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## 1. How to Read these Operating Instructions

# 1

### 1.1.1. Copyright, Limitation of Liability and Revision Rights

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## 1

These Operating Instructions will introduce all aspects of your VLT AQUA Drive.

**Available literature for VLT AQUA Drive:**

- Operating Instructions MG.20.MX.YY provide the necessary information for getting the drive up and running.
- Design Guide MG.20.NX.YY entails technical information about the drive design and customer applications.
- Programming Guide MG.20.OX.YY provides information on how to programme and includes complete parameter descriptions.

X = Revision number

YY = Language code

Danfoss Drives technical literature is also available online at [www.danfoss.com/BusinessAreas/DrivesSolutions/Documentations/Technical+Documentation](http://www.danfoss.com/BusinessAreas/DrivesSolutions/Documentations/Technical+Documentation).

**1.1.2. Approvals****1.1.3. Symbols**

Symbols used in these Operating Instructions.

**NB!**

Indicates something to be noted by the reader.



Indicates a general warning.



Indicates a high-voltage warning.

\*

Indicates default setting

## 2. Safety

### 2.1.1. Safety note



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

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#### Safety Regulations

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

#### Installation at High Altitudes



By altitudes above 2 km, please contact Danfoss regarding PELV.

#### Warning against Unintended Start

1. The motor can be brought to a stop by means of digital commands, bus commands, references or a local stop, while the frequency converter is connected to mains. If personal safety considerations make it necessary to ensure that no unintended start occurs, these stop functions are not sufficient.
2. While parameters are being changed, the motor may start. Consequently, the stop key [STOP/RESET] must always be activated; following which data can be modified.
3. A motor that has been stopped may start if faults occur in the electronics of the frequency converter, or if a temporary overload or a fault in the supply mains or the motor connection ceases.



#### Warning:

Touching the electrical parts may be fatal - even after the equipment has been disconnected from mains.

Also make sure that other voltage inputs have been disconnected, such as external 24 V DC, load sharing (linkage of DC intermediate circuit), as well as the motor connection for kinetic back up.

### 2.1.2. General Warning


**Warning:**

Touching the electrical parts may be fatal - even after the equipment has been disconnected from mains.

Also make sure that other voltage inputs have been disconnected, (linkage of DC intermediate circuit), as well as the motor connection for kinetic back-up.

Before touching any potentially live parts of the VLT AQUA Drive FC 200, wait at least as follows:

200 - 240 V, 0.25 - 3.7 kW: wait at least 4 minutes.

200 - 240 V, 5.5 - 45 kW: wait at least 15 minutes.

380 - 480 V, 0.37 - 7.5 kW: wait at least 4 minutes.

380 - 480 V, 11 - 90 kW, wait at least 15 minutes.

525 - 600 V, 1.1 - 7.5 kW, wait at least 4 minutes.

525 - 600 V, 110 - 250 kW, wait at least 20 minutes.

525 - 600 V, 315 - 560 kW, wait at least 30 minutes.

Shorter time is allowed only if indicated on the nameplate for the specific unit.


**Leakage Current**

The earth leakage current from the VLT AQUA Drive FC 200 exceeds 3.5 mA. According to IEC 61800-5-1 a reinforced Protective Earth connection must be ensured by means of: a min. 10mm<sup>2</sup> Cu or 16mm<sup>2</sup> Al PE-wire or an additional PE wire - with the same cable cross section as the Mains wiring - must be terminated separately.

**Residual Current Device**

This product can cause a D.C. current in the protective conductor. Where a residual current device (RCD) is used for extra protection, only an RCD of Type B (time delayed) shall be used on the supply side of this product. See also RCD Application Note MN.90.GX.02.

Protective earthing of the VLT AQUA Drive FC 200 and the use of RCD's must always follow national and local regulations.

### 2.1.3. Before Commencing Repair Work

1. Disconnect the frequency converter from mains
2. Disconnect DC bus terminals 88 and 89
3. Wait at least the time mentioned in section 2.1.2
4. Remove motor cable

### 2.1.4. Special conditions

**Electrical ratings:**

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

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

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

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

**Installation requirements:**

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

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

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

2.1.5. Caution



The frequency converter DC link capacitors remain charged after power has been disconnected. To avoid an electrical shock hazard, disconnect the frequency converter from the mains before carrying out maintenance. Wait at least as follows before doing service on the frequency converter:

| Voltage     | Min. Waiting Time |             |              |              |
|-------------|-------------------|-------------|--------------|--------------|
|             | 4 min.            | 15 min.     | 20 min.      | 30 min.      |
| 200 - 240 V | 0.25 - 3.7 kW     | 5.5 - 45 kW |              |              |
| 380 - 480 V | 0.37 - 7.5 kW     | 11 - 90 kW  | 110 - 250 kW | 315 - 450 kW |
| 525-600 V   | 0.75 kW - 7.5 kW  |             | 110 - 250 kW | 315 - 560 kW |
| 525-690 V   |                   |             | 45 - 400 kW  | 450 - 630 kW |

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

2.1.6. Avoid unintended Start

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

- Disconnect the frequency converter from mains whenever personal safety considerations make it necessary to avoid unintended start.
- To avoid unintended start, always activate the [OFF] key before changing parameters.
- Unless terminal 37 is turned off, an electronic fault, temporary overload, a fault in the mains supply, or lost motor connection may cause a stopped motor to start.

2.1.7. Safe Stop of the Frequency Converter (optional)

For versions fitted with a Safe Stop terminal 37 input, the frequency converter 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 VLT AQUA Drive Design Guide MG.20.NX.YY must be followed! The information and instructions of the Operating Instructions are not sufficient for a correct and safe use of the Safe Stop functionality!

Prüf- und Zertifizierungsstelle  
im BG-PRÜFZERT

**BGIA**  
Berufsgenossenschaftliches  
Institut für Arbeitsschutz  
Hauptverband der gewerblichen  
Berufsgenossenschaften

**Type Test Certificate**

05 06004  
No. of certificate: 130BA373.10

**Information**  
Inserting name, the German  
original shall prevail.

Name and address of the  
holder of the certificate  
(customer): Danfoss Drives A/S, Ulmøse 1  
DK-6300 Græsten, Denmark.

Name and address of the  
manufacturer: Danfoss Drives A/S, Ulmøse 1  
DK-6300 Græsten, Denmark.

Ref. of customer: Ref. of Test and Certification Body:  
Ap/Kah 15-Nr. 2003 23220 Date of issue:  
13.04.2005

Product designation: Frequency converter with integrated safety functions

Type: VLT® Automation Drive FC 302

Intended purpose: Implementation of safety function „Safe Stop“

Testing based on: EN 954-1, 1997-03,  
DKE AK 226.03, 1998-06,  
EN ISO 13849-2, 2003-12,  
EN 61800-3, 2001-02,  
EN 61800-5-1, 2003-09.

Test certificate: No. 2003 23220 from 13.04.2005

Remarks: The presented types of the frequency converter FC 302 meet the requirements laid  
down in the test bases.  
With correct wiring a category 3 according to DIN EN 954-1 is reached for the safety  
function.

The type tested complies with the provisions laid down in the directive 98/37/EC (Machinery).

Further conditions are laid down in the Rules of Procedure for Testing and Certification of April 2004.

Head of certification body: (Prof. Dr. rer. nat. Diether Rainer)

Certification officer: (Dipl.-Ing. R. Apfeld)

FZS/IK  
01-05

Postal address: 58734 Sankt Augustin

Office: Alte Heerenstraße 111  
58737 Sankt Augustin

Phone: 0 22 41/2 31-02  
Fax: 0 22 41/2 31-22 34

2.1.8. IT Mains



**IT Mains**

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

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

par. 14-50 RFI *Filter* can be used to disconnect the internal RFI capacitors from the RFI filter to ground. If this is done it will reduce the RFI performance to A2 level.

2.1.9. Software Version and Approvals

**VLT AQUA Drive**

**Software version: 1.24**



This manual can be used with all VLT AQUA Drive frequency converters with software version 1.24.  
The software version number can be found in parameter 15-43.

### 2.1.10. Disposal Instruction



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

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## 3. Introduction

### 3.1. Introduction

#### 3.1.1. Type Code String

|             |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|-------------|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 1           | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 |
| FC-         |   | 2 | 0 | 2 | P |   |   |   | T  |    |    |    |    | H  |    |    |    |    |    | X  | X  | S  | X  | X  | X  | X  | A  | B  | C  |    |    |    |    |    |    | D  |    |    |
| 130BA484.10 |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |

| Description                                                                           | Pos   | Possible choice                                                                                                                                                                                                                                                                                                                                 |
|---------------------------------------------------------------------------------------|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Product group & VLT Series                                                            | 1-6   | FC 202                                                                                                                                                                                                                                                                                                                                          |
| Power rating                                                                          | 8-10  | 0.25 - 630 kW                                                                                                                                                                                                                                                                                                                                   |
| Number of phases                                                                      | 11    | Three phases (T)                                                                                                                                                                                                                                                                                                                                |
| Mains voltage                                                                         | 11-12 | S2: 220-240 VAC single phase<br>S4: 380-480 VAC single phase<br>T 2: 200-240 VAC<br>T 4: 380-480 VAC<br>T 6: 525-600 VAC<br>T 7: 525-690 VAC                                                                                                                                                                                                    |
| Enclosure                                                                             | 13-15 | E20: IP20<br>E21: IP 21/NEMA Type 1<br>E55: IP 55/NEMA Type 12<br>E2M: IP21/NEMA Type 1 w/mains shield<br>E5M: IP 55/NEMA Type 12 w/mains shield<br>E66: IP66<br>F21: IP21 kit without backplate<br>G21: IP21 kit with backplate<br>P20: IP20/Chassis with backplate<br>P21: IP21/NEMA Type 1 w/backplate<br>P55: IP55/NEMA Type 12 w/backplate |
| RFI filter                                                                            | 16-17 | HX: No RFI filter<br>H1: RFI filter class A1/B<br>H2: RFI filter class A2<br>H3: RFI filter class A1/B (reduced cable length)<br>H4: RFI filter class A2/A1                                                                                                                                                                                     |
| Brake                                                                                 | 18    | X: No brake chopper included<br>B: Brake chopper included<br>T: Safe Stop<br>U: Safe + brake                                                                                                                                                                                                                                                    |
| Display                                                                               | 19    | G: Graphical Local Control Panel (GLCP)<br>N: Numeric Local Control Panel (NLCP)<br>X: No Local Control Panel                                                                                                                                                                                                                                   |
| Coating PCB                                                                           | 20    | X: No coated PCB<br>C: Coated PCB                                                                                                                                                                                                                                                                                                               |
| Mains option                                                                          | 21    | D: Loadsharing<br>X: No Mains disconnect switch<br>1: With Mains disconnect switch<br>8: Mains Disconnect + Loadsharing                                                                                                                                                                                                                         |
| Adaptation                                                                            | 22    | Reserved                                                                                                                                                                                                                                                                                                                                        |
| Adaptation                                                                            | 23    | Reserved                                                                                                                                                                                                                                                                                                                                        |
| Software release                                                                      | 24-27 | Actual software                                                                                                                                                                                                                                                                                                                                 |
| Software language                                                                     | 28    |                                                                                                                                                                                                                                                                                                                                                 |
| A options                                                                             | 29-30 | AX: No options<br>A0: MCA 101 Profibus DP V1<br>A4: MCA 104 DeviceNet                                                                                                                                                                                                                                                                           |
| B options                                                                             | 31-32 | BX: No option<br>BK: MCB 101 General purpose I/O option<br>BP: MCB 105 Relay option<br>BO: MCB 109 Analog I/O option                                                                                                                                                                                                                            |
| C0 options MCO                                                                        | 33-34 | CX: No options                                                                                                                                                                                                                                                                                                                                  |
| C1 options                                                                            | 35    | X: No options                                                                                                                                                                                                                                                                                                                                   |
| C option software                                                                     | 36-37 | XX: Standard software                                                                                                                                                                                                                                                                                                                           |
| D options                                                                             | 38-39 | DX: No option<br>D0: DC back-up                                                                                                                                                                                                                                                                                                                 |
| The various options are described further in the <i>VLT AQUA Drive Design Guide</i> . |       |                                                                                                                                                                                                                                                                                                                                                 |

Table 3.1: Type code description.

### 3.1.2. Frequency Converter Identification

Below is an example of an identification label. This label is situated on the frequency converter and shows the type and options fitted to the unit. See table 2.1 for details of how to read the Type code string (T/C).



Illustration 3.1: This example shows an identification label for VLT AQUA Drive.

Please have T/C (type code) number and serial number ready before contacting Danfoss.

### 3.1.3. Abbreviations and Standards

| Abbreviations:   | Terms:                        | SI-units:             | I-P units:            |
|------------------|-------------------------------|-----------------------|-----------------------|
|                  | Acceleration                  | m/s <sup>2</sup>      | ft/s <sup>2</sup>     |
| AWG              | American wire gauge           |                       |                       |
| Auto Tune        | Automatic Motor Tuning        |                       |                       |
| °C               | Celsius                       |                       |                       |
|                  | Current                       | A                     | Amp                   |
| I <sub>LIM</sub> | Current limit                 |                       |                       |
|                  | Energy                        | J = N•m               | ft-lb, Btu            |
| °F               | Fahrenheit                    |                       |                       |
| FC               | Frequency Converter           |                       |                       |
|                  | Frequency                     | Hz                    | Hz                    |
| kHz              | Kilohertz                     |                       |                       |
| LCP              | Local Control Panel           |                       |                       |
| mA               | Milliampere                   |                       |                       |
| ms               | Millisecond                   |                       |                       |
| min              | Minute                        |                       |                       |
| MCT              | Motion Control Tool           |                       |                       |
| M-TYPE           | Motor Type Dependent          |                       |                       |
| Nm               | Newton Metres                 |                       | in-lbs                |
| I <sub>M,N</sub> | Nominal motor current         |                       |                       |
| f <sub>M,N</sub> | Nominal motor frequency       |                       |                       |
| P <sub>M,N</sub> | Nominal motor power           |                       |                       |
| U <sub>M,N</sub> | Nominal motor voltage         |                       |                       |
| par.             | Parameter                     |                       |                       |
| PELV             | Protective Extra Low Voltage  |                       |                       |
|                  | Power                         | W                     | Btu/hr, hp            |
|                  | Pressure                      | Pa = N/m <sup>2</sup> | psi, psf, ft of water |
| I <sub>INV</sub> | Rated Inverter Output Current |                       |                       |
| RPM              | Revolutions Per Minute        |                       |                       |
| SR               | Size Related                  |                       |                       |
|                  | Temperature                   | C                     | F                     |
|                  | Time                          | s                     | s,hr                  |
| T <sub>LIM</sub> | Torque limit                  |                       |                       |
|                  | Voltage                       | V                     | V                     |

Table 3.2: Abbreviation and Standards table .

4. Mechanical installation

4.1. Before starting

4.1.1. Checklist

When unpacking the frequency converter, ensure that the unit is undamaged and complete. Use the following table to identify the packaging:

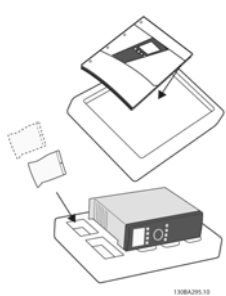
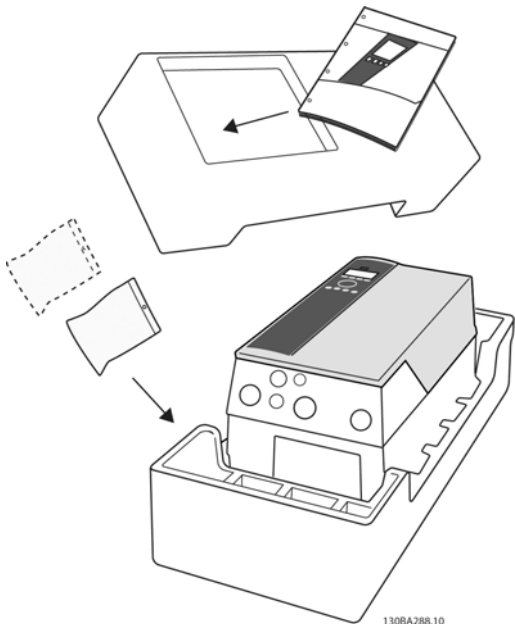
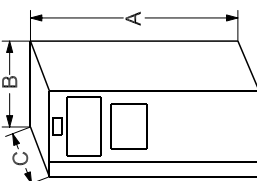
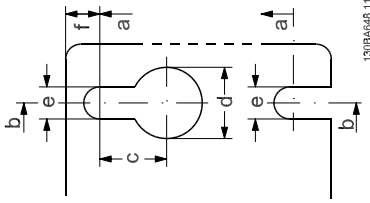
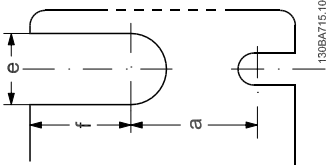
| Enclosure type: | A2<br>(IP 20/ 21)                                                                 | A3<br>(IP 20/21) | A5<br>(IP 55/ 66)                                                                   | B1/B3<br>(IP20/ 21/ 55/ 66) | B2/B4<br>(IP20/ 21/ 55/66) | C1/C3<br>(IP20/21/ 55/66) | C2/C4<br>(IP20/21/ 55/66) |
|-----------------|-----------------------------------------------------------------------------------|------------------|-------------------------------------------------------------------------------------|-----------------------------|----------------------------|---------------------------|---------------------------|
|                 |  |                  |  |                             |                            |                           |                           |
| Unit size (kW): |                                                                                   |                  |                                                                                     |                             |                            |                           |                           |
| 200-240 V       | 0.25-3.0                                                                          | 3.7              | 0.25-3.7                                                                            | 5.5-11/<br>5.5-11           | 15/<br>15-18.5             | 18.5-30/<br>22-30         | 37-45/<br>37-45           |
| 380-480 V       | 0.37-4.0                                                                          | 5.5-7.5          | 0.37-7.5                                                                            | 11-18.5/<br>11-18.5         | 22-30/<br>22-37            | 37-55/<br>45-55           | 75 - 90/<br>75-90         |
| 525-600 V       | 0.75-4.0                                                                          | 5.5-7.5          | 0.75-7.5                                                                            | 11-18.5/<br>11-18.5         | 22-37/<br>22-37            | 45-55/<br>45-55           | 75 - 90/<br>75-90         |

Table 4.1: Unpacking table

Please note that a selection of screwdrivers (philips or cross-thread screwdriver and torx), a side-cutter, drill and knife is also recommended to have handy for unpacking and mounting the frequency converter. The packaging for these enclosures contains, as shown: Accessories bag(s), documentation and the unit. Depending on options fitted there may be one or two bags and one or more booklets.

4.2.1. Mechanical Front Views

|                                                                                                                 |                                                                                     |                                                                                     |                                                                                     |                                                                                     |                                                                                     |                                                                                     |                                                                                    |                                                                                   |                                                                                   |                                                                                   |
|-----------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|
|                              |  |  |  |  |  |  |  |  |  |  |
| IP20/21                                                                                                         | IP20/21                                                                             | IP55/66                                                                             | IP21/55/66                                                                          | IP21/55/66                                                                          | IP20                                                                                | IP20                                                                                | IP21/55/66                                                                         | IP21/55/66                                                                        | IP20                                                                              | IP20                                                                              |
|                              |                                                                                     |                                                                                     |                                                                                     |                                                                                     |                                                                                     |  |                                                                                    |                                                                                   |                                                                                   |                                                                                   |
|                                                                                                                 |                                                                                     |                                                                                     |                                                                                     |                                                                                     |                                                                                     |    |                                                                                    |                                                                                   |                                                                                   |                                                                                   |
| Accessory bags containing necessary brackets, screws and connectors are included with the drives upon delivery. |                                                                                     |                                                                                     |                                                                                     |                                                                                     |                                                                                     | Top and bottom mounting holes. (C3+C4 only)                                         |                                                                                    |                                                                                   |                                                                                   |                                                                                   |
| All measurements in mm.<br>* A5 in IP55/66 only!                                                                |                                                                                     |                                                                                     |                                                                                     |                                                                                     |                                                                                     |                                                                                     |                                                                                    |                                                                                   |                                                                                   |                                                                                   |

## 4.2.2. Mechanical Dimensions

| Mechanical dimensions                                                                                                                  |          |          |          |           |           |         |         |           |           |         |         |  |
|----------------------------------------------------------------------------------------------------------------------------------------|----------|----------|----------|-----------|-----------|---------|---------|-----------|-----------|---------|---------|--|
| Frame size (kW):                                                                                                                       | A2       | A3       | A5       | B1        | B2        | B3      | B4      | C1        | C2        | C3      | C4      |  |
| 200-240 V                                                                                                                              | 0.25-3.0 | 3.7      | 0.25-3.7 | 5.5-11    | 15        | 5.5-11  | 15-18.5 | 18.5-30   | 37-45     | 22-30   | 37-45   |  |
| 380-480 V                                                                                                                              | 0.37-4.0 | 5.5-7.5  | 0.37-7.5 | 11-18.5   | 22-30     | 11-18.5 | 22-37   | 37-55     | 75-90     | 45-55   | 75-90   |  |
| 525-600 V                                                                                                                              | -        | 0.75-7.5 | 0.75-7.5 | 11-18.5   | 22-30     | 11-18.5 | 22-37   | 37-55     | 75-90     | 45-55   | 75-90   |  |
| IP                                                                                                                                     | 20       | 20       | 55/66    | 21/ 55/66 | 21/55/66  | 20      | 20      | 21/55/66  | 21/55/66  | 20      | 20      |  |
| NEMA                                                                                                                                   | Chassis  | Type 1   | Type 12  | Type 1/12 | Type 1/12 | Chassis | Chassis | Type 1/12 | Type 1/12 | Chassis | Chassis |  |
| Height (mm)                                                                                                                            |          |          |          |           |           |         |         |           |           |         |         |  |
| Enclosure                                                                                                                              | A**      | 246      | 372      | 420       | 480       | 650     | 350     | 680       | 770       | 490     | 600     |  |
| ..with de-coupling plate                                                                                                               | A2       | 374      | -        | -         | -         | -       | 419     | 595       | -         | 630     | 800     |  |
| Back plate                                                                                                                             | A1       | 268      | 375      | 420       | 480       | 650     | 399     | 520       | 680       | 770     | 660     |  |
| Distance between mount. holes                                                                                                          | a        | 257      | 350      | 402       | 454       | 624     | 380     | 495       | 648       | 739     | 631     |  |
| Width (mm)                                                                                                                             |          |          |          |           |           |         |         |           |           |         |         |  |
| Enclosure                                                                                                                              | B        | 90       | 130      | 242       | 242       | 242     | 165     | 231       | 308       | 370     | 370     |  |
| With one C option                                                                                                                      | B        | 130      | 170      | 242       | 242       | 242     | 205     | 231       | 308       | 370     | 370     |  |
| Back plate                                                                                                                             | B        | 90       | 130      | 242       | 242       | 242     | 165     | 231       | 308       | 370     | 370     |  |
| Distance between mount. holes                                                                                                          | b        | 70       | 110      | 215       | 210       | 210     | 140     | 200       | 272       | 270     | 330     |  |
| Depth (mm)                                                                                                                             |          |          |          |           |           |         |         |           |           |         |         |  |
| Without option A/B                                                                                                                     | C        | 205      | 205      | 200       | 260       | 260     | 248     | 242       | 310       | 333     | 333     |  |
| With option A/B                                                                                                                        | C*       | 220      | 220      | 200       | 260       | 260     | 262     | 242       | 310       | 333     | 333     |  |
| Screw holes (mm)                                                                                                                       |          |          |          |           |           |         |         |           |           |         |         |  |
|                                                                                                                                        | c        | 8.0      | 8.0      | 8.2       | 12        | 12      | 8       | -         | 12        | 12      | -       |  |
| Diameter ø                                                                                                                             | d        | 11       | 11       | 12        | 19        | 19      | 12      | -         | 19        | 19      | -       |  |
| Diameter ø                                                                                                                             | e        | 5.5      | 5.5      | 6.5       | 9         | 9       | 6.8     | 8.5       | 9.0       | 9.0     | 8.5     |  |
|                                                                                                                                        | f        | 9        | 9        | 9         | 9         | 9       | 7.9     | 15        | 9.8       | 17      | 17      |  |
| Max weight (kg)                                                                                                                        |          | 4.9      | 5.3      | 14        | 23        | 27      | 12      | 23.5      | 45        | 65      | 50      |  |
| * Depth of enclosure will vary with different options installed.                                                                       |          |          |          |           |           |         |         |           |           |         |         |  |
| ** The free space requirements are above and below the bare enclosure height measurement A. See section 3.2.3 for further information. |          |          |          |           |           |         |         |           |           |         |         |  |

\* Depth of enclosure will vary with different options installed.

\*\* The free space requirements are above and below the bare enclosure height measurement A. See section 3.2.3 for further information.

4.2.3. Mechanical mounting

All IP20 enclosure sizes as well as IP21/ IP55 enclosure sizes except A2 and A3 allow side-by-side installation.

If the IP 21 Enclosure kit (130B1122 or 130B1123) is used on enclosure A2 or A3, there must be a clearance between the drives of min. 50 mm.

For optimal cooling conditions allow a free air passage above and below the frequency converter. See table below.

4

**Air passage for different enclosures**

| Enclo-<br>sure: | A2  | A3  | A5  | B1  | B2  | B3  | B4  | C1  | C2  | C3  | C4  |
|-----------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| a (mm):         | 100 | 100 | 100 | 200 | 200 | 200 | 200 | 200 | 225 | 200 | 225 |
| b (mm):         | 100 | 100 | 100 | 200 | 200 | 200 | 200 | 200 | 225 | 200 | 225 |

- 1. Drill holes in accordance with the measurements given.
- 2. You must provide screws suitable for the surface on which you want to mount the frequency converter. Retighten all four screws.

Table 4.2: Mounting frame sizes A5, B1, B2, B3, B4, C1, C2, C3 and C4 on a non-solid back wall, the drive must be provided with a back plate A due to insufficient cooling air over the heat sink.

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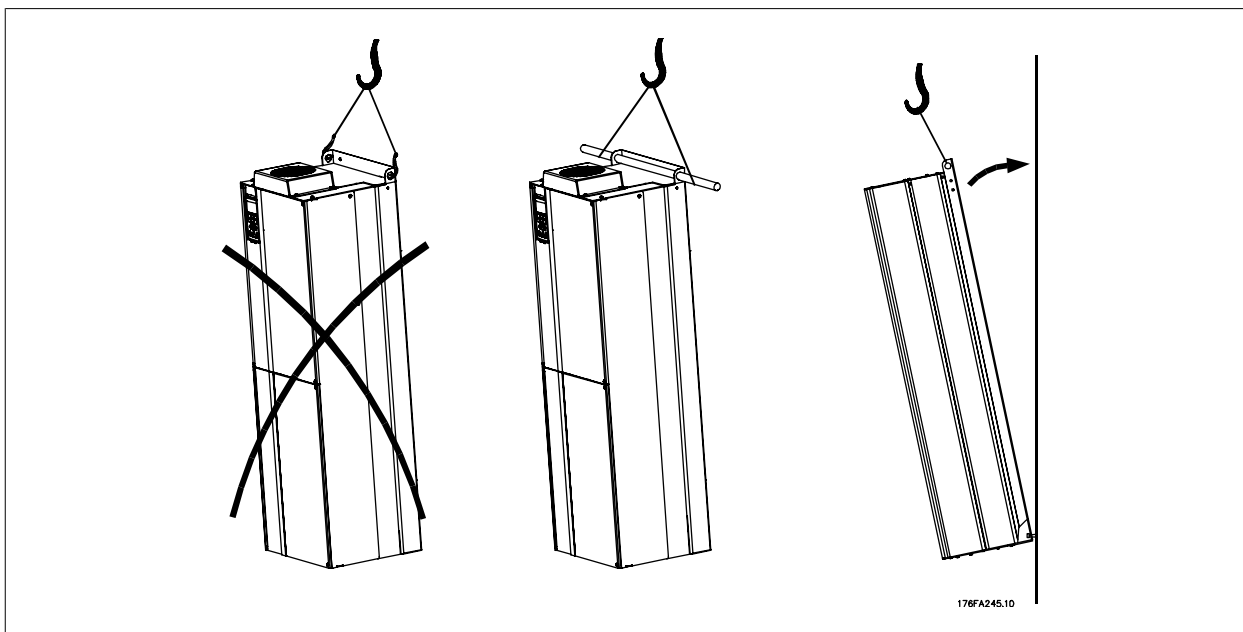


Illustration 4.1: With heavier drives, use a lift. First wall-mount the 2 lower bolts - then lift the drive onto the lower bolts - finally fasten the drive against the wall with the 2 top bolts.

#### 4.2.4. Safety Requirements of Mechanical Installation



Pay attention to the requirements that apply to integration and field mounting kit. Observe the information in the list to avoid serious damage or injury, especially when installing large units.

The frequency converter is cooled by means of air circulation.

To protect the unit from overheating, it must be ensured that the ambient temperature *does not exceed the maximum temperature stated for the frequency converter* and that the 24-hour average temperature *is not exceeded*. Locate the maximum temperature and 24-hour average in the paragraph *Derating for Ambient Temperature*.

If the ambient temperature is in the range of 45 °C - 55 °C, derating of the frequency converter will become relevant, see *Derating for Ambient Temperature*.

The service life of the frequency converter is reduced if derating for ambient temperature is not taken into account.

#### 4.2.5. Field Mounting

For field mounting the IP 21/IP 4X top/TYPE 1 kits or IP 54/55 units are recommended.

#### 4.2.6. Panel Through Mounting

A Panel Through Mount Kit is available for frequency converter series , VLT Aqua Drive and .

In order to increase heatsink cooling and reduce panel depth, the frequency converter may be mounted in a through panel. Furthermore the in-built fan can then be removed.

The kit is available for enclosures A5 through C2.



**NB!**

This kit cannot be used with cast front covers. No cover or imminent plastic cover must be used instead.

Information on ordering numbers is found in the *Design Guide*, section *Ordering Numbers*.

More detailed information is available in the *Panel Through Mount Kit instruction*, *MI.33.H1.YY*, where yy=language code.

## 5. Electrical installation

### 5.1. How to connect

#### 5.1.1. Cables General



**NB!**

Always comply with national and local regulations on cable cross-sections.

#### Details of terminal tightening torques.

| Enclosure | Power (kW) |            |            | Torque (Nm)         |                     |               |       |       |       |
|-----------|------------|------------|------------|---------------------|---------------------|---------------|-------|-------|-------|
|           | 200-240 V  | 380-480 V  | 525-600 V  | Line                | Motor               | DC connection | Brake | Earth | Relay |
| A2        | 0.25 - 3.0 | 0.37 - 4.0 | 0.75 - 4.0 | 1.8                 | 1.8                 | 1.8           | 1.8   | 3     | 0.6   |
| A3        | 3.7        | 5.5 - 7.5  | 5.5 - 7.5  | 1.8                 | 1.8                 | 1.8           | 1.8   | 3     | 0.6   |
| A5        | 0.25 - 3.7 | 0.37 - 7.5 | 0.75 - 7.5 | 1.8                 | 1.8                 | 1.8           | 1.8   | 3     | 0.6   |
| B1        | 5.5 - 11   | 11 - 18.5  | -          | 1.8                 | 1.8                 | 1.5           | 1.5   | 3     | 0.6   |
| B2        | -          | 22         | -          | 4.5                 | 4.5                 | 3.7           | 3.7   | 3     | 0.6   |
|           | 15         | 30         | -          | 4.5 <sup>2)</sup>   | 4.5 <sup>2)</sup>   | 3.7           | 3.7   | 3     | 0.6   |
| B3        | 5.5 - 11   | 11 - 18.5  | 11 - 18.5  | 1.8                 | 1.8                 | 1.8           | 1.8   | 3     | 0.6   |
| B4        | 11 - 18.5  | 18.5 - 37  | 18.5 - 37  | 4.5                 | 4.5                 | 4.5           | 4.5   | 3     | 0.6   |
| C1        | 18.5 - 30  | 37 - 55    | -          | 10                  | 10                  | 10            | 10    | 3     | 0.6   |
| C2        | 37         | 75         | -          | 14                  | 14                  | 14            | 14    | 3     | 0.6   |
|           | 45         | 90         | -          | 24                  | 24                  | 14            | 14    | 3     | 0.6   |
| C3        | 18.5 - 30  | 37 - 55    | 37 - 55    | 10                  | 10                  | 10            | 10    | 3     | 0.6   |
| C4        | 30 - 45    | 55 - 90    | 55 - 90    | 14/24 <sup>1)</sup> | 14/24 <sup>1)</sup> | 14            | 14    | 3     | 0.6   |

Table 5.1: Tightening of terminals

1. For different cable dimensions x/y where  $x \leq 95 \text{ mm}^2$  and  $y \geq 95 \text{ mm}^2$ .
2. Cable dimensions above 18.5 kW  $\geq 35 \text{ mm}^2$  and below 22 kW  $\leq 10 \text{ mm}^2$

#### 5.1.2. Enclosure Knock-outs

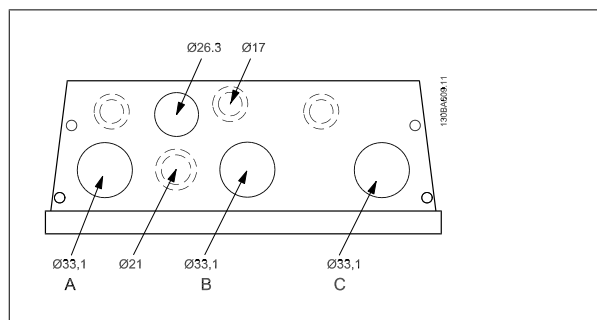


Illustration 5.1: Cable entry holes for enclosure B1. The suggested use of the holes are purely recommendations and other solutions are possible.

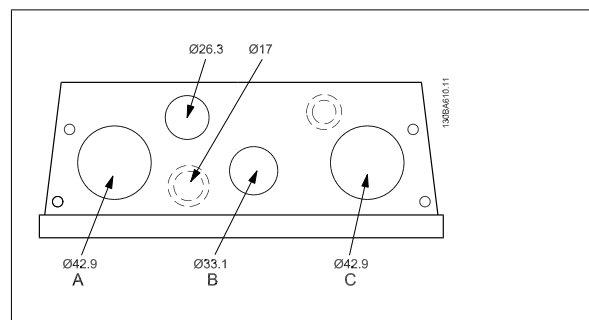


Illustration 5.2: Cable entry holes for enclosure B2. The suggested use of the holes are purely recommendations and other solutions are possible.

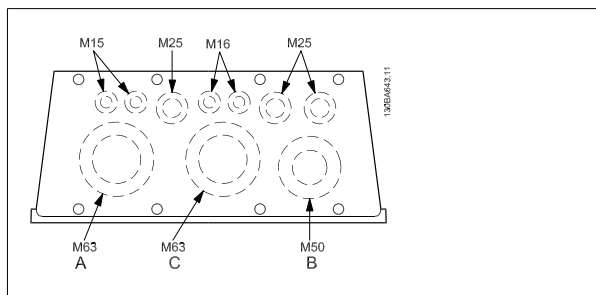


Illustration 5.3: Cable entry holes for enclosure C1. The suggested use of the holes are purely recommendations and other solutions are possible.

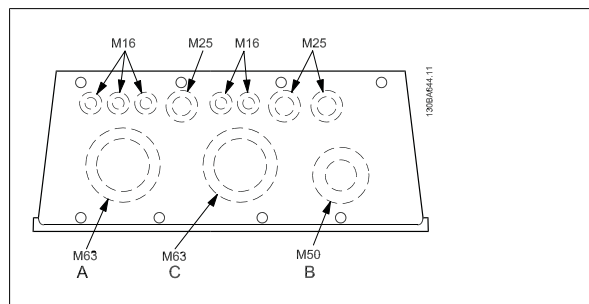


Illustration 5.4: Cable entry holes for enclosure C2. The suggested use of the holes are purely recommendations and other solutions are possible.

## 5

### 5.1.3. 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 shortcircuit and overcurrent protected according to the national/international regulations.

#### Short circuit protection

The frequency converter must be protected against short-circuit to avoid electrical or fire hazard. Danfoss recommends using the fuses mentioned in tables 4.3 and 4.4 to protect service personnel or other equipment in case of an internal failure in the unit. The frequency converter provides full short circuit protection in case of a short-circuit on the motor output.

#### Over-current protection:

Provide overload protection to avoid fire hazard due to overheating of the cables in the installation. Over current protection must always be carried out according to national regulations. The frequency converter is equipped with an internal over current protection that can be used for upstream overload protection (UL-applications excluded). See par. 4-18. Fuses must be designed for protection in a circuit capable of supplying a maximum of 100,000  $A_{rms}$  (symmetrical), 500 V/600 V maximum.

#### Non UL compliance

If UL/cUL is not to be complied with, Danfoss recommends using the fuses mentioned in table 4.2, which will ensure compliance with EN50178:

In case of malfunction, not following the recommendation may result in unnecessary damage to the frequency converter.

| Frequency converter | Max. fuse size    | Voltage   | Type    |
|---------------------|-------------------|-----------|---------|
| <b>200-240 V</b>    |                   |           |         |
| K25-1K1             | 16A <sup>1</sup>  | 200-240 V | type gG |
| 1K5                 | 16A <sup>1</sup>  | 200-240 V | type gG |
| 2K2                 | 25A <sup>1</sup>  | 200-240 V | type gG |
| 3K0                 | 25A <sup>1</sup>  | 200-240 V | type gG |
| 3K7                 | 35A <sup>1</sup>  | 200-240 V | type gG |
| 5K5                 | 50A <sup>1</sup>  | 200-240 V | type gG |
| 7K5                 | 63A <sup>1</sup>  | 200-240 V | type gG |
| 11K                 | 63A <sup>1</sup>  | 200-240 V | type gG |
| 15K                 | 80A <sup>1</sup>  | 200-240 V | type gG |
| 18K5                | 125A <sup>1</sup> | 200-240 V | type gG |
| 22K                 | 125A <sup>1</sup> | 200-240 V | type gG |
| 30K                 | 160A <sup>1</sup> | 200-240 V | type gG |
| 37K                 | 200A <sup>1</sup> | 200-240 V | type aR |
| 45K                 | 250A <sup>1</sup> | 200-240 V | type aR |
| <b>380-480 V</b>    |                   |           |         |
| K37-1K5             | 10A <sup>1</sup>  | 380-480 V | type gG |
| 2K2-4K0             | 20A <sup>1</sup>  | 380-480 V | type gG |
| 5K5-7K5             | 32A <sup>1</sup>  | 380-480 V | type gG |
| 11K                 | 63A <sup>1</sup>  | 380-480 V | type gG |
| 15K                 | 63A <sup>1</sup>  | 380-480 V | type gG |
| 18K                 | 63A <sup>1</sup>  | 380-480 V | type gG |
| 22K                 | 63A <sup>1</sup>  | 380-480 V | type gG |
| 30K                 | 80A <sup>1</sup>  | 380-480 V | type gG |
| 37K                 | 100A <sup>1</sup> | 380-480 V | type gG |
| 45K                 | 125A <sup>1</sup> | 380-480 V | type gG |
| 55K                 | 160A <sup>1</sup> | 380-480 V | type gG |
| 75K                 | 250A <sup>1</sup> | 380-480 V | type aR |
| 90K                 | 250A <sup>1</sup> | 380-480 V | type aR |

Table 5.2: Non UL fuses 200 V to 480 V

1) Max. fuses - see national/international regulations for selecting an applicable fuse size.

## UL Compliance

| Frequency converter | Bussmann | Bussmann | Bussmann | SIBA        | Littel fuse | Ferraz-Shawmut | Ferraz-Shawmut |
|---------------------|----------|----------|----------|-------------|-------------|----------------|----------------|
| <b>200-240 V</b>    |          |          |          |             |             |                |                |
| Type                | Type RK1 | Type J   | Type T   | Type RK1    | Type RK1    | Type CC        | Type RK1       |
| K25-1K1             | KTN-R10  | JKS-10   | JJN-10   | 5017906-010 | KLN-R10     | ATM-R10        | A2K-10R        |
| 1K5                 | KTN-R15  | JKS-15   | JJN-15   | 5017906-015 | KLN-R15     | ATM-R15        | A2K-15R        |
| 2K2                 | KTN-R20  | JKS-20   | JJN-20   | 5012406-020 | KLN-R20     | ATM-R20        | A2K-20R        |
| 3K0                 | KTN-R25  | JKS-25   | JJN-25   | 5012406-025 | KLN-R25     | ATM-R25        | A2K-25R        |
| 3K7                 | KTN-R30  | JKS-30   | JJN-30   | 5012406-030 | KLN-R30     | ATM-R30        | A2K-30R        |
| 5K5                 | KTN-R50  | JKS-50   | JJN-50   | 5012406-050 | KLN-R50     | -              | A2K-50R        |
| 7K5                 | KTN-R50  | JKS-60   | JJN-60   | 5012406-050 | KLN-R60     | -              | A2K-50R        |
| 11K                 | KTN-R60  | JKS-60   | JJN-60   | 5014006-063 | KLN-R60     | -              | A2K-60R        |
| 15K                 | KTN-R80  | JKS-80   | JJN-80   | 5014006-080 | KLN-R80     | -              | A2K-80R        |
| 18K5                | KTN-R125 | JKS-150  | JJN-125  | 2028220-125 | KLN-R125    | -              | A2K-125R       |
| 22K                 | KTN-R125 | JKS-150  | JJN-125  | 2028220-125 | KLN-R125    | -              | A2K-125R       |
| 30K                 | FWX-150  | -        | -        | 2028220-150 | L25S-150    | -              | A25X-150       |
| 37K                 | FWX-200  | -        | -        | 2028220-200 | L25S-200    | -              | A25X-200       |
| 45K                 | FWX-250  | -        | -        | 2028220-250 | L25S-250    | -              | A25X-250       |

Table 5.3: UL fuses 200 - 240 V

| Frequency converter         | Bussmann | Bussmann | Bussmann | SIBA        | Littel fuse | Ferraz-Shawmut | Ferraz-Shawmut |
|-----------------------------|----------|----------|----------|-------------|-------------|----------------|----------------|
| <b>380-480 V, 525-600 V</b> |          |          |          |             |             |                |                |
| kW                          | Type RK1 | Type J   | Type T   | Type RK1    | Type RK1    | Type CC        | Type RK1       |
| K37-1K1                     | KTS-R6   | JKS-6    | JJS-6    | 5017906-006 | KLS-R6      | ATM-R6         | A6K-6R         |
| 1K5-2K2                     | KTS-R10  | JKS-10   | JJS-10   | 5017906-010 | KLS-R10     | ATM-R10        | A6K-10R        |
| 3K0                         | KTS-R15  | JKS-15   | JJS-15   | 5017906-016 | KLS-R16     | ATM-R16        | A6K-16R        |
| 4K0                         | KTS-R20  | JKS-20   | JJS-20   | 5017906-020 | KLS-R20     | ATM-R20        | A6K-20R        |
| 5K5                         | KTS-R25  | JKS-25   | JJS-25   | 5017906-025 | KLS-R25     | ATM-R25        | A6K-25R        |
| 7K5                         | KTS-R30  | JKS-30   | JJS-30   | 5012406-032 | KLS-R30     | ATM-R30        | A6K-30R        |
| 11K                         | KTS-R40  | JKS-40   | JJS-40   | 5014006-040 | KLS-R40     | -              | A6K-40R        |
| 15K                         | KTS-R40  | JKS-40   | JJS-40   | 5014006-040 | KLS-R40     | -              | A6K-40R        |
| 18K                         | KTS-R50  | JKS-50   | JJS-50   | 5014006-050 | KLS-R50     | -              | A6K-50R        |
| 22K                         | KTS-R60  | JKS-60   | JJS-60   | 5014006-063 | KLS-R60     | -              | A6K-60R        |
| 30K                         | KTS-R80  | JKS-80   | JJS-80   | 2028220-100 | KLS-R80     | -              | A6K-80R        |
| 37K                         | KTS-R100 | JKS-100  | JJS-100  | 2028220-125 | KLS-R100    | -              | A6K-100R       |
| 45K                         | KTS-R125 | JKS-150  | JJS-150  | 2028220-125 | KLS-R125    | -              | A6K-125R       |
| 55K                         | KTS-R150 | JKS-150  | JJS-150  | 2028220-160 | KLS-R150    | -              | A6K-150R       |
| 75K                         | FWH-220  | -        | -        | 2028220-200 | L50S-225    | -              | A50-P225       |
| 90K                         | FWH-250  | -        | -        | 2028220-250 | L50S-250    | -              | A50-P250       |

Table 5.4: UL fuses 380 - 600 V

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

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

KLRS fuses from LITTEL FUSE may substitute KLN-R fuses for 240 V frequency converters.

L50S fuses from LITTEL FUSE may substitute L50S fuses for 240 V frequency converters.

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

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

## 5.1.4. Earthing and IT mains



The earth connection cable cross section must be at least 10 mm<sup>2</sup> or 2 rated mains wires terminated separately according to *EN 50178* or *IEC 61800-5-1* unless national regulations specify differently. Always comply with national and local regulations on cable cross-sections.

The mains is connected to the main disconnect switch if this is included.

**NB!**

Check that mains voltage corresponds to the mains voltage of the frequency converter name plate.

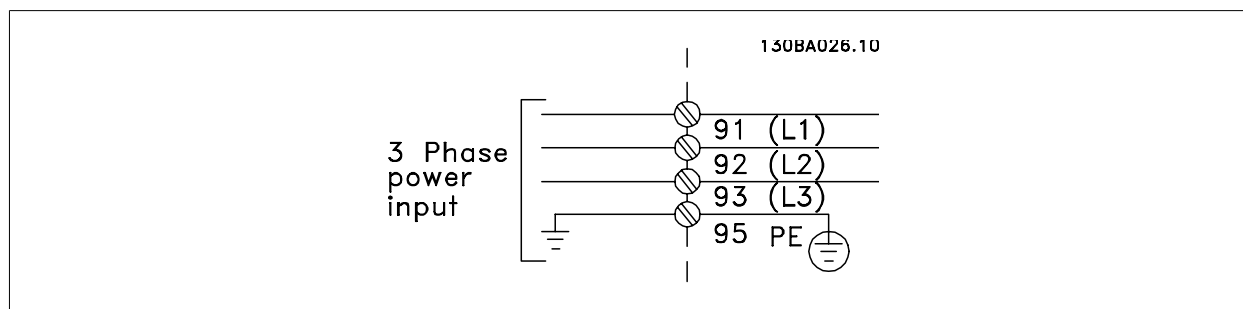


Illustration 5.5: Terminals for mains and earthing.

5

**IT Mains**

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

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

5.1.5. Mains wiring overview

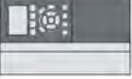
| Enclosure:              | A2<br>(IP 20/IP 21)                                                                 | A3<br>(IP 20/IP 21)                                                                 | A5<br>(IP 55/IP 66)                                                                 | B1<br>(IP 21/IP 55/IP 66)                                                           | B2<br>(IP 21/IP 55/IP 66)                                                           | B3<br>(IP 20)                                                                      | B4<br>(IP 20)                                                                     | C1<br>(IP 21/IP 55/66)                                                            | C2<br>(IP 21/IP 55/66)                                                            | C3<br>(IP 20)                                                                     | C4<br>(IP 20)                                                                     |
|-------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|
|                         |  |  |  |  |  |  |  |  |  |  |  |
| <b>Motor size (kW):</b> |                                                                                     |                                                                                     |                                                                                     |                                                                                     |                                                                                     |                                                                                    |                                                                                   |                                                                                   |                                                                                   |                                                                                   |                                                                                   |
| 200-240 V               | 0.25-3.0                                                                            | 3.7                                                                                 | 1.1-3.7                                                                             | 5.5-11                                                                              | 15                                                                                  | 5.5-11                                                                             | 15-18.5                                                                           | 18.5-30                                                                           | 37-45                                                                             | 22-30                                                                             | 37-45                                                                             |
| 380-480 V               | 0.37-4.0                                                                            | 5.5-7.5                                                                             | 1.1-7.5                                                                             | 11-18.5                                                                             | 22-30                                                                               | 11-18.5                                                                            | 22-37                                                                             | 37-55                                                                             | 75-90                                                                             | 45-55                                                                             | 75-90                                                                             |
| 525-600 V               |                                                                                     | 1.1-7.5                                                                             | 1.1-7.5                                                                             | 11-18.5                                                                             | 22-30                                                                               | 11-18.5                                                                            | 22-37                                                                             | 37-55                                                                             | 75-90                                                                             | 45-55                                                                             | 75-90                                                                             |
| <b>Goto:</b>            | <b>5.1.6</b>                                                                        |                                                                                     | <b>5.1.7</b>                                                                        |                                                                                     | <b>5.1.8</b>                                                                        |                                                                                    | <b>5.1.9</b>                                                                      |                                                                                   | <b>5.1.10</b>                                                                     |                                                                                   |                                                                                   |

Table 5.5: Mains wiring table.

