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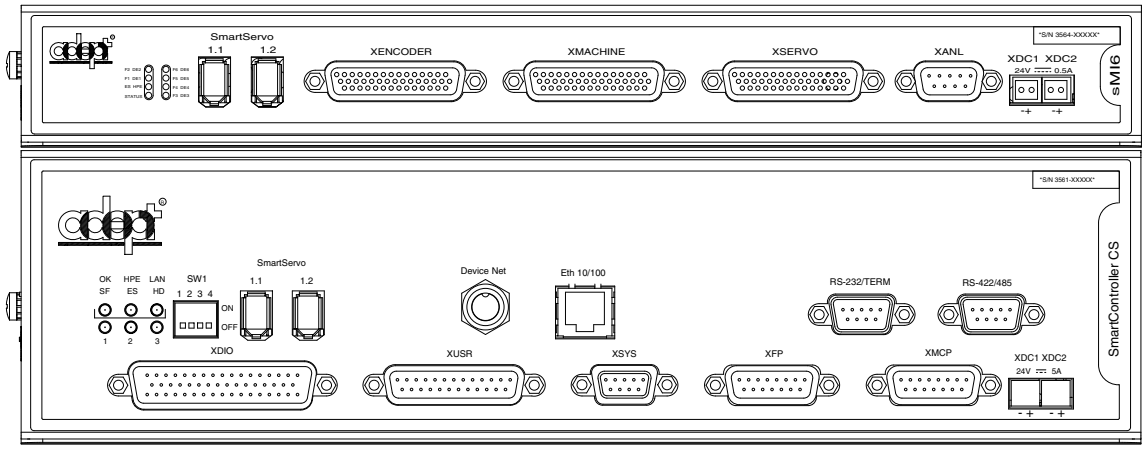
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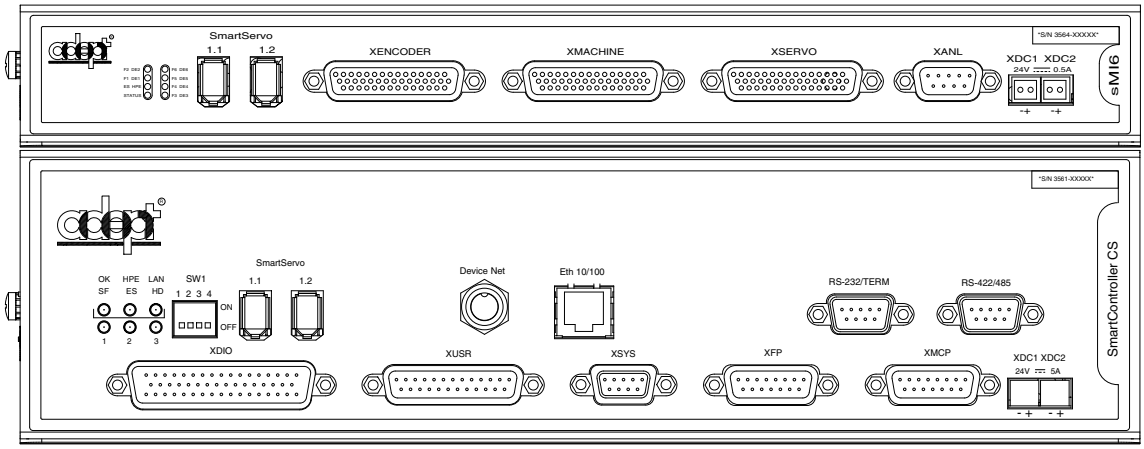
Installation Guide



Adept SmartController CS with sMI6 Motion Interface Module

Adept SmartMotion

Installation Guide



Adept SmartController CS with sMI6 Motion Interface Module

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1 Introduction

1.1 Product Description

The Adept SmartMotion product consists of a hardware and software package that provides high-performance coordinated motion control for industrial automation devices. Adept SmartMotion includes the sMI6 motion interface module and the Adept SmartController, communicating via the SmartServo network, Adept's distributed controls network built on IEEE 1394. Completely integrated V+ software provides the same high-level motion instructions that are used for Adept robots. The sMI6 supports up to six axes of motion control per module.

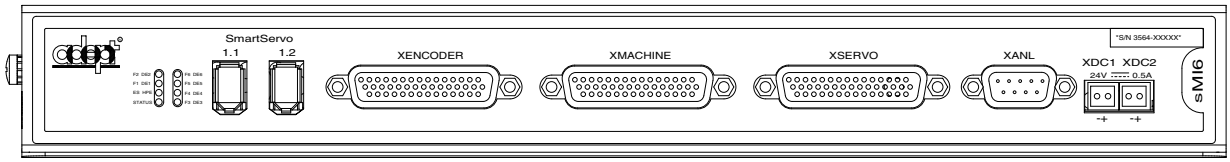


Figure 1-1. Adept sMI6 Module

System Overview

Adept SmartMotion has been designed to function as an integral part of Adept's control system. Typical components include an Adept SmartController (CS or CX model), one or more sMI6 modules, MP6 panels, a manual control pendant, a desktop or laptop PC, and a user-supplied mechanism with servomotors, encoders, and amplifiers. Additional options such as Adept-supplied robots and vision systems are available.

Adept SmartMotion is intended to provide complete motion control of user-supplied mechanisms. Users retain the flexibility of selecting the drive components that are best suited for their applications. Adept SmartMotion can interface to industry standard drive components including most servo amplifiers and optical encoders. Motion-related I/O signals can utilize voltage levels chosen by the user.

Adept SmartMotion Hardware Overview

There are two major hardware components of the system, in addition to the SmartController:

- Adept sMI6 Motion Interface Module
- Motion Interface Kit, includes MP6 panels and interface cables (this kit is optional)

Adept sMI6 Motion Interface Module

The Adept sMI6 Motion Interface module is a six-channel unit that runs the Adept SmartMotion product. The sMI6 module is a stand-alone unit designed to control a total of six motion axes or external encoders. Each sMI6 module has six servo drive outputs, six incremental encoder inputs, and digital I/O for machine and amplifier control.

Motion Interface Kit

The Motion Interface Kit includes the three Motion-interface Panels (MP6-E, MP6-M, and MP6-S) that serve as the interface between the sMI6 module and the user's hardware. The MP6 panels provide mounting sockets for I/O modules used in conjunction with the dedicated discrete input/output signals. The MP6 panels also provide detachable barrier-type screw terminal strips and 9-Pin D connectors for all field wiring terminations. Interface cables (3 meter) for connecting the sMI6 to the MP6 panels are included in the kit.

> **NOTE:** The Motion Interface Kit is optional, but it is recommended for typical installations. Customers who do not order this option must provide similar functionality.

1.2 Safety



WARNING: See the ***Adept SmartController User's Guide*** for additional safety information.

Reading and Training for Users and Operators

Adept systems can include computer-controlled mechanisms that are capable of moving at high speeds and exerting considerable force. Like all robot and motion systems, and most industrial equipment, they must be treated with respect by the user and the operator.

This manual should be read by all personnel who operate or maintain Adept systems, or who work within or near the workcell.

We recommend you read the *American National Standard for Industrial Robot Systems - Safety Requirements,* published by the Robotic Industries Association (RIA), in conjunction with the American National Standards Institute. The publication, ANSI/RIA R15.06 - 1992, contains guidelines for robot system installation, safeguarding, maintenance, testing, start-up, and operator training.

We also recommend you read the European Standard EN 60204, *Safety of Machinery – Electrical Equipment of Machines*, particularly if the country of use requires a CE-certified installation. (See the ***Adept SmartController User's Guide*** for ordering information for national and international standards.)

This manual assumes that the user has attended an Adept training course, or at least has a basic working knowledge of the system. The user should provide the necessary additional training for all personnel who will be working with the system.

There are several warnings in this manual that say only skilled or instructed persons should attempt certain procedures. These are defined as:

- **Skilled persons** have technical knowledge or sufficient experience to enable them to avoid the dangers which electricity may create (engineers and technicians).
- **Instructed persons** are adequately advised or supervised by skilled persons to enable them to avoid the dangers which electricity may create (operating and maintenance staff).

System Safeguards

Safeguards should be an integral part of robot or motion workcell design, installation, operator training, and operating procedures.

Adept systems have various communication features to aid in constructing system safeguards. These include the emergency stop circuitry and digital input and output lines. Some of these features are described in the *Adept SmartController User's Guide*.

Safety Features on Front Panel

The optional Front Panel has important safety features, including the HIGH POWER indicator, the AUTO/MANUAL keyswitch, and the EMERGENCY STOP switch. If you choose not to use the Front Panel, you should provide similar safety features by using the connectors on the SmartController. Refer to the *Adept SmartController User's Guide* for more information.



WARNING: Entering the workcell when the HIGH POWER light is on can result in severe injury. This warning applies to each of the next three sections.

Computer Controlled Robots and Motion Devices

Adept systems are computer controlled, and the program that is currently running the robot or motion device may cause it to move at times or along paths you may not anticipate. When the HIGH POWER light is illuminated, do not enter the workcell because the robot or motion device might move unexpectedly.

Manually Controlled Robots and Motion Devices

Adept robots and other motion devices can also be controlled manually when the HIGH POWER light on the Front Panel is illuminated. When this light is lit, motion can be initiated from the system keyboard or from the optional Manual Control Pendant (MCP). If you have to enter the workcell when this light is lit, press the MAN/HALT button on the MCP. This will prevent anyone else from initiating unexpected motion from the system keyboard.

Other Computer Controlled Devices

In addition, Adept systems can be programmed to control equipment or devices other than the robot or main motion device. The program controlling these other devices may cause them to operate unexpectedly. Make sure that safeguards are in place to prevent personnel from entering the workcell when a program is running.

Adept Technology highly recommends the use of additional safety features such as light curtains, safety gates, or safety floor mats to prevent entry to the workcell while HIGH POWER is enabled. These devices can be connected using the emergency stop circuitry.

Program Security

Programs and data stored in memory can be changed by trained personnel using the V+ commands and instructions documented in the V+ manuals. To prevent unauthorized alteration of programs, you should restrict access to the keyboard. This can be done by placing the keyboard in a locked cabinet. Alternatively, the V+ ATTACH instruction can be used in your programs to restrict access to the V+ command prompt.

Overspeed Protection

Overspeed protection for a robot or motion system has to be taken into account during system integration by the integrator or end-user. Overspeed protection is not guaranteed by the controller hardware alone. The V+ system software offers some overspeed protection capabilities.

Voltage Interruptions

If the power supply to the controller is interrupted, the passive E-stop output will be automatically turned on (opened). In addition, the High Power, Brake Release, and Drive Enable signals will be turned off. You must ensure that these signals are used to prevent a hazardous condition.

Inappropriate Uses of the Adept SmartController

The Adept SmartController is intended for use as a component sub-assembly of a complete industrial automation system. The SmartController sub-assembly must be installed inside a suitable enclosure. Installation and usage must comply with all safety instructions and warnings in this manual. Installation and usage must also comply with all applicable local or national statutory requirements and safety standards.The SmartController sub-assembly is not intended for use in any of the following situations:

- In hazardous (explosive) atmospheres
- In mobile, portable, marine, or aircraft systems
- In residential installations
- In situations where the SmartController sub-assembly may come into contact with liquids.
- In situations where the SmartController sub-assembly will be subject to extremes of heat or humidity. See the specifications for allowable temperature and humidity ranges.

See the ***Adept SmartController User's Guide*** for any additional restrictions.

1.3 Warnings, Cautions, and Notes

There are four levels of special alert notation used in this manual. In descending order of importance, they are:



DANGER: This indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.



WARNING: This indicates a potentially hazardous situation which, if not avoided, could result in serious injury or major damage to the equipment.



CAUTION: This indicates a situation which, if not avoided, could result in minor injury or damage to the equipment.

NOTE: This provides supplementary information, emphasizes a point or procedure, or gives a tip for easier operation.

1.4 How Can I Get Help?

Refer to the *How to Get Help Resource Guide* (Adept P/N 00961-00700) for details on getting assistance with your Adept software and hardware. This document is available on the Adept Documentation Library CD-ROM that is shipped with all systems. Additionally, you can access information sources on Adept's corporate Web site:

http://www.adept.com

1.5 Related Manuals

This manual covers the installation of an Adept SmartMotion system. There are additional manuals that cover software configuration, programming the system, reconfiguring installed components, and adding other optional components. Refer to the following manuals for additional information your Adept system.

> **NOTE:** Al l of the manuals in **Table 1-1** are available on the Adept Documentation Library CD-ROM provided with each system. (Previously this was known as the Knowledge Express CD-ROM.)

Table 1-1. Related Manuals

Manual Title	Description
Adept SmartMotion Developer's Guide	Describes the software configuration process for the Adept SmartMotion product. See **Chapter 3** for more information. The *Adept SmartMotion Developer's Guide* is provided as an online HTML document with a Table of Contents, Search, and Index features to navigate the document. If you do not see these features when you are viewing a topic, click the SHOW TOC icon that displays in the upper left corner of each page.
Adept SmartController User's Guide	Contains complete information on the installation and operation of the Adept SmartController and the optional sDIO product.
AdeptWindows Installation Guide and AdeptWindows Online Help	Describes complex network installations, installation and use of NFS server software, and the AdeptWindows DDE software.
Instructions for Adept Utility Programs	Describes the utility programs used for advanced system configurations, system upgrades, file copying, and other system configuration procedures.
V+ Operating System User's Guide	Describes the V+ operating system, including disk file operations, monitor commands, and monitor command programs.
V+ Language User's Guide	Describes the V+ language and programming of an Adept control system.

