Adjustable Frequency Drives—Low Voltage

Contents

Adjustable Frequency Drives

Motor Application and Performance

AFD Output Harmonics

For the purpose of performance evaluation, the non-sinusoidal output waveforms produced by AFDs are represented by their mathematically equivalent component parts. All such waveforms consist of an infinite number of sinusoidal components of different amplitudes and frequencies. The fundamental component is the "good" part of the waveform, which provides power to the motor at the desired operating frequencies. The harmonics are unwanted components, which provide unusable voltages and currents to the motor at frequencies that are multiples of the fundamental.

State-of-the-art designs for pulse width modulated AFDs provide a sine weighted modulation strategy with a high switching frequency, and reduced output harmonic content as compared to other types of drives. A motor operating on a PWM drive will have an additional heat loss due to the harmonic content as compared to utility line operation.

PWM drives that are comprised of IGBT (insulated gate bipolar transistor) power devices are also capable of rapid voltage rise times, which can stress the insulation system of the AC motor. For this reason, motors designed for operation on IGBT PWM inverter power incorporating insulation systems rated for rapid voltage rise times and higher operating temperatures are recommended for use with the drives. Standard motors with a 1.15 service factor or energy efficient motors can be used provided that additional drive output filtering is incorporated to limit voltage rise times and to reduce the output harmonic content.

Multiple Motor Operation

Any number of motors can be connected in parallel and controlled on an open loop (frequency control) configuration by a single AFD as long as the total connected load does not exceed the rating of the drive. A closed loop vector controlled drive cannot be used with multiple motors. Although the basic principles of multiple motor operation are not difficult to understand, Application Engineering assistance should be requested to make certain that the application is successful.

Because the frequency of the power supplied by the AFD is the same for all motors, the motors will always operate at relatively the same speed. With NEMA design B motors, the speeds will be matched within 3% or less, depending on the load variation among the motors and their rated slip. Exact speed matching between motors is not possible. If an adjustable speed ratio is required between motors, each motor must be connected to its own individual AFD.

AC Drive Application

Matching the AFD to the Motor

Voltage source AFDs are designed for use with any standard three-phase induction motor. AFD sizing and motor matching are often simply a matter of matching the AFD output voltage, frequency and current ratings to the requirements of the motor. If the load torque exceeds 150% for Constant Torque (CT) drives or 110% for Variable Torque (VT) drives during starting or intermittently while running the drive, oversizing may be required.

Output Voltage and Frequency

For AFDs rated at 480 V, motors are connected for 460 V at 60 Hz. 380 V/50 Hz motors can also be used because the V/Hz ratio, 380/50, is 7.6V/Hz, the same as a 460 V/60 Hz motor. 415 V motors can be operated if the AFD V/Hz adjustment is reset. With proper V/Hz adjustment, 575 V motors can be operated at constant V/Hz up to 80% speed and at constant voltage from 80% to 100% speed. Maximum motor torque and hp for this mode of operation is limited above 80% speed because of the reduced V/Hz levels. For AFDs rated at 240 V, the motor will be connected for 230 V.

Output Current

The full load current ratings of typical AFDs are matched to typical full load motor current ratings as listed in National Electrical Code® Table 430.150. Generally, an AFD of a given horsepower rating will be adequate for a motor of the same rating, but the actual motor current required under operating conditions is the determining factor for AFD sizing. If the motor will be run at full load, the AFD output current rating must be equal to or greater than the motor nameplate current. If the motor is oversized to provide a wide speed range, the AFD should be sized to provide the current required by the motor at the maximum operating torque. Motor oversizing should generally be limited to one horsepower size increase.

Motor Protection

Motor overload protection must be provided as required by applicable codes. Direct motor protection is not automatically provided as part of the AC drive.

AFDs are equipped with electronic protection circuits with an inverse time or I^2t characteristic equivalent to a conventional overload relay. Conventional overload relays are also used with AFDs equipped with bypass. If these current sensing protective devices are used with motors driving constant torque loads, the minimum speed should be adjusted to prevent the motor from running at speeds at which overheating could occur, unless the I^2t circuit provides a speed and load calibrated trip. The best means of AC drive motor protection is direct winding overtemperature sensing, such as an overtemperature switch or thermistor imbedded in the motor windings. Overtemperature switches are more convenient because they can normally be connected directly to the AC drive control circuit. Thermistors generally require a special sensing relay. Direct overtemperature protection is preferred over overcurrent sensing protective devices because motor overheating can occur with normal operating current at low operating speeds.

Motor short-circuit protection is not required because the AC drive protection circuits nearly always adequately protect the motor in this respect.

When a single AFD provides power to multiple motors connected in parallel, special considerations must be given to motor protection. Individual overload protection must be provided for each motor. Short-circuit protection may be required for some applications.

Bearing and DV/DT Protection

The rapid voltage rise times present in today's IGBT PWM drives may cause current to flow in the motor bearings due to shaft voltage caused by capacitive coupling. This current flow can result in minute electrical discharges within the bearing, potentially damaging the bearing over time. Therefore a DV/DT filter should be used where the drive and motor are separated by 100 feet or more. Using an insulated motor shaft bearing and/or setting the inverter carrier frequency to the lowest acceptable level can help minimize the potential for this phenomenon as well.

AC Drive Performance

Operator Control and Interface

Operator controls are often via the drive keypad. In other situations, an operator station or remote control may be desired. If these requirements cannot be achieved by remotely mounting the keypad, terminal blocks with digital and analog interface capability are provided.

Acceleration and Deceleration

AFDs are always equipped with adjustable acceleration and deceleration control. Acceleration and deceleration rates must be adjusted to suit the characteristics of the load to prevent shutdown due to overcurrent or overvoltage. Increasing acceleration or deceleration times will proportionally decrease the torque requirement.

Speed Range

The characteristics of the motor usually determine the speed range of an AC drive. The AFD output frequency range is usually wider than the range that can be effectively used by the motor.

Speed Regulation

The open loop speed regulation of an AC drive is determined by the motor slip. Because NEMA design B motors usually have 3% slip or less, at 60 Hz and rated load the speed regulation of the drive is 3%.

AFDs equipped with slip compensation or flux or vector control can provide speed regulation, which is better than the open loop regulation of the motor. Slip compensation and flux or vector control improves speed regulation by increasing and decreasing the operating frequency by a small amount as the load increases and decreases.

Further improvement in steady-state speed regulation can be obtained by using a tachometer generator to provide speed feedback to a closed loop speed regulator option, or an external device such as the Durant® Strider.

Service Deviation

Speed regulation specifies only that portion of the drive speed change that is directly caused by a change in load. Several other factors can cause unintended changes in the drive operating speed. These factors contribute to the drive's service deviation. **Table 31.0-1** lists some of these factors and the typical effect that they have on drive speed.

Table 31.0-1. Factors Affecting Service Deviation

Influencing Factor	Typical Speed Change
Line voltage variations within rated tolerance.	0.0%
Ambient temperature variations of controller within rated tolerance after warmup.	0.25%
Motor temperature variations. Cold to maximum operating temperature.	0.5%

Current Limit

If an AC drive was not equipped with current limit, the overcurrent trip circuits would shut down the drive should the motor draw excessive current due to an overload or too rapid an acceleration rate. Current limit provides a means of maintaining control of the drive under these conditions.

If the output current reaches the current limit setting while the drive is running at set speed, the drive will decelerate to a lower speed. If possible, the speed will decrease to whatever operating speed is required to prevent exceeding the current limit setting.

If the output current reaches the current limit setting while the drive is accelerating, the drive will deviate from the programmed acceleration ramp and accelerate at a rate that will prevent the current from exceeding the set limit.

If the drive reaches the negative current limit setting (if applicable) while the drive is decelerating, the drive will deviate from the programmed deceleration ramp, and decelerate at a rate that will try to prevent the current from exceeding the limit.

Regeneration Limit and Braking

Regeneration limit prevents the motor from developing braking torque above a limit that corresponds to the normal losses that are inherent in the motor and controller.

When the drive is equipped with dynamic braking, the motor is allowed to develop a higher level of braking torque. The regenerated braking energy is dissipated in the dynamic braking resistors. A fully regenerative drive includes circuitry that returns the regenerated braking energy to the power lines.

IR Compensation

A V/Hz AC drive can provide improved starting torque and low speed overload capability if the lower speed voltage boost is changed automatically to compensate for changing load conditions. This feature is called IR compensation. Without IR compensation, it is difficult to achieve the maximum possible motor torque because the voltage boost required for maximum torque can cause the motor to saturate and draw excessive current when it is lightly loaded. The IR compensation circuit senses the motor load and reduces the voltage boost when the motor is lightly loaded.

A flux control AC drive provides a similar result by modifying its instantaneous voltage and frequency to allow the motor to develop the required torque for the load.

Installation Compatibility

The successful application of an AC drive requires the assurance that the drive will be compatible with the environment in which it will be installed. The following are some of the aspects of compatibility that should be considered.

Cooling Air

Even though AFDs are very efficient, the heat produced in the controller cabinet can be substantial. The electronic circuitry is subject to immediate failure if its operating temperature limits are exceeded. Junction temperatures of transistors, SCRs and IGBTs typically can only increase 20–25 °C from full load to failure. It is important to remove heat through the usual mechanisms of radiation, conduction (heat sinks) or convection (fans). The enclosure must be located away from direct sunlight and hot surfaces. The room temperature must be kept within the specified limits and adequate cooling air must be allowed to flow around the enclosure. Excessively moist, corrosive or dirty air must be prevented from entering the enclosure.

Isolation Transformers

Drive isolation transformers are sometimes recommended or specified by others for various reasons. Eaton does not require the use of isolation transformers because Eaton drives are designed to operate directly from plant power distribution systems without using isolation transformers.

Eaton AFDs are designed to withstand line voltage transients and noise generated by other equipment in a typical installation environment when applied to systems with the required minimum impedance levels. They are also designed to prevent nuisance levels of noise from being reflected back to the power lines. Electronic protection circuits fully protect the drives from output short circuits and ground faults regardless of available fault current without requiring isolation or external impedance. Isolation transformers are generally not recommended as a preventative or curative measure for suspected difficulties of these types.

Example:

Suppose you wish to estimate AC drive efficiency for a 50 hp drive on a centrifugal pump. Efficiency is to be estimated for operation at full speed and 70% speed. The motor is nameplated 94.5% NEMA nominal efficiency.

From the variable torque columns in **Table 31.0-2**, the adjustment factors for full speed operation range from 0.93 to 0.95 and the adjustment factors for 70% speed range from 0.874 to 0.895.

For 100% speed:

- Eff. = 94.5 x 0.93 = 87.9% (low estimate)
- Eff. = 94.5 x 0.95 = 89.8% (high estimate)

For 70% speed:

- Eff. = 94.5 x 0.874 = 82.6% (low estimate)
- Eff. = 94.5 x 0.895 = 84.6% (high estimate)

Power Factor

The power factor typically specified for AFDs is displacement power factor, which is defined as the cosine of the angle between the fundamental voltage and current. Many instruments used for utility billing purposes give readings equivalent to displacement power factor. Another definition and measurement method combines the effects of power and harmonic content to define total power factor. Newer utility instrumentation is capable of recording total power factor, resulting in potential power factor penalty billing.

Displacement power factor for a PWM drive is approximately 0.95 at all operating points. The displacement power factor is not significantly affected by the motor speed, the motor load or the motor power factor. Total power factor will vary with line voltage, utility feeder size and total system and drive load.

Power factor correction capacitors should not be connected at the AC drive power input. Correction should be done on a plantwide basis. If capacitors are located too close to the drive, or if drives represent a high percentage of the total plant electrical load, there may be an undesirable interaction between the capacitors and the drives, leading to a failure of either or both.

Capacitor Banks

If the capacitors must be located near the drive, a line reactor should be used on the drive input to reduce the possibility of interaction. Note that adding this reactor does not eliminate the potential for harmonic resonance.

To be assured of a solution that will improve power factor and avoid resonance, a system study must be performed to determine the optimum selection of capacitance and inductive reactance.

Power factor correction capacitors must never, under any circumstances, be connected at the AC drive controller output. They would serve no useful purpose, and they may damage the drive.

AC Drive Input Harmonics

AFDs use a rectifier to convert AC line voltage to the DC levels required by the inverter section. Rectifiers are nonlinear devices that cause a current to be drawn from the line, which includes many harmonics. These harmonic currents will cause harmonic voltages to be created in the line, which may affect sensitive devices on the same line. IEEE 519-1992 provides recommendations for the harmonic current levels reflected to the utility by any user, where the feeder ties into the utility grid. For difficult installations where the levels of IEEE 519 cannot be met, or those using on-site generated power, a “Clean Power” rectifier can be used. The “Clean Power” rectifier uses phase shifted semiconductors to significantly reduce harmonics to levels well within the IEEE guidelines. For more specific information, see CPX section on **Page 31.2-53**.

Motor Load Types and Characteristics

Introduction

This section of your *Application Guide* discusses the following topics on motor load types and characteristics:

- Motor load types
- Other functional considerations

The process of selecting an electrical adjustable speed drive is one where the load is of primary consideration. It is important to understand the speed and torque characteristics as well as horsepower requirements of the type of load to be considered.

When considering load characteristics, the following should be evaluated:

- What type of load is associated with the application?
- Does the load have a shock component?
- What is the size of the load?
- Are large inertial loads involved?
- What are the motor considerations?
- Over what speed range are heavy loads encountered?
- How fast is the load to be accelerated or decelerated?

Motor loads are classified into three main groups, depending on how their torque and horsepower vary with operating speed. The following paragraphs deal with the various motor load types usually found in process, manufacturing, machining and commercial applications.

Motor Load Types

Constant Torque Load

This type of load is frequently encountered. In this group, the torque demanded by the load is constant throughout the speed range. The load requires the same amount of torque at low speeds as at high speeds. Loads of this type are essentially friction loads. In other words, the constant torque characteristic is needed to overcome friction. **Figure 31.0-1** shows the constant torque and variable horsepower demanded by the load.

As seen in **Figure 31.0-1**, torque remains constant while horsepower is directly proportional to speed. A look at the basic horsepower equation also verifies this fact:

$$hp = \frac{\text{Torque} \times \text{Speed}}{5252}$$

Where:

Torque is measured in lb-ft.
Speed is measured in rpm.
5252 is proportionality constant.

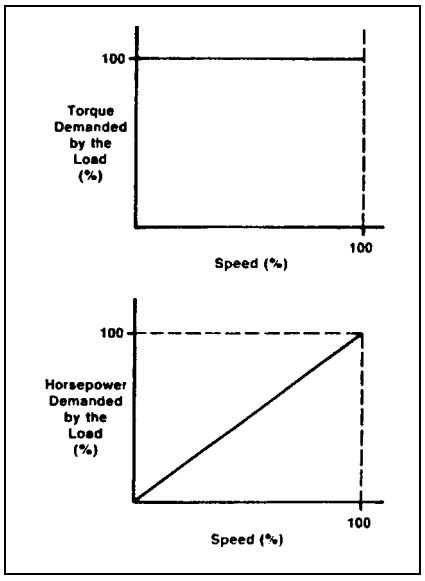


Figure 31.0-1. Constant Torque Load

Examples of this type of load are conveyors, extruders and surface winders. Constant torque capability may also be used when shock loads, overloads or high inertia loads require special drive sizing.

Constant Horsepower Load

In this type of load, the horsepower demanded by the load is constant over the speed range. The load requires high torque at low speeds. From the previous formula, you can see that with the horsepower held constant, the torque will decrease as the speed increases. Put another way, the speed and torque are inversely proportional to each other. **Figure 31.0-2** shows the constant horsepower and variable torque demanded by the load.

Examples of this type of load are center-driven winders and machine tool spindles. A specific example of this application would be a lathe that requires slow speeds for rough cuts where large amounts of material are removed, and high speeds for fine cuts where little material is removed. Usually very high starting torques are required for quick acceleration. Constant horsepower range is usually limited on an AC drive from base speed to 1.5–2 times base speed.

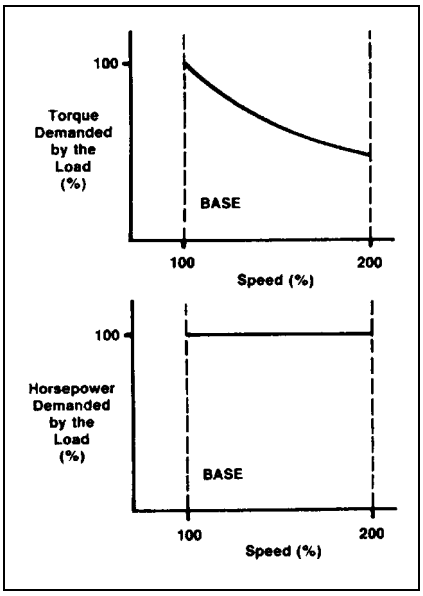


Figure 31.0-2. Constant Horsepower Load

31

Variable Torque Load

With this type of load, the torque is directly proportional to some mathematical power of speed, usually speed squared (Speed^2). Mathematically:

$$\text{Torque} = \text{Constant}\left(\frac{\text{Operating Speed}}{\text{Nameplate Speed}}\right)^2$$

Horsepower is typically proportional to speed cubed (speed^3). **Figure 31.0-3** shows the variable torque and variable horsepower demanded by the load.

Examples of loads that exhibit variable load torque characteristics are centrifugal fans, pumps and blowers. This type of load requires much lower torque at low speeds than at high speeds.

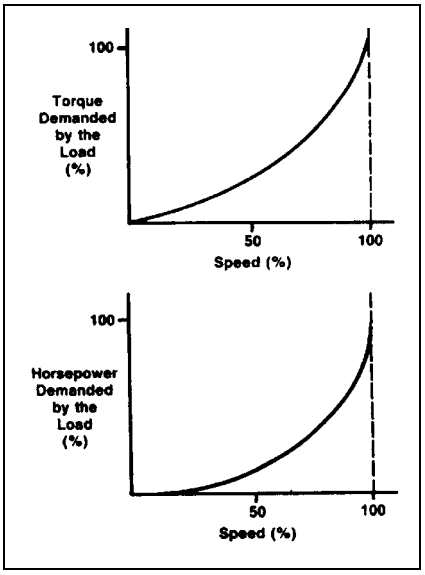


Figure 31.0-3. Variable Torque Load

31

Drive Selection

Introduction

This section discusses the following topics on selecting the appropriate drive:

- Selection considerations
- Selecting a drive for a machine
- Drive application questions

Selection Considerations

When selecting a drive and associated equipment for an application, the following points should be considered:

Environment

The environment in which the motor and power conversion equipment operates is of prime concern. Conditions such as ambient temperature, cooling air supply and the presence of gas, moisture and dust should all be considered when choosing a drive, its enclosures and protective features.

Speed Range

The minimum and maximum motor speeds for the application will determine the drive's base speed.

Speed Regulation

The allowable amount of speed variation should be considered. Does the application require unvarying speed at all torque values or will variations be tolerated?

Torque Requirements

The starting, peak and running torques should be considered when selecting a drive. Starting torque requirements can vary from a small percentage of the full load to a value several times full load torque. The peak torque varies because of a change in load conditions or mechanical nature of the machine. The motor torque available to the driven machine must be more than that required by the machine from start to full speed. The greater the excess torque, the more rapid the acceleration potential.

Acceleration

The necessary acceleration time should be considered. Acceleration time is directly proportional to the total inertia and inversely proportional to the torque available.

Duty Cycle

Selecting the proper drive depends on whether the load is steady, varies, follows a repetitive cycle of variation or has pulsating torques. The duty cycle, which is defined as a fixed repetitive load pattern over a given period of time, is expressed as the ratio of on-time to the cycle period. When the operating cycle is such that the drive operates at idle, or a reduced load for more than 25% of the time, the duty cycle becomes a factor in selecting the proper drive.

Heating

The temperature of a motor or controller is a function of ventilation and losses. Operating self-ventilated motors at reduced speeds may cause above normal temperature rises. Derating or forced ventilation may be necessary to achieve the rated motor torque output at reduced speeds.

Drive Type

Does the application require performance elements such as quick speed response or torque control? These may require the use of a flux vector or closed loop vector drive, instead of a volts per hertz drive.

Table 31.0-2. Drive Specifications

Description	hp Range	Current Harmonic Distortion	Applications
M-Max H-Max SVX	1/4–10 10–600 3/4–800	35–40% 35–40% 35–40%	Micro drive HVAC specific—6 pulse General use—6 pulse
CFX CPX	3/4–400 25–800	7–10% 3%	General use with passive filters 18 pulse clean power

Harmonics

Clean Power Drives Overview

What are Harmonics?

Take a perfect wave with a fundamental frequency of 60 Hz, which is close to what is supplied by the power company.

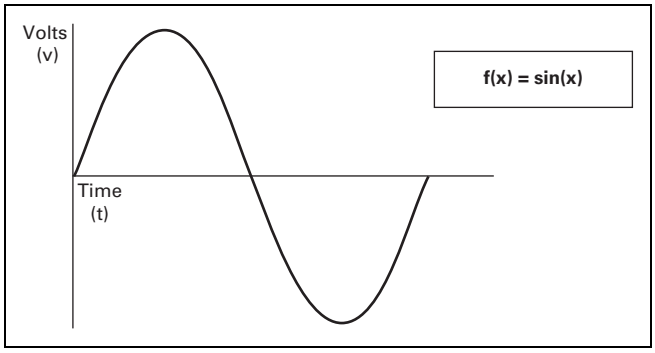


Figure 31.0-4. Perfect Wave

Add a second wave that is five times the fundamental frequency—300 Hz (typical of frequency added to the line by a fluorescent light).

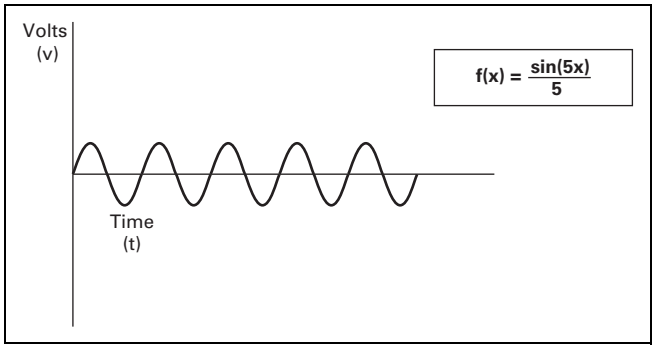


Figure 31.0-5. Second Wave

Combine the two waves. The result is a 60 Hz supply rich in fifth harmonics.

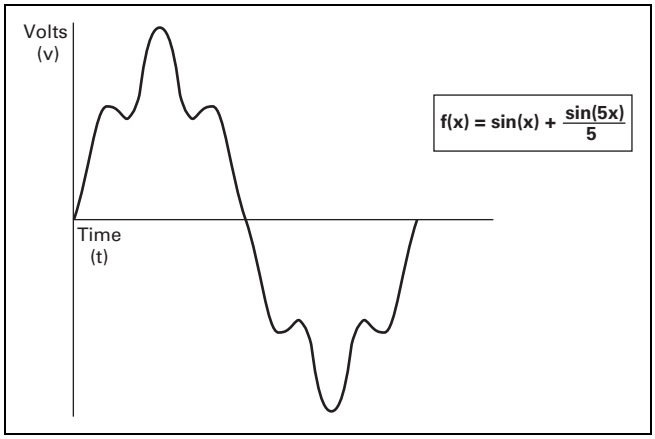


Figure 31.0-6. Resulting Supply

What Causes Harmonics?

Harmonics are the result of non-linear loads that convert AC line voltage to DC. Examples of equipment that are non-linear loads are listed below:

- AC variable frequency drives
- DC drives
- Fluorescence lighting, computers, UPS systems
- Industrial washing machines, punch presses, welders, etc.

How Can Harmonics Due to VFDs Be Diminished?

By applying drives from the Eaton Clean Power drives family: EGF and CFX passive filtered drives, HCX 12-pulse drives, EGP and CPX 18-pulse drives, and RGX regenerative drives.

What are Linear Loads?

Linear loads are primarily devices that run across the line and do not add harmonics. Motors are prime examples. The downside to having large motor linear loads is that they draw more energy than a VFD, because of their inability to control motor speed. In most applications there is a turn down valve used with the motor which will reduce the flow of the material, without significantly reducing the load to the motor. While this provides some measure of speed control, it is extremely inefficient.

Why be Concerned About Harmonics?

1. ***Installation and utility costs increase.*** Harmonics cause damage to transformers and lower efficiencies due to the voltage drop. These losses can become significant (from 16.6–21.6%) which can have a dramatic effect on the HVAC systems that are controlling the temperatures of the building where the transformer and drive equipment reside.
2. ***Downtime and loss of productivity.*** Telephones and data transmissions links may not be guaranteed to work on the same power grids polluted with harmonics.
3. ***Downtime and nuisance trips of drives and other equipment.*** Emergency generators have up to three times the impedance that is found in a conventional utility source. Thus the harmonic voltage can be up to three times as large, causing risk of operation problems.
4. ***Larger motors must be used.*** Motors running across the line that are connected on polluted power distribution grids can overheat or operate at lower efficiency due to harmonics.
5. ***Higher installation costs.*** Transformers and power equipment must be oversized to accommodate the loss of efficiencies. This is due to the harmonic currents circulating through the distribution without performing useful work.

How Does a VFD Convert Three-Phase AC to a Variable Output Voltage and Frequency?

The six-pulse VFD: The majority of all conventional drives that are built consist of a six-pulse configuration. The figure below represents a six-diode rectifier design that converts three-phase utility power to DC. The inverter section uses IGBTs to convert DC power to a simulated AC sine wave that can vary in frequency from 0–400 Hz.

The six-pulse VFD drive creates harmonic current distortion. The harmonic current that is created is energy that can not be used by customers and causes external heat and losses to all components including other drives that are on the same power distribution. The figure is a 100 hp drive with 45 A of damaging harmonic current.

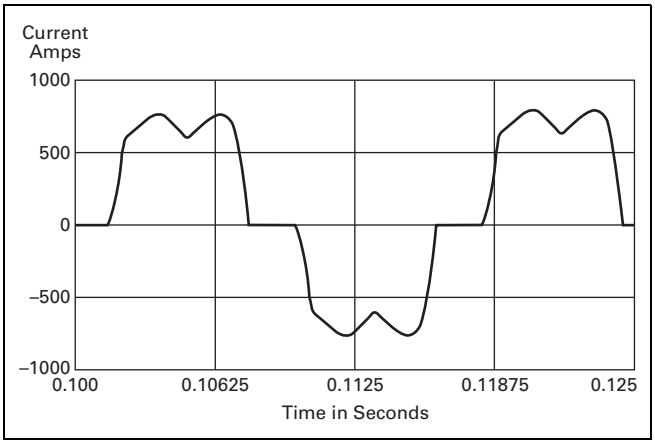


Figure 31.0-7. 100 hp Six-Diode Rectifier Design

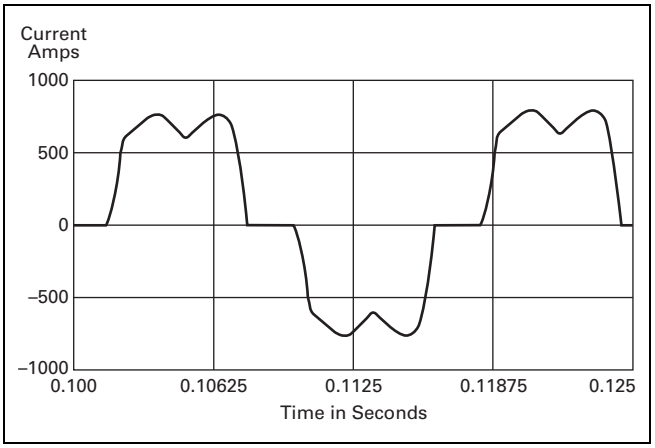


Figure 31.0-8. 100 hp Six-Pulse Nonproductive Harmonic Current

Table 31.0-3. Six-Pulse Nonproductive Harmonic Current

Six-Pulse Circuit		
Current Harmonics		
I_1 = 100%	I_{11} = 6.10%	I_{19} = 1.77%
I_5 = 22.5%	I_{13} = 4.06%	I_{23} = 1.12%
I_7 = 9.38%	I_{17} = 2.26%	I_{25} = 0.86%
Power = 100 hp		
Harmonic current = 45 amps		

Guidelines of Meeting IEEE Std. 519-2014 Harmonic Distortion Limits

The IEEE 519-2014 Specification is a standard that provides guidelines for commercial and industrial users that are implementing medium and low voltage equipment.

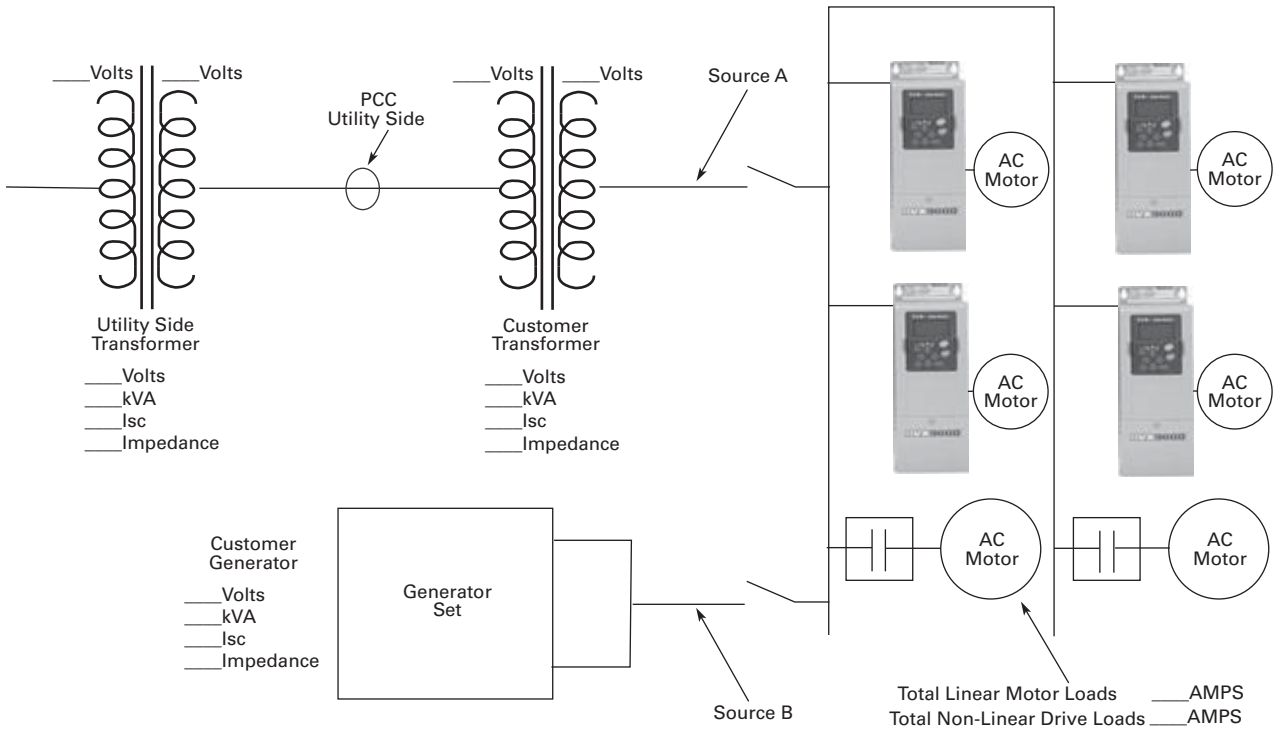
Table 31.0-4. Current Distortion Limits for Systems Rated 120 V through 69 kV

Maximum Harmonic Current Distortion in percent of I_L						
Individual Harmonic Order (Odd Harmonics) ①②						
I_{SC}/I_L	$3 \le h < 11$	$11 \le h < 17$	$17 \le h < 23$	$23 \le h < 35$	$35 \le h \le 50$	TDD
<20 ③	4.0	2.0	1.5	0.6	0.3	5.0
20 <50	7.0	3.5	2.5	1.0	0.5	8.0
50 <100	10.0	4.5	4.0	1.5	0.7	12.0
100 <1000	12.0	5.5	5.0	2.0	1.0	15.0
>1000	15.0	7.0	6.0	2.5	1.4	20.0

① Even harmonics are limited to 25% of the odd harmonic limits shown in table above.

② Current distortions that result in a DC offset, e.g., half-wave converters, are not allowed.

③ All power generation equipment is limited to these values of current distortion, regardless of actual I_{SC}/I_L.
where
I_{SC} = maximum short-circuit current at PCC.
I_L = maximum demand load current (fundamental frequency component) at the PCC under normal load operating conditions.



The best way to estimate AFD harmonic contribution to an electrical system is to perform a harmonic analysis based on known system characteristics. The one line in this figure would provide the data to complete the calculations.

Figure 31.0-9. One-Line Diagram for Harmonic Analysis

Terms

- PCC (Point of Common Coupling) is defined as the electrical connecting point between the utility and multiple customers per the specifications in IEEE 519
- POA (Point of Analysis) is defined as where the harmonic calculations are taken

An oscilloscope can make all measurements at the PCC or POA to do an on-site harmonic evaluation.

Harmonic Reduction Methods to Meet IEEE 519

1. Line Reactor

A line reactor is a three-phase series inductance on the line side of an AFD. If a line reactor is applied on all AFDs, it is possible to meet IEEE guidelines where 10–25% of system loads are AFDs, depending on the stiffness of the line and the value of line reactance. Line reactors are available in various values of percent impedance, most typically 1–1.5%, 3% and 5%.

Note: The SVX/SPX drives come standard with a nominal 3% input impedance.

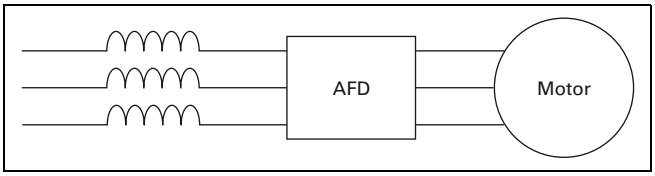


Figure 31.0-10. Line Reactor

Advantages

- Low cost
- Can provide moderate reduction in voltage and current harmonics
- Available in various values of percent impedance
- Provides increased input protection for AFD and its semiconductors from line transients

Disadvantages

- May not reduce harmonic levels to below IEEE 519-2014 guidelines
- Voltage drop due to IR loss

2. Passive Filters

Tuned harmonic filters involve the series connection of an inductor with the shunt connection of an inductor and capacitor to form a low impedance path to ground for a specific range of frequencies. This path presents an alternative to the flow of harmonic currents back into the utility source.

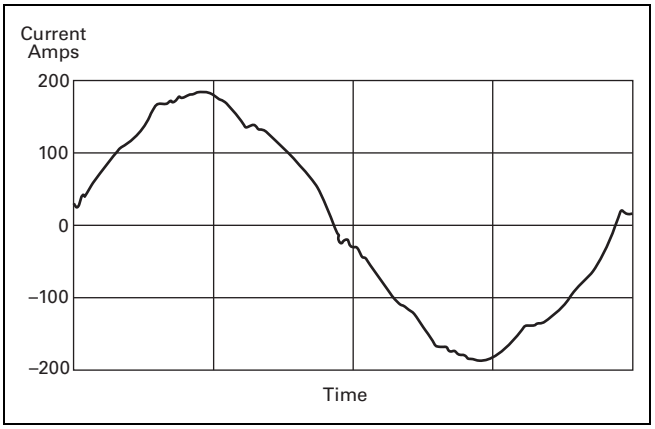


Figure 31.0-11. 100 hp Enclosed 480 V Drive with Integrated Passive Filter

Table 31.0-5. 100 hp Enclosed 480 V Drive with Integrated Passive Filter

Passive Filter		
Current Harmonics		
I_1 = 100%	I_{11} = 0.24%	I_{19} = 0.50%
I_5 = 3.76%	I_{13} = 1.1%	I_{23} = 0.55%
I_7 = 1.65%	I_{17} = 0.80%	I_{25} = 0.80%
Power = 100 hp		
H_c = 8.6 amps		

Advantages

- Low cost for smaller horsepower applications
- More effective harmonic attenuation than 12-pulse drives
- Provides increased input protection for AFD from line transients

Disadvantages

- Capacitors age over time, unlike magnetics
- Not as effective as 18-pulse drives
- Challenging to retrofit with bypass applications

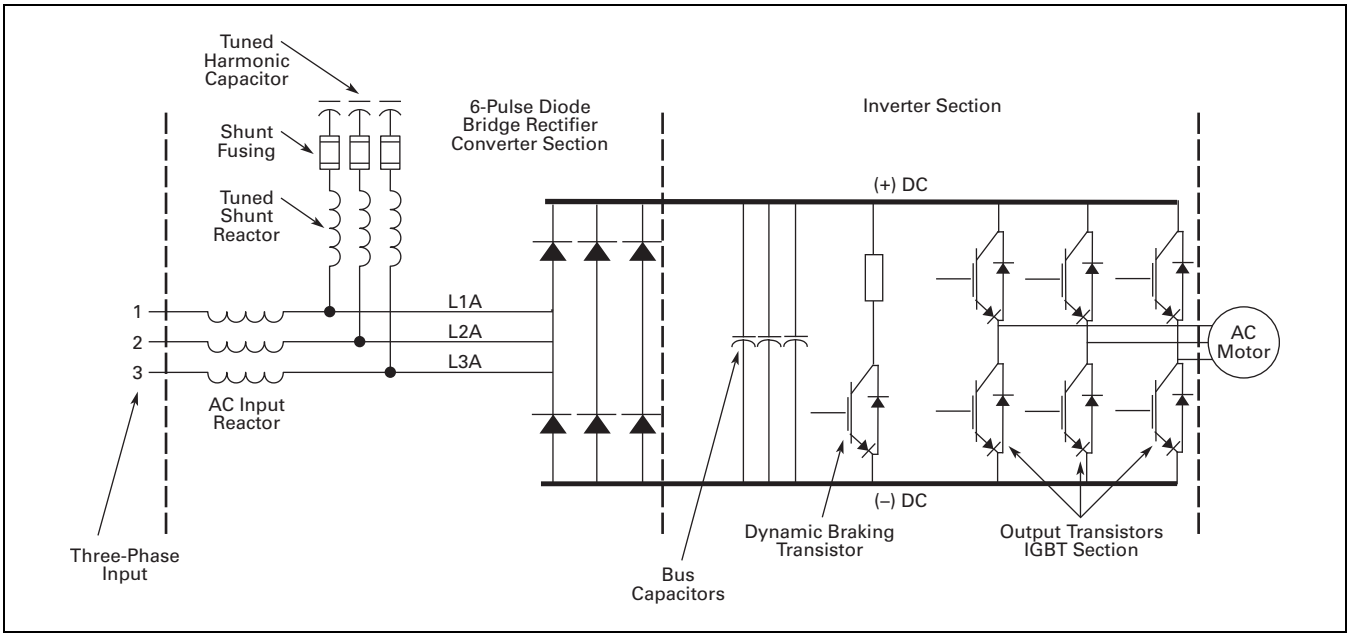


Figure 31.0-12. Enclosed Drive with Integrated Passive Filter

3. 12-Pulse Converters

A 12-pulse converter incorporates two separate AFD input semiconductor bridges, which are fed from 30° phase shifted power sources with identical impedance. The sources may be two isolation transformers, where one is a delta/wye design (which provides the phase shift) and the second a delta/delta design (which does not phase shift). The 12-pulse arrangement allows the harmonics from the first converter to cancel the harmonics of the second. Up to approximately 85% reduction of harmonic current and voltage distortion may be achieved (over standard six-pulse converter). This permits a facility to use a larger percentage of AFD loads under IEEE 519-2014 guidelines than allowable using line reactors or DC chokes. A harmonic analysis is required to guarantee compliance with guidelines.

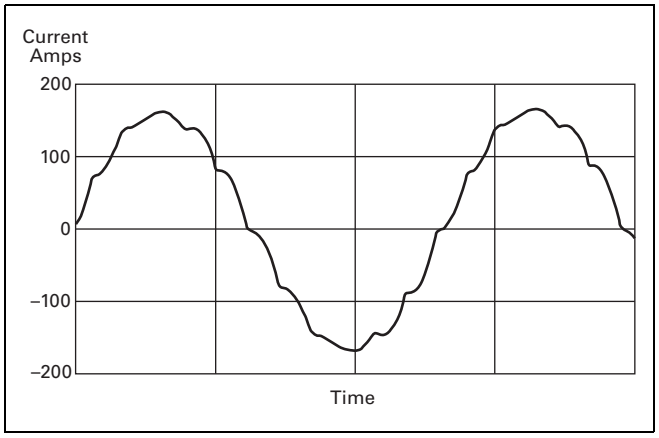


Figure 31.0-13. 100 hp 480 V Drive with 12-Pulse Rectifier

Table 31.0-6. 100 hp 480 V Drive with 12-Pulse Rectifier

12-Pulse Circuit		
Current Harmonics		
I_1 = 100%	I_{11} = 4.19%	I_{19} = 0.06%
I_5 = 1.25%	I_{13} = 2.95%	I_{23} = 0.87%
I_7 = 0.48%	I_{17} = 0.21%	I_{25} = 0.73%
Power = 100 hp		
H_c = 20 amps		

Advantages

- Reasonable cost, although significantly more than reactors or chokes
- Substantial reduction (up to approx. 85%) in voltage and current harmonics
- Provides increased input protection for AFD and its semiconductors from line transients

Disadvantages

- Impedance matching of phase shifted sources is critical to performance
- Transformers often require separate mounting or larger AFD enclosures
- May not reduce distribution harmonic levels to below IEEE 519-2014 guidelines
- Cannot retrofit for most AFDs

31

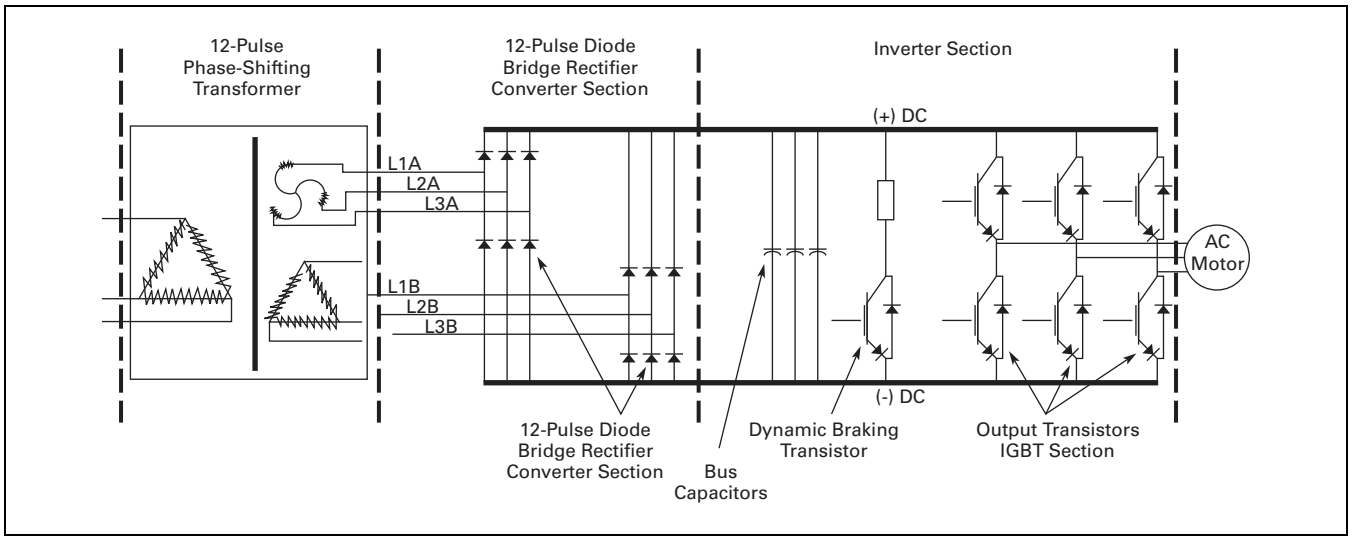


Figure 31.0-14. Basic 12-Pulse Rectifier with "Phase-Shifting" Transformer

4. 18-Pulse Converters

When the total load is comprised of non-linear load such as drives, and the ratio is I_{SC}/I_L, the greatest harmonic mitigation is required. Under these conditions, the currents drawn from the supply need to be sinusoidal and "clean" such that system interference and additional losses are negligible. Eaton's enclosed 18-pulse drive uses a phase-shifting auto-transformer with delta-connected winding that carries only the ampere-turns caused by the difference in load currents. This results in nine separate phases. In this type of configuration, the total kVA rating of the transformer magnetic system was only 48% that of the motor load. A traditional isolated transformer system, with multipulse windings, would require the full kVA rating to be supported, which is more common in an MV step-down transformer.

The integrated 18-pulse drive, with near sine wave input current and low harmonics will meet the requirements of IEEE 519-2014 under all practical operating conditions. The comparisons with six-pulse passive filter and 12-pulse systems are shown on **Pages 31.0-8**, **31.0-11** and below.

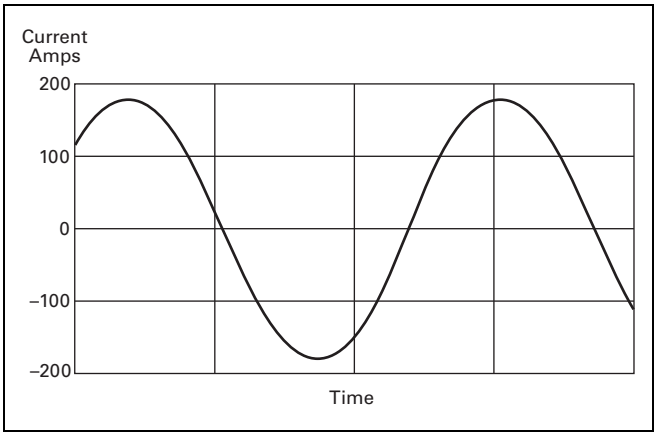


Figure 31.0-15. 100 hp 480 V Drive with 18-Pulse Rectifier

Table 31.0-7. 100 hp 480 V Drive with 18-Pulse Rectifier

18-Pulse Clean Power		
Current Harmonics		
I_1 = 100%	I_{11} = 0.24%	I_{19} = 1.00%
I_5 = 0.16%	I_{13} = 0.10%	I_{23} = 0.01%
I_7 = 0.33%	I_{17} = 0.86%	I_{25} = 0.01%
Power = 100 hp		
H_c = 5.9 amps		

Advantages

- Effectively guarantees compliance with IEEE 519-2014
- Provides increased input protection for AFD and its semiconductors from line transients
- Up to 4 times the harmonic reduction of 12-pulse methods
- Smaller transformer than isolation transformer used in 12-pulse converter
- Minimizes ripple current in capacitors, doubling expected capacitor life

Disadvantages

- Not as cost-effective as some other methods at small (<50) horsepower

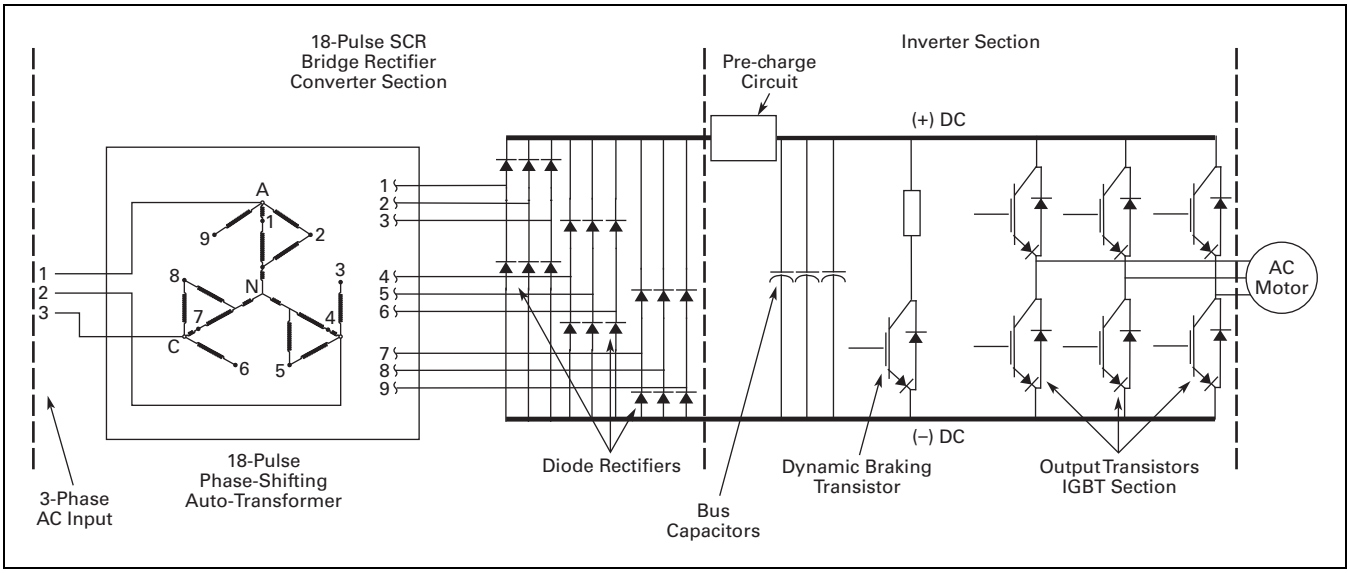


Figure 31.0-16. Basic 18-Pulse Rectifier with Phase-Shifting Auto-Transformer

PowerXL DE1 Series

PowerXL DE1 Series

Product Description

Eaton's PowerXL® DE1 variable speed starter offers the advantages of both a motor starter and a variable frequency drive in a single device. The DE1 is a compact and easy-to-use device with the ability to change the speed of the motor with the simplicity of a contactor starter. With 14 basic parameters, SmartWire-DT® connectivity and an intuitive configuration module, the DE1 setup and commissioning is easy for any panel builder and MOEM. The DE1 was designed for customers who have concerns of the complexity of a VFD but still require variable frequency and advanced motor protection.

Models rated at 480 V, three-phase, 50/60 Hz are available in sizes ranging from 0.5 to 10 hp. Models rated at 230 V, single-phase in/three-phase out, 50/60 Hz are available in sizes ranging from 0.33 to 3 hp.

The DE1 VSS is designed without a keypad to provide a simplistic, cost effective solution. Units are shipped without a keypad. In order to change parameters, there are accessories such as the configuration module that can change up to 5 parameters or connectivity products to connect to the drivesConnect PC Tool.

Features

- Compact, space-saving design
- Rugged design rated up to 60 °C without derating
- DIN rail and screw mountable
- Narrow footprint for true side-by-side installation
- Rated for group motor applications
- Low capacitor design for low harmonics
- Control terminal blocks
- Three digital inputs
- One digital/analog (programmable) input
- One relay output
- Contactor style power wiring
- RS-485/Modbus as standard
- Efficient, simple design without a keypad
- Three indicating LEDs for fault and condition status
- Reliable design—
  150% for 60 s
  175% for 2 s
- Smartwire-DT ready for expanding communication gateways

Standards and Certifications

Product

- Complies with EN 61800-3

Safety

- IEC 61800-5-1
- CE
- UL
- CSA/cUL
- cTick
- UKRSekpro
- GOST R
- RoHS compliant

Catalog Number Selection

Table 31.1-1. DE1 Series Variable Speed Starter

D E1 - 1 2 4D3 N N - N 20 N

Basic Naming
D = Drive

Device Series
E1 = Economy

Number of Phases
1 = Single-phase main connection/ three-phase motor connection
3 = Three-phase main connection/ three-phase motor connection

Input/Output Voltage
2 = 230 V
4 = 480 V

Current Rating

230 V	460 V
1D4 = 1.4 A, 0.33 hp, 0.25 kW	**1D3** = 1.3 A, 0.5 hp, 0.37 kW
2D3 = 2.3 A, 0.5 hp, 0.37 kW	**2D1** = 2.1 A, 1.0 hp, 0.75 kW
2D7 = 2.7 A, 0.75 hp, 0.55 kW	**3D6** = 3.6 A, 2.0 hp, 1.5 kW
4D3 = 4.3 A, 1.0 hp, 0.75 kW	**5D0** = 5.0 A, 3.0 hp, 2.2 kW
7D0 = 7.0 A, 2.0 hp, 1.5 kW	**6D6** = 6.6 A, 4.0 hp, 3.0 kW
9D6 = 9.6 A, 3.0 hp, 2.2 kW	**8D5** = 8.5 A, 5.0 hp, 4.0 kW
	011 = 11 A, 7.5 hp, 5.5 kW
	016 = 16 A, 10 hp, 7.5 kW

Filter Option
N = No filter

Brake Chopper Option
N = No brake chopper

Display Option
N = No display

Environment Rating
20 = IP20, NEMA 0

Conformation Coated Option
N = Not conformal coated boards

Product Selection

IP20

Table 31.1-2. DE1 Series IP20 Enclosure Drives

hp ①	kW	Volts	100% Continuous Current In (A)	Frame Size	Catalog Number ②
0.33	0.25	200–240 V single-phase in/ 230 V three-phase out	1.4	1	**DE1-121D4NN-N20N**
0.5	0.37		2.3	1	**DE1-122D3NN-N20N**
0.75	0.55		2.7	1	**DE1-122D7NN-N20N**
1	0.75		4.3	1	**DE1-124D3NN-N20N**
2	1.5		7	1	**DE1-127D0NN-N20N**
3	2.2		9.6	2	**DE1-129D6NN-N20N**
0.5	0.37	380–480 V three-phase in/ 480 V three-phase out	1.3	1	**DE1-341D3NN-N20N**
1	0.75		2.1	1	**DE1-342D1NN-N20N**
2	1.5		3.6	1	**DE1-343D6NN-N20N**
3	2.2		5	2	**DE1-345D0NN-N20N**
4	3		6.6	2	**DE1-346D6NN-N20N**
5	4		8.5	2	**DE1-348D5NN-N20N**
7.5	5.5		11.3	2	**DE1-34011NN-N20N**
10	7.5		16	2	**DE1-34016NN-N20N**

① For all applications, select the unit such that the motor current is less than or equal to the rated continuous output current.
② These are constant torque/high overload rated drives.

Accessories

Table 31.1-3. PC Communication Kit and Copy/Paste Module

Description	Catalog Number
Bluetooth copy/paste communication stick	DX-COM-STICK
USB to RJ45 panel mount kit	DX-COM-PCKIT
USB to RJ45 PC Tool cable	DX-CBL-PC-3M0

Table 31.1-4. Keypad Options

Description	Catalog Number
LED remote keypad—7-segment display, IP54 rated	DX-KEY-LED ①
Configuration module—plug-in unit, DIP switch and dial control	DXE-EXT-SET

① Includes 1 m RS-485 data cable.

Table 31.1-5. Extension Cables and Data Cable Splitter

Description	Catalog Number
RJ45 communication cable w/terminating resistor	EASY-NT-R
RS-485 data cable, RJ45, 0.5 m	DX-CBL-RJ45-0M5
RS-485 data cable, RJ45, 1.0 m	DX-CBL-RJ45-1M0
RS-485 data cable, RJ45, 3.0 m	DX-CBL-RJ45-3M0
RS-485 three-way data cable splitter, RJ45	DX-SPL-RJ45-3SL
RS-485 data cable splitter, RJ45, (1 connector to 2 socket)	DX-SPL-RJ45-2SL1PL

Table 31.1-6. SmartWire Modules

Description	Catalog Number
SmartWire-DT interface for DE1 and DC1 IP20	DX-NET-SWD3

Table 31.1-7. Commoning Links ②

Description	Max. Devices Used	Catalog Number
460 V, three-phase link	3xFS1	XTCEXCLK3B
	2xFS1 + 1xFS2	
	2xFS2	
	4xFS1	XTCEXCLK4B
	3xFS1 + 1xFS2	
	1xFS1 + 2xFS2 ③	
	5xFS1	XTCEXCLK5B
	4xFS1 + 1xFS2	
	2xFS1 + 2xFS2 ③	
	3xFS2 ③	
460 V, incoming terminal	—	XTCEXITB ④

② Commoning links can be used to connect multiple line side 460 V DE1 units for use in group motor applications.

③ These combinations may result in the total of the individual input currents exceeding the three-phase commoning link's and incoming connection block's ampacity (35 A).

④ Required for group motor applications when using the 460 V commoning links.

Technical Data and Specifications

Ratings

Table 31.1-8. PowerXL DE1 Basic Controller Standard Ratings

Description	Specification
Protections	
Overload protection	150% for 60s for every 600 seconds
Overvoltage protection	Yes
Undervoltage protection	Yes
Ground fault protection	Yes
Overtemperature protection	Yes
Motor overload protection	Yes
Motor stall protection	Yes
Short-circuit protection	100 kAIC with fuses, 65 kAIC with PKZM, 10 kAIC with FAZ

Table 31.1-9. Programmable Parameters

Description
14 Standard operation parameters
Programmable start function
DC-brake at start and stop
Adjustable switching frequency
Autorestart function after fault
Protections and supervisions
Power section fault indication
External fault
Fieldbus communication
Analog input range selection, signal scaling and filtering
Four preset speed reference

Specifications

Table 31.1-10. PowerXL DE1 Series

Description	Specification
Input Ratings	
Input voltage (V_{in})	±10%
Input frequency (f_{in})	50/60 Hz (variation up to 48–62 Hz)
Connection to power	Maximum of one time every 30 seconds
Output Ratings	
Output voltage	0 to V_{in}
Continuous output current	Continuous rated current I_N at ambient temperature max. 140 °F (60 °C), 150% for 60 seconds, 175% for 2 seconds
Output frequency	0 to 500 Hz
Frequency resolution	0.1 Hz
Initial output current (I_H)	175% for 2s for every 20 seconds Torque depends on motor
Control Characteristics	
Operation mode	U/f control, slip compensation
Switching frequency	4 to 32 kHz
Voltage reference	10 Vdc (max. 10 mA)
Field weakening point	0 to 500 Hz
Acceleration time	0.1 to 600 seconds
Deceleration time	0.1 to 600 seconds
Ambient Conditions	
Ambient operating temperature	–10 °C to +50 °C, for 60 °C there is no derating required ⑤
Storage temperature	–40 °C to +70 °C
Relative humidity	0 to 95% RH, noncondensing, non-corrosive, no dripping water
Enclosure class	IP20 (FS1–FS3)

⑤ All units do not require derating except for the 10 hp 460 V unit which may require derating depending on the switching frequency used.

Standards—DE1 Series Variable Speed Starter

I/O Specifications

- Digital inputs DI1–DI4 are programmable
- Relay output is programmable
- DI3 and DI4 can be programmed to be digital, thermistor or analog

Includes:

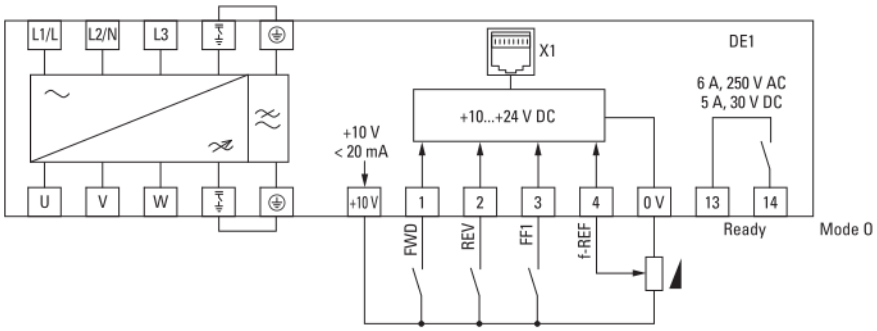
- Four inputs (three digital and one digital/analog)
- Analog input
  - 4–20 mA
  - 0–10 V
- One relay output
- RS-485 interface

Reliability

- Pretested components
- Computerized testing
- Robust design rated to 60 °C

Table 31.1-11. DE1 Series I/O Interface

Terminal		Signal	Factory Preset	Description
0 V	0 V	Reference potential	—	0 V connection
+0 V	+24 Vdc	Control voltage for DI1-DI4	—	Maximum load 100 mA Reference potential V
1	DI1	Digital Input 1	FWD	+10 to 24 V
2	DI2	Digital Input 2	REV	+10 to 24 V
3	DI3	Digital Input 3	Fixed frequency FF1	+10 to 24 V
	Ther.	Thermistor	Fixed frequency FF1	External fault: [Need info] Trip at 3600 ? Reset at 1600 ?
4	DI4	Digital Input 4	Frequency reference value	+10 to 24 V
	AI1	Analog Input	Frequency reference value	0 to 10 V 0/4–20 mA Can be switched with parameter P16
13	K13	Relay 1, normally open contact	Active = RUN	Maximum switching load: 250 Vac/6 A or 30 Vdc/5 A
14	K14	Relay 1, normally open contact	Active = RUN	Maximum switching load: 250 Vac/6 A or 30 Vdc/5 A



Dimensions—Approximate Dimensions in Inches (mm)

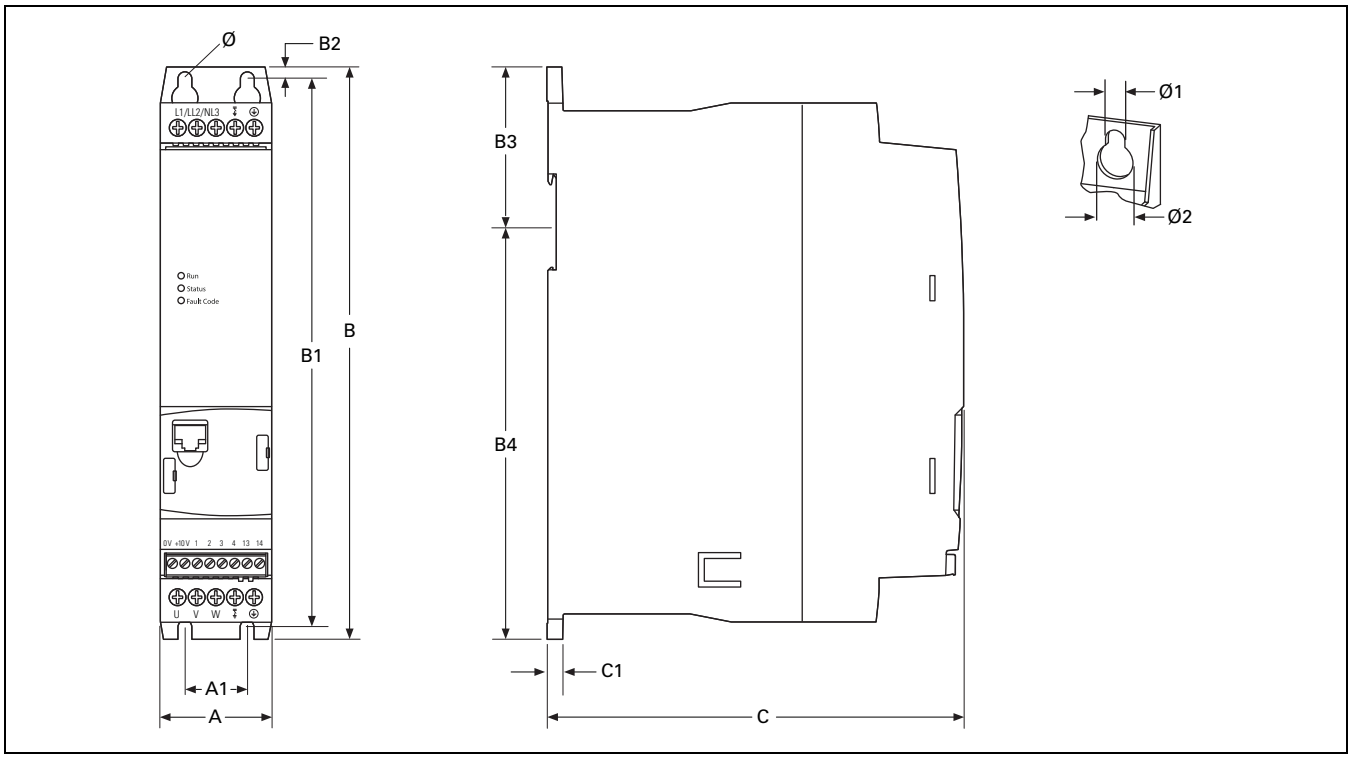


Figure 31.1-1. DE1, Sizes FS1 and FS2, Degree of Protection IP20/NEMA 0

Frame Size	A	A1	B	B1	B2	B3	B4	C	C1	Ø1	Ø2	Weight Lb (kg)
FS1	1.77 (45.0)	0.98 (25.0)	9.09 (231.0)	8.66 (220.0)	0.20 (5.1)	2.52 (64.0)	6.54 (166.1)	6.65 (169.0)	0.26 (6.6)	0.20 (5.1)	0.39 (10.0)	2.29 (1.04)
FS2	3.54 (90.0)	1.97 (50.0)	9.09 (231.0)	8.66 (220.0)	0.20 (5.1)	2.52 (64.0)	6.54 (166.1)	6.65 (169.0)	0.26 (6.6)	0.20 (5.1)	0.39 (10.0)	3.70 (1.68)

PowerXL DC1 Series Drives

DG1 General Purpose Drive

Product Description

Eaton's PowerXL® DC1 variable frequency drives are the next generation of drives specifically engineered for today's machinery applications.

The DC1 is compact with only 14 basic parameters, SmartWire-DT® connectivity, and outstanding ease of mounting and installation. The DC1 is perfect for quick commissioning and is ideal for panel builders. This drive supports single-phase motor applications, and detachable terminal blocks make control wiring much easier.

