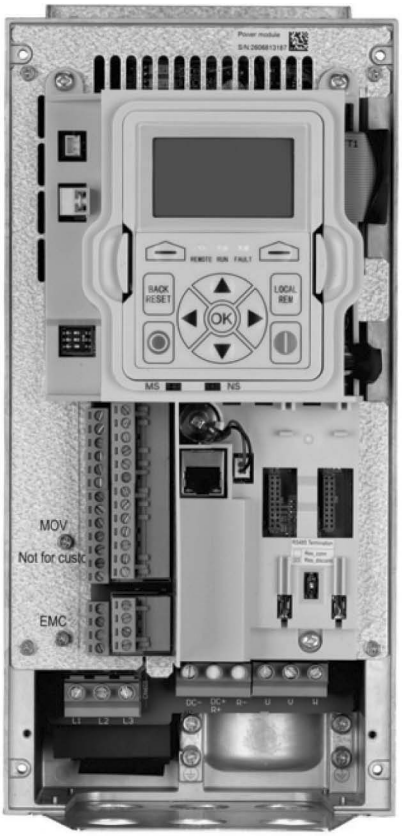
PowerXL DG1 Series VFD

Installation Manual

Effective March 2014
New Information



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Cover Photo: Eaton PowerXL DG1 Series Drive

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Support Services

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Safety

Warning!
Dangerous Electrical Voltage!

Before Commencing the Installation

- Disconnect the power supply of the device
- Ensure that devices cannot be accidentally restarted
- Verify isolation from the supply
- Earth and short circuit the device
- Cover or enclose any adjacent live components
- Only suitably qualified personnel in accordance with EN 50110-1/-2 (VDE 0105 Part 100) may work on this device/system
- Before installation and before touching the device ensure that you are free of electrostatic charge
- The functional earth (FE, PES) must be connected to the protective earth (PE) or the potential equalization. The system installer is responsible for implementing this connection
- Connecting cables and signal lines should be installed so that inductive or capacitive interference does not impair the automation functions
- Install automation devices and related operating elements in such a way that they are well protected against unintentional operation
- Suitable safety hardware and software measures should be implemented for the I/O interface so that an open circuit on the signal side does not result in undefined states in the automation devices
- Ensure a reliable electrical isolation of the extra-low voltage of the 24V supply. Only use power supply units complying with IEC 60364-4-41 (VDE 0100 Part 410) or HD384.4.41 S2
- Deviations of the input voltage from the rated value must not exceed the tolerance limits given in the specifications, otherwise this may cause malfunction and dangerous operation
- Emergency stop devices complying with IEC/EN 60204-1 must be effective in all operating modes of the automation devices. Unlatching the emergency-stop devices must not cause a restart
- Devices that are designed for mounting in housings or control cabinets must only be operated and controlled after they have been installed and with the housing closed. Desktop or portable units must only be operated and controlled in enclosed housings
- Measures should be taken to ensure the proper restart of programs interrupted after a voltage dip or failure. This should not cause dangerous operating states even for a short time. If necessary, emergency-stop devices should be implemented
- Wherever faults in the automation system may cause injury or material damage, external measures must be implemented to ensure a safe operating state in the event of a fault or malfunction (for example, by means of separate limit switches, mechanical interlocks, and so on)
- Depending on their degree of protection, adjustable frequency drives may contain live bright metal parts, moving or rotating components, or hot surfaces during and immediately after operation
- Removal of the required covers, improper installation, or incorrect operation of motor or adjustable frequency drive may cause the failure of the device and may lead to serious injury or damage
- The applicable national accident prevention and safety regulations apply to all work carried out on live adjustable frequency drives
- The electrical installation must be carried out in accordance with the relevant regulations (for example, with regard to cable cross sections, fuses, PE)
- Transport, installation, commissioning, and maintenance work must be carried out only by qualified personnel (IEC 60364, HD 384 and national occupational safety regulations)
- Installations containing adjustable frequency drives must be provided with additional monitoring and protective devices in accordance with the applicable safety regulations. Modifications to the adjustable frequency drives using the operating software are permitted
- All covers and doors must be kept closed during operation
- To reduce hazards for people or equipment, the user must include in the machine design measures that restrict the consequences of a malfunction or failure of the drive (increased motor speed or sudden standstill of motor). These measures include:
  - Other independent devices for monitoring safety-related variables (speed, travel, end positions, and so on)
  - Electrical or non-electrical system-wide measures (electrical or mechanical interlocks)
  - Never touch live parts or cable connections of the adjustable frequency drive after it has been disconnected from the power supply. Due to the charge in the capacitors, these parts may still be live after disconnection. Fit appropriate warning signs

Read this manual thoroughly and make sure you understand the procedures before you attempt to install, set up, operate or carry out any maintenance work on this DG1 Adjustable Frequency Drive.

Definitions and Symbols

WARNING

This symbol indicates high voltage. It calls your attention to items or operations that could be dangerous to you and other persons operating this equipment. Read the message and follow the instructions carefully.

This symbol is the "Safety Alert Symbol." It occurs with either of two signal words: CAUTION or WARNING, as described below.

WARNING

Indicates a potentially hazardous situation which, if not avoided, can result in serious injury or death.

CAUTION

Indicates a potentially hazardous situation which, if not avoided, can result in minor to moderate injury, or serious damage to the product. The situation described in the CAUTION may, if not avoided, lead to serious results. Important safety measures are described in CAUTION (as well as WARNING).

Hazardous High Voltage

WARNING

Motor control equipment and electronic controllers are connected to hazardous line voltages. When servicing drives and electronic controllers, there may be exposed components with housings or protrusions at or above line potential. Extreme care should be taken to protect against shock.

- **Stand on an insulating pad and make it a habit to use only one hand when checking components.**
- **Always work with another person in case an emergency occurs.**
- **Disconnect power before checking controllers or performing maintenance.**
- **Be sure equipment is properly earthed.**
- **Wear safety glasses whenever working on electronic controllers or rotating machinery.**

WARNING

The components in the drive's power section remain energized after the supply voltage has been switched off. After disconnecting the supply, wait at least five minutes before removing the cover to allow the intermediate circuit capacitors to discharge.

Pay attention to hazard warnings!

DANGER

5 MIN

WARNING

Electric shock hazard—risk of injuries! Carry out wiring work only if the unit is de-energized.

WARNING

Do not perform any modifications on the AC drive when it is connected to mains.

Warnings and Cautions

WARNING

Be sure to ground the unit following the instructions in this manual. Ungrounded units may cause electric shock and/or fire.

WARNING

This equipment should only be installed, adjusted, and serviced by qualified electrical maintenance personnel familiar with the construction and operation of this type of equipment and the hazards involved. Failure to observe this precaution could result in death or severe injury.

WARNING

Components within the drive are live when it is connected to power. Contact with this voltage is extremely dangerous and may cause death or severe injury.

WARNING

Line terminals (L1, L2, L3), motor terminals (U, V, W) and the DC link/brake resistor terminals (DC–, DC+/R+, R–) are live when the drive is connected to power, even if the motor is not running. Contact with this voltage is extremely dangerous and may cause death or severe injury.

WARNING

Even though the control I/O-terminals are isolated from line voltage, the relay outputs and other I/O-terminals may have dangerous voltage present even when the drive is disconnected from power. Contact with this voltage is extremely dangerous and may cause death or severe injury.

WARNING

This equipment has a large capacitive leakage current during operation, which can cause enclosure parts to be above ground potential. Proper grounding, as described in this manual, is required. Failure to observe this precaution could result in death or severe injury.

WARNING

Before applying power to this drive, make sure that the front and cable covers are closed and fastened to prevent exposure to potential electrical fault conditions. Failure to observe this precaution could result in death or severe injury.

WARNING

An upstream disconnect/protective device must be provided as required by the National Electric Code® (NEC®). Failure to follow this precaution may result in death or severe injury.

WARNING

This drive can cause a DC current in the protective earthing conductor. Where a residual current-operated protective (RCD) or monitoring (RCM) device is used for protection in case of direct or indirect contact, only an RCD or RCM of Type B is allowed on the supply side of this product.

WARNING

Carry out wiring work only after the drive has been correctly mounted and secured.

WARNING

Before opening the drive covers:

- **Disconnect all power to the drive, including external control power that may be present.**
- **Wait a minimum of five minutes after all the lights on the keypad are off. This allows time for the DC bus capacitors to discharge.**
- **A hazard voltage may still remain in the DC bus capacitors even if the power has been turned off. Confirm that the capacitors have fully discharged by measuring their voltage using a multimeter set to measure the DC voltage.**

Failure to follow these precautions may cause death or severe injury.

WARNING

The opening of the branch-circuit protective device may be an indication that a fault current has been interrupted. To reduce the risk of fire or electric shock, current-carrying parts and other components of the controller should be examined and replaced if damaged. If burnout of the current element of an overload relay occurs, the complete overload relay must be replaced.

WARNING

Operation of this equipment requires detailed installation and operation instructions provided in the Installation/Operation manual intended for use with this product. This information is provided on the CD-ROM, floppy diskette(s) or other storage device included in the container this device was packaged in. it should be retained with this device at all times. A hard copy of this information may be ordered from Eaton literature fulfillment.

⚠ WARNING

Before servicing the drive:

- **Disconnect all power to the drive, including external control power that may be present.**
- **Place a "DO NOT TURN ON" label on the disconnect device.**
- **Lock the disconnect device in the open position.**

Failure to follow these instructions will result in death or serious injury.

⚠ WARNING

The drive outputs (U, V, W) must not be connected to the input voltage or the utility line power as severe damage to the device may occur and there may be a risk of fire.

⚠ WARNING

The heat sink and/or outer enclosure may reach a high temperature.

Pay attention to hazard warnings!

Hot Surface—Risk of Burn. DO NOT TOUCH!

⚠ CAUTION

Any electrical or mechanical modification to this drive without prior written consent of Eaton will void all warranties and may result in a safety hazard in addition and voiding of the UL® listing.

⚠ CAUTION

Install this drive on flame-resistant material such as a steel plate to reduce the risk of fire.

⚠ CAUTION

Install this drive on a perpendicular surface that is able to support the weight of the drive and is not subject to vibration, to lessen the risk of the drive falling and being damaged and/or causing personal injury.

⚠ CAUTION

Prevent foreign material such as wire clippings or metal shavings from entering the drive enclosure, as this may cause arcing damage and fire.

⚠ CAUTION

Install this drive in a well-ventilated room that is not subject to temperature extremes, high humidity, or condensation, and avoid locations that are directly exposed to sunlight, or have high concentrations of dust, corrosive gas, explosive gas, inflammable gas, grinding fluid mist, etc. Improper installation may result in a fire hazard.

⚠ CAUTION

When selecting the cable cross-section, take the voltage drop under load conditions into account. The consideration of other standards is the responsibility of the user.

The user is responsible for compliance with all international and national electrical standards in force concerning protective grounding of all equipment.

⚠ CAUTION

The specified minimum PE conductor cross-sections in this manual must be maintained.

Touch current in this equipment exceeds 3.5 mA (AC). The minimum size of the protective earthing conductor shall comply with the requirements of EN 61800-5-1 and/or the local safety regulations.

⚠ CAUTION

Touch currents in this frequency inverter are greater than 3.5 mA (AC). According to product standard IEC/EN 61800-5-1, an additional equipment grounding conductor of the same cross-sectional area as the original protective earthing conductor must be connected, or the cross-section of the equipment grounding conductor must be at least 10 mm^2 Cu. Drive requires that only copper conductor should be used.

⚠ CAUTION

Debounced inputs may not be used in the safety circuit diagram. Residual current circuit breakers (RCD) are only to be installed between the AC power supply network and the drive.

⚠ CAUTION

Debounced inputs may not be used in the safety circuit diagram. If you are connecting multiple motors on one drive, you must design the contactors for the individual motors according to utilization category AC-3.

Selecting the motor contactor is done according to the rated operational current of the motor to be connected.

CAUTION

Debounced inputs may not be used in the safety circuit diagram. A changeover between the drive and the input supply must take place in a voltage-free state.

CAUTION

Debounced inputs may not be used in the safety circuit diagram. Fire hazard!

Only use cables, protective switches, and contactors that feature the indicated permissible nominal current value.

CAUTION

Before connecting the drive to AC mains make sure that the EMC protection class settings of the drive are appropriately made according to instructions in this manual.

- If the drive is to be used in a floating distribution network, remove screws at MOV and EMC. See "Installation in Corner-Grounded Network" on **Page 43** and "Installation in IT System" on **Page 43** respectively.
- Disconnect the internal EMC filter when installing the drive on an IT system (an ungrounded power system or a high-resistance-grounded [over 30 ohm] power system), otherwise the system will be connected to ground potential through the EMC filter capacitors. This may cause danger, or damage the drive.
- Disconnect the internal EMC filter when installing the drive on a corner grounded TN system, otherwise the drive will be damaged.

  Note: When the internal EMC filter is disconnected, the drive might be not EMC compatible.

- Do not attempt to install or remove the MOV or EMC screws while power is applied to the drive's input terminals.

Motor and Equipment Safety

CAUTION

Do not perform any meggar or voltage withstand tests on any part of the drive or its components. Improper testing may result in damage.

CAUTION

Prior to any tests or measurements of the motor or the motor cable, disconnect the motor cable at the drive output terminals (U, V, W) to avoid damaging the drive during motor or cable testing.

CAUTION

Do not touch any components on the circuit boards. Static voltage discharge may damage the components.

CAUTION

Before starting the motor, check that the motor is mounted properly and aligned with the driven equipment. Ensure that starting the motor will not cause personal injury or damage equipment connected to the motor.

CAUTION

Set the maximum motor speed (frequency) in the drive according to the requirements of the motor and the equipment connected to it. Incorrect maximum frequency settings can cause motor or equipment damage and personal injury.

CAUTION

Before reversing the motor rotation direction, ensure that this will not cause personal injury or equipment damage.

CAUTION

Make sure that no power correction capacitors are connected to the drive output or the motor terminals to prevent drive malfunction and potential damage.

CAUTION

Make sure that the drive output terminals (U, V, W) are not connected to the utility line power as severe damage to the drive may occur.

CAUTION

When the control terminals of two or more drive units are connected in parallel, the auxiliary voltage for these control connections must be taken from a single source which can either be one of the units or an external supply.

CAUTION

The drive will start up automatically after an input voltage interruption if the external run command is on.

CAUTION

Do not control the motor with the disconnecting device (disconnecting means); instead, use the control panel start and stop keys and, or commands via the I/O board of the drive. The maximum allowed number of charging cycles of the DC capacitors (i.e. power-ups by applying power) is five in ten minutes.

⚠ CAUTION

Improper drive operation:

- If the drive is not turned on for a long period, the performance of its electrolytic capacitors will be reduced.
- If it is stopped for a prolonged period, turn the drive on at least every six months for at least 5 hours to restore the performance of the capacitors, and then check its operation. It is recommended that the drive is not connected directly to the line voltage. The voltage should be increased gradually using an adjustable AC source.

Failure to follow these instructions can result in injury and/or equipment damage.

For more technical information, contact the factory or your local Eaton sales representative.

Chapter 1—DG1 Series Overview

This chapter describes the purpose and contents of this manual, the receiving inspection recommendations and the DG1 Series Open Drive catalog numbering system.

How to Use this Manual

The purpose of this manual is to provide you with information necessary to install, set and customize parameters, start up, troubleshoot and maintain the Eaton DG1 Series adjustable frequency drive (AFD). To provide for safe installation and operation of the equipment, read the safety guidelines at the beginning of this manual and follow the procedures outlined in the following chapters before connecting power to the DG1 Series AFD. Keep this operating manual handy and distribute to all users, technicians and maintenance personnel for reference.

Receiving and Inspection

The DG1 Series AFD has met a stringent series of factory quality requirements before shipment. It is possible that packaging or equipment damage may have occurred during shipment. After receiving your DG1 Series AFD, please check for the following:

Check to make sure that the package includes the Instruction Leaflet (IL040016EN), Quick Start Guide (MN040006EN), User Manual CD (CD040002EN) and accessory packet. The accessory packet includes:

- Rubber grommets
- Control cable grounding clamps
- Additional grounding screw

Inspect the unit to ensure it was not damaged during shipment.

Make sure that the part number indicated on the nameplate corresponds with the catalog number on your order.

If shipping damage has occurred, please contact and file a claim with the carrier involved immediately.

If the delivery does not correspond to your order, please contact your Eaton Electrical representative.

Note: Do not destroy the packing. The template printed on the protective cardboard can be used for marking the mounting points of the DG1 AFD on the wall or in a cabinet.

Real Time Clock Battery Activation

To activate the real time clock (RTC) functionality in the PowerXL DG1 Series AFD, the RTC battery (already mounted in the drive) must be connected to the control board.

Simply remove the primary drive cover, locate the RTC battery directly below the keypad, and connect the white 2-wire connector to the receptacle on the control board.

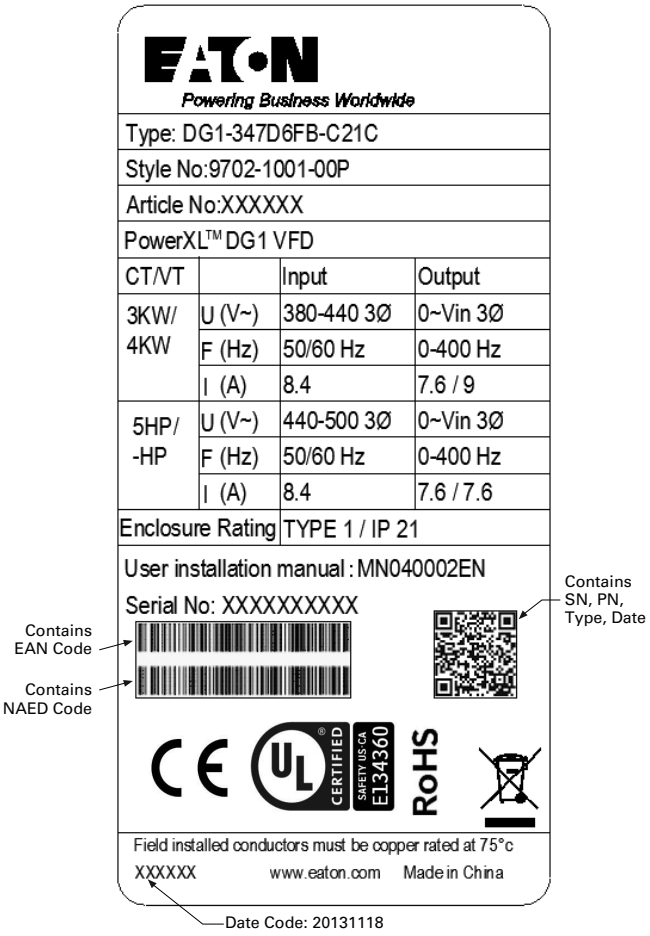
Figure 1. RTC Battery Connection

Table 1. Common Abbreviations

Abbreviation	Definition
CT	Constant torque with high overload rating (150%)
VT	Variable torque with low overload rating (110%)
I_H	High Overload (150%)
I_L	Low Overload (110%)
AFD	Adjustable Frequency Drive
VFD	Variable Frequency Drive

Rating Label

Figure 2. Rating Label

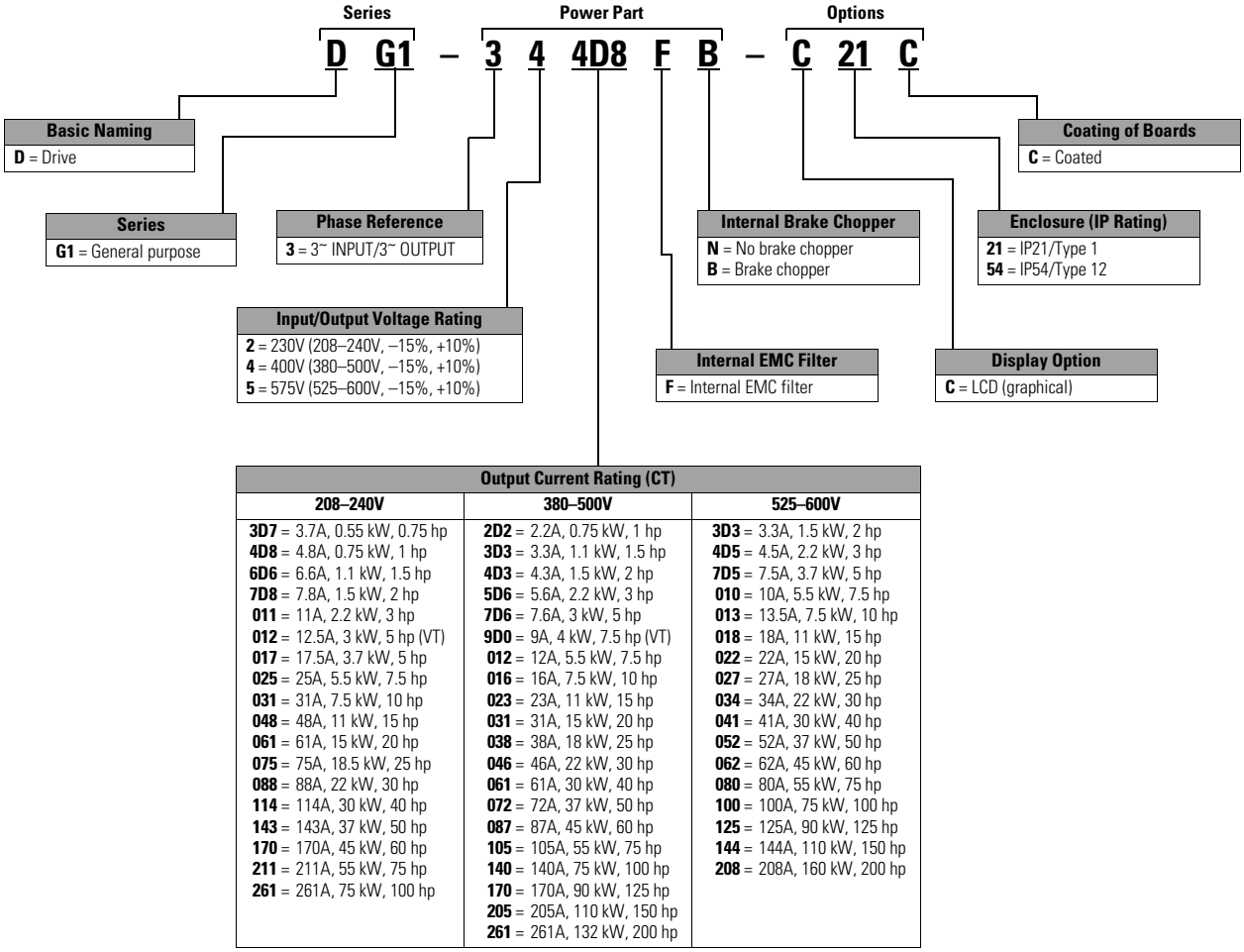


Carton Labels (U.S. and Europe)

Same as rating label shown above.

Catalog Number System

Figure 3. Catalog Numbering System



Output Current Rating (CT)		
208–240V	**380–500V**	**525–600V**
3D7 = 3.7A, 0.55 kW, 0.75 hp	**2D2** = 2.2A, 0.75 kW, 1 hp	**3D3** = 3.3A, 1.5 kW, 2 hp
4D8 = 4.8A, 0.75 kW, 1 hp	**3D3** = 3.3A, 1.1 kW, 1.5 hp	**4D5** = 4.5A, 2.2 kW, 3 hp
6D6 = 6.6A, 1.1 kW, 1.5 hp	**4D3** = 4.3A, 1.5 kW, 2 hp	**7D5** = 7.5A, 3.7 kW, 5 hp
7D8 = 7.8A, 1.5 kW, 2 hp	**5D6** = 5.6A, 2.2 kW, 3 hp	**010** = 10A, 5.5 kW, 7.5 hp
011 = 11A, 2.2 kW, 3 hp	**7D6** = 7.6A, 3 kW, 5 hp	**013** = 13.5A, 7.5 kW, 10 hp
012 = 12.5A, 3 kW, 5 hp (VT)	**9D0** = 9A, 4 kW, 7.5 hp (VT)	**018** = 18A, 11 kW, 15 hp
017 = 17.5A, 3.7 kW, 5 hp	**012** = 12A, 5.5 kW, 7.5 hp	**022** = 22A, 15 kW, 20 hp
025 = 25A, 5.5 kW, 7.5 hp	**016** = 16A, 7.5 kW, 10 hp	**027** = 27A, 18 kW, 25 hp
031 = 31A, 7.5 kW, 10 hp	**023** = 23A, 11 kW, 15 hp	**034** = 34A, 22 kW, 30 hp
048 = 48A, 11 kW, 15 hp	**031** = 31A, 15 kW, 20 hp	**041** = 41A, 30 kW, 40 hp
061 = 61A, 15 kW, 20 hp	**038** = 38A, 18 kW, 25 hp	**052** = 52A, 37 kW, 50 hp
075 = 75A, 18.5 kW, 25 hp	**046** = 46A, 22 kW, 30 hp	**062** = 62A, 45 kW, 60 hp
088 = 88A, 22 kW, 30 hp	**061** = 61A, 30 kW, 40 hp	**080** = 80A, 55 kW, 75 hp
114 = 114A, 30 kW, 40 hp	**072** = 72A, 37 kW, 50 hp	**100** = 100A, 75 kW, 100 hp
143 = 143A, 37 kW, 50 hp	**087** = 87A, 45 kW, 60 hp	**125** = 125A, 90 kW, 125 hp
170 = 170A, 45 kW, 60 hp	**105** = 105A, 55 kW, 75 hp	**144** = 144A, 110 kW, 150 hp
211 = 211A, 55 kW, 75 hp	**140** = 140A, 75 kW, 100 hp	**208** = 208A, 160 kW, 200 hp
261 = 261A, 75 kW, 100 hp	**170** = 170A, 90 kW, 125 hp	
	205 = 205A, 110 kW, 150 hp	
	261 = 261A, 132 kW, 200 hp	

Power Ratings and Product Selection

DG1 Series Drives—208–240 Volt

Table 2. Type 1/IP21

Frame Size	230V, 50 Hz kW Rating (CT/I_H)	230V, 50 Hz kW Rating (VT/I_L)	230V, 60 Hz hp (CT/I_H)	230V, 60 Hz hp (VT/I_L)	Current A (CT/I_H)	Current A (VT/I_L)	Catalog Number
FR1	0.55	0.75	0.75	1	3.7	4.8	**DG1-323D7FB-C21C**
	0.75	1.1	1	1.5	4.8	6.6	**DG1-324D8FB-C21C**
	1.1	1.5	1.5	2	6.6	7.8	**DG1-326D6FB-C21C**
	1.5	2.2	2	3	7.8	11	**DG1-327D8FB-C21C**
	2.2	3	3	—	11	12.5	**DG1-32011FB-C21C**
FR2	3	3.7	—	5	12.5	17.5	**DG1-32012FB-C21C**
	3.7	5.5	5	7.5	17.5	25	**DG1-32017FB-C21C**
	5.5	7.5	7.5	10	25	31	**DG1-32025FB-C21C**
FR3	7.5	11	10	15	31	48	**DG1-32031FB-C21C**
	11	15	15	20	48	61	**DG1-32048FB-C21C**
FR4	15	18.5	20	25	61	75	**DG1-32061FN-C21C**
	18.5	22	25	30	75	88	**DG1-32075FN-C21C**
	22	30	30	40	88	114	**DG1-32088FN-C21C**
FR5	30	37	40	50	114	143	**DG1-32114FN-C21C**
	37	45	50	60	143	170	**DG1-32143FN-C21C**
	45	55	60	75	170	211	**DG1-32170FN-C21C**
FR6 ①	55	75	75	100	211	261	**DG1-32211FN-C21C**
	75	90	100	125	261	312	**DG1-32261FN-C21C**

Table 3. Type 12/IP54

Frame Size	230V, 50 Hz kW Rating (CT/I_H)	230V, 50 Hz kW Rating (VT/I_L)	230V, 60 Hz hp (CT/I_H)	230V, 60 Hz hp (VT/I_L)	Current A (CT/I_H)	Current A (VT/I_L)	Catalog Number
FR1	0.55	0.75	0.75	1	3.7	4.8	**DG1-323D7FB-C54C**
	0.75	1.1	1	1.5	4.8	6.6	**DG1-324D8FB-C54C**
	1.1	1.5	1.5	2	6.6	7.8	**DG1-326D6FB-C54C**
	1.5	2.2	2	3	7.8	11	**DG1-327D8FB-C54C**
	2.2	3	3	—	11	12.5	**DG1-32011FB-C54C**
FR2	3	3.7	—	5	12.5	17.5	**DG1-32012FB-C54C**
	3.7	5.5	5	7.5	17.5	25	**DG1-32017FB-C54C**
	5.5	7.5	7.5	10	25	31	**DG1-32025FB-C54C**
FR3	7.5	11	10	15	31	48	**DG1-32031FB-C54C**
	11	15	15	20	48	61	**DG1-32048FB-C54C**
FR4	15	18.5	20	25	61	75	**DG1-32061FN-C54C**
	18.5	22	25	30	75	88	**DG1-32075FN-C54C**
	22	30	30	40	88	114	**DG1-32088FN-C54C**
FR5	30	37	40	50	114	143	**DG1-32114FN-C54C**
	37	45	50	60	143	170	**DG1-32143FN-C54C**
	45	55	60	75	170	211	**DG1-32170FN-C54C**
FR6 ①	55	75	75	100	211	261	**DG1-32211FN-C54C**
	75	90	100	125	261	312	**DG1-32261FN-C54C**

Note

① FR6 available in 2015.