## 5.1.6. Mains connection for A2 and A3

5

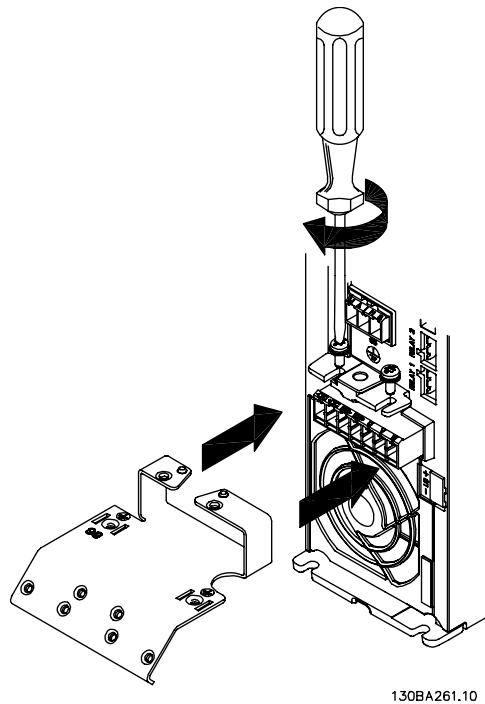
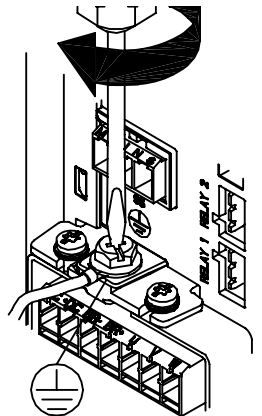


Illustration 5.6: First mount the two screws on the mounting plate, slide it into place and tighten fully.

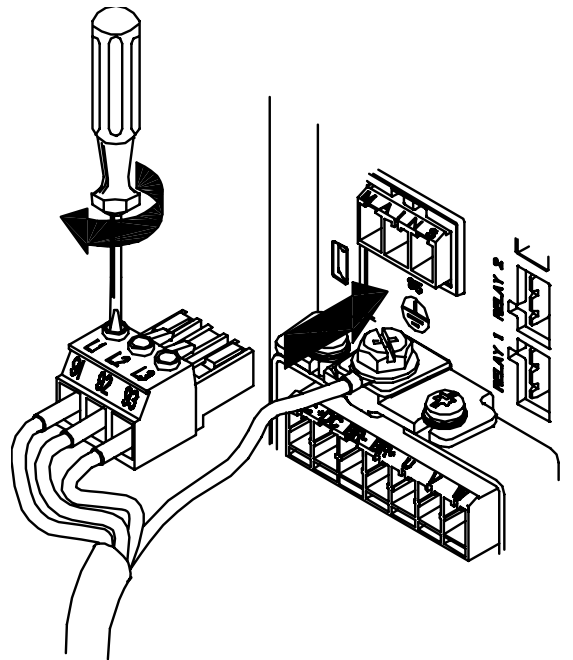


130BA262.1C

Illustration 5.7: When mounting cables, first mount and tighten earth cable.

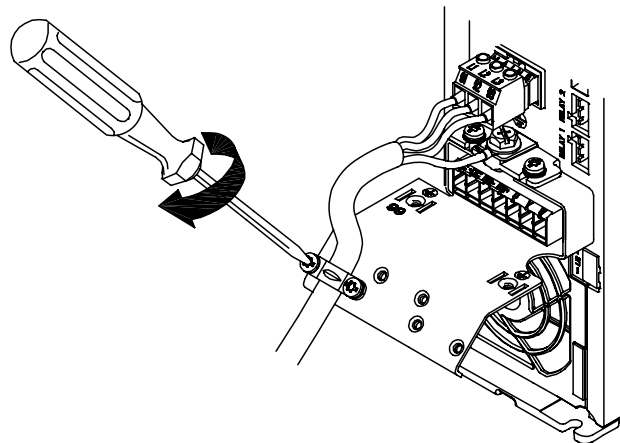


The earth connection cable cross section must be at least 10 mm<sup>2</sup> or 2 rated mains wires terminated separately according to *EN 50178/IEC 61800-5-1*.



130BA263.10

Illustration 5.8: Then mount mains plug and tighten wires.



130BA264.10

Illustration 5.9: Finally tighten support bracket on mains wires.

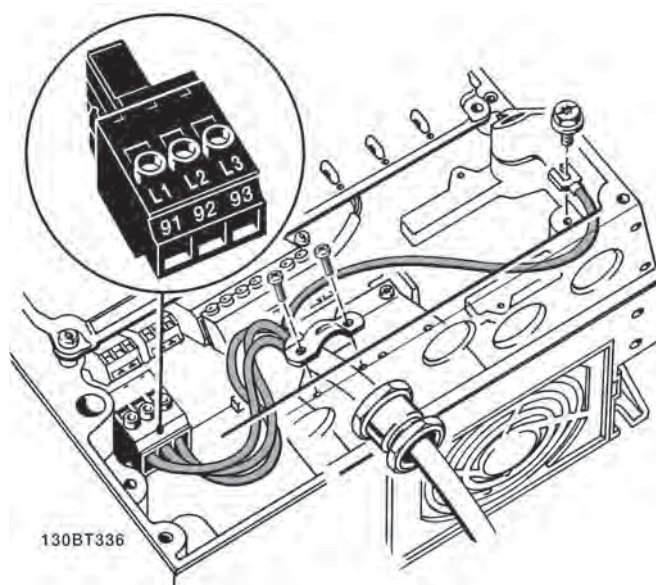
**5.1.7. Mains connection for A5**

Illustration 5.10: How to connect to mains and earthing without mains disconnect switch. Note that a cable clamp is used.

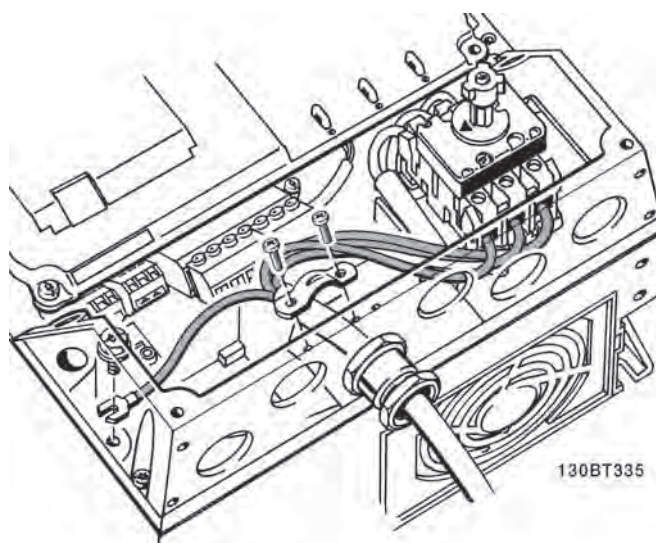


Illustration 5.11: How to connect to mains and earthing with mains disconnect switch.

### 5.1.8. Mains connection for B1, B2 and B3

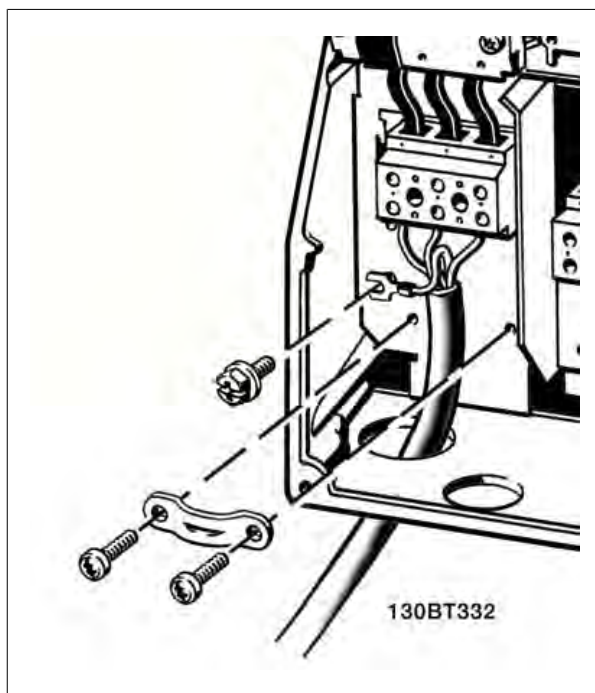


Illustration 5.12: How to connect to mains and earthing for B1 and B2

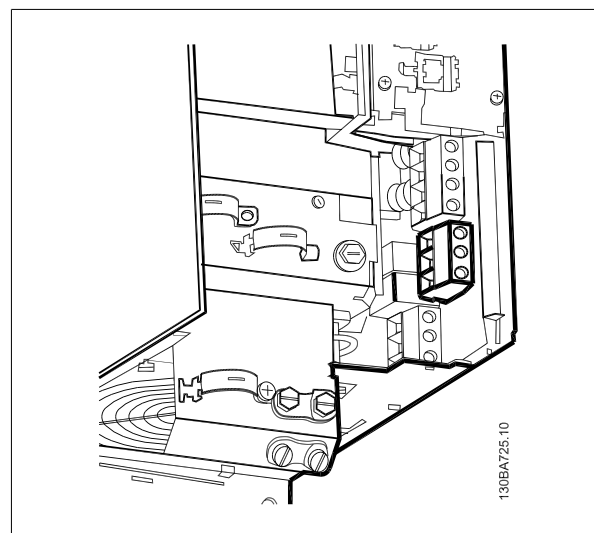


Illustration 5.13: How to connect to mains and earthing for B3 without RFI.

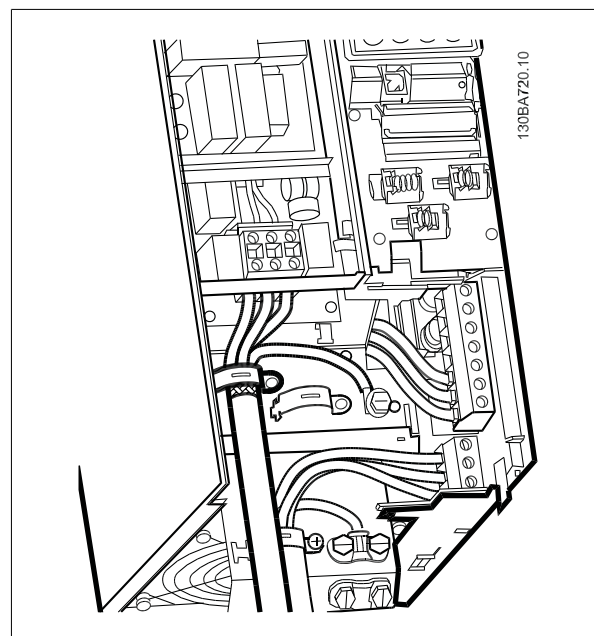


Illustration 5.14: How to connect to mains and earthing for B3 with RFI.



**NB!**

For correct cable dimensions please see the section General Specifications at the back of this manual.

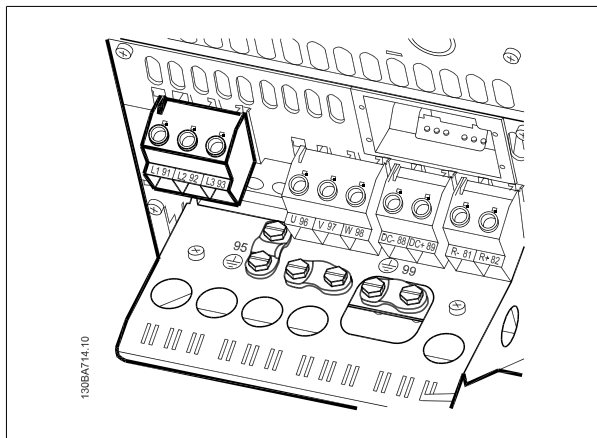
**5.1.9. Mains connection for B4, C1 and C2**

Illustration 5.15: How to connect to mains and earthing for B4.

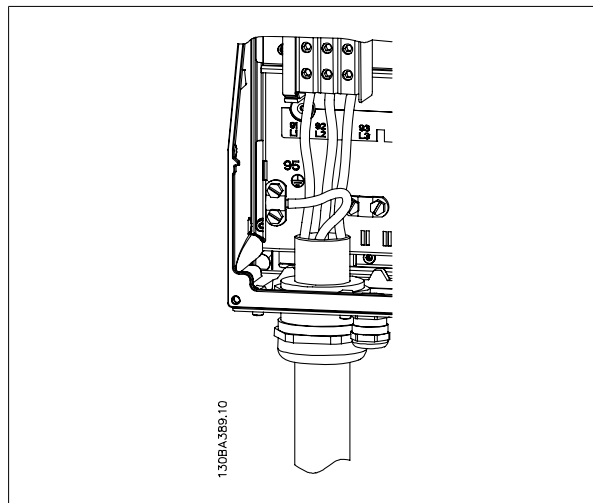


Illustration 5.16: How to connect to mains and earthing for C1 and C2.

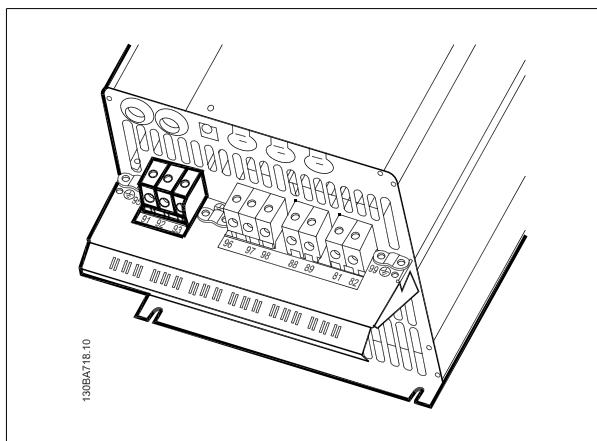
**5.1.10. Mains connection for C3 and C4**

Illustration 5.17: How to connect C3 to mains and earthing.

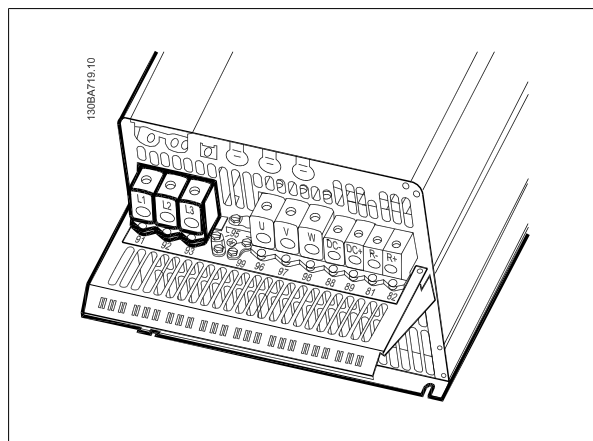


Illustration 5.18: How to connect C4 to mains and earthing.

**5.1.11. How to connect motor - foreword**

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

- Use a screened/armoured motor cable to comply with EMC emission specifications (or install the cable in metal conduit).
- Keep the motor cable as short as possible to reduce the noise level and leakage currents.
- Connect the motor cable screen/armour to both the decoupling plate of the frequency converter and to the metal of the motor. (Same applies to both ends of metal conduit if used instead of screen.)
- Make the screen connections with the largest possible surface area (cable clamp or by using an EMC cable gland). This is done by using the supplied installation devices in the frequency converter.
- Avoid terminating the screen by twisting the ends (pigtailed), as this will spoil high frequency screening effects.
- If it is necessary to break the continuity of the screen to install a motor isolator or motor relay, the continuity must be maintained with the lowest possible HF impedance.

**Cable length and cross-section**

The frequency converter has been tested with a given length of cable and a given cross-section of that cable. If the cross-section is increased, the cable capacitance - and thus the leakage current - may increase, and the cable length must be reduced correspondingly.

Switching frequency

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

Precautions while using Aluminium conductors

Aluminium conductors are not recommended for cable cross sections below 35 mm². Terminals can accept aluminium conductors but the conductor surface has to be clean and the oxidation must be removed and sealed by neutral acid free Vaseline grease before the conductor is connected. Furthermore, the terminal screw must be retightened after two days due to the softness of the aluminium. It is crucial to ensure the connection makes a gas tight joint, otherwise the aluminium surface will oxidize again.

All types of three-phase asynchronous standard motors can be connected to the frequency converter. Normally, small motors are star-connected (230/400 V, D/Y). Large motors are delta-connected (400/690 V, D/Y). Refer to the motor name plate for correct connection mode and voltage.

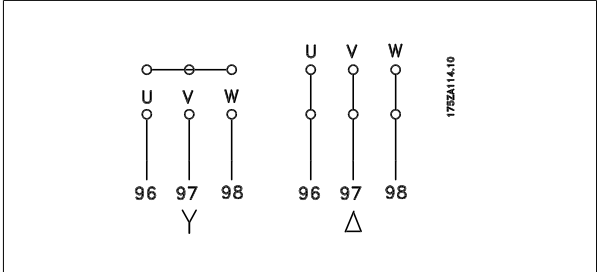


Illustration 5.19: Terminals for motor connection



**NB!**

In motors without phase insulation paper or other insulation reinforcement suitable for operation with voltage supply (such as a frequency converter), fit a sine-wave filter on the output of the frequency converter. (Motors that comply with IEC 60034-17 do not require an Sine-wave filter).

|     |    |    |    |                                                                      |
|-----|----|----|----|----------------------------------------------------------------------|
| No. | 96 | 97 | 98 | Motor voltage 0-100% of mains voltage.                               |
|     | U  | V  | W  | 3 cables out of motor                                                |
|     | U1 | V1 | W1 |                                                                      |
|     | W2 | U2 | V2 | 6 cables out of motor, Delta-connected                               |
|     | U1 | V1 | W1 | 6 cables out of motor, Star-connected                                |
|     |    |    |    | U2, V2, W2 to be interconnected separately (optional terminal block) |
| No. | 99 |    |    | Earth connection                                                     |
|     | PE |    |    |                                                                      |

Table 5.6: 3 and 6 cable motor connection.

## 5.1.12. Motor wiring overview

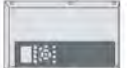
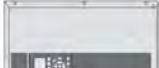
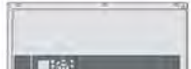
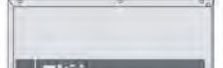
| Enclosure:              | A2<br>(IP 20/IP 21)                                                                 | A3<br>(IP 20/IP 21)                                                                 | A5<br>(IP 55/IP 66)                                                                 | B1<br>(IP 21/IP 55/<br>IP 66)                                                       | B2<br>(IP 21/IP 55/<br>IP 66)                                                       | B3<br>(IP 20)                                                                      | B4<br>(IP 20)                                                                     | C1<br>(IP 21/IP 55/66)                                                            | C2<br>(IP 21/IP 55/66)                                                            | C3<br>(IP 20)                                                                     | C4<br>(IP 20)                                                                     |
|-------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|
|                         |  |  |  |  |  |  |  |  |  |  |  |
| <b>Motor size (kW):</b> |                                                                                     |                                                                                     |                                                                                     |                                                                                     |                                                                                     |                                                                                    |                                                                                   |                                                                                   |                                                                                   |                                                                                   |                                                                                   |
| 200-240 V               | 0.25-3.0                                                                            | 3.7                                                                                 | 1.1-3.7                                                                             | 5.5-11                                                                              | 15                                                                                  | 5.5-11                                                                             | 15-18.5                                                                           | 18.5-30                                                                           | 37-45                                                                             | 22-30                                                                             | 37-45                                                                             |
| 380-480 V               | 0.37-4.0                                                                            | 5.5-7.5                                                                             | 1.1-7.5                                                                             | 11-18.5                                                                             | 22-30                                                                               | 11-18.5                                                                            | 22-37                                                                             | 37-55                                                                             | 75-90                                                                             | 45-55                                                                             | 75-90                                                                             |
| 525-600 V               |                                                                                     | 1.1-7.5                                                                             | 1.1-7.5                                                                             | 11-18.5                                                                             | 22-30                                                                               | 11-18.5                                                                            | 22-37                                                                             | 37-55                                                                             | 75-90                                                                             | 45-55                                                                             | 75-90                                                                             |
| <b>Goto:</b>            | <b>5.1.13</b>                                                                       |                                                                                     | <b>5.1.14</b>                                                                       | <b>5.1.15</b>                                                                       |                                                                                     | <b>5.1.16</b>                                                                      |                                                                                   | <b>5.1.17</b>                                                                     |                                                                                   | <b>5.1.18</b>                                                                     |                                                                                   |

Table 5.7: Motor wiring table.

### 5.1.13. Motor connection for A2 and A3

Follow these drawings step by step for connecting the motor to the frequency converter.

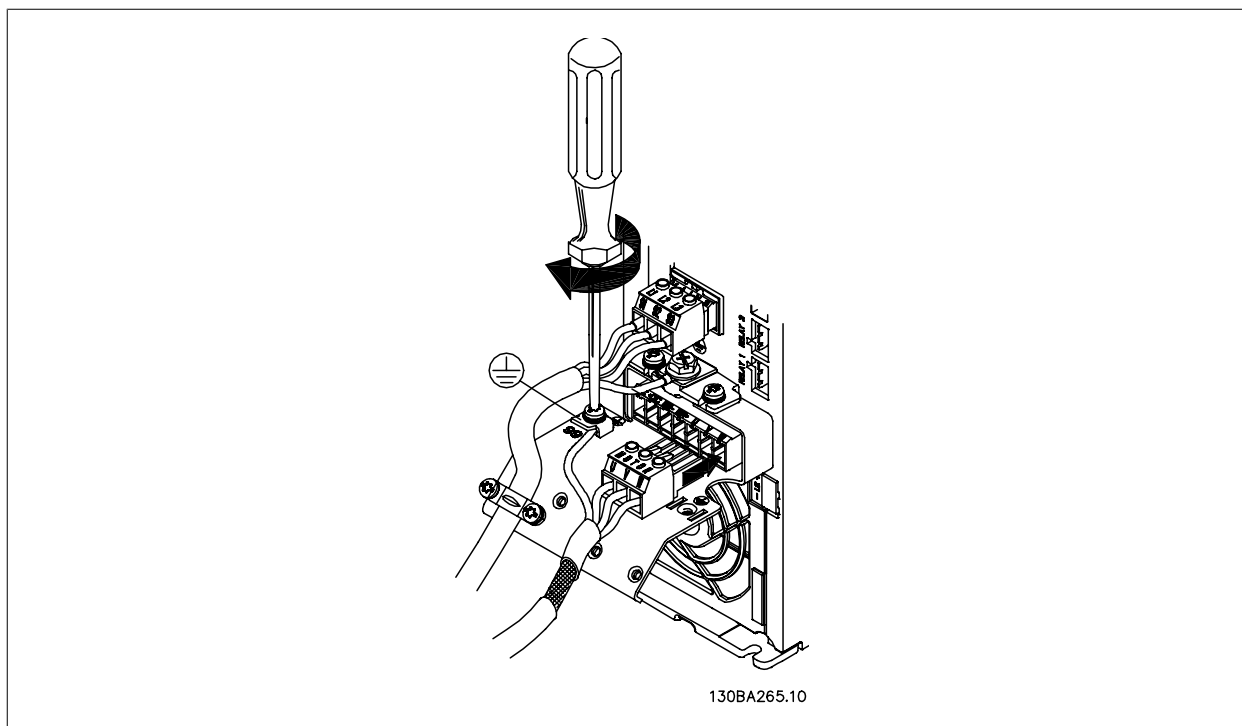


Illustration 5.20: First terminate the motor earth, then place motor U, V and W wires in plug and tighten.

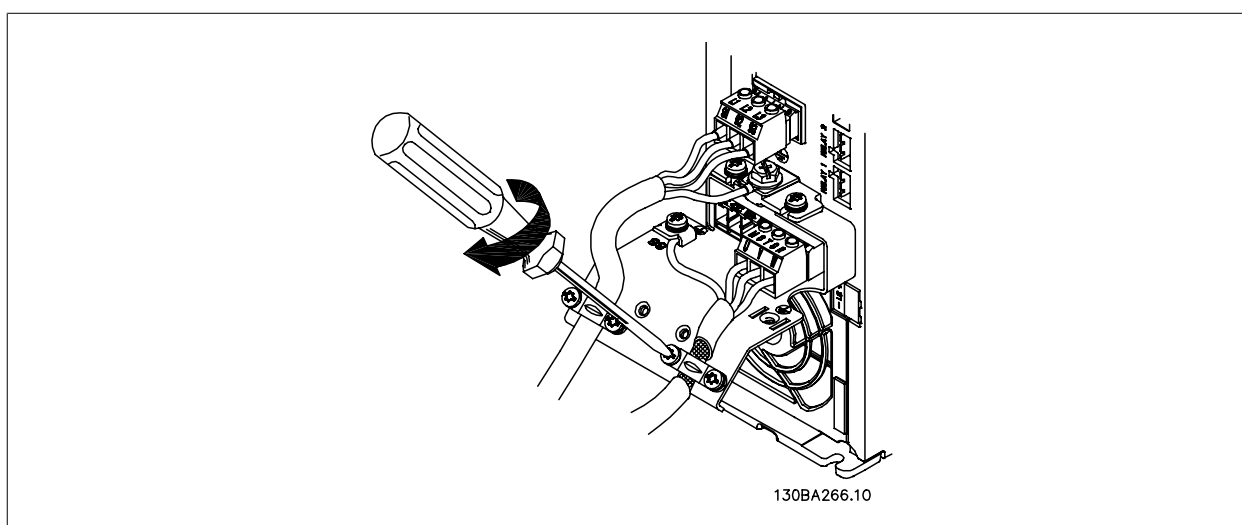


Illustration 5.21: Mount cable clamp to ensure 360 degree connection between chassis and screen, note the outer insulation of the motor cable is removed under the clamp.

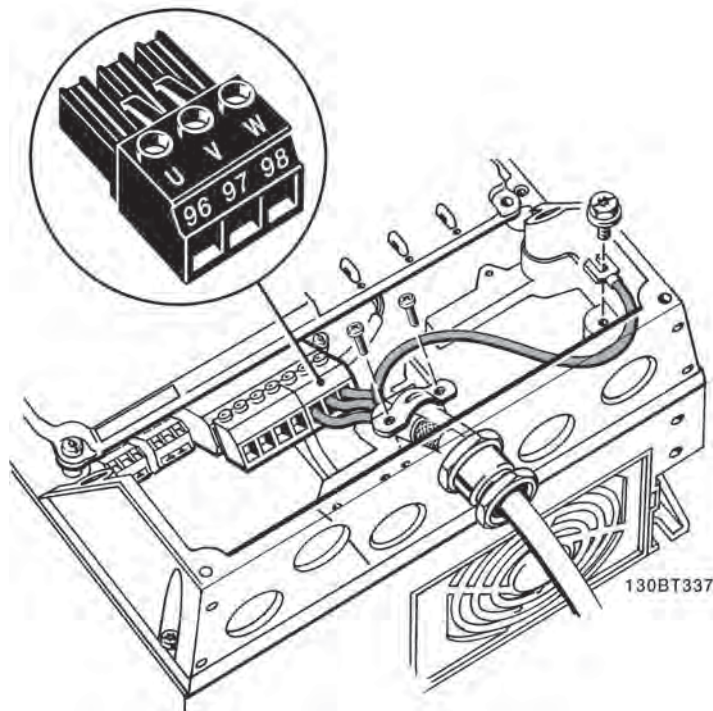
**5.1.14. Motor connection for A5**

Illustration 5.22: First terminate the motor earth, then place motor U, V and W wires in terminal and tighten. Please ensure that the outer insulation of the motor cable is removed under the EMC clamp.

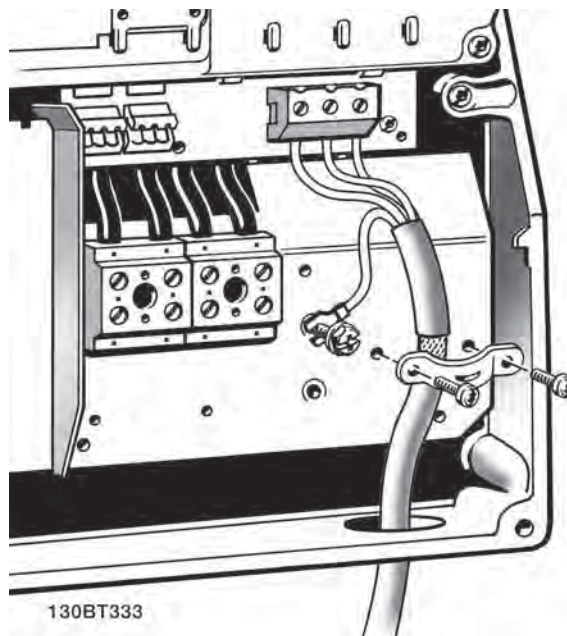
**5.1.15. Motor connection for B1 and B2**

Illustration 5.23: First terminate the motor earth, then Place motor U, V and W wires in terminal and tighten. Please ensure that the outer insulation of the motor cable is removed under the EMC clamp.

### 5.1.16. Motor connection for B3 and B4

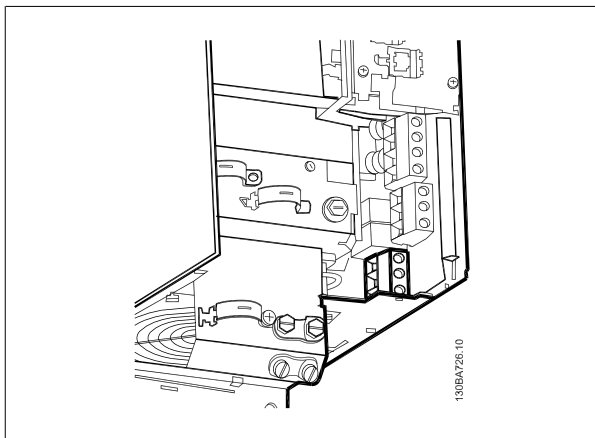


Illustration 5.24: First terminate the motor earth, then Place motor U, V and W wires in terminal and tighten. Please ensure that the outer insulation of the motor cable is removed under the EMC clamp.

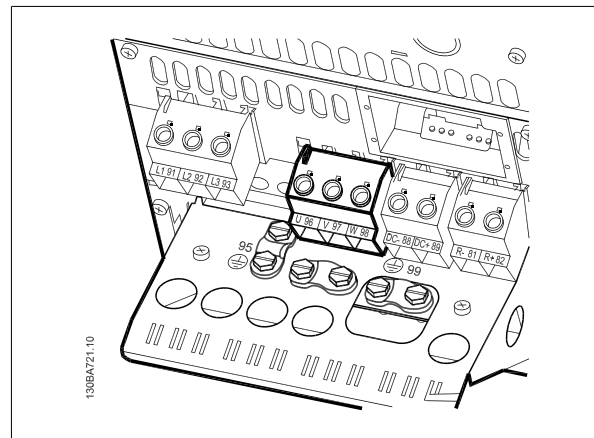


Illustration 5.25: First terminate the motor earth, then Place motor U, V and W wires in terminal and tighten. Please ensure that the outer insulation of the motor cable is removed under the EMC clamp.

5

### 5.1.17. Motor connection for C1 and C2

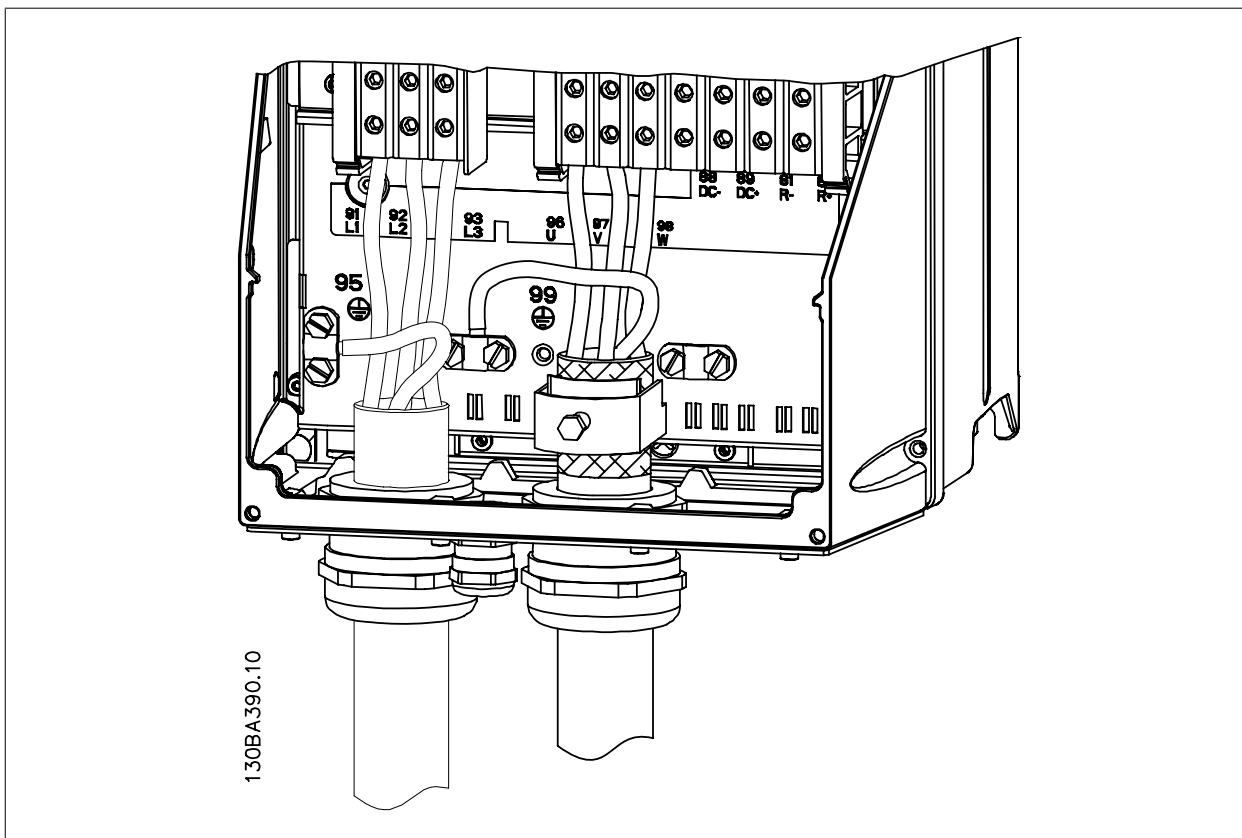


Illustration 5.26: First terminate the motor earth, then Place motor U, V and W wires in terminal and tighten. Please ensure that the outer insulation of the motor cable is removed under the EMC clamp.

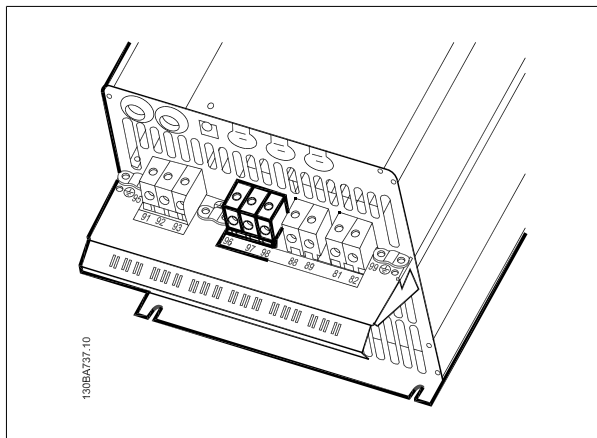
**5.1.18. Motor connection for C3 and C4**

Illustration 5.27: First terminate the motor earth, then Place motor U, V and W wires in terminal and tighten. Please ensure that the outer insulation of the motor cable is removed under the EMC clamp.

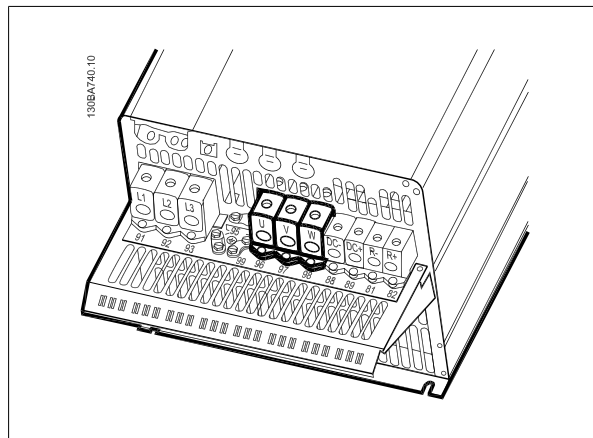


Illustration 5.28: First terminate the motor earth, then Place motor U, V and W wires in terminal and tighten. Please ensure that the outer insulation of the motor cable is removed under the EMC clamp.

**5.1.19. DC bus connection**

The DC bus terminal is used for DC back-up, with the intermediate circuit being supplied from an external source.

Terminal numbers used: 88, 89

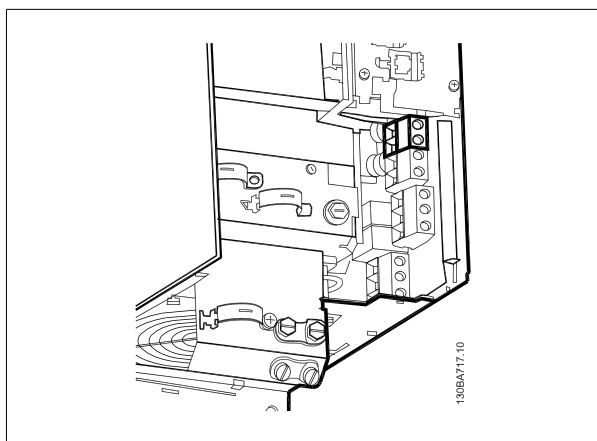


Illustration 5.29: DC bus connections for enclosure B3.

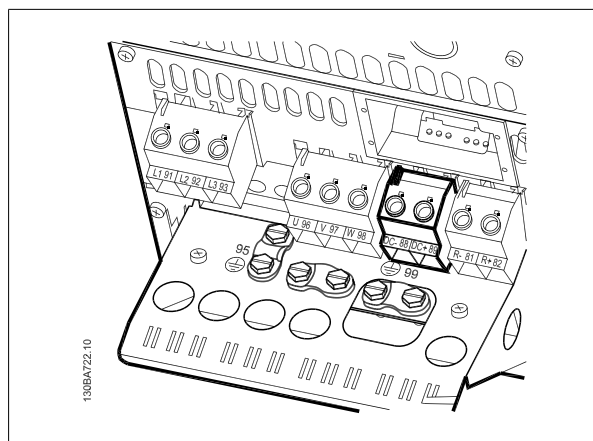


Illustration 5.30: DC bus connections for enclosure B4.

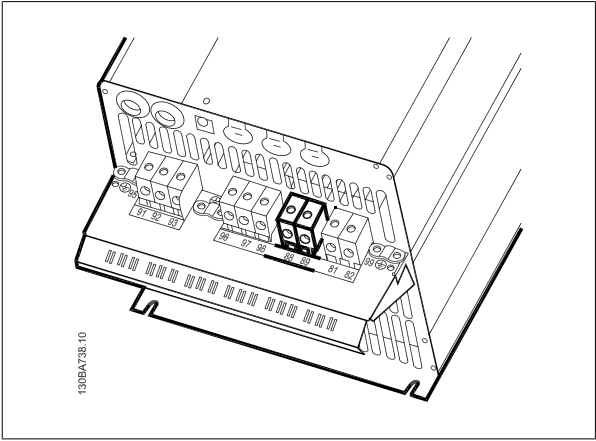


Illustration 5.31: DC bus connections for enclosure C3.

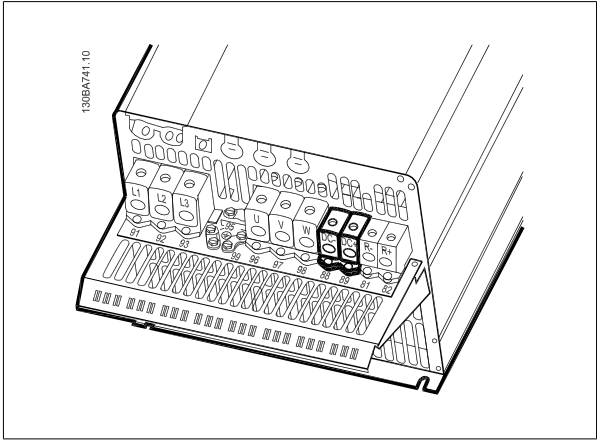


Illustration 5.32: DC bus connections for enclosure C4.

Please contact Danfoss if you require further information.

5.1.20. Brake Connection Option

The connection cable to the brake resistor must be screened/armoured.

| Enclosure      | A+B+C+D+F | A+B+C+D+F |
|----------------|-----------|-----------|
| Brake resistor | 81        | 82        |
| Terminals      | R-        | R+        |

**NB!**

Dynamic brake calls for extra equipment and safety considerations. For further information, please contact Danfoss.

- 1. Use cable clamps to connect the screen to the metal cabinet of the frequency converter and to the decoupling plate of the brake resistor.
- 2. Dimension the cross-section of the brake cable to match the brake current.

**NB!**

Voltages up to 975 V DC (@ 600 V AC) may occur between the terminals.

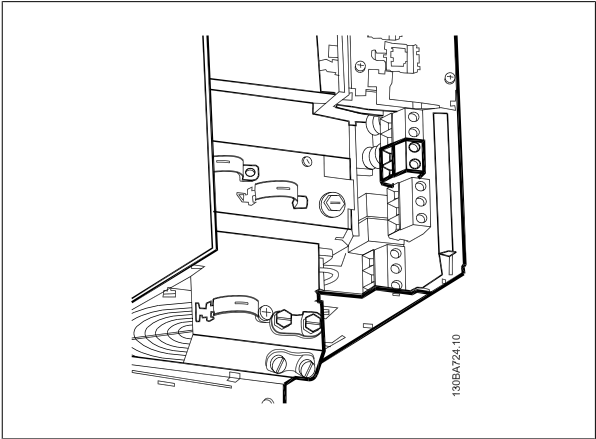


Illustration 5.33: Brake connection terminal for B3.

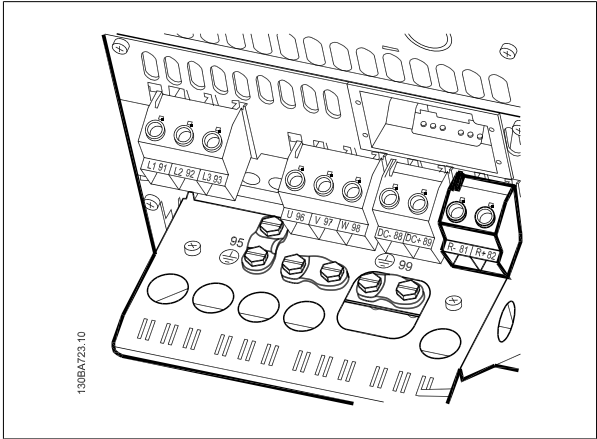


Illustration 5.34: Brake connection terminal for B4.

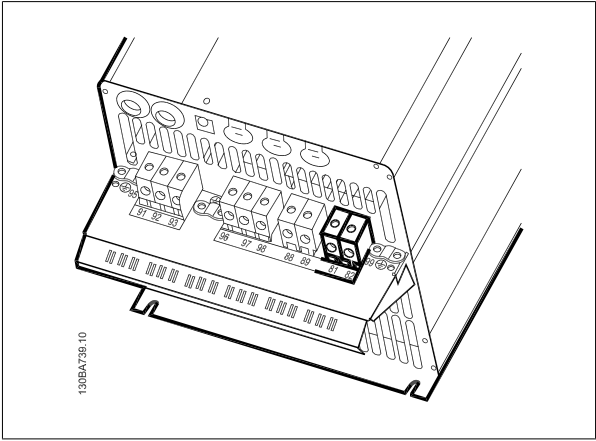


Illustration 5.35: Brake connection terminal for C3.

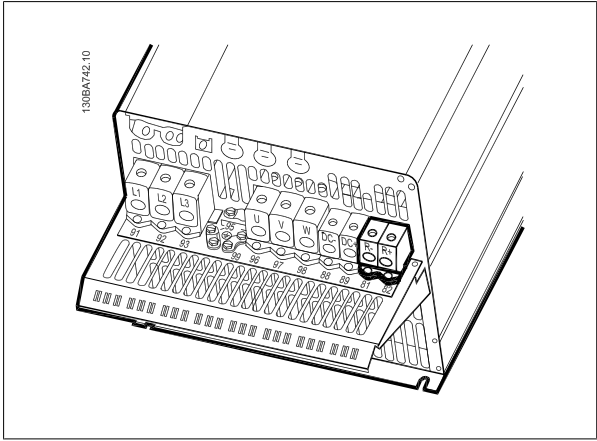


Illustration 5.36: Brake connection terminal for C4.

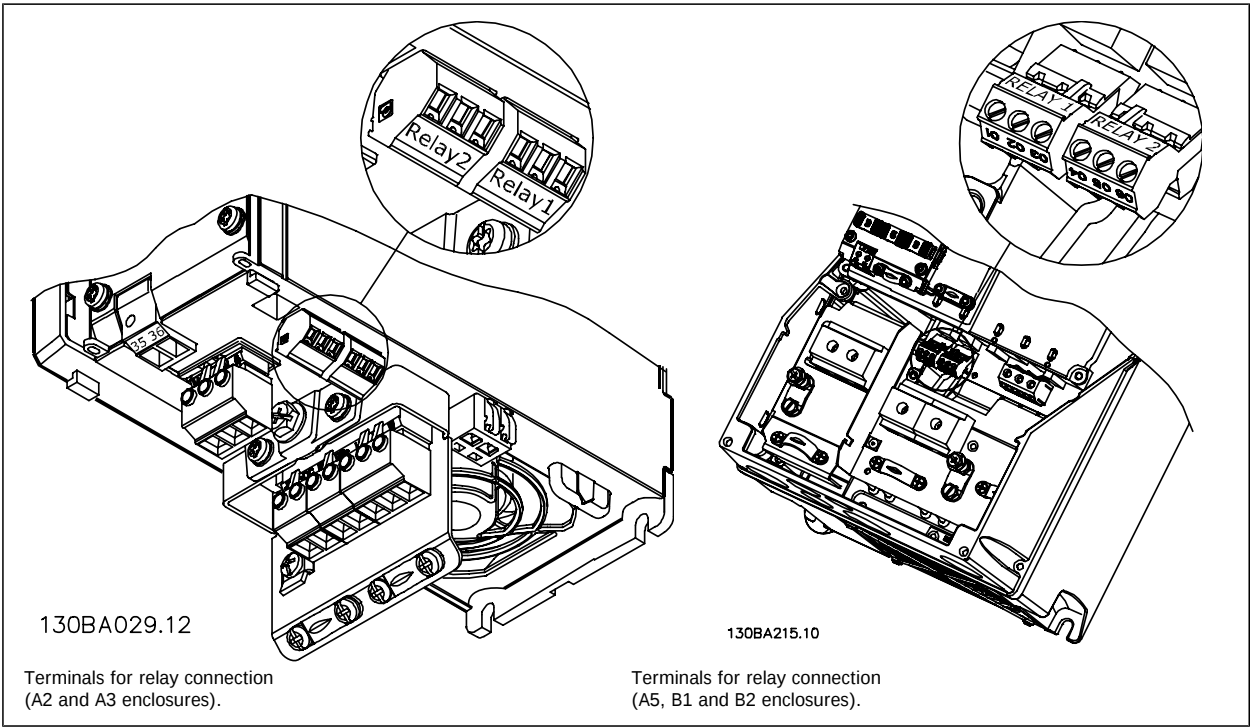


**NB!**  
If a short circuit in the brake IGBT occurs, prevent power dissipation in the brake resistor by using a mains switch or contactor to disconnect the mains for the frequency converter. Only the frequency converter shall control the contactor.

5.1.21. Relay Connection

To set relay output, see par. group 5-4\* Relays.

|     |         |                         |
|-----|---------|-------------------------|
| No. | 01 - 02 | make (normally open)    |
|     | 01 - 03 | break (normally closed) |
|     | 04 - 05 | make (normally open)    |
|     | 04 - 06 | break (normally closed) |



130BA029.12

Terminals for relay connection  
(A2 and A3 enclosures).

