1201

Variable-Frequency AC Drives

User Manual

60 to 1200 hp
(45 to 900 kW)

Preface

Thank you for choosing the UNICO Series 1201 Variable Frequency Drive.

This Unico Series 1201 User Manual provides instructions and precautions for installation and wiring of the drive, care and maintenance recommendations, fault diagnosis, and troubleshooting guidelines.

To ensure proper use, best performance, and the safety of both users and equipment; be sure to read this manual carefully before using Series 1201 products. Improper use may cause a malfunction of the drive, reduce its service life, damage other equipment, or even lead to personal injury or death.

An electronic version of the manual is provided on the compact disc with each Series 1201 Variable Frequency Drive. Please keep it in a convenient location so it can be referred to for installation and maintenance.

Owing to the constant improvement of these products, the information in future versions of this manual may be changed without further notice.

Series 1201 / Variable Frequency Drive / User Manual
Document Number: 115008 ECL 001
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Safety Information

Overview

This section states important safety information that must be followed when installing, operating, and servicing the drive. Study this information carefully before working on or with the unit. Failure to follow these instructions may lead to personal injury or death. It may also lead to damaging the drive, motor, or the equipment being driven.

Conventions Used

The following notation conventions are used throughout this manual to indicate information important to personal safety or machine hazards.

Warning – Electrical Hazard

Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss due to contact with high voltages.

Attention

Identifies requirements and procedures that deserve extra attention to detail and must be followed to avoid risk of injury and/or damage to the drive or machine.

General Precautions

Attention
Only qualified personnel with the proper skills, instruction, and familiarity with the drive and its application should install, start up, operate, troubleshoot, and maintain the drive. You must be familiar with the electrical and mechanical components of the system to perform the procedures outlined in this manual. Failure to comply may result in personal injury, death, and/or equipment damage.

Warning – Electrical Hazard
Failure to take proper precautions for electrical hazard could cause injury or death.

Attention
Failure to follow industry safety standards and instructions in this manual could damage the drive and void the manufacturer's warranty.

Attention
Portions of the drive may be sensitive to electrostatic discharge. Proper static handling procedures must be followed when servicing or repairing the unit.

Attention
Drives are intended to be connected to earth ground for safety. The use of EMC filters on drive systems increases the leakage current in the protective conductor and may adversely affect the operation of residual-current-operated protective devices (i.e. ground fault circuit interrupters). Refer to the EMC filter documentation before installation.

Attention

The drive provides solid-state motor overload protection. The level of protection is dependent upon the rating of the unit as well as the software overload specified by the user. Please refer to the application program documentation for instructions on adjusting the motor's rms current limit.

Installation Precautions

Attention
An incorrectly installed or operated drive can result in damage to the equipment it controls. Make certain installation and operating specifications are followed.

Warning – Electrical Hazard
To provide protection against electrical shock, drives must be mounted in an enclosure meeting at least the requirements of Protective Type IP20 (or NEMA equivalent) according to EN60529 and with top surfaces meeting at least the requirements of IP40 (or NEMA equivalent). It is recommended that a key or tool be required to open the enclosure and that enclosure doors be interlocked with the electrical supply disconnect.

Warning – Electrical Hazard
The drive and associated equipment must be properly earth grounded.

Attention
Any site insulation tests must be performed before making electrical connections to the drive.

Warning – Electrical Hazard
The drive is not equipped with a supply-disconnecting device. An external supply-disconnecting device must be provided to isolate incoming electrical supplies during installation and maintenance work. This device should comply with the requirements of EN-60204-1 as well as all applicable national and local regulations.

Application Precautions

Warning – Electrical Hazard

Emergency stop devices shall be located at each operator control station and at other operating stations where emergency stop may be required. Control inputs and keypad motor-control functions do not generate an emergency stop of the motor and do not remove power that can cause hazardous conditions. Regardless of the operating state, the drive's motor output terminals may be at dangerous voltage levels whenever input power is applied and the bus is charged.

Attention

Drive functionality depends upon the application software installed. Some application software offers automatic restart functions that allow the unit to reset and resume operation after a fault. These functions must not be enabled when hazardous conditions might arise from such action. Certain features may present additional hazardous situations. Refer to the associated application documentation for further safety information.

Service Precautions

Warning – Electrical Hazard

Always disconnect and lock out all electrical supplies before working on the drive or associated equipment. Do this before touching any electrical or mechanical components associated with the drive application.

Warning – Electrical Hazard

No one should attempt to service the drive while power is applied. High voltage may be present at the motor output terminals (U, V, W) whenever input power is applied, regardless of whether the motor is moving or not. Furthermore, after power is removed, no one should service the drive until the bus voltage has been measured to be at a safe level.

Warning – Electrical Hazard

High voltage may be present even when all electrical power supplies are disconnected. After switching off electrical power, wait at least 15 minutes for bus circuit capacitors to discharge before working on the drive or associated equipment. Use an appropriate voltmeter to further verify that capacitors are discharged before beginning work. Do not rely exclusively on the bus voltage indicator. Dangerous voltage levels may still be present even when the indicator is off.

Attention

Before energizing the motor, verify that there is no dust, debris, or loose components that could result in injury or damage to the equipment.

Safe Service Practices

- Follow industry recognized safety procedures.
- Use only one hand to hold test equipment probes.
- Wear approved eye protection.
- Stand on insulated material.
- Use an isolated oscilloscope.
- Keep unnecessary personnel out of the work area.
- Never leave a drive cabinet open and unattended.

1 About the Manual

1.1 Overview

This chapter describes the contents and intended audience of this document.

1.2 Contents

The manual provides the instructions and technical information necessary to install and maintain the hardware of UNICO's 1201 family of AC drives.

What's covered

- *Safety Instructions* discusses safety hazards and procedures important to anyone working with the drive
- Chapter 2, *Product Overview*, tells how to receive the drive and provides an overview of its architecture, features, and specifications
- Chapter 3, *Mechanical Installation*, provides instructions on physical installation
- Chapter 4, *Electrical Installation*, explains the routine electrical connections
- Chapter 5, *Troubleshooting*, discusses troubleshooting for the drive hardware
- Chapter 6, *Maintenance*, discusses routine maintenance of the drive to keep it performing well
- Chapter 7, *Accessories*, covers control modules, options, and external connections

What's not covered

This manual does not address aspects of the drive that depend upon the application software. Please refer to application documentation for the following:

- Application-specific control signal wiring and definitions
- Detailed description of drive features and modes of operation
- Parameter descriptions
- Fault identification and troubleshooting

This manual is not intended to provide in-depth service instructions. For service beyond that described in this manual, please contact Unico, Inc. or your representative.

1.3 Intended Audience

The manual is intended for anyone who will be using, installing, and servicing the drive. Only qualified electrical personnel should perform installation to ensure that correct electrical practices and applicable electrical codes are applied.

The audience is expected to have a basic knowledge of physical and electrical fundamentals, be familiar with good electrical wiring practices, be able to identify common electrical components, and be capable of reading electrical schematics. No prior experience with the drive is presumed or required.

Follow instructions

You can prevent injury and damage to the drive or equipment by carefully following the procedures outlined in this manual.

Follow regulations

All electrical work should conform to the National Electrical Code (NEC) as well as all state and local government regulations. Please familiarize yourself with these regulations.

Read the manual first

Read this manual in its entirety before installing the drive.

2 Product Overview

2.1 Overview

This chapter provides an overview of the UNICO 1201 family of drives. It familiarizes the user with the basic features, architecture, and specifications of the drives.

2.2 Nameplate Identification

Drives are ordered using a model number similar to that shown in Figure 2-1. The model number identifies the drive type (1201) and its configuration, including rated voltage, power, overload, controller, braking, and package.

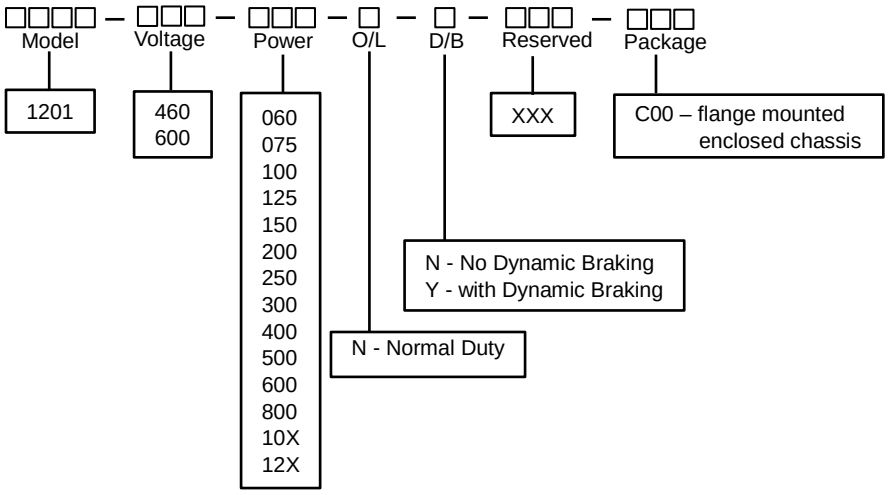


Figure 2-1: Drive Model Number

Each drive is labeled with a nameplate marked with the model number, the input and output ratings, and the product serial number and bar code. An example nameplate is shown in Figure 2-2.

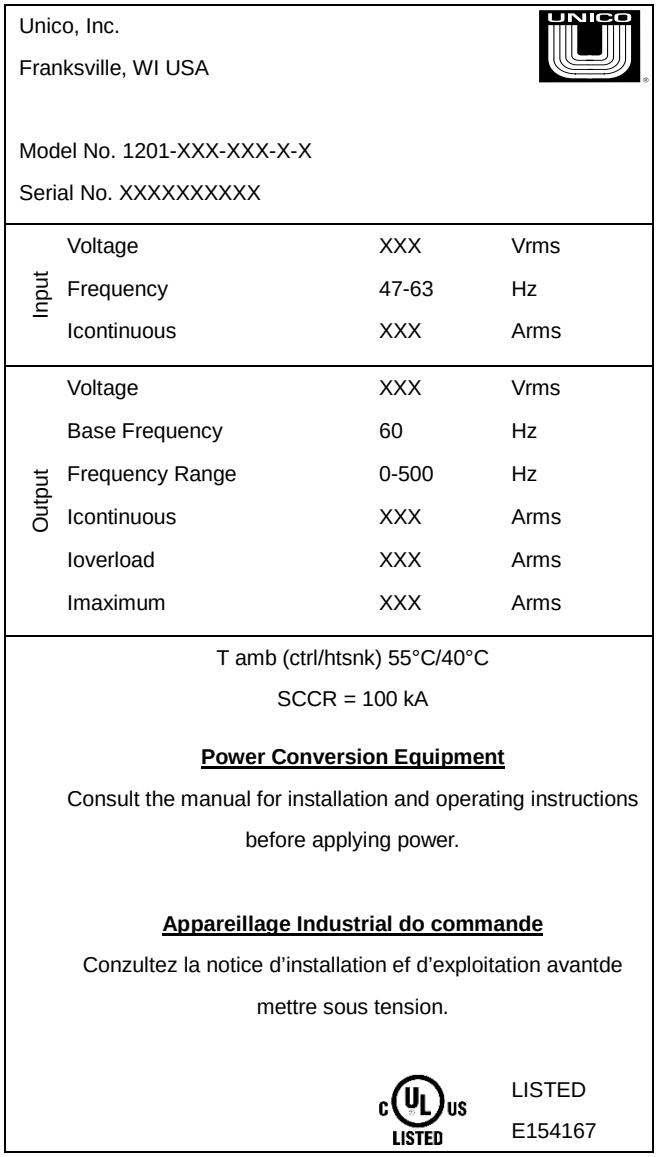


Figure 2-2: Drive Nameplate

2.3 Family Overview

The 1201 family of AC drives provides flux vector control of three-phase AC motors. The drives combine the latest insulated-gate-bipolar-transistor (IGBT), pulse-width modulation (PWM), and digital signal processor (DSP) technologies with digital-current-regulator (DCR) or digital-space-vector (DSV) control to deliver optimum motor performance, complete programmability, and simplicity of operation. Variable-frequency drive (VFD) operation is also available for cost-effective control of motor speed in simple applications.

