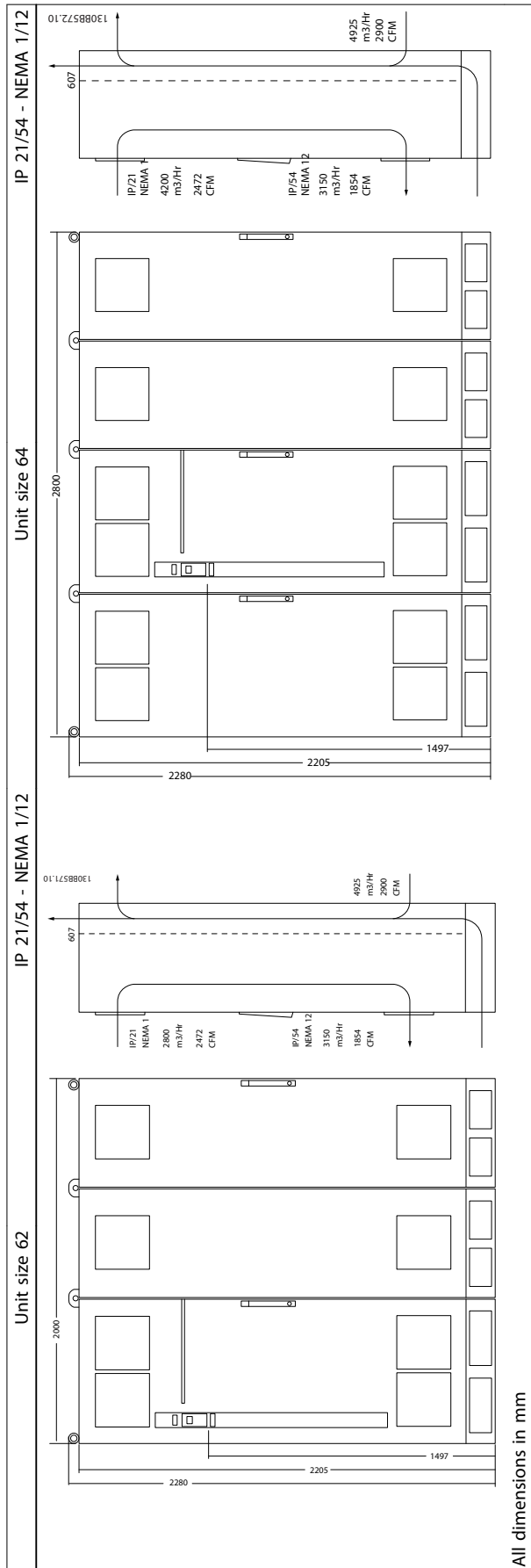
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Figure 3.3 Recommended lifting method, Unit Size 64 (460V, 1000–1200 HP, 575/600V, 1250–1350 HP).

3.1.5 Mechanical Dimensions







| Mechanical dimensions, Unit Sizes 4 and 5 | | | | | | | | | | | |
|--|------------|--|--------------------|---|--------------------|---|---------------------|--------------------|--------------------|--------------------|--------------------|
| Unit size | | 51 | | 61 | | 62 | | 63 | | 64 | |
| | | | | | | | | | | | |
| Heavy-duty rated power - 160% overload torque | | 425–600 hp [315–450 kW] (380–480 V) 535–850 hp [400–630 kW] (525–690 V) | | 675–950 hp [500–710 kW] (380–480 V) 950–1200 hp [710–900 kW] (525–690 V) | | 1075–1350 hp [800–1000 kW] (380–480 V) 1350–1875 hp [1000–1400 kW] (525–690 V) | | | | | |
| IP NEMA | | 21, 54 Type 12 | | 21, 54 Type 12 | | 21, 54 Type 12 | | | | | |
| Shipping dimensions | Height | 91.5 in [2324 mm] | 91.5 in [2324 mm] | 91.5 in [2324 mm] | 91.5 in [2324 mm] | 91.5 in [2324 mm] | 91.5 in [2324 mm] | 91.5 in [2324 mm] | 91.5 in [2324 mm] | 91.5 in [2324 mm] | 91.5 in [2324 mm] |
| | Width | 38.2 in [970 mm] | 61.7 in [1568 mm] | 69.3 in [1760 mm] | 69.3 in [1760 mm] | 100.75 in [2559 mm] | 100.75 in [2559 mm] | 85 in [2160 mm] | 85 in [2160 mm] | 116.5 in [2960 mm] | 116.5 in [2960 mm] |
| | Depth | 44.49 in [1130 mm] | 44.49 in [1130 mm] | 44.49 in [1130 mm] | 44.49 in [1130 mm] | 44.49 in [1130 mm] | 44.49 in [1130 mm] | 44.49 in [1130 mm] | 44.49 in [1130 mm] | 44.49 in [1130 mm] | 44.49 in [1130 mm] |
| Drive dimensions | Height | 86.8 in [2204 mm] | 86.8 in [2204 mm] | 86.8 in [2204 mm] | 86.8 in [2204 mm] | 86.8 in [2204 mm] | 86.8 in [2204 mm] | 86.8 in [2204 mm] | 86.8 in [2204 mm] | 86.8 in [2204 mm] | 86.8 in [2204 mm] |
| | Width | 31.50 in [800 mm] | 55.1 in [1400 mm] | 63 in [1600 mm] | 63 in [1600 mm] | 86.6 in [2200 mm] | 86.6 in [2200 mm] | 78.74 in [2000 mm] | 78.74 in [2000 mm] | 102.4 in [2600 mm] | 102.4 in [2600 mm] |
| | Depth | 28.86 in [606 mm] | 28.86 in [606 mm] | 28.86 in [606 mm] | 28.86 in [606 mm] | 28.86 in [606 mm] | 28.86 in [606 mm] | 28.86 in [606 mm] | 28.86 in [606 mm] | 28.86 in [606 mm] | 28.86 in [606 mm] |
| | Max weight | 970 lbs [440 kg] | 1446 lbs [656 kg] | 1940 lbs [880 kg] | 1940 lbs [880 kg] | 2416 lbs [1096 kg] | 2416 lbs [1096 kg] | 2253 lbs [1022 kg] | 2253 lbs [1022 kg] | 2729 lbs [1238 kg] | 2729 lbs [1238 kg] |

3.2 Mechanical Installation

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

3.2.1 Tools Needed

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

- Drill with 0.39 or 0.47 in [10 or 12 mm] drill.
- Tape measure
- Wrench with relevant metric sockets (7–17mm)
- Extensions to wrench
- Sheet metal punch for conduits or cable connectors in IP 21/Nema 1 and IP 54/Nema 12 drive types.
- Lifting bar to lift the unit (rod or tube max. Ø 25mm (1 inch), able to lift minimum 400kg (880lbs)).
- Crane or other lifting aid to place the adjustable frequency drive in position
- A Torx T50 tool is needed to install the Unit Size 511P 21/Nema 1 and IP 54/Nema 12 drive types.

3.2.2 General Considerations

Space

Ensure proper space above and below the adjustable frequency drive to allow airflow and cable access. In addition, space in front of the unit must be considered to allow the panel door to be opened.

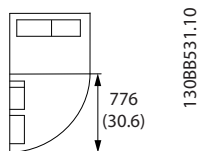


Figure 3.4 Space in front of

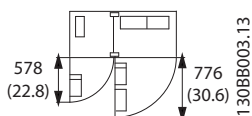


Figure 3.5 Space in front of

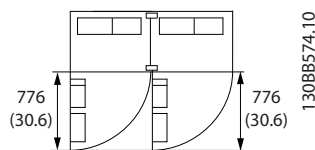


Figure 3.6 Space in front of

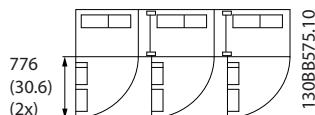


Figure 3.7 Space in front of

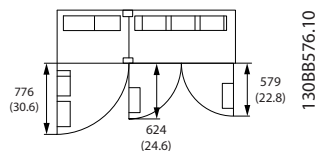


Figure 3.8 Space in front of

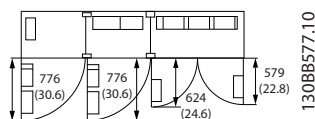


Figure 3.9 Space in front of

Wire access

Ensure that proper cable access is present including the necessary bending allowance.

NOTE!

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

3.2.3 Terminal Locations, F8-F13

The F enclosures have six different sizes, 61, 62, 63, F11, F12 and 64. The F1061 and 62 consist of an inverter cabinet on the right and rectifier cabinet on the left. The F1163 and 64 have an additional options cabinet left of the rectifier cabinet. The 63 is an 61 with an additional

options cabinet. The F11 is an 62 with an additional options cabinet. The F13 is an 62 with an additional options cabinet.

Terminal locations - Unit Sizes 61 and 63

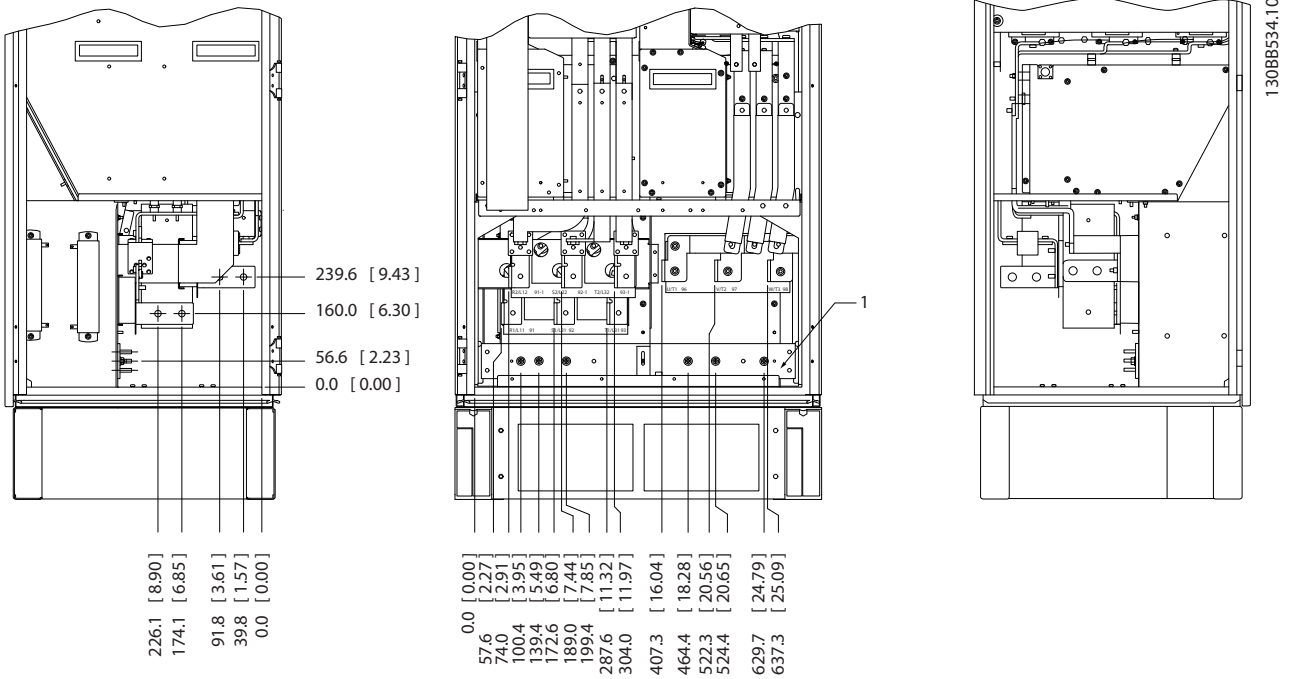


Figure 3.10 Terminal locations - Inverter and Rectifier Cabinet - and (front, left and right side view). The connector plate is 1.65 in [42 mm] below .0 level.
1) Ground bar

Terminal locations - Unit Sizes 61 and 63

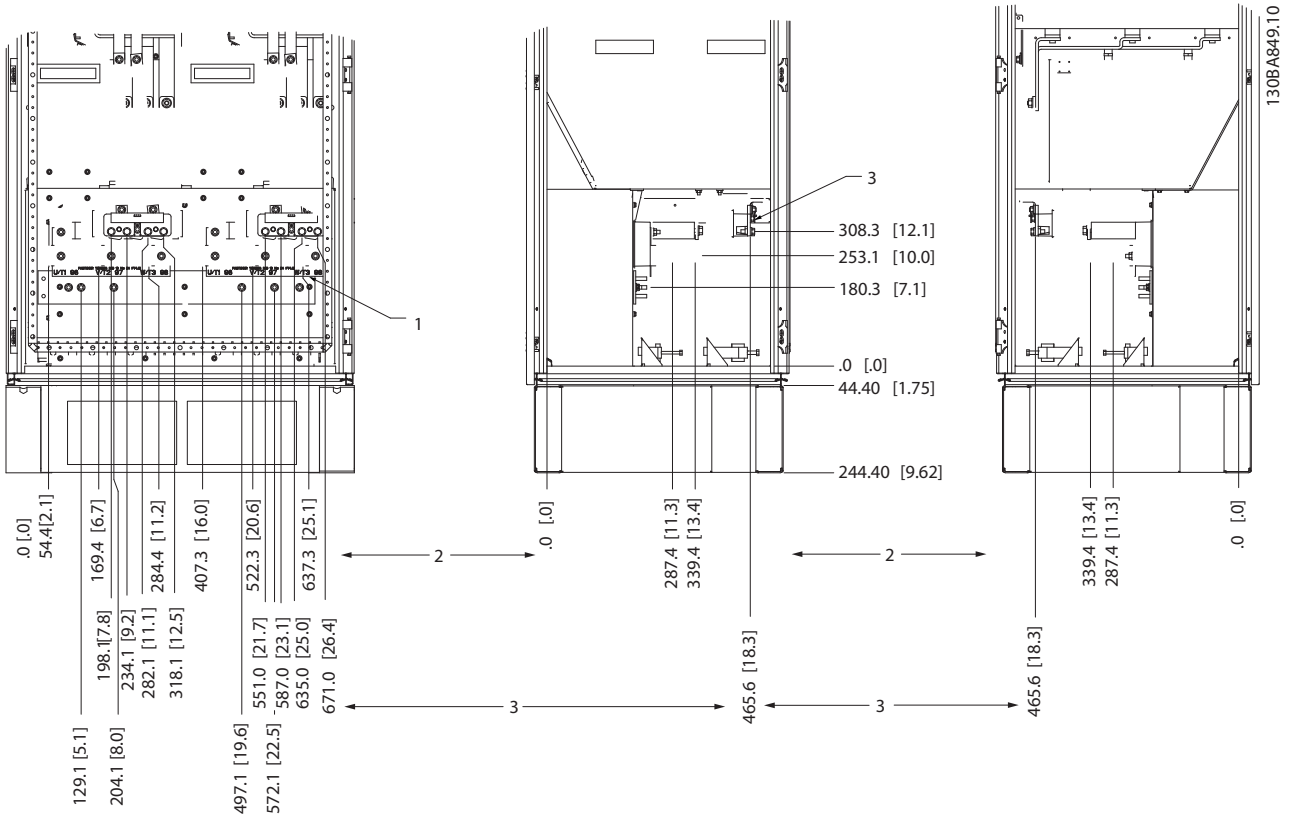


Figure 3.11 Terminal locations - Inverter Cabinet (front, left and right side view). The connector plate is 1.65 in [42 mm] below .0 level.

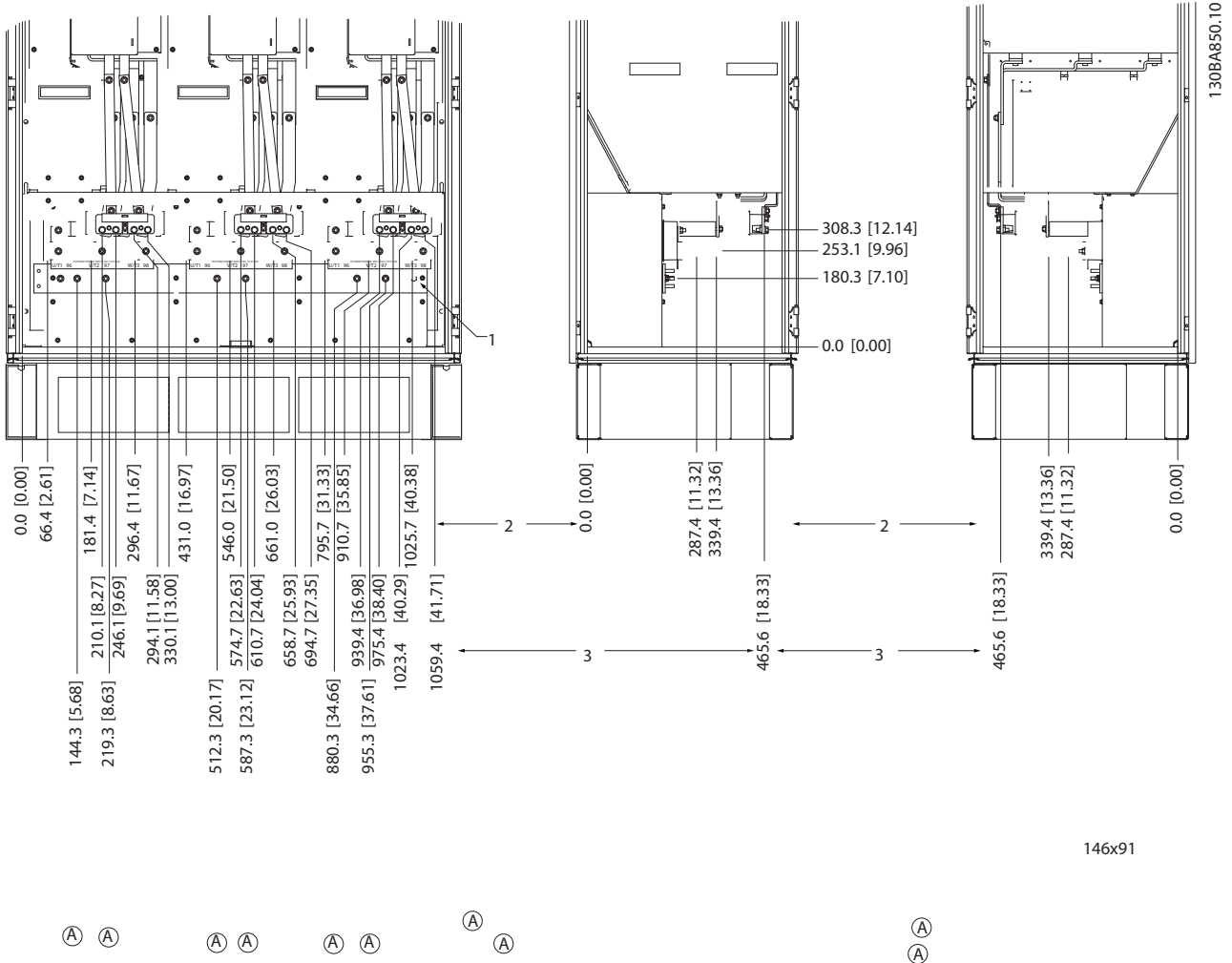
- 1) Ground bar
- 2) Motor terminals
- 3) Brake terminals

Terminal locations - Unit Sizes 62/64

TERMINAL LOCATIONS FRONT VIEW

TERMINAL LOCATIONS LEFT VIEW

TERMINAL LOCATIONS RIGHT VIEW



146x91

Figure 3.12 Terminal locations - Inverter Cabinet (front, left and right side view). The connector plate is 1.65 in [42 mm] below .0 level.
1) Ground bar

Terminal locations - Rectifier ()

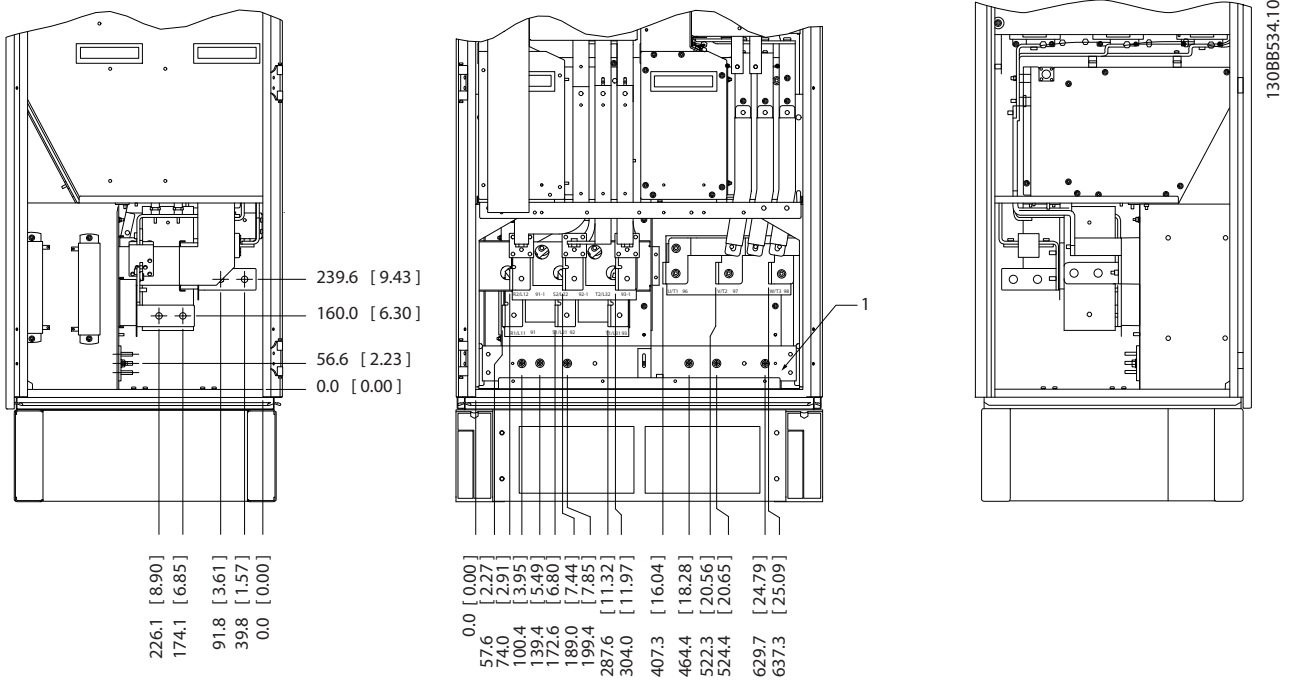


Figure 3.13 Terminal locations - Rectifier (left side, front and right side view). The connector plate is 1.65 in [42 mm] below .0 level.

- 1) Load share Terminal (-)
- 2) Ground bar
- 3) Load share Terminal (+)

Terminal locations - Options Cabinet Frame Size F9

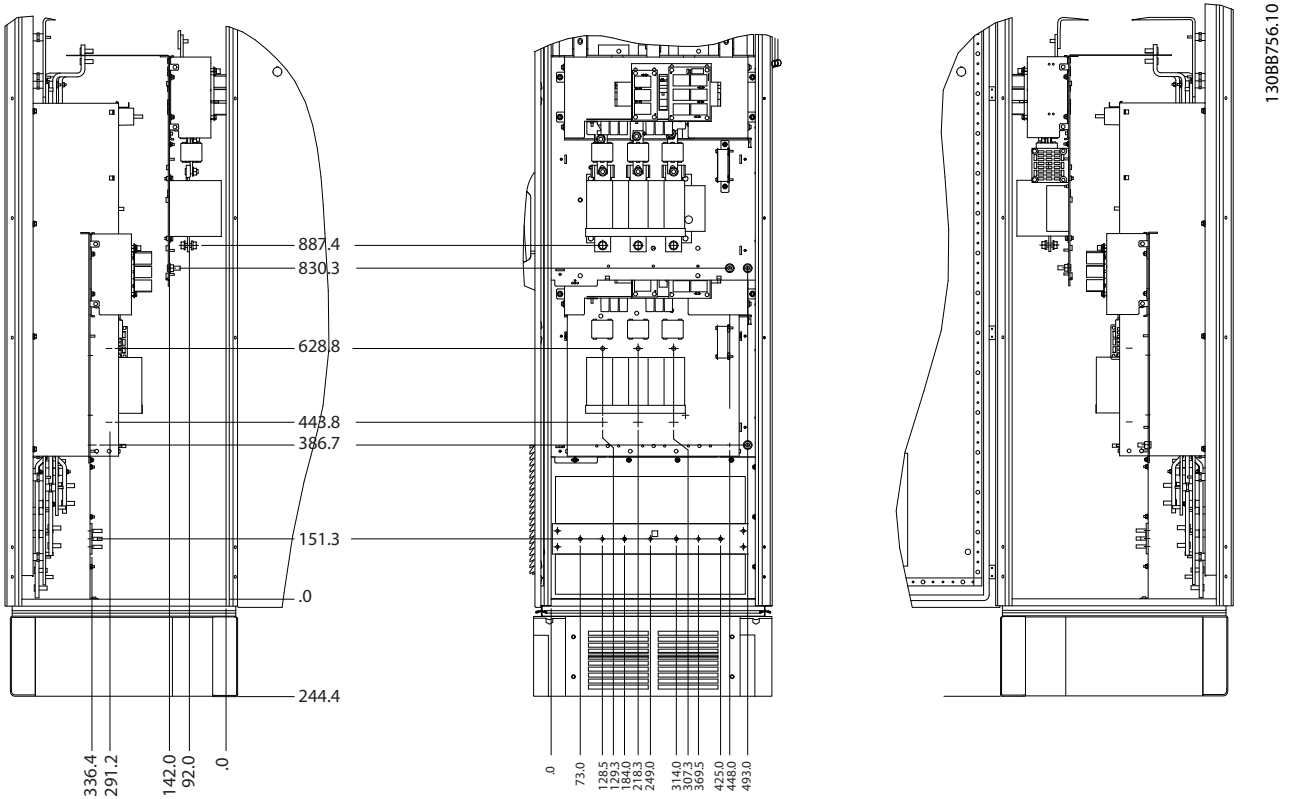


Figure 3.14 Terminal locations - Options cabinet (left side, front and right side view).

Terminal locations - Options Cabinet Frame Size F11/F13

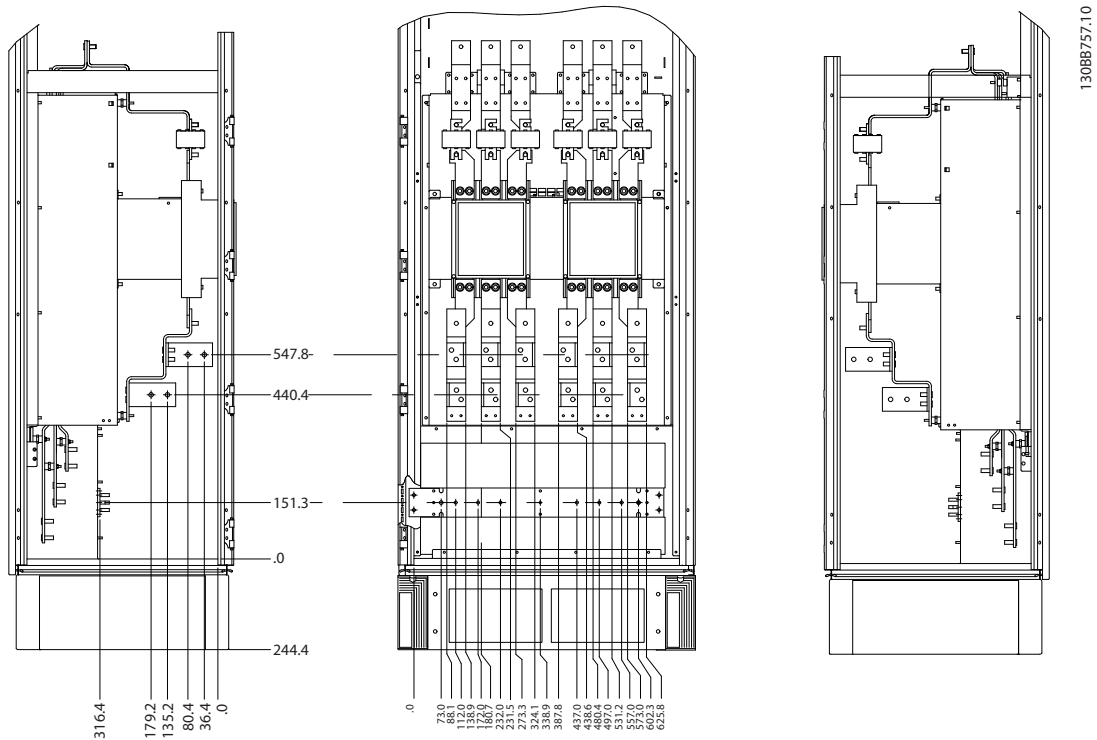


Figure 3.15 Terminal locations - Options cabinet (left side, front and right side view).

3.2.4 Cooling and Airflow

Cooling

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

Duct cooling

A dedicated option has been developed to optimize installation of drive types in Rittal TS8 Units utilizing the fan of the adjustable frequency drive for forced air cooling of the backchannel. Please consult GE for more details.

The air out the top of the Unit could but ducted outside a facility so the heat losses from the backchannel are not dissipated within the control room reducing air-conditioning requirements of the facility.

Back cooling

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

Airflow

The necessary airflow over the heatsink must be ensured. The flow rate is shown below.

| Unit Size protection | Door fan(s) / Top fan airflow | Heatsink fan(s) |
|----------------------|----------------------------------|----------------------------------|
| IP21 / NEMA 1 | 700 m ³ /h (412 cfm)* | 985 m ³ /h (580 cfm)* |
| IP54 / NEMA 12 | 525 m ³ /h (309 cfm)* | 985 m ³ /h (580 cfm)* |

Table 3.1 Heatsink Air Flow

* Airflow per fan. Unit Sizes 5X contain multiple fans.

External ducts

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

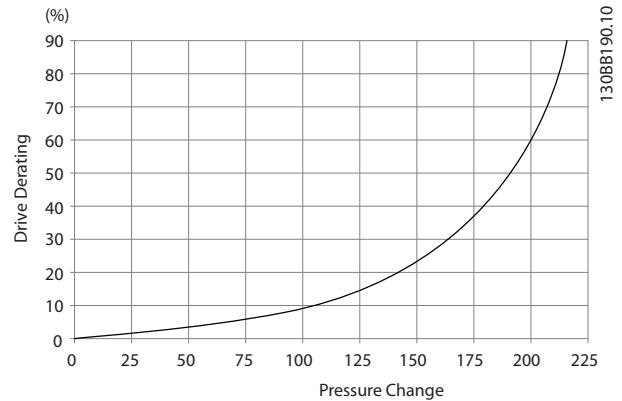


Figure 3.16 Unit Size 61, 62, 63 and 64 Derating vs. Pressure Change

Drive air flow: 985 m³/h (580 cfm)

3.2.5 Connector/Conduit Entry - IP21 (NEMA 1) and IP54 (NEMA12)

Cables are connected through the connector plate from the bottom. Remove the plate and plan where to place the entry for the connectors or conduits. Prepare holes in the marked area on the drawing.

NOTE!

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

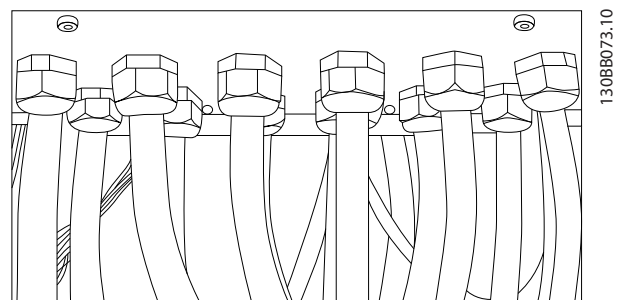
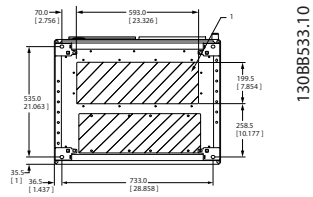
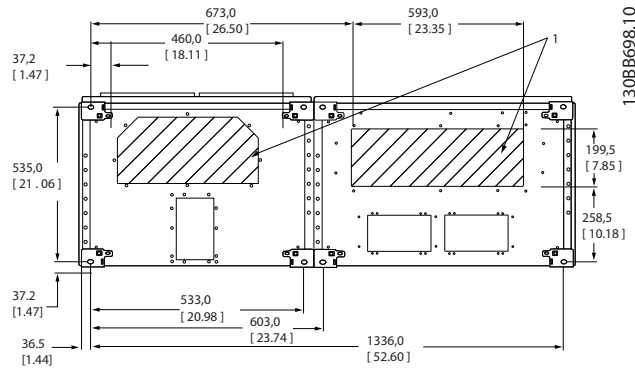


Figure 3.17 Example of proper installation of the connector plate.

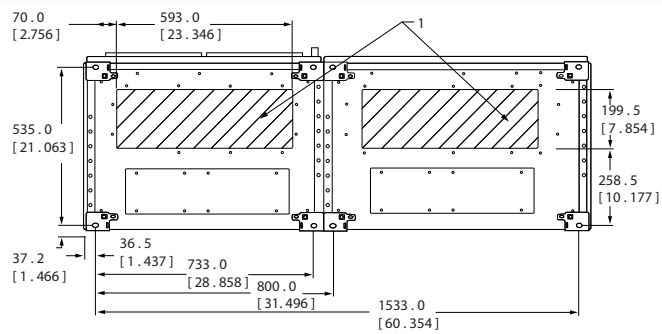
Unit Size 61



Unit Size 62

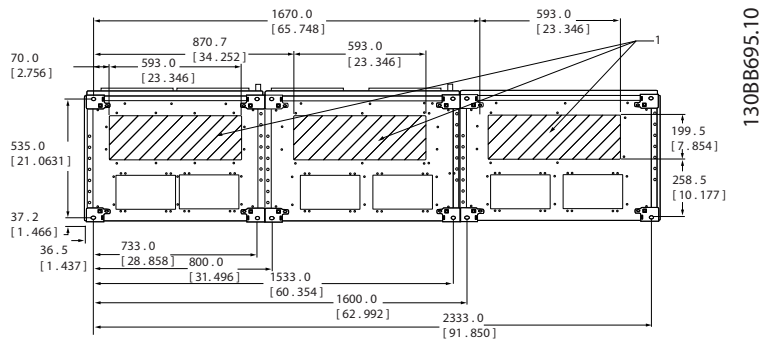


Unit Size 63

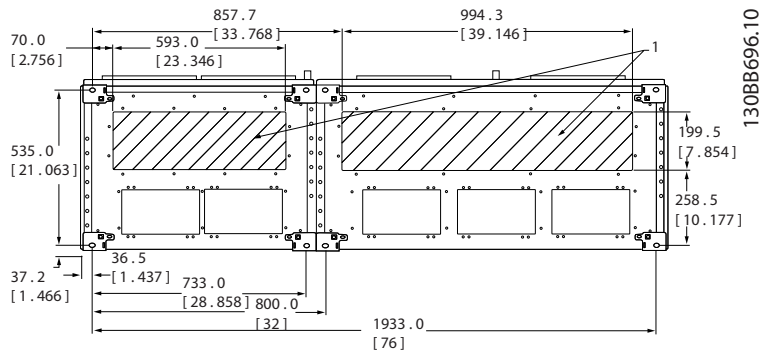


3

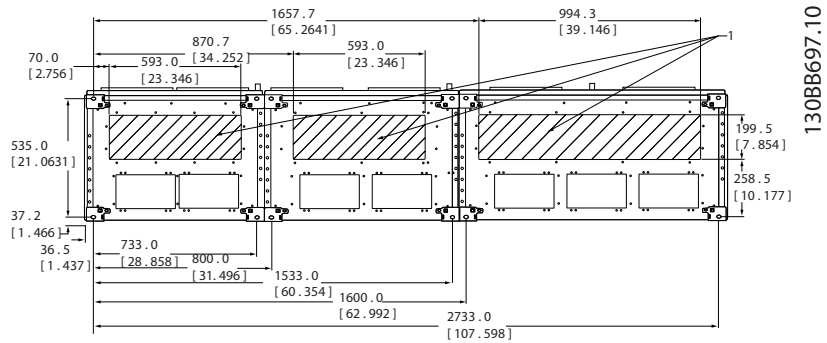
Unit Size 64



Unit Size 64



Unit Size 64



: Cable entries viewed from the bottom of the adjustable frequency drive - 1) Place conduits in marked areas.

3.3 Frame size F Panel Options

4 How to Install

4.1 Electrical Installation

4.1.1 Power Connections

Cabling and Fusing

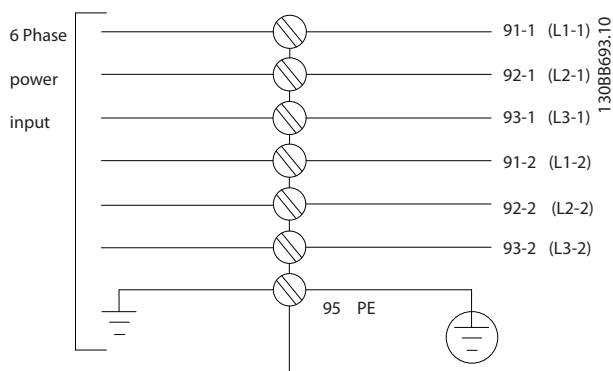
NOTE!

Cables General

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

The power cable connections are situated as shown below. Dimensioning of cable cross-section must be done in accordance with the current ratings and local legislation. See 7.1 *General Specifications* for details.

For protection please see fuse in the tables of the fuse section. Always ensure that proper fusing is done according to local regulations.



NOTE!

Use a shielded/armored motor cable to comply with EMC emission specifications. For more information, see *EMC specifications* in the */FC 300 Design Guide*.

See 7.1 *General Specifications* for correct dimensioning of motor cable cross-section and length.

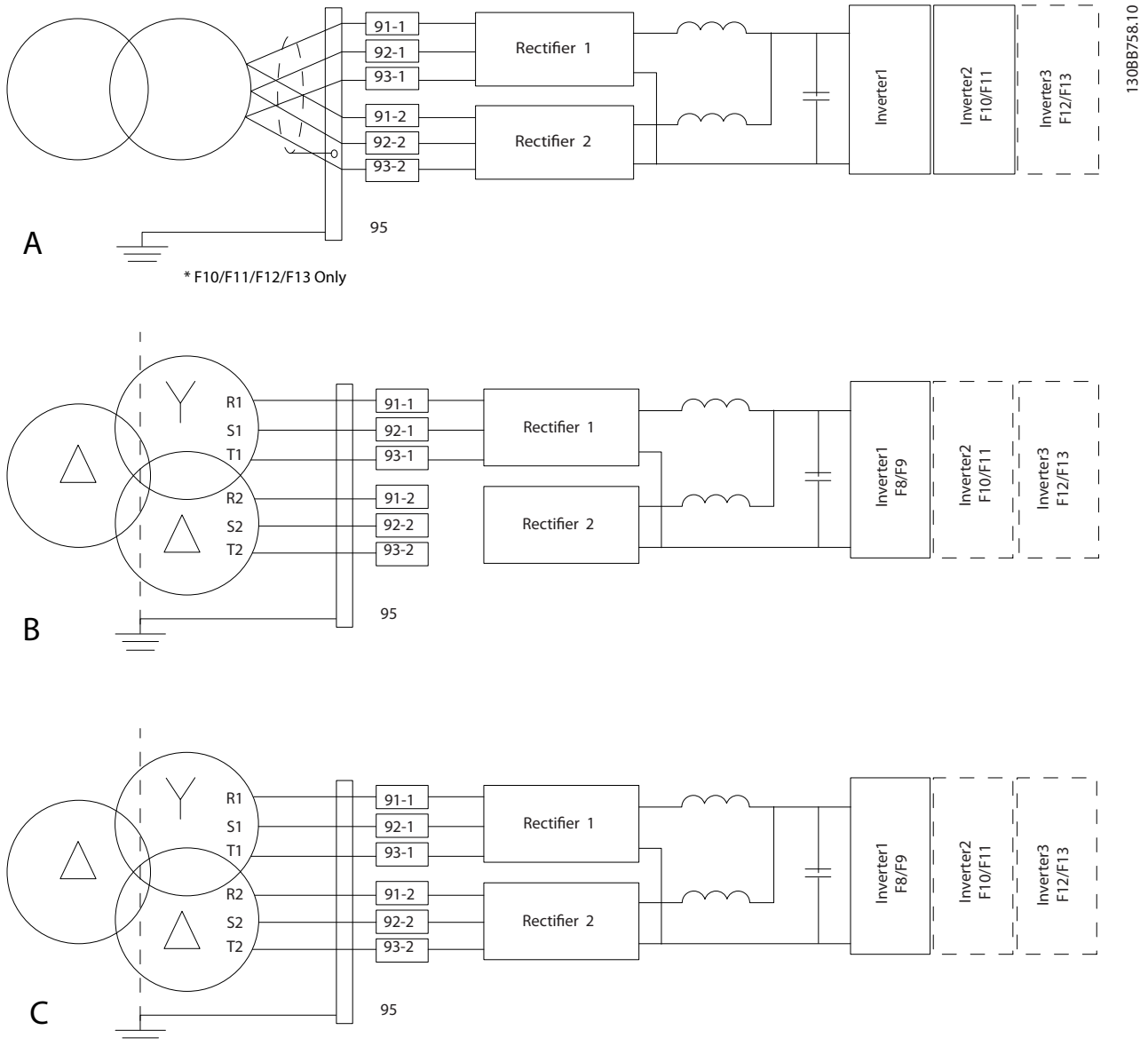


Figure 4.1

- A) 6-Pulse Connection^{1), 2), 3)}
- B) Modified 6-Pulse Connection^{2), 3), 4)}
- C) 12-Pulse Connection^{3), 5)}

Notes:

- 1) Parallel connection shown. A single 3-phase cable may be used with sufficient carrying capability. Shorting busbars must be installed.
- 2) 6-pulse connection eliminates the harmonics reduction benefits of the 12-pulse rectifier.
- 3) Suitable for IT and TN AC line input connections.
- 4) In the unlikely event that one of the 6-pulse modular rectifiers becomes inoperable, it is possible to operate the drive at reduced load with a single 6-pulse rectifier. Contact factory for reconnection details.
- 5) No paralleling of line power cabling is shown here.

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, the shield must be continued at the lowest possible HF impedance.

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

Make the shield connections with the largest possible surface area (cable clamp). This is done by using the

supplied installation devices within the adjustable frequency drive.

Cable-length and cross-section:

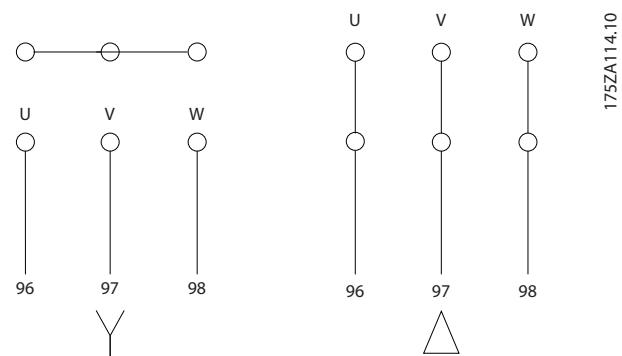
The adjustable frequency drive has been EMC tested with a given length of cable. Keep the motor cable as short as possible to reduce the noise level and leakage currents.

