

MAKING MODERN LIVING POSSIBLE

Danfoss



## Quick Guide

### VLT® HVAC Basic Drive Cascade Control

## Contents

<b>1 Quick Guide</b>	2
1.1 Safety	2
1.1.1 Warnings	2
1.1.2 Safety Instructions	2
1.2 Introduction	2
1.2.1 Available Literature	2
1.2.2 Approvals	2
1.2.3 IT Mains	3
1.2.4 Avoid Unintended Start	3
1.2.5 Disposal Instruction	3
1.3 Installation	3
1.3.1 Before Starting Repair Work	3
1.3.2 Side-by-Side Installation	3
1.3.3 Mechanical Dimensions	4
1.3.4 Electrical Installation in General	4
1.3.5 Connecting to Mains and Motor	5
1.3.6 Fuses	6
1.3.7 EMC-Correct Electrical Installation	7
1.3.8 Control Terminals	9
1.3.9 Electrical Overview	10
1.4 Programming	11
1.4.1 Programming with the Local Control Panel (LCP)	11
1.4.2 The Start-up Wizard for Open Loop Applications	12
1.5 Cascade Controller	19
1.5.1 BASIC Cascade Controller	19
1.5.2 System Status and Operation	19
1.5.3 Start/Stop Conditions	21
1.5.4 Cascade Application Wizard	22
1.6 Parameter Overview	23
1.7 Warnings and Alarms	30
1.8 General Specifications	32
1.8.1 Mains Supply 3 x 380-480VAC	33
1.8.2 EMC Test Results	35
1.9 Special Conditions	38
1.9.1 Derating for Ambient Temperature	38
1.9.2 Derating for Low Air Pressure	38
1.10 Options for VLT HVAC Basic Drive FC 111	38

# 1 Quick Guide

## 1.1 Safety

### 1.1.1 Warnings

#### **WARNING**

##### High Voltage Warning

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

#### **WARNING**

##### Electrical Hazard

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). Be aware that there may be high voltage on the DC link even when the LEDs are turned off. Before touching any potentially live parts of the frequency converter, wait at least as stated in the table below:

Voltage (V)	Power range (kW)	Min. waiting time (min.)
3 x 400	0,37 – 7,5	4
3 x 400	11 – 90	15

#### **CAUTION**

##### Leakage Current:

The earth leakage current from the frequency converter exceeds 3.5 mA. According to IEC 61800-5-1 a reinforced Protective Earth connection must be ensured by means of a min. 10mm<sup>2</sup> Cu 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 DC current in the protective conductor. Where a residual current device (RCD) is used for extra protection, only an RCD of Type B (time delayed) shall be used on the supply side of this product. See also Danfoss Application Note on RCD, MN.90.GX.YY.

Protective earthing of the frequency converter and the use of RCDs must always follow national and local regulations.

##### Motor Thermal Protection:

Motor overload protection is possible by setting Parameter 1-90 Motor thermal protection to the value Electronic Thermal Relay (ETR) trip.

#### **WARNING**

##### Installation at high altitudes

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

### 1.1.2 Safety Instructions

- Make sure the frequency converter is properly connected to earth.
- Do not remove mains connections, motor connections or other power connections while the frequency converter is connected to power.
- Protect users against supply voltage.
- Protect the motor against overloading according to national and local regulations.
- The earth leakage current exceeds 3.5 mA.
- The [OFF] key is not a safety switch. It does not disconnect the frequency converter from mains.

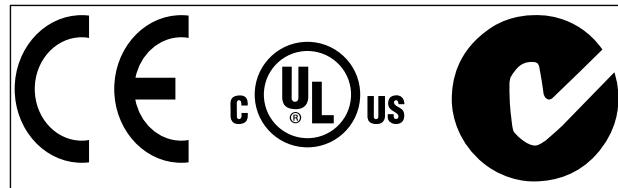
## 1.2 Introduction

### 1.2.1 Available Literature

This quick guide contains the basic information necessary for installing and running the frequency converter. If more information is needed, literature can be found on the enclosed cd or downloaded from:

<http://www.danfoss.com/Products/Literature/Technical+Documentation.htm>

### 1.2.2 Approvals



### 1.2.3 IT Mains

#### **CAUTION**

##### IT Mains

Installation on isolated mains source, i.e. IT mains.

Max. supply voltage allowed when connected to mains:  
440V (3x380-480V units).

On 380-480V IP20 0,37-22kW, open the RFI switch by removing the screw on the side of the frequency converter when at IT grid.

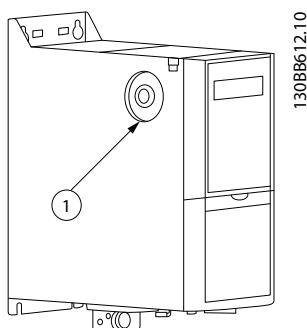


Illustration 1.1 IP20 0,37-22kW 380-480V.

1: EMC screw

On all units, set par. 14-50 *RFI filter* to *OFF* when operating in IT mains.

#### **CAUTION**

If reinserted, only use M3x12 screw.

### 1.2.4 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 LCP.

- Disconnect the frequency converter from mains whenever personal safety considerations make it necessary to avoid unintended start of any motors.
- To avoid unintended start, always activate the [OFF] key before changing parameters.

### 1.2.5 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.

### 1.3 Installation

#### 1.3.1 Before Starting Repair Work

1. Disconnect FC 111 from mains (and external DC supply, if present.)
2. Wait as stated in the table below for discharge of the DC-link:

Voltage (V)	Power range (kW)	Min. waiting time (min.)
3 x 400	0.37 – 7.5	4
3 x 400	11 – 90	15

3. Remove motor cable

#### 1.3.2 Side-by-Side Installation

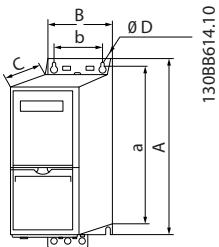
The frequency converter can be mounted side-by-side and requires the clearance above and below for cooling.

Frame	IP class	Power	Clearance above/below (mm/inch)
H1	IP20	0.37-1.5kW/ 0.5-2Hp	100/4
H2	IP20	2.2-4kW/ 3-5.4Hp	100/4
H3	IP20	5.5-7.5 kW/ 7.5-10 Hp	100/4
H4	IP20	11-15kW/ 15-20Hp	100/4
H5	IP20	18.5-22kW/ 25-30Hp	100/4
H6	IP20	30-45kW/ 40-60Hp	200/7,9
H7	IP20	55-75kW/ 100-120Hp	200/7,9
H8	IP20	90kW/ 125Hp	225/8,9

#### NOTE

With IP21/Nema Type1 option kit mounted, a distance of 50mm between the units is required.

### 1.3.3 Mechanical Dimensions



		Power	Height (mm/inch)			Width (mm/inch)		Depth (mm/inch)	Hole (mm)
Frame	IP class	3 x 380-480V	A	A incl. Decoupling plate	A	B	b	C	D
H1	IP20	0.37-1.5kW/ 0.5-2Hp	195/7.7	273/10.7	183/7.2	75/3	56/2.2	168/6.6	4.5
H2	IP20	2.2-4kW/ 3-5.4Hp	227/8.4	303/11.9	212/8.3	90/3.5	65/2.6	190/7.5	5.5
H3	IP20	5.5-7.5kW/ 7.5-10Hp	255/10	329/13	240/9.4	100/3.9	74/2.9	206/8.1	5.5
H4	IP20	11-15kW/ 15-20Hp	296/11.7	359/14.1	275/10.8	135/5.3	105/4.1	241/9.5	7
H5	IP20	18.5-22kW/ 25-30Hp	334/13.1	402/15.8	314/12.4	150/5.9	120/4.7	255/10	7
H6	IP20	30-45kW/ 40-60Hp	518/20.4	595/23.4 635/25	495/19.5	239/31.5	200/7.9	242/9.5	8.5
H7	IP20	55-75kW/ 100-120Hp	550/21.7	630/24.8 690/27.2	521/20.5	313/12.3	270/10.6	335/13.2	8.5
H8	IP20	90kW/ 120Hp	660/26	800/31.5	631/24.8	375/14.8	330/13	335/13.2	8.5

Table 1.1 Mechanical Dimensions

### 1.3.4 Electrical Installation in General

All cabling must comply with national and local regulations on cable cross-sections and ambient temperature. Copper conductors required, (75°C) recommended.

Power (kW)			Torque (Nm)					
Frame	IP class	3 x 380-480	Line	Motor	DC connection	Control terminals	Earth	Relay
H1	IP20	0.37-1.5	1.4	0.8	0.8	0.5	3	0.5
H2	IP20	2.2-4	1.4	0.8	0.8	0.5	3	0.5
H3	IP20	5.5-7.5	1.4	0.8	0.8	0.5	3	0.5
H4	IP20	11-15	1.2	1.2	1.2	0.5	3	0.5
H5	IP20	18.5-22	1.2	1.2	1.2	0.5	3	0.5
H6	IP20	30-45	4.5	4.5	-	0.5	3	0.5
H7	IP20	55	10	10	-	0.5	3	0.5
H7	IP20	75	14	14	-	0.5	3	0.5
H8	IP20	90	14 <sup>1</sup>	14 <sup>1</sup>	-	0.5	3	0.5
H8	IP20	90	24 <sup>2</sup>	24 <sup>2</sup>	-	0.5	3	0.5

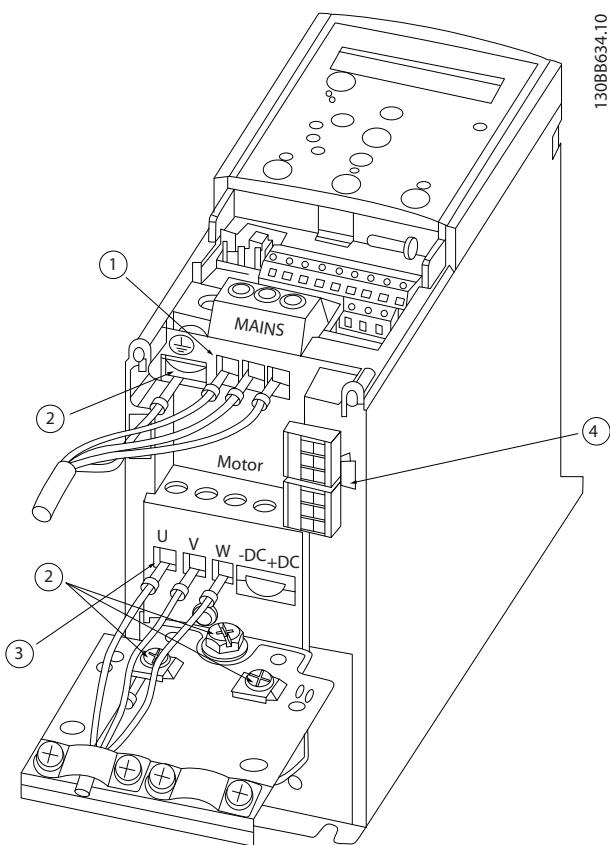
<sup>1</sup> Cable dimensions ≤ 95mm<sup>2</sup>

<sup>2</sup> Cable dimensions > 95mm<sup>2</sup>

### 1.3.5 Connecting to Mains and Motor

The frequency converter is designed to operate all standard three-phased asynchronous motors. For maximum cross-section on wires please see section *Mains Supply*.

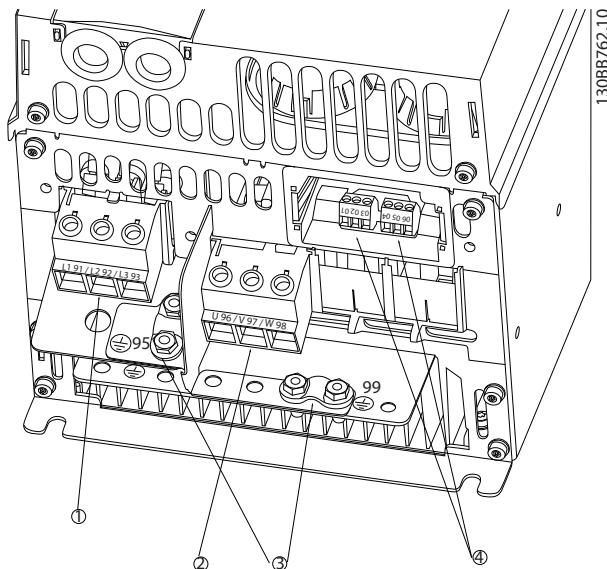
- Use a shielded/armored motor cable to comply with EMC emission specifications, and connect this cable to both the decoupling plate and the motor metal.
  - Keep motor cable as short as possible to reduce the noise level and leakage currents.
  - For further details on mounting of the decoupling plate, please see instruction MI. 02.QX.YY
  - Also see *EMC-Correct Installation* in the Design Guide, MG.18.CX.YY.
1. Mount the earth wires to earth terminal.
  2. Connect motor to terminals U, V and W.
  3. Mount mains supply to terminals L1, L2 and L3 and tighten.



**Illustration 1.2 IP20 380-480V 0.37-22kW.**

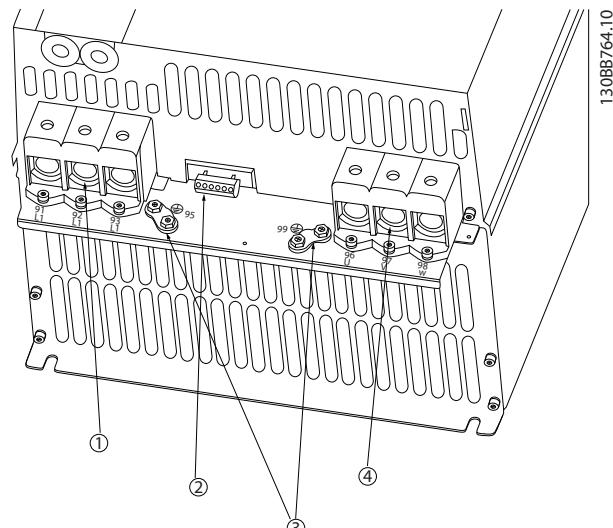
1	Line
2	Earth
3	Motor
4	Relays

IP20 380-480V 30-45kW



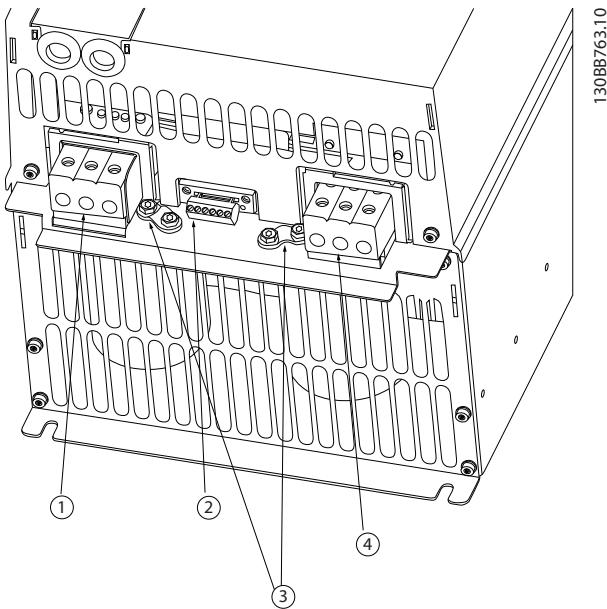
1	Line
2	Motor
3	Earth
4	Relays

IP20 380-480V 90kW



1	Line
2	Relays
3	Earth
4	Motor

IP20 380-480V 55-75kW



1	Line
2	Relays
3	Earth
4	Motor

### 1.3.6 Fuses

#### Branch circuit protection

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

#### Short circuit protection

Danfoss recommends using the fuses mentioned in the following tables to protect service personnel or other equipment in case of an internal failure in the unit or short-circuit on DC-link. The frequency converter provides full short circuit protection in case of a short-circuit on the motor.

