MMC Smart Drive™

Hardware Manual

Version 1.0

Sheffield Automation, LLC

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Should information not covered in this document be required, contact the Customer Service Department, Sheffield Automation, LLC 660 South Military Road, P.O. Box 1658, Fond du Lac, WI 54936-1658. Telephone us at (800) 558-4808 (within the United States only) or (920) 921–7100.

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1 Introduction to the MMC Smart Drive

1.1 Overview

Features include:

- 230V, Single Phase drives available with power ratings of .5kW, 1kW, and 2 kW
- 460V, Three Phase drives available with power ratings of 1.3kW through 24kW
- Drive firmware in user upgradeable Flash memory
- Serial port for communications with PC-resident PiCPro for Windows
- Internal switch to control a mechanical brake
- Green Power LED and yellow Diagnostic LED
- Motor feedback types include incremental encoder, high resolution encoder, and resolver.
- Eight General Purpose 24VDC Inputs
- Four General Purpose 24VDC outputs
- UL Listed and CE Marked.

1.2 Contents of This Manual

This manual includes the following major topics:

- Information to safely operate and maintain the equipment in a safe manner.
- User responsibilities for product acceptance and storage.
- Power and environmental information for general power, control cabinet, grounding, heat control and handling.
- Procedures for mounting, wiring, and connecting the MMC Smart Drive and standard Sheffield Automation motors recommended for use with the MMC Smart Drive.
- Recommended drive system wiring guidelines for signal separation and differential devices. Methods to ensure ElectroMagnetic Compatibility.
- The location of connectors on the drive and descriptions of their functionality including I/O, encoder, serial interface and motor/brake connector locations and signal descriptions.

- Physical, electrical, environmental and functional specifications/ dimensions.
- Description of the minimal maintenance necessary.
- A troubleshooting chart of potential problems and possible solutions.
- Part numbers and descriptions for the drive and related equipment.

1.3 Software and Manuals

1.3.1 Required Software and Manuals

- PicPro for Windows V14.0 (one of the following)
  - Professional Edition, Part Number M.1300.7213
  - MMC Limited Edition, Part Number M.1300.7214
  - Monitor Edition, Part Number M.1300.7215
- PiCPro for Windows Software Manual V14.0, Part Number M.1300.7592

1.3.2 Suggested Manuals

- Function/Function Block Reference Guide V14.0, Part Number M.1300.7591
- Motion Application Specific Function Block Manual V14.0.1, Part Number M.1300.7573
- Ethernet Application Specific Function Block Manual V14.0.1 Part Number M.1300.7521
- General Purpose Application Specific Function Block Manual V13.0.1, Part Number M.1300.7505

1.4 Sheffield Automation Support Contact

Contact your local Sheffield Automation representative for

- Sales and order support
- Product technical training
- Warranty support
- Support service agreements

Sheffield Automation Technical Support can be reached:

- In the United States, telephone (800) 558-4808
- Outside the United States, telephone (920) 921-7100
- In Europe, telephone (+44)151-546-2010,
  fax (+44)151-547-2801
- E-mail address:
  tech.support@giddings.com

NOTES

2 Safety Precautions

READ AND UNDERSTAND THIS SECTION IN ITS ENTIRETY BEFORE UNDERTAKING INSTALLATION OR ADJUSTMENT OF THE MMC SMART DRIVE AND ANY ASSOCIATED SYSTEMS OR EQUIPMENT

The instructions contained in this section will help users to operate and maintain the equipment in a safe manner.

PLEASE REMEMBER THAT SAFETY IS EVERYONE'S RESPONSIBILITY

2.1 System Safety

The basic rules of safety set forth in this section are intended as a guide for the safe operation of equipment. This general safety information, along with explicit service, maintenance and operational materials, make up the complete instruction set. All personnel who operate, service or are involved with this equipment in any way should become totally familiar with this information prior to operating.

2.1.1 User Responsibility

It is the responsibility of the user to ensure that the procedures set forth here are followed and, should any major deviation or change in use from the original specifications be required, appropriate procedures should be established for the continued safe operation of the system. It is strongly recommended that you contact your OEM to ensure that the system can be safely converted for its new use and continue to operate in a safe manner.

2.1.2 Safety Instructions

1. Do not operate your equipment with safety devices bypassed or covers removed.
2. Only qualified personnel should operate the equipment.
3. Never perform service or maintenance while automatic control sequences are in operation.
4. To avoid shock or serious injury, only qualified personnel should perform maintenance on the system.

ATTENTION

Do not touch the main power supply fuses or any components internal to the power modules while the main power supply switch is ON. Note that when the main power switch is OFF, the incoming supply cable may be live.

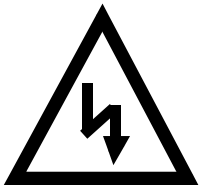
5. **GROUNDING (Protective Earth)**
   The equipment must be grounded (connected to the protective earth connection) according to OEM recommendations and to the latest local regulations for electrical safety. The grounding (protective earth) conductor must not be interrupted inside or outside the equipment enclosures. The wire used for equipment grounding (connection to protective earth) should be green with a yellow stripe.

2.2 Safety Signs

The purpose of a system of safety signs is to draw attention to objects and situations which could affect personal or plant safety. It should be noted that the use of safety signs does not replace the need for appropriate accident prevention measures. Always read and follow the instructions based upon the level of hazard or potential danger.

2.3 Warning Labels

Hazard warning



Danger Electric
Shock Risk

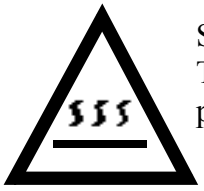
When you see this safety sign on a system, it gives a warning of a hazard or possibility of a hazard existing. The type of warning is given by the pictorial representation on the sign plus text if used.

To ignore such a caution could lead to severe injury or death arising from an unsafe practice.

Danger, Warning, or Caution warning

Symbol plus DANGER, WARNING or CAUTION:
These notices provide information intended to prevent potential personal injury and equipment damage.

Hot Surface warning



Symbol plus HOT SURFACE:
These notices provide information intended to prevent potential personal injury.

2.4 Safety First

Sheffield Automation equipment is designed and manufactured with consideration and care to generally accepted safety standards. However, the proper and safe performance of the equipment depends upon the use of sound and prudent operating, maintenance and servicing procedures by trained personnel under adequate supervision.

For your protection, and the protection of others, learn and always follow these safety rules. Observe warnings on machines and act accordingly. Form safe working habits by reading the rules and abiding by them. Keep these safety rules handy and review them from time to time to refresh your understanding of them.

2.5 Safety Inspection

2.5.1 Before Starting System

1. Ensure that all guards and safety devices are installed and operative and all doors which carry warning labels are closed and locked.
2. Ensure that all personnel are clear of those areas indicated as potentially hazardous.
3. Remove (from the operating zone) any materials, tools or other objects that could cause injury to personnel or damage the system.
4. Make sure that the control system is in an operational condition.
5. Make certain that all indicating lights, horns, pressure gauges or other safety devices or indicators are in working order.

2.6 After Shutdown

Make certain all controlled equipment in the plant is safe and the associated electrical, pneumatic or hydraulic power is turned off. It is permissible for the control equipment contained in enclosures to remain energized provided this does not conflict with the safety instructions found in this section.

2.7 Operating Safely

1. Do not operate the control system until you read and understand the operating instructions and become thoroughly familiar with the system and the controls.
2. Never operate the control system while a safety device or guard is removed or disconnected
3. Where access to the control system is permitted for manual operation, only those doors which provide that access should be unlocked. They should be locked immediately after the particular operation is completed.
4. Never remove warnings that are displayed on the equipment. Torn or worn labels should be replaced.
5. Do not start the control system until all personnel in the area have been warned.
6. Never sit or stand on anything that might cause you to fall onto the control equipment or its peripheral equipment.

7. Horseplay around the control system and its associated equipment is dangerous and should be prohibited.
8.

ATTENTION
 Know the emergency stop procedures for the system.

9. Never operate the equipment outside specification limits.
10. Keep alert and observe indicator lights, system messages and warnings that are displayed on the system.
11. Do not operate faulty or damaged equipment. Make certain proper service and maintenance procedures have been performed.

2.8 Electrical Service & Maintenance Safety

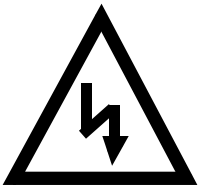
1. **ALL ELECTRICAL OR ELECTRONIC MAINTENANCE AND SERVICE SHOULD BE PERFORMED BY TRAINED AND AUTHORIZED PERSONNEL ONLY.**
2. It should be assumed at all times that the POWER is ON and all conditions treated as live. This practice assures a cautious approach which may prevent accident or injury.
3. To remove power:
   LOCK THE SUPPLY CIRCUIT DISCONNECTING MEANS IN THE OPEN POSITION.
   APPLY LOCKOUT/TAGOUT DEVICES IN ACCORDANCE WITH A DOCUMENTED AND ESTABLISHED POLICY.
4. Make sure the circuit is safe by using the proper test equipment. Check test equipment regularly

5.

ATTENTION

Care should be taken if you are manually discharging the bus capacitors.

WARNING



Even after power to the drive is removed, it may take up to 10 minutes for bus capacitors to discharge to a level below 50 VDC. To be sure the capacitors are discharged, measure the voltage across the + and - terminals for the DC bus.

6. There may be circumstances where troubleshooting on live equipment is required. Under such conditions, special precautions must be taken:
   - Make sure your tools and body are clear of the areas of equipment which may be live.
   - Extra safety measures should be taken in damp areas.
   - Be alert and avoid any outside distractions.
   - Make certain another qualified person is in attendance.
7. Before applying power to any equipment, make certain that all personnel are clear of associated equipment.
8. Control panel doors should be unlocked only when checking out electrical equipment or wiring. On completion, close and lock panel doors.
9. All covers on junction panels should be fastened closed before leaving any job.
10. Never operate any controls while others are performing maintenance on the system.
11. Do not bypass a safety device.
12. Always use the proper tool for the job.
13. Replace the main supply fuses only when electrical power is OFF (locked out).

2.9 Safe Cleaning Practices

1. Do not use toxic or flammable solvents to clean control system hardware.
2. Turn off electrical power (lock out) before cleaning control system assemblies.
3. Keep electrical panel covers closed and power off when cleaning an enclosure.
4. Always clean up spills around the equipment immediately after they occur.
5. Never attempt to clean a control system while it is operating.
6. Never use water to clean control equipment unless you are certain that the equipment has been certified as sealed against water ingress. Water is a very good conductor of electricity and the single largest cause of death by electrocution.

NOTES

3 Installing the Drive

Note: The National Electrical Code and any other governing regional or local codes overrule the information in this manual. Sheffield Automation, LLC does not assume responsibility for the user's compliance or non-compliance with any code, national, local or otherwise, for the proper installation of this drive and associated systems or equipment. Failure to abide by applicable codes creates the hazard of personal injury and/or equipment damage.

3.1 Storing the Drive Before Installation

The drive should remain in the shipping container prior to installation. If the equipment is not to be used for a period of time, store it as follows:

- Use a clean, dry location
- Maintain the storage temperature and humidity as shown in the specifications section of this manual.
- Store it where it cannot be exposed to a corrosive atmosphere
- Store it in a non-construction area

3.2 Unpacking the Drive

Remove all packing material, wedges, and braces from within and around the components. After unpacking, check the name plate Material Number against the purchase order of the item(s) against the packing list. The model number, serial number and manufacturing date code are located on the side of the unit.

3.3 Handling an MMC Smart Drive

The case protects the MMC Smart Drive's internal circuitry against mechanical damage in shipping and handling.

However, like any electronic device, the circuitry can be destroyed by:

- Conditions exceeding those detailed in the specifications tables shown in the Specifications sections in this manual.
- moisture condensing inside the module
- static discharge
- exposure to a magnetic field strong enough to induce a current in the circuitry
- vibration, and other hazards

3.4 Inspecting the Drive Before Installation

Inspect the unit for any physical damage that may have been sustained during shipment.

If you find damage, either concealed or visible, contact your buyer to make a claim with the shipper. If degraded performance is detected when testing the unit, contact your distributor or Sheffield Automation. Do this as soon as possible after receipt of the unit.

3.5 Complying with European Directives

For industrial products installed within the European Union or EEC regions, certain directives and standards apply. See "Conformity" in the Specifications sections of Chapters 5 and 6 for applicable directives.

Servo amplifiers are considered to be subsystems when incorporated into electrical plants and machines for industrial use. The Sheffield Automation servo amplifiers have been designed and tested as such. They bear the CE mark and are provided with a Declaration of Conformance. However, it is the overall machine or system design that must meet European Directives and standards. To help the manufacturer of the machine or plant meet these directives and standards, specific guidelines are provided in this documentation. These include such things as shielding, grounding, filters, treatment of connectors and cable layout.

3.6 Conforming with UL and cUL Standards

Sheffield Automation drives meet safety and fire hazard requirements as outlined in "Conformity" in the Specifications sections of Chapters 5 and 6.

3.7 General Installation and Ventilation Requirements

- The drive must be enclosed in a grounded NEMA12 enclosure offering protection to IP55 such that they are not accessible to an operator or unskilled person, in order to comply with UL® and CE requirements. A NEMA 4X enclosure exceeds these requirements providing protection to IP66.
- The environmental conditions must not exceed those detailed in the specifications tables shown in the Specifications sections in this manual.
- Install the panel on a properly bonded, flat, rigid, non-painted galvanized steel, vertical surface that won't be subjected to shock, vibration, moisture, oil mist, dust, or corrosive vapors.

- Maintain minimum clearances for proper airflow, easy module access, and proper cable bend radius.
- Plan the installation of your system so that you can perform all cutting, drilling, tapping, and welding with the drive removed from the enclosure. Because the drive is of the open type construction, be careful to keep any metal debris from falling into it. Metal debris or other foreign matter can become lodged in the circuitry, which can result in damage to components.

The MMC Smart Drive is suitable for operation in a pollution degree 2 environment (i.e., normally, only non-conductive pollution occurs). Install the drive away from all sources of strong electromagnetic noise. Such noise can interfere with MMC Smart Drive operation.

Protect the MMC Smart Drive system from all the following:

- conductive fluids and particles
- corrosive atmosphere
- explosive atmosphere

Diagrams included with this manual and recommendations may be modified if necessary so the wiring conforms to current NEC standards or government regulations.

Table 3-1: Cabinet Clearance Dimensions

Location	Minimum Clearance
Front of Drive to Enclosure Door	3.0 in. (76.2 mm)
Side of Drive to Cabinet Enclosure Wall	1.5 in. (38.1 mm)
Bottom of Drive to Floor	12.0 in. (304.8 mm)

NOTE

Use filtered or conditioned air in ventilated cabinets. The air should be free of oil, corrosives, or electrically conductive contaminants.

3.8 Controlling Heat Within the System

The MMC Smart Drive hardware case is designed to promote air circulation and dissipate heat. Normally no fans or air conditioners are needed. However, if the environment outside the control cabinet is hot or humid, you may need to use a fan, heat exchanger, dehumidifier or air conditioner to provide the correct operating environment.

Make sure that the temperature and humidity within the drive cabinet does not exceed that which is shown in the specifications sections of this manual.

Make sure that components installed in the cabinet with the MMC Smart Drive do not raise the temperature above system limits and that any hot spots do not exceed specifications. For example, when heat-generating components such as transformers, other drives or motor controls are installed, separate them from the drive by doing one of the following:

- Place them near the top of the control cabinet so their heat output rises away from the MMC Smart Drive.
- Put them in another control cabinet above or to one side of the cabinet with the MMC Smart Drive. This protects the MMC Smart Drive from both heat and electrical noise.

The MMC Smart Drive itself is a source of heat, though in most installations its heat dissipates without harmful effects. System heat is generated from power dissipated by:

- the drive
- field side input/output components
- other drives in the cabinet
- the logic power supply
- external shunt resistors
- line reactors

CAUTION
If the MMC Smart Drive is operated outside the recommended environmental limits, it may be damaged. This will void the warranty.

3.9 Bonding

Connecting metal chassis, assemblies, frames, shields and enclosures to reduce the effects of electromagnetic interference (EMI) is the process of bonding.

Most paints act as insulators. To achieve a good bond between system components, surfaces need to be paint-free or metal plated. Bonding metal surfaces creates a low-impedance exit path for high-frequency energy. Improper bonding blocks this direct exit path and allows high-frequency energy to travel elsewhere in the cabinet. Excessive high-frequency energy can negatively affect the operation of the drive.

3.9.1 Bonding a Subpanel Using a Stud

1. Weld threaded mounting studs to the back of the enclosure.
2. Brush off any non-conductive materials (e.g. paint) from the studs.
3. Remove any non-conductive materials from the front of the subpanel.
4. Position the mounting holes on the subpanel over the mounting studs on the back of the enclosure and slide the subpanel onto the studs.
5. Attach the subpanel to the mounting stud by sliding a star washer over the stud and then turn and tighten a nut onto the stud.

3.9.2 Bonding a Ground Bus Using a Stud

1. Weld threaded mounting studs to the back of the subpanel.
2. Brush off any non-conductive materials (e.g. paint) from the studs.
3. Slide a flat washer over the studs.
4. Remove any non-conductive materials from around the mounting hole on the chassis mounting bracket or ground bus.
5. Position the mounting hole of the chassis or ground bus over the studs on the back of the subpanel and slide the mounting bracket or ground bus onto the stud.
6. Attach the subpanel to the subpanel stud by sliding a star washer and then a flat washer over the stud. Turn and tighten a nut onto the stud.

3.9.3 Bonding a Ground Bus or Chassis Using a Bolt

1. Brush off any non-conductive materials (e.g. paint) from the threaded bolt (s).
2. Slide a star washer over the threaded bolt (s).
3. Use a subpanel having tapped mounting holes. Remove any non-conductive materials from around the mounting holes on both sides of the subpanel.
4. Turn the threaded bolts into the subpanel mounting holes.
5. Slide a star washer onto the threaded end of the bolt.
6. Turn and tighten a nut onto the stud.
7. Slide a flat washer onto the threaded end of the bolt.
8. Position the mounting holes on the groundbus or mounting bracket over the threaded bolts and turn the bolts until they come through the grounding bus or mounting bracket.
9. Slide a star washer onto the threaded end of the bolt.
10. Slide a flat washer onto the threaded end of the bolt.
11. Turn and tighten a nut onto the bolt.

3.9.4 Grounding Multiple Drive Cabinets

1. Mount one bonded ground bus in each cabinet.
2. Designate the cabinet ground bus in one and only one of the cabinets as the common ground bus for all of the cabinets in the system.
3. Connect the ground wires from the ground bus in each individual cabinet ground bus to the designated common ground bus (mounted in only one of the cabinets).
4. Connect the common cabinet ground bus to an external ground system that is connected to a single point ground.

3.9.5 Bonding Multiple Subpanels

Sheffield Automation recommends bonding both the top and bottom of subpanels sharing the same enclosure. Use a 25.4 mm (1.0 in.) x 6.35 mm (0.25) wire braid. Be sure the area around each wire braid fastener is clear of any non-conductive materials. Bond the cabinet ground bus to at least one of the subpanels.

NOTE

Subpanels that are not bonded together may not share a common low impedance path. This difference in impedance may affect networks and other devices that span multiple panels.

3.10 Drive Mounting Guidelines

- A control cabinet for the MMC Smart Drive should have a NEMA-12 rating or better. A cabinet with this rating protects its contents from dust and mechanical damage.
- The cabinet must be large enough to provide adequate air circulation for the MMC Smart Drive and other components. Always allow for adequate air flow through the MMC Smart Drive vents.
- The cabinet must have a rigid non-painted galvanized metal surface to mount the MMC Smart Drive on.
- The cabinet door should open fully for easy access.

IMPORTANT

Post warnings according to National, State, or local codes for the voltage present in the control cabinet. Diagrams included with this manual and recommendations may be modified if necessary so the wiring conforms to current NEC standards or government regulations.

NOTE

This drive contains parts and assemblies that are sensitive to ESD (Electrostatic Discharge). Follow static control precautions during installation, testing, service, or repair of this assembly. Parts and assemblies can be damaged if proper precautions are not taken.

1. Lay out the positions for the drive and accessories in the enclosure.
2. Attach the drive to the cabinet, first using the upper mounting slots of the drive and then the lower. The recommended mounting hardware is M5 metric(#10-32).
3. Tighten all mounting fasteners.

3.11 Drive System Grounding Procedures

The ground of the MMC Smart Drive power source must be connected directly to a ***Single Point Ground*** **(SPG)** tie block. The tie block should be made of brass or copper, bolted or brazed to the control cabinet. If the tie block is bolted rather than brazed, scrape away paint or grease at the point of contact. Put star washers between the tie block and the cabinet to ensure good electrical contact.

Metal enclosures of power supplies, drives, etc., should also have good electrical contact with the SPG.

CAUTION
The Single Point Ground should be the only common point for all the ground lines. If not, ground loops may cause current flow among components of the system which can interfere with proper operation of the MMC Smart Drive.

Devices to be connected directly to the Single Point Ground include:

- Plant safety ground.
- Protective earth ground(s) from the MMC Smart Drive power terminals.
- The metal panel or cabinet on which the MMC Smart Drive is mounted.
- "Common" or "0 V" lines from power supplies that provide +24 power to devices and external power to the I/O modules and the devices to which they are connected.
- Protective grounds from the devices themselves, such as device drivers, machinery, and operator interface devices.
- Protective earth ground from line and load sides of any AC line filters.
- The ground of the power source of the computer workstation, if any, from which you monitor the system operation. An AC outlet in the control cabinet is recommended.
- Single point grounds from other control cabinets, if any, in the system.

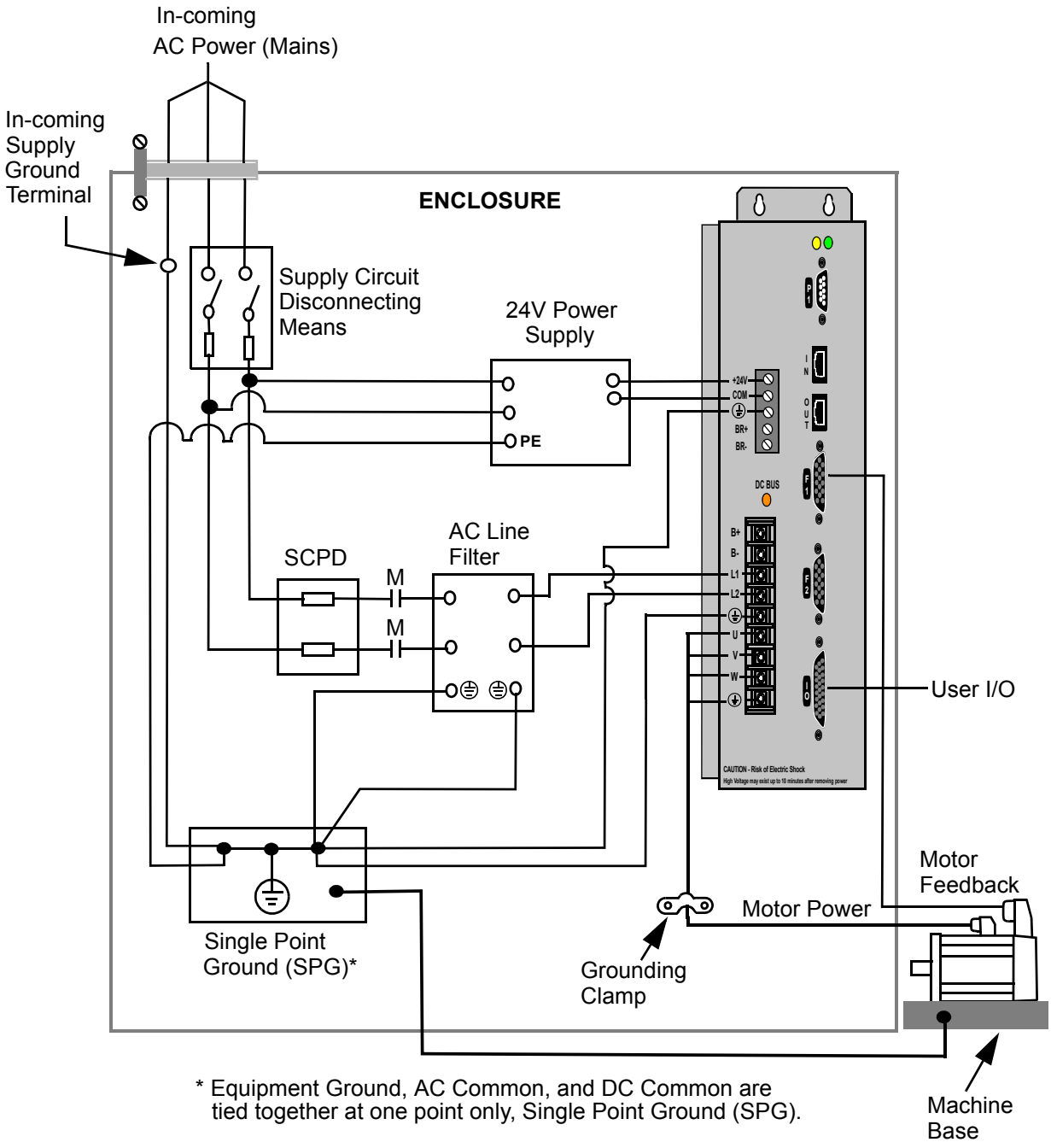
IMPORTANT

You must ensure that the "0V" or "Common" of all devices connected to the MMC Smart Drive are connected to Single Point Ground (SPG). Failure to do so may result in erratic operation or damage to the MMC Smart Drive and devices connected to it. Examples of devices connected to the MMC Smart Drive include the power source that supplies power to the MMC Smart Drive and devices connected to the MMC Smart Drive PiCPro Port. Note that some devices (for example, a Personal Computer) may have their "0V" and "Protective Earth Ground" connected together internally, in which case only one connection has to be made to SPG for that device. Also note that the AC/DC converter for some portable PCs have chassis connected from the wall plug to the PC. The ground for the AC outlet must be connected to the SPG.

Also, you must ensure that the MMC Smart Drive "Protective Earth Ground" connection is connected to SPG, and that the MMC Smart Drive is mounted to a metal panel or enclosure that is connected to SPG.

3.11.1 Grounding Requirements

Figure 3-1: Example of Grounding Required for CE Compliant Single Phase 230V Drive System



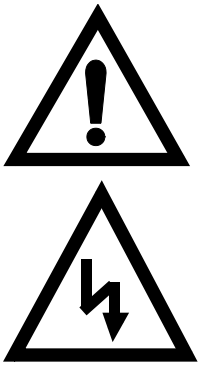
1. Mount the filter as close to the Drive as possible. If the distance exceeds 600 mm (2.0 ft), use shielded cable between the Drive and the filter, strapping the shield to chassis at each end of the cable. This is particularly important for attenuation of higher frequency emissions (5-30 MHz).

2. Shield or separate the wires connecting the AC power to the filter from other power cables (e.g., connections between the Drive and the filter, motor power cable, etc.). If the connections are not separated from each other, the EMI on the Drive side of the filter can couple over to the source side of the filter, thereby reducing or eliminating the filter's effectiveness. The coupling mechanism can radiate or allow stray capacitance between the wires.
3. Bond the filter and the Drive to a grounded conductive surface (the enclosure) to establish a high frequency (HF) connection. To achieve the HF ground, the contact surface interface between the filter, Drive, and the enclosure should be free from paint or any other type of insulator.
4. Size the filter following manufacturer recommendations.
5. Provide a large enough ground bar to connect all wires with no more than two wires per connection.
6. Clamp motor power cable shield for EMC termination.

IMPORTANT

Filter AC power to the drives to be compliant to CE emission requirements.

WARNING



High voltage exists in AC line filters. The filter must be grounded properly before applying power. Filter capacitors retain high voltages after power removal. Before handling the equipment, voltages should be measured to determine safe levels. Failure to observe this precaution could result in personal injury.

3.11.2 Grounding Multiple Drives in the Same Cabinet

1. Mount a common bonded ground bus in the cabinet.
2. Connect the ground wires for all drives to the common bonded cabinet ground bus.
3. Connect the common bonded cabinet ground bus to an external ground system that is connected to a single point ground.

3.12 System Wiring Guidelines

The MMC Smart Drive relies on electrical signals to report what is going on in the application and to send commands to it. In addition, signals are constantly being exchanged within the system. The MMC Smart Drive is designed for use in industrial environments, but some guidelines should be followed.

This section contains common system wiring configurations, size, and practices that can be used in a majority of applications. National Electrical Code, local electrical codes, special operating temperatures, duty cycles, or system configurations take precedence over the values and methods provided.