Switching frequency:

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

| Term. no. | 96 | 97 | 98 | 99 | |
|-----------|----|----|----|------------------|---|
| | U | V | W | PE ¹⁾ | Motor voltage 0–100% of AC line voltage. |
| | U1 | V1 | W1 | PE ¹⁾ | 3 wires out of motor |
| | W2 | U2 | V2 | | Delta-connected |
| | U1 | V1 | W1 | PE ¹⁾ | 6 wires out of motor |
| | | | | | Star-connected U2, V2, W2 U2, V2 and W2 to be interconnected separately. |

¹⁾Protected Ground Connection



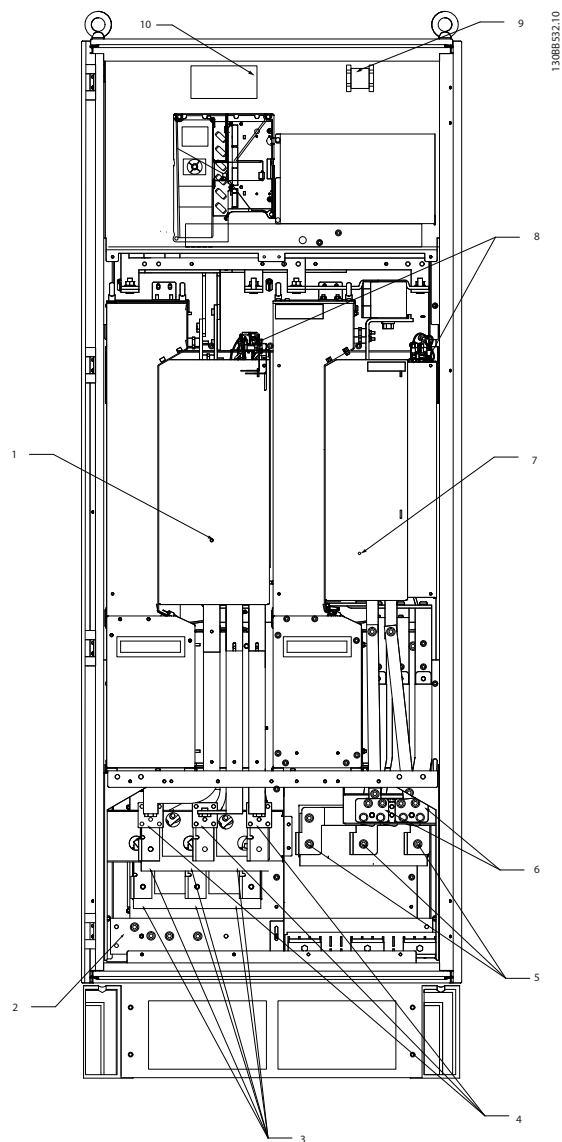


Figure 4.2 Rectifier and Inverter Cabinet, unit sizes 61, 62, 63 and 64.

| | |
|------------------------------|-------------------------|
| 1) 12-pulse rectifier module | 5) Motor connection |
| 2) Ground PE Terminals | U V W |
| 3) Line / Fuses | T1 T2 T3 |
| R1 S1 T1 | 96 97 98 |
| L1-1 L2-1 L3-1 | 6) Brake Terminals |
| 91-1 92-1 93-1 | -R +R |
| 4) Line / Fuses | 81 82 |
| R2 S2 T2 | 7) Inverter Module |
| L2-1 L2-2 L3-2 | 8) SCR Enable / Disable |
| 91-2 92-2 93-2 | 9) Relay 1 Relay 2 |
| | 01 02 03 04 05 06 |
| | 10) Auxillary Fan |
| | 104 106 |

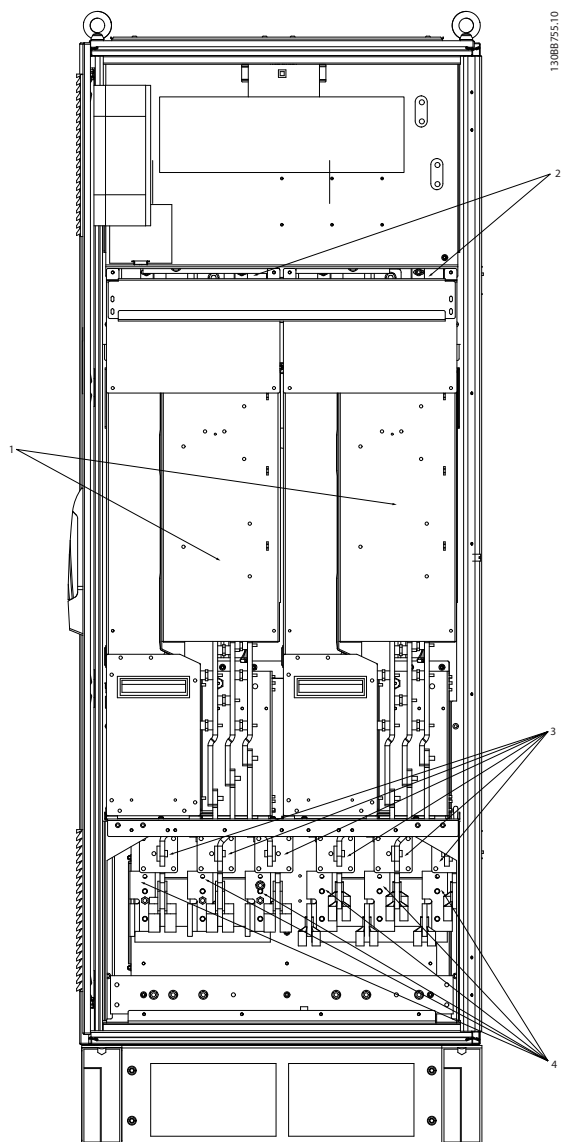


Figure 4.3 Rectifier Cabinet, unit sizes 61, 62, 63 and 64.

| | |
|----------------------------------|---|
| 1) 12-pulse rectifier module | 4) Line |
| 2) AUX Fan | R1 S1 T1 R2 S2 T2 |
| 100 101 102 103 | L1-1 L2-1 L3-1 L1-2 L2-2 L3-2 |
| L1 L2 L1 L2 | 5) DC Bus Connections for Common DC Bus |
| 3) Line Fuses F10/F12 (6 pieces) | DC+ DC- |
| | 6) DC Bus Connections for Common DC Bus |
| | DC+ DC- |

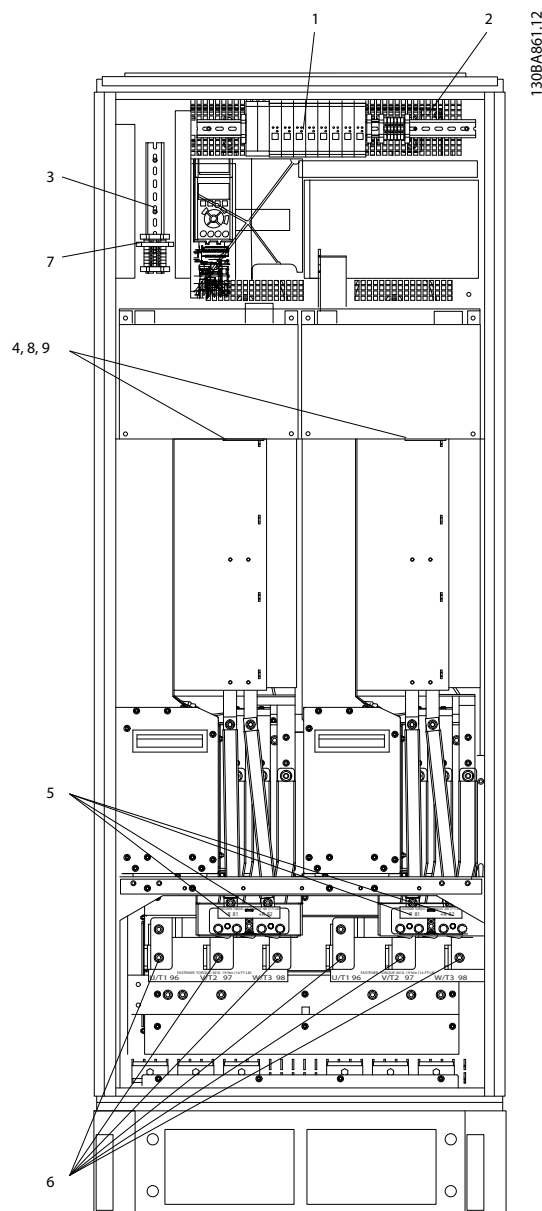


Figure 4.4 Inverter Cabinet, unit sizes 61 and 63.

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

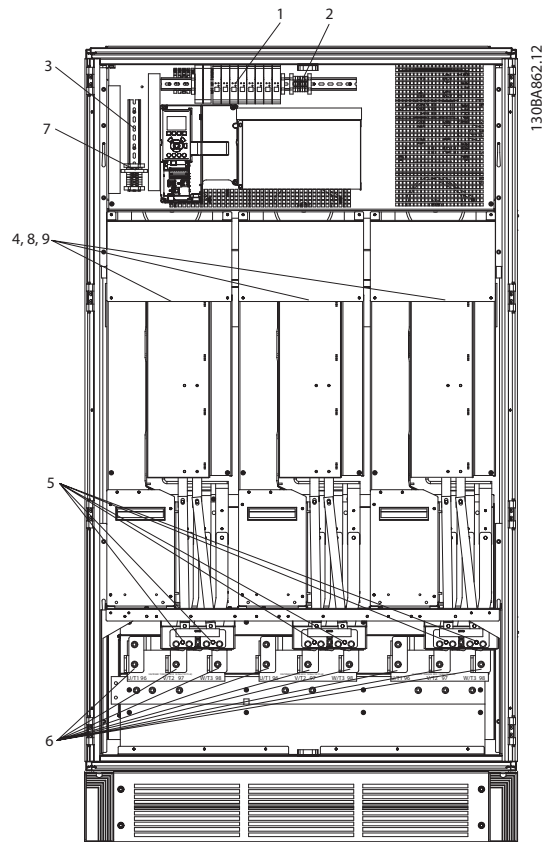


Figure 4.5 Inverter Cabinet, unit sizes 62 and 64

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

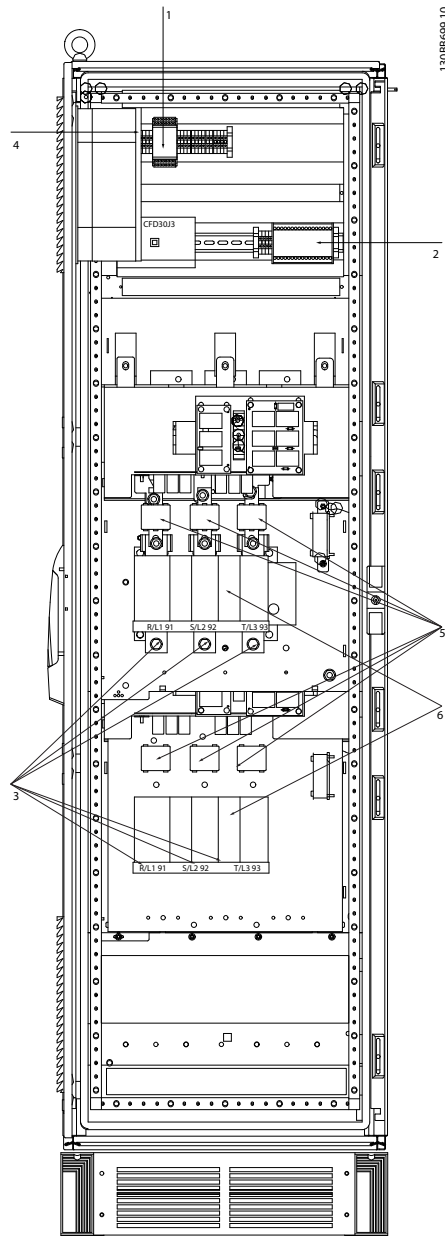


Figure 4.6 Options Cabinet, frame size F9

4.1.2 Grounding

The following basic issues need to be considered when installing an adjustable frequency drive, so as to obtain electromagnetic compatibility (EMC).

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

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

The metal cabinets of the different devices are mounted on the cabinet rear plate using the lowest possible HF impedance. This prevents having different HF voltages for the individual devices and prevents the risk of radio interference currents running in connection cables that may be used between the devices, as radio interference is reduced.

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

4.1.3 Extra Protection (RCD)

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

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

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

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

4.1.4 Drives with Factory-installed A1/B1 RFI Filter Option:

Line power supply isolated from ground

If 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, the RFI switch is recommended to be turned off (OFF) via 14-50 RFI 1 on the drive and 14-50 RFI 1 on the filter.

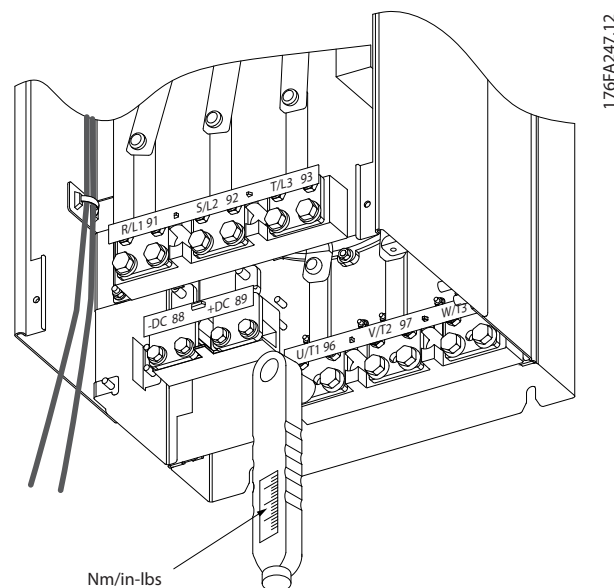
For further reference, see IEC 364-3. In case optimum EMC performance is needed, parallel motors are connected or the motor cable length is above 82 ft [25 m], it is recommended to set 14-50 RFI 1 to [ON].

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

It is important to use isolation monitors that are capable for use together with power electronics (IEC 61557-8).

4.1.5 Torque

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



176FA247.12

Figure 4.7 Always use a torque wrench to tighten the bolts.

4.1.6 Shielded Cables

NOTE!

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

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

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

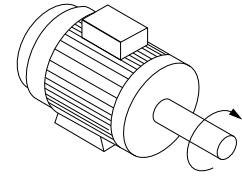
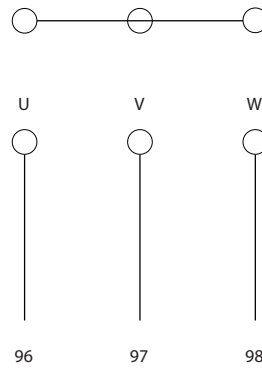
- EMC cable connectors: generally available cable connectors can be used to ensure an optimum EMC connection.
- EMC cable clamp: Clamps allowing for easy connection are supplied with the adjustable frequency drive.

4.1.7 Motor Cable

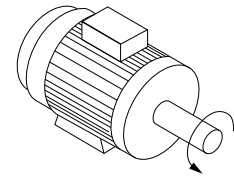
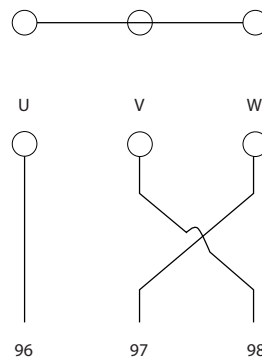
The motor must be connected to terminals U/T1/96, V/T2/97, W/T3/98. Ground to terminal 99. All types of three-phase asynchronous standard motors can be used with an adjustable frequency drive unit. The factory setting is for clockwise rotation with the adjustable frequency drive output connected as follows:

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

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



130HA036.10



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

Unit Size 6X Requirements

requirements: The cables are required to be equal length within 10% between the inverter module terminals and the first common point of a phase. The recommended common point is the motor terminals.

Unit Size 61/63 requirements: Motor phase cable quantities must be multiples of 2, resulting in 2, 4, 6, or 8 (1 cable is not allowed) to obtain equal amount of wires attached to both inverter module terminals. The cables are required to be equal length within 10% between the inverter module terminals and the first common point of a phase. The recommended common point is the motor terminals.

Unit Size 62 and 64 requirements: Motor phase cable quantities must be multiples of 3, resulting in 3, 6, 9, or 12 (1 or 2 cables are not allowed) to obtain equal amount of wires attached to each inverter module terminal. The wires are required to be equal length within 10% between the inverter module terminals and the first common point of a phase. The recommended common point is the motor terminals.

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

4.1.8 Shielding against Electrical Noise

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

NOTE!

The EMC metal cover is only included in units with factory-installed A1/B1 RFI Filter option..

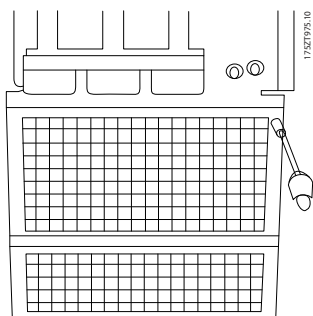


Figure 4.8 Mount the EMC shield.

be used for protection. In UL applications, this should be a LittleFuse KLK-5 or equivalent.

4.1.9 AC line input connections

Line power must be connected to terminals 91-1, 92-1, 93-1, 91-2, 92-2 and 93-2 (see *Table 4.1*). Ground is connected to the terminal to the right of terminal 93.

| Terminal No. | Function |
|------------------|--------------------------------------|
| 91-1, 92-1, 93-1 | Line power R1/L1-1, S1/L2-1, T1/L3-1 |
| 91-2, 92-2, 93-2 | Line power R2/L1-2, S2/L2-2, T2/L3-2 |
| 94 | Ground |

NOTE!

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

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

4.1.10 External Fan Supply

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

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

The connector located on the power card provides the AC line voltage connection for the cooling fans. The fans are factory-equipped 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. A 5A fuse should

4.1.11 Fuses

Branch circuit protection:

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

Short-circuit protection:

The adjustable frequency drive must be protected against short-circuit to avoid electrical or fire hazard. Danfoss recommends using the fuses mentioned below to protect service personnel and equipment in case of an internal failure in the drive. The adjustable frequency drive provides full short-circuit protection in case of a short-circuit on the motor output.

Overcurrent protection

Provide overload protection to avoid fire hazard due to overheating of the cables in the installation. 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.

UL compliance

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

| Power size | Frame | Rating | | Bussmann | Spare Bussmann | Est. Fuse Power Loss [W] | |
|------------|---------|--------------|---------|----------|----------------|--------------------------|------|
| | | Voltage (UL) | Amperes | | | P/N | P/N |
| P315T5 | F8/F9 | 700 | 700 | 170M4017 | 176F9179 | 25 | 19 |
| P355T5 | F8/F9 | 700 | 700 | 170M4017 | 176F9179 | 30 | 22 |
| P400T5 | F8/F9 | 700 | 700 | 170M4017 | 176F9179 | 38 | 29 |
| P450T5 | F8/F9 | 700 | 700 | 170M4017 | 176F9179 | 3500 | 2800 |
| P500T5 | F10/F11 | 700 | 900 | 170M6013 | 176F9180 | 3940 | 4925 |
| P560T5 | F10/F11 | 700 | 900 | 170M6013 | 176F9180 | 2625 | 2100 |
| P630T5 | F10/F11 | 700 | 900 | 170M6013 | 176F9180 | 3940 | 4925 |
| P710T5 | F10/F11 | 700 | 1500 | 170M6018 | 176F9181 | 45 | 34 |
| P800T5 | F12/F13 | 700 | 1500 | 170M6018 | 176F9181 | 60 | 45 |
| P1M0T5 | F12/F13 | 700 | 1500 | 170M6018 | 176F9181 | 83 | 63 |

Table 4.1 Line Fuses, 380–500V

| Power size | Frame | Rating | | Bussmann | Spare Bussmann | Est. Fuse Power Loss [W] | |
|------------|---------|--------------|---------|----------|----------------|--------------------------|-----|
| | | Voltage (UL) | Amperes | | | P/N | P/N |
| P450T7 | F8/F9 | 700 | 630 | 170M4016 | 176F9179 | 13 | 10 |
| P500T7 | F8/F9 | 700 | 630 | 170M4016 | 176F9179 | 17 | 13 |
| P560T7 | F8/F9 | 700 | 630 | 170M4016 | 176F9179 | 22 | 16 |
| P630T7 | F8/F9 | 700 | 630 | 170M4016 | 176F9179 | 24 | 18 |
| P710T7 | F10/F11 | 700 | 900 | 170M6013 | 176F9180 | 26 | 20 |
| P800T7 | F10/F11 | 700 | 900 | 170M6013 | 176F9180 | 35 | 27 |
| P900T7 | F10/F11 | 700 | 900 | 170M6013 | 176F9180 | 44 | 33 |
| P1M0T7 | F12/F13 | 700 | 1500 | 170M6018 | 176F9181 | 26 | 20 |
| P1M2T7 | F12/F13 | 700 | 1500 | 170M6018 | 176F9181 | 37 | 28 |
| P1M4T7 | F12/F13 | 700 | 1500 | 170M6018 | 176F9181 | 47 | 36 |

Table 4.2 Line Fuses, 525–690V

| AF-650 GP | Bussmann PN* | Rating | Siba |
|-----------|--------------|----------------|----------------|
| 600 HP | 170M8611 | 1100 A, 1000 V | 20 781 32.1000 |
| 650 HP | 170M8611 | 1100 A, 1000 V | 20 781 32.1000 |
| 750 HP | 170M6467 | 1400 A, 700 V | 20 681 32.1400 |
| 900 HP | 170M6467 | 1400 A, 700 V | 20 681 32.1400 |
| 1000 HP | 170M8611 | 1100 A, 1000 V | 20 781 32.1000 |
| 1200 HP | 170M6467 | 1400 A, 700 V | 20 681 32.1400 |

Table 4.3 Inverter Module DC Link Fuses, 380–480V

| AF-650 GP | Bussmann PN* | Rating | Siba |
|-----------|--------------|----------------|-----------------|
| 900 HP | 170M8611 | 1100 A, 1000 V | 20 781 32. 1000 |
| 1000 HP | 170M8611 | 1100 A, 1000 V | 20 781 32. 1000 |
| 1200 HP | 170M8611 | 1100 A, 1000 V | 20 781 32. 1000 |
| 1250 HP | 170M8611 | 1100 A, 1000 V | 20 781 32. 1000 |
| 1350 HP | 170M8611 | 1100 A, 1000 V | 20 781 32. 1000 |
| | 170M8611 | 1100A, 1000V | 20 781 32.1000 |

Table 4.4 525–690V

*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.

Supplementary fuses

| | Size/Type | Bussmann PN* | Rating | Alternative Fuses |
|----------------|------------------------|------------------|-------------|---|
| 2.5–4.0 A Fuse | , 380– V | LPJ-6 SP or SPI | 6 A, 600 V | Any listed Class J Dual Element, Time Delay, 6 A |
| | 750–1350 HP, 525–690 V | LPJ-10 SP or SPI | 10 A, 600 V | Any listed Class J Dual Element, Time Delay, 10 A |
| 4.0–6.3 A Fuse | 600–1200HP, 380–480 V | LPJ-10 SP or SPI | 10 A, 600 V | Any listed Class J Dual Element, Time Delay, 10 A |
| | 750–1350 HP, 525–690 V | LPJ-15 SP or SPI | 15 A, 600 V | Any listed Class J Dual Element, Time Delay, 15 A |
| 6.3–10 A Fuse | 600–1200HP, 380–480 V | LPJ-15 SP or SPI | 15 A, 600 V | Any listed Class J Dual Element, Time Delay, 15 A |
| | 750–1350 HP, 525–690 V | LPJ-20 SP or SPI | 20 A, 600 V | Any listed Class J Dual Element, Time Delay, 20 A |
| 10–16 A Fuse | 600–1200HP, 380–480 V | LPJ-25 SP or SPI | 25 A, 600 V | Any listed Class J Dual Element, Time Delay, 25 A |
| | 750–1350 HP, 525–690 V | LPJ-20 SP or SPI | 20 A, 600 V | Any listed Class J Dual Element, Time Delay, 20 A |

Table 4.5 Manual Motor Controller Fuses

| Unit Sizes | Bussmann PN* | Rating |
|------------|--------------|-----------|
| | KTK-4 | 4 A, 600V |

Table 4.6 SMPS Fuse

| Size/Type | Bussmann PN* | LittelFuse | Rating |
|-----------------------|--------------|------------|-----------|
| 400–1200HP, 380–480 V | | KLK-15 | 15A, 600V |
| 650–1350HP, 525–690 V | | KLK-15 | 15A, 600V |

Table 4.7 Fan Fuses

| Unit Sizes | Bussmann PN* | Rating | Alternative Fuses |
|------------|------------------|-------------|---|
| F8-F13 | LPJ-30 SP or SPI | 30 A, 600 V | Any listed Class J Dual Element, Time Delay, 30 A |

Table 4.8 30 A Fuse Protected Terminal Fuse

| Unit Sizes | Bussmann PN* | Rating | Alternative Fuses |
|------------|-----------------|------------|--|
| F8-F13 | LPJ-6 SP or SPI | 6 A, 600 V | Any listed Class J Dual Element, Time Delay, 6 A |

Table 4.9 Control Transformer Fuse

| Unit Sizes | Bussmann PN* | Rating |
|------------|--------------|-------------|
| F8-F13 | GMC-800MA | 800mA, 250V |

Table 4.10 NAMUR Fuse

4.1.12 Motor Insulation

For motor cable lengths \leq than the maximum cable length listed in the General Specifications tables, the following motor insulation ratings are recommended because 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 lower insulation rating, it is recommended to 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 |

4.1.13 Motor Bearing Currents

All motors installed with 425 hp [315 kW] or higher power drives should have NDE (Non-Drive End) insulated bearings installed to eliminate circulating bearing currents. To minimize DE (Drive End) bearing and shaft currents proper grounding of the drive, motor, driven machine, and motor to the driven machine is required.

Standard Mitigation Strategies:

1. Use an insulated bearing
2. Apply rigorous installation procedures
 - Ensure the motor and load motor are aligned
 - Strictly follow the EMC Installation guideline
 - Reinforce the PE so the high frequency impedance is lower in the PE than the input power leads.
 - Provide a good high frequency connection between the motor and the adjustable frequency drive for instance by shielded cable which has a 360° connection in the motor and the adjustable frequency drive
 - Make sure that the impedance from adjustable frequency drive to building ground is lower than the grounding

impedance of the machine. This can be difficult for pumps.

- Make a direct ground connection between the motor and load motor.
3. Lower the IGBT switching frequency
 4. Modify the inverter waveform, 60° AVM vs. SFAVM
 5. Install a shaft grounding system or use an isolating coupling.
 6. Apply conductive lubrication
 7. Use minimum speed settings, if possible.
 8. Try to ensure the line voltage is balanced to ground. This can be difficult for IT, TT, TN-CS or Grounded leg systems
 9. Use a dU/dt or sinus filter

4.1.14 Control Cable Routing

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

Field Installed Network Module options connection

Connections are made to the network options on the control card. For details, see the relevant network instructions. The cable must be placed in the provided path inside the adjustable frequency drive and tied down together with other control wires.

Installation of field-installed 24 volt external DC supply option module (OPC24VPS)

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

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

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

⚠ WARNING

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

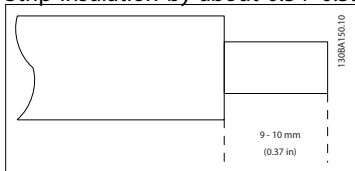
4.1.15 Access to Control Terminals

All terminals to the control cables are located beneath the LCP. They are accessed by opening the door of the Nema 1 / Nema 12 or removing the covers of the IP00 Open Chassis version.

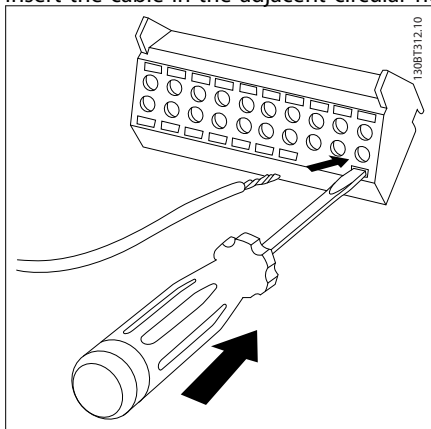
4.1.16 Electrical Installation, Control Terminals

To connect the cable to the terminal:

1. Strip insulation by about 0.34–0.39 in [9–10 mm].



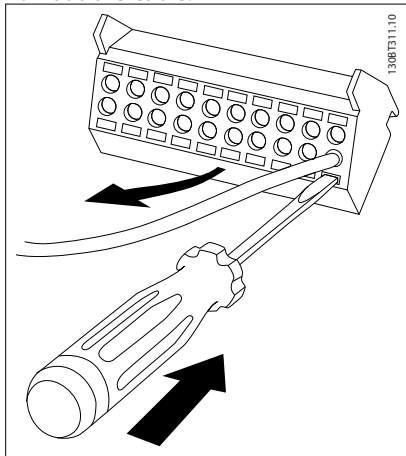
2. Insert a screwdriver¹⁾ in the square hole.
3. Insert the cable in the adjacent circular hole.



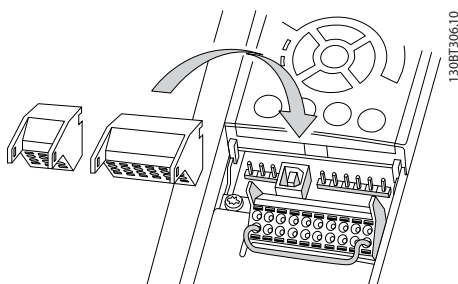
4. Remove the screwdriver. The cable is now mounted in the terminal.

To remove the cable from the terminal:

1. Insert a screw driver¹⁾ in the square hole.
2. Pull out the cable.



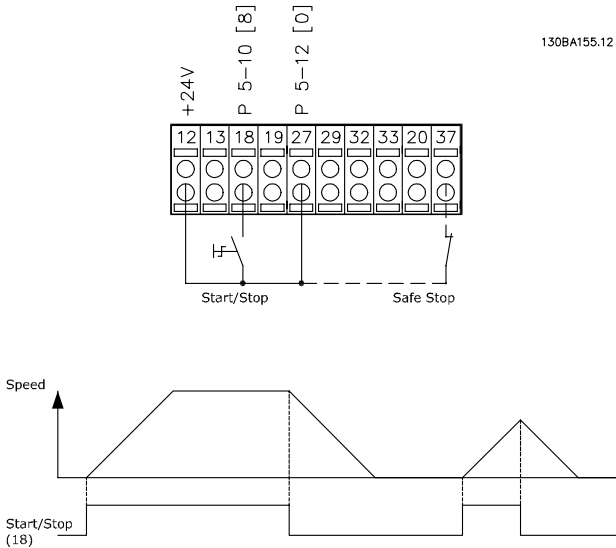
¹⁾ Max. 0.015 x 0.1 in [0.4 x 2.5 mm]



4.2 Connection Examples

4.2.1 Start/Stop

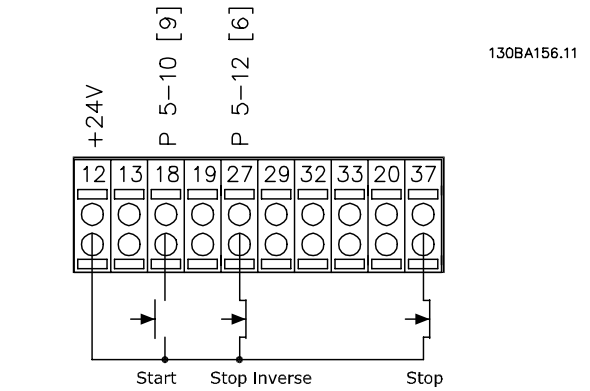
Terminal 18 = 5-10 Terminal 18 Digital Input [8] Start
 Terminal 27 = 5-12 Terminal 27 Digital Input [0] No operation (Default coast inverse)



4.2.2 Pulse Start/Stop

Terminal 18 = 5-10 Terminal 18 Digital Input [9] Latched start

Terminal 27 = 5-12 Terminal 27 Digital Input [6] Stop inverse



4.2.3 Speed Up/Down

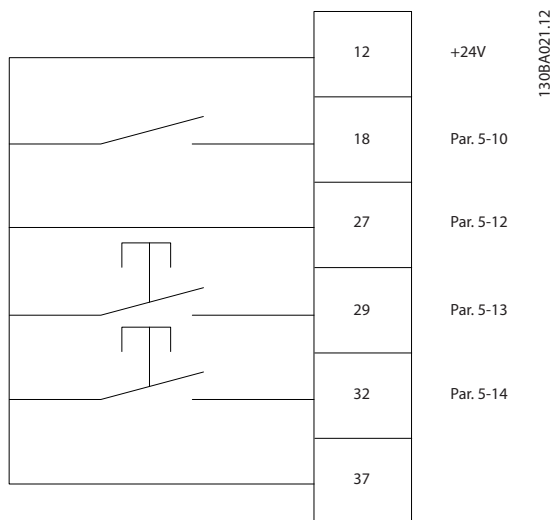
Terminals 29/32 = Speed up/down

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

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

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

Terminal 32 = 5-14 Terminal 32 Digital Input Slow [22]



4.2.4 Potentiometer Reference

Voltage reference via a potentiometer

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

Terminal 53, Low Voltage = 0V

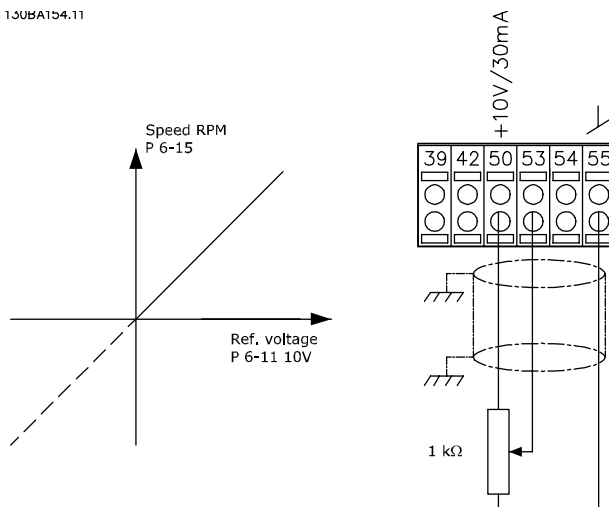
Terminal 53, High Voltage = 10V

Terminal 53, Low Ref./Feedback = 0 RPM

Terminal 53, High Ref./Feedback = 1500 RPM

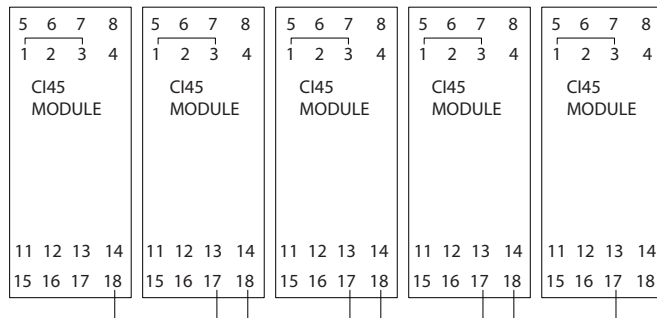
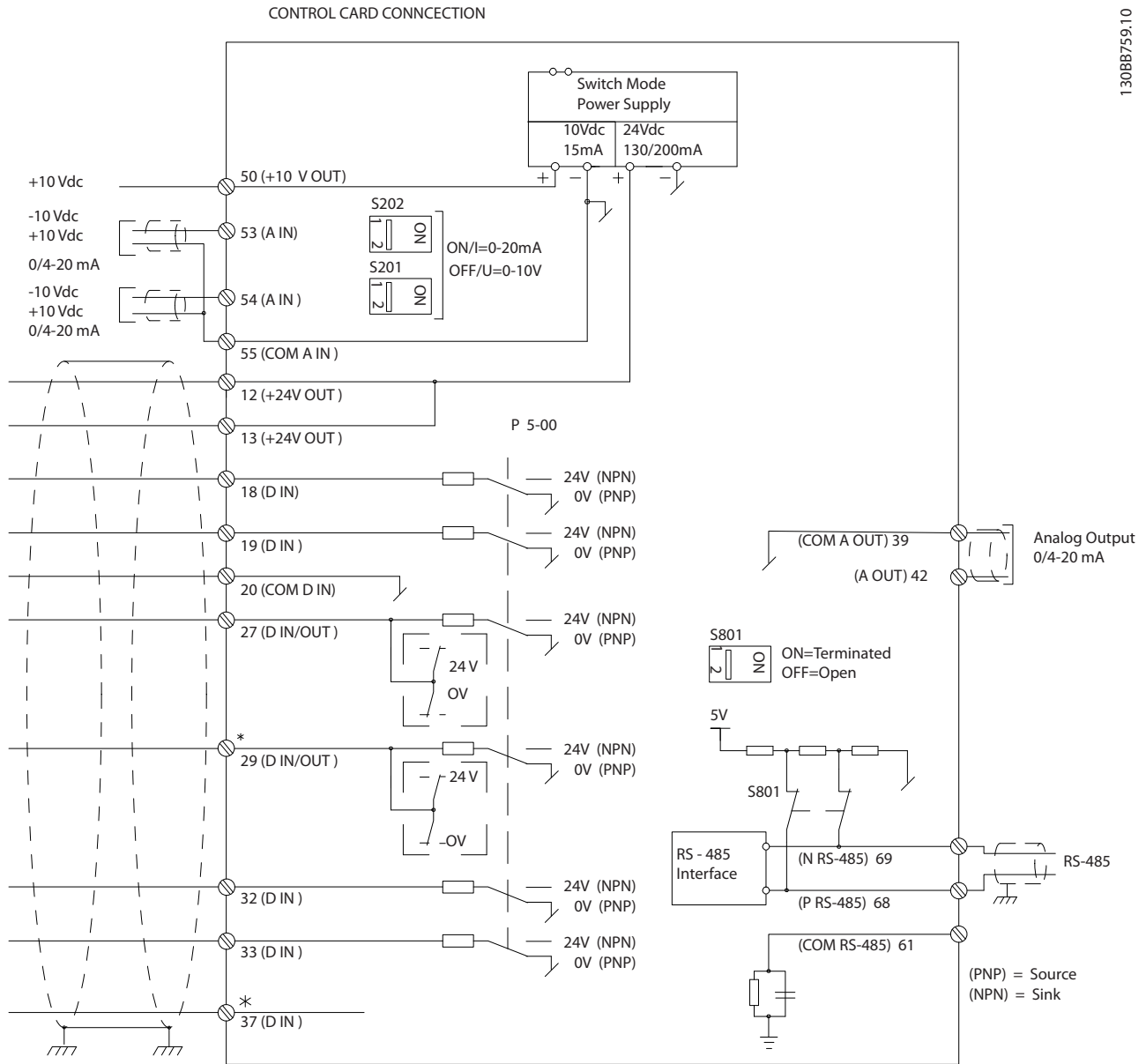
Switch S201 = OFF (U)

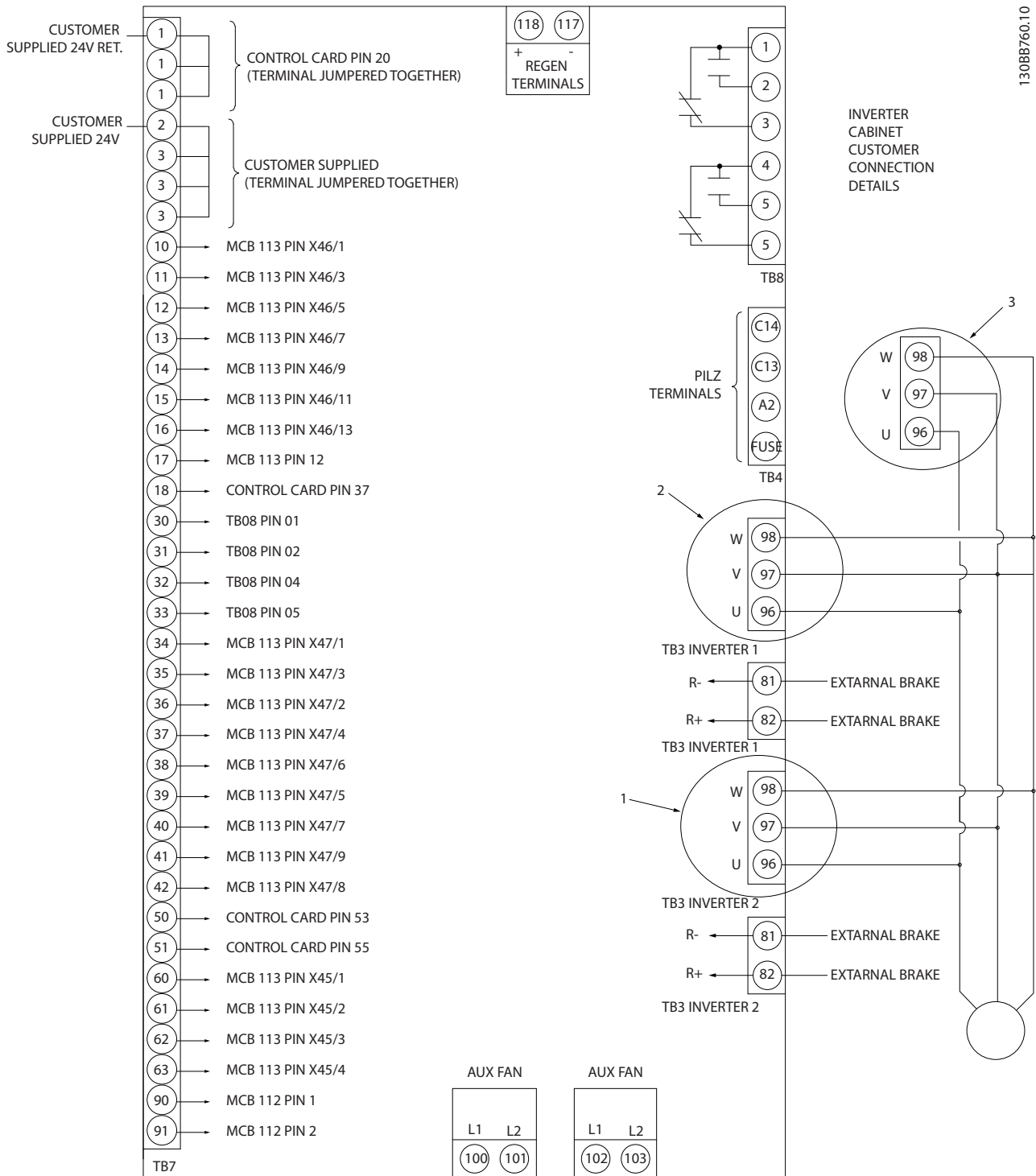
130BA154.11



4.3 Electrical Installation - additional

4.3.1 Electrical Installation, Control Cables



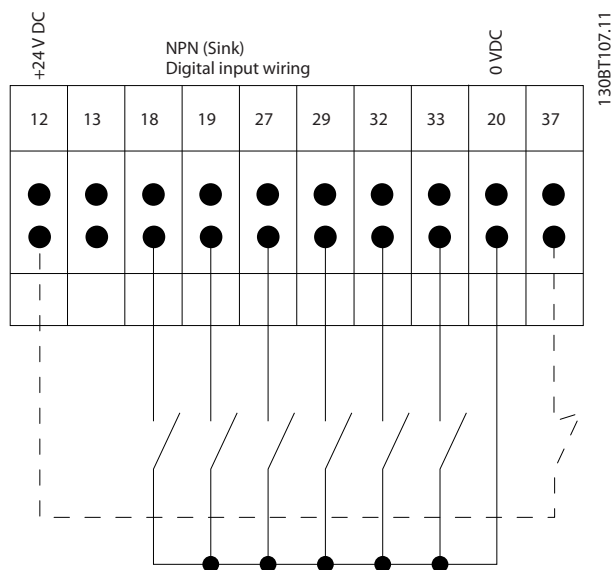
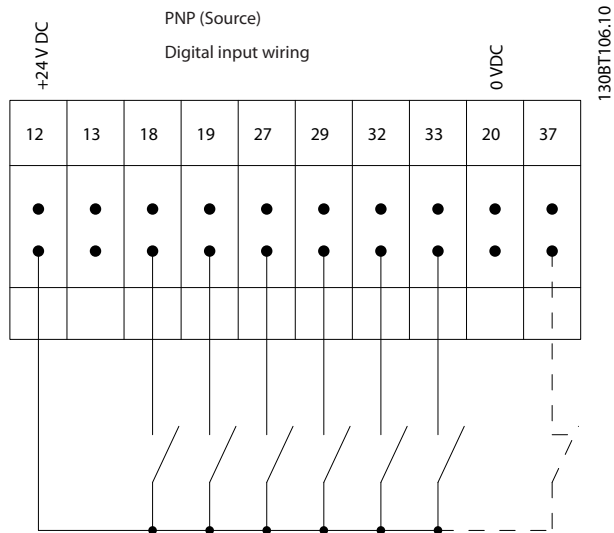


In rare cases, very long control cables and analog signals may, depending on installation, result in 50/60 Hz ground loops due to noise from line power supply cables.

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

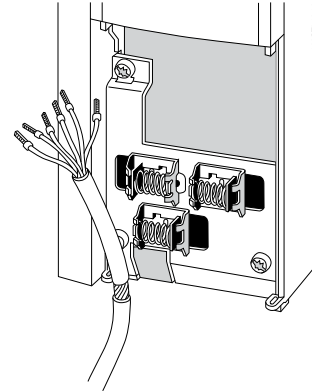
The digital and analog inputs and outputs must be connected separately to the adjustable frequency drive common inputs (terminal 20, 55, 39) to avoid ground currents from both groups to affect other groups. For example, switching on the digital input may disturb the analog input signal.

Input polarity of control terminals



NOTE!

Control cables must be shielded/armored.



Connect the wires as described in the Instruction Manual for the adjustable frequency drive. Remember to connect the shields in a proper way to ensure optimum electrical immunity.

4.3.2 Switches S201, S202, and S801

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

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

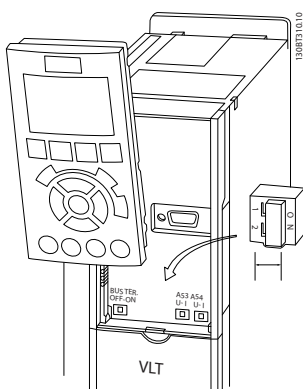
See drawing *Diagram showing all electrical terminals* in section *Electrical Installation*.