#### Overcurrent protection

Provide overload protection to avoid overheating of the cables in the installation. Overcurrent protection must always be carried out according to national regulations. Fuses must be designed for protection in a circuit capable of supplying a maximum of 100,000A<sub>rms</sub> (symmetrical), 480V maximum.

**Non UL compliance**

If UL/cUL is not to be complied with, Danfoss recommends using the fuses mentioned in the below table, which will ensure compliance with IEC 61800-5-1:

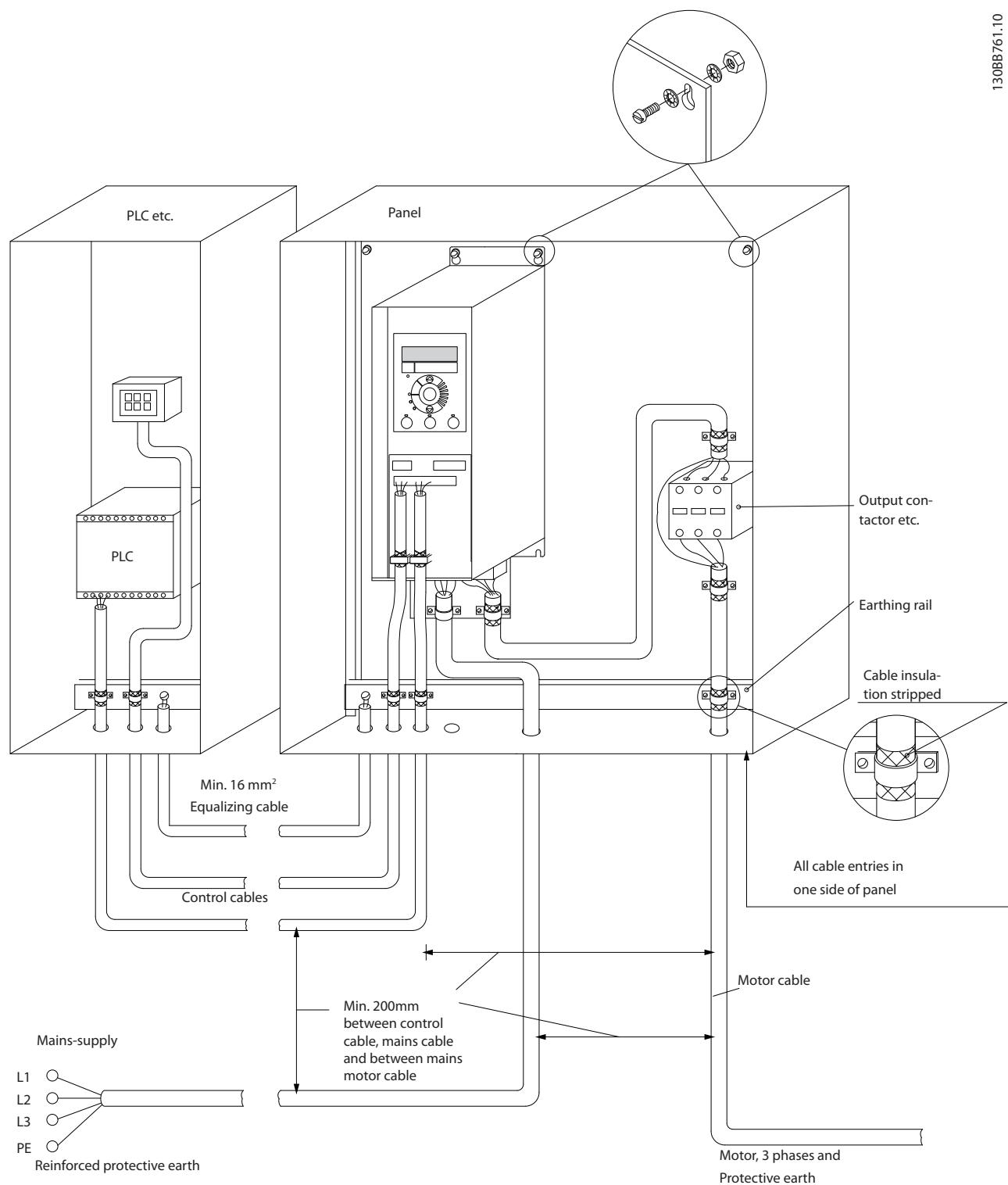
In case of malfunction, not following the fuse recommendation may result in damage to the frequency converter.

UL					Non UL
	Bussmann	Bussmann	Bussmann	Bussmann	Max. Fuse
<b>Power kW</b>	<b>Type RK5</b>	<b>Type RK1</b>	<b>Type J</b>	<b>Type T</b>	<b>Type gG</b>
<b>3 x 380-480V</b>					
<b>0.37</b>	FRS-R-10	KTS-R10	JKS-10	JJS-10	10
<b>0.75</b>	FRS-R-10	KTS-R10	JKS-10	JJS-10	10
<b>1.5</b>	FRS-R-10	KTS-R10	JKS-10	JJS-10	10
<b>2.2</b>	FRS-R-15	KTS-R15	JKS-15	JJS-15	16
<b>3</b>	FRS-R-15	KTS-R15	JKS-15	JJS-15	16
<b>4</b>	FRS-R-15	KTS-R15	JKS-15	JJS-15	16
<b>5.5</b>	FRS-R-25	KTS-R25	JKS-25	JJS-25	25
<b>7.5</b>	FRS-R-25	KTS-R25	JKS-25	JJS-25	25
<b>11</b>	FRS-R-50	KTS-R50	JKS-50	JJS-50	50
<b>15</b>	FRS-R-50	KTS-R50	JKS-50	JJS-50	50
<b>18.5</b>	FRS-R-80	KTS-R80	JKS-80	JJS-80	65
<b>22</b>	FRS-R-80	KTS-R80	JKS-80	JJS-80	65
<b>30</b>	FRS-R-80	KTS-R80	JKS-R80	JJS-R80	80
<b>37</b>	FRS-R-100	KTS-R100	JKS-R100	JJS-R100	100
<b>45</b>	FRS-R-125	KTS-R125	JKS-R125	JJS-R125	125
<b>55</b>	FRS-R-150	KTS-R150	JKS-R150	JJS-R150	150
<b>75</b>	FRS-R-200	KTS-R200	JKS-R200	JJS-R200	200
<b>90</b>	FRS-R-250	KTS-R250	JKS-R250	JJS-R250	250

**1.3.7 EMC-Correct Electrical Installation**

General points to be observed to ensure EMC-correct electrical installation.

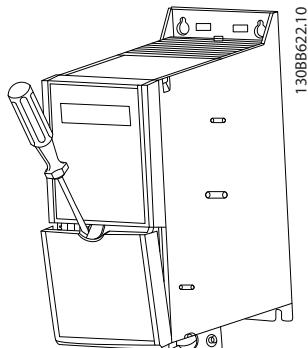
- Use only screened/armoured motor cables and screened/armoured control cables.
- Connect the screen to earth at both ends.
- Avoid installation with twisted screen ends (pigtails), since this ruins the screening effect at high frequencies. Use the cable clamps provided instead.
- It is important to ensure good electrical contact from the installation plate through the installation screws to the metal cabinet of the frequency converter.
- Use starwashers and galvanically conductive installation plates.
- Do not use unscreened/unarmoured motor cables in the installation cabinets.

**Illustration 1.3 EMC-correct Electrical Installation**

For North America use metal conduits instead of shielded cables.

### 1.3.8 Control Terminals

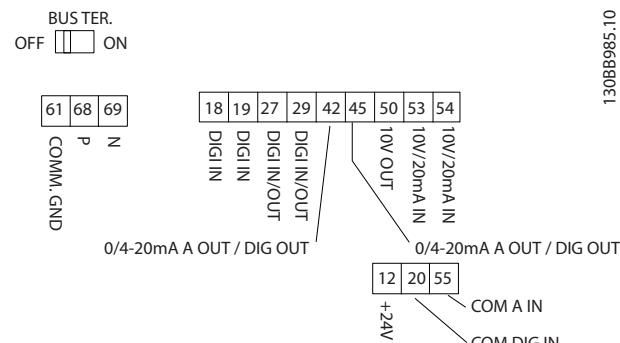
IP20 380-480V 0.37-22kW:



**Illustration 1.4 Location of Control Terminals**

#### Control terminals:

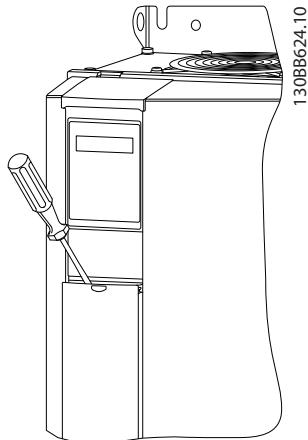
*Illustration 1.5 shows all control terminals of the frequency converter. Applying Start (term. 18), connection between terminal 12-27 and an analog reference (term. 53 or 54 and 55) make the frequency converter run.*



**Illustration 1.5 Control Terminals**

1. Place a screwdriver behind the terminal cover to activate snap.
2. Tilt the screwdriver outwards to open the cover.

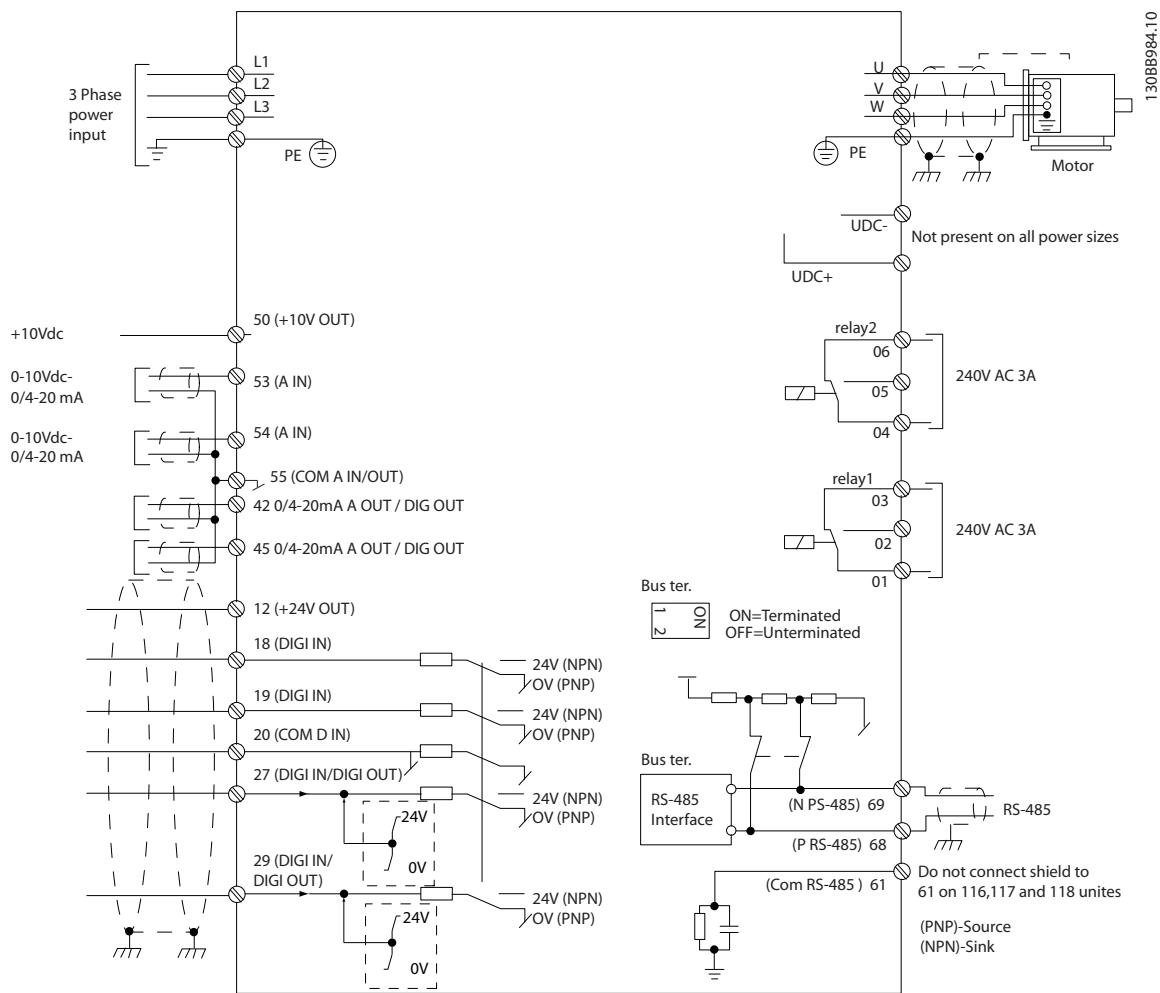
IP20 380-480V 30-90kW.



1. Place a screwdriver behind the terminal cover to activate snap.
2. Tilt the screwdriver outwards to open the cover.

Digital input 18, 19 and 27 mode is set in 5-00 *Terminal 18 Digital Input* (PNP is default value) and digital input 29 mode is set in 5-03 *Digital Input 29 Mode* (PNP is default value).

## 1.3.9 Electrical Overview

**NOTE**

Please note there is no access to UDC- and UDC+ on the following units:

IP20 380-480V 30-90kW

## 1.4 Programming

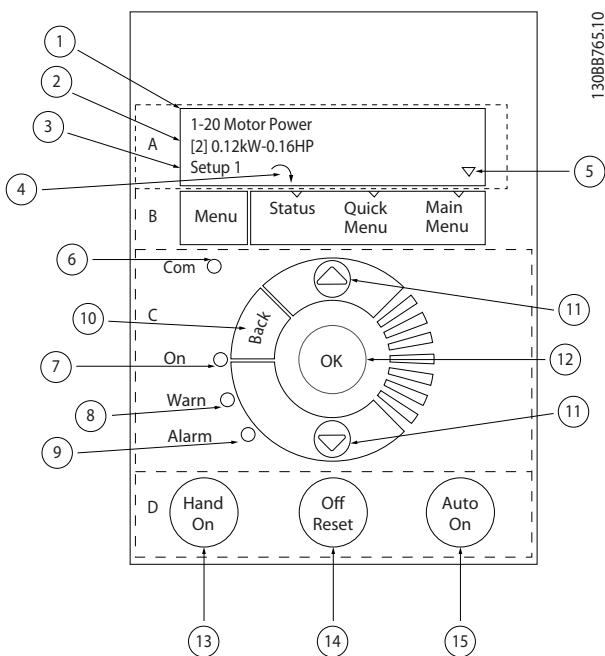
### 1.4.1 Programming with the Local Control Panel (LCP)

#### NOTE

The frequency converter can also be programmed from a PC via RS485 com-port by installing the MCT-10 Set-up Software. This software can either be ordered using code number 130B1000 or downloaded from the Danfoss Web site: [www.danfoss.com/BusinessAreas/DrivesSolutions/softwaredownload](http://www.danfoss.com/BusinessAreas/DrivesSolutions/softwaredownload)

The following instructions are valid for the FC 111 LCP. The LCP is divided into four functional sections.

- A. Alphanumeric display
- B. Menu key
- C. Navigation keys and indicator lights (LEDs)
- D. Operation keys and indicator lights (LEDs)



#### A. Alpha Numeric Display

The LCD-display is back-lit with 2 alpha-numeric lines. All data is displayed on the LCP.

