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Danfoss

Design Guide
VLT® Compressor Drive CDS 803

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VLT® THE REAL DRIVE

Contents

1 Introduction

1.1 Purpose of the Manual

This design guide is intended for project and systems engineers, design consultants, and application and product specialists. Technical information is provided to understand the capabilities of the frequency converter for integration into motor control and monitoring systems. Details concerning operation, requirements, and recommendations for system integration are described. Information is proved for input power characteristics, output for motor control, and ambient operating conditions for the frequency converter.

Also included are:

- Safety features.
- Fault condition monitoring.
- Operational status reporting.
- Serial communication capabilities.
- Programmable options and features.

Also provided are design details such as:

- Site requirements.
- Cables.
- Fuses.
- Control wiring.
- Unit sizes and weights.
- Other critical information necessary to plan for system integration.

Reviewing the detailed product information in the design stage enables developing a well-conceived system with optimal functionality and efficiency.

VLT® is a registered trademark.

1.2 Document and Software Version

This manual is regularly reviewed and updated. All suggestions for improvement are welcome. *Table 1.1* shows the document version and the corresponding software version.

Edition	Remarks	Software version
MG18N2xx	–	1.20

Table 1.1 Document and Software Version

1.3 Safety Symbols

The following symbols are used in this manual:

⚠WARNING

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

⚠CAUTION

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

NOTICE

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

1.4 Abbreviations

°C	Degrees celsius
A	Ampere/AMP
AC	Alternating current
AMA	Automatic motor adaptation
AUG.	American wire gauge
DC	Direct current
EMC	Electro magnetic compatibility
ETR	Electronic thermal relay
FC	Frequency converter
$f_{M,N}$	Nominal motor frequency
g	Gram
Hz	Hertz
I_{INV}	Rated inverter output current
I_{LIM}	Current limit
$I_{M,N}$	Nominal motor current
$I_{VLT,MAX}$	The maximum output current
$I_{VLT,N}$	The rated output current supplied by the frequency converter
kHz	Kilohertz
LCP	Local control panel
m	Meter
mA	Milliampere
MCT	Motion control tool
mH	Millihenry inductance
min	Minute
ms	Millisecond
nF	Nanofarad
Nm	Newton meters
n_s	Synchronous motor speed
$P_{M,N}$	Nominal motor power

PCB	Printed circuit board
PELV	Protective extra low voltage
Regen	Regenerative terminals
RPM	Revolutions per minute
s	Second
T_{LIM}	Torque limit
$U_{M,N}$	Nominal motor voltage
V	Volts

Table 1.2 Abbreviations

1.5 Additional Resources

- *VLT® Compressor Drive CDS 803 Quick Guide* provides basic information on mechanical dimensions, installation and programming.
- *VLT® Compressor Drive CDS 803 Programming Guide* provides information on how to program and includes complete parameter descriptions.
- *VLT® Compressor Drive CDS 803 Design Guide* entails all technical information about the frequency converter and customer design and applications.
- *MCT 10 Set-up Software* enables the user to configure the frequency converter from a Windows™ based PC environment.

Danfoss technical literature is available in print from a local Danfoss Sales Office or at:
vlt-drives.danfoss.com/Support/Technical-Documentation/

1.6 Definitions

Frequency converter

$I_{VLT,MAX}$
The maximum output current.

$I_{VLT,N}$
The rated output current supplied by the frequency converter.

$U_{VLT, MAX}$
The maximum output voltage.

Input

The connected compressor can start and stop with LCP and the digital inputs. Functions are divided into 2 groups. Functions in group 1 have higher priority than functions in group 2.	Group 1	Reset, coasting stop, reset and coasting stop, quick-stop, DC braking, stop, and the [Off] key.
	Group 2	Start, pulse start, reversing, start reversing, jog, and freeze output

Table 1.3 Control Commands

Compressor

f_{JOG}
The motor frequency when the jog function is activated (via digital terminals).

f_M
The motor frequency.

f_{MAX}
The maximum compressor frequency.

f_{MIN}
The minimum compressor frequency.

$f_{M,N}$
The rated motor frequency (nameplate data).

I_M
The motor current.

$I_{M,N}$
The rated motor current (nameplate data).

$n_{M,N}$
The nominal motor speed (nameplate data).

$P_{M,N}$
The rated motor power (nameplate data).

U_M
The instant motor voltage.

$U_{M,N}$
The rated motor voltage (nameplate data).

Break-away torque

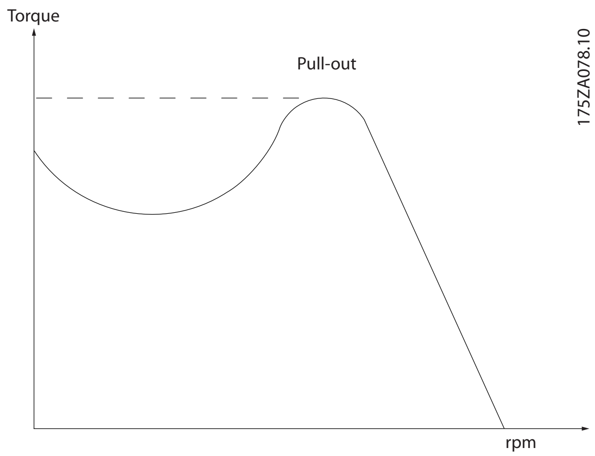


Illustration 1.1 Break-away Torque

η_{VLT}
The efficiency of the frequency converter is defined as the ratio between the power output and the power input.

Start-disable command
A stop command belonging to the group 1 control commands, see *Table 1.3*.

Stop command
See control commands, *Table 1.3*.

References

Analog reference
A signal transmitted to the analog inputs 53 or 54, can be voltage or current.

Bus reference
A signal transmitted to the serial communication port (FC port).

Preset reference
A defined preset reference to be set from -100% to +100% of the reference range. Selection of 8 preset references via the digital terminals.

Ref_{MAX}
Determines the relationship between the reference input at 100% full scale value (typically 10 V, 20 mA) and the resulting reference. The maximum reference value set in *parameter 3-03 Maximum Reference*.

Ref_{MIN}
Determines the relationship between the reference input at 0% value (typically 0 V, 0 mA, 4 mA) and the resulting reference. The minimum reference value set in *parameter 3-02 Minimum Reference*.

Miscellaneous
Analog inputs
The analog inputs are used for controlling various functions of the frequency converter.
There are 2 types of analog inputs:

- Current input, 0–20 mA, and 4–20 mA.
- Voltage input, 0–10 V DC.

Analog outputs
The analog outputs can supply a signal of 0–20 mA, 4–20 mA, or a digital signal.

Automatic Motor Adaptation, AMA
AMA algorithm determines the electrical parameters for the connected compressor at standstill.

Digital inputs
The digital inputs can be used for controlling various functions of the frequency converter.

Digital outputs
The frequency converter features 2 solid-state outputs that can supply a 24 V DC (maximum 40 mA) signal.

Relay outputs
The frequency converter features 2 programmable relay outputs.

ETR
Electronic thermal relay is a thermal load calculation based on present load and time. Its purpose is to estimate the compressor temperature.

Initializing
If initializing is carried out (*parameter 14-22 Operation Mode*), the programmable parameters of the frequency converter return to their default settings.
Parameter 14-22 Operation Mode does not initialize communication parameters.

Intermittent duty cycle
An intermittent duty rating refers to a sequence of duty cycles. Each cycle consists of an on-load and an off-load period. The operation can be either periodic duty or none-periodic duty.

LCP
The local control panel (LCP) makes up a complete interface for control and programming of the frequency converter. The control panel is detachable and can be installed up to 3 m (9.8 ft) from the frequency converter, that is, in a front panel with the installation kit option.

lsb
Least significant bit.

MCM
Short for Mille Circular Mil, an American measuring unit for cable cross-section. 1 MCM ≡ 0.5067 mm^2.

msb
Most significant bit.

On-line/Off-line parameters
Changes to on-line parameters are activated immediately after the data value is changed. To activate the off-line parameters, press [OK].

PI controller
The PI controller maintains the desired speed, pressure, temperature, and so on, by adjusting the output frequency to match the varying load.

RCD
Residual current device.

Set-up
Parameter settings in 2 set-ups can be saved. Change between the 2 parameter set-ups and edit 1 set-up, while another set-up is active.

Slip compensation
The frequency converter compensates for the compressor slip by giving the frequency a supplement that follows the measured compressor load keeping the compressor speed almost constant.

Smart logic control (SLC)
The SLC is a sequence of user-defined actions executed when the associated user-defined events are evaluated as true by the SLC.

Thermistor
A temperature-dependent resistor placed where the temperature is to be monitored (frequency converter or compressor).

Trip
A state entered in fault situations, for example, if the frequency converter is subject to an overtemperature or when the frequency converter is protecting the compressor, process, or mechanism. Restart is prevented until the cause of the fault has disappeared and the trip state is canceled by activating reset or, sometimes, by

being programmed to reset automatically. Do not use trip for personal safety.

Trip lock
A state entered in fault situations when the frequency converter is protecting itself and requiring physical intervention, for example, if the frequency converter is subject to a short circuit on the output. A locked trip can only be canceled by cutting off mains, removing the cause of the fault, and reconnecting the frequency converter. Restart is prevented until the trip state is canceled by activating reset or, sometimes, by being programmed to reset automatically. Trip lock may not be used for personal safety.

VT characteristics
Variable torque characteristics used for pumps and fans.

VVC+
If compared with standard voltage/frequency ratio control, voltage vector control (VVC+) improves the dynamics and the stability, both when the speed reference is changed and in relation to the load torque.

1.7 Power Factor

The power factor indicates to which extent the frequency converter imposes a load on the mains supply. The power factor is the ratio between I_1 and I_{RMS}, where I_1 is the fundamental current, and I_{RMS} is the total RMS current including harmonic currents. The lower the power factor, the higher the I_{RMS} for the same kW performance.

$$Power\ factor = \frac{\sqrt{3} \times U \times I_1 \times COS\phi}{\sqrt{3} \times U \times I_{RMS}}$$

The power factor for 3-phase control:

$$Power\ factor = \frac{I_1 \times cos\phi 1}{I_{RMS}} = \frac{I_1}{I_{RMS}}\ since\ cos\phi 1 = 1$$

$$I_{RMS} = \sqrt{I_1^2 + I_5^2 + I_7^2 + \ .\ .\ + I_n^2}$$

A high-power factor indicates that the different harmonic currents are low.
The frequency converters built-in DC coils produce a high-power factor, which minimizes the imposed load on the mains supply.

2 Product Overview

2.1 Safety

2.1.1 Safety Precautions

Safety regulations

- Disconnect the frequency converter from mains, before carrying out repair work. Check that the mains supply has been disconnected and that the necessary time has passed before removing compressor and mains plugs.
- The [Off/Reset] key does not disconnect the equipment from mains and is thus not to be used as a safety switch.
- Establish correct protective earthing of the equipment, protect the user against supply voltage, and protect the compressor against overload in accordance with applicable national and local regulations.
- The ground leakage currents are higher than 3.5 mA.
- Set protection against motor overload in *parameter 1-90 Motor Thermal Protection*. If this function is desired, set *parameter 1-90 Motor Thermal Protection* to data value *[4], [6], [8], [10] ETR trip* or data value *[3], [5], [7], [9] ETR warning*.

NOTICE

The function is initialized 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.

- Do not remove the plugs for the compressor 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 elapsed before removing compressor and mains plugs.
- Check that all voltage inputs have been disconnected and that the necessary time has elapsed before commencing repair work.

Installation at high altitudes

CAUTION

At altitudes above 2000 m (6561 ft), contact Danfoss regarding PELV.

WARNING

HIGH VOLTAGE

Frequency converters contain high voltage when connected to AC mains input power. Qualified personnel only should perform installation, start up, and maintenance. Failure to perform installation, start up, and maintenance by qualified personnel could result in death or serious injury.

WARNING

UNINTENDED START

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

WARNING

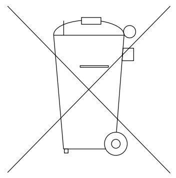
DISCHARGE TIME

The frequency converter contains DC-link capacitors, which can remain charged even when the frequency converter is not powered. High voltage can be present even when the warning LED indicator lights are off. Failure to wait the specified time after power has been removed before performing service or repair work can result in death or serious injury.

- **Stop the motor.**
- **Disconnect AC mains and remote DC-link power supplies, including battery back-ups, UPS, and DC-link connections to other frequency converters.**
- **Disconnect or lock PM motor.**
- **Wait for the capacitors to discharge fully. The minimum duration of waiting time is specified in *Table 2.1*.**
- **Before performing any service or repair work, use an appropriate voltage measuring device to make sure that the capacitors are fully discharged.**

Voltage [V]	Cooling capacity [TR]	Minimum waiting time (minutes)
3x200	4–6.5	15
3x400	4–5	4
3x400	6.5	15

Table 2.1 Discharge Time

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

2.2 CE Labelling

2.2.1 CE Conformity and Labeling

What is CE conformity and labeling?
The purpose of CE labelling is to avoid technical trade obstacles within EFTA and the EU. The EU has introduced the CE label as a simple way of showing whether a product complies with the relevant EU directives. The CE label says nothing about the specifications or quality of the product. Frequency converters are regulated by 3 EU directives:

The machinery directive (98/37/EEC)
All machines with critical moving parts are covered by the machinery directive of January 1, 1995. Since a frequency converter is largely electrical, it does not fall under the machinery directive. However, if a frequency converter is supplied for use in a machine, Danfoss provides information on safety aspects relating to the frequency converter. Danfoss does this with a manufacturer's declaration.

The Low Voltage Directive (73/23/EEC)
Frequency converters must be CE labeled in accordance with the Low Voltage Directive of January 1, 1997. The directive applies to all electrical equipment and appliances used in the 50–1000 V AC and the 75–1500 V DC voltage ranges. Danfoss CE-labels in accordance with the directive and issues a declaration of conformity on request.

The EMC directive (89/336/EEC)
EMC is short for electromagnetic compatibility. The presence of electromagnetic compatibility means that the mutual interference between different components/ appliances does not affect the way the appliances work. The EMC directive came into effect January 1, 1996. Danfoss CE-labels in accordance with the directive and issues a declaration of conformity after request. To carry out EMC-correct installation, see the instructions in this design guide. In addition, Danfoss specifies which standards our products comply with. Danfoss offers the filters presented in the specifications and provide other types of assistance to ensure the optimum EMC result.

The frequency converter is most often used by professionals of the trade as a complex component forming part of a larger appliance, system, or installation. Note that the responsibility for the final EMC properties of the appliance, system or installation rests with the installer.

2.2.2 What is Covered

The EU *Guidelines on the Application of Council Directive 89/336/EEC* outline 3 typical situations of using a frequency converter. See *chapter 2.2.3 Danfoss Frequency Converter and CE Labelling* for EMC coverage and CE labelling.

- The frequency converter is sold directly to the end-consumer. The frequency converter is for example sold to a DIY market. The end-consumer is a layman. The end-consumer installs the frequency converter himself for use with a hobby machine, a kitchen appliance, and so on. For such applications, the frequency converter must be CE labeled in accordance with the EMC directive.
- The frequency converter is sold for installation in a plant. The plant is built up by professionals of the trade. It could be a production plant or a heating/ventilation plant designed and installed by professionals of the trade. Neither the frequency converter nor the finished plant has to be CE labeled under the EMC directive. However, the unit must comply with the basic EMC requirements of the directive. This is ensured by using components, appliances, and systems that are CE labeled under the EMC directive.
- The frequency converter is sold as part of a complete system. The system is being marketed as complete and could for example, be an air-conditioning system. The complete system must be CE labeled in accordance with the EMC directive. The manufacturer can ensure CE labelling under the EMC directive either by using CE labeled components or by testing the EMC of the system. It is not necessary to test the entire system if only CE labeled components are selected.

2.2.3 Danfoss Frequency Converter and CE Labelling

CE labelling is a positive feature when used for its original purpose, that is, to facilitate trade within the EU and EFTA.

However, CE labelling may cover many different specifications. Check what a given CE label specifically covers.

The covered specifications can be different and a CE label may therefore give the installer a false feeling of security when using a frequency converter as a component in a system or an appliance.

Danfoss CE labels the frequency converters in accordance with the Low Voltage Directive. This means that if the frequency converter is installed correctly, Danfoss guarantees compliance with the Low Voltage Directive. Danfoss issues a declaration of conformity that confirms our CE labelling in accordance with the Low Voltage Directive.

The CE label also applies to the EMC directive if the instructions for EMC-correct installation and filtering are followed. On this basis, a declaration of conformity in accordance with the EMC directive is issued.

The Design Guide offers detailed instructions for installation to ensure EMC-correct installation. Furthermore, Danfoss specifies which our different products comply with.

Danfoss provides other types of assistance that can help to obtain the best EMC result.

2.2.4 Compliance with EMC Directive 89/336/EEC

As mentioned, the frequency converter is mostly used by professionals of the trade as a complex component forming part of a larger appliance, system, or installation. Note that the responsibility for the final EMC properties of the appliance, system, or installation rests with the installer. As an aid to the installer, Danfoss has prepared EMC installation guidelines for the power drive system. If the EMC-correct instructions for installation are followed, the standards and test levels stated for power drive systems are complied with.

2.3 Air Humidity

The frequency converter has been designed to meet the IEC/EN 60068-2-3 standard, EN 50178 9.4.2.2 at 50 °C (122 °F).

2.4 Aggressive Environments

A frequency converter contains many mechanical and electronic components. All are to some extent vulnerable to environmental effects.

⚠CAUTION

Do not install the frequency converter in environments with airborne liquids, particles, or gases that may affect or damage the electronic components. Failure to take necessary protective measures increases the risk of stoppages, potentially causing equipment damage and personnel injury.

Liquids can be carried through the air and condense in the frequency converter and may cause corrosion of components and metal parts. Steam, oil, and salt water may cause corrosion of components and metal parts. In such environments, use equipment with enclosure rating IP54. As an extra protection, coated printed circuit boards can be ordered as an option (standard on some power sizes).

Airborne particles such as dust may cause mechanical, electrical, or thermal failure in the frequency converter. A typical indicator of excessive levels of airborne particles is dust particles around the frequency converter fan. In dusty environments, use equipment with enclosure rating IP54 or a cabinet for IP20/TYPE 1 equipment.

In environments with high temperatures and humidity, corrosive gases such as sulphur, nitrogen, and chlorine compounds causes chemical processes on the frequency converter components.

Such chemical reactions rapidly affect and damages the electronic components. In such environments, mount the equipment in a cabinet with fresh air ventilation, keeping aggressive gases away from the frequency converter.
An extra protection in such areas is a coating of the printed circuit boards, which can be ordered as an option.

Before installing the frequency converter, check the ambient air for liquids, particles, and gases. This is done by observing existing installations in this environment. Typical indicators of harmful airborne liquids are water or oil on metal parts, or corrosion of metal parts.

Excessive dust particle levels are often found on installation cabinets and existing electrical installations. One indicator of aggressive airborne gases is blackening of copper rails and cable ends on existing installations.

2.5 Vibration and Shock

The frequency converter has been tested according to the procedure based on the shown standards, *Table 2.2*.

The frequency converter complies with requirements that exist for units mounted on the walls and floors of production premises, and in panels bolted to walls or floors.

IEC/EN 60068-2-6	Vibration (sinusoidal) - 1970
IEC/EN 60068-2-64	Vibration, broad-band random

Table 2.2 Standards

2.6 Control Structures

Select open loop or closed loop in *parameter 1-00 Configuration Mode*.

2.6.1 Control Structure Open Loop

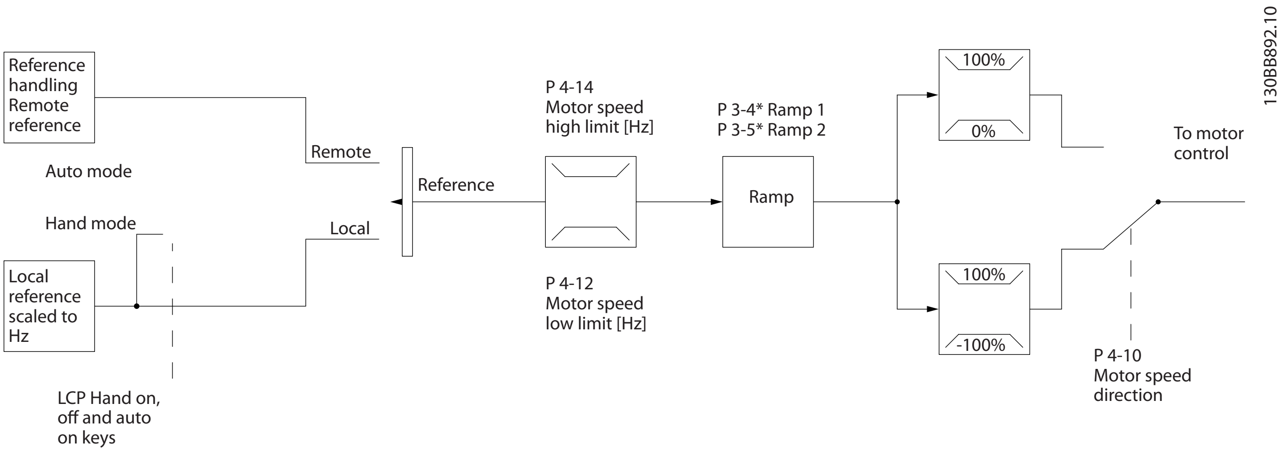


Illustration 2.1 Open-loop Structure

In the configuration shown in *Illustration 2.1*, *parameter 1-00 Configuration Mode* is set to *[0] Open loop*. The resulting reference from the reference handling system or the local reference is received and fed through the ramp limitation and speed limitation before being sent to the motor control. The output from the motor control is then limited by the maximum frequency limit.

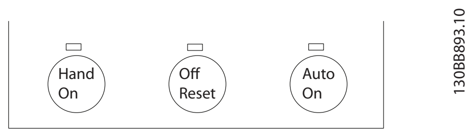


Illustration 2.2 LCP Keys

2.6.2 Local (Hand On) and Remote (Auto On) Control

The frequency converter can be operated manually via the local control panel (LCP) or remotely via analog/digital inputs or serial bus. If allowed in *parameter 0-40 [Hand on] Key on LCP*, *parameter 0-44 [Off/Reset] Key on LCP*, and *parameter 0-42 [Auto on] Key on LCP*, it is possible to start and stop the frequency converter via LCP by pressing [Hand On] and [Off/Reset]. Alarms can be reset via the [Off/Reset] key.

Local reference forces the configuration mode to open loop, independent on the setting of *parameter 1-00 Configuration Mode*.

Local reference is restored at power-down.

2.6.3 Control Structure Closed Loop

The internal controller allows the frequency converter to become a part of the controlled system. The frequency converter receives a feedback signal from a sensor in the system. It then compares this feedback to a setpoint reference value and determines the error, if any, between these 2 signals. It then adjusts the speed of the motor to correct this error.

For example, consider an application where the speed is to be controlled so that the static pressure in a pipe is constant. The desired static pressure value is supplied to the frequency converter as the setpoint reference. A static pressure sensor measures the actual static pressure in the pipe and supplies this to the frequency converter as a feedback signal. If the feedback signal is greater than the setpoint reference, the frequency converter slows down to reduce the pressure. In a similar way, if the pipe pressure is lower than the setpoint reference, the frequency converter automatically speeds up to increase the pressure provided by the pump.