Default setting:

- S201 (A53) = OFF (voltage input)
- S202 (A54) = OFF (voltage input)
- S801 (Bus termination) = OFF

NOTE!

When changing the function of S201, S202 or S801, be careful not to force the switch over. It is recommended to remove the LCP fixture (cradle) when operating the switches. The switches must not be operated while the adjustable frequency drive is powered.



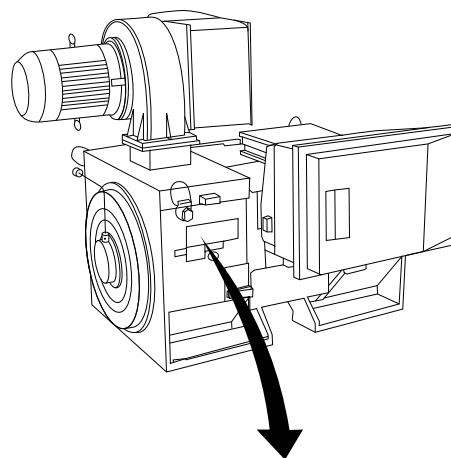
4.4 Final Set-up and Test

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

Step 1. Locate the motor nameplate

NOTE!

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



| THREE PHASE INDUCTION MOTOR | | | | | |
|-----------------------------|--------------|--------------|--------|----------------|-----------------|
| MOD MCV 315E | Nr. | 135189 12 04 | | IL/IN 6.5 | |
| kW 400 | PRIMARY | | | | |
| HP 536 | V 690 | A 410.6 | CONN Y | SF 1.15 | COS f 0.85 40 |
| mm 1481 | V | A | CONN | AMB 40 | °C |
| Hz 50 | V | A | CONN | ALT 1000 | m |
| DESIGNN | | SECONDARY | | RISE 80 | °C |
| DUTY S1 | V | A | CONN | ENCLOSURE IP23 | |
| INSUL I | EFFICIENCY % | 95.8% | 100% | 95.8% | 75% |
| | | | | | WEIGHT 1.83 ton |
| ⚠ CAUTION | | | | | |

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

To access this list, first press the [QUICK MENU] key, then select "Quick Set-up". Use the up and down arrow keys to navigate to the parameters associated with the motor nameplate values.

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

Step 3. Activate the Auto-tune

Performing an auto tune will ensure optimum performance. The auto tune measures the values from the motor model equivalent diagram.

1. Activate the auto tune *1-29 Automatic Motor Adaptation (AMA)*.
2. Choose between complete or reduced auto-tune. If a sine-wave filter is mounted, run only the reduced auto-tune, or remove the sine-wave filter and run complete Auto-tune.
3. Press the [OK] key. The display shows "Press [Hand] to start".
4. Press the [Hand] key. A progress bar indicates if the auto tune is in progress.

Stop the Auto Tune during operation

1. Press the [OFF] key - the adjustable frequency drive enters into alarm mode and the display shows that the Auto Tune was terminated by the user.

Successful Auto Tune

1. The display shows "Press [OK] to finish Auto Tune".
2. Press the [OK] key to exit the Auto Tune state.

Unsuccessful Auto Tune

1. The adjustable frequency drive enters into alarm mode. A description of the alarm can be found in the *Warnings and Alarms* chapter.
2. "Report Value" in the [Alarm Log] shows the last measuring sequence carried out by the Auto Tune before the adjustable frequency drive entered alarm mode. This number along with the description of the alarm will assist you in troubleshooting. If you contact Danfoss for service, make sure to mention the number and alarm description.

NOTE!

Unsuccessful auto-tune is often caused by incorrectly entering motor nameplate data or a too big difference between the motor power size and the adjustable frequency drive power size.

Step 4. Set speed limit and accel/decel times.

| |
|------------------------|
| 3-02 Minimum Reference |
| 3-03 Maximum Reference |

Table 4.11 Set up the desired limits for speed and ramp time.

| |
|---|
| 4-11 Motor Speed Low Limit [RPM] or 4-12 Motor Speed Low Limit [Hz] |
| 4-13 Motor Speed High Limit [RPM] or 4-14 Motor Speed High Limit [Hz] |

| |
|----------------------------|
| 3-41 Ramp 1 Ramp-up Time |
| 3-42 Ramp 1 Ramp-down Time |

4.5 Additional Connections

4.5.1 Parallel Connection of Motors

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

NOTE!

Installation with cables connected in a common joint, as in the figure below, is only recommended for short cable lengths.

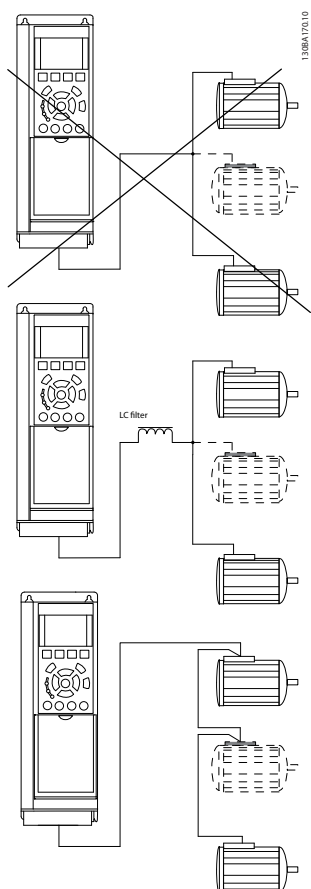
NOTE!

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

NOTE!

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

4



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

5 How to operate the adjustable frequency drive

5.1.1 Ways of Operation

The adjustable frequency drive can be operated in 3 ways:

1. Graphical Local Control Panel (GLCP), see 6.1.2
2. Numeric Local Control Panel (NLCP), see 6.1.3
3. RS-485 serial communication or USB, both for PC connection, see 6.1.4

If the adjustable frequency drive is equipped with the serial communication option, please 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 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 back lit with a total of 6 alpha-numeric lines. All data is displayed on the LCP, which can show up to five operating variables while in [Status] mode.

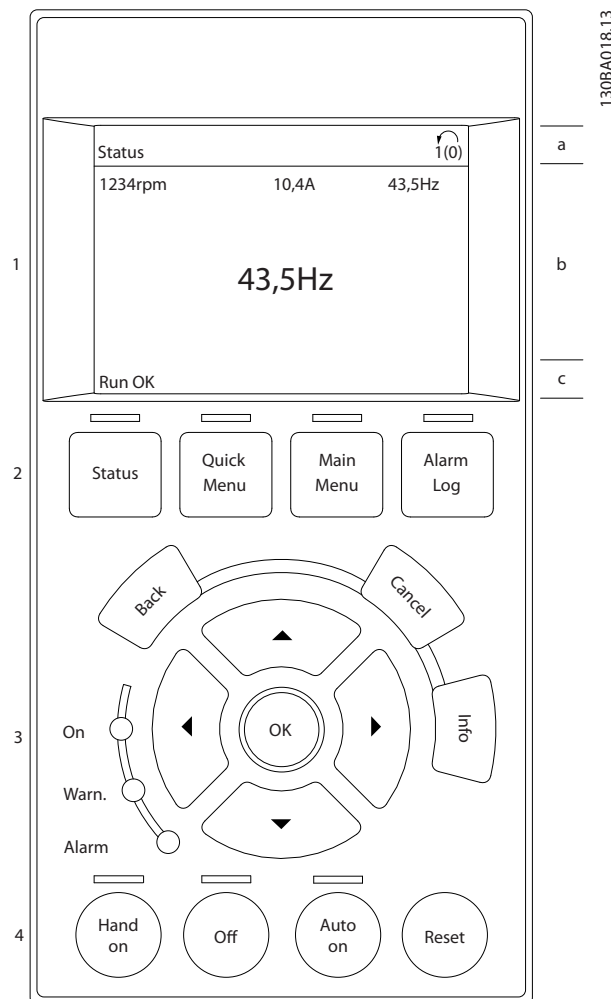
Display lines:

- a. **Status line:** Status messages displaying icons and graphics.
- b. **Line 1-2:** Operator data lines displaying data and variables defined or chosen by the user. By pressing the [Status] key, up to one extra line can be added.
- c. **Status line:** Status messages displaying text.

The display is divided into 3 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 an alarm/warning.



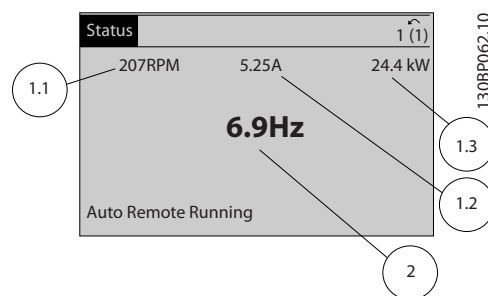
The number of the Active Set-up (selected as the Active Set-up in par. 0-10) is shown. When programming in another set-up than the Active Set-up, the number of the set-up being programmed appears to the right in brackets.

Middle section (b)

shows up to 5 variables with related unit, regardless of status. In the case of an alarm/warning, the warning is shown instead of the variables.

It is possible to toggle between three status read-out displays by pressing the [Status] key.

Operating variables with different formatting are shown in each status screen - see below.



Several values or measurements can be linked to each of the displayed operating variables. The values/measurements to be displayed can be defined via par. 0-20, 0-21, 0-22, 0-23, and 0-24, which can be accessed via [QUICK MENU], "Q3 Function Set-ups", "Q3-1 General Settings", "Q3-11 Display Settings".

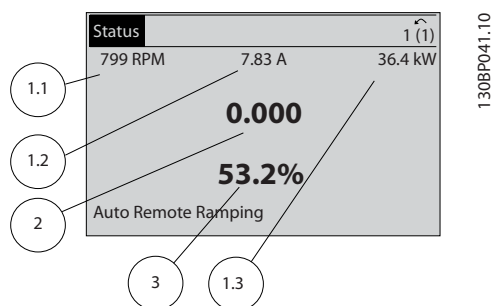
Each value / measurement readout parameter selected in par. 0-20 to par. 0-24 has its own scale and number of digits after a possible decimal point. Larger numeric values are displayed with few digits after the decimal point.

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

Status display I

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

See the operating variables shown in the display in this figure. 1.1, 1.2 and 1.3 are shown in small size. 2 and 3 are shown in medium size.



Status display II

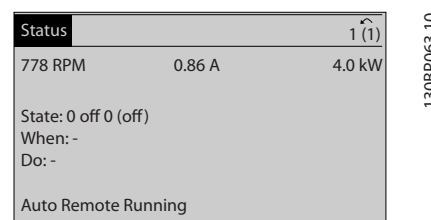
See the operating variables (1.1, 1.2, 1.3, and 2) shown in the display in this figure.

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.

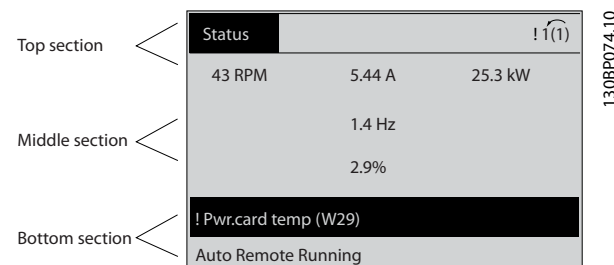
Status display III:

This state displays the event and action of the Smart Logic Control. For further information, see the section *Smart Logic Control*.



Bottom section

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



Display contrast adjustment

Press [status] and [▲] for darker display

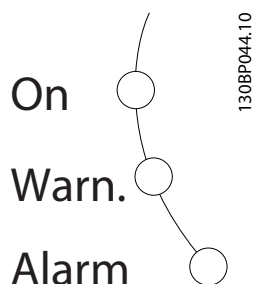
Press [status] and [▼] for brighter display

LEDs:

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

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

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



GLCP keys

Menu keys

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



[Status]

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

5 line readouts, 4 line readouts or Smart Logic Control.

Use [Status] for selecting the mode of display or for changing back to display mode from either the quick menu mode, the main menu mode or alarm mode. Also use the [Status] key to toggle single or double readout mode.

[Quick Menu]

Allows quick set-up of the adjustable frequency drive. **The most common functions can be programmed here.**

The [Quick Menu] consists of:

- Q1: My Personal Menu
- Q2: Quick Setup
- Q3: Function Setups
- Q5: Changes Made
- Q6: Loggings

The Function set-up provides quick and easy access to all parameters required for the majority of water and wastewater applications including variable torque, constant torque, pumps, dosing pumps, well pumps, booster pumps, mixer pumps, aeration blowers and other pump and fan applications. Among other features, it also includes parameters for selecting which variables to display on the LCP, digital preset speeds, scaling of analog references, closed-loop single zone and multi-zone applications and specific functions related to water and wastewater applications.

The Quick Menu parameters can be accessed immediately unless a password has been created via par. 0-60, 0-61, 0-65 or 0-66.

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

[Main Menu]

is used for programming all parameters.

The Main Menu parameters can be accessed immediately unless a password has been created via par. 0-60, 0-61, 0-65 or 0-66. For the majority of water and wastewater applications it is not necessary to access the main menu parameters, but instead the quick menu, quick set-up and function set-ups provide the simplest and quickest access to the typical required parameters.

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

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

[Alarm Log]

displays an alarm list of the five latest alarms (numbered A1-A5). To obtain additional details about an alarm, use the arrow 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.

[Back]

reverts to the previous step or layer in the navigation structure.

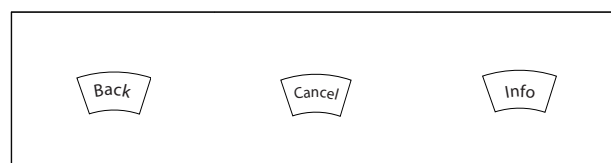
[Cancel]

the last change or command will be canceled as long as the display has not been changed.

[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].

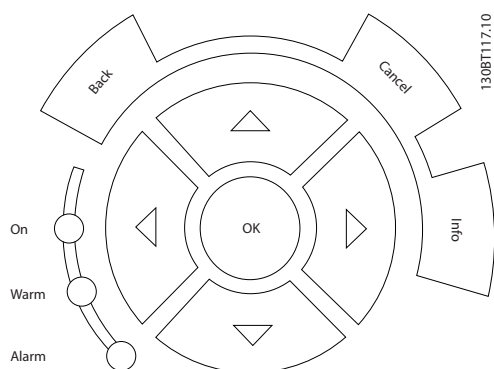


Navigation keys

The four navigation arrows are used to navigate between the different choices available in [Quick Menu], [Main Menu] and [Alarm Log]. Use the keys to move the cursor.

[OK]

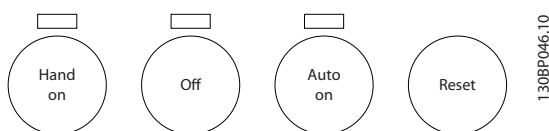
is used for choosing a parameter marked by the cursor and for enabling the change of a parameter.



130BT117.10

Operation keys

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



130BP046.10

[Hand on]

enables control of the adjustable frequency drive via the GLCP. [Hand on] also starts the motor, and makes it possible to give the motor speed reference using the arrow keys. The key can be *Enabled* [1] or *Disabled* [0] via par. 0-40 [Hand on] Key on LCP.

The following control signals will still be active when [Hand on] is activated:

- [Hand on] - [Off] - [Auto on]
- Reset
- Coasting stop inverse (motor coasting to stop)
- Reversing
- Set-up select lsb - Set-up select msb
- Stop command from serial communication
- Quick stop
- DC brake

External stop signals activated by means of control signals or a serial bus will override a "start" command via the LCP.

[Off]

stops the connected motor. The key can be *Enabled* [1] or *Disabled* [0] via par. 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]

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 will start. The key can be *Enabled* [1] or *Disabled* [0] via par. 0-42 [Auto on] key on LCP.

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

[Reset]

is used for resetting the adjustable frequency drive after an alarm (trip). The key can be *Enabled* [1] or *Disabled* [0] via par. 0-43 Reset Keys on LCP.

The parameter shortcut

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

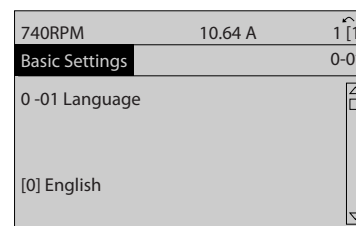
5.1.3 Changing Data

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

5.1.4 Changing a Text Value

If the selected parameter is a text value, it can be changed by using the up/down navigation keys.

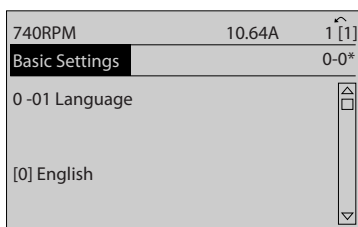
The up key increases the value, and the down key decreases the value. Place the cursor on the value to be saved and press [OK].



130BP068.10

Figure 5.1 Display example.

Choose a parameter group from the main menu and press [OK]. Then further select the parameter sub-groups by using the up and down arrows and then press [OK]. 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.

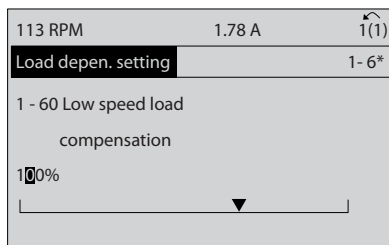


130BP067:10

Figure 5.2 Display example.

5.1.5 Changing a Group of Numeric Data Values

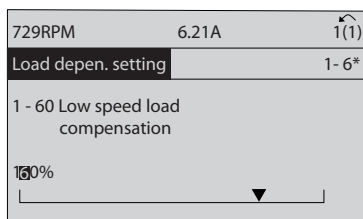
If the chosen parameter represents a numeric data value, change the chosen data value by means of the [◀] and [▶] navigation keys as well as the up/down [▲] [▼] navigation keys. Use the [◀] and [▶] navigation keys to move the cursor horizontally.



130BP069:10

Figure 5.3 Display example.

Use the up/down navigation keys to change the data value. The up key increases the data value, while the down key reduces it. Place the cursor on the value to be saved and press [OK].



130BP070:10

Figure 5.4 Display example.

5.1.6 Changing Data Values, Step-by-Step

Certain parameters can be changed step-by-step or by an infinite number of variables. This applies to 1-20 Motor Power [kW], 1-22 Motor Voltage and 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.

5.1.7 Readout and Programming of Indexed Parameters

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

Use 3-10 Preset Reference as another example: Choose the parameter, press [OK], and use the up/down navigation keys to scroll through the indexed values. To change the parameter value, select the indexed value and press [OK]. Change the value by using the up/down keys. Press [OK] to accept the new setting. Press [Cancel] to abort. Press [Back] to leave the parameter.

5.1.8 Tips and tricks

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

Table 5.1 Tips and Tricks

5.1.9 Quick Transfer of Parameter Settings When Using Keypad

Once the set-up of an adjustable frequency drive is complete, it is recommended to store (backup) the parameter settings in the or on a PC via DCT 10 software.

⚠ WARNING

Stop the motor before performing any of these operations.

Data storage in LCP:

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

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

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

Data transfer from LCP to adjustable frequency drive:

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

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

5.1.10 Restore Factory Settings

There are two ways to restore the drive to factory settings: Recommended restore and manual restore. Please be aware that they have different impacts according to the below description.

Recommended restore (via 14-22 Operation Mode)

1. Select 14-22 Operation Mode
2. Press [OK]
3. Select [2] Restore Factory Settings
4. Press [OK]
5. Disconnect the power from the unit and wait for the display to turn off.
6. Reconnecting the power resets the adjustable frequency drive. Note that first start-up takes a few more seconds
7. Press [Reset]

14-22 Operation Mode restores all except:

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

Manual restore

NOTE!

When carrying out manual restore, serial communication, RFI filter settings and fault log settings are reset.

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

The Manual Restore restores all except:
 15-00 Operating Hours
 15-03 Power-ups
 15-04 Over Temps
 15-05 Over Volts

In order 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

The RS-485 bus must be terminated by a resistor network at both ends. If the 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*.

5.1.12 How to Connect a PC to the Adjustable Frequency Drive

5.1.11 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.

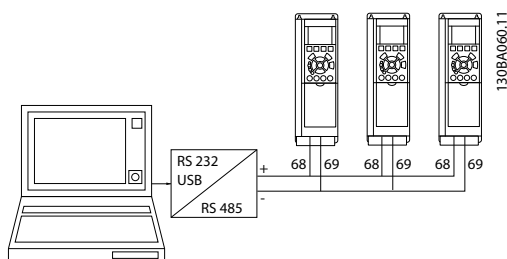


Figure 5.5 Connection example.

To control or program the adjustable frequency drive from a PC, install the PC-based Drive Control Tool DCT 10. The PC is connected via a standard (host/device) USB cable, or via the RS-485 interface as shown in the *Design Guide, chapter How to Install > Installation of misc. connections*.

NOTE!

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

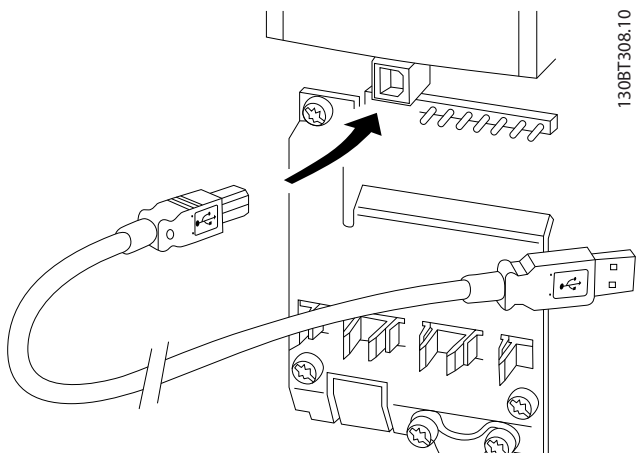


Figure 5.6 For control cable connections, see section on *Control Terminals*.

5.1.13 PC Software Tools

PC-based Drive Control Tool DCT 10

All adjustable frequency drives are equipped with a serial communication port. Danfoss provides a PC tool for communication between PC and adjustable frequency drive, PC-based Drive Control Tool DCT 10. Please check the section on *Available Literature* for detailed information on this tool.

Drive Control Tool DCT 10

DCT 10 has been designed as an easy to use interactive tool for setting parameters in our adjustable frequency drives. .

The DCT 10 Drive Control Tool will be useful for:

- Planning a communication network off-line. DCT 10 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
- Adjustable frequency drives developed in the future will be fully supported.

Drive Control Tool DCT 10 software supports Profibus DP-V1 via a master class 2 connection. This makes it possible to access read/write parameters online in an adjustable

frequency drive via the Profibus network. This will eliminate 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 the line power, in conjunction with the USB port. Failure to do so may damage equipment.)
2. Open Drives Control Tool DCT 10 Software
3. Choose "Read from drive"
4. Choose "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 the USB com port
2. Open Drives Control Tool DCT 10 software
3. Choose "Open" – stored files will be shown
4. Open the appropriate file
5. Choose "Write to drive"

All parameter settings are now transferred to the adjustable frequency drive.

A separate manual for Drives Control Tool DCT 10 Software is available from GE or the website: www.geelectrical.com/drives.

The Drives Control Tool DCT 10 software modules

The following modules are included in the software package:

| |
|---|
| <p>DCT 10 Software Setting parameters Copy to and from adjustable frequency drives Documentation and print out of parameter settings incl. diagrams</p> <p>Ext. user interface Preventive Maintenance Schedule Clock settings Timed Action Programming Logic Controller Set-up</p> |
|---|

Ordering number:

Please contact GE or visit: www.geelectrical.com/drives

6 How to program the adjustable frequency drive

6.1 How to program

6.1.1 Parameter set-up

Overview of parameter groups

| Group | Title | Function |
|-------|------------------------------------|--|
| 0- | Operation/Display | Parameters related to the fundamental functions of the adjustable frequency drive, function of the LCP buttons and configuration of the LCP display. |
| 1- | Load / Motor | Parameter group for motor settings. |
| 2- | Brakes | Parameter group for setting brake features in the adjustable frequency drive. |
| 3- | Reference / Ramps | Parameters for reference handling, defining limitations, and configuring the reaction of the adjustable frequency drive to changes. |
| 4- | Limits / Warnings | Parameter group for configuring limits and warnings. |
| 5- | Digital In/Out | Parameter group for configuring the digital inputs and outputs. |
| 6- | Analog In/Out | Parameter group for configuring the analog inputs and outputs. |
| 8- | Communication and Options | Parameter group for configuring communications and options. |
| 9- | Profibus | Parameter group for Profibus-specific parameters. |
| 10- | DeviceNet Serial Communication Bus | Parameter group for DeviceNet-specific parameters. |
| 13- | Smart Logic | Parameter group for Smart Logic Control |
| 14- | Special Functions | Parameter group for configuring special adjustable frequency drive functions. |
| 15- | Drive Information | Parameter group containing adjustable frequency drive information such as operating data, hardware configuration and software versions. |
| 16- | Data Readouts | Parameter group for data readouts, such as current references, voltages, control, alarm, warning and status words. |
| 18- | Info and Readouts | This parameter group contains the last 10 Preventive Maintenance logs. |
| 20- | Drive Closed-loop | This parameter group is used for configuring the closed-loop PID controller that controls the output frequency of the unit. |
| 21- | Extended Closed-loop | Parameters for configuring the three extended closed-loop PID controllers. |
| 22- | Application Functions | These parameters monitor water applications. |
| 23- | Time-based Functions | These parameters are for actions to be performed on a daily or weekly basis, such as different references for working hours/non-working hours. |
| 25- | Basic Cascade Controller Functions | Parameters for configuring the Basic Cascade Controller for sequence control of multiple pumps. |
| 26- | Analog I/O Option MCB 109 | Parameters for configuring the Analog I/O Option MCB 109. |
| 27- | Extended Cascade Control | Parameters for configuring the extended cascade control. |
| 29- | Water Application Functions | Parameters for setting water specific functions. |
| 31- | Bypass Option | Parameters for configuring the bypass option |

Table 6.1 Parameter Groups

Parameter descriptions and selections are displayed on the Graphic LCP or Numeric LCP in the display area (See Section 5 for details.) Access the parameters by pressing the [Quick Menu] or [Main Menu] key on the control panel. The quick menu is used primarily for commissioning the unit at start-up by providing those parameters necessary to start operation. The main menu provides access to all the parameters for detailed application programming.

All digital input/output and analog input/output terminals are multifunctional. All terminals have factory default functions suitable for the majority of water applications but if other special functions are required, they must be programmed in parameter group 5 or 6.

6.1.2 Quick Menu Mode

The GLCP provides access to all parameters listed under the Quick Menus. To set parameters using the [Quick Menu] button:

Pressing [Quick Menu] the list indicates the different areas contained in the quick menu.

Efficient parameter set-up for water applications

The parameters can easily be set up for the vast majority of the water and wastewater applications only by using the [Quick Menu].

The best way to set parameters using the [Quick Menu] is by following the steps below:

1. Press [Quick Setup] for selecting basic motor settings, ramp times, etc.
2. Press [Function Set-ups] for setting up the required functionality of the adjustable frequency drive - if not already covered by the settings in [Quick Setup].
3. Choose between *General Settings*, *Open-loop Settings* and *Closed-loop Settings*.

It is recommended to do the set-up in the order listed.



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Figure 6.1 Quick Menu view.

| Par. | Designation | [Units] |
|------|----------------------------------|---------|
| 0-01 | Language | |
| 1-20 | Motor Power | [kW] |
| 1-22 | Motor Voltage | [V] |
| 1-23 | Motor Frequency | [Hz] |
| 1-24 | Motor Current | [A] |
| 1-25 | Motor Nominal Speed | [RPM] |
| 3-41 | Ramp 1 Ramp-up Time | [s] |
| 3-42 | Ramp 1 Ramp-down Time | [s] |
| 4-11 | Motor Speed Low Limit | [RPM] |
| 4-13 | Motor Speed High Limit | [RPM] |
| 1-29 | Automatic Motor Adaptation (AMA) | |

Table 6.2 Quick Setup parameters. Please see section *Commonly Used Parameters - Explanations*

If *No Operation* is selected in terminal 27, no connection to +24 V on terminal 27 is necessary to enable start. If *Coast Inverse* (factory default value) is selected in Terminal 27, a connection to +24V is necessary to enable start.

For detailed parameter descriptions, please see the following section on *Commonly Used Parameters - Explanations*.

6.1.3 Q1 My Personal Menu

Parameters defined by the user can be stored in Q1 My Personal Menu.

Select *My Personal Menu* to display only the parameters, which have been pre-selected and programmed as personal parameters. For example, a pump or equipment OEM may have pre-programmed these to be in My Personal Menu during factory commissioning to make on-site commissioning / fine tuning simpler. These parameters are selected in par. 0-25 *My Personal Menu*. Up to 20 different parameters can be defined in this menu.

| Q1 My Personal Menu |
|-----------------------------|
| 20-21 Setpoint 1 |
| 20-93 PID Proportional Gain |
| 20-94 PID Integral Time |

6.1.4 Q2 Quick Set-up

The parameters in Q2 Quick Set-up are the basic parameters which are always needed to set up the adjustable frequency drive for operation.

| Q2 Quick Set-up | |
|---------------------------------------|------|
| Parameter number and name | Unit |
| 0-01 Language | |
| 1-20 Motor Power | kW |
| 1-22 Motor Voltage | V |
| 1-23 Motor Frequency | Hz |
| 1-24 Motor Current | A |
| 1-25 Motor Nominal Speed | RPM |
| 3-41 Ramp 1 Ramp-up Time | s |
| 3-42 Ramp 1 Ramp-down Time | s |
| 4-11 Motor Speed Low Limit | RPM |
| 4-13 Motor Speed High Limit | RPM |
| 1-29 Automatic Motor Adaptation (AMA) | |

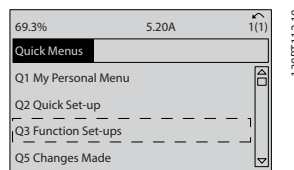


Figure 6.4 Step 3: Use the up/down navigation keys to scroll down to Function Setups. Press [OK].

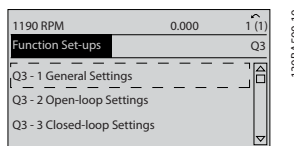


Figure 6.5 Step 4: Function Setups choices appear. Choose 03-1 General Settings. Press [OK].

6.1.5 Q3 Function Setups

The Function Setup provides quick and easy access to all parameters required for the majority of water and wastewater applications including variable torque, constant torque, pumps, dosing pumps, well pumps, booster pumps, mixer pumps, aeration blowers and other pump and fan applications. Among other features, it also includes parameters for selecting which variables to display on the LCP, digital preset speeds, scaling of analog references, closed-loop single zone and multi-zone applications and specific functions related to water and wastewater applications.

How to access Function Setups - example:

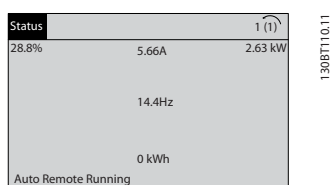


Figure 6.2 Step 1: Turn on the adjustable frequency drive (on LED lights).

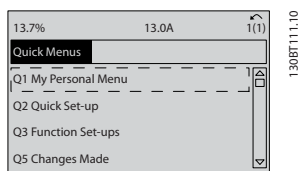


Figure 6.3 Step 2: Press the [Quick Menus] button (Quick Menu choices appear).

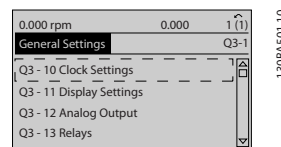


Figure 6.6 Step 5: Use the up/down navigation keys to scroll down to, e.g., 03-12 Analog Outputs. Press [OK].

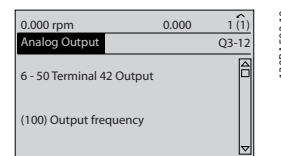


Figure 6.7 Step 6: Choose parameter 6-50 Terminal 42 Output. Press [OK].

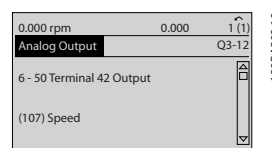


Figure 6.8 Step 7: Use the up/down navigation keys to select between the different choices. Press [OK].

The Function Setup parameters are grouped in the following way:

| Q3-1 General Settings | | | |
|---------------------------|-----------------------------|-----------------------------------|---|
| Q3-10 Clock Settings | Q3-11 Display Settings | Q3-12 Analog Output | Q3-13 Relays |
| 0-70 Set Date and Time | 0-20 Display Line 1.1 Small | 6-50 Terminal 42 Output | Relay 1 → 5-40 Function Relay |
| 0-71 Date Format | 0-21 Display Line 1.2 Small | 6-51 Terminal 42 Output Min Scale | Relay 2 → 5-40 Function Relay |
| 0-72 Time Format | 0-22 Display Line 1.3 Small | 6-52 Terminal 42 Output Max Scale | Option relay 7 → 5-40 Function Relay |
| 0-74 DST/Summertime | 0-23 Display Line 2 Large | | Option relay 8 → 5-40 Function Relay |
| 0-76 DST/Summertime Start | 0-24 Display Line 3 Large | | Option relay 9 → 5-40 Function Relay |
| 0-77 DST/Summertime End | 0-37 Display Text 1 | | |
| | 0-38 Display Text 2 | | |
| | 0-39 Display Text 3 | | |

| Q3-2 Open-loop Settings | |
|--------------------------------|--|
| Q3-20 Digital Reference | Q3-21 Analog Reference |
| 3-02 Minimum Reference | 3-02 Minimum Reference |
| 3-03 Maximum Reference | 3-03 Maximum Reference |
| 3-10 Preset Reference | 6-10 Terminal 53 Low Voltage |
| 5-13 Terminal 29 Digital Input | 6-11 Terminal 53 High Voltage |
| 5-14 Terminal 32 Digital Input | 6-14 Terminal 53 Low Ref/Feedb. Value |
| 5-15 Terminal 33 Digital Input | 6-15 Terminal 53 High Ref/Feedb. Value |

| Q3-3 Closed-loop Settings | |
|---------------------------------------|----------------------------------|
| Q3-30 Feedback Settings | Q3-31 PID Settings |
| 1-00 Configuration Mode | 20-81 PID Normal/Inverse Control |
| 20-12 Reference/Feedb.Unit | 20-82 PID Start Speed [RPM] |
| 3-02 Minimum Reference | 20-21 Setpoint 1 |
| 3-03 Maximum Reference | 20-93 PID Proportional Gain |
| 6-20 Terminal 54 Low Voltage | 20-94 PID Integral Time |
| 6-21 Terminal 54 High Voltage | |
| 6-24 Terminal 54 Low Ref/Feedb Value | |
| 6-25 Terminal 54 High Ref/Feedb Value | |
| 6-00 Live Zero Timeout Time | |
| 6-01 Live Zero Timeout Function | |

6.1.6 Q5 Changes Made

Q5 Changes Made can be used for fault finding.

Select Changes made to get information about:

- the last 10 changes. Use the up/down navigation keys to scroll between the last 10 changed parameters.
- the changes made since default setting.

Select *Loggings* to get information about the display line readouts. The information is shown as graphs.

Only display parameters selected in par. 0-20 and par. 0-24 can be viewed. It is possible to store up to 120 samples in the memory for later reference.

Please notice that the parameters listed in the below tables for Q5 only serve as examples since they will vary depending on the programming of the particular adjustable frequency drive.

| Q5-1 Last 10 Changes |
|-----------------------------|
| 20-94 PID Integral Time |
| 20-93 PID Proportional Gain |

| Q5-2 Since Factory Setting |
|-----------------------------|
| 20-93 PID Proportional Gain |
| 20-94 PID Integral Time |

| Q5-3 Input Assignments |
|------------------------|
| Analog Input 53 |
| Analog Input 54 |

6.1.7 Q6 Loggings

Q6 Loggings can be used for fault finding.

Please notice that the parameters listed in the table for Q6 below only serve as examples since they will vary depending on the programming of the particular adjustable frequency drive.

| Q6 Loggings |
|---------------------|
| Reference |
| Analog Input 53 |
| Motor Current |
| Frequency |
| Feedback |
| Energy Log |
| Trending Cont Bin |
| Trending Timed Bin |
| Trending Comparison |

6.1.8 Main Menu Mode

The keypad provides access to the main menu mode.

Select main menu mode by pressing the [Main Menu] key. Figure 6.2 shows the resulting readout, which appears on the display of the LCP.

Lines 2 through 5 on the display show a list of parameter groups which can be chosen by toggling the up and down buttons.

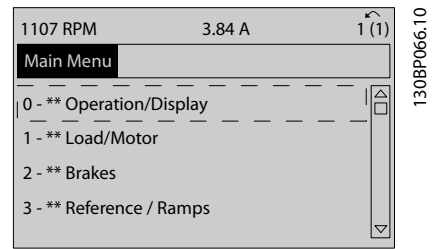


Figure 6.9 Display example.

Each parameter has character(s) and number which remain the same regardless of the programming mode. In main menu mode, the parameters are further divided into groups: Macros, Keypad Set-up, Parameter Data Set, Parameter Data Check, Drive Information, Data Readouts, Logs & I/O Option Status, and Advanced Parameter Data Set.

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

6.1.9 Parameter Selection

| Main Menu Item | Parameter Groups: |
|-----------------------------|---|
| Keypad Set-Up | K-## |
| Parameter Data Set | F-##, E-##, C-##, P-##, H-##, AN-##, SP-##, O-##, AO-##, DN-##, PB-##, LN-##, BN-## |
| Drive Information | ID-## |
| Data Readouts | DR-## |
| Logs & I/O Option Status | LG-## |
| Advanced Parameter Data Set | AP-##, FB-##, T-##, CL-##, XC-##, PC-##, LC-##, B-## |

Table 6.3 Parameter Groups in Main Menu Items

| | |
|-----------|-----------------------------|
| Group no. | Parameter group: |
| K-## | Keypad Set-Up |
| F-## | Fundamental Parameters |
| E-## | Digital In/Out |
| C-## | Frequency Control Functions |
| P-## | Motor Data |
| H-## | High Perf Parameters |
| AN-## | Analog In/Out |
| SP-## | Special Functions |
| O-## | Options / Comms |
| AO-## | Analog I/O Option |
| DN-## | DeviceNet |
| PB-## | Profibus |
| LN-## | LonWorks |
| BN-## | BACnet |
| ID-## | Drive Information |
| DR-## | Data Readouts |
| LG-## | Logs & I/O Opt. Status |
| AP-## | HVAC Appl. Param. |
| FB-## | Fire/Bypass Operation |
| EN-## | EtherNet |
| T-## | Timed Functions |
| CL-## | PID Closed-loop |
| XC-## | Ext. PID Closed-loop |
| PC-## | Pump Controller |
| LC-## | Logic Controller |
| B-## | Braking Functions |

Table 6.4 Parameter groups.

Choose a parameter group from the main menu and press [OK]. Then further select the parameter sub-groups by using the up and down arrows and then press [OK]. 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.

6.2 Commonly Used Parameters - Explanations

6.2.1 Main Menu

The main menu includes all available parameters in the VLT® AQUA Drive FC 200 adjustable frequency drive. All parameters are grouped logically with a group name indicating the function of the parameter group. All parameters are listed by name and number in the section *Parameter Options* in this Instruction Manual.

All parameters included in the quick menus (Q1, Q2, Q3, Q5 and Q6) can be found in the following.

Some of the most commonly used parameters for VLT® AQUA Drive applications are also explained in the following section.

For a detailed explanation of all parameters, please refer to the VLT® AQUA Drive Programming Guide MG.20.OX.YY which is available at www.danfoss.com or by ordering it from the local Danfoss office.

Parameters related to the fundamental functions of the , function of the LCP buttons and configuration of the LCP display.