A number of information can be read from the display.

1	Parameter number and name.
2	Parameter value.
3	Set-up number shows the active set-up and the edit set-up. If the same set-up acts as both active and edit set-up, only that set-up number is shown (factory setting). When active and edit set-up differ, both numbers are shown in the display (Setup 12). The number flashing, indicates the edit set-up.
4	Motor direction is shown to the bottom left of the display – indicated by a small arrow pointing either clockwise or counterclockwise.
5	The triangle indicates if the LCP is in status, quick menu or main menu.

#### B. Menu Key

Use the menu key to select between status, quick menu or main menu.

#### C. Navigation keys and indicator lights (LEDs)

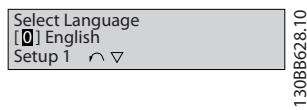
6	Com led: Flashes when bus communication is communicating.
7	Green LED/On: Control section is working.
8	Yellow LED/Warn.: Indicates a warning.
9	Flashing Red LED/Alarm: Indicates an alarm.
10	[Back]: For moving to the previous step or layer in the navigation structure
11	Arrows [▲] [▼]: For maneuvering between parameter groups, parameters and within parameters. Can also be used for setting local reference.
12	[OK]: For selecting a parameter and for accepting changes to parameter settings

#### D. Operation keys and indicator lights (LEDs)

13	[Hand on]: Starts the motor and enables control of the frequency converter via the LCP.  <b>NOTE</b> Please note that terminal 27 Digital Input (5-12 Terminal 27 Digital Input) has coast inverse as default setting. This means that [Hand On] will not start the motor if there is no 24V to terminal 27, so please connect terminal 12 to terminal 27.
14	[Off/Reset]: Stops the motor (off). If in alarm mode the alarm will be reset.
15	[Auto on]: Frequency converter is controlled either via control terminals or serial communication.

**At power-up**

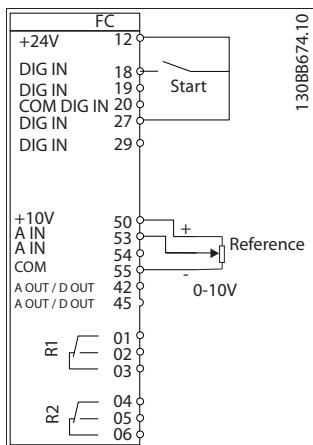
At the first power-up the user is asked to choose preferred language. Once selected this screen will never be shown again in the following powerups, but language can still be changed in *0-01 Language*.



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### 1.4.2 The Start-up Wizard for Open Loop Applications

The built in “wizard” menu guides the installer through the set up of the drive in a clear and structured manner in order to setup an open loop application. A open loop application is here an application with a start signal, analog reference (voltage or current) and optionally also relay signals (but no feed back signal from the process applied).



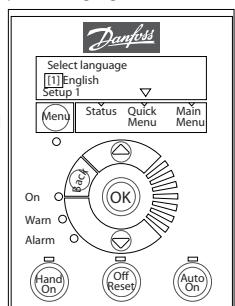
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The wizard will initially be shown after power up until any parameter has been changed. The wizard can always be accessed again through the quick menu. Press [OK] to start the wizard. If [BACK] is pressed, the FC 111 will return to the status screen.



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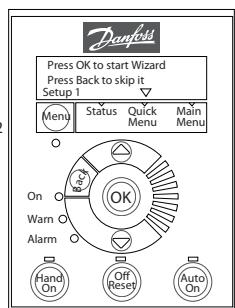
At power up the user is asked to choose the preferred language.



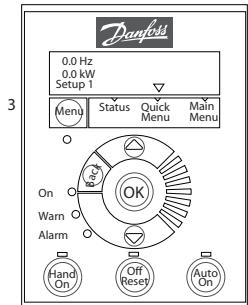
Power Up Screen



The next screen will be the Wizard screen.



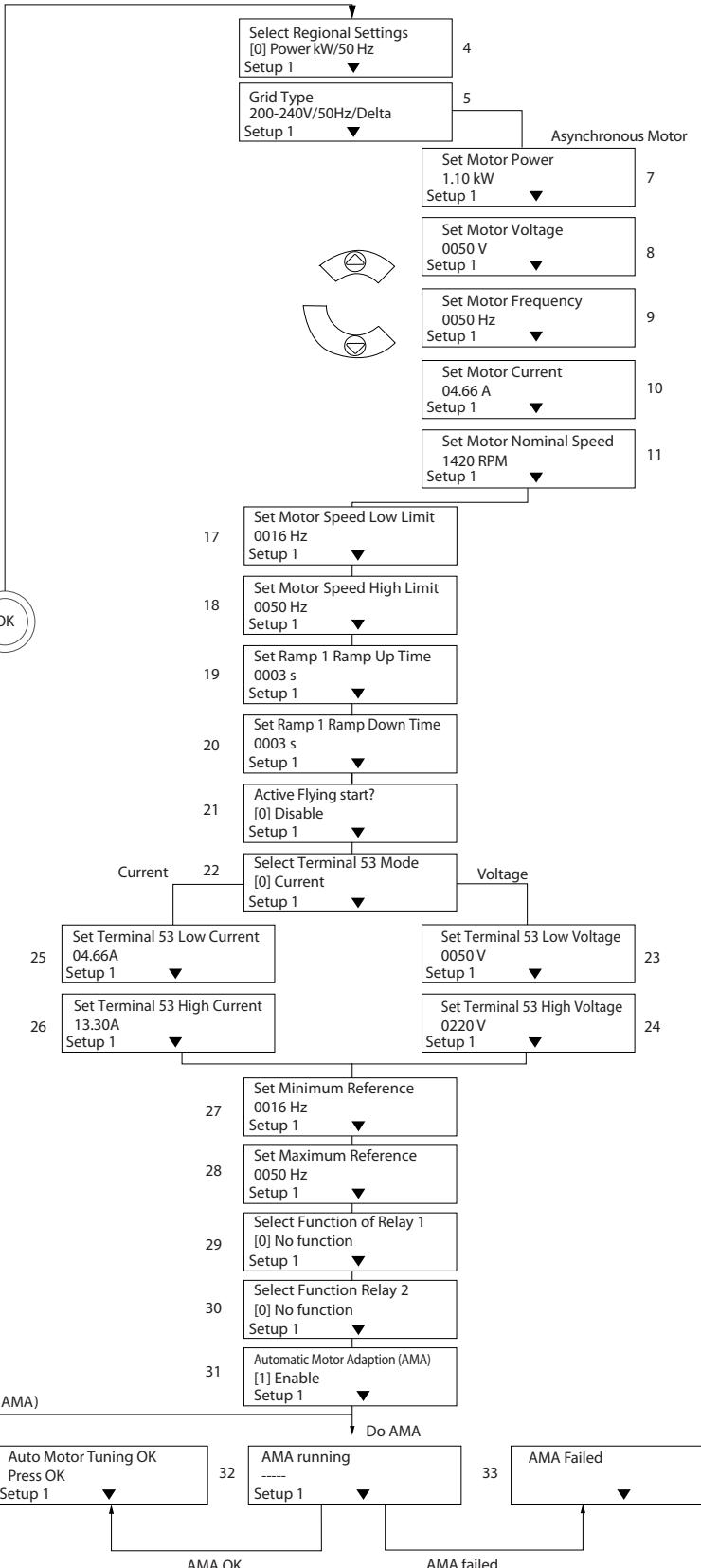
Wizard Screen



Status Screen

The Wizard can always be reentered via the Quick Menu!

- the HVAC FC 101 Wizard starts

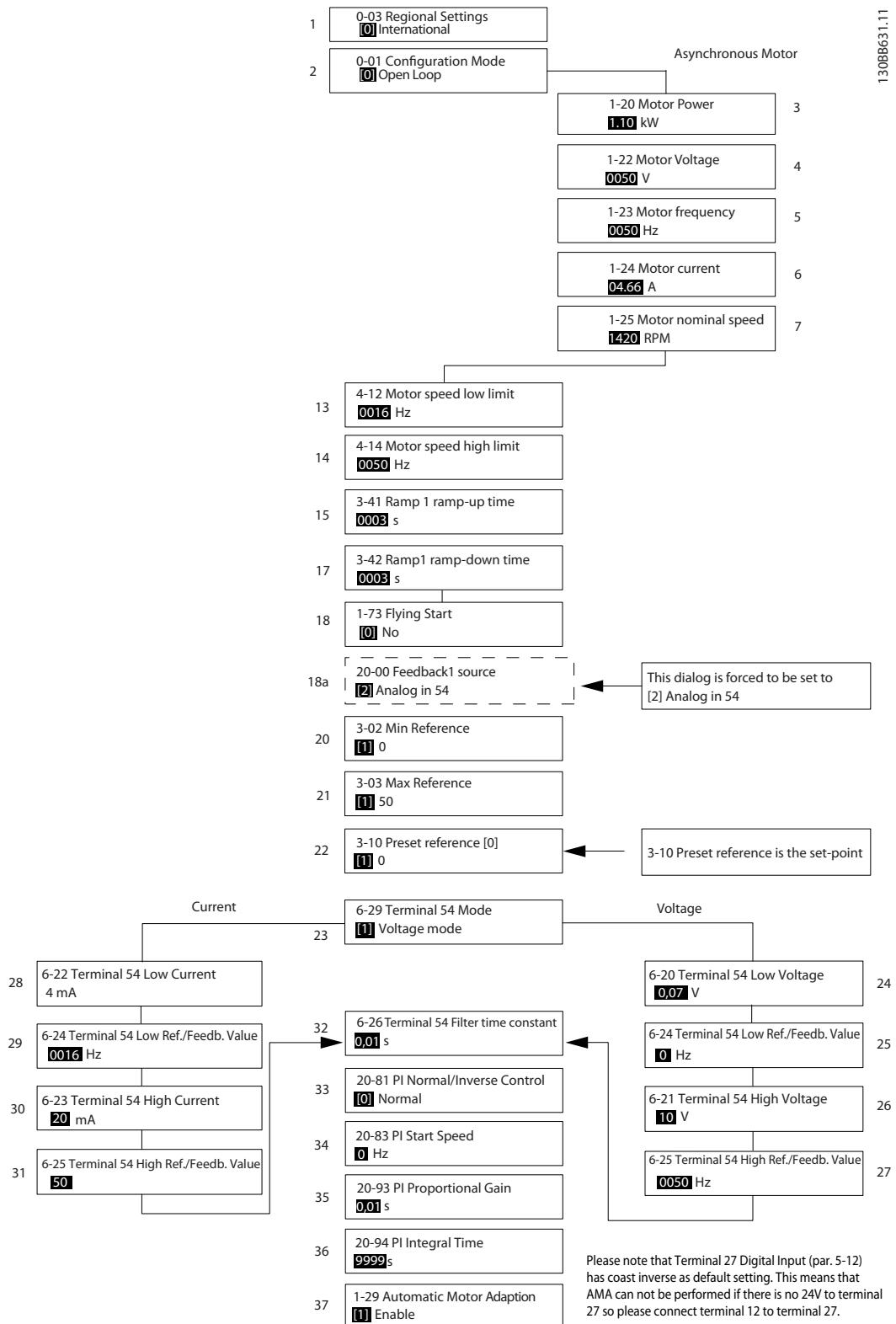


## The FC 111 Start-up Wizard for Open Loop Applications

No & Name	Range	Default	Function
0-03 Regional Settings	[0] International [1] US	0	
0-06 Grid Type	0] 200-240V/50Hz/IT-grid [1] 200-240V/50Hz/Delta [2] 200-240V/50Hz [10] 380-440V/50Hz/IT-grid [11] 380-440V/50Hz/Delta [12] 380-440V/50Hz [20] 440-480V/50Hz/IT-grid [21] 440-480V/50Hz/Delta [22] 440-480V/50Hz [30] 525-600V/50Hz/IT-grid [31] 525-600V/50Hz/Delta [32] 525-600V/50Hz [100] 200-240V/60Hz/IT-grid [101] 200-240V/60Hz/Delta [102] 200-240V/60Hz [110] 380-440V/60Hz/IT-grid [111] 380-440V/60Hz/Delta [112] 380-440V/60Hz [120] 440-480V/60Hz/IT-grid [121] 440-480V/60Hz/Delta [122] 440-480V/60Hz [130] 525-600V/60Hz/IT-grid [131] 525-600V/60Hz/Delta [132] 525-600V/60Hz	Size related	Select operating mode for restart upon reconnection of the drive to mains voltage after power down
1-20 Motor Power	0.12-110kW/0.16-150hp	Size related	Enter motor power from nameplate data
1-22 Motor Voltage	50.0 - 1000.0V	Size related	Enter motor voltage from nameplate data
1-23 Motor Frequency	20.0 - 400.0Hz	Size related	Enter motor frequency from nameplate data
1-24 Motor Current	0.01 - 10000.00A	Size related	Enter motor current from nameplate data
1-25 Motor Nominal Speed	100.0 - 9999.0 RPM	Size related	Enter motor nominal speed from nameplate data
4-12 Motor Speed Low Limit [Hz]	0.0 - 400 Hz	0 Hz	Enter the minimum limit for low speed
4-14 Motor Speed High Limit [Hz]	0.0 - 400 Hz	65 Hz	Enter the maximum limit for high speed
3-41 Ramp 1 Ramp up time	0.05 - 3600.0 s	Size related	Ramp up time from 0 to rated 1-23 Motor Frequency
3-42 Ramp 1 Ramp down time	0.05 - 3600.0 s	Size related	Ramp down time from rated 1-23 Motor Frequency to 0
1-73 Flying Start	[0] Disabled [1] Enabled	0	Select Enable to enable the frequency converter to catch a spinning motor i.e. fan applications
6-19 Terminal 53 mode	[0] Current [1] Voltage	1	Select if terminal 53 is used for current- or voltage input
6-10 Terminal 53 Low Voltage	0-10V	0.07V	Enter the voltage that corresponds to the low reference value
6-11 Terminal 53 High Voltage	0-10V	10V	Enter the voltage that corresponds to the high reference value
6-12 Terminal 53 Low Current	0-20mA	4	Enter the current that corresponds to the low reference value
6-13 Terminal 53 High Current	0-20mA	20	Enter the current that corresponds to the high reference value
3-02 Minimum Reference	-4999-4999	0	The minimum reference is the lowest value obtainable by summing all references

No & Name	Range	Default	Function
3-03 Maximum Reference	-4999-4999	50	The maximum reference is the lowest obtainable by summing all references
5-40 Function Relay [0] Function relay	See 5-40 Function Relay	Alarm	Select the function to control output relay 1
5-40 Function Relay [1] Function relay	See 5-40 Function Relay	Drive running	Select the function to control output relay 2
1-29 Auto Tune	See 1-29 Auto Tune	Off	Performing an AMA optimizes motor performance

