ENGINEERING TOMORROW

Operating Guide

VLT® AutomationDrive FC 301/302

0.25–75 kW

vlt-drives.danfoss.com

Contents

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1 Introduction

1.1 Purpose of the Manual

This operating guide provides information for safe installation and commissioning of the frequency converter.

The operating guide is intended for use by qualified personnel.
Read and follow the instructions to use the frequency converter safely and professionally, and pay particular attention to the safety instructions and general warnings. Always keep this operating guide available with the frequency converter.

VLT® is a registered trademark.

1.2 Additional Resources

Other resources are available to understand advanced frequency converter functions and programming.

- The *VLT® AutomationDrive FC 301/FC 302 Programming Guide* provides greater detail on working with parameters and shows many application examples.
- The *VLT® AutomationDrive FC 301/FC 302 Design Guide* provides detailed information about capabilities and functionality to design motor control systems.
- Instructions for operation with optional equipment.

Supplementary publications and manuals are available from Danfoss. See *www.danfoss.com/en/search/?filter=type%3Adocumentation%2Csegment%3Adds* for listings.

1.3 Manual and Software Version

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

Edition	Remarks	Software version
MG33ATxx	Error correction. Changing minimum cable cross-section to 10 mm^2 (7 AWG)	8.1x, 48.20 (IMC)

Table 1.1 Manual and Software Version

1.4 Product Overview

1.4.1 Intended Use

The frequency converter is an electronic motor controller intended for:

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

The frequency converter can also be used for motor overload protection.

Depending on the configuration, the frequency converter can be used in standalone applications or form part of a larger appliance or installation.

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

NOTICE

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

Foreseeable misuse
Do not use the frequency converter in applications which are non-compliant with specified operating conditions and environments. Ensure compliance with the conditions specified in *chapter 8 Specifications*.

NOTICE

The output frequency of the frequency converter is limited to 590 Hz.
For demands exceeding 590 Hz, contact Danfoss.

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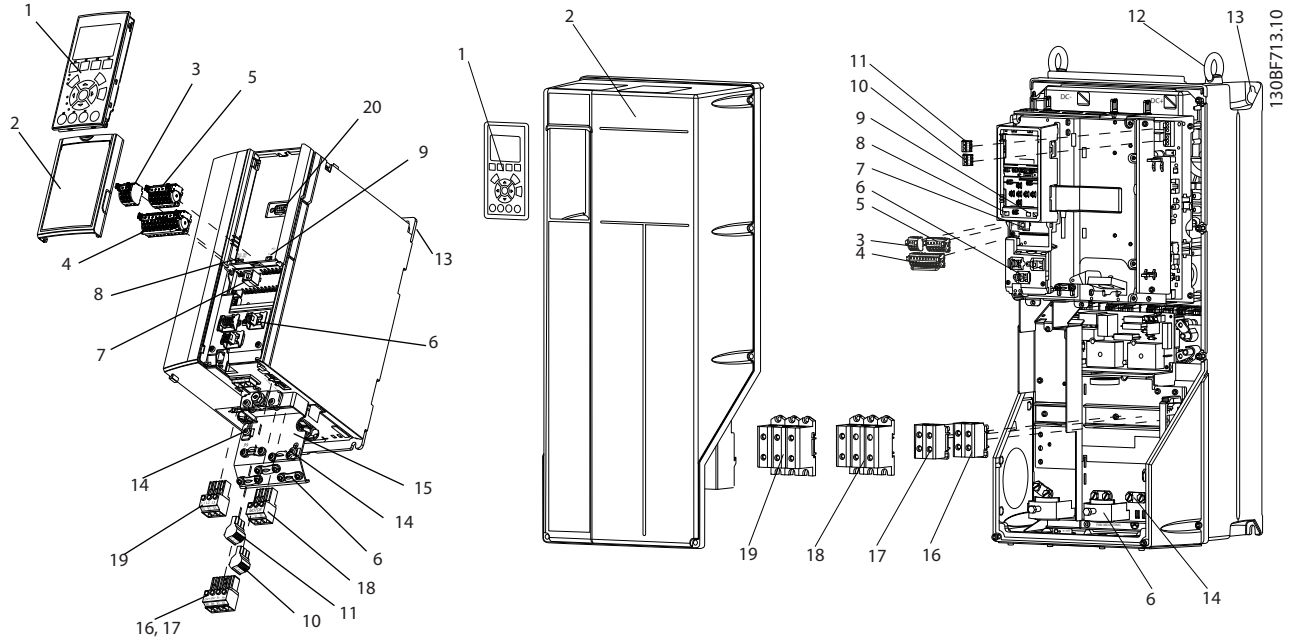
1

1.4.2 Exploded Views



1	Local control panel (LCP)	11	Relay 2 (04, 05, 06)
2	Cover	12	Lifting ring
3	RS485 fieldbus connector	13	Mounting slot
4	Digital input/output connector	14	Ground connection (PE)
5	Digital input/output connector	15	Cable shield connector
6	Shielded cable grounding and relief	16	Brake terminal (-81, +82)
7	USB connector	17	Load sharing terminal (-88, +89)
8	RS485 termination switch	18	Motor terminals 96 (U), 97 (V), 98 (W)
9	DIP switch for A53 and A54	19	Mains input terminals 91 (L1), 92 (L2), 93 (L3)
10	Relay 1 (01, 02, 03)	20	LCP connector

Illustration 1.1 Exploded View Enclosure Size A, IP20 (left), and Enclosure Size C, IP55/IP66 (right)

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1.5 Type Approvals and Certifications

The following list is a selection of possible type approvals and certifications for Danfoss frequency converters:

NOTICE

The specific approvals and certification for the frequency converter are on the nameplate of the frequency converter. For more information, contact the local Danfoss office or partner.

For more information on UL 508C thermal memory retention requirements, refer to the section *Motor Thermal Protection* in the product-specific *design guide*.

For more information on compliance with the European Agreement concerning International Carriage of Dangerous Goods by Inland Waterways (ADN), refer to the section *ADN-compliant Installation* in the product-specific *design guide*.

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2 Safety

2

2.1 Safety Symbols

The following symbols are used in this guide:

⚠WARNING

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

⚠CAUTION

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

NOTICE

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

2.2 Qualified Personnel

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

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

2.3 Safety Precautions

⚠WARNING

HIGH VOLTAGE

Frequency converters contain high voltage when connected to AC mains input, DC supply, or load sharing. Failure to perform installation, start-up, and maintenance by qualified personnel can result in death or serious injury.

- **Only qualified personnel must perform installation, start-up, and maintenance.**
- **Before performing any service or repair work, use an appropriate voltage measuring device to make sure that there is no remaining voltage on the frequency converter.**

⚠WARNING

UNINTENDED START

When the frequency converter is connected to AC mains, DC supply, or load sharing, the motor may start at any time. Unintended start during programming, service, or repair work can result in death, serious injury, or property damage. The motor can start via an external switch, a fieldbus command, an input reference signal from the LCP, or after a cleared fault condition.

To prevent unintended motor start:

- **Disconnect the frequency converter from the mains.**
- **Press [Off/Reset] on the LCP before programming parameters.**
- **Completely wire and assemble the frequency converter, motor, and any driven equipment before connecting the frequency converter to AC mains, DC supply, or load sharing.**

⚠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 waiting time is specified in *Table 2.1* and is also visible on the product label on top of the frequency converter.**
- **Before performing any service or repair work, use an appropriate voltage measuring device to make sure that the capacitors are fully discharged.**

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Voltage [V]	Minimum waiting time (minutes)		
	4	7	15
200–240	0.25–3.7 kW (0.34–5 hp)	–	5.5–37 kW (7.5–50 hp)
380–500	0.25–7.5 kW (0.34–10 hp)	–	11–75 kW (15–100 hp)
525–600	0.75–7.5 kW (1–10 hp)	–	11–75 kW (15–100 hp)
525–690	–	1.5–7.5 kW (2–10 hp)	11–75 kW (15–100 hp)

Table 2.1 Discharge Time

⚠WARNING

LEAKAGE CURRENT HAZARD

Leakage currents exceed 3.5 mA. Failure to ground the frequency converter properly can result in death or serious injury.

- **Ensure the correct grounding of the equipment by a certified electrical installer.**

⚠WARNING

EQUIPMENT HAZARD

Contact with rotating shafts and electrical equipment can result in death or serious injury.

- **Ensure that only trained and qualified personnel perform installation, start-up, and maintenance.**
- **Ensure that electrical work conforms to national and local electrical codes.**
- **Follow the procedures in this guide.**

⚠WARNING

UNINTENDED MOTOR ROTATION WINDMILLING

Unintended rotation of permanent magnet motors creates voltage and can charge the unit, resulting in death, serious injury, or equipment damage.

- **Ensure that permanent magnet motors are blocked to prevent unintended rotation.**

⚠CAUTION

INTERNAL FAILURE HAZARD

An internal failure in the frequency converter can result in serious injury when the frequency converter is not properly closed.

- **Ensure that all safety covers are in place and securely fastened before applying power.**

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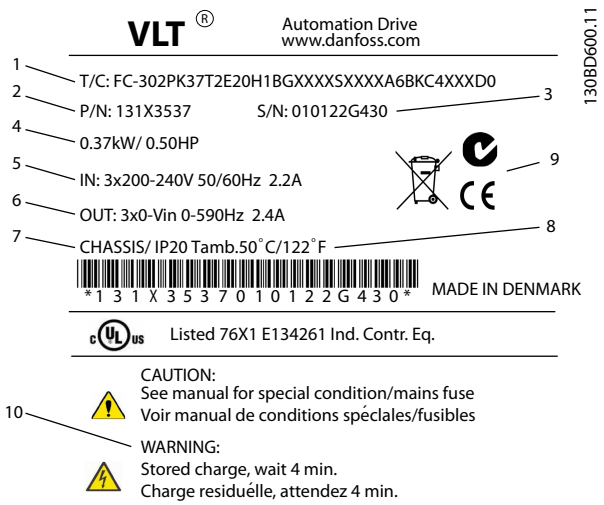
3 Mechanical Installation

3.1 Unpacking

3.1.1 Items Supplied

Items supplied vary according to product configuration.

- Make sure that the items supplied and the information on the nameplate correspond to the order confirmation.
- Check the packaging and the frequency converter visually for damage caused by inappropriate handling during shipment. File any claim for damage with the carrier. Retain damaged parts for clarification.



1	Type code
2	Code number
3	Serial number
4	Power rating
5	Input voltage, frequency, and current (at low/high voltages)
6	Output voltage, frequency, and current (at low/high voltages)
7	Enclosure size and IP rating
8	Maximum ambient temperature
9	Certifications
10	Discharge time (Warning)

Illustration 3.1 Product Nameplate (Example)

NOTICE

Do not remove the nameplate from the frequency converter (loss of warranty).

Ensure that the requirements for storage are fulfilled. Refer to *chapter 8.4 Ambient Conditions* for further details.

3.2 Installation Environments

NOTICE

In environments with airborne liquids, particles, or corrosive gases, ensure that the IP/type rating of the equipment matches the installation environment. Failure to meet requirements for ambient conditions can reduce the lifetime of the frequency converter. Ensure that requirements for air humidity, temperature, and altitude are met.

Vibration and shock

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

For detailed ambient conditions specifications, refer to *chapter 8.4 Ambient Conditions*.

3.3 Mounting

NOTICE

Improper mounting can result in overheating and reduced performance.

Cooling

- Ensure that top and bottom clearance for air cooling is provided. See *Illustration 3.2* for clearance requirements.

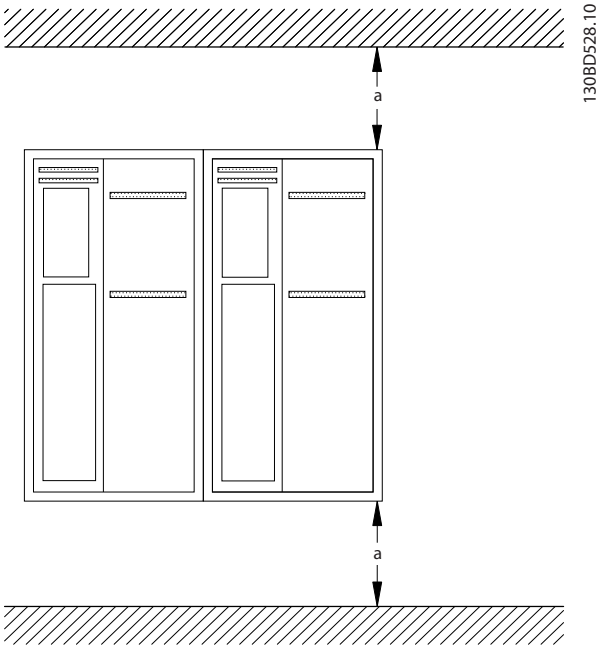


Illustration 3.2 Top and Bottom Cooling Clearance

Enclosure	A1–A5	B1–B4	C1, C3	C2, C4
a [mm (in)]	100 (3.9)	200 (7.8)	200 (7.8)	225 (8.9)

Table 3.1 Minimum Airflow Clearance Requirements

Lifting

- Ensure that the lifting device is suitable for the task.
- If necessary, plan for a hoist, crane, or forklift with the appropriate rating to move the unit.
- For lifting, use hoist rings on the unit, when provided.

⚠WARNING

HEAVY LOAD

Unbalanced loads can fall and loads can tip over. Failure to take proper lifting precautions increases risk of death, serious injury, or equipment damage.

- **Never walk under suspended loads.**
- **To guard against injury, wear personal protective equipment such as gloves, safety glasses, and safety shoes.**
- **Be sure to use lifting devices with the appropriate weight rating. To determine a safe lifting method, check the weight of the unit, see *chapter 8.9 Power Ratings, Weight, and Dimensions*.**
- **The angle from the top of the drive module to the lifting cables has an impact on the maximum load force on the cable. This angle must be 65° or greater. Attach and dimension the lifting cables properly.**

Mounting

1. Ensure that the strength of the mounting location supports the unit weight. The frequency converter allows side-by-side installation.
2. Locate the unit as near to the motor as possible. Keep the motor cables as short as possible.
3. Mount the unit vertically to a solid flat surface or to the optional backplate to provide cooling airflow.
4. Use the slotted mounting holes on the unit for wall mount, when provided.

Mounting with mounting plate and railings

A mounting plate is required when mounted on railings.

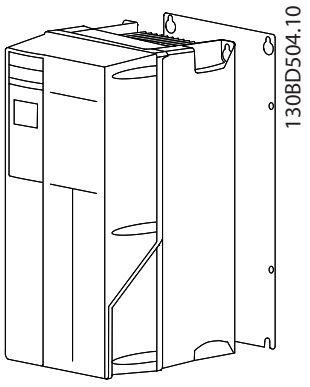


Illustration 3.3 Proper Mounting with Mounting Plate

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4 Electrical Installation

4.1 Safety Instructions

See *chapter 2 Safety* for general safety instructions.

4

⚠WARNING

INDUCED VOLTAGE

Induced voltage from output motor cables that run together can charge equipment capacitors, even with the equipment turned off and locked out. Failure to run output motor cables separately or to use shielded cables could result in death or serious injury.

- **Run output motor cables separately, or**
- **Use shielded cables.**

⚠CAUTION

SHOCK HAZARD

The frequency converter can cause a DC current in the PE conductor. Failure to follow the recommendation may lead to the RCD not providing the intended protection.

- **When a residual current-operated protective device (RCD) is used for protection against electrical shock, only an RCD of Type B is allowed on the supply side.**

Overcurrent protection

- Extra protective equipment, such as short-circuit protection or motor thermal protection between frequency converter and motor, is required for applications with multiple motors.
- Input fusing is required to provide short-circuit and overcurrent protection. If not factory-supplied, the installer must provide fuses. See maximum fuse ratings in *chapter 8.7 Fuses and Circuit Breakers*.

Wire type and ratings

- All wiring must comply with local and national regulations regarding cross-section and ambient temperature requirements.
- Power connection wire recommendation: Minimum 75 °C (167 °F) rated copper wire.

See *chapter 8.1 Electrical Data* and *chapter 8.5 Cable Specifications* for recommended wire sizes and types.

4.2 EMC-compliant Installation

To obtain an EMC-compliant installation, follow the instructions provided in *chapter 4.3 Grounding*, *chapter 4.4 Wiring Schematic*, *chapter 4.5 Motor Connection*, and *chapter 4.7 Control Wiring*.

4.3 Grounding

⚠WARNING

LEAKAGE CURRENT HAZARD

Leakage currents exceed 3.5 mA. Failure to ground the frequency converter properly could result in death or serious injury.

- **Ensure the correct grounding of the equipment by a certified electrical installer.**

For electrical safety

- Ground the frequency converter in accordance with applicable standards and directives.
- Use a dedicated ground wire for input power, motor power, and control wiring.
- Do not ground 1 frequency converter to another in a daisy-chain fashion (see *Illustration 4.1*).
- Keep the ground wire connections as short as possible.
- Follow motor manufacturer wiring requirements.
- Minimum cable cross-section for the ground wires: 10 mm^2 (7 AWG).
- Separately terminate individual ground wires, both complying with the dimension requirements.

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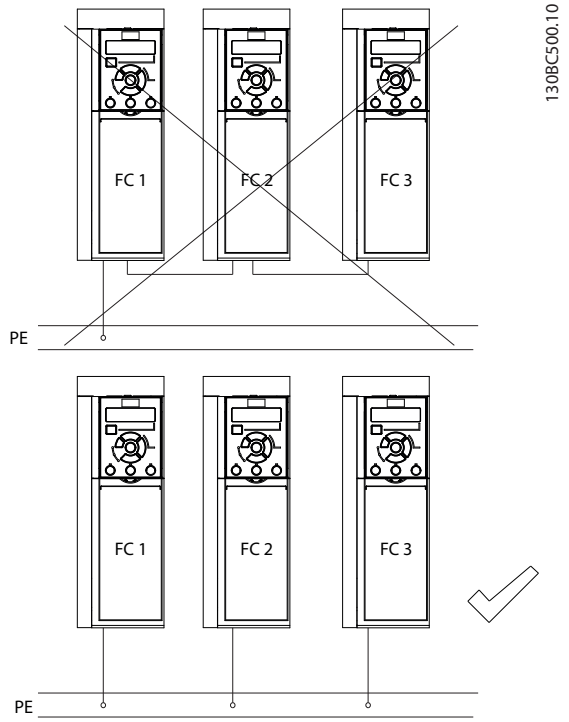

Illustration 4.1 Grounding Principle

For EMC-compliant installation

- Establish electrical contact between the cable shield and the frequency converter enclosure by using metal cable glands or by using the clamps provided on the equipment (see *chapter 4.5 Motor Connection*).
- Use high-strand wire to reduce burst transient.
- Do not use pigtails.

NOTICE

POTENTIAL EQUALIZATION

Risk of burst transient when the ground potential between the frequency converter and the control system is different. Install equalizing cables between the system components. Recommended cable cross-section: 16 mm² (6 AWG).

4.4 Wiring Schematic

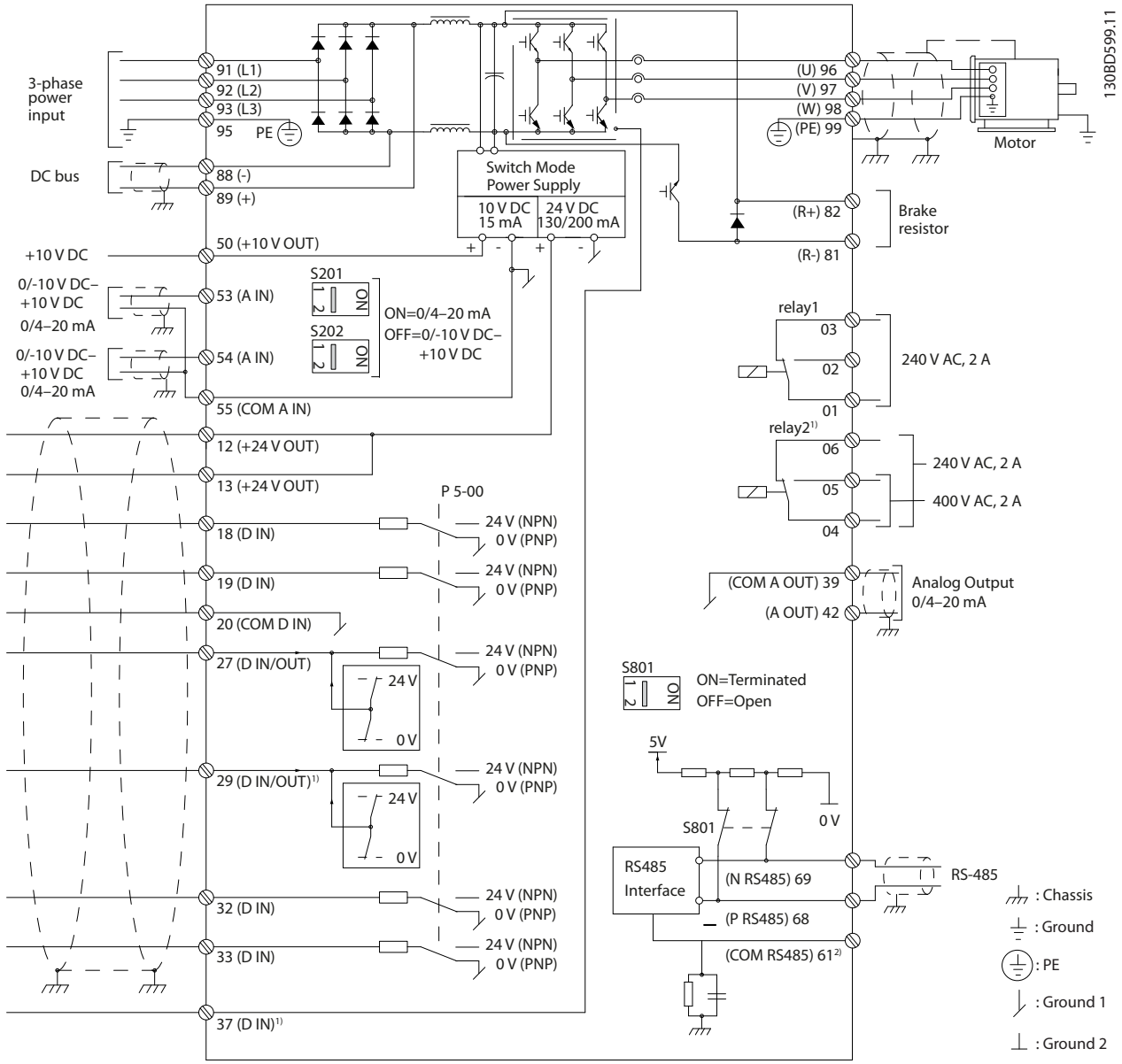

Illustration 4.2 Basic Wiring Schematic

A=Analog, D=Digital

1) Terminal 37 (optional) is used for Safe Torque Off (STO). For installation instructions, refer to the *VLT® Safe Torque Off Operating Guide*. For FC 301, terminal 37 is only included in enclosure size A1. Relay 2 and terminal 29 have no function in FC 301.

2) Do not connect cable shield.

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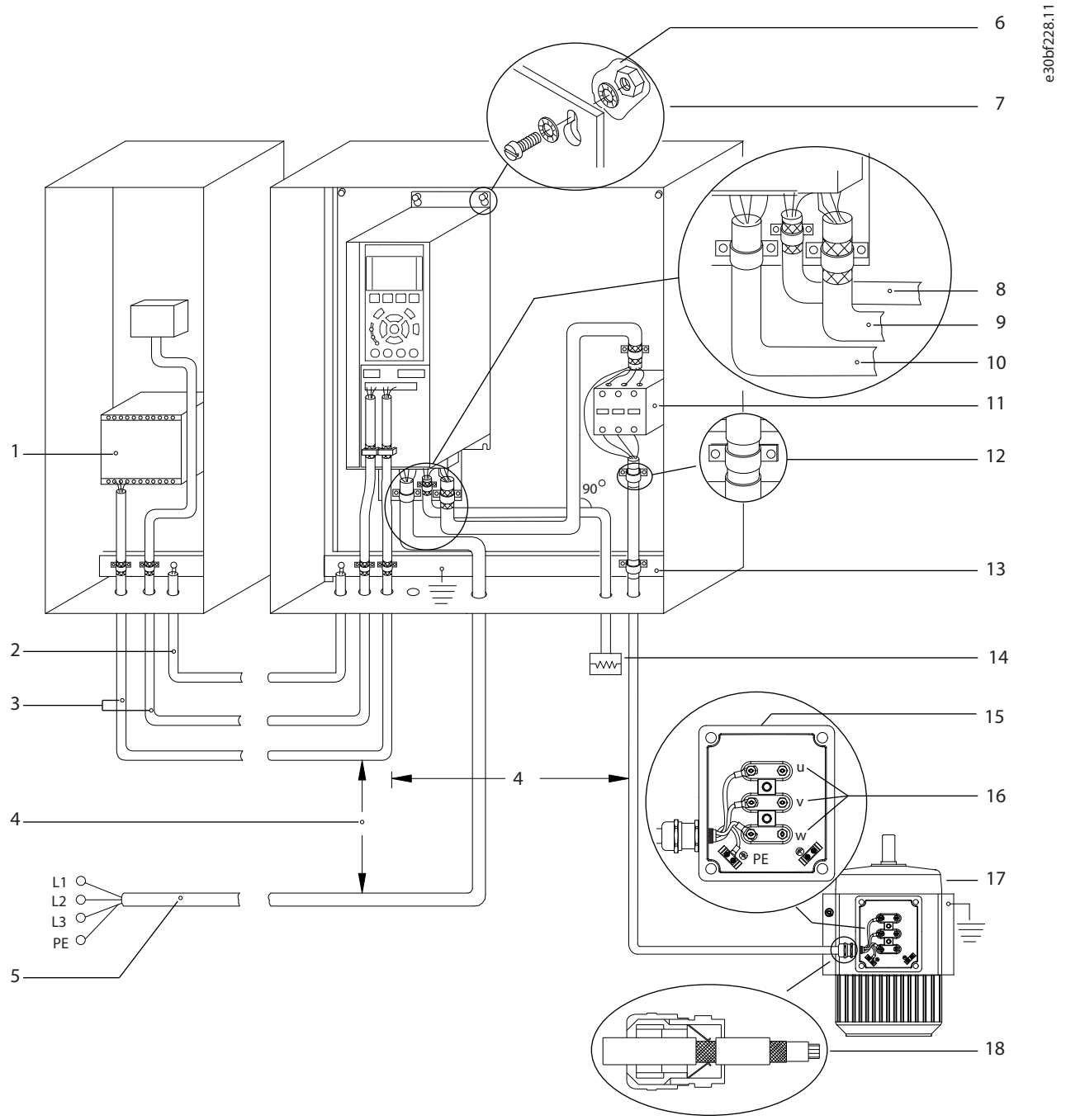

1	PLC.	10	Mains cable (unshielded).
2	Minimum 16 mm^2 (6 AWG) equalizing cable.	11	Output contactor.
3	Control cables.	12	Cable insulation stripped.
4	Minimum 200 mm (7.9 in) between control cables, motor cables, and mains cables.	13	Common ground busbar. Follow local and national requirements for cabinet grounding.
5	Mains supply.	14	Brake resistor.
6	Bare (unpainted) surface.	15	Metal box.
7	Star washers.	16	Connection to motor.
8	Brake cable (shielded).	17	Motor.
9	Motor cable (shielded).	18	EMC cable gland.

Illustration 4.3 Example of Proper EMC Installation

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For more information about EMC, see *chapter 4.2 EMC-compliant Installation*

NOTICE

EMC INTERFERENCE

Use shielded cables for motor and control wiring, and separate cables for input power, motor wiring, and control wiring. Failure to isolate power, motor, and control cables can result in unintended behavior or reduced performance. Minimum 200 mm (7.9 in) clearance is required between power, motor, and control cables.

4

4.5 Motor Connection

⚠WARNING

INDUCED VOLTAGE

Induced voltage from output motor cables that run together can charge equipment capacitors, even with the equipment turned off and locked out. Failure to run output motor cables separately or use shielded cables could result in death or serious injury.

- Run output motor cables separately, or
- Use shielded cables.
- Comply with local and national electrical codes for cable sizes. For maximum wire sizes, see *chapter 8.1 Electrical Data*.
- Follow motor manufacturer wiring requirements.
- Motor wiring knockouts or access panels are provided at the base of IP21 (NEMA1/12) and higher units.
- Do not wire a starting or pole-changing device (for example Dahlander motor or slip ring asynchronous motor) between the frequency converter and the motor.

Procedure for grounding the cable shield

1. Strip a section of the outer cable insulation.
2. Position the stripped wire under the cable clamp to establish mechanical fixation and electrical contact between the cable shield and ground.
3. Connect the ground wire to the nearest grounding terminal in accordance with the grounding instructions provided in *chapter 4.3 Grounding*, see *Illustration 4.4*.
4. Connect the 3-phase motor wiring to terminals 96 (U), 97 (V), and 98 (W), see *Illustration 4.4*.
5. Tighten the terminals in accordance with the information provided in *chapter 8.8 Connection Tightening Torques*.

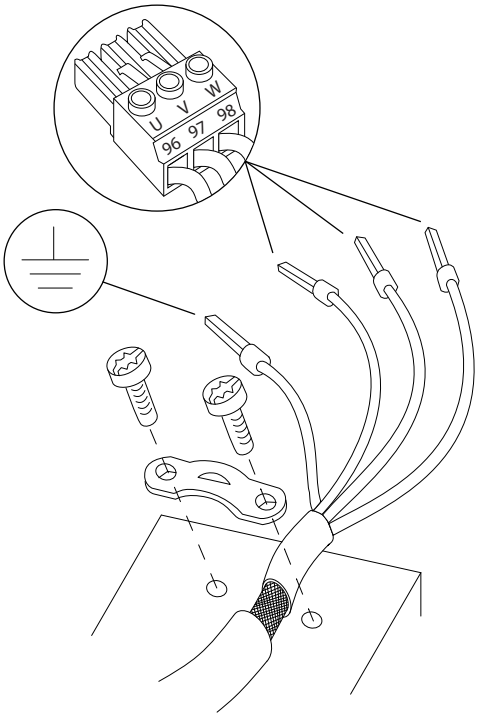

Illustration 4.4 Motor Connection

Illustration 4.5 shows mains input, motor, and grounding for basic frequency converters. Actual configurations vary with unit types and optional equipment.