0-01 Language

Option:

Function:

| Option: | Function: |
|---------|--|
| | Defines the language to be used in the display. The adjustable frequency drive can be delivered with 4 different language packages. English and German are included in all packages. English cannot be erased or manipulated. |
| [0] * | English |
| [1] | German |
| [2] | French |
| [3] | Danish |
| [4] | Spanish |
| [5] | Italian |
| [6] | Swedish |
| [7] | Dutch |
| [10] | Chinese |
| [20] | Finnish |
| [22] | English US |
| [27] | Greek |
| [28] | Portuguese |
| [36] | Slovenian |
| [39] | Korean |
| [40] | Japanese |
| [41] | Turkish |
| [42] | Traditional Chinese |
| [43] | Bulgarian |
| [44] | Serbian |
| [45] | Romanian |
| [46] | Hungarian |
| [47] | Czech |
| [48] | Polish |
| [49] | Russian |
| [50] | Thai |
| [51] | Bahasa Indonesian |

0-20 Display Line 1.1 Small

Option:

Function:

| Option: | Function: |
|---------|---|
| | Select a variable for display in line 1, left position. |
| [0] | None |
| [953] | Profibus Warning Word |

| 0-20 Display Line 1.1 Small | | |
|-----------------------------|--------------------------------|--|
| Option: | | Function: |
| [1005] | Readout Transmit Error Counter | View the number of CAN control transmission errors since the last power-up. |
| [1006] | Readout Receive Error Counter | View the number of CAN control receipt errors since the last power-up. |
| [1007] | Readout Bus Off Counter | View the number of Bus Off events since the last power-up. |
| [1013] | Warning Parameter | View a DeviceNet-specific warning word. One separate bit is assigned to every warning. |
| [1230] | | |
| [1472] | | |
| [1473] | | |
| [1474] | | |
| [1501] | Running Hours | View the number of running hours of the motor. |
| [1502] | kWh Counter | View the line power consumption in kWh. |
| [1600] | Control Word | View the control word sent from the adjustable frequency drive via the serial communication port in hex code. |
| [1601] * | Reference [Unit] | Total reference (sum of digital/analog/preset/bus/freeze ref./catch up and slow-down) in selected unit. |
| [1602] | Reference % | Total reference (sum of digital/analog/preset/bus/freeze ref./catch up and slow-down) in percent. |
| [1603] | Status Word | Present status word |
| [1605] | Main Actual Value [%] | One or more warnings in a Hex code |
| [1609] | Custom Readout | View the user-defined readouts as defined in <i>0-30 Custom Readout Unit</i> , <i>0-31 Custom Readout Min Value</i> and <i>0-32 Custom Readout Max Value</i> . |
| [1610] | Power [kW] | Actual power consumed by the motor in kW. |
| [1611] | Power [hp] | Actual power consumed by the motor in HP. |
| [1612] | Motor voltage | Voltage supplied to the motor. |
| [1613] | Frequency | Motor frequency, i.e., the output frequency from the adjustable frequency drive in Hz. |

| 0-20 Display Line 1.1 Small | | |
|-----------------------------|------------------------|---|
| Option: | | Function: |
| [1614] | Motor Current | Phase current of the motor measured as effective value. |
| [1615] | Frequency [%] | Motor frequency, i.e., the output frequency from the adjustable frequency drive in percent. |
| [1616] | Torque [Nm] | Present motor load as a percentage of the rated motor torque. |
| [1617] * | Speed [RPM] | Speed in RPM (revolutions per minute), i.e., the motor shaft speed in closed-loop based on the entered motor nameplate data, the output frequency and the load on the adjustable frequency drive. |
| [1618] | Motor Thermal | Thermal load on the motor, calculated by the ETR function. See also parameter group 1-9* Motor Temperature. |
| [1619] | KTY sensor temperature | |
| [1620] | Motor Angle | |
| [1622] | Torque [%] | Shows the actual torque produced, in percentage. |
| [1625] | | |
| [1630] | DC Link Voltage | Intermediate circuit voltage in the adjustable frequency drive. |
| [1632] | Brake Energy /s | Present braking energy transferred to an external brake resistor. Stated as an instantaneous value. |
| [1633] | Brake Energy /2 min | Braking energy transferred to an external brake resistor. The mean power is calculated continuously for the most recent 120 seconds. |
| [1634] | Heatsink Temp. | Present heatsink temperature of the adjustable frequency drive. The cut-out limit is 203°F ±41°F [95°C ± 5°C]; cutting back in occurs at 158°F ±41°F [70°C ± 5°C]. |
| [1635] | Inverter Thermal | Percentage load of the inverters |
| [1636] | Inv. Nom. Current | Nominal current of the adjustable frequency drive. |
| [1637] | Inv. Max. Current | Maximum current of the adjustable frequency drive. |
| [1638] | SL Controller State | State of the event executed by the control |

| 0-20 Display Line 1.1 Small | | |
|-----------------------------|----------------------------|---|
| Option: | Function: | |
| [1639] | Control Card Temp. | Temperature of the control card. |
| [1650] | External Reference | Sum of the external reference as a percentage, i.e., the sum of analog/pulse/bus. |
| [1651] | Pulse Reference | |
| [1652] | Feedback [Unit] | Signal value in units from the programmed digital input(s). |
| [1653] | Digi Pot Reference | View the contribution of the digital potentiometer to the actual reference Feedback. |
| [1660] | Digital Input | Displays the status of the digital inputs. Signal low = 0; Signal high = 1. Regarding order, see <i>16-60 Digital Input</i> . Bit 0 is at the extreme right. |
| [1661] | Terminal 53 Switch Setting | Setting of input terminal 53. Current = 0; Voltage = 1. |
| [1662] | Analog Input 53 | Actual value at input 53 either as a reference or protection value. |
| [1663] | Terminal 54 Switch Setting | Setting of input terminal 54. Current = 0; Voltage = 1. |
| [1664] | Analog Input 54 | Actual value at input 54 either as reference or protection value. |
| [1665] | Analog Output 42 [mA] | Actual value at output 42 in mA. Use <i>6-50 Terminal 42 Output</i> to select the variable to be represented by output 42. |
| [1666] | Digital Output [bin] | Binary value of all digital outputs. |
| [1667] | Freq. Input #29 [Hz] | Actual value of the frequency applied at terminal 29 as a pulse input. |
| [1668] | Freq. Input #33 [Hz] | Actual value of the frequency applied at terminal 33 as a pulse input. |
| [1669] | Pulse Output #27 [Hz] | Actual value of pulses applied to terminal 27 in digital output mode. |
| [1670] | Pulse Output #29 [Hz] | Actual value of pulses applied to terminal 29 in digital output mode. |
| [1671] | Relay Output [bin] | View the setting of all relays. |
| [1672] | Counter A | View the present value of Counter A. |
| [1673] | Counter B | View the present value of Counter B. |

| 0-20 Display Line 1.1 Small | | |
|-----------------------------|-----------------------|---|
| Option: | Function: | |
| [1674] | Prec. Stop Counter | |
| [1675] | Analog In X30/11 | Actual value of the signal on input X30/11 (General Purpose I/O Card. Option) |
| [1676] | Analog In X30/12 | Actual value of the signal on input X30/12 (General Purpose I/O Card. Optional) |
| [1677] | Analog Out X30/8 [mA] | Actual value at output X30/8 (General Purpose I/O Card. Optional) Use <i>6-60 Terminal X30/8 Output</i> to select the variable to be shown. |
| [1678] | | |
| [1679] | | |
| [1680] | Fieldbus CTW 1 | Control word (CTW) received from the bus master. |
| [1682] | Fieldbus REF 1 | Main reference value sent with control word via the serial communications network, e.g., from the BMS, PLC or other master controller. |
| [1684] | Comm. Option Status | Extended serial communication option status word. |
| [1685] | FC Port CTW 1 | Control word (CTW) received from the bus master. |
| [1686] | FC Port REF 1 | Status word (STW) sent to the bus master. |
| [1690] | Alarm Word | One or more alarms in a Hex code (used for serial communications) |
| [1691] | Alarm word 2 | One or more alarms in a Hex code (used for serial communications) |
| [1692] | Warning Word | One or more warnings in a Hex code (used for serial communications) |
| [1693] | Warning word 2 | One or more warnings in a Hex code (used for serial communications) |
| [1694] | Ext. Status Word | One or more status conditions in a Hex code (used for serial communications) |
| [3401] | PCD 1 Write to MCO | |
| [3402] | PCD 2 Write to MCO | |
| [3403] | PCD 3 Write to MCO | |

| 0-20 Display Line 1.1 Small | | |
|-----------------------------|------------------------|--|
| Option: | Function: | |
| [3404] | PCD 4 Write to MCO | |
| [3405] | PCD 5 Write to MCO | |
| [3406] | PCD 6 Write to MCO | |
| [3407] | PCD 7 Write to MCO | |
| [3408] | PCD 8 Write to MCO | |
| [3409] | PCD 9 Write to MCO | |
| [3410] | PCD 10 Write to MCO | |
| [3421] | PCD 1 Read from MCO | |
| [3422] | PCD 2 Read from MCO | |
| [3423] | PCD 3 Read from MCO | |
| [3424] | PCD 4 Read from MCO | |
| [3425] | PCD 5 Read from MCO | |
| [3426] | PCD 6 Read from MCO | |
| [3427] | PCD 7 Read from MCO | |
| [3428] | PCD 8 Read from MCO | |
| [3429] | PCD 9 Read from MCO | |
| [3430] | PCD 10 Read from MCO | |
| [3440] | Digital Inputs | |
| [3441] | Digital Outputs | |
| [3450] | Actual Position | |
| [3451] | Commanded Position | |
| [3452] | Actual Master Position | |
| [3453] | Slave Index Position | |
| [3454] | Master Index Position | |
| [3455] | Curve Position | |
| [3456] | Track Error | |
| [3457] | Synchronizing Error | |
| [3458] | Actual Velocity | |
| [3459] | Actual Master Velocity | |

| 0-20 Display Line 1.1 Small | | |
|-----------------------------|----------------------|--|
| Option: | Function: | |
| [3460] | Synchronizing Status | |
| [3461] | Axis Status | |
| [3462] | Program Status | |
| [3470] | MCO Alarm Word 1 | |
| [3471] | MCO Alarm Word 2 | |
| [9913] | | |
| [9914] | | |
| [9920] | | |
| [9921] | | |
| [9922] | | |
| [9923] | | |
| [9924] | | |
| [9925] | | |
| [9926] | | |
| [9927] | | |

0-21 Display Line 1.2 Small

Option: **Function:**

| | | |
|----------|-----------------|--|
| | | Select a variable for display in line 1, middle position. |
| [1662] * | Analog input 53 | The options are the same as those listed for par. 0-20 <i>Display Line 1.1 Small</i> . |

0-22 Display Line 1.3 Small

Option: **Function:**

| | | |
|----------|---------------|---|
| | | Select a variable for display in line 1, right position. |
| [1614] * | Motor Current | The options are the same as those listed for 0-20 <i>Display Line 1.1 Small</i> . |

0-23 Display Line 2 Large

Option: **Function:**

| | | |
|----------|-----------|--|
| | | Select a variable for display in line 2. |
| [1615] * | Frequency | The options are the same as those listed for par. 0-20 <i>Display Line 1.1 Small</i> |

0-24 Display Line 3 Large

Option: **Function:**

| | | |
|----------|-----------------|---|
| [1652] * | Feedback [Unit] | The options are the same as those listed for 0-20 <i>Display Line 1.1 Small</i> . |
| | | Select a variable for display in line 2. |

| 0-37 Display Text 1 | | |
|------------------------|-------------------|---|
| Range: | Function: | |
| 0 N/A* 0 N/A] | [0 - 0 N/A] | In this parameter, it is possible to write an individual text string for display in the LCP or to be read via serial communication. If it is to be displayed permanently, select Display Text 1 in <i>0-20 Display Line 1.1 Small, 0-21 Display Line 1.2 Small, 0-22 Display Line 1.3 Small, 0-23 Display Line 2 Large or 0-24 Display Line 3 Large</i> . Use the [▲] or [▼] buttons on the LCP to change a character. Use the [◀] and [▶] buttons to move the cursor. When a character is highlighted by the cursor, it can be changed. Use the [▲] or [▼] buttons on the LCP to change a character. A character can be inserted by placing the cursor between two characters and pressing [▲] or [▼]. |

| 0-38 Display Text 2 | | |
|------------------------|-------------------|---|
| Range: | Function: | |
| 0 N/A* 0 N/A] | [0 - 0 N/A] | In this parameter, it is possible to write an individual text string for display in the LCP or to be read via serial communication. If to be displayed permanently select Display Text 2 in <i>0-20 Display Line 1.1 Small, 0-21 Display Line 1.2 Small, 0-22 Display Line 1.3 Small, 0-23 Display Line 2 Large or 0-24 Display Line 3 Large</i> . Use the [▲] or [▼] buttons on the LCP to change a character. Use the [◀] and [▶] buttons to move the cursor. When a character is highlighted by the cursor, this character can be changed. A character can be inserted by placing the cursor between two characters and pressing [▲] or [▼]. |

| 0-39 Display Text 3 | | |
|------------------------|-------------------|--|
| Range: | Function: | |
| 0 N/A* 0 N/A] | [0 - 0 N/A] | In this parameter, it is possible to write an individual text string for display in the LCP or to be read via serial communication. If it is to be displayed permanently, select Display Text 3 in <i>0-20 Display Line 1.1 Small, 0-21 Display Line 1.2 Small, 0-22 Display Line 1.3 Small, 0-23 Display Line 2 Large or 0-24 Display Line 3 Large</i> . Use the [▲] or [▼] buttons on the LCP to change a character. Use the [◀] and [▶] buttons to move the cursor. When a character is highlighted by the cursor, this character can be changed. A character can be inserted by placing the cursor between two characters and pressing [▲] or [▼]. |

| 0-70 Date and Time | | |
|--------------------|-----------|--|
| Range: | Function: | |
| Size related* | [0-0] | |

| 0-71 Date Format | | |
|------------------|------------|---|
| Option: | Function: | |
| [0] * | YYYY-MM-DD | Sets the date format to be used in the LCP. |
| [1] | DD-MM-YYYY | Sets the date format to be used in the LCP. |
| [2] | MM/DD/YYYY | Sets the date format to be used in the LCP. |

| 0-72 Time Format | | |
|------------------|-----------|---|
| Option: | Function: | |
| | | Sets the time format to be used in the LCP. |
| [0] * | 24 h | |
| [1] | 12 h | |

| 0-74 DST/Summertime | | |
|---------------------|-----------|--|
| Option: | Function: | |
| | | Choose how Daylight Saving Time/Summertime should be handled. For manual DST/Summertime enter the start date and end date in <i>0-76 DST/Summertime Start</i> and <i>0-77 DST/Summertime End</i> . |
| [0] * | OFF | |
| [2] | Manual | |

| 0-76 DST/Summertime Start | | |
|---------------------------|-----------|---|
| Range: | Function: | |
| 0 N/A* [0 - 0 N/A] | | Sets the date and time when summertime/DST starts. The date is programmed in the format selected in <i>0-71 Date Format</i> . |

| 0-77 DST/Summertime End | | |
|-------------------------|-----------|--|
| Range: | Function: | |
| 0 N/A* [0 - 0 N/A] | | |

6.2.2 General Settings

Define whether the adjustable frequency drive operates in open-loop or closed-loop.

| 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 CL-## or via the Function Setups accessed by pressing the [Quick Menus] button. |

NOTE!

This parameter cannot be changed when the motor is running.

NOTE!

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

| 1-20 Motor Power [kW] | | |
|-----------------------|---------------------|--|
| Range: | Function: | |
| 4.00 kW* | [0.09 - 3000.00 kW] | |

| 1-22 Motor Voltage | | |
|--------------------|-----------------|--|
| Range: | Function: | |
| 400. V* | [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. This parameter cannot be adjusted while the motor is running. |

| 1-23 Motor Frequency | | |
|----------------------|----------------|---|
| Range: | Function: | |
| 50. Hz* | [20 - 1000 Hz] | Select the motor frequency value from the motor nameplate data. |

NOTE!

This parameter cannot be adjusted while the motor is running.

| 1-24 Motor Current | | |
|--------------------|---------------------|--|
| Range: | Function: | |
| 7.20 A* | [0.10 - 10000.00 A] | Enter the nominal motor current value from the motor nameplate data. |

| 1-24 Motor Current | | |
|--------------------|-----------|--|
| Range: | Function: | |
| | | This data is used for calculating motor torque, motor thermal protection, etc. |

NOTE!

This parameter cannot be adjusted while the motor is running.

| 1-25 Motor Nominal Speed | | |
|--------------------------|-------------------|--|
| Range: | Function: | |
| 1420. RPM* | [100 - 60000 RPM] | |

NOTE!

This parameter cannot be adjusted while the motor is running.

| 1-29 Automatic Motor Adaptation (AMA) | | |
|---------------------------------------|---------------------|--|
| Option: | Function: | |
| | | The Auto Tune function optimizes dynamic motor performance by automatically optimizing the advanced motor 1-30 Stator Resistance (R_s) to 1-35 Main Reactance (X_h) while the motor is stationary. |
| [0] * | Off | No function |
| [1] | Enable complete AMA | performs Auto Tune 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 Auto Tune 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. |

Activate the Auto Tune function by pressing [Hand] after selecting [1] or [2]. After a normal sequence, the display will read: "Press [OK] to finish Auto Tune". After pressing the [OK] key, the adjustable frequency drive is ready for operation.

NOTE!

- For the best results of the adjustable frequency drive, run Auto Tune on a cold motor
- Auto Tune cannot be performed while the motor is running.

NOTE!

Avoid generating external torque during Auto Tune.

NOTE!

If one of the settings in parameter group P-## Motor Data is changed, 1-30 Stator Resistance (Rs) to 1-39 Motor Poles, the advanced motor parameters will return to default setting.

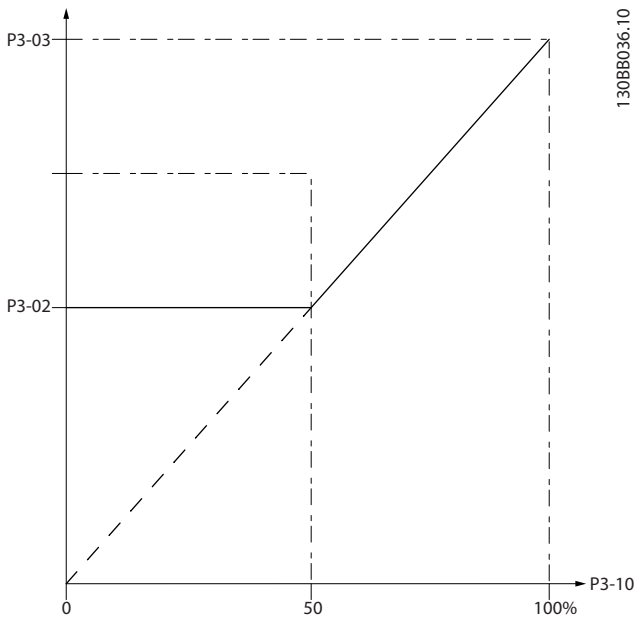
This parameter cannot be adjusted while the motor is running.

NOTE!

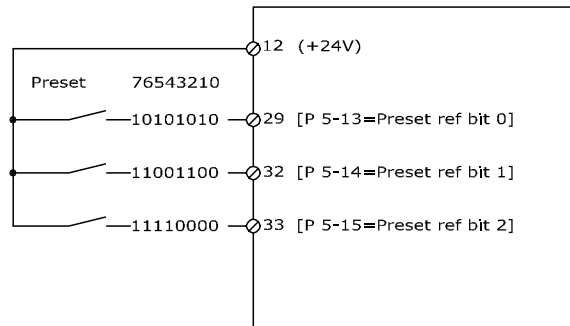
Full Auto Tune should be run without filter only while reduced Auto Tune should be run with filter.

6.2.3 3-0* Reference Limits

| 3-10 Preset Reference | |
|-----------------------|----------------------|
| Array [8] | |
| Range: | Function: |
| 0.00 %* | [-100.00 - 100.00 %] |



130BA149.10



| 3-41 Ramp 1 Ramp-up Time | | |
|--------------------------|--------------------|--|
| Range: | Function: | |
| 10.00 s* | [1.00 - 3600.00 s] | Enter the accel time, i.e., the acceleration time from 0 RPM to 1-25 Motor Nominal Speed. Choose a accel time such that the output current does not exceed the current limit in 4-18 Current Limit during ramping. See decel time in 3-42 Ramp 1 Ramp-down Time. |

$$par. F - 07 = \frac{tacc \times nnorm [par.P - 06]}{ref [rpm]} [s]$$

| 3-42 Ramp 1 Ramp-down Time | | |
|----------------------------|--------------------|--|
| Range: | Function: | |
| 20.00 s* | [1.00 - 3600.00 s] | Enter the decel time, i.e., the deceleration time from 1-25 Motor Nominal Speed to 0 RPM. Choose a decel time such that no overvoltage arises in the inverter due to regenerative operation of the motor, and such that the generated current does not exceed the current limit set in 4-18 Current Limit. See accel time in 3-41 Ramp 1 Ramp-up Time. |

$$par. F - 08 = \frac{tdec \times nnorm [par.P - 06]}{ref [rpm]} [s]$$

| 3-84 Initial Ramp Time | | |
|------------------------|-----------------|--|
| Range: | Function: | |
| 0.00 s* | [0.00- 60.00 s] | Enter the initial ramp-up time from zero speed to Motor Speed Low Limit, 4-11 Motor Speed Low Limit [RPM] or 4-12 Motor Speed Low Limit [Hz]. Submersible deep well pumps can be damaged by running below minimum speed. A fast ramp time below minimum pump speed is recommended. This parameter may be applied as a fast ramp rate from zero speed to Motor Speed Low Limit. |

6

| 3-85 Check Valve Ramp Time | | |
|----------------------------|---|--|
| Range: | Function: | |
| 0.00 s* [0.00–60.00 s] | <p>In order to protect ball check valves in a stop situation, the check valve ramp can be utilized as a slow ramp rate from 4-11 Motor Speed Low Limit [RPM] or 4-12 Motor Speed Low Limit [Hz], to Check Valve Ramp End Speed, set by the user in or . When is different from 0 seconds, the Check Valve Ramp Time is effectuated and will be used to ramp down the speed from Motor Speed Low Limit to the Check Valve End Speed in or ..</p> | |
| | | |

| 3-86 Check Valve Ramp End Speed [RPM] | | |
|---------------------------------------|-----------|--|
| Range: | Function: | |
| | | |

| 3-87 Check Valve Ramp End Speed [Hz] | | |
|--------------------------------------|-----------|--|
| Range: | Function: | |
| | | |

| 3-88 Final Ramp Time | | |
|---------------------------|--|--|
| Range: | Function: | |
| 0.00 s* [0.00–60.00 s] | <p>Enter the Final Ramp Time to be used when ramping down from Motor Speed Low Limit, 4-11 Motor Speed Low Limit [RPM] or 4-12 Motor Speed Low Limit [Hz], to zero speed. Submersible deep well pumps can be damaged by running below minimum speed. A fast ramp time below minimum pump speed is recommended. This parameter may be applied as a fast ramp rate from Motor Speed Low Limit to zero speed.</p> | |
| | | |

6.2.4 Limits and Warnings

Parameter group for configuring limits and warnings.

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

| 4-13 Motor Speed High Limit [RPM] | | |
|---|---|--|
| Range: | Function: | |
| 1500. RPM* [par. 4-11 - 60000. RPM] | Enter the maximum limit for motor speed. The Motor Speed High Limit can be set to correspond to the manufacturer's maximum rated motor. The Motor Speed High Limit must exceed the setting in <i>4-11 Motor Speed Low Limit [RPM]</i> . Only <i>4-11 Motor Speed Low Limit [RPM]</i> or <i>4-12 Motor Speed Low Limit [Hz]</i> will be displayed, depending on other parameters in the main menu, and depending on default settings dependant on global location. | |

NOTE!

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

NOTE!

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

Parameter group for configuring the digital input and output.

| 5-01 Terminal 27 Mode | | |
|-----------------------|-----------|--|
| Option: | Function: | |
| [0] * | Input | Defines terminal 27 as a digital input. |
| [1] | Output | Defines terminal 27 as a digital output. |

6.2.5 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 *term 32, 33 |
| Reset | [1] | All |
| Coast inverse | [2] | All |
| Coast and reset inverse | [3] | All |
| DC brake inverse | [5] | All |
| Stop inverse | [6] | All |
| External interlock | [7] | All |
| Start | [8] | All *term 18 |
| Latched start | [9] | All |
| Reversing | [10] | All *term 19 |
| Start reversing | [11] | All |
| Jog | [14] | All *term 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] | term 29, 33 |
| Ramp bit 0 | [34] | All |
| Mains failure inverse | [36] | All |
| Run Permissive | [52] | |
| Hand start | [53] | |
| Auto start | [54] | |
| 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] | |
| Reset Maintenance Word | [78] | |
| Lead Pump Start | [120] | |
| Lead Pump Alternation | [121] | |
| Pump 1 Interlock | [130] | |
| Pump 2 Interlock | [131] | |
| Pump 3 Interlock | [132] | |

All = Terminals 18, 19, 27, 29, 32, X30/2, X30/3, X30/4. X30/ are the terminals on MCB 101.

Functions dedicated to only one digital input are stated in the associated parameter.

All digital inputs can be programmed to these functions:

| | | |
|-----|-------------------------|---|
| [0] | No operation | No reaction to signals transmitted to terminal. |
| [1] | Reset | Resets adjustable frequency drive after a TRIP/ALARM. Not all alarms can be reset. |
| [2] | Coast inverse | Leaves motor in free mode. Logic '0' => coasting stop. (Default Digital input 27): Coasting stop, inverted input (NC). |
| [3] | Coast and reset inverse | Reset and coasting stop Inverted input (NC). Leaves motor in free mode and resets the adjustable frequency drive. Logic '0' => coasting stop and reset. |
| [5] | DC brake inverse | Inverted input for DC braking (NC). Stops motor by energizing it with a DC current for a certain time period. See 2-01 DC Brake Current to 2-03 DC Brake Cut-in Speed [RPM]. The function is only active when the value in 2-02 DC Braking Time is different from 0. Logic '0' => DC braking. |
| [6] | Stop inverse | Stop Inverted function. Generates a stop function when the selected terminal goes from logical level '1' to '0'. The stop is performed according to the selected ramp time (3-42 Ramp 1 Ramp-down Time and 3-52 Ramp 2 Ramp-down Time). When the adjustable frequency drive is at the torque limit and has received a stop command, it may not stop by itself. To ensure that the adjustable frequency drive stops, configure a digital output to Torque limit & stop [27] and connect this digital output to a digital input that is configured as coast. |
| [7] | External Interlock | Same function as Coasting stop, inverse, but External Interlock generates the alarm message 'external fault' on the display when the terminal which is programmed for Coast Inverse is logic '0'. The alarm message will also be active via digital outputs and relay outputs, if programmed for External Interlock. The alarm can be reset using a digital input or the [RESET] key if the cause for the External Interlock has been removed. A delay can be programmed in 22-00 External Interlock Delay. After applying a signal to the input, the reaction described above will be delayed with the time set in 22-00 External Interlock Delay. |
| [8] | Start | Select start for a start/stop command. Logic '1' = start, logic '0' = stop. (Default Digital input 18) |

| [9] | Latched start | Motor starts, if a pulse is applied for min. 2 ms. Motor stops when Stop inverse is activated | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|-----------------|---------------------|--|-----------------|---|---|---|---------------|---|---|---|---------------|---|---|---|---------------|---|---|---|---------------|---|---|---|---------------|---|---|---|---------------|---|---|---|---------------|---|---|---|---------------|---|---|---|
| [10] | Reversing | Changes direction of motor shaft rotation. Select Logic '1' to reverse. The reversing signal only changes the direction of rotation. It does not activate the start function. Select both directions in 4-10 Motor Speed Direction. (Default Digital input 19). | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| [11] | Start reversing | Used for start/stop and for reversing on the same wire. Signals on start are not allowed at the same time. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| [14] | Jog | Used for activating jog speed. See 3-11 Jog Speed [Hz]. (Default Digital input 29) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| [15] | Preset reference on | Used for shifting between external reference and preset reference. It is assumed that External/preset [1] has been selected in 3-04 Reference Function. Logic '0' = external reference active; logic '1' = one of the eight preset references is active. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| [16] | Preset ref bit 0 | Enables a choice between one of the eight preset references according to the table below. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| [17] | Preset ref bit 1 | Enables a choice between one of the eight preset references according to the table below. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| [18] | Preset ref bit 2 | Enables a choice between one of the eight preset references according to the table below. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | <table border="1"> <thead> <tr> <th>Preset ref. bit</th> <th>2</th> <th>1</th> <th>0</th> </tr> </thead> <tbody> <tr> <td>Preset ref. 0</td> <td>0</td> <td>0</td> <td>0</td> </tr> <tr> <td>Preset ref. 1</td> <td>0</td> <td>0</td> <td>1</td> </tr> <tr> <td>Preset ref. 2</td> <td>0</td> <td>1</td> <td>0</td> </tr> <tr> <td>Preset ref. 3</td> <td>0</td> <td>1</td> <td>1</td> </tr> <tr> <td>Preset ref. 4</td> <td>1</td> <td>0</td> <td>0</td> </tr> <tr> <td>Preset ref. 5</td> <td>1</td> <td>0</td> <td>1</td> </tr> <tr> <td>Preset ref. 6</td> <td>1</td> <td>1</td> <td>0</td> </tr> <tr> <td>Preset ref. 7</td> <td>1</td> <td>1</td> <td>1</td> </tr> </tbody> </table> | Preset ref. bit | 2 | 1 | 0 | Preset ref. 0 | 0 | 0 | 0 | Preset ref. 1 | 0 | 0 | 1 | Preset ref. 2 | 0 | 1 | 0 | Preset ref. 3 | 0 | 1 | 1 | Preset ref. 4 | 1 | 0 | 0 | Preset ref. 5 | 1 | 0 | 1 | Preset ref. 6 | 1 | 1 | 0 | Preset ref. 7 | 1 | 1 | 1 |
| Preset ref. bit | 2 | 1 | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Preset ref. 0 | 0 | 0 | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Preset ref. 1 | 0 | 0 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Preset ref. 2 | 0 | 1 | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Preset ref. 3 | 0 | 1 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Preset ref. 4 | 1 | 0 | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Preset ref. 5 | 1 | 0 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Preset ref. 6 | 1 | 1 | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Preset ref. 7 | 1 | 1 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| [19] | Freeze ref | Freezes actual reference. The frozen reference is now the point of enable/condition for Speed up and Slow to be used. If Speed up/down is used, the speed change always follows ramp 2 (3-51 Ramp 2 Ramp-up Time and 3-52 Ramp 2 Ramp-down Time) in the range 0 - 3-03 Maximum Reference Maximum Reference. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| [20] | Freeze output | Freezes actual motor frequency (Hz). The frozen motor frequency is now the point of enable/condition for Speed up and Slow to be used. If Speed up/down is used, the | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

| | | |
|------|-----------------------|---|
| | | <p>speed change always follows ramp 2 (3-51 <i>Ramp 2 Ramp-up Time</i> and 3-52 <i>Ramp 2 Ramp-down Time</i>) in the range 0 - 1-23 <i>Motor Frequency</i>.</p> <p>When Freeze output is active, the adjustable frequency drive cannot be stopped via a low 'start [13]' signal. Stop the adjustable frequency drive via a terminal programmed for Coasting inverse [2] or Coast and reset, inverse [3].</p> |
| [21] | Speed up | <p>For digital control of the up/down speed is desired (motor potentiometer). Activate this function by selecting either Freeze reference or Freeze output. When Speed up is activated for less than 400 msec. the resulting reference will be increased by 0.1%. If Speed up is activated for more than 400 msec. the resulting reference will ramp according to Ramp 1 in 3-41 <i>Ramp 1 Ramp-up Time</i>.</p> |
| [22] | Slow | Same as Speed up [21]. |
| [23] | Set-up select bit 0 | Selects one of the four set-ups. Set 0-10 <i>Active Set-up to Multi Set-up</i> . |
| [24] | Set-up select bit 1 | Same as Set-up select bit 0 [23]. (Default Digital input 32) |
| [32] | Pulse input | Select Pulse input when using a pulse sequence as either reference or feedback. Scaling is done in par. group 5-5*. |
| [34] | Ramp bit 0 | Select which ramp to use. Logic "0" will select ramp 1 while logic "1" will select ramp 2. |
| [36] | Mains failure inverse | Activates 14-10 <i>Line Failure</i> . Line failure inverse is active in the Logic "0" situation. |
| [52] | Run Permissive | <p>The input terminal, for which the Run permissive has been programmed must be logic "1" before a start command can be accepted. Run permissive has a logic 'AND' function related to the terminal which is programmed for <i>START</i> [8], <i>Jog</i> [14] or <i>Freeze Output</i> [20], which means that in order to start running the motor, both conditions must be fulfilled. If Run Permissive is programmed on multiple terminals, Run permissive needs only be logic '1' on one of the terminals for the function to be carried out. The digital output signal for Run Request (<i>Start</i> [8], <i>Jog</i> [14] or <i>Freeze output</i> [20]) programmed in par. group 5-3* Digital outputs, or par. group 5-4* Relays, will not be affected by Run Permissive.</p> |
| [53] | Hand start | A signal applied will put the adjustable frequency drive into hand mode as if button <i>Hand On</i> on the LCP has been |

| | | |
|------|-----------------------------------|---|
| | | <p>pressed and a normal stop command will be overridden. If disconnecting the signal, the motor will stop. To make any other start commands valid, another digital input must be assigned to <i>Auto-Start</i> and a signal applied to this. The <i>Hand On</i> and <i>Auto On</i> buttons on the LCP has no impact. The <i>Off</i> button on the LCP will override <i>Hand Start</i> and <i>Auto-Start</i>. Press either the <i>Hand On</i> or <i>Auto On</i> button to make <i>Hand Start</i> and <i>Auto-Start</i> active again. If no signal on neither <i>Hand Start</i> nor <i>Auto-Start</i>, the motor will stop regardless of any normal Start command applied. If signal applied to both <i>Hand Start</i> and <i>Auto-Start</i>, the function will be <i>Auto-Start</i>. If pressing the <i>Off</i> button on the LCP, the motor will stop regardless of signals on <i>Hand Start</i> and <i>Auto-Start</i>.</p> |
| [54] | Auto start | A signal applied will put the adjustable frequency drive into auto mode as if the LCP button <i>Auto On</i> has been pressed. See also <i>Hand Start</i> [53] |
| [55] | DigiPot Increase | Uses the input as an INCREASE signal to the Digital Potentiometer function described in parameter group 3-9* |
| [56] | DigiPot Decrease | Uses the input as a DECREASE signal to the Digital Potentiometer function described in parameter group 3-9* |
| [57] | DigiPot Clear | Uses the input to CLEAR the Digital Potentiometer reference described in parameter group 3-9* |
| [60] | Counter A (up) | (Terminal 29 or 33 only) Input for increment counting in the SLC counter. |
| [61] | Counter A (down) | (Terminal 29 or 33 only) Input for decrement counting in the SLC counter. |
| [62] | Reset Counter A | Input for reset of counter A. |
| [63] | Counter B (up) | (Terminal 29 and 33 only) Input for increment counting in the SLC counter. |
| [64] | Counter B (down) | (Terminal 29 and 33 only) Input for decrement counting in the SLC counter. |
| [65] | Reset Counter B | Input for reset of counter B. |
| [66] | Sleep Mode | Forces adjustable frequency drive into sleep mode (see par. group 22-4*, <i>Sleep Mode</i>). Reacts on the rising edge of signal applied! |
| [78] | Reset Preventive Maintenance Word | Resets all data in 16-96 <i>Maintenance Word</i> to 0. |

The setting options below are all related to the cascade controller. Wiring diagrams and settings for parameter, see par. group 25-** for more details.

| [120] | Lead Pump Start | Starts/stops the lead pump (controlled by the adjustable frequency drive). A start requires that also a System Start signal has been applied, e.g., to one of the digital inputs set for <i>Start</i> [8]! | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|-----------------------|--|--|----------------------|----------------------------------|--|--------|---------|-----------------------|--|---|-----------------------|----------------------|----------------------|-----------------------|----------------------|----------------------|-----------------------|----------------------|----------------------|-----------------------|----------------------|----------------------|-----------------------|----------------------|----------------------|-----------------------|----------------------|----------------------|-----------------------|----------------------|----------------------|-----------------------|----------------------|----------------------|
| [121] | Lead Pump Alternation | Forces alternation of the lead pump in a cascade controller. <i>Lead Pump Alternation</i> , <i>25-50 Lead Pump Alternation</i> must be set to either <i>At Command</i> [2] or <i>At Staging or At Command</i> [3]. <i>Alternation Event</i> , <i>25-51 Alternation Event</i> can be set to any of the four options. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| [130 - 138] | Pump1 Interlock - Pump9 Interlock | <p>The function will depend on the setting in <i>25-06 Number Of Pumps</i>. If set to <i>No</i> [0], then Pump1 refers to the pump controlled by relay RELAY1 etc. If set to <i>Yes</i> [1], Pump1 refers to the pump controlled by the adjustable frequency drive only (without any of the built-in relays involved) and Pump2 to the pump controlled by the relay RELAY1. Variable speed pump (lead) cannot be interlocked in the basic cascade controller.</p> <p>See table below:</p> <table border="1" style="margin-left: 20px;"> <thead> <tr> <th rowspan="2">Setting in Par. 5-1*</th> <th colspan="2">Setting in 25-06 Number Of Pumps</th> </tr> <tr> <th>[0] No</th> <th>[1] Yes</th> </tr> </thead> <tbody> <tr> <td>[130] Pump1 Interlock</td> <td>Controlled by RELAY1 (only if not lead pump)</td> <td>Adjustable frequency drive controlled (cannot be interlocked)</td> </tr> <tr> <td>[131] Pump2 Interlock</td> <td>Controlled by RELAY2</td> <td>Controlled by RELAY1</td> </tr> <tr> <td>[132] Pump3 Interlock</td> <td>Controlled by RELAY3</td> <td>Controlled by RELAY2</td> </tr> <tr> <td>[133] Pump4 Interlock</td> <td>Controlled by RELAY4</td> <td>Controlled by RELAY3</td> </tr> <tr> <td>[134] Pump5 Interlock</td> <td>Controlled by RELAY5</td> <td>Controlled by RELAY4</td> </tr> <tr> <td>[135] Pump6 Interlock</td> <td>Controlled by RELAY6</td> <td>Controlled by RELAY5</td> </tr> <tr> <td>[136] Pump7 Interlock</td> <td>Controlled by RELAY7</td> <td>Controlled by RELAY6</td> </tr> <tr> <td>[137] Pump8 Interlock</td> <td>Controlled by RELAY8</td> <td>Controlled by RELAY7</td> </tr> <tr> <td>[138] Pump9 Interlock</td> <td>Controlled by RELAY9</td> <td>Controlled by RELAY8</td> </tr> </tbody> </table> | Setting in Par. 5-1* | Setting in 25-06 Number Of Pumps | | [0] No | [1] Yes | [130] Pump1 Interlock | Controlled by RELAY1 (only if not lead pump) | Adjustable frequency drive controlled (cannot be interlocked) | [131] Pump2 Interlock | Controlled by RELAY2 | Controlled by RELAY1 | [132] Pump3 Interlock | Controlled by RELAY3 | Controlled by RELAY2 | [133] Pump4 Interlock | Controlled by RELAY4 | Controlled by RELAY3 | [134] Pump5 Interlock | Controlled by RELAY5 | Controlled by RELAY4 | [135] Pump6 Interlock | Controlled by RELAY6 | Controlled by RELAY5 | [136] Pump7 Interlock | Controlled by RELAY7 | Controlled by RELAY6 | [137] Pump8 Interlock | Controlled by RELAY8 | Controlled by RELAY7 | [138] Pump9 Interlock | Controlled by RELAY9 | Controlled by RELAY8 |
| Setting in Par. 5-1* | Setting in 25-06 Number Of Pumps | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | [0] No | [1] Yes | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| [130] Pump1 Interlock | Controlled by RELAY1 (only if not lead pump) | Adjustable frequency drive controlled (cannot be interlocked) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| [131] Pump2 Interlock | Controlled by RELAY2 | Controlled by RELAY1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| [132] Pump3 Interlock | Controlled by RELAY3 | Controlled by RELAY2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| [133] Pump4 Interlock | Controlled by RELAY4 | Controlled by RELAY3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| [134] Pump5 Interlock | Controlled by RELAY5 | Controlled by RELAY4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| [135] Pump6 Interlock | Controlled by RELAY6 | Controlled by RELAY5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| [136] Pump7 Interlock | Controlled by RELAY7 | Controlled by RELAY6 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| [137] Pump8 Interlock | Controlled by RELAY8 | Controlled by RELAY7 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| [138] Pump9 Interlock | Controlled by RELAY9 | Controlled by RELAY8 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

| 5-13 Terminal 29 Digital Input | | |
|---|----------------------|--|
| Option: | | Function: |
| [0] * | No Operation | Same options and functions as parameter group 5-1* <i>Digital Inputs</i> . |
| E-05 Terminal 32 Digital Input | | |
| Option: | | Function: |
| [0] * | No Operation | Same options and functions as parameter group E-0# and E-5# <i>Digital Inputs</i> , except for <i>Pulse input</i> . |
| E-06 Terminal 33 Digital Input | | |
| Option: | | Function: |
| [0] * | No Operation | Same options and functions as parameter group E-0# and E-5# <i>Digital Inputs</i> . |
| 5-30 Terminal 27 Digital Output | | |
| Same options and functions as parameter group 5-3*. | | |
| Option: | | Function: |
| [0] * | No operation | |
| 5-40 Function Relay | | |
| Option: | | Function: |
| | | Select options to define the function of the relays. The selection of each mechanical relay is realized in an array parameter. |
| [0] * | No operation | |
| [1] | Control ready | |
| [2] | Drive ready | |
| [3] | Drive rdy/rem ctrl | |
| [4] | Enable / no warning | |
| [5] | VLT running | |
| [6] | Running / no warning | |
| [7] | Run in range/no warn | |
| [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 | |
| [19] | Below feedback, low | |
| [20] | Above feedback, high | |
| [21] | Thermal warning | |
| [22] | Ready,no thermal W | |
| [23] | Remote,ready,no TW | |

| 5-40 Function Relay | |
|---------------------|------------------------|
| Option: | Function: |
| [24] | Ready, voltage OK |
| [25] | Reverse |
| [26] | Bus OK |
| [27] | Torque limit stop |
| [28] | Brake: No Brake War |
| [29] | Brake ready, no fault |
| [30] | Brake fault (IGBT) |
| [31] | Relay 123 |
| [32] | Mech brake ctrl |
| [33] | Safe stop active |
| [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 |
| [51] | MCO controlled |
| [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 |
| [120] | Local ref active |
| [121] | Remote ref active |
| [122] | No alarm |
| [123] | Start command activ |
| [124] | Running reverse |
| [125] | Drive in hand mode |
| [126] | Drive in auto mode |

| 5-53 Term. 29 High Ref./Feedb. Value | | |
|--------------------------------------|--------------------------------|--|
| Range: | Function: | |
| 100.000 N/A* | [-999999.999 - 999999.999 N/A] | Enter the high reference value [RPM] for the motor shaft speed and the high feedback value, see also 5-58 Term. 33 High Ref./Feedb. Value. |

6.2.6 AN-## Analog In/Out

Parameter group for configuring the analog input and output.

| 6-00 Live Zero Timeout Time | | |
|-----------------------------|------------|--|
| Range: | Function: | |
| 10 s* | [1 - 99 s] | Enter the Live Zero Timeout time period. Live Zero Timeout Time is active for analog inputs, 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 6-10 Terminal 53 Low Voltage, 6-12 Terminal 53 Low Current, 6-20 Terminal 54 Low Voltage or 6-22 Terminal 54 Low Current for a time period longer than the time set in 6-00 Live Zero Timeout Time, the function selected in 6-01 Live Zero Timeout Function will be activated. |

| 6-01 Live Zero Timeout Function | | |
|---------------------------------|--|--|
| Option: | Function: | |
| | Select the timeout function. The function set in 6-01 Live Zero Timeout Function will be activated if the input signal on terminal 53 or 54 is below 50% of the value in 6-10 Terminal 53 Low Voltage, 6-12 Terminal 53 Low Current, 6-20 Terminal 54 Low Voltage or 6-22 Terminal 54 Low Current for a time period defined in 6-00 Live Zero Timeout Time. If several timeouts occur simultaneously, the adjustable frequency drive prioritizes the timeout functions as follows: <ol style="list-style-type: none"> 6-01 Live Zero Timeout Function 8-04 Control Timeout Function The output frequency of the adjustable frequency drive can be: <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 | |

| 6-10 Terminal 53 Low Voltage | | |
|------------------------------|----------------------|---|
| Range: | Function: | |
| 0.07 V* | [0.00 - par. 6-11 V] | Enter the low voltage value. This analog input scaling value should correspond to the low reference/feedback value set in 6-14 Terminal 53 Low Ref./Feedb. Value. |

| 6-11 Terminal 53 High Voltage | | |
|-------------------------------|-----------------------|--|
| Range: | Function: | |
| 10.00 V* | [par. 6-10 - 10.00 V] | Enter the high voltage value. This analog input scaling value should correspond to the high reference/feedback value set in 6-15 Terminal 53 High Ref./Feedb. Value. |

| 6-14 Terminal 53 Low Ref./Feedb. Value | | |
|--|--------------------------------|--|
| Range: | Function: | |
| 0.000 N/A* | [-999999.999 - 999999.999 N/A] | Enter the analog input scaling value that corresponds to the low voltage/low current set in 6-10 Terminal 53 Low Voltage and 6-12 Terminal 53 Low Current. |

| 6-15 Terminal 53 High Ref./Feedb. Value | | |
|---|--------------------------------|--|
| Range: | Function: | |
| 50.000 N/A* | [-999999.999 - 999999.999 N/A] | Enter the analog input scaling value that corresponds to the high voltage/high current value set in 6-11 Terminal 53 High Voltage and 6-13 Terminal 53 High Current. |

| 6-20 Terminal 54 Low Voltage | | |
|------------------------------|----------------------|--|
| Range: | Function: | |
| 0.07 V* | [0.00 - par. 6-21 V] | Enter the low voltage value. This analog input scaling value should correspond to the low reference/feedback value, set in 6-24 Terminal 54 Low Ref./Feedb. Value. |

| 6-21 Terminal 54 High Voltage | | |
|-------------------------------|-----------------------|--|
| Range: | Function: | |
| 10.00 V* | [par. 6-20 - 10.00 V] | Enter the high voltage value. This analog input scaling value should correspond to the high reference/feedback value set in 6-25 Terminal 54 High Ref./Feedb. Value. |

| 6-24 Terminal 54 Low Ref./Feedb. Value | | |
|--|--------------------------------|--|
| Range: | Function: | |
| 0.000 N/A* | [-999999.999 - 999999.999 N/A] | Enter the analog input scaling value that corresponds to the low voltage/low current value set in 6-20 Terminal 54 Low Voltage and 6-22 Terminal 54 Low Current. |

| 6-25 Terminal 54 High Ref./Feedb. Value | | |
|---|--------------------------------|--|
| Range: | Function: | |
| 100.000 N/A* | [-999999.999 - 999999.999 N/A] | Enter the analog input scaling value that corresponds to the high voltage/high current value set in 6-21 Terminal 54 High Voltage and 6-23 Terminal 54 High Current. |

| 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 frequency | 0–100 Hz, (0–20 mA) |
| [101] | Reference | Minimum reference - Maximum reference, (0–20 mA) |
| [102] | Feedback | -200% to +200% of 20-14 Maximum Reference/Feedb., (0–20 mA) |
| [103] | Motor current | 0 - Inverter Max. Current (16-37 Inv. Max. Current), (0–20 mA) |
| [104] | Torque rel to limit | 0 - Torque limit (4-16 Torque Limit Motor Mode), (0–20 mA) |
| [105] | Torq relate to rated | 0 - Motor rated torque, (0–20 mA) |
| [106] | Power | 0 - Motor rated power, (0–20 mA) |
| [107] * | Speed | 0 - Speed High Limit (4-13 Motor Speed High Limit [RPM] and 4-14 Motor Speed High Limit [Hz]), (0–20 mA) |
| [113] | Ext. Closed-loop 1 | 0–100%, (0–20 mA) |
| [114] | Ext. Closed-loop 2 | 0–100%, (0–20 mA) |
| [115] | Ext. Closed-loop 3 | 0–100%, (0–20 mA) |
| [130] | Output freq. 4-20mA | 0–100 Hz |
| [131] | Reference 4-20mA | Minimum Reference - Maximum Reference |
| [132] | Feedback 4-20mA | -200% to +200% of 20-14 Maximum Reference/Feedb. |
| [133] | Motor cur. 4-20mA | 0 - Inverter Max. Current (16-37 Inv. Max. Current) |
| [134] | Torq.% lim 4-20 mA | 0 - Torque limit (4-16 Torque Limit Motor Mode) |
| [135] | Torq.% nom 4-20 mA | 0 - Motor rated torque |
| [136] | Power 4-20mA | 0 - Motor rated power |
| [137] | Speed 4-20mA | 0 - Speed High Limit (F-17 and F-15) |
| [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 4-20mA t.o. | 0 - 100% |

| 6-50 Terminal 42 Output | | |
|-------------------------|----------------------------|----------|
| Option: | Function: | |
| [143] | Ext. Closed-loop 1 4-20 mA | 0 - 100% |
| [144] | Ext. Closed-loop 2 4-20 mA | 0 - 100% |
| [145] | Ext. Closed-loop 3 4-20 mA | 0 - 100% |

NOTE!