These drives share a common architecture that provides a high degree of internal consistency. By combining this core drive topology with unique input sections, the 1201 drive family furnishes flexible, efficient, and cost-effective solutions to a variety of application needs.

2.3.1 Features

Performance Flexibility

The 1201 drive accommodates a broad range of performance requirements. Units may be configured for heavy-duty cyclic loads, normal-duty requirements for centrifugal loads (such as fans and pumps), or light-duty operation. The drive operates in a transducerless vector control mode that does not require a feedback device and produces full torque up to base speed. For demanding applications, an encoder interface can be added for precise position, velocity, and torque regulation and improved dynamic performance. Dual- and triple-encoder interfaces are also available for position-following and dual-transducer applications. Variable-frequency control is alternately available for applications that do not require critical velocity or torque control.

Motor-Independent Design

The 1201 drives operate any standard- or inverter-duty AC induction or synchronous motor making it ideal for retrofits and new applications alike. A unique, proprietary digital current regulator (DCR) tunes the drive continuously in real time, eliminating the usual current-loop tuning process required by conventional drives. Digital space vector (DSV) control can be selected for reduced motor noise and low current ripple.

Auto Tuning

Once routine electrical connections have been made, simple-to-use auto-tuning features adjust virtually all motor- and load-dependent parameters. No motor maps are required. Simply enter basic motor information from the nameplate and the advanced setup routines do the rest. The drive is completely tuned within minutes.

Control Options

Several control and interface options are available. Each control module provides digital and analog inputs and outputs as well as asynchronous and synchronous serial communication capabilities. In addition, there is a provision for an optional Anybus® module for communication using a variety of industry-standard protocols. Wireless communication is possible through a provision for a MaxStream™ module. Drives can accept motor and/or machine feedback with a single, dual, or triple incremental encoder interface, a resolver interface, or resolver and encoder interfaces. An optional analog interface module is also available for expanding the analog I/O capabilities of a drive.

Application Software

A wide variety of embedded program options are available to tailor a drive to its application, from a fully featured velocity/torque control for general purpose use to a host of powerful programs pre-engineered for specific applications. Customization is possible using *UEdit*™, a Windows-based programming tool that allows users to extend an application using IEC 1131 standard ladder diagrams and function blocks.

Digital Setup, Easy Operation

A keypad and liquid crystal display provide a simple interface for setting and viewing operating parameters and diagnostics. All controller settings are made digitally for precision and repeatability. Readouts and fault messages are displayed in readily understandable language. A graphical display option provides on-board oscilloscope-type viewing of drive and system parameters.

Multi-axis and Tandem Operation

A built-in high-speed synchronous communication port allows multiple “slave” drives to be precisely controlled by a “master” drive. With optional software, a position, velocity, or torque signal can be sent from the master drive to the slave drives for coordination. Multiple motors can also be operated in parallel from a single drive using optional variable-frequency control. Two drive sections can be operated in tandem for high power applications.

Power Quality

Series 1201 drives offer as a minimum, a 6-phase (12-pulse) configuration for minimizing line harmonics in critical applications. Larger 1201 drives can be purchased in 9-phase (18-pulse) and 12-phase (24-pulse) configurations.

Protection and Advanced Diagnostics

Drives monitor their operating conditions and provide a comprehensive set of overload, short circuit, and other electronic protective features to ensure safe, reliable operation. Faults are displayed in plain language. A log maintains a history of fault occurrences and externally triggered events.

Serial Connectivity

An RS-422/485 serial interface is provided for connecting the drive to a process controller, communication network, or programmable controller. A variety of popular communication protocols are available through software or optional Anybus modules. Optional Bluetooth and MaxStream modules provide short- and long-range wireless communications. An RS-232 connection is also provided for connecting a personal computer. Windows-based PCs can set up, monitor, and control a network of drives using optional UEdit™ software. The DriveTalk™ application provides remote interface capabilities for the iPhone and iPad.

Packaging

Drives are intended to be flange-mounted as part of a packaged electrical enclosure. The drive’s heatsink is designed to extend through a cutout in the back of the enclosure to reduce internal cooling requirements.

2.3.2 Drive Architecture

The general function of the drive is to convert a fixed voltage and frequency from an electrical power source into a variable voltage and frequency for controlling an AC motor. The basic architecture of the Series 12O1 drives is shown in Figure 2-3.

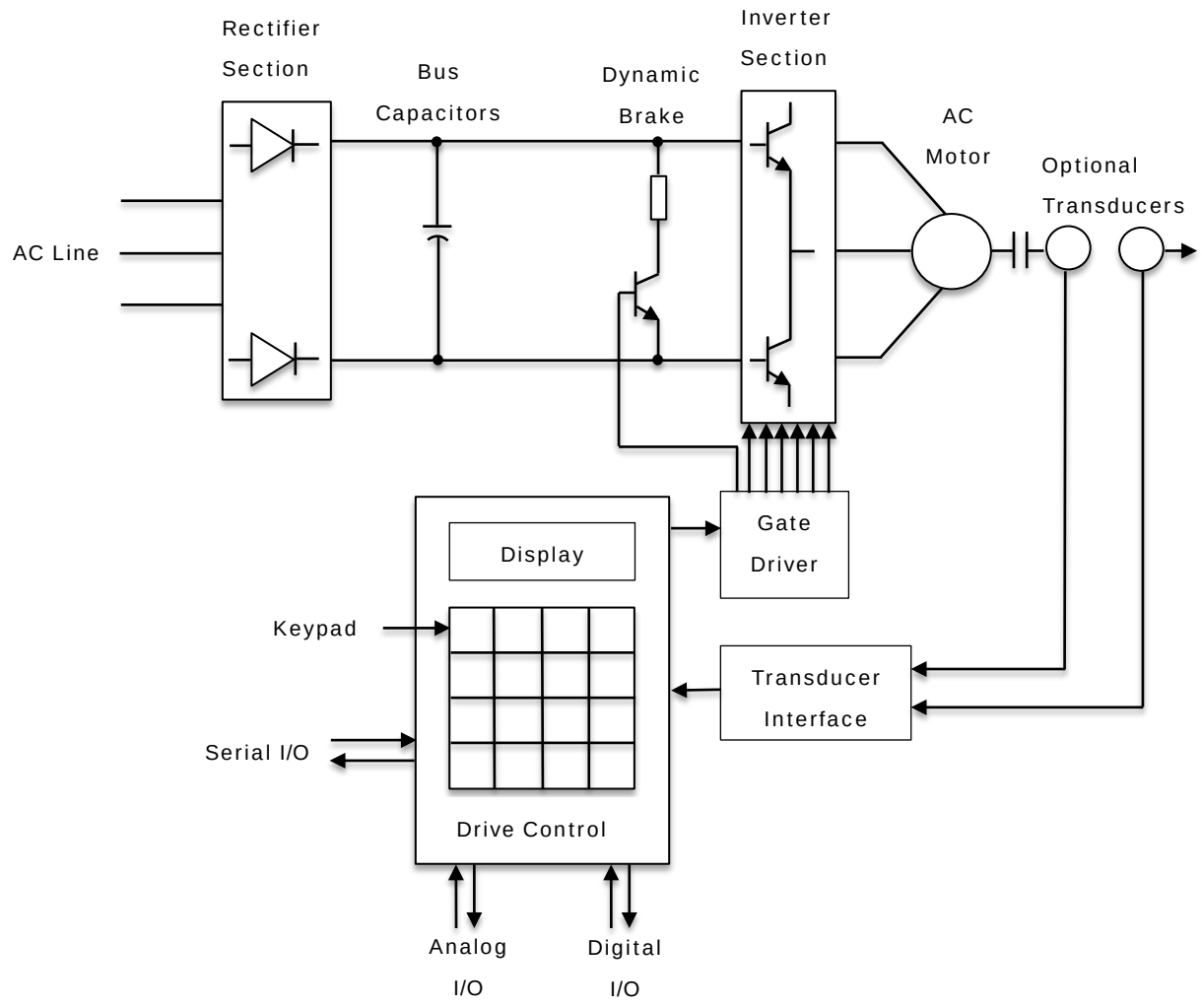


Figure 2-3: Series 12O1 Drive Architecture

A *rectifier section* converts the AC line voltage into a DC bus voltage. Series 12O1 drives provide enough diode pairs for 12pulse, (6-phase) operation. Larger drives support 18-pulse, (9-phase) and 24-pulse, (12-phase) connections of the input to further reduce harmonic currents.

Film capacitors form a dc link that filters the output of the rectifier section. An optional *dynamic brake* device on these units allows regenerative energy from the load to be dissipated in an external resistor when the drive is braking.

An *inverter section* consisting of six insulated gate bipolar transistors (IGBTs) is used to power an AC motor. This section can produce sine-wave motor voltages and currents of any desired amplitude by rapidly switching the IGBTs using a technique called pulse-width modulation (PWM). A *gate driver* is used to pass switching signals from the drive controller to the IGBTs.

Overall operation of the unit is regulated by a *drive control* that incorporates a digital signal processor (DSP) and a digital current regulator (DCR) or digital space vector (DSV) control. This high-speed digital control uses both voltage and current feedback to regulate the output to the motor. Optional *encoder interfaces* are available to provide closed-loop control of motor velocity and/or position. Variable-frequency drive (VFD) operation is an option for controlling AC motors in simple applications.

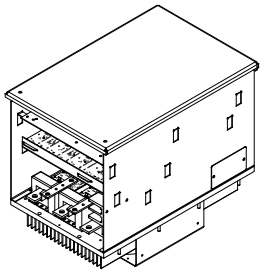
A *keypad/display unit* connected to the control module provides access to operating and setup parameters. The control module also provides analog and digital I/O that can be used as input to and output from the drive. Serial communication channels are available for connecting drives to process controllers, communication networks, programmable controllers, or personal computers.

2.4 Product Range

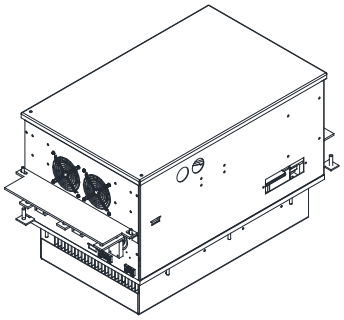
Drives are divided into package sizes. They are available as 460V or 690V units. The input section is configured for 6-phase/12-pulse (standard) with 9-phase/18-pulse and 12-phase/24pulse available on the larger drives.