## Closed Loop Set-up Wizard



**Closed Loop Set-up Wizard**

No & Name	Range	Default	Function
0-03 Regional Settings	[0] International [1] US	0	
1-20 Motor power	0.09-110kW	Size related	Enter motor power from nameplate data
1-22 Motor Voltage	50.0 - 1000.0V	Size related	Enter motor voltage from nameplate data
1-23 Motor Frequency	20.0 - 400.0Hz	Size related	Enter motor frequency from nameplate data
1-24 Motor Current	0.01 - 10000.00A	Size related	Enter motor current from nameplate data
1-25 Motor Nominal Speed	100.0 - 9999.0RPM	Size related	Enter motor nominal speed from nameplate data
4-12 Motor Speed Low Limit [Hz]	0.0 - 400Hz	0.0 Hz	Enter the minimum limit for low speed
4-14 Motor Speed High Limit [Hz]	0.1 - 400Hz	65Hz	Enter the maximum limit for high speed
3-41 Ramp 1 Ramp up time	0.05 - 3600.0 s	Size related	Ramp up time from 0 to rated motor frequency par. 1-23
3-42 Ramp 1 Ramp down time	0.05 - 3600.0 s	Size related	Ramp down time from rated motor frequency par. 1-23 to 0
1-73 Flying Start	[0] Disabled [1] Enabled	0	Select Enable to enable the drive to catch a spinning motor
3-02 Minimum Reference	-4999-4999	0	The minimum reference is the lowest value obtainable by summing all references
3-03 Maximum Reference	-4999-4999	50	The maximum reference is the highest value obtainable by summing all references
3-10 Preset Reference	-100-100%	0	Enter the set point
6-29 Modo terminal 54	[0] Current [1] Voltage	1	Select if terminal 54 is used for current- or voltage input
6-20 Terminal 53 Low Voltage	0-10V	0.07V	Enter the voltage that corresponds to the low reference value
6-21 Terminal 53 High Voltage	0-10V	10V	Enter the voltage that corresponds to the low high reference value
6-22 Terminal 60 Low Current	0-20mA	4	Enter the current that corresponds to the high reference value
6-23 Terminal 60 High Current	0-20mA	20	Enter the current that corresponds to the high reference value
6-24 Terminal 60 Low Ref./Feedb. Value	-4999-4999	0	Enter the feedback value that corresponds to the voltage or current set in par. 6-20/6-22
6-25 Terminal 60 High Ref./Feedb. Value	-4999-4999	50	Enter the feedback value that corresponds to the voltage or current set in par. 6-21/6-23
6-26 Terminal 60 Filter Time Constant	0-10 s	0.01	Enter the filter time constant
20-81 PI Normal/Inverse control	[0] Normal [1] Inverse	0	Select <i>Normal</i> [0] to set the process control to increase the output speed when the process error is positive. Select <i>Inverse</i> [1] to reduce the output speed.
20-83 PI Start Speed	0-200Hz	0	Enter the motor speed to be attained as a start signal for commencement of PI control
20-93 PI Proportional Gain	0-10	0.01	Enter the process controller proportional gain. Quick control is obtained at high amplification. However if amplification is too great, the process may become unstable
20-94 PID Integral Time	0.1-999.0s	999.0s	Enter the process controller integral time. Obtain quick control through a short integral time, though if the integral time is too short, the process becomes unstable. An excessively long integral time disables the integral action.
1-29 Automatic Motor Adaption (AMA)		Off	Performing an AMA optimizes motor performance

**Motor Set-up**

The Quick Menu Motor Set-up guides through the needed motor parameters.

No & Name	Range	Default	Function
0-03 Regional Settings	[0] International [1] US	0	
1-20 Motor power	0.12-110kW/ 0.16-150Hp	Size related	Enter motor power from nameplate data
1-22 Motor Voltage	50.0 - 1000.0V	Size related	Enter motor voltage from nameplate data
1-23 Motor Frequency	20.0 - 400.0Hz	Size related	Enter motor frequency from nameplate data
1-24 Motor Current	0.01 - 10000.00A	Size related	Enter motor current from nameplate data
1-25 Motor Nominal Speed	100.0 - 9999.0 RPM	Size related	Enter motor nominal speed from nameplate data
4-12 Motor Speed Low Limit [Hz]	0.0 - 400Hz	0.0 Hz	Enter the minimum limit for low speed
4-14 Motor Speed High Limit [Hz]	0-400HZ	65	Enter the maximum limit for high speed
3-41 Ramp 1 Ramp up time	0.05 - 3600.0 s	Size related	Ramp up time from 0 to rated motor frequency 1-23 Motor Frequency
3-42 Ramp 1 Ramp down time	0.05 - 3600.0 s	Size related	Ramp down time from rated motor frequency 1-23 Motor Frequency to 0
1-73 Flying Start	[0] Disabled [1] Enabled	0	Select Enable to enable the frequency converter to catch a spinning motor

**Changes Made**

Changes Made lists all parameters changed since factory setting. Only the changed parameters in current edit-setup are listed in changes made.

If the parameter's value is changed back to factory setting's value from another different value, the parameter will NOT be listed in Changes Made.

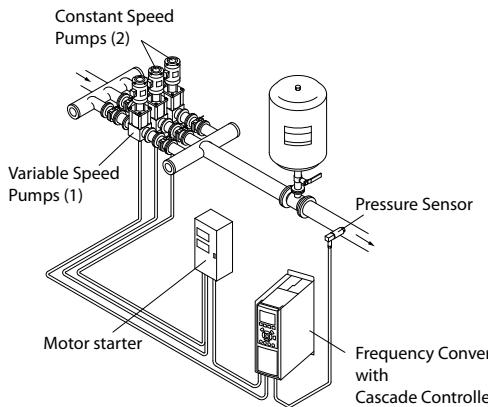
1. Press [MENU] key to enter the Quick Menu until indicator in display is placed above Quick Menu.
2. Press [ $\Delta$ ] [ $\nabla$ ] to select either FC 111 wizard, closed loop setup, motor setup or changes made, then press [OK].
3. Press [ $\Delta$ ] [ $\nabla$ ] to browse through the parameters in the Quick Menu.
4. Press [OK] to select a parameter.
5. Press [ $\Delta$ ] [ $\nabla$ ] to change the value of a parameter setting.
6. Press [OK] to accept the change.
7. Press either [Back] twice to enter "Status", or press [Menu] once to enter "Main Menu".

The Main Menu accesses all parameters.

1. Press [MENU] key until indicator in display is placed above "Main Menu".
2. Use [ $\Delta$ ] [ $\nabla$ ] to browse through the parameter groups.
3. Press [OK] to select a parameter group.
4. Use [ $\Delta$ ] [ $\nabla$ ] to browse through the parameters in the specific group.
5. Press [OK] to select the parameter.
6. Use [ $\Delta$ ] [ $\nabla$ ] to set/change the parameter value.

## 1.5 Cascade Controller

### 1.5.1 BASIC Cascade Controller



The BASIC Cascade Controller is used for pump applications where a certain pressure ("head") or level needs to be maintained over a wide dynamic range. Running a large pump at variable speed over a wide range is not an ideal solution because of low pump efficiency and because there is a practical limit of about 25% rated full load speed for running a pump.

In the BASIC Cascade Controller the frequency converter controls a variable speed motor as the variable speed pump (lead) and can stage up to two additional constant speed pumps on and off. By varying the speed of the initial pump, variable speed control of the entire system is provided. This maintains constant pressure while eliminating pressure surges, resulting in reduced system stress and quieter operation in pumping systems.

#### Fixed Lead Pump

The motors must be of equal size. The BASIC Cascade Controller allows the frequency converter to control up to 3 equal size pumps using the drives two built-in relays. When the variable pump (lead) is connected directly to the frequency converter, the other 2 pumps are controlled by the two built-in relays. When lead pump alternations is enabled, pumps are connected to the built-in relays and the frequency converter is capable of operating 2 pumps.

#### Lead Pump Alternation

The motors must be of equal size. This function makes it possible to cycle the frequency converter between the pumps in the system (maximum of 2 pumps). In this operation the run time between pumps is equalized reducing the required pump maintenance and increasing reliability and lifetime of the system. The alternation of the lead pump can take place at a command signal or at staging (adding another pump).

The command can be a manual alternation or an alternation event signal. If the alternation event is selected, the lead pump alternation takes place every time the

event occurs. Selections include whenever an alternation timer expires, at a predefined time of day or when the lead pump goes into sleep mode. Staging is determined by the actual system load.

A separate parameter limits alternation only to take place if total capacity required is > 50%. Total pump capacity is determined as lead pump plus fixed speed pumps capacities.

#### Bandwidth Management

In cascade control systems, to avoid frequent switching of fixed speed pumps, the desired system pressure is kept within a bandwidth rather than at a constant level. The Staging Bandwidth provides the required bandwidth for operation. When a large and quick change in system pressure occurs, the Override Bandwidth overrides the Staging Bandwidth to prevent immediate response to a short duration pressure change. An Override Bandwidth Timer can be programmed to prevent staging until the system pressure has stabilized and normal control established.

When the Cascade Controller is enabled and running normally and the frequency converter issues a trip alarm, the system head is maintained by staging and destaging fixed speed pumps. To prevent frequent staging and destaging and minimize pressure fluxuations, a wider Fixed Speed Bandwidth is used instead of the Staging bandwidth.

### 1.5.2 System Status and Operation

If the lead pump goes into Sleep Mode, the function is displayed on the LCP. It is possible to alternate the lead pump on a Sleep Mode condition.

When the Cascade Controller is enabled, the operation status for each pump and the Cascade Controller is displayed by 25-81, *Pump Status* and 25-80, *Cascade Status* on the LCP. Information displayed includes:

- **Pumps Status**, is a read out of the status for the relays assigned to each pump. The display shows pumps that are disabled, off, running on the frequency converter or running on the mains/motor starter.
- **Cascade Status**, is a read out of the status for the Cascade Controller. The display shows the Cascade Controller is disabled, all pumps are running off, fixed speed pumps are being staged/de-staged and lead pump alternation is occurring.
- When all relays are de-energized, the first built-in relay to be energized will cut in the contactor corresponding to the pump controlled by the relay. E.g. RELAY 1 cuts in contactor K1, which becomes the lead pump.

- K1 blocks for K2 via the mechanical interlock preventing mains to be connected to the output of the frequency converter (via K1).
- Auxiliary break contact on K1 prevents K3 to cut in.
- RELAY 2 controls contactor K4 for on/off control of the fixed speed pump.
- At alternation, both relays de-energize and now RELAY 2 will be energized as the first relay.

### 1.5.3 Start/Stop Conditions

Commands assigned to digital inputs. See *Digital Inputs*, parameter group 5-1\*.

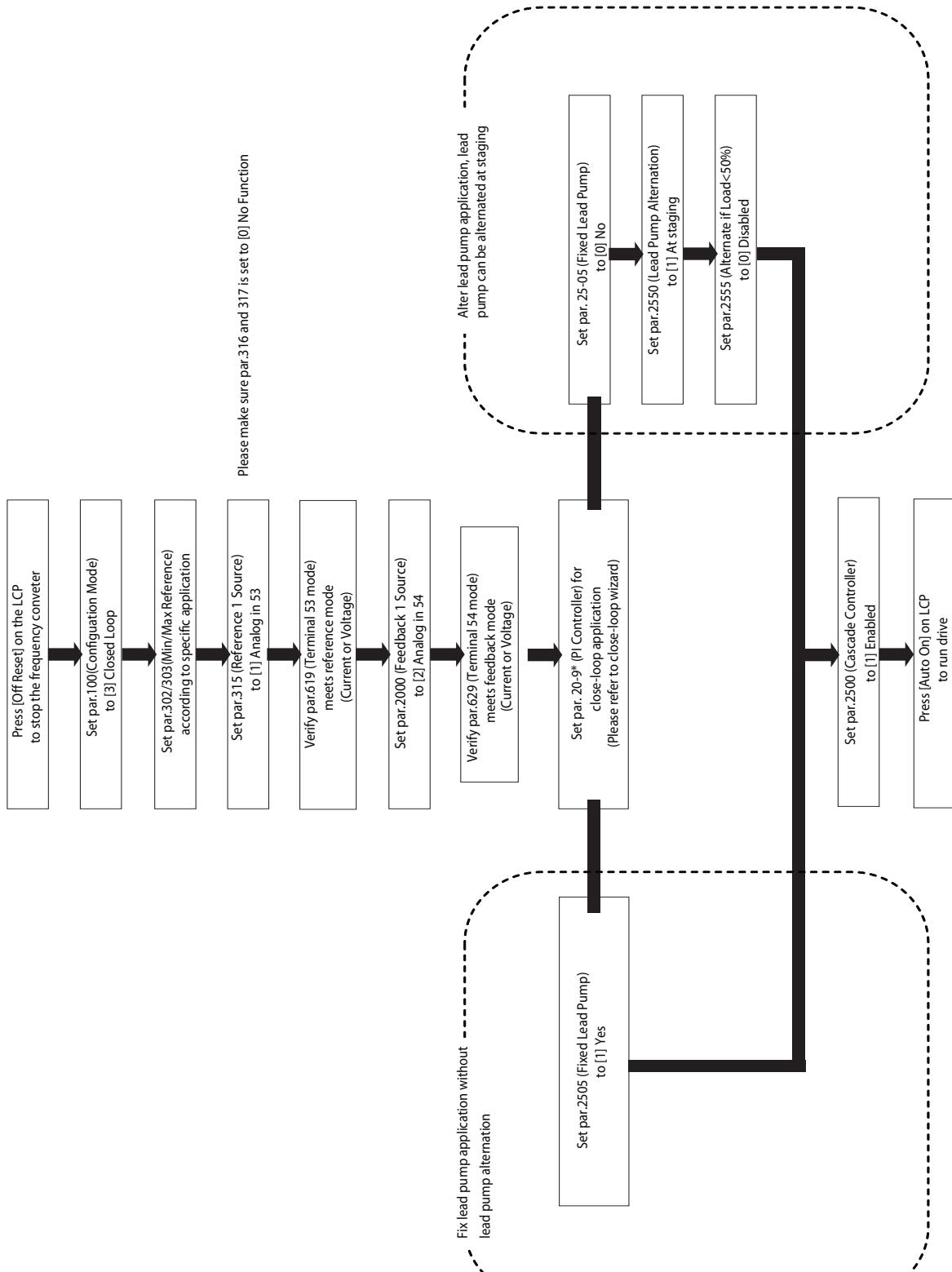
	<b>Variable speed pump (lead)</b>	<b>Fixed speed pumps</b>
Start (SYSTEM START /STOP)	Ramps up (if stopped and there is a demand)	Staging (if stopped and there is a demand)
Lead Pump Start	Ramps up if SYSTEM START is active	Not affected
Coast (EMERGENCY STOP)	Coast to stop	Cut out (built in relays are de-energized)
External Interlock	Coast to stop	Cut out (built in relays are de-energized)

Function of buttons on LCP:

	<b>Variable speed pump (lead)</b>	<b>Fixed speed pumps</b>
Hand On	Ramps up (if stopped by a normal stop command) or stays in operation if already running	Destaging (if running)
Off	Ramps down	Destaging
Auto On	Starts and stops according to commands via terminals or serial bus	Staging/Destaging