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

| 6-51 Terminal 42 Output Min Scale | | |
|-----------------------------------|-------------------|--|
| Range: | Function: | |
| 0.00 %* | [0.00 - 200.00 %] | |

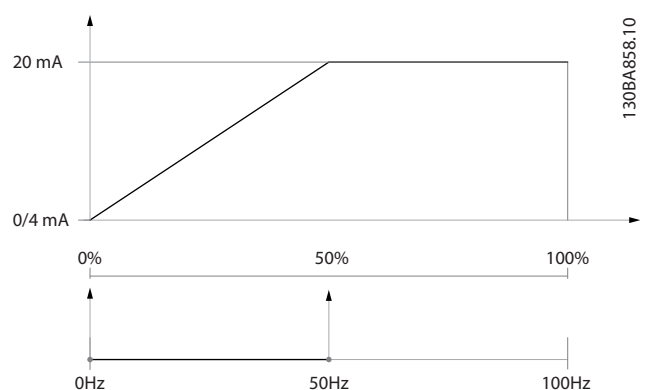
| 6-52 Terminal 42 Output Max Scale | | |
|-----------------------------------|-------------------|--|
| Range: | Function: | |
| 100.00 %* | [0.00 - 200.00 %] | |

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

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

EXAMPLE 1:

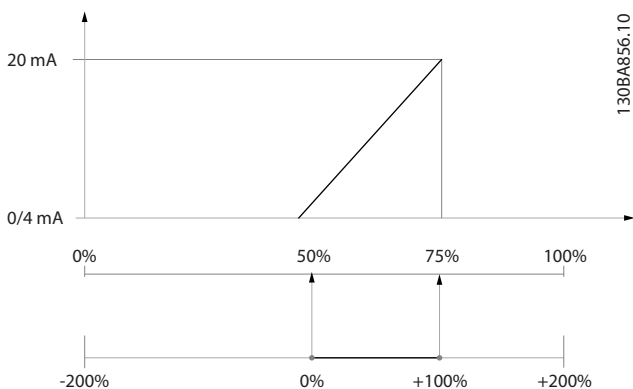
Variable value= OUTPUT FREQUENCY, range = 0–100 Hz
 Range needed for output = 0–50 Hz
 Output signal 0 or 4 mA is needed at 0 Hz (0% of range) - set 6-51 Terminal 42 Output Min Scale to 0%
 Output signal 20 mA is needed at 50 Hz (50% of range) - set 6-52 Terminal 42 Output Max Scale to 50%



EXAMPLE 2:

Variable= FEEDBACK, range= -200% to +200%
 Range needed for output= 0–100%

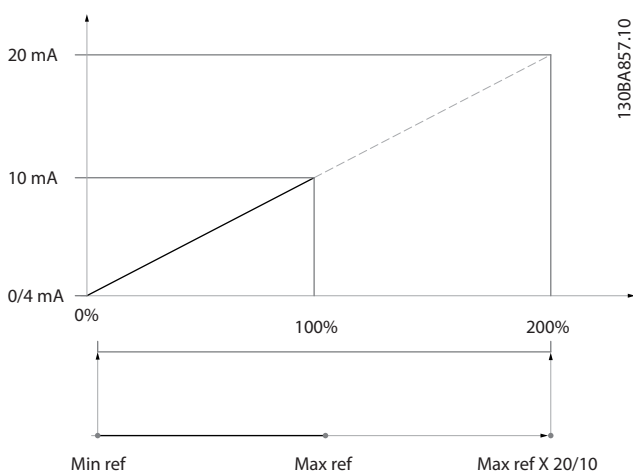
Output signal 0 or 4 mA is needed at 0% (50% of range) - set 6-51 Terminal 42 Output Min Scale to 50%
 Output signal 20 mA is needed at 100% (75% of range) - set 6-52 Terminal 42 Output Max Scale to 75%



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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 6-51 Terminal 42 Output Min Scale to 0%
 Output signal 10 mA is needed at Max ref (100% of range) - set 6-52 Terminal 42 Output Max Scale to 200% (20 mA / 10 mA x 100%=200%).



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6.2.7 Drive Closed-loop, 20-**

This parameter group is used for configuring the closed-loop PID controller that controls the output frequency of the adjustable frequency drive.

| 20-12 Reference/Feedback Unit | |
|-------------------------------|-----------|
| Option: | Function: |

| 20-21 Setpoint 1 | | |
|--|---|---|
| Range: | Function: | |
| 0.000 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 20-20 Feedback Function. |
| <p>NOTE! Setpoint reference entered here is added to any other references that are enabled (see par. C-30 and par. C-34).</p> | | |

| 20-81 PID Normal/ Inverse Control | | |
|-----------------------------------|-----------|---|
| Option: | Function: | |
| [0] * | Normal | |
| [1] | Inverse | <p><i>Normal</i> [0] causes the adjustable frequency drive's output frequency to decrease when the feedback is greater than the setpoint reference. This is common for pressure-controlled supply fan and pump applications.</p> <p><i>Inverse</i> [1] causes the adjustable frequency drive's output frequency to increase when the feedback is greater than the setpoint reference.</p> |

| 20-82 PID Start Speed [RPM] | | |
|-----------------------------|---------------------|---|
| Range: | Function: | |
| 0 RPM* | [0 - par. 4-13 RPM] | <p>When the adjustable frequency drive is first started, it initially ramps up to this output speed in open-loop mode, following the active ramp-up time. When the output speed programmed here is reached, the adjustable frequency drive will automatically switch to closed-loop mode and the PID controller will begin to function. This is useful in applications in which the driven load must first quickly accelerate to a minimum speed when it is started.</p> <p>NOTE! This parameter will only be visible if 0-02 Motor Speed Unit is set to [0], RPM.</p> |

| 20-93 PID Proportional Gain | | |
|-----------------------------|--------------------|--|
| Range: | Function: | |
| 0.50 N/A* | [0.00 - 10.00 N/A] | |

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

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

| 20-94 PID Integral Time | | |
|-------------------------|---------------------------|--|
| Range: | Function: | |
| 20.00 s* | [0.01 - 10000.00 s] | Over time, the integrator accumulates a contribution to the output from the PID controller as long as there is a deviation between the reference/setpoint and feedback signals. The contribution is proportional to the size of the deviation. This ensures that the deviation (error) approaches zero. Quick response on any deviation is obtained when the integral time is set to a low value. Setting it too low, however, may cause the control to become unstable. The value set is the time needed for the integrator to add the same contribution as the proportional part for a certain deviation. If the value is set to 10,000, the controller will act as a pure proportional controller with a P-band based on the value set in 20-93 <i>PID Proportional Gain</i> . When no deviation is present, the output from the proportional controller will be 0. |

6.2.8 22-** Miscellaneous

This group contains parameters used for monitoring water/wastewater applications.

| 22-20 Low Power Auto Set-up | | |
|--|---|--|
| Start of auto set-up of power data for No-Flow Power tuning. | | |
| Option: | Function: | |
| [0] * OFF | | |
| [1] Enabled | When set for <i>Enabled</i> , an auto set-up sequence is activated, automatically setting speed to approx. 50% and 85% of rated motor speed (4-13 <i>Motor Speed High Limit [RPM]</i> , 4-14 <i>Motor Speed High Limit [Hz]</i>). At those two speeds, the power consumption is automatically measured and stored. Before enabling Auto Set-up: | |

22-20 Low Power Auto Set-up

Start of auto set-up of power data for No-Flow Power tuning.

| Option: | Function: | |
|---------|--|--|
| | 1. Close valve(s) in order to create a no-flow condition | |
| | 2. The adjustable frequency drive must be set for open-loop (1-00 <i>Configuration Mode</i>). Note that it is important also to set 1-03 <i>Torque Characteristics</i> . | |

NOTE!

Auto set-up must be done when the system has reached normal operating temperature!

NOTE!

It is important that the 4-13 *Motor Speed High Limit [RPM]* or 4-14 *Motor Speed High Limit [Hz]* is set to the max. operational speed of the motor!

It is important to do the auto set-up before configuring the integrated PI controller as settings will be reset when changing from closed to open-loop in 1-00 *Configuration Mode*.

NOTE!

Carry out the tuning with the same settings in 1-03 *Torque Characteristics*, as for operation after the tuning.

22-21 Low Power Detection

| Option: | Function: | |
|----------------|---|--|
| [0] * Disabled | | |
| [1] Enabled | If selecting Enabled, the low power detection commissioning must be carried out in order to set the parameters in group AP-3# for proper operation! | |

22-22 Low Speed Detection

| Option: | Function: | |
|----------------|---|--|
| [0] * Disabled | | |
| [1] Enabled | Select Enabled for detecting when the motor operates with a speed as set in 4-11 <i>Motor Speed Low Limit [RPM]</i> or 4-12 <i>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 | The drive will not respond to a No Flow condition. | |
| [1] | Sleep Mode | The drive will enter sleep mode and stop when a No Flow condition is detected. See parameter group AP-4# for programming options for sleep mode. |
| [2] | Warning | The drive will continue to run, but activate a No-Flow Warning [W92]. A drive digital output or a serial communication bus can communicate a warning to other equipment. |
| [3] | Alarm | The drive will stop running and activate a No-Flow Alarm [A 92]. A drive digital output or a serial communication bus can communicate an alarm to other equipment. |

NOTE!

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

NOTE!

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

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

| 22-26 Dry Pump Function | | |
|---|-----------|---|
| Select desired action for dry pump operation. | | |
| Option: | Function: | |
| [0] * OFF | | |
| [1] | Warning | The drive will continue to run, but activate a dry pump warning [W93]. A drive digital output or a serial communication bus can communicate a warning to other equipment. |
| [2] | Alarm | The drive will stop running and activate a dry pump alarm [A93]. A drive digital output or a |

| 22-26 Dry Pump Function | | |
|---|-----------|---|
| Select desired action for dry pump operation. | | |
| Option: | Function: | |
| | | serial communication bus can communicate an alarm to other equipment. |

NOTE!

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

NOTE!

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

NOTE!

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

| 22-27 Dry Pump Delay | | |
|----------------------|-------------|---|
| Range: | Function: | |
| 10 s* | [0 - 600 s] | Defines for how long the Dry Pump condition must be active before activating Warning or Alarm |

| 22-30 No-Flow Power | | |
|---------------------|------------------|--|
| Range: | Function: | |
| 0.00 kW* | [0.00 - 0.00 kW] | Readout of calculated no-flow power at actual speed. If power drops to the display value, the adjustable frequency drive will consider the condition as a no-flow situation. |

| 22-31 Power Correction Factor | | |
|-------------------------------|-------------|---|
| Range: | Function: | |
| 100 %* | [1 - 400 %] | Make corrections to the calculated power at 22-30 No-Flow Power. If No Flow is detected when it should not be detected, the setting should be decreased. However, if No Flow is not detected when it should be detected, the setting should be increased to above 100%. |

| 22-32 Low Speed [RPM] | | |
|-----------------------|-------------------------|---|
| Range: | Function: | |
| 0 RPM* | [0 - par. 22-36 RPM] | To be used if <i>0-02 Motor Speed Unit</i> has been set for RPM (parameter not visible if Hz selected). Set used speed to the 50% level. This function is used for storing values needed to tune No-Flow Detection. |

| 22-33 Low Speed [Hz] | | |
|----------------------|--------------------------|--|
| Range: | Function: | |
| 0 Hz* | [0.0 - par. 22-37 Hz] | To be used if <i>0-02 Motor Speed Unit</i> has been set for Hz (parameter not visible if RPM selected). Set used speed to the 50% level. The function is used for storing values needed to tune No-Flow Detection. |

| 22-34 Low Speed Power [kW] | | |
|----------------------------|---------------------|--|
| Range: | Function: | |
| 0 kW* | [0.00 - 0.00 kW] | To be used if <i>0-03 Regional Settings</i> has been set for International (parameter not visible if North America selected). Set power consumption to 50% speed level. This function is used for storing values needed to tune No-Flow Detection. |

| 22-35 Low Speed Power [HP] | | |
|----------------------------|---------------------|--|
| Range: | Function: | |
| 0 hp* | [0.00 - 0.00 hp] | To be used if <i>0-03 Regional Settings</i> has been set for North America (parameter not visible if International selected). Set power consumption to 50% speed level. This function is used for storing values needed to tune No-Flow Detection. |

| 22-36 High Speed [RPM] | | |
|------------------------|------------------------|---|
| Range: | Function: | |
| 0 RPM* | [0 - par. 4-13 RPM] | To be used if <i>0-02 Motor Speed Unit</i> has been set for RPM (parameter not visible if Hz selected). Set used speed for the 85% level. The function is used for storing values needed to tune No-Flow Detection. |

| 22-37 High Speed [Hz] | | |
|-----------------------|-------------------------|--|
| Range: | Function: | |
| 0.0 Hz* | [0.0 - par. 4-14 Hz] | To be used if <i>0-02 Motor Speed Unit</i> has been set for Hz (parameter not visible if RPM selected). Set used speed for the 85% level. |

| 22-37 High Speed [Hz] | | |
|-----------------------|-----------|---|
| Range: | Function: | |
| | | The function is used for storing values needed to tune No-Flow Detection. |

| 22-38 High Speed Power [kW] | | |
|-----------------------------|---------------------|--|
| Range: | Function: | |
| 0 kW* | [0.00 - 0.00 kW] | To be used if <i>0-03 Regional Settings</i> has been set for International (parameter not visible if North America selected). Set power consumption to 85% speed level. This function is used for storing values needed to tune No-Flow Detection. |

| 22-39 High Speed Power [HP] | | |
|-----------------------------|---------------------|--|
| Range: | Function: | |
| 0 hp* | [0.00 - 0.00 hp] | To be used if <i>0-03 Regional Settings</i> has been set for North America (parameter not visible if International selected). Set power consumption to 85% speed level. This function is used for storing values needed to tune No-Flow Detection. |

| 22-40 Minimum Run Time | | |
|------------------------|-------------|--|
| Range: | Function: | |
| 10 s* | [0 - 600 s] | |

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

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

| 22-43 Wake-up Speed [Hz] | | |
|--------------------------|----------------------------|---|
| Range: | Function: | |
| 0 Hz* | [par. 4-12 - par. 4-14 Hz] | To be used if <i>0-02 Motor Speed Unit</i> has been set for Hz (parameter not visible if RPM selected). Only to be used if <i>1-00 Configuration Mode</i> is set for open-loop and speed reference is applied by an external controller controlling the pressure. Set the reference speed at which sleep mode should be canceled. |

| 22-44 Wake-up Ref./FB Difference | | |
|----------------------------------|-----------|---|
| Range: | Function: | |
| 10%* | [0–100%] | Only to be used if <i>1-00 Configuration Mode</i> is set for closed-loop and the integrated PI controller is used for controlling the pressure. Set the pressure drop allowed in percentage of setpoint for the pressure (Pset) before canceling sleep mode. NOTE! If used in an application where the integrated PI controller is set for inverse control in <i>20-71 Tuning Mode</i> , the value set in <i>22-44 Wake-up Ref./FB Difference</i> will automatically be added. |

| 22-45 Setpoint Boost | | |
|----------------------|----------------|---|
| Range: | Function: | |
| 0 %* | [-100 - 100 %] | Only to be used if <i>1-00 Configuration Mode</i> , is set for closed-loop and the integrated PI controller is used. For example, in systems with constant pressure control, it is advantageous to increase the system pressure before the motor is stopped. This will extend the time during which the motor is stopped and help to avoid frequent start/stop. Set the desired overpressure/temperature as a percentage of the setpoint for the pressure (Pset)/temperature before entering sleep mode. If set at 5%, the boost pressure will be $Pset * 1.05$. The negative values can be used, for example, for cooling tower control, where a negative change is needed. |

| 22-46 Maximum Boost Time | | |
|--------------------------|-------------|---|
| Range: | Function: | |
| 60 s* | [0 - 600 s] | Only to be used if <i>1-00 Configuration Mode</i> is set for closed-loop and the integrated PI controller is used for controlling the pressure. Set the maximum time for which boost mode will be allowed. If the set time is exceeded, |

| 22-46 Maximum Boost Time | | |
|--------------------------|-----------|--|
| Range: | Function: | |
| | | sleep mode will be entered and will not wait for the set boost pressure to be reached. |

| 22-50 End of Curve Function | | |
|-----------------------------|-----------|---|
| Option: | Function: | |
| [0] * | OFF | End of Curve monitoring not active. |
| [1] | Warning | The drive will continue to run, but activate a End of Curve warning [W94]. A drive digital output or a serial communication bus can communicate a warning to other equipment. |
| [2] | Alarm | The drive will stop running and activate a End of Curve alarm [A 94]. A drive digital output or a serial communication bus can communicate an alarm to other equipment. |

NOTE!

Automatic restart will reset the alarm and start the system again.

NOTE!

Do not set *14-20 Reset Mode*, to [13] Infinite auto reset, when *22-50 End of Curve Function* is set to [2] Alarm. Doing so will cause the drive to continuously cycle between running and stopping when a End of Curve condition is detected.

NOTE!

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

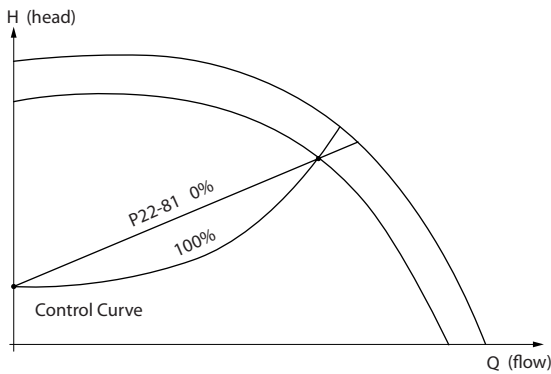
| 22-51 End of Curve Delay | | |
|--------------------------|-------------|---|
| Range: | Function: | |
| 10 s* | [0 - 600 s] | When an end of curve condition is detected, a timer is activated. When the time set in this parameter expires and the End of Curve condition has been steady in the entire period, the function set in <i>22-50 End of Curve Function</i> will be activated. If the condition disappears before the timer expires, the timer will be reset. |

| 22-80 Flow Compensation | | |
|-------------------------|-----------|--|
| Option: | Function: | |
| [0] * | Disabled | [0] <i>Disabled:</i> Setpoint compensation not active. |
| [1] | Enabled | [1] <i>Enabled:</i> Setpoint compensation is active. Enabling this parameter allows the Flow Compensated Setpoint operation. |

| 22-81 Square-linear Curve Approximation | | |
|---|-------------|--|
| Range: | Function: | |
| 100 %* | [0 - 100 %] | |

NOTE!

Not visible when running in cascade.



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| 22-82 Work Point Calculation | |
|------------------------------|--|
| Option: | Function: |
| | <p>Example 1: Speed at system design working point is known:</p> <p>From the data sheet showing characteristics for the specific equipment at different speeds, simply reading across from the H_{DESIGN} point and the Q_{DESIGN} point allows us to find point A, which is the system design working point. The pump characteristics at this point should be identified and the associated speed programmed. Closing the valves and adjusting the speed until H_{MIN} has been achieved allows the speed at the no flow point to be identified. Adjustment of 22-81 Square-linear Curve Approximation then allows the shape of the control curve to be adjusted infinitely.</p> |

| 22-82 Work Point Calculation | |
|------------------------------|---|
| Option: | Function: |
| | <p>Example 2: Speed at system design working point is not known: Where the speed at system design working point is unknown, another reference point on the control curve needs to be determined by means of the data sheet. By looking at the curve for the rated speed and plotting the design pressure (H_{DESIGN}, Point C), the flow at that pressure Q_{RATED} can be determined. Similarly, by plotting the design flow (Q_{DESIGN}, Point D), the pressure H_D at that flow can be determined. Knowing these two points on the pump curve, along with H_{MIN} described above, allows the adjustable frequency drive to calculate the reference point B and thus to plot the control curve that will also include the system design working point A.</p> |
| [0] | <p>Disabled <i>Disabled</i> [0]: Work point calculation is not active. To be used if speed at design point is known (see table above).</p> |
| [1] | <p>Enabled <i>Enabled</i> [1]: Work point calculation is active. Enabling this parameter allows the calculation of the unknown System Design Working Point at 50/60 Hz speed, from the input data set in 22-83 Speed at No-Flow [RPM], 22-84 Speed at No-Flow [Hz], 22-87 Pressure at No-Flow Speed, 22-88 Pressure at Rated Speed, 22-89 Flow at Design Point and 22-90 Flow at Rated Speed.</p> |

| 22-84 Speed at No-Flow [Hz] | | |
|-----------------------------|-----------------------|--|
| Range: | Function: | |
| 50.0 Hz* | [0.0 - par. 22-86 Hz] | Resolution 0.033 Hz. The speed of the motor at which flow has effectively stopped and minimum pressure H_{MIN} is achieved should be entered here in Hz. Alternatively, the speed in RPM can be entered in 22-83 Speed at No-Flow [RPM]. If it has been decided to use Hz in 0-02 Motor Speed Unit, then 22-86 Speed at Design Point [Hz] should also be used. Closing the valves and reducing the speed until minimum pressure H_{MIN} is achieved will determine this value. |

| 22-85 Speed at Design Point [RPM] | | |
|-----------------------------------|------------------------------|---|
| Range: | Function: | |
| 1500. RPM* | [par. 22-83 - 60000. RPM] | Resolution 1 RPM. Only visible when 22-82 <i>Work Point Calculation</i> is set to <i>Disable</i> . The speed of the motor at which the system design working point is achieved should be entered here in RPM. Alternatively, the speed in Hz can be entered in 22-86 <i>Speed at Design Point [Hz]</i> . If it has been decided to use RPM in 0-02 <i>Motor Speed Unit</i> , then 22-83 <i>Speed at No-Flow [RPM]</i> should also be used. |

| 22-86 Speed at Design Point [Hz] | | |
|----------------------------------|--------------------------------|--|
| Range: | Function: | |
| 50/60.0 Hz* | [par. 22-84 - par. 4-19 Hz] | Resolution 0.033 Hz. Only visible when 22-82 <i>Work Point Calculation</i> is set to <i>Disable</i> . The speed of the motor at which the system design working point is achieved should be entered here in Hz. Alternatively, the speed in RPM can be entered in 22-85 <i>Speed at Design Point [RPM]</i> . If it has been decided to use Hz in 0-02 <i>Motor Speed Unit</i> , then 22-83 <i>Speed at No-Flow [RPM]</i> should also be used. |

| 22-87 Pressure at No-Flow Speed | | |
|---------------------------------|--------------------------|---|
| Range: | Function: | |
| 0.000 N/A* | [0.000 - par. 22-88 N/A] | Enter the pressure H_{MIN} corresponding to Speed at No Flow in Reference/Feedback Units. |

Please also see 22-82 *Work Point Calculation* point D.

| 22-88 Pressure at Rated Speed | | |
|-------------------------------|-------------------------------|--|
| Range: | Function: | |
| 999999.999 N/A* | [par. 22-87 - 999999.999 N/A] | Enter the value corresponding to the Pressure at Rated Speed, in Reference/Feedback Units. This value can be defined using the pump datasheet. |

| 22-83 Speed at No-Flow [RPM] | | |
|------------------------------|-------------------------|---|
| Range: | Function: | |
| 300. RPM* | [0 - par. 22-85 RPM] | Resolution 1 RPM. The speed of the motor at which the flow is zero and the minimum pressure H_{MIN} is |

| 22-83 Speed at No-Flow [RPM] | | |
|------------------------------|-----------|--|
| Range: | Function: | |
| | | achieved should be entered here in RPM. Alternatively, the speed in Hz can be entered in 22-84 <i>Speed at No-Flow [Hz]</i> . If it has been decided to use RPM in 0-02 <i>Motor Speed Unit</i> , then 22-85 <i>Speed at Design Point [RPM]</i> should also be used. Closing the valves and reducing the speed until minimum pressure H_{MIN} is achieved will determine this value. |

Please also see 22-82 *Work Point Calculation* point C.

| 22-90 Flow at Rated Speed | | |
|---------------------------|--------------------------|---|
| Range: | Function: | |
| 0.000 N/A* | [0.000 - 999999.999 N/A] | Enter the value corresponding to Flow at Rated Speed. This value can be defined using the pump datasheet. |

6.2.9 T-0#

Use *Timed Actions* for actions needing to be performed on a daily or weekly basis, e.g., different references for working hours / non-working hours. Up to 10 Timed Actions can be programmed in the adjustable frequency drive. The Timed Action number is selected from the list when entering parameter group T-0# from the LCP. 23-00 *ON Time* – 23-04 *Occurrence* then refer to the selected Timed Action number. Each Timed Action is divided into an ON time and an OFF time, in which two different actions may be performed.

The clock control (parameter group K-7* *Clock Settings*) of Timed Actions can be overridden from *Timed Actions Auto* (clock controlled) to *Timed Actions Disabled*, *Constant OFF Actions* or *Constant ON Actions* either in T-08 *Timed Actions Mode* or with commands applied to the digital inputs ([68] *Timed Actions Disabled*, [69] *Constant OFF Actions* or [70] *Constant ON Actions*, in parameter group E-0* *Digital Inputs*).

Display lines 2 and 3 in the LCP show the status for Timed Actions Mode (0-23 *Display Line 2 Large* and 0-24 *Display Line 3 Large*, setting).

NOTE!

A change in mode via the digital inputs can only take place if *T-08 Timed Actions Mode* is set for *[0] Times Actions Auto*.

If commands are applied simultaneously to the digital inputs for Constant OFF and Constant ON, Timed Actions mode will change to Timed Actions Auto and the two commands will be disregarded.

If *0-70 Set Date and Time* is not set or the adjustable frequency drive is set to HAND or OFF mode (e.g., via the LCP), Timed Actions mode will be change to *Timed Actions Disabled*.

The Timed Actions have a higher priority than the same actions/commands activated by the digital inputs or the Smart Logic Controller.

NOTE!

The clock (parameter group K-7#) must be correctly programmed for Timed Actions to function correctly.

NOTE!

When mounting an Analog I/O OPCAIO option card, a battery backup of the date and time is included.

| 23-00 ON Time | | |
|---|----------------|--|
| Array [10] | | |
| Range: | | Function: |
| 0 N/A* | [0 - 0 N/A] | Sets the ON time for the timed action. |
| <p>NOTE! The adjustable frequency drive has no backup of the clock function and the set date/time will reset to default (2000-01-01 00:00) after a power-down unless the Analog I/O option module (OPCAIO) with battery backup of the Real Time Clock is installed. In <i>0-79 Clock Fault</i>, it is possible to program for a warning in case the clock has not been set properly, e.g., after a power-down.</p> | | |

| 23-01 ON Action | | |
|-----------------|-----------------|--|
| Arra [10] | | |
| Option: | | Function: |
| | | Select the action during ON Time. See 13-52 <i>SL Controller Action</i> for descriptions of the options. |
| [0] * | DISABLED | |
| [1] | No action | |
| [2] | Select set-up 1 | |
| [3] | Select set-up 2 | |

| 23-01 ON Action | | |
|-----------------|------------------------|------------------|
| Arra [10] | | |
| Option: | | Function: |
| [4] | Select set-up 3 | |
| [5] | Select set-up 4 | |
| [10] | Select preset ref 0 | |
| [11] | Select preset ref 1 | |
| [12] | Select preset ref 2 | |
| [13] | Select preset ref 3 | |
| [14] | Select preset ref 4 | |
| [15] | Select preset ref 5 | |
| [16] | Select preset ref 6 | |
| [17] | Select preset ref 7 | |
| [18] | Select ramp 1 | |
| [19] | Select ramp 2 | |
| [22] | Run | |
| [23] | Run reverse | |
| [24] | Stop | |
| [26] | Dcstop | |
| [27] | Coast | |
| [28] | Freeze output | |
| [29] | Start timer 0 | |
| [30] | Start timer 1 | |
| [31] | Start timer 2 | |
| [32] | Set digital out A low | |
| [33] | Set digital out B low | |
| [34] | Set digital out C low | |
| [35] | Set digital out D low | |
| [36] | Set digital out E low | |
| [37] | Set digital out F low | |
| [38] | Set digital out A high | |
| [39] | Set digital out B high | |
| [40] | Set digital out C high | |
| [41] | Set digital out D high | |
| [42] | Set digital out E high | |
| [43] | Set digital out F high | |
| [60] | Reset Counter A | |
| [61] | Reset Counter B | |
| [70] | Start Timer 3 | |
| [71] | Start Timer 4 | |
| [72] | Start Timer 5 | |
| [73] | Start Timer 6 | |
| [74] | Start Timer 7 | |

| 23-02 OFF Time | | |
|--|---|--|
| Array [10] | | |
| Range: | Function: | |
| 0 N/A* [0 - 0 N/A] | Sets the OFF time for the timed action. | |
| <p>NOTE! The adjustable frequency drive has no backup of the clock function and the set date/time will reset to default (2000-01-01 00:00) after a power-down unless the Analog I/O option module (OPCAIO) with battery backup of the Real Time Clock is installed. In 0-79 Clock Fault, it is possible to program for a warning in case the clock has not been set properly, e.g., after a power-down.</p> | | |

| 23-03 OFF Action | | |
|------------------|--|--|
| Array [10] | | |
| Option: | Function: | |
| | Select the action during OFF Time. See 13-52 SL Controller Action for descriptions of the options. | |
| [0] * | DISABLED | |
| [1] | No action | |
| [2] | Select set-up 1 | |
| [3] | Select set-up 2 | |
| [4] | Select set-up 3 | |
| [5] | Select set-up 4 | |
| [10] | Select preset ref 0 | |
| [11] | Select preset ref 1 | |
| [12] | Select preset ref 2 | |
| [13] | Select preset ref 3 | |
| [14] | Select preset ref 4 | |
| [15] | Select preset ref 5 | |
| [16] | Select preset ref 6 | |
| [17] | Select preset ref 7 | |
| [18] | Select ramp 1 | |
| [19] | Select ramp 2 | |
| [22] | Run | |
| [23] | Run reverse | |
| [24] | Stop | |
| [26] | Dcstop | |
| [27] | Coast | |
| [28] | Freeze output | |
| [29] | Start timer 0 | |
| [30] | Start timer 1 | |
| [31] | Start timer 2 | |
| [32] | Set digital out A low | |
| [33] | Set digital out B low | |
| [34] | Set digital out C low | |

| 23-03 OFF Action | | |
|------------------|------------------------|--|
| Array [10] | | |
| Option: | Function: | |
| [35] | Set digital out D low | |
| [36] | Set digital out E low | |
| [37] | Set digital out F low | |
| [38] | Set digital out A high | |
| [39] | Set digital out B high | |
| [40] | Set digital out C high | |
| [41] | Set digital out D high | |
| [42] | Set digital out E high | |
| [43] | Set digital out F high | |
| [60] | Reset Counter A | |
| [61] | Reset Counter B | |
| [70] | Start Timer 3 | |
| [71] | Start Timer 4 | |
| [72] | Start Timer 5 | |
| [73] | Start Timer 6 | |
| [74] | Start Timer 7 | |

| 23-04 Occurrence | | |
|------------------|--|--|
| Array [10] | | |
| Option: | Function: | |
| | Select the day(s) to which the timed action applies. Specify working/non-working days in 0-81 Working Days, 0-82 Additional Working Days and 0-83 Additional Non-Working Days. | |
| [0] * | All days | |
| [1] | Working days | |
| [2] | Non-working days | |
| [3] | Monday | |
| [4] | Tuesday | |
| [5] | Wednesday | |
| [6] | Thursday | |
| [7] | Friday | |
| [8] | Saturday | |
| [9] | Sunday | |

6.2.10 Water Application Functions, 29-**

The group contains parameters used for monitoring water/wastewater applications.

| 29-00 Pipe Fill Enable | | |
|-----------------------------|-----------------------------|--|
| Option: | Function: | |
| | | |
| 29-01 Pipe Fill Speed [RPM] | | |
| Range: | Function: | |
| Size related* | [par. 4-11 - par. 4-13 RPM] | |

| 29-02 Pipe Fill Speed [Hz] | | |
|----------------------------|----------------------------|-----------|
| Range: | | Function: |
| Size related* | [par. 4-12 - par. 4-14 Hz] | |

| 29-03 Pipe Fill Time | | |
|----------------------|--|-----------|
| Range: | | Function: |
| | | |

| 29-04 Pipe Fill Rate | | |
|---------------------------|---|--|
| Range: | | Function: |
| 0.001 ProcessCtrlUnit* | [0.001– 999999.999 ProcessCtrlUnit] | Specifies the filling rate in units/second using the PI controller. Filling rate units are feedback units/second. This function is used for filling up vertical pipe systems but will be active when the filling time has expired regardless until the pipe fill setpoint set in is reached. |

| 29-05 Filled Setpoint | | |
|---------------------------|---|---|
| Range: | | Function: |
| 0.000 ProcessCtrlUnit* | [-999999.999– 999999.999 ProcessCtrlUnit] | Specifies the filled setpoint at which the pipe fill function will be disabled and the PID controller will take control. This function can be used both for horizontal and vertical pipe systems. |

6.3 Parameter Options

6.3.1 Default settings

Changes during operation:

"TRUE" means that the parameter can be changed while the adjustable frequency drive is in operation and "FALSE" means that the adjustable frequency drive must be stopped before a change can be made.

4 set-up:

'All set-up': the parameter can be set individually in each of the four set-ups, i.e., one single parameter can have four different data values.

'1 set-up': the data value will be the same in all set-ups.

SR:

Size related

N/A:

No default value available.

Conversion index:

This number refers to a conversion figure used when writing or reading by means of an adjustable frequency drive.

| Conv. index | 100 | 75 | 74 | 70 | 67 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | -1 | -2 | -3 | -4 | -5 | -6 |
|--------------|-----|---------|------|----|------|-------------|------------|-------|------|-----|----|---|-----|------|-------|------------|---------|--------------|
| Conv. factor | 1 | 3600000 | 3600 | 60 | 1/60 | 100000 0 | 10000 0 | 10000 | 1000 | 100 | 10 | 1 | 0.1 | 0.01 | 0.001 | 0.000 1 | 0.00001 | 0.00000 1 |

| Data type | Description | Type |
|-----------|--------------------------------------|--------|
| 2 | Integer 8 | Int8 |
| 3 | Integer 16 | Int16 |
| 4 | Integer 32 | Int32 |
| 5 | Unsigned 8 | UInt8 |
| 6 | Unsigned 16 | UInt16 |
| 7 | Unsigned 32 | UInt32 |
| 9 | Visible String | VisStr |
| 33 | Normalized value 2 bytes | N2 |
| 35 | Bit sequence of 16 Boolean variables | V2 |
| 54 | Time difference w/o date | TimD |

6.3.2 Operation/Display 0-**

| Par. No. # | Parameter description | Default value | 4 set-up | FC 302 only | Change during operation | Conversion index | Type |
|--------------------------------|--------------------------------------|--------------------------|-------------|-------------|-------------------------|------------------|------------|
| 0-0* Basic Settings | | | | | | | |
| 0-01 | Language | [0] English | 1 set-up | | TRUE | - | Uint8 |
| 0-02 | Motor Speed Unit | [0] RPM | 2 set-ups | | FALSE | - | Uint8 |
| 0-03 | Regional Settings | [0] International | 2 set-ups | | FALSE | - | Uint8 |
| 0-04 | Operating State at Power-up | [0] Resume | All set-ups | | TRUE | - | Uint8 |
| 0-05 | Local Mode Unit | [0] As Motor Speed Unit | 2 set-ups | | FALSE | - | Uint8 |
| 0-1* Set-up Operations | | | | | | | |
| 0-10 | Active Set-up | [1] Set-up 1 | 1 set-up | | TRUE | - | Uint8 |
| 0-11 | Programming Set-up | [9] Active Set-up | All set-ups | | TRUE | - | Uint8 |
| 0-12 | This Set-up Linked to | [0] Not linked | All set-ups | | FALSE | - | Uint8 |
| 0-13 | Readout: Linked Set-ups | 0 N/A | All set-ups | | FALSE | 0 | Uint16 |
| 0-14 | Readout: Prog. Set-ups/Channel | 0 N/A | All set-ups | | TRUE | 0 | Int32 |
| 0-2* LCP Display | | | | | | | |
| 0-20 | Display Line 1.1 Small | 1601 | All set-ups | | TRUE | - | Uint16 |
| 0-21 | Display Line 1.2 Small | 1662 | All set-ups | | TRUE | - | Uint16 |
| 0-22 | Display Line 1.3 Small | 1614 | All set-ups | | TRUE | - | Uint16 |
| 0-23 | Display Line 2 Large | 1613 | All set-ups | | TRUE | - | Uint16 |
| 0-24 | Display Line 3 Large | 1652 | All set-ups | | TRUE | - | Uint16 |
| 0-25 | My Personal Menu | ExpressionLimit | 1 set-up | | TRUE | 0 | Uint16 |
| 0-3* LCP Custom Readout | | | | | | | |
| 0-30 | Custom Readout Unit | [1] % | All set-ups | | TRUE | - | Uint8 |
| 0-31 | Custom Readout Min Value | ExpressionLimit | All set-ups | | TRUE | -2 | Int32 |
| 0-32 | Custom Readout Max Value | 100.00 CustomReadoutUnit | All set-ups | | TRUE | -2 | Int32 |
| 0-37 | Display Text 1 | 0 N/A | 1 set-up | | TRUE | 0 | VisStr[25] |
| 0-38 | Display Text 2 | 0 N/A | 1 set-up | | TRUE | 0 | VisStr[25] |
| 0-39 | Display Text 3 | 0 N/A | 1 set-up | | TRUE | 0 | VisStr[25] |
| 0-4* LCP Keypad | | | | | | | |
| 0-40 | [Hand on] Key on LCP | [1] Enabled | All set-ups | | TRUE | - | Uint8 |
| 0-41 | [Off] Key on LCP | [1] Enabled | All set-ups | | TRUE | - | Uint8 |
| 0-42 | [Auto on] Key on LCP | [1] Enabled | All set-ups | | TRUE | - | Uint8 |
| 0-43 | [Reset] Key on LCP | [1] Enabled | All set-ups | | TRUE | - | Uint8 |
| 0-44 | [Off/Reset] Key on LCP | [1] Enabled | All set-ups | | TRUE | - | Uint8 |
| 0-45 | [Drive Bypass] Key on LCP | [1] Enabled | All set-ups | | TRUE | - | Uint8 |
| 0-5* Copy/Save | | | | | | | |
| 0-50 | LCP Copy | [0] No copy | All set-ups | | FALSE | - | Uint8 |
| 0-51 | Set-up Copy | [0] No copy | All set-ups | | FALSE | - | Uint8 |
| 0-6* Password | | | | | | | |
| 0-60 | Main Menu Password | 100 N/A | 1 set-up | | TRUE | 0 | Uint16 |
| 0-61 | Access to Main Menu w/o Password | [0] Full access | 1 set-up | | TRUE | - | Uint8 |
| 0-65 | Personal Menu Password | 200 N/A | 1 set-up | | TRUE | 0 | Uint16 |
| 0-66 | Access to Personal Menu w/o Password | [0] Full access | 1 set-up | | TRUE | - | Uint8 |

| Par. No. # | Parameter description | Default value | 4 set-up | Change during operation | Conver- sion index | Type |
|----------------------------|-----------------------------|-----------------|-------------|----------------------------|-----------------------|------------|
| 0-7* Clock Settings | | | | | | |
| 0-70 | Date and Time | ExpressionLimit | All set-ups | TRUE | 0 | TimeOfDay |
| 0-71 | Date Format | [0] YYYY-MM-DD | 1 set-up | TRUE | - | UInt8 |
| 0-72 | Time Format | [0] 24 h | 1 set-up | TRUE | - | UInt8 |
| 0-74 | DST/Summertime | [0] Off | 1 set-up | TRUE | - | UInt8 |
| 0-76 | DST/Summertime Start | ExpressionLimit | 1 set-up | TRUE | 0 | TimeOfDay |
| 0-77 | DST/Summertime End | ExpressionLimit | 1 set-up | TRUE | 0 | TimeOfDay |
| 0-79 | Clock Fault | null | 1 set-up | TRUE | - | UInt8 |
| 0-81 | Working Days | null | 1 set-up | TRUE | - | UInt8 |
| 0-82 | Additional Working Days | ExpressionLimit | 1 set-up | TRUE | 0 | TimeOfDay |
| 0-83 | Additional Non-Working Days | ExpressionLimit | 1 set-up | TRUE | 0 | TimeOfDay |
| 0-89 | Date and Time Readout | 0 N/A | All set-ups | TRUE | 0 | VisStr[25] |

6.3.3 Load/Motor 1-**

| Par. No. # | Parameter description | Default value | 4 set-up | Change during operation | Conver- sion index | Type |
|---------------------------------|---------------------------------------|------------------------------|-------------|----------------------------|-----------------------|--------|
| 1-0* General Settings | | | | | | |
| 1-00 | Configuration Mode | null | All set-ups | TRUE | - | Uint8 |
| 1-01 | Motor Control Principle | null | All set-ups | FALSE | - | Uint8 |
| 1-03 | Torque Characteristics | [3] Auto Energy Optim. VT | All set-ups | TRUE | - | Uint8 |
| 1-1* Motor Selection | | | | | | |
| 1-10 | Motor Construction | [0] Asynchron | All set-ups | FALSE | - | Uint8 |
| 1-2* Motor Data | | | | | | |
| 1-20 | Motor Power [kW] | ExpressionLimit | All set-ups | FALSE | 1 | Uint32 |
| 1-21 | Motor Power [HP] | ExpressionLimit | All set-ups | FALSE | -2 | Uint32 |
| 1-22 | Motor Voltage | ExpressionLimit | All set-ups | FALSE | 0 | Uint16 |
| 1-23 | Motor Frequency | ExpressionLimit | All set-ups | FALSE | 0 | Uint16 |
| 1-24 | Motor Current | ExpressionLimit | All set-ups | FALSE | -2 | Uint32 |
| 1-25 | Motor Nominal Speed | ExpressionLimit | All set-ups | FALSE | 67 | Uint16 |
| 1-28 | Motor Rotation Check | [0] Off | All set-ups | FALSE | - | Uint8 |
| 1-29 | Automatic Motor Adaptation (AMA) | [0] Off | All set-ups | FALSE | - | Uint8 |
| 1-3* Adv. Motor Data | | | | | | |
| 1-30 | Stator Resistance (Rs) | ExpressionLimit | All set-ups | FALSE | -4 | Uint32 |
| 1-31 | Rotor Resistance (Rr) | ExpressionLimit | All set-ups | FALSE | -4 | Uint32 |
| 1-35 | Main Reactance (Xh) | ExpressionLimit | All set-ups | FALSE | -4 | Uint32 |
| 1-36 | Iron Loss Resistance (Rfe) | ExpressionLimit | All set-ups | FALSE | -3 | Uint32 |
| 1-39 | Motor Poles | ExpressionLimit | All set-ups | FALSE | 0 | Uint8 |
| 1-5* Load Indep. Setting | | | | | | |
| 1-50 | Motor Magnetization at Zero Speed | 100 % | All set-ups | TRUE | 0 | Uint16 |
| 1-51 | Min Speed Normal Magnetizing [RPM] | ExpressionLimit | All set-ups | TRUE | 67 | Uint16 |
| 1-52 | Min Speed Normal Magnetizing [Hz] | ExpressionLimit | All set-ups | TRUE | -1 | Uint16 |
| 1-6* Load Depen. Setting | | | | | | |
| 1-60 | Low Speed Load Compen- sation | 100 % | All set-ups | TRUE | 0 | Int16 |
| 1-61 | High Speed Load Compen- sation | 100 % | All set-ups | TRUE | 0 | Int16 |
| 1-62 | Slip Compensation | 0 % | All set-ups | TRUE | 0 | Int16 |
| 1-63 | Slip Compensation Time Constant | ExpressionLimit | All set-ups | TRUE | -2 | Uint16 |
| 1-64 | Resonance Dampening | 100 % | All set-ups | TRUE | 0 | Uint16 |
| 1-65 | Resonance Dampening Time Constant | 5 ms | All set-ups | TRUE | -3 | Uint8 |
| 1-7* Start Adjustments | | | | | | |
| 1-71 | Start Delay | 0.0 s | All set-ups | TRUE | -1 | Uint16 |
| 1-73 | Flying Start | [0] Disabled | All set-ups | FALSE | - | Uint8 |
| 1-74 | Start Speed [RPM] | ExpressionLimit | All set-ups | TRUE | 67 | Uint16 |
| 1-75 | Start Speed [Hz] | ExpressionLimit | All set-ups | TRUE | -1 | Uint16 |
| 1-76 | Start Current | 0.00 A | All set-ups | TRUE | -2 | Uint32 |

| Par. No. # | Parameter description | Default value | 4 set-up | Change during operation | Conver- sion index | Type |
|-------------------------------|---|-----------------|-------------|----------------------------|-----------------------|--------|
| 1-7* Start Adjustments | | | | | | |
| 1-71 | Start Delay | 0.0 s | All set-ups | TRUE | -1 | Uint16 |
| 1-73 | Flying Start | [0] Disabled | All set-ups | FALSE | - | Uint8 |
| 1-74 | Start Speed [RPM] | ExpressionLimit | All set-ups | TRUE | 67 | Uint16 |
| 1-75 | Start Speed [Hz] | ExpressionLimit | All set-ups | TRUE | -1 | Uint16 |
| 1-76 | Start Current | 0.00 A | All set-ups | TRUE | -2 | Uint32 |
| 1-8* Stop Adjustments | | | | | | |
| 1-80 | Function at Stop | [0] Coast | All set-ups | TRUE | - | Uint8 |
| 1-81 | Min Speed for Function at Stop [RPM] | ExpressionLimit | All set-ups | TRUE | 67 | Uint16 |
| 1-82 | Min. Speed for Function at Stop [Hz] | ExpressionLimit | All set-ups | TRUE | -1 | Uint16 |
| 1-86 | Trip Speed Low [RPM] | 0 RPM | All set-ups | TRUE | 67 | Uint16 |
| 1-87 | Trip Speed Low [Hz] | 0 Hz | All set-ups | TRUE | -1 | Uint16 |
| 1-9* Motor Temperature | | | | | | |
| 1-90 | Motor Thermal Protection | [4] ETR trip 1 | All set-ups | TRUE | - | Uint8 |
| 1-91 | Motor External Fan | [0] No | All set-ups | TRUE | - | Uint16 |
| 1-93 | Thermistor Source | [0] None | All set-ups | TRUE | - | Uint8 |