Wherever possible, install wiring and related components in the following order:

1. main power line disconnecting means
2. transformer (optional)
3. fuses (SCPD)
4. motor control
5. line reactor (as required)
6. line filter (optional)
7. drive
8. shunt resistors (optional)

3.12.1 Recommended Signal Separation

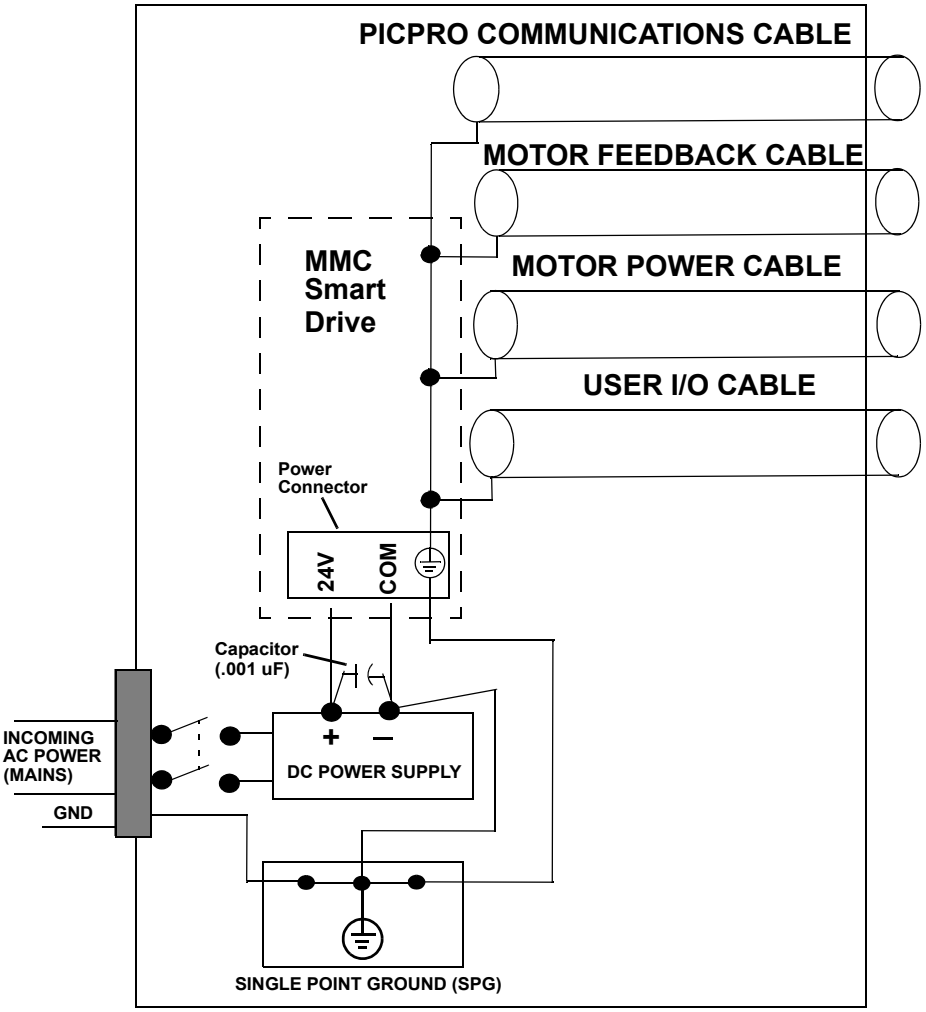
Sheffield Automation recommends separation of low level signals (encoder, analog, communications, fast DC inputs) from high voltage or high current lines. Maintain at least two inches of separation.

Inside a control cabinet, connect the shields of shielded cables at the MMC Smart Drive. It is recommended that factory cables (from Sheffield Automation) are used between MMC drives, controls, and motors to ensure CE compliance.

WARNING

Use care when wiring I/O devices to the MMC Smart Drive and when plugging in cables. Wiring the wrong device to the connector or plugging a connector into the wrong location could cause intermittent or incorrect machine operation or damage to equipment.

Figure 3-2: Recommended Signal Separation



To prevent excessive conducted emissions from a DC power source (typically 24V) used for digital I/O, a .001 micro farad capacitor should be used. Connect the capacitor from the +24V DC to COMMON at the distribution terminals.

3.12.2 Building Your Own Cables

- Connect the cable shield to the connector shells on both ends of the cable for a complete 360 degree connection.
- Use a twisted pair cable whenever possible, twisting differential signals with each other, and single-ended signals with the appropriate ground return.

NOTE
Sheffield Automation cables are designed to minimize EMI and are recommended over hand-built cables.

3.12.3 Routing Cables

Guidelines for routing cables in a cabinet include the following:

- Always route power and control cables separately.
- Do not run high and low voltage wires/cable in the same wireway.
- Cross high and low voltage conductors at 90 degree angles.
- On parallel cable runs, maximize the distance between high and low voltage cables.
- Maintain the least amount of unshielded cable leads.

3.13 Wiring the Drive

These procedures assume you have bonded and mounted your MMC Smart Drive to the subpanel and that there is no power applied to the system.

3.13.1 Sizing the 24V Power Supply

When you size your power supply, you must ensure that the supply is large enough to handle the total load. Refer to the specification tables for the +24VDC input power requirements.

In most cases, one power supply can be used for an entire control system. However, depending upon the drives and external I/O used in the application, the power distribution may be split into two or more power supplies.

Use of switches in series with the 24VDC power input is not recommended. The drive contains energy storage capacitors at the inputs. While no harm is done to the drive, this much capacitance across the 24VDC source may cause voltage dips when the switch in series with the 24VDC power is closed.

.

CAUTION

A possible ignition hazard within the MMC Smart Drive exists if excessive current is drawn from the power line going into the MMC Smart Drive. If these currents might be exceeded (due to improper wiring or external device failure), circuit breakers or fuses should be used in series with the 24 VDC going to and coming from the MMC Smart Drive. Specifically, the circuit breakers or fuses should be sized for 4 A total on the 24V line coming into the MMC Smart Drive. For maximum protection, use fast blow fuses.

The +24V power to the MMC Smart Drive is connected through a Phoenix 5-pin connector with a plug-in terminal block. The ground from the power source and the ground from the MMC Smart Drive must be connected to the Single-Point Ground (SPG). Devices connected to the User I/O Port may have their own power sources for input or output control signals provided that each one is:

- at the correct voltage and current levels for the module and the device.
- connected to the same Single-Point Ground that the MMC Smart Drive uses.

It is recommended that the same main disconnect switch be used for the MMC Smart Drive and for all devices in the application.

IMPORTANT

No matter how the system is installed, before you connect the MMC Smart Drive to the application, make sure that power is off to the system and to the devices that are wired to the MMC Smart Drive.

3.13.2 System AC Power Wiring Guidelines

NOTE
In addition to the guidelines listed below, follow all national and local electrical codes and regulations.

- Install a supply circuit disconnecting means.
- Install a Short Circuit Protective Device (SCPD).
- Refer to the Specifications sections in Chapter 5 and Chapter 6 of this manual for wire sizes and screw terminal torque requirements.
- Clamp the motor power cable shield to the drive using the Sheffield Automation supplied bracket. Maximum tightening torque for bracket screws is 10 lb-in.
- Use shielded cables and AC line filters (for CE Compliance). Make sure that wiring from the drive to the line filter is as short as possible. Locate common grounding bus bars as close as possible to the drive. The braid shield of the cable should be clamped at the drive or mounting panel.
- Power connections for each drive in a system should be separately connected directly to the AC power supply. Do not daisy chain drive power connections.
- Make sure the phase to neutral ground voltage does not exceed the input ratings of the drive when using an autotransformer.
- Due to high inrush current at power-up, use dual element time delay fuses for the SCPD.

3.13.3 Connecting Interface Cables

IMPORTANT
This drive contains ESD (Electrostatic Discharge) sensitive parts and assemblies. Follow static control precautions when installing, testing, servicing, or repairing components in a drive system.

- Plug the 9-pin D-shell, serial PiCPro cable into the PiCPro port.
- Plug the one 15-pin D-shell, Feedback cable into the FBK1 connector.

- Plug the 26-pin D-shell, User I/O cable into the I/O connector.
- Tighten the attachment screws for all cables to the drive connectors.

WARNING

To avoid personal injury and/or equipment damage:

- Ensure installation complies with specifications regarding wire types, conductor sizes, branch circuit protection, and disconnect devices. The National Electrical Code (NEC) and local codes outline provisions for safely installing electrical equipment.
- Ensure motor power connectors are used for connection purposes only. Do not use them to turn the unit on and off.
- To avoid personal injury and/or equipment damage, ensure shielded power cables are grounded to prevent potentially high voltages on the shield.

3.13.4 Preparing Motor Connection Wires

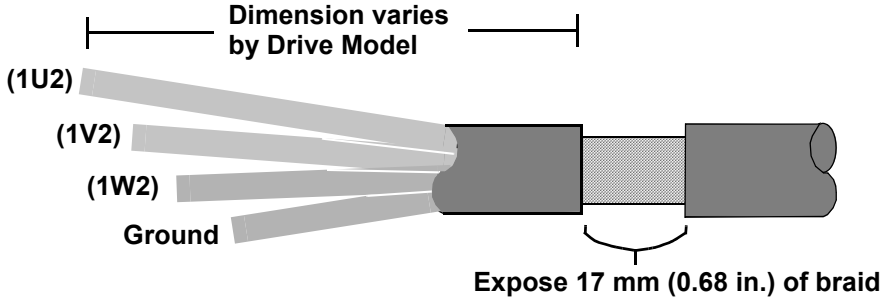
NOTE
It is recommended that Sheffield Automation cables be used. Sheffield Automation cables are designed to minimize EMI and are recommended over hand-built cables.

1. Strip back cable jacket approximately 152 mm (6.0 in.) from the end of the cable.
2. Strip approximately 12 mm (0.50 in.) of insulation from the end of each conductor. Do not tin ends after stripping.

IMPORTANT
Do not nick, cut or damage wire strands while removing wire insulation.

3. Strip the cable jacket away from the cable until the shield braid is visible. Expose 17 mm (0.68 in.) of cable shield braid.

Figure 3-3: : Motor Cable



4. Attach the individual wires from the motor cable to their assigned terminal. Refer to Chapters 5 and 6 for front panel connectors and terminal assignments.
5. Tighten each terminal screw.
6. Gently pull on each wire to make sure it does not come out of its terminal. Reinsert and tighten any loose wires.
7. Attach the plastic cover to terminal block

Factory supplied motor power cables for LSM, MSM, FSM, HSM, XSM, YSM and NSM Series motors are shielded, and the power cable is designed to be terminated at the drive during installation. A small portion of the cable jacket is removed which exposes the shield braid. The exposed shield braid must be clamped to the drive chassis using the provided clamp and clamp screws

Figure 3-4: Terminating Motor Power Cable for 230V Drive

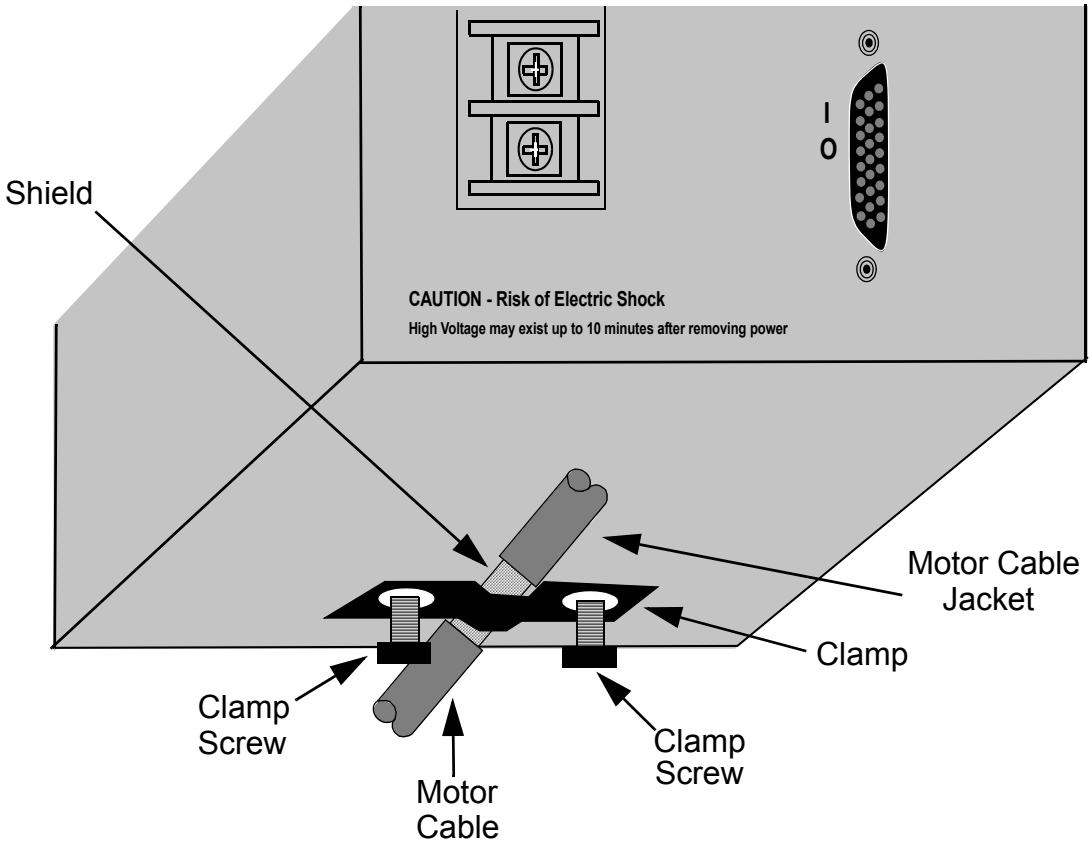
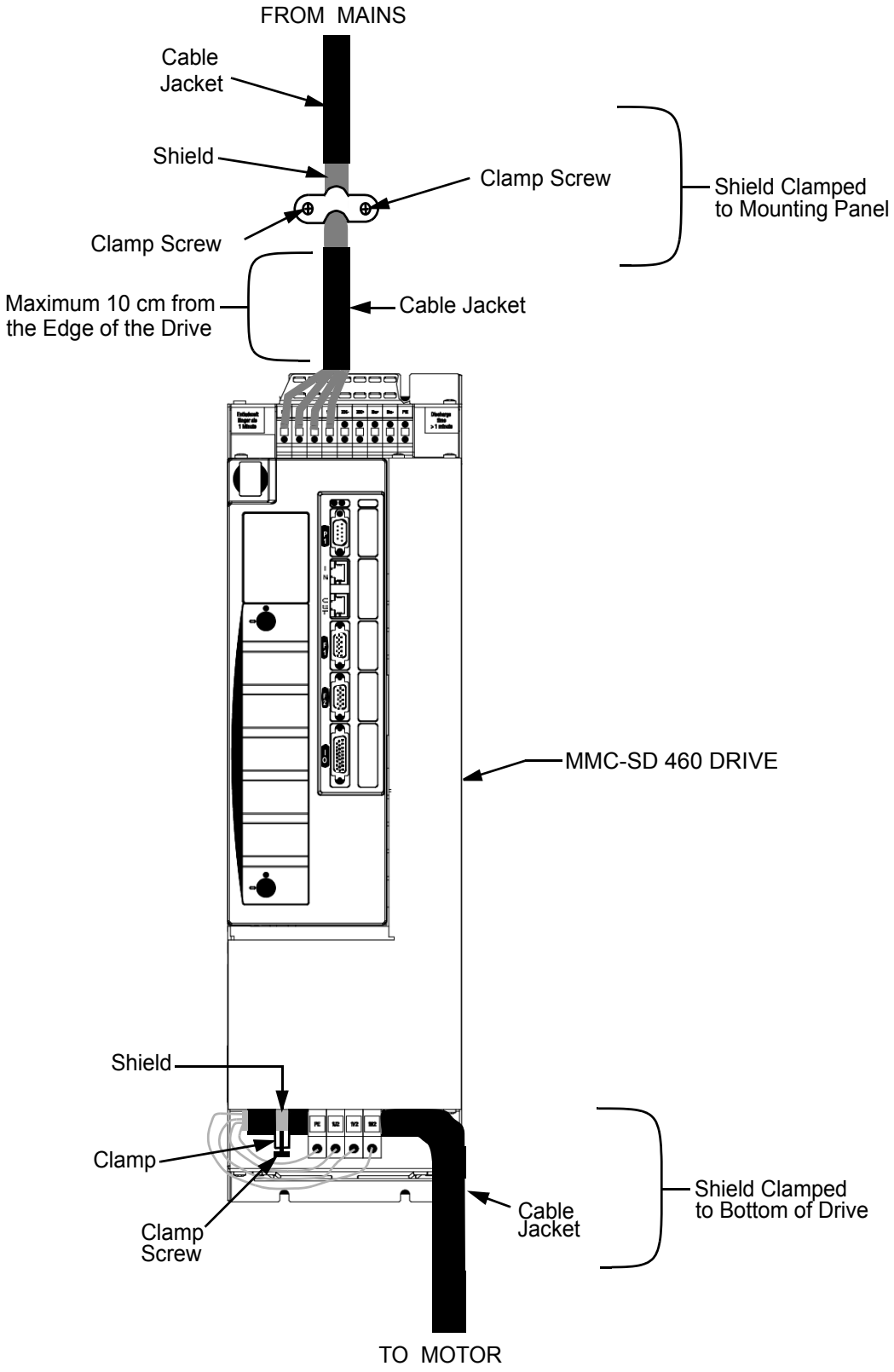


Figure 3-5: Terminating Incoming AC Power (Mains) Cable for 460V Drive



NOTES

4 System Power Protection and Related Devices

4.1 Motor Overload Protection

The MMC Smart Drive utilizes solid state motor overload protection in accordance with UL508C that operates:

- within 8 minutes at 200% overload
- within 20 seconds at 600% overload

4.2 Fuses

4.2.1 Fuse Sizing

Branch circuit Protection must be provided for the MMC Smart Drive in accordance with NFPA 79 7.2.3 and 7.2.10. Class RK1, J, or CC dual element time delay type fuses should be used as the branch circuit SCPD (Short Circuit Protection Device). Supplemental UL1007 protectors shall not be used to provide Branch Circuit Protection. Fuses are sized based on the drive input current rating and maximum SCPD rating designations shown in NFPA 79 Table 7.2.10.1. Input mains conductor size is based on designations shown in NFPA Table 7.2.10.4 and 13.5.1.

Table 4-1: AC Input Power Requirements

Drive Model	Requirements			
	Input Current	Fuse (Amps)	Conductor (AWG)	Transformer (kVA)*
MMC-SD-0.5-230	5	7.5	14	1
MMC-SD-1.0-230	9	15	14	2
MMC-SD-2.0-230	18	30	14	4
MMC-SD-1.3-460	2.5	4	14	1.94
MMC-SD-2.4-460	4.2	7	14	3.33
MMC-SD-4.0-460	7	12	14	5.6
MMC-SD-6.0-460	10.8	17.5	14	8.6
MMC-SD-8.0-460	14.8	25	12	11.8
MMC-SD-12.0-460	16.7	25	12	13.3
MMC-SD-16.0-460	21.1	35	10	16.8
MMC-SD-24.0-460	33.1	50	8	26.3

* See Section 4.5 for calculating application transformer requirements.

Table 4-2: NFPA 79 Table 7.2.10.1 (Extraction)

Fuse Class with Time Delay	Full Load Current (%)		
	AC-2	AC-3	AC-4
RK-1	150	175	175
J	150	175	225
CC	150	300	300

Table 4-3: NFPA 79 Table 7.2.10.4 (Extraction)

Conductor Size (AWG)	Maximum Rating
	Time Delay-Dual Element Fuse (amps)
14	30
12	40
10	50
8	80
6	100

4.3 Short Circuit Protection

Table 4-4: Motor Short Circuit Protection Ratings

Drive	Short Circuit Current Rating with No Fuse Restrictions	Short Circuit Current Rating with Fuse Restrictions
230V Drives	Suitable for use on a circuit capable of delivering not more than 5000 RMS symmetrical short circuit Amperes, 240 Volts maximum.	Suitable for use on a circuit capable of delivering not more than 200,000 RMS symmetrical Amperes, 240 Volts maximum, when protected by high interrupting capacity, current limiting fuses as the SCPD (Fuse Class RK-1, J, or CC).
460V Drives	Suitable for use on a circuit capable of delivering not more than 5000 RMS symmetrical short circuit Amperes, 480 Volts maximum.	Suitable for use on a circuit capable of delivering not more than 200,000 RMS symmetrical Amperes, 480 Volts maximum, when protected by high interrupting capacity, current limiting fuses (Fuse Class RK-1, J, or CC).

4.4 Line Reactors

AC Line Reactors, when required, are mounted between the drive and the mains input power source. They protect the drive from impermissible rates of current and reduce harmonic current distortion.

Line reactors are not necessary for the MMC-SD-230V and the MMC-SD-460V size 1 and 2 drives. Line reactors are required for the MMC-SD-460V size 3 drives and are selected based on the input rated current of the drive.

Table 4-5: AC Line Reactors

Drive Model	Required Line Reactor	Watts Loss	Approximate Weight (lbs.)	Part Number
MMC-SD-12.0-460	25 A	TBD	TBD	M.1302.7038
MMC-SD-16.0-460	25 A	TBD	TBD	M.1302.7038
MMC-SD-24.0-460	41 A	TBD	TBD	M.1302.7039

4.5 Isolation Transformers

The MMC Smart Drive does not require the use of isolation transformers. However, a transformer may be required to match the voltage requirements of the controller to the available service. To size a transformer for the main AC power inputs, the power output (KVA) of each axis must be known. This can be derived by calculating the horsepower for each axis and converting that horsepower into units of watts. If power is being supplied to more than one motor and a drive, simply add the kW ratings together from each calculation to get a system kW total.

For an autotransformer, ensure that the phase to neutral/ground voltages do not exceed the input voltage ratings of the drive.

If you are using the Motions Solutions Sizing Software, the average speed and average torque data has already been calculated and can be used in the equation. If you are not sure of the exact speed and torque in your application, record the speed/torque curve for your drive/motor combination and use the resulting values as a worst case continuous speed and torque.

Calculations are multiplied by a factor to compensate for the power and loss elements within a power system. A factor of 2.0 is used with a single phase system and a factor of 1.5 is used with a three phase system. This factor should minimize the effects of the secondary line voltage sagging in the transformer during peak current periods.

The speed/torque curve information for 230V motors is based upon a drive input voltage of 230V AC. For a 115V AC input voltage, the maximum speed can be reduced up to one half.

Example 230V Formula:

$$KVA = \frac{Speed(RPM) \cdot Torque(lb-in)}{63,025} \cdot \frac{0.746 \cdot KVA}{HP} \cdot 2.0$$

Example 460V Formula:

$$KVA = \frac{Speed(RPM) \cdot Torque(lb-in)}{63,025} \cdot \frac{0.746 \cdot KVA}{HP} \cdot 1.5$$

NOTE
The 3-Phase source powering the drive has to be a center-grounded "Y" configuration. Do not exceed 304 Volts RMS from any phase to ground.

4.6 External Shunts

4.6.1 Choosing an External Shunt

Power from the motor is returned to the MMC Smart Drive during motor deceleration. Excessive power may have to be dissipated from the MMC Smart drive when large inertia loads are present. External shunts should be used to avoid excessive bus over voltage faults.

Sheffield Automation recommends you use the Motion Solutions Sizing Software to determine the need for and type of external shunt. However, you may perform the following calculations to choose the external shunt for your application.

1. Obtain the Peak Generating Power for the drive in watts (W).
2. Perform the following calculation:

   W x T = Watts/sec or Joules

   where:

   W is watts from Step 1 above,

   T is decel time required by the application
3. Obtain the Absorption Energy in Joules for the drive from the Specifications section of the drive manual.
4. Determine the Peak Shunt Power from the drive that would be delivered to the shunt resistor for your application:

   - (Number calculated in Step 2 above) - (Absorption Energy from the drive Specifications table in either Chapter 5 or 6)
     = Watt-seconds
   - (Watt-seconds computed in 5a. above) ÷ (Decel Time for the application) = Peak Shunt Power in Watts
5. Determine the Continuous Shunt Power that would be delivered to the shunt resistor for this application:

   - (Duty Cycle of Peak or Peak x Decel Time) ÷ (Total Cycle Time) = Continuous Shunt Power in Watts
6. Choose an external shunt from Table 4-6 on page 44.

Table 4-6: Part Numbers for Shunt Resistors

Shunt Module	For Drive	Part Number
Dynamic Shunt, 230 Volt, 300 Watts, 100 Ohms	MMC-SD-0.5-230 MMC-SD-1.0-230 MMC-SD-2.0-230	M.1015.7046
Passive Shunt, 460 Volt, 450 Watts, 130 Ohms	MMC-SD-1.3-460 MMC-SD-2.4-460	M.1302.7048
Passive Shunt, 460 Volt, 700 Watts, 95 Ohms	MMC-SD-4.0-460	M.1302.7049
Passive Shunt, 460 Volt, 1400 Watts, 50 Ohms	MMC-SD-6.0-460 MMC-SD-8.0-460	M.1302.7060
Passive Shunt, 460 Volt, 2800 Watts, 25 Ohms	MMC-SD-12.0-460 MMC-SD-16.0-460	M.1302.7061
Passive Shunt, 460 Volt, 3900 Watts, 18 Ohms	MMC-SD-24.0-460	M.1302.7063

4.6.2 Mounting Dimensions for External Shunts

Figure 4-1: Mounting Dimensions for 230V External Shunt (P/N M.1015.7046)

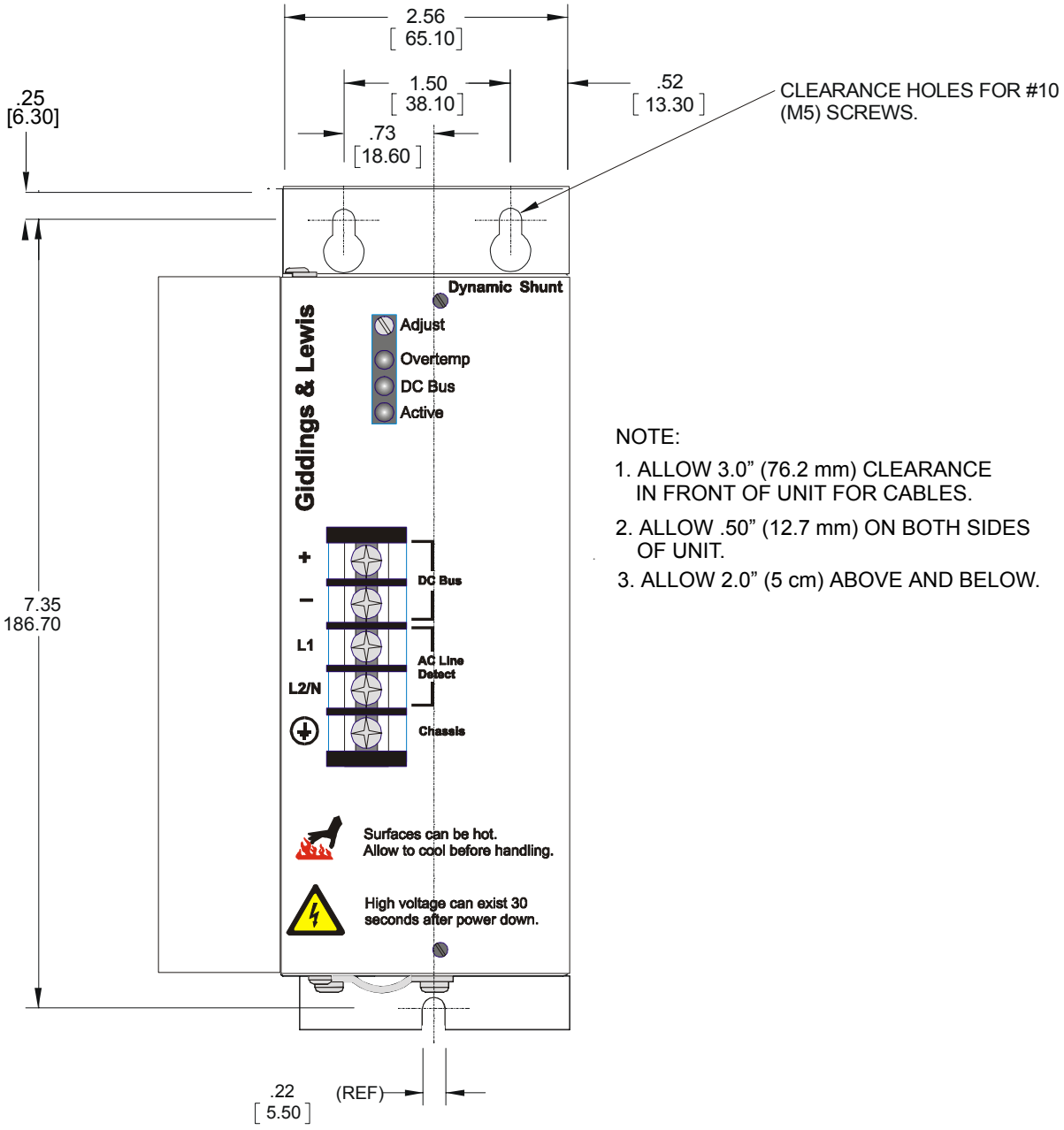


Figure 4-2: Mounting Dimensions for 460V External Shunt (P/N M.1302.7048)