## 1.5.4 Cascade Application Wizard

130BB983.10



## 1.6 Parameter Overview

Parameter Overview			
<b>0-** Operation / Display</b>	<b>0-3* LCP Readout</b>	*[1] Enable All [7] Enable Reset Only	[25] 90kW-120Hp [26] 110kW-150Hp
<b>0-0* Basic Settings</b>	<b>0-30 Custom Readout Unit</b>	[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 *[0] Resume [1] Forced stop, ref=old <b>0-06 GridType</b>	[0] Disabled *[1] Enabled <b>0-5* Copy/Save</b> <b>0-50 LCP Copy</b> *[0] No copy [1] All to LCP [2] All from LCP [3] Size indep. from LCP <b>0-51 Set-up Copy</b> *[0] No copy [1] Copy from setup 1 [2] Copy from setup 2 [9] Copy from Factory setup <b>0-6* Password</b> <b>0-60 Main Menu Password</b> 0 - 999, * 0 <b>1-** Load and Motor</b> <b>1-0* General Settings</b> <b>1-00 Configuration Mode</b> *[0] Open loop [3] Closed loop <b>1-01 Motor Control Principle</b> [0] U/f *[1] VVC+ <b>1-03 Torque Characteristics</b> *[1] Variable torque [3] Auto Energy Optim. <b>1-06 Clockwise Direction</b> *[0] Normal [1] Inverse <b>1-20 Motor Power</b> [2] 0.12kW - 0.16Hp [3] 0.18kW - 0.25Hp [4] 0.25kW - 0.33Hp [5] 0.37 kW - 0.50Hp [6] 0.55 kW - 0.75Hp [7] 0.75 kW - 1.00Hp [8] 1.10 kW - 1.50Hp [9] 1.50 kW - 2.00Hp [10] 2.20 kW - 3.00Hp [11] 3.00 kW - 4.00Hp [12] 3.70 kW - 5.00Hp [13] 4.00 kW - 5.40Hp [14] 5.50 kW - 7.50Hp [15] 7.50 kW - 10.0Hp [16] 11.00 kW - 15.00Hp [17] 15.00kW - 20Hp [18] 18.5kW - 25Hp [19] 22kW - 30Hp [20] 30kW - 40Hp [21] 37kW-50Hp [22] 45kW-60Hp [23] 55kW-75Hp [24] 75kW-100Hp
<b>0-01 Language</b>	[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 *[0] Resume [1] Forced stop, ref=old <b>0-06 GridType</b>	[0] Disabled *[1] Enabled <b>0-5* Copy/Save</b> <b>0-50 LCP Copy</b> *[0] No copy [1] All to LCP [2] All from LCP [3] Size indep. from LCP <b>0-51 Set-up Copy</b> *[0] No copy [1] Copy from setup 1 [2] Copy from setup 2 [9] Copy from Factory setup <b>0-6* Password</b> <b>0-60 Main Menu Password</b> 0 - 999, * 0 <b>1-** Load and Motor</b> <b>1-0* General Settings</b> <b>1-00 Configuration Mode</b> *[0] Open loop [3] Closed loop <b>1-01 Motor Control Principle</b> [0] U/f *[1] VVC+ <b>1-03 Torque Characteristics</b> *[1] Variable torque [3] Auto Energy Optim. <b>1-06 Clockwise Direction</b> *[0] Normal [1] Inverse <b>1-20 Motor Power</b> [2] 0.12kW - 0.16Hp [3] 0.18kW - 0.25Hp [4] 0.25kW - 0.33Hp [5] 0.37 kW - 0.50Hp [6] 0.55 kW - 0.75Hp [7] 0.75 kW - 1.00Hp [8] 1.10 kW - 1.50Hp [9] 1.50 kW - 2.00Hp [10] 2.20 kW - 3.00Hp [11] 3.00 kW - 4.00Hp [12] 3.70 kW - 5.00Hp [13] 4.00 kW - 5.40Hp [14] 5.50 kW - 7.50Hp [15] 7.50 kW - 10.0Hp [16] 11.00 kW - 15.00Hp [17] 15.00kW - 20Hp [18] 18.5kW - 25Hp [19] 22kW - 30Hp [20] 30kW - 40Hp [21] 37kW-50Hp [22] 45kW-60Hp [23] 55kW-75Hp [24] 75kW-100Hp	<b>1-22 Motor Voltage</b> 50 - 1000V <b>1-23 Motor Frequency</b> 20 - 400, *(50)Hz <b>1-24 Motor Current</b> 0.01 - (26.00), [A] <b>1-25 Motor Nominal Speed</b> 100 rpm - 6000 rpm, <b>1-29 Automatic Motor Adaption (AMA)</b> *[0] Off [1] Enable Complete AMA [2] Enable Reduced AMA <b>1-3* Adv. Motor Data I</b> <b>1-30 Stator Resistance (Rs)</b> 0.000 ohm - 99.990 ohm <b>1-33 Stator Leakage Reactance (X1)</b> 0.000 ohm - 999.900 ohm <b>1-35 Main Reactance (Xh)</b> 0.00 - 999.90 ohm <b>1-39 Motor Poles</b> 2 - 100, * 4 <b>1-4* Adv. Motor Data II</b> <b>1-42 Motor Cable Length</b> 0 - 150, * 50m <b>1-43 Motor Cable Length Feet</b> 0 - 431, * 144 <b>1-5* Load Indep. Setting</b> <b>1-50 Motor Magnetisation at Zero Speed</b> 0 - 300, * 100% <b>1-52 Min Speed Normal Magnetising [Hz]</b> 0.0 - 10.0, * 0.0 <b>1-55 U/f Characteristic - U</b> 0 - 999V, *0V <b>1-56 U/f Characteristic - F</b> 0 - 400Hz, *(0) <b>1-6* Load Depend. Setting</b> <b>1-62 Slip Compensation</b> -400 - 399%, *0% <b>1-63 Slip Compensation Time Constant</b> 0.05 - 5.00s, * 0.10 <b>1-64 Resonance Dampening</b> 0 - 500%, * 100 <b>1-65 Resonance Dampening Time Constant</b> 0.001 - 0.050s, * 0.005 <b>1-7* Start Adjustments</b> <b>1-71 Start Delay</b> 0.0 - 10.0s, * 0.0
<b>0-07 Auto DC Braking IT</b>	<b>0-31 Custom Readout Min Value</b>	0.00 - 1,000,000.0, * 0.00	<b>1-63 Slip Compensation Time Constant</b> 0.05 - 5.00s, * 0.10 <b>1-64 Resonance Dampening</b> 0 - 500%, * 100 <b>1-65 Resonance Dampening Time Constant</b> 0.001 - 0.050s, * 0.005 <b>1-7* Start Adjustments</b> <b>1-71 Start Delay</b> 0.0 - 10.0s, * 0.0
<b>0-1* Set-up Operations</b>	<b>0-32 Custom Readout Max Value</b>	0.00 - 1,000,000.0, * 100.00	
<b>0-10 Active Set-up</b>	<b>0-37 Display Text 1</b>	0.00 - 1,000,000.0, * 100.00	
*[1] Set-up 1	<b>0-38 Display Text 2</b>	0.00 - 1,000,000.0, * 100.00	
[2] Set-up 2	<b>0-39 Display Text 3</b>	0.00 - 1,000,000.0, * 100.00	
[9] Multi Set-up	<b>0-4* LCP Keypad</b>	0.00 - 1,000,000.0, * 100.00	
<b>0-11 Programming Set-up</b>	<b>0-40 [Hand on] Key on LCP</b>	0.00 - 1,000,000.0, * 100.00	
[1] Set-up 1	[0] Disabled	0.00 - 1,000,000.0, * 100.00	
[2] Set-up 2	*[1] Enabled	0.00 - 1,000,000.0, * 100.00	
*[9] Active Set-up	<b>0-44 [Off / Reset] Key on LCP</b>	0.00 - 1,000,000.0, * 100.00	
<b>0-12 Link Setups</b>	[0] Disable All	0.00 - 1,000,000.0, * 100.00	
[0] Not linked			
*[20] Linked			

Parameter Overview			
<b>1-72 Start Function</b> [0] DC Hold/delay time *[2] Coast/delay time	<b>3-16 Reference 2 Resource</b> [0] No function [1] Analog in 53 *[2] Analog in 54 [11] Local bus reference	<b>4 -57 Warning Feedback High</b> -4999.000 - 4999.000, *4999.000 <b>4-58 Missing Motor Phase Function</b> [0] Off *[1] On	[62] Reset Counter A [63] Counter B (up) [64] Counter B (down) [65] Reset Counter B [120] Lead Pump Start [121] Lead Pump Alternation [130] Pump 1 Interlock [131] Pump 2 Interlock [132] Pump 3 Interlock
<b>1-73 Flying Start</b> *[0] Disabled [1] Enabled			
<b>1-8* Stop Adjustments</b>	<b>3-17 Reference 3 Resource</b> [0] No function [1] Analog in 53 [2] Analog in 54 *[11] Local bus reference	<b>4-6* Speed Bypass</b> 0.0 - 400.0, * 0.0 <b>4-61 Bypass Speed From [Hz]</b> 0.0 - 400.0, * 0.0 <b>4-63 Bypass Speed To [Hz]</b> 0.0 - 400.0, * 0.0	<b>5-11 Terminal 19 Digital Input</b> See par. 5-10, *[0] No operation
<b>1-80 Function at Stop</b> *[0] Coast			
<b>1-82 Min Speed for Function at Stop [Hz]</b> 0.0 - 20.0Hz, * 0.0	<b>3-4* Ramp 1</b> 0.05 - 3600.00s, *Size related	<b>4-64 Semi-Auto Bypass Set-up</b> *[0] Off [1] Enable	<b>5-12 Terminal 27 Digital Input</b> See par. 5-10, *[2] Coast inverse
<b>1-9* Motor Temperature</b>	<b>3-42 Ramp 1 Ramp Down Time</b> 0.05 - 3600.00s, *Size related		
<b>1-90 Motor Thermal Protection</b> *[0] No protection	<b>3-5* Ramp 2</b> 0.05 - 3600.00s, *Size related	<b>5-** Digital In/Out</b>	<b>5-13 Terminal 29 Digital Input</b> See par. 5-10, *[14] Jog
[1] Thermistor warning	<b>3-51 Ramp 2 Ramp up Time</b> 0.05 - 3600.00s, *Size related	<b>5-0* Digital I/O mode</b>	<b>5-3* Digital Outputs</b>
[2] Thermistor trip	<b>3-52 Ramp 2 Ramp down Time</b> 0.05 - 3600.00s, *Size related	<b>5-00 Digital Input Mode</b>	<b>5-30 Terminal 27 Digital Output</b>
[3] ETR warning 1		*[0] PNP [1] NPN	[0] No operation
[4] ETR trip 1			[1] Control ready
<b>1-93 Thermistor Resource</b> *[0] None	<b>3-8* Other Ramps</b>	<b>5-01 Terminal 27 I/O Mode</b>	[2] Drive ready
[1] Analog input 53	<b>3-80 Jog Ramp Time</b> 0.05 - 3600.00s, *Size related	*[0] Input [1] Output	[3] Drive ready/remote control
[6] Digital input 29	<b>3-81 Quick Stop Ramp Time</b> 0.05 - 3600.00s, *Size related	<b>5-02 Terminal 29 I/O Mode</b>	[4] Standby/no warning
<b>2-** Brakes</b>		*[0] Input [1] Output	[5] Drive running
<b>2-0* DC-Brake</b>	<b>4-** Limits / Warnings</b>	<b>5-03 Digital Input 29 Mode</b>	[6] Running/no warning
<b>2-00 DC Hold/Motor Preheat</b>	<b>4-1* Motor Limits</b>	*[0] PNP [1] NPN	[7] Run in range/no warning
<b>Current</b> 0 - 160%, * 50	<b>4-10 Motor Speed Direction</b> [0] Clockwise *[2] Both directions		[8] Run on ref/no warning
<b>2-01 DC Brake Current</b> 0 - 150%, * 50	<b>4-12 Motor Speed Low Limit</b> [Hz] 0.0 - 400Hz, *0.0Hz	<b>5-1* Digital Inputs</b>	[9] Alarm
<b>2-02 DC Braking Time</b> 0.0 - 60.0s, * 10.0	<b>4-14 Motor Speed High Limit</b> [Hz] 0.1 - 400Hz, *65.0Hz	<b>5-10 Terminal 18 Digital Input</b>	[10] Alarm or warning
<b>2-04 DC Brake Cut In Speed</b> 0.0 - 400.0Hz, * 0.0	<b>4-18 Current Limit</b> 0 - 300%, *110%	[0] No operation [1] Reset	[12] Out of current range
<b>2-1* Brake Energy Funct.</b>		[2] Coast inverse	[13] Below current, low
<b>2-17 Over-voltage Control</b> [0] Disabled	<b>4-19 Max Output Frequency</b> 0.0 - 400.0Hz, * 65.0	[3] Coast and reset inverse	[14] Above current, high
*[2] Enabled	<b>4-4* Adj. Warnings 2</b>	[4] Quick stop inverse	[19] Below feedback, low
<b>3-** Reference / Ramps</b>	<b>4-40 Warning Freq. Low</b> 0.0-400.0Hz, *400.0	[5] DC-brake inverse	[20] Above feedback, high
<b>3-0* Reference Limits</b>	<b>4-41 Warning Freq. High</b> 0.0-400.0Hz, *400.0	[6] Stop inverse	[21] Thermal warning
<b>3-02 Minimum Reference</b> (-4999.000) - 4999.000, * 0.000	<b>4-45 Adj. Warnings</b>	[7] External Interlock	[22] Ready, no thermal warning
<b>3-03 Maximum Reference</b> (-4999.000) - 4999.000, * 50.000	<b>4-50 Warning Current Low</b>	*[8] Start	[23] Remote, ready, no thermal warning
<b>3-1* References</b>	<b>4-51 Warning Current High</b> 0.00 - 194.00A, * 194.00	[9] Latched start	[24] Ready, Voltage OK
<b>3-10 Preset Reference</b> -100.00 - 100.00%, * 0.00	<b>4-54 Warning Reference Low</b> -4999.000 - 4999.000, -*4999.000	[10] Reversing	[25] Reverse
<b>3-11 Jog Speed [Hz]</b> 0.0 - 400.0Hz, * 5.0	<b>4-55 Warning Reference High</b> -4999.000 - 4999.000, *4999.000	[11] Start reversing	[26] Bus OK
<b>3-14 Preset Relative Reference</b> -100.00 - 100.00, * 0.00		[14] Jog	[28] Brake, no brake warning
<b>3-15 Reference Resource 1</b> [0] No function	<b>4-56 Warning Feedback Low</b> -4999.000 - 4999.000, -*4999.000	[16] Preset ref bit 0	[29] Brake ready, no fault
*[1] Analog in 53		[17] Preset ref bit 1	[30] Brake fault (IGBT)
[2] Analog in 54		[18] Preset ref bit 2	[32] Mech brake control
[11] Local bus reference		[19] Freeze reference	[35] External interlock
		[20] Freeze output	[36] Control word bit 11
		[21] Speed up	[37] Control word bit 12
		[22] Speed down	[45] Bus Control
		[23] Set-up select bit 0	[60] Comparator 0
		[34] Ramp bit 0	[61] Comparator 1
		[37] Fire mode	[62] Comparator 2
		[52] Run permissive	[63] Comparator 3
		[53] Hand Start	[64] Comparator 4
		[54] Auto start	[65] Comparator 5
		[60] Counter A (up)	[70] Logic rule 0
		[61] Counter A (down)	[71] Logic rule 1
			[72] Logic rule 2
			[73] Logic rule 3