6.3.4 Brakes 2-**

| Par. No. # | Parameter description | Default value | 4 set-up | Change during operation | Conversion index | Type |
|---------------------------------|-----------------------------|-----------------|-------------|-------------------------|------------------|--------|
| 2-0* DC Brake | | | | | | |
| 2-00 | DC Hold/Preheat Current | 50 % | All set-ups | TRUE | 0 | Uint8 |
| 2-01 | DC Brake Current | 50 % | All set-ups | TRUE | 0 | Uint16 |
| 2-02 | DC Braking Time | 10.0 s | All set-ups | TRUE | -1 | Uint16 |
| 2-03 | DC Brake Cut-in Speed [RPM] | ExpressionLimit | All set-ups | TRUE | 67 | Uint16 |
| 2-04 | DC Brake Cut-in Speed [Hz] | ExpressionLimit | All set-ups | TRUE | -1 | Uint16 |
| 2-1* Brake Energy Funct. | | | | | | |
| 2-10 | Brake Function | [0] Off | All set-ups | TRUE | - | Uint8 |
| 2-11 | Brake Resistor (ohm) | ExpressionLimit | All set-ups | TRUE | 0 | Uint16 |
| 2-12 | Braking Energy Limit (kW) | ExpressionLimit | All set-ups | TRUE | 0 | Uint32 |
| 2-13 | Braking Energy Monitoring | [0] Off | All set-ups | TRUE | - | Uint8 |
| 2-15 | Brake Check | [0] Off | All set-ups | TRUE | - | Uint8 |
| 2-16 | AC Brake Max. Current | 100.0% | All set-ups | TRUE | -1 | Uint32 |
| 2-17 | Overvoltage Control | [2] Enabled | All set-ups | TRUE | - | Uint8 |

6.3.5 Reference / Ramps 3-**

| Par. No. # | Parameter description | Default value | 4 set-up | Change during operation | Conver- sion index | Type |
|------------------------------------|-------------------------------------|------------------------------|-------------|----------------------------|-----------------------|--------|
| 3-0* Reference Limits | | | | | | |
| 3-02 | Minimum Reference | ExpressionLimit | All set-ups | TRUE | -3 | Int32 |
| 3-03 | Maximum Reference | ExpressionLimit | All set-ups | TRUE | -3 | Int32 |
| 3-04 | Reference Function | [0] Sum | All set-ups | TRUE | - | UInt8 |
| 3-1* References | | | | | | |
| 3-10 | Preset Reference | 0.00% | All set-ups | TRUE | -2 | Int16 |
| 3-11 | Jog Speed [Hz] | ExpressionLimit | All set-ups | TRUE | -1 | UInt16 |
| 3-13 | Reference Site | [0] Linked to Hand / Auto | All set-ups | TRUE | - | UInt8 |
| 3-14 | Preset Relative Reference | 0.00% | All set-ups | TRUE | -2 | Int32 |
| 3-15 | Reference 1 Source | [1] Analog input 53 | All set-ups | TRUE | - | UInt8 |
| 3-16 | Reference 2 Source | [0] No function | All set-ups | TRUE | - | UInt8 |
| 3-17 | Reference 3 Source | [0] No function | All set-ups | TRUE | - | UInt8 |
| 3-19 | Jog Speed [RPM] | ExpressionLimit | All set-ups | TRUE | 67 | UInt16 |
| 3-4* Ramp 1 | | | | | | |
| 3-41 | Ramp 1 Ramp-up Time | ExpressionLimit | All set-ups | TRUE | -2 | UInt32 |
| 3-42 | Ramp 1 Ramp-down Time | ExpressionLimit | All set-ups | TRUE | -2 | UInt32 |
| 3-5* Ramp 2 | | | | | | |
| 3-51 | Ramp 2 Ramp-up Time | ExpressionLimit | All set-ups | TRUE | -2 | UInt32 |
| 3-52 | Ramp 2 Ramp-down Time | ExpressionLimit | All set-ups | TRUE | -2 | UInt32 |
| 3-8* Other Ramps | | | | | | |
| 3-80 | Jog Ramp Time | ExpressionLimit | All set-ups | TRUE | -2 | UInt32 |
| 3-81 | Quick Stop Ramp Time | ExpressionLimit | 2 set-ups | TRUE | -2 | UInt32 |
| 3-84 | Initial Ramp Time | 0.00 s | All set-ups | TRUE | -2 | UInt16 |
| 3-85 | Check Valve Ramp Time | 0.00 s | All set-ups | TRUE | -2 | UInt16 |
| 3-86 | Check Valve Ramp End Speed [RPM] | ExpressionLimit | All set-ups | TRUE | 67 | UInt16 |
| 3-87 | Check Valve Ramp End Speed [HZ] | ExpressionLimit | All set-ups | TRUE | -1 | UInt16 |
| 3-88 | Final Ramp Time | 0.00 s | All set-ups | TRUE | -2 | UInt16 |
| 3-9 * Digital Potentiometer | | | | | | |
| 3-90 | Step Size | 0.10% | All set-ups | TRUE | -2 | UInt16 |
| 3-91 | Ramp Time | 1.00 s | All set-ups | TRUE | -2 | UInt32 |
| 3-92 | Power Restore | [0] Off | All set-ups | TRUE | - | UInt8 |
| 3-93 | Maximum Limit | 100 % | All set-ups | TRUE | 0 | Int16 |
| 3-94 | Minimum Limit | 0 % | All set-ups | TRUE | 0 | Int16 |
| 3-95 | Ramp Delay | ExpressionLimit | All set-ups | TRUE | -3 | TimD |

6.3.6 Limits / Warnings 4-**

| Par. No. # | Parameter description | Default value | 4 set-up | Change during operation | Conver- sion index | Type |
|---------------------------|------------------------------|--|-------------|----------------------------|-----------------------|--------|
| 4-1* Motor Limits | | | | | | |
| 4-10 | Motor Speed Direction | [0] Clockwise | All set-ups | FALSE | - | Uint8 |
| 4-11 | Motor Speed Low Limit [RPM] | ExpressionLimit | All set-ups | TRUE | 67 | Uint16 |
| 4-12 | Motor Speed Low Limit [Hz] | ExpressionLimit | All set-ups | TRUE | -1 | Uint16 |
| 4-13 | Motor Speed High Limit [RPM] | ExpressionLimit | All set-ups | TRUE | 67 | Uint16 |
| 4-14 | Motor Speed High Limit [Hz] | ExpressionLimit | All set-ups | TRUE | -1 | Uint16 |
| 4-16 | Torque Limit Motor Mode | 110.0% | All set-ups | TRUE | -1 | Uint16 |
| 4-17 | Torque Limit Generator Mode | 100.0% | All set-ups | TRUE | -1 | Uint16 |
| 4-18 | Current Limit | ExpressionLimit | All set-ups | TRUE | -1 | Uint32 |
| 4-19 | Max. Output Frequency | ExpressionLimit | All set-ups | FALSE | -1 | Uint16 |
| 4-5* Adj. Warnings | | | | | | |
| 4-50 | Warning Current Low | 0.00 A | All set-ups | TRUE | -2 | Uint32 |
| 4-51 | Warning Current High | ImaxVLT (P1637) | All set-ups | TRUE | -2 | Uint32 |
| 4-52 | Warning Speed Low | 0 RPM | All set-ups | TRUE | 67 | Uint16 |
| 4-53 | Warning Speed High | outputSpeed- HighLimit (P413) | All set-ups | TRUE | 67 | Uint16 |
| 4-54 | Warning Reference Low | -999999.999 N/A | All set-ups | TRUE | -3 | Int32 |
| 4-55 | Warning Reference High | 999999.999 N/A | All set-ups | TRUE | -3 | Int32 |
| 4-56 | Warning Feedback Low | -999999.999 Referen- ceFeedbackUnit | All set-ups | TRUE | -3 | Int32 |
| 4-57 | Warning Feedback High | 999999.999 Referen- ceFeedbackUnit | All set-ups | TRUE | -3 | Int32 |
| 4-58 | Missing Motor Phase Function | [1] On | All set-ups | TRUE | - | Uint8 |
| 4-6* Speed Bypass | | | | | | |
| 4-60 | Bypass Speed From [RPM] | ExpressionLimit | All set-ups | TRUE | 67 | Uint16 |
| 4-61 | Bypass Speed From [Hz] | ExpressionLimit | All set-ups | TRUE | -1 | Uint16 |
| 4-62 | Bypass Speed To [RPM] | ExpressionLimit | All set-ups | TRUE | 67 | Uint16 |
| 4-63 | Bypass Speed To [Hz] | ExpressionLimit | All set-ups | TRUE | -1 | Uint16 |
| 4-64 | Semi-Auto Bypass Set-up | [0] Off | All set-ups | FALSE | - | Uint8 |

6.3.7 Digital In/Out 5-**

| Par. No. # | Parameter description | Default value | 4 set-up | Change during operation | Conversion index | Type |
|------------------------------|--------------------------------------|--------------------------|-------------|-------------------------|------------------|--------|
| 5-0* Digital I/O mode | | | | | | |
| 5-00 | Digital I/O Mode | [0] PNP - Active at 24 V | All set-ups | FALSE | - | Uint8 |
| 5-01 | Terminal 27 Mode | [0] Input | All set-ups | TRUE | - | Uint8 |
| 5-02 | Terminal 29 Mode | [0] Input | All set-ups | TRUE | - | Uint8 |
| 5-1* Digital Inputs | | | | | | |
| 5-10 | Terminal 18 Digital Input | [8] Start | All set-ups | TRUE | - | Uint8 |
| 5-11 | Terminal 19 Digital Input | [0] No operation | All set-ups | TRUE | - | Uint8 |
| 5-12 | Terminal 27 Digital Input | null | All set-ups | TRUE | - | Uint8 |
| 5-13 | Terminal 29 Digital Input | [0] No operation | All set-ups | TRUE | - | Uint8 |
| 5-14 | Terminal 32 Digital Input | [0] No operation | All set-ups | TRUE | - | Uint8 |
| 5-15 | Terminal 33 Digital Input | [0] No operation | All set-ups | TRUE | - | Uint8 |
| 5-16 | Terminal X30/2 Digital Input | [0] No operation | All set-ups | TRUE | - | Uint8 |
| 5-17 | Terminal X30/3 Digital Input | [0] No operation | All set-ups | TRUE | - | Uint8 |
| 5-18 | Terminal X30/4 Digital Input | [0] No operation | All set-ups | TRUE | - | Uint8 |
| 5-3* Digital Outputs | | | | | | |
| 5-30 | Terminal 27 Digital Output | [0] No operation | All set-ups | TRUE | - | Uint8 |
| 5-31 | Terminal 29 Digital Output | [0] No operation | All set-ups | TRUE | - | Uint8 |
| 5-32 | Term X30/6 Digi Out (MCB 101) | [0] No operation | All set-ups | TRUE | - | Uint8 |
| 5-33 | Term X30/7 Digi Out (MCB 101) | [0] No operation | All set-ups | TRUE | - | Uint8 |
| 5-4* Relays | | | | | | |
| 5-40 | Function Relay | null | All set-ups | TRUE | - | Uint8 |
| 5-41 | On Delay, Relay | 0.01 s | All set-ups | TRUE | -2 | Uint16 |
| 5-42 | Off Delay, Relay | 0.01 s | All set-ups | TRUE | -2 | Uint16 |
| 5-5* Pulse Input | | | | | | |
| 5-50 | Term. 29 Low Frequency | 100 Hz | All set-ups | TRUE | 0 | Uint32 |
| 5-51 | Term. 29 High Frequency | 100 Hz | All set-ups | TRUE | 0 | Uint32 |
| 5-52 | Term. 29 Low Ref./Feedb. Value | 0.000 N/A | All set-ups | TRUE | -3 | Int32 |
| 5-53 | Term. 29 High Ref./Feedb. Value | 100.000 N/A | All set-ups | TRUE | -3 | Int32 |
| 5-54 | Pulse Filter Time Constant #29 | 100 ms | All set-ups | FALSE | -3 | Uint16 |
| 5-55 | Term. 33 Low Frequency | 100 Hz | All set-ups | TRUE | 0 | Uint32 |
| 5-56 | Term. 33 High Frequency | 100 Hz | All set-ups | TRUE | 0 | Uint32 |
| 5-57 | Term. 33 Low Ref./Feedb. Value | 0.000 N/A | All set-ups | TRUE | -3 | Int32 |
| 5-58 | Term. 33 High Ref./Feedb. Value | 100.000 N/A | All set-ups | TRUE | -3 | Int32 |
| 5-59 | Pulse Filter Time Constant #33 | 100 ms | All set-ups | FALSE | -3 | Uint16 |
| 5-6* Pulse Output | | | | | | |
| 5-60 | Terminal 27 Pulse Output Variable | [0] No operation | All set-ups | TRUE | - | Uint8 |
| 5-62 | Pulse Output Max Freq #27 | 5000 Hz | All set-ups | TRUE | 0 | Uint32 |
| 5-63 | Terminal 29 Pulse Output Variable | [0] No operation | All set-ups | TRUE | - | Uint8 |
| 5-65 | Pulse Output Max Freq #29 | 5000 Hz | All set-ups | TRUE | 0 | Uint32 |
| 5-66 | Terminal X30/6 Pulse Output Variable | [0] No operation | All set-ups | TRUE | - | Uint8 |
| 5-68 | Pulse Output Max Freq #X30/6 | 5000 Hz | All set-ups | TRUE | 0 | Uint32 |

| Par. No. # | Parameter description | Default value | 4 set-up | Change during operation | Conversion index | Type |
|----------------------------|---------------------------------|---------------|-------------|-------------------------|------------------|--------|
| 5-9* Bus Controlled | | | | | | |
| 5-90 | Digital & Relay Bus Control | 0 N/A | All set-ups | TRUE | 0 | Uint32 |
| 5-93 | Pulse Out #27 Bus Control | 0.00% | All set-ups | TRUE | -2 | N2 |
| 5-94 | Pulse Out #27 Timeout Preset | 0.00% | 1 set-up | TRUE | -2 | Uint16 |
| 5-95 | Pulse Out #29 Bus Control | 0.00% | All set-ups | TRUE | -2 | N2 |
| 5-96 | Pulse Out #29 Timeout Preset | 0.00% | 1 set-up | TRUE | -2 | Uint16 |
| 5-97 | Pulse Out #X30/6 Bus Control | 0.00% | All set-ups | TRUE | -2 | N2 |
| 5-98 | Pulse Out #X30/6 Timeout Preset | 0.00% | 1 set-up | TRUE | -2 | Uint16 |

6.3.8 Analog In/Out 6-**

| Par. No. # | Parameter description | Default value | 4 set-up | Change during operation | Conver- sion index | Type |
|---------------------------------|-------------------------------------|-----------------|-------------|----------------------------|-----------------------|--------|
| 6-0* Analog I/O Mode | | | | | | |
| 6-00 | Live Zero Timeout Time | 10 s | All set-ups | TRUE | 0 | Uint8 |
| 6-01 | Live Zero Timeout Function | [0] Off | All set-ups | TRUE | - | Uint8 |
| 6-1* Analog Input 53 | | | | | | |
| 6-10 | Terminal 53 Low Voltage | 0.07 V | All set-ups | TRUE | -2 | Int16 |
| 6-11 | Terminal 53 High Voltage | 10.00 V | All set-ups | TRUE | -2 | Int16 |
| 6-12 | Terminal 53 Low Current | 4.00 mA | All set-ups | TRUE | -5 | Int16 |
| 6-13 | Terminal 53 High Current | 20.00 mA | All set-ups | TRUE | -5 | Int16 |
| 6-14 | Terminal 53 Low Ref./Feedb. Value | 0.000 N/A | All set-ups | TRUE | -3 | Int32 |
| 6-15 | Terminal 53 High Ref./Feedb. Value | ExpressionLimit | All set-ups | TRUE | -3 | Int32 |
| 6-16 | Terminal 53 Filter Time Constant | 0.001 s | All set-ups | TRUE | -3 | Uint16 |
| 6-17 | Terminal 53 Live Zero | [1] Enabled | All set-ups | TRUE | - | Uint8 |
| 6-2* Analog Input 54 | | | | | | |
| 6-20 | Terminal 54 Low Voltage | 0.07 V | All set-ups | TRUE | -2 | Int16 |
| 6-21 | Terminal 54 High Voltage | 10.00 V | All set-ups | TRUE | -2 | Int16 |
| 6-22 | Terminal 54 Low Current | 4.00 mA | All set-ups | TRUE | -5 | Int16 |
| 6-23 | Terminal 54 High Current | 20.00 mA | All set-ups | TRUE | -5 | Int16 |
| 6-24 | Terminal 54 Low Ref./Feedb. Value | 0.000 N/A | All set-ups | TRUE | -3 | Int32 |
| 6-25 | Terminal 54 High Ref./Feedb. Value | 100.000 N/A | All set-ups | TRUE | -3 | Int32 |
| 6-26 | Terminal 54 Filter Time Constant | 0.001 s | All set-ups | TRUE | -3 | Uint16 |
| 6-27 | Terminal 54 Live Zero | [1] Enabled | All set-ups | TRUE | - | Uint8 |
| 6-3* Analog Input X30/11 | | | | | | |
| 6-30 | Terminal X30/11 Low Voltage | 0.07 V | All set-ups | TRUE | -2 | Int16 |
| 6-31 | Terminal X30/11 High Voltage | 10.00 V | All set-ups | TRUE | -2 | Int16 |
| 6-34 | Term. X30/11 Low Ref./Feedb. Value | 0.000 N/A | All set-ups | TRUE | -3 | Int32 |
| 6-35 | Term. X30/11 High Ref./Feedb. Value | 100.000 N/A | All set-ups | TRUE | -3 | Int32 |
| 6-36 | Term. X30/11 Filter Time Constant | 0.001 s | All set-ups | TRUE | -3 | Uint16 |
| 6-37 | Term. X30/11 Live Zero | [1] Enabled | All set-ups | TRUE | - | Uint8 |
| 6-4* Analog Input X30/12 | | | | | | |
| 6-40 | Terminal X30/12 Low Voltage | 0.07 V | All set-ups | TRUE | -2 | Int16 |
| 6-41 | Terminal X30/12 High Voltage | 10.00 V | All set-ups | TRUE | -2 | Int16 |
| 6-44 | Term. X30/12 Low Ref./Feedb. Value | 0.000 N/A | All set-ups | TRUE | -3 | Int32 |
| 6-45 | Term. X30/12 High Ref./Feedb. Value | 100.000 N/A | All set-ups | TRUE | -3 | Int32 |
| 6-46 | Term. X30/12 Filter Time Constant | 0.001 s | All set-ups | TRUE | -3 | Uint16 |
| 6-47 | Term. X30/12 Live Zero | [1] Enabled | All set-ups | TRUE | - | Uint8 |

| Par. No. # | Parameter description | Default value | 4 set-up | Change during operation | Conver- sion index | Type |
|---------------------------------|---|-----------------------------|-------------|----------------------------|-----------------------|--------|
| 6-5* Analog Output 42 | | | | | | |
| 6-50 | Terminal 42 Output | [100] Output freq. 0-100 | All set-ups | TRUE | - | Uint8 |
| 6-51 | Terminal 42 Output Min Scale | 0.00% | All set-ups | TRUE | -2 | Int16 |
| 6-52 | Terminal 42 Output Max Scale | 100.00% | All set-ups | TRUE | -2 | Int16 |
| 6-53 | Terminal 42 Output Bus Control | 0.00% | All set-ups | TRUE | -2 | N2 |
| 6-54 | Terminal 42 Output Timeout Preset | 0.00% | 1 set-up | TRUE | -2 | Uint16 |
| 6-6* Analog Output X30/8 | | | | | | |
| 6-60 | Terminal X30/8 Output | [0] No operation | All set-ups | TRUE | - | Uint8 |
| 6-61 | Terminal X30/8 Min. Scale | 0.00% | All set-ups | TRUE | -2 | Int16 |
| 6-62 | Terminal X30/8 Max. Scale | 100.00% | All set-ups | TRUE | -2 | Int16 |
| 6-63 | Terminal X30/8 Output Bus Control | 0.00% | All set-ups | TRUE | -2 | N2 |
| 6-64 | Terminal X30/8 Output Timeout Preset | 0.00% | 1 set-up | TRUE | -2 | Uint16 |

6.3.9 Comm. and Options 8-**

| Par. No. # | Parameter description | Default value | 4 set-up | Change during operation | Conver- sion index | Type |
|---------------------------------|-------------------------------|------------------------|-------------|----------------------------|-----------------------|------------|
| 8-0* General Settings | | | | | | |
| 8-01 | Control Site | null | All set-ups | TRUE | - | Uint8 |
| 8-02 | Control Source | null | All set-ups | TRUE | - | Uint8 |
| 8-03 | Control Timeout Time | ExpressionLimit | 1 set-up | TRUE | -1 | Uint32 |
| 8-04 | Control Timeout Function | [0] Off | 1 set-up | TRUE | - | Uint8 |
| 8-05 | End-of-Timeout Function | [1] Resume set-up | 1 set-up | TRUE | - | Uint8 |
| 8-06 | Reset Control Timeout | [0] Do not reset | All set-ups | TRUE | - | Uint8 |
| 8-07 | Diagnosis Trigger | [0] Disable | 2 set-ups | TRUE | - | Uint8 |
| 8-1* Control Settings | | | | | | |
| 8-10 | Control Profile | [0] FC profile | All set-ups | TRUE | - | Uint8 |
| 8-13 | Configurable Status Word STW | [1] Profile Default | All set-ups | TRUE | - | Uint8 |
| 8-14 | Configurable Control Word CTW | [1] Profile default | All set-ups | TRUE | - | Uint8 |
| 8-3* FC Port Settings | | | | | | |
| 8-30 | Protocol | null | 1 set-up | TRUE | - | Uint8 |
| 8-31 | Address | ExpressionLimit | 1 set-up | TRUE | 0 | Uint8 |
| 8-32 | Baud Rate | null | 1 set-up | TRUE | - | Uint8 |
| 8-33 | Parity / Stop Bits | null | 1 set-up | TRUE | - | Uint8 |
| 8-35 | Minimum Response Delay | ExpressionLimit | 1 set-up | TRUE | -3 | Uint16 |
| 8-36 | Max Response Delay | ExpressionLimit | 1 set-up | TRUE | -3 | Uint16 |
| 8-37 | Maximum Inter-Char Delay | ExpressionLimit | 1 set-up | TRUE | -5 | Uint16 |
| 8-4* FC MC protocol set | | | | | | |
| 8-40 | Message Selection | [1] Standard message 1 | 2 set-ups | TRUE | - | Uint8 |
| 8-5* Digital/Bus | | | | | | |
| 8-50 | Coasting Select | [3] Logic OR | All set-ups | TRUE | - | Uint8 |
| 8-52 | DC Brake Select | [3] Logic OR | All set-ups | TRUE | - | Uint8 |
| 8-53 | Start Select | [3] Logic OR | All set-ups | TRUE | - | Uint8 |
| 8-54 | Reversing Select | null | All set-ups | TRUE | - | Uint8 |
| 8-55 | Set-up Select | [3] Logic OR | All set-ups | TRUE | - | Uint8 |
| 8-56 | Preset Reference Select | [3] Logic OR | All set-ups | TRUE | - | Uint8 |
| 8-7* BACnet | | | | | | |
| 8-70 | BACnet Device Instance | 1 N/A | 1 set-up | TRUE | 0 | Uint32 |
| 8-72 | MS/TP Max Masters | 127 N/A | 1 set-up | TRUE | 0 | Uint8 |
| 8-73 | MS/TP Max Info Frames | 1 N/A | 1 set-up | TRUE | 0 | Uint16 |
| 8-74 | "I-Am" Service | [0] Send at power-up | 1 set-up | TRUE | - | Uint8 |
| 8-75 | Initialization Password | ExpressionLimit | 1 set-up | TRUE | 0 | VisStr[20] |
| 8-8* FC Port Diagnostics | | | | | | |
| 8-80 | Bus Message Count | 0 N/A | All set-ups | TRUE | 0 | Uint32 |
| 8-81 | Bus Error Count | 0 N/A | All set-ups | TRUE | 0 | Uint32 |
| 8-82 | Slave Message Rcvd | 0 N/A | All set-ups | TRUE | 0 | Uint32 |
| 8-83 | Slave Error Count | 0 N/A | All set-ups | TRUE | 0 | Uint32 |
| 8-9* Bus Jog/Feedback | | | | | | |
| 8-90 | Bus Jog 1 Speed | 100 RPM | All set-ups | TRUE | 67 | Uint16 |
| 8-91 | Bus Jog 2 Speed | 200 RPM | All set-ups | TRUE | 67 | Uint16 |
| 8-94 | Bus Feedback 1 | 0 N/A | 1 set-up | TRUE | 0 | N2 |
| 8-95 | Bus Feedback 2 | 0 N/A | 1 set-up | TRUE | 0 | N2 |
| 8-96 | Bus Feedback 3 | 0 N/A | 1 set-up | TRUE | 0 | N2 |

6.3.10 Profibus 9-**

| Par. No. # | Parameter description | Default value | 4 set-up | Change during operation | Conver- sion index | Type |
|---------------|---------------------------|-----------------------------|-------------|----------------------------|-----------------------|-----------|
| 9-00 | Setpoint | 0 N/A | All set-ups | TRUE | 0 | Uint16 |
| 9-07 | Actual Value | 0 N/A | All set-ups | FALSE | 0 | Uint16 |
| 9-15 | PCD Write Configuration | ExpressionLimit | 2 set-ups | TRUE | - | Uint16 |
| 9-16 | PCD Read Configuration | ExpressionLimit | 2 set-ups | TRUE | - | Uint16 |
| 9-18 | Node Address | 126 N/A | 1 set-up | TRUE | 0 | Uint8 |
| 9-22 | Message Selection | [108] PPO 8 | 1 set-up | TRUE | - | Uint8 |
| 9-23 | Parameters for Signals | 0 | All set-ups | TRUE | - | Uint16 |
| 9-27 | Parameter Edit | [1] Enabled | 2 set-ups | FALSE | - | Uint16 |
| 9-28 | Process Control | [1] Enable cyclic master | 2 set-ups | FALSE | - | Uint8 |
| 9-44 | Error Message Counter | 0 N/A | All set-ups | TRUE | 0 | Uint16 |
| 9-45 | Fault Code | 0 N/A | All set-ups | TRUE | 0 | Uint16 |
| 9-47 | Fault Number | 0 N/A | All set-ups | TRUE | 0 | Uint16 |
| 9-52 | Error Counter | 0 N/A | All set-ups | TRUE | 0 | Uint16 |
| 9-53 | Profibus Warning Word | 0 N/A | All set-ups | TRUE | 0 | V2 |
| 9-63 | Actual Baud Rate | [255] No baud rate found | All set-ups | TRUE | - | Uint8 |
| 9-64 | Device Identification | 0 N/A | All set-ups | TRUE | 0 | Uint16 |
| 9-65 | Profile Number | 0 N/A | All set-ups | TRUE | 0 | OctStr[2] |
| 9-67 | Control Word 1 | 0 N/A | All set-ups | TRUE | 0 | V2 |
| 9-68 | Status Word 1 | 0 N/A | All set-ups | TRUE | 0 | V2 |
| 9-71 | Profibus Save Data Values | [0] Off | All set-ups | TRUE | - | Uint8 |
| 9-72 | ProfibusDriveReset | [0] No action | 1 set-up | FALSE | - | Uint8 |
| 9-80 | Defined Parameters (1) | 0 N/A | All set-ups | FALSE | 0 | Uint16 |
| 9-81 | Defined Parameters (2) | 0 N/A | All set-ups | FALSE | 0 | Uint16 |
| 9-82 | Defined Parameters (3) | 0 N/A | All set-ups | FALSE | 0 | Uint16 |
| 9-83 | Defined Parameters (4) | 0 N/A | All set-ups | FALSE | 0 | Uint16 |
| 9-84 | Defined Parameters (5) | 0 N/A | All set-ups | FALSE | 0 | Uint16 |
| 9-90 | Changed Parameters (1) | 0 N/A | All set-ups | FALSE | 0 | Uint16 |
| 9-91 | Changed Parameters (2) | 0 N/A | All set-ups | FALSE | 0 | Uint16 |
| 9-92 | Changed Parameters (3) | 0 N/A | All set-ups | FALSE | 0 | Uint16 |
| 9-93 | Changed Parameters (4) | 0 N/A | All set-ups | FALSE | 0 | Uint16 |
| 9-94 | Changed Parameters (5) | 0 N/A | All set-ups | FALSE | 0 | Uint16 |

6.3.11 CAN Fieldbus 10-**

| Par. No. # | Parameter description | Default value | 4 set-up | Change during operation | Conver- sion index | Type |
|-------------------------------|-----------------------------------|-----------------|-------------|----------------------------|-----------------------|--------|
| 10-0* Common Settings | | | | | | |
| 10-00 | CAN Protocol | null | 2 set-ups | FALSE | - | Uint8 |
| 10-01 | Baud Rate Select | null | 2 set-ups | TRUE | - | Uint8 |
| 10-02 | MAC ID | ExpressionLimit | 2 set-ups | TRUE | 0 | Uint8 |
| 10-05 | Readout Transmit Error Counter | 0 N/A | All set-ups | TRUE | 0 | Uint8 |
| 10-06 | Readout Receive Error Counter | 0 N/A | All set-ups | TRUE | 0 | Uint8 |
| 10-07 | Readout Bus-off Counter | 0 N/A | All set-ups | TRUE | 0 | Uint8 |
| 10-1* DeviceNet | | | | | | |
| 10-10 | Process Data Type Selection | null | All set-ups | TRUE | - | Uint8 |
| 10-11 | Process Data Config Write | ExpressionLimit | 2 set-ups | TRUE | - | Uint16 |
| 10-12 | Process Data Config Read | ExpressionLimit | 2 set-ups | TRUE | - | Uint16 |
| 10-13 | Warning Parameter | 0 N/A | All set-ups | TRUE | 0 | Uint16 |
| 10-14 | Net Reference | [0] Off | 2 set-ups | TRUE | - | Uint8 |
| 10-15 | Net Control | [0] Off | 2 set-ups | TRUE | - | Uint8 |
| 10-2* COS Filters | | | | | | |
| 10-20 | COS Filter 1 | 0 N/A | All set-ups | FALSE | 0 | Uint16 |
| 10-21 | COS Filter 2 | 0 N/A | All set-ups | FALSE | 0 | Uint16 |
| 10-22 | COS Filter 3 | 0 N/A | All set-ups | FALSE | 0 | Uint16 |
| 10-23 | COS Filter 4 | 0 N/A | All set-ups | FALSE | 0 | Uint16 |
| 10-3* Parameter Access | | | | | | |
| 10-30 | Array Index | 0 N/A | 2 set-ups | TRUE | 0 | Uint8 |
| 10-31 | Store Data Values | [0] Off | All set-ups | TRUE | - | Uint8 |
| 10-32 | DeviceNet Revision | ExpressionLimit | All set-ups | TRUE | 0 | Uint16 |
| 10-33 | Store Always | [0] Off | 1 set-up | TRUE | - | Uint8 |
| 10-34 | DeviceNet Product Code | 130 N/A | 1 set-up | TRUE | 0 | Uint16 |
| 10-39 | DeviceNet F Parameters | 0 N/A | All set-ups | TRUE | 0 | Uint32 |

6.3.12 Smart Logic 13-**

| Par. No. # | Parameter description | Default value | 4 set-up | Change during operation | Conver- sion index | Type |
|---------------------------|-----------------------|----------------------|-------------|----------------------------|-----------------------|-------|
| 13-0* SLC Settings | | | | | | |
| 13-00 | SL Controller Mode | null | 2 set-ups | TRUE | - | UInt8 |
| 13-01 | Start Event | null | 2 set-ups | TRUE | - | UInt8 |
| 13-02 | Stop Event | null | 2 set-ups | TRUE | - | UInt8 |
| 13-03 | Reset SLC | [0] Do not reset SLC | All set-ups | TRUE | - | UInt8 |
| 13-1* Comparators | | | | | | |
| 13-10 | Comparator Operand | null | 2 set-ups | TRUE | - | UInt8 |
| 13-11 | Comparator Operator | null | 2 set-ups | TRUE | - | UInt8 |
| 13-12 | Comparator Value | ExpressionLimit | 2 set-ups | TRUE | -3 | Int32 |
| 13-2* Timers | | | | | | |
| 13-20 | SL Controller Timer | ExpressionLimit | 1 set-up | TRUE | -3 | TimD |
| 13-4* Logic Rules | | | | | | |
| 13-40 | Logic Rule Boolean 1 | null | 2 set-ups | TRUE | - | UInt8 |
| 13-41 | Logic Rule Operator 1 | null | 2 set-ups | TRUE | - | UInt8 |
| 13-42 | Logic Rule Boolean 2 | null | 2 set-ups | TRUE | - | UInt8 |
| 13-43 | Logic Rule Operator 2 | null | 2 set-ups | TRUE | - | UInt8 |
| 13-44 | Logic Rule Boolean 3 | null | 2 set-ups | TRUE | - | UInt8 |
| 13-5* States | | | | | | |
| 13-51 | SL Controller Event | null | 2 set-ups | TRUE | - | UInt8 |
| 13-52 | SL Controller Action | null | 2 set-ups | TRUE | - | UInt8 |

6.3.13 Special Functions 14-**

| Par. No. # | Parameter description | Default value | 4 set-up | Change during operation | Conver- sion index | Type |
|----------------------------------|-------------------------------------|------------------------------|-------------|----------------------------|-----------------------|--------|
| 14-0* Inverter Switching | | | | | | |
| 14-00 | Switching Pattern | null | All set-ups | TRUE | - | Uint8 |
| 14-01 | Switching Frequency | null | All set-ups | TRUE | - | Uint8 |
| 14-03 | Overmodulation | [1] On | All set-ups | FALSE | - | Uint8 |
| 14-04 | PWM Random | [0] Off | All set-ups | TRUE | - | Uint8 |
| 14-1* Mains On/Off | | | | | | |
| 14-10 | Line Failure | [0] No function | All set-ups | FALSE | - | Uint8 |
| 14-11 | AC Line Voltage at Line Fault | ExpressionLimit | All set-ups | TRUE | 0 | Uint16 |
| 14-12 | Function at Line Imbalance | [3] Derate | All set-ups | TRUE | - | Uint8 |
| 14-2* Reset Functions | | | | | | |
| 14-20 | Reset Mode | [10] Automatic reset x 10 | All set-ups | TRUE | - | Uint8 |
| 14-21 | Automatic Restart Time | 10 s | All set-ups | TRUE | 0 | Uint16 |
| 14-22 | Operation Mode | [0] Normal operation | All set-ups | TRUE | - | Uint8 |
| 14-23 | Typecode Setting | null | 2 set-ups | FALSE | - | Uint8 |
| 14-25 | Trip Delay at Torque Limit | 60 s | All set-ups | TRUE | 0 | Uint8 |
| 14-26 | Trip Delay at Inverter Fault | ExpressionLimit | All set-ups | TRUE | 0 | Uint8 |
| 14-28 | Production Settings | [0] No action | All set-ups | TRUE | - | Uint8 |
| 14-29 | Service Code | 0 N/A | All set-ups | TRUE | 0 | Int32 |
| 14-3* Current Limit Ctrl. | | | | | | |
| 14-30 | Current Lim Ctrl, Proportional Gain | 100 % | All set-ups | FALSE | 0 | Uint16 |
| 14-31 | Current Lim Ctrl, Integration Time | 0.020 s | All set-ups | FALSE | -3 | Uint16 |
| 14-4* Energy Optimizing | | | | | | |
| 14-40 | VT Level | 66 % | All set-ups | FALSE | 0 | Uint8 |
| 14-41 | AEO Minimum Magnetization | ExpressionLimit | All set-ups | TRUE | 0 | Uint8 |
| 14-42 | Minimum AEO Frequency | 10 Hz | All set-ups | TRUE | 0 | Uint8 |
| 14-43 | Motor Cos-Phi | ExpressionLimit | All set-ups | TRUE | -2 | Uint16 |
| 14-5* Environment | | | | | | |
| 14-50 | RFI Filter | [1] On | 1 set-up | FALSE | - | Uint8 |
| 14-52 | Fan Control | [0] Auto | All set-ups | TRUE | - | Uint8 |
| 14-53 | Fan Monitor | [1] Warning | All set-ups | TRUE | - | Uint8 |
| 14-55 | Output Filter | [0] No Filter | 1 set-up | FALSE | - | Uint8 |
| 14-59 | Actual Number of Inverter Units | ExpressionLimit | 1 set-up | FALSE | 0 | Uint8 |
| 14-6* Auto Derate | | | | | | |
| 14-60 | Function at Overtemperature | [1] Derate | All set-ups | TRUE | - | Uint8 |
| 14-61 | Function at Inverter Overload | [1] Derate | All set-ups | TRUE | - | Uint8 |
| 14-62 | Inv. Overload Derate Current | 95 % | All set-ups | TRUE | 0 | Uint16 |
| 14-8* Options | | | | | | |
| 14-80 | Option Supplied by External 24VDC | [0] No | 2 set-ups | FALSE | - | Uint8 |

6.3.14 Adj. Freq. Drive Information 15-**

| Par. No. # | Parameter description | Default value | 4 set-up | Change during operation | Conversion index | Type |
|-----------------------------------|--|-----------------------|-------------|-------------------------|------------------|------------|
| 15-0* Operating Data | | | | | | |
| 15-00 | Operating Hours | 0 h | All set-ups | FALSE | 74 | Uint32 |
| 15-01 | Running Hours | 0 h | All set-ups | FALSE | 74 | Uint32 |
| 15-02 | kWh Counter | 0 kWh | All set-ups | FALSE | 75 | Uint32 |
| 15-03 | Power-ups | 0 N/A | All set-ups | FALSE | 0 | Uint32 |
| 15-04 | Overtemps | 0 N/A | All set-ups | FALSE | 0 | Uint16 |
| 15-05 | Overvolts | 0 N/A | All set-ups | FALSE | 0 | Uint16 |
| 15-06 | Reset kWh Counter | [0] Do not reset | All set-ups | TRUE | - | Uint8 |
| 15-07 | Reset Running Hours Counter | [0] Do not reset | All set-ups | TRUE | - | Uint8 |
| 15-08 | Number of Starts | 0 N/A | All set-ups | FALSE | 0 | Uint32 |
| 15-1* Data Log Settings | | | | | | |
| 15-10 | Logging Source | 0 | 2 set-ups | TRUE | - | Uint16 |
| 15-11 | Logging Interval | ExpressionLimit | 2 set-ups | TRUE | -3 | TimD |
| 15-12 | Trigger Event | [0] False | 1 set-up | TRUE | - | Uint8 |
| 15-13 | Logging Mode | [0] Log always | 2 set-ups | TRUE | - | Uint8 |
| 15-14 | Samples Before Trigger | 50 N/A | 2 set-ups | TRUE | 0 | Uint8 |
| 15-2* Historic Log | | | | | | |
| 15-20 | Historic Log: Event | 0 N/A | All set-ups | FALSE | 0 | Uint8 |
| 15-21 | Historic Log: Value | 0 N/A | All set-ups | FALSE | 0 | Uint32 |
| 15-22 | Historic Log: Time | 0 ms | All set-ups | FALSE | -3 | Uint32 |
| 15-23 | Historic Log: Date and Time | ExpressionLimit | All set-ups | FALSE | 0 | TimeOfDay |
| 15-3* Alarm Log | | | | | | |
| 15-30 | Alarm Log: Error Code | 0 N/A | All set-ups | FALSE | 0 | Uint8 |
| 15-31 | Alarm Log: Value | 0 N/A | All set-ups | FALSE | 0 | Int16 |
| 15-32 | Alarm Log: Time | 0 s | All set-ups | FALSE | 0 | Uint32 |
| 15-33 | Alarm Log: Date and Time | ExpressionLimit | All set-ups | FALSE | 0 | TimeOfDay |
| 15-34 | Alarm Log: Setpoint | 0.000 ProcessCtrlUnit | All set-ups | FALSE | -3 | Int32 |
| 15-35 | Alarm Log: Feedback | 0.000 ProcessCtrlUnit | All set-ups | FALSE | -3 | Int32 |
| 15-36 | Alarm Log: Current Demand | 0 % | All set-ups | FALSE | 0 | Uint8 |
| 15-37 | Alarm Log: Process Ctrl Unit | [0] | All set-ups | FALSE | - | Uint8 |
| 15-4* Drive Identification | | | | | | |
| 15-40 | Adj. Freq. Drive Type | 0 N/A | All set-ups | FALSE | 0 | VisStr[6] |
| 15-41 | Power Section | 0 N/A | All set-ups | FALSE | 0 | VisStr[20] |
| 15-42 | Voltage | 0 N/A | All set-ups | FALSE | 0 | VisStr[20] |
| 15-43 | Software Version | 0 N/A | All set-ups | FALSE | 0 | VisStr[5] |
| 15-44 | Ordered Typecode String | 0 N/A | All set-ups | FALSE | 0 | VisStr[40] |
| 15-45 | Actual Typecode String | 0 N/A | All set-ups | FALSE | 0 | VisStr[40] |
| 15-46 | Adjustable Frequency Drive Ordering No. | 0 N/A | All set-ups | FALSE | 0 | VisStr[8] |
| 15-47 | Power Card Ordering No. | 0 N/A | All set-ups | FALSE | 0 | VisStr[8] |
| 15-48 | LCP ID No | 0 N/A | All set-ups | FALSE | 0 | VisStr[20] |
| 15-49 | SW ID Control Card | 0 N/A | All set-ups | FALSE | 0 | VisStr[20] |
| 15-50 | SW ID Power Card | 0 N/A | All set-ups | FALSE | 0 | VisStr[20] |
| 15-51 | Adjustable Frequency Drive Serial Number | 0 N/A | All set-ups | FALSE | 0 | VisStr[10] |
| 15-53 | Power Card Serial Number | 0 N/A | All set-ups | FALSE | 0 | VisStr[19] |

| Par. No. # | Parameter description | Default value | 4 set-up | Change during operation | Conversion index | Type |
|-----------------------------|---------------------------|---------------|-------------|-------------------------|------------------|------------|
| 15-6* Option Ident | | | | | | |
| 15-60 | Option Mounted | 0 N/A | All set-ups | FALSE | 0 | VisStr[30] |
| 15-61 | Option SW Version | 0 N/A | All set-ups | FALSE | 0 | VisStr[20] |
| 15-62 | Option Ordering No | 0 N/A | All set-ups | FALSE | 0 | VisStr[8] |
| 15-63 | Option Serial No | 0 N/A | All set-ups | FALSE | 0 | VisStr[18] |
| 15-70 | Option in Slot A | 0 N/A | All set-ups | FALSE | 0 | VisStr[30] |
| 15-71 | Slot A Option SW Version | 0 N/A | All set-ups | FALSE | 0 | VisStr[20] |
| 15-72 | Option in Slot B | 0 N/A | All set-ups | FALSE | 0 | VisStr[30] |
| 15-73 | Slot B Option SW Version | 0 N/A | All set-ups | FALSE | 0 | VisStr[20] |
| 15-74 | Option in Slot C0 | 0 N/A | All set-ups | FALSE | 0 | VisStr[30] |
| 15-75 | Slot C0 Option SW Version | 0 N/A | All set-ups | FALSE | 0 | VisStr[20] |
| 15-76 | Option in Slot C1 | 0 N/A | All set-ups | FALSE | 0 | VisStr[30] |
| 15-77 | Slot C1 Option SW Version | 0 N/A | All set-ups | FALSE | 0 | VisStr[20] |
| 15-9* Parameter Info | | | | | | |
| 15-92 | Defined Parameters | 0 N/A | All set-ups | FALSE | 0 | Uint16 |
| 15-93 | Modified Parameters | 0 N/A | All set-ups | FALSE | 0 | Uint16 |
| 15-98 | Drive Identification | 0 N/A | All set-ups | FALSE | 0 | VisStr[40] |
| 15-99 | Parameter Metadata | 0 N/A | All set-ups | FALSE | 0 | Uint16 |