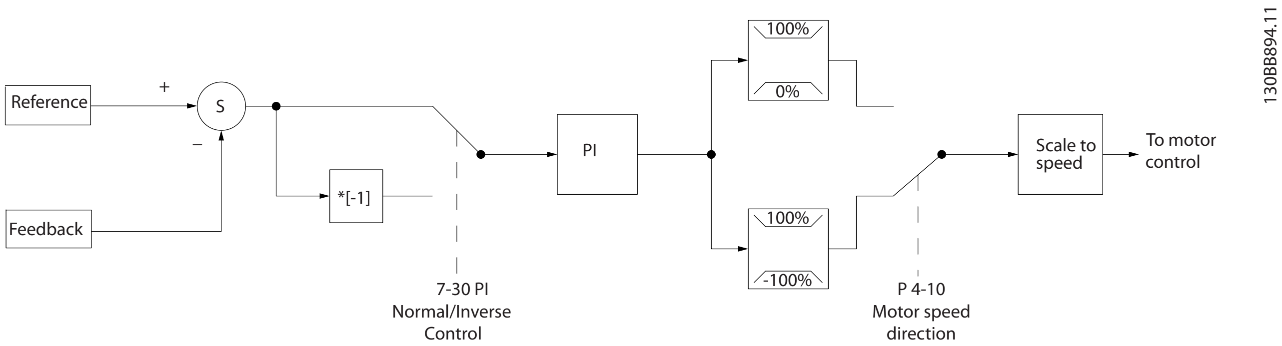


Illustration 2.3 Control Structure Closed Loop

While the default values for the frequency converter's closed-loop controller often provides satisfactory performance, the control of the system can often be optimized by adjusting some of the closed-loop controller's parameters.

2.6.4 Feedback Conversion

In some applications, it may be useful to convert the feedback signal. One example of this is using a pressure signal to provide flow feedback. Since the square root of pressure is proportional to flow, the square root of the pressure signal yields a value proportional to the flow. See *Illustration 2.4*.

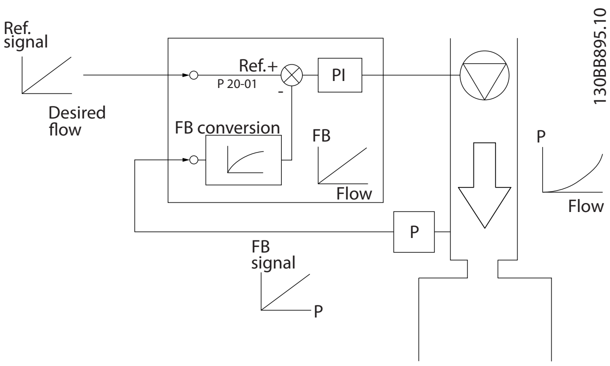


Illustration 2.4 Feedback Signal Conversion

2

2.6.5 Reference Handling

Details for open loop and closed loop operation.

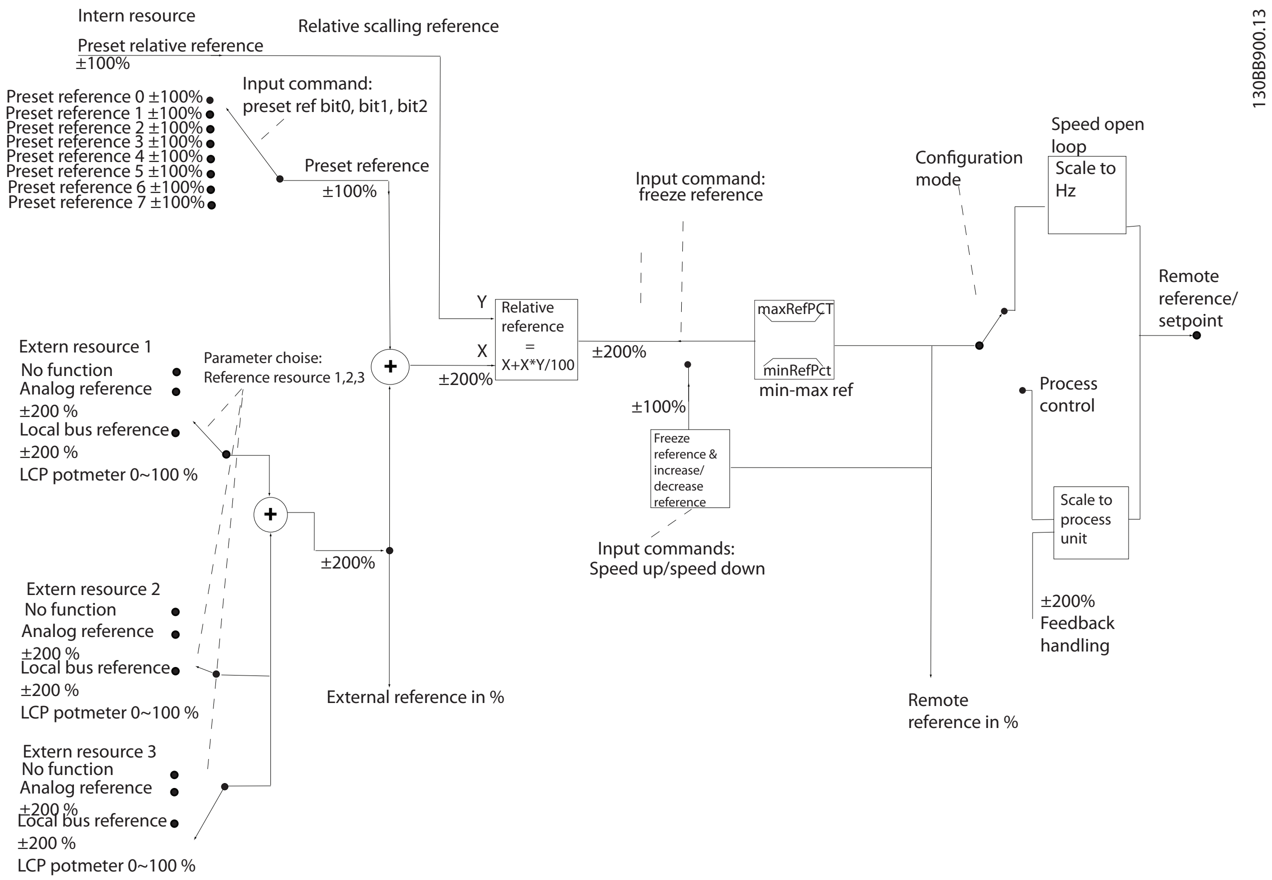


Illustration 2.5 Block Diagram Showing Remote Reference

The remote reference consists of:

- Preset references;
- External references (analog inputs and serial communication bus references);
- The preset relative reference;
- Feedback-controlled setpoint

Up to 8 preset references can be programmed in the frequency converter. The active preset reference can be selected using digital inputs or the serial communications bus. The reference can also be supplied externally, most commonly from an analog input. This external source is selected by 1 of the 3 reference source parameters (*parameter 3-15 Reference 1 Source*, *parameter 3-16 Reference 2 Source*, and *parameter 3-17 Reference 3 Source*). All reference resources and the bus reference are added to produce the total external reference. The external reference, the preset reference, or the sum of the 2 can be selected to be the active reference. Finally, this reference can by be scaled using *parameter 3-14 Preset Relative Reference*.

The scaled reference is calculated as follows:

$$Reference = X + X \times \left(\frac{Y}{100}\right)$$

Where X is the external reference, the preset reference or the sum of these and Y is *parameter 3-14 Preset Relative Reference* in [%].

If Y, *parameter 3-14 Preset Relative Reference*, is set to 0%, the reference is not affected by the scaling.

2.6.6 Closed-loop Set-up Quick Guide

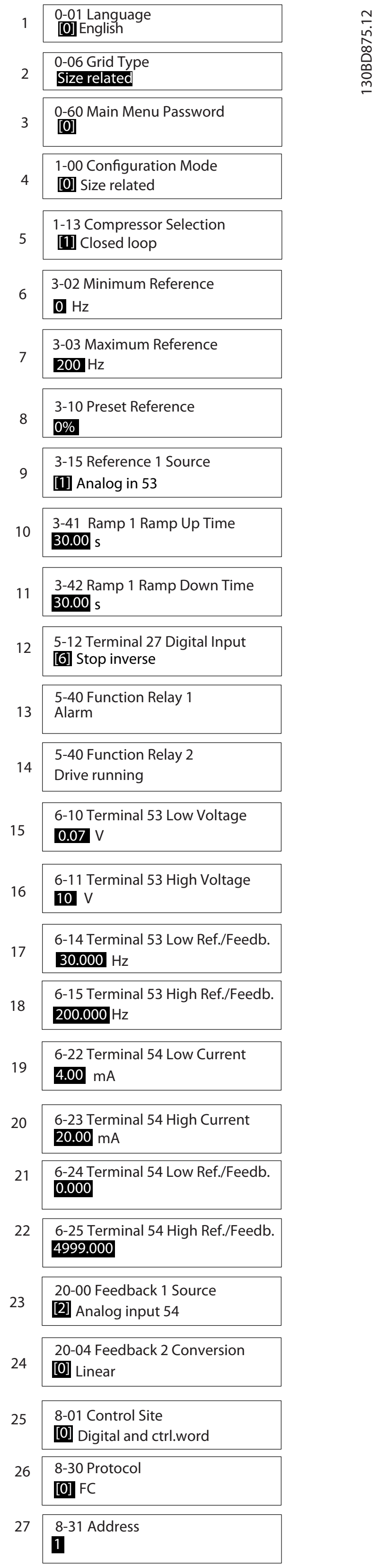


Illustration 2.6 Closed-loop Set-up Quick Guide

Closed-loop quick guide

Parameter	Option	Default	Function
Parameter 0-01 Language	[0] English [1] Deutsch [2] Francais [3] Dansk [4] Spanish [5] Italiano [28] Bras.port	0	Select the language for the display.
Parameter 0-06 GridType	[0] 200-240 V/50 Hz/IT-grid [1] 200-240 V/50 Hz/Delta [2] 200-240 V/50 Hz [10] 380-440 V/50 Hz/IT-grid [11] 380-440 V/50 Hz/Delta [12] 380-440 V/50 Hz [20] 440-480 V/50 Hz/IT-grid [21] 440-480 V/50 Hz/Delta [22] 440-480 V/50 Hz [30] 525-600 V/50 Hz/IT-grid [31] 525-600 V/50 Hz/Delta [32] 525-600 V/50 Hz [100] 200-240 V/60 Hz/IT-grid [101] 200-240 V/60 Hz/Delta [102] 200-240 V/60 Hz [110] 380-440 V/60 Hz/IT-grid [111] 380-440 V/60 Hz/Delta [112] 380-440 V/60 Hz [120] 440-480 V/60 Hz/IT-grid [121] 440-480 V/60 Hz/Delta [122] 440-480 V/60 Hz [130] 525-600 V/60 Hz/IT-grid [131] 525-600 V/60 Hz/Delta [132] 525-600 V/60 Hz	Size related	Select the operating mode for restart after reconnection of the frequency converter to mains voltage after power-down.
Parameter 0-60 Main Menu Password	0-999	0	Define the password for access to the LCP.
Parameter 1-00 Configuration Mode	[0] Open loop [3] Closed loop	[0] Open loop	Select closed loop.
Parameter 1-13 Compressor Selection	[24] VZH028-R410A [25] VZH035-R410A [26] VZH044-R410A	Size related	Select which compressor to use.
Parameter 3-02 Minimum Reference	-4999.0 - 200 Hz	0 Hz	The minimum reference is the lowest value obtainable by summing all references.
Parameter 3-03 Maximum Reference	0 - 200 Hz	200 Hz	The maximum reference is the highest value obtainable by summing all references
Parameter 3-10 Preset Reference	-100 - 100 %	0 %	Set up a fix setpoint preset reference [0].
Parameter 3-15 Reference 1 Source	[0] No function [1] Analog in 53 [2] Analog in 54 [7] Pulse input 29 [11] Local bus reference	[1] Analog in 53	Select the input to be used for the reference signal.
Parameter 3-41 Ramp 1 Ramp Up Time	0.05-3600.0 s	30.00 s	Ramp-up time from 0 to *parameter 1-25 Motor Nominal Speed.*
Parameter 3-42 Ramp 1 Ramp Down Time	0.05-3600.0 s	30.00 s	Ramp-down time from nominal motor speed to 0.

Parameter	Option	Default	Function
Parameter 5-12 Terminal 27 Digital Input	[0] No operation [1] Reset [2] Coast inverse [3] Coast and reset inverse [4] Quick stop inverse [5] DC-brake inverse [6] Stop inverse [7] External Interlock [8] Start [9] Latched start [10] Reversing [11] Start reversing [14] Jog [16] Preset ref bit 0 [17] Preset ref bit 1 [18] Preset ref bit 2 [19] Freeze reference [20] Speed up [22] Speed down [23] Set-up select bit 0 [34] Ramp bit 0 [52] Run permissive [53] Hand start [54] Auto start [60] Counter A (up) [61] Counter A (down) [62] Reset Counter A [63] Counter B (up) [64] Counter B (down) [65] Reset Counter B	[6] Stop inverse	Select the input function for terminal 27.
Parameter 5-40 Function Relay [0] Function relay	See parameter 5-40 Function Relay	Alarm	To control output relay 1, select this function.
Parameter 5-40 Function Relay [1] Function relay	See parameter 5-40 Function Relay	Drive running	To control output relay 2, select this function.
Parameter 6-10 Terminal 53 Low Voltage	0-10 V	0.07 V	Enter the voltage that corresponds to the low reference value.
Parameter 6-11 Terminal 53 High Voltage	0-10 V	10 V	Enter the voltage that corresponds to the high reference value.
Parameter 6-14 Terminal 53 Low Ref./ Feedb. Value	-4999 - 4999	30	Enter the reference value that corresponds to the voltage set in *parameter 6-10 Terminal 53 Low Voltage*.
Parameter 6-15 Terminal 53 High Ref./ Feedb. Value	-4999 - 4999	200	Enter the reference value that corresponds to the voltage set in *parameter 6-11 Terminal 53 High Voltage*.
Parameter 6-22 Terminal 54 Low Current	0.00-20.00 mA	4.00 mA	Enter the current that corresponds to the low reference value.
Parameter 6-23 Terminal 54 High Current	0-10 V	10 V	Enter the current that corresponds to the high reference value.
Parameter 6-24 Terminal 54 Low Ref./ Feedb. Value	-0.00-20.00 mA	20.00 mA	Enter the reference value that corresponds to the current set in *parameter 6-20 Terminal 54 Low Voltage*.
Parameter 6-25 Terminal 54 High Ref./ Feedb. Value	-4999 - 4999	Size related	Enter the reference value that corresponds to the current set in *parameter 6-21 Terminal 54 High Voltage*.

Parameter	Option	Default	Function
Parameter 8-01 Control Site	[0] Digital and ctrl.word [1] Digital only [2] Controlword only	[0] Digital and ctrl.word	Select if digital, bus, or a combination of both should control the frequency converter.
Parameter 8-30 Protocol	[0] FC [2] Modbus RTU	[0] FC	Select the protocol for the integrated RS485 port.
Parameter 8-32 Baud Rate	[0] 2400 Baud [1] 4800 Baud [2] 9600 Baud [3] 19200 Baud [4] 38400 Baud [5] 57600 Baud [6] 76800 Baud [7] 115200 Baud	[2] 9600 Baud	Select the baud rate for the RS485 port.
Parameter 20-00 Feedback 1 Source	[0] No function [1] Analog Input 53 [2] Analog Input 54 [3] Pulse input 29 [100] Bus Feedback 1 [101] Bus Feedback 2	[0] No function	Select which input is used as the source of the feedback signal.
Parameter 20-01 Feedback 1 Conversion	[0] Linear [1] Square root	[0] Linear	Select how the feedback should be calculated

Table 2.3 Closed-loop Applications Set-up

2.6.7 Tuning the Drive Closed-loop Controller

Once the frequency converter's closed-loop controller has been set up, test the performance of the controller. Often, its performance may be acceptable using the default values of *parameter 20-93 PI Proportional Gain* and *parameter 20-94 PI Integral Time*. However, sometimes it may be helpful to optimize these parameter values to provide faster system response while still controlling speed overshoot.

2.6.8 Manual PI Adjustment

1. Start the compressor.
2. Set *parameter 20-93 PI Proportional Gain* to 0.3 and increase it until the feedback signal begins to oscillate. If necessary, start and stop the frequency converter or make step changes in the setpoint reference to attempt to cause oscillation. Next, reduce the PI proportional gain until the feedback signal stabilizes. Then reduce the proportional gain by 40–60%.
3. Set *parameter 20-94 PI Integral Time* to 20 s and reduce it until the feedback signal begins to oscillate. If necessary, start and stop the frequency converter or make step changes in the setpoint reference to attempt to cause oscillation. Next, increase the PI integral time until the feedback signal stabilizes. Then increase of the integral time by 15–50%.

2.7 General Aspects of EMC

2.7.1 General Aspects of EMC Emissions

Frequency converter (and other electrical devices) generate electronic or magnetic fields that may interfere with their environment. The electromagnetic compatibility (EMC) of these effects depends on the power and the harmonic characteristics of the devices.

Uncontrolled interaction between electrical devices in a system can degrade compatibility and impair reliable operation. Interference may take the form of mains harmonics distortion, electrostatic discharges, rapid voltage fluctuations, or high frequency interference. Electrical devices generate interference along with being affected by interference from other generated sources.

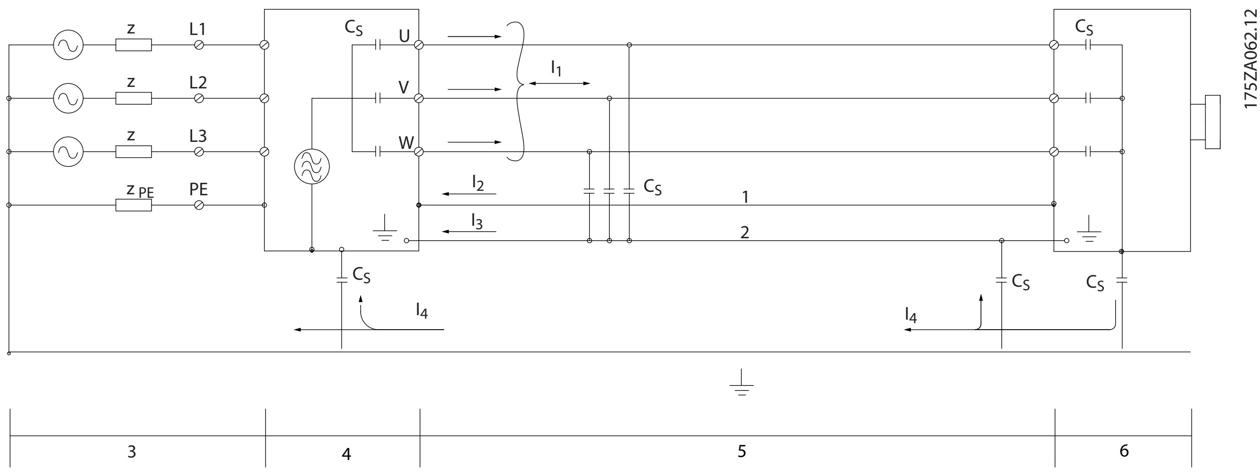
Burst transient usually occur at frequencies in the range 150 kHz to 30 MHz. Airborne interference from the frequency converter system in the range 30 MHz to 1 GHz is generated from the inverter, motor cable, and the compressor. Capacitive currents in the motor cable coupled with a high dU/dt from the compressor voltage generate leakage currents, as shown in *Illustration 2.7*.
The use of a screened motor cable increases the leakage current (see *Illustration 2.7*) because screened cables have higher capacitance to ground than unscreened cables. If the leakage current is not filtered, it causes greater interference on the mains in the radio frequency range below approximately 5 MHz. Since the leakage current (I_1) is carried back to the unit through the screen (I_3), there is in principle only a small electro-magnetic field (I_4) from the screened motor cable according to *Illustration 2.7*.

The screen reduces the radiated interference, but increases the low-frequency interference on the mains. Connect the motor cable screen to the frequency converter enclosure and on the compressor enclosure. This is best done by using integrated screen clamps to avoid twisted screen ends (pigtails). Pigtails increase the screen impedance at higher frequencies, which reduces the screen effect and increases the leakage current (I_4).
If a screened cable is used for relay, control cable, signal interface, and brake, mount the screen on the enclosure at both ends. In some situations, however, it is necessary to break the screen to avoid current loops.

If the screen is to be placed on a mounting plate for the frequency converter, use a metal mounting plate to convey the screen currents back to the unit. Moreover, ensure good electrical contact from the mounting plate through the mounting screws to the frequency converter chassis.

When unscreened cables are used, some emission requirements are not complied with, although most immunity requirements are observed.

To reduce the interference level from the entire system (unit+installation), make compressor and brake cables as short as possible. Avoid placing cables with a sensitive signal level alongside compressor and brake cables. Radio interference higher than 50 MHz (airborne) is especially generated by the control electronics.



1	Ground wire	3	AC mains supply	5	Screened motor cable
2	Screen	4	Frequency converter	6	Motor

Illustration 2.7 Generation of Leakage Currents

2.7.2 Emission Requirements

The EMC product standard for frequency converters defines 4 categories (C1, C2, C3, and C4) with specified requirements for emission and immunity. *Table 2.4* states the definition of the 4 categories and the equivalent classification from EN 55011.

Category	Definition	Equivalent emission class in EN 55011
C1	Frequency converters installed in the first environment (home and office) with a supply voltage less than 1000 V.	Class B
C2	Frequency converters installed in the first environment (home and office) with a supply voltage less than 1000 V, which are not plug-in and not movable, and must be installed and commissioned by a professional.	Class A Group 1
C3	Frequency converters installed in the second environment (industrial) with a supply voltage lower than 1000 V.	Class A Group 2
C4	Frequency converters installed in the second environment with a supply voltage equal to or above 1000 V or rated current equal to or above 400 A or intended for use in complex systems.	No limit line. Make an EMC plan.

Table 2.4 Correlation between IEC 61800-3 and EN 55011

When the generic (conducted) emission standards are used, the frequency converters are required to comply with the limits in *Table 2.5*.

Environment	Generic emission standard	Equivalent emission class in EN 55011
First environment (home and office)	EN/IEC 61000-6-3 Emission standard for residential, commercial, and light industrial environments.	Class B
Second environment (industrial environment)	EN/IEC 61000-6-4 Emission standard for industrial environments.	Class A Group 1

Table 2.5 Correlation between Generic Emission Standards and EN 55011

2.7.3 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, and a motor screened cable.

RFI filter type	Conduct emission. Maximum screened cable length [m]						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	Without external filter	With external filter
H4 RFI filter (Class A1)										
CDS 803 IP20	–	–	25	50	–	20	Yes	Yes	–	No

Table 2.6 Test Results

2.8 Harmonics

2.8.1 Overview of Harmonics Emission

A frequency converter takes up a non-sinusoidal current from mains, which increases the input current I_{RMS}. A non-sinusoidal current is transformed with a Fourier analysis and split into sine-wave currents with different frequencies, that is, different harmonic currents I_n with 50 Hz basic frequency:

	I_1	I_5	I_7
Hz	50	250	350

Table 2.7 Harmonic Currents

The harmonics do not affect the power consumption directly, but increase the heat losses in the installation (transformer, cables). So, in plants with a high percentage of rectifier load, maintain harmonic currents at a low level to avoid overload of the transformer and high temperature in the cables.