Models rated at 480 volts, three-phase, 50/60 Hz are available in sizes ranging from 1 to 30 hp. Models rated at 240 volts, single- or three-phase, 50/60 Hz are available in sizes ranging from 0.5 to 15 hp. Models rated at 115 volts, single-phase, 50/60 Hz are available in the 0.5 to 3 hp size range.

Features

- Compact, space-saving design
- Rugged and reliable—175% for 2 s, 50 °C rated
- DIN rail and screw mountable (FS1 and FS2)
- Side-by-side installation
- Industry-leading efficiency delivers energy savings to the customer
- Optional integrated EMC filters make the unit suitable for commercial and industrial networks
- Brake chopper as standard in frames 2 and higher
- Temperature-controlled fan
- RS-485/Modbus® and CANopen™ as standard
- PI controller as standard
- SmartWire capability
- Removable I/O terminal blocks
- Contactor style power wiring
- Designed for shaded-pole, single-phase motors and permanent split capacitor single-phase motors
- Designed to run surface mounted (SPM) and rotor in-built (IPM) permanent magnet motors

Standards and Certifications

Product

- Complies with EN61800-3 (2004)

EMC (At Default Settings)

- EMC Category C1, C2 and C3 at default settings (1 m, 5 m, 25 m)

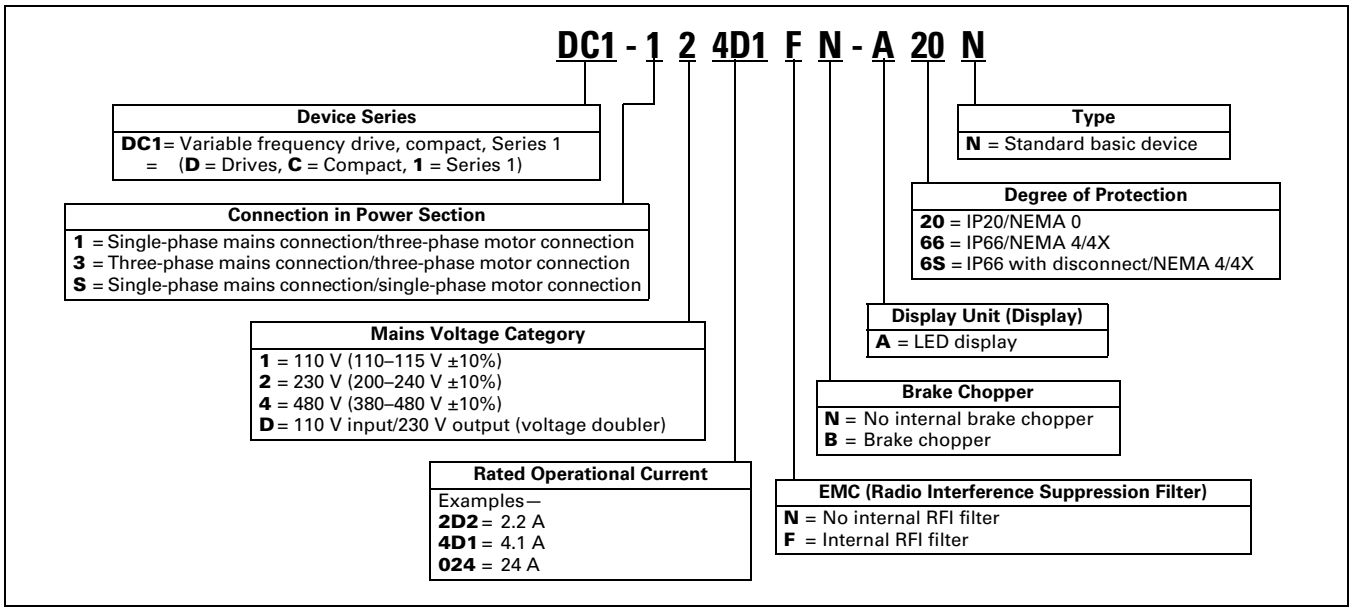
Safety ①

- 61800-5-1
- EN 60529
- CE
- UL
- cUL
- UkrSepro
- c-Tick
- RoHS compliant

① See unit nameplate for more detailed approvals.

Catalog Number Selection

Table 31.1-12. DC1 Series Adjustable Frequency AC Drives



Product Selection

Table 31.1-13. DC1 Series IP20 Enclosure Drives ①

hp ②	kW	Volts	100% Continuous Current In (A)	Frame Size ③	Catalog Number
0.5 0.75	0.37 0.55	115 V single-phase in/ ④ 115 V single-phase out	7 10.5	1 2	**DC1-S17D0NN-A20N** **DC1-S1011NB-A20N**
0.5 1 1.5	0.37 0.75 1.1	200–240 V single-phase in/ ④ 200–240 V single-phase out	4.3 7 10	1 1 2	**DC1-S24D3NN-A20N** ⑤ **DC1-S27D0NN-A20N** ⑤ **DC1-S2011NB-A20N** ⑤
0.5 1 1.5	0.37 0.75 1.1	115 V single-phase in/ 230 V three-phase out	2.3 4.3 5.8	1 1 2	**DC1-1D2D3NN-A20N** **DC1-1D4D3NN-A20N** **DC1-1D5D8NB-A20N**
0.5 1 2	0.37 0.75 1.5	200–240 V single-phase in/ 230 V three-phase out	2.3 4.3 7	1 1 1	**DC1-122D3NN-A20N** ⑤ **DC1-124D3NN-A20N** ⑤ **DC1-127D0NN-A20N** ⑤
2 3 5	1.5 2.2 4		7 10.5 15	2 2 3	**DC1-127D0NB-A20N** ⑤ **DC1-12011NB-A20N** ⑤ **DC1-12015NB-A20N**
0.5 1 2	0.37 0.75 1.5	200–240 V three-phase in/ 230 V three-phase out	2.3 4.3 7	1 1 1	**DC1-322D3NN-A20N** **DC1-324D3NN-A20N** **DC1-327D0NN-A20N**
2 3 5	1.5 2.2 4		7 10.5 18	2 2 3	**DC1-327D0NB-A20N** ⑤ **DC1-32011NB-A20N** ⑤ **DC1-32018NB-A20N** ⑤
7.5 10 15	5.5 7.5 11		24 30 46	4 4 4	**DC1-32024NB-A20N** ⑤ **DC1-32030NB-A20N** ⑤ **DC1-32046NB-A20N** ⑤
1 2 2	0.75 1.5 1.5	380–480 V three-phase in/ 480 V three-phase out	2.2 4.1 4.1	1 1 2	**DC1-342D2NN-A20N** ⑤ **DC1-344D1NN-A20N** ⑤ **DC1-344D1NB-A20N** ⑤
3 5 7.5	2.2 4 5.5		5.8 9.5 14	2 2 3	**DC1-345D8NB-A20N** ⑤ **DC1-349D5NB-A20N** ⑤ **DC1-34014NB-A20N** ⑤
10 15 20	7.5 11 15		18 24 30	3 3 4	**DC1-34018NB-A20N** ⑤ **DC1-34024NB-A20N** ⑤ **DC1-34030NB-A20N** ⑤
25 30	18.5 22		39 46	4 4	**DC1-34039NB-A20N** ⑤ **DC1-34046NB-A20N** ⑤

① These are constant torque/high overload rated drives.
② For all applications, select the unit such that the motor current is less than or equal to the rated continuous output current.
③ Brake chopper circuit available as standard in frames 2 and 3.
④ Only for use with shaded pole or split capacitor single-phase motors.
⑤ RFI version available. Substitute with DC1-*****F*-**** for this option.

IP66 NEMA 4/4X Interior DC1 Drive

The IP66 version of the DC1 is a unique solution to allow for mounting the drive outside of a control panel or next to a motor for distributed control.

"-A66N" Option

This version comes with the keypad that is similar to that of IP20 version. There are no additional cover controls to address security concerns.

"-A6SN" Option

This version has an integrated potentiometer, a forward/off/reverse switch and a disconnect switch with lock-off capability with the standard keypad. This allows for reduced labor and materials when compared to a IP20 solution in separate enclosure.

Table 31.1-14. DC1 Series IP66 Enclosure Drives ①

hp ②	kW	Volts	100% Continuous Current In (A)	Frame Size ③	Catalog Number
0.5 0.75	0.37 0.55	115 V single-phase in/ 115 V single-phase out	7 10.5	1 2	**DC1-S17D0NN-A6SN** ④ **DC1-S1011NB-A6SN** ④
0.5 1 1.5	0.37 0.75 1.1	200–240 V single-phase in/ 200–240 V single-phase out	4.3 7 10	1 1 2	**DC1-S24D3NN-A6SN** ④⑤ **DC1-S27D0NN-A6SN** ④⑤ **DC1-S2011NB-A6SN** ④⑤
0.5 1 1.5	0.37 0.75 1.1	115 V single-phase in/ 230 V three-phase out	2.3 4.3 5.8	1 1 2	**DC1-1D2D3NN-A6SN** ④ **DC1-1D4D3NN-A6SN** ④ **DC1-1D5D8NB-A6SN** ④
0.5 1 2	0.37 0.75 1.5	200–240 V single-phase in/ 230 V three-phase out	2.3 4.3 7	1 1 1	**DC1-122D3NN-A6SN** ④⑤ **DC1-124D3NN-A6SN** ④⑤ **DC1-127D0NN-A6SN** ④⑤
2 3 5	1.5 2.2 4		7 10.5 15	2 2 3	**DC1-127D0NB-A6SN** ④⑤ **DC1-12011NB-A6SN** ④⑤ **DC1-12015NB-A6SN** ④
0.5 1 2	0.37 0.75 1.5	200–240 V three-phase in/ 230 V three-phase out	2.3 4.3 7	1 1 1	**DC1-322D3NN-A6SN** ④ **DC1-324D3NN-A6SN** ④ **DC1-327D0NN-A6SN** ④
2 3 5	1.5 2.2 4		7 10.5 18	2 2 3	**DC1-327D0NB-A6SN** ④⑤ **DC1-32011NB-A6SN** ④⑤ **DC1-32018NB-A6SN** ④⑤
1 2 2	0.75 1.5 1.5	380–480 V three-phase in/ 460 V three-phase out	2.2 4.1 4.1	1 1 2	**DC1-342D2NN-A6SN** ④⑤ **DC1-344D1NN-A6SN** ④⑤ **DC1-344D1NB-A6SN** ④⑤
3 5 7.5 10	2.2 4 5.5 7.5		5.8 9.5 14 18	2 2 3 3	**DC1-345D8NB-A6SN** ④⑤ **DC1-349D5NB-A6SN** ④⑤ **DC1-34014NB-A6SN** ④⑤ **DC1-34018NB-A6SN** ④⑤

① These are constant torque/high overload rated drives.
② For all applications, select the unit such that the motor current is less than or equal to the rated continuous output current.
③ Brake chopper circuit available as standard in frames 2 and 3.
④ Non-disconnect version available. Substitute with **-A66N**.
⑤ RFI version available. Substitute with DC1-*****F*-**** for this option.

Accessories

DC1 Series

Table 31.1-15. PC Communication Kit and Copy/Paste Module

Description	Catalog Number
Bluetooth copy/paste communication stick	**DX-COM-STICK**
USB to RJ45 panel mount kit	**DX-COM-PCKIT**
USB to RJ45 converter cable	**DX-COM-PCCABLE**
USB to RJ45 PC Tool cable	**DX-CBL-PC-3MO**

Table 31.1-16. Encoder Feedback Plug-In Option Module and Miscellaneous Cards

Description	Catalog Number
Local control/test option card	**DXC-EXT-LOCSIM**
HVACO drive running and tripped relay output card	**DXC-EXT-2RO1 AO**
Dual relay output card	**DXC-EXT-2RO**
110 V logic input card	**DXC-EXT-IO110**
230 V logic input card	**DXC-EXT-IO230**

Table 31.1-17. Remote Keypad

Description	Catalog Number
LED remote keypad—7-segment display, IP54 rated	**DX-KEY-LED** ①
OLED remote keypad—full text display, multi-line text, multi-language, IP54 hand/auto buttons	**DX-KEY-OLED** ①

① Includes 1 m RS-485 data cable.

Table 31.1-18. Brake Resistor (FR2 and FR3)

Description	Catalog Number
DC1, DA1 internal mount 200 W, 100 R	**DX-BR3-100**

Table 31.1-19. Extension Cables and Data Cable Splitter

Description	Catalog Number
RJ45 communication cable with terminating resistor	**EASY-NT-R**
RS-485 data cable, RJ45, 0.5 m	**DX-CBL-RJ45-0M5**
RS-485 data cable, RJ45, 1.0 m	**DX-CBL-RJ45-1M0**
RS-485 data cable, RJ45, 3.0 m	**DX-CBL-RJ45-3M0**
RS-485 three-way data cable splitter, RJ45	**DX-SPL-RJ45-3SL**
RS-485 data cable splitter, RJ45, (1 connector to 2 socket)	**DX-SPL-RJ45-2SL1PL**

Table 31.1-20. SmartWire Modules

Description	Catalog Number
SmartWire-DT interface for DC1 IP20	**DX-NET-SWD3**

Technical Data and Specifications

DC1 Series

Ratings

Table 31.1-21. PowerXL DC1 Basic Controller IP20 Standard Ratings

Description	Specification
Protections	
Overload protection	150% for 60s for every 600 seconds
Overvoltage protection	Yes
Undervoltage protection	Yes
Ground fault protection	Yes
Overtemperature protection	Yes
Motor overload protection	Yes
Motor stall protection	Yes
Short-circuit withstand rating	100 kAIC with Type 1 fuses

Table 31.1-22. Programmable Parameters

Description
Built-in Help card
14 Standard operation parameters
Reference scaling
Programmable start and stop functions
DC-brake at start and stop
Programmable V/Hz curve
Adjustable switching frequency
Autorestart function after fault
Protections and supervisions
Power section fault indication
External fault
Fieldbus communication
Second deceleration time
Analog input range selection, signal scaling and filtering
PI controller
Skip frequencies

Specifications

Table 31.1-23. PowerXL DC1 Series Drives

Description	Specification
Input Ratings	
Input voltage (V_{in})	±10%
Input frequency (f_{in})	50/60 Hz (variation up to 48–62 Hz)
Connection to power	Maximum of one time every 30 seconds
Output Ratings	
Output voltage	0 to V_{in} ①
Continuous output current	Continuous rated current I_N at ambient temperature max. 122 °F (50 °C), 150% for 60 seconds, 175% for 2 seconds
Output frequency	0 to 500 Hz
Frequency resolution	0.1 Hz
Initial output current (I_H)	175% for 2s for every 20 seconds Torque depends on motor
Control Characteristics	
Operation mode	U/f control, slip compensation
Switching frequency	4 to 32 kHz
Voltage reference	10 Vdc (max. 10 mA)
Field weakening point	0 to 500 Hz
Acceleration time	0.1 to 600 seconds
Deceleration time	0.1 to 600 seconds
Brake Resistor (Minimum Values) ②	
230 V Series	FS2 and FS3 47 ohms
400 V Series	FS2 100 ohms, FS3 47 ohms
Ambient Conditions	
Ambient operating temperature	+14 °F (–10 °C), no frost to +122 °F (+50 °C): Rated loadability I_N IP20—NEMA 0
Storage temperature	–40 °F (–40 °C) to +140 °F (+60 °C)
Relative humidity	0 to 95% RH, noncondensing, non-corrosive, no dripping water
Enclosure class	IP20 (FS1–FS4)

① Exception: 115 V single-phase in, 230 V three-phase out.
② Only FS2, FS3 and FS4 drives are equipped with brake chopper circuit.

Standards—DC1 Series

I/O Specifications

- Digital inputs DI1–DI4 are programmable
- Digital, relay and analog outputs are programmable

Includes:

- Four inputs (two digital and two digital/analog)
- Analog inputs
  - 4–20 mA
  - 0–10 V
- One output (analog or digital)
- One relay output
- RS-485 interface

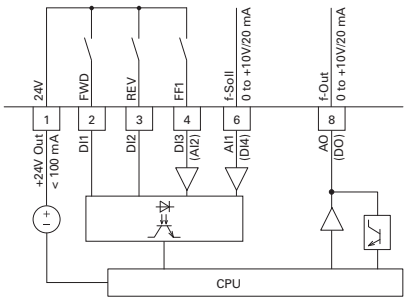
Reliability

- Pretested components
- Computerized testing
- Final test with full load
- Conformal-coated boards
- Eaton's Electrical Services & Systems: national network of AF drive specialists

Table 31.1-24. DC1 Series I/O Interface

Terminal		Signal	Factory Preset	Description
1	+24 Vdc	Control voltage for DI1–DI4	—	Maximum load 100 mA Reference potential V
2	DI1	Digital Input 1	Start Enable FWD	8 to +30 V (High, R_1 > 6 k Ω)
3	DI2	Digital Input 2	Start Enable REV	8 to +30 V (High, R_1 > 6 k Ω)
4	DI3	Digital Input 3	Fixed frequency FF1	Digital: 8–30 V (high)
	AI2	Analog Input 2	Fixed frequency FF1	Analog: 0 to +10 V (R_i >72 k Ω) 0/4–20 mA (Rß = 500 Ω) Can be switched with parameter P16
5	+10 Vdc	Reference voltage, Output (+10 V)	—	Maximum load 10 mA Reference potential 0 V
6	AI1	Analog Input 1	Frequency reference value ① (fixed frequency)	Analog: 0 to +10 V (R_i >72 k Ω) 0/4–20 mA (Rß = 500 Ω) Can be switched with parameter P16
	DI4	Digital Input 5	Frequency reference value ① (fixed frequency)	Digital: 8–30 V (high)
7	0 V	Reference potential	—	0 V = connection terminal 9
8	AO1	Analog Output 1	Output frequency	Analog: 0 to +10 V, maximum 4–20 mA Can be switched with parameter P-25
	DO1	Digital Output 1	Output frequency	Digital: 8 to +24 V
9	0 V	Reference potential	—	0 V connection terminal 7
10	K13	Relay 1, normally open contact	Active = RUN	Maximum switching load: 250 Vac/6 A or 30 Vdc/5 A
11	K14	Relay 1, normally open contact	Active = RUN	Maximum switching load: 250 Vac/6 A or 30 Vdc/5 A

① Programmable function.



Dimensions—Approximate Dimensions in Inches (mm)

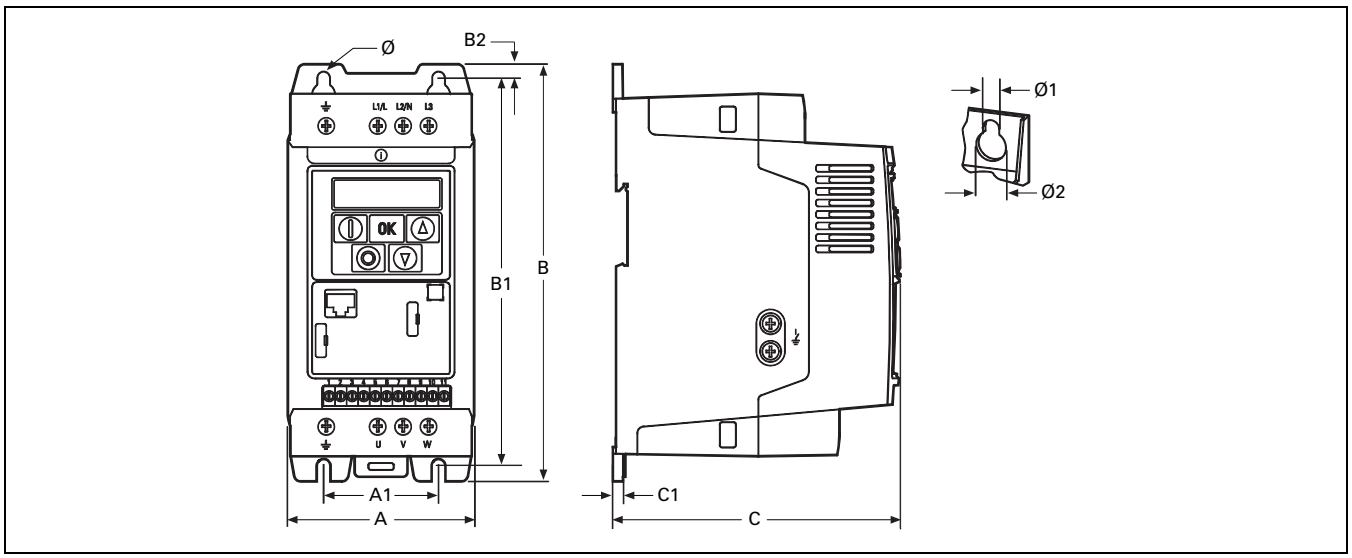


Figure 31.1-2. DC1, Sizes FS1–FS4, Degree of Protection IP20/NEMA 0

Frame Size	A	A1	B	B1	B2	C	C1	Ø1	Ø2	Weight Lb (kg)
FS1	3.19 (81.0)	1.97 (50.0)	7.24 (184.0)	6.69 (170.0)	0.28 (7.0)	4.88 (124.0)	0.16 (4.0)	0.24 (6.0)	0.47 (12.0)	2.43 (1.1)
FS2	4.21 (107.0)	2.95 (75.0)	9.09 (231.0)	8.46 (215.0)	0.31 (8.0)	5.98 (152.0)	0.20 (5.0)	0.24 (6.0)	0.47 (12.0)	5.73 (2.6)
FS3	5.16 (131.0)	3.94 (100.0)	10.75 (273.0)	10.04 (255.0)	0.33 (8.5)	6.89 (175.0)	0.20 (5.0)	0.24 (6.0)	0.47 (12.0)	8.82 (4.0)
FS4	6.30 (160.0)	—	16.54 (420.0)	—	—	8.35 (212.0)	—	—	—	—

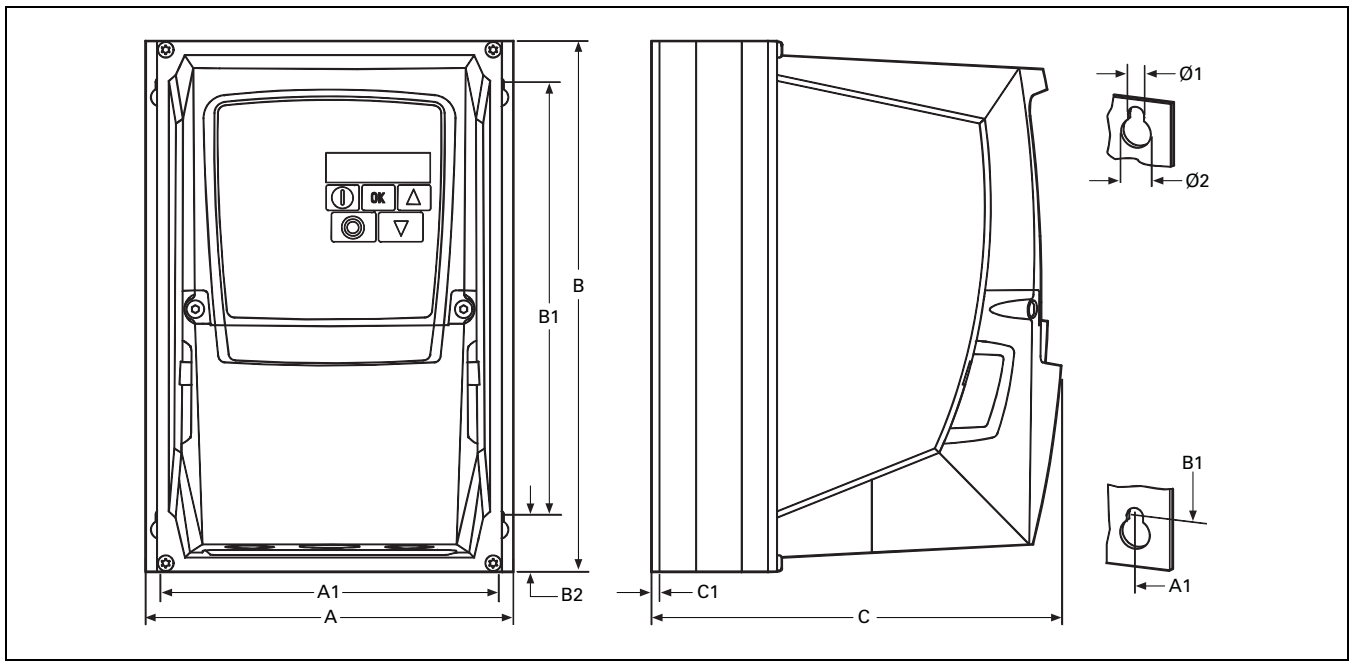


Figure 31.1-3. DC1, Sizes FS1–FS3, Degree of Protection IP66/NEMA 4

31

Frame Size	A	A1	B	B1	B2	C	C1	Ø1	Ø2	Weight Lb (kg)
FS1	6.34 (161.0)	5.85 (148.5)	9.13 (232.0)	7.44 (189.0)	0.98 (25.0)	7.24 (184.0)	0.14 (3.5)	0.15 (4.0)	0.31 (8.0)	5.51 (2.5)
FS2	7.40 (188.0)	6.93 (176.0)	10.12 (257.0)	7.87 (200.0)	1.12 (28.5)	7.58 (192.0)	0.14 (3.5)	0.16 (4.2)	0.33 (8.5)	10.36 (4.7)
FS3	8.29 (210.5)	7.78 (197.5)	12.20 (310.0)	9.90 (251.5)	1.31 (33.4)	9.21 (234.0)	0.14 (3.5)	0.16 (4.2)	0.33 (8.5)	17.42 (7.9)

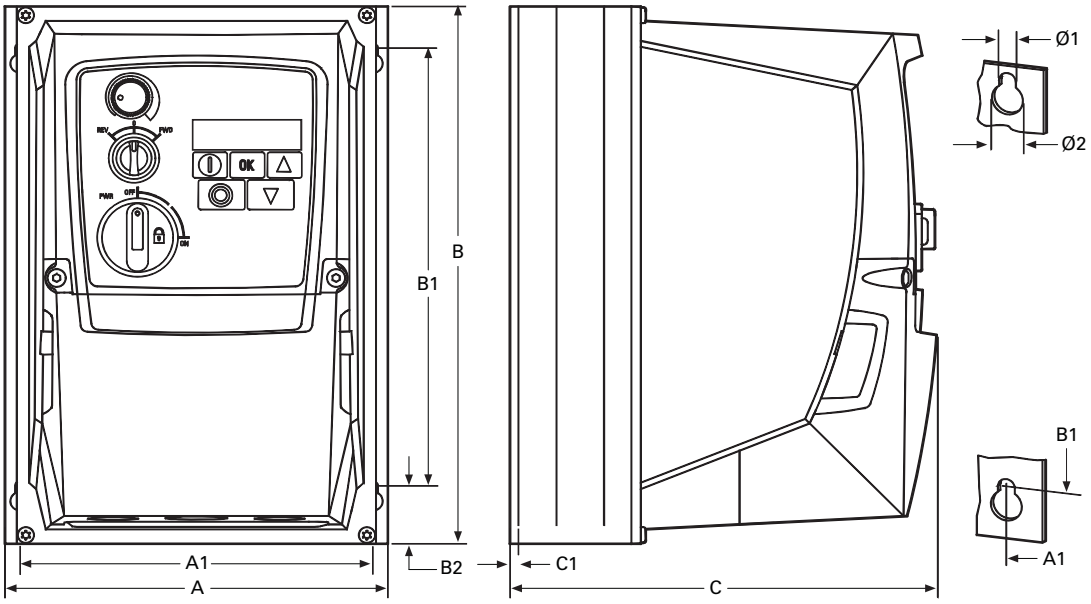


Figure 31.1-4. DC1, Sizes FS1–FS3, Degree of Protection IP66/NEMA 4, with Local Controls

31

Frame Size	A	A1	B	B1	B2	C	C1	Ø1	Ø2	Weight Lb (kg)
FS1	6.34 (161.0)	5.85 (148.5)	9.13 (232.0)	7.44 (189.0)	0.98 (25.0)	7.24 (184.0)	0.14 (3.5)	0.15 (4.0)	0.31 (8.0)	6.17 (2.8)
FS2	7.40 (188.0)	6.93 (176.0)	10.12 (257.0)	7.87 (200.0)	1.12 (28.5)	7.58 (192.0)	0.14 (3.5)	0.16 (4.2)	0.33 (8.5)	11.02 (5.0)
FS3	8.29 (210.5)	7.78 (197.5)	12.20 (310.0)	9.90 (251.5)	1.31 (33.4)	9.21 (234.0)	0.14 (3.5)	0.16 (4.2)	0.33 (8.5)	18.08 (8.2)

PowerXL DG1 Series Drives

DG1 General Purpose Drive

Product Description

The DG1 general purpose drives are part of Eaton's next generation PowerXL Series of adjustable frequency drives specifically engineered for today's more demanding commercial and industrial applications. The power unit makes use of the most sophisticated semiconductor technology and a highly modular construction that can be flexibly adapted to meet the customer's needs.

The control module was designed to include today's standard communication protocols and I/O while still having the modularity to add additional option cards.

Eaton's patented Active Energy Control is also a standard feature on DG1 drives, offering customers increased efficiency, safety and reliability.

These drives continue the tradition of robust performance and raise the bar on features and functionality, ensuring the best solution at the right price.

Product Range

- 230 V to 125 hp, 312 A, 90 kW
- 480 V to 250 hp, 310 A, 160 kW
- 575 V to 250 hp, 250 A, 160 kW

Features and Benefits

Harmonic Reduction

- All DG-1 Drives have a DC choke as standard
- Line and load reactors are available as an option, consult factory for sizing

Hardware

- Brake chopper standard on Frames 1, 2, 3
- Dual overload ratings
  - 110% variable torque (I_L)
  - 150% constant torque (I_H)
- Type 1/IP21 and Type 12/IP54 enclosures available
- Integrated common mode reduction 5% DC link choke with input surge protection
- EMI/RFI filters standard on all drives—meets EMC Category C2
- Real-time clock—supports calendaring and PLC functionality
- Graphic LCD display and keypad—supports simple menu navigation as well as on-screen diagnostics and troubleshooting
- LOCAL/REMOTE operation from keypad and two configurable soft keys
- Conformal coated control and power boards standard
- Control logic can be powered from an external auxiliary control panel—internal drive functions and fieldbus if necessary
- Standard I/O:
  - 8DI, 1DO
  - 2AI, 2AO
  - 2FC, 1FA relays
- Standard communications:
  - EtherNet/IP, Modbus TCP
  - RS-485: Modbus RTU, BACnet MS/TP
- Seamless integration into EtherNet/IP networks via EIP-Assist I/O tag-generation tool
- Two expansion slots—intended to support additional I/O or communication protocols as necessary
- Quick disconnect terminals for I/O connections—supports fast easy installation
- Safe Torque Off (STO) built-in with functional safety SIL1 certification

Dynamic Braking

- Available on all DG-1 drives
- Consult factory for sizing and options

Software

- Active Energy Control®—minimizes energy losses in your motor, resulting in industry-leading energy efficiency for your application
- Quick Start Wizard upon initial power-up supports fast, easy installation
- Standard applications:
  - Standard
  - Multi-pump and fan Control
  - Multi-PID
  - Multi-purpose
- Copy/paste functionality on drive keypad—allows for fast setup of multiple drives
- Pre-programmed I/O—supports fast, easy installation for most applications
- Dynamic motor regenerative energy management
- Advanced PC Tool with diagnostic capabilities
- Two keypad software keys for easy menu navigation and shortcuts

Standards and Certifications

Product

- IEC/EN 61800-5-1
- IEC/EN 61800-5-2
- UL 508C
- IEC 61508
- EN 62061
- EN ISO 13849-1

EMC

- Immunity: IEC/EN 61800-3
- Category C2

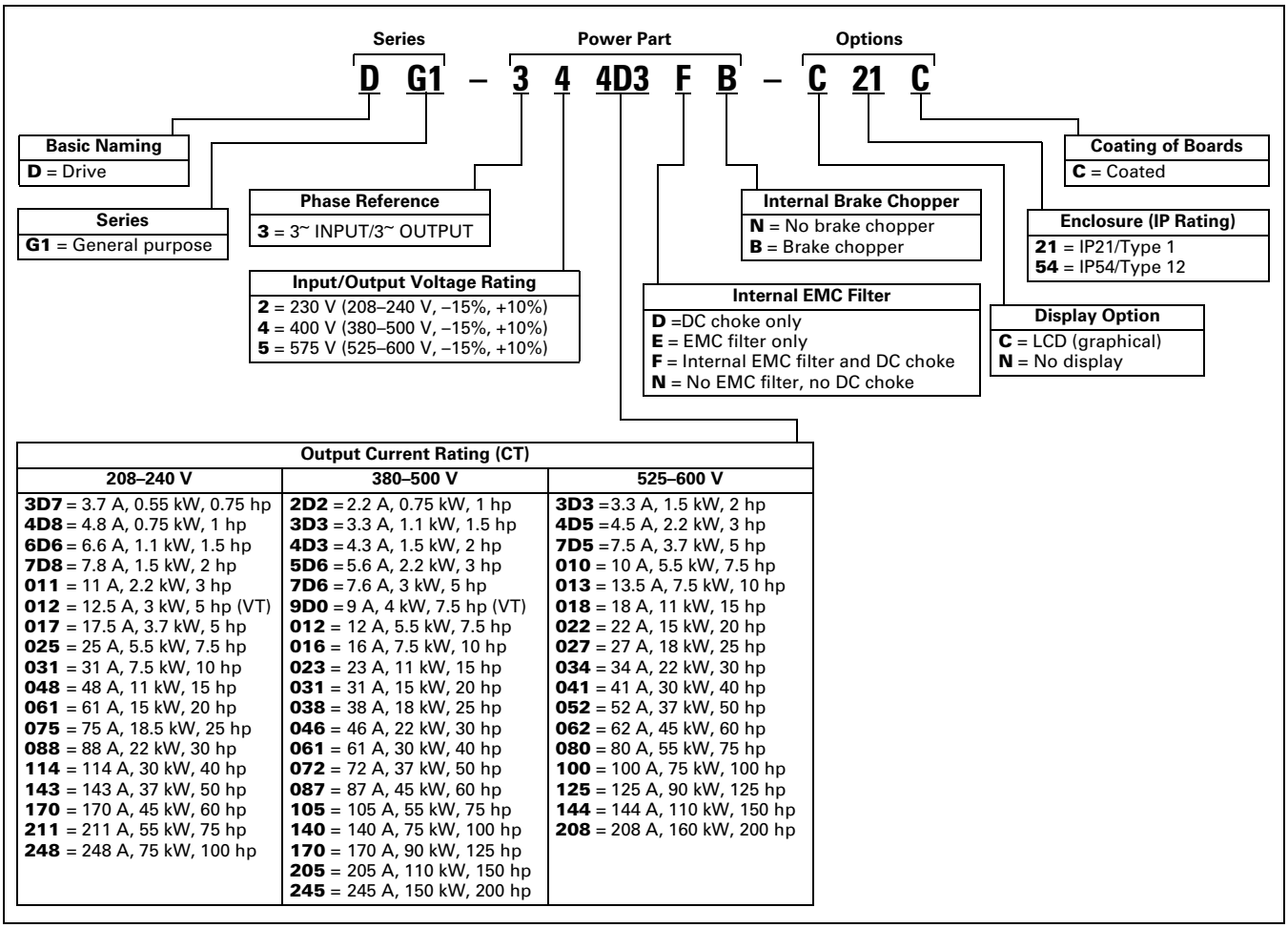
Certification

- UL
- cUL
- CE
- C-Tick
- RoHS
- EAC
- Plenum rated

Catalog Number Selection

Catalog Number Selection is for illustrative purposes only and not to be used to create new catalog numbers.

Table 31.1-25. PowerXL Series—DG1 General Purpose Drive



Output Current Rating (CT)		
208–240 V	380–500 V	525–600 V
3D7 = 3.7 A, 0.55 kW, 0.75 hp	**2D2** = 2.2 A, 0.75 kW, 1 hp	**3D3** = 3.3 A, 1.5 kW, 2 hp
4D8 = 4.8 A, 0.75 kW, 1 hp	**3D3** = 3.3 A, 1.1 kW, 1.5 hp	**4D5** = 4.5 A, 2.2 kW, 3 hp
6D6 = 6.6 A, 1.1 kW, 1.5 hp	**4D3** = 4.3 A, 1.5 kW, 2 hp	**7D5** = 7.5 A, 3.7 kW, 5 hp
7D8 = 7.8 A, 1.5 kW, 2 hp	**5D6** = 5.6 A, 2.2 kW, 3 hp	**010** = 10 A, 5.5 kW, 7.5 hp
011 = 11 A, 2.2 kW, 3 hp	**7D6** = 7.6 A, 3 kW, 5 hp	**013** = 13.5 A, 7.5 kW, 10 hp
012 = 12.5 A, 3 kW, 5 hp (VT)	**9D0** = 9 A, 4 kW, 7.5 hp (VT)	**018** = 18 A, 11 kW, 15 hp
017 = 17.5 A, 3.7 kW, 5 hp	**012** = 12 A, 5.5 kW, 7.5 hp	**022** = 22 A, 15 kW, 20 hp
025 = 25 A, 5.5 kW, 7.5 hp	**016** = 16 A, 7.5 kW, 10 hp	**027** = 27 A, 18 kW, 25 hp
031 = 31 A, 7.5 kW, 10 hp	**023** = 23 A, 11 kW, 15 hp	**034** = 34 A, 22 kW, 30 hp
048 = 48 A, 11 kW, 15 hp	**031** = 31 A, 15 kW, 20 hp	**041** = 41 A, 30 kW, 40 hp
061 = 61 A, 15 kW, 20 hp	**038** = 38 A, 18 kW, 25 hp	**052** = 52 A, 37 kW, 50 hp
075 = 75 A, 18.5 kW, 25 hp	**046** = 46 A, 22 kW, 30 hp	**062** = 62 A, 45 kW, 60 hp
088 = 88 A, 22 kW, 30 hp	**061** = 61 A, 30 kW, 40 hp	**080** = 80 A, 55 kW, 75 hp
114 = 114 A, 30 kW, 40 hp	**072** = 72 A, 37 kW, 50 hp	**100** = 100 A, 75 kW, 100 hp
143 = 143 A, 37 kW, 50 hp	**087** = 87 A, 45 kW, 60 hp	**125** = 125 A, 90 kW, 125 hp
170 = 170 A, 45 kW, 60 hp	**105** = 105 A, 55 kW, 75 hp	**144** = 144 A, 110 kW, 150 hp
211 = 211 A, 55 kW, 75 hp	**140** = 140 A, 75 kW, 100 hp	**208** = 208 A, 160 kW, 200 hp
248 = 248 A, 75 kW, 100 hp	**170** = 170 A, 90 kW, 125 hp	
	205 = 205 A, 110 kW, 150 hp	
	245 = 245 A, 150 kW, 200 hp	

Table 31.1-26. PowerXL Series—DG1 General Purpose Option Boards

DX G – NET – PROFIBUS

Basic Naming	Series	Type	Function
DX = PowerXL Drive	**G** = General purpose	**NET** = Communication card **EXT** = I/O card **ACC** = Accessory **SPR** = Spare part **KEY** = Keypad **CBL** = Cable	**PROFIBUS** = PROFIBUS **DEVICENET** = DeviceNet **CANOPEN** = CANopen **SWD** = SmartWire See Accessories on **Page 31.1-10** for full offering

Product Selection

Table 31.1-27. DG1 Series Drives—208–240 V

Frame Size	Constant Torque (CT) / High Overload (I_H)			Variable Torque (VT) / Low Overload (I_L)			Catalog Number
	230 V, 50 Hz kW Rating	230 V, 60 Hz hp	Current A	230 V, 50 Hz kW Rating	230 V, 60 Hz hp	Current A	
Type 1/IP21							
FR1	0.55 0.75 1.1	0.75 1 1.5	3.7 4.8 6.6	0.75 1.1 1.5	1 1.5 2	4.8 6.6 7.8	**DG1-323D7FB-C21C** **DG1-324D8FB-C21C** **DG1-326D6FB-C21C**
	1.5 2.2	2 3	7.8 11	2.2 3	3 —	11 12.5	**DG1-327D8FB-C21C** **DG1-32011FB-C21C**
FR2	3 3.7 5.5	— 5 7.5	12.5 17.5 25	3.7 5.5 7.5	5 7.5 10	17.5 25 31	**DG1-32012FB-C21C** **DG1-32017FB-C21C** **DG1-32025FB-C21C**
FR3	7.5 11	10 15	31 48	11 15	15 20	48 61	**DG1-32031FB-C21C** **DG1-32048FB-C21C**
FR4	15 18.5 22	20 25 30	61 75 88	18.5 22 30	25 30 40	75 88 114	**DG1-32061FN-C21C** **DG1-32075FN-C21C** **DG1-32088FN-C21C**
FR5	30 37 45	40 50 60	114 143 170	37 45 55	50 60 75	143 170 211	**DG1-32114FN-C21C** **DG1-32143FN-C21C** **DG1-32170FN-C21C**
FR6 ①	55 75	75 100	211 248	75 90	100 125	261 312	**DG1-32211FN-C21C** **DG1-32248FN-C21C**
Type 12/IP54							
FR1	0.55 0.75 1.1	0.75 1 1.5	3.7 4.8 6.6	0.75 1.1 1.5	1 1.5 2	4.8 6.6 7.8	**DG1-323D7FB-C54C** **DG1-324D8FB-C54C** **DG1-326D6FB-C54C**
	1.5 2.2	2 3	7.8 11	2.2 3	3 —	11 12.5	**DG1-327D8FB-C54C** **DG1-32011FB-C54C**
FR2	3 3.7 5.5	— 5 7.5	12.5 17.5 25	3.7 5.5 7.5	5 7.5 10	17.5 25 31	**DG1-32012FB-C54C** **DG1-32017FB-C54C** **DG1-32025FB-C54C**
FR3	7.5 11	10 15	31 48	11 15	15 20	48 61	**DG1-32031FB-C54C** **DG1-32048FB-C54C**
FR4	15 18.5 22	20 25 30	61 75 88	18.5 22 30	25 30 40	75 88 114	**DG1-32061FN-C54C** **DG1-32075FN-C54C** **DG1-32088FN-C54C**
FR5	30 37 45	40 50 60	114 143 170	37 45 55	50 60 75	143 170 211	**DG1-32114FN-C54C** **DG1-32143FN-C54C** **DG1-32170FN-C54C**
FR6 ①	55 75	75 100	211 248	75 90	100 125	261 312	**DG1-32211FN-C54C** **DG1-32248FN-C54C**

① FR6 available in 2016.

Table 31.1-28. DG1 Series Drives—380–500 V

Frame Size	Constant Torque (CT) / High Overload (I_H)			Variable Torque (VT) / Low Overload (I_L)			Catalog Number
	400 V, 50 Hz kW Rating	460 V, 60 Hz hp	Current A	400 V, 50 Hz kW Rating	460 V, 60 Hz hp	Current A	
Type 1/IP24							
FR1	0.75	1	2.2	1.1	1.5	3.3	**DG1-342D2FB-C21C**
	1.1	1.5	3.3	1.5	2	4.3	**DG1-343D3FB-C21C**
	1.5	2	4.3	2.2	3	5.6	**DG1-344D3FB-C21C**
	2.2	3	5.6	3	5	7.6	**DG1-345D6FB-C21C**
	3	5	7.6	4	—	9	**DG1-347D6FB-C21C**
	4	—	9	5.5	7.5	12	**DG1-349D0FB-C21C**
FR2	5.5	7.5	12	7.5	10	16	**DG1-34012FB-C21C**
	7.5	10	16	11	15	23	**DG1-34016FB-C21C**
	11	15	23	15	20	31	**DG1-34023FB-C21C**
FR3	15	20	31	18.5	25	38	**DG1-34031FB-C21C**
	18.5	25	38	22	30	46	**DG1-34038FB-C21C**
	22	30	46	30	40	61	**DG1-34046FB-C21C**
FR4	30	40	61	37	50	72	**DG1-34061FN-C21C**
	37	50	72	45	60	87	**DG1-34072FN-C21C**
	45	60	87	55	75	105	**DG1-34087FN-C21C**
FR5	55	75	105	75	100	140	**DG1-34105FN-C21C**
	75	100	140	90	125	170	**DG1-34140FN-C21C**
	90	125	170	110	150	205	**DG1-34170FN-C21C**
FR6 ①	110	150	205	132	200	261	**DG1-34205FN-C21C**
	150	200	245	160	250	310	**DG1-34245FN-C21C**
Type 12/IP54							
FR1	0.75	1	2.2	1.1	1.5	3.3	**DG1-342D2FB-C54C**
	1.1	1.5	3.3	1.5	2	4.3	**DG1-343D3FB-C54C**
	1.5	2	4.3	2.2	3	5.6	**DG1-344D3FB-C54C**
	2.2	3	5.6	3	5	7.6	**DG1-345D6FB-C54C**
	3	5	7.6	4	—	9	**DG1-347D6FB-C54C**
	4	—	9	5.5	7.5	12	**DG1-349D0FB-C54C**
FR2	5.5	7.5	12	7.5	10	16	**DG1-34012FB-C54C**
	7.5	10	16	11	15	23	**DG1-34016FB-C54C**
	11	15	23	15	20	31	**DG1-34023FB-C54C**
FR3	15	20	31	18.5	25	38	**DG1-34031FB-C54C**
	18.5	25	38	22	30	46	**DG1-34038FB-C54C**
	22	30	46	30	40	61	**DG1-34046FB-C54C**
FR4	30	40	61	37	50	72	**DG1-34061FN-C54C**
	37	50	72	45	60	87	**DG1-34072FN-C54C**
	45	60	87	55	75	105	**DG1-34087FN-C54C**
FR5	55	75	105	75	100	140	**DG1-34105FN-C54C**
	75	100	140	90	125	170	**DG1-34140FN-C54C**
	90	125	170	110	150	205	**DG1-34170FN-C54C**
FR6 ①	110	150	205	132	200	261	**DG1-34205FN-C54C**
	150	200	245	160	250	310	**DG1-34245FN-C54C**

① FR6 available in 2016.

Table 31.1-29. DG1 Series Drives—575 V

Frame Size	Constant Torque (CT) / High Overload (I_H)			Variable Torque (VT) / Low Overload (I_L)			Catalog Number
	575 V, 60 Hz kW Rating	575 V, 60 Hz hp	Current A	575 V, 60 Hz kW Rating	575 V, 60 Hz hp	Current A	
Type 1/IP21							
FR1	1.5 2.2 3.7	2 3 5	3.3 4.5 7.5	2.2 3.7 5.5	3 5 7.5	4.5 7.5 10	**DG1-353D3FB-C21C** **DG1-354D5FB-C21C** **DG1-357D5FB-C21C**
FR2	5.5 7.5 11	7.5 10 15	10 13.5 18	7.5 11 15	10 15 20	13.5 18 22	**DG1-35010FB-C21C** **DG1-35013FB-C21C** **DG1-35018FB-C21C**
FR3	15 18.5 22	20 25 30	22 27 34	18.5 22 30	25 30 40	27 34 41	**DG1-35022FB-C21C** **DG1-35027FB-C21C** **DG1-35034FB-C21C**
FR4	30 37 45	40 50 60	41 52 62	37 45 55	50 60 75	52 62 80	**DG1-35041FN-C21C** **DG1-35052FN-C21C** **DG1-35062FN-C21C**
FR5	55 75 90	75 100 125	80 100 125	75 90 110	100 125 150	100 125 144	**DG1-35080FN-C21C** **DG1-35100FN-C21C** **DG1-35125FN-C21C**
FR6 ①	110 150	150 200	144 208	150 187	200 250	208 250	**DG1-35144FN-C21C** **DG1-35208FN-C21C**
Type 12/IP54							
FR1	1.5 2.2 3.7	2 3 5	3.3 4.5 7.5	2.2 3.7 5.5	3 5 7.5	4.5 7.5 10	**DG1-353D3FB-C54C** **DG1-354D5FB-C54C** **DG1-357D5FB-C54C**
FR2	5.5 7.5 11	7.5 10 15	10 13.5 18	7.5 11 15	10 15 20	13.5 18 22	**DG1-35010FB-C54C** **DG1-35013FB-C54C** **DG1-35018FB-C54C**
FR3	15 18.5 22	20 25 30	22 27 34	18.5 22 30	25 30 40	27 34 41	**DG1-35022FB-C54C** **DG1-35027FB-C54C** **DG1-35034FB-C54C**
FR4	30 37 45	40 50 60	41 52 62	37 45 55	50 60 75	52 62 80	**DG1-35041FN-C54C** **DG1-35052FN-C54C** **DG1-35062FN-C54C**
FR5	55 75 90	75 100 125	80 100 125	75 90 110	100 125 150	100 125 144	**DG1-35080FN-C54C** **DG1-35100FN-C54C** **DG1-35125FN-C54C**
FR6 ①	110 150	150 200	144 208	150 187	200 250	208 250	**DG1-35144FN-C54C** **DG1-35208FN-C54C**

① FR6 available in 2016.

Accessories

The PowerXL Series—DG1 drives can accommodate a wide selection of expander and adapter option boards to customize the drive for your application needs. The drive's control unit is designed to accept a total of two additional option boards.

The PowerXL Series—DG1 drives come with a factory-installed standard board configuration including the following:

- Standard I/O:
  - 8DI, 1DO
  - 2AI, 2AO
  - 2FC, 1FA relays
- Standard communications:
  - EtherNet/IP, Modbus TCP
  - RS-485: Modbus RTU, BACnet MS/TP

Table 31.1-30. PowerXL Series—DG1 I/O Card Kits

Description	Catalog Number
3 x DI, 3 x DO, 1 x thermistor, 24 Vdc/EXT option card	DXG-EXT-3DI3DO1T
1 x AI, 2 x AO (isolated to control board) option card	DXG-EXT-1AI2AO
3 x relay dry contact (2NO + 1NO/NC) option card	DXG-EXT-3RO
3 x PT100 RTD thermistor input option card	DXG-EXT-THER1
6 x DI 240 Vac input option card	DXG-EXT-6DI

Table 31.1-31. PowerXL Series—DG1 Communication Card Kits

Description	Catalog Number
PROFIBUS-DP communication card	DXG-NET-PROFIBUS
CANopen communication card	DXG-NET-CANOPEN
DeviceNet communication card	DXG-NET-DEVICENET
PROFIBUS DB9 to 5-pin adapter card	DXG-MNT-PROFIBUS
SmartWire communication card and module	DXG-NET-SWD

Table 31.1-32. PowerXL Series—DG1 Keypad Kits

Description	Catalog Number
Standard keypad	DXG-KEY-LCD
Remote keypad kit (IP 54 rated keypad holder and 3 m cable)	DXG-KEY-RMTKIT
1 m remote keypad cable	DXG-CBL-1M0
3 m remote keypad cable	DXG-CBL-3M0
Remote keypad mounting holder only	DXG-KEY-HOLDER
Type 12/IP54 keypad hole plug (maintain rating without keypad)	DXG-KEY-N12PLUG

PowerXL Series—DG1 Conversion and Flange Kits

The Type 12/IP54 option kit is used to convert a Type 1/IP21 to a Type 12/IP54 drive. The kit includes cover, fan and grommets.

Table 31.1-33. Type 12/IP54 Conversion Kits ①

Description	Catalog Number
Frame 1 230 V Type 12/IP54 kit	DXG-ACC-2FR1N12KIT
Frame 1 480 V Type 12/IP54 kit	DXG-ACC-4FR1N12KIT
Frame 2 Type 12/IP54 kit	DXG-ACC-FR2N12KIT

① For Frame 3 and above, consult factory.

The flange kit is used when the power section heat sink is mounted through the back panel of an enclosure. The kit includes hardware, top flange plate, bottom flange plate and two side flange plates.

Table 31.1-34. Flange Kits

Description	Catalog Number
Frame 1 flange kit Type 12/IP54	DXG-ACC-FR1N12FK
Frame 2 flange kit Type 12/IP54	DXG-ACC-FR2N12FK
Frame 3 flange kit Type 12/IP54	DXG-ACC-FR3N12FK
Frame 4 flange kit Type 12/IP54	DXG-ACC-FR4N12FK
Frame 5 flange kit Type 12/IP54	DXG-ACC-FR5N12FK

PowerXL Series—DG1 Demo Units

Table 31.1-35. Demo Units

Description	Catalog Number
DG1 control module demo stand	DG1-DEMO1
DG1 full drive demo case	DG1-DEMO2

Technical Data and Specifications

Table 31.1-36. PowerXL Series—DG1 Technical Data and Specifications

Attribute	Description	Specification
Input ratings	Input voltage U_{in}	208 V to 240 V, 380 V to 500 V, 525 V to 600 V, –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 and FR6)
	Short-circuit withstand rating	100 kAIC (fuses and circuit breakers)
Output ratings	Output voltage	0 to U_{in}
	Continuous output current	I_L: ambient temperature maximum 40 °C, up to 60 °C with derating, overload 1.1 x I_L (1 min./10 min.) I_H: ambient temperature maximum 50 °C, up to 60 °C with derating, overload 1.5 x I_H (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	230 V / 480 V range: FR1–3: 1 kHz to 12 kHz FR4–6: 1 kHz to 10 kHz 230 V / 480 V defaults: FR1–3: 4 kHz FR4–5: 3.6 kHz FR6: 2 kHz 575 V range: FR1–6: 1 kHz to 6 kHz 575 V defaults: FR1–4: 3 kHz FR5–6: 2 kHz Automatic switching frequency derating in case of overload.
	Frequency reference	Analog input: resolution 0.1% (10-bit), accuracy +1% Analog output: 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 +60 °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) For 575 V product, maximum altitude is 6561 ft (2000 m) regardless of main system

Table 31.1-36. PowerXL Series—DG1 Technical Data and Specifications (Continued)

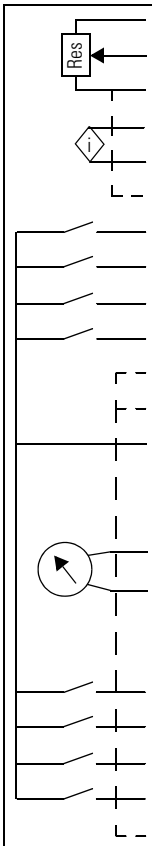
Attribute	Description	Specification
Ambient conditions (continued)	Vibration: • EN 61800-5-1 • EN 60668-2-6	5–150 Hz Displacement amplitude: 1 mm (peak) at 5 Hz to 15.8 Hz (FR1–FR6) Maximum acceleration amplitude: 1g at 15.8 Hz to 150 Hz (FR1–FR6)
	Shock: • ISTA 1 A • EN 60068-2-27	Storage and shipping: 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 2016
	Noise	FR1: 51.2 dB FR2: 58.6 dB FR3: 61.0 dB FR4: 68.0 dB FR5: 69.1 dB FR6: Available in 2016
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	EAC, RCM (C-Tick), RoHS, CE, UL and cUL (see nameplate for more detailed approvals)
Fieldbus connections		Onboard: EtherNet/IP, Modbus® TCP, Modbus RTU, BACnet

Table 31.1-36. PowerXL Series—DG1 Technical Data and Specifications (Continued)

Attribute	Description	Specification
Safety/protections	Overvoltage protection	Yes
	Overvoltage trip limit	230 V drives: 456 V 480 V drives: 911 V 575 V drives: 1100 V
	Undervoltage protection	Yes
	Undervoltage trip limit	230 V drives: 211 V 480 V drives: 370 V 575 V drives: 550 V
	Earth fault protection	Yes Default: 15% motor FLA Minimum: 0% motor FLA Maximum: 30% motor FLA
	Input phase supervision	Yes
	Motor phase supervision	Yes
	Overcurrent protection	Trip limit 4.0 x IH instantaneously
	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 24 V reference voltages	Yes
	Surge protection	Yes (differential mode 2 kV; common mode 4 kV 230 V drives: 275 Vac, 10,000 A 480 V drives: 320 Vac, 8000 A 575 V drives: 385 Vac, 10,000 A
	Common coated boards	Yes (prevents corrosion)
Efficiency	Drive efficiency ratings	480 V: FR1 = 97.7% FR2 = 97.9% FR3 = 97.7% FR4 = 98.0% FR5 = 98.2% 230 V: FR1 = 96.7% FR2 = 97.4% FR3 = 97.2% FR4 = 97.4% FR5 = 97.7%

Wiring Diagram

Table 31.1-37. PowerXL Series—DG1 Control Wiring Diagram

External Wiring	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 0–10 V)
	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	—	—
	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	24 V	+24 Vdc Output	—	Control voltage output (100 mA max.)
	14	DO1	Digital Output 1	Ready	Shows the drive is ready to run
	15	24 Vo	+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	24 Vi	+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		

Note: The above wiring demonstrates a SINK configuration. It is important that CMA and CMB are wired to ground (as shown by dashed line). If a SOURCE configuration is desired, wire 24 V to CMA and CMB and close the inputs to ground. When using the +10 V for AI1, it is important to wire AI1– to ground (as shown by dashed line). If using +10 V for AI1 or AI2, terminals 3, 5 and 6 need to be jumpered together.

Control Board Layout

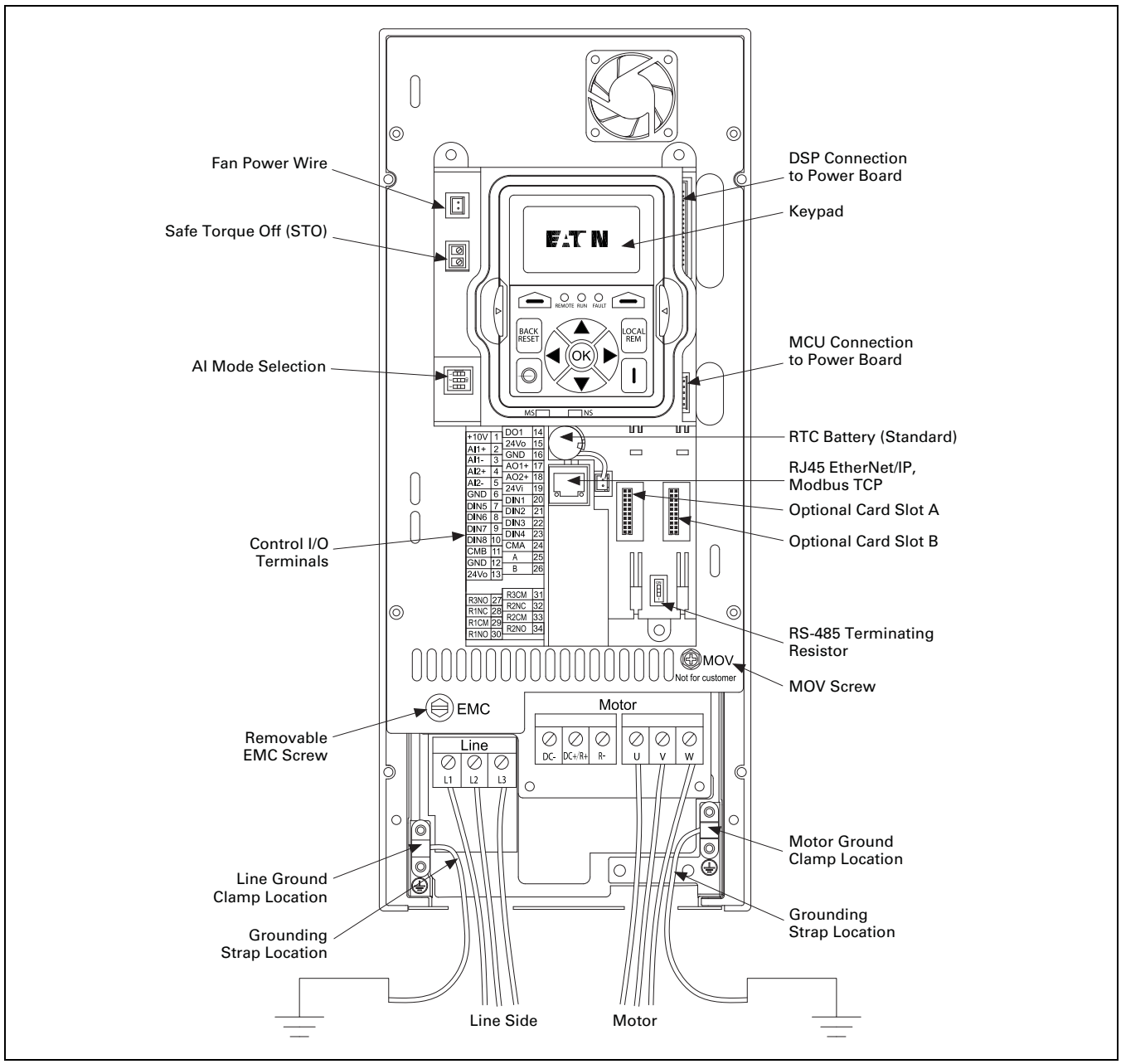


Figure 31.1-5. PowerXL Series—DG1 Control Board Layout

Dimensions—Approximate Dimensions in Inches (mm)

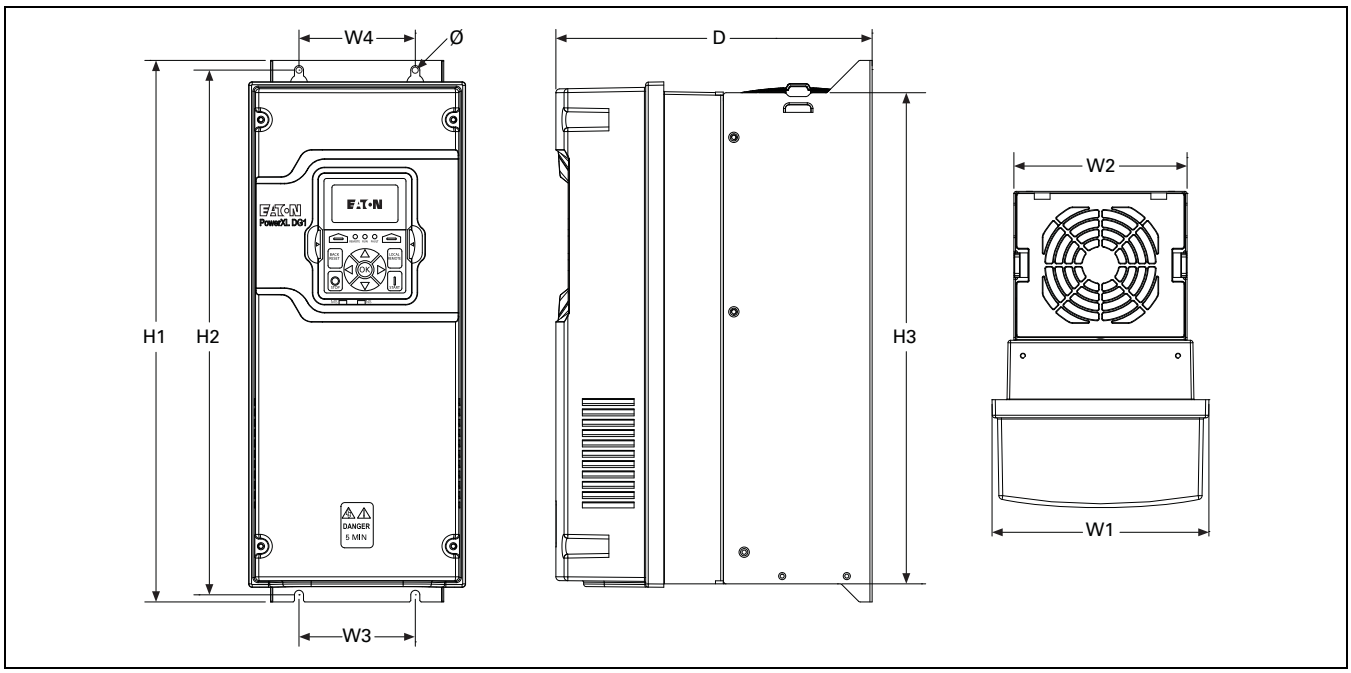


Figure 31.1-6. PowerXL Series—DG1 Dimensions

Frame Size	Voltage	hp (CT/I_H)	kW	Amperes (VT/I_L)	Approximate Dimensions in Inches (mm)									Weight Lb (kg)
					D	H1	H2	H3	W1	W2	W3	W4	Ø	
FR1	230 Vac	0.75–3	0.55–2.2	3.5–11	7.91 (200.9)	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	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	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)	20.41 (518.5)	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	20–30	15–22	22–34										
FR4	230 Vac	20–30	15–22	61–88	11.57 (294.0)	24.80 (629.9)	24.31 (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	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	75–125	55–90	80–125										
FR6 ①	230 Vac	75–100	55–75	211–248	①	①	①	①	①	①	①	①	①	①
	480 Vac	150–200	110–150	205–261										
	575 Vac	150–200	110–160	144–208										

① FR6 available in 2016.

EGS Enclosed DG1

DG1 General Purpose Drive Enclosed Drive

Product Description

The DG1 Enclosed Drive family incorporates the latest Eaton drive technology into pre-engineered enclosed solutions covering the industry's most common applications. Using the benefits of the PowerXL DG1, the enclosed family provides enhanced user safety with the Safe Torque feature as well as industry-leading energy efficiency from the patented Active Energy Control algorithm. Eaton further raises the bar by providing customers with industry best lead times with the Rapid Response System. This system allows customers to select from 9 million standard configurations that have been pre-engineered with each configuration having a set lead time. The Rapid Response System delivers an improved quotation process and a faster delivery.

