Pioneering for You

Wilo-EFC 110–315 kW

en Installation and operating instructions

Contents

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.

1.2 Additional Resources

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

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

1.3 Document and Software Version

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

Edition	Remarks	Software version
MG21M1xx	Initial revision	2.6x

Table 1.1 Document 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 the 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.

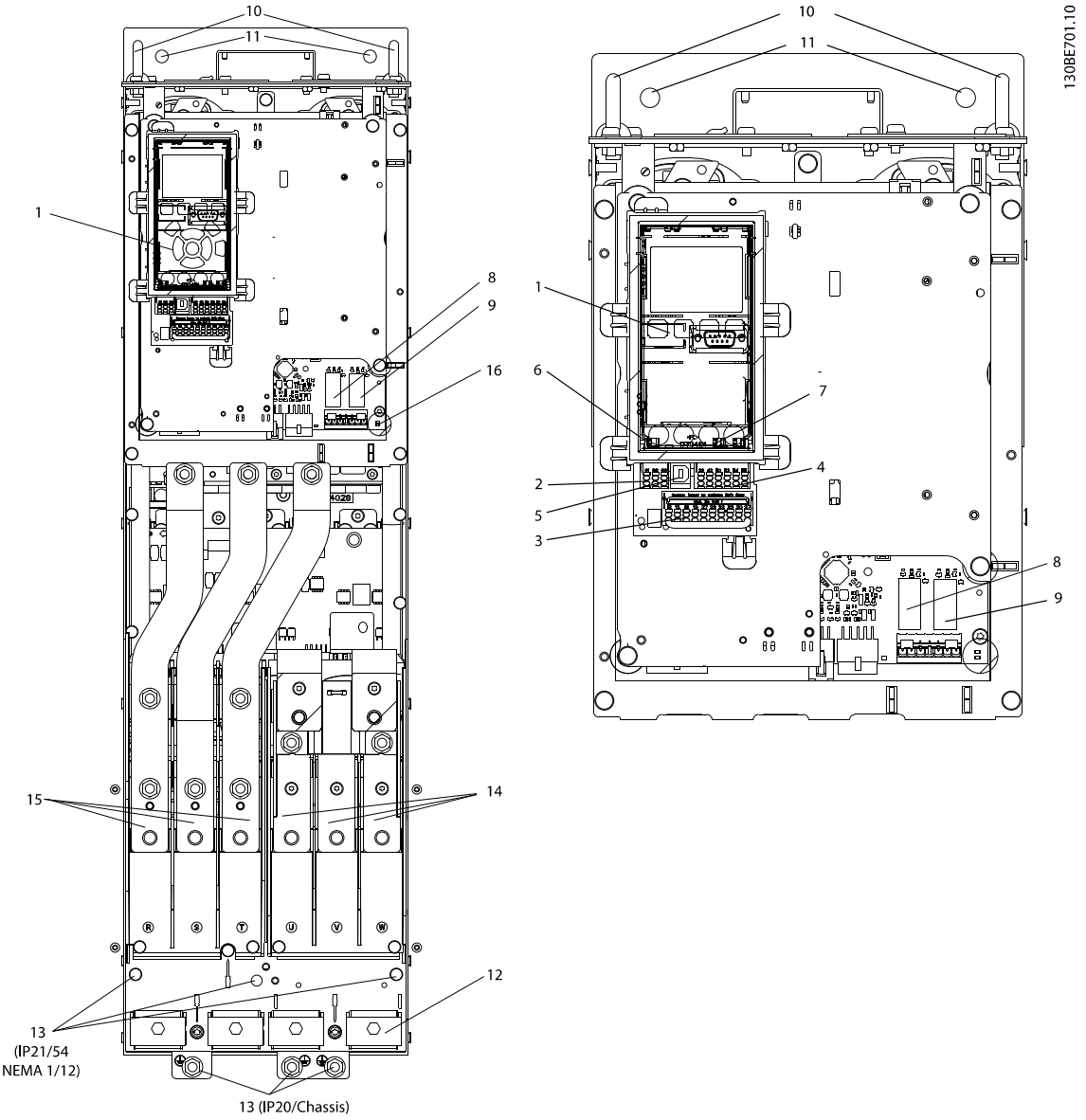
NOTICE

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*.

1

1.4.2 Interior Views



1	LCP (local control panel)	9	Relay 2 (04, 05, 06)
2	RS485 fieldbus connector	10	Lifting ring
3	Digital I/O and 24 V power supply	11	Mounting holes
4	Analog I/O connector	12	Cable clamp (PE)
5	USB connector	13	Ground
6	Fieldbus terminal switch	14	Motor output terminals 96 (U), 97 (V), 98 (W)
7	Analog switches (A53, A54)	15	Mains input terminals 91 (L1), 92 (L2), 93 (L3)
8	Relay 1 (01, 02, 03)	16	TB5 (IP21/54 only). Terminal block for anti-condensation heater

Illustration 1.1 D1 Interior Components (left); Close-up View: LCP and Control Functions (right)

NOTICE

For location of TB6 (terminal block for contactor), see *chapter 4.6 Motor Connection*.

1.4.3 Extended Options Cabinets

If a frequency converter is ordered with 1 of the following options, it is supplied with an options cabinet that increases the height.

- Brake chopper.
- Mains disconnect.
- Contactor.
- Mains disconnect with contactor.
- Circuit breaker.
- Oversized wiring cabinet.
- Regeneration terminals.
- Load sharing terminals.

Illustration 1.2 shows an example of a frequency converter with an options cabinet. *Table 1.2* lists the variants for the frequency converters that include input options.

Options unit designations	Extension cabinets	Possible options
D5h	D1h enclosure with short extension.	• Brake. • Disconnect.
D6h	D1h enclosure with tall extension.	• Contactor. • Contactor with disconnect. • Circuit breaker.
D7h	D2h enclosure with short extension.	• Brake. • Disconnect.
D8h	D2h enclosure with tall extension.	• Contactor. • Contactor with disconnect. • Circuit breaker.

Table 1.2 Overview of Extended Options

The D7h and D8h frequency converters (D2h plus options cabinet) include a 200 mm (7.9 in) pedestal for floor mounting.

There is a safety latch on the front cover of the options cabinet. If the frequency converter is supplied with a mains disconnect or circuit breaker, the safety latch prevents the cabinet door from being opened while the frequency converter is energized. Before opening the door of the frequency converter, open the disconnect or circuit breaker (to de-energize the frequency converter) and remove the cover of the options cabinet.

For frequency converters purchased with a disconnect, contactor or circuit breaker, the nameplate label includes a type code for a replacement that does not include the option. If there is a problem with the frequency converter, it is replaced independently of the options.

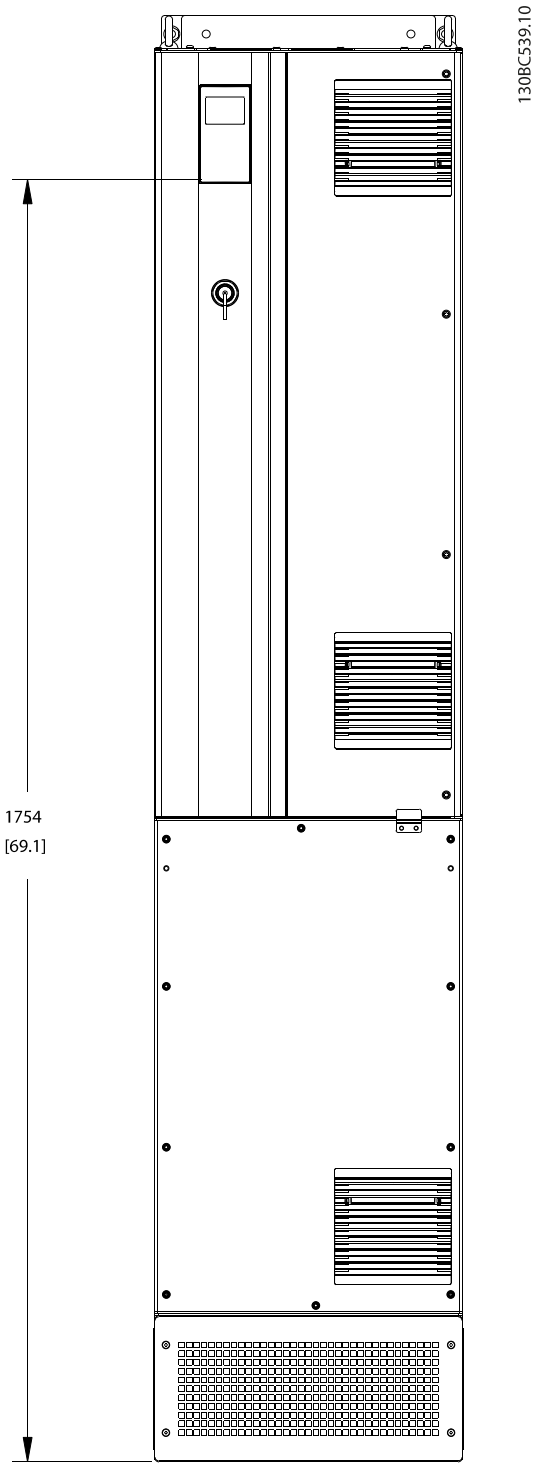
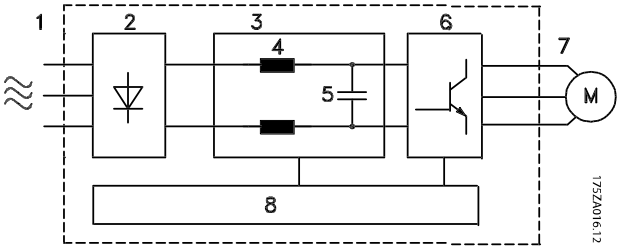


Illustration 1.2 D7h Enclosure

1.4.4 Block Diagram of the Frequency Converter

Illustration 1.3 is a block diagram of the internal components of the frequency converter.



Area	Title	Functions
1	Mains input	• 3-phase AC mains supply to the frequency converter.
2	Rectifier	• The rectifier bridge converts the AC input to DC current to supply inverter power.
3	DC bus	• Intermediate DC-bus circuit handles the DC current.
4	DC reactors	• Filter the intermediate DC circuit voltage. • Prove mains transient protection. • Reduce RMS current. • Raise the power factor reflected back to the line. • Reduce harmonics on the AC input.
5	Capacitor bank	• Stores the DC power. • Provides ride-through protection for short power losses.
6	Inverter	• Converts the DC into a controlled PWM AC waveform for a controlled variable output to the motor.
7	Output to motor	• Regulated 3-phase output power to the motor.
8	Control circuitry	• Input power, internal processing, output, and motor current are monitored to provide efficient operation and control. • User interface and external commands are monitored and performed. • Status output and control can be provided.

Illustration 1.3 Block Diagram of Frequency Converter

1.4.5 Enclosure Sizes and Power Ratings

For enclosure sizes and power ratings of the frequency converters, refer to *chapter 8.9 Power Ratings, Weight, and Dimensions*.

1.5 Approvals and Certifications

Table 1.3 Approvals and Certifications

More approvals and certifications are available. Contact the local Wilo office or partner.

NOTICE

Frequency converters of enclosure size T7 (525–690 V) are not UL listed.

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

NOTICE

IMPOSED LIMITATIONS ON THE OUTPUT FREQUENCY (due to export control regulations):

From software version 1.99, the output frequency of the frequency converter is limited to 590 Hz.

1.6 Disposal

Do not dispose of equipment containing electrical components together with domestic waste.
Collect it separately in accordance with local and currently valid legislation.

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 drive.**

⚠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 20 minutes.**
- **Before performing any service or repair work, use an appropriate voltage measuring device to make sure that the capacitors are fully discharged.**

⚠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.**

3 Mechanical Installation

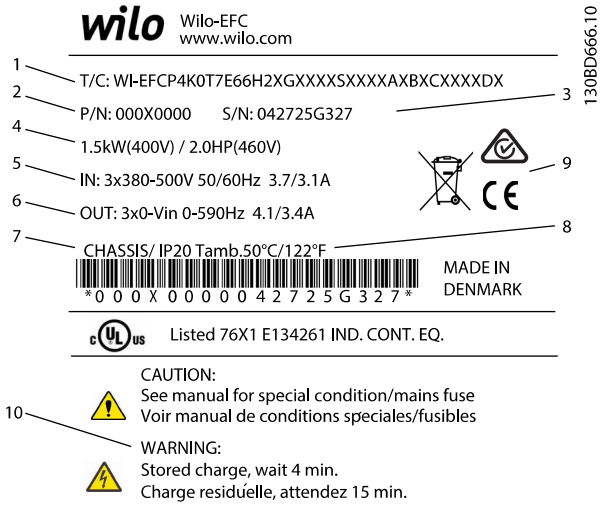
3

3.1 Unpacking

3.1.1 Items Supplied

Items supplied may vary according to product configuration.

- Make sure 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	Ordering 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 type and IP protection 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).

3.1.2 Storage

Ensure that the requirements for storage are fulfilled. Refer to *chapter 8.4.1 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.

Voltage [V]	Altitude restrictions
380–500	At altitudes above 3000 m (9842 ft), contact Wilo regarding PELV.
525–690	At altitudes above 2000 m (6562 ft), contact Wilo regarding PELV.

Table 3.1 Installation at High Altitudes

For detailed ambient conditions specifications, refer to *chapter 8.4.1 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. Clearance requirement: 225 mm (9 in).
- Consider derating for temperatures starting between 45 °C (113 °F) and 50 °C (122 °F) and elevation 1000 m (3300 ft) above sea level. See the frequency converter *design guide* for detailed information.

The frequency converter utilizes a back-channel cooling concept that removes heat sink cooling air. The heat sink cooling air carries approximately 90% of the heat out of the back channel of the frequency converter. Redirect the back-channel air from the panel or room by using:

- Duct cooling. A back-channel cooling kit is available to direct the heat sink cooling air out of the panel when an IP20/chassis frequency converter is installed in a Rittal enclosure. Use of

this kit reduces the heat in the panel and smaller door fans can be specified on the enclosure.

- Cooling out the back (top and base covers). The back-channel cooling air can be ventilated out of the room so that the heat from the back channel is not dissipated into the control room.

NOTICE

One or more door fans are required on the enclosure to remove the heat not contained in the back channel of the frequency converter. The fans also remove any additional losses generated by other components inside the frequency converter. To select the appropriate fan, calculate the total required airflow.

Secure the necessary airflow over the heat sink. The flow rate is shown in *Table 3.2*.

Enclosure size	Door fan/top fan	Heat sink fan
D1h/D3h/D5h/D6h	102 m^3/hr (60 CFM)	420 m^3/hr (250 CFM)
D2h/D4h/D7h/D8h	204 m^3/hr (120 CFM)	840 m^3/hr (500 CFM)

Table 3.2 Airflow

Lifting

Always lift the frequency converter using the dedicated lifting eyes. To avoid bending the lifting holes, use a lifting bar.

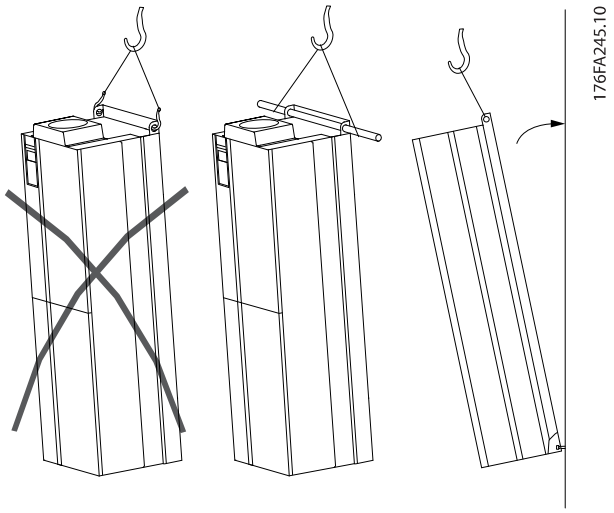


Illustration 3.2 Recommended Lifting Method

⚠WARNING

RISK OF INJURY OR DEATH

The lifting bar must be able to support the weight of the frequency converter to ensure that it does not break during lifting.

- **See *chapter 8.9 Power Ratings, Weight, and Dimensions* for the weight of the different enclosure sizes.**
- **Maximum diameter for bar: 25 mm (1 in).**
- **The angle from the top of the frequency converter to the lifting cable: 60° or greater.**

Failure to follow recommendations could result in death or serious injury.

Mounting

1. Ensure that the strength of the mounting location supports the unit weight.
2. Place 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 to provide cooling airflow. Ensure free space for cooling.
4. Ensure the access, to open the door.
5. Ensure the cable entry from below.

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 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 means that the RCD may not provide 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

- More 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 the fuses. See maximum fuse ratings in *chapter 8.7 Fuses*.

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 4.4 Wiring Schematic*.
- *Chapter 4.6 Motor Connection*.
- *Chapter 4.3 Grounding*.
- *Chapter 4.8 Control Wiring*.

4.3 Grounding

⚠WARNING

LEAKAGE CURRENT HAZARD

Leakage currents exceed 3.5 mA. Failure to ground the drive properly can 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.
- Keep the ground wire connections as short as possible.
- Follow motor manufacturer wiring requirements.
- Minimum cable cross-section: 10 mm^2 (6 AWG) (or 2 rated ground wires terminated separately).
- Tighten the terminals in accordance with the information provided in *Table 8.10*.

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.
- Reduce burst transient by using high-strand wire.
- Do not use pigtails.

NOTICE

POTENTIAL EQUALIZATION

There is a 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 mm^2 (5 AWG).

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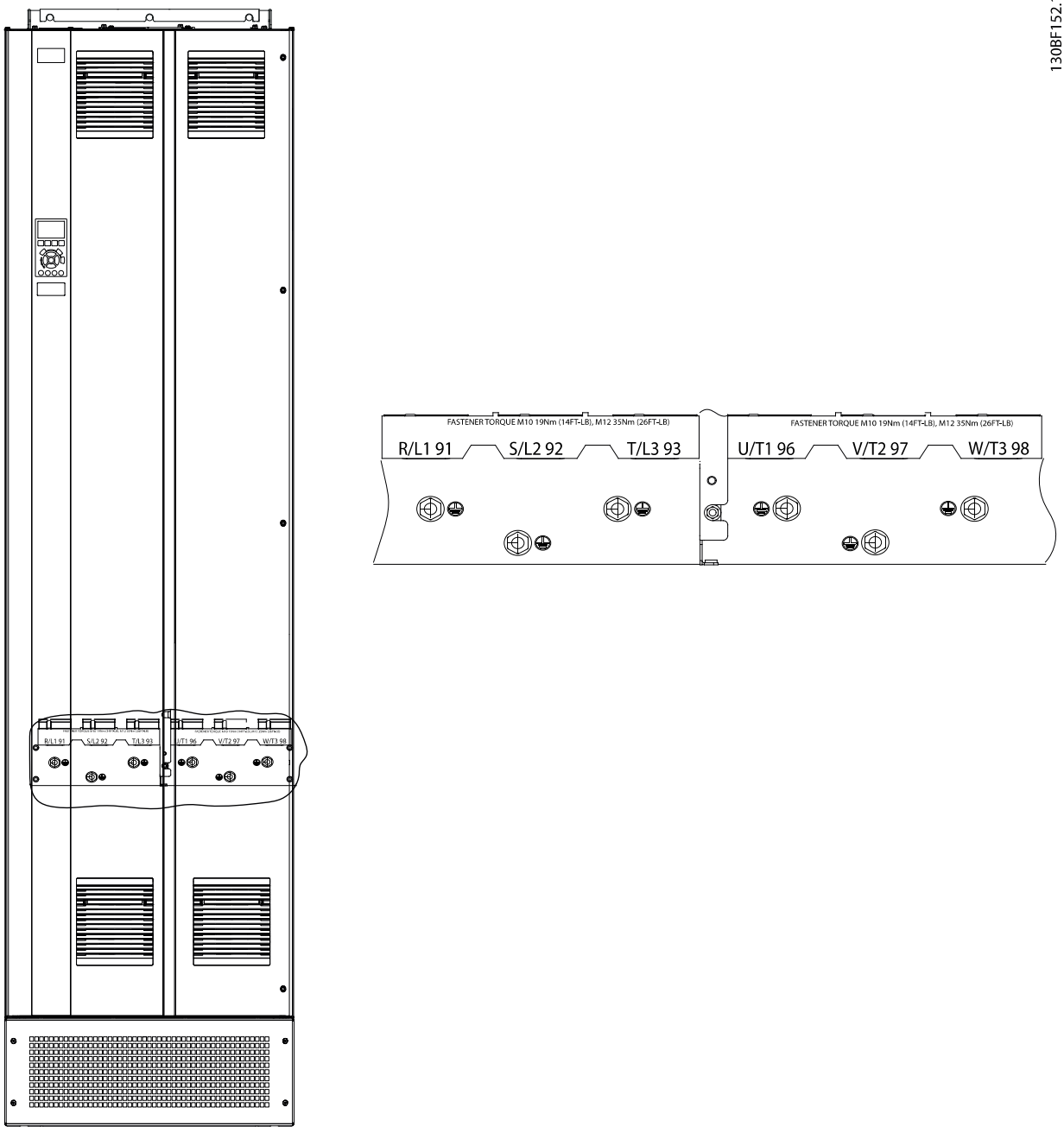

1	Ground terminal (ground terminals are marked with symbol)	2	Ground symbol

Illustration 4.1 Ground Terminals (D1h shown)

4.4 Wiring Schematic

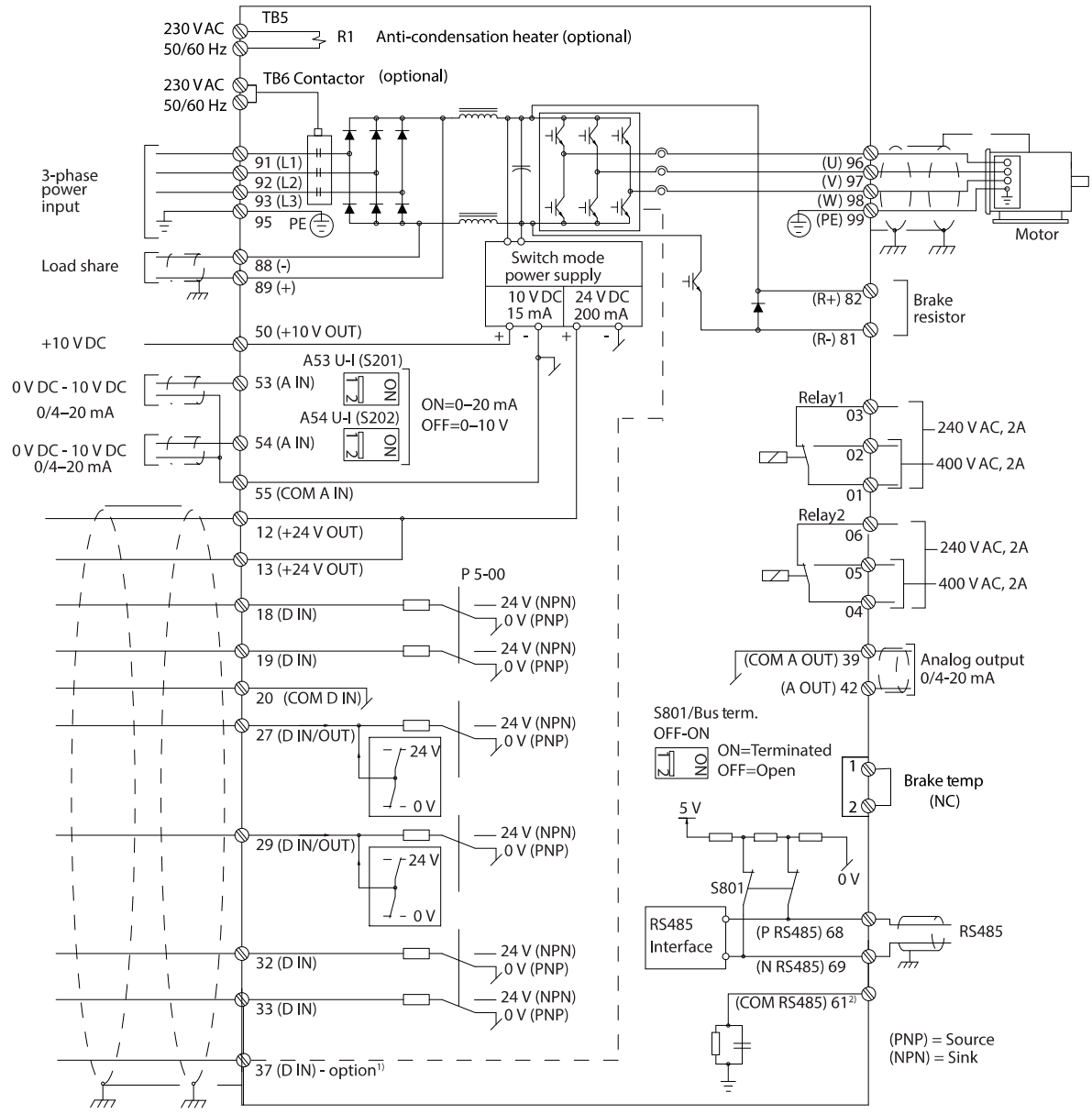

Illustration 4.2 Basic Wiring Schematic

A=Analog, D=Digital

1) Terminal 37 (optional) is used for Safe Torque Off. For Safe Torque Off installation instructions, refer to the *Frequency Converters - Safe Torque Off Operating Guide*.

