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Solid state motor control > variable frequency drives

Variable frequency drives—low voltage—PowerXL DG1 Series

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Powering Business Worldwide

More about this product
Eaton.com/drives

Complete library of design guides
Eaton.com/designguides

Demand the Right Drive for Your Application

Your application might call for an ultra-compact solution, clean power solution or future configurability. Whether it is a standard product from the catalog or a custom variable frequency drive (VFD) solution, Eaton delivers.

Eaton drives are designed for industrial, HVAC, water/wastewater treatment, pumping, machinery OEM, continuous process and commercial application demands.

From designing a new industrial complex, renovating an existing structure or developing a new machine, Eaton has the right product for your application.

Application Considerations

Water/Wastewater

- Spare parts inventory maximize uptime with PowerXL™ DG1
- Various harmonic mitigation solutions to ensure IEEE® 519 guidelines for total harmonic distortion (THD)
  - ❑ PowerXL EGS includes 5% DC line choke for 32%THD
  - ❑ PowerXL EGF includes passive filtered design for 5%THD
  - ❑ PowerXL EGP includes 18-pulse design for 3%THD

Commercial Infrastructure

- PowerXL EGS enclosed drives are built-to-order to meet specific motor control requirements
- Versatile horsepower range from 1 to1000 hp
- Utilize onboard PLC programming capability or integrate into existing building management system

Machinery Control

- PowerXL DG1 offers flexibility in machine design
- Versatile horsepower range from 1 to 1000 hp
- Onboard programming and control eliminate need for external PLC
- Communication protocol compatibility
  - ❑ EtherNet/IP
  - ❑ Modbus® TCP
  - ❑ Modbus RTU
  - ❑ BACnet MS/TP
- Communication options
  - ❑ PROFIBUS DP
  - ❑ CANopen
  - ❑ SmartWire-DT™

Industrial Processing

- PowerXL EGS is built-to-order to meet specific motor control requirements including extra space for controls
- Various harmonic mitigation solutions to ensure IEEE 519 guidelines forTHD
  - ❑ PowerXL EGS includes 5% DC line choke for 32%THD
  - ❑ PowerXL EGF includes passive filtered design for 5%THD
  - ❑ PowerXL EGP includes 18-pulse design for 3%THD

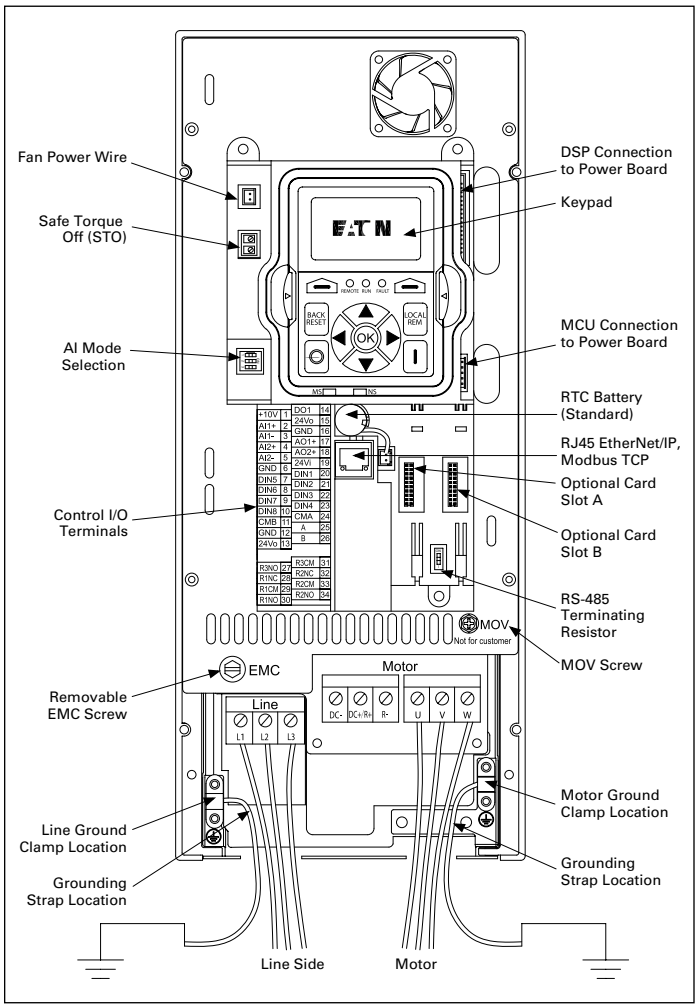


Figure 31.1-1. Control Board Layout

Outdoor Pumping

- PowerXL DG1 irrigation pump panel is designed for outdoor remote pumping
- Equipped with cellular connectivity to enable remote monitoring and control through Eaton's Control Xpert™ mobile app
- Painted white, NEMA® 3R enclosure for optimal heat dissipation
- Tamper-resistant covers

Additional Resources

- VFD home page
- VFD catalog
- PowerXL DG1
- PowerXL EGS
- PowerXL EGF
- PowerXL EGP
- Harmonics portal
- Control Xpert
- Markets
- Consultants
- Seismic certificates

PowerXL DG1 Component General Purpose Drive



DG1 General Purpose Drive

Product Description

Eaton's DG1 general purpose drives are part of Eaton's next generation PowerXL series of VFDs 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 1000 hp, 1180 A, 630 kW
- 575 V to 800 hp, 820 A, 597 kW

Enclosure Rating

- NEMA Type 1 open

Features and Benefits

Hardware

- Brake chopper standard on Frames 0, 1, 2, 3
- Dual overload ratings:
  - 110% variable torque (I_L)
  - 150% constant torque (I_H)
- Open Type/IP00 or IP20 or Type 1/IP21 or 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, ModbusTCP
  - 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
- SafeTorque Off (STO) built in with functional safety SIL1 certification

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 PCTool 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 reference only. Not all option combinations may be available.

Table 31.1-1. DG1 General Purpose Drive—Base Catalog Number

Series		Power Part						Options			
D	G1	–	3	4	4D3	F	B	–	C	21	C

Basic Naming
D = Drive

Series
G1 = General purpose

Phase Reference
3 = 3~ INPUT/3~ OUTPUT

Input/Output Voltage Rating
2 = 230 V (208–240 V, –15%, +10%)
4 = 400 V (380–500 V, –15%, +10%)
5 = 600 V (525–600 V, –15%, +10%)

Internal EMC Filter
D = DC choke only
E = EMC filter only
F = Internal EMC filter and DC choke
N = No EMC filter, no DC choke

Internal Brake Chopper
N = No brake chopper
B = Brake chopper

Display Option
C = LCD (graphical)
N = No display

Enclosure (IP Rating)
00 = IP00
20 = IP20
21 = IP21/Type 1
54 = IP54/Type 12

Coating of Boards
C = Coated

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	**105** = 105 A, 55 kW, 75 hp	**3D3** = 3.3 A, 1.5 kW, 2 hp	**100** = 100 A, 75 kW, 100 hp
4D8 = 4.8 A, 0.75 kW, 1 hp	**3D3** = 3.3 A, 1.1 kW, 1.5 hp	**140** = 140 A, 75 kW, 100 hp	**4D5** = 4.5 A, 2.2 kW, 3 hp	**125** = 125 A, 90 kW, 125 hp
6D6 = 6.6 A, 1.1 kW, 1.5 hp	**4D3** = 4.3 A, 1.5 kW, 2 hp	**170** = 170 A, 90 kW, 125 hp	**7D5** = 7.5 A, 3.7 kW, 5 hp	**144** = 144 A, 110 kW, 150 hp
7D8 = 7.8 A, 1.5 kW, 2 hp	**5D6** = 5.6 A, 2.2 kW, 3 hp	**205** = 205 A, 110 kW, 150 hp	**010** = 10 A, 5.5 kW, 7.5 hp	**208** = 208 A, 132 kW, 200 hp
011 = 11 A, 2.2 kW, 3 hp	**7D6** = 7.6 A, 3 kW, 5 hp	**245** = 245 A, 132 kW, 200 hp	**013** = 13.5 A, 7.5 kW, 10 hp	**261** = 261 A, 187 kW, 250 hp
012 = 12.5 A, 3 kW, 4 hp	**9D0** = 9 A, 4 kW, 7.5 hp (VT)	**310** = 310 A, 160 kW, 250 hp	**018** = 18 A, 11 kW, 15 hp	**325** = 325 A, 224 kW, 300 hp
017 = 17.5 A, 3.7 kW, 5 hp	**012** = 12 A, 5.5 kW, 7.5 hp	**385** = 385 A, 200 kW, 300 hp	**022** = 22 A, 15 kW, 20 hp	**385** = 385 A, 224 kW, 300 hp
025 = 25 A, 5.5 kW, 7.5 hp	**016** = 16 A, 7.5 kW, 10 hp	**460** = 460 A, 250 kW, 350 hp	**027** = 27 A, 18.5 kW, 25 hp	**416** = 416 A, 298 kW, 400 hp
031 = 31 A, 7.5 kW, 10 hp	**023** = 23 A, 11 kW, 15 hp	**520** = 520 A, 250 kW, 450 hp	**034** = 34 A, 22 kW, 30 hp	**460** = 460 A, 336 kW, 450 hp
048 = 48 A, 11 kW, 15 hp	**031** = 31 A, 15 kW, 20 hp	**590** = 590 A, 315 kW, 500 hp	**041** = 41 A, 30 kW, 40 hp	**520** = 520 A, 373 kW, 500 hp
061 = 61 A, 15 kW, 20 hp	**038** = 38 A, 18.5 kW, 25 hp	**650** = 650 A, 355 kW, 500 hp	**052** = 52 A, 37 kW, 50 hp	**590** = 590 A, 448 kW, 600 hp
075 = 75 A, 18.5 kW, 25 hp	**046** = 46 A, 22 kW, 30 hp	**730** = 730 A, 400 kW, 600 hp	**062** = 62 A, 45 kW, 60 hp	**650** = 650 A, 485 kW, 650 hp
088 = 88 A, 22 kW, 30 hp	**061** = 61 A, 30 kW, 40 hp	**820** = 820 A, 450 kW, 700 hp	**080** = 80 A, 55 kW, 75 hp	**820** = 820 A, 597 kW, 800 hp (VT)
114 = 114 A, 30 kW, 40 hp	**072** = 72 A, 37 kW, 50 hp	**920** = 920 A, 500 kW, 800 hp		
143 = 143 A, 37 kW, 50 hp	**087** = 87 A, 45 kW, 60 hp	**1K0** = 1180 A, 630 kW, 1000 hp (VT)		
170 = 170 A, 45 kW, 60 hp				
211 = 211 A, 55 kW, 75 hp				
248 = 248 A, 75 kW, 100 hp				

Table 31.1-2. DG1 General Purpose Drive—Option Boards Catalog Number

DX	G	–	NET	–	CANOPEN		

Basic Naming
DX = PowerXL Drive

Series
G = General purpose

Type
NET = Communication card
EXT = I/O card
ACC = Accessory
SPR = Spare part
KEY = Keypad
CBL = Cable

Function
CANOPEN = CANopen
SWD = SmartWire
See Accessories on **Page 31.1-16** for full offering

PowerXL EGS Enclosed General Purpose Drive



EGS Enclosed General Purpose Drives

Product Description

Eaton's EGS enclosed general purpose drives incorporate 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 SafeTorque Off 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 (I_L) applications
- Optional brake chopper for external braking applications
- Available circuit breaker, motor circuit protector, fused disconnect, isolation fusing and surge protective device (SPD) 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 transient 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
- SmartWire-DT
- CANopen

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: 1–1000 hp
- 230 V single-phase: 1–30 hp
- 480 V single-phase: 1.5–60 hp

Standards and Certifications

- UL 508C

UL Listed

Catalog Number Selection

Catalog number selection is for reference only. Not all option combinations may be available.

Table 31.1-3. EGS Enclosed General Purpose Drive—Base Catalog Number

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

Product Family

EGS = Enclosed DG1 drives—standard

Output Current 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 A, 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
		361 = 361 A, 300 hp
		414 = 414 A, 350 hp
		477 = 477 A, 400 hp
		515 = 515 A, 450 hp
		590 = 590 A, 500 hp
		730 = 730 A, 600 hp
		818 = 818 A, 700 hp
		920 = 920 A, 800 hp
		954 = 954 A, 800 hp
		1K0 = 1030 A, 900 hp
		1K2 = 1180 A, 1000 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

Options ③

See **Page 31.1-7** for catalog number option selection.

Enclosure Rating ②

1 = NEMA Type 1
2 = NEMA Type 12
3 = NEMA Type 3R
6 = NEMA Type 1 filtered and gasketed
• = Custom option

① Brake chopper is a factory-installed option only. Braking resistors sold separately. See DG1 drives starting on **Page 31.1-3** 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.

Catalog number selection is for reference only. Not all option combinations may be available.

Table 31.1-4. EGS Enclosed General Purpose Drive—Options Catalog Number

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

Base Catalog Number Example

See **Page 31.1-6** 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

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

Output Power Options ④

0 = None
A = Output contactor
B = 3% Output reactor
D = dV/dt filter
E = 3% Output reactor/output contactor
G = dV/dt/output contactor
• = 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
2 = 1 x AI, 2 x AO (isolated to control board)
3 = 3 x relay dry contact (2NO + 1NO/NC)
4 = 3 x PT100 RTD thermistor input
5 = 6 DI 240 Vac input
• = Custom option ②

Communication Options

0 = No option
1 = PROFIBUS DP
3 = CANopen (slave)
5 = PROFIBUS DP (D9 connector)
D = SmartWire-DT
• = 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.

PowerXL EGF Enclosed Passive Filtered Drive



EGF Passive Filtered Drive

Product Description

Eaton's EGF passive filtered drives combine harmonic distortion reduction and true power factor performance with the latest in Eaton VFD 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 VFDs on generators and other high-impedance power systems.

Features and Benefits

- Tuned passive filter
- Delivers 5–8% THD
- Generator compatible
- Uses the same DG1 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
- NEMA Type 1, Type 12 and Type 3R
- 480 V, 1–500 hp

Standards and Certifications

- UL 508C up to frame 6
- UL 508 A for frame 7

UL Listed

Catalog Number Selection

Catalog number selection is for reference only. Not all option combinations may be available.

Table 31.1-5. EGF Passive Filtered Drive—Base Catalog Number

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

Product Family
EGF = Enclosed DG1 drives—passive filtered

Output Current Rating
480 V

011 = 11 A, 7.5 hp	**065** = 65 A, 50 hp	**302** = 302 A, 250 hp
014 = 14 A, 10 hp	**077** = 77 A, 60 hp	**361** = 361 A, 300 hp
021 = 21 A, 15 hp	**096** = 96 A, 75 hp	**414** = 414 A, 350 hp
027 = 27 A, 20 hp	**124** = 124 A, 100 hp	**477** = 477 A, 400 hp
034 = 34 A, 25 hp	**156** = 156 A, 125 hp	**515** = 515 A, 450 hp
040 = 40 A, 30 hp	**180** = 180 A, 150 hp	**590** = 590 A, 500 hp
052 = 52 A, 40 hp	**240** = 240 A, 200 hp	

Phasing, Voltage
4 = Input: Three-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

Options ③
See **Page 31.1-9** for catalog number option selection.

Enclosure Rating ②
1 = NEMA Type 1
2 = NEMA Type 12
3 = NEMA Type 3R
• = Custom option

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

Catalog number selection is for reference only. Not all option combinations may be available.

Table 31.1-6. EGF Passive Filtered Drive—Options Catalog Number

EGF 3D5 1 D 1 — **2 0 0 B 1 0 0 0 0**

Base Catalog Number Example
See **Page 31.1-8** for base catalog number selection.