Features and Benefits

- Dual rated for both constant torque (CT) / high overload (I_H) and variable torque (VT) / low overload applications
- Optional Brake Chopper for external braking applications
- Available circuit breaker, motor circuit protector, fused disconnect, isolation fusing and surge protection device options to provide input power protection
- Optional 3% input and output reactors provide a reduction in voltage and current harmonics on both line and load side
- Bypass options include a standard three-contactor design and a reduced voltage soft starter design
- Output contactor option provides a means for positive disconnection of the drive output from the motor terminals
- MotoRX and dV/dt filter options are used to reduce transients voltages at the motor terminals
- Customizable cover control options
- Padlockable disconnect
- The PowerXL DG1 comes standard with the following communication protocols:
  - ❑ EtherNet/IP
  - ❑ Modbus/TCP
  - ❑ Modbus RTU
  - ❑ BACnet MS/TP

Communication Options

- PROFIBUS-DP
- LonWorks
- CANopen
- DeviceNet

Enclosure Ratings

- NEMA Type 1
- NEMA Type 12
- NEMA Type 3R

Mounting

- Wall mount
- Floor mount: 12-inch legs
- Floor mount: 22-inch legs

Product Range

- 208 V: 0.75–100 hp
- 230 V: 0.75–125 hp
- 480 V: 1–250 hp
- 230 V single-phase: 1–60 hp
- 480 V single-phase: 1.5–125 hp

Standards and Certifications

- UL 508C tested, listed and approved
- OSHPD

Technical Specifications

- See PowerXL DG1 open drive for technical specifications (**Table 31.1-36**)
- See PowerXL DG1 open drive (**Table 31.1-37**) for control wiring

Catalog Number Selection

Catalog Number Selection is for illustrative purposes only and not to be used to create new catalog numbers.

Table 31.1-38. DG1 Enclosed—Base Catalog Number

EGS 3D5 1 D 1 _ _ _ _ _ _

Product Family
EGS = Enclosed DG1 drives—standard

Output Ampere Rating

208 V	230 V	480 V
3D5 = 3.5 A, 0.75 hp	**3D2** = 3.2 A, 0.75 hp	**2D1** = 2.1 A, 1 hp
4D6 = 4.6 A, 1 hp	**4D2** = 4.2 A, 1 hp	**3D0** = 3.0 A, 1.5 hp
6D6 = 6.6 A, 1.5 hp	**6D0** = 6.0 A, 1.5 hp	**3D4** = 3.4 A, 2 hp
7D5 = 7.5 A, 2 hp	**6D8** = 6.8 A, 2 hp	**4D8** = 4.8 A, 3 hp
010 = 10.6 A, 3 hp	**9D6** = 9.6 A, 3 hp	**7D6** = 7.6 A, 5 hp
016 = 16.7 A, 5 hp	**015** = 15.2, 5 hp	**011** = 11 A, 7.5 hp
024 = 24.2 A, 7.5 hp	**022** = 22 A, 7.5 hp	**014** = 14 A, 10 hp
030 = 30.8 A, 10 hp	**028** = 28 A, 10 hp	**021** = 21 A, 15 hp
046 = 46.2 A, 15 hp	**042** = 42 A, 15 hp	**027** = 27 A, 20 hp
059 = 59.4 A, 20 hp	**054** = 54 A, 20 hp	**034** = 34 A, 25 hp
074 = 74.8 A, 25 hp	**068** = 68 A, 25 hp	**040** = 40 A, 30 hp
088 = 88 A, 30 hp	**080** = 80 A, 30 hp	**052** = 52 A, 40 hp
114 = 114 A, 40 hp	**104** = 104 A, 40 hp	**065** = 65 A, 50 hp
143 = 143 A, 50 hp	**130** = 130 A, 50 hp	**077** = 77 A, 60 hp
169 = 169 A, 60 hp	**154** = 154 A, 60 hp	**096** = 96 A, 75 hp
211 = 211 A, 75 hp	**192** = 192 A, 75 hp	**124** = 124 A, 100 hp
273 = 273 A, 100 hp	**248** = 248 A, 100 hp	**156** = 156 A, 125 hp
	312 = 312 A, 125 hp	**180** = 180 A, 150 hp
		240 = 240 A, 200 hp
		302 = 302 A, 250 hp

Phasing, Voltage
1 = Input: Three-phase, 208 V
Output: Three-phase
2 = Input: Three-phase, 230 V
Output: Three-phase
4 = Input: Three-phase, 480 V
Output: Three-phase
5 = Input: Three-phase, 575 V
Output: Three-phase
J = Input: Single-phase, 230 V
Output: Three-phase
K = Input: Single-phase, 480 V
Output: Three-phase

Braking Application ①
A = No brake chopper, low overload
B = Brake chopper, low overload
C = No brake chopper, high overload
D = Brake chopper, high overload

Enclosure Rating ②
1 = NEMA Type 1
2 = NEMA Type 12
3 = NEMA Type 3R
6 = NEMA Type 1 Filtered and gasketed
• = Custom option

Options ③
See **Page 31.1-30** for catalog number option selection.

① Brake chopper is a factory-installed option only. Braking resistors sold separately. See DG1 drives starting on **Page 31.1-31** for selection.
② Additional enclosure options including NEMA 4, 4X, 7 and 9 are available. Please contact the factory for configuration and pricing.
③ Part number configuration continued on the following page.

Table 31.1-39. DG1 Enclosed—Base Catalog Number

EGS 3D5 1 D 1 **2 0 0 B 1 0 0 0 0**

Base Catalog Number Example

See **Page 31.1-29** for base catalog number selection.

Power Disconnect Options

0 = None
1 = MCP disconnect ①
2 = Circuit breaker
3 = Circuit breaker/isolation fusing
4 = Circuit breaker/isolation fusing/3% input reactor
5 = Circuit breaker/isolation fusing/SPD
6 = Circuit breaker/isolation fusing/SPD/3% input reactor
7 = Circuit breaker/3% input reactor
8 = Circuit breaker/SPD
9 = Circuit breaker/SPD/3% input reactor
A = Fused disconnect
B = Fused disconnect/SPD
C = Fused disconnect/SPD/3% input reactor
D = Fused disconnect/3% input reactor
E = Isolation fuses
F = Isolation fuses/3% input reactor
G = Isolation fuses/SPD
H = Isolation fuses/SPD/3% input reactor
• = Custom option ②

Bypass Options ③

0 = None
1 = Manual HOA bypass
2 = Manual HOA bypass/isolation fusing
3 = Manual HOA bypass/isolation fusing/3% input reactor
4 = Manual HOA bypass/isolation fusing/SPD
5 = Manual HOA bypass/isolation fusing/SPD/3% input reactor
6 = Manual HOA bypass/3% input reactor
7 = Manual HOA bypass/SPD
8 = Manual HOA bypass/SPD/3% input reactor
H = Manual HOA RVSS bypass
J = Manual HOA RVSS bypass/isolation fusing
K = Manual HOA RVSS bypass/isolation fusing/3% input reactor
L = Manual HOA RVSS bypass/isolation fusing/SPD
M = Manual HOA RVSS bypass/isolation fusing/SPD/3% input reactor
N = Manual HOA RVSS bypass/3% input reactor
P = Manual HOA RVSS bypass/SPD
R = Manual HOA RVSS bypass/SPD/3% input reactor
• = Custom option ②

Output Power Options ④

0 = None
A = Output contactor
B = 3% Output reactor
C = MotoRX filter
D = dV/dt filter
E = 3% Output Reactor/ = output contactor
F = MotoRX/output contactor
G = dV/dt/output contactor
• = Custom option ②

Control Options ⑤

0 = None
1 = Speed pot
2 = Start-stop pushbutton
3 = Start-stop pushbutton with speed pot
A = HOA switch
B = Start-stop pushbutton with speed pot and HOA switch
C = Start-stop pushbutton with HOA switch
D = HOA switch with speed pot
• = Custom option ②

Option Boards 2

Same options and codes as Option Boards 1

Option Boards 1

0 = No option
1 = 3 x DI, 3 x DO, 1 Thermistor, 24 Vdc/EXT (DG1 only)
2 = 1 x AI, 2 x AO (isolated to control board) (DG1 only)
3 = 3 x relay dry contact (2NO + 1NO/NC) (DG1 only)
4 = 3 x PT100 RTD thermistor input (DG1 only)
5 = 6 DI 240 Vac input (DG1 only)
6 = 6 DI, 1 ext +24 Vdc/EXT +24 Vdc (SVX only)
7 = 1 RO (NC-NO), 1 RO (NO), 1 therm (SVX only)
8 = 1 AI (mA isolated), 2 AO (mA isolated), 1 ext +24 Vdc/EXT +24 Vdc (SVX only)
9 = 3 RO (NO) (SVX only)
A = 1 ext +24 Vdc/EXT +24 Vdc, 3 Pt100 (SVX only)
B = 1 RO (NO), 5 DI 42–240 Vac input (SVX only)
C = Encoder low volt +5 V / 15 V / 24 V (high-performance drive only)
D = Encoder high volt +15 V / 24 V (high-performance drive only)
E = Double encoder (high-performance drive only)
• = Custom option ②

Communication Options

0 = No option
1 = PROFIBUS-DP
2 = LonWorks (SVX only)
3 = CANopen (slave)
4 = DeviceNet
5 = PROFIBUS-DP (D9 connector)
6 = Modbus (SVX only)
7 = Modbus (D9 connector) (SVX only)
8 = Johnson Controls N2 (SVX only)
9 = Modbus TCP (SVX only)
A = BACnet (SVX only)
B = EtherNet/IP (SVX only)
C = RS-232 with D9 connector (SVX only)
D = SmartWire-DT (DG1 only)
• = Custom option ②

Enclosure Options

0 = None
1 = Floor stand—12 inches
2 = Floor stand—22 inches
A = Space heater
B = Space heater and 12-inch floor stands
C = Space heater and 22-inch floor stands
• = Custom option ②

Light Options ⑤

0 = None
1 = Non-bypass light kit—Power On, Run, Fault
2 = Bypass light kit—On, VFD Run, Fault, Bypass Run
• = Custom option ②

① HMCP disconnect option required and only available when bypass is selected.
② More options are available as Engineered to Order through the Bid Manager tool.
③ All bypass options include third contactor for drive isolation when in bypass mode.
④ Output contactor not available with bypass. Bypass comes standard with output contactor.
⑤ Pilot devices are 22 mm standard. 30 mm options are available as engineered to order through the Bid Manager tool

Production Selection

Table 31.1-40. 208 V Drives—Constant Torque (CT)/High Overload (I_H) Enclosed Drives

hp	Current (A)	Drive Frame Size	NEMA Type 1	NEMA Type 12	NEMA Type 3R
			Base Catalog Number ①	Base Catalog Number ①	Base Catalog Number ①
0.75	3.5	1	EGS3D51D1	EGS3D51D2	EGS3D51D3
1	4.6	1	EGS4D61D1	EGS4D61D2	EGS4D61D3
1.5	6.6	1	EGS6D61D1	EGS6D61D2	EGS6D61D3
2	7.5	1	EGS7D51D1	EGS7D51D2	EGS7D51D3
3	10.6	1	EGS0101D1	EGS0101D2	EGS0101D3
5	16.7	2	EGS0161D1	EGS0161D2	EGS0161D3
7.5	24.2	2	EGS0241D1	EGS0241D2	EGS0241D3
10	30.8	3	EGS0301D1	EGS0301D2	EGS0301D3
15	46.2	3	EGS0461D1	EGS0461D2	EGS0461D3
20	59.4	4	EGS0591C1	EGS0591C2	EGS0591C3
25	74.8	4	EGS0741C1	EGS0741C2	EGS0741C3
30	88	4	EGS0881C1	EGS0881C2	EGS0881C3
40	114	5	EGS1141C1	EGS1141C2	EGS1141C3
50	143	5	EGS1431C1	EGS1431C2	EGS1431C3
60	169	5	EGS1691C1	EGS1691C2	EGS1691C3
75	211	6	EGS2111C1	EGS2111C2	EGS2111C3
100 ②	261 ②	6	EGS2611C1	EGS2611C2	EGS2611C3

① Table is for base catalog number reference only. For complete catalog number selection, see **Page 31.1-30**.
② These units are current rated. They do not meet NEC ampere rating at this horsepower.

Table 31.1-41. 208 V Drives—Variable Torque (VT)/Low Overload (I_L) Enclosed Drives

hp	Current (A)	Drive Frame Size	NEMA Type 1	NEMA Type 12	NEMA Type 3R
			Base Catalog Number ③	Base Catalog Number ③	Base Catalog Number ③
1	4.6	1	EGS4D61B1	EGS4D61B2	EGS4D61B3
1.5	6.6	1	EGS6D61B1	EGS6D61B2	EGS6D61B3
2	7.5	1	EGS7D51B1	EGS7D51B2	EGS7D51B3
3	10.6	1	EGS0101B1	EGS0101B2	EGS0101B3
5	16.7	2	EGS0161B1	EGS0161B2	EGS0161B3
7.5	24.2	2	EGS0241B1	EGS0241B2	EGS0241B3
10	30.8	2	EGS0301B1	EGS0301B2	EGS0301B3
15	46.2	3	EGS0461B1	EGS0461B2	EGS0461B3
20	59.4	3	EGS0591B1	EGS0591B2	EGS0591B3
25	74.8	4	EGS0741A1	EGS0741A2	EGS0741A3
30	88	4	EGS0881A1	EGS0881A2	EGS0881A3
40	114	4	EGS1141A1	EGS1141A2	EGS1141A3
50	143	5	EGS1431A1	EGS1431A2	EGS1431A3
60	169	5	EGS1691A1	EGS1691A2	EGS1691A3
75	211	5	EGS2111A1	EGS2111A2	EGS2111A3
100	273	6	EGS2731A1	EGS2731A2	EGS2731A3

③ Table is for base catalog number reference only. For complete catalog number selection, see **Page 31.1-30**.

Table 31.1-42. 230 V Drives—Constant Torque (CT)/High Overload (I_H) Enclosed Drives

hp	Current (A)	Drive Frame Size	NEMA Type 1	NEMA Type 12	NEMA Type 3R
			Base Catalog Number ①	Base Catalog Number ①	Base Catalog Number ①
0.75	3.2	1	EGS3D22D1	EGS3D22D2	EGS3D22D3
1	4.2	1	EGS4D22D1	EGS4D22D2	EGS4D22D3
1.5	6	1	EGS6D02D1	EGS6D02D2	EGS6D02D3
2	6.8	1	EGS6D82D1	EGS6D82D2	EGS6D82D3
3	9.6	1	EGS9D62D1	EGS9D62D2	EGS9D62D3
5	15.2	2	EGS0152D1	EGS0152D2	EGS0152D3
7.5	22	2	EGS0222D1	EGS0222D2	EGS0222D3
10	28	3	EGS0282D1	EGS0282D2	EGS0282D3
15	42	3	EGS0422D1	EGS0422D2	EGS0422D3
20	54	4	EGS0542C1	EGS0542C2	EGS0542C3
25	68	4	EGS0682C1	EGS0682C2	EGS0682C3
30	80	4	EGS0802C1	EGS0802C2	EGS0802C3
40	104	5	EGS1042C1	EGS1042C2	EGS1042C3
50	130	5	EGS1302C1	EGS1302C2	EGS1302C3
60	154	5	EGS1542C1	EGS1542C2	EGS1542C3
75	192	6	EGS1922C1	EGS1922C2	EGS1922C3
100	248	6	EGS2482C1	EGS2482C2	EGS2482C3

① Table is for base catalog number reference only. For complete catalog number selection, see **Page 31.1-30**.

Table 31.1-43. 230 V Drives—Variable Torque (VT)/Low Overload (I_L) Enclosed Drives

hp	Current (A)	Drive Frame Size	NEMA Type 1	NEMA Type 12	NEMA Type 3R
			Base Catalog Number ②	Base Catalog Number ②	Base Catalog Number ②
1	4.2	1	EGS4D22B1	EGS4D22B2	EGS4D22B3
1.5	6	1	EGS6D02B1	EGS6D02B2	EGS6D02B3
2	6.8	1	EGS6D82B1	EGS6D82B2	EGS6D82B3
3	9.6	1	EGS9D62B1	EGS9D62B2	EGS9D62B3
5	15.2	2	EGS0152B1	EGS0152B2	EGS0152B3
7.5	22	2	EGS0222B1	EGS0222B2	EGS0222B3
10	28	2	EGS0282B1	EGS0282B2	EGS0282B3
15	42	3	EGS0422B1	EGS0422B2	EGS0422B3
20	54	3	EGS0542B1	EGS0542B2	EGS0542B3
25	68	4	EGS0682A1	EGS0682A2	EGS0682A3
30	80	4	EGS0802A1	EGS0802A2	EGS0802A3
40	104	4	EGS1042A1	EGS1042A2	EGS1042A3
50	130	5	EGS1302A1	EGS1302A2	EGS1302A3
60	154	5	EGS1542A1	EGS1542A2	EGS1542A3
75	192	5	EGS1922A1	EGS1922A2	EGS1922A3
100	248	6	EGS2482A1	EGS2482A2	EGS2482A3
125	312	6	EGS3122A1	EGS3122A2	EGS3122A3

② Table is for base catalog number reference only. For complete catalog number selection, see **Page 31.1-30**.

Table 31.1-44. 480 V Drives—Constant Torque (CT)/High Overload (I_H) Enclosed Drives

hp	Current (A)	Drive Frame Size	NEMA Type 1	NEMA Type 12	NEMA Type 3R
			Base Catalog Number ①	Base Catalog Number ①	Base Catalog Number ①
1	2.1	1	EGS2D14D1	EGS2D14D2	EGS2D14D3
1.5	3	1	EGS3D04D1	EGS3D04D2	EGS3D04D3
2	3.4	1	EGS3D44D1	EGS3D44D2	EGS3D44D3
3	4.8	1	EGS4D84D1	EGS4D84D2	EGS4D84D3
5	7.6	1	EGS7D64D1	EGS7D64D2	EGS7D64D3
7.5	11	2	EGS0114D1	EGS0114D2	EGS0114D3
10	14	2	EGS0144D1	EGS0144D2	EGS0144D3
15	21	2	EGS0214D1	EGS0214D2	EGS0214D3
20	27	3	EGS0274D1	EGS0274D2	EGS0274D3
25	34	3	EGS0344D1	EGS0344D2	EGS0344D3
30	40	3	EGS0404D1	EGS0404D2	EGS0404D3
40	52	4	EGS0524C1	EGS0524C2	EGS0524C3
50	65	4	EGS0654C1	EGS0654C2	EGS0654C3
60	77	4	EGS0774C1	EGS0774C2	EGS0774C3
75	96	5	EGS0964C1	EGS0964C2	EGS0964C3
100	124	5	EGS1244C1	EGS1244C2	EGS1244C3
125	156	5	EGS1564C1	EGS1564C2	EGS1564C3
150	180	6	EGS1804C1	EGS1804C2	EGS1804C3
200	240	6	EGS2404C1	EGS2404C2	EGS2404C3

① Table is for base catalog number reference only. For complete catalog number selection, see **Page 31.1-30**.

Table 31.1-45. 480 V Drives—Variable Torque (VT)/Low Overload (I_L) Enclosed Drives

hp	Current (A)	Drive Frame Size	NEMA Type 1	NEMA Type 12	NEMA Type 3R
			Base Catalog Number ②	Base Catalog Number ②	Base Catalog Number ②
1.5	3	1	EGS3D04B1	EGS3D04B2	EGS3D04B3
2	3.4	1	EGS3D44B1	EGS3D44B2	EGS3D44B3
3	4.8	1	EGS4D84B1	EGS4D84B2	EGS4D84B3
5	7.6	1	EGS7D64B1	EGS7D64B2	EGS7D64B3
7.5	11	1	EGS0114B1	EGS0114B2	EGS0114B3
10	14	2	EGS0144B1	EGS0144B2	EGS0144B3
15	21	2	EGS0214B1	EGS0214B2	EGS0214B3
20	27	2	EGS0274B1	EGS0274B2	EGS0274B3
25	34	3	EGS0344B1	EGS0344B2	EGS0344B3
30	40	3	EGS0404B1	EGS0404B2	EGS0404B3
40	52	3	EGS0524B1	EGS0524B2	EGS0524B3
50	65	4	EGS0654A1	EGS0654A2	EGS0654A3
60	77	4	EGS0774A1	EGS0774A2	EGS0774A3
75	96	4	EGS0964A1	EGS0964A2	EGS0964A3
100	124	5	EGS1244A1	EGS1244A2	EGS1244A3
125	156	5	EGS1564A1	EGS1564A2	EGS1564A3
150	180	5	EGS1804A1	EGS1804A2	EGS1804A3
200	240	6	EGS2404A1	EGS2404A2	EGS2404A3
250	302	6	EGS3024A1	EGS3024A2	EGS3024A3

② Table is for base catalog number reference only. For complete catalog number selection, see **Page 31.1-30**.

Table 31.1-46. 230 V Single-Phase Drives—Variable Torque (VT)/Low Overload (I_L) Enclosed Drives

hp	Current (A)	Drive Frame Size	NEMA Type 1	NEMA Type 12	NEMA Type 3R
			Base Catalog Number ①	Base Catalog Number ①	Base Catalog Number ①
1	4.2	1	EGS4D2JB1	EGS4D2JB2	EGS4D2JB3
1.5	6	1	EGS6D0JB1	EGS6D0JB2	EGS6D0JB3
2	6.8	1	EGS6D8JB1	EGS6D8JB2	EGS6D8JB3
3	9.6	1	EGS9D6JB1	EGS9D6JB2	EGS9D6JB3
5	15.2	2	EGS015JB1	EGS015JB2	EGS015JB3
7.5	22	2	EGS022JB1	EGS022JB2	EGS022JB3
10	28	2	EGS028JB1	EGS028JB2	EGS028JB3
15	42	3	EGS042JB1	EGS042JB2	EGS042JB3
20	54	3	EGS054JB1	EGS054JB2	EGS054JB3
25	68	4	EGS068JA1	EGS068JA2	EGS068JA3
30	80	4	EGS080JA1	EGS080JA2	EGS080JA3
40	104	4	EGS104JA1	EGS104JA2	EGS104JA3
50	130	5	EGS130JA1	EGS130JA2	EGS130JA3
60	154	5	EGS154JA1	EGS154JA2	EGS154JA3

① Table is for base catalog number reference only. For complete catalog number selection, see **Page 31.1-30**.

Table 31.1-47. 480 V Single-Phase Drives—Variable Torque (VT)/Low Overload (I_L) Enclosed Drives

hp	Current (A)	Drive Frame Size	NEMA Type 1	NEMA Type 12	NEMA Type 3R
			Base Catalog Number ②	Base Catalog Number ②	Base Catalog Number ②
1.5	3	1	EGS3D0KB1	EGS3D0KB2	EGS3D0KB3
2	3.4	1	EGS3D4KB1	EGS3D4KB2	EGS3D4KB3
3	4.8	1	EGS4D8KB1	EGS4D8KB2	EGS4D8KB3
5	7.6	1	EGS7D6KB1	EGS7D6KB2	EGS7D6KB3
7.5	11	1	EGS011KB1	EGS011KB2	EGS011KB3
10	14	2	EGS014KB1	EGS014KB2	EGS014KB3
15	21	2	EGS021KB1	EGS021KB2	EGS021KB3
20	27	2	EGS027KB1	EGS027KB2	EGS027KB3
25	34	3	EGS034KB1	EGS034KB2	EGS034KB3
30	40	3	EGS040KB1	EGS040KB2	EGS040KB3
40	52	3	EGS052KB1	EGS052KB2	EGS052KB3
50	65	4	EGS065KA1	EGS065KA2	EGS065KA3
60	77	4	EGS077KA1	EGS077KA2	EGS077KA3
75	96	4	EGS096KA1	EGS096KA2	EGS096KA3
100	124	5	EGS124KA1	EGS124KA2	EGS124KA3
125	156	5	EGS156KA1	EGS156KA2	EGS156KA3

② Table is for base catalog number reference only. For complete catalog number selection, see **Page 31.1-30**.

Options

Table 31.1-48. Input Power Options

Option	Description
HMCP Disconnect	The HMCP motor protection circuit breaker uses an electronic trip unit to provide typical motor overload relay functionality and short-circuit protection against potential phase-to-phase or phase-to-ground faults.
Circuit Breaker	Utilizes a circuit breaker to provide a means of short-circuit protection for the power cables between it and the drive, and protection from high-level ground faults on the power cable. Allows a convenient means of disconnecting the drive from the line, and the operating mechanism can be padlocked in the OFF position. This is factory mounted in the enclosure.
Isolation Fusing	Provides high-level fault protection of the drive input power circuit from the load side of the fuses to the input side of the power transistors. This option consists of three 200 kA fuses that are factory mounted in the enclosure.
3% Input Reactor	The input reactor is a three-phase series inductance on the line side of an AFD. It is used to provide a reduction in voltage and current harmonics. It also provides increased input protection for AFD and its semiconductors from line transients.
SPD	Provides a surge protection device (SPD) connected to the line side terminals and is designed to clip line side transients.
Fused Disconnect	Utilizes fusing to provide a means of short-circuit protection for the power cables between it and the drive, and protection from high-level ground faults on the power cable. Allows a convenient means of disconnecting the drive from the line, and the operating mechanism can be padlocked in the OFF position. This is factory mounted in the enclosure.

Table 31.1-49. Bypass Options

Option	Description
Manual HOA Bypass	Provides a three-position selector switch that allows the user to select either a HAND or AUTO mode of operation. HAND mode is defaulted keypad operation, and AUTO mode is defaulted to control from an external terminal source. These modes of operation can be configured via programming to allow for alternate combinations of start and speed sources. Start and speed sources include keypad, I/O and fieldbus.
Manual HOA RVSS Bypass	This option adds a reduced voltage soft starter to bypass assembly for soft starting in bypass mode.

Table 31.1-50. Output Power Options

Option	Description
Output Contactor	Provides a means for positive disconnection of the drive output from the motor terminals. The contactor coil is controlled by the drive's run or permissive logic. NC and NO auxiliary contacts rated at 10 A, 600 Vac are provided for customer use. This option includes a low VA 115 Vac fused control power transformer and is factory mounted in the enclosure.
3% Output Reactor	The output reactor is a three-phase series inductance on the load side of an AFD. It is used to provide a reduction in voltage and current harmonics.
MotoRX Filter	Used to reduce transient voltage (dV/dt) and peak voltages at the motor terminals. This option is comprised of a 0.5% line reactor, followed by capacitive filtering and an energy recovery/clamping circuit. Unlike the traditional dV/dt filter, the MotoRx recovers most of the energy from the voltage peaks, resulting in a lower voltage drop to the motor, therefore conserving power. This option is used when the distance between a single motor and the drive is 300–600 ft (91–183 m). This option can not be used with the brake chopper circuit. in this case, the traditional dV/dt filter should be investigated as an alternative.
dV/dt Filter	Used to reduce the transient voltage (dV/dt) at the motor terminals. The traditional dV/dt filter is recommended for cable lengths exceeding 100 ft (30 m) with a drive of 3 hp and above, for cable lengths of 33 ft (10 m) with a drive of 2 hp and below, or for a drive rated at 525–690 V. This option is mounted in the enclosure and may be used in conjunction with a brake chopper circuit. This option is mounted in the enclosure.

Table 31.1-51. Control Options

Option	Description
Speed Pot	Provides the ability to adjust the frequency reference using a door-mounted potentiometer. This option uses the 10 Vdc reference to generate a 0–10 V signal at the analog voltage input signal terminal. When the HOA bypass option is added, the speed is controlled when the HOA switch is in the HAND position. Without the HOA bypass option, a two-position switch (labeled local/remote) is provided on the keypad to select speed reference from the speed potentiometer or a remote speed signal.
HOA Switch	Provides a three-position selector switch that allows the user to select either a HAND or AUTO mode of peration. HAND mode is defaulted to keypad operation, and AUTO mode is defaulted to control from an external terminal source. These modes of operation can be configured via drive programming to allow for alternate combinations of start and speed sources. Start and speed sources include Keypad, I/O and fieldbus.
Start-Stop Pushbutton	Provides door-mounted START and STOP pushbuttons for either bypass or non-bypass configurations.

Table 31.1-52. Light Options

Option	Description
Non-Bypass Light Kit—Power On, Run, Fault	Provides a white POWER ON light that indicates power to the enclosed cabinet, a green RUN light that indicates the drive is running and a red FAULT light that indicates a drive fault has occurred.
Bypass Light Kit—On, VFD Run, Fault, Bypass Run	Provides a white POWER ON light that indicates power to the enclosed cabinet, a green RUN light that indicates the drive is running, a red FAULT light that indicates a drive fault has occurred and an amber light that indicates when the motor is running in Bypass mode.

Table 31.1-53. Enclosure Options

Option	Description
Floor Stand 12 in	Converts a normally wall-mounted enclosure to a floor-standing enclosure with a height of 12 in (304.8 mm).
Floor Stand 22 in	Converts a normally wall-mounted enclosure to a floor-standing enclosure with a height of 22 in (558.8 mm).

EGF Passive Filtered DG1

EGF Enclosed Drives

Product Description

Eaton's Enclosed EGF Drives combine harmonic distortion reduction and true power factor performance with the latest in Eaton adjustable frequency drive technology to deliver an industry-leading solution. This pre-engineered passive filtered solution prevents transformer overheating and overloading of breakers and feeders, which enables the application of adjustable frequency drives on generators and other high impedance power systems.

Features and Benefits

- Tuned passive filter
- Delivers 5–8% THD
- Generator compatible
- Uses the same DG1, SVX or SPX drive that is stocked in the warehouse
- Simple to retrofit
- Provides a low-impedance path to ground for the harmonic frequencies
- Meets IEEE 519-2014
- Excellent cost for performance
- Small footprint, compact enclosure design
- Insensitive to voltage imbalance
- Customizable cover control options
- Padlockable disconnect
- The PowerXL DG1 comes standard with the following communication protocols:
  - EtherNet/IP
  - Modbus/TCP
  - Modbus RTU
  - BACnet MS/TP

Communication Options

- PROFIBUS-DP
- LonWorks
- CANopen
- DeviceNet

Enclosure Ratings

- NEMA Type 1
- NEMA Type 12
- NEMA Type 3R

Mounting

- Wall mount
- Floor mount: 12-inch legs
- Floor mount: 22-inch legs

Product Range

- 208 V: 0.75–100 hp
- 230 V: 0.75–125 hp
- 480 V: 1–250 hp

Standards and Certifications

- UL 508C tested, listed and approved
- OSHPD

Catalog Number Selection

Catalog Number Selection is for illustrative purposes only and not to be used to create new catalog numbers.

Table 31.1-54. EGF Enclosed—Base Catalog Number

EGF 3D5 1 D 1 _ _ _ _ _ _

Product Family

EGF = Enclosed DG1 drives—passive filtered

Output Ampere Rating

208 V	230 V	480 V
3D5 = 3.5 A, 0.75 hp	**3D2** = 3.2 A, 0.75 hp	**2D1** = 2.1 A, 1 hp
4D6 = 4.6 A, 1 hp	**4D2** = 4.2 A, 1 hp	**3D0** = 3.0 A, 1.5 hp
6D6 = 6.6 A, 1.5 hp	**6D0** = 6.0 A, 1.5 hp	**3D4** = 3.4 A, 2 hp
7D5 = 7.5 A, 2 hp	**6D8** = 6.8 A, 2 hp	**4D8** = 4.8 A, 3 hp
010 = 10.6 A, 3 hp	**9D6** = 9.6 A, 3 hp	**7D6** = 7.6 A, 5 hp
016 = 16.7 A, 5 hp	**015** = 15.2, 5 hp	**011** = 11 A, 7.5 hp
024 = 24.2 A, 7.5 hp	**022** = 22 A, 7.5 hp	**014** = 14 A, 10 hp
030 = 30.8 A, 10 hp	**028** = 28 A, 10 hp	**021** = 21 A, 15 hp
046 = 46.2 A, 15 hp	**042** = 42 A, 15 hp	**027** = 27 A, 20 hp
059 = 59.4 A, 20 hp	**054** = 54 A, 20 hp	**034** = 34 A, 25 hp
074 = 74.8 A, 25 hp	**068** = 68 A, 25 hp	**040** = 40 A, 30 hp
088 = 88 A, 30 hp	**080** = 80 A, 30 hp	**052** = 52 A, 40 hp
114 = 114 A, 40 hp	**104** = 104 A, 40 hp	**065** = 65 A, 50 hp
143 = 143 A, 50 hp	**130** = 130 A, 50 hp	**077** = 77 A, 60 hp
169 = 169 A, 60 hp	**154** = 154 A, 60 hp	**096** = 96 A, 75 hp
211 = 211 A, 75 hp	**192** = 192 A, 75 hp	**124** = 124 A, 100 hp
273 = 273 A, 100 hp	**248** = 248 A, 100 hp	**156** = 156 A, 125 hp
	312 = 312 A, 125 hp	**180** = 180 A, 150 hp
		240 = 240 A, 200 hp
		302 = 302 A, 250 hp

Phasing, Voltage

1 = Input: Three-phase, 208 V
Output: Three-phase
2 = Input: Three-phase, 230 V
Output: Three-phase
4 = Input: Three-phase, 480 V
Output: Three-phase
5 = Input: Three-phase, 575 V
Output: Three-phase
J = Input: Single-phase, 230 V
Output: Three-phase
K = Input: Single-phase, 480 V
Output: Three-phase

Braking Application ①

A = No brake chopper, low overload
B = Brake chopper, low overload
C = No brake chopper, high overload
D = Brake chopper, high overload

Enclosure Rating ②

1 = NEMA Type 1
2 = NEMA Type 12
3 = NEMA Type 3R
6 = NEMA Type 1 Filtered
• = Custom option

Options ③

See **Page 31.1-39** for catalog number option selection.

① Brake chopper is a factory-installed option only. Braking resistors sold separately. See DG1 drives starting on **Page 31.1-31** for selection.
② Additional enclosure options including NEMA 4, 4X, 7 and 9 are available. Please contact the factory for configuration and pricing.
③ Part number configuration continued on the following page.

Table 31.1-55. EGF Enclosed—Catalog Number Options

EGF 3D5 1 D 1 2 0 0 B 1 0 0 0 0

Base Catalog Number Example

See **Page 31.1-38** for base catalog number selection.

Power Disconnect Options

0 = None
1 = MCP disconnect ①
2 = Circuit breaker
3 = Circuit breaker/isolation fusing
4 = Circuit breaker/isolation fusing/3% input reactor
5 = Circuit breaker/isolation fusing/SPD
6 = Circuit breaker/isolation fusing/SPD/3% input reactor
7 = Circuit breaker/3% input reactor
8 = Circuit breaker/SPD
9 = Circuit breaker/SPD/3% input reactor
A = Fused disconnect
B = Fused disconnect/SPD
C = Fused disconnect/SPD/3% input reactor
D = Fused disconnect/3% input reactor
E = Isolation fuses
F = Isolation fuses/3% input reactor
G = Isolation fuses/SPD
H = Isolation fuses/SPD/3% input reactor
• = Custom option ②

Bypass Options ③

0 = None
1 = Manual HOA bypass
2 = Manual HOA bypass/isolation fusing
3 = Manual HOA bypass/isolation fusing/3% input reactor
4 = Manual HOA bypass/isolation fusing/SPD
5 = Manual HOA bypass/isolation fusing/SPD/3% input reactor
6 = Manual HOA bypass/3% input reactor
7 = Manual HOA bypass/SPD
8 = Manual HOA bypass/SPD/3% input reactor
H = Manual HOA RVSS bypass
J = Manual HOA RVSS bypass/isolation fusing
K = Manual HOA RVSS bypass/isolation fusing/3% input reactor
L = Manual HOA RVSS bypass/isolation fusing/SPD
M = Manual HOA RVSS bypass/isolation fusing/SPD/3% input reactor
N = Manual HOA RVSS bypass/3% input reactor
P = Manual HOA RVSS bypass/SPD
R = Manual HOA RVSS bypass/SPD/3% input reactor
• = Custom option ②

Output Power Options ④

0 = None
A = Output contactor
B = 3% Output reactor
C = MotoRX filter
D = dV/dt filter
E = 3% Output Reactor/ = output contactor
F = MotoRX/output contactor
G = dV/dt/output contactor
• = Custom option ②

Control Options ⑤

0 = None
1 = Speed pot
2 = Start-stop pushbutton
3 = Start-stop pushbutton with speed pot
A = HOA switch
B = Start-stop pushbutton with speed pot and HOA switch
C = Start-stop pushbutton with HOA switch
D = HOA switch with speed pot
• = Custom option ②

Option Boards 2

Same options and codes as Option Boards 1

Option Boards 1

0 = No option
1 = 3 x DI, 3 x DO, 1 Thermistor, 24 Vdc/EXT (DG1 only)
2 = 1 x AI, 2 x AO (isolated to control board) (DG1 only)
3 = 3 x relay dry contact (2NO + 1NO/NC) (DG1 only)
4 = 3 x PT100 RTD thermistor input (DG1 only)
5 = 6 DI 240 Vac input (DG1 only)
6 = 6 DI, 1 ext +24 Vdc/EXT +24 Vdc (SVX only)
7 = 1 RO (NC-NO), 1 RO (NO), 1 therm (SVX only)
8 = 1 AI (mA isolated), 2 AO (mA isolated), 1 ext +24 Vdc/EXT +24 Vdc (SVX only)
9 = 3 RO (NO) (SVX only)
A = 1 ext +24 Vdc/EXT +24 Vdc, 3 Pt100 (SVX only)
B = 1 RO (NO), 5 DI 42–240 Vac input (SVX only)
C = Encoder low volt +5 V / 15 V / 24 V (high-performance drive only)
D = Encoder high volt +15 V / 24 V (high-performance drive only)
E = Double encoder (high-performance drive only)
• = Custom option ②

Communication Options

0 = No option
1 = PROFIBUS-DP
2 = LonWorks (SVX only)
3 = CANopen (slave)
4 = DeviceNet
5 = PROFIBUS-DP (D9 connector)
6 = Modbus (SVX only)
7 = Modbus (D9 connector) (SVX only)
8 = Johnson Controls N2 (SVX only)
9 = Modbus TCP (SVX only)
A = BACnet (SVX only)
B = EtherNet/IP (SVX only)
C = RS-232 with D9 connector (SVX only)
D = SmartWire-DT (DG1 only)
• = Custom option ②

Enclosure Options

0 = None
1 = Floor stand—12 inches
2 = Floor stand—22 inches
A = Space heater
B = Space heater and 12-inch floor stands
C = Space heater and 22-inch floor stands
• = Custom option ②

Light Options ⑤

0 = None
1 = Non-bypass light kit—Power On, Run, Fault
2 = Bypass light kit—On, VFD Run, Fault, Bypass Run
• = Custom option ②

① HMCP disconnect option required and only available when bypass is selected.
② More options are available as Engineered to Order through the Bid Manager tool.
③ All bypass options include third contactor for drive isolation when in bypass mode.
④ Output contactor not available with bypass. Bypass comes standard with output contactor.
⑤ Pilot devices are 22 mm standard. 30 mm options are available as engineered to order through the Bid Manager tool.

Production Selection

Table 31.1-56. 208 V Drives—Constant Torque (CT)/High Overload (I_H) Enclosed Drives

hp	Current (A)	Drive Frame Size	NEMA Type 1	NEMA Type 12	NEMA Type 3R
			Base Catalog Number ①	Base Catalog Number ①	Base Catalog Number ①
0.75	3.5	1	EGF3D51D1	EGF3D51D2	EGF3D51D3
1	4.6	1	EGF4D61D1	EGF4D61D2	EGF4D61D3
1.5	6.6	1	EGF6D61D1	EGF6D61D2	EGF6D61D3
2	7.5	1	EGF7D51D1	EGF7D51D2	EGF7D51D3
3	10.6	1	EGF0101D1	EGF0101D2	EGF0101D3
5	16.7	2	EGF0161D1	EGF0161D2	EGF0161D3
7.5	24.2	2	EGF0241D1	EGF0241D2	EGF0241D3
10	30.8	3	EGF0301D1	EGF0301D2	EGF0301D3
15	46.2	3	EGF0461D1	EGF0461D2	EGF0461D3
20	59.4	4	EGF0591C1	EGF0591C2	EGF0591C3
25	74.8	4	EGF0741C1	EGF0741C2	EGF0741C3
30	88	4	EGF0881C1	EGF0881C2	EGF0881C3
40	114	5	EGF1141C1	EGF1141C2	EGF1141C3
50	143	5	EGF1431C1	EGF1431C2	EGF1431C3
60	169	5	EGF1691C1	EGF1691C2	EGF1691C3
75	211	6	EGF2111C1	EGF2111C2	EGF2111C3
100 ②	261 ②	6	EGF2611C1	EGF2611C2	EGF2611C3

① Table is for base catalog number reference only. For complete catalog number selection, see **Page 31.1-38**.
② These units are current rated. They do not meet NEC ampere rating at this horsepower.

Table 31.1-57. 208 V Drives—Variable Torque (VT)/Low Overload (I_L) Enclosed Drives

hp	Current (A)	Drive Frame Size	NEMA Type 1	NEMA Type 12	NEMA Type 3R
			Base Catalog Number ③	Base Catalog Number ③	Base Catalog Number ③
1	4.6	1	EGF4D61B1	EGF4D61B2	EGF4D61B3
1.5	6.6	1	EGF6D61B1	EGF6D61B2	EGF6D61B3
2	7.5	1	EGF7D51B1	EGF7D51B2	EGF7D51B3
3	10.6	1	EGF0101B1	EGF0101B2	EGF0101B3
5	16.7	2	EGF0161B1	EGF0161B2	EGF0161B3
7.5	24.2	2	EGF0241B1	EGF0241B2	EGF0241B3
10	30.8	2	EGF0301B1	EGF0301B2	EGF0301B3
15	46.2	3	EGF0461B1	EGF0461B2	EGF0461B3
20	59.4	3	EGF0591B1	EGF0591B2	EGF0591B3
25	74.8	4	EGF0741A1	EGF0741A2	EGF0741A3
30	88	4	EGF0881A1	EGF0881A2	EGF0881A3
40	114	4	EGF1141A1	EGF1141A2	EGF1141A3
50	143	5	EGF1431A1	EGF1431A2	EGF1431A3
60	169	5	EGF1691A1	EGF1691A2	EGF1691A3
75	211	5	EGF2111A1	EGF2111A2	EGF2111A3
100	273	6	EGF2731A1	EGF2731A2	EGF2731A3

③ Table is for base catalog number reference only. For complete catalog number selection, see **Page 31.1-38**.

Table 31.1-58. 230 V Drives—Constant Torque (CT)/High Overload (I_H) Enclosed Drives

hp	Current (A)	Drive Frame Size	NEMA Type 1	NEMA Type 12	NEMA Type 3R
			Base Catalog Number ①	Base Catalog Number ①	Base Catalog Number ①
0.75	3.2	1	EGF3D22D1	EGF3D22D2	EGF3D22D3
1	4.2	1	EGF4D22D1	EGF4D22D2	EGF4D22D3
1.5	6	1	EGF6D02D1	EGF6D02D2	EGF6D02D3
2	6.8	1	EGF6D82D1	EGF6D82D2	EGF6D82D3
3	9.6	1	EGF9D62D1	EGF9D62D2	EGF9D62D3
5	15.2	2	EGF0152D1	EGF0152D2	EGF0152D3
7.5	22	2	EGF0222D1	EGF0222D2	EGF0222D3
10	28	3	EGF0282D1	EGF0282D2	EGF0282D3
15	42	3	EGF0422D1	EGF0422D2	EGF0422D3
20	54	4	EGF0542C1	EGF0542C2	EGF0542C3
25	68	4	EGF0682C1	EGF0682C2	EGF0682C3
30	80	4	EGF0802C1	EGF0802C2	EGF0802C3
40	104	5	EGF1042C1	EGF1042C2	EGF1042C3
50	130	5	EGF1302C1	EGF1302C2	EGF1302C3
60	154	5	EGF1542C1	EGF1542C2	EGF1542C3
75	192	6	EGF1922C1	EGF1922C2	EGF1922C3
100	248	6	EGF2482C1	EGF2482C2	EGF2482C3

① Table is for base catalog number reference only. For complete catalog number selection, see **Page 31.1-38**.

Table 31.1-59. 230 V Drives—Variable Torque (VT)/Low Overload (I_L) Enclosed Drives

hp	Current (A)	Drive Frame Size	NEMA Type 1	NEMA Type 12	NEMA Type 3R
			Base Catalog Number ②	Base Catalog Number ②	Base Catalog Number ②
1	4.2	1	EGF4D22B1	EGF4D22B2	EGF4D22B3
1.5	6	1	EGF6D02B1	EGF6D02B2	EGF6D02B3
2	6.8	1	EGF6D82B1	EGF6D82B2	EGF6D82B3
3	9.6	1	EGF9D62B1	EGF9D62B2	EGF9D62B3
5	15.2	2	EGF0152B1	EGF0152B2	EGF0152B3
7.5	22	2	EGF0222B1	EGF0222B2	EGF0222B3
10	28	2	EGF0282B1	EGF0282B2	EGF0282B3
15	42	3	EGF0422B1	EGF0422B2	EGF0422B3
20	54	3	EGF0542B1	EGF0542B2	EGF0542B3
25	68	4	EGF0682A1	EGF0682A2	EGF0682A3
30	80	4	EGF0802A1	EGF0802A2	EGF0802A3
40	104	4	EGF1042A1	EGF1042A2	EGF1042A3
50	130	5	EGF1302A1	EGF1302A2	EGF1302A3
60	154	5	EGF1542A1	EGF1542A2	EGF1542A3
75	192	5	EGF1922A1	EGF1922A2	EGF1922A3
100	248	6	EGF2482A1	EGF2482A2	EGF2482A3
125	312	6	EGF3122A1	EGF3122A2	EGF3122A3

② Table is for base catalog number reference only. For complete catalog number selection, see **Page 31.1-38**.

Table 31.1-60. 480 V Drives—Constant Torque (CT)/High Overload (I_H) Enclosed Drives

hp	Current (A)	Drive Frame Size	NEMA Type 1	NEMA Type 12	NEMA Type 3R
			Base Catalog Number ①	Base Catalog Number ①	Base Catalog Number ①
1	2.1	1	EGF2D14D1	EGF2D14D2	EGF2D14D3
1.5	3	1	EGF3D04D1	EGF3D04D2	EGF3D04D3
2	3.4	1	EGF3D44D1	EGF3D44D2	EGF3D44D3
3	4.8	1	EGF4D84D1	EGF4D84D2	EGF4D84D3
5	7.6	1	EGF7D64D1	EGF7D64D2	EGF7D64D3
7.5	11	2	EGF0114D1	EGF0114D2	EGF0114D3
10	14	2	EGF0144D1	EGF0144D2	EGF0144D3
15	21	2	EGF0214D1	EGF0214D2	EGF0214D3
20	27	3	EGF0274D1	EGF0274D2	EGF0274D3
25	34	3	EGF0344D1	EGF0344D2	EGF0344D3
30	40	3	EGF0404D1	EGF0404D2	EGF0404D3
40	52	4	EGF0524C1	EGF0524C2	EGF0524C3
50	65	4	EGF0654C1	EGF0654C2	EGF0654C3
60	77	4	EGF0774C1	EGF0774C2	EGF0774C3
75	96	5	EGF0964C1	EGF0964C2	EGF0964C3
100	124	5	EGF1244C1	EGF1244C2	EGF1244C3
125	156	5	EGF1564C1	EGF1564C2	EGF1564C3
150	180	6	EGF1804C1	EGF1804C2	EGF1804C3
200	240	6	EGF2404C1	EGF2404C2	EGF2404C3

① Table is for base catalog number reference only. For complete catalog number selection, see **Page 31.1-38**.

Table 31.1-61. 480 V Drives—Variable Torque (VT)/Low Overload (I_L) Enclosed Drives

hp	Current (A)	Drive Frame Size	NEMA Type 1	NEMA Type 12	NEMA Type 3R
			Base Catalog Number ②	Base Catalog Number ②	Base Catalog Number ②
1.5	3	1	EGF3D04B1	EGF3D04B2	EGF3D04B3
2	3.4	1	EGF3D44B1	EGF3D44B2	EGF3D44B3
3	4.8	1	EGF4D84B1	EGF4D84B2	EGF4D84B3
5	7.6	1	EGF7D64B1	EGF7D64B2	EGF7D64B3
7.5	11	1	EGF0114B1	EGF0114B2	EGF0114B3
10	14	2	EGF0144B1	EGF0144B2	EGF0144B3
15	21	2	EGF0214B1	EGF0214B2	EGF0214B3
20	27	2	EGF0274B1	EGF0274B2	EGF0274B3
25	34	3	EGF0344B1	EGF0344B2	EGF0344B3
30	40	3	EGF0404B1	EGF0404B2	EGF0404B3
40	52	3	EGF0524B1	EGF0524B2	EGF0524B3
50	65	4	EGF0654A1	EGF0654A2	EGF0654A3
60	77	4	EGF0774A1	EGF0774A2	EGF0774A3
75	96	4	EGF0964A1	EGF0964A2	EGF0964A3
100	124	5	EGF1244A1	EGF1244A2	EGF1244A3
125	156	5	EGF1564A1	EGF1564A2	EGF1564A3
150	180	5	EGF1804A1	EGF1804A2	EGF1804A3
200	240	6	EGF2404A1	EGF2404A2	EGF2404A3
250	302	6	EGF3024A1	EGF3024A2	EGF3024A3

② Table is for base catalog number reference only. For complete catalog number selection, see **Page 31.1-38**.

Options

Table 31.1-62. Input Power Options

Option	Description
HMCP Disconnect	The HMCP motor protection circuit breaker uses an electronic trip unit to provide typical motor overload relay functionality and short-circuit protection against potential phase-to-phase or phase-to-ground faults.
Circuit Breaker	Utilizes a circuit breaker to provide a means of short-circuit protection for the power cables between it and the drive, and protection from high-level ground faults on the power cable. Allows a convenient means of disconnecting the drive from the line, and the operating mechanism can be padlocked in the OFF position. This is factory mounted in the enclosure.
Isolation Fusing	Provides high-level fault protection of the drive input power circuit from the load side of the fuses to the input side of the power transistors. This option consists of three 200 kA fuses that are factory mounted in the enclosure.
3% Input Reactor	The input reactor is a three-phase series inductance on the line side of an AFD. It is used to provide a reduction in voltage and current harmonics. It also provides increased input protection for AFD and its semiconductors from line transients.
SPD	Provides a surge protection device (SPD) connected to the line side terminals and is designed to clip line side transients.
Fused Disconnect	Utilizes fusing to provide a means of short-circuit protection for the power cables between it and the drive, and protection from high-level ground faults on the power cable. Allows a convenient means of disconnecting the drive from the line, and the operating mechanism can be padlocked in the OFF position. This is factory mounted in the enclosure.

Table 31.1-63. Bypass Options

Option	Description
Manual HOA Bypass	Provides a three-position selector switch that allows the user to select either a HAND or AUTO mode of operation. HAND mode is defaulted keypad operation, and AUTO mode is defaulted to control from an external terminal source. These modes of operation can be configured via programming to allow for alternate combinations of start and speed sources. Start and speed sources include keypad, I/O and fieldbus.
Manual HOA RVSS Bypass	This option adds a reduced voltage soft starter to bypass assembly for soft starting in bypass mode.

Table 31.1-64. Output Power Options

Option	Description
Output Contactor	Provides a means for positive disconnection of the drive output from the motor terminals. The contactor coil is controlled by the drive's run or permissive logic. NC and NO auxiliary contacts rated at 10 A, 600 Vac are provided for customer use. This option includes a low VA 115 Vac fused control power transformer and is factory mounted in the enclosure.
3% Output Reactor	The output reactor is a three-phase series inductance on the load side of an AFD. It is used to provide a reduction in voltage and current harmonics.
MotoRX Filter	Used to reduce transient voltage () and peak voltages at the motor terminals. This option is comprised of a 0.5% line reactor, followed by capacitive filtering and an energy recovery/clamping circuit. Unlike the traditional filter, the MotoRx recovers most of the energy from the voltage peaks, resulting in a lower voltage drop to the motor, therefore conserving power. This option is used when the distance between a single motor and the drive is 300–600 ft (91–183 m). This option can not be used with the brake chopper circuit. in this case, the traditional filter should be investigated as an alternative.
dV/dt Filter	Used to reduce the transient voltage () at the motor terminals. The traditional filter is recommended for cable lengths exceeding 100 ft (30 m) with a drive of 3 hp and above, for cable lengths of 33 ft (10 m) with a drive of 2 hp and below, or for a drive rated at 525–690 V. This option is mounted in the enclosure and may be used in conjunction with a brake chopper circuit. This option is mounted in the enclosure.

Table 31.1-65. Control Options

Option	Description
Speed Pot	Provides the ability to adjust the frequency reference using a door-mounted potentiometer. This option uses the 10 Vdc reference to generate a 0–10 V signal at the analog voltage input signal terminal. When the HOA bypass option is added, the speed is controlled when the HOA switch is in the HAND position. Without the HOA bypass option, a two-position switch (labeled local/remote) is provided on the keypad to select speed reference from the speed potentiometer or a remote speed signal.
HOA Switch	Provides a three-position selector switch that allows the user to select either a HAND or AUTO mode of operation. HAND mode is defaulted to keypad operation, and AUTO mode is defaulted to control from an external terminal source. These modes of operation can be configured via drive programming to allow for alternate combinations of start and speed sources. Start and speed sources include Keypad, I/O and fieldbus.
Start-Stop Pushbutton	Provides door-mounted START and STOP pushbuttons for either bypass or non-bypass configurations.

Table 31.1-66. Light Options

Option	Description
Non-Bypass Light Kit—Power On, Run, Fault	Provides a white POWER ON light that indicates power to the enclosed cabinet, a green RUN light that indicates the drive is running and a red FAULT light that indicates a drive fault has occurred.
Bypass Light Kit—On, VFD Run, Fault, Bypass Run	Provides a white POWER ON light that indicates power to the enclosed cabinet, a green RUN light that indicates the drive is running, a red FAULT light that indicates a drive fault has occurred and an amber light that indicates when the motor is running in Bypass mode.

Table 31.1-67. Enclosure Options

Option	Description
Floor Stand 12 in	Converts a normally wall-mounted enclosure to a floor-standing enclosure with a height of 12 in (304.8 mm).
Floor Stand 22 in	Converts a normally wall-mounted enclosure to a floor-standing enclosure with a height of 22 in (558.8 mm).

Dimensions—Approximate Dimensions in Inches (mm)

