ENGINEERING TOMORROW

Operating Guide
VLT® HVAC Drive FC 102

110–400 kW, Enclosure Sizes D1h–D8h

vlt-drives.danfoss.com

ENGINEERING TOMORROW

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EU DECLARATION OF CONFORMITY

Danfoss A/S

Danfoss Drives A/S

declares under our sole responsibility that the

Product category: Frequency Converter
Type designation(s): FC-102XYYYZZ**********

Character X: N or P
Character YYY: K37, K75, 1K1, 1K5, 2K2, 3K0, 3K7, 4K0, 5K5, 7K5, 11K, 15K, 18K, 22K, 30K, 37K, 45K, 55K, 75K, 90K, 110, 132, 150, 160, 200, 250, 315, 355, 400, 450, 500, 560, 630, 710, 800, 900, 1M0, 1M2, 1M4
Character ZZ: T2, T4, T6, T7
* may be any number or letter indicating drive options which do not impact this DoC.
The meaning of the 39 characters in the type code string can be found in appendix 00729776.

Covered by this declaration is in conformity with the following directive(s), standard(s) or other normative document(s), provided that the product is used in accordance with our instructions.

Low Voltage Directive 2014/35/EU

EN61800-5-1:2007 + A1:2017	Adjustable speed electrical power drive systems – Part 5-1: Safety requirements – Electrical, thermal and energy.

EMC Directive 2014/30/EU

EN61800-3:2004 + A1:2012	Adjustable speed electrical power drive systems – Part 3: EMC requirements and specific test methods.

RoHS Directive 2011/65/EU including amendment 2015/863.

EN63000:2018	Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

Date: 2020.09.02 Place of issue:	Issued by	Date: 2020.09.02 Place of issue:	Approved by
Graasten, DK	**Signature:** **Name: Gert Kjær** **Title: Senior Director, GDE**	Graasten, DK	**Signature:** **Name: Michael Termansen** **Title: VP, PD Center Denmark**

Danfoss only vouches for the correctness of the English version of this declaration. In the event of the declaration being translated into any other language, the translator concerned shall be liable for the correctness of the translation

Classified as Business

For products including available Safe Torque Off (STO) function according to unit typecode on the nameplate: **T or U at character 18 of the typecode.**

Machine Directive 2006/42/EC

EN/IEC 61800-5-2:2007 (Safe Stop function conforms with STO – Safe Torque Off, SIL 2 Capability)	Adjustable speed electrical power drive systems – Part 5-2: Safety requirements – Functional

Other standards considered:

EN ISO 13849-1:2015 (Safe Stop function, PL d (MTTFd=14000 years, DC=90%, Category 3)	Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design
EN/IEC 61508-1:2011, EN/IEC 61508-2:2011 (Safe Stop function, SIL 2 (PFH = 1E-10/h, 1E-8/h for specific variants, PFD = 1E-10, 1E-4 for specific variants, SFF>99%, HFT=0))	Functional safety of electrical/electronic/ programmable electronic safety-related systems Part 1: General requirements Part 2: Requirements for electrical/ electronic / programmable electronic safety-related systems
EN/IEC 62061:2005 + A1:2013 (Safe Stop function, SILCL 2)	Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems
EN/IEC 60204-1:2006 + A1:2009 (Stop Category 0)	Safety of machinery - Electrical equipment of machines - Part 1: General requirements

For products including ATEX option, it requires STO function in the products. The products can have the VLT PTC Thermistor Card MCB112 installed from factory **(2 at character 32 in the typecode)**, or it can be separately installed as an additional part.

2014/34/EU - Equipment for explosive atmospheres (ATEX)

Based on EU harmonized standard: EN 50495: 2010	Safety devices required for safe functioning of equipment with respect to explosion risks.

Notified Body:
PTB Physikalisch-Technische Bundesanstalt, Bundesallee 100, 38116 Braunschweig,
has assessed the conformity of the "ATEX certified motor thermal protection systems" of Danfoss FC VLT Drives with Safe Torque Off function and has issued the certificate PTB 14 ATEX 3009.

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1

1 Introduction

1.1 Purpose of the Manual

This operating guide provides information for safe installation and commissioning of the VLT® drives.

The operating guide is intended for use by qualified personnel. To use the unit safely and professionally, read and follow this operating guide. Pay particular attention to the safety instructions and general warnings. Always keep the operating guide with the drive.

VLT® is a registered trademark.

1.2 Additional Resources

Other resources are available to understand advanced drive 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 provide information for operation with optional equipment.

Supplementary publications and manuals are available from Danfoss. See *drives.danfoss.com/knowledge-center/technical-documentation/* for listings.

1.3 Manual and Software Version

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

Manual version	Remarks	Software version
MG16D5xx	Replaces MG16D4xx	5.20

Table 1.1 Manual and Software Version

1.4 Approvals and Certifications

Table 1.2 Approvals and Certifications

More approvals and certifications are available. Contact the local Danfoss office or partner. Drives of voltage 525–690 V are UL certified for only 525–600 V.

The drive complies with UL 61800-5-1 thermal memory retention requirements. For more information, refer to the section *Motor Thermal Protection* in the product-specific *design guide*.

NOTICE

OUTPUT FREQUENCY LIMIT

Due to export control regulations, the output frequency of the drive is limited to 590 Hz. For demands exceeding 590 Hz, contact Danfoss.

1.4.1 Compliance with ADN

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

1.5 Disposal

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

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2 Safety

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 drive. Only qualified personnel are allowed to install or 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 personnel must be familiar with the instructions and safety measures described in this manual.

2.3 Safety Precautions

⚠WARNING

HIGH VOLTAGE

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

- **Only qualified personnel must install, start up, and maintain the drive.**

⚠WARNING

UNINTENDED START

When the drive is connected to the 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 drive from the mains.**
- **Completely wire and assemble the drive, motor, and any driven equipment before connecting the drive to the AC mains, DC supply, or load sharing.**

⚠WARNING

DISCHARGE TIME

The drive contains DC-link capacitors, which can remain charged even when the drive 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 drives.**
- **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 drive properly can result in death or serious injury.

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

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⚠WARNING

EQUIPMENT HAZARD

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

- **Ensure that only trained and qualified personnel install, start up, and maintain the drive.**
- **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.**

⚠WARNING

INTERNAL FAILURE HAZARD

Under certain circumstances, an internal failure can cause a component to explode. Failure to keep the enclosure closed and properly secured can cause death or serious injury.

- **Do not operate the drive with the door open or panels off.**
- **Ensure that the enclosure is properly closed and secured during operation.**

⚠CAUTION

HOT SURFACES

The drive contains metal components that are still hot even after the drive has been powered off. Failure to observe the high temperature symbol (yellow triangle) on the drive can result in serious burns.

- **Be aware that internal components, such as busbars, can be extremely hot even after the drive has been powered off.**
- **Exterior areas marked by the high-temperature symbol (yellow triangle) are hot while the drive is in use and immediately after being powered off.**

NOTICE

MAINS SHIELD SAFETY OPTION

A mains shield option is available for enclosures with a protection rating of IP21/IP54 (Type 1/Type 12). The mains shield is a cover installed inside the enclosure to protect against the unintended touch of the power terminals, according to BGV A2, VBG 4.

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3 Product Overview

3.1 Intended Use

The drive is an electronic motor controller that converts AC mains input into a variable AC waveform output. The frequency and voltage of the output are regulated to control the motor speed or torque. The drive is designed to:

- Regulate motor speed in response to system feedback or to remote commands from external controllers.
- Monitor system and motor status.
- Provide motor overload protection.

The drive is designed for industrial and commercial environments in accordance with local laws and standards. Depending on configuration, the drive can be used in standalone applications or form part of a larger system or installation.

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 drive in applications which are non-compliant with specified operating conditions and environments. Ensure compliance with the conditions specified in *chapter 10 Specifications*.

3.2 Power Ratings, Weight, and Dimensions

For enclosure sizes and power ratings of the drives, refer to *Table 3.1*. For more dimensions, see *chapter 10.9 Enclosure Dimensions*.

Enclosure size		D1h	D2h	D3h	D4h	D3h	D4h
		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 sharing terminals	
IP NEMA		21/54 Type 1/12	21/54 Type 1/12	20 Chassis	20 Chassis	20 Chassis	20 Chassis
Shipping dimensions [mm (in)]	Height	587 (23.1)	587 (23.1)	587 (23.1)	587 (23.1)	587 (23.1)	587 (23.1)
	Width	997 (39.3)	1170 (46.1)	997 (39.3)	1170 (46.1)	1230 (48.4)	1430 (56.3)
	Depth	460 (18.1)	535 (21.1)	460 (18.1)	535 (21.1)	460 (18.1)	535 (21.1)
Drive dimensions [mm (in)]	Height	901 (35.5)	1060 (41.7)	909 (35.8)	1122 (44.2)	1004 (39.5)	1268 (49.9)
	Width	325 (12.8)	420 (16.5)	250 (9.8)	350 (13.8)	250 (9.8)	350 (13.8)
	Depth	378 (14.9)	378 (14.9)	375 (14.7)	375 (14.7)	375 (14.7)	375 (14.8)
Maximum weight [kg (lb)]		98 (216)	164 (362)	98 (216)	164 (362)	108 (238)	179 (395)

Table 3.1 Mechanical Dimensions, Enclosure Sizes D1h–D4h

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Enclosure size		D5h	D6h	D7h	D8h
		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 (in)]	Height	660 (26)	660 (26)	660 (26)	660 (26)
	Width	1820 (71.7)	1820 (71.7)	2470 (97.4)	2470 (97.4)
	Depth	510 (20.1)	510 (20.1)	590 (23.2)	590 (23.2)
Drive dimensions [mm (in)]	Height	1324 (52.1)	1663 (65.5)	1978 (77.9)	2284 (89.9)
	Width	325 (12.8)	325 (12.8)	420 (16.5)	420 (16.5)
	Depth	381 (15)	381 (15)	386 (15.2)	406 (16)
Maximum weight [kg (lb)]		116 (256)	129 (284)	200 (441)	225 (496)

Table 3.2 Mechanical Dimensions, Enclosure Sizes D5h–D8h

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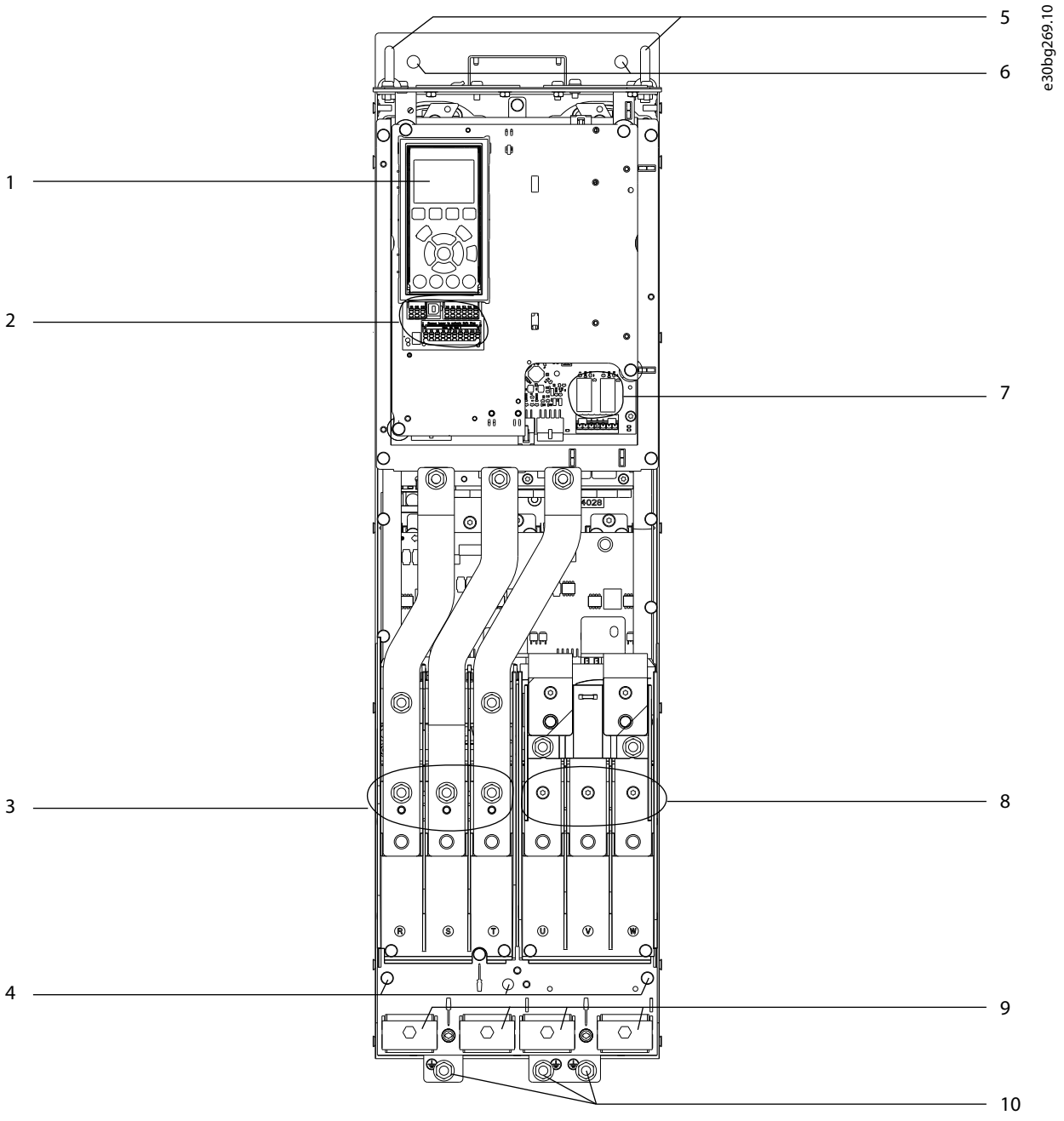
3.3 Interior View of D1h Drive

Illustration 3.1 shows the D1h components relevant to installation and commissioning. The D1h drive interior is similar to that of the D3h, D5h, and D6h drives. Drives with the contactor option also contain a contactor terminal block (TB6). For the location of TB6, see *chapter 5.8 Terminal Dimensions*.



1	LCP (local control panel)	6	Mounting holes
2	Control terminals	7	Relays 1 and 2
3	Mains input terminals 91 (L1), 92 (L2), 93 (L3)	8	Motor output terminals 96 (U), 97 (V), 98 (W)
4	Ground terminals for IP21/54 (Type 1/12)	9	Cable clamps
5	Lifting ring	10	Ground terminals for IP20 (Chassis)

Illustration 3.1 Interior View of D1h Drive (similar to D3h/D5h/D6h)

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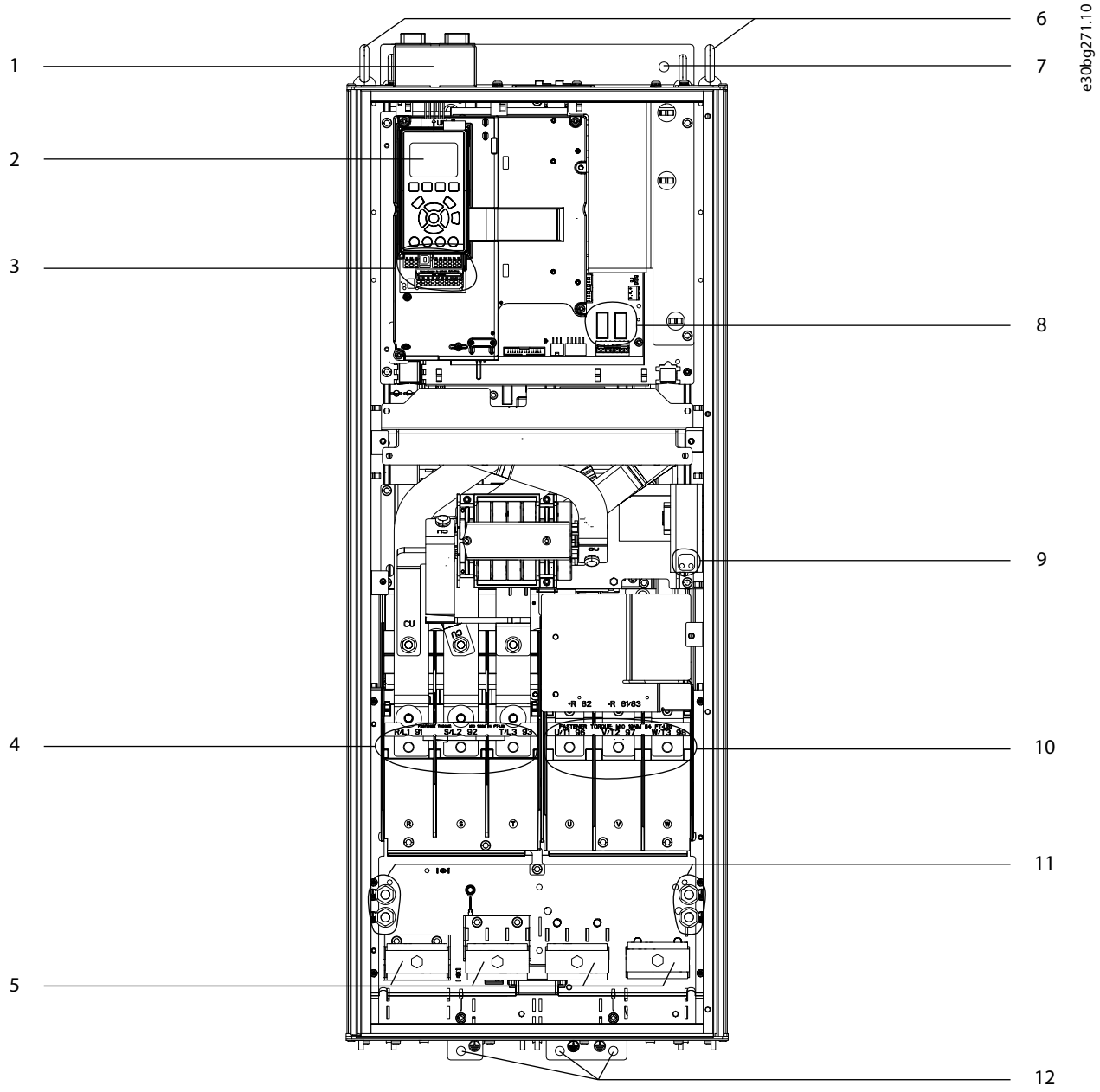
3.4 Interior View of D2h Drive

Illustration 3.2 shows the D2h components relevant to installation and commissioning. The D2h drive interior is similar to that of the D4h, D7h, and D8h drives. Drives with the contactor option also contain a contactor terminal block (TB6). For the location of TB6, see *chapter 5.8 Terminal Dimensions*.

3



1	Fieldbus top entry kit (optional)	7	Mounting hole
2	LCP (local control panel)	8	Relays 1 and 2
3	Control terminals	9	Terminal block for anti-condensation heater (optional)
4	Mains input terminals 91 (L1), 92 (L2), 93 (L3)	10	Motor output terminals 96 (U), 97 (V), 98 (W)
5	Cable clamps	11	Ground terminals for IP21/54 (Type 1/12)
6	Lifting ring	12	Ground terminals for IP20 (Chassis)

Illustration 3.2 Interior View of D2h Drive (Similar to D4h/D7h/D8h)

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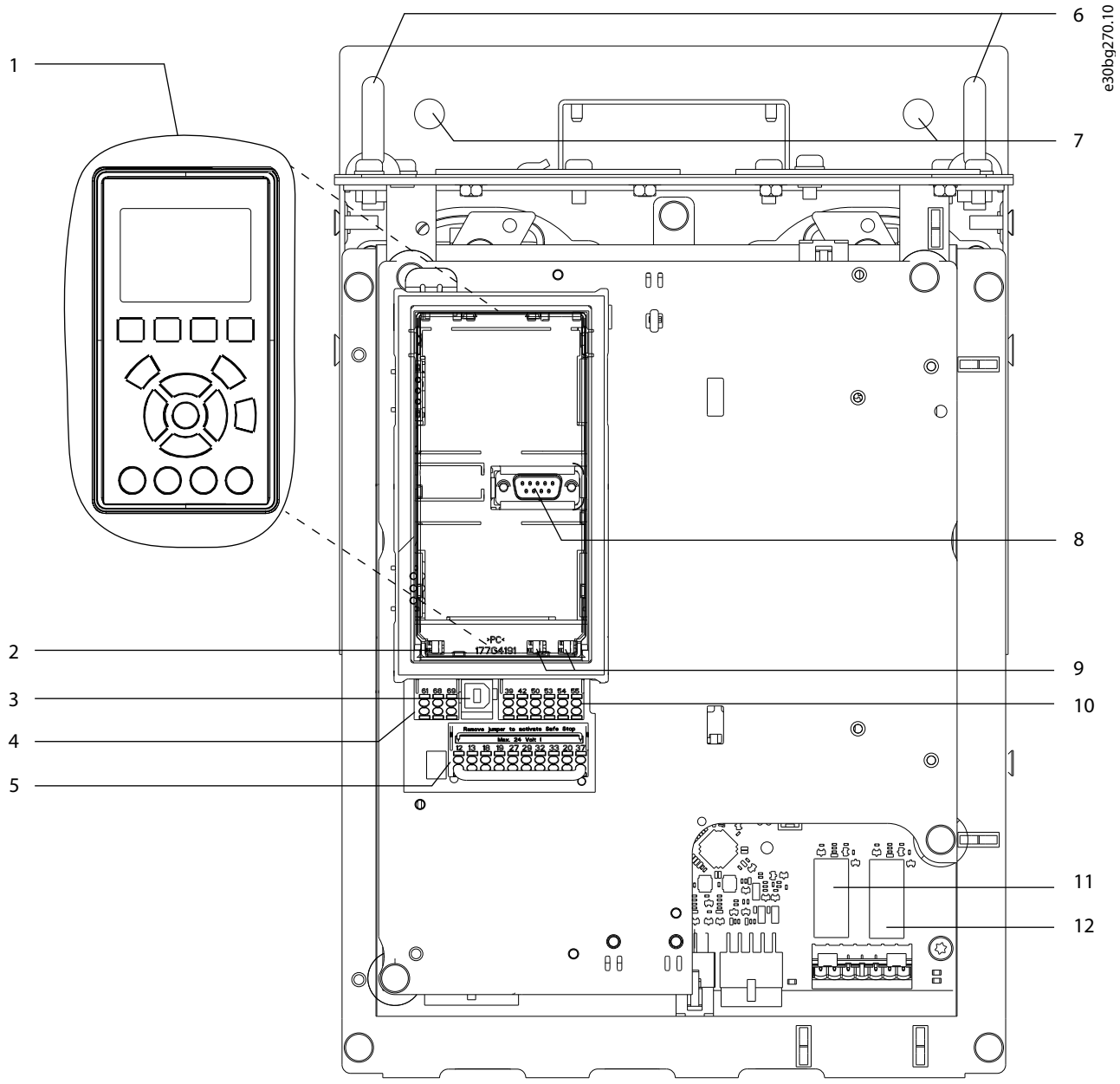
3.5 View of Control Shelf

The control shelf holds the keypad, known as the local control panel or LCP. The control shelf also includes the control terminals, relays, and various connectors.



1	Local control panel (LCP)	7	Mounting holes
2	RS485 termination switch	8	LCP connector
3	USB connector	9	Analog switches (A53, A54)
4	RS485 fieldbus connector	10	Analog I/O connector
5	Digital I/O and 24 V supply	11	Relay 1 (01, 02, 03) on power card
6	Lifting rings	12	Relay 2 (04, 05, 06) on power card

Illustration 3.3 View of Control Shelf

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3.6 Extended Options Cabinets

If a drive is ordered with any of the following options, it is supplied with an extended options cabinet to contain the optional components.

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

Illustration 3.4 shows an example of a drive with an options cabinet. *Table 3.3* lists the variants of the drive that include these options.

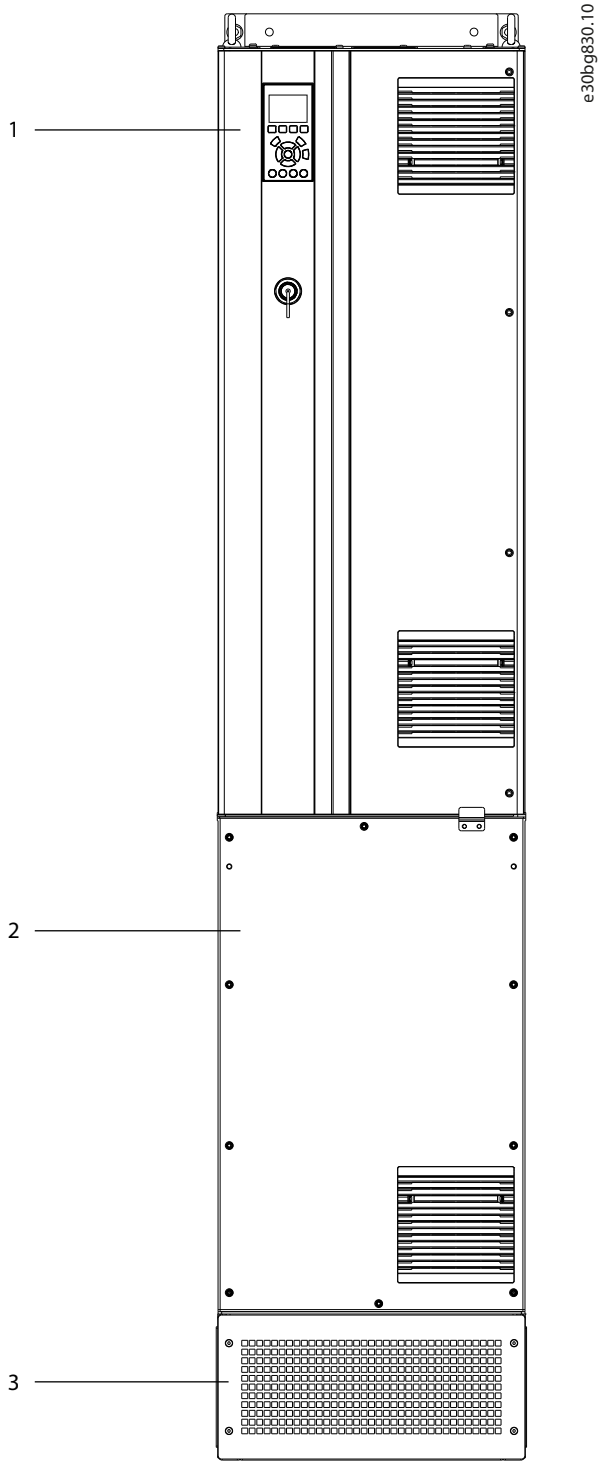
Drive model	Possible options
D5h	Brake, disconnect
D6h	Contactor, contactor with disconnect, circuit breaker
D7h	Brake, disconnect, multiwire kit
D8h	Contactor, contactor with disconnect, circuit breaker, multiwire kit

Table 3.3 Overview of Extended Options

The D7h and D8h drives 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 drive includes a mains disconnect or circuit breaker, the safety latch locks the cabinet door while the drive is energized. Before opening the door, open the disconnect or circuit breaker to de-energize the drive, and remove the cover of the options cabinet.

For drives purchased with a disconnect, contactor or circuit breaker, the nameplate label includes a type code for a replacement drive that does not include the options. If the drive is replaced, it can be replaced independently of the options cabinet.



1	Drive enclosure
2	Extended options cabinet
3	Pedestal

Illustration 3.4 Drive with Extended Options Cabinet (D7h)

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3.7 Local Control Panel (LCP)

The local control panel (LCP) is the combined display and keypad on the front of the drive. The term LCP refers to the graphical LCP. A numeric local control panel (NLCP) is available as an option. The NLCP operates in a manner similar to the LCP, but there are differences. For details on how to use the NLCP, see the product-specific *programming guide*.

Use the LCP to:

- Control the drive and motor.
- Access drive parameters and program the drive.
- Display operational data, drive status, and warnings.

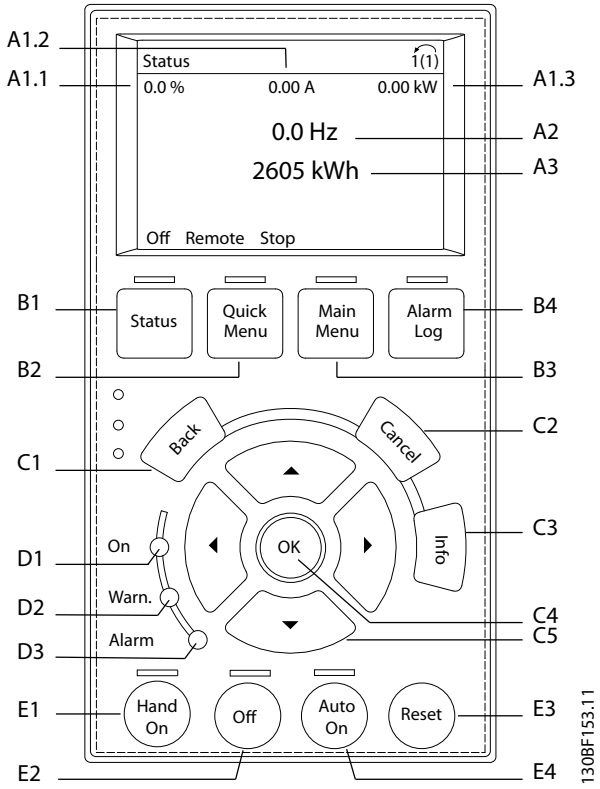

Illustration 3.5 Graphical Local Control Panel (LCP)

A. Display area

Each display readout has a parameter associated with it. See *Table 3.4*. The information shown on the LCP can be customized for specific applications. Refer to *chapter 3.8.1.2 Q1 My Personal Menu*.

Callout	Parameter	Default setting
A1.1	*Parameter 0-20 Display Line 1.1 Small*	Reference [%]
A1.2	*Parameter 0-21 Display Line 1.2 Small*	Motor current [A]
A1.3	*Parameter 0-22 Display Line 1.3 Small*	Power [kW]
A2	*Parameter 0-23 Display Line 2 Large*	Frequency [Hz]
A3	*Parameter 0-24 Display Line 3 Large*	kWh counter

Table 3.4 LCP Display Area

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B. Menu keys

Menu keys are used to access the menu for setting up parameters, toggling through status display modes during normal operation, and viewing fault log data.

Callout	Key	Function
B1	Status	Shows operational information.
B2	Quick Menu	Allows access to parameters for initial set-up instructions. Also provides detailed application steps. Refer to *chapter 3.8.1.1 Quick Menus*.
B3	Main Menu	Allows access to all parameters. Refer to *chapter 3.8.1.8 Main Menu Mode*.
B4	Alarm Log	Shows a list of current warnings and the last 10 alarms.

Table 3.5 LCP Menu Keys

C. Navigation keys

Navigation keys are used for programming functions and moving the display cursor. The navigation keys also provide speed control in local (hand) operation. The display brightness can be adjusted by pressing [Status] and [▲]/[▼] keys.

Callout	Key	Function
C1	Back	Reverts to the previous step or list in the menu structure.
C2	Cancel	Cancels the last change or command as long as the display mode has not changed.
C3	Info	Shows a definition of the function being shown.
C4	OK	Accesses parameter groups or enables an option.
C5	▲ ▼ ◄ ►	Moves between items in the menu.

Table 3.6 LCP Navigation Keys

D. Indicator lights

Indicator lights are used to identify the drive status and to provide a visual notification of warning or fault conditions.

Callout	Indicator	Indicator light	Function
D1	On	Green	Activates when the drive receives power from the mains voltage or a 24 V DC external supply.
D2	Warn.	Yellow	Activates when warning conditions are active. Text appears in the display area identifying the problem.
D3	Alarm	Red	Activates during a fault condition. Text appears in the display area identifying the problem.

Table 3.7 LCP Indicator Lights

E. Operation keys and reset

The operation keys are found toward the bottom of the local control panel.

Callout	Key	Function
E1	Hand on	Starts the drive in local control. An external stop signal by control input or serial communication overrides the local [Hand On].
E2	Off	Stops the motor but does not remove power to the drive.
E3	Reset	Resets the drive manually after a fault has been cleared.
E4	Auto on	Puts the system in remote operational mode so it can respond to an external start command by control terminals or serial communication.

Table 3.8 LCP Operation Keys and Reset

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3.8 LCP Menus

3.8.1.1 Quick Menus

The *Quick Menus* mode provides a list of menus used to configure and operate the drive. Select *Quick Menus* by pressing the [Quick Menu] key. The resulting readout appears on the LCP display.

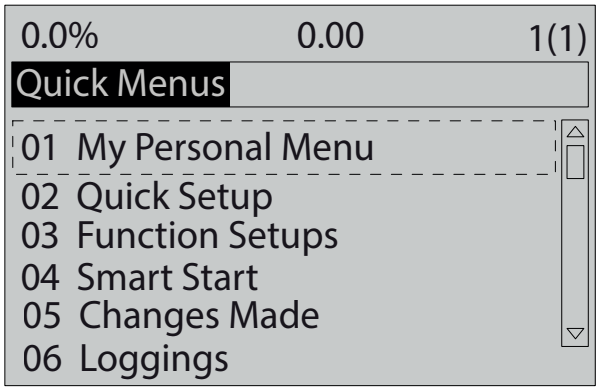


Illustration 3.6 Quick Menu View

3.8.1.2 Q1 My Personal Menu

Use *My Personal Menu* to determine what is shown in the display area. Refer to *chapter 3.7 Local Control Panel (LCP)*. This menu can also show up to 50 pre-programmed parameters. These 50 parameters are manually entered using *parameter 0-25 My Personal Menu*.

3.8.1.3 Q2 Quick Setup

The parameters found in *Q2 Quick Setup* contain basic system and motor data that are always necessary for configuring the drive. See *chapter 7.2.3 Entering System Information* for the set-up procedures.

3.8.1.4 Q4 Smart Setup

Q4 Smart Setup guides the user through typical parameter settings used to configure 1 of the following 3 applications:

- Mechanical brake.
- Conveyor.
- Pump/fan.

The [Info] key can be used to display help information for various selections, settings, and messages.

3.8.1.5 Q5 Changes Made

Select *Q5 Changes Made* for information about:

- The 10 most recent changes.
- Changes made from default setting.

3.8.1.6 Q6 Loggings

Use *Q6 Loggings* for fault finding. To get information about the display line readout, select *Loggings*. The information is shown as graphs. Only parameters selected in *parameter 0-20 Display Line 1.1 Small* through *parameter 0-24 Display Line 3 Large* can be viewed. It is possible to store up to 120 samples in the memory for later reference.

Q6 Loggings	
Parameter 0-20 Display Line 1.1 Small	Reference [%]
Parameter 0-21 Display Line 1.2 Small	Motor current [A]
Parameter 0-22 Display Line 1.3 Small	Power [kW]
Parameter 0-23 Display Line 2 Large	Frequency [Hz]
Parameter 0-24 Display Line 3 Large	kWh Counter

Table 3.9 Logging Parameter Examples

3.8.1.7 Q7 Motor Setup

The parameters found in *Q7 Motor Setup* contain basic and advanced motor data that are always necessary for configuring the drive. This option also includes parameters for encoder set-up.

3.8.1.8 Main Menu Mode

The *Main Menu* mode lists all the parameter groups available to the drive. Select the *Main Menu* mode by pressing the [Main Menu] key. The resulting readout appears on the LCP display.

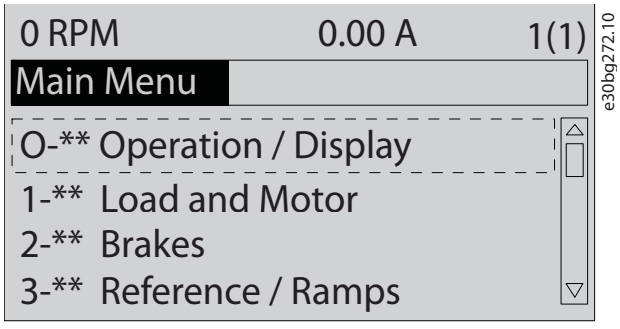


Illustration 3.7 Main Menu View

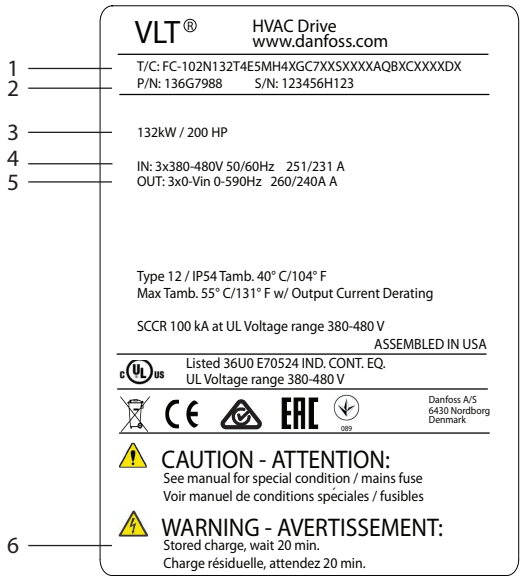
All parameters can be changed in the main menu. Option cards added to the unit enable extra parameters associated with the option device.

4 Mechanical Installation

4.1 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. *Illustration 4.1* and *Illustration 4.2* show sample nameplates for a D-sized drive either with or without an options cabinet.
- Check the packaging and the drive visually for damage caused by inappropriate handling during shipment. File any claim for damage with the carrier. Retain damaged parts for clarification.



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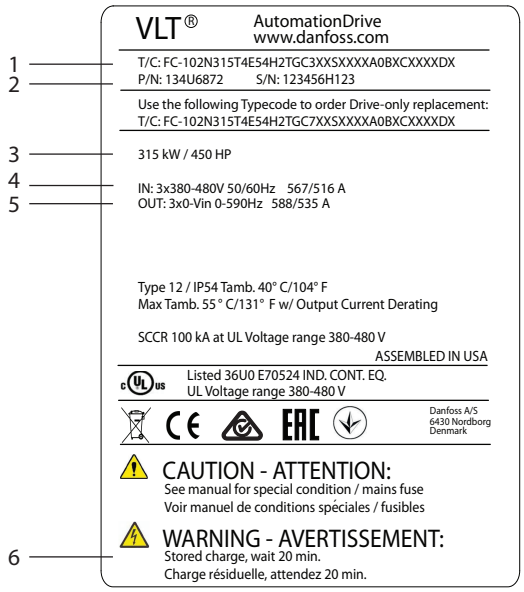
1	Type code
2	Part number and serial number
3	Power rating
4	Input voltage, frequency, and current
5	Output voltage, frequency, and current
6	Discharge time

Illustration 4.1 Example Nameplate for Drive Only (D1h–D4h)



e30bg624.10

1	Type code
2	Part number and serial number
3	Power rating
4	Input voltage, frequency, and current
5	Output voltage, frequency, and current
6	Discharge time

Illustration 4.2 Example Nameplate for Drive with Options Cabinet (D5h-D8h)

NOTICE

LOSS OF WARRANTY

Do not remove the nameplate from the drive. Removing the nameplate can result in loss of warranty.

4.2 Tools Needed

Receiving/unloading

- I-beam and hooks rated to lift the weight of the drive. Refer to *chapter 3.2 Power Ratings, Weight, and Dimensions*.
- Crane or other lifting aid to place the unit into position.

Installation

- Drill with 10 mm (0.39 in) or 12 mm (0.47 in) drill bits.
- Tape measurer.
- Various sizes of Phillips and flat bladed screwdrivers.

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- Wrench with relevant metric sockets (7–17 mm/ 0.28–0.67 in).
- Wrench extensions.
- Torx drives (T25 and T50).
- Sheet metal punch for conduits or cable glands.
- I-beam and hooks to lift the weight of the drive. Refer to *chapter 3.2 Power Ratings, Weight, and Dimensions*.
- Crane or other lifting aid to place the drive onto pedestal and into position.

4.3 Storage

Store the drive in a dry location. Keep the equipment sealed in its packaging until installation. Refer to *chapter 10.4 Ambient Conditions* for recommended ambient temperature.

Periodic forming (capacitor charging) is not necessary during storage unless storage exceeds 12 months.

4.4 Operating Environment

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 drive. Ensure that requirements for humidity, temperature, and altitude are met.

Voltage [V]	Altitude restrictions
200–240	At altitudes above 3000 m (9842 ft), contact Danfoss regarding PELV.
380–480	At altitudes above 3000 m (9842 ft), contact Danfoss regarding PELV.
525–690	At altitudes above 2000 m (6562 ft), contact Danfoss regarding PELV.

Table 4.1 Installation at High Altitudes

For detailed ambient conditions specifications, refer to *chapter 10.4 Ambient Conditions*.

NOTICE

CONDENSATION

Moisture can condense on the electronic components and cause short circuits. Avoid installation in areas subject to frost. Install an optional space heater when the drive is colder than the ambient air. Operating in standby mode reduces the risk of condensation as long as the power dissipation keeps the circuitry free of moisture.

NOTICE

EXTREME AMBIENT CONDITIONS

Hot or cold temperatures compromise unit performance and longevity.

- **Do not operate in environments where the ambient temperature exceeds 55 °C (131 °F).**
- **The drive can operate at temperatures down to -10 °C (14 °F). However, proper operation at rated load is only guaranteed at 0 °C (32 °F) or higher.**
- **If temperature exceeds ambient temperature limits, extra air conditioning of the cabinet or installation site is required.**

4.4.1 Gases

Aggressive gases, such as hydrogen sulfide, chlorine, or ammonia can damage the electrical and mechanical components. The unit uses conformal-coated circuit boards to reduce the effects of aggressive gases. For conformal-coating class specifications and ratings, see *chapter 10.4 Ambient Conditions*.

4.4.2 Dust

When installing the drive in dusty environments, pay attention to the following:

Periodic maintenance

When dust accumulates on electronic components, it acts as a layer of insulation. This layer reduces the cooling capacity of the components, and the components become warmer. The hotter environment decreases the life of the electronic components.

Keep the heat sink and fans free from dust buildup. For more service and maintenance information, refer to *chapter 9 Maintenance, Diagnostics, and Troubleshooting*.

Cooling fans

Fans provide airflow to cool the drive. When fans are exposed to dusty environments, the dust can damage the fan bearings and cause premature fan failure. Also, dust can accumulate on fan blades causing an imbalance which prevents the fans from properly cooling the unit.

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4.4.3 Potentially Explosive Atmospheres

⚠WARNING

EXPLOSIVE ATMOSPHERE

Do not install the drive in a potentially explosive atmosphere. Install the unit in a cabinet outside of this area. Failure to follow this guideline increases risk of death or serious injury.

4

Systems operated in potentially explosive atmospheres must fulfill special conditions. EU Directive 94/9/EC (ATEX 95) classifies the operation of electronic devices in potentially explosive atmospheres.

- Class d specifies that if a spark occurs, it is contained in a protected area.
- Class e prohibits any occurrence of a spark.

Motors with class d protection
Do not require approval. Special wiring and containment are required.

Motors with class e protection
When combined with an ATEX–approved PTC monitoring device like the VLT® PTC Thermistor Card MCB 112, the installation does not need an individual approval from an approbated organization.

Motors with class d/e protection
The motor itself has an e ignition protection class, while the motor cabling and connection environment is in compliance with the d classification. To attenuate the high peak voltage, use a sine-wave filter at the drive output.

When using a drive in a potentially explosive atmosphere, use the following:

- Motors with ignition protection class d or e.
- PTC temperature sensor to monitor the motor temperature.
- Short motor cables.
- Sine-wave output filters when shielded motor cables are not used.

NOTICE

MOTOR THERMISTOR SENSOR MONITORING

Drives with the VLT® PTC Thermistor Card MCB 112 option are PTB-certified for potentially explosive atmospheres.

4.5 Installation and Cooling Requirements

NOTICE

MOUNTING PRECAUTIONS

Improper mounting can result in overheating and reduced performance. Observe all installation and cooling requirements.

Installation requirements

- Ensure unit stability by mounting vertically to a solid flat surface.
- Ensure that the strength of the mounting location supports the unit weight. Refer to *chapter 3.2 Power Ratings, Weight, and Dimensions*.
- Ensure that the mounting location allows access to open the enclosure door. See *chapter 10.9 Enclosure Dimensions*.
- Ensure that there is adequate space around the unit for cooling airflow.
- Place the unit as near to the motor as possible. Keep the motor cables as short as possible. See *chapter 10.5 Cable Specifications*.
- Ensure that the location allows for cable entry at the bottom of the unit.

Cooling and airflow requirements

- 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 product-specific *design guide* for detailed information.

The drive uses back-channel cooling to circulate the heat sink cooling air. The cooling duct carries approximately 90% of the heat out of the back channel of the drive. Redirect the back-channel air from the panel or room by using:

- Duct cooling. Back-channel cooling kits are available to direct the air away from the panel when an IP20/chassis drive is installed in a Rittal enclosure. Use of a 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.

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NOTICE

One or more door fans are required on the enclosure to remove heat not contained in the back channel of the drive. The fans also remove any additional losses generated by other components inside the drive.

Ensure that the fans supply adequate airflow over the heat sink. To select the appropriate number of fans, calculate the total required airflow. The flow rate is shown in *Table 4.2*.

Enclosure size	Door fan/top fan	Power size	Heat sink fan
D1h/D3h/D5h/D6h	102 m^3/hr (60 CFM)	90–110 kW, 380–480 V	420 m^3/hr (250 CFM)
		75–132 kW, 525–690 V	420 m^3/hr (250 CFM)
		132 kW, 380–480 V	840 m^3/hr (500 CFM)
		All, 200–240 V	840 m^3/hr (500 CFM)
D2h/D4h/D7h/D8h	204 m^3/hr (120 CFM)	160 kW, 380–480 V	420 m^3/hr (250 CFM)
		160 kW, 525–690 V	420 m^3/hr (250 CFM)
		All, 200–240 V	840 m^3/hr (500 CFM)

Table 4.2 Airflow

4.6 Lifting the Drive

Always lift the drive using the dedicated eye bolts at the top of the drive. See *Illustration 4.3*.

⚠WARNING

HEAVY LOAD

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

- **Move the unit using a hoist, crane, forklift, or other lifting device with the appropriate weight rating. See *chapter 3.2 Power Ratings, Weight, and Dimensions* for the weight of the drive.**
- **Failure to locate the center of gravity and correctly position the load can cause unexpected shifting during lifting and transport. For measurements and center of gravity, see *chapter 10.9 Enclosure Dimensions*.**
- **The angle from the top of the drive module to the lifting cables affects the maximum load force on the cable. This angle must be 65° or greater. Refer to *Illustration 4.3*. Attach and dimension the lifting cables properly.**
- **Never walk under suspended loads.**
- **To guard against injury, wear personal protective equipment such as gloves, safety glasses, and safety shoes.**

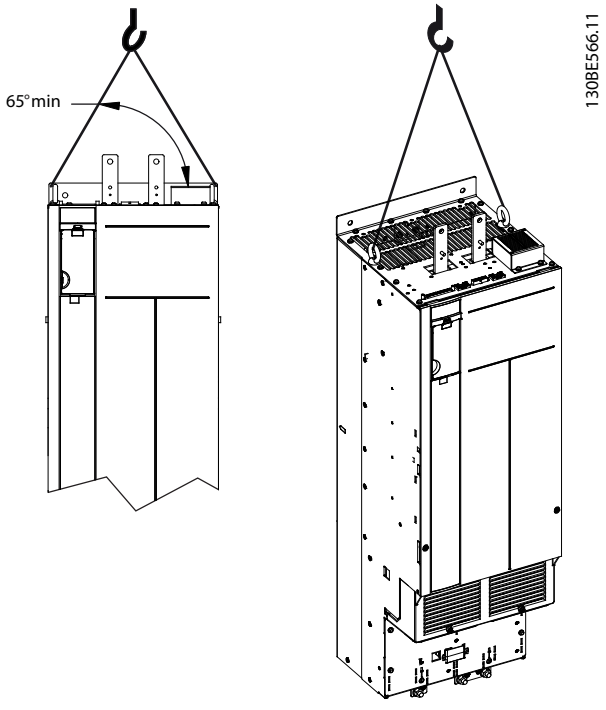


Illustration 4.3 Lifting the Drive

4.7 Mounting the Drive

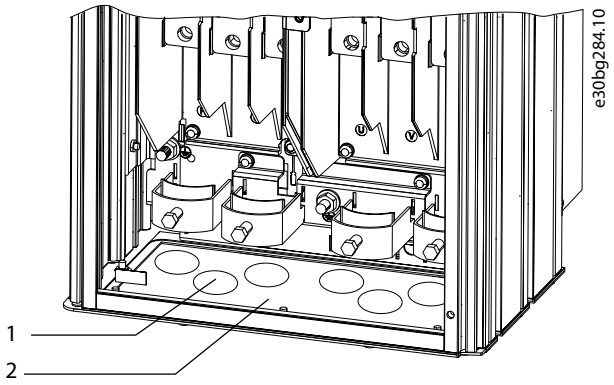
Depending on the drive model and configuration, the drive can floor-mounted or wall-mounted.

Drive models D1h–D2h and D5h–D8h can be floor mounted. Floor-mounted drives require space below the drive for airflow. To provide this space, the drives can be mounted on a pedestal. The D7h and D8h drives come with a standard pedestal. Optional pedestal kits are available for other D-sized drives.

Drives in enclosure sizes D1h–D6h can be wall-mounted. Drive models D3h and D4h are P20/Chassis drives, which can be mounted on a wall or on a mounting plate within a cabinet.

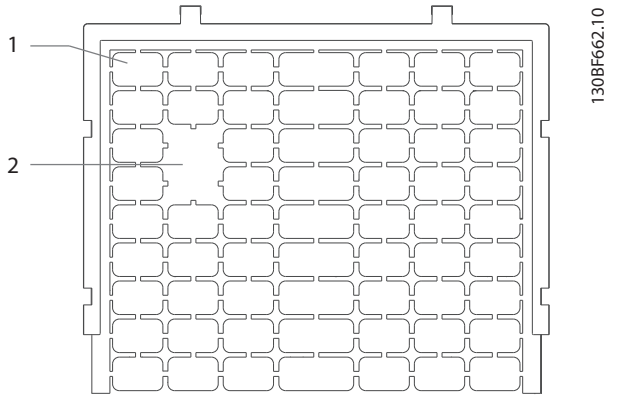
Creating cable openings
Before attaching the pedestal or mounting the drive, create cable openings in the gland plate and install it at the bottom of the drive. The gland plate provides access for AC mains and motor cable entry while maintaining IP21/IP54 (Type 1/Type 12) protection ratings. For gland plate dimensions, see *chapter 10.9 Enclosure Dimensions*.

- If the gland plate is a metal plate, punch cable entry holes in the plate with a sheet metal punch. Insert cable fittings into the holes. See *Illustration 4.4*.
- If the gland plate is plastic, punch out plastic tabs to accommodate the cables. See *Illustration 4.5*.



1	Cable entry hole
2	Metal gland plate

Illustration 4.4 Cable Openings in Sheet Metal Gland Plate



1	Plastic tabs
2	Tabs removed for cable access

Illustration 4.5 Cable Openings in Plastic Gland Plate

Attaching the drive to the pedestal
To install a standard pedestal, use the following steps. To install an optional pedestal kit, refer to the instructions that shipped with the kit. See *Illustration 4.6*.