Power Disconnect Options
0 = None
1 = MCP disconnect ①
2 = Circuit breaker
3 = Circuit breaker/isolation fusing
5 = Circuit breaker/isolation fusing/SPD
8 = Circuit breaker/SPD
A = Fused disconnect
B = Fused disconnect/SPD
E = Isolation fuses
G = Isolation fuses/SPD
• = Custom option ②

Bypass Options ③
0 = None
1 = Manual HOA bypass
2 = Manual HOA bypass/isolation fusing
4 = Manual HOA bypass/isolation fusing/SPD
7 = Manual HOA bypass/SPD
H = Manual HOA RVSS bypass
J = Manual HOA RVSS bypass/isolation fusing
L = Manual HOA RVSS bypass/isolation fusing/SPD
P = Manual HOA RVSS bypass/SPD
• = 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

Output Power Options ④
0 = None
A = Output contactor
B = 3% Output reactor
D = dV/dt filter
E = 3% Output reactor/output contactor
G = dV/dt/output contactor
• = 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
2 = 1 x AI, 2 x AO (isolated to control board)
3 = 3 x relay dry contact (2NO + 1NO/NC)
4 = 3 x PT100 RTD thermistor input
5 = 6 DI 240 Vac input
• = Custom option ②

Communication Options
0 = No option
1 = PROFIBUS DP
3 = CANopen (slave)
5 = PROFIBUS DP (D9 connector)
D = SmartWire-DT
• = 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.

PowerXL EGP Enclosed 18-Pulse Drive



EGP 18-Pulse Drive

Product Description

Eaton's EGP 18-pulse drives use advanced 18-pulse technology that significantly reduces line harmonics at the drive input terminals, resulting in one of the purest sinusoidal waveforms available.

The enclosed 18-pulse drive also delivers True Power Factor—in addition to reducing harmonic distortion, the enclosed 18-pulse drive prevents upstream transformer overheating and overloading of breakers and feeders, enabling the application of VFDs on generators and other high-impedance power systems.

Features and Benefits

- Space optimized enclosure
- Simple layout for power options
- NEMA Type 1, Type 1 filtered and gasketed, Type 3R, Type 4 and Type 4X
- IEEE 519 compliance
- Robust design includes phase-shifting transformers
- Complete range of control, network and power options
- Input voltage and horsepower range:
  - 480 V, 25–800 hp (consult factory for larger sizes)
  - 208/230 V consult factory
  - 575 V consult factory
- Over 30 years of 18-pulse clean power experience
- 100 kAIC standard

Standards and Certifications

- UL 508C 7

Catalog Number Selection

Catalog number selection is for reference only. Not all option combinations may be available.

Table 31.1-7. EGP 18-Pulse Drive—Base Catalog Number

Build options alphabetically and numerically.

EGP 034 4 A – 1 _ _ _ _ _ _

Product Family

EGP = PowerXL 18-pulse clean power enclosed drives

Output Power Rating/Horsepower

480 V		
034 = 34 A, 25 hp	**180** = 180 A, 150 hp	**590** = 590 A, 500 hp
040 = 40 A, 30 hp	**240** = 240 A, 200 hp	**730** = 730 A, 600 hp
052 = 52 A, 40 hp	**302** = 302 A, 250 hp	**818** = 818 A, 700 hp
065 = 65 A, 50 hp	**361** = 361 A, 300 hp	**920** = 920 A, 800 hp
077 = 77 A, 60 hp	**414** = 414 A, 350 hp	**954** = 954 A, 800 hp
096 = 96 A, 75 hp	**477** = 477 A, 400 hp	**1K0** = 1030 A, 900 hp
124 = 124 A, 100 hp	**515** = 515 A, 450 hp	**1K2** = 1180 A, 1000 hp
156 = 156 A, 125 hp		

Drive Type/Braking/Application

- **A** = Variable torque, 40 °C, standard drive/no brake chopper/low overload
- **B** = Variable torque, 40 °C, standard drive/brake chopper/low overload
- **C** = Constant torque, 40 °C, standard drive/no brake chopper/high overload
- **D** = Constant torque, 40 °C, standard drive/brake chopper/high overload
- **J** = Constant torque, 50 °C, standard drive/no brake chopper/high overload
- **K** = Constant torque, 50 °C, standard drive/brake chopper/high overload

Phasing, Voltage

4 = Three-phase, 480 V

Options ①

See **Page 31.1-11** for catalog number option selection.

Enclosure Rating

- **1** = NEMA Type 1
- **3** = NEMA Type 1 filtered
- **4** = NEMA Type 3R
- **5** = NEMA Type 4
- **6** = NEMA Type 4X
- • = Custom option

① Part number configuration continued on the following page.

Catalog number selection is for reference only. Not all option combinations may be available.

Table 31.1-8. EGP 18-Pulse Drive—Options Catalog Number

EGP 034 3 A — 1

0 0 A 1 1 1 0 0 0

Base Catalog Number Example

See **Page 31.1-10** for base catalog number selection.

Power Disconnect Options

0 = None (+PTB, single-phase only) ①
1 = MCP Disc (1)
2 = Circuit breaker
3 = Circuit breaker/VFD fuses
4 = Circuit breaker/VFD fuses/3% input reactor
5 = Circuit breaker/VFD fuses/SPD
6 = Circuit breaker/VFD fuses/SPD/3% input reactor
7 = Circuit breaker/3% input reactor
8 = Circuit breaker/SPD
9 = Circuit breaker/SPD/3% input reactor
A = Fused disc (DG1 only)
B = Fused disc/SPD (DG1 only)
C = Fused disc/SPD/3% input reactor (DG1 only)
D = Fused disc/3% input reactor (DG1 only)
E = Isolation fuses (+PTB)
F = Isolation fuses/3% input reactor (+PTB)
G = Isolation fuses/SPD (+PTB)
H = Isolation fuses/SPD/ 3% input reactor (+PTB)
• = Custom option ②

Bypass Options ③

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

Output Power Options

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

Control Options

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

Light Options

0 = None
1 = Non-bypass 22 mm—Power On, Run, Fault Indicator Lights
2 = Bypass 22 mm—Power On, VFD Run, Fault, Bypass Run Indicator Lights

Enclosure Options

0 = None
1 = Floor stand—12 inches
2 = Floor stand—22 inches
A = Space heater (7)
B = Space heater and 12-inch floor stands (7)
C = Space heater and 22-inch floor stands (7)
• = Custom option ②

Communication Options

0 = No option
1 = PROFIBUS DP
3 = CANopen (slave)
5 = PROFIBUS DP (D9 connector)
D = SmartWire-DT
• = Custom option ②

Option Boards 2

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 thermistor (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

Option Boards 2

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 thermistor (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

① For standard designs (non-bypass, not filtered). If any of the following are required, the input option code cannot be zero: Code 12 = A, E, F or G or Code 13 = 2, 3, A, B, C, D or Code 14 = 1 or Code 15 = A. These options require some sort of input disconnect or input PTB defined by code 10 not as 0.

② Catalog number selection is for reference only. Not all configurations are possible. Utilize Eaton's suite of digital tools, including Bid Manager, to configure desired options. Consult your Eaton representative for details.

③ Configurations above 300 hp low overload come standard with reduced-voltage soft starter.

PowerXL DG1 Irrigation Pump Panel



DG1 Pump Panel Exterior

Product Description

Eaton's PowerXL DG1 three-phase irrigation drive pump panel is specifically designed for the irrigation pumping industry. With a weathertight, painted white NEMA 3R enclosure, the PowerXL DG1 drive pump panel is an energy-efficient and environmentally friendly solution for motor-driven equipment.

Whether operating a center pivot, drip irrigation or water flooding system, the PowerXL DG1 drive pump panel is designed to meet your three-phase irrigation control needs.

- 480 V variable torque DG1 drive
- NEMA 3R weathertight enclosure for outdoor environments
- Bottom entry for easy cable access
- Reduces environmental impact
- Reduces water hammer with ramp-up speed control
- Internet of Things (IoT) connectivity via cellular gateway enables remote monitoring and control
- 25–600 hp available
- Local inventory in our W87 Fontana California Distribution Center as well as through our Eaton Authorized Distributors

Features and Benefits

Primary Design Features

- 45–66 Hz input frequency
- Maximum Vac output based on supply voltage
- 110% of rated overload (1 minute [I_L])
- 100 kAIC fault current rating
- Weathertight NEMA 3R enclosure
- Ambient operating temperature of 14 °F (–10 °C) no frost, to 104 °F (40 °C)

Protection Features

- Input molded case circuit breaker
- EMI filter
- Input overvoltage protection
- Line surge protection to 50 kA
- Output short-circuit protection
- Output ground fault protection
- Output phase protection
- Overtemperature protection
- DC overvoltage protection
- Drive overload protection
- Keypad lockout
- Fault alarm output
- Built-in diagnostics
- Pilot device cover

Panel Features

- 480 Vac three-phase input
- START/STOP pushbuttons
- Speed control potentiometer
- Hand–Off–Auto selector switch
- Power ON, run and fault lights
- 22-inch floor stands on AX–CX enclosures (25–150 hp)
- Lockable door-mounted power disconnect handle
- Padlockable pilot device cover
- Service entrance label
- Transient voltage surge suppression
- Control power transformer
- Painted white NEMA 3R enclosure
- Cellular gateway for data transmission and analytics via Eaton's IoT solution services

Durable Design

The PowerXL DG1 drive pump panel is enclosed in a painted white NEMA 3R panel to provide weathertight protection, allowing panel installation outdoors near irrigation equipment without additional shelter.

Easy installation and connection

The PowerXL DG1 drive pump panel is one of the first irrigation panels with an easy-to-use bottom entry. The floor stand enables mounting the panel as a standalone electrical panel.

Clean Solution

The PowerXL DG1 drive pump panel greatly reduces environmental impact and the high costs associated with powering agricultural and irrigation pump equipment.

- Reduces air and groundwater contamination
- Decreases fuel and lubricant leakage

Efficient Power

The PowerXL DG1 drive pump panel is an efficient and cost-effective solution.

- Eliminates pump motor inrush current
- Lower energy consumption than rotary phase converters



DG1 Pump Panel Interior

Standards and Certifications

- UL Listed
- cUL Listed

Listed Listed

Table 31.1-9. Eaton PowerXL DG1 Pump Panel Quick Ship Program

Variable torque hp standard	Constant torque hp heavy-duty	Description	Enclosure size	Style number	Catalog number
25	20	DG1 pump, 480 V, 25 hp, VT, white NEMA 3R, CB, SPD	AX	3–4903–10A	**EGS0344B380–PUMP01**
30	25	DG1 pump, 480 V, 30 hp, VT, white NEMA 3R, CB, SPD	AX	3–4903–11A	**EGS0404B380–PUMP01**
40	30	DG1 pump, 480 V, 40 hp, VT, white NEMA 3R, CB, SPD	AX	3–4903–12A	**EGS0524B380–PUMP01**
50	40	DG1 pump, 480 V, 50 hp, VT, white NEMA 3R, CB, SPD	BX	3–4903–13A	**EGS0654A380–PUMP01**
60	50	DG1 pump, 480 V, 60 hp, VT, white NEMA 3R, CB, SPD	BX	3–4903–14A	**EGS0774A380–PUMP01**
75	60	DG1 pump, 480 V, 75 hp, VT, white NEMA 3R, CB, SPD	BX	3–4903–15A	**EGS0964A380–PUMP01**
100	75	DG1 pump, 480 V, 100 hp, VT, white NEMA 3R, CB, SPD	CX	3–4903–16A	**EGS1244A380–PUMP01**
125	100	DG1 pump, 480 V, 125 hp, VT, white NEMA 3R, CB, SPD	CX	3–4903–17A	**EGS1564A380–PUMP01**
150	125	DG1 pump, 480 V, 150 hp, VT, white NEMA 3R, CB, SPD	CX	3–4903–18A	**EGS1804A380–PUMP01**
200	150	DG1 pump, 480 V, 200 hp, VT, white NEMA 3R, CB, SPD	DX	3–4903–19A	**EGS2404A380–PUMP01**



Control Xpert Mobile App: Learn more at www.eaton.com/controlxpert

The features detailed in this next section are shared across the PowerXL DG1 series of drives. This includes the PowerXL DG1, EGS, EGF and EGP drives that have already been outlined.

Active Energy Control

Figure 31.1-2 shows a comparison of the energy savings using the Eaton exclusive Active Energy Control algorithm. VFD A, VFD B and VFD C are other drive manufacturers in the HVAC drives market. The Eaton PowerXL drive is represented by the blue curve. As all the drives approach full speed at 60 Hz, the difference in efficiency between all four drives is minimal.

However, a VAV system fan operates at a lower speed the majority of the time. Inspection of the energy comparison shows at 50% of maximum speed, or 30 Hz, the Eaton PowerXL drives realize a 10% reduction in electric energy usage when compared to the SVX drive platform without the Active Energy Control.

Further, the Active Energy Control achieves a 7% energy savings over the next closest competitor's energy control operation.

Active Energy Control does not require any extra setup or parameter programming. This feature optimizes the electric motor curve by only supplying the motor with the needed power to reach the required torque.