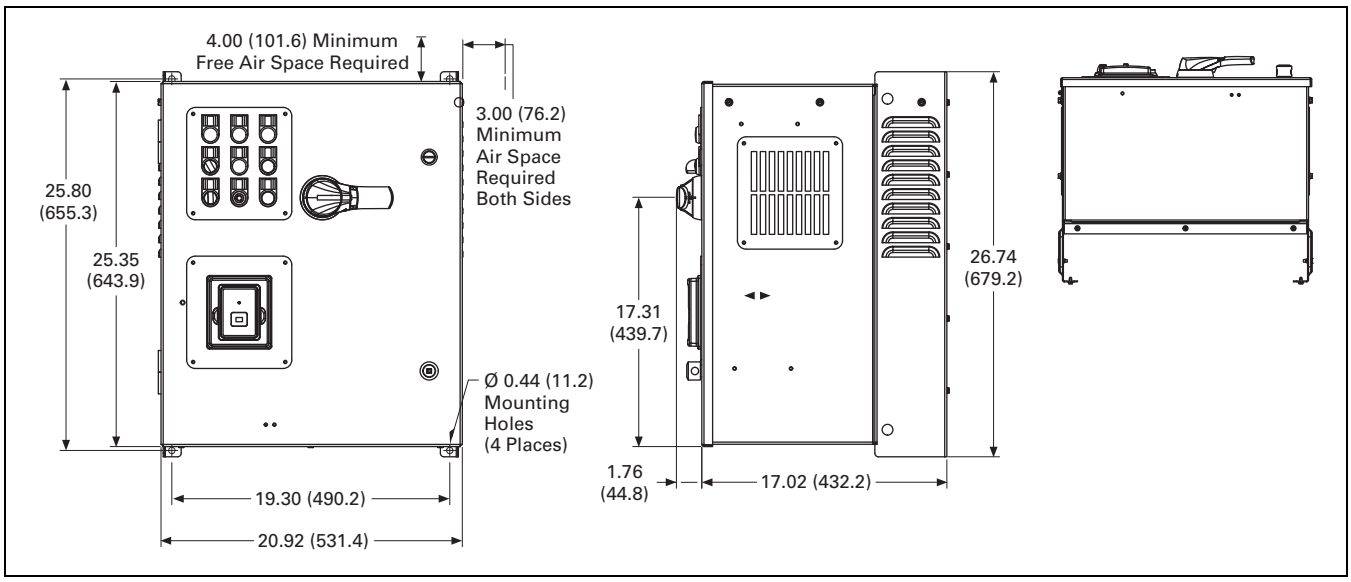


Figure 31.1-7. AX Box, NEMA 1/12

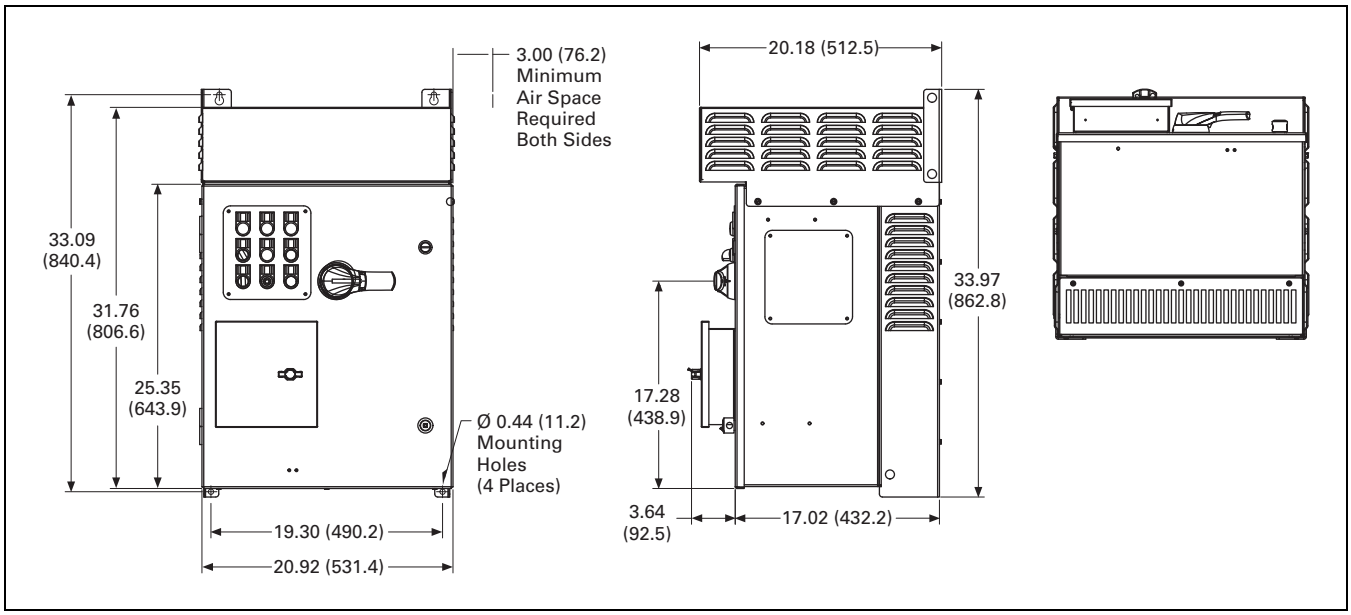


Figure 31.1-8. AX Box, NEMA 3R

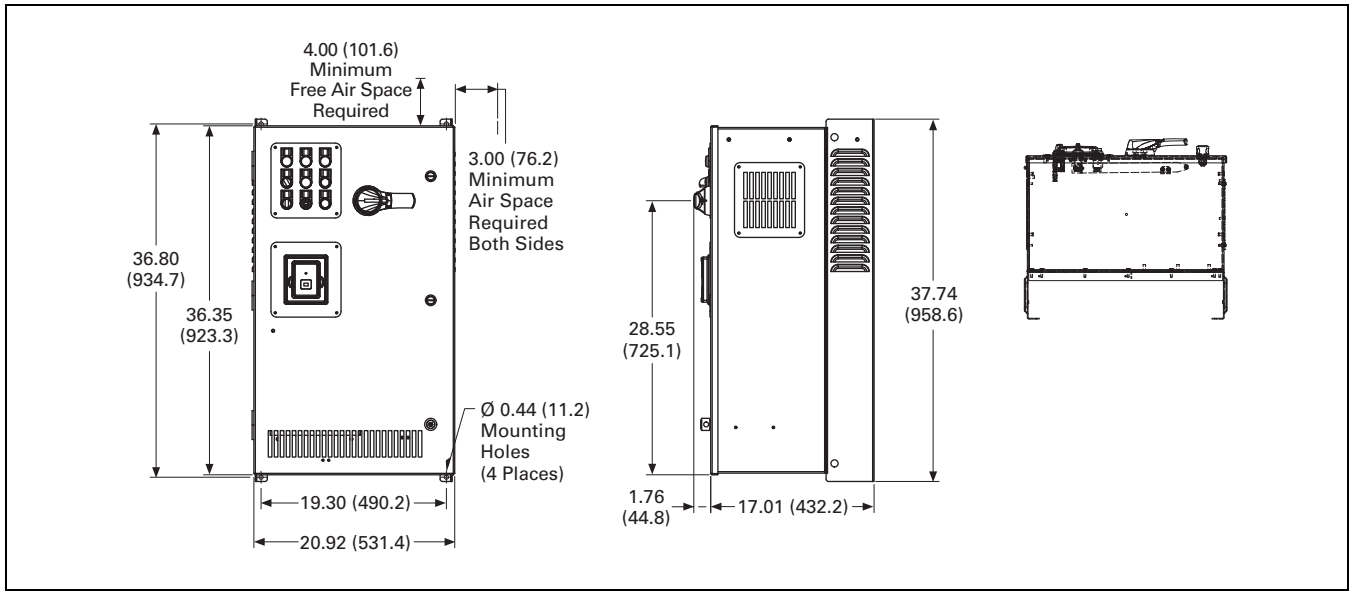


Figure 31.1-9. BX Box, NEMA 1/12

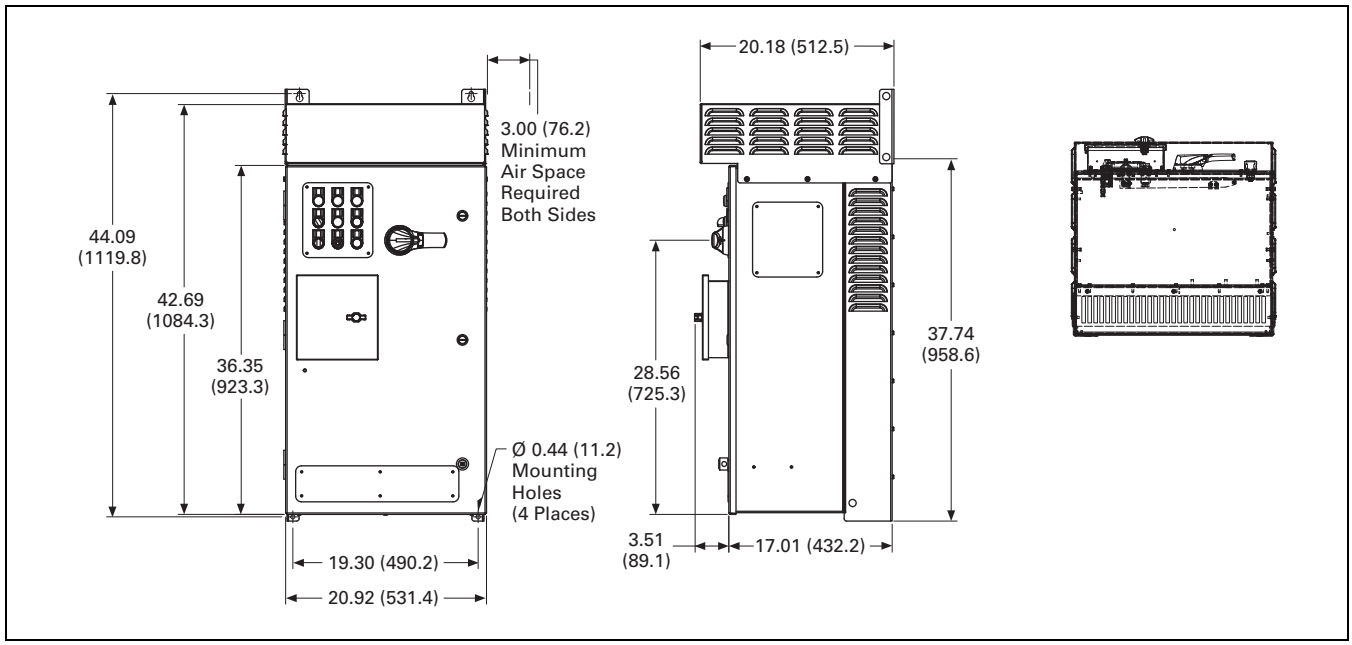


Figure 31.1-10. BX Box, NEMA 3R

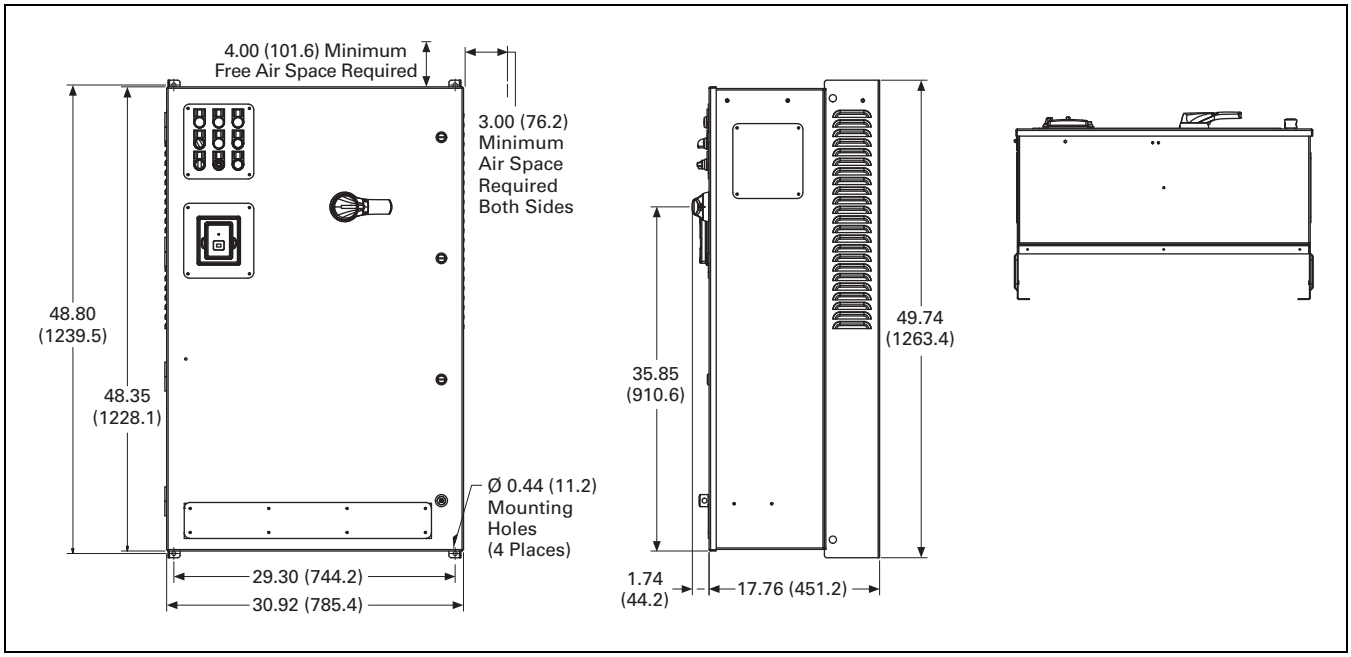


Figure 31.1-11. CX Box, NEMA 1/12

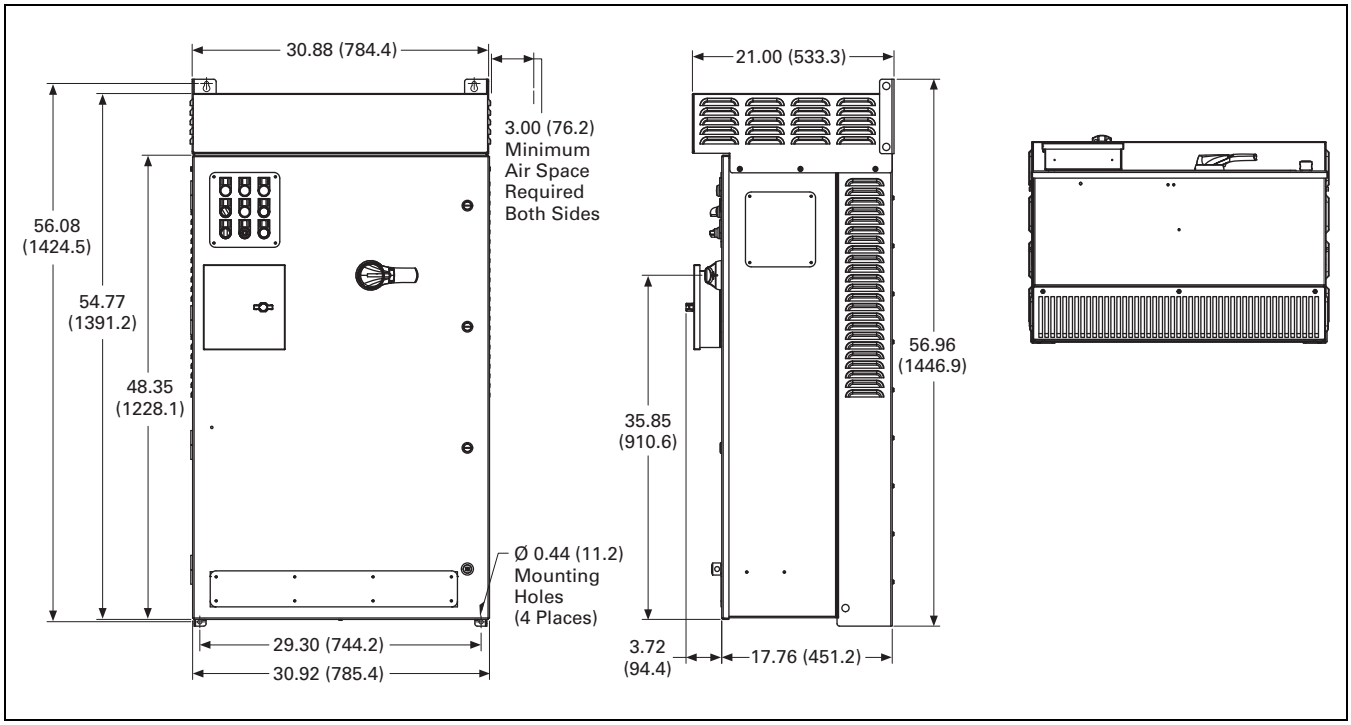


Figure 31.1-12. CX Box, NEMA 3R

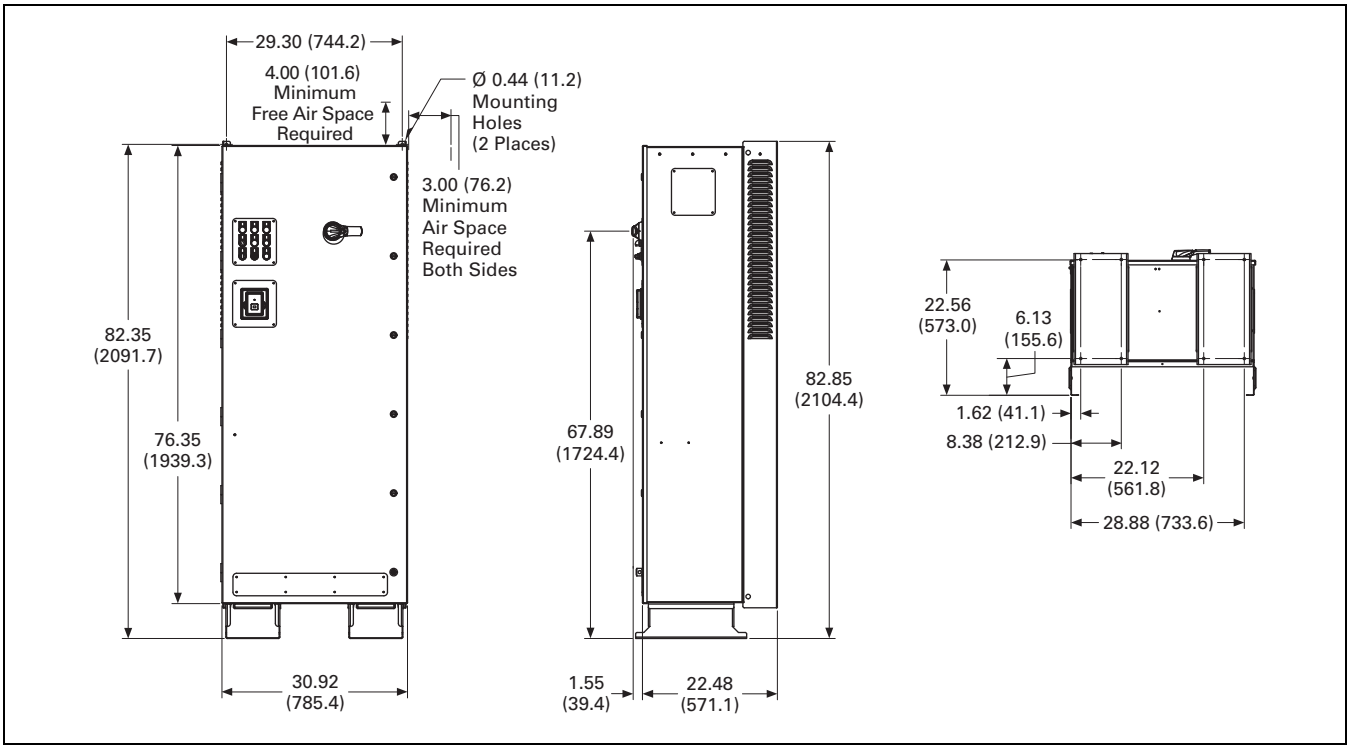


Figure 31.1-13. DX Box, NEMA 1/12

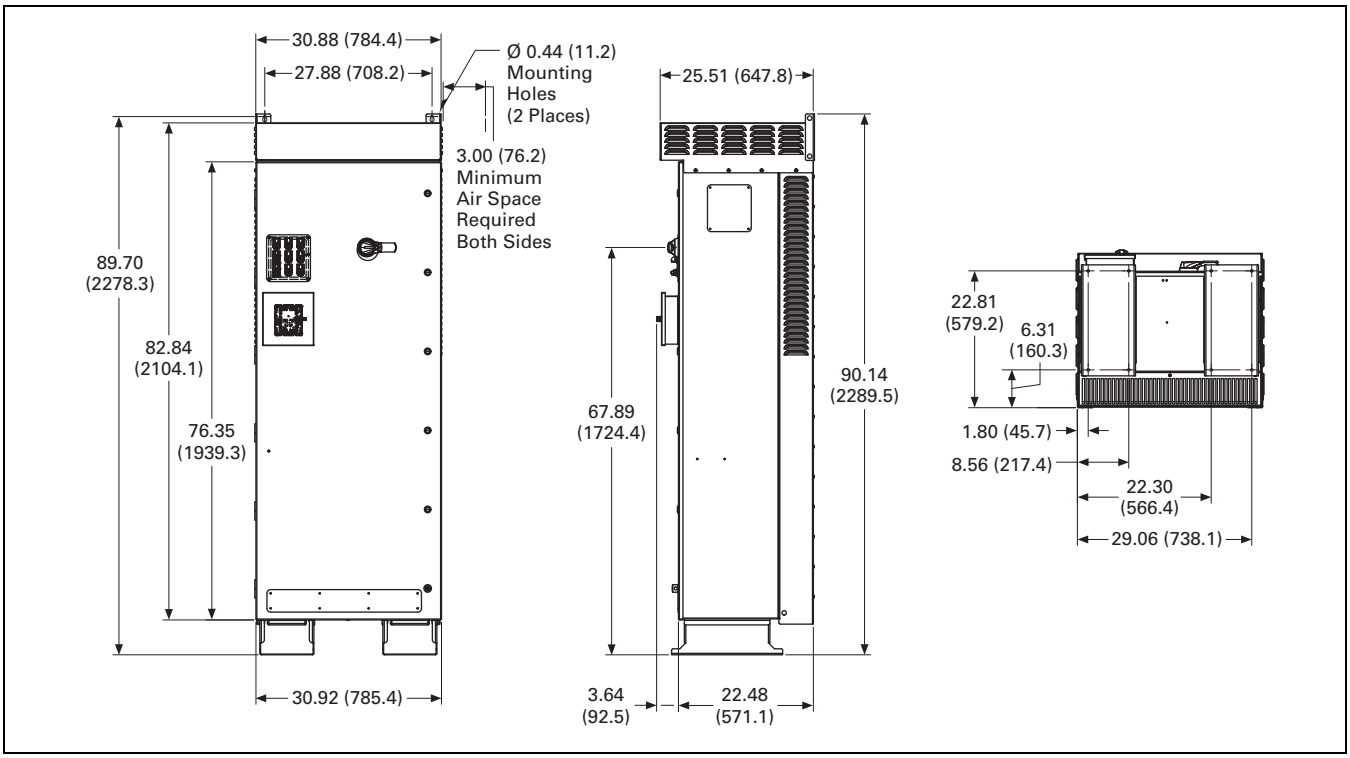


Figure 31.1-14. DX Box, NEMA 3R

SVX Drives

SVX Drives

Product Description

SVX Series Adjustable Frequency Drives from Eaton's Electrical Sector are the next generation of drives specifically engineered for today's commercial and industrial applications. The power unit makes use of the most sophisticated semiconductor technology and a highly modular construction that can be flexibly adapted to the customer's needs.

The input and output configuration (I/O) is designed with modularity in mind. The I/O is compromised of option cards, each with its own input and output configuration. The control module is designed to accept a total of five of these cards. The cards contain not only normal analog and digital inputs but also fieldbus cards.

These drives continue the tradition of robust performance, and raise the bar on features and functionality, ensuring the best solution at the right price.

Features

- Robust design—proven 500,000 hours MTBF
- Integrated 3% line reactors standard on drives from FR4 through FR9
- EMI/RFI Filters H standard up to 200 hp I_H 480 V, 100 hp I_H 230 V
- Simplified operating menu allows for typical programming changes, while programming mode provides control of everything
- Quick Start Wizard built into the programming of the drive ensures a smooth start-up
- Keypad can display up to three monitored parameters simultaneously
- LOCAL/REMOTE operation from keypad
- Copy/paste function allows transfer of parameter settings from one drive to the next
- Standard NEMA Type 12/IP54 keypad on all drives
- The SVX can be flexibly adapted to a variety of needs using our pre-installed "Seven in One" precision application programs consisting of:
  - ❑ Basic
  - ❑ Standard
  - ❑ Local/remote
  - ❑ Multi step speed control
  - ❑ PID control
  - ❑ Multi-purpose control
  - ❑ Pump and fan control with auto change
- Additional I/O and communication cards provide plug and play functionality
- I/O connections with simple quick connection terminals
- Hand-held auxiliary 24 V power supply allows programming/monitoring of control module without applying full power to the drive
- Control logic can be powered from an external auxiliary control panel, internal drive functions and fieldbus if necessary
- Brake chopper standard from:
  1–30 hp/380–500 V
  3/4–15 hp/208–230 V
- NEMA Type 1/IP21 and NEMA Type 12/IP54 enclosures available, Frame Sizes FR4–FR9
- Open chassis FR10 and greater
- Standard option board configuration includes an A9 I/O board and an A2 relay output board installed in slots A and B

Standards and Certifications

Product

- IEC 61800-2

EMC (at Default Settings)

- Immunity: Fulfills all EMC immunity requirements; Emissions: EN 61800-3, LEVEL H

Safety

- UL 508C
- CE

Catalog Number Selection

Table 31.2-1. SVX Adjustable Frequency Drives

SVX 010 A 1 – 4 A 1 B 1 _ _ _ _ _ _

Product Family
SVX= Open drives
SPX = Open drives FR10 and greater

Horsepower Rating
F07 = 3/4 hp
F15 = 1-1/2 hp
007 = 7-1/2 hp
010 = 10 hp
050 = 50 hp
125 = 125 hp
350 = 350 hp
700 = 700 hp
800 = 800 hp
900 = 900 hp
H10 = 1000 hp
H12 = 1200 hp
H13 = 1350 hp
H15 = 1500 hp
H16 = 1600 hp
H20 = 2000 hp

Enclosure ③
0 = Chassis
1 = NEMA Type 1/IP21
2 = NEMA Type 12/IP54

Voltage Rating
2 = 230 V (208–240)
4 = 480 V (380–500)
5 = 575 V (525–690)

AFD Software Series
A = Standard software

Keypad
A = Alphanumeric

Input Options ①
1 = Three-phase, EMC H
2 = Three-phase, EMC N
4 = Three-phase, EMC L

Brake Chopper Options ②
N = No brake chopper circuit
B = Internal brake chopper circuit

Board Modifications
1 = Standard boards
2 = Conformal (varnished) coating ④

Options
Options appear in alphabetical order.

Extended I/O Card Options
B1 = 6 DI, 1 ext +24 Vdc/EXT +24 Vdc
B2 = 1 RO (NC-NO), 1 RO (NO), 1 therm
B4 = 1 AI (mA isolated), 2 AO (mA isolated), 1 ext +24 Vdc/EXT + 24 Vdc
B5 = 3 RO (NO)
B8 = 1 ext +24 Vdc/EXT +24 Vdc, 3 Pt100
B9 = RO (NO), 5 DI 42–240 Vac input

Communication Cards
CA = Johnson Controls N2
CI = Modbus TCP
CJ = BACnet
CQ = EtherNet/IP
C2 = Modbus
C3 = PROFIBUS DP
C4 = LonWorks
C5 = PROFIBUS DP (D9 connector)
C6 = CANopen (slave)
C7 = DeviceNet
C8 = Modbus (D9 Type connector)
D3 = RS-232 with D9 connection

① All 230 V drives and 480 V drives up to 200 hp (IH) are only available with input option **1** (EMC Level H). 480 V drives 250 hp (IH) or larger are available with input option **2** (EMC Level N). 480 V drives are available with input option **4** (EMC Level L). 575 V drives 200 hp (IH) or larger are only available with input option **2**. 575 V drives up to 150 hp (IH) are only available with input option **4** (EMC Level L).

② 480 V drives up to 30 hp (IH) are only available with brake chopper option **B**. 480 V drives 40 hp (IH) or larger come standard with brake chopper option **N**. 230 V drives up to 15 hp (IH) are only available with brake chopper option **B**. 230 V drives 20 hp or larger come standard with brake chopper option **N**. All 575 V drives come standard without brake chopper option (N). **N** = **No** brake chopper.

③ 480 V drives 250 hp (I_H) and larger are available with enclosure style **0** (chassis); 690 V drives 200 hp (I_H) and larger are available with enclosure style **0** (chassis).

④ Factory promise delivery. Consult sales office for availability.

Product Selection

Table 31.2-2. SVX Drives—230 V

Frame Size	hp (I_H)	Current (I_H)	hp (I_L)	Current (I_L)	Catalog Number
208–240 V, NEMA Type 1/IP21 Drives					
FR4	3/4 1 1-1/2 2 3	3.7 4.8 6.6 7.8 11	1 1-1/2 2 3 —	4.8 6.6 7.8 11 12.5	**SVXF07A1-2A1B1** **SVX001A1-2A1B1** **SVXF15A1-2A1B1** **SVX002A1-2A1B1** **SVX003A1-2A1B1**
FR5	— 5 7-1/2	12.5 17.5 25	5 7-1/2 10	17.5 25 31	**SVX004A1-2A1B1** **SVX005A1-2A1B1** **SVX007A1-2A1B1**
FR6	10 15	31 48	15 20	48 61	**SVX010A1-2A1B1** **SVX015A1-2A1B1**
FR7	20 25 30	61 75 88	25 30 40	75 88 114	**SVX020A1-2A1N1** **SVX025A1-2A1N1** **SVX030A1-2A1N1**
FR8	40 50 60	114 140 170	50 60 75	140 170 205	**SVX040A1-2A1N1** **SVX050A1-2A1N1** **SVX060A1-2A1N1**
FR9	75 100	205 261	100 125	261 300	**SVX075A1-2A1N1** **SVX100A1-2A1N1**
208–240 V, NEMA Type 12/IP54 Drives					
FR4	3/4 1 1-1/2 2 3	3.7 4.8 6.6 7.8 11	1 1-1/2 2 3 —	4.8 6.6 7.8 11 12.5	**SVXF07A2-2A1B1** **SVX001A2-2A1B1** **SVXF15A2-2A1B1** **SVX002A2-2A1B1** **SVX003A2-2A1B1**
FR5	— 5 7-1/2	12.5 17.5 25	5 7-1/2 10	17.5 25 31	**SVX004A2-2A1B1** **SVX005A2-2A1B1** **SVX007A2-2A1B1**
FR6	10 15	31 48	15 20	48 61	**SVX010A2-2A1B1** **SVX015A2-2A1B1**
FR7	20 25 30	61 75 88	25 30 40	75 88 114	**SVX020A2-2A1N1** **SVX025A2-2A1N1** **SVX030A2-2A1N1**
FR8	40 50 60	114 140 170	50 60 75	140 170 205	**SVX040A2-2A1N1** **SVX050A2-2A1N1** **SVX060A2-2A1N1**
FR9	75 100	205 261	100 125	261 300	**SVX075A2-2A1N1** **SVX100A2-2A1N1**

Table 31.2-3. 480 V SVX Drives

Frame Size	hp (I_H)	Current (I_H)	hp (I_L)	Current (I_L)	Catalog Number
380–500 V, NEMA Type 1/IP21 Drives					
FR4	1	2.2	1-1/2	3.3	**SVX001A1-4A1B1**
	1-1/2	3.3	2	4.3	**SVXF15A1-4A1B1**
	2	4.3	3	5.6	**SVX002A1-4A1B1**
	3	5.6	5	7.6	**SVX003A1-4A1B1**
	5	7.6	—	9	**SVX005A1-4A1B1**
	—	9	7-1/2	12	**SVX006A1-4A1B1**
FR5	7-1/2	12	10	16	**SVX007A1-4A1B1**
	10	16	15	23	**SVX010A1-4A1B1**
	15	23	20	31	**SVX015A1-4A1B1**
FR6	20	31	25	38	**SVX020A1-4A1B1**
	25	38	30	46	**SVX025A1-4A1B1**
	30	46	40	61	**SVX030A1-4A1B1**
FR7	40	61	50	72	**SVX040A1-4A1N1**
	50	72	60	87	**SVX050A1-4A1N1**
	60	87	75	105	**SVX060A1-4A1N1**
FR8	75	105	100	140	**SVX075A1-4A1N1**
	100	140	125	170	**SVX100A1-4A1N1**
	125	170	150	205	**SVX125A1-4A1N1**
FR9	150	205	200	261	**SVX150A1-4A1N1**
	200	245	250	300	**SVX200A1-4A1N1**
380–500 V, NEMA Type 12/IP54 Drives					
FR4	1	2.2	1-1/2	3.3	**SVX001A2-4A1B1**
	1-1/2	3.3	2	4.3	**SVXF15A2-4A1B1**
	2	4.3	3	5.6	**SVX002A2-4A1B1**
	3	5.6	5	7.6	**SVX003A2-4A1B1**
	5	7.6	—	9	**SVX005A2-4A1B1**
	—	9	7-1/2	12	**SVX006A2-4A1B1**
FR5	7-1/2	12	10	16	**SVX007A2-4A1B1**
	10	16	15	23	**SVX010A2-4A1B1**
	15	23	20	31	**SVX015A2-4A1B1**
FR6	20	31	25	38	**SVX020A2-4A1B1**
	25	38	30	46	**SVX025A2-4A1B1**
	30	46	40	61	**SVX030A2-4A1B1**
FR7	40	61	50	72	**SVX040A2-4A1N1**
	50	72	60	87	**SVX050A2-4A1N1**
	60	87	75	105	**SVX060A2-4A1N1**
FR8	75	105	100	140	**SVX075A2-4A1N1**
	100	140	125	170	**SVX100A2-4A1N1**
	125	170	150	205	**SVX125A2-4A1N1**
FR9	150	205	200	261	**SVX150A2-4A1N1**
	200	245	250	300	**SVX200A2-4A1N1**
380–500 V, Open Chassis Drives					
FR10 ①	250	330	300	385	**SPX250A0-4A2N1**
	300	385	350	460	**SPX300A0-4A2N1**
	350	460	400	520	**SPX350A0-4A2N1**
FR11	400	520	500	590	**SPX400A0-4A2N1**
	500	590	—	650	**SPX500A0-4A2N1**
	—	650	600	730	**SPX550A0-4A2N1**
FR12	600	730	—	820	**SPX600A0-4A2N1**
	—	820	700	920	**SPX650A0-4A2N1**
	700	920	800	1030	**SPX700A0-4A2N1**
FR13	800	1030	900	1150	**SPX800A0-4A2N1**
	900	1150	1000	1300	**SPX900A0-4A2N1**
	1000	1300	1200	1450	**SPXH10A0-4A2N1**
FR14	1200	1600	1500	1770	**SPXH12A0-4A2N1**
	1600	1940	1800	2150	**SPXH16A0-4A2N1**
	1900	2300	2200	2700	**SPXH19A0-4A2N1**

① FR10–FR14 includes 3% line reactor, but it is not integral to chassis.

Table 31.2-4. 575 V SVX Drives

Frame Size	hp (I_H)	Current (I_H)	hp (I_L)	Current (I_L)	Catalog Number
525–690 V, NEMA Type 1/IP21 Drives					
FR6	2	3.3	3	4.5	**SVX002A1-5A4N1**
	3	4.5	—	5.5	**SVX003A1-5A4N1**
	—	5.5	5	7.5	**SVX004A1-5A4N1**
	5	7.5	7-1/2	10	**SVX005A1-5A4N1**
	7-1/2	10	10	13.5	**SVX007A1-5A4N1**
	10	13.5	15	18	**SVX010A1-5A4N1**
	15	18	20	22	**SVX015A1-5A4N1**
	20	22	25	27	**SVX020A1-5A4N1**
	25	27	30	34	**SVX025A1-5A4N1**
FR7	30	34	40	41	**SVX030A1-5A4N1**
	40	41	50	52	**SVX040A1-5A4N1**
FR8	50	52	60	62	**SVX050A1-5A4N1**
	60	62	75	80	**SVX060A1-5A4N1**
	75	80	100	100	**SVX075A1-5A4N1**
FR9	100	100	125	125	**SVX100A1-5A4N1**
	125	125	150	144	**SVX125A1-5A4N1**
	150	144	—	170	**SVX150A1-5A4N1**
	—	170	200	208	**SVX175A1-5A4N1**
525–690 V, NEMA Type 12/IP54 Drives					
FR6	2	3.3	3	4.5	**SVX002A2-5A4N1**
	3	4.5	—	5.5	**SVX003A2-5A4N1**
	—	5.5	5	7.5	**SVX004A2-5A4N1**
	5	7.5	7-1/2	10	**SVX005A2-5A4N1**
	7-1/2	10	10	13.5	**SVX007A2-5A4N1**
	10	13.5	15	18	**SVX010A2-5A4N1**
	15	18	20	22	**SVX015A2-5A4N1**
	20	22	25	27	**SVX020A2-5A4N1**
	25	27	30	34	**SVX025A2-5A4N1**
FR7	30	34	40	41	**SVX030A2-5A4N1**
	40	41	50	52	**SVX040A2-5A4N1**
FR8	50	52	60	62	**SVX050A2-5A4N1**
	60	62	75	80	**SVX060A2-5A4N1**
	75	80	100	100	**SVX075A2-5A4N1**
FR9	100	100	125	125	**SVX100A2-5A4N1**
	125	125	150	144	**SVX125A2-5A4N1**
	150	144	—	170	**SVX150A2-5A4N1**
	—	170	200	208	**SVX175A2-5A4N1**
525–690 V, Open Chassis Drives					
FR10	200	208	250	261	**SPX200A0-5A2N1**
	250	261	300	325	**SPX250A0-5A2N1**
	300	325	400	385	**SPX300A0-5A2N1**
FR11	400	385	450	460	**SPX400A0-5A2N1**
	450	460	500	502	**SPX450A0-5A2N1**
	500	502	—	590	**SPX500A0-5A2N1**
FR12	—	590	600	650	**SPX550A0-5A2N1**
	600	650	700	750	**SPX600A0-5A2N1**
	700	750	800	820	**SPX700A0-5A2N1**
FR13	800	820	900	920	**SPX800A0-5A2N1**
	900	920	1000	1030	**SPX900A0-5A2N1**
	1000	1030	1250	1180	**SPXH10A0-5A2N1**
FR14	1350	1300	1500	1500	**SPXH13A0-5A2N1**
	1500	1500	2000	1900	**SPXH15A0-5A2N1**
	2000	1900	2300	2250	**SPXH20A0-5A2N1**

Options

SVX Series Option Board Kits

The SVX Series drives can accommodate a wide selection of expander and adapter option boards to customize the drive for your application needs. The drive's control unit is designed to accept a total of five option boards.

The SVX Series factory installed standard board configuration includes an A9 I/O board and an A2 relay output board, which are installed in slots A and B.

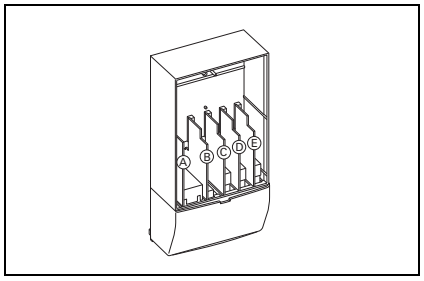


Figure 31.2-1. Option Boards

Table 31.2-5. Option Board Kits

Option Kit Description ①	Allowed Slot Locations ②	Field Installed	Factory Installed	SVX Ready Programs						
		Catalog Number	Option Designator	Basic	Local/ Remote	Standard	MSS	PID	Multi-P.	PFC
Standard I/O Cards										
6 DI, 1 DO, 2 AI, 1 AO, 1 +10 Vdc ref, 2 ext +24 Vdc/EXT +24 Vdc	A	**OPTA9**	—	■	■	■	■	■	■	■
2 RO (NC-NO)	B	**OPTA2**	—	■	■	■	■	■	■	■
Extended I/O Cards										
2 RO, therm	B	**OPTA3**	**A3**	—	■	■	■	■	■	■
Encoder low volt +5 V/15 V/24 V—SPX only	C	**OPTA4**	**A4**	—	■	■	■	■	■	■
Encoder high volt +15 V/24 V—SPX only	C	**OPTA5**	**A5**	—	■	■	■	■	■	■
Double encoder—SPX only	C	**OPTA7**	**A7**	■	■	■	■	■	■	■
6 DI, 1 DO, 2 AI, 1 AO	A	**OPTA8**	**A8**	—	■	■	■	■	■	■
3 DI (encoder 10–24 V), out +15 V/+24 V, 2 DO (pulse+direction)—SPX only	C	**OPTAE**	**AE**	■	■	■	■	■	■	■
6 DI, 1 ext +24 Vdc/EXT +24 Vdc	B, C, **D**, E	**OPTB1**	**B1**	—	—	—	—	—	■	■
1 RO (NC-NO), 1 RO (NO), 1 therm	B, C, **D**, E	**OPTB2**	**B2**	—	—	—	—	—	■	■
1 AI (mA isolated), 2 AO (mA isolated), 1 ext +24 Vdc/EXT +24 Vdc	B, C, **D**, E	**OPTB4**	**B4**	■	■	■	■	■	■	■
3 RO (NO)	B, C, **D**, E	**OPTB5**	**B5**	—	—	—	—	—	■	■
1 ext +24 Vdc/EXT +24 Vdc, 3 Pt100	B, C, **D**, E	**OPTB8**	**B8**	—	—	—	—	—	—	—
1 RO (NO), 5 DI 42–240 Vac input	B, C, **D**, E	**OPTB9**	**B9**	—	—	—	—	—	■	■
Communication Cards										
Modbus ③	D, **E**	**OPTC2**	**C2**	■	■	■	■	■	■	■
Johnson Controls N2 ③	D, **E**	**OPTC2**	**CA**	—	—	—	—	—	—	—
Modbus TCP	D, **E**	**OPTCI**	**CI**	■	■	■	■	■	■	■
BACnet	D, **E**	**OPTCJ**	**CJ**	■	■	■	■	■	■	■
EtherNet/IP	D, **E**	**OPTCQ**	**CQ**	■	■	■	■	■	■	■
PROFIBUS DP	D, **E**	**OPTC3**	**C3**	■	■	■	■	■	■	■
LonWorks	D, **E**	**OPTC4**	**C4**	■	■	■	■	■	■	■
PROFIBUS DP (D9 connector)	D, **E**	**OPTC5**	**C5**	■	■	■	■	■	■	■
CANopen (slave)	D, **E**	**OPTC6**	**C6**	■	■	■	■	■	■	■
DeviceNet	D, **E**	**OPTC7**	**C7**	■	■	■	■	■	■	■
Modbus (D9 type connector)	D, **E**	**OPTC8**	**C8**	■	■	■	■	■	■	■
Adapter—SPX only	D, **E**	**OPTD1**	**D1**	■	■	■	■	■	■	■
Adapter—SPX only	D, **E**	**OPTD2**	**D2**	■	■	■	■	■	■	■
RS-232 with D9 connection	D, **E**	**OPTD3**	**D3**	■	■	■	■	■	■	■

① AI = Analog Input; AO = Analog Output, DI = Digital Input, DO = Digital Output, RO = Relay Output
② Option card must be installed in one of the slots listed for that card. Slot indicated in bold is the preferred location.
③ OPTC2 is a multi-protocol option card.

Technical Data and Specifications

Table 31.2-6. SVX Drives

Description	Specification
Input Ratings	
Input voltage (V_{in})	+10%/–15%
Input frequency (f_{in})	50/60 Hz (variation up to 45–66 Hz)
Connection to power	Once per minute or less (typical operation)
High withstand rating	100 kAIC
Output Ratings	
Output voltage	0 to V_{in}
Continuous output current	I_H rated 100% at 122 °F (50 °C), FR9 and below I_L rated 100% at 104 °F (40 °C), FR9 and below I_H/I_L 100% at 104 °F (40 °C), FR10 and above
Overload current (I_H/I_L)	150% I_H, 110% I_L for 1 min.
Output frequency	0 to 320 Hz
Frequency resolution	0.01 Hz
Initial output current (I_H)	250% for 2 seconds
Efficiency	>96%
Control Characteristics	
Control method	Frequency control (V/f) Open loop: Sensorless vector control Closed loop: SPX drives only
Switching frequency Frame 4–6 Frame 7–12	Adjustable with parameter 2.6.9 1–16 kHz; default 10 kHz 1–10 kHz; default 3.6 kHz
Frequency reference	Analog input: Resolution 0.1% (10-bit), accuracy ±1% V/Hz Panel reference: Resolution 0.01 Hz
Field weakening point	30–320 Hz
Acceleration time	0–3000 sec.
Deceleration time	0–3000 sec.
Braking torque	DC brake: 30% x T_n (without brake option)
Ambient Conditions	
Ambient operating temperature	14 °F (–10 °C), no frost to 122 °F (50 °C) I_H (FR4–FR9) 14 °F (–10 °C), no frost to 104 °F (40 °C) I_H (FR10 and up) 14 °F (–10 °C), no frost to 104 °F (40 °C) I_L (all frames)
Storage temperature	–40° to 158 °F (–40° to 70 °C)
Relative humidity	0 to 95% RH, noncondensing, non-corrosive, no dripping water
Air quality	Chemical vapors: IEC 721-3-3, unit in operation, class 3C2; Mechanical particles: IEC 721-3-3, 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)
Vibration	EN 50178, EN 60068-2-6; 5 to 50 Hz, displacement amplitude 1 mm (peak) at 3 to 15.8 Hz, max. acceleration amplitude 1G at 15.8 to 150 Hz
Shock	EN 50178, EN 60068-2-27 UPS Drop test (for applicable UPS weights) Storage and shipping: max. 15 g, 11 ms (in package)
Enclosure class	NEMA 1/IP21 or NEMA 12/IP54, open chassis/IP20

Table 31.2-6. SVX Drives (Continued)

Description	Specification
Control Connections	
Analog input voltage	0 to 10 V, R = 200 kohms (–10 to 10 V joystick control) resolution 0.1%; accuracy ±1%
Analog input current	0(4) to 20 mA; R_i—250 ohms differential
Digital inputs (6)	Positive or negative logic; 18 to 30 Vdc
Auxiliary voltage	+24 V ±15%, max. 250 mA
Output reference voltage	+10 V +3%, max. load 10 mA
Analog output	0(4) to 20 mA; R_L max. 500 ohms; resolution 10 bit; accuracy ±2%
Digital outputs	Open collector output, 50 mA/48 V
Relay outputs	Two programmable Form C relay outputs switching capacity: 24 Vdc/8 A, 250 Vac/8 A, 125 Vdc/0.4 A
Protections	
Overcurrent protection	Trip limit 4.0 x I_H instantaneously
Overvoltage protection	Yes
Undervoltage protection	Yes
Earth fault protection	In case of earth fault in motor or motor cable, only the frequency converter is protected
Input phase supervision	Trips if any of the input phases are missing
Motor phase supervision	Trips if any of the output phases are missing
Overtemperature protection	Yes
Motor overload protection	Yes
Motor stall protection	Yes
Motor underload protection	Yes
Short-circuit protection	Yes (+24 V and +10 V reference voltages)

Table 31.2-7. Standard I/O Specifications

Description	Specification
Six–digital input programmable	24 V: "0" ≤10 V, "1" ≥18V,R_i >5 kohms
Two–analog input configurable w/jumpers	Voltage: 0–±10 V, R_i >200 kohms Current: 0 (4)–20 mA, R_i = 250 ohms
Two–digital output programmable	Form C relays 250 Vac 30 Vdc 2 amp resistive
One–analog output programmable configurable w/jumper	0–20 mA, R_L max. 500 ohms 10 bits ±2%
One digital output programmable	Open collector 48 Vdc 50 mA

Dimensions—Approximate Dimensions in Inches (mm)

9000X Open Drives

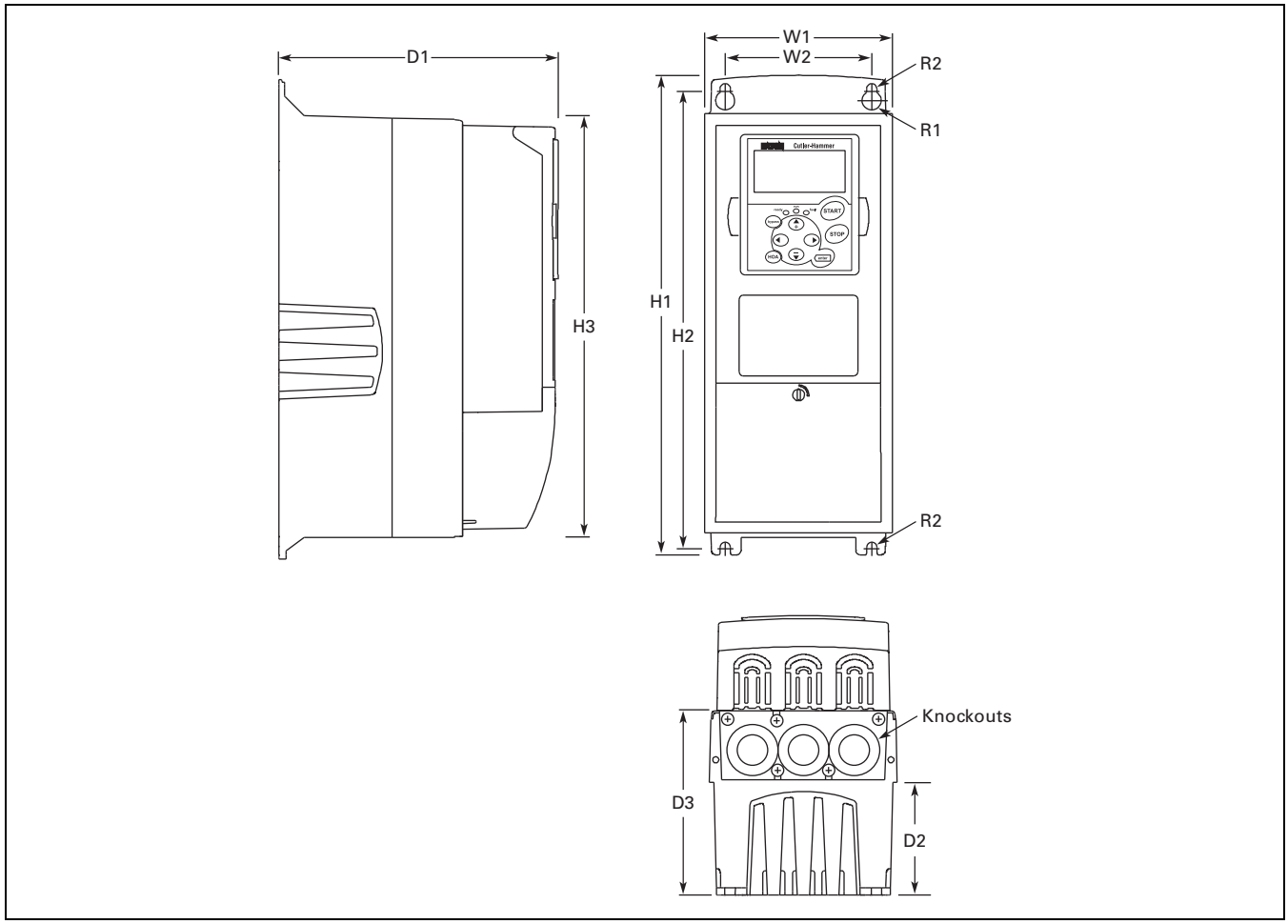


Figure 31.2-2. NEMA Type 1/IP21 and NEMA Type 12/IP54, FR4, FR5 and FR6

Voltage	hp (I_H)	H1	H2	H3	D1	D2	D3	W1	W2	R1 Dia.	R2 Dia.	Weight Lb (kg)	Knockouts in Inches (mm) N1 (O.D.)
FR4													
230 V 480 V	3/4–3 1–5	12.9 (327)	12.3 (313)	11.5 (292)	7.5 (190)	3.0 (77)	4.9 (126)	5.0 (128)	3.9 (100)	0.5 (13)	0.3 (7)	11.0 (5)	3 at 1.1 (28)
FR5													
230 V 480 V	5–7-1/2 7-1/2–15	16.5 (419)	16.0 (406)	15.3 (389)	8.4 (214)	3.9 (100)	5.8 (148)	5.6 (143)	3.9 (100)	0.5 (13)	0.3 (7)	17.9 (8)	2 at 1.5 (37) 1 at 1.1 (28)
FR6													
230 V 480 V 575 V	10–15 20–30 2–25	22.0 (558)	21.3 (541)	20.4 (519)	9.3 (237)	4.2 (105)	6.5 (165)	7.6 (195)	5.8 (148)	0.6 (15.5)	0.4 (9)	40.8 (19)	3 at 1.5 (37)

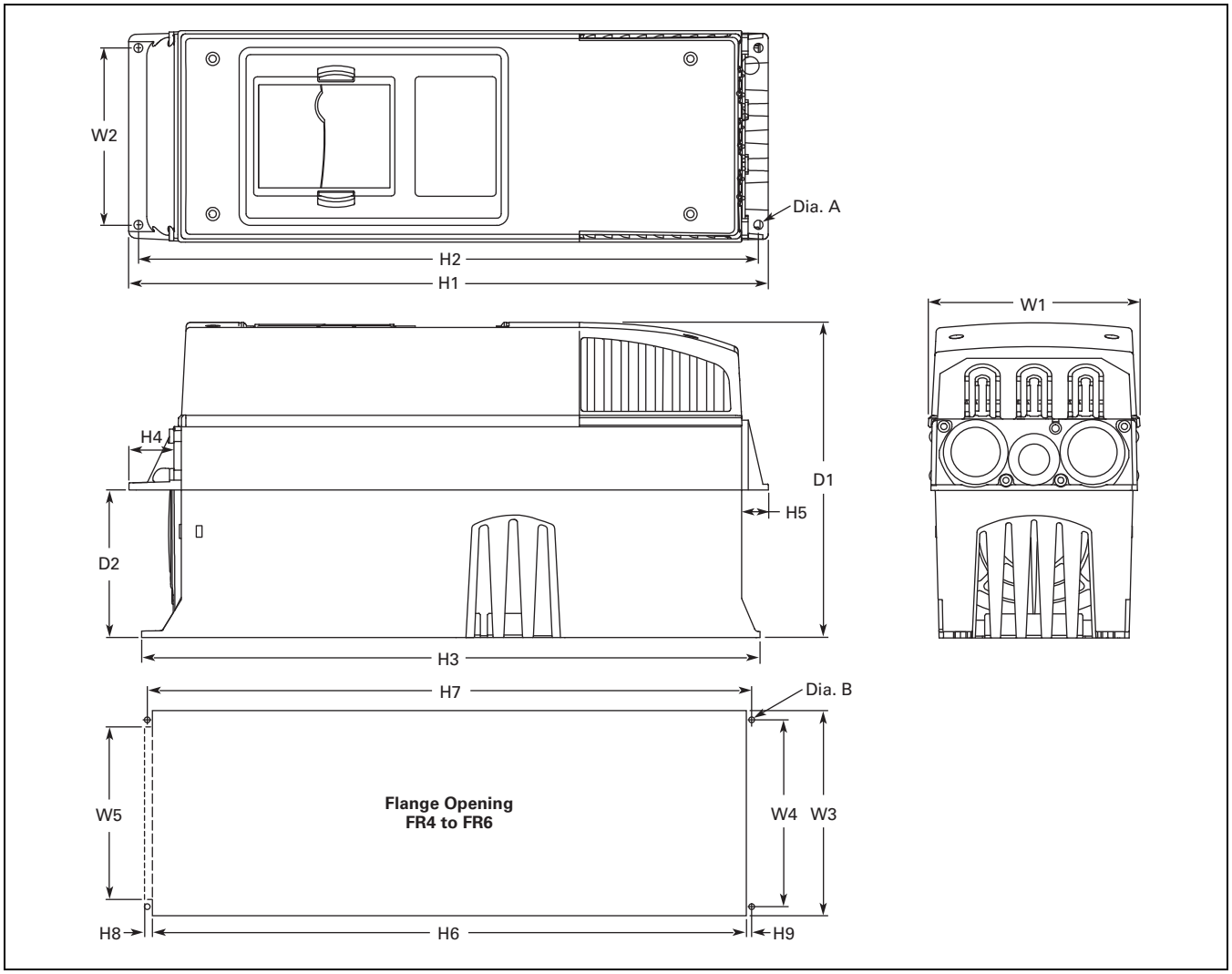


Figure 31.2-3. NEMA Type 1/IP21 and NEMA Type 12/IP54 with Flange Kit, FR4, FR5 and FR6

Table 31.2-8. FR4, FR5 and FR6 with Flange Kit

W1	W2	H1	H2	H3	H4	H5	D1	D2	Dia. A
FR4									
5.0 (128)	4.5 (113)	13.3 (337)	12.8 (325)	12.9 (327)	1.2 (30)	0.9 (22)	7.5 (190)	3.0 (77)	0.3 (7)
FR5									
5.6 (143)	4.7 (120)	17.0 (434)	16.5 (420)	16.5 (419)	1.4 (36)	0.7 (18)	8.4 (214)	3.9 (100)	0.3 (7)
FR6									
7.7 (195)	6.7 (170)	22.0 (560)	21.6 (549)	22.0 (558)	1.2 (30)	0.8 (20)	9.3 (237)	4.2 (106)	0.3 (7)

Table 31.2-9. Flange Opening, FR4 to FR6

W3	W4	W5	H6	H7	H8	H9	Dia. B
FR4							
4.8 (123)	4.5 (113)	—	12.4 (315)	12.8 (325)	—	0.2 (5)	0.3 (7)
FR5							
5.3 (135)	4.7 (120)	—	16.2 (410)	16.5 (420)	—	0.2 (5)	0.3 (7)
FR6							
7.3 (185)	6.7 (170)	6.2 (157)	21.2 (539)	21.6 (549)	0.3 (7)	0.2 (5)	0.3 (7)

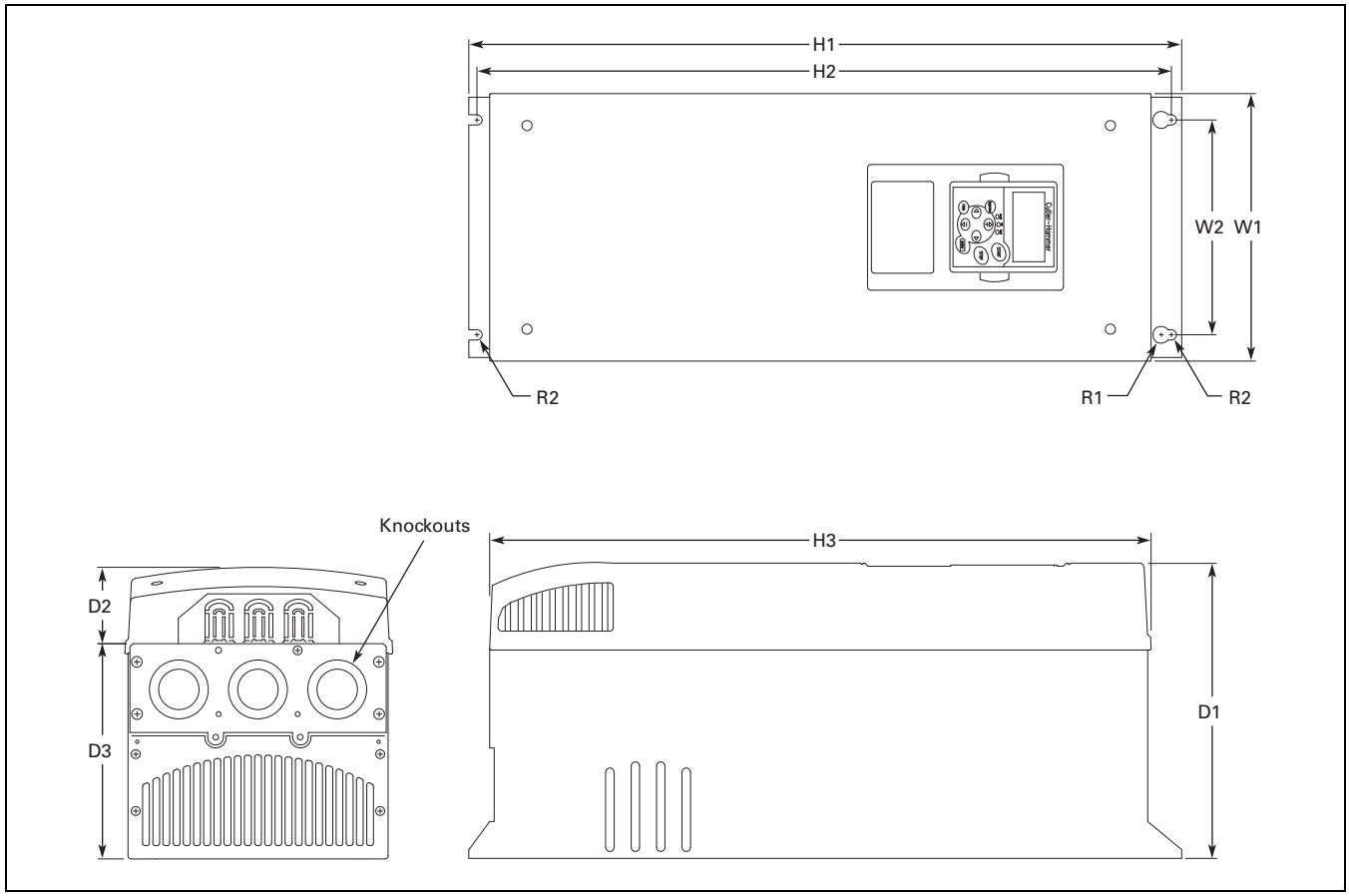


Figure 31.2-4. NEMA Type 1/IP21 and NEMA Type 12/IP54, FR7

Voltage	hp (I_H)	H1	H2	H3	D1	D2	D3	W1	W2	R1 Dia.	R2 Dia.	Weight Lb (kg)	Knockouts in Inches (mm) N1 (O.D.)
230 V 480 V 575 V	20–30 40–60 30–40	24.8 (630)	24.2 (614)	23.2 (590)	10.1 (257)	3.0 (77)	7.3 (184)	9.3 (237)	7.5 (190)	0.7 (18)	0.4 (9)	77.2 (35)	3 at 1.5 (37)

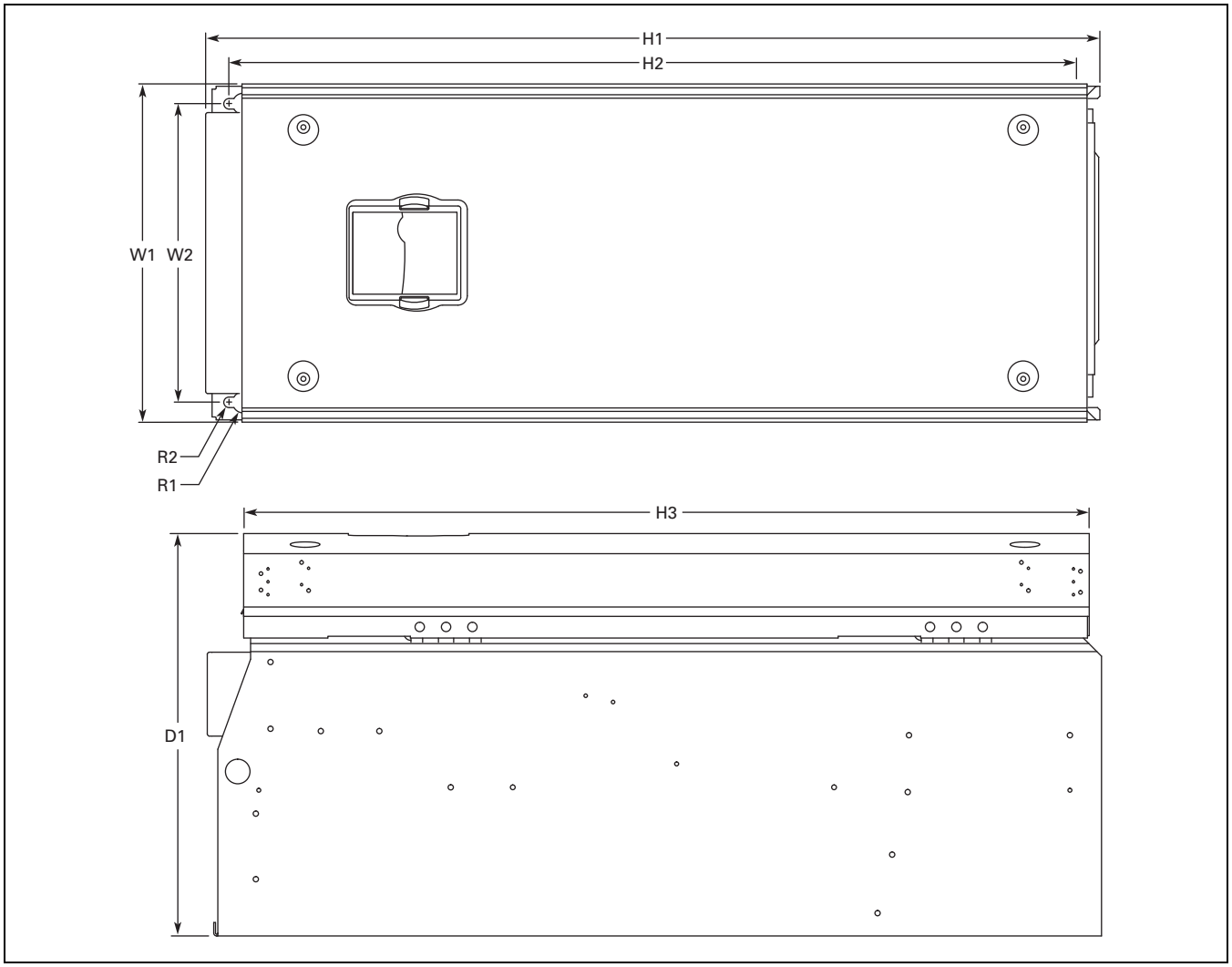


Figure 31.2-5. NEMA Type 1/IP21 and NEMA Type 12/IP54, FR8

Voltage	hp (I_H)	D1	H1	H2	H3	W1	W2	R1 Dia.	R2 Dia.	Weight Lb (kg)
230 V 480 V 575 V	40–60 75–125 50–75	13.5 (344)	30.1 (764)	28.8 (732)	28.4 (721)	11.5 (291)	10 (255)	0.7 (18)	0.4 (9)	127 (58)

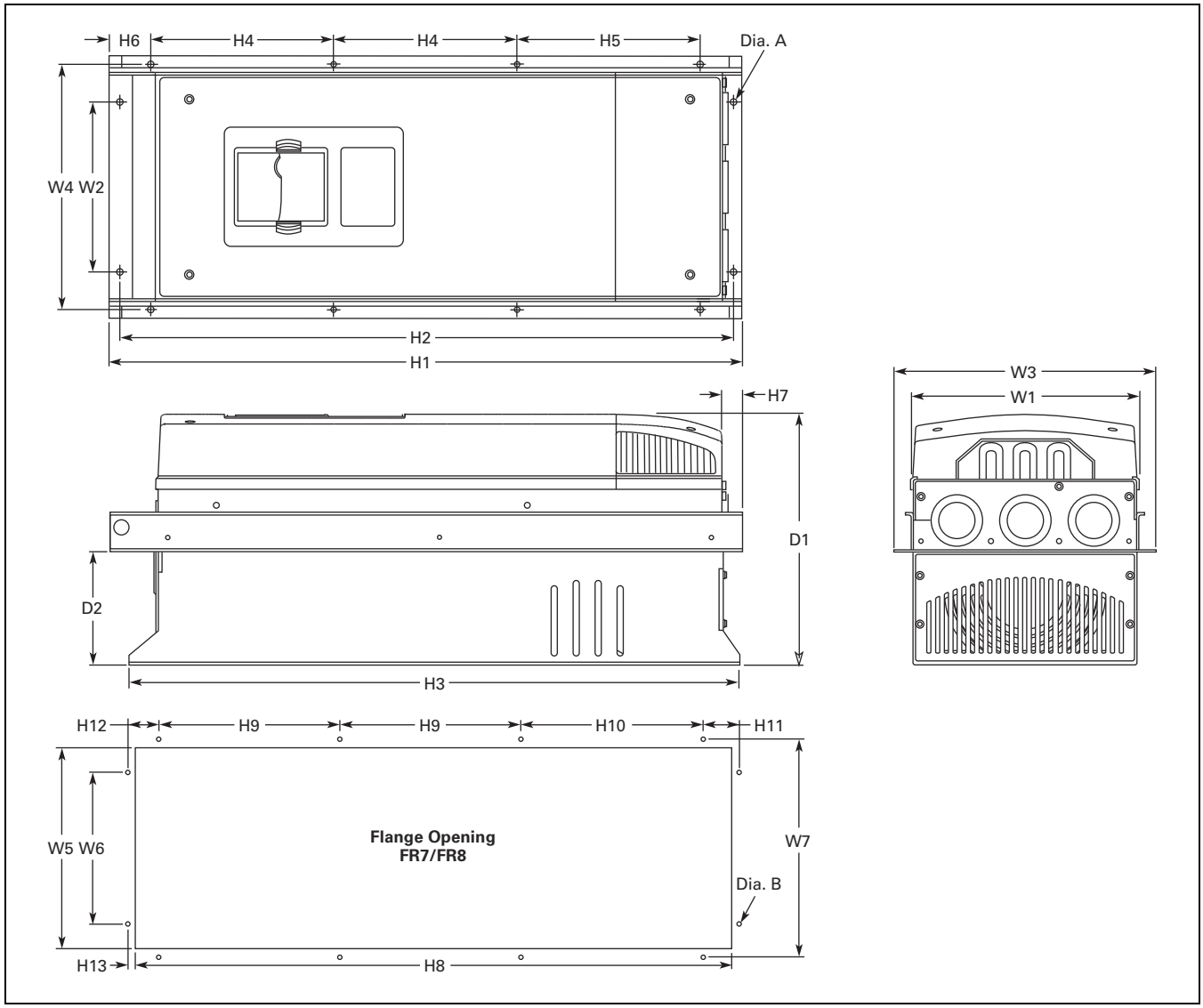


Figure 31.2-6. NEMA Type 1/IP21 and NEMA Type 12/IP54, with Flange Kit, FR7 and FR8

W1	W2	W3	W4	H1	H2	H3	H4	H5	H6	H7	D1	D2	Dia. A
FR7													
9.3 (237)	6.8 (175)	10.6 (270)	10.0 (253)	24.9 (652)	24.8 (632)	24.8 (630)	7.4 (189)	7.4 (189)	0.9 (23)	0.8 (20)	10.1 (257)	4.6 (117)	0.3 (6)
FR8													
11.2 (285)	—	14.0 (355)	13.0 (330)	32.8 (832)	—	29.3 (745)	10.2 (258)	10.4 (265)	1.7 (43)	2.2 (57)	13.5 (344)	4.3 (110)	0.4 (9)

Table 31.2-10. Flange Opening, FR7 and FR8

W5	W6	W7	H8	H9	H10	H11	H12	H13	Dia. B
FR7									
9.2 (233)	6.9 (175)	10.0 (253)	24.4 (619)	7.4 (189)	7.4 (189)	1.4 (35)	1.3 (32)	1.0 (25)	0.3 (6)
FR8									
11.9 (301)	—	13.0 (330)	31.9 (810)	10.2 (258)	10.4 (265)	—	—	1.3 (33)	0.4 (9)

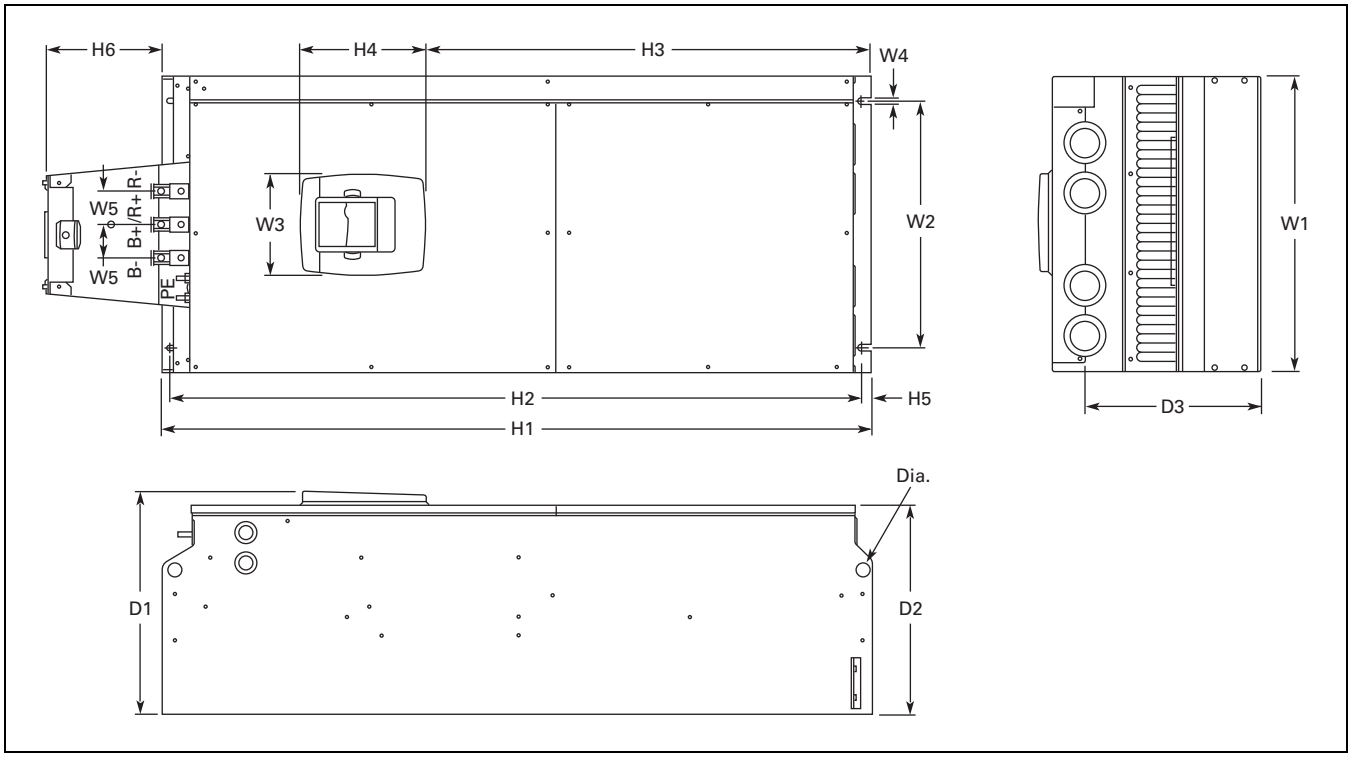


Figure 31.2-7. NEMA Type 1/IP21 and NEMA Type 12/IP54 FR9

Voltage	hp (I_H)	W1	W2	W3	W4	H1	H2	H3	H4 ①	D1	D2	D3	Dia.	Weight Lb (kg)
230 V 480 V 575 V	75–100 150–200 100–175	18.9 (480)	15.7 (400)	0.4 (9)	2.1 (54)	45.3 (1150)	44.1 (1120)	0.6 (16)	7.4 (188)	14.2 (361.5)	13.4 (340)	11.2 (285)	0.8 (21)	321.9 (146)

① Brake resistor terminal box (H6) included when brake chopper ordered.