2 System Installation

2.1 Overview of Installation Process

This section provides a summary of the major steps involved with installing a Adept SmartMotion system.

1. Verify that the default hardware configuration for the sMI6 module is correct for your application. The area to look at is:
   - Digital Input Logic Voltage - see **page 21**.

   If you need to change these settings, you will have to open the chassis and install or move jumpers.
2. Review the proper field wiring practices. See **Section 2.5 on page 23**.
3. Select an enclosure for the SmartController and sMI6 chassis. See **Section 2.6 on page 24**.

   NOTE: Refer to the system cable diagram in **Figure 2-3 on page 20** for the remaining steps in this process.
4. Install the SmartController and peripherals. See **Section 2.7 on page 25**.
5. Install the sMI6 module. See **Section 2.8 on page 25**.
6. Install mounting rails for the three MP6 panels, then mount the three MP6 panels on the rails. See **Section 2.9 on page 26**.
7. Connect cables from the sMI6 to the MP6-M, MP6-S, and MP6-E panels.
8. Install wiring to user equipment from the MP6-M and MP6-S panels. Also select and install opto-modules. See **Section 2.10 on page 31** and **Section 2.11 on page 35**.
9. Install wiring to user encoders from the MP6-E. See **Section 2.12 on page 38**.

When the above process is complete, the next step is to use the CONFIG_C and SPEC utility programs to configure the software for your system. An overview for this process is located in **Chapter 3**.

2.2 Adept sMI6 Connectors and Indicators

Adept sMI6 LED Descriptions

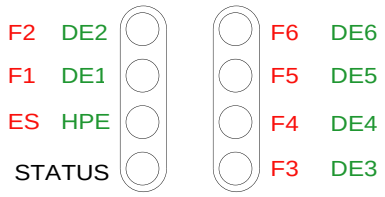


Figure 2-1. Close-up of sMI6 LED Labels

The LEDs on the sMI6 are two-color devices - they can display either green or red.

Table 2-1. sMI6 LED Functions

LED Name	Color	Function Description
Fx (1-6)	Solid Red	Indicates a Fault condition exists on channel x (1-6). Possible causes are Drive Fault, Overtravel, quadrature error, or broken wire.
DEx (1-6)	Solid Green	Indicates a Drive Enable signal has been asserted for channel x (1-6).
ES	Solid Red	Indicates an E-Stop signal has been asserted from the sMI6.
HPE	Solid Green	Indicates the High Power Enable signal has been asserted.
STATUS	Solid Red	Boot up or microprocessor problem (set by the sMI6 hardware, other patterns are software generated)
	Slow Blinking Green	Normal operation, high power OFF
	Fast Blinking Green	Normal operation, high power ON
	Fast Blinking Red	An error caused High Power to be disabled. See V+ message for source of error.
	Fast Blinking Red/Green	Triggered by utility for identifying a node on the 1394 network
	Short blink red, long blink red, off, then repeat	If this pattern appears at boot-up, it means the SDRAM has failed and the unit must be returned to Adept.

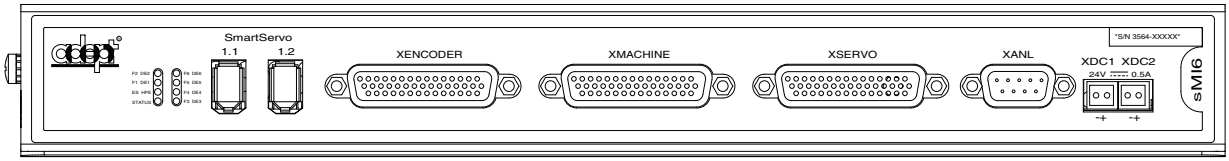


Figure 2-2. Adept sMI6 Module Front Panel

Adept sMI6 Connectors

1. **SmartServo 1.1 and 1.2**
   These are SmartServo ports. Port 1.1 or 1.2 connects to the SmartController. The other port can connect to an additional sMI6 module or an optional sDIO.

2. **XENCODER connector**
   Connects to the MP6-E Panel to communicate signals to and from encoders.

3. **XMACHINE connector**
   Connects to the MP6-M Panel to communicate machine signals, such as overtravel, home, brake release, etc.

4. **XSERVO connector**
   Connects to the MP6-S Panel to communicate servo signals, such as drive enable, drive fault, etc.

5. **XANL connector**
   Reserved for future use.

6. **24VDC connectors**
   Connects user-supplied 24VDC power from the SmartController to the sMI6 connector. The XDC1 and XDC2 connectors are interchangeable - you can use either one.

2.3 System Cable Diagram

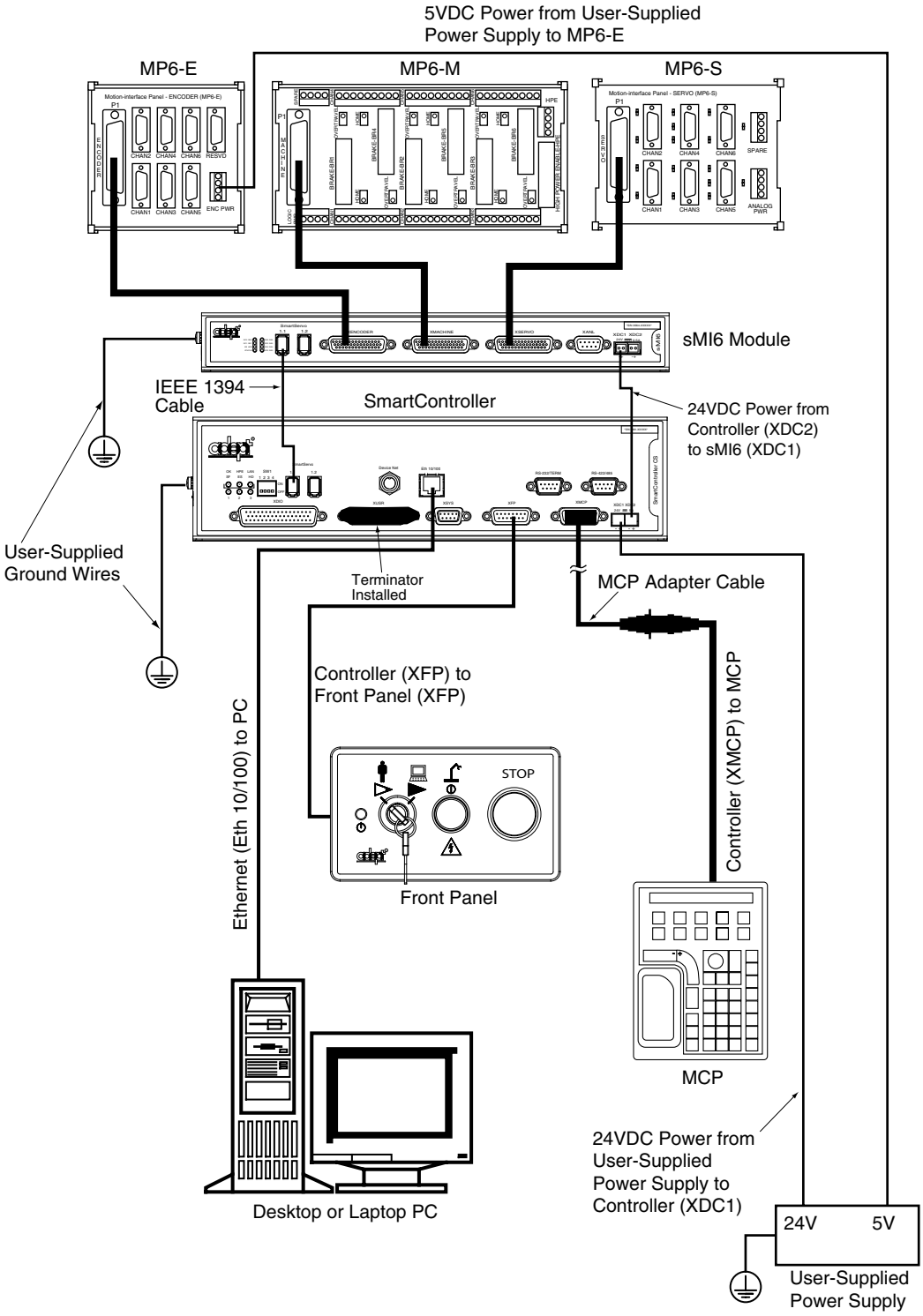


Figure 2-3. Adept SmartMotion System Cable Diagram

2.4 Adept sMI6 Hardware Configuration

sMI6 Digital Input Logic Voltage Configuration

The sMI6 can be configured to operate with either a 5V (min 3.0V, max 5.7V) or a 12/24V (min 8.75V, max 27.5V) logic interface. This affects the Home, Overtravel, and Drive Fault signals. The sMI6 is normally shipped configured for 12V input, and must be reconfigured if you decide to operate at 5V. After you configure the sMI6 voltage option, then you must install the MP6 Machine and Servo panels accordingly.

> **NOTE:** Refer to **Figure 4-5 on page 53** for a typical input circuit in the sMI6.

The input voltage is determined by jumpers on the main printed circuit assembly (PCA) inside the chassis. To reconfigure the sMI6 for 5V logic operation, follow this procedure.

1. Verify that the sMI6 is disconnected from the 24VDC power source.
2. Remove the cover of the chassis by removing three screws at the back of the chassis. See **Figure 2-4**.
3. Install jumpers for each channel that you are using. See **Figure 2-5 on page 22**.
4. Reinstall the cover on the chassis.

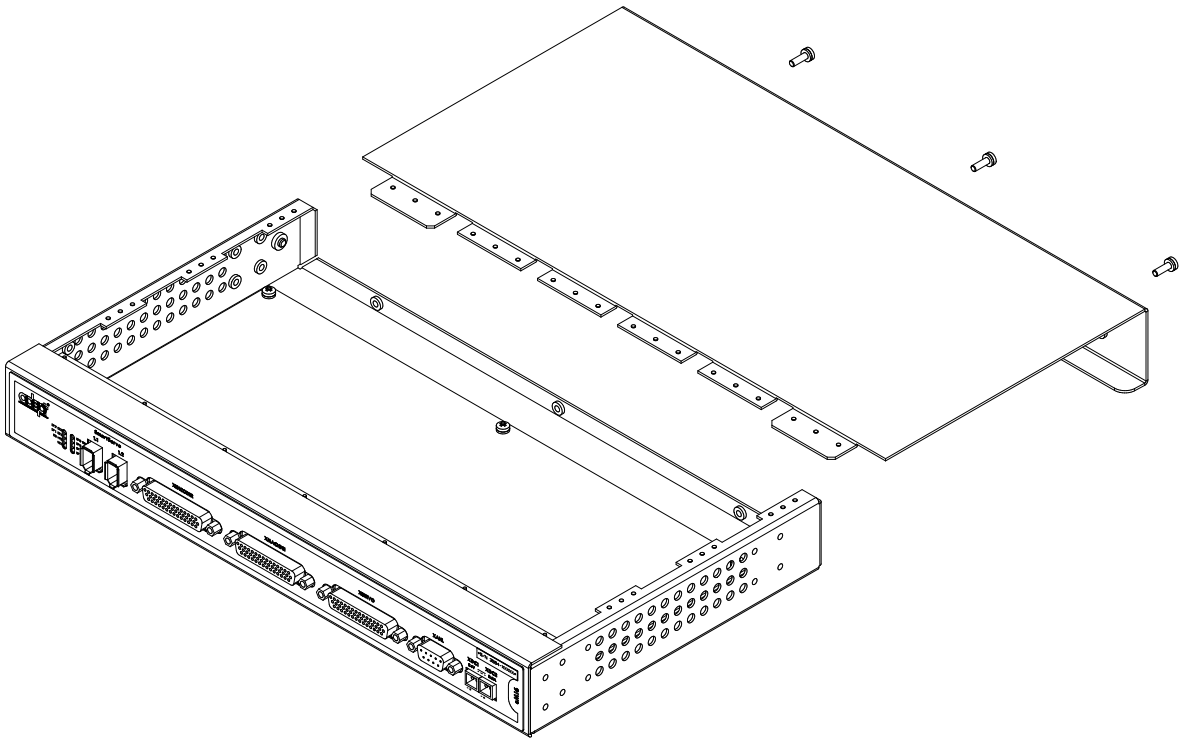
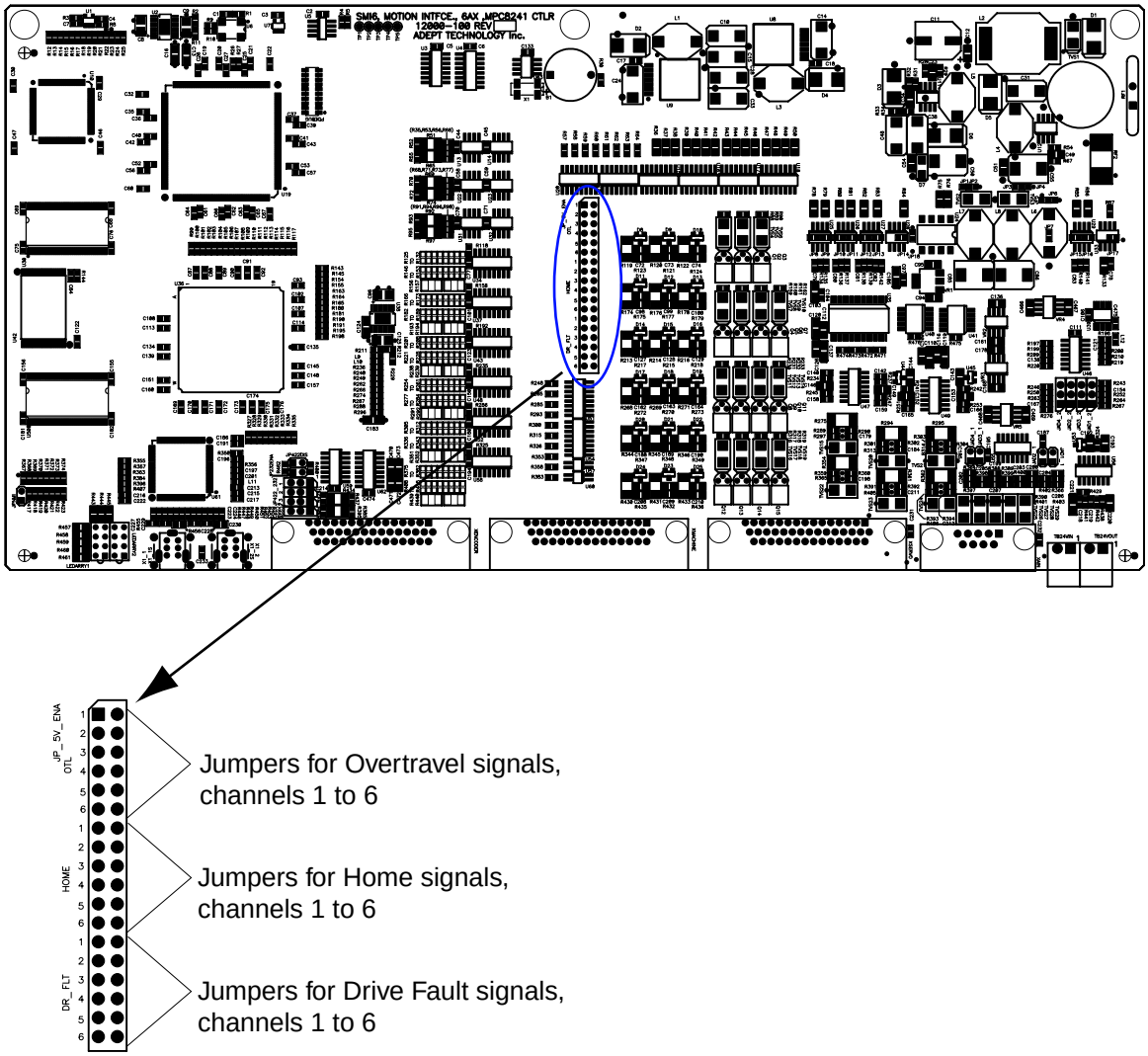