DG1 Series Drives—380–500 Volt

Table 4. Type 1/IP21

Frame Size	400V, 50 Hz kW Rating (CT/I_H)	400V, 50 Hz kW Rating (VT/I_L)	460V, 60 Hz hp (CT/I_H)	460V, 60 Hz hp (VT/I_L)	Current A (CT/I_H)	Current A (VT/I_L)	Catalog Number
FR1	0.75	1.1	1	1.5	2.2	3.3	**DG1-342D2FB-C21C**
	1.1	1.5	1.5	2	3.3	4.3	**DG1-343D3FB-C21C**
	1.5	2.2	2	3	4.3	5.6	**DG1-344D3FB-C21C**
	2.2	3	3	5	5.6	7.6	**DG1-345D6FB-C21C**
	3	4	5	—	7.6	9	**DG1-347D6FB-C21C**
	4	5.5	—	7.5	9	12	**DG1-349D0FB-C21C**
FR2	5.5	7.5	7.5	10	12	16	**DG1-34012FB-C21C**
	7.5	11	10	15	16	23	**DG1-34016FB-C21C**
	11	15	15	20	23	31	**DG1-34023FB-C21C**
FR3	15	18.5	20	25	31	38	**DG1-34031FB-C21C**
	18.5	22	25	30	38	46	**DG1-34038FB-C21C**
	22	30	30	40	46	61	**DG1-34046FB-C21C**
FR4	30	37	40	50	61	72	**DG1-34061FN-C21C**
	37	45	50	60	72	87	**DG1-34072FN-C21C**
	45	55	60	75	87	105	**DG1-34087FN-C21C**
FR5	55	75	75	100	105	140	**DG1-34105FN-C21C**
	75	90	100	125	140	170	**DG1-34140FN-C21C**
	90	110	125	150	170	205	**DG1-34170FN-C21C**
FR6 ①	110	132	150	200	205	261	**DG1-34205FN-C21C**
	132	160	200	250	261	310	**DG1-34261FN-C21C**

Table 5. Type 12/IP54

Frame Size	400V, 50 Hz kW Rating (CT/I_H)	400V, 50 Hz kW Rating (VT/I_L)	460V, 60 Hz hp (CT/I_H)	460V, 60 Hz hp (VT/I_L)	Current A (CT/I_H)	Current A (VT/I_L)	Catalog Number
FR1	0.75	1.1	1	1.5	2.2	3.3	**DG1-342D2FB-C54C**
	1.1	1.5	1.5	2	3.3	4.3	**DG1-343D3FB-C54C**
	1.5	2.2	2	3	4.3	5.6	**DG1-344D3FB-C54C**
	2.2	3	3	5	5.6	7.6	**DG1-345D6FB-C54C**
	3	4	5	—	7.6	9	**DG1-347D6FB-C54C**
	4	5.5	—	7.5	9	12	**DG1-349D0FB-C54C**
FR2	5.5	7.5	7.5	10	12	16	**DG1-34012FB-C54C**
	7.5	11	10	15	16	23	**DG1-34016FB-C54C**
	11	15	15	20	23	31	**DG1-34023FB-C54C**
FR3	15	18.5	20	25	31	38	**DG1-34031FB-C54C**
	18.5	22	25	30	38	46	**DG1-34038FB-C54C**
	22	30	30	40	46	61	**DG1-34046FB-C54C**
FR4	30	37	40	50	61	72	**DG1-34061FN-C54C**
	37	45	50	60	72	87	**DG1-34072FN-C54C**
	45	55	60	75	87	105	**DG1-34087FN-C54C**
FR5	55	75	75	100	105	140	**DG1-34105FN-C54C**
	75	90	100	125	140	170	**DG1-34140FN-C54C**
	90	110	125	150	170	205	**DG1-34170FN-C54C**
FR6 ①	110	132	150	200	205	261	**DG1-34205FN-C54C**
	132	160	200	250	261	310	**DG1-34261FN-C54C**

Note

① FR6 available in 2015.

Replacement Parts

Table 6. Frame 1

Description	Catalog Number 230V	Catalog Number 480V	Catalog Number 575V
Standard keypad ①	**DXG-KEY-LCD**	**DXG-KEY-LCD**	**DXG-KEY-LCD**
Main control board ①	**DXG-SPR-CTRLBOARD**	**DXG-SPR-CTRLBOARD**	**DXG-SPR-CTRLBOARD**
Control board cover	**DXG-SPR-BCOVER**	**DXG-SPR-BCOVER**	**DXG-SPR-BCOVER**
Type 1/IP21 standard cover	**DXG-SPR-FR1CVR**	**DXG-SPR-FR1CVR**	②
Main fan kit ①	**DXG-SPR-FR1FAN**	**DXG-SPR-FR1FAN**	②
Control fan	**DXG-SPR-2FR1CF**	**DXG-SPR-4FR1CF**	②
Main power board	**DXG-SPR-2FR1MPB**	**DXG-SPR-4FR1MPB**	②
EMI board	**DXG-SPR-2FR1EB**	**DXG-SPR-4FR1EB**	②
Middle chassis cover	**DXG-SPR-FR1MCC**	**DXG-SPR-FR1MCC**	②
Outer housing	**DXG-SPR-FR1OH**	**DXG-SPR-FR1OH**	②
UL conduit plate	**DXG-SPR-FR1CPUL**	**DXG-SPR-FR1CPUL**	②
IEC conduit plate	**DXG-SPR-FR1CPIEC**	**DXG-SPR-FR1CPIEC**	②

Notes

① Factory recommended spare parts.
② 575V available in 2015.

Table 7. Frame 2

Description	Catalog Number 230V	Catalog Number 480V	Catalog Number 575V
Standard keypad ①	**DXG-KEY-LCD**	**DXG-KEY-LCD**	**DXG-KEY-LCD**
Main control board ①	**DXG-SPR-CTRLBOARD**	**DXG-SPR-CTRLBOARD**	**DXG-SPR-CTRLBOARD**
Control board cover	**DXG-SPR-BCOVER**	**DXG-SPR-BCOVER**	**DXG-SPR-BCOVER**
Type 1/IP21 standard cover	**DXG-SPR-FR2CVR**	**DXG-SPR-FR2CVR**	②
Main fan kit ①	**DXG-SPR-FR2FAN**	**DXG-SPR-FR2FAN**	②
Control fan	**DXG-SPR-FR2CF**	**DXG-SPR-FR2CF**	②
Bus capacitor	**DXG-SPR-2FR2BC**	**DXG-SPR-4FR24BC**	②
Main power board	**DXG-SPR-2FR2MPB**	**DXG-SPR-4FR2MPB**	②
EMI board	**DXG-SPR-2FR2EB**	**DXG-SPR-4FR2EB**	②
IGBT module	**DXG-SPR-FR2IGBT**	**DXG-SPR-FR2IGBT**	②
Middle chassis cover	**DXG-SPR-FR2MCC**	**DXG-SPR-FR2MCC**	②
Outer housing	**DXG-SPR-FR2OH**	**DXG-SPR-FR2OH**	②
UL conduit plate	**DXG-SPR-FR2CPUL**	**DXG-SPR-FR2CPUL**	②
IEC conduit plate	**DXG-SPR-FR2CPIEC**	**DXG-SPR-FR2CPIEC**	②

Notes

① Factory recommended spare parts.
② 575V available in 2015.

Table 8. Frame 3

Description	Catalog Number 230V	Catalog Number 480V	Catalog Number 575V
Standard keypad ①	**DXG-KEY-LCD**	**DXG-KEY-LCD**	**DXG-KEY-LCD**
Main control board ①	**DXG-SPR-CTRLBOARD**	**DXG-SPR-CTRLBOARD**	**DXG-SPR-CTRLBOARD**
Control board cover	**DXG-SPR-BCOVER**	**DXG-SPR-BCOVER**	**DXG-SPR-BCOVER**
Type 1/IP21 standard cover	**DXG-SPR-FR3CVR**	**DXG-SPR-FR3CVR**	②
Main fan kit ①	**DXG-SPR-FR3FAN**	**DXG-SPR-FR3FAN**	②
Control fan	**DXG-SPR-FR34CF**	**DXG-SPR-FR34CF**	②
Bus capacitor	**DXG-SPR-FR3BC**	**DXG-SPR-FR3BC**	②
Main power board	**DXG-SPR-2FR3MPB**	**DXG-SPR-4FR3MPB**	②
EMI board	**DXG-SPR-2FR3EB**	**DXG-SPR-4FR3EB**	②
Drive board	**DXG-SPR-2FR3DB**	**DXG-SPR-4FR3DB**	②
Output board	**DXG-SPR-FR3OB**	**DXG-SPR-FR3OB**	②
Middle chassis cover	**DXG-SPR-FR3MCC**	**DXG-SPR-FR3MCC**	②
Outer housing	**DXG-SPR-FR3OH**	**DXG-SPR-FR3OH**	②
UL conduit plate	**DXG-SPR-FR3CPUL**	**DXG-SPR-FR3CPUL**	②
IEC conduit plate	**DXG-SPR-FR3CPIEC**	**DXG-SPR-FR3CPIEC**	②

Notes

① Factory recommended spare parts.
② 575V available in 2015.

Table 9. Frame 4

Description	Catalog Number 230V	Catalog Number 480V	Catalog Number 575V
Standard keypad ①	**DXG-KEY-LCD**	**DXG-KEY-LCD**	**DXG-KEY-LCD**
Main control board ①	**DXG-SPR-CTRLBOARD**	**DXG-SPR-CTRLBOARD**	**DXG-SPR-CTRLBOARD**
Control board cover	**DXG-SPR-BCOVER**	**DXG-SPR-BCOVER**	**DXG-SPR-BCOVER**
Type 1/IP21 standard cover	**DXG-SPR-FR4CVR**	**DXG-SPR-FR4CVR**	②
Main fan kit ①	**DXG-SPR-FR4FAN**	**DXG-SPR-FR4FAN**	②
Control fan	**DXG-SPR-FR34CF**	**DXG-SPR-FR34CF**	②
Bus capacitor	**DXG-SPR-2FR4BC**	**DXG-SPR-4FR24BC**	②
Main power board	**DXG-SPR-2FR4MPB**	**DXG-SPR-4FR4MPB**	②
EMI board	**DXG-SPR-2FR4EB**	**DXG-SPR-4FR4EB**	②
Softstart board	**DXG-SPR-2FR4SB**	**DXG-SPR-4FR4SB**	②
IGBT module	**DXG-SPR-2FR4IGBT**	**DXG-SPR-4FR4IGBT**	②
Rectifier module	**DXG-SPR-2FR4RM**	**DXG-SPR-4FR4RM**	②
Brake chopper module	**DXG-SPR-2FR4BCM**	**DXG-SPR-4FR4BCM**	②
Middle chassis cover	**DXG-SPR-FR4MCC**	**DXG-SPR-FR4MCC**	②
Outer housing	**DXG-SPR-FR4OH**	**DXG-SPR-FR4OH**	②
UL conduit plate	**DXG-SPR-FR4CPUL**	**DXG-SPR-FR4CPUL**	②
IEC conduit plate	**DXG-SPR-FR4CPIEC**	**DXG-SPR-FR4CPIEC**	②

Notes

① Factory recommended spare parts.
② 575V available in 2015.

Table 10. Frame 5

Description	Catalog Number 230V	Catalog Number 480V	Catalog Number 575V
Standard keypad ①	**DXG-KEY-LCD**	**DXG-KEY-LCD**	**DXG-KEY-LCD**
Main control board ①	**DXG-SPR-CTRLBOARD**	**DXG-SPR-CTRLBOARD**	**DXG-SPR-CTRLBOARD**
Control board cover	**DXG-SPR-BCOVER**	**DXG-SPR-BCOVER**	**DXG-SPR-BCOVER**
Type 1/IP21 standard cover	**DXG-SPR-FR5CVR**	**DXG-SPR-FR5CVR**	②
Main fan kit ①	**DXG-SPR-FR5FAN**	**DXG-SPR-FR5FAN**	②
Control fan	**DXG-SPR-FR5CF**	**DXG-SPR-FR5CF**	②
Bus capacitor	**DXG-SPR-FR5BC**	**DXG-SPR-FR5BC**	②
Main power board	**DXG-SPR-2FR5MPB**	**DXG-SPR-4FR5MPB**	②
EMI-1 board	**DXG-SPR-2FR5E1B**	**DXG-SPR-4FR5E1B**	②
EMI-2 board	**DXG-SPR-2FR5E2B**	**DXG-SPR-4FR5E2B**	②
EMI-3 board	**DXG-SPR-FR5E3B**	**DXG-SPR-FR5E3B**	②
IGBT module	**DXG-SPR-FR5IGBT**	**DXG-SPR-FR5IGBT**	②
Rectifier module	**DXG-SPR-2FR5RM**	**DXG-SPR-4FR5RM**	②
Brake chopper module	**DXG-SPR-2FR5BCM**	**DXG-SPR-4FR5BCM**	②
Middle chassis cover	**DXG-SPR-FR5MCC**	**DXG-SPR-FR5MCC**	②
Outer housing	**DXG-SPR-FR5OH**	**DXG-SPR-FR5OH**	②
UL conduit plate	**DXG-SPR-FR5CPUL**	**DXG-SPR-FR5CPUL**	②
IEC conduit plate	**DXG-SPR-FR5IECCP**	**DXG-SPR-FR5IECCP**	②

Notes

① Factory recommended spare parts.

② 575V available in 2015.

Chapter 2—Engineering Considerations

Introduction

This chapter describes the most important features in the energy circuit of a drive system that you should take into consideration in your project planning.

Figure 4. Drive System (PDS = Power Drive System)

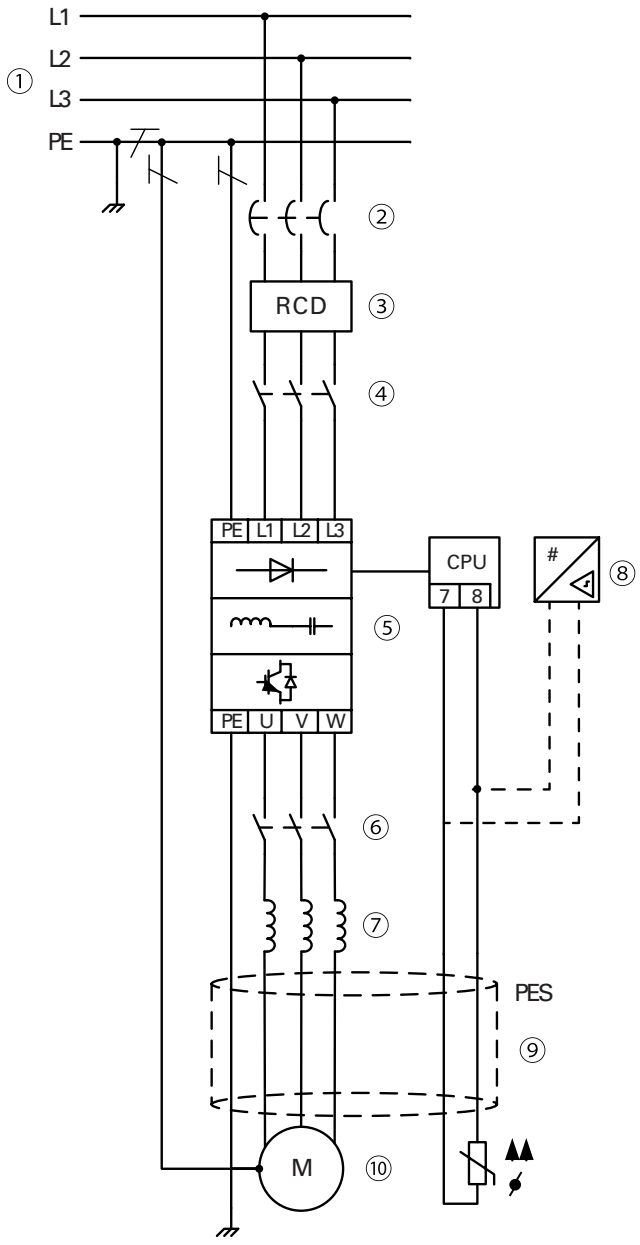


Table 11. Drive System Components

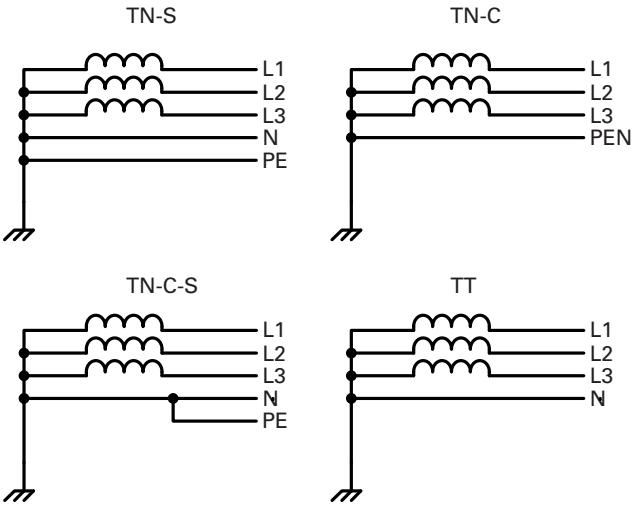
Item No.	Description
1	Power grid configuration, input voltage, input frequency, interactions with PF correction systems
2	Breakers, fuses, cable cross-sections
3	Protection of persons and animals with residual-current protective devices
4	Input contactor, disconnector
5	Frequency inverter: mounting, installation; power connection; EMC measures; circuit examples
6	Output contactor, disconnector
7	Output reactor, dV/dT filter, sine-wave filter
8	Motor protection; thermistor (can be connected to drive directly)
9	Cable lengths, motor cables, shielding (EMC)
10	Motor and application, parallel operation of multiple motors on a VFD, bypass circuit, DC braking

Electrical Power Network

Input Connection and Configuration

The DG1 Series frequency inverters can be connected and operated with all control-point grounded AC power networks (see IEC 60364 for more information).

Figure 5. AC Power Networks with Grounded Neutral Point (TN- / TT Networks)



The frequency inverter can be applied to all types of power networks above. If multiple frequency inverters with single-phase supplies are to be connected, a symmetrical distribution to the three external conductors shall be taken into account. In addition, the total current of all single-phase consumers is not to cause an overload of the neutral conductor (N-conductor).

The connection and operation of frequency inverters to asymmetrically grounded TN networks (phase-grounded delta network "Grounded Delta", USA) or neutral point ungrounded or high-resistance grounded (>30 ohms) IT networks is only conditionally permissible. In these networks above-mentioned, the internal interference suppression filter of frequency inverter must be disconnected (unscrew the screw marked 'EMC', see "Installation in IT System" on **Page 43**). Then the required filtering for EMC (electromagnetic compatibility) is no longer present (degrade to Class T).

Measures for EMC are mandatory in a drive system in order to meet the legal requirements for EMC and low voltage regulations.

Good grounding measures are a prerequisite for the effective insert of further measures such as shielding of filters. Without respective grounding measures, further steps are superfluous.

Input Voltage and Frequency

The standardized input voltages (IEC 60038, VDE017-1) for energy suppliers (EVU) guarantee the following conditions at the transition points:

- Deviation from the rated value of voltage: Max. ±10%
- Deviation in voltage phase balance: Max. ±3%
- Deviation from rated value of the frequency: Max. ±4%

The board tolerance band of the DG1 frequency inverter considers the rated value for European as (EU: U_{LN} = 230V / 400V, 50 Hz) and American as (USA: U_{LN} = 240V / 480V, 60 Hz) standard voltages:

- 230V, 50 Hz (EU) and 240V, 60 Hz (USA) at DG1-32_
- 400V, 50 Hz (EU) and 480V, 60 Hz (USA) at DG1-34_

For the bottom voltage value, the permitted voltage drop of 4% in the consumer circuits is also taken into account, therefore a total of U_{LN} –14%.

- 230V device class (DG1-32_): 208V –15% to 240V +10% (177V –0% to 264V +0%)
- 400V device class (DG1-34_): 380V –15% to 500V +10% (323V –0% to 550V +0%)

The permitted frequency range is 50/60 Hz (45 Hz –0% to 66 Hz +0%).

Input Voltage Balance

Due to the uneven loading on the conductor, and with the direct connection of greater power ratings, deviations from the ideal voltage form and asymmetrical voltages can be caused in three-phase AC power networks. These asymmetric divergences in the input voltage can lead to different loading of the diodes in input rectifiers with three-phase supplied frequency inverters, and as a result, an advance failure of this diode.

In the project planning for the connection of three-phase supplied frequency inverters, consider only AC power networks that handle permitted asymmetric divergences in the input voltage ≤ +3%.

If this condition is not fulfilled, or symmetry at the connection location is uncertain, the use of an assigned AC choke is recommended.

Total Harmonic Distortion (THD)

Non-linear consumers (loads) in an AC supply system produce harmonic voltages that again result in harmonic currents. These harmonic currents at the inductive and capacitive reactances of a mains supply system produce additional voltage drops with different values that are then overlaid on the sinusoidal mains voltage and result in distortions. In supply systems, this form of "noise" can give rise to problems in an installation if the sum of the harmonics exceeds certain limit values.

Non-linear consumers (harmonics producers) include for example:

- Induction and arc furnaces, welding devices
- Current converters, rectifiers and inverters, soft starters, variable frequency drives
- Switched-mode power supply units (computers, monitors, lighting), uninterrupted power supply (UPS)

The THD value (THD = Total Harmonic Distortion) is defined in standard IEC/EN 61800-3 as the ratio of the rms value of all harmonic components to the rms value of the fundamental frequency. It is given in percent of the total value.

$$\mathrm{THD} \quad \frac{\sqrt{U_2^2 + U_3^2 + U_4^2 + \cdots U_n^2}}{U_1} \times 100\%$$

U_1 — *fundamental component*

U_n — n^{th} *order harmonic component*

The THD value of the harmonic distortion is stated in relation to the rms value of the total signal as a percentage. On a variable frequency drive, the total harmonic distortion is around 120%.

To assist in the calculation of system harmonics, a Harmonic Estimation Calculator Tool is available at www.eaton.com/drives.

Reactive Power Compensation Devices

Special compensation measures on the power supply side is not required for DG1 Series drives, which take on very little reactive power of the fundamental harmonics from the AC power supply network ($\cos\varphi$ ~0.98).

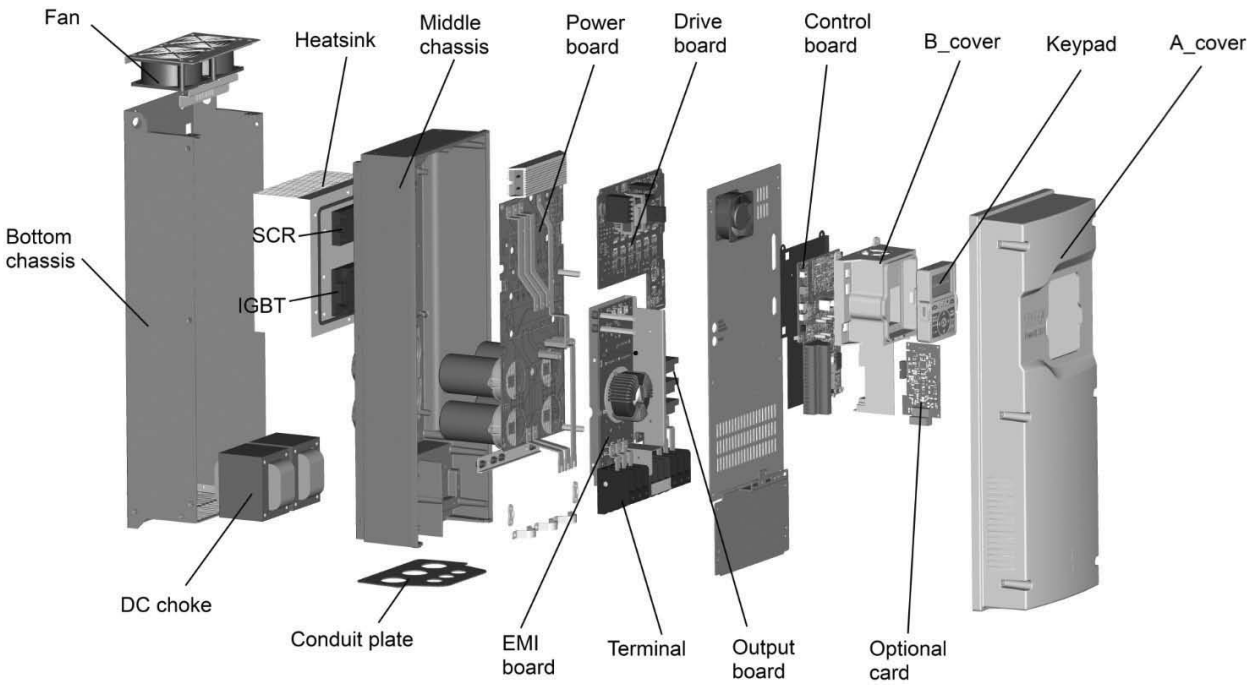
In the AC power networks with non-choked reactive current compensation devices, current deviations can enable parallel resonance and undefinable circumstances.

In the project planning for the connection of frequency inverters to AC power networks with undefined circumstances, please consider using AC chokes.

Chapter 3—Product Overview

Component Identification

Figure 6. Description of the DG1 Series



Features

The DG1 frequency inverter converts the voltage and frequency of an existing AC network into a DC voltage. This DC voltage is used to generate a three-phase AC voltage with adjustable frequency and assigned amplitude values for the variable speed control of three-phase asynchronous motors.

Figure 7. Block Diagram, Elements of DG1 Frequency Inverters

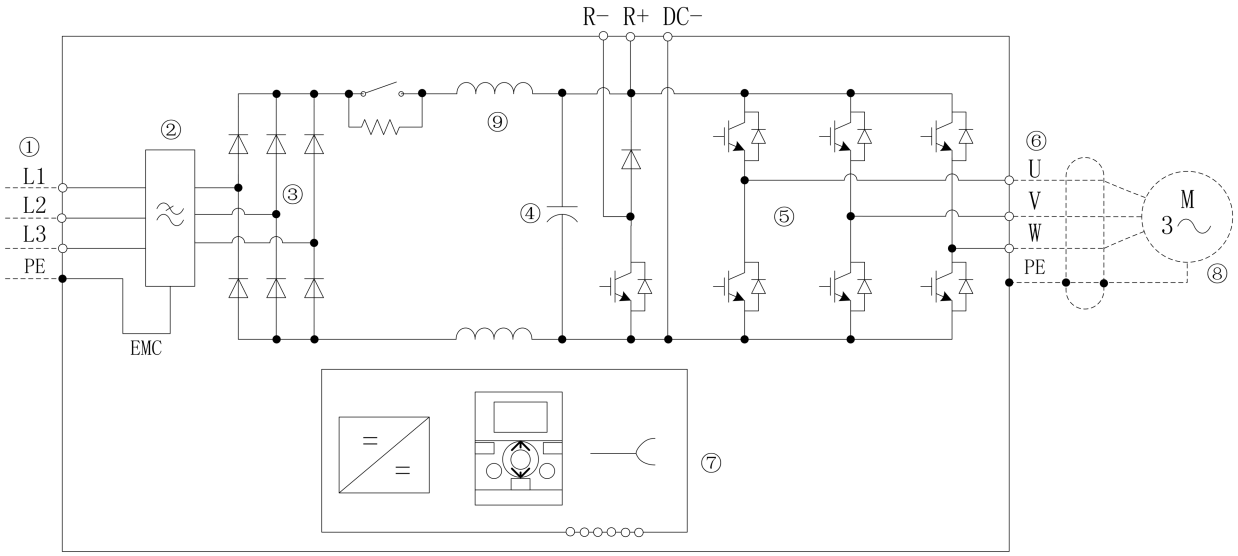


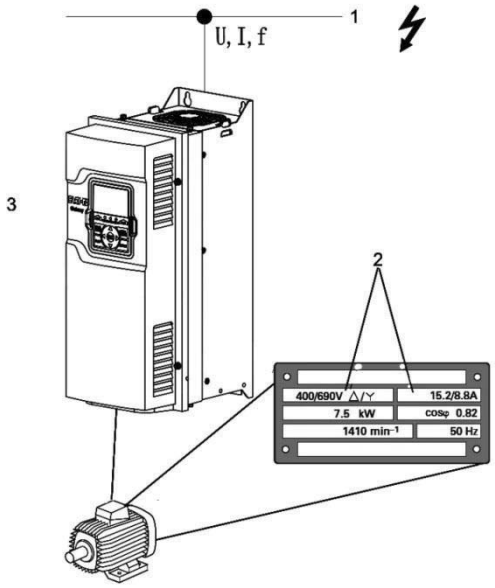
Table 12. Elements of DG1 Frequency Inverters

Item No.	Description
1	Supply L1, L2 L3, PE, input supply voltage U_{LN} = U_e at 50/60 Hz: DG1-32: 230V class, three-phase input connection (3 AC 230V/240V) DG1-34: 400V class, three-phase input connection (3 AC 400V/480V)
2	Internal interference suppression filter, category C2 to IEC/EN 61800-3 EMC-connection of internal interference suppression filter to PE
3	Rectifier bridge, converts the AC voltage of the electrical network into DC voltage
4	DC link with charging resistor, capacitor and switching mode power supply unit (SMPS = Switching Mode Power Supply): DC link voltage U_{DC} with three-phase input connection (3 AC): U_{DC} = 1.41 x U_{LN}
5	Inverter. The IGBT based inverter converts the DC voltage of the DC link (U_{DC}) into a three-phase AC voltage (U2) with variable amplitude and frequency (f2). Sinusoidal pulse width modulation (PWM) with V/f control can be switched to speed control with slip compensation
6	Motor connection U/T1, V/T2, W/T3 with output voltage U2 (0–100% U_e) and output frequency f2 (0–400 Hz) output current (I2): DG1-32: 3.7A to 261A DG1-34: 2.2A to 261A 100% at an ambient temperature of 122°F (50°C) with an overload capacity of 150% for 60 s every 600 s and a starting current of 200% for 2 s every 20 s
7	Keypad with control buttons, graphic display, control voltage, control signal terminals, micro-switches, and interface for the PC interface module (option)
8	Three-phase asynchronous motor, variable speed control of three-phase asynchronous motor for assigned motor shaft power values (P2): DG1-32: 0.55 kW to 75 kW (230V, 50 Hz) or 0.75 hp to 100 hp (240V, 60 Hz) DG1-34: 0.75 kW to 150 kW (400V, 50 Hz) or 1 hp to 200 hp (460V, 60 Hz)
9	DC link—chokes, to minimize current harmonics

Selection Criteria

The frequency inverter **[3]** is selected according to the supply voltage U_{LN} of the input supply **[1]** and the rated current of the assigned motor **[2]**. The circuit type (Δ/Y) of the motor must be selected according to the supply voltage **[1]**. The rated output current I_e of the frequency inverter must be greater than/equal to the rated motor current.