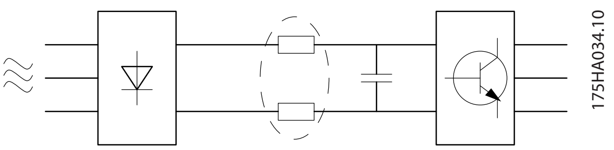


Illustration 2.8 Intermediate Circuit Coils

NOTICE

Some of the harmonic currents might disturb communication equipment connected to the same transformer or cause resonance with power factor correction batteries.

To ensure low harmonic currents, the frequency converter is equipped with intermediate circuit coils as standard. This normally reduces the input current I_{RMS} by 40%.

The voltage distortion on the mains supply voltage depends on the size of the harmonic currents multiplied by the mains impedance for the frequency in question. The total voltage distortion THD is calculated based on the individual voltage harmonics using this formula:

$$THD\% = \sqrt{U_5^2 + U_7^2 + ... + U_N^2}$$

(U_N% of U)

2.8.2 Harmonics Emission Requirements

Equipment connected to the public supply network

Options	Definition
1	IEC/EN 61000-3-2 Class A for 3-phase balanced equipment (for professional equipment only up to 1 kW total power).
2	IEC/EN 61000-3-12 Equipment 16–75 A and professional equipment as from 1 kW up to 16 A phase current.

Table 2.8 Connected Equipment

2

2.8.3 Harmonics Test Results (Emission)

Power sizes up to PK75 in T4 and P3K7 in T2 complies with IEC/EN 61000-3-2 Class A. Power sizes from P1K1 and up to P18K in T2 and up to P90K in T4 complies with IEC/EN 61000-3-12, Table 4.

	Individual Harmonic Current I_n/I_1 (%)			
	I_5	I_7	I_{11}	I_{13}
Actual 6.0–10 kW, IP20, 200 V (typical)	32.6	16.6	8.0	6.0
Limit for R_{sce}≥120	40	25	15	10
	Harmonic current distortion factor (%)			
	THD		**PWHD**	
Actual 6.0–10 kW, 200 V (typical)	39		41.4	
Limit for R_{sce}≥120	48		46	

Table 2.9 Harmonic Current 6.0–10 kW, 200 V

	Individual Harmonic Current I_n/I_1 (%)			
	I_5	I_7	I_{11}	I_{13}
Actual 6.0–10 kW, IP20, 380–480 V (typical)	36.7	20.8	7.6	6.4
Limit for R_{sce}≥120	40	25	15	10
	Harmonic current distortion factor (%)			
	THD		**PWHD**	
Actual 6.0–10 kW, 380–480 V (typical)	44.4		40.8	
Limit for R_{sce}≥120	48		46	

Table 2.10 Harmonic Current 6.0–10 kW, 380–480 V

It is the responsibility of the installer or user of the equipment to ensure, by consultation with the distribution network operator if necessary, that the equipment is connected only to a supply with a short circuit power S_{sc} greater than or equal to specified above.
Other power sizes can be connected to the public supply network by consultation with the distribution network operator.

Compliance with various system level guidelines:
The harmonic current data in *Table 2.9* to are given in accordance with IEC/EN 61000-3-12 regarding the power drive systems product standard. They may be used as the basis for calculation of the harmonic currents' influence on the power supply system and for the documentation of compliance with relevant regional guidelines: IEEE 519-1992; G5/4.
If there is a need for further reduction of harmonic currents, passive or active filters in front of the frequency converters can be installed. Consult Danfoss for further information.

2.8.4 Immunity Requirements

The immunity requirements for frequency converters depend on the environment where they are installed. The requirements for the industrial environment are higher than the requirements for the home and office environment. All Danfoss frequency converters comply with the requirements for the industrial environment and therefore comply also with the lower requirements for home and office environment with a large safety margin.

2.9 Galvanic Isolation (PELV)

2.9.1 PELV - Protective Extra Low Voltage

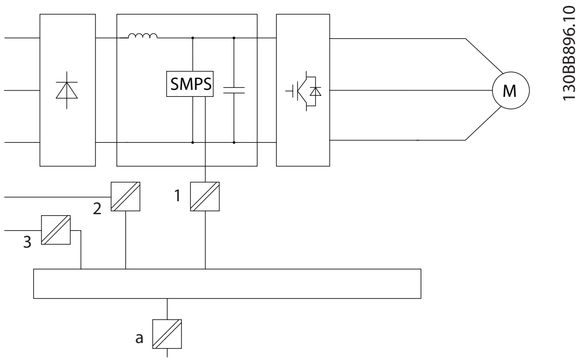
PELV offers protection by way of extra low voltage. Protection against electric shock is ensured when the electrical supply is of the PELV type and the installation is made as described in local/national regulations on PELV supplies.

All control terminals and relay terminals 01–03/04–06 comply with PELV (Protective Extra Low Voltage) (Does not apply to grounded Delta leg above 440 V).

Galvanic (ensured) isolation is obtained by fulfilling requirements for higher isolation and by providing the relevant creapage/clearance distances. These requirements are described in the EN 61800-5-1 standard.

The components that make up the electrical isolation, as described, also comply with the requirements for higher isolation and the relevant test as described in EN 61800-5-1.
The PELV galvanic isolation can be shown in *Illustration 2.9*.

To maintain PELV, all connections made to the control terminals must be PELV, for example, the thermistor must be reinforced/double insulated.



1	Power supply (SMPS)
2	Optocouplers, communication between AOC and BOC
3	Custom relays
a	Control card terminals

Illustration 2.9 Galvanic Isolation

CAUTION

Installation at high altitude:
At altitudes above 2000 m (6562 ft), contact Danfoss regarding PELV.

2.10 Ground Leakage Current

WARNING

DISCHARGE TIME

Touching the electrical parts could be fatal - even after the equipment has been disconnected from mains.
Also make sure that other voltage inputs have been disconnected, such as load sharing (linkage of DC intermediate circuit), and the compressor connection for kinetic back-up.
Before touching any electrical parts, wait at least the amount of time indicated in *Table 2.1*.
Shorter time is allowed only if indicated on the nameplate for the specific unit.

NOTICE

Leakage current
The ground leakage current from the frequency converter exceeds 3.5 mA. To ensure that the ground cable has a good mechanical connection to the ground connection, the cable cross-section must be at least 10 mm^2 (8 AWG) Cu or 16 mm^2 (6 AWG) Al or 2 rated ground wires terminated separately.
Residual current device protection RCD
This product can cause a DC current in the protective conductor. Where a residual current device (RCD) is used for protection in case of direct or indirect contact, only an RCD of Type B is allowed on the supply side of this product. Otherwise, another protective measure shall be applied, such as separation from the environment by double or reinforced insulation, or isolation from the supply system by a transformer.See also Application Note *Protection against Electrical Hazards*.
Protective earthing of the frequency converter and the use of RCDs must always follow national and local regulations.

2.11 Extreme Running Conditions

Short circuit (compressor phase – phase)

Current measurement in each of the 3 compressor phases or in the DC-link, protects the frequency converter against short circuits. A short circuit between 2 output phases causes an overcurrent in the inverter. The inverter is turned off individually when the short circuit current exceeds the permitted value (*Alarm 16, Trip Lock*).
For information about protecting the frequency converter against a short circuit at the load sharing and brake outputs, see the design guidelines.

Switching on the output

Switching on the output between the compressor and the frequency converter is fully permitted. The frequency converter is not damaged in any way by switching on the output. However, fault messages may appear.

Mains drop-out

During a mains drop-out, the frequency converter keeps running until the DC-link voltage drops below the minimum stop level, which is typically 15% below the frequency converter's lowest rated supply voltage. The mains voltage before the drop-out and the compressor load determines how long it takes for the frequency converter to coast.

3

3 Selection

3.1 Options and Accessories

3.1.1 Local Control Panel (LCP)

Ordering number	Description
120Z0581	LCP for all IP20 units

Table 3.1 Ordering Number

Enclosure	IP55 front
Maximum cable length to unit	3 m (10 ft)
Communication std.	RS485

Table 3.2 Technical Data

3.1.2 Mounting of LCP in Panel Front

Ordering number	Description
132B0201	LCP kit for remote mounting

Table 3.3 Ordering Number

Step 1
Fit gasket on LCP.

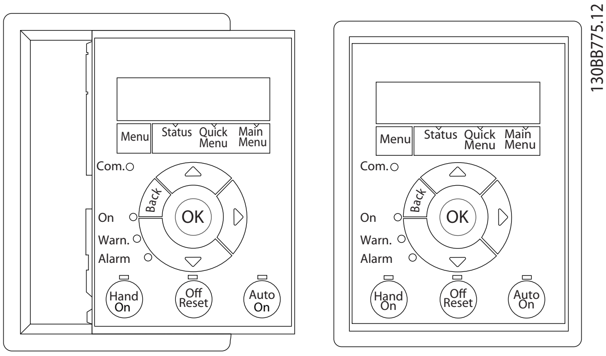


Illustration 3.1 Fit Gasket

Step 2
Place LCP on panel, see dimensions of hole on *Illustration 3.2*.

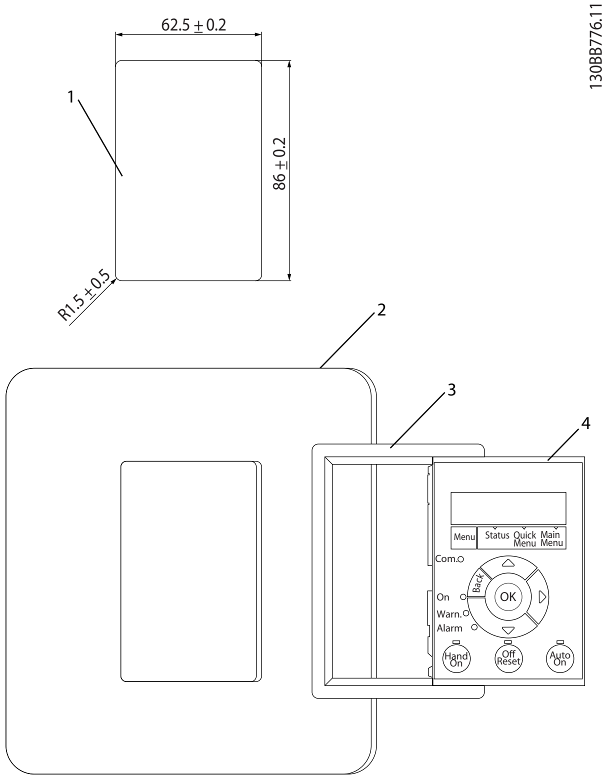


Illustration 3.2 Place LCP on Panel

Step 3
Place bracket on back of the LCP, then slide down. Tighten screws and connect cable female side to LCP.

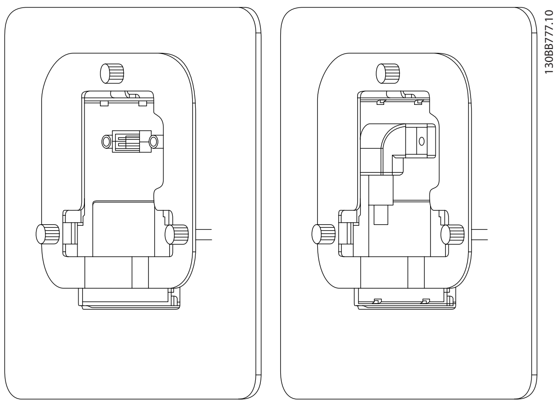


Illustration 3.3 Place Bracket on LCP

Step 4
Connect cable to frequency converter.

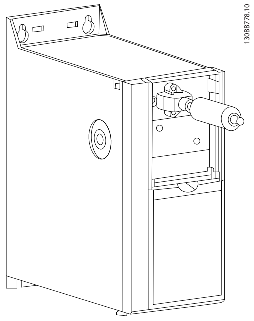


Illustration 3.4 Connect Cable

NOTICE

To fasten connector to the frequency converter, use the provided thread cutting screws, tightening torque 1.3 Nm.

3.1.3 IP21/TYPE 1 Enclosure Kit

IP21/TYPE 1 is an optional enclosure element available for IP20 units.
If the enclosure kit is used, an IP20 unit is upgraded to comply with enclosure IP21/TYPE 1.

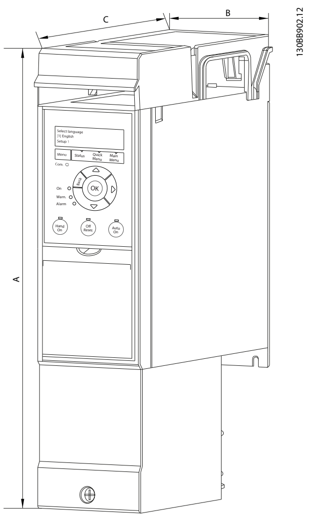


Illustration 3.5 H3–H5

Enclosure	Cooling capacity		Height [mm/ (in)] A	Width [mm/ (in)] B	Depth [mm/ (in)] C	IP21 kit ordering number	Type 1 kit ordering number
–	**3x200–240 V**	**3x380–480 V**	–	–	–	–	–
H3	–	4–5 TR	346 (13.6)	106 (4.2)	210 (8.3)	132B0214	132B0224
H4	4–5 TR	6.5 TR	374 (14.7)	141 (5.6)	245 (9.6)	132B0215	132B0225
H5	6.5 TR	–	418 (16.5)	161 (6.3)	260 (10.2)	132B0216	132B0226

Table 3.4 Enclosure Kit Specifications

3

3.1.4 Decoupling Plate

Use the decoupling plate for EMC-correct installation.

Shown here on an H3 enclosure.

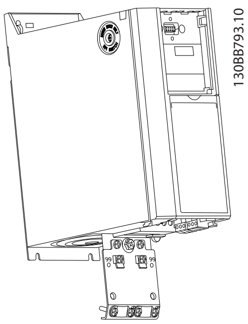


Illustration 3.6 Decoupling Plate

	Length [mm/(in)]	Width [mm/(in)]
H3	80.8 (3.2)	72.0 (2.8)
H4/H5	85.0 (3.3)	84.8 (3.3)

Table 3.5 Dimensions, Decoupling Plate

	Cooling capacity		Decoupling plate
Enclosure	3x200–240 V	3x380–480 V	–
H3	–	4–5 TR	120Z0582
H4	4–5 TR	6.5 TR	120Z0583
H5	6.5 TR	–	120Z0583

Table 3.6 Decoupling Plate Specifications

4 How to Order

4.1 Configuration

4.1.1 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
C	D	S	8	0	3	P				T					H		X			X	X	X	S	X	X	X	X	A	X	B	X	C	X	X	X	X	D	X

130BD938.10

Illustration 4.1 Type Code

Description	Position	Possible option
Product group & FC series	1–6	CDS 803
Power rating	7–10	6.0–10 kW (P6K0–P10K)
Number of phases	11	Three phases (T)
Mains voltage	11–12	T2: 200–240 V AC T4: 380–480 V AC
Enclosure	13–15	E20: IP20/Chassis
RFI filter	16–17	H4: RFI filter class A1
Brake	18	X: No brake chopper included
Display	19	A: Alpha numeric local control panel X: No local control panel
Coating PCB	20	X: No coated PCB C: Coated PCB
Mains option	21	X: No mains option
Adaption	22	X: No adaption
Adaption	23	X: No adaption
Software release	24–27	SXXXX: Latest release - std. software
Software language	28	X: Standard
A options	29–30	AX: No A options
B options	31–32	BX: No B options
C0 options MCO	33–34	CX: No C options
C1 options	35	X: No C1 options
C option software	36–37	XX: No options
D options	38–39	DX: No D0 options

Table 4.1 Type Code Descriptions

4.2 Ordering Numbers

4.2.1 External RFI Filter

External filters to fulfill A1 50 m/B1 20 m.

Power size 380–480 V [kW/(hp)]	Type	A	B	C	D	E	F	G	H	I	J	K	L1	Torque [Nm (in-lb)]	Weight [kg (lb)]	Ordering number
		[mm (in)]														
6–7.5 (8–10)	FN3258-16-45	250 (9.8)	45 (1.8)	70 (2.8)	220 (8.7)	235 (9.2)	25 (1)	4.5 (0.2)	1 (0.04)	10.6 (0.4)	M5	22.5 (0.9)	31 (1.2)	0.7–0.8 (6.2–7.1)	0.8 (1.8)	132B0245
10 (13)	FN3258-30-47	270 (10.6)	50 (2)	85 (3.3)	240 (9.4)	255 (10)	30 (1.2)	5.4 (0.2)	1 (0.04)	10.6 (0.4)	M5	25 (1)	40 (1.6)	1.9–2.2 (16.8–19.5)	1.2 (2.6)	132B0246

Table 4.2 RFI Filters - Details

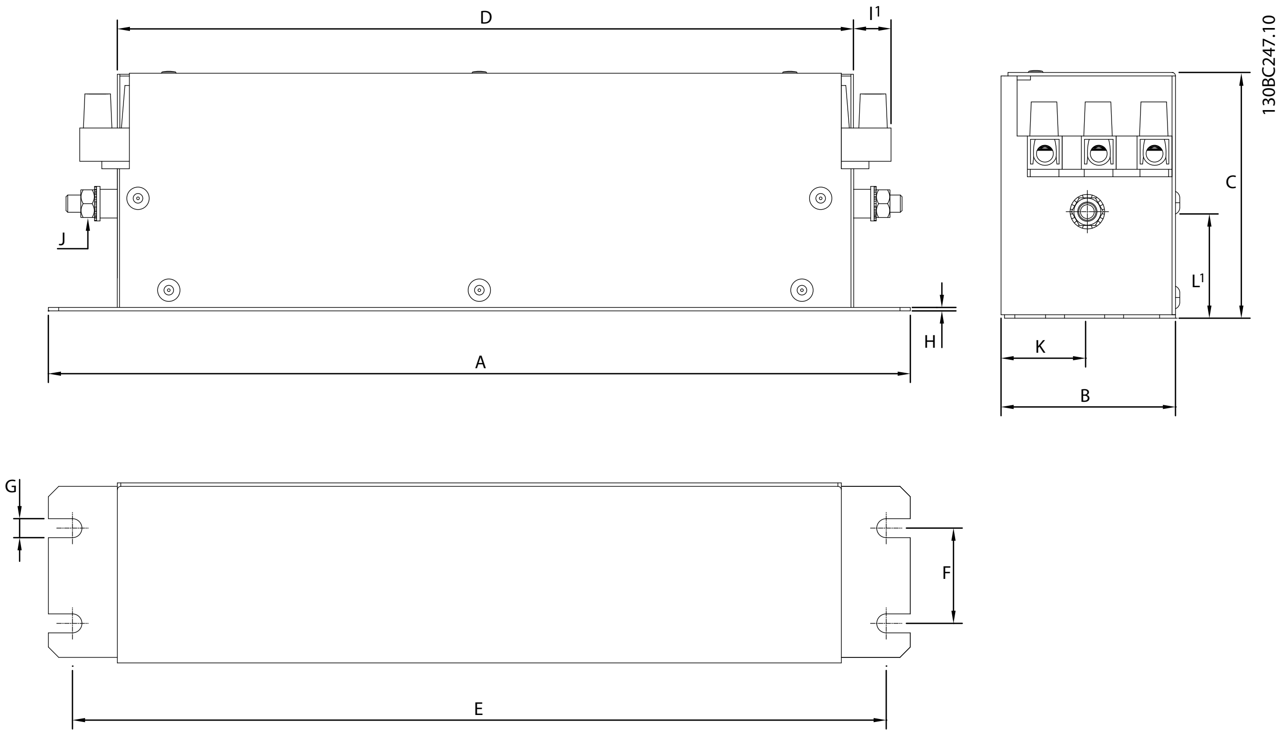
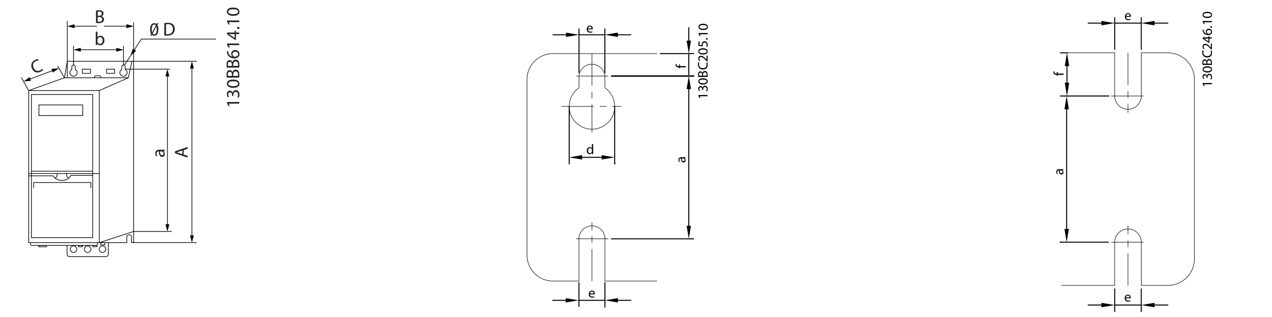


Illustration 4.2 RFI Filter

5 How to Install

5.1 Mechanical Dimensions

5.1.1 Dimensions



Enclosure		Power [kW(hp)]		Height [mm(in)]			Width [mm(in)]		Depth [mm(in)]	Mounting hole [mm(in]			Max. weight
Size	IP class	3x200–240 V	3x380–480 V	A	A1)	a	B	b	C	d	e	f	kg(lb)
H3	IP20	3.7 (5)	5.5–7.5 (7.5–10)	255 (10.0)	329 (13.0)	240 (9.4)	100 (3.9)	74 (2.9)	206 (8.1)	11 (0.43)	5.5 (0.22)	8.1 (0.32)	4.5 (9.9)
H4	IP20	5.5–7.5 (7.5–10)	11–15 (15–20)	296 (11.7)	359 (14.1)	275 (10.8)	135 (5.3)	105 (4.1)	241 (9.5)	12.6 (0.50)	7 (0.28)	8.4 (0.33)	7.9 (17.4)
H5	IP20	11 (15)	18.5–22 (25–30)	334 (13.1)	402 (15.8)	314 (12.4)	150 (5.9)	120 (4.7)	255 (10)	12.6 (0.50)	7 (0.28)	8.5 (0.33)	9.5 (20.9)
1) Including decoupling plate													

Table 5.1 Dimensions, Enclosure Sizes

NOTICE

The dimensions are only for the physical units. When installing in an application, allow space above and below the units for cooling. The amount of space for free air passage is listed in *Table 5.3*.

5.1.2 Shipping Dimensions

Enclosure size mains voltage	H3	H4	H5
200–240 V AC [kW(hp)]	3.7 (5)	5.5–7.5 (7.5–10)	11 (15)
380–480 V AC [kW(hp)]	5.5–7.5 (7.5–10)	11–15 (15–20)	18.5–22 (25–30)
IP protection rating			
Maximum weight [kg(lb)]	4.5 (9.9)	7.9 (17.4)	9.5 (20.9)
Shipping dimensions			
Height [mm(in)]	330 (13.0)	380 (15.0)	420 (16.5)
Width [mm(in)]	188 (7.4)	250 (9.8)	290 (11.4)
Depth [mm(in)]	282 (11.1)	375 (14.8)	375 (14.8)

Table 5.2 Shipping Dimensions

5.1.3 Side-by-side Installation

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

		Power [kW(hp)]		Clearance above/below [mm(in)]
Size	IP class	3x200–240 V	3x380–480 V	
H3	IP20	3.7 (5)	5.5–7.5 (7.5–10)	100 (4)
H4	IP20	5.5–7.5 (7.5–10)	11–15 (15–20)	100 (4)
H5	IP20	11 (15)	18.5–22 (25–30)	100 (4)

Table 5.3 Clearance Required for Cooling

NOTICE

With IP21/NEMA Type1 option kit mounted, a distance of 50 mm (2 in) between the units is required.