130BA215.10

Terminals for relay connection  
(A5, B1 and B2 enclosures).

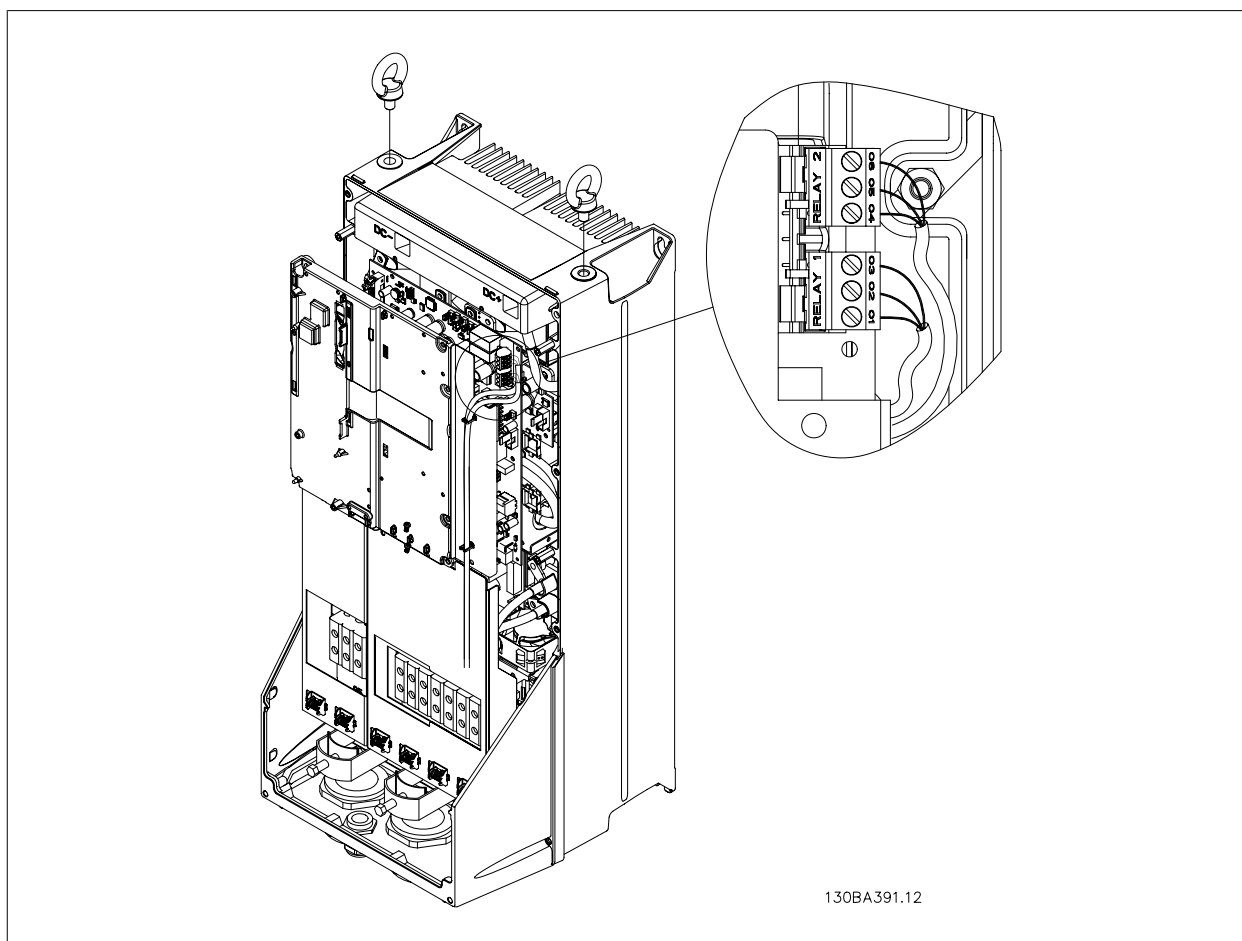


Illustration 5.37: Terminals for relay connection (C1 and C2 enclosures).  
The relay connections are shown in the cut-out with relay plugs (from the Accessory Bag) fitted.

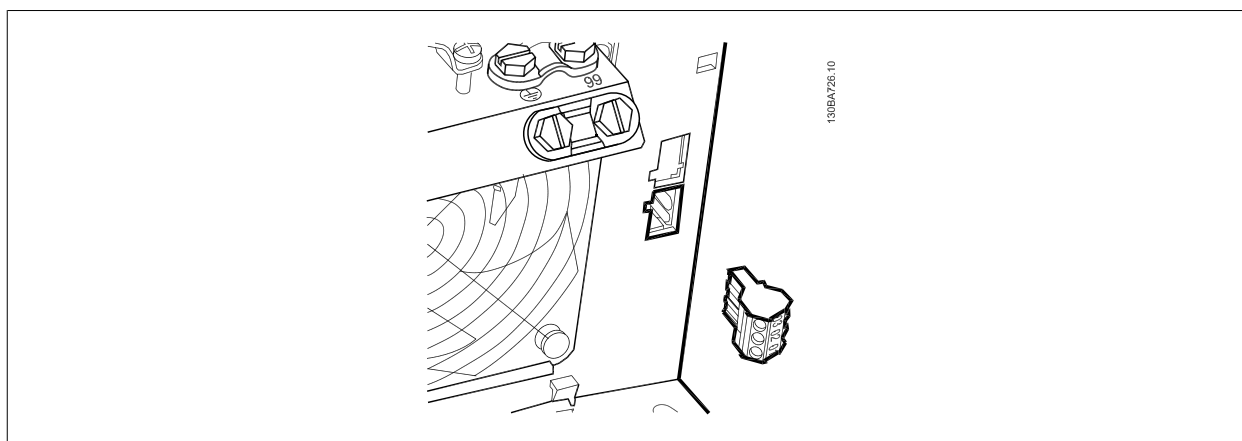


Illustration 5.38: Terminals for relay connections for B3. Only one knock-out is fitted from the factory.

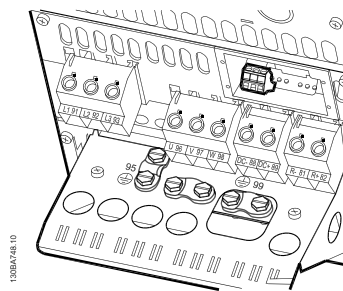


Illustration 5.39: Terminals for relay connections for B4.

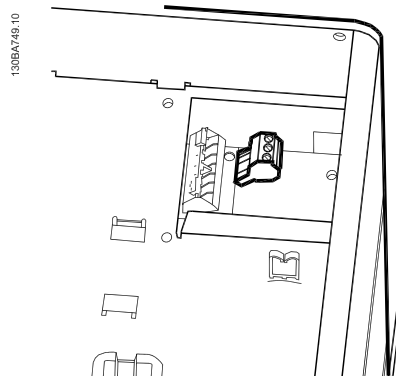


Illustration 5.40: Terminals for relay connections for C3 and C4. Located in the upper right corner of the frequency converter.

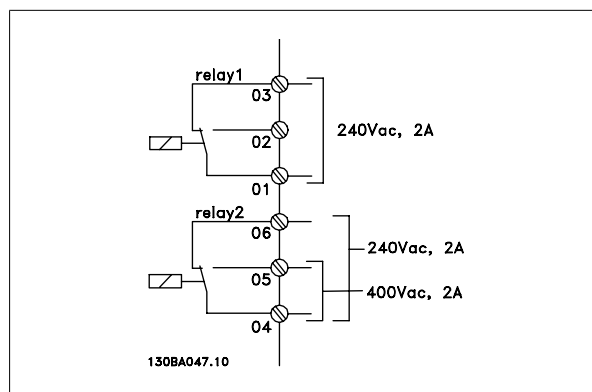
### 5.1.22. Relay Output

#### Relay 1

- Terminal 01: common
- Terminal 02: normal open 240 V AC
- Terminal 03: normal closed 240 V AC

#### Relay 2

- Terminal 04: common
- Terminal 05: normal open 400 V AC
- Terminal 06: normal closed 240 V AC



Relay 1 and relay 2 are programmed in par. 5-40 Function *Relay*, par. 5-41 On *Delay*, *Relay*, and par. 5-42 Off *Delay*, *Relay*.

Additional relay outputs by using option module MCB 105.

### 5.1.23. Wiring Example and Testing

The following section describes how to terminate control wires and how to access them. For an explanation of the function, programming and wiring of the control terminals, please see chapter, *How to programme the frequency converter*.

### 5.1.24. Access to Control Terminals

All terminals to the control cables are located underneath the terminal cover on the front of the frequency converter. Remove the terminal cover with a screwdriver.

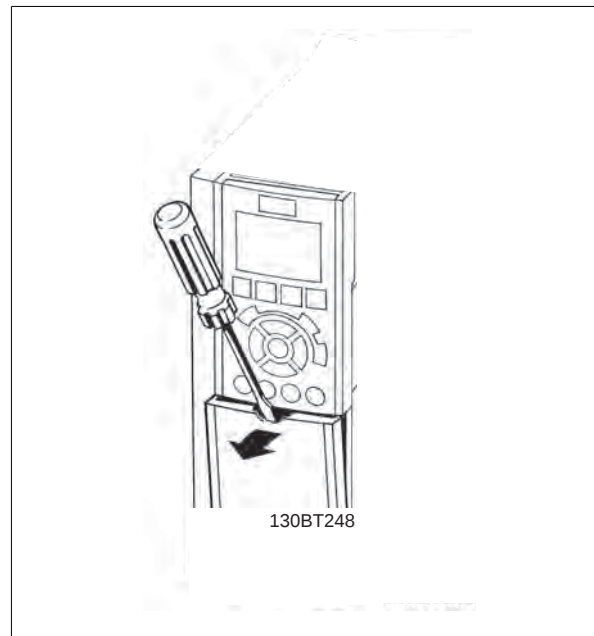


Illustration 5.41: Access to control terminals for A2, A3, B3, B4, C3 and C4 enclosures

Remove front-cover to access control terminals. When replacing the front-cover, please ensure proper fastening by applying a torque of 2 Nm.

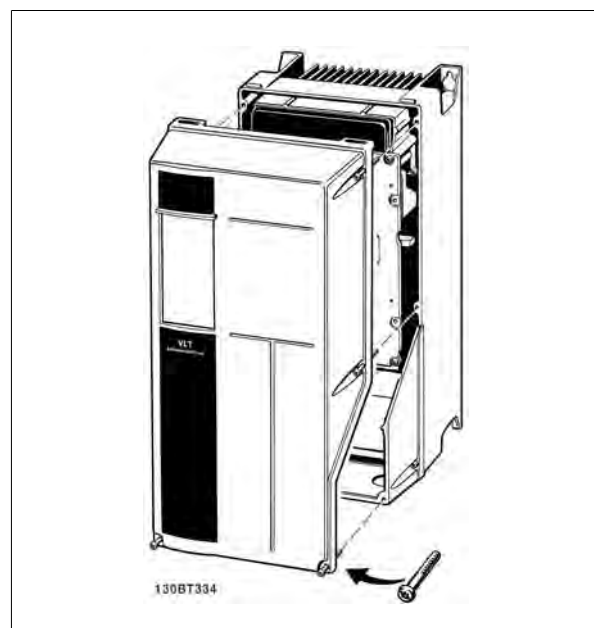


Illustration 5.42: Access to control terminals for A5, B1, B2, C1 and C2 enclosures

**5.1.25. Control Terminals****Drawing reference numbers:**

1. 10 pole plug digital I/O.
2. 3 pole plug RS-485 Bus.
3. 6 pole analog I/O.
4. USB connection.

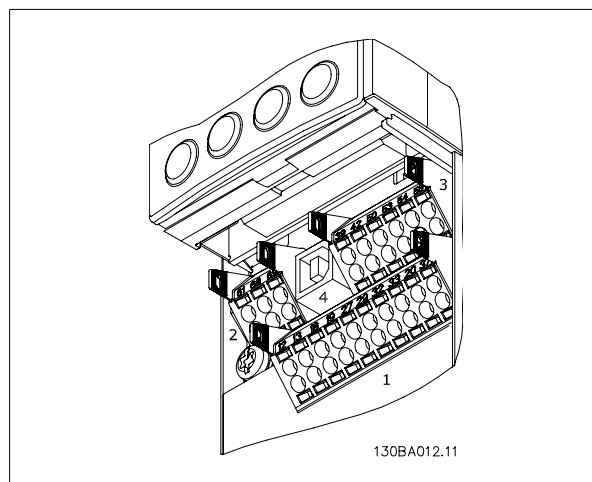


Illustration 5.43: Control terminals (all enclosures)

**5.1.26. Control Cable Clamp**

1. Use a clamp from the accessory bag to connect screen to frequency converter decoupling plate for control cables.

See section entitled *Earthing of Screened/Armoured Control Cables* for the correct termination of control cables.

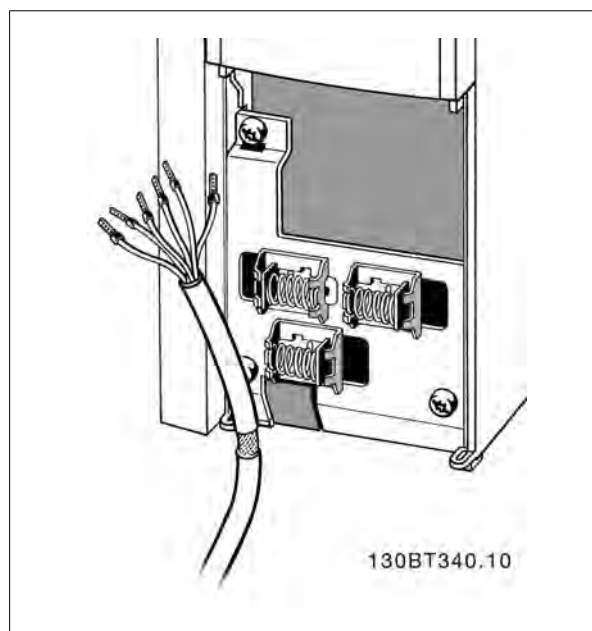


Illustration 5.44: Control cable clamp.

#### 5.1.27. Electrical Installation and Control Cables

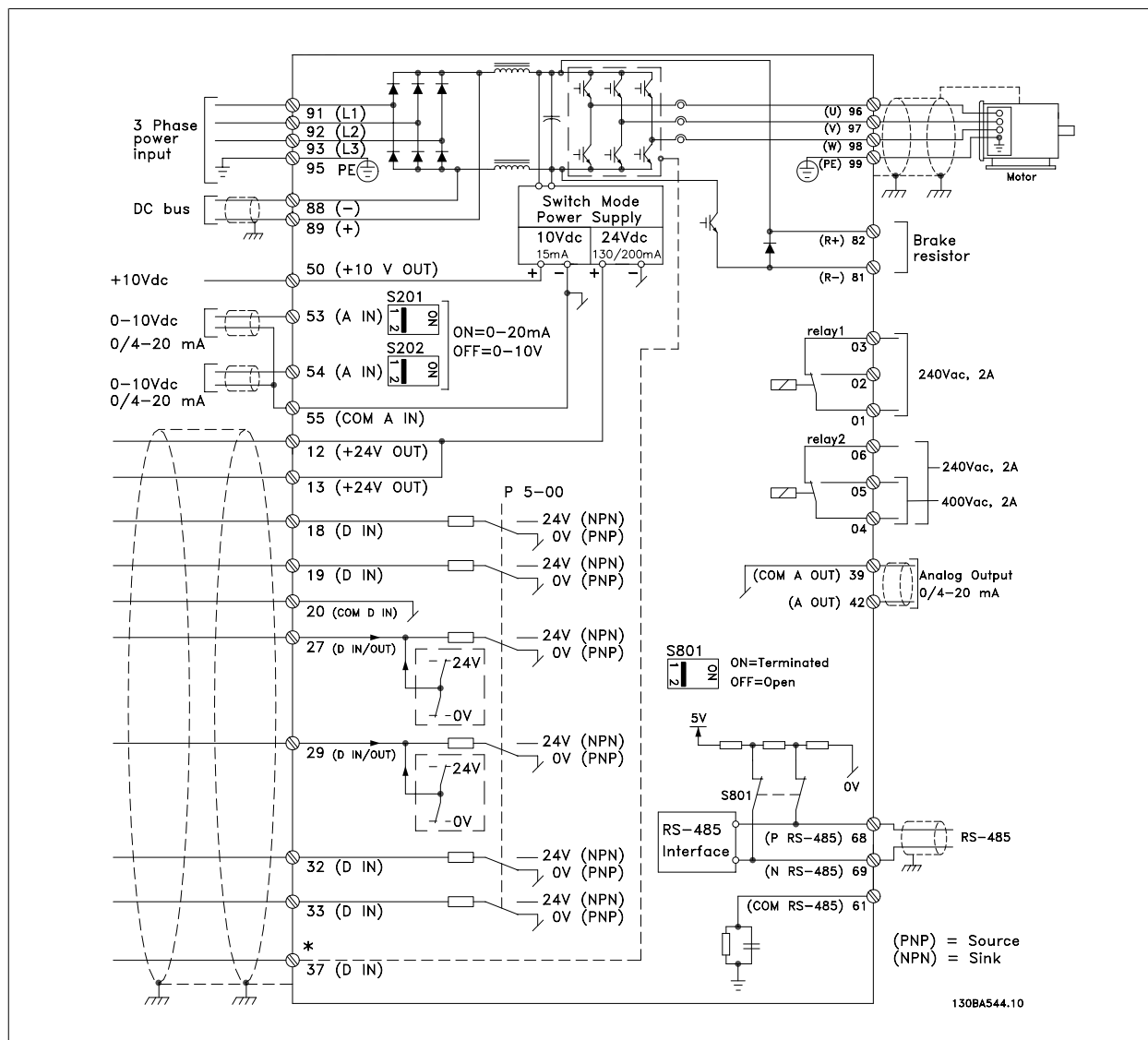


Illustration 5.45: Diagram showing all electrical terminals. (Terminal 37 present for units with Safe Stop Function only.)

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

If this occurs, break the screen or insert a 100 nF capacitor between screen and chassis.



**NB!**

The common of digital / analog inputs and outputs should be connected to separate common terminals 20, 39, and 55. This will avoid ground current interference among groups. For example, it avoids switching on digital inputs disturbing analog inputs.



**NB!**

Control cables must be screened/armoured.

**5.1.28. How to Test Motor and Direction of Rotation.**

Note that unintended motor start can occur, ensure no personnel or equipment is in danger!

Please follow these steps to test the motor connection and direction of rotation. Start with no power to the unit.

5

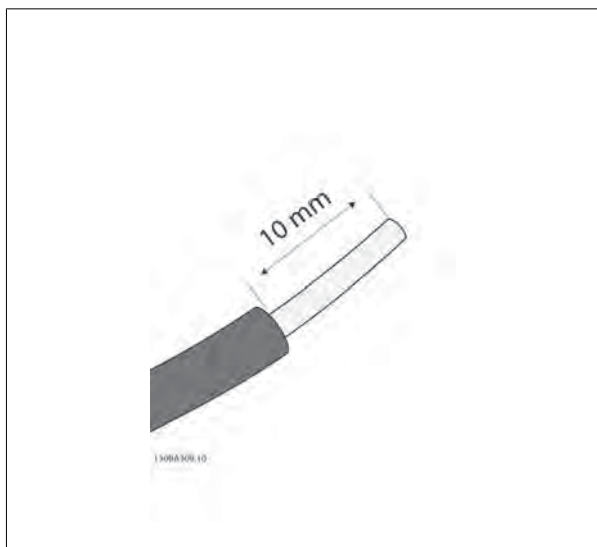


Illustration 5.46:

**Step 1:** First remove the insulation on both ends of a 50 to 70 mm piece of wire.

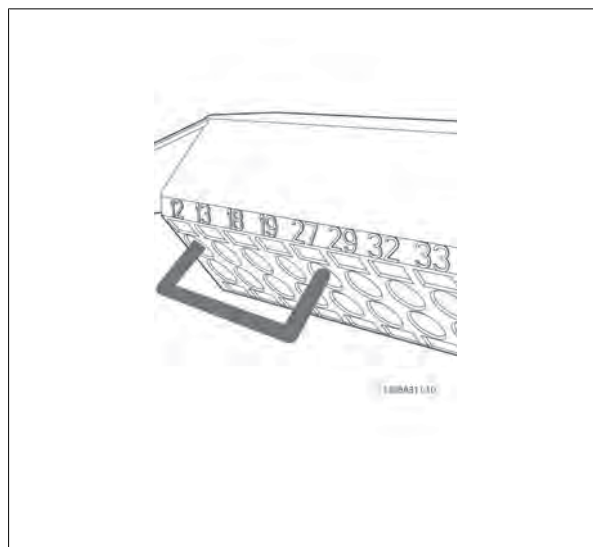


Illustration 5.48:

**Step 3:** Insert the other end in terminal 12 or 13. (Note: For units with Safe Stop function, the existing jumper between terminal 12 and 37 should not be removed for the unit to be able to run!)

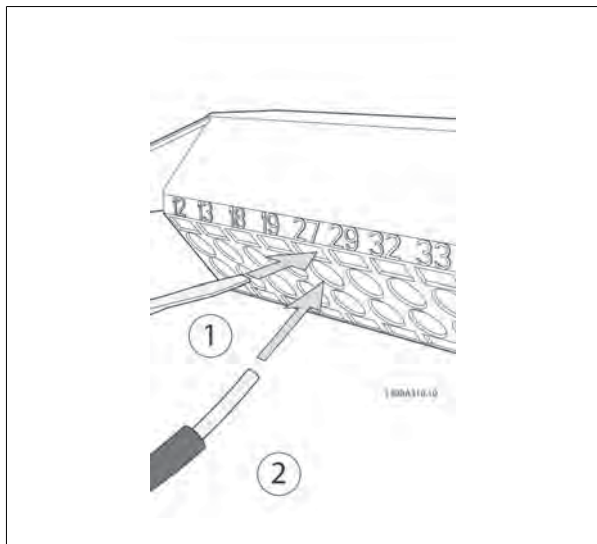


Illustration 5.47:

**Step 2:** Insert one end in terminal 27 using a suitable terminal screwdriver. (Note: For units with Safe Stop function, the existing jumper between terminal 12 and 37 should not be removed for the unit to be able to run!)



Illustration 5.49:

**Step 4:** Power-up the unit and press the [Off] button. In this state the motor should not rotate. Press [Off] to stop the motor at any time. Note the LED at the [OFF] button should be lit. If alarms or warnings are flashing, please see chapter 7 regarding these.

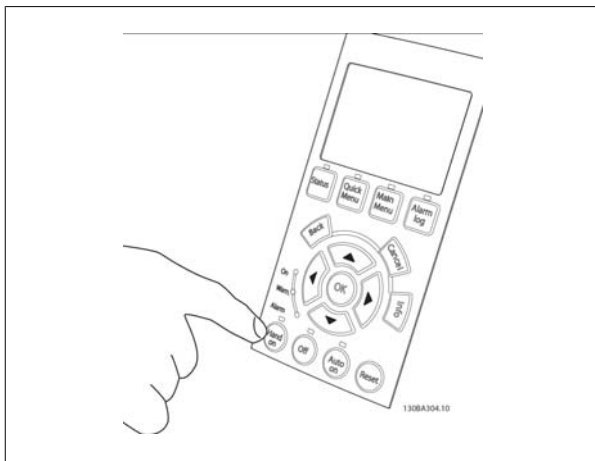


Illustration 5.50:

**Step 5:** By pressing the [Hand on] button, the LED above the button should be lit and the motor may rotate.

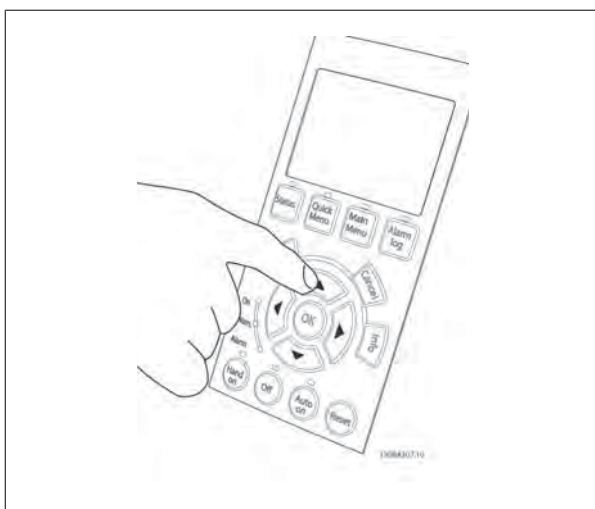


Illustration 5.51:

**Step 6:** The speed of the motor can be seen in the LCP. It can be adjusted by pushing the up ▲ and down ▼ arrow buttons.



Illustration 5.52:

**Step 7:** To move the cursor, use the left ◀ and right ▶ arrow buttons. This enables changing the speed in larger increments.

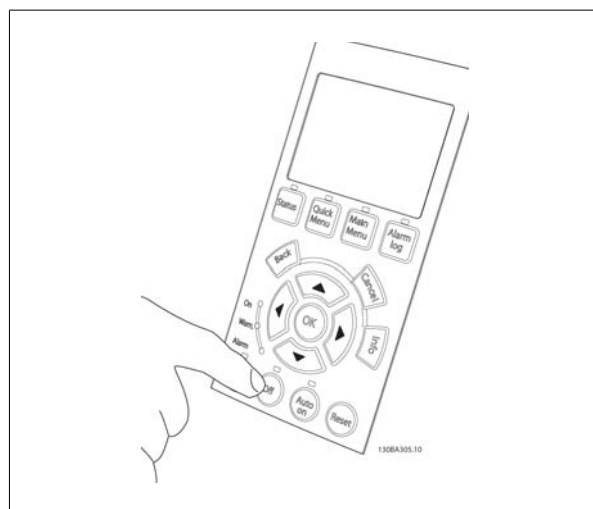


Illustration 5.53:

**Step 8:** Press the [Off] button to stop the motor again.

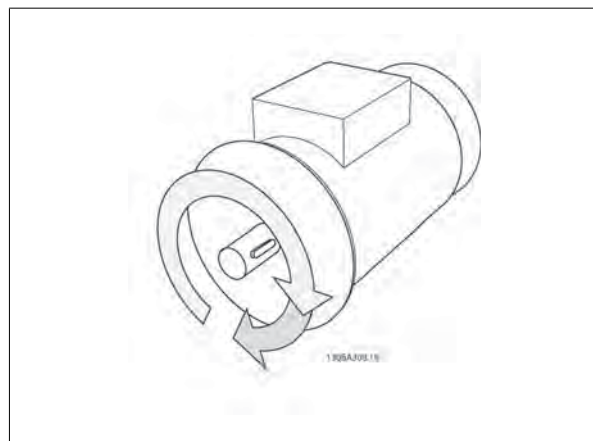


Illustration 5.54:

**Step 9:** Change two motor wires if the desired rotation of direction is not achieved.



Remove mains power from the frequency converter before changing motor wires.

### 5.1.29. Switches S201, S202, and S801

Switches S201 (AI 53) and S202 (AI 54) are used to select a current (0-20 mA) or a voltage (0 to 10 V) 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).

Please note that the switches may be covered by an option, if fitted.

**Default setting:**

S201 (AI 53) = OFF (voltage input)

S202 (AI 54) = OFF (voltage input)

S801 (Bus termination) = OFF

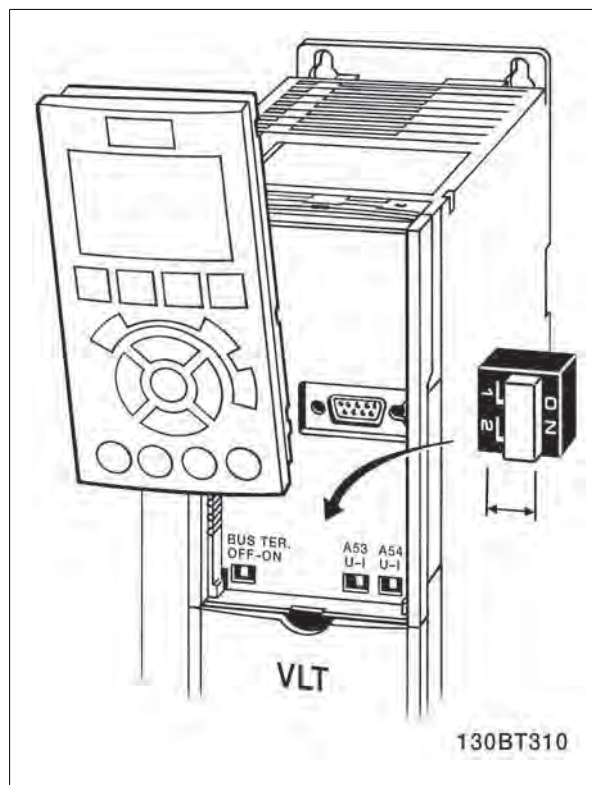
**5**

Illustration 5.55: Switches location.

5.2. Final optimization and test

5.2.1. Final optimization and test

To optimize motor shaft performance and optimize the frequency converter for the connected motor and installation, please follow these steps. Ensure that frequency converter and motor are connected, and power is applied to frequency converter.

**NB!**

Before power up ensure that connected equipment is ready for use.

Step 1. Locate motor name plate.

**NB!**

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

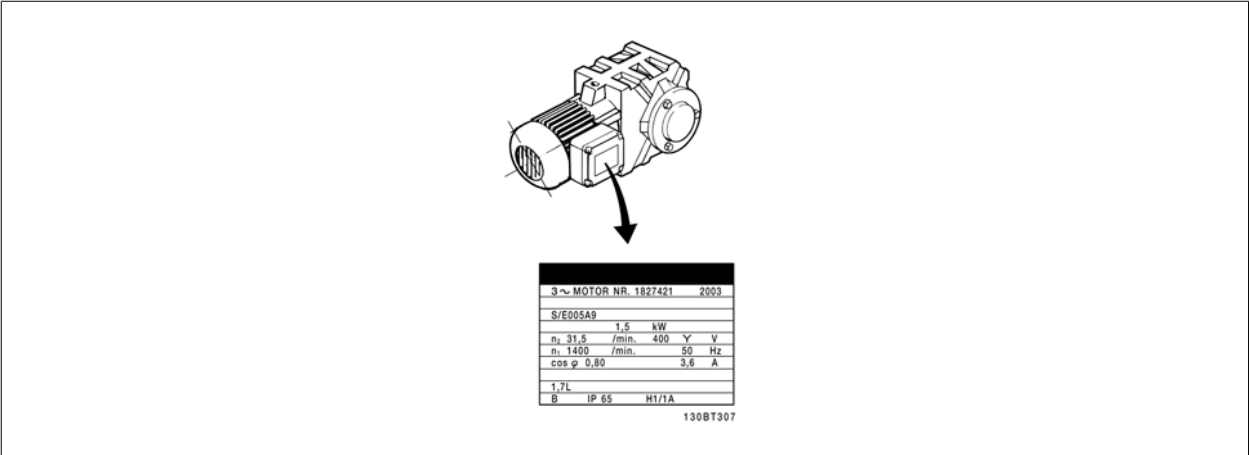


Illustration 5.56: Motor name plate example

Step 2. Enter motor name plate data in following parameter list.  
To access list first press [QUICK MENU] key then select “Q2 Quick Setup”.

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

Table 5.8: Motor related parameters

Step 3. Activate Automatic Motor Adaptation (AMA)

Performing AMA ensures best possible performance. AMA automatically takes measurements from the specific motor connected and compensates for installation variances.

1. Connect terminal 27 to terminal 12 or use [MAIN MENU] and set Terminal 27 par. 5-12 to *No operation* (par. 5-12 [0])
2. Press [QUICK MENU], select "Q2 Quick Setup", scroll down to AMA par. 1-29.
3. Press [OK] to activate the AMA par. 1-29.
4. Choose between complete or reduced AMA. If sine wave filter is mounted, run only reduced AMA, or remove sine wave filter during AMA procedure.
5. Press [OK] key. Display should show "Press [Hand on] to start".
6. Press [Hand on] key. A progress bar indicates if AMA is in progress.

5

Stop the AMA during operation

1. Press the [OFF] key - the frequency converter enters into alarm mode and the display shows that the AMA was terminated by the user.

Successful AMA

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

Unsuccessful AMA

1. The frequency converter enters into alarm mode. A description of the alarm can be found in the *Troubleshooting* section.
2. "Report Value" in the [Alarm Log] shows the last measuring sequence carried out by the AMA, before the frequency converter entered alarm mode. This number along with the description of the alarm will assist troubleshooting. If contacting Danfoss Service, make sure to mention number and alarm description.



**NB!**  
Unsuccessful AMA is often caused by incorrectly entered motor name plate data or too big difference between the motor power size and the frequency converter power size.

Step 4. Set speed limit and ramp time

Set up the desired limits for speed and ramp time.

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

|                        |                   |
|------------------------|-------------------|
| Motor Speed Low Limit  | par. 4-11 or 4-12 |
| Motor Speed High Limit | par. 4-13 or 4-14 |

|                             |           |
|-----------------------------|-----------|
| Ramp 1 Ramp Up Time [s]     | par. 3-41 |
| Ramp 1 Ramp Down Time 1 [s] | par. 3-42 |

## 6. Application Examples

### 6.1.1. Start/Stop

Terminal 18 = start/stop par. 5-10 [8] *Start*

Terminal 27 = No operation par. 5-12 [0] *No operation* (Default *coast inverse*)

Par. 5-10 *Digital Input*, Terminal 18 = *Start* (default)

Par. 5-12 *Digital Input*, Terminal 27 = *coast inverse* (default)

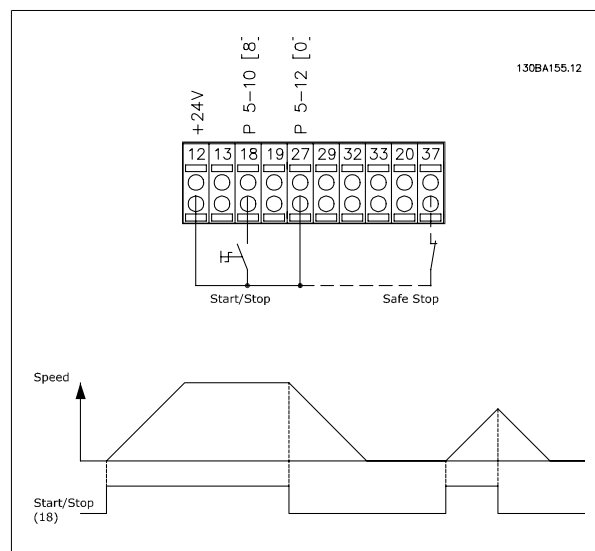


Illustration 6.1: Terminal 37: Available only with Safe Stop Function!

### 6.1.2. Closed Loop Wiring

Terminal 12 /13: +24V DC

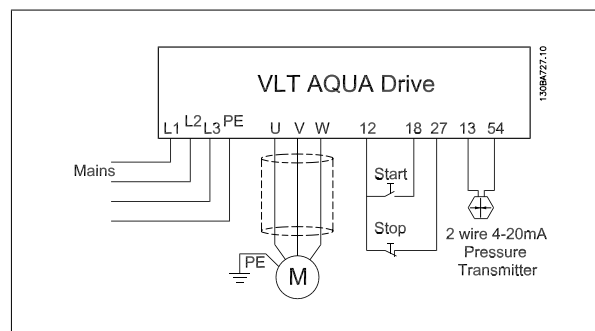
Terminal 18: Start par. 5-18 [8] Start (Default)

Terminal 27: Coast par. 5-12 [2] coast inverse (Default)

Terminal 54: Analog input

L1-L3: Mains terminals

U,V and W: Motor terminals



### 6.1.3. Submersible Pump Application

The system consists of a submersible pump controlled by a Danfoss VLT AQUA Drive and a pressure transmitter. The transmitter gives a 4-20 mA feedback signal to the VLT AQUA Drive, which keeps a constant pressure by controlling the speed of the pump. To design a drive for a submersible pump application, there are a few important issues to take into consideration. Therefore the drive used must be chosen according to motor current.

1. The motor is a so called "Can motor" with a stainless steel can between the rotor and stator. There is a larger and a more magnetic resistant air-gap than on a normal motor hence a weaker field which results in the motors being designed with a higher rated current than a norm motor with similar rated power.
2. The pump contains thrust bearings which will be damaged when running below minimum speed which normally will be 30 Hz.
3. The motor reactance is nonlinear in submersible pump motors and therefore Automatic Motor Adaption (AMA) may not be possible. However, normally submersible pumps are operated with very long motor cables that might eliminate the nonlinear motor reactance and enable the drive to perform AMA. If AMA fails, the motor data can be set from parameter group 1-3\* (see motor datasheet). Be aware that if AMA has succeeded the drive will compensate for voltage drop in the long motor cables, so if the Advanced motor data are set manually, the length of the motor cable must be taken into considerations to optimize system performance.
4. It is important that the system is operated with a minimum of wear and tear of the pump and motor. A Danfoss Sine-Wave filter can lower the motor insulation stress and increase lifetime (check actual motor insulation and the frequency converter du/dt specification). It is recommended to use a filter to reduce the need for service.
5. EMC performance can be difficult to achieve due to the fact that the special pump cable which is able to withstand the wet conditions in the well normally is unscreened. A solution could be to use a screened cable above the well and fix the screen to the well pipe if it is made of steel (can also be made of plastic). A Sine-Wave filter will also reduce the EMI from unscreened motor cables.

The special "can motor" is used due to the wet installation conditions. The drive needs to be designed for the system according to output current to be able to run the motor at nominal power.

To prevent damage to the thrust bearings of the pump, it is important to ramp the pump from stop to min. speed as quick as possible. Well-known manufacturers of submersible pumps recommend that the pump is ramped to min. speed (30 Hz) in max. 2 -3 seconds. The new VLT® AQUA Drive is designed with initial and final Ramp for these applications. The initial and final ramps are 2 individual ramps, where Initial Ramp, if enabled, will ramp the motor from stop to min. speed and automatically switch to normal ramp, when min. speed is reached. Final ramp will do the opposite from min. speed to stop in a stop situation.

Pipe-Fill mode can be enabled to prevent water hammering. The Danfoss frequency converter is capable of filling vertical pipes using the PID controller to slowly ramp up the pressure with a user specified rate (units/sec). If enabled the drive will, when it reaches min. speed after startup, enter pipe fill mode. The pressure will slowly be ramped up until it reaches a user specified Filled Set Point, where after the drive automatically disables Pipe Fill Mode and continues in normal closed loop operation.

This feature is designed for irrigation applications.

#### Electrical Wiring

##### Typical parameter settings

Typical/recommended settings in brackets().

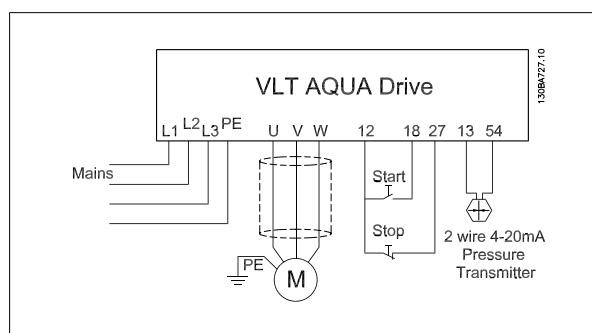
Parameters:

|                                                              |                       |
|--------------------------------------------------------------|-----------------------|
| Motor Rated Power                                            | Par. 1-20 / par. 1-21 |
| Motor Rated Voltage                                          | Par. 1-22             |
| Motor Current                                                | Par. 1-24             |
| Motor Rated Speed                                            | Par. 1-28             |
| Enable Reduced Automatic Motor Adaptation (AMA in par. 1-29) |                       |



##### NB!

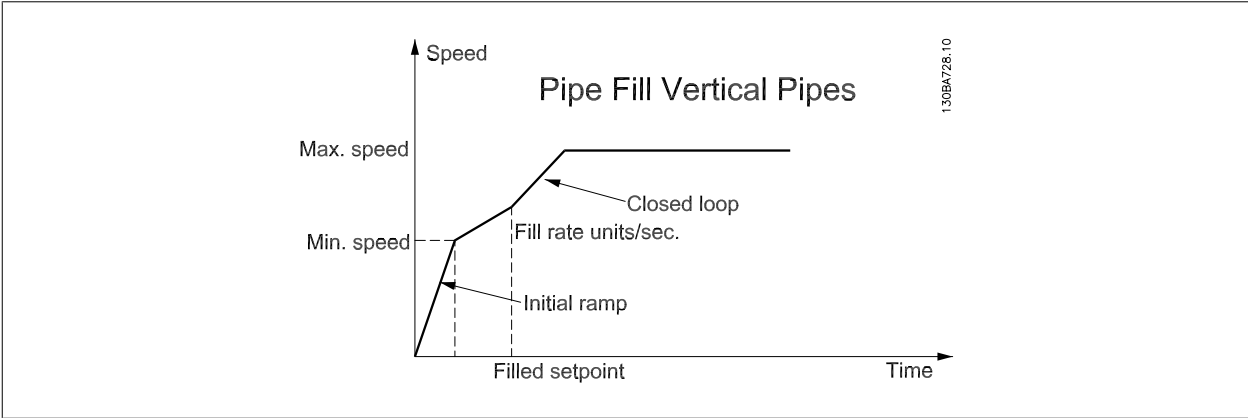
Note the analog input 2, (terminal (54) format must be set to mA. (switch 202).



|                       |           |                            |
|-----------------------|-----------|----------------------------|
| Min. Reference        | Par. 3-01 | (30 Hz)                    |
| Max. Reference        | Par. 3-02 | (50/60 Hz)                 |
| Initial Ramp Up Time  | Par. 3-84 | (2 sec.)                   |
| Final Ramp Down Time  | Par. 3-88 | (2 sec.)                   |
| Normal Ramp Up Time   | Par. 3-41 | (8 sec. depending on size) |
| Normal Ramp Down Time | Par. 3-42 | (8 sec. depending on size) |
| Motor Min. Speed      | Par. 4-11 | (30 Hz)                    |
| Motor Max. Speed      | Par. 4-13 | (50/60 Hz)                 |

Use the "Closed Loop" wizard under "Quick Menu\_Funtion\_Setup", to easily set up the feedback settings in the PID controller.

|                       |            |                       |
|-----------------------|------------|-----------------------|
| <b>Pipe Fill Mode</b> |            |                       |
| Pipe Fill Enable      | Par. 29-00 |                       |
| Pipe Fill Rate        | Par. 29-04 | (Feedback units/sec.) |
| Filled Set Point      | Par. 29-05 | (Feedback units)      |





## 7. How to operate the frequency converter

### 7.1. Ways of Operation

#### 7.1.1. Ways of Operation

The frequency converter 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 frequency converter is fitted with fieldbus option, please refer to relevant documentation.

#### 7.1.2. How to operate graphical LCP (GLCP)

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

The GLCP is divided into four functional groups:

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

#### Graphical display:

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

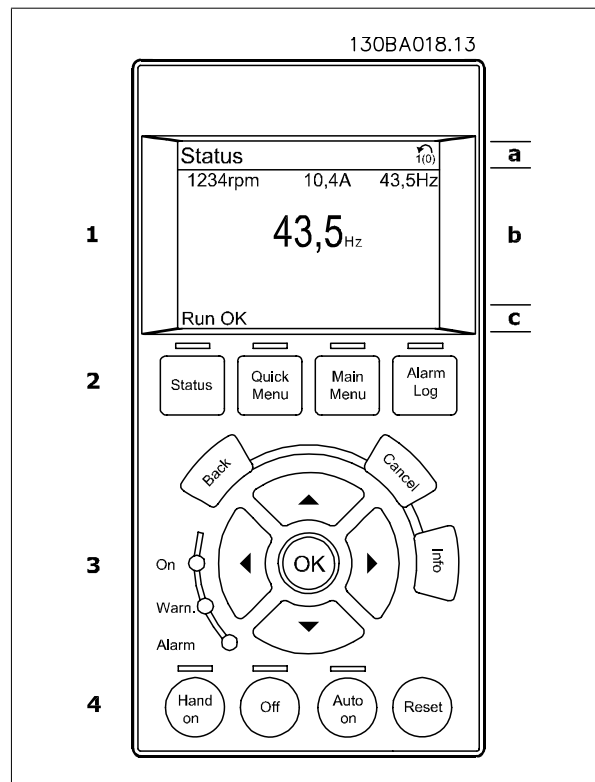
#### Display lines:

- 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 2 variables when not in status mode and in the case of Alarm/Warning.



The number of the Active Set-up (selected as the Active Set-up in 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 case of 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 Setups", "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

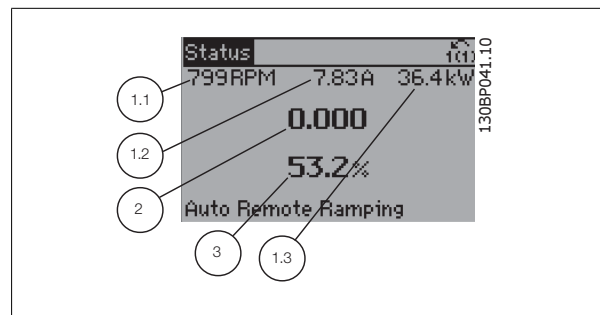
5.25 A; 15.2 A 105 A.

### Status display I

This read-out 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 illustration. 1.1, 1.2 and 1.3 are shown in small size. 2 and 3 are shown in medium size.

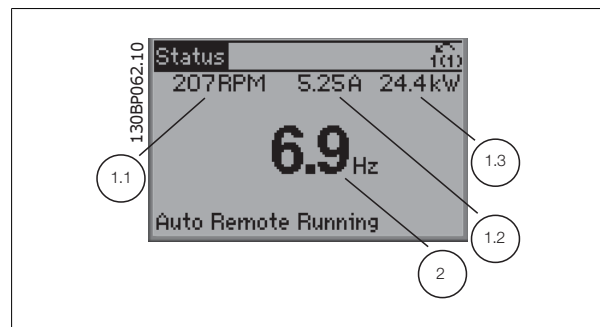


### Status display II

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

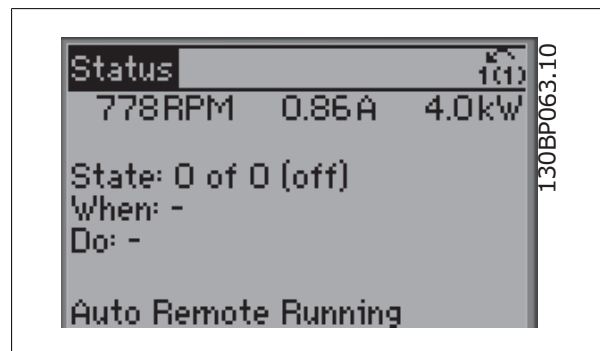
In the example, Speed, Motor current, Motor power and Frequency are selected as variables in the first and second lines.

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



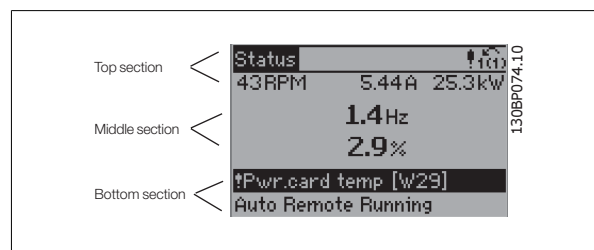
### Status display III:

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



### Bottom section

always shows the state of the frequency converter in Status mode.



### Display Contrast Adjustment

Press [status] and [▲] for darker display

Press [status] and [▼] for brighter display

### Indicator lights (LEDs):

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

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

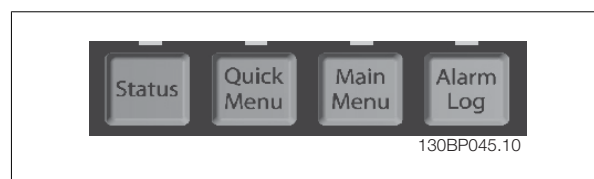
- Green LED/On: Control section is working.
- Yellow LED/Warn.: Indicates a warning.
- Flashing Red LED/Alarm: Indicates an alarm.



### GLCP keys

#### Menu keys

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



### [Status]

Indicates the status of the frequency converter and/or the motor. 3 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 read-out mode.

### [Quick Menu]

Allows quick set-up of the frequency converter. **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. Amongst other features it also includes parameters for selecting which variables to display on the LCP, digital preset speeds, scaling of analog references, closed loop single zone and multi-zone applications and specific functions related to 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 Setup and Function Setups provides the simplest and quickest access to the typical required parameters.