1. Unfasten 4 M5 screws, and remove the pedestal front cover plate.
2. Secure 2 M10 nuts over the threaded studs at the back of the pedestal, securing it to the drive back channel.
3. Fasten 2 M5 screws through the back flange of the pedestal into the pedestal mounting bracket on the drive.
4. Fasten 4 M5 screws through the front flange of the pedestal and into the gland plate mounting holes.

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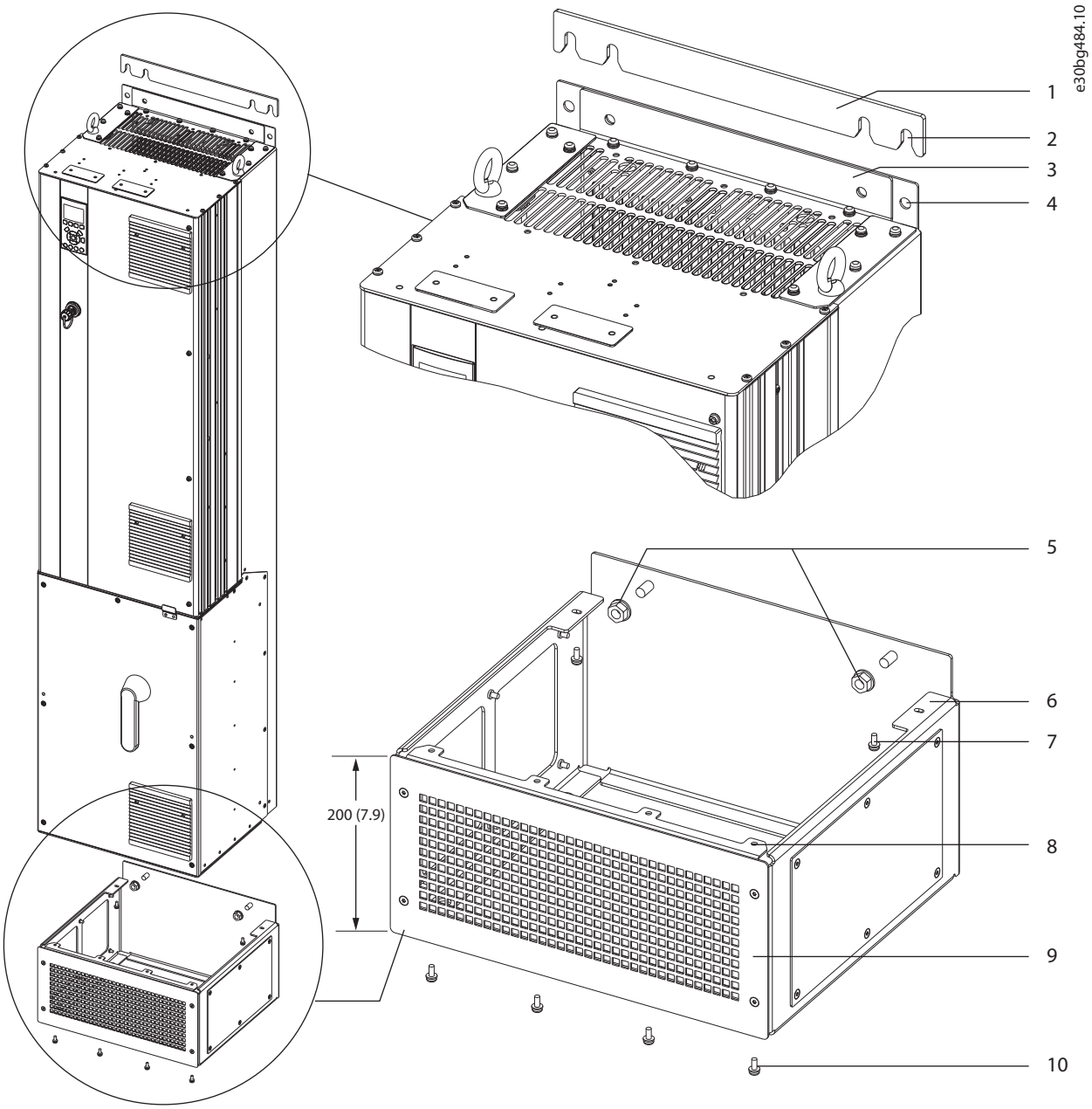

1	Pedestal wall spacer	6	Back flange of pedestal
2	Fastener slots	7	M5 screw (fasten through back flange)
3	Mounting flange at drive top	8	Front flange of pedestal
4	Mounting holes	9	Front cover plate of pedestal
5	M10 nuts (fasten to threaded posts)	10	M5 screw (fasten through front flange)

Illustration 4.6 Pedestal Installation in D7h/D8h Drives

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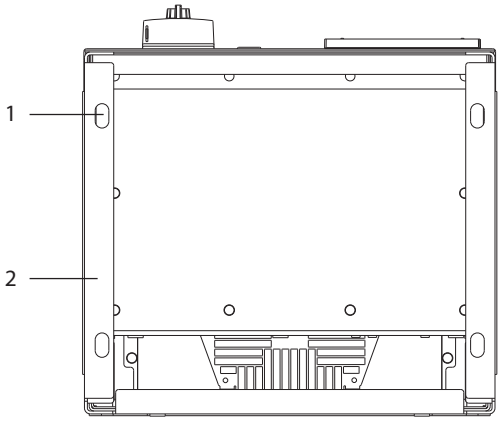
4

Floor mounting the drive

To secure the pedestal to the floor (after attaching the drive to the pedestal), use the following steps.

1. Fasten 4 M10 bolts in the mounting holes at the bottom of the pedestal, securing it to the floor. See *Illustration 4.7*.
2. Reposition the pedestal front cover plate, and fasten with 4 M5 screws. See *Illustration 4.6*.
3. Slide the pedestal wall spacer behind the mounting flange at the top of the drive. See *Illustration 4.6*.
4. Fasten 2–4 M10 bolts in the mounting holes at the top of the drive, securing it to the wall. Use 1 bolt for each mounting hole. The number varies with enclosure size. See *Illustration 4.6*.



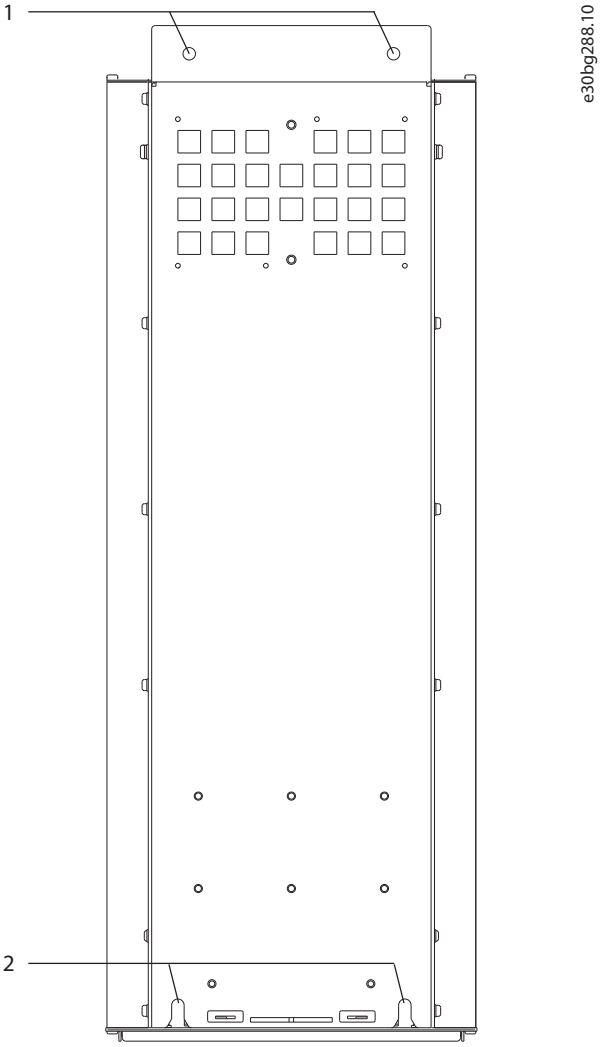
1	Mounting holes
2	Bottom of pedestal

Illustration 4.7 Pedestal-to-floor Mounting Holes

Wall mounting the drive

To wall mount a drive, use the following steps. Refer to *Illustration 4.8*.

1. Fasten 2 M10 bolts in the wall to align with the fastener slots at the bottom of drive.
2. Slide the fastener slots over the M10 bolts.
3. Tip the drive against the wall, and secure the top with 2 M10 bolts in the mounting holes.



1	Top mounting holes
2	Lower fastener slots

Illustration 4.8 Drive-to-wall Mounting Holes

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5 Electrical Installation

5.1 Safety Instructions

See *chapter 2 Safety* for general safety instructions.

⚠WARNING

INDUCED VOLTAGE

Induced voltage from output motor cables from different drives that are 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.**
- **Simultaneously lock out all the drives.**

⚠WARNING

SHOCK HAZARD

The drive can cause a DC current in the ground conductor and thus result in death or serious injury.

- **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.**

Failure to follow the recommendation means that the RCD cannot provide the intended protection.

Overcurrent protection

- Additional protective equipment such as short-circuit protection or motor thermal protection between drive and motor is required for applications with multiple motors.
- Input fusing is required to provide short circuit and overcurrent protection. If fuses are not factory-supplied, the installer must provide them. See maximum fuse ratings in *chapter 10.7 Fuses and Circuit Breakers*.

Wire type and ratings

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

See *chapter 10.5 Cable Specifications* for recommended wire sizes and types.

⚠CAUTION

PROPERTY DAMAGE

Protection against motor overload is not included in the default setting. To add this function, set *parameter 1-90 Motor Thermal Protection* to *[ETR trip]* or *[ETR warning]*. For the North American market, the ETR function provides class 20 motor overload protection in accordance with NEC. Failure to set *parameter 1-90 Motor Thermal Protection* to *[ETR trip]* or *[ETR warning]* means that motor overload protection is not provided and, if the motor overheats, property damage can occur.

5.2 EMC-compliant Installation

To obtain an EMC-compliant installation, follow the instructions provided in:

- *Chapter 5.3 Wiring Schematic*.
- *Chapter 5.4 Connecting to Ground*.
- *Chapter 5.5 Connecting the Motor*.
- *Chapter 5.6 Connecting the AC Mains*.

NOTICE

TWISTED SHIELD ENDS (PIGTAILS)

Twisted shield ends (pigtails) increase the shield impedance at higher frequencies, reducing the shield effect and increasing the leakage current. To avoid twisted shield ends, use integrated shield clamps.

- For use with relays, control cables, a signal interface, fieldbus, or brake, connect the shield to the enclosure at both ends. If the ground path has high impedance, is noisy, or is carrying current, break the shield connection on 1 end to avoid ground current loops.
- Convey the currents back to the unit using a metal mounting plate. Ensure good electrical contact from the mounting plate through the mounting screws to the drive chassis.
- Use shielded cables for motor output cables. An alternative is unshielded motor cables within metal conduit.

NOTICE

SHIELDED CABLES

If shielded cables or metal conduits are not used, the unit and the installation do not meet regulatory limits on radio frequency (RF) emission levels.

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- Ensure that motor and brake cables are as short as possible to reduce the interference level from the entire system.
- Avoid placing cables with a sensitive signal level alongside motor and brake cables.
- For communication and command/control lines, follow the particular communication protocol standards. Danfoss recommends use of shielded cables.
- Ensure that all control terminal connections are PELV.

5

NOTICE

EMC INTERFERENCE

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

NOTICE

INSTALLATION AT HIGH ALTITUDE

There is a risk of overvoltage. Isolation between components and critical parts could be insufficient, and not comply with PELV requirements. Reduce the risk of overvoltage by using external protective devices or galvanic isolation.
For installations above 2000 m (6500 ft) altitude, contact Danfoss regarding PELV compliance.

NOTICE

PELV COMPLIANCE

Prevent electric shock by using protective extra low voltage (PELV) electrical supply and complying with local and national PELV regulations.

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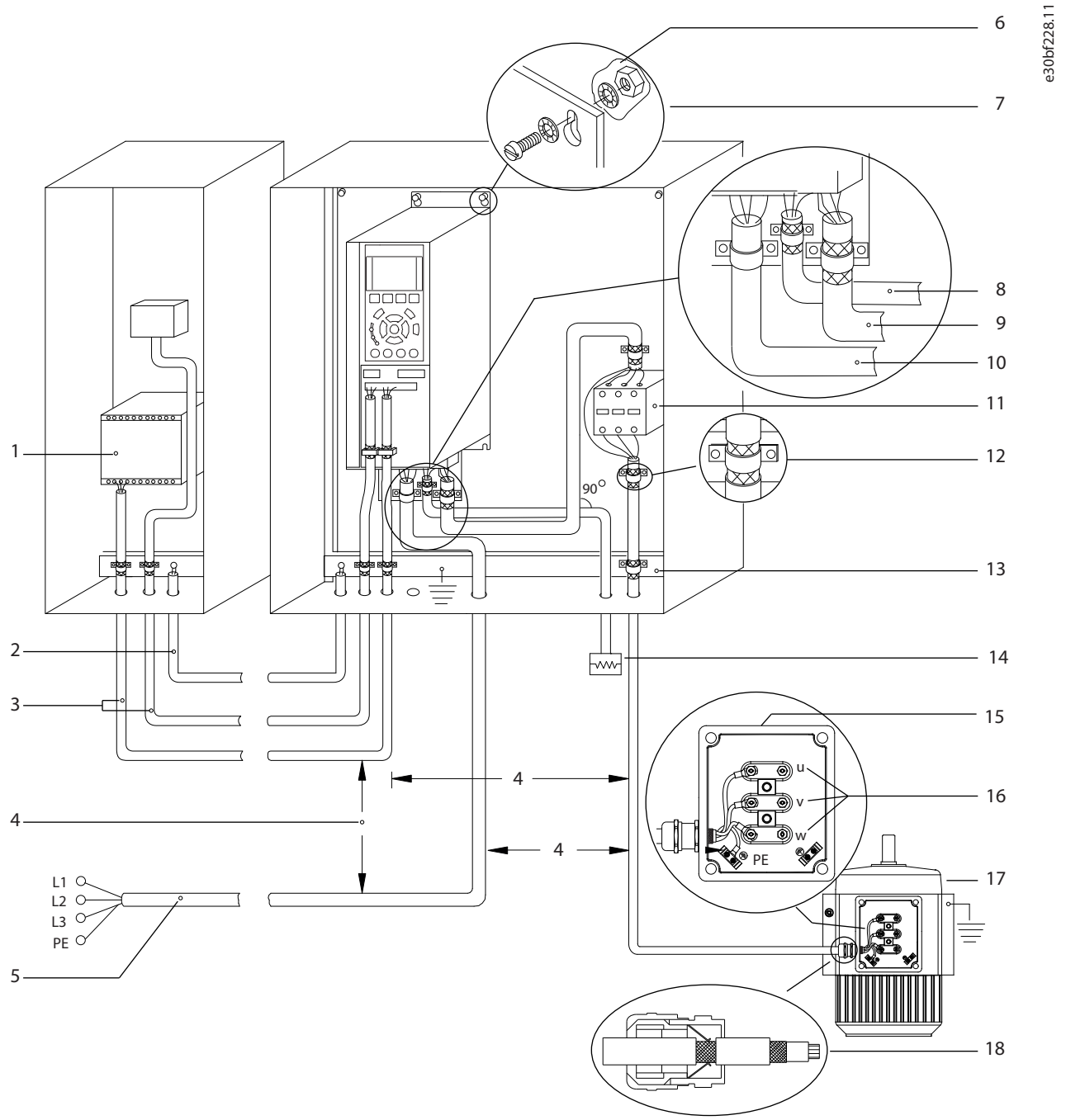

1	PLC	10	Mains cable (unshielded)
2	Minimum 16 mm^2 (6 AWG) equalizing cable	11	Output contactor and similar options
3	Control cables	12	Cable insulation stripped
4	Required minimum separation of 200 mm (7.9 in) between control cables, motor cables, and mains cables	13	Common ground busbar (Follow local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

Illustration 5.1 Example of Proper EMC Installation

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5.3 Wiring Schematic

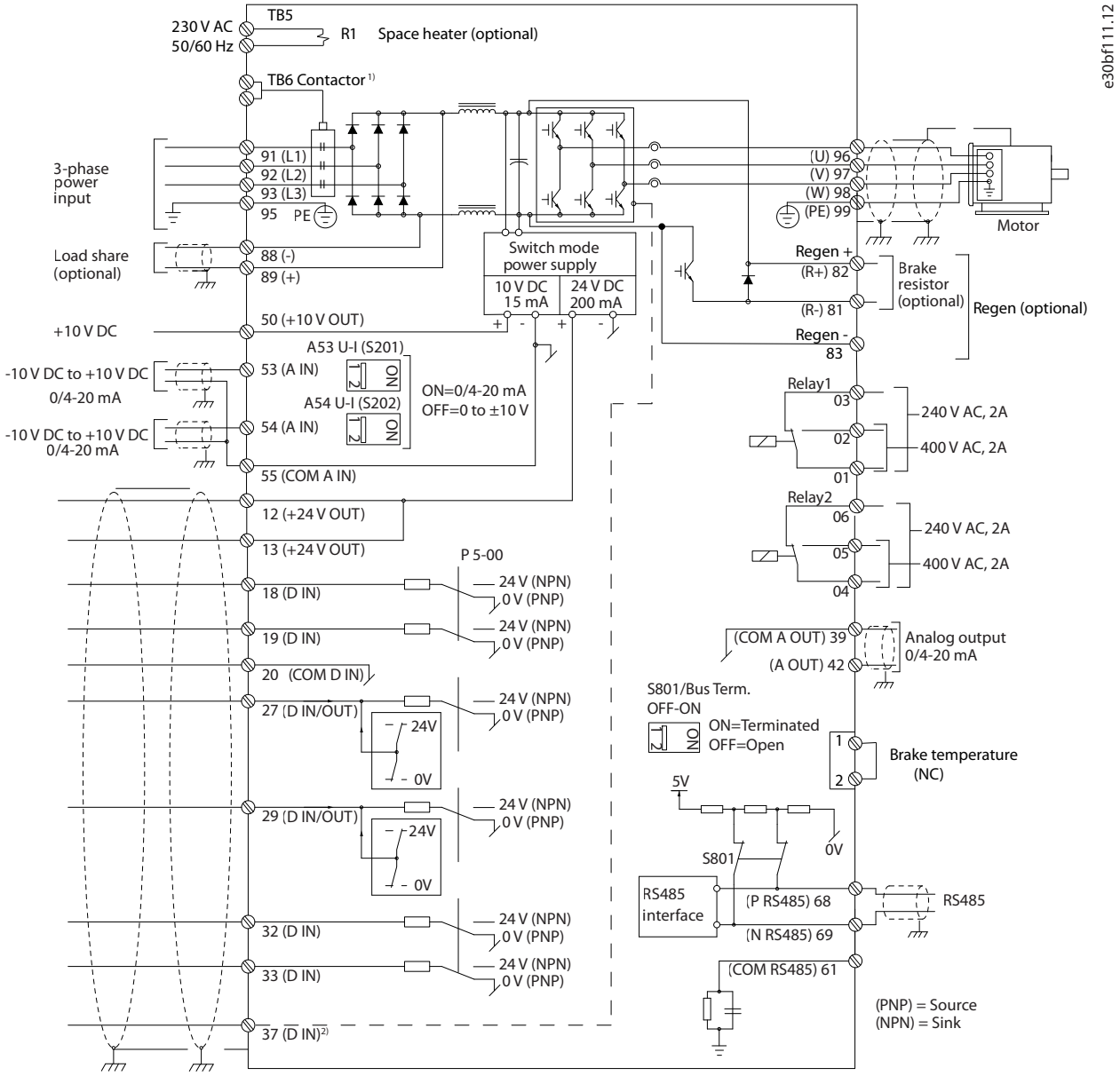

Illustration 5.2 Basic Wiring Schematic

1) TB6 contactor is found only in D6h and D8h drives with a contactor option.

2) Terminal 37 (optional) is used for Safe Torque Off. Refer to the VLT® FC Series - Safe Torque Off Operating Guide for installation instructions.

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5.4 Connecting to Ground

⚠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 drive in accordance with applicable standards and directives.
- Use a dedicated ground wire for input power, motor power, and control wiring.
- Do not ground 1 drive 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 *chapter 10.8.1 Fastener Torque Ratings*.

For EMC-compliant installation

- Establish electrical contact between the cable shield and the drive 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 twisted shield ends (pigtails).

NOTICE

POTENTIAL EQUALIZATION

There is a risk of burst transient when the ground potential between the drive 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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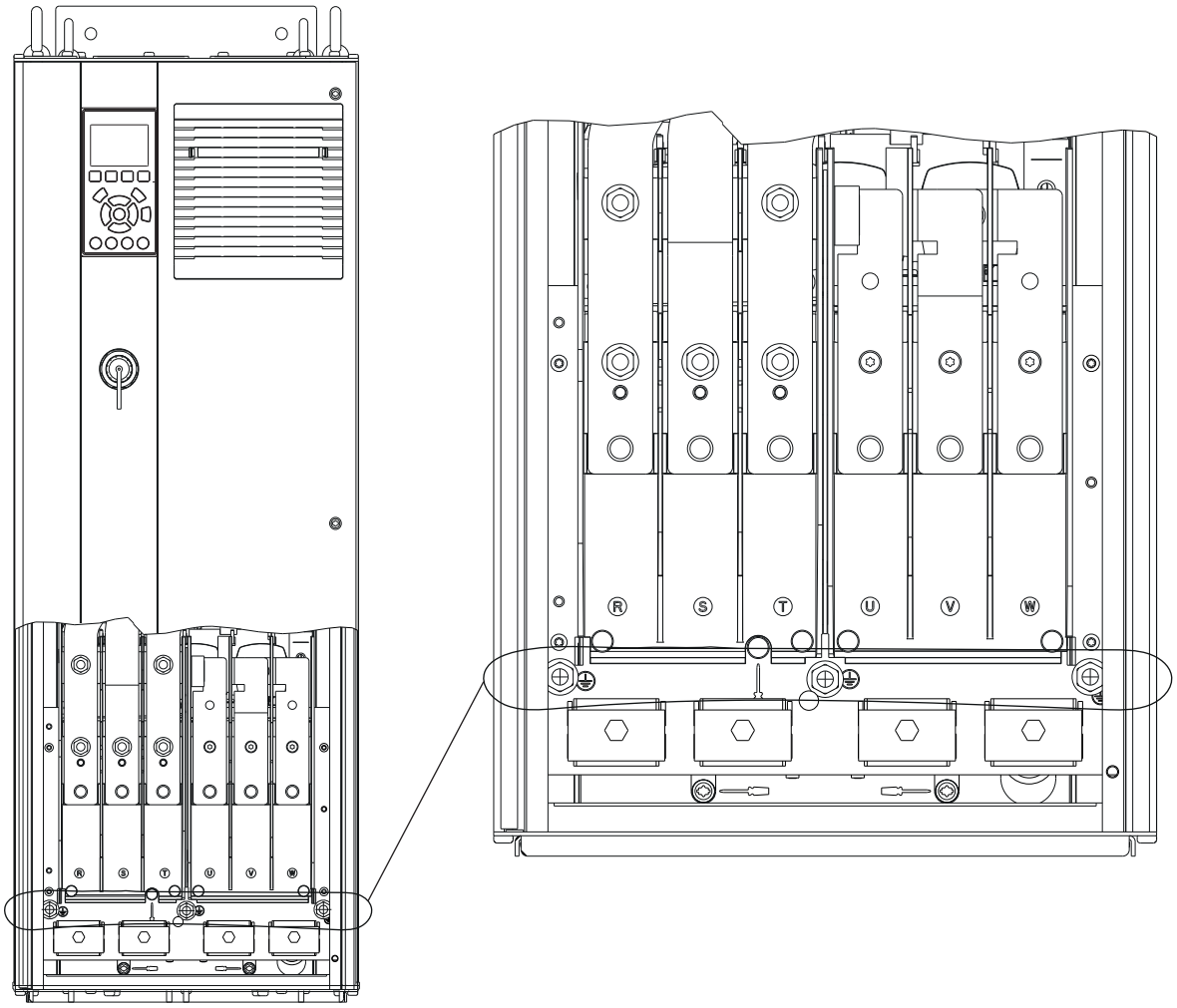

Illustration 5.3 Ground Terminals (D1h shown)

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5.5 Connecting the Motor

⚠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 10.5 Cable Specifications*.
- 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 drive and the motor.

Procedure

1. Strip a section of the outer cable insulation.
2. Position the stripped wire under the cable clamp, establishing 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 5.4 Connecting to Ground*. See *Illustration 5.4*.
4. Connect the 3-phase motor wiring to terminals 96 (U), 97 (V), and 98 (W). See *Illustration 5.4*.
5. Tighten the terminals in accordance with the information provided in *chapter 10.8.1 Fastener Torque Ratings*.

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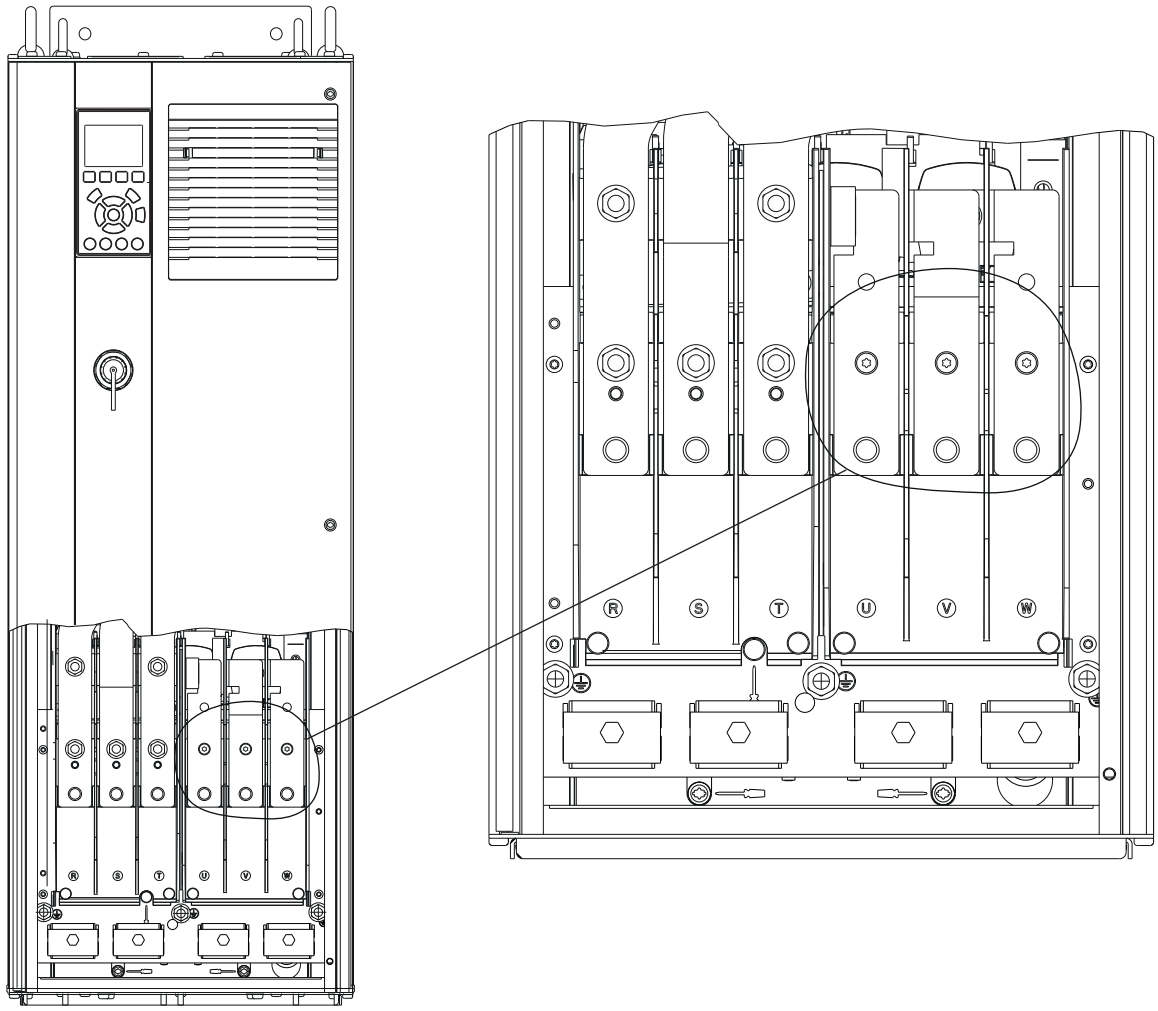

Illustration 5.4 Motor Terminals (D1h shown)

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5.6 Connecting the AC Mains

- Size the wiring according to the input current of the drive. For maximum wire sizes, see *chapter 10.1 Electrical Data*.
- Comply with local and national electrical codes for cable sizes.

Procedure

1. Strip a section of the outer cable insulation.
2. Position the stripped wire under the cable clamp, establishing 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 5.4 Connecting to Ground*.
4. Connect the 3-phase AC input power wiring to terminals R, S, and T. See *Illustration 5.5*.
5. Tighten the terminals in accordance with the information provided in *chapter 10.8.1 Fastener Torque Ratings*.
6. 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* to avoid damage to the DC link and to reduce ground capacity currents.

NOTICE

OUTPUT CONTACTOR

Danfoss does not recommend using an output contactor on 525–690 V drives that are connected to an IT mains network.

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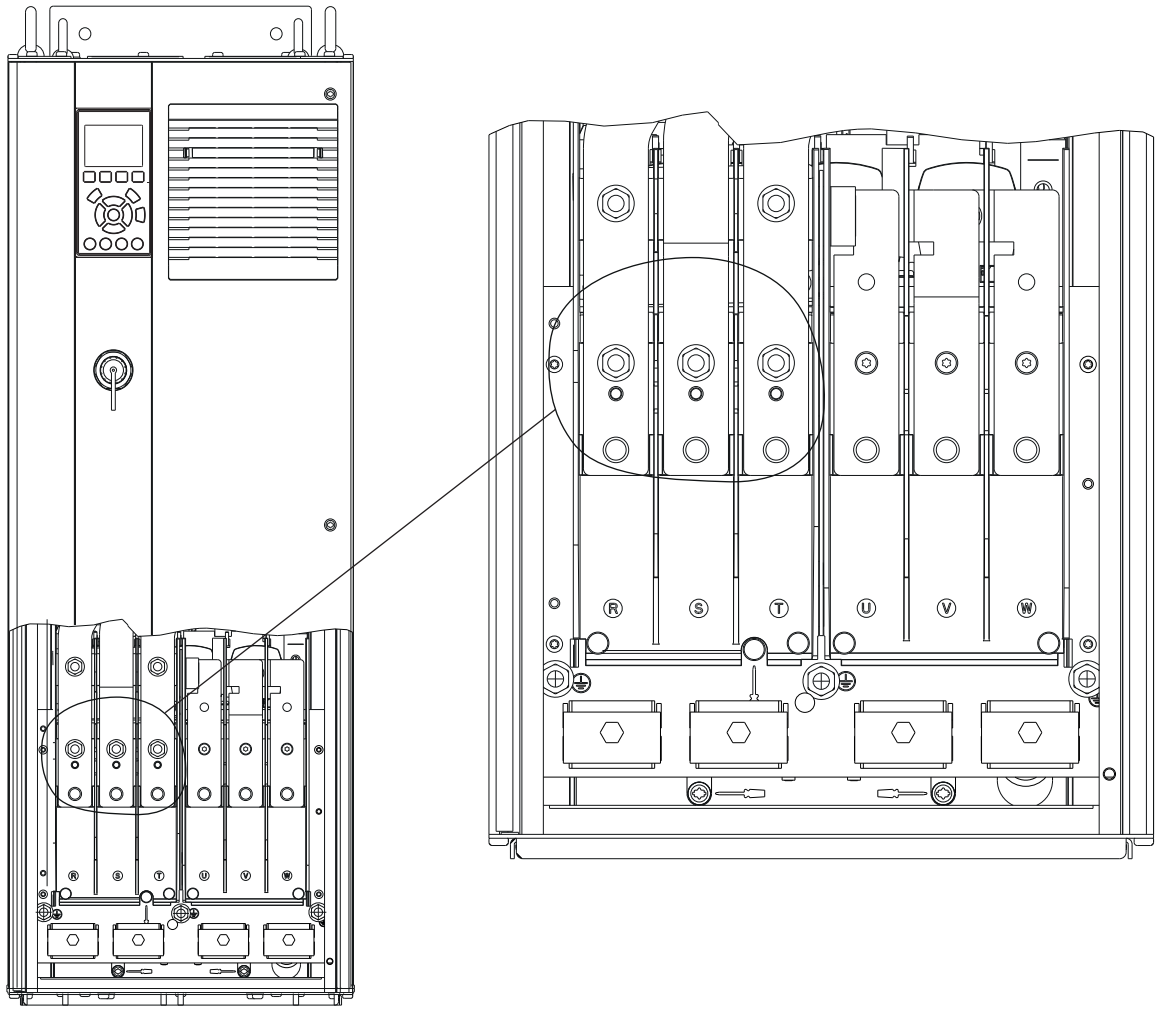

Illustration 5.5 AC Mains Terminals (D1h shown). For a detailed view of terminals, see *chapter 5.8 Terminal Dimensions*.

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5.7 Connecting Regen/Load Share Terminals

The optional regeneration/load share terminals are found at the top of the drive. For drives with IP21/IP54 enclosures, the wiring is routed through a cover surrounding the terminals. Refer to *Illustration 5.5*.

- Size the wiring according to the current of the drive. For maximum wire sizes, see *chapter 10.1 Electrical Data*.
- Comply with local and national electrical codes for cable sizes.

Procedure

1. Remove 2 plugs (for either top entry or side entry) from the terminal cover.
2. Insert cable fittings into the terminal cover holes.
3. Strip a section of the outer cable insulation.
4. Position the stripped cable through the fittings.
5. Connect the DC(+) cable to the DC(+) terminal, and secure with 1 M10 fastener.
6. Connect the DC(-) cable to the DC(-) terminal, and secure with 1 M10 fastener.
7. Tighten the terminals in accordance with *chapter 10.8.1 Fastener Torque Ratings*.

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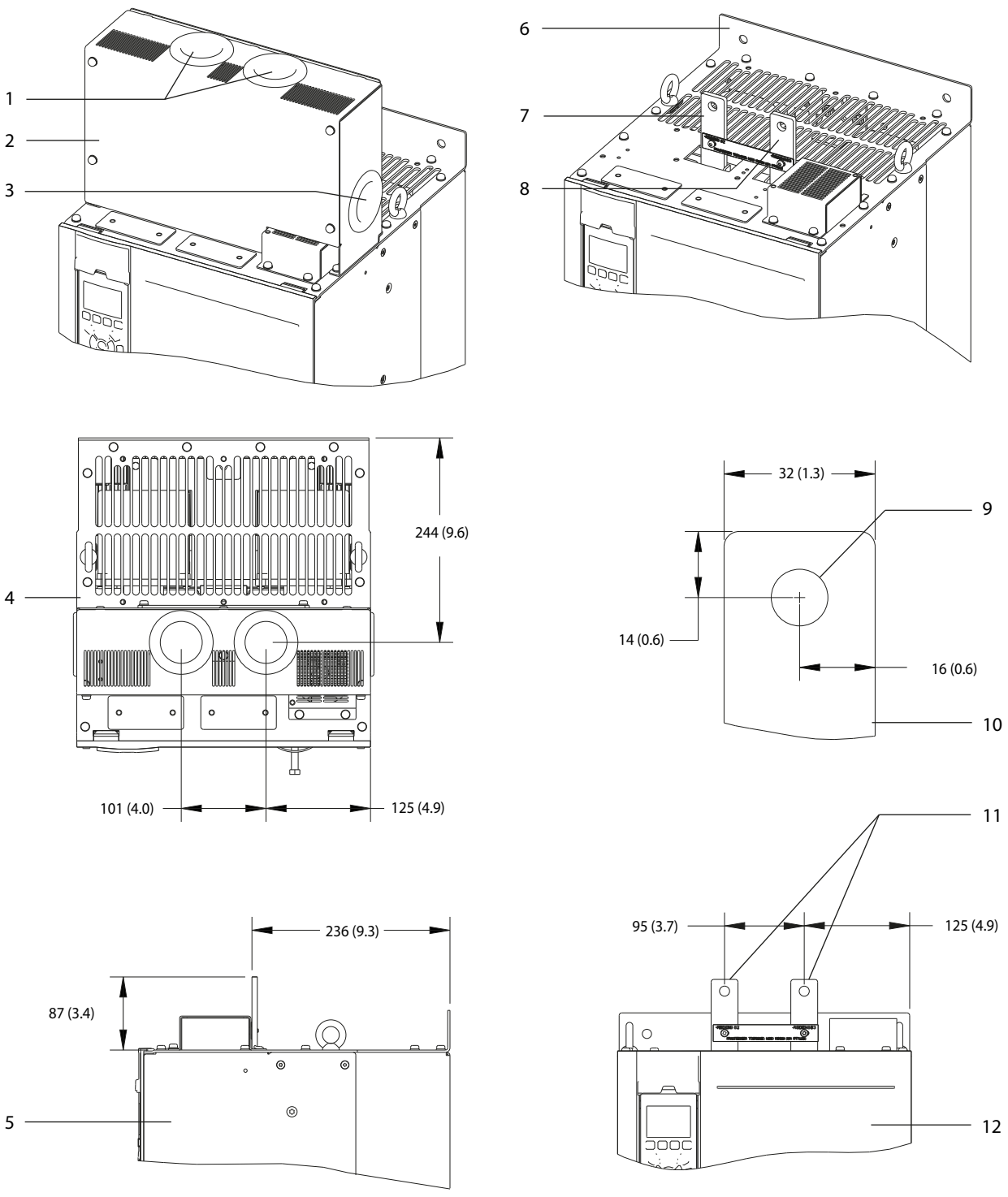
5



1	Top openings for regen/load share terminals	7	DC(+) terminal
2	Terminal cover	8	DC(-) terminal
3	Side opening for regen/load share terminals	9	Hole for M10 fastener
4	Top view	10	Close-up view
5	Side view	11	Regen/load share terminals
6	View without cover	12	Front view

Illustration 5.6 Regen/Load Share Terminals in Enclosure Size D

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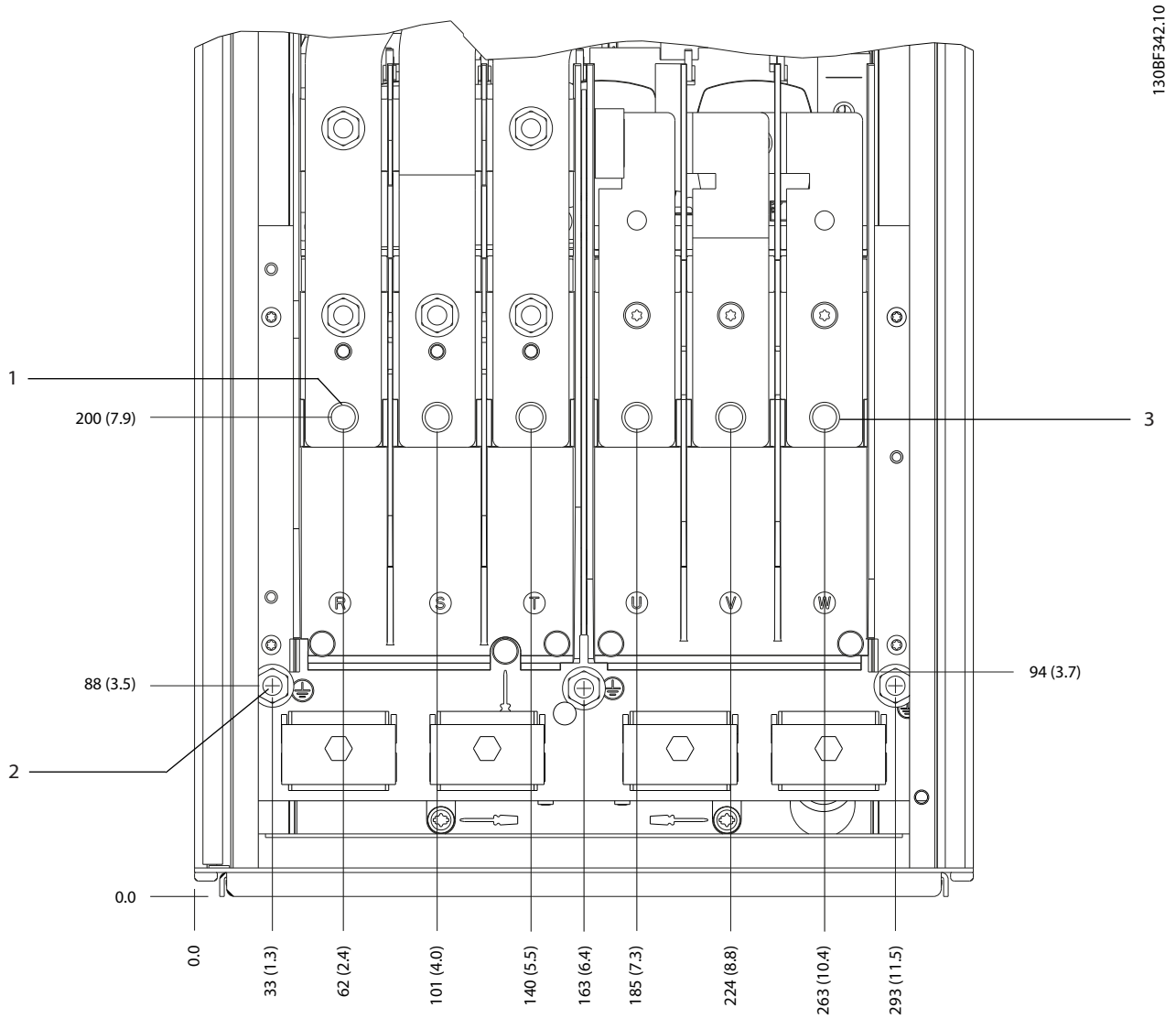
5.8 Terminal Dimensions

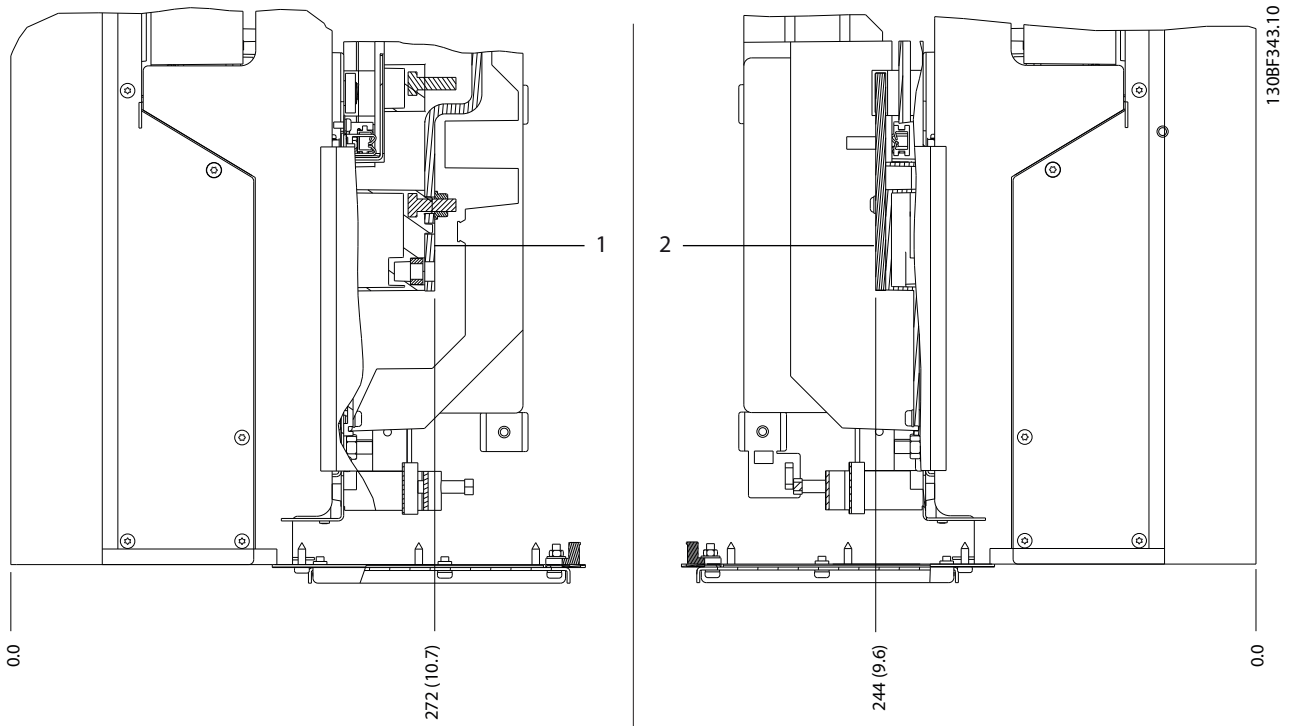
5.8.1 D1h Terminal Dimensions

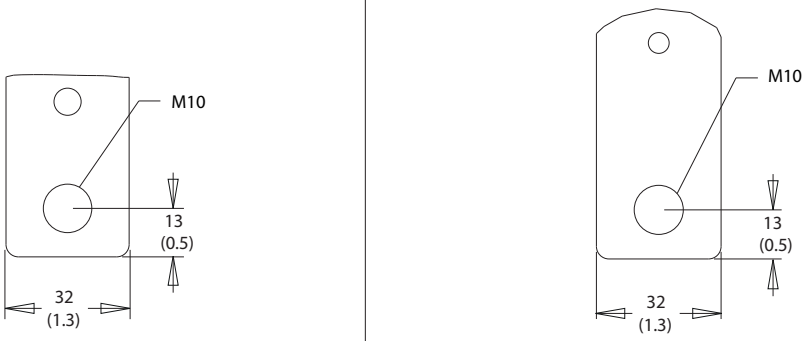


1	Mains terminals	3	Motor terminals
2	Ground terminals	–	–

Illustration 5.7 D1h Terminal Dimensions (Front View)

5





1	Mains terminals	2	Motor terminals

Illustration 5.8 D1h Terminal Dimensions (Side Views)

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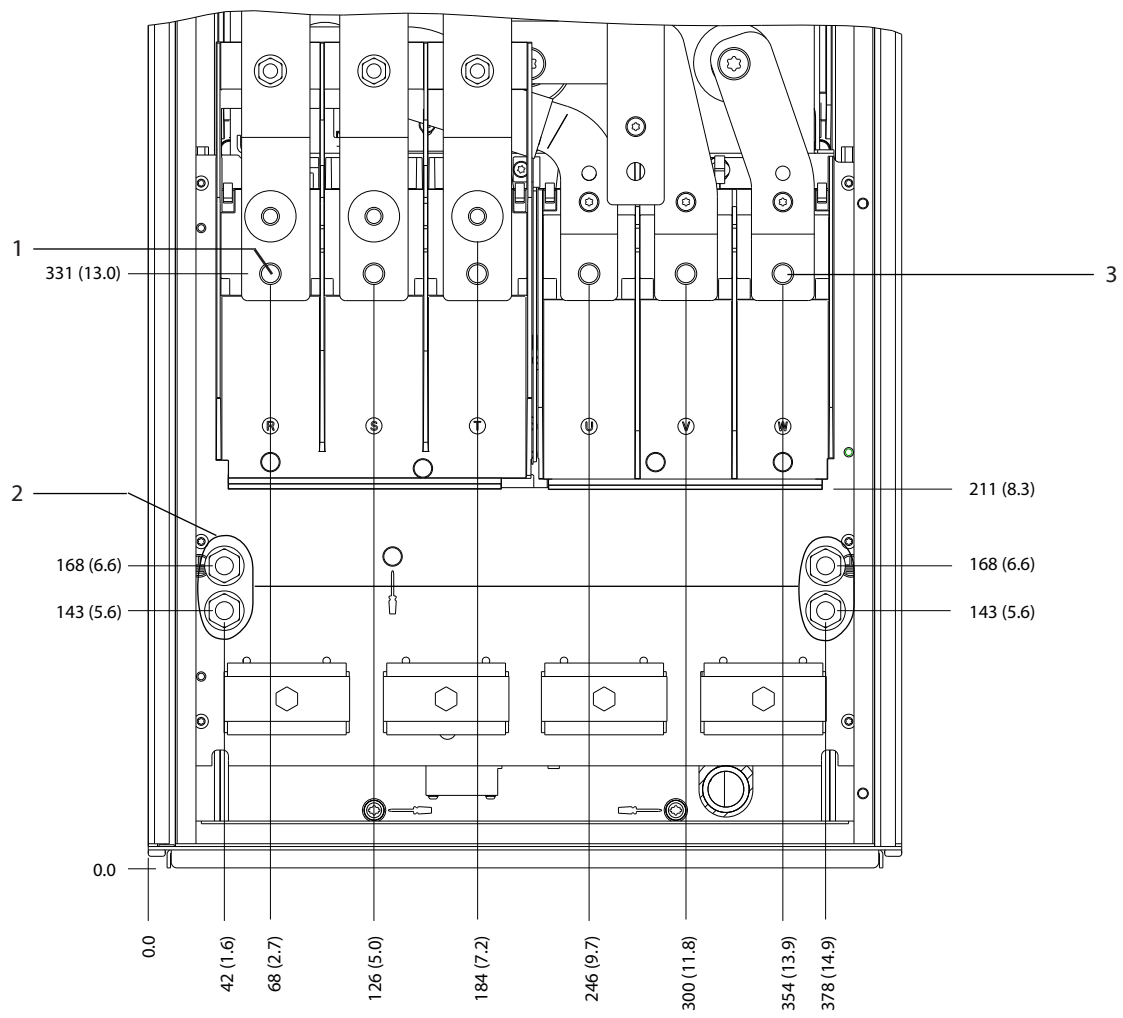
5.8.2 D2h Terminal Dimensions



1	Mains terminals	3	Motor terminals
2	Ground terminals	–	–

Illustration 5.9 D2h Terminal Dimensions (Front View)