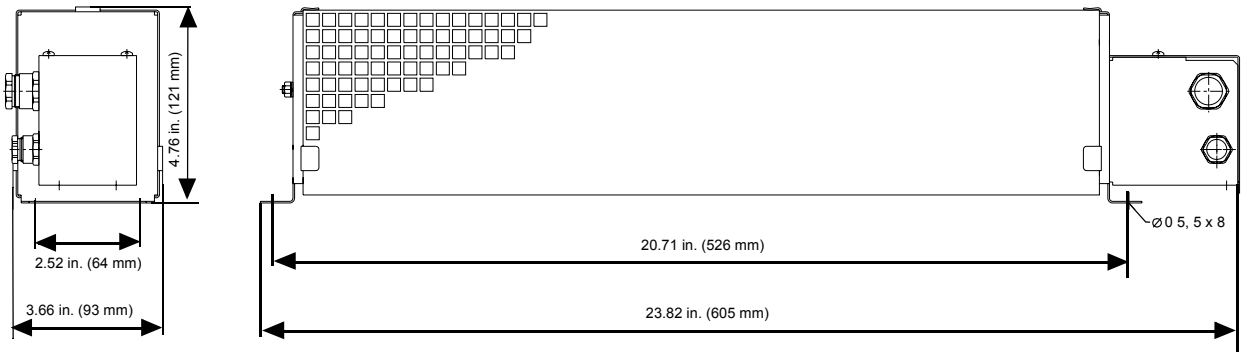


Figure 4-3: Mounting Dimensions for 460V External Shunt (P/N M.1302.7049)

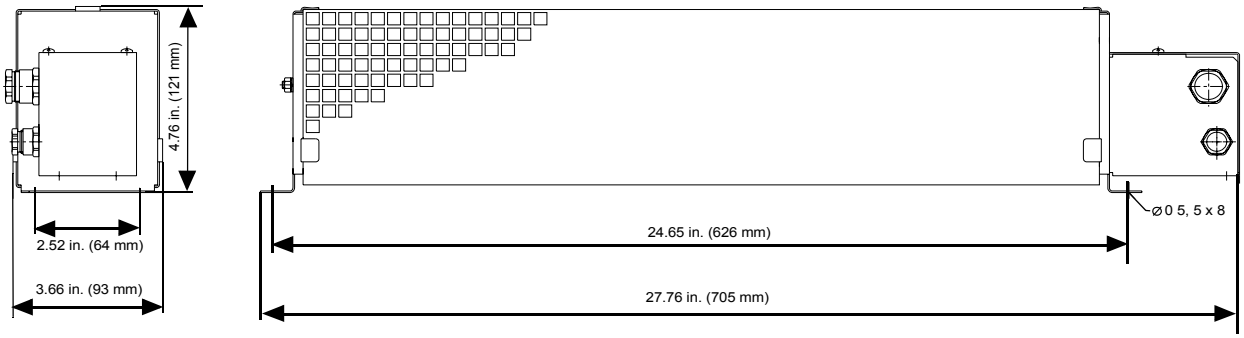


Figure 4-4: Mounting Dimensions for 460V External Shunt (P/N M.1302.7060)

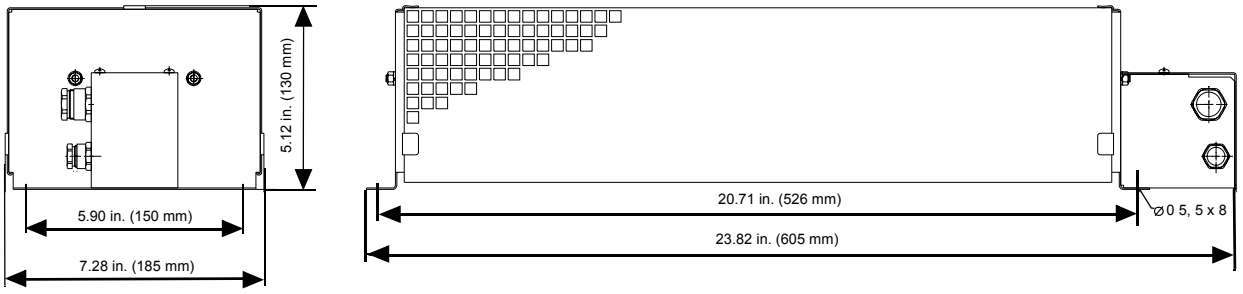


Figure 4-5: Mounting Dimensions for 460V External Shunt (P/N M.1302.7061)

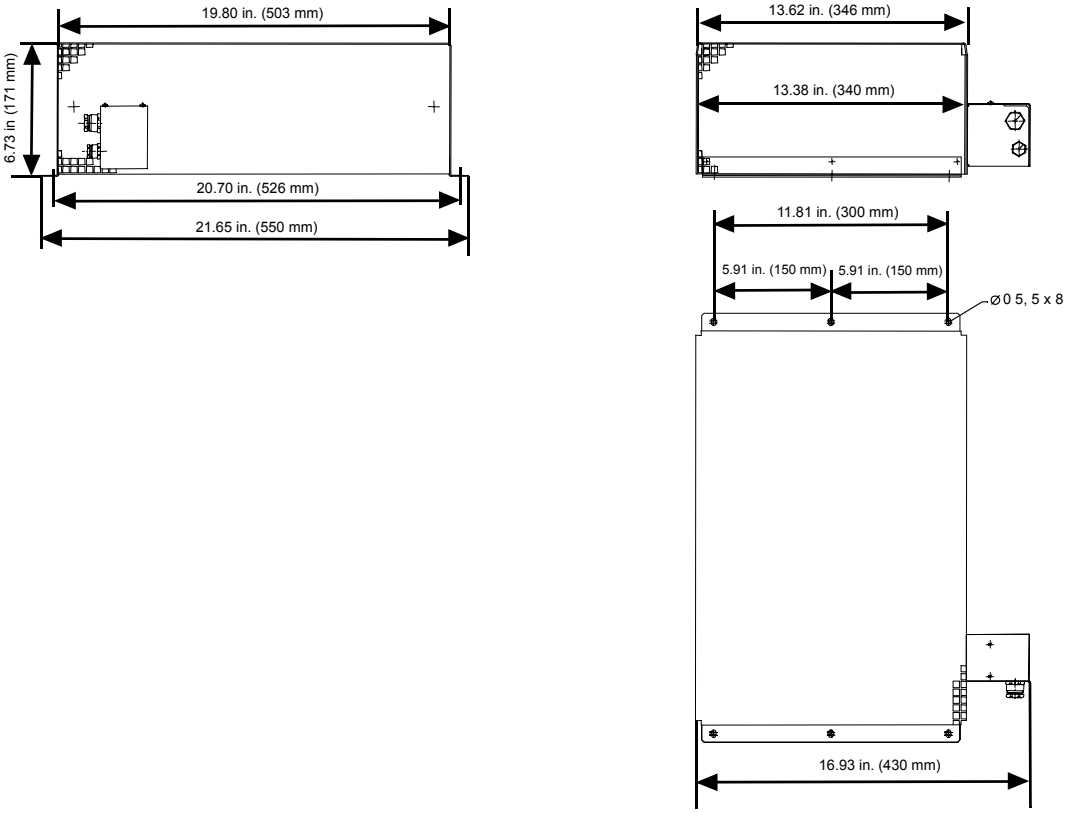
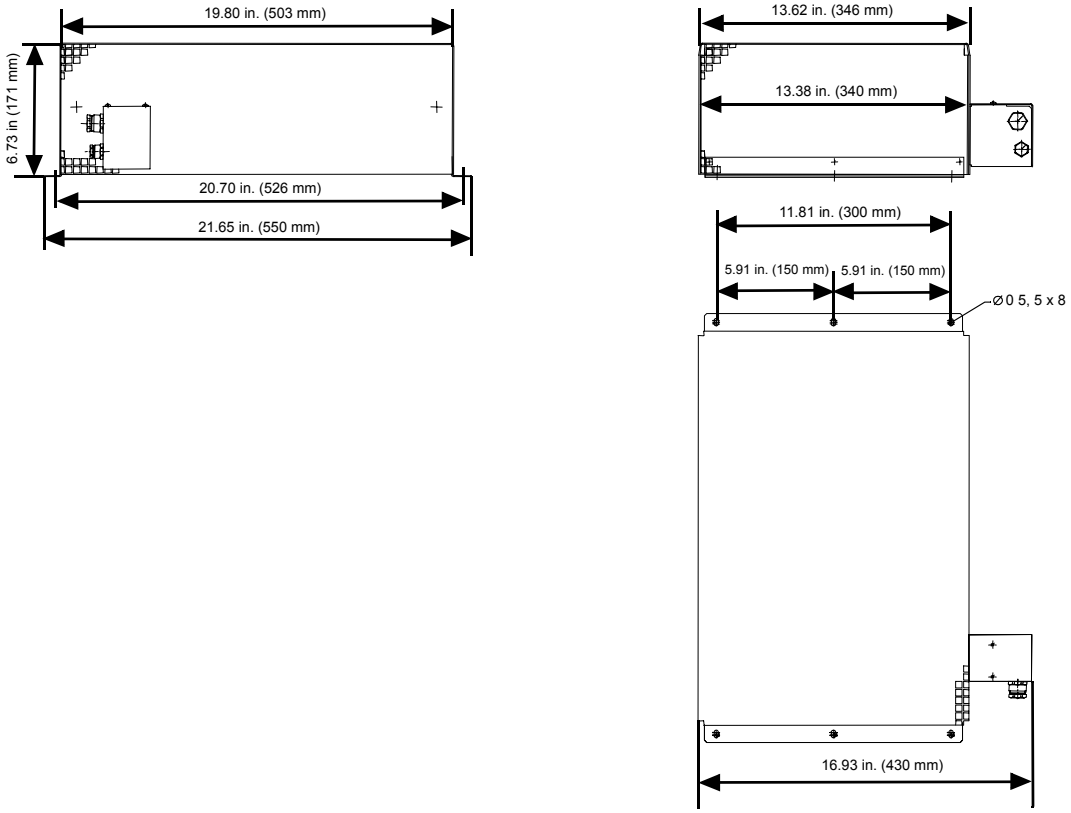


Figure 4-6: Mounting Dimensions for 460V External Shunt (P/N M.1302.7063)



4.7 Line Filters

Line Filters consist of combinations of capacitors, reactors, resistors and voltage limiters that are intended to reduce the electromagnetic influence of the environment.

4.7.1 Line Filters and CE Compliance

The direction of influence is bi-directional, i.e. there is a reaction in the units of emission of conducted disturbances, and, at the same time, an improvement in the immunity of the drive to interference that occurs in the case of lightning strikes, tripped fuses, or simple switching activities.

1. The filter should be mounted to a grounded conductive surface.
2. The filter must be mounted close to the drive input terminals. If the distance exceeds 2 feet (600 mm), then a shielded cable should be used to connect the drive and filter, rather than a wire.
3. The wires connecting the AC source to the filter should be shielded from, or at least separated from the wires (or strap) connecting the drive to the filter. If the connections are not segregated from each other, then the EMI on the drive side of the filter can couple over to the source side of the filter, thereby reducing, or eliminating the filter effectiveness. The coupling mechanism can be radiation, or stray capacitance between the wires. The best method of achieving this is to mount the filter where the AC power enters the enclosure. Figure 4-7 shows a good installation and a poor installation.

Figure 4-7: Block Diagram for 3-Phase Line Filter

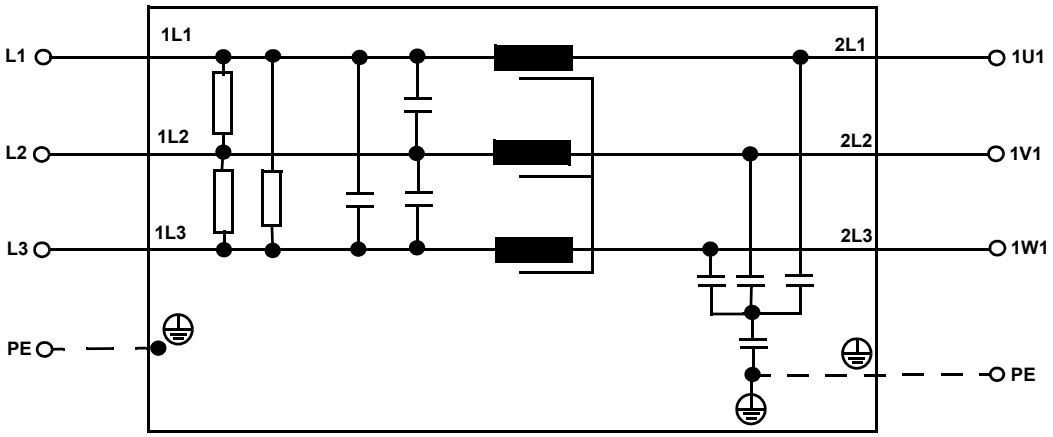
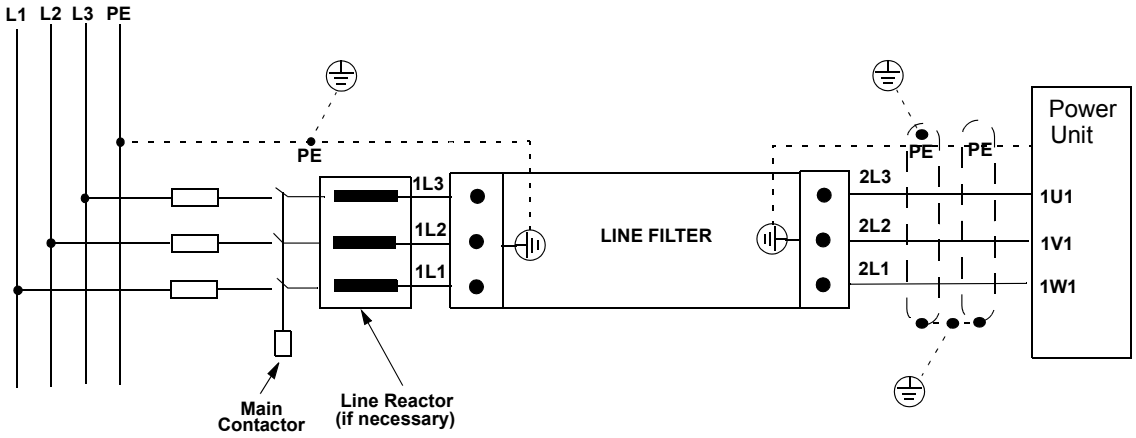


Figure 4-8: Connection Diagram for 3-Phase Line Filter



WARNING

High leakage currents exist in AC line filters. The filters must be grounded properly before applying power. Filter capacitors retain high voltages after removal. Measure voltages to determine safe levels prior to handling the equipment. Failure to do so could result in severe bodily injury.

NOTE

To be able to route the interference currents at low impedance back to the interference sources, the filter, the power unit, and the contact area of the motor cable shield must have a junction with the common mounting plate over as wide a surface as possible that has good conductive properties. The best way to ensure this is to use unpainted zink-coated mounting plates.

4.7.2 Part Numbers for AC Line Filters

Table 4-7: Part Numbers for AC Line Filters

Current	For Drive	Part Number
6 A, 250 V, 1 Phase	MMC-SD-0.5-230 MMC-SD-1.0-230	M.1015.6922
10 A, 250 V, 1 Phase	MMC-SD-2.0-230	M.1015.6917
7 A, 480 V, 3 Phase	MMC-SD-1.3-460 MMC-SD-2.4-460	M.1302.5241
16 A, 480 V, 3 Phase	MMC-SD-4.0-460 MMC-SD-6.0-460 MMC-SD-8.0-460	M.1302.5244
30 A, 480 V, 3 Phase	MMC-SD-12.0-460 MMC-SD-16.0-460	M.1302.5245
42 A, 480 V, 3 Phase	MMC-SD-24.0-460	M.1302.5246
56 A, 480 V, 3 Phase	For filtering multiple drives	M.1302.5247
75 A, 480 V, 3 Phase	For filtering multiple drives	M.1302.5248

4.8 Technical Data for AC Line Filters

4.8.1 Technical Data for 230V Line Filters

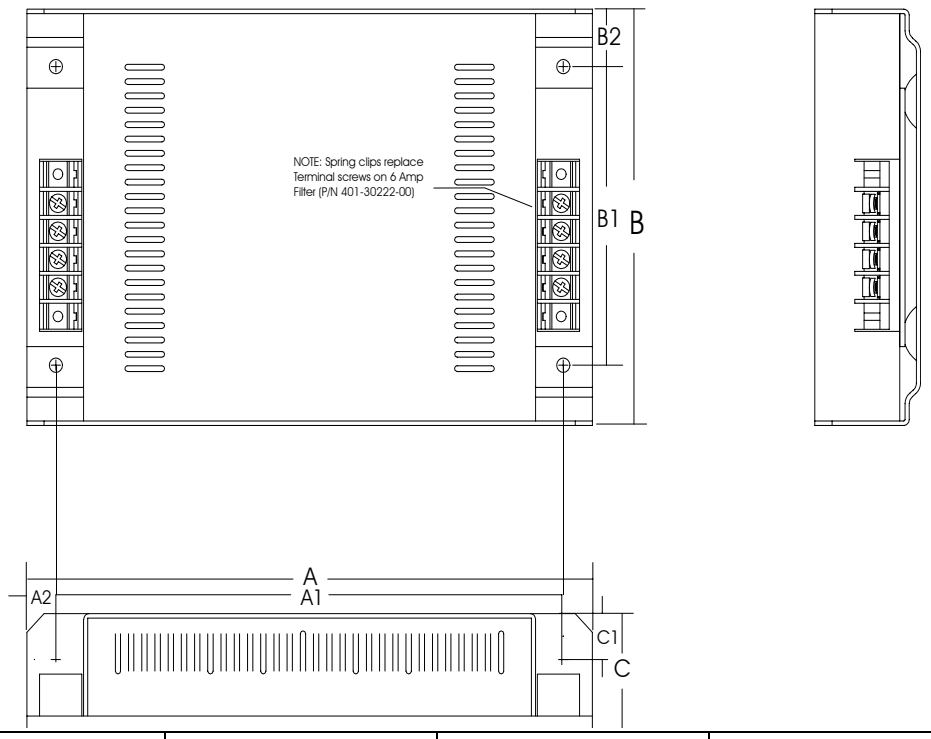
	M.1015.6922	M.1015.6917	M.1015.6918
Voltage/Freq.	250 VAC @ 50/50 Hz	250 VAC @ 50/50 Hz	250 VAC @ 50/50 Hz
Current	6A @ 50°C	10A @ 50°C	23A @ 50°C
Overload Current	150% 1 minute 200% 1 second	150% 1 minute 200% 1 second	150% 1 minute 200% 1 second
Temperature	-25 to 95°C	-25 to 95°C	-25 to 95°C
Leakage Current	5 mA @ 240V, 50 Hz	46 mA @ 240V, 50 Hz	200 mA @ 250V, 50 Hz
Electric Strength	2500 VAC/1 minute	2500 VAC/1 minute	2500 VAC/1 minute
Power Loss	3.5 Watts (Full Load)	2.7 Watts (Full Load)	10 Watts (Full Load)
Terminals	2mm sq. spring clamp	M4 screw cross/ sq. 2x 2.5mm	M4 screw cross/ sq. 2x 2.5mm
Weight	0.3 Kg (0.66 Lb.)	0.95 Kg (2.0 Lb)	1.6 Kg (2.5 Lb)
Back Mounting	4 x M4	4 x M4	4 x M4
Side Mounting	2 x M5	2 x M6	2 x M6
Line filters are manufactured to millimeter dimensions (inches are approximate conversions).			

4.8.2 Technical Data for 460V Line Filters

Item	Part Number					
	M.1302.5241	**M.1302.5244**	**M.1302.5245**	**M.1302.5246**	**M.1302.5247**	**M.1302.5248**
Maximum Supply Voltage	3 x 480 VAC, 50/60 Hz					
Rated current (at 40°C)	7 A	16 A	30 A	42 A	56 A	75 A
Peak current	1.5 x I_N for < 1 min. per hour at T_B = 40°					
Test Voltage Phase/Phase Phase/Ground	2.1 kVDC for 2 sec. at 25°C 2.7 kVDC for 2 sec. at 25°C					
Maximum Connection Cross-section	4 mm^2	4 mm^2	10 mm^2	10 mm^2	4 mm^2	25 mm^2
Operational Environmental Temperature Range T_B	-25°C ... +55°C Reduction of rated current from 40°C onwards by 1.4% / °C					
Power Loss (typical)	4 W	8 W	12 W	15 W	18 W	24 W
Site Altitude	Below 2000 m above sea level (higher altitudes on request)					
Storage Temperature Range	-25°C ... +85°C					
Type of Protection	IP20					
Weight	0.6 kg	1.0 kg	1.3 kg	1.6 kg	1.9 kg	2.6 kg

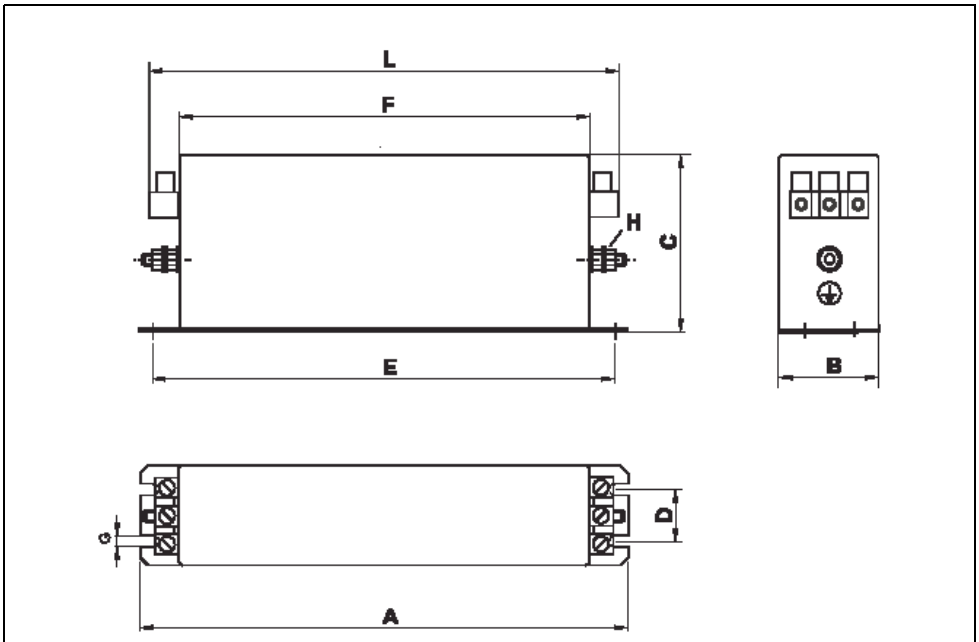
4.8.3 Dimensions for AC Line Filters

4.8.4 230V Line Filter Dimensions



	SINGLE PHASE 6A M.1015.6922		SINGLE PHASE 10A M.1015.6917		SINGLE PHASE 23A M.1015.6918	
MEASUREMENT	**mm**	**in**	**mm**	**in**	**mm**	**in**
A	170	6.7	214	8.4	214	8.4
A1	152	6.0	192	7.6	192	7.6
A2	9	0.4	11	0.4	11	0.4
B	92	3.6	145	5.7	204	8.0
B1	55	2.2	104	4.1	164	6.6
B2	18	0.7	20	0.8	20	0.8
C	25	1.0	40	1.6	47	1.8
C1	10	0.4	16	0.6	19	0.8

4.8.4.1 460V Line Filter Dimensions



Part Number	A	B	C	D	E	F	L	G	H
M.1302.5241	190	40	70	20	180	160	185	5.4	M5
M.1302.5244	250	50	70	25	235	220	245		
M.1302.5245	270	50	85	30	255	240	265		
M.1302.5246	310	50	85	30	295	280	305		M6
M.1302.5247	250	85	90	60	235	220	258		
M.1302.5248	270	80	135	60	255	240	278	6.5	

5 230V Single Phase MMC Smart Drive

5.1 LEDs

Table 5-1: LEDs Description for 230V Single Phase MMC Smart Drive

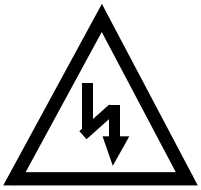
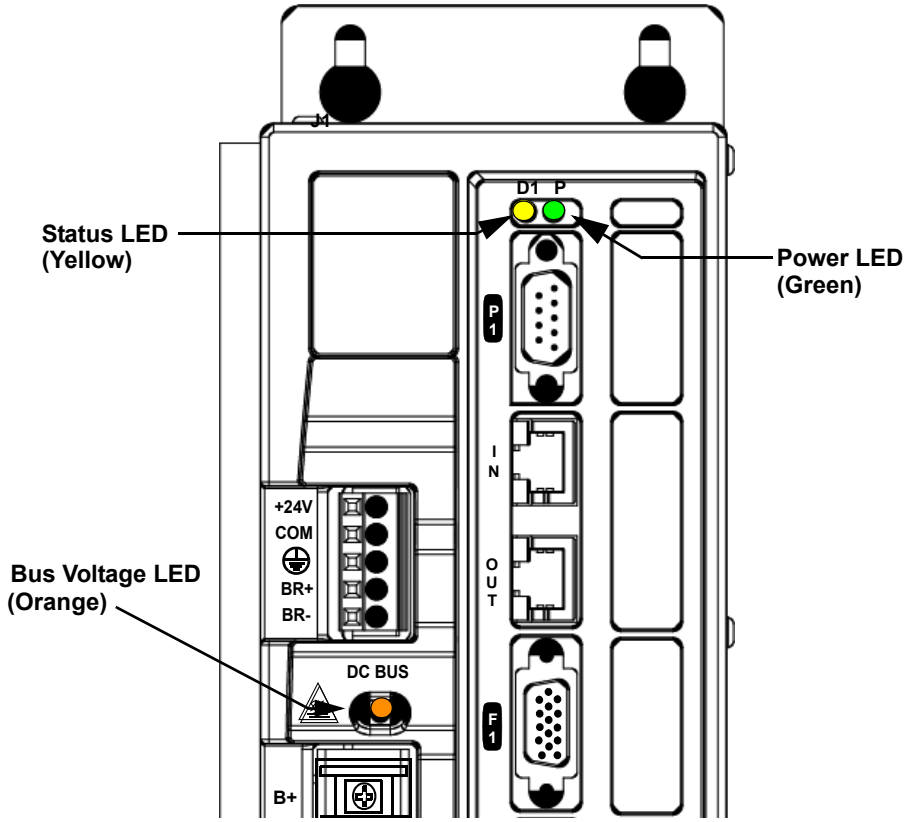
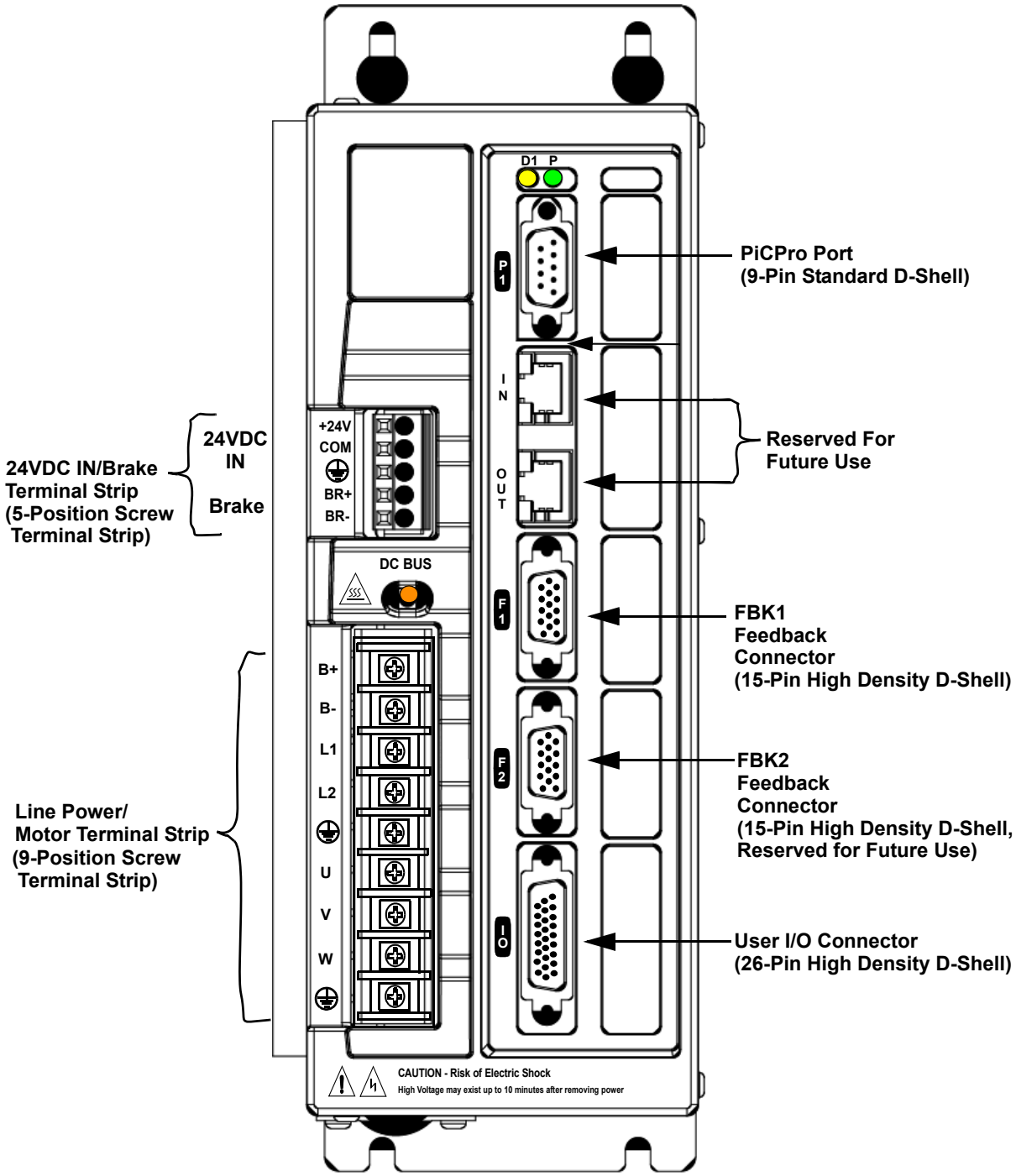
LED	Color	Description
P	Green	Power LED. Indicates when illuminated that power is being supplied to the 24V input terminal strip.
D1	Yellow	Status LED. Drive status and fault information.
DC BUS 	Orange	Bus Voltage LED. Indicates when illuminated that the DC bus is at a hazardous voltage. **DANGER** **DC bus capacitors may retain hazardous voltages for up to ten minutes after input power has been removed. Always use a voltmeter to ensure that the DC bus voltage is below 50VDC before servicing the drive. Failure to observe this precaution could result in severe bodily injury or loss of life.**

Figure 5-1: Location of LEDs on 230V Single Phase MMC Smart Drive



5.2 Connectors on the 230V Drive

Figure 5-2: Front Panel, 230V Single Phase (500W, 1kW, 2 kW)



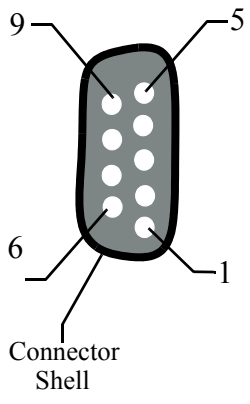
5.2.1 P1 PiCPro Communications Port

The PiCPro port provides serial communication for the PiCPro programming interface.