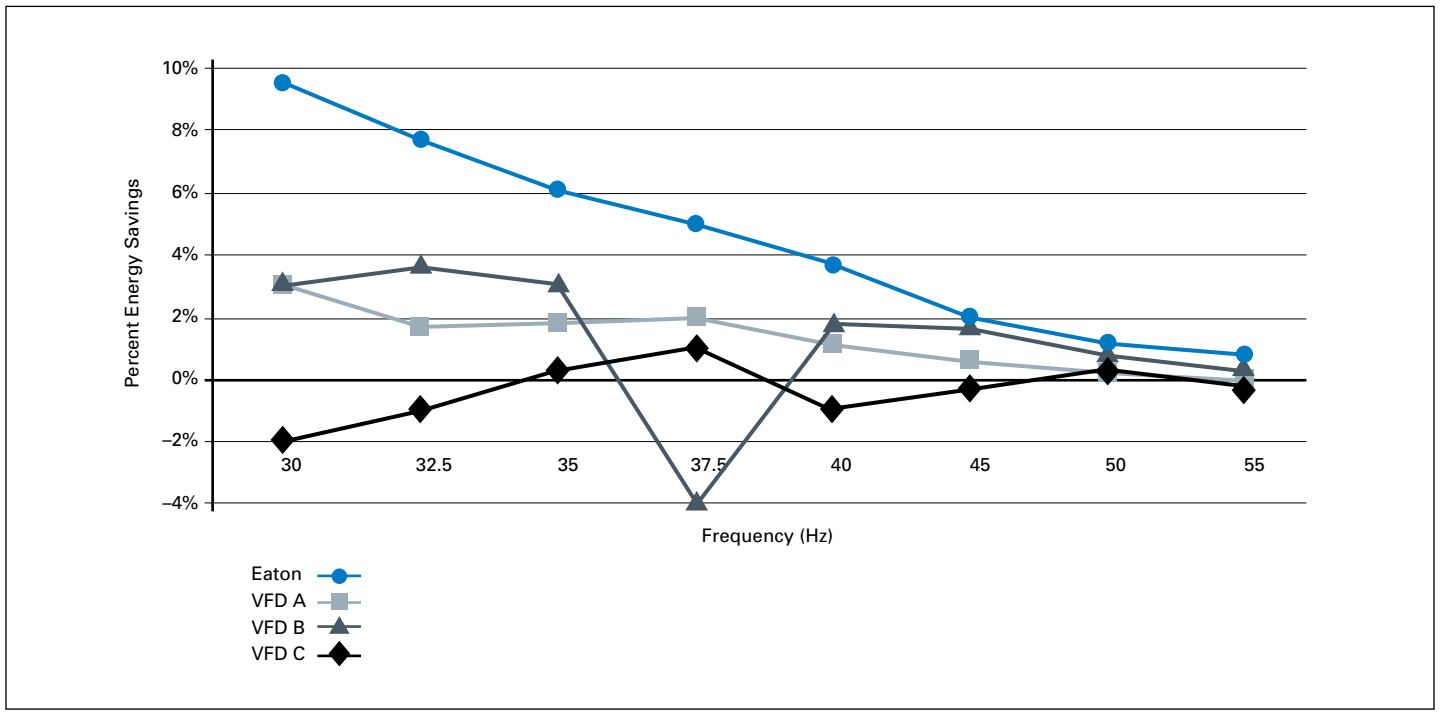


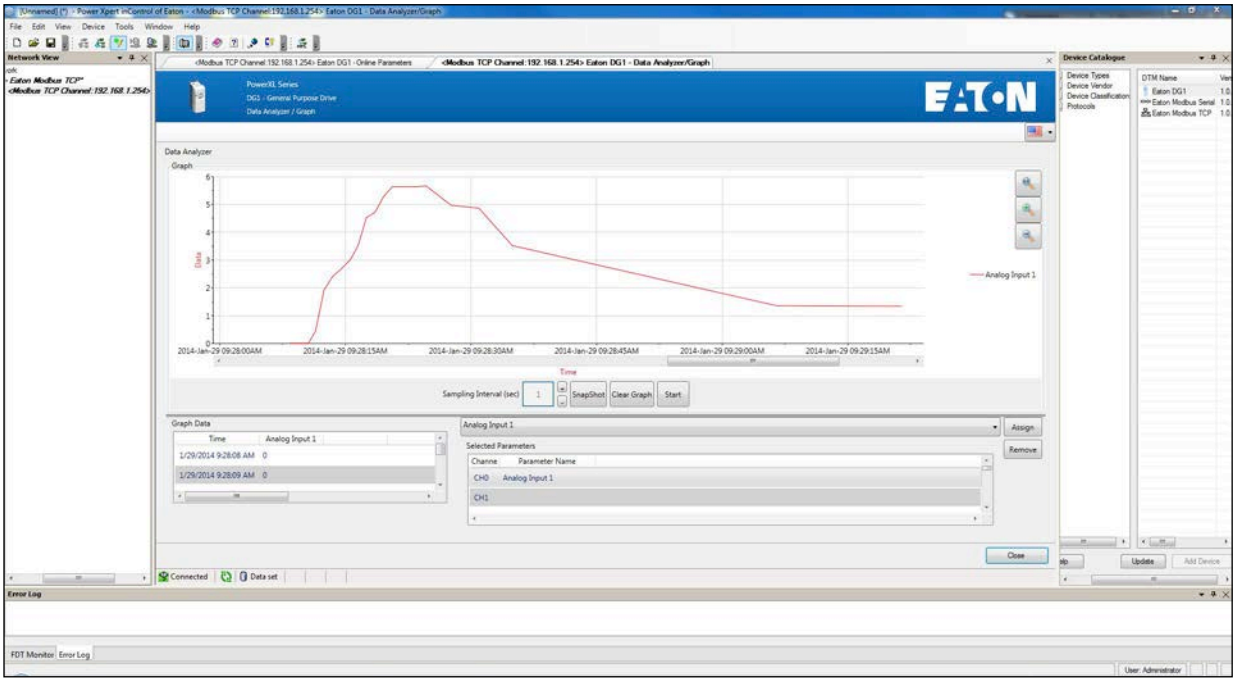
Figure 31.1-2. Energy Consumption Comparison

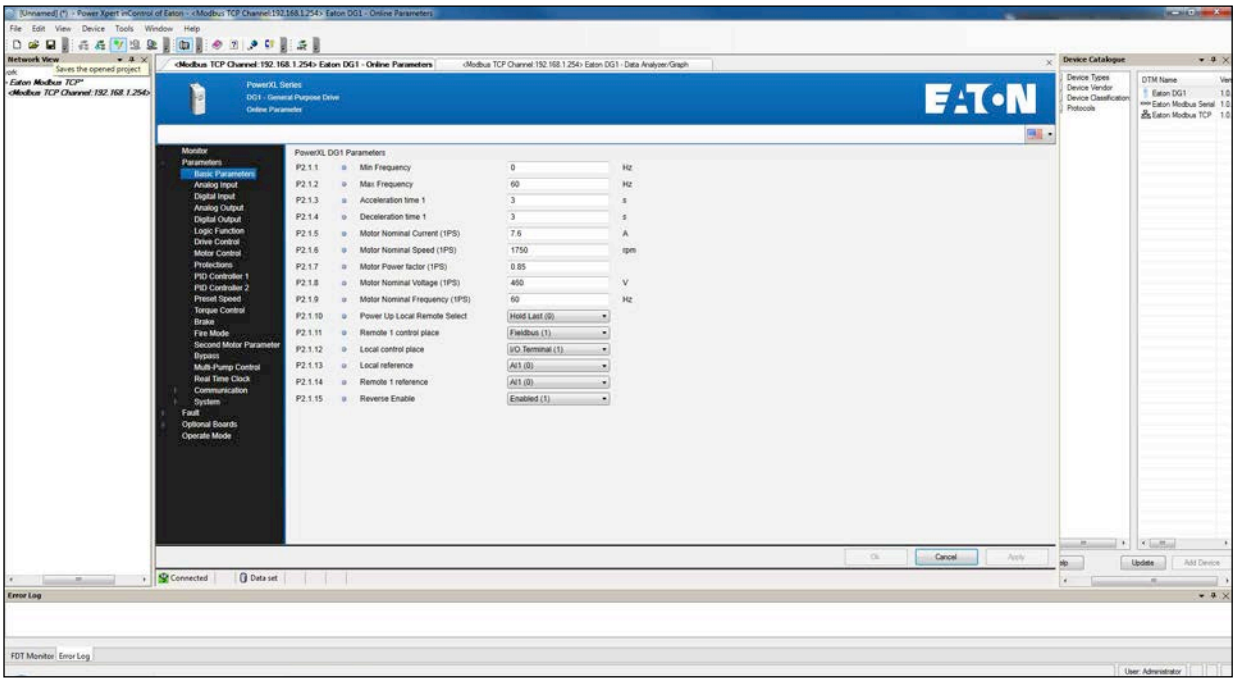
Power Xpert *in*Control Software

The PowerXL series PCTool is designed for programming, controlling and monitoring of the DG1 drives. Features include loading parameters that can be saved to a file or printed, setting references, starting and stopping the motor, monitoring signals in graphical or text form, and real-time display.

Table 31.1-10. PowerXpert *in*Control Software

Description	Catalog Number
Software kit (software, cable, manual)	**DXG–ACC–SOFTWARE**
Software cable (USB to keypad [RJ45])	**DXG–CBL–PCCABLE**
Real-time clock battery (approximately 10,000 hours life)	**DXG–ACC–RTBATT**





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, ModbusTCP
  - RS-485: Modbus RTU, BACnet MS/TP

Table 31.1-11. 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 31.1-12. PowerXL Series—DG1 Communication Card Kits

Description	Catalog Number
PROFIBUS DP communication card	**DXG–NET–PROFB**
CANopen communication card	**DXG–NET–CANOPEN**
PROFIBUS DB9 to 5-pin adapter card	**DXG–NET–PROAD**
SmartWire communication card and module	**IP20 DXG–NET–SWD–IP20**
SmartWire communication card and module	**IP54 DXG–NET–SWD–IP54**

Table 31.1-13. 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 31.1-14. 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 NEMA 12 DG1 drives from W34 are available within 3 business days.

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 31.1-15. 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**
Frame 6 flange kit Type 12/IP54	**DXG–ACC–FR6N12FK**

PowerXL Series—DG1 Demo Units

Table 31.1-16. Demo Units

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

Options

Table 31.1-17. 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 a VFD. It is used to provide a reduction in voltage and current harmonics. It also provides increased input protection for the VFD and its semiconductors from line transients.
SPD	Provides a UL 1449 SPD rated for 40 kA/phase that is connected to the line side terminals.
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 31.1-18. 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 31.1-19. 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 a VFD. It is used to reduce transient voltage (dV/dt) and peak voltages at the motor terminals. A 3% output filter is recommended for motor cable lengths up to 300 ft (10 m).
dV/dt Filter	Used to reduce the transient voltage (dV/dt) at the motor terminals. Recommended for motor cable lengths over 300 ft (10 m) and up to 1000 ft (304.8 m). This option is mounted in the enclosure.

Table 31.1-20. 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 31.1-21. 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 31.1-22. Enclosure Options

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

Technical Data and Specifications

Table 31.1-23. PowerXL Series—DG1 Technical Data and Specifications

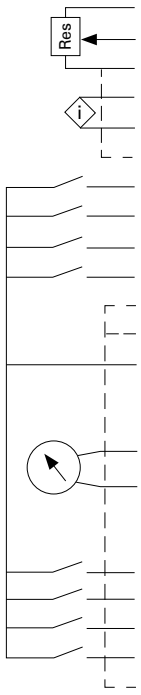
Attribute	Description	Specification
Input Ratings	Input voltage U_{in}	208 V to 240 V, 380 V to 500 V, 525 V to 600 V, –15 to 10%
	Input frequency	50 Hz to 60 Hz (variation up to 45 Hz to 66 Hz)
	Connection to power	Once per minute or less
	Starting delay	3 s (FR1 to FR2), 4 s (FR3), 5 s (FR4), 6 s (FR5 and FR6)
	Short-circuit withstand rating	100 kAIC (fuses and circuit breakers); 5 kAIC (without fuses or 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% of drive rating for constant torque, 110% for variable torque
	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 RatedTorque (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 60068-2-60Test Key: Flowing mixed gas corrosion test, Method 1 (H_2S [hydrogen sulfide] and SO_2 [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); maximum 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
	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

Table 31.1-23. PowerXL Series—DG1 Technical Data and Specifications, Continued

Attribute	Description	Specification
Ambient Conditions, Continued	MTBF	FR1: 165,457 hours FR2: 134,833 hours FR3: 102,515 hours FR4: 121,567 hours FR5: 108,189 hours FR6: 100,000 hours
	Noise	FR1: 51.2 dB FR2: 58.6 dB FR3: 61.0 dB FR4: 68.0 dB FR5: 69.1 dB FR6: 73.2 dB
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, ModbusTCP, Modbus RTU, BACnet
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	Yes
	Unit overtemperature protection	Yes
	Motor overload protection	Yes
	Motor stall protection	Yes
	Motor underload protection	Yes
	DC bus overvoltage control	Yes
	Short-circuit protection of 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)

Wiring Diagram

Table 31.1-24. PowerXL Series—DG1 Control Wiring

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.

Dimensions for PowerXL DG1 Drives

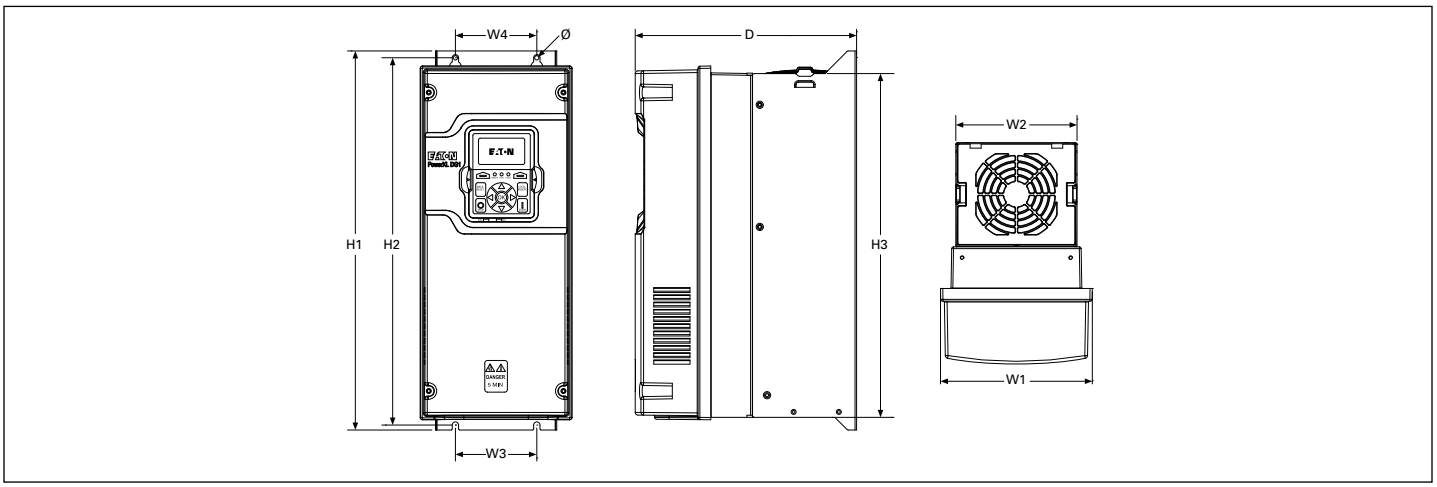


Figure 31.1-3. PowerXL Series—DG1 Dimensions

Table 31.1-25. PowerXL Series—DG1 Dimensions and Weights

Frame Size	Voltage	hp (CT/IH)	kW	Amperes (CT/IH)	Dimensions in Inches (mm)									Weight Lb (kg)
					D	H1	H2	H3	W1	W2	W3	W4	Ø	
FR0	230 Vac	0.75–1.5	0.55–1.1	3.7–6.6	6.83 (173.5)	10.58 (268.7)	10.16 (258)	9.54 (242.3)	5.00 (127)	4.97 (126.3)	4.26 (108.3)	4.26 (108.3)	0.28 (7.0)	4.41 (2.0)
	480 Vac	1–3	0.75–2.2	2.2–5.6										
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	230 Vac	75–100	55–75	211–248	14.61 (371.0)	34.04 (864.5)	33.27 (845.0)	40.75 (1035.0)	19.13 (486.0)	18.90 (480.0)	15.75 (400.0)	15.75 (400.0)	0.35 (9.0)	281.3 (127.6)
	480 Vac	150–200	110–150	205–261										
	575 Vac	150–200	110–160	144–208										
FR7	480 Vac	250–450	160–250	311–520	20.51 (507.0)	38.58 (980.0)	34.25 (870.0)	34.49 (876.0)	19.92 (506.0)	19.92 (506.0)	17.99 (457.0)	18.74 (476.0)	0.98 (25.0)	452 (205.0)
	575 Vac	250–400	187–298	261–416										
	690 Vac	335–536	250–400	261–416										
FR7 with brake chopper	480 Vac	250–450	160–250	311–520	20.67 (525.0)	60.55 (1538.0)	56.81 (1442.0)	59.13 (1501.9.0)	19.92 (506.0)	19.92 (506.0)	15.91 (404.0)	18.74 (476.0)	0.98 (25.0)	904 (410.0)
	575 Vac	250–400	187–298	261–416										
	690 Vac	335–536	250–400	261–416										
FR8	480 Vac	500–800	315–500	590–920	20.51 (507.0)	38.58 (980.0)	34.25 (870.0)	34.49 (876.0)	39.84 (1012.0)	39.84 (1012.0)	17.99 (457.0)	18.74 (476.0)	0.98 (25.0)	904 (410.0)
	575 Vac	450–650	336–485	460–650										
	690 Vac	603–845	450–630	460–650										
FR8 with brake chopper	480 Vac	500–800	315–500	590–920	20.67 (525.0)	60.55 (1538.0)	56.81 (1442.0)	59.13 (1501.9.0)	39.84 (1012.0)	39.84 (1012.0)	15.91 (404.0)	18.74 (476.0)	0.98 (25.0)	1808 (820.0)
	575 Vac	450–650	336–485	460–650										
	690 Vac	603–845	450–630	460–650										

Note: The FR8 drive includes 2 FR7 power units coupled together.