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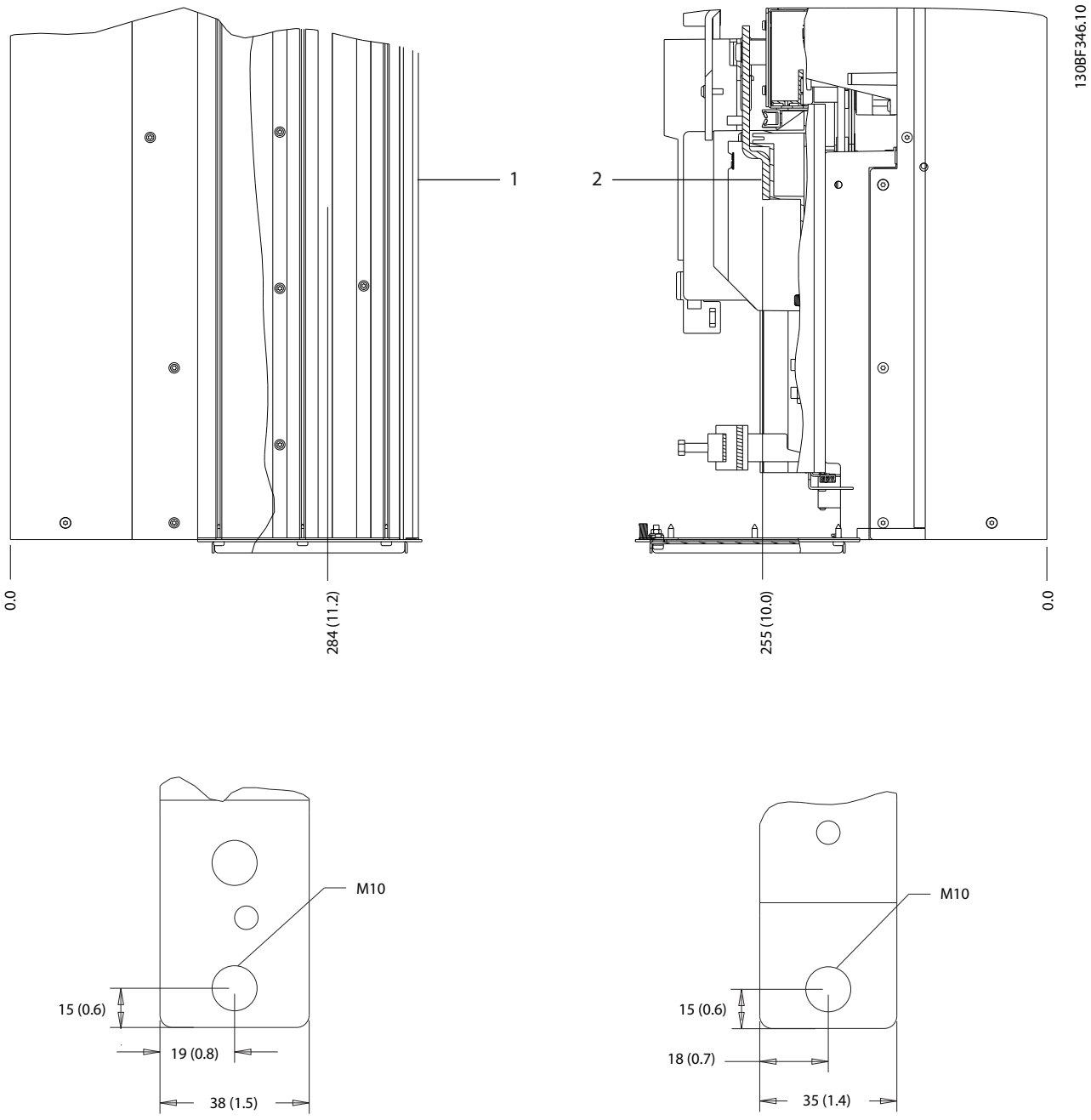

1	Mains terminals	2	Motor terminals

Illustration 5.10 D2h Terminal Dimensions (Side Views)

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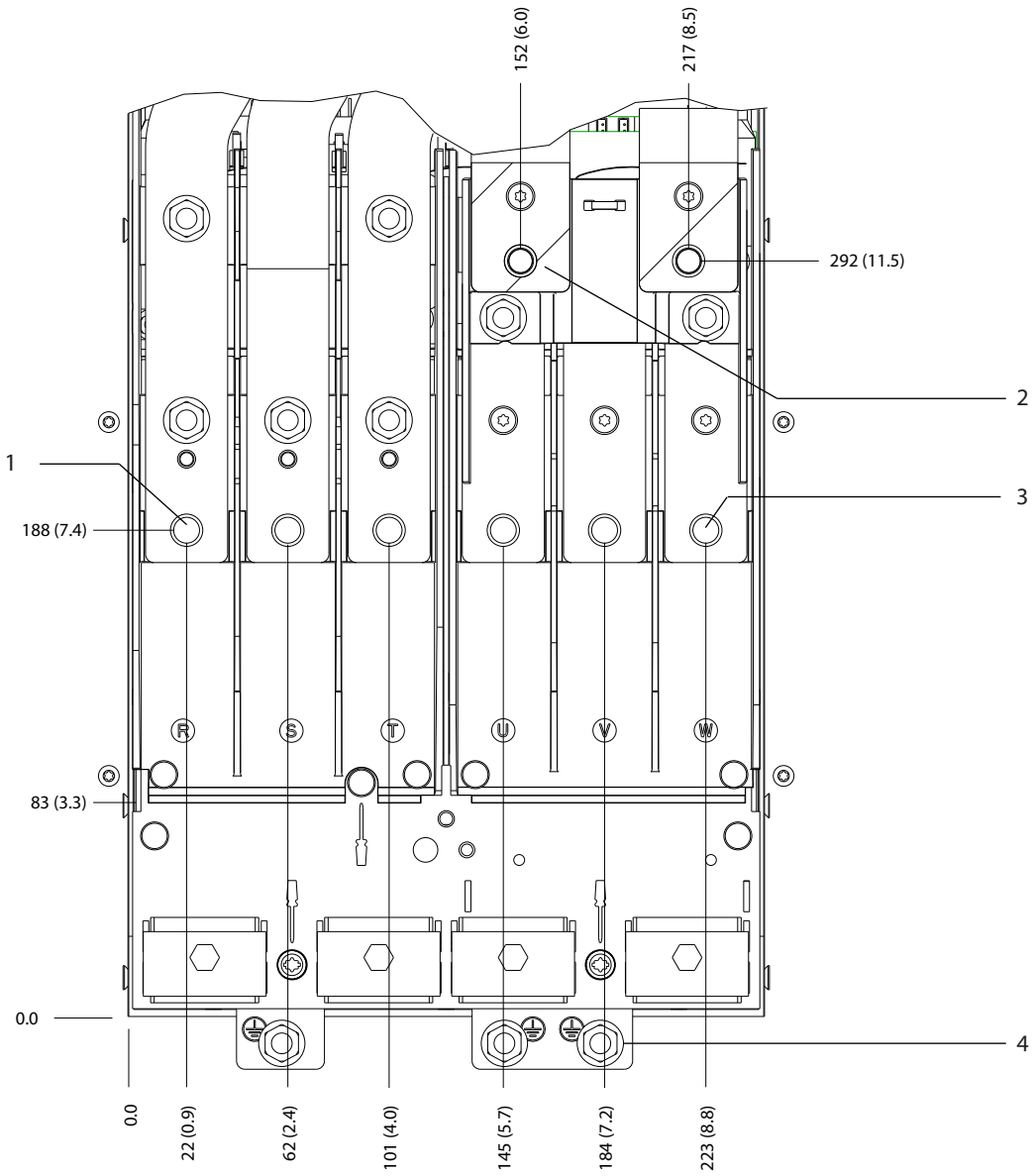
5.8.3 D3h Terminal Dimensions



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

Illustration 5.11 D3h Terminal Dimensions (Front View)

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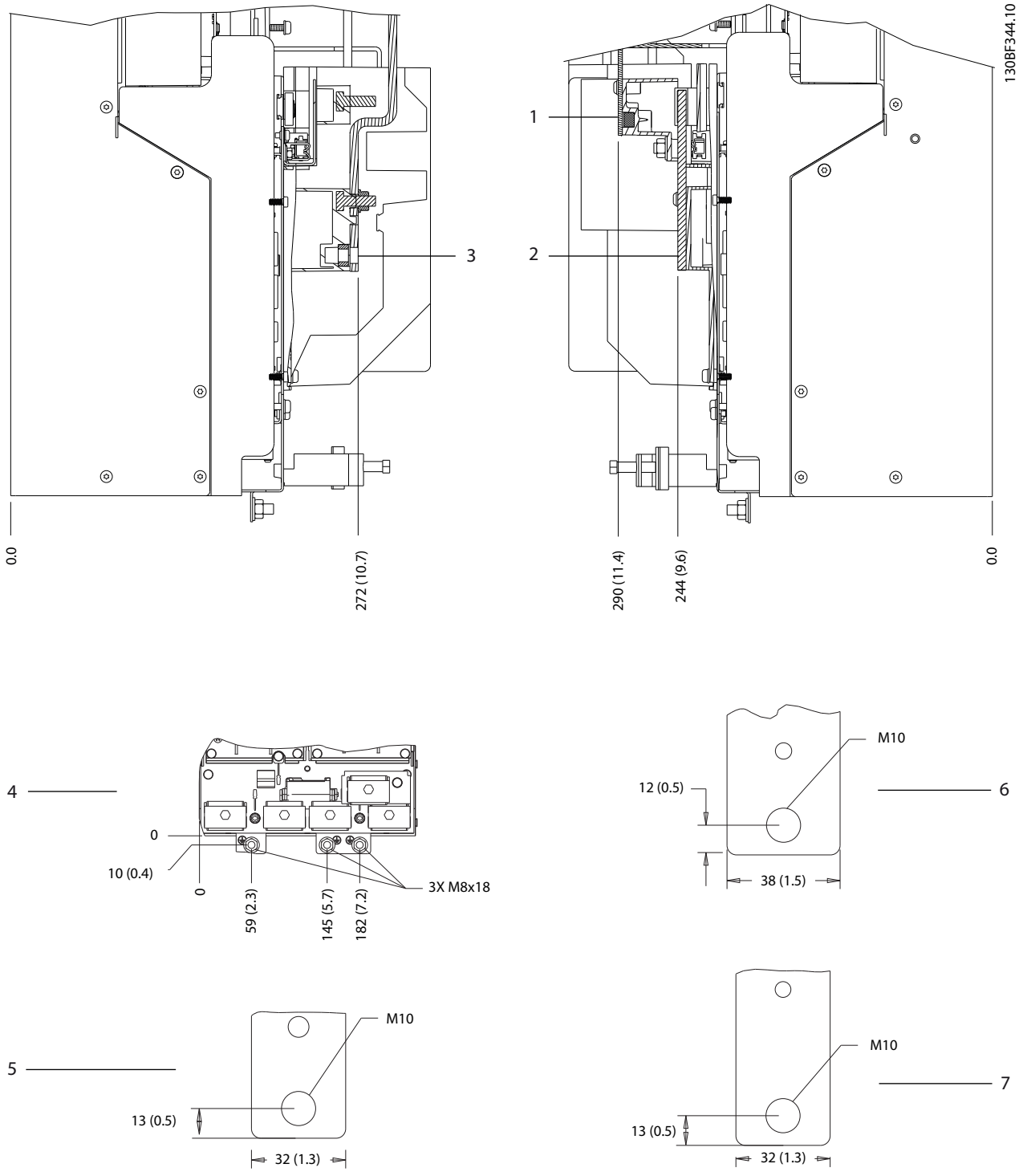

1 and 6	Bottom brake/regen terminals	3 and 5	Mains terminals
2 and 7	Motor terminals	4	Ground terminals

Illustration 5.12 D3h Terminal Dimensions (Side Views)

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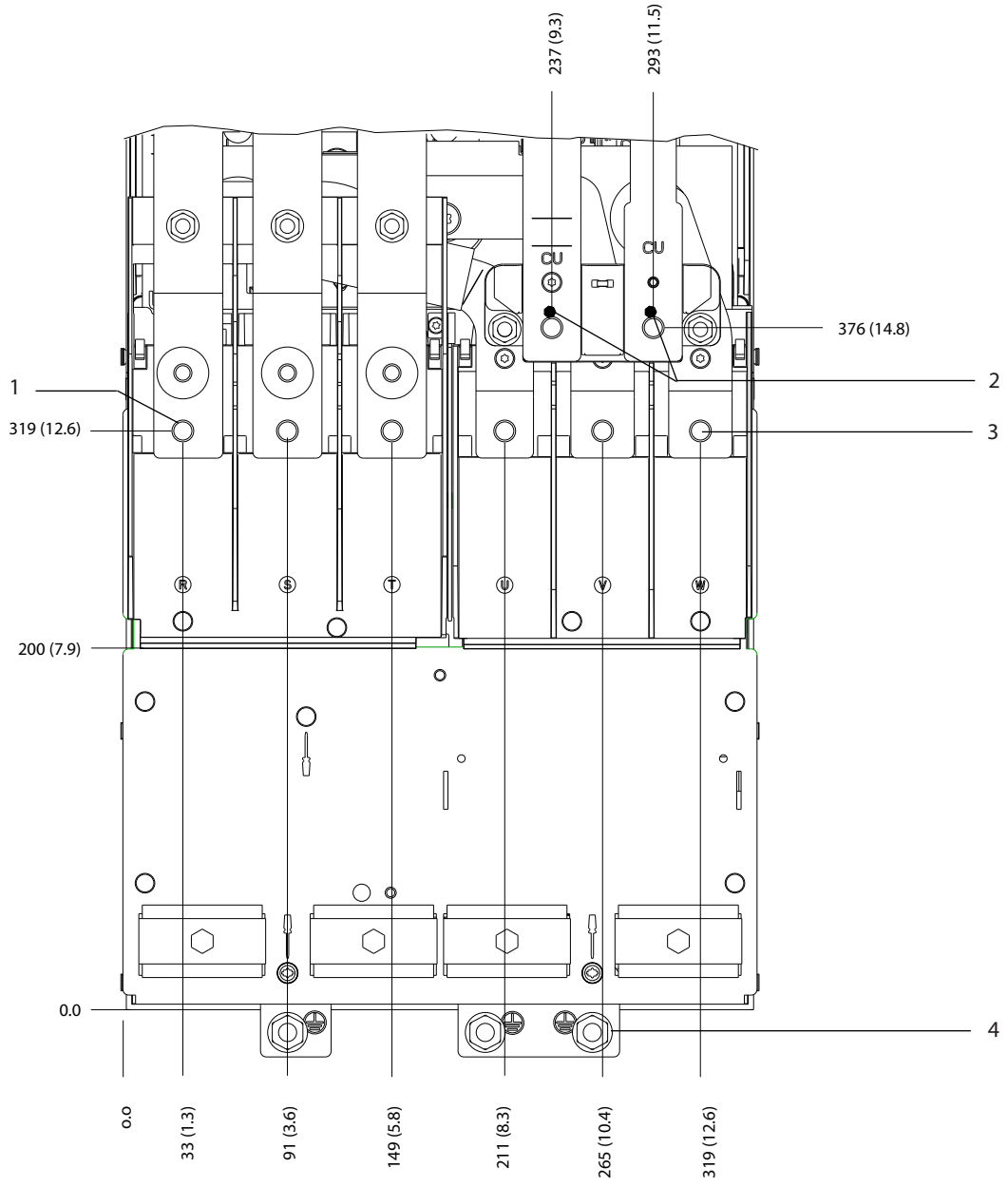
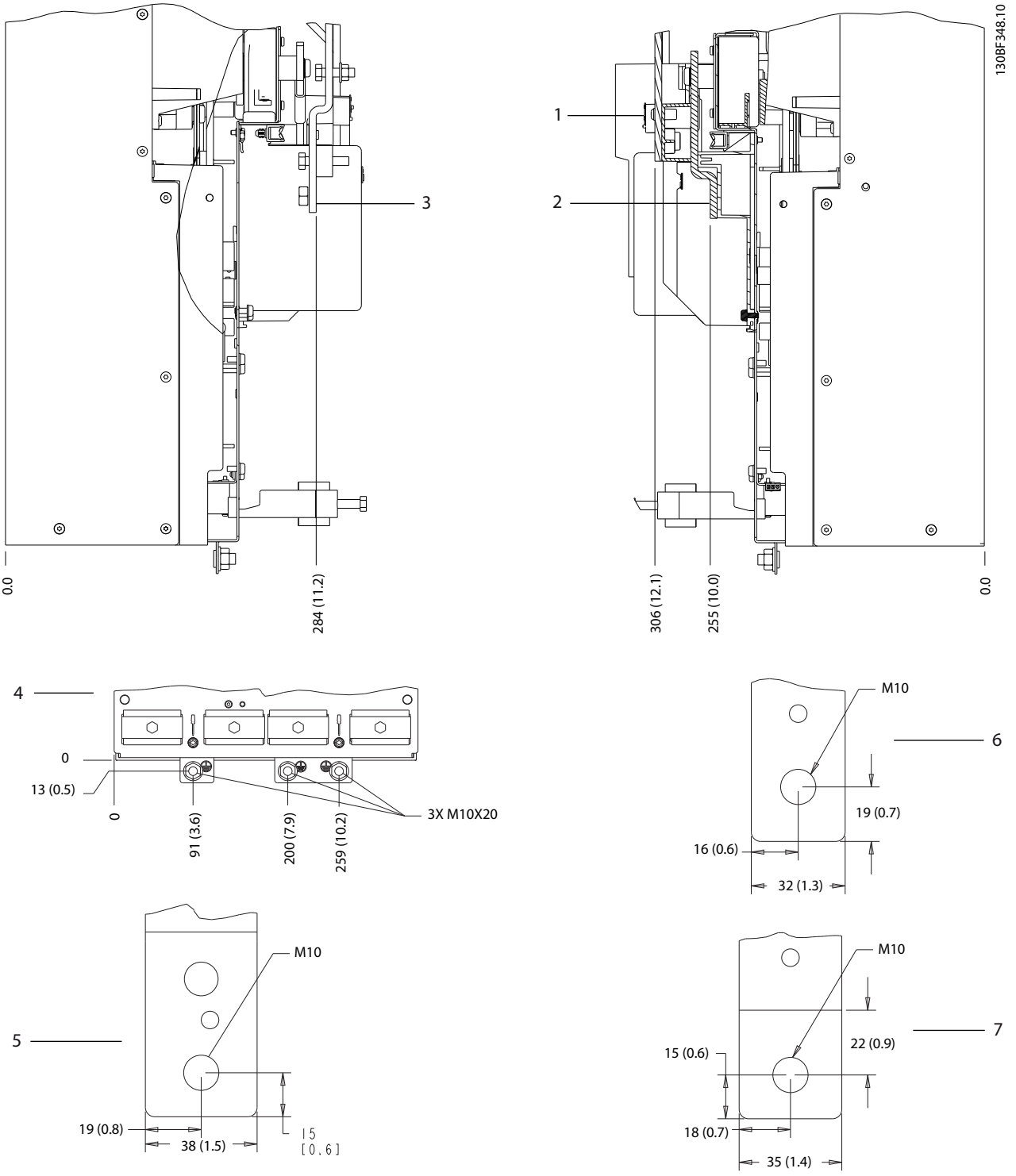
5.8.4 D4h Terminal Dimensions



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

Illustration 5.13 D4h Terminal Dimensions (Front View)

5



1 and 6	Brake/regen terminals	3 and 5	Mains terminals
2 and 7	Motor terminals	4	Ground terminals

Illustration 5.14 D4h Terminal Dimensions (Side Views)

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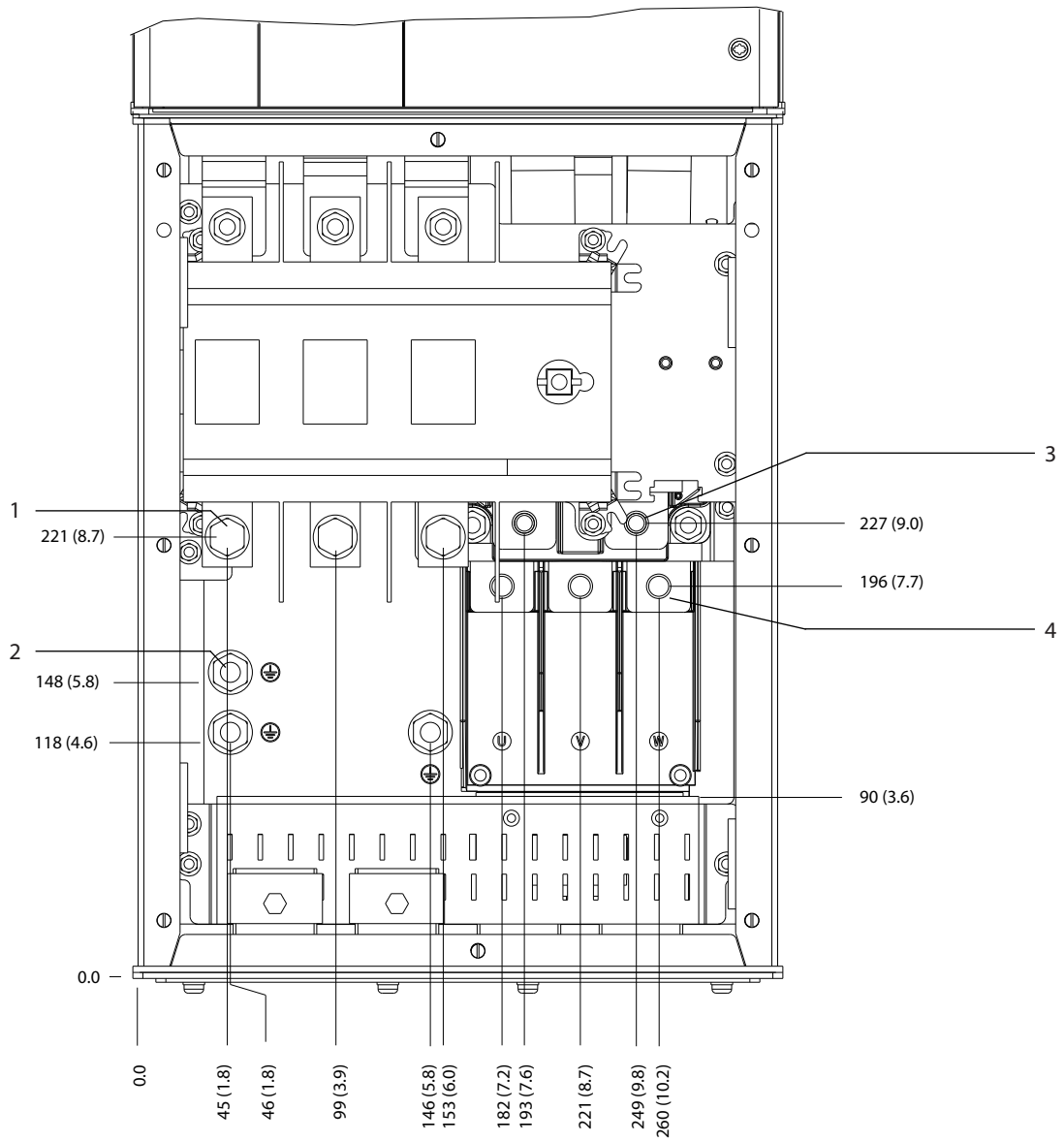
5.8.5 D5h Terminal Dimensions



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

Illustration 5.15 D5h Terminal Dimensions with Disconnect Option (Front View)

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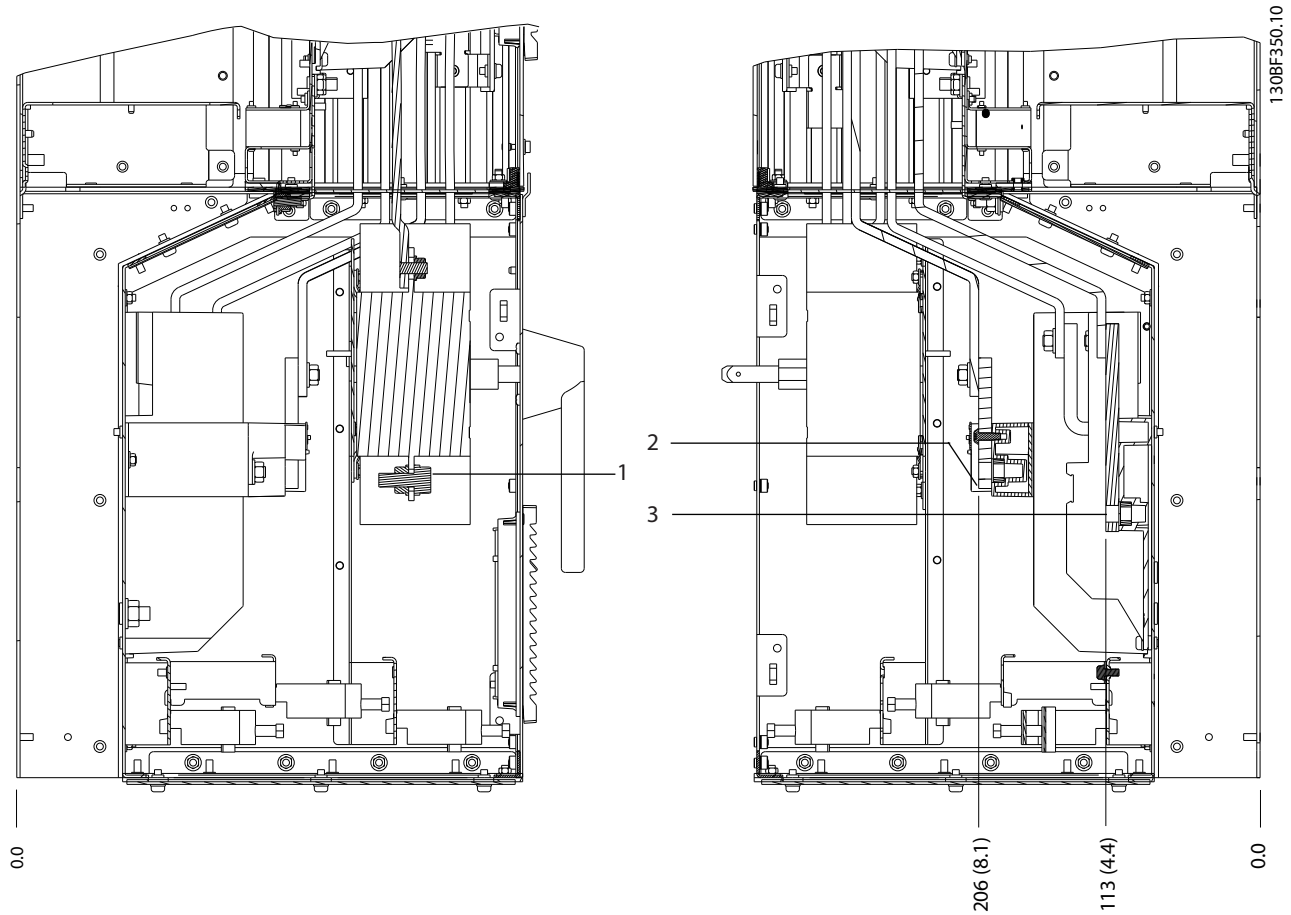

1	Mains terminals	3	Motor terminals
2	Brake terminals	–	–

Illustration 5.16 D5h Terminal Dimensions with Disconnect Option (Side Views)

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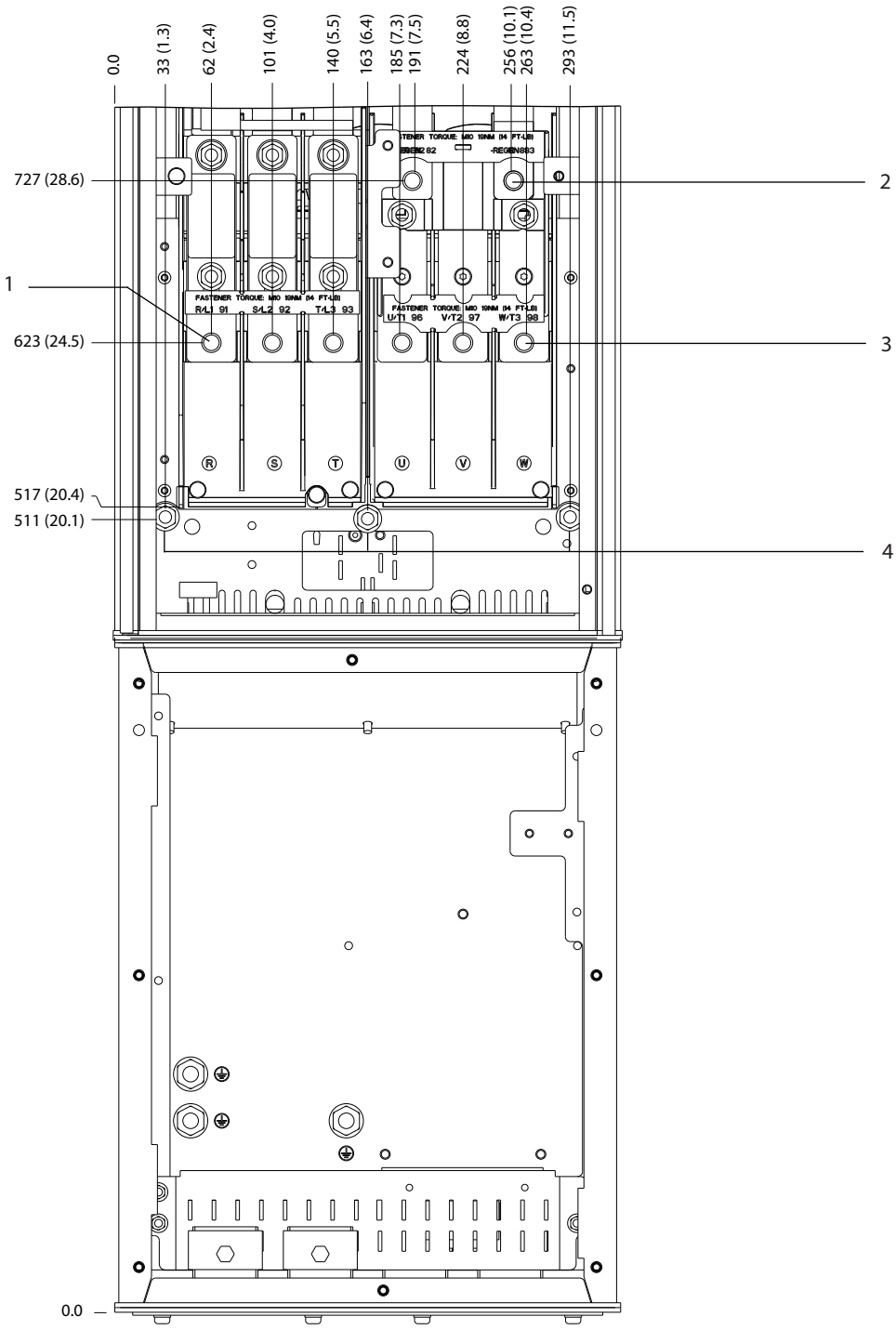
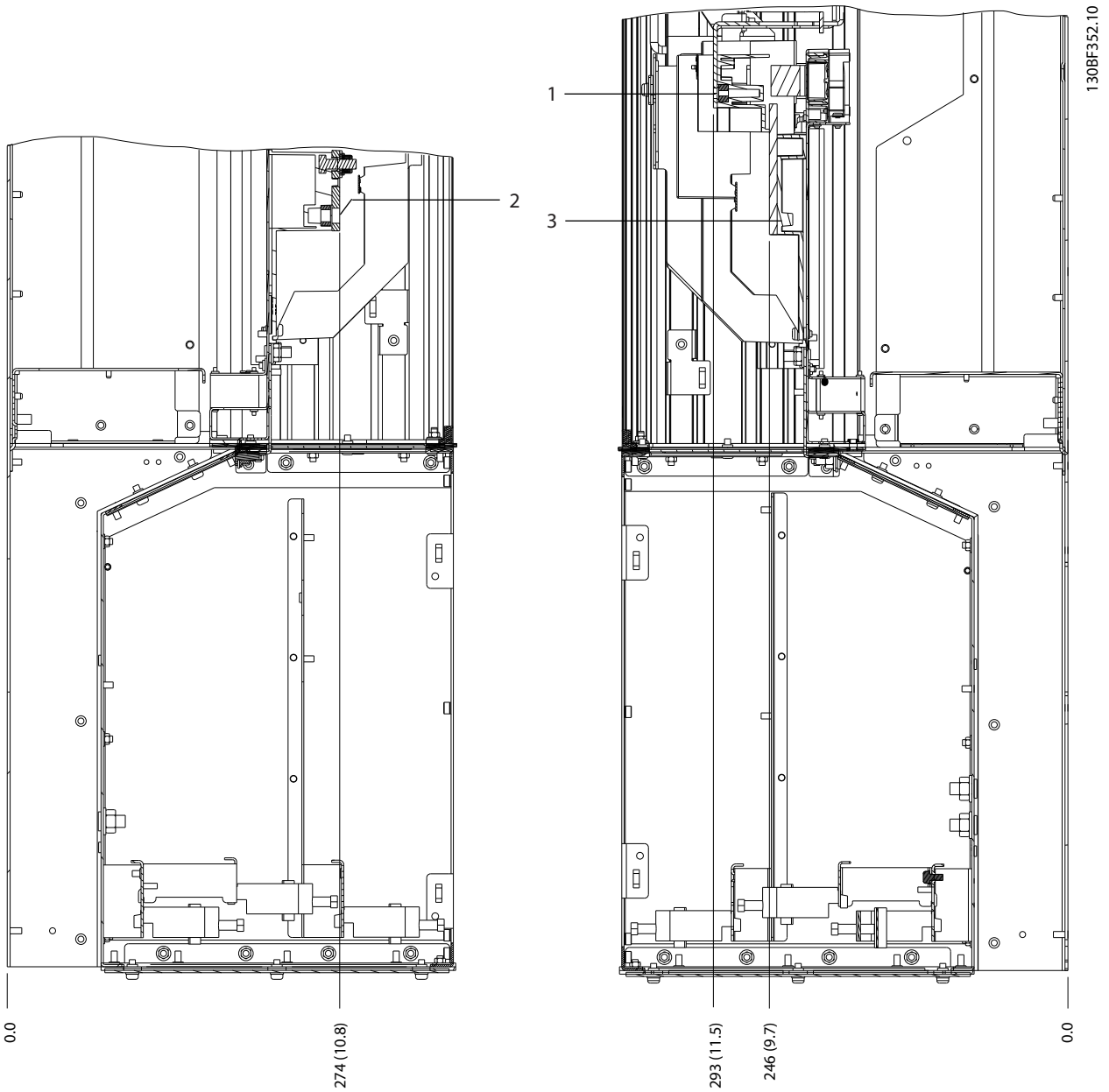


1	Mains terminals	3	Motor terminals
2	Brake terminals	4	Ground terminals

Illustration 5.17 D5h Terminal Dimensions with Brake Option (Front View)



1	Brake terminals	3	Motor terminals
2	Mains terminals	–	–

Illustration 5.18 D5h Terminal Dimensions with Brake Option (Side Views)

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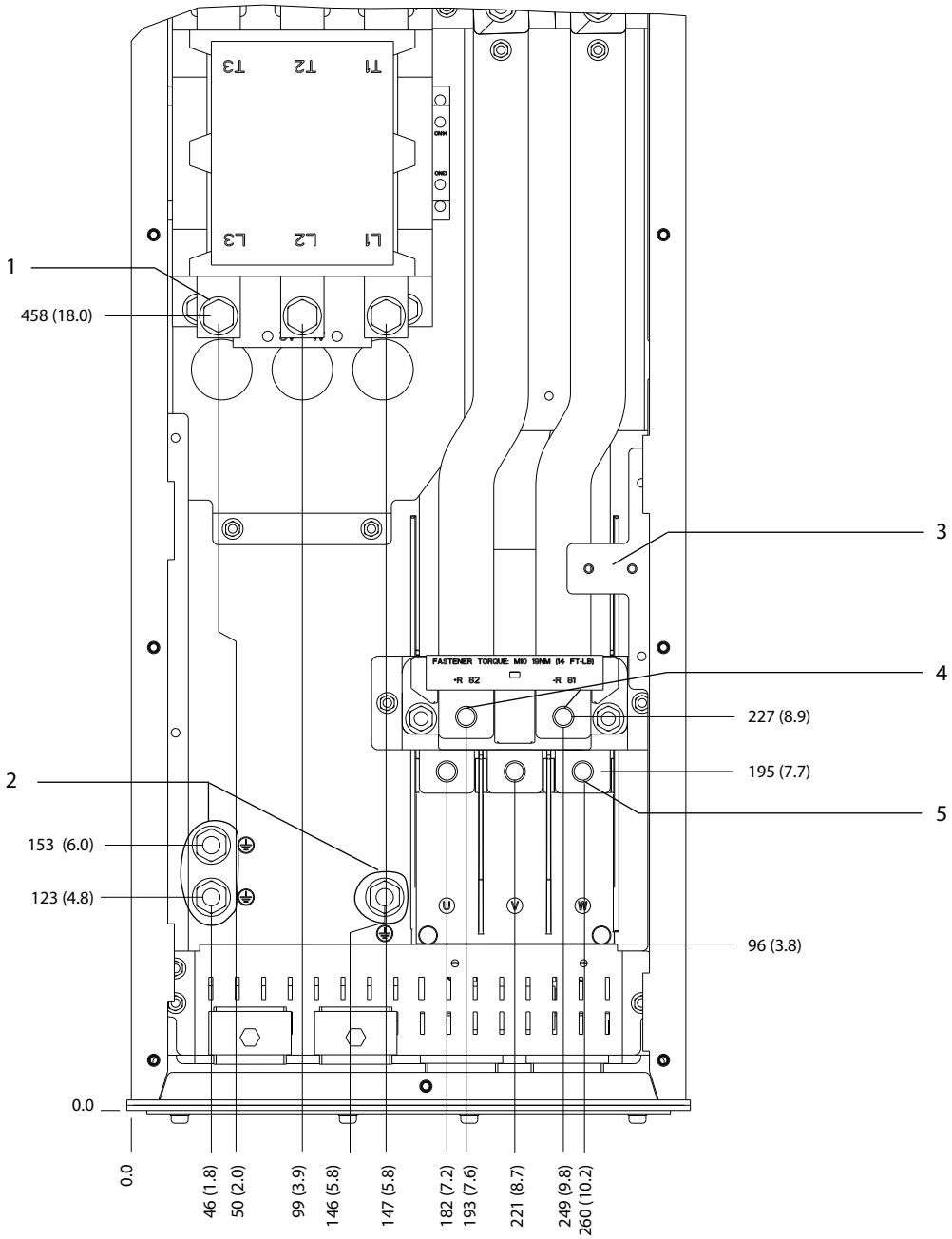
5.8.6 D6h Terminal Dimensions



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

Illustration 5.19 D6h Terminal Dimensions with Contactor Option (Front View)

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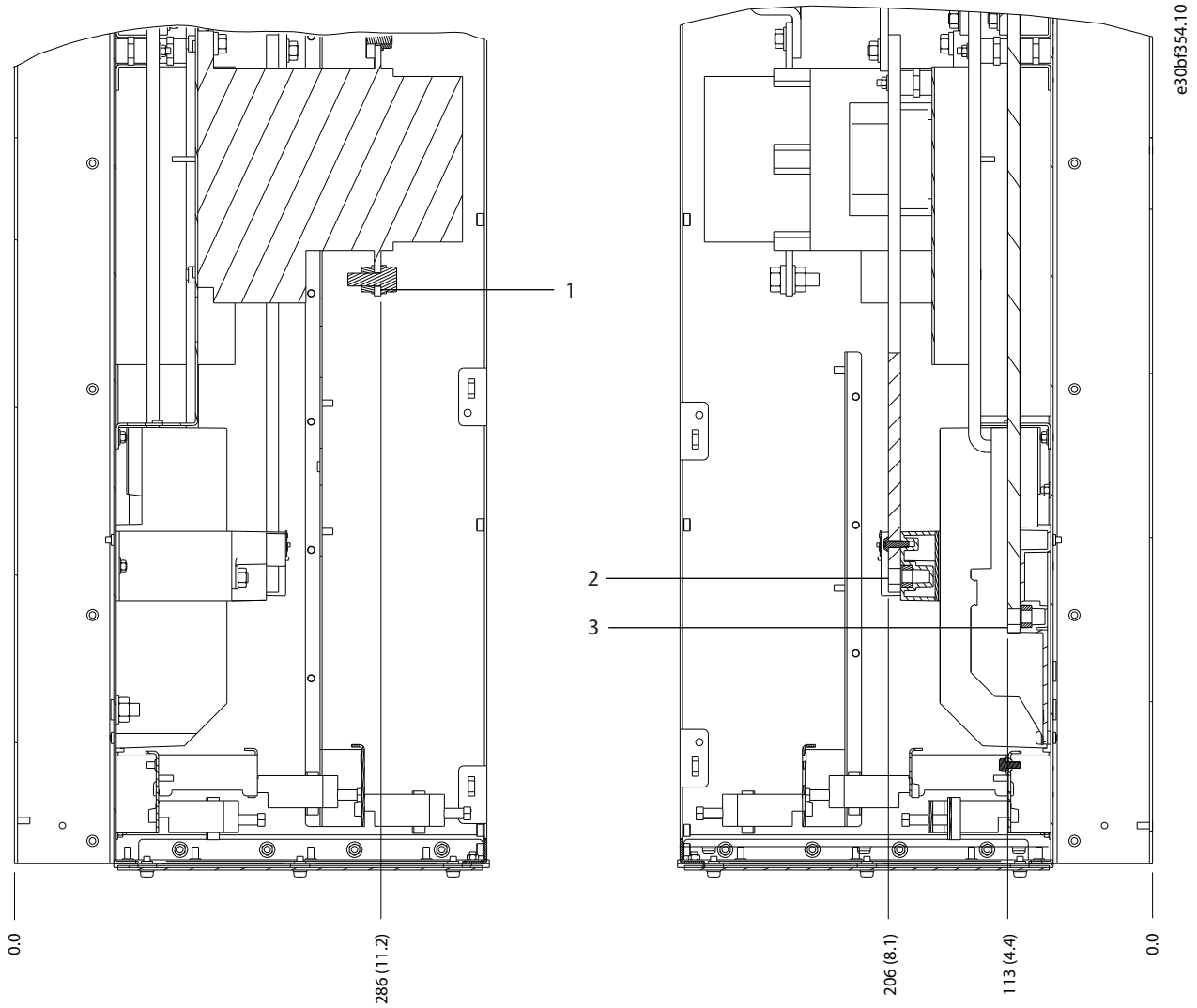

1	Mains terminals	3	Motor terminals
2	Brake terminals	–	–

Illustration 5.20 D6h Terminal Dimensions with Contactor Option (Side Views)

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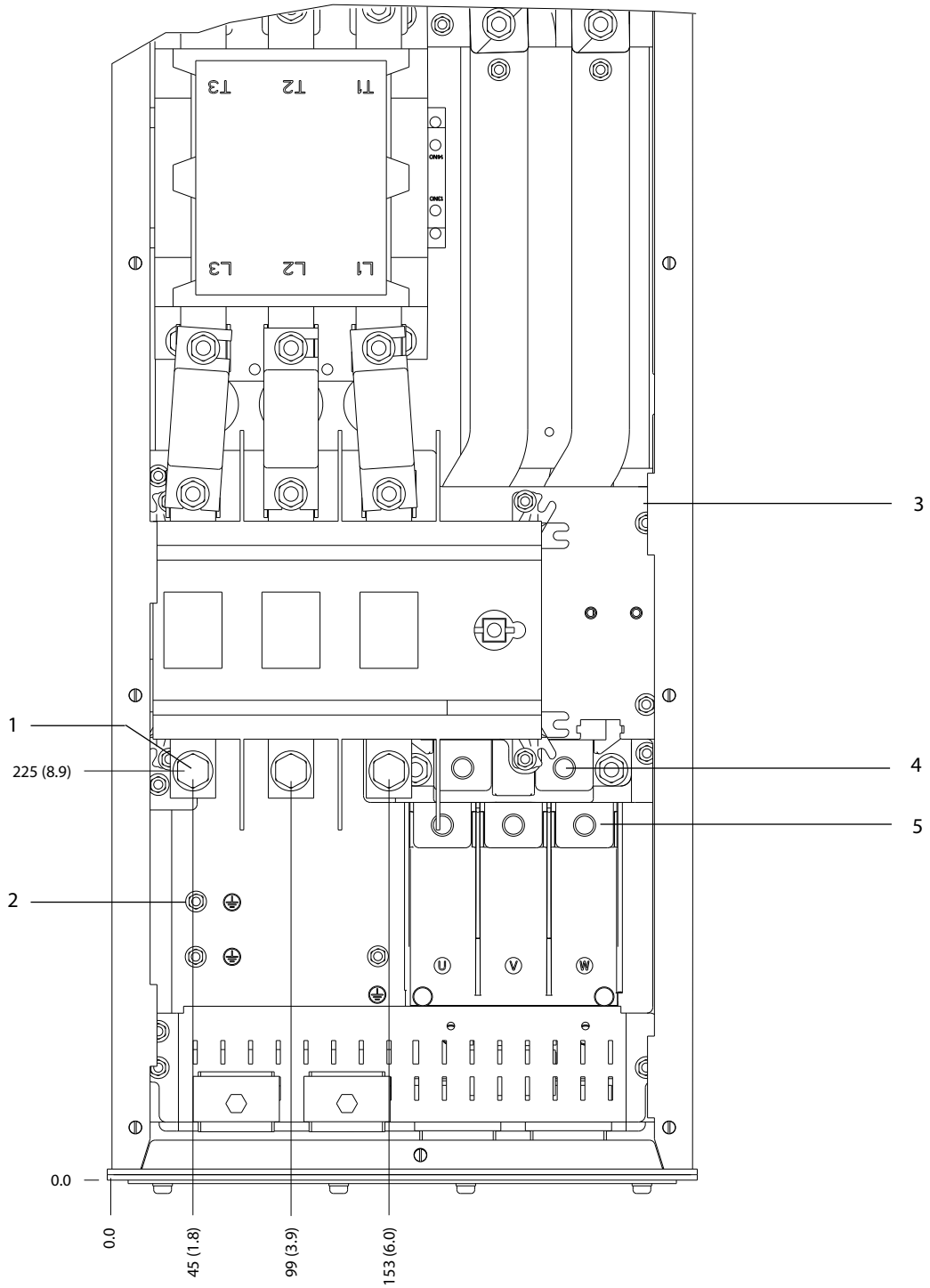

1	Mains terminals	4	Brake terminals
2	Ground terminals	5	Motor terminals
3	TB6 terminal block for contactor	–	–

Illustration 5.21 D6h Terminal Dimensions with Contactor and Disconnect Options (Front View)

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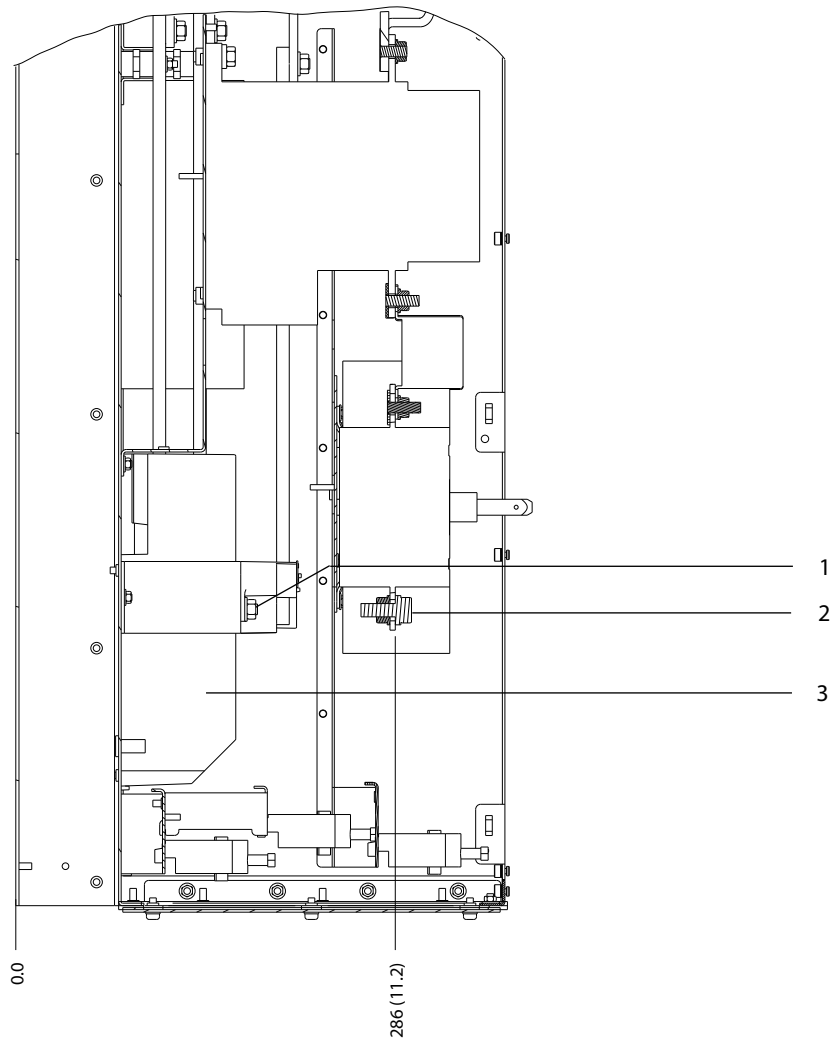

1	Brake terminals	3	Motor terminals
2	Mains terminals	–	–

Illustration 5.22 D6h Terminal Dimensions with Contactor and Disconnect Options (Side Views)