Table 2-1: Product Range

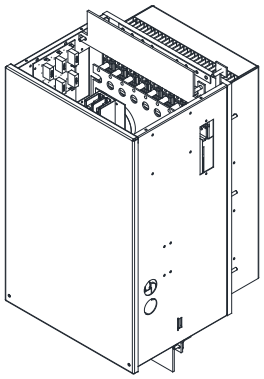
Form	Frame Size	Input Voltage	Input Phase/Pulses	Horsepower Range	
	Height x Width			**Heavy Duty**	**Normal Duty**
1710	17" x 10.5" *(432 mm x 267 mm)*	460 VAC	6-phase/12-pulse	40	60
				50	75
				60	100
				75	125
				100	150
2415	24" x 15" *(610 mm x 381 mm)*	460 or 600 VAC	6-phase/12-pulse or 9-phase/18-pulse	125	200
				150	250
				200	300
4015	40" x 15" *(1016 mm x 381 mm)*	460 or 600 VAC	6-phase/12-pulse or 9-phase/18-pulse	250	400
				300	500
				400	600
4824	48" x 24" *(1219 mm x 610 mm)*	460 or 600 VAC	6-phase/12-pulse, 9-phase/18-pulse, or 12-phase/24-pulse	500	800
				600	1000
				800	1200



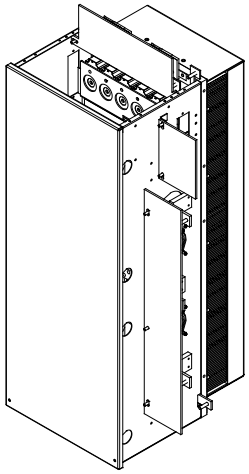
Form 1710



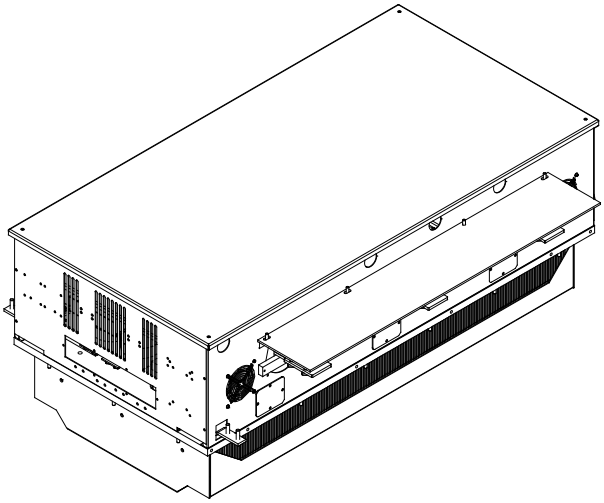
Form 2415 (12-Pulse)



Form 2415 (18-Pulse)



Form 4015



Form 4824

Figure 2-4: Series 1201 Drive Forms

3 Mechanical Installation

3.1 Overview

Proper mechanical installation of the drive is essential for safe, reliable operation and to simplify electrical wiring and maintenance. This chapter provides information and instructions for determining the best mounting location, selecting an enclosure, planning a layout, and installing the unit.

3.2 Unpacking

This unit has been subject to strict packaging guidelines before being released from the factory. However, please check the outer package carefully for any damage that may have occurred during transportation. Do not accept delivery if any obvious damage is observed. Document any damage with photographs if possible and notify the freight agent immediately.

3.3 Verification

Open the packing list provided on the outside of the package. Confirm that the drive model number and any loose parts agree with your order. After opening the package, you should verify that all materials have been received and inspect the drive for any damage before installing, storing, or transporting the unit. Contact your supplier promptly if any item(s) are missing or damaged.

3.4 Storage/Transportation

If the drive must be stored or transported to another location before installation, verify that the ambient conditions are acceptable according to the environmental specifications given in Table 9-2. Choose a storage location that is clean, dry, and noncorrosive. Repack and store the drive in its original packaging.

3.5 Lifting

Before attempting to lift a drive out of its packaging, remove all packing material and braces from around the components. Carefully unpack any loose parts. Make sure that any bolts or screws used to secure the drive during shipment are removed.

Drives are designed to be supported by the base of their heatsink. Small drives may be lifted by this base. Larger drives incorporate lifting brackets to facilitate using a hoist. Avoid contact or pressure on the sides of the cooling fins as this may result in damage to the drive.

Attention

Drives may weigh a considerable amount. To avoid the risk of personal injury and/or product damage follow industry-prescribed safe-lifting practices at all times.

Attention
Do not lift a drive by its cover, even when it is secured by retaining screws. The cover is not intended to support the weight of the unit.

3.6 Notices Regarding Mechanical Installation

Attention
The drive shall not be installed on combustible material due to the risk of fire.

Attention
The drive shall not be installed in direct sunlight.

Attention
The drive shall not be installed within areas in which it may be exposed to hazardous environments such as explosive gases or combustible liquids or dust.

Attention
Do not install the drive if it is damaged or if components are missing. Such installations may lead to personal injury, fire, or other accidents.

Attention

Do not remove or modify the drive without proper authorization.

Attention

Do not drop any foreign matter into the drive (e.g.: wire strands, metal filings, dust etc.) Entry of foreign materials may result in destruction of the drive.

Attention

The drive shall be installed only on a structure capable of supporting its weight.

3.7 Forms

Series 1201 drives come in different forms based on their physical size and construction. These forms correspond to the size of the heatsink to which the power devices are mounted. Refer to Table 2-1 in Chapter 2 to determine the form factor of a drive based on its voltage and power rating.

3.8 Installation Site Considerations

It is important to choose a mounting location that protects the drive from harmful environmental conditions, while safeguarding personnel from the dangerous voltages of the drive system.

3.8.1 Enclosure

Drives may be supplied either as a separate unit or mounted within a larger enclosure as part of a packaged drive system incorporating additional components. For enclosure and package options, please consult the factory.

Attention

To provide protection against electrical shock, units must be mounted in an enclosure meeting at least the requirements of Protective Type IP20 (or NEMA equivalent) according to EN60529 and with top surfaces meeting at least the requirements of IP40 (or NEMA equivalent).

It is recommended that a key or tool be required to open the enclosure and that enclosure doors be interlocked with the electrical supply disconnect.

3.8.2 Operating Environment

The drive should be mounted in an environment that is free from corrosive and volatile vapors, dust and particles, mechanical shock, excessive vibration, water or excessive moisture, and temperature extremes. The required ambient operating conditions are specified in Table 9-2.

3.8.3 Cooling

Thermal management techniques may be necessary to keep the drive operating within required temperature specifications, particularly when units are installed within confined spaces. Drives cool themselves using fans that circulate air across a heatsink designed to be mounted through a cutout in the enclosure. Some applications may require additional ventilating or cooling equipment for additional equipment mounted inside the control enclosure.

3.8.3.1 Thermal Load

Dissipation figures are provided for the control section and heatsink independently (Table 3-2). Since the heatsink is usually mounted through the wall of the enclosure, the losses through the heatsink may be neglected when calculating enclosure cooling requirements. Use this information, in conjunction with the enclosure manufacturer's recommendations, to size the enclosure and to determine additional cooling airflow requirements. Power dissipation of units operating on 380 V power lines is the same as that listed for 460 V.

3.8.3.2 Air Circulation

Flange-mounted drives dissipate heat outside an enclosure by allowing the heatsink to protrude through a cutout in the enclosure wall. Additional fans, vents, heat exchangers, or other cooling equipment may be required if additional equipment within the enclosure generates a significant amount of heat.

3.9 Layout Considerations

The following information should be considered when planning a mechanical layout.

3.9.1 Dimensions and Weights

The physical dimensions and approximate weights for the various drive sizes are provided in Table 3-1.

Attention

Make certain that the mounting surface is strong enough to support the weight of all components to be mounted on it.

3.9.2 Space Requirements

Sufficient space must be provided around each drive for cooling airflow, access to electrical connections, and maintenance. Minimum recommended clearances above and below the drive, to the side of the drive, and behind the heatsink and fans of the various units are indicated in Table 3-1. If multiple drives are to be installed adjacent to each other, allow twice the indicated clearances between units. Be sure to leave enough clearance for removing and replacing the cover during installation and servicing. Additional clearance may be required to allow for an appropriate bending radius of the power conductors.

Table 3-1: Dimensions, Weights, and Mounting Clearances

Form	Overall Dimensions				Weight	Minimum Mounting Clearances		
	Height	Width	Depth	Flange		Vertical	Horizontal	Behind
	in *(mm)*	in *(mm)*	in *(mm)*	in *(mm)*	Lb *(kg)*	in *(mm)*	in *(mm)*	in *(mm)*
1710	17.25	11.38	14.60	10.90	52	3	3	4
	(438)	(289)	(371)	(277)	(23.6)	(76)	(76)	(50)
2415	30.00	15.50	16.44	12.06	114	4	3	6
	(762)	(394)	(418)	(306)	(51.7)	(102)	(76)	(150)
4015	44.13	20.38	18.38	12.44	TBD	4	8	6
	(1121)	(517)	(466)	(316)	TBD	(102)	(200)	(150)
4824	50.00	33.25	12.31	7.38	490	4	8	12
	(1270)	(845)	(313)	(187)	(222)	(102)	(203)	(305)

3.9.3 Orientation

Drives must be mounted upright to permit proper cooling airflow. Under no circumstances should units be installed upside down or on their sides in an attempt to change the direction of airflow or to facilitate wiring.

3.9.4 Cable Routing

Separate electrical conduits are required for incoming power, output to the motor, and control wiring.

3.10 Installation Procedure

Series 1201 Drives are designed to be flange mounted with the heatsink protruding through a cutout in the back of the enclosure. This reduces enclosure cooling requirements since most of the heat generated by the drive is dissipated outside the enclosure. The flange is actually formed by the perimeter of the drive's heatsink, which is provided with integral studs for securing the unit to the enclosure wall. Drives are designed to provide NEMA 4 (IP66) integrity when mounted inside a suitable NEMA 4 enclosure using the gasket provided.

Refer to Figure 3-1 through Figure 3-4 for physical dimensions, mounting hole locations, and cutout sizes.

Allow adequate clearance behind the heatsink and fans for proper airflow.

Attention

Make certain that the mounting surface is secure before mounting the drive unit. Equipment damage could result from an improperly mounted unit.

Attention

Exercise care during installation to prevent metal shavings, conduit knockouts, and other debris from falling into the unit. Personal injury and/or equipment damage could result.

Attention

Drive units may weigh a considerable amount. To avoid the risk of personal injury and/or damage to the equipment, two or more people should work in unison when lifting and maneuvering a unit. Follow industry-prescribed safe-lifting practices at all times.

Attention

Do not lift a unit by its cover, even when it is secured by retaining screws. The cover is not intended to support the weight of the unit. Always rest the unit on its back, never face down or on its side.

