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Adept SmartController EX
User's Guide

Covers the SmartController EX Motion Controller and sDIO Module



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Adept SmartController EX
User's Guide

Covers the SmartController EX Motion Controller and sDIO Module



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Table of Contents

Chapter 1: Introduction 9

1.1 Product Description 9

sDIO Module Expansion Module 9

Optional Adept T20 Pendant 9

1.2 Dangers, Warnings, Cautions, and Notes in Manual 10

1.3 Safety Precautions 11

1.4 What to Do in an Emergency Situation 12

1.5 Additional Safety Information 12

Manufacturer's Declaration of Compliance (MDOC) 12

Adept Robot Safety Guide 12

1.6 Manufacturer's Declaration 12

1.7 How Can I Get Help? 13

Related Manuals 13

Adept Document Library 13

Chapter 2: Installation 15

2.1 Controller Installation 15

Before Unpacking 15

Upon Unpacking 15

Repacking for Relocation 16

Space Around the Chassis 16

Mounting the Adept SmartController EX Motion Controller 16

Memory Card 19

Connecting Power 21

IEEE 1394 Cable Specifications 24

2.2 System Cable Installation 25

Chapter 3: Operation 27

3.1 Connectors and Indicators 27

3.2 Front Panel 31

Programming the E-Stop Delay 32

3.3 Installing the Adept ACE Software 32

3.4 Configuring the SmartController 33

Configuring Serial Ports 33

RS-232 Connectors 34

RS-422/485 Connector 35

3.5 Connecting User-Supplied Safety and Power-Control Equipment 36

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Emergency Stop Circuits ... 41
Remote Manual Mode ... 43
User Manual/Auto Indication ... 43
User High Power On Indication ... 43
Remote High Power On/Off Control ... 43
High Power On/Off Lamp ... 44
Remote Front Panel or User-Supplied Control Panel Usage ... 44
Remote Pendant Usage ... 45
3.6 Connecting User-Supplied Digital I/O Equipment ... 45
DeviceNet Connector ... 45
XDIO Connector ... 45
3.7 Belt Encoder Interface ... 50

Chapter 4: Maintenance ... 55
4.1 Changing the Lamp in the Front Panel High-Power Indicator ... 55

Chapter 5: Technical Specifications ... 57
5.1 Adept SmartController EX Motion Controller Dimensions ... 57
5.2 sDIO Module Dimensions ... 58
5.3 Adept Front Panel Dimensions ... 59
5.4 Adept T20 Pendant Dimensions ... 60

Chapter 6: sDIO Module ... 61
6.1 Mounting the sDIO Module ... 61
Rack-Mounting the sDIO Module ... 61
Panel-Mounting the sDIO Module ... 63
Table-Mounting the sDIO Module ... 63
Stack-Mounting the sDIO Module ... 64
6.2 Installing the sDIO Module ... 64
6.3 sDIO Module Connectors and Indicators ... 65
6.4 Configuring an sDIO Module ... 66
Default sDIO I/O Configuration ... 66
Modifying the Default sDIO Configuration ... 66
6.5 Installing Multiple sDIO Modules ... 71
Configuring Multiple sDIO Modules ... 71
6.6 sDIO Digital I/O Signals ... 72
sDIO Inputs ... 72
sDIO Outputs ... 74
Optional DIO Cables ... 77

Chapter 7: Adept DeviceNet ... 85
7.1 DeviceNet Specifications ... 85

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7.2 Limitations of the Adept DeviceNet Scanner 86
7.3 DeviceNet Port on the Controller 86
Connecting DeviceNet Hardware to the Controller 86
Configuring DeviceNet 87
7.4 DeviceNet Physical Layer and Media 87
DeviceNet Connectors 90
Termination of the DeviceNet Network 91
Power Supply and the DeviceNet Bus 91

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Chapter 1: Introduction

1.1 Product Description

The Adept SmartController EX motion controller is a member of Adept's family of high-performance distributed motion controllers. The Adept SmartController EX motion controller is designed for use with Adept Python Linear Modules, Adept Cobra s-series robots, the Adept Viper line of six-axis robots, the Adept sMI6 Module for the SmartMotion product, Adept SmartServo kits, and Adept Quattro robots.