5.1.4 Field Mounting

For field mounting, IP21/NEMA Type 1 kits are recommended.

5.2 Electrical Data

5.2.1 Electrical Overview

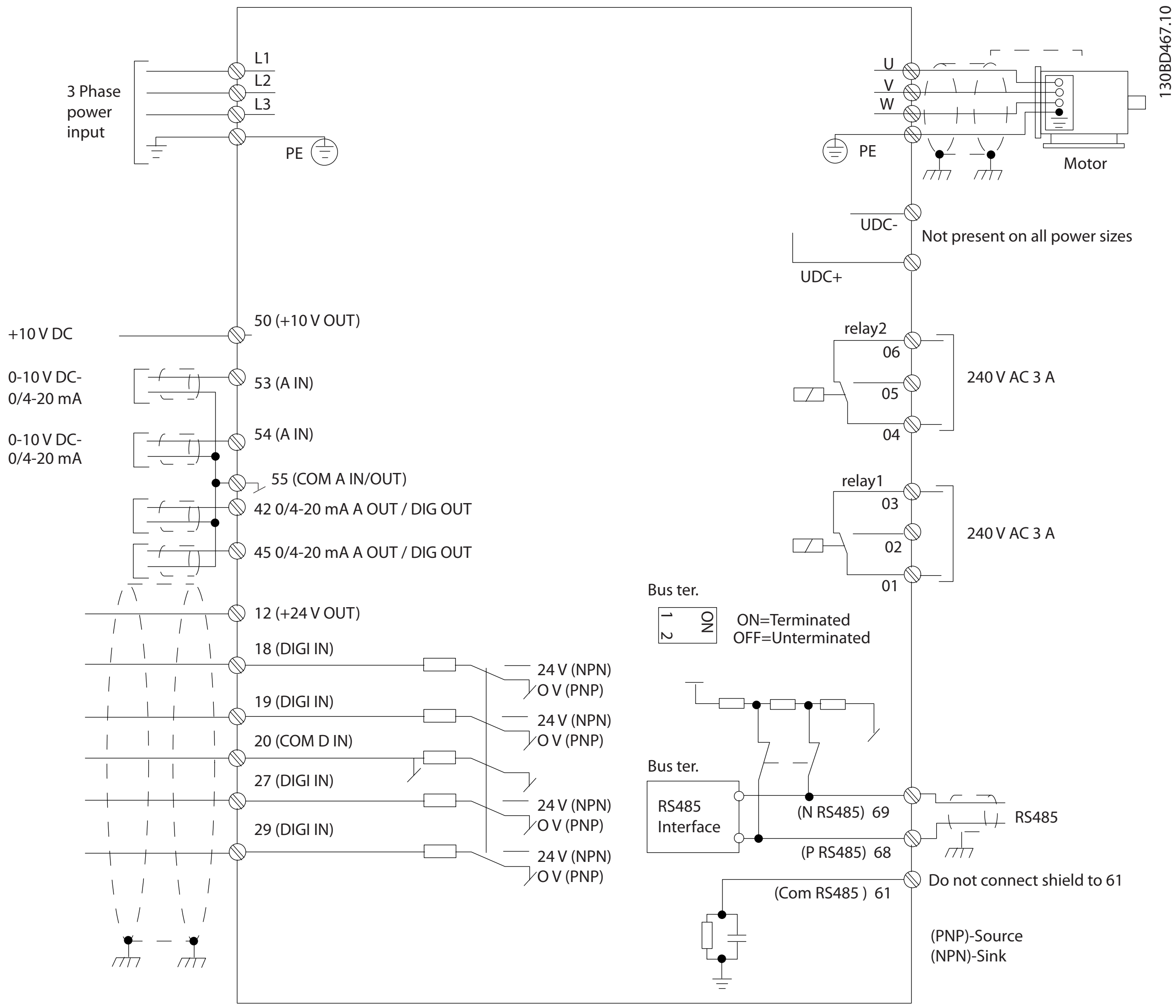


Illustration 5.1 Basic Wiring Schematic Drawing

5.2.2 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/167 °F) recommended.

Enclosure		Torque [Nm(in-lb)]					
Enclosure	IP class	Line	Compressor connection	DC connection	Control terminals	Ground	Relay
H3	IP20	1.4 (12.4)	0.8 (7.1)	0.8 (7.1)	0.5 (4.4)	0.8 (7.1)	0.5 (4.4)
H4	IP20	1.2 (10.6)	1.2 (10.6)	1.2 (10.6)	0.5 (4.4)	0.8 (7.1)	0.5 (4.4)
H5	IP20	1.2 (10.6)	1.2 (10.6)	1.2 (10.6)	0.5 (4.4)	0.8 (7.1)	0.5 (4.4)

Table 5.4 Enclosure H3–H5

5.2.3 Connecting to Mains and Compressor

The frequency converter is designed to operate Danfoss VZH Compressors. For maximum cross-section on wires, see *chapter 8.2 General Specifications*.

- To comply with EMC emission specifications, use a shielded/armored compressor cable and connect this cable to both the decoupling plate and the compressor metal.
- Keep compressor cable as short as possible to reduce the noise level and leakage currents.
- For further details on mounting of the decoupling plate, see *VLT® Compressor Drive CDS 803 Decoupling Plate Installation Instructions*.
- Also see *chapter 5.2.5 EMC Compliant Electrical Installation*.

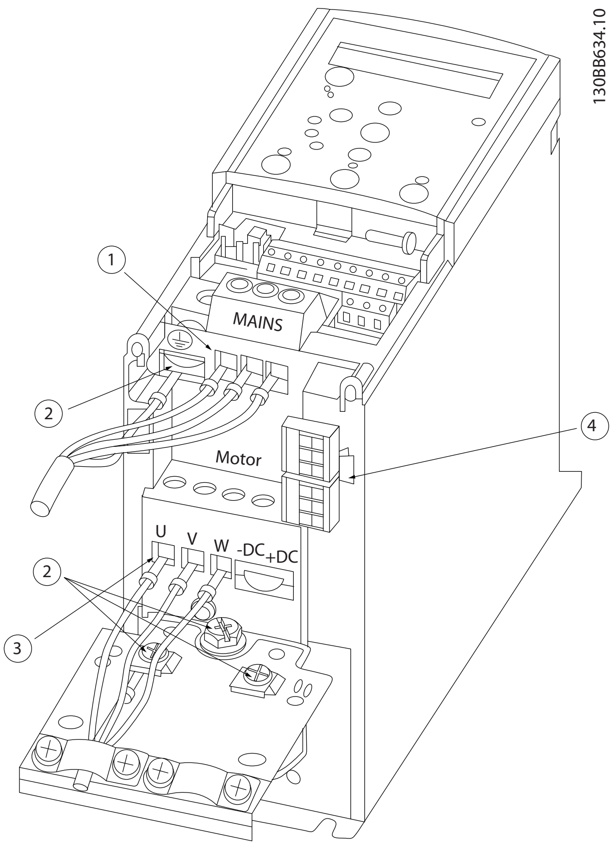
Connecting to mains and compressor

1. Mount the ground wires to ground terminal.
2. Connect compressor to terminals U, V, and W, see *Table 5.5*.

U	T1
V	T2
W	T3

Table 5.5 Connection of Compressor to Terminals

3. Mount mains supply to terminals L1, L2, and L3 and tighten.



1	Line
2	Ground
3	Compressor
4	Relays

Illustration 5.2 H3–H5 Enclosure
IP20 200–240 V 4–6.5 tons
IP20 380–480 V 4–6.5 tons

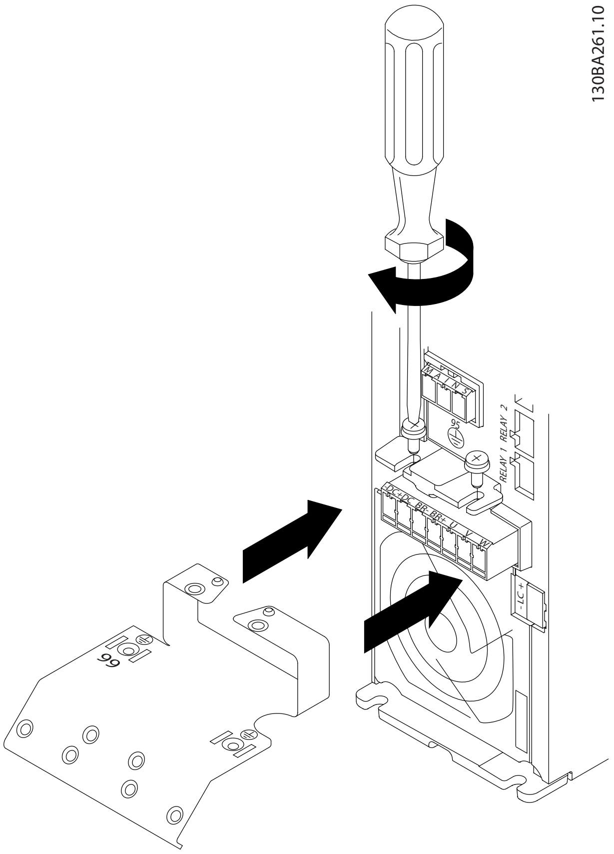


Illustration 5.3 Mount the 2 screws in the mounting plate, slide it into place and tighten fully.

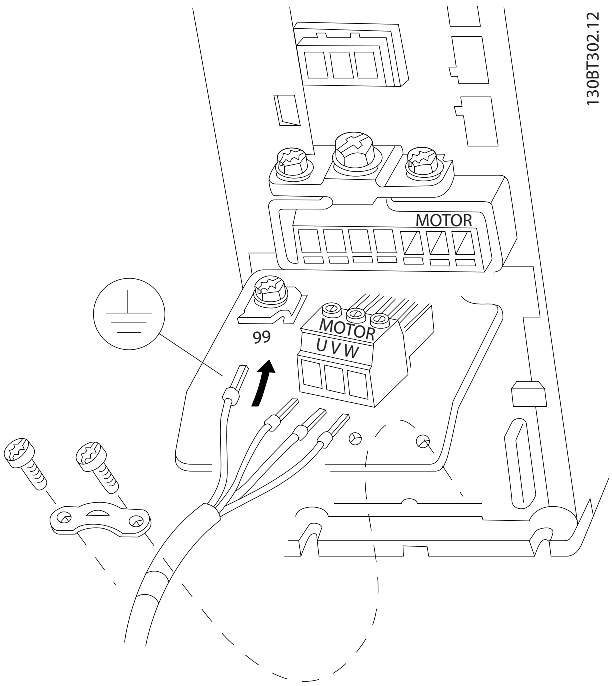


Illustration 5.4 H3–H5 Enclosure

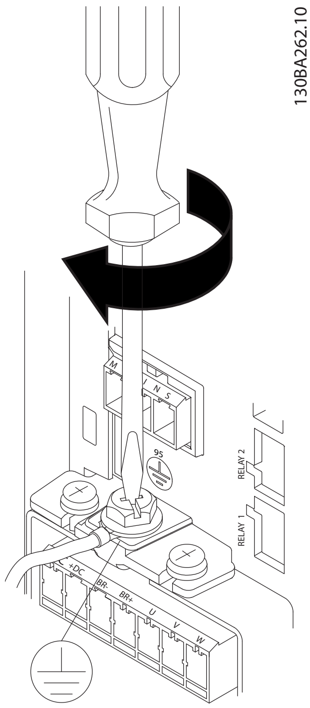


Illustration 5.5 When mounting cables, first mount and tighten the ground cable.

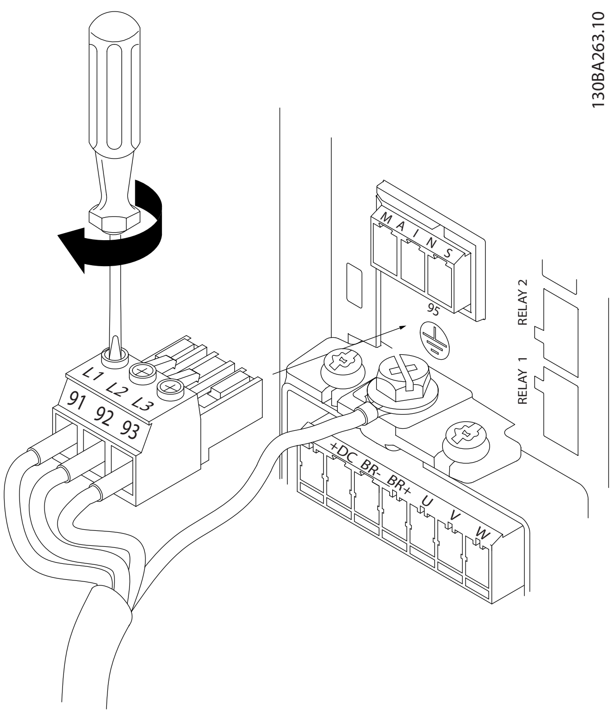


Illustration 5.6 Mount mains plug and tighten wires.

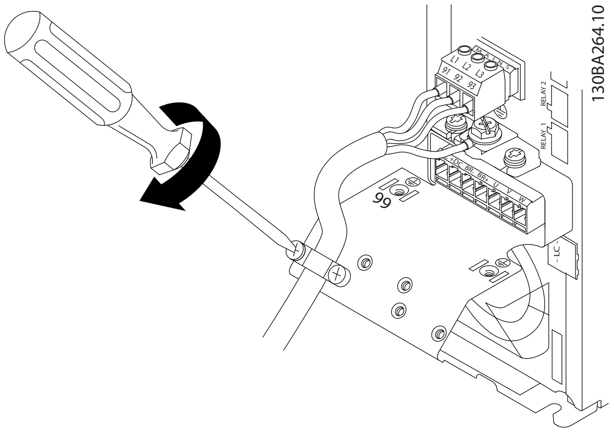


Illustration 5.7 Tighten support bracket on mains wires.

5.2.4 Fuses

Branch circuit protection
To protect the installation against electrical and fire hazard, all branch circuits in an installation, switch gear, machines, and so on, must be short circuit and overcurrent protected according to national and local regulations.

Short-circuit protection
Danfoss recommends using the fuses listed in *Table 5.6* to protect service personnel or equipment if there is an internal failure in the unit or a short circuit on the DC-link. The frequency converter provides full short-circuit protection if there is a short circuit on the compressor.

Overcurrent protection
To avoid overheating of the cables in the installation, provide overload protection. Overcurrent protection must always be carried out according to local and national regulations. Design circuit breakers and fuses for protection in a circuit capable of supplying a maximum of 100000 A_{rms} (symmetrical), 480 V maximum.

UL/Non UL compliance
To ensure compliance with UL or IEC 61800-5-1, use the fuses listed in *Table 5.6*.

NOTICE

In the event of malfunction, failure to follow the protection recommendation may result in damage to the frequency converter.

	Fuse				
	UL				Non-UL
CDS 803	Bussmann Type RK5	Bussmann Type RK1	Bussmann Type J	Bussmann Type T	Maximum fuse Type G
3x200–240 V IP20					
4 TR/VZH028	FRS-R-50	KTN-R50	JKS-50	JJN-50	50
5 TR/VZH035	FRS-R-50	KTN-R50	JKS-50	JJN-50	50
6.5 TR/VZH044	FRS-R-80	KTN-R80	JKS-80	JJN-80	65
3x380–480 V IP20					
4 TR/VZH028	FRS-R-25	KTS-R25	JKS-25	JJS-25	25
5 TR/VZH035	FRS-R-25	KTS-R25	JKS-25	JJS-25	25
6.5 TR/VZH044	FRS-R-50	KTS-R50	JKS-50	JJS-50	50

Table 5.6 Fuses

5.2.5 EMC Compliant Electrical Installation

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

- Use only shielded/armored motor cables and shielded/armored control cables.
- Connect the screen to ground 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 star washers and galvanically conductive installation plates.
- Do not use unshielded/unarmored motor cables in the installation cabinets.

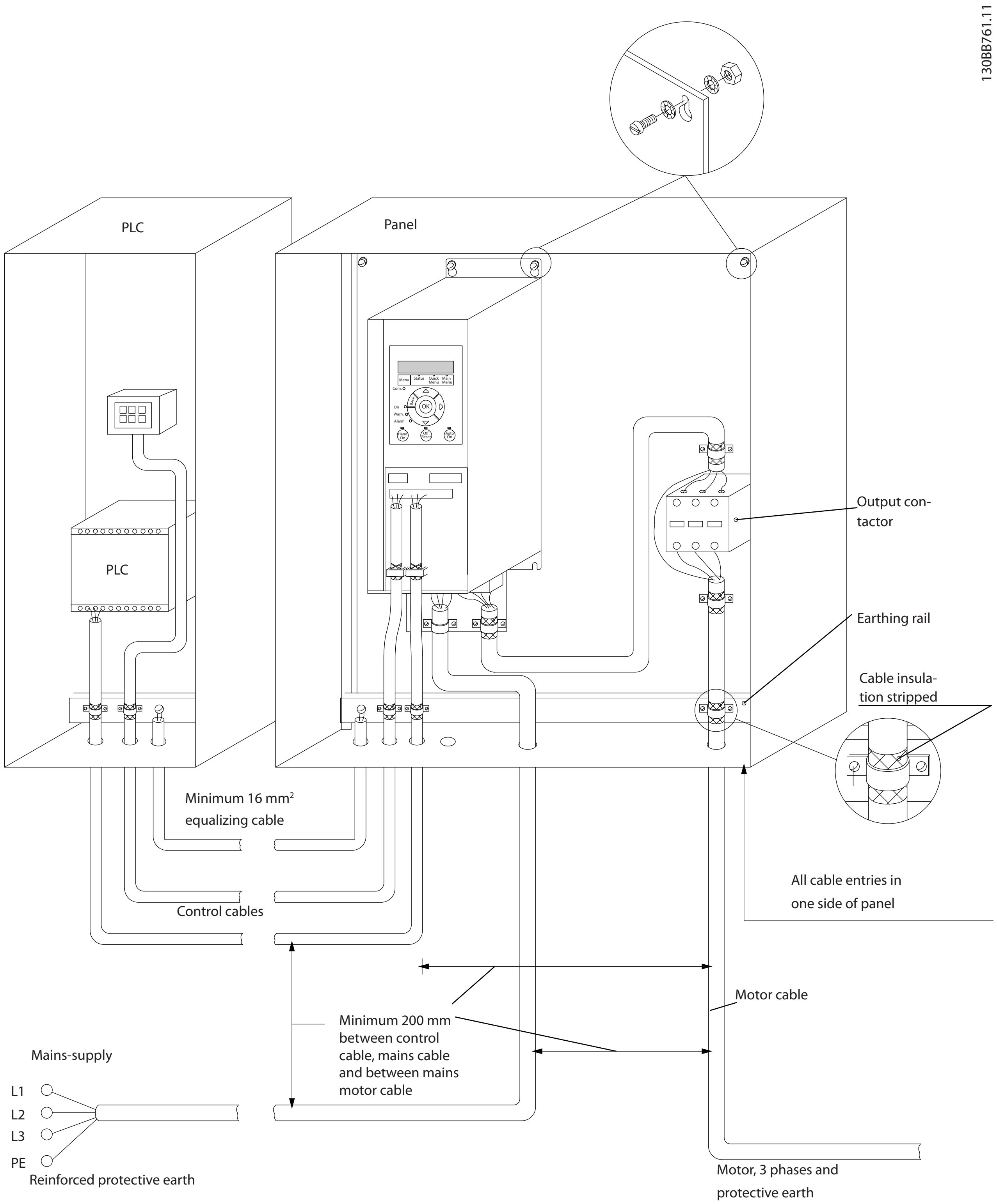


Illustration 5.8 EMC-correct Electrical Installation

NOTICE

For North America use metal conduits instead of shielded cables.

5.2.6 Control Terminals

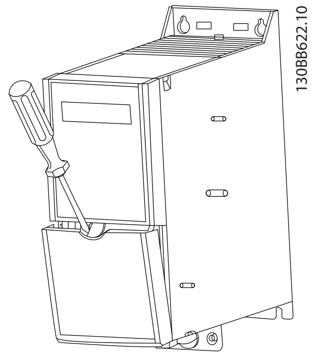


Illustration 5.9 Location of Control Terminals

1. To activate the snap, place a screwdriver behind the terminal cover.
2. Tilt the screwdriver outwards to open the cover.

Control terminals
To make the compressor run:

1. Apply start signal on terminal 18.
2. Connect terminals 12, 27, and terminal 53, 54, or 55.

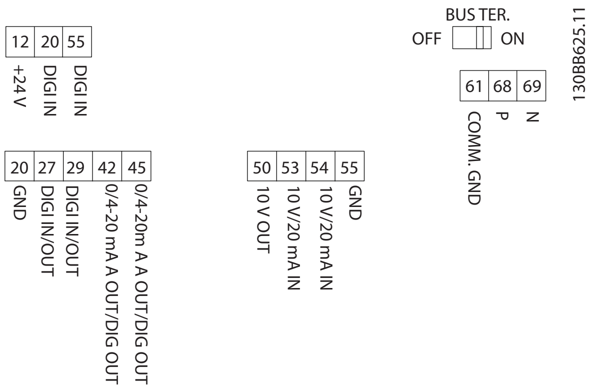


Illustration 5.10 Control Terminals

Set the functions of digital input 18, 19, and 27 in *parameter 5-00 Digital Input Mode* (PNP is default value).
Set the function of digital input 29 in *parameter 5-03 Digital Input 29 Mode* (PNP is default value).

6 How to Program

6.1 Programming with MCT 10 Set-up Software

The frequency converter can be programmed from the LCP, or from a PC via the RS485 COM port by installing the MCT 10 Set-up Software. Refer to *chapter 1.5 Additional Resources* for more details about the software.

6.2 Local Control Panel (LCP)

The LCP is divided into 4 functional sections.

A. Display

B. Menu key

C. Navigation keys and indicator lights

D. Operation keys and indicator lights

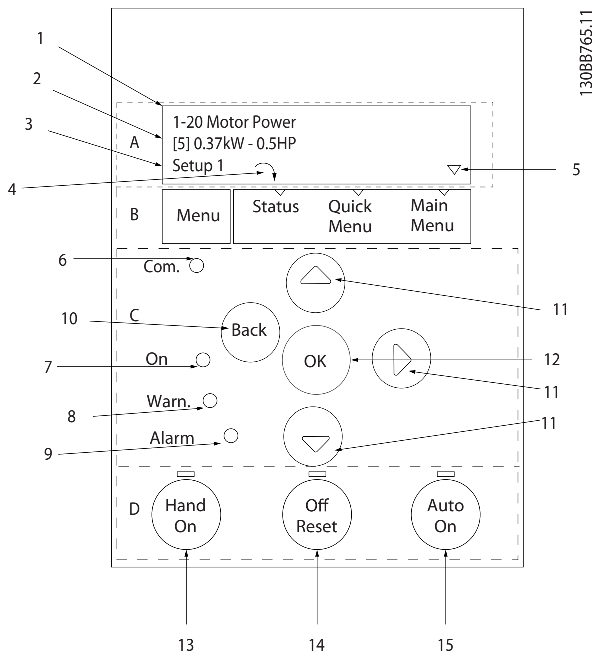


Illustration 6.1 Local Control Panel (LCP)

A. Display
The LCD-display is illuminated with 2 alphanumeric lines. All data is displayed on the LCP.

Illustration 6.1 describes the information that 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 (set-up 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*.