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

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

**[Alarm Log]**

displays an Alarm list of the five latest alarms (numbered A1-A5). To obtain additional details about an alarm, use the arrow keys to manoeuvre to the alarm number and press **[OK]**. Information is displayed about the condition of the frequency converter before it enters the alarm mode.

**[Back]**

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

**[Cancel]**

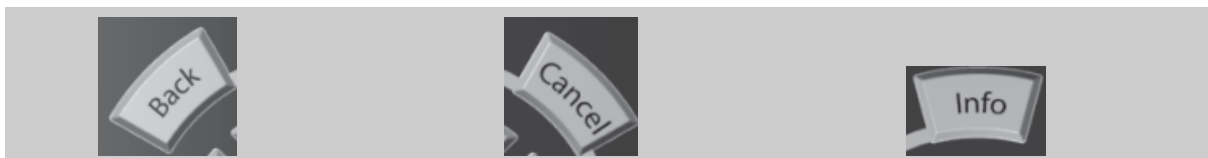
last change or command will be cancelled as long as the display has not been changed.

**[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]**.

7

**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]**

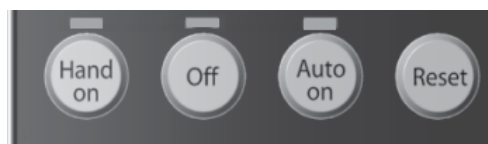
is used for choosing a parameter marked by the cursor and for enabling the change of a parameter.



130BT117.10

**Operation Keys**

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



130BP046.10

**[Hand On]**

enables control of the frequency converter via the GLCP. **[Hand on]** also starts the motor, and it is now possible to give the motor speed reference by means of 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



**NB!**

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 mains supply.

**[Auto On]**

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



**NB!**

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

7

**[Reset]**

is used for resetting the frequency converter 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.

### 7.1.3. How to operate numeric LCP (NLCP)

The following instructions are valid for the NLCP (LCP 101).

**The control panel is divided into four functional groups:**

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



**NB!**

Parameter copy is not possible with Numeric Local Control Panel (LCP101).

**Select one of the following modes:**

**Status Mode:** Displays the status of the frequency converter or the motor.

If an alarm occurs, the NLCP automatically switches to status mode.

A number of alarms can be displayed.

**Quick Setup or Main Menu Mode:** Display parameters and parameter settings.

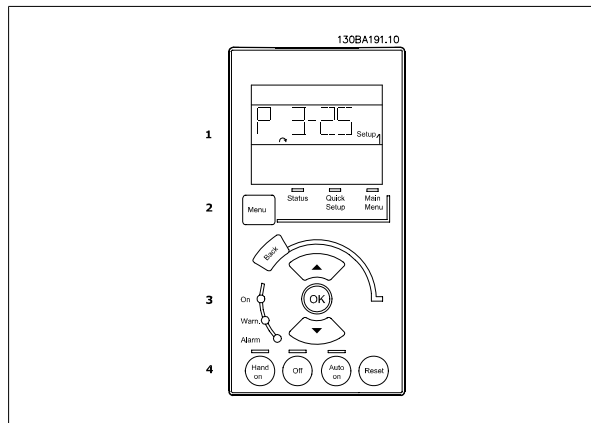


Illustration 7.1: Numerical LCP (NLCP)

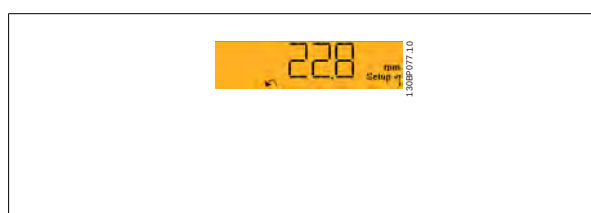


Illustration 7.2: Status display example



Illustration 7.3: Alarm display example

**Indicator lights (LEDs):**

- Green LED/On: Indicates if control section is on.
- Yellow LED/Wrn.: Indicates a warning.
- Flashing red LED/Alarm: Indicates an alarm.

**Menu key**

**[Menu]** Select one of the following modes:

- Status
- Quick Setup
- Main Menu

**Main Menu**

is used for programming all parameters.

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

**Quick Setup** is used to set up the frequency converter using only the most essential parameters.

The parameter values can be changed using the up/down arrows when the value is flashing.

Select Main Menu by pressing the [Menu] key a number of times until the Main Menu LED is lit.

Select the parameter group [xx-\_\_] and press [OK]

Select the parameter [\_\_-xx] and press [OK]

If the parameter is an array parameter select the array number and press [OK]

Select the wanted data value and press [OK]

### Navigation Keys

#### [Back]

for stepping backwards

#### Arrow [▲] [▼]

keys are used for manoeuvring between parameter groups, parameters and within parameters

#### [OK]

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

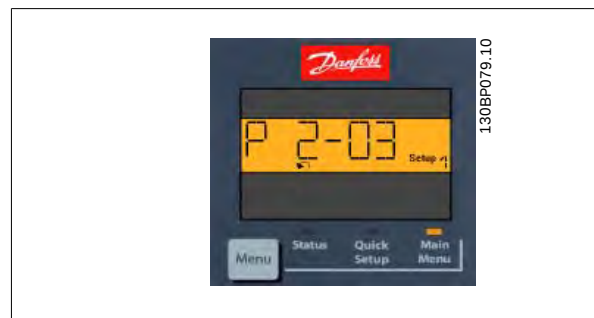


Illustration 7.4: Display example

### Operation Keys

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



Illustration 7.5: Operation keys of the numerical LCP (NLCP)

#### [Hand on]

enables control of the frequency converter via the LCP. [Hand on] also starts the motor and it is now possible to enter the motor speed data by means of the arrow keys. The key can be *Enabled* [1] or *Disabled* [0] via par. 0-40 [Hand on] Key on LCP.

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

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

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

#### [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 be stopped by disconnecting the mains supply.

#### [Auto on]

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



#### NB!

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

#### [Reset]

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

### 7.1.4. Changing Data

1. Press [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 keys. Cursor indicates digit selected to change. [▲] key increases the value, [▼] key decreases the value.
7. Press [Cancel] key to disregard change, or press [OK] key to accept change and enter new setting.

### 7.1.5. Changing a Text Value

If the selected parameter is a text value, change the text value by means of 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].

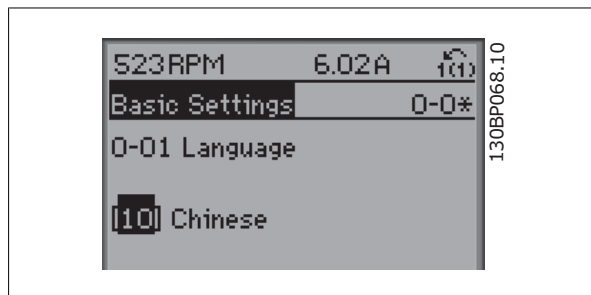


Illustration 7.6: Display example.

### 7.1.6. 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 <> navigation keys as well as the up/down navigation keys. Use the <> navigation keys to move the cursor horizontally.

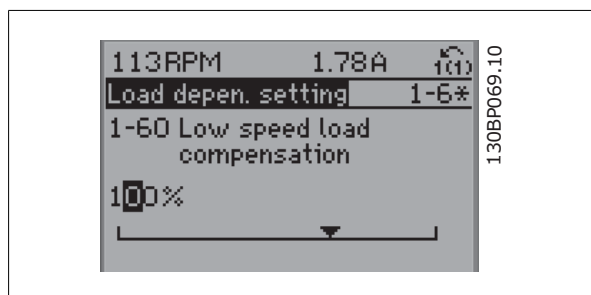


Illustration 7.7: Display example.

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

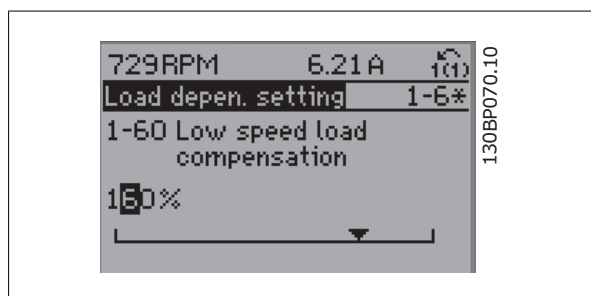


Illustration 7.8: Display example.

### 7.1.7. Changing of Data Value, Step-by-Step

Certain parameters can be changed step by step or infinitely variably. This applies to par. 1-20 *Motor Power [kW]*, par. 1-22 *Motor Voltage* and par. 1-23 *Motor Frequency*.

The parameters are changed both as a group of numeric data values and as numeric data values infinitely variably.

### 7.1.8. Read-out and Programming of Indexed Parameters

Parameters are indexed when placed in a rolling stack.

par. 15-30 Alarm *Log: Error Code* to par. 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 par. 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.

### 7.1.9. Tips and tricks

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

Table 7.1: Tips and tricks

### 7.1.10. Quick Transfer of Parameter Settings when using GLCP

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



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

#### Data storage in LCP:

1. Go to par. 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 GLCP indicated by the progress bar. When 100% is reached, press [OK].

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

#### Data transfer from LCP to Frequency converter:

1. Go to par. 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 GLCP are now transferred to the frequency converter indicated by the progress bar. When 100% is reached, press [OK].

### 7.1.11. Initialisation to Default Settings

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

#### Recommended initialisation (via par. 14-22 Operation Mode)

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

par. 14-22 Operation Mode initialises all except:

- par. 14-50 RFI Filter
- par.
- par.
- par. 8-32 Baud Rate
- par. 8-35 Minimum Response Delay
- par. 8-36 Maximum Response Delay
- par. 8-37 Maximum Inter-Char Delay
- par. 15-00 Operating Hours to par. 15-05 Over Volt's
- par. 15-20 Historic Log: Event to par. 15-22 Historic Log: Time
- par. 15-30 Alarm Log: Error Code to par. 15-32 Alarm Log: Time

**NB!**

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

7

#### Manual initialisation

**NB!**

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

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

This parameter initialises all except:

- par. 15-00 Operating Hours
- par. 15-03 Power Up's
- par. 15-04 Over Temp's
- par. 15-05 Over Volt's

### 7.1.12. RS-485 Bus Connection

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

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

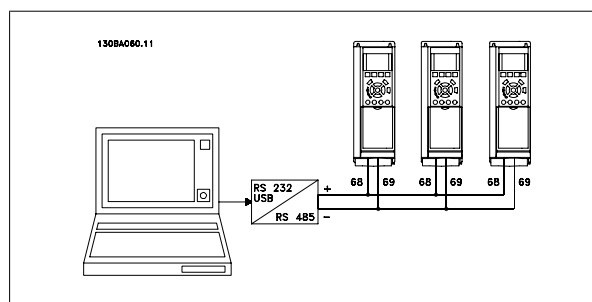


Illustration 7.9: Connection example.

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

#### Bus termination

The RS-485 bus must be terminated by a resistor network at both ends. If the drive is the first or the last device in the RS-485 loop, set the switch S801 on the control card for ON.

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

### 7.1.13. How to Connect a PC to the frequency converter

To control or program the frequency converter from a PC, install the PC-based Configuration Tool MCT 10.

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.*



**NB!**

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

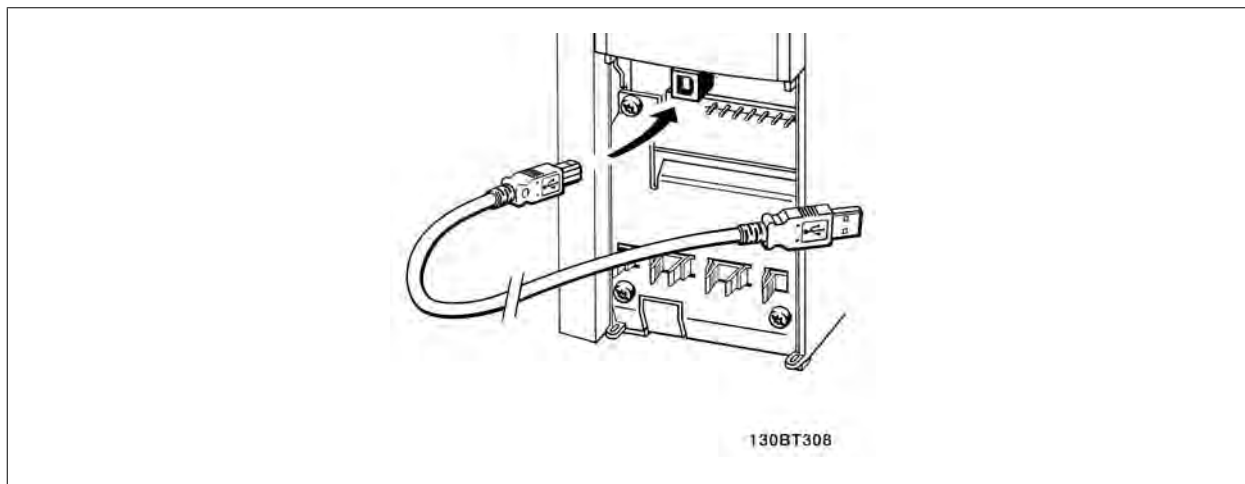


Illustration 7.10: For control cable connections, see section on *Control Terminals*.

### 7.1.14. PC Software tools

#### PC-based Configuration Tool MCT 10

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

#### MCT 10 Set-up Software

MCT 10 has been designed as an easy to use interactive tool for setting parameters in our frequency converters. The software can be downloaded from the Danfoss internet site <http://www.Danfoss.com/BusinessAreas/DrivesSolutions/SoftwareDownload/DDPC+Software+Program.htm>.

The MCT 10 Set-up software will be useful for:

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

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

#### Save Frequency Converter Settings:

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

- 2. Open MCT 10 Set-up Software
- 3. Choose "Read from drive"
- 4. Choose "Save as"

All parameters are now stored in the PC.

**Load Frequency Converter Settings:**

- 1. Connect a PC to the frequency converter via USB com port
- 2. Open MCT 10 Set-up software
- 3. 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 frequency converter.

A separate manual for MCT 10 Set-up Software is available: *MG.10.Rx.yy*.

**The MCT 10 Set-up Software Modules**

The following modules are included in the software package:

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

**Ordering number:**

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

MCT 10 can also be downloaded from the Danfoss Internet: *WWW.DANFOSS.COM, Business Area: Motion Controls*.

## 8. How to programme the frequency converter

### 8.1. How to programme

#### 8.1.1. Parameter Set-Up

##### Overview of parameter groups

| Group | Title                              | Function                                                                                                                                           |
|-------|------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|
| 0-    | Operation / Display                | Parameters related to the fundamental functions of the frequency converter, 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 frequency converter.                                                                             |
| 3-    | Reference / Ramps                  | Parameters for reference handling, definitions of limitations, and configuration of the reaction of the frequency converter 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 configuration of 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 Fieldbus                 | Parameter group for DeviceNet-specific parameters.                                                                                                 |
| 11-   | LonWorks                           | Parameter group for LonWorks parameters                                                                                                            |
| 13-   | Smart Logic                        | Parameter group for Smart Logic Control                                                                                                            |
| 14-   | Special Functions                  | Parameter group for configuring special frequency converter functions.                                                                             |
| 15-   | Drive Information                  | Parameter group containing frequency converter information such as operating data, hardware configuration and software versions.                   |
| 16-   | Data Readouts                      | Parameter group for data read-outs, e.g. actual 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 needed to be performed on a daily or weekly basis, e.g. 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 8.1: Parameter Groups

Parameter descriptions and selections are displayed on the graphic (GLCP) or numeric (NLCP) 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 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.

#### 8.1.2. Quick Menu Mode

The GLCP provides access to all parameters listed under the Quick Menu. 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 optimum way to set parameters through the [Quick Menu] is by following the below steps:**

1. Press [Quick Setup] for selecting basic motor settings, ramp times, etc.
2. Press [Function Setups] for setting up the required functionality of the frequency converter - 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.

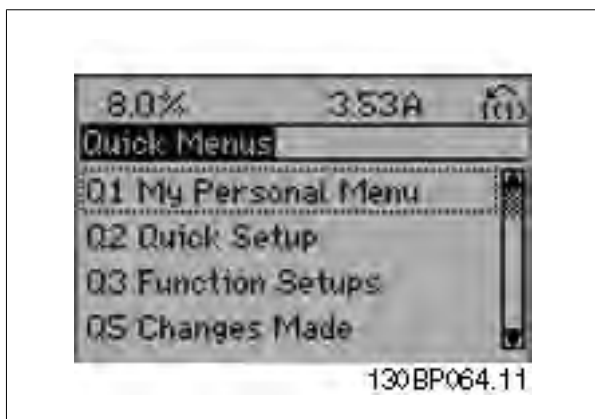


Illustration 8.1: Quick menu view.

| 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 8.2: Quick Setup parameters

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.

#### NB!

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

## 8

### 8.1.3. 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     |

### 8.1.4. Q2 Quick Setup

The parameters in Q2 Quick Setup are the basic parameters which are always needed to set-up the frequency converter to operation.

| Q2 Quick Setup                        |      |
|---------------------------------------|------|
| 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) |      |

### 8.1.5. 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. Amongst other features it also includes parameters for selecting which variables to display on the LCP, digital preset speeds, scaling of analog references, closed loop single zone and multi-zone applications and specific functions related to water and wastewater applications.

How to access Function Set-up - example

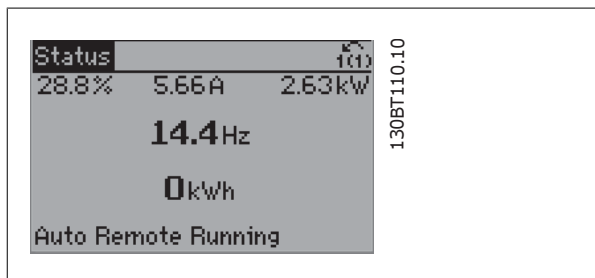


Illustration 8.2: Step 1: Turn on the frequency converter (On LED lights)

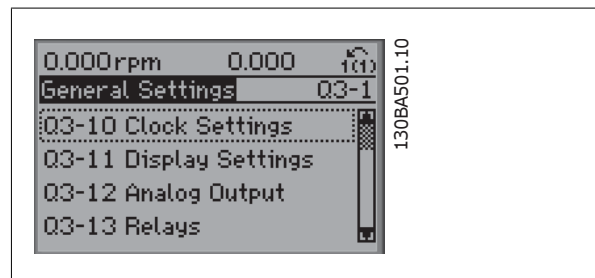


Illustration 8.6: Step 5: Use the up/down navigation keys to scroll down to i.e. 03-12 *Analog Outputs*. Press [OK].

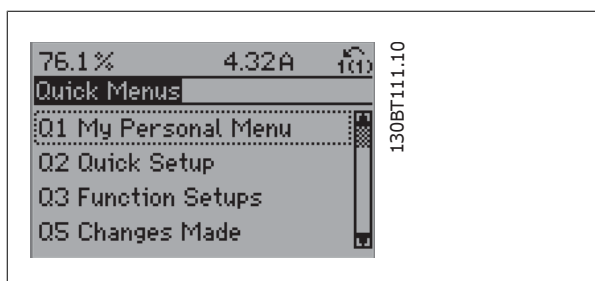


Illustration 8.3: Step 2: Press the [Quick Menus] button (Quick Menu choices appear).

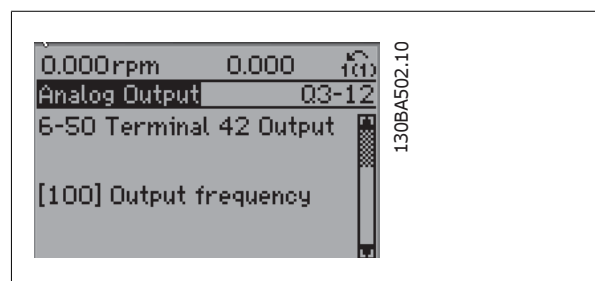


Illustration 8.7: Step 6: Choose parameter 6-50 *Terminal 42 Output*. Press [OK].

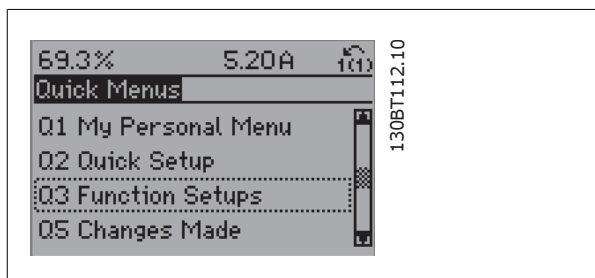


Illustration 8.4: Step 3: Use the up/down navigation keys to scroll down to Function Setups. Press [OK].

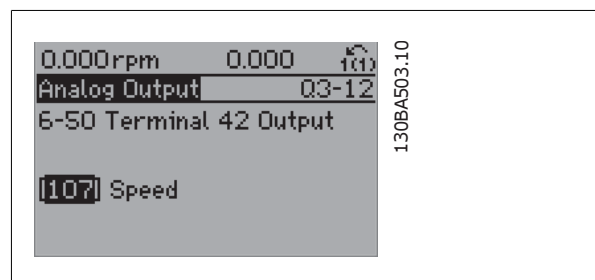


Illustration 8.8: Step 7: Use the up/down navigation keys to select between the different choices. Press [OK].

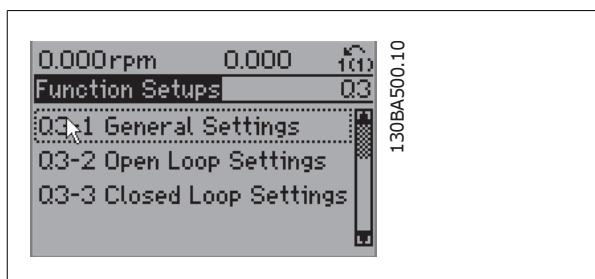


Illustration 8.5: Step 4: Function Setups choices appear. Choose 03-1 *General Settings*. Press [OK].

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       |                                  |

8.1.6. 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 read-outs. 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 as they will vary depending on the programming of the particular frequency converter.

| 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        |  |

8.1.7. Q6 Loggings

Q6 Loggings can be used for fault finding.

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

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

8.1.8. Main Menu Mode

Both the GLCP and NLCP provide access to the main menu mode. Select the Main Menu mode by pressing the [Main Menu] key. Illustration 6.2 shows the resulting read-out, which appears on the display of the GLCP. Lines 2 through 5 on the display show a list of parameter groups which can be chosen by toggling the up and down buttons.

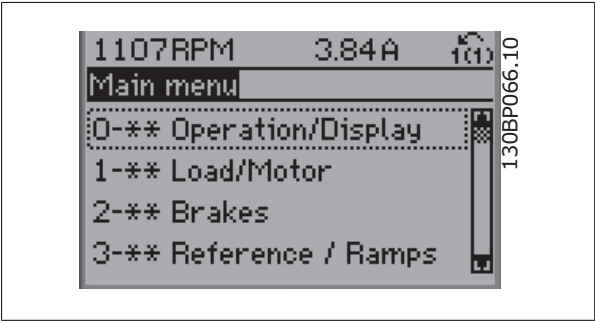


Illustration 8.9: Display example.

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

All parameters can be changed in the Main Menu. The configuration of the unit (par. 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.

8.1.9. Parameter Selection

8

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

| Group no. | Parameter group:          |
|-----------|---------------------------|
| 0         | Operation/Display         |
| 1         | Load/Motor                |
| 2         | Brakes                    |
| 3         | References/Ramps          |
| 4         | Limits/Warnings           |
| 5         | Digital In/Out            |
| 6         | Analog In/Out             |
| 8         | Comm. and Options         |
| 9         | Profibus                  |
| 10        | CAN Fieldbus              |
| 11        | LonWorks                  |
| 13        | Smart Logic               |
| 14        | Special Functions         |
| 15        | Drive Information         |
| 16        | Data Readouts             |
| 18        | Data Readouts 2           |
| 20        | Drive Closed Loop         |
| 21        | Ext. Closed Loop          |
| 22        | Application Functions     |
| 23        | Time-based Functions      |
| 24        | Fire Mode                 |
| 25        | Cascade Controller        |
| 26        | Analog I/O Option MCB 109 |

Table 8.3: Parameter groups.

After selecting a parameter group, choose a parameter by means of the navigation keys.

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

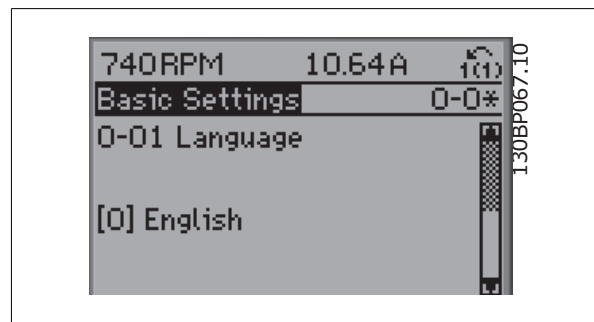


Illustration 8.10: Display example.

## 8.2. Commonly Used Parameters - Explanations

### 8.2.1. Main Menu

The Main Menu includes all available parameters in the VLT® AQUA Drive FC 200 frequency converter.

All parameters are grouped in a logic way 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 these Operating Instructions.

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

Some of the most 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 on [www.danfoss.com](http://www.danfoss.com) or by ordering at the local Danfoss office.

### 8.2.2. 0-\*\* Operation / Display

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

**0-01 Language****Option:****Function:**

Defines the language to be used in the display.

The frequency converter can be delivered with 4 different language packages. English and German are included in all packages. English cannot be erased or manipulated.

|       |                     |                                 |
|-------|---------------------|---------------------------------|
| [0] * | English             | Part of Language packages 1 - 4 |
| [1]   | German              | Part of Language packages 1 - 4 |
| [2]   | French              | Part of Language package 1      |
| [3]   | Danish              | Part of Language package 1      |
| [4]   | Spanish             | Part of Language package 1      |
| [5]   | Italian             | Part of Language package 1      |
| [6]   | Swedish             | Part of Language package 1      |
| [7]   | Dutch               | Part of Language package 1      |
| [10]  | Chinese             | Language package 2              |
| [20]  | Finnish             | Part of Language package 1      |
| [22]  | English US          | Part of Language package 4      |
| [27]  | Greek               | Part of Language package 4      |
| [28]  | Portuguese          | Part of Language package 4      |
| [36]  | Slovenian           | Part of Language package 3      |
| [39]  | Korean              | Part of Language package 2      |
| [40]  | Japanese            | Part of Language package 2      |
| [41]  | Turkish             | Part of Language package 4      |
| [42]  | Traditional Chinese | Part of Language package 2      |
| [43]  | Bulgarian           | Part of Language package 3      |
| [44]  | Serbian             | Part of Language package 3      |
| [45]  | Romanian            | Part of Language package 3      |
| [46]  | Hungarian           | Part of Language package 3      |
| [47]  | Czech               | Part of Language package 3      |
| [48]  | Polish              | Part of Language package 4      |
| [49]  | Russian             | Part of Language package 3      |
| [50]  | Thai                | Part of Language package 2      |
| [51]  | Bahasa Indonesian   | Part of Language package 2      |

**0-20 Display Line 1.1 Small****Option:****Function:**

Select a variable for display in line 1, left position.

|        |                                |                                                                                                                 |
|--------|--------------------------------|-----------------------------------------------------------------------------------------------------------------|
| [0]    | None                           | No display value selected                                                                                       |
| [37]   | Display Text 1                 | Present control word                                                                                            |
| [38]   | Display Text 2                 | Enables an individual text string to be written, for display in the LCP or to be read via serial communication. |
| [39]   | Display Text 3                 | Enables an individual text string to be written, for display in the LCP or to be read via serial communication. |
| [89]   | Date and Time Readout          | Displays the current date and time.                                                                             |
| [953]  | Profibus Warning Word          | Displays Profibus communication warnings.                                                                       |
| [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.                                                                                                   |
| [1115]   | LON Warning Word           | Shows the LON-specific warnings.                                                                                                                                                         |
| [1117]   | XIF Revision               | Shows the version of the external interface file of the Neuron C chip on the LON option.                                                                                                 |
| [1118]   | LON Works Revision         | Shows the software version of the application program of the Neuron C chip on the LON option.                                                                                            |
| [1500]   | Operating Hours            | View the number of running hours of the frequency converter.                                                                                                                             |
| [1501]   | Running Hours              | View the number of running hours of the motor.                                                                                                                                           |
| [1502]   | kWh Counter                | View the mains power consumption in kWh.                                                                                                                                                 |
| [1600]   | Control Word               | View the Control Word sent from the frequency converter 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 par. 0-30, 0-31 and 0-32.                                                                                                                   |
| [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]   | Motor Frequency            | Motor frequency, i.e. the output frequency from the frequency converter in Hz.                                                                                                           |
| [1614]   | Motor Current              | Phase current of the motor measured as effective value.                                                                                                                                  |
| [1615]   | Frequency [%]              | Motor frequency, i.e. the output frequency from the frequency converter 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 frequency converter. |
| [1618]   | Motor Thermal              | Thermal load on the motor, calculated by the ETR function. See also parameter group 1-9* Motor Temperature.                                                                              |
| [1622]   | Torque [%]                 | Shows the actual torque produced, in percentage.                                                                                                                                         |
| [1630]   | DC Link Voltage            | Intermediate circuit voltage in the frequency converter.                                                                                                                                 |
| [1632]   | BrakeEnergy/s              | Present brake power transferred to an external brake resistor. Stated as an instantaneous value.                                                                                         |
| [1633]   | BrakeEnergy/2 min          | Brake power transferred to an external brake resistor. The mean power is calculated continuously for the most recent 120 seconds.                                                        |
| [1634]   | Heatsink Temp.             | Present heat sink temperature of the frequency converter. The cut-out limit is 95 ±5 °C; cutting back in occurs at 70 ±5 °C.                                                             |
| [1635]   | Thermal Drive Load         | Percentage load of the inverters                                                                                                                                                         |
| [1636]   | Inv. Nom. Current          | Nominal current of the frequency converter                                                                                                                                               |
| [1637]   | Inv. Max. Current          | Maximum current of the frequency converter                                                                                                                                               |
| [1638]   | SL Control State           | State of the event executed by the control                                                                                                                                               |
| [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.                                                                                                         |
| [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.                                                                                                     |
| [1654]   | Feedback 1 [Unit]          | View the value of Feedback 1. See also par. 20-0*.                                                                                                                                       |
| [1655]   | Feedback 2 [Unit]          | View the value of Feedback 2. See also par. 20-0*.                                                                                                                                       |
| [1656]   | Feedback 3 [Unit]          | View the value of Feedback 3. See also par. 20-0*.                                                                                                                                       |
| [1660]   | Digital Input              | Displays the status of the 6 digital input terminals (18, 19, 27, 29, 32 and 33). Input 18 corresponds to the bit at the far left. Signal low = 0; Signal high = 1                       |
| [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 par. 6-50 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.                                                                                                 |
| [1675] | Analog input X30/11        | Actual value of the signal on input X30/11 (General Purpose I/O Card. Option)                                                        |
| [1676] | Analog input X30/12        | Actual value of the signal on input X30/12 (General Purpose I/O Card. Optional)                                                      |
| [1677] | Analog output X30/8 [mA]   | Actual value at output X30/8 (General Purpose I/O Card. Optional) Use Par. 6-60 to select the variable to be shown.                  |
| [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 STW           | Extended fieldbus 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)                                                         |
| [1695] | Ext. Status Word 2         | One or more status conditions in a Hex code (used for serial communications)                                                         |
| [1696] | Maintenance Word           | The bits reflect the status for the programmed Preventive Maintenance Events in parameter group 23-1*                                |
| [1830] | Analog Input X42/1         | Shows the value of the signal applied to terminal X42/1 on the Analog I/O card.                                                      |
| [1831] | Analog Input X42/3         | Shows the value of the signal applied to terminal X42/3 on the Analog I/O card.                                                      |
| [1832] | Analog Input X42/5         | Shows the value of the signal applied to terminal X42/5 on the Analog I/O card.                                                      |
| [1833] | Analog Out X42/7 [V]       | Shows the value of the signal applied to terminal X42/7 on the Analog I/O card.                                                      |
| [1834] | Analog Out X42/9 [V]       | Shows the value of the signal applied to terminal X42/9 on the Analog I/O card.                                                      |
| [1835] | Analog Out X42/11 [V]      | Shows the value of the signal applied to terminal X42/11 on the Analog I/O card.                                                     |
| [2117] | Ext. 1 Reference [Unit]    | The value of the reference for extended Closed Loop Controller 1                                                                     |
| [2118] | Ext. 1 Feedback [Unit]     | The value of the feedback signal for extended Closed Loop Controller 1                                                               |
| [2119] | Ext. 1 Output [%]          | The value of the output from extended Closed Loop Controller 1                                                                       |
| [2137] | Ext. 2 Reference [Unit]    | The value of the reference for extended Closed Loop Controller 2                                                                     |
| [2138] | Ext. 2 Feedback [Unit]     | The value of the feedback signal for extended Closed Loop Controller 2                                                               |
| [2139] | Ext. 2 Output [%]          | The value of the output from extended Closed Loop Controller 2                                                                       |
| [2157] | Ext. 3 Reference [Unit]    | The value of the reference for extended Closed Loop Controller 3                                                                     |
| [2158] | Ext. 3 Feedback [Unit]     | The value of the feedback signal for extended Closed Loop Controller 3                                                               |
| [2159] | Ext. Output [%]            | The value of the output from extended Closed Loop Controller 3                                                                       |
| [2230] | No-Flow Power              | The calculated No Flow Power for the actual operating speed                                                                          |
| [2580] | Cascade Status             | Status for the operation of the Cascade Controller                                                                                   |

[2581]      Pump Status      Status for the operation of each individual pump controlled by the Cascade Controller



**NB!**  
Please consult the VLT® AQUA Drive Programming Guide, MG.20.OX.YY for detailed information.

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 *Display Line 1.1 Small*.

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 par. 0-20 *Display Line 1.1 Small*.

0-23 Display Line 2 Large

**Option:**      **Function:**  
Select a variable for display in line 2. The options are the same as those listed for par. 0-20 *Display Line 1.1 Small*.

[1615] \*      Frequency

0-24 Display Line 3 Large

**Option:**      **Function:**  
Select a variable for display in line 2. The options are the same as those listed for par. 0-20 *Display Line 1.1 Small*.

[1652] \*      Feedback [Unit]

0-37 Display Text 1

**Range:**      **Function:**  
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 1 in par. 0-20 *Display Line 1.1 Small*, par. 0-21 *Display Line 1.2 Small*, par. 0-22 *Display Line 1.3 Small*, par. 0-23 *Display Line 2 Large* or par. 0-24 *Display Line 3 Large*. 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 - 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 par. 0-20 *Display Line 1.1 Small*, par. 0-21 *Display Line 1.2 Small*, par. 0-22 *Display Line 1.3 Small*, par. 0-23 *Display Line 2 Large* or par. 0-24 *Display Line 3 Large*. 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:**

0 N/A\* [0 - 0 N/A]

**Function:**

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 3 in par. 0-20 Display *Line 1.1 Small*, par. 0-21 Display *Line 1.2 Small*, par. 0-22 Display *Line 1.3 Small*, par. 0-23 Display *Line 2 Large* or par. 0-24 Display *Line 3 Large*. 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 Set Date and Time****Range:**

2000-01-01 [2000-01-01 00:00]  
00:00 –  
2099-12-01  
23:59 \*

**Function:**

Sets the date and time of the internal clock. The format to be used is set in par. 0-71 and 0-72.

**NB!**

This parameter does not display the actual time. This can be read in par. 0-89. The clock will not begin counting until a setting different from default has been made.

**0-71 Date Format****Option:**

[0] \* YYYY-MM-DD  
[1] DD-MM-YYYY  
[2] MM/DD/YYYY

**Function:**

Sets the date format to be used in the LCP.  
Sets the date format to be used in the LCP.  
Sets the date format to be used in the LCP.

**0-72 Time Format****Option:**

[0] \* 24 h  
[1] 12 h

**Function:**

Sets the time format to be used in the LCP.

**0-74 DST/Summertime****Option:**

[0] \* Off  
[2] Manual

**Function:**

Choose how Daylight Saving Time/Summertime should be handled. For manual DST/Summertime enter the start date and end date in par. 0-76 *DST/Summertime Start* and par. 0-77 *DST/Summertime End*.

**0-76 DST/Summertime Start****Range:**

0 N/A\* [0 - 0 N/A]

**Function:**

Sets the date and time when summertime/DST starts. The date is programmed in the format selected in par. 0-71 *Date Format*.

**0-77 DST/Summertime End****Range:**

0 N/A\* [0 - 0 N/A]

**Function:**

Sets the date and time when summertime/DST ends. The date is programmed in the format selected in par. 0-71 *Date Format*.

**8.2.3. General Settings, 1-0\***

Define whether the frequency converter 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.<br><br>Open Loop is also used if the frequency converter 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 par. 20-** or via the Function Setups accessed by pressing the [Quick Menus] button. |



**NB!**

This parameter cannot be changed when motor is running.



**NB!**

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] | Enter the nominal motor power in kW according to the motor nameplate data. The default value corresponds to the nominal rated output of the unit.<br><br>This parameter cannot be adjusted while the motor is running. Depending on the choices made in par. 0-03 Regional <i>Settings</i> , either par. 1-20 <i>Motor Power [kW]</i> or par. 1-21 <i>Motor Power [HP]</i> is made invisible. |

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.<br><br>This parameter cannot be adjusted while the motor is running. |

**1-23 Motor Frequency****Range:**

50. Hz\* [20 - 1000 Hz]

**Function:**

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

**NB!**

This parameter cannot be adjusted while the motor is running.

**1-24 Motor Current****Range:**

7.20 A\* [0.10 - 10000.00 A]

**Function:**

Enter the nominal motor current value from the motor nameplate data. This data is used for calculating motor torque, motor thermal protection etc.

**NB!**

This parameter cannot be adjusted while the motor is running.

**8****1-25 Motor Nominal Speed****Range:**

1420. RPM\* [100 - 60000 RPM]

**Function:**

Enter the nominal motor speed value from the motor nameplate data. This data is used for calculating automatic motor compensations.

**NB!**

This parameter cannot be changed while the motor is running.

**1-29 Automatic Motor Adaptation (AMA)****Option:****Function:**

The AMA function optimizes dynamic motor performance by automatically optimizing the advanced motor parameters par. 1-30 Stator *Resistance (Rs)* to par. 1-35 Main *Reactance (Xh)* while the motor is stationary.

[0] \* Off

No function

[1] Enable complete AMA

performs AMA of the stator resistance  $R_s$ , the rotor resistance  $R_r$ , the stator leakage reactance  $X_1$ , the rotor leakage reactance  $X_2$  and the main reactance  $X_h$ .

[2] Enable reduced AMA

performs a reduced AMA of the stator resistance  $R_s$  in the system only. Select this option if an LC filter is used between the frequency converter and the motor.

Activate the AMA function by pressing [Hand on] after selecting [1] or [2]. See also the section *Automatic Motor Adaptation*. After a normal sequence, the display will read: "Press [OK] to finish AMA". After pressing the [OK] key the frequency converter is ready for operation.

**Note:**

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



**NB!**

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



**NB!**

Avoid generating external torque during AMA



**NB!**

If one of the settings in par. 1-2\* Motor Data is changed, par. 1-30 Stator *Resistance (Rs)* to par. 1-39 Motor *Poles*, the advanced motor parameters, will return to default setting.

This parameter cannot be adjusted while the motor is running



**NB!**

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

See section *Automatic Motor Adaptation* - application example.

### 8.2.4. 3-0\* Reference Limits

Parameters for setting the reference unit, limits and ranges.

#### 3-02 Minimum Reference

**Range:**

0.000 Ref- [-999999.999 - par. 3-03 ReferenceFeed-ceFeedbackUnit]  
backUnit\*

**Function:**

Enter the Minimum Reference. The Minimum Reference is the lowest value obtainable by summing all references. The Minimum Reference value and unit matches the configuration choice made in par. 1-00 *Configuration Mode* and par. 20-12 Reference/Feedback *Unit*, respectively.



**NB!**

This parameter is used in open loop only.

#### 3-03 Maximum Reference

**Range:**

50.000 Ref- [par. 3-02 - 999999.999 ReferenceFeed-ceFeedbackUnit]  
backUnit\*

**Function:**

Enter the Maximum Reference. The Maximum Reference is the highest value obtainable by summing all references. The Maximum Reference value and unit matches the configuration choice made in par. 1-00 *Configuration Mode* and par. 20-12 Reference/Feedback *Unit*, respectively.



**NB!**

This parameter is used in open loop only.

## 3-10 Preset Reference

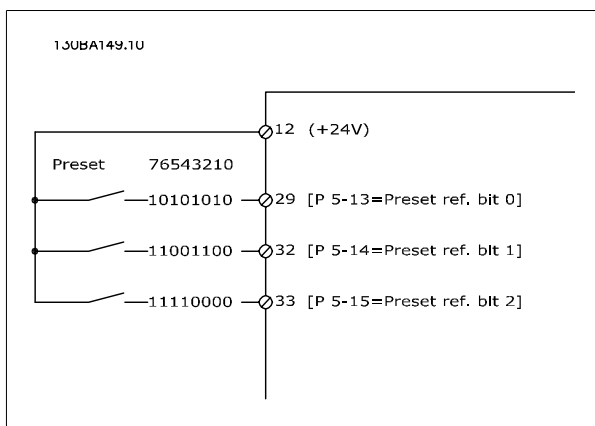
Array [8]

## Range:

0.00 %\* [-100.00 - 100.00 %]

## Function:

Enter up to eight different preset references (0-7) in this parameter, using array programming. The preset reference is stated as a percentage of the value Ref<sub>MAX</sub> (par. 3-03 Maximum Reference) or as a percentage of the other external references. If a Ref<sub>MIN</sub> different from 0 (Par. 3-02 Minimum Reference) is programmed, the preset reference is calculated as a percentage of the full reference range, i.e. on the basis of the difference between Ref<sub>MAX</sub> and Ref<sub>MIN</sub>. Afterwards, the value is added to Ref<sub>MIN</sub>. When using preset references, select Preset ref. bit 0 / 1 / 2 [16], [17] or [18] for the corresponding digital inputs in parameter group 5.1\* Digital Inputs.



8

## 3-41 Ramp 1 Ramp Up Time

## Range:

10.00 s\* [1.00 - 3600.00 s]

## Function:

Enter the ramp-up time, i.e. the acceleration time from 0 RPM to par. 1-25. Choose a ramp-up time such that the output current does not exceed the current limit in par. 4-18 during ramping. See ramp-down time in par. 3-42 *Ramp 1 Ramp Down Time*.

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

See drawing above!

## 3-42 Ramp 1 Ramp Down Time

## Range:

20.00 s\* [1.00 - 3600.00 s]

## Function:

Enter the ramp-down time, i.e. the deceleration time from par. 1-25 *Motor Nominal Speed* to 0 RPM. Choose a ramp-down time such that no over-voltage arises in the inverter due to regenerative operation of the motor, and such that the generated current does not exceed the current limit set in par. 4-18 *Current Limit*. See ramp-up time in par. 3-41 *Ramp 1 Ramp Up Time*.

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

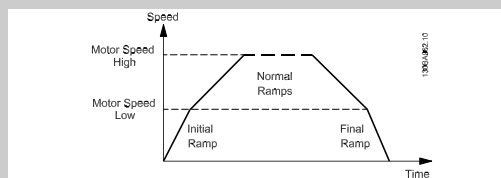
## 3-84 Initial Ramp Time

## Range:

0 s\* [0 - 60 s]

## Function:

Enter the initial ramp up time from zero speed to Motor Speed Low Limit, par. 4-11 or 4-12. 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.



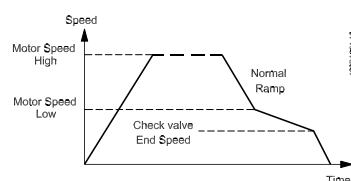
### 3-85 Check Valve Ramp Time

**Range:**

0 s\* [0 – 60 s]

**Function:**

In order to protect ball check valves in a stop situation, the check valve ramp can be utilized as a slow ramp rate from par. 4-11 *Motor Speed Low Limit [RPM]* or par. 4-12 *Motor Speed Low Limit [Hz]*, to Check Valve Ramp End Speed, set by the user in par. 3-86 or par. 3-87. When par. 3-85 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 par. 3-86 or par. 3-87.



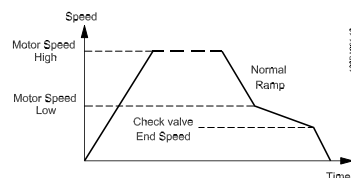
### 3-86 Check Valve Ramp End Speed [RPM]

**Range:**

0 [RPM]\* [0 – Motor Speed Low Limit [RPM]]

**Function:**

Set the speed in [RPM] below Motor Speed Low Limit where the Check Valve is expected to be closed and the Check Valve no longer shall be active.



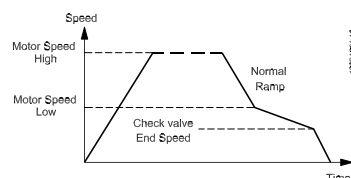
### 3-87 Check Valve Ramp End Speed [Hz]

**Range:**

0 [Hz]\* [0 – Motor Speed Low Limit [Hz]]

**Function:**

Set the speed in [Hz] below Motor Speed Low Limit where the Check Valve Ramp will no longer be active.



### 3-88 Final Ramp Time

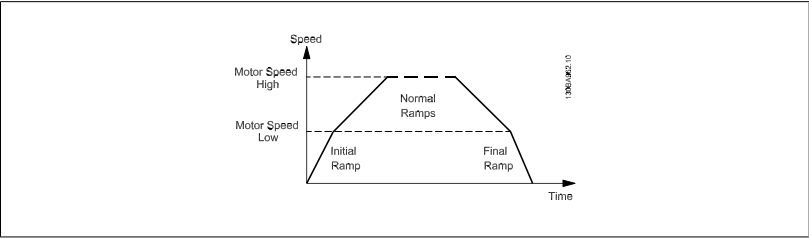
**Range:**

0 [s]\* [0 – 60 [s]]

**Function:**

Enter the Final Ramp Time to be used when ramping down from Motor Speed Low Limit, par. 4-11 or 4-12, 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.



8.2.5. 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 par. 4-13 Motor Speed High Limit [RPM]. |

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 par. 4-11 Motor Speed Low Limit [RPM]. Only par. 4-11 Motor Speed Low Limit [RPM] or par. 4-12 Motor Speed Low Limit [Hz] will be displayed depending on other parameters in the Main Menu and depending on default settings dependant on global location. |



**NB!**  
The output frequency value of the frequency converter not exceed a value higher than 1/10 of the switching frequency.



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

### 8.2.6. 5-\*\* Digital In/Out

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. |

This parameter cannot be adjusted while the motor is running.

### 8.2.7. 5-1\* Digital Inputs

Parameters for configuring the input functions for the input terminals.