Figure 1-1. Adept SmartController EX Motion Controller

sDIO Module Expansion Module

The sDIO module expansion module provides 32 optical-isolated digital inputs, 32 optical-isolated outputs, and an IEEE 1394 interface.

Customers can access I/O signals from the following points using these products:

- the XDIO connector on an Adept SmartController EX motion controller
- the DeviceNet connector on an Adept SmartController EX motion controller
- the DIO X1 - X4 connectors on an sDIO module

Optional Adept T20 Pendant

The optional Adept T20 pendant provides a user interface and teach pendant in an ergonomic and rugged package. The pendant is designed for right- or left-handed use. All gripping and holding positions enable comfortable and fatigue-free operation.

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The safety features include:

- Emergency-stop switch (dual channel circuit)
- 3-position enable switch (dual channel circuits)

See the *Adept T20 pendant User's Guide*, shipped with each pendant, for complete information on the product.



Figure 1-2. Adept T20 Pendant

1.2 Dangers, Warnings, Cautions, and Notes in Manual

There are six levels of special alert notation that may be used in Adept manuals. In descending order of importance, they are:

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



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



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



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 damage to the equipment.

NOTE: Notes provide supplementary information, emphasize a point or procedure, or give a tip for easier operation.

1.3 Safety Precautions



DANGER: Adept robots can cause serious injury or death, or damage to themselves and other equipment, if the following safety precautions are not observed:

- All personnel who install, operate, teach, program, or maintain the system must read this guide, read the *Adept Robot Safety Guide*, and complete a training course for their responsibilities in regard to the system.
- All personnel who design the robot system must read this guide, read the *Adept Robot Safety Guide*, and must comply with all local and national safety regulations for the location in which the system is installed.
- The robot system must not be used for purposes other than described in the robot user's guide. Contact Adept if you are not sure of the suitability for your application.
- The user is responsible for providing safety barriers around the robot to prevent anyone from accidentally coming into contact with the robot when it is in motion.

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- Power to the robot and its power supply must be locked out and tagged out before any maintenance is performed.

1.4 What to Do in an Emergency Situation

Press any E-Stop button (a red push-button on a yellow background/field) and then follow the internal procedures of your company or organization for an emergency situation. If a fire occurs, use CO2 to extinguish the fire.

1.5 Additional Safety Information

Adept provides other sources for more safety information:

Manufacturer's Declaration of Compliance (MDOC)

This lists all standards with which each robot complies. See "Manufacturer's Declaration" on page 18.

Adept Robot Safety Guide

The *Adept Robot Safety Guide* provides detailed information on safety for Adept robots. It also gives resources for more information on relevant standards.

It ships with each robot manual, and is also available from the Adept Document Library. See "Adept Document Library ".

1.6 Manufacturer's Declaration

The Manufacturer's Declaration of Incorporation and Conformity for Adept robot systems can be found on the Adept website, in the Download Center of the Support section.

http://www.adept.com/support/downloads/file-search

NOTE: The Download Center requires that you are logged in for access. If you are not logged in, you will be redirected to the Adept website Login page, and then automatically returned to the Download Center when you have completed the login process.

1. From the Download Types drop-down list, select Manufacturer Declarations.
2. From the Product drop-down list, select SmartControls.
3. Click Begin Search.

   The list of available documents is shown in the Search Results area, which opens at the bottom of the page. You may need to scroll down to see it.
4. Use the Description column to locate the document for your SmartController, and then click the corresponding Download ID number to access the Download Details page.
5. On the Download Details page, click Download to open or save the file.

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1.7 How Can I Get Help?