2) Do not connect cable shield.

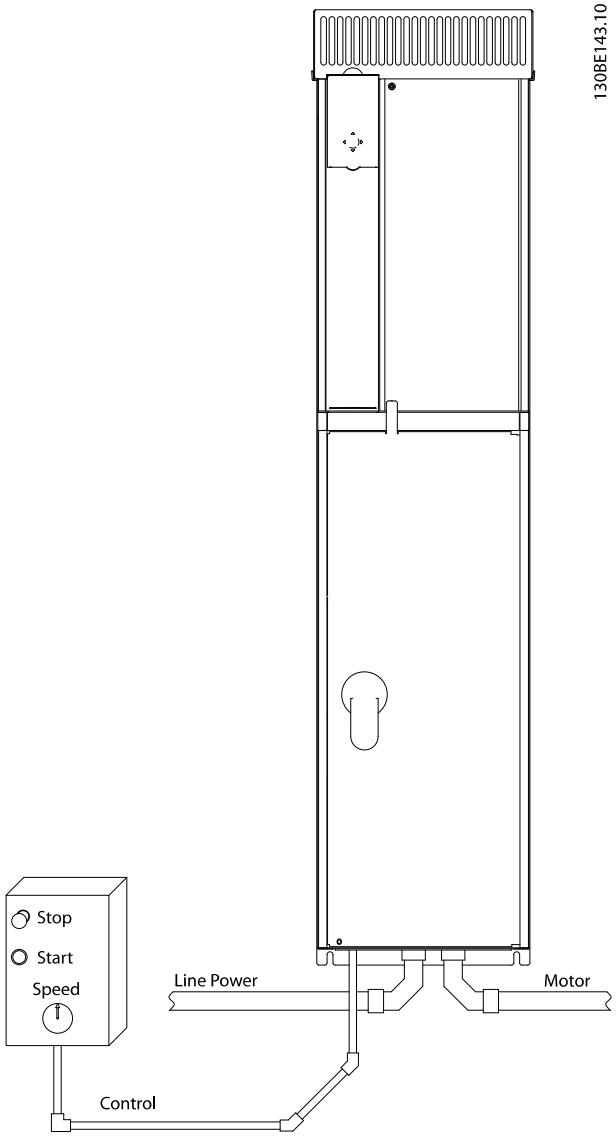

Illustration 4.3 Example of Proper Electrical Installation Using Conduit

NOTICE

EMC INTERFERENCE

Use shielded cables for motor and control wiring, and separate cables for mains input, 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 between mains input, motor, and control cables is required.

4.5 Access

All terminals to the control cables are inside the drive below the LCP. To access, either open the door (E1h and E2h) or remove the front panel (E3h and E4h).

4.6 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.

- 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

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*.

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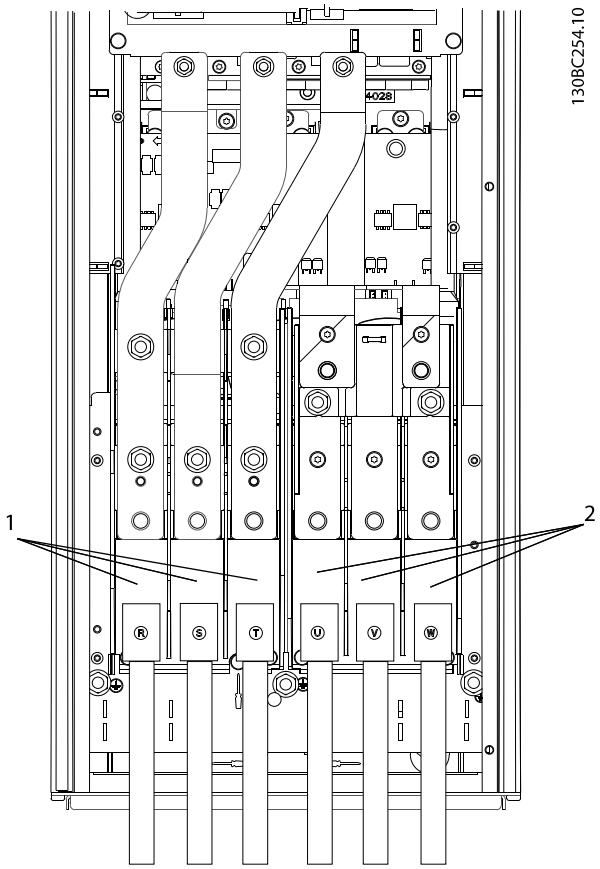


1	Mains connection (R, S, T)
2	Motor connection (U, V, W)

Illustration 4.4 Motor Connection

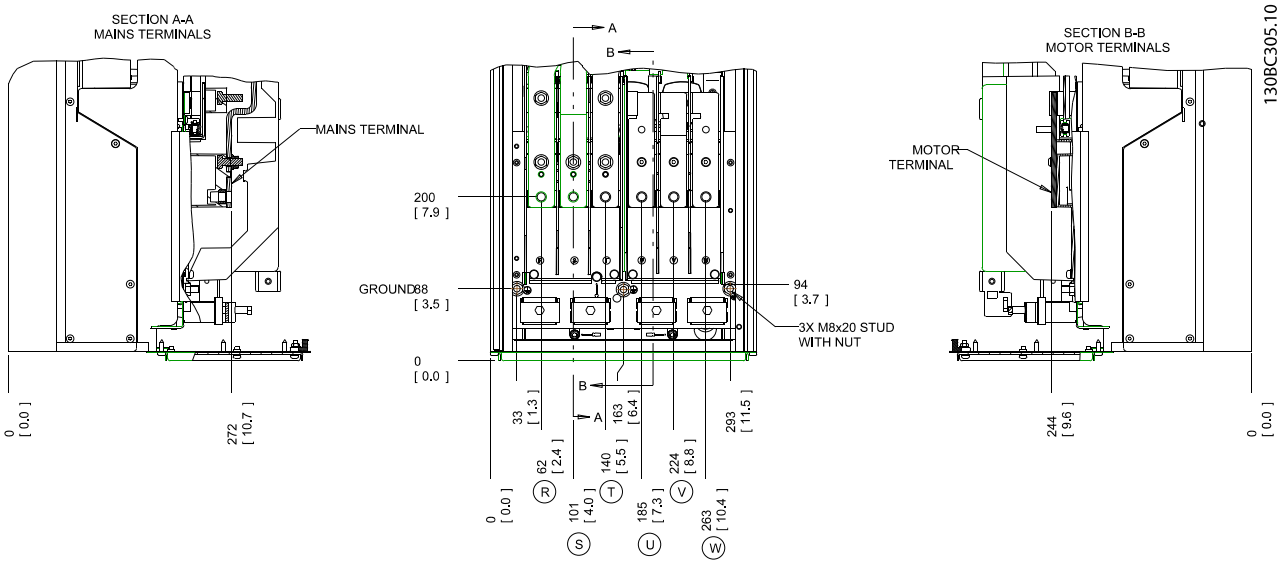


Illustration 4.5 Terminal Locations, D1h

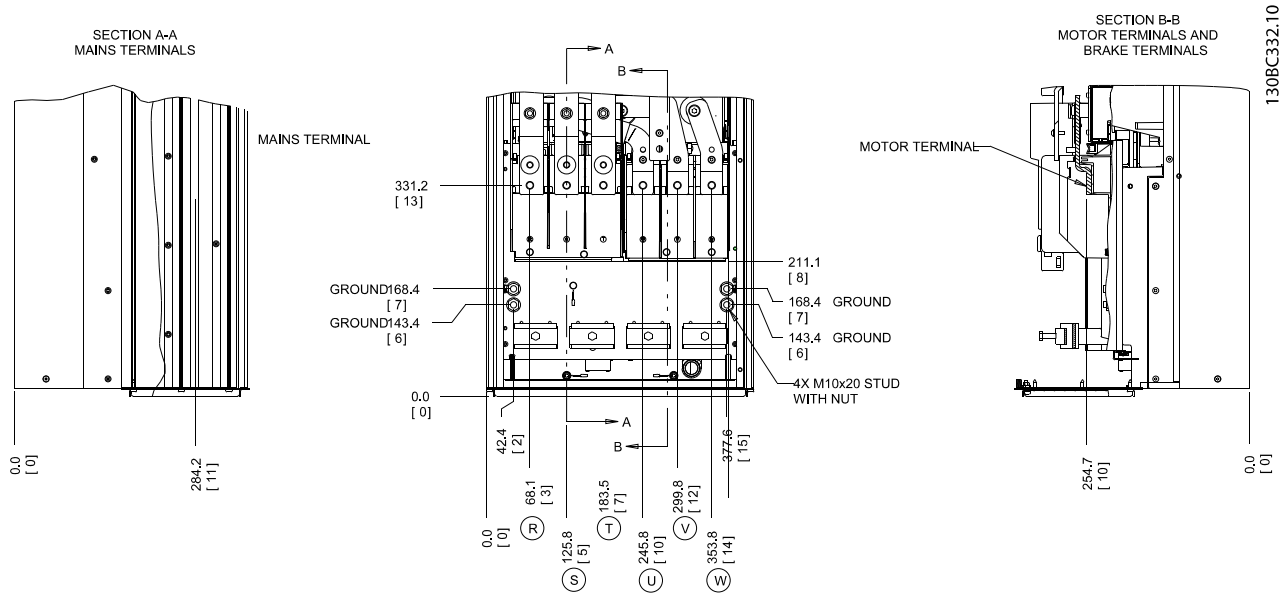


Illustration 4.6 Terminal Locations, D2h

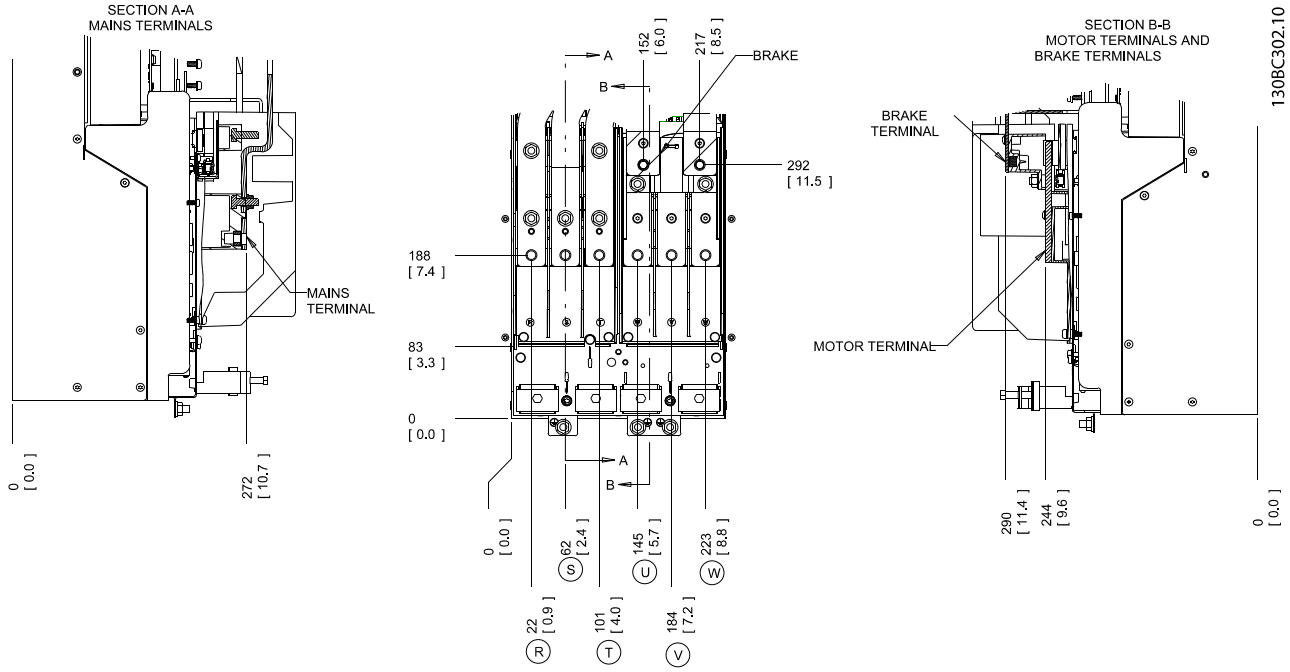
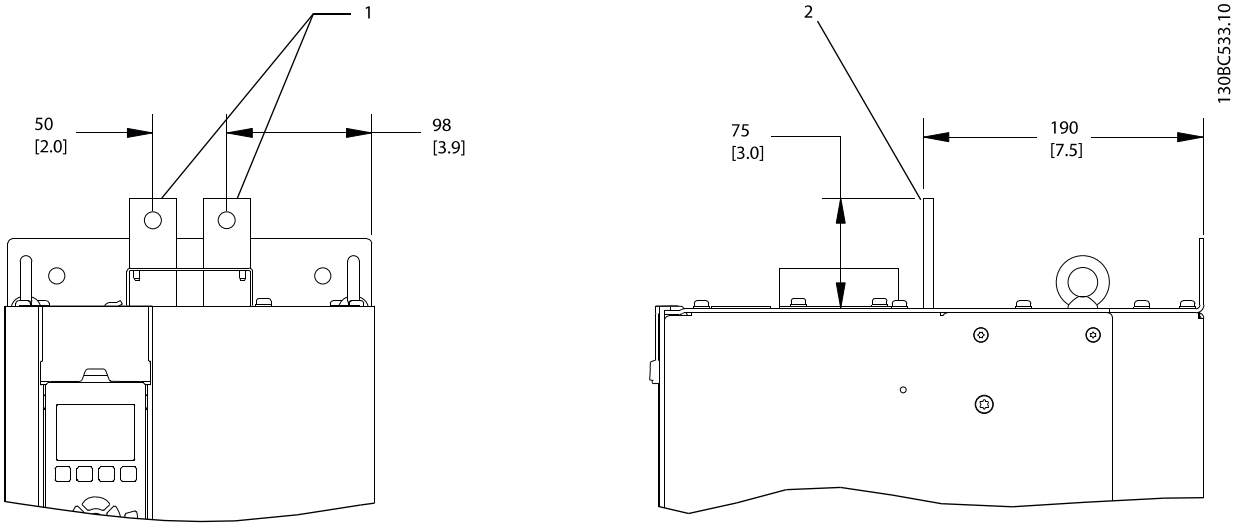


Illustration 4.7 Terminal Locations, D3h



1	Front view
2	Side view

Illustration 4.8 Load Sharing and Regeneration Terminals, D3h

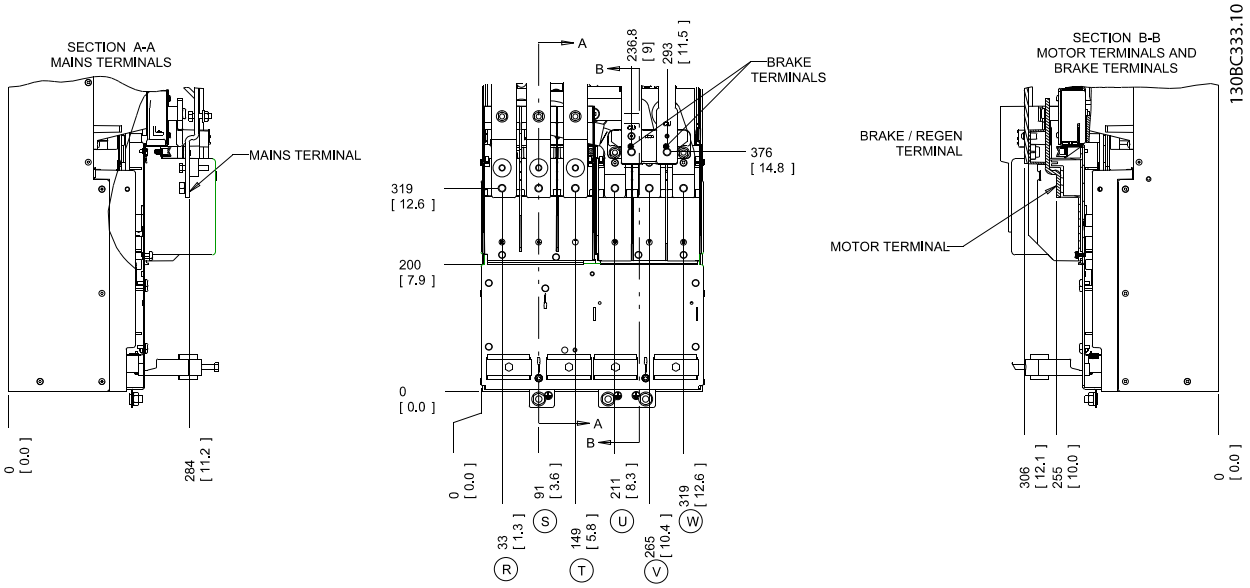
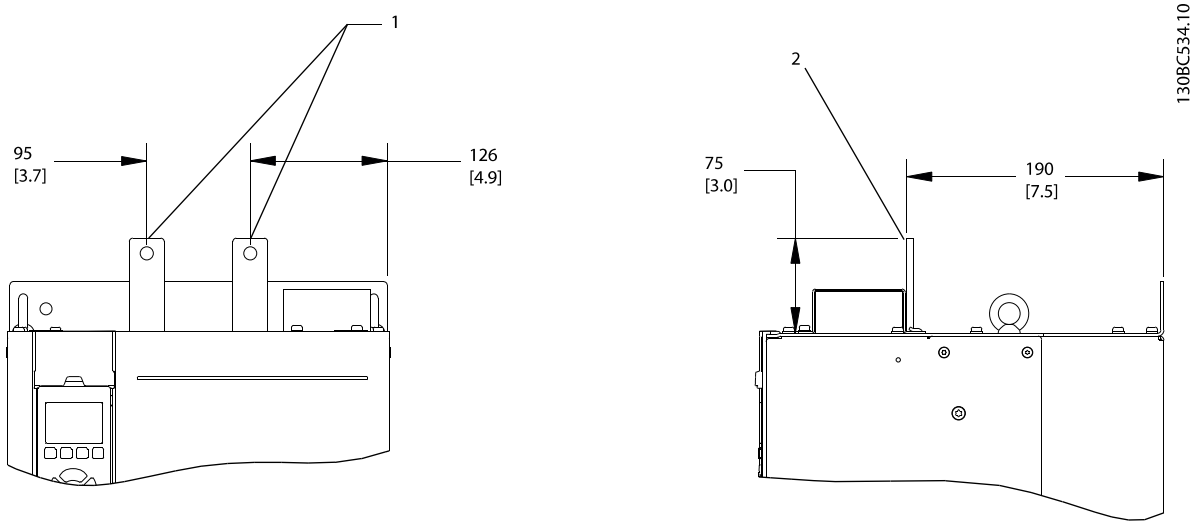
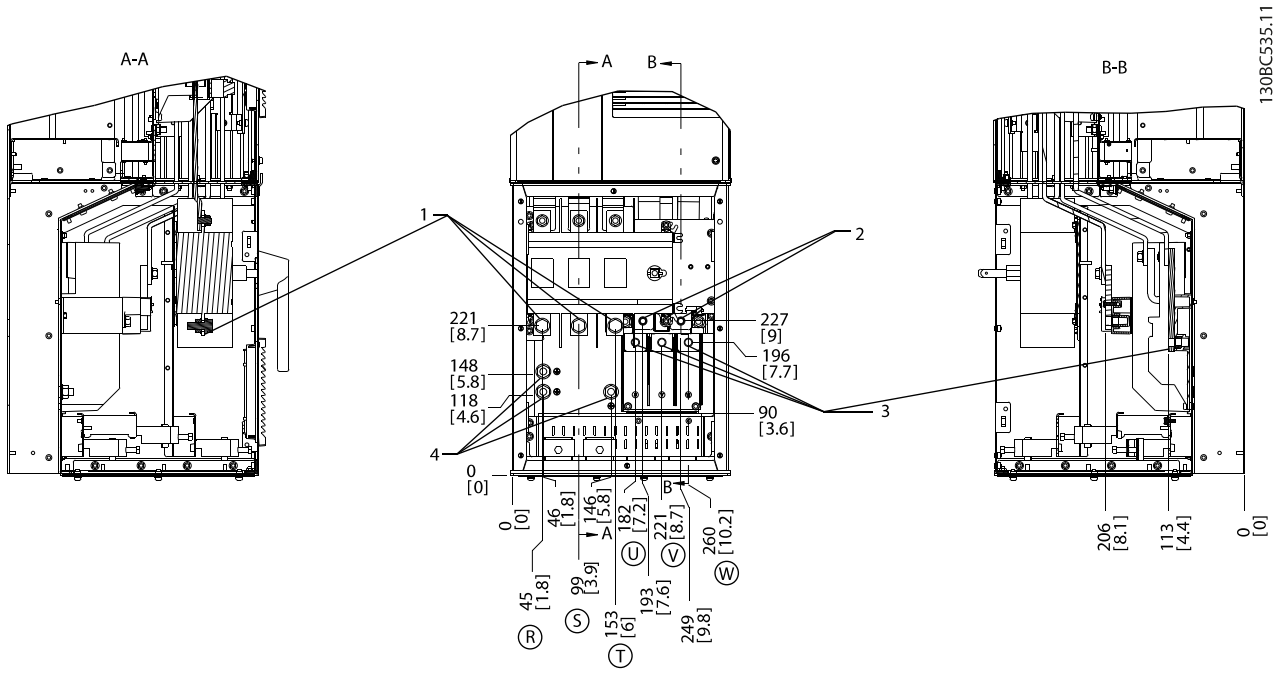