Figure 2-4. Opening the sMI6 Chassis



Digital Input Logic Voltage Configuration

No jumper = 12/24 V logic (factory default)

Jumper installed = 5 V logic

Figure 2-5. Location of Jumpers on Main PCA

2.5 Proper Wiring and Electrical Design Practices

Designing a high-performance servo system requires attention to electrical design. Adept SmartMotion is designed to respond to high-resolution encoder inputs, up to 32 MHz count rate. Most drive amplifiers, DC power supplies, and brush-type motors are potential sources of high-frequency electrical noise. Other equipment in the workcell can also generate noise. Proper system wiring, and especially grounding, is very important to a successful installation. The function of proper grounding is two-fold: first, to reduce the risk of electrical shock from faults in your high-voltage equipment; and second, to help shield from electro-magnetic and radio frequency interference (EMI and RFI).

All connections of Adept SmartMotion signals to user-supplied hardware are made via connectors on the three MP6 panels. For proper operation, you must use good wiring practices. Follow the general guidelines presented below. In addition, observe all applicable local and national safety codes.

Be sure to:

- Verify that all equipment, including motor drives (amplifiers), the robot mechanism, and the SmartController and sMI6 chassis, are properly grounded.
- Ensure that all three MP6 Ground terminals are connected to the user-supplied ground point.
- Ensure that the MP6 DIN-mounting rail is connected to the user-supplied ground point.
- Use only one ground point (star ground system) and keep all ground wires as short as possible. For best results, use braided ground straps for ground connections. (Braid has lower high-frequency impedance, for a given cross-sectional area.)
- Use shielded twisted-pair cable for all encoder connections and analog drive signals, and preferably for all signals.
- Use separate cables for every encoder and motor drive. Route digital signals, motor power, and encoder signal cables separately from one another.
- Locate noise inducing devices away from the controller and other Adept SmartMotion hardware.
- Provide noise-free regulated power for all Adept SmartMotion hardware.
- Maintain the integrity of optical isolation by using power sources other than the Adept controller to power all signals from user-supplied equipment.
- Size all wire according to recognized electrical standards and applicable codes.
- Use proper arc suppression devices on all relay and solenoid coils.
- Adept recommends using power line filters to help prevent electrical noise from the drive amplifiers “contaminating” the AC power lines, and vice-versa.

2.6 Enclosure for SmartController and sMI6

The Adept SmartController and the Adept sMI6 module should be installed in a suitable enclosures. All of the equipment can be installed in one enclosure, or the sMI6 and associated components can be placed in a separate enclosure near the user's equipment; see Note below. Enclosures can be very beneficial in helping protect the controller, sMI6 chassis, and associated peripherals and wiring from noise problems and other hazards that are typical in many industrial settings.

> **NOTE:** While the sMI6 and MP6 panels should be installed in an enclosure for protection, they can be installed, along with the third-party servo amplifiers, in a remote location closer to the user's mechanism. The interface between the SmartController system and the sMI6 module is via the SmartServo network using an IEEE 1394 cable.

The enclosure must provide the internal environmental conditions (temperature, humidity, etc.) required by the equipment. The enclosure must also meet all local and national safety codes after the equipment is installed. The Emergency Stop circuitry must be incorporated into the setup of the enclosure.

It is a good idea to select an enclosure that is large enough so the three MP6 panels can be installed in the same enclosure as the other equipment. The enclosure is also a good place to install additional user equipment such as power supplies, DIN mounting rails, wiring terminal strips, etc.

Make sure to keep low-voltage control signal wiring away from high-voltage wiring to avoid interference and noise problems.

2.7 Installing the Adept SmartController

Refer to the System Cable Diagram in **Figure 2-3 on page 20** and to the ***Adept SmartController User's Guide*** to install the SmartController and related peripherals. A brief summary is presented here.

1. Mount the SmartController in the workcell according to the instructions in the ***Adept SmartController User's Guide***.
2. Install the Compact Flash.
3. Install the user-supplied ground wire from the ground screw on the side of the controller chassis to ground.
4. Install the user-supplied 24VDC power to the controller. Power must be turned off.
5. Connect the optional Adept Front Panel.
6. Connect the MCP.
7. Connect the user-supplied PC and install the AdeptWindows user interface on the PC.

2.8 Installing the Adept sMI6 Module

Refer to the System Cable Diagram in **Figure 2-3 on page 20**.

1. Mount the sMI6 module in the workcell. The mounting options include rack mounting, panel mounting, and table mounting. See **Section 4.2 on page 48** for dimension drawings of the different mounting brackets.

   You can also stack-mount the sMI6 directly above the SmartController with combining brackets. See the Stacking Components section in the ***Adept SmartController User's Guide***. The sMI6 has the same dimensions as the sDIO module that is shown there.
2. Connect an IEEE 1394 cable from the SmartController to the sMI6.
3. Connect a user-supplied ground wire from the ground screw on the side of the sMI6 chassis to ground. The ground wire must be less than 3 meters long.
4. Connect a 24VDC cable from the SmartController to the sMI6. The DC power cable must be less than 10 meters long.

2.9 Installing MP6 Panels

The three 6-channel Motion-interface Panels (MP6-M, MP6-S, and MP6-E) serve as the interface between the sMI6 module and the user's hardware. The MP6-M panel also provides mounting sockets for up to seven Opto-22 output modules. **Figure 2-6**, **Figure 2-7**, and **Figure 2-8** show the layout and dimensions of the MP6 panels. **Figure 2-9 on page 30** shows a typical system wiring for one axis of motion. One set of MP6 panels is required for every sMI6.



WARNING: The six removable connectors on the MP6-M are purposely not keyed so they can be interchanged for diagnostic purposes. It is important that these connectors are not interchanged during normal operation. Doing so can cause unstable operation which could result in serious equipment damage and injury to personnel.

Rail Mounting the MP6 Panels

The MP6 panels are designed to be installed on DIN-style industrial mounting rails. The MP6 panels will fit on these types of rails:

TS 35	Symmetrical	35mm x 7.5mm
TS 35	Symmetrical	35mm x 15mm
TS 32	Asymmetrical	32mm x 15mm

DIN rail hardware is available from many vendors, including:

- Weidmüller
- Allen-Bradley
- Phoenix

Install the mounting rails in the workcell in a location that is easily accessible and close enough to the Adept SmartController so the motion interface cables can reach between the controller and the MP6 panels. One of the best places to install the mounting rails is in the same enclosure as the controller.

A variety of other DIN-rail mountable hardware is available from the vendors listed above, including terminal blocks, end brackets, opto-isolation systems (for voltage-level shifting and additional current drive) and power supplies.

Panel Mounting the MP6 Panels

If you do not want to use DIN-rail mounting, you can use panel (screw) mounting instead.

1. Remove and discard the MP6 mounting enclosures. This is done by removing two screws on either end of each unit, then sliding out the printed circuit assembly (PCA).
2. Use the four mounting holes provided on each MP6 panel to mount the PCA with appropriate screws.



WARNING: Be sure to use suitable stand-offs or spacers and comply with national and local electrical regulations regarding spacing and insulation.

Plug-In Opto Modules on the MP6-M

The plug-in opto-isolator output modules are standard Opto-22 Generation-4 single-point type, or equivalent. These modules have built-in indicator LEDs and are individually fused. The mounting panels are supplied from Adept without I/O modules so you can choose the type of modules (AC, DC, voltage range) which best suit your particular application.

See **Section 2.10** for more detailed information on the opto modules.