For details on getting assistance with your Adept software or hardware, you can access the following information sources on the Adept corporate website:

- For contact information: http://www.adept.com/contact/americas
- For product support information:

  http://www.adept.com/support/service-and-support/main
- For user discussions, support, and programming examples:

  http://www.adept.com/forum/
- For further information about Adept Technology, Inc.: http://www.adept.com

Related Manuals

This manual covers the installation and maintenance of an Adept SmartController EX motion controller system, including the sDIO module. There are additional manuals that cover programming the system, reconfiguring installed components, and adding other optional components. The following manuals provide information on advanced configurations and system specifications.

Table 1-1. Related Manuals

Manual Title	Description
Adept Robot Safety Guide	Contains safety information for Adept robots.
Adept T20 User's Guide	Contains information on the installation and operation of the Adept T20 pendant.
Adept ACE User's Guide	Describes installation and use of the Adept ACE software.
eV+ OS User Guide	Describes the eV+ operating system, including disk file operations, monitor commands, and monitor command programs.
eV+ Language User's Guide	Describes the eV+ language and programming of an Adept control system.

1 The eV+ manuals are accessible through the Adept Document Library:

Document Library > V+ > eV+ Document (preliminary) > [select a manual]

Adept Document Library

The Adept Document Library (ADL) contains documentation for Adept products. You can access the ADL through either of the following methods:

- Select **Support > Document Library** from the menu bar on the Adept website.
- Type the following URL into your web browser:

  http://www.adept.com/Main/KE/DATA/adept_search.htm

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To locate information on a specific topic, use the Document Library search engine on the ADL main page.

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Chapter 2: Installation

2.1 Controller Installation

This equipment must be shipped and stored in a temperature-controlled environment. See the following table. It should be shipped and stored in the Adept-supplied packaging, which is designed to prevent damage from normal shock and vibration. You should protect the package from excess shock and vibration.

Table 2-1. Environmental Specifications

Ambient temperature	5° to 40° C (41° to 104° F)
Storage and shipment temperature	–25° to +55° C (-13° to 131° F)
Humidity range	5 to 90%, non-condensing
Altitude	up to 2000 m (6500 ft)
Free space around controller (for proper cooling)	10 mm at back, 13 mm on sides (0.4 in., 0.5 in.)
Chassis protection class	IP-20 (NEMA Type 1)

Before Unpacking

Carefully inspect all shipping containers for evidence of damage during transit. If any damage is indicated, request that the carrier's agent be present at the time the container is unpacked.

Upon Unpacking

Compare the actual items received (not just the packing slip) with your equipment purchase order, and verify that all items are present and that the shipment is correct. Inspect each item for external damage as it is removed from its container. Contact Adept immediately if any damage is evident. For contact information, see How Can I Get Help? on page 13

Retain all containers and packaging materials. These items may be needed in the future to settle a damage claim.

Perform the following steps to unpack the Adept SmartController EX motion controller and Front Panel, optional Adept sDIO module Expansion Module, and optional pendant. Refer to the following sections for information on mounting the equipment.

1. Remove the Adept SmartController EX motion controller and any optional sDIO module from their boxes. Place them near the robot, or mount them in a rack. For details, see Mounting the Adept SmartController EX Motion Controller on page 16.
2. Remove the optional Front Panel from its box and set it on a flat surface near the Adept SmartController EX motion controller.

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3. Remove the optional fromT20 pendant its box and place it on a flat surface near the Front Panel.

Repacking for Relocation

If the controller needs to be relocated, reverse the steps in the installation procedure. Reuse all original packing containers and materials and follow all safety notes used for installation. Improper packaging for shipment will void your warranty.

Space Around the Chassis

When the Adept SmartController EX motion controller and/or sDIO module is installed, you must allow 10 mm at the back of the unit and 13 mm on the sides of the unit for proper air cooling.

Mounting the Adept SmartController EX Motion Controller

The following mounting options are available for the controller:

- Rack
- Panel
- Table
- Stack

  The controller and compatible Adept units can be mounted with one unit placed on top of another.

See Mounting the sDIO Module on page 61 for information on mounting the sDIO module.