Dimensions for PowerXL Enclosed Drives

Table 31.1-26. Minimum Enclosure Reference for Standard PowerXL Drives Without Bypass (No Additional Power or Output Options)

Variable Torque (VT) / Low Overload (IH)			Constant Torque (CT) / High Overload (IH)			Enclosure Size	Dimensions in Inches W x H x D
Power (hp)	Current (A)	Heat Loss (W)	Power (hp)	Current (A)	Heat Loss (W)		
EGS: Enclosed General Purpose—480 V, Three-Phase—NEMA Type 1, NEMA Type 1F ①, NEMA Type 12 ②							
1–40	2.1–52	19–746	1–30	2.1–40	19–559	AX	21 x 27 x 17
50–75	65–96	932–1398	40–60	52–77	746–1119	BX	21 x 38 x 17
100–150	124–180	1864–2796	75–125	96–156	1398–2330	CX	31 x 50 x 18
200–250	240–302	3729–4661	150–200	180–240	2796–3729	DX	31 x 83 x 22
300–500	361–590	5593–9321	250–450	302–515	4661–8389	6X	30 x 90 x 28
600–1000	730–1180	11,186–18,643	500–800	590–920	9321–14914	9X	60 x 90 x 27
EGS: Enclosed General Purpose—208 V and 230 V, Three-Phase—NEMA Type 1, NEMA Type 1F ①, NEMA Type 12 ②							
1–20	2.1–27	19–373	1–15	2.1–21	19–280	AX	21 x 27 x 17
25–40	34–52	466–746	20–30	27–40	373–559	BX	21 x 38 x 17
50–75	65–96	932–1398	40–60	52–77	746–1119	CX	31 x 50 x 18
100–125	124–156	1864–2330	75–100	96–124	1398–1864	DX	31 x 83 x 22
EGS: Enclosed General Purpose—480 V, Single-Phase—NEMA Type 1, NEMA Type 1F ①, NEMA Type 12 ②							
1–7.5	2.1–11	19–140	—	—	—	AX	21 x 27 x 17
10–30	14–40	186–559	—	—	—	BX	21 x 38 x 17
40–60	52–77	746–1119	—	—	—	CX	31 x 50 x 18
75–125	96–156	1398–2330	—	—	—	DX	31 x 83 x 22
EGS: Enclosed General Purpose—230 V, Single-Phase—NEMA Type 1, NEMA Type 1F ①, NEMA Type 12 ②							
1–5	2.1–7.6	19–93	—	—	—	AX	21 x 27 x 17
7.5–20	11–27	140–373	—	—	—	BX	21 x 38 x 17
25–40	34–52	466–746	—	—	—	CX	31 x 50 x 18
50–75	65–96	932–1398	—	—	—	DX	31 x 83 x 22
EGF: Enclosed Passive Filtered—480 V, Three-Phase—NEMA Type 1, NEMA Type 1F ①							
3–20	4.8–27	56–373	3–15	4.8–21	56–280	CX	31 x 50 x 18
25–250	34–302	466–4661	20–200	27–240	373–3729	DX	31 x 83 x 22
300–500	361–590	5593–9321	250–450	302–515	4661–8389	9X	60 x 90 x 27
EGF: Enclosed Passive Filtered—480 V, Three-Phase—NEMA Type 12							
3–20	4.8–27	56–373	3–15	4.8–21	56–280	CX	31 x 50 x 18
25–100	34–124	466–1864	20–100	27–124	373–1864	DX	31 x 83 x 22
125–250	156–302	2330–4661	125–200	156–240	2330–3729	EX	40 x 90 x 34
300–500	361–590	5593–9321	250–450	302–515	4661–8389	Contact factory	Contact factory
EGF: Enclosed Passive Filtered—480 V, Three-Phase—NEMA Type 3R							
3–20	4.8–27	56–373	3–15	4.8–21	56–280	CX	31 x 57 x 21
25–150	34–180	466–2796	20–125	27–156	373–2330	DX	31 x 90 x 26
200–250	240–302	3729–4661	150–200	180–240	2796–3729	EX	41 x 94 x 39
300–500	361–590	5593–9321	250–450	302–515	4661–8389	Contact factory	Contact factory
EGP: Enclosed 18-Pulse—480 V, Three-Phase—NEMA Type 1, NEMA Type 1F ①							
30–150	40–180	559–2796	25–125	34–156	466–2330	7X	30 x 90 x 20
200–250	240–302	3729–4661	150–200	180–240	2796–3729	8X	48 x 90 x 27
300–500	361–590	5593–9321	250–450	302–515	4661–8389	9X	60 x 90 x 27
600–800	730–920	11,186–14,914	500–700	590–818	9321–13050	11X	120 x 90 x 27
900–1000	1030–1180	16,778–18,643	800	920	14,914	Contact factory	Contact factory
EGP: Enclosed 18-Pulse—480 V, Three-Phase—NEMA Type 3R							
30–250	40–302	559–4661	25–200	34–240	466–3729	FX	41 x 94 x 39
300–1000	361–1180	5593–18643	250–800	302–920	4661–14914	Contact factory	Contact factory

① NEMA Type 1F is the filtered and gasketed variant of NEMA Type 1.

② For EGS, NEMA Type 3R up to 250 hp has the same enclosure style and horsepower breakdown as NEMA Type 1. The only difference is the dimensions, which can be referenced in the outline drawings on the next several pages.

Table 31.1-27. Minimum Enclosure Reference for Standard PowerXL Drives with Bypass (No additional power or output options)

Variable Torque (VT) / Low Overload (IH)			Constant Torque (CT) / High Overload (IH)			Enclosure Size	Dimensions in Inches W x H x D
Power (hp)	Current (A)	Heat Loss (W)	Power (hp)	Current (A)	Heat Loss (W)		
EGS: Enclosed General Purpose—480 V, Three-Phase—NEMA Type 1, NEMA Type 1F ①, NEMA Type 12 ②							
1–40 50–75 100–250	2.1–52 65–96 124–302	19–746 932–1398 1864–4661	1–30 40–60 75–200	2.1–40 52–77 96–240	19–559 746–1119 1398–3729	AX CX DX	21 x 27 x 17 31 x 50 x 18 31 x 83 x 22
300–400 450–500 600–1000	361–477 515–590 730–1180	5593–7457 8389–9321 11,186–18,643	250–350 400–450 500–800	302–414 477–515 590–920	4661–6525 7457–8389 9321–14914	8X 9X 9AX	48 x 90 x 27 60 x 90 x 27 86 x 90 x 27
EGS: Enclosed General Purpose—208 V and 230 V, Three-Phase—NEMA Type 1, NEMA Type 1F ①, NEMA Type 12 ②							
1–20 25–40 50–125	2.1–27 34–52 65–156	19–373 466–746 932–2330	1–15 20–30 40–100	2.1–21 27–40 52–124	19–280 373–559 746–1864	AX CX DX	21 x 27 x 17 31 x 50 x 18 31 x 83 x 22
EGF: Enclosed Passive Filtered—480 V, Three-Phase—NEMA Type 1, NEMA Type 1F ①, NEMA Type 12							
3–20 25–75 100–250 300–500	4.8–27 34–96 124–302 361–590	56–373 466–1398 1864–4661 5593–9321	3–15 20–60 75–200 250–450	4.8–21 27–77 96–240 302–515	56–280 373–1119 1398–3729 4661–8389	CX DX EX Contact factory	31 x 50 x 18 31 x 83 x 22 40 x 90 x 34 Contact factory
EGF: Enclosed Passive Filtered—480 V, Three-Phase—NEMA Type 3R							
3–20 25–75 100–250 300–500	4.8–27 34–96 124–302 361–590	56–373 466–1398 1864–4661 5593–9321	3–15 20–60 75–200 250–450	4.8–21 27–77 96–240 302–515	56–280 373–1119 1398–3729 4661–8389	CX DX EX Contact factory	31 x 57 x 21 31 x 90 x 26 41 x 94 x 39 Contact factory
EGP: Enclosed 18-Pulse—480 V, Three-Phase—NEMA Type 1, NEMA Type 1F ①							
30–150 200–250 300–500	40–180 240–302 361–590	559–2796 3729–4661 5593–9321	25–125 150–200 250–450	34–156 180–240 302–515	466–2330 2796–3729 4661–8389	7X 8X 9X	30 x 90 x 20 48 x 90 x 27 60 x 90 x 27
600–800 900–1000	730–920 1030–1180	11,186–14,914 16,778–18,643	500–700 800	590–818 920	9321–13,050 14,914	11X Contact factory	120 x 90 x 27 Contact factory
EGP: Enclosed 18-Pulse—480 V, Three-Phase—NEMA Type 3R							
30–250 300–1000	40–302 361–1180	559–4661 5593–18,643	25–200 250–800	34–240 302–920	466–3729 4661–14,914	FX Contact factory	41 x 94 x 39 Contact factory

① NEMA Type 1F is the filtered and gasketed variant of NEMA Type 1.

② For EGS, NEMA Type 3R up to 250 hp has the same enclosure style and horsepower breakdown as NEMA Type 1. The only difference is the dimensions, which can be referenced in the outline drawings on the next several pages.

Outline Drawings for PowerXL Enclosed Drives

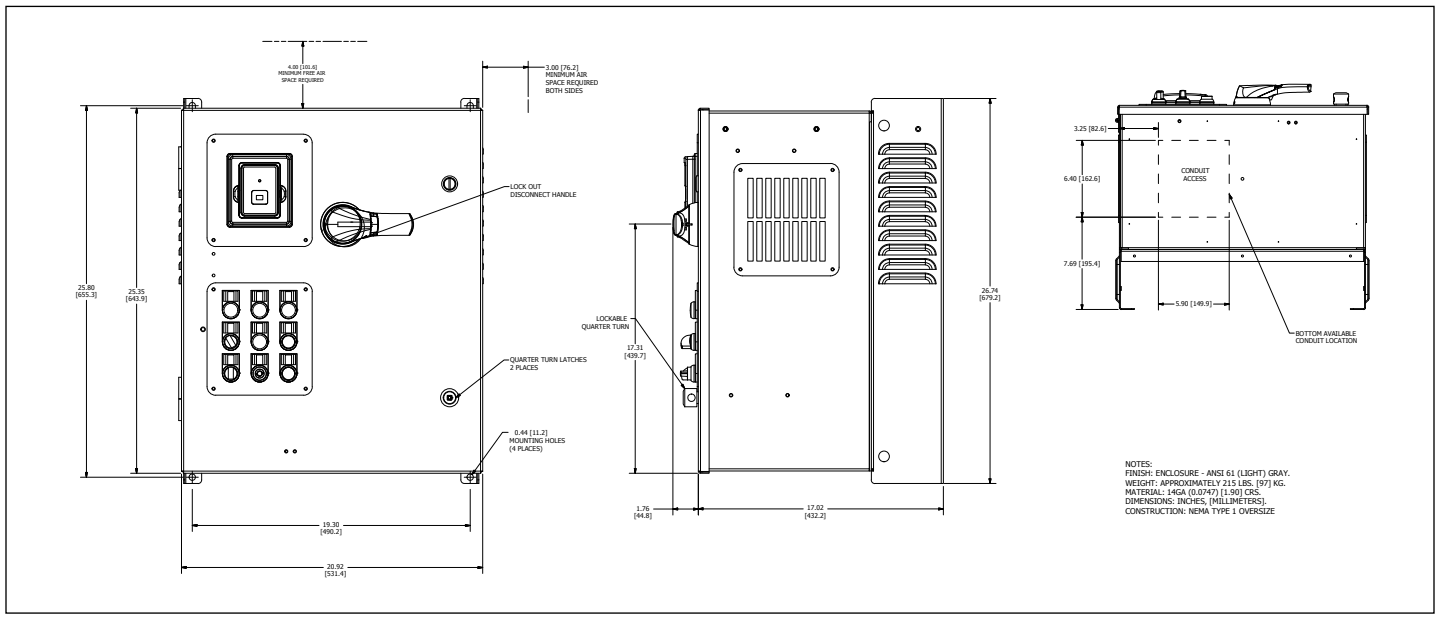


Figure 31.1-4. AX Enclosure, NEMA Type 1 and Type 12

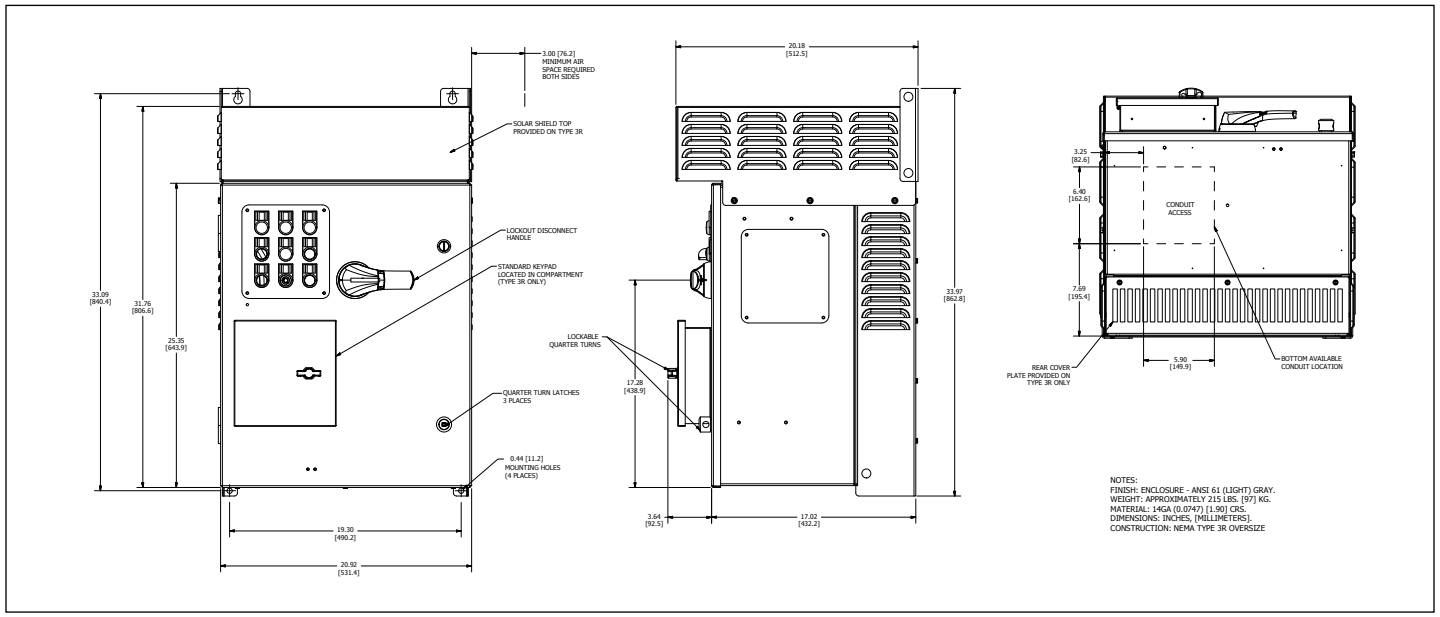


Figure 31.1-5. AX Enclosure, NEMA Type 3R

Note: NEMA Type 1 configurations are also available in a filtered and gasketed variant.