Figure 8. Selection Criteria



When selecting the drive, the following criteria must be known:

- Type of motor (three-phase asynchronous motor)
- Input voltage = rated operating voltage of the motor (for example, 3 AC ~400V)
- Rated motor current (guide value, dependent on the circuit type and the supply voltage)
- Load torque (quadratic, constant)
- Starting torque
- Ambient temperature (rated value 122°F [50°C])

When connecting multiple motors in parallel to the output of a frequency inverter, the motor currents are added geometrically—separated by effective and idle current components. When you select a frequency inverter, make sure that it can supply the total resulting current. If necessary, for dampening and compensating the deviating current values, motor reactors or sinusoidal filters must be connected between the frequency inverter and the motor.

The parallel connection of multiple motors in the output of the frequency inverter is only permitted with V/Hz characteristic curve control.

If you connect a motor to an operational frequency inverter, the motor draws a multiple of its rated operational current. When you select a frequency inverter, make sure that the starting current plus the sum of the currents of the running motors will not exceed the rated output current of the frequency inverter.

Switching in the output of the frequency inverter is only permitted with V/Hz characteristic curve control.

Proper Use

The DG1 frequency inverters are electrical apparatus for controlling variable speed drives with three-phase motors. They are designed for installation in machines or for use in combination with other components within a machine or system.

After installation in a machine, the frequency inverters must not be taken into operation until the associated machine has been confirmed to comply with the safety requirements of Machinery Safety Directive (MSD) 89/392/EEC (meets the requirements of EN 60204). The user of the equipment is responsible for ensuring that the machine use complies with the relevant EU Directives.

The CE markings on the DG1 frequency inverter confirm that, when used in a typical drive configuration, the apparatus complies with the European Low Voltage Directive (LVD) and the EMC Directives (Directive 2006/95/EC and Directive 2004/108/EC).

In the described system configurations, DG1 frequency inverters are suitable for use in public and non-public networks.

A connection to IT networks (networks without reference to earth potential) is permissible only to a limited extent, because the device's built-in filter capacitors connect the network with the earth potential (enclosure). On earth free networks, this can lead to dangerous situations or damage to the device (isolation monitoring required).

To the output of the frequency inverter (terminals U, V, W) you must not:

- connect a voltage or capacitive loads (for example, phase compensation capacitors)
- connect multiple frequency inverters in parallel
- make a direct connection to the input (bypass)

Observe the technical data and connection requirements. For additional information, refer to the equipment nameplate or label at the frequency inverter, and the documentation.

Any other usage constitutes improper use.

Maintenance and Inspection

DG1 frequency inverters are maintenance free. However, external influences may affect the function and the lifespan of the DG1 frequency inverter. We therefore recommend that the devices are checked regularly and the following maintenance measures are carried out at the specified intervals.

If the DG1 frequency inverter is damaged by external influences, contact Eaton Technical Service.

Table 13. Maintenance Measures and Intervals

Maintenance Measure	Maintenance Interval
Clean cooling vents (cooling slits)	If required
Check the fan function	6–24 months (depending on the environment)
Filter in the switching cabinet doors (see manufacturer specifications)	6–24 months (depending on the environment)
Check the tightening torques of the terminals (control signal terminals, power terminals)	Regularly
Check connection terminals and all metallic surfaces for corrosion	6–24 months (depending on the environment)

Storage

If the frequency inverter is stored before use, suitable ambient conditions must be ensured at the site of storage:

- Storage temperature: –40°F to 158°F (–40°C to 70°C)
- Relative average air humidity: <95%, noncondensing (EN 50178)
- To prevent damage to the DC link capacitors, storage times longer than 12 months are not recommended

Charging the Internal DC Link Capacitors

After extended storage times or extended downtimes during which no power is supplied (>12 months), the capacitors in the internal DC link must be recharged in a controlled manner in order to prevent damage. To do this, the DG1 variable frequency drive must be supplied with power, with a controlled DC power supply unit, via two mains DC bus connection terminals. Please consult the factory for detailed instructions.

Service and Warranty

In the unlikely event that you have a problem with your DG1 frequency inverter, please contact your local sales office.

When you call, have the following information ready:

- the exact frequency inverter part no. (see nameplate)
- the date of purchase
- a detailed description of the problem that has occurred with the frequency inverter

If some of the information printed on the nameplate is not legible, please state only the information that is clearly legible. This information can also be found on the cover of the control terminals.

Information concerning the guarantee can be found in the Eaton General Terms and Conditions of Sale.

Chapter 4—Safety and Switching

Fuses and Cable Cross-Sections

The fuses and wire cross-sections allocated for power-side connections depend on the rated input current and output current of the frequency inverter (without AC choke).

CAUTION

When selecting the cable cross-section, take the voltage drop under load conditions into account.

The consideration of other standards (for example, VDE 0113 or VDE 0289) is the responsibility of the user.

The national and regional standards (for example VDE 0113, EN 60204) must be observed and the necessary approvals (for example UL) at the site of installation must be fulfilled.

When the device is operated in a UL-approved system, use only UL-approved fuses, fuse bases, and cables.

See **Appendix D**—Safety Instructions for UL and cUL for details.

CAUTION

The specified minimum PE conductor cross-sections in this manual must be maintained. The minimum size of the protective earthing conductor must comply with the requirements of EN 61800-5-1 and/or the local safety regulations.

Touch currents in this frequency inverter are greater than 3.5 mA (AC). According to product standard IEC/EN 61800-5-1, an additional equipment grounding conductor of the same cross-sectional area as the original protective earthing conductor must be connected, or the cross-section of the equipment grounding conductor must be at least 10 mm^2 Cu.

Choose the cross-section of the PE conductor in the motor lines at least as large as the cross-section of the phase lines (U, V, W).

Cables and Fuses

The cross-sections of the cables and line protection fuses used must correspond with local standards.

For an installation in accordance with UL guidelines:

- Use UL recognized Class T fuses for the branch circuit protection
- Use 75°C copper wire only
- Use UL listed conduit fittings with the same type rating (Type 1/Type 12) as the enclosure

See **Appendix D**—Safety Instructions for UL and cUL for details.

Use power cables with insulation according to the specified input voltages for the permanent installation. A shielded cable is not required on the input side.

A completely (360°) shielded low impedance cable is required on the motor side. The length of the motor cable depends on the RFI class and must not exceed approximately 300 ft (100m) without additional filtering.

Residual-Current Device (RCD)

RCD (Residual Current Device): Residual current device, residual current circuit breaker (FI circuit breaker).

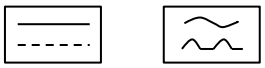
Residual current circuit breakers protect persons and animals from the existence (not the origination) of impermissibly high contact voltages. They prevent dangerous, and in some cases deadly injuries caused by electrical accidents, and also serve as fire prevention.

CAUTION

This drive can cause a DC current in the protective earthing conductor. Where a residual current-operated protective (RCD) or monitoring (RCM) device is used for protection in case of direct or indirect contact, only an RCD or RCM of Type B is allowed on the supply side of this product.

Figure 9. Identification on the FI Circuit Breakers

AC/DC sensitive (RCD, type B)



Frequency inverters work internally with rectified AC currents. If an error occurs, the DC currents can block a type A RCD circuit breaker from triggering and therefore disable the protective functionality.

CAUTION

Debounced inputs may not be used in the safety circuit diagram.

Residual current circuit breakers (RCD) are only to be installed between the AC power supply network and the frequency inverter.

Safety-relevant leakage currents can occur while handling and when operating the frequency inverter, if the frequency inverter is not grounded (because of a fault).

Leakage currents to ground are mainly caused by foreign capacities with frequency inverters, between the motor phases and the shielding of the motor cable and via the Y-capacitors of the RFI filter. The size of the leakage current is mainly dependent upon the:

- length of the motor cable
- shielding of the motor cable
- height of the switching frequency of the inverter
- design of the RFI filter
- grounding measures at the site of the motor

The leakage current to ground is greater than 3.5 mA with a frequency inverter. According to product standard IEC/EN 61800-5-1, an additional equipment grounding (PE) conductor of the same cross-sectional area as the original protective earthing conductor must be connected, or the cross-section of the equipment grounding conductor must be at least 10 mm^2 Cu.

Residual current circuit breakers must be suitable for:

- the protection of installations with DC current component in case of fault scenario (RCD type B)
- high leakage currents
- brief discharges of pulse current spikes

Input Contactor

The input contactor enables an operational switching on and off of the supply voltage for the frequency inverter, and switching off in case of a fault.

The input contactor is designed based on the input current (ILN) of the frequency inverter and the utilization category AC-1 (IEC 60947). Input contactors and the assignment to DG1 frequency inverters are explained in **Appendix A**.

While planning the project, make sure that inching operation is not done via the input contactor of the frequency inverter on frequency-controlled drives, but through a controller input of the frequency inverter.

The maximum permitted operating frequency of the input voltage with the DG1 frequency inverter is one time per minute (normal operation).

EMC Measures

Electrical components in a system (machine) have an interaction effect on each other. Each device not only emits interference but is also affected by it. The interference can be produced by galvanic, capacitive, and/or inductive sources, or by electromagnetic radiation. In practice, the limit between line-conducted interference and radiated emitted interference is around 30 MHz. Above 30 MHz, cables and conductors act like antennas that radiate electromagnetic waves.

Electromagnetic compatibility (EMC) for frequency controlled drives (variable frequency drives) is implemented in accordance with product standard IEC/EN 61800-3. This includes the complete power drive system (PDS), from the input supply to the motor, including all components, as well as cables. This type of drive system can consist of several individual drives.

The generic standards of the individual components in a PDS compliant with IEC/EN 61800-3 do not apply. These component manufacturers, however, must offer solutions that ensure standards-compliant use.

In Europe, maintaining the EMC guidelines is mandatory.

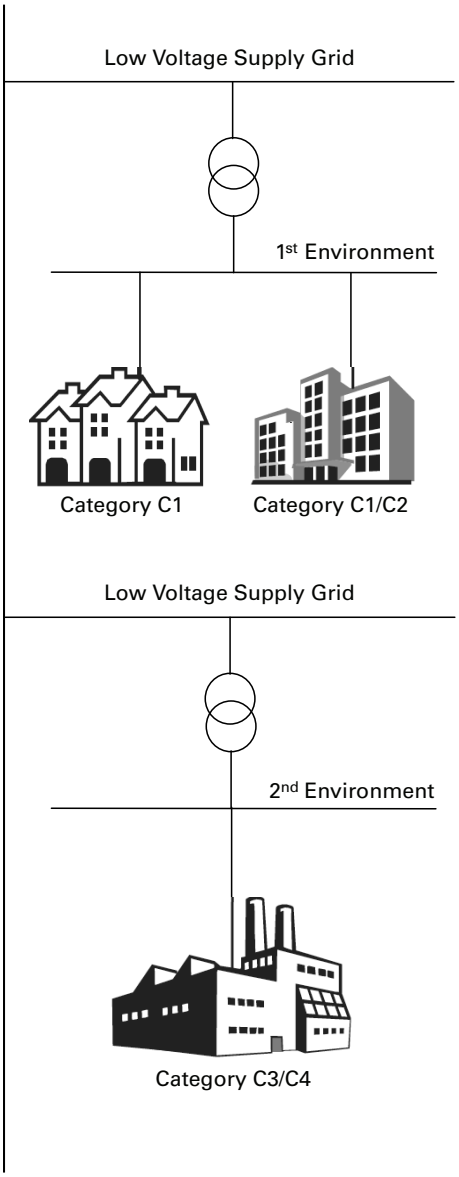
A declaration of conformity (CE) always refers to a "typical" power drive system (PDS). The responsibility to comply with the legally stipulated limit values and thus the provision of electromagnetic compatibility is ultimately the responsibility of the end user or system operator. This operator must also take measures to minimize or remove emission in the environment concerned (see **Figure 10**). He must also use means to increase the interference immunity of the devices of the system.

With their high interference immunity up to category C2, DG1 frequency inverters are ideal for use in commercial networks (1st environment).

Table 14. Maximum Motor Cable Length by Frame Size without dV/dT Protected C2 Ratings

Frame Size	Maximum Cable Length (m)
FR1	100
FR2	150
FR3	150
FR4	200
FR5	200

Figure 10. EMC Measures



Chapter 5—Motor and Application

Motor Selection

General recommendations for motor selection:

- Use three-phase powered asynchronous motors with short-circuit rotors and surface cooling, also called inverter motors or standard motors for the frequency-controlled drive system (PDS). Other specifications such as external rotor motors, slip-ring motors, reluctance motors, synchronous or servo motors can also be run with a frequency inverter, but normally require additional planning and discussion with the motor manufacturer.
- Use only motors with at least heat class F (311°F [155°C] maximum steady state temperature).
- Four-pole motors are preferred (synchronous speed: 1500 min^{-1} at 50 Hz or 1800 min^{-1} at 60 Hz).
- Take the operating conditions into account for S1 operation (IEC 60034-1).
- When operating multiple motors in parallel on one frequency inverter, the motor output should not be more than three power classes apart.
- Ensure that the motor is not over-dimensioned. If a motor in speed control mode is under-dimensioned, the motor rating must only be one rating level lower.

Connecting Motors in Parallel

The DG1 frequency inverters allow parallel operation of several motors using multi-pump application control mode:

- *Multi-pump application: several motors with the same or different rated operational data*. The sum of all motor currents must be less than the frequency inverter's rated operational current.
- *Multi-pump application: parallel control of several motors*. The sum of the motor currents plus the motors' inrush currents must be less than the frequency inverter's rated operational current.

Parallel operation at different motor speeds can be implemented only by changing the number of pole pairs and/or changing the motor's transmission ratio.

⚠ CAUTION

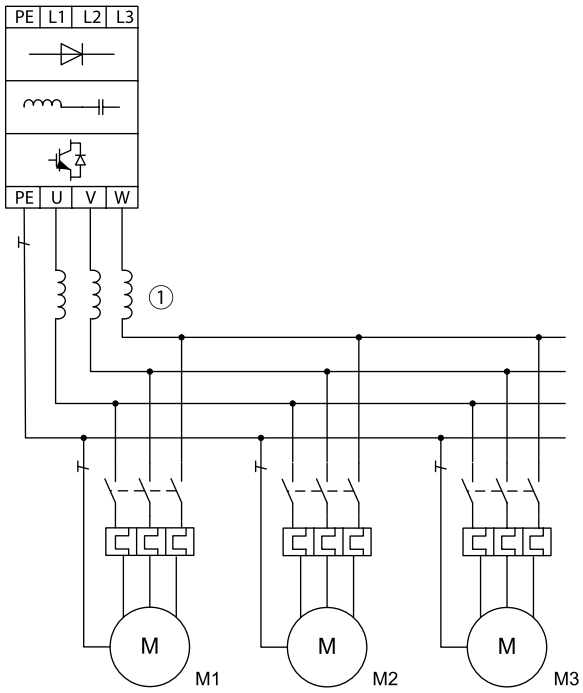
Debounced inputs may not be used in the safety circuit diagram.

If you are connecting multiple motors on one frequency inverter, you must design the contactors for the individual motors according to utilization category AC-3.

Selecting the motor contactor is done according to the rated operational current of the motor to be connected.

Parallel Connection of Several Motors to One Frequency Inverter

Figure 11. Parallel Connection



Connecting motors in parallel reduces the load resistance at the frequency inverter output. The total stator inductance is lower and the leakage capacity of the lines greater. As a result, the current distortion is greater than in a single-motor circuit. To reduce the current distortion, you should use motor reactors (see ① in **Figure 11**) in the output of the frequency inverter.

The current consumption of all motors connected in parallel must not exceed the frequency inverter's rated output current I_{2N}.

Electronic motor protection cannot be used when operating the frequency inverter with several parallel connected motors. You must, however, protect each motor with thermistors and/or overload relays.

The use of a motor protective circuit breaker at the frequency inverter's output can lead to nuisance tripping.

Motor and Circuit Type

The motor's stator winding can be connected in a star or delta configuration, in accordance with the rated operational data on the nameplate.

Figure 12. Example of a Motor Ratings Plate

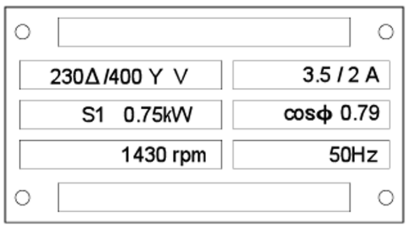
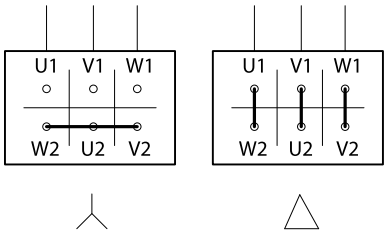


Figure 13. Star and Delta Circuit Types



The three-phase motor with the rating plate based on **Figure 13**, can be run in a star or delta connection. The operational characteristic curve is determined by the ratio of motor voltage and motor frequency, in this case.

87 Hz Characteristic Curve

In the delta circuit with 400V and 87 Hz, the motor shown in **Figure 13** was released with three times-fold output (~1.3 kW).

Because of the higher thermal loading, using only the next higher motor output according to the list (1.1 kW) is recommended. The motor (in this example) therefore still has 1.47-fold higher output compared with the listed output (0.75 kW).

With the 87 Hz characteristic curve, the motor also works in the range from 50 Hz to 87 Hz with an un-attenuated field. The pull-out torque remains at the same level as in input operation with 50 Hz.

The heat class of the motor must be at least F in 87 Hz operation.

V/Hz Characteristic Curve

Figure 14. V/Hz Characteristic Curve

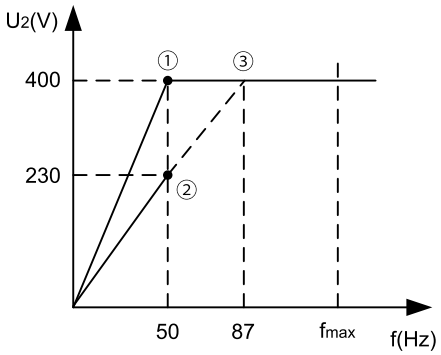


Table 15 shows the allocation of possible frequency inverters depending on the input voltage and the type of circuit.

Table 15. Assignment of Frequency Inverters to Example Motor Circuit (See Figure 14)

Frequency Inverters	DG1-323D7FB	DG1-343D3FB	DG1-344D3FB
Rated operational current	3.7A	3.3A	4.3A
Input voltage	3 AC, 230V	3 AC, 400V	3 AC, 400V
Motor circuit	Delta	Star	Delta
V/Hz characteristic curve	②	①	③
Motor current	3.5A	2.0A	3.5A
Motor voltage (ratings plate)	230V	400V	230V
Motor speed	1430 min^{-1}	1430 min^{-1}	2474 min^{-1} ④
Motor frequency	50 Hz	50 Hz	87 Hz ③

Notes

① Star connection: 400V, 50 Hz.
② Delta connection: 230V, 50 Hz.
③ Delta connection: 400V, 87 Hz.
④ Note the permitted limit values of the motor.

Bypass Operation

If you want to have the option of operating the motor with the frequency inverter or directly from the input supply, the input branches must be interlocked mechanically.

CAUTION

Debounced inputs may not be used in the safety circuit diagram.

A changeover between the frequency inverter and the input supply must take place in a voltage-free state.

WARNING

The frequency inverter outputs (U, V, W) must not be connected to the input voltage (destruction of the device, risk of fire).

Figure 15. Bypass Motor Control (Example)

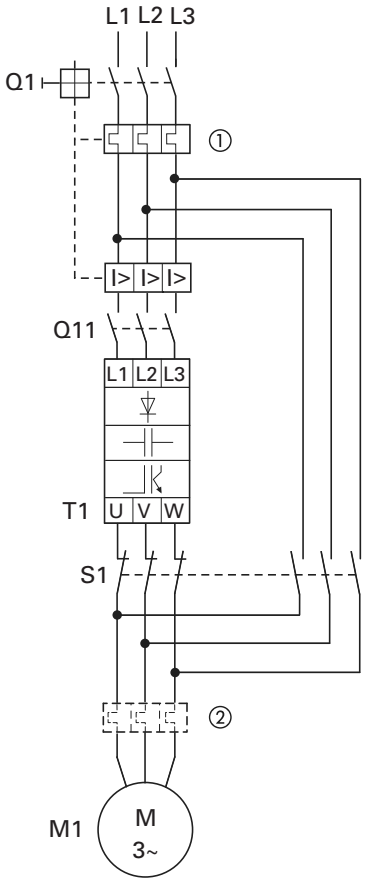


Table 16. Bypass Motor Control

Item No.	Description
1	Input/bypass contactor
2	Output contactor

CAUTION

Debounced inputs may not be used in the safety circuit diagram.

Switch S1 must switch only when frequency inverter T1 is at zero current.

Contactors and switches (S1) in the frequency inverter output and for the direct start must be designed based on utilization category AC-3 for the rated operational current of the motor.

Connecting EX Motors

Note the following when connecting explosion-protected motors:

- The frequency inverter must be installed outside the EX area.
- Note the branch- and country-specific standards for explosion-protected areas (ATEX 100a).
- Note the standards and information of the motor manufacturer regarding operation on frequency inverters—for example, if motor reactors or sine-wave filters are specified.
- Temperature monitors in the motor windings (thermistor, thermo-Click) are not to be connected directly to frequency inverters but must be connected via an approved trigger apparatus for EX areas.

Chapter 6—Installation Requirements

This chapter contains all of the information required to properly install and prepare the DG1 Series VFD for operation. The contents are listed to serve as a list of tasks needed to complete the installation. Included in this section are:

- Line (mains) and motor power wiring
- I/O control wiring

Electrical Installation Warnings and Cautions

WARNING

Carry out wiring work only after the frequency inverter has been correctly mounted and secured.

WARNING

Electric shock hazard—risk of injuries!

Carry out wiring work only if the unit is de-energized.

CAUTION

Debounced inputs may not be used in the safety circuit diagram.

Fire hazard!

Only use cables, protective switches, and contactors that feature the indicated permissible nominal current value.

CAUTION

Debounced inputs may not be used in the safety circuit diagram.

According to product standard IEC/EN 61800-5-1, an additional equipment grounding (PE) conductor of the same cross-sectional area as the original protective earthing conductor must be connected, or the cross-section of the equipment grounding conductor must be at least 10 mm^2 Cu.

WARNING

The components in the drive's power section remain energized after the supply voltage has been switched off. After disconnecting the supply, wait at least five minutes before removing the cover to allow the intermediate circuit capacitors to discharge.

Pay attention to hazard warnings!

Standard Mounting Instructions

- Select the mounting location based on requirements listed in this chapter
- Mounting surface must be a vertical, flat, non-flammable surface
- DG1 Series open drives may be mounted side-by-side or stacked vertically, as outlined in this chapter
- Surface must be strong enough to support the drive and not subject to excessive motion or vibration
- Mark the location of the mounting holes on the mounting surface ("using the template provided on the cover of the cardboard shipping package",
- Using fasteners appropriate to your VFD and mounting surface, securely attach the VFD to the mounting surface using all four mounting hole locations

When mounting one unit above the other, the lower unit air outlet must be directed away from the inlet air used by the upper one. The clearance between the upper and lower unit should equal C + D. See **Figure 16** on next page.

1. Measure the mounting space to ensure that it allows the minimum space surrounding the VFD Series drive. Drive dimensions are on **Appendix C**.
2. Make sure the mounting surface is flat and strong enough to support the drive, is not flammable, and is not subject to excessive motion or vibration.
3. Ensure that the minimum airflow requirements for your drive are met at the mounting location.
4. Mark the location of the mounting holes on the mounting surface, using the template provided on the cover of the cardboard shipping package.
5. Using fasteners appropriate to your drive and mounting surface, securely attached the drive to the mounting surface using all four screws or bolts.

Mounting Dimensions

Refer to **Appendix C** for drive dimensions.

Figure 16. Mounting Space

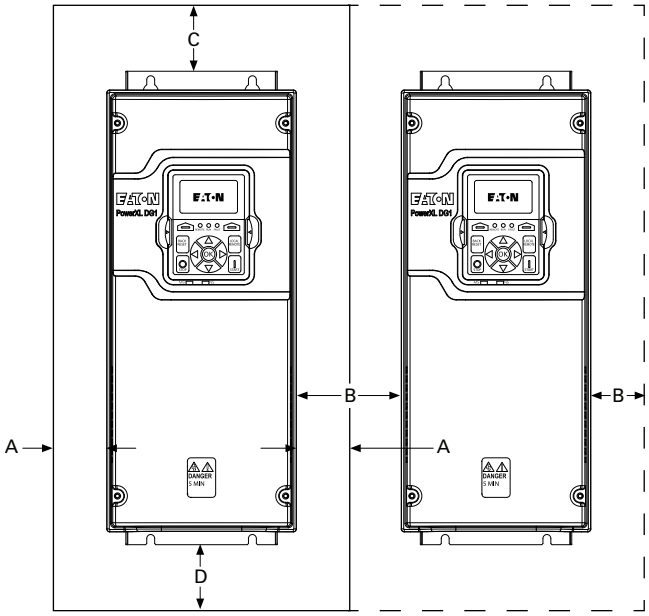


Table 17. Space Requirements for Mounting the DG1 Series VFD and Airflow

Frame Size	Voltage	hp (CT/I_H)	kW ②	Amperes	A ① In (mm)	B ① In (mm)	C In (mm)	D In (mm)	Cooling Air Required CFM (m^3/h)
FR1	230 Vac	0.75–3	0.55–2.2	3.7–11	0.79 (20)	0.79 (20)	3.94 (100)	1.97 (50)	22 (38)
	480 Vac	1–5	0.75–3.7	2.2–7.6					
	575 Vac ③	2–5	1.5–3.7	3.3–7.5					
FR2	230 Vac	4–7.5	3–5.5	12.5–25	1.18 (30)	1.18 (30)	6.30 (160)	2.36 (60)	55 (94)
	480 Vac	7.5–15	5.5–11	12–23					
	575 Vac ③	7.5–15	5.5–11	10–18					
FR3	230 Vac	10–15	7.5–11	31–48	1.97 (50)	1.97 (50)	7.87 (200)	3.15 (80)	126 (214)
	480 Vac	20–30	15–22	31–46					
	575 Vac ③	20–30	15–22	22–34					
FR4	230 Vac	20–30	15–22	61–88	3.15 (80)	3.15 (80)	11.81 (300)	3.94 (100)	153 (260)
	480 Vac	40–60	30–45	61–87					
	575 Vac ③	40–60	30–45	41–62					
FR5	230 Vac	40–60	30–45	114–170	3.15 (80)	3.15 (80)	11.81 (300)	7.87 (200)	366 (622)
	480 Vac	75–125	55–90	105–170					
	575 Vac ③	75–125	55–90	80–125					
FR6 ③	230 Vac	75–100	55–75	211–261	③	③	③	③	③
	480 Vac	150–200	110–150	205–261					
	575 Vac ③	150–200	110–160	144–208					

Notes

① Minimum clearances A and B for drives with Type 12 (IP54) enclosure is 0 mm (in).