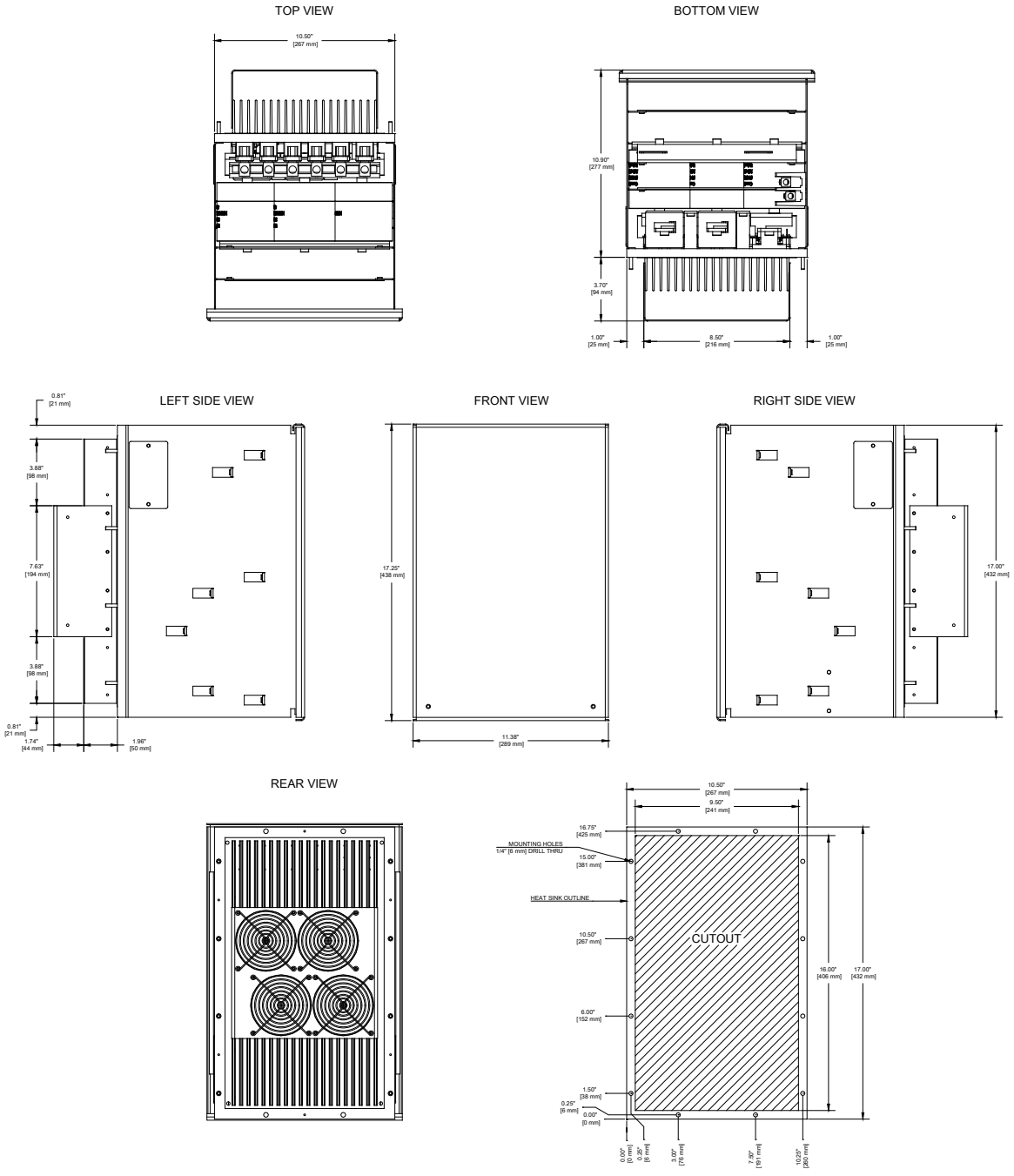


Figure 3-1: Form 1710 Mounting Dimensions

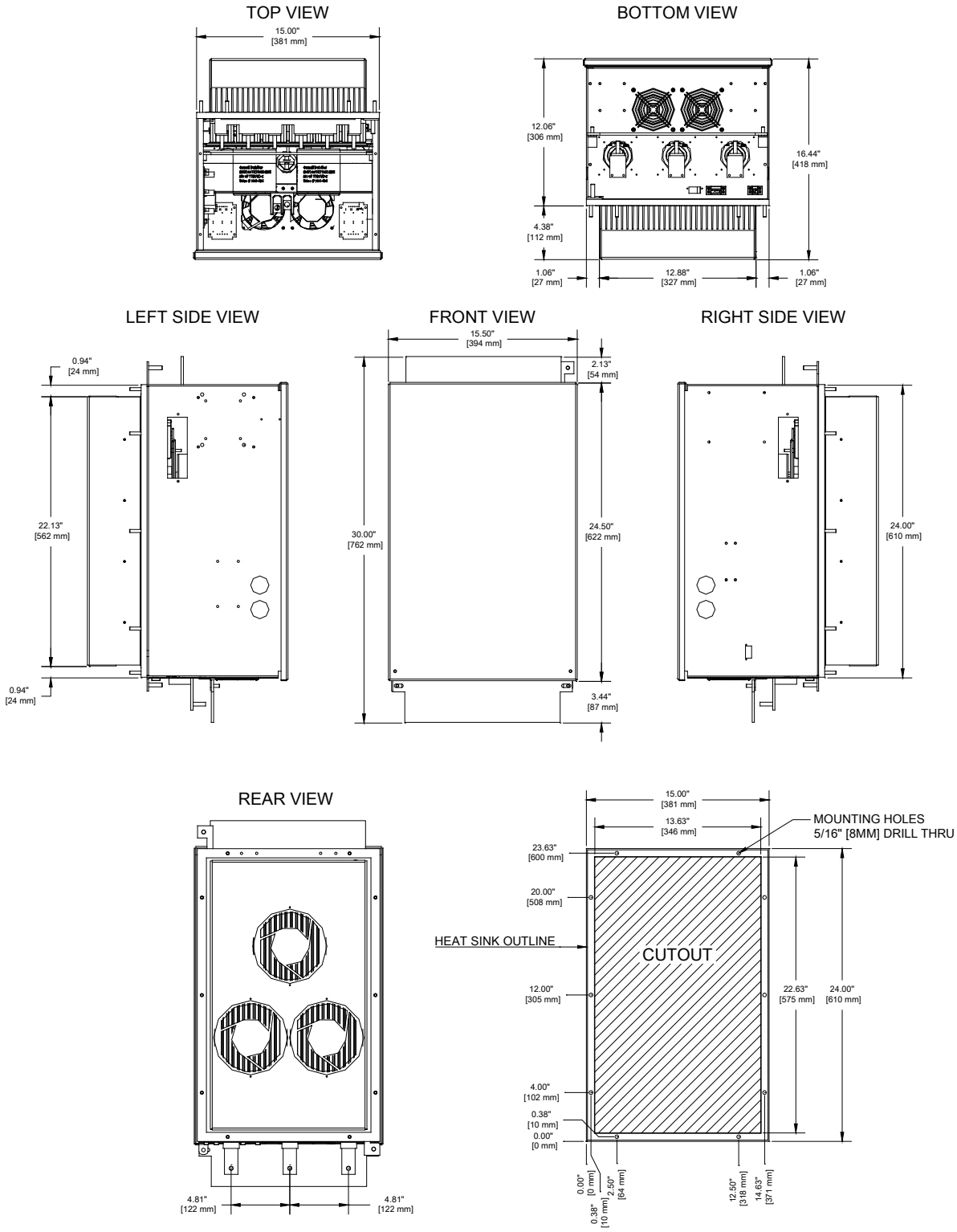


Figure 3-2: Form 2415 Mounting Dimensions

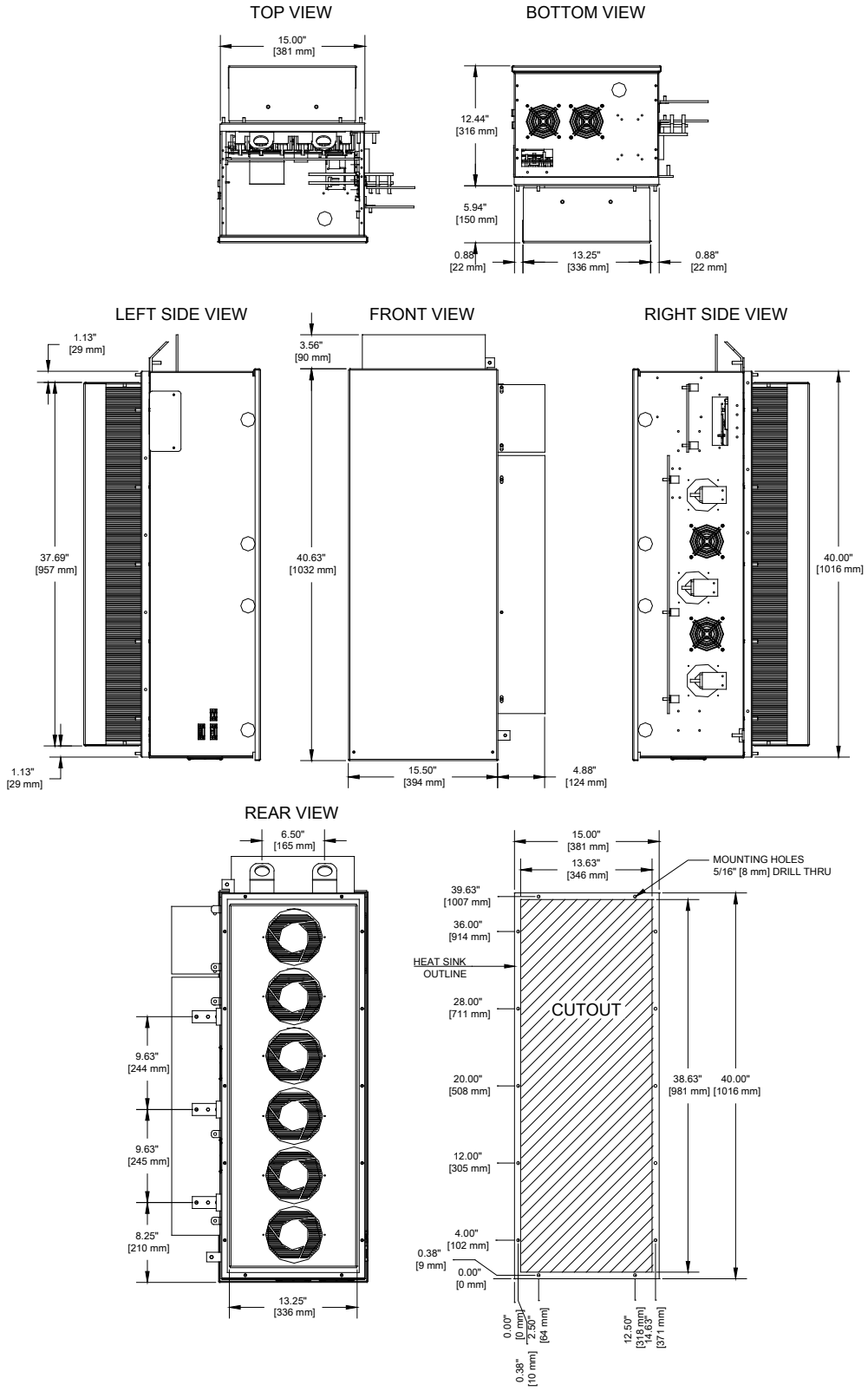


Figure 3-3: Form 4015 Mounting Dimensions

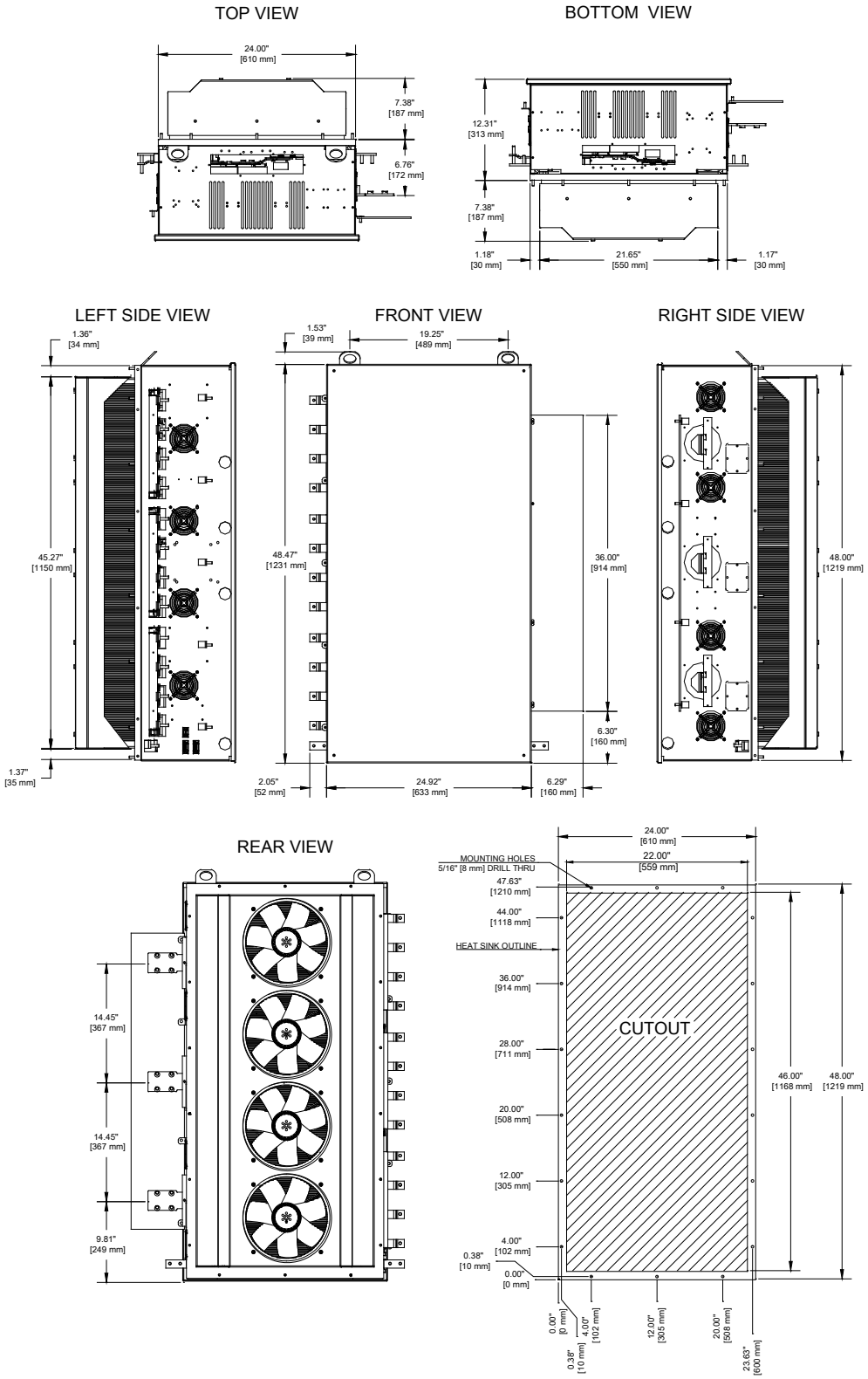


Figure 3-4: Form 4824 Mounting Dimensions

Table 3-2: Power Dissipation

Power Dissipation *(@ 2kHz switching frequency)*			
Normal Duty	**Internal**	**Heatsink**	**Total**
hp (kW)	kW	kW	kW
460 V			
60 *(45)*	0.041	0.699	0.740
75 *(55)*	0.041	0.871	0.913
100 *(75)*	0.041	1.130	1.172
125 *(90)*	0.046	1.421	1.467
150 *(110)*	0.046	1.648	1.694
200 *(150)*	0.087	2.197	2.285
250 *(185)*	0.092	2.747	2.839
300 *(225)*	0.096	3.296	3.392
400 *(300)*	0.109	4.395	4.504
500 *(370)*	0.123	5.494	5.617
600 *(450)*	0.123	6.592	6.715
800 *(600)*	0.241	8.790	9.031
1000 *(750)*	0.254	10.987	11.242
1200 *(900)*	0.281	13.185	13.466

4 Electrical Installation

4.1 Overview

This chapter explains the electrical installation of the drive. It covers grounding, input power, motor output, dynamic braking, and bus connections. Control wiring for the various option modules is covered in Chapter 8, "Options/Accessories." Since control signals vary from application to application, specific wiring instructions may be discussed in the application documentation.

4.2 Wiring Requirements

Follow the instructions below to ensure safe, reliable electrical connections.

4.2.1 Standards and Codes

All wiring must conform to applicable local and national codes.

Attention

The supplier cannot assume responsibility for compliance or noncompliance to any code governing the proper installation of this unit. The following information is intended only as a guide for proper installation. All wiring must conform to the National Electrical Code (NEC), described in publication NFPA-70. Local codes may overrule this information.

4.2.2 Conductors

Size conductors according to the National Electrical Code (NEC) based upon the required current-carrying capacity. All wires should be stranded copper with a rating of 167° F (75° C) or higher.

Solid or flexible copper bar may be used inside the control enclosure for connecting the drive to fuses, circuit breakers, terminals, or other power devices as long as the conductors are properly sized for the application and have the appropriate industry approvals (for example UL).

Wires connected to terminal blocks must not exceed the minimum or maximum gauge limitations of the terminals.

Wires terminating on studs or bolts must use ring lugs to provide a solid connection. Use UL-approved lugs suitable for the currents required.

4.2.3 Power Connections

Form 1710 drives have lugs for input power and ground connections while termination bars are used for the output power. For all other drive forms, copper termination bars are provided for input, output, and ground connections. These bars are fitted with either 5/16 x 18 studs or nuts.

4.2.4 Tightening Torque

Tighten connections by applying the recommended tightening torque indicated in the connection diagrams (Figure 4-1 through Figure 4-4). Use a torque wrench to ensure that connections are properly tightened. The use of Belleville (conical spring) compression washers is recommended to prevent the fasteners from loosening under temperature variations.

4.3 Insulation Tests

Any site insulation tests must be performed before making electrical connections to the drive. These tests should conform to all applicable national and local codes. A suggested procedure for checking installation insulation is outlined below.

Attention

Before performing the insulation tests, make certain that the drive is disconnected from the input power (all R, S, and T terminals). Also verify that the motor cable is disconnected from drive output terminals (U, V, and W) and from the motor.

- Measure the insulation resistance of the motor between the phases and between each phase and protective ground. The voltage range of the meter must be at least equal to the line voltage but not higher than 1,000 V. The insulation resistance must be greater than 1 MΩ.
- Measure the insulation resistance of the motor cable between the phases and between each phase and protective ground. The insulation resistance must be greater than 1 MΩ.

4.4 Ground Connections

Proper grounding procedures are essential to the safe, successful operation of the drive. Careful attention to these procedures can reduce the chances of exposure to electrical shock and prevent electrical noise from disrupting drive operation.