NOTE: To maintain compliance with many standards, the mounting of the controller and all terminations at the controller must be performed in accordance with local and national regulations.

Rack-Mounting the Adept SmartController EX Motion Controller

To rack-mount the controller in a standard 19-inch equipment rack, install the optional mounting brackets on the side of the controller, as shown in the following figure. These brackets must be ordered separately. They do not come with the controller.

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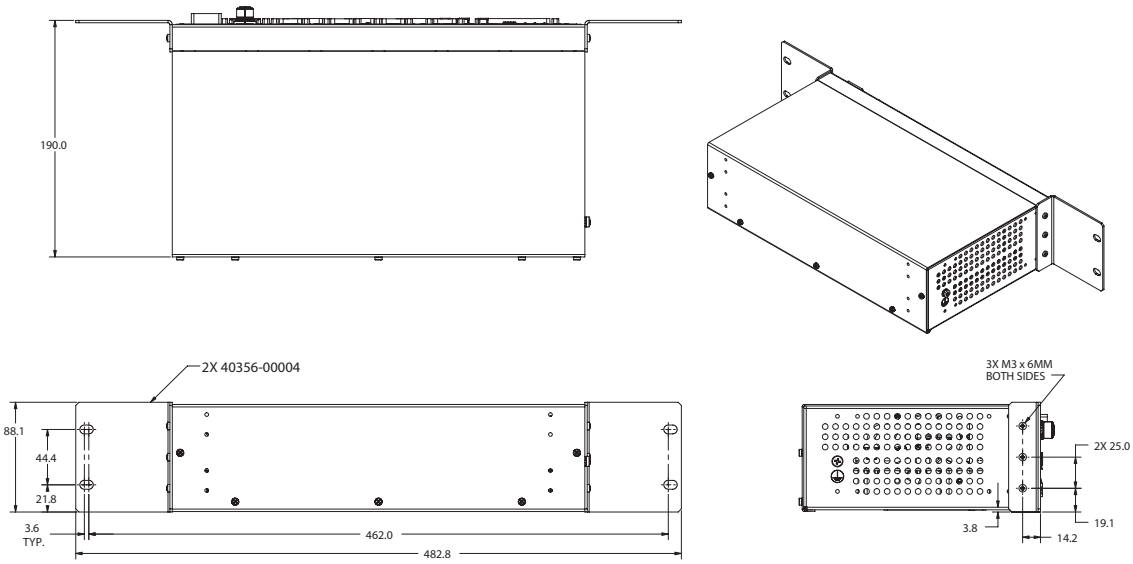


Figure 2-1. Rack-Mounting the Adept SmartController EX Motion Controller

Panel-Mounting the Adept SmartController EX Motion Controller

To panel-mount the controller, install two brackets on each side at the rear of the unit, as shown in the following figure. Use the screws from the accessories kit.