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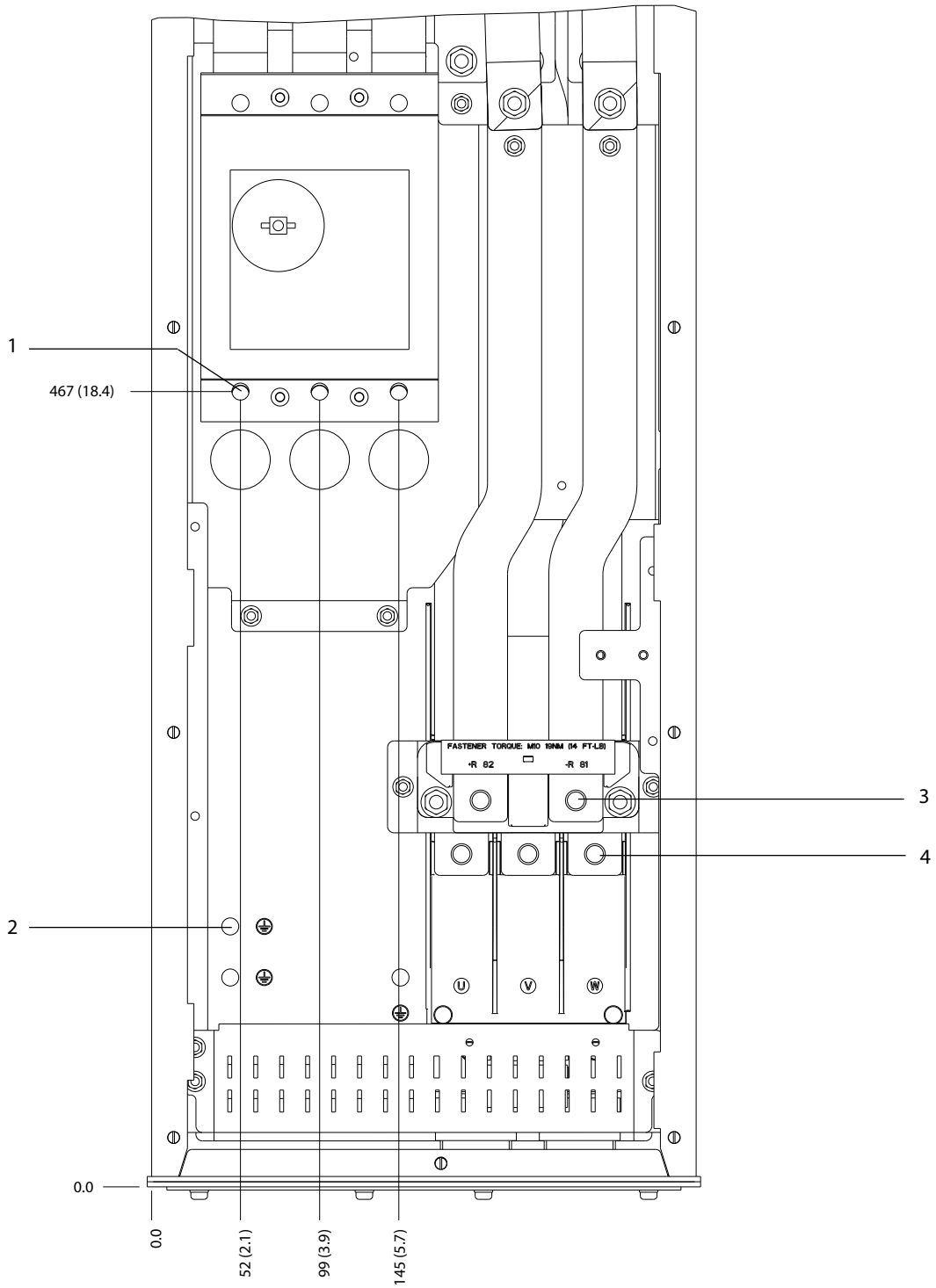
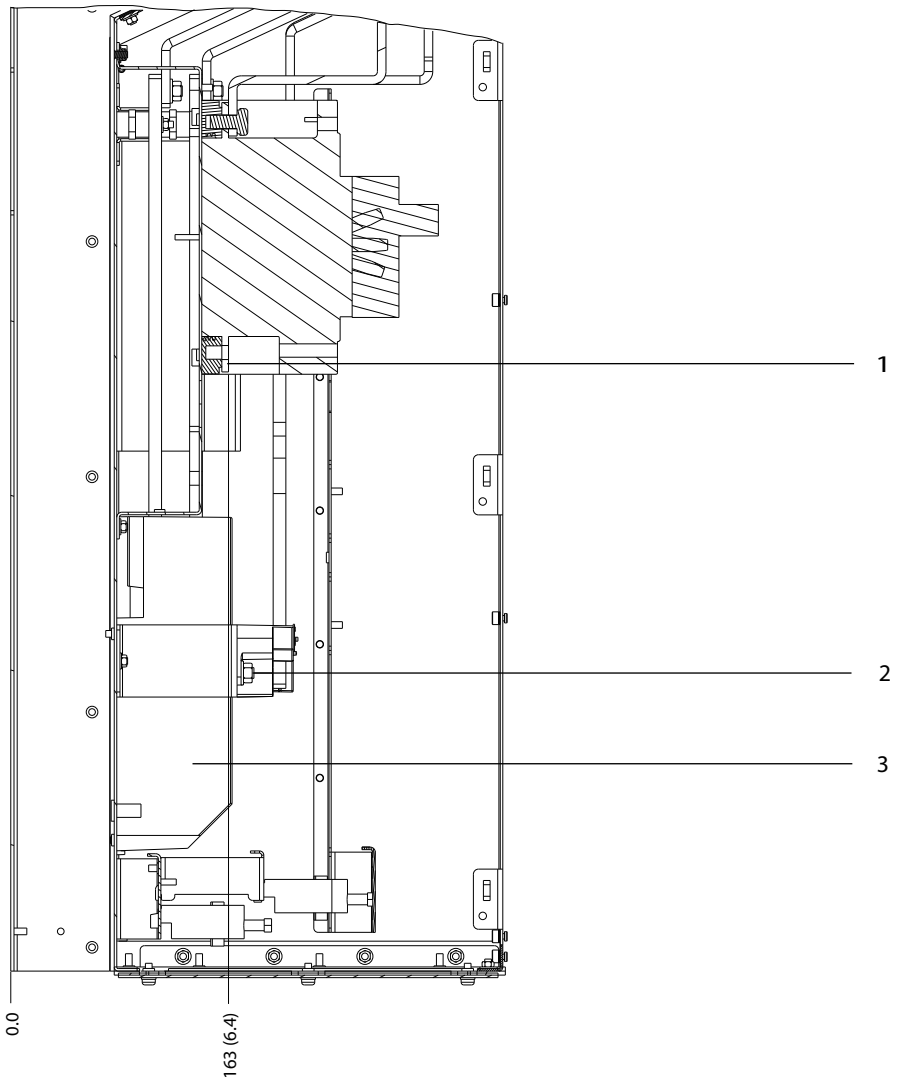


1	Mains terminals	3	Brake terminals
2	Ground terminals	4	Motor terminals

Illustration 5.23 D6h Terminal Dimensions with Circuit Breaker Option (Front View)



1	Mains terminals	3	Motor terminals
2	Brake terminals	–	–

Illustration 5.24 D6h Terminal Dimensions with Circuit Breaker Option (Side Views)

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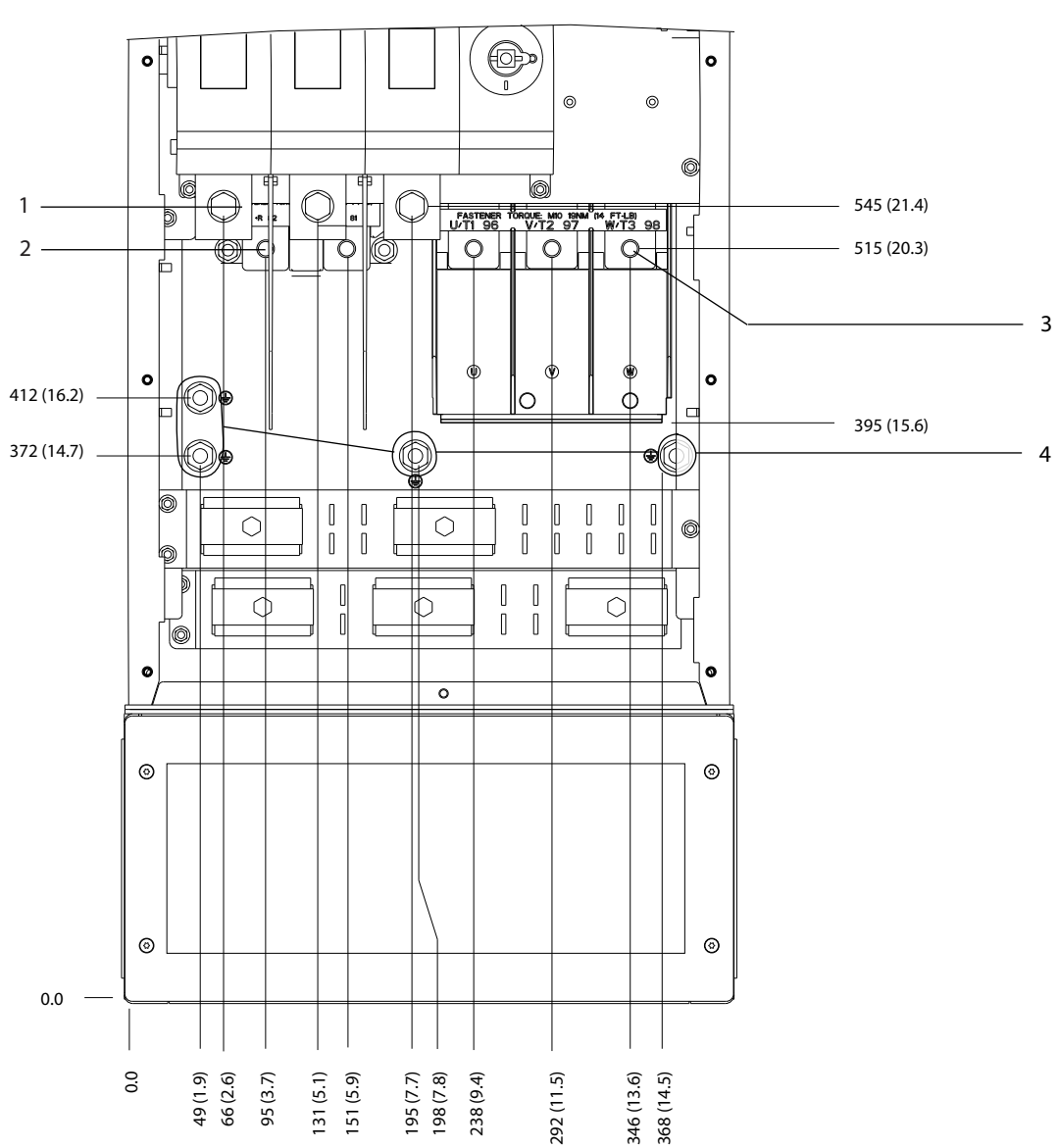
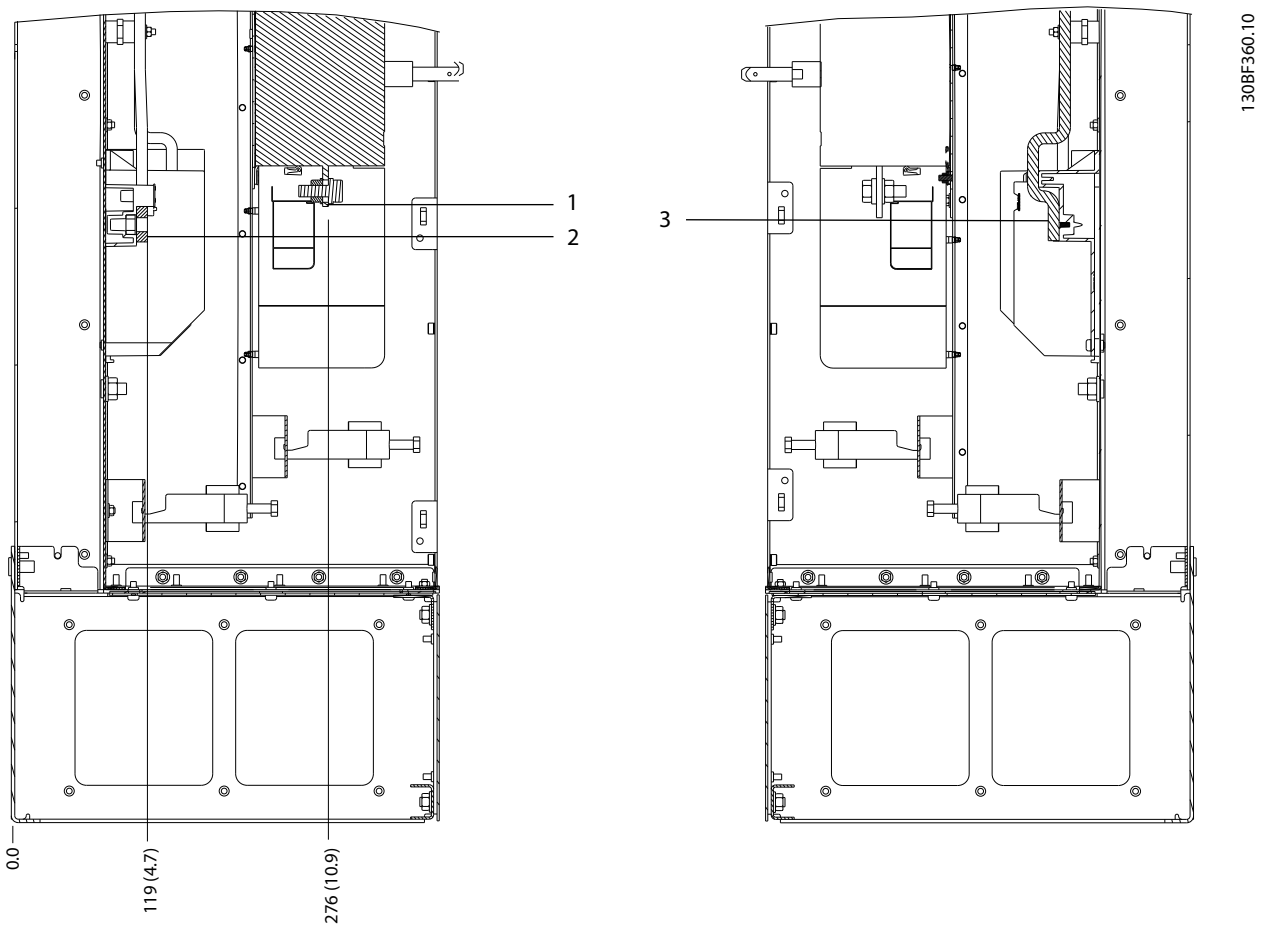
5.8.7 D7h Terminal Dimensions



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

Illustration 5.25 D7h Terminal Dimensions with Disconnect Option (Front View)



1	Mains terminals	3	Motor terminals
2	Brake terminals	–	–

Illustration 5.26 D7h Terminal Dimensions with Disconnect Option (Side Views)

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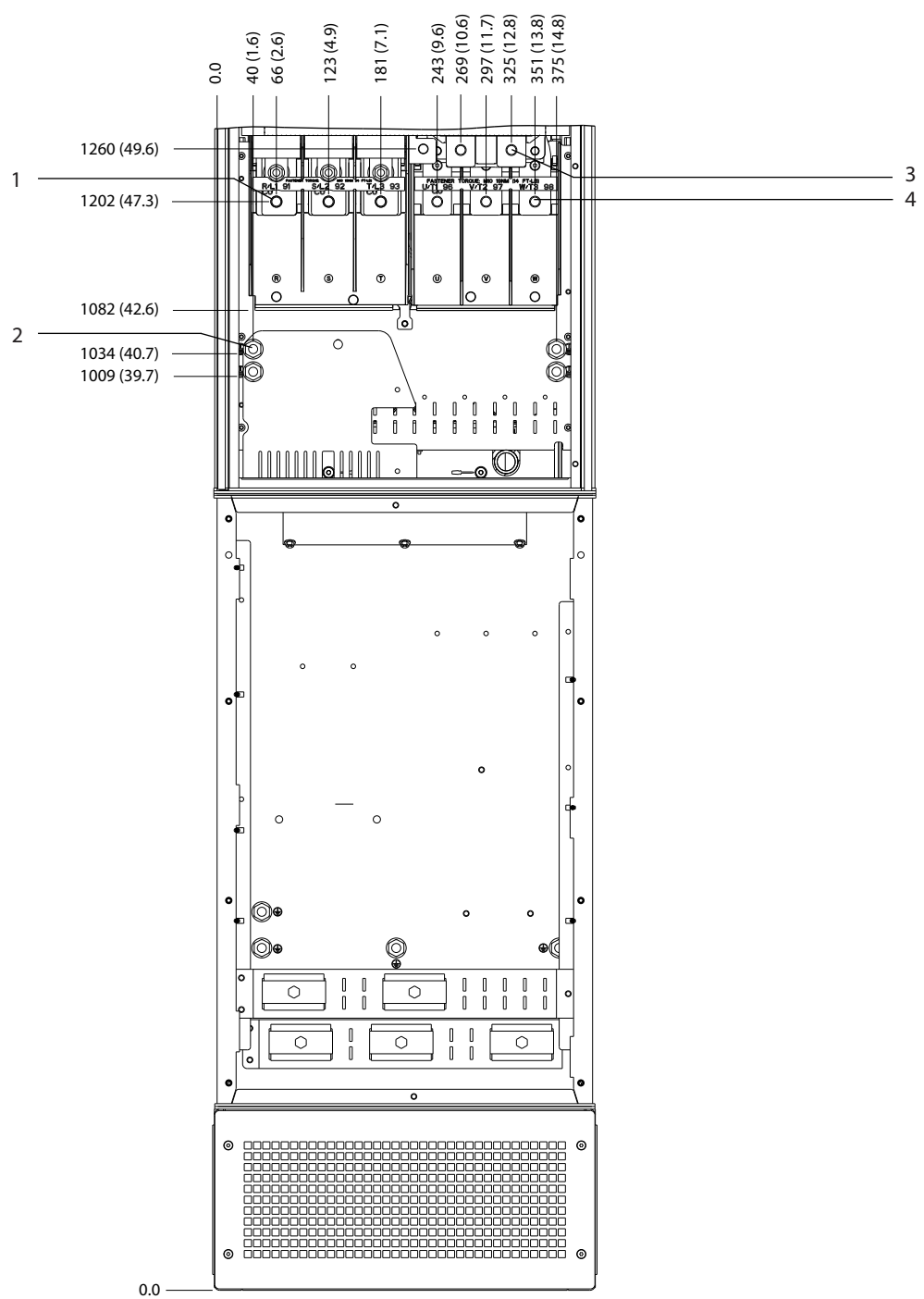

1	Mains terminals	3	Brake terminals
2	Ground terminals	4	Motor terminals

Illustration 5.27 D7h Terminal Dimensions with Brake Option (Front View)

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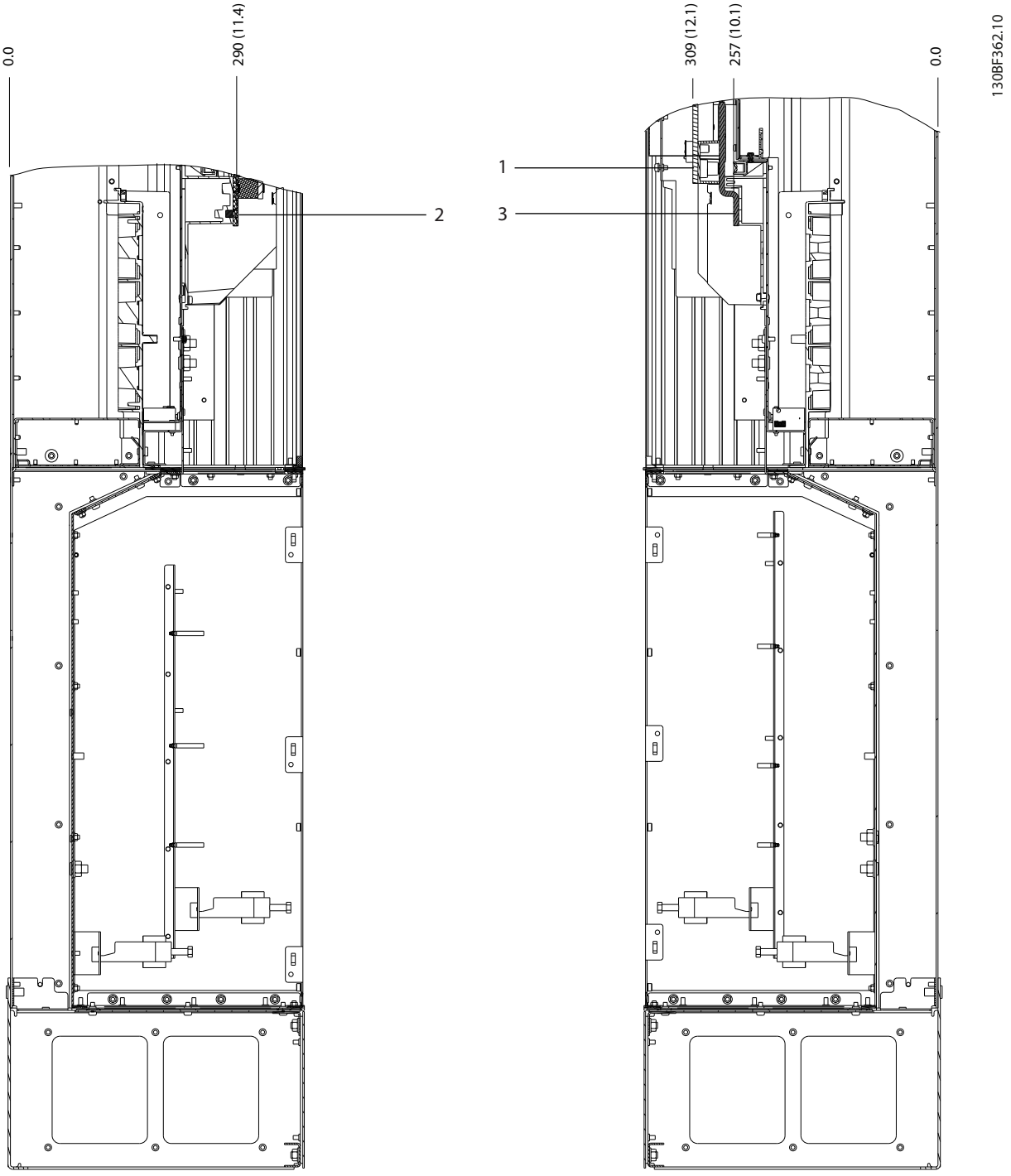

1	Brake terminals	3	Motor terminals
2	Mains terminals	–	–

Illustration 5.28 D7h Terminal Dimensions with Brake Option (Side Views)

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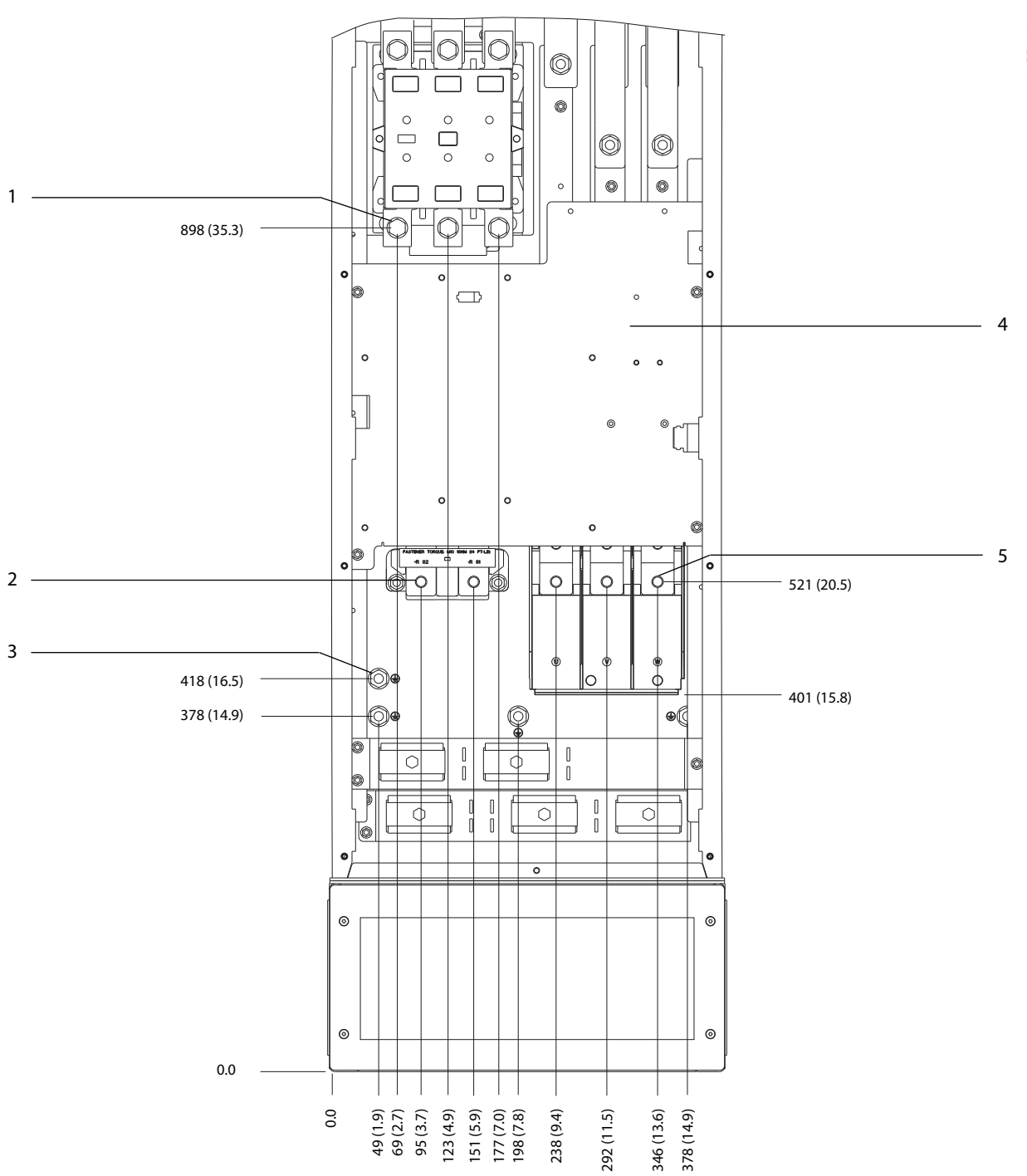
5.8.8 D8h Terminal Dimensions



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

Illustration 5.29 D8h Terminal Dimensions with Contactor Option (Front View)

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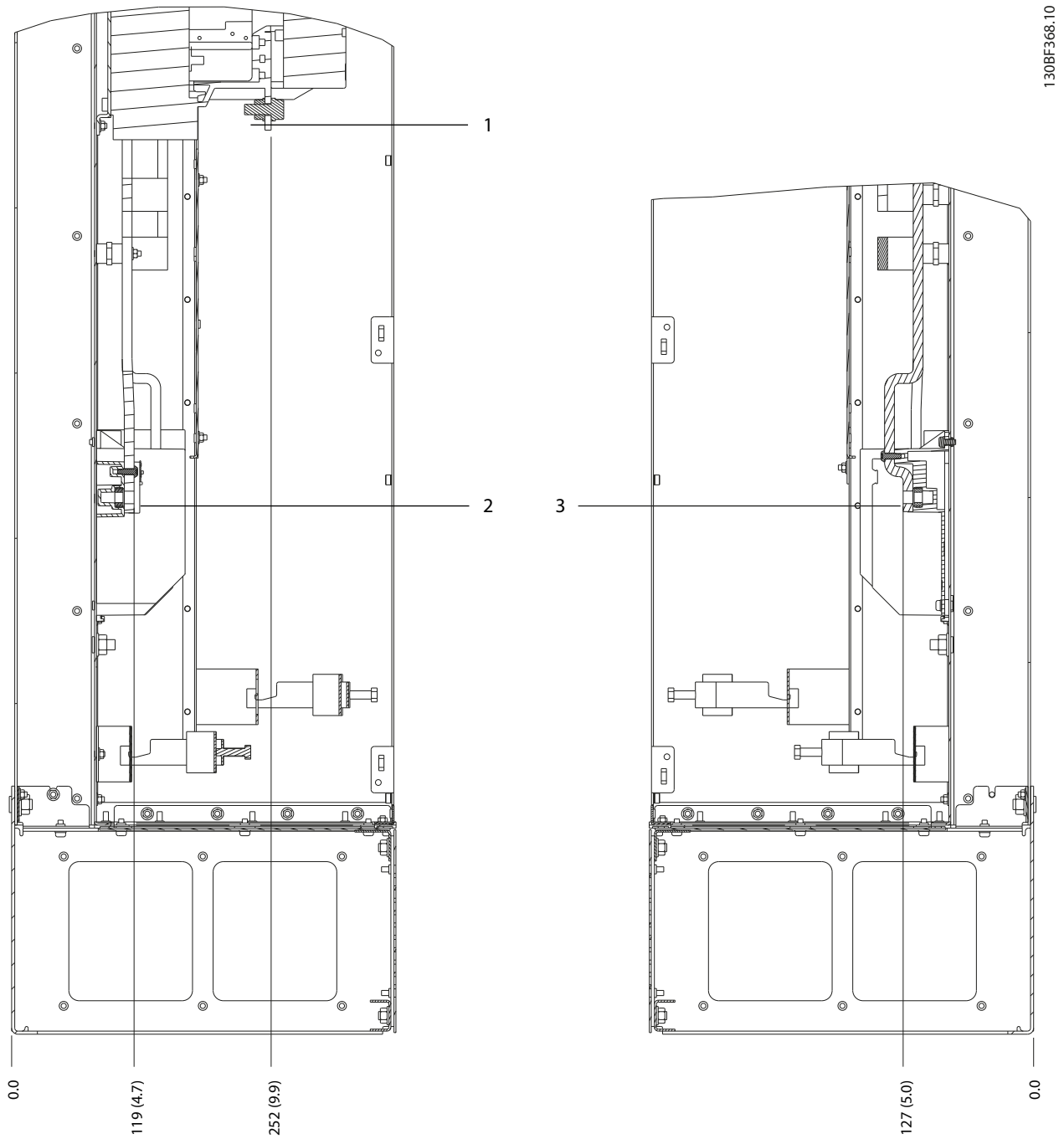

1	Mains terminals	3	Motor terminals
2	Brake terminals	–	–

Illustration 5.30 D8h Terminal Dimensions with Contactor Option (Side Views)

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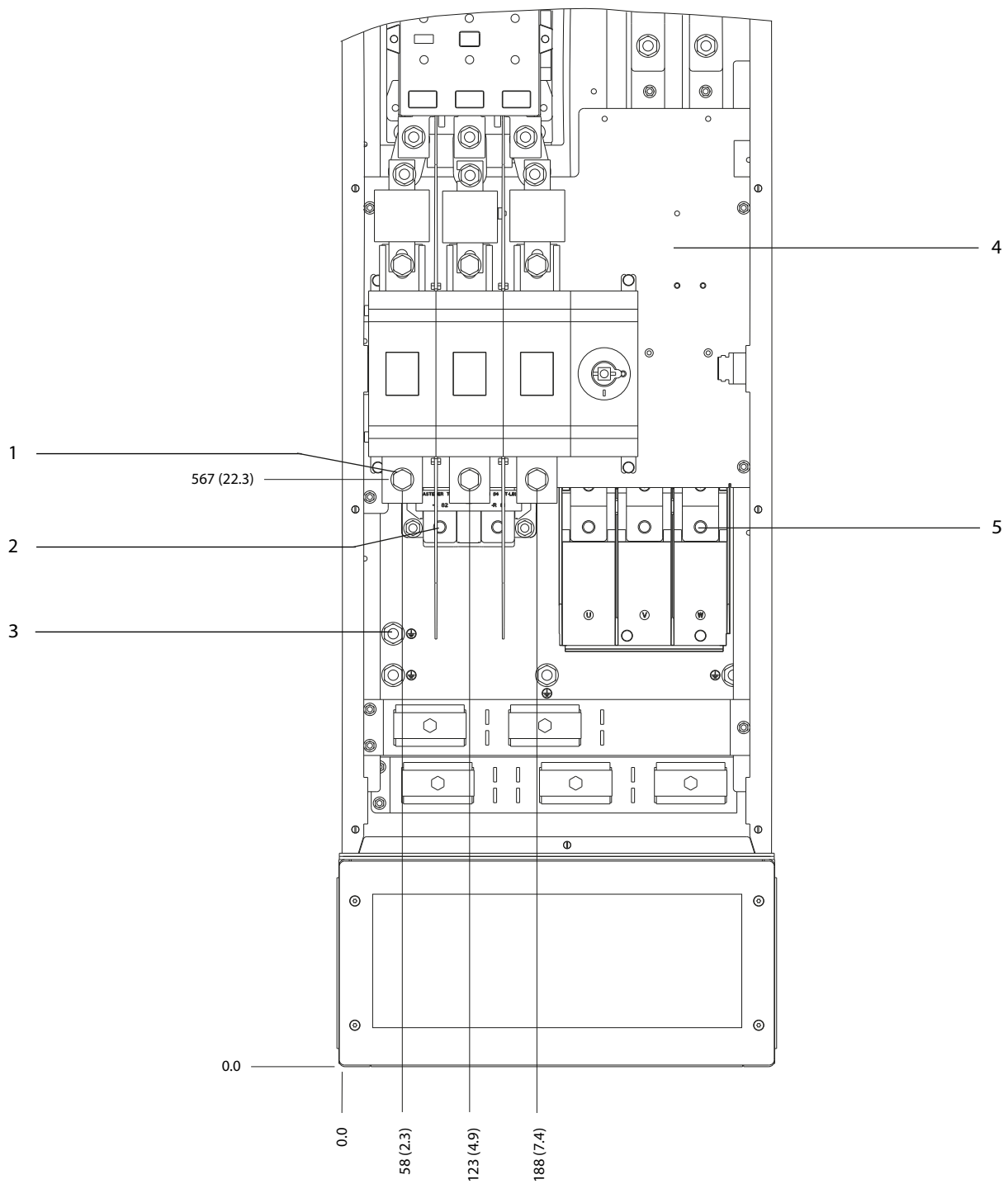

1	Mains terminals	4	TB6 terminal block for contactor
2	Brake terminals	5	Motor terminals
3	Ground terminals	–	–

Illustration 5.31 D8h Terminal Dimensions with Contactor and Disconnect Options (Front View)

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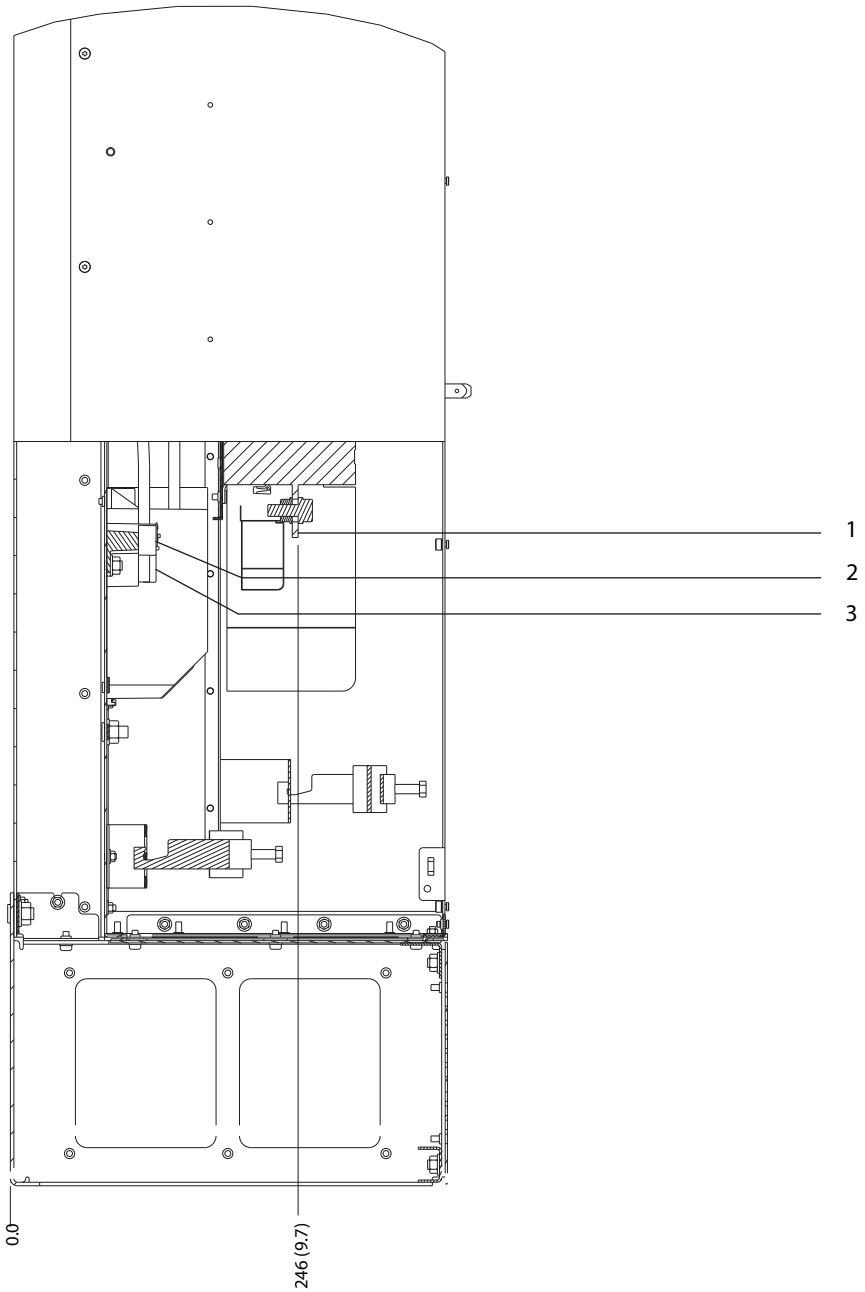

1	Mains terminals	3	Motor terminals
2	Brake terminals	–	–

Illustration 5.32 D8h Terminal Dimensions with Contactor and Disconnect Options (Side View)

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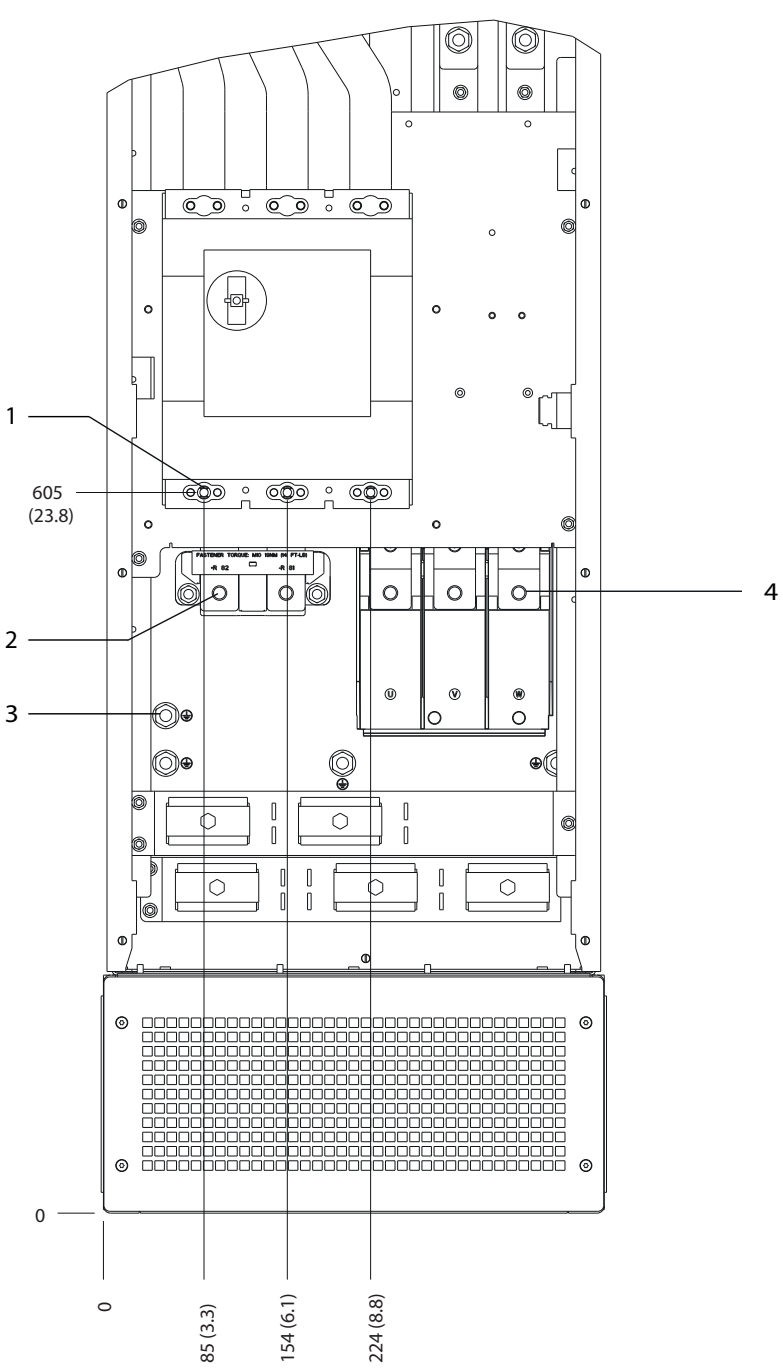

1	Mains terminals	3	Ground terminals
2	Brake terminals	4	Motor terminals

Illustration 5.33 D8h Terminal Dimensions with Circuit Breaker Option (Front View)

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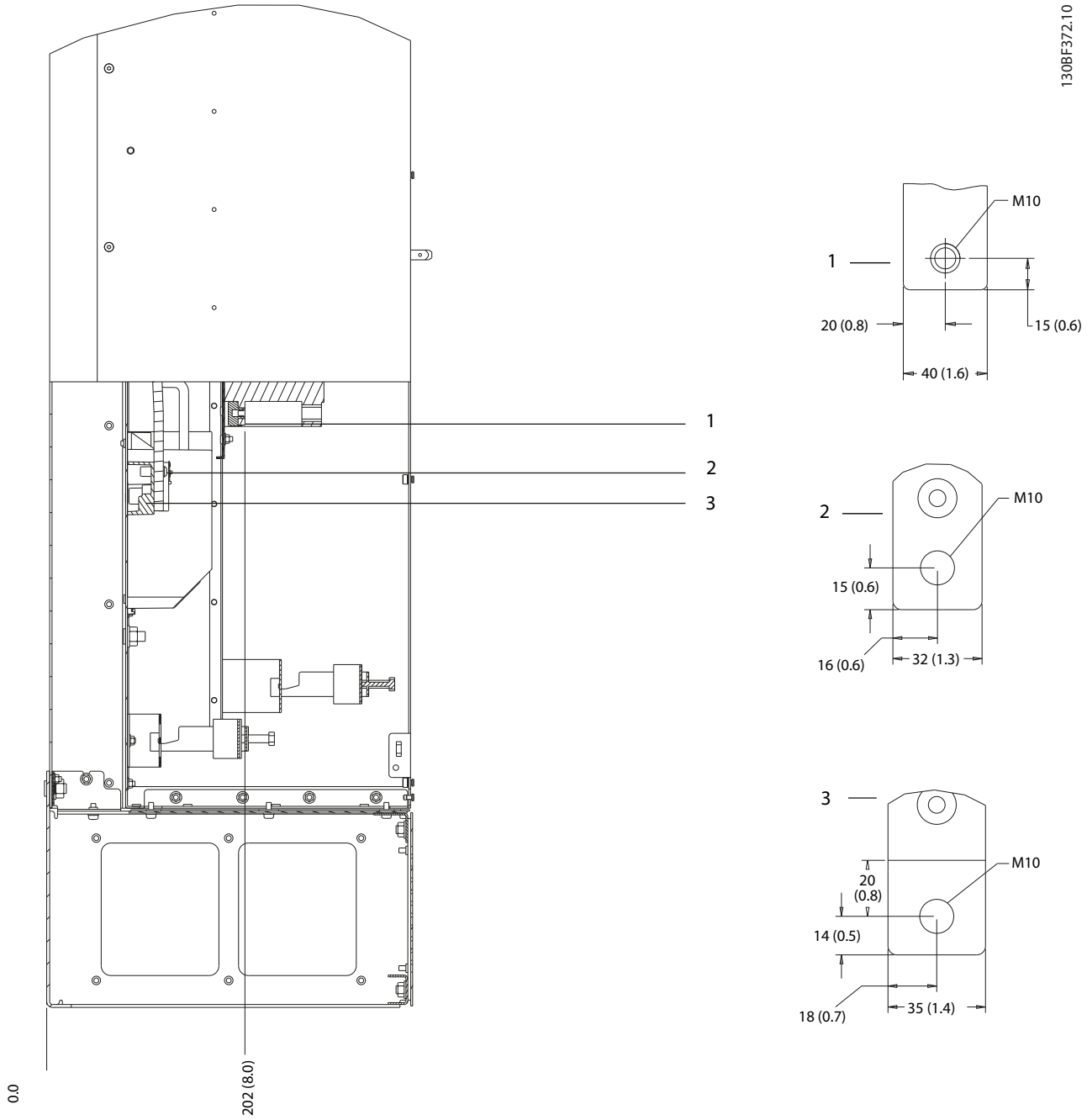

1	Mains terminals	3	Motor terminals
2	Brake terminals	–	–

Illustration 5.34 D8h Terminal Dimensions with Circuit Breaker Option (Side View)

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5.9 Control Wiring

All terminals to the control cables are inside the drive below the LCP. To access the control terminals, either open the door (D1h/D2h/D5h/D6h/D7h/D8h) or remove the front panel (D3h/D4h).

5.9.1 Control Cable Routing

- Isolate control wiring from high-power components in the drive.
- Tie down all control wires after routing them.
- Connect shields to ensure optimum electrical immunity.
- When the drive 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.

Fieldbus connection
Connections are made to the relevant options on the control card. For more detail, see the relevant fieldbus instruction. The cable must be tied down and routed along with other control wires inside the unit.

5.9.2 Control Terminal Types

Illustration 5.35 shows the removable drive connectors. Terminal functions and default settings are summarized in *Table 5.1 – Table 5.3*.

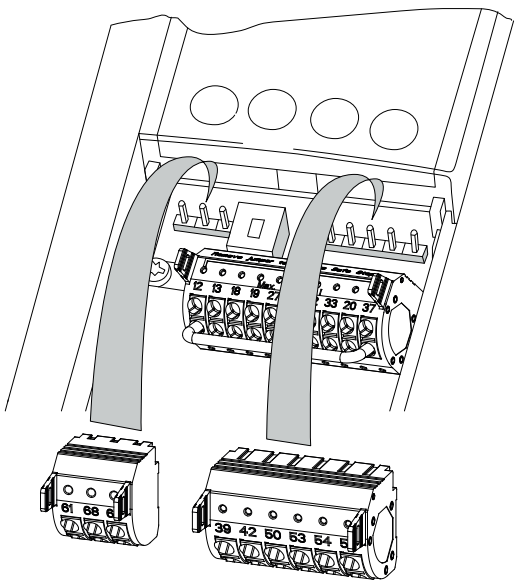
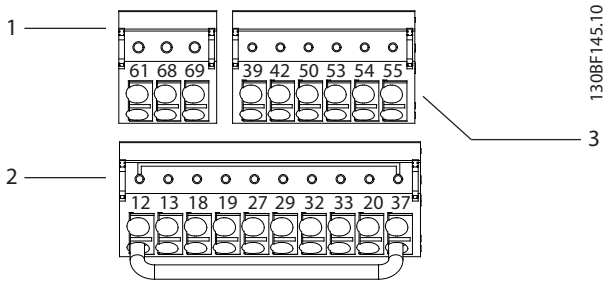


Illustration 5.35 Control Terminal Locations



1	Serial communication terminals
2	Digital input/output terminals
3	Analog input/output terminals

Illustration 5.36 Terminal Numbers Located on the Connectors

Terminal	Parameter	Default setting	Description
61	–	–	Integrated RC-filter for cable shield. ONLY for connecting the shield to correct EMC problems.
68 (+)	*Parameter group 8-3* FC Port Settings*	–	RS485 interface. A switch (BUS TER.) is provided on the control card for bus termination resistance. See *Illustration 5.40*.
69 (-)	*Parameter group 8-3* FC Port Settings*	–	

Table 5.1 Serial Communication Terminal Descriptions

Digital input/output terminals			
Terminal	**Parameter**	**Default setting**	**Description**
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*	

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Digital input/output terminals			
Terminal	**Parameter**	**Default setting**	**Description**
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	When not using the optional STO feature, a jumper wire is required between terminal 12 (or 13) and terminal 37. This set-up allows the drive to operate with factory default programming values.

Table 5.2 Digital Input/Output Terminal Descriptions

Analog input/output terminals			
Terminal	**Parameter**	**Default setting**	**Description**
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 1*	Reference	Analog input. For voltage or current. Switches A53 and A54 select mA or V.
54	*Parameter group 6-2* Analog Input 2*	Feedback	
55	–	–	Common for analog input.

Table 5.3 Analog Input/Output Terminal Descriptions

5.9.3 Wiring to Control Terminals

The control terminals are located near the LCP. The control terminal connectors can be unplugged from the drive for convenience when wiring, as shown in *Illustration 5.35*.

Either solid or flexible wire can be connected to the control terminals. Use the following procedures to connect or disconnect the control wires.

NOTICE

Minimize interference by keeping control wires as short as possible and separate from high-power cables.

Connecting wire to control terminals

1. Strip 10 mm (0.4 in) of the outer plastic layer from the end of the wire.
2. Insert the control wire into the terminal.
   - For a solid wire, push the bare wire into the contact. See *Illustration 5.37*.
   - For a flexible wire, open the contact by inserting a small screwdriver into the slot between the terminal holes and push the screwdriver inward. See *Illustration 5.38*. Then, insert the stripped wire into the contact, and remove the screwdriver.
3. Pull gently on the wire to ensure that the contact is firmly established. Loose control wiring can be the source of equipment faults or reduced performance.

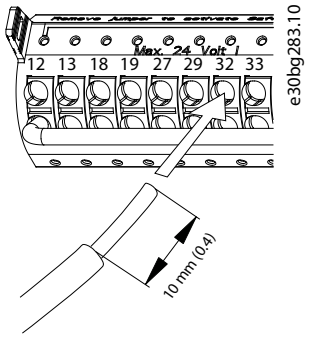

Illustration 5.37 Connecting Solid Control Wires

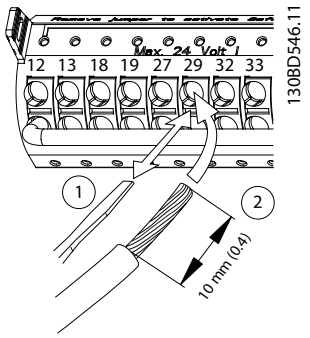

Illustration 5.38 Connecting Flexible Control Wires

Disconnecting wires from the control terminals

1. To open the contact, insert a small screwdriver into the slot between the terminal holes and push the screwdriver inward.
2. Pull gently on the wire to free it from the control terminal contact.

See *chapter 10.5 Cable Specifications* for control terminal wiring sizes and *chapter 8 Wiring Configuration Examples* for typical control wiring connections.

5.9.4 Enabling Motor Operation (Terminal 27)

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

- Digital input terminal 27 is designed to receive 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 wire provides an internal 24 V signal on terminal 27.
- When the status line at the bottom of the LCP reads *AUTO REMOTE COAST*, 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 drive cannot operate without a signal on terminal 27, unless terminal 27 is reprogrammed using *parameter 5-12 Terminal 27 Digital Input*.

5.9.5 Configuring RS485 Serial Communication

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

- Either Danfoss 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 5.40*.

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 5.4 Connecting to Ground* 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*.

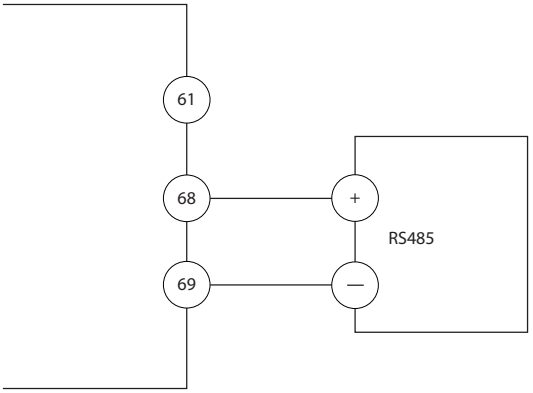

Illustration 5.39 Serial Communication Wiring Diagram

5.9.6 Wiring Safe Torque Off (STO)

The Safe Torque Off (STO) function is a component in a safety control system. STO prevents the unit from generating the voltage required to rotate the motor.

To run STO, more wiring for the drive is required. Refer to *Safe Torque Off Operating Guide* for further information.

5.9.7 Wiring the Space Heater

The space heater is an option used to prevent condensation from forming inside the enclosure when the unit is turned off. It is designed to be field wired and controlled by an external system.