Table 6.1 Legend to *Illustration 6.1*, Part I

B. Menu key
Press [Menu] to select among *Status*, *Quick Menu*, or *Main Menu*.

C. Navigation keys and indicator lights

6	Com. LED: Flashes when bus communication is communicating.
7	Green LED/On: Control section is working correctly.
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	[▲] [▼] [►]: For navigating among parameter groups and parameters, and within parameters. They can also be used for setting local reference.
12	[OK]: For selecting a parameter and for accepting changes to parameter settings.

Table 6.2 Legend to *Illustration 6.1*, Part II

D. Operation keys and indicator lights

13	[Hand On]: Starts the motor and enables control of the frequency converter via the LCP. **NOTICE** ***[2] coast inverse*** **is the default option for** ***parameter 5-12 Terminal 27 Digital Input*****. If there is no 24 V supply to terminal 27, [Hand On] does not start the motor. Connect terminal 12 to terminal 27.**
14	[Off/Reset]: Stops the motor (Off). If in alarm mode, the alarm is reset.
15	[Auto On]: The frequency converter is controlled either via control terminals or serial communication.

Table 6.3 Legend to *Illustration 6.1*, Part III

6.3 Menus

6.3.1 Status Menu

In the *Status* menu, the selection options are:

- Motor frequency [Hz], *parameter 16-13 Frequency*.
- Motor current [A], *parameter 16-14 Motor current*.
- Motor speed reference in percentage [%], *parameter 16-02 Reference [%]*.
- Feedback, *parameter 16-52 Feedback[Unit]*.
- Motor power *parameter 16-10 Power [kW]* for kW, *parameter 16-11 Power [hp]* for hp. If *parameter 0-03 Regional Settings* is set to *[1] North America*, motor power is shown in hp instead of kW.
- Custom readout *parameter 16-09 Custom Readout*.

6.3.2 Quick Menu

Use the Quick Menu to program the most common functions. The Quick Menu consists of:

- Quick guide for open-loop applications.
- Closed-loop set-up quick guide.
- Changes made.
- Compressor functions.

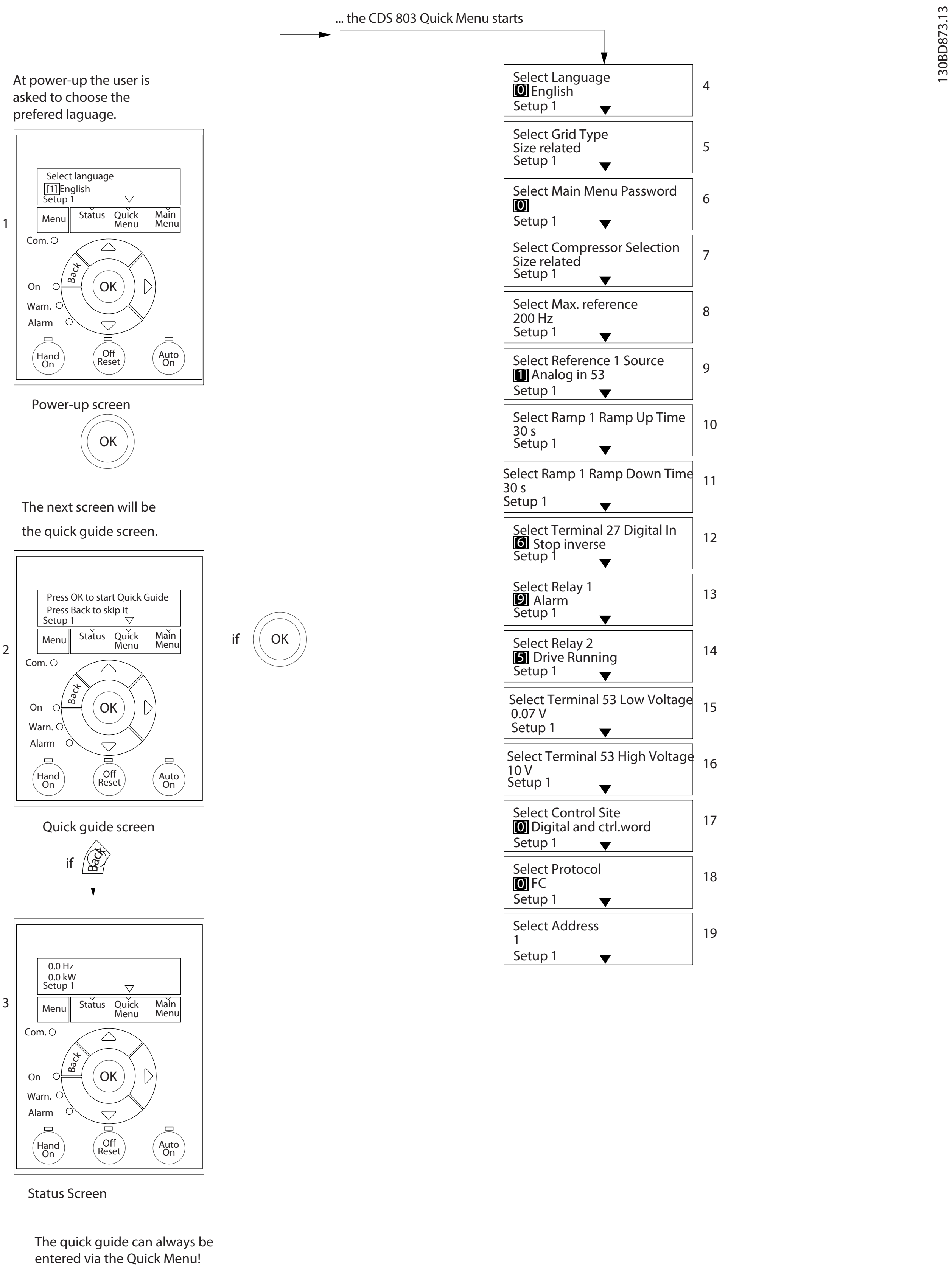


Illustration 6.2 Open-Loop Applications

The Start-up quick guide for open-loop applications

Parameter	Option	Default	Function
Parameter 0-01 Language	[0] English [1] Deutsch [2] Francais [3] Dansk [4] Spanish [5] Italiano [28] Bras.port	[0] English	Select the language for the display.
Parameter 0-06 GridType	[0] 200–240 V/50 Hz/IT-grid [1] 200–240 V/50 Hz/Delta [2] 200–240 V/50 Hz [10] 380–440 V/50 Hz/IT-grid [11] 380–440 V/50 Hz/Delta [12] 380–440 V/50 Hz [20] 440–480 V/50 Hz/IT-grid [21] 440–480 V/50 Hz/Delta [22] 440–480 V/50 Hz [30] 525–600 V/50 Hz/IT-grid [31] 525–600 V/50 Hz/Delta [32] 525–600 V/50 Hz [100] 200–240 V/60 Hz/IT-grid [101] 200–240 V/60 Hz/Delta [102] 200–240 V/60 Hz [110] 380–440 V/60 Hz/IT-grid [111] 380–440 V/60 Hz/Delta [112] 380–440 V/60 Hz [120] 440–480 V/60 Hz/IT-grid [121] 440–480 V/60 Hz/Delta [122] 440–480 V/60 Hz [130] 525–600 V/60 Hz/IT-grid [131] 525–600 V/60 Hz/Delta [132] 525–600 V/60 Hz	Size related	Select operating mode for restart after reconnection of the frequency converter to mains voltage after power-down.
Parameter 0-60 Main Menu Password	0–999	0	Define the password for access to the LCP.
Parameter 1-13 Compressor Selection	[24] VZH028-R410A [25] VZH035-R410A [26] VZH044-R410A	Size related	Select which compressor to use.
Parameter 3-03 Maximum Reference	0–200 Hz	200 Hz	The maximum reference is the highest obtainable by summing all references.
Parameter 3-15 Reference 1 Source	[0] No function [1] Analog in 53 [2] Analog in 54 [7] Pulse input 29 [11] Local bus reference	[1] Analog in 53	Select the input to be used for the reference signal.
Parameter 3-41 Ramp 1 Ramp Up Time	0.05–3600.0 s	30.00 s	Ramp-up time from 0 to *parameter 1-25 Motor Nominal Speed*.
Parameter 3-42 Ramp 1 Ramp Down Time	0.05–3600.0 s	30.00 s	Ramp-down time from nominal motor speed to 0.

Parameter	Option	Default	Function
Parameter 5-12 Terminal 27 Digital Input	[0] No operation [1] Reset [2] Coast inverse [3] Coast and reset inverse [4] Quick stop inverse [5] DC-brake inverse [6] Stop inverse [7] External Interlock [8] Start [9] Latched start [10] Reversing [11] Start reversing [14] Jog [16] Preset ref bit 0 [17] Preset ref bit 1 [18] Preset ref bit 2 [19] Freeze reference [20] Speed up [22] Speed down [23] Set-up select bit 0 [34] Ramp bit 0 [52] Run permissive [53] Hand start [54] Auto start [60] Counter A (up) [61] Counter A (down) [62] Reset Counter A [63] Counter B (up) [64] Counter B (down) [65] Reset Counter B	[6] Stop inverse	Select the input function for terminal 27.
Parameter 5-40 Function Relay [0] Function relay	See *parameter 5-40 Function Relay*	Alarm	Select the function to control output relay 1.
Parameter 5-40 Function Relay [1] Function relay	See *parameter 5-40 Function Relay*	Drive running	Select the function to control output relay 2.
Parameter 6-10 Terminal 53 Low Voltage	0–10 V	0.07 V	Enter the voltage that corresponds to the low reference value.
Parameter 6-11 Terminal 53 High Voltage	0–10 V	10 V	Enter the voltage that corresponds to the high reference value.
Parameter 8-01 Control Site	[0] Digital and ctrl.word [1] Digital only [2] Controlword only	[0] Digital and ctrl. word	Select if digital, bus, or a combination of both should control the frequency converter.
Parameter 8-30 Protocol	[0] FC [2] Modbus RTU	[0] FC	Select the protocol for the integrated RS485 port.
Parameter 8-32 Baud Rate	[0] 2400 Baud [1] 4800 Baud *[2] 9600 Baud [3] 19200 Baud 4] 38400 Baud 5] 57600 Baud [6] 76800 Baud [7] 115200 Baud	9600	Select the baud rate for the RS485 port.

Table 6.4 Open-loop Applications Set-up

The Start-up quick guide for compressor functions

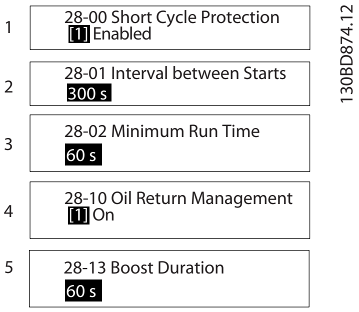


Illustration 6.3 Compressor Function Quick Guide

Compressor function quick guide

Parameter	Option	Default	Function
Parameter 28-00 Short Cycle Protection	[0] Disabled [1] Enabled	[1] Enabled	Select if short cycle protection is to be used.
Parameter 28-01 Interval between Starts	0–3600 s	300 s	Enter the minimum allowed time between starts.
Parameter 28-02 Minimum Run Time	10–3600 s	60 s	Enter the minimum allowed time to run before stop.
Parameter 28-10 Oil Return Management	[0] Off [1] On	[1] On	Select if oil return management is to be used.
Parameter 28-13 Boost Duration	60–300 s	60 s	Enter the boost duration for the oil return.

Table 6.5 Compressor Function

The Start-up quick guide for compressor closed-loop applications

130BD875.12

1	0-01 Language	[0] English
2	0-06 Grid Type	Size related
3	0-60 Main Menu Password	[0]
4	1-00 Configuration Mode	[0] Size related
5	1-13 Compressor Selection	[1] Closed loop
6	3-02 Minimum Reference	0 Hz
7	3-03 Maximum Reference	200 Hz
8	3-10 Preset Reference	0%
9	3-15 Reference 1 Source	[1] Analog in 53
10	3-41 Ramp 1 Ramp Up Time	30.00 s
11	3-42 Ramp 1 Ramp Down Time	30.00 s
12	5-12 Terminal 27 Digital Input	[6] Stop inverse
13	5-40 Function Relay 1	Alarm
14	5-40 Function Relay 2	Drive running
15	6-10 Terminal 53 Low Voltage	0.07 V
16	6-11 Terminal 53 High Voltage	10 V
17	6-14 Terminal 53 Low Ref./Feedb.	30.000 Hz
18	6-15 Terminal 53 High Ref./Feedb.	200.000 Hz
19	6-22 Terminal 54 Low Current	4.00 mA
20	6-23 Terminal 54 High Current	20.00 mA
21	6-24 Terminal 54 Low Ref./Feedb.	0.000
22	6-25 Terminal 54 High Ref./Feedb.	4999.000
23	20-00 Feedback 1 Source	[2] Analog input 54
24	20-04 Feedback 2 Conversion	[0] Linear
25	8-01 Control Site	[0] Digital and ctrl.word
26	8-30 Protocol	[0] FC
27	8-31 Address	1

Illustration 6.4 Closed-loop Quick Guide

Closed-loop quick guide

Parameter	Option	Default	Function
Parameter 0-01 Language	[0] English [1] Deutsch [2] Francais [3] Dansk [4] Spanish [5] Italiano [28] Bras.port	0	Select the language for the display.
Parameter 0-06 GridType	[0] 200–240 V/50 Hz/IT-grid [1] 200–240 V/50 Hz/Delta [2] 200–240 V/50 Hz [10] 380–440 V/50 Hz/IT-grid [11] 380–440 V/50 Hz/Delta [12] 380–440 V/50 Hz [20] 440–480 V/50 Hz/IT-grid [21] 440–480 V/50 Hz/Delta [22] 440–480 V/50 Hz [30] 525–600 V/50 Hz/IT-grid [31] 525–600 V/50 Hz/Delta [32] 525–600 V/50 Hz [100] 200–240 V/60 Hz/IT-grid [101] 200–240 V/60 Hz/Delta [102] 200–240 V/60 Hz [110] 380–440 V/60 Hz/IT-grid [111] 380–440 V/60 Hz/Delta [112] 380–440 V/60 Hz [120] 440–480 V/60 Hz/IT-grid [121] 440–480 V/60 Hz/Delta [122] 440–480 V/60 Hz [130] 525–600 V/60 Hz/IT-grid [131] 525–600 V/60 Hz/Delta [132] 525–600 V/60 Hz	Size related	Select the operating mode for restart after reconnection of the frequency converter to mains voltage after power-down.
Parameter 0-60 Main Menu Password	0–999	0	Define the password for access to the LCP.
Parameter 1-00 Configuration Mode	[0] Open loop [3] Closed loop	[0] Open loop	Select closed loop.
Parameter 1-13 Compressor Selection	[24] VZH028-R410A [25] VZH035-R410A [26] VZH044-R410A	Size related	Select the used compressor.
Parameter 3-02 Minimum Reference	-4999.0 – 200 Hz	0 Hz	The minimum reference is the lowest value obtainable by summing all references.
Parameter 3-03 Maximum Reference	0–200 Hz	200 Hz	The maximum reference is the highest obtainable by summing all references.
Parameter 3-10 Preset Reference	-100 – 100 %	0%	Set up a fix setpoint in preset reference [0].
Parameter 3-15 Reference 1 Source	[0] No function [1] Analog in 53 [2] Analog in 54 [7] Pulse input 29 [11] Local bus reference	[1] Analog in 53	Select the input to be used for the reference signal.
Parameter 3-41 Ramp 1 Ramp Up Time	0.05–3600.0 s	30.00 s	Ramp-up time from 0 to *parameter 1-25 Motor Nominal Speed.*
Parameter 3-42 Ramp 1 Ramp Down Time	0.05–3600.0 s	30.00 s	Ramp-down time from nominal motor speed to 0.

Parameter	Option	Default	Function
Parameter 5-12 Terminal 27 Digital Input	[0] No operation [1] Reset [2] Coast inverse [3] Coast and reset inverse [4] Quick stop inverse [5] DC-brake inverse [6] Stop inverse [7] External Interlock [8] Start [9] Latched start [10] Reversing [11] Start reversing [14] Jog [16] Preset ref bit 0 [17] Preset ref bit 1 [18] Preset ref bit 2 [19] Freeze reference [20] Speed up [22] Speed down [23] Set-up select bit 0 [34] Ramp bit 0 [52] Run permissive [53] Hand start [54] Auto start [60] Counter A (up) [61] Counter A (down) [62] Reset Counter A [63] Counter B (up) [64] Counter B (down) [65] Reset Counter B	[6] Stop inverse	Select the input function for terminal 27.
Parameter 5-40 Function Relay [0] Function relay	See *parameter 5-40 Function Relay*	Alarm	Select the function to control output relay 1.
Parameter 5-40 Function Relay [1] Function relay	See *parameter 5-40 Function Relay*	Drive running	Select the function to control output relay 2.
Parameter 6-10 Terminal 53 Low Voltage	0–10 V	0.07 V	Enter the voltage that corresponds to the low reference value.
Parameter 6-11 Terminal 53 High Voltage	0–10 V	10 V	Enter the voltage that corresponds to the high reference value.
Parameter 6-14 Terminal 53 Low Ref./ Feedb. Value	-4999 – 4999	30	Enter the reference value that corresponds to the voltage set in *parameter 6-10 Terminal 53 Low Voltage*.
Parameter 6-15 Terminal 53 High Ref./ Feedb. Value	-4999 – 4999	200	Enter the reference value that corresponds to the voltage set in *parameter 6-11 Terminal 53 High Voltage*.
Parameter 6-22 Terminal 54 Low Current	0.00–20.00 mA	4.00 mA	Enter the current that corresponds to the low reference value.
Parameter 6-23 Terminal 54 High Current	0–10 V	10 V	Enter the current that corresponds to the high reference value.
Parameter 6-24 Terminal 54 Low Ref./ Feedb. Value	-0.00–20.00 mA	20.00 mA	Enter the reference value that corresponds to the current set in *parameter 6-20 Terminal 54 Low Voltage*.
Parameter 6-25 Terminal 54 High Ref./ Feedb. Value	-4999 – 4999	Size related	Enter the reference value that corresponds to the current set in *parameter 6-21 Terminal 54 High Voltage*.

Parameter	Option	Default	Function
Parameter 8-01 Control Site	[0] Digital and ctrl.word [1] Digital only [2] Controlword only	[0] Digital and ctrl.word	Select if digital, bus, or a combination of both should control the frequency converter.
Parameter 8-30 Protocol	[0] FC [2] Modbus RTU	[0] FC	Select the protocol for the integrated RS485 port.
Parameter 8-32 Baud Rate	[0] 2400 Baud [1] 4800 Baud [2] 9600 Baud [3] 19200 Baud [4] 38400 Baud [5] 57600 Baud [6] 76800 Baud [7] 115200 Baud	[2] 9600 Baud	Select the baud rate for the RS485 port.
Parameter 20-00 Feedback 1 Source	[0] No function [1] Analog Input 53 [2] Analog Input 54 [3] Pulse input 29 [100] Bus Feedback 1 [101] Bus Feedback 2	[0] No function	Select which input to use as the source of the feedback signal.
Parameter 20-01 Feedback 1 Conversion	[0] Linear [1] Square root	[0] Linear	Select how to calculate the feedback.

Table 6.6 Closed-loop Applications Set-up

Changes made

Changes Made lists all parameters changed from default settings.

- The list shows only parameters which have been changed in the current edit set-up.
- Parameters which have been reset to default values are not listed.
- The message *Empty* indicates that no parameters have been changed.

To change parameter settings

1. To enter the *Quick Menu*, press [Menu] until indicator in display is placed above *Quick Menu*.
2. Press [▲] [▼] to select quick guide, closed-loop set-up, compressor set-up, or changes made, then press [OK].
3. Press [▲] [▼] to browse through the parameters in the *Quick Menu*.
4. Press [OK] to select a parameter.
5. Press [▲] [▼] 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] until indicator in display is placed above *Main Menu*.
2. Press [▲] [▼] to browse through the parameter groups.
3. Press [OK] to select a parameter group.
4. Press [▲] [▼] to browse through the parameters in the specific group.
5. Press [OK] to select the parameter.
6. Press [▲] [▼] to set/change the parameter value.

6.3.3 Main Menu

Press [Main Menu] to access and program all parameters. The main menu parameters can be accessed readily unless a password has been created via *parameter 0-60 Main Menu Password*.
For most applications, it is not necessary to access the main menu parameters. The quick menu provides the simplest and quickest access to the typical required parameters.

6

6.4 Quick Transfer of Parameter Settings between Multiple Frequency Converters

When the set-up of a frequency converter is completed, it is recommended to store the data in the LCP or on a PC via MCT 10 Set-up Software.

Data transfer from the frequency converter to the LCP:

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

Connect the LCP to another frequency converter and copy the parameter settings to this frequency converter as well.

Data transfer from the LCP to the frequency converter:

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

6.5 Readout and Programming of Indexed Parameters

Select the parameter, press [OK], and press [▲]/[▼] to scroll through the indexed values. To change the parameter value, select the indexed value and press [OK]. Change the value by pressing [▲]/[▼]. Press [OK] to accept the new setting. Press [Cancel] to abort. Press [Back] to leave the parameter.

6.6 Initialize the Frequency Converter to Default Settings in two Ways

There are 2 ways to initialize the frequency converter to the default settings.

Recommended initialization

1. Select *parameter 14-22 Operation Mode*.
2. Press [OK].
3. Select *[2] Initialisation* and Press [OK].
4. Power off the frequency converter and wait until the display turns off.
5. Reconnect the mains supply. The frequency converter is now reset, except the following parameters:
    - *Parameter 1-06 Clockwise Direction*
    - *Parameter 8-30 Protocol*
    - *Parameter 8-31 Address*
    - *Parameter 8-32 Baud Rate*
    - *Parameter 8-33 Parity / Stop Bits*
    - *Parameter 8-35 Minimum Response Delay*
    - *Parameter 8-36 Maximum Response Delay*
    - *Parameter 8-37 Maximum Inter-char delay*
    - *Parameter 8-70 BACnet Device Instance*
    - *Parameter 8-72 MS/TP Max Masters*
    - *Parameter 8-73 MS/TP Max Info Frames*
    - *Parameter 8-74 "I am" Service*
    - *Parameter 8-75 Intialisation Password*
    - *Parameter 15-00 Operating hours* to *parameter 15-05 Over Volt's*
    - *Parameter 15-03 Power Up's*
    - *Parameter 15-04 Over Temp's*
    - *Parameter 15-05 Over Volt's*
    - *Parameter 15-30 Alarm Log: Error Code*
    - 15-4* Drive identification parameters

2-finger initialization
The other way to initialize the frequency converter to default settings is through 2-finger initialization, which is described in the following steps.

1. Power off the frequency converter.
2. Press [OK] and [Menu].
3. Power up the frequency converter while still pressing the keys for 10 s.
4. The frequency converter is now reset, except the following parameters:
    - *Parameter 15-00 Operating hours*
    - *Parameter 15-03 Power Up's*
    - *Parameter 15-04 Over Temp's*
    - *Parameter 15-05 Over Volt's*
    - 15-4* Drive identification parameters

Initialization of parameters is confirmed by *alarm 80, Drive initialised* in the display after the power cycle.