6.3.15 Data Readouts 16-**

| Par. No. # | Parameter description | Default value | 4 set-up | Change during operation | Conver- sion index | Type |
|--------------------------------|-----------------------|----------------------------------|-------------|----------------------------|-----------------------|--------|
| 16-0* General Status | | | | | | |
| 16-00 | Control Word | 0 N/A | All set-ups | TRUE | 0 | V2 |
| 16-01 | Reference [Unit] | 0.000 Reference- FeedbackUnit | All set-ups | TRUE | -3 | Int32 |
| 16-02 | Reference [%] | 0.0% | All set-ups | TRUE | -1 | Int16 |
| 16-03 | Status Word | 0 N/A | All set-ups | TRUE | 0 | V2 |
| 16-05 | Main Actual Value [%] | 0.00% | All set-ups | TRUE | -2 | N2 |
| 16-09 | Custom Readout | 0.00 CustomRea- doutUnit | All set-ups | TRUE | -2 | Int32 |
| 16-1* Motor Status | | | | | | |
| 16-10 | Power [kW] | 0.00 kW | All set-ups | TRUE | 1 | Int32 |
| 16-11 | Power [hp] | 0.00 hp | All set-ups | TRUE | -2 | Int32 |
| 16-12 | Motor Voltage | 0.0 V | All set-ups | TRUE | -1 | UInt16 |
| 16-13 | Frequency | 0.0 Hz | All set-ups | TRUE | -1 | UInt16 |
| 16-14 | Motor Current | 0.00 A | All set-ups | TRUE | -2 | Int32 |
| 16-15 | Frequency [%] | 0.00% | All set-ups | TRUE | -2 | N2 |
| 16-16 | Torque [Nm] | 0.0 Nm | All set-ups | TRUE | -1 | Int32 |
| 16-17 | Speed [RPM] | 0 RPM | All set-ups | TRUE | 67 | Int32 |
| 16-18 | Motor Thermal | 0 % | All set-ups | TRUE | 0 | UInt8 |
| 16-22 | Torque [%] | 0 % | All set-ups | TRUE | 0 | Int16 |
| 16-3* Drive Status | | | | | | |
| 16-30 | DC Link Voltage | 0 V | All set-ups | TRUE | 0 | UInt16 |
| 16-32 | Brake Energy /s | 0.000 kW | All set-ups | TRUE | 0 | UInt32 |
| 16-33 | Brake Energy/2 min | 0.000 kW | All set-ups | TRUE | 0 | UInt32 |
| 16-34 | Heatsink Temp. | 0 °C | All set-ups | TRUE | 100 | UInt8 |
| 16-35 | Inverter Thermal | 0 % | All set-ups | TRUE | 0 | UInt8 |
| 16-36 | Inv. Nom. Current | ExpressionLimit | All set-ups | TRUE | -2 | UInt32 |
| 16-37 | Inv. Max. Current | ExpressionLimit | All set-ups | TRUE | -2 | UInt32 |
| 16-38 | SL Controller State | 0 N/A | All set-ups | TRUE | 0 | UInt8 |
| 16-39 | Control Card Temp. | 0 °C | All set-ups | TRUE | 100 | UInt8 |
| 16-40 | Logging Buffer Full | [0] No | All set-ups | TRUE | - | UInt8 |
| 16-5* Ref. & Feedb. | | | | | | |
| 16-50 | External Reference | 0.0 N/A | All set-ups | TRUE | -1 | Int16 |
| 16-52 | Feedback [Unit] | 0.000 ProcessCtrlUnit | All set-ups | TRUE | -3 | Int32 |
| 16-53 | Digi Pot Reference | 0.00 N/A | All set-ups | TRUE | -2 | Int16 |
| 16-54 | Feedback 1 [Unit] | 0.000 ProcessCtrlUnit | All set-ups | TRUE | -3 | Int32 |
| 16-55 | Feedback 2 [Unit] | 0.000 ProcessCtrlUnit | All set-ups | TRUE | -3 | Int32 |
| 16-56 | Feedback 3 [Unit] | 0.000 ProcessCtrlUnit | All set-ups | TRUE | -3 | Int32 |
| 16-58 | PID Output [%] | 0.0% | All set-ups | TRUE | -1 | Int16 |
| 16-59 | Adjusted Setpoint | 0.000 ProcessCtrlUnit | All set-ups | TRUE | -3 | Int32 |

| Par. No. # | Parameter description | Default value | 4 set-up | Change during operation | Conver- sion index | Type |
|-------------------------------------|-----------------------------|---------------|-------------|----------------------------|-----------------------|--------|
| 16-6* Inputs & Outputs | | | | | | |
| 16-60 | Digital Input | 0 N/A | All set-ups | TRUE | 0 | Uint16 |
| 16-61 | Terminal 53 Switch Setting | [0] Current | All set-ups | TRUE | - | Uint8 |
| 16-62 | Analog Input 53 | 0.000 N/A | All set-ups | TRUE | -3 | Int32 |
| 16-63 | Terminal 54 Switch Setting | [0] Current | All set-ups | TRUE | - | Uint8 |
| 16-64 | Analog Input 54 | 0.000 N/A | All set-ups | TRUE | -3 | Int32 |
| 16-65 | Analog Output 42 [mA] | 0.000 N/A | All set-ups | TRUE | -3 | Int16 |
| 16-66 | Digital Output [bin] | 0 N/A | All set-ups | TRUE | 0 | Int16 |
| 16-67 | Pulse Input #29 [Hz] | 0 N/A | All set-ups | TRUE | 0 | Int32 |
| 16-68 | Pulse Input #33 [Hz] | 0 N/A | All set-ups | TRUE | 0 | Int32 |
| 16-69 | Pulse Output #27 [Hz] | 0 N/A | All set-ups | TRUE | 0 | Int32 |
| 16-70 | Pulse Output #29 [Hz] | 0 N/A | All set-ups | TRUE | 0 | Int32 |
| 16-71 | Relay Output [bin] | 0 N/A | All set-ups | TRUE | 0 | Uint16 |
| 16-72 | Counter A | 0 N/A | All set-ups | TRUE | 0 | Int32 |
| 16-73 | Counter B | 0 N/A | All set-ups | TRUE | 0 | Int32 |
| 16-75 | Analog In X30/11 | 0.000 N/A | All set-ups | TRUE | -3 | Int32 |
| 16-76 | Analog In X30/12 | 0.000 N/A | All set-ups | TRUE | -3 | Int32 |
| 16-77 | Analog Out X30/8 [mA] | 0.000 N/A | All set-ups | TRUE | -3 | Int16 |
| 16-8* Fieldbus & FC Port | | | | | | |
| 16-80 | Serial com. bus CTW 1 | 0 N/A | All set-ups | TRUE | 0 | V2 |
| 16-82 | Serial com. bus REF 1 | 0 N/A | All set-ups | TRUE | 0 | N2 |
| 16-84 | Comm. Option STW | 0 N/A | All set-ups | TRUE | 0 | V2 |
| 16-85 | Adj. Freq. Drive Port CTW 1 | 0 N/A | All set-ups | TRUE | 0 | V2 |
| 16-86 | Adj. Freq. Drive Port REF 1 | 0 N/A | All set-ups | TRUE | 0 | N2 |
| 16-9* Diagnosis Readouts | | | | | | |
| 16-90 | Alarm Word | 0 N/A | All set-ups | TRUE | 0 | Uint32 |
| 16-91 | Alarm Word 2 | 0 N/A | All set-ups | TRUE | 0 | Uint32 |
| 16-92 | Warning Word | 0 N/A | All set-ups | TRUE | 0 | Uint32 |
| 16-93 | Warning Word 2 | 0 N/A | All set-ups | TRUE | 0 | Uint32 |
| 16-94 | Ext. Status Word | 0 N/A | All set-ups | TRUE | 0 | Uint32 |
| 16-95 | Ext. Status Word 2 | 0 N/A | All set-ups | TRUE | 0 | Uint32 |
| 16-96 | Maintenance Word | 0 N/A | All set-ups | TRUE | 0 | Uint32 |

6.3.16 Data Readouts 2 18-**

| Par. No. # | Parameter description | Default value | 4 set-up | Change during operation | Conversion index | Type |
|-----------------------------------|--------------------------------|-----------------|-------------|-------------------------|------------------|-----------|
| 18-0* Maintenance Log | | | | | | |
| 18-00 | Maintenance Log: Item | 0 N/A | All set-ups | FALSE | 0 | UInt8 |
| 18-01 | Maintenance Log: Action | 0 N/A | All set-ups | FALSE | 0 | UInt8 |
| 18-02 | Maintenance Log: Time | 0 s | All set-ups | FALSE | 0 | UInt32 |
| 18-03 | Maintenance Log: Date and Time | ExpressionLimit | All set-ups | FALSE | 0 | TimeOfDay |
| 18-3* Inputs & Outputs | | | | | | |
| 18-30 | Analog Input X42/1 | 0.000 N/A | All set-ups | FALSE | -3 | Int32 |
| 18-31 | Analog Input X42/3 | 0.000 N/A | All set-ups | FALSE | -3 | Int32 |
| 18-32 | Analog Input X42/5 | 0.000 N/A | All set-ups | FALSE | -3 | Int32 |
| 18-33 | Analog Out X42/7 [V] | 0.000 N/A | All set-ups | FALSE | -3 | Int16 |
| 18-34 | Analog Out X42/9 [V] | 0.000 N/A | All set-ups | FALSE | -3 | Int16 |
| 18-35 | Analog Out X42/11 [V] | 0.000 N/A | All set-ups | FALSE | -3 | Int16 |

6.3.17 Adj. Freq. Drive Closed-loop 20-**

| Par. No. # | Parameter description | Default value | 4 set-up | Change during operation | Conver- sion index | Type |
|---------------------------------|-----------------------------|--------------------------------|-------------|----------------------------|-----------------------|--------|
| 20-0* Feedback | | | | | | |
| 20-00 | Feedback 1 Source | [2] Analog input 54 | All set-ups | TRUE | - | Uint8 |
| 20-01 | Feedback 1 Conversion | [0] Linear | All set-ups | FALSE | - | Uint8 |
| 20-02 | Feedback 1 Source Unit | null | All set-ups | TRUE | - | Uint8 |
| 20-03 | Feedback 2 Source | [0] No function | All set-ups | TRUE | - | Uint8 |
| 20-04 | Feedback 2 Conversion | [0] Linear | All set-ups | FALSE | - | Uint8 |
| 20-05 | Feedback 2 Source Unit | null | All set-ups | TRUE | - | Uint8 |
| 20-06 | Feedback 3 Source | [0] No function | All set-ups | TRUE | - | Uint8 |
| 20-07 | Feedback 3 Conversion | [0] Linear | All set-ups | FALSE | - | Uint8 |
| 20-08 | Feedback 3 Source Unit | null | All set-ups | TRUE | - | Uint8 |
| 20-12 | Reference/Feedback Unit | null | All set-ups | TRUE | - | Uint8 |
| 20-2* Feedback/Setpoint | | | | | | |
| 20-20 | Feedback Function | [4] Maximum | All set-ups | TRUE | - | Uint8 |
| 20-21 | Setpoint 1 | 0.000 ProcessCtrlUnit | All set-ups | TRUE | -3 | Int32 |
| 20-22 | Setpoint 2 | 0.000 ProcessCtrlUnit | All set-ups | TRUE | -3 | Int32 |
| 20-23 | Setpoint 3 | 0.000 ProcessCtrlUnit | All set-ups | TRUE | -3 | Int32 |
| 20-7* PID Auto tuning | | | | | | |
| 20-70 | Closed-loop Type | [0] Auto | 2 set-ups | TRUE | - | Uint8 |
| 20-71 | PID Performance | [0] Normal | 2 set-ups | TRUE | - | Uint8 |
| 20-72 | PID Output Change | 0.10 N/A | 2 set-ups | TRUE | -2 | Uint16 |
| 20-73 | Minimum Feedback Level | -999999.000 ProcessCtrlUnit | 2 set-ups | TRUE | -3 | Int32 |
| 20-74 | Maximum Feedback Level | 999999.000 ProcessCtrlUnit | 2 set-ups | TRUE | -3 | Int32 |
| 20-79 | PID Auto-tuning | [0] Disabled | All set-ups | TRUE | - | Uint8 |
| 20-8* PID Basic Settings | | | | | | |
| 20-81 | PID Normal/ Inverse Control | [0] Normal | All set-ups | TRUE | - | Uint8 |
| 20-82 | PID Start Speed [RPM] | ExpressionLimit | All set-ups | TRUE | 67 | Uint16 |
| 20-83 | PID Start Speed [Hz] | ExpressionLimit | All set-ups | TRUE | -1 | Uint16 |
| 20-84 | On Reference Bandwidth | 5 % | All set-ups | TRUE | 0 | Uint8 |
| 20-9* PID Controller | | | | | | |
| 20-91 | PID Anti Windup | [1] On | All set-ups | TRUE | - | Uint8 |
| 20-93 | PID Proportional Gain | 2.00 N/A | All set-ups | TRUE | -2 | Uint16 |
| 20-94 | PID Integral Time | 8.00 s | All set-ups | TRUE | -2 | Uint32 |
| 20-95 | PID Differentiation Time | 0.00 s | All set-ups | TRUE | -2 | Uint16 |
| 20-96 | PID Diff. Gain Limit | 5.0 N/A | All set-ups | TRUE | -1 | Uint16 |

6.3.18 Ext. Closed-loop 21-**

| Par. No. # | Parameter description | Default value | 4 set-up | Change during operation | Conver- sion index | Type |
|---------------------------------|-------------------------------|---------------------|-------------|----------------------------|-----------------------|--------|
| 21-0* Ext. CL Autotuning | | | | | | |
| 21-00 | Closed-loop Type | [0] Auto | 2 set-ups | TRUE | - | Uint8 |
| 21-01 | PID Performance | [0] Normal | 2 set-ups | TRUE | - | Uint8 |
| 21-02 | PID Output Change | 0.10 N/A | 2 set-ups | TRUE | -2 | Uint16 |
| 21-03 | Minimum Feedback Level | -999999.000 N/A | 2 set-ups | TRUE | -3 | Int32 |
| 21-04 | Maximum Feedback Level | 999999.000 N/A | 2 set-ups | TRUE | -3 | Int32 |
| 21-09 | PID Auto Tuning | [0] Disabled | All set-ups | TRUE | - | Uint8 |
| 21-1* Ext. CL 1 Ref./Fb. | | | | | | |
| 21-10 | Ext. 1 Ref./Feedback Unit | [0] | All set-ups | TRUE | - | Uint8 |
| 21-11 | Ext. 1 Minimum Reference | 0.000 ExtPID1Unit | All set-ups | TRUE | -3 | Int32 |
| 21-12 | Ext. 1 Maximum Reference | 100.000 ExtPID1Unit | All set-ups | TRUE | -3 | Int32 |
| 21-13 | Ext. 1 Reference Source | [0] No function | All set-ups | TRUE | - | Uint8 |
| 21-14 | Ext. 1 Feedback Source | [0] No function | All set-ups | TRUE | - | Uint8 |
| 21-15 | Ext. 1 Setpoint | 0.000 ExtPID1Unit | All set-ups | TRUE | -3 | Int32 |
| 21-17 | Ext. 1 Reference [Unit] | 0.000 ExtPID1Unit | All set-ups | TRUE | -3 | Int32 |
| 21-18 | Ext. 1 Feedback [Unit] | 0.000 ExtPID1Unit | All set-ups | TRUE | -3 | Int32 |
| 21-19 | Ext. 1 Output [%] | 0 % | All set-ups | TRUE | 0 | Int32 |
| 21-2* Ext. CL 1 PID | | | | | | |
| 21-20 | Ext. 1 Normal/Inverse Control | [0] Normal | All set-ups | TRUE | - | Uint8 |
| 21-21 | Ext. 1 Proportional Gain | 0.50 N/A | All set-ups | TRUE | -2 | Uint16 |
| 21-22 | Ext. 1 Integral Time | 20.00 s | All set-ups | TRUE | -2 | Uint32 |
| 21-23 | Ext. 1 Differentiation Time | 0.00 s | All set-ups | TRUE | -2 | Uint16 |
| 21-24 | Ext. 1 Dif. Gain Limit | 5.0 N/A | All set-ups | TRUE | -1 | Uint16 |
| 21-3* Ext. CL 2 Ref./Fb. | | | | | | |
| 21-30 | Ext. 2 Ref./Feedback Unit | [0] | All set-ups | TRUE | - | Uint8 |
| 21-31 | Ext. 2 Minimum Reference | 0.000 ExtPID2Unit | All set-ups | TRUE | -3 | Int32 |
| 21-32 | Ext. 2 Maximum Reference | 100.000 ExtPID2Unit | All set-ups | TRUE | -3 | Int32 |
| 21-33 | Ext. 2 Reference Source | [0] No function | All set-ups | TRUE | - | Uint8 |
| 21-34 | Ext. 2 Feedback Source | [0] No function | All set-ups | TRUE | - | Uint8 |
| 21-35 | Ext. 2 Setpoint | 0.000 ExtPID2Unit | All set-ups | TRUE | -3 | Int32 |
| 21-37 | Ext. 2 Reference [Unit] | 0.000 ExtPID2Unit | All set-ups | TRUE | -3 | Int32 |
| 21-38 | Ext. 2 Feedback [Unit] | 0.000 ExtPID2Unit | All set-ups | TRUE | -3 | Int32 |
| 21-39 | Ext. 2 Output [%] | 0 % | All set-ups | TRUE | 0 | Int32 |
| 21-4* Ext. CL 2 PID | | | | | | |
| 21-40 | Ext. 2 Normal/Inverse Control | [0] Normal | All set-ups | TRUE | - | Uint8 |
| 21-41 | Ext. 2 Proportional Gain | 0.50 N/A | All set-ups | TRUE | -2 | Uint16 |
| 21-42 | Ext. 2 Integral Time | 20.00 s | All set-ups | TRUE | -2 | Uint32 |
| 21-43 | Ext. 2 Differentiation Time | 0.00 s | All set-ups | TRUE | -2 | Uint16 |
| 21-44 | Ext. 2 Dif. Gain Limit | 5.0 N/A | All set-ups | TRUE | -1 | Uint16 |

| Par. No. # | Parameter description | Default value | 4 set-up | Change during operation | Conversion index | Type |
|---------------------------------|-------------------------------|---------------------|-------------|-------------------------|------------------|--------|
| 21-5* Ext. CL 3 Ref./Fb. | | | | | | |
| 21-50 | Ext. 3 Ref./Feedback Unit | [0] | All set-ups | TRUE | - | UInt8 |
| 21-51 | Ext. 3 Minimum Reference | 0.000 ExtPID3Unit | All set-ups | TRUE | -3 | Int32 |
| 21-52 | Ext. 3 Maximum Reference | 100.000 ExtPID3Unit | All set-ups | TRUE | -3 | Int32 |
| 21-53 | Ext. 3 Reference Source | [0] No function | All set-ups | TRUE | - | UInt8 |
| 21-54 | Ext. 3 Feedback Source | [0] No function | All set-ups | TRUE | - | UInt8 |
| 21-55 | Ext. 3 Setpoint | 0.000 ExtPID3Unit | All set-ups | TRUE | -3 | Int32 |
| 21-57 | Ext. 3 Reference [Unit] | 0.000 ExtPID3Unit | All set-ups | TRUE | -3 | Int32 |
| 21-58 | Ext. 3 Feedback [Unit] | 0.000 ExtPID3Unit | All set-ups | TRUE | -3 | Int32 |
| 21-59 | Ext. 3 Output [%] | 0 % | All set-ups | TRUE | 0 | Int32 |
| 21-6* Ext. CL 3 PID | | | | | | |
| 21-60 | Ext. 3 Normal/Inverse Control | [0] Normal | All set-ups | TRUE | - | UInt8 |
| 21-61 | Ext. 3 Proportional Gain | 0.50 N/A | All set-ups | TRUE | -2 | UInt16 |
| 21-62 | Ext. 3 Integral Time | 20.00 s | All set-ups | TRUE | -2 | UInt32 |
| 21-63 | Ext. 3 Differentiation Time | 0.00 s | All set-ups | TRUE | -2 | UInt16 |
| 21-64 | Ext. 3 Dif. Gain Limit | 5.0 N/A | All set-ups | TRUE | -1 | UInt16 |

6.3.19 Application Functions 22-**

| Par. No. # | Parameter description | Default value | 4 set-up | Change during operation | Conversion index | Type |
|-------------------------------------|----------------------------|------------------------------------|-------------|-------------------------|------------------|--------|
| 22-0* Miscellaneous | | | | | | |
| 22-00 | External Interlock Delay | 0 s | All set-ups | TRUE | 0 | Uint16 |
| 22-2* No-Flow Detection | | | | | | |
| 22-20 | Low Power Auto Set-up | [0] Off | All set-ups | FALSE | - | Uint8 |
| 22-21 | Low Power Detection | [0] Disabled | All set-ups | TRUE | - | Uint8 |
| 22-22 | Low Speed Detection | [0] Disabled | All set-ups | TRUE | - | Uint8 |
| 22-23 | No-Flow Function | [0] Off | All set-ups | TRUE | - | Uint8 |
| 22-24 | No-Flow Delay | 10 s | All set-ups | TRUE | 0 | Uint16 |
| 22-26 | Dry Pump Function | [0] Off | All set-ups | TRUE | - | Uint8 |
| 22-27 | Dry Pump Delay | 10 s | All set-ups | TRUE | 0 | Uint16 |
| 22-3* No-Flow Power Tuning | | | | | | |
| 22-30 | No-Flow Power | 0.00 kW | All set-ups | TRUE | 1 | Uint32 |
| 22-31 | Power Correction Factor | 100 % | All set-ups | TRUE | 0 | Uint16 |
| 22-32 | Low Speed [RPM] | ExpressionLimit | All set-ups | TRUE | 67 | Uint16 |
| 22-33 | Low Speed [Hz] | ExpressionLimit | All set-ups | TRUE | -1 | Uint16 |
| 22-34 | Low Speed Power [kW] | ExpressionLimit | All set-ups | TRUE | 1 | Uint32 |
| 22-35 | Low Speed Power [HP] | ExpressionLimit | All set-ups | TRUE | -2 | Uint32 |
| 22-36 | High Speed [RPM] | ExpressionLimit | All set-ups | TRUE | 67 | Uint16 |
| 22-37 | High Speed [Hz] | ExpressionLimit | All set-ups | TRUE | -1 | Uint16 |
| 22-38 | High Speed Power [kW] | ExpressionLimit | All set-ups | TRUE | 1 | Uint32 |
| 22-39 | High Speed Power [HP] | ExpressionLimit | All set-ups | TRUE | -2 | Uint32 |
| 22-4* Sleep Mode | | | | | | |
| 22-40 | Minimum Run Time | 60 s | All set-ups | TRUE | 0 | Uint16 |
| 22-41 | Minimum Sleep Time | 30 s | All set-ups | TRUE | 0 | Uint16 |
| 22-42 | Wake-up Speed [RPM] | ExpressionLimit | All set-ups | TRUE | 67 | Uint16 |
| 22-43 | Wake-up Speed [Hz] | ExpressionLimit | All set-ups | TRUE | -1 | Uint16 |
| 22-44 | Wake-up Ref./FB Difference | 10 % | All set-ups | TRUE | 0 | Int8 |
| 22-45 | Setpoint Boost | 0 % | All set-ups | TRUE | 0 | Int8 |
| 22-46 | Maximum Boost Time | 60 s | All set-ups | TRUE | 0 | Uint16 |
| 22-5* End of Curve | | | | | | |
| 22-50 | End of Curve Function | [0] Off | All set-ups | TRUE | - | Uint8 |
| 22-51 | End of Curve Delay | 10 s | All set-ups | TRUE | 0 | Uint16 |
| 22-6* Broken Belt Detection | | | | | | |
| 22-60 | Broken Belt Function | [0] Off | All set-ups | TRUE | - | Uint8 |
| 22-61 | Broken Belt Torque | 10 % | All set-ups | TRUE | 0 | Uint8 |
| 22-62 | Broken Belt Delay | 10 s | All set-ups | TRUE | 0 | Uint16 |
| 22-7* Short Cycle Protection | | | | | | |
| 22-75 | Short Cycle Protection | [0] Disabled | All set-ups | TRUE | - | Uint8 |
| 22-76 | Interval between Starts | start_to_start_min_on_time (P2277) | All set-ups | TRUE | 0 | Uint16 |
| 22-77 | Minimum Run Time | 0 s | All set-ups | TRUE | 0 | Uint16 |

| Par. No. # | Parameter description | Default value | 4 set-up | Change during operation | Conver- sion index | Type |
|--------------------------------|-----------------------------------|-----------------|-------------|----------------------------|-----------------------|--------|
| 22-8* Flow Compensation | | | | | | |
| 22-80 | Flow Compensation | [0] Disabled | All set-ups | TRUE | - | Uint8 |
| 22-81 | Square-linear Curve Approximation | 100 % | All set-ups | TRUE | 0 | Uint8 |
| 22-82 | Work Point Calculation | [0] Disabled | All set-ups | TRUE | - | Uint8 |
| 22-83 | Speed at No-Flow [RPM] | ExpressionLimit | All set-ups | TRUE | 67 | Uint16 |
| 22-84 | Speed at No-Flow [Hz] | ExpressionLimit | All set-ups | TRUE | -1 | Uint16 |
| 22-85 | Speed at Design Point [RPM] | ExpressionLimit | All set-ups | TRUE | 67 | Uint16 |
| 22-86 | Speed at Design Point [Hz] | ExpressionLimit | All set-ups | TRUE | -1 | Uint16 |
| 22-87 | Pressure at No-Flow Speed | 0.000 N/A | All set-ups | TRUE | -3 | Int32 |
| 22-88 | Pressure at Rated Speed | 999999.999 N/A | All set-ups | TRUE | -3 | Int32 |
| 22-89 | Flow at Design Point | 0.000 N/A | All set-ups | TRUE | -3 | Int32 |
| 22-90 | Flow at Rated Speed | 0.000 N/A | All set-ups | TRUE | -3 | Int32 |

6.3.20 Timed Actions 23-**

| Par. No. # | Parameter description | Default value | 4 set-up | Change during operation | Conver- sion index | Type |
|--------------------------------|---------------------------|--------------------|-------------|----------------------------|-----------------------|-----------------|
| 23-0* Timed Actions | | | | | | |
| 23-00 | ON Time | ExpressionLimit | 2 set-ups | TRUE | 0 | TimeOfDayWoDate |
| 23-01 | ON Action | [0] Disabled | 2 set-ups | TRUE | - | Uint8 |
| 23-02 | OFF Time | ExpressionLimit | 2 set-ups | TRUE | 0 | TimeOfDayWoDate |
| 23-03 | OFF Action | [0] Disabled | 2 set-ups | TRUE | - | Uint8 |
| 23-04 | Occurrence | [0] All days | 2 set-ups | TRUE | - | Uint8 |
| 23-1* Maintenance | | | | | | |
| 23-10 | Maintenance Item | [1] Motor bearings | 1 set-up | TRUE | - | Uint8 |
| 23-11 | Maintenance Action | [1] Lubricate | 1 set-up | TRUE | - | Uint8 |
| 23-12 | Maintenance Time Base | [0] Disabled | 1 set-up | TRUE | - | Uint8 |
| 23-13 | Maintenance Time Interval | 1 h | 1 set-up | TRUE | 74 | Uint32 |
| 23-14 | Maintenance Date and Time | ExpressionLimit | 1 set-up | TRUE | 0 | TimeOfDay |
| 23-1* Maintenance Reset | | | | | | |
| 23-15 | Reset Maintenance Word | [0] Do not reset | All set-ups | TRUE | - | Uint8 |
| 23-16 | Maintenance Text | 0 N/A | 1 set-up | TRUE | 0 | VisStr[20] |
| 23-5* Energy Log | | | | | | |
| 23-50 | Energy Log Resolution | [5] Last 24 Hours | 2 set-ups | TRUE | - | Uint8 |
| 23-51 | Period Start | ExpressionLimit | 2 set-ups | TRUE | 0 | TimeOfDay |
| 23-53 | Energy Log | 0 N/A | All set-ups | TRUE | 0 | Uint32 |
| 23-54 | Reset Energy Log | [0] Do not reset | All set-ups | TRUE | - | Uint8 |
| 23-6* Trending | | | | | | |
| 23-60 | Trend Variable | [0] Power [kW] | 2 set-ups | TRUE | - | Uint8 |
| 23-61 | Continuous Bin Data | 0 N/A | All set-ups | TRUE | 0 | Uint32 |
| 23-62 | Timed Bin Data | 0 N/A | All set-ups | TRUE | 0 | Uint32 |
| 23-63 | Timed Period Start | ExpressionLimit | 2 set-ups | TRUE | 0 | TimeOfDay |
| 23-64 | Timed Period Stop | ExpressionLimit | 2 set-ups | TRUE | 0 | TimeOfDay |
| 23-65 | Minimum Bin Value | ExpressionLimit | 2 set-ups | TRUE | 0 | Uint8 |
| 23-66 | Reset Continuous Bin Data | [0] Do not reset | All set-ups | TRUE | - | Uint8 |
| 23-67 | Reset Timed Bin Data | [0] Do not reset | All set-ups | TRUE | - | Uint8 |
| 23-8* Payback Counter | | | | | | |
| 23-80 | Power Reference Factor | 100 % | 2 set-ups | TRUE | 0 | Uint8 |
| 23-81 | Energy Cost | 1.00 N/A | 2 set-ups | TRUE | -2 | Uint32 |
| 23-82 | Investment | 0 N/A | 2 set-ups | TRUE | 0 | Uint32 |
| 23-83 | Energy Savings | 0 kWh | All set-ups | TRUE | 75 | Int32 |
| 23-84 | Cost Savings | 0 N/A | All set-ups | TRUE | 0 | Int32 |

6.3.21 Cascade Controller 25-**

| Par. No. # | Parameter description | Default value | 4 set-up | Change during operation | Conversion index | Type |
|-----------------------------------|-----------------------------|---------------------------------|-------------|-------------------------|------------------|------------------|
| 25-0* System Settings | | | | | | |
| 25-00 | Cascade Controller | null | 2 set-ups | FALSE | - | Uint8 |
| 25-02 | Motor Start | [0] Direct on Line | 2 set-ups | FALSE | - | Uint8 |
| 25-04 | Pump Cycling | null | All set-ups | TRUE | - | Uint8 |
| 25-05 | Fixed Lead Pump | null | 2 set-ups | FALSE | - | Uint8 |
| 25-06 | Number of Pumps | 2 N/A | 2 set-ups | FALSE | 0 | Uint8 |
| 25-2* Bandwidth Settings | | | | | | |
| 25-20 | Staging Bandwidth | ExpressionLimit | All set-ups | TRUE | 0 | Uint8 |
| 25-21 | Override Bandwidth | 100 % | All set-ups | TRUE | 0 | Uint8 |
| 25-22 | Fixed Speed Bandwidth | casco_staging_bandwidth (P2520) | All set-ups | TRUE | 0 | Uint8 |
| 25-23 | SBW Staging Delay | 15 s | All set-ups | TRUE | 0 | Uint16 |
| 25-24 | SBW De-staging Delay | 15 s | All set-ups | TRUE | 0 | Uint16 |
| 25-25 | OBW Time | 10 s | All set-ups | TRUE | 0 | Uint16 |
| 25-26 | Destage At No-Flow | [0] Disabled | All set-ups | TRUE | - | Uint8 |
| 25-27 | Stage Function | null | All set-ups | TRUE | - | Uint8 |
| 25-28 | Stage Function Time | 15 s | All set-ups | TRUE | 0 | Uint16 |
| 25-29 | De-stage Function | null | All set-ups | TRUE | - | Uint8 |
| 25-30 | De-stage Function Time | 15 s | All set-ups | TRUE | 0 | Uint16 |
| 25-4* Staging Settings | | | | | | |
| 25-40 | Ramp-down Delay | 10.0 s | All set-ups | TRUE | -1 | Uint16 |
| 25-41 | Ramp-up Delay | 2.0 s | All set-ups | TRUE | -1 | Uint16 |
| 25-42 | Staging Threshold | ExpressionLimit | All set-ups | TRUE | 0 | Uint8 |
| 25-43 | De-staging Threshold | ExpressionLimit | All set-ups | TRUE | 0 | Uint8 |
| 25-44 | Staging Speed [RPM] | 0 RPM | All set-ups | TRUE | 67 | Uint16 |
| 25-45 | Staging Speed [Hz] | 0.0 Hz | All set-ups | TRUE | -1 | Uint16 |
| 25-46 | De-staging Speed [RPM] | 0 RPM | All set-ups | TRUE | 67 | Uint16 |
| 25-47 | De-staging Speed [Hz] | 0.0 Hz | All set-ups | TRUE | -1 | Uint16 |
| 25-5* Alternation Settings | | | | | | |
| 25-50 | Lead Pump Alternation | null | All set-ups | TRUE | - | Uint8 |
| 25-51 | Alternation Event | [0] External | All set-ups | TRUE | - | Uint8 |
| 25-52 | Alternation Time Interval | 24 h | All set-ups | TRUE | 74 | Uint16 |
| 25-53 | Alternation Timer Value | 0 N/A | All set-ups | TRUE | 0 | VisStr[7] |
| 25-54 | Alternation Predefined Time | ExpressionLimit | All set-ups | TRUE | 0 | TimeOfDay-WoDate |
| 25-55 | Alternate if Load < 50% | [1] Enabled | All set-ups | TRUE | - | Uint8 |
| 25-56 | Staging Mode at Alternation | [0] Slow | All set-ups | TRUE | - | Uint8 |
| 25-58 | Run Next Pump Delay | 0.1 s | All set-ups | TRUE | -1 | Uint16 |
| 25-59 | Run-on Line Delay | 0.5 s | All set-ups | TRUE | -1 | Uint16 |

| Par. No. # | Parameter description | Default value | 4 set-up | Change during operation | Conver- sion index | Type |
|----------------------|-----------------------|------------------|-------------|----------------------------|-----------------------|------------|
| 25-8* Status | | | | | | |
| 25-80 | Cascade Status | 0 N/A | All set-ups | TRUE | 0 | VisStr[25] |
| 25-81 | Pump Status | 0 N/A | All set-ups | TRUE | 0 | VisStr[25] |
| 25-82 | Lead Pump | 0 N/A | All set-ups | TRUE | 0 | UInt8 |
| 25-83 | Relay Status | 0 N/A | All set-ups | TRUE | 0 | VisStr[4] |
| 25-84 | Pump ON Time | 0 h | All set-ups | TRUE | 74 | UInt32 |
| 25-85 | Relay ON Time | 0 h | All set-ups | TRUE | 74 | UInt32 |
| 25-86 | Reset Relay Counters | [0] Do not reset | All set-ups | TRUE | - | UInt8 |
| 25-9* Service | | | | | | |
| 25-90 | Pump Interlock | [0] Off | All set-ups | TRUE | - | UInt8 |
| 25-91 | Manual Alternation | 0 N/A | All set-ups | TRUE | 0 | UInt8 |

6.3.22 Analog I/O Option MCB 109 26-**

| Par. No. # | Parameter description | Default value | 4 set-up | Change during operation | Conversion index | Type |
|---------------------------------|------------------------------------|------------------|-------------|-------------------------|------------------|--------|
| 26-0* Analog I/O Mode | | | | | | |
| 26-00 | Terminal X42/1 Mode | [1] Voltage | All set-ups | TRUE | - | Uint8 |
| 26-01 | Terminal X42/3 Mode | [1] Voltage | All set-ups | TRUE | - | Uint8 |
| 26-02 | Terminal X42/5 Mode | [1] Voltage | All set-ups | TRUE | - | Uint8 |
| 26-1* Analog Input X42/1 | | | | | | |
| 26-10 | Terminal X42/1 Low Voltage | 0.07 V | All set-ups | TRUE | -2 | Int16 |
| 26-11 | Terminal X42/1 High Voltage | 10.00 V | All set-ups | TRUE | -2 | Int16 |
| 26-14 | Term. X42/1 Low Ref./Feedb. Value | 0.000 N/A | All set-ups | TRUE | -3 | Int32 |
| 26-15 | Term. X42/1 High Ref./Feedb. Value | 100.000 N/A | All set-ups | TRUE | -3 | Int32 |
| 26-16 | Term. X42/1 Filter Time Constant | 0.001 s | All set-ups | TRUE | -3 | Uint16 |
| 26-17 | Term. X42/1 Live Zero | [1] Enabled | All set-ups | TRUE | - | Uint8 |
| 26-2* Analog Input X42/3 | | | | | | |
| 26-20 | Terminal X42/3 Low Voltage | 0.07 V | All set-ups | TRUE | -2 | Int16 |
| 26-21 | Terminal X42/3 High Voltage | 10.00 V | All set-ups | TRUE | -2 | Int16 |
| 26-24 | Term. X42/3 Low Ref./Feedb. Value | 0.000 N/A | All set-ups | TRUE | -3 | Int32 |
| 26-25 | Term. X42/3 High Ref./Feedb. Value | 100.000 N/A | All set-ups | TRUE | -3 | Int32 |
| 26-26 | Term. X42/3 Filter Time Constant | 0.001 s | All set-ups | TRUE | -3 | Uint16 |
| 26-27 | Term. X42/3 Live Zero | [1] Enabled | All set-ups | TRUE | - | Uint8 |
| 26-3* Analog Input X42/5 | | | | | | |
| 26-30 | Terminal X42/5 Low Voltage | 0.07 V | All set-ups | TRUE | -2 | Int16 |
| 26-31 | Terminal X42/5 High Voltage | 10.00 V | All set-ups | TRUE | -2 | Int16 |
| 26-34 | Term. X42/5 Low Ref./Feedb. Value | 0.000 N/A | All set-ups | TRUE | -3 | Int32 |
| 26-35 | Term. X42/5 High Ref./Feedb. Value | 100.000 N/A | All set-ups | TRUE | -3 | Int32 |
| 26-36 | Term. X42/5 Filter Time Constant | 0.001 s | All set-ups | TRUE | -3 | Uint16 |
| 26-37 | Term. X42/5 Live Zero | [1] Enabled | All set-ups | TRUE | - | Uint8 |
| 26-4* Analog Out X42/7 | | | | | | |
| 26-40 | Terminal X42/7 Output | [0] No operation | All set-ups | TRUE | - | Uint8 |
| 26-41 | Terminal X42/7 Min. Scale | 0.00% | All set-ups | TRUE | -2 | Int16 |
| 26-42 | Terminal X42/7 Max. Scale | 100.00% | All set-ups | TRUE | -2 | Int16 |
| 26-43 | Terminal X42/7 Bus Control | 0.00% | All set-ups | TRUE | -2 | N2 |
| 26-44 | Terminal X42/7 Timeout Preset | 0.00% | 1 set-up | TRUE | -2 | Uint16 |
| 26-5* Analog Out X42/9 | | | | | | |
| 26-50 | Terminal X42/9 Output | [0] No operation | All set-ups | TRUE | - | Uint8 |
| 26-51 | Terminal X42/9 Min. Scale | 0.00% | All set-ups | TRUE | -2 | Int16 |
| 26-52 | Terminal X42/9 Max. Scale | 100.00% | All set-ups | TRUE | -2 | Int16 |
| 26-53 | Terminal X42/9 Bus Control | 0.00% | All set-ups | TRUE | -2 | N2 |
| 26-54 | Terminal X42/9 Timeout Preset | 0.00% | 1 set-up | TRUE | -2 | Uint16 |
| 26-6* Analog Out X42/11 | | | | | | |
| 26-60 | Terminal X42/11 Output | [0] No operation | All set-ups | TRUE | - | Uint8 |
| 26-61 | Terminal X42/11 Min. Scale | 0.00% | All set-ups | TRUE | -2 | Int16 |
| 26-62 | Terminal X42/11 Max. Scale | 100.00% | All set-ups | TRUE | -2 | Int16 |
| 26-63 | Terminal X42/11 Bus Control | 0.00% | All set-ups | TRUE | -2 | N2 |
| 26-64 | Terminal X42/11 Timeout Preset | 0.00% | 1 set-up | TRUE | -2 | Uint16 |

6.3.23 Cascade CTL Option 27-**

| Par. No. # | Parameter description | Default value | 4 set-up | Change during operation | Conversion index | Type |
|-----------------------------------|----------------------------------|-------------------------|-------------|-------------------------|------------------|------------------|
| 27-0* Control & Status | | | | | | |
| 27-01 | Pump Status | [0] Ready | All set-ups | TRUE | - | Uint8 |
| 27-02 | Manual Pump Control | [0] No Operation | 2 set-ups | TRUE | - | Uint8 |
| 27-03 | Current Runtime Hours | 0 h | All set-ups | TRUE | 74 | Uint32 |
| 27-04 | Pump Total Lifetime Hours | 0 h | All set-ups | TRUE | 74 | Uint32 |
| 27-1* Configuration | | | | | | |
| 27-10 | Cascade Controller | [0] Disabled | 2 set-ups | FALSE | - | Uint8 |
| 27-11 | Number Of Drives | 1 N/A | 2 set-ups | FALSE | 0 | Uint8 |
| 27-12 | Number Of Pumps | ExpressionLimit | 2 set-ups | FALSE | 0 | Uint8 |
| 27-14 | Pump Capacity | 100 % | 2 set-ups | FALSE | 0 | Uint16 |
| 27-16 | Runtime Balancing | [0] Balanced Priority 1 | 2 set-ups | TRUE | - | Uint8 |
| 27-17 | Motor Starters | [0] Direct Online | 2 set-ups | FALSE | - | Uint8 |
| 27-18 | Spin Time for Unused Pumps | ExpressionLimit | All set-ups | TRUE | 0 | Uint16 |
| 27-19 | Reset Current Runtime Hours | [0] Do not reset | All set-ups | TRUE | - | Uint8 |
| 27-2* Bandwidth Settings | | | | | | |
| 27-20 | Normal Operating Range | ExpressionLimit | All set-ups | TRUE | 0 | Uint8 |
| 27-21 | Override Limit | 100 % | All set-ups | TRUE | 0 | Uint8 |
| 27-22 | Fixed Speed Only Operating Range | ExpressionLimit | All set-ups | TRUE | 0 | Uint8 |
| 27-23 | Staging Delay | 15 s | All set-ups | TRUE | 0 | Uint16 |
| 27-24 | De-staging Delay | 15 s | All set-ups | TRUE | 0 | Uint16 |
| 27-25 | Override Hold Time | 10 s | All set-ups | TRUE | 0 | Uint16 |
| 27-27 | Min Speed De-stage Delay | ExpressionLimit | All set-ups | TRUE | 0 | Uint16 |
| 27-3* Staging Speed | | | | | | |
| 27-31 | Stage On Speed [RPM] | ExpressionLimit | All set-ups | TRUE | 67 | Uint16 |
| 27-32 | Stage On Speed [Hz] | ExpressionLimit | All set-ups | TRUE | -1 | Uint16 |
| 27-33 | Stage Off Speed [RPM] | ExpressionLimit | All set-ups | TRUE | 67 | Uint16 |
| 27-34 | Stage Off Speed [Hz] | ExpressionLimit | All set-ups | TRUE | -1 | Uint16 |
| 27-4* Staging Settings | | | | | | |
| 27-40 | Auto-tune Staging Settings | [1] Enabled | All set-ups | TRUE | - | Uint8 |
| 27-41 | Ramp-down Delay | 10.0 s | All set-ups | TRUE | -1 | Uint16 |
| 27-42 | Ramp-up Delay | 2.0 s | All set-ups | TRUE | -1 | Uint16 |
| 27-43 | Staging Threshold | ExpressionLimit | All set-ups | TRUE | 0 | Uint8 |
| 27-44 | De-staging Threshold | ExpressionLimit | All set-ups | TRUE | 0 | Uint8 |
| 27-45 | Staging Speed [RPM] | 0 RPM | All set-ups | TRUE | 67 | Uint16 |
| 27-46 | Staging Speed [Hz] | 0.0 Hz | All set-ups | TRUE | -1 | Uint16 |
| 27-47 | De-staging Speed [rpm] | 0 RPM | All set-ups | TRUE | 67 | Uint16 |
| 27-48 | De-staging Speed [Hz] | 0.0 Hz | All set-ups | TRUE | -1 | Uint16 |
| 27-5* Alternate Settings | | | | | | |
| 27-50 | Automatic Alternation | [0] Disabled | All set-ups | FALSE | - | Uint8 |
| 27-51 | Alternation Event | null | All set-ups | TRUE | - | Uint8 |
| 27-52 | Alternation Time Interval | 0 min | All set-ups | TRUE | 70 | Uint16 |
| 27-53 | Alternation Timer Value | 0 min | All set-ups | TRUE | 70 | Uint16 |
| 27-54 | Alternation At Time of Day | [0] Disabled | All set-ups | TRUE | - | Uint8 |
| 27-55 | Alternation Predefined Time | ExpressionLimit | All set-ups | TRUE | 0 | TimeOfDay-WoDate |
| 27-56 | Alternate Capacity is < | 0 % | All set-ups | TRUE | 0 | Uint8 |
| 27-58 | Run Next Pump Delay | 0.1 s | All set-ups | TRUE | -1 | Uint16 |

| Par. No. # | Parameter description | Default value | 4 set-up | Change during operation | Conversion index | Type |
|-----------------------------|-------------------------------|--------------------|-------------|-------------------------|------------------|--------|
| 27-6* Digital Inputs | | | | | | |
| 27-60 | Terminal X66/1 Digital Input | [0] No operation | All set-ups | TRUE | - | Uint8 |
| 27-61 | Terminal X66/3 Digital Input | [0] No operation | All set-ups | TRUE | - | Uint8 |
| 27-62 | Terminal X66/5 Digital Input | [0] No operation | All set-ups | TRUE | - | Uint8 |
| 27-63 | Terminal X66/7 Digital Input | [0] No operation | All set-ups | TRUE | - | Uint8 |
| 27-64 | Terminal X66/9 Digital Input | [0] No operation | All set-ups | TRUE | - | Uint8 |
| 27-65 | Terminal X66/11 Digital Input | [0] No operation | All set-ups | TRUE | - | Uint8 |
| 27-66 | Terminal X66/13 Digital Input | [0] No operation | All set-ups | TRUE | - | Uint8 |
| 27-7* Connections | | | | | | |
| 27-70 | Relay | [0] Standard Relay | 2 set-ups | FALSE | - | Uint8 |
| 27-9* Readouts | | | | | | |
| 27-91 | Cascade Reference | 0.0 % | All set-ups | TRUE | -1 | Int16 |
| 27-92 | % Of Total Capacity | 0 % | All set-ups | TRUE | 0 | Uint16 |
| 27-93 | Cascade Option Status | [0] Disabled | All set-ups | TRUE | - | Uint8 |

6.3.24 Water Application Functions 29-**

| Par. No. # | Parameter description | Default value | 4 set-up | Change during operation | Conversion index | Type |
|------------------------|-----------------------|-----------------------|-------------|-------------------------|------------------|--------|
| 29-0* Pipe Fill | | | | | | |
| 29-00 | Pipe Fill Enable | [0] Disabled | 2 set-ups | FALSE | - | Uint8 |
| 29-01 | Pipe Fill Speed [RPM] | ExpressionLimit | All set-ups | TRUE | 67 | Uint16 |
| 29-02 | Pipe Fill Speed [Hz] | ExpressionLimit | All set-ups | TRUE | -1 | Uint16 |
| 29-03 | Pipe Fill Time | 0.00 s | All set-ups | TRUE | -2 | Uint32 |
| 29-04 | Pipe Fill Rate | 0.001 ProcessCtrlUnit | All set-ups | TRUE | -3 | Int32 |
| 29-05 | Filled Setpoint | 0.000 ProcessCtrlUnit | All set-ups | TRUE | -3 | Int32 |

6.3.25 Bypass Option 31-**

| Par. No. # | Parameter description | Default value | 4 set-up | Change during operation | Conversion index | Type |
|---------------|--------------------------|---------------|-------------|-------------------------|------------------|--------|
| 31-00 | Bypass Mode | [0] Drive | All set-ups | TRUE | - | Uint8 |
| 31-01 | Bypass Start Time Delay | 30 s | All set-ups | TRUE | 0 | Uint16 |
| 31-02 | Bypass Trip Time Delay | 0 s | All set-ups | TRUE | 0 | Uint16 |
| 31-03 | Test Mode Activation | [0] Disabled | All set-ups | TRUE | - | Uint8 |
| 31-10 | Bypass Status Word | 0 N/A | All set-ups | FALSE | 0 | V2 |
| 31-11 | Bypass Running Hours | 0 h | All set-ups | FALSE | 74 | Uint32 |
| 31-19 | Remote Bypass Activation | [0] Disabled | 2 set-ups | TRUE | - | Uint8 |

7 General Specifications

Line Power Supply (L1-1, L2-1, L3-1, L1-2, L2-2, L3-2):

| | |
|----------------|----------------------|
| Supply voltage | 380–500 V $\pm 10\%$ |
| Supply voltage | 525–600 V $\pm 10\%$ |

AC line voltage low / line drop-out:

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

| | |
|---|---|
| Supply frequency | 50/60 Hz $\pm 5\%$ |
| Max. imbalance temporary between line 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 100.000 RMS symmetrical Amperes, 480/600 V maximum.