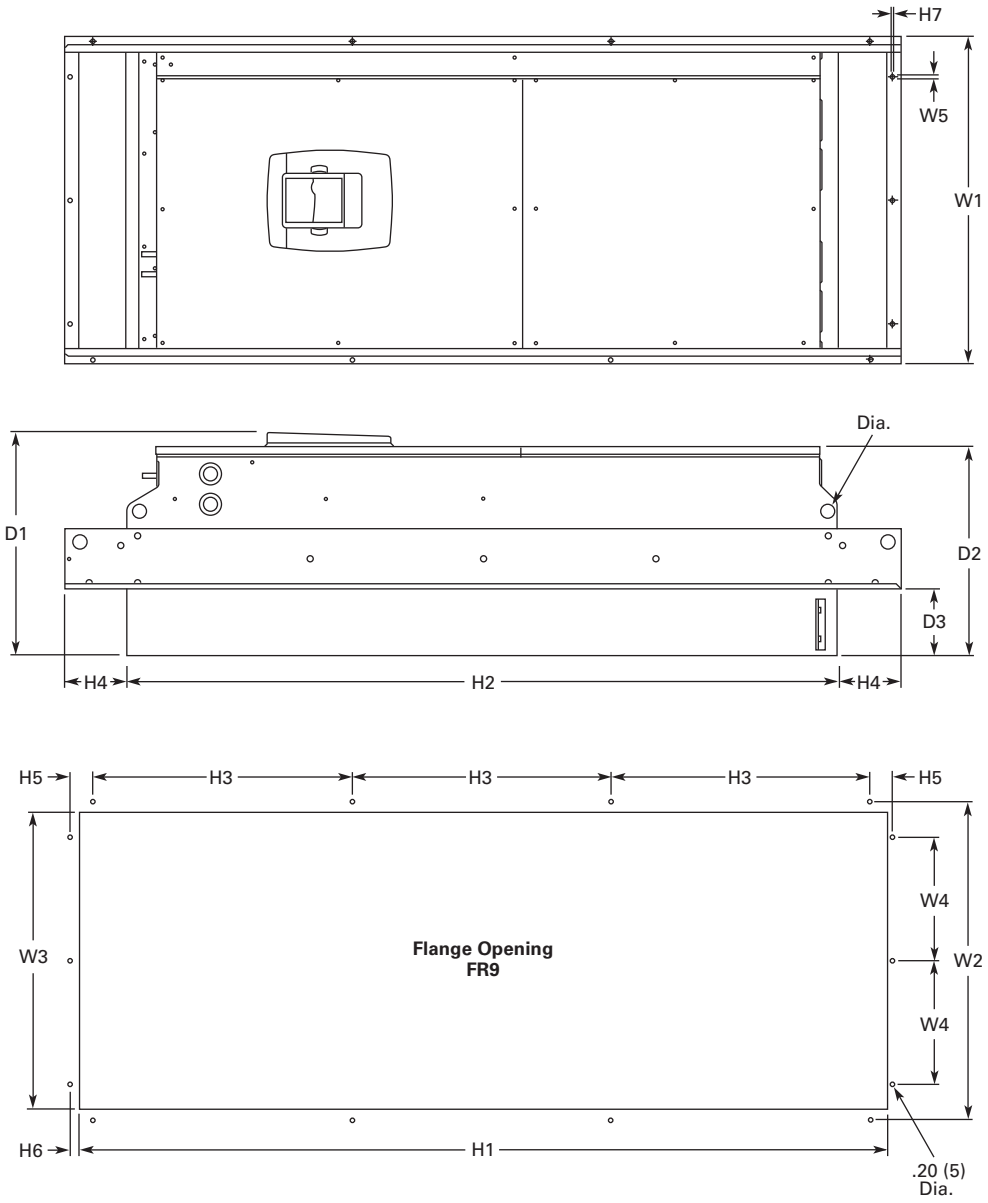


Figure 31.2-8. NEMA Type 1/IP21 and NEMA Type 12/IP54, FR9 with Flange Kit

W1	W2	W3	W4	W5	H1	H2	H3	H4	H5	H6	H7	D1	D2	D3	Dia.
20.9 (530)	20.0 (510)	19.1 (485)	7.9 (200)	0.2 (5.5)	51.7 (1312)	45.3 (1150)	16.5 (420)	3.9 (100)	1.4 (35)	0.4 (9)	0.1 (2)	24.9 (362)	13.4 (340)	4.3 (109)	0.8 (21)

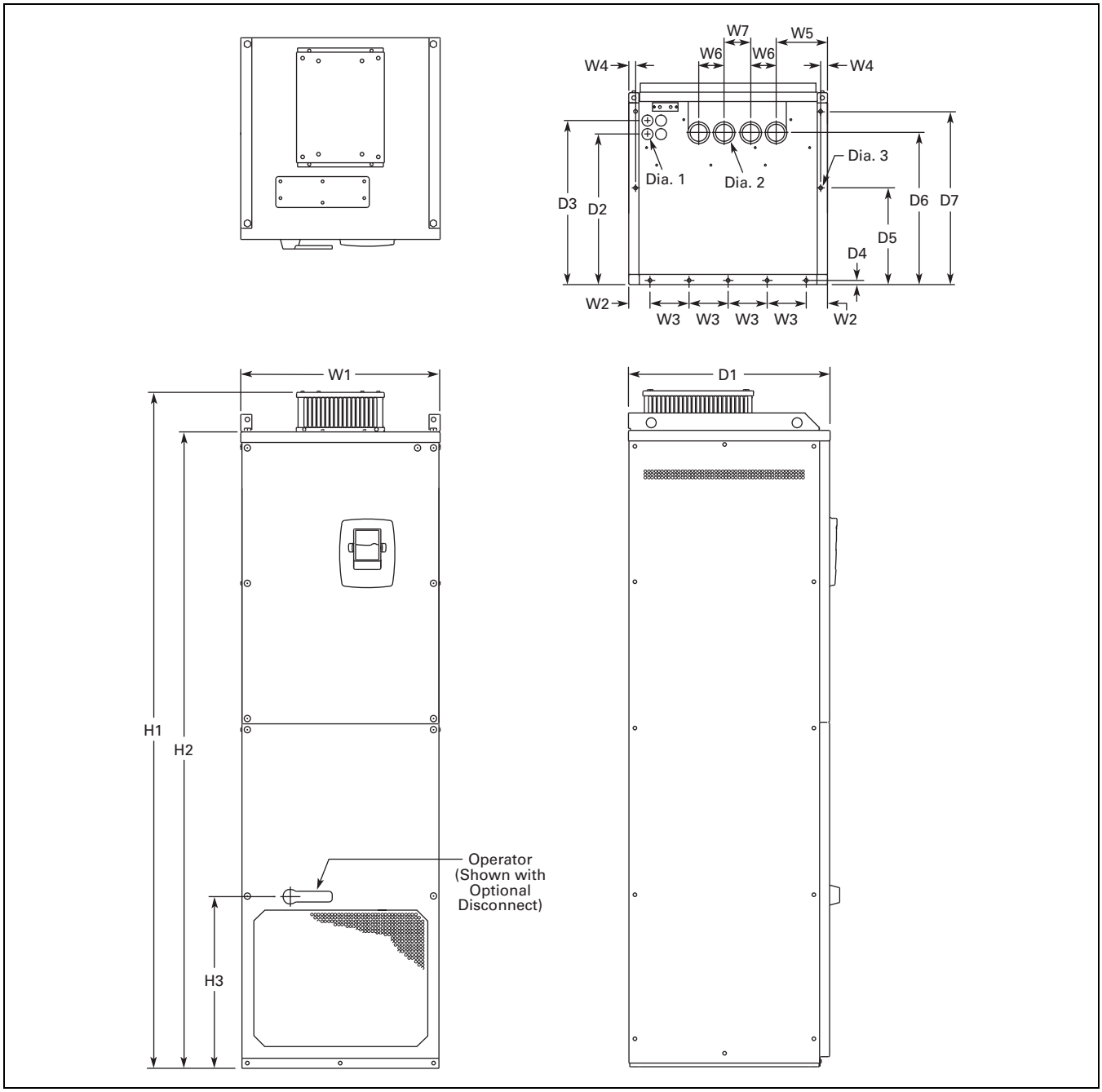


Figure 31.2-9. NEMA Type 1/IP21 and NEMA Type 12/IP54, FR10 Freestanding

W1	W2	W3	W4	W5	W6	W7	H1	H2	H3	D1	D2	D3	D4	D5	D6	D7	Dia. 1	Dia. 2	Dia. 3	Weight Lb (kg)
23.43 (595)	2.46 (62.5)	4.53 (115)	0.79 (20)	5.95 (151)	2.95 (75)	30.11 (79)	79.45 (2018)	74.80 (1900)	20.18 (512.5)	23.70 (602)	17.44 (443)	19.02 (483)	0.47 (12)	11.22 (285)	17.60 (447)	20.08 (510)	0.83 (21)	1.89 (48)	0.43 (11)	857 (389)

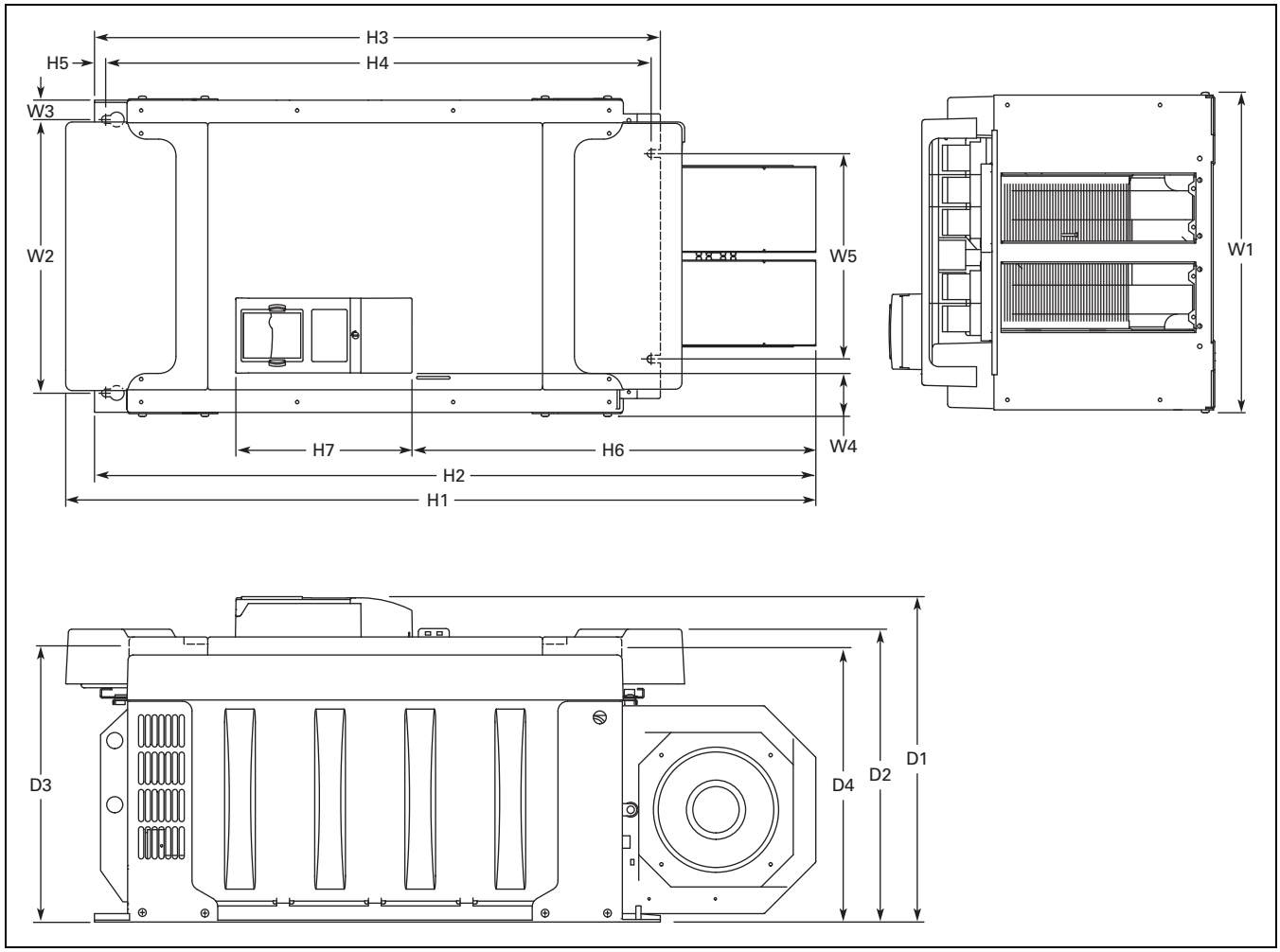


Figure 31.2-10. FR10 Open Chassis ①

Voltage	hp (I_H)	W1	W2	W3	W4	W5	H1	H2	H3	H4	H5	H6	H7	D1	D2	D3	D4	Weight Lb (kg)
480 V 575 V	250–350 200–300	19.7 (500)	16.7 (425)	1.2 (30)	2.6 (67)	12.8 (325)	45.9 (1165)	44.1 (1121)	34.6 (879)	33.5 (850)	0.7 (17)	24.7 (627)	10.8 (275)	19.9 (506)	17.9 (455)	16.7 (423)	16.6 (421)	518 (235)

① 9000X FR12 is built of two FR10 modules. Please refer to SPX installation manual for mounting instructions.

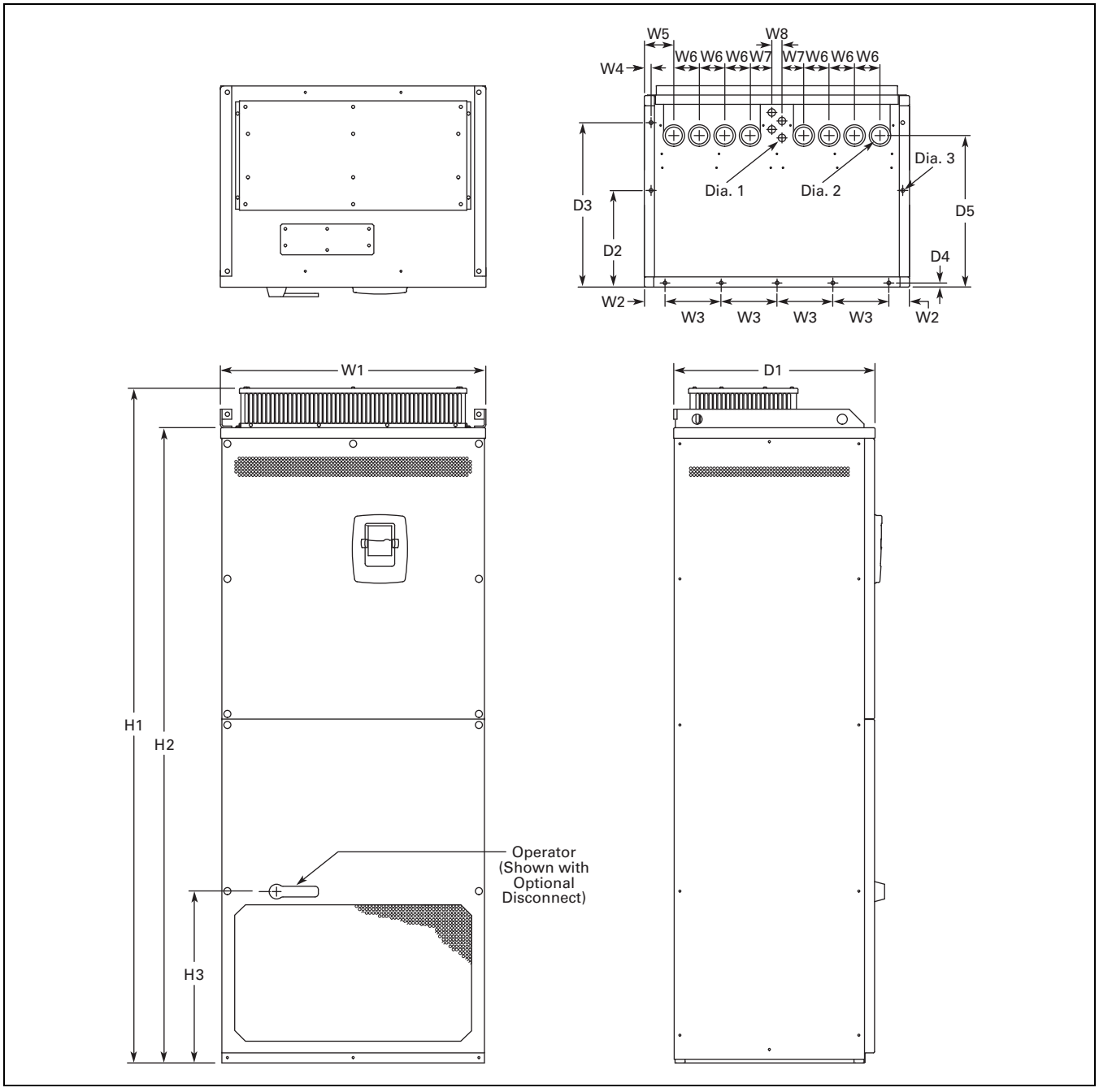


Figure 31.2-11. NEMA Type 1/IP21, FR11 Freestanding Drive

Voltage	hp (I_H)	W1	W2	W3	W4	W5	W6	W7	W8	H1	H2	H3	D1	D2	D3	D4	D5	Dia. 1	Dia. 2	Dia. 3	Weight Lb (kg)
480	400–550	31.26 (794)	2.40 (61)	6.50 (165)	0.79 (20)	3.43 (87)	2.95 (75)	2.52 (64)	1.18 (30)	79.45 (2018)	74.80 (1900)	20.18 (512.5)	23.70 (602)	11.22 (285)	19.09 (485)	0.47 (12)	17.60 (447)	0.83 (21)	1.89 (48)	0.35 x 0.43 (9 x 11)	526 (239)

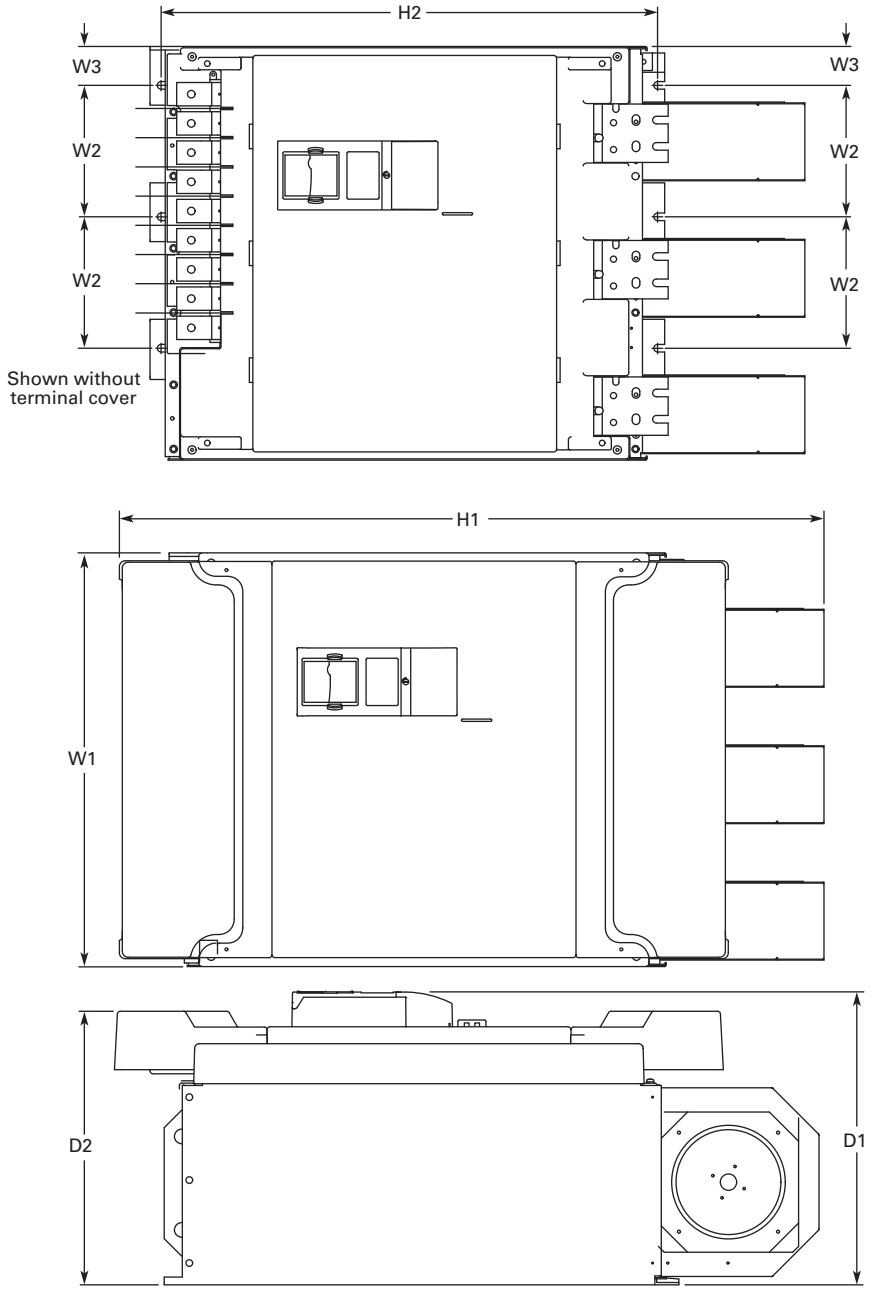


Figure 31.2-12. FR11 Open Chassis

Voltage	hp (I_H)	W1	W2	W3	H1	H2	D1	D2	Weight Lb (kg)
480 V 575 V	400–550 400–500	27.9 (709)	8.86 (225)	2.6 (67)	45.5 (1155)	33.5 (850)	19.8 (503)	18.4 (468)	833 (378)

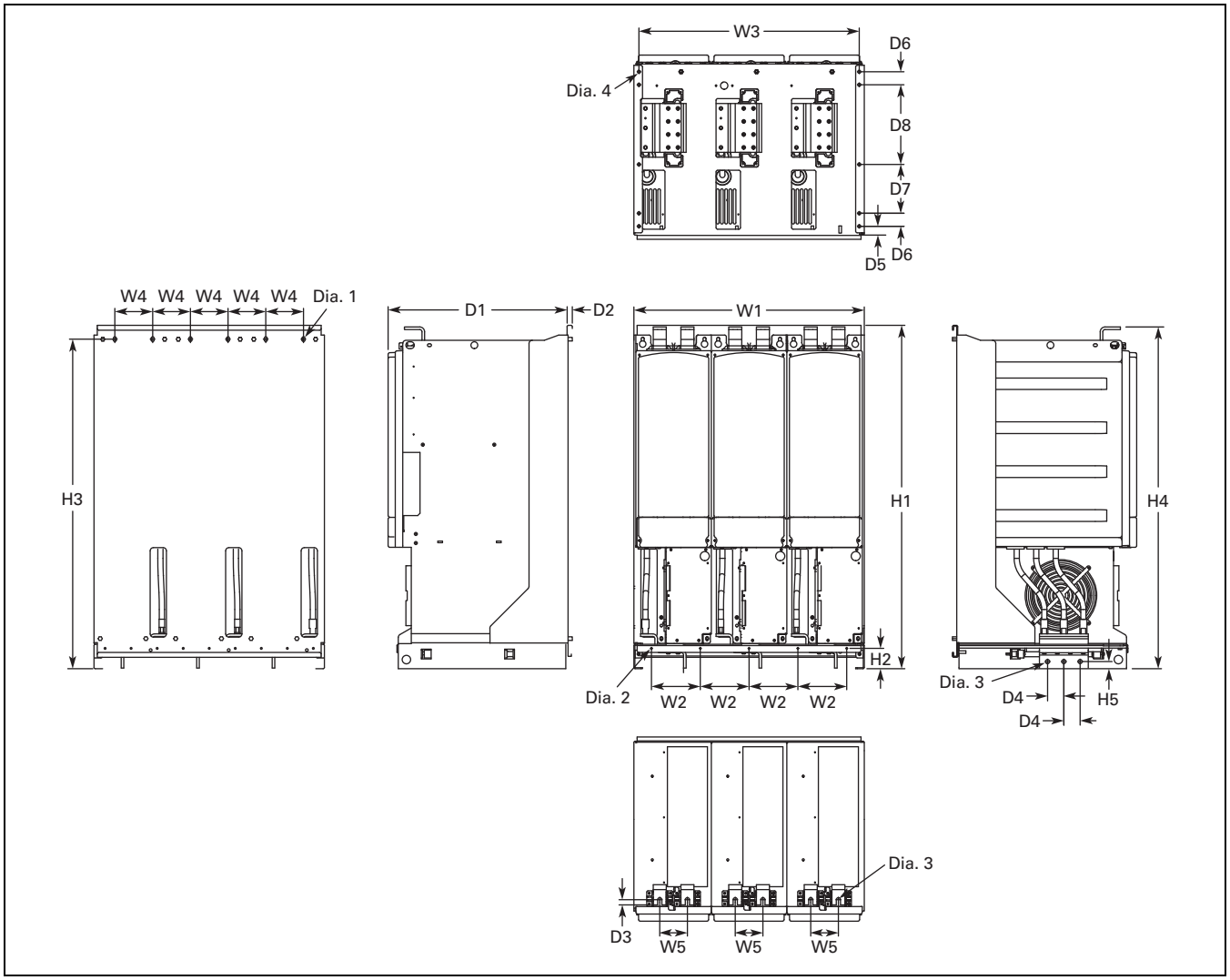


Figure 31.2-13. FR13, Open Chassis Inverter

W1	W2	W3	W4	W5	H1	H2	H3	H4	H5	D1	D2	D3	D4	D5	D6	D7	D8	Dia. 1	Dia. 2	Dia. 3	Dia. 4	Weight Lb (kg)
27.87 (708)	5.91 (150)	26.65 (677)	4.57 (116)	3.35 (85)	41.54 (1055)	2.46 (62.5)	39.86 (1012.5)	41.34 (1050)	0.79 (20)	21.77 (553)	0.51 (13)	0.63 (16)	1.97 (50)	1.06 (27)	1.57 (40)	5.91 (150)	9.64 (244.8)	0.35x0.59 (9x15)	0.18 (4.6)	0.51 (13)	0.37 (9.5)	683 (310)

Note: 9000X FR14 is built of two FR13 modules. Please refer to SPX installation manual for mounting instructions.
FR13 is built from an inverter module and a converter module. Please refer to SPX installation manual for mounting instructions.

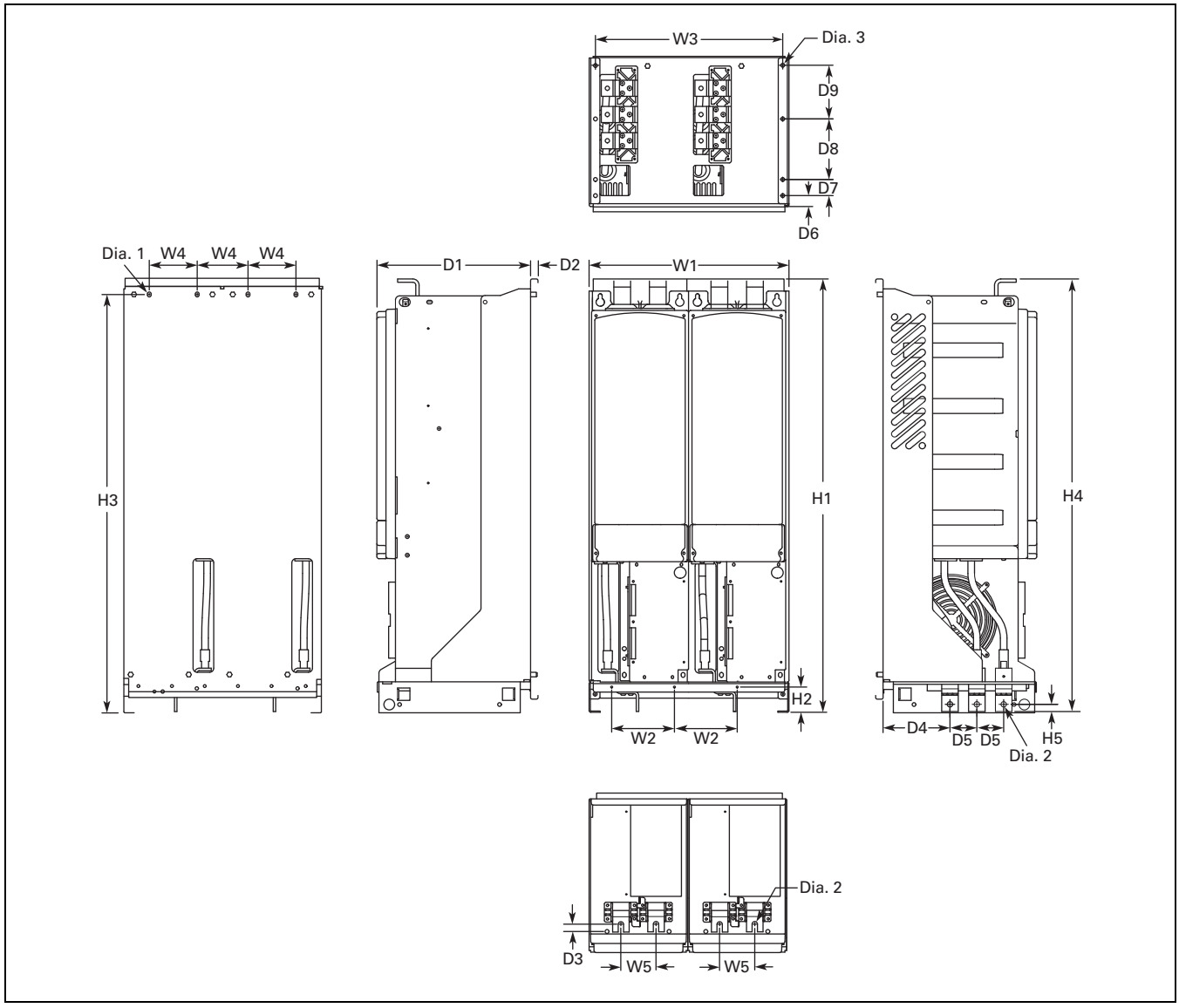


Figure 31.2-14. FR13, Open Chassis Converter

W1	W2	W3	W4	W5	H1	H2	H3	H4	H5	D1	D2	D3	D4	D5	D6	D7	D8	D9	Dia. 1	Dia. 2	Dia. 3	Weight Lb (kg)
18.74 (476)	5.91 (150)	17.52 (445)	4.57 (116)	3.35 (85)	41.54 (1055)	2.46 (62.5)	39.86 (1012.5)	41.34 (1050)	0.69 (17.5)	14.69 (373)	0.51 (13)	0.73 (18.5)	6.42 (163)	2.56 (65)	1.06 (27)	1.57 (40)	5.91 (150)	5.24 (133)	0.35x0.59 (9x15)	0.51 (13)	0.37 (9.5)	295 (134)

Table 31.2-11. Number of Input Units

hp	Input Modules	Catalog Number
480 V		
800	2	**SPX800A0-4A2N1**
690 V		
800	2	**SPX800A0-5A2N1**
900	2	**SPX900A0-5A2N1**
1000	2	**SPXH10A0-5A2N1**

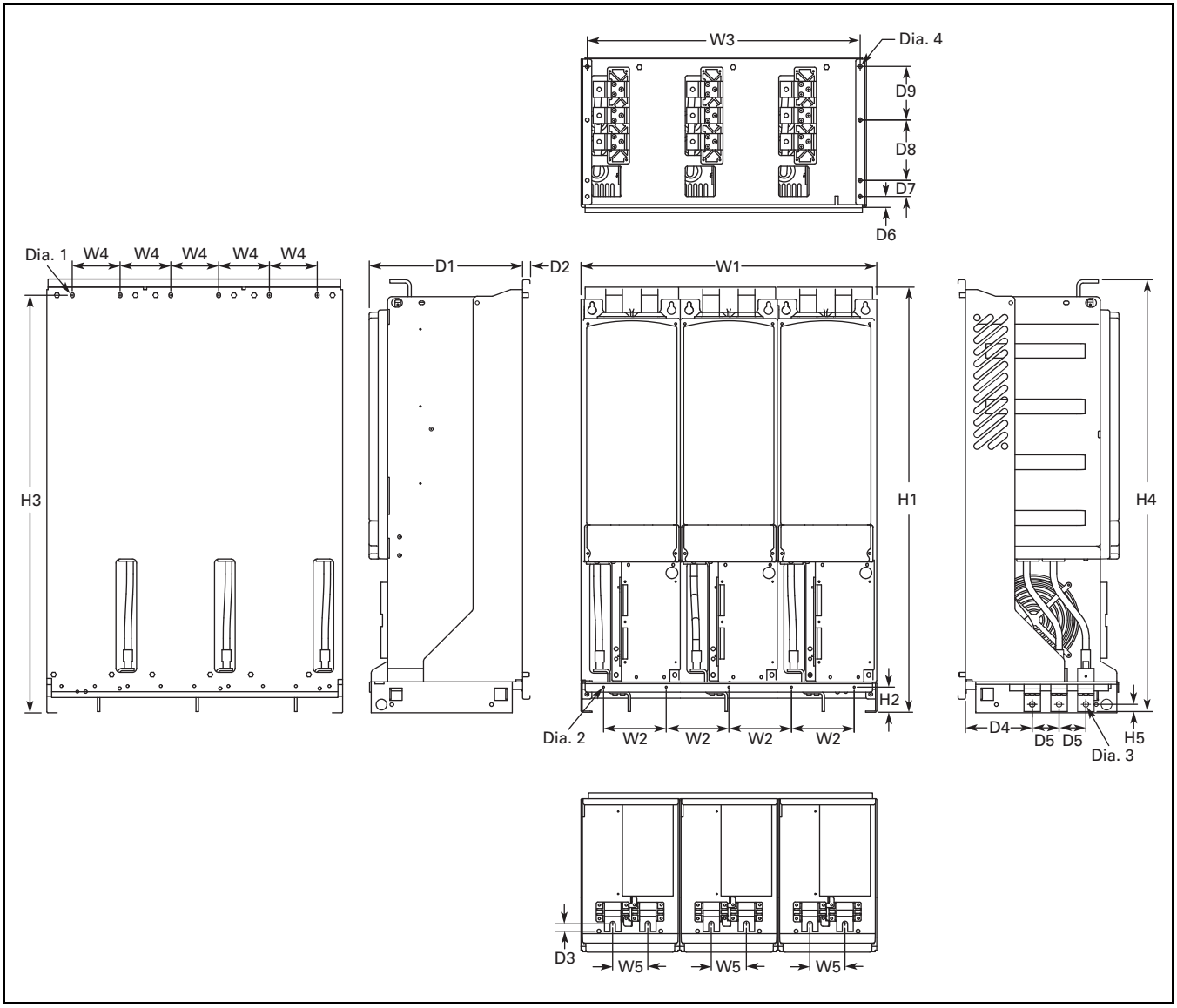


Figure 31.2-15. FR13, Open Chassis Converter—900/1000 hp 480 V

W1	W2	W3	W4	W5	H1	H2	H3	H4	H5	D1	D2	D3	D4	D5	D6	D7	D8	D9	Dia. 1	Dia. 2	Dia. 3	Dia. 4	Weight Lb (kg)
27.87 (708)	5.91 (150)	26.65 (677)	4.57 (116)	3.35 (85)	41.54 (1055)	2.46 (62.5)	39.86 (1012.5)	41.34 (1050)	0.69 (17.5)	14.69 (373)	0.51 (13)	0.73 (18.5)	6.42 (163)	2.56 (65)	1.06 (27)	1.57 (40)	5.91 (150)	5.24 (133)	0.35x0.59 (9x15)	0.18 (4.6)	0.51 (13)	0.37 (9.5)	443 (201)

Table 31.2-12. Number of Input Units

hp	Input Modules	Catalog Number
480 V		
900	3	**SPX900A0-4A2N1**
1000	3	**SPXH10A0-4A2N1**

AC Choke Dimensions

Table 31.2-13. Choke Types

Frame Size	Choke Type ①	Catalog Number
Voltage Range 380–500 V		
FR10	CHK0400 CHK0520 CHK0520	**SPX2504** **SPX3004** **SPX3504**
FR11	2 x CHK0400 2 x CHK0400 2 x CHK0400	**SPX4004** **SPX5004** **SPX5504**
FR12	2 x CHK0520 2 x CHK0520 2 x CHK0520	**SPX6004** **SPX6504** **SPX7004**
FR13	2 x CHK0400 3 x CHK0520 3 x CHK0520	**SPX8004** **SPX9004** **SPXH104**
FR14	4 x CHK0520 6 x CHK0400	**SPXH124** **SPXH164**

Frame Size	Choke Type ①	Catalog Number
Voltage Range 525–690 V		
FR10	CHK0261 CHK0400 CHK0400	**SPX2005** **SPX2505** **SPX3005**
FR11	CHK0520 CHK0520 2 x CHK0400	**SPX4005** **SPX4505** **SPX5005**
FR12	2 x CHK0400 2 x CHK0400 2 x CHK0400	**SPX5505** **SPX6005** **SPX7005**
FR13	2 x CHK0400 2 x CHK0400 2 x CHK0400	**SPX8005** **SPX9005** **SPXH105**
FR14	4 x CHK0400 6 x CHK0400	**SPXH135** **SPXH155**

① Chokes are provided with all FR10–FR14 drives.

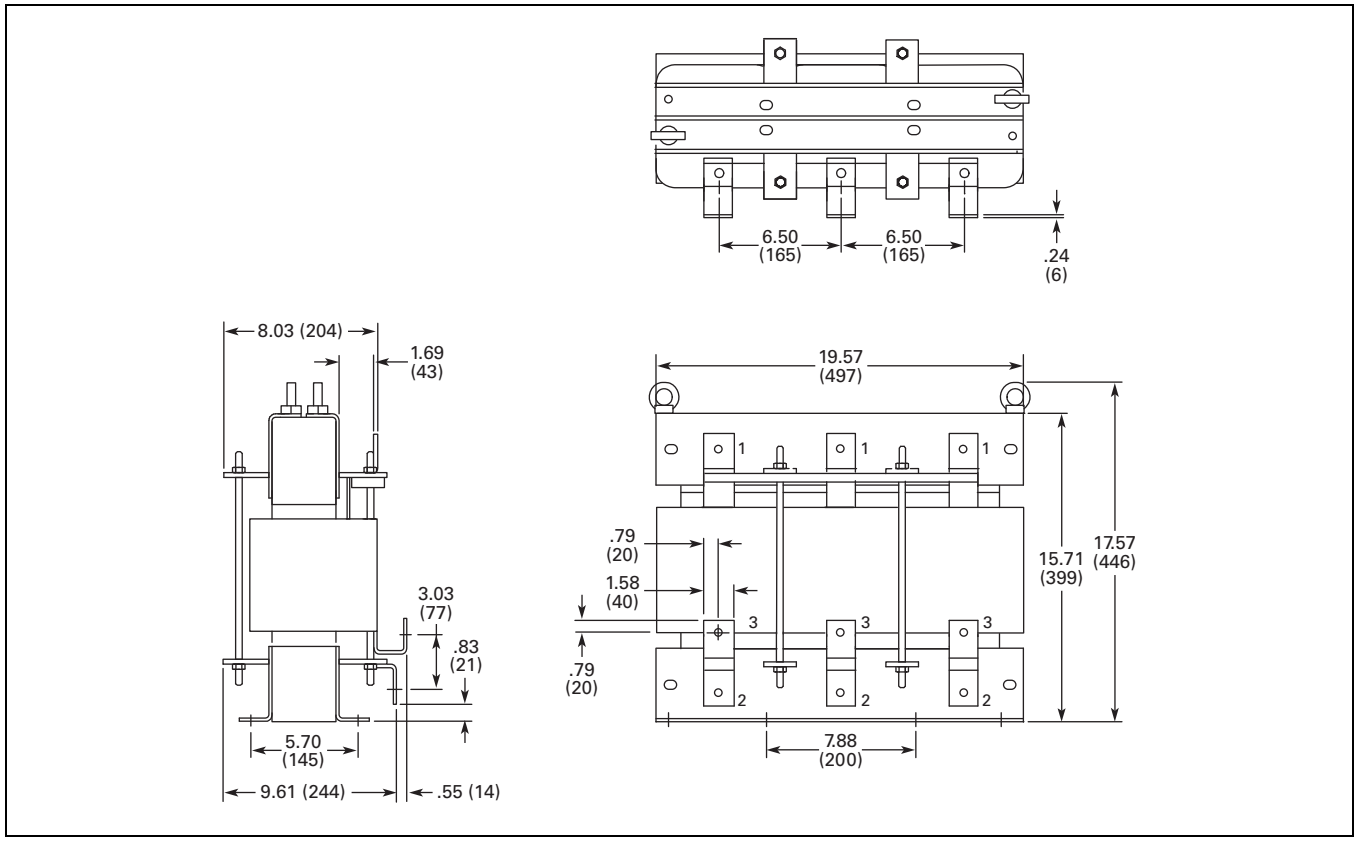


Figure 31.2-16. CHK0520

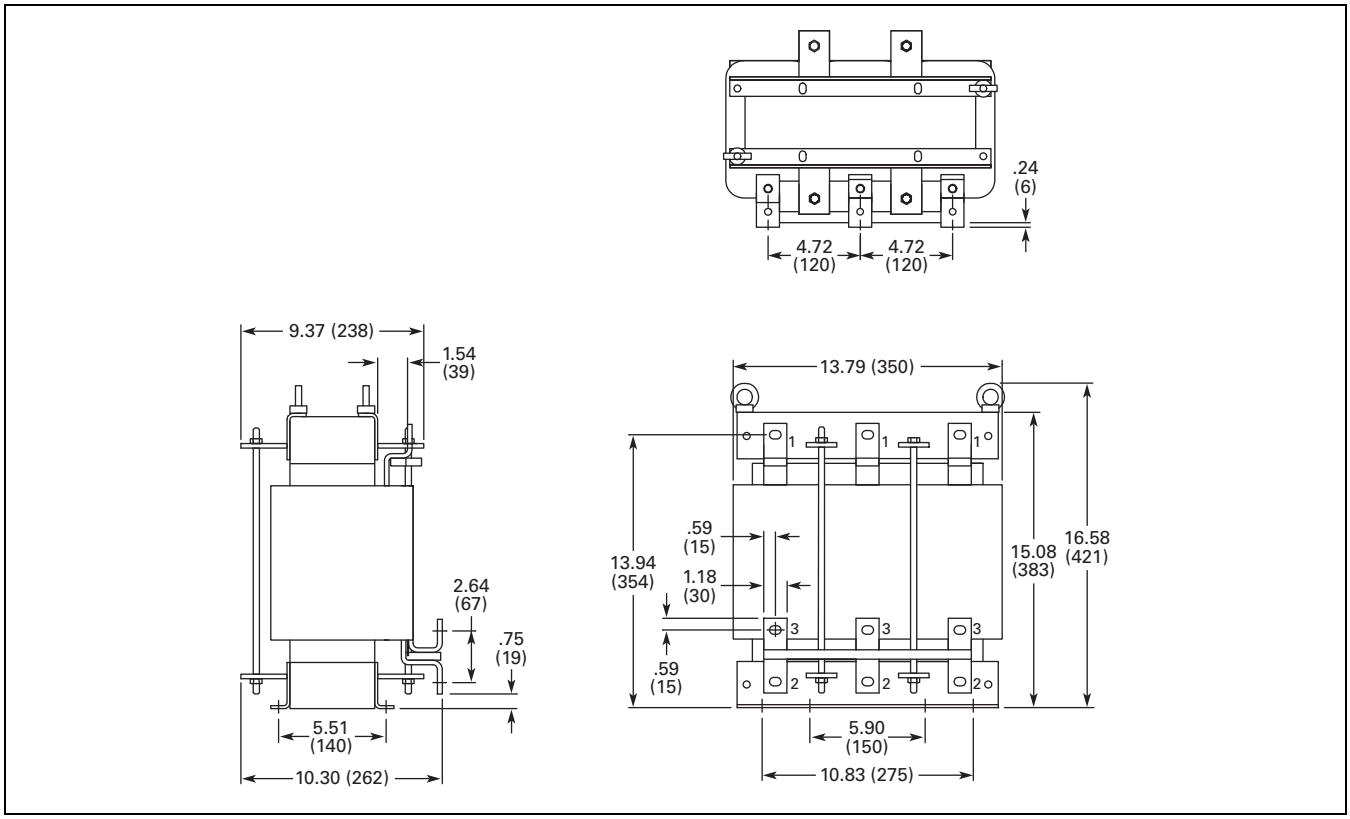


Figure 31.2-17. CHK0400

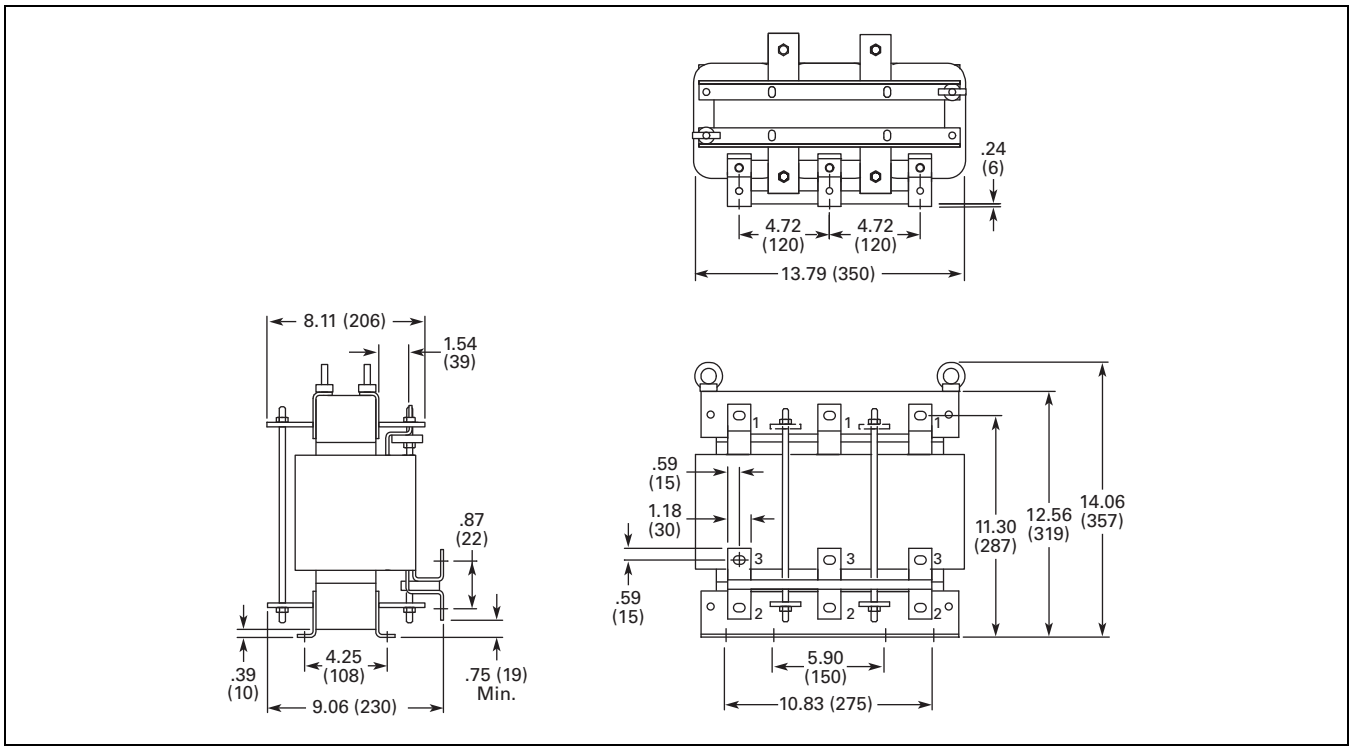
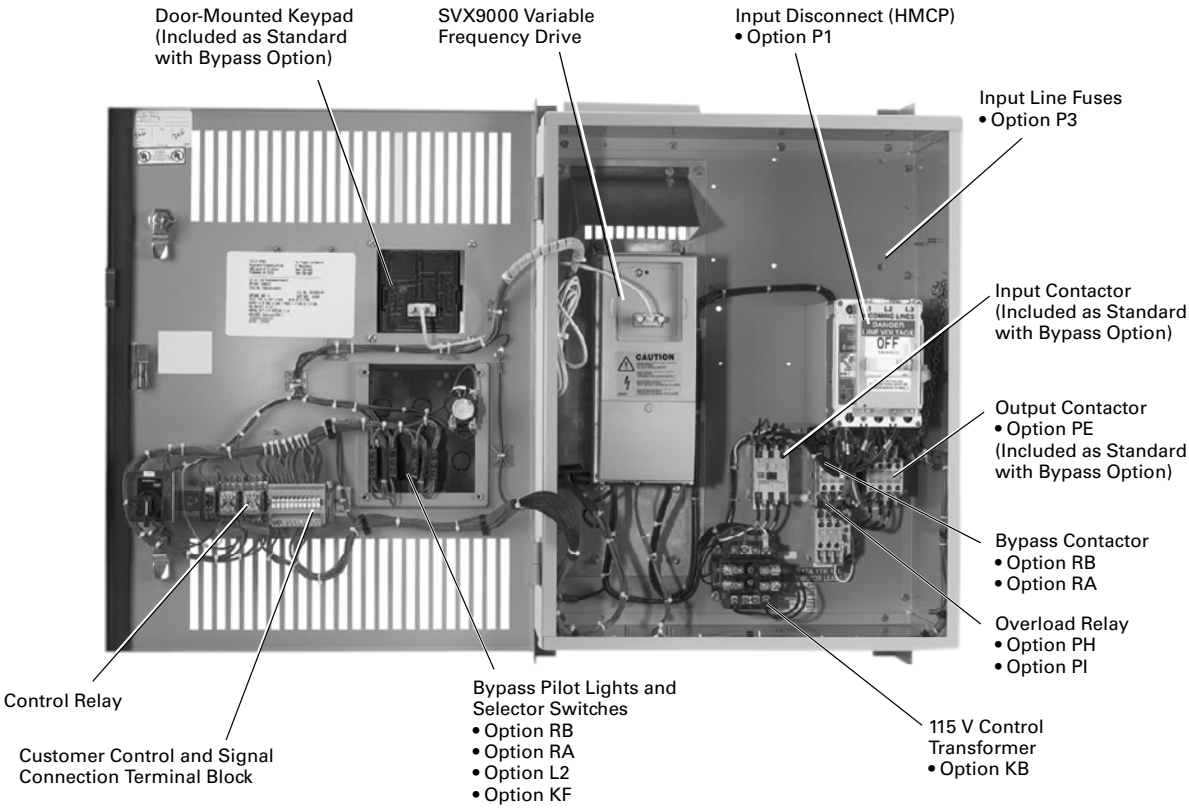


Figure 31.2-18. CHK0261

Enclosed SVX



Enclosed 9000X Series Drive

General Description

- **Standard enclosed**—covers a wide range of the most commonly ordered options. Pre-engineering eliminates the lead time normally associated with customer specific options
- **Modified standard enclosed**—applies to specific customer requirements that vary from the Standard Enclosed offering, such as the need for an additional indicating light or minor modifications to drawings. *Consult your Eaton representative for assistance in pricing and lead time*
- **Custom engineered**—for those applications with more unique or complex requirements, these are individually engineered to the customer's needs. *Consult your Eaton representative for assistance in pricing and lead time*

Features

- NEMA Type 1 or Type 12 enclosures
- Input voltage: 208 V, 230 V, 480 V and 575 V
- Complete range of control, network and power options
- Horsepower range:
  - 208 V—3/4 to 100 hp I_H; 1 to 100 hp I_L
  - 230 V—3/4 to 100 hp I_H; 1 to 100 hp I_L
  - 480 V—1 to 700 hp I_H; 1-1/2 to 800 hp I_L
- HMCP padlockable

Standards and Certifications

- UL listed
- cUL listed

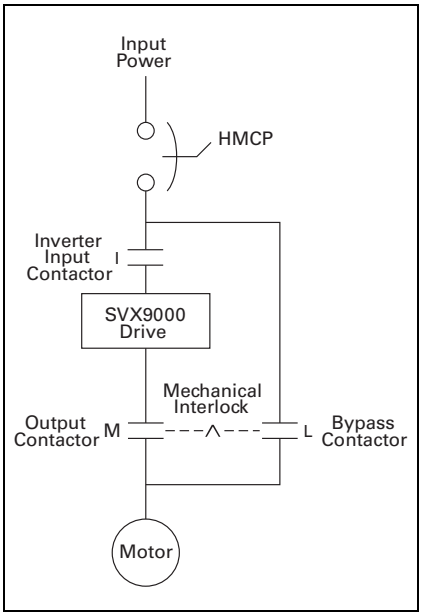


Figure 31.2-19. Power Diagram for Bypass Options RB and RA

Catalog Number Selection

Table 31.2-14. SVX9000 Enclosed NEMA Type 1/12 Drive Catalog Numbering System

SVX F07 1 4 A A _ _ _ _ _ _ _ _ _ _

Build Alphabetically and Numerically

Product Family
SVX = Enclosed drives

Horsepower Rating	
F07 = 3/4 hp	**100** = 100 hp
001 = 1 hp	**125** = 125 hp
F15 = 1-1/2 hp	**150** = 150 hp
002 = 2 hp	**200** = 200 hp
003 = 3 hp	**250** = 250 hp
005 = 5 hp	**300** = 300 hp
007 = 7-1/2 hp	**350** = 350 hp
010 = 10 hp	**400** = 400 hp
015 = 15 hp	**500** = 500 hp
020 = 20 hp	**550** = 550 hp
025 = 25 hp	**600** = 600 hp
030 = 30 hp	**650** = 650 hp
040 = 40 hp	**700** = 700 hp
050 = 50 hp	
060 = 60 hp	
075 = 75 hp	

Enclosure Rating
1 = NEMA Type 1
2 = NEMA Type 12
6 = NEMA 12 filtered

Voltage Rating
1 = 208 V
2 = 230 V
4 = 480 V

Application—Torque/Braking ②
A = I_L/no brake chopper
B = I_L/internal brake chopper
D = I_H/no brake chopper
E = I_H/internal brake chopper

Enclosed Style
A = Enclosed drive

Enclosed Options ①④⑤		Type
K1	Door-mounted speed potentiometer ③	Control
K2	Door-mounted speed potentiometer with HOA selector switch ③	Control
K3	3–15 psig Follower	Control
K4	HAND/OFF/AUTO switch (22 mm)	Control
K5	MANUAL/AUTO ref switch (22 mm)	Control
K6	START/STOP pushbuttons (22 mm)	Control
KB	115 V control transformer–550 VA	Control
KF	Bypass test switch for RA and RB	Addl. bypass
KO	Standard elapsed time meter	Control
L1	Power on and fault pilot lights	Light
L2	Bypass pilot lights for RA, RB bypass options	Addl. bypass
LE	Red RUN light	Light
P1	Input disconnect (HMCP) 100 kAIC	Input
P2	Disconnect switch ⑥	Input
P3	Input line fuses (200 kAIC)	Input
P7	Input power surge protection	Input
PE	Output contactor	Output
PF	Output filter	Output
PG	MotoRx (up to 600 ft) 1000 V/µS DV/DT filter	Output
PH	Single overload relay	Output
PI	Dual overload relays	Output
PN	Dual overloads for bypass	Addl. bypass
RA	Manual HOA bypass controller	Bypass
RB	Manual IOB bypass controller	Bypass
RC	Auto transfer HOA bypass controller	Bypass
RD	Auto transfer IOB bypass controller	Bypass
S5	Floor stand 22 inches	Enclosure
S6	Floor stand 12 inches	Enclosure
S7	10 inch expansion	Enclosure
S8	20 inch expansion	Enclosure
S9	Space heater	Enclosure

Communication Options	
C2 = Modbus	**C8** = Modbus (D9 Type connector)
C3 = PROFIBUS DP	**CA** = Johnson Controls N2
C4 = LonWorks	**CI** = Modbus TCP
C5 = PROFIBUS DP (D9 connector)	**CJ** = BACnet
C6 = CANopen (slave)	**D3** = RS-232 with D9 connection
C7 = DeviceNet	

Control Options
B1 = 6 DI, 1 ext +24 Vdc/EXT +24 Vdc
B2 = 1 RO (NC/NO), 1 RO (NO), 1 Therm
B4 = 1 AI (mA isolated), 2 AO (mA isolated), 1 ext +24 Vdc/EXT +24 Vdc
B5 = 3 RO (NO)
B8 = 1 ext +24 Vdc/EXT +24 Vdc, 3 Pt100
B9 = 1 RO (NO), 5 DI 42–240 Vac input

Engineered Options
HT = High Temperature rating for 50°C (FR10 and above) ⑦
VB = Varnished Boards

① Local/remote keypad is included as the standard control panel.

② Brake chopper is a factory installed option only, see drive option tables on **Pages 31.2-27–31.2-29**. **Note:** External dynamic braking resistors not included. Consult factory.

③ Includes local/remote speed reference switch.

④ Some options are voltage and/or horsepower specific. Consult your Eaton representative for details.

⑤ See **Pages 31.2-30** and **31.2-31** for descriptions.

⑥ Applicable only with FR10 and FR11 Freestanding designs.

⑦ Consult Eaton for pricing and availability.

Table 31.2-15. Input Molded-Case Breaker Sizes—230 V Ratings

hp	Frame Size	FLA	Breaker Current
1	FR4	4.8	15
1-1/2	FR4	6.6	15
2	FR4	7.8	15
3	FR4	11	15
5	FR5	17.5	20
7-1/2	FR5	25	30
10	FR6	31	40
15	FR6	48	60
20	FR7	61	80
25	FR7	72	100
30	FR7	87	100

Note: Based on a maximum of 104 °F (40 °C). A UL listed breaker must be used.

Table 31.2-16. Input Molded-Case Breaker Sizes—480 V Ratings

hp	Frame Size	FLA	Breaker Current
1-1/2	FR4	3.3	15
2	FR4	4.3	15
3	FR4	5.6	15
5	FR4	7.6	15
7-1/2	FR5	12	20
10	FR5	16	30
15	FR5	23	30
20	FR6	31	40
25	FR6	38	50
30	FR6	46	60
40	FR7	61	80
50	FR7	72	100
60	FR7	87	100
75	FR8	105	1 25
100	FR8	140	150
125	FR8	170	200
150	FR9	205	250
200	FR9	261	300
250	FR10	300	400
300	FR10	385	500
350	FR10	460	600
400	FR11	520	700
500	FR11	590	800
550	FR11	650	900
600	FR12	750	1000
650	FR12	820	1000
700	FR12	920	1200

Note: Based on a maximum of 104 °F (40 °C). A UL listed breaker must be used.

Table 31.2-17. Input Fuse Sizes—230 V Ratings

VT hp	Frame Size	NEC I (A)	I (A)	Fuse Quantity	Fuse (A)
1	FR4	4.2	4.8	3	10
1-1/2	FR4	6	6.6	3	10
2	FR4	6.8	7.8	3	10
3	FR4	9.6	11	3	15
5	FR5	15.2	17.5	3	20
7-1/2	FR5	22	25	3	30
10	FR5	28	31	3	40
15	FR6	42	48	3	60
20	FR6	54	61	3	80
25	FR7	68	72	3	100
30	FR7	80	87	3	110
40	FR7	104	114	3	125
50	FR8	130	140	3	175
60	FR8	154	170	3	200
75	FR8	192	205	3	250
100	FR9	248	261	3	300

Note: UL recognized type JJS preferred but RK acceptable.

Table 31.2-18. Input Fuse Sizes—480 V Ratings

VT hp	Frame Size	NEC I (A)	I (A)	Fuse Quantity	Fuse (A)
1-1/2	FR4	3	3.3	3	10
2	FR4	3.4	4.3	3	10
3	FR4	4.8	5.6	3	10
5	FR4	7.6	7.6	3	10
7-1/2	FR4	11	12	3	15
10	FR5	14	16	3	20
15	FR5	21	23	3	30
20	FR5	27	31	3	35
25	FR6	34	38	3	50
30	FR6	40	46	3	60
40	FR6	52	61	3	80
50	FR7	65	72	3	100
60	FR7	77	87	3	110
75	FR7	96	105	3	125
100	FR8	124	140	3	175
125	FR8	156	170	3	200
150	FR8	180	205	3	250
200	FR9	240	261	3	350
250	FR9	302	300	3	400
300	FR10	361	385	3	450
350	FR10	414	460	3	500
400	FR10	477	520	3	600
500	FR11	590	590	6	350
550	FR11	NS	650	6	400
600	FR11	NS	730	6	450
650	FR12	NS	820	6	500
700	FR12	NS	920	6	500
800	FR12	NS	1030	6	600

Note: UL recognized type JJS preferred but RK acceptable.

Product Selection

When Ordering

- Select a base catalog number that meets the application requirements—nominal horsepower, voltage and enclosure rating (the enclosed drive's continuous output amp rating should be equal to or greater than the motor's full load amp rating). The base enclosed package includes a standard drive, door mounted Local/Remote Keypad and enclosure
- If dynamic brake chopper or Control/Communication option is desired, change the appropriate code in the base catalog number
- Select enclosed options. Add the codes as suffixes to the base catalog number in alphabetical and numeric order
- **Read all footnotes**

208 V Drives

Table 31.2-19. 208 Vac Input Base Drive

Enclosure Size ①	hp	Current (A)	NEMA Type 1 Frame Size	NEMA Type 12 Frame Size	Drawing Number
208 V High Overload Drive and Enclosure—I_H = Constant Torque					
0	3/4	3.7	4	4	9
0	1	4.8	4 FR4	4	9
0	1-1/2	6.6	4	4	9
0	2	7.8	4	4	9
0	3	11	4	4	9
0	5	17.5	5	5	9
0	7-1/2	25	5	5	9
1	10	31	6	6	10
1	15	48	6	6	10
2	20	61	7	7	11
2	25	75	7	7	11
2	30	88	7	7	11
3	40	114	8	8	12
4	50	143	8	8	13
5	60	170	8	8	14
5	75	211	9	9	14
5	100	273	9	9	14
208 V Low Overload Drive and Enclosure—I_L = Variable Torque					
0	1	4.8	4	4	9
0	1-1/2	6.6	4	4	9
0	2	7.8	4	4	9
0	3	11	4	4	9
0	5	17.5	5	5	9
0	7-1/2	25	5	5	9
0	10	31	5	5	9
1	15	48	6	6	10
1	20	61	6	6	10
2	25	75	7	7	11
2	30	88	7	7	11
2	40	114	7	7	11
3	50	—	8	8	12
4	60	170	8	8	13
5	75	—	8	8	14
5	100	—	9	9	14

① Enclosure dimensions listed on **Pages 31.2-32–31.2-40.**
② Includes drive, Local/Remote keypad and enclosure.

Note: Drive heat dissipation calculations listed on **Page 31.2-29**.

31

230 V Drives

Table 31.2-20. 230 Vac Input Base Drive

Enclosure Size ①	hp	Current (A)	NEMA Type 1 Frame Size	NEMA Type 12 Frame Size	Drawing Number
230 V High Overload Drive and Enclosure—I_H = Constant Torque					
0	3/4	3.7	4	4	9
0	1	4.8	4	4	9
0	1-1/2	6.6	4 FR	4 FR	9
0	2	7.8	4	4	9
0	3	11	4	4	9
0	5	17.5	5	5	9
0	7-1/2	25	5	5	9
1	10	31	6	6	10
1	15	48	6	6	10
2	20	61	7	7	11
2	25	75	7	7	11
2	30	88	7	7	11
3	40	114	8	8	12
4	50	140	8	8	13
5	60	170	8	8	14
5	75	205	9	9	14
5	100	261	9	9	14
230 V Low Overload Drive and Enclosure—I_L = Variable Torque					
0	1	4.8	4	4	9
0	1-1/2	6.6	4	4	9
0	2	7.8	4	4	9
0	3	11	4	4	9
0	5	17.5	5	5	9
0	7-1/2	25	5	5	9
0	10	31	5	5	9
1	15	48	6	6	10
1	20	61	6	6	10
2	25	75	7	7	11
2	30	88	7	7	11
2	40	114	7	7	11
3	50	140	8	8	12
4	60	170	8	8	13
5	75	205	8	8	14
5	100	261	9	9	14

① Enclosure dimensions listed on **Pages 31.2-32–31.2-40.**
② Includes drive, Local/Remote keypad and enclosure.