The purpose of grounding is three-fold:

Electrical Safety

Chassis grounds provide a path of least resistance for short circuits and fault currents. This minimizes the shock hazard to personnel and electronic equipment. A good ground is also essential for the correct operation of overcurrent and ground fault detection devices.

Zero Voltage Reference

A solid ground provides a reference potential of zero volts for control and communication circuits. This increases the reliability between source and receiver and prevents the low voltage supplies from floating at dangerously high levels relative to earth ground.

Noise Reduction

High frequency electrical noise is introduced by drive systems via the switching of the power devices. Sensitive electronic equipment can be protected from this noise through the proper use and grounding of shielded cable and conductors.

4.4.1 Common Ground Point

The drive, power supply, motor, and control circuits should all share a common earth ground. All grounds should terminate at a central grounding point such as a ground bus bar or distribution terminal. Ground wires should be star-connected to this point, rather than linking them in series, to avoid creating ground loops that can introduce electrical noise into the system.

Refer to the appropriate connection diagram (Figure 4-1 through Figure 4-4). Ground connection terminal specifications for the various drives are provided in these figures. Refer to Section 4.2 for wiring requirements.

PE

Ground Terminal Designation

Ground terminals are designated by the IEC symbol shown to the left, by PE (protective earth), or both. Such terminals are internally connected and tied to the chassis or enclosure. They are intended for connecting both the protective earth ground electrode as well as any external protective grounding conductors.

4.4.2 Ground the Drive

The ground terminals (PE) of the drive should be connected to either a grounding electrode buried in the earth or a suitable plant ground with a solid connection to earth ground. The ground connector should be an electrode conductor or bonding jumper of sufficient capacity.

Refer to Publication NFPA No. 70, Article 250, and to the IEEE “greenbook” for details on grounding and grounding electrodes.

4.4.3 Ground the Power Supply

The incoming power supply must be earth grounded for ground fault protection.

4.4.4 Ground the Motor

The motor case must be earth grounded. To minimize electrical noise emissions, it is highly recommended that a ground lead from the motor case return with the motor stator leads and be connected to the drive’s ground terminal rather than the enclosure ground bus bar.

4.4.5 Connect the Control Grounds

Connect the logic common of any low-voltage supplies and the neutral of any control transformers to the ground bus bar or terminal.

4.5 Input Power Supply

When connecting the drives to the input power supply, fuses or a circuit breaker must be used to protect the unit from short circuits. A line reactor, isolation transformer, or multi-pulse autotransformer may also be necessary for conditioning the power source.

Attention

- Do not supply input voltages higher than specified. Higher input voltages may damage the drive.
- Input power should be able to supply at least 1.5 times the inverter capacity.
- Do not connect supply input voltage (R, S, or T) to the output terminals (U, V, and W).
- Do not use power factor correction capacitors on the input or the output.
- Do not run or stop the inverter by applying and removing power. Use only the keypad, digital inputs, or serial commands to operate the drive.
- Do not perform a Megger test.

Attention

The drive itself is not equipped with a supply-disconnecting device. An external supply-disconnecting device must be provided to isolate incoming electrical supplies during installation and maintenance work. This supply-disconnecting device should comply with all applicable national and local codes.

Attention

High voltage may be present even when all electrical power supplies are disconnected. After switching off electrical power, wait at least 15 minutes for bus circuit capacitors to discharge before working on the drive or associated equipment. Use an appropriate voltmeter to further verify that capacitors are discharged before beginning work. Do not rely exclusively on the bus voltage indicator. Dangerous voltage levels may remain even when the indicator is off.