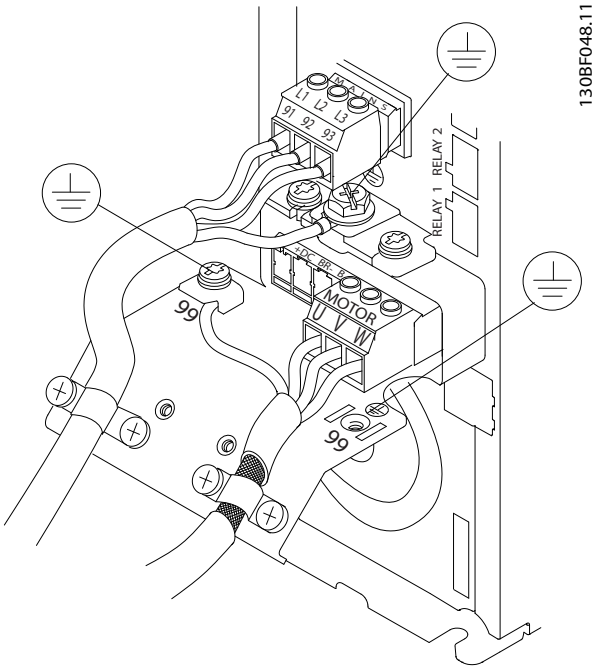

Illustration 4.5 Example of Motor, Mains, and Ground Wiring

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4.6 AC Mains Connection

- Size the wiring based on the input current of the frequency converter. For maximum wire sizes, see *chapter 8.1 Electrical Data*.
- Comply with local and national electrical codes for cable sizes.

Procedure

1. Connect the 3-phase AC input power wiring to terminals L1, L2, and L3 (see *Illustration 4.5*).
2. Depending on the configuration of the equipment, connect the input power to the mains input terminals or the input disconnect.
3. Ground the cable in accordance with the grounding instructions provided in *chapter 4.3 Grounding*.
4. When supplied from an isolated mains source (IT mains or floating delta) or TT/TN-S mains with a grounded leg (grounded delta), ensure that *parameter 14-50 RFI Filter* is set to *[0] Off*. This setting prevents damage to the DC link and reduces ground capacity currents in accordance with IEC 61800-3.

4.7 Control Wiring

- Isolate the control wiring from the high-power components in the frequency converter.
- When the frequency converter is connected to a thermistor, ensure that the thermistor control wiring is shielded and reinforced/double insulated. A 24 V DC supply voltage is recommended.

4.7.1 Safe Torque Off (STO)

To run STO, more wiring for the frequency converter is required. Refer to *VLT® Frequency Converters Safe Torque Off Operating Guide* for further information.

4.7.2 Mechanical Brake Control

In hoisting/lowering applications, it is necessary to control an electro-mechanical brake.

- Control the brake using any relay output or digital output (terminal 27 or 29).
- Keep the output closed (voltage-free) as long as the frequency converter is unable to keep the motor at standstill, for example due to the load being too heavy.
- Select *[32] Mechanical brake control* in *parameter group 5-4* Relays* for applications with an electro-mechanical brake.
- The brake is released when the motor current exceeds the value in *parameter 2-20 Release Brake Current*.
- The brake is engaged when the output frequency is less than the frequency set in *parameter 2-21 Activate Brake Speed [RPM]* or *parameter 2-22 Activate Brake Speed [Hz]*, and only if the frequency converter carries out a stop command.

If the frequency converter is in alarm mode or in an overvoltage situation, the mechanical brake immediately closes.

NOTICE

The frequency converter is not a safety device. It is the responsibility of the system designer to integrate safety devices according to relevant national crane/lift regulations.

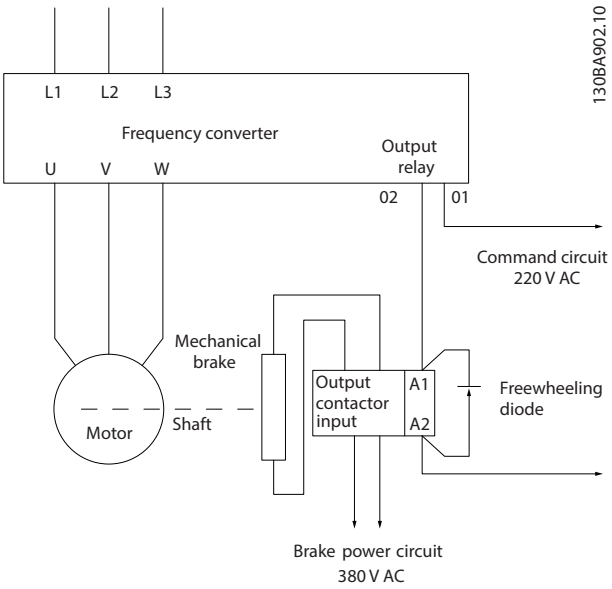

Illustration 4.6 Connecting the Mechanical Brake to the Frequency Converter

4.8 Installation Check List

Before completing installation of the unit, inspect the entire installation as detailed in *Table 4.1*. Check and mark the items when completed.

Inspect for	Description	☑
Auxiliary equipment	• Look for auxiliary equipment, switches, disconnects, or input fuses/circuit breakers, residing on the input power side of the frequency converter, or output side to the motor. Ensure that they are ready for full-speed operation. • Check the function and installation of any sensors used for feedback to the frequency converter. • Remove any power factor correction caps on the motor. • Adjust any power factor correction caps on the mains side and ensure that they are dampened.	
Cable routing	• Ensure that the motor wiring and control wiring are separated, shielded, or in 3 separate metallic conduits for high frequency interference isolation.	
Control wiring	• Check for broken or damaged wires and loose connections. • Check that the control wiring is isolated from power and motor wiring for noise immunity. • Check the voltage source of the signals, if necessary. The use of shielded cable or twisted pair is recommended. Ensure that the shield is terminated correctly.	
Cooling clearance	• Ensure that the top and bottom clearance is adequate to ensure proper airflow for cooling, see *chapter 3.3.1 Mounting*.	
Ambient conditions	• Check that requirements for ambient conditions are met.	
Fusing and circuit breakers	• Check for proper fusing or circuit breakers. • Check that all fuses are inserted firmly and are in operational condition, and that all circuit breakers are in the open position.	
Grounding	• Check for sufficient ground connections and ensure that those connections are tight and free of oxidation. • Grounding to conduit, or mounting the back panel to a metal surface, is not a suitable grounding.	
Input and output power wiring	• Check for loose connections. • Check that the motor and mains cables are in separate conduit or separated shielded cables.	
Panel interior	• Inspect that the unit interior is free of dirt, metal chips, moisture, and corrosion. • Check that the unit is mounted on an unpainted metal surface.	
Switches	• Ensure that all switch and disconnect settings are in the proper positions.	
Vibration	• Check that the unit is mounted solidly, or that shock mounts are used, as necessary. • Check for an unusual amount of vibration.	

Table 4.1 Installation Check List

⚠CAUTION

POTENTIAL HAZARD IN THE EVENT OF INTERNAL FAILURE

Risk of personal injury if the frequency converter is not properly closed.

- **Before applying power, ensure that all safety covers are in place and securely fastened.**

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5 Commissioning

5.1 Safety Instructions

See *chapter 2 Safety* for general safety instructions.

⚠WARNING

HIGH VOLTAGE

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

- **Installation, start-up, and maintenance must be performed by qualified personnel only.**

NOTICE

The front covers with warning signs are an integrated part of the frequency converter and considered safety covers. The covers must be in place before applying power and at all times.

Before applying power:

1. Close the safety cover properly.
2. Check that all cable glands are firmly tightened.
3. Ensure that input power to the unit is off and locked out. Do not rely on the frequency converter disconnect switches for input power isolation.
4. Verify that there is no voltage on input terminals L1 (91), L2 (92), and L3 (93), phase-to-phase, and phase-to-ground.
5. Verify that there is no voltage on output terminals 96 (U), 97 (V), and 98 (W), phase-to-phase, and phase-to-ground.
6. Confirm continuity of the motor by measuring Ω values on U–V (96–97), V–W (97–98), and W–U (98–96).
7. Check for proper grounding of the frequency converter and the motor.
8. Inspect the frequency converter for loose connections on the terminals.
9. Confirm that the supply voltage matches the voltage of the frequency converter and the motor.

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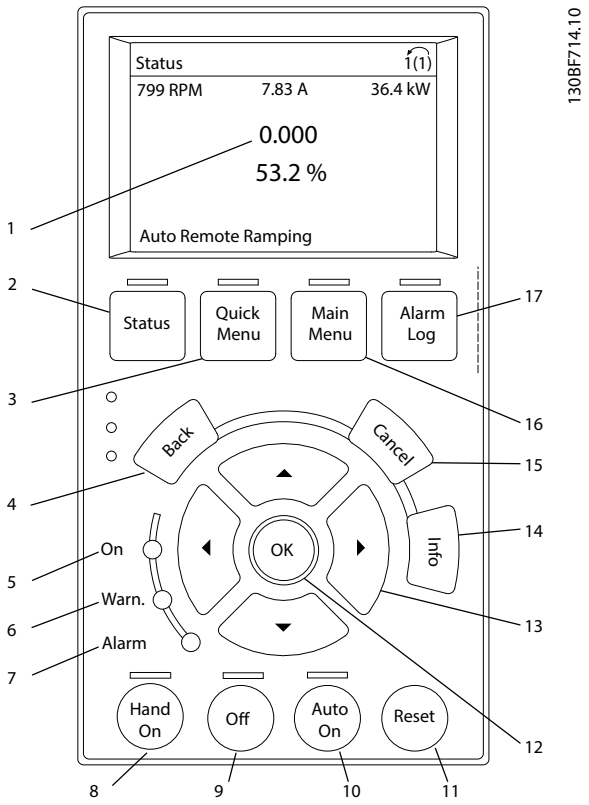
5.2 Local Control Panel Operation



	Key	Function
1		The information shown in the display area depends on the selected function or menu (in this case *Quick Menu Q3-13 Display Settings*).
2	Status	Shows operational information.
3	Quick Menu	Allows access to programming parameters for initial set-up instructions and many detailed application instructions.
4	Back	Reverts to the previous step or list in the menu structure.
5	Green indicator light.	Power on.
6	Yellow indicator light.	The indicator light comes on when a warning is active. A text appears in the display area identifying the problem.
7	Red indicator light.	A fault condition causes the indicator light to flash, and an alarm text is shown.
8	[Hand On]	Puts the frequency converter in local control mode, so that it responds to the LCP. • An external stop signal by control input or serial communication overrides the local [Hand On].
9	Off	Stops the motor but does not remove power to the frequency converter.
10	[Auto On]	Puts the system in remote operational mode. • Responds to an external start command by control terminals or serial communication.
11	Reset	Resets the frequency converter manually after a fault has been cleared.
12	OK	Press to access parameter groups or to enable a selection.
13	Navigation Keys	Press the navigation keys to move between items in the menu.
14	Info	Press for a definition of the function being shown.
15	Cancel	Cancels the last change or command as long as the display mode is not changed.
16	Main Menu	Allows access to all programming parameters.
17	Alarm Log	Shows a list of current warnings, the last 10 alarms, and the maintenance log.

Illustration 5.1 Graphic Local Control Panel (GLCP)

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5.3 System Set-up

1. Perform automatic motor adaption (AMA):
   - 1a Set the following basic motor parameters as shown in *Table 5.1* before performing AMA.
   - 1b Optimize the compatibility between motor and frequency converter via *parameter 1-29 Automatic Motor Adaptation (AMA)*.
2. Check motor rotation.
3. If encoder feedback is used, perform the following steps:
   - 3a Select *[0] Speed open loop* in *parameter 1-00 Configuration Mode*.
   - 3b Select *[1] 24V encoder* in *parameter 7-00 Speed PID Feedback Source*.
   - 3c Press [Hand On].
   - 3d Press [►] for positive speed reference (*parameter 1-06 Clockwise Direction* at *[0] Normal*).
   - 3e In *parameter 16-57 Feedback [RPM]*, check that the feedback is positive.

	Parameter 1-10 Motor Construction		
	ASM	**PM**	**SynRM**
Parameter 1-20 Motor Power [kW] *Parameter 1-21 Motor Power [HP]*	X		
Parameter 1-22 Motor Voltage	X		
Parameter 1-23 Motor Frequency	X		X
Parameter 1-24 Motor Current	X	X	X
Parameter 1-25 Motor Nominal Speed	X	X	X
Parameter 1-26 Motor Cont. Rated Torque		X	X
Parameter 1-39 Motor Poles		X	

Table 5.1 Basic Parameters to be checked before AMA

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6 Basic I/O Configuration

The examples in this section are intended as a quick reference for common applications.

- Parameter settings are the regional default values unless otherwise indicated (selected in *parameter 0-03 Regional Settings*).
- Parameters associated with the terminals and their settings are shown next to the drawings.
- Required switch settings for analog terminals A53 or A54 are also shown.

6

NOTICE

When using the optional Safe Torque Off (STO) feature, a jumper wire may be required between terminal 12 (or 13) and terminal 37 for the frequency converter to operate with factory default programming values.

6.1 Application Examples

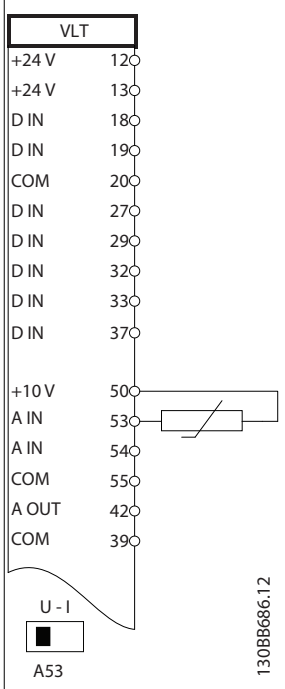
6.1.1 Motor Thermistor

⚠CAUTION

THERMISTOR INSULATION

Risk of personal injury or equipment damage.

- **Use only thermistors with reinforced or double insulation to meet PELV insulation requirements.**



	Parameters	
	Function	**Setting**
	Parameter 1-90 Motor Thermal Protection	*[2] Thermistor trip*
	Parameter 1-93 Thermistor Source	*[1] Analog input 53*
	* = Default value	
	Notes/comments: If only a warning is required, set *parameter 1-90 Motor Thermal Protection* to *[1] Thermistor warning*. D IN 37 is an option.	

Table 6.1 Motor Thermistor

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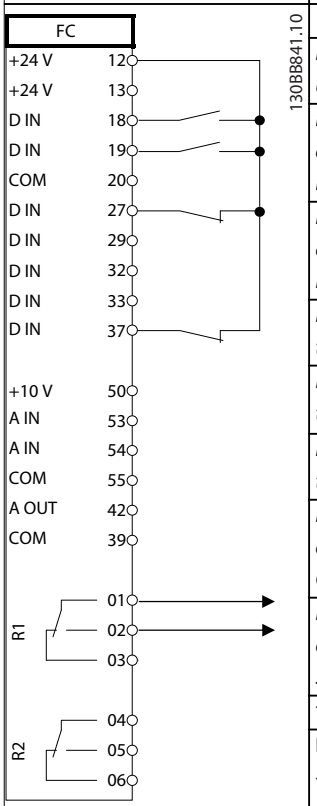
6.1.2 Mechanical Brake Control



Parameters	
Function	**Setting**
Parameter 5-40 Function Relay	*[32] Mech. brake ctrl.*
Parameter 5-10 Terminal 18 Digital Input	*[8] Start**
Parameter 5-11 Terminal 19 Digital Input	*[11] Start reversing*
Parameter 1-71 Start Delay	0.2
Parameter 1-72 Start Function	*[5] VVC+/FLUX Clockwise*
Parameter 1-76 Start Current	$I_{m,n}$
Parameter 2-20 Release Brake Current	Application dependent
Parameter 2-21 Activate Brake Speed [RPM]	Half of nominal slip of the motor
*=Default Value	
Notes/comments: –	

Table 6.2 Mechanical Brake Control

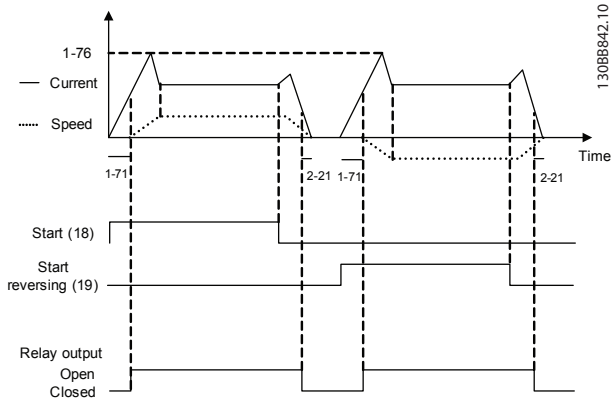


Illustration 6.1 Mechanical Brake Control

7 Maintenance, Diagnostics, and Troubleshooting

7.1 Maintenance and Service

Under normal operating conditions and load profiles, the frequency converter is maintenance-free throughout its designed lifetime. To prevent breakdown, danger, and damage, examine the frequency converter for terminal connections tightness, dust entry, and so on at regular intervals depending on the operating conditions. Replace worn or damaged parts with original spare parts or standard parts. For service and support, contact the local Danfoss supplier.

⚠WARNING

UNINTENDED START

When the frequency converter is connected to AC mains, DC supply, or load sharing, the motor may start at any time. Unintended start during programming, service, or repair work can result in death, serious injury, or property damage. The motor can start via an external switch, a fieldbus command, an input reference signal from the LCP, or after a cleared fault condition.

To prevent unintended motor start:

- **Disconnect the frequency converter from the mains.**
- **Press [Off/Reset] on the LCP before programming parameters.**
- **Completely wire and assemble the frequency converter, motor, and any driven equipment before connecting the frequency converter to AC mains, DC supply, or load sharing.**

7.2 Warning and Alarm Types

Warnings

A warning is issued when an alarm condition is impending, or when an abnormal operating condition is present and may result in the frequency converter issuing an alarm. A warning clears by itself when the abnormal condition ceases.

Alarms

An alarm indicates a fault that requires immediate attention. The fault always triggers a trip or a trip lock. Reset the system after an alarm.

Trip

An alarm is issued when the frequency converter is tripped, meaning that the frequency converter suspends operation to prevent frequency converter or system damage. The motor coasts to a stop. The frequency converter logic continues to operate and monitor the frequency converter status. After the fault condition is remedied, the frequency converter can be reset. It is then ready to start operation again.

Resetting the frequency converter after trip/trip lock

A trip can be reset in any of 4 ways:

- Press [Reset] on the LCP.
- Digital reset input command.
- Serial communication reset input command.
- Auto reset.

Trip lock

Input power is cycled. The motor coasts to a stop. The frequency converter continues to monitor the frequency converter status. Remove input power to the frequency converter, correct the cause of the fault, and reset the frequency converter.

Warning and alarm displays

- A warning is shown in the LCP along with the warning number.
- An alarm flashes along with the alarm number.

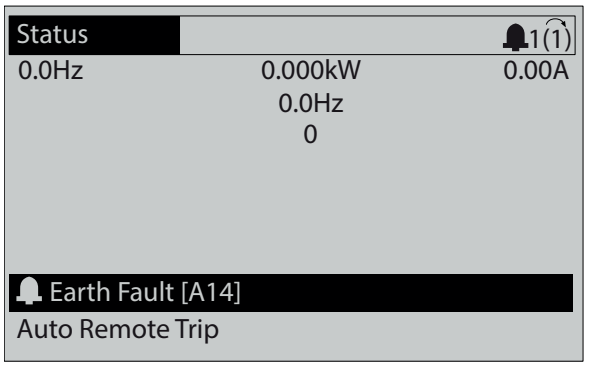


Illustration 7.1 Alarm Example

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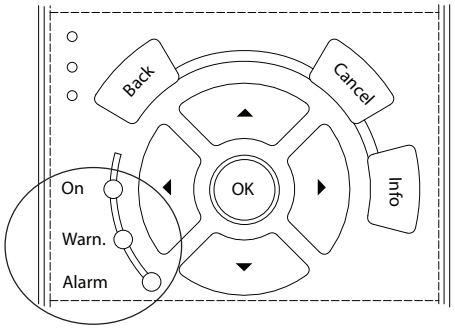
In addition to the text and alarm code in the LCP there are 3 status indicator lights.



	Warning indicator light	Alarm indicator light
Warning	On	Off
Alarm	Off	On (flashing)
Trip lock	On	On (flashing)

Illustration 7.2 Status Indicator Lights

7.3 List of Warnings and Alarms

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

WARNING 1, 10 Volts low
The control card voltage is less than 10 V from terminal 50. Remove some of the load from terminal 50, as the 10 V supply is overloaded. Maximum 15 mA or minimum 590 Ω.

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

Troubleshooting

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

WARNING/ALARM 2, Live zero error
This warning or alarm only appears if programmed by the user in *parameter 6-01 Live Zero Timeout Function*. The signal on 1 of the analog inputs is less than 50% of the minimum value programmed for that input. Broken wiring or faulty device sending the signal can cause this condition.

Troubleshooting

Check connections on all the analog input terminals. Control card terminals 53 and 54 for signals, terminal 55 common. VLT® General Purpose I/O MCB 101 terminals 11 and 12 for signals, terminal 10 common. VLT® Analog I/O MCB 109 terminals 1, 3, 5 for signals, terminals 2, 4, 6 common.

Check that the frequency converter programming and switch settings match the analog signal type.

Perform Input Terminal Signal Test.

WARNING/ALARM 3, No motor
No motor is connected to the output of the frequency converter.

WARNING/ALARM 4, Mains phase loss
A phase is missing on the supply side, or the mains voltage imbalance is too high. This message also appears for a fault in the input rectifier. Options are programmed in *parameter 14-12 Response to Mains Imbalance*.

Troubleshooting

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

WARNING 5, DC link voltage high
The DC-link voltage is higher than the high-voltage warning limit. The limit depends on the frequency converter voltage rating. The unit is still active.

WARNING 6, DC link voltage low
The DC-link voltage is lower than the low-voltage warning limit. The limit depends on the frequency converter voltage rating. The unit is still active.

WARNING/ALARM 7, DC overvoltage
If the DC-link voltage exceeds the limit, the frequency converter trips after some time.

Troubleshooting

- Connect a brake resistor.
- Extend the ramp time.
- Change the ramp type.
- Activate the functions in *parameter 2-10 Brake Function*.
- Increase *parameter 14-26 Trip Delay at Inverter Fault*.

WARNING/ALARM 8, DC under voltage
If the DC-link voltage drops below the undervoltage limit, the frequency converter checks if a 24 V DC back-up supply is connected. If no 24 V DC back-up supply is connected, the frequency converter trips after a fixed time delay. The time delay varies with unit size.

Troubleshooting

- Check that the supply voltage matches the frequency converter voltage.
- Perform an input voltage test.
- Perform a soft charge circuit test.

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WARNING/ALARM 9, Inverter overload
The frequency converter has run with more than 100% overload for too long and is about to cut out. The counter for electronic thermal inverter protection issues a warning at 98% and trips at 100% with an alarm. The frequency converter cannot be reset until the counter is below 90%.

Troubleshooting

- Compare the output current shown on the LCP with the frequency converter rated current.
- Compare the output current shown on the LCP with the measured motor current.
- Show the thermal frequency converter load on the LCP and monitor the value. When running above the frequency converter continuous current rating, the counter increases. When running below the frequency converter continuous current rating, the counter decreases.

7

WARNING/ALARM 10, Motor overload temperature
According to the electronic thermal protection (ETR), the motor is too hot.

Select 1 of these options:

- The frequency converter issues a warning or an alarm when the counter is >90% if *parameter 1-90 Motor Thermal Protection* is set to warning options.
- The frequency converter trips when the counter reaches 100% if *parameter 1-90 Motor Thermal Protection* is set to trip options.

The fault occurs when the motor runs with more than 100% overload for too long.

Troubleshooting

- Check for motor overheating.
- Check if the motor is mechanically overloaded.
- Check that the motor current set in *parameter 1-24 Motor Current* is correct.
- Ensure that the motor data in *parameters 1-20* to *1-25* is set correctly.
- If an external fan is in use, check that it is selected in *parameter 1-91 Motor External Fan*.
- Running AMA in *parameter 1-29 Automatic Motor Adaptation (AMA)* tunes the frequency converter to the motor more accurately and reduces thermal loading.

WARNING/ALARM 11, Motor thermistor overtemp
Check whether the thermistor is disconnected. Select whether the frequency converter issues a warning or an alarm in *parameter 1-90 Motor Thermal Protection*.

Troubleshooting

- Check for motor overheating.
- Check if the motor is mechanically overloaded.
- When using terminal 53 or 54, check that the thermistor is connected correctly between either terminal 53 or 54 (analog voltage input) and terminal 50 (+10 V supply). Also check that the terminal switch for 53 or 54 is set for voltage. Check that *parameter 1-93 Thermistor Resource* selects terminal 53 or 54.
- When using terminal 18, 19, 31, 32, or 33 (digital inputs), check that the thermistor is connected correctly between the digital input terminal used (digital input PNP only) and terminal 50. Select the terminal to use in *parameter 1-93 Thermistor Resource*.

WARNING/ALARM 12, Torque limit
The torque has exceeded the value in *parameter 4-16 Torque Limit Motor Mode* or the value in *parameter 4-17 Torque Limit Generator Mode*.
Parameter 14-25 Trip Delay at Torque Limit can change this warning from a warning-only condition to a warning followed by an alarm.

Troubleshooting

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

WARNING/ALARM 13, Over current
The inverter peak current limit (approximately 200% of the rated current) is exceeded. The warning lasts approximately 1.5 s, then the frequency converter trips and issues an alarm. Shock loading or quick acceleration with high-inertia loads can cause this fault. If the acceleration during ramp-up is quick, the fault can also appear after kinetic back-up. If extended mechanical brake control is selected, a trip can be reset externally.

Troubleshooting

- Remove the power and check if the motor shaft can be turned.
- Check that the motor size matches the frequency converter.
- Check that the motor data is correct in *parameters 1-20* to *1-25*.

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ALARM 14, Earth (ground) fault
There is current from the output phase-to-ground, either in the cable between the frequency converter and the motor, or in the motor itself. The current transducers detect the ground fault by measuring current going out from the frequency converter and current going into the frequency converter from the motor. Ground fault is issued if the deviation of the 2 currents is too large. The current going out of the frequency converter must be the same as the current going into the frequency converter.

Troubleshooting

- Remove power to the frequency converter and repair the ground fault.
- Check for ground faults in the motor by measuring the resistance to ground of the motor cables and the motor with a megohmmeter.
- Reset any potential individual offset in the 3 current transducers in the frequency converter. Perform the manual initialization or perform a complete AMA. This method is most relevant after changing the power card.

ALARM 15, Hardware mismatch
A fitted option is not operational with the present control card hardware or software.

Record the value of the following parameters and contact Danfoss.

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

ALARM 16, Short circuit
There is short-circuiting in the motor or motor wiring.

Troubleshooting

- Remove the power to the frequency converter and repair the short circuit.

⚠WARNING

HIGH VOLTAGE

Frequency converters contain high voltage when connected to AC mains input, DC supply, or load sharing. Failure to use qualified personnel to install, start up, and maintain the frequency converter can result in death or serious injury.

- **Disconnect power before proceeding.**

WARNING/ALARM 17, Control word timeout
There is no communication to the frequency converter. The warning is only active when *parameter 8-04 Control Word Timeout Function* is NOT set to *[0] Off*.
If *parameter 8-04 Control Word Timeout Function* is set to *[5] Stop and trip*, a warning appears, and the frequency converter ramps down to a stop and shows an alarm.

Troubleshooting

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

WARNING/ALARM 20, Temp. input error
The temperature sensor is not connected.

WARNING/ALARM 21, Parameter error
The parameter is out of range. The parameter number is shown in the display.

Troubleshooting

- Set the affected parameter to a valid value.

WARNING/ALARM 22, Hoist mechanical brake
The value of this warning/alarm shows the type of warning/alarm.
0 = The torque reference was not reached before timeout (*parameter 2-27 Torque Ramp Time*).
1 = Expected brake feedback was not received before timeout (*parameter 2-23 Activate Brake Delay*, *parameter 2-25 Brake Release Time*).

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WARNING 23, Internal fan fault
The fan warning function is a protective function that checks if the fan is running/mounted. The fan warning can be disabled in *parameter 14-53 Fan Monitor* (*[0] Disabled*).

There is a feedback sensor mounted in the fan. If the fan is commanded to run and there is no feedback from the sensor, this alarm appears. This alarm also shows if there is a communication error between the fan power card and the control card.

Check the alarm log (see *chapter 5.2 Local Control Panel Operation*) for the report value associated with this warning.

If the report value is 2, there is a hardware problem with 1 of the fans. If the report value is 12, there is a communication problem between the fan power card and the control card.

Fan troubleshooting

- Cycle power to the frequency converter and check that the fan operates briefly at start-up.
- Check for proper fan operation. Use *parameter group 43-**Unit Readouts* to show the speed of each fan.

Fan power card troubleshooting

- Check the wiring between the fan power card and the control card.
- Fan power card may need to be replaced.
- Control card may need to be replaced.

WARNING 24, External fan fault
The fan warning function is a protective function that checks if the fan is running/mounted. The fan warning can be disabled in *parameter 14-53 Fan Monitor* (*[0] Disabled*).

There is a feedback sensor mounted in the fan. If the fan is commanded to run and there is no feedback from the sensor, this alarm appears. This alarm also shows if there is a communication error between the power card and the control card.

Check the alarm log (see *chapter 5.2 Local Control Panel Operation*) for the report value associated with this warning.

If the report value is 1, there is a hardware problem with 1 of the fans. If the report value is 11, there is a communication problem between the power card and the control card.

Fan troubleshooting

- Cycle power to the frequency converter and check that the fan operates briefly at start-up.
- Check for proper fan operation. Use *parameter group 43-**Unit Readouts* to show the speed of each fan.

Power card troubleshooting

- Check the wiring between the power card and the control card.
- Power card may need to be replaced.
- Control card may need to be replaced.

WARNING 25, Brake resistor short circuit
The brake resistor is monitored during operation. If a short circuit occurs, the brake function is disabled and the warning appears. The frequency converter is still operational, but without the brake function.

Troubleshooting

- Remove the power to the frequency converter and replace the brake resistor (refer to *parameter 2-15 Brake Check*).

WARNING/ALARM 26, Brake resistor power limit
The power transmitted to the brake resistor is calculated as an average value over the last 120 s of run-time. The calculation is based on the DC-link voltage and the brake resistor value set in *parameter 2-16 AC brake Max. Current*. The warning is active when the dissipated braking power is higher than 90% of the brake resistor power. If option *[2] Trip* is selected in *parameter 2-13 Brake Power Monitoring*, the frequency converter trips when the dissipated braking power reaches 100%.

WARNING/ALARM 27, Brake chopper fault
The brake transistor is monitored during operation, and if a short circuit occurs, the brake function is disabled, and a warning is issued. The frequency converter is still operational, but since the brake transistor has short-circuited, substantial power is transmitted to the brake resistor, even if it is inactive.