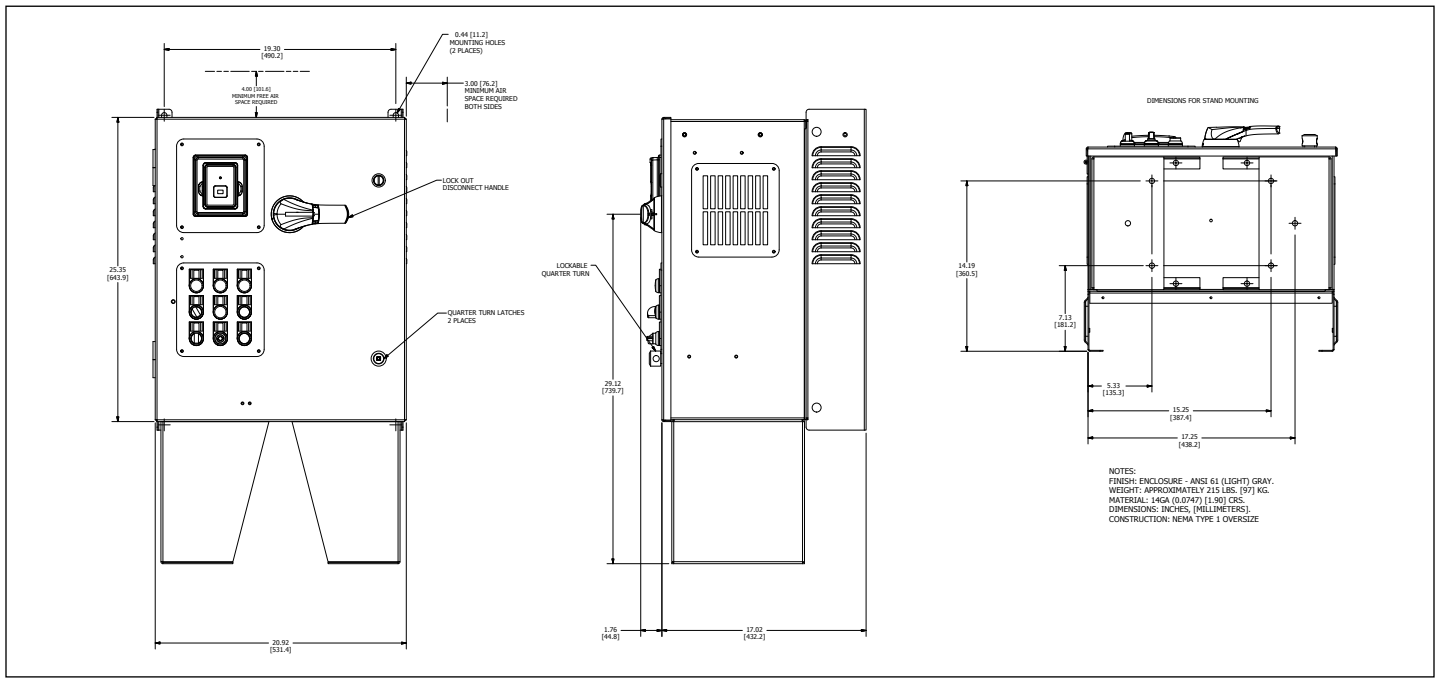


Figure 31.1-6. AX Enclosure, 12-Inch Floor Stands

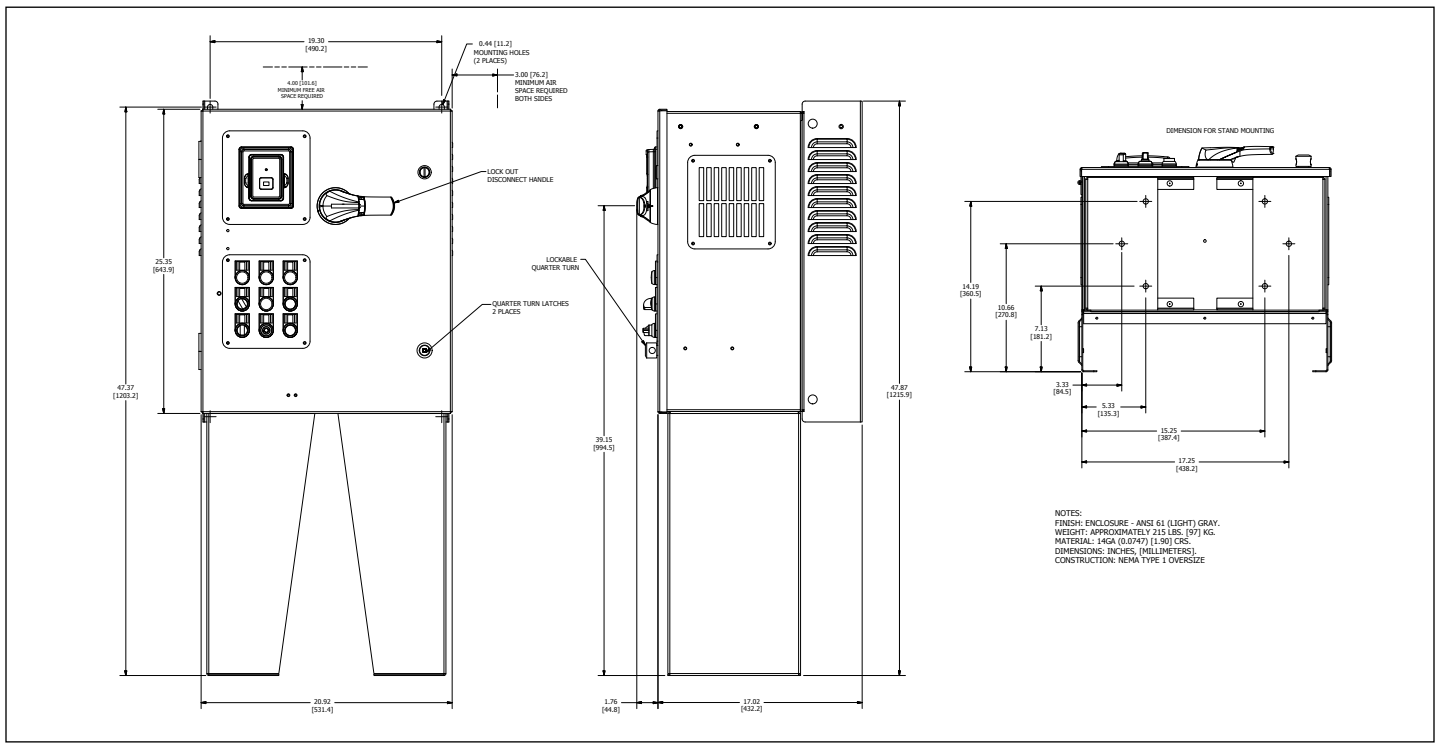


Figure 31.1-7. AX Enclosure, 22-Inch Floor Stands

Note: 12- and 22-inch floor stands are available for AX, BX and CX enclosures. 12- and 22-inch floor stands are available for NEMATypes 1, 12 and 3R.

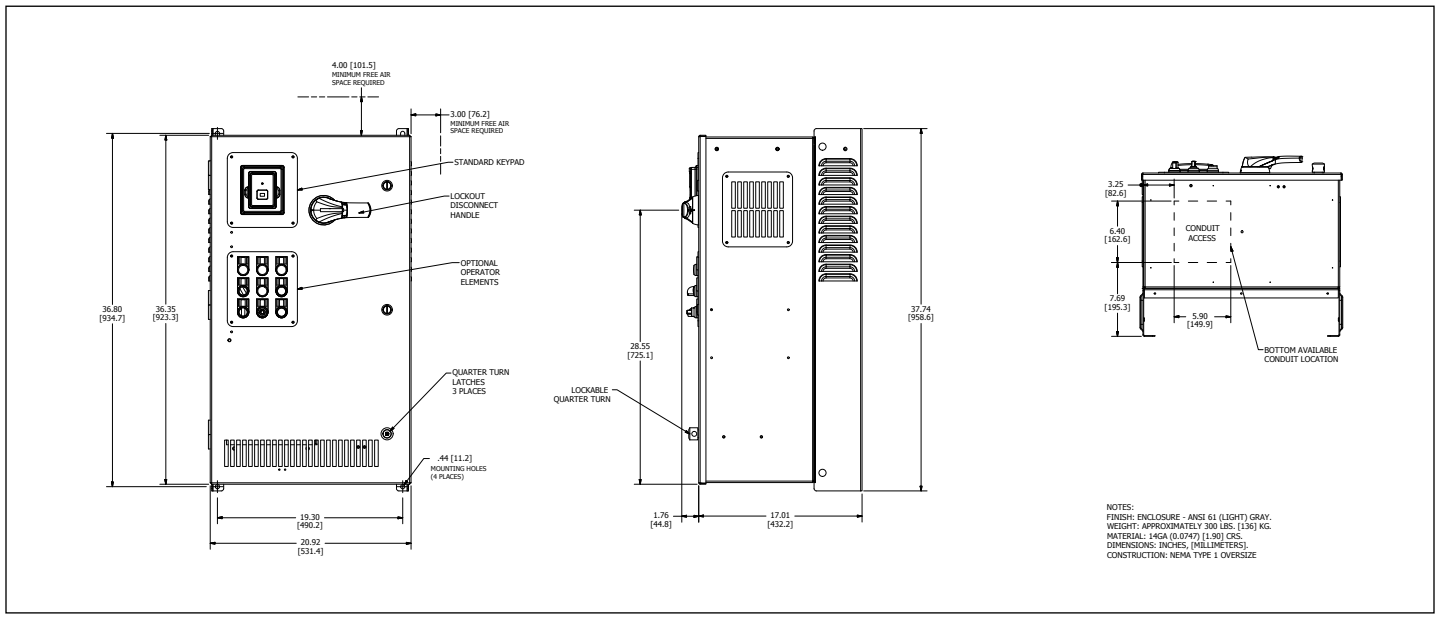


Figure 31.1-8. BX Enclosure, NEMA Type 1 and Type 12

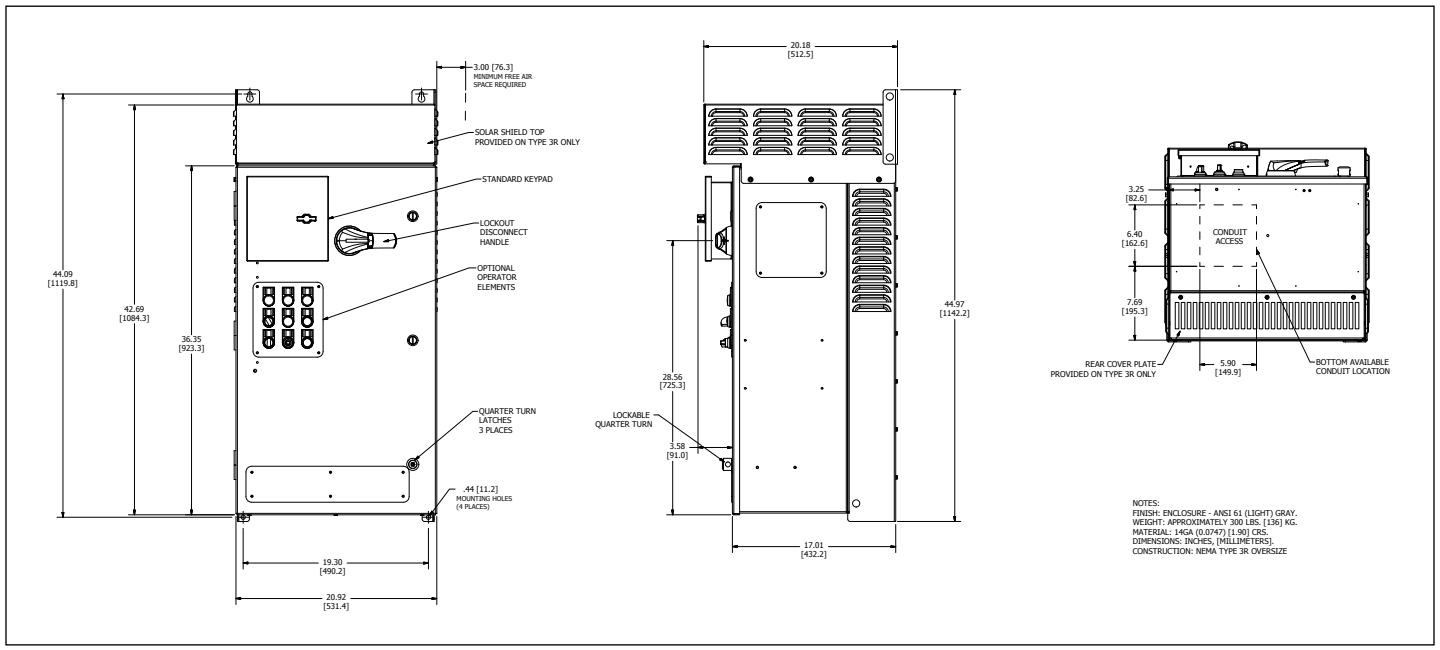


Figure 31.1-9. BX Enclosure, NEMA Type 3R

Note: NEMA Type 1 configurations are also available in a filtered and gasketed variant.