Illustration 4.9 Terminal Locations, D4h



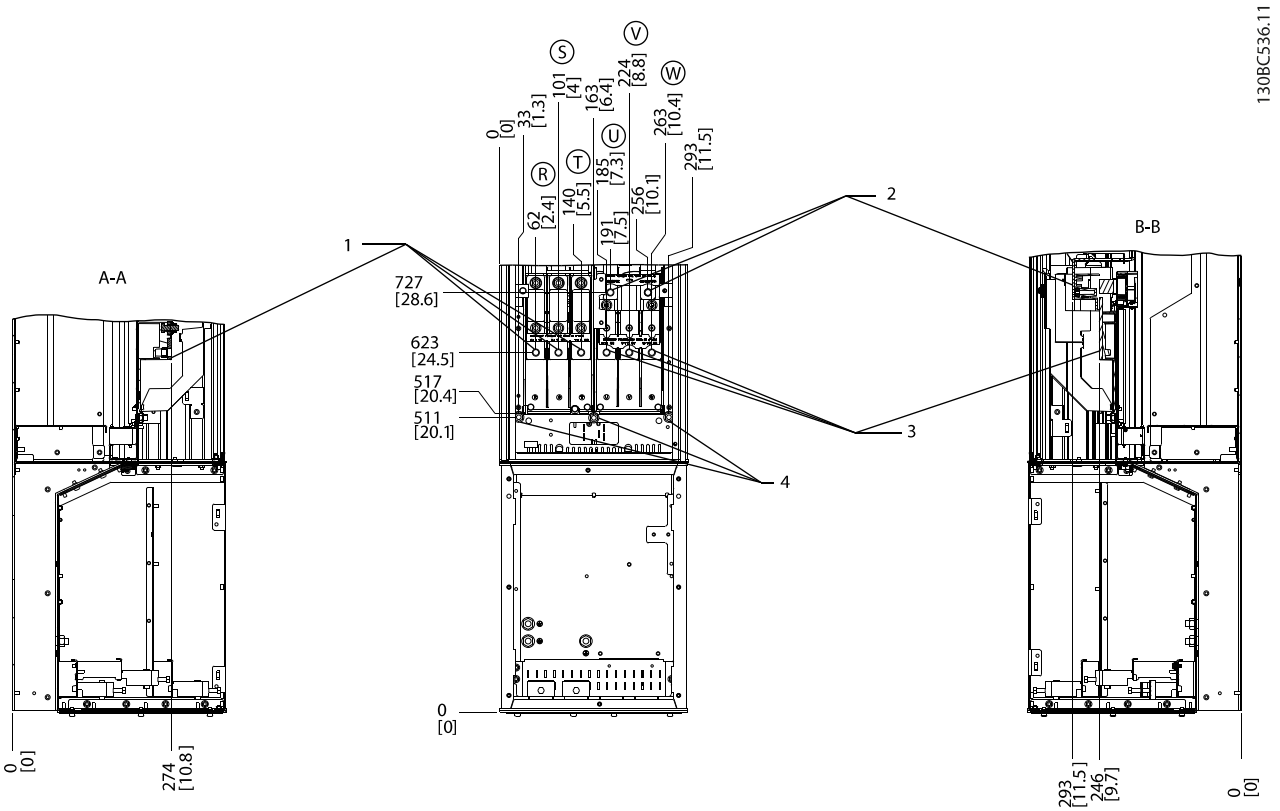
1	Front view
2	Side view

Illustration 4.10 Load Sharing and Regeneration Terminals, D4h



1	Mains terminals
2	Brake terminals
3	Motor terminals
4	Ground terminals

Illustration 4.11 Terminal Locations, D5h with Disconnect Option



1	Mains terminals
2	Brake terminals
3	Motor terminals
4	Ground terminals

Illustration 4.12 Terminal Locations, D5h with Brake Option

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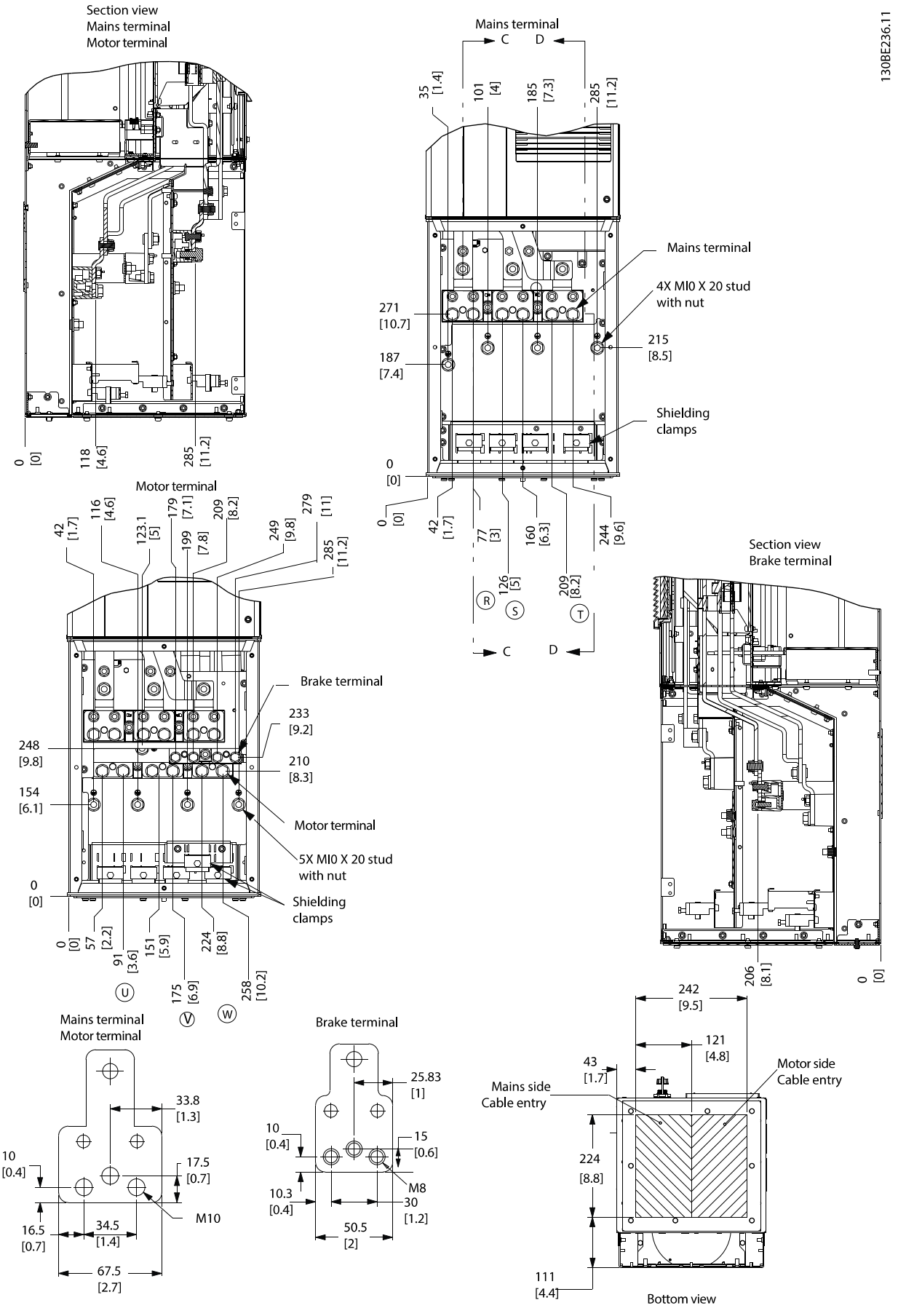
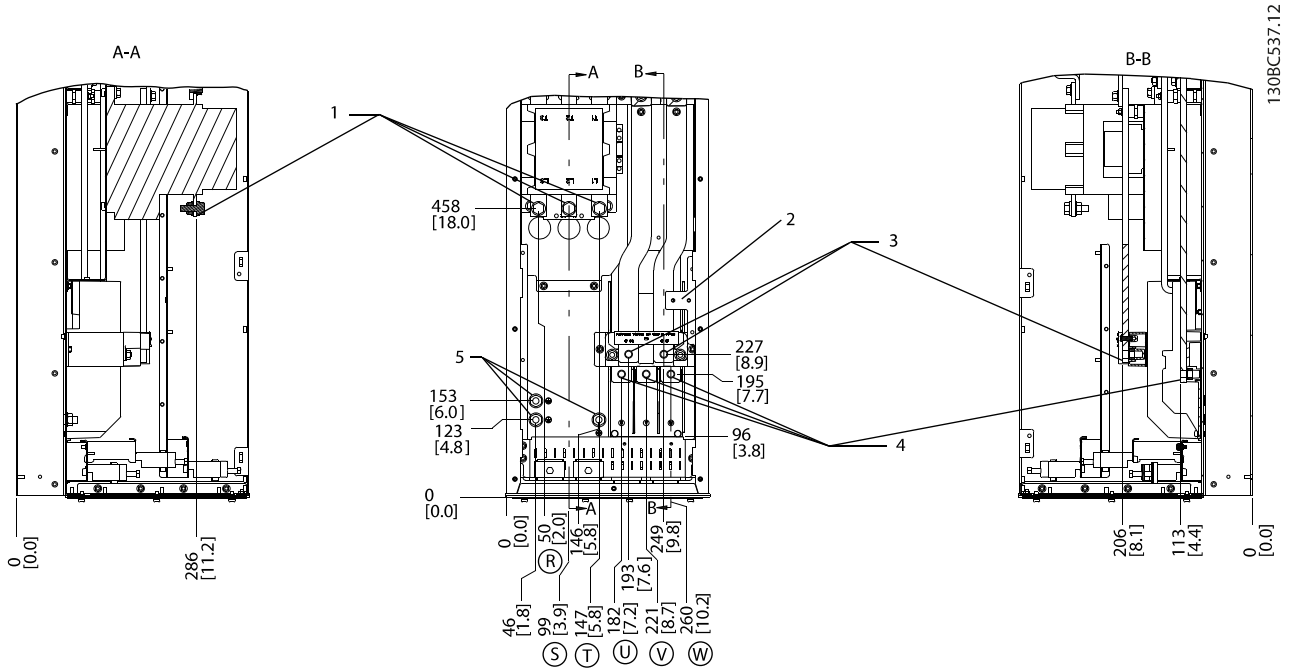


Illustration 4.13 Oversized Wiring Cabinet, D5h



1	Mains terminals
2	TB6 terminal block for contactor
3	Brake terminals
4	Motor terminals
5	Ground terminals

Illustration 4.14 Terminal Locations, D6h with Contactor Option

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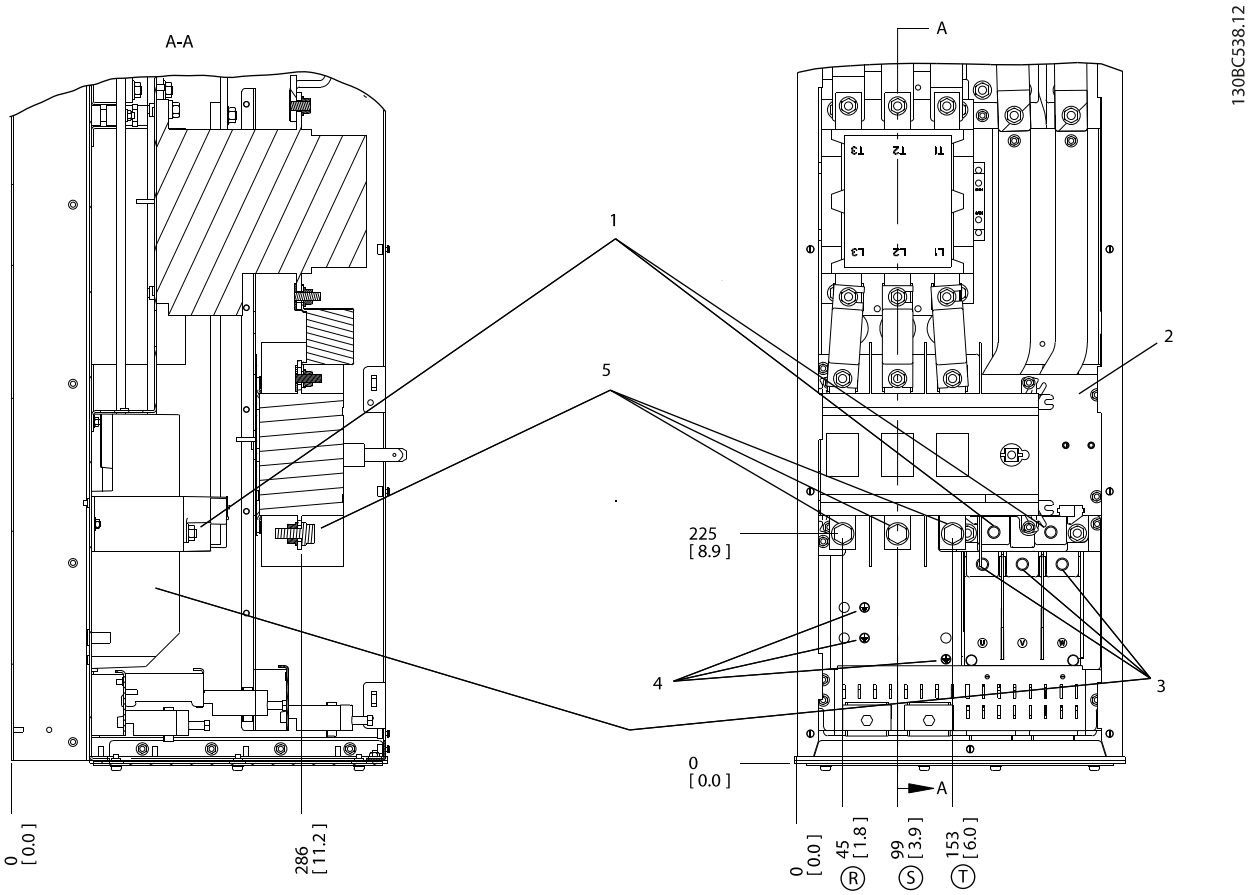
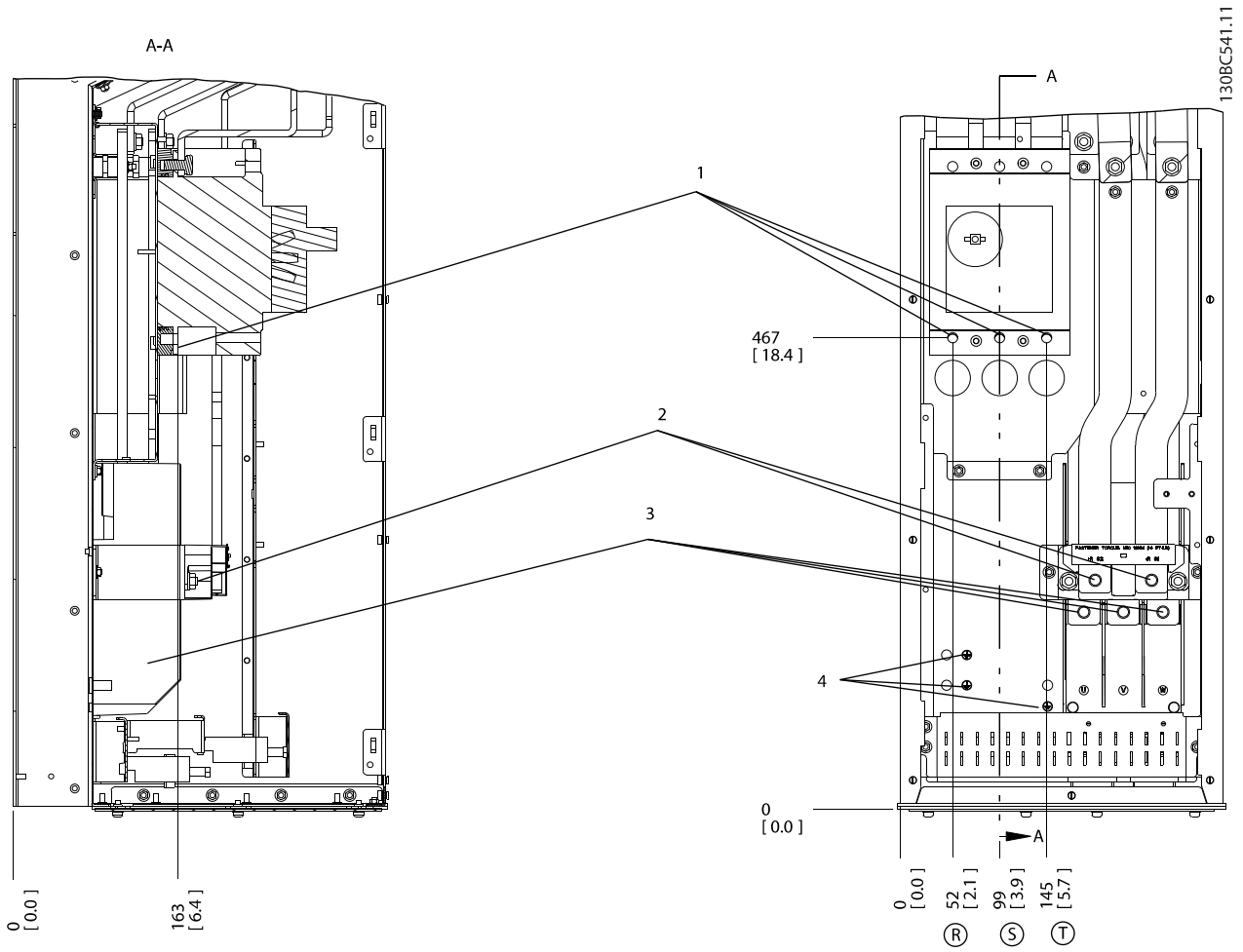


1	Brake terminals
2	TB6 terminal block for contactor
3	Motor terminals
4	Ground terminals
5	Mains terminals

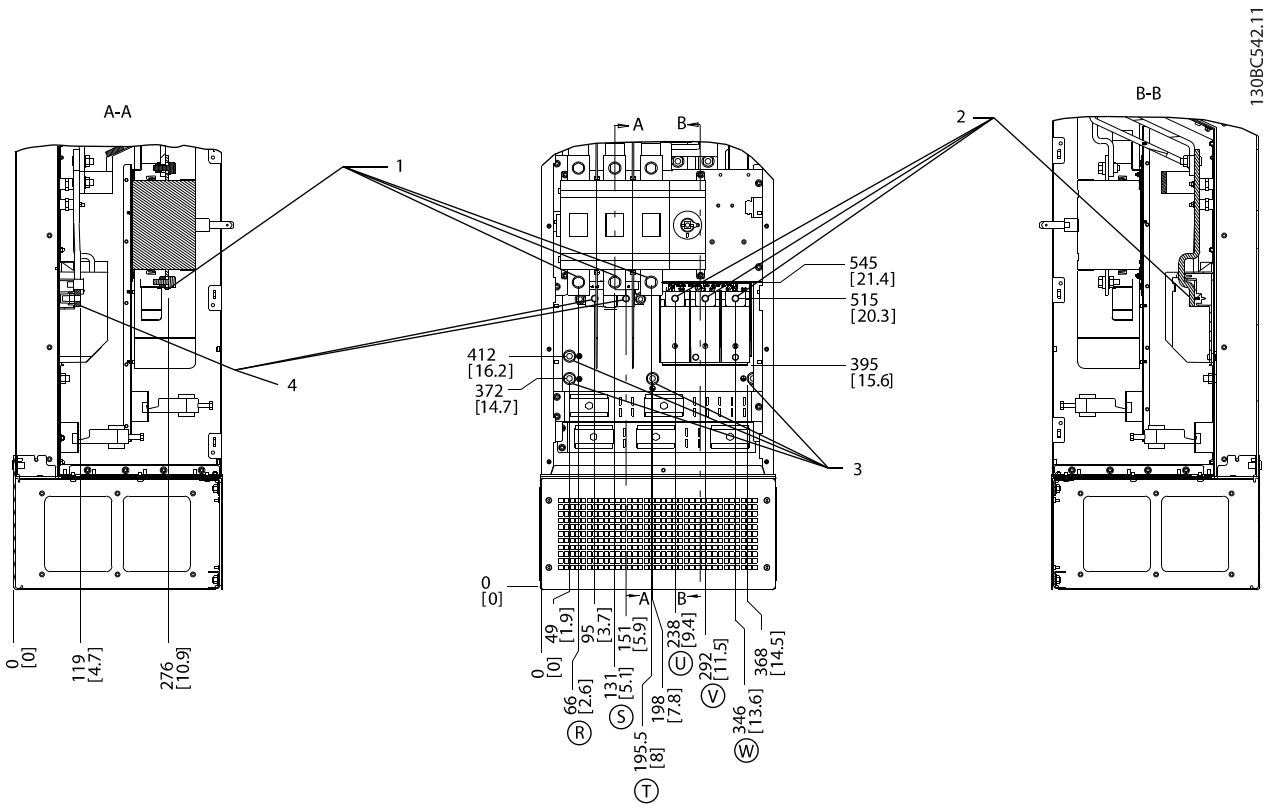
Illustration 4.15 Terminal Locations, D6h with Contactor and Disconnect Options