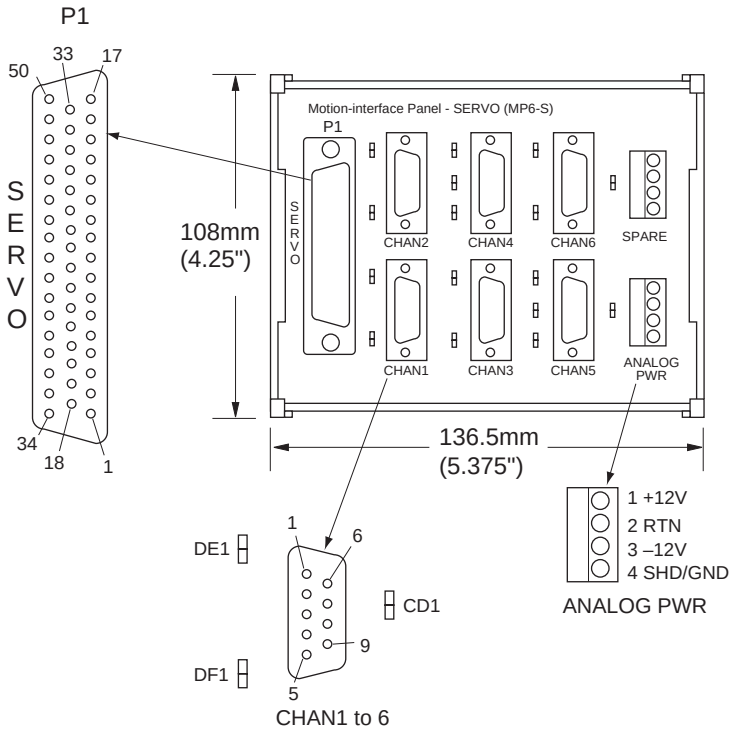


Figure 2-6. MP6-S Panel – Layout and Dimensions

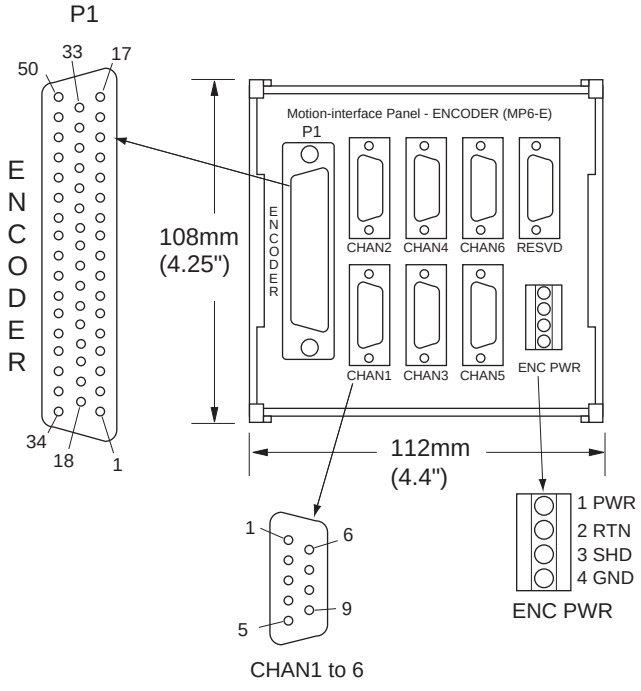


Figure 2-7. MP6-E Panel – Layout and Dimensions

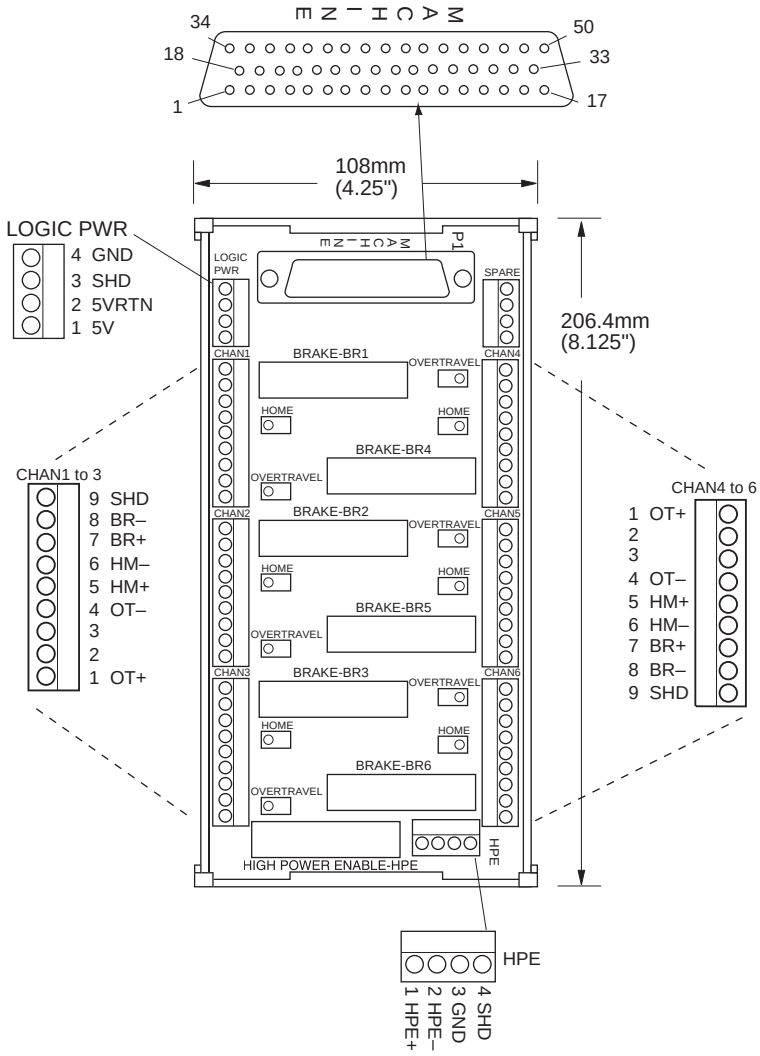


Figure 2-8. MP6-M Panel – Layout and Dimensions

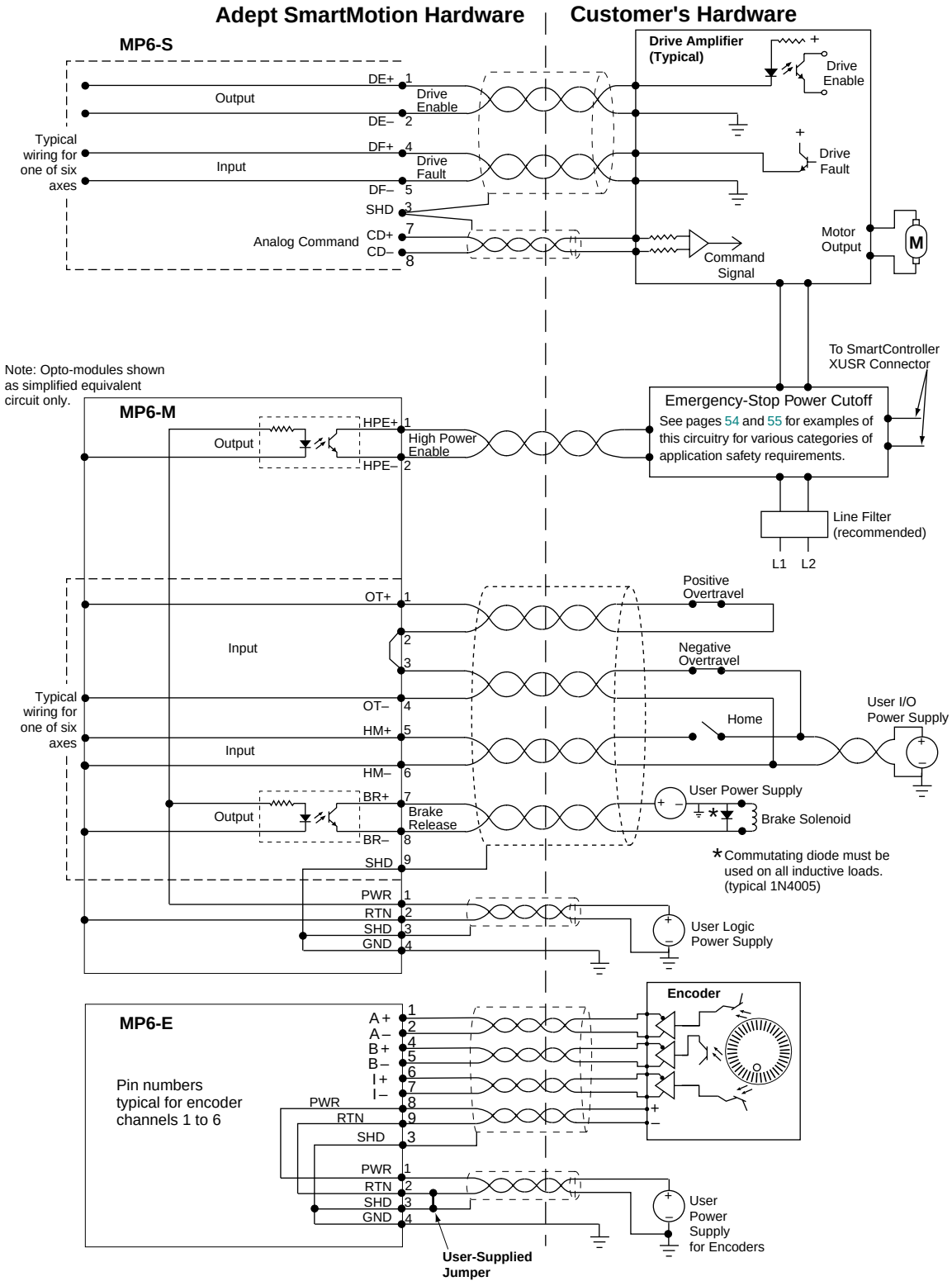


Figure 2-9. Typical System Wiring for One Axis of Motion

2.10 MP6 Machine (MP6-M) Panel Wiring

The MP6-M is used to interface to the machine (robot or motion mechanism). It provides two digital inputs and one digital output for each of six channels (Channels 1 to 6). See **Figure 2-8 on page 29** for the location of the various connectors.

- digital input for Overtravel (OT)
- digital input for Home Switch (HM)
- digital output for Brake Release (BR)

The MP6-M also has one independent output for high power enable (HPE).

The function of the MP6-M is to provide convenient interconnect points and to perform voltage level-shifting of some signals, for example, to interface 120VAC or 230VAC user circuits to the HPE output.

Optical Isolation

All signals (input and output) are isolated inside the sMI6 module. Additional isolation for the *output* channels (6 for Brake Release (BR), one for High Power Enable) is provided on the MP6-M using Opto-22 modules. The main functions of the Opto-22 modules on the output channels of the MP6-M are to give enhanced current drive capability, and allow flexibility in connecting to a variety of voltage levels.

Input Current Requirements (OT, HM)

The inputs on the MP6-M are connected directly to the sMI6. Therefore, the input specifications for the MP6-M are the same as for the MP6-S. See **Table 2-2**.

Table 2-2. Digital Input Specifications (sMI6 module)

Operational voltage range	0 to 24 VDC
"Off" state voltage range	0 to 3 VDC
"On" state voltage range	10 to 24 VDC
Operational current range[a]	0 to 20 mA
"Off" state current range[a]	0 to 1.2 mA
"On" state current range[a]	7 to 20 mA
Typical threshold current, per channel[a]	10 mA
Impedance (V_{in}/I_{in})	1.3 K Ω minimum
Current at V_{in} = +24 VDC	I_{in} ≤20 mA
Turn on response time (hardware[b])	5 µsec maximum
Turn off response time (hardware[b])	5 µsec maximum

[a] The input current specifications are provided for reference; voltage sources are typically used to drive the inputs.

[b] The *software* scan rate depends on Servo software, and is currently 1 ms.

Input Voltage Configuration

See "sMI6 Digital Input Logic Voltage Configuration" on page 21.

Output Current Requirements (MP6-M, HPE and BR, External)

The digital outputs (HPE and BR) on the MP6-M are optically-isolated via Opto-22 modules. (Therefore, the output specifications for the MP6-M are different than the MP6-S.) Select an appropriate plug-in single-channel module from the "Generation 4" (G4) range manufactured by Opto-22. (Compatible modules are also made by other manufacturers.)

Modules are available for various external voltages to suit the user's equipment, including 12V DC and 24V DC, and 110VAC and 230VAC. See **Table 2-3** for specifications of some commonly-used modules. (See the manufacturer's documentation for any parameters or module types not listed.) You must provide logic-power to connect to and from the Opto-22 modules. The logic input current required depends on the number, voltage, and type of Opto-22 modules.

The Opto-22 DC output modules can each supply from 0.5 to 3 Amps to the user's external equipment. The total current actually required for outputs will depend on the user-supplied external equipment (relays, solenoids, limit switches, etc.).

Table 2-3. Digital Output Specifications for HPE and BR (Opto-22 module, typical)

Opto-22 module type	G4ODC5	G4ODC5A	G4OAC5	G4OAC5A
Operating voltage range	5 - 60 VDC	5 - 200 VDC	12 - 140 VAC	24 - 280 VAC
Current rating @45°C ambient @70°C ambient	3 A 2 A	1 A 0.55 A	— 1.5 A	— 1.5 A
Output voltage drop maximum	1.6 V	1.6 V	1.6 V peak	1.6 V peak
Off-state leakage @max voltage	1 mA	1 mA	5 mA rms[a]	5 mA rms[b]
Turn-on time (hardware), max[c]	50 µs	100 µs	1/2 cycle	1/2 cycle
Turn-off time (hardware), max[c]	50 µs	750 µs	1/2 cycle	1/2 cycle
Logic voltage range (V_{cc})	2.4-8 VDC	2.4-8 VDC	4-8 VDC	4-8 VDC
Logic input current	12mA@5V	12mA@5V	12mA@5V	12mA@5V

[a] At 60 Hz, 140VAC
[b] At 60 Hz, 280VAC (2.5 mA rms at 60 Hz, 120VAC)
[c] The *software* scan rate depends on Servo software, and is currently 1 ms.

User-Supplied Logic Power (Internal)

The Opto-22 opto-isolator modules also require logic voltage to interface with the Adept sMI6 module. This voltage must be provided by the user at the PWR terminals. The power supply voltage should be the same as the logic voltage rating of the Opto 22 output module. For example: 5V logic voltage Opto 22 requires a 5V logic user-supplied power supply. Use of shielded, twisted-pair cable is recommended. Allow 12mA per output channel (a total 0.1A for 7 modules) for each MP6-M.

Overtravel Limit Switches (Input)

One Overtravel Limit switch input is provided for each axis. (Two normally-closed switches must be wired in series or normally-open switches in parallel for one input.) These inputs can be used to help protect the mechanical hardware when the end of axis travel is reached. Each switch should be normally closed, and open only when an overtravel condition is reached. If any of the overtravel switches is opened on an active channel, the controller will disable High Power.

The input polarity for the overtravel inputs is configurable using the SPEC program.

The presence of an Overtravel signal will prevent the successful completion of the Drive Enable sequence. Any unused Overtravel inputs on active channels must be configured to provide a "no fault" condition. In most industrial situations there will be considerable electrical noise in the operating environment. An unterminated input may not function as anticipated. Adept recommends that you install a shorting wire between the MP6-M terminals of any unused overtravel inputs.

> **NOTE:** Refer to **Figure 4-5 on page 53** for a typical input circuit in the sMI6.

Home Switch (Input)

The Home Switch inputs are used during the calibration sequence of each axis. These inputs can be activated anywhere within the travel of the axis, however, it is advantageous to locate the home switch just inside one of the overtravel limit switches. The input polarity of the Home input is configurable using the SPEC program. You should design the home switch so that it remains active all the way through one of the overtravel limits, then Adept SmartMotion will always be able to calibrate the axis.

Brake Release (Output)

The Brake Release (BR) signals are provided to control external safety brakes. These signals are asserted to release the brakes after the drive has been successfully enabled. The output modules are on (conduct) when in the "Brake Released" condition.