4.5.1 Power Source Conditioning

The use of an AC line reactor and/or isolation transformer is recommended under certain circumstances. The drive is designed for direct connection to AC lines of the correct voltage and impedance. Use the guidelines that follow to determine whether an isolation transformer or line reactor is required. You may purchase isolation transformers and line reactors directly from Unico. Contact the factory for more information.

Impedance Mismatch

Input lines must have a minimum impedance of 1% relative to the rated input kVA of the drive (assume the drive's horsepower rating is approximately equal to its kVA rating). If the line has a lower impedance, a line reactor or isolation transformer must be added ahead of the drive to increase line impedance. If line impedance is too low, transient voltage spikes or interruptions can create excessive current spikes that may cause nuisance input fuse blowing and may damage the drive. Generally, if the kVA capacity of the AC line is greater than four times the rated power of the motor (in horsepower), an isolation transformer or AC line reactor should be used.

No Neutral or Referenced Phase

If the AC input power system does not have a neutral or one phase referenced to ground, an isolation transformer with the neutral of the secondary grounded is highly recommended. If the line-to-ground voltages on any phase exceed 125% of the nominal line-to-line voltage, an isolation transformer with the neutral of the secondary grounded is always required.

Transient Power Interruptions or Voltage Spikes

If the AC line frequently experiences transient power interruptions or significant voltage spikes, an isolation transformer or AC line reactor must be installed. The drive can be damaged by extreme voltage and current spikes.

Power Factor Correction Capacitors

If the AC line supplying the drive has power factor correction capacitors that are switched in and out, an isolation transformer or AC line reactor must be installed between the drive and the capacitors. The drive can be damaged by the extreme voltage and current spikes caused by capacitor switching. If the capacitors are permanently connected and not switched, the guideline for impedance mismatch applies.

4.5.2 Connect the Power Supply

Connect the line power supply leads to the 1201 drive using the appropriate connection diagram (Figure 4-1 through Figure 4-4). Depending upon the drive model and its power rating, the drive may accept a 3-phase, 6-phase, 9-phase, or 12-phase input. If 6-phase (12-pulse) operation is unnecessary, drives may be configured for 3-phase (six-pulse) operation.

The inverter is phase-sequence insensitive, so the input leads may be connected in any order. Make certain that AC power inputs are routed separately from control signals.

4.5.3 Input Protection

The 1201 drives must be protected from short circuits using either a circuit breaker or fusing.

Fuses are not supplied with the unit and must be provided externally. Recommended input fuse current ratings are provided in Table 4-1. Fuse recommendations differ for 3-phase, 6-phase, 9-phase, and 12-phase configurations.

Fuses from other manufacturers may be used as long as they meet the specifications given. Semiconductor fuses provide the highest level of protection and are recommended. UL-listed drives must use UL-recognized fuses under category JFHR2. For help in locating additional UL-recognized fuse manufacturers, please contact the factory.

If a circuit breaker is to be used, determine the proper current rating using the input current and applying a margin of approximately 33%. You may purchase a circuit breaker directly from Unico. Contact the factory directly for more information.

Table 4-1: Recommended Input Fuse Current Ratings

Rated	Input	Fuse Current			
Power	***Current***	**3 Phase**	**6 Phase**	**9 Phase**	**12 Phase**
hp (kW)	A_{rms}	A_{rms}	A_{rms}	A_{rms}	A_{rms}
460 V					
60 *(45)*	66.8	90	60	-	-
75 *(55)*	83.4	125	70	-	-
100 *(75)*	109.4	150	90	-	-
125 *(90)*	137.2	200	125	-	-
150 *(110)*	161.4	225	150	-	-
200 *(150)*	215.2	300	175	125	-
250 *(185)*	269.1	350	225	150	-
300 *(225)*	322.9	450	275	175	-
400 *(300)*	430.5	600	350	225	175
500 *(375)*	538.1	700	450	300	225
600 *(450)*	645.7	1,000	500	350	275
800 *(600)*	861.0	1,200	700	450	350
1000 *(750)*	1076.2	1,400	1,000	600	450
1200 *(890)*	1291.5	1,400	1,000	700	600

4.6 Connect the Motor

Connect the motor leads using the appropriate connection diagram (See Figure 4-1 through Figure 4-4). Motor output terminal specifications for the various drives are indicated in these figures.

Motor leads may be connected in any order. Phasing can be changed in the drive program during commissioning and start-up. Refer to the application program documentation for instructions on motor phasing.

Refer to Section 4.2 for wiring requirements. Use of metal-jacketed motor cable is recommended to minimize noise emissions. Refer to Table 9-4 to determine the output current rating of the drive.

High-frequency voltage switching on these connections necessitates care to minimize electrical noise interference. Make certain that motor outputs are routed separately from control signals and AC input power and that control signals are appropriately shielded.