Table 5-2: Pin Description for PiCPro Communications Port

P1 PiCPro Port Signals		
Function	**Notes**	**Pin**
Receive Data	Receives parameter and control data from the PiCPro for Windows software loaded on a PC.	2
Transmit Data	Transmits data from the user application via the drive to the PiCPro for Windows software loaded on a PC.	3
Data Terminal Ready	Indicates that the drive is ready to send data to the PiCPro for Windows software loaded on a PC.	4
Protective Ground	Provides a path for the ground signal to an external single point ground.	5
Request to send	Sends a request to the PiCPro for Windows software loaded on a PC to send data from the drive to PiCPro.	7
Clear to send	Indicates it is OK for the drive to send data to the PiCPro for Windows software loaded on a PC.	8

Table 5-3: Pin Assignment for PiCPro Communications Port

Pin Assignment P1 PiCPro Port - 230V Single Phase (500W, 1kW, 2kW)			
Pin	**Label**	**In/Out**	**Pin Sequence**
1	NC	N/A	9-pin Male D-sub 
2	Receive Data	In	
3	Transmit Data	Out	
4	Data Terminal Ready	Out	
5	Signal Ground	In/Out	
6	NC	N/A	
7	Request to Send	Out	
8	Clear to Send	In	
9	NC		
Connector Shell	Shield	N/A	

5.2.2 F1 Feedback Connector

- All signals (other than the encoder inputs) are bussed internally between the two feedback connectors F1 and F2. The bussed signals include motor commutation inputs, temperature input, and encoder power outputs.
- F1 can interface with incremental encoders, sinewave encoders, and resolvers (using the optional resolver interface module). These signals are conditioned and routed to the I/O connector.

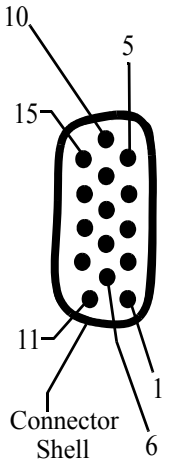
NOTE

Because of the variety of feedback devices that can be used, the following table contains signal descriptions only (no pin numbers). Refer to *Table 5-5: Encoder/Resolver Pin Assignments for F1 Feedback Connector* for feedback device specific pin numbers.

Table 5-4: Pin Description for F1 Feedback Connector

F1 Feedback Signals			
Signal Type	**Signal Name**	**Notes**	**Pin**
Incremental Encoder Inputs	A1, A1/, B1, B1/, I1, I1/	Differential A quad B encoder signals.	Pin Assignments vary depending on the type of Feedback Device used. Refer to Table 5-5 on the following page for pin assignments.
Sinewave Encoder Inputs	Sin, Sin/, Cos, Cos/	Sinewave Encoder signals	
Sinewave Encoder Data Channel In/Out	RS-485 Data +, RS-485 Data -, RS-485 Clock+, RS-485 Clock-	Rs-485 signals for connecting the Sinewave Encoder Data Channel to the drive	
Motor Commutation Hall Sensor Inputs	Commutation Track S1, S2, S3	Hall device input signals that are used to initialize the commutation angle. They consist of a 74HC14 input with 10µs filter and 1 K pull up to +5V.	
Sinewave Encoder Commutation Inputs	Commutation Sin+, Commutation Sin-	Sinewave signals that are used to initialize the motor commutation angle when a Heidenhein Sincoder is used as the motor feedback device.	
Resolver Inputs	Sin+, Sin-, Cos+, Cos-	Resolver rotor feedback signals used when optional Resolver Interface Board is installed.	
Resolver Outputs	Carrier+, Carrier-	Resolver rotor excitation signals used when optional Resolver Interface Board is installed.	
Temperature Input	Temperature	Thermostat (normally-closed) or Thermistor (Phillips KTY84-130 PTC or equivalent recommended) input for detecting over temperature conditions within the motor.	
Travel Limit Inputs	+ Travel Limit, -Travel Limit	Over travel limit inputs (Reserved for future use).	
Encoder Power Outputs	+5V Source, +9V Source	Regulated +5VDC and regulated +9VDC for powering the attached encoder.	
Sinewave Encoder Reference Mark Input	Ref Mark/	Reference Mark input used with some Sinewave Encoders used to indicate motor position within one revolution.	
Signal and Power Common	Common	Return path for feedback signals and power supplies (+5V and +9V).	

Table 5-5: Encoder/Resolver Pin Assignments for F1 Feedback Connector

Encoder/Resolver Pin Assignments for F1 Motor Feedback 15 Pin Connector 230V Single Phase (500W, 1kW, 2kW)								
Pin	**Feedback Device**						**In/ Out**	**Pin Sequence**
	Digital Incremental	**Stegman n Hiperface**	**Endat*** **	**SSI*** **	**Heidenhain Sincoder*** **	**Resolver ***		
1	A1	Cos				Cos+	In	15-pin Female HD D-Sub 
2	A1/	Cos/				Cos-		
3	B1	Sine				Sin+		
4	B1/	Sine/				Sin-		
5	I1	RS-485 Data +				Carrier+	In**	
6	Common						In/Out	
7	N/U	+9V Source	N/U	N/U	N/U	N/U	Out	
8	Commutation Track S3	N/U	N/U	N/U	N/U	N/U	In	
9	+ Travel Limit				Commutation Cos+	+Travel Limit		
10	I1/	RS-485 Data-			Ref Mark/	Carrier-	In**	
11	Temperature						In	
12	Commutation Track S1	N/U	RS-485 Clock+		Commutation Sin+	N/U		
13	Commutation Track S2	N/U	RS-485 Clock-		Commutation Sin-	N/U		
14	+5V Source	N/U	+5V Source			N/U	Out	
15	- Travel Limit				Commutation Cos-	-Travel Limit	In	
Shell	Shield						N/A	

*Requires installation of optional resolver board.

**Pins 5 and 10 are outputs when optional resolver module is installed.

***For future use.

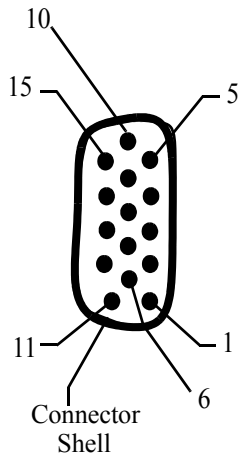
5.2.3 F2 Feedback Connector (For Future Use)

- All motor signals (other than the encoder inputs) are bussed internally between the two feedback connectors F1 and F2. The bussed signals include motor commutation inputs, temperature input, travel limit inputs, and encoder power outputs.
- F2 can be designated (in PiCPro) as the motor feedback connector but only if F1 is not (either one or the other must be designated as such).
- Travel Limits can be defined in PiCPro for Windows software as either coming into the MMC Smart Drive at the F2 connector or at the User I/O connector.
- F2 can interface with only incremental type encoders.

Table 5-6: Pin Description for F2 Feedback Connector

F2 Feedback Signals		
Signal Type	**Notes**	**Pins**
Incremental Encoder Input	Differential A quad B encoder signals.	1,2, 3, 4, 5, 10
Motor Commutation Hall Sensor Inputs	Hall-device input signals that are used to initialize the motor commutation angle. They consist of a 74HC14 input with a 10µs filter and a 1K pull-up to +5V.	8, 12, 13
Temperature Input	Thermostat (normally-closed) or Thermistor (Phillips KTY84-130 PTC or equivalent recommended) input for detecting over temperature conditions within the motor.	11
Travel Limit Inputs	Over-travel limit inputs. They consist of a 74HC14 input with a 10µs filter and a 1K pull-up to +5V.	9, 15
Encoder Power Outputs	Regulated +5VDC and regulated +9V VDC for powering the attached encoder.	7, 14
Signal and Power Common	Return path for feedback signals and power supplies (+5V and 9 V).	6

Table 5-7: Pin Assignments for F2 Feedback Connector

Pin Assignments F2 Feedback 15 Pin Connector 230V Single Phase (500W, 1kW, 2kW)			
Pin	**Label**	**In/Out**	**Pin Sequence**
1	A2	In	15-pin Female HD D-Sub 
2	A2/	In	
3	B2	In	
4	B2/	In	
5	I2	In	
6	Common	In/Out	
7	+9V	Out	
8	S3	In	
9	Travel Limit+	In	
10	I2/	In	
11	Temperature	In	
12	S1	In	
13	S2	In	
14	+5V	Out	
15	Travel Limit-	In	
Shell	Shield	In	

5.2.4 User I/O Connector

Table 5-8: Pin Description for User I/O Connector

I/O Signals		
Signal Type	**Notes**	**Pins**
Analog Command Inputs	• Analog velocity or torque commands of 0 to +/- 10V • Separate scale and offset parameters are used relative to the command signal being velocity or torque	14, 15
Fast Inputs (Reserved for Future Use)	Used for latching encoder position.	8, 9, 11, 12
General Purpose Software Assignable Inputs	24VDC sourcing type. Default assignments: Pin 17 (GPIN1) = Drive Enable, Pin 18 (GPIN2) = Fault Reset	17, 18, 19, 20, 21, 22
Buffered F1 Encoder Output	• RS485 drivers are used and the signal that is output depends on the encoder or resolver type used. See Specifications in Chapter 5 of this manual. • These signals are generated after the feedback from the F1connector is filtered and processed.	1, 2, 3, 4, 5, 6
General Purpose Software Assignable Outputs	24VDC sourcing type. Default assignment: Pin 26 (GPOUT4) = Drive Ready	23, 24, 25, 26
IO24V, IO24COM	24 VDC inputs for powering GPIN and GPOUT I/O.	10, 16

Table 5-9: Pin Assignment for User I/O Connector

Pin Assignment User I/O Connector 26-Pin 230V Single Phase (500W, 1kW, 2kW)								
Pin	**Wiring Label**	**PiCPro I/O Label**	**In/Out**	**Pin**	**Wiring Label**	**PiCPro I/O Label**	**In/Out**	**Pin Sequence**
1	FDBK1B A		Out	14	CMD +		In	26-pin Female HD D-Sub
2	FDBK1B A/		Out	15	CMD -		In	
3	FDBK1B B		Out	16	IO24COM		In	
4	FDBK1B B/		Out	17	GPIN1	Input1	In	
5	FDBK1B I		Out	18	GPIN2	Input2	In	
6	FDBK1B I/		Out	19	GPIN3	Input3	In	
7	Shield		Out	20	GPIN4	Input4	In	
8	GPIN7 +	Input7	In	21	GPIN5	Input5	In	
9	GPIN7 -		In	22	GPIN6	Input6	In	
10	IO24V		In	23	GPOUT1	Output1	Out	
11	GPIN8 +	Input8	In	24	GPOUT2	Output2	Out	
12	GPIN8 -		In	25	GPOUT3	Output3	Out	
13	Shield			26	GPOUT4	Output4	Out	

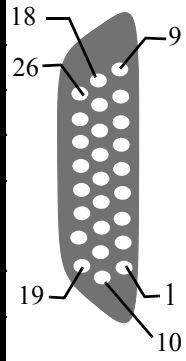
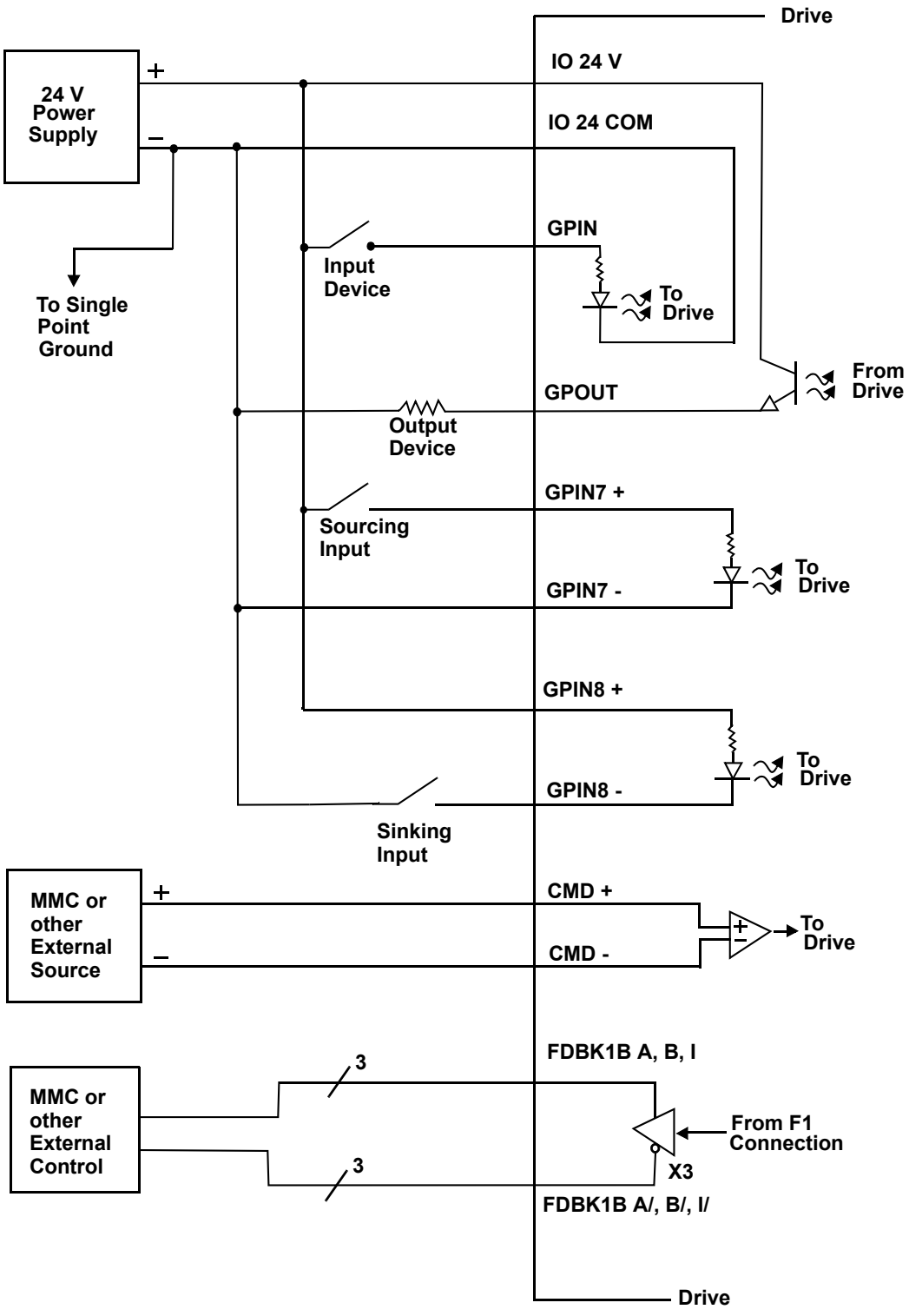
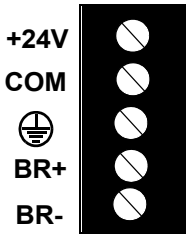


Figure 5-3: Wiring Diagram for User I/O Connector



5.2.5 24 VDC IN/Brake Terminal Strip

Table 5-10: Pin Assignment for 24 VDC IN/Brake Terminal Strip

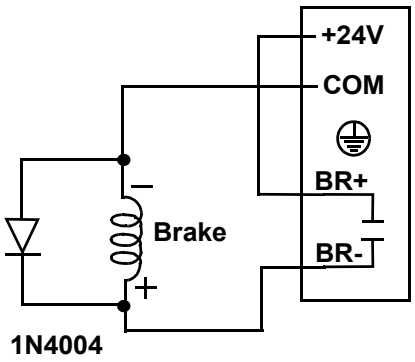
24VDC IN/Brake Terminal Strip					
Terminal	**Terminal Label**	**Signal Type**	**Signal Description**	**PiCPro I/O Label**	**In/Out**
	+24V	Logic Power	+24V user supplied power signal terminal.	N/A	In
	COM	Common	+24V Common	N/A	In
	⏚	Protective Ground	Must be connected to Protective Earth Ground (SPG)	N/A	In
	BR+	Brake Relay +	Refer to Figure 5-3 below.	Output5/ Relay	Out
	BR-	Brake Relay -			Out

NOTE

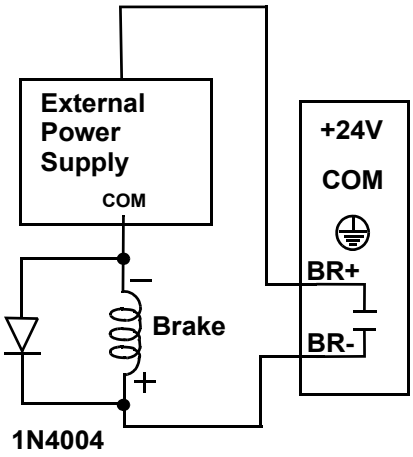
Use of a diode (as shown) or an external RC type snubber is highly recommended for use with inductive loads, especially DC inductive loads.

Figure 5-4: BR+ and BR- Wiring Examples

Using 24V Power Source

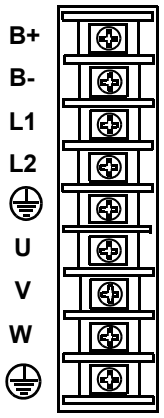


Using External Power Source



5.2.6 Motor Terminal Strip

Table 5-11: Pin Assignment for Motor Terminal Strip

Motor Terminal Strip				
Terminal	**Terminal Label**	**Signal Type**	**Signal Description**	**In/Out**
	B+	DC Bus	Power from drive to active shunt	Out
	B-			
	L1	AC Power	100-240VAC single phase power in to drive.	In
	L2			
	⏚	Protective Ground	Must be connected to Protective Earth Ground (SPG).	In
	U	Motor Power	Power U-phase from the drive to the motor.	Out
	V		Power V-phase from the drive to the motor.	Out
	W		Power W-Phase from the drive to the motor.	Out
	⏚	Protective Ground	Connection for motor ground.	In

5.3 Specifications - 230V MMC Smart Drive

5.3.1 General Data for all 230V Models

General Drive Data	
Minimum wire size for input power wires	1.5mm2 (16 AWG) 75° C copper.
Maximum tightening torque for power wire terminals	1.17 Nm (10.4 in-lbs.)
Commutation	Three Phase Sinusoidal
Current Regulator	Digital PI 125 µsec. update rate
Velocity Regulator	Digital PID - 250 µsec. update rate
Environmental Data	
Operating Temperature Range	7^{o} C to 55^{o} C (45^{o} F to 131^{o} F)
Storage Temperature Range	-30^{o} C to 70^{o} C (-22^{o} F to 158^{o} F)
Humidity	5% to 95% non-condensing
Altitude	1500 m (5000 ft) Derate 3% for each 300 m above 1500m
Vibration Limits (per IEC 68-2-6) Operating/Non-operating	10-57 Hz (constant amplitude.15 mm) 57 - 2000 Hz (acceleration 2 g)
Shock (per IEC 68-2-27) Non-operating	Four shocks per axis (15g/11 msec)
F1 and F2 Feedback Inputs	
Input receiver type	Maxim 3098 A quad B differential RS422 receiver
Encoder signals	Differential quadrature
Input threshold	±200 mV
Input termination	150Ω, provided internally
Maximum input voltage	5V peak to peak differential -10 to +13.2V common mode
Maximum input signal frequency	720 K Hz (2.88 M feedback counts per second)

General Purpose Inputs	
Configuration	• 8 optically isolated 24V DC inputs • Active high • 6 are current sourcing only (current flow into input) • 2 are sink or source
Guaranteed On	15 VDC
Guaranteed Off	5 VDC
Time delay on	1 ms max.
Time delay off	1 ms max.
Input voltage	Nominal 24 VDC, maximum 30 VDC
General Purpose Outputs	
Configuration	• 4 optically isolated 24V DC outputs • Active high • Current sourcing only (current into load) • Short circuit and overload protected
Maximum current	50mA per output
Voltage range	24VDC +15%-10%
Time delay on for resistive loads	50 µsec. max
Time delay off for resistive loads	50 µsec. max
Leakage current in off state	0.5 mA max
Command Input	
Command Input	• Analog velocity or torque, 0 to $\pm$ 10V • 14 bit effective resolution

User I/O Connector Encoder Emulation Output		
F1 Motor Feedback Type	**Input Limit**	**Encoder Emulation Output (A quad B Differential Output)**
Incremental Encoder	720 KHz 8.22 M counts/sec.	The motor encoder A/B/I inputs are electrically buffered and retransmitted via the User I/O connector.
High Resolution Encoder	100 KHz 400 K counts/sec.	The encoder SIN/COS signals are electrically squared and retransmitted as A/B. The index mark "I" is synthesized by the drive control DSP. Absolute position information is not available via the Encoder Emulation Output.
Resolver	500 RPS 2.00 M counts/sec.	The field-installable resolver interface module converts the motor resolver to 1024 lines/ 4096 counts per revolution of A/B encoder output. The module synthesizes the index mark "I" once per revolution of the resolver. Absolute position information is not available via the Encoder Emulation Output.
Conformity		
CE Marked	In Process Conforms to Low Voltage Directive 73/23/EEC (amended by 93/68/EEC) and EMC Directive 89/336/EEC (amended by 92/31/EEC and 93/68/EEC). Conformance is in accordance with the following standards: EN 50178 and EN61800-3	
UL and C/UL Listed	E233454	

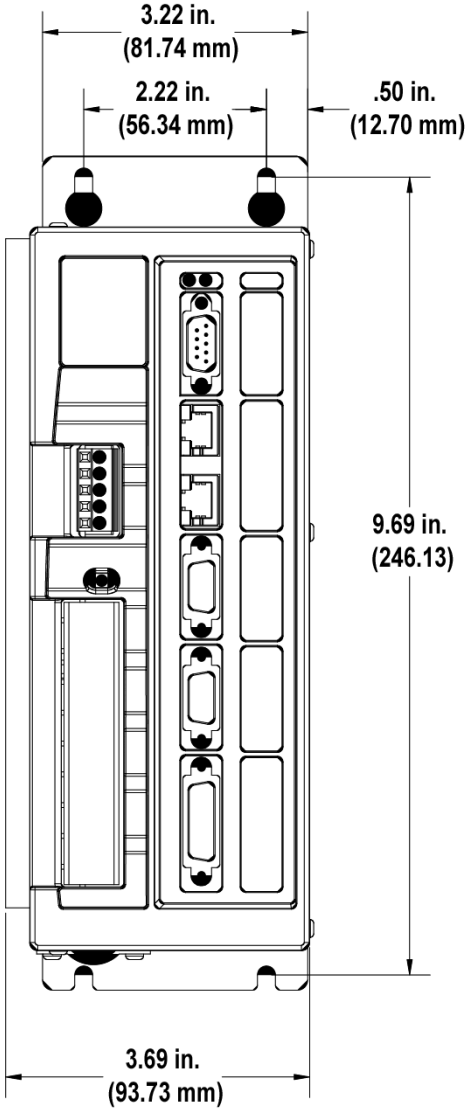
5.3.2 Physical and Electrical Data for 230V Drives

	Model		
	MMC-SD-0.5-230	MMC-SD-1.0-230	MMC-SD-2.0-230
Physical			
Weight	4.9 lbs. (2.23 kg)	5.6 lbs. (2.55 kg)	5.7 lbs. (2.59 kg)
Electrical Specifications			
AC Input Specifications			
Nominal Input Power	1.0 kVA	2.0 kVA	4.0 kVA
Input Voltage	100-240 VAC (nominal), Single Phase, 88-265 VAC (absolute limits)		
Input Frequency	47 - 63 Hz		
Nominal Input Current	$5A_{RMS}$	$9A_{RMS}$	$18A_{RMS}$
Maximum Inrush Current (0-Peak)	70A	70A	70A
Power Loss	22W	37W	70W
AC Output Specifications			
Continuous Output Current (0-Peak)	2.5A	5A	10A
Continuous Output Power			
Input = 115 VAC	250W	500W	1kW
Input = 230 VAC	500W	1kW	2kW
Peak Output Current (0-Peak)	7.5A	15A	30A
Output Frequency	0-266 Hz		
DC Input Power Specifications (24VDC)			
Input Voltage Range	24 VDC +15% -10%		
Typical Input Current	350 mA		650 mA
Typical Input Wattage	9 W		16 W
Inrush Current	1.5 A for 10 ms		

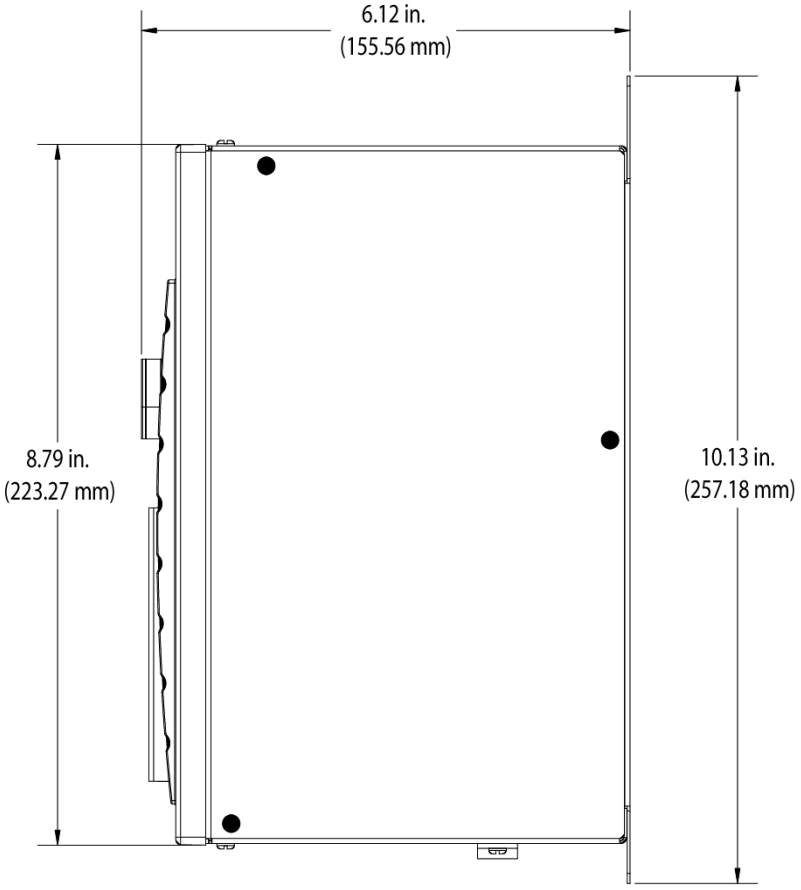
Relay Contact for Motor Mechanical Brake		
Rating (resistive load)		
Nominal switching capacity	24 VDC	
Maximum switching power	831 VA	
Maximum switching voltage	250 VAC / 100 VDC	
Maximum switching current	5 A (AC) / 2.5 A (DC)	
Energy Absorbtion Specifications		
DC Bus Capacitance (Internal)	1410 µF	1880 µF
Bus overvoltage threshold	420 VDC	
Joules available for energy absorption		
230V motor w/ 115V line input	94 joules	126 joules
230V motor w/ 230V line input	38 joules	51 joules