7 RS485 Installation and Set-up

7.1 RS485

7.1.1 Overview

RS485 is a 2-wire bus interface compatible with multi-drop network topology, that is, nodes can be connected as a bus, or via drop cables from a common trunk line. A total of 32 nodes can be connected to 1 network segment.
Repeaters divide network segments, see *Illustration 7.1*.

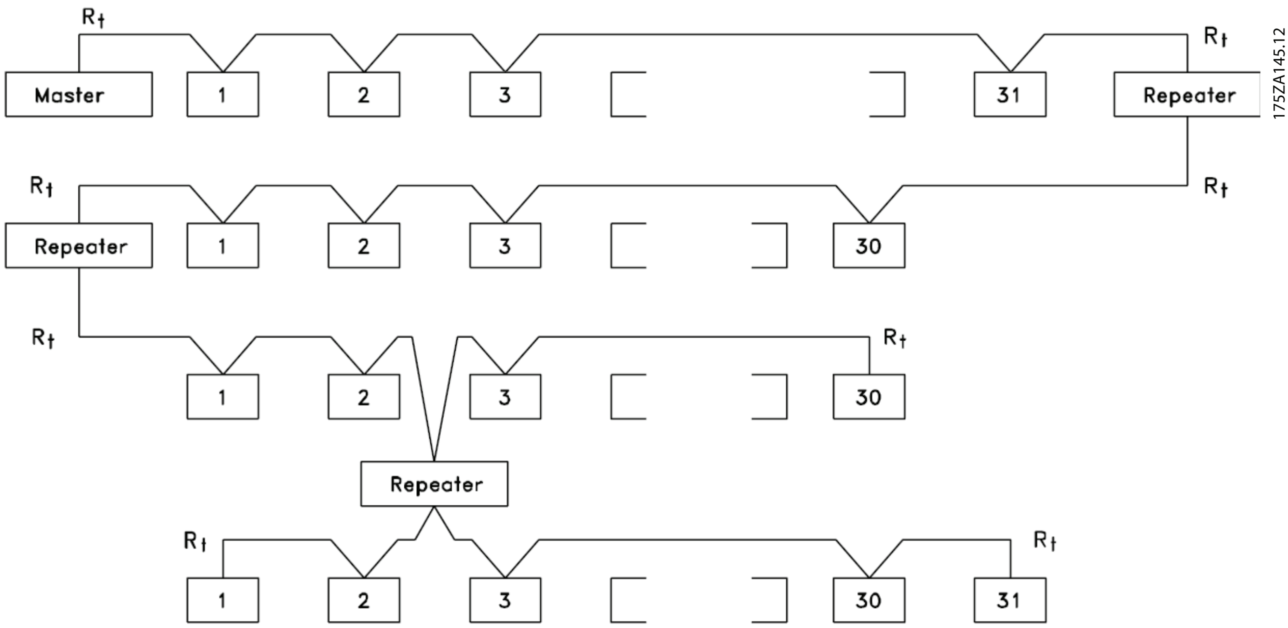


Illustration 7.1 RS485 Bus Interface

NOTICE

Each repeater functions as a node within the segment in which it is installed. Each node connected within a given network must have a unique node address across all segments.

Terminate each segment at both ends, using either the termination switch (S801) of the frequency converters or a biased termination resistor network. Always use screened twisted pair (STP) cable for bus cabling, and follow good common installation practice.

Low-impedance ground connection of the screen at every node is important, including at high frequencies. Thus, connect a large surface of the screen to ground, for example with a cable clamp or a conductive cable gland. It may be necessary to apply potential-equalising cables to maintain the same earth potential throughout the network - particularly in installations with long cables.

To prevent impedance mismatch, always use the same type of cable throughout the entire network. When connecting a motor to the frequency converter, always use screened motor cable.

Cable	**Screened twisted pair (STP)**
Impedance [Ω]	120
Cable length [m]	Maximum 1200 (including drop lines) Maximum 500 station-to-station

Table 7.1 Cable Specifications

7.1.2 Network Connection

Connect the frequency converter to the RS485 network as follows (see also *Illustration 7.2*):

1. Connect signal wires to terminal 68 (P+) and terminal 69 (N-) on the main control board of the frequency converter.
2. Connect the cable shield to the cable clamps.

NOTICE

To reduce noise between conductors, use shielded, twisted-pair cables

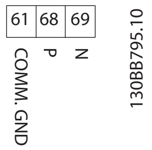


Illustration 7.2 Network Connection

7.1.3 Frequency Converter Hardware Set-up

Use the terminator dip switch on the main control board of the frequency converter to terminate the RS485 bus.

The factory setting for the dip switch is OFF.

7.1.4 Parameter Settings for Modbus Communication

Parameter	Function
Parameter 8-30 Protocol	Select the application protocol to run for the RS485 interface.
Parameter 8-31 Address	Set the node address. **NOTICE** **The address range depends on the protocol selected in *parameter 8-30 Protocol*.**
Parameter 8-32 Baud Rate	Set the baud rate. **NOTICE** **The default baud rate depends on the protocol selected in *parameter 8-30 Protocol*.**
Parameter 8-33 Parity / Stop Bits	Set the parity and number of stop bits. **NOTICE** **The default selection depends on the protocol selected in *parameter 8-30 Protocol*.**
Parameter 8-35 Minimum Response Delay	Specify a minimum delay time between receiving a request and transmitting a response. This function is for overcoming modem turnaround delays.
Parameter 8-36 Maximum Response Delay	Specify a maximum delay time between transmitting a request and receiving a response.
Parameter 8-37 Maximum Inter-char delay	If transmission is interrupted, specify a maximum delay time between 2 received bytes to ensure timeout. **NOTICE** **The default selection depends on the protocol selected in *parameter 8-30 Protocol*.**

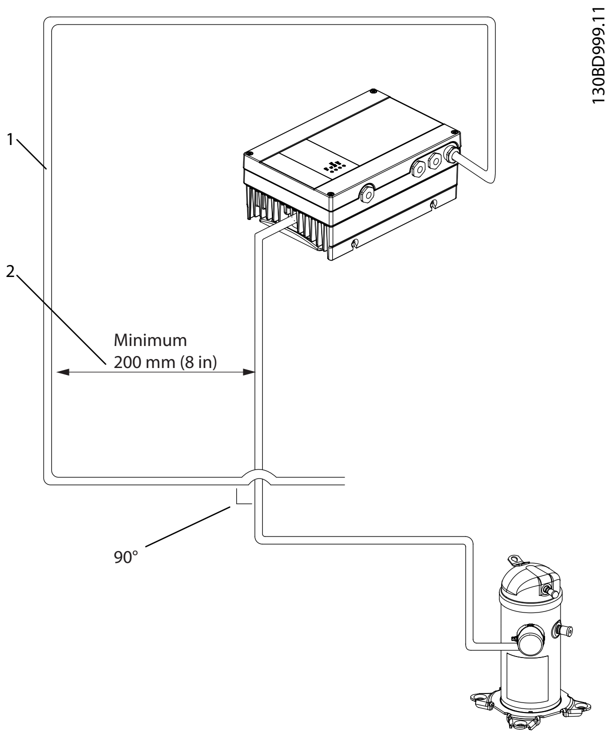
Table 7.2 Modbus Communication Parameter Settings

7.1.5 EMC Precautions

To achieve interference-free operation of the RS485 network, Danfoss recommends the following EMC precautions.

NOTICE

Observe relevant national and local regulations, for example regarding protective earth connection. To avoid coupling of high-frequency noise between the cables, the RS485 communication cable must be kept away from motor and brake resistor cables. Normally, a distance of 200 mm (8 inches) is sufficient. Maintain the greatest possible distance between the cables, especially where cables run in parallel over long distances. When crossing is unavoidable, the RS485 cable must cross motor and brake resistor cables at an angle of 90°.



1	Fieldbus cable
2	Minimum 200 mm (8 in) distance

Illustration 7.3 Minimum Distance between Communication and Power Cables

7.2 FC Protocol Overview

7.2.1 Overview

The FC protocol, also referred to as FC fieldbus, is the Danfoss standard fieldbus. It defines an access technique according to the master/slave principle for communications via a fieldbus.
1 master and a maximum of 126 slaves can be connected to the bus. The master selects the individual slaves via an address character in the telegram. A slave itself can never transmit without first being requested to do so, and direct message transfer between the individual slaves is not possible. Communications occur in the half duplex mode. The master function cannot be transferred to another node (single-master system).

The physical layer is RS485, thus utilizing the RS485 port built into the frequency converter. The FC protocol supports different telegram formats:

- A short format of 8 bytes for process data.
- A long format of 16 bytes that also includes a parameter channel.
- A format used for texts.

7.2.2 FC with Modbus RTU

The FC protocol provides access to the control word and bus reference of the frequency converter.

The control word allows the Modbus master to control several important functions of the frequency converter:

- Start.
- Stop of the frequency converter in various ways:
  - Coast stop.
  - Quick stop.
  - DC Brake stop.
  - Normal (ramp) stop.
- Reset after a fault trip.
- Run at various preset speeds.
- Run in reverse.
- Change of the active set-up.
- Control of the 2 relays built into the frequency converter.

The bus reference is commonly used for speed control. It is also possible to access the parameters, read their values, and where possible, write values to them. Accessing the parameters offers a range of control options, including controlling the setpoint of the frequency converter when its internal PI controller is used.

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7.3 Network Configuration

To enable the FC protocol for the frequency converter, set the following parameters.

Parameter	Setting
Parameter 8-30 Protocol	FC
Parameter 8-31 Address	1–126
Parameter 8-32 Baud Rate	2400–115200
Parameter 8-33 Parity / Stop Bits	Even parity, 1 stop bit (default)

Table 7.3 Parameters to Enable the Protocol

7.4 FC Protocol Message Framing Structure

7.4.1 Content of a Character (byte)

Each character transferred begins with a start bit. Then 8 data bits are transferred, corresponding to a byte. Each character is secured via a parity bit. This bit is set at 1 when it reaches parity. Parity is when there is an equal number of 1 s in the 8 data bits and the parity bit in total. A stop bit completes a character, thus consisting of 11 bits in all.

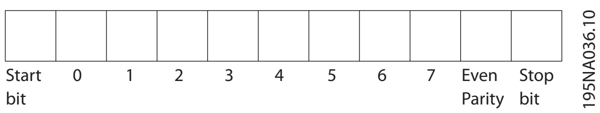

Illustration 7.4 Content of a Character

7.4.2 Telegram Structure

Each telegram has the following structure:

1. Start character (STX)=02 hex.
2. A byte denoting the telegram length (LGE).
3. A byte denoting the frequency converter address (ADR).

Several data bytes (variable, depending on the type of telegram) follow.

A data control byte (BCC) completes the telegram.

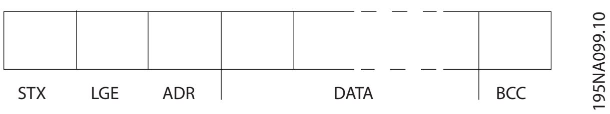

Illustration 7.5 Telegram Structure

7.4.3 Telegram Length (LGE)

The telegram length is the number of data bytes plus the address byte ADR and the data control byte BCC.

4 data bytes	LGE=4+1+1=6 bytes
12 data bytes	LGE=12+1+1=14 bytes
Telegrams containing texts	10[1)]+n bytes

Table 7.4 Length of Telegrams

1) The 10 is the fixed characters, while the n is variable (depending on the length of the text).

7.4.4 Frequency Converter Address (ADR)

Address format 1–126

- Bit 7 = 1 (address format 1–126 active).
- Bit 0–6 = frequency converter address 1–126.
- Bit 0–6 = 0 broadcast.

The slave returns the address byte unchanged to the master in the response telegram.

7.4.5 Data Control Byte (BCC)

The checksum is calculated as an XOR-function. Before the first byte in the telegram is received, the calculated checksum is 0.

7.4.6 The Data Field

The structure of data blocks depends on the type of telegram. There are 3 telegram types, and the type applies for both control telegrams (master⇒slave) and response telegrams (slave⇒master).

The 3 types of telegram are:

- Process block (PCD)
- Parameter block
- Text block

Process block (PCD)
The PCD is made up of a data block of 4 bytes (2 words) and contains:

- Control word and reference value (from master to slave).
- Status word and present output frequency (from slave to master).

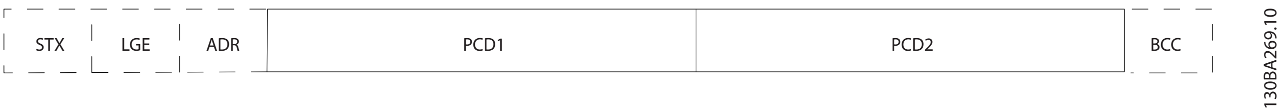

Illustration 7.6 Process Block

Parameter block
The parameter block is used to transfer parameters between master and slave. The data block is made up of 12 bytes (6 words) and also contains the process block.

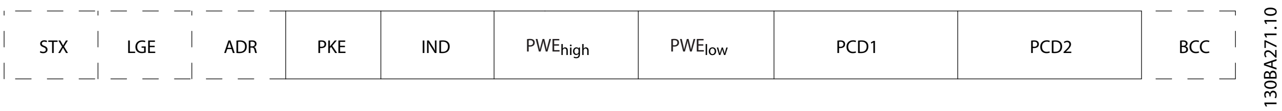

Illustration 7.7 Parameter Block

Text block
The text block is used to read or write texts via the data block.

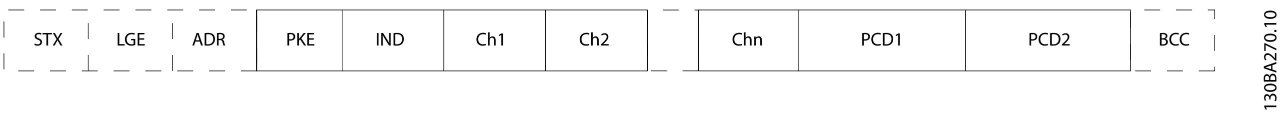

Illustration 7.8 Text Block

7.4.7 The PKE Field

The PKE field contains 2 subfields:

- Parameter command and response (AK)
- Parameter number (PNU)

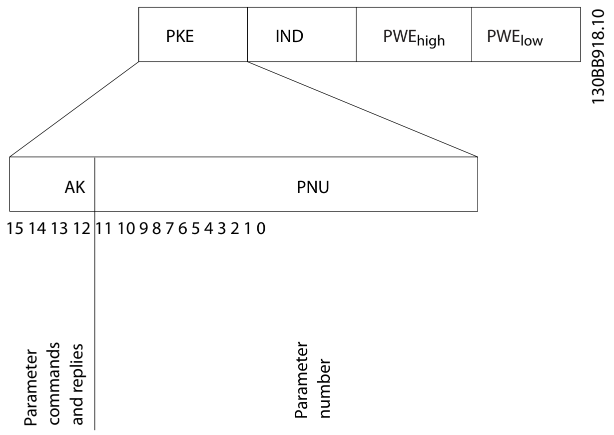

Illustration 7.9 PKE Field

Bits 12–15 transfer parameter commands from master to slave and return processed slave responses to the master.

Parameter commands master⇒slave				
Bit number				**Parameter command**
15	14	13	12	
0	0	0	0	No command.
0	0	0	1	Read parameter value.
0	0	1	0	Write parameter value in RAM (word).
0	0	1	1	Write parameter value in RAM (double word).
1	1	0	1	Write parameter value in RAM and EEPROM (double word).
1	1	1	0	Write parameter value in RAM and EEPROM (word).
1	1	1	1	Read text.

Table 7.5 Parameter Commands

Response slave⇒master				
Bit number				**Response**
15	14	13	12	
0	0	0	0	No response.
0	0	0	1	Parameter value transferred (word).
0	0	1	0	Parameter value transferred (double word).
0	1	1	1	Command cannot be performed.
1	1	1	1	Text transferred.

Table 7.6 Response

If the command cannot be performed, the slave sends this response *0111 Command cannot be performed* and issues the following fault report in *Table 7.7*.

Fault code	FC specification
0	Illegal parameter number.
1	Parameter cannot be changed.
2	Upper or lower limit is exceeded.
3	Subindex is corrupted.
4	No array.
5	Wrong data type.
6	Not used.
7	Not used.
9	Description element is not available.
11	No parameter write access.
15	No text available.
17	Not applicable while running.
18	Other errors.
100	–
>100	–
130	No bus access for this parameter.
131	Write to factory set-up is not possible.
132	No LCP access.
252	Unknown viewer.
253	Request is not supported.
254	Unknown attribute.
255	No error.

Table 7.7 Slave Report

7.4.8 Parameter Number (PNU)

Bit numbers 0–11 transfer parameter numbers. The function of the relevant parameter is defined in the parameter description in *chapter 6 How to Program*.

7.4.9 Index (IND)

The index is used with the parameter number to read/write access parameters with an index, for example, *parameter 15-30 Alarm Log: Error Code*. The index consists of 2 bytes; a low byte, and a high byte.

Only the low byte is used as an index.

7.4.10 Parameter Value (PWE)

The parameter value block consists of 2 words (4 bytes), and the value depends on the defined command (AK). The master prompts for a parameter value when the PWE block contains no value. To change a parameter value (write), write the new value in the PWE block and send from the master to the slave.

When a slave responds to a parameter request (read command), the present parameter value in the PWE block is transferred and returned to the master. If a parameter contains several data options, for example *parameter 0-01 Language*, select the data value by entering the value in the PWE block. Serial communication is only capable of reading parameters containing data type 9 (text string).

Parameter 15-40 FC Type to *parameter 15-53 Power Card Serial Number* contain data type 9.
For example, read the unit size and mains voltage range in *parameter 15-40 FC Type*. When a text string is transferred (read), the length of the telegram is variable, and the texts are of different lengths. The telegram length is defined in the 2nd byte of the telegram (LGE). When using text transfer, the index character indicates whether it is a read or a write command.

To read a text via the PWE block, set the parameter command (AK) to F hex. The index character high-byte must be 4.

7.4.11 Data Types Supported by the Frequency Converter

Unsigned means that there is no operational sign in the telegram.

Data types	Description
3	Integer 16
4	Integer 32
5	Unsigned 8
6	Unsigned 16
7	Unsigned 32
9	Text string

Table 7.8 Data Types

7.4.12 Conversion

The *programming guide* contains the descriptions of attributes of each parameter. Parameter values are transferred as whole numbers only. Conversion factors are used to transfer decimals.

Parameter 4-12 Motor Speed Low Limit [Hz] has a conversion factor of 0.1. To preset the minimum frequency to 10 Hz, transfer the value 100. A conversion factor of 0.1 means that the value transferred is multiplied by 0.1. The value 100 is thus perceived as 10.0.

Conversion index	Conversion factor
74	3600
2	100
1	10
0	1
-1	0.1
-2	0.01
-3	0.001
-4	0.0001
-5	0.00001

Table 7.9 Conversion

7.4.13 Process Words (PCD)

The block of process words is divided into 2 blocks of 16 bits, which always occur in the defined sequence.

PCD 1	PCD 2
Control telegram (master⇒slave control word)	Reference value
Control telegram (slave⇒master) status word	Present output frequency

Table 7.10 Process Words (PCD)

7.5 Examples

7.5.1 Writing a Parameter Value

Change *parameter 4-14 Motor Speed High Limit [Hz]* to 100 Hz.
Write the data in EEPROM.

PKE = E19E hex - Write single word in *parameter 4-14 Motor Speed High Limit [Hz]*:

- IND = 0000 hex.
- PWEHIGH = 0000 hex.
- PWELOW = 03E8 hex.

Data value 1000, corresponding to 100 Hz, see *chapter 7.4.12 Conversion*.

The telegram looks like *Illustration 7.10*.

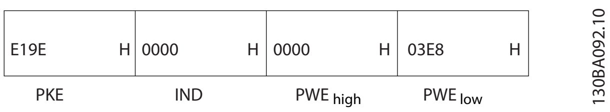

Illustration 7.10 Telegram

NOTICE

***Parameter 4-14 Motor Speed High Limit [Hz]* is a single word, and the parameter command for write in EEPROM is *E. Parameter 4-14 Motor Speed High Limit [Hz]* is 19E in hexadecimal.**

The response from the slave to the master is shown in *Illustration 7.11*.

PKE	IND	PWE high	PWE low
119E H	0000 H	0000 H	03E8 H

130BA093.10

Illustration 7.11 Response from Master

7.5.2 Reading a Parameter Value

Read the value in *parameter 3-41 Ramp 1 Ramp Up Time*.

PKE = 1155 hex - Read parameter value in *parameter 3-41 Ramp 1 Ramp Up Time*:

- IND = 0000 hex.
- PWE_{HIGH} = 0000 hex.
- PWE_{LOW} = 0000 hex.

PKE	IND	PWE high	PWE low
1155 H	0000 H	0000 H	0000 H

130BA094.10

Illustration 7.12 Telegram

If the value in *parameter 3-41 Ramp 1 Ramp Up Time* is 10 s, the response from the slave to the master is shown in *Illustration 7.13*.

PKE	IND	PWE high	PWE low
1155 H	0000 H	0000 H	03E8 H

130BA267.10

Illustration 7.13 Response

3E8 hex corresponds to 1000 decimal. The conversion index for *parameter 3-41 Ramp 1 Ramp Up Time* is -2, that is, 0.01.
Parameter 3-41 Ramp 1 Ramp Up Time is of the type *Unsigned 32*.

7.6 Modbus RTU Overview

7.6.1 Prerequisite Knowledge

Danfoss assumes that the installed controller supports the interfaces in this manual, and strictly observes all requirements and limitations stipulated in the controller and frequency converter.

The built-in Modbus RTU (remote terminal unit) is designed to communicate with any controller that supports the interfaces defined in this manual. It is assumed that the user has full knowledge of the capabilities and limitations of the controller.

7.6.2 What the User Should Already Know

The built-in Modbus RTU (Remote Terminal Unit) is designed to communicate with any controller that supports the interfaces defined in this manual. It is assumed that the user has full knowledge of the capabilities and limitations of the controller.

7.6.3 Overview

Regardless of the type of physical communication networks, this section describes the process a controller uses to request access to another device. This process includes how the Modbus RTU responds to requests from another device, and how errors are detected and reported. It also establishes a common format for the layout and contents of telegram fields.
During communications over a Modbus RTU network, the protocol:

- Determines how each controller learns its device address.
- Recognizes a telegram addressed to it.
- Determines which actions to take.
- Extracts any data or other information contained in the telegram.

If a reply is required, the controller constructs the reply telegram and sends it.
Controllers communicate using a master/slave technique in which only the master can initiate transactions (called queries). Slaves respond by supplying the requested data to the master, or by acting as requested in the query.
The master can address individual slaves, or initiate a broadcast telegram to all slaves. Slaves return a response to queries that are addressed to them individually. No responses are returned to broadcast queries from the master.

The Modbus RTU protocol establishes the format for the master query by providing the following information:

- The device (or broadcast) address.
- A function code defining the requested action.
- Any data to be sent.
- An error-checking field.

The response telegram of the slave device is also constructed using Modbus protocol. It contains fields confirming the action taken, any data to be returned, and an error-checking field. If an error occurs in receipt of the telegram, or if the slave is unable to perform the requested action, the slave constructs and sends an error message. Alternatively, a timeout occurs.