Specifications

- Nominal voltage: 100–240
- Wire size: 12–24 AWG

5.9.8 Wiring the Auxiliary Contacts to the Disconnect

The disconnect is an option that is installed at the factory. The auxiliary contacts, which are signal accessories used with the disconnect, are not installed at the factory to allow more flexibility during installation. The contacts snap into place without the need for tools.

Contacts must be installed in specific locations on the disconnect depending on their functions. Refer to the datasheet included in the accessory bag that comes with the drive.

5

Specifications

- U_i/[V]: 690
- U_{imp}/[kV]: 4
- Pollution degree: 3
- I_{th}/[A]: 16
- Cable size: 1...2x0.75...2.5 mm^2
- Maximum fuse: 16 A/gG
- NEMA: A600, R300, wire size: 18–14 AWG, 1(2)

5.9.9 Wiring the Brake Resistor Temperature Switch

The brake resistor terminal block is found on the power card and allows for the connection of an external brake resistor temperature switch. The switch can be configured as normally closed or normally open. If the input changes, a signal trips the drive and shows *alarm 27, Brake chopper fault* on the LCP display. At the same time, the drive stops braking and the motor coasts.

1. Locate the brake resistor terminal block (terminals 104–106) on the power card. See *Illustration 3.3*.
2. Remove the M3 screws that hold the jumper to the power card.
3. Remove the jumper and wire the brake resistor temperature switch in 1 of the following configurations:
   - 3a **Normally closed**. Connect to terminals 104 and 106.
   - 3b **Normally open**. Connect to terminals 104 and 105.
4. Secure the switch wires with the M3 screws. Torque to 0.5–0.6 Nm (5 in-lb).

5.9.10 Selecting Voltage/Current Input Signal

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 drive before changing switch positions.

1. Remove the LCP. See *Illustration 5.40*.
2. Remove any optional equipment covering the switches.
3. Set switches A53 and A54 to select the signal type (U = voltage, I = current).

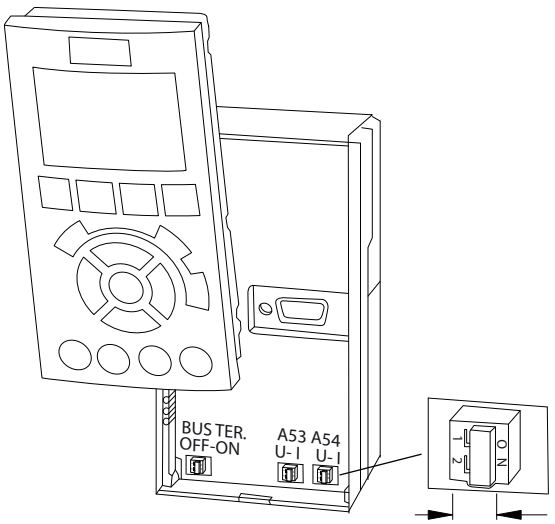

Illustration 5.40 Location of Terminal 53 and 54 Switches

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6 Pre-start Checklist

Before completing installation of the unit, inspect the entire installation as detailed in *Table 6.1*. Check and mark the items when completed.

Inspect for	Description	☑
Motor	• Confirm continuity of the motor by measuring ohm values on U–V (96–97), V–W (97–98), and W–U (98–96). • Confirm that the supply voltage matches the voltage of the drive and the motor.	
Switches	• Ensure that all switch and disconnect settings are in the proper positions.	
Auxiliary equipment	• Look for auxiliary equipment, switches, disconnects, or input fuses/circuit breakers that reside on the input power side of the drive or output side to the motor. Ensure that they are ready for full-speed operation. • Check function and installation of any sensors used for feedback to the drive. • Remove any power factor correction caps on motor. • Adjust any power factor correction caps on the mains side and ensure that they are dampened.	
Cable routing	• Ensure that motor wiring, brake wiring (if equipped), and control wiring are separated or 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 control wiring is isolated from high-power wiring for noise immunity. • Check the voltage source of the signals, if necessary. • Use shielded cable or twisted pair and ensure that the shield is terminated correctly.	
Input and output power wiring	• Check for loose connections. • Check that motor and mains are in separate conduit or separated shielded cables.	
Grounding	• Check for good ground connections that are tight and free of oxidation. • Grounding to conduit, or mounting the back panel to a metal surface, is not a suitable grounding.	
Fuses 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 (if used) are in the open position.	
Cooling clearance	• Look for any obstructions in the airflow path. • Measure top and bottom clearance of the drive to verify adequate airflow for cooling, see *chapter 4.5 Installation and Cooling Requirements*.	
Ambient conditions	• Check that requirements for ambient conditions are met. See *chapter 10.4 Ambient Conditions*.	
Interior of the drive	• Inspect that the unit interior is free of dirt, metal chips, moisture, and corrosion. • Verify that all installation tools have been removed from unit interior. • For D3h and D4h enclosures, ensure that the unit is mounted on an unpainted, metal surface.	
Vibration	• Check that the unit is mounted solidly, or that shock mounts are used, if necessary. • Check for an unusual amount of vibration.	

Table 6.1 Pre-start Check List

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7 Commissioning

7.1 Applying Power

⚠WARNING

UNINTENDED START

When the drive is connected to AC mains, DC supply, or load sharing, the motor can start at any time, causing risk of death, serious injury, and equipment, or property damage. The motor can start by activation of 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.

To prevent unintended motor start:

- **Press [Off] on the LCP before programming parameters.**
- **Disconnect the drive from mains whenever personal safety considerations make it necessary to avoid unintended motor start.**
- **Check that the drive, motor, and any driven equipment are in operational readiness.**

NOTICE

MISSING SIGNAL

If the status at the bottom of the LCP reads AUTO REMOTE COASTING, or *alarm 60, External interlock* is shown, it indicates that the unit is ready to operate but is missing an input signal on, for example, terminal 27. See *chapter 5.9.4 Enabling Motor Operation (Terminal 27)*.

Apply power to the drive 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 requirements.
3. Ensure that all operator devices are in the OFF position.
4. Close and securely fasten all covers and doors on the drive.
5. Apply power to the unit, but do not start the drive. For units with a disconnect switch, turn the switch to the ON position to apply power to the drive.

7.2 Programming the Drive

7.2.1 Parameter Overview

Parameters contain various settings that are used to configure and operate the drive and motor. These parameter settings are programmed into the local control panel (LCP) through the different LCP menus. For more detail on parameters, see the product-specific *programming guide*.

Parameter settings are assigned a default value at the factory, but can be configured for their unique application. Each parameter has a name and number that remain the same regardless of the programming mode.

In the *Main Menu* mode, the parameters are divided into groups. The 1st digit of the parameter number (from the left) indicates the parameter group number. The parameter group is then broken down into sub-groups, if necessary. For example:

*0-** Operation/Display*	Parameter group
0-0 Basic Settings*	Parameter sub-group
Parameter 0-01 Language	Parameter
Parameter 0-02 Motor Speed Unit	Parameter
Parameter 0-03 Regional Settings	Parameter

Table 7.1 Example of Parameter Group Hierarchy

7.2.2 Parameter Navigation

Use the following LCP keys to navigate through the parameters:

- Press [▲] [▼] to scroll up or down.
- Press [◄] [►] to shift a space to the left or right of a decimal point while editing a decimal parameter value.
- Press [OK] to accept the change.
- Press [Cancel] to disregard the change and exit edit mode.
- Press [Back] twice to show the status view.
- Press [Main Menu] once to go back to the main menu.

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7.2.3 Entering System Information

NOTICE

SOFTWARE DOWNLOAD

For commissioning via PC, install MCT 10 Set-up Software. The software is available for download (basic version) or for ordering (advanced version, code number 130B1000). For more information and downloads, see *www.danfoss.com/en/service-and-support/downloads/dds/vlt-motion-control-tool-mct-10/*.

The following steps are used to enter basic system information into the drive. Recommended parameter settings are intended for start-up and checkout purposes. Application settings vary.

NOTICE

Although these steps assume that an asynchronous motor is used, a permanent magnet motor can be used. For more information on specific motor types, see the product-specific *programming guide*.

1. Press [Main Menu] on the LCP.
2. Select *0-** Operation/Display* and press [OK].
3. Select *0-0* Basic Settings* and press [OK].
4. Select *parameter 0-03 Regional Settings* and press [OK].
5. Select *[0] International* or *[1] North America* as appropriate and press [OK]. (This action changes the default settings for some basic parameters).
6. Press [Quick Menus] on the LCP and then select *02 Quick Setup*.
7. Change the following parameters settings listed in *Table 7.2* if necessary. The motor data is found on the motor nameplate.

Parameter	Default setting
Parameter 0-01 Language	English
Parameter 1-20 Motor Power [kW]	4.00 kW
Parameter 1-22 Motor Voltage	400 V
Parameter 1-23 Motor Frequency	50 Hz
Parameter 1-24 Motor Current	9.00 A
Parameter 1-25 Motor Nominal Speed	1420 RPM
Parameter 5-12 Terminal 27 Digital Input	Coast inverse
Parameter 3-02 Minimum Reference	0.000 RPM
Parameter 3-03 Maximum Reference	1500.000 RPM
Parameter 3-41 Ramp 1 Ramp Up Time	3.00 s
Parameter 3-42 Ramp 1 Ramp Down Time	3.00 s
Parameter 3-13 Reference Site	Linked to Hand/ Auto
Parameter 1-29 Automatic Motor Adaptation (AMA)	Off

Table 7.2 Quick Set-up Settings

NOTICE

MISSING INPUT SIGNAL

When the LCP shows AUTO REMOTE COASTING or *alarm 60, External Interlock*, the unit is ready to operate but is missing an input signal. See *chapter 5.9.4 Enabling Motor Operation (Terminal 27)* for details.

7.2.4 Configuring Automatic Energy Optimization

Automatic energy optimization (AEO) is a procedure that minimizes voltage to the motor, reducing energy consumption, heat, and noise.

1. Press [Main Menu].
2. Select *1-** Load and Motor* and press [OK].
3. Select *1-0* General Settings* and press [OK].
4. Select *parameter 1-03 Torque Characteristics* and press [OK].
5. Select either *[2] Auto Energy Optim CT* or *[3] Auto Energy Optim VT* and press [OK].

7.2.5 Configuring Automatic Motor Adaptation

Automatic motor adaptation is a procedure that optimizes compatibility between the drive and the motor.

The drive builds a mathematical model of the motor for regulating output motor current. The procedure also tests the input phase balance of electrical power. It compares the motor characteristics with the data entered in *parameters 1-20* to *1-25*.

NOTICE

If warnings or alarms occur, see *chapter 9.5 List of Warnings and Alarms*. Some motors are unable to run the complete version of the test. In that case, or if an output filter is connected to the motor, select *[2] Enable reduced AMA*.

Run this procedure on a cold motor for best results.

1. Press [Main Menu].
2. Select *1-** Load and Motor* and press [OK].
3. Select *1-2* Motor Data* and press [OK].
4. Select *parameter 1-29 Automatic Motor Adaptation (AMA)* and press [OK].
5. Select *[1] Enable complete AMA* and press [OK].
6. Press [Hand On] and then [OK].
   The test runs automatically and indicates when it is complete.

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7.3 Testing Before System Start-up

⚠WARNING

MOTOR START

Failure to ensure that the motor, system, and any attached equipment are ready for start can result in personal injury or equipment damage. Before start,

- **Ensure that equipment is safe to operate under any condition.**
- **Ensure that the motor, system, and any attached equipment are ready for start.**

7.3.1 Motor Rotation

NOTICE

If the motor runs in the wrong direction, it can damage equipment. Before running the unit, check the motor rotation by briefly running the motor. The motor runs briefly at either 5 Hz or the minimum frequency set in *parameter 4-12 Motor Speed Low Limit [Hz]*.

1. Press [Hand On].
2. Move the left cursor to the left of the decimal point by using the left arrow key, and enter an RPM that slowly rotates the motor.
3. Press [OK].
4. If the motor rotation is wrong, set *parameter 1-06 Clockwise Direction* to *[1] Inverse*.

7.3.2 Encoder Rotation

If encoder feedback is used, perform the following steps:

1. Select *[0] Open Loop* in *parameter 1-00 Configuration Mode*.
2. Select *[1] 24 V encoder* in *parameter 7-00 Speed PID Feedback Source*.
3. Press [Hand On].
4. Press [►] for positive speed reference (*parameter 1-06 Clockwise Direction* at *[0] Normal*).
5. In *parameter 16-57 Feedback [RPM]*, check that the feedback is positive.

For more information on the encoder option, refer to the option manual.

NOTICE

NEGATIVE FEEDBACK

If the feedback is negative, the encoder connection is wrong. Use either *parameter 5-71 Term 32/33 Encoder Direction* or *parameter 17-60 Feedback Direction* to inverse the direction, or reverse the encoder cables. *Parameter 17-60 Feedback Direction* is only available with the VLT® Encoder Input MCB 102 option.

7.4 System Start-up

⚠WARNING

MOTOR START

Failure to ensure that the motor, system, and any attached equipment are ready for start can result in personal injury or equipment damage. Before start,

- **Ensure that equipment is safe to operate under any condition.**
- **Ensure that the motor, system, and any attached equipment are ready for start.**

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. Examples of external run commands are a switch, key, or programmable logic controller (PLC).
3. Adjust the speed reference throughout the speed range.
4. Ensure that the system is working as intended by checking sound and vibration level of the motor.
5. Remove the external run command.

If warnings or alarms occur, see *chapter 9.5 List of Warnings and Alarms*.

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7.5 Parameter Setting

NOTICE

REGIONAL SETTINGS

Some parameters have different default settings for international or North America. For a list of the different default values, see *chapter 11.2 International/North American Default Parameter Settings*.

Establishing the correct programming for applications requires setting several parameter functions. Details for parameters are provided in the *programming guide*.

Parameter settings are stored internally in the drive, allowing the following advantages:

- Parameter settings can be uploaded into the LCP memory and stored as a back-up.
- Multiple units can be programmed quickly by connecting the LCP to the unit and downloading the stored parameter settings.
- Settings that are stored in the LCP are not changed when restoring factory default settings.
- Changes made to default settings as well as any programming entered into parameters are stored and available for viewing in the quick menu. See *chapter 3.8 LCP Menus*.

7.5.1 Uploading and Downloading Parameter Settings

The drive operates using parameters stored on the control card, which is located within the drive. The upload and download functions move the parameters between the control card and the LCP.

1. Press [Off].
2. Go to *parameter 0-50 LCP Copy* and press [OK].
3. Select 1 of the following:
   - 3a To upload data from the control card to the LCP, select *[1] All to LCP*.
   - 3b To download data from the LCP to the control card, select *[2] All from LCP*.
4. Press [OK]. A progress bar shows the uploading or downloading process.
5. Press [Hand On] or [Auto On].

7.5.2 Restoring Factory Default Settings

NOTICE

LOSS OF DATA

Loss of programming, motor data, localization, and monitoring records occurs when restoring default settings. To create a back-up, upload data to the LCP before initialization. Refer to *chapter 7.5.1 Uploading and Downloading Parameter Settings*.

Restore the default parameter settings by initializing the unit. Initialization is carried out through *parameter 14-22 Operation Mode* or manually.

Parameter 14-22 Operation Mode does not reset settings such as the following:

- Running hours.
- Serial communication options.
- Personal menu settings.
- Fault log, alarm log, and other monitoring functions.

Recommended initialization

1. Press [Main Menu] twice to access parameters.
2. Go to *parameter 14-22 Operation Mode* and press [OK].
3. Scroll to *Initialization* 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. Start-up takes slightly longer than normal.
6. After *alarm 80, Drive initialized to default value* appears, press [Reset].

Manual initialization

Manual initialization resets all factory settings except for the following:

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

To perform manual initialization:

1. Remove power to the unit and wait for the display to turn off.
2. Press and hold [Status], [Main Menu], and [OK] simultaneously while applying power to the unit (approximately 5 s or until an audible click sounds and the fan starts). Start-up takes slightly longer than normal.

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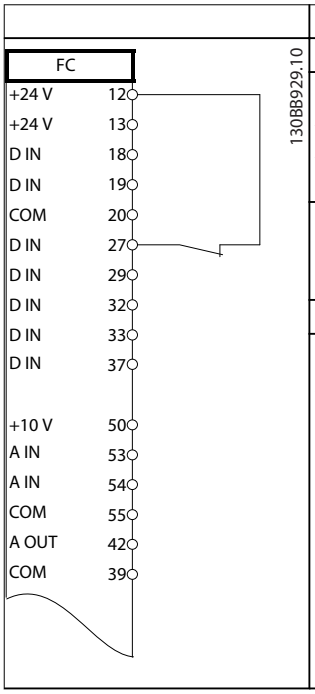
8 Wiring Configuration Examples

8.1 Introduction

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

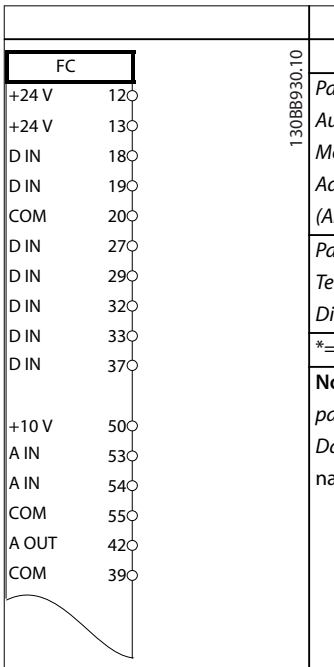
- Parameter settings are the regional default values unless otherwise indicated (selected in *parameter 0-03 Regional Settings*).
- Parameters associated with the terminals and their settings are shown next to the drawings.
- Switch settings for analog terminals A53 or A54 are shown where required.
- For STO, a jumper wire may be required between terminal 12 and terminal 37 when using factory default programming values.

8.2 Wiring Configurations for 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: Set *parameter group 1-2* Motor Data* according to motor nameplate.	

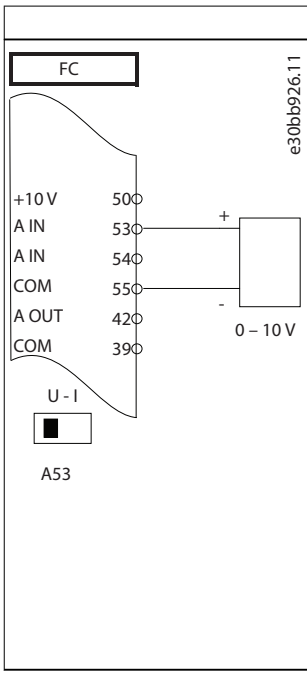
Table 8.1 Wiring Configuration for AMA with T27 Connected



	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: Set *parameter group 1-2* Motor Data* according to motor nameplate.	

Table 8.2 Wiring Configuration for AMA without T27 Connected

8.3 Wiring Configurations for Analog Speed Reference



	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 RPM
	Parameter 6-15 Terminal 53 High Ref./Feedb. Value	1500 RPM
	*=Default value	
	Notes/comments:	

Table 8.3 Wiring Configuration for Analog Speed Reference (Voltage)

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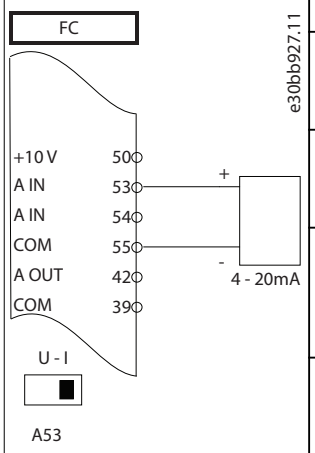
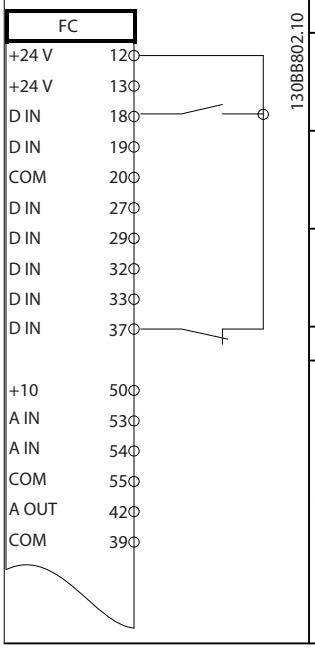


Parameters	
Function	**Setting**
Parameter 6-12 Terminal 53 Low Current	4 mA*
Parameter 6-13 Terminal 53 High Current	20 mA*
Parameter 6-14 Terminal 53 Low Ref./Feedb. Value	0 RPM
Parameter 6-15 Terminal 53 High Ref./Feedb. Value	1500 RPM
*=Default value	
Notes/comments:	

Table 8.4 Wiring Configuration for Analog Speed Reference (Current)

8.4 Wiring Configurations for Start/Stop



Parameters	
Function	**Setting**
Parameter 5-10 Terminal 18 Digital Input	*[8] Start**
Parameter 5-12 Terminal 27 Digital Input	*[0] No operation*
Parameter 5-19 Terminal 37 Safe Stop	*[1] Safe Torque Off 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.	

Table 8.5 Wiring Configuration for Start/Stop Command with Safe Torque Off

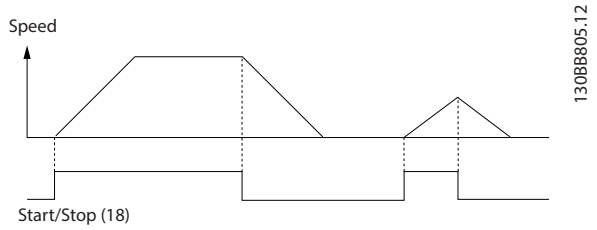
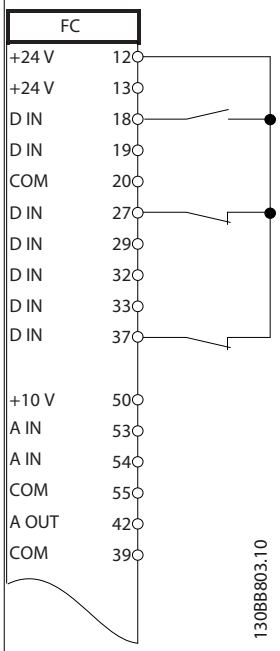


Illustration 8.1 Start/Stop with Safe Torque Off



Parameters	
Function	**Setting**
Parameter 5-10 Terminal 18 Digital Input	*[9] Latched Start*
Parameter 5-12 Terminal 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.	

Table 8.6 Wiring Configuration for Pulse Start/Stop

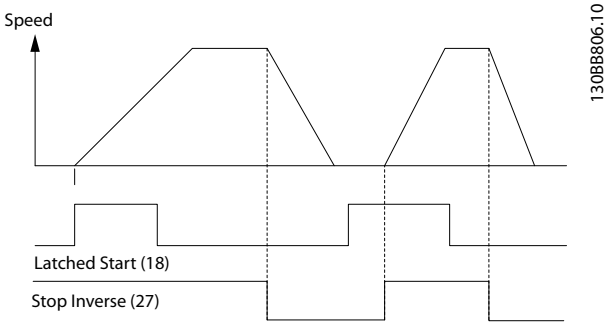


Illustration 8.2 Latched Start/Stop Inverse

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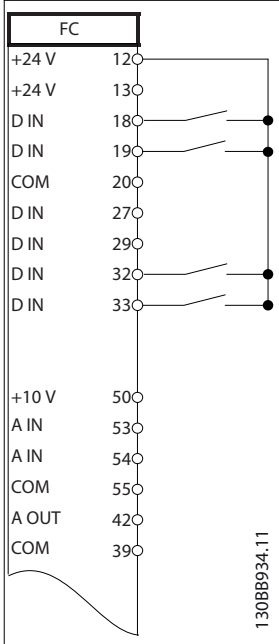
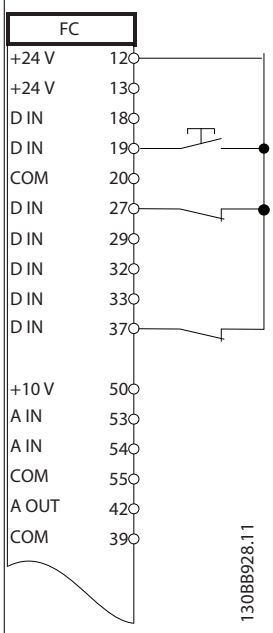


	Parameters	
	Function	**Setting**
	Parameter 5-10 Terminal 18 Digital Input	*[8] Start*
	Parameter 5-11 Terminal 19 Digital Input	*[10] Reversing**
	Parameter 5-12 Terminal 27 Digital Input	*[0] No operation*
	Parameter 5-14 Terminal 32 Digital Input	*[16] Preset ref bit 0*
	Parameter 5-15 Terminal 33 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:	

Table 8.7 Wiring Configuration for Start/Stop with Reversing and 4 Preset Speeds

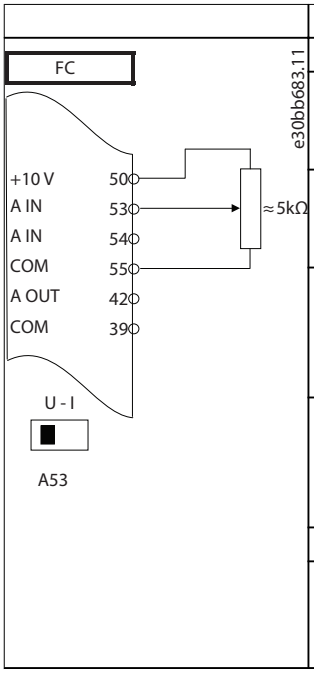
8.5 Wiring Configuration for an External Alarm Reset



	Parameters	
	Function	**Setting**
	Parameter 5-11 Terminal 19 Digital Input	*[1] Reset*
	*=Default value	
	Notes/comments:	

Table 8.8 Wiring Configuration for an External Alarm Reset

8.6 Wiring Configuration for Speed Reference Using a Manual Potentiometer



	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 RPM
	Parameter 6-15 Terminal 53 High Ref./Feedb. Value	1500 RPM
	*=Default value	
	Notes/comments:	

Table 8.9 Wiring Configuration for Speed Reference

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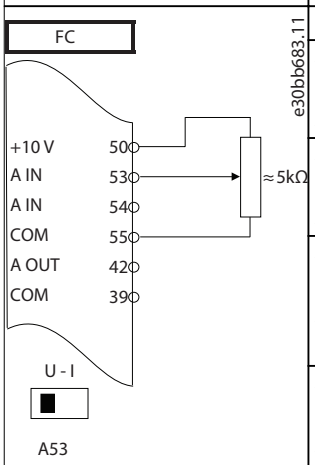
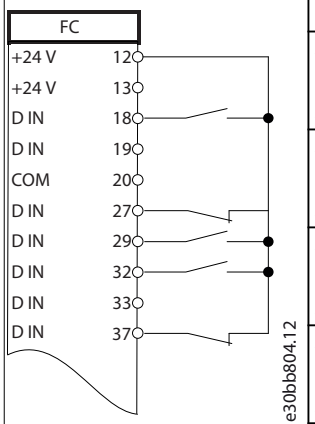
(Using a Manual Potentiometer)



	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 RPM
	Parameter 6-15 Terminal 53 High Ref./Feedb. Value	1500 RPM
	*=Default value	
	Notes/comments:	

Table 8.10 Wiring Configuration for Speed Reference (Using a Manual Potentiometer)

8.7 Wiring Configuration for Speed Up/ Speed Down



	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:	

Table 8.11 Wiring Configuration for Speed Up/Speed Down

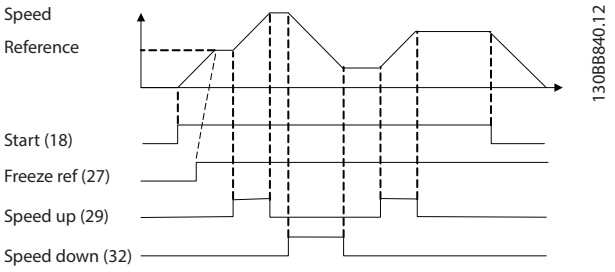
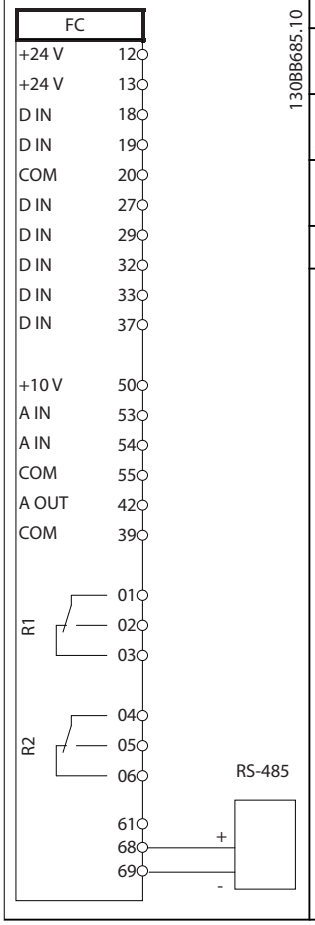


Illustration 8.3 Speed Up/Speed Down

8.8 Wiring Configuration for RS485 Network Connection



	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 the parameters.	

Table 8.12 Wiring Configuration for RS485 Network Connection

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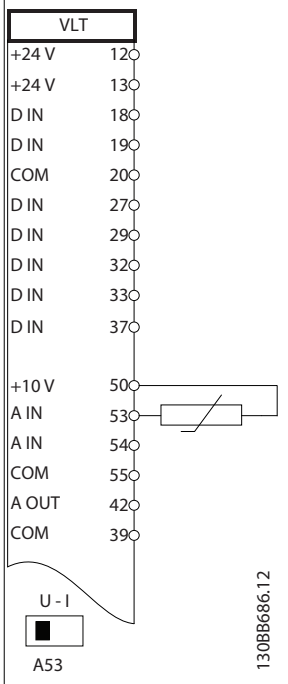
8.9 Wiring Configuration for a Motor Thermistor

NOTICE

Thermistors must use 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 wanted, set *parameter 1-90 Motor Thermal Protection* to *[1] Thermistor warning*.	

Table 8.13 Wiring Configuration for a Motor Thermistor

8.10 Wiring Configuration for a Cascade Controller

Illustration 8.4 shows an example with the built-in basic cascade controller with 1 variable-speed pump (lead) and 2 fixed-speed pumps, a 4–20 mA transmitter, and system safety interlock.

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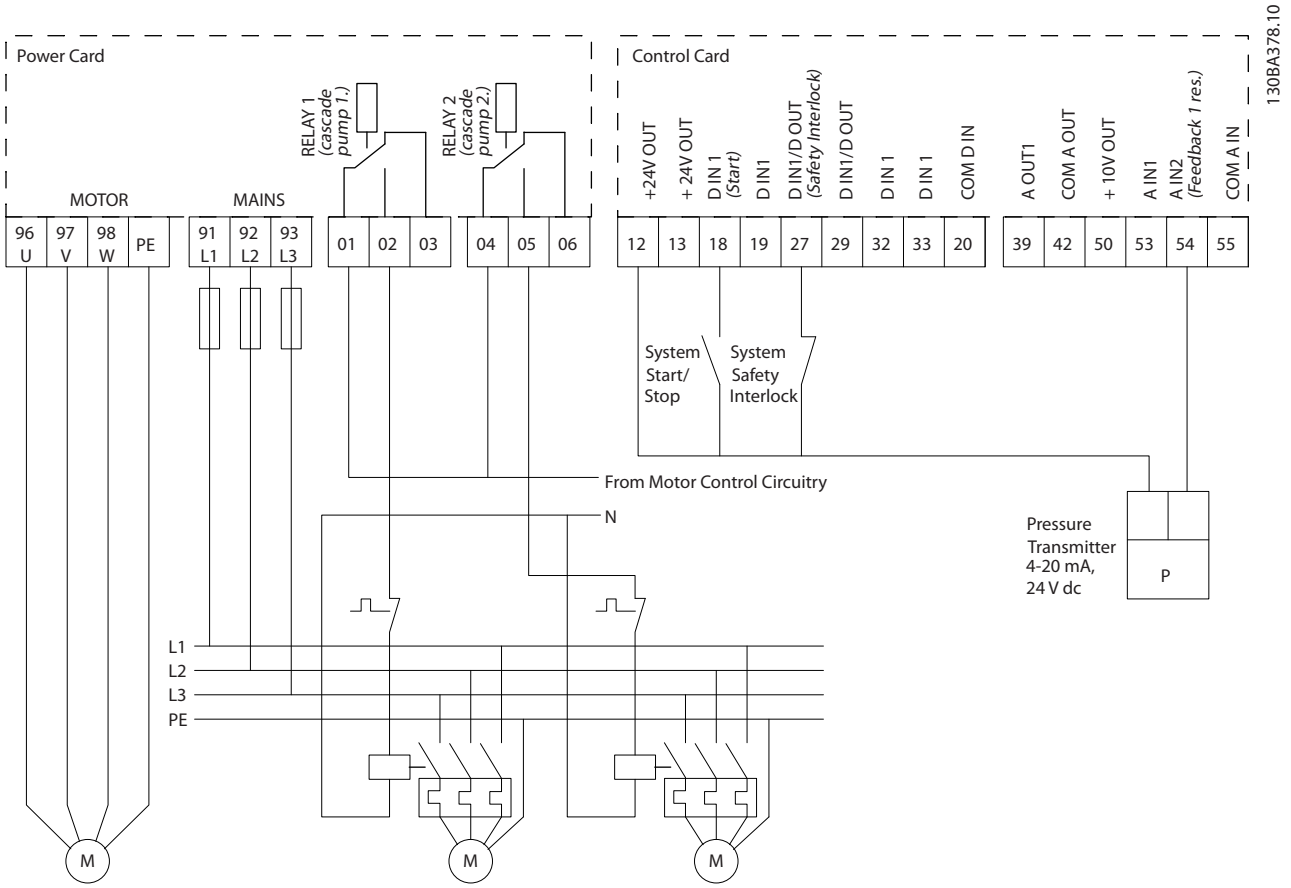

Illustration 8.4 Cascade Controller Wiring Diagram

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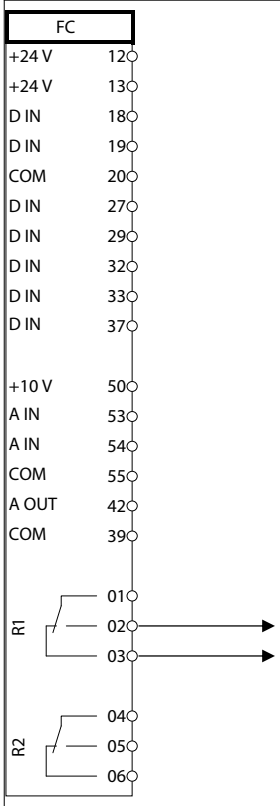
8.11 Wiring Configuration for Relay Set-up with Smart Logic Control



	Parameters	
	Function	**Setting**
	Parameter 4-30 Motor Feedback Loss Function	*[1] Warning*
	Parameter 4-31 Motor Feedback Speed Error	100 RPM
	Parameter 4-32 Motor Feedback Loss Timeout	5 s
	Parameter 7-00 Speed PID Feedback Source	*[2] MCB 102*
	Parameter 17-11 Resolution (PPR)	1024*
	Parameter 13-00 SL Controller Mode	*[1] On*
	Parameter 13-01 Start Event	*[19] Warning*
	Parameter 13-02 Stop Event	*[44] Reset key*
	Parameter 13-10 Comparator Operand	*[21] Warning no.*
	Parameter 13-11 Comparator Operator	*[1] ≈ (equal)**
	Parameter 13-12 Comparator Value	90
	Parameter 13-51 SL Controller Event	*[22] Comparator 0*
	Parameter 13-52 SL Controller Action	*[32] Set digital out A low*
	Parameter 5-40 Function Relay	*[80] SL digital output A*
	*=Default value	

Notes/comments:
If the limit in the feedback monitor is exceeded, *warning 90, Feedback Mon.* is issued. The SLC monitors *warning 90, Feedback Mon.* and if the warning becomes true, relay 1 is triggered. External equipment may require service. If the feedback error goes below the limit again within 5 s, the drive continues and the warning disappears. Reset relay 1 by pressing [Reset] on the LCP.

Table 8.14 Wiring Configuration for a Relay Set-up with Smart Logic Control

8.12 Wiring Configuration for a Fixed Variable Speed Pump

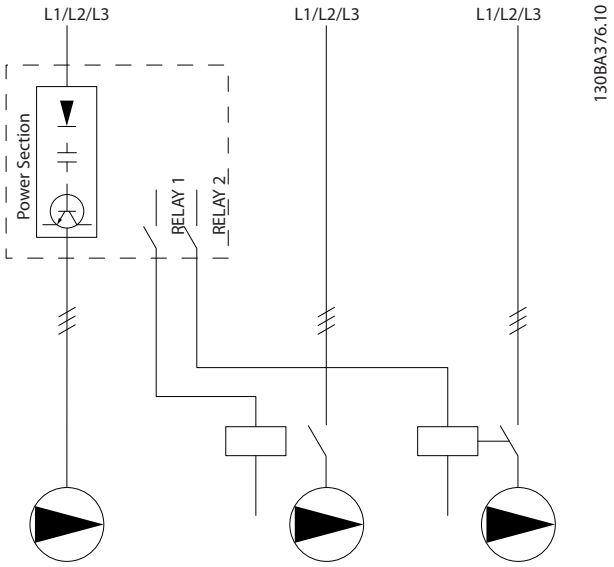


Illustration 8.5 Fixed Variable Speed Pump Wiring Diagram

8.13 Wiring Configuration for Lead Pump Alternation

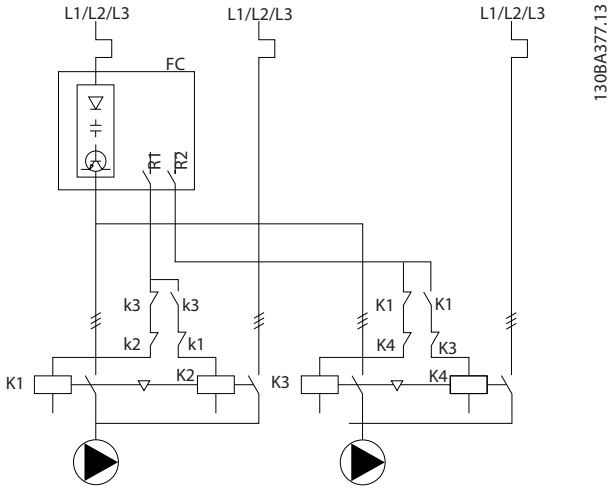


Illustration 8.6 Lead Pump Alternation Wiring Diagram

Every pump must be connected to 2 contactors (K1/K2 and K3/K4) with a mechanical interlock. Thermal relays or other motor overload protection devices must be applied according to local regulation and/or individual demands.

- Relay 1 (R1) and relay 2 (R2) are the built-in relays in the drive.
- When all relays are de-energized, the 1st built-in relay that is energized cuts in the contactor corresponding to the pump controlled by the

relay. For example, relay 1 cuts in contactor K1, which becomes the lead pump.

- K1 blocks for K2 via the mechanical interlock, preventing mains from being connected to the output of the drive (via K1).
- Auxiliary break contact on K1 prevents K3 from cutting in.
- Relay 2 controls contactor K4 for on/off control of the fixed speed pump.
- At alternation, both relays de-energize and now relay 2 is energized as the 1st relay.

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9 Maintenance, Diagnostics, and Troubleshooting

This chapter includes:

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

9.1 Maintenance and Service

Under normal operating conditions and load profiles, the drive is maintenance-free throughout its designed lifetime. To prevent breakdown, danger, and damage, examine the drive at regular intervals depending on the operating conditions. Replace worn or damaged parts with original spare parts or standard parts. For service and support, refer to *www.danfoss.com/en/contact-us/contacts-list/?filter=type%3Adanfoss-sales-service-center%2Csegments%3ADDS*.

⚠WARNING

UNINTENDED START

When the drive 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 drive from the mains.**
- **Completely wire and assemble the drive, motor, and any driven equipment before connecting the drive to AC mains, DC supply, or load sharing.**

9.2 Heat Sink Access Panel

9.2.1 Removing the Heat Sink Access Panel

The drive can be ordered with an optional access panel in the back of the unit. This panel provides access to the heat sink and allows the heat sink to be cleaned of any dust buildup.

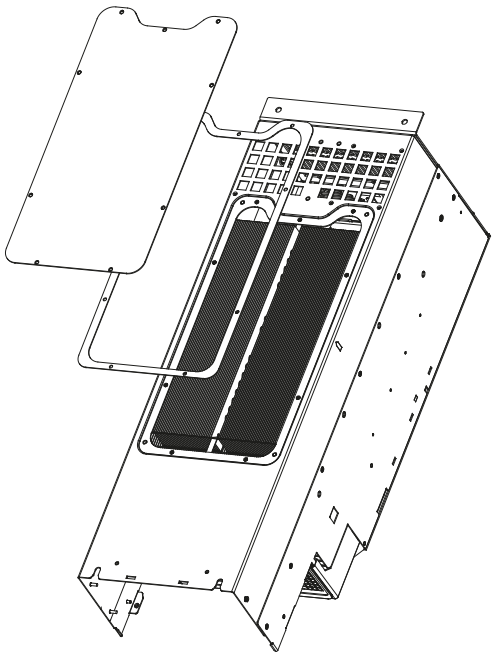

Illustration 9.1 Heat Sink Access Panel

NOTICE

DAMAGE TO HEAT SINK

Using fasteners that are longer than those originally supplied with the heat sink panel can damage the heat sink cooling fins.

1. Remove power from the drive and wait 20 minutes for the capacitors to discharge completely. Refer to *chapter 2 Safety*.
2. Position the drive so that the back of the drive is accessible.
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 drive.
4. Inspect the heat sink for damage or dust buildup.
5. Remove dust and debris with a vacuum.
6. Replace the panel and secure it to the back of the enclosure with the screws previously removed. Tighten the fasteners according to *chapter 10.8 Fastener Tightening Torques*.

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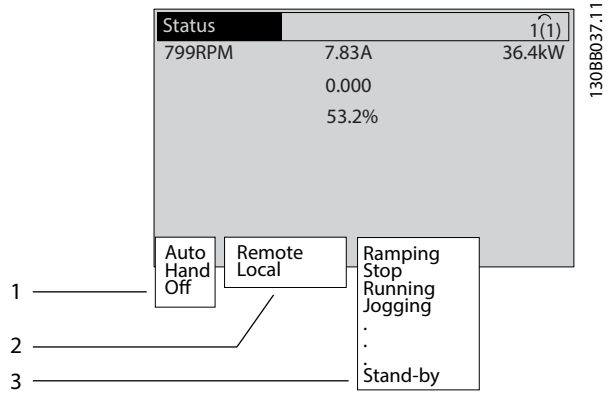
9.3 Status Messages

When the drive is in status mode, status messages automatically appear in the lowest line of the LCP display. Refer to *Illustration 9.2*. Status messages are defined in *Table 9.1 – Table 9.3*.



1	Where the stop/start command originates. Refer to *Table 9.1*.
2	Where the speed control originates. Refer to *Table 9.2*.
3	Provides the drive status. Refer to *Table 9.3*.

Illustration 9.2 Status Display

NOTICE

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

Table 9.1 to *Table 9.3* define the meaning of the shown status messages.

Off	The drive does not react to any control signal until [Auto On] or [Hand On] is pressed.
Auto	The start/stop commands are sent via the control terminals and/or the serial communication.
Hand	The navigation keys on the LCP can be used to control the drive. Stop commands, reset, reversing, DC brake, and other signals applied to the control terminals override local control.

Table 9.1 Operating Mode

Remote	The speed reference is given from: • External signals. • Serial communication. • Internal preset references.
Local	The drive uses reference values from the LCP.

Table 9.2 Reference Site

AC brake	AC brake 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. To start, press [Hand On].
AMA running	AMA process is in progress.
Braking	The brake chopper is in operation. The brake resistor absorbs the generative energy.
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	• *[2] 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] Ctrl. 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 drive ramps down the motor using a controlled ramp-down.
Current high	The drive output current is above the limit set in *parameter 4-51 Warning Current High*.
Current low	The drive output current is below the limit set in *parameter 4-52 Warning Speed Low*.
DC hold	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 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*). • DC brake is activated 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*.

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Freeze output	The remote reference, which holds the present speed, is active. • *[20] 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 has been given, but the motor remains stopped until a run permissive signal is received.
Freeze ref.	*[19] Freeze Reference* was selected as a function for a digital input (*parameter group 5-1* Digital Inputs*). The corresponding terminal is active. The drive saves the actual reference. Changing the reference is now only possible via terminal functions speed up and speed down.
Jog request	A jog command has been given, but the motor is stopped until a run permissive signal is received via a digital input.
Jogging	The motor is running as programmed in *parameter 3-19 Jog Speed [RPM]*. • *[14] Jog* was selected as 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 drive, 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 is supplying the drive with generative energy. The overvoltage control adjusts the V/Hz ratio to run the motor in controlled mode and to prevent the drive from tripping.
Power unit off	(For drives with a 24 V DC external supply installed only.) Mains supply to the drive is removed, but the control card is supplied by the 24 V DC external supply.
Protection md	Protection mode is active. The unit has detected a critical status (an overcurrent or overvoltage). • To avoid tripping, the switching frequency is reduced to 1500 kHz if *parameter 14-55 Output Filter* is set to *[2] Sine-Wave Filter Fixed*. Otherwise, the switching frequency is reduced to 1000 Hz. • 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*. • *[4] 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 drive is running in the reference range. The feedback value matches the setpoint value.
Run request	A start command has been given, but the motor is stopped until a run permissive signal is received via digital input.
Running	The drive is driving the motor.
Sleep mode	The energy saving function is enabled. This function being enabled means that the motor has stopped, but that it restarts automatically when required.
Speed high	The motor speed is above the value set in *parameter 4-53 Warning Speed High*.
Speed low	The motor speed is below the value set in *parameter 4-52 Warning Speed Low*.
Standby	In auto-on mode, the drive 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.

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Start fwd/rev	*[12] Enable Start Forward* and *[13] Enable Start Reverse* were selected as functions for 2 different digital inputs (*parameter group 5-1* Digital Inputs*). The motor starts in forward or reverse depending on which corresponding terminal is activated.
Stop	The drive has received a stop command from 1 of the following: • LCP. • Digital input. • Serial communication.
Trip	An alarm occurred and the motor is stopped. Once the cause of the alarm is cleared, reset the drive using 1 of the following: • Pressing [Reset]. • Remotely by control terminals. • Via serial communication. Pressing [Reset] or remotely by control terminals or via serial communication.
Trip lock	An alarm occurred and the motor is stopped. Once the cause of the alarm is cleared, cycle power to the drive. Reset the drive manually by 1 of the following: • Pressing [Reset]. • Remotely by control terminals. • Via serial communication.

Table 9.3 Operation Status

9.4 Warning and Alarm Types

The drive software issues warnings and alarms to help diagnose issues. The warning or alarm number appears in the LCP.

Warning
A warning indicates that the drive has encountered an abnormal operating condition that leads to an alarm. A warning stops when the abnormal condition is removed or resolved.

Alarm
An alarm indicates a fault that requires immediate attention. The fault always triggers a trip or trip lock. Reset the drive after an alarm.
Reset the drive in any of 4 ways:

- Press [Reset]/[Off/Reset].
- Digital reset input command.
- Serial communication reset input command.
- Auto reset.

Trip
When tripping, the drive suspends operation to prevent damage to the drive and other equipment. When a trip occurs, the motor coasts to a stop. The drive logic continues to operate and monitor the drive status. After the fault condition is remedied, the drive is ready for a reset.

Trip lock
When trip locking, the drive suspends operation to prevent damage to the drive and other equipment. When a trip lock occurs, the motor coasts to a stop. The drive logic continues to operate and monitor the drive status. The drive starts a trip lock only when serious faults occur that can damage the drive or other equipment. After the faults are fixed, cycle the input power before resetting the drive.

Warning and alarm displays

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

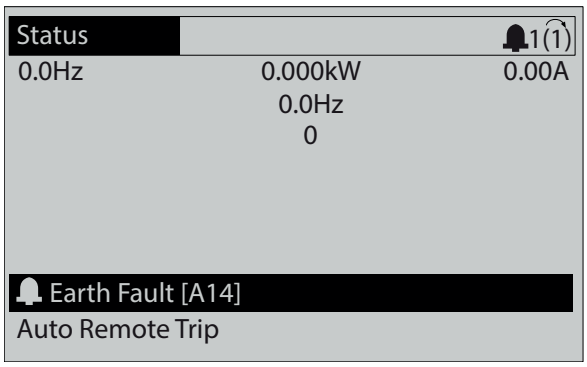
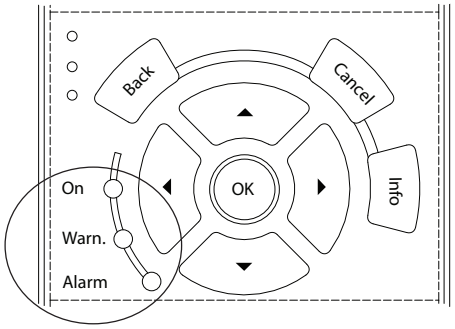


Illustration 9.3 Alarm Example

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



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

Illustration 9.4 Status Indicator Lights

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9.5 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.
  - VLT® General Purpose I/O MCB 101 terminals 11 and 12 for signals, terminal 10 common.
  - VLT® 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 has been connected to the output of the drive. This warning or alarm appears only if programmed in *parameter 1-80 Function at Stop*.

Troubleshooting

- Check the connection between the drive and the motor.

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

Troubleshooting

- Check the supply voltage and supply currents to the drive.

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 drive 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 drive 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 drive cannot be reset until the counter is below 90%.

Troubleshooting

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

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

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Select 1 of these options:

- The drive issues a warning or an alarm when the counter is >90% if *parameter 1-90 Motor Thermal Protection* is set to warning options.
- The drive 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 drive to the motor more accurately and reduces thermal loading.

WARNING/ALARM 11, Motor thermistor overtemp

Check whether the thermistor is disconnected. Select whether the drive issues a warning or an alarm in *parameter 1-90 Motor Thermal Protection*.

Troubleshooting

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

WARNING/ALARM 12, Torque limit

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

Troubleshooting

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

WARNING/ALARM 13, Over current

The inverter peak current limit (approximately 200% of the rated current) is exceeded. The warning lasts approximately 1.5 s, then the drive 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 drive.
- 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 drive and the motor, or in the motor itself. The current transducers detect the ground fault by measuring current going out from the drive and current going into the drive from the motor. Ground fault is issued if the deviation of the 2 currents is too large. The current going out of the drive must be the same as the current going into the drive.

Troubleshooting

- Remove power to the drive 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 drive. Perform the manual initialization or perform a complete AMA. This method is most relevant after changing the power card.

ALARM 15, Hardware mismatch

A fitted option is not operational with the present control card hardware or software.

Record the value of the following parameters and contact Danfoss.

- *Parameter 15-40 FC Type*.
- *Parameter 15-41 Power Section*.

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- *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).

There is short-circuiting in the motor or motor wiring.

⚠WARNING

HIGH VOLTAGE

Drives 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.

ALARM 16, Short circuit

Troubleshooting

- Remove the power to the drive and repair the short circuit.
- Check that the drive contains the correct current scaling card and the correct number of current scaling cards for the system.

WARNING/ALARM 17, Control word timeout

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

Troubleshooting

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

WARNING/ALARM 20, Temp. input error

The temperature sensor is not connected.