Parameter Overview			
[74] Logic rule 4	[45] Bus Control	[5] Stop and trip	<b>6-72 Terminal 45 Digital Output</b>
[75] Logic rule 5	[60] Comparator 0	<b>6-1* Analog Input 53</b>	*[0] No operation
[80] SL digital output A	[61] Comparator 1	<b>6-10 Terminal 53 Low Voltage</b>	[1] Control ready
[81] SL digital output B	[62] Comparator 2	0.00 - 10.00V, * 0.07	[2] Drive ready
[82] SL digital output C	[63] Comparator 3	<b>6-11 Terminal 53 High Voltage</b>	[3] Drive ready/remote control
[83] SL digital output D	[64] Comparator 4	0.00 - 10.00V, * 10.00	[4] Standby / no warning
[160] No alarm	[65] Comparator 5	<b>6-12 Terminal 53 Low Current</b>	[5] Drive running
[161] Running reverse	[70] Logic rule 0	0.00 - 20.00, * 4.00mA	[6] Running / no warning
[165] Local ref. active	[71] Logic rule 1	<b>6-13 Terminal 53 High Current</b>	[7] Run in range/no warning
[166] Remote ref. active	[72] Logic rule 2	0.00 - 20.00, * 20.00mA	[8] Run on ref/no warning
[167] Start command active	[73] Logic rule 3	<b>6-14 Terminal 53 Low Ref./Feedb.</b>	[9] Alarm
[168] Drive in hand mode	[74] Logic rule 4	<b>Value</b>	[10] Alarm or warning
[169] Drive in auto mode	[75] Logic rule 5	-4999.000 - 4999.000, * 0.000	[12] Out of current range
[193] Sleep mode	[80] SL digital output A	<b>6-15 Terminal 53 High Ref./Feedb.</b>	[13] Below current, low
[194] Broken belt function	[81] SL digital output B	<b>Value</b>	[14] Above current, high
[196] Fire mode	[82] SL digital output C	-4999.000 - 4999.000, * 50.000	[19] Below feedback, low
[198] Drive bypass	[83] SL digital output D	<b>6-16 Terminal 53 Filter Time</b>	[20] Above feedback, high
[200] Full capacity	[160] No alarm	<b>Constant</b>	[21] Thermal warning
[201] Pump 1 running	[161] Running reverse	0.01 - 10.00s, * 0.01	[22] Ready, no thermal warning
[202] Pump 2 running	[165] Local ref. active	<b>6-19 Terminal 53 mode</b>	[23] Remote, ready, no thermal warning
[203] Pump 3 running	[166] Remote ref. active	[0] Current mode	[24] Ready, Voltage OK
<b>5-31 Terminal 29 Digital Output</b>	[167] Start command activ	*[1] Voltage mode	[25] Reverse
see par. 5-30	[168] Drive in hand mode	<b>6-2* Analog Input 54</b>	[26] Bus OK
<b>5 -34 On Delay, Digital Output</b>	[169] Drive in auto mode	<b>6-20 Terminal 54 Low Voltage</b>	[35] External Interlock
0.00 - 600.00 s, *0.01 s	[193] Sleep Mode	0.00 - 10.00V, * 0.07	[45] Bus Control
<b>5 -35 Off Delay, Digital Output</b>	[194] Broken Belt Function	<b>6-21 Terminal 54 High Voltage</b>	[60] Comparator 0
0.00 - 600.00 s, *0.01 s	[196] Fire Mode	0.00 - 10.00V, * 10.00	[61] Comparator 1
0.00 ~ 600.00 secs	[198] Drive Bypass	<b>6-22 Terminal 54 Low Current</b>	[62] Comparator 2
<b>5-4* Relays</b>	[211] Cascade Pump 1	0.00 - 20.00, * 4.00mA	[63] Comparator 3
<b>5-40 Function Relay</b>	[212] Cascade Pump 2	<b>6-23 Terminal 54 High Current</b>	[64] Comparator 4
*[0] No operation	[213] Cascade Pump 3	0.00 - 20.00, * 20.00mA	[65] Comparator 5
[1] Control ready	<b>5 -41 On Delay, Relay</b>	<b>6-24 Terminal 54 Low Ref./Feedb.</b>	[70] Logic rule 0
[2] Drive ready	0.00 - 600.00 s, *0.01 s	<b>Value</b>	[71] Logic rule 1
[3] Drive ready/remote control	<b>5 -42 Off Delay, Relay</b>	-4999.000 - 4999.000, * 0.000	[72] Logic rule 2
[4] Enable / no warning	0.00 ~ 600.00s, *0.01s	<b>6-25 Terminal 54 High Ref./Feedb.</b>	[73] Logic rule 3
[5] VLT running	<b>5-5* Pulse Input</b>	<b>Value</b>	[74] Logic rule 4
[6] Running / no warning	<b>5-9* Bus Controlled</b>	-4999.000 - 4999.000, * 50.000	[75] Logic rule 5
[7] Run in range/no warning	<b>5-90 Digital and Relay Bus</b>	<b>6-26 Terminal 54 Filter Time</b>	[80] SL digital output A
[8] Run on ref/no warning	<b>Control</b>	<b>Constant</b>	[81] SL digital output B
[9] Alarm	0 - 0xFFFFFFFF, * 0	[0] Current mode	[82] SL digital output C
[10] Alarm or warning	<b>6-** Analog In/Out</b>	*[1] Voltage mode	[83] SL digital output D
[12] Out of current range	<b>6-0* Analog I/O Mode</b>	<b>6-29 Terminal 54 mode [0]</b>	[160] No alarm
[13] Below current, low	<b>6-00 Live Zero Timeout Time</b>	<b>Current mode</b>	[161] Running reverse
[14] Above current, high	1 - 99s, * 105-5* Pulse Input	[0] Current mode	[165] Local ref. active
[16] Below frequency, low	<b>5-9* Bus Controlled</b>	*[1] Voltage mode	[166] Remote ref. active
[17] Above frequency, high	<b>5-90 Digital and Relay Bus</b>	<b>6-7* Analog Output 45</b>	[167] Start command activ
[19] Below feedback, low	<b>Control</b>	[0] 0-20 mA	[168] Drive in hand mode
[20] Above feedback, high	<b>6-** Analog In/Out</b>	[1] 4-20 mA	[169] Drive in auto mode
[21] Thermal warning	<b>6-0* Analog I/O Mode</b>	[2] Digital Output	[193] Sleep Mode
[22] Ready, no thermal warning	<b>6-00 Live Zero Timeout Time</b>	<b>6-71 Terminal 45 Analog Output</b>	[194] Broken Belt Function
[23] Remote, ready, no thermal warning	1 - 99s, * 10	*[0] No operation	[196] Fire Mode
[24] Ready, Voltage OK	<b>6-01 Live Zero Timeout Function</b>	[100] Output frequency	[198] Bypass Mode
[25] Reverse	*[0] Off	[101] Reference	[200] Full capacity
[26] Bus OK	[1] Freeze output	[102] Feedback	[201] Pump 1 running
[35] External Interlock	[2] Stop	[103] Motor current	[202] Pump 2 running
[36] Control word bit 11	[3] Jogging	[106] Power	[203] Pump 3 running
[37] Control word bit 12	[4] Max. speed	[139] Bus Control	

Parameter Overview			
<b>6-73 Terminal 45 Output Min Scale</b> 0.00 - 200.00%, * 0.00	[75] Logic rule 5 [80] SL digital output A	<b>8-32 FC Port Baud Rate</b> [0] 2400 Baud [1] 4800 Baud *[2] 9600 Baud [3] 19200 Baud [4] 38400 Baud [5] 57600 Baud [6] 76800 Baud [7] 115200 Baud	<b>8-70 BACnet Device Instance</b> 0 - 0x400000UL, *1
<b>6-74 Terminal 45 Output Max Scale</b> 0.00 - 200.00%, * 100.00	[81] SL digital output B [82] SL digital output C		<b>8-72 MS/TP Maxmaster</b> 0 - 127, * 127
<b>6-76 Terminal 45 Output Bus Control</b> 0.00 - 100.00%, * 0.00	[83] SL digital output D [160] No alarm [161] Running reverse [165] Local ref. active [166] Remote ref. active [167] Start command activ [168] Drive in hand mode [169] Drive in auto mode [193] Sleep Mode [194] Broken Belt Function [196] Fire Mode [198] Drive Bypass [200] Full capacity [201] Pump 1 running [202] Pump 2 running [203] Pump 3 running		<b>8-73 MS/TP Max Info Frames</b> 1 - 65534, * 1
<b>6-9* Analog Output 42</b>			<b>8-74 "I am" Service</b> *[0] Send at power-up [1] Continuously
<b>6-90 Terminal 42 Mode</b> *[0] 0-20 mA [1] 4-20 mA [2] Digital Output	[166] Remote ref. active [167] Start command activ [168] Drive in hand mode [169] Drive in auto mode [193] Sleep Mode [194] Broken Belt Function [196] Fire Mode [198] Drive Bypass [200] Full capacity [201] Pump 1 running [202] Pump 2 running [203] Pump 3 running		<b>8-75 Initialisation Password</b>
<b>6-91 Terminal 42 Analog Output</b> *[0] No operation [100] Output frequency [101] Reference [102] Feedback [103] Motor current [105] TorquereltoRated [106] Power [139] Bus Control	[196] Fire Mode [198] Drive Bypass [200] Full capacity [201] Pump 1 running [202] Pump 2 running [203] Pump 3 running		<b>8-8* FC Port Diagnostics</b>
<b>6-92 Terminal 42 Digital Output</b> *[0] No operation [1] Control ready [2] Drive ready [3] Drive ready/remote control [4] Enable / no warning [5] Drive running [6] Running / no warning [7] Run in range/no warning [8] Run on ref/no warning [9] Alarm [10] Alarm or warning [12] Out of current range [13] Below current, low [14] Above current, high [19] Below feedback, low [20] Above feedback, high [21] Thermal warning [22] Ready, no thermal warning [23] Remote, ready, no thermal warning [24] Ready, Voltage OK [25] Reverse [26] Bus OK [35] External Interlock [45] Bus Control [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			<b>8-80 Bus Message Count</b> 0 - 65536, * 0
			<b>8-81 Bus Error Count</b> 0 - 65536, * 0
			<b>8-82 Slave Message Rcvd</b> 0 - 65536, * 0
			<b>8-83 Slave Error Count</b> 0 - 65536, * 0
			<b>8-84 Slave Message Sent</b> 0 - 65536, * 0
			<b>8-85 Slave Timeout Errors</b> 0 - 65536, * 0
			<b>8-88 Reset FC port Diagnostics</b> *[0] Do not reset [1] Reset counter
			<b>8-9* Bus Feedback</b>
			<b>8-94 Bus feedback 1</b> -32768 - 32767, * 0
			<b>13-** Smart Logic</b>
			<b>13-0* SLC Settings</b>
			<b>13-00 SL Controller Mode</b> *[0] Off [1] On
			<b>13-01 Start Event</b> [0] False [1] True
			<b>13-02 Stop Event</b> [0] True [1] False
			<b>13-03 Emergency Stop</b> [0] False [1] True
			<b>13-04 Fault Recovery</b> [0] False [1] True
			<b>13-05 Fault Recovery</b> [0] False [1] True
			<b>13-06 Fault Recovery</b> [0] False [1] True
			<b>13-07 Fault Recovery</b> [0] False [1] True
			<b>13-08 Fault Recovery</b> [0] False [1] True
			<b>13-09 Fault Recovery</b> [0] False [1] True
			<b>13-10 Fault Recovery</b> [0] False [1] True
			<b>13-11 Fault Recovery</b> [0] False [1] True
			<b>13-12 Fault Recovery</b> [0] False [1] True
			<b>13-13 Fault Recovery</b> [0] False [1] True
			<b>13-14 Fault Recovery</b> [0] False [1] True
			<b>13-15 Fault Recovery</b> [0] False [1] True
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			<b>13-18 Fault Recovery</b> [0] False [1] True
			<b>13-19 Fault Recovery</b> [0] False [1] True
			<b>13-20 Fault Recovery</b> [0] False [1] True
			<b>13-21 Fault Recovery</b> [0] False [1] True
			<b>13-22 Fault Recovery</b> [0] False [1] True
			<b>13-23 Fault Recovery</b> [0] False [1] True
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			<b>13-26 Fault Recovery</b> [0] False [1] True
			<b>13-27 Fault Recovery</b> [0] False [1] True
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			<b>13-30 Fault Recovery</b> [0] False [1] True
			<b>13-31 Fault Recovery</b> [0] False [1] True
			<b>13-32 Fault Recovery</b> [0] False [1] True
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			<b>13-37 Fault Recovery</b> [0] False [1] True
			<b>13-38 Fault Recovery</b> [0] False [1] True
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			<b>13-40 Fault Recovery</b> [0] False [1] True
			<b>13-41 Fault Recovery</b> [0] False [1] True
			<b>13-42 Fault Recovery</b> [0] False [1] True
			<b>13-43 Fault Recovery</b> [0] False [1] True
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			<b>13-165 Fault Recovery</b> [0] False [1] True
			<b>13-166 Fault Recovery</b> [0] False [1] True
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			<b>13-171 Fault Recovery</b> [0] False [1] True
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			<b>13-174 Fault Recovery</b> [0] False [1] True
			<b>13-175 Fault Recovery</b> [0] False [1] True
			<b>13-176 Fault Recovery</b> [0] False [1] True
			<b>13-177 Fault Recovery</b> [0] False [1] True
			<b>13-178 Fault Recovery</b> [0] False [1] True
			<b>13-179 Fault Recovery</b> [0] False [1] True
			<b>13-180 Fault Recovery</b> [0] False [1] True
			<b>13-181 Fault Recovery</b> [0] False [1] True
			<b>13-182 Fault Recovery</b> [0] False [1] True
			<b>13-183 Fault Recovery</b> [0] False [1] True
			<b>13-184 Fault Recovery</b> [0] False [1] True
			<b>13-185 Fault Recovery</b> [0] False [1] True
			<b>13-186 Fault Recovery</b> [0] False [1] True
			<b>13-187 Fault Recovery</b> [0] False [1] True
			<b>13-188 Fault Recovery</b> [0] False [1] True
			<b>13-189 Fault Recovery</b> [0] False [1] True
			<b>13-190 Fault Recovery</b> [0] False [1] True
			<b>13-191 Fault Recovery</b> [0] False [1] True
			<b>13-192 Fault Recovery</b> [0] False [1] True
			<b>13-193 Fault Recovery</b> [0] False [1] True
			<b>13-194 Fault Recovery</b> [0] False [1] True
			<b>13-195 Fault Recovery</b> [0] False [1] True
			<b></b>