1	Mains terminals
2	Brake terminals
3	Motor terminals
4	Ground terminals

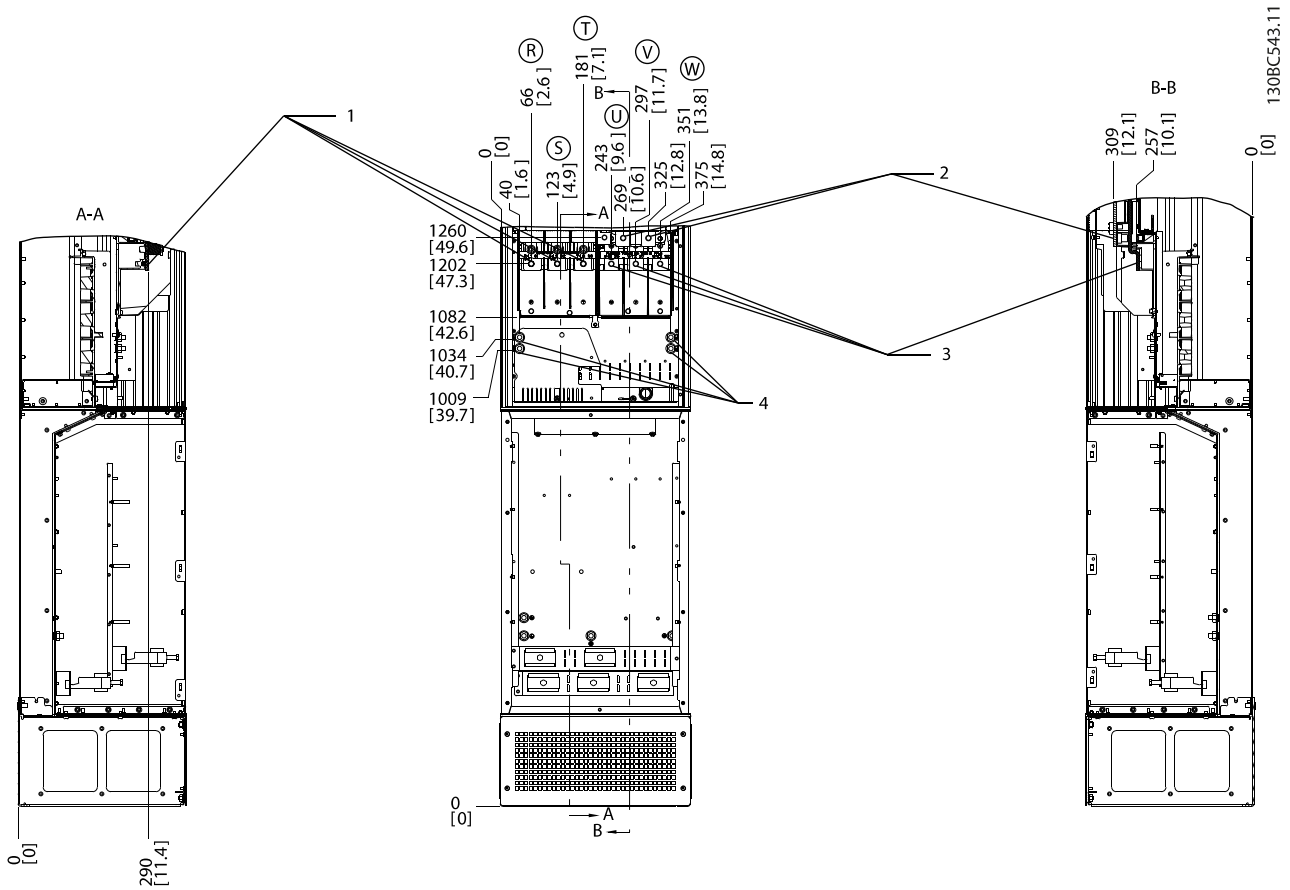
Illustration 4.16 Terminal Locations, D6h with Circuit Breaker Option

4



1	Mains terminals
2	Motor terminals
3	Ground terminals
4	Brake terminals

Illustration 4.17 Terminal Locations, D7h with Disconnect Option



1	Mains terminals
2	Brake terminals
3	Motor terminals
4	Ground terminals

Illustration 4.18 Terminal Locations, D7h with Brake Option

4

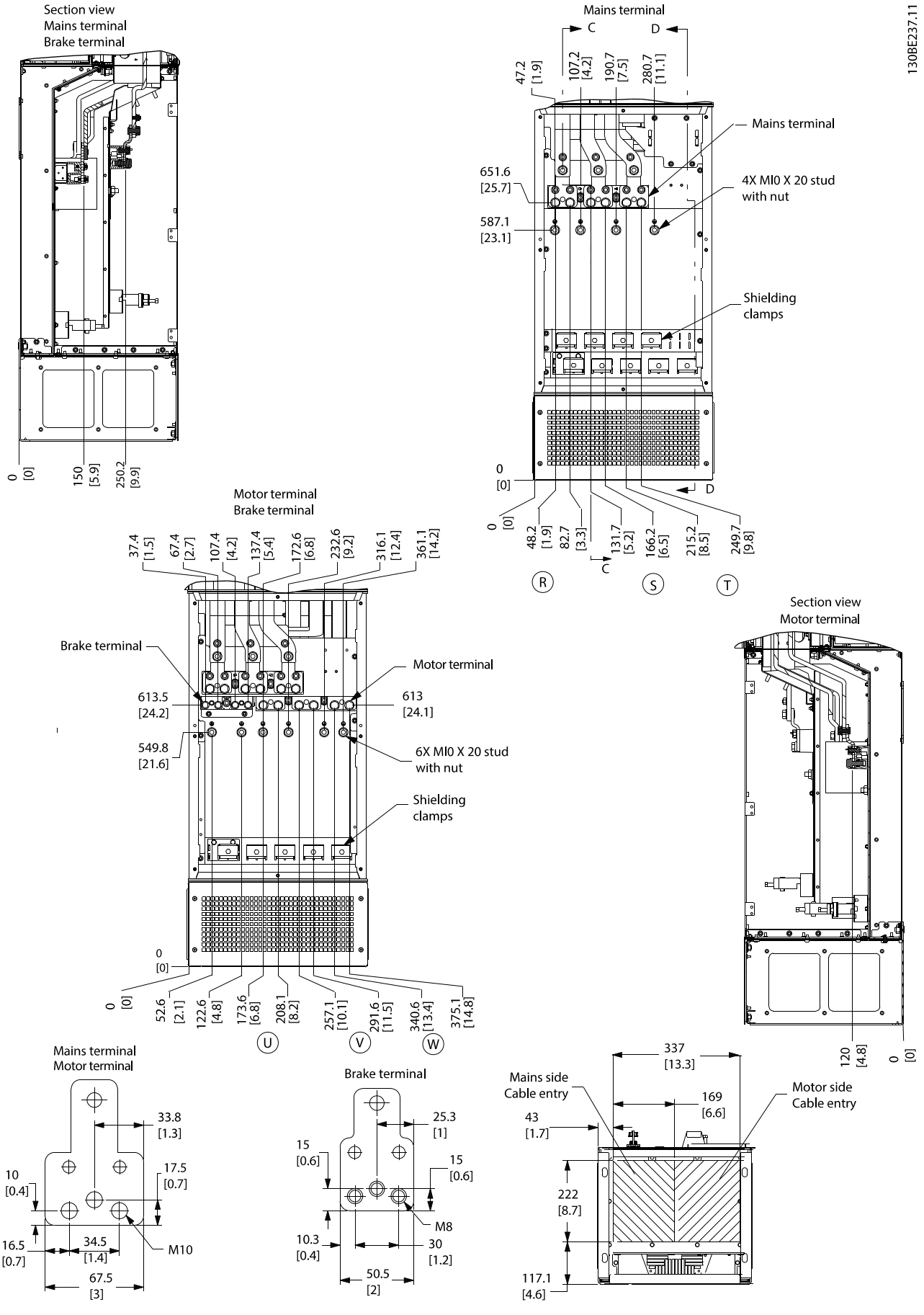
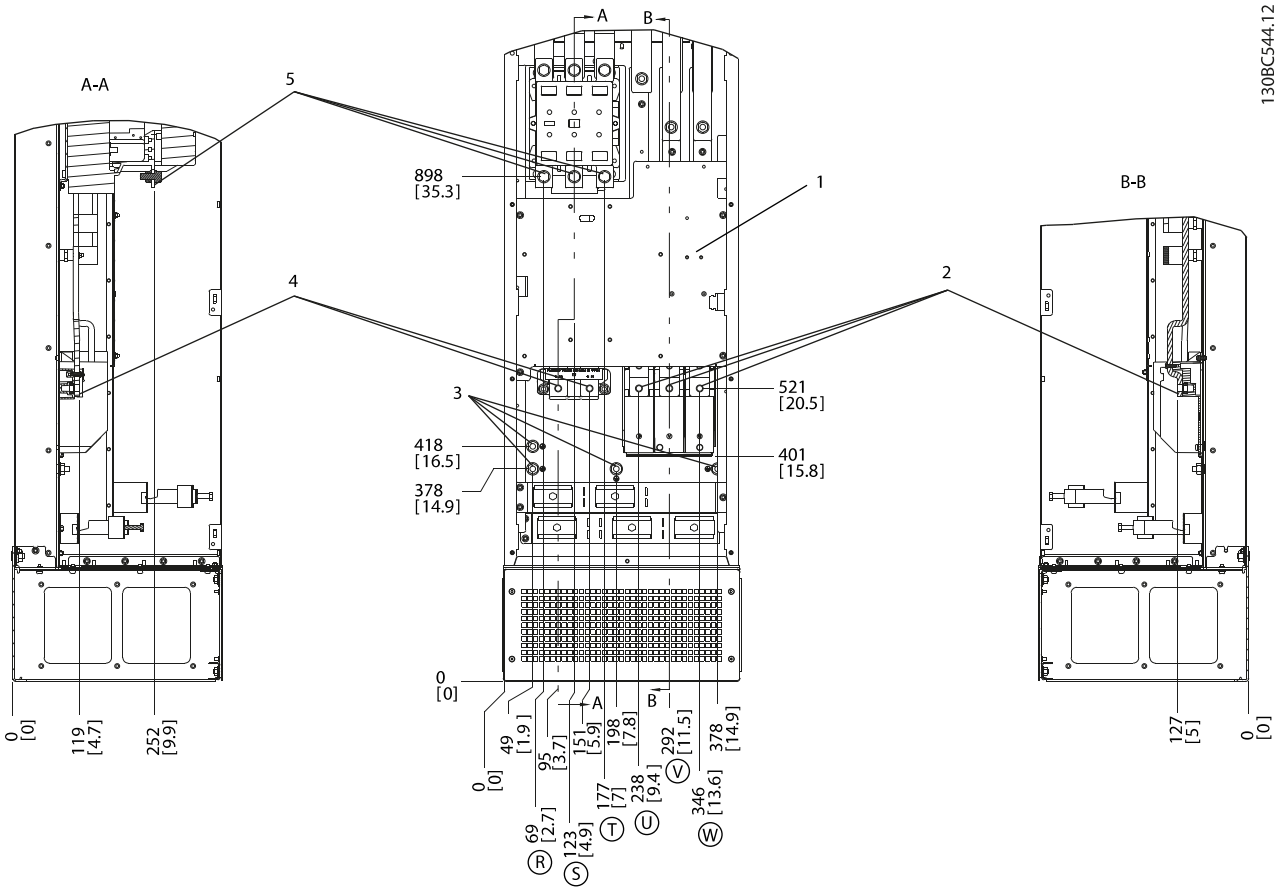


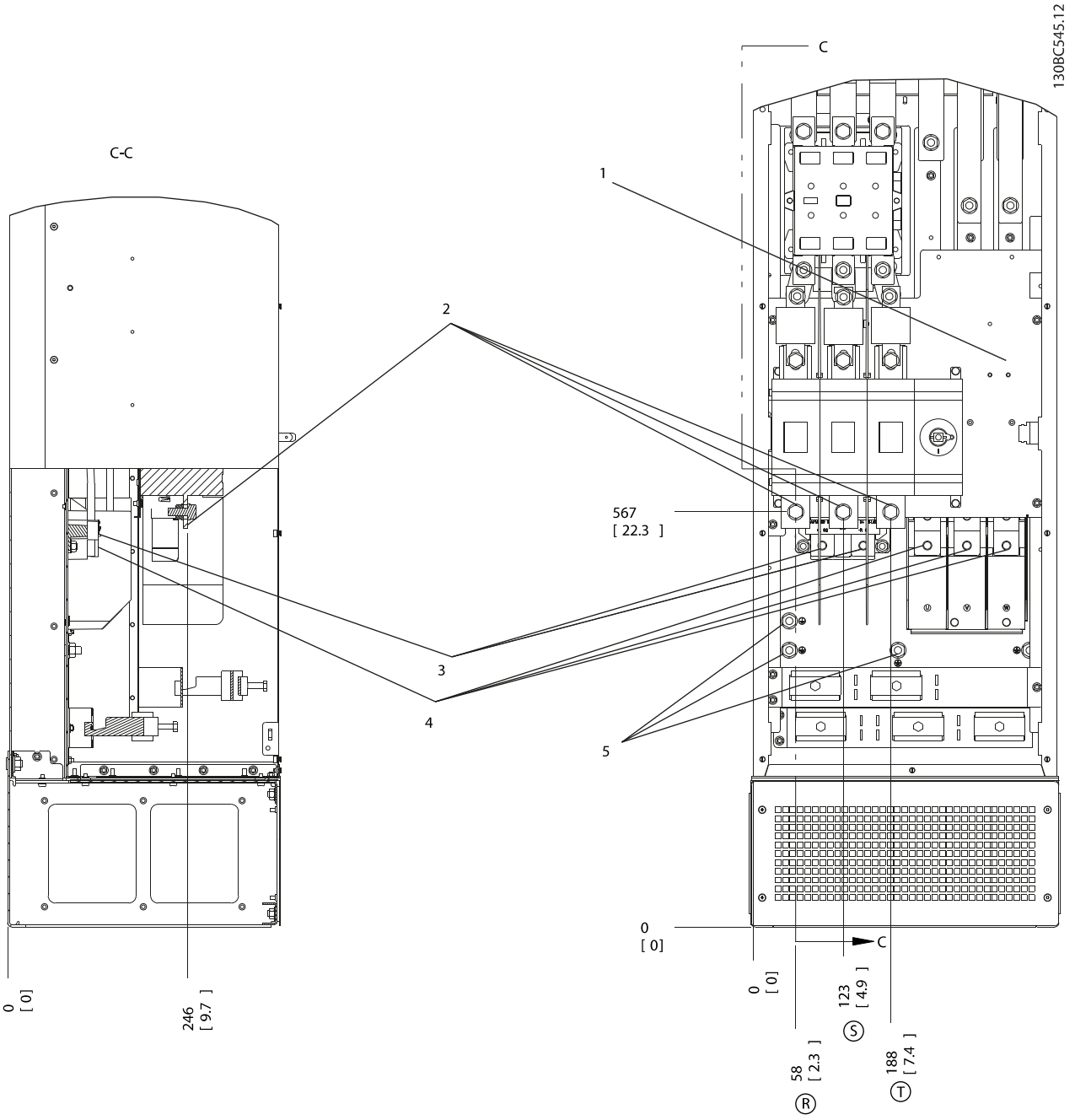
Illustration 4.19 Oversized Wiring Cabinet, D7h



1	TB6 terminal block for contactor	4	Brake terminals
2	Motor terminals	5	Mains terminals
3	Ground terminals		

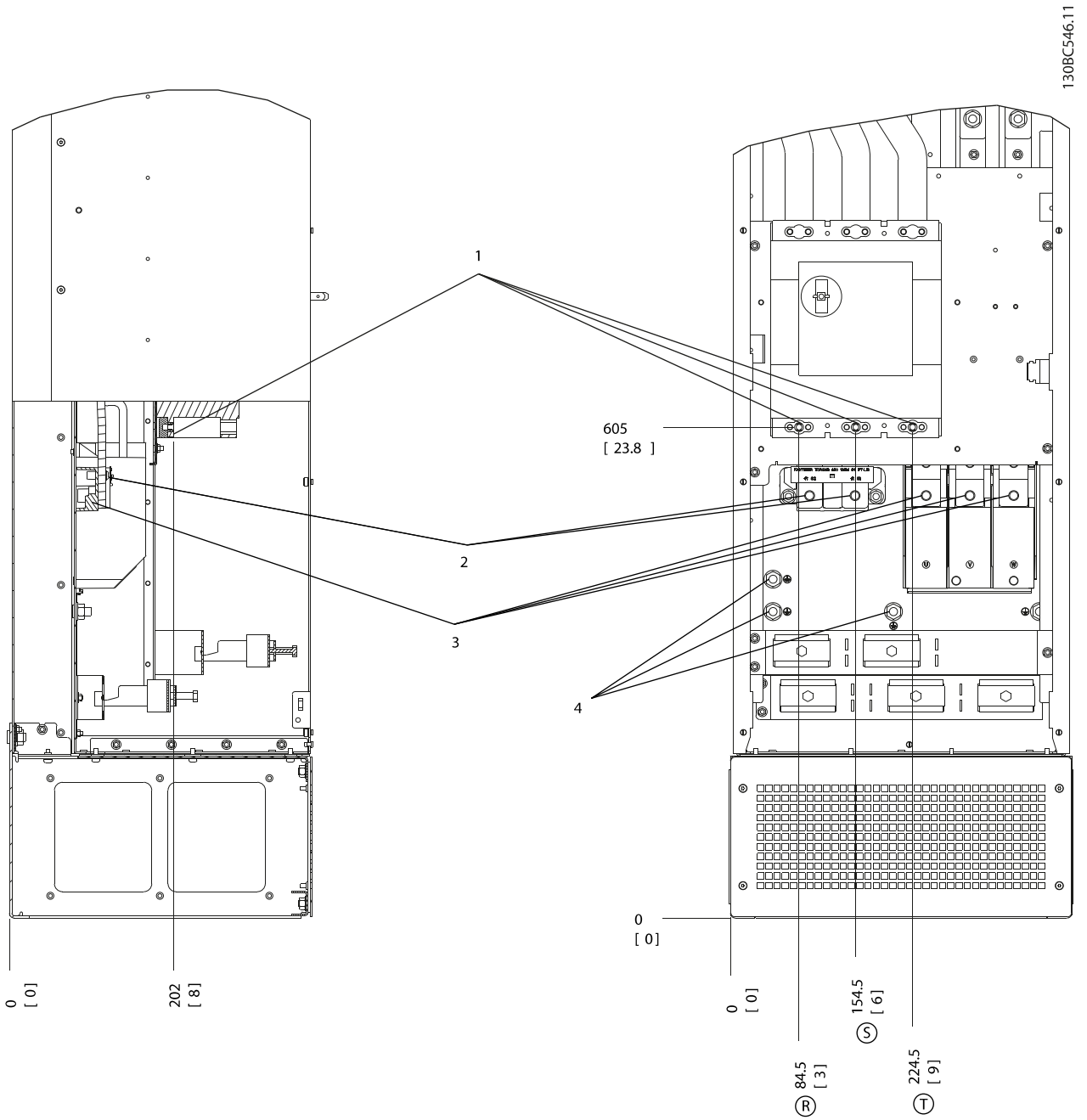
Illustration 4.20 Terminal Locations, D8h with Contactor Option

4



1	TB6 terminal block for contactor	4	Motor terminals
2	Mains terminals	5	Ground terminals
3	Brake terminals		

Illustration 4.21 Terminal Locations, D8h with Contactor and Disconnect Options



1	Mains terminals	3	Motor terminals
2	Brake terminals	4	Ground terminals

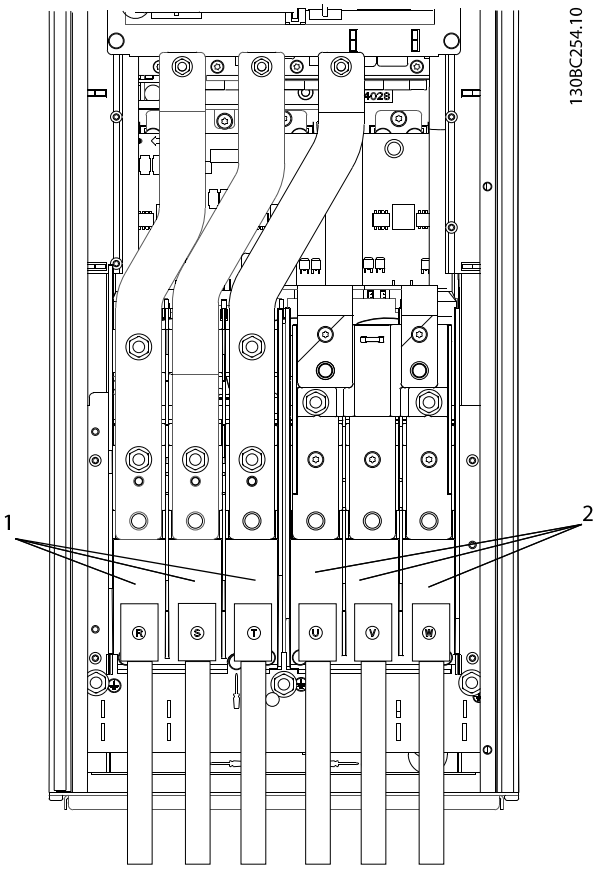
Illustration 4.22 Terminal Locations, D8h with Circuit Breaker Option

4.7 AC Mains Connection

- Size the wiring according to 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 R, S, and T (see *Illustration 4.23*).
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.



1	Mains connection (R, S, T)
2	Motor connection (U, V, W)

Illustration 4.23 Connecting to AC Mains

4.8 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.

4.8.1 Control Terminal Types

Illustration 4.24 and *Illustration 4.25* show the removable frequency converter connectors. Terminal functions and default settings are summarized in *Table 4.1* and *Table 4.3*.

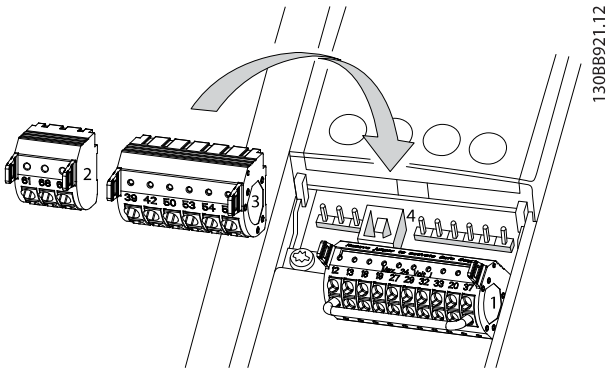


Illustration 4.24 Control Terminal Locations

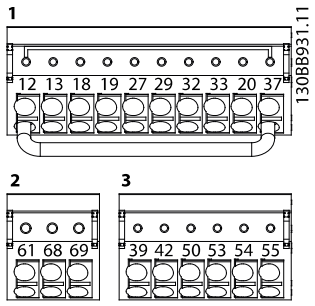


Illustration 4.25 Terminal Numbers

- Connector 1 provides:
  - 4 programmable digital input terminals.
  - 2 additional digital terminals programmable as either input or output.
  - A 24 V DC terminal supply voltage.
  - A common for optional customer supplied 24 V DC voltage.

  WILO EFC also provides a digital input for STO function.
- Connector 2 terminals (+)68 and (-)69 for RS485 serial communication connection.
- Connector 3 provides:
  - 2 analog inputs.
  - 1 analog output.
  - 10 V DC supply voltage.
  - Commons for the inputs and output.
- Connector 4 is a USB port available for use with the MCT 10 Set-up Software.

Terminal description			
Terminal	**Parameter**	**Default setting**	**Description**
Digital inputs/outputs			
12, 13	–	+24 V DC	24 V DC supply voltage for digital inputs and external transducers. Maximum output current 200 mA for all 24 V loads.
18	*Parameter 5-10 Terminal 18 Digital Input*	*[8] Start*	Digital inputs.
19	*Parameter 5-11 Terminal 19 Digital Input*	*[10] Reversing*	
32	*Parameter 5-14 Terminal 32 Digital Input*	*[0] No operation*	
33	*Parameter 5-15 Terminal 33 Digital Input*	*[0] No operation*	
27	*Parameter 5-12 Terminal 27 Digital Input*	*[2] Coast inverse*	For digital input or output. Default setting is input.
29	*Parameter 5-13 Terminal 29 Digital Input*	*[14] Jog*	
20	–	–	Common for digital inputs and 0 V potential for 24 V supply.
37	–	STO	Safe input.