> **NOTE:** Refer to **Figure 4-6 on page 53** for a typical output circuit in the sMI6.

High Power Enable (Output)

One High Power Enable (HPE) signal is provided for the entire system. (If you have more than one sMI6 module, the signal is internally connected in parallel to every sMI6.) The HPE signal drives the user-supplied power contactor for the motor drive-amplifiers. The output is controlled via the Emergency Stop circuitry in the controller. The High Power Enable signal is accessible on the HPE terminal block of the MP6-M.

Table 2-4. MP6-M Connector Terminal Assignments (Typical, 1 of 6)

Pin	Signal Abbrev.	Description	Signal Type	Default Mode of Operation
1	OT+	Overtravel(+)	input	Open on overtravel (configurable using SPEC program)
2	—	(Connected to terminal 3)[a]	—	
3	—	(Connected to terminal 2)[a]	—	
4	OT–	Overtravel (return)	return	
5	HM+	Home Switch(+)	input	Closed at home (configurable using SPEC program)
6	HM–	Home Switch (return)	return	
7	BR+	Brake Release (+)	output	Closed in brake released condition (not configurable)
8	BR–	Brake Release (return)	return	
9	SHD	Shield	shield	——

[a] Pins 2 and 3 are connected to each other to help you connect a normally-closed switch in series, if you have separate OT signals from the limit switches at each end of the axis. Use them if you need, otherwise make no connection.

Table 2-5. MP6-M Opto Power (Logic) Connectors (one per MP6-M)

Pin	Signal Abbrev.	Description
1	+PWR	If using Opto-22 G4ODC5 or G4OAC5 series modules: 5V.
2	RTN	Common (return) for the above voltage
3	SHD	Shield for power cable
4	GND	Ground for all MP6-M shield connections. Connect this to your ground point.

2.11 MP6 Servo (MP6-S) Panel Wiring

The MP6-S is used to interface to the Servo Drive amplifiers. It provides one digital input (drive fault, DF) and one digital output (drive enable, DE) for each of six channels (channels 1 to 6). It also provides one analog output (command drive, CD) for each of six channels. The function of the MP6-S is to interconnect the signals from user circuits to the sMI6 module.

Drive Compatibility

The Adept SmartMotion control system is compatible with most industry-standard motor drives that accept a ±10 Volt analog input signal for current (torque) or velocity commands. In addition, Adept SmartMotion provides two discrete I/O signals that are dedicated to specific functions supported by most commercially available motor drives. In summary, each motion channel supports the following drive signals:

- analog output (±10V) for Command Drive (CD)
- digital output (to the drive) for Drive Enable (DE)
- digital input (from the drive) to monitor for a Drive Fault (DF)

Optical Isolation

The digital signals, Drive Enable and Drive Fault, are optically isolated. No additional isolation is required on the MP6-S. The MP6-S does *not* use Opto-22 modules. Note that the Analog Output is not optically isolated in the sMI6 module, unlike in previous versions of the Adept Motion Interface products.

MP6-S Input Current Requirements (Drive Fault)

The digital inputs on the MP6-S are connected directly to the sMI6. Therefore, the input specifications for the MP6-S are the same as for the MP6-M. See **Table 2-2 on page 31**.

MP6-S Output Current Requirements (Drive Enable)

The digital outputs on the MP6-S are connected directly to the sMI6. Therefore, the output specifications for the MP6-S are different than the MP6-M. See **Table 2-6**.

Table 2-6. Digital Output Specifications for Drive Enable Signal

Operating voltage range	5 to 24 VDC
Operational current range, per channel	I_{out} ≤100 mA
V_{drop} across output in ON condition	V_{drop} ≤0.85 V at 100 mA V_{drop} ≤0.80 V at 10 mA
Output-off leakage current	I_{out} ≤600 µA
Turn-on response time (hardware[a])	3 µsec maximum
Turn-off response time (hardware[a])	200 µsec maximum

[a] The *software* scan rate depends on Servo software, and is currently 1 ms.

Connecting the Drives

Each channel (1 to 6) has a 9-pin female D-connector that connects to the user's equipment. All six connectors have the same pin assignments (see Table 2-4 on page 34). Refer to Figure 2-6 for the physical location of each connector. All signal nomenclature is defined as viewed from the controller. Thus, an output is controlled by the Adept controller and an input is monitored by the Adept controller.

Table 2-7. MP6-S Connector Pin Assignments (Typical, 1 of 6)

Pin	Signal Abbrev.	Description	Signal Type	Mode of Operation
1	DE+	Drive Enable (+)	output	Not configurable – On to enable drive
2	DE–	Drive Enable (return)	return	
4	DF+	Drive Fault (+)	input	Configurable using SPEC program
5	DF–	Drive Fault (return)	return	
7	CD+	DAC Command (+)	output	±10V, configurable using SPEC program
8	CD–	DAC Command (return)	return	
3	SHD	Shield[a]	shield	——
6		Not connected		
9		Not connected		

[a] If two separate cables are used for Command signals and Drive signals, then their shields should be tied together at Pin 3 SHD.

Drive Enable (Output)

The Drive Enable signals (DE+, DE–) are outputs to the drives which command the drives to enable motor power. These signals are activated as part of the power enable sequence, after the High Power Enable signal has been activated. Refer to the SPEC program for complete details on the power enable sequence and software-timing parameters.

The Drive Enable output logic is set to normally open (closed/on to enable drive). The signal polarity is *not* user configurable. However, the user can provide an external circuit, such as a relay, to change the polarity if required.

Delay Time

Refer to the SPEC program for information on setting the delay time for ignoring an amplifier fault immediately after the amplifier has been enabled with a Drive Enable signal.

Drive Fault (Input)

The Drive Fault input (DF+, DF–) is used to indicate a drive fault, such as over-temperature, over-current, etc., and causes all drives to power down via the Drive Enable signals. This input is configurable via software (SPEC program) so that a fault is declared in either a voltage-present or voltage-absent condition. Thus, this input can also be used to monitor a "drive ready" signal. Drive Fault inputs are only monitored while Drive Enable is on, therefore, drive faults on unused channels are not monitored.

The presence of a drive fault will prevent the successful completion of the Drive Enable sequence. Any unused Drive Fault inputs on active channels must be configured to provide a "no fault" condition. In many industrial situations there will be considerable electrical noise in the operating environment. An unterminated input may not function as anticipated. Adept recommends that you install a shorting wire between the MP6-S pins of any unused Drive Fault inputs.

Command Drive (Output)

The Command Drive outputs (CD+, CD–) provide a command signal to each of the drives. Maximum output is ± 10 Volts into a 10K ohm input resistance. These analog outputs are rated at 100 mA (max) per channel. Short-circuit protection is provided by a 100 ohm internal current limiting resistor. Refer to the SPEC program for complete details on configuring this signal.

A separate tie point for the cable shield is provided to help minimize electrical noise. The shield should normally be left floating at the amplifier end. For the shield to be effective, you must connect the GND terminal of the MP6-M Opto Pwr connector to a suitable ground point.

Separate + and – outputs are provided for each of the six CD (Command Drive) outputs. You should use a separate twisted-pair wire for each CD pair. Do not use a "common" wire to connect the negative outputs as this will seriously reduce the noise-immunity of the system.

2.12 MP6 Encoder (MP6-E) Panel Wiring

Encoder Compatibility

The MP6-E is used to interface to the encoders. It supports up to six encoder channels, with differential input (A, B and Index) for each encoder. Each channel is designed to interface directly to encoders which use industry standard AB quadrature outputs and an optional zero-index channel. The encoder input circuitry is compatible with encoders using differential line driver outputs (RS-422 signal, +5VDC). (Alternatively, 5V single-ended outputs may be used, but they will be much more sensitive to external electrical noise. For information on compatibility with other types of encoders, please consult Adept Customer Service.) Adept strongly recommends using differential encoders, with index pulse.

Each of the six encoder channels has its own 9-pin female D-connector located on the MP6-E. Refer to **Figure 2-7 on page 28** for the physical location of each connector.

Connecting Power to the Encoders

All encoder inputs for the sMI6 use a scheme similar to an RS-422 differential receiver based on industry standard 75175 integrated circuits. The difference is that a custom resistor network and two differential receivers are used on each of the A and B inputs. This scheme allows for the detection of broken or shorted encoder wiring. See **Figure 2-11 on page 41** for a schematic.

The encoder inputs for the previous Adept MI6 product are optically isolated at the MI6 module. This provided the ability to use different power supplies for different channels with no common ground. Although this provided some noise immunity, it was at the expense of a slower input pulse rate due to the slow switching speed of the optical inputs. To provide higher encoder pulse rates, the sMI6 was designed with standard RS-422 receivers to replace these optical isolation components.

In order to maintain compatibility with the Adept MI6, all encoder power must be supplied by an external source. Power for each encoder can be supplied from independent power supplies or from one common power supply. However, all encoder power supply commons must be connected together and must be connected to the sMI6's 24V power input common. Encoder power should be supplied from a source that remains on when High Power and/or Drive Enable is off. This eliminates the need to re-calibrate the mechanism after High Power has been cycled off.

Adept strongly recommends using shielded, twisted-pair cable for all encoder and power connections. The MP6-E can be used to distribute power to the encoders. The power, voltage, and current required depend upon the encoders chosen by the user. If one common power supply is being used for all encoder channels, the power source is connected to the “Encoder Pwr” terminal on the lower section of the MP6-E. The encoder power supply should not be used to power other equipment, because this may cause electrical interference to the encoder signals.

If separate power is desired for any of the encoder channels (for example, if any of your encoders require different supply voltages), power connections must be made directly to that encoder. The encoder input circuitry on the MP6-E does not require power from an external supply.

Adept recommends using a linear power supply instead of a switching power supply. If a switching power supply is used, make sure to meet the minimum current requirements.

Encoder Power Grounding

Because the 75175 input circuits on the sMI6 have a common-mode input range of +/-12V, the nominal differential signal swing of 0 to 5V must remain within common-mode input range. Since a separate power supply is used to power the encoder RS-422 (or single-ended) drivers, the common of the separate supplies must share a common ground reference with the voltage supply into the sMI6. Thus, it is very important that the common signals for these separate supplies be connected to the common of the 24V plug-in terminal on the front of the sMI6.

If an older MI6-based system is being retrofitted with the sMI6, a modification to the encoder power supply circuit may need to be made to provide this common power supply connection. In some cases, new wiring must be provided. For example, the Yaskawa Sigma amplifiers provide an “SG” or signal ground wire in the “CN” connector that may not have been needed on the MI6. Since this SG ground must now be connected to the sMI6 common for differential-signal common-mode reference, a new connection might have to be made.

The DC power supply common for the internal voltages, including the 5V for the differential receivers, is connected to the frame ground of the sMI6 internally. The shield for the sMI6/MP6E cable is also connected to frame ground at the sMI6 XENCODER connector. Thus, one can sometimes provide the common ground reference at the MP6E Encoder Power terminal block by connecting pin 2, User's Encoder Power Supply Return “RTN”, to pin 3 Cable Shield “SHD”. See **Table 2-8** and **Figure 2-10 on page 41**. This Terminal can thus serve as the common ground wiring point on an encoder power system of separate encoder voltage sources.

Table 2-8. MP6-E Power Connectors (one per MP6-E)

Pin	Signal Abbrev.	Description
1	PWR	Encoder voltage supply
2	RTN	Common (return) for the above voltage
3	SHD	Shield for power cable
4	GND	Ground for all MP6-E shield connections. Connect this to your ground point.

Encoder Cable Length (User Supplied)

Because encoders are not supplied with the system and output circuitry varies between different encoders, it is not possible for Adept to specify a maximum cable length. However, it is good practice to keep the encoder cable length to a minimum. This practice helps to improve noise immunity and reduces the risk of encoder signal problems.

Connecting the Encoders

Each encoder channel has its own 9-pin D-connector. The connectors are intentionally not keyed and can be interchanged for diagnostic purposes, provided that no attempt is made to enable the associated axis. The pin assignment for each connector is detailed in **Table 2-9**. For best protection against noise, use shielded twisted-pair cable. The shield should encase only those signals associated with that particular encoder channel. A separate terminal is provided for connection of the shield. To avoid creating a "ground loop," the shield should normally be left floating (not connected) at the encoder end, unless the encoder body is electrically isolated from the equipment it is mounted to.

Table 2-9. Encoder Channel Pin Assignments (Channel 1 to 6)

Pin Number	Encoder Signal	Pin Number	Encoder Signal
1	A +	6	Index +
2	A –	7	Index –
3	Cable Shield	8	+Power
4	B +	9	Power Com
5	B –		

Encoder Input Circuitry

All incremental-encoder input circuits are identical. Standard hardware configurations of the sMI6 support RS-422 +5VDC signal levels in a differential mode. Adept strongly recommends using differential encoders for maximum noise immunity. Using differential encoders also enables the Encoder failure detection system to function. However, Adept SmartMotion hardware is compatible with single-ended and open-collector outputs. Schematics to connect these types of encoders are located in **Figure 2-12** and **Figure 2-13**.

> **NOTE:** If you use single-ended inputs, say by connecting the encoder's A signal to the sMI6's "A-" input as in earlier MI6 systems, then you must now connect the opposite polarity signal, "A+" in this example, to the encoder and sMI6 power supply common.