Troubleshooting

- Remove power to the frequency converter and remove the brake resistor.

WARNING/ALARM 28, Brake check failed
The brake resistor is not connected or not working.

Troubleshooting

- Check *parameter 2-15 Brake Check*.

ALARM 29, Heat sink temp
The maximum temperature of the heat sink is exceeded. The temperature fault is not reset until the temperature drops below a defined heat sink temperature. The trip and reset points are different based on the frequency converter power size.

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Troubleshooting

Check for the following conditions:

- The ambient temperature is too high.
- The motor cables are too long.
- Incorrect airflow clearance above and below the frequency converter.
- Blocked airflow around the frequency converter.
- Damaged heat sink fan.
- Dirty heat sink.

ALARM 30, Motor phase U missing

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

⚠WARNING

HIGH VOLTAGE

Frequency converters contain high voltage when connected to AC mains input, DC supply, or load sharing. Failure to use qualified personnel to install, start up, and maintain the frequency converter can result in death or serious injury.

- **Disconnect power before proceeding.**

Troubleshooting

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

ALARM 31, Motor phase V missing

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

⚠WARNING

HIGH VOLTAGE

Frequency converters contain high voltage when connected to AC mains input, DC supply, or load sharing. Failure to use qualified personnel to install, start up, and maintain the frequency converter can result in death or serious injury.

- **Disconnect power before proceeding.**

Troubleshooting

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

ALARM 32, Motor phase W missing

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

⚠WARNING

HIGH VOLTAGE

Frequency converters contain high voltage when connected to AC mains input, DC supply, or load sharing. Failure to use qualified personnel to install, start up, and maintain the frequency converter can result in death or serious injury.

- **Disconnect power before proceeding.**

Troubleshooting

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

ALARM 33, Inrush fault

Too many power-ups have occurred within a short time period.

Troubleshooting

- Let the unit cool to operating temperature.

WARNING/ALARM 34, Fieldbus communication fault

The fieldbus on the communication option card is not working.

WARNING/ALARM 35, Option fault

An option alarm is received. The alarm is option-specific. The most likely cause is a power-up or a communication fault.

WARNING/ALARM 36, Mains failure

This warning/alarm is only active if the supply voltage to the frequency converter is lost and *parameter 14-10 Mains Failure* is NOT set to *[0] No Function*. Check the fuses to the frequency converter and mains power supply to the unit.

ALARM 37, Phase imbalance

There is a current imbalance between the power units.

ALARM 38, Internal fault

When an internal fault occurs, a code number defined in *Table 7.1* is shown.

Troubleshooting

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

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It may be necessary to contact the Danfoss supplier or service department. Note the code number for further troubleshooting directions

Number	Text
0	The serial port cannot be initialized. Contact the Danfoss supplier or Danfoss service department.
256–258	The power EEPROM data is defective or too old. Replace the power card.
512–519	Internal fault. Contact the Danfoss supplier or Danfoss service department.
783	Parameter value outside of minimum/maximum limits.
1024–1284	Internal fault. Contact the Danfoss supplier or Danfoss service department.
1299	The option software in slot A is too old.
1300	The option software in slot B is too old.
1302	The option software in slot C1 is too old.
1315	The option software in slot A is not supported/ allowed.
1316	The option software in slot B is not supported/ allowed.
1318	The option software in slot C1 is not supported/ allowed.
1379–2819	Internal fault. Contact the Danfoss supplier or Danfoss service department.
1792	Hardware reset of digital signal processor.
1793	Motor-derived parameters not transferred correctly to the digital signal processor.
1794	Power data not transferred correctly at power-up to the digital signal processor.
1795	The digital signal processor has received too many unknown SPI telegrams. The frequency converter also uses this fault code if the MCO does not power up correctly. This situation can occur due to poor EMC protection or improper grounding.
1796	RAM copy error.
2561	Replace the control card.
2820	LCP stack overflow.
2821	Serial port overflow.
2822	USB port overflow.
3072–5122	Parameter value is outside its limits.
5123	Option in slot A: Hardware incompatible with the control board hardware.
5124	Option in slot B: Hardware incompatible with the control board hardware.
5125	Option in slot C0: Hardware incompatible with the control board hardware.
5126	Option in slot C1: Hardware incompatible with the control board hardware.
5376–6231	Internal fault. Contact the Danfoss supplier or Danfoss service department.

Table 7.1 Internal Fault Codes

ALARM 39, Heat sink sensor
No feedback from the heat sink temperature sensor.

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

WARNING 40, Overload of digital output terminal 27
Check the load connected to terminal 27 or remove the short-circuit connection. Check *parameter 5-00 Digital I/O Mode* and *parameter 5-01 Terminal 27 Mode*.

WARNING 41, Overload of digital output terminal 29
Check the load connected to terminal 29 or remove the short-circuit connection. Also check *parameter 5-00 Digital I/O Mode* and *parameter 5-02 Terminal 29 Mode*.

WARNING 42, Overload of digital output on X30/6 or overload of digital output on X30/7
For terminal X30/6, check the load connected to terminal X30/6 or remove the short-circuit connection. Also check *parameter 5-32 Term X30/6 Digi Out (MCB 101)* (VLT® General Purpose I/O MCB 101).

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

ALARM 43, Ext. supply
VLT® Extended Relay Option MCB 113 is mounted without external 24 V DC. Either connect a 24 V DC external supply or specify that no external supply is used via *parameter 14-80 Option Supplied by External 24VDC*, *[0] No*. A change in *parameter 14-80 Option Supplied by External 24VDC* requires a power cycle.

ALARM 45, Earth fault 2
Ground fault.

Troubleshooting

- Check for proper grounding and loose connections.
- Check for proper wire size.
- Check the motor cables for short circuits or leakage currents.

ALARM 46, Power card supply
The supply on the power card is out of range. Another reason can be a defective heat sink fan.

There are 3 supplies generated by the switch mode supply (SMPS) on the power card:

- 24 V.
- 5 V.
- ±18 V.

When powered with VLT® 24 V DC Supply MCB 107, only the 24 V and 5 V supplies are monitored. When powered with 3-phase mains voltage, all 3 supplies are monitored.

Troubleshooting

- Check for a defective power card.
- Check for a defective control card.

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- Check for a defective option card.
- If a 24 V DC supply is used, verify proper supply power.
- Check for a defective heat sink fan.

WARNING 47, 24 V supply low
The supply on the power card is out of range.

There are 3 supplies generated by the switch mode supply (SMPS) on the power card:

- 24 V.
- 5 V.
- ±18 V.

Troubleshooting

- Check for a defective power card.

WARNING 48, 1.8 V supply low
The 1.8 V DC supply used on the control card is outside of the allowable limits. The supply is measured on the control card.

Troubleshooting

- Check for a defective control card.
- If an option card is present, check for overvoltage.

WARNING 49, Speed limit
The warning is shown when the speed is outside of the specified range in *parameter 4-11 Motor Speed Low Limit [RPM]* and *parameter 4-13 Motor Speed High Limit [RPM]*. When the speed is below the specified limit in *parameter 1-86 Trip Speed Low [RPM]* (except when starting or stopping), the frequency converter trips.

ALARM 50, AMA calibration failed
Contact the Danfoss supplier or Danfoss Service Department.

ALARM 51, AMA check U_{nom} and I_{nom}
The settings for motor voltage, motor current, and motor power are wrong.

Troubleshooting

- Check the settings in *parameters 1-20 to 1-25*.

ALARM 52, AMA low I_{nom}
The motor current is too low.

Troubleshooting

- Check the settings in *parameter 1-24 Motor Current*.

ALARM 53, AMA motor too big
The motor is too large for the AMA to operate.

ALARM 54, AMA motor too small
The motor is too small for the AMA to operate.

ALARM 55, AMA parameter out of range
The AMA cannot run because the parameter values of the motor are outside of the acceptable range.

ALARM 56, AMA interrupted by user
The AMA is manually interrupted.

ALARM 57, AMA internal fault
Try to restart the AMA. Repeated restarts can overheat the motor.

ALARM 58, AMA Internal fault
Contact the Danfoss supplier.

WARNING 59, Current limit
The current is higher than the value in *parameter 4-18 Current Limit*. Ensure that the motor data in *parameters 1-20 to 1-25* is set correctly. Increase the current limit if necessary. Ensure that the system can operate safely at a higher limit.

WARNING 60, External interlock
A digital input signal indicates a fault condition external to the frequency converter. An external interlock has commanded the frequency converter to trip.

Troubleshooting

- Clear the external fault condition.
- To resume normal operation, apply 24 V DC to the terminal programmed for external interlock.
- Reset the frequency converter.

WARNING/ALARM 61, Feedback error
An error between calculated speed and speed measurement from feedback device.

Troubleshooting

- Check the settings for warning/alarm/disabling in *parameter 4-30 Motor Feedback Loss Function*.
- Set the tolerable error in *parameter 4-31 Motor Feedback Speed Error*.
- Set the tolerable feedback loss time in *parameter 4-32 Motor Feedback Loss Timeout*.

WARNING 62, Output frequency at maximum limit
If the output frequency reaches the value set in *parameter 4-19 Max Output Frequency*, the frequency converter issues a warning. The warning ceases when the output drops below the maximum limit. If the frequency converter is unable to limit the frequency, it trips and issues an alarm. The latter may happen in the flux mode if the frequency converter loses control of the motor.

Troubleshooting

- Check the application for possible causes.
- Increase the output frequency limit. Ensure that the system can operate safely at a higher output frequency.

ALARM 63, Mechanical brake low
The actual motor current has not exceeded the release brake current within the start delay time window.

WARNING 64, Voltage Limit
The load and speed combination demands a motor voltage higher than the actual DC-link voltage.

WARNING/ALARM 65, Control card over temperature
The cutout temperature of the control card is 85 °C (185 °F).

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Troubleshooting

- Check that the ambient operating temperature is within the limits.
- Check for clogged filters.
- Check the fan operation.
- Check the control card.

WARNING 66, Heat sink temperature low
The frequency converter is too cold to operate. This warning is based on the temperature sensor in the IGBT module. Increase the ambient temperature of the unit. Also, a trickle amount of current can be supplied to the frequency converter whenever the motor is stopped by setting *parameter 2-00 DC Hold/Preheat Current* to 5% and *parameter 1-80 Function at Stop*.

ALARM 67, Option module configuration has changed
One or more options have either been added or removed since the last power-down. Check that the configuration change is intentional and reset the unit.

ALARM 68, Safe Stop activated
Safe Torque Off (STO) has been activated. To resume normal operation, apply 24 V DC to terminal 37, then send a reset signal (via bus, digital I/O, or by pressing [Reset]).

ALARM 69, Power card temperature
The temperature sensor on the power card is either too hot or too cold.

Troubleshooting

- Check that the ambient operating temperature is within limits.
- Check for clogged filters.
- Check fan operation.
- Check the power card.

ALARM 70, Illegal FC configuration
The control card and power card are incompatible. To check compatibility, contact the Danfoss supplier with the type code from the unit nameplate and the part numbers of the cards.

ALARM 71, PTC 1 safe stop
STO has been activated from the VLT® PTC Thermistor Card MCB 112 (motor too warm). Normal operation can be resumed when the MCB 112 applies 24 V DC to terminal 37 again (when the motor temperature reaches an acceptable level), and when the digital input from the MCB 112 is deactivated. When that happens, send a reset signal (via bus or digital I/O, or press [Reset]).

ALARM 72, Dangerous failure

STO with trip lock. An unexpected combination of STO commands has occurred:

- VLT® PTC Thermistor Card MCB 112 enables X44/10, but STO is not enabled.
- MCB 112 is the only device using STO (specified through selection *[4] PTC 1 alarm* or *[5] PTC 1 warning* in *parameter 5-19 Terminal 37 Safe Stop*), STO is activated, and X44/10 is not activated.

WARNING 73, Safe Stop auto restart
STO activated. With automatic restart enabled, the motor can start when the fault is cleared.

ALARM 74, PTC Thermistor
Alarm related to VLT® PTC Thermistor Card MCB 112. The PTC is not working.

ALARM 75, Illegal profile sel.
Do not write the parameter value while the motor is running. Stop the motor before writing the MCO profile to *parameter 8-10 Control Word Profile*.

WARNING 77, Reduced power mode
The frequency converter is operating in reduced power mode (less than the allowed number of inverter sections). This warning is generated on power cycle when the frequency converter is set to run with fewer inverters and remains on.

ALARM 78, Tracking error
The difference between setpoint value and actual value exceeds the value in *parameter 4-35 Tracking Error*.

Troubleshooting

- Disable the function or select an alarm/warning in *parameter 4-34 Tracking Error Function*.
- Investigate the mechanics around the load and motor. Check feedback connections from motor encoder to frequency converter.
- Select motor feedback function in *parameter 4-30 Motor Feedback Loss Function*.
- Adjust the tracking error band in *parameter 4-35 Tracking Error* and *parameter 4-37 Tracking Error Ramping*.

ALARM 79, Illegal power section configuration
The scaling card has an incorrect part number or is not installed. The MK102 connector on the power card could not be installed.

ALARM 80, Drive initialised to default value
Parameter settings are initialized to default settings after a manual reset. To clear the alarm, reset the unit.

ALARM 81, CSIV corrupt
CSIV file has syntax errors.

ALARM 82, CSIV parameter error
CSIV failed to initialize a parameter.

ALARM 83, Illegal option combination
The mounted options are incompatible.

ALARM 84, No safety option
The safety option was removed without applying a general reset. Reconnect the safety option.

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ALARM 88, Option detection
A change in the option layout is detected.
Parameter 14-89 Option Detection is set to *[0] Frozen configuration* and the option layout has been changed.

- To apply the change, enable option layout changes in *parameter 14-89 Option Detection*.
- Alternatively, restore the correct option configuration.

WARNING 89, Mechanical brake sliding
The hoist brake monitor detects a motor speed exceeding 10 RPM.

ALARM 90, Feedback monitor
Check the connection to encoder/resolver option and, if necessary, replace VLT® Encoder Input MCB 102 or VLT® Resolver Input MCB 103.

ALARM 91, Analog input 54 wrong settings
Set switch S202 in position OFF (voltage input) when a KTY sensor is connected to analog input terminal 54.

ALARM 99, Locked rotor
The rotor is blocked.

WARNING/ALARM 104, Mixing fan fault
The fan is not operating. The fan monitor checks that the fan is spinning at power-up or whenever the mixing fan is turned on. The mixing-fan fault can be configured as a warning or an alarm trip in *parameter 14-53 Fan Monitor*.

Troubleshooting

- Cycle power to the frequency converter to determine if the warning/alarm returns.

WARNING/ALARM 122, Mot. rotat. unexp.
The frequency converter performs a function that requires the motor to be at standstill, for example DC hold for PM motors.

WARNING 163, ATEX ETR cur.lim.warning
The frequency converter has run above the characteristic curve for more than 50 s. The warning is activated at 83% and deactivated at 65% of the allowed thermal overload.

ALARM 164, ATEX ETR cur.lim.alarm
Operating above the characteristic curve for more than 60 s within a period of 600 s activates the alarm, and the frequency converter trips.

WARNING 165, ATEX ETR freq.lim.warning
The frequency converter is running for more than 50 s below the allowed minimum frequency (*parameter 1-98 ATEX ETR interpol. points freq.*).

ALARM 166, ATEX ETR freq.lim.alarm
The frequency converter has operated for more than 60 s (in a period of 600 s) below the allowed minimum frequency (*parameter 1-98 ATEX ETR interpol. points freq.*).

WARNING 250, New spare part
A component in the drive system has been replaced.

Troubleshooting

- Reset the drive system to restore normal operation.

WARNING 251, New typecode
The power card or other components are replaced, and the type code has changed.

7

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8 Specifications

8.1 Electrical Data

8.1.1 Mains Supply 200–240 V

Type designation	PK25	PK37	PK55	PK75	P1K1	P1K5	P2K2	P3K0	P3K7
Typical shaft output [kW/(hp)], high overload	0.25 (0.34)	0.37 (0.5)	0.55 (0.75)	0.75 (1.0)	1.1 (1.5)	1.5 (2.0)	2.2 (3.0)	3.0 (4.0)	3.7 (5.0)
Enclosure protection rating IP20 (FC 301 only)	A1	A1	A1	A1	A1	A1	–	–	–
Enclosure protection rating IP20, IP21	A2	A2	A2	A2	A2	A2	A2	A3	A3
Enclosure protection rating IP55, IP66	A4/A5	A4/A5	A4/A5	A4/A5	A4/A5	A4/A5	A4/A5	A5	A5
Output current									
Continuous (200–240 V) [A]	1.8	2.4	3.5	4.6	6.6	7.5	10.6	12.5	16.7
Intermittent (200–240 V) [A]	2.9	3.8	5.6	7.4	10.6	12.0	17.0	20.0	26.7
Continuous kVA (208 V) [kVA]	0.65	0.86	1.26	1.66	2.38	2.70	3.82	4.50	6.00
Maximum input current									
Continuous (200–240 V) [A]	1.6	2.2	3.2	4.1	5.9	6.8	9.5	11.3	15.0
Intermittent (200–240 V) [A]	2.6	3.5	5.1	6.6	9.4	10.9	15.2	18.1	24.0
Additional specifications									
Maximum cable cross-section[2),5)] for mains, motor, brake, and load sharing [mm²] ([AWG])	4, 4, 4 (12,12,12) (minimum 0.2 (24))								
Maximum cable cross-section[2),5)] for disconnect [mm²] ([AWG])	6, 4, 4 (10,12,12)								
Estimated power loss at rated maximum load [W][3)]	21	29	42	54	63	82	116	155	185
Efficiency[4)]	0.94	0.94	0.95	0.95	0.96	0.96	0.96	0.96	0.96

Table 8.1 Mains Supply 200–240 V, PK25–P3K7

Type designation	P5K5		P7K5		P11K	
High/normal overload[1)]	HO	NO	HO	NO	HO	NO
Typical shaft output [kW/(hp)]	5.5 (7.5)	7.5 (10)	7.5 (10)	11 (15)	11 (15)	15 (20)
Enclosure protection rating IP20	B3		B3		B4	
Enclosure protection rating IP21, IP55, IP66	B1		B1		B2	
Output current						
Continuous (200–240 V) [A]	24.2	30.8	30.8	46.2	46.2	59.4
Intermittent (60 s overload) (200–240 V) [A]	38.7	33.9	49.3	50.8	73.9	65.3
Continuous kVA (208 V) [kVA]	8.7	11.1	11.1	16.6	16.6	21.4
Maximum input current						
Continuous (200–240 V) [A]	22.0	28.0	28.0	42.0	42.0	54.0
Intermittent (60 s overload) (200–240 V) [A]	35.2	30.8	44.8	46.2	67.2	59.4
Additional specifications						
IP20 maximum cable cross-section[2),5)] for mains, brake, motor, and load sharing [mm²] ([AWG])	10, 10,- (8, 8,-)		10, 10,- (8, 8,-)		35,-,- (2,-,-)	
IP21 maximum cable cross-section[2),5)] for mains, brake, and load sharing [mm²] ([AWG])	16,10,16 (6, 8, 6)		16,10,16 (6, 8, 6)		35,-,- (2,-,-)	
IP21 maximum cable cross-section[2),5)] for motor [mm²] ([AWG])	10, 10,- (8, 8,-)		10, 10,- (8, 8,-)		35,25,25 (2, 4, 4)	
Maximum cable cross-section[2),5)] for disconnect [mm²] ([AWG])	16,10,10 (6, 8, 8)					
Estimated power loss at rated maximum load [W][3)]	239	310	371	514	463	602
Efficiency[4)]	0.96		0.96		0.96	

Table 8.2 Mains Supply 200–240 V, P5K5–P11K

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Type designation	P15K		P18K		P22K		P30K		P37K	
High/normal overload[1)]	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output [kW/(hp)]	15 (20)	18.5 (25)	18.5 (25)	22 (30)	22 (30)	30 (40)	30 (40)	37 (50)	37 (50)	45 (60)
Enclosure protection rating IP20	B4		C3		C3		C4		C4	
Enclosure protection rating IP21, IP55, IP66	C1		C1		C1		C2		C2	
Output current										
Continuous (200–240 V) [A]	59.4	74.8	74.8	88.0	88.0	115	115	143	143	170
Intermittent (60 s overload) (200–240 V) [A]	89.1	82.3	112	96.8	132	127	173	157	215	187
Continuous kVA (208 V) [kVA]	21.4	26.9	26.9	31.7	31.7	41.4	41.4	51.5	51.5	61.2
Maximum input current										
Continuous (200–240 V) [A]	54.0	68.0	68.0	80.0	80.0	104	104	130	130	154
Intermittent (60 s overload) (200–240 V) [A]	81.0	74.8	102	88.0	120	114	156	143	195	169
Additional specifications										
IP20 maximum cable cross-section[5)] for mains, brake, motor, and load sharing [mm^2] ([AWG])	35 (2)		50 (1)		50 (1)		150 (300 MCM)		150 (300 MCM)	
IP21, IP55, IP66 maximum cable cross-section[5)] for mains and motor [mm^2] ([AWG])	50 (1)		50 (1)		50 (1)		150 (300 MCM)		150 (300 MCM)	
IP21, IP55, IP66 maximum cable cross-section[5)] for brake and load sharing [mm^2] ([AWG])	50 (1)		50 (1)		50 (1)		95 (3/0)		95 (3/0)	
Maximum cable cross-section[2),5)] for disconnect [mm^2] ([AWG])	50, 35, 35 (1, 2, 2)						95, 70, 70 (3/0, 2/0, 2/0)		185, 150, 120 (350 MCM, 300 MCM, 4/0)	
Estimated power loss at rated maximum load [W][3)]	624	737	740	845	874	1140	1143	1353	1400	1636
Efficiency[4)]	0.96		0.97		0.97		0.97		0.97	

Table 8.3 Mains Supply 200–240 V, P15K–P37K

8

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8.1.2 Mains Supply 380–500 V

Type designation	PK37	PK55	PK75	P1K1	P1K5	P2K2	P3K0	P4K0	P5K5	P7K5
Typical shaft output [kW/(hp)], high overload	0.37 (0.5)	0.55 (0.75)	0.75 (1.0)	1.1 (1.5)	1.5 (2.0)	2.2 (3.0)	3.0 (4.0)	4.0 (5.0)	5.5 (7.5)	7.5 (10)
Enclosure protection rating IP20 (FC 301 only)	A1	A1	A1	A1	A1	–	–	–	–	–
Enclosure protection rating IP20, IP21	A2	A2	A2	A2	A2	A2	A2	A2	A3	A3
Enclosure protection rating IP55, IP66	A4/A5	A4/A5	A4/A5	A4/A5	A4/A5	A4/A5	A4/A5	A4/A5	A5	A5
Output current high overload 160% for 1 minute										
Shaft output [kW/(hp)]	0.37 (0.5)	0.55 (0.75)	0.75 (1.0)	1.1 (1.5)	1.5 (2.0)	2.2 (3.0)	3.0 (4.0)	4.0 (5.0)	5.5 (7.5)	7.5 (10)
Continuous (380–440 V) [A]	1.3	1.8	2.4	3.0	4.1	5.6	7.2	10	13	16
Intermittent (380–440 V) [A]	2.1	2.9	3.8	4.8	6.6	9.0	11.5	16	20.8	25.6
Continuous (441–500 V) [A]	1.2	1.6	2.1	2.7	3.4	4.8	6.3	8.2	11	14.5
Intermittent (441–500 V) [A]	1.9	2.6	3.4	4.3	5.4	7.7	10.1	13.1	17.6	23.2
Continuous kVA (400 V) [kVA]	0.9	1.3	1.7	2.1	2.8	3.9	5.0	6.9	9.0	11
Continuous kVA (460 V) [kVA]	0.9	1.3	1.7	2.4	2.7	3.8	5.0	6.5	8.8	11.6
Maximum input current										
Continuous (380–440 V) [A]	1.2	1.6	2.2	2.7	3.7	5.0	6.5	9.0	11.7	14.4
Intermittent (380–440 V) [A]	1.9	2.6	3.5	4.3	5.9	8.0	10.4	14.4	18.7	23
Continuous (441–500 V) [A]	1.0	1.4	1.9	2.7	3.1	4.3	5.7	7.4	9.9	13
Intermittent (441–500 V) [A]	1.6	2.2	3.0	4.3	5.0	6.9	9.1	11.8	15.8	20.8
Additional specifications										
IP20, IP21 maximum cable cross-section[2),5)] for mains, motor, brake, and load sharing [mm^2] ([AWG])	4, 4, 4 (12,12,12) (minimum 0.2(24))									
IP55, IP66 maximum cable cross-section[2),5)] for mains, motor, brake, and load sharing [mm^2] ([AWG])	4, 4, 4 (12,12,12)									
Maximum cable cross-section[2),5)] for disconnect [mm^2] ([AWG])	6, 4, 4 (10,12,12)									
Estimated power loss at rated maximum load [W][3)]	35	42	46	58	62	88	116	124	187	255
Efficiency[4)]	0.93	0.95	0.96	0.96	0.97	0.97	0.97	0.97	0.97	0.97

Table 8.4 Mains Supply 380–500 V (FC 302), 380–480 V (FC 301), PK37–P7K5

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Type designation	P11K		P15K		P18K		P22K	
High/normal overload[1)]	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output [kW/(hp)]	11 (15)	15 (20)	15 (20)	18.5 (25)	18.5 (25)	22 (30)	22 (30)	30 (40)
Enclosure protection rating IP20	B3		B3		B4		B4	
Enclosure protection rating IP21, IP55, IP66	B1		B1		B2		B2	
Output current								
Continuous (380–440 V) [A]	24	32	32	37.5	37.5	44	44	61
Intermittent (60 s overload) (380–440 V) [A]	38.4	35.2	51.2	41.3	60	48.4	70.4	67.1
Continuous (441–500 V) [A]	21	27	27	34	34	40	40	52
Intermittent (60 s overload) (441–500 V) [A]	33.6	29.7	43.2	37.4	54.4	44	64	57.2
Continuous kVA (400 V) [kVA]	16.6	22.2	22.2	26	26	30.5	30.5	42.3
Continuous kVA (460 V) [kVA]	–	21.5	–	27.1	–	31.9	–	41.4
Maximum input current								
Continuous (380–440 V) [A]	22	29	29	34	34	40	40	55
Intermittent (60 s overload) (380–440 V) [A]	35.2	31.9	46.4	37.4	54.4	44	64	60.5
Continuous (441–500 V) [A]	19	25	25	31	31	36	36	47
Intermittent (60 s overload) (441–500 V) [A]	30.4	27.5	40	34.1	49.6	39.6	57.6	51.7
Additional specifications								
IP21, IP55, IP66 maximum cable cross-section[2),5)] for mains, brake, and load sharing [mm^2] ([AWG])	16, 10, 16 (6, 8, 6)		16, 10, 16 (6, 8, 6)		35,-,-(2,-,-)		35,-,-(2,-,-)	
IP21, IP55, IP66 maximum cable cross-section[2),5)] for motor [mm^2] ([AWG])	10, 10,- (8, 8,-)		10, 10,- (8, 8,-)		35, 25, 25 (2, 4, 4)		35, 25, 25 (2, 4, 4)	
IP20 maximum cable cross-section[2),5)] for mains, brake, motor, and load sharing [mm^2] ([AWG])	10, 10,- (8, 8,-)		10, 10,- (8, 8,-)		35,-,-(2,-,-)		35,-,-(2,-,-)	
Maximum cable cross-section[2),5)] for disconnect [mm^2] ([AWG])	16, 10, 10 (6, 8, 8)							
Estimated power loss at rated maximum load [W][3)]	291	392	379	465	444	525	547	739
Efficiency[4)]	0.98		0.98		0.98		0.98	

Table 8.5 Mains Supply 380–500 V (FC 302), 380–480 V (FC 301), P11K–P22K

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Type designation	P30K		P37K		P45K		P55K		P75K	
High/normal overload[1]	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output [kW/(hp)]	30 (40)	37 (50)	37 (50)	45 (60)	45 (60)	55 (75)	55 (75)	75 (100)	75 (100)	90 (125)
Enclosure protection rating IP20	B4		C3		C3		C4		C4	
Enclosure protection rating IP21, IP55, IP66	C1		C1		C1		C2		C2	
Output current										
Continuous (380–440 V) [A]	61	73	73	90	90	106	106	147	147	177
Intermittent (60 s overload) (380–440 V) [A]	91.5	80.3	110	99	135	117	159	162	221	195
Continuous (441–500 V) [A]	52	65	65	80	80	105	105	130	130	160
Intermittent (60 s overload) (441–500 V) [A]	78	71.5	97.5	88	120	116	158	143	195	176
Continuous kVA (400 V) [kVA]	42.3	50.6	50.6	62.4	62.4	73.4	73.4	102	102	123
Continuous kVA (460 V) [kVA]	–	51.8	–	63.7	–	83.7	–	104	–	128
Maximum input current										
Continuous (380–440 V) [A]	55	66	66	82	82	96	96	133	133	161
Intermittent (60 s overload) (380–440 V) [A]	82.5	72.6	99	90.2	123	106	144	146	200	177
Continuous (441–500 V) [A]	47	59	59	73	73	95	95	118	118	145
Intermittent (60 s overload) (441–500 V) [A]	70.5	64.9	88.5	80.3	110	105	143	130	177	160
Additional specifications										
IP20 maximum cable cross-section[5] for mains and motor [mm^2] ([AWG])	35 (2)		50 (1)		50 (1)		150 (300 MCM)		150 (300 MCM)	
IP20 maximum cable cross-section[5] for brake and load sharing [mm^2)] ([AWG])	35 (2)		50 (1)		50 (1)		95 (4/0)		95 (4/0)	
IP21, IP55, IP66 maximum cable cross-section[5] for mains and motor [mm^2] ([AWG])	50 (1)		50 (1)		50 (1)		150 (300 MCM)		150 (300 MCM)	
IP21, IP55, IP66 maximum cable cross-section[5] for brake and load sharing [mm^2] ([AWG])	50 (1)		50 (1)		50 (1)		95 (3/0)		95 (3/0)	
Maximum cable cross-section[2),5)] for mains disconnect [mm^2] ([AWG])	50, 35, 35 (1, 2, 2)						95, 70, 70 (3/0, 2/0, 2/0)		185, 150, 120 (350 MCM, 300 MCM, 4/0)	
Estimated power loss at rated maximum load [W][3]	570	698	697	843	891	1083	1022	1384	1232	1474
Efficiency[4]	0.98		0.98		0.98		0.98		0.99	