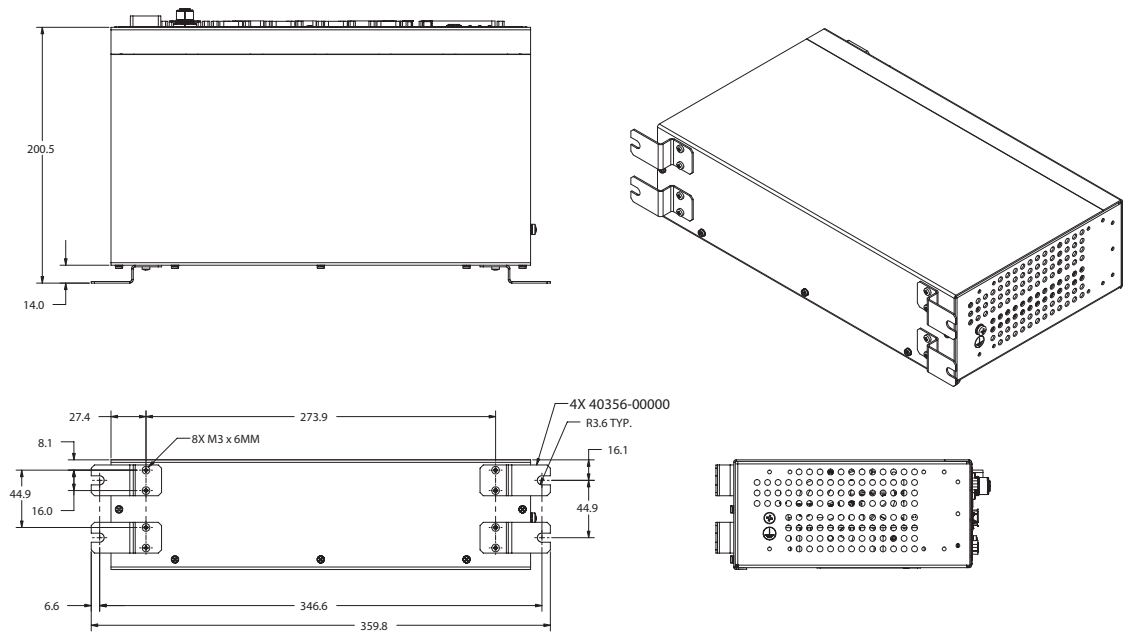


Figure 2-2. Panel-Mounting the Adept SmartController EX Motion Controller

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Table-Mounting the Adept SmartController EX Motion Controller

To table-mount the controller, install two brackets on each side near the bottom of the unit, as shown in the following figure. These brackets must be ordered separately. They do not come with the controller.

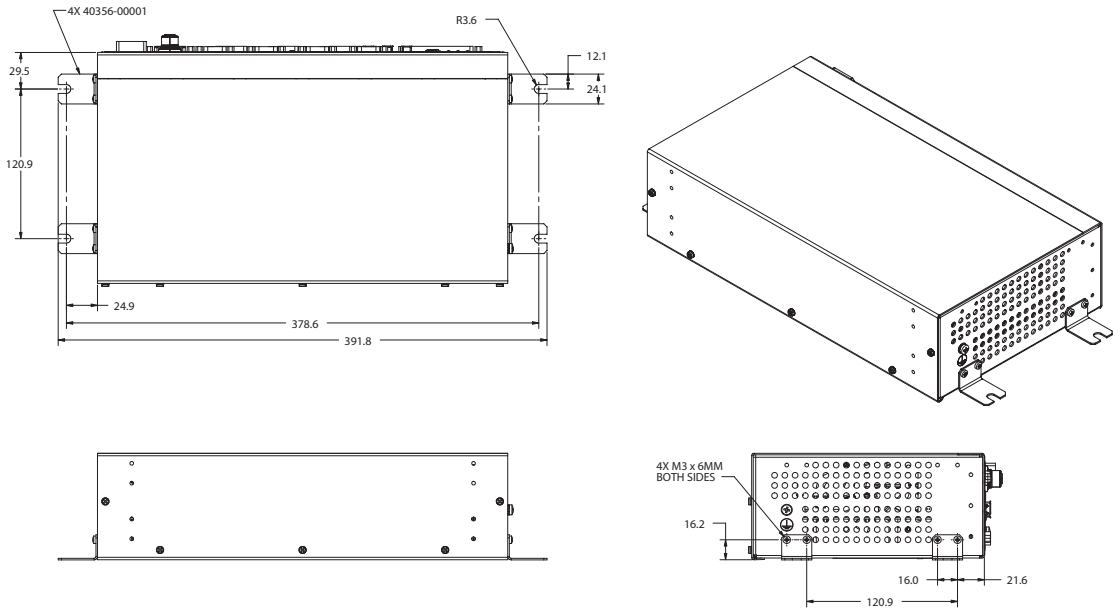


Figure 2-3. Table-Mounting the Adept SmartController EX Motion Controller

Stack-Mounting Components

To stack-mount the Adept SmartController EX Motion Controller and a compatible unit, such as an Adept SmartVision EX vision controller, install two brackets on each side of the units, as shown in the following figure. These brackets are supplied with compatible Adept units.