7.6.4 Frequency Converter with Modbus RTU

The frequency converter communicates in Modbus RTU format over the built-in RS485 interface. Modbus RTU provides access to the control word and bus reference of the frequency converter.

The control word allows the Modbus master to control several important functions of the frequency converter:

- Start.
- Various stops:
  - Coast stop.
  - Quick stop.
  - DC brake stop.
  - Normal (ramp) stop.
- Reset after a fault trip.
- Run at various preset speeds.
- Run in reverse.
- Change the active set-up.
- Control built-in relay of the frequency converter.

The bus reference is commonly used for speed control. It is also possible to access the parameters, read their values, and, where possible, write values to them. Accessing the parameters offers a range of control options, including controlling the setpoint of the frequency converter when its internal PI controller is used.

7.7 Network Configuration

To enable Modbus RTU on the frequency converter, set the following parameters:

Parameter	Setting
Parameter 8-30 Protocol	Modbus RTU
Parameter 8-31 Address	1–247
Parameter 8-32 Baud Rate	2400–115200
Parameter 8-33 Parity / Stop Bits	Even parity, 1 stop bit (default)

Table 7.11 Network Configuration

7.8 Modbus RTU Message Framing Structure

7.8.1 Introduction

The controllers are set up to communicate on the Modbus network using RTU (remote terminal unit) mode, with each byte in a telegram containing 2 4-bit hexadecimal characters. The format for each byte is shown in *Table 7.12*.

Start bit	**Data byte**								**Stop/ parity**	**Stop**

Table 7.12 Format for Each Byte

Coding system	8-bit binary, hexadecimal 0–9, A–F. 2 hexadecimal characters contained in each 8-bit field of the telegram.
Bits per byte	• 1 start bit. • 8 data bits, least significant bit sent first. • 1 bit for even/odd parity; no bit for no parity. • 1 stop bit if parity is used; 2 bits if no parity.
Error check field	Cyclic redundancy check (CRC).

Table 7.13 Byte Details

7.8.2 Modbus RTU Telegram Structure

The transmitting device places a Modbus RTU telegram into a frame with a known beginning and ending point. This allows receiving devices to begin at the start of the telegram, read the address portion, determine which device is addressed (or all devices, if the telegram is broadcast), and to recognize when the telegram is completed. Partial telegrams are detected and errors set as a result. Characters for transmission must be in hexadecimal 00–FF format in each field. The frequency converter continuously monitors the network bus, also

7

during silent intervals. When the first field (the address field) is received, each frequency converter or device decodes it to determine which device is being addressed. Modbus RTU telegrams addressed to 0 are broadcast telegrams. No response is permitted for broadcast telegrams. A typical telegram frame is shown in *Table 7.14*.

Start	Address	Function	Data	CRC check	End
T1-T2-T3-T4	8 bits	8 bits	N x 8 bits	16 bits	T1-T2-T3-T4

Table 7.14 Typical Modbus RTU Telegram Structure

7.8.3 Start/Stop Field

Telegrams start with a silent period of at least 3.5 character intervals. The silent period is implemented as a multiple of character intervals at the selected network baud rate (shown as Start T1-T2-T3-T4). The first field to be transmitted is the device address. Following the last transmitted character, a similar period of at least 3.5 character intervals marks the end of the telegram. A new telegram can begin after this period.

Transmit the entire telegram frame as a continuous stream. If a silent period of more than 1.5 character intervals occurs before completion of the frame, the receiving device flushes the incomplete telegram and assumes that the next byte is the address field of a new telegram. Similarly, if a new telegram begins before 3.5 character intervals after a previous telegram, the receiving device considers it a continuation of the previous telegram. This behavior causes a timeout (no response from the slave), since the value in the final CRC field is not valid for the combined telegrams.

7.8.4 Address Field

The address field of a telegram frame contains 8 bits. Valid slave device addresses are in the range of 0–247 decimal. The individual slave devices are assigned addresses in the range of 1–247. (0 is reserved for broadcast mode, which all slaves recognize.) A master addresses a slave by placing the slave address in the address field of the telegram. When the slave sends its response, it places its own address in this address field to let the master know which slave is responding.

7.8.5 Function Field

The function field of a telegram frame contains 8 bits. Valid codes are in the range of 1–FF. Function fields are used to send telegrams between master and slave. When a telegram is sent from a master to a slave device, the function code field tells the slave what kind of action to perform. When the slave responds to the master, it uses the function code field to indicate either a normal (error-free) response, or that some kind of error occurred (called an exception response).

For a normal response, the slave simply echoes the original function code. For an exception response, the slave returns a code that is equivalent to the original function code with its most significant bit set to logic 1. In addition, the slave places a unique code into the data field of the response telegram. This code tells the master what kind of error occurred, or the reason for the exception. Also refer to *chapter 7.8.10 Function Codes Supported by Modbus RTU* and *chapter 7.8.11 Modbus Exception Codes*.

7.8.6 Data Field

The data field is constructed using sets of 2 hexadecimal digits, in the range of 00–FF hexadecimal. These digits are made up of 1 RTU character. The data field of telegrams sent from a master to a slave device contains additional information which the slave must use to perform accordingly. The information can include items such as:

- Coil or register addresses.
- The quantity of items to be handled.
- The count of actual data bytes in the field.

7.8.7 CRC Check Field

Telegrams include an error-checking field, operating based on a cyclic redundancy check (CRC) method. The CRC field checks the contents of the entire telegram. It is applied regardless of any parity check method used for the individual characters of the telegram. The transmitting device calculates the CRC value and appends the CRC as the last field in the telegram. The receiving device recalculates a CRC during receipt of the telegram and compares the calculated value to the actual value received in the CRC field. Two unequal values result in bus timeout. The error-checking field contains a 16-bit binary value implemented as 2 8-bit bytes. After the implementation, the low-order byte of the field is appended first, followed by the high-order byte. The CRC high-order byte is the last byte sent in the telegram.

7.8.8 Coil Register Addressing

In Modbus, all data is organized in coils and holding registers. Coils hold a single bit, whereas holding registers hold a 2 byte word (that is 16 bits). All data addresses in Modbus telegrams are referenced to 0. The first occurrence of a data item is addressed as item number 0. For example: The coil known as coil 1 in a programmable controller is addressed as coil 0000 in the data address field of a

Modbus telegram. Coil 127 decimal is addressed as coil 007Ehex (126 decimal).
Holding register 40001 is addressed as register 0000 in the data address field of the telegram. The function code field already specifies a holding register operation. Therefore, the 4XXXX reference is implicit. Holding register 40108 is addressed as register 006Bhex (107 decimal).

Coil number	Description	Signal direction
1–16	Frequency converter control word (see *Table 7.16*).	Master to slave
17–32	Frequency converter speed or setpoint reference range 0x0–0xFFFF (-200% ... ~200%).	Master to slave
33–48	Frequency converter status word (see *Table 7.17*).	Slave to master
49–64	Open-loop mode: Frequency converter output frequency. Closed-loop mode: Frequency converter feedback signal.	Slave to master
65	Parameter write control (master to slave). 0 = Parameter changes are written to the RAM of the frequency converter. 1 = Parameter changes are written to the RAM and EEPROM of the frequency converter.	Master to slave
66–65536	Reserved.	–

Table 7.15 Coil Register

Coil	0	1
01	Preset reference lsb	
02	Preset reference msb	
03	DC brake	No DC brake
04	Coast stop	No coast stop
05	Quick stop	No quick stop
06	Freeze frequency	No freeze frequency
07	Ramp stop	Start
08	No reset	Reset
09	No jog	Jog
10	Ramp 1	Ramp 2
11	Data not valid	Data valid
12	Relay 1 off	Relay 1 on
13	Relay 2 off	Relay 2 on
14	Set up lsb	
15	–	
16	No reversing	Reversing

Table 7.16 Frequency Converter Control Word (FC Profile)

Coil	0	1
33	Control not ready	Control ready
34	Frequency converter not ready	Frequency converter ready
35	Coast stop	Safety closed
36	No alarm	Alarm
37	Not used	Not used
38	Not used	Not used
39	Not used	Not used
40	No warning	Warning
41	Not at reference	At reference
42	Hand mode	Auto mode
43	Out of frequency range	In frequency range
44	Stopped	Running
45	Not used	Not used
46	No voltage warning	Voltage warning
47	Not in current limit	Current limit
48	No thermal warning	Thermal warning

Table 7.17 Frequency Converter Status Word (FC Profile)

Bus address	Bus register[1)]	PLC register	Content	Access	Description
0	1	40001	Reserved	–	Reserved for legacy frequency converters VLT® 5000 and VLT® 2800.
1	2	40002	Reserved	–	Reserved for legacy frequency converters VLT® 5000 and VLT® 2800.
2	3	40003	Reserved	–	Reserved for legacy frequency converters VLT® 5000 and VLT® 2800.
3	4	40004	Free	–	–
4	5	40005	Free	–	–
5	6	40006	Modbus configuration	Read/Write	TCP only. Reserved for Modbus TCP (*parameter 12-28 Store Data Values* and *parameter 12-29 Store Always* - stored in, for example, EEPROM).
6	7	40007	Last fault code	Read only	Fault code received from parameter database, refer to WHAT 38295 for details.
7	8	40008	Last error register	Read only	Address of register with which last error occurred, refer to WHAT 38296 for details.
8	9	40009	Index pointer	Read/Write	Sub index of parameter to be accessed. Refer to WHAT 38297 for details.
9	10	40010	*Parameter 0-01 Language*	Dependent on parameter access	*Parameter 0-01 Language* (Modbus register = 10 parameter number) 20 bytes space reserved for parameter in Modbus map.
19	20	40020	*Parameter 0-02 Motor Speed Unit*	Dependent on parameter access	*Parameter 0-02 Motor Speed Unit* 20 bytes space reserved for parameter in Modbus map.
29	30	40030	*Parameter 0-03 Regional Settings*	Dependent on parameter access	*Parameter 0-03 Regional Settings* 20 bytes space reserved for parameter in Modbus map.

Table 7.18 Address/Registers

1) Value written in the Modbus RTU telegram must be 1 or less than the register number. For example, Read Modbus Register 1 by writing value 0 in the telegram.

7.8.9 How to Control the Frequency Converter

This section describes codes which can be used in the function and data fields of a Modbus RTU telegram.

7.8.10 Function Codes Supported by Modbus RTU

Modbus RTU supports use of the following function codes in the function field of a telegram.

Function	Function code (hex)
Read coils	1
Read holding registers	3
Write single coil	5
Write single register	6
Write multiple coils	F
Write multiple registers	10
Get comm. event counter	B
Report slave ID	11

Table 7.19 Function Codes

Function	Function code	Subfunction code	Subfunction
Diagnostics	8	1	Restart communication.
		2	Return diagnostic register.
		10	Clear counters and diagnostic register.
		11	Return bus message count.
		12	Return bus communi-cation error count.
		13	Return slave error count.
		14	Return slave message count.

Table 7.20 Function Codes

7.8.11 Modbus Exception Codes

For a full explanation of the structure of an exception code response, refer to *chapter 7.8.5 Function Field*.

Code	Name	Meaning
1	Illegal function	The function code received in the query is not an allowable action for the server (or slave). This may be because the function code is only applicable to newer devices, and was not implemented in the unit selected. It could also indicate that the server (or slave) is in the wrong state to process a request of this type, for example because it is not configured and is being asked to return register values.
2	Illegal data address	The data address received in the query is not an allowable address for the server (or slave). More specifically, the combination of reference number and transfer length is invalid. For a controller with 100 registers, a request with offset 96 and length 4 succeeds, while a request with offset 96 and length 5 generates exception 02.
3	Illegal data value	A value contained in the query data field is not an allowable value for server (or slave). This indicates a fault in the structure of the remainder of a complex request, such as that the implied length is incorrect. It does NOT mean that a data item submitted for storage in a register has a value outside the expectation of the application program, since the Modbus protocol is unaware of the significance of any value of any register.
4	Slave device failure	An unrecoverable error occurred while the server (or slave) was attempting to perform the requested action.

Table 7.21 Modbus Exception Codes

7.9 How to Access Parameters

7.9.1 Parameter Handling

The PNU (parameter number) is translated from the register address contained in the Modbus read or write message. The parameter number is translated to Modbus as (10 x parameter number) *decimal*. Example: Reading *parameter 3-12 Catch up/slow Down Value* (16 bit): The holding register 3120 holds the parameters value. A value of 1352 (decimal), means that the parameter is set to 12.52%

Reading *parameter 3-14 Preset Relative Reference* (32 bit): The holding registers 3410 and 3411 hold the parameters values. A value of 11300 (*decimal*), means that the parameter is set to 1113.00.

For information on the parameters, size, and conversion index, see the *programming guide*.

7.9.2 Storage of Data

The coil 65 decimal determines whether data written to the frequency converter is stored in EEPROM and RAM (coil 65=1), or only in RAM (coil 65=0).

7.9.3 IND (Index)

Some parameters in the frequency converter are array parameters, for example *parameter 3-10 Preset Reference*. Since the Modbus does not support arrays in the holding registers, the frequency converter has reserved the holding register 9 as pointer to the array. Before reading or writing an array parameter, set the holding register 9. Setting holding register to the value of 2 causes all following read/write to array parameters to be to the index 2.

7.9.4 Text Blocks

Parameters stored as text strings are accessed in the same way as the other parameters. The maximum text block size is 20 characters. If a read request for a parameter is for more characters than the parameter stores, the response is truncated. If the read request for a parameter is for fewer characters than the parameter stores, the response is space filled.

7

7.9.5 Conversion Factor

A parameter value can only be transferred as a whole number. To transfer decimals, use a conversion factor.

7.9.6 Parameter Values

Standard data types
Standard data types are int 16, int 32, uint 8, uint 16, and uint 32. They are stored as 4x registers (40001–4FFFF). The parameters are read using function 03 hex *read holding registers*. Parameters are written using the function 6 hex *preset single register* for 1 register (16 bits), and the function 10 hex *preset multiple registers* for 2 registers (32 bits). Readable sizes range from 1 register (16 bits) up to 10 registers (20 characters).

Non-standard data types
Non-standard data types are text strings and are stored as 4x registers (40001–4FFFF). The parameters are read using function 03 hex *read holding registers* and written using function 10 hex *preset multiple registers*. Readable sizes range from 1 register (2 characters) up to 10 registers (20 characters).

7.10 Examples

The following examples show various Modbus RTU commands.

7.10.1 Read Coil Status (01 hex)

Description
This function reads the ON/OFF status of discrete outputs (coils) in the frequency converter. Broadcast is never supported for reads.

Query
The query telegram specifies the starting coil and quantity of coils to be read. Coil addresses start at 0, that is, coil 33 is addressed as 32.

Example of a request to read coils 33–48 (status word) from slave device 01.

Field name	Example (hex)
Slave address	01 (frequency converter address)
Function	01 (read coils)
Starting address HI	00
Starting address LO	20 (32 decimals) coil 33
Number of points HI	00
Number of points LO	10 (16 decimals)
Error check (CRC)	–

Table 7.22 Query

Response
The coil status in the response telegram is packed as 1 coil per bit of the data field. Status is indicated as: 1=ON; 0=OFF. The lsb of the first data byte contains the coil addressed in the query. The other coils follow toward the high-order end of this byte, and from low order to high order in subsequent bytes.
If the returned coil quantity is not a multiple of 8, the remaining bits in the final data byte are padded with 0s (toward the high-order end of the byte). The byte count field specifies the number of complete bytes of data.

Field name	Example (hex)
Slave address	01 (frequency converter address)
Function	01 (read coils)
Byte count	02 (2 bytes of data)
Data (coils 40–33)	07
Data (coils 48–41)	06 (STW=0607hex)
Error check (CRC)	–

Table 7.23 Response

NOTICE

Coils and registers are addressed explicitly with an off-set of -1 in Modbus.
For example, coil 33 is addressed as coil 32.

7.10.2 Force/Write Single Coil (05 hex)

Description
This function forces the coil to either ON or OFF. When broadcast, the function forces the same coil references in all attached slaves.

Query
The query telegram specifies the coil 65 (parameter write control) to be forced. Coil addresses start at 0, that is, coil 65 is addressed as 64. Force data = 00 00 hex (OFF) or FF 00 hex (ON).

Field name	Example (hex)
Slave address	01 (Frequency converter address)
Function	05 (write single coil)
Coil address HI	00
Coil address LO	40 (64 decimal) Coil 65
Force data HI	FF
Force data LO	00 (FF 00 = ON)
Error check (CRC)	–

Table 7.24 Query

Response
The normal response is an echo of the query, returned after the coil state has been forced.

Field name	Example (hex)
Slave address	01
Function	05
Force data HI	FF
Force data LO	00
Quantity of coils HI	00
Quantity of coils LO	01
Error check (CRC)	–

Table 7.25 Response

7.10.3 Force/Write Multiple Coils (0F hex)

Description
This function forces each coil in a sequence of coils to either on or off. When broadcasting, the function forces the same coil references in all attached slaves.

Query
The query telegram specifies the coils 17–32 (speed setpoint) to be forced.

NOTICE
Coil addresses start at 0, that is, coil 17 is addressed as 16.

Field name	Example (hex)
Slave address	01 (frequency converter address)
Function	0F (write multiple coils)
Coil address HI	00
Coil address LO	10 (coil address 17)
Quantity of coils HI	00
Quantity of coils LO	10 (16 coils)
Byte count	02
Force data HI (Coils 8–1)	20
Force data LO (Coils 16–9)	00 (reference=2000 hex)
Error check (CRC)	–

Table 7.26 Query

Response
The normal response returns the slave address, function code, starting address, and quantity of coils forced.

Field name	Example (hex)
Slave address	01 (frequency converter address)
Function	0F (write multiple coils)
Coil address HI	00
Coil address LO	10 (coil address 17)
Quantity of coils HI	00
Quantity of coils LO	10 (16 coils)
Error check (CRC)	–

Table 7.27 Response

7.10.4 Read Holding Registers (03 hex)

Description
This function reads the contents of holding registers in the slave.

Query
The query telegram specifies the starting register and quantity of registers to be read. Register addresses start at 0, that is, registers 1–4 are addressed as 0–3.

Example: Read *parameter 3-03 Maximum Reference*, register 03030.

Field name	Example (hex)
Slave address	01
Function	03 (Read holding registers)
Starting address HI	0B (Register address 3029)
Starting address LO	D5 (Register address 3029)
Number of points HI	00
Number of points LO	02 – (*parameter 3-03 Maximum Reference* is 32 bits long, that is, 2 registers)
Error check (CRC)	–

Table 7.28 Query

Response
The register data in the response telegram is packed as 2 bytes per register, with the binary contents right justified within each byte. For each register, the 1st byte contains the high-order bits, and the 2nd contains the low-order bits.

Example: hex 000088B8=35.000=35 Hz.

Field name	Example (hex)
Slave address	01
Function	03
Byte count	04
Data HI (register 3030)	00
Data LO (register 3030)	16
Data HI (register 3031)	E3
Data LO (register 3031)	60
Error check (CRC)	–

Table 7.29 Response

7.10.5 Preset Single Register (06 hex)

Description

This function presets a value into a single holding register.

Query

The query telegram specifies the register reference to be preset. Register addresses start at 0, that is, register 1 is addressed as 0.

Example: Write to *parameter 1-00 Configuration Mode*, register 1000.

Field name	Example (hex)
Slave address	01
Function	06
Register address HI	03 (register address 999)
Register address LO	E7 (register address 999)
Preset data HI	00
Preset data LO	01
Error check (CRC)	–

Table 7.30 Query

Response

The normal response is an echo of the query, returned after the register contents have been passed.

Field name	Example (hex)
Slave address	01
Function	06
Register address HI	03
Register address LO	E7
Preset data HI	00
Preset data LO	01
Error check (CRC)	–

Table 7.31 Response

7.10.6 Preset Multiple Registers (10 hex)

Description

This function presets values into a sequence of holding registers.

Query

The query telegram specifies the register references to be preset. Register addresses start at 0, that is, register 1 is addressed as 0. Example of a request to preset 2 registers (set *parameter 1-24 Motor Current* to 738 (7.38 A)):

Field name	Example (hex)
Slave address	01
Function	10
Starting address HI	04
Starting address LO	07
Number of registers HI	00
Number of registers LO	02
Byte count	04
Write data HI (Register 4: 1049)	00
Write data LO (Register 4: 1049)	00
Write data HI (Register 4: 1050)	02
Write data LO (Register 4: 1050)	E2
Error check (CRC)	–

Table 7.32 Query

Response

The normal response returns the slave address, function code, starting address, and quantity of registers preset.

Field name	Example (hex)
Slave address	01
Function	10
Starting address HI	04
Starting address LO	19
Number of registers HI	00
Number of registers LO	02
Error check (CRC)	–

Table 7.33 Response

7.11 Danfoss FC Control Profile

7.11.1 Control Word According to FC Profile (8-10 Protocol = FC profile)

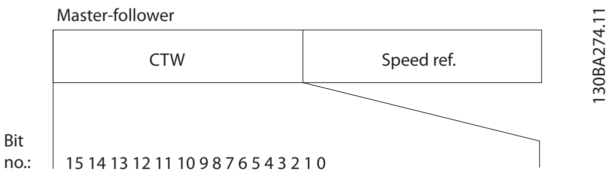

Illustration 7.14 Control Word According to FC Profile

Bit	Bit value=0	Bit value=1
00	Reference value	External selection lsb
01	Reference value	External selection msb
02	DC brake	Ramp
03	Coasting	No coasting
04	Quick stop	Ramp
05	Hold output frequency	Use ramp
06	Ramp stop	Start
07	No function	Reset
08	No function	Jog
09	Ramp 1	Ramp 2
10	Data invalid	Data valid
11	Relay 01 open	Relay 01 active
12	Relay 02 open	Relay 02 active
13	Parameter set-up	Selection lsb
15	No function	Reverse

Table 7.34 Control Word According to FC Profile

Explanation of the control bits

Bits 00/01
Bits 00 and 01 are used to select between the 4 reference values, which are pre-programmed in *parameter 3-10 Preset Reference* according to *Table 7.35*.

Programmed reference value	Parameter	Bit 01	Bit 00
1	*Parameter 3-10 Preset Reference* [0]	0	0
2	*Parameter 3-10 Preset Reference* [1]	0	1
3	*Parameter 3-10 Preset Reference* [2]	1	0
4	*Parameter 3-10 Preset Reference* [3]	1	1

Table 7.35 Control Bits

NOTICE

Make a selection in *parameter 8-56 Preset Reference Select* to define how bit 00/01 gates with the corresponding function on the digital inputs.

Bit 02, DC brake
Bit 02=0 leads to DC braking and stop. Set braking current and duration in *parameter 2-01 DC Brake Current* and *parameter 2-02 DC Braking Time*.
Bit 02=1 leads to ramping.

Bit 03, Coasting
Bit 03=0: The frequency converter immediately releases the compressor, (the output transistors are shut off) and it coasts to a standstill.
Bit 03=1: The frequency converter starts the compressor if the other starting conditions are met.

Make a selection in *parameter 8-50 Coasting Select* to define how bit 03 gates with the corresponding function on a digital input.

Bit 04, Quick stop
Bit 04=0: Makes the compressor speed ramp down to stop (set in *parameter 3-81 Quick Stop Ramp Time*).

Bit 05, Hold output frequency
Bit 05=0: The present output frequency (in Hz) freezes. Change the frozen output frequency only with the digital inputs (*parameter 5-10 Terminal 18 Digital Input* to *parameter 5-13 Terminal 29 Digital Input*) programmed to *Speed up=21* and *Slow down=22*.