Table 8.6 Mains Supply 380–500 V (FC 302), 380–480 V (FC 301), P30K–P75K

8.1.3 Mains Supply 525–600 V (FC 302 only)

Type designation	PK75	P1K1	P1K5	P2K2	P3K0	P4K0	P5K5	P7K5
Typical shaft output [kW/(hp)]	0.75 (1)	1.1 (1.5)	1.5 (2.0)	2.2 (3.0)	3 (4.0)	4 (5.0)	5.5 (7.5)	7.5 (10)
Enclosure protection rating IP20, IP21	A3	A3	A3	A3	A3	A3	A3	A3
Enclosure protection rating IP55	A5	A5	A5	A5	A5	A5	A5	A5
Output current								
Continuous (525–550 V) [A]	1.8	2.6	2.9	4.1	5.2	6.4	9.5	11.5
Intermittent (525–550 V) [A]	2.9	4.2	4.6	6.6	8.3	10.2	15.2	18.4
Continuous (551–600 V) [A]	1.7	2.4	2.7	3.9	4.9	6.1	9.0	11.0
Intermittent (551–600 V) [A]	2.7	3.8	4.3	6.2	7.8	9.8	14.4	17.6
Continuous kVA (525 V) [kVA]	1.7	2.5	2.8	3.9	5.0	6.1	9.0	11.0
Continuous kVA (575 V) [kVA]	1.7	2.4	2.7	3.9	4.9	6.1	9.0	11.0
Maximum input current								
Continuous (525–600 V) [A]	1.7	2.4	2.7	4.1	5.2	5.8	8.6	10.4
Intermittent (525–600 V) [A]	2.7	3.8	4.3	6.6	8.3	9.3	13.8	16.6
Additional specifications								
Maximum cable cross-section[2),5)] for mains, motor, brake, and load sharing [mm^2] ([AWG])	4, 4, 4 (12,12,12) (minimum 0.2 (24))							
Maximum cable cross-section[2),5)] for disconnect [mm^2] ([AWG])	6, 4, 4 (10,12,12)							
Estimated power loss at rated maximum load [W][3)]	35	50	65	92	122	145	195	261
Efficiency[4)]	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97

Table 8.7 Mains Supply 525–600 V (FC 302 only), PK75–P7K5

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Type designation	P11K		P15K		P18K		P22K		P30K	
High/normal load[1]	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output [kW/(hp)]	11 (15)	15 (20)	15 (20)	18.5 (25)	18.5 (25)	22 (30)	22 (30)	30 (40)	30 (40)	37 (50)
Enclosure protection rating IP20	B3		B3		B4		B4		B4	
Enclosure protection rating IP21, IP55, IP66	B1		B1		B2		B2		C1	
Output current										
Continuous (525–550 V) [A]	19	23	23	28	28	36	36	43	43	54
Intermittent (525–550 V) [A]	30	25	37	31	45	40	58	47	65	59
Continuous (551–600 V) [A]	18	22	22	27	27	34	34	41	41	52
Intermittent (551–600 V) [A]	29	24	35	30	43	37	54	45	62	57
Continuous kVA (550 V) [kVA]	18.1	21.9	21.9	26.7	26.7	34.3	34.3	41.0	41.0	51.4
Continuous kVA (575 V) [kVA]	17.9	21.9	21.9	26.9	26.9	33.9	33.9	40.8	40.8	51.8
Maximum input current										
Continuous at 550 V [A]	17.2	20.9	20.9	25.4	25.4	32.7	32.7	39	39	49
Intermittent at 550 V [A]	28	23	33	28	41	36	52	43	59	54
Continuous at 575 V [A]	16	20	20	24	24	31	31	37	37	47
Intermittent at 575 V [A]	26	22	32	27	39	34	50	41	56	52
Additional specifications										
IP20 maximum cable cross-section[2),5)] for mains, brake, motor, and load sharing [mm²] ([AWG])	10, 10,- (8, 8,-)		10, 10,- (8, 8,-)		35,-,-(2,-,-)		35,-,-(2,-,-)		35,-,-(2,-,-)	
IP21, IP55, IP66 maximum cable cross-section[2),5)] for mains, brake, and load sharing [mm²] ([AWG])	16, 10, 10 (6, 8, 8)		16, 10, 10 (6, 8, 8)		35,-,-(2,-,-)		35,-,-(2,-,-)		50,-,- (1,-,-)	
IP21, IP55, IP66 maximum cable cross-section[2),5)] for motor [mm²] ([AWG])	10, 10,- (8, 8,-)		10, 10,- (8, 8,-)		35, 25, 25 (2, 4, 4)		35, 25, 25 (2, 4, 4)		50,-,- (1,-,-)	
Maximum cable cross-section[2),5)] for disconnect [mm²] ([AWG])	16, 10, 10 (6, 8, 8)								50, 35, 35 (1, 2, 2)	
Estimated power loss at rated maximum load [W][3)]	220	300	300	370	370	440	440	600	600	740
Efficiency[4)]	0.98		0.98		0.98		0.98		0.98	

Table 8.8 Mains Supply 525–600 V (FC 302 only), P11K–P30K

Type designation	P37K		P45K		P55K		P75K	
High/normal load[1)]	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output [kW/(hp)]	37 (50)	45 (60)	45 (60)	55 (75)	55 (75)	75 (100)	75 (100)	90 (125)
Enclosure protection rating IP20	C3	C3	C3		C4		C4	
Enclosure protection rating IP21, IP55, IP66	C1	C1	C1		C2		C2	
Output current								
Continuous (525–550 V) [A]	54	65	65	87	87	105	105	137
Intermittent (525–550 V) [A]	81	72	98	96	131	116	158	151
Continuous (551–600 V) [A]	52	62	62	83	83	100	100	131
Intermittent (551–600 V) [A]	78	68	93	91	125	110	150	144
Continuous kVA (550 V) [kVA]	51.4	61.9	61.9	82.9	82.9	100.0	100.0	130.5
Continuous kVA (575 V) [kVA]	51.8	61.7	61.7	82.7	82.7	99.6	99.6	130.5
Maximum input current								
Continuous at 550 V [A]	49	59	59	78.9	78.9	95.3	95.3	124.3
Intermittent at 550 V [A]	74	65	89	87	118	105	143	137
Continuous at 575 V [A]	47	56	56	75	75	91	91	119
Intermittent at 575 V [A]	70	62	85	83	113	100	137	131
Additional specifications								
IP20 maximum cable cross-section[5)] for mains and motor [mm^2] ([AWG])	50 (1)				150 (300 MCM)			
IP20 maximum cable cross-section[5)] for brake and load sharing [mm^2] ([AWG])	50 (1)				95 (4/0)			
IP21, IP55, IP66 maximum cable cross-section[5)] for mains and motor [mm^2] ([AWG])	50 (1)				150 (300 MCM)			
IP21, IP55, IP66 maximum cable cross-section[5)] for brake and load sharing [mm^2] ([AWG])	50 (1)				95 (4/0)			
Maximum cable cross-section[2),5)] for mains disconnect [mm^2] ([AWG])	50, 35, 35 (1, 2, 2)				95, 70, 70 (3/0, 2/0, 2/0)		185, 150, 120 (350 MCM, 300 MCM, 4/0)	
Estimated power loss at rated maximum load [W][3)]	740	900	900	1100	1100	1500	1500	1800
Efficiency[4)]	0.98		0.98		0.98		0.98	

Table 8.9 Mains Supply 525–600 V P37K–P75K (FC 302 only), P37K–P75K

For fuse ratings, see chapter 8.7 Fuses and Circuit Breakers.

1) High overload=150% or 160% torque for a duration of 60 s. Normal overload=110% torque for a duration of 60 s.

2) The 3 values for the maximum cable cross-section are for single core, flexible wire, and flexible wire with sleeve, respectively.

3) Applies to dimensioning of frequency converter cooling. If the switching frequency is higher than the default setting, the power losses may increase. LCP and typical control card power consumptions are included. For power loss data according to EN 50598-2, refer to drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/

4) Efficiency measured at nominal current. For energy efficiency class, see chapter 8.4 Ambient Conditions. For part load losses, see drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/.

5) Cable cross-section is regarded for copper cables.

8

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8.1.4 Mains Supply 525–690 V (FC 302 only)

Type designation	P1K1	P1K5	P2K2	P3K0	P4K0	P5K5	P7K5
High/normal overload[1)]	HO/NO	HO/NO	HO/NO	HO/NO	HO/NO	HO/NO	HO/NO
Typical shaft output [kW/(hp)]	1.1 (1.5)	1.5 (2.0)	2.2 (3.0)	3.0 (4.0)	4.0 (5.0)	5.5 (7.5)	7.5 (10)
Enclosure protection rating IP20	A3	A3	A3	A3	A3	A3	A3
Output current							
Continuous (525–550 V) [A]	2.1	2.7	3.9	4.9	6.1	9.0	11.0
Intermittent (525–550 V) [A]	3.4	4.3	6.2	7.8	9.8	14.4	17.6
Continuous (551–690 V) [A]	1.6	2.2	3.2	4.5	5.5	7.5	10.0
Intermittent (551–690 V) [A]	2.6	3.5	5.1	7.2	8.8	12.0	16.0
Continuous kVA 525 V	1.9	2.5	3.5	4.5	5.5	8.2	10.0
Continuous kVA 690 V	1.9	2.6	3.8	5.4	6.6	9.0	12.0
Maximum input current							
Continuous (525–550 V) [A]	1.9	2.4	3.5	4.4	5.5	8.1	9.9
Intermittent (525–550 V) [A]	3.0	3.9	5.6	7.0	8.8	12.9	15.8
Continuous (551–690 V) [A]	1.4	2.0	2.9	4.0	4.9	6.7	9.0
Intermittent (551–690 V) [A]	2.3	3.2	4.6	6.5	7.9	10.8	14.4
Additional specifications							
Maximum cable cross-section[2),5)] for mains, motor, brake, and load sharing [mm^2] ([AWG])	4, 4, 4 (12, 12, 12) (minimum 0.2 (24)						
Maximum cable cross-section[2),5)] for disconnect [mm^2] ([AWG])	6, 4, 4 (10, 12, 12)						
Estimated power loss at rated maximum load (W)[3)]	44	60	88	120	160	220	300
Efficiency[4)]	0.96	0.96	0.96	0.96	0.96	0.96	0.96

Table 8.10 A3 Enclosure, Mains Supply 525–690 V IP20/Protected Chassis, P1K1–P7K5

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Type designation	P11K		P15K		P18K		P22K	
High/normal overload[1)]	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output at 550 V [kW/(hp)]	7.5 (10)	11 (15)	11 (15)	15 (20)	15 (20)	18.5 (25)	18.5 (25)	22 (30)
Typical shaft output at 690 V [kW/(hp)]	11 (15)	15 (20)	15 (20)	18.5 (25)	18.5 (25)	22 (30)	22 (30)	30 (40)
Enclosure protection rating IP20	B4		B4		B4		B4	
Enclosure protection rating IP21, IP55	B2		B2		B2		B2	
Output current								
Continuous (525–550 V) [A]	14.0	19.0	19.0	23.0	23.0	28.0	28.0	36.0
Intermittent (60 s overload) (525–550 V) [A]	22.4	20.9	30.4	25.3	36.8	30.8	44.8	39.6
Continuous (551–690 V) [A]	13.0	18.0	18.0	22.0	22.0	27.0	27.0	34.0
Intermittent (60 s overload) (551–690 V) [A]	20.8	19.8	28.8	24.2	35.2	29.7	43.2	37.4
Continuous kVA (at 550 V) [kVA]	13.3	18.1	18.1	21.9	21.9	26.7	26.7	34.3
Continuous kVA (at 690 V) [kVA]	15.5	21.5	21.5	26.3	26.3	32.3	32.3	40.6
Maximum input current								
Continuous (at 550 V) [A]	15.0	19.5	19.5	24.0	24.0	29.0	29.0	36.0
Intermittent (60 s overload) (at 550 V) [A]	23.2	21.5	31.2	26.4	38.4	31.9	46.4	39.6
Continuous (at 690 V) [A]	14.5	19.5	19.5	24.0	24.0	29.0	29.0	36.0
Intermittent (60 s overload) (at 690 V) [A]	23.2	21.5	31.2	26.4	38.4	31.9	46.4	39.6
Additional specifications								
Maximum cable cross-section[2),5)] for mains/motor, load share, and brake [mm^2] ([AWG])	35, 25, 25 (2, 4, 4)							
Maximum cable cross-section[2),5)] for mains disconnect [mm^2] ([AWG])	16, 10, 10 (6, 8, 8)							
Estimated power loss at rated maximum load (W)[3)]	150	220	220	300	300	370	370	440
Efficiency[4)]	0.98		0.98		0.98		0.98	

Table 8.11 B2/B4 Enclosure, Mains Supply 525–690 V IP20/IP21/IP55 - Chassis/NEMA 1/NEMA 12 (FC 302 only), P11K–P22K

8

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Type designation	P30K		P37K		P45K		P55K		P75K	
High/normal overload[1]	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output at 550 V [kW/(hp)]	22 (30)	30 (40)	30 (40)	37 (50)	37 (50)	45 (60)	45 (60)	55 (75)	55 (75)	75 (100)
Typical shaft output at 690 V [kW/(hp)]	30 (40)	37 (50)	37 (50)	45 (60)	45 (60)	55 (75)	55 (75)	75 (100)	75 (100)	90 (125)
Enclosure protection rating IP20	B4		C3		C3		D3h		D3h	
Enclosure protection rating IP21, IP55	C2		C2		C2		C2		C2	
Output current										
Continuous (525–550 V) [A]	36.0	43.0	43.0	54.0	54.0	65.0	65.0	87.0	87.0	105
Intermittent (60 s overload) (525–550 V) [A]	54.0	47.3	64.5	59.4	81.0	71.5	97.5	95.7	130.5	115.5
Continuous (551–690 V) [A]	34.0	41.0	41.0	52.0	52.0	62.0	62.0	83.0	83.0	100
Intermittent (60 s overload) (551–690 V) [A]	51.0	45.1	61.5	57.2	78.0	68.2	93.0	91.3	124.5	110
Continuous kVA (at 550 V) [kVA]	34.3	41.0	41.0	51.4	51.4	61.9	61.9	82.9	82.9	100
Continuous kVA (at 690 V) [kVA]	40.6	49.0	49.0	62.1	62.1	74.1	74.1	99.2	99.2	119.5
Maximum input current										
Continuous (at 550 V) [A]	36.0	49.0	49.0	59.0	59.0	71.0	71.0	87.0	87.0	99.0
Intermittent (60 s overload) (at 550 V) [A]	54.0	53.9	72.0	64.9	87.0	78.1	105.0	95.7	129	108.9
Continuous (at 690 V) [A]	36.0	48.0	48.0	58.0	58.0	70.0	70.0	86.0	–	–
Intermittent (60 s overload) (at 690 V) [A]	54.0	52.8	72.0	63.8	87.0	77.0	105	94.6	–	–
Additional specifications										
Maximum cable cross-section[5] for mains and motor [mm²] ([AWG])	150 (300 MCM)									
Maximum cable cross-section[5] for load share and brake [mm²] ([AWG])	95 (3/0)									
Maximum cable cross-section[2),5] for mains disconnect [mm²] ([AWG])	95, 70, 70 (3/0, 2/0, 2/0)						185, 150, 120 (350 MCM, 300 MCM, 4/0)		–	
Estimated power loss at rated maximum load [W][3]	600	740	740	900	900	1100	1100	1500	1500	1800
Efficiency[4]	0.98		0.98		0.98		0.98		0.98	

Table 8.12 B4, C2, C3 Enclosure, Mains Supply 525–690 V IP20/IP21/IP55 – Chassis/NEMA 1/NEMA 12 (FC 302 only), P30K–P75K

For fuse ratings, see chapter 8.7 Fuses and Circuit Breakers.

1) High overload=150% or 160% torque for a duration of 60 s. Normal overload=110% torque for a duration of 60 s.

2) The 3 values for the maximum cable cross-section are for single core, flexible wire, and flexible wire with sleeve, respectively.

3) Applies to dimensioning of frequency converter cooling. If the switching frequency is higher than the default setting, the power losses may increase. LCP and typical control card power consumptions are included. For power loss data according to EN 50598-2, refer to drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/

4) Efficiency measured at nominal current. For energy efficiency class, see chapter 8.4 Ambient Conditions. For part load losses, see drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/.

5) Cable cross-section is regarded for copper cables.

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8.2 Mains Supply

Mains supply	
Supply terminals (6-pulse)	L1, L2, L3
Supply terminals (12-pulse)	L1-1, L2-1, L3-1, L1-2, L2-2, L3-2
Supply voltage	200–240 V ±10%
Supply voltage	FC 301: 380–480 V/FC 302: 380–500 V ±10%
Supply voltage	FC 302: 525–600 V ±10%
Supply voltage	FC 302: 525–690 V ±10%

Mains voltage low/mains dropout:
During low mains voltage or a mains dropout, the frequency converter continues until the DC-link voltage drops below the minimum stop level, which corresponds typically to 15% below the frequency converter's lowest rated supply voltage. Power-up and full torque cannot be expected at mains voltage lower than 10% below the frequency converter's lowest rated supply voltage.

Supply frequency	50/60 Hz ±5%
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 (cos ϕ)	Near unity (>0.98)
Switching on input supply L1, L2, L3 (power-ups) ≤7.5 kW (10 hp)	Maximum twice per minute.
Switching on input supply L1, L2, L3 (power-ups) 11–75 kW (15–101 hp)	Maximum once per minute.
Switching on input supply L1, L2, L3 (power-ups) ≥90 kW (121 hp)	Maximum once per 2 minutes.
Environment according to EN60664-1	Overvoltage category III/pollution degree 2

The unit is suitable for use on a circuit capable of delivering not more than 100000 RMS symmetrical Amperes, 240/500/600/690 V maximum.

8.3 Motor Output and Motor Data

Motor output (U, V, W)	
Output voltage	0–100% of supply voltage
Output frequency	0–590 Hz[1)]
Output frequency in flux mode	0–300 Hz
Switching on output	Unlimited
Ramp times	0.01–3600 s

1) Dependent on voltage and power.

Torque characteristics	
Starting torque (constant torque)	Maximum 160% for 60 s[1)] once in 10 minutes
Starting/overload torque (variable torque)	Maximum 110% up to 0.5 s[1)] once in 10 minutes
Torque rise time in flux (for 5 kHz f_{sw})	1 ms
Torque rise time in VVC$^+$ (independent of f_{sw})	10 ms

1) Percentage relates to the nominal torque.

8.4 Ambient Conditions

Environment	
Enclosure	IP20/Chassis, IP21/Type 1, IP55/Type 12, IP66/Type 4X
Vibration test	1.0 g
Maximum THD_v	10%
Maximum relative humidity	5–93% (IEC 721-3-3; Class 3K3 (non-condensing) during operation
Aggressive environment (IEC 60068-2-43) H_2S test	Class Kd
Ambient temperature[1)]	Maximum 50 °C (122 °F) (24-hour average maximum 45 °C (113 °F))
Minimum ambient temperature during full-scale operation	0 °C (32 °F)
Minimum ambient temperature at reduced performance	-10 °C (14 °F)
Temperature during storage/transport	-25 to +65/70 °C (-13 to +149/158 °F)
Maximum altitude above sea level without derating[1)]	1000 m (3280 ft)
EMC standards, Emission	EN 61800-3
EMC standards, Immunity	EN 61800-3
Energy efficiency class[2)]	IE2

1) See special conditions in the design guidefor:

- *Derating for high ambient temperature.*
- *Derating for high altitude.*

2) Determined according to EN 50598-2 at:

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

8.5 Cable Specifications

Cable lengths and cross-sections for control cables[1)]	
Maximum motor cable length, shielded	FC 301: 50 m (164 ft)/FC 302: 150 m (492 ft)
Maximum motor cable length, unshielded	FC 301: 75 m (246 ft)/FC 302: 300 m (984 ft)
Maximum cross-section to control terminals, flexible/rigid wire without cable end sleeves	1.5 mm^2/16 AWG
Maximum cross-section to control terminals, flexible wire with cable end sleeves	1 mm^2/18 AWG
Maximum cross-section to control terminals, flexible wire with cable end sleeves with collar	0.5 mm^2/20 AWG
Minimum cross-section to control terminals	0.25 mm^2/24 AWG

1) For power cables, see electrical tables in chapter 8.1 Electrical Data.

8.6 Control Input/Output and Control Data

Digital inputs	
Programmable digital inputs	FC 301: 4 (5)[1)]/FC 302: 4 (6)[1)]
Terminal number	18, 19, 27[1)], 29[1)], 32, 33
Logic	PNP or NPN
Voltage level	0–24 V DC
Voltage level, logic 0 PNP	<5 V DC
Voltage level, logic 1 PNP	>10 V DC
Voltage level, logic 0 NPN[2)]	>19 V DC
Voltage level, logic 1 NPN[2)]	<14 V DC
Maximum voltage on input	28 V DC
Pulse frequency range	0–110 kHz
(Duty cycle) minimum pulse width	4.5 ms
Input resistance, R_i	Approximately 4 kΩ

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

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2) Except STO input terminal 37.

STO terminal 37[1, 2] (terminal 37 is fixed PNP logic)	
Voltage level	0–24 V DC
Voltage level, logic 0 PNP	<4 V DC
Voltage level, logic 1 PNP	>20 V DC
Maximum voltage on input	28 V DC
Typical input current at 24 V	50 mA rms
Typical input current at 20 V	60 mA rms
Input capacitance	400 nF

All digital inputs are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.
1) See chapter 4.7.1 Safe Torque Off (STO) for further information about terminal 37 and STO.
2) When using a contactor with a DC coil inside in combination with STO, it is important to make a return way for the current from the coil when turning it off. This can be done by using a freewheel diode (or, alternatively, a 30 V or 50 V MOV for quicker response time) across the coil. Typical contactors can be bought with this diode.

Analog inputs	
Number of analog inputs	2
Terminal number	53, 54
Modes	Voltage or current
Mode select	Switch S201 and switch S202
Voltage mode	Switch S201/switch S202 = OFF (U)
Voltage level	-10 V to +10 V (scaleable)
Input resistance, R_i	Approximately 10 kΩ
Maximum voltage	±20 V
Current mode	Switch S201/switch S202 = ON (I)
Current level	0/4 to 20 mA (scaleable)
Input resistance, R_i	Approximately 200 Ω
Maximum current	30 mA
Resolution for analog inputs	10 bit (+ sign)
Accuracy of analog inputs	Maximum error 0.5% of full scale
Bandwidth	100 Hz

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

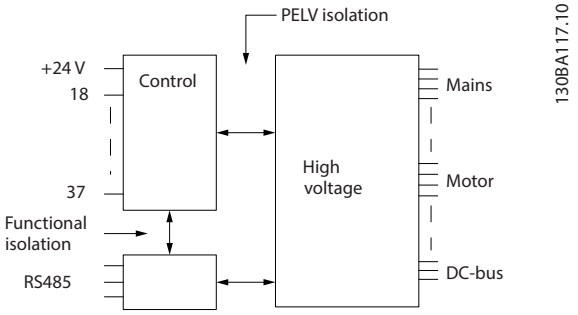

Illustration 8.1 PELV Isolation

Pulse/encoder inputs	
Programmable pulse/encoder inputs	2/1
Terminal number pulse/encoder	29[1)], 33[2)]/32[3)], 33[3)]
Maximum frequency at terminal 29, 32, 33	110 kHz (Push-pull driven)
Maximum frequency at terminal 29, 32, 33	5 kHz (Open collector)
Minimum frequency at terminal 29, 32, 33	4 Hz
Voltage level	See *parameter group 5-1* Digital Inputs* in the *programming guide*.
Maximum voltage on input	28 V DC
Input resistance, R_i	Approximately 4 kΩ
Pulse input accuracy (0.1–1 kHz)	Maximum error: 0.1% of full scale

Encoder input accuracy (1–11 kHz)	Maximum error: 0.05% of full scale

The pulse and encoder inputs (terminals 29, 32, 33) are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.
1) FC 302 only.
2) Pulse inputs are 29 and 33.
3) Encoder inputs: 32=A, 33=B.

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

1) Terminal 27 and 29 can also be programmed as input.
The digital output is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

8

Analog output	
Number of programmable analog outputs	1
Terminal number	42
Current range at analog output	0/4 to 20 mA
Maximum load GND - analog output less than	500 Ω
Accuracy on analog output	Maximum error: 0.5% of full scale
Resolution on analog output	12 bit

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

Control card, 24 V DC output	
Terminal number	12, 13
Output voltage	24 V +1, -3 V
Maximum load	200 mA

The 24 V DC supply is galvanically isolated from the supply voltage (PELV), but has the same potential as the analog and digital inputs and outputs.

Control card, 10 V DC output	
Terminal number	±50
Output voltage	10.5 V ±0.5 V
Maximum load	15 mA

The 10 V DC supply is 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

The RS485 serial communication circuit is functionally separated from other central circuits and galvanically isolated from the supply voltage (PELV).

Control card, USB serial communication	
USB standard	1.1 (full speed)
USB plug	USB type B plug

Connection to PC is carried out via a standard host/device USB cable.
The USB connection is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.
The USB ground connection is not galvanically isolated from protective earth. Use only an isolated laptop as PC connection to the USB connector on the frequency converter.

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Relay outputs	
Programmable relay outputs	FC 301 all kW: 1/FC 302 all kW: 2
Relay 01 terminal number	1–3 (break), 1–2 (make)
Maximum terminal load (AC-1)[1] on 1–3 (NC), 1–2 (NO) (resistive load)	240 V AC, 2 A
Maximum terminal load (AC-15)[1] (inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1)[1] on 1–2 (NO), 1–3 (NC) (resistive load)	60 V DC, 1 A
Maximum terminal load (DC-13)[1] (inductive load)	24 V DC, 0.1 A
Relay 02 (FC 302 only) terminal number	4–6 (break), 4–5 (make)
Maximum terminal load (AC-1)[1] on 4–5 (NO) (resistive load)[2],[3] overvoltage cat. II	400 V AC, 2 A
Maximum terminal load (AC-15)[1] on 4–5 (NO) (inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1)[1] on 4–5 (NO) (resistive load)	80 V DC, 2 A
Maximum terminal load (DC-13)[1] on 4–5 (NO) (inductive load)	24 V DC, 0.1 A
Maximum terminal load (AC-1)[1] on 4–6 (NC) (resistive load)	240 V AC, 2 A
Maximum terminal load (AC-15)[1] on 4–6 (NC) (inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1)[1] on 4–6 (NC) (resistive load)	50 V DC, 2 A
Maximum terminal load (DC-13)[1] on 4–6 (NC) (inductive load)	24 V DC, 0.1 A
Minimum terminal load on 1–3 (NC), 1–2 (NO), 4–6 (NC), 4–5 (NO)	24 V DC 1 mA, 24 V AC 20 mA
Environment according to EN 60664-1	Overvoltage category III/pollution degree 2

1) IEC 60947 part 4 and 5

The relay contacts are galvanically isolated from the rest of the circuit by reinforced isolation (PELV).

2) Overvoltage Category II.

3) UL applications 300 V AC 2 A.

Control card performance	
Scan interval	1 ms

Control characteristics	
Resolution of output frequency at 0–590 Hz	±0.003 Hz
Repeat accuracy of precise start/stop (terminals 18, 19)	≤±0.1 ms
System response time (terminals 18, 19, 27, 29, 32, 33)	≤2 ms
Speed control range (open loop)	1:100 of synchronous speed
Speed control range (closed loop)	1:1000 of synchronous speed
Speed accuracy (open loop)	30–4000 RPM: Error ±8 RPM
Speed accuracy (closed loop), depending on resolution of feedback device	0–6000 RPM: Error ±0.15 RPM
Torque control accuracy (speed feedback)	Maximum error ±5% of rated torque

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

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8.7 Fuses and Circuit Breakers

Use recommended fuses and/or circuit breakers on the supply side as protection if there is component break-down inside the frequency converter (first fault).

NOTICE

Use of fuses on the supply side is mandatory for IEC 60364 (CE) and NEC 2009 (UL) compliant installations.

Recommendations

- gG type fuses.
- Moeller type circuit breakers. For other circuit breaker types, ensure that the energy into the frequency converter is equal to or lower than the energy provided by Moeller types.

Use of recommended fuses and circuit breakers ensures that possible damage to the frequency converter is limited to damage inside the unit. For further information, see *Application Note Fuses and Circuit Breakers*.

The fuses in *chapter 8.7.1 CE Compliance* to *chapter 8.7.2 UL Compliance* are suitable for use on a circuit capable of delivering 100000 A_{rms} (symmetrical), depending on the frequency converter voltage rating. With the proper fusing, the frequency converter short-circuit current rating (SCCR) is 100000 A_{rms}.