Motor output (U, V, W):

| | |
|---------------------|--------------------------|
| Output voltage | 0–100% of supply voltage |
| Output frequency | 0–800* Hz |
| Switching on output | Unlimited |
| Accel/Decel Times | 1–3600 sec. |

* Voltage and power dependent

Torque characteristics:

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

*Percentage relates to the nominal torque of the AF-600 FP drive.

Cable lengths and cross-sections:

| | |
|--|---|
| Max. motor cable length, shielded/armored | 492 ft [150 m] |
| Max. motor cable length, unshielded/unarmored | 984 ft [300 m] |
| Max. cross-section to motor, line power and brake * | |
| Maximum cross-section to control terminals, rigid wire | 0.0023 in ² [1.5 mm ²]/16 AWG (2 x 0.00112 in ² in [0.75 mm ²]) |
| Maximum cross-section to control terminals, flexible cable | 0.0016 in ² [1 mm ²]/18 AWG |
| Maximum cross-section to control terminals, cable with enclosed core | 0.0008 in ² [0.5 mm ²]/20 AWG |
| Minimum cross-section to control terminals | 0.039 in ² [0.25 mm ²] |

* See Line Power Supply tables for more information!

Digital inputs:

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

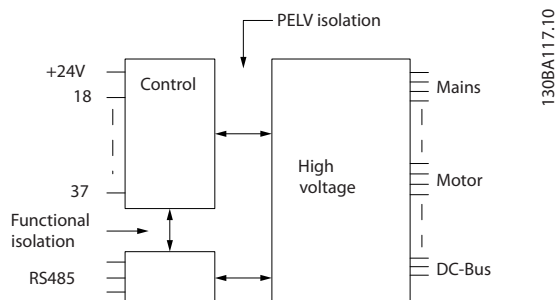
All digital inputs are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

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

Analog inputs:

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

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



Pulse inputs:

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

Analog output:

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

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

Control card, RS-485 serial communication:

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

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

Digital output:

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

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

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

Control card, 24 V DC output:

| | |
|-----------------|--------|
| Terminal number | 12, 13 |
| Max. load | 200mA |

The 24V 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 @ cos ϕ 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, 1A |
| Max. terminal load (DC-13) ¹⁾ (Inductive load) | 24 V DC, 0.1A |
| 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 @ cos ϕ 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, 0.1A |
| 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 @ cos ϕ 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 t 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 \pm 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 0–1000Hz | +/- 0.003Hz |
| System response time (terminals 18, 19, 27, 29, 32, 33) | \leq 2ms |
| Speed control range (open-loop) | 1:100 of synchronous speed |

Speed accuracy (open-loop) 30–4000 rpm: Maximum error of ±8 rpm

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

Surroundings:

| | |
|--|--|
| Enclosure, frame size 4X and 5X | IP 00, IP 21, IP 54 |
| Enclosure, frame size 6X | IP 21, IP 54 |
| Vibration test | 0.7 g |
| Relative humidity | 5%–95% (IEC 721-3-3; Class 3K3 (non-condensing) during operation |
| Aggressive environment (IEC 60068-2-43) H ₂ S test | class kD |
| Test method according to IEC 60068-2-43 H ₂ S (10 days) | |
| - with derating | max. 131°F [55°C] ¹⁾ |
| - with full output power, typical EFF2 motors | max. 122°F [50°C] ¹⁾ |
| - at full continuous drive output current | max. 113°F [45°C] ¹⁾ |

¹⁾ For more information on derating see the AF-600 FP, section on Special Conditions.

| | |
|---|-----------------------------------|
| Minimum ambient temperature during full-scale operation | 32°F [0°C] |
| Minimum ambient temperature at reduced performance | 14°F [- 10 °C] |
| Temperature during storage/transport | -13°–+149°/158°F [-25°–+65°/70°C] |
| Maximum altitude above sea level without derating | 3280 ft [1000 m] |
| Maximum altitude above sea level with derating | 9842 ft [3000 m] |

Derating for high altitude, see section on special conditions.

| | |
|-------------------------|--|
| 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 |

See section on special conditions!

Control card performance:

| | |
|--|--------------------------|
| Scan interval | 5ms |
| 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 protection 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.
- Temperature monitoring of the heatsink ensures that the adjustable frequency drive trips if the temperature reaches a predefined level. An overload temperature cannot be reset until the temperature of the heatsink is below the values stated in the tables on the following pages (guideline - these temperatures may vary for different power sizes, Unit 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).
- Monitoring of the intermediate circuit voltage ensures that the adjustable frequency drive trips if the intermediate circuit voltage is too low or too high.
- The adjustable frequency drive is protected against ground faults on motor terminals U, V, W.

| Line Power Supply 6 x 380–480V AC | | | | |
|---|-----------------------|-----------------------|-----------------------|-----------------------|
| | 350 HP | 450 HP | 500 HP | 550 HP |
| Typical Shaft output at 400 V [kW] | 315 | 355 | 400 | 450 |
| Typical Shaft output at 460 V [HP] | 450 | 500 | 600 | 600 |
| Typical Shaft output at 480 V [kW] | 355 | 400 | 500 | 530 |
| IP21/Nema 1 Drive Type | F8/F9 | F8/F9 | F8/F9 | F8/F9 |
| IP54/Nema 12 Drive Type | F8/F9 | F8/F9 | F8/F9 | F8/F9 |
| Output current | | | | |
| Continuous (at 400 V) [A] | 600 | 648 | 745 | 800 |
| Intermittent (60 sec overload) (at 400 V) [A] | 660 | 724 | 820 | 880 |
| Continuous (at 460/ 480 V) [A] | 540 | 590 | 678 | 730 |
| Intermittent (60 sec overload) (at 460/ 480 V) [A] | 594 | 649 | 746 | 803 |
| Continuous KVA (at 400 V) [KVA] | 416 | 456 | 516 | 554 |
| Continuous KVA (at 460 V) [KVA] | 430 | 470 | 540 | 582 |
| Continuous KVA (at 480 V) [KVA] | 468 | 511 | 587 | 632 |
| Max. input current | | | | |
| Continuous (at 400 V) [A] | 590 | 647 | 733 | 787 |
| Continuous (at 460/ 480 V) [A] | 531 | 580 | 667 | 718 |
| Max. cable size, line power [mm ² (AWG ²)] | 4x90 (3/0) | 4x90 (3/0) | 4x240 (500 mcm) | 4x240 (500 mcm) |
| Max. cable size, motor [mm ² (AWG ²)] | 4x240 (4x500 mcm) | 4x240 (4x500 mcm) | 4x240 (4x500 mcm) | 4x240 (4x500 mcm) |
| Max. cable size, brake [mm ² (AWG ²)] | 2 x 185 (2 x 350 mcm) | 2 x 185 (2 x 350 mcm) | 2 x 185 (2 x 350 mcm) | 2 x 185 (2 x 350 mcm) |
| Max. external electrical fuses [A] 1 | 700 | | | |
| Estimated power loss at 400 V [W] ⁴⁾ | 6790 | 7701 | 8879 | 9670 |
| Estimated power loss at 460 V [W] | 6082 | 6953 | 8089 | 8803 |
| Weight, Unit Size IP21, IP 54 [kg] | 440/656 | | | |
| Efficiency ⁴⁾ | 0.98 | | | |
| Output frequency | 0–600Hz | | | |
| Heatsink overtemp. trip | 203°F [95°C] | | | |
| Power card ambient trip | 154.4°F [68°C] | | | |

* Heavy Duty = 160% torque during 60 sec, Light Duty = 110% torque during 60 sec.

| Line Power Supply 6 x 380–480V AC | | | | | | |
|---|----------------------|------------|------------|------------|------------------------|------------|
| | 650 HP | 750 HP | 900 HP | 1000 HP | 1200 HP | 1400 HP |
| 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 |
| Typical Shaft output at 480 V [kW] | 560 | 630 | 710 | 800 | 1000 | 1100 |
| IP21/Nema 1 and IP54/Nema 12 Drive Types without/with options cabinet | F10/F11 | F10/F11 | F10/F11 | F10/F11 | F12/F13 | F12/F13 |
| Output current | | | | | | |
| Continuous (at 400 V) [A] | 880 | 990 | 1120 | 1260 | 1460 | 1720 |
| Intermittent (60 sec overload) (at 400 V) [A] | 968 | 1089 | 1232 | 1386 | 1606 | 1892 |
| Continuous (at 460/ 480 V) [A] | 780 | 890 | 1050 | 1160 | 1380 | 1530 |
| Intermittent (60 sec overload) (at 460/ 480 V) [A] | 858 | 979 | 1155 | 1276 | 1518 | 1683 |
| Continuous KVA (at 400 V) [KVA] | 610 | 686 | 776 | 873 | 1012 | 1192 |
| Continuous KVA (at 460 V) [KVA] | 621 | 709 | 837 | 924 | 1100 | 1219 |
| Continuous KVA (at 480 V) [KVA] | 675 | 771 | 909 | 1005 | 1195 | 1325 |
| Max. input current | | | | | | |
| Continuous (at 400 V) [A] | 857 | 964 | 1090 | 1227 | 1422 | 1675 |
| Continuous (at 460/ 480 V) [A] | 759 | 867 | 1022 | 1129 | 1344 | 1490 |
| Max. cable size, motor [mm ² (AWG ²)] | 8x150 (8x300 mcm) | | | | 12x150 (12x300 mcm) | |
| Max. cable size, line power [mm ² (AWG ²)] | 6x120 (6x250 mcm) | | | | | |
| Max. cable size, brake [mm ² (AWG ²)] | 4x185 (4x350 mcm) | | | | 6x185 (6x350 mcm) | |
| Max. external electrical fuses [A] 1 | 900 | | | 1500 | | |
| Estimated power loss at 400 V [W] ⁴⁾ | 10647 | 12338 | 13201 | 15436 | 18084 | 20358 |
| Estimated power loss at 460 V [W] | 9414 | 11006 | 12353 | 14041 | 17137 | 17752 |
| max. added losses A1 RFI, CB or Disconnect, & contactor | 963 | 1054 | 1093 | 1230 | 2280 | 2541 |
| Max. panel options losses | 400 | | | | | |
| Weight, Unit Size IP21, IP 54 [kg] | 1004/ 1299 | 1004/ 1299 | 1004/ 1299 | 1004/ 1299 | 1246/ 1541 | 1246/ 1541 |
| Weight Rectifier Module [kg] | 102 | 102 | 102 | 102 | 136 | 136 |
| Weight Inverter Module [kg] | 102 | 102 | 102 | 136 | 102 | 102 |
| Efficiency ⁴⁾ | 0.98 | | | | | |
| Output frequency | 0–600Hz | | | | | |
| Heatsink overtemp. trip | 203°F [95°C] | | | | | |
| Power card ambient trip | 154.4°F [68°C] | | | | | |

* Heavy Duty = 160% torque during 60 sec., Light Duty = 110% torque during 60 sec.

| Line Power Supply 3 x 525–690V AC | | | | |
|---|-----------------------|-----------------------|-----------------------|-----------------------|
| 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 |
| IP21/Nema 1 Drive Type | F8/F9 | F8/F9 | F8/F9 | F8/F9 |
| IP54/Nema Drive Type | F8/F9 | F8/F9 | F8/F9 | F8/F9 |
| Output current | | | | |
| Continuous (at 550 V) [A] | 470 | 523 | 596 | 630 |
| Intermittent (60 sec overload) (at 550 V) [A] | 517 | 575 | 656 | 693 |
| Continuous (at 575/690 V) [A] | 450 | 500 | 570 | 630 |
| Intermittent (60 sec 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 |
| Max. 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 |
| Max. cable size, line power [mm ² (AWG)] | 4x85 (3/0) | | | |
| Max. cable size, motor [mm ² (AWG)] | 4 x 250 (500 mcm) | | | |
| Max. cable size, brake [mm ² (AWG)] | 2 x 185 (2 x 350 mcm) | 2 x 185 (2 x 350 mcm) | 2 x 185 (2 x 350 mcm) | 2 x 185 (2 x 350 mcm) |
| Max. external electrical fuses [A] 1 | 630 | | | |
| Estimated power loss at 600 V [W] ⁴⁾ | 6132 | 6903 | 8343 | 9244 |
| Estimated power loss at 690 V [W] ⁴⁾ | 6449 | 7249 | 8727 | 9673 |
| Weight, Unit Size IP21, IP 54 [kg] | 440/656 | | | |
| Efficiency ⁴⁾ | 0.98 | | | |
| Output frequency | 0–500 Hz | | | |
| Heatsink overtemp. trip | 185°F [85°C] | | | |
| Power card ambient trip | 154.4°F [68°C] | | | |
| * Heavy Duty = 160% torque during 60 sec, Light Duty = 110% torque during 60 sec. | | | | |

| Line Power Supply 3 x 525–690V AC | | | |
|---|-------------------|------------|------------|
| Typical Shaft output at 550 V [kW] | 560 | 670 | 750 |
| Typical Shaft output at 575 V [HP] | 750 | 950 | 1050 |
| Typical Shaft output at 690 V [kW] | 710 | 800 | 900 |
| IP21/Nema 1 and IP54/Nema 12 Drive Types without/with options cabinet | F10/F11 | F10/F11 | F10/F11 |
| Output current | | | |
| Continuous (at 550 V) [A] | 763 | 889 | 988 |
| Intermittent (60 sec overload) (at 550 V) [A] | 839 | 978 | 1087 |
| Continuous (at 575/690 V) [A] | 730 | 850 | 945 |
| Intermittent (60 sec overload) (at 575/690 V) [A] | 803 | 935 | 1040 |
| Continuous KVA (at 550 V) [KVA] | 727 | 847 | 941 |
| Continuous KVA (at 690 V) [KVA] | 872 | 1016 | 1129 |
| Max. input current | | | |
| Continuous (at 550 V) [A] | 743 | 866 | 962 |
| Continuous (at 575 V) [A] | 711 | 828 | 920 |
| Continuous (at 690 V) [A] | 711 | 828 | 920 |
| Max. cable size, motor [mm ² (AWG ²)] | 8x150 (8x300 mcm) | | |
| Max. cable size, line power [mm ² (AWG ²)] | 6x120 (6x250 mcm) | | |
| Max. cable size, brake [mm ² (AWG ²)] | 4x185 (4x350 mcm) | | |
| Max. external electrical fuses [A] 1 | 900 | | |
| Estimated power loss at 600 V [W] ⁴⁾ | 10771 | 12272 | 13835 |
| Estimated power loss at 690V [W] ⁴⁾ | 11315 | 12903 | 14533 |
| 63/64 Max added losses CB or Disconnect & Contactor | 427 | 532 | 615 |
| Max panel options losses | 400 | | |
| Weight, Unit Size IP21, IP 54 [kg] | 1004/ 1299 | 1004/ 1299 | 1004/ 1299 |
| Weight, Rectifier Module [kg] | 102 | 102 | 102 |
| Weight, Inverter Module [kg] | 102 | 102 | 136 |
| Efficiency ⁴⁾ | 0.98 | | |
| Output frequency | 0–500 Hz | | |
| Heatsink overtemp. trip | 185°F [85°C] | | |
| Power card ambient trip | 154.4°F [68°C] | | |

* Heavy Duty = 160% torque during 60 sec., Light Duty = 110% torque during 60 sec.

- 1) For type of fuse, see section Fuses.
- 2) American Wire Gauge.
- 3) Measured using 16.4 ft. [5 m] shielded motor cables at rated load and rated frequency.
- 4) The typical power loss is at nominal load conditions and expected to be within +/-15% (tolerance relates to variety in voltage and cable conditions).
 Values are based on a typical motor efficiency (eff2/eff3 border line). Motors with lower efficiency will also add to the power loss in the adjustable frequency drive and opposite.
 If the switching frequency is increased compared to the default setting, the power losses may rise significantly. LCP and typical control card power consumptions are included. Further options and customer load may add up to 30W to the losses. (Though typical, only 4 W extra for a fully loaded control card, or options for slot A or slot B, each.)
 Although measurements are made with state of the art equipment, some measurement inaccuracy must be allowed for (+/-5%).

8 Troubleshooting

8.1 Alarms and Warnings

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

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

In the event of an alarm, the adjustable frequency drive will have tripped. Alarms must be reset to restart operation once their cause has been rectified.

This may be done in four ways:

1. By using the [RESET] control button on the keypad.
2. Via a digital input with the "Reset" function.
3. Via serial communication/optional network.
4. By resetting automatically using the [Auto Reset] function, which is a default setting for AF-600 FP Drive, see *14-20 Reset Mode* in *AF-600 FP Programming Guide*

After a manual reset using the [RESET] button on the LCP, the [AUTO] or [HAND] button must be pressed to restart the motor.

If an alarm cannot be reset, the reason may be that its cause has not been rectified, or the alarm is trip-locked (see also table on following page).

Alarms that are trip-locked offer additional protection, means 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 above, once the cause has been rectified.

Alarms that are not trip-locked can also be reset using the automatic reset function in *14-20 Reset Mode* (Warning: automatic wake-up is possible!)

If a warning and alarm is marked against a code in the table on the following page, this means that either a warning occurs before an alarm, or it can be specified whether it is a warning or an alarm that is to be displayed for a given fault.

This is possible, for instance, in *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) | | par. AN-01 |
| 3 | No motor | (X) | | | par. H-80 |
| 4 | Mains phase loss | (X) | (X) | (X) | par. SP-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) | | par. F-10 |
| 11 | Motor thermistor over-temperature | (X) | (X) | | par. F-10 |
| 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) | | par. O-04 |
| 23 | Internal Fan Fault | X | | | |
| 24 | External Fan Fault | X | | | par. SP-53 |
| 29 | Drive overtemperature | X | X | X | |
| 30 | Motor phase U missing | (X) | (X) | (X) | par. E-78 |
| 31 | Motor phase V missing | (X) | (X) | (X) | par. E-78 |
| 32 | Motor phase W missing | (X) | (X) | (X) | par. E-78 |
| 33 | Inrush fault | | X | X | |
| 34 | Fieldbus communication fault | X | X | | |
| 36 | Mains failure | X | X | | |
| 38 | Internal fault | | X | X | |
| 39 | Heatsink sensor | | X | X | |
| 40 | Overload of Digital Output Terminal 27 | (X) | | | par. E-00, E-51 |
| 41 | Overload of Digital Output Terminal 29 | (X) | | | par. E-00, E-51 |
| 42 | Overload of Digital Output On X30/6 (OPCGPIO) | (X) | | | par. E-56 |
| 42 | Overload of Digital Output On X30/7 (OPCGPIO) | (X) | | | par. E-57 |
| 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 | | | |
| 50 | Auto Tune calibration failed | | X | | |
| 51 | Auto Tune check U _{nom} and I _{nom} | | X | | |
| 52 | Auto Tune low I _{nom} | | X | | |
| 53 | Auto Tune motor too big | | X | | |
| 54 | Auto Tune motor too small | | X | | |
| 55 | Auto Tune parameter out of range | | X | | |
| 56 | Auto Tune interrupted by user | | X | | |
| 57 | Auto Tune timeout | | X | | |
| 58 | Auto Tune internal fault | X | X | | |
| 59 | Current limit | X | | | |
| 61 | Tracking Error | (X) | (X) | | par. H-20 |
| 62 | Output Frequency at Maximum Limit | X | | | |
| 65 | Control Board Overtemperature | X | X | X | |
| 66 | Heat sink Temperature Low | X | | | |
| 67 | Option Configuration has Changed | | X | | |
| 68 | Safe Stop Activated | | X ¹⁾ | | |
| 69 | Pwr. Card Temp | | X | X | |
| 70 | Illegal Drive configuration | | | X | |
| 72 | Dangerous Failure | | | X ¹⁾ | |
| 73 | Safe Stop Auto Restart | | | | |
| 77 | Reduced power mode | X | | | |
| 79 | Illegal PS config | | X | X | |
| 80 | Drive Restored to Factory Settings | | X | | |
| 85 | Profibus/Profisafe Error | | | | |
| 92 | No-Flow | X | X | | par. AP-2# |
| 93 | Dry Pump | X | X | | par. AP-2# |
| 94 | End of Curve | X | X | | par. AP-5# |
| 95 | Broken Belt | X | X | | par. AP-6# |
| 96 | Start Delayed | X | | | par. AP-7# |
| 97 | Stop Delayed | X | | | par. AP-7# |
| 98 | Clock Fault | X | | | par. K-7# |

Table 8.1 Alarm/Warning Code List

| No. | Description | Warning | Alarm/Trip | Alarm/Trip Lock | Parameter Reference |
|-----|-------------------|---------|------------|-----------------|---------------------|
| 220 | Overload Trip | | X | | |
| 244 | Heatsink temp | X | X | X | |
| 245 | Heatsink sensor | | X | X | |
| 246 | Pwr.card supply | | X | X | |
| 247 | Pwr.card temp | | X | X | |
| 248 | Illegal PS config | | X | X | |
| 250 | New spare part | | | X | |
| 251 | New Model Number | | X | X | |

Table 8.2 Alarm/Warning Code List

(X) Dependent on parameter

1) Cannot be Auto reset via 14-20 Reset Mode

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

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



| 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 | Auto Tune 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 | Thrmstr Overld | Thrmstr Overld | Output Current High |
| 8 | 00000100 | 256 | Motor Elec. OL Over | Motor Elec. OL 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 | Inrush Fault | DC Voltage High | Braking |
| 14 | 00004000 | 16384 | Mains phs. Loss | Mains phs. Loss | Out of Speed Range |
| 15 | 00008000 | 32768 | Auto Tune Not OK | No Motor | OVC Active |
| 16 | 00010000 | 65536 | Live Zero Error | Live Zero Error | |
| 17 | 00020000 | 131072 | Internal Fault | 10V low | |
| 18 | 00040000 | 262144 | | | |
| 19 | 00080000 | 524288 | U phase Loss | | |
| 20 | 00100000 | 1048576 | V phase Loss | | |
| 21 | 00200000 | 2097152 | W phase Loss | Speed Limit | |
| 22 | 00400000 | 4194304 | Fieldbus Fault | Fieldbus Fault | |
| 23 | 00800000 | 8388608 | 24 V Supply Low | 24V Supply Low | |
| 24 | 01000000 | 16777216 | Mains Failure | Line Failure | |
| 25 | 02000000 | 33554432 | 1.8V supply low | Current Limit | |
| 26 | 04000000 | 67108864 | Brake Resistor | Low Temp | |
| 27 | 08000000 | 134217728 | Brake IGBT | Voltage Limit | |
| 28 | 10000000 | 268435456 | Option Change | Unused | |
| 29 | 20000000 | 536870912 | Drive Restored to Factory Settings | Unused | |
| 30 | 40000000 | 1073741824 | | Unused | |

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

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

8.1.1 Fault messages

WARNING 1, 10 volts low

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

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

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

WARNING/ALARM 2, Live zero error

This warning or alarm will only appear if programmed by the user in parameter 6-01, Live Zero Timeout Function. The signal on one of the analog inputs is less than 50% of the minimum value programmed for that input. This condition can be caused by broken wiring or faulty device sending the signal.

WARNING/ALARM 3, No motor

No motor has been connected to the output of the adjustable frequency drive. This warning or alarm will only appear if programmed by the user in parameter 1-80, Function at Stop.

Troubleshooting: Check the connection between the drive and the motor.

WARNING/ALARM 4, Mains phase loss

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

Troubleshooting: Check the supply voltage and supply currents to the adjustable frequency drive.

WARNING 5, DC link voltage high

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

WARNING 6, DC link voltage low

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

WARNING/ALARM 7, DC overvoltage

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

Troubleshooting:

- Connect a brake resistor
- Extend the ramp time

Change the ramp type

Activate functions in *2-10 Brake Function*

Increase *14-26 Trip Delay at Inverter Fault*

WARNING/ALARM 8, DC under voltage

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

WARNING/ALARM 9, Inverter overloaded

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 gives a warning at 98% and trips at 100%, while giving an alarm. The adjustable frequency drive *cannot* be reset until the counter is below 90%.

The fault is that the adjustable frequency drive is overloaded by more than 100% for too long. Note: See the derating section in the Design Guide for more details if a high switching frequency is required.

WARNING/ALARM 10, Motor overload temperature

According to the electronic thermal protection, the motor is too hot. Select whether the adjustable frequency drive gives a warning or an alarm when the counter reaches 100% in *1-90 Motor Thermal Protection*. The fault is that the motor is overloaded by more than 100% for too long.

Troubleshooting:

- Check if the motor is overheating.
- If the motor is mechanically overloaded
- That the motor *1-24 Motor Current* is set correctly.
- Motor data in parameters 1-20 through 1-25 are set correctly.
- The setting in parameter 1-91, Motor External Fan.
- Run AMA in parameter 1-29.

WARNING/ALARM 11, Motor thermistor over temp

The thermistor or the thermistor connection is disconnected. Select whether the adjustable frequency drive gives a warning or an alarm when the counter reaches 100% in *1-90 Motor Thermal Protection*.

Troubleshooting:

- Check if the motor is overheating.
- Check if the motor is mechanically overloaded.
- Check that the thermistor is connected correctly between terminal 53 or 54 (analog voltage input) and terminal 50 (+10 V supply), or between

terminal 18 or 19 (digital input PNP only) and terminal 50.

If a KTY sensor is used, check for correct connection between terminal 54 and 55.

If using a thermal switch or thermistor, check the programming of parameter 1-93 matches sensor wiring.

If using a KTY sensor, check the programming of parameters 1-95, 1-96, and 1-97 match sensor wiring.

WARNING/ALARM 12, Torque limit

The torque is higher than the value in *4-16 Torque Limit Motor Mode* (in motor operation) or the torque is higher than the value in *4-17 Torque Limit Generator Mode* (in regenerative operation). Parameter 14-25 can be used to change this from a warning only condition to a warning followed by an alarm.

WARNING/ALARM 13, Overcurrent

The inverter peak current limit (approx. 200% of the rated current) is exceeded. The warning lasts about 1.5 sec. Then the adjustable frequency drive trips and issues an alarm. If extended mechanical brake control is selected, trip can be reset externally.

Troubleshooting:

This fault may be caused by shock loading or fast acceleration with high inertia loads.

Turn off the adjustable frequency drive. Check if the motor shaft can be turned.

Make sure that the motor size matches the adjustable frequency drive.

Incorrect motor data in parameters 1-20 through 1-25.

ALARM 14, Ground Fault

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

Troubleshooting:

Turn off the adjustable frequency drive and remove the ground fault.

Measure the resistance to ground of the motor leads and the motor with a megohmmeter to check for ground faults in the motor.

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 your Danfoss supplier:

15-40 FC Type

15-41 Power Section

15-42 Voltage

15-43 Software Version

15-45 Actual Typecode String

15-49 SW ID Control Card

15-50 SW ID Power Card

15-60 Option Mounted (for each option slot)

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

ALARM 16, Short circuit

There is short-circuiting in the motor or on the motor terminals.

Turn off the adjustable frequency drive and remove the short circuit.

WARNING/ALARM 17, Control word timeout

There is no communication to the adjustable frequency drive.

The warning will only be active when *8-04 Control Word Timeout Function* is NOT set to OFF.

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

Troubleshooting:

Check connections on the serial communication cable.

Increase *8-03 Control Word Timeout Time*

Check the operation of the communication equipment.

Verify proper installation based on EMC requirements.

WARNING 23, Internal fan fault

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

For the D, E, and F Frame drives, the regulated voltage to the fans is monitored.

Troubleshooting:

Check fan resistance.

Check soft charge fuses.

WARNING 24, External fan fault

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

For the D, E, and F Frame drives, the regulated voltage to the fans is monitored.

Troubleshooting:

- Check fan resistance.
- Check soft charge fuses.

WARNING 25, Brake resistor short circuit

The brake resistor is monitored during operation. If it short circuits, the brake function is disconnected and the warning appears. The adjustable frequency drive still works, but without the brake function. Turn off the adjustable frequency drive and replace the brake resistor (see 2-15 Brake Check).

WARNING/ALARM 26, Brake resistor power limit

The power transmitted to the brake resistor is calculated: as a percentage, as a mean value over the last 120 seconds, on the basis of the resistance value of the brake resistor, and the intermediate circuit voltage. The warning is active when the dissipated braking energy is higher than 90%. If Trip [2] has been selected in 2-13 Brake Power Monitoring, the adjustable frequency drive cuts out and issues this alarm, when the dissipated braking energy is higher than 100%.

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

WARNING/ALARM 27, Brake chopper fault

The brake transistor is monitored during operation and if it short-circuits, the brake function disconnects and issues a warning. The adjustable frequency drive is still able to run, but since the brake transistor has short-circuited, substantial power is transmitted to the brake resistor, even if it is inactive.

Turn off the adjustable frequency drive and remove the brake resistor.

This alarm/ warning could also occur should the brake resistor overheat. Terminal 104 to 106 are available as brake resistor. Klixon inputs, see section Brake Resistor Temperature Switch.

WARNING/ALARM 28, Brake check failed

Brake resistor fault: 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 will not be reset until the temperature falls below a defined heatsink temperature. The trip and reset point are different based on the drive power size.

Troubleshooting:

- Ambient temperature too high.
- Too long motor cable.

- Incorrect clearance above and below the drive.
- Dirty heatsink.
- Blocked air flow around the drive.
- Damaged heatsink fan.

For the D, E, and F Frame Drives, this alarm is based on the temperature measured by the heatsink sensor mounted inside the IGBT modules. For the F Frame drives, this alarm can also be caused by the thermal sensor in the Rectifier module.

Troubleshooting:

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

ALARM 30, Motor phase U missing

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

Turn off 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.

Turn off 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.

Turn off 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 unit cool to operating temperature.

WARNING/ALARM 34, Network communication fault

The network 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) or low limit (set in parameter 4-52). In *Process Control, Closed-loop* (parameter 1-00), 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 14-10 Line Failure is NOT set to OFF. Check the fuses to the adjustable frequency drive.

ALARM 38, Internal fault

It may be necessary to contact your Danfoss supplier. Some typical alarm messages:

0 Serial port cannot be initialized. Serious hardware failure

| | |
|-----------|---|
| 256-258 | Power EEPROM data is defect or too old |
| 512 | Control board EEPROM data is defect or too old |
| 513 | Communication time out reading EEPROM data |
| 514 | Communication time out reading EEPROM data |
| 515 | Application Orientated Control cannot recognize the EEPROM data |
| 516 | Cannot write to the EEPROM because a write command is on progress |
| 517 | Write command is under time out |
| 518 | Failure in the EEPROM |
| 519 | Missing or invalid Barcode data in EEPROM |
| 783 | Parameter value outside of min/max limits |
| 1024-1279 | A CAN message that has to be sent, couldn't be sent |
| 1281 | Digital Signal Processor flash timeout |
| 1282 | Power micro software version mismatch |
| 1283 | Power EEPROM data version mismatch |
| 1284 | Cannot read Digital Signal Processor software version |
| 1299 | Option SW in slot A is too old |
| 1300 | Option SW in slot B is too old |
| 1301 | Option SW in slot C0 is too old |
| 1302 | Option SW in slot C1 is too old |
| 1315 | Option SW in slot A is not supported (not allowed) |
| 1316 | Option SW in slot B is not supported (not allowed) |
| 1317 | Option SW in slot C0 is not supported (not allowed) |
| 1318 | Option SW in slot C1 is not supported (not allowed) |
| 1379 | Option A did not respond when calculating Platform Version. |
| 1380 | Option B did not respond when calculating Platform Version. |
| 1381 | Option C0 did not respond when calculating Platform Version. |
| 1382 | Option C1 did not respond when calculating Platform Version. |
| 1536 | An exception in the Application Orientated Control is registered. Debug information written in LCP |
| 1792 | DSP watchdog is active. Debugging of power part data |
| 2049 | Motor Orientated 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 | H083x: option in slot x has issued a legal power-up wait. |
| 2304 | Could not read any data from power EEPROM. |
| 2305 | Missing SW version from power unit |
| 2314 | Missing power unit data from power unit |
| 2315 | Missing SW version from power unit |
| 2316 | Missing io_statepage from power unit |
| 2324 | Power card configuration is determined to be incorrect at power-up. |
| 2325 | A power card has stopped communicating while main power is applied. |
| 2326 | Power card configuration is determined to be incorrect after the delay for power cards to register. |
| 2327 | Too many power card locations have been registered as present. |
| 2330 | Power size information between the power cards does not match. |
| 2561 | No communication from DSP to ATACD. |
| 2562 | No communication from ATACD to DSP (state running). |
| 2816 | Stack overflow Control board module |
| 2817 | Scheduler slow tasks |
| 2818 | Fast tasks |
| 2819 | Parameter thread |
| 2820 | LCP Stack overflow |
| 2821 | Serial port overflow |
| 2822 | USB port overflow |
| 2836 | cflistMemppool to 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 |

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 short-circuit connection. Check *5-00 Digital I/O Mode* and *5-01 Terminal 27 Mode*.

WARNING 41, Overload of Digital Output Terminal 29

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

WARNING 42, Overload of Digital Output on X30/6 or Overload of Digital Output on X30/7

For X30/6, check the load connected to X30/6 or remove short-circuit connection. Check par. E-56 X30/6 Digital Out (OPCGPIO).

For X30/7, check the load connected to X30/7 or remove short-circuit connection. Check par. E-57 Term X30/7 Digital Out (OPCGPIO).

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 VDC 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 supplied are monitored.

WARNING 47, 24 V supply low

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

WARNING 48, 1.8 V supply low

The 1.8 Volt DC supply used on the control card is outside of allowable limits. The power supply is measured on the control card.

WARNING 49, Speed limit

The speed is not within the specified range in *4-11 Motor Speed Low Limit [RPM]* and *4-13 Motor Speed High Limit [RPM]*.

ALARM 50, Auto Tune calibration failed

Contact your Danfoss supplier.

ALARM 51, Auto Tune check Unom and Inom

The setting of the motor voltage, motor current, and motor power is presumably wrong. Check the settings.

ALARM 52, Auto tune low I_{nom}

The motor current is too low. Check the settings.

ALARM 53, Auto tune motor too big

The motor is too big for the Auto tune to be carried out.

ALARM 54, Auto tune motor too small

The motor is too big for the Auto tune to be carried out.

ALARM 55, Auto Tune parameter out of range

The parameter values found from the motor are outside acceptable range.

ALARM 56, Auto Tune interrupted by user

The Auto Tune has been interrupted by the user.

ALARM 57, Auto tune timeout

Try to start the Auto Tune again a number of times, until the Auto Tune is carried out. Please note that repeated runs may heat the motor to a level where the resistances R_s and R_r are increased. In most cases, however, this is not critical.

ALARM 58, Auto Tune internal fault

Contact your Danfoss supplier.

WARNING 59, Current limit

The current is higher than the value in par. 4-18, *Current Limit*.

WARNING 60, External interlock

External interlock has been activated. To resume normal operation, apply 24 VDC to the terminal programmed for external interlock and reset the adjustable frequency drive (via serial communication, digital I/O, or by pressing reset button on keypad).

WARNING 61, Tracking error

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

WARNING 62, Output frequency at maximum limit

The output frequency is higher than the value set in 4-19 *Max Output Frequency*

WARNING 64, Voltage limit

The load and speed combination demands a motor voltage higher than the actual DC link voltage.

WARNING/ALARM/TRIP 65, Control card over temperature

Control card overtemperature: The cutout temperature of the control card is 176°F [80°C].

WARNING 66, Heatsink temperature low

This warning is based on the temperature sensor in the IGBT module.

Troubleshooting:**ALARM 67, Option module configuration has changed**

One or more options have either been added or removed since the last power-down.

ALARM 68, Safe stop activated

Safe stop has been activated. To resume normal operation, apply 24 VDC to terminal 37, then send a reset signal (via Bus, Digital I/O, or by pressing the reset key. See parameter 5-19, Terminal 37 Safe Stop.

ALARM 69, Power card temperature

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

Troubleshooting:

Check the operation of the door fans.

Make sure that the filters for the door fans are not blocked.

Check that the connector plate is properly installed on IP 21 and IP 54 (NEMA 1 and NEMA 12) drives.

ALARM 70, Illegal Drive Configuration

The current control board and power board combination is illegal.

WARNING/ALARM 71, PTC 1 safe stop

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

ALARM 72, Dangerous failure

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

Warning 73, Safe stop auto restart

Safe stopped. Note that 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 does not match the detected number of active power units. When replacing an F frame module, this will occur if the power specific data in the module power card does not match the rest of the drive. Please confirm the spare part and its power card are the correct part number.

WARNING 77, Reduced power mode:

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

ALARM 79, Illegal power section configuration

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

ALARM 80, Drive Restored to Factory Settings

Parameter settings are restored to factory settings after a manual reset.

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-load situation has been detected in the system. See parameter group 22-2.

ALARM 93, Dry pump

A No-Flow situation and high speed indicates that the pump has run dry. See parameter group 22-2.

ALARM 94, End of curve

Feedback stays lower than the setpoint which may indicate leakage in the pipe system. See parameter group 22-5.

ALARM 95, Broken belt

Torque is below the torque level set for no load, indicating a broken belt. See parameter group 22-6.

ALARM 96, Start delayed

Motor start has been delayed due to short-cycle protection active. See parameter group 22-7.

WARNING 97, Stop delayed

Stopping the motor has been delayed due to short cycle protection is active. See parameter group 22-7.

WARNING 98, Clock fault

Clock Fault. Time is not set or RTC clock (if mounted) has failed. See parameter group 0-7.

ALARM 243, Brake IGBT

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

- 1 = left most inverter module.
- 2 = middle inverter module in F2 or F4 drive.
- 2 = right inverter module in F1 or F3 drive.
- 3 = right inverter module in F2 or F4 drive.
- 5 = rectifier module.

ALARM 244, Heatsink temperature

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

- 1 = left most inverter module.
- 2 = middle inverter module in F2 or F4 drive.

2 = right inverter module in F1 or F3 drive.

3 = right inverter module in F2 or F4 drive.

5 = rectifier module.

ALARM 245, Heatsink sensor

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

- 1 = left most inverter module.
- 2 = middle inverter module in F2 or F4 drive.
- 2 = right inverter module in F1 or F3 drive.
- 3 = right inverter module in F2 or F4 drive.
- 5 = rectifier module.

ALARM 246, Power card supply

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

- 1 = left most inverter module.
- 2 = middle inverter module in F2 or F4 drive.
- 2 = right inverter module in F1 or F3 drive.
- 3 = right inverter module in F2 or F4 drive.
- 5 = rectifier module.

ALARM 247, Power card temperature

This alarm is only for F Frame drives. It is equivalent to Alarm 69. The report value in the alarm log indicates which power module generated the alarm:

- 1 = left most inverter module.
- 2 = middle inverter module in F2 or F4 drive.
- 2 = right inverter module in F1 or F3 drive.
- 3 = right inverter module in F2 or F4 drive.
- 5 = rectifier module.

ALARM 248, Illegal power section configuration

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

- 1 = left most inverter module.
- 2 = middle inverter module in F2 or F4 drive.
- 2 = right inverter module in F1 or F3 drive.
- 3 = right inverter module in F2 or F4 drive.
- 5 = rectifier module.

ALARM 250, New spare part

The power or switch mode power supply has been exchanged. The adjustable frequency drive type code must be restored in the EEPROM. Remember to select 'Save to EEPROM' to complete.

ALARM 251, New model number

The adjustable frequency drive has a new model number.

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