② kW ratings are at 400V / 50 Hz.
The above guidelines apply unless testing has been completed to validate a design outside of these recommendations.

③ FR6 and 575 Vac available in 2015.

Dimensions

Approximate Dimensions in mm

Figure 17. Type 1/12 Open Drives

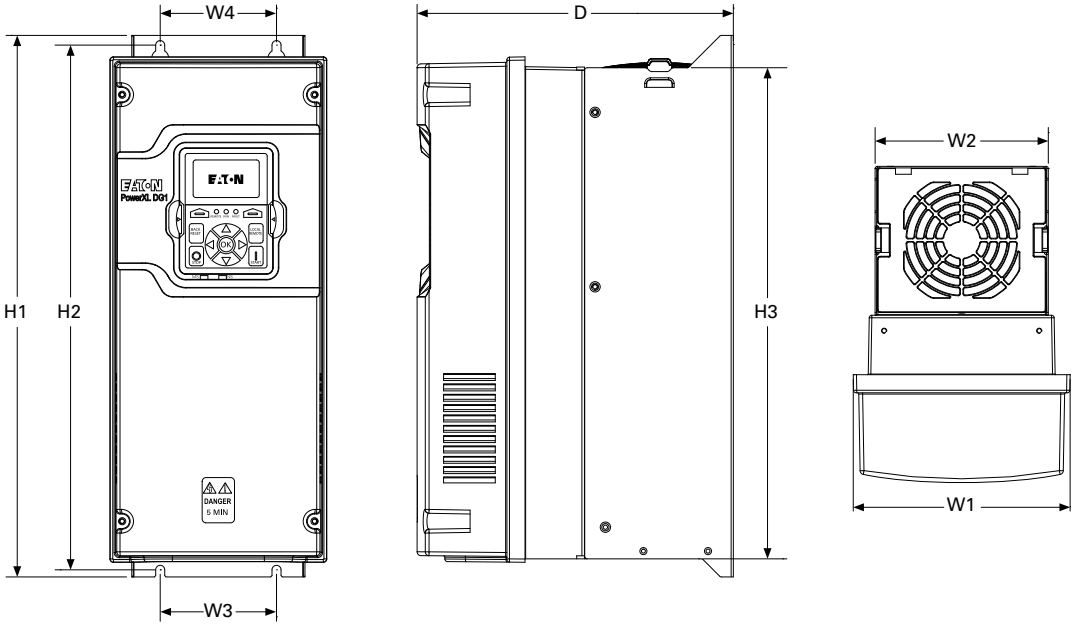


Table 18. Mounting Drive Dimensions

Frame Size	Voltage	hp (CT/I_H)	kW	Amperes (CT/I_H)	Approximate Dimensions in Inches (mm) D	H1	H2	H3	W1	W2	W3	W4	Ø	Weight Lb (kg)
FR1	230 Vac	0.75–3	0.55–2.2	3.5–11	7.89 (200.4)	12.87 (326.9)	12.28 (311.9)	11.50 (292.1)	6.02 (153.0)	4.80 (121.9)	3.94 (100.1)	3.94 (100.1)	0.28 (7.0)	14.33 (6.5)
	480 Vac	1–5	0.75–3.7	2.3–7.6										
	575 Vac ①	2–5	1.5–3.7	3.3–7.5										
FR2	230 Vac	5–7.5	3–5.5	12.5–25	9.63 (244.7)	16.50 (419.1)	15.98 (405.9)	14.96 (380.0)	6.61 (167.8)	5.28 (134.1)	3.54 (90.0)	3.54 (90.0)	0.28 (7.0)	23.37 (10.6)
	480 Vac	7.5–15	5.5–11	12–23										
	575 Vac ①	7.5–15	5.5–11	10–18										
FR3	230 Vac	10–15	7.5–11	31–48	10.44 (265.1)	21.97 (558.0)	21.46 (545.0)	20.43 (518.9)	8.06 (204.6)	7.24 (183.9)	4.92 (125.0)	4.92 (125.0)	0.35 (9.0)	49.82 (22.6)
	480 Vac	20–30	15–22	31–46										
	575 Vac ①	20–30	15–22	22–34										
FR4	230 Vac	20–30	15–22	61–88	11.57 (294.0)	24.80 (629.9)	34.31 (617.5)	23.27 (591.1)	9.36 (237.7)	9.13 (231.9)	8.07 (205.0)	8.07 (205.0)	0.35 (9.0)	77.60 (35.2)
	480 Vac	40–60	30–45	61–87										
	575 Vac ①	40–60	30–45	41–62										
FR5	230 Vac	40–60	30–45	114–170	13.41 (340.7)	34.98 (888.5)	29.65 (753.1)	27.83 (706.9)	11.34 (288.0)	11.10 (281.9)	8.66 (220.0)	8.66 (220.0)	0.35 (9.0)	154.32 (70.0)
	480 Vac	75–125	55–90	105–170										
	575 Vac ①	75–125	55–90	80–125										
FR6 ①	230 Vac	75–100	55–75	211–261	①	①	①	①	①	①	①	①	①	①
	480 Vac	150–200	110–150	205–261										
	575 Vac ①	150–200	110–160	144–208										

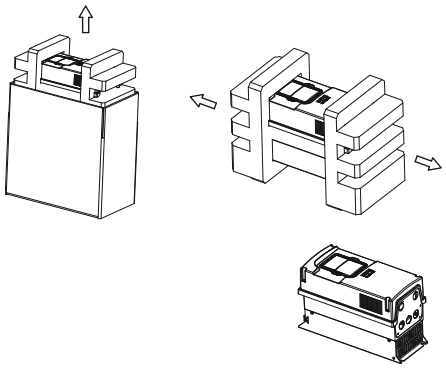
Note

① FR6 and 575 Vac available in 2015.

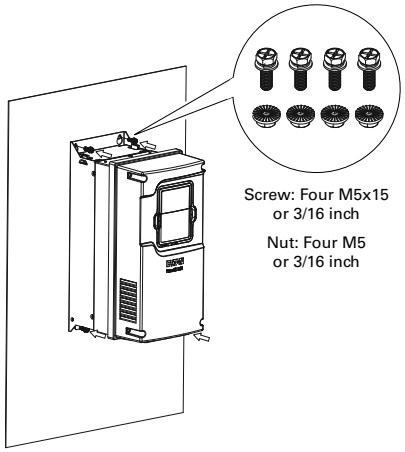
Standard Drive Mounting

FR1 Mounting Instructions

Step 1: Lift the drive out from the carton. Remove the packaging.

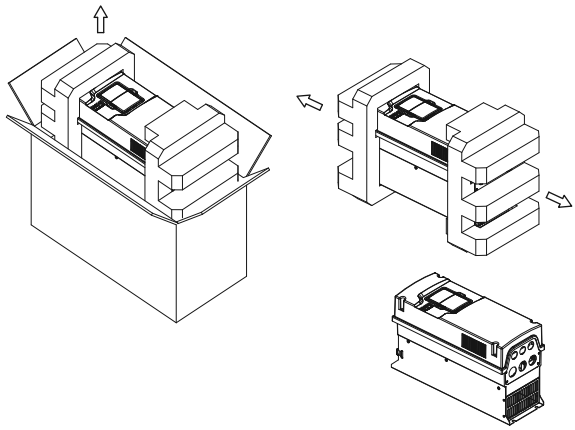


Step 2: Attach the drive to the mounting plate with four M5x15 or 3/16 inch screws and four M5 or 3/16 inch nuts. The opening dimensions on the mounting plate should follow required dimensions (refer to the drive mounting template printed on the outside carton).

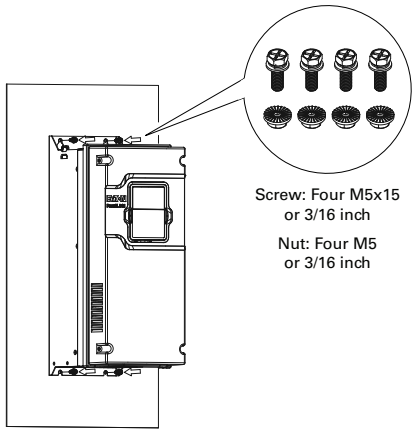


FR2 Mounting Instructions

Step 1: Lift the drive out from the carton. Remove the packaging.

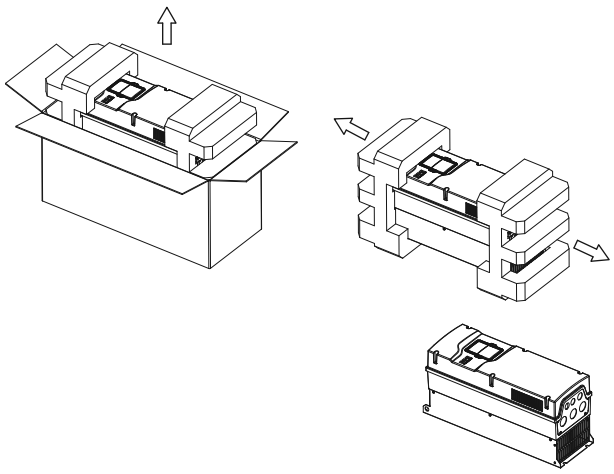


Step 2: Attach the drive to the mounting plate with four M5x15 or 3/16 inch screws and four M5 or 3/16 inch nuts. The opening dimensions on the mounting plate should follow required dimensions (refer to the drive mounting template printed on the outside carton).

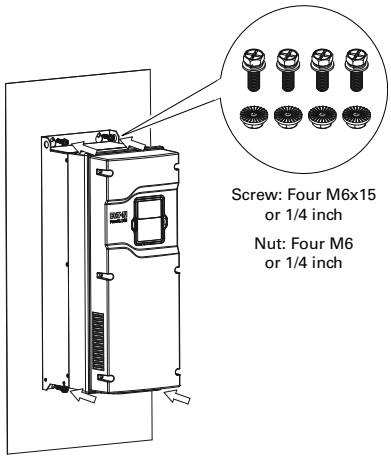


FR3 Mounting Instructions

Step 1: Lift the drive out of the carton. Remove the packaging.

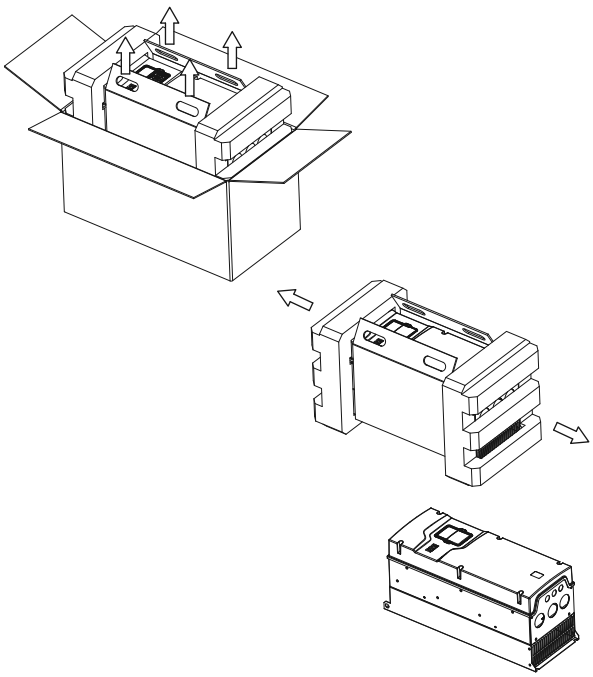


Step 2: Attach the drive to the mounting plate with four M6x15 or 1/4 inch screws and four M6 or 1/4 inch nuts. The opening dimensions on the mounting plate should follow required dimensions (refer to the drive mounting template printed on the outside carton).

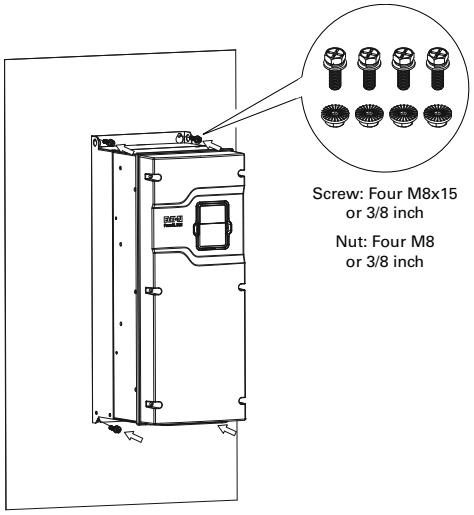


FR4 Mounting Instructions

Step 1: Lift the drive out of the carton with the cardboard. Remove the packaging.

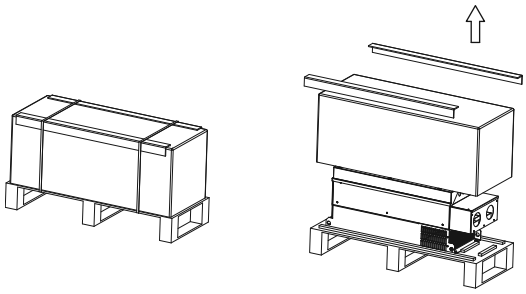


Step 2: Attach the drive to the mounting plate with four M8x15 or 3/8 inch screws and four M8 or 3/8 inch nuts. The opening dimensions on the mounting plate should follow required dimensions (refer to the drive mounting template printed on the outside carton).

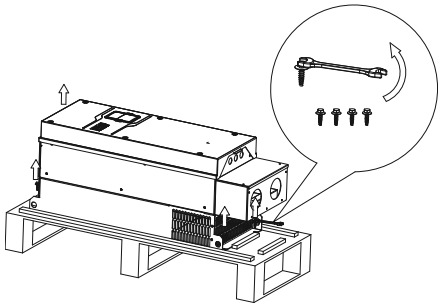


FR5 Mounting Instructions

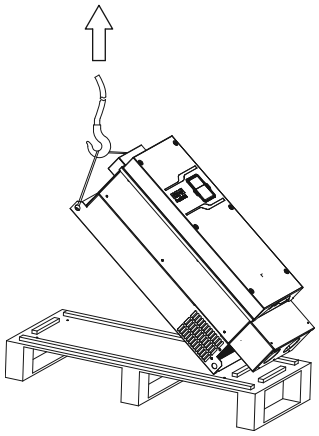
Step 1: Remove the carton from the drive.



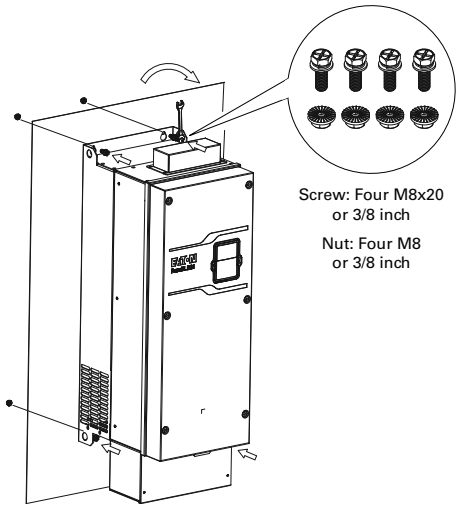
Step 2: Remove the four screws (used to fix the drive to the pallet) with an M8 or 3/8 inch wrench.



Step 3: Use a hook to lift the drive.



Step 4: Attach the drive to the mounting plate with four M8x20 or 3/8 inch screws and four M8 or 3/8 inch nuts with an M8 or 3/8 inch wrench. The opening dimensions on the mounting plate should follow required dimensions (refer to the drive mounting template printed on the outside carton).



Power Wiring Selection

Motor cable connections are made to terminals U, V, and W.

Cable Selection: Power and Motor Leads

- Use UL approved heat-resistant copper cables only
- 75°C or higher for all units rated
- Line voltage/mains should be Class 1 wire only outside North America
- Refer to the following tables for cable sizing guidelines
  - North America 208V to 240V: **Appendix B**
  - North America 380V to 500V: **Appendix B**
  - All other International 380V to 600V: **Appendix B**

Line (Mains) and Motor Cable Installation

The input line and motor cables must be sized in accordance with the rated DG1 VFD input and output current.

If motor temperature sensing is used for overload protection, the output cable size may be selected based on the motor specifications.

Maximum symmetrical supply current is 100,000A RMS for all size DG1 VFDs.

Input Fusing

Fuses are rated based on DG1 rated input and output current. Use Class T (UL and cUL/CSA®) or type gG/gL (IEC 60269-1). Refer to **Appendix B** for proper fuse size selection.

Consult with Eaton Electrical for further information on fusing requirements.

Connection Tightening Torque

Table 19. Tightening Torque ①②

Frame Size	Power Wire In-Lb (Nm)	Ground Wire In-Lb (Nm)	Control Wire ③ In-Lb (Nm)
FR1	230V: 12.1 (1.4) 480V/575V: 5.5 (0.6)	10 (1.1)	4.5 (0.5)
FR2	15.6 (1.8)	10 (1.1)	4.5 (0.5)
FR3	40 (4.5)	10 (1.1)	4.5 (0.5)
FR4	95 (10.7)	14 (1.6)	4.5 (0.5)
FR5	354 (40)	35 (4.0)	4.5 (0.5)
FR6	Available in 2015	—	—

Notes

① Strip the motor and power cables as shown in **Figure 18** on next page.
② Both UL and IEC tools may be used.
③ Applies to strained wire, solid wire, or ferrule installations.

Table 20. Spacing Between Parallel Motor Cables

Cable Length	Distance Between Cables
Less than 164 ft (50m)	1 ft (0.3 m)
Less than 657 ft (200m)	3 ft (1.0 m)

Table 21. Maximum Motor Cable Length by Frame Size without dV/dT Protected C2 Ratings ①②

Frame Size	Maximum Cable Length (m)
FR1	100
FR2	150
FR3	150
FR4	200
FR5	200

Notes

① C1 protection requires external filtering. Consult factory.
② C3 protection is covered under C2 protection levels.

Figure 18. Input Power and Motor Cable Stripping Lengths

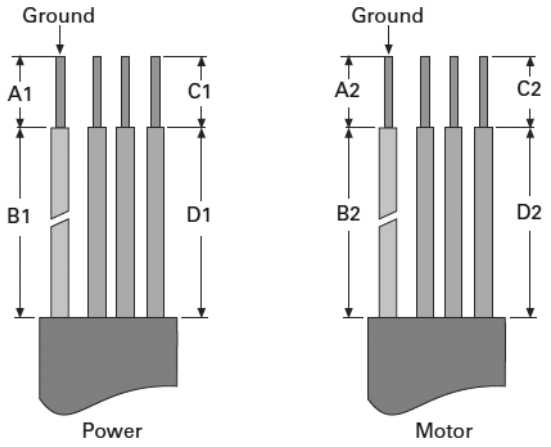


Table 22. Input Power and Motor Cable Stripping and Wire Lengths

Frame Size	Power Wiring in Inches (mm)				Motor Wiring in Inches (mm)			
	A1	B1	C1	D1	A2	B2	C2	D2
FR1	0.39 (10)	1.77 (45)	0.39 (10)	1.38 (35)	0.39 (10)	1.77 (45)	0.39 (10)	1.38 (35)
FR2	0.59 (15)	1.77 (45)	0.59 (15)	1.77 (45)	0.59 (15)	1.57 (40)	0.59 (15)	1.57 (40)
FR3	0.59 (15)	1.57 (40)	0.59 (15)	1.97 (50)	0.59 (15)	1.57 (40)	0.59 (15)	1.97 (50)
FR4	0.98 (25)	2.56 (65)	0.98 (25)	4.72 (120)	0.98 (25)	2.56 (65)	0.98 (25)	4.72 (120)
FR5	1.10 (28)	6.10 (155)	1.10 (28)	9.45 (240)	1.10 (28)	6.10 (155)	1.10 (28)	9.45 (240)
FR6	①	①	①	①	①	①	①	①

Note

① FR6 available in 2015.

Cable Routing

If conduit is being used for wiring, use separate conduits for line voltage (mains), motor cables, and all interface/control wiring.

To meet the UL requirements, if conduit is being used for wiring, the enclosure openings provided for conduit connections in the field shall be closed by UL listed conduit fittings with the same type rating (Type 1 / Type 12) as the enclosure.

Avoid running motor cables alongside or parallel to any other wiring. If it is necessary to run motor cables with other wiring, then maintain spacing between motor cables and other wiring in accordance with the table on **Page 30**.

Wiring the VFD

Refer to the table on **Page 30** for maximum cable lengths by frame size.

If three or more motor cables are used, each conductor must have its own overcurrent protection.

Power Wiring Notice

Do not discard the plastic bag containing the wiring hardware.

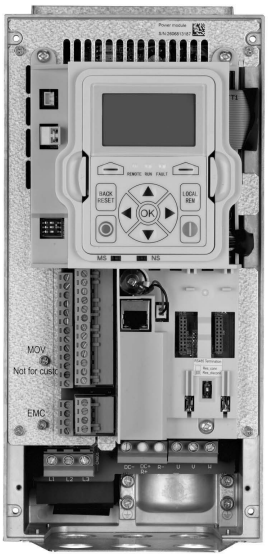
1. Remove the A-cover by removing (4) screws, then lifting the A-cover away from the base.

Wiring Hardware Contents

- European rubber grommet and flat rubber grommet (for IP54 integrity)
- Modification label
- Detachable cable clamp
- Attachable grounding strap
- Ground strap mounting screws

Power Wiring/Grounding

2. Remove power wiring protection plate. Use power/motor cable tables on **Appendix B**.
3. Add attachable grounding clamps (qty 2), one on each side of drive.
4. Pass motor, input power wires/cables through base wiring plate.
5. If shielded cable is used, connect the shields of input power and motor cables shields to ground.

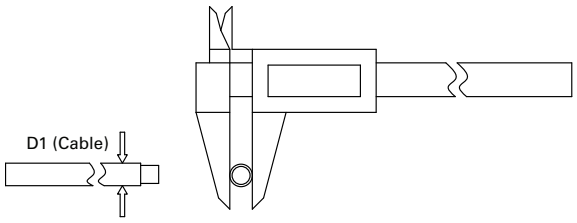


6. Wire power terminals (L1, L2, L3), motor terminal (U, V, W), and grounding terminals per **Figure 19**. Power and motor leads must be in separate conduit.

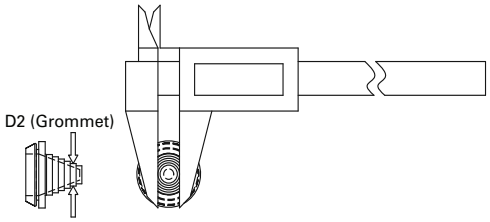
   To meet the UL requirements, if conduit is being used for wiring, the enclosure openings provided for conduit connections in the field shall be closed by UL listed conduit fittings with the same type rating (Type 1/ Type 12) as the enclosure.

Rubber Grommet Installation Instructions

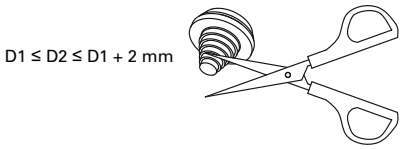
Step 1: Measure the outside diameter of the cable (D1) used to connect to the drive.



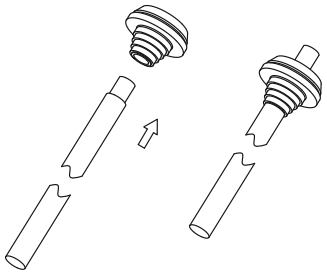
Step 2: Measure the outside diameter of the rubber grommet (D2) and select a suitable D2 (D1 ≤ D2 ≤ D1 + 2 mm).



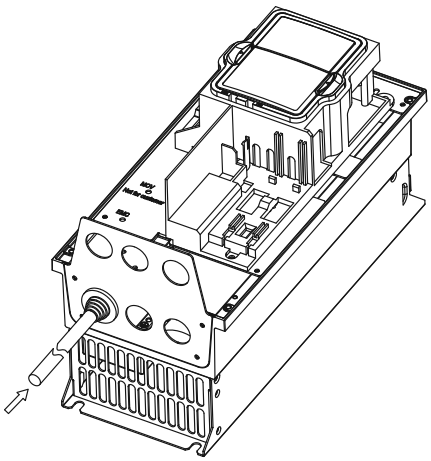
Step 3: Cut the rubber grommet at the selected diameter.



Step 4: Run the cable through the rubber grommet.



Step 5: Insert the rubber grommet into the conduit plate together with the cable.



Step 6: Fasten the rubber grommet and cable with a self-locking cable tie.

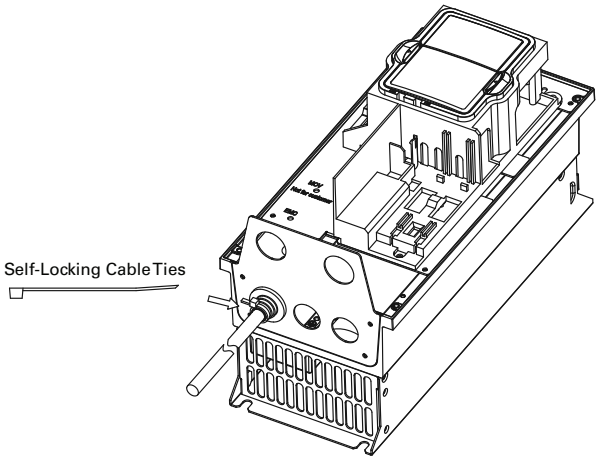
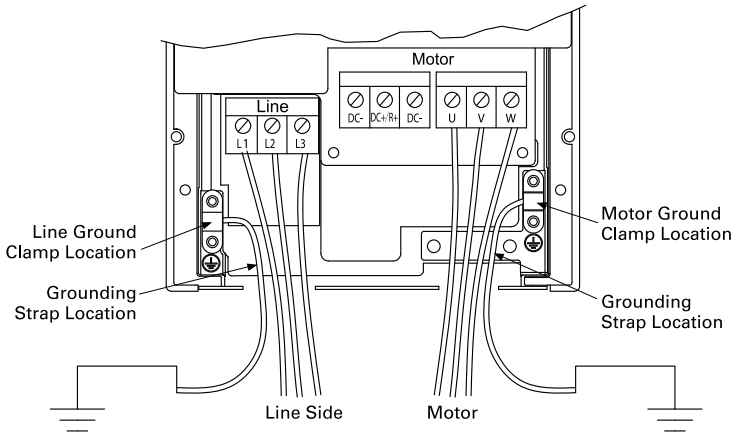


Figure 19. Ground Wiring

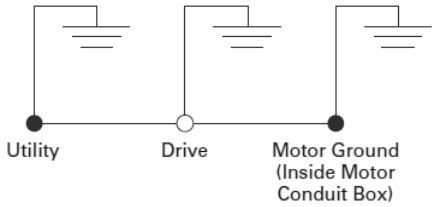


Note: Do not wire motor leads to R+, R–. This will cause damage to the drive.

Note: Actual layout may vary slightly by frame.

Ground Wiring

- Run motor cables in separate conduit
- DO NOT RUN CONTROL WIRES in same conduit
- Cables sized per **Appendix B**
- Provide **dedicated** wire for low impedance ground between drive and motor. DO NOT USE conduit as ground

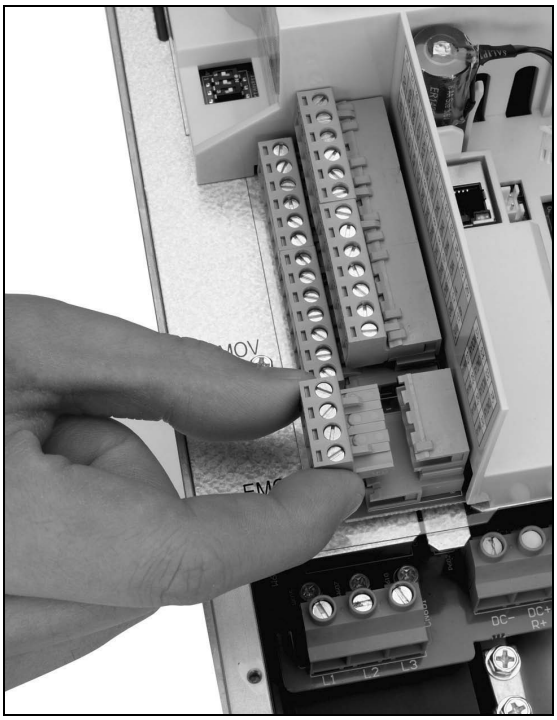


⚠ CAUTION

Improper grounding could result in damage to the motor and/or drive and could void warranty.

Control Wiring

7. Wire the control terminals following the details for the specific option boards shown on the following pages.



Note: For ease of access, the board terminals blocks can be unplugged for wiring.