Table 4.1 Terminal Description Digital Inputs/Outputs

4

Terminal description			
Terminal	Parameter	Default setting	Description
Analog inputs/outputs			
39	–	–	Common for analog output.
42	*Parameter 6-50 Terminal 42 Output*	*[0] No operation*	Programmable analog output. 0–20 mA or 4–20 mA at a maximum of 500 Ω.
50	–	+10 V DC	10 V DC analog supply voltage for potentiometer or thermistor. 15 mA maximum.
53	*Parameter group 6-1* Analog Input 53*	Reference	Analog input. For voltage or current. Switches A53 and A54 select mA or V.
54	*Parameter group 6-2* Analog Input 54*	Feedback	
55	–	–	Common for analog input.

Table 4.2 Terminal Description Analog Inputs/Outputs

Terminal description			
Terminal	Parameter	Default setting	Description
Serial communication			
61	–		Integrated RC-filter for cable shield. ONLY for connecting the shield if EMC problems occur.
68 (+)	*Parameter group 8-3* FC Port Settings*		RS485 interface. A control card switch is provided for termination resistance.
69 (-)	*Parameter group 8-3* FC Port Settings*		

Table 4.3 Terminal Description Serial Communication

Terminal description			
Terminal	Parameter	Default setting	Description
Relays			
01, 02, 03	*Parameter 5-40 Function Relay* [0]	*[0] No operation*	Form C relay output. For AC or DC voltage and resistive or inductive loads.
04, 05, 06	*Parameter 5-40 Function Relay* [1]	*[0] No operation*	

Table 4.4 Terminal Description Relays

Additional terminals:

- 2 form C relay outputs. The location of the outputs depends on the frequency converter configuration.
- Terminals on built-in optional equipment. See the manual provided with the equipment option.

4.8.2 Wiring to Control Terminals

Control terminal connectors can be unplugged from the frequency converter for ease of installation as shown in *Illustration 4.26*.

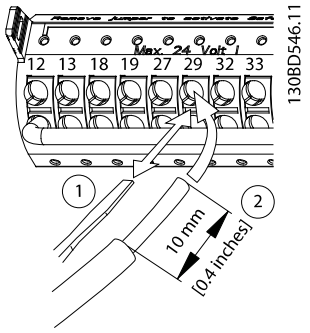


Illustration 4.26 Connecting Control Wires

NOTICE

Keep control wires as short as possible and separate them from high-power cables to minimize interference.

1. Open the contact by inserting a small screwdriver into the slot above the contact and push the screwdriver slightly upwards.
2. Insert the bare control wire into the contact.
3. Remove the screwdriver to fasten the control wire into the contact.
4. Ensure that the contact is firmly established and not loose. Loose control wiring can be the source of equipment faults or reduced performance.

See *chapter 8.5 Cable Specifications* for control terminal wiring sizes and *chapter 6 Application Set-up Examples* for typical control wiring connections.

4.8.3 Enabling Motor Operation (Terminal 27)

A jumper wire may be required between terminal 12 (or 13) and terminal 27 for the frequency converter to operate when using factory default programming values.

- Digital input terminal 27 is designed to receive a 24 V DC external interlock command.
- When no interlock device is used, wire a jumper between control terminal 12 (recommended) or 13 to terminal 27. This connection provides an internal 24 V signal on terminal 27.
- When the status line at the bottom of the LCP reads *AUTO REMOTE COAST*, it indicates that the unit is ready to operate but is missing an input signal on terminal 27.
- When factory-installed optional equipment is wired to terminal 27, do not remove that wiring.

NOTICE

The frequency converter cannot operate without a signal on terminal 27, unless terminal 27 is reprogrammed.

4.8.4 Voltage/Current Input Selection (Switches)

The analog input terminals 53 and 54 allow setting of input signal to voltage (0–10 V) or current (0/4–20 mA).

Default parameter setting:

- Terminal 53: Speed reference signal in open loop (see *parameter 16-61 Terminal 53 Switch Setting*).
- Terminal 54: Feedback signal in closed loop (see *parameter 16-63 Terminal 54 Switch Setting*).

NOTICE

Disconnect power to the frequency converter before changing switch positions.

1. Remove the LCP (local control panel) (see *Illustration 4.27*).
2. Remove any optional equipment covering the switches.
3. Set switches A53 and A54 to select the signal type. U selects voltage, I selects current.

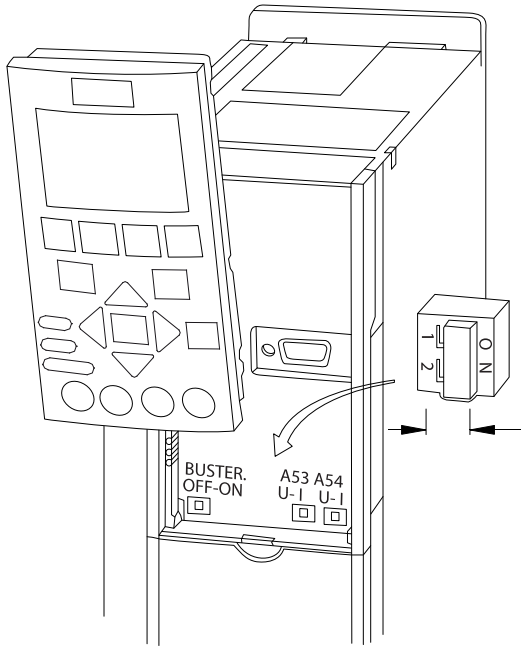


Illustration 4.27 Location of Terminal 53 and 54 Switches

4.8.5 Safe Torque Off (STO)

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

4.8.6 Configuring RS485 Serial Communication

RS485 is a 2-wire bus interface compatible with multi-drop network topology, and it contains the following features:

- Either Wilo FC or Modbus RTU communication protocol, which are internal to the drive, can be used.
- Functions can be programmed remotely using the protocol software and RS485 connection or in *parameter group 8-** Communications and Options*.
- Selecting a specific communication protocol changes various default parameter settings to match the specifications of the protocol, making more protocol-specific parameters available.
- Option cards for the drive are available to provide more communication protocols. See the option card documentation for installation and operation instructions.
- A switch (BUS TER) is provided on the control card for bus termination resistance. See *Illustration 4.27*.

For basic serial communication set-up, perform the following steps:

1. Connect RS485 serial communication wiring to terminals (+)68 and (-)69.
   - 1a Use shielded serial communication cable (recommended).
   - 1b See *chapter 4.3 Grounding* for proper grounding.
2. Select the following parameter settings:
   - 2a Protocol type in *parameter 8-30 Protocol*.
   - 2b Drive address in *parameter 8-31 Address*.
   - 2c Baud rate in *parameter 8-32 Baud Rate*.

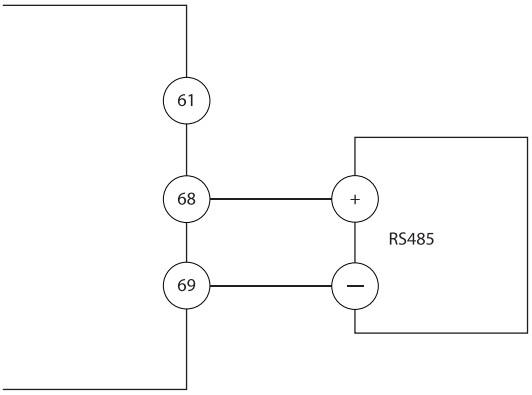


Illustration 4.28 Serial Communication Wiring Diagram

4.9 Installation Check List

Before completing installation of the unit, inspect the entire installation as detailed in *Table 4.5*. Check and mark the items when completed.

Inspect for	Description	☑
Auxiliary equipment	• Look for auxiliary equipment, switches, disconnects, or input fuses/circuit breakers which may reside 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 capacitors on the motor. • Adjust any power factor correction capacitors 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 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 they 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 4.5 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.**

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.**

Before applying power:

1. Verify that there is no voltage on input terminals L1 (91), L2 (92), and L3 (93), phase-to-phase, and phase-to-ground.
2. Verify that there is no voltage on output terminals 96 (U), 97 (V), and 98 (W), phase-to-phase, and phase-to-ground.
3. Confirm continuity of the motor by measuring Ω values on U-V (96–97), V-W (97–98), and W-U (98–96).
4. Check for proper grounding of the frequency converter and the motor.
5. Inspect the frequency converter for loose connections on the terminals.
6. Check that all cable glands are firmly tightened.
7. 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.
8. Confirm that the supply voltage matches the voltage of the frequency converter and the motor.
9. Close the door properly.

5.2 Applying Power

Apply power to the frequency converter using the following steps:

1. Confirm that the input voltage is balanced within 3%. If not, correct the input voltage imbalance before proceeding. Repeat this procedure after the voltage correction.
2. Ensure that any optional equipment wiring matches the installation application.
3. Ensure that all operator devices are in the OFF position. Close all panel doors and fasten covers securely.
4. Apply power to the unit. DO NOT start the frequency converter now. For units with a disconnect switch, turn it to the ON position to apply power to the frequency converter.

5.3 Local Control Panel Operation

5.3.1 Local Control Panel

The local control panel (LCP) is the combined display and keypad on the front of the unit.

The LCP has several user functions:

- Start, stop, and control speed when in local control.
- Show operational data, status, warnings, and cautions.
- Program frequency converter functions.
- Manually reset the frequency converter after a fault when auto reset is inactive.

An optional numeric LCP (NLCP) is also available. The NLCP operates in a manner similar to the LCP. See the product-relevant *programming guide* for details on how to use the NLCP.

NOTICE

For commissioning via PC, install the MCT 10 Set-up Software. The software is available for download (basic version) or for ordering (advanced version, ordering number 130B1000). For service and support, contact the local Wilo supplier.

5.3.2 Start-up Message

NOTICE

During start-up, the LCP shows the message *INITIALISING*. When this message is no longer shown, the frequency converter is ready for operation. Adding or removing options can extend the duration of start-up.

5.3.3 LCP Layout

The LCP is divided into 4 functional groups (see *Illustration 5.1*).

A. Display area.

B. Display menu keys.

C. Navigation keys and indicator lights (LEDs).

D. Operation keys and reset.

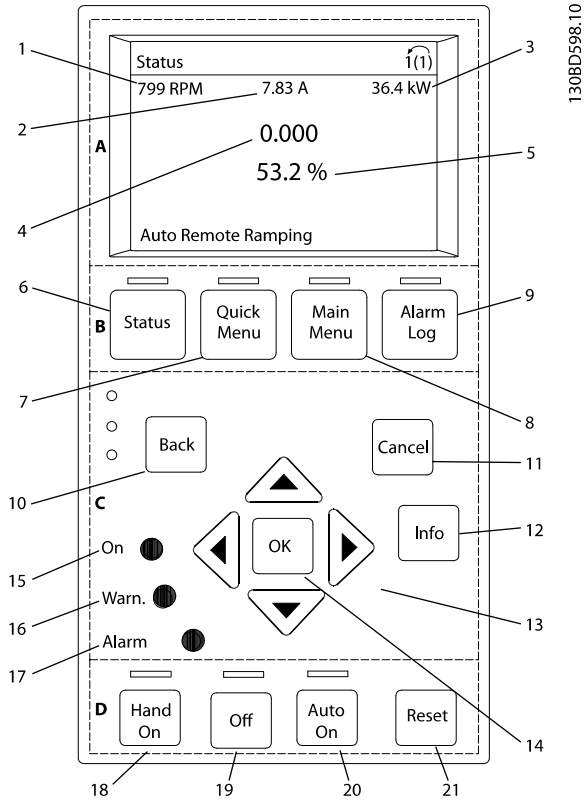


Illustration 5.1 Local Control Panel (LCP)

A. Display area

The display area is activated when the frequency converter receives power from the mains voltage, a DC bus terminal, or a 24 V DC external supply.

The information shown on the LCP can be customized for user application. Select options in the *Quick Menu Q3-13 Display Settings*.

Display	Parameter number	Default setting
1	0-20	Speed [RPM]
2	0-21	Motor Current
3	0-22	Power [kW]
4	0-23	Frequency
5	0-24	Reference [%]

Table 5.1 Legend to *Illustration 5.1*, Display Area

B. Display menu keys

Menu keys are used for menu access for parameter set-up, toggling through status display modes during normal operation, and viewing fault log data.

	Key	Function
6	Status	Shows operational information.
7	Quick Menu	Allows access to programming parameters for initial set-up instructions and many detailed application instructions.
8	Main Menu	Allows access to all programming parameters.
9	Alarm Log	Shows a list of current warnings, the last 10 alarms, and the maintenance log.

Table 5.2 Legend to *Illustration 5.1*, Display Menu Keys

C. Navigation keys and indicator lights (LEDs)

Navigation keys are used for programming functions and moving the display cursor. The navigation keys also provide speed control in local operation. There are also 3 frequency converter status indicator lights in this area.

	Key	Function
10	Back	Reverts to the previous step or list in the menu structure.
11	Cancel	Cancels the last change or command as long as the display mode has not changed.
12	Info	Press for a definition of the function being shown.
13	Navigation keys	Use the 4 navigation keys to move between items in the menu.
14	OK	Use to access parameter groups or to enable a selection.

Table 5.3 Legend to *Illustration 5.1*, Navigation Keys

	Indicator	LED	Function
15	On	Green	The ON LED activates when the frequency converter receives power from the mains voltage, a DC bus terminal, or a 24 V external supply.
16	Warn	Yellow	When warning conditions are met, the yellow WARN LED comes on and text appears in the display area identifying the problem.
17	Alarm	Red	A fault condition causes the red alarm LED to flash and an alarm text is shown.

Table 5.4 Legend to *Illustration 5.1*, Indicator Lights (LEDs)

D. Operation keys and reset
Operation keys are at the bottom of the LCP.

	Key	Function
18	Hand On	Starts the frequency converter in local control. • An external stop signal by control input or serial communication overrides the local hand on.
19	Off	Stops the motor but does not remove power to the frequency converter.
20	Auto On	Puts the system in remote operational mode. • Responds to an external start command by control terminals or serial communication.
21	Reset	Resets the frequency converter manually after a fault has been cleared.

Table 5.5 Legend to *Illustration 5.1*, Operation Keys and Reset

NOTICE

The display contrast can be adjusted by pressing [Status] and the [▲]/[▼] keys.

5.3.4 Parameter Settings

Establishing the correct programming for applications often requires setting functions in several related parameters. Parameter details are provided in *chapter 9.2 Parameter Menu Structure*.

Programming data is stored internally in the frequency converter.

- For back-up, upload data to the LCP memory.
- To download data to another frequency converter, connect the LCP to that unit and download the stored settings.
- Restoring factory default settings does not change data stored in the LCP memory.

5.3.5 Uploading/Downloading Data to/from the LCP

1. Press [Off] to stop the motor before uploading or downloading data.
2. Press [Main Menu], *parameter 0-50 LCP Copy* and press [OK].
3. Select *[1] All to LCP* to upload data to the LCP, or select *[2] All from LCP* to download data from the LCP.
4. Press [OK]. A progress bar shows the uploading or downloading progress.
5. Press [Hand On] or [Auto On] to return to normal operation.

5.3.6 Changing Parameter Settings

Parameter settings can be accessed and changed from the *Quick Menu* or from the *Main Menu*. The *Quick Menu* only gives access to a limited number of parameters.

1. Press [Quick Menu] or [Main Menu] on the LCP.
2. Press [▲] [▼] to browse through the parameter groups.
3. Press [OK] to select a parameter group.
4. Press [▲] [▼] to browse through the parameters.
5. Press [OK] to select a parameter.
6. Press [▲] [▼] to change the value of a parameter setting.
7. Press [◄] [►] to shift digit when a decimal parameter is in the editing state.
8. Press [OK] to accept the change.
9. Press either [Back] twice to enter *Status*, or press [Main Menu] once to enter the *Main Menu*.

View changes
Quick Menu Q5 - Changes Made lists all parameters changed from default settings.

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

5.3.7 Restoring Default Settings

NOTICE

Risk of losing programming, motor data, localization, and monitoring records by restoration of default settings. To provide a back-up, upload data to the LCP before initialization.

Restoring the default parameter settings is done by initialization of the frequency converter. Initialization is carried out through *parameter 14-22 Operation Mode* (recommended) or manually.

- Initialization using *parameter 14-22 Operation Mode* does not reset frequency converter settings, such as hours run, serial communication selections, personal menu settings, fault log, alarm log, and other monitoring functions.
- Manual initialization erases all motor, programming, localization, and monitoring data and restores factory default settings.

Recommended initialization procedure via *parameter 14-22 Operation Mode*

1. Press [Main Menu] twice to access parameters.
2. Scroll to *parameter 14-22 Operation Mode* and press [OK].
3. Scroll to *[2] Initialisation* and press [OK].
4. Remove power to the unit and wait for the display to turn off.
5. Apply power to the unit.

Default parameter settings are restored during start-up. The restore may take slightly longer than normal.

1. *Alarm 80, Drive initialised* is shown.
2. Press [Reset] to return to operating mode.

Manual initialization procedure

1. Remove power to the unit and wait for the display to turn off.
2. Press and hold [Status], [Main Menu], and [OK] at the same time while applying power to the unit. Press the keys for approximately 5 s, or until a click is heard and the fan starts.

Factory default parameter settings are restored during start-up. The restore may take slightly longer than normal.

Manual initialization does not reset the following frequency converter information:

- *Parameter 15-00 Operating hours*
- *Parameter 15-03 Power Up's*
- *Parameter 15-04 Over Temp's*
- *Parameter 15-05 Over Volt's*

5.4 Basic Programming

5.4.1 Commissioning with SmartStart

The SmartStart wizard enables fast configuration of basic motor and application parameters.

- SmartStart starts automatically at first power-up or after initialization of the frequency converter.
- Follow the on-screen instructions to complete the commissioning of the frequency converter. Always reactivate SmartStart by selecting *Quick Menu Q4 - SmartStart*.
- For commissioning without use of the SmartStart wizard, refer to *chapter 5.4.2 Commissioning via [Main Menu]* or the *programming guide*.

NOTICE

Motor data is required for the SmartStart set-up. The required data is normally available on the motor nameplate.

5.4.2 Commissioning via [Main Menu]

Recommended parameter settings are intended for start-up and checkout purposes. Application settings may vary.

Enter data with power ON, but before operating the frequency converter.

1. Press [Main Menu] on the LCP.
2. Press the navigation keys to scroll to *parameter group 0-** Operation/Display* and press [OK].

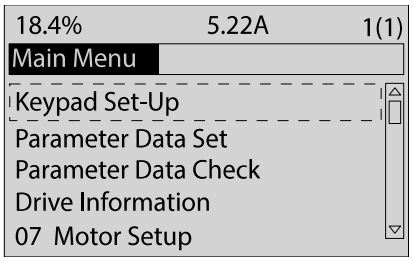


Illustration 5.2 Main Menu

3. Press the navigation keys to scroll to *parameter group 0-0* Basic Settings* and press [OK].

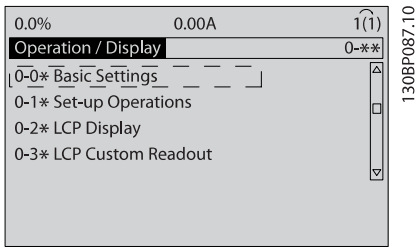


Illustration 5.3 Operation/Display

4. Press the navigation keys to scroll to *parameter 0-03 Regional Settings* and press [OK].

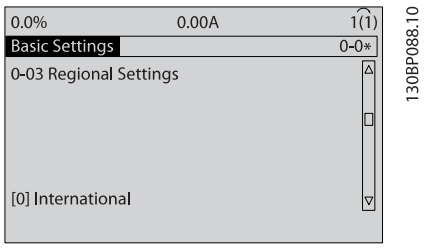


Illustration 5.4 Basic Settings

5. Press the navigation keys to select *[0] International* or *[1] North America* as appropriate and press [OK]. (This selection changes the default settings for several basic parameters).
6. Press [Main Menu] on the LCP.

7. Press the navigation keys to scroll to *parameter 0-01 Language*.
8. Select the language and press [OK].
9. If a jumper wire is in place between control terminals 12 and 27, leave *parameter 5-12 Terminal 27 Digital Input* at factory default. Otherwise, select *[0] No Operation* in *parameter 5-12 Terminal 27 Digital Input*.
10. Make the application-specific settings in the following parameters:
    - 10a *Parameter 3-02 Minimum Reference*.
    - 10b *Parameter 3-03 Maximum Reference*.
    - 10c *Parameter 3-41 Ramp 1 Ramp Up Time*.
    - 10d *Parameter 3-42 Ramp 1 Ramp Down Time*.
    - 10e *Parameter 3-13 Reference Site*. Linked to Hand/Auto Local Remote.

5.5 Checking Motor Rotation

The direction of rotation can be changed by switching 2 phases in the motor cable, or by changing the setting of *parameter 4-10 Motor Speed Direction*.

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

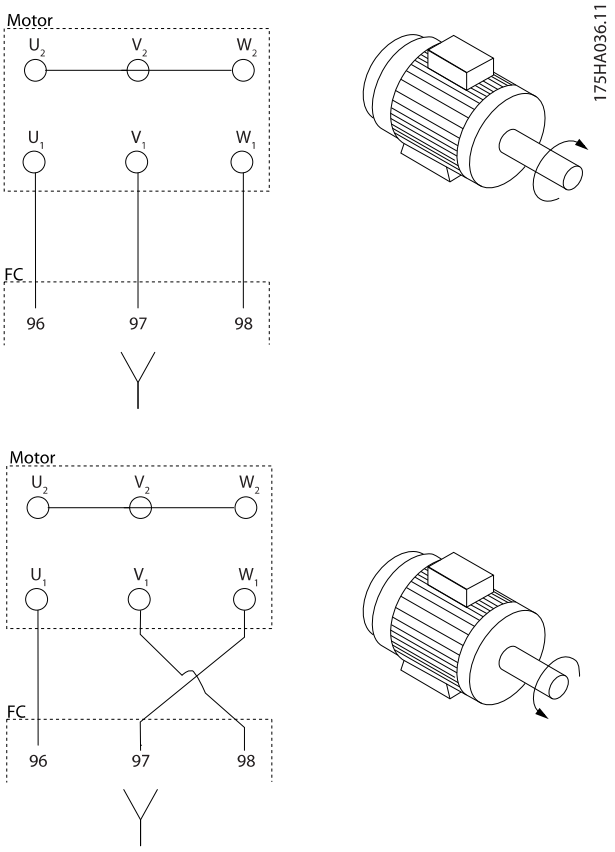


Illustration 5.5 Wiring for Changing Motor Direction

Perform a motor rotation check using *parameter 1-28 Motor Rotation Check* and follow the steps shown in the display.

5.6 Local-control Test

1. Press [Hand On] to provide a local start command to the frequency converter.
2. Press [▲] to accelerate the frequency converter to full speed. Moving the cursor left of the decimal point provides quicker input changes.
3. Note any acceleration problems.
4. Press [Off]. Note any deceleration problems.