8

8.7.1 CE Compliance

200–240 V

Enclosure	Power [kW (hp)]	Recommended fuse size	Recommended maximum fuse	Recommended circuit breaker Moeller	Maximum trip level [A]
A1	0.25–1.5 (0.34–2.0)	gG-10	gG-25	PKZM0-16	16
A2	0.25–1.5 (0.34–2.0)	gG-10	gG-25	PKZM0-25	25
	2.2 (3.0)	gG-16			
A3	3.0 (4.0)	gG-16	gG-32	PKZM0-25	25
	3.7 (5.0)	gG-20			
A4	0.25–1.5 (0.34–2.0)	gG-10	gG-32	PKZM0-25	25
	2.2 (3.0)	gG-16			
A5	0.25–1.5 (0.34–2.0)	gG-10	gG-32	PKZM0-25	25
	2.2–3.0 (3.0–4.0)	gG-16			
	3.7 (5.0)	gG-20			
B1	5.5 (7.5)	gG-25	gG-80	PKZM4-63	63
	7.5 (10.0)	gG-32			
B2	11.0 (15.0)	gG-50	gG-100	NZMB1-A100	100
B3	5.5 (7.5)	gG-25	gG-63	PKZM4-50	50
B4	7.5 (10.0)	gG-32	gG-125	NZMB1-A100	100
	11.0 (15.0)	gG-50			
	15.0 (20.0)	gG-63			
C1	15.0 (20.0)	gG-63	gG-160	NZMB2-A200	160
	18.5 (25.0)	gG-80			
	22.0 (30.0)	gG-100	aR-160		
C2	30.0 (40.0)	aR-160	aR-200	NZMB2-A250	250
	37.0 (50.0)	aR-200	aR-250		
C3	18.5 (25.0)	gG-80	gG-150	NZMB2-A200	150
	22.0 (30.0)	aR-125	aR-160		
C4	30.0 (40.0)	aR-160	aR-200	NZMB2-A250	250
	37.0 (50.0)	aR-200	aR-250		

Table 8.13 200–240 V, Enclosure Sizes A, B, and C

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380–500 V

Enclosure	Power [kW (hp)]	Recommended fuse size	Recommended maximum fuse	Recommended circuit breaker Moeller	Maximum trip level [A]
A1	0.37–1.5 (0.5–2.0)	gG-10	gG-25	PKZM0-16	16
A2	0.37–3.0 (0.5–4.0)	gG-10	gG-25	PKZM0-25	25
	4.0 (5.0)	gG-16			
A3	5.5–7.5 (7.5–10.0)	gG-16	gG-32	PKZM0-25	25
A4	0.37–3.0 (0.5–4.0)	gG-10	gG-32	PKZM0-25	25
	4.0 (5.0)	gG-16			
A5	0.37–3.0 (0.5–4.0)	gG-10	gG-32	PKZM0-25	25
	4.0–7.5 (5.0–10.0)	gG-16			
B1	11–15 (15.0–20.0)	gG-40	gG-80	PKZM4-63	63
B2	18.5 (25.0)	gG-50	gG-100	NZMB1-A100	100
	22.0 (30.0)	gG-63			
B3	11–15 (15.0–20.0)	gG-40	gG-63	PKZM4-50	50
B4	18.5 (25.0)	gG-50	gG-125	NZMB1-A100	100
	22.0 (30.0)	gG-63			
	30.0 (40.0)	gG-80			
C1	30.0 (40.0)	gG-80	gG-160	NZMB2-A200	160
	37.0 (50.0)	gG-100			
	45.0 (60.0)	gG-160			
C2	55.0 (75.0)	aR-200	aR-250	NZMB2-A250	250
	75.0 (100.0)	aR-250			
C3	37.0 (50.0)	gG-100	gG-150	NZMB2-A200	150
	45.0 (60.0)	gG-160	gG-160		
C4	55.0 (75.0)	aR-200	aR-250	NZMB2-A250	250
	75.0 (100.0)	aR-250			

Table 8.14 380–500 V, Enclosure Sizes A, B, and C

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525–600 V

Enclosure	Power [kW (hp)]	Recommended fuse size	Recommended maximum fuse	Recommended circuit breaker Moeller	Maximum trip level [A]
A2	0-75-4.0 (1.0–5.0)	gG-10	gG-25	PKZM0-25	25
A3	5.5 (7.5)	gG-10	gG-32	PKZM0-25	25
	7.5 (10.0)	gG-16			
A5	5.5 (7.5)	gG-10	gG-32	PKZM0-25	25
	7.5 (10.0)	gG-16			
B1	11.0 (15.0)	gG-25	gG-80	PKZM4-63	63
	15.0 (20.0)	gG-32			
	18.5 (25.0)	gG-40			
B2	22.0 (30.0)	gG-50	gG-100	NZMB1-A100	100
	30.0 (40.0)	gG-63			
B3	11.0 (15.0)	gG-25	gG-63	PKZM4-50	50
	15.0 (20.0)	gG-32			
B4	18.5 (25.0)	gG-40	gG-125	NZMB1-A100	100
	22.0 (30.0)	gG-50			
	30.0 (40.0)	gG-63			
C1	37.0 (50.0)	gG-63	gG-160	NZMB2-A200	160
	45.0 (60.0)	gG-100			
	55.0 (60.0)	aR-160	aR-250		
C2	75.0 (100.0)	aR-200	aR-250	NZMB2-A250	250
C3	37.0 (50.0)	gG-63	gG-150	NZMB2-A200	150
	45.0 (60.0)	gG-100	gG-150	NZMB2-A200	
C4	55.0 (75.0)	aR-160	aR-250	NZMB2-A250	250
	75.0 (100.0)	aR-200			

Table 8.15 525–600 V, Enclosure Sizes A, B, and C

525–690 V

Enclosure	Power [kW (hp)]	Recommended fuse size	Recommended maximum fuse	Recommended circuit breaker Moeller	Maximum trip level [A]
A3	1.1 (1.5)	gG-6	gG-25	PKZM0-16	16
	1.5 (2.0)	gG-6	gG-25		
	2.2 (3.0)	gG-6	gG-25		
	3.0 (4.0)	gG-10	gG-25		
	4.0 (5.0)	gG-10	gG-25		
	5.5 (7.5)	gG-16	gG-25		
	7.5 (10.0)	gG-16	gG-25		
B2/B4	11.0 (15.0)	gG-25	gG-63	–	–
	15.0 (20.0)	gG-32			
	18.5 (25.0)	gG-32			
	22.0 (30.0)	gG-40			
B4/C2	30.0 (40.0)	gG-63	gG-80	–	–
C2/C3	37.0 (50.0)	gG-63	gG-100	–	–
	45.0 (60.0)	gG-80	gG-125		
C2	55.0 (75.0)	gG-100	gG-160	–	–
	75.0 (100.0)	gG-125			

Table 8.16 525–690 V, Enclosure Sizes A, B, and C

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8.7.2 UL Compliance

200–240 V

	Recommended maximum fuse					
Power [kW (hp)]	Bussmann Type RK1[1)]	Bussmann Type J	Bussmann Type T	Bussmann Type CC	Bussmann Type CC	Bussmann Type CC
0.25–0.37 (0.34–0.5)	KTN-R-05	JKS-05	JJN-05	FNQ-R-5	KTK-R-5	LP-CC-5
0.55–1.1 (0.75–1.5)	KTN-R-10	JKS-10	JJN-10	FNQ-R-10	KTK-R-10	LP-CC-10
1.5 (2.0)	KTN-R-15	JKS-15	JJN-15	FNQ-R-15	KTK-R-15	LP-CC-15
2.2 (3.0)	KTN-R-20	JKS-20	JJN-20	FNQ-R-20	KTK-R-20	LP-CC-20
3.0 (4.0)	KTN-R-25	JKS-25	JJN-25	FNQ-R-25	KTK-R-25	LP-CC-25
3.7 (5.0)	KTN-R-30	JKS-30	JJN-30	FNQ-R-30	KTK-R-30	LP-CC-30
5.5 (7.5)	KTN-R-50	KS-50	JJN-50	–	–	–
7.5 (10.0)	KTN-R-60	JKS-60	JJN-60	–	–	–
11.0 (15.0)	KTN-R-80	JKS-80	JJN-80	–	–	–
15–18.5 (20.0–25.0)	KTN-R-125	JKS-125	JJN-125	–	–	–
22.0 (30.0)	KTN-R-150	JKS-150	JJN-150	–	–	–
30.0 (40.0)	KTN-R-200	JKS-200	JJN-200	–	–	–
37.0 (50.0)	KTN-R-250	JKS-250	JJN-250	–	–	–

Table 8.17 200–240 V, Enclosure Sizes A, B, and C

	Recommended maximum fuse							
Power [kW (hp)]	SIBA Type RK1	Littelfuse Type RK1	Ferraz-Shawmut Type CC	Ferraz-Shawmut Type RK1[3)]	Bussmann Type JFHR2[2)]	Littelfuse JFHR2	Ferraz-Shawmut JFHR2[4)]	Ferraz-Shawmut J
0.25–0.37 (0.34–0.5)	5017906-005	KLN-R-05	ATM-R-05	A2K-05-R	FWX-5	–	–	HSJ-6
0.55–1.1 (0.75–1.5)	5017906-010	KLN-R-10	ATM-R-10	A2K-10-R	FWX-10	–	–	HSJ-10
1.5 (2.0)	5017906-016	KLN-R-15	ATM-R-15	A2K-15-R	FWX-15	–	–	HSJ-15
2.2 (3.0)	5017906-020	KLN-R-20	ATM-R-20	A2K-20-R	FWX-20	–	–	HSJ-20
3.0 (4.0)	5017906-025	KLN-R-25	ATM-R-25	A2K-25-R	FWX-25	–	–	HSJ-25
3.7 (5.0)	5012406-032	KLN-R-30	ATM-R-30	A2K-30-R	FWX-30	–	–	HSJ-30
5.5 (7.5)	5014006-050	KLN-R-50	–	A2K-50-R	FWX-50	–	–	HSJ-50
7.5 (10.0)	5014006-063	KLN-R-60	–	A2K-60-R	FWX-60	–	–	HSJ-60
11.0 (15.0)	5014006-080	KLN-R-80	–	A2K-80-R	FWX-80	–	–	HSJ-80
15–18.5 (20.0–25.0)	2028220-125	KLN-R-125	–	A2K-125-R	FWX-125	–	–	HSJ-125
22.0 (30.0)	2028220-150	KLN-R-150	–	A2K-150-R	FWX-150	L25S-150	A25X-150	HSJ-150
30.0 (40.0)	2028220-200	KLN-R-200	–	A2K-200-R	FWX-200	L25S-200	A25X-200	HSJ-200
37.0 (50.0)	2028220-250	KLN-R-250	–	A2K-250-R	FWX-250	L25S-250	A25X-250	HSJ-250

Table 8.18 200–240 V, Enclosure Sizes A, B, and C

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

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

3) A6KR fuses from Ferraz Shawmut may substitute A2KR for 240 V frequency converters.

4) A50X fuses from Ferraz Shawmut may substitute A25X for 240 V frequency converters.

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380–500 V

	Recommended maximum fuse					
Power [kW (hp)]	Bussmann Type RK1	Bussmann Type J	Bussmann Type T	Bussmann Type CC	Bussmann Type CC	Bussmann Type CC
0.37–1.1 (0.5–1.5)	KTS-R-6	JKS-6	JJS-6	FNQ-R-6	KTK-R-6	LP-CC-6
1.5–2.2 (2.0–3.0)	KTS-R-10	JKS-10	JJS-10	FNQ-R-10	KTK-R-10	LP-CC-10
3.0 (4.0)	KTS-R-15	JKS-15	JJS-15	FNQ-R-15	KTK-R-15	LP-CC-15
4.0 (5.0)	KTS-R-20	JKS-20	JJS-20	FNQ-R-20	KTK-R-20	LP-CC-20
5.5 (7.5)	KTS-R-25	JKS-25	JJS-25	FNQ-R-25	KTK-R-25	LP-CC-25
7.5 (10.0)	KTS-R-30	JKS-30	JJS-30	FNQ-R-30	KTK-R-30	LP-CC-30
11.0 (15.0)	KTS-R-40	JKS-40	JJS-40	–	–	–
15.0 (20.0)	KTS-R-50	JKS-50	JJS-50	–	–	–
18.5 (25.0)	KTS-R-60	JKS-60	JJS-60	–	–	–
22.0 (30.0)	KTS-R-80	JKS-80	JJS-80	–	–	–
30.0 (40.0)	KTS-R-100	JKS-100	JJS-100	–	–	–
37.0 (50.0)	KTS-R-125	JKS-125	JJS-125	–	–	–
45.0 (60.0)	KTS-R-150	JKS-150	JJS-150	–	–	–
55.0 (75.0)	KTS-R-200	JKS-200	JJS-200	–	–	–
75.0 (100.0)	KTS-R-250	JKS-250	JJS-250	–	–	–

Table 8.19 380–500 V, Enclosure Sizes A, B, and C

	Recommended maximum fuse							
Power [kW (hp)]	SIBA Type RK1	Littelfuse Type RK1	Ferraz Shawmut Type CC	Ferraz Shawmut Type RK1	Bussmann JFHR2	Ferraz Shawmut JFerraz Shawmut J	Ferraz Shawmut JFHR2[1)]	Littelfuse JFHR2
0.37–1.1 (0.5–1.5)	5017906-006	KLS-R-6	ATM-R-6	A6K-6-R	FWH-6	HSJ-6	–	–
1.5–2.2 (2.0–3.0)	5017906-010	KLS-R-10	ATM-R-10	A6K-10-R	FWH-10	HSJ-10	–	–
3.0 (4.0)	5017906-016	KLS-R-15	ATM-R-15	A6K-15-R	FWH-15	HSJ-15	–	–
4.0 (5.0)	5017906-020	KLS-R-20	ATM-R-20	A6K-20-R	FWH-20	HSJ-20	–	–
5.5 (7.5)	5017906-025	KLS-R-25	ATM-R-25	A6K-25-R	FWH-25	HSJ-25	–	–
7.5 (10.0)	5012406-032	KLS-R-30	ATM-R-30	A6K-30-R	FWH-30	HSJ-30	–	–
11.0 (15.0)	5014006-040	KLS-R-40	–	A6K-40-R	FWH-40	HSJ-40	–	–
15.0 (20.0)	5014006-050	KLS-R-50	–	A6K-50-R	FWH-50	HSJ-50	–	–
18.5 (25.0)	5014006-063	KLS-R-60	–	A6K-60-R	FWH-60	HSJ-60	–	–
22.0 (30.0)	2028220-100	KLS-R-80	–	A6K-80-R	FWH-80	HSJ-80	–	–
30.0 (40.0)	2028220-125	KLS-R-100	–	A6K-100-R	FWH-100	HSJ-100	–	–
37.0 (50.0)	2028220-125	KLS-R-125	–	A6K-125-R	FWH-125	HSJ-125	–	–
45.0 (60.0)	2028220-160	KLS-R-150	–	A6K-150-R	FWH-150	HSJ-150	–	–
55.0 (75.0)	2028220-200	KLS-R-200	–	A6K-200-R	FWH-200	HSJ-200	A50-P-225	L50-S-225
75.0 (100.0)	2028220-250	KLS-R-250	–	A6K-250-R	FWH-250	HSJ-250	A50-P-250	L50-S-250

Table 8.20 380–500 V, Enclosure Sizes A, B, and C

1) Ferraz Shawmut A50QS fuses may substitute for A50P fuses.

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525–600 V

	Recommended maximum fuse									
Power [kW (hp)]	**Bussmann Type RK1**	**Bussmann Type J**	**Bussmann Type T**	**Bussmann Type CC**	**Bussmann Type CC**	**Bussmann Type CC**	**SIBA Type RK1**	**Littelfuse Type RK1**	**Ferraz Shawmut Type RK1**	**Ferraz Shawmut J**
0.75–1.1 (1.0–1.5)	KTS-R-5	JKS-5	JJS-6	FNQ-R-5	KTK-R-5	LP-CC-5	5017906-005	KLS-R-005	A6K-5-R	HSJ-6
1.5–2.2 (2.0–3.0)	KTS-R-10	JKS-10	JJS-10	FNQ-R-10	KTK-R-10	LP-CC-10	5017906-010	KLS-R-010	A6K-10-R	HSJ-10
3.0 (4.0)	KTS-R15	JKS-15	JJS-15	FNQ-R-15	KTK-R-15	LP-CC-15	5017906-016	KLS-R-015	A6K-15-R	HSJ-15
4.0 (5.0)	KTS-R20	JKS-20	JJS-20	FNQ-R-20	KTK-R-20	LP-CC-20	5017906-020	KLS-R-020	A6K-20-R	HSJ-20
5.5 (7.5)	KTS-R-25	JKS-25	JJS-25	FNQ-R-25	KTK-R-25	LP-CC-25	5017906-025	KLS-R-025	A6K-25-R	HSJ-25
7.5 (10.0)	KTS-R-30	JKS-30	JJS-30	FNQ-R-30	KTK-R-30	LP-CC-30	5017906-030	KLS-R-030	A6K-30-R	HSJ-30
11 (15.0)	KTS-R-35	JKS-35	JJS-35	–	–	–	5014006-040	KLS-R-035	A6K-35-R	HSJ-35
15.0 (20.0)	KTS-R-45	JKS-45	JJS-45	–	–	–	5014006-050	KLS-R-045	A6K-45-R	HSJ-45
18.5 (25.0)	KTS-R-50	JKS-50	JJS-50	–	–	–	5014006-050	KLS-R-050	A6K-50-R	HSJ-50
22.0 (30.0)	KTS-R-60	JKS-60	JJS-60	–	–	–	5014006-063	KLS-R-060	A6K-60-R	HSJ-60
30.0 (40.0)	KTS-R-80	JKS-80	JJS-80	–	–	–	5014006-080	KLS-R-075	A6K-80-R	HSJ-80
37.0 (50.0)	KTS-R-100	JKS-100	JJS-100	–	–	–	5014006-100	KLS-R-100	A6K-100-R	HSJ-100
45.0 (60.0)	KTS-R-125	JKS-125	JJS-125	–	–	–	2028220-125	KLS-R-125	A6K-125-R	HSJ-125
55.0 (75.0)	KTS-R-150	JKS-150	JJS-150	–	–	–	2028220-150	KLS-R-150	A6K-150-R	HSJ-150
75.0 (100.0)	KTS-R-175	JKS-175	JJS-175	–	–	–	2028220-200	KLS-R-175	A6K-175-R	HSJ-175

Table 8.21 525–600 V, Enclosure Sizes A, B, and C

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525–690 V

	Recommended maximum fuse					
Power [kW (hp)]	Bussmann Type RK1	Bussmann Type J	Bussmann Type T	Bussmann Type CC	Bussmann Type CC	Bussmann Type CC
1.1 (1.5)	KTS-R-5	JKS-5	JJS-6	FNQ-R-5	KTK-R-5	LP-CC-5
1.5–2.2 (2.0–3.0)	KTS-R-10	JKS-10	JJS-10	FNQ-R-10	KTK-R-10	LP-CC-10
3.0 (4.0)	KTS-R15	JKS-15	JJS-15	FNQ-R-15	KTK-R-15	LP-CC-15
4.0 (5.0)	KTS-R20	JKS-20	JJS-20	FNQ-R-20	KTK-R-20	LP-CC-20
5.5 (7.5)	KTS-R-25	JKS-25	JJS-25	FNQ-R-25	KTK-R-25	LP-CC-25
7.5 (10.0)	KTS-R-30	JKS-30	JJS-30	FNQ-R-30	KTK-R-30	LP-CC-30
11.0 (15.0)	KTS-R-35	JKS-35	JJS-35	–	–	–
15.0 (20.0)	KTS-R-45	JKS-45	JJS-45	–	–	–
18.5 (25.0)	KTS-R-50	JKS-50	JJS-50	–	–	–
22.0 (30.0)	KTS-R-60	JKS-60	JJS-60	–	–	–
30.0 (40.0)	KTS-R-80	JKS-80	JJS-80	–	–	–
37.0 (50.0)	KTS-R-100	JKS-100	JJS-100	–	–	–
45.0 (60.0)	KTS-R-125	JKS-125	JJS-125	–	–	–
55.0 (75.0)	KTS-R-150	JKS-150	JJS-150	–	–	–
75.0 (100.0)	KTS-R-175	JKS-175	JJS-175	–	–	–

Table 8.22 525–690 V, Enclosure Sizes A, B, and C

	Recommended maximum fuse							
Power [kW (hp)]	Maximum pre-fuse	Bussmann E52273 RK1/JDDZ	Bussmann E4273 J/JDDZ	Bussmann E4273 T/JDDZ	SIBA E180276 RK1/JDDZ	Littelfuse E81895 RK1/JDDZ	Ferraz Shawmut E163267/ E2137 RK1/JDDZ	Ferraz Shawmut E2137 J/HSJ
11.0 (15.0)	30 A	KTS-R-30	JKS-30	JKJS-30	5017906-030	KLS-R-030	A6K-30-R	HST-30
15–18.5 (20.0–25.0)	45 A	KTS-R-45	JKS-45	JJS-45	5014006-050	KLS-R-045	A6K-45-R	HST-45
22.0 (30.0)	60 A	KTS-R-60	JKS-60	JJS-60	5014006-063	KLS-R-060	A6K-60-R	HST-60
30.0 (40.0)	80 A	KTS-R-80	JKS-80	JJS-80	5014006-080	KLS-R-075	A6K-80-R	HST-80
37.0 (50.0)	90 A	KTS-R-90	JKS-90	JJS-90	5014006-100	KLS-R-090	A6K-90-R	HST-90
45.0 (60.0)	100 A	KTS-R-100	JKS-100	JJS-100	5014006-100	KLS-R-100	A6K-100-R	HST-100
55.0 (75.0)	125 A	KTS-R-125	JKS-125	JJS-125	2028220-125	KLS-150	A6K-125-R	HST-125
75.0 (100.0)	150 A	KTS-R-150	JKS-150	JJS-150	2028220-150	KLS-175	A6K-150-R	HST-150

Table 8.23 525–690 V, Enclosure Sizes B, and C

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8.8 Connection Tightening Torques

Enclosure Size	200–240 V [kW (hp)]	380–500 V [kW (hp)]	525–690 V [kW (hp)]	Purpose	Tightening torque [Nm] ([in-lb])
A2	0.25–2.2 (0.34–3.0)	0.37–4 (0.5–5.0)	–	Mains, brake resistor, load sharing, motor cables.	0.5–0.6 (4.4–5.3)
A3	3–3.7 (4.0–5.0)	5.5–7.5 (7.5–10.0)	1.1–7.5 (1.5–10.0)		
A4	0.25–2.2 (0.34–3.0)	0.37–4 (0.5–5.0)	–		
A5	3–3.7 (4.0–5.0)	5.5–7.5 (7.5–10.0)	–		
B1	5.5–7.5 (7.5–10.0)	11–15 (15–20)	–	Mains, brake resistor, load sharing, motor cables.	1.8 (15.9)
				Relay.	0.5–0.6 (4.4–5.3)
				Ground.	2–3 (17.7–26.6)
B2	11 (15)	18.5–22 (25–30)	11–22 (15–30)	Mains, brake resistor, load sharing cables.	4.5 (39.8)
				Motor cables.	4.5 (39.8)
				Relay.	0.5–0.6 (4.4–5.3)
				Ground.	2–3 (17.7–26.6)
B3	5.5–7.5 (7.5–10.0)	11–15 (15–20)	–	Mains, brake resistor, load sharing, motor cables.	1.8 (15.9)
				Relay.	0.5–0.6 (4.4–5.3)
				Ground.	2–3 (17.7–26.6)
B4	11–15 (15–20)	18.5–30 (25–40)	11–30 (15–40)	Mains, brake resistor, load sharing, motor cables.	4.5 (39.8)
				Relay.	0.5–0.6 (4.4–5.3)
				Ground.	2–3 (17.7–26.6)
C1	15–22 (20–30)	30–45 (40–60)	–	Mains, brake resistor, load sharing cables.	10 (89)
				Motor cables.	10 (89)
				Relay.	0.5–0.6 (4.4–5.3)
				Ground.	2–3 (17.7–26.6)
C2	30–37 (40–50)	55–75 (75–100)	30–75 (40–100)	Mains, motor cables.	14 (124) (up to 95 mm^2 (3 AWG)) 24 (212) (over 95 mm^2 (3 AWG))
				Load sharing, brake cables.	14 (124)
				Relay.	0.5–0.6 (4.4–5.3)
				Ground.	2–3 (17.7–26.6)
C3	18.5–22 (25–30)	30–37 (40–50)	37–45 (50–60)	Mains, brake resistor, load sharing, motor cables.	10 (89)
				Relay.	0.5–0.6 (4.4–5.3)
				Ground.	2–3 (17.7–26.6)
C4	37–45 (50–60)	55–75 (75–100)	11–22 (15–30)	Mains, motor cables.	14 (124) (up to 95 mm^2 (3 AWG)) 24 (212) (over 95 mm^2 (3 AWG))
				Load sharing, brake cables.	14 (124)
				Relay.	0.5–0.6 (4.4–5.3)
				Ground.	2–3 (17.7–26.6)

Table 8.24 Tightening Torque for Cables

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Enclosure size			A1	A2		A3		A4	A5
Rated power [kW (hp)]	**200–240 V**		**0.25–1.5 (0.34–2)**	**0.25–2.2 (0.34–3)**		**3–3.7 (4–5)**		**0.25–2.2 (0.34–3)**	**0.25–3.7 (0.34–5)**
	380–480/500 V		**0.37–1.5 (0.5–2)**	**0.37–4 (0.5–5)**		**5.5–7.5 (7.5–10)**		**0.37–4 (0.5–5)**	**0.37–7.5 (0.5–10)**
	525–600 V		–	–		**0.75–7.5 (1–10)**		–	**0.75–7.5 (1–10)**
	525–690 V		–	–		**1.1–7.5 (1.5–10)**		–	–
IP NEMA	–		20 Chassis	20 Chassis	21 Type 1	20 Chassis	21 Type 1	55/66 Type 12/4X	55/66 Type 12/4X
Height [mm (in)]									
Height of mounting plate		A[1)]	200 (7.9)	268 (10.6)	375 (14.8)	268 (10.6)	375 (14.8)	390 (15.4)	420 (16.5)
Height with ground termination plate for fieldbus cables		A	316 (12.4)	374 (14.7)	–	374 (14.7)	–	–	–
Distance between mounting holes		a	190 (7.5)	257 (10.1)	350 (13.8)	257 (10.1)	350 (13.8)	401 (15.8)	402 (15.8)
Width [mm (in)]									
Width of mounting plate		B	75 (3)	90 (3.5)	90 (3.5)	130 (5.1)	130 (5.1)	200 (7.9)	242 (9.5)
Width of mounting plate with 1 C option		B	–	130 (5.1)	130 (5.1)	170 (6.7)	170 (6.7)	–	242 (9.5)
Width of mounting plate with 2 C options		B	–	150 (5.9)	150 (5.9)	190 (7.5)	190 (7.5)	–	242 (9.5)
Distance between mounting holes		b	60 (2.4)	70 (2.8)	70 (2.8)	110 (4.3)	110 (4.3)	171 (6.7)	215 (8.5)
Depth [mm (in)]									
Depth without option A/B		C	207 (8.1)	205 (8.1)	207 (8.1)	205 (8.1)	207 (8.1)	175 (6.9)	200 (7.9)
With option A/B		C	222 (8.7)	220 (8.7)	222 (8.7)	220 (8.7)	222 (8.7)	175 (6.9)	200 (7.9)
Screw holes [mm (in)]									
		c	6.0 (0.24)	8.0 (0.31)	8.0 (0.31)	8.0 (0.31)	8.0 (0.31)	8.25 (0.32)	8.25 (0.32)
		d	ø8 (ø0.31)	ø11 (ø0.43)	ø11 (ø0.43)	ø11 (ø0.43)	ø11 (ø0.43)	ø12 (ø0.47)	ø12 (ø0.47)
		e	ø5 (ø0.2)	ø5.5 (ø0.22)	ø5.5 (ø0.22)	ø5.5 (ø0.22)	ø5.5 (ø0.22)	ø6.5 (ø0.26)	ø6.5 (ø0.26)
		f	5 (0.2)	9 (0.35)	9 (0.35)	6.5 (0.26)	6.5 (0.26)	6 (0.24)	9 (0.35)
Maximum weight [kg (lb)]			2.7 (6)	4.9 (10.8)	5.3 (11.7)	6.6 (14.6)	7 (15.4)	9.7 (21.4)	13.5/14.2 (30/31)
Front cover tightening torque [Nm (in-lb)]									
Plastic cover (low IP)			Click	Click		Click		–	–

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Enclosure size		A1	A2	A3	A4	A5
Rated power [kW (hp)]	200–240 V	0.25–1.5 (0.34–2)	0.25–2.2 (0.34–3)	3–3.7 (4–5)	0.25–2.2 (0.34–3)	0.25–3.7 (0.34–5)
	380–480/500 V	0.37–1.5 (0.5–2)	0.37–4 (0.5–5)	5.5–7.5 (7.5–10)	0.37–4 (0.5–5)	0.37–7.5 (0.5–10)
	525–600 V	–	–	0.75–7.5 (1–10)	–	0.75–7.5 (1–10)
	525–690 V	–	–	1.1–7.5 (1.5–10)	–	–
Metal cover (IP55/66)		–	–	–	1.5 (13.3)	1.5 (13.3)
1) See *Illustration 8.2* and *Illustration 8.3* for top and bottom mounting holes.						

Table 8.25 Power Ratings, Weight, and Dimensions, Enclosure Sizes A1–A5

Enclosure size			B1	B2	B3	B4
Rated power [kW (hp)]	**200–240 V**		**5.5–7.5 (7.5–10)**	**15**	**5.5–7.5 (7.5–10)**	**11–15 (15–20)**
	380–480/500 V		**11–15 (15–20)**	**18.5–22 (25–30)**	**11–15 (15–20)**	**18.5–30 (25–40)**
	525–600 V		**11–15 (15–20)**	**18.5–22 (25–30)**	**11–15 (15–20)**	**18.5–30 (25–40)**
	525–690 V		–	**11–22 (15–30)**	–	**11–30 (15–40)**
IP NEMA	–		21/55/66 Type 1/12/4X	21/55/66 Type 1/12/4X	20 Chassis	20 Chassis
Height [mm (in)]						
Height of mounting plate		A[1)]	480 (18.9)	650 (25.6)	399 (15.7)	520 (20.5)
Height with ground termination plate for fieldbus cables		A	–	–	420 (16.5)	595 (23.4)
Distance between mounting holes		a	454 (17.9)	624 (24.6)	380 (15)	495 (19.5)
Width [mm (in)]						
Width of mounting plate		B	242 (9.5)	242 (9.5)	165 (6.5)	230 (9.1)
Width of mounting plate with 1 C option		B	242 (9.5)	242 (9.5)	205 (8.1)	230 (9.1)
Width of mounting plate with 2 C options		B	242 (9.5)	242 (9.5)	225 (8.9)	230 (9.1)
Distance between mounting holes		b	210 (8.3)	210 (8.3)	140 (5.5)	200 (7.9)
Depth [mm (in)]						
Depth without option A/B		C	260 (10.2)	260 (10.2)	249 (9.8)	242 (9.5)
With option A/B		C	260 (10.2)	260 (10.2)	262 (10.3)	242 (9.5)
Screw holes [mm (in)]						
		c	12 (0.47)	12 (0.47)	8 (0.31)	–
		d	ø19 (ø0.75)	ø19 (ø0.75)	12 (0.47)	–
		e	ø9 (ø0.35)	ø9 (ø0.35)	6.8 (0.27)	8.5 (0.33)
		f	9 (0.35)	9 (0.35)	7.9 (0.31)	15 (0.59)
Maximum weight [kg (lb)]			23 (51)	27 (60)	12 (26.5)	23.5 (52)
Front cover tightening torque [Nm (in-lb)]						
Plastic cover (low IP)			Click	Click	Click	Click
Metal cover (IP55/66)			2.2 (19.5)	2.2 (19.5)	–	–

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Enclosure size		B1	B2	B3	B4
Rated power [kW (hp)]	200–240 V	5.5–7.5 (7.5–10)	15	5.5–7.5 (7.5–10)	11–15 (15–20)
	380–480/500 V	11–15 (15–20)	18.5–22 (25–30)	11–15 (15–20)	18.5–30 (25–40)
	525–600 V	11–15 (15–20)	18.5–22 (25–30)	11–15 (15–20)	18.5–30 (25–40)
	525–690 V	–	11–22 (15–30)	–	11–30 (15–40)
1) See *Illustration 8.2* and *Illustration 8.3* for top and bottom mounting holes.					