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

| Digital input function  | Select | Terminal         |
|-------------------------|--------|------------------|
| No operation            | [0]    | All *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              |
| Speed down              | [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 frequency converter after a TRIP/ALARM. Not all alarms can be reset.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                 |   |   |   |               |   |   |   |               |   |   |   |               |   |   |   |               |   |   |   |               |   |   |   |               |   |   |   |               |   |   |   |               |   |   |   |
| [2]             | Coast inverse           | Leaves motor in free mode. Logic '0' => coasting stop.<br>(Default Digital input 27): Coasting stop, inverted input (NC).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                 |   |   |   |               |   |   |   |               |   |   |   |               |   |   |   |               |   |   |   |               |   |   |   |               |   |   |   |               |   |   |   |               |   |   |   |
| [3]             | Coast and reset inverse | Reset and coasting stop Inverted input (NC).<br>Leaves motor in free mode and resets the frequency converter. Logic '0' => coasting stop and reset.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                 |   |   |   |               |   |   |   |               |   |   |   |               |   |   |   |               |   |   |   |               |   |   |   |               |   |   |   |               |   |   |   |               |   |   |   |
| [5]             | DC-brake inverse        | Inverted input for DC braking (NC).<br>Stops motor by energizing it with a DC current for a certain time period. See par. 2-01 to par. 2-03.<br>The function is only active when the value in par. 2-02 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 (par. 3-42, par. 3-52, par. 3-62, par. 3-72). <div><div><b>NB!</b><br/>When the frequency converter is at the torque limit and has received a stop command, it may not stop by itself. To ensure that the frequency converter stops, configure a digital output to <i>Torque limit &amp; stop</i> [27] and connect this digital output to a digital input that is configured as coast.</div></div>                   |                 |   |   |   |               |   |   |   |               |   |   |   |               |   |   |   |               |   |   |   |               |   |   |   |               |   |   |   |               |   |   |   |               |   |   |   |
| [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 par. 22-00, External Interlock Time. After applying a signal to the input, the reaction described above will be delayed with the time set in par. 22-00.                                             |                 |   |   |   |               |   |   |   |               |   |   |   |               |   |   |   |               |   |   |   |               |   |   |   |               |   |   |   |               |   |   |   |               |   |   |   |
| [8]             | Start                   | Select start for a start/stop command. Logic '1' = start, logic '0' = stop.<br>(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 par. 4-10 <i>Motor Speed Direction</i> .<br>(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 par. 3-11.<br>(Default Digital input 29)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                 |   |   |   |               |   |   |   |               |   |   |   |               |   |   |   |               |   |   |   |               |   |   |   |               |   |   |   |               |   |   |   |               |   |   |   |
| [15]            | Preset reference on     | Used for shifting between external reference and preset reference. It is assumed that <i>External/preset</i> [1] has been selected in par. 3-04. 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><tr><td>Preset ref. bit</td><td>2</td><td>1</td><td>0</td></tr><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></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 Speed down to be used. If Speed up/down is used, the speed change always follows ramp 2 (par. 3-51 and 3-52) in the range 0 - par. 3-03 <i>Maximum Reference</i> .                                                                                                                                                                                                                                                                                                                                                                                                          |                 |   |   |   |               |   |   |   |               |   |   |   |               |   |   |   |               |   |   |   |               |   |   |   |               |   |   |   |               |   |   |   |               |   |   |   |

|                                                                                                                                                                                                                                                                                                                                                                       |                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| [20]                                                                                                                                                                                                                                                                                                                                                                  | Freeze output                     | Freezes actual motor frequency (Hz). The frozen motor frequency is now the point of enable/condition for Speed up and Speed down to be used. If Speed up/down is used, the speed change always follows ramp 2 (par. 3-51 and 3-52) in the range 0 - par. 1-23 <i>Motor Frequency</i> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <div>  <div> <b>NB!</b><br/>           When Freeze output is active, the frequency converter cannot be stopped via a low 'start [13]' signal. Stop the frequency converter via a terminal programmed for Coasting inverse [2] or Coast and reset, inverse [3].         </div> </div> |                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| [21]                                                                                                                                                                                                                                                                                                                                                                  | Speed up                          | 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 par. 3-41.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| [22]                                                                                                                                                                                                                                                                                                                                                                  | Speed down                        | Same as Speed up [21].                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| [23]                                                                                                                                                                                                                                                                                                                                                                  | Set-up select bit 0               | Selects one of the four set-ups. Set par. 0-10 <i>Active Set-up</i> to Multi Set-up.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| [24]                                                                                                                                                                                                                                                                                                                                                                  | Set-up select bit 1               | Same as Set-up select bit 0 [23].<br>(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 par. 14-10 <i>Mains Failure</i> . Mains failure inverse is active in the Logic "0" situation.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| [52]                                                                                                                                                                                                                                                                                                                                                                  | Run Permissive                    | 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. 5-3* Digital outputs, or par. 5-4* Relays, will not be affected by Run Permissive.                                                                                                                                                                                                                                                                           |
| [53]                                                                                                                                                                                                                                                                                                                                                                  | Hand start                        | A signal applied will put the frequency converter into Hand mode as if button <i>Hand On</i> on the LCP has been 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 assign 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> . |
| [54]                                                                                                                                                                                                                                                                                                                                                                  | Auto start                        | A signal applied will put the frequency converter 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 frequency converter into Sleep Mode (see par. 22-4*, Sleep Mode). Reacts on the rising edge of signal applied!                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| [78]                                                                                                                                                                                                                                                                                                                                                                  | Reset Preventive Maintenance Word | Resets all data in par. 16-96, Preventive Maintenance Word, to 0.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

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

|       |                 |                                                                                                                                                                                                   |
|-------|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| [120] | Lead Pump Start | Starts/Stops the Lead Pump (controlled by the frequency converter). 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> , par. 25-50, must be set to either <i>At Command</i> [2] or <i>At Staging or At Command</i> [3]. <i>Alternation Event</i> , par. 25-51, can be set to any of the four options. |
|-------|-----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

|             |                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-------------|-----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| [130 - 138] | Pump1 Interlock - Pump9 Interlock | For the above 9 setting options, par. 25-10, Pump Interlock, must be set to <i>On</i> [1]. The function will also depend on the setting in par. 25-06, Fixed Lead Pump. 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 frequency converter only (without any of the build 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.<br>See below table: |
|-------------|-----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

| Setting in Par. 5-1*  | Setting in Par. 25-06                           |                                                           |
|-----------------------|-------------------------------------------------|-----------------------------------------------------------|
|                       | [0] No                                          | [1] Yes                                                   |
| [130] Pump1 Interlock | Controlled by RELAY1<br>(only if not lead pump) | Frequency Converter controlled<br>(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:

[0] \* No Operation

#### Function:

Same options and functions as par. 5-1\* *Digital Inputs*.

### 5-14 Terminal 32 Digital Input

#### Option:

[0] \* No operation

#### Function:

Same options and functions as par. 5-1\*, except for *Pulse input*.

[1] Reset

[2] Coast inverse

[3] Coast and reset inv

[5] DC-brake inverse

[6] Stop inverse

[7] External interlock

[8] Start

[9] Latched start

[10] Reversing

[11] Start reversing

[14] Jog

[15] Preset reference on

[16] Preset ref bit 0

[17] Preset ref bit 1

[18] Preset ref bit 2

|       |                       |
|-------|-----------------------|
| [19]  | Freeze reference      |
| [20]  | Freeze output         |
| [21]  | Speed up              |
| [22]  | Speed down            |
| [23]  | Set-up select bit 0   |
| [24]  | Set-up select bit 1   |
| [34]  | Ramp bit 0            |
| [36]  | Mains failure inverse |
| [37]  | Fire Mode             |
| [52]  | Run permissive        |
| [53]  | Hand start            |
| [54]  | Auto start            |
| [55]  | DigiPot increase      |
| [56]  | DigiPot decrease      |
| [57]  | DigiPot clear         |
| [62]  | Reset Counter A       |
| [65]  | Reset Counter B       |
| [66]  | Sleep Mode            |
| [78]  | Reset Maint. Word     |
| [120] | Lead Pump Start       |
| [121] | Lead Pump Alternation |
| [130] | Pump 1 Interlock      |
| [131] | Pump 2 Interlock      |
| [132] | Pump 3 Interlock      |

#### 5-15 Terminal 33 Digital Input

##### Option:

##### Function:

|       |                     |                                                         |
|-------|---------------------|---------------------------------------------------------|
| [0] * | No operation        | Same options and functions as par. 5-1* Digital Inputs. |
| [1]   | Reset               |                                                         |
| [2]   | Coast inverse       |                                                         |
| [3]   | Coast and reset inv |                                                         |
| [5]   | DC-brake inverse    |                                                         |
| [6]   | Stop inverse        |                                                         |
| [7]   | External interlock  |                                                         |
| [8]   | Start               |                                                         |
| [9]   | Latched start       |                                                         |
| [10]  | Reversing           |                                                         |
| [11]  | Start reversing     |                                                         |
| [14]  | Jog                 |                                                         |
| [15]  | Preset reference on |                                                         |
| [16]  | Preset ref bit 0    |                                                         |
| [17]  | Preset ref bit 1    |                                                         |
| [18]  | Preset ref bit 2    |                                                         |
| [19]  | Freeze reference    |                                                         |
| [20]  | Freeze output       |                                                         |
| [21]  | Speed up            |                                                         |
| [22]  | Speed down          |                                                         |

|       |                       |
|-------|-----------------------|
| [23]  | Set-up select bit 0   |
| [24]  | Set-up select bit 1   |
| [30]  | Counter input         |
| [32]  | Pulse input           |
| [34]  | Ramp bit 0            |
| [36]  | Mains failure inverse |
| [37]  | Fire Mode             |
| [52]  | Run permissive        |
| [53]  | Hand start            |
| [54]  | Auto start            |
| [55]  | DigiPot increase      |
| [56]  | DigiPot decrease      |
| [57]  | DigiPot clear         |
| [60]  | Counter A (up)        |
| [61]  | Counter A (down)      |
| [62]  | Reset Counter A       |
| [63]  | Counter B (up)        |
| [64]  | Counter B (down)      |
| [65]  | Reset Counter B       |
| [66]  | Sleep Mode            |
| [78]  | Reset Maint. Word     |
| [120] | Lead Pump Start       |
| [121] | Lead Pump Alternation |
| [130] | Pump 1 Interlock      |
| [131] | Pump 2 Interlock      |
| [132] | Pump 3 Interlock      |

**5-30 Terminal 27 Digital Output**

| Option: | Function:            |
|---------|----------------------|
| [0] *   | No operation         |
| [1]     | Control ready        |
| [2]     | Drive ready          |
| [3]     | Drive rdy/rem ctrl   |
| [4]     | Standby / no warning |
| [5]     | Running              |
| [6]     | Running / no warning |
| [8]     | Run on ref/no warn   |
| [9]     | Alarm                |
| [10]    | Alarm or warning     |
| [11]    | At torque limit      |
| [12]    | Out of current range |
| [13]    | Below current, low   |
| [14]    | Above current, high  |
| [15]    | Out of speed range   |
| [16]    | Below speed, low     |
| [17]    | Above speed, high    |
| [18]    | Out of feedb. range  |

Same options and functions as par. 5-3\*.

|       |                        |
|-------|------------------------|
| [19]  | Below feedback, low    |
| [20]  | Above feedback, high   |
| [21]  | Thermal warning        |
| [25]  | Reverse                |
| [26]  | Bus OK                 |
| [27]  | Torque limit & stop    |
| [28]  | Brake, no brake war    |
| [29]  | Brake ready, no fault  |
| [30]  | Brake fault (IGBT)     |
| [35]  | External Interlock     |
| [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 |
| [55]  | Pulse output           |
| [60]  | Comparator 0           |
| [61]  | Comparator 1           |
| [62]  | Comparator 2           |
| [63]  | Comparator 3           |
| [64]  | Comparator 4           |
| [65]  | Comparator 5           |
| [70]  | Logic rule 0           |
| [71]  | Logic rule 1           |
| [72]  | Logic rule 2           |
| [73]  | Logic rule 3           |
| [74]  | Logic rule 4           |
| [75]  | Logic rule 5           |
| [80]  | SL digital output A    |
| [81]  | SL digital output B    |
| [82]  | SL digital output C    |
| [83]  | SL digital output D    |
| [84]  | SL digital output E    |
| [85]  | SL digital output F    |
| [160] | No alarm               |
| [161] | Running reverse        |
| [165] | Local ref active       |
| [166] | Remote ref active      |
| [167] | Start command act.     |
| [168] | Hand mode              |
| [169] | Auto mode              |
| [180] | Clock Fault            |
| [181] | Prev. Maintenance      |
| [190] | No-Flow                |
| [191] | Dry Pump               |
| [192] | End Of Curve           |

|       |                      |
|-------|----------------------|
| [193] | Sleep Mode           |
| [194] | Broken Belt          |
| [195] | Bypass Valve Control |
| [196] | Fire Mode            |
| [197] | Fire Mode was Act.   |
| [198] | Drive Bypass         |
| [200] | Full capacity        |
| [201] | Pump 1 running       |
| [202] | Pump 2 running       |
| [203] | Pump 3 running       |

## 5-40 Function Relay

Array [8]

(Relay 1 [0], Relay 2 [1], Relay 7 [6], Relay 8 [7], Relay 9 [8])

Select options to define the function of the relays.

The selection of each mechanical relay is realised in an array parameter.

8

|       |                        |
|-------|------------------------|
| [0]   | No Operation           |
| [1]   | Control Ready          |
| [2]   | Drive Ready            |
| [3]   | Drive Ready/Remote     |
| [4]   | Stand-by/No Warning    |
| [5] * | Running                |
| [6]   | Running/No Warning     |
| [8]   | Run on Ref./No Warning |
| [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        |
| [25]  | Reverse                |
| [26]  | Bus OK                 |
| [27]  | Torque Limit & Stop    |
| [28]  | Brake, No Warning      |
| [29]  | Brake Ready, No Fault  |
| [30]  | Brake Fault (IGBT)     |
| [35]  | External Interlock     |
| [36]  | Control Word Bit 11    |
| [37]  | Control Word Bit 12    |

|       |                        |
|-------|------------------------|
| [40]  | Out of Ref. Range      |
| [41]  | Below Reference, low   |
| [42]  | Above Ref. high        |
| [45]  | Bus ctrl               |
| [46]  | Bus ctrl, 1 if timeout |
| [47]  | Bus ctrl, 0 if timeout |
| [60]  | Comparator 0           |
| [61]  | Comparator 1           |
| [62]  | Comparator 2           |
| [63]  | Comparator 3           |
| [64]  | Comparator 4           |
| [65]  | Comparator 5           |
| [70]  | Logic Rule 0           |
| [71]  | Logic Rule 1           |
| [72]  | Logic Rule 2           |
| [73]  | Logic Rule 3           |
| [74]  | Logic Rule 4           |
| [75]  | Logic Rule 5           |
| [80]  | SL Digital Output A    |
| [81]  | SL Digital Output B    |
| [82]  | SL Digital Output C    |
| [83]  | SL Digital Output D    |
| [84]  | SL Digital Output E    |
| [85]  | SL Digital Output F    |
| [160] | No Alarm               |
| [161] | Running Reverse        |
| [165] | Local Ref. Active      |
| [166] | Remote Ref. Active     |
| [167] | Start Cmd. Active      |
| [168] | Drive in Hand Mode     |
| [169] | Drive in Auto Mode     |
| [180] | Clock Fault            |
| [181] | Prev. Maintenance      |
| [190] | No-Flow                |
| [191] | Dry Pump               |
| [192] | End of Curve           |
| [193] | Sleep Mode             |
| [194] | Broken Belt            |
| [195] | Bypass Valve Control   |
| [199] | Pipe Filling           |
| [211] | Cascade Pump1          |
| [212] | Cascade Pump2          |
| [213] | Cascade Pump3          |
| [223] | Alarm, Trip Locked     |
| [224] | Bypass Mode Active     |

**5-53 Term. 29 High Ref./Feedb. Value****Range:**

100.000 N/ [-999999.999 - 999999.999 N/A]

A\*

**Function:**

Enter the high reference value [RPM] for the motor shaft speed and the high feedback value, see also par. 5-58 Term. 33 *High Ref./Feedb. Value*.

**8.2.8. 6- \*\* Analog In/Out**

Parameter group for configuration of the analog input and output.

**6-00 Live Zero Timeout Time****Range:**

10 s\* [1 - 99 s]

**Function:**

Enter the Live Zero Time-out time period. Live Zero Time-out Time is active for analog inputs, i.e. terminal 53 or terminal 54, allocated to current and 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 par. 6-10 *Terminal 53 Low Voltage*, par. 6-12 *Terminal 53 Low Current*, par. 6-20 *Terminal 54 Low Voltage* or par. 6-22 *Terminal 54 Low Current* for a time period longer than the time set in par. 6-00 *Live Zero Timeout Time*, the function selected in par. 6-01 *Live Zero Timeout Function* will be activated.

**6-01 Live Zero Timeout Function****Option:****Function:**

Select the time-out function. The function set in par. 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 par. 6-10 *Terminal 53 Low Voltage*, par. 6-12 *Terminal 53 Low Current*, par. 6-20 *Terminal 54 Low Voltage* or par. 6-22 *Terminal 54 Low Current* for a time period defined in par. 6-00 *Live Zero Timeout Time*. If several time-outs occur simultaneously, the frequency converter prioritises the time-out functions as follows:

1. par. 6-01 *Live Zero Timeout Function*
2. par. 8-04 *Control Timeout Function*

The output frequency of the frequency converter can be:

- [1] frozen at the present value
- [2] overruled to stop
- [3] overruled to jog speed
- [4] overruled to max. speed
- [5] overruled to stop with subsequent trip

If you select set-up 1-4, par. 0-10 *Active Set-up* must be set to *Multi Set-up*, [9].

This parameter cannot be adjusted while the motor is running.

[0] \* Off

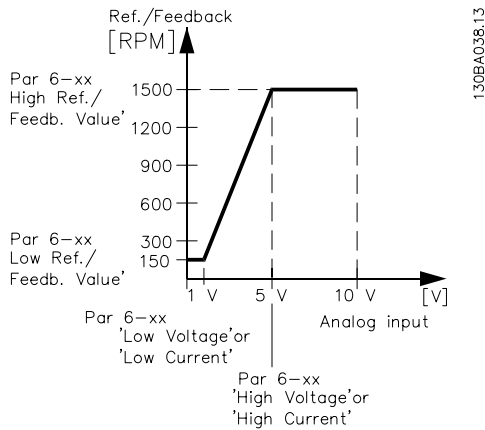
[1] Freeze output

[2] Stop

[3] Jogging

[4] Max. speed

[5] Stop and trip



**6-10 Terminal 53 Low Voltage**

**Range:**

0.07 V\* [0.00 - par. 6-11 V]

**Function:**

Enter the low voltage value. This analog input scaling value should correspond to the low reference/feedback value set in par. 6-14 *Terminal 53 Low Ref./Feedb. Value*.

**6-11 Terminal 53 High Voltage**

**Range:**

10.00 V\* [par. 6-10 - 10.00 V]

**Function:**

Enter the high voltage value. This analog input scaling value should correspond to the high reference/feedback value set in par. 6-15 *Terminal 53 High Ref./Feedb. Value*.

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

**Range:**

0.000 N/A\* [-999999.999 - 999999.999 N/A]

**Function:**

Enter the analog input scaling value that corresponds to the low voltage/low current set in par. 6-10 *Terminal 53 Low Voltage* and par. 6-12 *Terminal 53 Low Current*.

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

**Range:**

50.000 N/A\* [-999999.999 - 999999.999 N/A]

**Function:**

Enter the analog input scaling value that corresponds to the high voltage/high current value set in par. 6-11 *Terminal 53 High Voltage* and par. 6-13 *Terminal 53 High Current*.

**6-20 Terminal 54 Low Voltage**

**Range:**

0.07 V\* [0.00 - par. 6-21 V]

**Function:**

Enter the low voltage value. This analog input scaling value should correspond to the low reference/feedback value, set in par. 6-24 *Terminal 54 Low Ref./Feedb. Value*.

**6-21 Terminal 54 High Voltage**

**Range:**

10.00 V\* [par. 6-20 - 10.00 V]

**Function:**

Enter the high voltage value. This analog input scaling value should correspond to the high reference/feedback value set in par. 6-25 *Terminal 54 High Ref./Feedb. Value*.

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

**Range:**

0.000 N/A\* [-999999.999 - 999999.999 N/A]

**Function:**

Enter the analog input scaling value that corresponds to the low voltage/low current value set in par. 6-20 *Terminal 54 Low Voltage* and par. 6-22 *Terminal 54 Low Current*.

**6-25 Terminal 54 High Ref. / Feedb. Value****Range:**100.000 N/ [-999999.999 - 999999.999 N/A]  
A\***Function:**Enter the analog input scaling value that corresponds to the high voltage/high current value set in par. 6-21 *Terminal 54 High Voltage* and par. 6-23 *Terminal 54 High Current*.**6-50 Terminal 42 Output****Option:****Function:**

Select the function of Terminal 42 as an analog current output.

|       |                      |                                                                  |
|-------|----------------------|------------------------------------------------------------------|
| [0] * | No operation         |                                                                  |
| [100] | Output freq. 0-100   | : 0 - 100 Hz                                                     |
| [101] | Reference Min-Max    | : Minimum reference - Maximum reference                          |
| [102] | Feedback +-200%      | : -200% to +200% of par. 2-14                                    |
| [103] | Motor cur. 0-Imax    | : 0 - Inverter Max. Current (par. 16-37)                         |
| [104] | Torque 0-Tlim        | : 0 - Torque limit (par. 4-16)                                   |
| [105] | Torque 0-Tnom        | : 0 - Motor rated torque                                         |
| [106] | Power 0-Pnom         | : 0 - Motor rated power                                          |
| [107] | Speed 0-HighLim      | : 0 - Speed High Limit (par. 4-13 and par. 4-14)                 |
| [113] | Ext. Closed Loop 1   | 0 - 100%                                                         |
| [114] | Ext. Closed Loop 2   | 0 - 100%                                                         |
| [115] | Ext. Closed Loop 3   | 0 - 100%                                                         |
| [130] | Out frq 0-100 4-20mA | :0 - 100 Hz                                                      |
| [131] | Reference 4-20mA     | Minimum Reference - Maximum Reference                            |
| [132] | Feedback 4-20mA      | -200% to +200% of par. 2-14                                      |
| [133] | Motor cur. 4-20mA    | 0 - Inverter Max. Current (par. 16-37 <i>Inv. Max. Current</i> ) |
| [134] | Torq.0-lim 4-20 mA   | :0 - Torque limit (par. 4-16)                                    |
| [135] | Torq.0-nom 4-20mA    | :0 - Motor rated torque                                          |
| [136] | Power 4-20mA         | 0 - Motor rated power                                            |
| [137] | Speed 4-20mA         | 0 - Speed High Limit (par. 4-13 and par. 4-14)                   |
| [139] | Bus ctrl.            | 0 - 100%                                                         |
| [140] | Bus ctrl. 4-20 mA    | 0 - 100%                                                         |
| [141] | Bus ctrl t.o.        | 0 - 100%                                                         |
| [142] | Bus ctrl t.o. 4-20mA | 0 - 100%                                                         |
| [143] | Ext. CL 1 4-20mA     | 0 - 100%                                                         |
| [144] | Ext. CL 2 4-20mA     | 0 - 100%                                                         |
| [145] | Ext. CL 3 4-20mA     | 0 - 100%                                                         |

**NB!**

Values for setting the Minimum Reference is found in par. 3-02 *Minimum Reference* and par. 20-13 *Minimum Reference/Feedb.* - values for Maximum Reference is found in par. 3-03 *Maximum Reference* and par. 20-14 *Maximum Reference/Feedb.*.

6-51 Terminal 42 Output Min Scale

Range:

0.00 %\* [0.00 - 200.00 %]

Function:

Scale for the minimum output (0 or 4 mA) of the analogue signal at terminal 42.  
Set the value to be the **percentage** of the full range of the variable selected in par. 6-50 *Terminal 42 Output*.

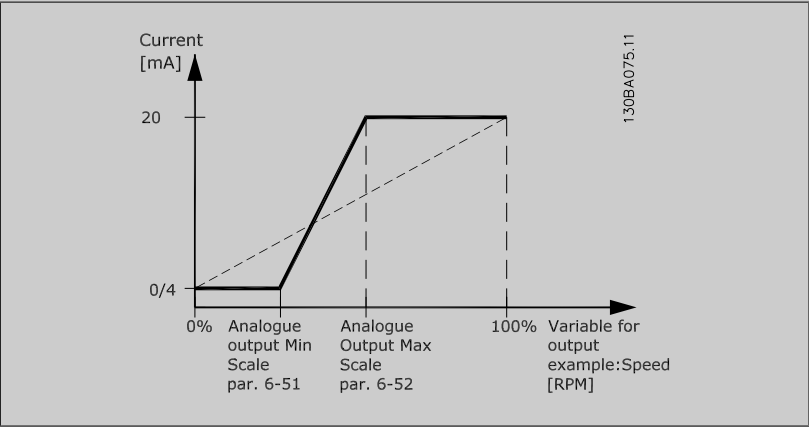
6-52 Terminal 42 Output Max Scale

Range:

100.00 %\* [0.00 - 200.00 %]

Function:

Scale for the maximum output (20 mA) of the analog signal at terminal 42.  
Set the value to be the percentage of the full range of the variable selected in par. 6-50 *Terminal 42 Output*.



It is possible to get a value lower than 20 mA at full scale by programming values >100% by using a formula as follows:

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

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

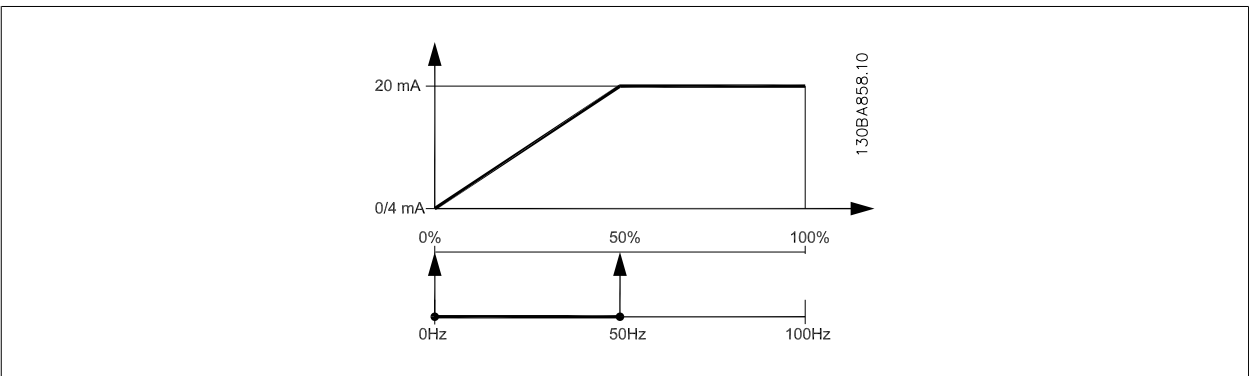
EXAMPLE 1:

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 par. 6-51 *Terminal 42 Output Min Scale* to 0%

Output signal 20 mA is needed at 50 Hz (50% of range) - set par. 6-52 *Terminal 42 Output Max Scale* to 50%



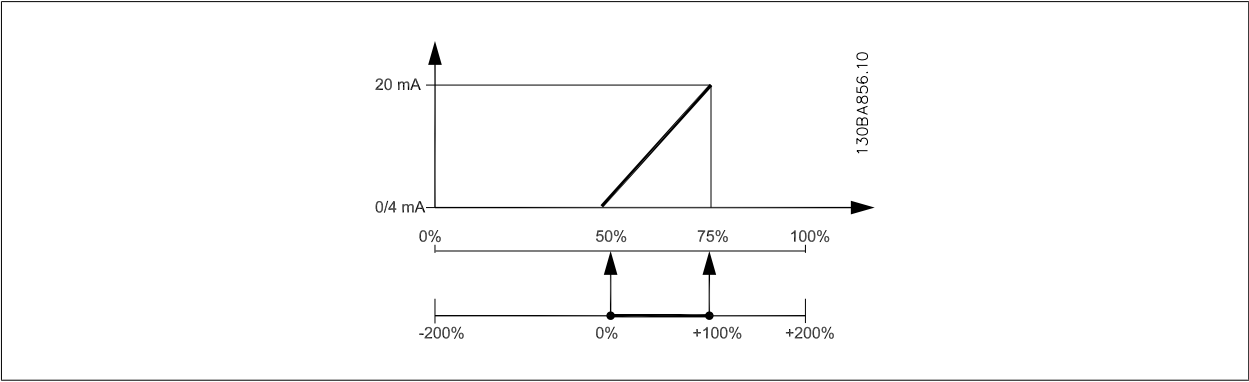
EXAMPLE 2:

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 par. 6-51 *Terminal 42 Output Min Scale* to 50%

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



EXAMPLE 3:

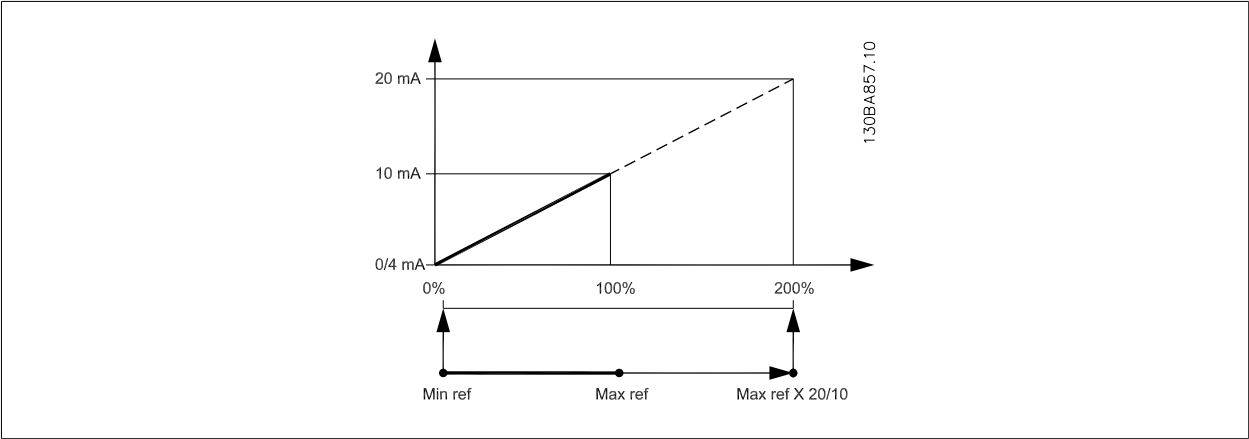
Variable value= REFERENCE, range= Min ref - Max ref

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 par. 6-51 *Terminal 42 Output Min Scale* to 0%

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

(20 mA / 10 mA x 100%=200%).



8

8.2.9. Drive Closed Loop, 20- \*\*

This parameter group is used for configuring the closed loop PID Controller, that controls the output frequency of the frequency converter.

20-12 Reference/Feedback Unit

Option:

Function:

[0] None

[1] \* %

[5] PPM

[10] 1/min

[11] RPM

[12] Pulse/s

[20] l/s

[21] l/min

[22] l/h

[23] m³/s

[24] m³/min

[25] m³/h

|       |                      |                                                                                                                                                                                           |
|-------|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| [30]  | kg/s                 |                                                                                                                                                                                           |
| [31]  | kg/min               |                                                                                                                                                                                           |
| [32]  | kg/h                 |                                                                                                                                                                                           |
| [33]  | t/min                |                                                                                                                                                                                           |
| [34]  | t/h                  |                                                                                                                                                                                           |
| [40]  | m/s                  |                                                                                                                                                                                           |
| [41]  | m/min                |                                                                                                                                                                                           |
| [45]  | m                    |                                                                                                                                                                                           |
| [60]  | °C                   |                                                                                                                                                                                           |
| [70]  | mbar                 |                                                                                                                                                                                           |
| [71]  | bar                  |                                                                                                                                                                                           |
| [72]  | Pa                   |                                                                                                                                                                                           |
| [73]  | kPa                  |                                                                                                                                                                                           |
| [74]  | m WG                 |                                                                                                                                                                                           |
| [75]  | mm Hg                |                                                                                                                                                                                           |
| [80]  | kW                   |                                                                                                                                                                                           |
| [120] | GPM                  |                                                                                                                                                                                           |
| [121] | gal/s                |                                                                                                                                                                                           |
| [122] | gal/min              |                                                                                                                                                                                           |
| [123] | gal/h                |                                                                                                                                                                                           |
| [124] | CFM                  |                                                                                                                                                                                           |
| [125] | ft <sup>3</sup> /s   |                                                                                                                                                                                           |
| [126] | ft <sup>3</sup> /min |                                                                                                                                                                                           |
| [127] | ft <sup>3</sup> /h   |                                                                                                                                                                                           |
| [130] | lb/s                 |                                                                                                                                                                                           |
| [131] | lb/min               |                                                                                                                                                                                           |
| [132] | lb/h                 |                                                                                                                                                                                           |
| [140] | ft/s                 |                                                                                                                                                                                           |
| [141] | ft/min               |                                                                                                                                                                                           |
| [145] | ft                   |                                                                                                                                                                                           |
| [160] | °F                   |                                                                                                                                                                                           |
| [170] | psi                  |                                                                                                                                                                                           |
| [171] | lb/in <sup>2</sup>   |                                                                                                                                                                                           |
| [172] | in WG                |                                                                                                                                                                                           |
| [173] | ft WG                |                                                                                                                                                                                           |
| [174] | in Hg                |                                                                                                                                                                                           |
| [180] | HP                   | This parameter determines the unit that is used for the setpoint reference and feedback that the PID Controller will use for controlling the output frequency of the frequency converter. |

### 20-21 Setpoint 1

**Range:**

0.000 Proc- [-999999.999 - 999999.999 Proc-  
essCtrlU- essCtrlUnit]  
nit\*

**Function:**

Setpoint 1 is used in Closed Loop Mode to enter a setpoint reference that is used by the frequency converter's PID Controller. See the description of par. 20-20 Feedback *Function*.



**NB!**

Setpoint reference entered here is added to any other references that are enabled (see par. group 3-1\*).

**20-81 PID Normal/ Inverse Control****Option:**

[0] \* Normal

[1] Inverse

**Function:**

*Normal* [0] causes the frequency converter'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.

*Inverse* [1] causes the frequency converter's output frequency to increase when the feedback is greater than the setpoint reference.

**20-82 PID Start Speed [RPM]****Range:**

0 RPM\* [0 - par. 4-13 RPM]

**Function:**

When the frequency converter 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 frequency converter 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.

**NB!**

This parameter will only be visible if par. 0-02 Motor *Speed Unit* is set to [0], RPM.

## 8

**20-93 PID Proportional Gain****Range:**

0.50 N/A\* [0.00 - 10.00 N/A]

**Function:**

When the difference between the feedback and the setpoint reference is less than the value of this parameter, the frequency converter's display will show "Run on Reference". This status can be communicated externally by programming the function of a digital output for *Run on Reference/No Warning* [8]. In addition, for serial communications, the On Reference status bit of the frequency converter's Status Word will be high (1).

The *On Reference Bandwidth* is calculated as a percentage of the setpoint reference.

**20-94 PID Integral Time****Range:**

20.00 s\* [0.01 - 10000.00 s]

**Function:**

The integrator adds over time (integrates) the error between the feedback and the setpoint reference. This is required to ensure that the error approaches zero. Quick frequency converter speed adjustment is obtained when this value is small. However, if too small of a value is used, the frequency converter's output frequency may become unstable.

**8.2.10. 22-\*\* Miscellaneous**

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

## 22-20 Low Power Auto Set-up

### Option:

### Function:

When set for *Enabled*, an auto set up sequence is activated, automatically setting speed to approx. 50 and 85% of rated motor speed (par. 4-13 *Motor Speed High Limit [RPM]*, par. 4-14 *Motor Speed High Limit [Hz]*). At those two speeds, the power consumption is automatically measured and stored. Before enabling Auto Set Up:

1. Close valve(s) in order to create a no flow condition
2. The frequency converter must be set for Open Loop (par. 1-00 *Configuration Mode*). Note that it is important also to set par. 1-03 *Torque Characteristics*.

[0] \* Off

[1] Enabled



#### NB!

Auto Set Up must be done when the system has reached normal operating temperature!



#### NB!

It is important that the par. 4-13 *Motor Speed High Limit [RPM]* or par. 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 par. 1-00 *Configuration Mode*.



#### NB!

Carry out the tuning with the same settings in par. 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 22-3\* 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 par. 4-11 *Motor Speed Low Limit [RPM]* or par. 4-12 *Motor Speed Low Limit [Hz]*.

## 22-23 No-Flow Function

### Option:

### Function:

Common actions for Low Power Detection and Low Speed Detection (Individual selections not possible).

[0] \* Off

[1] Sleep Mode

[2] Warning

Messages in the Local Control Panel display (if mounted) and/or signal via a relay or a digital output.

[3] Alarm

The frequency converter trips and motor stays stopped until reset.

**22-24 No-Flow Delay****Range:**

10 s\* [1 - 600 s]

**Function:**

Set the time Low Power/Low Speed must stay detected to activate signal for actions. If detection disappears before run out of the timer, the timer will be reset.

**22-26 Dry Pump Function****Option:****Function:**

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

[0] \* Off

[1] Warning

Messages in the Local Control Panel display (if mounted) and/or signal via a relay or a digital output.

[2] Alarm

The frequency converter trips and motor stays stopped until reset.

**22-27 Dry Pump Delay****Range:**

10 s\* [0 - 600 s]

**Function:**

Defines for how long the Dry Pump condition must be active before activating Warning or Alarm

**22-30 No-Flow Power****Range:**

0.00 kW\* [0.00 - 0.00 kW]

**Function:**

Read out of calculated No Flow power at actual speed. If power drops to the display value the frequency converter will consider the condition as a No Flow situation.

**22-31 Power Correction Factor****Range:**

100 %\* [1 - 400 %]

**Function:**

Make corrections to the calculated power at par. 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:**

0 RPM\* [0 - par. 22-36 RPM]

**Function:**

To be used if par. 0-02 Motor *Speed Unit* has been set for RPM (parameter not visible if Hz selected).  
Set used speed for the 50% level.  
This function is used for storing values needed to tune No Flow Detection.

**22-33 Low Speed [Hz]****Range:**

0 Hz\* [0.0 - par. 22-37 Hz]

**Function:**

To be used if par. 0-02 Motor *Speed Unit* has been set for Hz (parameter not visible if RPM selected).  
Set used speed for the 50% level.  
The function is used for storing values needed to tune No Flow Detection.

**22-34 Low Speed Power [kW]****Range:**

0 kW\* [0.00 - 0.00 kW]

**Function:**

To be used if par. 0-03 Regional *Settings* has been set for International (parameter not visible if North America selected).  
Set power consumption at 50% speed level.  
This function is used for storing values needed to tune No Flow Detection.

### 22-35 Low Speed Power [HP]

**Range:**

0 hp\* [0.00 - 0.00 hp]

**Function:**

To be used if par. 0-03 *Regional Settings* has been set for North America (parameter not visible if International selected).  
Set power consumption at 50% speed level.  
This function is used for storing values needed to tune No Flow Detection.

### 22-36 High Speed [RPM]

**Range:**

0 RPM\* [0 - par. 4-13 RPM]

**Function:**

To be used if par. 0-02 *Motor Speed Unit* 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:**

0.0 Hz\* [0.0 - par. 4-14 Hz]

**Function:**

To be used if par. 0-02 *Motor Speed Unit* has been set for Hz (parameter not visible if RPM selected).  
Set used speed for the 85% level.  
The function is used for storing values needed to tune No Flow Detection.

### 22-38 High Speed Power [kW]

**Range:**

0 kW\* [0.00 - 0.00 kW]

**Function:**

To be used if par. 0-03 *Regional Settings* has been set for International (parameter not visible if North America selected).  
Set power consumption at 85% speed level.  
This function is used for storing values needed to tune No Flow Detection.

### 22-39 High Speed Power [HP]

**Range:**

0 hp\* [0.00 - 0.00 hp]

**Function:**

To be used if par. 0-03 *Regional Settings* has been set for North America (parameter not visible if International selected).  
Set power consumption at 85% speed level.  
This function is used for storing values needed to tune No Flow Detection.

### 22-40 Minimum Run Time

**Range:**

10 s\* [0 - 600 s]

**Function:**

Set the desired minimum running time for the motor after a Start command (digital input or Bus) before entering Sleep Mode.

### 22-41 Minimum Sleep Time

**Range:**

10 s\* [0 - 600 s]

**Function:**

Set the desired minimum time for staying in Sleep Mode. This will override any wake up conditions.

### 22-42 Wake-up Speed [RPM]

**Range:**

0 RPM\* [par. 4-11 - par. 4-13 RPM]

**Function:**

To be used if par. 0-02 *Motor Speed Unit* has been set for RPM (parameter not visible if Hz selected).  
Only to be used if par. 1-00 *Configuration Mode* is set for Open Loop and speed reference is applied by an external controller.  
Set the reference speed at which the Sleep Mode should be cancelled.

**22-43 Wake-up Speed [Hz]****Range:**

0 Hz\* [par. 4-12 - par. 4-14 Hz]

**Function:**

To be used if par. 0-02 *Motor Speed Unit*, has been set for Hz (parameter not visible if RPM selected).  
Only to be used if par. 1-00 *Configuration Mode*, is set for Open Loop and speed reference is applied by an external controller controlling the pressure.  
Set the reference speed at which the Sleep Mode should be cancelled.

**22-44 Wake-up Ref./FB Difference****Range:**

10%\* [0-100%]

**Function:**

Only to be used if par. 1-00, *Configuration Mode*, is set for Closed Loop and the integrated PI controller is used for controlling the pressure.  
Set the pressure drop allowed in percentage of set point for the pressure (Pset) before cancelling the Sleep Mode.

**NB!**

If used in application where the integrated PI controller is set for inverse control in par. 20-71, *PID, Normal/Inverse Control*, the value set in par. 22-44 will automatically be added.

**22-45 Setpoint Boost****Range:**

0 %\* [-100 - 100 %]

**Function:**

Only to be used if par. 1-00 *Configuration Mode*, is set for Closed Loop and the integrated PI controller is used. In systems with e.g. constant pressure control, it is advantageous to increase the system pressure before the motor is stopped. This will extend the time in which the motor is stopped and help to avoid frequent start/stop.  
Set the desired over pressure/temperature in percentage of set point for the pressure (Pset)/temperature before entering the Sleep Mode.  
If setting for 5%, the boost pressure will be  $Pset \times 1.05$ . The negative values can be used for e.g. cooling tower control where a negative change is needed.

**22-46 Maximum Boost Time****Range:**

60 s\* [0 - 600 s]

**Function:**

Only to be used if par. 1-00 *Configuration Mode* 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, Sleep Mode will be entered, not waiting for the set boost pressure to be reached.

**22-50 End of Curve Function****Option:**

[0] \* Off

**Function:**

End of Curve monitoring not active.

[1] Warning

A warning is issued in the display [W94].

[2] Alarm

An alarm is issued and the frequency converter trips. A message [A94] appears in the display.

**NB!**

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

**22-51 End of Curve Delay****Range:**

10 s\* [0 - 600 s]

**Function:**

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 par. 22-50 *End of Curve Function* will be activated. If the condition disappears before the timer expires, the timer will be reset.

22-80 Flow Compensation

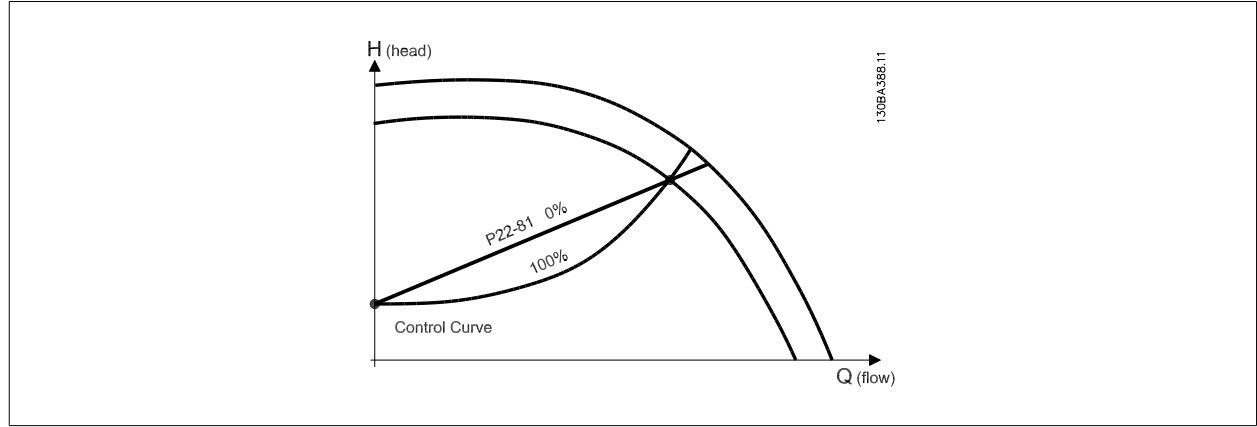
| Option:        | Function:                                                                                                                  |
|----------------|----------------------------------------------------------------------------------------------------------------------------|
| [0] * Disabled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

22-81 Square-linear Curve Approximation

| Range:             | Function:                                                                                                                                                  |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 100 %* [0 - 100 %] | <b>Example 1:</b><br>Adjustment of this parameter allows the shape of the control curve to be adjusted.<br>0 = Linear<br>100% = Ideal shape (theoretical). |



**NB!**  
Please note: Not visible when running in cascade.

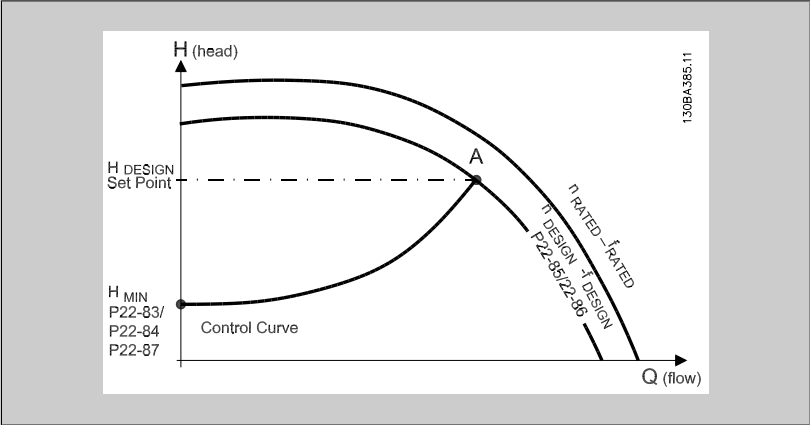


22-82 Work Point Calculation

Option:

Function:

Example 1: Speed at System Design Working Point is known:

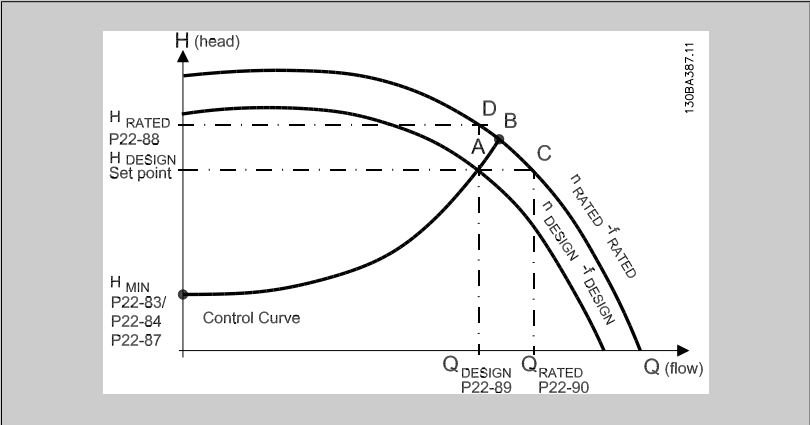


From the data sheet showing characteristics for the specific equipment at different speeds, simply reading across from the  $H_{\text{DESIGN}}$  point and the  $Q_{\text{DESIGN}}$  point allows us to find point A, which is the System Design Working Point. The pump characteristics at this point should be identified and the associated speed programmed. Closing the valves and adjusting the speed until  $H_{\text{MIN}}$  has been achieved allows the speed at the no flow point to be identified.

Adjustment of par. 22-81 *Square-linear Curve Approximation* then allows the shape of the control curve to be adjusted infinitely.

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 ( $H_{\text{DESIGN}}$ , Point C) the flow at that pressure  $Q_{\text{RATED}}$  can be determined. Similarly, by plotting the design flow ( $Q_{\text{DESIGN}}$ , Point D), the pressure  $H_D$  at that flow can be determined. Knowing these two points on the pump curve, along with  $H_{\text{MIN}}$  as described above, allows the frequency converter to calculate the reference point B and thus to plot the control curve which will also include the System design Working Point A.



[0] \* Disabled

Disabled [0]: Work Point Calculation not active. To be used if speed at design point is known (see table above).

[1] Enabled

Enabled [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 par. 22-83 *Speed at No-Flow [RPM]*, par. 22-84 *Speed at No-Flow [Hz]*, par. 22-87 *Pressure at No-Flow Speed*, par. 22-88 *Pressure at Rated Speed*, par. 22-89 *Flow at Design Point* and par. 22-90 *Flow at Rated Speed*.

### 22-84 Speed at No-Flow [Hz]

**Range:**

50.0 Hz\* [0.0 - par. 22-86 Hz]

**Function:**

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 par. 22-83 *Speed at No-Flow [RPM]*. If it has been decided to use Hz in par. 0-02 Motor *Speed Unit* then par. 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:**

1500. RPM\* [par. 22-83 - 60000. RPM]

**Function:**

Resolution 1 RPM.

Only visible when par. 22-82 *Work Point Calculation* is set to *Disable*. 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 par. 22-86 *Speed at Design Point [Hz]*. If it has been decided to use RPM in par. 0-02 Motor *Speed Unit* then par. 22-83 *Speed at No-Flow [RPM]* should also be used.