If acceleration or deceleration problems occur, see *chapter 7.7 Troubleshooting*. See *chapter 7.6 List of Warnings and Alarms* for resetting the frequency converter after a trip.

5.7 System Start-up

The procedure in this section requires user-wiring and application programming to be completed. The following procedure is recommended after application set-up is completed.

1. Press [Auto On].
2. Apply an external run command.
3. Adjust the speed reference throughout the speed range.
4. Remove the external run command.
5. Check the sound and vibration levels of the motor to ensure that the system is working as intended.

If warnings or alarms occur, see *chapter 7.6 List of Warnings and Alarms*.

6 Application Set-up Examples

6.1 Introduction

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

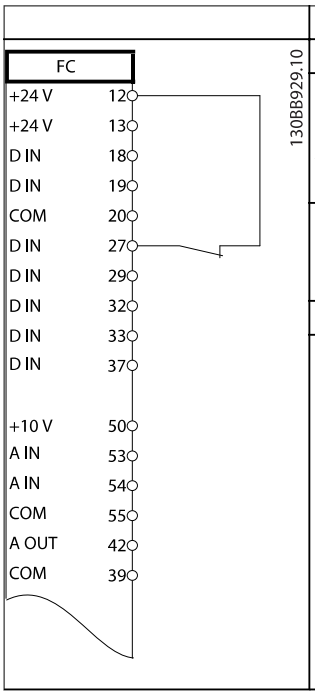
- Parameter settings are the regional default values unless otherwise indicated (selected in *parameter 0-03 Regional Settings*).
- Parameters associated with the terminals and their settings are shown next to the drawings.
- Where switch settings for analog terminals A53 or A54 are required, these settings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

NOTICE

When the optional STO feature is used, 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.

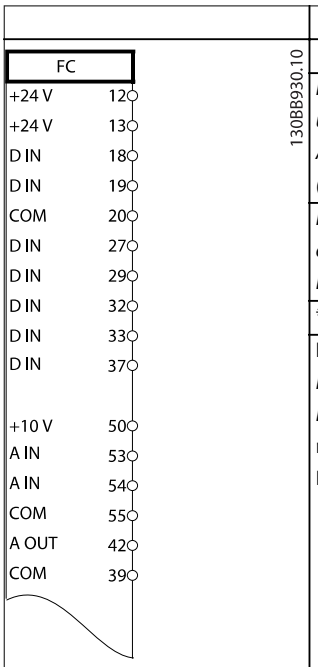
6.2 Application Examples

6.2.1 Automatic Motor Adaptation (AMA)



	Parameters	
	Function	**Setting**
	Parameter 1-29 Automatic Motor Adaptation (AMA)	*[1] Enable complete AMA*
	Parameter 5-12 Terminal 27 Digital Input	*[2]* Coast inverse*
	* = Default value	
	Notes/comments: *Parameter group 1-2* Motor Data* must be set according to motor. D IN 37 is an option.	

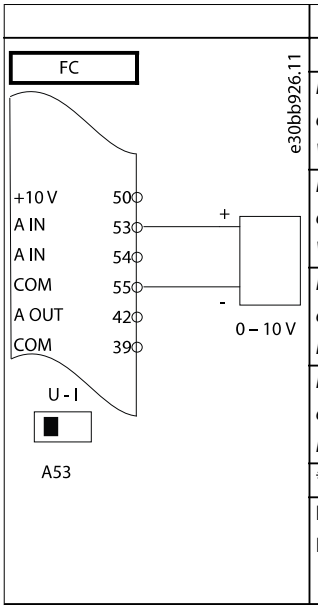
Table 6.1 AMA with T27 Connected



	Parameters	
	Function	**Setting**
	Parameter 1-29 Automatic Motor Adaptation (AMA)	*[1] Enable complete AMA*
	Parameter 5-12 Terminal 27 Digital Input	*[0] No operation*
	* = Default value	
	Notes/comments: *Parameter group 1–2* Motor Data* must be set according to motor. D IN 37 is an option.	

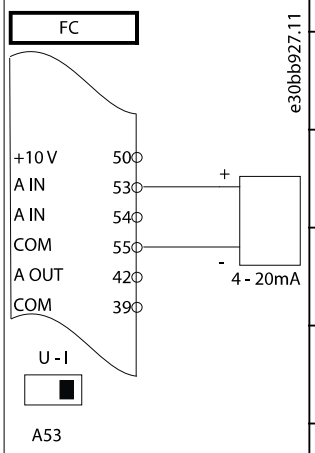
Table 6.2 AMA without T27 Connected

6.2.2 Speed



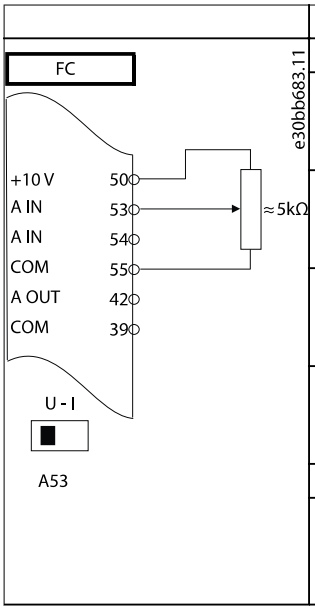
	Parameters	
	Function	**Setting**
	Parameter 6-10 Terminal 53 Low Voltage	0.07 V*
	Parameter 6-11 Terminal 53 High Voltage	10 V*
	Parameter 6-14 Terminal 53 Low Ref./Feedb. Value	0 Hz
	Parameter 6-15 Terminal 53 High Ref./Feedb. Value	50 Hz
	* = Default value	
	Notes/comments: D IN 37 is an option.	

Table 6.3 Analog Speed Reference (Voltage)



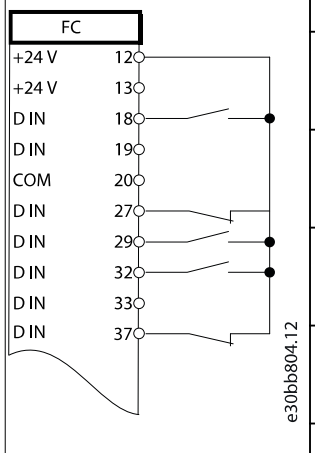
Parameters	
Function	**Setting**
Parameter 6-12 Terminal 53 Low Current	4 mA*
Parameter 6-13 Terminal 53 High Current	20 mA*
Parameter 6-14 Terminal 53 Low Ref./Feedb. Value	0 Hz
Parameter 6-15 Terminal 53 High Ref./Feedb. Value	50 Hz
* = Default value	
Notes/comments: D IN 37 is an option.	

Table 6.4 Analog Speed Reference (Current)



Parameters	
Function	**Setting**
Parameter 6-10 Terminal 53 Low Voltage	0.07 V*
Parameter 6-11 Terminal 53 High Voltage	10 V*
Parameter 6-14 Terminal 53 Low Ref./Feedb. Value	0 Hz
Parameter 6-15 Terminal 53 High Ref./Feedb. Value	1500 Hz
* = Default value	
Notes/comments: D IN 37 is an option.	

Table 6.5 Speed Reference (Using a Manual Potentiometer)



Parameters	
Function	**Setting**
Parameter 5-10 Terminal 18 Digital Input	*[8]* Start*
Parameter 5-12 Terminal 27 Digital Input	*[19] Freeze Reference*
Parameter 5-13 Terminal 29 Digital Input	*[21] Speed Up*
Parameter 5-14 Terminal 32 Digital Input	*[22] Speed Down*
* = Default value	
Notes/comments: D IN 37 is an option.	

Table 6.6 Speed Up/Down

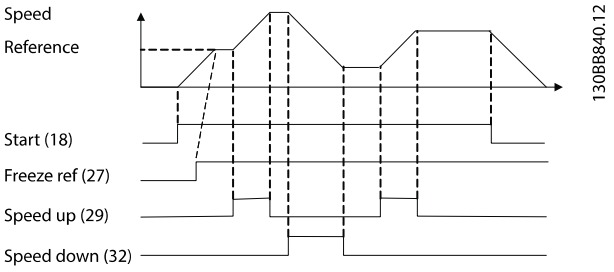
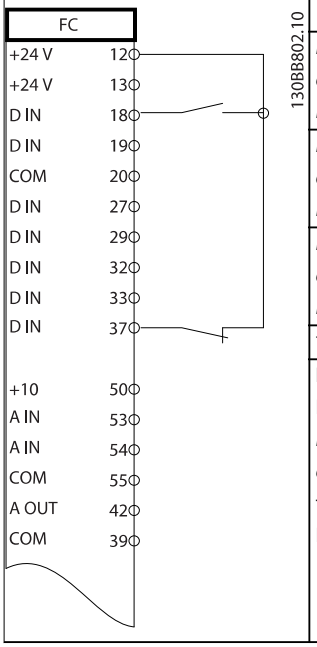


Illustration 6.1 Speed Up/Down

6.2.3 Start/Stop



	Parameters	
	Function	**Setting**
	Parameter 5-10 T erminal 18 Digital Input	*[8]* Start*
	Parameter 5-12 T erminal 27 Digital Input	*[0] No operation*
	Parameter 5-19 T erminal 37 Digital Input	*[1] Safe Stop Alarm*
* = Default value		
Notes/comments: If *parameter 5-12 Terminal 27 Digital Input* is set to *[0] No operation*, a jumper wire to terminal 27 is not needed. D IN 37 is an option.		

Table 6.7 Start/Stop Command with STO

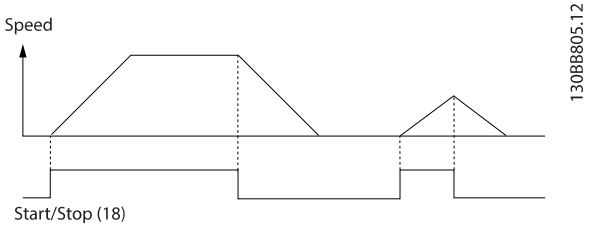
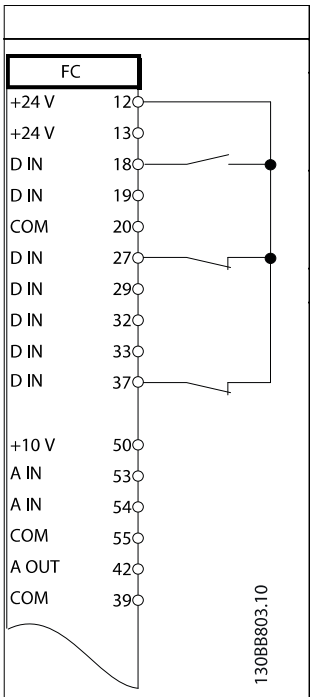


Illustration 6.2 Start/Stop Command with STO



	Parameters	
	Function	**Setting**
	Parameter 5-10 T erminal 18 Digital Input	*[9] Latched Start*
	Parameter 5-12 T erminal 27 Digital Input	*[6] Stop Inverse*
* = Default value		
Notes/comments: If *parameter 5-12 Terminal 27 Digital Input* is set to *[0] No operation*, a jumper wire to terminal 27 is not needed. D IN 37 is an option.		

Table 6.8 Pulse Start/Stop

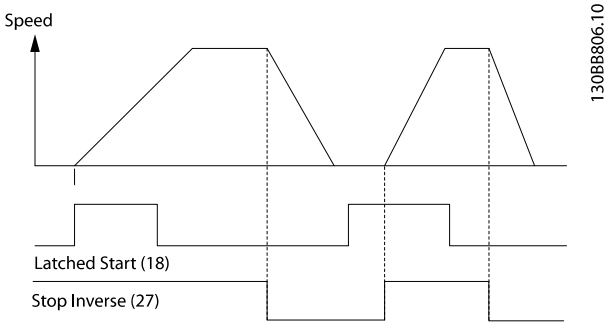
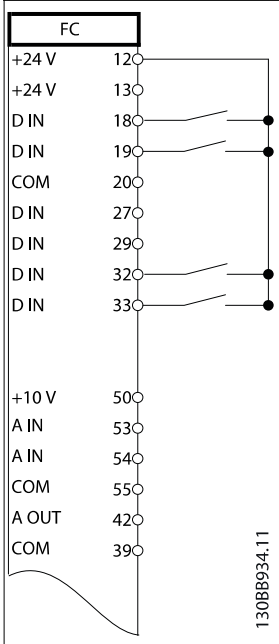


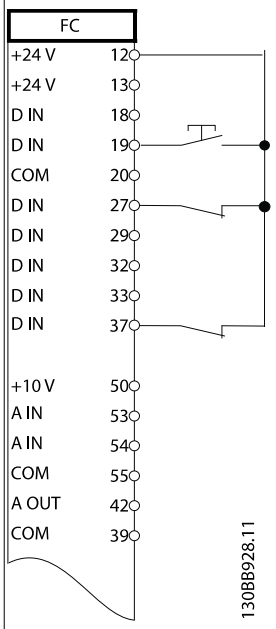
Illustration 6.3 Latched Start/Stop Inverse



	Parameters	
	Function	**Setting**
	Parameter 5-10 Terminal 18 Digital Input	*[8] Start*
	Parameter 5-11 Terminal 19 Digital Input	*[10]* Reversing*
	Parameter 5-12 Terminal 27 Digital Input	*[0] No operation*
	Parameter 5-14 Terminal 32 Digital Input	*[16] Preset ref bit 0*
	Parameter 5-15 Terminal 33 Digital Input	*[17] Preset ref bit 1*
	Parameter 3-10 Preset Reference	
	Preset ref. 0	25%
	Preset ref. 1	50%
	Preset ref. 2	75%
	Preset ref. 3	100%
	* = Default value	
	Notes/comments: D IN 37 is an option.	

Table 6.9 Start/Stop with Reversing and 4 Preset Speeds

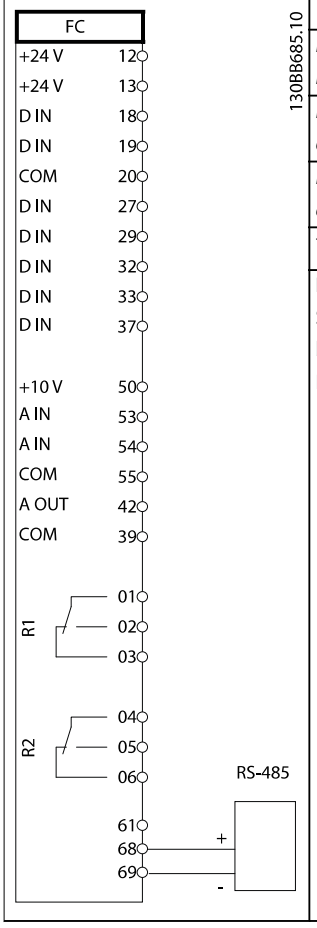
6.2.4 External Alarm Reset



	Parameters	
	Function	**Setting**
	Parameter 5-11 Terminal 19 Digital Input	*[1] Reset*
	* = Default value	
	Notes/comments: D IN 37 is an option.	

Table 6.10 External Alarm Reset

6.2.5 RS485



	Parameters	
	Function	**Setting**
	Parameter 8-30 Protocol	FC*
	Parameter 8-31 Address	1*
	Parameter 8-32 Baud Rate	9600*
	* = Default value	
	Notes/comments: Select protocol, address, and baud rate in these parameters. D IN 37 is an option.	

Table 6.11 RS485 Network Connection

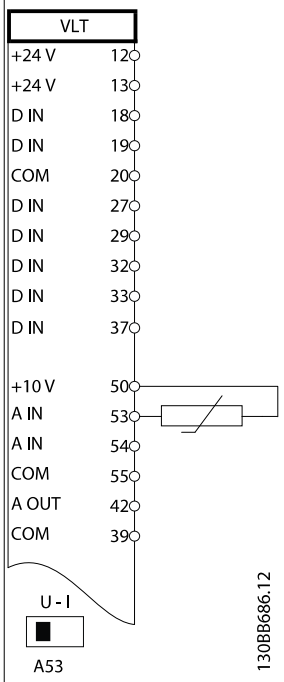
6.2.6 Motor Thermistor

⚠WARNING

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 desired, set parameter *parameter 1-90 Motor Thermal Protection* to *[1] Thermistor warning*. D IN 37 is an option.	

Table 6.12 Motor Thermistor

7 Maintenance, Diagnostics, and Troubleshooting

7.1 Introduction

This chapter includes:

- Maintenance and service guidelines.
- Status messages.
- Warnings and alarms.
- Basic troubleshooting.

7.2 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 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 Wilo supplier.

⚠WARNING

UNINTENDED START

When the frequency converter is connected to AC mains, DC supply, or load sharing, the motor can 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 with an external switch, a fieldbus command, an input reference signal from the LCP or LOP, via remote operation using MCT 10 Set-up Software, or after a cleared fault condition.

To prevent unintended motor start:

- **Press [Off/Reset] on the LCP before programming parameters.**
- **Disconnect the frequency converter from the mains.**
- **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.**

7.3 Heat Sink Access Panel

7.3.1 Removing the Heat Sink Access Panel

The frequency converter has an optional access panel for accessing the heat sink.

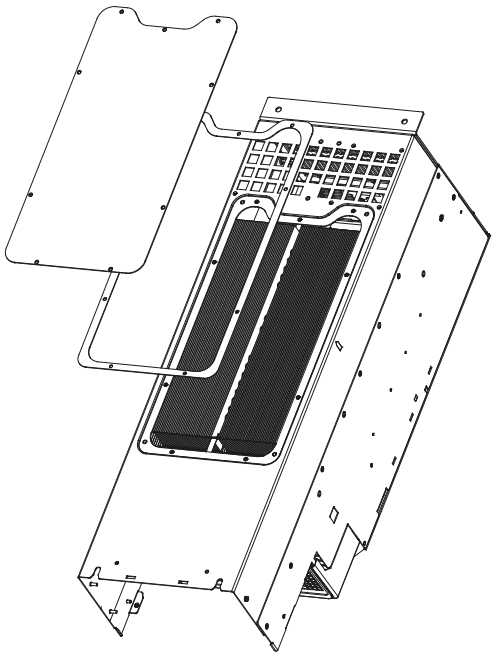


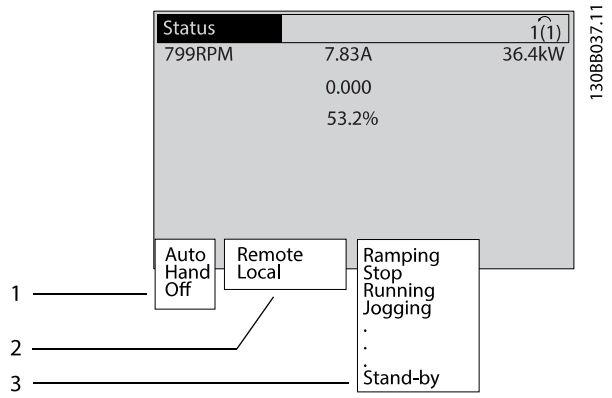
Illustration 7.1 Heat Sink Access Panel

1. Do not run the frequency converter while removing the heat sink access panel.
2. If the frequency converter is mounted on a wall, or its back is otherwise inaccessible, reposition it to provide full access.
3. Remove the screws (3 mm (0.12 in) internal hex) connecting the access panel to the back of the enclosure. There are 5 or 9 screws depending on the size of the frequency converter.

Reinstall in reverse order of this procedure and tighten fasteners according to *chapter 8.8 Connection Tightening Torques*.

7.4 Status Messages

When the frequency converter is in status mode, status messages are generated automatically and appear in the bottom line of the display (see *Illustration 7.2*).



1	Operating mode (see *Table 7.1*)
2	Reference site (see *Table 7.2*)
3	Operation status (see *Table 7.3*)

Illustration 7.2 Status Display

Table 7.1 to *Table 7.3* describe the status messages shown.

Off	The frequency converter does not react to any control signal until [Auto On] or [Hand On] is pressed.
Auto On	The frequency converter is controlled from the control terminals and/or the serial communication.
Hand On	Use the navigation keys on the LCP to control the frequency converter. Stop commands, reset, reversing, DC brake, and other signals applied to the control terminals override local control.

Table 7.1 Operating Mode

Remote	The speed reference is given from external signals, serial communication, or internal preset references.
Local	The frequency converter uses [Hand On] control or reference values from the LCP.

Table 7.2 Reference Site

AC Brake	*Parameter 2-16 AC brake Max. Current* was selected in *parameter 2-10 Brake Function*. The AC brake overmagnetizes the motor to achieve a controlled slow-down.
AMA finish OK	Automatic motor adaptation (AMA) was carried out successfully.
AMA ready	AMA is ready to start. Press [Hand On] to start.
AMA running	AMA process is in progress.
Braking	The brake chopper is in operation. Generative energy is absorbed by the brake resistor.
Braking max.	The brake chopper is in operation. The power limit for the brake resistor defined in *parameter 2-12 Brake Power Limit (kW)* has been reached.
Coast	• *Coast inverse* was selected as a function for a digital input (*parameter group 5-1* Digital Inputs*). The corresponding terminal is not connected. • Coast activated by serial communication.
Ctrl. ramp-down	*[1] Control ramp-down* was selected in *parameter 14-10 Mains Failure*. • The mains voltage is below the value set in *parameter 14-11 Mains Voltage at Mains Fault* at mains fault. • The frequency converter ramps down the motor using a controlled ramp down.
Current High	The frequency converter output current is above the limit set in *parameter 4-51 Warning Current High*.
Current Low	The frequency converter output current is below the limit set in *parameter 4-52 Warning Speed Low*.
DC Hold	*[1] DC hold* is selected in *parameter 1-80 Function at Stop* and a stop command is active. The motor is held by a DC current set in *parameter 2-00 DC Hold/Preheat Current*.
DC Stop	The motor is held with a DC current (*parameter 2-01 DC Brake Current*) for a specified time (*parameter 2-02 DC Braking Time*). • The DC brake cut-in speed is reached in *parameter 2-03 DC Brake Cut In Speed [RPM]*, and a stop command is active. • DC brake (inverse) is selected as a function for a digital input (*parameter group 5-1* Digital Inputs*). The corresponding terminal is not active. • The DC brake is activated via serial communication.
Feedback high	The sum of all active feedbacks is above the feedback limit set in *parameter 4-57 Warning Feedback High*.
Feedback low	The sum of all active feedbacks is below the feedback limit set in *parameter 4-56 Warning Feedback Low*.