Figure 4-1: Form 1710 Drive Power Connections

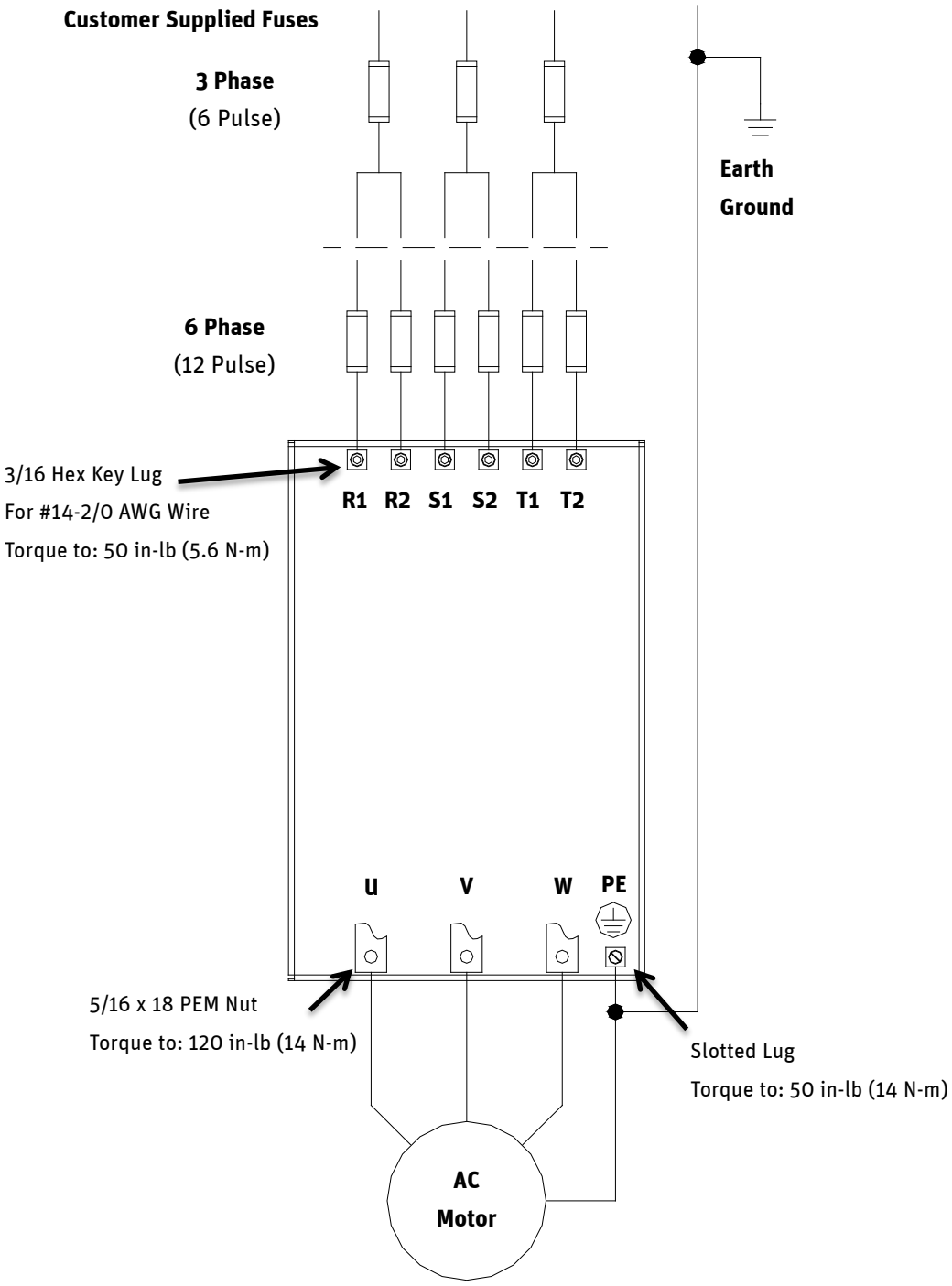


Figure 4-2: Form 2415 Drive Power Connections

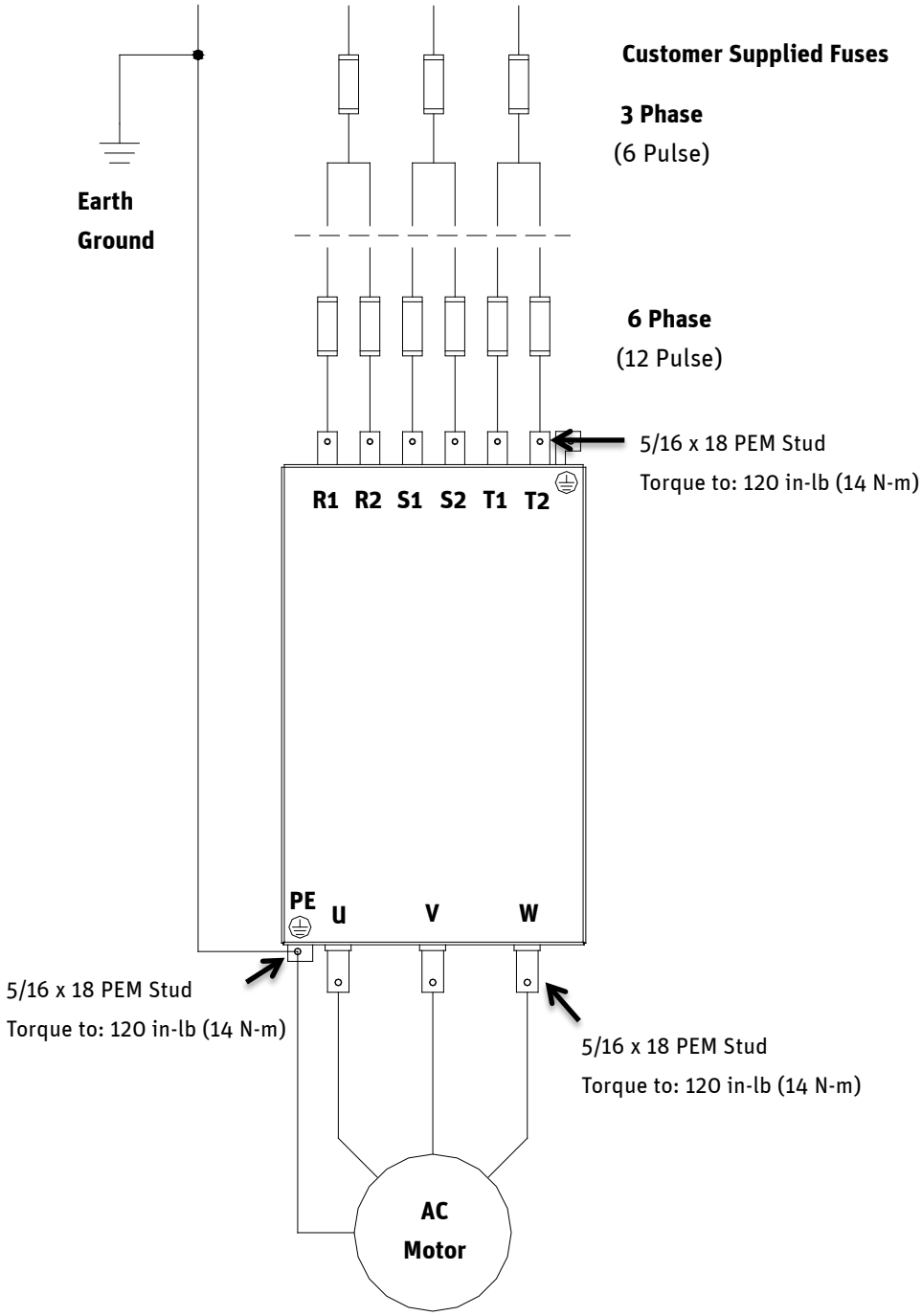


Figure 4-3: Form 4015 Drive Power Connections

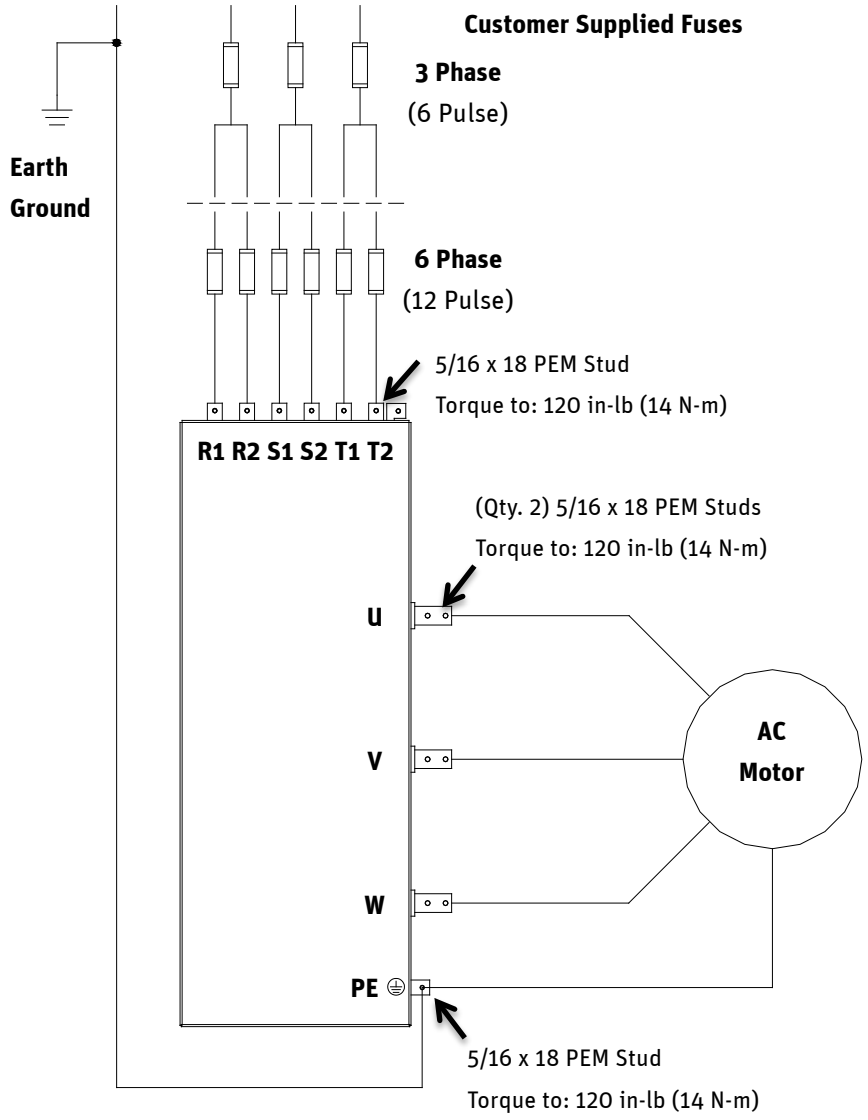
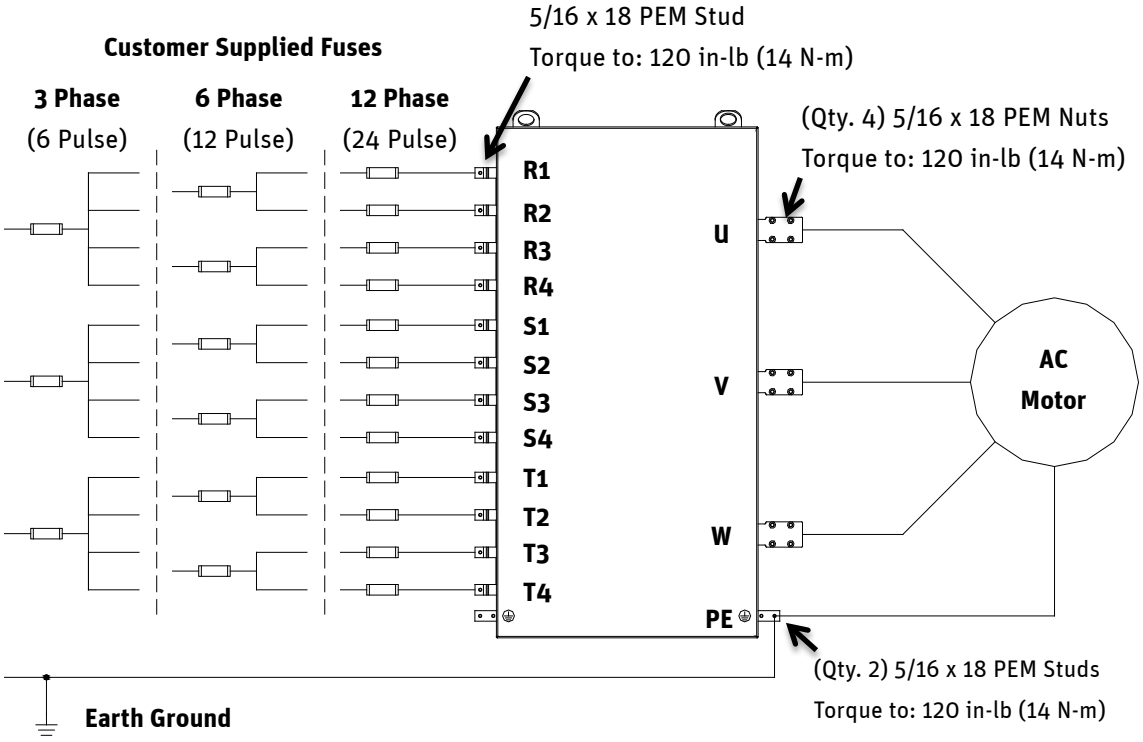


Figure 4-4: Form 4824 Drive Power Connections



4.7 Fan and Control Power

The Form 2415, 4015, and 4824 drives require an external source of power for the heatsink fans and control power. The Series 1201 Form 1710 drive is the only size that derives its low voltage supplies for fan and control power from the DC bus.

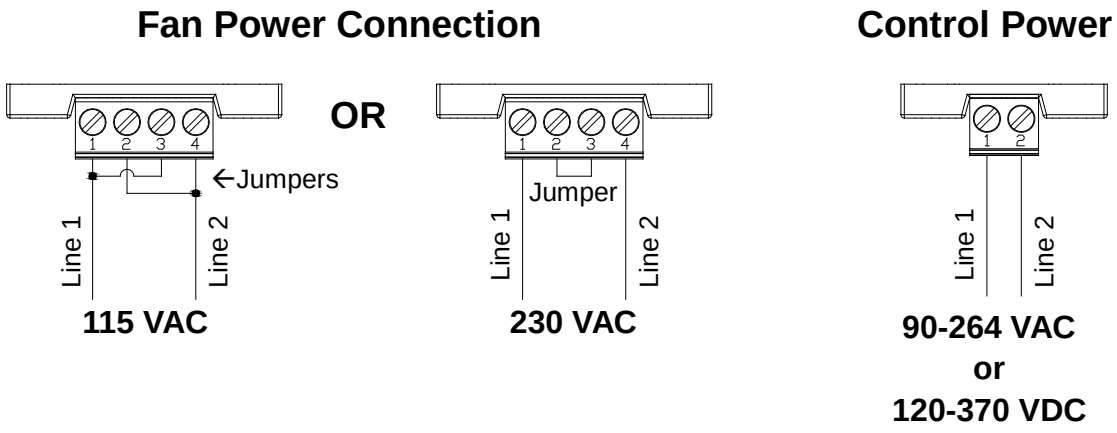
Table 4-2: Power Requirements for 1201 Drives

Form	Fan Voltage*	Fan Power	Control Voltage**	Control Power
2415	115/230 VAC	120 W (1.15A @ 120V)	90-264 VAC or 120-370 VDC	50 W (0.75A @ 120V)
4015	115/230 VAC	240 W (2.3A @ 230V)	90-264 VAC or 120-370 VDC	TBD
4824	115 VAC	740 W (6A @ 120V)	90-264 VAC or 120-370 VDC	100 W (1.5A @ 120V)

*The heatsink fan voltage is configurable as either 115V or 230V by making the following connections to the fan power connector.

Input Voltage	Line 1 Connection	Line 2 Connection	Jumper
115	Pin 1	Pin 4	Pin 1-3 Pin 2-4
230	Pin 1	Pin 4	Pin 2-3

**Control power accepts a universal input voltage. For applications that require extra control power hold-up time, a DC input can be used with external capacitance to extend ride-thru time.



5 Troubleshooting

5.1 Overview

This chapter provides information useful for troubleshooting the drive hardware. It presents power electronics troubleshooting procedures and general troubleshooting guidelines.

This manual is not intended to provide in-depth service instructions. For service beyond that described in this manual, please contact Unico or your representative.

Warning – Electrical Hazard

High voltage may be present even when all electrical power supplies are disconnected. After switching off electrical power, wait at least 15 minutes for bus circuit capacitors to discharge before working on the drive or associated equipment. Use an appropriate voltmeter to further verify that capacitors are discharged before beginning work. Do not rely exclusively on the bus voltage indicator. Dangerous voltage levels may remain even when the indicator is off.

5.2 Theory of Operation

If you are unfamiliar with the operation of a drive, please refer to **Section 2.3.2**, "Drive Architecture."

5.3 Hardware Checks

This section explains how to check the diodes in the rectifier section and the transistors in the inverter section of the drive. These checks will only determine if one of the power devices has failed.

5.3.1 Rectifier Checking Procedure

The rectifier bridge diodes can be checked using a multi-meter on the diode range. Follow the procedure outlined below.

Warning – Electrical Hazard

To avoid an electrical shock and possible damage to the equipment, follow all safety instructions listed in the front of this manual.