### 22-86 Speed at Design Point [Hz]

**Range:**

50/60.0 [par. 22-84 - par. 4-19 Hz]  
Hz\*

**Function:**

Resolution 0.033 Hz.

Only visible when par. 22-82 *Work Point Calculation* is set to *Disable*. 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 par. 22-85 *Speed at Design Point [RPM]*. If it has been decided to use Hz in par. 0-02 Motor *Speed Unit*, then par. 22-83 *Speed at No-Flow [RPM]* should also be used.

### 22-87 Pressure at No-Flow Speed

**Range:**

0.000 N/A\* [0.000 - par. 22-88 N/A]

**Function:**

Enter the pressure  $H_{MIN}$  corresponding to Speed at No Flow in Reference/Feedback Units.

### 22-88 Pressure at Rated Speed

**Range:**

999999.999 [par. 22-87 - 999999.999 N/A]  
N/A\*

**Function:**

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:**

300. RPM\* [0 - par. 22-85 RPM]

**Function:**

Resolution 1 RPM.

The speed of the motor at which flow is zero and minimum pressure  $H_{MIN}$  is achieved should be entered here in RPM. Alternatively, the speed in Hz can be entered in par. 22-84 *Speed at No-Flow [Hz]*. If it has been decided to use RPM in par. 0-02 Motor *Speed Unit* then par. 22-85 *Speed at Design Point [RPM]* should also be used. Closing the valves and reducing the speed until minimum pressure  $H_{MIN}$  is achieved will determine this value.

### 22-90 Flow at Rated Speed

**Range:**

0.000 N/A\* [0.000 - 999999.999 N/A]

**Function:**

Enter the value corresponding to Flow at Rated Speed. This value can be defined using the pump datasheet.

**8.2.11. Timed Actions, 23-0\***

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 frequency converter. The Timed Action number is selected from the list when entering parameter group 23-0\* from the Local Control Panel. par. 23-00 *ON Time* – par. 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.

**NB!**

The clock (parameter group 0-7\*) must be correctly programmed for Timed Actions to function correctly.

**NB!**

When mounting an Analog I/O MCB109 option card, a battery back up of the date and time is included.

**23-00 ON Time**

Array [10]

**Range:**

0 N/A\* [0 - 0 N/A]

**Function:**

Sets the ON time for the Timed Action.

**NB!**

The frequency converter has no back up of the clock function and the set date/time will reset to default (2000-01-01 00:00) after a power down unless a Real Time Clock module with back up is installed. In par. 0-79 Clock *Fault* it is possible to program for a Warning in case clock has not been set properly, e.g. after a power down.

**23-01 ON Action**

Arra [10]

**Option:****Function:**

Select the action during ON Time. See par. 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] | DC Brake               |
| [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:

0 N/A\* [0 - 0 N/A]

#### Function:

Sets the OFF time for the Timed Action.



#### NB!

The frequency converter has no back up of the clock function and the set date/time will reset to default (2000-01-01 00:00) after a power down unless a Real Time Clock module with back up is installed. In par. 0-79 Clock *Fault* it is possible to program for a Warning in case clock has not been set properly, e.g. after a power down.

### 23-03 OFF Action

Array [10]

#### Option:

#### Function:

Select the action during OFF Time. See par. 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] | DC Brake               |
| [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          |

## 23-04 Occurrence

Array [10]

### Option:

### Function:

Select which day(s) the Timed Action applies to. Specify working/non-working days in par. 0-81 *Working Days*, par. 0-82 Additional *Working Days* and par. 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           |

## 8.2.12. Water Application Functions, 29-\*\*

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

8

## 29-00 Pipe Fill Enable

### Option:

### Function:

|       |          |                                                          |
|-------|----------|----------------------------------------------------------|
| [0] * | Disabled | Select Enabled to fill pipes at a user specified rate.   |
| [1]   | Enabled  | Select Enabled to fill pipes with a user specified rate. |

## 29-01 Pipe Fill Speed [RPM]

### Range:

### Function:

Speed Low [Speed Low Limit - Speed High Limit\* it]

Set the filling speed for filling horizontal pipe systems. The speed can be selected in Hz or RPM depending on the choices made in par. 4-11 / par. 4-13 (RPM) or in par. 4-12 / par. 4-14 (Hz).

## 29-02 Pipe Fill Speed [Hz]

### Range:

### Function:

Motor [Speed Low Limit - Speed High Limit\* it]  
Speed Low it]  
Limit\*

Set the filling speed for filling horizontal pipe systems. The speed can be selected in Hz or RPM depending on the choices made in par. 4-11 / par. 4-13 (RPM) or in par. 4-12 / par. 4-14 (Hz).

## 29-03 Pipe Fill Time

### Range:

### Function:

0 s\* [0 - 3600 s]

Set the specified time for pipe filling of horizontal pipe systems.

## 29-04 Pipe Fill Rate

### Range:

### Function:

0.001 units/ s\* [0.001 – 999999.999 units/s]

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, no matter what, until the pipe fill-set-point set in par. 29-05 is reached.

29-05 Filled Setpoint

|                         |                                                                                                                                                                                                    |
|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Range:</b>           | <b>Function:</b>                                                                                                                                                                                   |
| 0 s* [0 – 999999,999 s] | Specifies the Filled Set-point 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. |

8.3. Parameter Options

8.3.1. Default settings

Changes during operation:  
"TRUE" means that the parameter can be changed while the frequency converter is in operation and "FALSE" means that the frequency converter 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': data value will be the same in all set-ups.

|              |                             |
|--------------|-----------------------------|
| <u>SR:</u>   | <u>N/A:</u>                 |
| Size related | No default value available. |

Conversion index:  
This number refers to a conversion figure used when writing or reading by means of a frequency converter.

|              |     |      |         |        |       |      |     |    |   |     |      |       |        |         |          |
|--------------|-----|------|---------|--------|-------|------|-----|----|---|-----|------|-------|--------|---------|----------|
| Conv. index  | 100 | 67   | 6       | 5      | 4     | 3    | 2   | 1  | 0 | -1  | -2   | -3    | -4     | -5      | -6       |
| Conv. factor | 1   | 1/60 | 1000000 | 100000 | 10000 | 1000 | 100 | 10 | 1 | 0.1 | 0.01 | 0.001 | 0.0001 | 0.00001 | 0.000001 |

| 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   |

### 8.3.2. Operation / Display 0-\*

| Par. No. #                     | Parameter description                | Default value            | 4-set-up    | FC 302 only | Change during operation | Conversion index | Type       |
|--------------------------------|--------------------------------------|--------------------------|-------------|-------------|-------------------------|------------------|------------|
| <b>0-0* Basic Settings</b>     |                                      |                          |             |             |                         |                  |            |
| 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      |
| <b>0-1* Set-up Operations</b>  |                                      |                          |             |             |                         |                  |            |
| 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      |
| <b>0-2* LCP Display</b>        |                                      |                          |             |             |                         |                  |            |
| 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     |
| <b>0-3* LCP Custom Readout</b> |                                      |                          |             |             |                         |                  |            |
| 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] |
| <b>0-4* LCP Keypad</b>         |                                      |                          |             |             |                         |                  |            |
| 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      |
| <b>0-5* Copy/Save</b>          |                                      |                          |             |             |                         |                  |            |
| 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      |
| <b>0-6* Password</b>           |                                      |                          |             |             |                         |                  |            |
| 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 | Conversion index | Type       |
|----------------------------|-----------------------------|-----------------|-------------|-------------------------|------------------|------------|
| <b>0-7* Clock Settings</b> |                             |                 |             |                         |                  |            |
| 0-70                       | Date and Time               | ExpressionLimit | All set-ups | TRUE                    | 0                | TimeOfDay  |
| 0-71                       | Date Format                 | [0] YYYY-MM-DD  | 1 set-up    | TRUE                    | -                | Unit8      |
| 0-72                       | Time Format                 | [0] 24 h        | 1 set-up    | TRUE                    | -                | Unit8      |
| 0-74                       | DST/Summertime              | [0] Off         | 1 set-up    | TRUE                    | -                | Unit8      |
| 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                    | -                | Unit8      |
| 0-81                       | Working Days                | null            | 1 set-up    | TRUE                    | -                | Unit8      |
| 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] |

## 8.3.3. Load / Motor 1-\*

| Par. No. #                      | Parameter description                | Default value             | 4-set-up    | Change during operation | Conversion index | Type   |
|---------------------------------|--------------------------------------|---------------------------|-------------|-------------------------|------------------|--------|
| <b>1-0* General Settings</b>    |                                      |                           |             |                         |                  |        |
| 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  |
| <b>1-1* Motor Selection</b>     |                                      |                           |             |                         |                  |        |
| 1-10                            | Motor Construction                   | [0] Asynchron             | All set-ups | FALSE                   | -                | Uint8  |
| <b>1-2* Motor Data</b>          |                                      |                           |             |                         |                  |        |
| 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  |
| <b>1-3* Adv. Motor Data</b>     |                                      |                           |             |                         |                  |        |
| 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  |
| <b>1-5* Load Indep. Setting</b> |                                      |                           |             |                         |                  |        |
| 1-50                            | Motor Magnetisation at Zero Speed    | 100 %                     | All set-ups | TRUE                    | 0                | Uint16 |
| 1-51                            | Min Speed Normal Magnetising [RPM]   | ExpressionLimit           | All set-ups | TRUE                    | 67               | Uint16 |
| 1-52                            | Min Speed Normal Magnetising [Hz]    | ExpressionLimit           | All set-ups | TRUE                    | -1               | Uint16 |
| <b>1-6* Load Depen. Setting</b> |                                      |                           |             |                         |                  |        |
| 1-60                            | Low Speed Load Compensation          | 100 %                     | All set-ups | TRUE                    | 0                | Int16  |
| 1-61                            | High Speed Load Compensation         | 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  |
| <b>1-7* Start Adjustments</b>   |                                      |                           |             |                         |                  |        |
| 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 |
| <b>1-8* Stop Adjustments</b>    |                                      |                           |             |                         |                  |        |
| 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 |
| <b>1-9* Motor Temperature</b>   |                                      |                           |             |                         |                  |        |
| 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  |

## 8.3.4. Brakes 2- \*\*

| Par. No. #                       | Parameter description       | Default value   | 4-set-up    | Change during operation | Conversion index | Type   |
|----------------------------------|-----------------------------|-----------------|-------------|-------------------------|------------------|--------|
| <b>2-0 * DC-Brake</b>            |                             |                 |             |                         |                  |        |
| 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 |
| <b>2-1 * Brake Energy Funct.</b> |                             |                 |             |                         |                  |        |
| 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                             | Brake Power Limit (kW)      | ExpressionLimit | All set-ups | TRUE                    | 0                | Uint32 |
| 2-13                             | Brake Power 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                             | Over-voltage Control        | [2] Enabled     | All set-ups | TRUE                    | -                | Uint8  |

### 8.3.5. Reference / Ramps 3-\*

| Par. No. #                    | Parameter description            | Default value             | 4-set-up    | Change during operation | Conversion index | Type  |
|-------------------------------|----------------------------------|---------------------------|-------------|-------------------------|------------------|-------|
| <b>3-0* Reference Limits</b>  |                                  |                           |             |                         |                  |       |
| 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 |
| <b>3-1* References</b>        |                                  |                           |             |                         |                  |       |
| 3-10                          | Preset Reference                 | 0.00 %                    | All set-ups | TRUE                    | -2               | Int16 |
| 3-11                          | Jog Speed [Hz]                   | ExpressionLimit           | All set-ups | TRUE                    | -1               | Int16 |
| 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               | Int16 |
| <b>3-4* Ramp 1</b>            |                                  |                           |             |                         |                  |       |
| 3-41                          | Ramp 1 Ramp Up Time              | ExpressionLimit           | All set-ups | TRUE                    | -2               | Int32 |
| 3-42                          | Ramp 1 Ramp Down Time            | ExpressionLimit           | All set-ups | TRUE                    | -2               | Int32 |
| <b>3-5* Ramp 2</b>            |                                  |                           |             |                         |                  |       |
| 3-51                          | Ramp 2 Ramp Up Time              | ExpressionLimit           | All set-ups | TRUE                    | -2               | Int32 |
| 3-52                          | Ramp 2 Ramp Down Time            | ExpressionLimit           | All set-ups | TRUE                    | -2               | Int32 |
| <b>3-8* Other Ramps</b>       |                                  |                           |             |                         |                  |       |
| 3-80                          | Jog Ramp Time                    | ExpressionLimit           | All set-ups | TRUE                    | -2               | Int32 |
| 3-81                          | Quick Stop Ramp Time             | ExpressionLimit           | 2 set-ups   | TRUE                    | -2               | Int32 |
| 3-84                          | Initial Ramp Time                | 0.00 s                    | All set-ups | TRUE                    | -2               | Int16 |
| 3-85                          | Check Valve Ramp Time            | 0.00 s                    | All set-ups | TRUE                    | -2               | Int16 |
| 3-86                          | Check Valve Ramp End Speed [RPM] | ExpressionLimit           | All set-ups | TRUE                    | 67               | Int16 |
| 3-87                          | Check Valve Ramp End Speed [Hz]  | ExpressionLimit           | All set-ups | TRUE                    | -1               | Int16 |
| 3-88                          | Final Ramp Time                  | 0.00 s                    | All set-ups | TRUE                    | -2               | Int16 |
| <b>3-9* Digital Pot.Meter</b> |                                  |                           |             |                         |                  |       |
| 3-90                          | Step Size                        | 0.10 %                    | All set-ups | TRUE                    | -2               | Int16 |
| 3-91                          | Ramp Time                        | 1.00 s                    | All set-ups | TRUE                    | -2               | Int32 |
| 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  |

**8.3.6. Limits / Warnings 4-\***

| Par. No. #                | Parameter description        | Default value                     | 4-set-up    | Change during operation | Conversion index | Type   |
|---------------------------|------------------------------|-----------------------------------|-------------|-------------------------|------------------|--------|
| <b>4-1* Motor Limits</b>  |                              |                                   |             |                         |                  |        |
| 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 |
| <b>4-5* Adj. Warnings</b> |                              |                                   |             |                         |                  |        |
| 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           | outputSpeedHighLimit (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 ReferenceFeedbackUnit | All set-ups | TRUE                    | -3               | Int32  |
| 4-57                      | Warning Feedback High        | 999999.999 ReferenceFeedbackUnit  | All set-ups | TRUE                    | -3               | Int32  |
| 4-58                      | Missing Motor Phase Function | [1] On                            | All set-ups | TRUE                    | -                | Uint8  |
| <b>4-6* Speed Bypass</b>  |                              |                                   |             |                         |                  |        |
| 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  |

### 8.3.7. Digital In/Out 5-\*

| Par. No. #                   | Parameter description                | Default value           | 4-set-up    | Change during operation | Conversion index | Type   |
|------------------------------|--------------------------------------|-------------------------|-------------|-------------------------|------------------|--------|
| <b>5-0* Digital I/O mode</b> |                                      |                         |             |                         |                  |        |
| 5-00                         | Digital I/O Mode                     | [0] PNP - Active at 24V | All set-ups | FALSE                   | -                | Unit8  |
| 5-01                         | Terminal 27 Mode                     | [0] Input               | All set-ups | TRUE                    | -                | Unit8  |
| 5-02                         | Terminal 29 Mode                     | [0] Input               | All set-ups | TRUE                    | -                | Unit8  |
| <b>5-1* Digital Inputs</b>   |                                      |                         |             |                         |                  |        |
| 5-10                         | Terminal 18 Digital Input            | [8] Start               | All set-ups | TRUE                    | -                | Unit8  |
| 5-11                         | Terminal 19 Digital Input            | [0] No operation        | All set-ups | TRUE                    | -                | Unit8  |
| 5-12                         | Terminal 27 Digital Input            | null                    | All set-ups | TRUE                    | -                | Unit8  |
| 5-13                         | Terminal 29 Digital Input            | [0] No operation        | All set-ups | TRUE                    | -                | Unit8  |
| 5-14                         | Terminal 32 Digital Input            | [0] No operation        | All set-ups | TRUE                    | -                | Unit8  |
| 5-15                         | Terminal 33 Digital Input            | [0] No operation        | All set-ups | TRUE                    | -                | Unit8  |
| 5-16                         | Terminal X30/2 Digital Input         | [0] No operation        | All set-ups | TRUE                    | -                | Unit8  |
| 5-17                         | Terminal X30/3 Digital Input         | [0] No operation        | All set-ups | TRUE                    | -                | Unit8  |
| 5-18                         | Terminal X30/4 Digital Input         | [0] No operation        | All set-ups | TRUE                    | -                | Unit8  |
| <b>5-3* Digital Outputs</b>  |                                      |                         |             |                         |                  |        |
| 5-30                         | Terminal 27 Digital Output           | [0] No operation        | All set-ups | TRUE                    | -                | Unit8  |
| 5-31                         | Terminal 29 Digital Output           | [0] No operation        | All set-ups | TRUE                    | -                | Unit8  |
| 5-32                         | Term X30/6 Digi Out (MCB 101)        | [0] No operation        | All set-ups | TRUE                    | -                | Unit8  |
| 5-33                         | Term X30/7 Digi Out (MCB 101)        | [0] No operation        | All set-ups | TRUE                    | -                | Unit8  |
| <b>5-4* Relays</b>           |                                      |                         |             |                         |                  |        |
| 5-40                         | Function Relay                       | null                    | All set-ups | TRUE                    | -                | Unit8  |
| 5-41                         | On Delay, Relay                      | 0.01 s                  | All set-ups | TRUE                    | -2               | Unit16 |
| 5-42                         | Off Delay, Relay                     | 0.01 s                  | All set-ups | TRUE                    | -2               | Unit16 |
| <b>5-5* Pulse Input</b>      |                                      |                         |             |                         |                  |        |
| 5-50                         | Term. 29 Low Frequency               | 100 Hz                  | All set-ups | TRUE                    | 0                | Unit32 |
| 5-51                         | Term. 29 High Frequency              | 100 Hz                  | All set-ups | TRUE                    | 0                | Unit32 |
| 5-52                         | Term. 29 Low Ref./Feedb. Value       | 0.000 N/A               | All set-ups | TRUE                    | -3               | Unit32 |
| 5-53                         | Term. 29 High Ref./Feedb. Value      | 100.000 N/A             | All set-ups | TRUE                    | -3               | Unit32 |
| 5-54                         | Pulse Filter Time Constant #29       | 100 ms                  | All set-ups | FALSE                   | -3               | Unit16 |
| 5-55                         | Term. 33 Low Frequency               | 100 Hz                  | All set-ups | TRUE                    | 0                | Unit32 |
| 5-56                         | Term. 33 High Frequency              | 100 Hz                  | All set-ups | TRUE                    | 0                | Unit32 |
| 5-57                         | Term. 33 Low Ref./Feedb. Value       | 0.000 N/A               | All set-ups | TRUE                    | -3               | Unit32 |
| 5-58                         | Term. 33 High Ref./Feedb. Value      | 100.000 N/A             | All set-ups | TRUE                    | -3               | Unit32 |
| 5-59                         | Pulse Filter Time Constant #33       | 100 ms                  | All set-ups | FALSE                   | -3               | Unit16 |
| <b>5-6* Pulse Output</b>     |                                      |                         |             |                         |                  |        |
| 5-60                         | Terminal 27 Pulse Output Variable    | [0] No operation        | All set-ups | TRUE                    | -                | Unit8  |
| 5-62                         | Pulse Output Max Freq #27            | 5000 Hz                 | All set-ups | TRUE                    | 0                | Unit32 |
| 5-63                         | Terminal 29 Pulse Output Variable    | [0] No operation        | All set-ups | TRUE                    | -                | Unit8  |
| 5-65                         | Pulse Output Max Freq #29            | 5000 Hz                 | All set-ups | TRUE                    | 0                | Unit32 |
| 5-66                         | Terminal X30/6 Pulse Output Variable | [0] No operation        | All set-ups | TRUE                    | -                | Unit8  |
| 5-68                         | Pulse Output Max Freq #X30/6         | 5000 Hz                 | All set-ups | TRUE                    | 0                | Unit32 |
| <b>5-9* Bus Controlled</b>   |                                      |                         |             |                         |                  |        |
| 5-90                         | Digital & Relay Bus Control          | 0 N/A                   | All set-ups | TRUE                    | 0                | Unit32 |
| 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               | Unit16 |
| 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               | Unit16 |
| 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               | Unit16 |

## 8.3.8. Analog In/Out 6-\*

| Par. No. #                      | Parameter description                | Default value            | 4-set-up    | Change during operation | Conversion index | Type   |
|---------------------------------|--------------------------------------|--------------------------|-------------|-------------------------|------------------|--------|
| <b>6-0* Analog I/O Mode</b>     |                                      |                          |             |                         |                  |        |
| 6-00                            | Live Zero Timeout Time               | 10 s                     | All set-ups | TRUE                    | 0                | Unit8  |
| 6-01                            | Live Zero Timeout Function           | [0] Off                  | All set-ups | TRUE                    | -                | Unit8  |
| <b>6-1* Analog Input 53</b>     |                                      |                          |             |                         |                  |        |
| 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               | Unit16 |
| 6-17                            | Terminal 53 Live Zero                | [1] Enabled              | All set-ups | TRUE                    | -                | Unit8  |
| <b>6-2* Analog Input 54</b>     |                                      |                          |             |                         |                  |        |
| 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               | Unit16 |
| 6-27                            | Terminal 54 Live Zero                | [1] Enabled              | All set-ups | TRUE                    | -                | Unit8  |
| <b>6-3* Analog Input X30/11</b> |                                      |                          |             |                         |                  |        |
| 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               | Unit16 |
| 6-37                            | Term. X30/11 Live Zero               | [1] Enabled              | All set-ups | TRUE                    | -                | Unit8  |
| <b>6-4* Analog Input X30/12</b> |                                      |                          |             |                         |                  |        |
| 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               | Unit16 |
| 6-47                            | Term. X30/12 Live Zero               | [1] Enabled              | All set-ups | TRUE                    | -                | Unit8  |
| <b>6-5* Analog Output 42</b>    |                                      |                          |             |                         |                  |        |
| 6-50                            | Terminal 42 Output                   | [100] Output freq. 0-100 | All set-ups | TRUE                    | -                | Unit8  |
| 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               | Unit16 |
| <b>6-6* Analog Output X30/8</b> |                                      |                          |             |                         |                  |        |
| 6-60                            | Terminal X30/8 Output                | [0] No operation         | All set-ups | TRUE                    | -                | Unit8  |
| 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               | Unit16 |

### 8.3.9. Comm. and Options 8-\*

| Par. No. #                      | Parameter description         | Default value           | 4-set-up    | Change during operation | Conversion index | Type       |
|---------------------------------|-------------------------------|-------------------------|-------------|-------------------------|------------------|------------|
| <b>8-0* General Settings</b>    |                               |                         |             |                         |                  |            |
| 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      |
| <b>8-1* Control Settings</b>    |                               |                         |             |                         |                  |            |
| 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      |
| <b>8-3* FC Port Settings</b>    |                               |                         |             |                         |                  |            |
| 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     |
| <b>8-4* FC MC protocol set</b>  |                               |                         |             |                         |                  |            |
| 8-40                            | Telegram Selection            | [1] Standard telegram 1 | 2 set-ups   | TRUE                    | -                | Uint8      |
| <b>8-5* Digital/Bus</b>         |                               |                         |             |                         |                  |            |
| 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      |
| <b>8-7* BACnet</b>              |                               |                         |             |                         |                  |            |
| 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                            | Initialisation Password       | ExpressionLimit         | 1 set-up    | TRUE                    | 0                | VisStr[20] |
| <b>8-8* FC Port Diagnostics</b> |                               |                         |             |                         |                  |            |
| 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     |
| <b>8-9* Bus Jog / Feedback</b>  |                               |                         |             |                         |                  |            |
| 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         |

**8.3.10. Profibus 9-\***

| Par. No. # | Parameter description     | Default value            | 4-set-up    | Change during operation | Conversion 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       | Telegram 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       | Fault 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       | Fault Situation Counter   | 0 N/A                    | All set-ups | TRUE                    | 0                | Uint16    |
| 9-53       | Profibus Warning Word     | 0 N/A                    | All set-ups | TRUE                    | 0                | Uint16    |
| 9-63       | Actual Baud Rate          | 0 N/A                    | All set-ups | TRUE                    | 0                | V2        |
| 9-64       | Device Identification     | [255] No baudrate found  | All set-ups | TRUE                    | -                | Uint8     |
| 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    |

### 8.3.11. CAN Fieldbus 10-\*

| Par. No. #                    | Parameter description          | Default value   | 4-set-up    | Change during operation | Conversion index | Type   |
|-------------------------------|--------------------------------|-----------------|-------------|-------------------------|------------------|--------|
| <b>10-0* Common Settings</b>  |                                |                 |             |                         |                  |        |
| 10-00                         | CAN Protocol                   | null            | 2 set-ups   | FALSE                   | -                | Unit8  |
| 10-01                         | Baud Rate Select               | null            | 2 set-ups   | TRUE                    | -                | Unit8  |
| 10-02                         | MAC ID                         | ExpressionLimit | 2 set-ups   | TRUE                    | 0                | Unit8  |
| 10-05                         | Readout Transmit Error Counter | 0 N/A           | All set-ups | TRUE                    | 0                | Unit8  |
| 10-06                         | Readout Receive Error Counter  | 0 N/A           | All set-ups | TRUE                    | 0                | Unit8  |
| 10-07                         | Readout Bus Off Counter        | 0 N/A           | All set-ups | TRUE                    | 0                | Unit8  |
| <b>10-1* DeviceNet</b>        |                                |                 |             |                         |                  |        |
| 10-10                         | Process Data Type Selection    | null            | All set-ups | TRUE                    | -                | Unit8  |
| 10-11                         | Process Data Config Write      | ExpressionLimit | 2 set-ups   | TRUE                    | -                | Unit16 |
| 10-12                         | Process Data Config Read       | ExpressionLimit | 2 set-ups   | TRUE                    | -                | Unit16 |
| 10-13                         | Warning Parameter              | 0 N/A           | All set-ups | TRUE                    | 0                | Unit16 |
| 10-14                         | Net Reference                  | [0] Off         | 2 set-ups   | TRUE                    | -                | Unit8  |
| 10-15                         | Net Control                    | [0] Off         | 2 set-ups   | TRUE                    | -                | Unit8  |
| <b>10-2* COS Filters</b>      |                                |                 |             |                         |                  |        |
| 10-20                         | COS Filter 1                   | 0 N/A           | All set-ups | FALSE                   | 0                | Unit16 |
| 10-21                         | COS Filter 2                   | 0 N/A           | All set-ups | FALSE                   | 0                | Unit16 |
| 10-22                         | COS Filter 3                   | 0 N/A           | All set-ups | FALSE                   | 0                | Unit16 |
| 10-23                         | COS Filter 4                   | 0 N/A           | All set-ups | FALSE                   | 0                | Unit16 |
| <b>10-3* Parameter Access</b> |                                |                 |             |                         |                  |        |
| 10-30                         | Array Index                    | 0 N/A           | 2 set-ups   | TRUE                    | 0                | Unit8  |
| 10-31                         | Store Data Values              | [0] Off         | All set-ups | TRUE                    | -                | Unit8  |
| 10-32                         | DeviceNet Revision             | ExpressionLimit | All set-ups | TRUE                    | 0                | Unit16 |
| 10-33                         | Store Always                   | [0] Off         | 1 set-up    | TRUE                    | -                | Unit8  |
| 10-34                         | DeviceNet Product Code         | 130 N/A         | 1 set-up    | TRUE                    | 0                | Unit16 |
| 10-39                         | DeviceNet F Parameters         | 0 N/A           | All set-ups | TRUE                    | 0                | Unit32 |

## 8.3.12. Smart Logic 13-\*

| Par. No. #                | Parameter description | Default value        | 4-set-up    | Change during operation | Conversion index | Type  |
|---------------------------|-----------------------|----------------------|-------------|-------------------------|------------------|-------|
| <b>13-0* SLC Settings</b> |                       |                      |             |                         |                  |       |
| 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 |
| <b>13-1* Comparators</b>  |                       |                      |             |                         |                  |       |
| 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 |
| <b>13-2* Timers</b>       |                       |                      |             |                         |                  |       |
| 13-20                     | SL Controller Timer   | ExpressionLimit      | 1 set-up    | TRUE                    | -3               | TimD  |
| <b>13-4* Logic Rules</b>  |                       |                      |             |                         |                  |       |
| 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 |
| <b>13-5* States</b>       |                       |                      |             |                         |                  |       |
| 13-51                     | SL Controller Event   | null                 | 2 set-ups   | TRUE                    | -                | UInt8 |
| 13-52                     | SL Controller Action  | null                 | 2 set-ups   | TRUE                    | -                | UInt8 |

### 8.3.13. Special Functions 14-\*

| Par. No. #                       | Parameter description               | Default value             | 4-set-up    | Change during operation | Conversion index | Type   |
|----------------------------------|-------------------------------------|---------------------------|-------------|-------------------------|------------------|--------|
| <b>14-0* Inverter Switching</b>  |                                     |                           |             |                         |                  |        |
| 14-00                            | Switching Pattern                   | null                      | All set-ups | TRUE                    | -                | Unit8  |
| 14-01                            | Switching Frequency                 | null                      | All set-ups | TRUE                    | -                | Unit8  |
| 14-03                            | Overmodulation                      | [1] On                    | All set-ups | FALSE                   | -                | Unit8  |
| 14-04                            | PWM Random                          | [0] Off                   | All set-ups | TRUE                    | -                | Unit8  |
| <b>14-1* Mains On/Off</b>        |                                     |                           |             |                         |                  |        |
| 14-10                            | Mains Failure                       | [0] No function           | All set-ups | FALSE                   | -                | Unit8  |
| 14-11                            | Mains Voltage at Mains Fault        | ExpressionLimit           | All set-ups | TRUE                    | 0                | Unit16 |
| 14-12                            | Function at Mains Imbalance         | [3] Derate                | All set-ups | TRUE                    | -                | Unit8  |
| <b>14-2* Reset Functions</b>     |                                     |                           |             |                         |                  |        |
| 14-20                            | Reset Mode                          | [10] Automatic reset x 10 | All set-ups | TRUE                    | -                | Unit8  |
| 14-21                            | Automatic Restart Time              | 10 s                      | All set-ups | TRUE                    | 0                | Unit16 |
| 14-22                            | Operation Mode                      | [0] Normal operation      | All set-ups | TRUE                    | -                | Unit8  |
| 14-23                            | Typecode Setting                    | null                      | 2 set-ups   | FALSE                   | -                | Unit8  |
| 14-25                            | Trip Delay at Torque Limit          | 60 s                      | All set-ups | TRUE                    | 0                | Unit8  |
| 14-26                            | Trip Delay at Inverter Fault        | ExpressionLimit           | All set-ups | TRUE                    | 0                | Unit8  |
| 14-28                            | Production Settings                 | [0] No action             | All set-ups | TRUE                    | -                | Unit8  |
| 14-29                            | Service Code                        | 0 N/A                     | All set-ups | TRUE                    | 0                | Int32  |
| <b>14-3* Current Limit Ctrl.</b> |                                     |                           |             |                         |                  |        |
| 14-30                            | Current Lim Ctrl. Proportional Gain | 100 %                     | All set-ups | FALSE                   | 0                | Unit16 |
| 14-31                            | Current Lim Ctrl. Integration Time  | 0.020 s                   | All set-ups | FALSE                   | -3               | Unit16 |
| <b>14-4* Energy Optimising</b>   |                                     |                           |             |                         |                  |        |
| 14-40                            | VT Level                            | 66 %                      | All set-ups | FALSE                   | 0                | Unit8  |
| 14-41                            | AEO Minimum Magnetisation           | ExpressionLimit           | All set-ups | TRUE                    | 0                | Unit8  |
| 14-42                            | Minimum AEO Frequency               | 10 Hz                     | All set-ups | TRUE                    | 0                | Unit8  |
| 14-43                            | Motor Cosphi                        | ExpressionLimit           | All set-ups | TRUE                    | -2               | Unit16 |
| <b>14-5* Environment</b>         |                                     |                           |             |                         |                  |        |
| 14-50                            | RFI Filter                          | [1] On                    | 1 set-up    | FALSE                   | -                | Unit8  |
| 14-52                            | Fan Control                         | [0] Auto                  | All set-ups | TRUE                    | -                | Unit8  |
| 14-53                            | Fan Monitor                         | [1] Warning               | All set-ups | TRUE                    | -                | Unit8  |
| 14-55                            | Output Filter                       | [0] No Filter             | 1 set-up    | FALSE                   | -                | Unit8  |
| 14-59                            | Actual Number of Inverter Units     | ExpressionLimit           | 1 set-up    | FALSE                   | 0                | Unit8  |
| <b>14-6* Auto Derate</b>         |                                     |                           |             |                         |                  |        |
| 14-60                            | Function at Over Temperature        | [1] Derate                | All set-ups | TRUE                    | -                | Unit8  |
| 14-61                            | Function at Inverter Overload       | [1] Derate                | All set-ups | TRUE                    | -                | Unit8  |
| 14-62                            | Inv. Overload Derate Current        | 95 %                      | All set-ups | TRUE                    | 0                | Unit16 |
| <b>14-8* Options</b>             |                                     |                           |             |                         |                  |        |
| 14-80                            | Option Supplied by External 24VDC   | [0] No                    | 2 set-ups   | FALSE                   | -                | Unit8  |

## 8.3.14. FC Information 15-\*\*

| Par. No. #                        | Parameter description             | Default value         | 4-set-up    | Change during operation | Conversion index | Type       |
|-----------------------------------|-----------------------------------|-----------------------|-------------|-------------------------|------------------|------------|
| <b>15-0* Operating Data</b>       |                                   |                       |             |                         |                  |            |
| 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 Up's                        | 0 N/A                 | All set-ups | FALSE                   | 0                | Uint32     |
| 15-04                             | Over Temp's                       | 0 N/A                 | All set-ups | FALSE                   | 0                | Uint16     |
| 15-05                             | Over Volt's                       | 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     |
| <b>15-1* Data Log Settings</b>    |                                   |                       |             |                         |                  |            |
| 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      |
| <b>15-2* Historic Log</b>         |                                   |                       |             |                         |                  |            |
| 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  |
| <b>15-3* Alarm Log</b>            |                                   |                       |             |                         |                  |            |
| 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      |
| <b>15-4* Drive Identification</b> |                                   |                       |             |                         |                  |            |
| 15-40                             | FC 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                             | Frequency Converter 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                             | Frequency Converter 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       |
|-----------------------------|---------------------------|---------------|-------------|-------------------------|------------------|------------|
| <b>15-6* Option Ident</b>   |                           |               |             |                         |                  |            |
| 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] |
| <b>15-9* Parameter Info</b> |                           |               |             |                         |                  |            |
| 15-92                       | Defined Parameters        | 0 N/A         | All set-ups | FALSE                   | 0                | Unit16     |
| 15-93                       | Modified Parameters       | 0 N/A         | All set-ups | FALSE                   | 0                | Unit16     |
| 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                | Unit16     |

## 8.3.15. Data Readouts 16-\*

| Par. No. #                     | Parameter description | Default value               | 4-set-up    | Change during operation | Conversion index | Type  |
|--------------------------------|-----------------------|-----------------------------|-------------|-------------------------|------------------|-------|
| <b>16-0* General Status</b>    |                       |                             |             |                         |                  |       |
| 16-00                          | Control Word          | 0 N/A                       | All set-ups | TRUE                    | 0                | V2    |
| 16-01                          | Reference [Unit]      | 0.000 ReferenceFeedbackUnit | 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 CustomReadoutUnit      | All set-ups | TRUE                    | -2               | Int32 |
| <b>16-1* Motor Status</b>      |                       |                             |             |                         |                  |       |
| 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               | Int16 |
| 16-13                          | Frequency             | 0.0 Hz                      | All set-ups | TRUE                    | -1               | Int16 |
| 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                | Int8  |
| 16-22                          | Torque [%]            | 0 %                         | All set-ups | TRUE                    | 0                | Int16 |
| <b>16-3* Drive Status</b>      |                       |                             |             |                         |                  |       |
| 16-30                          | DC Link Voltage       | 0 V                         | All set-ups | TRUE                    | 0                | Int16 |
| 16-32                          | Brake Energy /s       | 0.000 kW                    | All set-ups | TRUE                    | 0                | Int32 |
| 16-33                          | Brake Energy /2 min   | 0.000 kW                    | All set-ups | TRUE                    | 0                | Int32 |
| 16-34                          | Heatsink Temp.        | 0 °C                        | All set-ups | TRUE                    | 100              | Int8  |
| 16-35                          | Inverter Thermal      | 0 %                         | All set-ups | TRUE                    | 0                | Int8  |
| 16-36                          | Inv. Nom. Current     | ExpressionLimit             | All set-ups | TRUE                    | -2               | Int32 |
| 16-37                          | Inv. Max. Current     | ExpressionLimit             | All set-ups | TRUE                    | -2               | Int32 |
| 16-38                          | SL Controller State   | 0 N/A                       | All set-ups | TRUE                    | 0                | Int8  |
| 16-39                          | Control Card Temp.    | 0 °C                        | All set-ups | TRUE                    | 100              | Int8  |
| 16-40                          | Logging Buffer Full   | [0] No                      | All set-ups | TRUE                    | -                | Int8  |
| <b>16-5* Ref. &amp; Feedb.</b> |                       |                             |             |                         |                  |       |
| 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 | Conversion index | Type   |
|-------------------------------------|----------------------------|---------------|-------------|-------------------------|------------------|--------|
| <b>16-6* Inputs &amp; Outputs</b>   |                            |               |             |                         |                  |        |
| 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  |
| <b>16-8* Fieldbus &amp; FC Port</b> |                            |               |             |                         |                  |        |
| 16-80                               | Fieldbus CTW 1             | 0 N/A         | All set-ups | TRUE                    | 0                | V2     |
| 16-82                               | Fieldbus 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                               | FC Port CTW 1              | 0 N/A         | All set-ups | TRUE                    | 0                | V2     |
| 16-86                               | FC Port REF 1              | 0 N/A         | All set-ups | TRUE                    | 0                | N2     |
| <b>16-9* Diagnosis Readouts</b>     |                            |               |             |                         |                  |        |
| 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 |

## 8.3.16. Data Readouts 2 18- \*\*

| Par. No. #                        | Parameter description          | Default value   | 4-set-up    | Change during operation | Conversion index | Type      |
|-----------------------------------|--------------------------------|-----------------|-------------|-------------------------|------------------|-----------|
| <b>18-0* Maintenance Log</b>      |                                |                 |             |                         |                  |           |
| 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 |
| <b>18-3* Inputs &amp; Outputs</b> |                                |                 |             |                         |                  |           |
| 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     |

### 8.3.17. FC Closed Loop 20-\*

| Par. No. #                      | Parameter description       | Default value               | 4-set-up    | Change during operation | Conversion index | Type   |
|---------------------------------|-----------------------------|-----------------------------|-------------|-------------------------|------------------|--------|
| <b>20-0* Feedback</b>           |                             |                             |             |                         |                  |        |
| 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  |
| <b>20-2* Feedback/Setpoint</b>  |                             |                             |             |                         |                  |        |
| 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  |
| <b>20-7* PID Autotuning</b>     |                             |                             |             |                         |                  |        |
| 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 Autotuning              | [0] Disabled                | All set-ups | TRUE                    | -                | UInt8  |
| <b>20-8* PID Basic Settings</b> |                             |                             |             |                         |                  |        |
| 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  |
| <b>20-9* PID Controller</b>     |                             |                             |             |                         |                  |        |
| 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               | Int32  |
| 20-95                           | PID Differentiation Time    | 0.00 s                      | All set-ups | TRUE                    | -2               | Int32  |
| 20-96                           | PID Diff. Gain Limit        | 5.0 N/A                     | All set-ups | TRUE                    | -1               | UInt16 |

**8.3.18. Ext. Closed Loop 21-\***

| Par. No. #                      | Parameter description         | Default value       | 4-set-up    | Change during operation | Conversion index | Type   |
|---------------------------------|-------------------------------|---------------------|-------------|-------------------------|------------------|--------|
| <b>21-0* Ext. CL Autotuning</b> |                               |                     |             |                         |                  |        |
| 21-00                           | Closed Loop Type              | [0] Auto            | 2 set-ups   | TRUE                    | -                | Unit8  |
| 21-01                           | PID Performance               | [0] Normal          | 2 set-ups   | TRUE                    | -                | Unit8  |
| 21-02                           | PID Output Change             | 0.10 N/A            | 2 set-ups   | TRUE                    | -2               | Unit16 |
| 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                    | -                | Unit8  |
| <b>21-1* Ext. CL 1 Ref./Fb.</b> |                               |                     |             |                         |                  |        |
| 21-10                           | Ext. 1 Ref./Feedback Unit     | [0]                 | All set-ups | TRUE                    | -                | Unit8  |
| 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                    | -                | Unit8  |
| 21-14                           | Ext. 1 Feedback Source        | [0] No function     | All set-ups | TRUE                    | -                | Unit8  |
| 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  |
| <b>21-2* Ext. CL 1 PID</b>      |                               |                     |             |                         |                  |        |
| 21-20                           | Ext. 1 Normal/Inverse Control | [0] Normal          | All set-ups | TRUE                    | -                | Unit8  |
| 21-21                           | Ext. 1 Proportional Gain      | 0.50 N/A            | All set-ups | TRUE                    | -2               | Unit16 |
| 21-22                           | Ext. 1 Integral Time          | 20.00 s             | All set-ups | TRUE                    | -2               | Unit32 |
| 21-23                           | Ext. 1 Differentiation Time   | 0.00 s              | All set-ups | TRUE                    | -2               | Unit16 |
| 21-24                           | Ext. 1 Dif. Gain Limit        | 5.0 N/A             | All set-ups | TRUE                    | -1               | Unit16 |
| <b>21-3* Ext. CL 2 Ref./Fb.</b> |                               |                     |             |                         |                  |        |
| 21-30                           | Ext. 2 Ref./Feedback Unit     | [0]                 | All set-ups | TRUE                    | -                | Unit8  |
| 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                    | -                | Unit8  |
| 21-34                           | Ext. 2 Feedback Source        | [0] No function     | All set-ups | TRUE                    | -                | Unit8  |
| 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  |
| <b>21-4* Ext. CL 2 PID</b>      |                               |                     |             |                         |                  |        |
| 21-40                           | Ext. 2 Normal/Inverse Control | [0] Normal          | All set-ups | TRUE                    | -                | Unit8  |
| 21-41                           | Ext. 2 Proportional Gain      | 0.50 N/A            | All set-ups | TRUE                    | -2               | Unit16 |
| 21-42                           | Ext. 2 Integral Time          | 20.00 s             | All set-ups | TRUE                    | -2               | Unit32 |
| 21-43                           | Ext. 2 Differentiation Time   | 0.00 s              | All set-ups | TRUE                    | -2               | Unit16 |
| 21-44                           | Ext. 2 Dif. Gain Limit        | 5.0 N/A             | All set-ups | TRUE                    | -1               | Unit16 |

| Par. No. #                      | Parameter description         | Default value       | 4-set-up    | Change during operation | Conversion index | Type   |
|---------------------------------|-------------------------------|---------------------|-------------|-------------------------|------------------|--------|
| <b>21-5* Ext. CL 3 Ref./Fb.</b> |                               |                     |             |                         |                  |        |
| 21-50                           | Ext. 3 Ref./Feedback Unit     | [0]                 | All set-ups | TRUE                    | -                | Unit8  |
| 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                    | -                | Unit8  |
| 21-54                           | Ext. 3 Feedback Source        | [0] No function     | All set-ups | TRUE                    | -                | Unit8  |
| 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  |
| <b>21-6* Ext. CL 3 PID</b>      |                               |                     |             |                         |                  |        |
| 21-60                           | Ext. 3 Normal/Inverse Control | [0] Normal          | All set-ups | TRUE                    | -                | Unit8  |
| 21-61                           | Ext. 3 Proportional Gain      | 0.50 N/A            | All set-ups | TRUE                    | -2               | Unit16 |
| 21-62                           | Ext. 3 Integral Time          | 20.00 s             | All set-ups | TRUE                    | -2               | Unit32 |
| 21-63                           | Ext. 3 Differentiation Time   | 0.00 s              | All set-ups | TRUE                    | -2               | Unit16 |
| 21-64                           | Ext. 3 Dif. Gain Limit        | 5.0 N/A             | All set-ups | TRUE                    | -1               | Unit16 |

## 8.3.19. Application Functions 22- \* \*

| Par. No. #                          | Parameter description      | Default value                      | 4-set-up    | Change during operation | Conversion index | Type   |
|-------------------------------------|----------------------------|------------------------------------|-------------|-------------------------|------------------|--------|
| <b>22-0* Miscellaneous</b>          |                            |                                    |             |                         |                  |        |
| 22-00                               | External Interlock Delay   | 0 s                                | All set-ups | TRUE                    | 0                | Uint16 |
| <b>22-2* No-Flow Detection</b>      |                            |                                    |             |                         |                  |        |
| 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 |
| <b>22-3* No-Flow Power Tuning</b>   |                            |                                    |             |                         |                  |        |
| 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 |
| <b>22-4* Sleep Mode</b>             |                            |                                    |             |                         |                  |        |
| 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 |
| <b>22-5* End of Curve</b>           |                            |                                    |             |                         |                  |        |
| 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 |
| <b>22-6* Broken Belt Detection</b>  |                            |                                    |             |                         |                  |        |
| 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 |
| <b>22-7* Short Cycle Protection</b> |                            |                                    |             |                         |                  |        |
| 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 | Conversion index | Type   |
|---------------------------------|-----------------------------------|-----------------|-------------|-------------------------|------------------|--------|
| <b>22-8 * Flow Compensation</b> |                                   |                 |             |                         |                  |        |
| 22-80                           | Flow Compensation                 | [0] Disabled    | All set-ups | TRUE                    | -                | Unit8  |
| 22-81                           | Square-linear Curve Approximation | 100 %           | All set-ups | TRUE                    | 0                | Unit8  |
| 22-82                           | Work Point Calculation            | [0] Disabled    | All set-ups | TRUE                    | -                | Unit8  |
| 22-83                           | Speed at No-Flow [RPM]            | ExpressionLimit | All set-ups | TRUE                    | 67               | Unit16 |
| 22-84                           | Speed at No-Flow [Hz]             | ExpressionLimit | All set-ups | TRUE                    | -1               | Unit16 |
| 22-85                           | Speed at Design Point [RPM]       | ExpressionLimit | All set-ups | TRUE                    | 67               | Unit16 |
| 22-86                           | Speed at Design Point [Hz]        | ExpressionLimit | All set-ups | TRUE                    | -1               | Unit16 |
| 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  |