5.4 Dimensions for 230V MMC Smart Drive

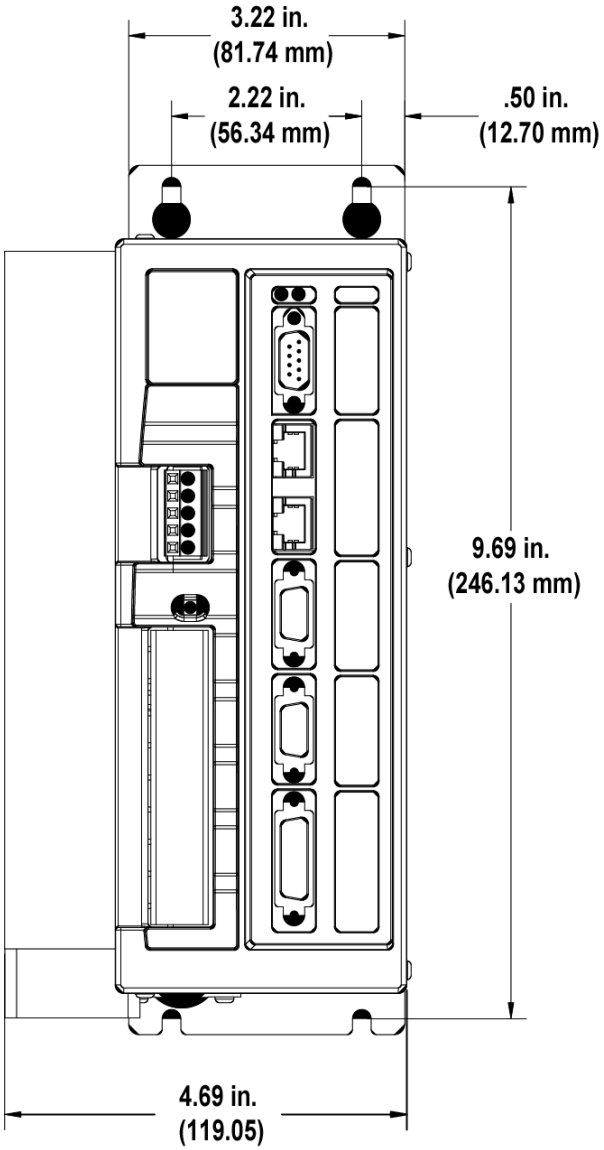
5.4.1 230V 500W Drive - Front View



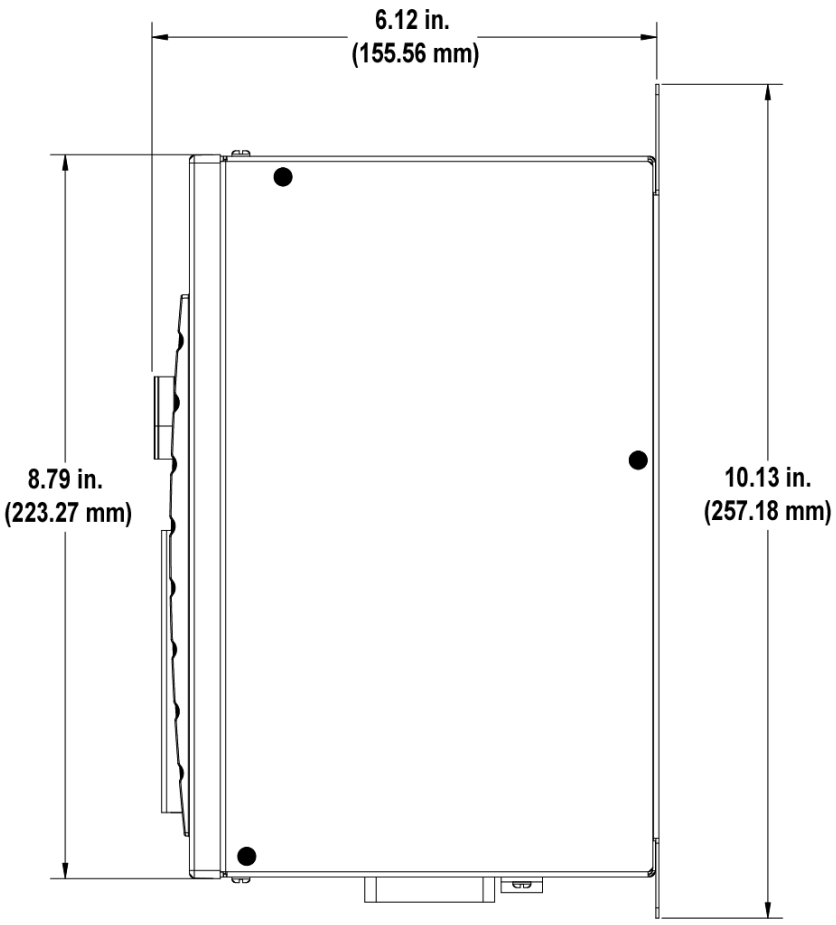
5.4.2 230V 500W Drive - Side View



5.4.3 230V 1kW and 2kW Drive - Front View



5.4.4 230V 1kW and 2kW Drive - Side View



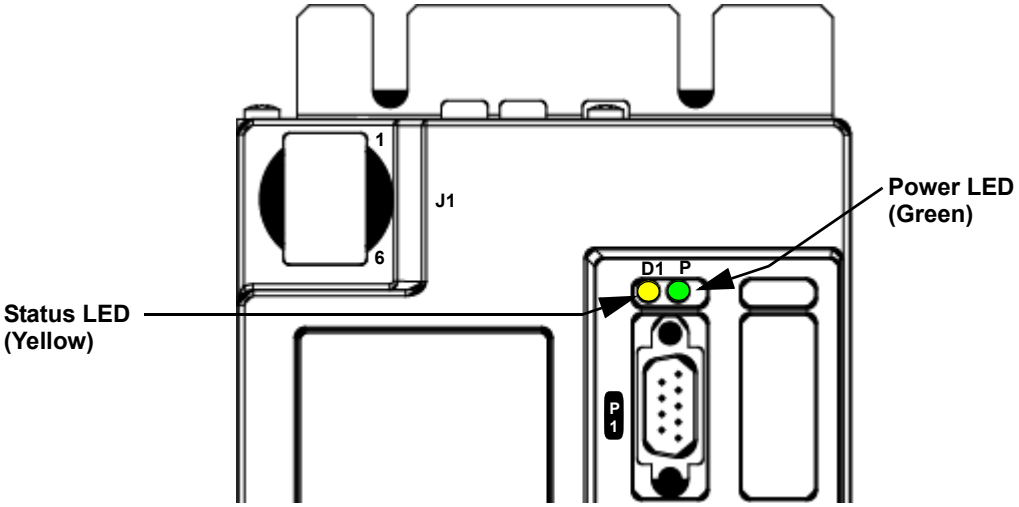
6 460V 3-Phase MMC Smart Drive

6.1 LEDs

Table 6-1: LEDs Description for 460V 3-Phase MMC Smart Drive

LED	Color	Description
P	Green	Power LED. Indicates when illuminated that DC voltage is being supplied to the drive.
D1	Yellow	Status LED. Indicates drive status and fault information.

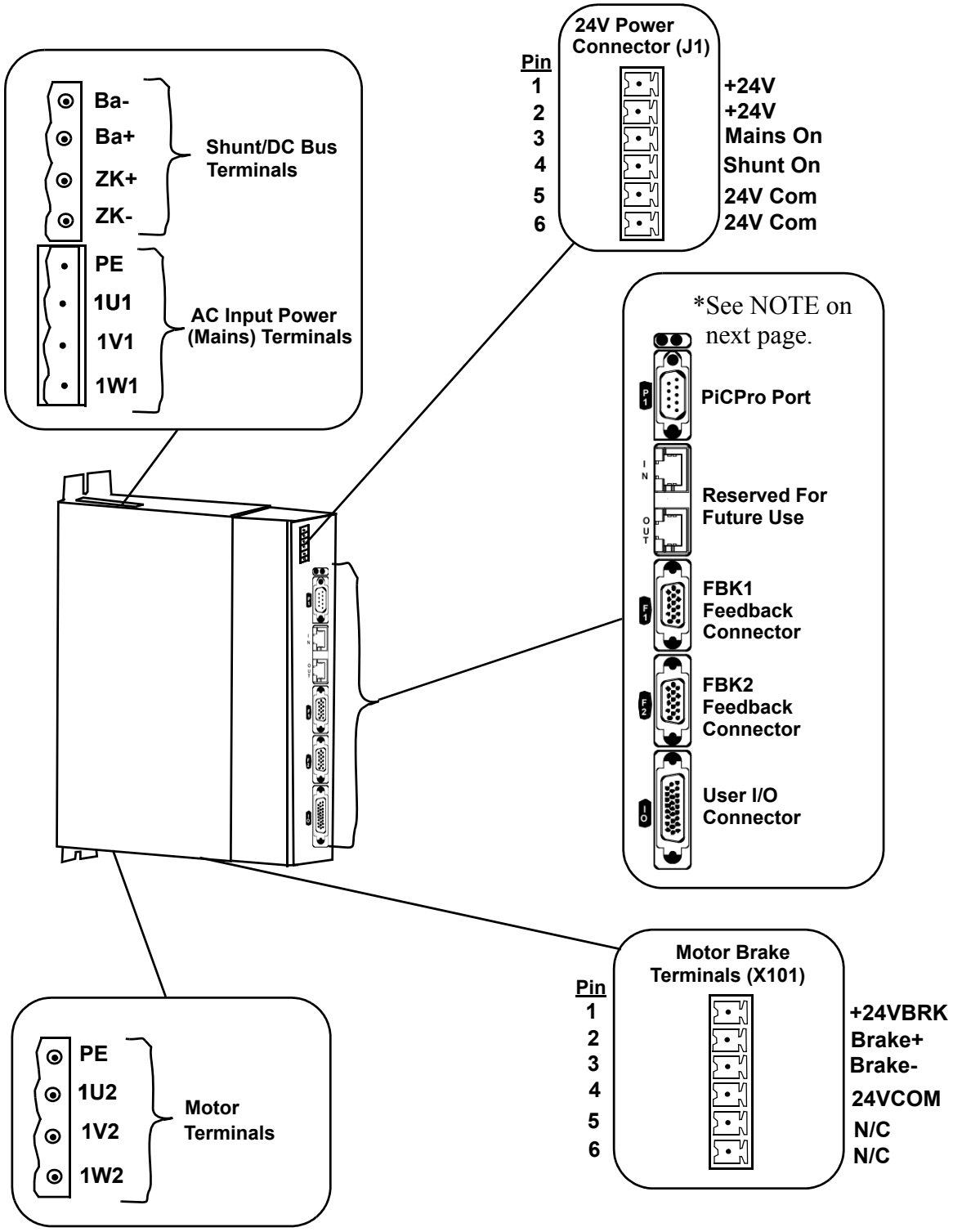
Figure 6-1: LEDs on the Size 1, Size 2 and Size 3 460V Drives



6.2 Connectors on the 460V Drive

6.2.1 Size 1 460V Drive Connectors

Figure 6-2: Connectors on the Size 1 460V Drive

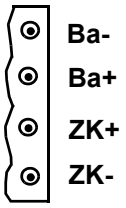


NOTE

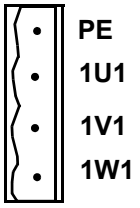
The functionality and descriptions for the software control, motor feedback and I/O connectors for the Size 1, Size 2, and Size 3 460V MMC Smart Drives are the same as those used for the 230V MMC Smart Drive. Refer to Chapter 5, *230V Single Phase MMC Smart Drive*, Section 5.2.1, *P1 PiCPro Communications Port*, Section 5.2.2, *F1 Feedback Connector*, Section 5.2.3, *F2 Feedback Connector (For Future Use)* and Section 5.2.4, *User I/O Connector*.

6.2.1.1 Shunt/DC Bus Terminals

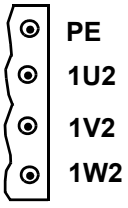
Table 6-2: 460V Size 1 Shunt/DC Bus Terminals

Signal Type	Signal Description	Terminal Label	In/Out	Terminal
Power	External Shunt Resistor. Used to dissipate energy returned to the drive by the motor.	Ba-	Out	
		Ba+		
DC Bus Power	Reserved for future use	ZK+	N/A	
		ZK-		

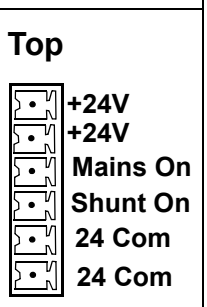
6.2.1.2 AC Power Terminal Strip

Table 6-3: 460V Size 1 AC Power Terminals				
Signal Type	**Signal Description**	**Terminal Label**	**In/Out**	**Terminal**
Protective Ground	Protective Earth Ground	PE	Out	
Power	3 phase input power AC source must be center grounded Y system.	1U1	In	
		1V1		
		1W1		

6.2.1.3 Motor Terminals

Table 6-4: 460V Size 1 Motor Terminals				
Signal Type	**Signal Description**	**Terminal Label**	**In/Out**	**Terminal**
Protective Ground	Protective Earth Ground	PE	Out	
Power	Drive output power to motor.	1U2	Out	
		1V2		
		1W2		

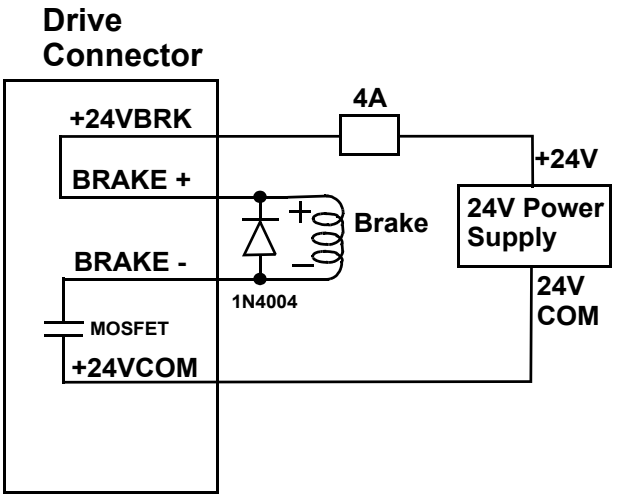
6.2.1.4 24V Power Connector (J1)

Table 6-5: 460V Size 1 24V Power Connector (J1)					
Signal Type	**Signal Description**	**Pin**	**Terminal Label**	**In/Out**	**Terminal**
Power	24 VDC input power	1	+24V	In	
		2	+24V		
24V Logic Output	Reserved for future use, do not use !	3	Mains On	Out	
24V Logic Output	Reserved for future use, do not use !	4	Shunt On	Out	
Power	24 VDC input power to the drive.	5	24V Com	In	
		6	24V Com		

6.2.1.5 Motor Brake Terminals (X101)

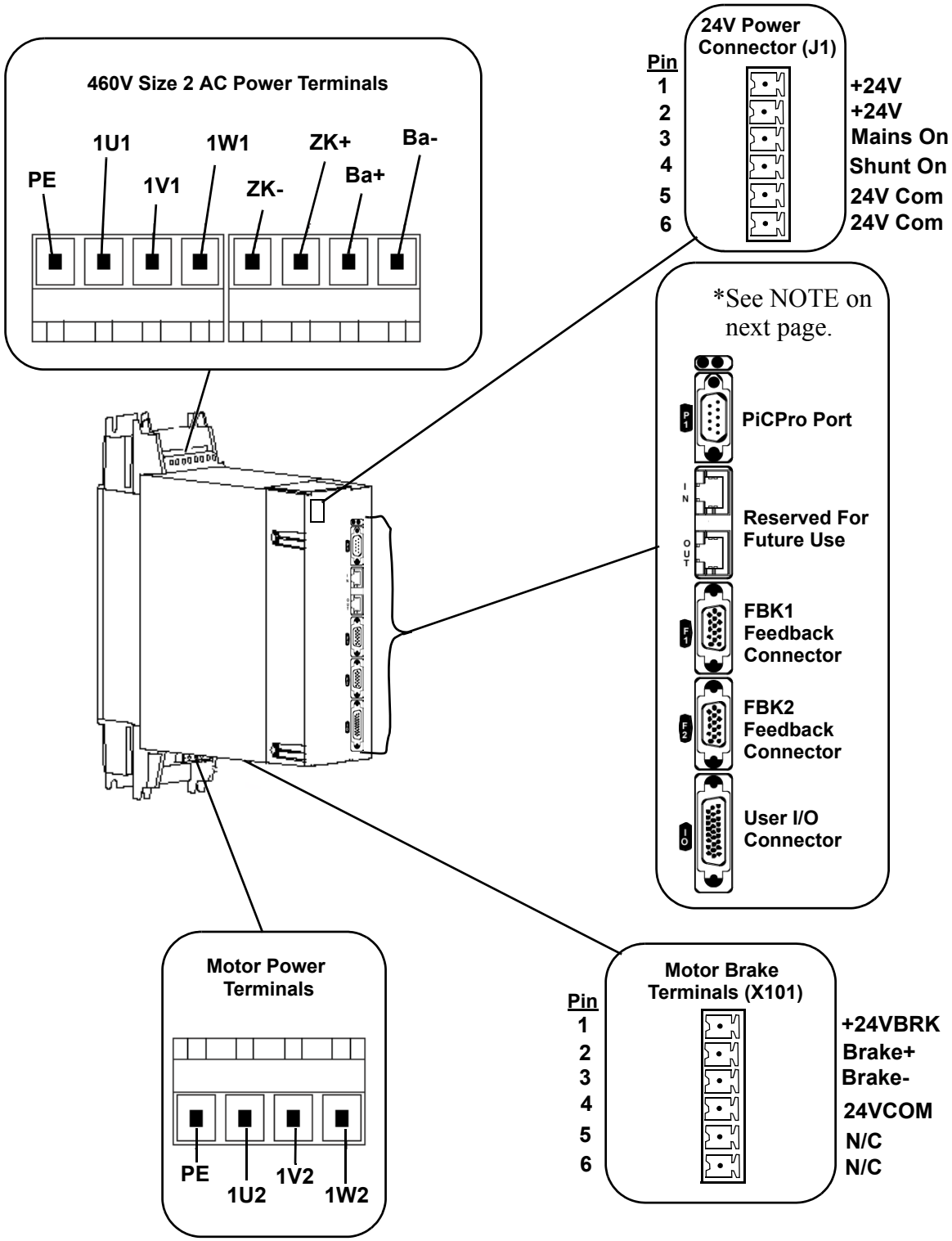
Table 6-6: 460V Size 1 Motor Brake Terminals (X101)					
Signal Type	**Signal Description**	**Pin**	**Terminal Label**	**In/Out**	**Terminal**
Power	24 VDC brake input power	1	+24VBRK	In	Top 1 +24VBRK 2 Brake + 3 Brake - 4 24VCOM 5 N/C 6 N/C
Brake control	Brake connections	2	Brake +	Out	
		3	Brake -	In	
Power	24 VDC common	4	24VCOM	Out	
Not Used.		5	N/C	Not Used	
		6			

Figure 6-3: Wiring Example for X101 Connector



6.2.2 Size 2 460V Drive

Figure 6-4: Connectors on the Size 2 460V Drive

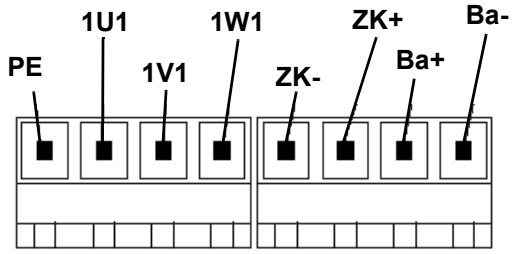


NOTE

The functionality and descriptions for the software control, motor feedback and I/O connectors for the Size 1, Size 2, and Size 3 460V MMC Smart Drives are the same as those used for the 230V MMC Smart Drive. Refer to Chapter 5, *230V Single Phase MMC Smart Drive*, Section 5.2.1, *P1 PiCPro Communications Port*, Section 5.2.2, *F1 Feedback Connector*, Section 5.2.3, *F2 Feedback Connector (For Future Use)* and Section 5.2.4, *User I/O Connector*.

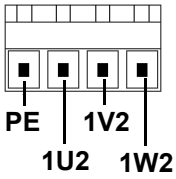
6.2.2.1 AC Power Terminals

Table 6-7: 460V Size 2 AC Power Terminals



Signal Type	Signal Description	Terminal Label	In/Out
Ground	Protective Ground (Earth)	PE	Out
Power	Three phase AC input power in to drive	1U1	In
		1V1	
		1W1	
DC Bus Power	Reserved for future use	ZK-	Out
		ZK+	
Power	External Shunt Resistor used to dissipate energy returned to the drive from motor	Ba+	Out
		Ba-	

6.2.2.2 Motor Power Terminals

Table 6-8: 460V Size 2 Motor Power Terminals				
Signal Type	**Signal Description**	**Terminal Label**	**In/Out**	**Terminal**
Ground	Protective Ground (Earth)	PE	Out	
Motor	Power U-phase from the drive to the motor	1U2	Out	
	Power V-phase from the drive to the motor	1V2	Out	
	Power W-phase from the drive to the motor	1W2	Out	

6.2.2.3 Motor Brake Terminals (X101)

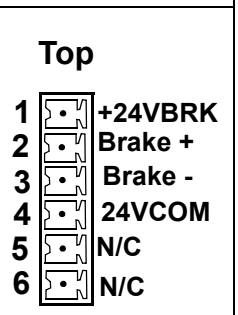
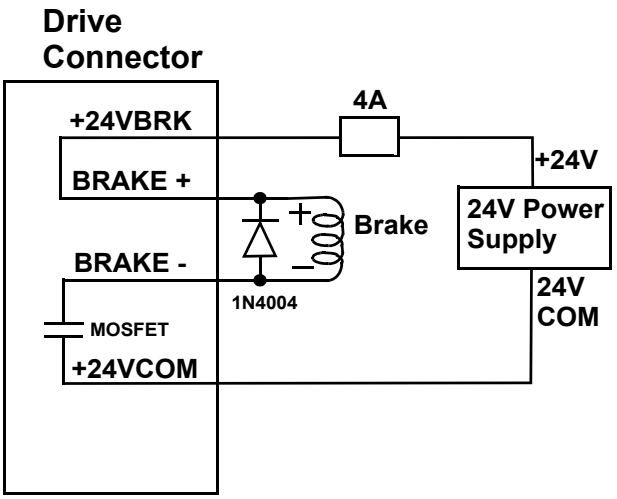
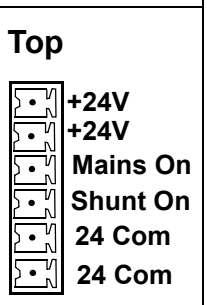
Table 6-9: 460V Size 2 Motor Brake Terminals (X101)					
Signal Type	**Signal Description**	**Pin**	**Terminal Label**	**In/Out**	**Terminal**
Power	24 VDC brake input power	1	+24VBRK	In	
Brake control	Brake connections	2	Brake +	Out	
		3	Brake -	In	
Power	24 VDC common (supply and magnet)	4	24VCOM	Out	
Not Used.		5	N/C	Not Used	
		6			

Figure 6-5: Wiring Example for X101 Connector

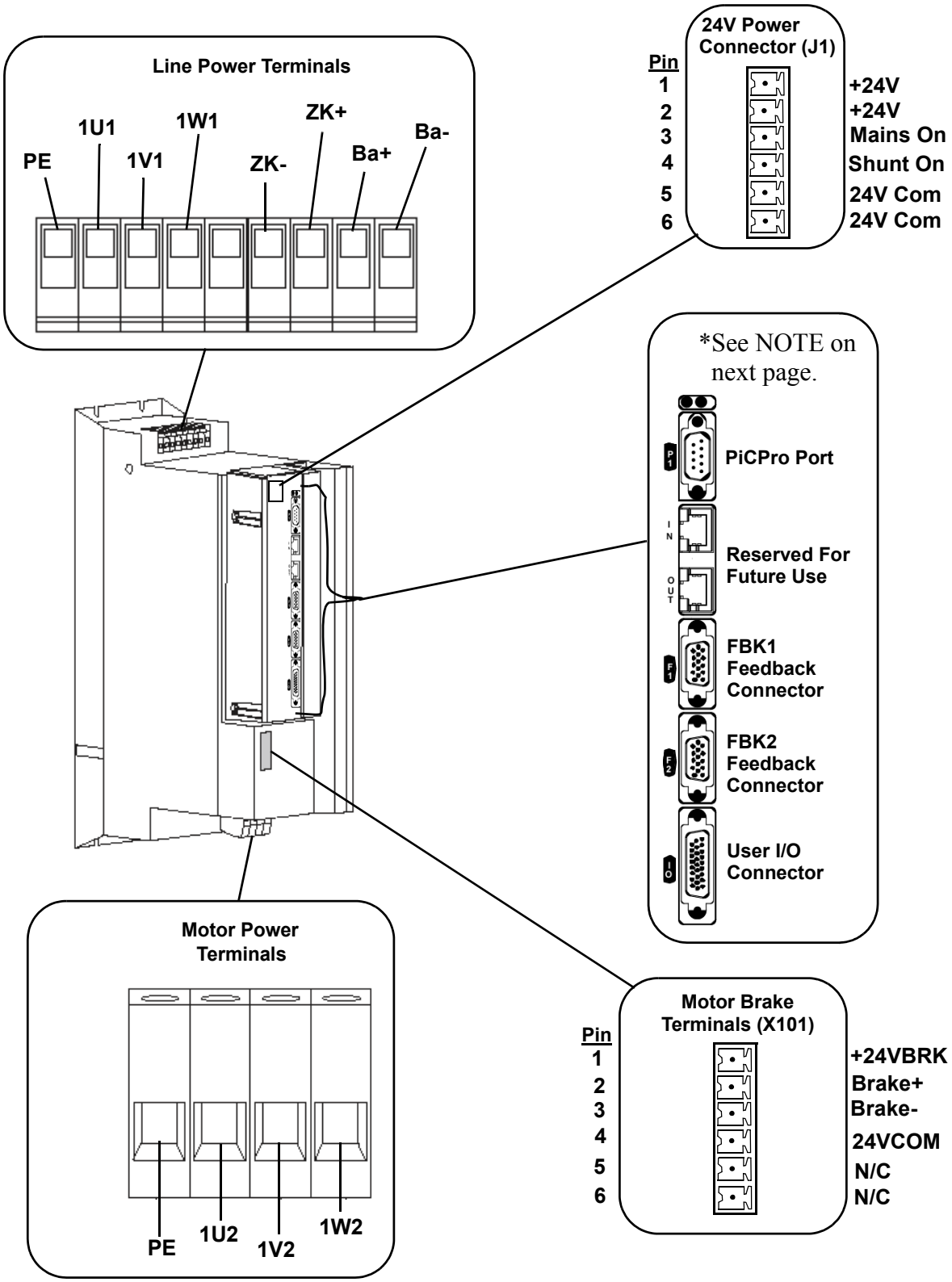


6.2.2.4 24V Power Connector (J1)

Table 6-10: 460V Size 2 24V Power Connector (J1)					
Signal Type	**Signal Description**	**Pin**	**Terminal Label**	**In/Out**	**Terminal**
Power	24 VDC input power	1	+24V	In	
		2	+24V		
24V Logic Output	Reserved for future use, do not use !	3	Mains On	Out	
24V Logic Output	Reserved for future use, do not use !	4	Shunt On	Out	
Power	24 VDC input power to the drive.	5	24V Com	In	
		6	24V Com		

6.2.3 Size 3 460V Drive

Figure 6-6: Connectors on the Size 3 460V Drive

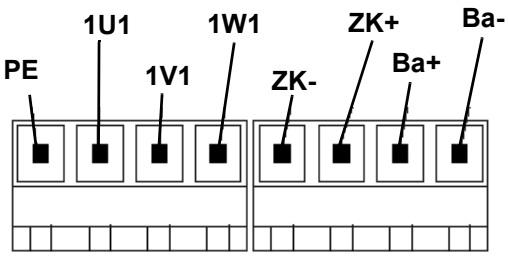


NOTE

The functionality and descriptions for the software control, motor feedback and I/O connectors for the Size 1, Size 2, and Size 3 460V MMC Smart Drives are the same as those used for the 230V MMC Smart Drive. Refer to Chapter 5, *230V Single Phase MMC Smart Drive*, Section 5.2.1, *P1 PiCPro Communications Port*, Section 5.2.2, *F1 Feedback Connector*, Section 5.2.3, *F2 Feedback Connector (For Future Use)* and Section 5.2.4, *User I/O Connector*.