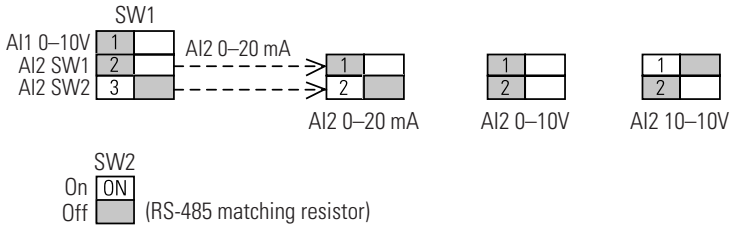
8. Wire control to the control board.

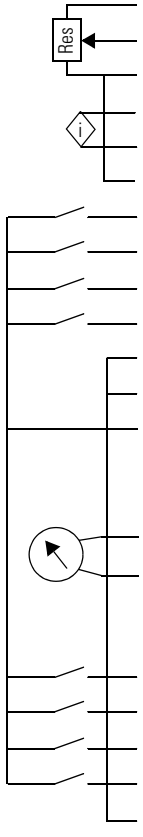
Note: Drive default is programmed for external interlock.

I/O Connection

- Run 240 Vac and 24 Vdc control wiring in separate conduit
- Communication wire to be shielded

Table 23. I/O Connection





Pin	Signal Name	Signal	Default Setting	Description
1	+10 V	Ref. Output Voltage	—	10 Vdc Supply Source
2	AI1+	Analog Input 1	0–10 V	Voltage Speed Reference (Programmable to 4 mA to 20 mA)
3	AI1–	Analog Input 1 Ground	—	Analog Input 1 Common (Ground)
4	AI2+	Analog Input 2	4 mA to 20 mA	Current Speed Reference (Programmable to 0–10V)
5	AI2–	Analog Input 2 Ground	—	Analog Input 2 Common (Ground)
6	GND	I/O Signal Ground	—	I/O Ground for Reference and Control
7	DIN5	Digital Input 5	Preset Speed B0	Sets frequency output to Preset Speed 1
8	DIN6	Digital Input 6	Preset Speed B1	Sets frequency output to Preset Speed 2
9	DIN7	Digital Input 7	Emergency Stop (TI–)	Input forces VFD output to shut off
10	DIN8	Digital Input 8	Force Remote (TI+)	Input takes VFD from Local to Remote
11	CMB	DI5 to DI8 Common	Grounded	Allows source input
12	GND	I/O Signal Ground	—	I/O Ground for Reference and Control
13	24V	+24 Vdc Output	—	Control voltage output (100 mA max.)
14	DO1	Digital Output 1	Ready	Shows the drive is ready to run
15	24Vo	+24 Vdc Output	—	Control voltage output (100 mA max.)
16	GND	I/O Signal Ground	—	I/O Ground for Reference and Control
17	AO1+	Analog Output 1	Output Frequency	Shows Output frequency to motor 0–60 Hz (4 mA to 20 mA)
18	AO2+	Analog Output 2	Motor Current	Shows Motor current of motor 0–FLA (4 mA to 20 mA)
19	24Vi	+24 Vdc Input	—	External control voltage input
20	DIN1	Digital Input 1	Run Forward	Input starts drive in forward direction (start enable)
21	DIN2	Digital Input 2	Run Reverse	Input starts drive in reverse direction (start enable)
22	DIN3	Digital Input 3	External Fault	Input causes drive to fault
23	DIN4	Digital Input 4	Fault Reset	Input resets active faults
24	CMA	DI1 to DI4 Common	Grounded	Allows source input
25	A	RS-485 Signal A	—	Fieldbus Communication (Modbus, BACnet)
26	B	RS-485 Signal B	—	Fieldbus Communication (Modbus, BACnet)
27	R3NO	Relay 3 Normally Open	At Speed	Relay output 3 shows VFD is at Ref. Frequency
28	R1NC	Relay 1 Normally Closed	Run	Relay output 1 shows VFD is in a run state
29	R1CM	Relay 1 Common		
30	R1NO	Relay 1 Normally Open		
31	R3CM	Relay 3 Common	At Speed	Relay output 3 shows VFD is at Ref. Frequency
32	R2NC	Relay 2 Normally Closed	Fault	Relay output 2 shows VFD is in a fault state
33	R2CM	Relay 2 Common		
34	R2NO	Relay 2 Normally Open		

Figure 20. Terminal Block Layout

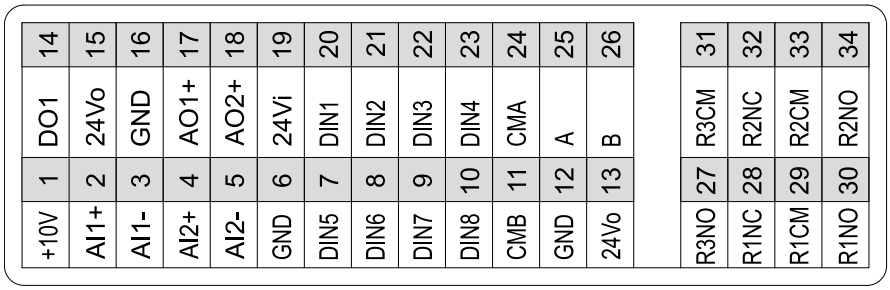
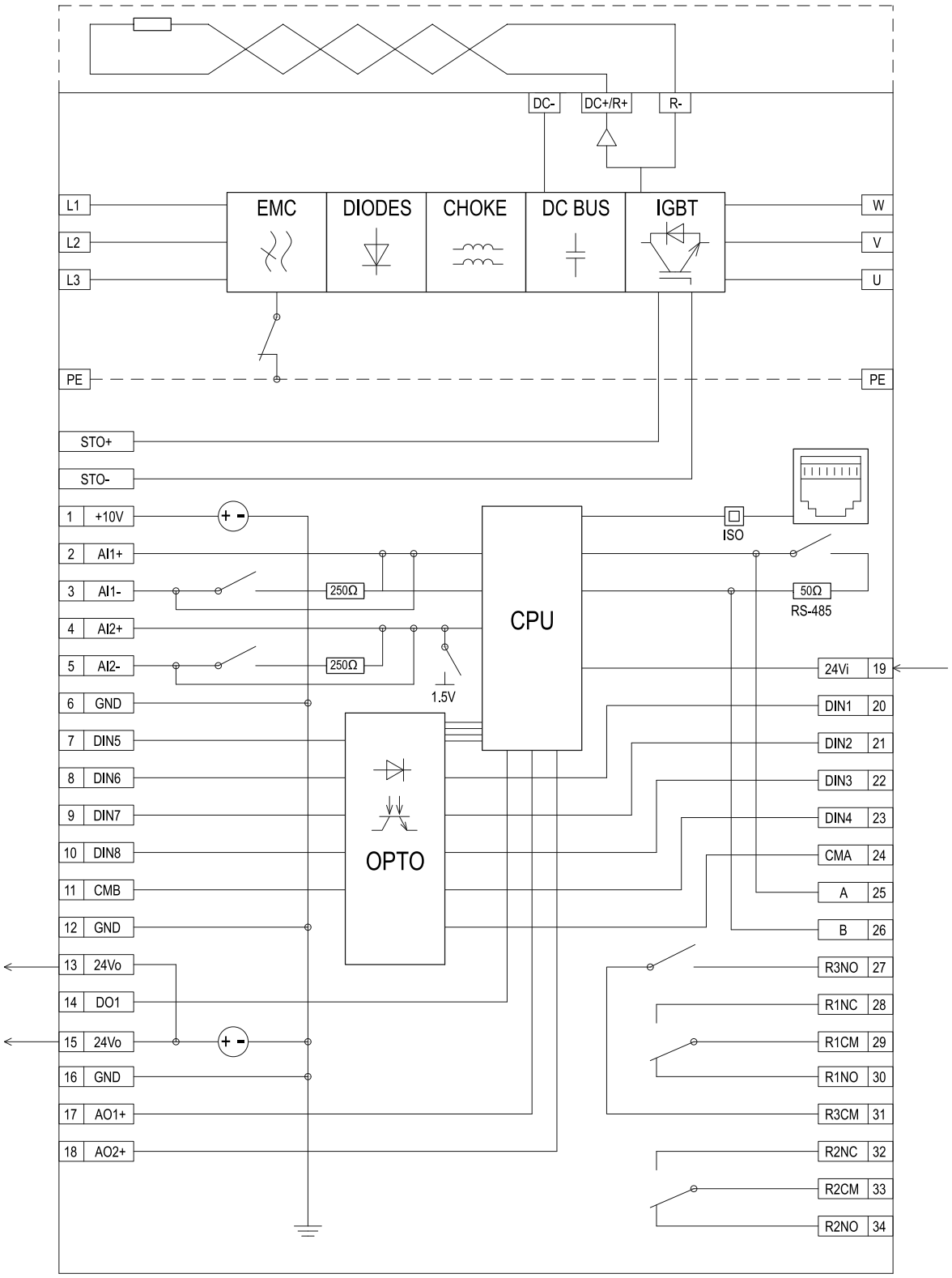


Table 24. I/O Specifications

Item	Specification
Analog Input 1	Selectable for either Voltage or Current reference signal
	0 to 10V, 0 (4) to 20 mA; R_i – 250 ohm differential
Analog Input 2	Selectable for either Voltage or Current reference signal
	0 to 10V, –10 to 10V, 0 (4) to 20 mA; R_i – 250 ohm differential
Digital inputs (8)	Positive or negative logic; 18 to 30 Vdc, one input can be used as thermistor input
+24V output	Auxiliary Voltage, +24V ±15%, total max. 250 mA on board (include optional cards)
+10 VREF	Output Reference Voltage, +10V +3%, max. load 10 mA
Analog Outputs	0 (4) to 20 mA; R_L max. 500 ohm
	0 to 10V, 10 mA
Digital Output	Open collector output, 50 mA/48V for CE, 50 mA/36V for UL
Relay Outputs (3)	Programmable relay outputs: 2 x Form C (Relay 1 and Relay 2) and 1 x Form A (Relay 3), Relay 3 can be used as thermistor output
	Switching capacity: 24 Vdc/6A, 48 Vdc/2A, 240 Vac/6A, 125 Vdc/0.4A

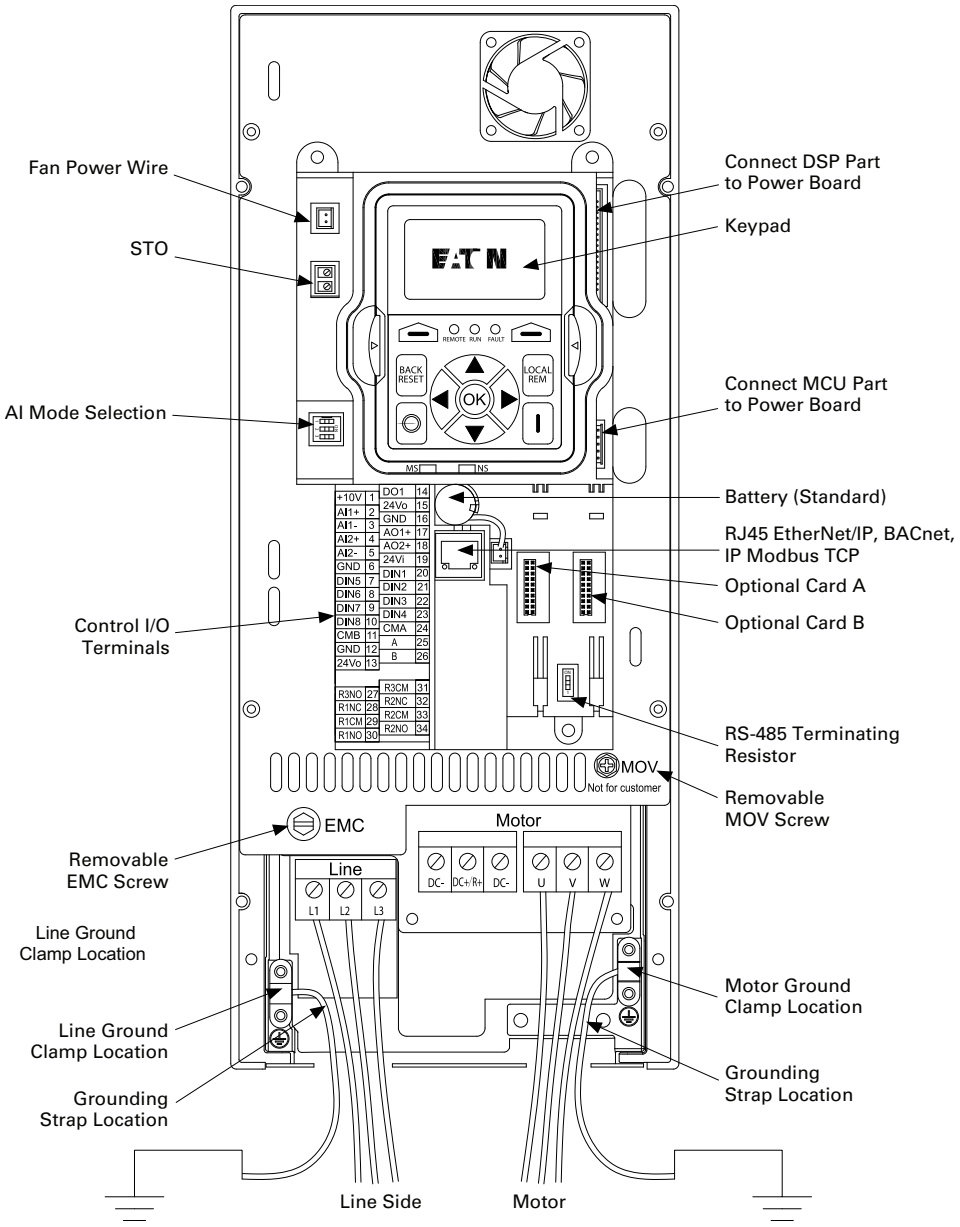
Figure 21. Basic Internal Control Wiring Diagram



Control Board

The main DG1 Series VFD consists of a main control board, control I/O connections block and two slots for extra option boards.

Figure 22. DG1 Series Adjustable Frequency Drive



Control Wiring

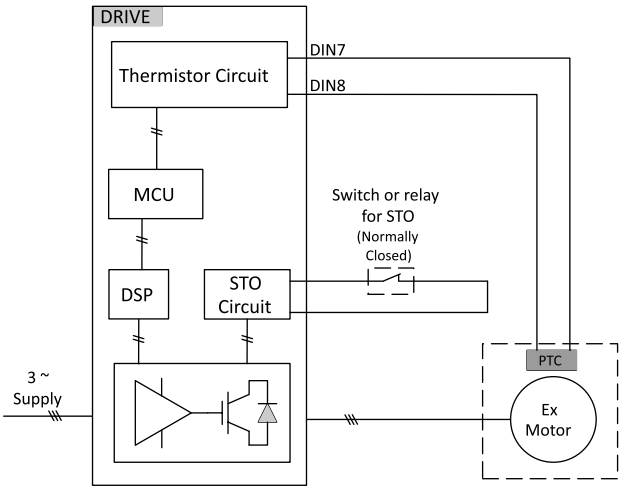
- All control I/O wiring must be segregated from line (mains) and motor cabling
- Control wiring shall be shielded twisted pairs to meet EMC levels required by IEC/EN 61800-3 (2004)
- Run 240 Vac and +24 Vdc control I/O in separate conduit
- Control I/O terminals must be tightened to 4.5 in-lb (0.5 Nm)
- Wiring or ferrule size: 28~12 (Sol) AWG, 30~12 (Str) AWG, or 0.2~2.5 mm^2

Safe Torque Off (STO)

The PowerXL DG1 includes Safe Torque Off (STO) functionality as standard and provides:

- Isolation from the control board will stop IGBT from firing
- Functional Safety SIL1 Certification: IEC/EN 61800-5-2 and DIN EN ISO 13849 Category 1, Level C
- Higher category levels achievable with safety relays

Figure 23. Thermistor STO Wiring Diagram

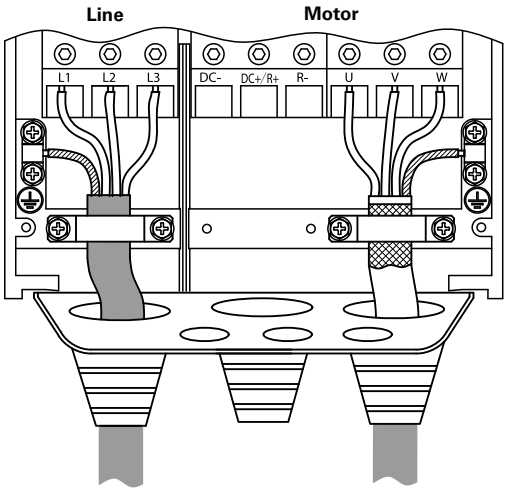


Connection to Power Section

Figure 24 shows the general connections for the frequency inverter in the power section.

Three-Phase Input Connection

Figure 24. Connection to Power Section



Terminal Designations in the Power Section

- L1, L2, L3: Connection terminals for the supply voltage (input, input voltage)
- U, V, W: Connection terminals for the three-phase line to the AC motor (output, frequency inverter)
- PE: Connection for protective ground (reference potential). PES with mounted cable routing plate for shielded cables

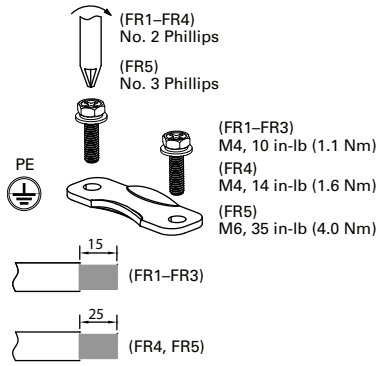
Ground Connection

The ground connection is connected directly with the cable clamp plates.

The shielded cables between the frequency inverter and the motor should be as short as possible. Connect the shielding on both ends and over a large surface area with protective ground PES (Protective Earth Shielding). You can connect the shielding of the motor cable directly to the cable clamp plate (360 degrees coverage) with the protective ground.

The frequency inverter must always be connected to the ground potential via a grounding cable (PE).

Figure 25. Grounding



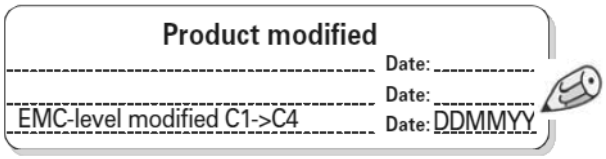
⚠ CAUTION

Before connecting the AC drive to mains make sure that the EMC protection class settings of the drive are appropriately made.

Note: After having performed the change write "EMC level modified" on the sticker included in the DG1 delivery (see **Figure 26**) and note the date. Unless already done, attach the sticker close to the name plate of the AC drive.

Product Modified Sticker

Figure 26. Product Modified Sticker



Checking the Cable and Motor Insulation

1. Check the motor cable insulation as follows:
   - Disconnect the motor cable from terminals U, V and W of the DG1 Series drive and from the motor
   - Measure the insulation resistance of the motor cable between each phase conductor as well as between each phase conductor and the protective ground conductor
   - The insulation resistance must be >1M ohm
2. Check the input power cable insulation as follows:
   - Disconnect the input power cable from terminals L1/N, L2/N and L3 of the DG1 Series drive and from the utility line feeder
   - Measure the insulation resistance of the input power cable between each phase conductor as well as between each phase conductor and the protective ground conductor
   - The insulation resistance must be >1M ohm
3. Check the motor insulation as follows:
   - Disconnect the motor cable from the motor and open any bridging connections in the motor connection box
   - Measure the insulation resistance of each motor winding. The measurement voltage must equal at least the motor nominal voltage but not exceed 1000V
   - The insulation resistance must be >1M ohm

Chapter 7—EMC Installation

The responsibility to meet the local system EMC limit values and electromagnetic compatibility requirements is the responsibility of the end user or the system operator. This operator must also take measures to minimize or remove emissions in the environment concerned (see figure on **Page 41**). He must also use means to increase the interference immunity of the system devices.

In a drive system (PDS) with frequency inverters, you should take measures for electromagnetic compatibility (EMC) while doing your planning, because changes or improvements to the installation site, which are required in the installation or while mounting, are normally associated with additional higher costs.

The technology and system of a frequency inverter cause the flow of high frequency leakage current during operation. All grounding measures must therefore be implemented with low impedance connections over a large surface area.

With leakage currents greater than 3.5 mA, in accordance with VDE 0160 or EN 61800-5-1, either

- the protective conductor must have a cross-section of at least 10 mm^2
- the protective conductor must be open-circuit monitored, and the supply must be automatically disconnected in case of discontinuity of the protective earthing conductor, or
- the second protective conductor must be fitted.

For an EMC-compliant installation, we recommend the following measures:

- Installation of the frequency inverter in a metallic, electrically conducting enclosure with a good connection to earth
- Shielded motor cables (short cable lengths)
- Ground all conductive components and housings in a drive system using as short a line as possible with the greatest possible cross-section (Cu-braid)

EMC Measures in the Control Panel

For EMC-compatible installation, connect all metallic parts of the device and the switching cabinet together over broad surfaces and so that high-frequencies will be conducted. Mounting plates and cabinet doors should make good contact and be connected with short HF-braided cables. Avoid using painted surfaces (anodized, chromized). An overview of all EMC measures is provided in the figure on **Page 41**.

Install the frequency inverter as directly as possible (without spacers) on a metal plate (mounting plate).

Route input and motor cables in the switch cabinet as close to the ground potential as possible. This is because free moving cables act as antennas.

When laying HF cables (for example, shielded motor cables) or suppressed cables (for example, input supply cables, control circuit and signal cables) in parallel, a minimum clearance of 11.81 in (300 mm) should be ensured in order to prevent the radiation of electromagnetic energy. Separate cable routing should also be ensured when large voltage potential differences are involved. Any necessary crossed cabling between the control signal and power cables should always be implemented at right angles (90 degrees).

Never lay control or signal cables in the same duct as power cables. Analog signal cables (measured, reference and correction values) must be shielded.

Earthing

The ground connection (PE) in the cabinet should be connected from the input supply to a central earth point (mounting plate). All protective conductors should be routed in star formation from this earth point and all conductive components of the PDS (frequency inverter, motor reactor, motor filter, main choke) are to be connected.

Avoid ground loops when installing multiple frequency inverters in one cabinet. Make sure that all metallic devices that are to be grounded have a broad area connection with the mounting plate.

Screen Earth Kit

Cables that are not shielded work like antennas (sending, receiving). Make sure that any cables that may carry disruptive signals (for example, motor cables) and sensitive cables (analog signal and measurement values) are shielded apart from one another with EMC-compatible connections.

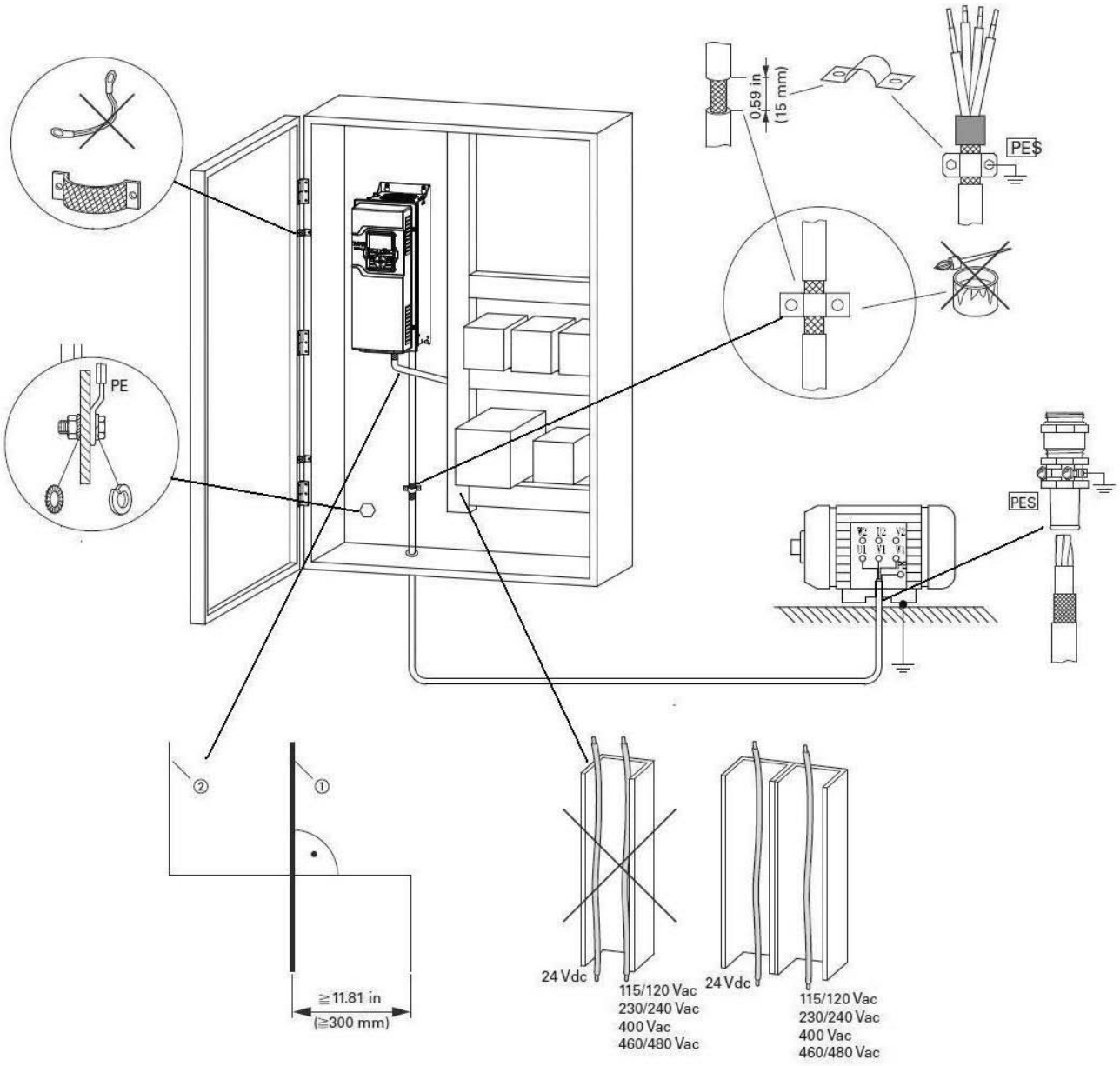
The effectiveness of the cable shield depends on a good shield connection and a low shield impedance.

Use only shields with tinned or nickel-plated copper braiding. Braided steel shields are unsuitable.

Control and signal lines (analog, digital) should always be grounded on one end, in the immediate vicinity of the supply voltage source (PES).

Installation Requirements

Figure 27. EMC-Compliant Setup—460/480 Vac



Notes

① Power cable: L1, L2, L3 and U, V, W.

② Control and signal lines: 1 to 36, fieldbus connection Large-area connection of all metallic control panel components. Mounting surfaces of frequency inverter and cable shielding must be free from paint. Connect the cable shielding in the output of the frequency inverter with a large surface area contact to the ground potential (PES). Large-area cable shield contacts with motor. Large-area earth connection of all metallic parts.

International EMC Protection Cable Requirements

The screened cables between the variable frequency drive and the motor should be as short as possible.

- Connect the screening, on both sides and across a large area (360° overlap), to the protective earth (PE). The power screening protective earth (PES) connection should be in the immediate proximity of the variable frequency drive and directly on the motor terminal box.
- Prevent the screening from becoming unbraided, e.g., by pushing the opened plastic sheath over the end of the screening or with a rubber grommet on the end of the screening. As an alternative, in addition to a broad area cable clip, you can also twist the shielding braid at the end and connect to protective ground with a cable clip. To prevent EMC disturbance, this twisted shielding connection should be made as short as possible
- Screened three- or four-wire cable is recommended for the motor cables. The green/yellow line of a four-wire cable connects the protective ground connections from the motor and the variable frequency drive and therefore minimizes the equalizing current loads on the shielding braid.
- If there are additional subassemblies in a motor feeder (such as motor contactors, overload relays, motor reactor, sinusoidal filters or terminals), the shielding of the motor cable can be interrupted close to these subassemblies and connected to the mounting plate (PES) with a large area connection.

Free or non-screened connection cables should not be any longer than about 300 mm.

Table 25. 1st Environment 2nd Environment EMC Levels According to EN 61800-3 (2004)

Cable Type	Category C2	Category C3	Level T
Line voltage/mains	1	1	1
Motor cable	3 ①	2	2
Control cable	4	4	4

Note

① 360° earthing of the shield with cable glands in motor end needed for EMC Level C2.