If an older MI6-based system is being retrofitted with the sMI6, the connections of any single-ended encoder signals must be modified in the customer wiring. The unused differential signal input on A, B or Index, must be connected to the encoder power common. For example, the standard wiring scheme was to connect the encoder single-ended A to Adept's A-, the encoder B to B- and encoder Index to Index-. For this example, the Adept A+, B+, and Index+ signals must be connected to Power Com in the user wiring, say at the 9-pin connector, for the single-ended encoder to work on the sMI6. See **Table 2-9**.

The encoder signals pass directly through the MP6-E to the sMI6 module. All encoder inputs use RS-422 receivers on the differential inputs. **Figure 2-10** and **Figure 2-11** illustrate the input circuit for each encoder channel. The A, B, and Index signals are then digitally filtered to improve noise immunity.

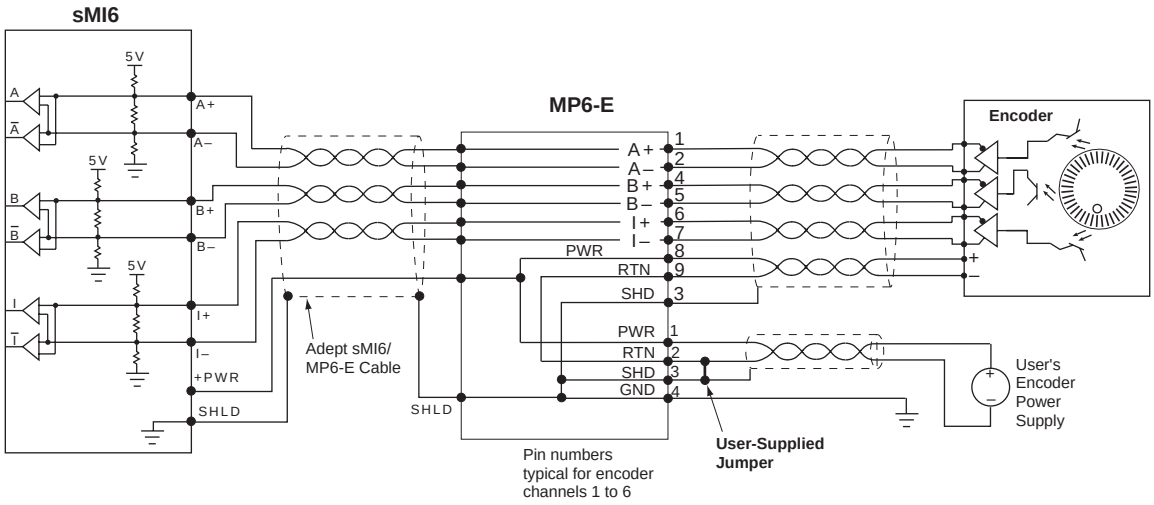


Figure 2-10. Encoder Input Circuitry

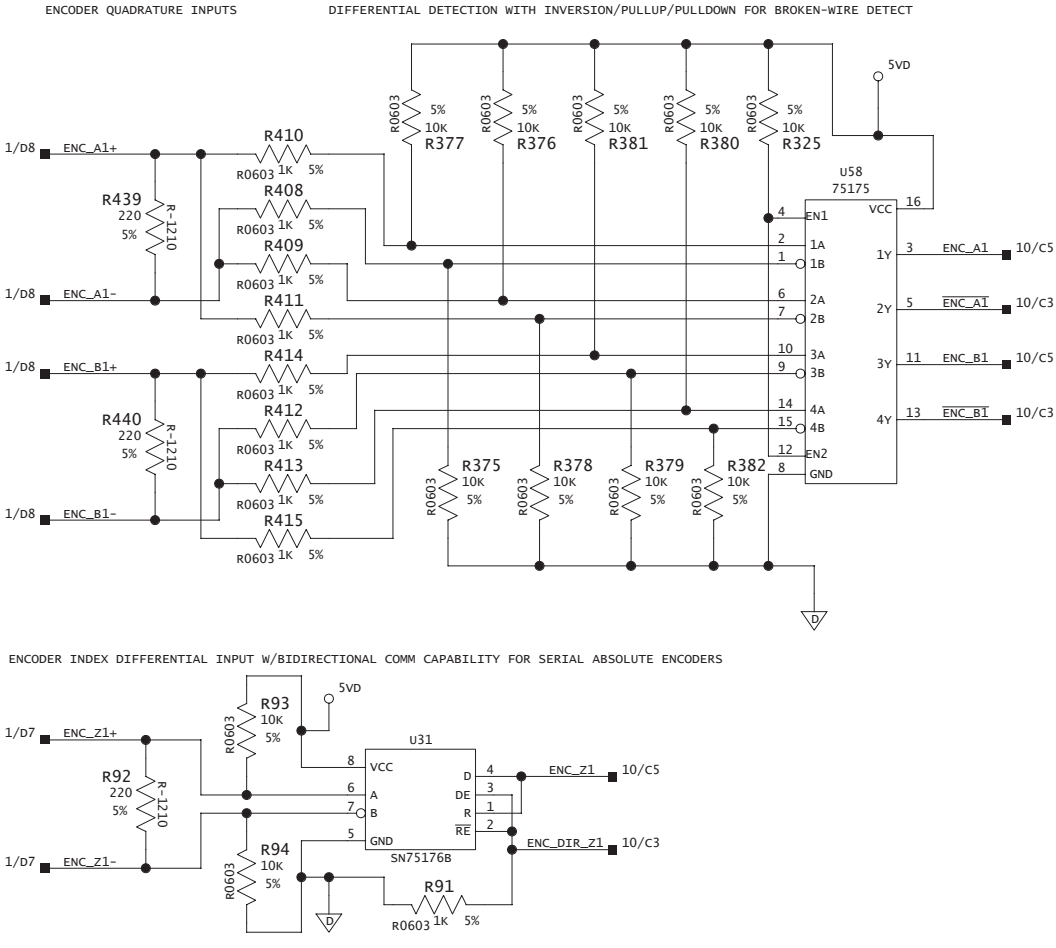


Figure 2-11. Encoder Input Schematic

Single-Ended Encoders

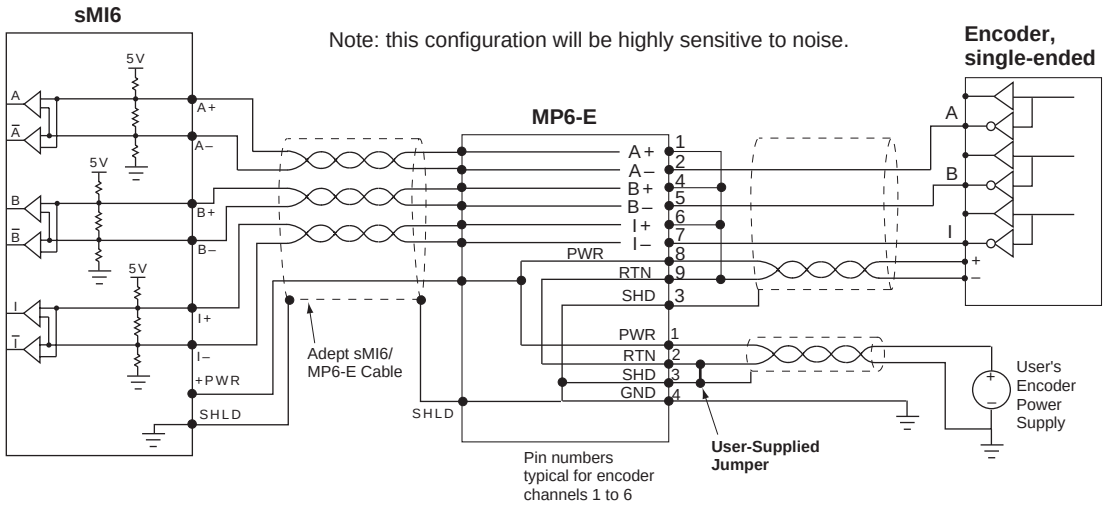
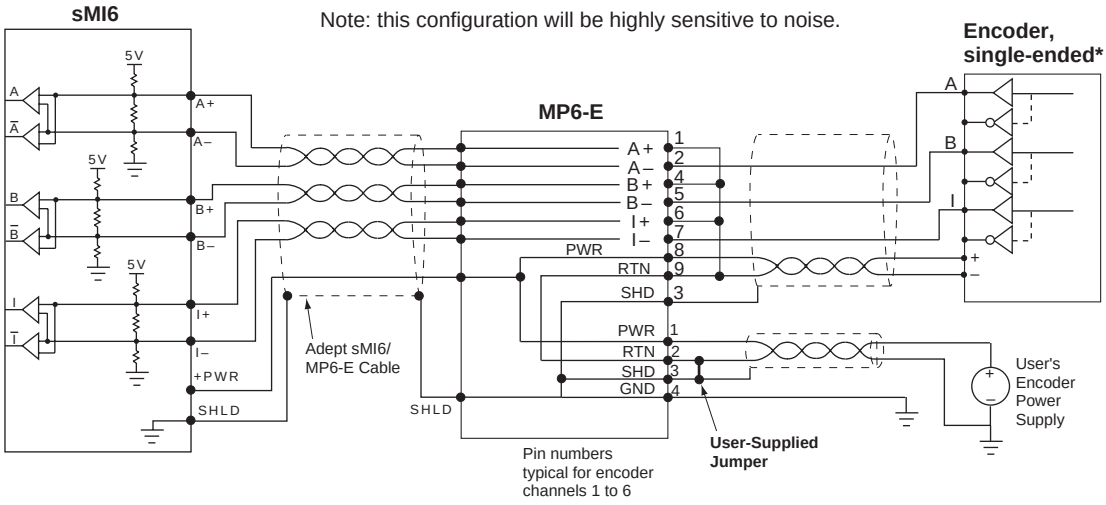


Figure 2-12. Single-Ended Encoder Wiring Using Inverted Outputs



*Note: this configuration leads to inversion of the encoder channel signals. Remember this when using the SPEC program to specify the Zero-Index configuration.

Figure 2-13. Single-Ended Encoder Wiring Using Non-Inverted Outputs

3 Software Configuration

3.1 Introduction

After the Adept SmartMotion system hardware has been installed (see **Figure 3-1**), and the wiring completed, you will be ready to start the software configuration process. This chapter provides an overview of this process.

For complete information on the process, refer to the ***Adept SmartMotion Developer's Guide*** which can be obtained by searching the Adept Documentation Library (formerly Knowledge Express) available from the following sources:

- Adept Documentation Library CD-ROM that was shipped with your system
- V+ Software CD MANUALS directory
- Adept website **(www.adept.com/main/services/index.asp)**

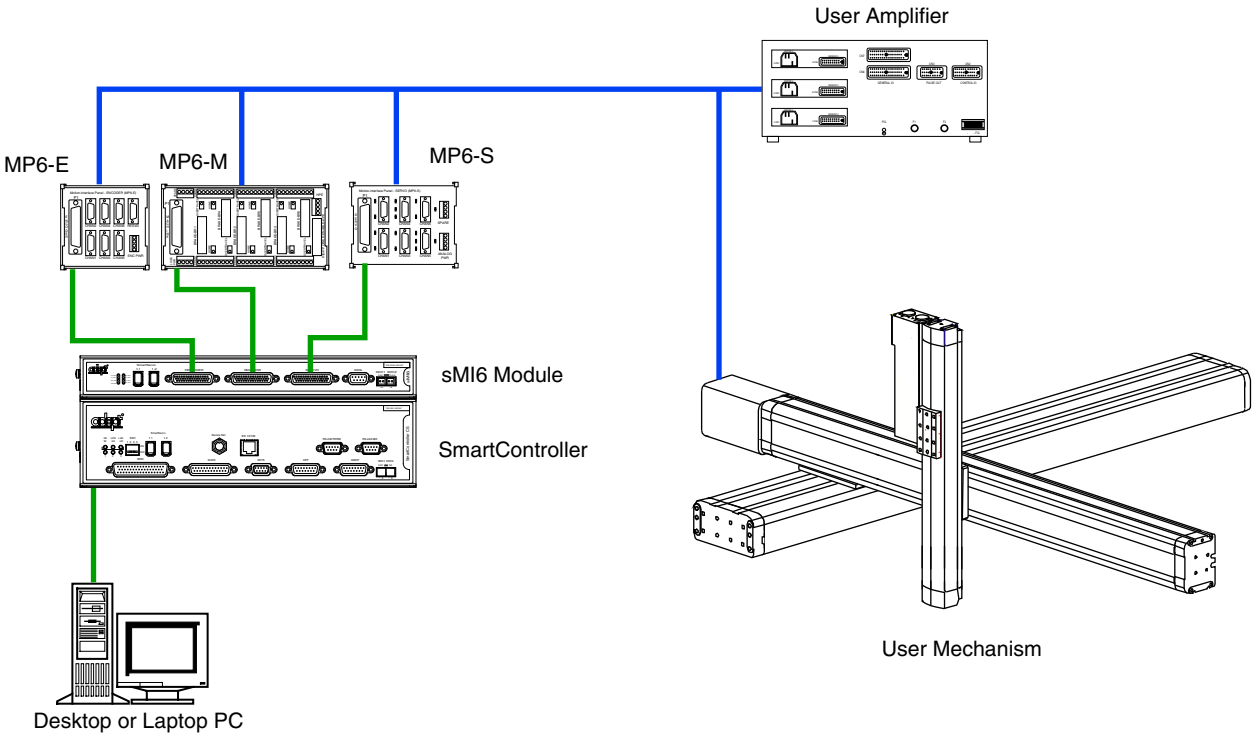


Figure 3-1. SmartMotion System Installed to Control a User Mechanism

3.2 Phase 1 - Preparation for Software Configuration

To prepare for the software configuration process, you should read the *SmartMotion Developer's Guide* for the following topics:

- **Adept SmartMotion: Key Concepts**
- **Introduction to Servo Parameters**
- **SPEC Program: Overview and Main Menu**
- **Managing SPEC Data**

NOTE: The *SmartMotion Developer's Guide* is provided as an online HTML document with a Table of Contents, Search, and Index features to navigate the document. If you do not see these features when you are viewing a topic, click the SHOW TOC icon that displays in the upper left corner of each page in the Developer's Guide.