[1] Remove Power

Lock-out the incoming power at the main disconnect switch. Use an appropriate meter to verify that all DC bus capacitor banks have been discharged to zero volts before proceeding. Set the meter to DC voltage and read across the bus connections B+ and B-. The reading should 0 V before working on the drive.

[2] Disconnect the Incoming Power Connections

Disconnect all wires from the input terminals of the drive. This will be any terminals labeled with R, S, or T followed by a number. Remove any jumpers between the input phases. Also, unplug the wires from the R, S, and T inputs to the Line Filter Board(s).

[3] Take Readings

Using a multi-meter on the diode setting, take each of the readings indicated in Table 6-1 at the bridge rectifier terminals and check for the appropriate meter reading.

[4] Replace Defective Parts

Any meter reading other than that specified in Table 6-1 indicates a defective diode. Replace defective components or replace the entire drive.

[5] Reconnect the Power Connections

Reconnect all wires to terminals R, S, and T. Reinstall any fuses and jumpers that were removed.

5.3.2 Transistor Checking Procedure

The inverter IGBTs can be checked using a multi-meter. Follow the procedure outlined below:

Warning – Electrical Hazard

To avoid an electrical shock and possible damage to the equipment, follow all safety instructions listed in the front of this manual.

[1] Remove Power

Lock-out the incoming power at the main disconnect switch. Use an appropriate meter to verify that all DC bus capacitor banks have been discharged to zero volts before proceeding. Set the meter to DC voltage and read across the bus connections B+ and B-. The reading should be 0 V before working on the drive.

[2] Disconnect Wires

Disconnect all wires from output terminals U, V, and W.

[3] Take Readings

Using a multi-meter on the diode setting, take each of the readings indicated in Table 6-2 and compare them with the proper values.

[4] Replace Defective Parts

Any meter reading other than that specified in Table 6-2 indicates a defective power device. Replace defective components or the entire drive.

[5] Reconnect

Replace all wires to terminals B+, B-, U, V, and W.

Table 6-1 – Rectifier Checking Terminal Readings

Ohmmeter (+) Lead	Ohmmeter (–) Lead	Proper Meter Reading	Diode Checked
Bus +	R1, R2, R3, R4	Open	DR1+, DR2+, DR3+, DR4+
Bus +	S1, S2, S3, S4	Open	DS1+, DS2+, DS3+, DS4+
Bus +	T1, T2, T3, T4	Open	DT1+, DT2+, DT3+, DT4+
R1, R2, R3, R4	Bus –	Open	DR1–, DR2–, DR3-, DR4-
S1, S2, S3, S4	Bus –	Open	DS1–, DS2–, DS3-, DS4-
T1, T2, T3, T4	Bus –	Open	DT1–, DT2–, DT3-, DT4-
R1, R2, R3, R4	Bus +	0.25 V to 0.40 V	DR1+, DR2+, DR3+, DR4+
S1, S2, S3, S4	Bus +	0.25 V to 0.40 V	DS1+, DS2+, DS3+, DS4+
T1, T2, T3, T4	Bus +	0.25 V to 0.40 V	DT1+, DT2+, DT3+, DT4+
Bus –	R1, R2, R3, R4	0.25 V to 0.40 V	DR1–, DR2–, DR3-, DR4-
Bus –	S1, S2, S3, S4	0.25 V to 0.40 V	DS1–, DS2–, DS3-, DS4-
Bus –	T1, T2, T3, T4	0.25 V to 0.40 V	DT1–, DT2–, DT3-, DT4-

Table 6-2 - Transistor Checking Terminal Readings

Ohmmeter (+) Lead	Ohmmeter (–) Lead	Proper Meter Reading	Transistor Checked
Bus +	B–	Open	Ddb flyback
Bus +	U	Open	QU+
Bus +	V	Open	QV+
Bus +	W	Open	QW+
B–	Bus –	Open	Qdb
U	Bus –	Open	QU–
V	Bus –	Open	QV–
W	Bus –	Open	QW–
B–	Bus +	0.25 V to 0.40 V	Ddb flyback
U	Bus +	0.25 V to 0.40 V	QU+
V	Bus +	0.25 V to 0.40 V	QV+
W	Bus +	0.25 V to 0.40 V	QW+
Bus –	B–	Forms 1, 2, and 3: Open	Qdb
Bus –	U	0.25 V to 0.40 V	QU–
Bus –	V	0.25 V to 0.40 V	QV–
Bus –	W	0.25 V to 0.40 V	QW–

6 Technical Specifications

Table 9-1: Electrical Specifications

Input Supply			
Line Voltage:	Nominally 460V (380 to 480V) or 600V (575 to 690V) AC, 3-phase, 50/60Hz		
	Three-phase (6-pulse)		
	Six-phase (12-pulse) available 60hp ND and above		
	Nine-phase (18-pulse) available 200hp ND and above		
	Twelve-phase (24-pulse) available 800hp ND and above		
	Phase-sequence insensitive		
	Overvoltage Category III (IEC 664-1)		
Frequency:	47 to 63 Hz		
Voltage Tolerance:	–50% to +15% of nominal		
Imbalance:	Maximum ±3% of nominal input voltage		
Short Circuit Rating:	100,000 A_{rms} symmetrical		
Power Factor:	Displacement:		
	1.00 at all loads and speeds		
	Overall:		
	0.94 at rated load		
Control Power:	90-264V AC, 120-370V DC		
Fan Power:	115 or 230V AC (200-600hp ND)		
	115V AC (above 800hp ND)		
Output Rating			
Voltage:	0 ~ input supply voltage, 3-phase		
Frequency:	0 ~ 400 Hz		
Switching Frequency:	Programmable from 1 to 12 kHz		
Service Conditions			
Efficiency:	97% nominal at rated switching frequency		
Overload Current (†):	*Drive Rating*	*Overload (1 min)*	*Maximum*
	Heavy Duty	150%-200% of rated	200% of rated
	Normal Duty	110%-120% of rated	120%-140% of rated

(†) Depending upon the application, the overload may reach the listed upper limit with a corresponding decrease in overload time. Refer to the application documentation for further information.

Table 9-2: Environmental Specifications

Operating Environment	
Temperature:	Control Section: 32°F ~ 131°F (0°C ~ +55°C)
	Heatsink (standard): -40°F ~ 104°F (-10°C ~ +40°C)
	Heatsink (derated): -40°F ~ 131°F (-40°C ~ +55°C)
Relative Humidity:	5% to 95%, noncondensing
Altitude:	0 to 3,300 ft. (0 to 1,000 m) above sea level
	Decrease the output power rating by 1% for every 330 ft. (100 m) above 3,300 ft. (1,000 m)
Air Pressure:	20.67" to 31.30" (70 to 106 kPa)
Vibration:	0.075 mm amplitude(10 Hz ≤ f ≤ 57 Hz) and
	1 g (57 Hz < f ≤ 150 Hz), sinusoidal (see Table 27 of IEC 61800-5-1)
Pollution:	Nonconductive pollution according to Pollution Degree 2 of IEC 664-1
	If the drive is to be used in a more polluted environment (Pollution Degree 3 or 4), suitable enclosures and air filtering or conditioning equipment must be used. To protect against dust ingress, an IP6x-rated enclosure (or NEMA equivalent) must be used.
Contamination Levels:	Class 3C2 for chemicals (IEC 721-3-3)
	Class 3S2 for dust (IEC 721-3-3)
Storage Environment	
Temperature:	–40°F ~ 158°F (–40°C ~ +70°C)
Relative Humidity:	5% ~ 95%, noncondensing
Air Pressure:	20.67” to 31.30” (70 to 106 kPa)
Transportation Environment	
Temperature:	–40° to 158° F (–40° to 70° C)
Relative Humidity:	5% to 95%, noncondensing
Air Pressure:	20.67" to 31.30" (70 to 106 kPa)

Table 9-3: Performance Specifications

Frequency Control	
Range:	0 to 400 Hz Heavy Duty
	0 to 200 Hz Normal Duty
Resolution:	0.024% with analog input (12-bit)
	0.1 Hz with digital input
Velocity Control	
Range:	0 to 400 Hz Heavy Duty
	0 to 200 Hz Normal Duty
Regulation:	±0.001% of base speed, down to zero with transducer
	±0.5% of base speed, 2 Hz and above, without transducer
Torque Control	
Starting Torque:	Heavy Duty: zero to 150% of rated
	Normal Duty: zero to 110% of rated
Regulation:	±2.0% of maximum with transducer
	±5.0% of maximum without transducer

Table 9-4: Output Current Ratings

Power	Current	Heavy Duty			Normal Duty		
	Continuous	Overload	Maximum	Switch Freq.	Overload	Maximum	Switch Freq.
hp (kW)	A_{rms}	A_{rms}	A_{rms}	*kHz*	A_{rms}	A_{rms}	*kHz*
460 V							
40	52.0	78.0	104.0	4	____	____	___
(30)							
50	65.0	97.5	130.0	4	____	____	___
(37)							
60	77.0	115.5	154.0	4	84.7	104.0	2
(45)							
75	96.0	144.0	192.0	4	105.6	130.0	2
(55)							
100	124.0	186.0	248.0	4	136.4	154.0	2
(75)							
125	156.0	234.0	312.0	4	171.6	192.0	2
(90)							
150	180.0	270.0	360.0	4	198.0	248.0	2
(110)							
200	240.0	360.0	480.0	4	264.0	312.0	2
(150)							
250	300.0	450.0	600.0	4	330.0	360.0	2
(185)							
300	360.0	540.0	720.0	4	396.0	480.0	2
(225)							
400	480.0	720.0	960.0	4	528.0	600.0	2
(300)							
500	600.0	900.0	1200.0	4	660.0	720.0	2
(370)							
600	720.0	1080.0	1440.0	4	792.0	960.0	2
(450)							
800	960.0	1440.0	1920.0	4	1056.0	1200.0	2
(600)							
1000	1200.0	____	____	___	1320.0	1440.0	2
(750)							
1200	1440.0	____	____	___	1584.0	1920.0	2
(900)							

(Continued)

Power	Current	Heavy Duty			Normal Duty		
	Continuous	*Overload*	*Maximum*	*Switch Freq.*	*Overload*	*Maximum*	*Switch Freq.*
hp (kW)	A_{rms}	A_{rms}	A_{rms}	*kHz*	A_{rms}	A_{rms}	*kHz*
600 V							
125 *(90)*	104.0	156.0	208.0	4	____	____	____
150 *(110)*	120.0	180.0	240.0	4	____	____	____
200 *(150)*	160.0	240.0	320.0	4	176.0	208.0	2
250 *(185)*	200.0	300.0	400.0	4	220.0	240.0	2
300 *(225)*	240.0	360.0	480.0	4	264.0	320.0	2
400 *(300)*	320.0	480.0	640.0	4	352.0	400.0	2
500 *(370)*	400.0	600.0	800.0	4	440.0	480.0	2
600 *(450)*	480.0	720.0	960.0	4	528.0	640.0	2
800 *(600)*	640.0	960.0	1280.0	4	704.0	800.0	2
1000 *(750)*	800.0	____	____	____	880.0	960.0	2
1200 *(900)*	960.0	____	____	____	1056.0	1280.0	2

UNICO-Worldwide

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