## 8.3.20. Timed Actions 23.-\*\*

| Par. No. #                     | Parameter description     | Default value      | 4-set-up    | Change during operation | Conversion index | Type                          |
|--------------------------------|---------------------------|--------------------|-------------|-------------------------|------------------|-------------------------------|
| <b>23-0* Timed Actions</b>     |                           |                    |             |                         |                  |                               |
| 23-00                          | ON Time                   | ExpressionLimit    | 2 set-ups   | TRUE                    | 0                | TimeOfDay-<br>WoDate<br>Unit8 |
| 23-01                          | ON Action                 | [0] Disabled       | 2 set-ups   | TRUE                    | -                | Unit8                         |
| 23-02                          | OFF Time                  | ExpressionLimit    | 2 set-ups   | TRUE                    | 0                | TimeOfDay-<br>WoDate<br>Unit8 |
| 23-03                          | OFF Action                | [0] Disabled       | 2 set-ups   | TRUE                    | -                | Unit8                         |
| 23-04                          | Occurrence                | [0] All days       | 2 set-ups   | TRUE                    | -                | Unit8                         |
| <b>23-1* Maintenance</b>       |                           |                    |             |                         |                  |                               |
| 23-10                          | Maintenance Item          | [1] Motor bearings | 1 set-up    | TRUE                    | -                | Unit8                         |
| 23-11                          | Maintenance Action        | [1] Lubricate      | 1 set-up    | TRUE                    | -                | Unit8                         |
| 23-12                          | Maintenance Time Base     | [0] Disabled       | 1 set-up    | TRUE                    | -                | Unit8                         |
| 23-13                          | Maintenance Time Interval | 1 h                | 1 set-up    | TRUE                    | 74               | Unit32                        |
| 23-14                          | Maintenance Date and Time | ExpressionLimit    | 1 set-up    | TRUE                    | 0                | TimeOfDay                     |
| <b>23-1* Maintenance Reset</b> |                           |                    |             |                         |                  |                               |
| 23-15                          | Reset Maintenance Word    | [0] Do not reset   | All set-ups | TRUE                    | -                | Unit8                         |
| 23-16                          | Maintenance Text          | 0 N/A              | 1 set-up    | TRUE                    | 0                | VisStr[20]                    |
| <b>23-5* Energy Log</b>        |                           |                    |             |                         |                  |                               |
| 23-50                          | Energy Log Resolution     | [5] Last 24 Hours  | 2 set-ups   | TRUE                    | -                | Unit8                         |
| 23-51                          | Period Start              | ExpressionLimit    | 2 set-ups   | TRUE                    | 0                | TimeOfDay                     |
| 23-53                          | Energy Log                | 0 N/A              | All set-ups | TRUE                    | 0                | Unit32                        |
| 23-54                          | Reset Energy Log          | [0] Do not reset   | All set-ups | TRUE                    | -                | Unit8                         |
| <b>23-6* Trending</b>          |                           |                    |             |                         |                  |                               |
| 23-60                          | Trend Variable            | [0] Power [kW]     | 2 set-ups   | TRUE                    | -                | Unit8                         |
| 23-61                          | Continuous Bin Data       | 0 N/A              | All set-ups | TRUE                    | 0                | Unit32                        |
| 23-62                          | Timed Bin Data            | 0 N/A              | All set-ups | TRUE                    | 0                | Unit32                        |
| 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                | Unit8                         |
| 23-66                          | Reset Continuous Bin Data | [0] Do not reset   | All set-ups | TRUE                    | -                | Unit8                         |
| 23-67                          | Reset Timed Bin Data      | [0] Do not reset   | All set-ups | TRUE                    | -                | Unit8                         |
| <b>23-8* Payback Counter</b>   |                           |                    |             |                         |                  |                               |
| 23-80                          | Power Reference Factor    | 100 %              | 2 set-ups   | TRUE                    | 0                | Unit8                         |
| 23-81                          | Energy Cost               | 1.00 N/A           | 2 set-ups   | TRUE                    | -2               | Unit32                        |
| 23-82                          | Investment                | 0 N/A              | 2 set-ups   | TRUE                    | 0                | Unit32                        |
| 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                         |

### 8.3.21.1. Cascade Controller 25- \*\*

| Par. No. #                         | Parameter description       | Default value                   | 4-set-up    | Change during operation | Conversion index | Type                 |
|------------------------------------|-----------------------------|---------------------------------|-------------|-------------------------|------------------|----------------------|
| <b>25-0 * System Settings</b>      |                             |                                 |             |                         |                  |                      |
| 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                |
| <b>25-2 * Bandwidth Settings</b>   |                             |                                 |             |                         |                  |                      |
| 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 Destaging 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                              | Destage Function            | null                            | All set-ups | TRUE                    | -                | Uint8                |
| 25-30                              | Destage Function Time       | 15 s                            | All set-ups | TRUE                    | 0                | Uint16               |
| <b>25-4 * Staging Settings</b>     |                             |                                 |             |                         |                  |                      |
| 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                              | Destaging 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                              | Destaging Speed [RPM]       | 0 RPM                           | All set-ups | TRUE                    | 67               | Uint16               |
| 25-47                              | Destaging Speed [Hz]        | 0.0 Hz                          | All set-ups | TRUE                    | -1               | Uint16               |
| <b>25-5 * Alternation Settings</b> |                             |                                 |             |                         |                  |                      |
| 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-<br>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 Mains Delay          | 0.5 s                           | All set-ups | TRUE                    | -1               | Uint16               |

| Par. No. #           | Parameter description | Default value    | 4-set-up    | Change during operation | Conversion index | Type       |
|----------------------|-----------------------|------------------|-------------|-------------------------|------------------|------------|
| <b>25-8* Status</b>  |                       |                  |             |                         |                  |            |
| 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      |
| <b>25-9* Service</b> |                       |                  |             |                         |                  |            |
| 25-90                | Pump Interlock        | [0] Off          | All set-ups | TRUE                    | -                | UInt8      |
| 25-91                | Manual Alternation    | 0 N/A            | All set-ups | TRUE                    | 0                | UInt8      |

### 8.3.22. Analog I/O Option MCB 109 26-\*\*

| Par. No. #                      | Parameter description              | Default value    | 4-set-up    | Change during operation | Conversion index | Type   |
|---------------------------------|------------------------------------|------------------|-------------|-------------------------|------------------|--------|
| <b>26-0* Analog I/O Mode</b>    |                                    |                  |             |                         |                  |        |
| 26-00                           | Terminal X42/1 Mode                | [1] Voltage      | All set-ups | TRUE                    | -                | Unit8  |
| 26-01                           | Terminal X42/3 Mode                | [1] Voltage      | All set-ups | TRUE                    | -                | Unit8  |
| 26-02                           | Terminal X42/5 Mode                | [1] Voltage      | All set-ups | TRUE                    | -                | Unit8  |
| <b>26-1* Analog Input X42/1</b> |                                    |                  |             |                         |                  |        |
| 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               | Unit16 |
| 26-17                           | Term. X42/1 Live Zero              | [1] Enabled      | All set-ups | TRUE                    | -                | Unit8  |
| <b>26-2* Analog Input X42/3</b> |                                    |                  |             |                         |                  |        |
| 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               | Unit16 |
| 26-27                           | Term. X42/3 Live Zero              | [1] Enabled      | All set-ups | TRUE                    | -                | Unit8  |
| <b>26-3* Analog Input X42/5</b> |                                    |                  |             |                         |                  |        |
| 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               | Unit16 |
| 26-37                           | Term. X42/5 Live Zero              | [1] Enabled      | All set-ups | TRUE                    | -                | Unit8  |
| <b>26-4* Analog Out X42/7</b>   |                                    |                  |             |                         |                  |        |
| 26-40                           | Terminal X42/7 Output              | [0] No operation | All set-ups | TRUE                    | -                | Unit8  |
| 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               | Unit16 |
| <b>26-5* Analog Out X42/9</b>   |                                    |                  |             |                         |                  |        |
| 26-50                           | Terminal X42/9 Output              | [0] No operation | All set-ups | TRUE                    | -                | Unit8  |
| 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               | Unit16 |
| <b>26-6* Analog Out X42/11</b>  |                                    |                  |             |                         |                  |        |
| 26-60                           | Terminal X42/11 Output             | [0] No operation | All set-ups | TRUE                    | -                | Unit8  |
| 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               | Unit16 |

## 8.3.23. Cascade CTL Option 27-.\*

| Par. No. #                        | Parameter description            | Default value           | 4-set-up    | Change during operation | Conversion index | Type   |
|-----------------------------------|----------------------------------|-------------------------|-------------|-------------------------|------------------|--------|
| <b>27-0* Control &amp; Status</b> |                                  |                         |             |                         |                  |        |
| 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 |
| <b>27-1* Configuration</b>        |                                  |                         |             |                         |                  |        |
| 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  |
| <b>27-2* Bandwidth Settings</b>   |                                  |                         |             |                         |                  |        |
| 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                             | Destaging 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 Destage Delay          | ExpressionLimit         | All set-ups | TRUE                    | 0                | Uint16 |
| <b>27-3* Staging Speed</b>        |                                  |                         |             |                         |                  |        |
| 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 |
| <b>27-4* Staging Settings</b>     |                                  |                         |             |                         |                  |        |
| 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                             | Destaging 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                             | Destaging Speed [RPM]            | 0 RPM                   | All set-ups | TRUE                    | 67               | Uint16 |
| 27-48                             | Destaging Speed [Hz]             | 0.0 Hz                  | All set-ups | TRUE                    | -1               | Uint16 |
| <b>27-5* Alternate Settings</b>   |                                  |                         |             |                         |                  |        |
| 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  |
| <b>TimeOfDayWo-</b>               |                                  |                         |             |                         |                  |        |
| 27-55                             | Alternation Predefined Time      | ExpressionLimit         | All set-ups | TRUE                    | 0                | Date   |
| 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   |
|-----------------------------|-------------------------------|--------------------|-------------|-------------------------|------------------|--------|
| <b>27-6* Digital Inputs</b> |                               |                    |             |                         |                  |        |
| 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  |
| <b>27-7* Connections</b>    |                               |                    |             |                         |                  |        |
| 27-70                       | Relay                         | [0] Standard Relay | 2 set-ups   | FALSE                   | -                | UInt8  |
| <b>27-9* Readouts</b>       |                               |                    |             |                         |                  |        |
| 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  |

### 8.3.24. Water Application Functions 29-.\* \*

| Par. No. #             | Parameter description | Default value         | 4-set-up    | Change during operation | Conversion index | Type   |
|------------------------|-----------------------|-----------------------|-------------|-------------------------|------------------|--------|
| <b>29-0* Pipe Fill</b> |                       |                       |             |                         |                  |        |
| 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  |

8.3.25. 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  |



## 9. Troubleshooting

### 9.1. Alarms and warnings

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

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

In the event of an alarm, the frequency converter 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 LCP control panel.
2. Via a digital input with the "Reset" function.
3. Via serial communication/optional fieldbus.
4. By resetting automatically using the [Auto Reset] function, which is a default setting for VLT AQUA Drive. see par. 14-20 Reset Mode in VLT AQUA Drive Programming Guide



**NB!**

After a manual reset using the [RESET] button on the LCP, the [AUTO ON] or [HAND ON] 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 mains supply must be switched off before the alarm can be reset. After being switched back on, the frequency converter is no longer blocked and may be reset as described above once the cause has been rectified.

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

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

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

| No. | Description                        | Warning | Alarm/Trip | Alarm/Trip Lock | Parameter Reference |
|-----|------------------------------------|---------|------------|-----------------|---------------------|
| 1   | 10 Volts low                       | X       |            |                 |                     |
| 2   | Live zero error                    | (X)     | (X)        |                 | 6-01                |
| 3   | No motor                           | (X)     |            |                 | 1-80                |
| 4   | Mains phase loss                   | (X)     | (X)        | (X)             | 14-12               |
| 5   | DC link voltage high               | X       |            |                 |                     |
| 6   | DC link voltage low                | X       |            |                 |                     |
| 7   | DC over voltage                    | X       | X          |                 |                     |
| 8   | DC under voltage                   | X       | X          |                 |                     |
| 9   | Inverter overloaded                | X       | X          |                 |                     |
| 10  | Motor ETR over temperature         | (X)     | (X)        |                 | 1-90                |
| 11  | Motor thermistor over temperature  | (X)     | (X)        |                 | 1-90                |
| 12  | Torque limit                       | X       | X          |                 |                     |
| 13  | Over Current                       | X       | X          | X               |                     |
| 14  | Earth fault                        | X       | X          | X               |                     |
| 15  | Hardware mesh mash                 |         | X          | X               |                     |
| 16  | Short Circuit                      |         | X          | X               |                     |
| 17  | Control word timeout               | (X)     | (X)        |                 | 8-04                |
| 25  | Brake resistor short-circuited     | X       |            |                 |                     |
| 26  | Brake resistor power limit         | (X)     | (X)        |                 | 2-13                |
| 27  | Brake chopper short-circuited      | X       | X          |                 |                     |
| 28  | Brake check                        | (X)     | (X)        |                 | 2-15                |
| 29  | Power board over temp              | X       | X          | X               |                     |
| 30  | Motor phase U missing              | (X)     | (X)        | (X)             | 4-58                |
| 31  | Motor phase V missing              | (X)     | (X)        | (X)             | 4-58                |
| 32  | Motor phase W missing              | (X)     | (X)        | (X)             | 4-58                |
| 33  | Inrush fault                       |         | X          | X               |                     |
| 34  | Fieldbus communication fault       | X       | X          |                 |                     |
| 38  | Internal fault                     |         | X          | X               |                     |
| 47  | 24 V supply low                    | X       | X          | X               |                     |
| 48  | 1.8 V supply low                   |         | X          | X               |                     |
| 50  | AMA calibration failed             |         | X          |                 |                     |
| 51  | AMA check $U_{nom}$ and $I_{nom}$  |         | X          |                 |                     |
| 52  | AMA low $I_{nom}$                  |         | X          |                 |                     |
| 53  | AMA motor too big                  |         | X          |                 |                     |
| 54  | AMA motor too small                |         | X          |                 |                     |
| 55  | AMA parameter out of range         |         | X          |                 |                     |
| 56  | AMA interrupted by user            |         | X          |                 |                     |
| 57  | AMA timeout                        |         | X          |                 |                     |
| 58  | AMA internal fault                 | X       | X          |                 |                     |
| 59  | Current limit                      | X       |            |                 |                     |
| 61  | Tracking Error                     | (X)     | (X)        |                 | 4-30                |
| 62  | Output Frequency at Maximum Limit  | X       |            |                 |                     |
| 64  | Voltage Limit                      | X       |            |                 |                     |
| 65  | Control Board Over-temperature     | X       | X          | X               |                     |
| 66  | Heat sink Temperature Low          | X       |            |                 |                     |
| 67  | Option Configuration has Changed   |         | X          |                 |                     |
| 68  | Safe Stop Activated                |         | X          |                 |                     |
| 80  | Drive Initialised to Default Value |         | X          |                 |                     |

Table 9.1: Alarm/Warning code list

(X) Dependent on parameter

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

Table 9.2: Description of Alarm Word, Warning Word and Extended Status Word

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

9

### 9.1.1. Fault messages

#### WARNING 1, 10 Volts low:

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

#### WARNING/ALARM 2, Live zero error:

The signal on terminal 53 or 54 is less than 50% of the value set in par. 6-10 *Terminal 53 Low Voltage*, par. 6-12 *Terminal 53 Low Current*, par. 6-20 *Terminal 54 Low Voltage*, or par. 6-22 *Terminal 54 Low Current* respectively.

#### WARNING/ALARM 3, No motor:

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

#### WARNING/ALARM 4, Mains phase loss:

A phase is missing on the supply side, or the mains voltage imbalance is too high.

This message also appears in case of a fault in the input rectifier on the frequency converter.

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

#### WARNING 5, DC link voltage high:

The intermediate circuit voltage (DC) is higher than the over-voltage limit of the control system. The frequency converter is still active.

#### WARNING 6, DC link voltage low:

The intermediate circuit voltage (DC) is below the undervoltage limit of the control system. The frequency converter is still active.

#### WARNING/ALARM 7, DC over voltage:

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

#### Possible corrections:

Select Over Voltage Control function in par. 2-17 *Over-voltage Control*

Connect a brake resistor

Extend the ramp time

Activate functions in par. 2-10 *Brake Function*

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

Selecting OVC function will extend the ramp times.

#### Alarm/warning limits:

| Voltage Range                                 | 3 x 200-240 V AC<br>[VDC] | 3 x 380-500 V AC<br>[VDC] |
|-----------------------------------------------|---------------------------|---------------------------|
| Undervoltage                                  | 185                       | 373                       |
| Voltage warning low                           | 205                       | 410                       |
| Voltage warning high (w/o<br>brake - w/brake) | 390/405                   | 810/840                   |
| Overvoltage                                   | 410                       | 855                       |

The voltages stated are the intermediate circuit voltage of the frequency converter with a tolerance of  $\pm 5\%$ . The corresponding mains voltage is the intermediate circuit voltage (DC-link) divided by 1.35

**WARNING/ALARM 8, DC under voltage:**

If the intermediate circuit voltage (DC) drops below the "voltage warning low" limit (see table above), the frequency converter checks if 24 V back-up supply is connected.

If no 24 V backup supply is connected, the frequency converter trips after a given time depending on the unit.

To check whether the supply voltage matches the frequency converter, see 3.1 General Specifications.

**WARNING/ALARM 9, Inverter overloaded:**

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

The fault is that the frequency converter is overloaded by more than nominal current for too long.

**WARNING/ALARM 10, Motor ETR over temperature:**

According to the electronic thermal protection (ETR), the motor is too hot. You can choose if you want the frequency converter to give a warning or an alarm when the counter reaches 100% in par. 1-90 Motor *Thermal Protection*. The fault is that the motor is overloaded by more than nominal current for too long. Check that the motor par. 1-24 *Motor Current* is set correctly.

**WARNING/ALARM 11, Motor thermistor over temp:**

The thermistor or the thermistor connection is disconnected. You can choose if you want the frequency converter to give a warning or an alarm in par. 1-90 Motor *Thermal Protection*. Check that the thermistor is connected correctly between terminal 53 or 54 (analog voltage input) and terminal 50 (+ 10 Volts 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.

**WARNING/ALARM 12, Torque limit:**

The torque is higher than the value in par. 4-16 Torque *Limit Motor Mode* (in motor operation) or the torque is higher than the value in par. 4-17 Torque *Limit Generator Mode* (in regenerative operation).

**WARNING/ALARM 13, Over Current:**

The inverter peak current limit (approx. 200% of the rated current) is exceeded. The warning will last approx. 8-12 sec., then the frequency converter trips and issues an alarm. Turn off the frequency converter and check if the motor shaft can be turned and if the motor size matches the frequency converter.

**ALARM 14, Earth fault:**

There is a discharge from the output phases to earth, either in the cable between the frequency converter and the motor or in the motor itself. Turn off the frequency converter and remove the earth fault.

**ALARM 15, In-complete hardware:**

A fitted option is not handled by the present control board (hardware or software).

**ALARM 16, Short-circuit:**

There is short-circuiting in the motor or on the motor terminals. Turn off the frequency converter and remove the short-circuit.

**WARNING/ALARM 17, Control word timeout:**

There is no communication to the frequency converter.

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

If par. 8-04 Control *Timeout Function* is set to *Stop* and *Trip*, a warning appears and the frequency converter ramps down to zero speed, while giving an alarm.

par. 8-03 Control *Timeout Time* could possibly be increased.

**WARNING 22, Hoist Mech. Brake:**

Report value will show what kind it is.

0 = The torque ref. was not reached before timeout

1 = There was no brake feedback before timeout

**WARNING 23, Internal fans:**

External fans have failed due to defect hardware or fans not mounted.

**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 par. 14-53 Fan *Monitor*, [0] Disabled.

**WARNING 25, Brake resistor short-circuited:**

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

**ALARM/WARNING 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 s, on the basis of the resistance value of the brake resistor (par. 2-11 Brake *Resistor (ohm)*) and the intermediate circuit voltage. The warning is active when the dissipated braking power is higher than 90%. If *Trip* [2] has been selected in par. 2-13 Brake *Power Monitoring*, the frequency converter cuts out and issues this alarm, when the dissipated braking power is higher than 100%.

**WARNING/ALARM 27, Brake chopper fault:**

The brake transistor is monitored during operation and if it short-circuits, the brake function disconnects and the warning comes up. The frequency converter 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 frequency converter and remove the brake resistor.



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

**ALARM/WARNING 28, Brake check failed:**

Brake resistor fault: the brake resistor is not connected/working.

**WARNING/ALARM 29, Drive over temperature:**

If the enclosure is IP00, IP20/Nema1 or IP21/TYPE 1, the cut-out temperature of the heat-sink is 95 °C  $\pm$  5 °C. The temperature fault cannot be reset, until the temperature of the heatsink is below 70 °C.

**The fault could be:**

- Ambient temperature too high
- Too long motor cable

**ALARM 30, Motor phase U missing:**

Motor phase U between the frequency converter and the motor is missing.

Turn off the frequency converter and check motor phase U.

**ALARM 31, Motor phase V missing:**

Motor phase V between the frequency converter and the motor is missing.  
Turn off the frequency converter and check motor phase V.

**ALARM 32, Motor phase W missing:**

Motor phase W between the frequency converter and the motor is missing.  
Turn off the frequency converter and check motor phase W.

**ALARM 33, Inrush fault:**

Too many powerups have occurred within a short time period. See the chapter *General Specifications* for the allowed number of power-ups within one minute.

**WARNING/ALARM 34, Fieldbus communication fault:**

The fieldbus on the communication option card is not working.

**WARNING/ALARM 36, Mains failure:**

This warning/alarm is only active if the supply voltage to the frequency converter is lost and parameter 14-10 is NOT set to OFF. Possible correction: check the fuses to the frequency converter

**WARNING/ALARM 37, Phase Imbalance:**

There is a current imbalance between the power units.

**ALARM 38, Internal fault:**

Contact your local Danfoss supplier.

**ALARM 39, Heatsink Sensor:**

No feedback from the heatsink sensor.

**WARNING 40, Overload of Digital Output Terminal 27**

Check the load connected to terminal 27 or remove short-circuit connection. Check parameters 5-00 and 5-01.

**WARNING 41, Overload of Digital Output Terminal 29:**

Check the load connected to terminal 29 or remove short-circuit connection. Check parameters 5-00 and 5-02.

**WARNING 42, Overload of Digital Output On X30/6 :**

Check the load connected to X30/6 or remove short-circuit connection. Check parameter 5-32.

**WARNING 42, Overload of Digital Output On X30/7 :**

Check the load connected to X30/7 or remove short-circuit connection. Check parameter 5-33.

**ALARM 46, Pwr. card supply:**

The supply on the power card is out of range.

**WARNING 47, 24 V supply low:**

The external 24 V DC backup power supply may be overloaded, otherwise contact your Danfoss supplier.

**ALARM 48, 1.8 V supply low:**

Contact your Danfoss supplier.

**WARNING 49, Speed limit:**

The speed has been limited by range in par. 4-11 *Motor Speed Low Limit [RPM]* and par. 4-13 *Motor Speed High Limit [RPM]*.

**ALARM 50, AMA calibration failed:**

Contact your Danfoss supplier.

**ALARM 51, AMA check Unom and Inom:**

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

**ALARM 52, AMA low Inom:**

The motor current is too low. Check the settings.

**ALARM 53, AMA motor too big:**

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

**ALARM 54, AMA motor too small:**

The motor is too small for the AMA to be carried out.

**ALARM 55, AMA par. out of range:**

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

**ALARM 56, AMA interrupted by user:**

The AMA has been interrupted by the user.

**ALARM 57, AMA timeout:**

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

**WARNING/ALARM 58, AMA 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 frequency converter (via Bus, Digital I/O or by pressing [Reset]).

**WARNING/ALARM 61, Tracking Error:**

Tracking error. Contact your supplier.

**WARNING 62, Output Frequency at Maximum Limit:**

The output frequency is limited by the value set in par. 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 over temperature: The cut-out temperature of the control card is 80° C.

**WARNING 66, Heatsink Temperature Low:**

The heat sink temperature is measured as 0° C. This could indicate that the temperature sensor is defective and thus the fan speed is increased to the maximum in case the power part or control card is very hot. If the temperature is below 15° C the warning will be present.

**ALARM 67, Option Configuration has Changed:**

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

**ALARM 68, Safe Stop:**

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 [Reset]).

**ALARM 69, Pwr. Card Temp:**

Power card over temperature.

**ALARM 70, Illegal Frequency Converter Configuration:**

Actual combination of control board and power board is illegal.

**ALARM 90, Feedback Mon.:**

**ALARM 91, Analogue Input 54 Wrong Settings:**

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

**ALARM 92, NoFlow:**

A no load situation has been detected for 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:**

Feed back stays lower than the set point, which may be indicates a 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:**

Start of the motor has been delayed due to short cycle protection is active. See parameter group 22-7\*.

**ALARM 250, New Spare Part:**

The power or Switch Mode Power Supply has been exchanged. The frequency converter type code must be restored in the EEPROM. Select the correct type code in Par 14-23 according to the label on unit. Remember to select 'Save to EEPROM' to complete.

**ALARM 251, New Type Code:**

The frequency converter has got a new type code.

## 10. Specifications

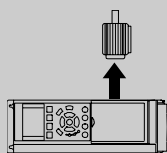
### 10.1. General Specifications

**10.1.1.1. Mains Supply 1 x 200 - 240 VAC****Mains Supply 1 x 200 - 240 VAC - Normal overload 110 % for 1 minute**

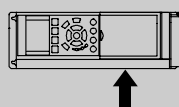
| Frequency converter<br>Typical Shaft Output [kW] | P5K<br>5 | P7K<br>5 | P15K | P22K |
|--------------------------------------------------|----------|----------|------|------|
| Typical Shaft Output [HP] at 240 V               | 7.5      | 10       | 20   | 30   |
| IP 21 / NEMA 1                                   | B1       | B2       | C1   | C2   |
| IP 55 / NEMA 12                                  | B1       | B2       | C1   | C2   |
| IP 66                                            | B1       | B2       | C1   | C2   |

|                                                                                    |      |      |        |        |
|------------------------------------------------------------------------------------|------|------|--------|--------|
| <b>Output current</b>                                                              |      |      |        |        |
| Continuous<br>(1 x 200-240 V) [A]                                                  | 24.2 | 30.8 | 59.4   | 88     |
| Intermittent<br>(1 x 200-240 V) [A]                                                | 26.6 | 33.4 | 65.3   | 96.8   |
| Continuous kVA<br>(208 V AC) [kVA]                                                 | 5.00 | 6.40 | 12.27  | 18.30  |
| Max. cable size:<br>(mains, motor, brake)<br>[mm <sup>2</sup> / AWG] <sup>2)</sup> | 10/7 | 35/2 | 50/1/0 | 95/4/0 |

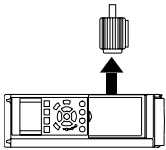


**Max. input current**

|                                                              |      |      |       |       |
|--------------------------------------------------------------|------|------|-------|-------|
| Continuous<br>(1 x 200-240 V) [A]                            | 46   | 59   | 111   | 172   |
| Intermittent<br>(1 x 200-240 V) [A]                          | 50.6 | 64.9 | 122.1 | 189.2 |
| Max. pre-fuses <sup>1)</sup> [A]                             | 80   | 100  | 150   | 200   |
| Environment                                                  |      |      |       |       |
| Estimated power loss<br>at rated max. load [W] <sup>4)</sup> | 110  | 150  | 300   | 440   |
| Weight enclosure IP 21 [kg]                                  | 23   | 27   | 45    | 65    |
| Weight enclosure IP 55 [kg]                                  | 23   | 27   | 45    | 65    |
| Weight enclosure IP 66 [kg]                                  | 23   | 27   | 45    | 65    |
| Efficiency <sup>3)</sup>                                     | 0.98 | 0.98 | 0.98  | 0.98  |



#### **10.1.1.2. Mains Supply 3 x 200 - 240 VAC**

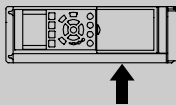
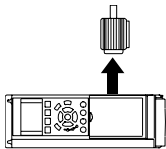
|                                                                                     |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|-------------------------------------------------------------------------------------|--|--|--|--|--|--|--|--|--|--|--|--|--|--|
| Normal overload 110 % for 1 minute                                                  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| IP 20 / NEMA Chassis                                                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| IP 21 / NEMA 1                                                                      |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| IP 55 / NEMA 12                                                                     |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| IP 66                                                                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Mains supply 200 - 240 VAC                                                          |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Frequency converter                                                                 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Typical Shaft Output [kW]                                                           |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Typical Shaft Output [HP] at 208 V                                                  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Output current                                                                      |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Continuous<br>(3 x 200-240 V ) [A]                                                  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Intermittent<br>(3 x 200-240 V ) [A]                                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Continuous<br>kVA (208 V AC) [kVA]                                                  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Max. cable size:<br>(mains, motor, brake)<br>[mm <sup>2</sup> /AWG] <sup>2)</sup>   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 0.2 - 4 mm <sup>2</sup> / 4 - 10 AWG                                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Max. input current                                                                  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Continuous<br>(3 x 200-240 V ) [A]                                                  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Intermittent<br>(3 x 200-240 V ) [A]                                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Max. pre-fuses <sup>1)</sup> [A]                                                    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Environment                                                                         |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Estimated power loss<br>at rated max. load [W] <sup>4)</sup>                        |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Weight enclosure IP20 [kg]                                                          |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Weight enclosure IP21 [kg]                                                          |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Weight enclosure IP55 [kg]                                                          |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Weight enclosure IP 66 [kg]                                                         |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Efficiency <sup>3)</sup>                                                            |  |  |  |  |  |  |  |  |  |  |  |  |  |  |



10.1.3. Mains Supply 1 x 380 - 480 VAC

Mains Supply 1x 380 VAC - Normal overload 110 % for 1 minute

| Frequency converter                                                                | P7K5 | P11K | P22K   | P37K    |
|------------------------------------------------------------------------------------|------|------|--------|---------|
| Typical Shaft Output [kW]                                                          | 7.5  |      |        |         |
| Typical Shaft Output [HP] at 460 V                                                 | 10   | 15   | 30     | 50      |
| IP 21 / NEMA 1                                                                     | B1   | B2   | C1     | C2      |
| IP 55 / NEMA 12                                                                    | B1   | B2   | C1     | C2      |
| IP 66                                                                              | B1   | B2   | C1     | C2      |
| Output current                                                                     |      |      |        |         |
| Continuous<br>(1 x 380-440 V) [A]                                                  | 16   | 24   | 44     | 73      |
| Intermittent<br>(1 x 380-440 V) [A]                                                | 17.6 | 26.4 | 48.4   | 80.3    |
| Continuous<br>(1 x 441-480 V) [A]                                                  | 14.5 | 21   | 40     | 65      |
| Intermittent<br>(1 x 441-480 V) [A]                                                | 15.4 | 23.1 | 44     | 71.5    |
| Continuous kVA<br>(400 V AC) [kVA]                                                 | 11.0 | 16.6 | 30.5   | 50.6    |
| Continuous kVA<br>(460 V AC) [kVA]                                                 | 11.6 | 16.7 | 31.9   | 51.8    |
| Max. cable size:<br>(mains, motor, brake)<br>[mm <sup>2</sup> / AWG] <sup>2)</sup> | 10/7 | 35/2 | 50/1/0 | 120/4/0 |
| Max. input current                                                                 |      |      |        |         |
| Continuous<br>(1 x 380-440 V) [A]                                                  | 33   | 48   | 94     | 151     |
| Intermittent<br>(1 x 380-440 V) [A]                                                | 36   | 53   | 103    | 166     |
| Continuous<br>(1 x 441-480 V) [A]                                                  | 30   | 41   | 85     | 135     |
| Intermittent<br>(1 x 441-480 V) [A]                                                | 33   | 46   | 93     | 148     |
| Max. pre-fuses <sup>1)</sup> [A]                                                   | 63   | 80   | 160    | 250     |
| Environment                                                                        |      |      |        |         |
| Estimated power loss<br>at rated max. load [W] <sup>4)</sup>                       | 300  | 440  | 880    | 1480    |
| Weight enclosure IP 21 [kg]                                                        | 23   | 27   | 45     | 65      |
| Weight enclosure IP 55 [kg]                                                        | 23   | 27   | 45     | 65      |
| Weight enclosure IP 66 [kg]                                                        | 23   | 27   | 45     | 65      |
| Efficiency <sup>3)</sup>                                                           | 0.96 | 0.96 | 0.96   | 0.96    |



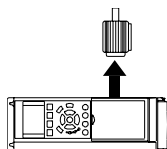
10

**10.1.4. Mains Supply 3 x 380 - 480 VAC****Mains Supply 3 x 380 - 480 VAC - Normal overload 110% for 1 minute**

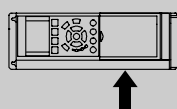
|                                                  |      |      |      |      |      |      |      |      |      |      |
|--------------------------------------------------|------|------|------|------|------|------|------|------|------|------|
| Frequency converter<br>Typical Shaft Output [kW] | PK37 | PK55 | PK75 | PK11 | PK15 | P2K2 | P3K0 | P4K0 | P5K5 | P7K5 |
| Typical Shaft Output [HP] at 460 V               | 0.37 | 0.55 | 0.75 | 1.1  | 1.5  | 2.2  | 3    | 4    | 5.5  | 7.5  |
| IP 20 / NEMA Chassis                             | A2   | A2   | A2   | A2   | A2   | A2   | A2   | A2   | A3   | A3   |
| IP 21 / NEMA 1                                   |      |      |      |      |      |      |      |      |      |      |
| IP 55 / NEMA 12                                  | A5   | A5   | A5   | A5   | A5   | A5   | A5   | A5   | A5   | A5   |
| IP 66                                            | A5   | A5   | A5   | A5   | A5   | A5   | A5   | A5   | AA   | A5   |

**Output current**

|                                                                                     |      |      |      |     |     |     |     |     |      |      |
|-------------------------------------------------------------------------------------|------|------|------|-----|-----|-----|-----|-----|------|------|
| Continuous<br>(3 x 380-440 V) [A]                                                   | 1.3  | 1.8  | 2.4  | 3   | 4.1 | 5.6 | 7.2 | 10  | 13   | 16   |
| Intermittent<br>(3 x 380-440 V) [A]                                                 | 1.43 | 1.98 | 2.64 | 3.3 | 4.5 | 6.2 | 7.9 | 11  | 14.3 | 17.6 |
| Continuous<br>(3 x 441-480 V) [A]                                                   | 1.2  | 1.6  | 2.1  | 2.7 | 3.4 | 4.8 | 6.3 | 8.2 | 11   | 14.5 |
| Intermittent<br>(3 x 441-480 V) [A]                                                 | 1.32 | 1.76 | 2.31 | 3.0 | 3.7 | 5.3 | 6.9 | 9.0 | 12.1 | 15.4 |
| Continuous kVA<br>(400 V AC) [kVA]                                                  | 0.9  | 1.3  | 1.7  | 2.1 | 2.8 | 3.9 | 5.0 | 6.9 | 9.0  | 11.0 |
| Continuous kVA<br>(460 V AC) [kVA]                                                  | 0.9  | 1.3  | 1.7  | 2.4 | 2.7 | 3.8 | 5.0 | 6.5 | 8.8  | 11.6 |
| Max. cable size:<br>(mains, motor, brake)<br>[[mm <sup>2</sup> / AWG] <sup>2)</sup> | 4/10 |      |      |     |     |     |     |     |      |      |

**Max. input current**

|                                                              |      |      |      |      |      |      |      |      |      |      |
|--------------------------------------------------------------|------|------|------|------|------|------|------|------|------|------|
| Continuous<br>(3 x 380-440 V) [A]                            | 1.2  | 1.6  | 2.2  | 2.7  | 3.7  | 5.0  | 6.5  | 9.0  | 11.7 | 14.4 |
| Intermittent<br>(3 x 380-440 V) [A]                          | 1.32 | 1.76 | 2.42 | 3.0  | 4.1  | 5.5  | 7.2  | 9.9  | 12.9 | 15.8 |
| Continuous<br>(3 x 441-480 V) [A]                            | 1.0  | 1.4  | 1.9  | 2.7  | 3.1  | 4.3  | 5.7  | 7.4  | 9.9  | 13.0 |
| Intermittent<br>(3 x 441-480 V) [A]                          | 1.1  | 1.54 | 2.09 | 3.0  | 3.4  | 4.7  | 6.3  | 8.1  | 10.9 | 14.3 |
| Max. pre-fuses <sup>1)</sup> [A]                             | 10   | 10   | 10   | 10   | 10   | 20   | 20   | 20   | 30   | 30   |
| Environment                                                  |      |      |      |      |      |      |      |      |      |      |
| Estimated power loss<br>at rated max. load [W] <sup>4)</sup> | 35   | 42   | 46   | 58   | 62   | 88   | 116  | 124  | 187  | 255  |
| Weight enclosure IP20 [kg]                                   | 4.7  | 4.7  | 4.8  | 4.8  | 4.9  | 4.9  | 4.9  | 4.9  | 6.6  | 6.6  |
| Weight enclosure IP 21 [kg]                                  |      |      |      |      |      |      |      |      |      |      |
| Weight enclosure IP 55 [kg]                                  | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 | 14.2 | 14.2 |
| Weight enclosure IP 66 [kg]                                  | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 | 13.5 | 14.2 | 14.2 |
| Efficiency <sup>3)</sup>                                     | 0.93 | 0.95 | 0.96 | 0.96 | 0.97 | 0.97 | 0.97 | 0.97 | 0.97 | 0.97 |

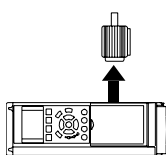


**Mains Supply 3 x 380 - 480 VAC - Normal overload 110 % for 1 minute**

| Frequency converter<br>Typical Shaft Output [kW]                                                                 | P11K<br>11 | P15K<br>15 | P18K<br>18.5 | P22K<br>22 | P30K<br>30 | P37K<br>37 | P45K<br>45 | P55K<br>55 | P75K<br>75 | P90K<br>90 |
|------------------------------------------------------------------------------------------------------------------|------------|------------|--------------|------------|------------|------------|------------|------------|------------|------------|
| Typical Shaft Output [HP] at 460 V                                                                               | 15         | 20         | 25           | 30         | 40         | 50         | 60         | 75         | 100        | 125        |
| IP 20 / NEMA Chassis<br>(B3+4 and C3+4 may be converted to IP21 using a conversion kit (Please contact Danfoss)) | B3         | B3         | B3           | B4         | B4         | B4         | C3         | C3         | C4         | C4         |
| IP 21 / NEMA 1                                                                                                   | B1         | B1         | B1           | B2         | B2         | C1         | C1         | C1         | C2         | C2         |
| IP 55 / NEMA 12                                                                                                  | B1         | B1         | B1           | B2         | B2         | C1         | C1         | C1         | C2         | -          |
| IP 66                                                                                                            | B1         | B1         | B1           | B2         | B2         | C1         | C1         | C1         | C2         | -          |

**Output current**

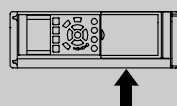
|                                     |      |      |      |      |      |      |      |      |     |     |
|-------------------------------------|------|------|------|------|------|------|------|------|-----|-----|
| Continuous<br>(3 x 380-440 V) [A]   | 24   | 32   | 37.5 | 44   | 61   | 73   | 90   | 106  | 147 | 177 |
| Intermittent<br>(3 x 380-440 V) [A] | 26.4 | 35.2 | 41.3 | 48.4 | 67.1 | 80.3 | 99   | 117  | 162 | 195 |
| Continuous<br>(3 x 441-480 V) [A]   | 21   | 27   | 34   | 40   | 52   | 65   | 80   | 105  | 130 | 160 |
| Intermittent<br>(3 x 441-480 V) [A] | 23.1 | 29.7 | 37.4 | 44   | 61.6 | 71.5 | 88   | 116  | 143 | 176 |
| Continuous kVA<br>(400 V AC) [kVA]  | 16.6 | 22.2 | 26   | 30.5 | 42.3 | 50.6 | 62.4 | 73.4 | 102 | 123 |
| Continuous kVA<br>(460 V AC) [kVA]  | 16.7 | 21.5 | 27.1 | 31.9 | 41.4 | 51.8 | 63.7 | 83.7 | 104 | 128 |



Max. cable size:  
(mains, motor, brake)  
[[mm<sup>2</sup>/ AWG] <sup>2)</sup>

**Max. input current**

|                                     |      |      |      |      |      |      |      |     |     |     |
|-------------------------------------|------|------|------|------|------|------|------|-----|-----|-----|
| Continuous<br>(3 x 380-440 V) [A]   | 22   | 29   | 34   | 40   | 55   | 66   | 82   | 96  | 133 | 161 |
| Intermittent<br>(3 x 380-440 V) [A] | 24.2 | 31.9 | 37.4 | 44   | 60.5 | 72.6 | 90.2 | 106 | 146 | 177 |
| Continuous<br>(3 x 441-480 V) [A]   | 19   | 25   | 31   | 36   | 47   | 59   | 73   | 95  | 118 | 145 |
| Intermittent<br>(3 x 441-480 V) [A] | 20.9 | 27.5 | 34.1 | 39.6 | 51.7 | 64.9 | 80.3 | 105 | 130 | 160 |
| Max. pre-fuses <sup>1)</sup> [A]    | 63   | 63   | 63   | 63   | 80   | 100  | 125  | 160 | 250 | 250 |



|                                                              |      |      |      |      |      |      |      |      |      |      |
|--------------------------------------------------------------|------|------|------|------|------|------|------|------|------|------|
| Estimated power loss<br>at rated max. load [W] <sup>4)</sup> | 278  | 392  | 465  | 525  | 698  | 739  | 843  | 1083 | 1384 | 1474 |
| Weight enclosure IP 20 [kg]                                  | 12   | 12   | 12   | 23.5 | 23.5 | 23.5 | 35   | 35   | 50   | 50   |
| Weight enclosure IP 21 [kg]                                  | 23   | 23   | 23   | 27   | 27   | 45   | 45   | 45   | 65   | 65   |
| Weight enclosure IP 55 [kg]                                  | 23   | 23   | 23   | 27   | 27   | 45   | 45   | 45   | 65   | 65   |
| Weight enclosure IP 66 [kg]                                  | 23   | 23   | 23   | 27   | 27   | 45   | 45   | 45   | 65   | 65   |
| Efficiency <sup>3)</sup>                                     | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.99 |

**Normal overload 110% for 1 minute**

|                                   |      |      |      |      |      |      |      |      |      |
|-----------------------------------|------|------|------|------|------|------|------|------|------|
| Frequency converter               | P110 | P132 | P160 | P200 | P250 | P315 | P355 | P400 | P450 |
| Typical Shaft Output [kW]         | 110  | 132  | 160  | 200  | 250  | 315  | 355  | 400  | 450  |
| Typical Shaft Output [HP] at 460V | 150  | 200  | 250  | 300  | 350  | 450  | 500  | 550  | 600  |
| IP 00                             | D3   | D3   | D4   | D4   | D4   | E2   | E2   | E2   | E2   |
| IP 21 / Nema 1                    | D1   | D1   | D2   | D2   | D2   | E1   | E1   | E1   | E1   |
| IP 54 / Nema 12                   | D1   | D1   | D2   | D2   | D2   | E1   | E1   | E1   | E1   |

**Output current**

|                                  |     |     |     |     |     |     |     |     |     |
|----------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Continuous (3 x 380-400 V) [A]   | 212 | 260 | 315 | 395 | 480 | 600 | 658 | 745 | 800 |
| Intermittent (3 x 380-400 V) [A] | 233 | 286 | 347 | 435 | 528 | 660 | 724 | 820 | 880 |
| Continuous (3 x 401-480V) [A]    | 190 | 240 | 302 | 361 | 443 | 540 | 590 | 678 | 730 |
| Intermittent (3 x 401-480V) [A]  | 209 | 264 | 332 | 397 | 487 | 594 | 649 | 746 | 803 |
| Continuous kVA (400 VAC) [kVA]   | 147 | 180 | 218 | 274 | 333 | 416 | 456 | 516 | 554 |
| Continuous kVA (460 VAC) [kVA]   | 151 | 191 | 241 | 288 | 353 | 430 | 470 | 540 | 582 |

Max. cable size:

|                                                             |       |           |           |
|-------------------------------------------------------------|-------|-----------|-----------|
| (mains, motor, brake) [mm <sup>2</sup> / AWG] <sup>2)</sup> | 2x70  | 2x185     | 4x240     |
|                                                             | 2x2/0 | 2x350 mcm | 4x500 mcm |

**Max. input current**

|                                  |     |     |     |     |     |     |     |     |     |
|----------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Continuous (3 x 380-400 V) [A]   | 204 | 251 | 304 | 381 | 463 | 590 | 647 | 733 | 787 |
| Continuous (3 x 401-480V) [A]    | 183 | 231 | 291 | 348 | 427 | 531 | 580 | 667 | 718 |
| Max. pre-fuses <sup>1)</sup> [A] | 300 | 350 | 400 | 500 | 600 | 700 | 900 | 900 | 900 |

**Environment**

|                                                           |      |       |       |       |       |       |       |       |       |
|-----------------------------------------------------------|------|-------|-------|-------|-------|-------|-------|-------|-------|
| Estimated power loss at rated max. load [W] <sup>4)</sup> | 3234 | 3782  | 4213  | 5119  | 5893  | 7630  | 7701  | 8879  | 9428  |
| Weight enclosure IP00 [kg]                                | 81.9 | 90.5  | 111.8 | 122.9 | 137.7 | 221.4 | 234.1 | 236.4 | 277.3 |
| Weight enclosure IP 21 [kg]                               | 95.5 | 104.1 | 125.4 | 136.3 | 151.3 | 263.2 | 270.0 | 272.3 | 313.2 |
| Weight enclosure IP 54 [kg]                               | 95.5 | 104.1 | 125.4 | 136.3 | 151.3 | 263.2 | 270.0 | 272.3 | 313.2 |
| Efficiency <sup>3)</sup>                                  | 0.98 | 0.98  | 0.98  | 0.98  | 0.98  | 0.98  | 0.98  | 0.98  | 0.98  |

<sup>1)</sup> For type of fuse see section *Fuses*<sup>2)</sup> American Wire Gauge<sup>3)</sup> Measured using 5 m screened motor cables at rated load and rated frequency<sup>4)</sup> The typical power loss is at normal 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). Lower efficiency motors will also add to the power loss in the frequency converter and vice versa.

If the switching frequency is raised from nominal 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 typically only 4W extra for a fully loaded control card, or options for slot A or slot B, each).

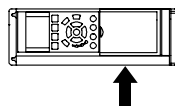
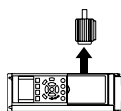
Although measurements are made with state of the art equipment, some measurement inaccuracy must be allowed for (+/- 5%).