Table 8.26 Power Ratings, Weight, and Dimensions, Enclosure Sizes B1–B4

Enclosure size			C1	C2	C3	C4	D3h
Rated power [kW (hp)]	**200–240 V**		**15–22 (20–30)**	**30–37 (40–50)**	**18.5–22 (25–30)**	**30–37 (40–50)**	–
	380–480/500 V		**30–45 (40–60)**	**55–75 (75–100)**	**37–45 (50–60)**	**55–75 (75–100)**	–
	525–600 V		**30–45 (40–60)**	**55–90 (75–125)**	**37–45 (50–60)**	**55–90 (75–125)**	–
	525–690 V		–	**30–75 (40–100)**	**37–45 (50–60)**	**37–45 (50–60)**	**55–75 (75–100)**
IP NEMA	–		21/55/66 Type 1/12/4X	21/55/66 Type 1/12/4X	20 Chassis	20 Chassis	20 Chassis
Height [mm (in)]							
Height of mounting plate		A[1)]	680 (26.8)	770 (30.3)	550 (21.7)	660 (26)	909 (35.8)
Height with ground termination plate for fieldbus cables		A	–	–	630 (24.8)	800 (31.5)	–
Distance between mounting holes		a	648 (25.5)	739 (29.1)	521 (20.5)	631 (24.8)	–
Width [mm (in)]							
Width of mounting plate		B	308 (12.1)	370 (14.6)	308 (12.1)	370 (14.6)	250 (9.8)
Width of mounting plate with 1 C option		B	308 (12.1)	370 (14.6)	308 (12.1)	370 (14.6)	–
Width of mounting plate with 2 C options		B	308 (12.1)	370 (14.6)	308 (12.1)	370 (14.6)	–
Distance between mounting holes		b	272 (10.7)	334 (13.1)	270 (10.6)	330 (13)	–
Depth [mm (in)]							
Depth without option A/B		C	310 (12.2)	335 (13.2)	333 (13.1)	333 (13.1)	375 (14.8)
With option A/B		C	310 (12.2)	335 (13.2)	333 (13.1)	333 (13.1)	375 (14.8)
Screw holes [mm (in)]							
		c	12.5 (0.49)	12.5 (0.49)	–	–	–
		d	ø19 (ø0.75)	ø19 (ø0.75)	–	–	–
		e	ø9 (ø0.35)	ø9 (ø0.35)	8.5 (0.33)	8.5 (0.33)	–
		f	9.8 (0.39)	9.8 (0.39)	17 (0.67)	17 (0.67)	–
Maximum weight [kg (lb)]			45 (99)	65 (143)	35 (77)	50 (110)	62 (137)
Front cover tightening torque [Nm (in-lb)]							
Plastic cover (low IP)			Click	Click	2 (17.7)	2 (17.7)	–
Metal cover (IP55/66)			2.2 (19.5)	2.2 (19.5)	2 (17.7)	2 (17.7)	–
1) See *Illustration 8.2* and *Illustration 8.3* for top and bottom mounting holes.							

Table 8.27 Power Ratings, Weight, and Dimensions, Enclosure Sizes C1–C4 and D3h

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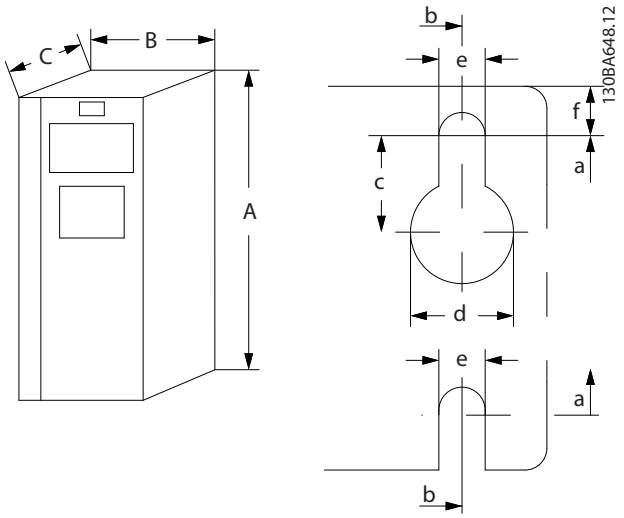

Illustration 8.2 Top and Bottom Mounting Holes (See *chapter 8.9 Power Ratings, Weight, and Dimensions*)

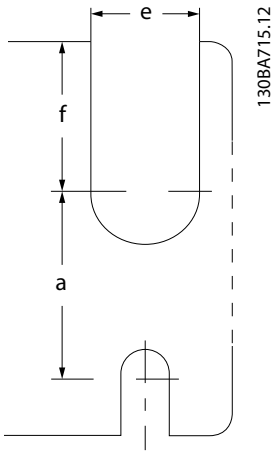

Illustration 8.3 Top and Bottom Mounting Holes (B4, C3, and C4)

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9 Appendix

9.1 Symbols, Abbreviations, and Conventions

°C	Degrees Celsius
°F	Degrees Fahrenheit
AC	Alternating current
AEO	Automatic energy optimization
AWG	American wire gauge
AMA	Automatic motor adaptation
DC	Direct current
EMC	Electro-magnetic compatibility
ETR	Electronic thermal relay
$f_{M,N}$	Nominal motor frequency
FC	Frequency converter
I_{INV}	Rated inverter output current
I_{LIM}	Current limit
$I_{M,N}$	Nominal motor current
$I_{VLT,MAX}$	Maximum output current
$I_{VLT,N}$	Rated output current supplied by the frequency converter
IP	Ingress protection
LCP	Local control panel
MCT	Motion control tool
n_s	Synchronous motor speed
$P_{M,N}$	Nominal motor power
PELV	Protective extra low voltage
PCB	Printed circuit board
PM Motor	Permanent magnet motor
PWM	Pulse width modulation
RPM	Revolutions per minute
Regen	Regenerative terminals
T_{LIM}	Torque limit
$U_{M,N}$	Nominal motor voltage

Table 9.1 Symbols and Abbreviations

Conventions

Numbered lists indicate procedures. Bullet lists indicate other information.

Italicized text indicates:

- Cross-reference.
- Link.
- Parameter name.
- Parameter group name.
- Parameter option.
- Footnote.

All dimensions in drawings are in [mm] (in).

9.2 Parameter Menu Structure

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9.2.1 Software 8.10

0- **	**Operation / Display**
0-0*	**Basic Settings**
0-01	Language
0-02	Motor Speed Unit
0-03	Regional Settings
0-04	Operating State at Power-up (Hand)
0-09	Performance Monitor
0-1*	**Set-up Operations**
0-10	Active Set-up
0-11	Edit Set-up
0-12	This Set-up Linked to
0-13	Readout: Linked Set-ups
0-14	Readout: Edit Set-ups / Channel
0-15	Readout: actual setup
0-2*	**LCP Display**
0-20	Display Line 1.1 Small
0-21	Display Line 1.2 Small
0-22	Display Line 1.3 Small
0-23	Display Line 2 Large
0-24	Display Line 3 Large
0-25	My Personal Menu
0-3*	**LCP Custom Readout**
0-30	Unit for User-defined Readout
0-31	Min Value of User-defined Readout
0-32	Max Value of User-defined Readout
0-33	Source for User-defined Readout
0-37	Display Text 1
0-38	Display Text 2
0-39	Display Text 3
0-4*	**LCP Keypad**
0-40	[Hand on] Key on LCP
0-41	[Off] Key on LCP
0-42	[Auto on] Key on LCP
0-43	[Reset] Key on LCP
0-44	[Off/Reset] Key on LCP
0-45	[Drive Bypass] Key on LCP
0-5*	**Copy/Save**
0-50	LCP Copy
0-51	Set-up Copy
0-6*	**Password**
0-60	Main Menu Password
0-61	Access to Main Menu w/o Password
0-65	Quick Menu Password
0-66	Access to Quick Menu w/o Password
0-67	Bus Password Access
0-68	Safety Parameters Password
0-69	Password Protection of Safety Parameters
0-7*	**Clock Settings**
0-70	Date and Time
0-71	Date Format
0-72	Time Format
0-73	Time Zone Offset
0-74	DST/Summertime
0-76	DST/Summertime Start
0-77	DST/Summertime End
0-79	Clock Fault
0-81	Working Days
0-82	Additional Working Days
0-83	Additional Non-Working Days
0-84	Time for Fieldbus
0-85	Summer Time Start for Fieldbus
0-86	Summer Time End for Fieldbus
0-89	Date and Time Readout
1- **	**Load and Motor**
1-0*	**General Settings**
1-00	Configuration Mode
1-01	Motor Control Principle
1-02	Flux Motor Feedback Source
1-03	Torque Characteristics
1-04	Overload Mode
1-05	Local Mode Configuration
1-06	Clockwise Direction
1-07	Motor Angle Offset Adjust
1-1*	**Special Settings**
1-10	Motor Construction
1-11	Motor Model
1-14	Damping Gain
1-15	Low Speed Filter Time Const.
1-16	High Speed Filter Time Const.
1-17	Voltage filter time const.
1-18	Min. Current at No Load
1-2*	**Motor Data**
1-20	Motor Power [kW]
1-21	Motor Power [HP]
1-22	Motor Voltage
1-23	Motor Frequency
1-24	Motor Current
1-25	Motor Nominal Speed
1-26	Motor Cont. Rated Torque
1-29	Automatic Motor Adaptation (AMA)
1-3*	**Adv. Motor Data**
1-30	Stator Resistance (Rs)
1-31	Rotor Resistance (Rr)
1-33	Stator Leakage Reactance (X1)
1-34	Rotor Leakage Reactance (X2)
1-35	Main Reactance (Xh)
1-36	Iron Loss Resistance (Rfe)
1-37	d-axis Inductance (Ld)
1-38	q-axis Inductance (Lq)
1-39	Motor Poles
1-40	Back EMF at 1000 RPM
1-41	Motor Angle Offset
1-44	d-axis Inductance Sat. (LdSat)
1-45	q-axis Inductance Sat. (LqSat)
1-46	Position Detection Gain
1-47	Torque Calibration
1-48	Inductance Sat. Point
1-49	q-Axis Inductance Saturation Point
1-5*	**Load Indep. Setting**
1-50	Motor Magnetisation at Zero Speed
1-51	Min Speed Normal Magnetising [RPM]
1-52	Min Speed Normal Magnetising [Hz]
1-53	Model Shift Frequency
1-54	Voltage reduction in fieldweakening
1-55	U/f Characteristic - U
1-56	U/f Characteristic - F
1-58	Flying Start Test Pulses Current
1-59	Flying Start Test Pulses Frequency
1-6*	**Load Depen. Setting**
1-60	Low Speed Load Compensation
1-61	High Speed Load Compensation
1-62	Slip Compensation
1-63	Slip Compensation Time Constant
1-64	Resonance Damping
1-65	Resonance Damping Time Constant
1-66	Min. Current at Low Speed
1-67	Load Type
1-68	Motor Inertia
1-69	System Inertia
1-7*	**Start Adjustments**
1-70	Start Mode
1-71	Start Delay
1-72	Start Function
1-73	Flying Start
1-74	Start Speed [RPM]
1-75	Start Speed [Hz]
1-76	Start Current
1-8*	**Stop Adjustments**
1-80	Function at Stop
1-81	Min Speed for Function at Stop [RPM]
1-82	Min Speed for Function at Stop [Hz]
1-83	Precise Stop Function
1-84	Precise Stop Counter Value
1-85	Precise Stop Speed Compensation Delay
1-9*	**Motor Temperature**
1-90	Motor Thermal Protection
1-91	Motor External Fan
1-93	Thermistor Resource
1-94	ATEX ETR cur.lim. speed reduction
1-95	Thermistor Sensor Type
1-96	Thermistor Sensor Resource
1-97	Thermistor Threshold level
1-98	ATEX ETR interpol. points freq.
1-99	ATEX ETR interpol points current
2- **	**Brakes**
2-0*	**DC-Brake**
2-00	DC Hold Current
2-01	DC Brake Current
2-02	DC Braking Time
2-03	DC Brake Cut In Speed [RPM]
2-04	DC Brake Cut In Speed [Hz]
2-05	Maximum Reference
2-06	Parking Current
2-07	Parking Time
2-1*	**Brake Energy Funct.**
2-10	Brake Function
2-11	Brake Resistor (ohm)
2-12	Brake Power Limit (kW)
2-13	Brake Power Monitoring
2-15	Brake Check
2-16	AC brake Max. Current
2-17	Over-voltage Control
2-18	Brake Check Condition
2-19	Over-voltage Gain
2-2*	**Mechanical Brake**
2-20	Release Brake Current
2-21	Activate Brake Speed [RPM]
2-22	Activate Brake Speed [Hz]
2-23	Activate Brake Delay
2-24	Stop Delay
2-25	Brake Release Time
2-26	Torque Ref
2-27	Torque Ramp Up Time
2-28	Gain Boost Factor
2-29	Torque Ramp Down Time
2-3*	**Adv. Mech Brake**
2-30	Position P Start Proportional Gain
2-31	Speed PID Start Proportional Gain
2-32	Speed PID Start Integral Time
2-33	Speed PID Start Lowpass Filter Time
3- **	**Reference / Ramps**
3-0*	**Reference Limits**
3-00	Reference Range
3-01	Reference/Feedback Unit
3-02	Minimum Reference
3-03	Maximum Reference
3-04	Reference Function
3-1*	**References**
3-10	Preset Reference
3-11	Jog Speed [Hz]
3-12	Catch up/slow Down Value
3-13	Reference Site
3-14	Preset Relative Reference
3-15	Reference Resource 1
3-16	Reference Resource 2
3-17	Reference Resource 3
3-18	Relative Scaling Reference Resource
3-19	Jog Speed [RPM]
3-4*	**Ramp 1**
3-40	Ramp 1 Type
3-41	Ramp 1 Ramp Up Time
3-42	Ramp 1 Ramp Down Time
3-45	Ramp 1 S-ramp Ratio at Accel. Start
3-46	Ramp 1 S-ramp Ratio at Accel. End
3-47	Ramp 1 S-ramp Ratio at Decel. Start
3-48	Ramp 1 S-ramp Ratio at Decel. End
3-5*	**Ramp 2**
3-50	Ramp 2 Type
3-51	Ramp 2 Ramp Up Time
3-52	Ramp 2 Ramp Down Time
3-55	Ramp 2 S-ramp Ratio at Accel. Start
3-56	Ramp 2 S-ramp Ratio at Accel. End
3-57	Ramp 2 S-ramp Ratio at Decel. Start
3-58	Ramp 2 S-ramp Ratio at Decel. End
3-6*	**Ramp 3**
3-60	Ramp 3 Type
3-61	Ramp 3 Ramp up Time
3-62	Ramp 3 Ramp down Time
3-65	Ramp 3 S-ramp Ratio at Accel. Start
3-66	Ramp 3 S-ramp Ratio at Accel. End
3-67	Ramp 3 S-ramp Ratio at Decel. Start
3-68	Ramp 3 S-ramp Ratio at Decel. End
3-7*	**Ramp 4**
3-70	Ramp 4 Type
3-71	Ramp 4 Ramp up Time
3-72	Ramp 4 Ramp Down Time
3-75	Ramp 4 S-ramp Ratio at Accel. Start
3-76	Ramp 4 S-ramp Ratio at Accel. End
3-77	Ramp 4 S-ramp Ratio at Decel. Start
3-78	Ramp 4 S-ramp Ratio at Decel. End
3-8*	**Other Ramps**
3-80	Jog Ramp Time
3-81	Quick Stop Ramp Time
3-82	Quick Stop Ramp Type
3-83	Quick Stop S-ramp Ratio at Decel. Start
3-84	Quick Stop S-ramp Ratio at Decel. End
3-89	Ramp Lowpass Filter Time
3-9*	**Digital Pot.Meter**
3-90	Step Size
3-91	Ramp Time
3-92	Power Restore
3-93	Maximum Limit
3-94	Minimum Limit
3-95	Ramp Delay
4- **	**Limits / Warnings**
4-1*	**Motor Limits**
4-10	Motor Speed Direction
4-11	Motor Speed Low Limit [RPM]
4-12	Motor Speed Low Limit [Hz]
4-13	Motor Speed High Limit [RPM]
4-14	Motor Speed High Limit [Hz]
4-16	Torque Limit Motor Mode
4-17	Torque Limit Generator Mode
4-18	Current Limit
4-19	Max Output Frequency
4-2*	**Limit Factors**
4-20	Torque Limit Factor Source
4-21	Speed Limit Factor Source
4-23	Brake Check Limit Factor Source
4-24	Brake Check Limit Factor
4-25	Power Limit Motor Factor Source
4-26	Power Limit Gener. Factor Source
4-3*	**Motor Speed Mon.**
4-30	Motor Feedback Loss Function
4-31	Motor Feedback Speed Error
4-32	Motor Feedback Loss Timeout
4-34	Tracking Error Function
4-35	Tracking Error
4-36	Tracking Error Timeout
4-37	Tracking Error Ramping
4-38	Tracking Error Ramping Timeout
4-39	Tracking Error After Ramping Timeout
4-4*	**Speed Monitor**
4-43	Motor Speed Monitor Function
4-44	Motor Speed Monitor Max
4-45	Motor Speed Monitor Timeout
4-5*	**Adj. Warnings**
4-50	Warning Current Low
4-51	Warning Current High
4-52	Warning Speed Low

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4-53 Warning Speed High
4-54 Warning Reference Low
4-55 Warning Reference High
4-56 Warning Feedback Low
4-57 Warning Feedback High
4-58 Missing Motor Phase Function
4-59 Motor Check At Start
4-6* Speed Bypass
4-60 Bypass Speed From [RPM]
4-61 Bypass Speed From [Hz]
4-62 Bypass Speed To [RPM]
4-63 Bypass Speed To [Hz]
4-8* Power Limit
4-80 Power Limit Func. Motor Mode
4-81 Power Limit Func. Generator Mode
4-82 Power Limit Motor Mode
4-83 Power Limit Generator Mode
4-9* Directional Limits
4-90 Directional Limit Mode
4-91 Positive Speed Limit [RPM]
4-92 Positive Speed Limit [Hz]
4-93 Negative Speed Limit [RPM]
4-94 Negative Speed Limit [Hz]
4-95 Positive Torque limit
4-96 Negative Torque limit
5- Digital In/Out**
5-0* Digital I/O mode
5-00 Digital I/O Mode
5-01 Terminal 27 Mode
5-02 Terminal 29 Mode
5-1* Digital Inputs
5-10 Terminal 18 Digital Input
5-11 Terminal 19 Digital Input
5-12 Terminal 27 Digital Input
5-13 Terminal 29 Digital Input
5-14 Terminal 32 Digital Input
5-15 Terminal 33 Digital Input
5-16 Terminal X30/2 Digital Input
5-17 Terminal X30/3 Digital Input
5-18 Terminal X30/4 Digital Input
5-19 Terminal 37 Safe Stop
5-20 Terminal X46/1 Digital Input
5-21 Terminal X46/3 Digital Input
5-22 Terminal X46/5 Digital Input
5-23 Terminal X46/7 Digital Input
5-24 Terminal X46/9 Digital Input
5-25 Terminal X46/11 Digital Input
5-26 Terminal X46/13 Digital Input
5-3* Digital Outputs
5-30 Terminal 27 Digital Output
5-31 Terminal 29 Digital Output
5-32 Term X30/6 Digi Out (MCB 101)
5-33 Term X30/7 Digi Out (MCB 101)
5-4* Relays
5-40 Function Relay
5-41 On Delay, Relay
5-42 Off Delay, Relay
5-5* Pulse Input
5-50 Term. 29 Low Frequency
5-51 Term. 29 High Frequency
5-52 Term. 29 Low Ref./Feedb. Value
5-53 Term. 29 High Ref./Feedb. Value
5-54 Pulse Filter Time Constant #29
5-55 Term. 33 Low Frequency
5-56 Term. 33 High Frequency
5-57 Term. 33 Low Ref./Feedb. Value
5-58 Term. 33 High Ref./Feedb. Value
5-59 Pulse Filter Time Constant #33
5-6* Pulse Output
5-60 Terminal 27 Pulse Output Variable
5-62 Pulse Output Max Freq #27
5-63 Terminal 29 Pulse Output Variable
5-65 Pulse Output Max Freq #29
5-66 Terminal X30/6 Pulse Output Variable
5-68 Pulse Output Max Freq #X30/6
5-7* 24V Encoder Input
5-70 Term 32/33 Pulses Per Revolution
5-71 Term 32/33 Encoder Direction
5-8* I/O Options
5-80 AHF Cap Reconnect Delay
5-9* Bus Controlled
5-90 Digital & Relay Bus Control
5-93 Pulse Out #27 Bus Control
5-94 Pulse Out #27 Timeout Preset
5-95 Pulse Out #29 Bus Control
5-96 Pulse Out #29 Timeout Preset
5-97 Pulse Out #X30/6 Bus Control
5-98 Pulse Out #X30/6 Timeout Preset
6- Analog In/Out**
6-0* Analog I/O Mode
6-00 Live Zero Timeout Time
6-01 Live Zero Timeout Function
6-1* Analog Input 1
6-10 Terminal 53 Low Voltage
6-11 Terminal 53 High Voltage
6-12 Terminal 53 Low Current
6-13 Terminal 53 High Current
6-14 Terminal 53 Low Ref./Feedb. Value
6-15 Terminal 53 High Ref./Feedb. Value
6-16 Terminal 53 Filter Time Constant
6-2* Analog Input 2
6-20 Terminal 54 Low Voltage
6-21 Terminal 54 High Voltage
6-22 Terminal 54 Low Current
6-23 Terminal 54 High Current
6-24 Terminal 54 Low Ref./Feedb. Value
6-25 Terminal 54 High Ref./Feedb. Value
6-26 Terminal 54 Filter Time Constant
6-3* Analog Input 3
6-30 Terminal X30/11 Low Voltage
6-31 Terminal X30/11 High Voltage
6-34 Term. X30/11 Low Ref./Feedb. Value
6-35 Term. X30/11 High Ref./Feedb. Value
6-36 Term. X30/11 Filter Time Constant
6-4* Analog Input 4
6-40 Terminal X30/12 Low Voltage
6-41 Terminal X30/12 High Voltage
6-44 Term. X30/12 Low Ref./Feedb. Value
6-45 Term. X30/12 High Ref./Feedb. Value
6-46 Term. X30/12 Filter Time Constant
6-5* Analog Output 1
6-50 Terminal 42 Output
6-51 Terminal 42 Output Min Scale
6-52 Terminal 42 Output Max Scale
6-53 Term 42 Output Bus Ctrl
6-54 Terminal 42 Output Timeout Preset
6-55 Analog Output Filter
6-6* Analog Output 2
6-60 Terminal X30/8 Output
6-61 Terminal X30/8 Min. Scale
6-62 Terminal X30/8 Max. Scale
6-63 Terminal X30/8 Bus Control
6-64 Terminal X30/8 Output Timeout Preset
6-7* Analog Output 3
6-70 Terminal X45/1 Output
6-71 Terminal X45/1 Min. Scale
6-72 Terminal X45/1 Max. Scale
6-73 Terminal X45/1 Bus Control
6-74 Terminal X45/1 Output Timeout Preset
6-8* Analog Output 4
6-80 Terminal X45/3 Output
6-81 Terminal X45/3 Min. Scale
6-82 Terminal X45/3 Max. Scale
6-83 Terminal X45/3 Bus Control
6-84 Terminal X45/3 Output Timeout Preset
7- Controllers**
7-0* Speed PID Ctrl.
7-00 Speed PID Feedback Source
7-01 Speed PID Droop
7-02 Speed PID Proportional Gain
7-03 Speed PID Integral Time
7-04 Speed PID Differentiation Time
7-05 Speed PID Diff. Gain Limit
7-06 Speed PID Lowpass Filter Time
7-07 Speed PID Feedback Gear Ratio
7-08 Speed PID Feed Forward Factor
7-09 Speed PID Error Correction w/ Ramp
7-1* Torque PI Ctrl.
7-10 Torque PI Feedback Source
7-12 Torque PI Proportional Gain
7-13 Torque PI Integration Time
7-16 Torque PI Lowpass Filter Time
7-18 Torque PI Feed Forward Factor
7-19 Current Controller Rise Time
7-2* Process Ctrl. Feedb
7-20 Process CL Feedback 1 Resource
7-22 Process CL Feedback 2 Resource
7-3* Process PID Ctrl.
7-30 Process PID Normal/ Inverse Control
7-31 Process PID Anti Windup
7-32 Process PID Start Speed
7-33 Process PID Proportional Gain
7-34 Process PID Integral Time
7-35 Process PID Differentiation Time
7-36 Process PID Diff. Gain Limit
7-38 Process PID Feed Forward Factor
7-39 On Reference Bandwidth
7-4* Adv. Process PID I
7-40 Process PID I-part Reset
7-41 Process PID Output Neg. Clamp
7-42 Process PID Output Pos. Clamp
7-43 Process PID Gain Scale at Min. Ref.
7-44 Process PID Gain Scale at Max. Ref.
7-45 Process PID Feed Fwd Resource
7-46 Process PID Feed Fwd Normal/ Inv. Ctrl.
7-48 PCD Feed Forward
7-49 Process PID Output Normal/ Inv. Ctrl.
7-5* Adv. Process PID II
7-50 Process PID Extended PID
7-51 Process PID Feed Fwd Gain
7-52 Process PID Feed Fwd Ramp up
7-53 Process PID Feed Fwd Ramp down
7-56 Process PID Ref. Filter Time
7-57 Process PID Fb. Filter Time
8- Comm. and Options**
8-0* General Settings
8-01 Control Site
8-02 Control Word Source
8-03 Control Word Timeout Time
8-04 Control Word Timeout Function
8-05 End-of-Timeout Function
8-06 Reset Control Word Timeout
8-07 Diagnosis Trigger
8-08 Readout Filtering
8-1* Ctrl. Word Settings
8-10 Control Word Profile
8-13 Configurable Status Word STW
8-14 Configurable Control Word CTW
8-17 Configurable Alarm and Warningword
8-19 Product Code
8-3* FC Port Settings
8-30 Protocol
8-31 Address
8-32 FC Port Baud Rate
8-33 Parity / Stop Bits
8-34 Estimated cycle time
8-35 Minimum Response Delay
8-36 Max Response Delay
8-37 Max Inter-Char Delay
8-4* FC MC protocol set
8-40 Telegram Selection
8-41 Parameters for Signals
8-42 PCD Write Configuration
8-43 PCD Read Configuration
8-45 BTM Transaction Command
8-46 BTM Transaction Status
8-47 BTM Timeout
8-48 BTM Maximum Errors
8-49 BTM Error Log
8-5* Digital/Bus
8-50 Coasting Select
8-51 Quick Stop Select
8-52 DC Brake Select
8-53 Start Select
8-54 Reversing Select
8-55 Set-up Select
8-56 Preset Reference Select
8-57 Profidrive OFF2 Select
8-58 Profidrive OFF3 Select
8-8* FC Port Diagnostics
8-80 Bus Message Count
8-81 Bus Error Count
8-82 Slave Messages Rcvd
8-83 Slave Error Count
8-9* Bus Jog
8-90 Bus Jog 1 Speed
8-91 Bus Jog 2 Speed
9- PROFIdrive**
9-00 Setpoint
9-07 Actual Value
9-15 PCD Write Configuration
9-16 PCD Read Configuration
9-18 Node Address
9-19 Drive Unit System Number
9-22 Telegram Selection
9-23 Parameters for Signals
9-27 Parameter Edit
9-28 Process Control
9-44 Fault Message Counter
9-45 Fault Code
9-47 Fault Number
9-52 Fault Situation Counter
9-53 Profibus Warning Word
9-63 Actual Baud Rate
9-64 Device Identification
9-65 Profile Number
9-67 Control Word 1
9-68 Status Word 1
9-70 Edit Set-up
9-71 Profibus Save Data Values
9-72 ProfibusDriveReset
9-75 DO Identification
9-80 Defined Parameters (1)
9-81 Defined Parameters (2)
9-82 Defined Parameters (3)
9-83 Defined Parameters (4)
9-84 Defined Parameters (5)
9-85 Defined Parameters (6)
9-90 Changed Parameters (1)
9-91 Changed Parameters (2)
9-92 Changed Parameters (3)
9-93 Changed Parameters (4)
9-94 Changed Parameters (5)
9-99 Profibus Revision Counter
10- CAN Fieldbus**
10-0* Common Settings
10-00 CAN Protocol
10-01 Baud Rate Select
10-02 MAC ID
10-05 Readout Transmit Error Counter
10-06 Readout Receive Error Counter
10-07 Readout Bus Off Counter
10-1* DeviceNet
10-10 Process Data Type Selection