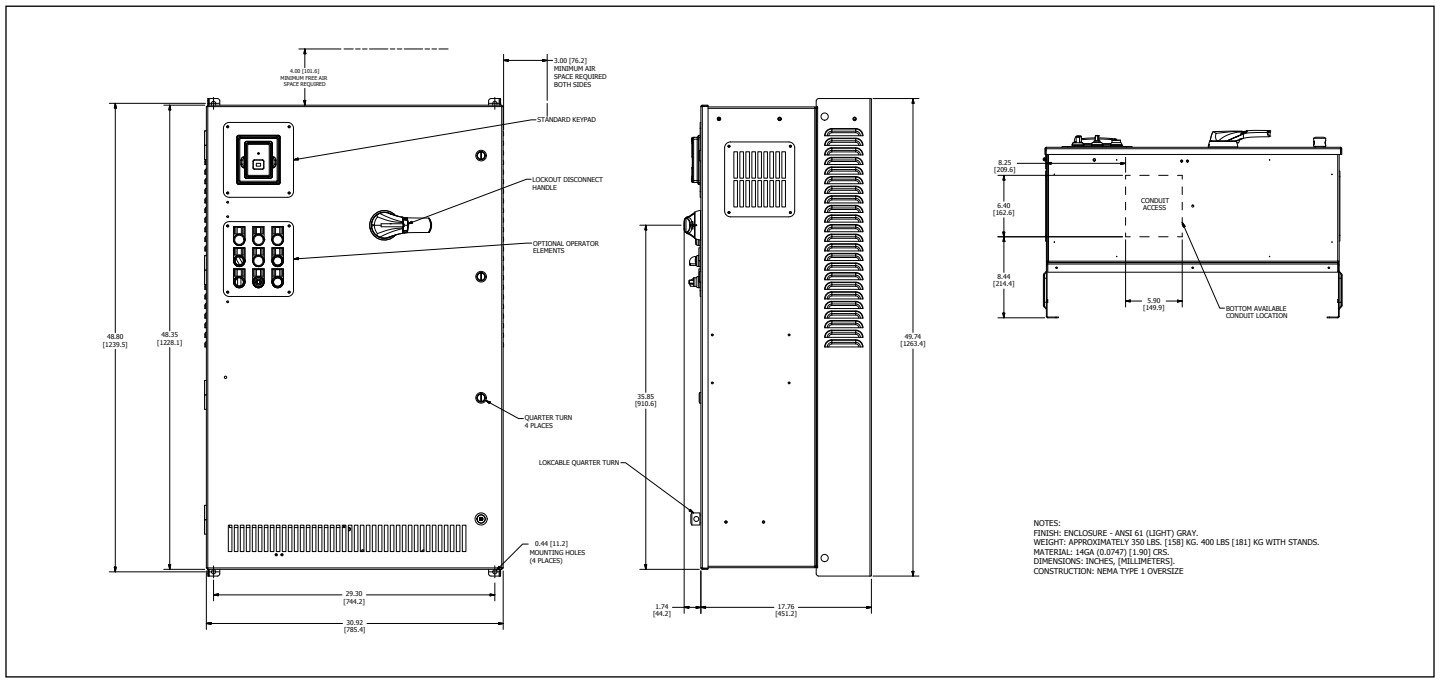


Figure 31.1-10. CX Enclosure, NEMA Type 1 and Type 12

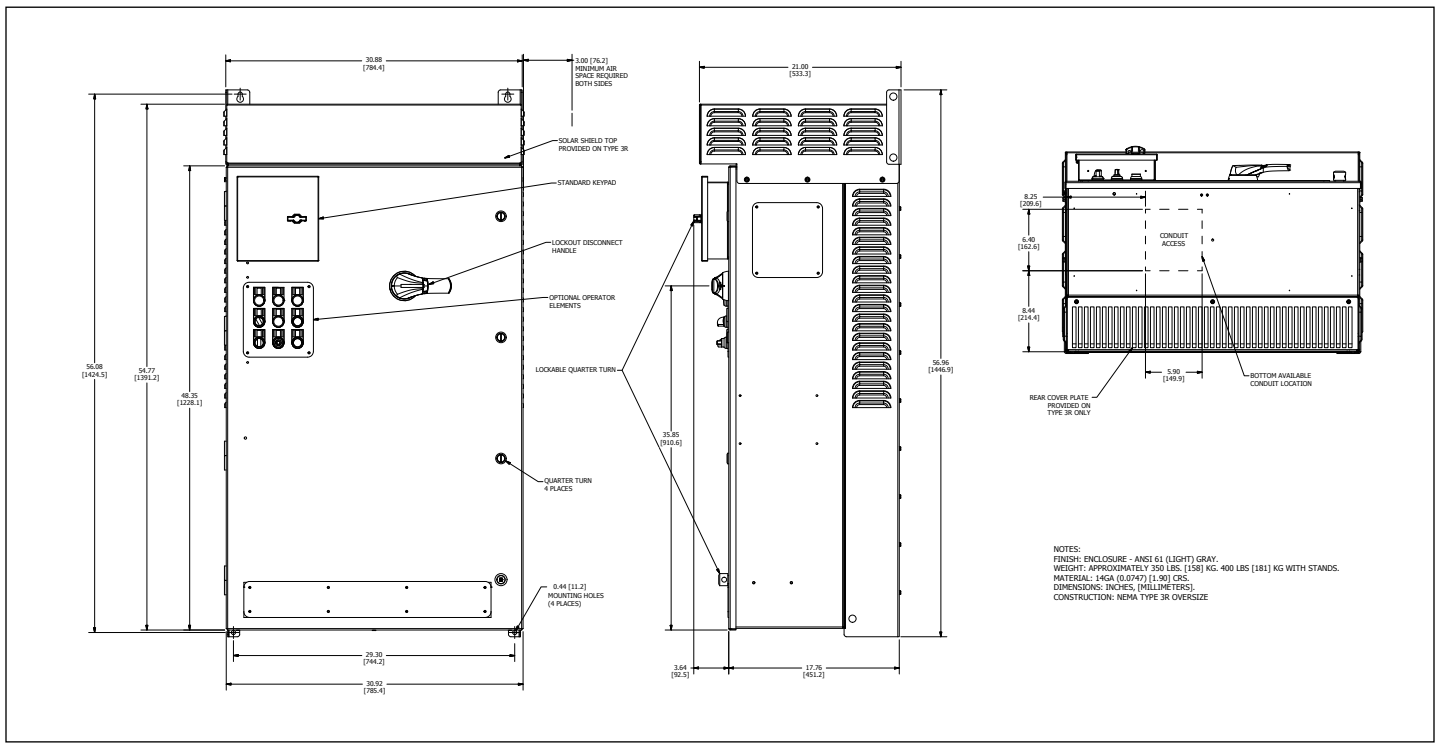


Figure 31.1-11. CX Enclosure, NEMA Type 3R

Note: NEMA Type 1 configurations are also available in a filtered and gasketed variant.

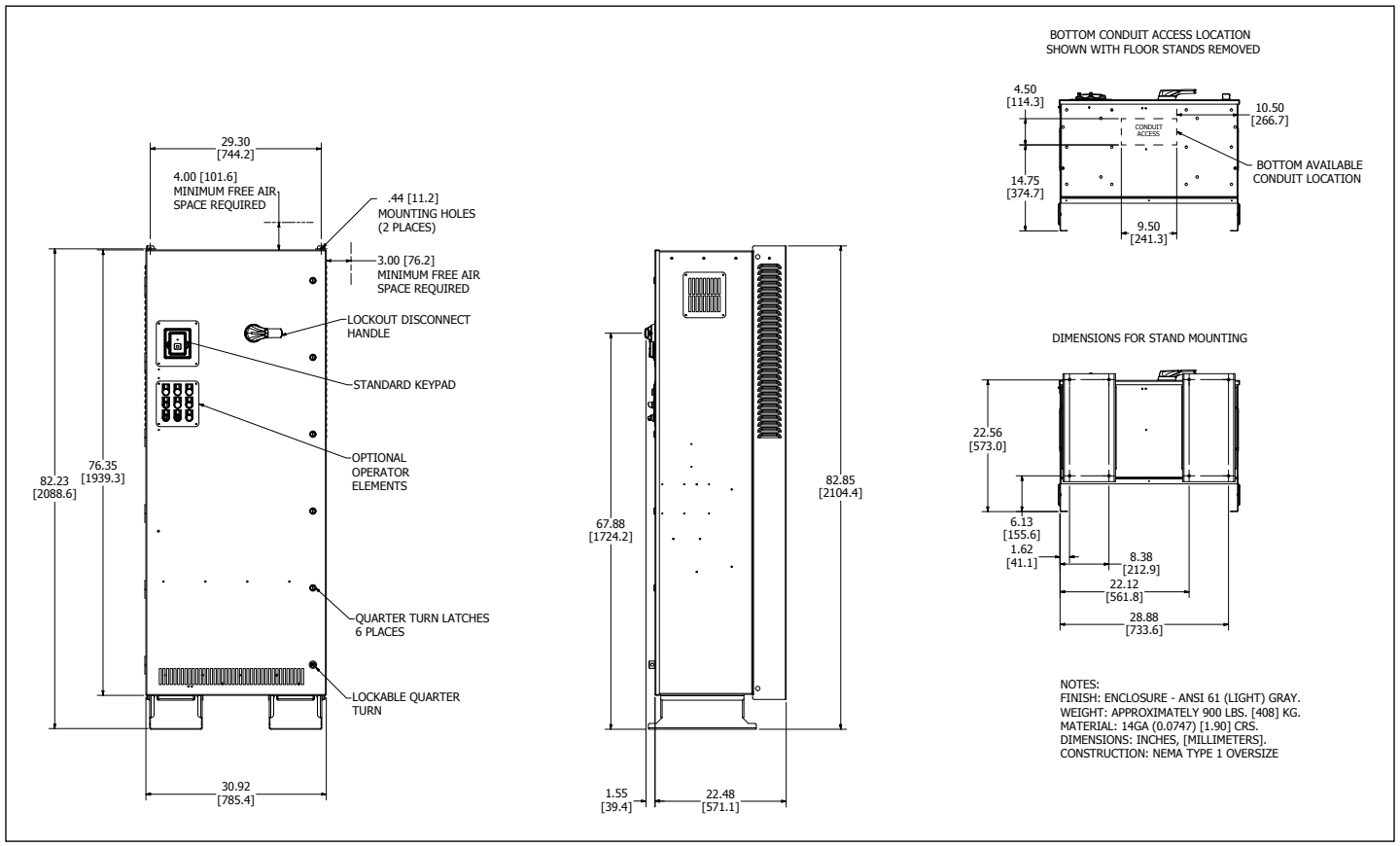


Figure 31.1-12. DX Enclosure, NEMA Type 1 and Type 12

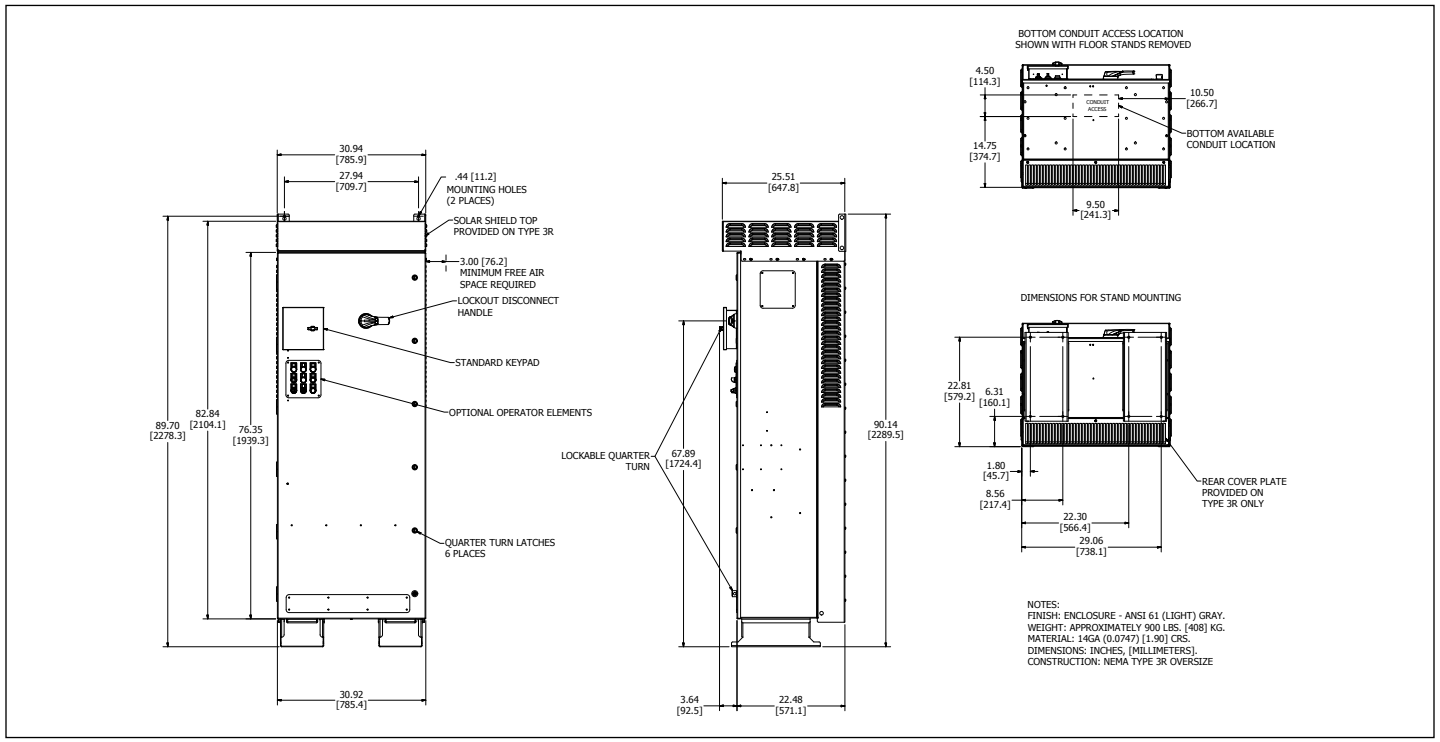


Figure 31.1-13. DX Enclosure, NEMA Type 3R

Note: NEMA Type 1 configurations are also available in a filtered and gasketed variant.

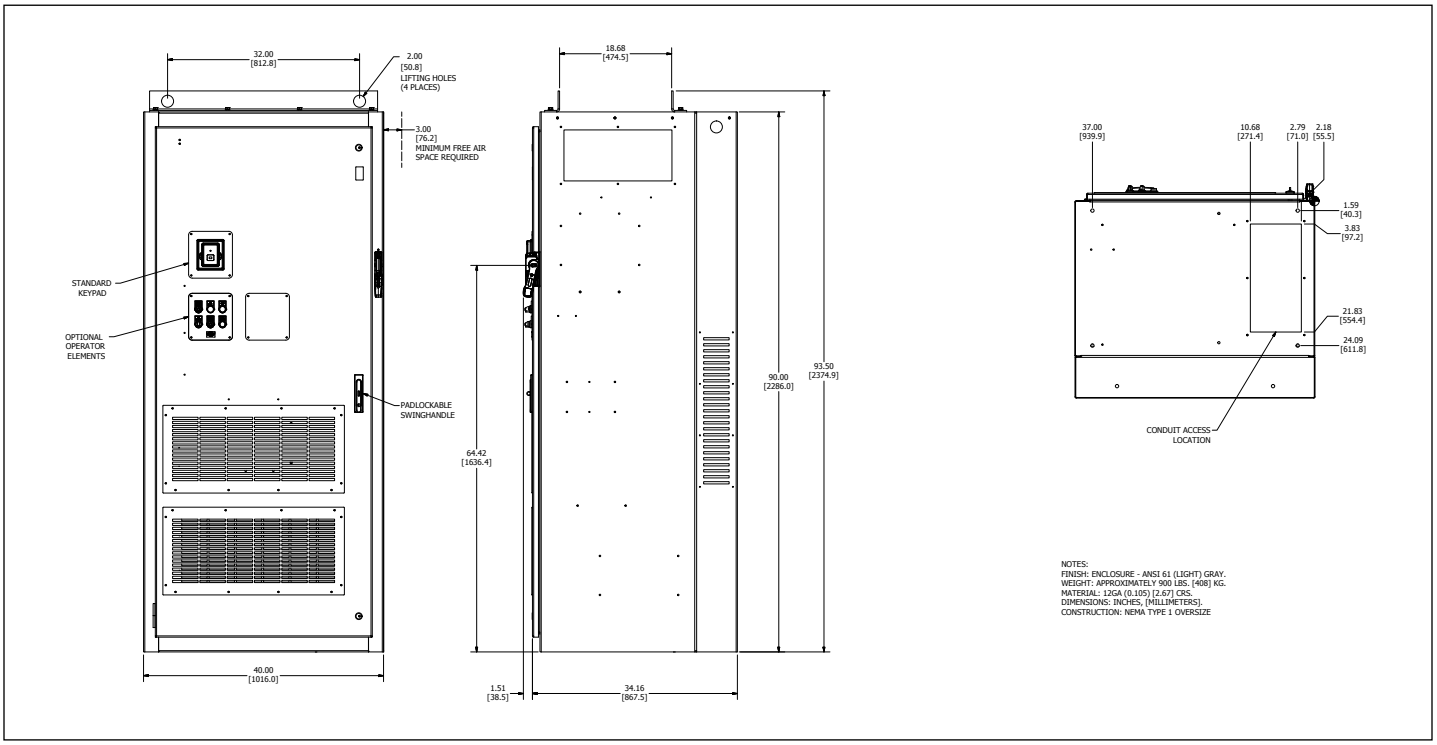


Figure 31.1-14. EX Enclosure, NEMA Type 1 and Type 12

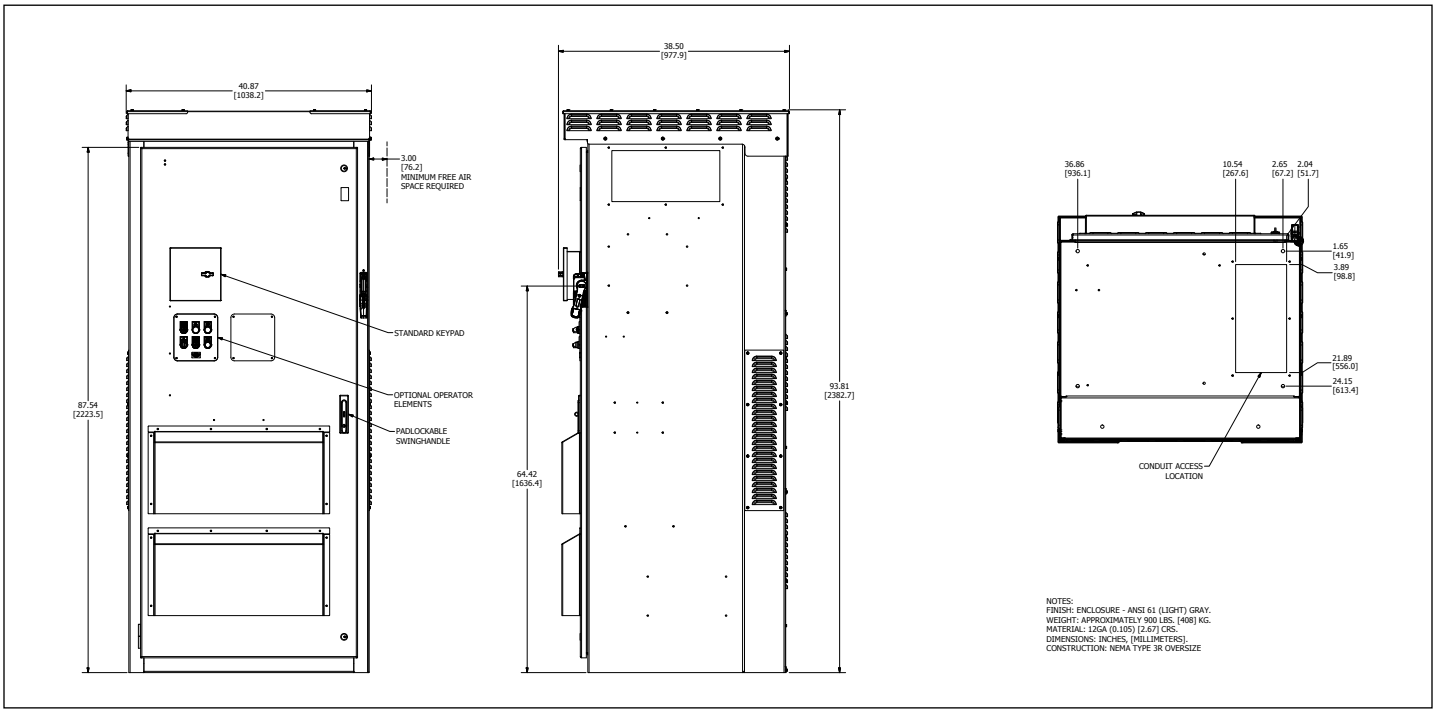


Figure 31.1-15. EX Enclosure, NEMA Type 3R

Note: NEMA Type 1 configurations are also available in a filtered and gasketed variant.