WARNING/ALARM 21, Parameter error

The parameter is out of range. The parameter number is shown in the display.

Troubleshooting

- Set the affected parameter to a valid value.

WARNING/ALARM 22, Hoist mechanical brake

The value of this warning/alarm indicates the cause:.

0 = The torque reference was not reached before timeout (*parameter 2-27 Torque Ramp Time*).
1 = Expected brake feedback was not received before timeout (*parameter 2-23 Activate Brake Delay*, *parameter 2-25 Brake Release Time*).

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 drives 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 drives with AC fans, the voltage to the fan is monitored.

Troubleshooting

- Check for proper fan operation.
- Cycle power to the drive 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*).

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. This alarm also shows if there is a communication error between the power card and the control card.

Check the alarm log for the report value associated with this warning.

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

Fan troubleshooting

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

Power card troubleshooting

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

WARNING 25, Brake resistor short circuit

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

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Troubleshooting

- Remove the power to the drive 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 drive trips when the dissipated braking power reaches 100%.

The brake transistor is monitored during operation, and if a short circuit occurs, the brake function is disabled, and a warning is issued. The drive is still operational, but since the brake transistor has short-circuited, substantial power is transmitted to the brake resistor, even if it is inactive.

⚠WARNING

OVERHEATING RISK

A surge in power can cause the brake resistor to overheat and possibly catch fire. Failure to remove power to the drive and remove the brake resistor can cause equipment damage.

Troubleshooting

- Remove power to the drive.
- Remove the brake resistor.
- Troubleshoot the short circuit.

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

Troubleshooting

- Check *parameter 2-15 Brake Check*.

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

Troubleshooting
Check for the following conditions:

- Ambient temperature too high.
- Motor cable too long.
- Incorrect airflow clearance above and below the drive.
- Blocked airflow around the drive.
- Damaged heat sink fan.
- Dirty heat sink.

For drives in enclosure sizes D and E, this alarm is based on the temperature measured by the heat sink sensor mounted inside the IGBT modules.

Troubleshooting

- Check fan resistance.
- Check soft charge fuses.
- Check IGBT thermal.

ALARM 30, Motor phase U missing
Motor phase U between the drive and the motor is missing.

⚠WARNING

HIGH VOLTAGE

Drives 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.**

Troubleshooting

- Remove the power from the drive and check motor phase U.

ALARM 31, Motor phase V missing
Motor phase V between the drive and the motor is missing.

⚠WARNING

HIGH VOLTAGE

Drives 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.**

Troubleshooting

- Remove the power from the drive and check motor phase V.

ALARM 32, Motor phase W missing
Motor phase W between the drive and the motor is missing.

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⚠WARNING

HIGH VOLTAGE

Drives 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.**

Troubleshooting

- Remove the power from the drive 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.
- Check potential DC-link fault to ground.

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 drive system is lost and *parameter 14-10 Mains Failure* is not set to option *[0] No Function*.

- Check the fuses to the drive system and the mains supply to the unit.
- Check that mains voltage conforms to product specifications.
- Check that the following conditions are not present:
  Alarm 307, Excessive THD(V), *alarm 321, Voltage imbalance*, *warning 417, Mains undervoltage*, or *warning 418, Mains overvoltage* is reported if any of the listed conditions are true:
  - The 3-phase voltage magnitude drops below 25% of the nominal mains voltage.
  - Any single-phase voltage exceeds 10% of the nominal mains voltage.
  - Percent of phase or magnitude imbalance exceeds 8%.
  - Voltage THD exceeds 10%.

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 9.4* 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 Danfoss supplier or service department. Note the code number for further troubleshooting directions.

Number	Text
0	The serial port cannot be initialized. Contact the Danfoss supplier or Danfoss service department.
256–258	The power EEPROM data is defective or too old. Replace the power card.
512–519	Internal fault. Contact the Danfoss supplier or Danfoss service department.
783	Parameter value outside of minimum/maximum limits.
1024–1284	Internal fault. Contact the Danfoss supplier or Danfoss service department.
1299	The option software in slot A is too old.
1300	The option software in slot B is too old.
1302	The option software in slot C1 is too old.
1315	The option software in slot A is not supported/ allowed.
1316	The option software in slot B is not supported/ allowed.
1318	The option software in slot C1 is not supported/ allowed.
1379–2819	Internal fault. Contact the Danfoss supplier or Danfoss service department.
1792	Hardware reset of digital signal processor.
1793	Motor-derived parameters not transferred correctly to the digital signal processor.
1794	Power data not transferred correctly at power-up to the digital signal processor.
1795	The digital signal processor has received too many unknown SPI telegrams. The AC drive 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.

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Number	Text
5123	Option in slot A: Hardware incompatible with the control board hardware.
5124	Option in slot B: Hardware incompatible with the control board hardware.
5125	Option in slot C0: Hardware incompatible with the control board hardware.
5126	Option in slot C1: Hardware incompatible with the control board hardware.
5376–6231	Internal fault. Contact the Danfoss supplier or Danfoss service department.

Table 9.4 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.

Troubleshooting

- Check the ribbon cable between the power card and gatedrive card.
- Check for a defective power card.
- Check for a defective gatedrive card.

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

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

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

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

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

ALARM 45, Earth fault 2
Ground fault.

Troubleshooting

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

ALARM 46, Power card supply
The supply on the power card is out of range.

There are 4 supplies generated by the switch mode power supply on the power card:

- 48 V.
- 24 V.
- 5 V.
- ±18 V.

When powered with VLT® 24 V DC Supply MCB 107, only the 24 V and 5 V supplies are monitored. When powered with 3-phase mains voltage, all 4 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 D-sized drives for a defective heat sink fan, top fan, or door fan.
- Check E-sized drives for a defective mixing fan.

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

There are 4 supplies generated by the switch mode supply (SMPS) on the power card:

- 48 V.
- 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

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parameter 1-86 Trip Speed Low [RPM] (except when starting or stopping), the drive trips.

ALARM 50, AMA calibration failed
Contact the Danfoss supplier or Danfoss service department.

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

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

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

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

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

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

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

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

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

ALARM 58, AMA Internal fault
Contact the Danfoss supplier.

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

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

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

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

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

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

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

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

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

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 drive 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 drive 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.

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- Check the power card.

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

WARNING/ALARM 71, PTC 1 Safe Stop
Safe Torque Off (STO) has been activated from the VLT® PTC Thermistor Card MCB 112 because the motor is too warm. Once the motor cools and the digital input from the MCB 112 is deactivated, normal operation can resume when the MCB 112 applies 24 V DC to terminal 37 again. When the motor is ready for normal operation, a reset signal is sent (via serial communication, digital I/O, or by pressing [Reset] on the LCP). If automatic restart is enabled, the motor can start when the fault is cleared.

ALARM 72, Dangerous failure

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

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

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

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

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

WARNING 76, Power unit setup
The required number of power units does not match the detected number of active power units. When replacing an enclosure size F module, this warning occurs if the power-specific data in the module power card does not match the rest of the drive. If the power card connection is lost, the unit also triggers this warning.

Troubleshooting

- Confirm that the spare part and its power card are the correct part number.
- Ensure that the 44-pin cables between the MDCIC and power cards are mounted properly.

WARNING 77, Reduced power mode
This alarm applies to only multi-drive systems. The system is operating in reduced power mode (fewer than the allowed number of drive modules). This warning is generated on power cycle when the system is set to run with fewer drive modules 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 drive.
- 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. Also, the MK101 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 VLT® Encoder Input MCB 102 or VLT® Resolver Input MCB 103.

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

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ALARM 96, Start delayed
The motor start has been delayed due to short-cycle protection. *Parameter 22-76 Interval between Starts* is enabled.

Troubleshooting
- Troubleshoot the system and reset the drive after clearing the fault.

WARNING 97, Stop delayed
Stopping the motor has been delayed because the motor has been running for less than the minimum time specified in *parameter 22-77 Minimum Run Time*.

WARNING 98, Clock fault
Time is not set, or the RTC clock has failed. Reset the clock in *parameter 0-70 Date and Time*.

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 drive to determine if the warning/alarm returns.

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

ALARM 144, Inrush Supply
A supply voltage on the inrush card is out of range. See the bit field result report value for more details.

- Bit 2: Vcc high.
- Bit 3: Vcc low.
- Bit 4: Vdd high.
- Bit 5: Vdd low.

ALARM 145, External SCR disable
The alarm indicates a series DC-link capacitor voltage imbalance.

WARNING/ALARM 146, Mains voltage
Mains voltage is outside valid operating range. The following report values provide more details.

- Voltage too low: 0=R-S, 1=S-T, 2=T-R
- Voltage too high: 3=R-S, 4=S-T, 5=T-R

WARNING/ALARM 147, Mains frequency
Mains frequency is outside valid operating range. Report value provides more details.

- 0: frequency too low.
- 1: frequency too high.

WARNING/ALARM 148, System temp
One or more of the system temperature measurements is too high.

WARNING 163, ATEX ETR cur.lim.warning
The drive 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 drive trips.

WARNING 165, ATEX ETR freq.lim.warning
The drive 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 drive has operated for more than 60 s (in a period of 600 s) below the allowed minimum frequency (*parameter 1-98 ATEX ETR interpol. points freq.*).

WARNING 200, Fire mode
The drive is operating in fire mode. The warning clears when fire mode is removed. Refer to the fire mode data in the alarm log.

WARNING 201, Fire mode was active
The drive has entered fire mode. Cycle power to the unit to remove the warning. Refer to the fire mode data in the alarm log.

WARNING 202, Fire mode limits exceeded
While operating in fire mode, 1 or more alarm conditions that would normally trip the unit have been ignored. Operating in this condition voids unit warranty. Cycle power to the unit to remove the warning. Refer to the fire mode data in the alarm log.

WARNING 203, Missing motor
With a drive operating multi-motors, an underload condition was detected. This condition can indicate a missing motor. Inspect the system for proper operation.

WARNING 204, Locked rotor
With a drive operating multi-motors, an overload condition was detected. This condition can indicate a locked rotor. Inspect the motor for proper operation.

WARNING 219, Compressor interlock
At least 1 compressor is inversely interlocked via a digital input. The interlocked compressors can be viewed in *parameter 25-87 Inverse Interlock*.

ALARM 243, Brake IGBT
This alarm is only for multi-drive systems. It is equivalent to *alarm 27, Brake chopper fault*. The report value in the alarm log indicates which drive module generated the alarm. This IGBT fault can be caused by any of the following:

- The DC fuse is blown.
- The brake jumper is not in position.
- The Klixon switch opened due to an overtemperature condition in the brake resistor.

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

1 = Left drive module.

2 = Second drive module from left.

3 = Third drive module from left (in 4-module module systems).

4 = Fourth drive module from left (in 4-module module systems).

ALARM 245, 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. This alarm is equivalent to *alarm 39, Heat sink sensor*. The report value in the alarm log indicates which drive module generated the alarm:

1 = Left drive module.

2 = Second drive module from left.

3 = Third drive module from left (in 4-module module systems).

4 = Fourth drive module from left (in 4-module module systems).

Troubleshooting
Check the following:

- Power card.
- Gatedrive card.
- Ribbon cable between the power card and the gatedrive card.

ALARM 246, Power card supply
This alarm is only for multi-drive systems. It is equivalent to *alarm 46, Power card supply*. The report value in the alarm log indicates which drive module generated the alarm:

1 = Left drive module.

2 = Second drive module from left.

3 = Third drive module from left (in 4-module module systems).

4 = Fourth drive module from left (in 4-module module systems).

ALARM 247, Power card temperature
This alarm is only for multi-drive systems. It is equivalent to *alarm 69, Power card temperature*. The report value in the alarm log indicates which drive module generated the alarm:

1 = Left drive module.

2 = Second drive module from left.

3 = Third drive module from left (in 4-module module systems).

4 = Fourth drive module from left (in 4-module module systems).

ALARM 248, Illegal power section configuration
This alarm is only for multi-drive systems. It is equivalent to *alarm 79, Illegal power section configuration*. The report value in the alarm log indicates which drive module generated the alarm:

1 = Left drive module.

2 = Second drive module from left.

3 = Third drive module from left (in 4-module module systems).

4 = Fourth drive module from left (in 4-module module systems).

Troubleshooting
Check the following:

- The current scaling cards on the MDCIC.

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

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

Troubleshooting

- Reset to remove the warning and to resume normal operation.

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9.6 Troubleshooting

Symptom	Possible cause	Test	Solution
Display dark/No function	Missing input power.	See *Table 6.1*.	Check the input power source.
	Missing or open fuses.	See *Open power fuses* 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.
	Shortcut 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 terminals 50–55.	Wire the terminals properly.
	Incompatible LCP (LCP from VLT® 2800 or 5000/6000/8000/ FCD or FCM).	–	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 AC drive.	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 AC drive.	Apply mains power.
	LCP Stop.	Check if [Off] has been pressed.	Press [Auto On] or [Hand On] (depending on operating mode).
	Missing start signal (Standby).	Check *parameter 5-10 Terminal 18 Digital Input* for correct setting for terminal 18. Use default setting.	Apply a valid start signal.
	Motor coast signal active (Coasting).	Check *parameter 5-12 Terminal 27 Digital Input* for correct setting for 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 7.3.1 Warning - Motor Start*.

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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 motor current is within specifications. If motor current is exceeding the nameplate full load current, the motor can 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 AC drive.	Rotate input power leads into the AC drive 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 AC drive. Contact supplier.
Motor current imbalance greater than 3%	Problem with motor or motor wiring.	Rotate output motor cables 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 AC drive.	Rotate output motor cables 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 supplier.
AC drive acceleration problems	Motor data are entered incorrectly.	If warnings or alarms occur, see *chapter 9.5 List of Warnings and Alarms*. Check that motor data are 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*.
AC drive deceleration problems	Motor data are entered incorrectly.	If warnings or alarms occur, see *chapter 9.5 List of Warnings and Alarms*. Check that motor data are 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 9.5 Troubleshooting

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10 Specifications

10.1 Electrical Data

10.1.1 Electrical Data for Enclosures D1h–D4h, 3x200–240 V

VLT® HVAC Drive FC 102	N55K	N75K
Normal overload (Normal overload=110% current during 60 s)	**NO**	**NO**
Typical shaft output at 230 V [kW]	55	75
Typical shaft output at 230 V [hp]	75	100
Enclosure size	**D1h/D3h**	
Output current (3-phase)		
Continuous (at 230 V) [A]	190	240
Intermittent (60 s overload) (at 230 V) [A]	209	264
Continuous kVA (at 230 V) [kVA]	76	96
Maximum input current		
Continuous (at 230 V) [A]	183	231
Maximum number and size of cables per phase		
Mains, motor, brake, and load share [mm^2 (AWG)]	2x95 (2x3/0)	2x95 (2x3/0)
Maximum external mains fuses [A][1)]	315	350
Estimated power loss at 230 V [W][2), 3)]	1505	2398
Efficiency[3)]	0.97	0.97
Output frequency [Hz]	0–590	0–590
Heat sink overtemperature trip [°C (°F)]	110 (230)	110 (230)
Control card overtemperature trip [°C (°F)]	75 (167)	75 (167)

Table 10.1 Electrical Data for Enclosures D1h/D3h, Mains Supply 3x200–240 V AC

1) For fuse ratings, see chapter 10.7 Fuses and Circuit Breakers.

2) 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 (IE/IE3 border line). Lower efficiency motors add to the power loss in the drive. Applies to dimensioning of drive cooling. If the switching frequency is higher than the default setting, the power losses can increase. LCP and typical control card power consumptions are included. For power loss data according to EN 50598-2, refer to www.danfoss.com/vltenergyefficiency. Options and customer load can add up to 30 W to the losses, though usually a fully loaded control card and options for slots A and B each add only 4 W.

3) 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 10.4 Ambient Conditions. For part load losses, see www.danfoss.com/vltenergyefficiency.

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VLT® HVAC Drive FC 102	N90K	N100	N150	N160
Normal overload (Normal overload=110% current during 60 s)	**NO**	**NO**	**NO**	**NO**
Typical shaft output at 230 V [kW]	90	110	150	160
Typical shaft output at 230 V [hp]	120	150	200	215
Enclosure size	**D2h/D4h**			
Output current (3-phase)				
Continuous (at 230 V) [A]	302	361	443	535
Intermittent (60 s overload) (at 230 V) [A]	332	397	487	589
Continuous kVA (at 230 V) [kVA]	120	144	176	213
Maximum input current				
Continuous (at 230 V) [A]	291	348	427	516
Maximum number and size of cables per phase				
Mains, motor, brake, and load share [mm^2 (AWG)]	2x185 (2x350 mcm)	2x185 (2x350 mcm)	2x185 (2x350 mcm)	2x185 (2x350 mcm)
Maximum external mains fuses [A][1)]	400	550	630	800
Estimated power loss at 230 V [W][2), 3)]	2623	3284	4117	5209
Efficiency[3)]	0.97	0.97	0.97	0.97
Output frequency [Hz]	0–590	0–590	0–590	0–590
Heat sink overtemperature trip [°C (°F)]	110 (230)	110 (230)	110 (230)	110 (230)
Control card overtemperature trip [°C (°F)]	80 (176)	80 (176)	80 (176)	80 (176)

Table 10.2 Electrical Data for Enclosures D2h/D4h, Mains Supply 3x200–240 V AC

1) For fuse ratings, see chapter 10.7 Fuses and Circuit Breakers.

2) 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 (IE/IE3 border line). Lower efficiency motors add to the power loss in the drive. Applies to dimensioning of drive cooling. If the switching frequency is higher than the default setting, the power losses can increase. LCP and typical control card power consumptions are included. For power loss data according to EN 50598-2, refer to www.danfoss.com/vltenergyefficiency. Options and customer load can add up to 30 W to the losses, though usually a fully loaded control card and options for slots A and B each add only 4 W.

3) 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 10.4 Ambient Conditions. For part load losses, see www.danfoss.com/vltenergyefficiency.

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10.1.2 Electrical Data for Enclosures D1h–D8h, 3x380–480 V

VLT® HVAC Drive FC 102	N110	N132	N160
Normal overload (Normal overload=110% current during 60 s)	**NO**	**NO**	**NO**
Typical shaft output at 400 V [kW]	110	132	160
Typical shaft output at 460 V [hp]	150	200	250
Typical shaft output at 480 V [kW]	132	160	200
Enclosure size	**D1h/D3h/D5h/D6h**		
Output current (3-phase)			
Continuous (at 400 V) [A]	212	260	315
Intermittent (60 s overload) (at 400 V) [A]	233	286	347
Continuous (at 460/480 V) [A]	190	240	302
Intermittent (60 s overload) (at 460/480 V) [kVA]	209	264	332
Continuous kVA (at 400 V) [kVA]	147	180	218
Continuous kVA (at 460 V) [kVA]	151	191	241
Continuous kVA (at 480 V) [kVA]	165	208	262
Maximum input current			
Continuous (at 400 V) [A]	204	251	304
Continuous (at 460/480 V) [A]	183	231	291
Maximum number and size of cables per phase			
Mains, motor, brake, and load share [mm^2 (AWG)]	2x95 (2x3/0)	2x95 (2x3/0)	2x95 (2x3/0)
Maximum external mains fuses [A][1)]	315	350	400
Estimated power loss at 400 V [W][2), 3)]	2555	2949	3764
Estimated power loss at 460 V [W][2), 3)]	2257	2719	3628
Efficiency[3)]	0.98	0.98	0.98
Output frequency [Hz]	0–590	0–590	0–590
Heat sink overtemperature trip [°C (°F)]	110 (230)	110 (230)	110 (230)
Control card overtemperature trip [°C (°F)]	75 (167)	75 (167)	75 (167)

Table 10.3 Electrical Data for Enclosures D1h/D3h/D5h/D6h, Mains Supply 3x380–480 V AC

1) For fuse ratings, see chapter 10.7 Fuses and Circuit Breakers.

2) 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 (IE/IE3 border line). Lower efficiency motors add to the power loss in the drive. Applies to dimensioning of drive cooling. If the switching frequency is higher than the default setting, the power losses can increase. LCP and typical control card power consumptions are included. For power loss data according to EN 50598-2, refer to www.danfoss.com/vltenergyefficiency. Options and customer load can add up to 30 W to the losses, though usually a fully loaded control card and options for slots A and B each add only 4 W.

3) 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 10.4 Ambient Conditions. For part load losses, see www.danfoss.com/vltenergyefficiency.

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VLT® HVAC Drive FC 102	N200	N250	N315
Normal overload (Normal overload=110% current during 60 s)	**NO**	**NO**	**NO**
Typical shaft output at 400 V [kW]	200	250	315
Typical shaft output at 460 V [hp]	300	350	450
Typical shaft output at 480 V [kW]	250	315	355
Enclosure size	**D2h/D4h/D7h/D8h**		
Output current (3-phase)			
Continuous (at 400 V) [A]	395	480	588
Intermittent (60 s overload) (at 400 V) [A]	435	528	647
Continuous (at 460/480 V) [A]	361	443	535
Intermittent (60 s overload) (at 460/480 V) [kVA]	397	487	589
Continuous kVA (at 400 V) [kVA]	274	333	407
Continuous kVA (at 460 V) [kVA]	288	353	426
Continuous kVA (at 480 V) [kVA]	313	384	463
Maximum input current			
Continuous (at 400 V) [A]	381	463	567
Continuous (at 460/480 V) [A]	348	427	516
Maximum number and size of cables per phase			
Mains, motor, brake, and load share [mm^2 (AWG)]	2x185 (2x350 mcm)	2x185 (2x350 mcm)	2x185 (2x350 mcm)
Maximum external mains fuses [A][1)]	550	630	800
Estimated power loss at 400 V [W][2), 3)]	4109	5129	6663
Estimated power loss at 460 V [W][2), 3)]	3561	4558	5703
Efficiency[3)]	0.98	0.98	0.98
Output frequency [Hz]	0–590	0–590	0–590
Heat sink overtemperature trip [°C (°F)]	110 (230)	110 (230)	110 (230)
Control card overtemperature trip [°C (°F)]	80 (176)	80 (176)	80 (176)

Table 10.4 Electrical Data for Enclosures D2h/D4h/D7h/D8h, Mains Supply 3x380–480 V AC

1) For fuse ratings, see chapter 10.7 Fuses and Circuit Breakers.

2) 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 (IE/IE3 border line). Lower efficiency motors add to the power loss in the drive. Applies to dimensioning of drive cooling. If the switching frequency is higher than the default setting, the power losses can increase. LCP and typical control card power consumptions are included. For power loss data according to EN 50598-2, refer to www.danfoss.com/vltenergyefficiency. Options and customer load can add up to 30 W to the losses, though usually a fully loaded control card and options for slots A and B each add only 4 W.

3) 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 10.4 Ambient Conditions. For part load losses, see www.danfoss.com/vltenergyefficiency.

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10.1.3 Electrical Data for Enclosures D1h–D8h, 3x525–690 V

VLT® HVAC Drive FC 102	N75K	N90K	N110K	N132	N160
Normal overload (Normal overload=110% current during 60 s)	**NO**	**NO**	**NO**	**NO**	**NO**
Typical shaft output at 525 V [kW]	55	75	90	110	132
Typical shaft output at 575 V [hp]	75	100	125	150	200
Typical shaft output at 690 V [kW]	75	90	110	132	160
Enclosure size	**D1h/D3h/D5h/D6h**				
Output current (3-phase)					
Continuous (at 525 V) [A]	90	113	137	162	201
Intermittent (60 s overload) (at 525 V) [A]	99	124	151	178	221
Continuous (at 575/690 V) [A]	86	108	131	155	192
Intermittent (60 s overload) (at 575/690 V) [A]	95	119	144	171	211
Continuous kVA (at 525 V) [kVA]	82	103	125	147	183
Continuous kVA (at 575 V) [kVA]	86	108	131	154	191
Continuous kVA (at 690 V) [kVA]	103	129	157	185	230
Maximum input current					
Continuous (at 525 V) [A]	87	109	132	156	193
Continuous (at 575/690 V)	83	104	126	149	185
Maximum number and size of cables per phase					
Mains, motor, brake, and load share [mm^2 (AWG)]	2x95 (2x3/0)	2x95 (2x3/0)	2x95 (2x3/0)	2x95 (2x3/0)	2x95 (2x3/0)
Maximum external mains fuses [A][1)]	160	315	315	315	315
Estimated power loss at 575 V [W][2), 3)]	1162	1428	1740	2101	2649
Estimated power loss at 690 V [W][2), 3)]	1204	1477	1798	2167	2740
Efficiency[3)]	0.98	0.98	0.98	0.98	0.98
Output frequency [Hz]	0–590	0–590	0–590	0–590	0–590
Heat sink overtemperature trip [°C (°F)]	110 (230)	110 (230)	110 (230)	110 (230)	110 (230)
Control card overtemperature trip [°C (°F)]	75 (167)	75 (167)	75 (167)	75 (167)	75 (167)

Table 10.5 Electrical Data for Enclosures D1h/D3h/D5h/D6h, Mains Supply 3x525–690 V AC

1) For fuse ratings, see chapter 10.7 Fuses and Circuit Breakers.

2) 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 (IE/IE3 border line). Lower efficiency motors add to the power loss in the drive. Applies to dimensioning of drive cooling. If the switching frequency is higher than the default setting, the power losses can increase. LCP and typical control card power consumptions are included. For power loss data according to EN 50598-2, refer to www.danfoss.com/vltenergyefficiency. Options and customer load can add up to 30 W to the losses, though usually a fully loaded control card and options for slots A and B each add only 4 W.

3) 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 10.4 Ambient Conditions. For part load losses, see www.danfoss.com/vltenergyefficiency.

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VLT® HVAC Drive FC 102	N200	N250	N315	N400
High/normal overload (Normal overload=110% current during 60 s)	**NO**	**NO**	**NO**	**NO**
Typical shaft output at 525 V [kW]	160	200	250	315
Typical shaft output at 575 V [hp]	250	300	350	400
Typical shaft output at 690 V [kW]	200	250	315	400
Enclosure size	**D2h/D4h/D7h/D8h**			
Output current (3-phase)				
Continuous (at 525 V) [A]	253	303	360	418
Intermittent (60 s overload) (at 525 V) [A]	278	333	396	460
Continuous (at 575/690 V) [A]	242	290	344	400
Intermittent (60 s overload) (at 575/690 V) [A]	266	219	378	440
Continuous kVA (at 525 V) [kVA]	230	276	327	380
Continuous kVA (at 575 V) [kVA]	241	289	343	398
Continuous kVA (at 690 V) [kVA]	289	347	411	478
Maximum input current				
Continuous (at 525 V) [A]	244	292	347	403
Continuous (at 575/690 V)	233	279	332	385
Maximum number and size of cables per phase				
Mains, motor, brake, and load share [mm^2 (AWG)]	2x185 (2x350)	2x185 (2x350)	2x185 (2x350)	2x185 (2x350)
Maximum external mains fuses [A][1)]	550	550	550	550
Estimated power loss at 575 V [W][2), 3)]	3074	3723	4465	5028
Estimated power loss at 690 V [W][2), 3)]	3175	3851	4614	5155
Efficiency[3)]	0.98	0.98	0.98	0.98
Output frequency [Hz]	0–590	0–590	0–590	0–590
Heat sink overtemperature trip [°C (°F)]	110 (230)	110 (230)	110 (230)	110 (230)
Control card overtemperature trip [°C (°F)]	80 (176)	80 (176)	80 (176)	80 (176)

Table 10.6 Electrical Data for Enclosures D2h/D4h/D7h/D8h, Mains Supply 3x525–690 V AC

1) For fuse ratings, see chapter 10.7 Fuses and Circuit Breakers.

2) 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 (IE/IE3 border line). Lower efficiency motors add to the power loss in the drive. Applies to dimensioning of drive cooling. If the switching frequency is higher than the default setting, the power losses can increase. LCP and typical control card power consumptions are included. For power loss data according to EN 50598-2, refer to www.danfoss.com/vltenergyefficiency. Options and customer load can add up to 30 W to the losses, though usually a fully loaded control card and options for slots A and B each add only 4 W.

3) 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 10.4 Ambient Conditions. For part load losses, see www.danfoss.com/vltenergyefficiency.

10.2 Mains Supply

Mains supply (L1, L2, L3)	
Supply voltage	200–240 V, 380–480 V ±10%, 525–690 V ±10%

Mains voltage low/mains voltage drop-out (for 380–480 V and 525–690 V only):
During low mains voltage or a mains drop-out, the drive continues until the DC-link voltage drops below the minimum stop level. Typically, the minimum level corresponds to 15% below the lowest rated supply voltage of the drive. Power-up and full torque cannot be expected at mains voltage lower than 10% below the lowest rated supply voltage of the drive.

Supply frequency	50/60 Hz ±5%
Maximum imbalance temporary between mains phases	3.0% of rated supply voltage[1)]
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 minute
Environment according to EN60664-1	Overvoltage category III/pollution degree 2

The drive is suitable for use on a circuit capable of delivering up to 100 kA short-circuit current rating (SCCR) at 240/480/600 V.
1) Calculations based on UL/IEC61800-3.

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10.3 Motor Output and Torque Data

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

1) Dependent on voltage and power.

Torque characteristics	
Starting torque (constant torque)	Maximum 150% for 60 s[1), 2)]
Overload torque (constant torque)	Maximum 150% for 60 s[1), 2)]

1) Percentage relates to the nominal current of the drive.

2) Once every 10 minutes.

10.4 Ambient Conditions

Environment	
D1h/D2h/D5h/D6h/D7h/D8h enclosure	IP21/Type 1, IP54/Type 12
D3h/D4h enclosure	IP20/Chassis
Vibration test (standard/ruggedized)	0.7 g/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
Aggressive gases (IEC 60721-3-3)	Class 3C3
Test method according to IEC 60068-2-43	H2S (10 days)
Ambient temperature (at 60 AVM)	
- with derating	Maximum 55 °C (131 °F)[1)]
- with full output power of typical EFF2 motors (up to 90% output current)	Maximum 50 °C (122 °F)[1)]
- at full continuous FC output current	Maximum 45 °C (113 °F)[1)]
Minimum ambient temperature during full-scale operation	0 °C (32 °F)
Minimum ambient temperature at reduced performance	-10 °C (14 °F)
Temperature during storage/transport	-25 to +65/70 °C (13 to 149/158 °F)
Maximum altitude above sea level without derating	1000 m (3281 ft)
Maximum altitude above sea level with derating	3000 m (9842 ft)

1) For more information on derating, see the design guide.

EMC standards, Emission	EN 61800-3
EMC standards, Immunity	EN 61800-3
Energy efficiency class[1)]	IE2

1) Determined according to EN 50598-2 at:

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

10.5 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 10.1 Electrical Data*
Maximum cross-section to control terminals, rigid wire	1.5 mm^2/16 AWG (2x0.75 mm^2)

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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 data tables in chapter 10.1 Electrical Data.

10.6 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.

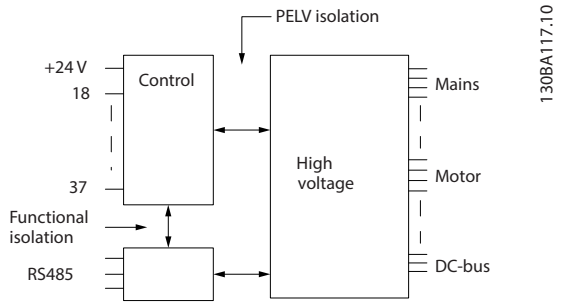

Illustration 10.1 PELV Isolation

Pulse inputs	
Programmable pulse inputs	2
Terminal number pulse	29, 33
Maximum frequency at terminal 29, 33 (push-pull driven)	110 kHz
Maximum frequency at terminal 29, 33 (open collector)	5 kHz

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Minimum frequency at terminal 29, 33	4 Hz
Voltage level	See *Digital Inputs* in *chapter 10.6 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

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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

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

1) IEC 60947 part 4 and 5.

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 drive or an isolated USB cable/converter.

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10.7 Fuses and Circuit Breakers

10.7.1 Fuse Selection

Installing fuses on the supply side ensures that potential damage is contained inside the drive enclosure if a component breakdown (first fault) occurs inside the drive. Use the recommended fuses to ensure compliance with EN 50178, refer to *Table 10.7*, *Table 10.8*, and *Table 10.9*.

NOTICE

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

D1h–D8h recommended fuses

Model	Bussmann part number
N55K	170M2620
N75K	170M2621
N90K	170M4015
N110	170M4015
N150	170M4016
N160	170M4018

Table 10.7 D1h–D8h Power/Semiconductor Fuse Options, 200–240 V

Model	Bussmann part number
N90K	170M2619
N110	170M2620
N132	170M2621
N160	170M4015
N200	170M4016
N250	170M4018

Table 10.8 D1h–D8h Power/Semiconductor Fuse Options, 380–480 V

Model	Bussmann part number
N55K	170M2616
N75K	170M2619
N90K	170M2619
N110	170M2619
N132	170M2619
N160	170M4015
N200	170M4015
N250	170M4015
N315	170M4015

Table 10.9 D1h–D8h Power/Semiconductor Fuse Options, 525–690 V

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Type aR fuses are recommended for drives in enclosure sizes D3h–D4h. See *Table 10.10*.

Model	200–240 V	380–480 V	525–690 V
N45K	ar-350	–	–
N55K	ar-400	–	ar-160
N75K	ar-500	–	ar-315
N90K	ar-500	ar-315	ar-315
N110	ar-630	ar-350	ar-315
N132	–	ar-400	ar-315
N150	ar-800	–	–
N160	–	ar-500	ar-550
N200	–	ar-630	ar-550
N250	–	ar-800	ar-550
N315	–	–	ar-550

Table 10.10 D3h–D4h Power/Semiconductor Fuse Sizes

Bussmann	Rating
LPJ-21/2SP	2.5 A, 600 V

Table 10.11 D1h–D8h Space Heater Fuse Recommendation

For UL compliance, use the Bussmann 170M series fuses for units supplied without a disconnect, contactor, or circuit breaker option. If a disconnect, contactor, or circuit breaker option is supplied with the drive, see *Table 10.12* to *Table 10.15* for SCCR ratings and UL fuse criteria.

10.7.2 Short-circuit Current Rating (SCCR)

The short-circuit current rating (SCCR) represents the maximum level of short-circuit current that the drive can safely withstand. If the drive is not supplied with a mains disconnect, contactor, or circuit breaker, the SCCR of the drive is 100000 A at all voltages (200–690 V).

If the drive is supplied with a mains disconnect only, the SCCR of the drive is 100000 amps at all voltages (200–600 V). See *Table 10.12*. If the drive is supplied with a contactor only, refer to *Table 10.13* for the SCCR. If the drive contains both a contactor and disconnect, see *Table 10.14*.

If the drive is supplied with a circuit breaker only, the SCCR depends on the voltage. Refer to *Table 10.15*.

Enclosure size	≤ 600 V IEC/UL
D5h	100000 A[1)]
D7h	100000 A[2)]

Table 10.12 D5h and D7h Drives Supplied with a Disconnect Only

[1)] With an upstream branch protection Class J fuse with maximum rating of 600 A.

[2)] With an upstream branch protection Class J fuse with maximum rating of 800 A.

Enclosure size	415 V IEC[1)]	480 V UL[2)]	600 V UL[2)]	690 V IEC[1)]
D6h	100000 A	100000 A	100000 A	100000 A
D8h (excluding N315 380–480 V model)	100000 A	100000 A	100000 A	100000 A
D8h (N315 380–480 V model only)	100000 A	Contact Danfoss	Not applicable	Not applicable

Table 10.13 D6h and D8h Drives Supplied with a Contactor Only

[1)] With gL/gG fuses: 425 A maximum fuse size for D6h, and 630 A maximum fuse size for D8h.

[2)] With external upstream Class J fuses: 450 A maximum fuse size for D6h, and 600 A maximum fuse size for D8h.

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Enclosure size	415 V IEC[1)]	480 V UL[2)]	600 V UL[2)]
D6h	100000 A	100000 A	100000 A
D8h (excluding N315 380–480 V model)	100000 A	100000 A	100000 A
D8h (N315 380–480 V model only)	100000 A	Contact Danfoss	Not applicable

Table 10.14 D6h and D8h Drives Supplied with a Disconnect and Contactor

1) With gL/gG fuses: 425A maximum fuse size for D6h, and 630A maximum fuse size for D8h.

2) With external upstream Class J fuses: 450 A maximum fuse size for D6h, and 600 A maximum fuse size for D8h.

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

Table 10.15 D6h and D8h Supplied with a Circuit Breaker

10.8 Fastener Tightening Torques

Apply the correct torque when tightening fasteners in the locations that are listed in *Table 10.16*. 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 D1h/D2h)	M8	9.6 (84)
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 10.16 Fastener Torque Ratings

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10.9 Enclosure Dimensions

10.9.1 D1h Exterior Dimensions

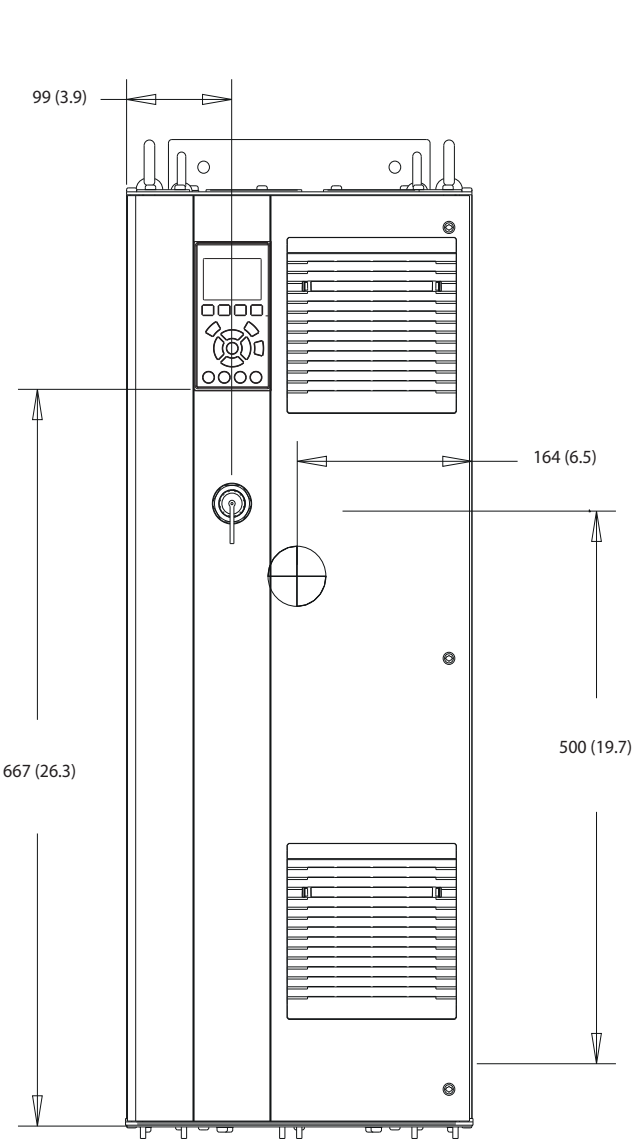

Illustration 10.2 Front View of D1h

10

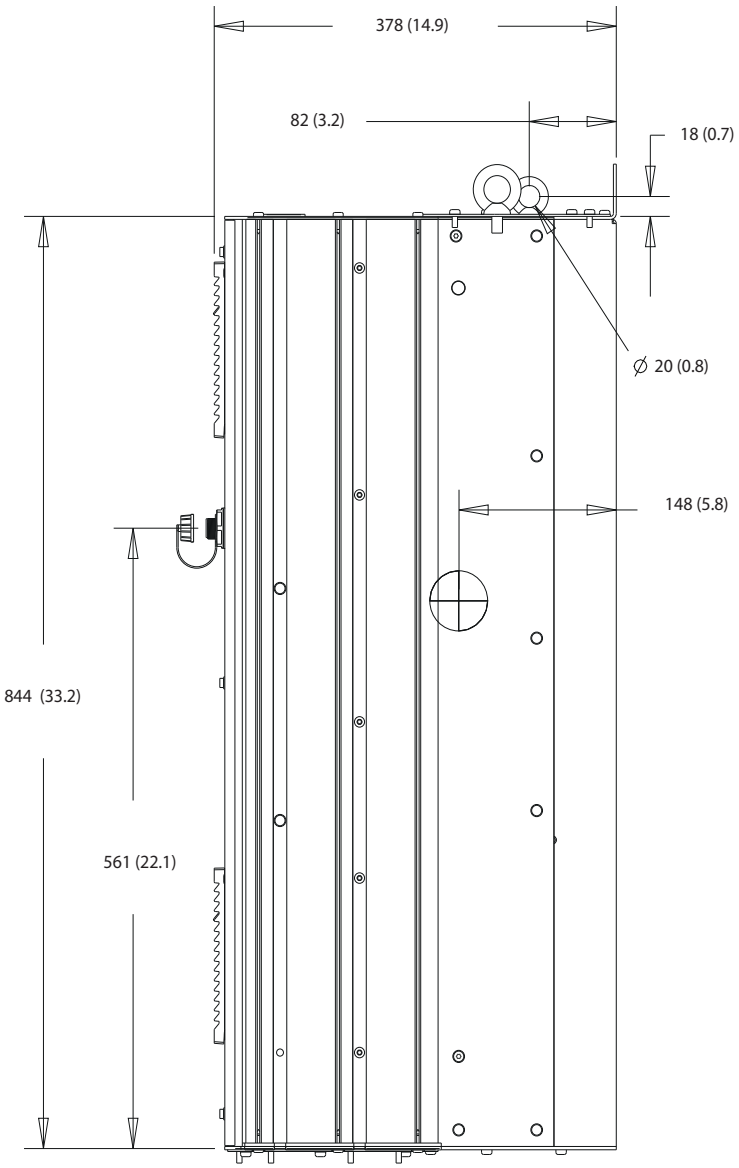

Illustration 10.3 Side View of D1h

10

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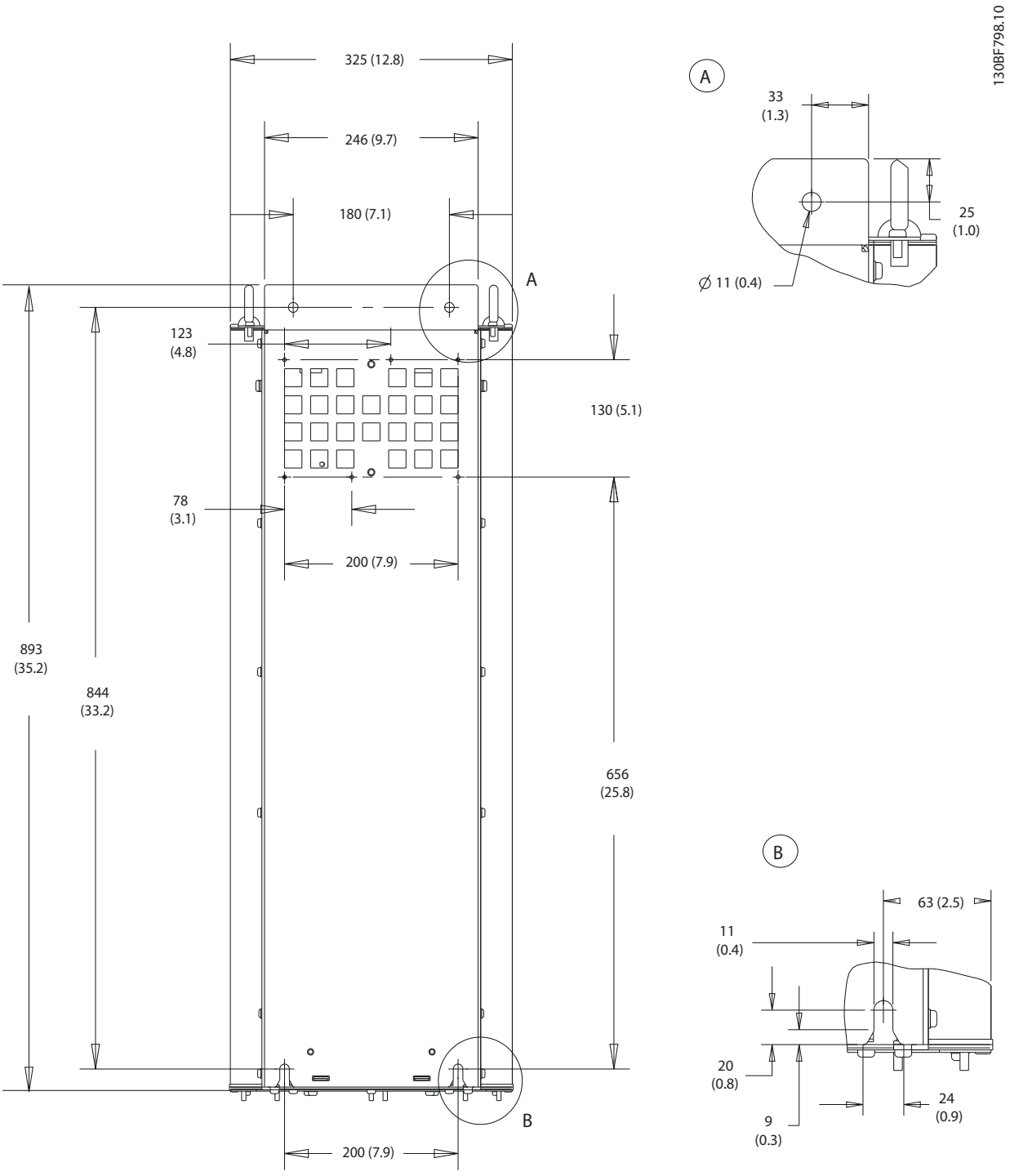

Illustration 10.4 Back View of D1h

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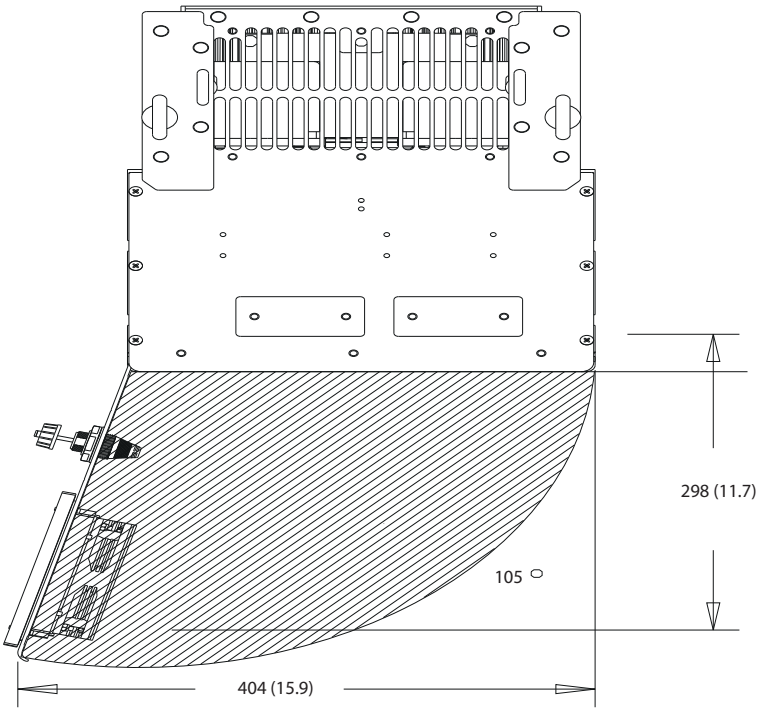

Illustration 10.5 Door Clearance for D1h

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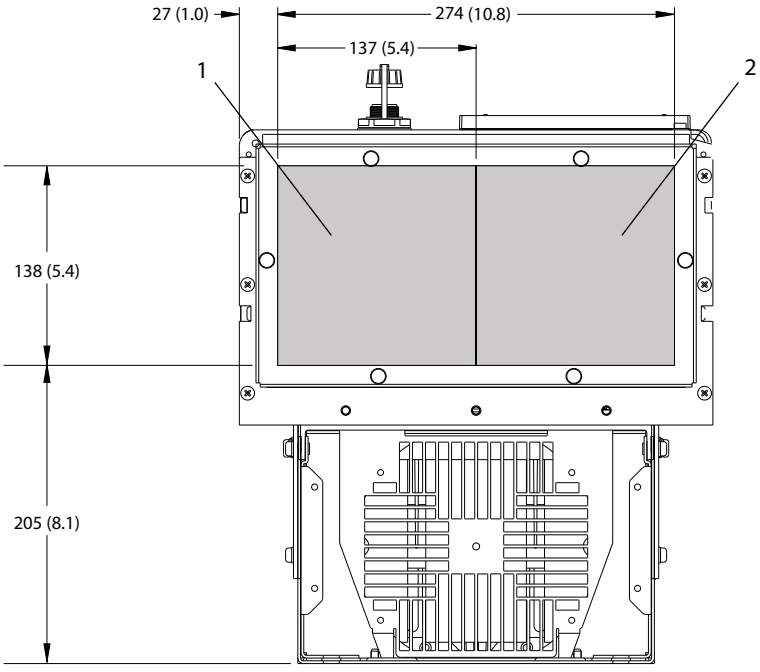

1	Mains side	2	Motor side

Illustration 10.6 Gland Plate Dimensions for D1h

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10.9.2 D2h Exterior Dimensions