3.3 Phase 2 - Load Device Modules

Select and load the proper device modules using the CONFIG_C utility. For instructions, see the topic **Loading Device Modules** in the *Adept SmartMotion Developer's Guide*.

3.4 Phase 3 - Configure SmartServo Network Map

Use the SPEC program to configure robots and motors on the Adept SmartServo network (a distributed controls network based on IEEE 1394). This enables the user's mechanism to communicate with devices in the Adept SmartMotion system.

Configuration includes specifying the number of motors in the robot, mapping the motors to hardware drive channels, and establishing the relationship of the joints to the axes of the device module.

For instructions, see the documentation for the **Robot Options and Configuration** menu option available in the *Adept SmartMotion Developer's Guide*.

3.5 Phase 4 - Create Software Specification

Create the software specification for each mechanism in your system. This includes specifying parameters for initialization, tuning, calibration, motion, trajectory generation, and other information required to operate your system.

For detailed instructions, see the **Creating the Software Specification** topic available in the *SmartMotion Developer's Guide*.

Then you can optimize your mechanism by fine tuning the performance using the servo tuning features in SPEC. For details, see the **Step-by-Step Tuning Process** topic in the *SmartMotion Developer's Guide*.

3.6 Phase 5 - Testing the System

Adept SmartMotion software provides diagnostic tools and tests that you can use to adjust the tuning and optimize the performance of your SmartMotion system. For details on the Test and Troubleshooting process, see the topic **Adept SmartMotion: Test and Troubleshooting** in the *Adept SmartMotion Developer's Guide*.

This phase can help you quickly test and troubleshoot a mechanism during development and after installation. Many of these tests can help identify tuning adjustments that can provide substantial performance improvements even if there are no obvious system problems. Use the diagnostic tests to evaluate all I/O signals, DAC outputs, encoder and motor signs, etc.

3.7 Motion Control Application Development

After you have configured and tested the SmartMotion system, you can create your motion control application using the Adept V+ development environment.

The following applications and tools are available:

V+ library of motion commands	see the ***V+ Language Reference Guide***
AdeptWindows	see the ***AdeptWindows User's Guide***
Adept DeskTop	see the ***Adept DeskTop documentation***
AIM MotionWare application	see the ***AIM MotionWare Users's Guide***
Advanced Servo Library	see the ***ASL Reference Guide***
Unique Kinematic Device Modules	see the ***Device Modules documentation***
AdeptVision sAVI and AIM VisionWare for integrated vision applications	see the ***AdeptVision Reference Guide*** and the ***VisionWare User's Guide***
Extensive Documentation for all products on the Adept Documentation Library CD	see the **Adept Documentation FAQs**

4 Technical Specifications

4.1 Dimensions for sMI6 Module

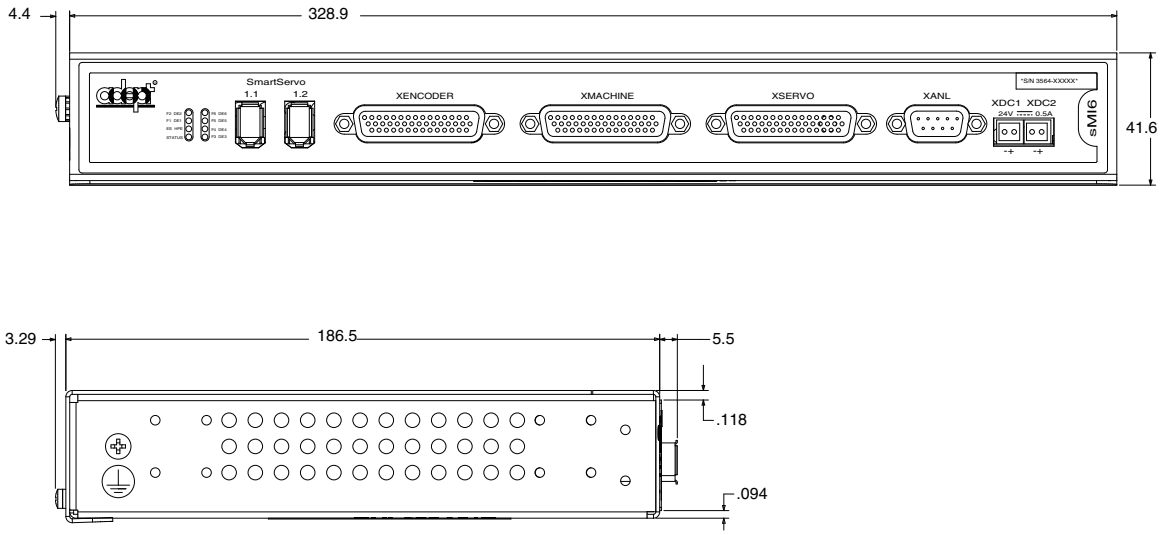


Figure 4-1. Dimensions for sMI6 Module

4.2 Dimensions for Mounting sMI6 Module

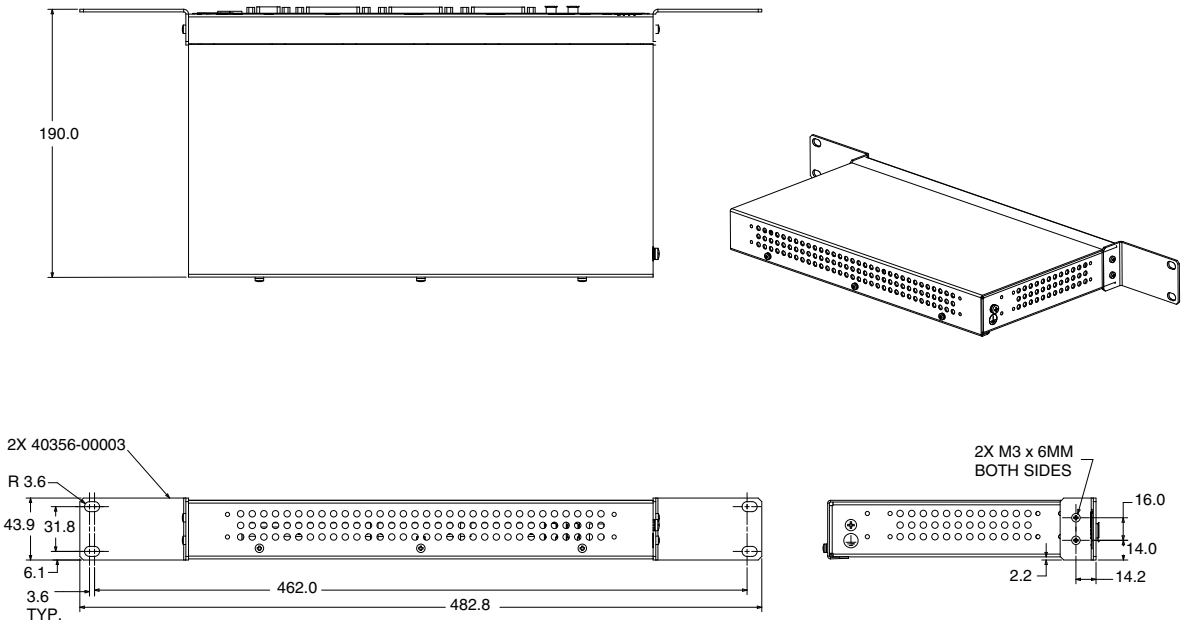


Figure 4-2. Rack Mounting

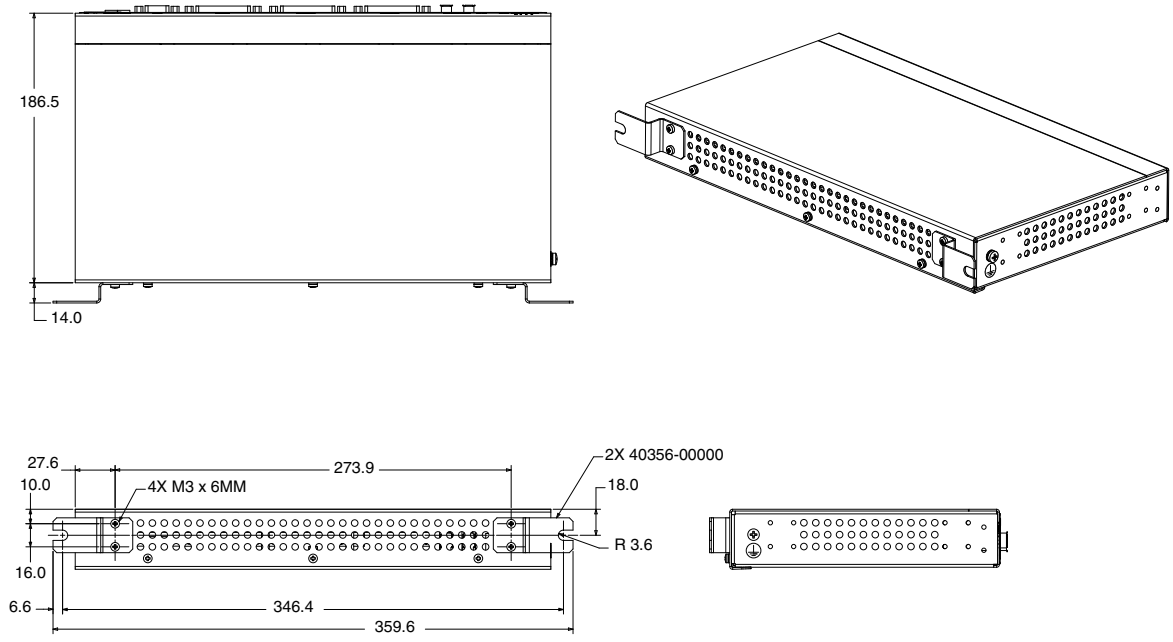


Figure 4-3. Panel Mounting

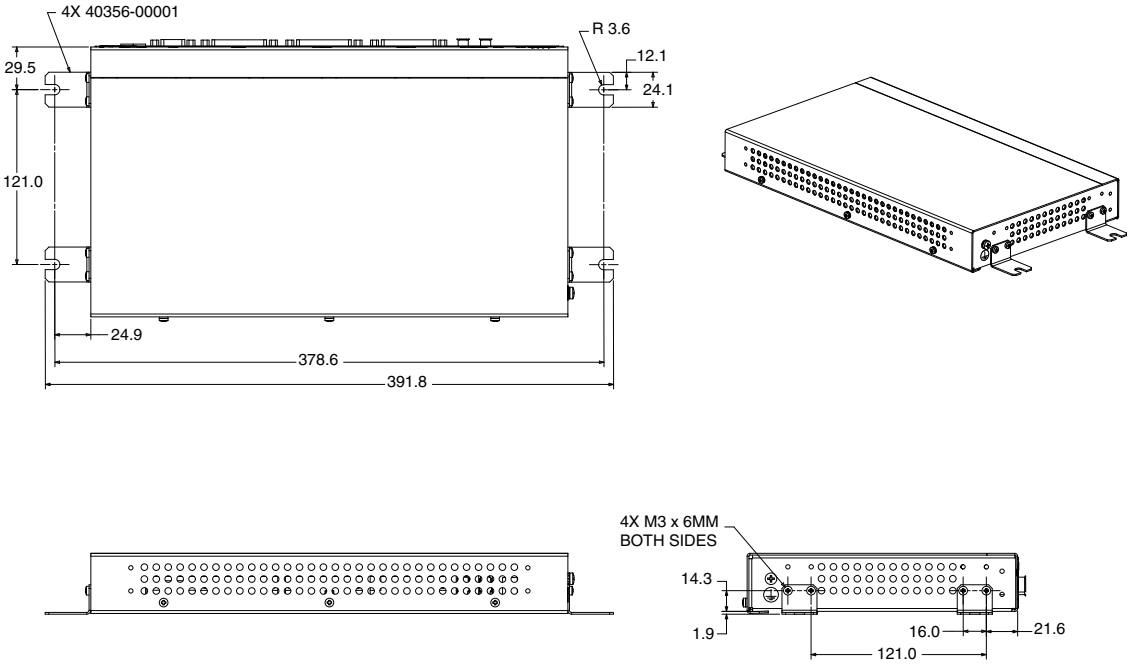


Figure 4-4. Table Mounting

4.3 MP6 to sMI6 Cables

Table 4-1 shows the pinout for the cable that connects between the XSERVO connector on the sMI6 module and the MP6-S panel.