NOTICE

If freeze output is active, the frequency converter can only be stopped by the following:

- **Bit 03 Coasting stop**
- **Bit 02 DC braking**
- **Digital input (*parameter 5-10 Terminal 18 Digital Input* to *parameter 5-13 Terminal 29 Digital Input*) programmed to *[5] DC braking*, *[2] Coasting stop*, or *[3] Reset and coasting stop*.**

Bit 06, Ramp stop/start
Bit 06=0: Causes a stop and makes the compressor speed ramp down to stop via the selected ramp down parameter.
Bit 06=1: Permits the frequency converter to start the compressor, if the other starting conditions are met.

Make a selection in *parameter 8-53 Start Select* to define how bit 06 Ramp stop/start gates with the corresponding function on a digital input.

Bit 07, Reset
Bit 07=0: No reset.
Bit 07=1: Resets a trip. Reset is activated on the signal's leading edge, that is, when changing from logic 0 to logic 1.

Bit 08, Jog
Bit 08=1: The output frequency is determined by *parameter 3-11 Jog Speed [Hz]*.

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Bit 09, Selection of ramp 1/2
Bit 09=0: Ramp 1 is active (*parameter 3-41 Ramp 1 Ramp Up Time* to *parameter 3-42 Ramp 1 Ramp Down Time*).
Bit 09=1: Ramp 2 (*parameter 3-51 Ramp 2 Ramp Up Time* to *parameter 3-52 Ramp 2 Ramp Down Time*) is active.

Bit 10, Data not valid/Data valid
Tell the frequency converter whether to use or ignore the control word.
Bit 10=0: The control word is ignored.
Bit 10=1: The control word is used. This function is relevant because the telegram always contains the control word, regardless of the telegram type. Turn off the control word if not wanting to use it when updating or reading parameters.

Bit 11, Relay 01
Bit 11=0: Relay not activated.
Bit 11=1: Relay 01 activated provided that *[36] Control word bit 11* is selected in *parameter 5-40 Function Relay*.

Bit 12, Relay 02
Bit 12=0: Relay 02 is not activated.
Bit 12=1: Relay 02 is activated provided that *[37] Control word bit 12* is selected in *parameter 5-40 Function Relay*.

Bit 13, Selection of set-up
Use bit 13 to select from the 2 menu set-ups according to *Table 7.36*.

Set-up	Bit 13
1	0
2	1

The function is only possible when *[9] Multi Set-Ups* is selected in *parameter 0-10 Active Set-up*.

Make a selection in *parameter 8-55 Set-up Select* to define how bit 13 gates with the corresponding function on the digital inputs.

Bit 15 Reverse
Bit 15=0: No reversing.
Bit 15=1: Reversing. In the default setting, reversing is set to digital in *parameter 8-54 Reversing Select*. Bit 15 causes reversing only when serial communication, logic, or logic and is selected.

7.11.2 Status Word According to FC Profile (STW) (*parameter 8-30 Protocol* = FC profile)

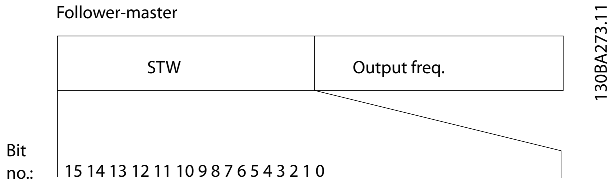

Illustration 7.15 Status Word

Bit	Bit=0	Bit=1
00	Control not ready	Control ready
01	Drive not ready	Drive ready
02	Coasting	Enable
03	No error	Trip
04	No error	Error (no trip)
05	Reserved	–
06	No error	Triplock
07	No warning	Warning
08	Speed≠reference	Speed=reference
09	Local operation	Bus control
10	Out of frequency limit	Frequency limit OK
11	No operation	In operation
12	Drive OK	Stopped, auto start
13	Voltage OK	Voltage exceeded
14	Torque OK	Torque exceeded
15	Timer OK	Timer exceeded

Table 7.36 Status Word According to FC Profile

Explanation of the status bits

Bit 00, Control not ready/ready
Bit 00=0: The frequency converter trips.
Bit 00=1: The frequency converter controls are ready but the power component does not necessarily receive any power supply (in case of external 24 V supply to controls).

Bit 01, Drive ready
Bit 01=0: The frequency converter is not ready.

Bit 01=1: The frequency converter is ready for operation, but the coasting command is active via the digital inputs or via serial communication.

Bit 02, Coasting stop
Bit 02=0: The frequency converter releases the compressor.
Bit 02=1: The frequency converter starts the compressor with a start command.

Bit 03, No error/trip
Bit 03=0: The frequency converter is not in fault mode.
Bit 03=1: The frequency converter trips. To re-establish operation, press [Reset].

Bit 04, No error/error (no trip)
Bit 04=0: The frequency converter is not in fault mode.
Bit 04=1: The frequency converter shows an error but does not trip.

Bit 05, Not used
Bit 05 is not used in the status word.

Bit 06, No error / triplock
Bit 06=0: The frequency converter is not in fault mode.
Bit 06=1: The frequency converter is tripped and locked.

Bit 07, No warning/warning
Bit 07=0: There are no warnings.
Bit 07=1: A warning has occurred.

Bit 08, Speed≠reference/speed=reference
Bit 08=0: The compressor runs but the present speed is different from the preset speed reference. It might, for example, be the case when the speed ramps up/down during start/stop.
Bit 08=1: The compressor speed matches the preset speed reference.

Bit 09, Local operation/bus control
Bit 09=0: [Off/Reset] is activate on the control unit or *[2] Local* in *parameter 3-13 Reference Site* is selected. It is not possible to control the frequency converter via serial communication.
Bit 09=1: It is possible to control the frequency converter via the fieldbus/serial communication.

Bit 10, Out of frequency limit
Bit 10=0: The output frequency has reached the value in *parameter 4-12 Motor Speed Low Limit [Hz]* or *parameter 4-14 Motor Speed High Limit [Hz]*.
Bit 10=1: The output frequency is within the defined limits.

Bit 11, No operation/in operation
Bit 11=0: The compressor does not run.
Bit 11=1: The coasting has a start signal or the output frequency is greater than 0 Hz.

Bit 12, Drive OK/stopped, autostart
Bit 12=0: There is no temporary overtemperature on the inverter.
Bit 12=1: The inverter stops because of overtemperature, but the unit does not trip and resumes operation once the overtemperature stops.

Bit 13, Voltage OK/limit exceeded
Bit 13=0: There are no voltage warnings.
Bit 13=1: The DC voltage in the frequency converter's intermediate circuit is too low or too high.

Bit 14, Torque OK/limit exceeded
Bit 14=0: The compressor current is lower than the torque limit selected in *parameter 4-18 Current Limit*.
Bit 14=1: The torque limit in *parameter 4-18 Current Limit* is exceeded.

Bit 15, Timer OK/limit exceeded
Bit 15=0: The timers for compressor thermal protection and thermal protection are not exceeded 100%.
Bit 15=1: One of the timers exceeds 100%.

7.11.3 Bus Speed Reference Value

Speed reference value is transmitted to the frequency converter in a relative value in %. The value is transmitted in the form of a 16-bit word. The integer value 16384 (4000 hex) corresponds to 100%. Negative figures are formatted using 2's complement. The actual output frequency (MAV) is scaled in the same way as the bus reference.

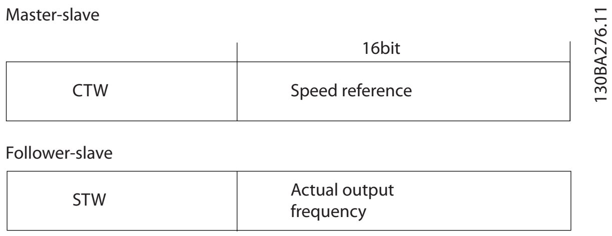

Illustration 7.16 Actual Output Frequency (MAV)

The reference and MAV are scaled as follows:

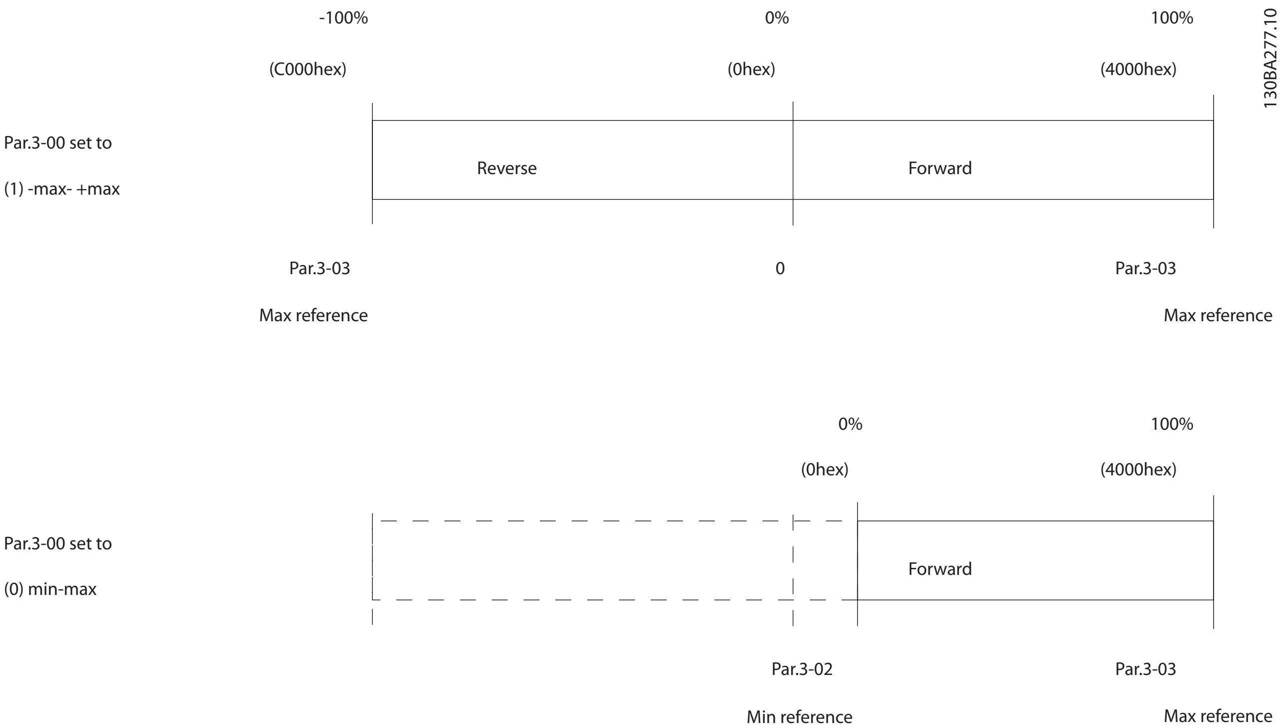

Illustration 7.17 Reference and MAV

8 General Specifications

8.1 Mains Supply Specifications

8.1.1 Mains Supply 3x200–240 V AC

Frequency converter	**4 TR/VZH028**	**5 TR/VZH035**	**6.5 TR/VZH044**
Typical shaft output [kW]	6.0	7.5	10
IP20 enclosure protection rating	H4	H4	H5
Maximum cable size in terminals (mains, compressor) [mm^2/AWG]	16/6	16/6	16/6
Output current			
Continuous (3x200–240 V) [A]	20.7	25.9	33.7
Intermittent (3x200–240 V) [A]	–	–	37.1
Maximum input current			
Continuous 3x200–240 V) [A]	23.0	28.3	37.0
Intermittent (3x200–240 V) [A]	–	–	41.5
Maximum mains fuses, see *Table 5.6*			
Estimated power loss [W], Best case/typical[1)]	182/ 204	229/ 268	369/ 386
Weight enclosure protection P20 [kg/(lb)]	7.9 (17.4)	7.9 (17.4)	9.5 (21)
Efficiency [%], best case/ typical[1)]	97.3/ 97.0	98.5/ 97.1	97.2/ 97.1

Table 8.1 3x200–240 V AC

1) At rated load conditions.

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8.1.2 Mains Supply 3x380–480 V AC

Frequency converter	**4 TR/VZH028**	**5 TR/VZH035**	**6.5 TR/VZH044**
Typical shaft output [kW]	6.0	7.5	10
IP20 enclosure protection rating	H3	H3	H4
Maximum cable size in terminals (mains, compressor) [mm^2/AWG]	4/10	4/10	16/6
Output current			
Continuous (3x380–440 V) [A]	11.6	14.3	16.4
Intermittent (3x380–440 V) [A]	–	–	18.0
Continuous (3x440–480 V) [A]	9.8	12.3	15.5
Intermittent (3x440–480 V) [A]	–	–	17.0
Maximum input current			
Continuous (3x380–440 V) [A]	12.7	15.1	18.0
Intermittent (3x380–440 V) [A]	–	–	19.8
Continuous (3x440–480 V) [A]	10.8	12.6	17.0
Intermittent (3x440–480 V) [A]	–	–	18.7
Maximum mains fuses			
Estimated power loss [W], best case/typical[1)]	104/131	159/198	248/274
Weight enclosure protection IP20 [kg/(lb)]	4.3 (9.5)	4.5 (9.9)	7.9 (17.4)
Efficiency [%], best case/typical[1)]	98.4/98.0	98.2/97.8	98.1/97.9

Table 8.2 3x380–480 V AC

1) At rated load conditions.

8.2 General Specifications

Protection and features

- Electronic thermal compressor protection against overload.
- Temperature monitoring of the heat sink ensures that the frequency converter trips if there is overtemperature.
- The frequency converter is protected against short circuits between compressor terminals U, V, W.
- When a compressor phase is missing, the frequency converter trips and issues an alarm.
- When a mains phase is missing, the frequency converter trips or issues a warning (depending on the load).
- Monitoring of the DC-link voltage ensures that the frequency converter trips, when the DC-link voltage is too low or too high.
- The frequency converter is protected against ground faults on compressor terminals U, V, W.

Mains supply (L1, L2, L3)

Supply voltage	200–240 V ±10%
Supply voltage	380–480 V ±10%
Supply frequency	50/60 Hz
Maximum imbalance temporary between mains phases	3.0% of rated supply voltage
True power factor (λ)	≥0.9 nominal at rated load
Displacement power factor (cosφ) near unity	(>0.98)
Switching on the input supply L1, L2, L3 (power-ups)	Maximum 2 times/minute
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 100000 RMS symmetrical Amperes, 240/480 V maximum.

Compressor output (U, V, W)

Output voltage	0–100% of supply voltage
Output frequency	0–200 Hz (VVC$^+$), 0–400 Hz (u/f)
Switching on output	Unlimited
Ramp times	0.05–3600 s

Cable lengths and cross-sections

Maximum compressor cable length, screened/armoured (EMC-correct installation)	See *chapter 2.7.3 EMC Test Results*
Maximum compressor cable length, unscreened/unarmoured	50 m (164 ft)
Maximum cross-section to compressor, mains[1)]	
Cross-section DC terminals for filter feedback on enclosure sizes H1–H3, I2, I3, I4	4 mm^2/11 AWG
Cross-section DC terminals for filter feedback on enclosure sizes H4–H5	16 mm^2/6 AWG
Maximum cross-section to control terminals, rigid wire	2.5 mm^2/14 AWG)
Maximum cross-section to control terminals, flexible cable	2.5 mm^2/14 AWG)
Minimum cross-section to control terminals	0.05 mm^2/30 AWG

1) See chapter 8.1.2 Mains Supply 3x380–480 V AC for more information.

Digital inputs

Programmable digital inputs	4
Terminal number	18, 19, 27, 29
Logic	PNP or NPN
Voltage level	0–24 V DC
Voltage level, logic 0 PNP	<5 V DC
Voltage level, logic 1 PNP	>10 V DC
Voltage level, logic 0 NPN	>19 V DC
Voltage level, logic 1 NPN	<14 V DC
Maximum voltage on input	28 V DC
Input resistance, R_i	Approximately 4 kΩ
Digital input 29 as thermistor input	Fault: >2.9 kΩ and no fault: <800 Ω
Digital input 29 as pulse input	Maximum frequency 32 kHz push-pull-driven & 5 kHz (O.C.)

Analog inputs

Number of analog inputs	2
Terminal number	53, 54
Terminal 53 mode	*Parameter 6-19 Terminal 53 mode*: 1=voltage, 0=current
Terminal 54 mode	*Parameter 6-29 Terminal 54 mode*: 1=voltage, 0=current
Voltage level	0–10 V
Input resistance, R_i	Approximately 10 kΩ
Maximum voltage	20 V
Current level	0/4–20 mA (scalable)
Input resistance, R_i	<500 Ω
Maximum current	29 mA
Resolution on analog input	10 bit

Analog output

Number of programmable analog outputs	2
Terminal number	42, 45[1)]
Current range at analog output	0/4–20 mA
Maximum load to common at analog output	500 Ω
Maximum voltage at analog output	17 V
Accuracy on analog output	Maximum error: 0.4% of full scale
Resolution on analog output	10 bit

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

Digital output

Number of digital outputs	4
Terminals 27 and 29	
Terminal number	27, 29[1)]
Voltage level at digital output	0–24 V
Maximum output current (sink and source)	40 mA
Terminals 42 and 45	
Terminal number	42, 45[2)]
Voltage level at digital output	17 V
Maximum output current at digital output	20 mA
Maximum load at digital output	1 kΩ

1) Terminals 27 and 29 can also be programmed as input.
2) Terminals 42 and 45 can also be programmed as analog output.
The digital outputs are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

Control card, RS485 serial communication

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

Control card, 24 V DC output

Terminal number	12
Maximum load	80 mA

Relay output

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

1) IEC 60947 parts 4 and 5.

Control card, 10 V DC output

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

Surroundings

Enclosure	IP20
Enclosure kit available	IP21, TYPE 1
Vibration test	1.0 g
Maximum relative humidity	5–95% (IEC 60721-3-3; Class 3K3 (non-condensing) during operation
Aggressive environment (IEC 60721-3-3), coated (standard)	Class 3C3
Test method according to IEC 60068-2-43 H2S (10 days)	
Ambient temperature	50 °C (122 °F)

Derating for high ambient temperature, see *chapter 8.4 Derating according to Ambient Temperature and Switching Frequency*.

Minimum ambient temperature during full-scale operation	0 °C (32 °F)
Minimum ambient temperature at reduced performance	-20 °C (-4 °F)
Temperature during storage/transport	-30 to +65/70 °C (-22 to +149/158 °F)
Maximum altitude above sea level without derating	1000 m (3280 ft)
Maximum altitude above sea level with derating	3000 m (9843 ft)
Derating for high altitude, see *chapter 8.4 Derating according to Ambient Temperature and Switching Frequency*.	
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 61000-3-12, 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

8.3 Acoustic Noise or Vibration

If the compressor or the equipment driven by the compressor - for example, a fan - is making noise or vibrations at certain frequencies, configure the following parameters or parameter groups to reduce or eliminate the noise or vibrations:

- Parameter group *4-6* Speed Bypass*.
- Set *parameter 14-03 Overmodulation* to *[0] Off*.
- Switching pattern and switching frequency parameter group *14-0* Inverter Switching*.
- *Parameter 1-64 Resonance Dampening*.

The acoustic noise from the frequency converter comes from 3 sources:

- DC intermediate circuit coils
- Integral fan
- RFI filter choke

Enclosure	Level [dBA]
H3	53.8
H4	64
H5	63.7

Table 8.3 Typical Values Measured at a Distance of 1 m from the Unit

8.4 Derating according to Ambient Temperature and Switching Frequency

The ambient temperature measured over 24 hours should be at least 5 °C (41 °F) lower than the maximum ambient temperature. If the frequency converter is operated at high ambient temperature, the constant output current should be decreased. If the ambient temperature is higher than 50 °C (122 °F) or the installation by altitude is higher than 1000 m (3281 ft), a larger CDS 803 drive might be needed to run an undersized compressor.
Consult Danfoss for support.

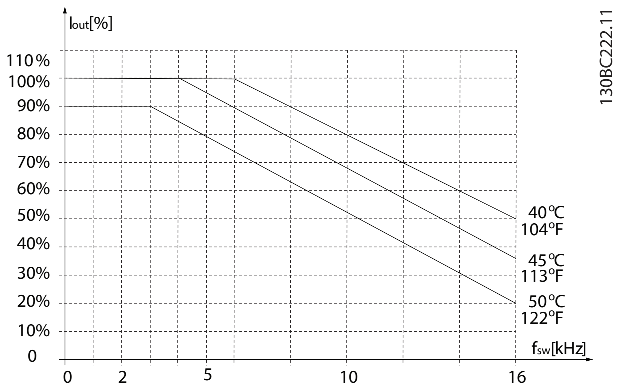

Illustration 8.1 400 V IP20 H3 6.0–7.5 kW (8-10 hp)

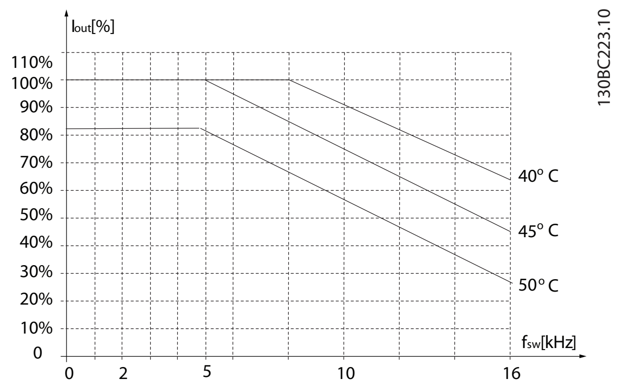

Illustration 8.2 200 V IP20 H4 6.0–7.5 kW (8-10 hp)

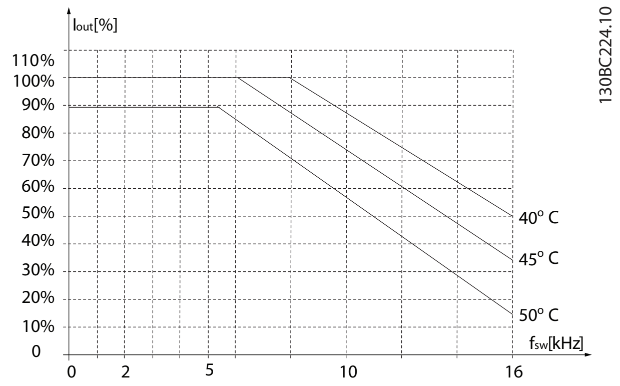

Illustration 8.3 400 V IP20 H4 10 kW (10 hp)

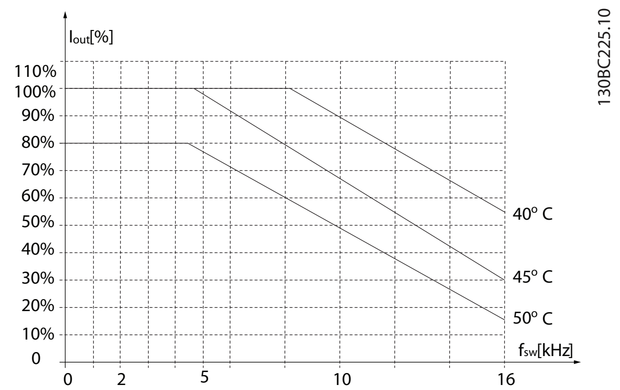

Illustration 8.4 200 V IP20 H5 10 kW (10 hp)

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