Parameter Overview			
[34] Digital input 19	See par. 13-01, *[0] False	[6] 6.0 kHz	<b>14-51 DC-link Voltage Compensation</b>
[35] Digital input 27	<b>13-43 Logic Rule Operator 2</b>	[7] 8.0 kHz	[0] Off
[36] Digital input 29	See par. 13-41, *[0] Disabled	[8] 10.0 kHz	*[1] On
*[39] Start command	<b>13-44 Logic Rule Boolean 3</b>	[9] 12.0kHz	<b>14-52 Fan Control</b>
[40] Drive stopped	See par. 13-01, *[0] False	[10] 16.0kHz	*[0] Auto
[41] Reset trip	<b>13-5* States</b>	<b>14-03 Overmodulation</b>	[4] Auto Low temp env
[42] Auto reset trip	<b>13-51 SL Controller Event</b>	[0] Off	<b>14-53 Fan Monitor</b>
[43] Key Ok	See par. 13-01, *[0] False	*[1] On	[0] Disabled
[44] Key Reset	<b>13-52 SL Controller Action</b>	<b>14-08 Damping Gain Factor</b>	*[1] Warning
[47] Key Up	*[0] Disabled	0 - 100%, * 96	[2] Trip
[48] Key Down	[1] No action	<b>14-1* Mains on/off</b>	<b>14-55 Output Filter</b>
[50] Comparator 4	[2] Select set-up 1	<b>14-12 Function at Mains</b>	*[0] No Filter
[51] Comparator 5	[3] Select set-up 2	<b>Imbalance</b>	[1] Sine-Wave Filter
[60] Logic rule 4	[10] Select preset ref 0	*[0] Trip	[3] Sine-Wave Filter with Feedback
[83] Broken belt	[11] Select preset ref 1	[1] Warning	<b>14-63 Min Switch Frequency</b>
<b>13-02 Stop Event</b>	[12] Select preset ref 2	[2] Disabled	1 - 16kHz, * 1
See par. 13-02, *[40] Drive stopped	[13] Select preset ref 3	[3] Derate	<b>15-** Drive Information</b>
<b>13-03 Reset SLC</b>	[14] Select preset ref 4	<b>14-2* Reset Functions</b>	<b>15-0* Operating Data</b>
*[0] Do not reset	[15] Select preset ref 5	<b>14-20 Reset Mode</b>	<b>15-00 Operating Hours</b>
[1] Reset SLC	[16] Select preset ref 6	*[0] Manual reset	0 - 2147483647, * 0
<b>13-1* Comparators</b>	[17] Select preset ref 7	[1] Automatic reset x 1	<b>15-01 Running Hours</b>
<b>13-10 Comparator Operand</b>	[18] Select ramp 1	[2] Automatic reset x 2	0 - 2147483647, * 0
*[0] Disabled	[19] Select ramp 2	[3] Automatic reset x 3	<b>15-02 kWh Counter</b>
[1] Reference	[22] Run	[4] Automatic reset x 4	0 - 65535, * 0
[2] Feedback	[23] Run reverse	[5] Automatic reset x 5	<b>15-03 Power Up's</b>
[3] Motor speed	[24] Stop	[6] Automatic reset x 6	0 - 2147483647, * 0
[4] Motor current	[25] Qstop	[7] Automatic reset x 7	<b>15-04 Over Temp's</b>
[6] Motor power	[26] DC Brake	[8] Automatic reset x 8	0 - 65535, * 0
[7] Motor voltage	[27] Coast	[9] Automatic reset x 9	<b>15-05 Over Volt's</b>
[8] DC-link voltage	[28] Freeze output	[10] Automatic reset x 10	0 - 65535, * 0
[12] Analog in 53	[29] Start timer 0	[11] Automatic reset x 15	<b>15-06 Reset kWh Counter</b>
[13] Analog in 54	[30] Start timer 1	[12] Automatic reset x 20	*[0] Do not reset
[20] Alarm number	[31] Start timer 2	[13] Infinite auto reset	[1] Reset counter
[30] Counter A	[32] Set digital out A low	<b>14-21 Automatic Restart Time</b>	<b>15-07 Reset Running Hours Counter</b>
[31] Counter B	[33] Set digital out B low	0 - 600s, * 10	*[0] Do not reset
<b>13-11 Comparator Operator</b>	[34] Set digital out C low	<b>14-22 Operation Mode</b>	[1] Reset counter
[0] Less Than	[35] Set digital out D low	*[0] Normal operation	<b>15-3* Fault Log</b>
*[1] Approx. Equal	[38] Set digital out A high	[2] Initialisation	<b>15-30 Fault Log:</b>
[2] GreaterThan	[39] Set digital out B high	<b>14-27 Action At Inverter Fault</b>	Error Code 0 - 255, * 0
<b>13-12 Comparator Value</b>	[40] Set digital out C high	[0] Off	<b>15-4* Drive Identification</b>
-9999.0 - 9999.0, * 0.0	[41] Set digital out D high	*[1] On	<b>15-40 FC Type</b>
<b>13-2* Timers</b>	[60] Reset Counter A	<b>14-28 Production Settings</b>	<b>15-41 Power Section</b>
<b>13-20 SL Controller Timer</b>	[61] Reset Counter B	*[0] No action	<b>15-42 Voltage</b>
0.00 - 3600.00, * 0.00	[70] Start timer 3	[1] Service reset	<b>15-43 Software Version</b>
<b>13-4* Logic Rules</b>	[71] Start timer 4	[3] Software Reset	<b>15-44 OrderedTypeCode</b>
<b>13-40 Logic Rule Boolean 1</b>	[72] Start timer 5	<b>14-29 Service Code</b>	<b>15-46 Frequency Converter</b>
See par. 13-01, *[0] False	[73] Start timer 6	0 - 0xFFFFFFFF, * 0	Ordering No
<b>13-41 Logic Rule Operator 1</b>	[74] Start timer 7	<b>14-3* Current Limit Ctrl.</b>	<b>15-47 Power Card Ordering No</b>
*[0] Disabled	[100] Reset Alarm	<b>14-4* Energy Optimising</b>	<b>15-48 LCP Id No</b>
[1] AND	<b>14-** Special Functions</b>	<b>14-40 VT Level</b>	<b>15-49 Software ID Control Card</b>
[2] OR	<b>14-0* Inverter Switching</b>	40 - 90%, *90%	<b>15-50 Software ID Power Card</b>
[3] AND NOT	<b>14-01 Switching Frequency</b>	<b>14-41 AEO Minimum Magnetisation</b>	<b>15-51 Frequency Converter Serial Number</b>
[4] OR NOT	[0] Ran3	40 - 75%, * 66	<b>15-53 Power Card Serial Number</b>
[5] NOT AND	[1] Ran5	<b>14-5* Environment</b>	<b>16-** Data Readouts</b>
[6] NOT OR	[2] 2.0 kHz	<b>14-50 RFI Filter</b>	<b>16-0* General Status</b>
[7] NOT AND NOT	[3] 3.0 kHz	[0] Off	
[8] NOT OR NOT	[4] 4.0 kHz	*[1] On	
	[5] 5.0 kHz		

Parameter Overview			
<b>16-00 Control Word</b> 0 - 65535, * 0	<b>16-86 FC Port REF 1</b> -32768 - 32767, * 0	-100 - 100%, * 0	0 ~ 300s, *15s
<b>16-01 Reference [Unit]</b> -4999.000 - 4999.000, * 0.000	<b>16-9* Diagnosis Readouts</b>	<b>22-46 Maximum Boost Time</b> 0 - 600s, * 60	<b>25-25 OBW Time</b> 0 ~ 300s, *10s
<b>16-02 Reference</b> % -200.0 - 200.0, * 0.0	<b>16-90 Alarm Word</b> 0 - 0xFFFFFFFF, * 0	<b>22-47 Sleep Speed [Hz]</b> 0.0 - 400.0, * 0.0	<b>25-27 Stage Function</b> [0] Disabled
<b>16-03 Status Word</b> 0 - 65535, * 0	<b>16-91 Alarm Word 2</b> 0 - 0xFFFFFFFF, * 0	<b>22-6* Broken Belt Detection</b> *[0] Off	*[1] Enabled
<b>16-05 Main Actual Value [%]</b> -200.00 - 200.00, * 0.00	<b>16-92 Warning Word</b> 0 - 0xFFFFFFFF, * 0	<b>22-60 Broken Belt Detection</b> *[1] Warning	<b>25-28 Stage Function Time</b> 0 ~ 300s, *15s
<b>16-09 Custom Readout</b> 0.00 - 9999.00, * 0.00	<b>16-93 Warning Word 2</b> 0 - 0xFFFFFFFF, * 0	[2] Trip	<b>25-29 Destage Function</b> [0] Disabled
<b>16-1* Motor Status</b>	<b>16-94 Ext. Status Word</b> 0 - 0xFFFFFFFF, * 0	<b>22-61 Broken Belt Torque</b> 5 - 100%, * 10	*[1] Enabled
<b>16-10 Power [kW]</b> 0.000-4.294, 967.500, *0.000	<b>16-95 Ext. Status Word 2</b> 0 - 0xFFFFFFFF, * 0	<b>22-62 Broken Belt Delay</b> 0 - 600s, * 10	<b>25-30 Destage Function Time</b> 0 ~ 300s, *15s
<b>16-11 Power [hp]</b> 0.000 - 2.294, 967.500 *0.000	<b>18-**Extended Motor Data</b>	<b>24-** Appl. functions 2</b>	<b>25-4* Staging Settings</b>
<b>16-3* Drive Status</b>	<b>18-1* Firemode Log</b>	<b>24-0* Fire mode</b>	<b>25-42 Staging Threshold</b>
<b>16-30 DC Link Voltage</b> 0 - 65535, * 0	<b>18-10 Firemode log: Event</b> 0-255, *0	<b>24-00 Fire Mode Function</b> *[0] Disabled	<b>P. 4-12/P. 4-14 ~ 100%, *90%</b>
<b>16-34 Heatsink Temp.</b> 0 - 255, * 0	<b>20-** FC Closed Loop</b>	[1] Enabled Run Forward	<b>25-43 Destaging Threshold</b> P. 4-12/P. 4-14 ~ 100%, *50%
<b>16-35 Inverter Thermal</b> 0 - 255%, * 0	<b>20-0* Feedback</b>	[2] Enabled Run Reverse	<b>25-45 Staging Speed [Hz]</b> P. 4-12 ~ P. 4-14 Hz, *0Hz
<b>16-36 Inv. Nom. Current</b> 0.00 - 655.35, * 0.00	<b>20-00 Feedback 1 Source</b> *[0] No function	[3] Enable-Coast	<b>25-47 Destaging Speed [Hz]</b> P. 4-12 ~ P. 4-14 Hz, *0Hz
<b>16-37 Inv. Max. Current</b> 0.00 - 655.35	[1] Analog in 53	[4] Enabled - Run Fwd/Rev	<b>25-5* Alternation Settings</b>
<b>16-38 SL Controller State</b> 0 - 255, * 0	[2] Analog in 54	<b>24-05 Fire Mode Preset</b> Reference	<b>25-50 Lead PUmp Alternation</b> *[0] Off
<b>16-5* Ref. and Feedb.</b>	[100] Bus Feedback 1	-100 - 100%, * 0	[1] At staging
<b>16-50 External Reference</b> -200.0 - 200.0%, * 0.0	<b>20-01 Feedback 1 Conversion</b> *[0] Linear	<b>24-09 Fire Mode Alarm Handling</b> *[1] Trip, Critical Alarms	[2] At command
<b>16-52 Feedback</b> -4999.000 - 4999.000, * 0.000	[1] Square root	[2] Trip, All Alarms/Test	[3] At staging or at command
<b>16-6* Inputs and Outputs</b>	<b>20-8* PI Basic Setting</b>	<b>24-1* Drive Bypass</b>	<b>25-51 Alternation Event</b>
<b>16-60 Digital input</b> 0 - 65535, * 0	<b>20-81 Process PI Normal/ Inverse Control</b> *[0] Normal	<b>24-10 Drive Bypass Function</b> *[0] Disabled	*[0] None
<b>16-61 Terminal 53 Setting</b> *[0] Current mode	[1] Inverse	[2] Enabled (Fire Mode only)	[1] Alternation timer
[1] Voltage mode	<b>20-83 Process PI Start Speed[Hz]</b> 0.0 - 200.0, * 0.0	<b>24-11 Bypass Delay Timer</b> 0 - 600s, * 0	[2] Sleep mode
<b>16-62 Analog Input 53</b> 0.00 - 10.00, * 1.00	<b>20-84 On Reference Bandwidth</b> 0 - 200%, * 5	<b>25-** Cascade Controller</b>	<b>25-52 Alternation Time Interval</b> 1 ~ 999h, *24h
<b>16-63 Terminal 54 Setting</b> *[0] Current mode	<b>20-9* PI Controller</b>	<b>25-0* System Settings</b>	<b>25-53 Alternation Time Value</b> N/A
[1] Voltage mode	<b>20-91 PI Anti Windup</b> [0] Off	<b>25-00 Cascade Controller</b> *[0] Disabled	<b>25-55 Alternate if Load &lt; 50%</b> [0] Disabled
<b>16-64 Analog Input 54</b> 0.00 - 20.00, * 1.00	<b>20-93 PI Proportional Gain</b> 0.00 - 10.00, * 0.01	[1] Enabled	*[1] Enabled
<b>16-65 Analog Output 42 [mA]</b> 0.00 - 20.00, * 0.00	<b>20-94 PI Integral Time</b> 0.10 - 9999.00s, * 9999.00	<b>25-04 Pump Cycling</b> *[0] Disabled	<b>25-56 Staging Mode at Alternation</b>
<b>16-66 Digital Output</b>	<b>20-97 Process PI Feed Forward Factor</b> 0 - 400%, * 022-** Appl. functions	[1] Enabled	*[0] Slow
<b>16-72 Counter A</b> -32768 - 32767, * 0	<b>22-4* Sleep mode</b>	<b>25-05 Fixed Lead Pump</b> [0] No	[1] Quick
<b>16-73 Counter B</b> -32768 - 32767, * 0	<b>22-40 Minimum Run Time</b> 0 - 600s, * 10	<b>25-06 Number of Pumps</b> *[1] Yes	<b>25-58 Run Next Pump Delay</b> 0.1 ~ 5.0s, *0.1s
<b>16-79 Analog output 45</b> 20 - 20mA, * 0	<b>22-41 Minimum Sleep Time</b> 0 - 600s, * 10	<b>25-07 Cascade Controller</b> If p. 25-05 = No, then 0-2, if p. 25-05 = Yes, then 0-3	<b>25-59 Run on Mains Delay</b> P. 25-58 ~ 5.0s, *0.5s
<b>16-8* Fieldbus / FC Port</b>	<b>22-43 Wake-Up Speed [Hz]</b> 0.0 - 400.0, * 100.0	<b>25-2* Bandwidth Settings</b>	<b>25-8* Status</b>
	<b>22-44 Wake-Up Ref./FB difference</b> 0 - 100%, * 10	<b>25-20 Staging Bandwidth</b> P. 25-20 ~ 100%, *100%	<b>25-80 Cascade Status</b> N/A
	<b>22-45 Setpoint Boost</b>	<b>25-22 Fixed Speed Bandwidth</b> P. 25-20 ~ P. 25-21%, *10%	<b>25-81 Pump Status</b> N/A
		<b>25-23 SBW Staging Delay</b> 0 ~ 300s, *15s	<b>25-84 Pump ON Time</b> 0 ~ 2147483647h, *0h
		<b>25-24 SBW Destaging Delay</b> *[0] Off	<b>25-9* Service</b>
			<b>25-90 Pump Interlock</b> [1] On

## 1.7 Warnings and Alarms

Fault number	Alarm/Warning Bit Number	Fault text	Warning	Alarm	Trip locked	Cause of problem
2	16	Live zero error	X	X		Signal on terminal 53 or 54 is less than 50% of value set in parameter 6-10, 6-12, 6-20 or 6-22. See also parameter group 6-0X
4	14	Mains ph. loss	X	X	X	Missing phase on supply side or too high voltage imbalance. Check supply voltage. See parameter 14-12
7	11	DC over volt	X	X		Intermediate circuit voltage exceeds limit.
8	10	DC under volt	X	X		Intermediate circuit voltage drops below "voltage warning low" limit.
9	9	Inverter overload	X	X		More than 100% load for too long.
10	8	Motor ETR over	X	X		Motor is too hot due to more than 100% load for too long. See parameter 1-90
11	7	Motor th over	X	X		Thermistor or thermistor connection is disconnected. See parameter 1-90.
13	5	Over Current	X	X	X	Inverter peak current limit is exceeded.
14	2	Earth Fault		X	X	Discharge from output phases to ground.
16	12	Short Circuit		X	X	Short-circuit in motor or on motor terminals.
17	4	Ctrl.word TO	X	X		No communication to frequency converter. See parameter group 8-0X
24	50	Fan Fault	X	X		The fan is not working (Only on 400V 30-90 kW units).
30	19	U phase loss		X	X	Motor phase U is missing. Check the phase. See parameter 4-58.
31	20	V phase loss		X	X	Motor phase V is missing. Check the phase. See parameter 4-58.
32	21	W phase loss		X	X	Motor phase W is missing. Check the phase. See parameter 4-58.
38	17	Internal fault		X	X	Contact your local Danfoss supplier.
40	10	Overload on Terminal 27, Digital Output	X			Overload on Terminal 27, Digital Output
41	11	Overload on Terminal 29, Digital Output	X			Overload on Terminal 29, Digital Output
44	28	Earth Fault		X	X	Discharge from output phases to ground.
47	23	Control Voltage Fault	X	X	X	24 V DC may be overloaded.
48	25	VDD1 Supply Low		X	X	Control voltage low. Please contact your local Danfoss supplier
50		AMA Calibration failed		X		Contact your local Danfoss supplier.
51	15	AMA Unom,Inom		X		The setting of motor voltage, motor current and motor power is presumably wrong. Check the settings.
52		AMA low Inom		X		The motor current is too low. Check the settings.
53		AMA big motor		X		The motor is too big for the AMA to be carried out
54		AMA small mot		X		The motor is too small for the AMA to be carried out
55		AMA par. range		X		The parameter values found from the motor are outside acceptable range
56		AMA user interrupt		X		The AMA has been interrupted by the user