Table 4-1. Pinout for MP6-S

sMI6 Pin	MP6-S Pin	Signal	sMI6 Pin	MP6-S Pin	Signal
	1			26	
5	2	DE1+	36	27	DE4+
20	3	DE1–	37	28	DE4–
10	4	DF1+	12	29	DF4+
11	5	DF1–	13	30	DF4–
1	6	CD1+	3	31	CD4+
2	7	CD1–	4	32	CD4–
6	8	DE2+		33	
7	9	DE2–	8	34	DE5+
25	10	DF2+	23	35	DE5–
26	11	DF2–	27	36	DF5+
16	12	CD2+	28	37	DF5–
17	13	CD2–	18	38	CD5+
21	14	DE3+	19	39	CD5–
22	15	DE3–	38	40	DE6+
40	16	DF3+	39	41	DE6–
41	17	DF3–	42	42	DF6+
31	18	CD3+	43	43	DF6–
33	19	CD3–	34	44	CD6+
	20		35	45	CD6–
	21			46	
	22			47	
14	23	not used		48	
29	24	not used	9	49	SP1+
44	25	not used	24	50	SP1–
			Shell	Shell	Shield

Table 4-2 shows the pinout for the cable that connects between the XMACHINE connector on the sMI6 module and the MP6-M panel.

Table 4-2. Pinout for MP6-M

sMI6 Pin	MP6-M Pin	Signal	sMI6 Pin	MP6-M Pin	Signal
	1		8	26	OT4+
1	2	OT1+	9	27	OT4–
3	3	OT1–	23	28	HM4+
17	4	HM1+	24	29	HM4–
18	5	HM1–	38	30	BR4+
32	6	BR1+	39	31	BR4–
33	7	BR1–		32	
4	8	OT2+		33	
5	9	OT2–		34	
19	10	HM2+	10	35	OT5+
20	11	HM2–	11	36	OT5–
34	12	BR2+	25	37	HM5+
35	13	BR2–	26	38	HM5–
6	14	OT3+	40	39	BR5+
7	15	OT3–	41	40	BR5–
21	16	HM3+	12	41	OT6+
22	17	HM3–	14	42	OT6–
36	18	BR3+	27	43	HM6+
37	19	BR3–	29	44	HM6–
	20		42	45	BR6+
	21		44	46	BR6–
	22			47	
	23			48	
15	24	HPE+	16	49	SP2+
30	25	HPE–	31	50	SP2–
			Shell	Shell	Shield

Table 4-3 shows the pinout for the cable that connects between the XENCODER connector on the sMI6 module and the MP6-E panel.

Table 4-3. Pinout for MP6-E

sMI6 Pin	MP6-E Pin	Signal	sMI6 Pin	MP6-E Pin	Signal
1	2	A1+	7	26	A4+
2	3	A1–	8	27	A4–
16	4	B1+	23	28	B4+
18	5	B1–	24	29	B4–
31	6	Z1+	37	30	Z4+
32	7	Z1–	38	31	Z4–
3	8	A2+		32	
4	9	A2–		33	
19	10	B2+		34	
20	11	B2–	9	35	A5+
33	12	Z2+	10	36	A5–
34	13	Z2–	25	37	B5+
	14		26	38	B5–
	15		39	39	Z5+
	16		40	40	Z5–
	17		11	41	A6+
5	18	A3+	12	42	A6–
6	19	A3–	27	43	B6+
21	20	B3+	28	44	B6–
22	21	B3–	41	45	Z6+
35	22	Z3+	42	46	Z6–
36	23	Z3–	14	47	Serial I/O_3 [a]
13	24	EPWR	15	48	Serial I/O_4 [a]
43	25	EPWR	29	49	Serial I/O_1 [a]
			44	50	Serial I/O_2 [a]
			Shell	Shell	Shield

[a] Serial I/O functionality to be added in future release.

4.4 Typical Input and Output Circuits in sMI6

Input Circuits

The circuit in **Figure 4-5** is typical of all digital inputs on the sMI6 (3 per axis, 18 total):

- Home Switch
- Overtravel
- Drive Fault

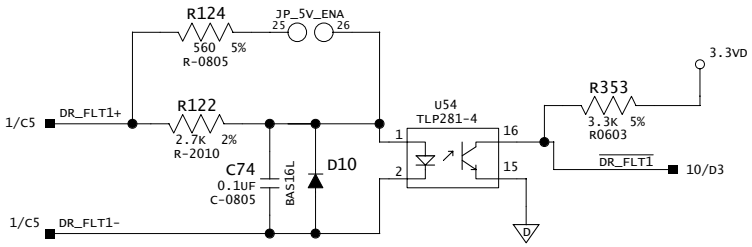


Figure 4-5. Typical Input Circuit in sMI6

Output Circuits

The circuit in **Figure 4-6** is typical of all digital outputs on the sMI6 (2 per axis + 3, 15 total):

- Drive Enable
- Brake Release
- High Power Enable (HPE)
- Spares

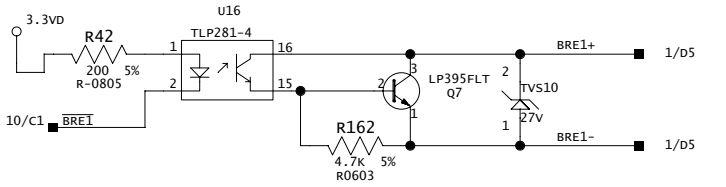


Figure 4-6. Typical Output Circuit in sMI6

4.5 Emergency Stop Circuits

- **Figure 4-7 on page 54** shows a Category 3 E-Stop circuit that can be created using a PILZ PNOZ1 relay.
- **Figure 4-8 on page 55** shows a Category 1 E-Stop circuit that can be created to cut off power to the user amplifier.

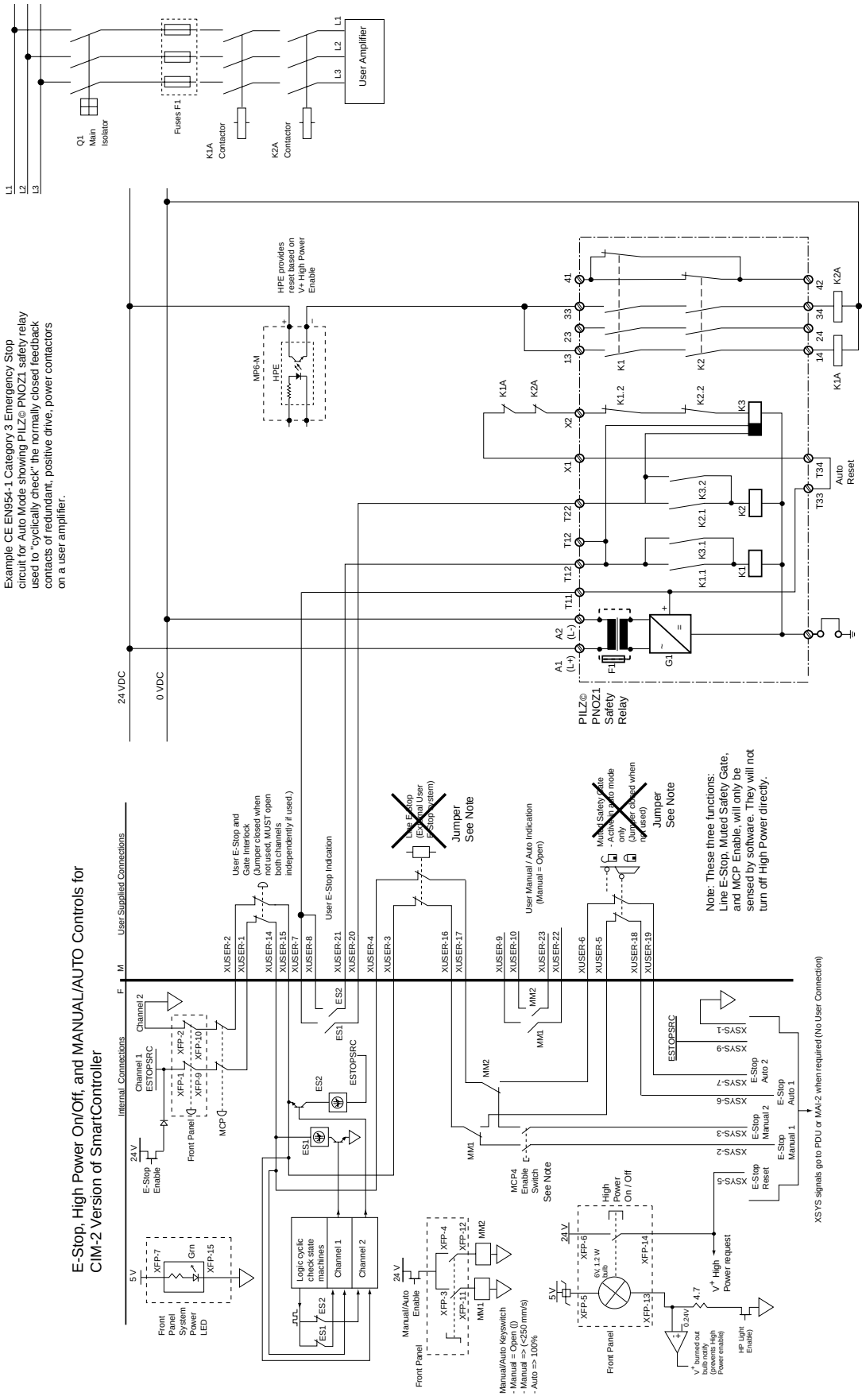


Figure 4-7. Category 3 E-Stop Circuit

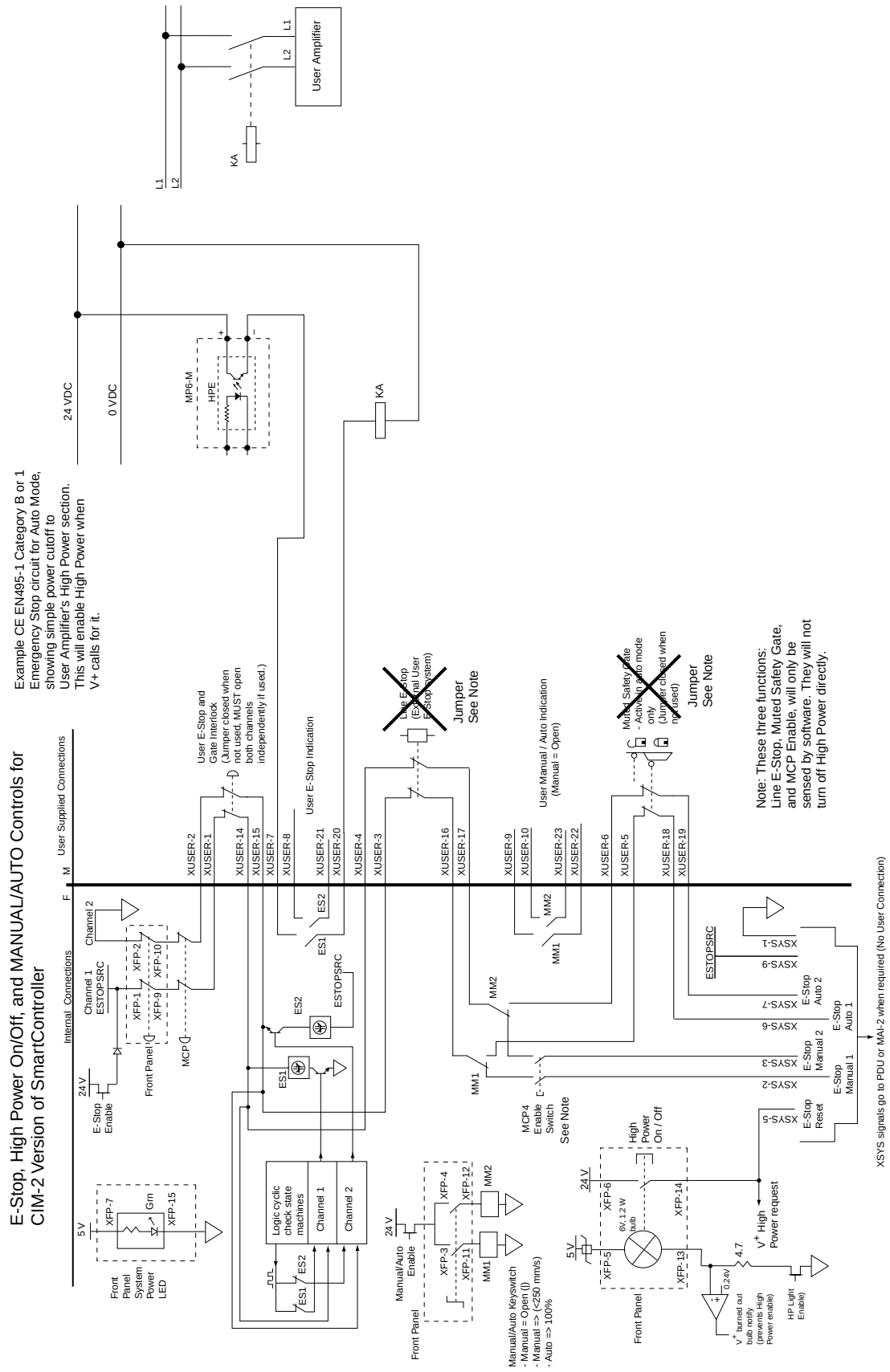


Figure 4-8. Category 1 E-Stop Circuit

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