Freeze output	The remote reference, which holds the present speed, is active. • Freeze output was selected as a function for a digital input (*parameter group 5-1* Digital Inputs*). The corresponding terminal is active. Speed control is only possible via the terminal functions speed up and speed down. • Hold ramp is activated via serial communication.
Freeze output request	A freeze output command was given, but the motor remains stopped until a run permissive signal is received.
Freeze ref.	Freeze reference was selected as a function for a digital input (*parameter group 5-1* Digital Inputs*). The corresponding terminal is active. The frequency converter saves the actual reference. Changing the reference is now only possible via terminal functions speed up and speed down.
Jog request	A jog command was given, but the motor remains stopped until a run permissive signal is received via a digital input.
Jogging	The motor runs as programmed in *parameter 3-19 Jog Speed [RPM]*. • Jog was selected as a function for a digital input (*parameter group 5-1* Digital Inputs*). The corresponding terminal (for example terminal 29) is active. • The jog function is activated via the serial communication. • The jog function was selected as a reaction for a monitoring function (for example No signal). The monitoring function is active.
Motor check	In *parameter 1-80 Function at Stop*, *[2] Motor check* was selected. A stop command is active. To ensure that a motor is connected to the frequency converter, a permanent test current is applied to the motor.
OVC control	Overvoltage control was activated in *parameter 2-17 Over-voltage Control*, *[2] Enabled*. The connected motor supplies the frequency converter with generative energy. The overvoltage control adjusts the V/Hz ratio to run the motor in controlled mode and to prevent the frequency converter from tripping.
PowerUnit Off	(Only frequency converters with a 24 V external supply installed). Mains supply to the frequency converter was removed, and the control card is supplied by the external 24 V.
Protection md	Protection mode is active. The unit has detected a critical status (overcurrent or overvoltage). • To avoid tripping, switching frequency is reduced to 4 kHz. • If possible, protection mode ends after approximately 10 s. • Protection mode can be restricted in *parameter 14-26 Trip Delay at Inverter Fault*.
Qstop	The motor is decelerating using *parameter 3-81 Quick Stop Ramp Time*. • Quick stop inverse was selected as a function for a digital input (*parameter group 5-1* Digital Inputs*). The corresponding terminal is not active. • The quick stop function was activated via serial communication.
Ramping	The motor is accelerating/decelerating using the active ramp up/down. The reference, a limit value, or a standstill is not yet reached.
Ref. high	The sum of all active references is above the reference limit set in *parameter 4-55 Warning Reference High*.
Ref. low	The sum of all active references is below the reference limit set in *parameter 4-54 Warning Reference Low*.
Run on ref.	The frequency converter is running in the reference range. The feedback value matches the setpoint value.
Run request	A start command was given, but the motor remains stopped until a run permissive signal is received via digital input.
Running	The frequency converter drives the motor.
Sleep Mode	The energy-saving function is enabled. The motor has stopped, but restarts automatically when required.
Speed high	Motor speed is above the value set in *parameter 4-53 Warning Speed High*.
Speed low	Motor speed is below the value set in *parameter 4-52 Warning Speed Low*.
Standby	In auto-on mode, the frequency converter starts the motor with a start signal from a digital input or serial communication.
Start delay	In *parameter 1-71 Start Delay*, a delay starting time was set. A start command is activated and the motor starts after the start delay time expires.
Start fwd/rev	Start forward and start reverse were selected as functions for 2 different digital inputs (*parameter group 5-1* Digital Inputs*). The motor starts in forward or reverse direction depending on which corresponding terminal is activated.

7

Stop	The frequency converter has received a stop command from the LCP, digital input, or serial communication.
Trip	An alarm occurred and the motor is stopped. Once the alarm is cleared, the frequency converter can be reset manually by pressing [Reset], or remotely by control terminals or serial communication.
Trip lock	An alarm occurred and the motor is stopped. Once the alarm is cleared, cycle power to the frequency converter. The frequency converter can then be reset manually by pressing [Reset], or remotely by control terminals or serial communication.

Table 7.3 Operation Status

NOTICE

In auto/remote mode, the frequency converter requires external commands to execute functions.

7.5 Warning and Alarm Types

Warnings

A warning is issued when an alarm condition is impending or when an abnormal operating condition is present. The warning may result in the frequency converter issuing an alarm. A warning clears 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 restart operation.

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.

1. Remove input power to the frequency converter.
2. Correct the cause of the fault.
3. Reset the frequency converter.

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

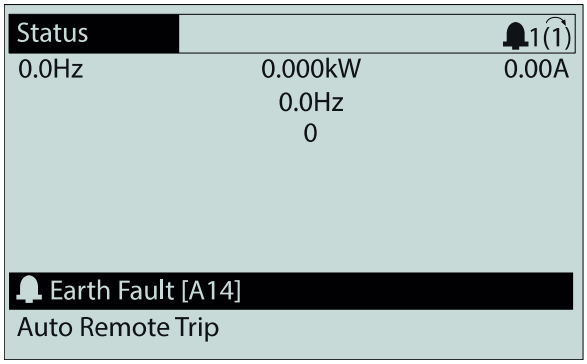
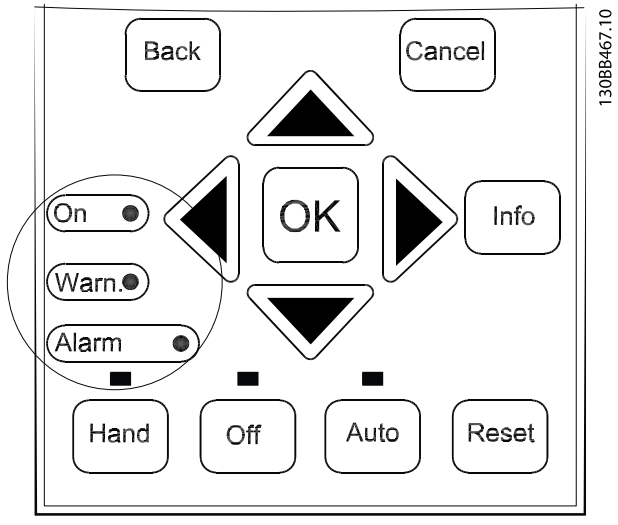


Illustration 7.3 Alarm Display Example

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



	Warning LED	Alarm LED
Warning	On	Off
Alarm	Off	On (flashing)
Trip lock	On	On (flashing)

Illustration 7.4 Status Indicator Lights (LEDs)

7.6 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 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 a faulty device sending the signal can cause this condition.

Troubleshooting

- Check connections on all analog mains terminals.
  - Control card terminals 53 and 54 for signals, terminal 55 common.
  - General Purpose I/O MCB 101 terminals 11 and 12 for signals, terminal 10 common.
  - Analog I/O Option MCB 109 terminals 1, 3, and 5 for signals, terminals 2, 4, and 6 common.
- Check that the drive programming and switch settings match the analog signal type.
- Perform an 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 Function at Mains Imbalance*.

Troubleshooting

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

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

WARNING 6, DC link voltage low
The DC-link voltage (DC) is lower than the low voltage warning limit. The limit depends on the drive 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 a certain 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*.
- If the alarm/warning occurs during a power sag, use kinetic back-up (*parameter 14-10 Mains Failure*).

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

Troubleshooting

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

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.

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 Source* 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 Source*.

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*.

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 Wilo.

- *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 Timeout Function* is NOT set to *[0] Off*.
If *parameter 8-04 Control 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 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 Up Time*).
1 = Expected brake feedback was not received before timeout (*parameter 2-23 Activate Brake Delay*, *parameter 2-25 Brake Release Time*).

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*).

For frequency converters with DC fans, a feedback sensor is mounted in the fan. If the fan is commanded to run and there is no feedback from the sensor, this alarm appears. For frequency converters with AC fans, the voltage to the fan is monitored.

Troubleshooting

- Check for proper fan operation.
- Cycle power to the frequency converter and check that the fan operates briefly at start-up.
- Check the sensors on the control card.

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*).

For frequency converters with DC fans, a feedback sensor is mounted in the fan. If the fan is commanded to run and there is no feedback from the sensor, this alarm appears. For frequency converters with AC fans, the voltage to the fan is monitored.

Troubleshooting

- Check for proper fan operation.
- Cycle power to the frequency converter and check that the fan operates briefly at start-up.
- Check the sensors on the heat sink.

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 a mean 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 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*.

Troubleshooting
- Check the fuses to the frequency converter and mains 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 7.4* is shown.

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

It may be necessary to contact the Wilo supplier or service department. Note the code number for further trouble-shooting directions.

Number	Text
0	The serial port cannot be initialized. Contact the Wilo supplier or Wilo service department.
256–258	The power EEPROM data is defective or too old. Replace the power card.
512–519	Internal fault. Contact the Wilo supplier or Wilo service department.

Number	Text
783	Parameter value outside of minimum/maximum limits.
1024–1284	Internal fault. Contact the Wilo supplier or Wilo 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 Wilo supplier or Wilo 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 Wilo supplier or Wilo service department.

Table 7.4 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)* (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)* (General Purpose I/O MCB 101).

ALARM 43, Ext. supply
The 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 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.
- 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 Wilo supplier or Wilo 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 Wilo 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. Clear the external fault condition. To resume normal operation, apply 24 V DC to the terminal programmed for external interlock, and 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
The output frequency has reached the value set in *parameter 4-19 Max Output Frequency*. Check the application for possible causes. Possibly increase the output frequency limit. Be sure that the system can operate safely at a higher output frequency. The warning clears when the output drops below the maximum limit.

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).

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 Wilo 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 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:

- 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 Digital Input*), 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 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 Profile*.

WARNING 76, Power unit setup
The required number of power units do not match the detected number of active power units.

Troubleshooting

- Confirm that the spare part and its power card are the correct part number.

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.

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 Encoder Input MCB 102 or 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.*).

ALARM 244, Heat sink temperature
This alarm is only for enclosure type F frequency converters. It is equivalent to *ALARM 29, Heat sink temp*.

The report value in the alarm log indicates which power module generated the alarm:

1 = Leftmost inverter module.

2 = Middle inverter module in enclosure size F12 or F13.

2 = Right inverter module in enclosure size F10 or F11.

2 = Second frequency converter from the left inverter module in enclosure size F14 or F15.

3 = Right inverter module in enclosure sizes F12 or F13.

3 = Third from the left inverter module in enclosure size F14 or F15.

4 = Far right inverter module in enclosure sizes F14 or F15.

5 = Rectifier module.

6 = Right rectifier module in enclosure sizes F14 or F15.

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

WARNING 250, New spare part
The power or switch mode supply has been exchanged. Restore the frequency converter type code in the EEPROM. Select the correct type code in *parameter 14-23 Typecode Setting* according to the label on the frequency converter. Remember to select Save to EEPROM at the end.

7.7 Troubleshooting

Symptom	Possible cause	Test	Solution
Display dark/No function	Missing input power.	See *Table 4.5*.	Check the input power source.
	Missing or open fuses, or circuit breaker tripped.	See *Open power fuses and tripped circuit breaker* in this table for possible causes.	Follow the recommendations provided.
	No power to the LCP.	Check the LCP cable for proper connection or damage.	Replace the faulty LCP or connection cable.
	Short circuit on control voltage (terminal 12 or 50) or at control terminals.	Check the 24 V control voltage supply for terminal 12/13 to 20–39, or 10 V supply for terminal 50–55.	Wire the terminals properly.
	Incompatible LCP	–	Use only LCP 101 (P/N 130B1124) or LCP 102 (P/N. 130B1107).
	Wrong contrast setting.	–	Press [Status] + [▲]/[▼] to adjust the contrast.
	Display (LCP) is defective.	Test using a different LCP.	Replace the faulty LCP or connection cable.
	Internal voltage supply fault or SMPS is defective.	–	Contact supplier.
Intermittent display	Overloaded supply (SMPS) due to improper control wiring or a fault within the frequency converter.	To rule out a problem in the control wiring, disconnect all control wiring by removing the terminal blocks.	If the display stays lit, the problem is in the control wiring. Check the wiring for shorts or incorrect connections. If the display continues to cut out, follow the procedure for *Display dark\No function*.
Motor not running	Service switch open or missing motor connection.	Check if the motor is connected and the connection is not interrupted by a service switch or other device.	Connect the motor and check the service switch.
	No mains power with 24 V DC option card.	If the display is functioning, but there is no output, check that mains power is applied to the frequency converter.	Apply mains power to run the unit.
	LCP stop.	Check if [Off] has been pressed.	Press [Auto On] or [Hand On] (depending on operating mode) to run the motor.
	Missing start signal (Standby).	Check *parameter 5-10 Terminal 18 Digital Input* for correct setting of terminal 18. Use default setting.	Apply a valid start signal to start the motor.
	Motor coast signal active (Coasting).	Check *parameter 5-12 Terminal 27 Digital Input* for correct setting of terminal 27 (use default setting).	Apply 24 V on terminal 27 or program this terminal to *[0] No operation*.
	Wrong reference signal source.	Check reference signal: • Local. • Remote or bus reference? • Preset reference active? • Terminal connection correct? • Scaling of terminals correct? • Reference signal available?	Program correct settings. Check *parameter 3-13 Reference Site*. Set preset reference active in *parameter group 3-1* References*. Check for correct wiring. Check scaling of terminals. Check reference signal.
Motor running in wrong direction	Motor rotation limit.	Check that *parameter 4-10 Motor Speed Direction* is programmed correctly.	Program correct settings.
	Active reversing signal.	Check if a reversing command is programmed for the terminal in *parameter group 5-1* Digital inputs*.	Deactivate reversing signal.
	Wrong motor phase connection.	–	See *chapter 5.5 Checking Motor Rotation*.

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Symptom	Possible cause	Test	Solution
Motor is not reaching maximum speed	Frequency limits set wrong.	Check output limits in *parameter 4-13 Motor Speed High Limit [RPM]*, *parameter 4-14 Motor Speed High Limit [Hz]*, and *parameter 4-19 Max Output Frequency*.	Program correct limits.
	Reference input signal not scaled correctly.	Check reference input signal scaling in *parameter group 6-0* Analog I/O mode* and *parameter group 3-1* References.*.	Program correct settings.
Motor speed unstable	Possible incorrect parameter settings.	Check the settings of all motor parameters, including all motor compensation settings. For closed-loop operation, check PID settings.	Check settings in *parameter group 1-6* Load Depen. Setting*. For closed-loop operation, check settings in *parameter group 20-0* Feedback*.
Motor runs rough	Possible overmagnetization.	Check for incorrect motor settings in all motor parameters.	Check motor settings in *parameter groups 1-2* Motor data, 1-3* Adv Motor Data*, and *1-5* Load Indep. Setting.*
Motor does not brake	Possible incorrect settings in the brake parameters. Ramp-down times may be too short.	Check brake parameters. Check ramp time settings.	Check *parameter groups 2-0* DC Brake* and *3-0* Reference Limits*.
Open power fuses	Phase-to-phase short.	Motor or panel has a short phase-to-phase. Check motor and panel phases for shorts.	Eliminate any shorts detected.
	Motor overload.	Motor is overloaded for the application.	Perform start-up test and verify that the motor current is within specifications. If the motor current exceeds the nameplate full-load current, the motor may run only with reduced load. Review the specifications for the application.
	Loose connections.	Perform pre-start-up check for loose connections.	Tighten loose connections.
Mains current imbalance greater than 3%	Problem with mains power (see *Alarm 4, Mains phase loss* description).	Rotate input power leads into the 1 position: A to B, B to C, C to A.	If imbalanced leg follows the wire, it is a power problem. Check the mains supply.
	Problem with the frequency converter.	Rotate input power leads into the frequency converter 1 position: A to B, B to C, C to A.	If the imbalanced leg stays on same input terminal, it is a problem with the frequency converter. Contact the supplier.
Motor current imbalance greater than 3%	Problem with motor or motor wiring.	Rotate output motor leads 1 position: U to V, V to W, W to U.	If the imbalanced leg follows the wire, the problem is in the motor or motor wiring. Check motor and motor wiring.
	Problem with frequency converter.	Rotate output motor leads 1 position: U to V, V to W, W to U.	If the imbalanced leg stays on same output terminal, it is a problem with the unit. Contact the supplier.
Frequency converter acceleration problems	Motor data is entered incorrectly.	If warnings or alarms occur, see *chapter 7.6 List of Warnings and Alarms*. Check that motor data is entered correctly.	Increase the ramp-up time in *parameter 3-41 Ramp 1 Ramp Up Time*. Increase current limit in *parameter 4-18 Current Limit*. Increase torque limit in *parameter 4-16 Torque Limit Motor Mode*.
Frequency converter deceleration problems	Motor data is entered incorrectly.	If warnings or alarms occur, see *chapter 7.6 List of Warnings and Alarms*. Check that motor data is entered correctly.	Increase the ramp-down time in *parameter 3-42 Ramp 1 Ramp Down Time*. Enable overvoltage control in *parameter 2-17 Over-voltage Control*.

Table 7.5 Troubleshooting

8 Specifications

8.1 Electrical Data

8.1.1 Mains Supply 3x380–480 V AC

	N110		N132		N160		N200		N250		N315	
High/normal load*	**HO**	**NO**	**HO**	**NO**	**HO**	**NO**	**HO**	**NO**	**HO**	**NO**	**HO**	**NO**
Typical shaft output at 400 V [kW]	90	110	110	132	132	160	160	200	200	250	250	315
Typical shaft output at 460 V [hp]	125	150	150	200	200	250	250	300	300	350	350	450
Enclosure IP20	D3h						D4h					
Enclosure IP21/IP54	D1h						D2h					
Output current												
Continuous (at 3x380–440 V) [A]	177	212	212	260	260	315	315	395	395	480	480	588
Intermittent (at 3x380–440 V) [A]	266	233	318	286	390	347	473	435	593	528	720	647
Continuous (at 3x441–480 V) [A]	160	190	190	240	240	302	302	361	361	443	443	535
Intermittent (at 3x441–480 V) [A]	240	209	285	264	360	332	453	397	542	487	665	588
Continuous kVA (at 400 V AC) [kVA]	123	147	147	180	180	218	218	274	274	333	333	407
Continuous kVA (at 460 V AC) [kVA]	127	151	151	191	191	241	241	288	288	353	353	426
Maximum input current												
Continuous (3x380–440 V) [A]	171	204	204	251	251	304	304	381	381	463	463	567
Continuous (3x441–480 V) [A]	154	183	183	231	231	291	291	348	348	427	427	516
Maximum pre-fuses[1] [A]	315		350		400		550		630		800	
Maximum cable size												
Motor (mm^2/AWG[2) 5)])	2x95 (2x3/0)						2x185 (2x350 mcm)					
Mains (mm^2/AWG[2) 5)])												
Load share (mm^2/AWG[2) 5)])												
Brake (mm^2/AWG[2) 5)])												
Estimated power loss at 400 V AC at rated maximum load [W][3]	2031	2559	2289	2954	2923	3770	3093	4116	4039	5137	5005	6674
Estimated power loss at 460 V AC at rated maximum load [W][3]	1828	2261	2051	2724	2089	3628	2872	3569	3575	4566	4458	5714
Weight, enclosure IP00/IP20, [kg (lbs)]	62 (135)						125 (275)					
Weight, enclosure IP21, [kg (lbs)]												
Weight, enclosure IP54, [kg (lbs)]												
Efficiency[4]	0.98											
Output frequency [Hz]	0–590											
Heat sink overtemperature trip [°C (°F)]	110 (230)											
Power card ambient trip [°C (°F)]	75 (167)											
*High overload=150% current for 60 s, Normal overload=110% current for 60 s												

Table 8.1 Technical Specifications, D1h-D4h, Mains Supply 3x380–480 V AC

1) For type of fuse, consult the operating instructions.

2) American Wire Gauge.

3) The typical power loss is at normal conditions and expected to be within ±15% (tolerance relates to variety in voltage and cable conditions.) These values are based on a typical motor efficiency (IE2/IE3 border line). Lower efficiency motors add to the power loss in the frequency converter and the opposite is also true. 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. Further options and customer load can add up to 30 W to the losses (though typically only 4 W extra for a fully loaded control card or options for slot A or slot B, each).

4) Measured using 5 m (16.4 ft) shielded motor cables at rated load and rated frequency.

Efficiency measured at nominal current. For energy efficiency class, see chapter 8.4.1 Ambient Conditions.

5) Wiring terminals on N132, N160, and N315 frequency converters cannot receive cables one size larger.

8.1.2 Mains Supply 3x525–690 V AC

	N75K		N90K		N110K		N132		N160	
High/normal load*	**HO**	**NO**	**HO**	**NO**	**HO**	**NO**	**HO**	**NO**	**HO**	**NO**
Typical shaft output at 550 V [kW]	45	55	55	75	75	90	90	110	110	132
Typical shaft output at 575 V [hp]	60	75	75	100	100	125	125	150	150	200
Typical shaft output at 690 V [kW]	55	75	75	90	90	110	110	132	132	160
Enclosure IP20	D3h									
Enclosure IP21/IP54	D1h									
Output current										
Continuous (at 550 V) [A]	76	90	90	113	113	137	137	162	162	201
Intermittent (60 s overload) (at 550 V) [A]	122	99	135	124	170	151	206	178	243	221
Continuous (at 575/690 V) [A]	73	86	86	108	108	131	131	155	155	192
Intermittent (60 s overload) (at 575/690 V) [kVA]	117	95	129	119	162	144	197	171	233	211
Continuous kVA (at 550 V) [kVA]	72	86	86	108	108	131	131	154	154	191
Continuous kVA (at 575 V) [kVA]	73	86	86	108	108	130	130	154	154	191
Continuous kVA (at 690 V) [kVA]	87	103	103	129	129	157	157	185	185	229
Maximum input current										
Continuous (at 550 V) [A]	77	89	89	110	110	130	130	158	158	198
Continuous (at 575 V) [A]	74	85	85	106	106	124	124	151	151	189
Continuous (at 690 V) [A]	77	87	87	109	109	128	128	155	155	197
Maximum cable size										
Mains, motor, brake, and load share (mm^2/AWG[2)])	2x95 (2x3/0)									
Maximum external mains fuses [A]	160		315							
Estimated power loss at 575 V [W][3)]	1098	1162	1162	1428	1430	1740	1742	2101	2080	2649
Estimated power loss at 690 V [W][3)]	1057	1204	1205	1477	1480	1798	1800	2167	2159	2740
Weight, enclosure IP20, [kg (lbs)]	125 [275]									
Weight, enclosure IP21/IP54, [kg (lbs)]	62 [135]									
Efficiency[4)]	0.98									
Output frequency [Hz]	0–590									
Heat sink overtemperature trip [°C (°F)]	110 (230)									
Power card ambient trip [°C °F)]	75 (167)									
*High overload=150% current for 60 s, Normal overload=110% current for 60 s.										

Table 8.2 Technical Specifications, D1h/D3h, Mains Supply 3x525–690 V AC

	N200		N250		N315		P400	
High/normal load*	**HO**	**NO**	**HO**	**NO**	**HO**	**NO**	**HO**	**NO**
Typical shaft output at 550 V [kW]	132	160	160	200	200	250	250	315
Typical shaft output at 575 V [hp]	200	250	250	300	300	350	350	400
Typical shaft output at 690 V [kW]	160	200	200	250	250	315	315	400
Enclosure IP20	D4h							
Enclosure IP21/IP54	D2h							
Output current								
Continuous (at 550 V) [A]	201	253	253	303	303	360	360	418
Intermittent (60 s overload) (at 550 V)[A]	302	278	380	333	455	396	540	460
Continuous (at 575/690 V) [A]	192	242	242	290	290	344	344	400
Intermittent (60 s overload) (at 575/690 V) [kVA]	288	266	363	319	435	378	516	440
Continuous kVA (at 550 V) [kVA]	191	241	241	289	289	343	343	398
Continuous kVA (at 575 V) [kVA]	191	241	241	289	289	343	343	398
Continuous kVA (at 690 V) [kVA]	229	289	289	347	347	411	411	478
Maximum input current								
Continuous (at 550 V) [A]	198	245	245	299	299	355	355	408
Continuous (at 575 V) [A]	189	234	234	286	286	339	339	390
Continuous (at 690 V) [A]	197	240	240	296	296	352	352	400
Maximum cable size								
Mains, motor, brake, and load share (mm^2/AWG[2)])	2x185 (2x350 mcm)							
Maximum external mains fuses [A]	550							
Estimated power loss at 575 V [W][3)]	2361	3074	3012	3723	3642	4465	4146	5028
Estimated power loss at 690 V [W][3)]	2446	3175	3123	3851	3771	4614	4258	5155
Weight, enclosure, IP20/IP21/IP54, [kg (lbs)]	125 [275]							
Efficiency[4)]	0.98							
Output frequency [Hz]	0–590						0–525	
Heat sink overtemperature trip [°C (°F)]	110 (230)							
Power card ambient trip [°C (°F)]	80 (176)							
*High overload=150% current for 60 s, Normal overload=110% current for 60 s.								