Fault number	Alarm/Warning Bit Number	Fault text	Warning	Alarm	Trip locked	Cause of problem
57		AMA timeout		X		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 Rs and Rr are increased. In most cases, however, this is not critical
58		AMA internal	X	X		Contact your local Danfoss supplier.
59	25	Current limit	X			The current is higher than the value in par. 4-18 Current Limit
60	44	External Interlock		X		External interlock has been activated. To resume normal operation, apply 24V DC to the terminal programmed for external interlock and reset the frequency converter (via serial communication, digital I/O, or by pressing reset button on keypad).
66	26	Heat sink Temperature Low	X			This warning is based on the temperature sensor in the IGBT module (Only on 400V 30-90 kW units).
69	1	Pwr. Card Temp	X	X	X	The temperature sensor on the power card is either too hot or too cold.
79		Illegal power section configuration	X	X		Internal fault. Contact your local Danfoss supplier.
80	29	Drive initialised		X		All parameter settings are initialized to default settings.
87	47	Auto DC Braking	X			The drive is auto DC braking
95	40	Broken Belt	X	X		Torque is below the torque level set for no load, indicating a broken belt. See parameter group 22-6.
200		Fire Mode	X			Fire mode has been activated
202		Fire Mode Limits Exceeded	X			Fire Mode has suppressed one or more warranty voiding alarms
250		New sparepart		X	X	The power or switch mode power supply has been exchanged. (Only on 400V 30-90 kW units). Contact your local Danfoss supplier
251		New Typecode		X	X	The frequency converter has a new type code (Only on 400V 30-90 kW units). Contact your local Danfoss supplier.

## 1.8 General Specifications

### 1.8.1 Mains Supply 3 x 380-480VAC

Frequency converter	PK37	PK75	P1K5	P2K2	P3K0	P4K0	P5K5	P11K	P15K	P18K	P22K	P30K	P37K	P45K	P55K	P75K	P90K
Typical shaft output (kW)	0.37	0.75	1.5	2.2	3.0	4.0	5.5	7.5	11.0	15.0	18.0	22.0	30.0	37.0	45.0	55.0	75.0
Typical shaft output (hp)	0.5	1.0	2.0	3.0	4.0	5.0	7.5	10.0	15.0	20.0	25.0	30.0	40.0	50.0	60.0	70.0	100.0
IP20 frame	H1	H1	H1	H2	H2	H2	H3	H3	H4	H4	H5	H5	H6	H6	H7	H7	H8
Max. cable size in terminals (mains, motor) [mm <sup>2</sup> /AWG]	4/10	4/10	4/10	4/10	4/10	4/10	4/10	4/10	4/10	4/10	4/10	16/6	16/6	35/2	35/2	50/1	95/0
<b>Output current</b>																	120/250 MCM
<b>40°C ambient temperature</b>																	
Continuous (3x380-440V)[A]	1.2	2.2	3.7	5.3	7.2	9.1	12.0	15.5	23.0	31.0	37.0	42.5	61.0	73.0	90.0	106.0	147.0
Intermittent (3x380-440V)[A]	1.3	2.4	4.1	5.8	7.9	9.9	13.2	17.1	25.3	34.0	40.7	46.8	67.1	80.3	99.0	116.0	161.0
Continuous (3x440-480V)[A]	1.1	2.1	3.4	4.8	6.3	8.2	11.0	14.0	21.0	27.0	34.0	40.0	52.0	65.0	80.0	105.0	130.0
Intermittent (3x440-480V)[A]	1.2	2.3	3.7	5.3	6.9	9.0	12.1	15.4	23.1	29.7	37.4	44.0	57.2	71.5	88.0	115.0	143.0
<b>Max. input current</b>																	176.0
Continuous (3x380-440V)[A]	1.2	2.1	3.5	4.7	6.3	8.3	11.2	15.1	22.1	29.2	35.2	41.5	57.0	70.0	84.0	103.0	140.0
Intermittent (3x380-440V)[A]	1.3	2.3	3.9	5.2	6.9	9.1	12.3	16.6	24.3	32.9	38.7	45.7	62.7	77.0	92.4	113.0	154.0
Continuous (3x440-480V)[A]	1.0	1.8	2.9	3.9	5.3	6.8	9.4	12.6	18.4	24.7	29.3	34.6	49.2	60.6	72.5	88.6	120.9
Intermittent (3x440-480V)[A]	1.1	2.0	3.2	4.3	5.8	7.5	10.3	13.9	20.2	27.2	32.2	38.1	54.1	66.7	79.8	97.5	132.9
<b>Max. mains fuses</b>																	157.0
See 5.1.4 Fuses																	

Frequency converter	PK37	PK75	P1K5	P2K2	P3K0	P4K0	P5K5	P7K5	P11K	P15K	P18K	P22K	P30K	P37K	P45K	P55K	P75K	P90K
Estimated power loss [W], Best case/typical <sup>1)</sup>	13/15	21/16	46/57	46/58	66/83	95/118	104/13	159/19	248/27	353/37	412/45	475/52	780	893	1160	1130	1460	1780
Weight enclosure [P20kg]							1	8	4	9	6	3						
Efficiency [%], Best case/Typical 1	97.8/97.	98.0/97.	97.7/97	98.3/97	98.2/97.	98.0/97.	98.4/98	98.2/97	98.1/97	98.0/97	98.1/97	98.1/97	97.8	97.9	97.1	98.3	98.3	98.3
<b>Output current</b>	3	6	.2	.9	8	6	.0	.8	.9	.8	.9	.9						
<b>50°C ambient temperature</b>																		
Continuous (3x380-440V) [A]	1.0	1.9	3.7	4.9	6.3	8.4	10.9	14.0	20.9	28.0	34.1	38.0	48.8	58.4	72.0	74.2	102.9	123.9
Intermittent (3x380-440V) [A]	1.1	2.1	4.07	5.4	6.9	9.2	12.0	15.4	23.0	30.8	37.5	41.8	53.7	64.2	79.2	81.6	113.2	136.3
Continuous (3x440-480V) [A]	1.0	1.89	3.4	4.4	5.5	7.5	10.0	12.6	19.1	24.0	31.3	35.0	41.6	52.0	64.0	73.5	91.0	112.0
Intermittent (3x440-480V) [A]	1.1	2.0	3.7	4.8	6.1	8.3	11.0	13.9	21.0	26.4	34.4	38.5	45.8	57.2	70.4	80.9	100.1	123.2

## 1.8.2 EMC Test Results

The following test results have been obtained using a system with a frequency converter, a screened control cable, a control box with potentiometer, as well as a motor screened cable.

RFI Filter Type	Conduct emission. Maximum shielded cable length				Radiated emission			
	Industrial environment		Housing, trades and light industries		Industrial environment		Housing, trades and light industries	
	EN 55011 Class A2	EN 55011 Class A1	EN 55011 Class B		EN 55011 Class A1	EN 55011 Class B		
	Without external filter	With external filter	Without external filter	With external filter	Without external filter	With external filter	Without external filter	With external filter
<b>H4 RFI filter (Class A1)</b>								
0.37-22kW 3x380-480V IP20			25m	50m		20m	Yes	Yes
<b>H3 RFI filter (Class A1/B)</b>								
30-90kW 3x380-480V IP20			50m		20m		yes	-

### Protection and features

- Electronic thermal motor protection against overload.
- Temperature monitoring of the heatsink ensures that the frequency converter trips in case of overtemperature.
- The frequency converter is protected against short-circuits between motor terminals U, V, W.
- If a motor phase is missing, the frequency converter trips and issues an alarm.
- 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	380-480V ±10%
Supply frequency	50/60Hz
Max. imbalance temporary between mains phases	3.0% of rated supply voltage
True Power Factor ( $\lambda$ )	≥ 0.9 nominal at rated load
Displacement Power Factor ( $\cos\phi$ ) near unity	(> 0.98)
Switching on the input supply L1, L2, L3 (power-ups) enclosure frame H1-H5	Max. 2 times/min.
Switching on the input supply L1, L2, L3 (power-ups) enclosure frame H6-H8	Max. 1 time/min.
Environment according to EN 60664-1	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, 240/480V maximum.	

### Motor output (U, V, W)

Output voltage	0 - 100% of supply voltage
Output frequency	0-200Hz (VVC+), 0-400Hz (u/f)
Switching on output	Unlimited
Ramp times	0.05 - 3600 sec.

**Cable lengths and cross sections**

Max. motor cable length, screened/armoured (EMC correct installation)	See chapter EMC test results
Max. motor cable length, unscreened/unarmoured	50m
Max. cross section to motor, mains*	
Cross section DC terminals for filter feedback on enclosure frame H1-H3	4mm <sup>2</sup> /11AWG
Cross section DC terminals for filter feedback on enclosure frame H4-H5	16mm <sup>2</sup> /6AWG
Maximum cross section to control terminals, rigid wire	2.5mm <sup>2</sup> /14AWG
Maximum cross section to control terminals, flexible cable	2.5mm <sup>2</sup> /14AWG
Minimum cross section to control terminals	0.05mm <sup>2</sup> /30AWG

\*See tables for mains supply for more information

**Digital inputs:**

Programmable digital inputs	4
Terminal number	18, 19, 27, 29
Logic	PNP or NPN
Voltage level	0-24V DC
Voltage level, logic '0' PNP	< 5V DC
Voltage level, logic '1' PNP	> 10V DC
Voltage level, logic '0' NPN	> 19V DC
Voltage level, logic '1' NPN	< 14V DC
Maximum voltage on input	28V DC
Input resistance, R <sub>i</sub>	Approx. 4 k
Digital input 29 as thermistor input	Fault: > 2.9kΩ and no fault: < 800Ω

**Digital output**

Programmable digital outputs	2
Terminal number	27, 29 <sup>1)</sup>
Voltage level at digital output	0-24V DC
Max. output current (SINK or Source)	40mA

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

**Analog inputs**

Number of analog inputs	2
Terminal number	53, 54
Terminal 53 mode	Parameter 6-19: 1 = voltage, 0 = current
Terminal 54 mode	Parameter 6-29: 1 = voltage, 0= current
Voltage level	0 - 10V
Input resistance, R <sub>i</sub>	approx. 10kΩ
Max. voltage	20V
Current level	0/4 to 20mA (scalable)
Input resistance, R <sub>i</sub>	<500Ω
Max. current	29mA

**Analog output**

Number of programmable analog outputs	2
Terminal number	42, 45 <sup>1)</sup>
Current range at analog output	0/4 - 20mA
Max. load to common at analog output	500Ω
Max. voltage at analog output	17V
Accuracy on analog output	Max. error: 0.4% of full scale
Resolution on analog output	12 bit

1) Terminal 42 and 45 can also be programmed as digital outputs.

**Digital output**

Number of digital outputs	2
Terminal number	42, 45 <sup>1)</sup>
Voltage level at digital output (output current = 20mA)	12V DC

Max Voltage level at digital output (output current < 4mA)	17V DC
Max. output current	20mA

<sup>1)</sup> Terminals 42 and 45 can also be programmed as analog outputs.

#### 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

#### Control card, 24V DC output:

Terminal number	12
Max. load enclosure frame H1-H8	80mA

#### Relay output

Programmable relay output	2
Relay 01 and 02	01-03 (NC), 01-02 (NO), 04-06 (NC), 04-05 (NO)
Max. terminal load (AC-1) <sup>1)</sup> on 01-02/04-05 (NO) (Resistive load)	250V AC, 3A
Max. terminal load (AC-15) <sup>1)</sup> on 01-02/04-05 (NO) (Inductive load @ cosφ 0.4)	250V AC, 0.2A
Max. terminal load (DC-1) <sup>1)</sup> on 01-02/04-05 (NO) (Resistive load)	30V DC, 2A
Max. terminal load (DC-13) <sup>1)</sup> on 01-02/04-05 (NO) (Inductive load)	24V DC, 0.1A
Max. terminal load (AC-1) <sup>1)</sup> on 01-03/04-06 (NC) (Resistive load)	250V AC, 3A
Max. terminal load (AC-15) <sup>1)</sup> on 01-03/04-06 (NC) (Inductive load @ cosφ 0.4)	250V AC, 0.2A
Max. terminal load (DC-1) <sup>1)</sup> on 01-03/04-06 (NC)	30V DC, 2A
(Resistive load)	Min. terminal load on 01-03 (NC), 01-02 (NO) 24V DC 10mA, 24V AC 20mA
Environment according to EN 60664-1	Overvoltage category III/pollution degree 2

<sup>1)</sup> IEC 60947 parts 4 and 5.

#### Control card, 10V DC output

Terminal number	50
Output voltage	10.5V ±0.5V
Max. load	25mA

All inputs, outputs, circuits, DC supplies and relay contacts are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

#### Surroundings

Enclosure	IP20
Enclosure kit available	IP21, TYPE 1
Vibration test	1.0g
Max. relative humidity	5% - 95% (IEC 60721-3-3; Class 3K3 (non-condensing) during operation
Aggressive environment (IEC 60721-3-3), coated (standard) frame H1-H5	Class 3C3
Aggressive environment (IEC 60721-3-3), non-coated frame H6-H10	Class 3C2
Aggressive environment (IEC 60721-3-3), coated (optional) frame H6-H10	Class 3C3
Test method according to IEC 60068-2-43 H2S (10 days)	
Ambient temperature	See max. output current at 40/50°C in the tables mains supply

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, enclosure frame H1-H5	-20°C
Minimum ambient temperature at reduced performance, enclosure frame H6-H10	-10°C
Temperature during storage/transport	-30 - +65/70°C
Maximum altitude above sea level without derating	1000m
Maximum altitude above sea level with derating	3000m
Derating for high altitude, see section on special conditions	
Safety standards	EN/IEC 61800-5-1, UL 508C
EMC standards, Emission	EN 61800-3, EN 61000-6-3/4, EN 55011, IEC 61800-3
EMC standards, Immunity	EN 61800-3, EN 61000-6-1/2, EN 61000-4-2, EN 61000-4-3, EN 61000-4-4, EN 61000-4-5, EN 61000-4-6

## 1.9 Special Conditions

### 1.9.1 Derating for Ambient Temperature

The ambient temperature measured over 24 hours should be at least 5°C lower than the max. ambient temperature. If the frequency converter is operated at high ambient temperature, the continuous output current should be decreased.

### 1.9.2 Derating for Low Air Pressure

The cooling capability of air is decreased at low air pressure. For altitudes above 2000m, please contact Danfoss regarding PELV. Below 1000m altitude no derating is necessary, but above 1000m the ambient temperature or the maximum output current should be decreased. Decrease the output by 1% per 100m altitude above 1000m or reduce the max. ambient temperature by 1 degree per 200m.

## 1.10 Options for VLT HVAC Basic Drive FC 111

For options please see the Design Guide.

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