480 V Drives

Table 31.2-21. 480 Vac Input Base Drive

Enclosure Size ①	hp	Current (A)	NEMA Type 1 Frame Size	NEMA Type 12 Frame Size	Drawing Number
High Overload Drive and Enclosure—I_H = Constant Torque					
0	1	2.2	4	4	9
0	1-1/2	3.3	4	4	9
0	2	4.3	4 FR	4 FR	9
0	3	5.6	4	4	9
0	5	7.6	4	4	9
0	7-1/2	12	5	5	9
0	10	16	5	5	9
0	15	23	5	5	9
1	20	31	6	6	10
1	25	38	6	6	10
1	30	46	6	6	10
2	40	61	7	7	11
2	50	72	7	7	11
2	60	87	7	7	11
3	75	105	8	8	12
3	100	140	8	8	12
4	125	170	8	8	13
5	150	205	9	9	14
5	200	245	9	9	14
6, 8 ④⑥	250	300	10	10	15 ④, 16 ⑥
6, 8 ④⑥	300	385	10	10	15 ④, 16 ⑥
6, 8 ④⑥	350	460	10	10	15 ④, 16 ⑥
8, 9 ⑤⑥	400	520	11	11	16 ⑤, 17 ⑥
8, 9 ⑤⑥	500	590	11	11	16 ⑤, 17 ⑥
8, 9 ⑤⑥	550	650	11	11	16 ⑤, 17 ⑥
③	600	730	12	12	③
③	650	820	12	12	③
③	700	920	12	12	③
Low Overload Drive and Enclosure—I_L = Variable Torque					
0	1-1/2	3.3	4	4	9
0	2	4.3	4	4	9
0	3	5.6	4	4	9
0	5	7.6	4	4	9
0	7-1/2	12	4	4	9
0	10	16	5	5	9
0	15	23	5	5	9
0	20	31	5	5	9
1	25	38	6	6	10
1	30	46	6	6	10
1	40	61	6	6	10
2	50	72	7	7	11
2	60	87	7	7	11
2	75	105	7	7	11
3	100	140	8	8	12
4	125	170	8	8	13
4	150	205	8	8	13
5	200	261	9	9	14
5	250	300	9	9	14
6, 8 ④⑥	300	385	10	10	15 ④, 16 ⑥
6, 8 ④⑥	350	460	10	10	15 ④, 16 ⑥
6, 8 ④⑥	400	520	10	10	15 ④, 16 ⑥
8, 9 ⑤⑥	500	590	11	11	16 ⑤, 17 ⑥
8, 9 ⑤⑥	550	650	11	11	16 ⑤, 17 ⑥
8, 9 ⑤⑥	600	730	11	11	16 ⑤, 17 ⑥
③	650	820	12	12	③
③	700	920	12	12	③
③	800	1030	12	12	③

① Enclosure dimensions listed on **Pages 31.2-32–31.2-40.**
② Includes drive, Local/Remote keypad and enclosure.
③ Consult Eaton.
④ The smaller enclosure Size 6 accommodates only power options, input disconnect (P1) and input line fuses (P3). Bypass and other options require Size 8. Adding any standard control option will not require the larger enclosure.
⑤ The smaller enclosure Size 8 accommodates only power options, input disconnect (P1) and input line fuses (P3). Bypass and other options require Size 9. Adding any standard control option will not require the larger enclosure.
⑥ For other options, consult factory.

Drive Heat Dissipation Calculations

The Eaton 9000X drive is a highly efficient electric power converter releasing minimal amounts of waste heat energy into the ambient air. The amount of heat loss from the drive in operation is directly proportional to the load of the connected motor, the drive switching frequency and operating frequency. Based on the drive operating load, the heat dissipation can be calculated at a given operating point. For most cases, the following general formula can be used to estimate the heat dissipation of the power module:

P_{motor} [kW] x 0.025 = P_{loss} [kW]

Where P_{motor} is the operating power of the motor and P_{loss} is the heat dissipated from the 9000X drive.

For example, a 20 hp [15 kW] motor is applied with a 9000X inverter on a pump application. The application has been designed so that maximum motor load will be 95% or 14.3 kW.

Using the formula above, the calculated heat dissipation of the drive will be approximately 356 watts/hour or 1215 BTU/hour at the designed maximum load.

15 kW x 0.95 = 14.3 kW

14.3 kW x 0.025 = 0.356 kW/hour or 356 watts/hour

356 watts/hour x 3.412 = 1215 BTU/hour

Note: This example assumes the default switching frequency has been used.

Additional conversion formulas:

hp x 0.7457 = kW

hp x 745.7 = watts

kW x 1000 = watts

Watts/hour x 3.412 = BTU/hour

31

SVX9000 Drives

Control/Communication Option Descriptions

Table 31.2-22. Available Control/Communications Options

Option	Description	Option Type
K1	**Door-Mounted Speed Potentiometer**—Provides the SVX9000 with the ability to adjust the frequency reference using a door-mounted potentiometer. This option uses the 10 Vdc reference to generate a 0–10 V signal at the analog voltage input signal terminal. When the HOA bypass option is added, the speed is controlled when the HOA switch is in the hand position. Without the HOA bypass option, a 2-position switch (labeled local/remote) is provided on the keypad to select speed reference from the Speed Potentiometer or a remote speed signal.	Control
K2	**Door-Mounted Speed Potentiometer with HOA Selector Switch**—Provides the SVX9000 with the ability to start/stop and adjust the speed reference from door-mounted control devices or remotely from customer supplied inputs. In HAND position, the drive will start and the speed is controlled by the door-mounted speed potentiometer. The drive will be disabled in the OFF position. When AUTO is selected, the run enable and speed reference are controlled from remote inputs. Speed reference can be either 0–10 Vdc or 4–20 mA. The drive default is 4–20 mA, parameter is field programmable. Run enable is controlled by a dry contact closure. *This option requires a customer supplied 115 V power source.*	Control
K3	**3–15 psig Follower**—Provides a pneumatic transducer that converts a 3–15 psig pneumatic signal to either 0–8 Vdc or a 1–9 Vdc signal interface with the SVX9000. The circuit board is mounted on the inside of the front enclosure panel and connects to the user's pneumatic control system via 6 ft (1.8 m) of flexible tubing and a 1/4-inch (6.4 mm) brass tube union.	Control
K4	**HAND/OFF/AUTO Switch for Non-bypass Configurations**—Provides a three-position selector switch that allows the user to select either a Hand or Auto mode of operation. Hand mode is defaulted to keypad operation, and Auto mode is defaulted to control from an external terminal source. These modes of operation can be configured via programming to allow for alternate combinations of start and speed sources. Start and speed sources include keypad, I/O and FieldBus.	Control
K5	**MANUAL/AUTO Speed Reference Switch**—Provides a door-mounted selector switch for Manual/Auto speed reference.	Control
K6	**START/STOP Pushbuttons**—Provides door-mounted START and STOP pushbuttons for either bypass or non-bypass configurations.	Control
KB	**115 V Control Transformer–550 VA**—Provides a fused control power transformer with additional 550 VA at 115 V for customer use.	Control
KF	**Bypass Test Switch for RB and RA**—Allows the user to energize the AF drive for testing while operating the motor on the bypass controller. The Test Switch is mounted on the inside of the enclosure door.	Addl. bypass
KO	**Standard Elapsed Time Meter**—Provides a door-mounted elapsed run time meter.	Control
L1	**Power On and Fault Pilot Lights**—Provides a white power on light that indicates power to the enclosed cabinet and a red fault light indicates a drive fault has occurred.	Light
L2	**Bypass Pilot Lights for RB, RA Bypass Options**—A green light indicates when the motor is running in inverter mode and an amber light indicates when the motor is running in bypass mode. The lights are mounted on the enclosure door, above the switches.	Addl. bypass
LE	**RUN Pilot Light**—Provides a green run light that indicates the drive has been commanded to start.	Light
P1	**Input Disconnect Assembly Rated to 100 kAIC**—High Interrupting Motor Circuit Protector (HMCP) that provides a means of short-circuit protection for the power cables between it and the SVX9000, and protection from high-level ground faults on the power cable. Allows a convenient means of disconnecting the SVX9000 from the line and the operating mechanism can be padlocked in the OFF position. This is factory mounted in the enclosure.	Input
P2	**Disconnect Switch**—Disconnect switch option is applicable only with NEMA Type 1 and NEMA Type 12 Freestanding drives. Allows a convenient means of disconnecting the SVX9000 from the line, and the operating mechanism can be padlocked in the OFF position. This is factory-mounted in the enclosure.	Input
P3	**Input Line Fuses Rated to 200 kAIC**—Provides high-level fault protection of the SVX9000 input power circuit from the load side of the fuses to the input side of the power transistors. This option consists of three 200 kA fuses, which are factory mounted in the enclosure.	Input
P7	**MOV Surge Suppressor**—Provides a metal oxide varistor (MOV) connected to the line side terminals and is designed to clip line side transients.	Input
PE	**Output Contactor**—Provides a means for positive disconnection of the drive output from the motor terminals. The contactor coil is controlled by the drive's run or permissive logic. NC and NO auxiliary contacts rated at 10 A, 600 Vac are provided for customer use. Bypass Options **RB** and **RA** include an Output Contactor as standard. This option includes a low VA 115 Vac fused Control Power Transformer and is factory mounted in the enclosure.	Output
PF	**Output Filter**—Used to reduce the transient voltage (DV/DT) at the motor terminals. The Output Filter is recommended for cable lengths exceeding 100 ft (30 m) with a drive of 3 hp and above, for cable lengths of 33 ft (10 m) with a drive of 2 hp and below, or for a drive rated at 525–690 V. This option is mounted in the enclosure, and may be used in conjunction with a brake chopper circuit.	Output
PG	**MotoRx (300–600 ft) 1000 V/µS DV/DT Filter**—Used to reduce transient voltage (DV/DT) and peak voltages at the motor terminals. This option is comprised of a 0.5% line reactor, followed by capacitive filtering and an energy recovery/clamping circuit. Unlike the Output Filter (See option **PF**), the MotoRx recovers most of the energy from the voltage peaks, resulting in a lower voltage drop to the motor, and therefore conserving power. This option is used when the distance between a single motor and the drive is 300–600 ft (91–183 m). *This option can not be used with the Brake Chopper Circuit. The Output Filter (option **PF**) should be investigated as an alternative.*	Output
PH	**Single Overload Relay**—Uses a bimetallic overload relay to provide additional overload current protection to the motor on configurations without bypass options. It is included with the Bypass Configurations for overload current protection in the bypass mode. The Overload Relay is mounted within the enclosure, and is manually resettable. Heater pack included.	Output

Table 31.2-22. Available Control/Communications Options (Continued)

Option	Description	Option Type
PI	**Dual Overload Relays**—This option is recommended when a single drive is operating two motors and overload current protection is needed for each of the motors. The standard configuration includes two bimetallic overload relays, each sized to protect a motor with 50% of the drive hp rating. For example, a 100 hp drive would include two overload relays sized to protect two 50 hp motors. The relays are mounted within the enclosure, and are manually resettable. Heater packs not included.	Output
PN	**Dual Overloads for Bypass**—This option is recommended when a single drive is operating two motors in the bypass mode and overload current protection is needed for each of the motors. The standard configuration includes two bimetallic overload relays, each sized to protect a motor with 50% of the drive hp rating. For example, a 100 hp drive would include two overload relays sized to protect two 50 hp motors. The relays are mounted within the enclosure, and are manually resettable.	Addl. bypass
RA	**Manual HOA Bypass Controller**—The Manual HAND/OFF/AUTO (HOA)—three-contactor—bypass option provides a means of bypassing the SVX9000, allowing the AC motor to be operated at full speed directly from the AC supply line. This option consists of an input disconnect, a fused control power transformer, and a full voltage bypass starter with a door-mounted HOA selector switch and an INVERTER/BYPASS switch. The HOA switch provides the ability to start and stop the drive in the inverter mode. The Bypass includes an input contactor, an output contactor, and a bypass starter with an electronic overload relay. The contactors are mechanically and electrically interlocked.	Bypass
RB	**Manual IOB Bypass Controller**—The Manual INVERTER/OFF/BYPASS (IOB)—three-contactor—bypass option provides a means of bypassing the SVX9000, allowing the AC motor to be operated at full speed directly from the AC supply line. This option consists of an input disconnect, a fused control power transformer, and a full voltage bypass starter with a door-mounted IOB selector switch. The Bypass includes an input contactor, an output contactor, and a bypass starter with an electronic overload relay. The contactors are mechanically and electrically interlocked.	Bypass
RC	**Auto Transfer HOA Bypass Controller**–The Manual HAND/OFF/AUTO (HOA)—three-contactor—bypass option provides a means of bypassing the SVX9000, allowing the AC motor to be operated at full speed directly from the AC supply line. The circuitry provides an automatic transfer of the load to "across the line" operation after a drive trip. This option consists of an input disconnect, a fused control power transformer, and a full voltage bypass starter with a door-mounted HOA selector switch and an INVERTER/BYPASS switch. The HOA switch provides the ability to start and stop the drive in either mode. The Bypass includes an input contactor, an output contactor, and a bypass starter with an electronic overload relay. The contactors are mechanically and electrically interlocked. Door-mounted pilot lights are provided that indicate bypass or inverter operation. A green light indicates when the motor is running in inverter mode and an amber light indicates when the motor is running in bypass mode. **Warning**: The motor may restart when the overcurrent relay is reset when operating in bypass, unless the IOB selector switch is turned to the OFF position.	Bypass
RD	**Auto Transfer IOB Bypass Controller**—The Auto INVERTER/OFF/BYPASS (IOB)—three-contactor—bypass option provides a means of bypassing the SVX9000, allowing the AC motor to be operated at full speed directly from the AC supply line. The circuitry provides an automatic transfer of the load to "across the line" operation after a drive trip. This option consists of an input disconnect, a fused control power transformer, and a full voltage bypass starter with a door mounted IOB selector switch. The Bypass includes an input contactor, an output contactor, and a bypass starter with an electronic overload relay. The contactors are mechanically and electrically interlocked. Door-mounted pilot lights are provided which indicate bypass or inverter operation. A green light indicates when the motor is running in inverter mode and an amber light indicates when the motor is running in bypass mode. **Warning**: The motor may restart when the overcurrent relay is reset when operating in bypass, unless the IOB selector switch is turned to the OFF position.	Bypass
S5	**Floor Stand 22 Inches**—Converts a Size 1 or 2, normally wall mounted enclosure to a floor standing enclosure with a height of 22 inches (558.8 mm).	Enclosure
S6	**Floor Stand 12 Inches**—Converts a Size 2, normally wall mounted enclosure to a floor standing enclosure with a height of 12 inches (304.8 mm).	Enclosure
S7	**10-Inch Expansion**—In a Size 5 enclosure, the extension allows for bottom cable entry and additional space for customer mounted components. **Note:** Enclosure expansion rated NEMA Type 1 only.	Enclosure
S8	**20-Inch Expansion**—In a Size 5 enclosure, the extension allows for bottom cable entry and additional space for customer mounted components. When the Output Filter (option **PF**) is selected for a drive using a Size 5 enclosure, this expansion box is required and included in the option pricing. **Note:** Enclosure expansion rated NEMA Type 1 only.	Enclosure
S9	**Space Heater—**Prevents condensation from forming in the enclosure when the drive is inactive or in storage. Includes a thermostat for variable temperature control. A 200W heater is installed in enclosures 0 and 1, and a 400W heater is installed in enclosures 2–5. Requires a customer supplied 115 V remote supply source.	Enclosure

Note: For availability, see base drive voltage required.

Dimensions—Approximate Dimensions in Inches (mm)

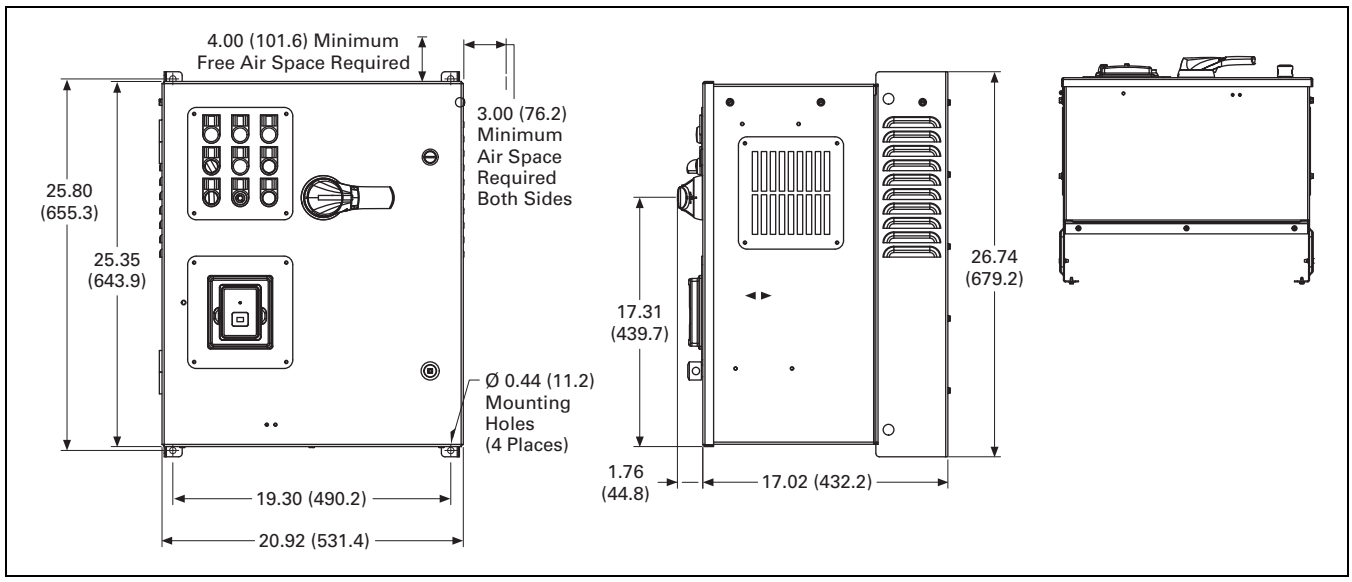


Figure 31.2-20. AX Box, NEMA 1/12

31

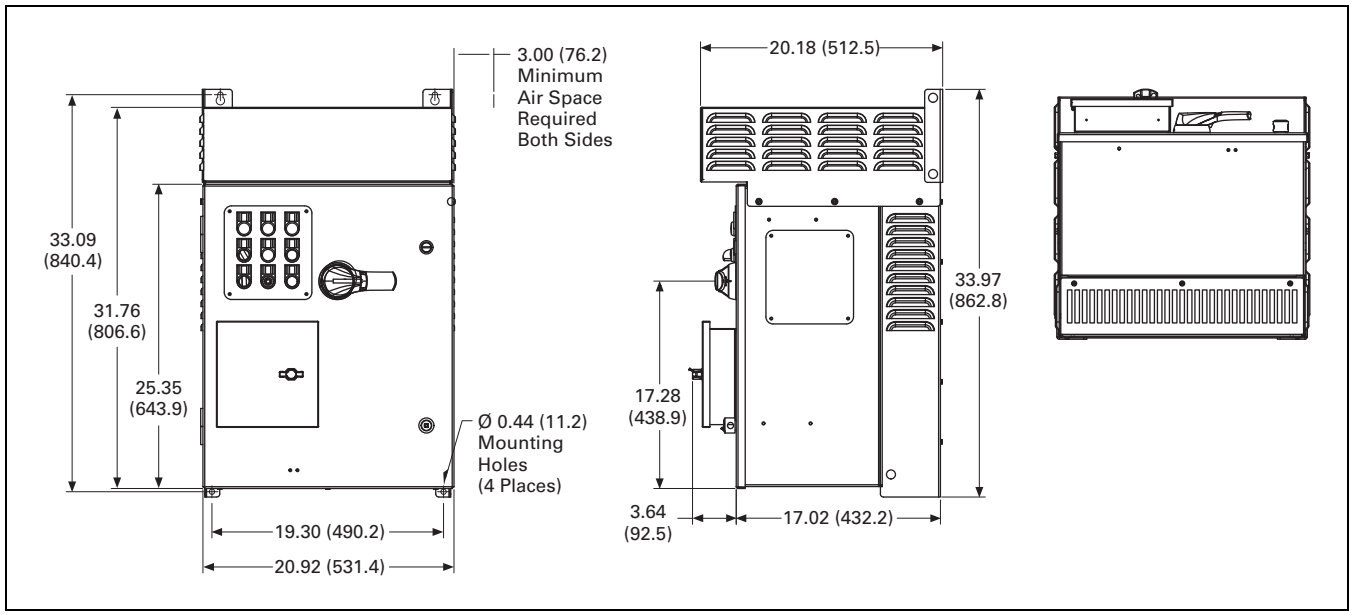


Figure 31.2-21. AX Box, NEMA 3R

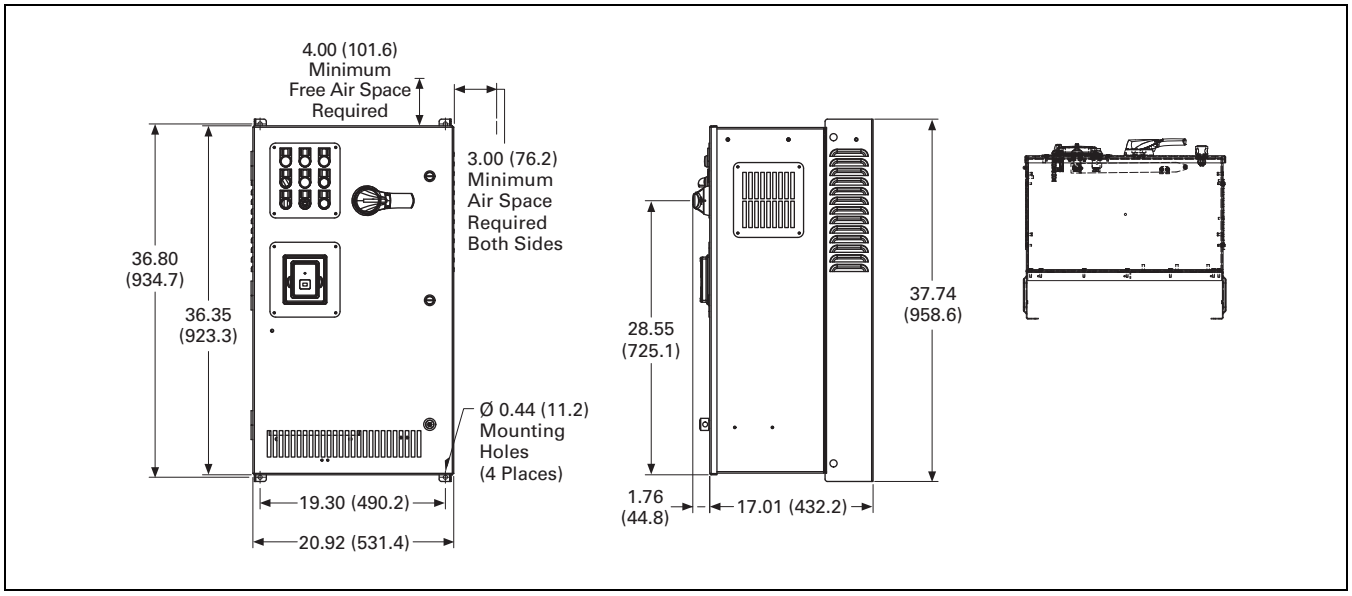


Figure 31.2-22. BX Box, NEMA 1/12

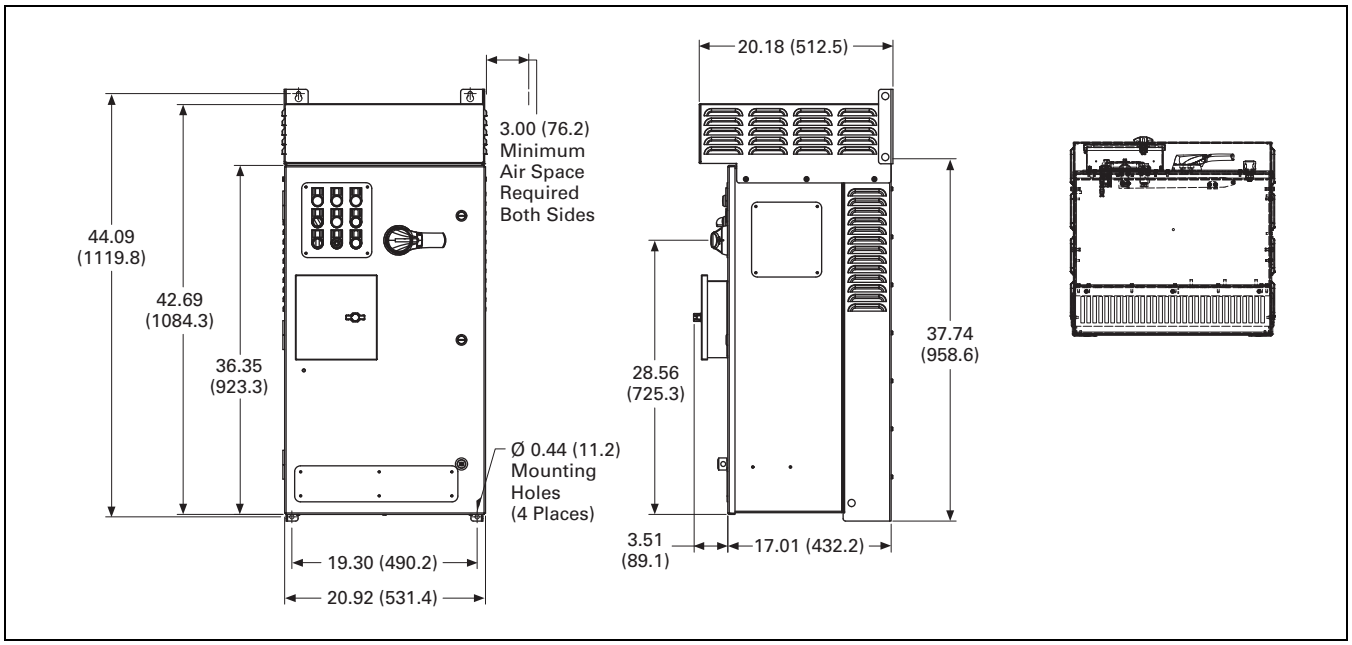


Figure 31.2-23. BX Box, NEMA 3R

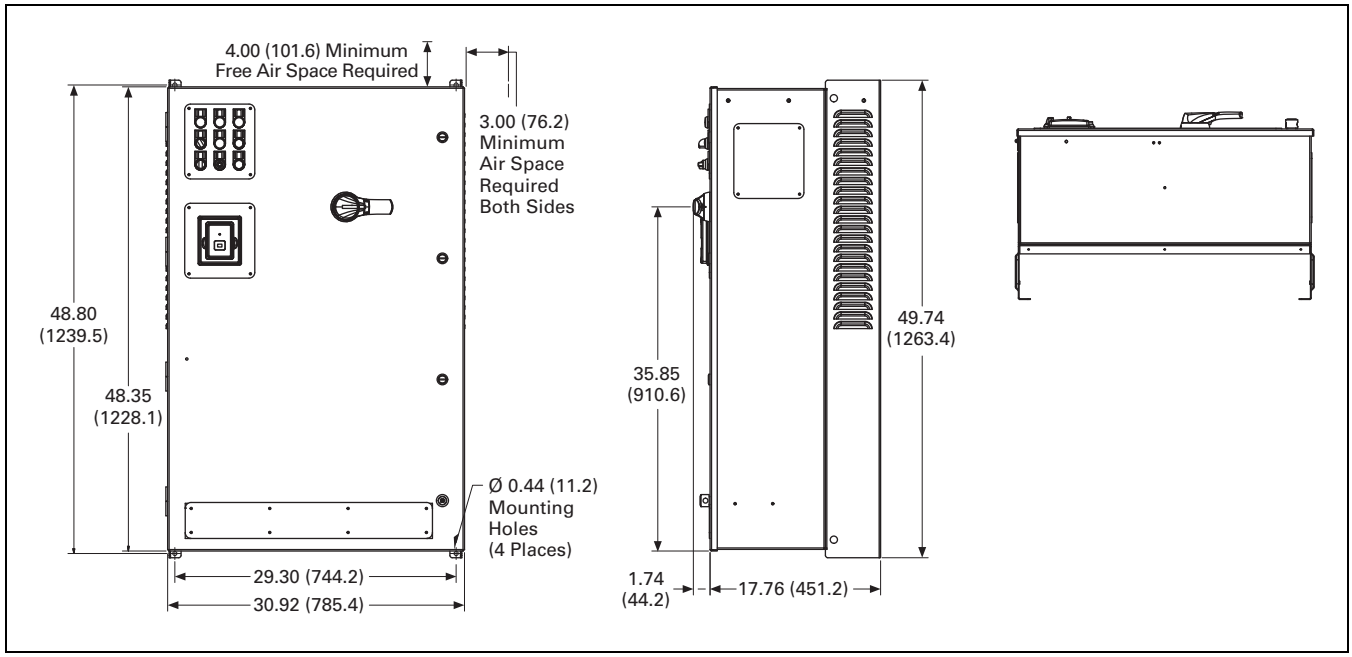


Figure 31.2-24. CX Box, NEMA 1/12

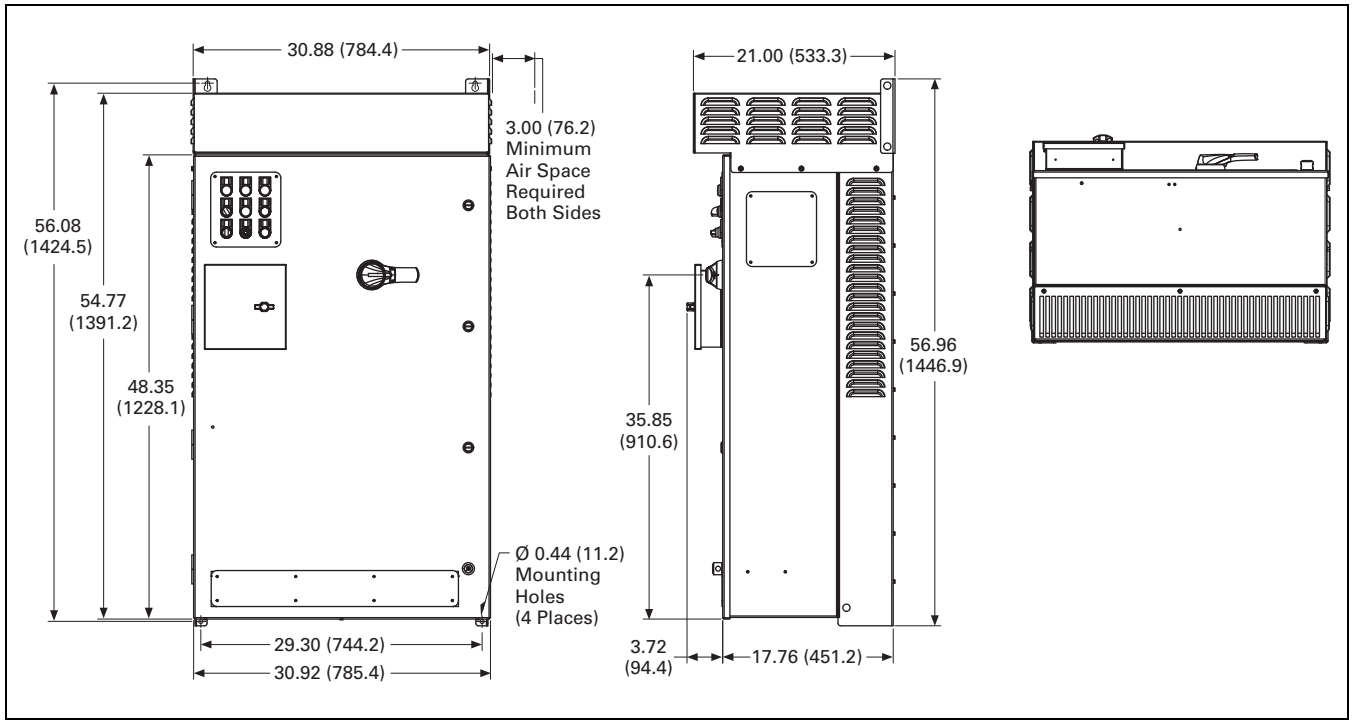


Figure 31.2-25. CX Box, NEMA 3R

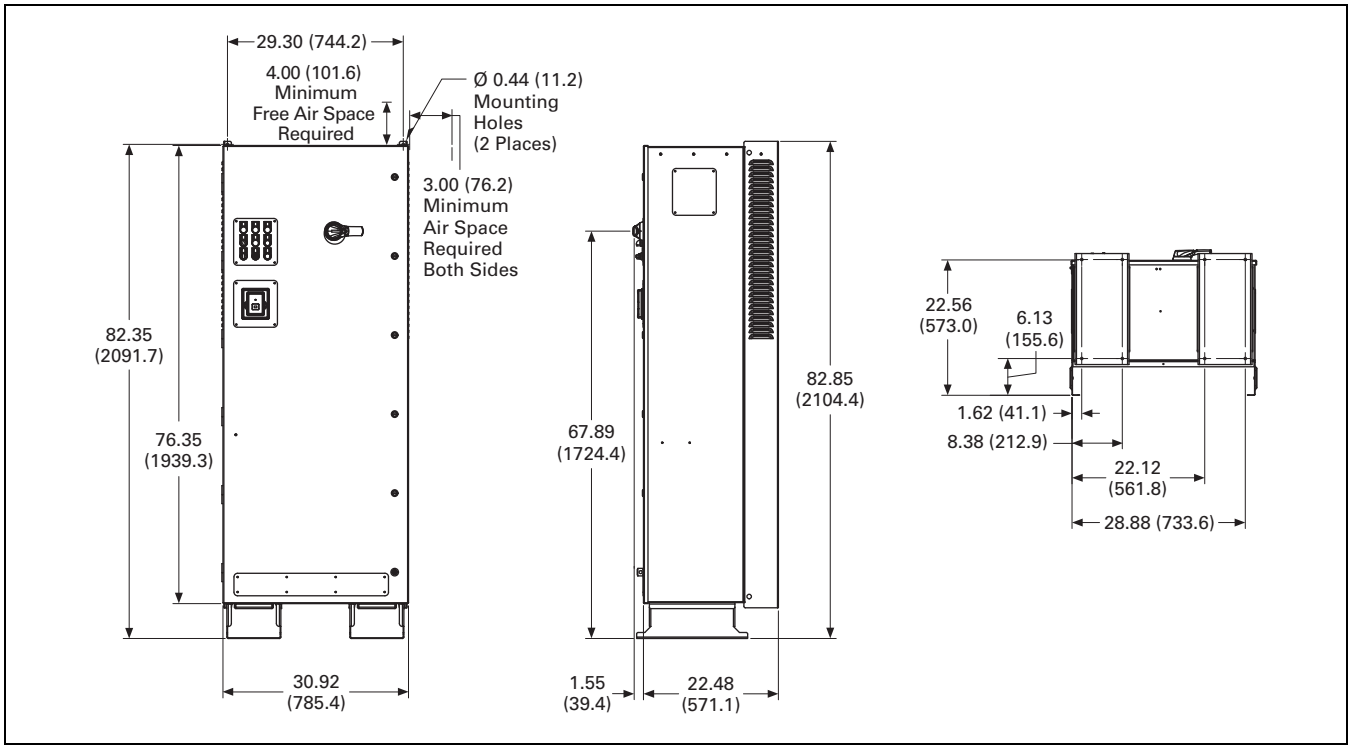


Figure 31.2-26. DX Box, NEMA 1/12

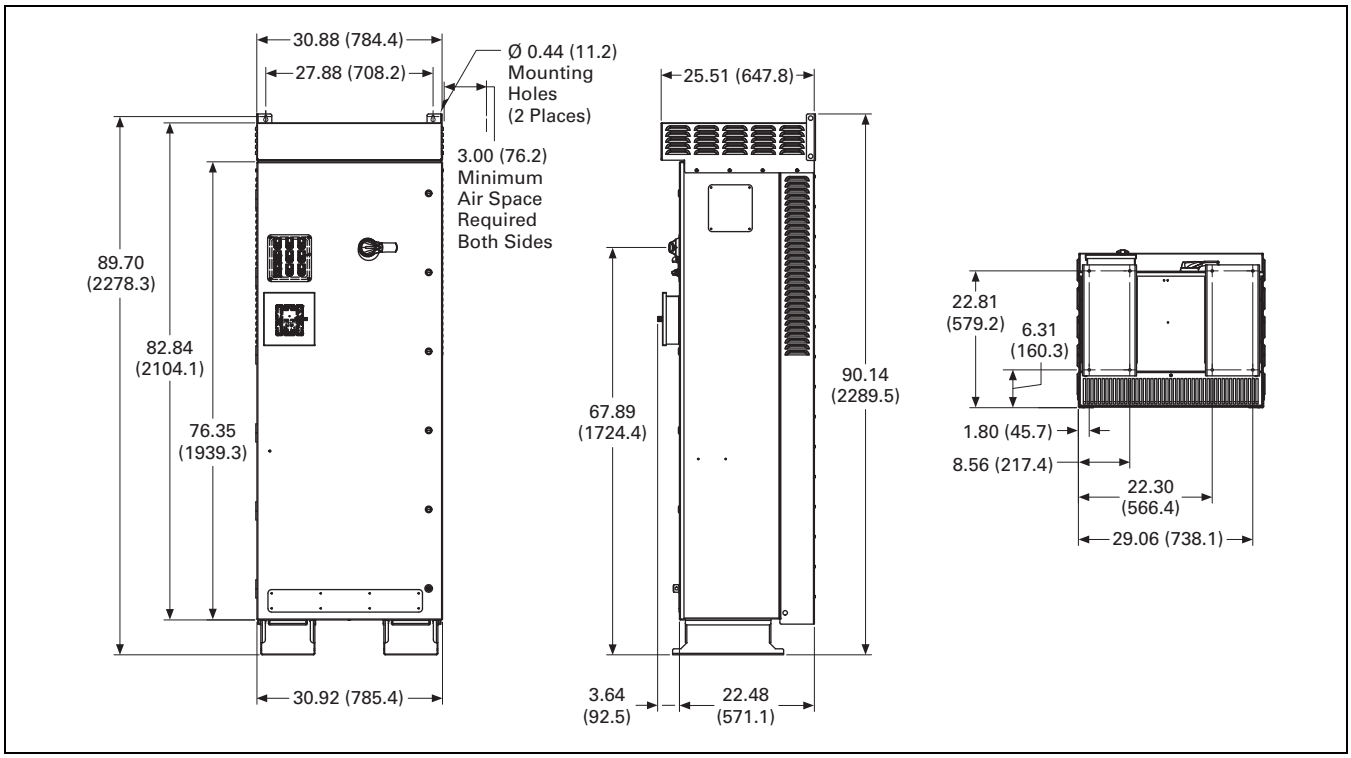


Figure 31.2-27. DX Box, NEMA 3R

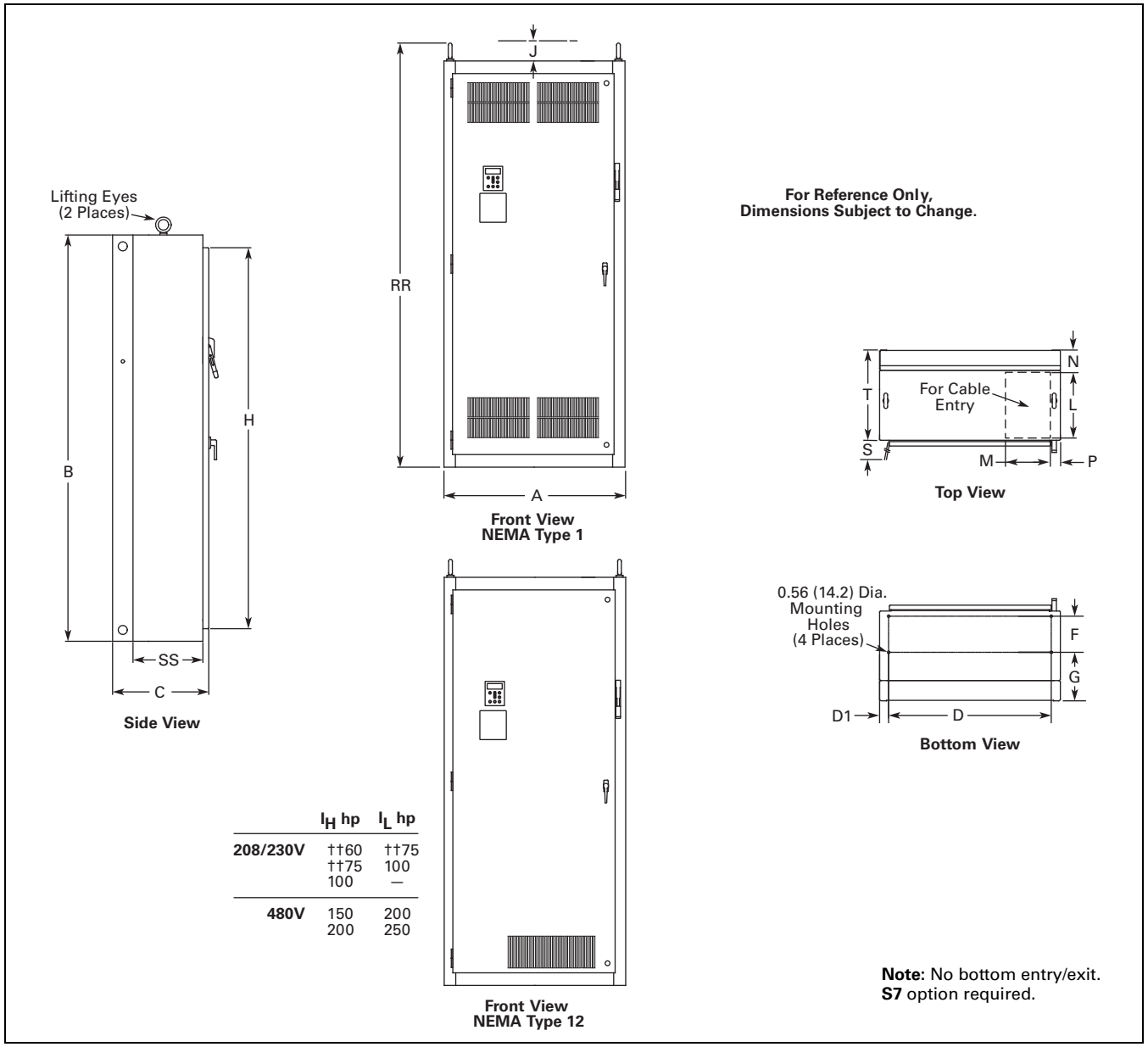
SVX Drawing 14—Enclosure Size 5

Table 31.2-23. Approximate Dimensions and Shipping Weight—Enclosed Products

Enclosure Size	Dimensions in Inches (mm)												
	Wide A	High B	Deep C	Mounting							H	Minimum Air Space	
				D	D1	E	E1	F	G	G1		J	K
5	40.00 (1016)	90.00 (2286)	21.30 (541)	36.00 (914)	2.00 (51)	—	—	8.00 (203)	10.80 (273)	—	84.40 (2143)	4.00 (102)	—

Table 31.2-23. Approximate Dimensions and Shipping Weight—Enclosed Products (Continued)

Enclosure Size	Dimensions in Inches (mm)														Max. Approx. Ship. Wt. Lb (kg)
	Cable Entry					Door Clearance S	T	U	V	W	RR	SS	TT	UU	VV	
	L	M	N	P	R											
5	15.00 (381)	10.00 (254)	4.80 (122)	2.00 (51)	—	36.30 (921)	20.00 (508)	—	—	—	94.00 (2387)	15.50 (394)	—	—	—	1275 (579)



	I_H hp	I_L hp
208/230V	††60	††75
	††75	100
	100	—
480V	150	200
	200	250

Figure 31.2-28. Approximate Dimensions

SVX Drawing 15—Enclosure Size 6

Table 31.2-24. Approximate Dimensions and Shipping Weight—Enclosed Products

Enclosure Size	Dimensions in Inches (mm)												
	Wide A	High B	Deep C	Mounting							H	Minimum Air Space	
				D	D1	D2	E	F	G	G1		J	K
6	30.00 (762)	90.00 (2286)	26.00 (660)	26.50 (673)	1.80 (46)	—	—	17.30 (438)	5.50 (140)	—	84.40 (2143)	4.00 (102)	—

Table 31.2-24. Approximate Dimensions and Shipping Weight—Enclosed Products (Continued)

Enclosure Size	Dimensions in Inches (mm)														Max. Approx. Ship. Wt. Lb (kg)
	Cable Entry					Door Clearance S	T	U	V	W	RR	SS	TT	UU	VV	
	L	M	N	P	R											
6	23.5 (597)	03.30 (84)	4.50 (114)	19.30 (490)	—	26.20 (667)	24.80 (629)	—	—	—	93.90 (2386)	—	—	—	—	1500 (681)

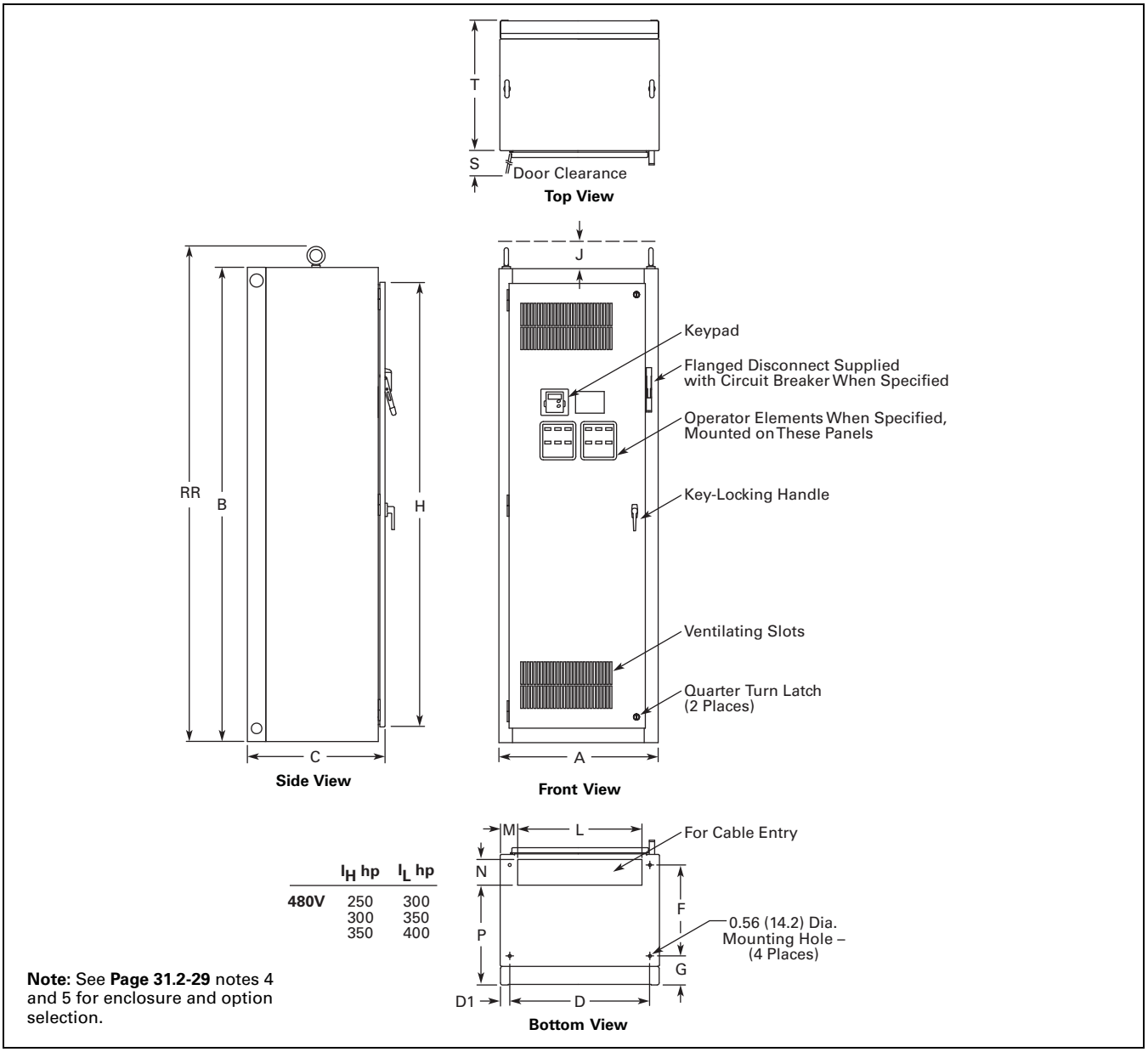


Figure 31.2-29. Approximate Dimensions

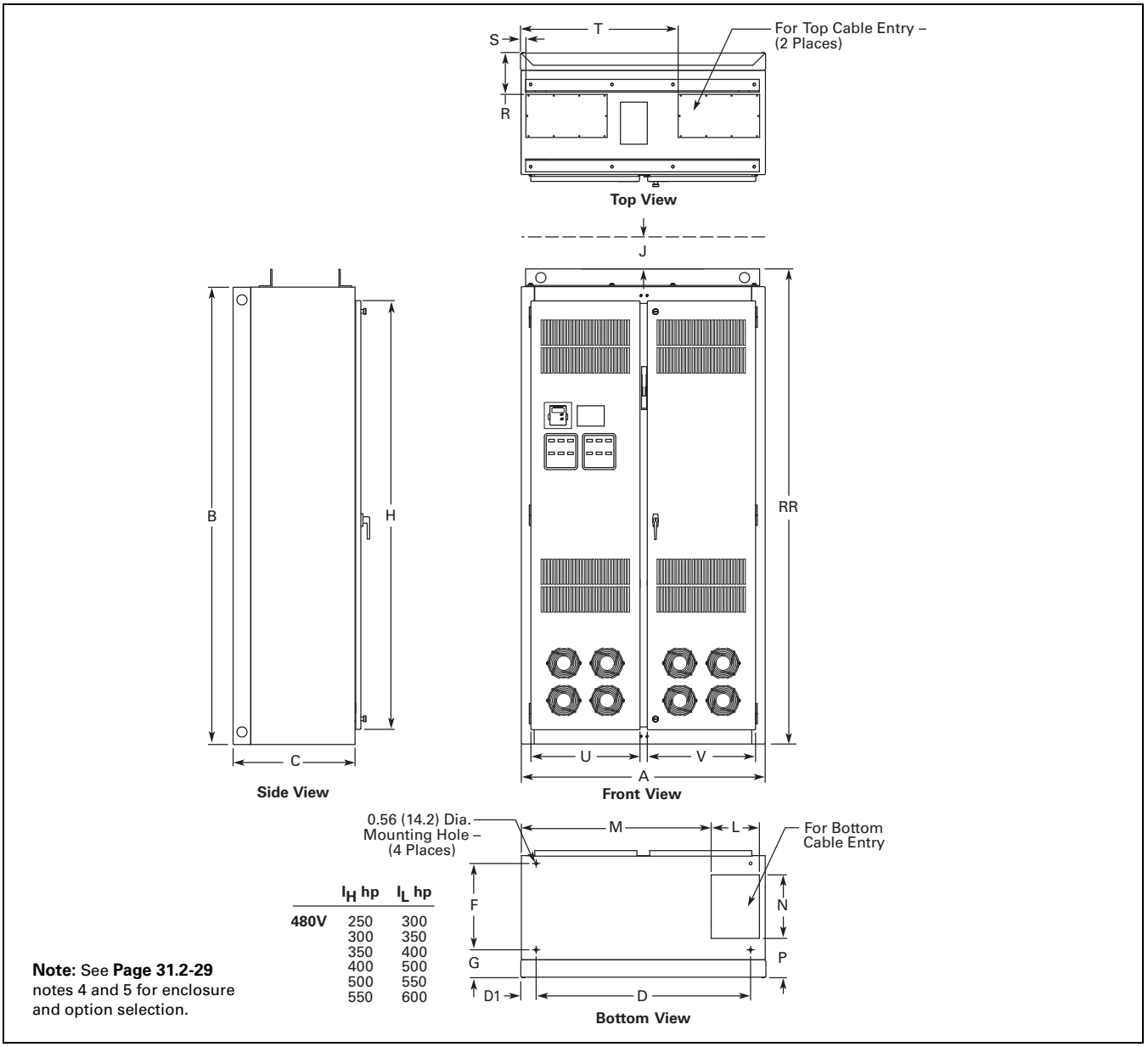
SVX Drawing 16—Enclosure Size 8

Table 31.2-25. Approximate Dimensions and Shipping Weight—Enclosed Products

Enclosure Size	Dimensions in Inches (mm)												
	Wide A	High B	Deep C	Mounting							H	Minimum Air Space	
				D	D1	D2	E	F	G	G1		J	K
8	48.00 (1219)	90.00 (2286)	24.00 (610)	42.20 (1072)	3.00 (77)	—	—	—	5.50 (139)	—	84.40 (2143)	4.00 (102)	—

Table 31.2-25. Approximate Dimensions and Shipping Weight—Enclosed Products (Continued)

Enclosure Size	Dimensions in Inches (mm)															Max. Approx. Ship. Wt. Lb (kg)
	Cable Entry							U	V	W	RR	SS	TT	UU	VV	
	L	M	N	P	R	S	T									
8	9.50 (241)	37.50 (952)	12.50 (318)	7.70 (196)	8.30 (210)	1.30 (32)	31.00 (787)	21.50 (545)	21.30 (541)	—	93.50 (2375)	—	—	—	—	2000 (908)



Note: See **Page 31.2-29** notes 4 and 5 for enclosure and option selection.

Figure 31.2-30. Approximate Dimensions

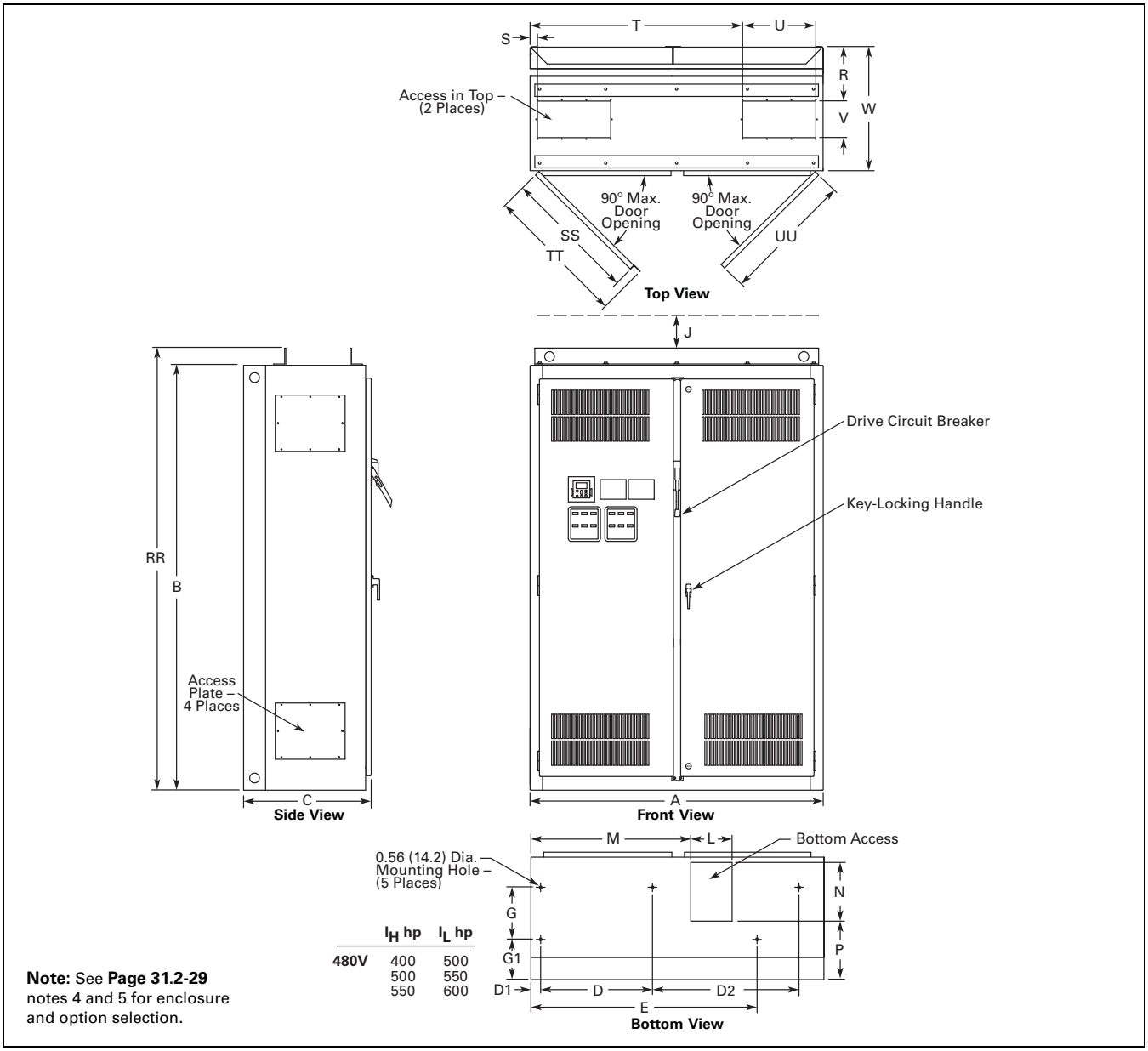
SVX Drawing 17—Enclosure Size 9

Table 31.2-26. Approximate Dimensions and Shipping Weight—Enclosed Products

Enclosure Size	Dimensions in Inches (mm)												
	Wide A	High B	Deep C	Mounting							H	Minimum Air Space	
				D	D1	D2	E	F	G	G1		J	K
9	60.00 (1524)	90.00 (2286)	26.10 (664)	22.90 (582)	2.00 (51)	30.00 (762)	44.30 (1125)	10.60 (270)	10.60 (270)	8.20 (208)	—	4.00 (102)	—

Table 31.2-26. Approximate Dimensions and Shipping Weight—Enclosed Products (Continued)

Enclosure Size	Dimensions in Inches (mm)															Max. Approx. Ship. Wt. Lb (kg)
	Cable Entry									W	RR	SS	TT	UU	VV	
	L	M	N	P	R	S	T	U	V							
9	8.50 (216)	32.70 (831)	12.00 (305)	11.90 (303)	9.80 (249)	1.50 (38)	43.50 (1105)	15.00 (381)	7.50 (191)	25.00 (635)	93.50 (2375)	27.40 (696)	29.10 (738)	27.10 (687)	—	2500 (1135)



Note: See **Page 31.2-29** notes 4 and 5 for enclosure and option selection.

Figure 31.2-31. Approximate Dimensions

CFX9000—Drawing 6

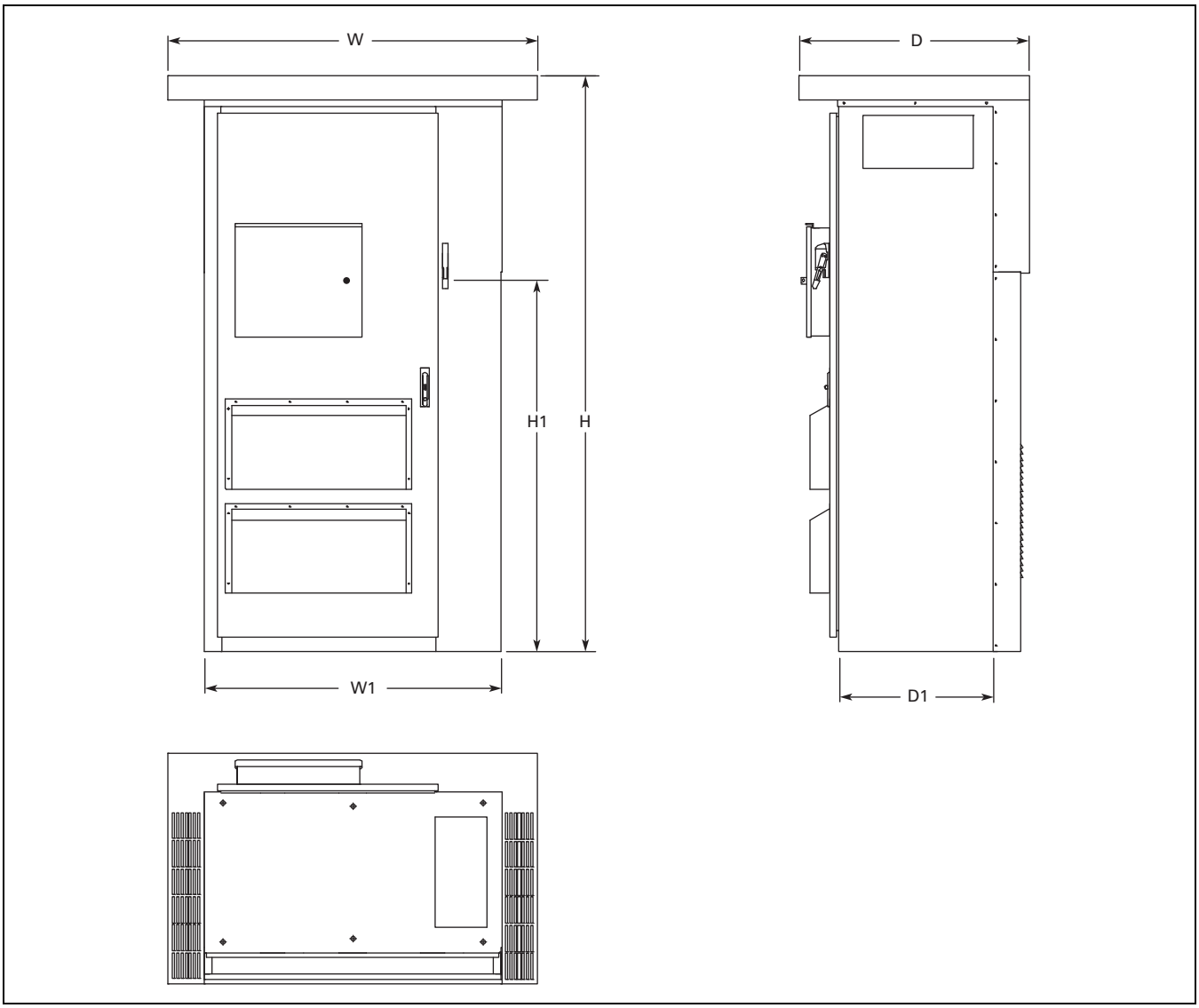


Figure 31.2-32. Enclosure Size F—Approximate Dimensions in Inches (mm)

Table 31.2-27. CFX9000 Drive Dimensions

H	H1	W	W1	D	D1	Approximate Weight Lb (kg)	Approximate Shipping Weight Lb (kg)
93.58 (2376.9)	69.51 (1765.60)	60.00 (1524.0)	48.00 (1219.2)	37.50 (952.5)	26.00 (660.4)	1700 (771)	1850 (839)

CFX Passive Filtered SVX

CFX9000 Enclosed Drives

General Description

Eaton's CFX9000 Clean Power Drives use tuned passive filters to significantly reduce line harmonics at the drive input terminals.

The CFX9000 drive also delivers true power factor—in addition to reducing harmonic distortion, the CFX9000 drive prevents transformer overheating and overloading of breakers and feeders, which enables the application of adjustable frequency drives on generators and other high impedance power systems.

CFX9000 Enclosed Products

- **Standard enclosed**—covers a wide range of the most commonly ordered options. Pre-engineering eliminates the lead time normally associated with customer specific options. Available configurations are listed on **Pages 31.3-3–31.3-9**
- **Modified standard enclosed**—applies to specific customer requirements that vary from the Standard Enclosed offering, such as the need for an additional indicating light or minor modifications to drawings. *Contact your local sales office for assistance in pricing and lead time*
- **Custom engineered**—for those applications with more unique or complex requirements, these are individually engineered to the customer's needs. *Contact your local sales office for assistance in pricing and lead time*

Application Description

Terms

- PCC (point of common coupling) is defined as the electrical connecting point between the utility and multiple customers per the specifications in IEEE 519
- POA (point of analysis) is defined as where the harmonic calculations are taken

An oscilloscope can make all measurements at the PCC or POA to do an on-site harmonic evaluation.