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10-11 Process Data Config Write
10-12 Process Data Config Read
10-13 Warning Parameter
10-14 Net Reference
10-15 Net Control
10-2* COS Filters
10-20 COS Filter 1
10-21 COS Filter 2
10-22 COS Filter 3
10-23 COS Filter 4
10-3* Parameter Access
10-30 Array Index
10-31 Store Data Values
10-32 Devicenet Revision
10-33 Store Always
10-34 DeviceNet Product Code
10-39 Devicenet F Parameters
10-5* CANopen
10-50 Process Data Config Write.
10-51 Process Data Config Read.
12- Ethernet**
12-0* IP Settings
12-00 IP Address Assignment
12-01 IP Address
12-02 Subnet Mask
12-03 Default Gateway
12-04 DHCP Server
12-05 Lease Expires
12-06 Name Servers
12-07 Domain Name
12-08 Host Name
12-09 Physical Address
12-1* Ethernet Link Parameters
12-10 Link Status
12-11 Link Duration
12-12 Auto Negotiation
12-13 Link Speed
12-14 Link Duplex
12-18 Supervisor MAC
12-19 Supervisor IP Addr.
12-2* Process Data
12-20 Control Instance
12-21 Process Data Config Write
12-22 Process Data Config Read
12-23 Process Data Config Write Size
12-24 Process Data Config Read Size
12-27 Master Address
12-28 Store Data Values
12-29 Store Always
12-3* EtherNet/IP
12-30 Warning Parameter
12-31 Net Reference
12-32 Net Control
12-33 CIP Revision
12-34 CIP Product Code
12-35 EDS Parameter
12-37 COS Inhibit Timer
12-38 COS Filter
12-4* Modbus TCP
12-40 Status Parameter
12-41 Slave Message Count
12-42 Slave Exception Message Count
12-5* EtherCAT
12-50 Configured Station Alias
12-51 Configured Station Address
12-59 EtherCAT Status
12-6* Ethernet PowerLink
12-60 Node ID
12-62 SDO Timeout
12-63 Basic Ethernet Timeout
12-66 Threshold
12-67 Threshold Counters
12-68 Cumulative Counters
12-69 Ethernet PowerLink Status
12-8* Other Ethernet Services
12-80 FTP Server
12-81 HTTP Server
12-82 SMTP Service
12-83 SNMP Agent
12-84 Address Conflict Detection
12-85 ACD Last Conflict
12-89 Transparent Socket Channel Port
12-9* Advanced Ethernet Services
12-90 Cable Diagnostic
12-91 Auto Cross Over
12-92 IGMP Snooping
12-93 Cable Error Length
12-94 Broadcast Storm Protection
12-95 Inactivity timeout
12-96 Port Config
12-97 QoS Priority
12-98 Interface Counters
12-99 Media Counters
13- Smart Logic**
13-0* SLC Settings
13-00 SL Controller Mode
13-01 Start Event
13-02 Stop Event
13-03 Reset SLC
13-1* Comparators
13-10 Comparator Operand
13-11 Comparator Operator
13-12 Comparator Value
13-1* RS Flip Flops
13-15 RS-FF Operand S
13-16 RS-FF Operand R
13-2* Timers
13-20 SL Controller Timer
13-4* Logic Rules
13-40 Logic Rule Boolean 1
13-41 Logic Rule Operator 1
13-42 Logic Rule Boolean 2
13-43 Logic Rule Operator 2
13-44 Logic Rule Boolean 3
13-5* States
13-51 SL Controller Event
13-52 SL Controller Action
13-9* User Defined Alerts
13-90 Alert Trigger
13-91 Alert Action
13-92 Alert Text
13-9* User Defined Readouts
13-97 Alert Alarm Word
13-98 Alert Warning Word
13-99 Alert Status Word
14- Special Functions**
14-0* Inverter Switching
14-00 Switching Pattern
14-01 Switching Frequency
14-03 Overmodulation
14-04 Acoustic Noise Reduction
14-06 Dead Time Compensation
14-1* Mains Failure
14-10 Mains Failure
14-11 Mains Fault Voltage Level
14-12 Response to Mains Imbalance
14-14 Kin. Back-up Time-out
14-15 Kin. Back-up Trip Recovery Level
14-16 Kin. Back-up Gain
14-2* Trip Reset
14-20 Reset Mode
14-21 Automatic Restart Time
14-22 Operation Mode
14-23 Typecode Setting
14-24 Trip Delay at Current Limit
14-25 Trip Delay at Torque Limit
14-26 Trip Delay at Inverter Fault
14-28 Production Settings
14-29 Service Code
14-3* Current Limit Ctrl.
14-30 Current Lim Ctrl, Proportional Gain
14-31 Current Lim Ctrl, Integration Time
14-32 Current Lim Ctrl, Filter Time
14-35 Stall Protection
14-36 Field-weakening Function
14-37 Fieldweakening Speed
14-4* Energy Optimising
14-40 VT Level
14-41 AEO Minimum Magnetisation
14-42 Minimum AEO Frequency
14-43 Motor Cosphi
14-5* Environment
14-50 RFI Filter
14-51 DC-Link Compensation
14-52 Fan Control
14-53 Fan Monitor
14-55 Output Filter
14-56 Capacitance Output Filter
14-57 Inductance Output Filter
14-59 Actual Number of Inverter Units
14-6* Auto Derate
14-60 Function at Over Temperature
14-61 Function at Inverter Overload
14-62 Inv. Overload Derate Current
14-7* Compatibility
14-72 Legacy Alarm Word
14-73 Legacy Warning Word
14-74 Leg. Ext. Status Word
14-8* Options
14-80 Option Supplied by External 24VDC
14-88 Option Data Storage
14-89 Option Detection
14-9* Fault Settings
14-90 Fault Level
15- Drive Information**
15-0* Operating Data
15-00 Operating hours
15-01 Running Hours
15-02 kWh Counter
15-03 Power Up's
15-04 Over Temp's
15-05 Over Volt's
15-06 Reset kWh Counter
15-07 Reset Running Hours Counter
15-1* Data Log Settings
15-10 Logging Source
15-11 Logging Interval
15-12 Trigger Event
15-13 Logging Mode
15-14 Samples Before Trigger
15-2* Historic Log
15-20 Historic Log: Event
15-21 Historic Log: Value
15-22 Historic Log: Time
15-3* Fault Log
15-30 Fault Log: Error Code
15-31 Fault Log: Value
15-32 Fault Log: Time
15-33 Fault log: Date and Time
15-4* Drive Identification
15-40 FC Type
15-41 Power Section
15-42 Voltage
15-43 Software Version
15-44 Ordered Typecode String
15-45 Actual Typecode String
15-46 Frequency Converter Ordering No
15-47 Power Card Ordering No
15-48 LCP Id No
15-49 SW ID Control Card
15-50 SW ID Power Card
15-51 Frequency Converter Serial Number
15-53 Power Card Serial Number
15-54 Config File Name
15-58 Smart Setup Filename
15-59 Filename
15-6* Option Ident
15-60 Option Mounted
15-61 Option SW Version
15-62 Option Ordering No
15-63 Option Serial No
15-70 Option in Slot A
15-71 Slot A Option SW Version
15-72 Option in Slot B
15-73 Slot B Option SW Version
15-74 Option in Slot C0/E0
15-75 Slot C0/E0 Option SW Version
15-76 Option in Slot C1/E1
15-77 Slot C1/E1 Option SW Version
15-8* Operating Data II
15-80 Fan Running Hours
15-81 Preset Fan Running Hours
15-89 Configuration Change Counter
15-9* Parameter Info
15-92 Defined Parameters
15-93 Modified Parameters
15-98 Drive Identification
15-99 Parameter Metadata
16- Data Readouts**
16-0* General Status
16-00 Control Word
16-01 Reference [Unit]
16-02 Reference %
16-03 Status Word
16-05 Main Actual Value [%]
16-06 Actual Position
16-09 Custom Readout
16-1* Motor Status
16-10 Power [kW]
16-11 Power [hp]
16-12 Motor Voltage
16-13 Frequency
16-14 Motor current
16-15 Frequency [%]
16-16 Torque [Nm]
16-17 Speed [RPM]
16-18 Motor Thermal
16-19 Thermistor Sensor Temperature
16-20 Motor Angle
16-21 Torque [%] High Res.
16-22 Torque [%]
16-23 Motor Shaft Power [kW]
16-24 Calibrated Stator Resistance
16-25 Torque [Nm] High
16-3* Drive Status
16-30 DC Link Voltage
16-31 System Temp.
16-32 Brake Energy /s
16-33 Brake Energy Average
16-34 Heatsink Temp.
16-35 Inverter Thermal
16-36 Inv. Nom. Current
16-37 Inv. Max. Current
16-38 SL Controller State
16-39 Control Card Temp.
16-40 Logging Buffer Full
16-41 Performance Measurements
16-42 Service Log Counter
16-43 Timed Actions Status
16-45 Motor Phase U Current
16-46 Motor Phase V Current
16-47 Motor Phase W Current
16-48 Speed Ref. After Ramp [RPM]
16-49 Current Fault Source

16-5* Ref. & Feedb.
16-50 External Reference
16-51 Pulse Reference
16-52 Feedback[Unit]
16-53 Digi Pot Reference
16-57 Feedback [RPM]
16-6* Inputs & Outputs
16-60 Digital Input
16-61 Terminal 53 Switch Setting
16-62 Analog Input 53
16-63 Terminal 54 Switch Setting
16-64 Analog Input 54
16-65 Analog Output 42 [mA]
16-66 Digital Output [bin]
16-67 Freq. Input #29 [Hz]
16-68 Freq. Input #33 [Hz]
16-69 Pulse Output #27 [Hz]
16-70 Pulse Output #29 [Hz]
16-71 Relay Output [bin]
16-72 Counter A
16-73 Counter B
16-74 Prec. Stop Counter
16-75 Analog In X30/11
16-76 Analog In X30/12
16-77 Analog Out X30/8 [mA]
16-78 Analog Out X45/1 [mA]
16-79 Analog Out X45/3 [mA]
16-8* Fieldbus & FC Port
16-80 Fieldbus CTW 1
16-82 Fieldbus REF 1
16-84 Comm. Option STW
16-85 FC Port CTW 1
16-86 FC Port REF 1
16-87 Bus Readout Alarm/Warning
16-89 Configurable Alarm/Warning Word
16-9* Diagnosis Readouts
16-90 Alarm Word
16-91 Alarm Word 2
16-92 Warning Word
16-93 Warning Word 2
16-94 Ext. Status Word
16-95 Ext. Status Word 2
16-96 Maintenance Word
17- Position Feedback**
17-1* Inc. Enc. Interface
17-10 Signal Type
17-11 Resolution (PPR)
17-2* Abs. Enc. Interface
17-20 Protocol Selection
17-21 Resolution (Positions/Rev)
17-22 Multiturn Revolutions
17-24 SSI Data Length
17-25 Clock Rate
17-26 SSI Data Format
17-34 HIPERFACE Baudrate
17-5* Resolver Interface
17-50 Poles
17-51 Input Voltage
17-52 Input Frequency
17-53 Transformation Ratio
17-56 Encoder Sim. Resolution
17-59 Resolver Interface
17-6* Monitoring and App.
17-60 Feedback Direction
17-61 Feedback Signal Monitoring
17-7* Position Scaling
17-70 Position Unit
17-71 Position Unit Scale
17-72 Position Unit Numerator
17-73 Position Unit Denominator
17-74 Position Offset
18- Data Readouts 2**
18-0* Maintenance Log
18-00 Maintenance Log: Item
18-01 Maintenance Log: Action
18-02 Maintenance Log: Time
18-03 Maintenance Log: Date and Time
18-2* Motor Readouts
18-27 Safe Opt. Est. Speed
18-28 Safe Opt. Meas. Speed
18-29 Safe Opt. Speed Error
18-3* Analog Readouts
18-36 Analog Input X48/2 [mA]
18-37 Temp. Input X48/4
18-38 Temp. Input X48/7
18-39 Temp. Input X48/10
18-4* PGIO Data Readouts
18-43 Analog Out X49/7
18-44 Analog Out X49/9
18-45 Analog Out X49/11
18-5* Active Alarms/Warnings
18-55 Active Alarm Numbers
18-56 Active Warning Numbers
18-6* Inputs & Outputs 2
18-60 Digital Input 2
18-7* Rectifier Status
18-70 Mains Voltage
18-71 Mains Frequency
18-72 Mains Imbalance
18-75 Rectifier DC Volt.
18-9* PID Readouts
18-90 Process PID Error
18-91 Process PID Output
18-92 Process PID Clamped Output
18-93 Process PID Gain Scaled Output
22- Appl. Functions**
22-0* Miscellaneous
22-00 External Interlock Delay
23- Time-based Functions**
23-0* Timed Actions
23-00 ON Time
23-01 ON Action
23-02 OFF Time
23-03 OFF Action
23-04 Occurrence
23-0* Timed Actions Settings
23-08 Timed Actions Mode
23-09 Timed Actions Reactivation
23-1* Maintenance
23-10 Maintenance Item
23-11 Maintenance Action
23-12 Maintenance Time Base
23-13 Maintenance Time Interval
23-14 Maintenance Date and Time
23-1* Maintenance Reset
23-15 Reset Maintenance Word
23-16 Maintenance Text
30- Special Features**
30-0* Wobbler
30-00 Wobble Mode
30-01 Wobble Delta Frequency [Hz]
30-02 Wobble Delta Frequency [%]
30-03 Wobble Delta Freq. Scaling Resource
30-04 Wobble Jump Frequency [Hz]
30-05 Wobble Jump Frequency [%]
30-06 Wobble Jump Time
30-07 Wobble Sequence Time
30-08 Wobble Up/ Down Time
30-09 Wobble Random Function
30-10 Wobble Ratio
30-11 Wobble Random Ratio Max.
30-12 Wobble Random Ratio Min.
30-19 Wobble Delta Freq. Scaled
30-2* Adv. Start Adjust
30-20 High Starting Torque Time [s]
30-21 High Starting Torque Current [%]
30-22 Locked Rotor Protection
30-23 Locked Rotor Detection Time [s]
30-24 Locked Rotor Detection Speed Error [%]
30-25 Light Load Delay [s]
30-26 Light Load Current [%]
30-27 Light Load Speed [%]
30-5* Unit Configuration
30-50 Heat Sink Fan Mode
30-8* Compatibility (I)
30-80 d-axis Inductance (Ld)
30-81 Brake Resistor (ohm)
30-83 Speed PID Proportional Gain
30-84 Process PID Proportional Gain
30-9* Wifi LCP
30-90 SSID
30-91 Channel
30-92 Password
30-93 Security type
30-94 IP address
30-95 Submask
30-96 Port
30-97 Wifi Timeout Action
31- Bypass Option**
31-00 Bypass Mode
31-01 Bypass Start Time Delay
31-02 Bypass Trip Time Delay
31-03 Test Mode Activation
31-10 Bypass Status Word
31-11 Bypass Running Hours
31-19 Remote Bypass Activation
32- MCO Basic Settings**
32-0* Encoder 2
32-00 Incremental Signal Type
32-01 Incremental Resolution
32-02 Absolute Protocol
32-03 Absolute Resolution
32-04 Absolute Encoder Baudrate X55
32-05 Absolute Encoder Data Length
32-06 Absolute Encoder Clock Frequency
32-07 Absolute Encoder Clock Generation
32-08 Absolute Encoder Cable Length
32-09 Encoder Monitoring
32-10 Rotational Direction
32-11 User Unit Denominator
32-12 User Unit Numerator
32-13 Enc.2 Control
32-14 Enc.2 node ID
32-15 Enc.2 CAN guard
32-3* Encoder 1
32-30 Incremental Signal Type
32-31 Incremental Resolution
32-32 Absolute Protocol
32-33 Absolute Resolution
32-35 Absolute Encoder Data Length
32-36 Absolute Encoder Clock Frequency
32-37 Absolute Encoder Clock Generation
32-38 Absolute Encoder Cable Length
32-39 Encoder Monitoring
32-40 Encoder Termination
32-43 Enc.1 Control
32-44 Enc.1 node ID
32-45 Enc.1 CAN guard
32-5* Feedback Source
32-50 Source Slave
32-51 MCO 302 Last Will
32-52 Source Master
32-6* PID Controller
32-60 Proportional factor
32-61 Derivative factor
32-62 Integral factor
32-63 Limit Value for Integral Sum
32-64 PID Bandwidth
32-65 Velocity Feed-Forward
32-66 Acceleration Feed-Forward
32-67 Max. Tolerated Position Error
32-68 Reverse Behavior for Slave
32-69 Sampling Time for PID Control
32-70 Scan Time for Profile Generator
32-71 Size of the Control Window (Activation)
32-72 Size of the Control Window (Deactiv.)
32-73 Integral limit filter time
32-74 Position error filter time
32-8* Velocity & Accel.
32-80 Maximum Velocity (Encoder)
32-81 Shortest Ramp
32-82 Ramp Type
32-83 Velocity Resolution
32-84 Default Velocity
32-85 Default Acceleration
32-86 Acc. up for limited jerk
32-87 Acc. down for limited jerk
32-88 Dec. up for limited jerk
32-89 Dec. down for limited jerk
32-9* Development
32-90 Debug Source
33- MCO Adv. Settings**
33-0* Home Motion
33-00 Force HOME
33-01 Zero Point Offset from Home Pos.
33-02 Ramp for Home Motion
33-03 Velocity of Home Motion
33-04 Behaviour during HomeMotion
33-1* Synchronization
33-10 Sync Factor Master
33-11 Sync Factor Slave
33-12 Position Offset for Synchronization
33-13 Accuracy Window for Position Sync.
33-14 Relative Slave Velocity Limit
33-15 Marker Number for Master
33-16 Marker Number for Slave
33-17 Master Marker Distance
33-18 Slave Marker Distance
33-19 Master Marker Type
33-20 Slave Marker Type
33-21 Master Marker Tolerance Window
33-22 Slave Marker Tolerance Window
33-23 Start Behaviour for Marker Sync
33-24 Marker Number for Fault
33-25 Marker Number for Ready
33-26 Velocity Filter
33-27 Offset Filter Time
33-28 Marker Filter Configuration
33-29 Filter Time for Marker Filter
33-30 Maximum Marker Correction
33-31 Synchronisation Type
33-32 Feed Forward Velocity Adaptation
33-33 Velocity Filter Window
33-34 Slave Marker filter time
33-4* Limit Handling
33-40 Behaviour atEnd Limit Switch
33-41 Negative Software End Limit
33-42 Positive Software End Limit
33-43 Negative Software End Limit Active
33-44 Positive Software End Limit Active
33-45 Time in Target Window
33-46 Target Window LimitValue
33-47 Size of Target Window
33-5* I/O Configuration
33-50 Terminal X57/1 Digital Input
33-51 Terminal X57/2 Digital Input
33-52 Terminal X57/3 Digital Input
33-53 Terminal X57/4 Digital Input
33-54 Terminal X57/5 Digital Input
33-55 Terminal X57/6 Digital Input
33-56 Terminal X57/7 Digital Input
33-57 Terminal X57/8 Digital Input
33-58 Terminal X57/9 Digital Input

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33-59 Terminal X57/10 Digital Input
33-60 Terminal X59/1 and X59/2 Mode
33-61 Terminal X59/1 Digital Input
33-62 Terminal X59/2 Digital Input
33-63 Terminal X59/1 Digital Output
33-64 Terminal X59/2 Digital Output
33-65 Terminal X59/3 Digital Output
33-66 Terminal X59/4 Digital Output
33-67 Terminal X59/5 Digital Output
33-68 Terminal X59/6 Digital Output
33-69 Terminal X59/7 Digital Output
33-70 Terminal X59/8 Digital Output
33-8* Global Parameters
33-80 Activated Program Number
33-81 Power-up State
33-82 Drive Status Monitoring
33-83 Behaviour afterError
33-84 Behaviour afterEsc.
33-85 MCO Supplied by External 24VDC
33-86 Terminal at alarm
33-87 Terminal state at alarm
33-88 Status word at alarm
33-9* MCO Port Settings
33-90 X62 MCO CAN node ID
33-91 X62 MCO CAN baud rate
33-94 X60 MCO RS485 serial termination
33-95 X60 MCO RS485 serial baud rate
34- MCO Data Readouts**
34-0* PCD Write Par.
34-01 PCD 1 Write to MCO
34-02 PCD 2 Write to MCO
34-03 PCD 3 Write to MCO
34-04 PCD 4 Write to MCO
34-05 PCD 5 Write to MCO
34-06 PCD 6 Write to MCO
34-07 PCD 7 Write to MCO
34-08 PCD 8 Write to MCO
34-09 PCD 9 Write to MCO
34-10 PCD 10 Write to MCO
34-2* PCD Read Par.
34-21 PCD 1 Read from MCO
34-22 PCD 2 Read from MCO
34-23 PCD 3 Read from MCO
34-24 PCD 4 Read from MCO
34-25 PCD 5 Read from MCO
34-26 PCD 6 Read from MCO
34-27 PCD 7 Read from MCO
34-28 PCD 8 Read from MCO
34-29 PCD 9 Read from MCO
34-30 PCD 10 Read from MCO
34-4* Inputs & Outputs
34-40 Digital Inputs
34-41 Digital Outputs
34-5* Process Data
34-50 Actual Position
34-51 Commanded Position
34-52 Actual Master Position
34-53 Slave Index Position
34-54 Master Index Position
34-55 Curve Position
34-56 Track Error
34-57 Synchronizing Error
34-58 Actual Velocity
34-59 Actual Master Velocity
34-60 Synchronizing Status
34-61 Axis Status
34-62 Program Status
34-64 MCO 302 Status
34-65 MCO 302 Control
34-66 SPI Error Counter
34-7* Diagnosis readouts
34-70 MCO Alarm Word 1
34-71 MCO Alarm Word 2
35- Sensor Input Option**
35-0* Temp. Input Mode
35-00 Term. X48/4 Temperature Unit
35-01 Term. X48/4 Input Type
35-02 Term. X48/7 Temperature Unit
35-03 Term. X48/7 Input Type
35-04 Term. X48/10 Temperature Unit
35-05 Term. X48/10 Input Type
35-06 Temperature Sensor Alarm Function
35-1* Temp. Input X48/4
35-14 Term. X48/4 Filter Time Constant
35-15 Term. X48/4 Temp. Monitor
35-16 Term. X48/4 Low Temp. Limit
35-17 Term. X48/4 High Temp. Limit
35-2* Temp. Input X48/7
35-24 Term. X48/7 Filter Time Constant
35-25 Term. X48/7 Temp. Monitor
35-26 Term. X48/7 Low Temp. Limit
35-27 Term. X48/7 High Temp. Limit
35-3* Temp. Input X48/10
35-34 Term. X48/10 Filter Time Constant
35-35 Term. X48/10 Temp. Monitor
35-36 Term. X48/10 Low Temp. Limit
35-37 Term. X48/10 High Temp. Limit
35-4* Analog Input X48/2
35-42 Term. X48/2 Low Current
35-43 Term. X48/2 High Current
35-44 Term. X48/2 Low Ref./Feedb. Value
35-45 Term. X48/2 High Ref./Feedb. Value
35-46 Term. X48/2 Filter Time Constant
36- Programmable I/O Option**
36-0* I/O Mode
36-03 Terminal X49/7 Mode
36-04 Terminal X49/9 Mode
36-05 Terminal X49/11 Mode
36-4* Output X49/7
36-40 Terminal X49/7 Analogue Output
36-42 Terminal X49/7 Min. Scale
36-43 Terminal X49/7 Max. Scale
36-44 Terminal X49/7 Bus Control
36-45 Terminal X49/7 Timeout Preset
36-5* Output X49/9
36-50 Terminal X49/9 Analogue Output
36-52 Terminal X49/9 Min. Scale
36-53 Terminal X49/9 Max. Scale
36-54 Terminal X49/9 Bus Control
36-55 Terminal X49/9 Timeout Preset
36-6* Output X49/11
36-60 Terminal X49/11 Analogue Output
36-62 Terminal X49/11 Min. Scale
36-63 Terminal X49/11 Max. Scale
36-64 Terminal X49/11 Bus Control
36-65 Terminal X49/11 Timeout Preset
40- Special Settings**
40-4* Extend. Fault Log
40-40 Fault Log: Ext. Reference
40-41 Fault Log: Frequency
40-42 Fault Log: Current
40-43 Fault Log: Voltage
40-44 Fault Log: DC Link Voltage
40-45 Fault Log: Control Word
40-46 Fault Log: Status Word
40-5* Advanced Control Settings
40-50 Flux Sensorless Model Shift
40-51 Flux Sensorless Corr. Gain
42- Safety Functions**
42-1* Speed Monitoring
42-10 Measured Speed Source
42-11 Encoder Resolution
42-12 Encoder Direction
42-13 Gear Ratio
42-14 Feedback Type
42-15 Feedback Filter
42-17 Tolerance Error
42-18 Zero Speed Timer
42-19 Zero Speed Limit
42-2* Safe Input
42-20 Safe Function
42-21 Type
42-22 Discrepancy Time
42-23 Stable Signal Time
42-24 Restart Behaviour
42-3* General
42-30 External Failure Reaction
42-31 Reset Source
42-33 Parameter Set Name
42-35 S-CRC Value
42-36 Level 1 Password
42-37 Level 1 Password Buffer
42-4* SS1
42-40 Type
42-41 Ramp Profile
42-42 Delay Time
42-43 Delta T
42-44 Deceleration Rate
42-45 Delta V
42-46 Zero Speed
42-47 Ramp Time
42-48 S-ramp Ratio at Decel. Start
42-49 S-ramp Ratio at Decel. End
42-5* SLS
42-50 Cut Off Speed
42-51 Speed Limit
42-52 Fail Safe Reaction
42-53 Start Ramp
42-54 Ramp Down Time
42-6* Safe Fieldbus
42-60 Telegram Selection
42-61 Destination Address
42-8* Status
42-80 Safe Option Status
42-81 Safe Option Status 2
42-82 Safe Control Word
42-83 Safe Status Word
42-85 Active Safe Func.
42-86 Safe Option Info
42-87 Time Until Manual Test
42-88 Supported Customization File Version
42-89 Customization File Version
42-9* Special
42-90 Restart Safe Option
43- Unit Readouts**
43-0* Component Status
43-00 Component Temp.
43-01 Auxiliary Temp.
43-02 Component SW ID
43-1* Power Card Status
43-10 HS Temp. ph.U
43-11 HS Temp. ph.V
43-12 HS Temp. ph.W
43-13 PC Fan A Speed
43-14 PC Fan B Speed
43-15 PC Fan C Speed
43-2* Fan Pow.Card Status
43-20 FPC Fan A Speed
43-21 FPC Fan B Speed
43-22 FPC Fan C Speed
43-23 FPC Fan D Speed
43-24 FPC Fan E Speed
43-25 FPC Fan F Speed
600- PROFIsafe**
600-22 PROFIdrive/safe Tel. Selected
600-44 Fault Message Counter
600-47 Fault Number
600-52 Fault Situation Counter
601- PROFIdrive 2**
601-22 PROFIdrive Safety Channel Tel. No.

9.2.2 Software 48.2X

0- **	**Operation / Display**
0-0*	**Basic Settings**
0-01	Language
0-02	Motor Speed Unit
0-03	Regional Settings
0-04	Operating State at Power-up (Hand)
0-09	Performance Monitor
0-1*	**Set-up Operations**
0-10	Active Set-up
0-11	Edit Set-up
0-12	This Set-up Linked to
0-13	Readout: Linked Set-ups
0-14	Readout: Edit Set-ups / Channel
0-15	Readout: actual setup
0-2*	**LCP Display**
0-20	Display Line 1.1 Small
0-21	Display Line 1.2 Small
0-22	Display Line 1.3 Small
0-23	Display Line 2 Large
0-24	Display Line 3 Large
0-25	My Personal Menu
0-3*	**LCP Custom Readout**
0-30	Unit for User-defined Readout
0-31	Min Value of User-defined Readout
0-32	Max Value of User-defined Readout
0-33	Source for User-defined Readout
0-37	Display Text 1
0-38	Display Text 2
0-39	Display Text 3
0-4*	**LCP Keypad**
0-40	[Hand on] Key on LCP
0-41	[Off] Key on LCP
0-42	[Auto on] Key on LCP
0-43	[Reset] Key on LCP
0-44	[Off/Reset] Key on LCP
0-45	[Drive Bypass] Key on LCP
0-5*	**Copy/Save**
0-50	LCP Copy
0-51	Set-up Copy
0-6*	**Password**
0-60	Main Menu Password
0-61	Access to Main Menu w/o Password
0-65	Quick Menu Password
0-66	Access to Quick Menu w/o Password
0-67	Bus Password Access
0-68	Safety Parameters Password
0-69	Password Protection of Safety Parameters
1- **	**Load and Motor**
1-0*	**General Settings**
1-00	Configuration Mode
1-01	Motor Control Principle
1-02	Flux Motor Feedback Source
1-03	Torque Characteristics
1-04	Overload Mode
1-05	Local Mode Configuration
1-06	Clockwise Direction
1-07	Motor Angle Offset Adjust
1-1*	**Special Settings**
1-10	Motor Construction
1-11	Motor Model
1-18	Min. Current at No Load
1-2*	**Motor Data**
1-20	Motor Power [kW]
1-21	Motor Power [HP]
1-22	Motor Voltage
1-23	Motor Frequency
1-24	Motor Current
1-25	Motor Nominal Speed
1-26	Motor Cont. Rated Torque
1-29	Automatic Motor Adaptation (AMA)
1-3*	**Adv. Motor Data**
1-30	Stator Resistance (Rs)
1-31	Rotor Resistance (Rr)
1-33	Stator Leakage Reactance (X1)
1-34	Rotor Leakage Reactance (X2)
1-35	Main Reactance (Xh)
1-36	Iron Loss Resistance (Rfe)
1-37	d-axis Inductance (Ld)
1-38	q-axis Inductance (Lq)
1-39	Motor Poles
1-40	Back EMF at 1000 RPM
1-41	Motor Angle Offset
1-44	d-axis Inductance Sat. (LdSat)
1-45	q-axis Inductance Sat. (LqSat)
1-46	Position Detection Gain
1-47	Torque Calibration
1-48	d-axis Inductance Sat. Point
1-49	q-axis Inductance Sat. Point
1-5*	**Load Indep. Setting**
1-50	Motor Magnetisation at Zero Speed
1-51	Min Speed Normal Magnetising [RPM]
1-52	Min Speed Normal Magnetising [Hz]
1-53	Model Shift Frequency
1-54	Voltage reduction in fieldweakening
1-55	U/f Characteristic - U
1-56	U/f Characteristic - F
1-57	Torque Estimation Time Constant
1-58	Flying Start Test Pulses Current
1-59	Flying Start Test Pulses Frequency
1-6*	**Load Depen. Setting**
1-60	Low Speed Load Compensation
1-61	High Speed Load Compensation
1-62	Slip Compensation
1-63	Slip Compensation Time Constant
1-64	Resonance Damping
1-65	Resonance Damping Time Constant
1-66	Min. Current at Low Speed
1-67	Load Type
1-68	Motor Inertia
1-69	System Inertia
1-7*	**Start Adjustments**
1-70	PM Start Mode
1-71	Start Delay
1-72	Start Function
1-73	Flying Start
1-74	Start Speed [RPM]
1-75	Start Speed [Hz]
1-76	Start Current
1-8*	**Stop Adjustments**
1-80	Function at Stop
1-81	Min Speed for Function at Stop [RPM]
1-82	Min Speed for Function at Stop [Hz]
1-9*	**Motor Temperature**
1-90	Motor Thermal Protection
1-91	Motor External Fan
1-93	Thermistor Resource
1-94	ATEX ETR cur.lim. speed reduction
1-95	KTY Sensor Type
1-96	KTY Thermistor Resource
1-97	KTY Threshold level
1-98	ATEX ETR interpol. points freq.
1-99	ATEX ETR interpol points current
2- **	**Brakes**
2-0*	**DC-Brake**
2-00	DC Hold Current
2-01	DC Brake Current
2-02	DC Braking Time
2-03	DC Brake Cut In Speed [RPM]
2-04	DC Brake Cut In Speed [Hz]
2-05	Maximum Reference
2-06	Parking Current
2-07	Parking Time
2-1*	**Brake Energy Funct.**
2-10	Brake Function
2-11	Brake Resistor (ohm)
2-12	Brake Power Limit (kW)
2-13	Brake Power Monitoring
2-15	Brake Check
2-16	AC brake Max. Current
2-17	Over-voltage Control
2-18	Brake Check Condition
2-19	Over-voltage Gain
2-2*	**Mechanical Brake**
2-20	Release Brake Current
2-21	Activate Brake Speed [RPM]
2-22	Activate Brake Speed [Hz]
2-23	Activate Brake Delay
2-24	Stop Delay
2-25	Brake Release Time
2-26	Torque Ref
2-27	Torque Ramp Up Time
2-28	Gain Boost Factor
2-29	Torque Ramp Down Time
2-3*	**Adv. Mech Brake**
2-30	Position P Start Proportional Gain
2-31	Speed PID Start Proportional Gain
2-32	Speed PID Start Integral Time
2-33	Speed PID Start Lowpass Filter Time
2-34	Zero Speed Position P Proportional Gain
3- **	**Reference / Ramps**
3-0*	**Reference Limits**
3-00	Reference Range
3-01	Reference/Feedback Unit
3-02	Minimum Reference
3-03	Maximum Reference
3-04	Reference Function
3-05	On Reference Window
3-06	Minimum Position
3-07	Maximum Position
3-08	On Target Window
3-09	On Target Time
3-1*	**References**
3-10	Preset Reference
3-11	Jog Speed [Hz]
3-12	Catch up/slow Down Value
3-13	Reference Site
3-14	Preset Relative Reference
3-15	Reference Resource 1
3-16	Reference Resource 2
3-17	Reference Resource 3
3-18	Relative Scaling Reference Resource
3-19	Jog Speed [RPM]
3-2*	**References II**
3-20	Preset Target
3-21	Touch Target
3-22	Master Scale Numerator
3-23	Master Scale Denominator
3-24	Master Lowpass Filter Time
3-25	Master Bus Resolution
3-26	Master Offset
3-27	Virtual Master Max Ref
3-28	Master Offset Speed Ref
3-4*	**Ramp 1**
3-40	Ramp 1 Type
3-41	Ramp 1 Ramp Up Time
3-42	Ramp 1 Ramp Down Time
3-45	Ramp 1 S-ramp Ratio at Accel. Start
3-46	Ramp 1 S-ramp Ratio at Accel. End
3-47	Ramp 1 S-ramp Ratio at Decel. Start
3-48	Ramp 1 S-ramp Ratio at Decel. End
3-5*	**Ramp 2**
3-50	Ramp 2 Type
3-51	Ramp 2 Ramp Up Time
3-52	Ramp 2 Ramp Down Time
3-55	Ramp 2 S-ramp Ratio at Accel. Start
3-56	Ramp 2 S-ramp Ratio at Accel. End
3-57	Ramp 2 S-ramp Ratio at Decel. Start
3-58	Ramp 2 S-ramp Ratio at Decel. End
3-6*	**Ramp 3**
3-60	Ramp 3 Type
3-61	Ramp 3 Ramp up Time
3-62	Ramp 3 Ramp down Time
3-65	Ramp 3 S-ramp Ratio at Accel. Start
3-66	Ramp 3 S-ramp Ratio at Accel. End
3-67	Ramp 3 S-ramp Ratio at Decel. Start
3-68	Ramp 3 S-ramp Ratio at Decel. End
3-7*	**Ramp 4**
3-70	Ramp 4 Type
3-71	Ramp 4 Ramp up Time
3-72	Ramp 4 Ramp Down Time
3-75	Ramp 4 S-ramp Ratio at Accel. Start
3-76	Ramp 4 S-ramp Ratio at Accel. End
3-77	Ramp 4 S-ramp Ratio at Decel. Start
3-78	Ramp 4 S-ramp Ratio at Decel. End
3-8*	**Other Ramps**
3-80	Jog/Homing Ramp Time
3-81	Quick Stop Ramp Time
3-82	Quick Stop Ramp Type
3-83	Quick Stop S-ramp Ratio at Decel. Start
3-84	Quick Stop S-ramp Ratio at Decel. End
3-89	Ramp Lowpass Filter Time
3-9*	**Digital Pot.Meter**
3-90	Step Size
3-91	Ramp Time
3-92	Power Restore
3-93	Maximum Limit
3-94	Minimum Limit
3-95	Ramp Delay
4- **	**Limits / Warnings**
4-1*	**Motor Limits**
4-10	Motor Speed Direction
4-11	Motor Speed Low Limit [RPM]
4-12	Motor Speed Low Limit [Hz]
4-13	Motor Speed High Limit [RPM]
4-14	Motor Speed High Limit [Hz]
4-16	Torque Limit Motor Mode
4-17	Torque Limit Generator Mode
4-18	Current Limit
4-19	Max Output Frequency
4-2*	**Limit Factors**
4-20	Torque Limit Factor Source
4-21	Speed Limit Factor Source
4-23	Brake Check Limit Factor Source
4-24	Brake Check Limit Factor
4-3*	**Motor Speed Mon.**
4-30	Motor Feedback Loss Function
4-31	Motor Feedback Speed Error
4-32	Motor Feedback Loss Timeout
4-34	Tracking Error Function
4-35	Tracking Error
4-36	Tracking Error Timeout
4-37	Tracking Error Ramping
4-38	Tracking Error Ramping Timeout
4-39	Tracking Error After Ramping Timeout
4-4*	**Speed Monitor**
4-43	Motor Speed Monitor Function
4-44	Motor Speed Monitor Max
4-45	Motor Speed Monitor Timeout
4-5*	**Adj. Warnings**
4-50	Warning Current Low
4-51	Warning Current High
4-52	Warning Speed Low
4-53	Warning Speed High
4-54	Warning Reference Low
4-55	Warning Reference High
4-56	Warning Feedback Low
4-57	Warning Feedback High
4-58	Missing Motor Phase Function
4-6*	**Speed Bypass**
4-60	Bypass Speed From [RPM]