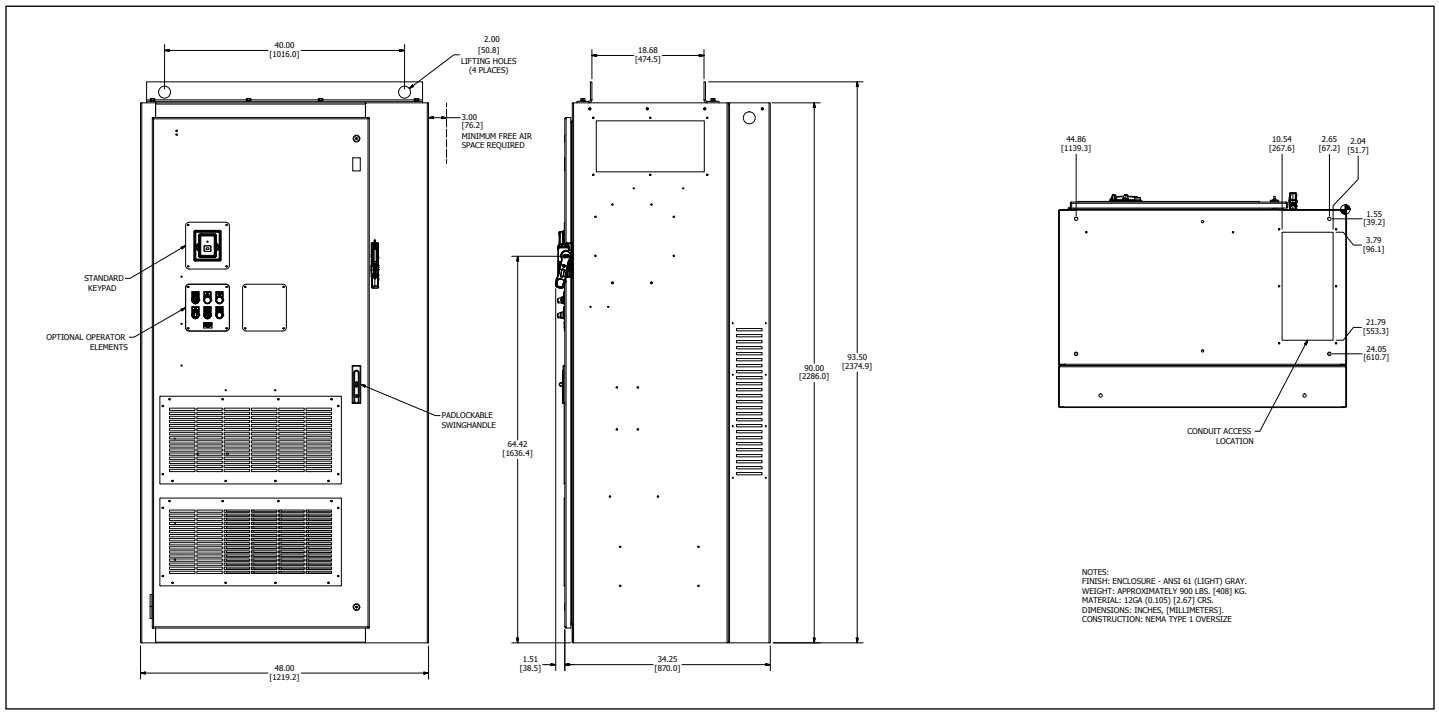


Figure 31.1-16. FX Enclosure, NEMA Type 1 and Type 12

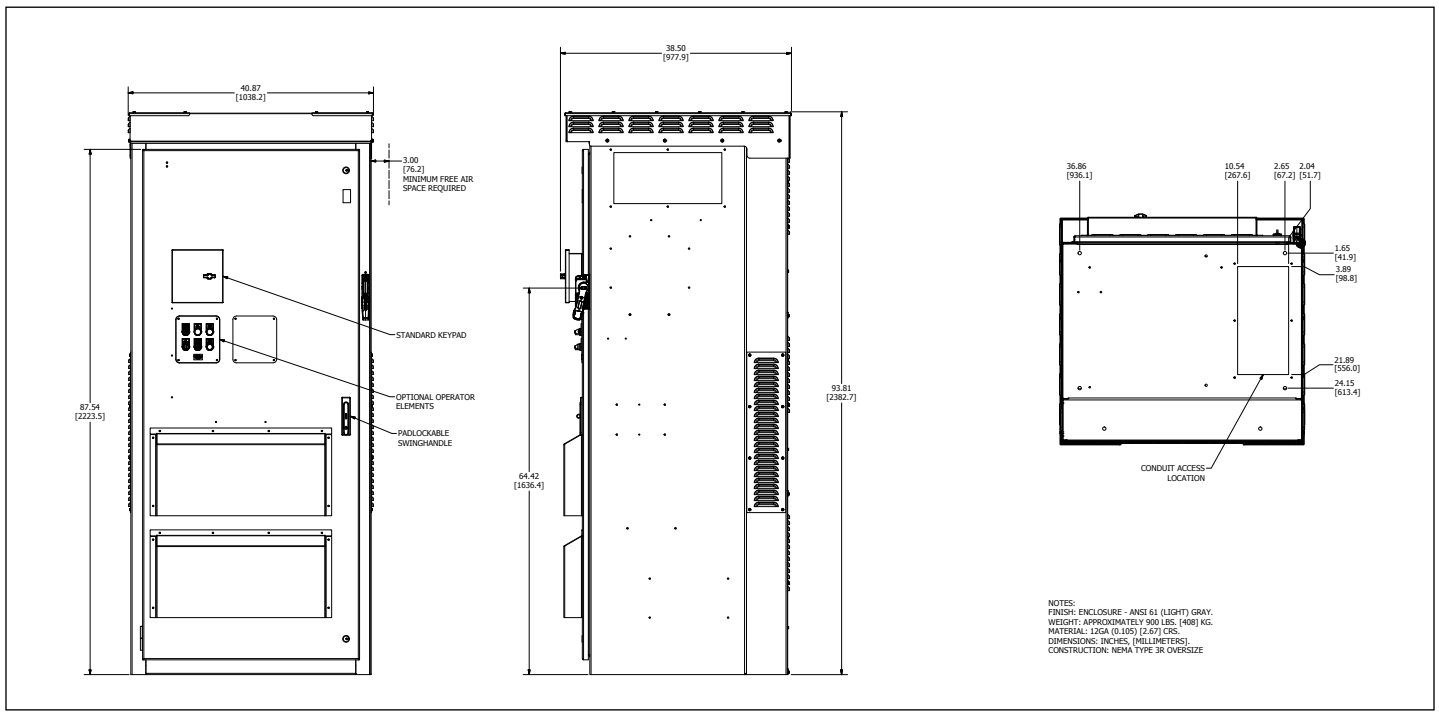


Figure 31.1-17. FX Enclosure, NEMA Type 3R

Note: NEMA Type 1 configurations are also available in a filtered and gasketed variant.

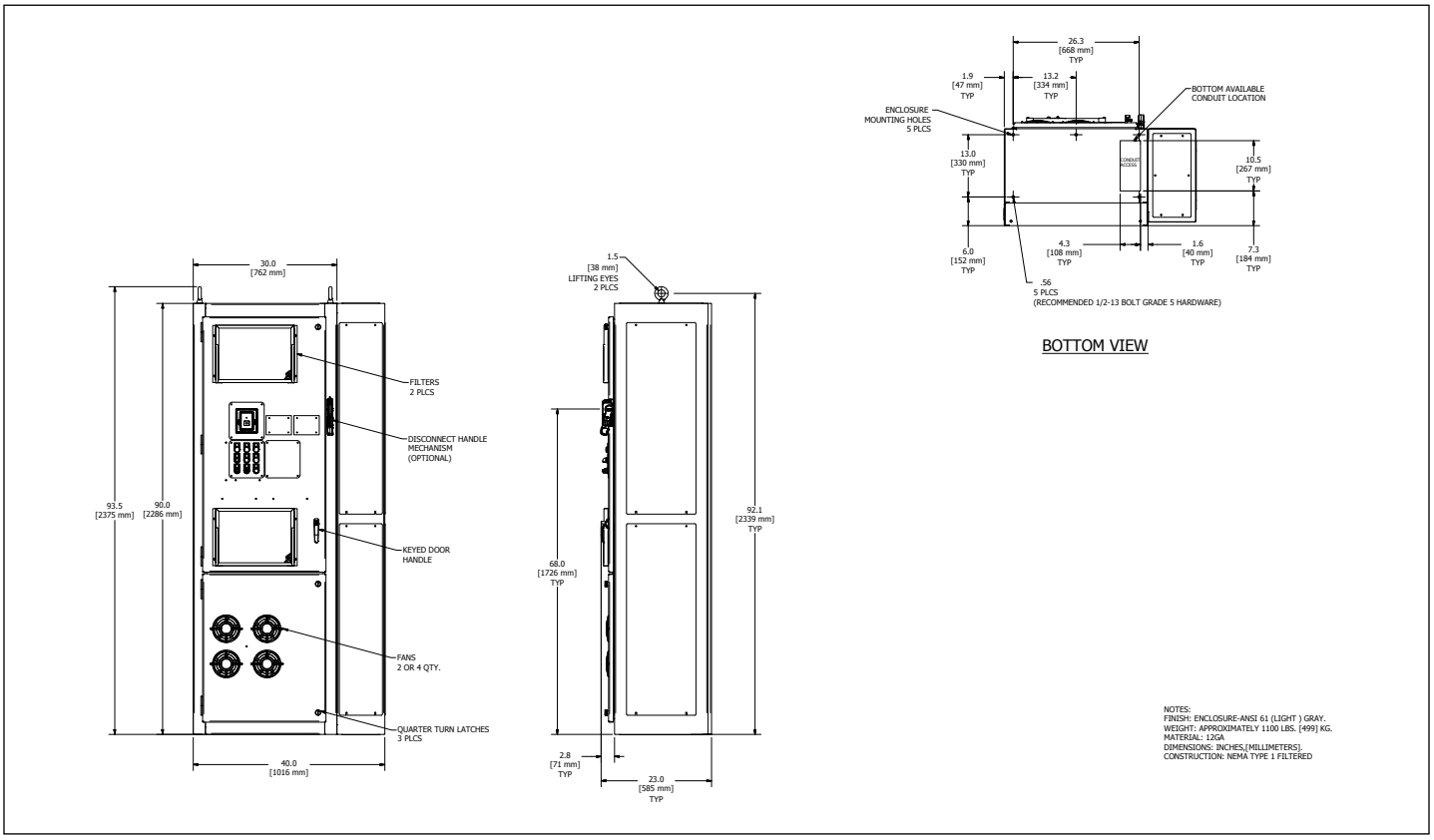


Figure 31.1-18. 7X Enclosure, NEMA Type 1

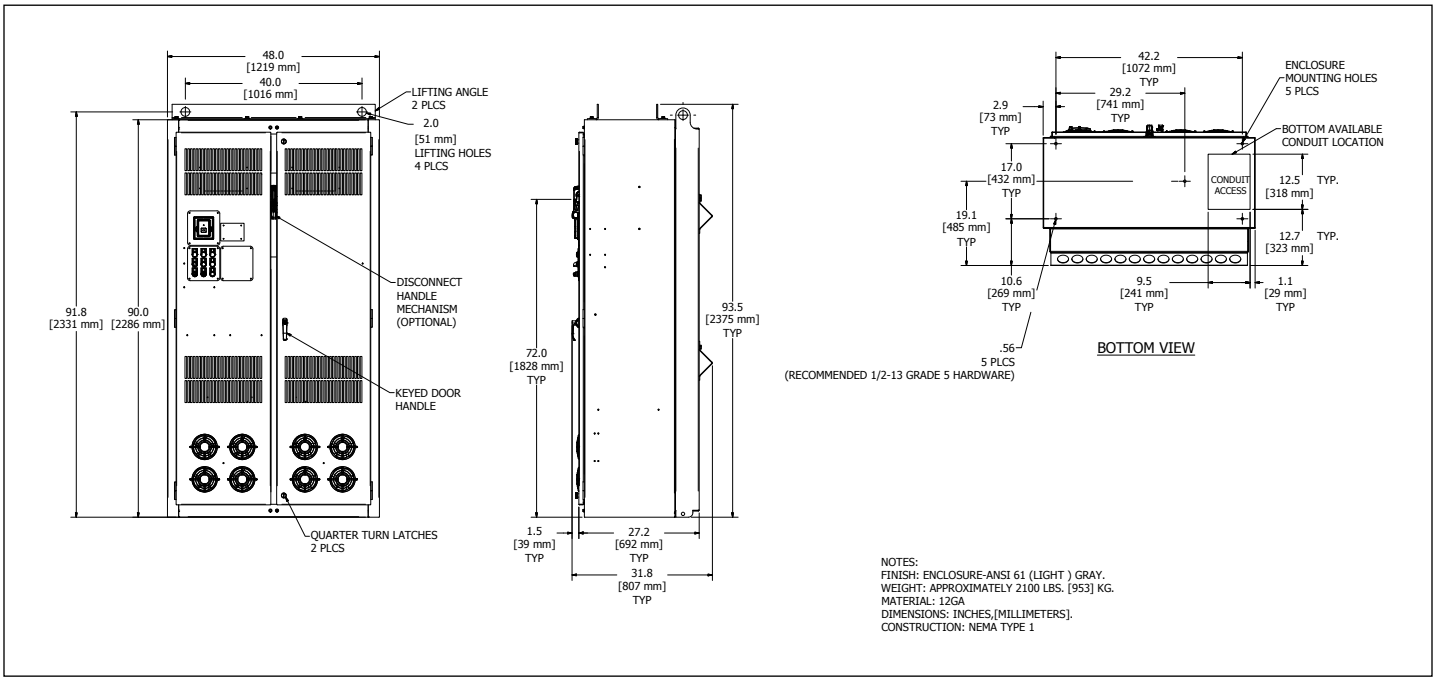


Figure 31.1-19. 8X Enclosure, NEMA Type 1

Note: NEMA Type 1 configurations are also available in a filtered and gasketed variant.