### 10.1.5. Mains Supply 3 x 525 - 600 VAC

Normal overload 110 % for 1 minute

| Size:                                                                              | PK75 | P1K1 | P1K5 | P2K2 | P3K0 | P3K7 | P4K0 | P5K5                   | P7K5 | P11K | P15K    | P18K | P22K | P30K    | P37K | P45K    | P55K | P75K                    | P90K  |
|------------------------------------------------------------------------------------|------|------|------|------|------|------|------|------------------------|------|------|---------|------|------|---------|------|---------|------|-------------------------|-------|
| Typical Shaft Output [kW]                                                          | 0.75 | 1.1  | 1.5  | 2.2  | 3    | 3.7  | 4    | 5.5                    | 7.5  | 11   | 15      | 18.5 | 22   | 30      | 37   | 45      | 55   | 75                      | 90    |
| IP 20 / NEMA Chassis                                                               | A2   | A2   | A2   | A2   | A2   | A2   | A2   | A3                     | A3   | B3   | B3      | B3   | B4   | B4      | B4   | C3      | C3   | C4                      | C4    |
| IP 21 / NEMA 1                                                                     | A2   | A2   | A2   | A2   | A2   | A2   | A2   | A3                     | A3   | B1   | B1      | B1   | B2   | B2      | B2   | C1      | C1   | C2                      | C2    |
| IP 55 / NEMA 12                                                                    | A5   | A5   | A5   | A5   | A5   | A5   | A5   | A5                     | A5   | B1   | B1      | B1   | B2   | B2      | B2   | C1      | C1   | C2                      | C2    |
| IP 66                                                                              | A5   | A5   | A5   | A5   | A5   | A5   | A5   | A5                     | A5   | B1   | B1      | B1   | B2   | B2      | B2   | C1      | C1   | C2                      | C2    |
| <b>Output current</b>                                                              |      |      |      |      |      |      |      |                        |      |      |         |      |      |         |      |         |      |                         |       |
| Continuous<br>(3 x 525-550 V) [A]                                                  | 1.8  | 2.6  | 2.9  | 4.1  | 5.2  | -    | 6.4  | 9.5                    | 11.5 | 19   | 23      | 28   | 36   | 43      | 54   | 65      | 87   | 105                     | 137   |
| Intermittent<br>(3 x 525-550 V) [A]                                                |      | 2.9  | 3.2  | 4.5  | 5.7  | -    | 7.0  | 10.5                   | 12.7 | 21   | 25      | 31   | 40   | 47      | 59   | 72      | 96   | 116                     | 151   |
| Continuous<br>(3 x 525-600 V) [A]                                                  | 1.7  | 2.4  | 2.7  | 3.9  | 4.9  | -    | 6.1  | 9.0                    | 11.0 | 18   | 22      | 27   | 34   | 41      | 52   | 62      | 83   | 100                     | 131   |
| Intermittent<br>(3 x 525-600 V) [A]                                                |      | 2.6  | 3.0  | 4.3  | 5.4  | -    | 6.7  | 9.9                    | 12.1 | 20   | 24      | 30   | 37   | 45      | 57   | 68      | 91   | 110                     | 144   |
| Continuous kVA (525 V AC)<br>[kVA]                                                 | 1.7  | 2.5  | 2.8  | 3.9  | 5.0  | -    | 6.1  | 9.0                    | 11.0 | 18.1 | 21.9    | 26.7 | 34.3 | 41      | 51.4 | 61.9    | 82.9 | 100                     | 130.5 |
| Continuous kVA (575 V AC)<br>[kVA]                                                 | 1.7  | 2.4  | 2.7  | 3.9  | 4.9  | -    | 6.1  | 9.0                    | 11.0 | 17.9 | 21.9    | 26.9 | 33.9 | 40.8    | 51.8 | 61.7    | 82.7 | 99.6                    | 130.5 |
| Max. cable size<br>(mains, motor, brake)<br>[AWG] <sup>2)</sup> [mm <sup>2</sup> ] |      |      |      |      |      | -    |      | 24 - 10 AWG<br>0.2 - 4 |      |      | 6<br>16 |      |      | 2<br>35 |      | 1<br>50 |      | 3/0<br>95 <sup>5)</sup> |       |
| <b>Max. input current</b>                                                          |      |      |      |      |      |      |      |                        |      |      |         |      |      |         |      |         |      |                         |       |
| Continuous<br>(3 x 525-600 V) [A]                                                  | 1.7  | 2.4  | 2.7  | 4.1  | 5.2  | -    | 5.8  | 8.6                    | 10.4 | 17.2 | 20.9    | 25.4 | 32.7 | 39      | 49   | 59      | 78.9 | 95.3                    | 124.3 |
| Intermittent<br>(3 x 525-600 V) [A]                                                |      | 2.7  | 3.0  | 4.5  | 5.7  | -    | 6.4  | 9.5                    | 11.5 | 19   | 23      | 28   | 36   | 43      | 54   | 65      | 87   | 105                     | 137   |
| Max. pre-fuses <sup>1)</sup> [A]                                                   | 10   | 10   | 10   | 20   | 20   | -    | 20   | 32                     | 32   |      |         |      |      |         |      |         |      |                         |       |
| Environment:                                                                       |      |      |      |      |      |      |      |                        |      |      |         |      |      |         |      |         |      |                         |       |
| Estimated power loss<br>at rated max. load [W] <sup>4)</sup>                       | 35   | 50   | 65   | 92   | 122  | -    | 145  | 195                    | 261  | 225  | 285     | 329  |      |         |      |         |      |                         |       |
| Enclosure IP 20:                                                                   |      |      |      |      |      |      |      |                        |      |      |         |      |      |         |      |         |      |                         |       |
| Weight<br>enclosure IP20 [kg]                                                      | 6.5  | 6.5  | 6.5  | 6.5  | 6.5  | -    | 6.5  | 6.6                    | 6.6  | 12   | 12      | 12   | 23.5 | 23.5    | 23.5 | 35      | 35   | 50                      | 50    |
| Efficiency <sup>4)</sup>                                                           | 0.97 | 0.97 | 0.97 | 0.97 | 0.97 | -    | 0.97 | 0.97                   | 0.97 | 0.98 | 0.98    | 0.98 | 0.98 | 0.98    | 0.98 | 0.98    | 0.98 | 0.98                    | 0.98  |

Table 10.1: <sup>5)</sup> Motor and mains cable: 300MCM/150mm<sup>2</sup>



## 10.1.6. Mains Supply 3 x 525 - 690 VAC

Normal overload 110% for 1 minute

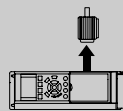
|                                    | P45K | P55K | P75K | P90K | P110 | P132 | P160 | P200 | P250 | P315 | P400 | P450 | P500 | P560 | P630 | P710                    | P800                    | P900                | P1M0                    | P1M2                |
|------------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|-------------------------|-------------------------|---------------------|-------------------------|---------------------|
| Frequency converter                | 45   | 55   | 75   | 90   | 110  | 132  | 160  | 200  | 250  | 315  | 400  | 450  | 500  | 560  | 630  | 710                     | 800                     | 900                 | 1000                    | 1200                |
| Typical Shaft Output [kW]          | 50   | 60   | 75   | 100  | 125  | 150  | 200  | 250  | 300  | 350  | 400  | 450  | 500  | 600  | 650  | 750                     | 950                     | 1050                | 1150                    | 1350                |
| Typical Shaft Output [HP] at 575 V | D3   | D3   | D3   | D3   | D3   | D3   | D3   | D4   | D4   | D4   | D4   | E2   | E2   | E2   | E2   | -                       | -                       | -                   | -                       | -                   |
| IP 00                              | D1   | D1   | D1   | D1   | D1   | D1   | D1   | D2   | D2   | D2   | D2   | E1   | E1   | E1   | E1   | F1/<br>F3 <sup>6)</sup> | F1/<br>F3 <sup>6)</sup> | F1/F3 <sup>6)</sup> | F2/<br>F4 <sup>6)</sup> | F2/F4 <sup>6)</sup> |
| IP 21 / Nema 1                     | D1   | D1   | D1   | D1   | D1   | D1   | D1   | D2   | D2   | D2   | D2   | E1   | E1   | E1   | E1   | F1/<br>F3 <sup>6)</sup> | F1/<br>F3 <sup>6)</sup> | F1/F3 <sup>6)</sup> | F1/<br>F3 <sup>6)</sup> | F1/F3 <sup>6)</sup> |
| IP 54 / Nema 12                    | D1   | D1   | D1   | D1   | D1   | D1   | D1   | D2   | D2   | D2   | D2   | E1   | E1   | E1   | E1   | F1/<br>F3 <sup>6)</sup> | F1/<br>F3 <sup>6)</sup> | F1/F3 <sup>6)</sup> | F1/<br>F3 <sup>6)</sup> | F1/F3 <sup>6)</sup> |

## Output current

|                                              |    |    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |      |      |      |      |
|----------------------------------------------|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| Continuous (3 x 550 V) [A]                   | 56 | 76 | 90  | 113 | 137 | 162 | 201 | 253 | 303 | 360 | 418 | 470 | 523 | 596 | 630 | 763 | 889  | 988  | 1108 | 1317 |
| Intermittent (3 x 550 V) [A]                 | 62 | 84 | 99  | 124 | 151 | 178 | 221 | 278 | 333 | 396 | 460 | 517 | 575 | 656 | 693 | 839 | 978  | 1087 | 1219 | 1449 |
| Continuous (3 x 690V) [A]                    | 54 | 73 | 86  | 108 | 131 | 155 | 192 | 242 | 290 | 344 | 400 | 450 | 500 | 570 | 630 | 730 | 850  | 945  | 1060 | 1260 |
| Intermittent (3 x 690 V) [A]                 | 59 | 80 | 95  | 119 | 144 | 171 | 211 | 266 | 319 | 378 | 440 | 495 | 550 | 627 | 693 | 803 | 935  | 1040 | 1166 | 1386 |
| Continuous kVA (550 VAC) [kVA]               | 53 | 72 | 86  | 108 | 131 | 154 | 191 | 241 | 289 | 343 | 398 | 448 | 498 | 568 | 600 | 727 | 847  | 941  | 1056 | 1255 |
| Continuous kVA (575 VAC) [kVA]               | 54 | 73 | 86  | 108 | 130 | 154 | 191 | 241 | 289 | 343 | 398 | 448 | 498 | 568 | 627 | 727 | 847  | 941  | 1056 | 1255 |
| Continuous kVA (690 VAC) <sup>1)</sup> [kVA] | 65 | 87 | 103 | 129 | 157 | 185 | 229 | 289 | 347 | 411 | 478 | 538 | 598 | 681 | 753 | 872 | 1016 | 1129 | 1267 | 1506 |

## Max. cable size:

|                                               |      |      |      |      |      |      |      |       |           |       |           |       |           |       |           |       |           |        |           |           |
|-----------------------------------------------|------|------|------|------|------|------|------|-------|-----------|-------|-----------|-------|-----------|-------|-----------|-------|-----------|--------|-----------|-----------|
| (Mains) [mm <sup>2</sup> / AWG] <sup>2)</sup> | 2x70 | 2x70 | 2x70 | 2x70 | 2x70 | 2x70 | 2x70 | 2x185 | 2x350 mcm | 2x185 | 2x350 mcm | 4x240 | 4x500 mcm | 4x240 | 4x500 mcm | 8x240 | 8x500 mcm | 8x240  | 8x500 mcm | 8x500 mcm |
| (Motor) [mm <sup>2</sup> / AWG] <sup>2)</sup> | 2x70 | 2x70 | 2x70 | 2x70 | 2x70 | 2x70 | 2x70 | 2x185 | 2x350 mcm | 2x185 | 2x350 mcm | 4x240 | 4x500 mcm | 4x240 | 4x500 mcm | 8x150 | 12x150    | 12x150 | 12x150    | 12x150    |
| (Brake) [mm <sup>2</sup> / AWG] <sup>2)</sup> | 2x70 | 2x70 | 2x70 | 2x70 | 2x70 | 2x70 | 2x70 | 2x185 | 2x350 mcm | 2x185 | 2x350 mcm | 2x185 | 2x350 mcm | 2x185 | 2x350 mcm | 4x185 | 6x185     | 6x185  | 6x185     | 6x350 mcm |



## Max. input current

|                                        |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
|----------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| Continuous (3 x 525 V) [A]             | 60  | 77  | 89  | 110 | 130 | 158 | 198 | 299 | 245 | 299 | 355 | 453 | 504 | 574 | 607 | 743  | 866  | 962  | 1079 | 1282 |
| Continuous (3 x 575 V) [A]             | 58  | 74  | 85  | 106 | 124 | 151 | 189 | 286 | 234 | 286 | 339 | 434 | 482 | 549 | 607 | 711  | 828  | 920  | 1032 | 1227 |
| Continuous (3 x 690 V) [A]             | 58  | 77  | 87  | 109 | 128 | 155 | 197 | 296 | 240 | 296 | 352 | 434 | 482 | 549 | 607 | 711  | 828  | 920  | 1032 | 1227 |
| Max. mains pre-fuses <sup>1)</sup> [A] | 125 | 160 | 200 | 200 | 250 | 315 | 350 | 350 | 400 | 500 | 550 | 700 | 700 | 900 | 900 | 2000 | 2000 | 2000 | 2000 | 2000 |

## Environment:

|                                                           |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|-----------------------------------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Estimated power loss at rated max. load [W] <sup>4)</sup> | 1458 | 1717 | 1913 | 2262 | 2662 | 3114 | 3612 | 4292 | 5156 | 5821 | 6149 | 6449 | 7249 | 8727 | 9673 | -    | -    | -    | -    | -    |
| Weight enclosure IP00 [kg]                                | 82   | 82   | 82   | 82   | 82   | 82   | 91   | 112  | 123  | 138  | 151  | 221  | 221  | 236  | 277  | -    | -    | -    | -    | -    |
| Weight enclosure IP 21 [kg] <sup>6)</sup>                 | 96   | 96   | 96   | 96   | 96   | 96   | 104  | 125  | 136  | 151  | 165  | 263  | 263  | 272  | 313  | 1004 | 1004 | 1004 | 1246 | 1246 |
| Weight enclosure IP 54 [kg] <sup>6)</sup>                 | 96   | 96   | 96   | 96   | 96   | 96   | 104  | 125  | 136  | 151  | 165  | 263  | 263  | 272  | 313  | 1004 | 1004 | 1004 | 1246 | 1246 |
| Efficiency <sup>3)</sup>                                  | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 |

<sup>1)</sup> For type of fuse see section Fuses<sup>2)</sup> American Wire Gauge<sup>3)</sup> Measured using 5 m screened motor cables at rated load and rated frequency<sup>4)</sup> The typical power loss is at normal 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). Lower efficiency motors will also add to the power loss in the frequency converter and vice versa.

If the switching frequency is raised from nominal 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 typically only 4W 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%).

<sup>6)</sup> Adding the F-enclosure option cabinet (resulting in the F3 and F4 enclosure sizes) adds 295 kg to the estimated weight.

## Protection and Features:

- Electronic thermal motor protection against overload.
- Temperature monitoring of the heatsink ensures that the frequency converter trips if the temperature reaches  $95\text{ °C} \pm 5\text{ °C}$ . An overload temperature cannot be reset until the temperature of the heatsink is below  $70\text{ °C} \pm 5\text{ °C}$  (Guideline - these temperatures may vary for different power sizes, enclosures etc.). The frequency converter has an auto derating function to avoid it's heatsink reaching  $95\text{ deg C}$ .
- The frequency converter is protected against short-circuits on motor terminals U, V, W.
- If a mains phase is missing, the frequency converter trips or issues a warning (depending on the load).
- Monitoring of the intermediate circuit voltage ensures that the frequency converter trips if the intermediate circuit voltage is too low or too high.
- The frequency converter is protected against earth faults on motor terminals U, V, W.

## Mains supply (L1, L2, L3):

|                                                                             |                                             |
|-----------------------------------------------------------------------------|---------------------------------------------|
| Supply voltage                                                              | 380-480 V $\pm 10\%$                        |
| Supply voltage                                                              | 525-690 V $\pm 10\%$                        |
| Supply frequency                                                            | 50/60 Hz                                    |
| Max. imbalance temporary between mains phases                               | 3.0 % of rated supply voltage               |
| True Power Factor ( $\lambda$ )                                             | $\geq 0.9$ nominal at rated load            |
| Displacement Power Factor ( $\cos\phi$ ) near unity                         | (> 0.98)                                    |
| Switching on input supply L1, L2, L3 (power-ups) $\leq$ enclosure type A    | maximum 2 times/min.                        |
| Switching on input supply L1, L2, L3 (power-ups) $\geq$ enclosure type B, C | maximum 1 time/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, 500/600/690 V maximum.*

## Motor output (U, V, W):

|                     |                            |
|---------------------|----------------------------|
| Output voltage      | 0 - 100% of supply voltage |
| Output frequency    | 0 - 1000 Hz                |
| Switching on output | Unlimited                  |
| Ramp times          | 1 - 3600 sec.              |

## 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 VLT AQUA Drive's nominal torque.*

## Cable lengths and cross sections:

|                                                                      |                                                         |
|----------------------------------------------------------------------|---------------------------------------------------------|
| Max. motor cable length, screened/armoured                           | VLT AQUA Drive: 150 m                                   |
| Max. motor cable length, unscreened/unarmoured                       | VLT AQUA Drive: 300 m                                   |
| Max. cross section to motor, mains, load sharing and brake *         |                                                         |
| Maximum cross section to control terminals, rigid wire               | 1.5 mm <sup>2</sup> /16 AWG (2 x 0.75 mm <sup>2</sup> ) |
| Maximum cross section to control terminals, flexible cable           | 1 mm <sup>2</sup> /18 AWG                               |
| Maximum cross section to control terminals, cable with enclosed core | 0.5 mm <sup>2</sup> /20 AWG                             |
| Minimum cross section to control terminals                           | 0.25 mm <sup>2</sup>                                    |

*\* See Mains Supply tables for more information!*

## Control card, RS-485 serial communication:

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

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

## Digital inputs:

|                                  |                                        |
|----------------------------------|----------------------------------------|
| Programmable digital inputs      | 4 (6)                                  |
| Terminal number                  | 18, 19, 27 <sup>1)</sup> , 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 <sub>i</sub> | approx. 4 kΩ                           |

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

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

## Digital output:

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

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

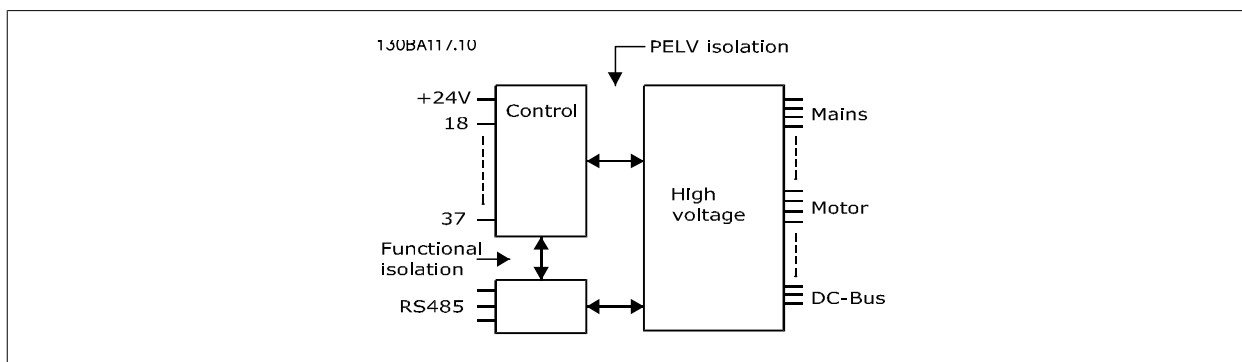
The digital output is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

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## Analog inputs:

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

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



#### 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, 24 V DC output:

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

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

#### Relay outputs:

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

1) IEC 60947 part 4 and 5

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

2) Overvoltage Category II

3) UL applications 300 V AC 2A

#### Control card, 10 V DC output:

|                 |               |
|-----------------|---------------|
| Terminal number | 50            |
| Output voltage  | 10.5 V ±0.5 V |
| Max. load       | 25 mA         |

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

## Control characteristics:

|                                                         |                                        |
|---------------------------------------------------------|----------------------------------------|
| Resolution of output frequency at 0 - 1000 Hz           | : +/- 0.003 Hz                         |
| System response time (terminals 18, 19, 27, 29, 32, 33) | : ≤ 2 ms                               |
| Speed control range (open loop)                         | 1:100 of synchronous speed             |
| Speed accuracy (open loop)                              | 30 - 4000 rpm: Maximum error of ±8 rpm |

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

## Surroundings:

|                                                       |                                                                   |
|-------------------------------------------------------|-------------------------------------------------------------------|
| Enclosure type A                                      | IP 20/Chassis, IP 21kit/Type 1, IP55/Type12, IP 66                |
| Enclosure type B1/B2                                  | IP 21/Type 1, IP55/Type12, IP 66                                  |
| Enclosure type B3/B4                                  | IP20/Chassis                                                      |
| Enclosure type C1/C2                                  | IP 21/Type 1, IP55/Type 12, IP66                                  |
| Enclosure type C3/C4                                  | IP20/Chassis                                                      |
| Enclosure type D1/D2/E1                               | IP21/Type 1, IP54/Type12                                          |
| Enclosure type D3/D4/E2                               | IP00/Chassis                                                      |
| Enclosure kit available ≤ enclosure type A            | IP21/TYPE 1/IP 4X top                                             |
| Vibration test                                        | 1.0 g                                                             |
| Max. relative humidity                                | 5% - 95%(IEC 721-3-3; Class 3K3 (non-condensing) during operation |
| Aggressive environment (IEC 721-3-3), uncoated        | class 3C2                                                         |
| Aggressive environment (IEC 721-3-3), coated          | class 3C3                                                         |
| Test method according to IEC 60068-2-43 H2S (10 days) |                                                                   |
| Ambient temperature                                   | Max. 50 °C                                                        |

*Derating for high ambient temperature, see section on special conditions*

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

*Derating for high altitude, see section on special conditions*

|                         |                                                                                  |
|-------------------------|----------------------------------------------------------------------------------|
| EMC standards, Emission | EN 61800-3, EN 61000-6-3/4, EN 55011, IEC 61800-3<br>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 | : 5 ms |
|---------------|--------|

## Control card, USB serial communication:

|              |                          |
|--------------|--------------------------|
| USB standard | 1.1 (Full speed)         |
| USB plug     | USB type B "device" plug |



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

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

The USB connection is not galvanically isolated from protection earth. Use only isolated laptop/PC as connection to the USB connector on VLT AQUA Drive or an isolated USB cable/converter.

### 10.1.7. Efficiency

#### Efficiency of the frequency converter ( $\eta_{VLT}$ )

The load on the frequency converter has little effect on its efficiency. In general, the efficiency is the same at the rated motor frequency  $f_{M,N}$ , even if the motor supplies 100% of the rated shaft torque or only 75%, i.e. in case of part loads.

This also means that the efficiency of the frequency converter does not change even if other U/f characteristics are chosen.

However, the U/f characteristics influence the efficiency of the motor.

The efficiency declines a little when the switching frequency is set to a value of above 5 kHz. The efficiency will also be slightly reduced if the mains voltage is 480 V, or if the motor cable is longer than 30 m.

#### Efficiency of the motor ( $\eta_{MOTOR}$ )

The efficiency of a motor connected to the frequency converter depends on magnetising level. In general, the efficiency is just as good as with mains operation. The efficiency of the motor depends on the type of motor.

In the range of 75-100% of the rated torque, the efficiency of the motor is practically constant, both when it is controlled by the frequency converter and when it runs directly on mains.

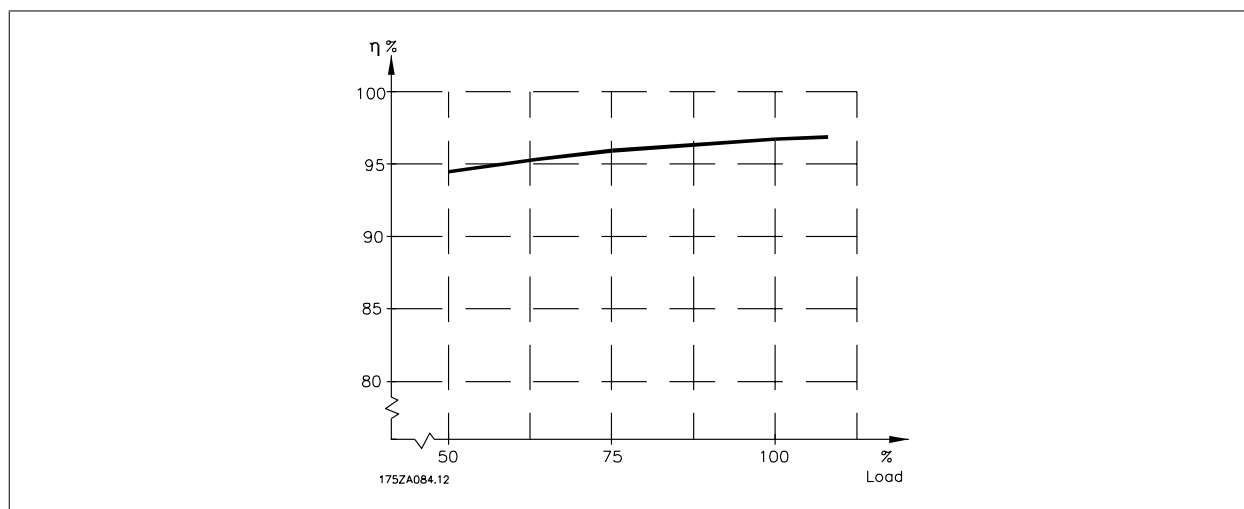
In small motors, the influence from the U/f characteristic on efficiency is marginal. However, in motors from 11 kW and up, the advantages are significant.

In general, the switching frequency does not affect the efficiency of small motors. Motors from 11 kW and up have their efficiency improved (1-2%). This is because the sine shape of the motor current is almost perfect at high switching frequency.

#### Efficiency of the system ( $\eta_{SYSTEM}$ )

To calculate the system efficiency, the efficiency of the frequency converter ( $\eta_{VLT}$ ) is multiplied by the efficiency of the motor ( $\eta_{MOTOR}$ ):

$$\eta_{SYSTEM} = \eta_{VLT} \times \eta_{MOTOR}$$



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Based on the graph outlined above, it is possible to calculate the system efficiency at different speeds.

#### The acoustic noise from the frequency converter comes from three sources:

1. DC intermediate circuit coils.
2. Integral fan.
3. RFI filter choke.

The typical values measured at a distance of 1 m from the unit:

| Enclosure                                                              | At reduced fan speed (50 %) [dBA] *** | Full fan speed [dBA] |
|------------------------------------------------------------------------|---------------------------------------|----------------------|
| A2                                                                     | 51                                    | 60                   |
| A3                                                                     | 51                                    | 60                   |
| A5                                                                     | 54                                    | 63                   |
| B1                                                                     | 61                                    | 67                   |
| B2                                                                     | 58                                    | 70                   |
| B3                                                                     | -                                     | -                    |
| B4                                                                     | -                                     | -                    |
| C1                                                                     | 52                                    | 62                   |
| C2                                                                     | 55                                    | 65                   |
| C3                                                                     | -                                     | -                    |
| C4                                                                     | -                                     | -                    |
| D1+D3                                                                  | 74                                    | 76                   |
| D2+D4                                                                  | 73                                    | 74                   |
| E1/E2 *                                                                | 73                                    | 74                   |
| E1/E2 **                                                               | 82                                    | 83                   |
| * 315 kW, 380-480 VAC and 355 kW, 525-600 VAC only!                    |                                       |                      |
| ** Remaining E1+E2 power sizes.                                        |                                       |                      |
| *** For D and E sizes, reduced fan speed is at 87%, measured at 200 V. |                                       |                      |

**When a transistor in the inverter bridge switches, the voltage across the motor increases by a  $du/dt$  ratio depending on:**

- the motor cable (type, cross-section, length screened or unscreened)
- inductance

The natural induction causes an overshoot  $U_{PEAK}$  in the motor voltage before it stabilises itself at a level depending on the voltage in the intermediate circuit. The rise time and the peak voltage  $U_{PEAK}$  affect the service life of the motor. If the peak voltage is too high, especially motors without phase coil insulation are affected. If the motor cable is short (a few metres), the rise time and peak voltage are lower.

If the motor cable is long (100 m), the rise time and peak voltage are higher.

In motors without phase insulation paper or other insulation reinforcement suitable for operation with voltage supply (such as a frequency converter), fit a  $du/dt$  filter or a sine-wave filter on the output of the frequency converter.

## 10.2. Special Conditions

### 10.2.1. Purpose of derating

Derating must be taken into account when using the frequency converter at low air pressure (heights), at low speeds, with long motor cables, cables with a large cross section or at high ambient temperature. The required action is described in this section.

### 10.2.2. Derating for Ambient Temperature

The average temperature ( $T_{AMB, AVG}$ ) measured over 24 hours must be at least 5 °C lower than the maximum allowed ambient temperature ( $T_{AMB, MAX}$ ).

If the frequency converter is operated at high ambient temperatures, the continuous output current should be decreased.

The derating depends on the switching pattern, which can be set to 60 AVM or SFAVM in parameter 14-00.

#### A enclosures

##### 60 AVM - Pulse Width Modulation

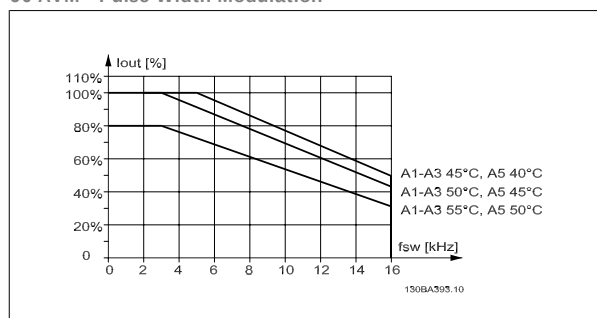


Illustration 10.1: Derating of  $I_{out}$  for different  $T_{AMB, MAX}$  for enclosure A, using 60 AVM

##### SFAVM - Stator Frequency Asynchron Vector Modulation

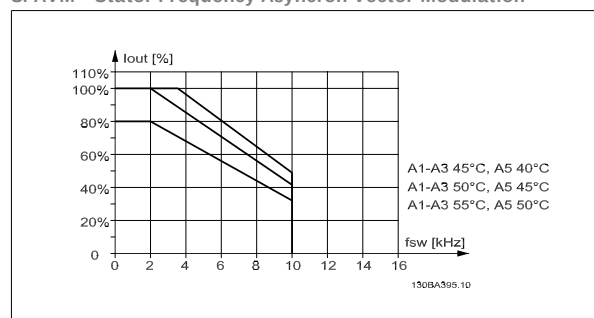


Illustration 10.2: Derating of  $I_{out}$  for different  $T_{AMB, MAX}$  for enclosure A, using SFAVM

In enclosure A, the length of the motor cable has a relatively high impact on the recommended derating. Therefore, the recommended derating for an application with max. 10 m motor cable is also shown.

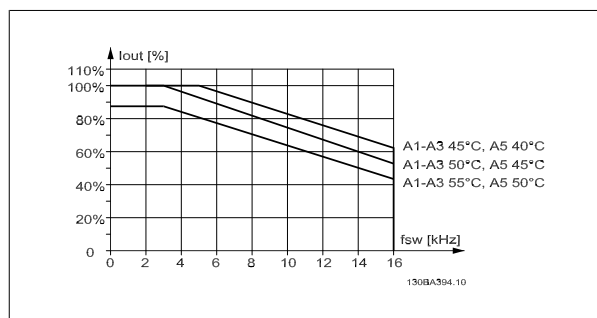


Illustration 10.3: Derating of  $I_{out}$  for different  $T_{AMB, MAX}$  for enclosure A, using 60 AVM and maximum 10 m motor cable

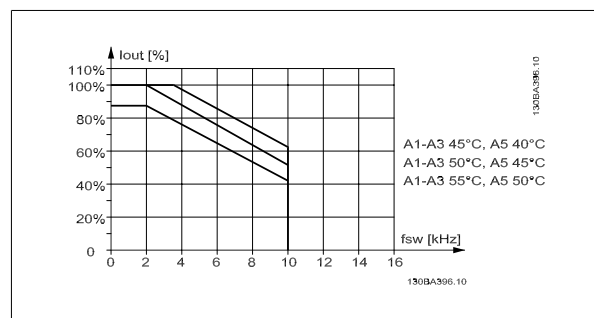


Illustration 10.4: Derating of  $I_{out}$  for different  $T_{AMB, MAX}$  for enclosure A, using SFAVM and maximum 10 m motor cable

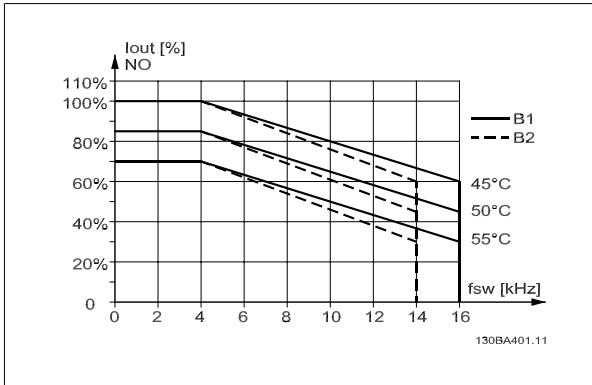
**B enclosures****60 AVM - Pulse Width Modulation**

Illustration 10.5: Derating of  $I_{out}$  for different  $T_{amb, MAX}$  for enclosure B, using 60 AVM in Normal torque mode (110% over torque)

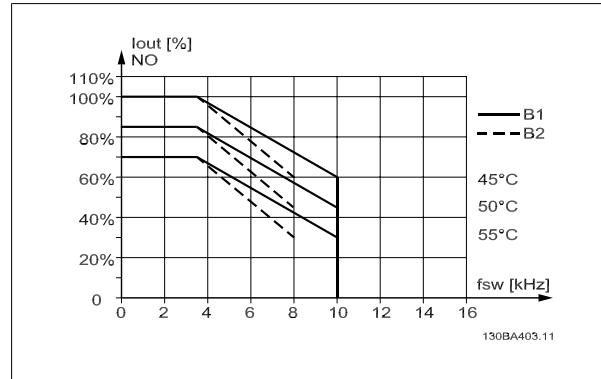
**SFAVM - Stator Frequency Asynchron Vector Modulation**

Illustration 10.6: Derating of  $I_{out}$  for different  $T_{amb, MAX}$  for enclosure B, using SFAVM in Normal torque mode (110% over torque)

**C enclosures**

Please note: For 90 kW in IP55 and IP66 the max. ambient temperature is 5° C lower.

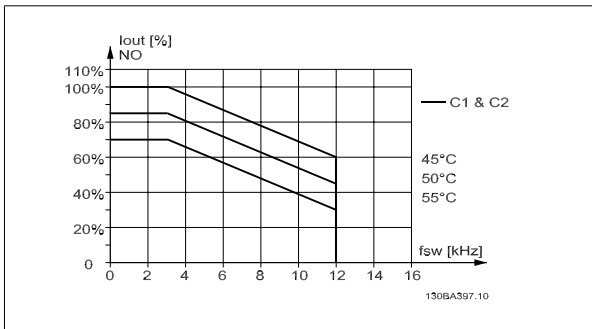
**60 AVM - Pulse Width Modulation**

Illustration 10.7: Derating of  $I_{out}$  for different  $T_{amb, MAX}$  for enclosure C, using 60 AVM in Normal torque mode (110% over torque)

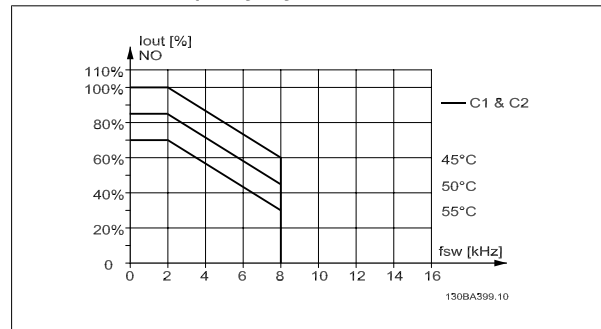
**SFAVM - Stator Frequency Asynchron Vector Modulation**

Illustration 10.8: Derating of  $I_{out}$  for different  $T_{amb, MAX}$  for enclosure C, using SFAVM in Normal torque mode (110% over torque)

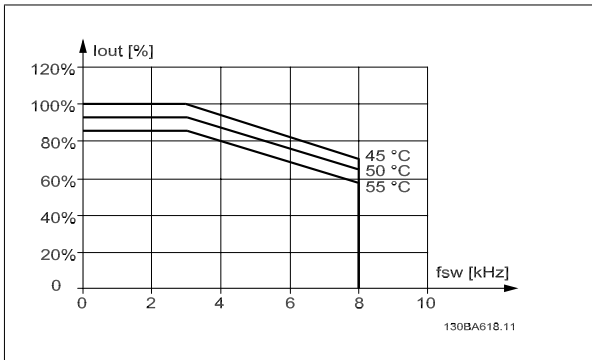
**D enclosures****60 AVM - Pulse Width Modulation, 380 - 480 V**

Illustration 10.9: Derating of  $I_{out}$  for different  $T_{amb, MAX}$  for enclosure D at 480 V, using 60 AVM in Normal torque mode (110% over torque)

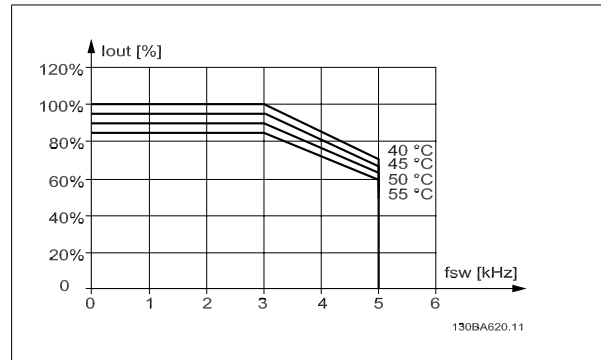
**SFAVM - Stator Frequency Asynchron Vector Modulation**

Illustration 10.10: Derating of  $I_{out}$  for different  $T_{amb, MAX}$  for enclosure D at 480 V, using SFAVM in Normal torque mode (110% over torque)

60 AVM - Pulse Width Modulation, 525 - 600 V (except P315)

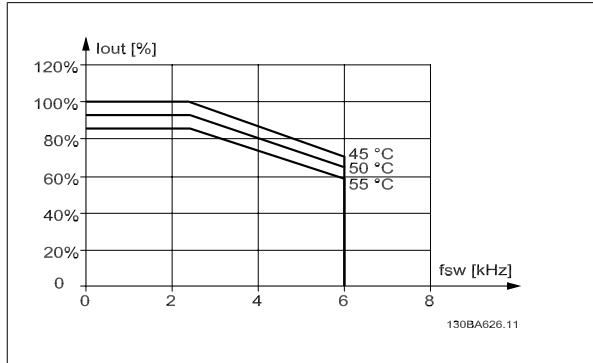


Illustration 10.11: Derating of  $I_{out}$  for different  $T_{AMB, MAX}$  for enclosure D at 600 V, using 60 AVM in Normal torque mode (110% over torque).  
Note: *not* valid for P315.

SFAVM - Stator Frequency Asyncon Vector Modulation

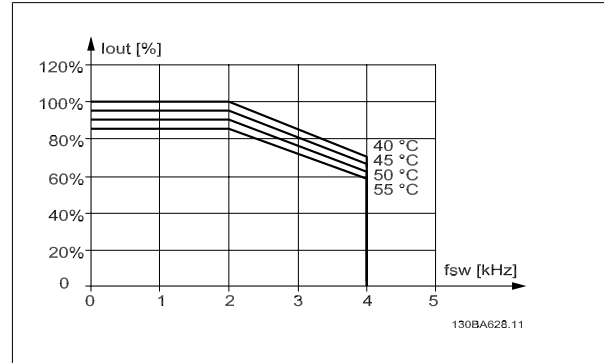


Illustration 10.12: Derating of  $I_{out}$  for different  $T_{AMB, MAX}$  for enclosure D at 600 V, using SFAVM in Normal torque mode (110% over torque).  
Note: *not* valid for P315.

60 AVM - Pulse Width Modulation, 525 - 600 V, P315

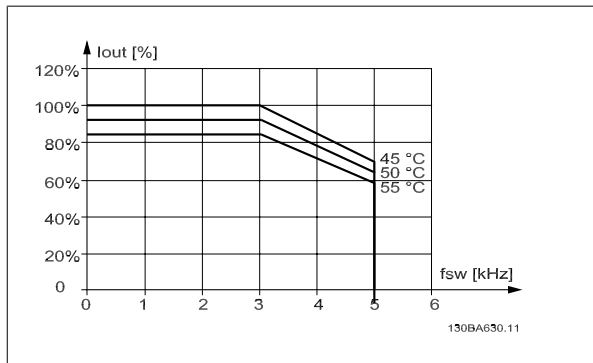


Illustration 10.13: Derating of  $I_{out}$  for different  $T_{AMB, MAX}$  for enclosure D at 600 V, using 60 AVM in Normal torque mode (110% over torque).  
Note: P315 *only*.

SFAVM - Stator Frequency Asyncon Vector Modulation

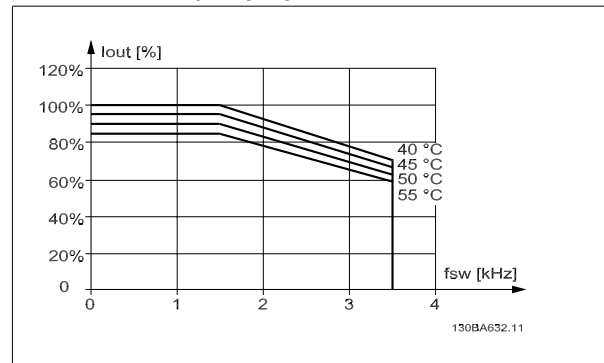


Illustration 10.14: Derating of  $I_{out}$  for different  $T_{AMB, MAX}$  for enclosure D at 600 V, using SFAVM in Normal torque mode (110% over torque).  
Note: P315 *only*.

## E enclosures

60 AVM - Pulse Width Modulation, 380 - 480 V

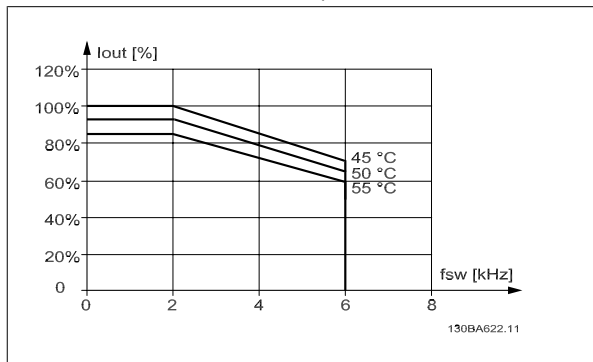


Illustration 10.15: Derating of  $I_{out}$  for different  $T_{AMB, MAX}$  for enclosure E at 480 V, using 60 AVM in Normal torque mode (110% over torque)

SFAVM - Stator Frequency Asyncon Vector Modulation

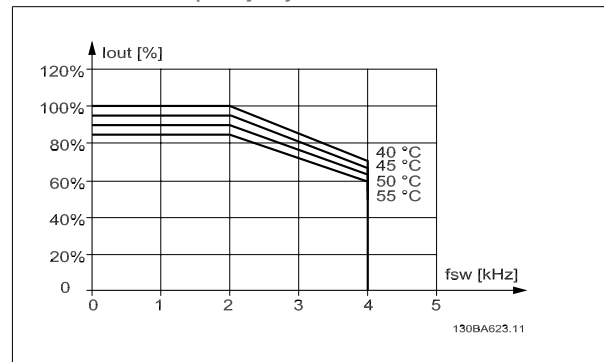


Illustration 10.16: Derating of  $I_{out}$  for different  $T_{AMB, MAX}$  for enclosure E at 480 V, using SFAVM in Normal torque mode (110% over torque)

60 AVM - Pulse Width Modulation, 525 - 600 V

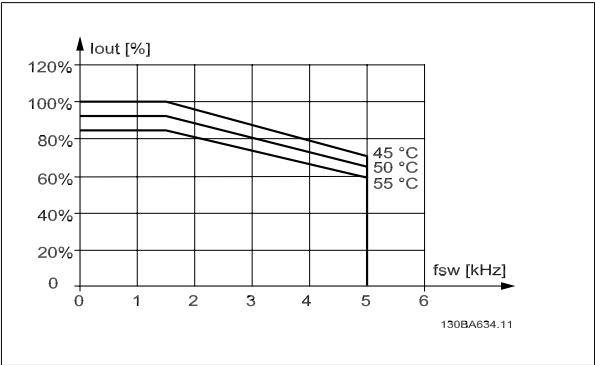


Illustration 10.17: Derating of  $I_{out}$  for different  $T_{AMB, MAX}$  for enclosure E at 600 V, using 60 AVM in Normal torque mode (110% over torque).

SFAVM - Stator Frequency Asyncon Vector Modulation

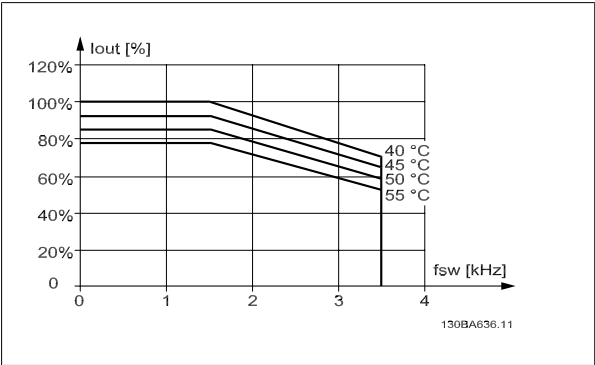


Illustration 10.18: Derating of  $I_{out}$  for different  $T_{AMB, MAX}$  for enclosure E at 600 V, using SFAVM in Normal torque mode (110% over torque).

10.2.3. Derating for Low Air Pressure

The cooling capability of air is decreased at lower air pressure.

At altitudes higher than 2 km, please contact Danfoss regarding PELV.

Below 1000 m altitude no derating is necessary but above 1000 m the ambient temperature ( $T_{AMB}$ ) or max. output current ( $I_{out}$ ) should be derated in accordance with the shown diagram.

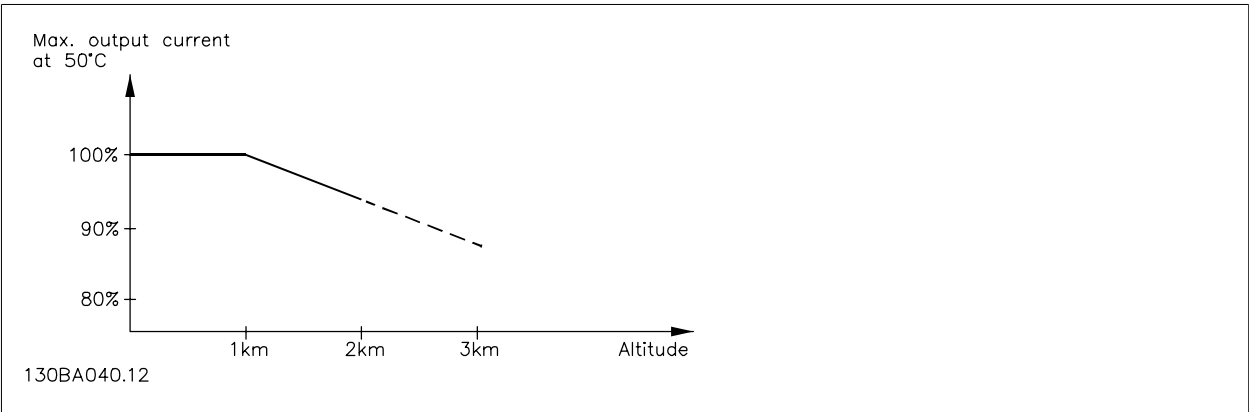


Illustration 10.19: Derating of output current versus altitude at  $T_{AMB, MAX}$ . By altitudes above 2 km, please contact Danfoss regarding PELV.

An alternative is to lower the ambient temperature at high altitudes and thereby ensure 100% output current at high altitudes.

### 10.2.4. Derating for Running at Low Speed

When a motor is connected to a frequency converter, it is necessary to check that the cooling of the motor is adequate. The level of heating depends on the load on the motor, as well as the operating speed and time.

#### Constant torque applications (CT mode)

A problem may occur at low RPM values in constant torque applications. In a constant torque application a motor may over-heat at low speeds due to less cooling air from the motor integral fan.

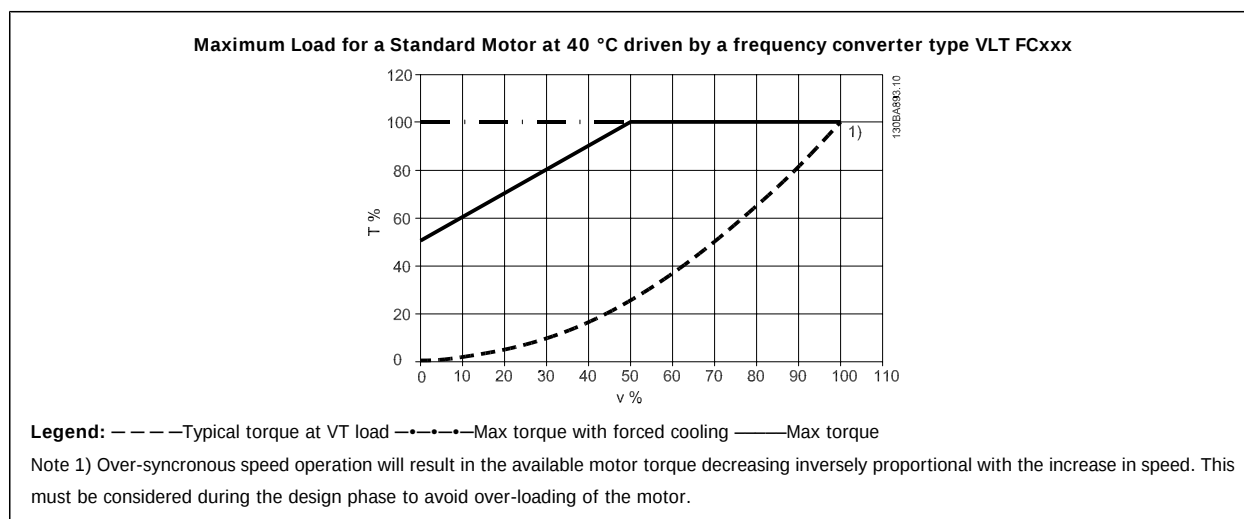
Therefore, if the motor is to be run continuously at an RPM value lower than half of the rated value, the motor must be supplied with additional air-cooling (or a motor designed for this type of operation may be used).

An alternative is to reduce the load level of the motor by choosing a larger motor. However, the design of the frequency converter puts a limit to the motor size.

#### Variable (Quadratic) torque applications (VT)

In VT applications such as centrifugal pumps and fans, where the torque is proportional to the square of the speed and the power is proportional to the cube of the speed, there is no need for additional cooling or de-rating of the motor.

In the graphs shown below, the typical VT curve is below the maximum torque with de-rating and maximum torque with forced cooling at all speeds.



### 10.2.5. Derating for Installing Long Motor Cables or Cables with Larger Cross-Section

The maximum cable length for this frequency converter is 300 m unscreened and 150 m screened cable.

The frequency converter has been designed to work using a motor cable with a rated cross-section. If a cable with a larger cross-section is used, reduce the output current by 5% for every step the cross-section is increased.

(Increased cable cross-section leads to increased capacity to earth, and thus an increased earth leakage current).

#### 10.2.6. Automatic adaptations to ensure performance

The frequency converter constantly checks for critical levels of internal temperature, load current, high voltage on the intermediate circuit and low motor speeds. As a response to a critical level, the frequency converter can adjust the switching frequency and / or change the switching pattern in order to ensure the performance of the frequency converter. The capability to automatically reduce the output current extends the acceptable operating conditions even further.

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