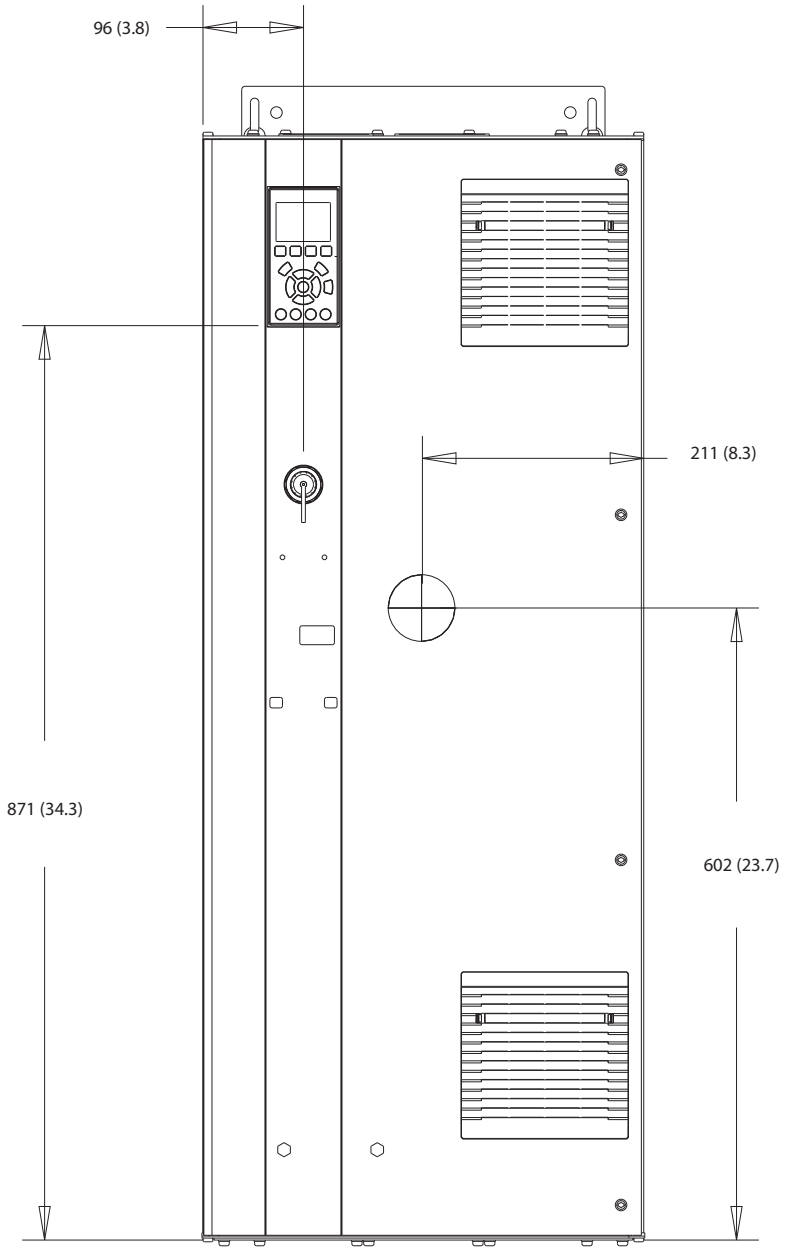

Illustration 10.7 Front View of D2h

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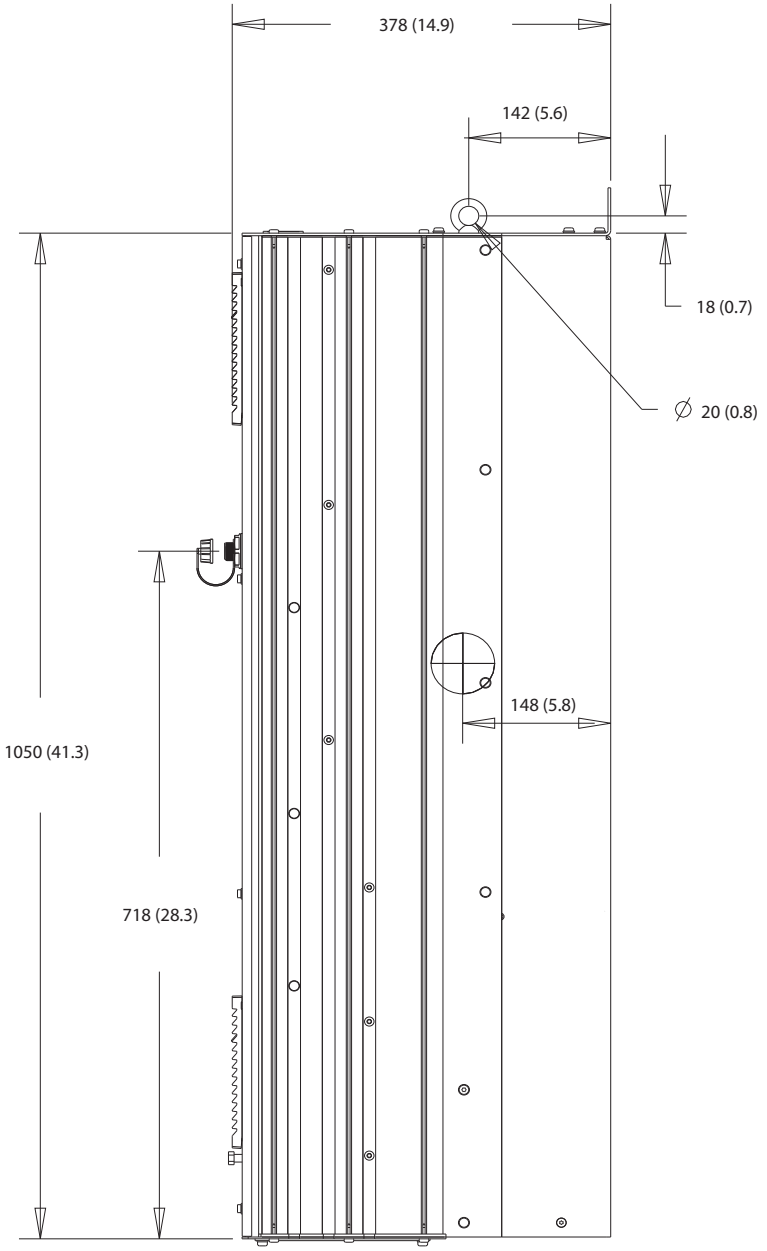

Illustration 10.8 Side View of D2h

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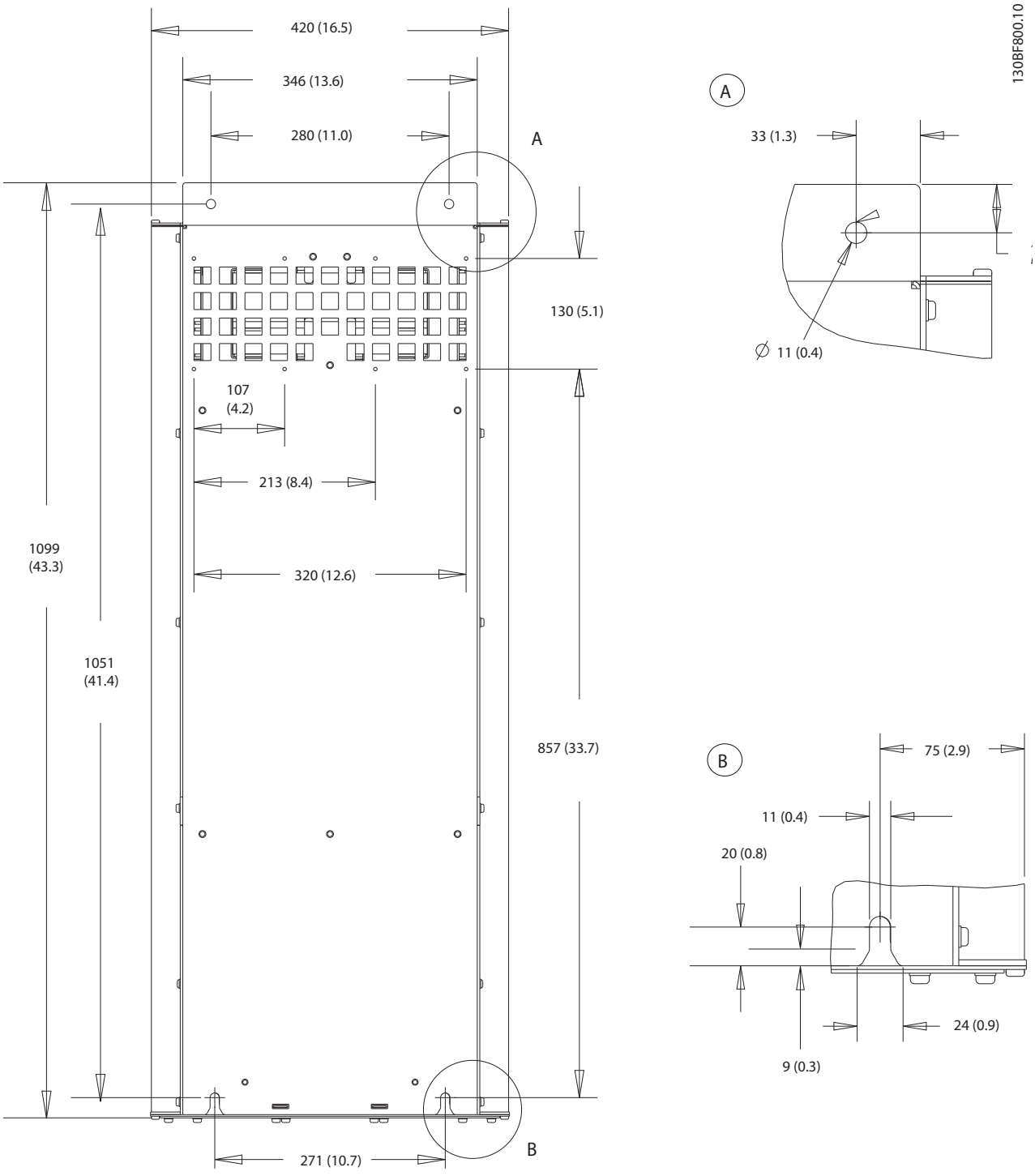

Illustration 10.9 Back View of D2h

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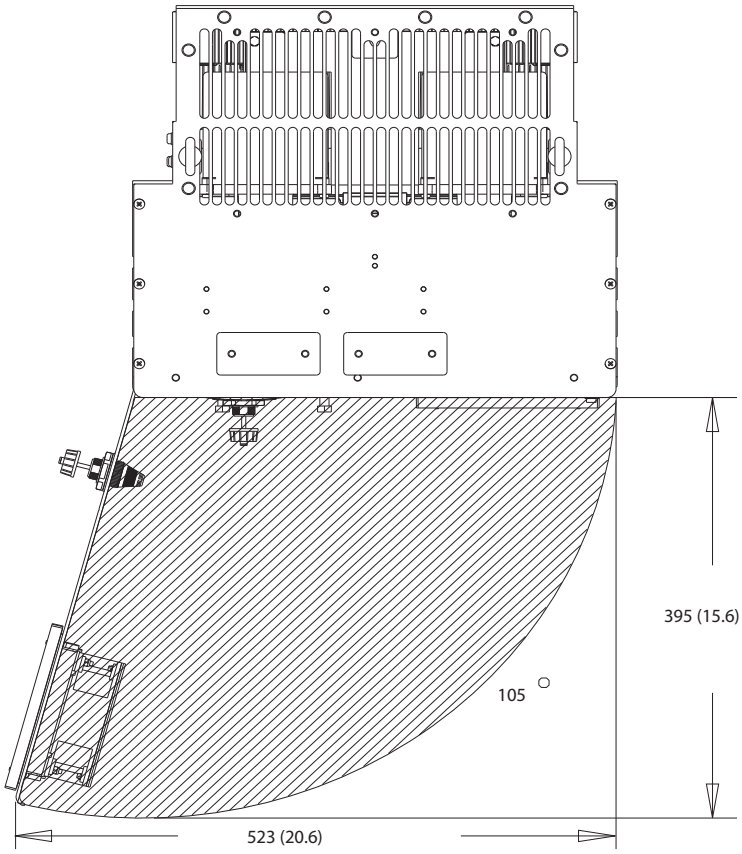
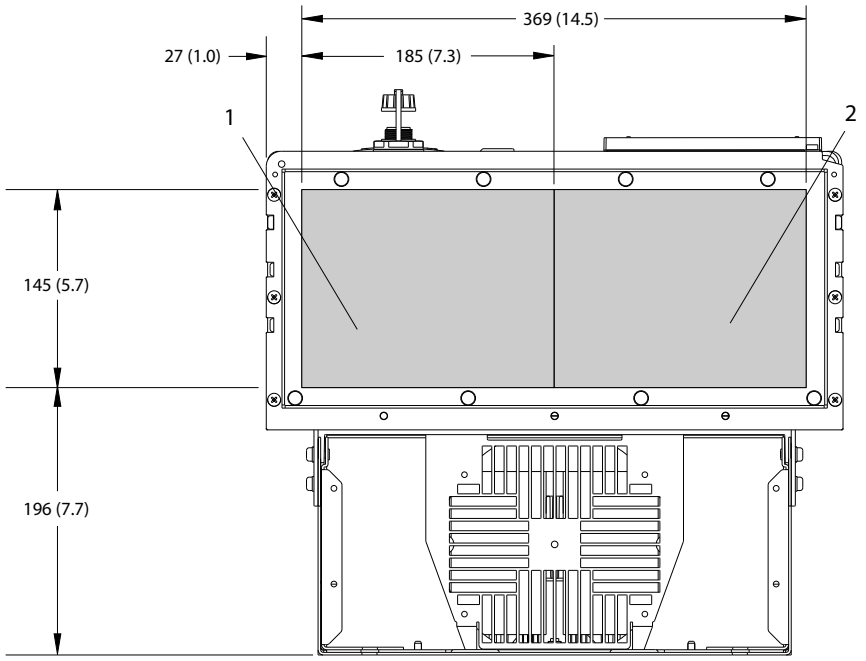


Illustration 10.10 Door Clearance for D2h



1	Mains side	2	Motor side

Illustration 10.11 Gland Plate Dimensions for D2h

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10.9.3 D3h Exterior Dimensions

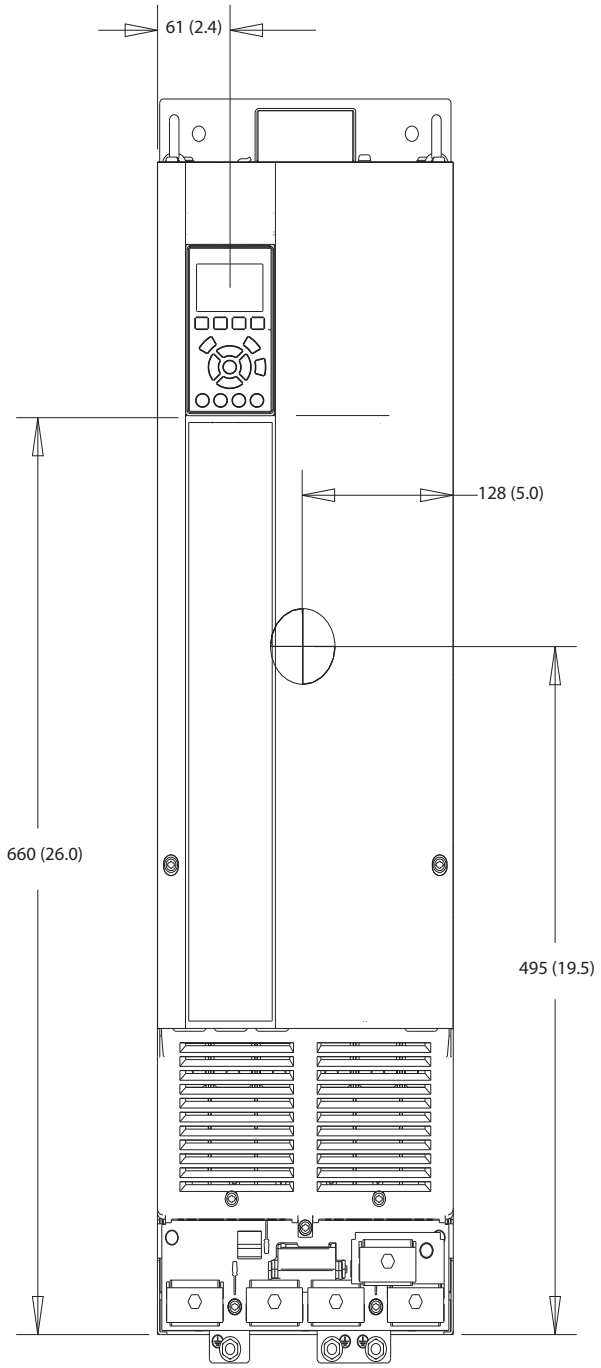

Illustration 10.12 Front View of D3h

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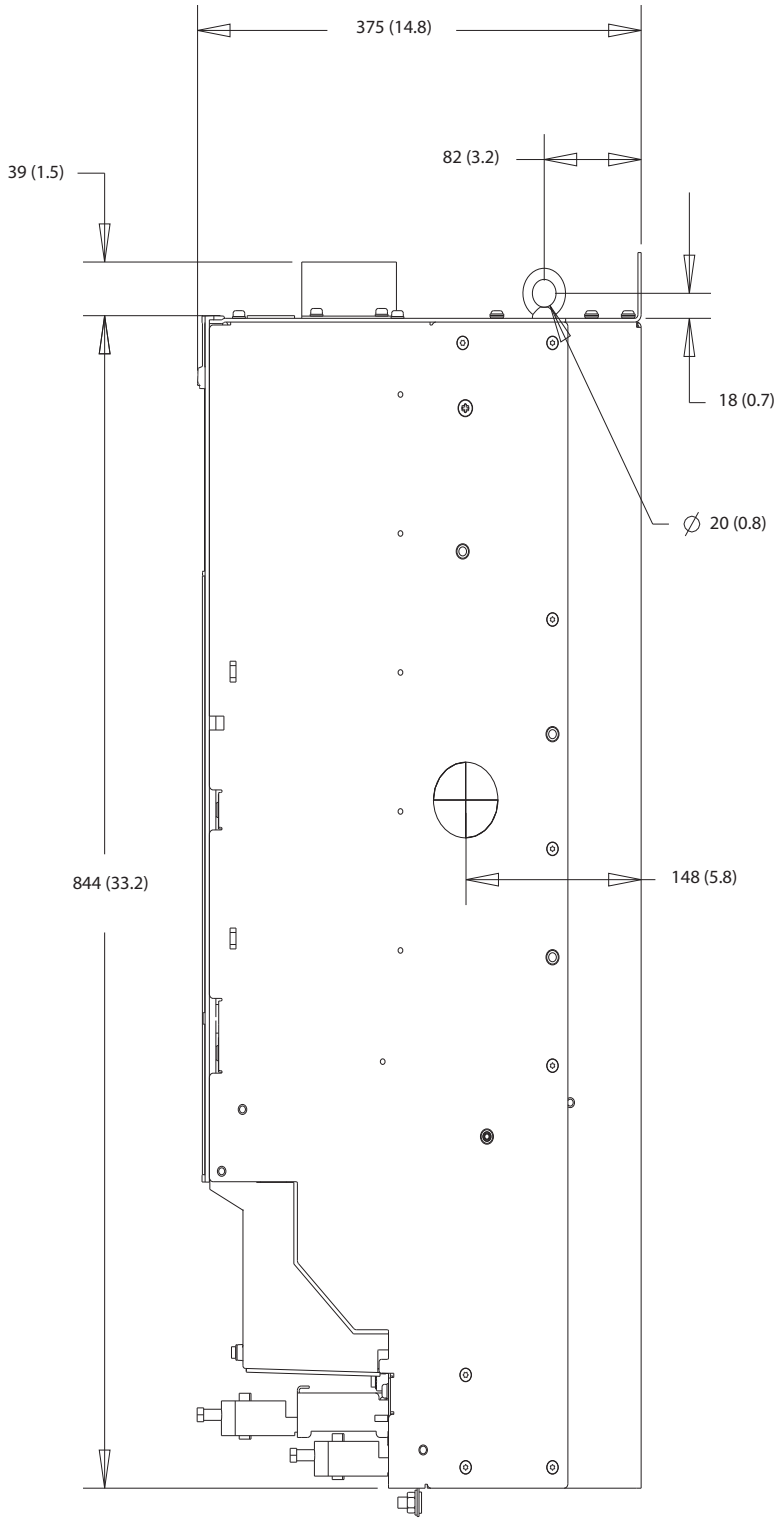

Illustration 10.13 Side View of D3h

10

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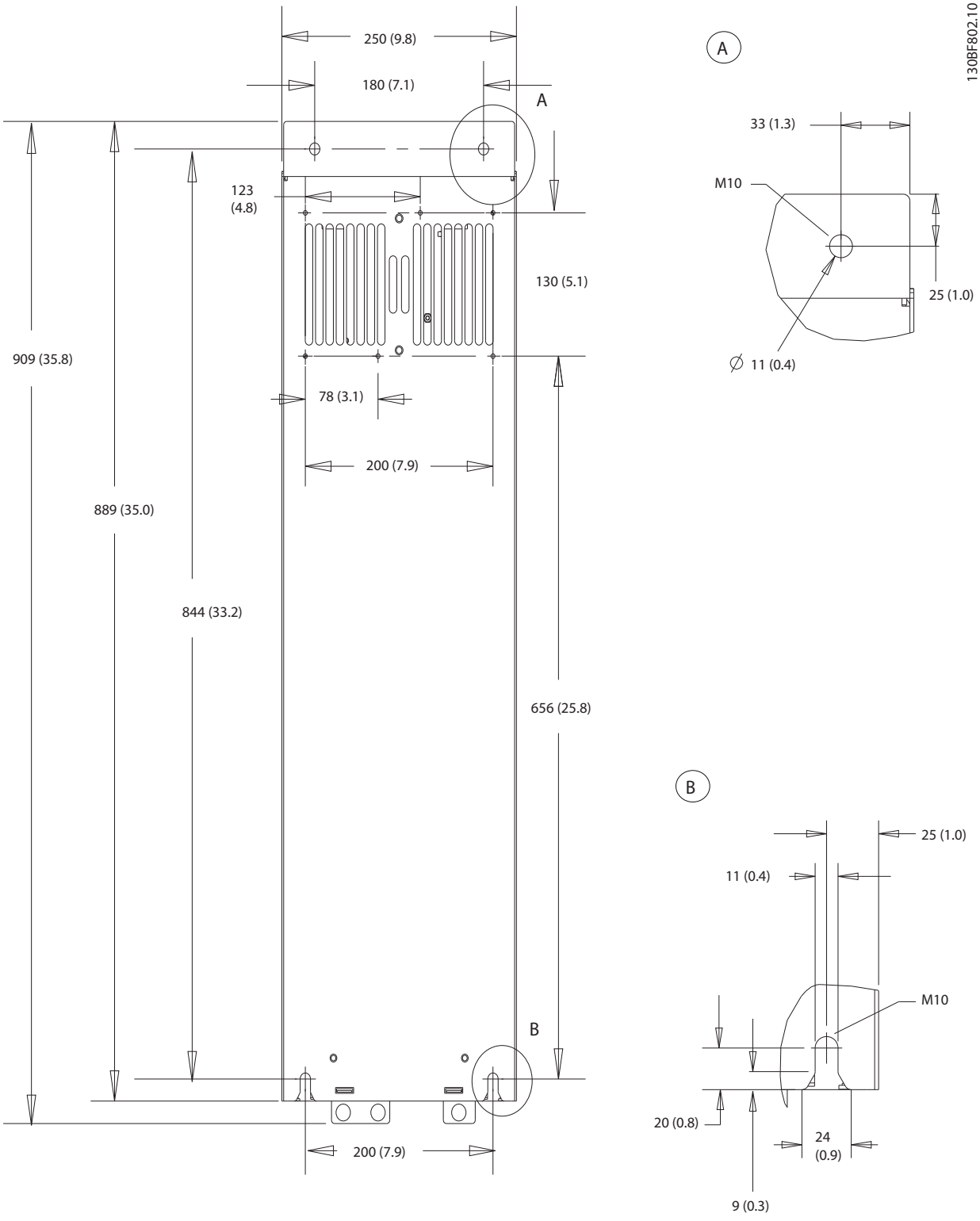

Illustration 10.14 Back View of D3h

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10.9.4 D4h Enclosure Dimensions

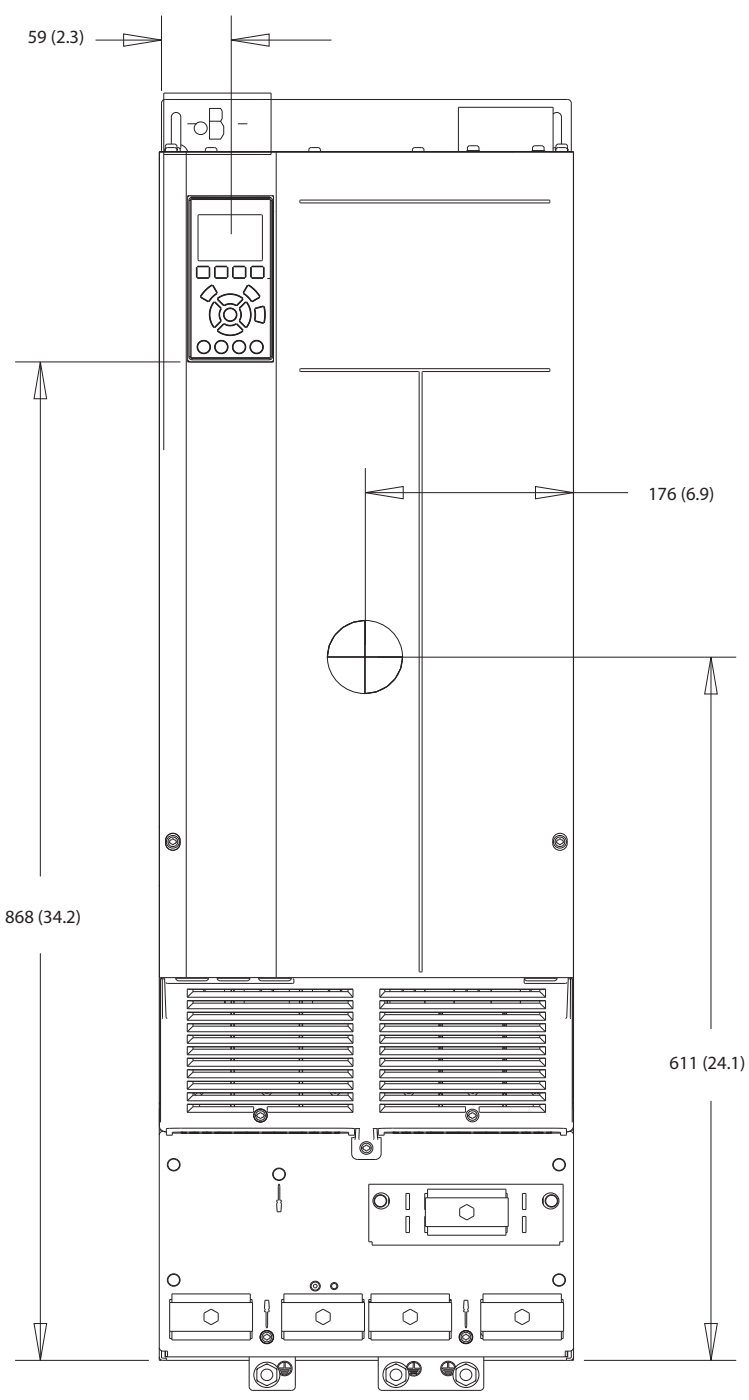

Illustration 10.15 Front View of D4h

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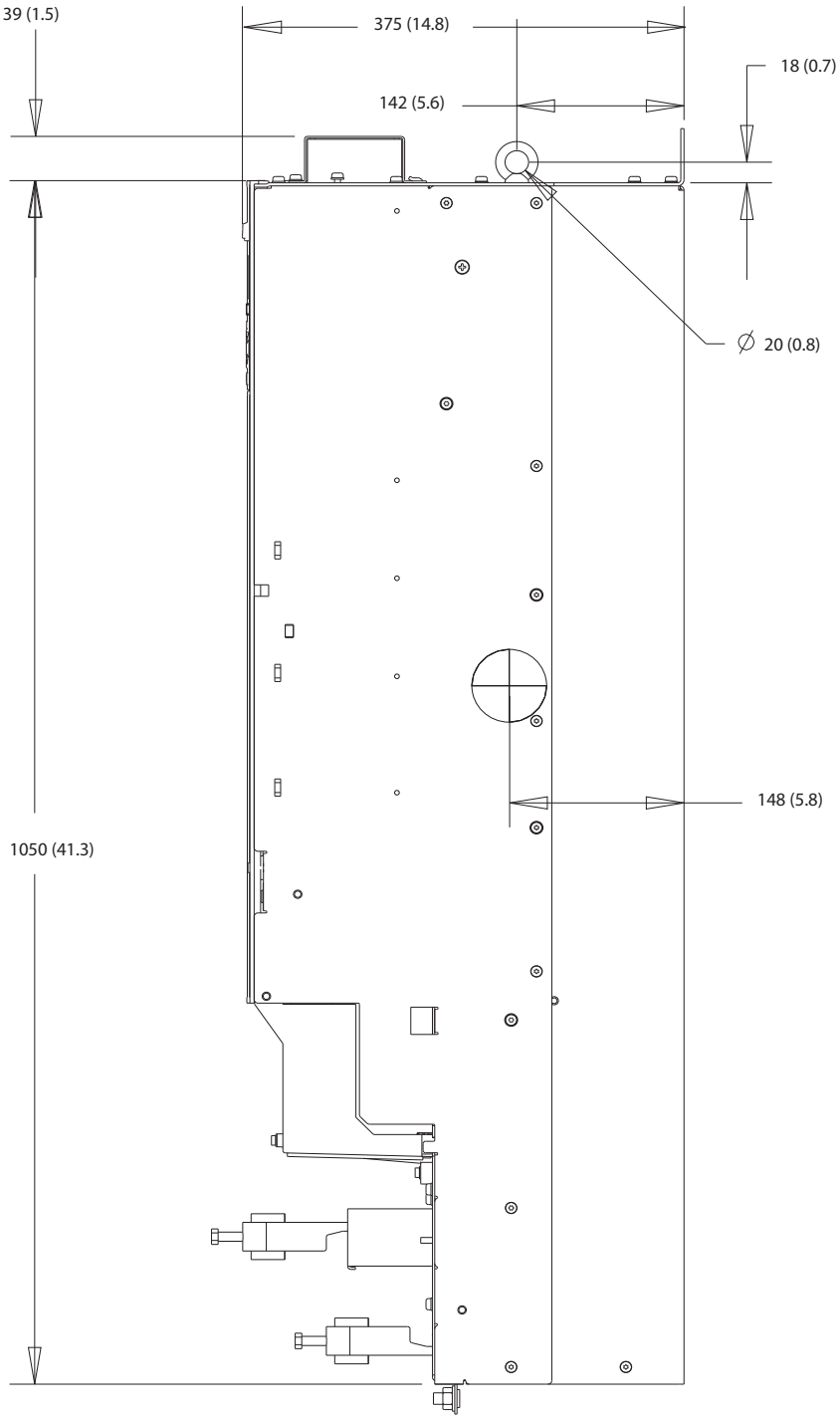

Illustration 10.16 Side View of D4h

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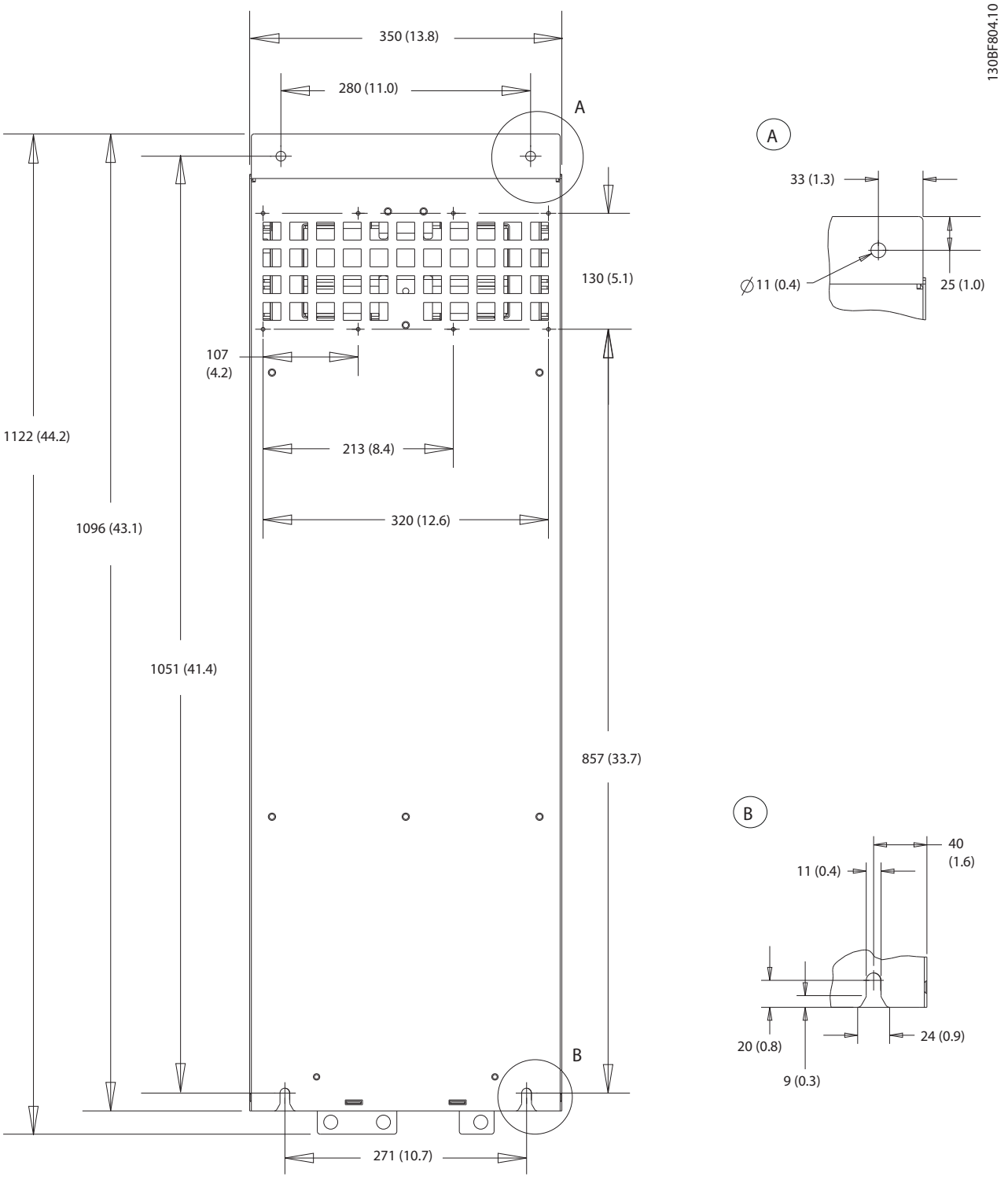

Illustration 10.17 Back View of D4h

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10.9.5 D5h Exterior Dimensions

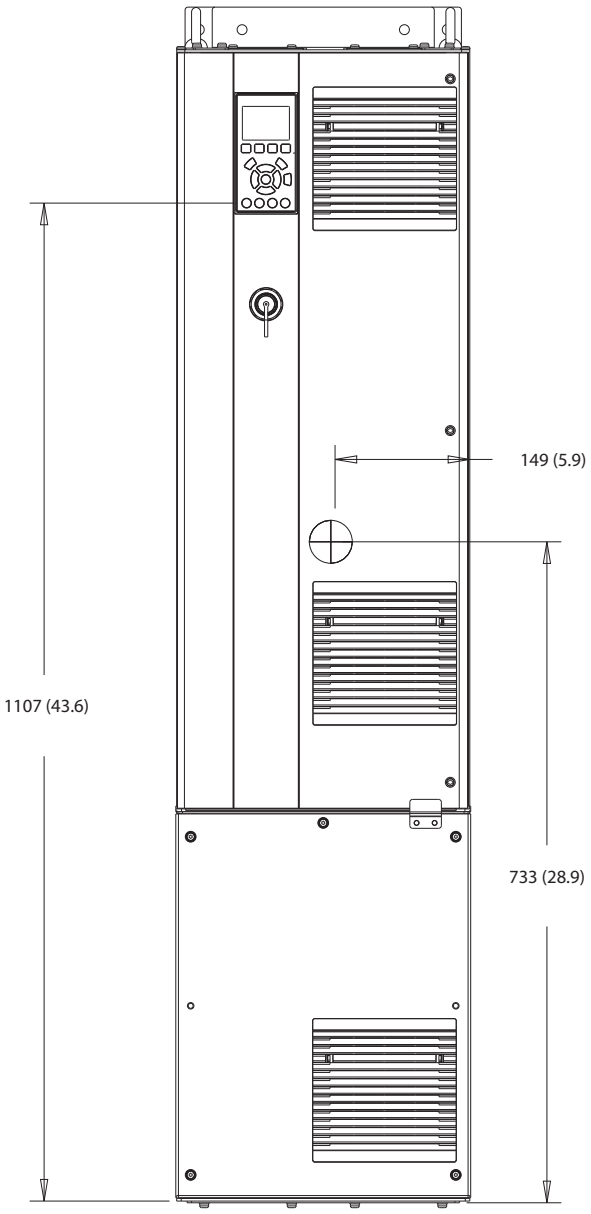

Illustration 10.18 Front View of D5h

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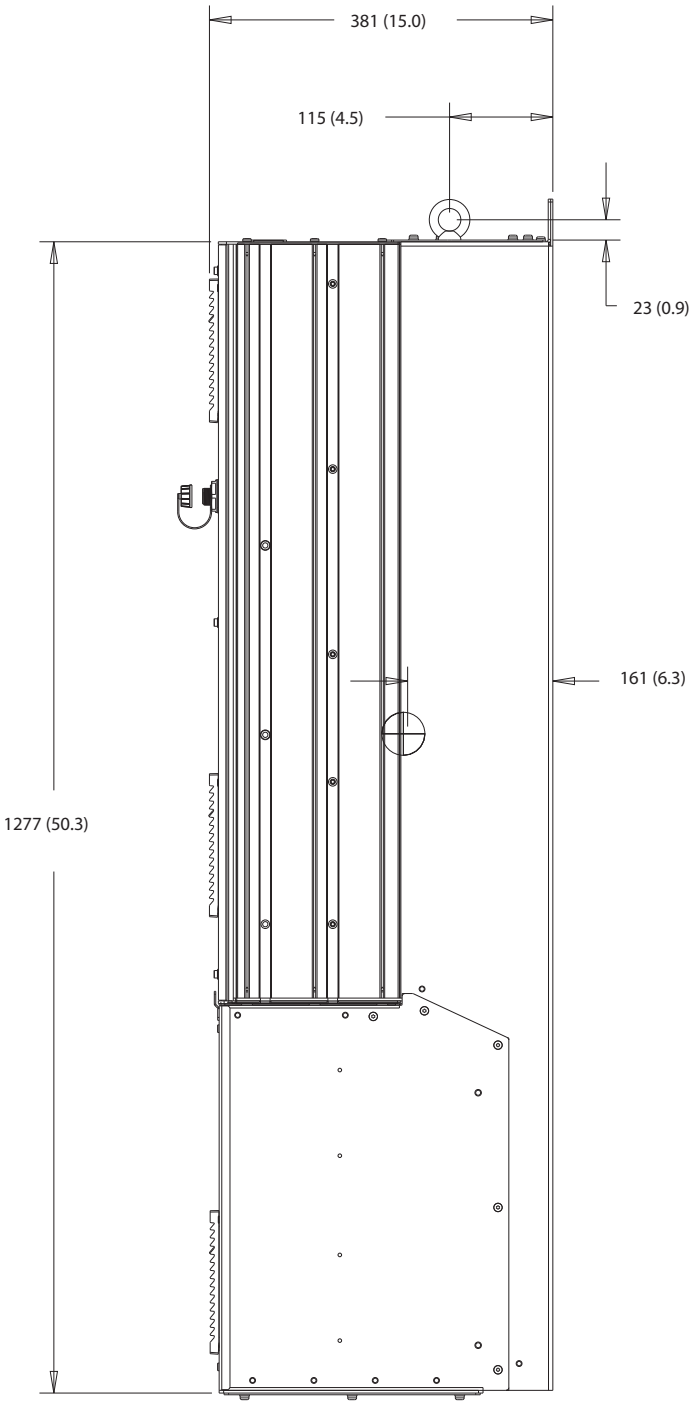

Illustration 10.19 Side View of D5h

10

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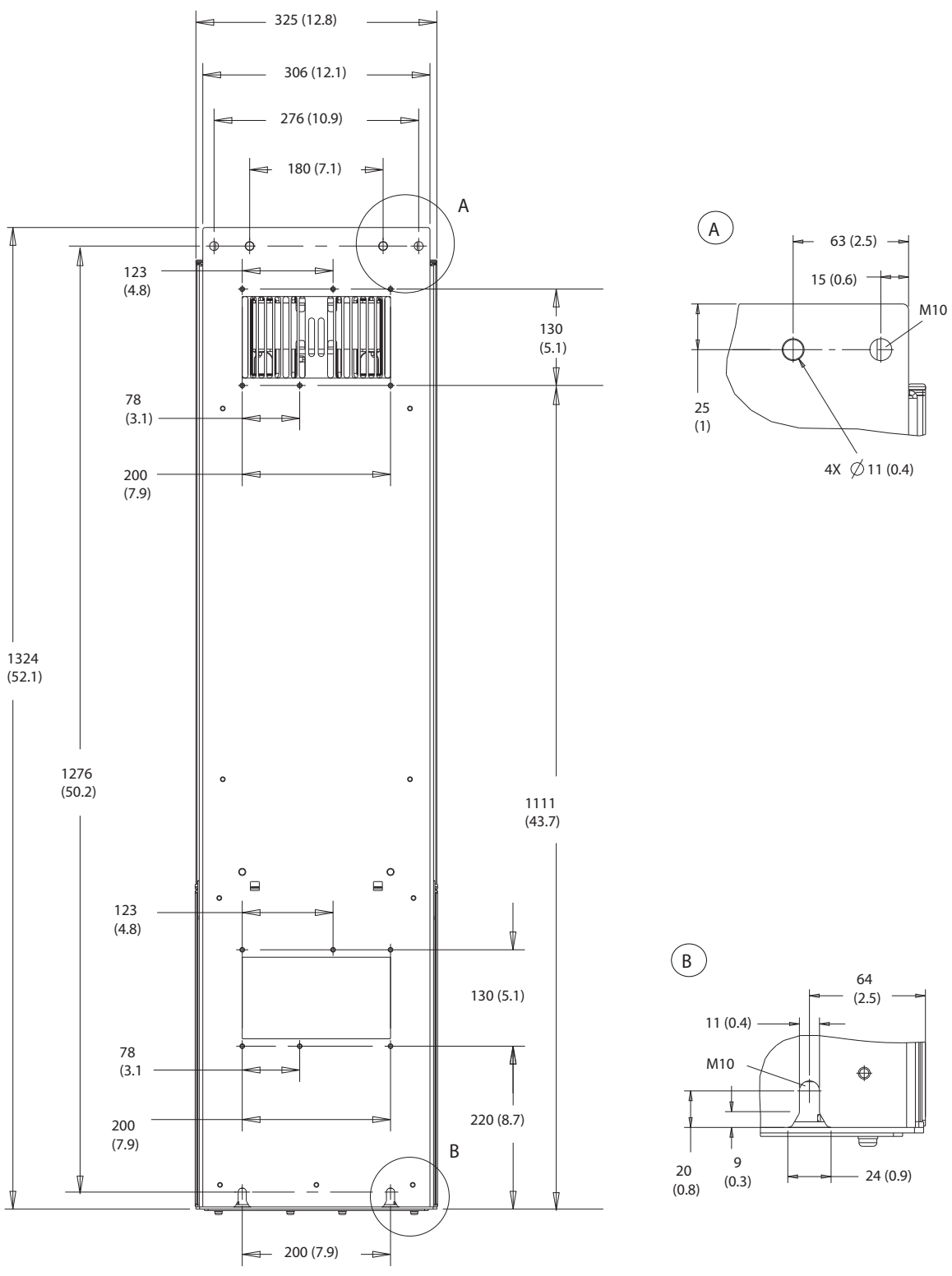

Illustration 10.20 Back View of D5h

10

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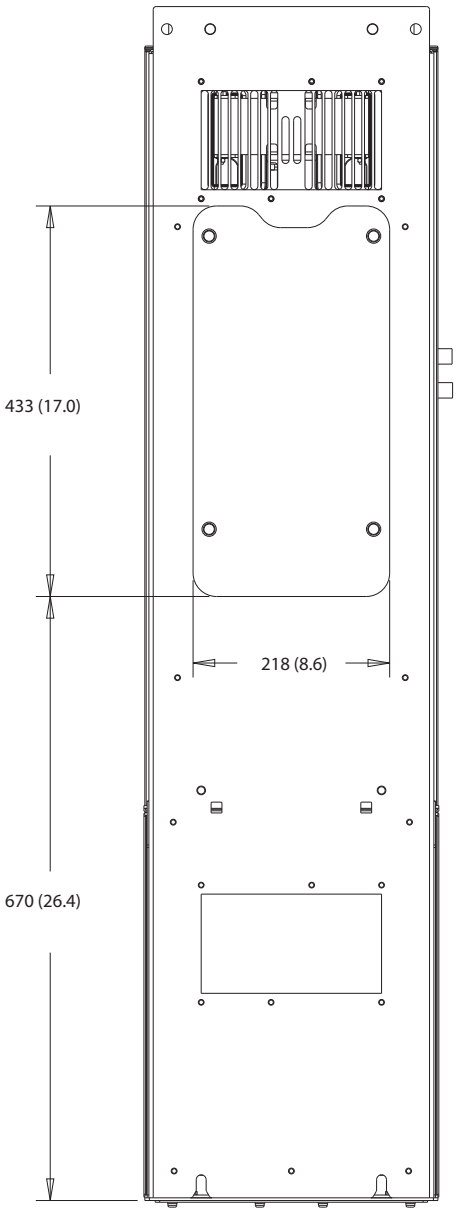

Illustration 10.21 Heat Sink Access Dimensions for D5h

10

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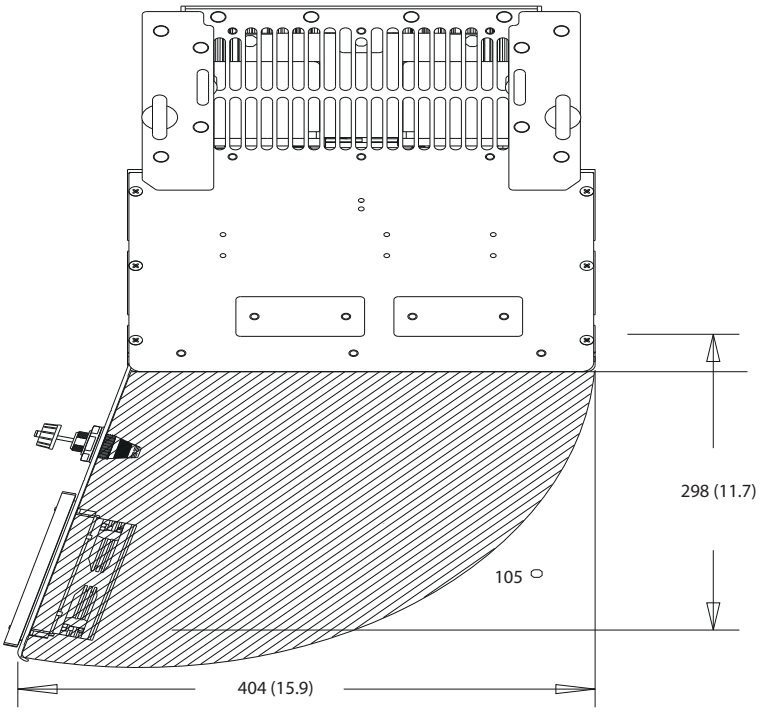
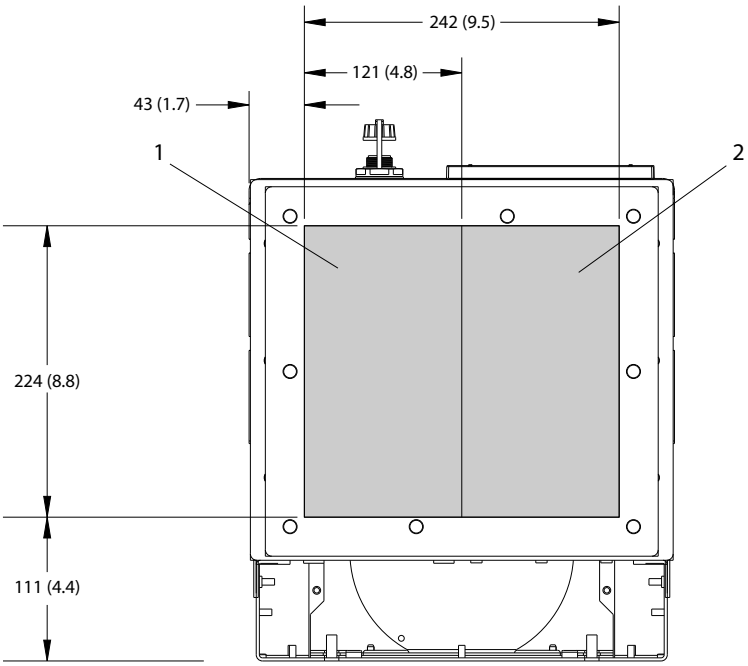


130BF669.10

Illustration 10.22 Door Clearance for D5h



130BF609.10

1	Mains side	2	Motor side

Illustration 10.23 Gland Plate Dimensions for D5h

10.9.6 D6h Exterior Dimensions

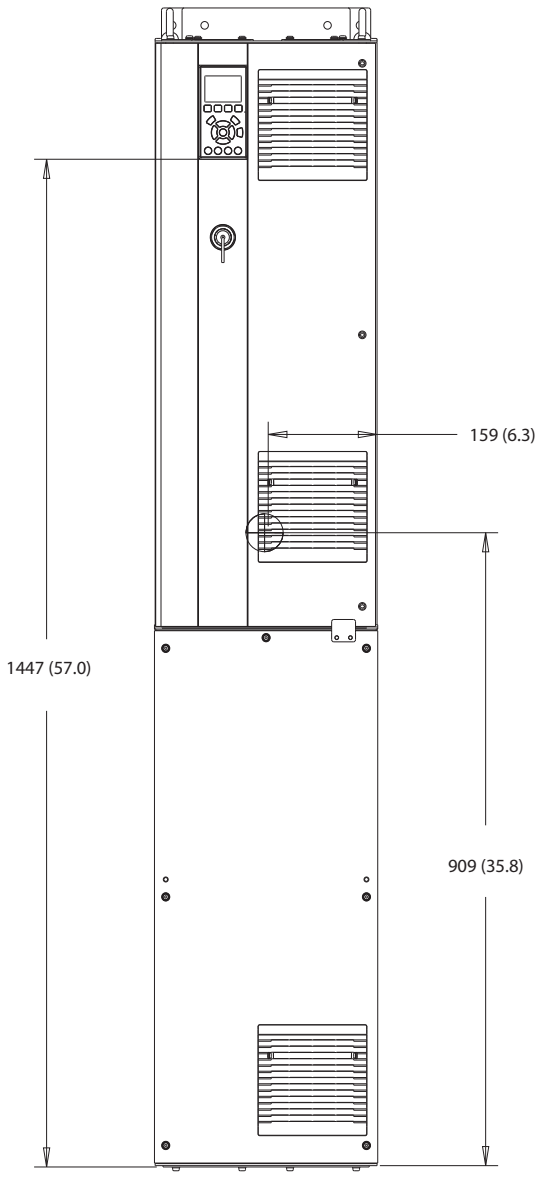


Illustration 10.24 Front View of D6h

10

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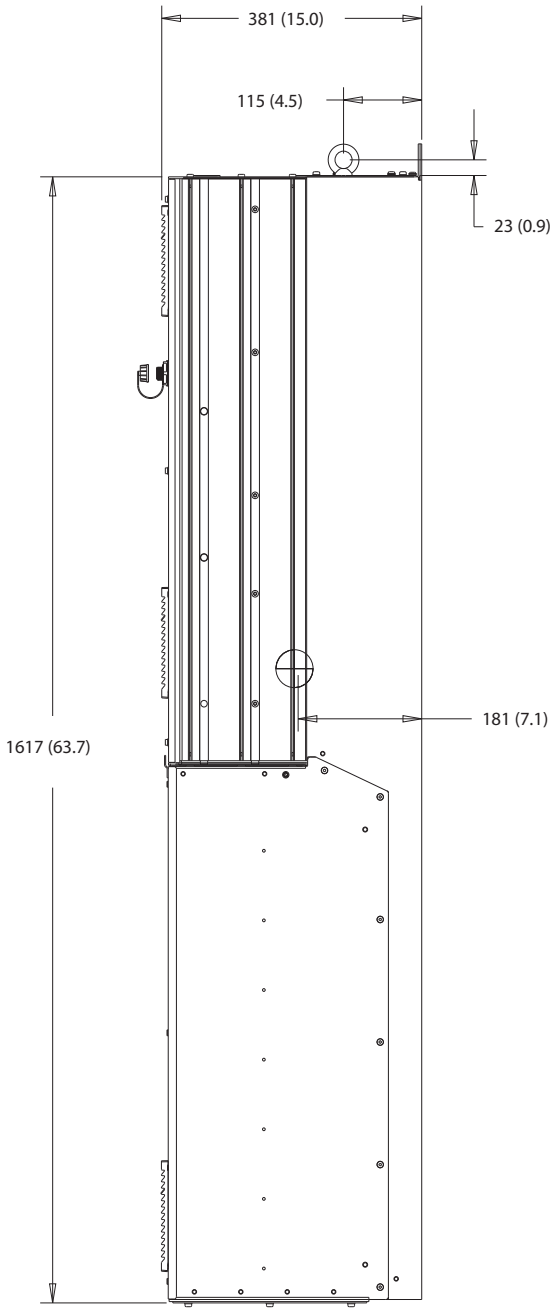