Table 8.3 Technical Specifications, D2h/D4h, Mains Supply 3x525–690 V AC

1) For type of fuse, consult the operating instructions.

2) American Wire Gauge.

3) The typical power loss is at normal conditions and expected to be within ±15% (tolerance relates to variety in voltage and cable conditions.) These values are based on a typical motor efficiency (IE2/IE3 border line). Lower efficiency motors add to the power loss in the frequency converter and the opposite is also true. 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. Further options and customer load can add up to 30 W to the losses (though typically only 4 W extra for a fully loaded control card or options for slot A or slot B, each).

4) Measured using 5 m (16.4 ft) shielded motor cables at rated load and rated frequency.

Efficiency measured at nominal current. For energy efficiency class, see chapter 8.4.1 Ambient Conditions.

Enclosure size	Description	Maximum weight, [kg (lbs)]
D5h	D1h ratings+disconnect and/or brake chopper	166 (255)
D6h	D1h ratings+contactor and/or circuit breaker	129 (285)
D7h	D2h ratings+disconnect and/or brake chopper	200 (440)
D8h	D2h ratings+contactor and/or circuit breaker	225 (496)

Table 8.4 D5h–D8h Weight

8.2 Mains Supply

Mains supply (L1, L2, L3)	
Supply voltage	380–480 V ±10%, 525–690 V ±10%

Mains voltage low/mains voltage dropout:
During low mains voltage or a mains drop-out, the frequency converter continues until the DC-link voltage drops below the minimum stop level. The minimum stop level 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)	Maximum 1 time/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, 480/600 V.

8.3 Motor Output and Motor Data

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Motor output (U, V, W)	
Output voltage	0–100% of supply voltage
Output frequency	0–590 Hz[1)]
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)]
Starting torque	Maximum 180% up to 0.5 s[1)]
Overload torque (constant torque)	Maximum 160% for 60 s[1)]

1) Percentage relates to the frequency converter's nominal torque.

8.4 Ambient Conditions

Environment	
Enclosure size D1h/D2h/D5h/D6h/D7h/D8h	IP21/Type 1, IP54/Type12
Enclosure size D3h/D4h	IP20/Chassis
Vibration test all enclosure sizes	1.0 g
Relative humidity	5–95% (IEC 721-3-3; Class 3K3 (non-condensing) during operation)
Aggressive environment (IEC 60068-2-43) H_2S test	Class Kd
Test method according to IEC 60068-2-43 H2S (10 days)	
Ambient temperature (at SFAVM switching mode)	
- with derating	Maximum 55 °C (maximum 131 °F)[1)]
- with full output power of typical EFF2 motors (up to 90% output current)	Maximum 50 °C (maximum 122 °F)[1)]
- at full continuous FC output current	Maximum 45 °C (maximum 113 °F)[1)]
Minimum ambient temperature during full-scale operation	0 °C (32 °F)
Minimum ambient temperature at reduced performance	10 °C (50 °F)
Temperature during storage/transport	-25 to +65/70 °C (13 to 149/158 °F)
Maximum altitude above sea level without derating	1000 m (3281 ft)
Maximum altitude above sea level with derating	3000 m (9842 ft)

1) For more information on derating, see section on special conditions in the design guide.

EMC standards, Emission	EN 61800-3
EMC standards, Immunity	EN 61800-3
Energy efficiency class[2)]	IE2

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/armored	150 m (492 ft)
Maximum motor cable length, unshielded/unarmored	300 m (984 ft)
Maximum cross-section to motor, mains, load sharing, and brake	See *chapter 8.1 Electrical Data*
Maximum cross-section to control terminals, rigid wire	1.5 mm^2/16 AWG (2x0.75 mm^2)
Maximum cross-section to control terminals, flexible cable	1 mm^2/18 AWG
Maximum cross-section to control terminals, cable with enclosed core	0.5 mm^2/20 AWG
Minimum cross-section to control terminals.	0.25 mm^2/23 AWG

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

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8.6 Control Input/Output and Control Data

Digital inputs	
Programmable digital inputs	4 (6)
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	>19 V DC
Voltage level, logic 1 NPN	<14 V DC
Maximum voltage on input	28 V DC
Input resistance, R_i	Approximately 4 kΩ

All digital inputs are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.
1) Terminals 27 and 29 can also be programmed as outputs.

Analog inputs	
Number of analog inputs	2
Terminal number	53, 54
Modes	Voltage or current
Mode select	Switches A53 and A54
Voltage mode	Switch A53/A54=(U)
Voltage level	-10 V to +10 V (scaleable)
Input resistance, R_i	Approximately 10 kΩ
Maximum voltage	±20 V
Current mode	Switch A53/A54=(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.

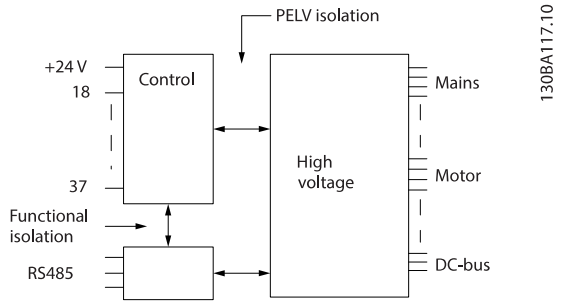

Illustration 8.1 PELV Isolation

Pulse inputs	
Programmable pulse inputs	2
Terminal number pulse	29, 33
Maximum frequency at terminal 29, 33	110 kHz (push-pull driven)
Maximum frequency at terminal 29, 33	5 kHz (open collector)
Minimum frequency at terminal 29, 33	4 Hz
Voltage level	See *Digital Inputs* in *chapter 8.6 Control Input/Output and Control Data*
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

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

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

Control card, 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).

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

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

Control card, 24 V DC output	
Terminal number	12, 13
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.

Relay outputs	
Programmable relay outputs	2
Maximum cross-section to relay terminals	2.5 mm^2 (12 AWG)
Minimum cross-section to relay terminals	0.2 mm^2 (30 AWG)
Length of stripped wire	8 mm (0.3 in)
Relay 01 terminal number	1–3 (break), 1–2 (make)
Maximum terminal load (AC-1)[1)] on 1–2 (NO) (Resistive load)[2)3)]	400 V AC, 2 A
Maximum terminal load (AC-15)[1)] on 1–2 (NO) (Inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1)[1)] on 1–2 (NO) (Resistive load)	80 V DC, 2 A
Maximum terminal load (DC-13)[1)] on 1–2 (NO) (Inductive load)	24 V DC, 0.1 A
Maximum terminal load (AC-1)[1)] on 1–3 (NC) (Resistive load)	240 V AC, 2 A
Maximum terminal load (AC-15)[1)] on 1–3 (NC) (Inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1)[1)] on 1–3 (NC) (Resistive load)	50 V DC, 2 A
Maximum terminal load (DC-13)[1)] on 1–3 (NC) (Inductive load)	24 V DC, 0.1 A
Minimum terminal load on 1–3 (NC), 1–2 (NO)	24 V DC 10 mA, 24 V AC 2 mA
Environment according to EN 60664-1	Overvoltage category III/pollution degree 2
Relay 02 terminal number	4–6 (break), 4–5 (make)
Maximum terminal load (AC-1)[1)] on 4–5 (NO) (Resistive load)[2)3)]	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 4–6 (NC), 4–5 (NO)	24 V DC 10 mA, 24 V AC 2 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, +10 V DC output	
Terminal number	50
Output voltage	10.5 V ±0.5 V
Maximum load	25 mA

The 10 V DC supply is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

Control characteristics	
Resolution of output frequency at 0–1000 Hz	±0.003 Hz
System response time (terminals 18, 19, 27, 29, 32, 33)	≤2 m/s
Speed control range (open loop)	1:100 of synchronous speed
Speed accuracy (open loop)	30–4000 RPM: Maximum error of ±8 RPM

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

Control card performance	
Scan interval	5 M/S

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

NOTICE

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

8.7 Fuses

8.7.1 Fuse Selection

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

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NOTICE

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

Use the recommended fuses to ensure compliance with EN 50178. Use of recommended fuses and circuit breakers ensures that possible damage to the frequency converter is limited to damages inside the unit. For further information, see *Application Note Fuses and Circuit Breakers*.

The fuses in *Table 8.5* to *Table 8.7* 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}.

N110K–N315	380–480 V	Type aR
N75K–N400	525–690 V	Type aR

Table 8.5 Recommended Fuses

Power size	Bussmann PN	Littelfuse PN	Littelfuse PN	Bussmann PN	Siba PN	Ferraz Shawmut PN	Ferraz Shawmut PN (Europe)	Ferraz Shawmut PN (North America)
N110K	170M2619	LA50QS300-4	L50S-300	FWH-300A	20 610 31.315	A50QS300-4	6,9URD31D08A0315	A070URD31KI0315
N132	170M2620	LA50QS350-4	L50S-350	FWH-350A	20 610 31.350	A50QS350-4	6,9URD31D08A0350	A070URD31KI0350
N160	170M2621	LA50QS400-4	L50S-400	FWH-400A	20 610 31.400	A50QS400-4	6,9URD31D08A0400	A070URD31KI0400
N200	170M4015	LA50QS500-4	L50S-500	FWH-500A	20 610 31.550	A50QS500-4	6,9URD31D08A0550	A070URD31KI0550
N250	170M4016	LA50QS600-4	L50S-600	FWH-600A	20 610 31.630	A50QS600-4	6,9URD31D08A0630	A070URD31KI0630
N315	170M4017	LA50QS800-4	L50S-800	FWH-800A	20 610 31.800	A50QS800-4	6,9URD32D08A0800	A070URD31KI0800

Table 8.6 Fuse Options for 380–480 V Frequency Converters

Power size	Bussmann PN	Siba PN	Ferraz Shawmut PN (Europe)	Ferraz Shawmut PN (North America)
N75k T7	170M2616	20 610 31.160	6,9URD30D08A0160	A070URD30KI0160
N90k T7	170M2619	20 610 31.315	6,9URD31D08A0315	A070URD31KI0315
N110 T7	170M2619	20 610 31.315	6,9URD31D08A0315	A070URD31KI0315
N132 T7	170M2619	20 610 31.315	6,9URD31D08A0315	A070URD31KI0315
N160 T7	170M2619	20 610 31.315	6,9URD31D08A0315	A070URD31KI0315
N200 T7	170M4015	20 620 31.550	6,9URD32D08A0550	A070URD32KI0550
N250 T7	170M4015	20 620 31.550	6,9URD32D08A0550	A070URD32KI0550
N315 T7	170M4015	20 620 31.550	6,9URD32D08A0550	A070URD32KI0550
N400 T7	170M4015	20 620 31.550	6,9URD32D08A0550	A070URD32KI0550

Table 8.7 Fuse Options for 525–690 V Frequency Converters

For UL Compliance, use the Bussmann 170M series fuses for units supplied without a contactor-only option. See *Table 8.9* for SCCR ratings and UL fuse criteria if a contactor-only option is supplied with the frequency converter.

8.7.2 Short-circuit Current Rating (SCCR)

If the frequency converter is not supplied with a mains disconnect, contactor or circuit breaker, the short-circuit current rating (SCCR) of the frequency converters is 100000 A at all voltages (380–690 V).

If the frequency converter is supplied with a mains disconnect, the SCCR of the frequency converter is 100000 A at all voltages (380–690 V).

If the frequency converter is supplied with a circuit breaker, the SCCR depends on the voltage, see *Table 8.8*:

	415 V	480 V	600 V	690 V
D6h enclosure	120000 A	100000 A	65000 A	70000 A
D8h enclosure	100000 A	100000 A	42000 A	30000 A

Table 8.8 Frequency Converter Supplied with a Circuit Breaker

If the frequency converter is supplied with a contactor-only option and is externally fused according to *Table 8.9*, the SCCR of the frequency converter is as follows:

	415 V IEC[1)] [A]	480 V UL[2)] [A]	600 V UL[2)] [A]	690 V IEC[1)] [A]
D6h enclosure	100000	100000	100000	100000
D8h enclosure (not including the N250T5)	100000	100000	100000	100000
D8h enclosure (N250T5 only)	100000	Consult factory	Not applicable	

Table 8.9 Frequency Converter Supplied with a Contactor

1) With a Bussmann type LPJ-SP or Gould Shawmut type AJT fuse. 450 A maximum fuse size for D6h, and 900 A maximum fuse size for D8h.

2) Must use Class J or L branch fuses for UL Approval. 450 A maximum fuse size for D6h, and 600 A maximum fuse size for D8h.

8

8.8 Connection Tightening Torques

Apply the correct torque when tightening fasteners in the locations that are listed in *Table 8.10*. Too low or too high torque when fastening an electrical connection results in a bad electrical connection. To ensure correct torque, use a torque wrench.

Location	Bolt size	Torque [Nm (in-lb)]
Mains terminals	M10/M12	19 (168)/37 (335)
Motor terminals	M10/M12	19 (168)/37 (335)
Ground terminals	M8/M10	9.6 (84)/19.1 (169)
Brake terminals	M8	9.6 (84)
Load sharing terminals	M10/M12	19 (168)/37 (335)
Regeneration terminals (Enclosures E1h/E2h)	M8	9.6 (84)
Regeneration terminals (Enclosures E3h/E4h)	M10/M12	19 (168)/37 (335)
Relay terminals	_	0.5 (4)
Door/panel cover	M5	2.3 (20)
Gland plate	M5	2.3 (20)
Heat sink access panel	M5	3.9 (35)
Serial communication cover	M5	2.3 (20)

Table 8.10 Fastener Torque Ratings

8

8.9 Power Ratings, Weight, and Dimensions

Enclosure size		D1h	D2h	D3h	D4h	D3h	D4h
Rated power [kW]		110–160 kW (380–480 V) 75–160 kW (525–690 V)	200–315 kW (380–480 V) 200–400 kW (525–690 V)	110–160 kW (380–480 V) 75–160 kW (525–690 V)	200–315 kW (380–480 V) 200–400 kW (525–690 V)	With regeneration or load share terminals	
IP NEMA		21/54 Type 1/12	21/54 Type 1/12	20 Chassis	20 Chassis	20 Chassis	20 Chassis
Shipping dimensions [mm (inch)]	Height	587 (23)	587 (23)	587 (23)	587 (23)	587 (23)	587 (23)
	Width	997 (39)	1170 (46)	997 (39)	1170 (46)	1230 (48)	1430 (56)
	Depth	460 (18)	535 (21)	460 (18)	535 (21)	460 (18)	535 (21)
Frequency converter dimensions [mm (inch)]	Height	893 (35)	1099 (43)	909 (36)	1122 (44)	1004 (40)	1268 (50)
	Width	325 (13)	420 (17)	250 (10)	350 (14)	250 (10)	350 (14)
	Depth	378 (15)	378 (15)	375 (15)	375 (15)	375 (15)	375 (15)
Maximum weight [kg (lb)]		98 (216)	164 (362)	98 (216)	164 (362)	108 (238)	179 (395)

Table 8.11 Power Ratings, Weight, and Dimensions, Enclosure Size D1h-D4h

Enclosure size		D5h	D6h	D7h	D8h
Rated power [kW]		**110–160 kW (380–480 V) 75–160 kW (525–690 V)**	**110–160 kW (380–480 V) 75–160 kW (525–690 V)**	**200–315 kW (380–480 V) 200–400 kW (525–690 V)**	**200–315 kW (380–480 V) 200–400 kW (525–690 V)**
IP **NEMA**		21/54 Type 1/12	21/54 Type 1/12	21/54 Type 1/12	21/54 Type 1/12
Shipping dimensions [mm (inch)]	Height	1805 (71)	1805 (71)	2490 (98)	2490 (98)
	Width	510 (20)	510 (20)	585 (23)	585 (23)
	Depth	635 (25)	635 (25)	640 (25)	640 (25)
Frequency converter dimensions [mm (inch)]	Height	1324 (52)	1665 (66)	1978 (78)	2284 (90)
	Width	325 (13)	325 (13)	420 (17)	420 (17)
	Depth	381 (15)	381 (15)	386 (15)	406 (16)
Maximum weight [kg (lb)]		449 (990)	449 (990)	530 (1168)	530 (1168)

Table 8.12 Power Ratings, Weight, and Dimensions, Enclosure Size D5h-D8h

8

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

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
0-05	Local Mode Unit
0-1*	**Set-up Operations**
0-10	Active Set-up
0-11	Programming Set-up
0-12	This Set-up Linked to
0-13	Readout: Linked Set-ups
0-14	Readout: Prog. Set-ups / Channel
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	Custom Readout Unit
0-31	Custom Readout Min Value
0-32	Custom Readout Max Value
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	Personal Menu Password
0-66	Access to Personal Menu w/o Password
0-67	Bus Password Access
0-7*	**Clock Settings**
0-70	Date and Time
0-71	Date Format
0-72	Time Format
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
0-89	Date and Time Readout
1- **	**Load and Motor**
1-0*	**General Settings**
1-00	Configuration Mode
1-01	Motor Control Principle
1-03	Torque Characteristics
1-04	Overload Mode
1-06	Clockwise Direction
1-1*	**Motor Selection**
1-10	Motor Construction
1-1*	**VVC+ PM/SYN RM**
1-14	Damping Gain
1-15	Low Speed Filter Time Const.
1-16	High Speed Filter Time Const.
1-17	Voltage filter time const.
1-2*	**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
1-28	Motor Rotation Check
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
1-44	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
1-5*	**Load Indep. Setting**
1-50	Motor Magnetisation at Zero Speed
1-51	Min Speed Normal Magnetising [RPM]
1-52	Min Speed Normal Magnetising [Hz]
1-55	V/f Characteristic - V
1-56	V/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
1-7*	**Start Adjustments**
1-70	PM Start Mode
1-71	Start Delay
1-72	Start Function
1-73	Flying Start
1-77	Compressor Start Max Speed [RPM]
1-78	Compressor Start Max Speed [Hz]
1-79	Pump Start Max Time to Trip
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]
1-86	Trip Speed Low [RPM]
1-87	Trip Speed Low [Hz]
1-9*	**Motor Temperature**
1-90	Motor Thermal Protection
1-91	Motor External Fan
1-93	Thermistor Source
1-94	ATEX ETR cur.lim. speed reduction
1-98	ATEX ETR interpol. points freq.
1-99	ATEX ETR interpol points current
2- **	**Brakes**
2-0*	**DC-Brake**
2-00	DC Hold/Preheat 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]
2-06	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
3- **	**Reference / Ramps**
3-0*	**Reference Limits**
3-02	Minimum Reference
3-03	Maximum Reference
3-04	Reference Function
3-1*	**References**
3-10	Preset Reference
3-11	Jog Speed [Hz]
3-13	Reference Site
3-14	Preset Relative Reference
3-15	Reference 1 Source
3-16	Reference 2 Source
3-17	Reference 3 Source
3-19	Jog Speed [RPM]
3-4*	**Ramp 1**
3-41	Ramp 1 Ramp Up Time
3-42	Ramp 1 Ramp Down Time
3-5*	**Ramp 2**
3-51	Ramp 2 Ramp Up Time
3-52	Ramp 2 Ramp Down Time
3-8*	**Other Ramps**
3-80	Jog Ramp Time
3-81	Quick Stop Ramp Time
3-84	Initial Ramp Time
3-85	Check Valve Ramp Time
3-86	Check Valve Ramp End Speed [RPM]
3-87	Check Valve Ramp End Speed [HZ]
3-88	Final Ramp 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
4-5*	**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]
4-61	Bypass Speed From [Hz]
4-62	Bypass Speed To [RPM]
4-63	Bypass Speed To [Hz]
4-64	Semi-Auto Bypass Set-up
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 Digital Input
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
5-8*	**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 53**
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
6-17	Terminal 53 Live Zero
6-2*	**Analog Input 54**
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
6-27	Terminal 54 Live Zero
6-3*	**Analog Input X30/11**
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
6-37 Term. X30/11 Live Zero
6-4* Analog Input X30/12
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
6-47 Term. X30/12 Live Zero
6-5* Analog Output 42
6-50 Terminal 42 Output
6-51 Terminal 42 Output Min Scale
6-52 Terminal 42 Output Max Scale
6-53 Terminal 42 Output Bus Control
6-54 Terminal 42 Output Timeout Preset
6-55 Terminal 42 Output Filter
6-6* Analog Output X30/8
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 Output Bus Control
6-64 Terminal X30/8 Output Timeout Preset
6-7* Analog Output X45/1
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 X45/3
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
8- Comm. and Options**
8-0* General Settings
8-01 Control Site
8-02 Control Source
8-03 Control Timeout Time
8-04 Control Timeout Function
8-05 End-of-Timeout Function
8-06 Reset Control Timeout
8-07 Diagnosis Trigger
8-08 Readout Filtering
8-1* Control Settings
8-10 Control Profile
8-13 Configurable Status Word STW
8-14 Configurable Control Word CTW
8-17 Configurable Alarm and Warningword
8-3* FC Port Settings
8-30 Protocol
8-31 Address
8-32 Baud Rate
8-33 Parity / Stop Bits
8-35 Minimum Response Delay
8-36 Max Response Delay
8-37 Maximum Inter-Char Delay
8-4* FC MC protocol set
8-40 Telegram Selection
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
8-7* BACnet
8-70 BACnet Device Instance
8-72 MS/TP Max Masters
8-73 MS/TP Max Info Frames
8-74 "I-Am" Service
8-75 Initialisation Password
8-8* FC Port Diagnostics
8-80 Bus Message Count
8-81 Bus Error Count
8-82 Slave Message Rcvd
8-83 Slave Error Count
8-9* Bus Jog / Feedback
8-90 Bus Jog 1 Speed
8-91 Bus Jog 2 Speed
8-94 Bus Feedback 1
8-95 Bus Feedback 2
8-96 Bus Feedback 3
9- PROFIdrive**
9-00 Setpoint
9-07 Actual Value
9-15 PCD Write Configuration
9-16 PCD Read Configuration
9-18 Node Address
9-22 Telegram Selection
9-23 Parameters for Signals
9-27 Parameter Edit
9-28 Process Control
9-31 Safe Address
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 Programming 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
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
12-27 Primary Master
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130R0821