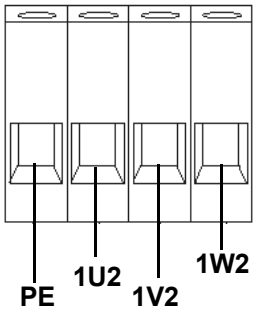
6.2.3.1 AC Power Terminals

Table 6-11: 460V Size 2 AC Power Terminals



Signal Type	Signal Description	Terminal Label	In/Out
Ground	Protective Ground (Earth)	PE	Out
Power	Three phase AC input power in to drive	1U1	In
		1V1	
		1W1	
DC Bus Power	Reserved for future use	ZK-	Out
		ZK+	
	External Shunt Resistor used to dissipate energy returned to the drive from motor	Ba+	Out
		Ba-	

6.2.3.2 Motor Power Terminals

Table 6-12: 460V Size 3 Motor Power Terminals				
Signal Type	**Signal Description**	**Terminal Label**	**In/Out**	**Terminal**
Ground	Protective Ground (Earth)	PE	Out	
Motor	Power U-phase from the drive to the motor	1U2	Out	
	Power V-phase from the drive to the motor	1V2	Out	
	Power W-phase from the drive to the motor	1W2	Out	

6.2.3.3 Motor Brake Terminals (X101)

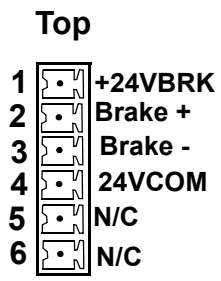
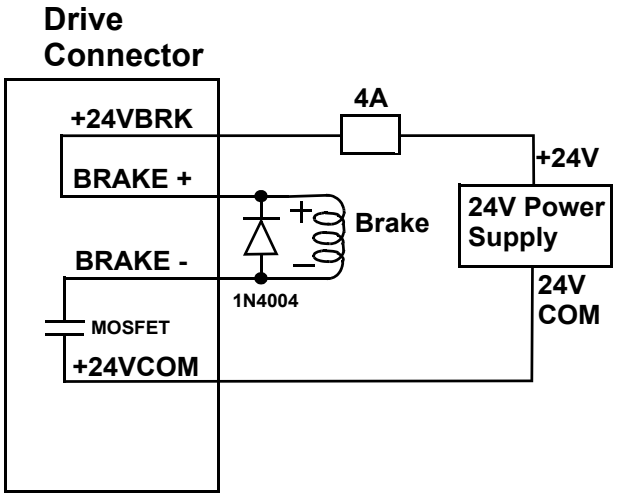
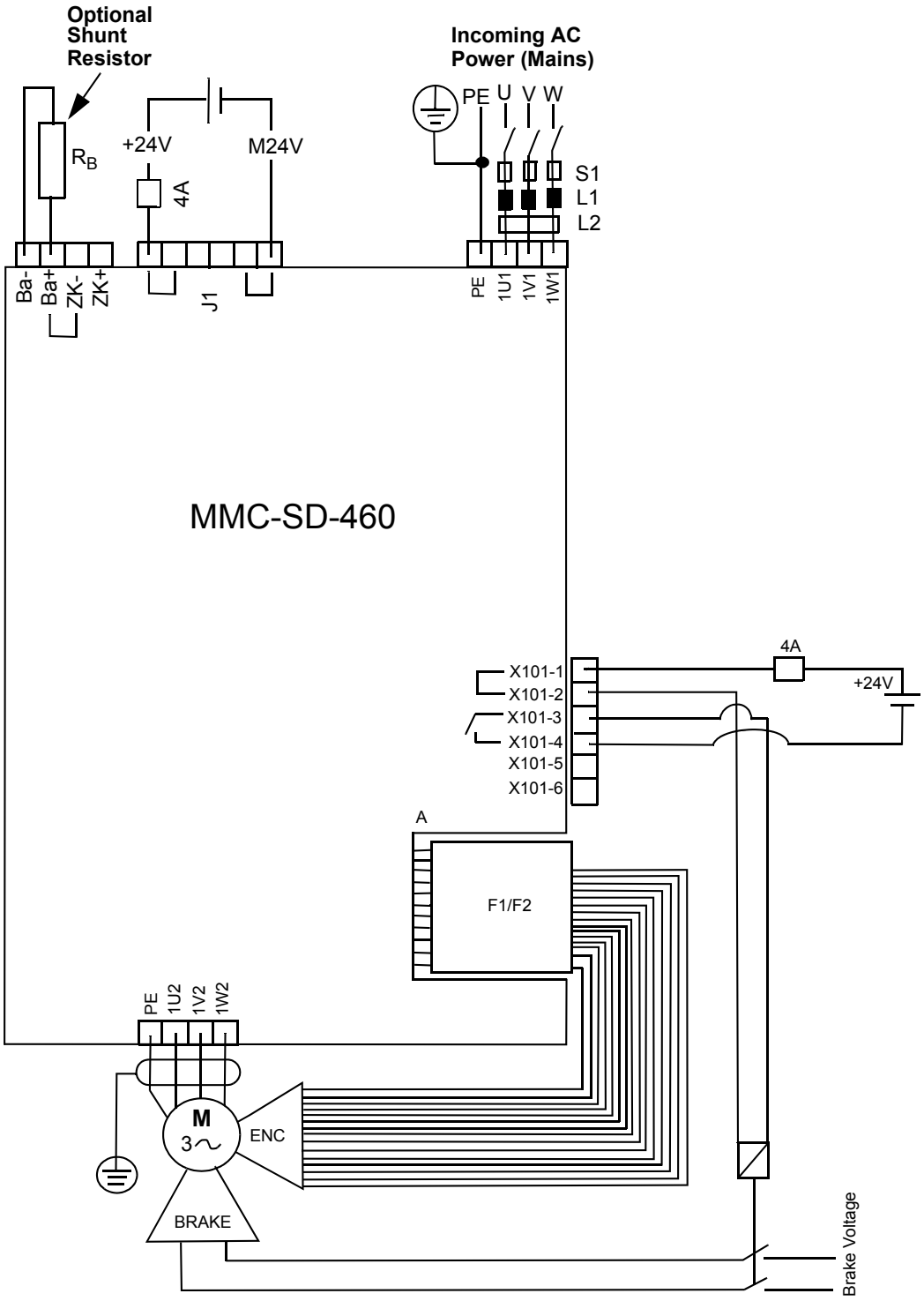
Table 6-13: 460V Size 3 Motor Brake Terminals (X101)					
Signal Type	**Signal Description**	**Pin**	**Terminal Label**	**In/Out**	**Terminal**
Power	24 VDC brake input power	1	+24VBRK	In	
Brake control	Brake connections	2	Brake +	Out	
		3	Brake -	In	
Power	24 VDC common (supply and magnet)	4	24VCOM	Out	
Not Used.		5	N/C	Not Used	
		6			

Figure 6-7: Wiring Example for X101 Connector



6.3 Typical 460V Drive Connection Layout



6.4 Specifications - 460V MMC Smart Drive

6.4.1 Common Data for Size 1/Size 2/Size 3 (All Models)

General Drive Data	
Minimum wire size for input power wires	1.5mm2 (16 AWG) 75° C copper
Maximum tightening torque for power wire terminals	1.25 Nm (11 in-lbs.)
Commutation	3 Phase Sinusoidal, Space Vector Modulated (SVM)
Current Regulator	Digital PI 125 µsec update rate
Velocity Regulator	Digital PID - 250 µsec update rate
General Operating Data	
Operating Temperature Range	7^{o} C to 50^{o} C (45^{o} F to 122^{o} F)
Storage Temperature Range	-30^{o} C to 70^{o} C (-22^{o} F to 158^{o} F)
Humidity	5% to 95% non-condensing
Altitude	1500 m (5000 ft) Derate 3% for each 300 m above 1500m
Vibration Limits (per IEC 68-2-6) Operating/Non-operating	10-57 Hz (constant amplitude .15 mm) 57 - 2000 Hz (acceleration 2 g)
Shock (per IEC 68-2-27) Non-operating	Four shocks per axis (15g/11 msec)
F1 and F2 Feedback Inputs	
Input receiver type	Maxim 3098 A quad B differential RS422 receiver
Encoder signals	Differential quadrature
Input threshold	±200 mV
Input termination	150Ω, provided internal
Maximum input voltage	5V pp differential -10 to +13.2V common mode
Maximum input signal frequency	720 K Hz (2.88 M feedback unit count rate)

General Purpose Inputs	
Configuration	• 8 optically isolated 24V DC inputs • Active high • 6 are current sourcing only (current flow into input) • 2 are sink or source
Guaranteed On	15 VDC
Guaranteed Off	5 VDC
Time delay on	1 ms max.
Time delay off	1 ms max.
Input voltage	Nominal 24 VDC, maximum 30 VDC
General Purpose Outputs	
Configuration	• 4 optically isolated 24V DC outputs • Active high • Current sourcing only (current into load) • Short circuit and overload protected
Maximum current	50mA per output
Voltage range	24VDC +15%-10%
Time delay on for resistive loads	50 µsec. max
Time delay off for resistive loads	50 µsec. max
Leakage current in off state	0.5 mA max
Command Input/Output	
Command Input	• Analog velocity or torque, 0 to $\pm$ 10V • 14 bit effective resolution

User I/O Connector Encoder Emulation Output		
F1 Motor Feedback Type	**Input Limit**	**Encoder Emulation Output (A quad B Differential Output)**
Incremental Encoder	720 KHz 8.22 M counts/sec.	The motor encoder A/B/I inputs are electrically buffered and retransmitted via the User I/O connector.
High Resolution Encoder	100 KHz 400 K counts/sec.	The encoder SIN/COS signals are electrically squared and retransmitted as A/B. The index mark "I" is synthesized by the drive control DSP. Absolute position information is not available via the Encoder Emulation Output.
Resolver	500 RPS 2.00 M counts/sec.	The field-installable resolver interface module converts the motor resolver to 1024 lines/ 4096 counts per revolution of A/B encoder output. The module synthesizes the index mark "I" once per revolution of the resolver. Absolute position information is not available via the Encoder Emulation Output.
Conformity		
CE Marked	In Process Conforms to Low Voltage Directive 73/23/EEC (amended by 93/68/EEC) and EMC Directive 89/336/EEC (amended by 92/31/EEC and 93/68/EEC). Conformance is in accordance with the following standards: EN 50178 and EN61800-3	
UL and C/UL Listed	E233454	

6.4.2 Physical/Electrical Data for 460V Size 1 Drives

	Model	
	MMC-SD-1.3-460	**MMC-SD-2.4-460**
Physical		
Weight	10 lbs.	
Electrical Specifications		
AC Input Specifications		
Nominal Input Power	1.94 kVA	3.33 kVA
Input Voltage	200-480 VAC (nominal), Three Phase, 180-528 VAC (absolute limits)	
Input Frequency	47-63 Hz	
Nominal Input Current	2.44 A_{RMS}	4.18 A_{RMS}
Maximum Inrush Current	4.56 A_{RMS}	7.81 A_{RMS}
Power Loss	34 W	60 W
AC Output Specifications		
Continuous Output Current (0-peak)	3.0 A	5.5 A
Continuous Output Power		
Input = 230 VAC	.65 kW	1.2 kW
Input = 460 VAC	1.3 kW	2.4 kW
Peak Output Current (0-Peak)	6.0 A	11.0 A
Output Frequency	0-300 Hz	
DC Input Power Specifications (24VDC)		
Input Voltage Range	24 VDC +15% -10%	
Typical Input Current	700 mA	
Typical Input Wattage	17 W	
Inrush Current	4 A for 10 ms	

Internal Holding Brake Driver		
Maximum Current	0.5 A	
Energy Absorbtion Specifications		
DC Bus Capacitance (Internal)	110 µF	240 µF
Shunt Switch Threshold	780 VDC	
Joules available for energy absorption		
230V motor w/ 230V line input	3 joules	7 joules
460V motor w/ 230V line input	28 joules	60 joules
460V motor w/ 460V line input	10 joules	22 joules
Exteranl Shunt		
Maximum shunt resistor current	5.9 A (AC)	
Minimum shunt resistor	130 Ω	
Maximum shunt resistor power at minimum shunt resistor	4.5 kW	5 kW

6.4.3 Physical/Electrical Data for 460V Size 2 Drive

	Model		
	MMC-SD-4.0-460	**MMC-SD-6.0-460**	**MMC-SD-8.0-460**
Physical			
Weight	16 lbs.		
Electrical Specifications			
AC Input Specifications			
Nominal Input Power	5.6 kVA	8.6 kVA	11.8 kVA
Input Voltage	200-480 VAC (nominal), Three Phase, 180-528 VAC (absolute limits)		
Input Frequency	47-63 Hz		
Nominal Input Current	7 A_{RMS}	10.8 A_{RMS}	14.8 A_{RMS}
Maximum Inrush Current	13.2 A_{RMS}	20.2 A_{RMS}	27.7 A_{RMS}
Power Loss	102 W	150 W	204 W
AC Output Specifications			
Continuous Output Current (0-Peak)	9.0 A	13.5 A	18.0 A
Continuous Output Power			
Input = 230 VAC	2.0 kW	3.0 kW	4.0 kW
Input = 460 VAC	4.0 kW	6.0 kW	8.0 kW
Peak Output Current (0-peak)	18.0 A	27.0 A	36.0 A
Output Frequency	0 Hz to 300 Hz		
Internal Holding Brake Driver			
Maximum Current	0.5 A		

DC Input Power Specifications (24VDC)			
Input Voltage Range	24 VDC +15% -10%		
Typical Input Current	1050 mA		
Typical Input Wattage	25 W		
Inrush Current	4 A for 10 ms		
Energy Absorbtion Specifications			
DC Bus Capacitance (Internal)	470 µF		705 µF
Shunt Switch Threshold	780 VDC		
Joules available for energy absorption			
230V motor w/ 230V line input	13 joules		19 joules
460V motor w/ 230V line input	188 joules		177 joules
460V motor w/ 460V line input	44 joules		66 joules
External Shunt			
Maximum shunt resistor current	9 A (AC)	9 A (AC)	9 A (AC)
Minimum shunt resistor	86 Ω	60 Ω	44 Ω
Maximum shunt resistor power at minimum shunt resistor	7 kW	10 kW	14 kW

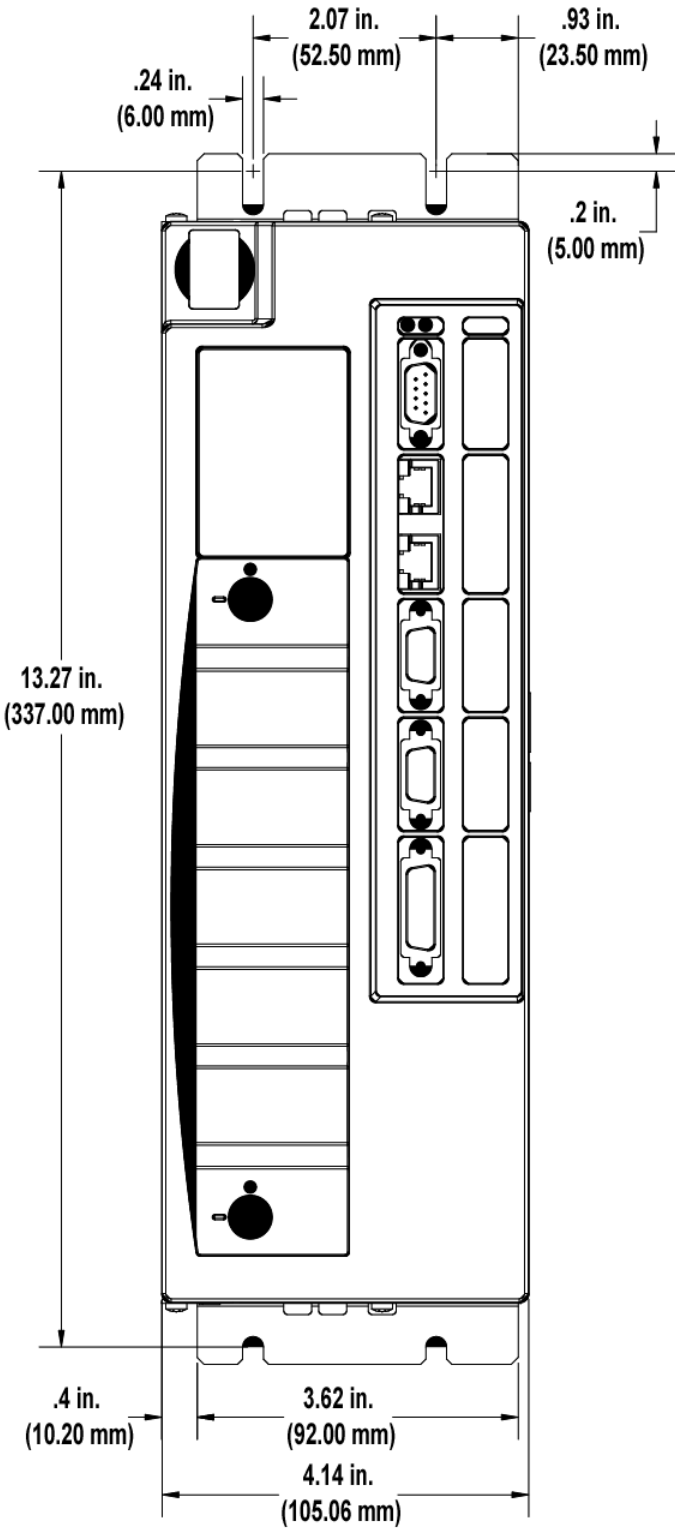
6.4.4 Physical/Electrical Data for 460V Size 3 Drive

	Model		
	MMC-SD-12.0-460	**MMC-SD-16.0-460**	**MMC-SD-24.0-460**
Physical			
Weight	35 lbs.		
Electrical Specifications			
AC Input Specifications			
Nominal Input Power	13.3 kVA	16.8 kVA	26.3 kVA
Input Voltage	200-480 VAC (nominal), Three Phase, 180-528 VAC (absolute limits)		
Input Frequency	47-63 Hz		
Nominal Input Current	16.7 A_{RMS}	21.1 A_{RMS}	33.1 A_{RMS}
Maximum Inrush Current	32.2 A_{RMS}	39.2 A_{RMS}	61.8 A_{RMS}
Power Loss	300 W	390 W	600 W
AC Output Specifications			
Continuous Output Current (0-Peak)	27.5 A	36.5 A	55.0 A
Continuous Output Power			
Input = 230 VAC	6.0 kW	8.0 kW	12.0 kW
Input = 460 VAC	12.0 kW	16.0 kW	24.0 kW
Peak Output Current (0-peak)	55.0 A	73.0 A	110.0 A
Output Frequency	0 Hz to 300 Hz		
Internal Holding Brake Driver			
Maximum Current	0.5 A		

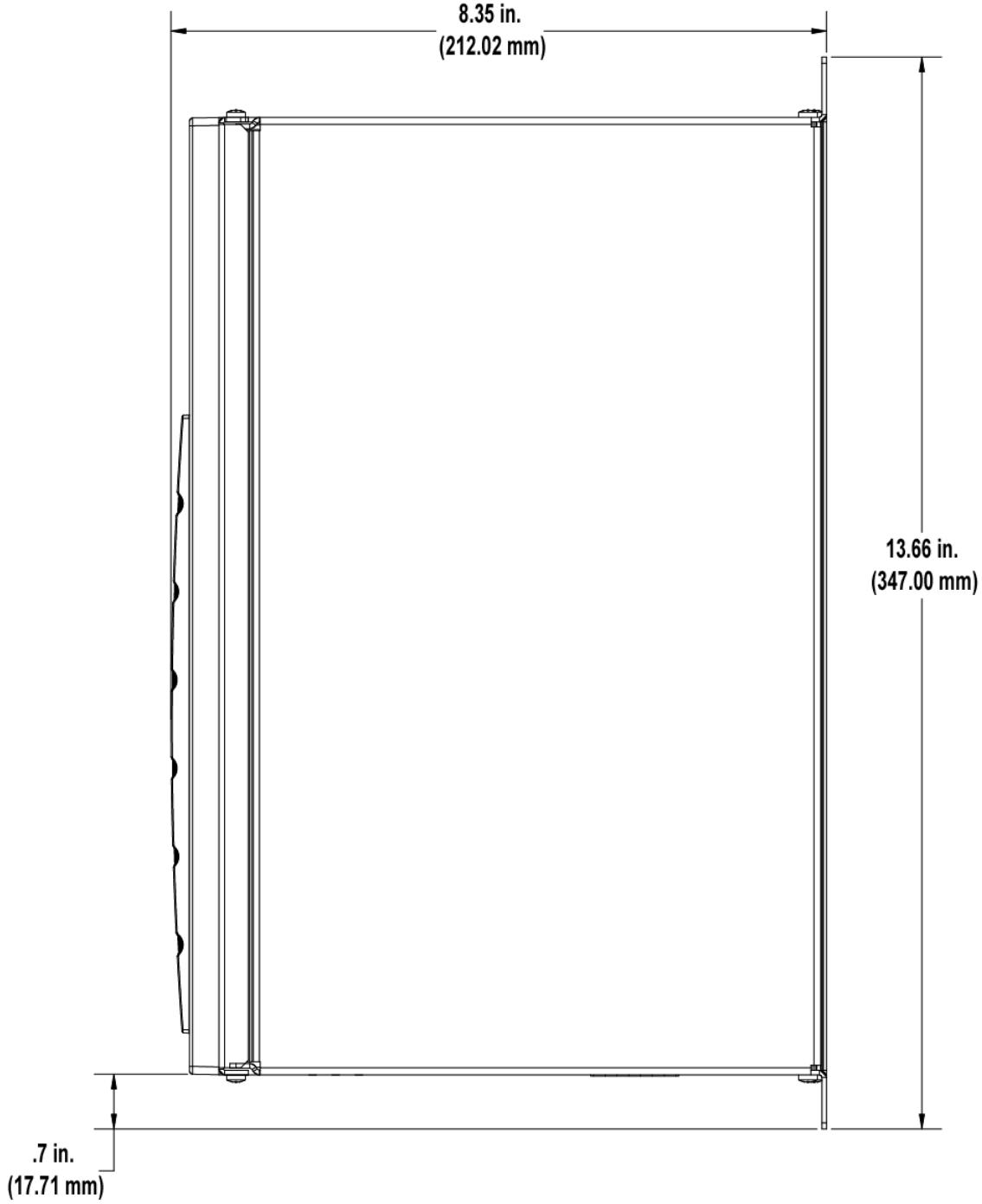
DC Input Power Specifications (24VDC)			
Input Voltage Range	24 VDC +15% -10%		
Typical Input Current	1050 mA		
Typical Input Wattage	25 W		
Inrush Current	4 A for 10 ms		
Energy Absorbtion Specifications			
DC Bus Capacitance (Internal)	820 µF	1230 µF	1640 µF
Shunt Switch Threshold	780 VDC		
Joules available for energy absorption			
230V motor w/ 230V line input	22 joules	33 joules	45 joules
460V motor w/ 230V line input	206 joules	309 joules	412 joules
460V motor w/ 460V line input	76 joules	114 joules	152 joules
External Shunt			
Maximum shunt resistor current	36 A (AC)		50 A (AC)
Minimum shunt resistor	22 Ω		16 Ω
Maximum shunt resistor power at minimum shunt resistor	29 kW		40 kW