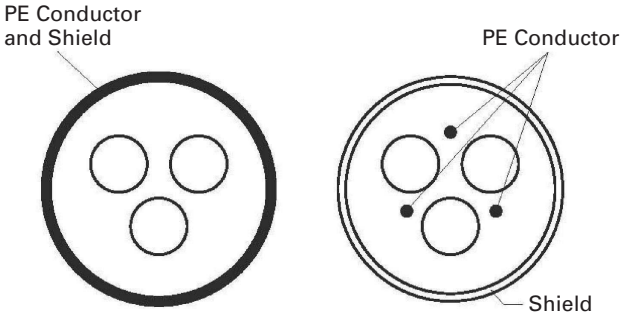
Table 26. Control Wiring Requirements

Item	Directive
Product	IEC 61800-2
Safety	UL 508C, IEC / EN 61800-5-1
EMC (at default settings)	Immunity: EN / IEC 61800-3, 2nd environment
	Radiated emissions: EN / IEC 61800-3 (Transient Testing included), 1st environment
	Conducted emissions: EN / IEC 61800-3
	Category C1: is possible with external filter connected to drive. Please consult factory
	Category C2: with internal filter maximum of 10m motor cable length
	Category C3: with internal filter maximum of 50m motor cable length

Table 27. Cable Categories

Cable Category	Description (All cables are rated for the specific operating voltage)
1	Intended for fixed installation
2	Symmetrical power cable equipped with a concentric protection wire.
3	Symmetrical power cable with compact low-impedance shield. Recommended cable transfer impedance of 1–30 MHz max. See figure below.
4	Screened cable equipped with compact low-impedance shield

Figure 28. Cable Description



Installation in Corner-Grounded Network

Corner grounding is allowed for all the drive types.

In these circumstances the EMC protection class must be changed to level C4 following the instructions below.

Installation in IT System

If your supply network is an IT (impedance-grounded) system but your AC drive is EMC-protected according to class C2 you need to modify the EMC protection of the AC drive to EMC level C4. This is done by removing the built-in EMC Screw with a simple procedure described below:

⚠ WARNING

Do not perform any modifications on the AC drive when it is connected to mains.

⚠ WARNING

Electric shock hazard—risk of injuries! Carry out wiring work only if the unit is de-energized.

After disconnecting the supply, wait at least five minutes before removing the cover to allow the intermediate circuit capacitors to discharge.

⚠ WARNING

Failure to follow these instructions will result in death or serious injury.

Frame 1 to Frame 5

Remove the main cover of the AC drive (see **Figure 30**) and locate the screw jumper connecting the built-in RFI-filters to ground. Remove the screw jumper to disconnect the EMC protection. Once the screw is removed, it can be reconnected to re-engage the EMC protection.

Figure 29. Locations of the EMC Screw in Frame 1, Frame 2, Frame 3 and Frame 4

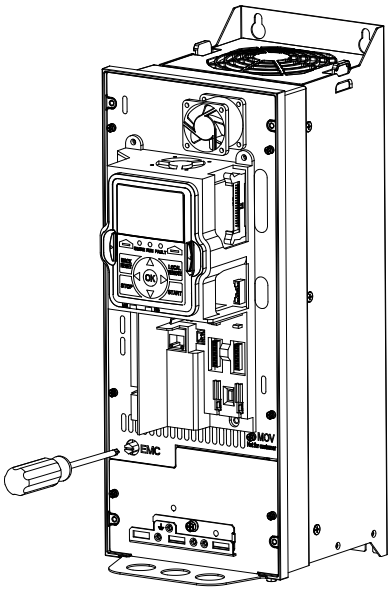
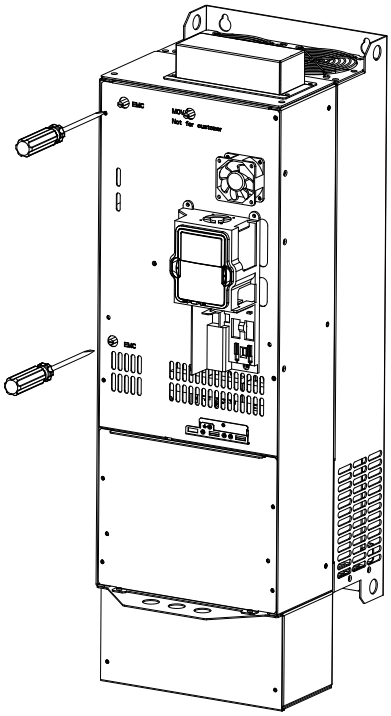


Figure 30. Locations of the EMC Screws in Frame 5



Appendix A—Technical Data and Specifications

Table 28. PowerXL Series—DG1

Attribute	Description	Specification
Input ratings	Input voltage U_{in}	208V to 240V, 380V to 500V, 525V to 600V, –15 to 10%
	Input frequency	50 Hz to 60 Hz (variation up to 45 Hz to 66 Hz)
	Connection to power	Once per minute or less
	Starting delay	3 s (FR1 to FR2), 4 s (FR3), 5 s (FR4), 6 s (FR5)
	Short-circuit withstand rating	100 kAIC
Output ratings	Output voltage	0 to U_{in}
	Continuous output current	IL: ambient temperature maximum 40°C, up to 60°C with derating, overload 1.1 x IL (1 min./10 min.) IH: ambient temperature maximum 50°C, up to 60°C with derating, overload 1.5 x IH (1 min./10 min.)
	Overload current	150% respectively 110% (1 min./10 min.)
	Initial output current	200% (2 s/20 s)
	Output frequency	0–400 Hz (standard)
	Frequency resolution	0.01 Hz
Control characteristics	Control methods	Frequency control Speed control Open-loop speed control Open-loop torque control
	Switching frequency	Range: FR1–3: 1 kHz to 12 kHz FR4–5: 1 kHz to 10 kHz Defaults: FR1–3: 4 kHz (IH), 6 kHz (IL) FR4–5: 3.6 kHz Automatic switching frequency derating in case of overload.
	Frequency reference	Analog input: resolution 0.1% (10-bit), accuracy +1% Panel reference: resolution 0.01 Hz
	Field weakening point	20 Hz to 400 Hz
	Acceleration time	0.1 s to 3000 s
	Deceleration time	0.1 s to 3000 s
	Braking torque	DC brake: 30% x Motor Rated Torque (Tn) (without brake chopper) Dynamic braking (with optional brake chopper using an external brake resistor): 100% continuous maximum rating
Ambient conditions	Ambient operating temperature	–10°C (no frost) to +50°C, up to +60°C with derating (CT) –10°C (no frost) to +40°C, up to +55°C with derating (VT)
	Storage temperature	–40°C to +70°C
	Relative humidity	0–95% RH, noncondensing, non-corrosive
	Air quality: • Chemical vapors • Mechanical particles	Tested according to IEC 60068-2-60 Test Key: Flowing mixed gas corrosion test, Method 1 (H2S [hydrogen sulfide] and SO2 [sulfur dioxide]) Designed according to: IEC 60721-3-3, unit in operation, class 3C2 IEC 60721-3-3, unit in operation, class 3S2
	Altitude	100% load capacity (no derating) up to 3280 ft (1000 m); 1% derating for each 328 ft (100 m) above 3280 ft (1000 m); max. 9842 ft (3000 m) (2000 m for corner grounded earth main systems)
	Vibration: • EN 61800-5-1 • EN 60668-2-6	5–150 Hz Displacement amplitude: 1 mm (peak) at 5 Hz to 15.8 Hz (FR1–FR5) Maximum acceleration amplitude: 1g at 15.8 Hz to 150 Hz (FR1–FR5)

Table 28. PowerXL Series—DG1, continued

Attribute	Description	Specification
Ambient conditions, continued	Shock: • ISTA 1 A • EN 60068-2-27	Storage and shipping: maximum 15 g, 11 ms (in package)
	Overvoltage	Overvoltage Category III
	Pollution degree	Pollution Degree 2
	Enclosure class	IP21/Type 1 standard in entire kW/hp range IP54/Type 12 option Note: Keypad or keypad hole plug required to be mounted in drive for IP54/Type 12 rating
	Immunity	Fulfills EN 61800-3 (2004), first and second environment
	MTBF	FR1: 165,457 hours FR2: 134,833 hours FR3: 102,515 hours FR4: 121,567 hours FR5: 108,189 hours FR6: Available in 2015
Standards	Safety	UL 508C, CSA C22.2 No. 274-13 and EN 61800-5-1
	EMC	+EMC2: EN 61800-3 (2004), Category C2 The drive can be modified for IT networks and corner grounding TN system
	Electrostatic discharge	Second environment, IEC 61000-4-2, 4 kV CD or 8 kV AD, Criterion B
	Fast transient burst	Second environment, IEC 61000-4-4, 2 kV/5 kHz, Criterion B
	Dielectrical strength	Primary to secondary: 3600 Vac/5100 Vdc Primary to earth: 2000 Vac/2828 Vdc
	Approvals	EN 61800-5-1 (2007), CE, UL and cUL (see nameplate for more detailed approvals)
Fieldbus connections		EtherNet/IP, Modbus® TCP, Modbus RTU, BACnet
Safety/protections	Overvoltage protection	Yes
	Overvoltage trip limit	240V drives: 456V 480V drives: 911V
	Undervoltage protection	Yes
	Undervoltage trip limit	240V drives: 211V 480V drives: 370V
	Earth fault protection	Yes
	Input phase supervision	Yes
	Motor phase supervision	Yes
	Overcurrent protection	Yes
	Unit overtemperature protection	Yes
	Motor overload protection	Yes
	Motor stall protection	Yes
	Motor underload protection	Yes
	DC bus overvoltage control	Yes
	Short-circuit protection of 24V reference voltages	Yes
	Surge protection	Yes (differential mode 2 kV; common mode 4 kV)
	Common coated boards	Yes (prevents corrosion)

Appendix B—Installation Guidelines

Cable and Fuse Sizing

See **Page 30** for cable stripping guidelines.

Table 29. North America Cable and Fuse Sizes—208 Vac to 240 Vac Ratings

Frame Size	Amp Suffix	208V Input Current (CT/I_H)	208V Input Current (VT/I_L)	NEC Motor Amp Rating at 230V	NEC Motor Amp Rating at 208V	Current (CT/I_H) at 50°C	Current (VT/I_L) at 40°C	Fuse Rating (Class T)	NEC Wire Size (AWG)		Terminal Connection Size (AWG)	
									Line and Motor	Ground	Line and Motor	Ground
FR1	3D7	3.2	4.4	4.2	4.6	3.7	4.8	10	14	14	24–10	18–10
	4D8	4.4	6.1	6.0	6.6	4.8	6.6	10	14	14	24–10	18–10
	6D6	6.1	7.2	6.8	7.5	6.6	7.8	10	14	14	24–10	18–10
	7D8	7.2	10.2	9.6	10.6	7.8	11	15	14	14	24–10	18–10
	011	10.2	11.6	—	—	11	12.5	15	12	14	24–10	18–10
FR2	012	10.2	16.3	15.2	16.7	12.5	17.5	20	10	12	20–6	12–6
	017	16.2	23.2	22	24.2	17.5	25	30	8	10	20–6	12–6
	025	23.1	29	28	30.8	25	31	35	8	10	20–6	12–6
FR3	031	28.7	44.2	42	46.2	31	48	60	6	10	6–2	14–4
	048	44.4	56	54	59.4	48	61	80	4	8	6–2	14–4
FR4	061	56.4	64.6	68	74.8	61	75	100	3	8	6–1/0	10–1/0
	075	69.4	78	80	88	75	88	110	2	6	6–1/0	10–1/0
	088	81.4	94.3	104	114	88	114	125	1/0	6	6–1/0	10–1/0
FR5	114	105.5	129	130	143	114	143	175	3/0	6	1/0–350 kcmil	8–250 kcmil
	143	132.3	157	154	169	143	170	200	4/0	6	1/0–350 kcmil	8–250 kcmil
	170	157.3	189	192	211	170	211	250	300	4	1/0–350 kcmil	8–250 kcmil
FR6	211	195.2	④	248	261	211	261	④	④	3	④	④
	261	241.4	④	312	312	261	312	④	④	3	④	④

Notes

① Line and motor cable size is selected according to UL508C Table 40.3 for copper conductor rated 75°C. Use only with copper wire rated 75°C here. Size requirements for other different wire types are defined in the National Electrical Code, ANSI/NFPA 70.

② Earthing conductor size is determined by the maximum overcurrent device rating used ahead of the drive according to UL508C Table 6.4.

③ If power cubes or bypass are used, a UL recognized Class T fuse is recommended.

④ Available in 2015.

Table 30. International Cable and Fuse Sizes—208 Vac to 240 Vac Ratings

Frame Size	Amp Suffix	208V Input Current (CT/I_H)	208V Input Current (VT/I_L)	Current (CT/I_H) at 50°C	Current (VT/I_L) at 40°C	Fuse Rating (gG/gL)	Mains and Motor Cable Cu (mm^2)	Terminal Cable Size	
								Main Terminal Cu (mm^2)	Earth Terminal Cu (mm^2)
FR1	3D7	3.2	4.4	3.7	4.8	6	3*1.5+1.5	0.2–6 solid or 0.2–4 stranded	0.75–6
	4D8	4.4	6.1	4.8	6.6	10	3*1.5+1.5	0.2–6 solid or 0.2–4 stranded	0.75–6
	6D6	6.1	7.2	6.6	7.8	16	3*1.5+1.5	0.2–6 solid or 0.2–4 stranded	0.75–6
	7D8	7.2	10.2	7.8	11	16	3*1.5+1.5	0.2–6 solid or 0.2–4 stranded	0.75–6
	011	10.2	11.6	11	12.5	16	3*1.5+1.5	0.2–6 solid or 0.2–4 stranded	0.75–6
FR2	012	10.2	16.3	12.5	17.5	20	3*4+4	0.5–16	4–16
	017	16.2	23.2	17.5	25	32	3*4+4	0.5–16	4–16
	025	23.1	29	25	31	32	3*6+6	0.5–16	4–16
FR3	031	28.7	44.2	31	48	50	3*16+16	16–35	2.5–25
	048	44.4	56	48	61	63	3*16+16	16–35	2.5–25
FR4	061	56.4	64.6	61	75	80	3*25+16	16–50	6–50
	075	69.4	78	75	88	100	3*35+16	16–50	6–50
	088	81.4	94.3	88	114	125	3*50+25	16–50	6–50
FR5	114	105.5	129	114	143	160	3*70+35	50–185	10–120
	143	132.3	157	143	170	200	3*95+50	50–185	10–120
	170	157.3	189	170	211	250	3*150+95	50–185	10–120
FR6	211	195.2	④	211	261	④	④	④	④
	261	241.4	④	261	312	④	④	④	④

Notes

① Line and motor cable size is selected according to IEC60364–5–52:2009 Table B.52.4 for copper conductor with PVC insulation with a wiring condition of ambient temperature 30°C in air and an installation method of "B2" (cables in conduit and cable trunking systems). For other wiring conditions, please refer to the standard of IEC60364–5–52:2009 for suitable cable sizes.

② Earthing conductor size is determined by the cross–sectional area of phase conductors according to IEC/EN61800–5–1:2007 Table 5. So if phase conductor size is changed, earthing conductor size should also be changed accordingly.

③ If power cubes or bypass are used, a Class gG/gL fuse is recommended.

④ Available in 2015.

Table 31. North America Cable and Fuse Sizes—440 Vac to 500 Vac Ratings

Frame Size	Amp Suffix	400V Input Current (CT/I_H)	400V Input Current (VT/I_L)	NEC Motor Amp Rating at 460V	Current (CT/I_H) at 50°C	Current (VT/I_L) at 40°C	Fuse Rating (Class T)	NEC Wire Size (AWG)		Terminal Connection Size (AWG)	
								Line and Motor	Ground	Line and Motor	Ground
FR1	2D2	2.0	3.1	3.0	2.1	3.0	10	14	14	30–10	18–10
	3D3	3.1	4	3.4	3.0	3.4	10	14	14	30–10	18–10
	4D3	4.0	5.2	4.8	3.4	4.8	10	14	14	30–10	18–10
	5D6	5.2	7.1	7.6	4.8	7.6	10	14	14	30–10	18–10
	7D6	7.1	8.4	—	7.6	9	15	14	14	30–10	18–10
	9D0	8.4	11.2	11	9	12	15	14	14	30-10	18–10
FR2	012	11.2	15	14	11	14	20	12	12	20–6	12–6
	016	14.9	21.5	21	14	21	30	10	10	20–6	12–6
	023	21.4	29	27	21	27	35	8	10	20–6	12–6
FR3	031	28.8	35.2	34	27	34	50	8	10	6–2	14–4
	038	35.3	42.6	40	34	40	60	6	10	6–2	14–4
	046	42.8	55.7	52	40	52	80	4	8	6–2	14–4
FR4	061	56.7	65.7	65	52	65	100	4	8	6–1/0	10–1/0
	072	66.9	79.4	77	65	77	110	3	6	6–1/0	10–1/0
	087	80.9	97	96	77	96	125	1	6	6–1/0	10–1/0
FR5	105	97.6	129	124	96	124	175	3/0	6	1/0–350 kcmil	8–250 kcmil
	140	130.1	157	156	124	156	200	3/0	6	1/0–350 kcmil	8–250 kcmil
	170	158.0	189	180	156	180	250	250 kcmil	4	1/0–350 kcmil	8–250 kcmil
FR6	205	190.6	④	240	180	240	350	④	3	④	④
	261	④	④	302	240	302	400	④	3	④	④

Notes

① Line and motor cable size is selected according to UL508C Table 40.3 for copper conductor rated 75°C. Use only with copper wire rated 75°C here. Size requirements for other different wire types are defined in the National Electrical Code, ANSI/NFPA 70.

② Earthing conductor size is determined by the maximum overcurrent device rating used ahead of the drive according to UL508C Table 6.4.

③ If power cubes or bypass are used, a UL recognized Class T fuse is recommended.

④ Available in 2015.

Table 32. International Cable and Fuse Sizes—380 Vac to 440 Vac Ratings

Frame Size	Amp Suffix	400V Input Current (CT/I_H)	400V Input Current (VT/I_L)	Current (CT/I_H) at 50°C	Current (VT/I_L) at 40°C	Fuse Rating (gG/gL)	Mains and Motor Cable Cu (mm^2)	Terminal Cable Size	
								Main Terminal Cu (mm^2)	Earth Terminal Cu (mm^2)
FR1	2D2	2.0	3.1	2.2	3.3	6	3*1.5+1.5	0.2–6 solid or 0.2–4 stranded	0.75–6
	3D3	3.1	4	3.3	4.3	6	3*1.5+1.5		0.75–6
	4D3	4.0	5.2	4.3	5.6	10	3*1.5+1.5		0.75–6
	5D6	5.2	7.1	5.6	7.6	16	3*1.5+1.5		0.75–6
	7D6	7.1	8.4	7.6	9	16	3*1.5+1.5		0.75–6
	9D0	8.4	11.2	9	12	16	3*1.5+1.5		0.75–6
FR2	012	11.2	15	12	16	20	3*4+4	0.5–16	4–16
	016	14.9	21.5	16	23	25	3*4+4	0.5–16	4–16
	023	21.4	29	23	31	32	3*6+6	0.5–16	4–16
FR3	031	28.8	35.2	31	38	40	3*16+16	16–35	2.5–25
	038	35.3	42.6	38	46	50	3*16+16	16–35	2.5–25
	046	42.8	55.7	46	61	63	3*16+16	16–35	2.5–25
FR4	061	56.7	65.7	61	72	80	3*25+16	16–50	6–50
	072	66.9	79.4	72	87	100	3*35+16	16–50	6–50
	087	80.9	97	87	105	125	3*50+25	16–50	6–50
FR5	105	97.6	129	105	140	160	3*70+35	50–185	10–120
	140	130.1	157	140	170	200	3*95+50	50–185	10–120
	170	158.0	189	170	205	250	3*120+70	50–185	10–120
FR6	205	190.6	④	205	261	315	3*240+120	④	④
	261	④	④	261	310	350	2*(3*95+50)	④	④

Notes

① Line and motor cable size is selected according to IEC60364–5–52:2009 Table B.52.4 for copper conductor with PVC insulation with a wiring condition of ambient temperature 30°C in air and an installation method of "B2" (cables in conduit and cable trunking systems). For other wiring conditions, please refer to the standard of IEC60364–5–52:2009 for suitable cable sizes.

② Earthing conductor size is determined by the cross–sectional area of phase conductors according to IEC/EN61800–5–1:2007 Table 5. So if phase conductor size is changed, earthing conductor size should also be changed accordingly.

③ If power cubes or bypass are used, a Class gG/gL fuse is recommended.

④ Available in 2015.

Temperature Deratings

Table 33. 230V Temperature and Switching Frequency Deratings (VT)

Variable Torque (VT) /Low Overload (I_L) Temperature	Frame Size	Percentage of Rated Current Switching Frequency 1 kHz	2 kHz	3 kHz	3.6 kHz	4 kHz	5 kHz	6 kHz	7 kHz	8 kHz	9 kHz	10 kHz	12 kHz
40°C	**FR1**	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	96.8%	93.6%	90.4%	85.6%	80.8%
	FR2	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	97.3%	94.6%	91.9%	87.9%	83.9%
	FR3	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	FR4	100.0%	100.0%	100.0%	100.0%	97.8%	95.6%	93.4%	91.2%	87.4%	83.6%	79.8%	—
	FR5	100.0%	100.0%	100.0%	100.0%	95.5%	91.0%	86.5%	82.0%	78.4%	74.7%	71.1%	—
	FR6	①	①	①	①	①	①	①	①	①	①	①	—
50°C	**FR1**	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	80.8%	77.6%	74.4%	69.6%	64.8%
	FR2	87.1%	87.1%	87.1%	87.1%	87.1%	87.1%	87.1%	84.4%	81.7%	79.0%	75.0%	71.0%
	FR3	93.4%	93.4%	93.4%	93.4%	93.4%	93.4%	93.4%	93.4%	93.4%	93.4%	90.2%	86.9%
	FR4	87.7%	87.7%	87.7%	87.7%	85.5%	83.3%	81.1%	78.9%	76.0%	73.1%	70.2%	—
	FR5	80.6%	80.6%	80.6%	80.6%	76.7%	72.7%	68.8%	64.9%	60.0%	55.1%	50.2%	—
	FR6	①	①	①	①	①	①	①	①	①	①	①	—
60°C	**FR1**	68.0%	68.0%	68.0%	68.0%	68.0%	68.0%	68.0%	65.9%	63.7%	61.6%	58.4%	55.2%
	FR2	74.2%	74.2%	74.2%	74.2%	74.2%	74.2%	74.2%	71.0%	67.7%	64.5%	59.7%	54.8%
	FR3	82.0%	82.0%	82.0%	82.0%	82.0%	82.0%	82.0%	80.3%	78.7%	77.0%	73.8%	70.5%
	FR4	74.6%	74.6%	74.6%	74.6%	72.1%	69.7%	67.3%	64.9%	62.3%	59.6%	57.0%	—
	FR5	64.0%	64.0%	64.0%	64.0%	60.9%	57.8%	54.7%	51.7%	47.9%	44.2%	40.5%	—
	FR6	①	①	①	①	①	①	①	①	①	①	①	—

Note

① FR6 available in 2015.

Table 34. 230V Temperature and Switching Frequency Deratings (CT)

Constant Torque (CT) /High Overload (I_H)		Percentage of Rated Current Switching Frequency											
Temperature	Frame Size	1 kHz	2 kHz	3 kHz	3.6 kHz	4 kHz	5 kHz	6 kHz	7 kHz	8 kHz	9 kHz	10 kHz	12 kHz
40°C	**FR1**	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	95.9%	91.8%
	FR2	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	FR3	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	FR4	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	96.2%	92.3%	88.5%	—
	FR5	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	96.1%	92.2%	88.2%	—
	FR6	①	①	①	①	①	①	①	①	①	①	①	—
50°C	**FR1**	100.0%	100.0%	100.0%	100.0%	100.0%	97.7%	95.5%	91.8%	88.2%	84.5%	79.1%	73.6%
	FR2	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	98.0%	96.0%	94.0%	91.0%	88.0%
	FR3	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	FR4	100.0%	100.0%	100.0%	100.0%	97.1%	94.3%	91.4%	88.5%	84.7%	80.8%	77.0%	—
	FR5	100.0%	100.0%	100.0%	100.0%	95.1%	90.3%	85.4%	80.6%	74.5%	68.4%	62.4%	—
	FR6	①	①	①	①	①	①	①	①	①	①	①	—
60°C	**FR1**	83.6%	83.6%	83.6%	83.6%	83.6%	80.9%	78.2%	75.5%	72.7%	70.0%	65.9%	61.8%
	FR2	92.0%	92.0%	92.0%	92.0%	92.0%	92.0%	92.0%	130.0%	168.0%	80.0%	101.3%	68.0%
	FR3	91.7%	91.7%	91.7%	91.7%	91.7%	90.6%	89.6%	88.5%	87.5%	86.1%	84.7%	83.3%
	FR4	83.9%	83.9%	83.9%	83.9%	80.7%	77.6%	74.4%	71.3%	67.4%	63.6%	59.8%	—
	FR5	79.4%	79.4%	79.4%	79.4%	75.6%	71.8%	67.9%	64.1%	59.5%	54.9%	50.3%	—
	FR6	①	①	①	①	①	①	①	①	①	①	①	—

Note

① FR6 available in 2015.

Table 35. 460V Temperature and Switching Frequency Deratings (VT)

Variable Torque (VT) /Low Overload (I_L) Temperature	Frame Size	Percentage of Rated Current Switching Frequency 1 kHz	2 kHz	3 kHz	3.6 kHz	4 kHz	5 kHz	6 kHz	7 kHz	8 kHz	9 kHz	10 kHz	12 kHz
40°C	**FR1**	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	93.8%	87.5%	81.3%	75.0%	62.5%
	FR2	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	95.2%	90.3%	85.5%	80.6%	71.0%
	FR3	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	95.5%	91.0%	86.5%	82.0%	73.0%
	FR4	100.0%	100.0%	100.0%	100.0%	95.7%	91.4%	87.1%	81.8%	76.4%	71.1%	65.7%	—
	FR5	100.0%	100.0%	100.0%	100.0%	94.8%	89.6%	84.4%	77.8%	71.2%	64.6%	58.0%	—
	FR6	①	①	①	①	①	①	①	①	①	①	①	—
50°C	**FR1**	75.0%	75.0%	75.0%	75.0%	75.0%	75.0%	75.0%	70.8%	66.7%	62.5%	58.3%	50.0%
	FR2	80.6%	80.6%	80.6%	80.6%	80.6%	80.6%	80.6%	77.4%	74.2%	71.0%	67.7%	61.3%
	FR3	84.9%	84.9%	84.9%	84.9%	84.9%	84.9%	84.9%	81.1%	77.2%	73.4%	69.5%	61.8%
	FR4	87.6%	87.6%	87.6%	87.6%	83.7%	79.8%	75.8%	70.9%	66.0%	61.1%	56.2%	—
	FR5	82.9%	82.9%	82.9%	82.9%	78.0%	73.2%	68.3%	62.2%	56.1%	50.0%	43.9%	—
	FR6	①	①	①	①	①	①	①	①	①	①	①	—
60°C	**FR1**	58.3%	58.3%	58.3%	58.3%	58.3%	58.3%	58.3%	54.2%	50.0%	45.8%	41.7%	33.3%
	FR2	67.7%	67.7%	67.7%	67.7%	67.7%	67.7%	67.7%	64.5%	61.3%	58.1%	54.8%	48.4%
	FR3	71.3%	71.3%	71.3%	71.3%	71.3%	71.3%	71.3%	67.5%	63.8%	60.0%	56.2%	48.7%
	FR4	72.4%	72.4%	72.4%	72.4%	68.8%	65.2%	61.7%	57.2%	52.7%	48.3%	43.8%	—
	FR5	68.3%	68.3%	68.3%	68.3%	64.0%	59.8%	55.5%	50.2%	44.8%	39.5%	34.1%	—
	FR6	①	①	①	①	①	①	①	①	①	①	①	—

Note

① FR6 available in 2015.

Table 36. 460V Temperature and Switching Frequency Deratings (CT)

Constant Torque (CT) /High Overload (I_H)		Percentage of Rated Current Switching Frequency											
Temperature	Frame Size	1 kHz	2 kHz	3 kHz	3.6 kHz	4 kHz	5 kHz	6 kHz	7 kHz	8 kHz	9 kHz	10 kHz	12 kHz
40°C	**FR1**	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	96.1%	92.1%	88.2%	82.2%	76.3%
	FR2	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	93.5%	87.0%
	FR3	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	95.7%	89.1%	82.6%
	FR4	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	94.8%	89.7%	84.5%	79.3%	—
	FR5	100.0%	100.0%	100.0%	100.0%	94.1%	88.2%	82.4%	75.0%	67.6%	60.3%	52.9%	—
	FR6	①	①	①	①	①	①	①	①	①	①	①	—
50°C	**FR1**	100.0%	100.0%	100.0%	100.0%	100.0%	95.7%	91.4%	87.1%	82.9%	78.6%	72.2%	65.8%
	FR2	100.0%	100.0%	100.0%	100.0%	100.0%	95.7%	91.3%	87.0%	82.6%	78.3%	71.7%	65.2%
	FR3	100.0%	100.0%	100.0%	100.0%	100.0%	94.6%	89.1%	83.7%	78.3%	72.8%	64.7%	56.5%
	FR4	100.0%	100.0%	100.0%	100.0%	96.0%	92.0%	87.9%	82.9%	77.9%	72.8%	67.8%	—
	FR5	100.0%	100.0%	100.0%	100.0%	94.1%	88.2%	82.4%	75.0%	67.6%	60.3%	52.9%	—
	FR6	①	①	①	①	①	①	①	①	①	①	①	—
60°C	**FR1**	92.1%	92.1%	92.1%	92.1%	92.1%	87.2%	82.2%	77.3%	72.3%	67.4%	60.0%	52.6%
	FR2	78.3%	78.3%	78.3%	78.3%	78.3%	73.9%	69.6%	65.2%	60.9%	56.5%	50.0%	43.5%
	FR3	80.4%	80.4%	80.4%	80.4%	80.4%	76.1%	71.7%	67.4%	63.0%	58.7%	52.2%	45.7%
	FR4	87.4%	87.4%	87.4%	87.4%	83.0%	78.7%	74.4%	69.0%	63.6%	58.3%	52.9%	—
	FR5	82.4%	82.4%	82.4%	82.4%	77.2%	72.1%	66.9%	60.5%	54.0%	47.6%	41.2%	—
	FR6	①	①	①	①	①	①	①	①	①	①	①	—

Note

① FR6 available in 2015.