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4-61 Bypass Speed From [Hz]
4-62 Bypass Speed To [RPM]
4-63 Bypass Speed To [Hz]
4-7* Position Monitor
4-70 Position Error Function
4-71 Maximum Position Error
4-72 Position Error Timeout
4-73 Position Limit Function
4-74 Start Fwd/Rev Function
4-75 Touch Timout
5- Digital In/Out**
5-0* Digital I/O mode
5-00 Digital I/O Mode
5-01 Terminal 27 Mode
5-02 Terminal 29 Mode
5-1* Digital Inputs
5-10 Terminal 18 Digital Input
5-11 Terminal 19 Digital Input
5-12 Terminal 27 Digital Input
5-13 Terminal 29 Digital Input
5-14 Terminal 32 Digital Input
5-15 Terminal 33 Digital Input
5-16 Terminal X30/2 Digital Input
5-17 Terminal X30/3 Digital Input
5-18 Terminal X30/4 Digital Input
5-19 Terminal 37 Safe Stop
5-20 Terminal X46/1 Digital Input
5-21 Terminal X46/3 Digital Input
5-22 Terminal X46/5 Digital Input
5-23 Terminal X46/7 Digital Input
5-24 Terminal X46/9 Digital Input
5-25 Terminal X46/11 Digital Input
5-26 Terminal X46/13 Digital Input
5-3* Digital Outputs
5-30 Terminal 27 Digital Output
5-31 Terminal 29 Digital Output
5-32 Term X30/6 Digi Out (MCB 101)
5-33 Term X30/7 Digi Out (MCB 101)
5-4* Relays
5-40 Function Relay
5-41 On Delay, Relay
5-42 Off Delay, Relay
5-5* Pulse Input
5-50 Term. 29 Low Frequency
5-51 Term. 29 High Frequency
5-52 Term. 29 Low Ref./Feedb. Value
5-53 Term. 29 High Ref./Feedb. Value
5-54 Pulse Filter Time Constant #29
5-55 Term. 33 Low Frequency
5-56 Term. 33 High Frequency
5-57 Term. 33 Low Ref./Feedb. Value
5-58 Term. 33 High Ref./Feedb. Value
5-59 Pulse Filter Time Constant #33
5-6* Pulse Output
5-60 Terminal 27 Pulse Output Variable
5-62 Pulse Output Max Freq #27
5-63 Terminal 29 Pulse Output Variable
5-65 Pulse Output Max Freq #29
5-66 Terminal X30/6 Pulse Output Variable
5-68 Pulse Output Max Freq #X30/6
5-7* 24V Encoder Input
5-70 Term 32/33 Pulses Per Revolution
5-71 Term 32/33 Encoder Direction
5-72 Term 32/33 Encoder Type
5-8* I/O Options
5-80 AHF Cap Reconnect Delay
5-9* Bus Controlled
5-90 Digital & Relay Bus Control
5-93 Pulse Out #27 Bus Control
5-94 Pulse Out #27 Timeout Preset
5-95 Pulse Out #29 Bus Control
5-96 Pulse Out #29 Timeout Preset
5-97 Pulse Out #X30/6 Bus Control
5-98 Pulse Out #X30/6 Timeout Preset
6- Analog In/Out**
6-0* Analog I/O Mode
6-00 Live Zero Timeout Time
6-01 Live Zero Timeout Function
6-1* Analog Input 1
6-10 Terminal 53 Low Voltage
6-11 Terminal 53 High Voltage
6-12 Terminal 53 Low Current
6-13 Terminal 53 High Current
6-14 Terminal 53 Low Ref./Feedb. Value
6-15 Terminal 53 High Ref./Feedb. Value
6-16 Terminal 53 Filter Time Constant
6-2* Analog Input 2
6-20 Terminal 54 Low Voltage
6-21 Terminal 54 High Voltage
6-22 Terminal 54 Low Current
6-23 Terminal 54 High Current
6-24 Terminal 54 Low Ref./Feedb. Value
6-25 Terminal 54 High Ref./Feedb. Value
6-26 Terminal 54 Filter Time Constant
6-3* Analog Input 3
6-30 Terminal X30/11 Low Voltage
6-31 Terminal X30/11 High Voltage
6-34 Term. X30/11 Low Ref./Feedb. Value
6-35 Term. X30/11 High Ref./Feedb. Value
6-36 Term. X30/11 Filter Time Constant
6-4* Analog Input 4
6-40 Terminal X30/12 Low Voltage
6-41 Terminal X30/12 High Voltage
6-44 Term. X30/12 Low Ref./Feedb. Value
6-45 Term. X30/12 High Ref./Feedb. Value
6-46 Term. X30/12 Filter Time Constant
6-5* Analog Output 1
6-50 Terminal 42 Output
6-51 Terminal 42 Output Min Scale
6-52 Terminal 42 Output Max Scale
6-53 Term 42 Output Bus Ctrl
6-54 Terminal 42 Output Timeout Preset
6-55 Analog Output Filter
6-6* Analog Output 2
6-60 Terminal X30/8 Output
6-61 Terminal X30/8 Min. Scale
6-62 Terminal X30/8 Max. Scale
6-63 Terminal X30/8 Bus Control
6-64 Terminal X30/8 Output Timeout Preset
6-7* Analog Output 3
6-70 Terminal X45/1 Output
6-71 Terminal X45/1 Min. Scale
6-72 Terminal X45/1 Max. Scale
6-73 Terminal X45/1 Bus Control
6-74 Terminal X45/1 Output Timeout Preset
6-8* Analog Output 4
6-80 Terminal X45/3 Output
6-81 Terminal X45/3 Min. Scale
6-82 Terminal X45/3 Max. Scale
6-83 Terminal X45/3 Bus Control
6-84 Terminal X45/3 Output Timeout Preset
7- Controllers**
7-0* Speed PID Ctrl.
7-00 Speed PID Feedback Source
7-01 Speed PID Droop
7-02 Speed PID Proportional Gain
7-03 Speed PID Integral Time
7-04 Speed PID Differentiation Time
7-05 Speed PID Diff. Gain Limit
7-06 Speed PID Lowpass Filter Time
7-07 Speed PID Feedback Gear Ratio
7-08 Speed PID Accel. Feed Forward Factor
7-09 Speed PID Error Correction w/ Ramp
7-1* Torque PI Ctrl.
7-10 Torque PI Feedback Source
7-12 Torque PI Proportional Gain
7-13 Torque PI Integration Time
7-16 Torque PI Lowpass Filter Time
7-18 Torque PI Feed Forward Factor
7-19 Current Controller Rise Time
7-2* Process Ctrl. Feedb
7-20 Process CL Feedback 1 Resource
7-22 Process CL Feedback 2 Resource
7-3* Process PID Ctrl.
7-30 Process PID Normal/ Inverse Control
7-31 Process PID Anti Windup
7-32 Process PID Start Speed
7-33 Process PID Proportional Gain
7-34 Process PID Integral Time
7-35 Process PID Differentiation Time
7-36 Process PID Diff. Gain Limit
7-38 Process PID Feed Forward Factor
7-39 On Reference Bandwidth
7-9* Position PI Ctrl.
7-90 Position PI Feedback Source
7-91 Position PI Droop
7-92 Position PI Proportional Gain
7-93 Position PI Integral Time
7-94 Position PI Feedback Scale Numerator
7-95 Position PI Feebback Scale Denominator
7-97 Position PI Maximum Speed Above Master
7-98 Position PI Feed Forward Factor
7-99 Position PI Minimum Ramp Time
8- Comm. and Options**
8-0* General Settings
8-01 Control Site
8-02 Control Word Source
8-03 Control Word Timeout Time
8-04 Control Word Timeout Function
8-05 End-of-Timeout Function
8-06 Reset Control Word Timeout
8-07 Diagnosis Trigger
8-08 Readout Filtering
8-1* Ctrl. Word Settings
8-10 Control Word Profile
8-13 Configurable Status Word STW
8-14 Configurable Control Word CTW
8-17 Configurable Alarm and Warningword
8-19 Product Code
8-3* FC Port Settings
8-30 Protocol
8-31 Address
8-32 FC Port Baud Rate
8-33 Parity / Stop Bits
8-34 Estimated cycle time
8-35 Minimum Response Delay
8-36 Max Response Delay
8-37 Max Inter-Char Delay
8-4* FC MC protocol set
8-40 Telegram Selection
8-41 Parameters for Signals
8-42 PCD Write Configuration
8-43 PCD Read Configuration
8-5* Digital/Bus
8-50 Coasting Select
8-51 Quick Stop Select
8-52 DC Brake Select
8-53 Start Select
8-54 Reversing Select
8-55 Set-up Select
8-56 Preset Reference Select
8-57 Profidrive OFF2 Select
8-58 Profidrive OFF3 Select
8-8* FC Port Diagnostics
8-80 Bus Message Count
8-81 Bus Error Count
8-82 Slave Messages Rcvd
8-83 Slave Error Count
8-9* Bus Jog
8-90 Bus Jog 1 Speed
8-91 Bus Jog 2 Speed
9- PROFIdrive**
9-00 Setpoint
9-07 Actual Value
9-15 PCD Write Configuration
9-16 PCD Read Configuration
9-18 Node Address
9-19 Drive Unit System Number
9-22 Telegram Selection
9-23 Parameters for Signals
9-27 Parameter Edit
9-28 Process Control
9-44 Fault Message Counter
9-45 Fault Code
9-47 Fault Number
9-52 Fault Situation Counter
9-53 Profibus Warning Word
9-63 Actual Baud Rate
9-64 Device Identification
9-65 Profile Number
9-67 Control Word 1
9-68 Status Word 1
9-70 Edit Set-up
9-71 Profibus Save Data Values
9-72 ProfibusDriveReset
9-75 DO Identification
9-80 Defined Parameters (1)
9-81 Defined Parameters (2)
9-82 Defined Parameters (3)
9-83 Defined Parameters (4)
9-84 Defined Parameters (5)
9-85 Defined Parameters (6)
9-90 Changed Parameters (1)
9-91 Changed Parameters (2)
9-92 Changed Parameters (3)
9-93 Changed Parameters (4)
9-94 Changed Parameters (5)
9-99 Profibus Revision Counter
10- CAN Fieldbus**
10-0* Common Settings
10-00 CAN Protocol
10-01 Baud Rate Select
10-02 MAC ID
10-05 Readout Transmit Error Counter
10-06 Readout Receive Error Counter
10-07 Readout Bus Off Counter
10-1* DeviceNet
10-10 Process Data Type Selection
10-11 Process Data Config Write
10-12 Process Data Config Read
10-13 Warning Parameter
10-14 Net Reference
10-15 Net Control
10-2* COS Filters
10-20 COS Filter 1
10-21 COS Filter 2
10-22 COS Filter 3
10-23 COS Filter 4
10-3* Parameter Access
10-30 Array Index
10-31 Store Data Values
10-32 Devicenet Revision
10-33 Store Always
10-34 DeviceNet Product Code
10-39 Devicenet F Parameters
10-5* CANopen
10-50 Process Data Config Write.
10-51 Process Data Config Read.
12- Ethernet**
12-0* IP Settings
12-00 IP Address Assignment
12-01 IP Address
12-02 Subnet Mask

12-03 Default Gateway
12-04 DHCP Server
12-05 Lease Expires
12-06 Name Servers
12-07 Domain Name
12-08 Host Name
12-09 Physical Address
12-1* Ethernet Link Parameters
12-10 Link Status
12-11 Link Duration
12-12 Auto Negotiation
12-13 Link Speed
12-14 Link Duplex
12-2* Process Data
12-20 Control Instance
12-21 Process Data Config Write
12-22 Process Data Config Read
12-23 Process Data Config Write Size
12-24 Process Data Config Read Size
12-27 Master Address
12-28 Store Data Values
12-29 Store Always
12-3* EtherNet/IP
12-30 Warning Parameter
12-31 Net Reference
12-32 Net Control
12-33 CIP Revision
12-34 CIP Product Code
12-35 EDS Parameter
12-37 COS Inhibit Timer
12-38 COS Filter
12-4* Modbus TCP
12-40 Status Parameter
12-41 Slave Message Count
12-42 Slave Exception Message Count
12-5* EtherCAT
12-50 Configured Station Alias
12-51 Configured Station Address
12-59 EtherCAT Status
12-6* Ethernet PowerLink
12-60 Node ID
12-62 SDO Timeout
12-63 Basic Ethernet Timeout
12-66 Threshold
12-67 Threshold Counters
12-68 Cumulative Counters
12-69 Ethernet PowerLink Status
12-8* Other Ethernet Services
12-80 FTP Server
12-81 HTTP Server
12-82 SMTP Service
12-89 Transparent Socket Channel Port
12-9* Advanced Ethernet Services
12-90 Cable Diagnostic
12-91 Auto Cross Over
12-92 IGMP Snooping
12-93 Cable Error Length
12-94 Broadcast Storm Protection
12-95 Broadcast Storm Filter
12-96 Port Config
12-98 Interface Counters
12-99 Media Counters
13- Smart Logic**
13-0* SLC Settings
13-00 SL Controller Mode
13-01 Start Event
13-02 Stop Event
13-03 Reset SLC
13-1* Comparators
13-10 Comparator Operand
13-11 Comparator Operator
13-12 Comparator Value
13-1* RS Flip Flops
13-15 RS-FF Operand S
13-16 RS-FF Operand R
13-2* Timers
13-20 SL Controller Timer
13-4* Logic Rules
13-40 Logic Rule Boolean 1
13-41 Logic Rule Operator 1
13-42 Logic Rule Boolean 2
13-43 Logic Rule Operator 2
13-44 Logic Rule Boolean 3
13-5* States
13-51 SL Controller Event
13-52 SL Controller Action
14- Special Functions**
14-0* Inverter Switching
14-00 Switching Pattern
14-01 Switching Frequency
14-03 Overmodulation
14-04 PWM Random
14-06 Dead Time Compensation
14-1* Mains On/Off
14-10 Mains Failure
14-11 Mains Voltage at Mains Fault
14-12 Function at Mains Imbalance
14-14 Kin. Backup Time Out
14-15 Kin. Backup Trip Recovery Level
14-16 Kin. Backup Gain
14-2* Trip Reset
14-20 Reset Mode
14-21 Automatic Restart Time
14-22 Operation Mode
14-23 Typecode Setting
14-24 Trip Delay at Current Limit
14-25 Trip Delay at Torque Limit
14-26 Trip Delay at Inverter Fault
14-28 Production Settings
14-29 Service Code
14-3* Current Limit Ctrl.
14-30 Current Lim Ctrl, Proportional Gain
14-31 Current Lim Ctrl, Integration Time
14-32 Current Lim Ctrl, Filter Time
14-35 Stall Protection
14-36 Fieldweakening Function
14-4* Energy Optimising
14-40 VT Level
14-41 AEO Minimum Magnetisation
14-42 Minimum AEO Frequency
14-43 Motor Cosphi
14-5* Environment
14-50 RFI Filter
14-51 DC Link Compensation
14-52 Fan Control
14-53 Fan Monitor
14-55 Output Filter
14-56 Capacitance Output Filter
14-57 Inductance Output Filter
14-59 Actual Number of Inverter Units
14-7* Compatibility
14-72 Legacy Alarm Word
14-73 Legacy Warning Word
14-74 Leg. Ext. Status Word
14-8* Options
14-80 Option Supplied by External 24VDC
14-88 Option Data Storage
14-89 Option Detection
14-9* Fault Settings
14-90 Fault Level
15- Drive Information**
15-0* Operating Data
15-00 Operating hours
15-01 Running Hours
15-02 kWh Counter
15-03 Power Up's
15-04 Over Temp's
15-05 Over Volt's
15-06 Reset kWh Counter
15-07 Reset Running Hours Counter
15-1* Data Log Settings
15-10 Logging Source
15-11 Logging Interval
15-12 Trigger Event
15-13 Logging Mode
15-14 Samples Before Trigger
15-2* Historic Log
15-20 Historic Log: Event
15-21 Historic Log: Value
15-22 Historic Log: Time
15-3* Fault Log
15-30 Fault Log: Error Code
15-31 Fault Log: Value
15-32 Fault Log: Time
15-4* Drive Identification
15-40 FC Type
15-41 Power Section
15-42 Voltage
15-43 Software Version
15-44 Ordered Typecode String
15-45 Actual Typecode String
15-46 Frequency Converter Ordering No
15-47 Power Card Ordering No
15-48 LCP Id No
15-49 SW ID Control Card
15-50 SW ID Power Card
15-51 Frequency Converter Serial Number
15-53 Power Card Serial Number
15-58 Smart Setup Filename
15-59 CSIV Filename
15-6* Option Ident
15-60 Option Mounted
15-61 Option SW Version
15-62 Option Ordering No
15-63 Option Serial No
15-70 Option in Slot A
15-71 Slot A Option SW Version
15-72 Option in Slot B
15-73 Slot B Option SW Version
15-74 Option in Slot C0/E0
15-75 Slot C0/E0 Option SW Version
15-76 Option in Slot C1/E1
15-77 Slot C1/E1 Option SW Version
15-8* Operating Data II
15-80 Fan Running Hours
15-81 Preset Fan Running Hours
15-89 Configuration Change Counter
15-9* Parameter Info
15-92 Defined Parameters
15-93 Modified Parameters
15-98 Drive Identification
15-99 Parameter Metadata
16- Data Readouts**
16-0* General Status
16-00 Control Word
16-01 Reference [Unit]
16-02 Reference %
16-03 Status Word
16-05 Main Actual Value [%]
16-06 Actual Position
16-07 Target Position
16-08 Position Error
16-09 Custom Readout
16-1* Motor Status
16-10 Power [kW]
16-11 Power [hp]
16-12 Motor Voltage
16-13 Frequency
16-14 Motor current
16-15 Frequency [%]
16-16 Torque [Nm]
16-17 Speed [RPM]
16-18 Motor Thermal
16-19 KTY sensor temperature
16-20 Motor Angle
16-21 Torque [%] High Res.
16-22 Torque [%]
16-23 Motor Shaft Power [kW]
16-24 Calibrated Stator Resistance
16-25 Torque [Nm] High
16-3* Drive Status
16-30 DC Link Voltage
16-32 Brake Energy /s
16-33 Brake Energy Average
16-34 Heatsink Temp.
16-35 Inverter Thermal
16-36 Inv. Nom. Current
16-37 Inv. Max. Current
16-38 SL Controller State
16-39 Control Card Temp.
16-40 Logging Buffer Full
16-41 LCP Bottom Statusline
16-44 Speed Error [RPM]
16-45 Motor Phase U Current
16-46 Motor Phase V Current
16-47 Motor Phase W Current
16-48 Speed Ref. After Ramp [RPM]
16-49 Current Fault Source
16-5* Ref. & Feedb.
16-50 External Reference
16-51 Pulse Reference
16-52 Feedback[Unit]
16-53 Digi Pot Reference
16-57 Feedback [RPM]
16-6* Inputs & Outputs
16-60 Digital Input
16-61 Terminal 53 Switch Setting
16-62 Analog Input 53
16-63 Terminal 54 Switch Setting
16-64 Analog Input 54
16-65 Analog Output 42 [mA]
16-66 Digital Output [bin]
16-67 Freq. Input #29 [Hz]
16-68 Freq. Input #33 [Hz]
16-69 Pulse Output #27 [Hz]
16-70 Pulse Output #29 [Hz]
16-71 Relay Output [bin]
16-72 Counter A
16-73 Counter B
16-75 Analog In X30/11
16-76 Analog In X30/12
16-77 Analog Out X30/8 [mA]
16-78 Analog Out X45/1 [mA]
16-79 Analog Out X45/3 [mA]
16-8* Fieldbus & FC Port
16-80 Fieldbus CTW 1
16-82 Fieldbus REF 1
16-83 Fieldbus REF 2
16-84 Comm. Option STW
16-85 FC Port CTW 1
16-86 FC Port REF 1
16-87 Bus Readout Alarm/Warning
16-89 Configurable Alarm/Warning Word
16-9* Diagnosis Readouts
16-90 Alarm Word
16-91 Alarm Word 2
16-92 Warning Word
16-93 Warning Word 2
16-94 Ext. Status Word
17- Position Feedback**
17-1* Inc. Enc. Interface
17-10 Signal Type
17-11 Resolution (PPR)
17-2* Abs. Enc. Interface
17-20 Protocol Selection

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17-21 Resolution (Positions/Rev)
17-22 Multiturn Revolutions
17-24 SSI Data Length
17-25 Clock Rate
17-26 SSI Data Format
17-34 HIPERFACE Baudrate
17-5* Resolver Interface
17-50 Poles
17-51 Input Voltage
17-52 Input Frequency
17-53 Transformation Ratio
17-56 Encoder Sim. Resolution
17-59 Resolver Interface
17-6* Monitoring and App.
17-60 Feedback Direction
17-61 Feedback Signal Monitoring
17-7* Position Scaling
17-70 Position Unit
17-71 Position Unit Scale
17-72 Position Unit Numerator
17-73 Position Unit Denominator
17-74 Position Offset
17-75 Position Recovery at Power-up
17-76 Position Axis Mode
17-77 Position Feedback Mode
17-8* Position Homing
17-80 Homing Function
17-81 Home Sync Function
17-82 Home Position
17-83 Homing Speed
17-84 Homing Torque Limit
17-85 Homing Timout
17-9* Position Config
17-90 Absolute Position Mode
17-91 Relative Position Mode
17-92 Position Control Selection
17-93 Master Offset Selection
17-94 Rotary Absolute Direction
18- Data Readouts 2**
18-3* Analog Readouts
18-36 Analog Input X48/2 [mA]
18-37 Temp. Input X48/4
18-38 Temp. Input X48/7
18-39 Temp. Input X48/10
18-5* Active Alarms/Warnings
18-55 Active Alarm Numbers
18-56 Active Warning Numbers
18-6* Inputs & Outputs 2
18-60 Digital Input 2
30- Special Features**
30-2* Adv. Start Adjust
30-20 High Starting Torque Time [s]
30-21 High Starting Torque Current [%]
30-22 Locked Rotor Protection
30-23 Locked Rotor Detection Time [s]
30-24 Locked Rotor Detection Speed Error [%]
30-8* Compatibility (I)
30-80 d-axis Inductance (Ld)
30-81 Brake Resistor (ohm)
30-83 Speed PID Proportional Gain
30-84 Process PID Proportional Gain
31- Bypass Option**
31-00 Bypass Mode
31-01 Bypass Start Time Delay
31-02 Bypass Trip Time Delay
31-03 Test Mode Activation
31-10 Bypass Status Word
31-11 Bypass Running Hours
31-19 Remote Bypass Activation
35- Sensor Input Option**
35-0* Temp. Input Mode
35-00 Term. X48/4 Temperature Unit
35-01 Term. X48/4 Input Type
35-02 Term. X48/7 Temperature Unit
35-03 Term. X48/7 Input Type
35-04 Term. X48/10 Temperature Unit
35-05 Term. X48/10 Input Type
35-06 Temperature Sensor Alarm Function
35-1* Temp. Input X48/4
35-14 Term. X48/4 Filter Time Constant
35-15 Term. X48/4 Temp. Monitor
35-16 Term. X48/4 Low Temp. Limit
35-17 Term. X48/4 High Temp. Limit
35-2* Temp. Input X48/7
35-24 Term. X48/7 Filter Time Constant
35-25 Term. X48/7 Temp. Monitor
35-26 Term. X48/7 Low Temp. Limit
35-27 Term. X48/7 High Temp. Limit
35-3* Temp. Input X48/10
35-34 Term. X48/10 Filter Time Constant
35-35 Term. X48/10 Temp. Monitor
35-36 Term. X48/10 Low Temp. Limit
35-37 Term. X48/10 High Temp. Limit
35-4* Analog Input X48/2
35-42 Term. X48/2 Low Current
35-43 Term. X48/2 High Current
35-44 Term. X48/2 Low Ref./Feedb. Value
35-45 Term. X48/2 High Ref./Feedb. Value
35-46 Term. X48/2 Filter Time Constant
42- Safety Functions**
42-1* Speed Monitoring
42-10 Measured Speed Source
42-11 Encoder Resolution
42-12 Encoder Direction
42-13 Gear Ratio
42-14 Feedback Type
42-15 Feedback Filter
42-17 Tolerance Error
42-18 Zero Speed Timer
42-19 Zero Speed Limit
42-2* Safe Input
42-20 Safe Function
42-21 Type
42-22 Discrepancy Time
42-23 Stable Signal Time
42-24 Restart Behaviour
42-3* General
42-30 External Failure Reaction
42-31 Reset Source
42-33 Parameter Set Name
42-35 S-CRC Value
42-36 Level 1 Password
42-4* SS1
42-40 Type
42-41 Ramp Profile
42-42 Delay Time
42-43 Delta T
42-44 Deceleration Rate
42-45 Delta V
42-46 Zero Speed
42-47 Ramp Time
42-48 S-ramp Ratio at Decel. Start
42-49 S-ramp Ratio at Decel. End
42-5* SLS
42-50 Cut Off Speed
42-51 Speed Limit
42-52 Fail Safe Reaction
42-53 Start Ramp
42-54 Ramp Down Time
42-6* Safe Fieldbus
42-60 Telegram Selection
42-61 Destination Address
42-8* Status
42-80 Safe Option Status
42-81 Safe Option Status 2
42-82 Safe Control Word
42-83 Safe Status Word
42-85 Active Safe Func.
42-86 Safe Option Info
42-88 Supported Customization File Version
42-89 Customization File Version
42-9* Special
42-90 Restart Safe Option
600- PROFIsafe**
600-22 PROFIdrive/safe Tel. Selected
600-44 Fault Message Counter
600-47 Fault Number
600-52 Fault Situation Counter
601- PROFIdrive 2**
601-22 PROFIdrive Safety Channel Tel. No.

Index

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I

L

M

N

O

P

Q

R

S

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T

U

V

W

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