6.5 Dimensions for the 460V Drives

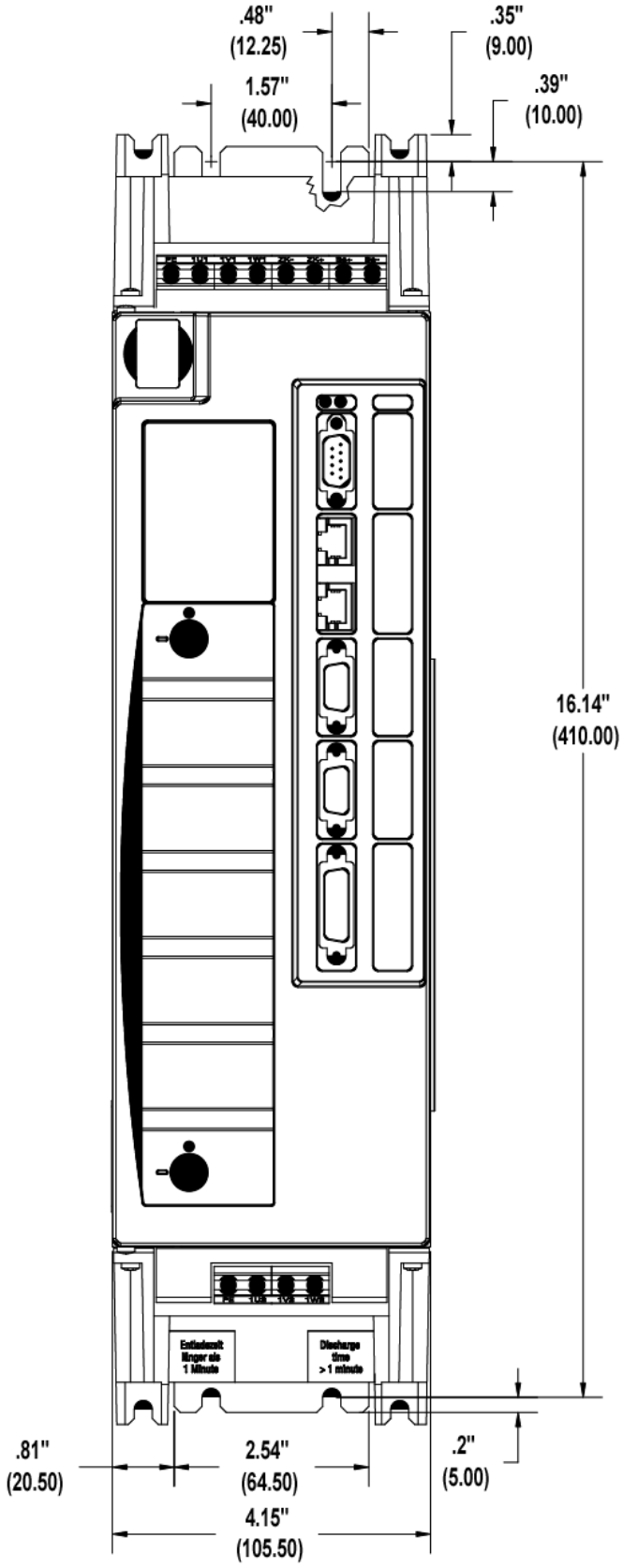
6.5.1 Size 1 460V Drive - Front View



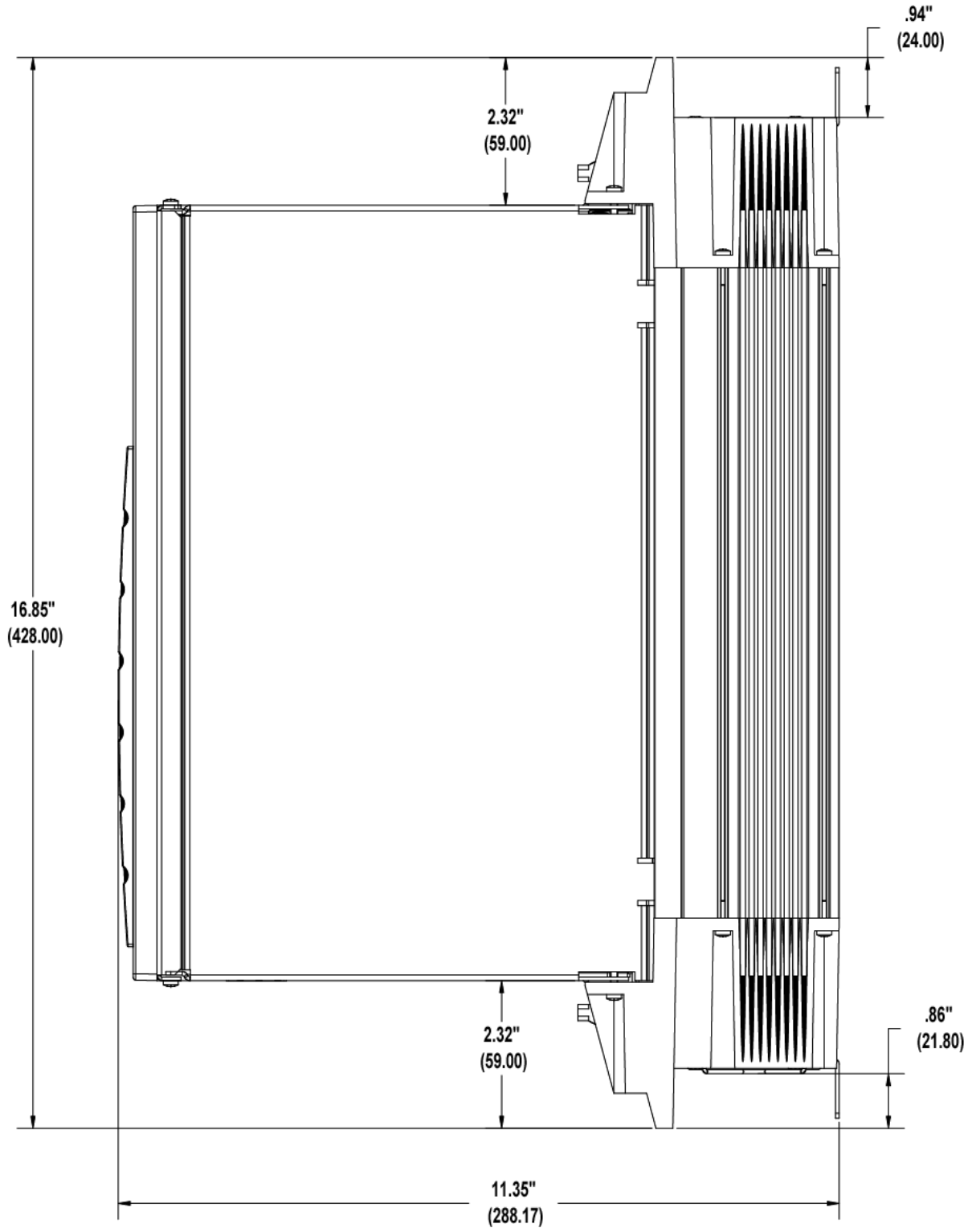
6.5.2 Size 1 460V Drive - Side View



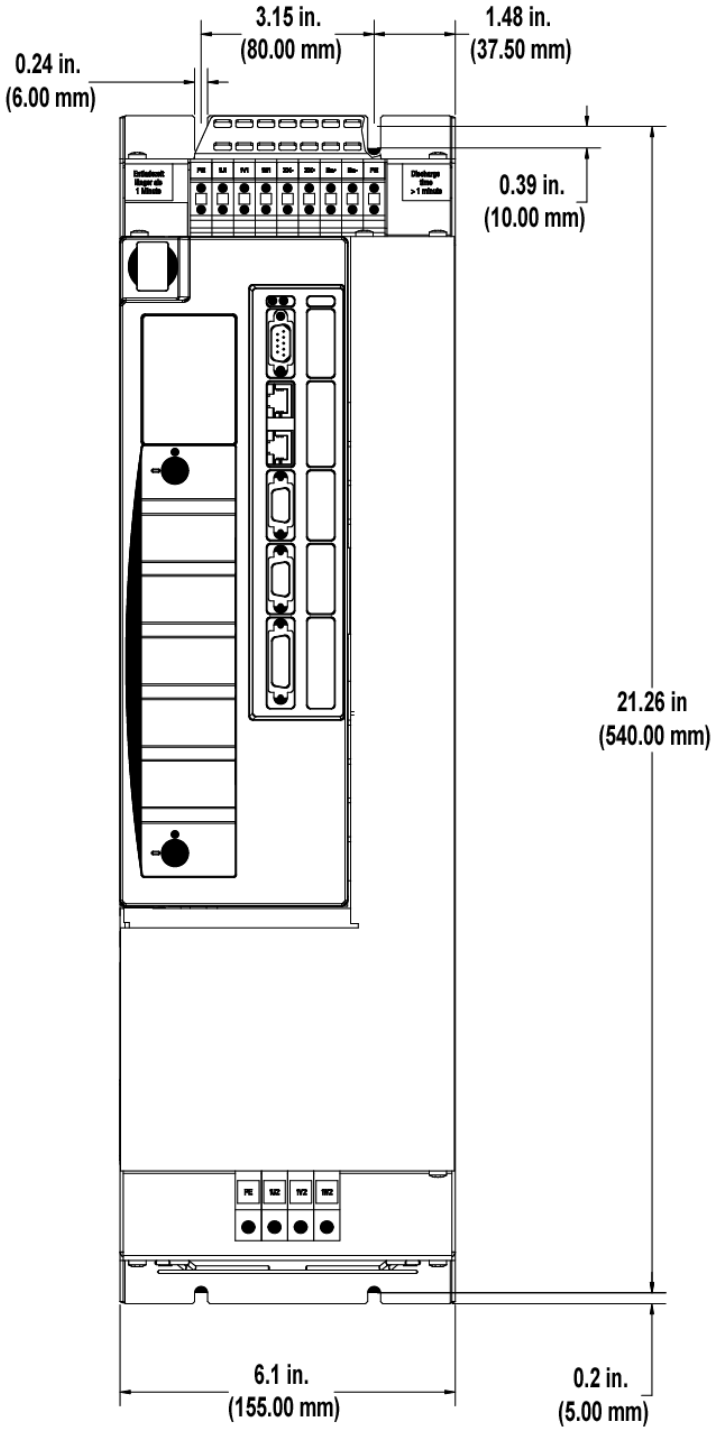
6.5.3 Size 2 460V Drive - Front View



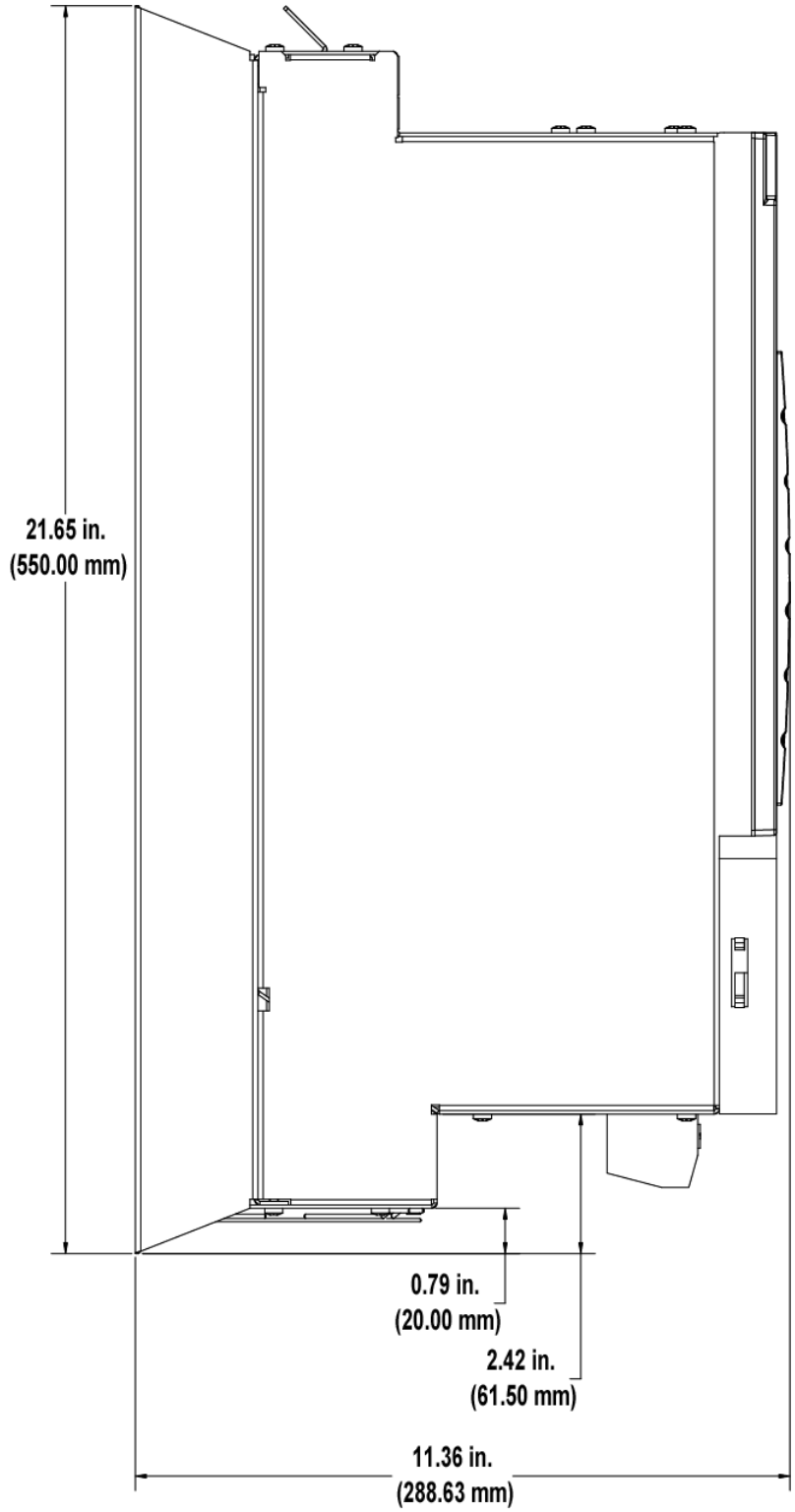
6.5.4 Size 2 460V Drive - Side View



6.5.5 Size 3 460V Drive - Front View



6.5.6 Size 3 460V Drive - Side View

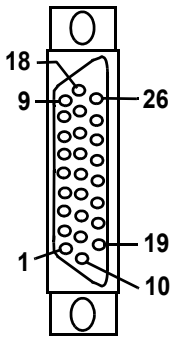
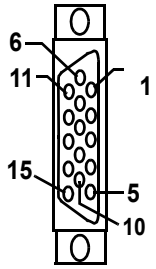


NOTES

7 Cables and Connections to External Devices

7.1 I/O Cable Pin Assignments

Table 7-1: I/O Cable to Controller

Twisted Pair 9 pair 28 AWG	D-sub 26-Pin HD Male Connector to MMC Smart Drive 		D-sub 15-Pin HD Male Connector to MMC Controller 		
Wire Color	**Pin Number**	**SignalType**	**Pin Number**	**Jumper Connection**	**Signal Type**
Black	1	A	1		A
White/Black	2	A/	2		A/
Red	3	B	3		B
White/Red	4	B/	4		B/
Green	5	I	5		I
White/Green	6	I/	10		I/
Orange	26	OUT4	6		DCIN+
White/Orange	N/U	N/U	7		DCIN-
Blue	14	CMD+	8		DA+
White/Blue	15	CMD-	9		DA-
Yellow	17	IN1	13		DCOUT1
White/Yellow	18	IN2	14		DCOUT2
Brown	N/U	N/U	N/U		N/A
White/Brown	N/U	N/U	15		DCOSS
Violet	N/U	N/U	N/U		N/A
White/Violet	N/U	N/U	N/U		N/A
Gray	10	IO24V	11		24VDCOUT
White/Gray	16	IOCOM	12		COM

7.2 LSM and MSM Motors Cable Pin Assignments

Table 7-2: F1/F2 Motor Encoder Cable to LSM or MSM Motors

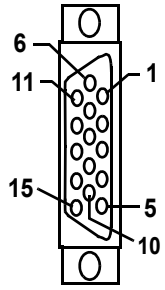
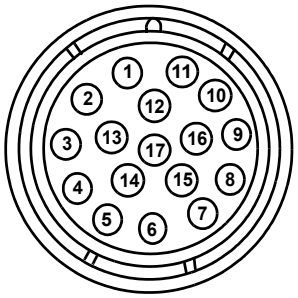
Twisted Pair 8 pair 28 AWG 1 pair 16 AWG	D-sub 15-Pin HD Male Connector to MMC Smart Drive  		Connector to Motor  		
Wire Color	**Pin Number**	**Signal Type**	**Pin Number**	**Jumper Connections**	**SignalType**
Yellow	1	A	1		A
White/Yellow	2	A/	2		A/
Blue	3	B	3		B
White/Blue	4	B/	4		B/
Black	5	I	5		I
White/Black	10	I/	6		I/
Violet	12	S1	15		S1
White/Violet	13	S2	16		S2
Red	8	S3	17		S3
White/Red	N/U	N/A	N/U		N/A
Green	11	TEMPERATURE	13		TEMPERATURE+
White/Green	N/U	N/A	14		TEMPERATURE-
Orange	N/U	N/A	N/U		N/A
White/Orange	N/U	N/A	N/U		N/A
Brown	7	9 VDC	9		9 VDC
White/Brown	N/U	N/A	N/U		N/A
Gray	14	+5 VDC	10		+5 VDC
White/Gray	6	COM	11		COM
N/C	9	N/A	7		N/C
N/C	15	N/A	8		N/C
			12		N/C

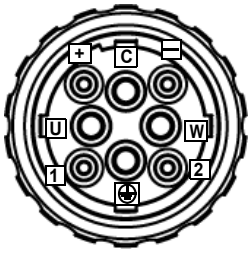
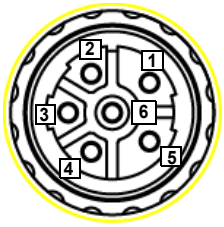
Table 7-3: Motor Power Connector to LSM or MSM Motors					
			Pin Number		
					
Wire Color	**Wire Number**	**Signal Type**	**Size 1 Power Connector (Kit No. M.1302.0479)**	**Size 1.5.1 Power Connector (Kit No. M.1302.1998)**	**Size 1.5.2 Power Connector (Kit No. M.1302.2354)**
Black (1)	1U2	Out	**1**	U	
Black (2)	1V2	Out	3	V	
Black (3)	1W2	Out	4	W	
Green/ Yellow	PE	Ground	2	⏚	
Black (5)	Brake+	Out	A	+	
Black (6)	Brake-	Out	B	-	

Table 7-4: Fan Motor Power Connector to LSM or MSM Motors			
			Pin Number
			
Wire Color	**Wire Number**	**Signal Type**	**Pin**
Brown	U	Out	**1**
Black	N	Out	2
Green/Yellow	PE	Ground	3

7.3 XSM Motors Cable Pin Assignments

Table 7-5: F1/F2 Motor Encoder Cable to XSM Motors

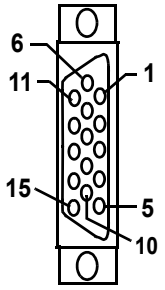
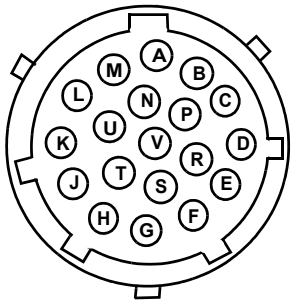
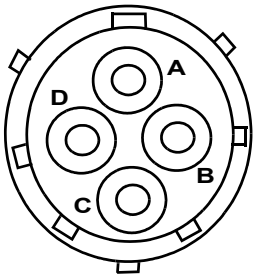
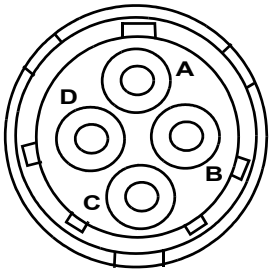
Twisted Pair 28 AWG 16 AWG	D-sub 15-Pin HD Male Connector to MMC Smart Drive  		Connector to Motor  		
Wire Color	**Pin Number**	**Signal Type**	**Pin Number**	**Jumper Connections**	**SignalType**
Black	1	A	A		A or SIN+
White/Black	2	A/	B		A/ or SIN-
Red	3	B	C		B or COS+
White/Red	4	B/	D		B/ COS-
Green	5	I	E		I or DATA+
White/Green	10	I/	F		I/ or DATA-
Violet	14	+5V	K		+5V
White/Violet	6	COM	L		COM
Orange	7	+9V	N		+9V
White/Orange	11	TEMPERATURE	R		TEMPERATURE+
Blue	N/U	N/A	S		TEMPERATURE-
White/Blue	12	S1	T		S1
Yellow	13	S2	U		S2
White/Yellow	8	S3	V		S3
Brown	9	TRAVEL LIMIT+	J		+LIMIT
White/Brown	15	TRAVEL LIMIT-	M		-LIMIT
	N/A	N/A	P		COM
	N/A	N/A	G		N/C
	N/A	N/A	H		N/C

Table 7-6: Motor Power Cable to XSM Motors				
				
	Drive Lower Screw Terminal		**Connector End to Motor**	
Wire Color	**Terminal**	**Signal Type**	**Pin Number**	**Signal Type**
Brown	U	Out	A	Out
Black	V	Out	B	Out
Blue	W	Out	C	Out
Green/Yellow	⏚	Ground	D	Ground

Motor Brake Cable Connector to LSM or MSM Motors	
	
Pin Number	**Signal Type**
A	B+
B (N/U)	N/A
C	B-
D (N/U)	N/A

7.4 NSM Motors Cable Pin Assignments

Table 7-7: F1/F2 Motor Encoder Cable to NSM Motors

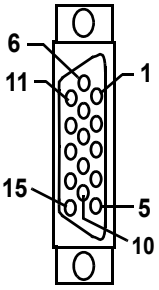
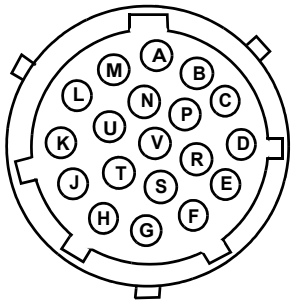
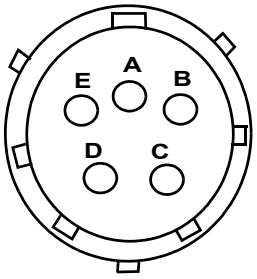
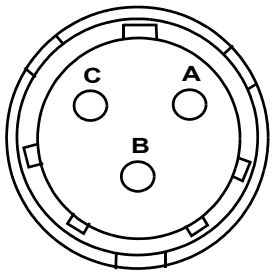
Twisted Pair 28 AWG 16 AWG	D-sub 15-Pin HD Male Connector to MMC Smart Drive  		Connector to Motor  		
Wire Color	**Pin Number**	**Signal Type**	**Pin Number**	**Jumper Connections**	**SignalType**
Black	1	A	A		A
White/Black	2	A/	B		A/
Red	3	B	C		B
White/Red	4	B/	D		B/
Green	5	I	E		I
White/Green	10	I/	F		I/
Gray	14	+5V	J		+5VDC
			K		+5VDC
White/Gray	6	COM	L		COM
			M		COM
			S		TEMPERATURE-
Blue	13	S2	U		S2
White/Blue	12	S1	T		S1
Brown	8	S3	V		S3
White/Brown	11	TEMPERATURE+	R		TEMPERATURE+
Orange	N/U	N/A	N/U		N/A
White/Orange	N/U	N/A	N/U		N/A
Violet	N/U	N/C	G		N/C
White/Violet	7	N/C	H		N/C
Yellow	9	N/C	N		N/C
White/Yellow	15	N/C	P		N/C

Table 7-8: Motor Power Cable to NSM Motors				
				
	Drive Lower Screw Terminal		**Connector End to Motor**	
Wire Color	**Terminal**	**Signal Type**	**Pin Number**	**Signal Type**
Brown	U	Out	A	Out
Black	V	Out	B	Out
Blue	W	Out	C	Out
Green/Yellow	⏚	Ground	D	Ground
N/A	N/C	N/A	E (N/C)	N/A

Motor Brake Cable Connector to NSM Motors	
	
Pin Number	**Signal Type**
A	B+
B	B-
C (N/U)	N/A

7.5 HSM and FSM Motors Cable Pin Assignments

Table 7-9: F1/F2 Motor Encoder Cable to HSM and FSM Motors

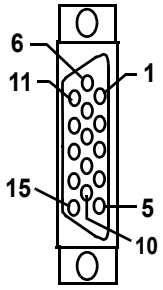
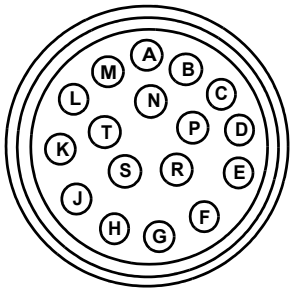
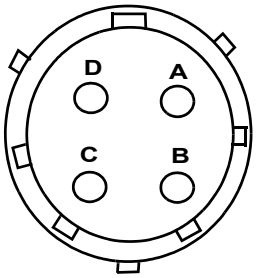
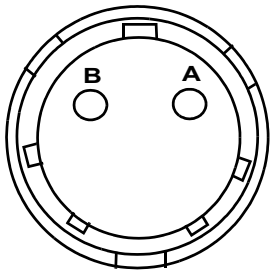
Twisted Pair 28 AWG 16 AWG	D-sub 15-Pin HD Male Connector to MMC Smart Drive 		Connector to Motor 		
Wire Color	**Pin Number**	**Signal Type**	**Pin Number**	**Jumper Connections**	**SignalType**
Black	1	A	A		A
White/Black	2	A/	B		A/
Red	3	B	C		B
White/Red	4	B/	D		B/
Green	5	I	E		I
White/Green	10	I/	F		I/
Gray	14	+5V	J		+5VDC
			K		+5VDC
White/Gray	6	COM	L		COM
			M		COM
			S		TEMPERATURE-
Blue	13	S2	N		S2
White/Blue	12	S1	T		S1
Brown	8	S3	P		S3
White/Brown	11	TEMPERATURE+	R		TEMPERATURE+
Orange	N/U	N/A	N/U		N/A
White/Orange	N/U	N/A	N/U		N/A
Violet	N/U	N/C	G		N/C
White/Violet	7	N/C	H		N/C
Yellow	9	N/C	N/U		N/A
White/Yellow	15	N/C	N/U		N/A

Table 7-10: Motor Power Cable to HSM and FSM Motors				
				
	Drive Lower Screw Terminal		**Connector End to Motor**	
Wire Color	**Terminal**	**Signal Type**	**Pin Number**	**Signal Type**
Brown	U	Out	A	Out
Black	V	Out	B	Out
Blue	W	Out	C	Out
Green/Yellow	⏚	Ground	D	Ground

Motor Brake Cable Connector to HSM and FSM Motors	
	
Pin Number	**Signal Type**
A	B+
B	B-

7.6 YSM Motors Cable Pin Assignments

Table 7-11: F1/F2 Motor Encoder Cable to YSM Motors

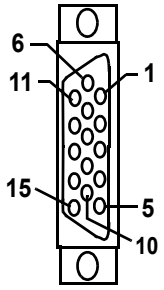
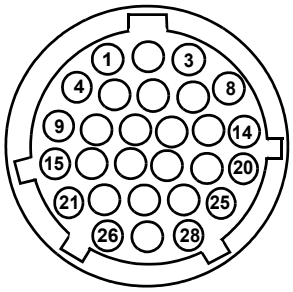
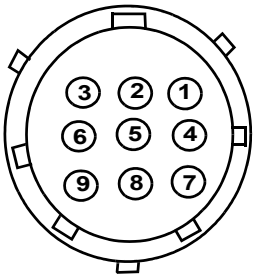
Twisted Pair 28 AWG 16 AWG	D-sub 15-Pin HD Male Connector to MMC Smart Drive 		Connector to Motor 		
Wire Color	**Pin Number**	**Signal Type**	**Pin Number**	**Jumper Connections**	**SignalType**
Black	1	A	9	NO JUMPERED PINS	A
White/Black	2	A/	10		A/
Red	3	B	11		B
White/Red	4	B/	12		B/
Green	5	I	13		I
White/Green	10	I/	14		I/
Gray	14	+5V	22		+5VDC
White/Gray	6	COM	23		COM
Blue	13	S2	17		S2
White/Blue	12	S1	15		S1
Brown	8	S3	19		S3
White/Brown	11	N/C	24		N/C
	7	N/C	1		N/C
	9	N/C	2		N/C
	15	N/C	3		N/C
			4		N/C
			5		N/C
			6		N/C
			7		N/C
			8		N/C
			16		N/C
			18		N/C
			20		N/C
			21		N/C
			25-28		N/C

Table 7-12: Motor Power and Brake Cable to YSM Motors



	Drive Lower Screw Terminal		Connector End to Motor	
Wire Color	**Terminal**	**Signal Type**	**Pin Number**	**Signal Type**
Brown	U	Out	1	Out
Black	V	Out	2	Out
Blue	W	Out	3	Out
N/A	N/U	N/A	4 (N/U)	N/A
Green/Yellow	⏚	Ground	5	Ground
N/A	N/U	N/A	6 (N/U)	N/A
N/A	N/U	N/A	8 (N/U)	N/A

Table 7-13: Motor Brake Cable Connector to YSM Motors

Pin Number	Signal Type
7	B+
9	B-

7.7 Connecting Shunt Modules

Use shielded, high temperature 75° C (167° F), 600V, 2.5-4.0 mm^2 (12-14 AWG), 3.05 m (10 ft) maximum, copper wire. Follow one of the methods given below to reduce the effects of EMI noise:

- Install wires using twisted pairs (two turns per foot minimum), as shown in the figure above. Keep unshielded wires as short as possible.
- Use shielded, twisted cable (ground shield at shunt and drive).
- Use shielded metal conduit (ground conduit at shunt and drive).

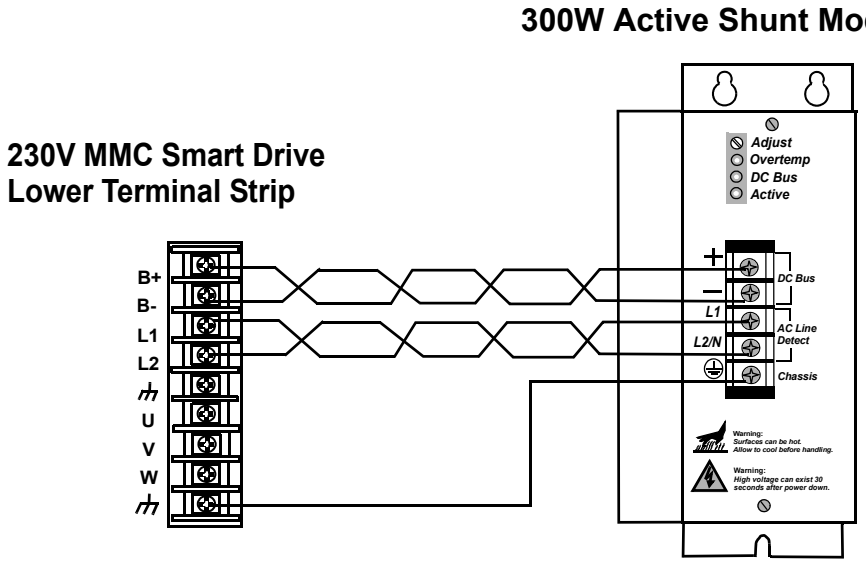
When two shunt modules are connected in parallel, the shunt capacity is doubled.

WARNING

Do not connect more than two shunt modules to an MMC Smart Drive.

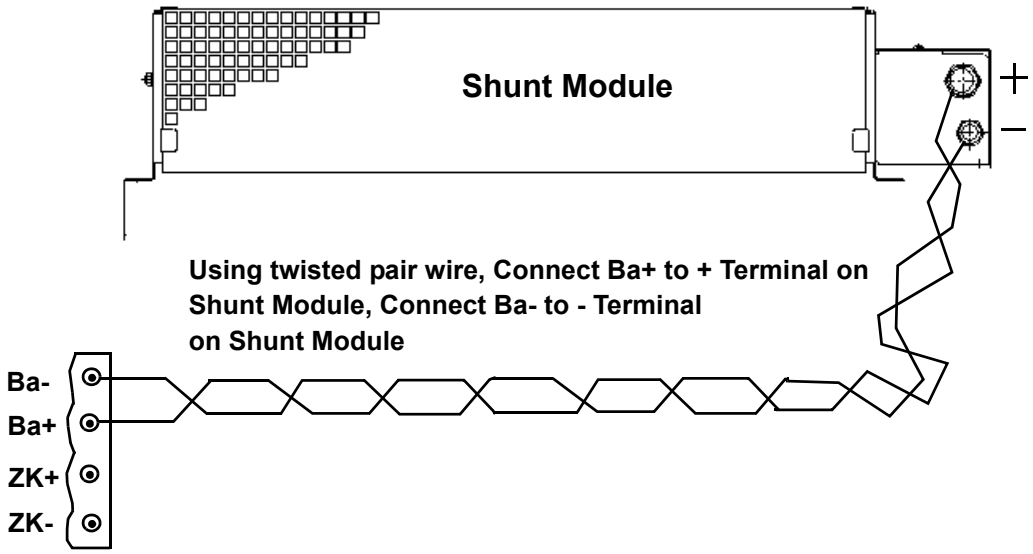
7.7.1 Connecting the 230V MMC Smart Drive to 300 W Shunt Module

Figure 7-1: Wiring 230V MMC Smart Drive to 300W Active Shunt Module



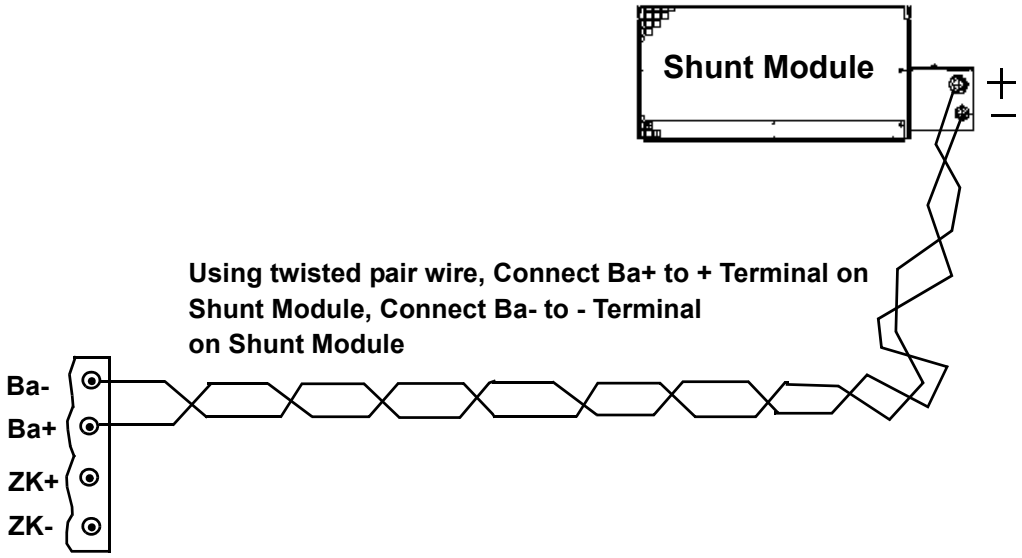
7.7.2 Connecting the 460V MMC Smart Drive to Sheffield Automation Shunt Modules

Figure 7-2: Wiring 460V MMC Smart Drive to 450 Watt, 130Ω Shunt Module / 700 Watt, 95Ω Shunt Module / 1400 Watt, 50Ω Shunt Module



460V MMC Smart Drive Shunt/DC Bus Terminal Strip

Figure 7-3: Wiring 460V MMC Smart Drive to 2800 Watt, 25Ω Shunt Module / 3900 Watt, 18Ω Shunt Module

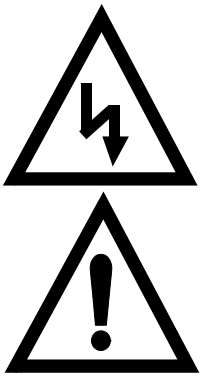


460V MMC Smart Drive Shunt/DC Bus Terminal Strip

8 Maintenance and Troubleshooting

8.1 Maintenance

WARNING



Disconnect input power before touching cables or connections.