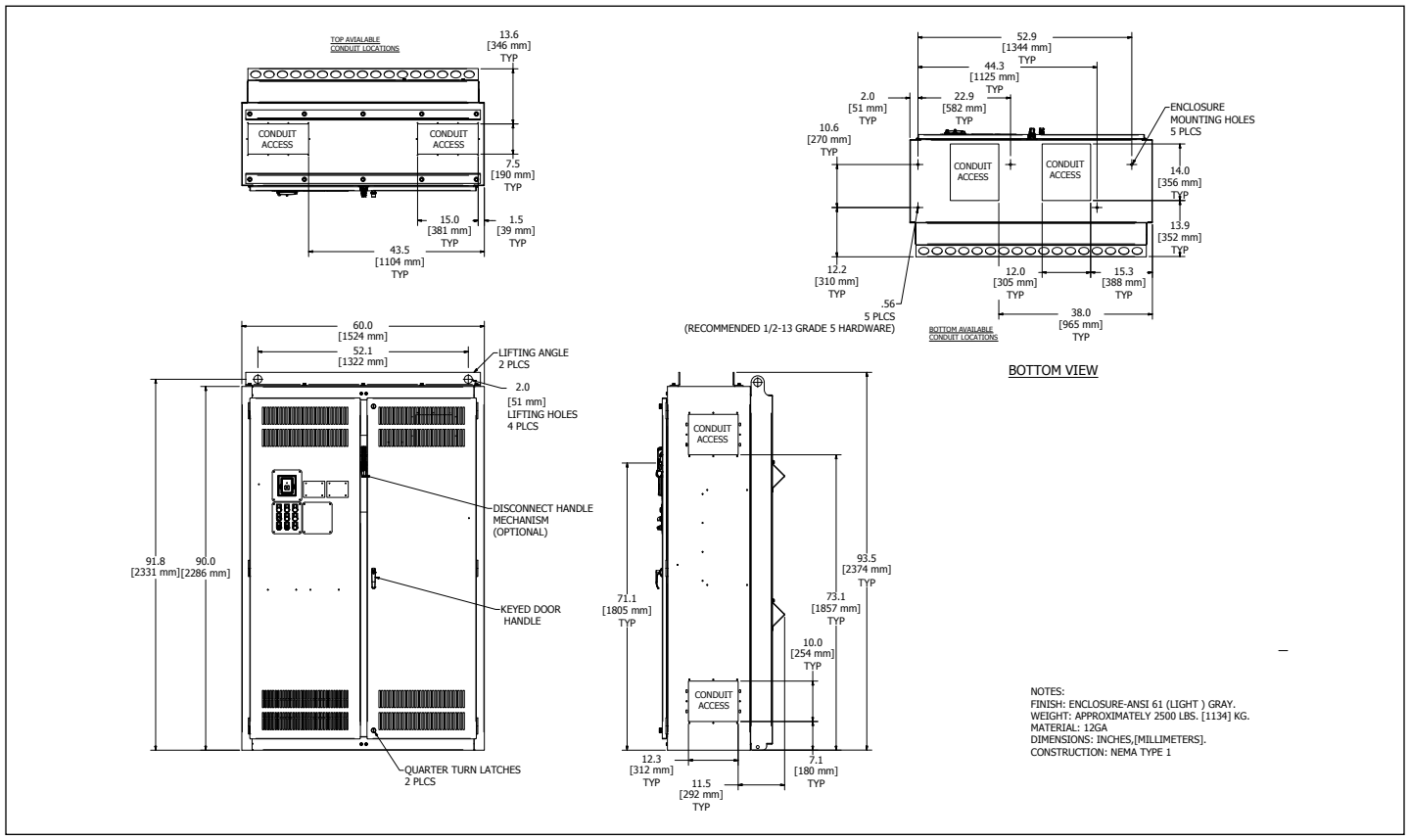


Figure 31.1-20. 9X Enclosure, NEMA Type 1

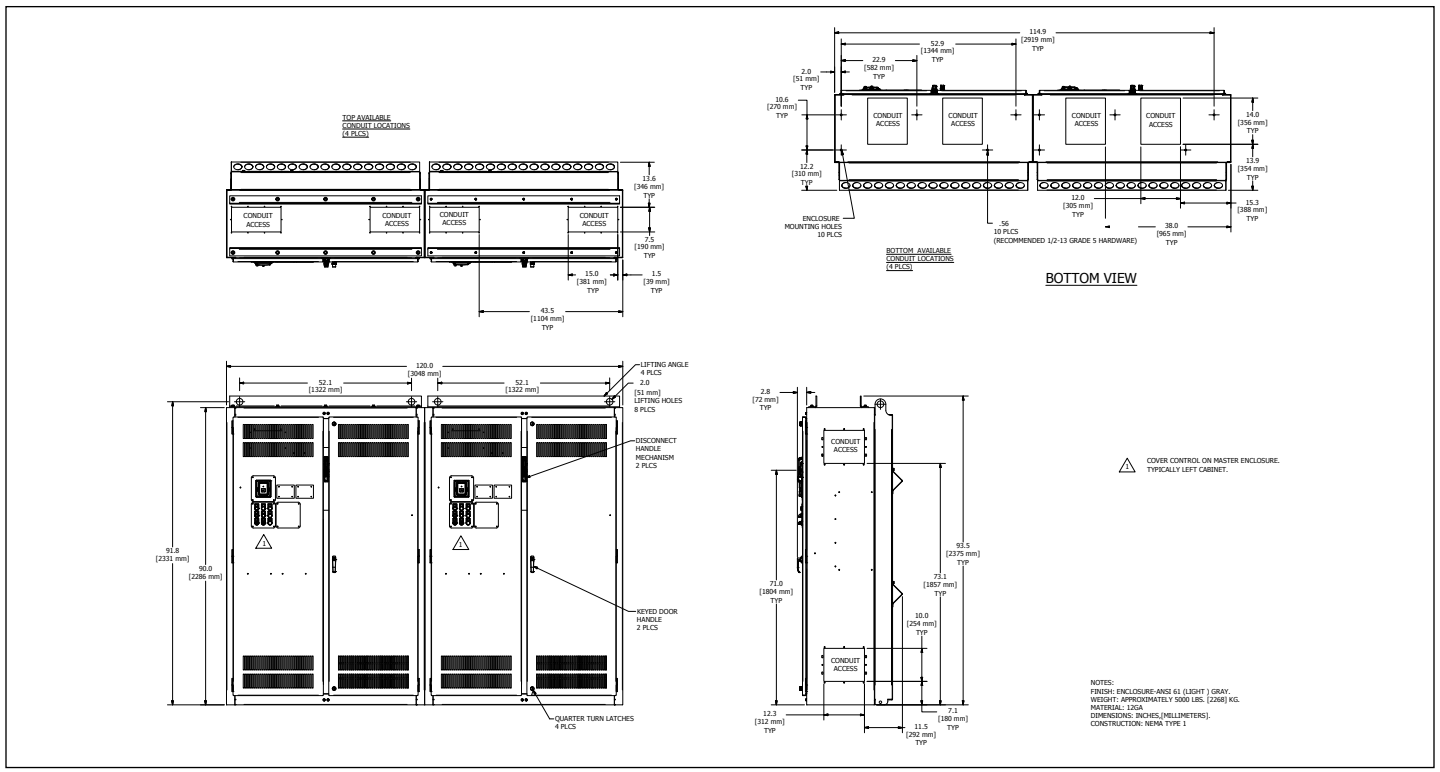


Figure 31.1-21. 11X Enclosure, NEMA Type 1

Note: NEMA Type 1 configurations are also available in a filtered and gasketed variant.

Motor Application and Performance

VFD Output Harmonics

For the purpose of performance evaluation, the non-sinusoidal output waveforms produced by VFDs 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 (PWM) VFDs 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 VFD 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 VFD 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 VFD.

AC Drive Application

Matching the VFD to the Motor

Voltage source VFDs are designed for use with any standard three-phase induction motor. VFD sizing and motor matching are often simply a matter of matching the VFD 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 VFDs 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 7.6 V/Hz, the same as a 460 V/60 Hz motor. 415 V motors can be operated if the VFD 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 horsepower for this mode of operation is limited above 80% speed because of the reduced V/Hz levels. For VFDs rated at 240 V, the motor will be connected for 230 V.

Output Current

The full load current ratings of typical VFDs are matched to typical full load motor current ratings as listed in National Electrical Code® Table 430.150. Generally, a VFD 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 VFD sizing. If the motor will be run at full load, the VFD 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 VFD 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.

VFDs 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 VFDs 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 VFD 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

VFDs 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 VFD 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%.

VFDs 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 31.1-28** lists some of these factors and the typical effect that they have on drive speed.

Table 31.1-28. 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 VFDs 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, silicon-controlled rectifiers (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 VFDs 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 preventive 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.

For this example, 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 VFDs 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

VFDs 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 519-2014 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 semi-conductors to significantly reduce harmonics to levels well within the IEEE guidelines.

Motor Load Types and Characteristics

Introduction

The process of selecting an electrical variable 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 31.1-22** shows the constant torque and variable horsepower demanded by the load.

As seen in **Figure 31.1-22**, 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.

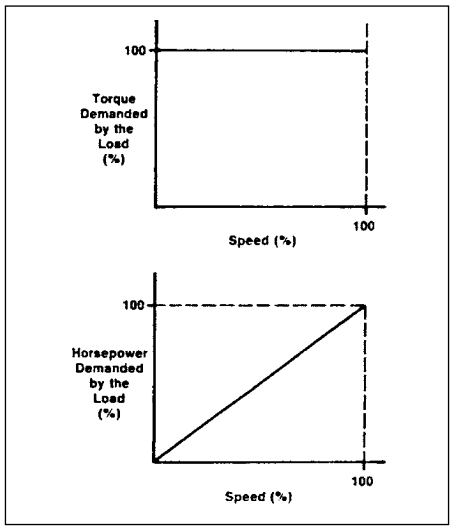


Figure 31.1-22. Constant Torque Load

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 31.1-23** 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.

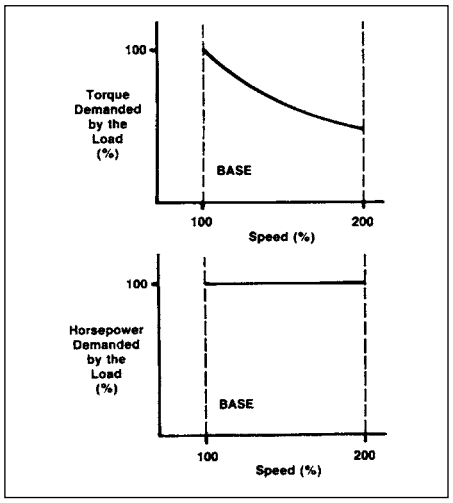


Figure 31.1-23. Constant Horsepower Load

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 31.1-24** 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.

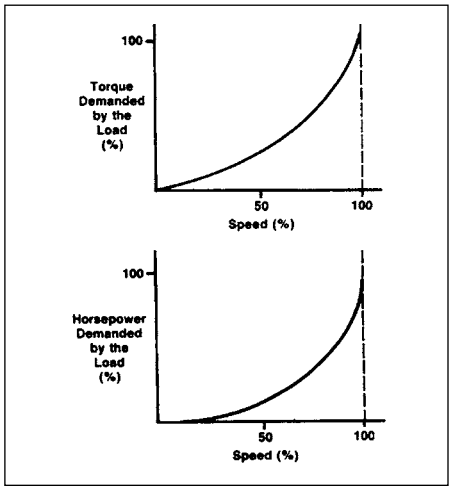


Figure 31.1-24. Variable Torque Load

Drive Selection

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.



PowerXL DG1 Drives

Harmonics

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.

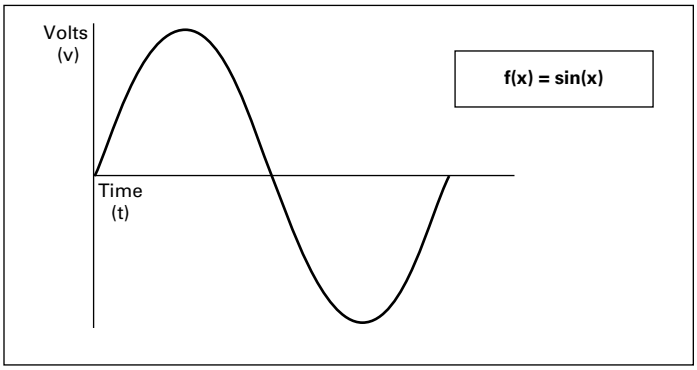


Figure 31.1-25. Perfect Wave

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

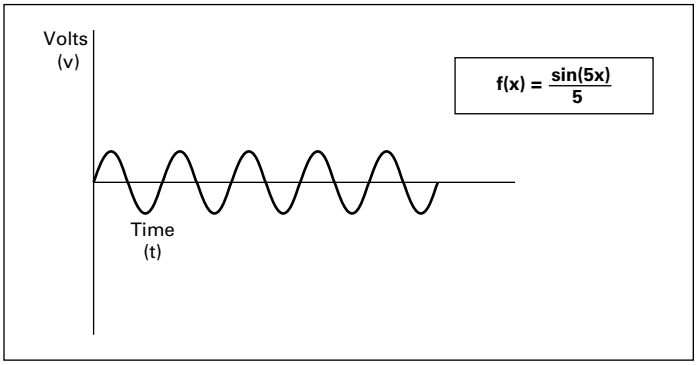


Figure 31.1-26. Second Wave

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

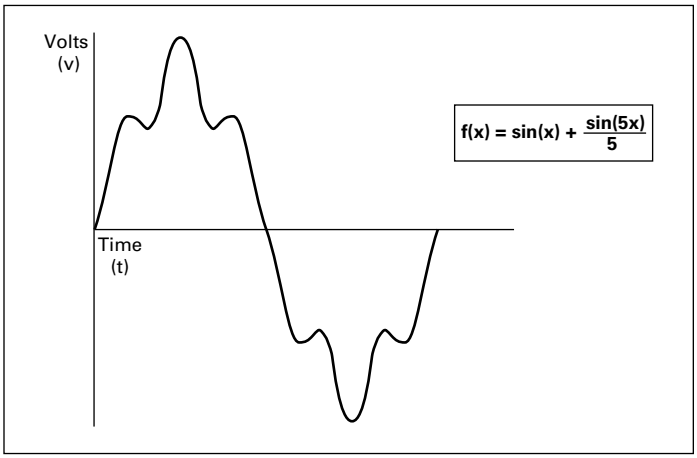


Figure 31.1-27. Resulting Supply

What Causes Harmonics?

Motors do not contribute harmonics because they are linear loads. In most applications, there is a turn-down valve to reduce the flow of material without significantly reducing the load to the motor. While this provides some measure of speed control, it is extremely inefficient. VFDs are a more energy-efficient alternative to control motor speed, but they are nonlinear loads. Harmonics result from nonlinear loads that convert AC line voltage to DC. Examples of nonlinear loads include:

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

Why be Concerned About Harmonics?

Uncontrolled harmonics can have a variety of consequences on devices, systems and operations reliant on the same power grid. Some of those concerns include:

- Poor performance of system transformers
- Overheating of system transformers
- Premature failure of connected devices
- Required oversizing of standby generation
- Interference with sensitive equipment
- False tripping of protective relays
- High neutral currents on single-phase loads
- Increased installation and utility costs
- Downtime and loss of productivity
- Utility fines or surcharges

How Do You Choose the Appropriate Harmonic Mitigation Solution?

The key to choosing the ideal harmonic mitigation solution is understanding the application while taking into consideration cost and size limitations. It is also important to consider the harmonic requirements of a system, so the best way to estimate VFD harmonic contribution is to perform a harmonic analysis. IEEE 519-2014 also outlines recommended harmonic guidelines for commercial and industrial users.

Comparing Eaton's passive filtered and 18-pulse designs, both may meet the harmonic needs of a given system, but the specific application may align better with one over the other. Commercial applications, as an example, may be more cost- and size-conscious, and the system's power quality may be relatively better due to a smaller presence of drives and generators. This application would lend itself to a passive filter solution, especially at lower horsepower loads. An industrial application, on the other hand, may be more concerned with minimal maintenance and resilience to power disturbances and standby generation interference. In this case, the 18-pulse design would be more effective, especially at higher horsepower loads.

For a closer look at harmonics and their symptoms, sources and solutions, refer to Eaton's harmonics portal linked below. Here you can learn more about harmonic technologies, download our harmonics calculator, and contact Eaton application engineers to assist with your harmonic analysis: www.eaton.com/harmonics.

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