Features and Benefits

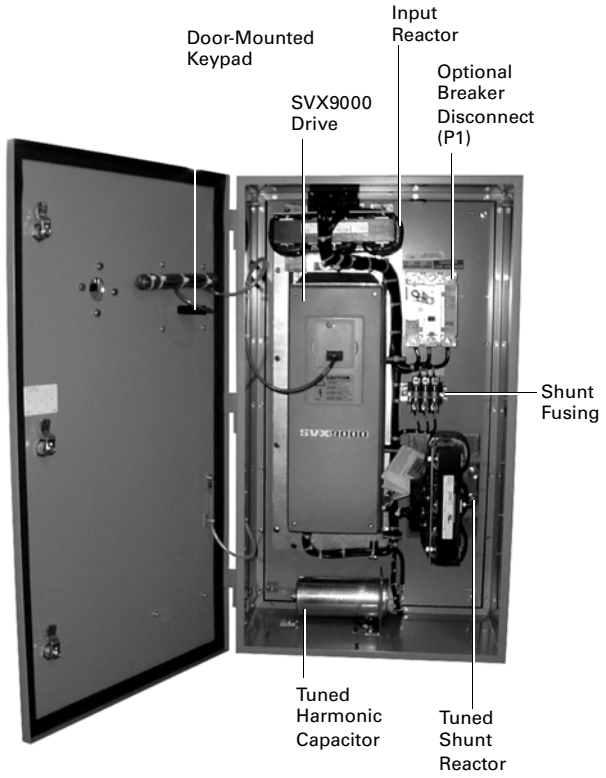
CFX9000 Integrated Filter Clean Power Drive features include (at 480 V):

- UL Type 1, UL Type 12, UL Type 3R and NEMA 12 with gaskets and filters
- Input voltage: 480 V, 230 V, 575 V
- Complete range of control, network and power options
- Horsepower range:
  - 480 V, 7-1/2–400 hp I_L
  - 230 V, 7-1/2–100 hp I_L; consult factory for details
  - 575 V, 15–400 hp I_L; consult factory for details
- Single enclosure for both drive and filter reduces field wiring and enables convenient bypass installation
- Packaged solution ensures optimal coordination of drive and filter

Standards and Certifications

- UL
- cUL
- 508C

Product Identification



CFX9000 Drive—UL Type 12, 40 hp

Catalog Number Selection

Table 31.2-28. CFX9000 Enclosed Drives Catalog Numbering System

CFX 050 1 4 A A — Build Alphabetically and Numerically

Product Family

CFX = Integrated filter clean power drive

Horsepower Rating

007 = 7-1/2	**075** = 75
010 = 10	**100** = 100
015 = 15	**125** = 125
020 = 20	**150** = 150
025 = 25	**200** = 200
030 = 30	**250** = 250
040 = 40	**300** = 300
050 = 50	**350** = 350
060 = 60	**400** = 400

Enclosure Rating

1 = UL Type 1
2 = UL Type 12
3 = UL Type 3R

Voltage Rating

1 = 208 V
2 = 230 V
4 = 480 V
5 = 575 V (575–600 V)

Application—Torque/Braking ①

A = I_L/no brake chopper
B = I_L/internal brake chopper
D = I_H/no brake chopper
E = I_H/internal brake chopper

Enclosed Style

A = Enclosed drive

Enclosed Options ②③④		Type
K1	Door-mounted speed potentiometer ⑤	Control
K2	Door-mounted speed potentiometer with HOA selector switch ⑤	Control
K3	3–15 psig follower	Control
K4	HAND/OFF/AUTO switch (22 mm)	Control
K5	MANUAL/AUTO reference switch (22 mm)	Control
K6	START/STOP pushbuttons (22 mm)	Control
KF	Bypass test switch for RA and RB	Addl. bypass
KO	Standard elapsed time meter	Control
L1	Power, RUN and fault pilot lights	Light
L2	Bypass pilot lights for RA, RB, bypass options	Addl. bypass
LE	Red RUN light	Light
P1	Input circuit breaker	Input
P3	Input line fuses (200 kAIC)	Input
P7	Input power surge protection	Input
P8	SPD surge protective device	Input
PE	Output contactor	Output
PF	Output filter	Output
PG	MotoRx (up to 600 ft) 1000 V/µS DV/DT filter	Output
PH	Single overload relay	Output
PI	Dual overload relays	Output
PN	Dual overloads for bypass	Addl. bypass
RA	Manual HOA bypass controller	Bypass
RB	Manual IOB bypass controller	Bypass
RC	Auto transfer HOA bypass controller	Bypass
RD	Auto transfer IOB bypass controller	Bypass
RG	Reduced voltage starter for bypass	Bypass
S4	Floor stand 6.00 inches	Enclosure
S5	Floor stand 22.00 inches	Enclosure
S6	Floor stand 12.00 inches	Enclosure
S9	Space heater	Enclosure

Communication Options ⑥

C2 = Modbus	**C8** = Modbus (D9 type connector)
C3 = PROFIBUS DP	**CA** = Johnson Controls N2
C4 = LonWorks	**CI** = Modbus TCP/EtherNet/IP
C5 = PROFIBUS DP (D9 connector)	**CJ** = BACnet
C6 = CANopen (slave)	**D3** = RS-232 with D9 connection
C7 = DeviceNet	

Control Options

B1 = 6 DI, 1 ext +24 Vdc/EXT +24 Vdc
B = 1 RO (NC-NO), 1 RO (NO), 1 therm
B4 = 1 AI (mA isolated), 2 AO (mA isolated), 1 ext +24 Vdc/EXT +24 Vdc
B5 = 3 RO (NO)
B8 = 1 ext +24 Vdc/EXT +24 Vdc, 3 Pt100
B9 = 1 RO (NO), 5 DI 42–240 Vac input

Engineered Options

HT = High temperature rating for 50°C ⑦
VB = Varnished boards

① Brake chopper is standard in 208 V, 230 V and 480 V drives up to FR6; optional in all other drives.
② Local/remote keypad is included as the standard control panel.
③ Some options are voltage and/or horsepower specific. Consult your Eaton representative for details.
④ See **Pages 31.2-30** and **31.2-31** for complete descriptions.
⑤ Includes local/remote speed reference switch.
⑥ See **Page 31.2-6** for complete descriptions.
⑦ Consult Eaton for availability.

Table 31.2-29. Ambient Temperature Ratings

Enclosure Size	I_H	I_L
B, C, 9 ①	40 °C	40 °C
7, 8	50 °C	50 °C

① For high temperature rating, select HT option code and contact factory.

- If dynamic brake chopper or control/communication option is desired, change the appropriate code in the base catalog number
- All of the programming is exactly the same as the standard SVX9000 drive
- Select enclosed options. Add the codes as suffixes to the base catalog number in alphabetical and numeric order

Technical Data and Specifications

Table 31.2-30. 208 Vac

hp	NEC Current	Chassis Frame	NEMA 1		NEMA 12		NEMA 3R	
			Disconnect Only	Power Options	Disconnect Only	Power Options	Disconnect Only	Power Options
Low Overload Drive (Variable Torque)								
7-1/2	24.2	FR5	DWG-1	DRW-3	DWG-1	DRW-3	DRW-2	DRW-4
10	30.8	FR5	DRW-1	DRW-3	DRW-1	DRW-3	DRW-2	DRW-4
15	46.2	FR6	DRW-1	DRW-3	DRW-1	DRW-3	DRW-2	DRW-4
20	59.4	FR6	DRW-1	DRW-3	DRW-1	DRW-3	DRW-2	DRW-4
25	74.8	FR7	DRW-3	DRW-7	DRW-3	DRW-7	DRW-4	DRW-5
30	88.0	FR7	DRW-3	DRW-7	DRW-3	DRW-7	DRW-4	DRW-5
40	114.0	FR7	DRW-3	DRW-7	DRW-3	DRW-7	DRW-4	DRW-5
50	143.0	FR8	DRW-7	DRW-7	DRW-7	DRW-7	DRW-6	DRW-6
60	169.0	FR8	DRW-7	DRW-7	DRW-7	DRW-7	DRW-6	DRW-6
75	211.0	FR8	DRW-7	DRW-7	DRW-7	DRW-7	DRW-6	DRW-6
100	273.0	FR9	DRW-8	DRW-8	DRW-8	DRW-8	DRW-6	DRW-6
High Overload Drive (Constant Torque)								
7-1/2	24.2	FR5	DWG-1	DRW-3	DWG-1	DRW-3	DRW-2	DRW-4
10	30.8	FR6	DRW-1	DRW-3	DRW-1	DRW-3	DRW-2	DRW-4
15	46.2	FR6	DRW-1	DRW-3	DRW-1	DRW-3	DRW-2	DRW-4
20	59.4	FR7	DRW-3	DRW-7	DRW-3	DRW-7	DRW-4	DRW-5
25	74.8	FR7	DRW-3	DRW-7	DRW-3	DRW-7	DRW-4	DRW-5
30	88.0	FR7	DRW-3	DRW-7	DRW-3	DRW-7	DRW-4	DRW-5
40	114.0	FR8	DRW-7	DRW-7	DRW-7	DRW-7	DRW-6	DRW-6
50	143.0	FR8	DRW-7	DRW-7	DRW-7	DRW-7	DRW-6	DRW-6
60	169.0	FR8	DRW-7	DRW-7	DRW-7	DRW-7	DRW-6	DRW-6
75	211.0	FR9	DRW-8	DRW-8	DRW-8	DRW-8	DRW-6	DRW-6
100	273.0	FR9	DRW-8	DRW-8	DRW-8	DRW-8	DRW-6	DRW-6

Table 31.2-31. 230 Vac

hp	NEC Current	Chassis Frame	NEMA 1		NEMA 12		NEMA 3R	
			Disconnect Only	Power Options	Disconnect Only	Power Options	Disconnect Only	Power Options
Low Overload Drive (Variable Torque)								
7-1/2	22.0	FR5	DWG-1	DRW-3	DWG-1	DRW-3	DRW-2	DRW-4
10	28.0	FR5	DRW-1	DRW-3	DRW-1	DRW-3	DRW-2	DRW-4
15	42.0	FR6	DRW-1	DRW-3	DRW-1	DRW-3	DRW-2	DRW-4
20	54.0	FR6	DRW-1	DRW-3	DRW-1	DRW-3	DRW-2	DRW-4
25	68.0	FR7	DRW-3	DRW-7	DRW-3	DRW-7	DRW-4	DRW-5
30	80.0	FR7	DRW-3	DRW-7	DRW-3	DRW-7	DRW-4	DRW-5
40	104.0	FR7	DRW-3	DRW-7	DRW-3	DRW-7	DRW-4	DRW-5
50	130.0	FR8	DRW-7	DRW-7	DRW-7	DRW-7	DRW-6	DRW-5
60	154.0	FR8	DRW-7	DRW-7	DRW-7	DRW-7	DRW-6	DRW-6
75	192.0	FR8	DRW-7	DRW-7	DRW-7	DRW-7	DRW-6	DRW-6
100	248.0	FR9	DRW-8	DRW-8	DRW-8	DRW-8	DRW-6	DRW-6
High Overload Drive (Constant Torque)								
7-1/2	22.0	FR5	DWG-1	DRW-3	DWG-1	DRW-3	DRW-2	DRW-4
10	28.0	FR6	DRW-1	DRW-3	DRW-1	DRW-3	DRW-2	DRW-4
15	42.0	FR6	DRW-1	DRW-3	DRW-1	DRW-3	DRW-2	DRW-4
20	54.0	FR7	DRW-1	DRW-3	DRW-1	DRW-3	DRW-2	DRW-4
25	68.0	FR7	DRW-3	DRW-7	DRW-3	DRW-7	DRW-4	DRW-5
30	80.0	FR7	DRW-3	DRW-7	DRW-3	DRW-7	DRW-4	DRW-5
40	104.0	FR8	DRW-3	DRW-7	DRW-3	DRW-7	DRW-4	DRW-5
50	130.0	FR8	DRW-7	DRW-7	DRW-7	DRW-7	DRW-6	DRW-6
60	154.0	FR8	DRW-7	DRW-7	DRW-7	DRW-7	DRW-6	DRW-6
75	192.0	FR9	DRW-8	DRW-8	DRW-8	DRW-8	DRW-6	DRW-6
100	248.0	FR9	DRW-8	DRW-8	DRW-8	DRW-8	DRW-6	DRW-6

Table 31.2-32. 480 Vac

hp	NEC Current	Chassis Frame	NEMA 1		NEMA 12		NEMA 3R	
			Disconnect Only	Power Options	Disconnect Only	Power Options	Disconnect Only	Power Options
Low Overload Drive (Variable Torque)								
7-1/2	11.0	FR4	DWG-1	DRW-3	DWG-1	DRW-3	DRW-2	DRW-4
10	14.0	FR5	DRW-1	DRW-3	DRW-1	DRW-3	DRW-2	DRW-4
15	21.0	FR5	DRW-1	DRW-3	DRW-1	DRW-3	DRW-2	DRW-4
20	27.0	FR5	DRW-1	DRW-3	DRW-1	DRW-3	DRW-2	DRW-4
25	34.0	FR6	DRW-1	DRW-3	DRW-1	DRW-3	DRW-2	DRW-4
30	40.0	FR6	DRW-1	DRW-3	DRW-1	DRW-3	DRW-2	DRW-4
40	52.0	FR7	DRW-1	DRW-3	DRW-1	DRW-3	DRW-2	DRW-4
50	65.0	FR8	DRW-3	DRW-7	DRW-3	DRW-7	DRW-4	DRW-5
60	77.0	FR8	DRW-3	DRW-7	DRW-3	DRW-7	DRW-4	DRW-5
75	96.0	FR8	DRW-3	DRW-7	DRW-3	DRW-7	DRW-4	DRW-5
100	124.0	FR9	DRW-3	DRW-7	DRW-3	DRW-7	DRW-4	DRW-5
125	156.0	FR8	DRW-3	DRW-7	DRW-3	DRW-7	DRW-4	DRW-5
150	180.0	FR8	DRW-3	DRW-7	DRW-3	DRW-7	DRW-4	DRW-5
200	240.0	FR9	DRW-8	DRW-8	DRW-8	DRW-8	DRW-6	DRW-6
250	302.0	FR9	DRW-8	DRW-8	DRW-8	DRW-8	DRW-6	DRW-6
300	361.0	FR10	DRW-9	DRW-9	DRW-9	DRW-9	①	①
350	414.0	FR10	DRW-9	DRW-9	DRW-9	DRW-9	①	①
400	477.0	FR10	DRW-9	DRW-9	DRW-9	DRW-9	①	①
High Overload Drive (Constant Torque)								
7-1/2	11.0	FR4	DRW-1	DRW-3	DRW-1	DRW-3	DRW-2	DRW-4
10	14.0	FR5	DRW-1	DRW-3	DRW-1	DRW-3	DRW-2	DRW-4
15	21.0	FR5	DRW-1	DRW-3	DRW-1	DRW-3	DRW-2	DRW-4
20	27.0	FR5	DRW-1	DRW-3	DRW-1	DRW-3	DRW-2	DRW-4
25	34.0	FR6	DRW-1	DRW-3	DRW-1	DRW-3	DRW-2	DRW-4
30	40.0	FR6	DRW-1	DRW-3	DRW-1	DRW-3	DRW-2	DRW-4
40	52.0	FR6	DRW-1	DRW-3	DRW-1	DRW-3	DRW-2	DRW-4
50	65.0	FR7	DRW-3	DRW-7	DRW-3	DRW-7	DRW-4	DRW-5
60	77.0	FR7	DRW-3	DRW-7	DRW-3	DRW-7	DRW-4	DRW-5
75	96.0	FR7	DRW-3	DRW-7	DRW-3	DRW-7	DRW-4	DRW-5
100	124.0	FR8	DRW-7	DRW-7	DRW-7	DRW-7	DRW-6	DRW-6
125	156.0	FR8	DRW-7	DRW-7	DRW-7	DRW-7	DRW-6	DRW-6
150	180.0	FR8	DRW-7	DRW-7	DRW-7	DRW-7	DRW-6	DRW-6
200	240.0	FR9	DRW-8	DRW-8	DRW-8	DRW-8	DRW-6	DRW-6
250	302.0	FR9	DRW-8	DRW-8	DRW-8	DRW-8	DRW-6	DRW-6
300	361.0	FR10	DRW-9	DRW-9	DRW-9	DRW-9	①	①
350	414.0	FR10	DRW-9	DRW-9	DRW-9	DRW-9	①	①

① Consult factory.

Table 31.2-33. 575 Vac

hp	NEC Current	Chassis Frame	NEMA 1		NEMA 12		NEMA 3R	
			Disconnect Only	Power Options	Disconnect Only	Power Options	Disconnect Only	Power Options
Low Overload Drive (Variable Torque)								
15	17.0	FR6	DWG-1	DRW-3	DWG-1	DRW-3	DRW-2	DRW-4
20	22.0	FR6	DRW-1	DRW-3	DRW-1	DRW-3	DRW-2	DRW-4
25	27.0	FR6	DRW-1	DRW-3	DRW-1	DRW-3	DRW-2	DRW-4
30	32.0	FR6	DRW-1	DRW-3	DRW-1	DRW-3	DRW-2	DRW-4
40	41.0	FR7	DRW-3	DRW-7	DRW-3	DRW-7	DRW-4	DRW-5
50	52.0	FR7	DRW-3	DRW-7	DRW-3	DRW-7	DRW-4	DRW-5
60	62.0	FR8	DRW-7	DRW-7	DRW-7	DRW-7	DRW-6	DRW-6
75	77.0	FR8	DRW-7	DRW-7	DRW-7	DRW-7	DRW-6	DRW-6
100	99.0	FR8	DRW-7	DRW-7	DRW-7	DRW-7	DRW-6	DRW-6
125	125.0	FR9	DRW-8	DRW-8	DRW-8	DRW-8	DRW-6	DRW-6
150	144.0	FR9	DRW-8	DRW-8	DRW-8	DRW-8	DRW-6	DRW-6
200	192.0	FR9	DRW-8	DRW-8	DRW-8	DRW-8	DRW-6	DRW-6
250	242.0	FR10	DRW-9	DRW-9	DRW-9	DRW-9	①	①
300	289.0	FR10	DRW-9	DRW-9	DRW-9	DRW-9	①	①
400	382.0	FR10	DRW-9	DRW-9	DRW-9	DRW-9	①	①
High Overload Drive (Constant Torque)								
10	14.0	FR6	DWG-1	DRW-3	DWG-1	DRW-3	DRW-2	DRW-4
15	17.0	FR6	DWG-1	DRW-3	DWG-1	DRW-3	DRW-2	DRW-4
20	22.0	FR6	DWG-1	DRW-3	DWG-1	DRW-3	DRW-2	DRW-4
25	27.0	FR6	DWG-1	DRW-3	DWG-1	DRW-3	DRW-2	DRW-4
30	32.0	FR7	DRW-3	DRW-7	DRW-3	DRW-7	DRW-4	DRW-5
40	41.0	FR7	DRW-3	DRW-7	DRW-3	DRW-7	DRW-4	DRW-5
50	52.0	FR8	DRW-7	DRW-7	DRW-7	DRW-7	DRW-6	DRW-6
60	62.0	FR8	DRW-7	DRW-7	DRW-7	DRW-7	DRW-6	DRW-6
75	77.0	FR8	DRW-7	DRW-7	DRW-7	DRW-7	DRW-6	DRW-6
100	99.0	FR9	DRW-8	DRW-8	DRW-8	DRW-8	DRW-6	DRW-6
125	125.0	FR9	DRW-8	DRW-8	DRW-8	DRW-8	DRW-6	DRW-6
150	144.0	FR9	DRW-8	DRW-8	DRW-8	DRW-8	DRW-6	DRW-6
200	192.0	FR10	DRW-9	DRW-9	DRW-9	DRW-9	①	①
250	242.0	FR10	DRW-9	DRW-9	DRW-9	DRW-9	①	①
300	289.0	FR10	DRW-9	DRW-9	DRW-9	DRW-9	①	①

① Consult factory.

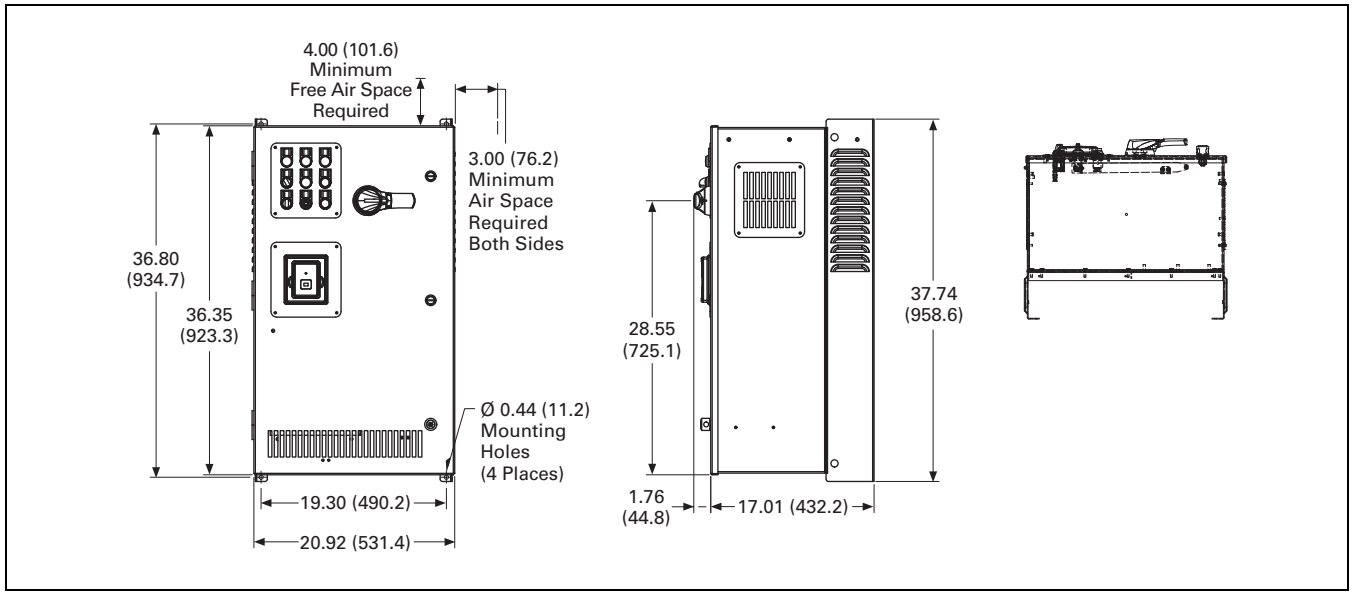


Figure 31.2-33. BX Box, NEMA 1/12

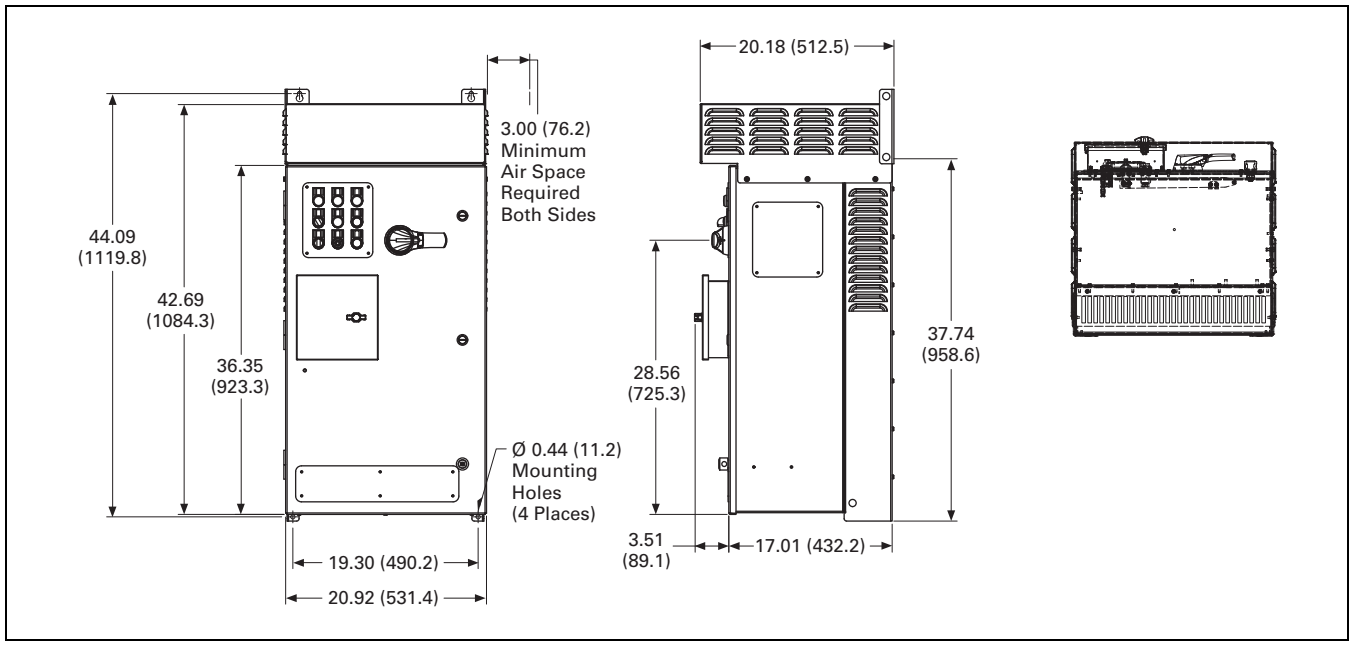


Figure 31.2-34. BX Box, NEMA 3R

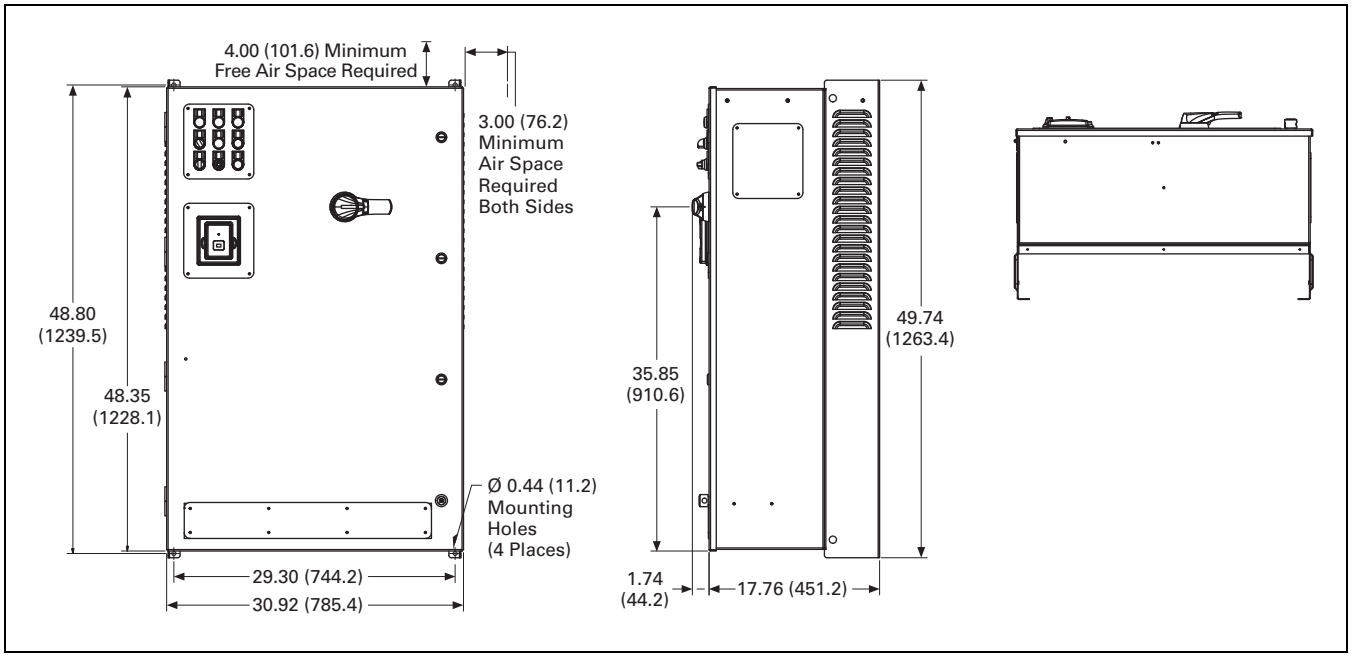


Figure 31.2-35. CX Box, NEMA 1/12

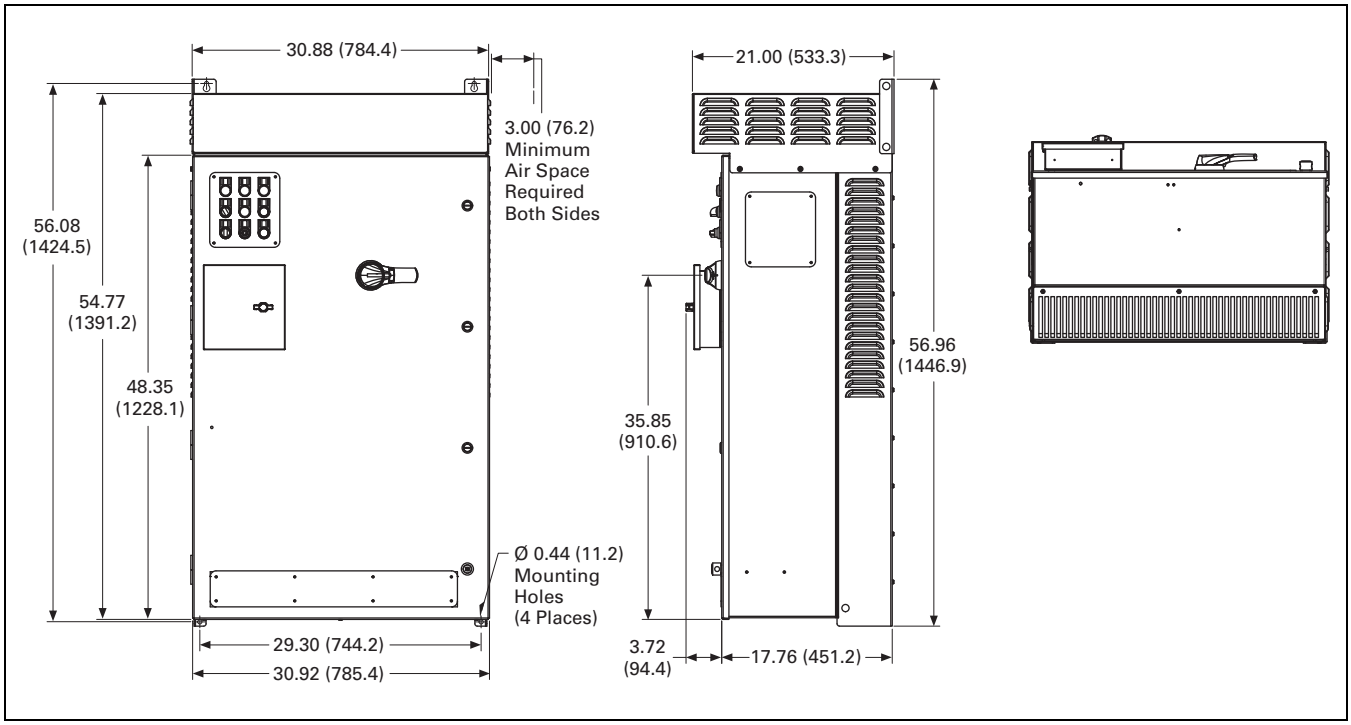


Figure 31.2-36. CX Box, NEMA 3R

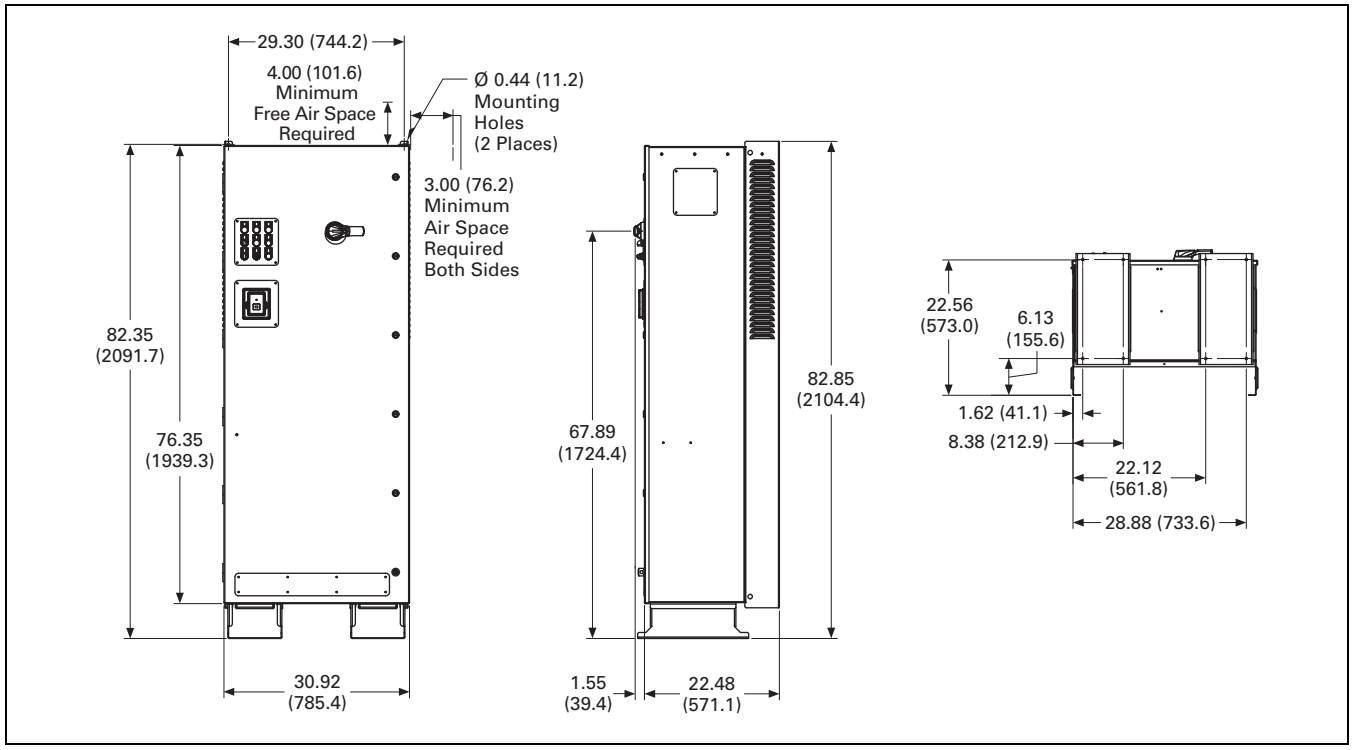


Figure 31.2-37. DX Box, NEMA 1/12

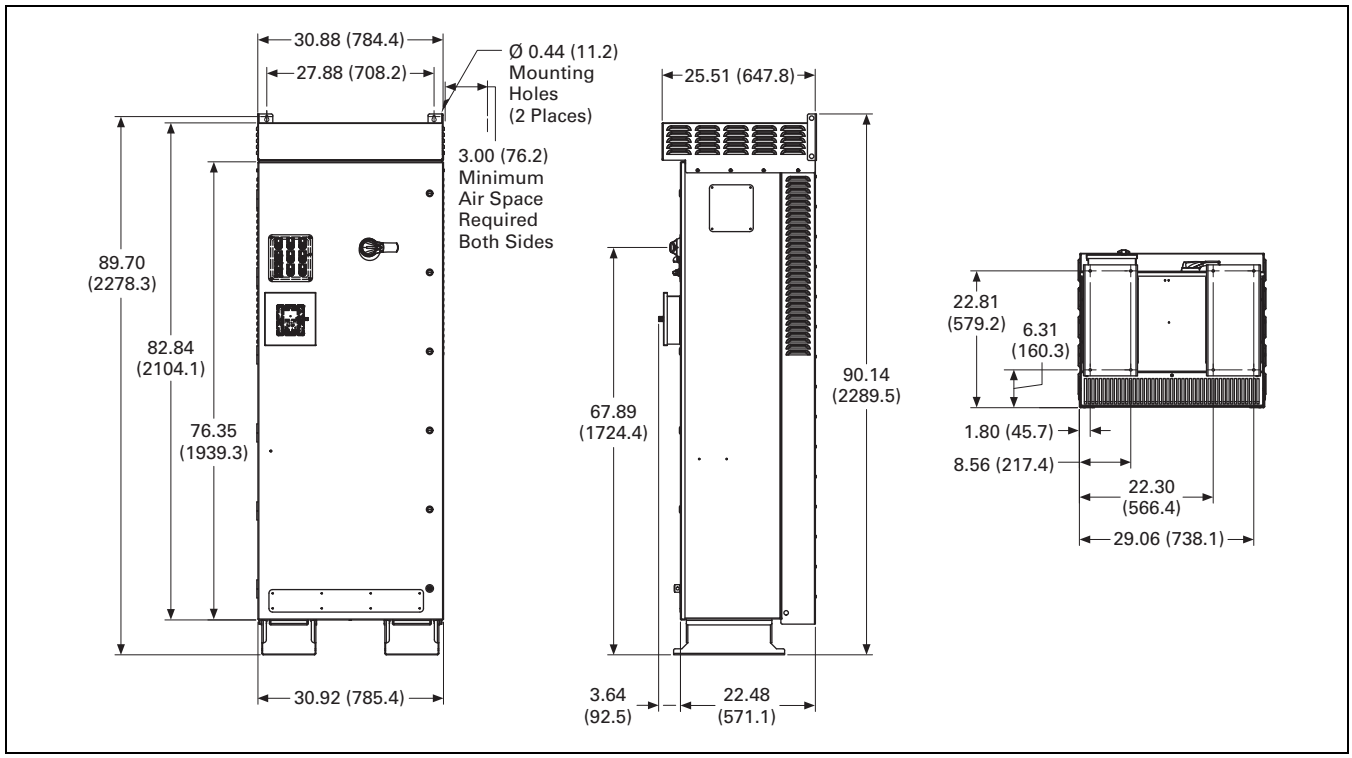


Figure 31.2-38. DX Box, NEMA 3R

CFX9000—Drawing 6

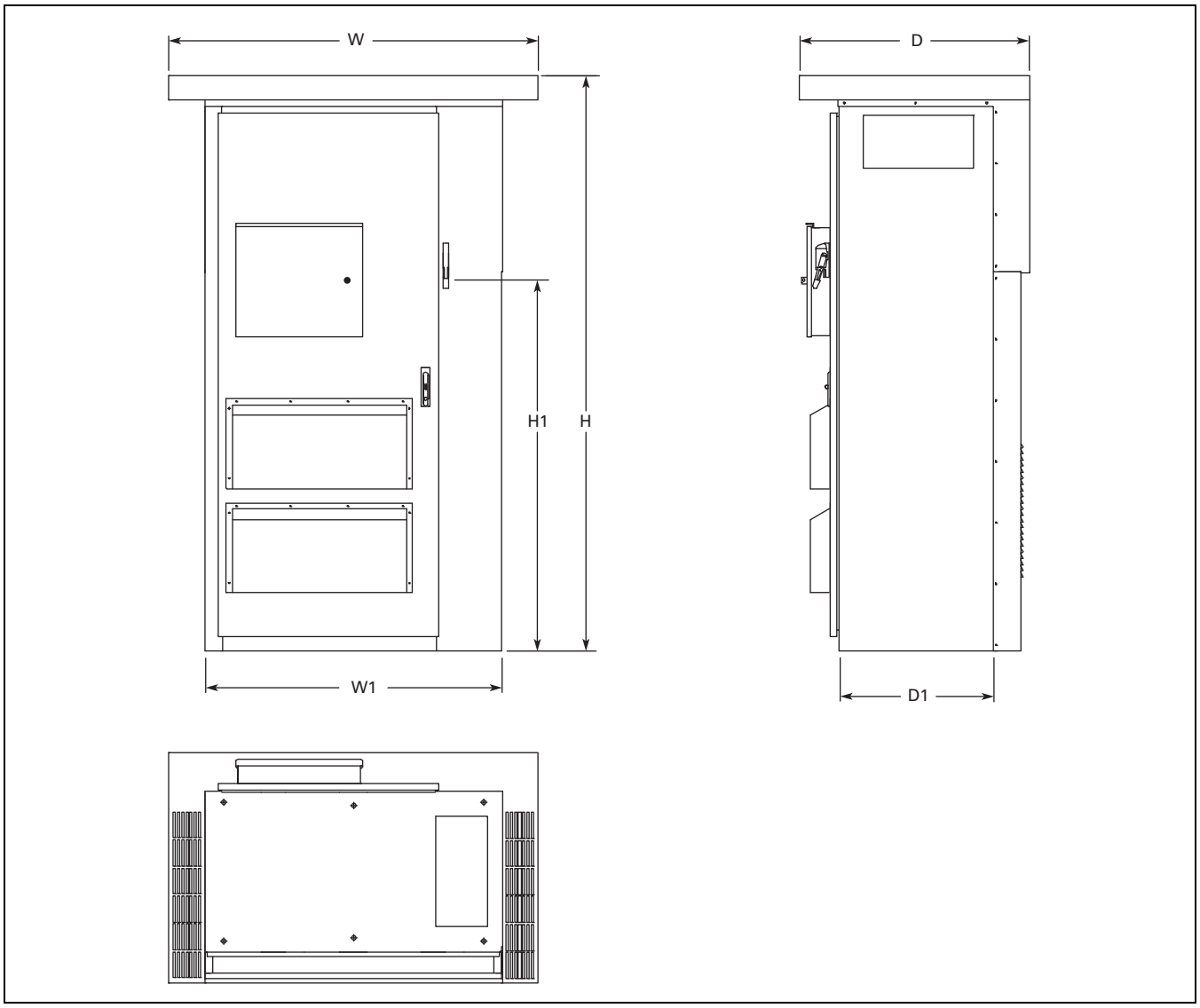


Figure 31.2-39. Enclosure Size F—Approximate Dimensions in Inches (mm)

Table 31.2-34. CFX9000 Drive Dimensions

H	H1	W	W1	D	D1	Approximate Weight Lb (kg)	Approximate Shipping Weight Lb (kg)
93.58 (2376.9)	69.51 (1765.60)	60.00 (1524.0)	48.00 (1219.2)	37.50 (952.5)	26.00 (660.4)	1700 (771)	1850 (839)

CFX9000—Drawing 7

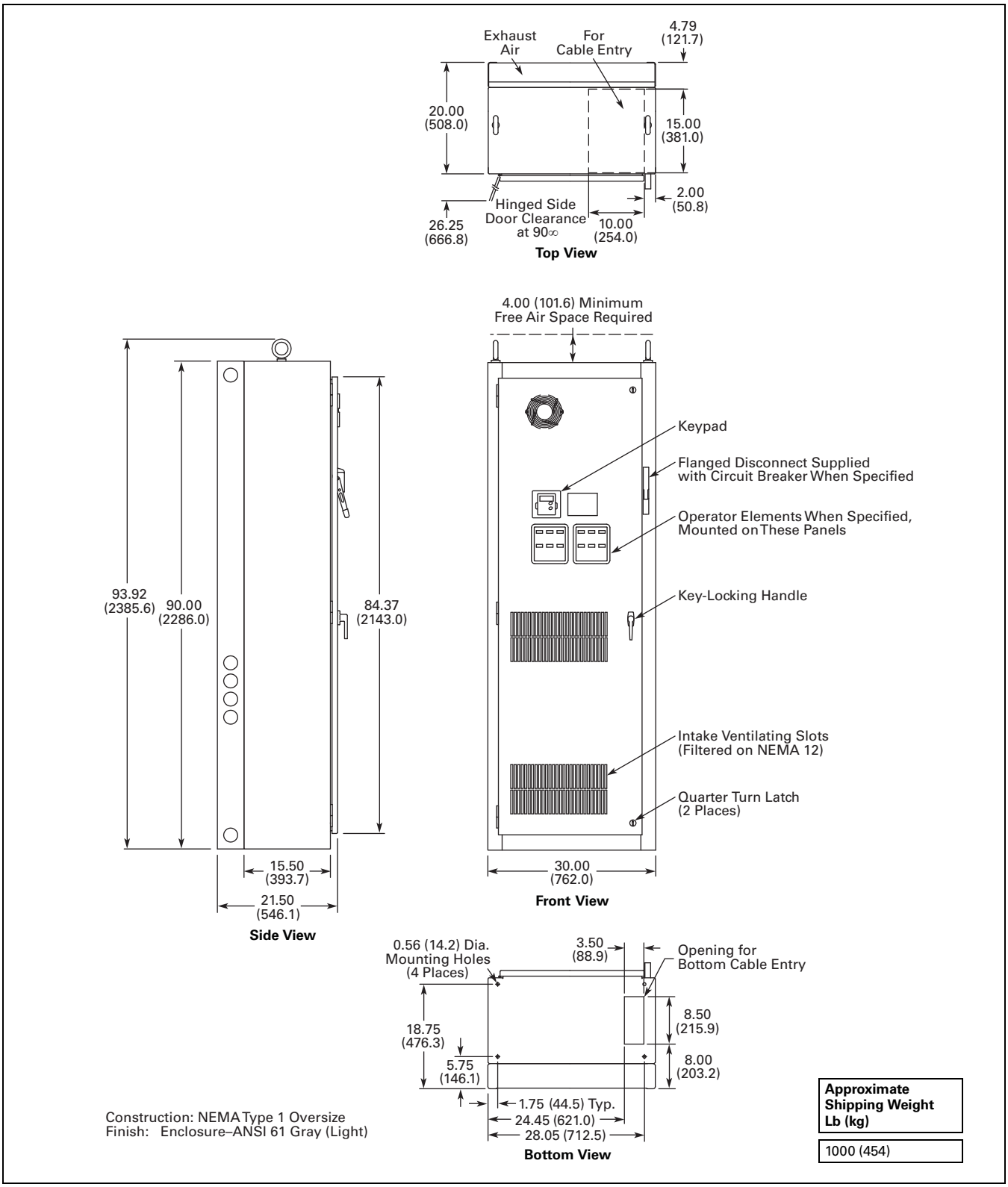


Figure 31.2-40. Enclosure Size 7—Approximate Dimensions in Inches (mm)

CFX9000—Drawing 8

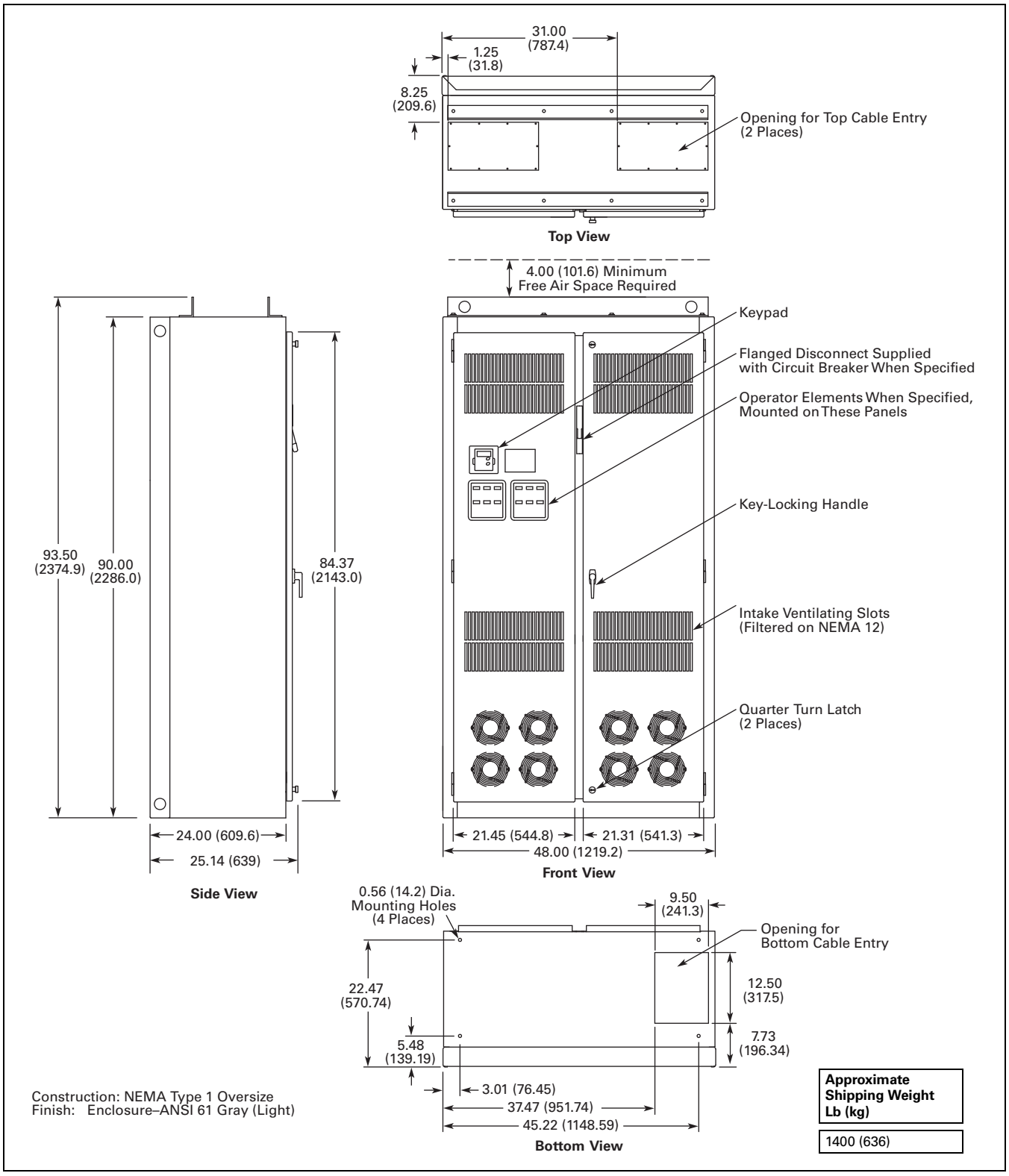


Figure 31.2-41. Enclosure Size 8—Approximate Dimensions in Inches (mm)

CFX9000—Drawing 9

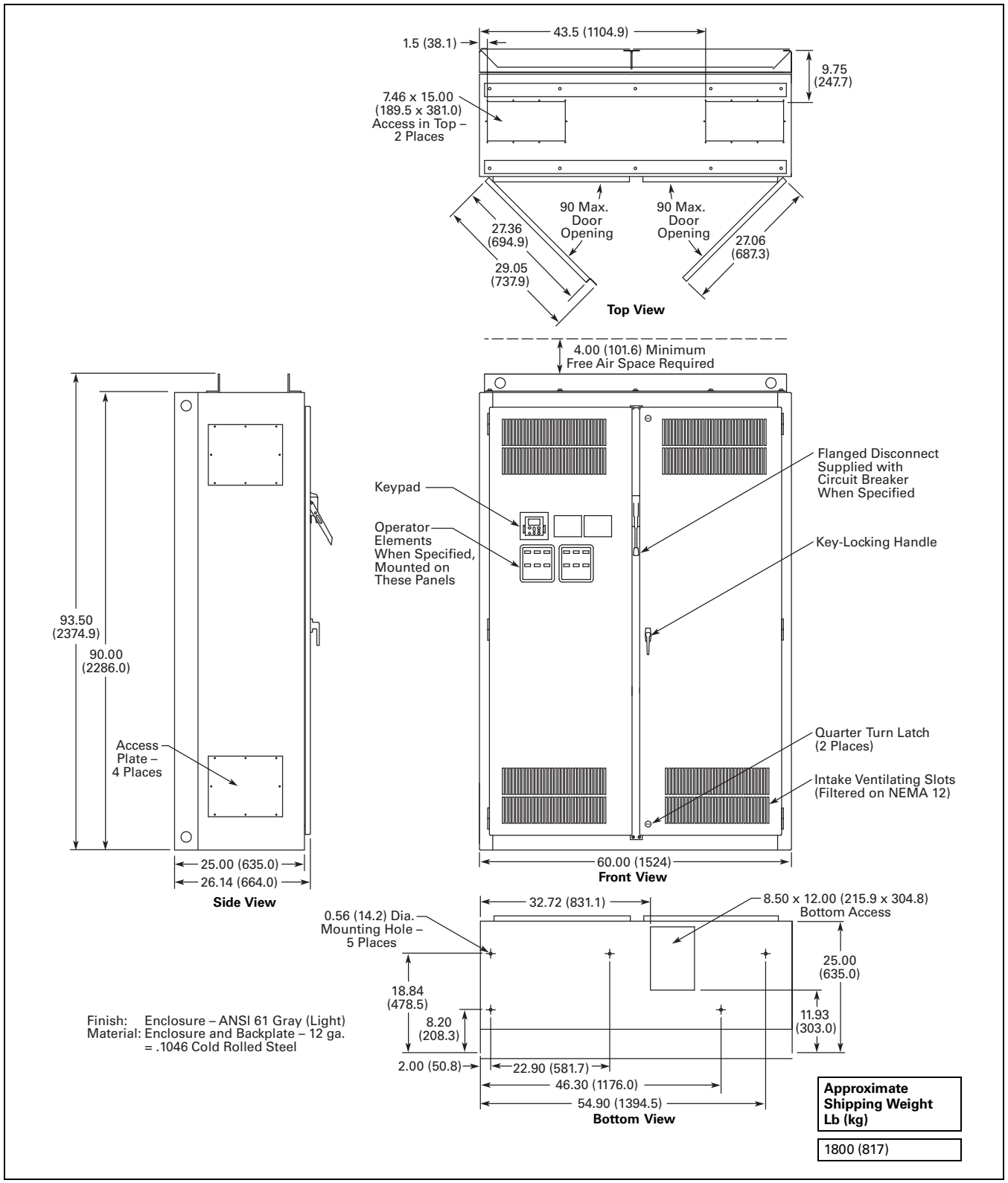


Figure 31.2-42. Enclosure Size 9—Approximate Dimensions in Inches (mm)

CPX 18-Pulse SVX

CPX9000—150 hp I_L

General Description

Eaton's CPX9000 Clean Power Drives use advanced 18-pulse, clean power technology that significantly reduces line harmonics at the drive input terminals, resulting in one of the purest sinusoidal waveforms available.

Enhancements to the CPX9000 Clean Power Drives include smaller enclosures and higher temperature ratings than CP9000 for selected drives.

The CPX9000 drive also delivers true power factor—in addition to reducing harmonic distortion, the CPX9000 drive prevents transformer overheating and overloading of breakers and feeders, which enables the application of adjustable frequency drives on generators and other high impedance power systems.

CPX9000 Enclosed Products

- **Standard enclosed**—covers a wide range of the most commonly ordered options. Pre-engineering eliminates the lead time normally associated with customer specific options
- **Modified standard enclosed**—applies to specific customer requirements that vary from the Standard Enclosed offering, such as the need for an additional indicating light or minor modifications to drawings. *Contact your local sales office for assistance in pricing and lead time*
- **Custom engineered**—for those applications with more unique or complex requirements, these are individually engineered to the customer's needs. *Contact your local sales office for pricing and lead time*

Features and Benefits

CPX9000 Clean Power Drive features include:

- 25–150 hp I_L drives available in 30-inch enclosure
- 200 and 250 hp I_L drives available in 48-inch enclosure
- 300–400 hp I_L drives available in 60-inch enclosure
- 500–600 hp I_L drives available in 80-inch enclosure
- NEMA Type 1, NEMA 12 with gaskets and filters
- Input voltage: 480 V, 208/230 V
- Complete range of control, network and power options
- Horsepower range:
  - 480 V, 25–700 hp I_H; 25–800 hp I_L
  - 208/230 V, 25–100 hp I_L; consult factory for details
- Over 10 years of 18-pulse clean power experience

Catalog Number Selection

Table 31.2-35. CPX9000 Enclosed NEMA Type 1 Drive Catalog Numbering System

CPX 100 1 4 A A _ _ _ _ _ _ _ _ _ _

Build options alphabetically and numerically.

Product Family

CPX = Clean power 18-pulse enclosed drives

Horsepower Rating

025 = 25 hp	**200** = 200 hp
030 = 30 hp	**250** = 250 hp
040 = 40 hp	**300** = 300 hp
050 = 50 hp	**350** = 350 hp
060 = 60 hp	**400** = 400 hp
075 = 75 hp	**500** = 500 hp
100 = 100 hp	**600** = 600 hp
125 = 125 hp	**700** = 700 hp
150 = 150 hp	**800** = 800 hp

Enclosure Rating

1 = NEMA Type 1
6 = NEMA 12 filtered

Voltage Rating

4 = 480 V

Application—Torque/Braking ②

A = I_L/no brake chopper
B = I_L/internal brake chopper
D = I_H/no brake chopper
E = I_H/internal brake chopper

Enclosed Style

A = Enclosed drive

Enclosed Options ①③⑤		Type
K1	Door-mounted speed potentiometer ⑤	Control
K2	Door-mounted speed potentiometer with HOA selector switch ⑤	Control
K3	3–15 psig follower	Control
K4	HAND/OFF/AUTO switch (22 mm)	Control
K5	MANUAL/AUTO reference switch (22 mm)	Control
K6	START/STOP pushbuttons (22 mm)	Control
KF	Bypass test switch for RA and RB	Addl. bypass
KO	Standard elapsed time meter	Control
L1	Power on and fault pilot lights	Light
L2	Bypass pilot lights for RA, RB, bypass options	Addl. bypass
LE	Red RUN light	Light
P1	Input disconnect	Input
PE	Output contactor	Output
PF	Output filter	Output
PG	MotoRx (up to 600 ft) 1000 V/µS DV/DT filter	Output
PH	Single overload relay	Output
PI	Dual overload relays	Output
PN	Dual overloads for bypass	Addl. bypass
RA	Manual HOA bypass controller	Bypass
RB	Manual IOB bypass controller	Bypass
RC	Auto transfer HOA bypass controller	Bypass
RD	Auto transfer IOB bypass controller	Bypass
RG	Reduced voltage starter for bypass	Bypass
S7	10-inch expansion	Enclosure
S8	20-inch expansion	Enclosure
S9	Space heater	Enclosure

Communication Options ⑥

C2 = Modbus	**C8** = Modbus (D9 Type connector)
C3 = PROFIBUS DP	**CA** = Johnson Controls N2
C4 = LonWorks	**CI** = Modbus TCP
C5 = PROFIBUS DP (D9 connector)	**CJ** = BACnet
C6 = CANopen (slave)	**D3** = RS-232 with D9 connection
C7 = DeviceNet	

Control Options

B1 = 6 DI, 1 ext +24 Vdc/EXT +24 Vdc
B2 = 1 RO (NC/NO), 1 RO (NO), 1 Therm
B4 = 1 AI (mA isolated), 2 AO (mA isolated), 1 ext +24 Vdc/EXT +24 Vdc
B5 = 3 RO (NO)
B8 = 1 ext +24 Vdc/EXT +24 Vdc, 3 Pt100
B9 = 1 RO (NO), 5 DI 42–240 Vac Input

Engineered Options

HT = High temperature rating for 50 °C (FR10 and above) ⑦
VB = Varnished boards

① Brake chopper is standard in drives up to 30 hp I_H or 40 hp I_L. It is optional in larger drives.
② Local/remote keypad is included as the standard control panel and as a digital HOA switch.
③ Some options are voltage and/or horsepower specific. Consult your Eaton representative for details.
④ See **Pages 31.2-30** and **31.2-31** for descriptions.
⑤ Includes local/remote speed reference switch.
⑥ See **Page 31.2-6** for complete descriptions.
⑦ Consult Eaton for pricing and availability.

Table 31.2-36. 480 Vac CPX9000 Base Drive Product Selection

Enclosure Size ①	hp	Current (A)	Chassis Frame	Drawing Number
Low Overload Drive—I_L = Variable Torque				
7	25 30 40	38 46 61	FR6 FR6 FR6	1 1 1
7	50 60 75	72 87 105	FR7 FR7 FR7	1 1 1
7	100 125 150	140 170 205	FR8 FR8 FR8	1 1 1
8	200 250	261 300	FR9 FR9	2 2
9	300 350 400	385 460 520	FR10 FR10 FR10	3 3 3
10	500 550 600	590 650 730	FR11 FR11 FR11	4 4 4
11	650 700 800	820 920 1030	FR12 FR12 FR12	② ② ②
High Overload Drive—I_H = Constant Torque				
7	25 30 40	38 46 61	FR6 FR6 FR7	1 1 1
7	50 60 75	72 87 105	FR7 FR7 FR8	1 1 1
7	100 125	140 170	FR8 FR8	1 1
8	150 200	205 245	FR9 FR9	2 2
9	250 300 350	300 385 460	FR10 FR10 FR10	3 3 3
10	400 500 550	520 590 650	FR11 FR11 FR11	4 4 4
11	600 650 700	720 820 840	FR12 FR12 FR12	② ② ②

① See enclosure dimensions in **Table 31.2-37**.
② Consult factory.

Table 31.2-37. CPX9000 Enclosure Dimensions

Enclosure Size ③	Approximate Dimensions in Inches (mm)		
	Width	Height	Depth
7 8 9	30.00 (762.0) 48.00 (1219.2) 60.00 (1524.0)	90.00 (2286.0) 90.00 (2286.0) 90.00 (2286.0)	21.50 (546.1) 26.14 (664.0) 25.74 (653.8)
10 11 ④	80.00 (2032.0) —	90.00 (2286.0) —	31.75 (806.5) —

③ Enclosure sizes accommodate drive and options, including bypass and disconnect. For other power options, consult your Eaton representative.
④ Consult factory.