DC bus capacitors may retain hazardous voltages after input power has been removed.

Before working on the drive, measure the DC bus voltage to verify it has reached a safe level.

Failure to observe this precaution could result in severe bodily injury or loss of life.

1. Remove superficial dust and dirt from the drive.
2. Check cable insulation and connections.
3. Clean exterior surfaces and airflow vents using an OSHA approved nozzle that provides compressed air under low pressure of less than 20 kPa (30 psi).
4. Visually check for cable damage. Replace all damaged cables.
5. Inspect D-shell connectors for proper seating and signal continuity end-to-end.

8.2 Diagnostics

8.2.1 Power-On Diagnostics

When the drive is powered up, it tests itself and reports the results of the tests in the form of LED signals.

8.2.1.1 Power LED

If the Power (P) LED does not go on, or goes off during operation of the system, check that 24 VDC power is still connected to the drive.

8.2.1.2 Diagnostic LEDs

The Status LED (D1) lights up briefly while diagnostic tests are running and then goes off. If the Status LED (D1) remains on, the drive has failed one of its diagnostic tests. Follow these steps:

1. Turn off power to the drive system and to the application.
2. Perform any necessary maintenance to the drive.
3. Check the I/O wiring and the devices the system is connected to. There may be a short or other problem other than the drive. Correct these problems.
4. Turn on power to check diagnostics again.

NOTE
Power-On diagnostics are run only when the system is powered up. If a drive fails during power-up, the Status LED (D1) light remains on. If you suspect that a drive is defective, cycle power to run diagnostics again.

8.2.2 Run-Time Diagnostics

While the MMC Smart Drive is running, other tests are performed on a regular basis with their results also reported through the Status LED (D1).

While the MMC Smart Drive is running, the Status LED (D1) will flash a two digit code signal if there is an error. The errors are described in Table 8-2: Fault Error Codes.

8.3 Troubleshooting

8.3.1 General Troubleshooting

Table 8-1: General Troubleshooting Symptoms, Causes, Remedies

Symptom	Possible Cause	Remedy
Power (P) indicator not ON	No 24VDC input power.	Verify 24 VDC power is applied to the drive.
	Internal power supply malfunction.	Contact your Sheffield Automation representative.
Motor jumps when first enabled	Motor wiring error.	Check motor wiring.
	Incorrect motor chosen.	Verify the proper motor is selected.
I/O not working correctly	I/O power supply disconnected.	Verify connections and I/O power source.

8.3.2 Troubleshooting Fault Error Codes

When a fault is detected the Status LED (D1) located above the PiCPro port on the face of the drive will flash a two-digit error code. The LED will continue to flash until the fault is eliminated.

For example, if there is a long pause-flash-pause-flash-flash-long pause, the code is 12. The Fault Error Codes are described in Table 8-2: Fault Error Codes.

Table 8-2: Fault Error Codes

Fault Code	Fault	Possible Causes	Possible Remedies
11	Drive Memory Fault	The drive's non-volatile memory is not functioning properly	Upgrade firmware. Contact Sheffield Automation.
12	Drive Bus Over Voltage Fault	Excessive regeneration of power. The motor may regenerate too much peak energy through the drive's power supply. A fault is generated to prevent overload.	Change the deceleration or motion profile. Reduce the reflected inertia of your mechanical system. Use a larger motor and/or drive. Use a shunt.
		Excessive AC input voltage.	Verify input AC voltage is within specifications. Adjust accordingly.
		Output short circuit.	Remove all power and motor connections, and perform a continuity check from the DC bus to the U, V, and W motor outputs. If a continuity exists, check for wire fibers between terminals, contact Sheffield Automation.
		Motor cabling wires shorted together.	Disconnect motor power cables from the drive. If faults stop, replace cable.
		Internal motor winding short circuit.	Disconnect motor power cables from the motor. If the motor is difficult to turn by hand, it may need to be replaced.
13	Drive PM1 Over Current Fault	Current feedback exceeds the drive over current fault limit.	Adjust the over current fault limit.
		Output short circuit.	Remove all power and motor connections, and perform a continuity check from the DC bus to the U, V, and W motor outputs. If a continuity exists, check for wire fibers between terminals, contact Sheffield Automation.
		Motor cabling wires shorted together.	Disconnect motor power cables from the drive. If faults stop, replace cable.
		Internal motor winding short circuit.	Disconnect motor power cables from the motor. If the motor is difficult to turn by hand, it may need to be replaced.
14	Drive Over Power Fault	Drive current and voltage output, in combination with the heatsink temperature indicate that the power output required by the drive would damage the power section.	Verify ambient temperature is not too high. Operate within the continuous power rating. Reduce acceleration rates.

15	Motor Temperature Fault	Motor thermostat trips due to high motor ambient temperature	Operate within (not above) the continuous torque rating for the ambient temperature (40°C maximum). Lower ambient temperature, increase motor cooling.
		Motor thermostat trips due to excessive current	Reduce acceleration rates. Increase time permitted for motion. Use larger drive and motor. Reduce duty cycle (ON/OFF) of commanded motion. Check tuning.
		Motor thermostat trips due to motor wiring error.	Check motor wiring.
		Motor thermostat trips due to incorrect motor selection.	Verify the proper motor has been selected.
16	Continuous Current Fault	Current exceeds the continuous motor current rating for an extended period of time.	Change motor and or drive to be compatible with load requirements.
17	Drive Heatsink Temperature Fault	Drive heatsink temperature exceeds drive heatsink fault limit	Let the drive cool down and/or reduce the load.
22	Drive F1 Feedback Fault	Error is detected in the motor feedback	Check encoder line and make sure the correct encoder is attached. Verify encoder wiring is correct. Use shielded cables with twisted pair wires. Route the encoder feedback cable away from potential noise sources. Check ground connections. Verify motor selection is correct.
23	Drive Ambient Temp. Fault	Drive ambient temperature exceeds the drive ambient temperature fault limit	Operate within (not above) the continuous rating for the ambient temperature. Lower ambient temperature, increase cabinet cooling.
24	Motor Calculated Temp. Fault	Motor calculated temperature exceeds the motor calculated temperature fault limit.	Check the machine for excessive loads. Motor may be undersized for the application.
25	Drive Timing Fault	Timing error is detected in the execution of the control algorithms performed by the drive's digital signal processor.	Contact Sheffield Automation.
26	Drive Interface Fault	Communication error is detected in the transmission of information between the drive's digital signal processor and the drive's power section.	Contact Sheffield Automation.
27	User Set Fault	PiCPro Set User Fault command selected.	The PiCPro Set User Fault command was selected or the Control Panel mode was activated or deactivated while the drive was enabled.

31	Drive F1 Communication Fault	Communication error is detected in the transmission of information between the drive and a high resolution or multi-turn absolute feedback device.	Check encoder line and make sure the correct encoder is attached. Verify encoder wiring is correct. Use shielded cables with twisted pair wires. Route the encoder feedback cable away from potential noise sources. Check ground connections. Verify motor selection is correct.
		Bad encoder.	Replace motor and encoder.
32	Over Speed Fault	User specified motor speed has been exceeded.	Check cables for noise. Check tuning.
33	Over Current Fault	User-Specified average current level has been exceeded.	Change to a less restrictive setting. Reduce the load.
34	Drive Communication Fault	Communication error occurs while drive control is being performed using the PiCPro Control Panel tools.	Do not disconnect the PiCPro cable while operating in Control Panel Mode.
35	Drive Power Module Fault	The drive's power section detects a fault condition.	Verify AC power is applied to drive. Contact Sheffield Automation.
36	Drive Setup Data Fault	The configuration data has been corrupted.	Re-download Drive Setup Data.
41	Drive Relay Fault	The drive's power section relay did not function properly during power-up.	Check the drive system connce-tions. Adjust as necessary. Contact Sheffield Automation.
42	Drive PM2 Over Current Fault	Current feedback exceeds the drive over current fault limit.	Adjust the over current fault limit.
		Output short circuit.	Remove all power and motor connections, and perform a continuity check from the DC bus to the U, V, and W motor outputs. If a continuity exists, check for wire fibers between terminals, contact Sheffield Automation.
		Motor cabling wires shorted together.	Disconnect motor power cables from the drive. If faults stop, replace cable.
		Internal motor winding short circuit.	Disconnect motor power cables from the motor. If the motor is difficult to turn by hand, it may need to be replaced.
43	Drive PM Over Temperature Fault	Drive power module temperature exceeds the drive power module temperature fault limit	Check to be sure that the drive is being operated within the continuous power rating. Check for adequate enclosure ventilation. Ensure cooling air flow is adequate in space around the drive. Check for clogged vents or defective fan. Contact Sheffield Automation.

44	Motor Ground Fault	Ground fault has occurred.	Make sure motor ground connections are correct. Replace defective motor ground wires. Check for internal motor winding short circuits.
45	Drive AC Input Over Voltage Fault	Incoming AC voltage is too high.	Verify input VAC is within specificaitons.

8.3.3 Troubleshooting Warning Error Codes

Table 8-3: Warning Error Codes

Error Code	Warning	Possible Causes	Possible Remedies
01	Drive Heatsink Temp. Warning	Drive heatsink temperature exceeds warning limit	TBD
02	Drive Ambient Temp. Warning	Acceptable ambient temperature limit has been exceeded warning limit	TBD
03	Motor Temp. Warning	Motor thermal device is a thermistor and thermistor temperature has exceeded acceptable limit	• Reduce acceleration rates. • Reduce duty cycle (ON/OFF) of commanded motion. • Increase time permitted for motion. • Use larger drive and motor. • Check tuning.
04	Motor Calculated Temp. Warning	Calculated motor temperature has exceeded acceptable limit	TBD

NOTES

9 Resolver Interface Option Module

9.1 Theory of Operation

The Resolver Interface Option Module provides the interface between the resolver and the drive's DSP. It is a tracking system where the rotor is excited with a sine wave. The outputs of the resolver are amplitude modulated by the sine and cosine of the rotor shaft angle. The tracking converter converts the sine and cosine amplitude ratio into a 12 bit number.

The module provides a 4 Vrms 5 kHz sine wave to excite the resolver rotor. The resolver transformer ratio is 3:4 so the stator outputs are 2V RMS with the shaft rotated to the angle of maximum coupling. The sine and cosine rotor outputs are returned to the resolver module's twin instrumentation amplifier inputs to produce a high common mode noise rejection and a high input impedance (220K Ω). The sine and cosine signals are then fed to a resolver to digital converter chip that performs the tracking conversion. The converter has both a serial output and an encoder emulator output. The serial output is read when the drive is powered up to obtain the absolute commutation angle for the motor. Thereafter, it is used as an encoder emulator.

The module is able to detect a loss of feedback by monitoring the sine and cosine signals. If both are near zero at the same time, a loss of feedback error is generated.

9.2 Installing the Resolver Module

1. Remove the five screws at the corners of the face of the 230V drive or loosen the 2 mounting screws on the face of the 460V drive.
2. Remove the shunt from the 24-pin DIP socket located on the MMC Smart Drive board.
3. Install the short end of the standoff into the circuit board so the slotted tip of the standoff protrudes through the standoff mounting holes on the MMC Smart Drive board.
4. Position the Resolver Option Module so the standoffs align with the mounting holes on the module, and the header is aligned with the socket.
5. Using even pressure, press the option module into place.
6. Verify that the module is fully seated into the socket and the locking tabs on the standoffs are in the locked position.

Figure 9-1: Before Shunt Removed and Resolver Module Installed

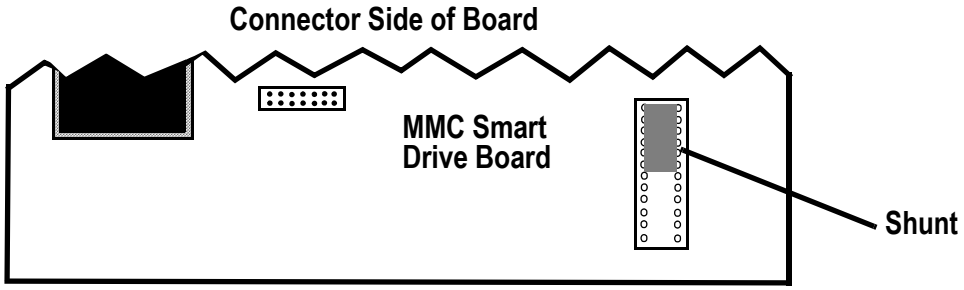
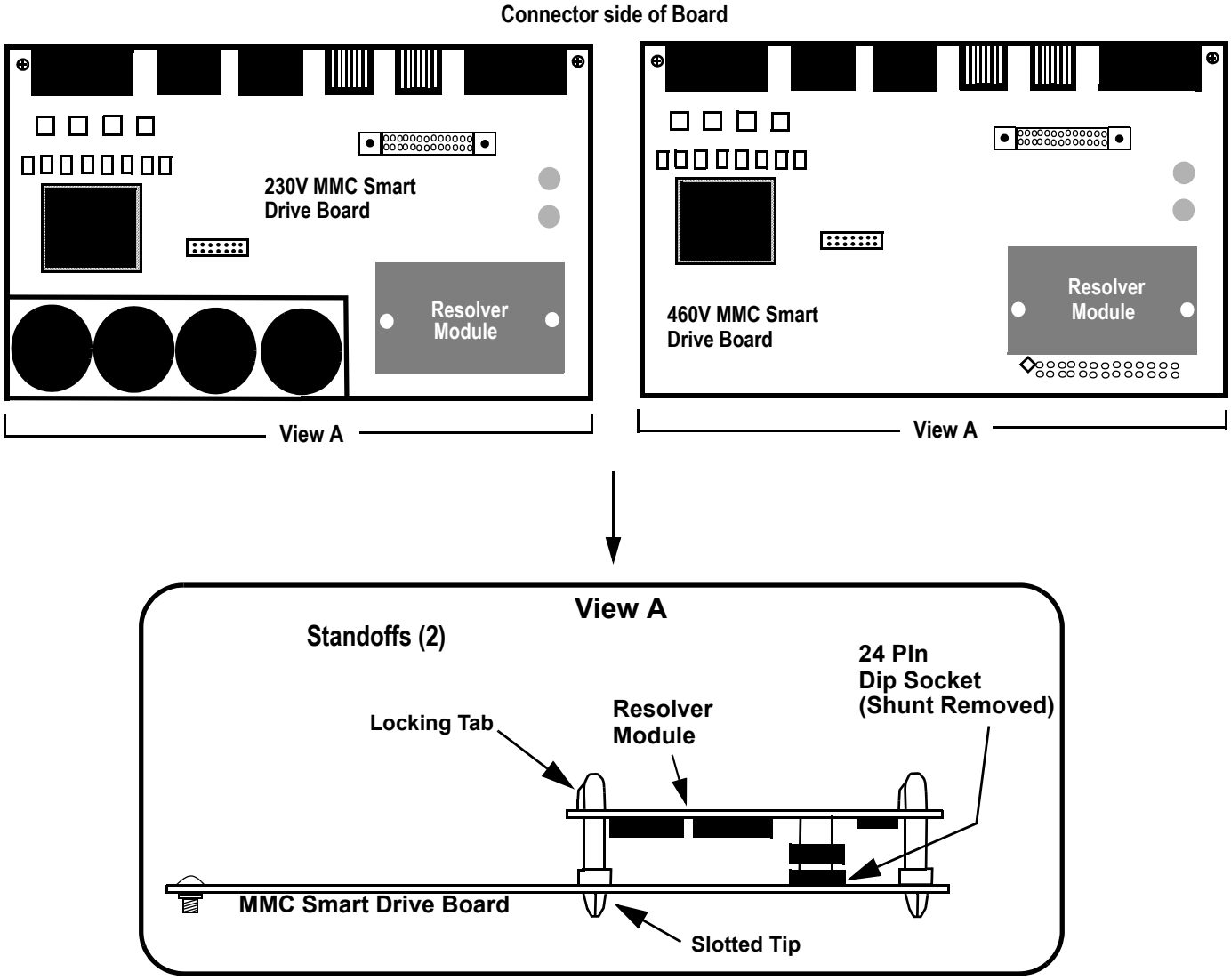


Figure 9-2: Shunt Removed and Resolver Module Installed



9.3 Specifications

Characteristics	Resolver Interface Option Module Specifications
Function	Resolver to encoder converter
Part Number	M.1302.4523
Field Side Connector	F1 Feedback Connector
Excitation Frequency	5 kHz
Output Voltage	4 V_{RMS}
Current per Output Channel, max.	28 mA_{RMS}
Resolver Transformer Ratio	0.5:1.0
Resolver Resolution	4096 Feedback Units (FUs) per electrical revolution
Accuracy Over Temperature Range	$\pm$ 15 minutes
Electrical Velocity, max.	500 RPS
Cable Length, max.	30 M
Power	Powered from MMC Smart Drive
Operating temperature range	7° C to 55° C (45° F to 131° F)
Storage temperature range	-40° C to 85° C (-40° F to 185° F)
Humidity	5 to 95%, non-condensing
Vibration (per IEC 68-2-6)	10-57 Hz (constant amplitude .15 mm) 57 - 2000 Hz (acceleration 2 g)
Shock (per IEC 68-2-27)	Four shocks per axis (15g/11 msec)
CE Marked	In Process Conforms to Low Voltage Directive 73/23/EEC (amended by 93/68/EEC) and EMC Directive 89/336/EEC (amended by 92/31/EEC and 93/68/EEC). Conformance is in accordance with the following standards: EN 50178 and EN61800-3
UL and C/UL Listed	In process (E233454)

NOTES

10 Part Numbers

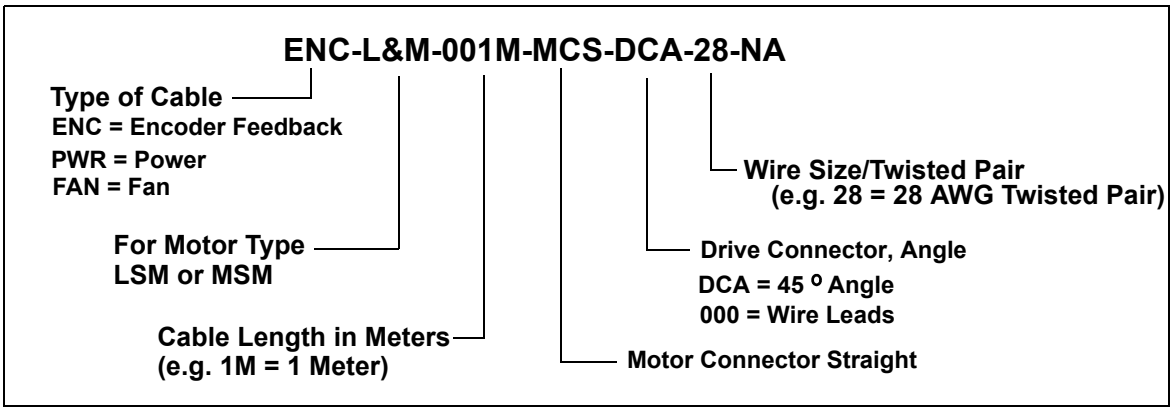
10.1 Drives

Description	Model Number	Part Number
230 V MMC Smart Drive		
2.5 Amp Cont. / 7.5 Amp Max./ .5kW	MMC-SD-0.5-230	M.1302.5090
5 Amp Cont. / 15 Amp Max./ 1 kW	MMC-SD-1.0-230	M.1302.5091
10 Amp Cont. / 30 Amp Max / 2kW	MMC-SD-2.0-230	M.1302.5092
460V MMC Smart Drive		
1.3 kW	MMC-SD-1.3-460	M.1302.5093
2.4 kW	MMC-SD-2.4-460	M.1302.5094
4.0 kW	MMC-SD-4.0-460	M.1302.5095
6.0 kW	MMC-SD-6.0-460	M.1302.5096
8.0 kW	MMC-SD-8.0-460	M.1302.5097
12.0 kW	MMC-SD-12.0-460	M.1302.5098
16.0 kW	MMC-SD-16.0-460	M.1302.5099
24.0 kW	MMC-SD-24.0-460	M.1302.5100

10.2 Software and Software Documentation

Description	Part Number
PiCPro for Windows Software Professional Edition MMC Limited Edition Monitor Edition	 M.1300.7213 M.1300.7214 M.1300.7215
PiCPro for Windows Software Manual	M.1300.7592

10.3 Feedback Cables for LSM and MSM Motors



10.3.1 Feedback Cables for LSM and MSM Motors

Feedback Cable	Part Number
Static Type	
ENC-L&M-001M-MCS-DCA-28-NA	M.1302.0944
ENC-L&M-003M-MCS-DCA-28-NA	M.1302.0945
ENC-L&M-009M-MCS-DCA-28-NA	M.1302.0946
ENC-L&M-015M-MCS-DCA-28-NA	M.1302.0947
ENC-L&M-030M-MCS-DCA-28-NA	M.1302.0948
Flexing Type	
ENC-L&M-001M-MCS-DCA-28-AA	M.1302.5834
ENC-L&M-003M-MCS-DCA-28-AA	M.1302.5835
ENC-L&M-009M-MCS-DCA-28-AA	M.1302.5836
ENC-L&M-015M-MCS-DCA-28-AA	M.1302.5837
ENC-L&M-030M-MCS-DCA-28-NA	M.1302.5838

10.3.2 Power Cables for LSM and MSM Motors

Power Cable	Part Number
Flexing Type	
PWR-L&M-001M-MCS-000-16-6H	M.1302.1114
PWR-L&M-003M-MCS-000-16-6H	M.1302.1115
PWR-L&M-009M-MCS-000-16-6H	M.1302.1116
PWR-L&M-015M-MCS-000-16-6H	M.1302.1117
PWR-L&M-030M-MCS-000-16-6H	M.1302.1118
PWR-L&M-001M-MCS-000-14-6H	M.1302.1119
PWR-L&M-003M-MCS-000-14-6H	M.1302.1130
PWR-L&M-009M-MCS-000-14-6H	M.1302.1131
PWR-L&M-015M-MCS-000-14-6H	M.1302.1132
PWR-L&M-030M-MCS-000-14-6H	M.1302.1133
PWR-L&M-001M-MCS-000-12-6H	M.1302.1134
PWR-L&M-003M-MCS-000-12-6H	M.1302.1135
PWR-L&M-009M-MCS-000-12-6H	M.1302.1136
PWR-L&M-015M-MCS-000-12-6H	M.1302.1137
PWR-L&M-030M-MCS-000-12-6H	M.1302.1139
PWR-L&M-001M-MCS-000-10-6H	M.1302.1140
PWR-L&M-003M-MCS-000-10-6H	M.1302.1142
PWR-L&M-009M-MCS-000-10-6H	M.1302.1143
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PWR-L&M-030M-MCS-000-10-6H	M.1302.1145
PWR-L&M-001M-MCS-000-08-6H	M.1302.1146
PWR-L&M-003M-MCS-000-08-6H	M.1302.1147
PWR-L&M-009M-MCS-000-08-6H	M.1302.1148
PWR-L&M-015M-MCS-000-08-6H	M.1302.1149
PWR-L&M-030M-MCS-000-08-6H	M.1302.1150

10.3.3 Power Cables for Blower Fan (LSM and MSM Motors)

Power Cable	Part Number
FAN-L&M-001M-MCS-000-16	M.1302.6310
FAN-L&M-003M-MCS-000-16	M.1302.6311
FAN-L&M-009M-MCS-000-16	M.13026312
FAN-L&M-015M-MCS-000-16	M.1302.6313
FAN-L&M-030M-MCS-000-16	M.1302.6314

10.4 Drive Direct Connect Cables

10.4.1 Drive Programming Cable

Description	Part Number
PiCPro Port to PC Connector	M.1016.9038

10.4.2 MMC to MMC Smart Drive I/O Cable

Description	Part Number
MMC An to MMC Smart Drive I/O 0.5M	M.1302.5990
MMC An to MMC Smart Drive I/O 1.0M	M.1302.5991
MMC An to MMC Smart Drive I/O 1.5M	M.1302.5992
MMC An to MMC Smart Drive I/O 3.0M	M.1302.5993

10.5 MMC Smart Drive Breakout Boards, Cables and Kits

10.5.1 Drive Mounted Breakout Boards

Description	Part Number
BKOUT BD, F1/F2 MMC-SD DR MT	M.1302.6970
BKOUT BD, I/O MMC-SD DR MT	M.1302.6971

10.5.2 Panel Mounted Breakout Boards

Description	Part Number
BKOUT BD, F1/F2 MMC-SD PNL MT	M.1302.6972
BKOUT BD, I/O MMC-SD PNL MT	M.1302.6973

10.5.3 Breakout Board Cables

Description	Part Number
CABLE, BKOUT BD, F1/F2 MMC-SD 1.0M	M.1302.6976
CABLE, BKOUT BD, F1/F2 MMC-SD 3.0M	M.1302.6977
CABLE, BKOUT BD, F1/F2 MMC-SD 9.0M	M.1302.6979
CABLE, BKOUT BD, F1/F2 MMC-SD 15.0M	M.1302.6980
CABLE, BKOUT BD, I/O MMC-SD 1.0M	M.1302.6982
CABLE, BKOUT BD, I/O MMC-SD 3.0M	M.1302.6984
CABLE, BKOUT BD, i/O MMC-SD 9.0M	M.1302.6985

10.5.4 User I/O Flying Lead Cables

Description	Part Number
CABLE, USER I/O, MMC-SD 1.0M	M.1302.7032
CABLE, USER I/O, MMC-SD 3.0M	M.1302.7034
CABLE, USER I/O MMC-SD 9.0M	M.1302.7035
CABLE, USER I/O, MMC-SD 15.0M	M.1302.7036
CABLE, USER I/O, MMC-SD 30.0M	M.1302.7037

10.5.5 Breakout Board Kits

Description	Part Number
KIT, BKOUT BD, F1/F2 MMC-SD 1.0M	M.1302.7005
KIT, BKOUT BD, F1/F2 MMC-SD 3.0M	M.1302.7006
KIT, BKOUT BD, F1/F2 MMC-SD 9.0M	M.1302.7007
KIT, BKOUT BD, F1/F2 MMC-SD 15.0M	M.1302.7008
KIT, BKOUT BD, I/O MMC-SD 1.0M	M.1302.7009
KIT, BKOUT BD, I/O MMC-SD 3.0M	M.1302.7030
KIT, BKOUT BD, I/O MMC-SD 9.0M	M.1302.7031

10.6 Connector Kits

Description	Part Number
CONN-FBK-17POS-16-28AWG	M.1302.0510
CONN-PWR-BRK-8POS-16AWG	M.1302.0479
CONN-PWR-BRK-8POS-12-14AWG	M.1302.1998
CONN-PWR-BRK-8POS-8-10AWG	M.1302.2354
CONN-PWR-FAN-6POS-16AWG	M.1302.6219
CONN-X100-X101	M.1302.7099
CONN-4TERM-MAINS	M.1302.7158
CONN-4TERM-MOTOR	M.1302.7159

10.7 Optional External Devices

10.7.1 AC Line Filters

For Drive Model	AC Line Filter Description	Line Filter Part Number
MMC-SD-0.5-230 MMC-SD-1.0-230	6 A, 250 V, Single phase	M.1015.6922
MMC-SD-2.0-230	10 A, 250 V, Single phase,	M.1015.6917
MMC-SD-1.3-460 MMC-SD-2.4-460	7 A, 480 V, Three phase	M.1302.5241
MMC-SD- 4.0-460 MMC-SD-6.0-460 MMC-SD- 8.0-460	16 A, 480 V, Three phase	M.1302.5244
MMC-SD-12.0-460 MMC-SD-16.0-460	30 A, 480 V, Three phase	M.1302.5245
MMC-SD-24.0-460	42 A, 480 V, Three phase	M.1302.5246
TBD	56 A, 480 V, Three phase	M.1302.5247
TBD	75 A, 480 V, Three phase	M.1302.5248

10.7.2 AC Line Reactors

For Drive Model	Required Line Reactor	Watts Loss	Approximate Weight (lbs.)	Line Reactor Part Number
MMC-SD.-12.0-460	25 A	TBD	TBD	M.1302.7038
MMC-SD-16.0-460	25 A	TBD	TBD	M.1302.7038
MMC-SD-24.0-460	41 A	TBD	TBD	M.1302.7039

10.7.3 External Shunt Kits

For Drive	Shunt Module	Part Number
MMC-SD-0.5-230 MMC-SD-1.0-230 MMC-SD-2.0-230	Shunt Resistor, 600 V, 300 W, Dynamic, 100 Ω	M.1015.7046
MMC-SD-1.3-460 MMC-SD-2.4-460	Shunt Resistor, 600 V, 450 W, 130 Ω	M.1302.7048
MMC-SD-4.0-460	Shunt Resistor, 600 V, 700 W, 95 Ω	M.1302.7049
MMC-SD-6.0-460 MMC-SD-8.0-460	Shunt Resistor, 600 V, 1400 W, 50 Ω	M.1302.7060
MMC-SD-12.0-460 MMC-SD-16.0-460	Shunt Resistor, 600 V, 2800 W, 25 Ω	M.1302.7061
MMC-SD-24.0-460	Shunt Resistor, 600 V, 3900 W, 18 Ω	M.1302.7063

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