Heat Loss Data

Table 37. Heat Loss Data

		230V, 60 Hz		400V, 50 Hz		460V, 60 Hz		575V, 60 Hz	
Frame Size	**Amp Suffix**	**VT/I_L (110%) Pv (W)**	**CT/I_H (150%) Pv (W)**	**VT/I_L (110%) Pv (W)**	**CT/I_H (150%) Pv (W)**	**VT/I_L (110%) Pv (W)**	**CT/I_H (150%) Pv (W)**	**VT/I_L (110%) Pv (W)**	**CT/I_H (150%) Pv (W)**
FR1	2D2								
	3D3								
	4D3								
	5D6								
	7D6								
	9D0			180	98	136	88		
FR2	012								
	016								
	023			390	330	360	292		
FR3	031								
	038								
	046			700	494	603	472		
FR4	061								
	072								
	087			1083	870	1080	875		
FR5	105								
	140								
	170			1906	1479	1755	1429		
FR6	205								
	261								

Brake Resistor Sizing

Table 38. Brake Resistor Sizing Data

	230V		460V		575V	
Frame Size	**Brake Chopper Nominal Current at 80°C (A)**	**Minimum Resistance (Ohm)**	**Brake Chopper Nominal Current at 80°C (A)**	**Minimum Resistance (Ohm)**	**Brake Chopper Nominal Current at 80°C (A)**	**Minimum Resistance (Ohm)**
FR1	30.0	15.3	25.0	36.4	①	①
FR2	53.0	8.7	52.0	17.5	①	①
FR3	70.0	6.6	70.0	13.0	①	①
FR4	200.0	2.3	400.0	2.3	①	①
FR5	200.0	2.3	400.0	2.3	①	①
FR6	①	①	①	①	①	①

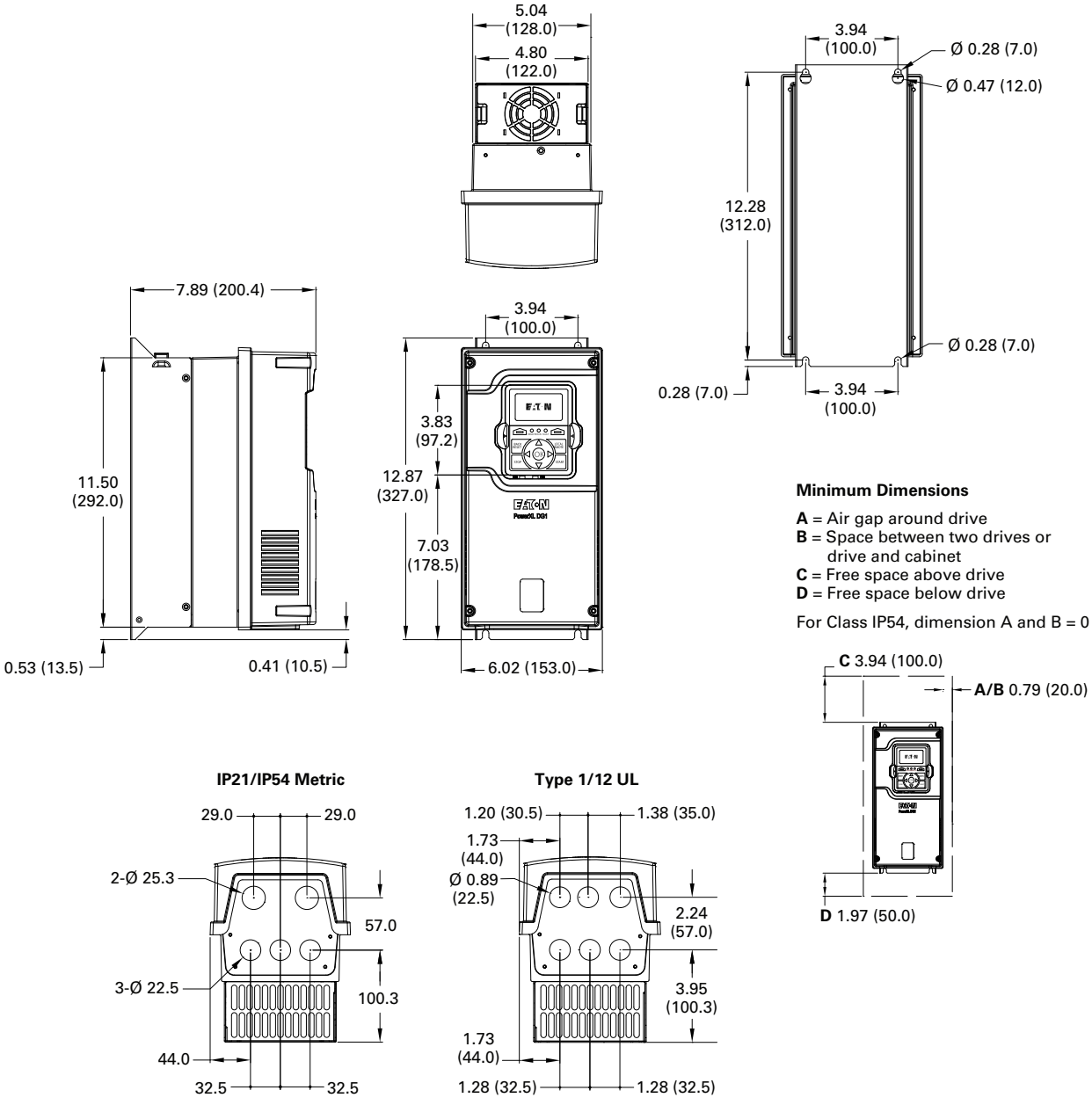
Note

① FR6 and 575V available in 2015.

Appendix C—Dimension Drawings

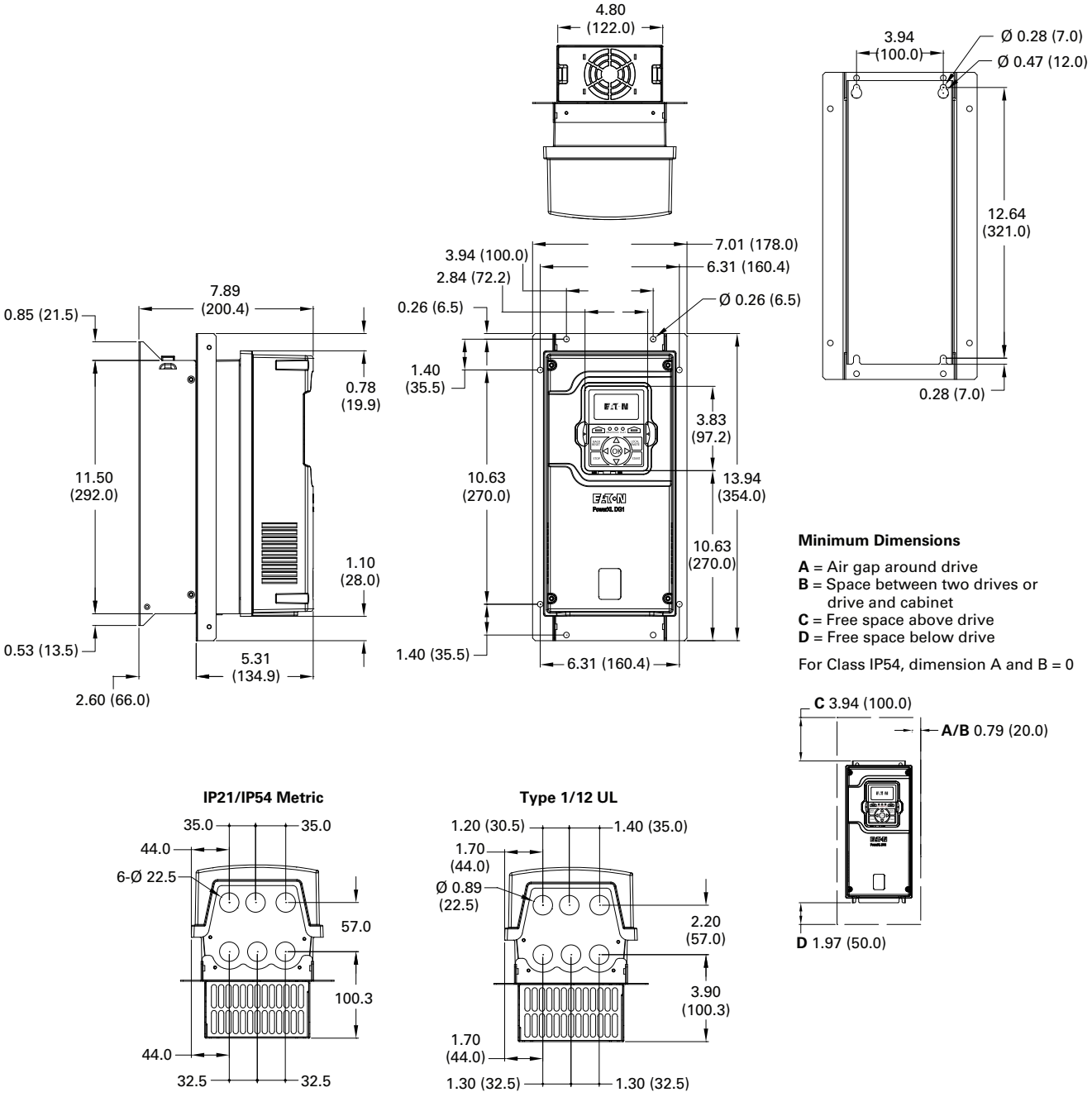
Approximate Dimensions in Inches (mm)

Figure 31. FR1 Dimension Drawing



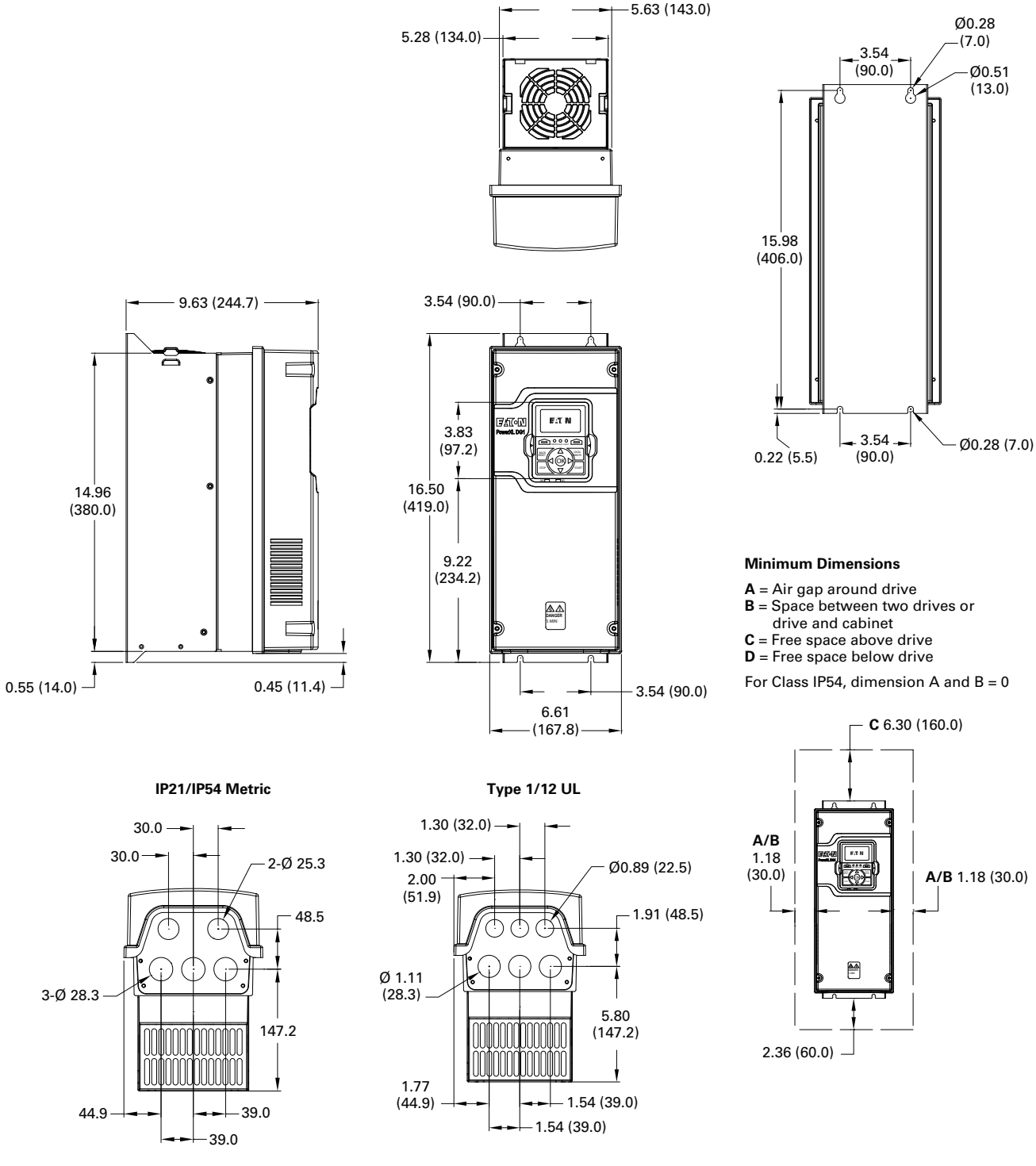
Approximate Dimensions in Inches (mm)

Figure 32. FR1 Dimension Drawing Flange Mount



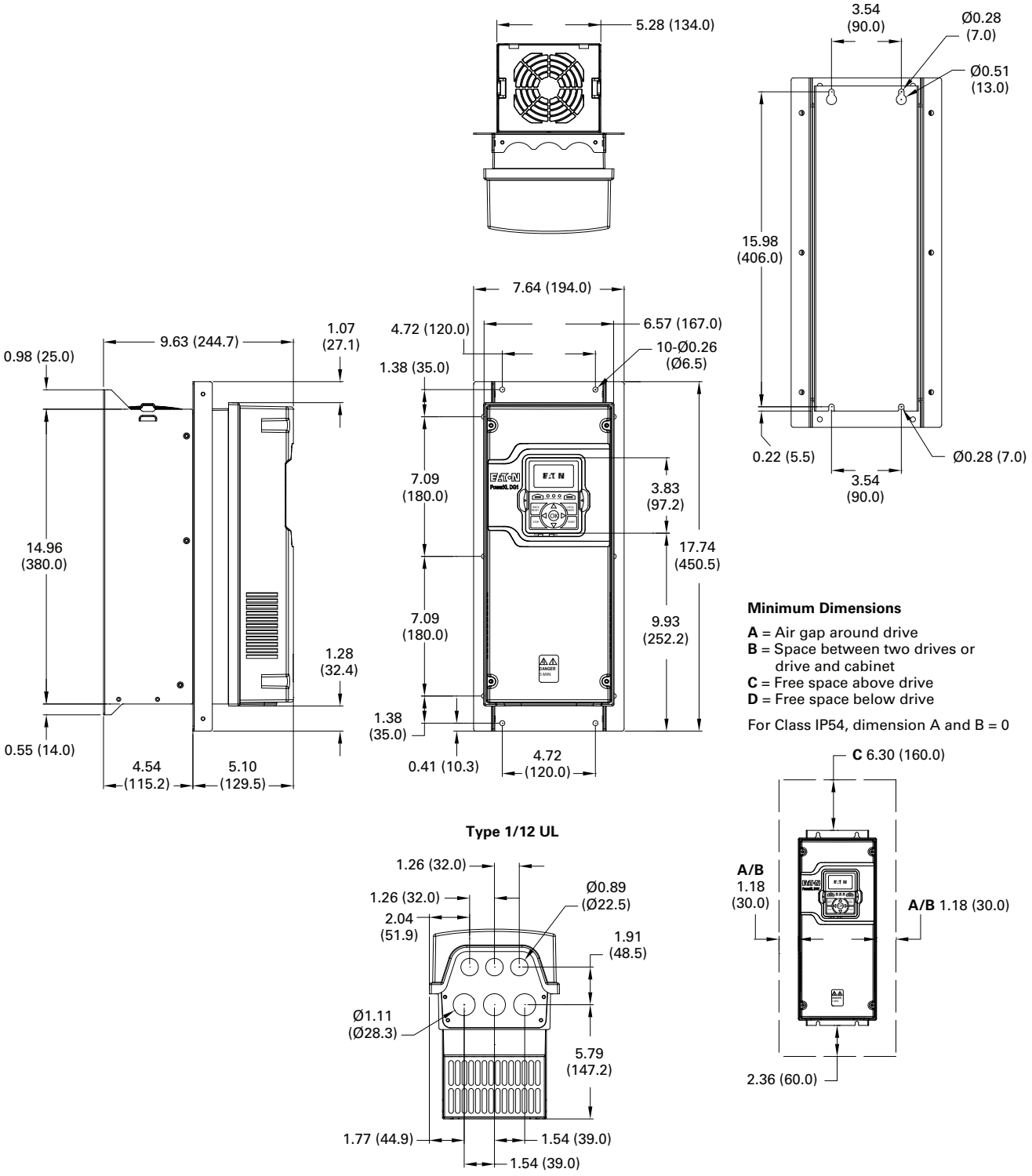
Approximate Dimensions in Inches (mm)

Figure 33. FR2 Dimension Drawing



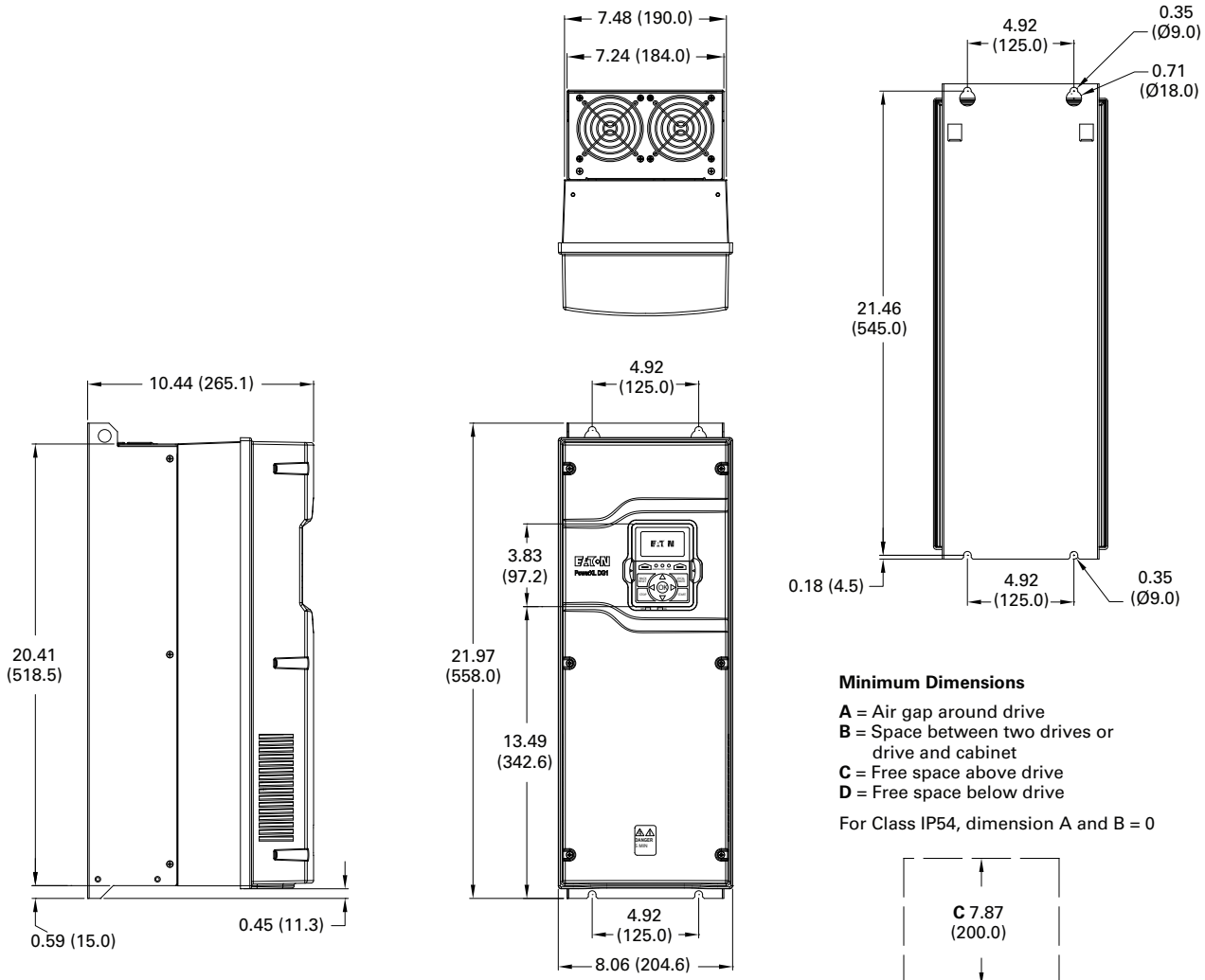
Approximate Dimensions in Inches (mm)

Figure 34. FR2 Dimension Drawing Flange Mount



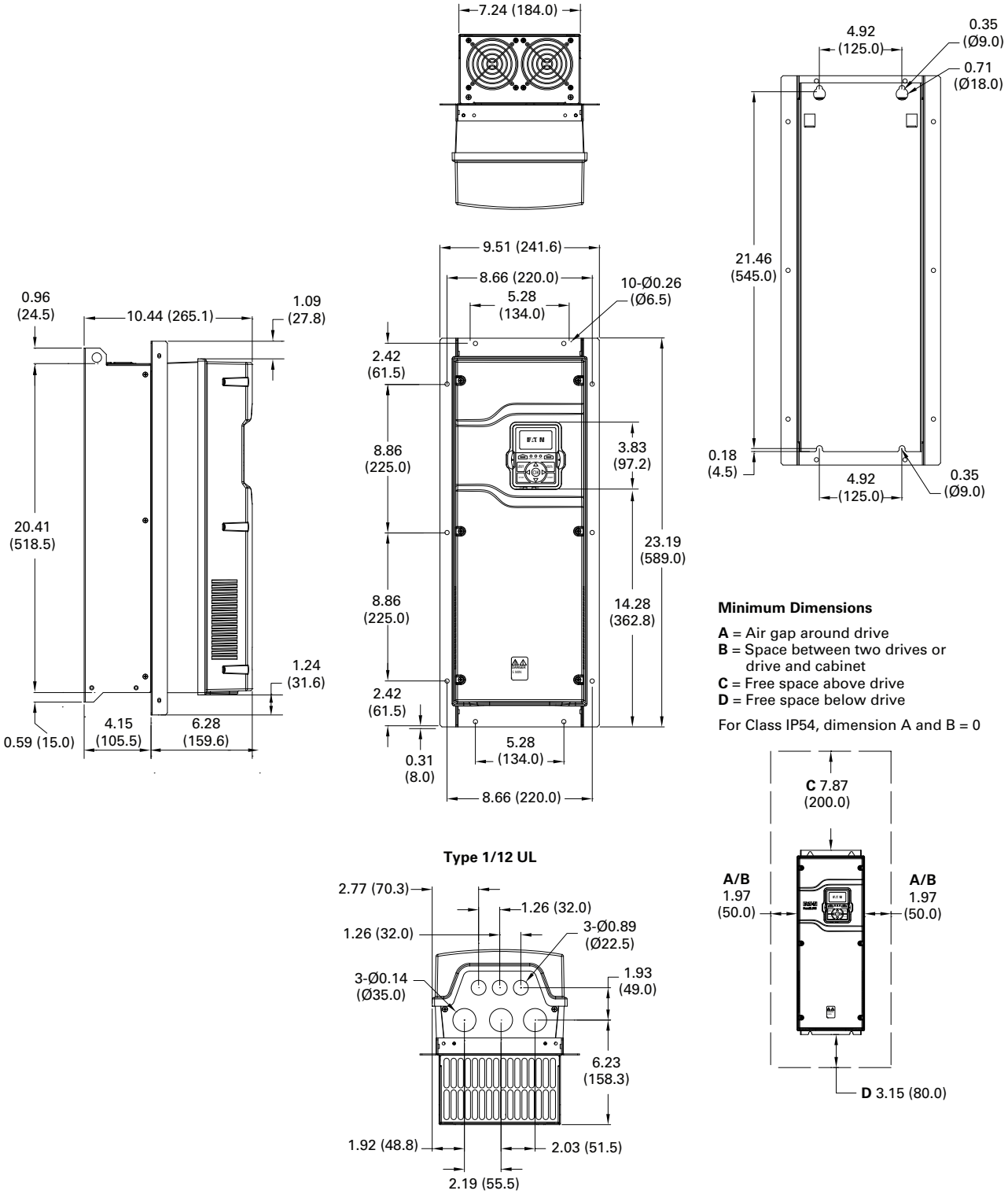
Approximate Dimensions in Inches (mm)

Figure 35. FR3 Dimension Drawing



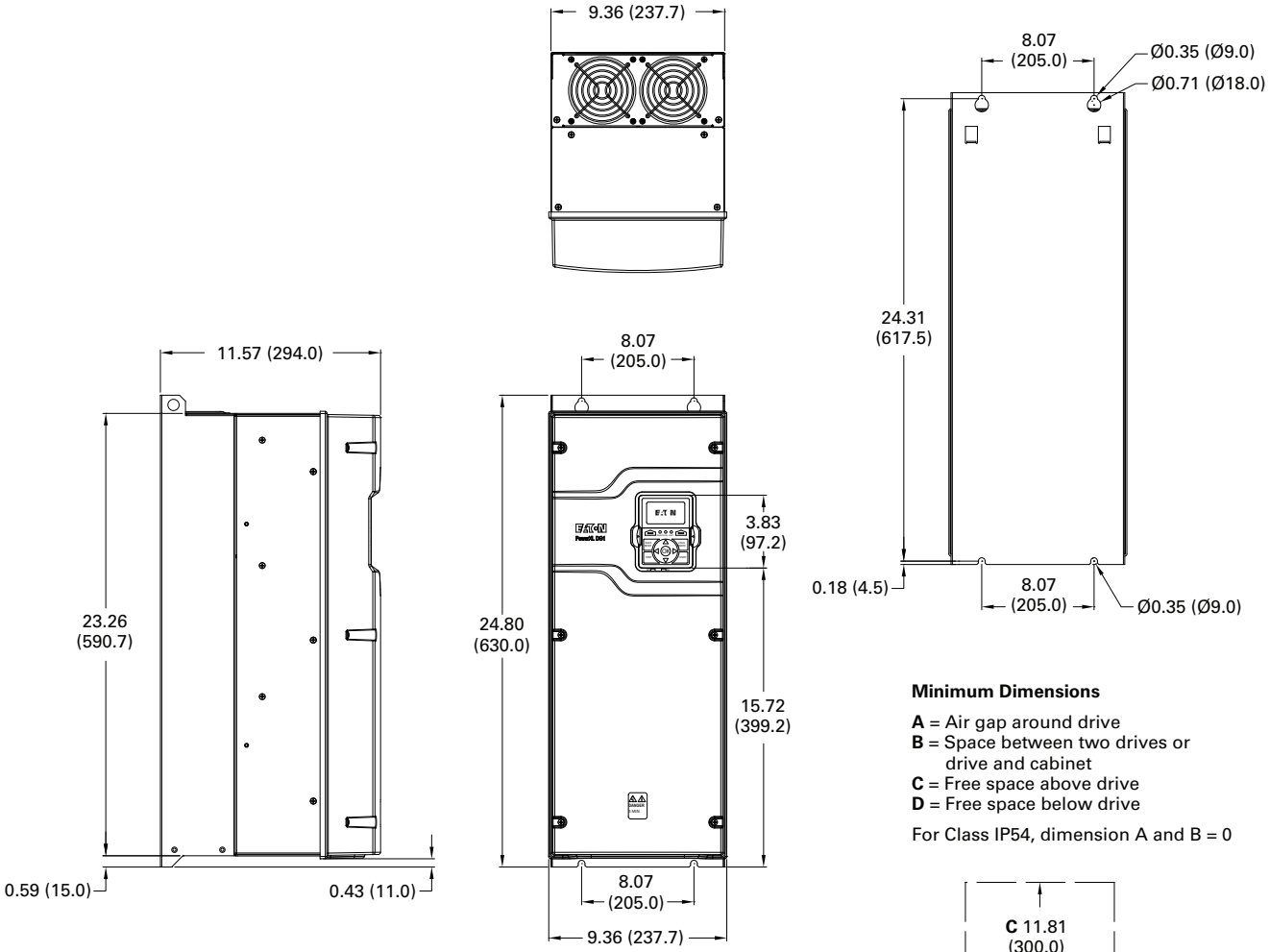
Approximate Dimensions in Inches (mm)