Dimensions

CPX Drawing 1—Enclosure Size 7

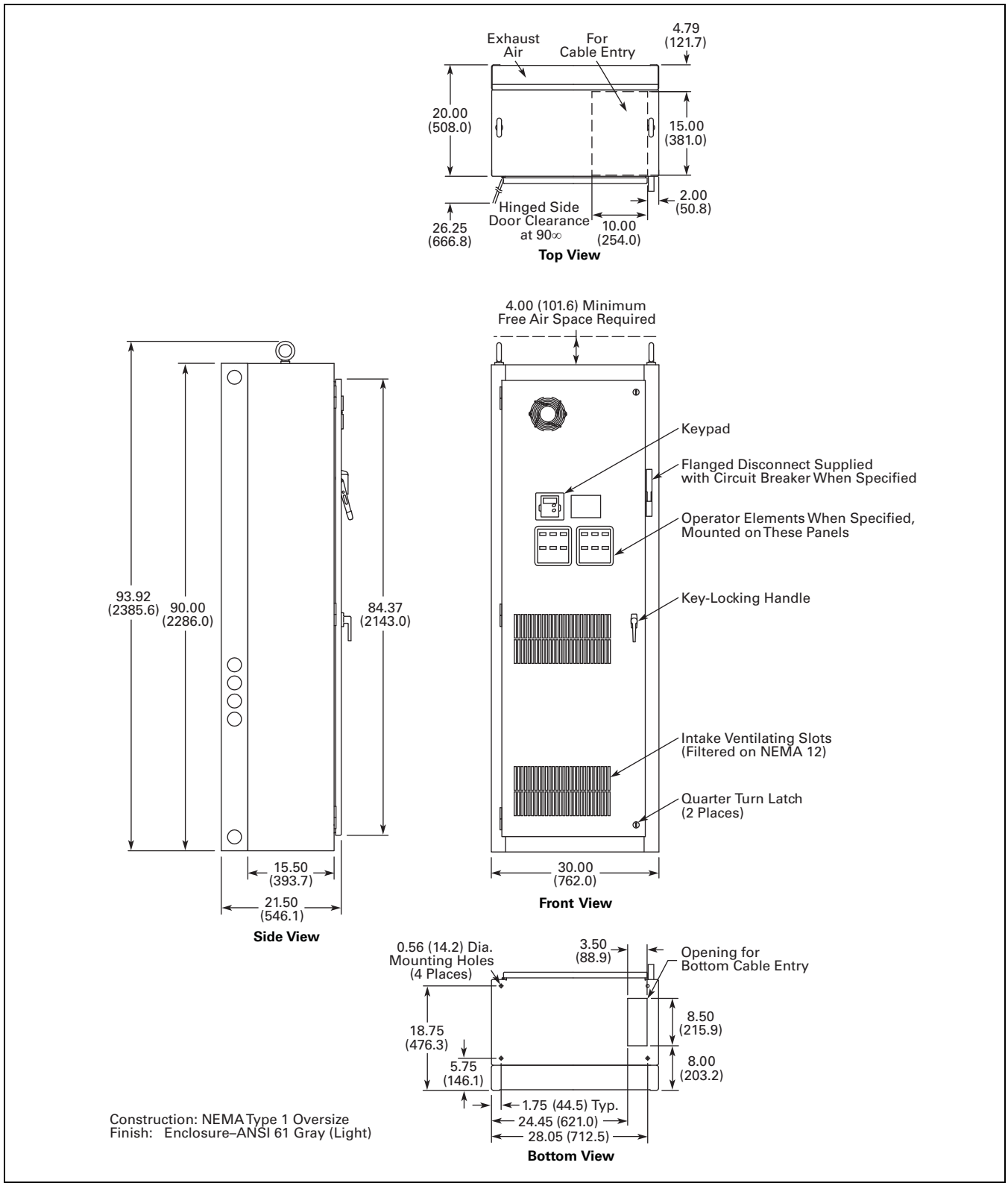


Figure 31.2-43. 25–150 hp I_L and 25–125 hp I_H—Approximate Dimensions in Inches (mm)

CPX Drawing 2—Enclosure Size 8

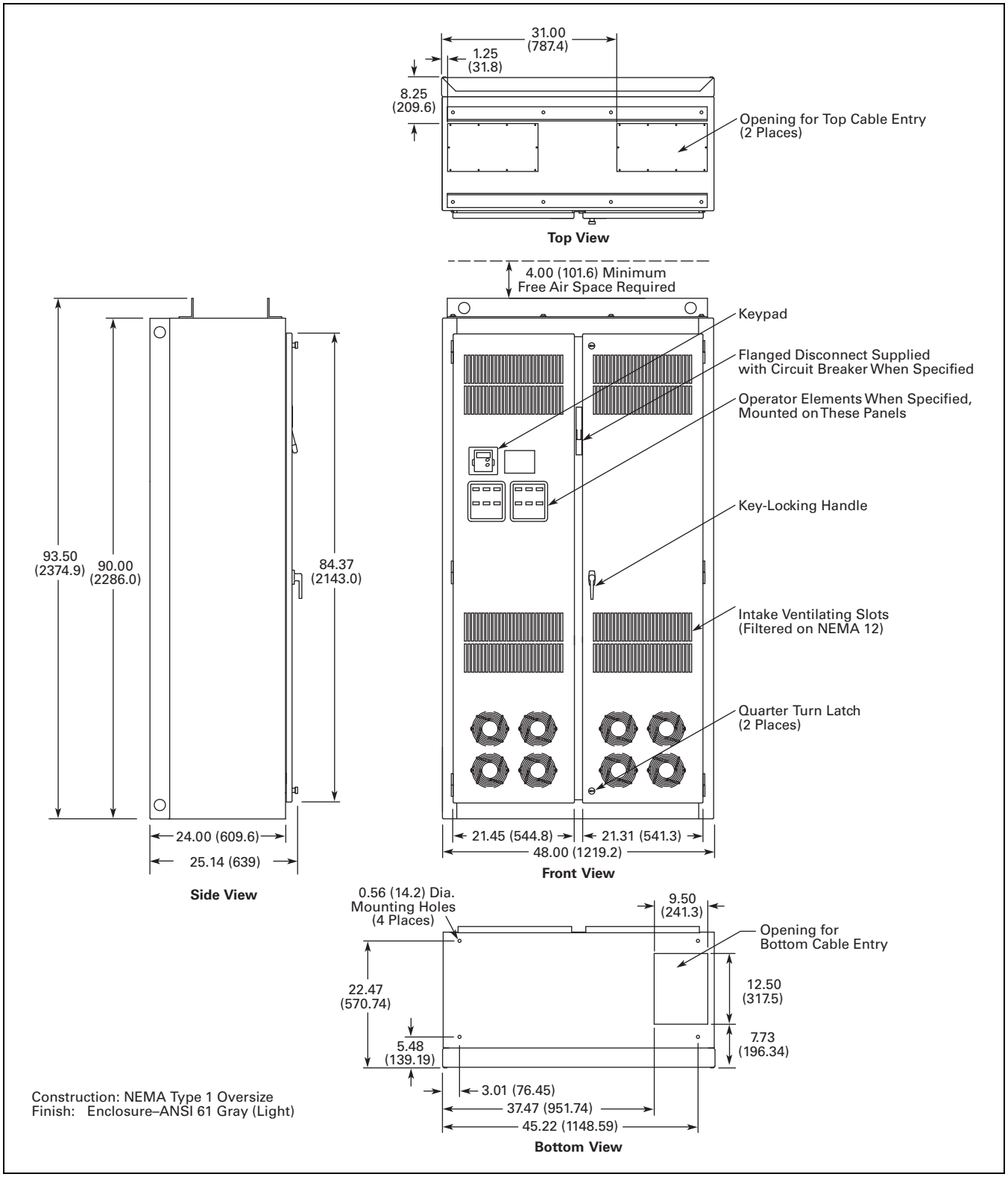


Figure 31.2-44. 200–250 hp I_L and 150–200 hp I_H—Approximate Dimensions in Inches (mm)

CPX Drawing 3—Enclosure Size 9

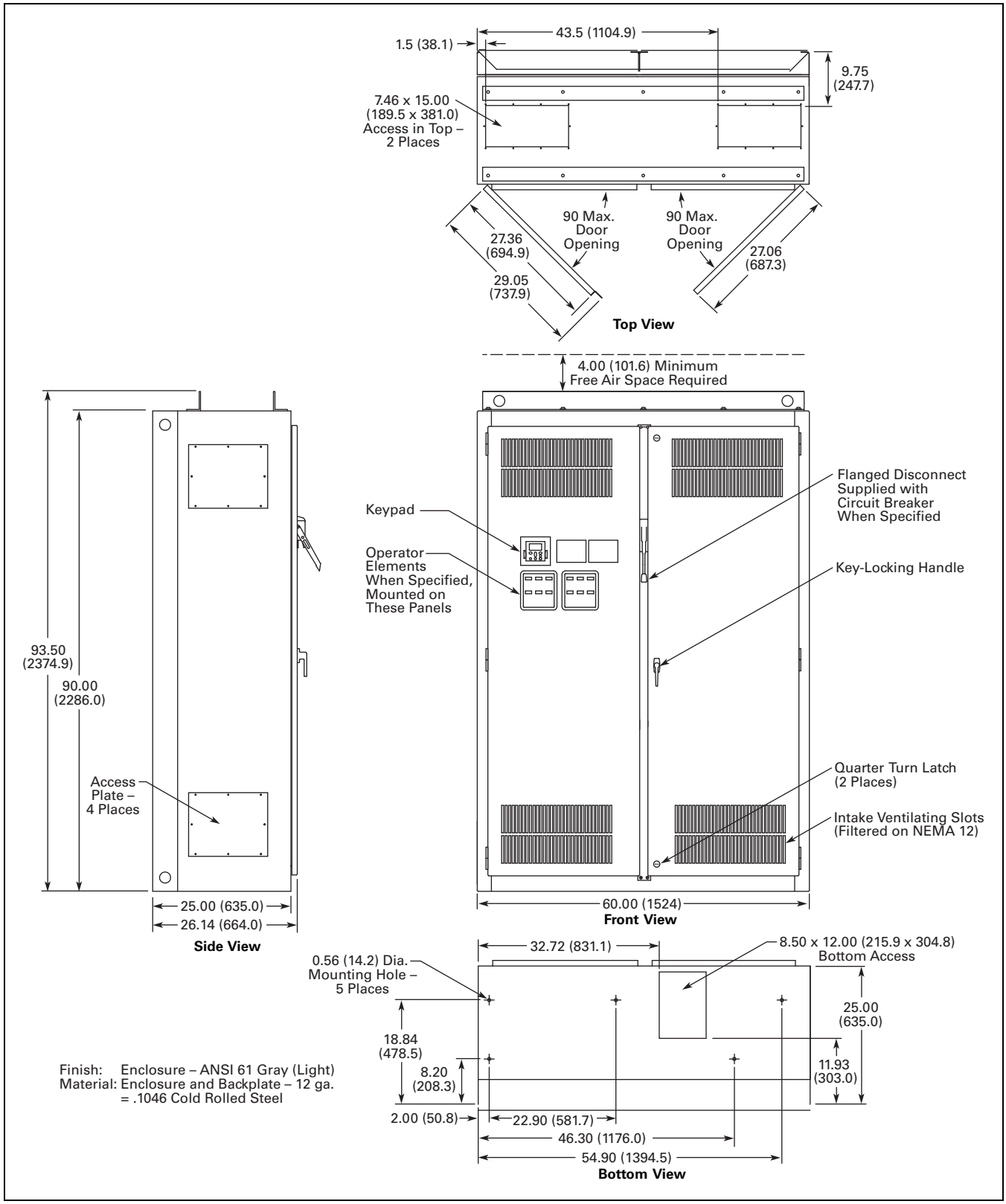


Figure 31.2-45. 300–400 hp I_L and 250–350 hp I_H—Approximate Dimensions in Inches (mm)

CPX Drawing 4—Enclosure Size 10

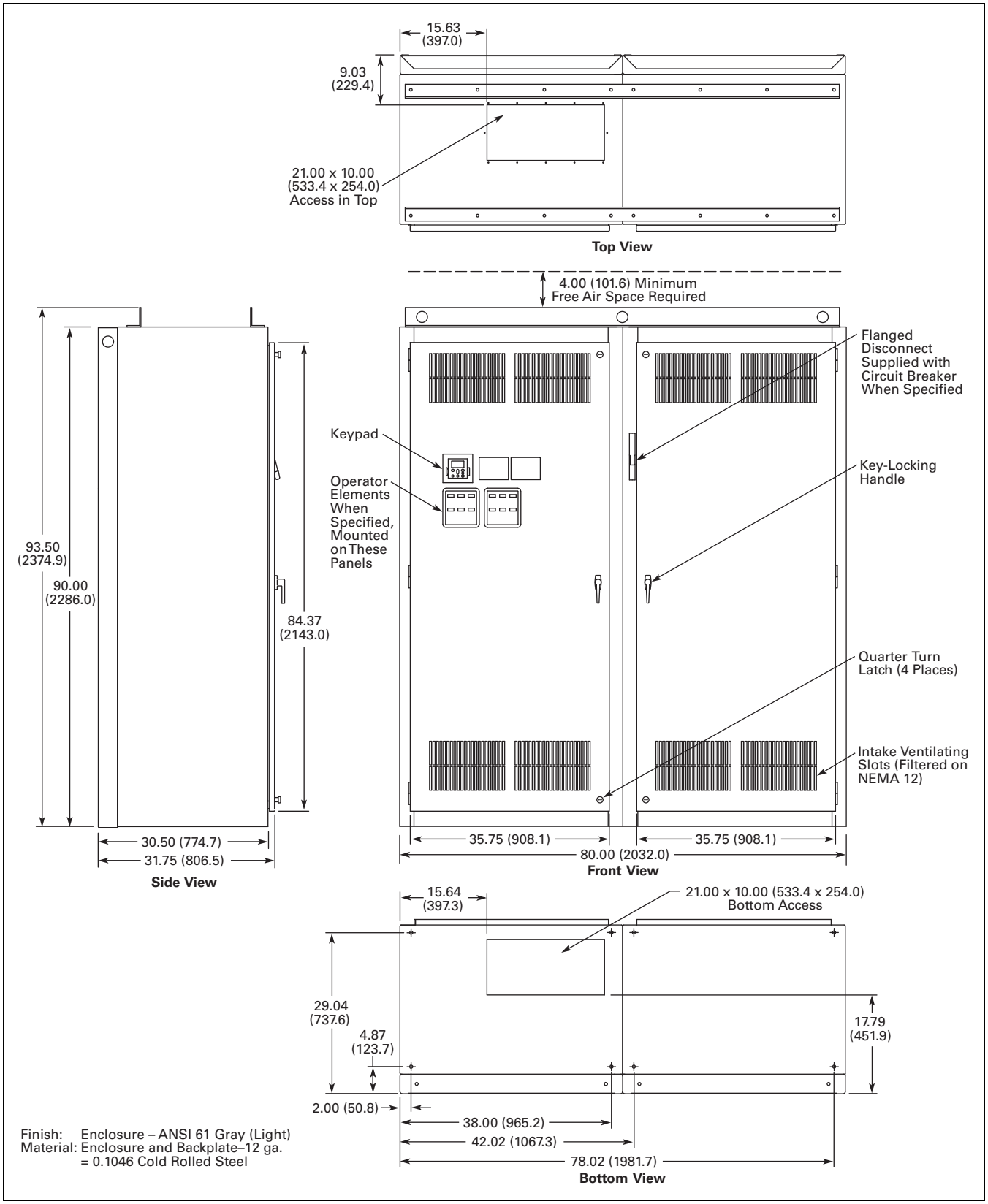


Figure 31.2-46. 500–600 hp I_L and 400–500 hp I_H—Approximate Dimensions in Inches (mm)

Wiring Diagrams

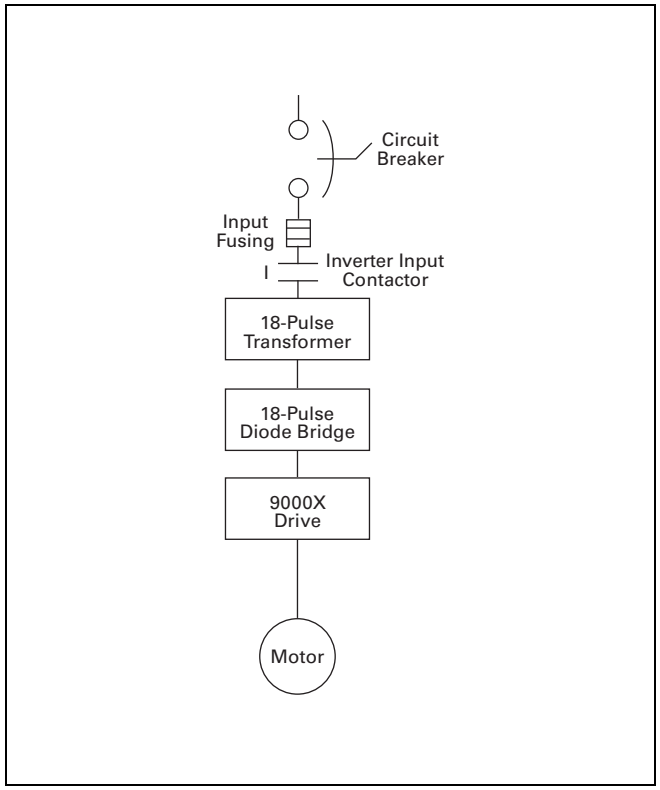


Figure 31.2-47. Power Diagram 25–250 hp I_L and 25–200 hp I_H

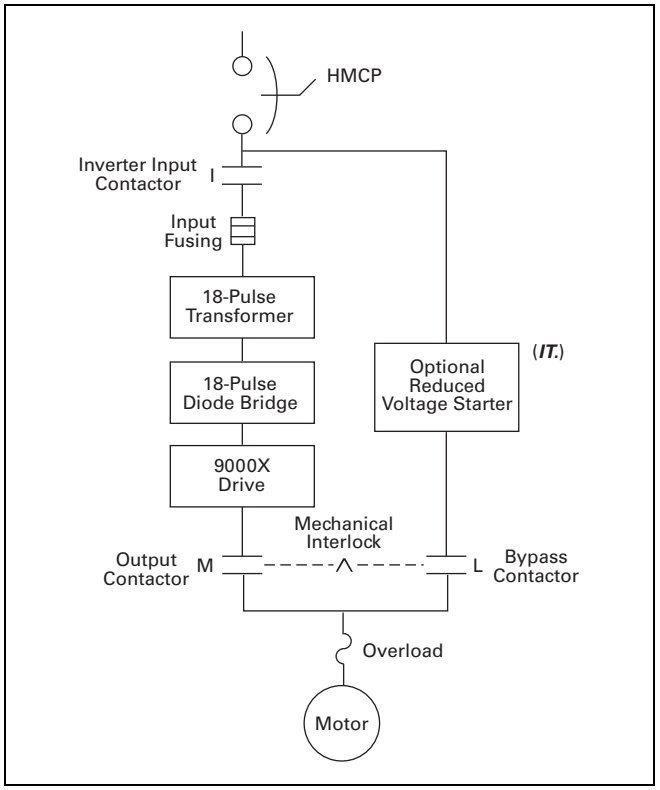


Figure 31.2-49. Power Diagram 25–250 hp I_L and 25–200 hp I_H with Bypass

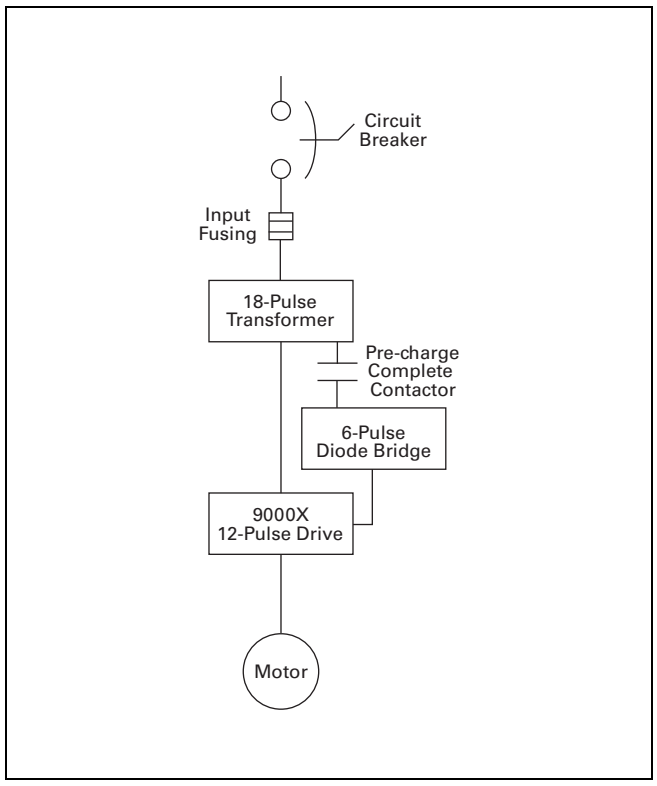


Figure 31.2-48. Power Diagram 300+ hp I_L and 250+ hp I_H

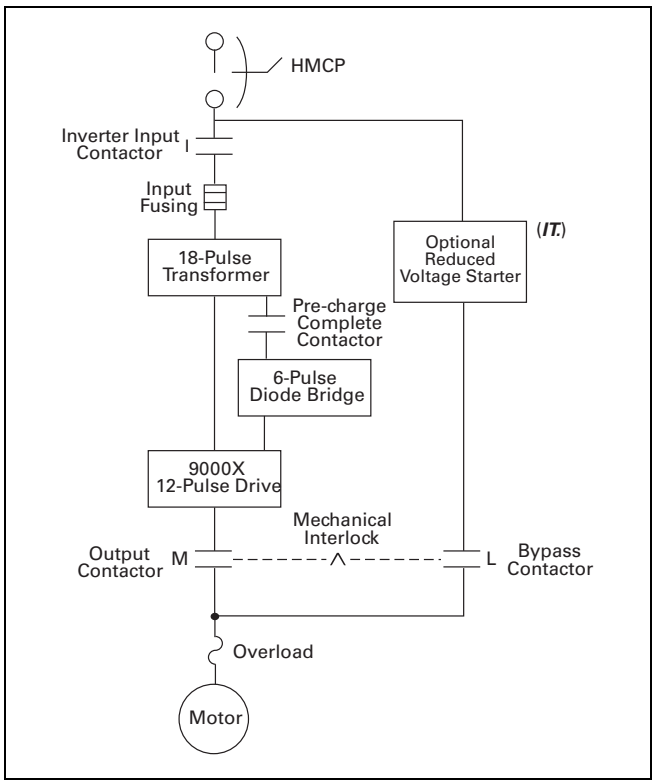


Figure 31.2-50. Power Diagram 300+ hp I_L/250+ hp I_H with Bypass

H-Max Drives

H-Max Drives

General Description

Eaton's H-Max Series VFD has software and hardware designed specifically for the HVAC, pump industry. The ultra-efficient DC capacitor and power structure allows the drive to consume less energy, lowering greenhouse gases.

The I/O configuration is designed with wiring ergonomics in mind by including removable terminal blocks. The main, easily removable, control board used for all drive frames with six digital IN, two analog IN, one analog OUT, three relay OUT accepts two additional I/O or communication board. In addition, the control board has built-in RS-485 and Ethernet communication.

These drives continue the tradition of robust performance, and raise the bar on features and functionality, ensuring the best solution at the right price.

Features and Benefits

- Integrated DC link choke standard on drives from FS4 through FS9
- DC bus regulation anti-trip
- Input surge protection against voltage spikes varistor input
- EMI/RFI filters standard on all drives from FS4 through FS9 to meet EMC Category 2
- HAND/OFF/AUTO and DRIVE/BYPASS selector on keypad simplifies control
- Additional I/O and communication cards provide plug-and-play functionality
- Copy/paste function allows transfer of parameter settings from one drive to the next
- Keypad can display up to nine monitored parameters simultaneously
- Remote mount keypad kit available
- NEMA Type 1 and NEMA Type 12 available
- Real-time clock with PLC functionality
- Two independent PID functions
- On-screen troubleshooting diagnostics with embedded manual assistance
- Onboard RS-485 (Modbus, N2, FLN, BACnet)
- Onboard Ethernet-based communications (BACnet/IP, Modbus/TCP
- Standard NEMA Type 12 keypad on all drives
- Quickstart wizard built into programming of drive ensures a smooth startup
- I/O connections with simple quick connection terminals
- Control logic can be powered from an external 24 V power supply to simulate internal drive functions and fieldbus, if necessary, used for testing and software downloads
- Standard I/O,6DI, 2AI, 1AO 2 Form C RO (NO/NC), 1 Form A RO (NO)
- Hard wired external/damper interlock

Standards and Certifications

Product

- IEC 61800-5-1
- CE
- cUL

Safety

- UL 508C
- EN 61800-5-1
- CE
- cUL

Seismic Qualification

Refer to **Tab 1** for information on seismic qualification for this and other Eaton products.

31

Catalog Number Selection

Table 31.3-1. H-Max Series Drives Catalog Numbering System

Build options alphabetically and numerically.

HMX 3 4 A G 3D4 2 1 - B

Product
HMX = HVAC drive

Phase
3 =Three-phase

Voltage
2 = 200–240 V
4 = 380–480 V

Software Series
A–Z

Keypad
G = Graphical panel

Input Options Frame and Voltage Specific
2 = EMC C2

Enclosure
1 = Open NEMA Type 1 IP21
2 = Open NEMA Type 12 IP54

Braking/Application
N = No brake chopper (low overload)
B = Internal brake chopper (low overload FS4–FS6 included)

Extended I/O Options in Slot D and E
B1 = 6 x DI /DO, Each digital input can be individually programmed as digital output
B2 = 1RO (NC/NO), 1RO (NO), 1 Thermistor
B4 = 1 x AI, 2 x AO (isolated)
B5 = 3 x RO
B8 = 1 ext +24 Vdc/ext +24 Vdc, 3 Pt100
B9 = 1RO (NO), 5 DI 42–240 Vac input

Optional Communications in Slot D and E
C4 = LonWorks®

Standard Onboard Communications

RS-485 Communications
BACnet MS/TP = Master slave/token protocol (Universal BACnet) RS-485
Modbus RTU RS-485, ASCII or RTU, remote terminal unit 32 nodes
FLN Siemens APOGEE FLN (P1) ASCII or RTU, remote terminal unit 32 nodes
N2 = Johnson Controls Metasys N2 network

Onboard Ethernet-Based Communications (port left side of keypad)
BACnet/IP Ethernet industrial protocol
Modbus/TCP Transmission control protocol (Ethernet-based)

Amperes

200–240 V	380–480 V
3D7 = 3.7 A—0.75 hp, 0.55 kW ①	**3D4** = 3.4 A—1.5 hp, 1.1 kW ①
4D8 = 4.8 A—1 hp, 0.75 kW ①	**4D8** = 4.8 A—2 hp, 1.5 kW ①
6D6 = 6.6 A—1.5 hp, 1.1 kW ①	**5D6** = 5.6 A—3 hp, 2.2 kW ①
8D0 = 8 A—2 hp, 1.5 kW ①	**8D0** = 8 A—4 hp, 3 kW ①
011 = 11 A—3 hp, 2.2 kW ①	**9D6** = 9.6 A—5 hp, 4 kW ①
012 = 12 A—4 hp, 3 kW ①	**012** = 12 A—7.5 hp, 5.5 kW ①
018 = 18 A—5 hp, 4 kW ①	**016** = 16 A—10 hp, 7.5 kW ①
024 = 24 A—7.5 hp, 5.5 kW ①	**023** = 23 A—15 hp, 11 kW ①
031 = 31 A—10 hp, 7.5 kW ①	**031** = 31 A—20 hp, 15 kW ①
048 = 48 A—15 hp, 11 kW ①	**038** = 38 A—25 hp, 18.5 kW ①
062 = 62A—20 hp, 15 kW ①	**046** = 46 A—30 hp, 22 kW ①
075 = 75 A—25 hp, 18.5 kW	**061** = 61 A—40 hp, 30 kW ①
088 = 88 A—30 hp, 22 kW	**072** = 72 A—50 hp, 37 kW
105 = 105 A—40 hp, 30 kW	**087** = 87 A—60 hp, 45 kW
140 = 140 A—50 hp, 37 kW	**105** = 105 A—75 hp, 55 kW
170 = 170 A—60 hp, 45 kW	**140** = 140 A—100 hp, 75 kW
205 = 205 A—75 hp, 55 kW	**170** = 170 A—125 hp, 90 kW
261 = 261 A—100 hp, 75 kW	**205** = 205 A—150 hp, 110 kW
310 = 310 A—125 hp, 90 kW	**261** = 261 A—200 hp, 132 kW
	310 = 310 A—250 hp, 160 kW

① DB chopper standard frames FS4–FS6. 1.5–40 hp, 3.4–61 A, 480 Vac; 0.75–20 hp, 3.7–62 A, 200–240 Vac.

Notes:

- All boards are varnished (conformed coated). Corrosion resistant.
- Battery included in all drives for real-time clock.
- Keypad kit includes HOA bypass.
- Keypad kit includes HOA, back reset for Europe application.
- EMI/RFI filters included.
- DC link choke included.

Product Selection

Table 31.3-2. H-Max Series Drives—230 Vac

FS Frame Size	Drive Output Current		Assigned Motor Ratings	230 Vac NEC Amperes ①	Low Overload Full Load Amperes at 50 °C
	Low Overload Full Load Amperes at 40 °C	Horsepower	Drive kW 230 Vac/50 Hz		
NEMA Type 1/IP21					
4	3.7 4.8 6.6	0.75 1.0 1.5	0.55 0.75 1.1	3.2 4.2 6.6	2.6 3.7 4.8
	8.0 11.0 12.5	2.0 3.0 4.0	1.5 2.2 3.0	6.8 9.6 N/A	6.6 8.0 11.0
5	18.0 24.0 31.0	5.0 7.5 10.0	4.0 5.5 7.5	15.2 22.0 28.0	12.5 18.0 24.0
6	48.0 62.0	15.0 20.0	11.0 15.0	42.0 54.0	31.0 48.0
7	75.0 88.0 105.0	25.0 30.0 40.0	18.5 22.0 30.0	68.0 80.0 104.0	62.0 75.0 88.0
8	140.0 170.0 205.0	50.0 60.0 75.0	37.0 45.0 55.0	130.0 154.0 192.0	105.0 140.0 170.0
9	261.0 310.0	100.0 125.0	75.0 90.0	248.0 N/A	205.0 261.0
NEMA Type 12/IP54					
4	3.7 4.8 6.6	0.75 1.0 1.5	0.55 0.75 1.1	3.2 4.2 6.6	2.6 3.7 4.8
	8.0 11.0 12.5	2.0 3.0 4.0	1.5 2.2 3.0	6.8 9.6 N/A	6.6 8.0 11.0
5	18.0 24.0 31.0	5.0 7.5 10.0	4.0 5.5 7.5	15.2 22.0 28.0	12.0 18.0 24.0
6	48.0 62.0	15.0 20.0	11.0 15.0	42.0 54.0	31.0 48.0
7	75.0 88.0 105.0	25.0 30.0 40.0	18.5 22.0 30.0	68.0 80.0 104.0	62.0 75.0 88.0
8	140.0 170.0 205.0	50.0 60.0 75.0	37.0 45.0 55.0	130.0 154.0 192.0	105.0 140.0 170.0
9	261.0 310.0	100.0 125.0	75.0 90.0	248.0 N/A	205.0 261.0

① For sizing reference.

Table 31.3-3. H-Max Series Drives—480 Vac

FS Frame Size	Drive Output Current		Assigned Motor Ratings	480 Vac NEC Amperes ①	Low Overload Full Load Amperes at 50 °C
	Low Overload Full Load Amperes at 40 °C	Horsepower	Drive kW 400 Vac/50 Hz		
NEMA Type 1/IP21					
4	3.4 4.8 5.6	1.5 2.0 3.0	1.1 1.5 2.2	2.1 3.4 5.6	2.6 3.4 4.8
	8.0 9.6 12.0	4.0 5.0 7.5	3.0 4.0 5.5	N/A 7.6 11.0	5.6 8.0 9.6
5	16.0 23.0 31.0	10.0 15.0 20.0	7.5 11.0 15.0	14.0 21.0 27.0	12.0 16.0 23.0
6	38.0 46.0 61.0	25.0 30.0 40.0	18.5 22.0 30.0	34.0 40.0 52.0	31.0 38.0 46.0
7	72.0 87.0 105.0	50.0 60.0 75.0	37.0 45.0 55.0	65.0 77.0 96.0	61.0 72.0 87.0
8	140.0 170.0 205.0	100.0 125.0 150.0	75.0 90.0 110.0	124.0 156.0 180.0	105.0 140.0 170.0
9	261.0 310.0	200.0 250.0	132.0 160.0	240.0 302.0	205.0 261.0
NEMA Type 12/IP54					
4	3.4 4.8 5.6	1.5 2.0 3.0	1.1 1.5 2.2	2.1 3.4 5.6	2.6 3.4 4.8
	8.0 9.6 12.0	4.0 5.0 7.5	3.0 4.0 5.5	N/A 7.6 11.0	5.6 8.0 9.6
5	16.0 23.0 31.0	10.0 15.0 20.0	7.5 11.0 15.0	14.0 21.0 27.0	12.0 16.0 23.0
6	38.0 46.0 61.0	25.0 30.0 40.0	18.5 22.0 30.0	34.0 40.0 52.0	31.0 38.0 46.0
7	72.0 87.0 105.0	50.0 60.0 75.0	37.0 45.0 55.0	65.0 77.0 96.0	61.0 72.0 87.0
8	140.0 170.0 205.0	100.0 125.0 150.0	75.0 90.0 110.0	124.0 156.0 180.0	105.0 140.0 170.0
9	261.0 310.0	200.0 250.0	132.0 160.0	240.0 302.0	205.0 261.0

① For sizing reference.

Onboard Network Communications

Johnson Controls Metasys N2

H-Max Series provides communication between the drive and a Johnson Controls Metasys N2 network. With this connection, the drive can be controlled, monitored and programmed from the Metasys system. N2 can be selected and programmed by the drive keypad.

BACnet

H-Max Series provides communication to BACnet networks. Data transfer is master-slave/token passing (MS/TP) RS-485.

BACnet IP

100Base-T interface.

Modbus TCP

Ethernet based protocol.

Modbus RTU

H-Max Series provides communication to Modbus RTU RS-485 as a slave on a Modbus network. Other communication parameters include an address range from 1 to 247; a parity of None, Odd or Even; and the stop bit is 1.

FLN

H-Max Series provides communication to Siemens APOGEE™ FLN (P1) RTU RS-485 as a slave on an FLN network. Other communication parameters include an address range from 1 to 247, a parity of None, Odd or Even and option boards.

H-Max Series Option Board Kits Available for Slots D and E

The H-Max Series drives can accommodate a wide selection of expander and adapter option boards to customize the drive for your application needs. The drive's control unit is designed to accept a total of two option boards.

The H-Max Series factory-installed standard board configuration includes an I/O board and a relay output board.

Table 31.3-4. Option Boards Mounted in Slots D and E

Option Kit Description	Option Kit Catalog Number
6 x DI /DO, each digital input can be individually programmed as digital output	**XMX-IO-B1-A**
1RO Form C (NO/NC), 1RO Form A (NO), 1 thermistor	**XMX-IO-B2-A**
1 x AI, 2 x AO (isolated)	**XMX-IO-B4-A**
3 x RO Form A (NO)	**XMX-IO-B5-A**
1 ext +24 Vdc/ext +24 Vdc, 3 Pt100	**XMX-IO-B8-A**
1RO Form A (NO), 5DI 42–240 Vac input	**XMX-IO-B9-A**
LonWorks	**XMX-COM-C4-A**

NEMA Type 1 to NEMA Type 12/ IP54 Conversion Kit

The NEMA Type 12/IP54 option kit is used to convert a NEMA Type 1 to a NEMA Type 12 drive.

Kit consists of a drive cover, a fan kit and plugs.

Table 31.3-5. NEMA Type 12/IP54 Cover

Option Kit Description	Option Kit Catalog Number
FS4-branded N12/IP54 cover with gasket, plastic plug, fans, Eaton logos	**FS4-N12KIT**
FS5-branded N12/IP54 cover with gasket, plastic plug, fans, Eaton logos	**FS5-N12KIT**
FS6-branded N12/IP54 cover with gasket, plastic plug, fans, Eaton logos	**FS6-N12KIT**

Flange Kits

The flange kit is used when the power section heat sink is mounted through the back panel of an enclosure.

Technical Data and Specifications

Table 31.3-6. H-Max Series Drives

Description	Specification
Input Ratings	
Input voltage (V_{in})	200–240 Vac, 380–480 Vac, –10%/+10%
Input frequency (f_{in})	50/60 Hz (variation up to 47–66 Hz)
Connection to power	Once per minute or less (typical operation)
Short-circuit withstand rating	100 kAIC
Output Ratings	
Output voltage	0 to V_{in}/U_{in} line voltage in
Continuous output current	Ambient temperature max. 104 °F (40 °C)
I_L overload	1.1 x I_L (1 min./10 min.)
Overload current	110% (1 min./10 min.)
Initial output current	150% for 2 seconds
Output frequency	0 to 320 Hz
Frequency resolution	0.01 Hz
Control Characteristics	
Control method	Frequency control (V/f) open loop sensorless vector control
Switching frequency	1–310 A FS4–9: default 6 kHz
Frequency reference	Analog input: Resolution 0.1% (10-bit), accuracy ±1% Panel reference: Resolution 0.01 Hz
Field weakening point	8 to 320 Hz
Acceleration time	0.1 to 3000 seconds
Deceleration time	0.1 to 3000 seconds
Braking torque	DC brake: 30% x T_n (without brake option)
Ambient Conditions	
Ambient operating temperature	FS4–FS9: 14 °F (–10 °C), no frost to 104 °F (40 °C) (Drive can operate at 122 °F (50 °C), see **Pages 31.3-3** and **31.3-4**)
Storage temperature	–40 °F to +158 °F (–40 °C to +70 °C)
Relative humidity	0 to 95% RH, noncondensing, non-corrosive, no dripping water
Air quality	Chemical vapors: IEC 60721-3-3, unit in operation, Class 3C2; Mechanical particles: 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); 380–480 V
Vibration	FS4–FS9: EN 61800-5-1, EN 60068-2-6; 5 to 150 Hz, displacement amplitude 1 mm (peak) at 5 to 15.8 Hz, max. acceleration amplitude 1G at 15.8 to 150 Hz
Shock	EN 61800-5-1, EN 60068-2-27 UPS Drop test (for applicable UPS weights) Storage and shipping: max. 15G, 11 ms (in package)
Enclosure class	NEMA Type 1/IP21 or NEMA Type 12/IP54 (keypad required for IP54/Type 12)
Standards	
EMC	Immunity: Fulfills all EMC immunity requirements; Emissions: EN 61800-3, LEVEL H (EMC C2)
Emissions	EMC level dependent—+EMC 2: EN61800-3 (2004) Category C2 Delivered with Class C2 EMC filtering as default.

Table 31.3-6. H-Max Series Drives (Continued)

Description	Specification
Control Connections	
Analog input voltage	0 to 10 V, R = 200 kohms differential Resolution 0.1%; Accuracy ±1% DIP switch selection (voltage/current)
Analog input current	0(4) to 20 mA; R_i –250 ohms differential
Digital inputs (6)	Positive or negative logic; 18 to 30 Vdc
Auxiliary voltage	+24 V ±10%, max. 250 mA
Output reference voltage	+10 V +3%, max. load 10 mA
Analog output	0–10 V, 0(4) to 20 mA; R_L max. 500 ohms; Resolution 10 bit; Accuracy ±2% DIP switch selection (voltage/current)
Relay outputs	3 programmable, 2 Form C, 1 Form A relay outputs Switching capacity: 24 Vdc/8 A, 250 Vac/8 A, 125 Vdc/0.4 A
Hard wire jumper	Between terminal 6 and 10 factory default
DIP switch setting default	RS-485 = off A01 = current A12 = current A11 = voltage
Protections	
Overcurrent protection	Trip limit 4.0 x IH instantaneously
Overvoltage protection	Yes
DC bus regulation anti-trip	Yes (accelerates or decelerates the load)
Undervoltage protection	Yes
Earth fault protection	Yes (in case of earth fault in motor or motor cable, only the frequency converter is protected)
Input phase supervision	Yes (trips if any of the input phases are missing)
Motor phase supervision	Yes (trips if any of the output phases are missing)
Overtemperature protection	Yes
Motor overload protection	Yes
Motor stall protection	Yes
Motor underload protection	Yes
Short-circuit protection	Yes
Surge protection	Yes (varistor input)
Conformed coated (varnished) boards	Yes (prevents corrosion)
Seismic	
OHSPD Special Seismic Certification Pre-Approved	

Wiring Diagram

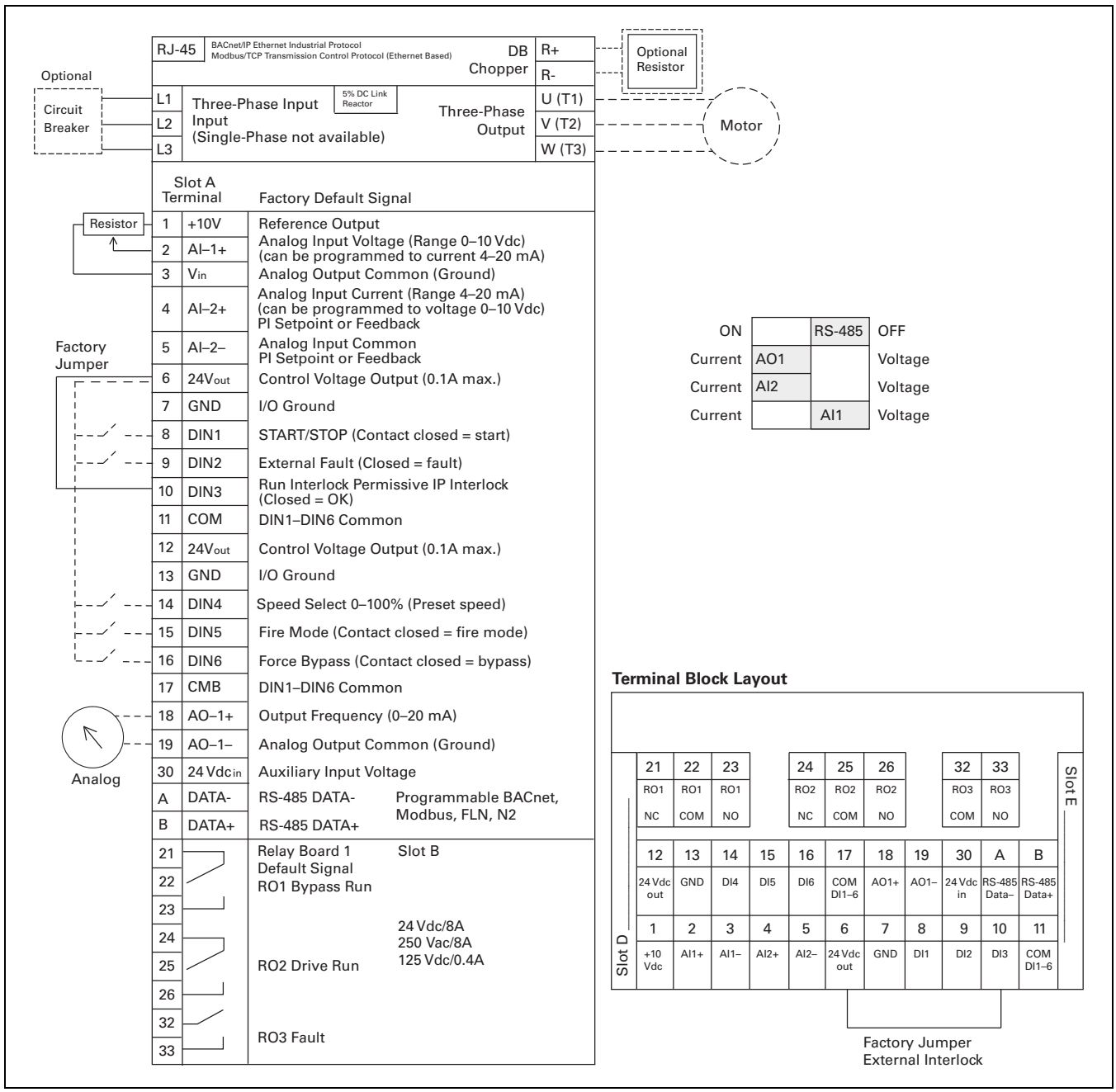


Figure 31.3-1. Control Input/Output, PID Application

Standards

- Digital inputs D1–D6, relay out, analog in/out are freely programmed
- The user can assign a single input to multiple functions

Includes

- Six digital input
- Two analog input
- One analog output
- Three relay output
- RS-485
- Ethernet (BACnet and Modbus)

Reliability

- Pretested components
- Conformal coated (varnished) boards
- 40°C rated
- 110% overload for one minute
- Eaton's Electrical Services & Systems national network of AF drive specialists

Dimensions—Approximate Dimensions in Inches (mm)

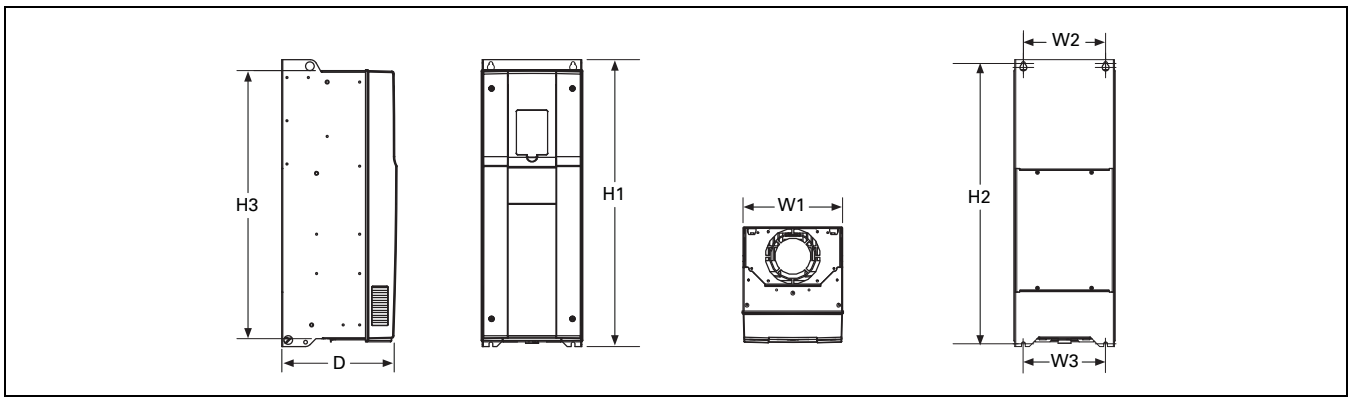


Figure 31.3-2. H-Max Series Frames FS4–FS7

Table 31.3-7. FS4–FS7 Dimensions and Weights

Voltage	hp	kW	Amperes	D	H1	Hole Center-to-Center H2	H3	W1	W2	W3	Weight in Lb (kg)
FS4											
230 Vac	0.75–4	0.55–3.0	3.7–12.5	7.77 (197.3)	12.89 (327.5)	12.32 (313.0)	11.22 (285.0)	5.04 (128.0)	3.94 (100.0)	3.94 (100.0)	13.2 (6)
480 Vac	1.5–7.5	1.1–5.5	3.4–12	7.77 (197.3)	12.89 (327.5)	12.32 (313.0)	11.22 (285.0)	5.04 (128.0)	3.94 (100.0)	3.94 (100.0)	13.2 (6)
FS5											
230 Vac	5–10	4–7.5	18–31	8.73 (221.6)	16.50 (419.0)	15.98 (406.0)	15.04 (382.0)	5.67 (144.0)	4.53 (115.0)	3.94 (100.0)	22.0 (10)
480 Vac	10–20	7.5–15	16–31	8.73 (221.6)	16.50 (419.0)	15.98 (406.0)	15.04 (382.0)	5.67 (144.0)	4.53 (115.0)	3.94 (100.0)	22.0 (10)
FS6											
230 Vac	15–20	11–15	48–62	9.29 (236.0)	21.93 (557.0)	21.28 (540.5)	20.24 (514.0)	7.68 (195.0)	5.83 (148.0)	5.83 (148.0)	44.1 (20)
480 Vac	25–40	18.5–30	38–61	9.29 (236.0)	21.93 (557.0)	21.28 (540.5)	20.24 (514.0)	7.68 (195.0)	5.83 (148.0)	5.83 (148.0)	44.1 (20)
FS7											
230 Vac	25–30	18.5–30	75–105	10.49 (266.5)	25.98 (660.0)	25.39 (645.0)	24.29 (617.0)	9.06 (230.0)	7.48 (190.0)	7.48 (190.0)	82.6 (37.5)
480 Vac	50–75	37–55	72–105	10.49 (266.5)	25.98 (660.0)	25.39 (645.0)	24.29 (617.0)	9.06 (230.0)	7.48 (190.0)	7.48 (190.0)	82.6 (37.5)

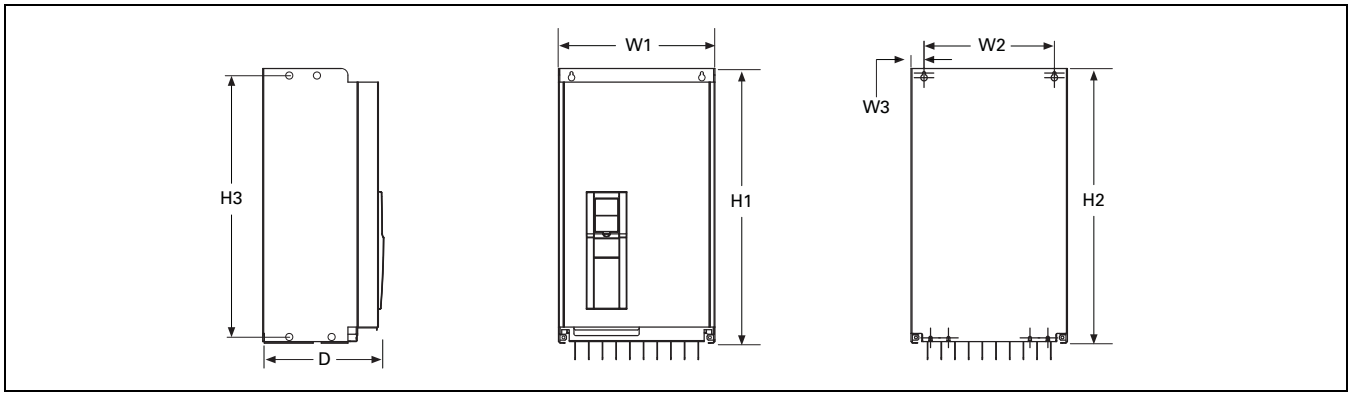


Figure 31.3-3. H-Max Series Frames FS8 and FS9

Table 31.3-8. FS8 and FS9 Dimensions and Weights

Voltage	hp	kW	Amperes	D	H1	Hole Center-to-Center H2	H3	W1	W2	W3	Weight in Lb (kg)
FS8											
230 Vac	50–75	37–55	140–205	13.76 (349.6)	38.02 (965.7)	37.26 (946.4)	37.26 (946.4)	11.42 (290.1)	9.29 (236.0)	1.42 (36.0)	154.3 (70)
480 Vac	100–150	75–110	140–205	13.76 (349.6)	38.02 (965.7)	37.26 (946.4)	37.26 (946.4)	11.42 (290.1)	9.29 (236.0)	1.42 (36.0)	154.3 (70)
FS9											
230 Vac	100–120	75–90	261–310	14.63 (371.6)	33.09 (890.4)	31.89 (810.0)	31.89 (810.0)	18.90 (480.0)	15.75 (400.0)	1.57 (40.0)	238.1 (108)
480 Vac	200–250	132–160	261–310	14.63 (371.6)	33.09 (890.4)	31.89 (810.0)	31.89 (810.0)	18.90 (480.0)	15.75 (400.0)	1.57 (40.0)	238.1 (108)

Note: For flange dimension, please reference User Manual.

H-Max IntelliPass and IntelliDisconnect

H-Max IntelliPass and IntelliDisconnect Drives

General Description

The IntelliPass electronic bypass is a two or optional three contactor design using a 24 Vdc ***XT*** Series contactor with an optional manual override switch that allows the unit to run in bypass without the H-Max Series drive.

The IntelliPass software parameters use engineering units common to the HVAC industry. Onboard startup wizard guarantees flawless commissioning with plug-and-play screen entry. Available in NEMA Type 1 and 12 with optional pre-engineered operator devices to meet all customized specification requirements.

The IntelliPass construction features allow for easy installation, reliable operation and serviceability with additional onboard wire space and removable conduit plates with knockouts.

Features and Benefits

IntelliPass/IntelliDisconnect

- Circuit breaker provides flexible drive isolation configurations to meet customers' needs
- Communication interface enables control of the motor operated by the drive or bypass
- Plenum rated
- Designed and tested to UL 508C specifications
- Standard DC link choke for enhanced transient and harmonic distortion protection
- DC bus regulation anti-trip
- Input surge protection against voltage spikes varistor input
- EMI/RFI filters standard on all drives to meet EMC Category 2
- Top and bottom conduit entry for installation ease
- Pass-through I/O capability
- Additional I/O and communication cards provide plug and play functionality
- Copy/paste keypad function allows transfer of parameter settings from one drive to the next. Also allows for redundant storage of drive settings in keypad as well as drive for backup
- Optional fusing—fuse rating 200 kAIC
- Keypad can display up to nine monitored parameters simultaneously
- OHSPD Special Seismic Certification Pre-Approved
- Standard NEMA Type 12 keypad on all drives
- Simplified operating menu allows for typical programming changes
- Accommodates a wide selection of expander boards and adapter boards
- Control logic can be powered from an external auxiliary control panel
- Standard I/O, 6 DI, 2 AI, 1 AO, 2 Form C RO, 1 Form A RO
- Onboard RS-485 (Modbus, N2, FLN, BACnet)
- Built-in Ethernet communication (BACnet/IP, Modbus/TCP)
- DB chopper standard frames FS4–FS6 for USA application
  - 1.5–40 hp, 2.1–52 A, 480 Vac
  - 1–20 hp, 4.2–54 A, 230 Vac
  - 1–20 hp, 4.6–60 A, 208 Vac
- Hard wired external/damper interlock

IntelliPass

- Fully rated, mechanically interlocked contacts
- HAND/OFF/AUTO and DRIVE/BYPASS selector on keypad simplifies control
- Two power sources for control ensure redundancy and provide additional ride-through capability
- Self-healing power supplies
- Bypass circuit current interrupting rating up to 65 kAIC without fusing
- Fully featured mechanically interlocked bypass featuring Eaton's ***XT*** contactors
- Pre-engineered options to allow custom configurations (see option P150)
- Robust steel enclosure for simple installation
- Programmable auto restart and auto bypass while allowing critical damper interlock functionality

Standards and Certifications

Product

- IEC 61800-5-1
- CE
- cUL

Safety

- UL 508C
- EN 61800-5-1
- CE
- cUL
- OHSPD Special Seismic Certification Pre-Approved

Note: For specifications and options, see H-Max (**Pages 31.3-1** through **31.3-9**).

Catalog Number Selection

Table 31.3-9. H-Max Series IntelliPass and IntelliDisconnect Drives Catalog Numbering System

Build options alphabetically and numerically.

HMX 011 3 4 B A

Product
HMX = HVAC drive (VT) (low overload)

NEC Ampere Ratings

208 V
4D6 = 4.6 A—1 hp ①
7D5 = 7.5 A—2 hp ①
011 = 11 A—3 hp ①
017 = 17 A—5 hp ①
025 = 25 A—7.5 hp ①
031 = 31 A—10 hp ①
047 = 47 A—15 hp ①
060 = 60 A—20 hp ①
075 = 75 A—25 hp
088 = 88 A—30 hp

230 V
4D2 = 4.2 A—1 hp ①
6D8 = 6.8 A—2 hp ①
9D6 = 9.6 A—3 hp ①
016 = 16 A—5 hp ①
022 = 22 A—7.5 hp ①
028 = 28 A—10 hp ①
042 = 42 A—15 hp ①
054 = 54 A—20 hp ①
068 = 68 A—25 hp
080 = 80 A—30 hp

480 V
2D1 = 2.1 A—1 hp ①
3D4 = 3.4 A—2 hp ①
5D6 = 5.6 A—3 hp ①
7D6 = 7.6 A—5 hp ①
011 = 11 A—7.5 hp ①
014 = 14 A—10 hp ①
021 = 21 A—15 hp ①
027 = 27 A—20 hp ①
034 = 34 A—25 hp ①
040 = 40 A—30 hp ①
052 = 52 A—40 hp ①
065 = 65 A—50 hp
077 = 77 A—60 hp
096 = 96 A—75 hp

Enclosure Style
3 = IntelliPass NEMA Type 1
A = IntelliDisconnect NEMA Type 1

Voltage
1 = 208 V
2 = 230 V
4 = 480 V

Braking/Application
N = No brake chopper (low overload)
B = Internal brake; chopper (low overload FS4–FS6 included)

Software Series
A–Z

Extended I/O Options in Slot D and E
B1 = 6 x DI /DO, Each digital input can be individually programmed as digital output
B2 = 1RO (NC/NO), 1RO (NO), 1 Thermistor
B4 = 1 x AI, 2 x AO (isolated)
B5 = 3 x RO
B8 = 1 ext +24 Vdc/ext +24 Vdc, 3 Pt100
B9 = 1RO (NO), 5 DI 42–240 Vac input

Optional Communications in Slot D and E
C4 = LonWorks

EMC Upgrade Option
EMC C2 Standard

Keypad Options
None available

IntelliDisconnect Options
P3 = Fused drive isolation
PE = Output contactor
SA = Space heater w/transformer (Type 3R only)

IntelliPass Bypass Options
P3 = Fused drive isolation (can not be used with P6)
P6 = Third contactor drive isolation
PE = Output contactor (used for IntelliDisconnect)
M1 = Manual bypass switch located on front door
SA = Space heater w/transformer (Type 3R only)
KF = Drive test switch (used only with P6 option)
L1 = Power on and fault light (two separate lights)
L2 = Bypass pilot light (red)
L3 = Manual bypass light (amber)
LE = Drive run light
K9 = Auxiliary contacts
IS = Isolation switch

Standard Onboard Communications

RS-485 Communications
BACnet MS/TP = Master slave/token protocol (Universal BACnet) RS-485
Modbus RTU RS-485, ASCII or RTU, remote terminal unit 32 nodes
FLN Siemens APOGEE FLN (P1) ASCII or RTU, remote terminal unit 32 nodes
N2 = Johnson Controls Metasys N2 network

Onboard Ethernet-Based Communications (port left side of keypad)
BACnet/IP Ethernet industrial protocol
Modbus/TCP Transmission control protocol (Ethernet-based)

① DB chopper standard frames FS4–FS6 for USA application. 1.5–40 hp, 2.1–52 A, 480 Vac; 1–20 hp, 4.2–54 A, 230 Vac; 1–20 hp, 4.6–60 A, 208 Vac.

Notes:
- IntelliPass—two contactor electronic bypass standard.
- All boards are varnished. Corrosion resistant.
- Battery included in all drives for real-time clock. Three year lifetime.
- Keypad kit includes HOA bypass.
- EMI/RFI filters included.
- DC link choke included.

Product Selection

Table 31.3-10. H-Max Series IntelliPass NEMA Type 1—Two Contactor Bypass Standard

FS Frame Size	Horsepower	Drive Rated NEC Amperes
208 Vac		
4	1.0 2.0 3.0	4.6 7.5 10.6
5	5.0 7.5 10.0	16.7 24.2 30.8
6	15.0 20.0	46.2 59.4
7	25.0 30.0	74.9 88.0
230 Vac		
4	1.0 2.0 3.0	4.2 6.8 9.6
5	5.0 7.5 10.0	15.2 22.0 28.0
6	15.0 20.0	42.0 54.0
7	25.0 30.0	68.0 80.0
480 Vac		
4	1.0 2.0 3.0	2.1 3.4 5.6
	5.0 7.5	9.6 11.0
5	10.0 15.0 20.0	14.0 21.0 27.0
6	25.0 30.0 40.0	34.0 40.0 52.0
7	50.0 60.0 75.0	65.0 77.0 96.0

Table 31.3-11. H-Max Series IntelliDisconnect NEMA Type 1—Main Disconnect Standard

FS Frame Size	Horsepower	Drive Rated NEC Amperes
208 Vac		
4	1.0 2.0 3.0	4.6 7.5 11.0
5	5.0 7.5 10.0	17.0 25.0 31.0
6	15.0 20.0	47.0 60.0
7	25.0 30.0	75.0 88.0
230 Vac		
4	1.0 2.0 3.0	4.2 6.8 9.6
5	5.0 7.5 10.0	15.2 22.0 28.0
6	15.0 20.0	42.0 54.0
7	25.0 30.0	68.0 80.0
480 Vac		
4	1.0 2.0 3.0	2.1 3.4 5.6
	5.0 7.5	9.6 11.0
5	10.0 15.0 20.0	14.0 21.0 27.0
6	25.0 30.0 40.0	34.0 40.0 52.0
7	50.0 60.0 75.0	65.0 77.0 96.0

Note: For Wiring Diagrams, see **Page 31.3-13**.

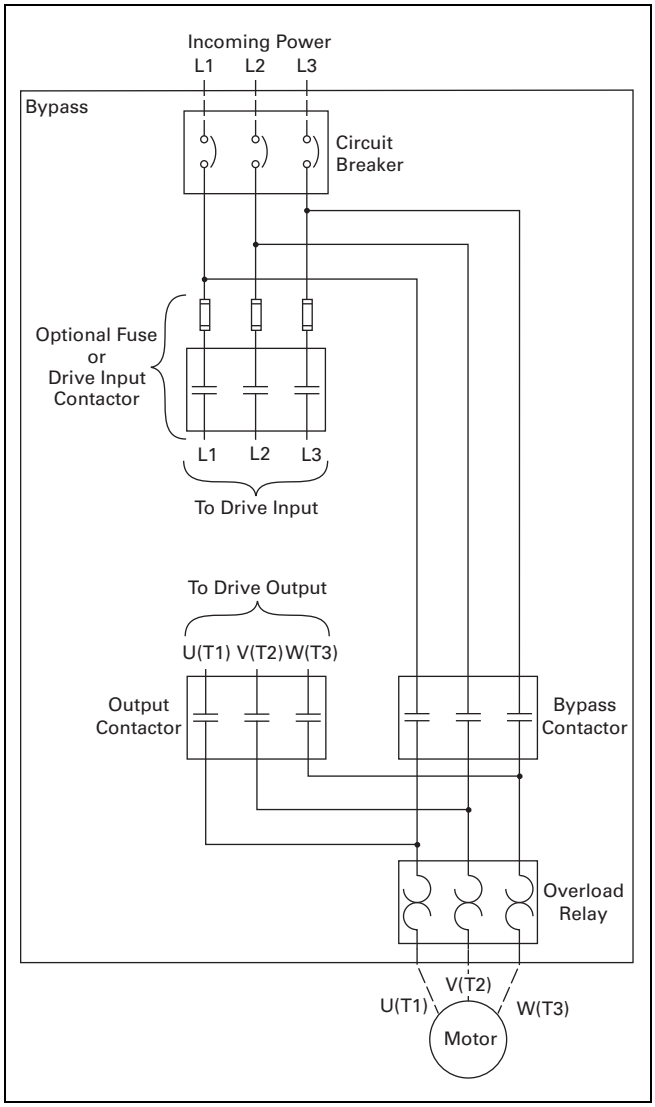


Figure 31.3-4. H-Max Series IntelliPass

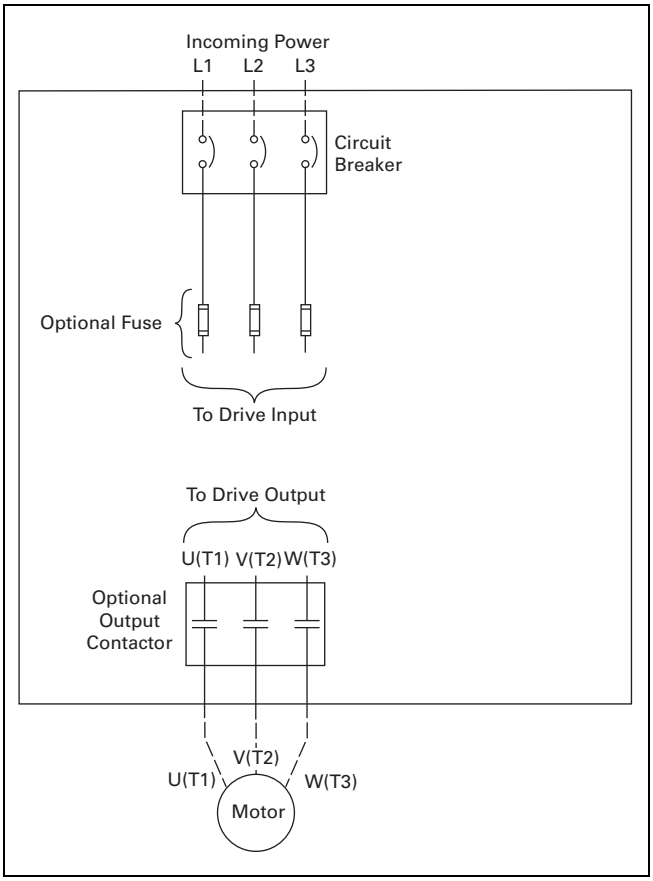


Figure 31.3-5. H-Max Series IntelliDisconnect Power Wiring

31

Dimensions—Approximate Dimensions in Inches (mm)

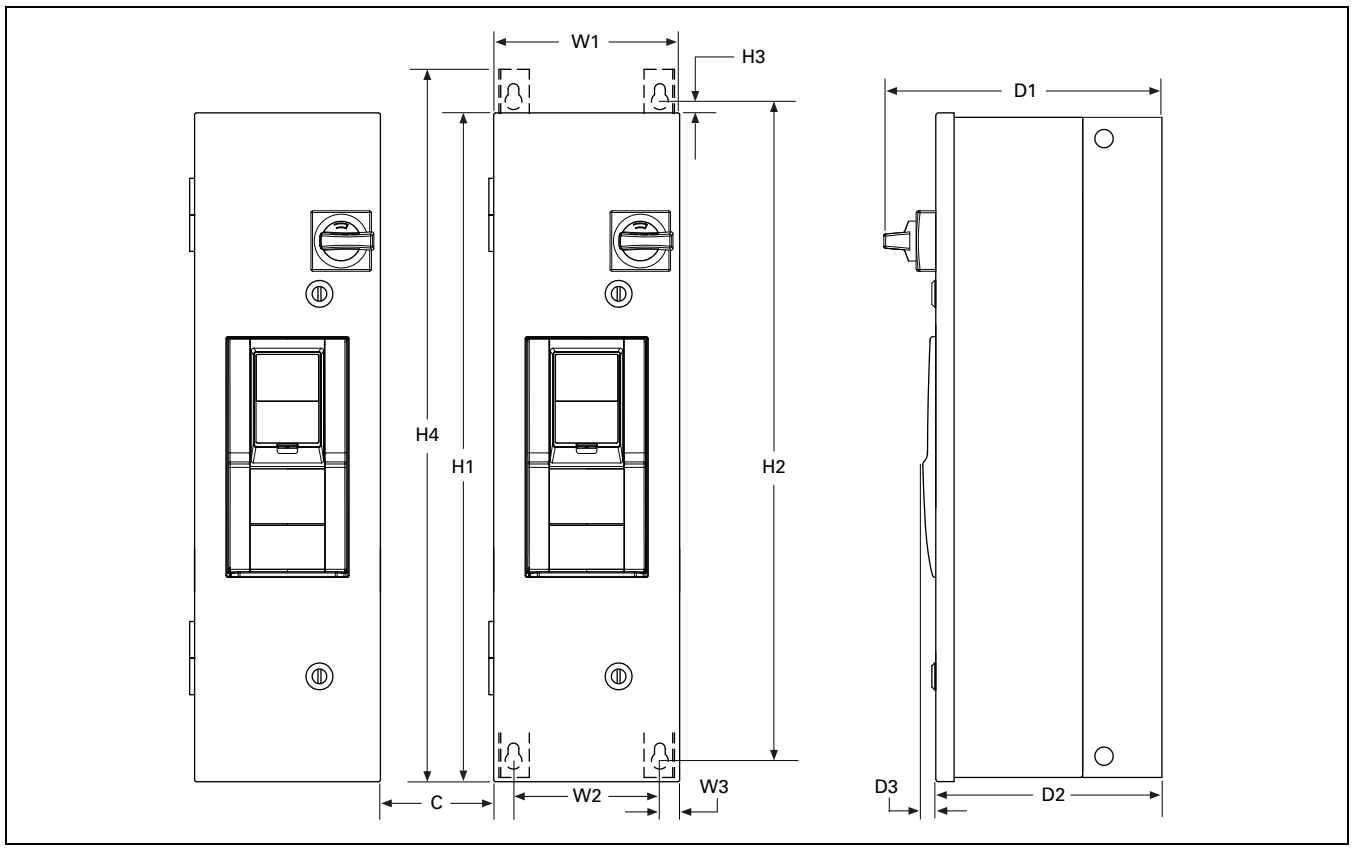


Figure 31.3-6. H-Max Series IntelliPass and IntelliDisconnect Drives
Note: Consult factory or use manual for final dimensions.

Table 31.3-12. IntelliPass and IntelliDisconnect Drive Dimensions and Weights

Frame Size	Voltage	Horsepower (I_L)	H1	H2	H3	H4	C	W1	W2	W3	D1	D2	Weight in Lb (kg)
FS4	208 230 480	1–3 1–3 1–7.5	29.69 (754.1)	37.12 (942.9)	0.25 (6.35)	31.00 (914.4)	3.00 (76.2)	7.88 (200.2)	6.33 (160.8)	0.75 (19.1)	11.40 (289.6)	9.27 (235.5)	45.0 (20.41)
FS5	208 230 480	5–10 5–10 10–20	37.00 (939.8)	34.47 (875.5)	0.25 (6.35)	38.31 (973.0)	3.00 (76.2)	9.40 (238.8)	7.75 (196.9)	0.75 (19.1)	15.30 (388.6)	13.17 (334.6)	57.5 (26.10)
FS6	208 230 480	15–20 15–20 25–40	45.08 (1145.0)	40.28 (1023.1)	0.25 (6.35)	46.4 (1178.6)	4.00 (101.6)	10.90 (276.9)	9.35 (327.5)	0.75 (19.1)	15.75 (400.0)	13.62 (346.0)	98.0 (44.45)
FS7	208 230 480	25–30 25–30 50–75	58.32 (1481.3)	56.30 (1430.0)	0.25 (6.35)	59.46 (1510.3)	5.00 (127.0)	13.98 (355.1)	12.35 (313.7)	0.75 (19.1)	15.50 (393.7)	13.55 (244.2)	165.0 (74.84)

Note: C distance is spacing required to mount multiple drives.