Illustration 10.25 Side View of D6h

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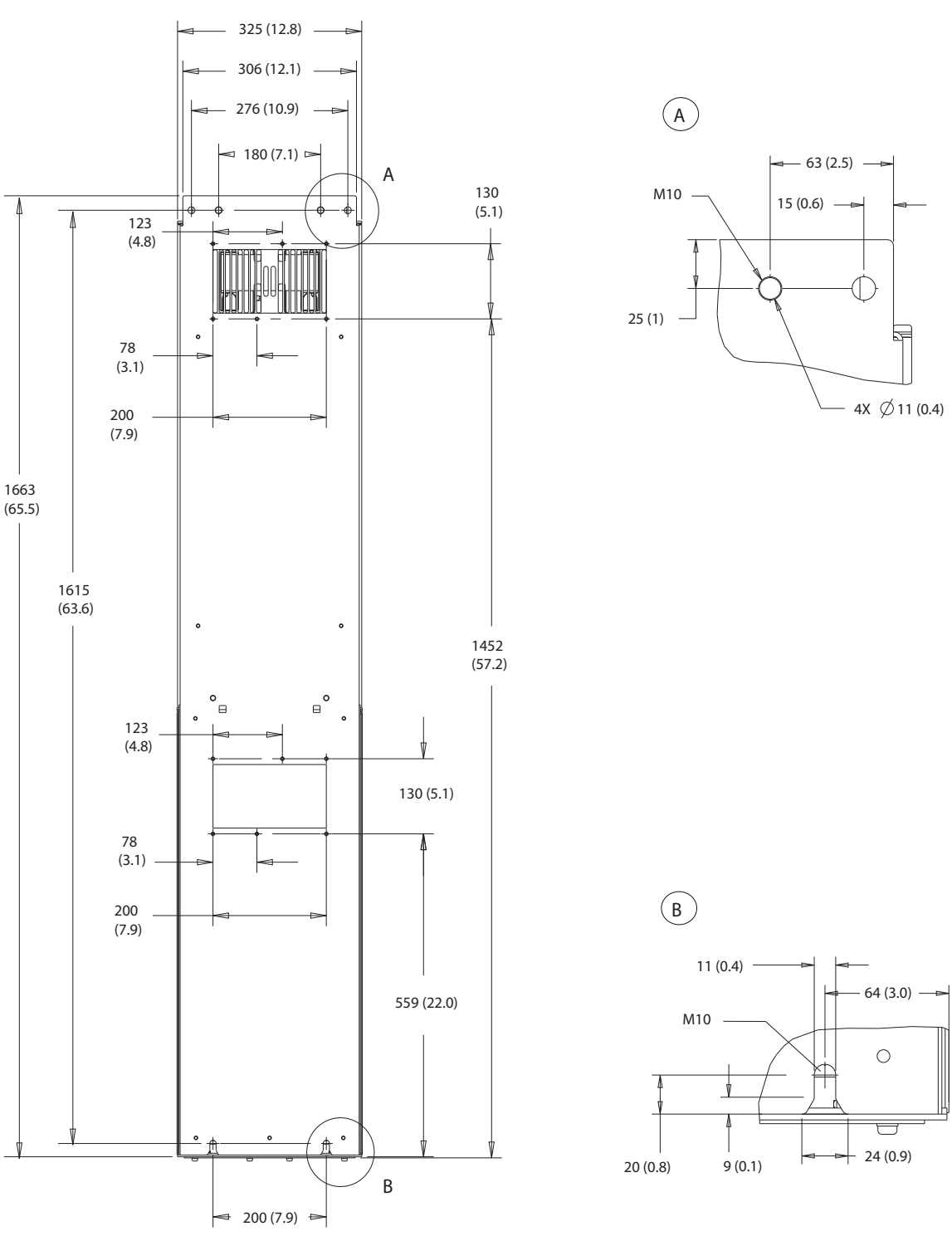
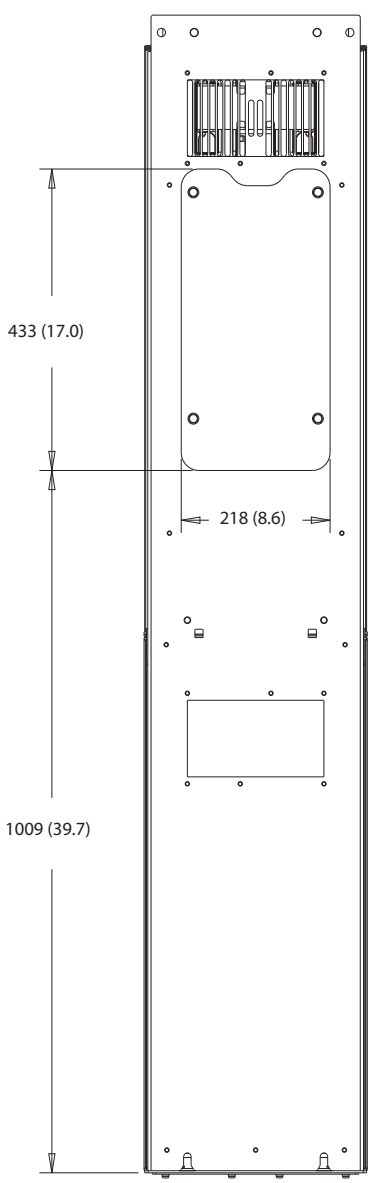


Illustration 10.26 Back View of D6h



130BF829.10

Illustration 10.27 Heat Sink Access Dimensions for D6h

10

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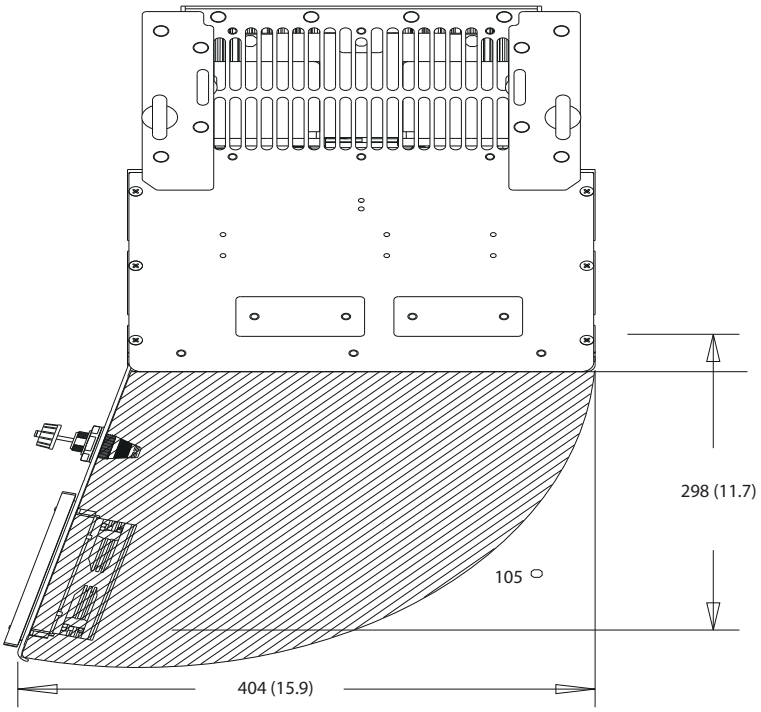
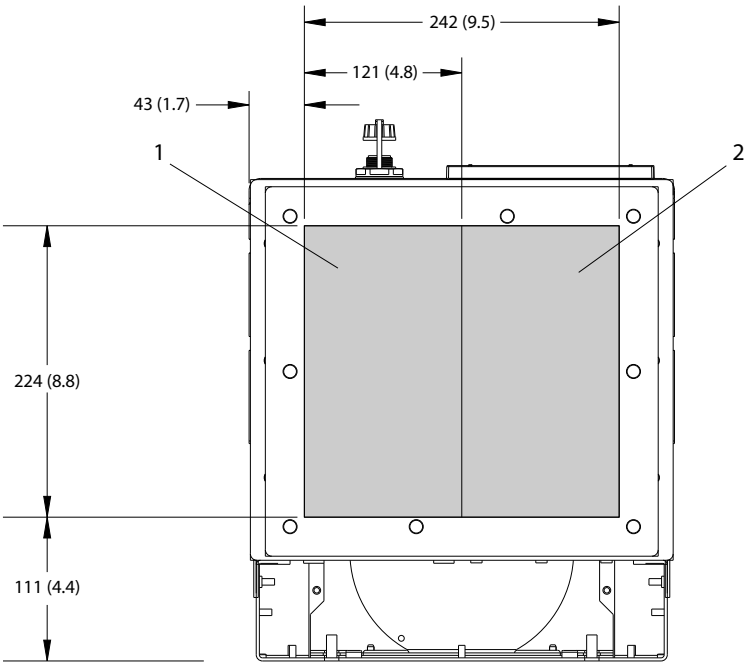


Illustration 10.28 Door Clearance for D6h

10



1	Mains side	2	Motor side

Illustration 10.29 Gland Plate Dimensions for D6h

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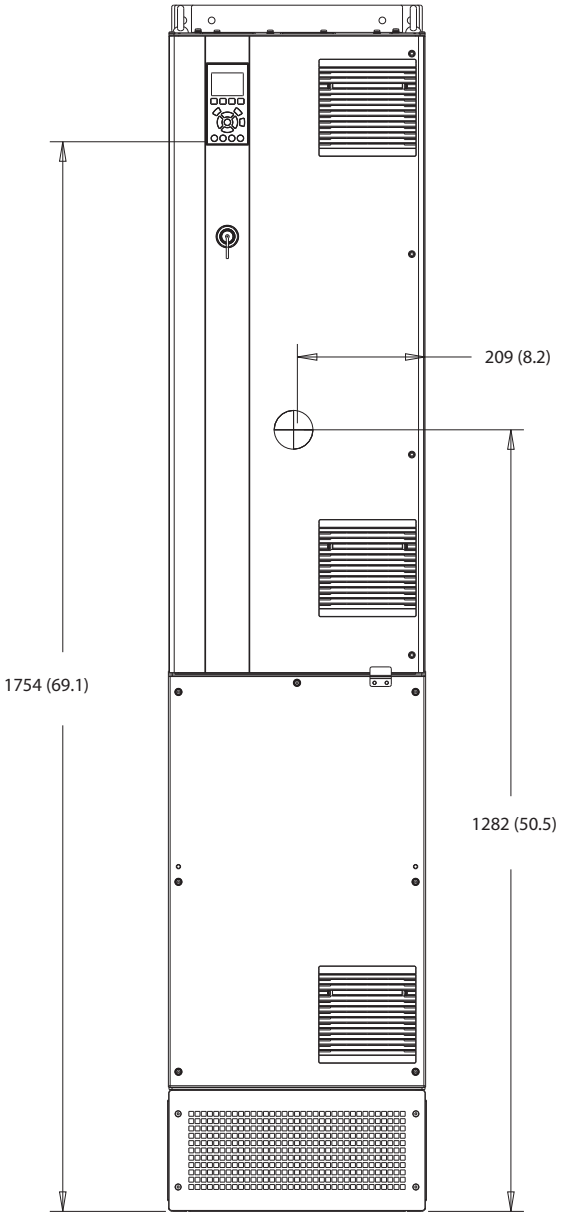
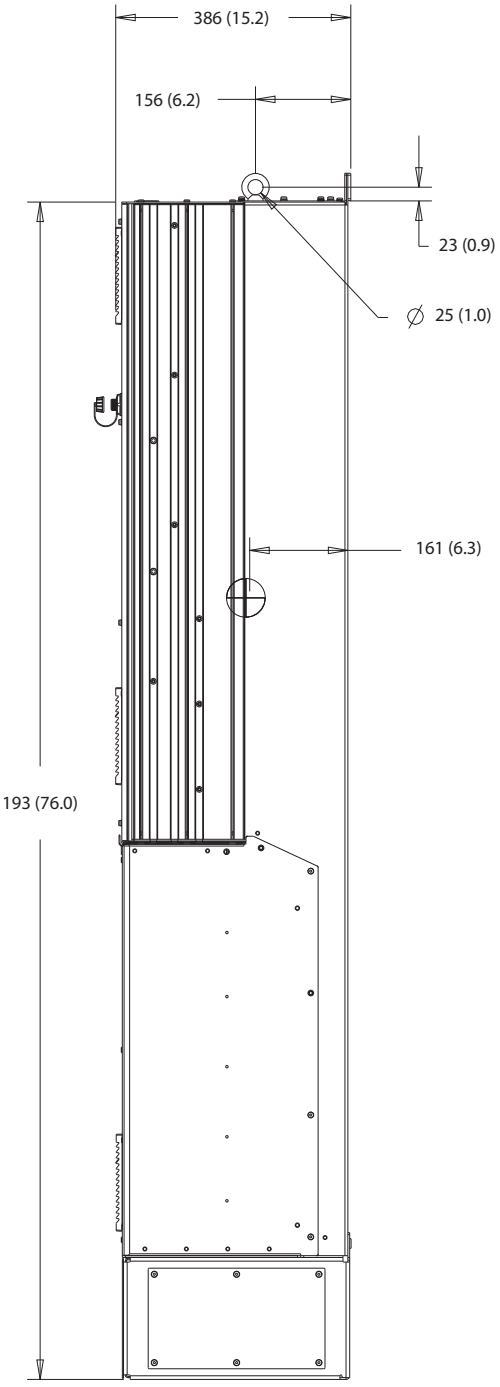
10.9.7 D7h Exterior Dimensions



130BF326.10

Illustration 10.30 Front View of D7h

10



130BF809.10

Illustration 10.31 Side View of D7h

10

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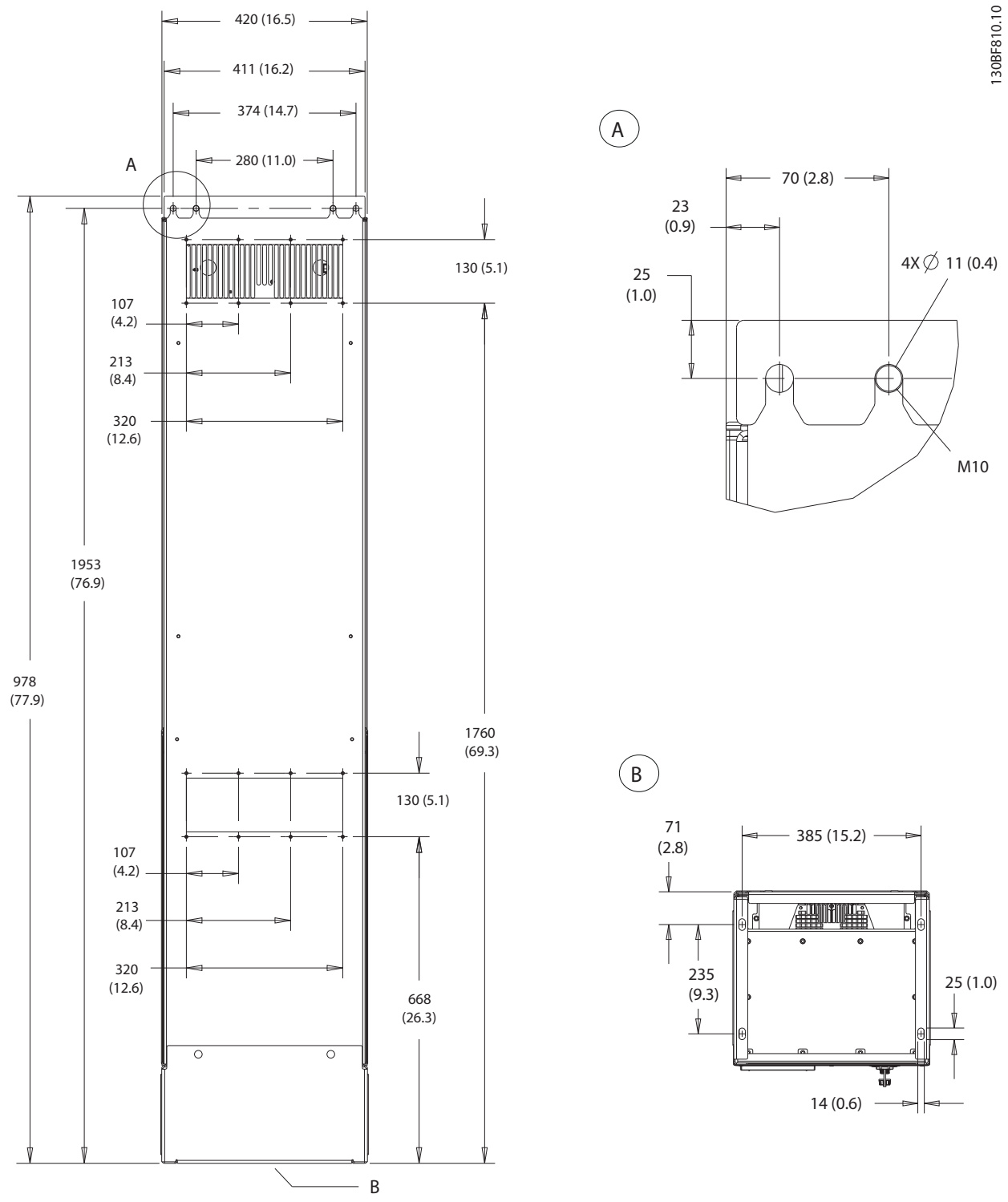

Illustration 10.32 Back View of D7h

10

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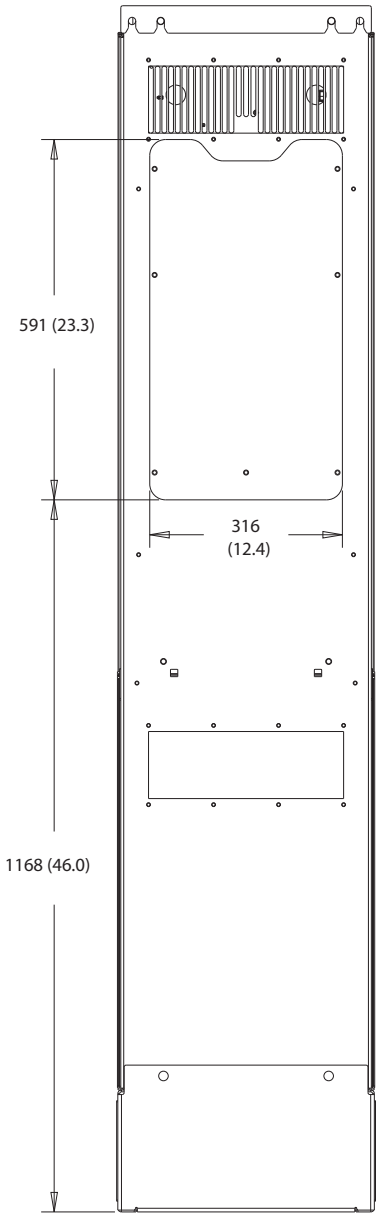

Illustration 10.33 Heat Sink Access Dimensions for D7h

10

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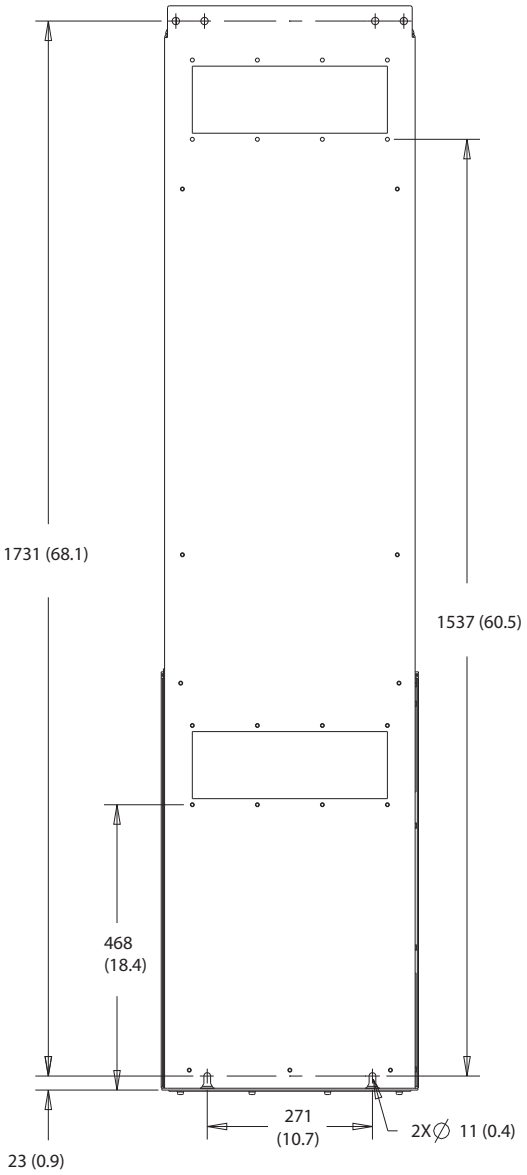

Illustration 10.34 Wall Mount Dimensions for D7h

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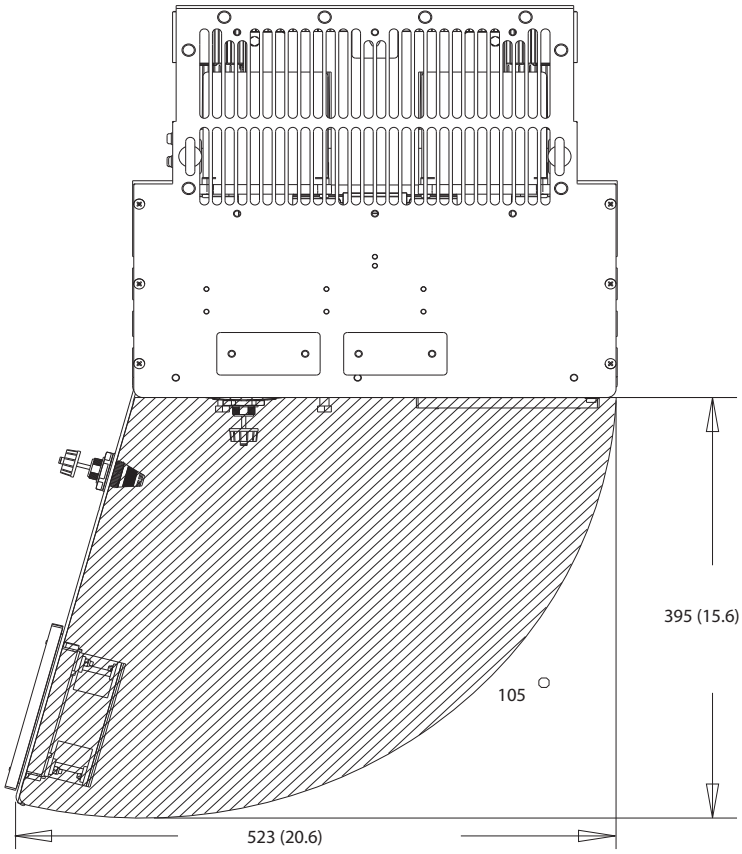
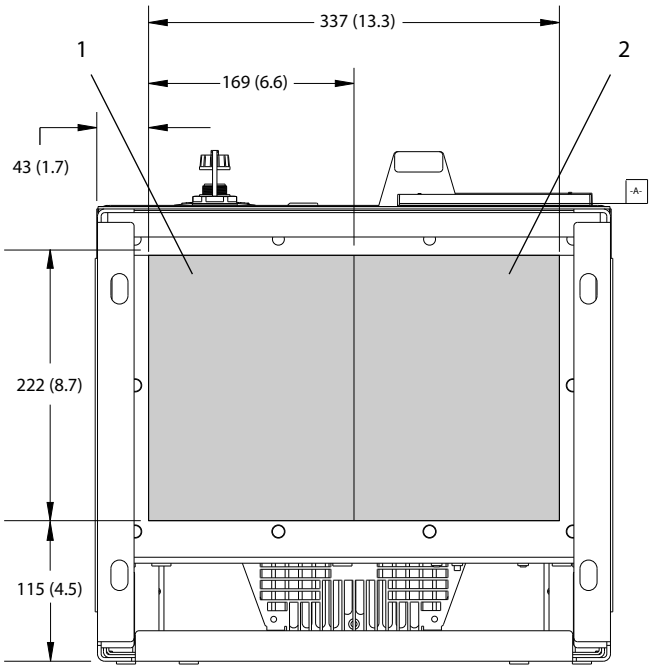


Illustration 10.35 Door Clearance for D7h



1	Mains side	2	Motor side

Illustration 10.36 Gland Plate Dimensions for D7h

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10.9.8 D8h Exterior Dimensions

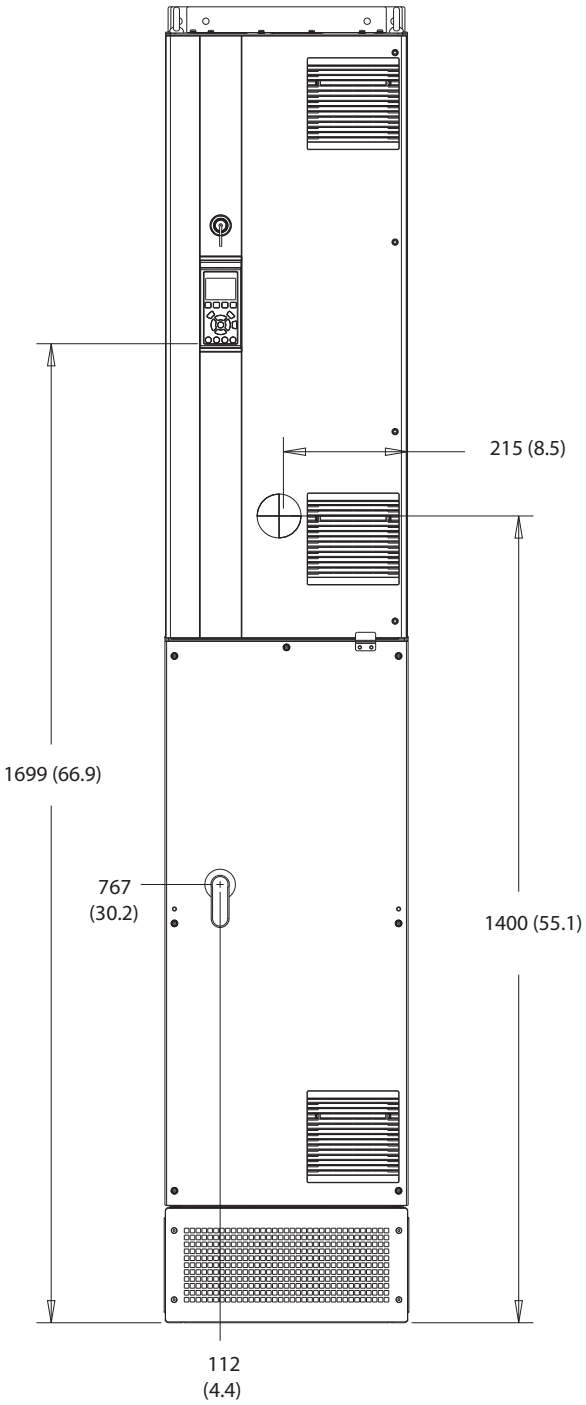

Illustration 10.37 Front View of D8h

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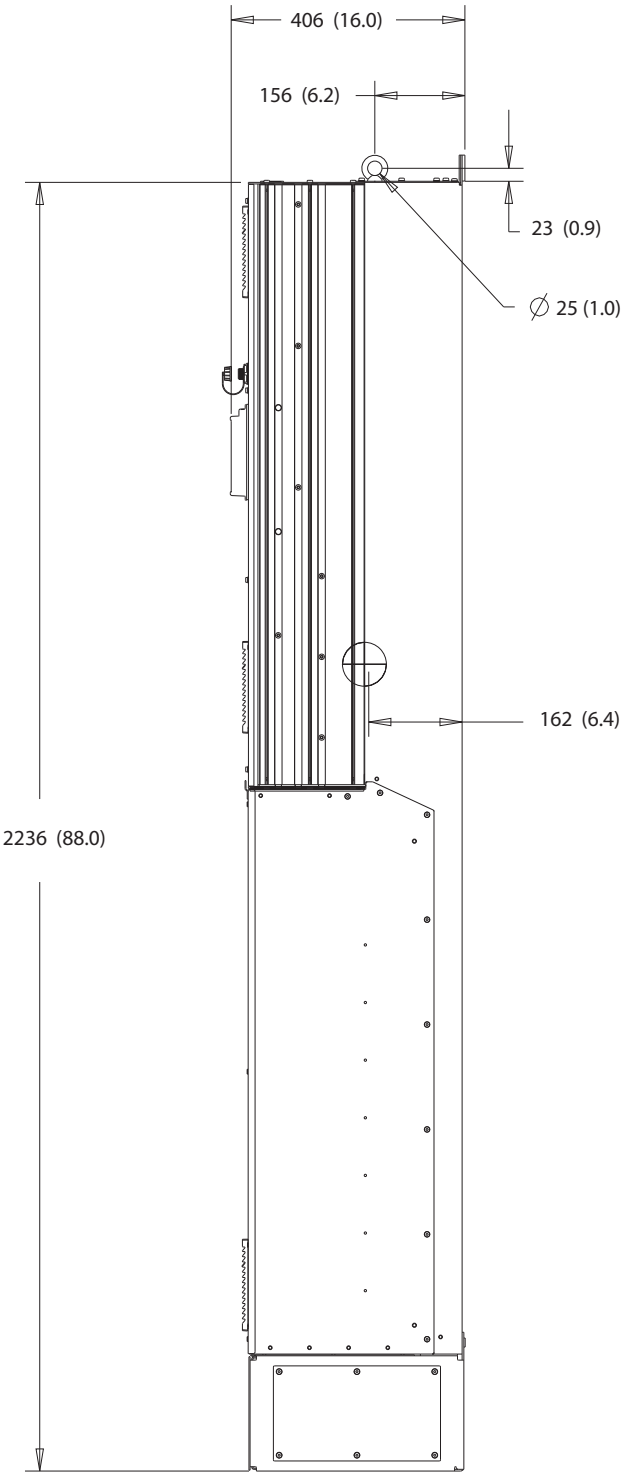

Illustration 10.38 Side View of D8h

10

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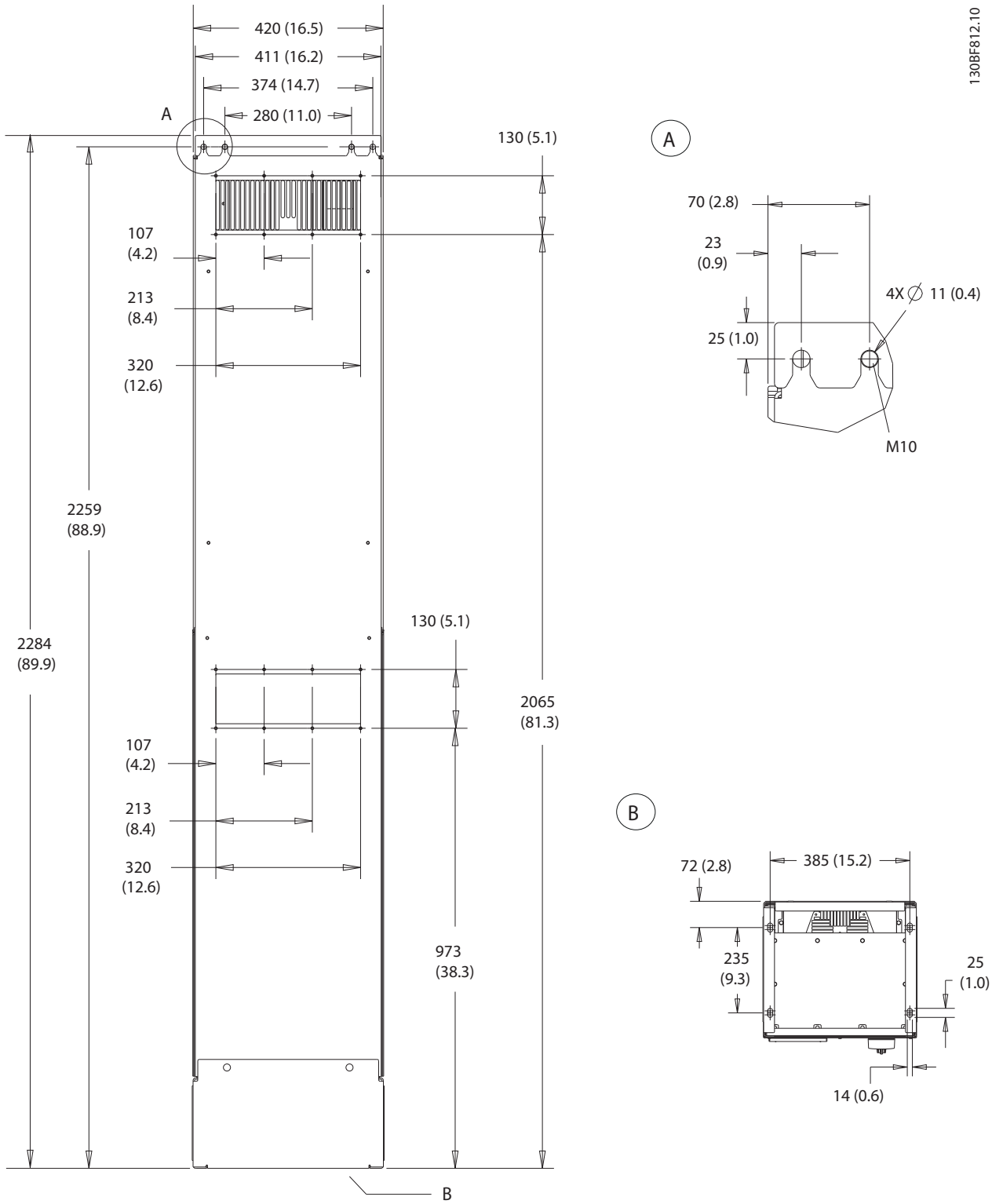

Illustration 10.39 Back View of D8h

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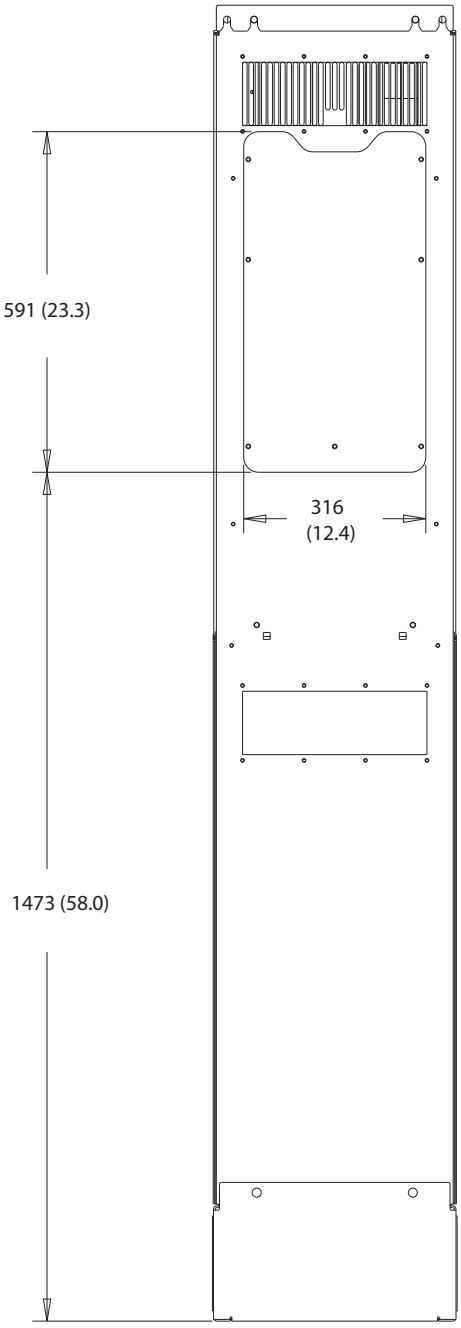

Illustration 10.40 Heat Sink Access Dimensions for D8h

10

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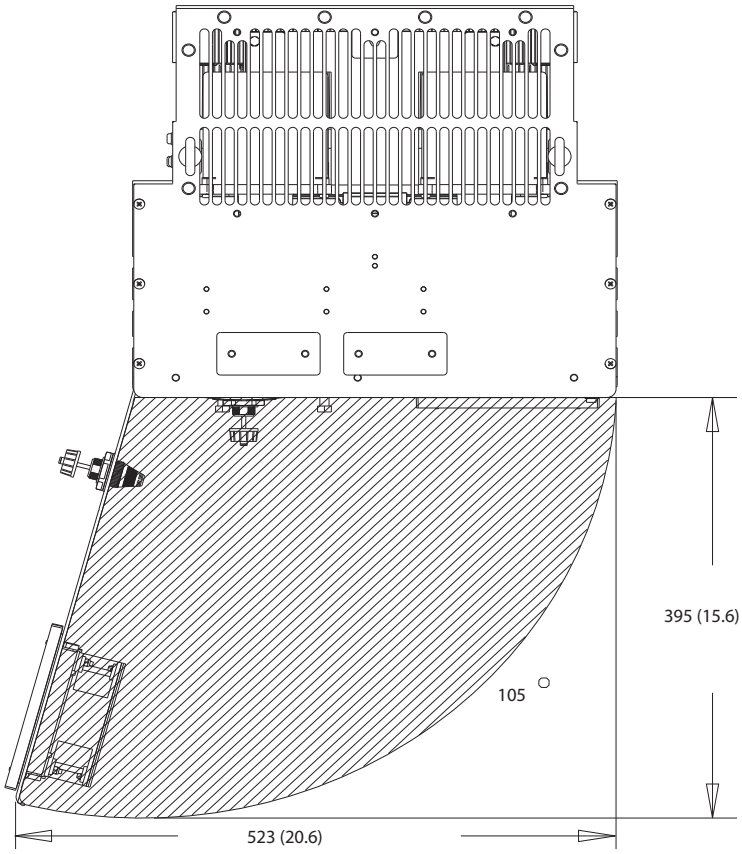
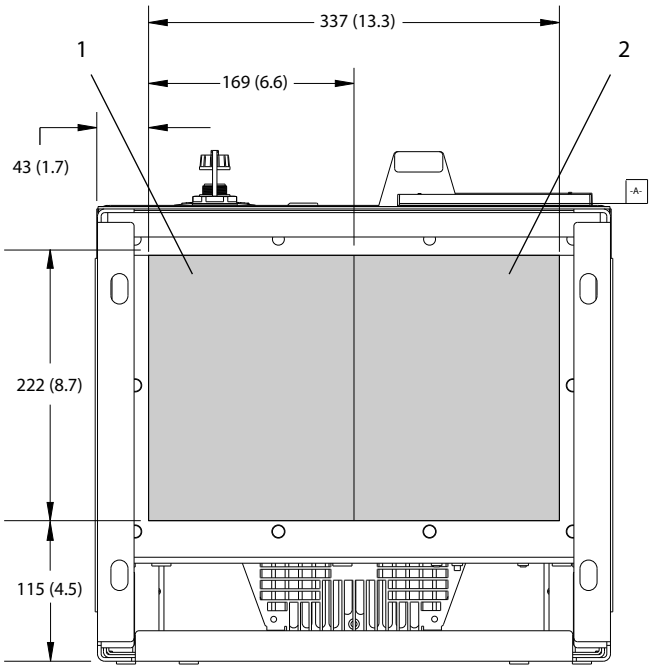


Illustration 10.41 Door Clearance for D8h



1	Mains side	2	Motor side

Illustration 10.42 Gland Plate Dimensions for D8h

11 Appendix

11.1 Abbreviations and Conventions

°C	Degrees Celsius
°F	Degrees Fahrenheit
Ω	Ohm
AC	Alternating current
AEO	Automatic energy optimization
ACP	Application control processor
AMA	Automatic motor adaptation
AWG	American wire gauge
CPU	Central processing unit
CSIV	Customer-specific initialization values
CT	Current transformer
DC	Direct current
DVM	Digital voltmeter
EEPROM	Electrically erasable programmable read-only memory
EMC	Electromagnetic compatibility
EMI	Electromagnetic interference
ESD	Electrostatic discharge
ETR	Electronic thermal relay
$f_{M,N}$	Nominal motor frequency
HF	High frequency
HVAC	Heating, ventilation, and air conditioning
Hz	Hertz
I_{LIM}	Current limit
I_{INV}	Rated inverter output current
$I_{M,N}$	Nominal motor current
$I_{VLT,MAX}$	Maximum output current
$I_{VLT,N}$	Rated output current supplied by the drive
IEC	International electrotechnical commission
IGBT	Insulated-gate bipolar transistor
I/O	Input/output
IP	Ingress protection
kHz	Kilohertz
kW	Kilowatt
L_d	Motor d-axis inductance
L_q	Motor q-axis inductance
LC	Inductor-capacitor
LCP	Local control panel
LED	Light-emitting diode
LOP	Local operation pad
mA	Milliamp
MCB	Miniature circuit breakers
MCO	Motion control option
MCP	Motor control processor
MCT	Motion control tool
MDCIC	Multi-drive control interface card
mV	Millivolts
NEMA	National Electrical Manufacturers Association
NTC	Negative temperature coefficient
$P_{M,N}$	Nominal motor power
PCB	Printed circuit board
PE	Protective earth
PELV	Protective extra low voltage
PID	Proportional integral derivative
PLC	Programmable logic controller
P/N	Part number
PROM	Programmable read-only memory
PS	Power section
PTC	Positive temperature coefficient
PWM	Pulse width modulation
R_s	Stator resistance
RAM	Random-access memory
RCD	Residual current device
Regen	Regeneration terminals
RFI	Radio frequency interference
RMS	Root means square (cyclically alternating electric current)
RPM	Revolutions per minute
SCR	Silicon controlled rectifier
SMPS	Switch mode power supply
S/N	Serial number
STO	Safe Torque Off
T_{LIM}	Torque limit
$U_{M,N}$	Nominal motor voltage
V	Volt
VVC	Voltage vector control
X_h	Motor main reactance

Table 11.1 Abbreviations, Acronyms, and Symbols

Conventions

- Numbered lists indicate procedures.
- Bullet lists indicate other information and description of illustrations.
- Italicized text indicates:
  - Cross reference
  - Link
  - Footnote
  - Parameter name
  - Parameter group name
  - Parameter option
- All dimensions are in mm (inch).

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11.2 International/North American Default Parameter Settings

Setting *parameter 0-03 Regional Settings* to *[0] International* or *[1] North America* changes the default settings for some parameters. *Table 11.2* lists those parameters that are affected.

Parameter	International default parameter value	North American default parameter value
Parameter 0-03 Regional Settings	International	North America
Parameter 0-71 Date Format	DD-MM-YYYY	MM/DD/YYYY
Parameter 0-72 Time Format	24 h	12 h
Parameter 1-20 Motor Power [kW]	1)	1)
Parameter 1-21 Motor Power [HP]	2)	2)
Parameter 1-22 Motor Voltage	230 V/400 V/575 V	208 V/460 V/575 V
Parameter 1-23 Motor Frequency	50 Hz	60 Hz
Parameter 3-03 Maximum Reference	50 Hz	60 Hz
Parameter 3-04 Reference Function	Sum	External/Preset
*Parameter 4-13 Motor Speed High Limit [RPM]*3)	1500 RPM	1800 RPM
*Parameter 4-14 Motor Speed High Limit [Hz]*4)	50 Hz	60 Hz
Parameter 4-19 Max Output Frequency	100 Hz	120 Hz
Parameter 4-53 Warning Speed High	1500 RPM	1800 RPM
Parameter 5-12 Terminal 27 Digital Input	Coast inverse	External interlock
Parameter 5-40 Function Relay	Alarm	No alarm
Parameter 6-15 Terminal 53 High Ref./Feedb. Value	50	60
Parameter 6-50 Terminal 42 Output	Speed 0-HighLim	Speed 4-20 mA
Parameter 14-20 Reset Mode	Manual reset	Infinite auto reset
*Parameter 22-85 Speed at Design Point [RPM]*3)	1500 RPM	1800 RPM
Parameter 22-86 Speed at Design Point [Hz]	50 Hz	60 Hz
Parameter 24-04 Fire Mode Max Reference	50 Hz	60 Hz

Table 11.2 International/North American Default Parameter Settings

1) Parameter 1-20 Motor Power [kW] is only visible when parameter 0-03 Regional Settings is set to [0] International.

2) Parameter 1-21 Motor Power [HP] is only visible when parameter 0-03 Regional Settings is set to [1] North America.

3) This parameter is only visible when parameter 0-02 Motor Speed Unit is set to [0] RPM.

4) This parameter is only visible when parameter 0-02 Motor Speed Unit is set to [1] Hz.

11.3 Parameter Menu Structure

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11.3.1 Software 5.20

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
0-15	Readout: actual setup
0-2*	**LCP Display**
0-20	Display Line 1.1 Small
0-21	Display Line 1.2 Small
0-22	Display Line 1.3 Small
0-23	Display Line 2 Large
0-24	Display Line 3 Large
0-25	My Personal Menu
0-3*	**LCP Custom Readout**
0-30	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 Access Password
0-7*	**Clock Settings**
0-70	Date and Time
0-71	Date Format
0-72	Time Format
0-73	Time Zone Offset
0-74	DST/Summertime
0-76	DST/Summertime Start
0-77	DST/Summertime End
0-79	Clock Fault
0-81	Working Days
0-82	Additional Working Days
0-83	Additional Non-Working Days
0-84	Time for Fieldbus
0-85	Summer Time Start for Fieldbus
0-86	Summer Time End for Fieldbus
0-89	Date and Time Readout
0-9*	**Varia**
0-95	Warning LED blinking
1- **	**Load and Motor**
1-0*	**General Settings**
1-00	Configuration Mode
1-03	Torque Characteristics
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)
1-35	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
1-49	q-Axis Inductance Saturation Point
1-5*	**Load Indep. Setting**
1-50	Motor Magnetisation at Zero Speed
1-51	Min Speed Normal Magnetising [RPM]
1-52	Min Speed Normal Magnetising [Hz]
1-58	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 Dampening
1-65	Resonance Dampening Time Constant
1-66	Min. Current at Low Speed
1-7*	**Start Adjustments**
1-70	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	Compressor 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
1-95	Thermistor Sensor Type
1-96	Thermistor Sensor Source
1-97	Thermistor Threshold level
1-98	ATEX ETR interpol. points freq.
1-99	ATEX ETR interpol points current
2- **	**Brakes**
2-0*	**DC-Brake**
2-00	DC Hold/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
2-19	Over-voltage Gain
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
3-82	Starting Ramp Up 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
4-59	Motor Check At Start
4-6*	**Speed Bypass**
4-60	Bypass Speed From [RPM]
4-61	Bypass Speed From [Hz]
4-62	Bypass Speed To [RPM]
4-63	Bypass Speed To [Hz]
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6-12	Terminal 53 Low Current
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6-14	Terminal 53 Low Ref./Feedb. Value
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6-21	Terminal 54 High Voltage
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6-23 Terminal 54 High Current
6-24 Terminal 54 Low Ref./Feedb. Value
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6-26 Terminal 54 Filter Time Constant
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8-74 "I-Am" Service
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16-11 Power [hp]
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16-13 Frequency
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16-17 Speed [RPM]
16-18 Motor Thermal
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16-54 Feedback 1 [Unit]
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18-50 Sensorless Readout [unit]
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18-70 Mains Voltage
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18-75 Rectifier DC Volt.
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20-00 Feedback 1 Source
20-01 Feedback 1 Conversion
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20-2* Feedback/Setpoint
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20-21 Setpoint 1
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20-31 User Defined Refrigerant A1
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20-34 Duct 1 Area [m2]
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20-38 Air Density Factor [%]
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20-7* PID Autotuning
20-70 Closed Loop Type
20-71 PID Performance
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21-09 PID Autotuning
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21-10 Ext. 1 Ref./Feedback Unit
21-11 Ext. 1 Minimum Reference
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21-13 Ext. 1 Reference Source
21-14 Ext. 1 Feedback Source
21-15 Ext. 1 Setpoint
21-17 Ext. 1 Reference [Unit]
21-18 Ext. 1 Feedback [Unit]
21-19 Ext. 1 Output [%]
21-2* Ext. CL 1 PID
21-20 Ext. 1 Normal/Inverse Control
21-21 Ext. 1 Proportional Gain
21-22 Ext. 1 Integral Time
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21-24 Ext. 1 Dif. Gain Limit
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21-30 Ext. 2 Ref./Feedback Unit
21-31 Ext. 2 Minimum Reference
21-32 Ext. 2 Maximum Reference
21-33 Ext. 2 Reference Source
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21-37 Ext. 2 Reference [Unit]
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21-39 Ext. 2 Output [%]
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21-40 Ext. 2 Normal/Inverse Control
21-41 Ext. 2 Proportional Gain
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21-50 Ext. 3 Ref./Feedback Unit
21-51 Ext. 3 Minimum Reference
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21-59 Ext. 3 Output [%]
21-6* Ext. CL 3 PID
21-60 Ext. 3 Normal/Inverse Control
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22-10 Air Pressure to Flow Signal source
22-11 Air Pressure to Flow Fan k-factor
22-12 Air Pressure to Flow Air density
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22-2* No-Flow Detection
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22-21 Low Power Detection
22-22 Low Speed Detection
22-23 No-Flow Function
22-24 No-Flow Delay
22-26 Dry Pump Function
22-27 Dry Pump Delay
22-3* No-Flow Power Tuning
22-30 No-Flow Power
22-31 Power Correction Factor
22-32 Low Speed [RPM]
22-33 Low Speed [Hz]
22-34 Low Speed Power [kW]
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22-37 High Speed [Hz]
22-38 High Speed Power [kW]
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22-51 End of Curve Delay
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22-60 Broken Belt Function
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22-80 Flow Compensation
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22-85 Speed at Design Point [RPM]
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23-01 ON Action
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23-04 Occurrence
23-0* Timed Actions Settings
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23-10 Maintenance Item
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23-1* Maintenance Reset
23-15 Reset Maintenance Word
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23-63 Timed Period Start
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24-00 Fire Mode Function
24-01 Fire Mode Configuration
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