Figure 36. FR3 Dimension Drawing Flange Mount



Approximate Dimensions in Inches (mm)

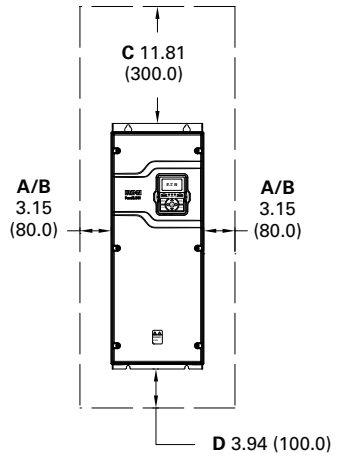
Figure 37. FR4 Dimension Drawing



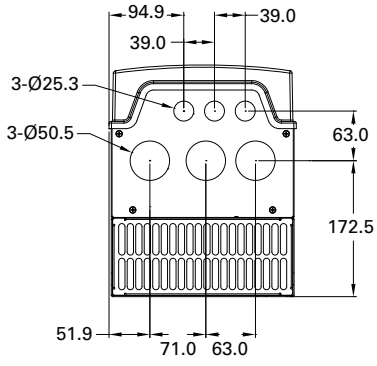
Minimum Dimensions

A = Air gap around drive
B = Space between two drives or drive and cabinet
C = Free space above drive
D = Free space below drive

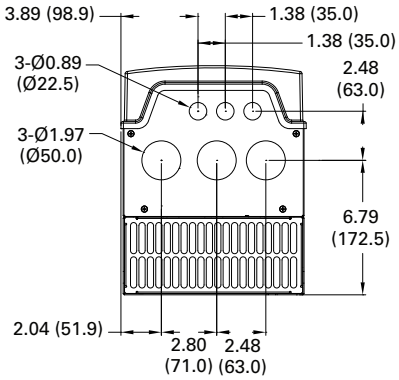
For Class IP54, dimension A and B = 0



IP21/IP54 Metric

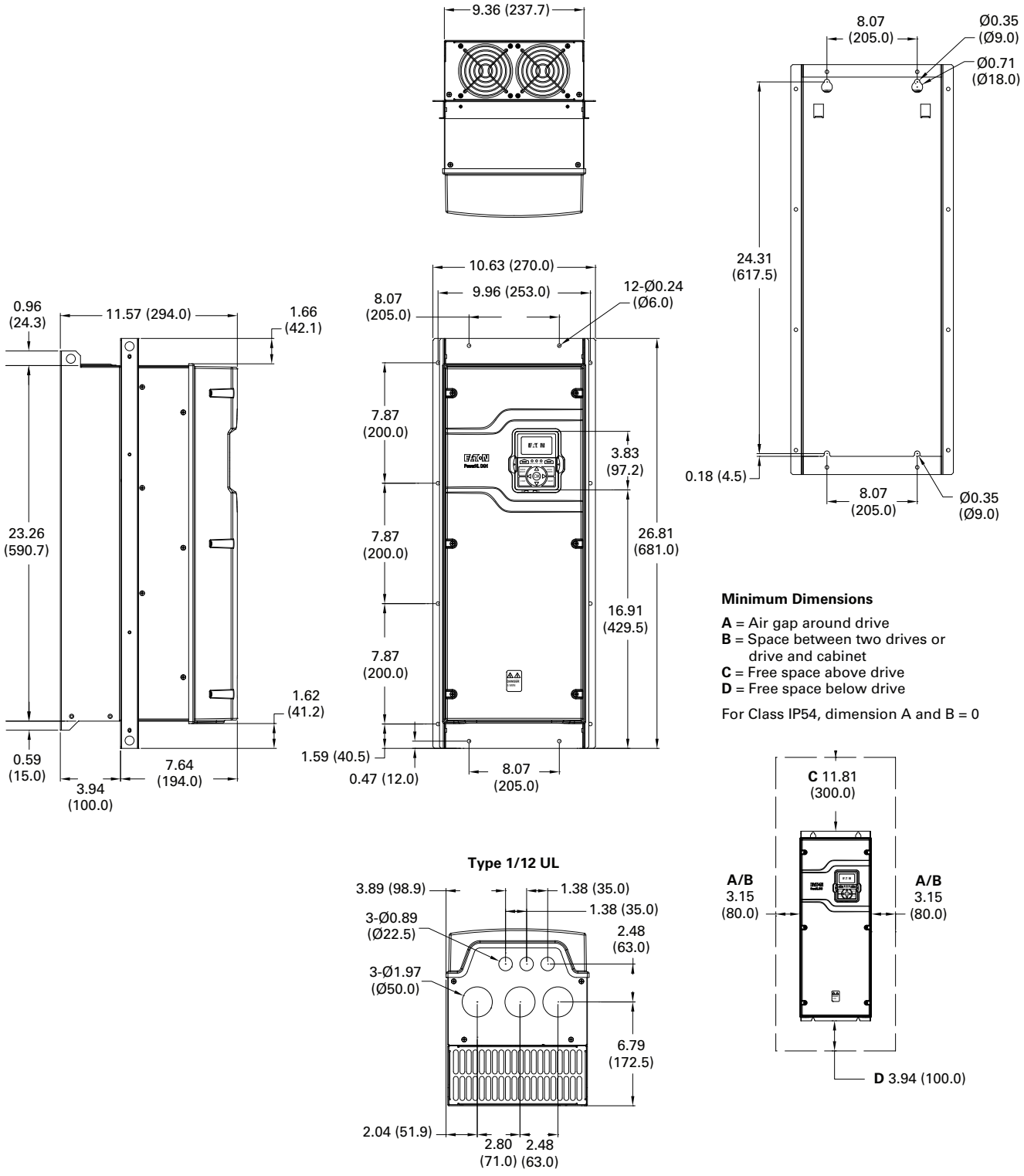


Type 1/12 UL



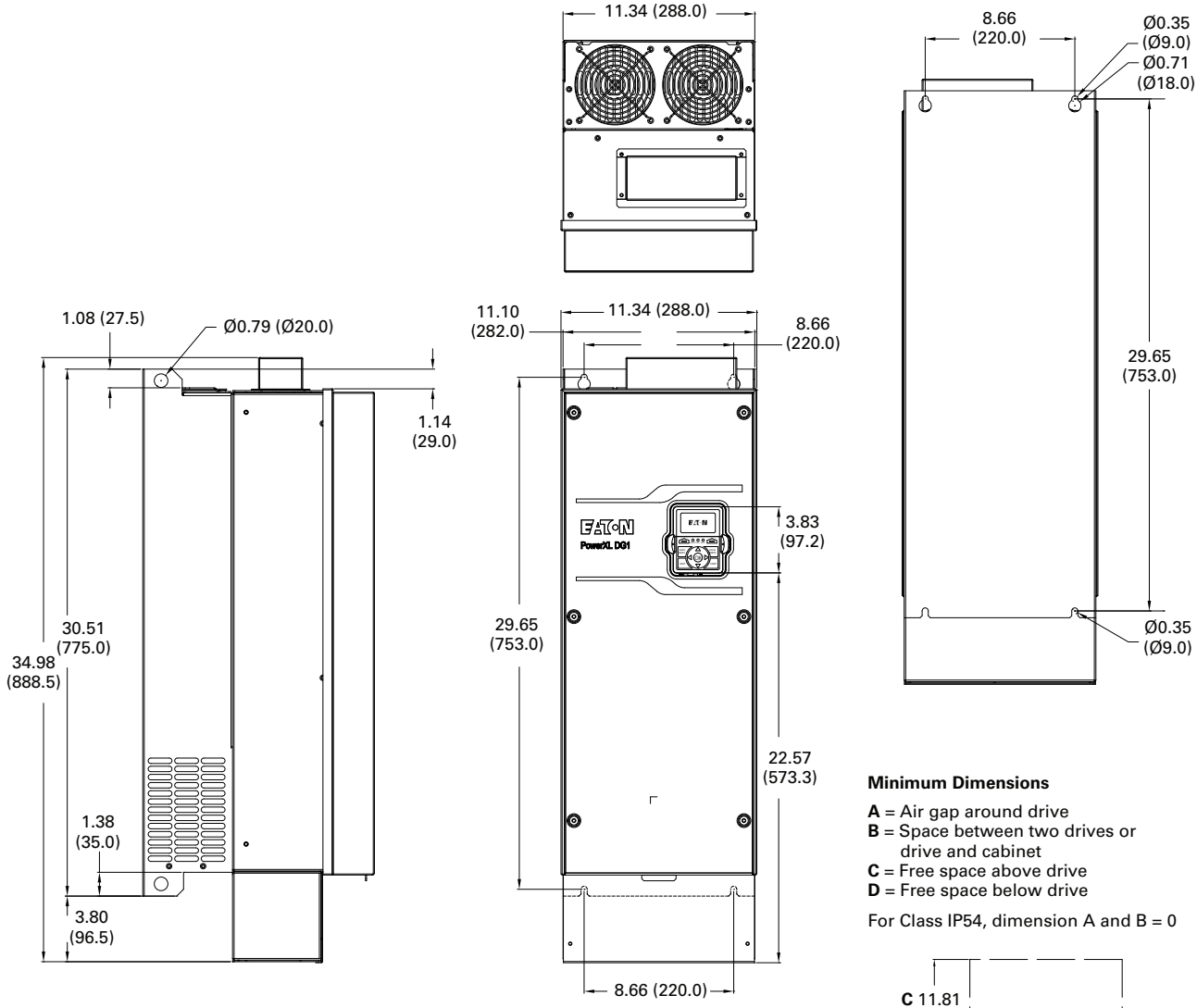
Approximate Dimensions in Inches (mm)

Figure 38. FR4 Dimension Drawing Flange Mount



Approximate Dimensions in Inches (mm)

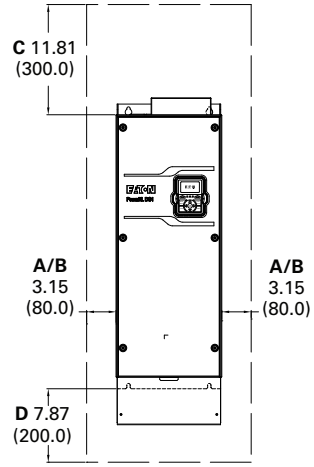
Figure 39. FR5 Dimension Drawing



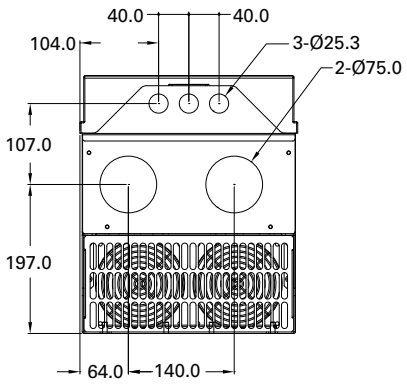
Minimum Dimensions

A = Air gap around drive
B = Space between two drives or drive and cabinet
C = Free space above drive
D = Free space below drive

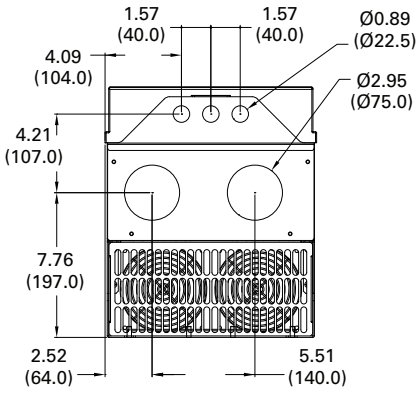
For Class IP54, dimension A and B = 0



IP21/IP54 Metric

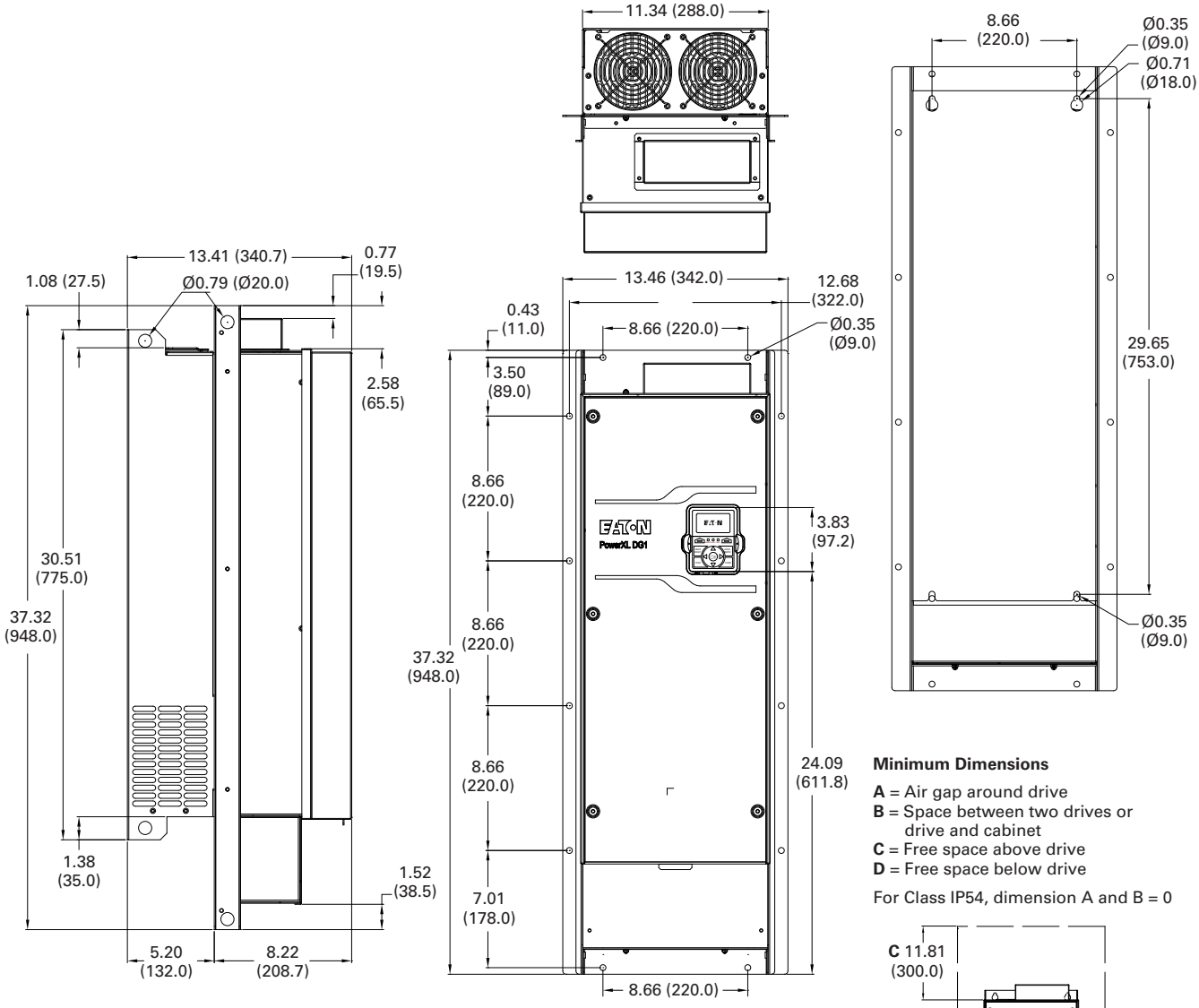


Type 1/12 UL



Approximate Dimensions in Inches (mm)

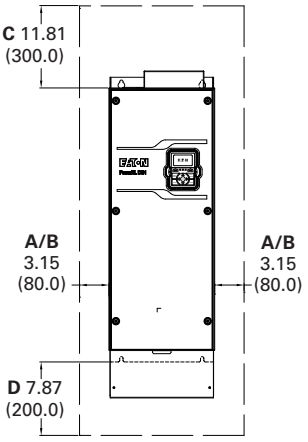
Figure 40. FR5 Dimension Drawing Flange Mount



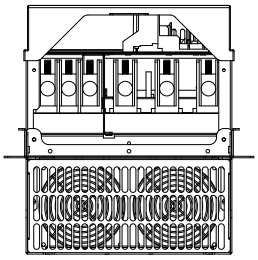
Minimum Dimensions

A = Air gap around drive
B = Space between two drives or drive and cabinet
C = Free space above drive
D = Free space below drive

For Class IP54, dimension A and B = 0



IP21/IP54 Metric and Type 1/12 UL



Note: With flange kit installed, the bottom wiring box should be removed.

Appendix D—Safety Instructions for UL and cUL

⚠ CAUTION

The UL and cUL compliance can be maintained only if this drive is installed according to the requirements of Appendix D — Safety Instructions for UL and cUL. Failure to follow these instructions may result in UL and cUL non-compliance.

UL Standards Compliance

This drive is tested in accordance with UL508C and CSA C22.2 No. 274-13 and is found to comply with these requirements. To ensure continued compliance when using this drive or when using it in combination with other equipment, meet the following conditions.

General

- This drive should be operated at a maximum ambient temperature of 40°C in low overload (VT) rating and 50°C in high overload (CT) rating
- This drive should be installed in environment of Pollution Degree 2 or better

Overvoltage Category

To comply with standard CSA C22.2 No. 274-13 requirement, the following applies to cUL applications:

- This drive should be installed in environment of Overvoltage Category III
- **For 400V Series**: Transient surge suppression shall be installed on the line side of this equipment and shall be rated 500V (phase to ground), suitable for Overvoltage Category III, and shall provide protection for a rated impulse withstand voltage peak of 6 kV
- **For 230V Series**: Transient surge suppression shall be installed on the line side of this equipment and shall be rated 240V (phase to ground), suitable for Overvoltage Category III, and shall provide protection for a rated impulse withstand voltage peak of 4 kV

Motor Overload and Over-Temperature Protection

- This drive provides solid-state motor overload protection that reacts when it reaches 102.5% of FLA
- This drive can accept and act upon a signal from a thermal sensor or switch embedded in the motor or from an external protective relay to achieve the motor over temperature protection. Therefore, in order to achieve the motor over temperature protection, a sensor from the motor will be needed

Branch Circuit Short Circuit Protection

- Integral solid-state short circuit protection does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the National Electrical Code and any additional local codes
- 400V Drive Series are suitable for use on a circuit capable of delivering not more than 100,000 rms symmetrical amperes, 500 volts maximum, when protected by UL and cUL/CSA Recognized Class T fuse with an A.I.C. rating of 100 kA minimum. Refer to the following information for recommended fuse ratings. See **Table 39**.

Table 39. Fuse Ratings—400V Drive Series

Frame Size	Catalog Number	Fuse Rating
1	**DG1-342D2xx-xxxx**	600V, 10A
	DG1-343D3xx-xxxx	600V, 10A
	DG1-344D3xx-xxxx	600V, 10A
	DG1-345D6xx-xxxx	600V, 10A
	DG1-347D6xx-xxxx	600V, 15A
	DG1-349D0xx-xxxx	600V, 15A
2	**DG1-34012xx-xxxx**	600V, 20A
	DG1-34016xx-xxxx	600V, 30A
	DG1-34023xx-xxxx	600V, 35A
3	**DG1-34031xx-xxxx**	600V, 50A
	DG1-34038xx-xxxx	600V, 60A
	DG1-34046xx-xxxx	600V, 80A
4	**DG1-34061xx-xxxx**	600V, 100A
	DG1-34072xx-xxxx	600V, 110A
	DG1-34087xx-xxxx	600V, 125A
5	**DG1-34105xx-xxxx**	600V, 175A
	DG1-34140xx-xxxx	600V, 200A
	DG1-34170xx-xxxx	600V, 250A

- 230V Drive Series are suitable for use on a circuit capable of delivering not more than 100,000 rms symmetrical amperes, 240 volts maximum when protected by UL and cUL/CSA Recognized Class T fuse with an A.I.C. rating of 100 kA minimum. Refer to the following information for recommended fuse ratings. See **Table 40**.

Table 40. Fuse Ratings—230V Drive Series

Frame Size	Catalog Number	Fuse Rating
1	**DG1-323D7xx-xxxx**	600V, 10A
	DG1-324D8xx-xxxx	600V, 10A
	DG1-326D6xx-xxxx	600V, 10A
	DG1-327D8xx-xxxx	600V, 15A
	DG1-32011xx-xxxx	600V, 15A
2	**DG1-32012xx-xxxx**	600V, 20A
	DG1-32017xx-xxxx	600V, 30A
	DG1-32025xx-xxxx	600V, 35A
3	**DG1-32031xx-xxxx**	600V, 60A
	DG1-32048xx-xxxx	600V, 80A
4	**DG1-32061xx-xxxx**	600V, 100A
	DG1-32075xx-xxxx	600V, 110A
	DG1-32088xx-xxxx	600V, 125A
5	**DG1-32114xx-xxxx**	600V, 175A
	DG1-32143xx-xxxx	600V, 200A
	DG1-32170xx-xxxx	600V, 250A

Field Wiring

- The field installed conductors for this drive should be 75°C copper wire only
- The enclosure openings provided for conduit connections in the field shall be closed by UL Listed conduit fittings with same type rating as the enclosure (Type 1/Type 12)

Line and Motor Wiring

- For 400V Drive Series, required line and motor wire torque, type and size range are listed in **Table 41**

Table 41. Required Line and Motor Wire Torque (400V)

Catalog Number	Terminal Type	Required Torque (in-lbs)	Required Wire Range
FR1			
DG1-342D2xx-xxxx	L1, L2, L3, DC+, DC–, R+, R–, U, V, W	5–7	14–10 AWG
DG1-343D3xx-xxxx		5–7	14–10 AWG
DG1-344D3xx-xxxx		5–7	14–10 AWG
DG1-345D6xx-xxxx		5–7	14–10 AWG
DG1-347D6xx-xxxx		5–7	14–10 AWG
DG1-349D0xx-xxxx		5–7	14–10 AWG
FR2			
DG1-34012xx-xxxx	L1, L2, L3, DC+, DC–, R+, R–, U, V, W	15.6	12–6 AWG
DG1-34016xx-xxxx		15.6	10–6 AWG
DG1-34023xx-xxxx		15.6	8–6 AWG
FR3			
DG1-34031xx-xxxx	L1, L2, L3, DC+, DC–, R+, R–, U, V, W	40	8–2 AWG
DG1-34038xx-xxxx		40	6–2 AWG
DG1-34046xx-xxxx		40	4–2 AWG
FR4			
DG1-34061xx-xxxx	L1, L2, L3, DC+, DC–, R+, R–, U, V, W	95	4–1/0 AWG
DG1-34072xx-xxxx		95	3–1/0 AWG
DG1-34087xx-xxxx		95	1–1/0 AWG
FR5			
DG1-34105xx-xxxx	L1, L2, L3, DC+, DC–, R+, R–, U, V, W	354	2/0 AWG–350 kcmil
DG1-34140xx-xxxx		354	3/0 AWG–350 kcmil
DG1-34170xx-xxxx		354	250–350 kcmil
All Frames Sizes (FR1–FR5)			
All models	Control terminal block	4.5	28~12 (Sol) AWG 30~12 (Str) AWG

- For 230V Drive Series, required line and motor wire torque, type and size range are listed in **Table 42**

Table 42. Required Line and Motor Wire Torque (230V)

Catalog Number	Terminal Type	Required Torque (in-lb)	Required Wire Range
FR1			
DG1-323D7xx-xxxx	L1, L2, L3, DC+, DC–, R+, R–, U, V, W	12.1	14–10 AWG
DG1-324D8xx-xxxx		12.1	14–10 AWG
DG1-326D6xx-xxxx		12.1	14–10 AWG
DG1-327D8xx-xxxx		12.1	14–10 AWG
DG1-32011xx-xxxx		12.1	12–10 AWG
FR2			
DG1-32012xx-xxxx	L1, L2, L3, DC+, DC–, R+, R–, U, V, W	15.6	10–6 AWG
DG1-32017xx-xxxx		15.6	8–6 AWG
DG1-32025xx-xxxx		15.6	8–6 AWG
FR3			
DG1-32031xx-xxxx	L1, L2, L3, DC+, DC–, R+, R–, U, V, W	40	6–2 AWG
DG1-32048xx-xxxx		40	4–2 AWG
FR4			
DG1-32061xx-xxxx	L1, L2, L3, DC+, DC–, R+, R–, U, V, W	95	3–1/0 AWG
DG1-32075xx-xxxx		95	2–1/0 AWG
DG1-32088xx-xxxx		95	1/0 AWG ①
FR5			
DG1-32114xx-xxxx	L1, L2, L3, DC+, DC–, R+, R–, U, V, W	354	3/0 AWG–350 kcmil
DG1-32143xx-xxxx		354	4/0 AWG–350 kcmil
DG1-32170xx-xxxx		354	300–350 kcmil
All Frames Sizes (FR1–FR5)			
All models	Control terminal block	4.5	28~12 (Sol) AWG 30~12 (Str) AWG

Note

① The line and motor wire size for DG1-32088xx-xxxx can only be 1/0 AWG.

Grounding

- For 400V Drive Series, required grounding wire torque, type and size range are listed in **Table 43**

Table 43. Required Line and Motor Wire Torque (400V)

Catalog Number	Terminal Type	Required Torque (in-lb)	Required Wire Range
FR1			
DG1-342D2xx-xxxx	Grounding terminal	10	14–10 AWG
DG1-343D3xx-xxxx		10	14–10 AWG
DG1-344D3xx-xxxx		10	14–10 AWG
DG1-345D6xx-xxxx		10	14–10 AWG
DG1-347D6xx-xxxx		10	14–10 AWG
DG1-349D0xx-xxxx		10	14–10 AWG
FR2			
DG1-34012xx-xxxx	Grounding terminal	10	12–6 AWG
DG1-34016xx-xxxx		10	10–6 AWG
DG1-34023xx-xxxx		10	10–6 AWG
FR3			
DG1-34031xx-xxxx	Grounding terminal	10	10–4 AWG
DG1-34038xx-xxxx		10	10–4 AWG
DG1-34046xx-xxxx		10	8–4 AWG
FR4			
DG1-34061xx-xxxx	Grounding terminal	14	8–1/0 AWG
DG1-34072xx-xxxx		14	6–1/0 AWG
DG1-34087xx-xxxx		14	6–1/0 AWG
FR5			
DG1-34105xx-xxxx	Grounding terminal	35	6 AWG–250 kcmil
DG1-34140xx-xxxx		35	6 AWG–250 kcmil
DG1-34170xx-xxxx		35	4 AWG–250 kcmil

- For 230V Drive Series, required grounding wire torque, type and size range are listed as below:

Table 44. Required Line and Motor Wire Torque (230V)

Catalog Number	Terminal Type	Required Torque (in-lb)	Required Wire Range
FR1			
DG1-323D7xx-xxxx	Grounding terminal	10	14–10 AWG
DG1-324D8xx-xxxx		10	14–10 AWG
DG1-326D6xx-xxxx		10	14–10 AWG
DG1-327D8xx-xxxx		10	14–10 AWG
DG1-32011xx-xxxx		10	14–10 AWG
FR2			
DG1-32012xx-xxxx	Grounding terminal	10	12–6 AWG
DG1-32017xx-xxxx		10	10–6 AWG
DG1-32025xx-xxxx		10	10–6 AWG
FR3			
DG1-32031xx-xxxx	Grounding terminal	10	10–4 AWG
DG1-32048xx-xxxx		10	10–4 AWG
FR4			
DG1-32061xx-xxxx	Grounding terminal	14	8–1/0 AWG
DG1-32075xx-xxxx		14	6–1/0 AWG
DG1-32088xx-xxxx		14	6–1/0 AWG
FR5			
DG1-32114xx-xxxx	Grounding terminal	35	6 AWG–250 kcmil
DG1-32143xx-xxxx		35	6 AWG–250 kcmil
DG1-32170xx-xxxx		35	4 AWG–250 kcmil

Eaton is dedicated to ensuring that reliable, efficient and safe power is available when it's needed most. With unparalleled knowledge of electrical power management across industries, experts at Eaton deliver customized, integrated solutions to solve our customers' most critical challenges.

Our focus is on delivering the right solution for the application. But, decision makers demand more than just innovative products. They turn to Eaton for an unwavering commitment to personal support that makes customer success a top priority. For more information, **visit www.eaton.com/electrical.**

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