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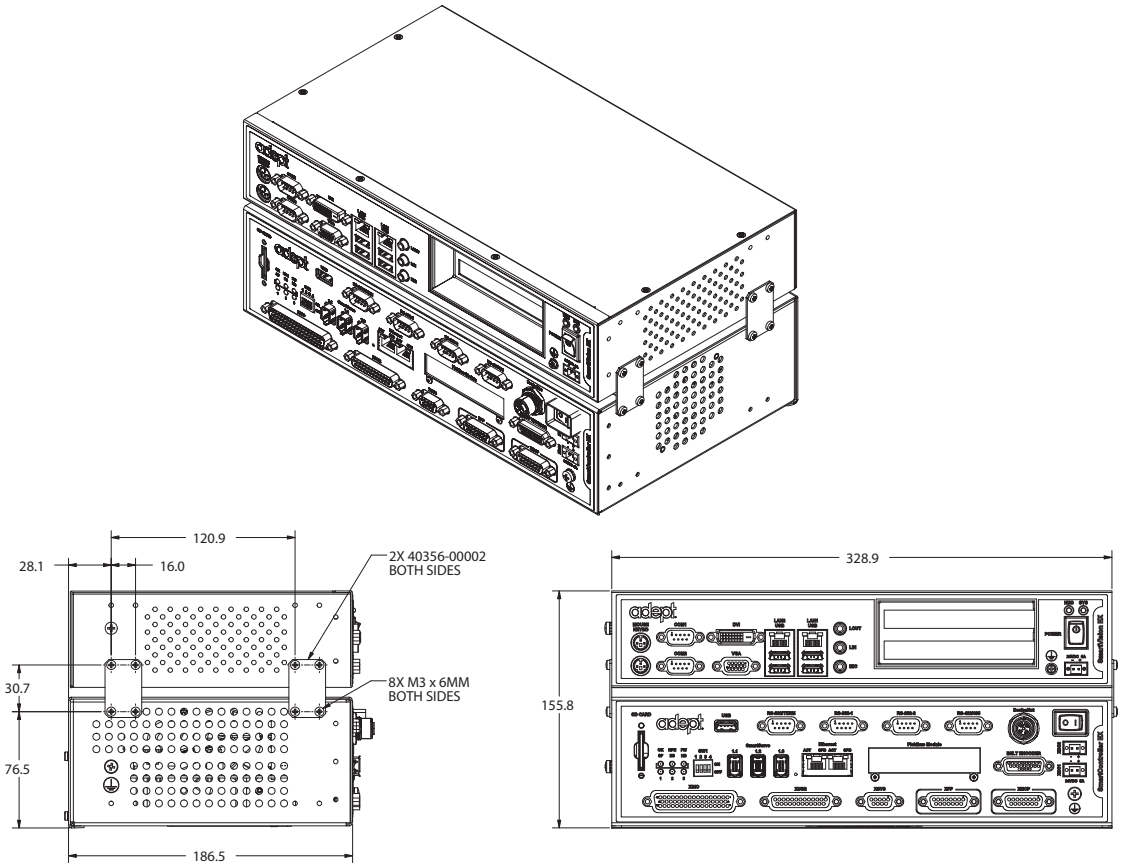


Figure 2-4. Stack-Mounting the Adept SmartController EX Motion Controller

Memory Card

The Adept SmartController EX motion controller is equipped with a Secure Digital™ (SD) memory card. The SD card is removable, and can be moved to another Adept SmartController EX motion controller for testing.

The SD card shipped with all systems is factory-configured and installed by Adept. The SD card stores the eV+ operating system, application programs, data files, and Adept licenses.

Only the SD card supplied by Adept will work with the Adept SmartController EX motion controller.

NOTE: This SD card is not compatible with the SmartController CX or CS motion controllers.



CAUTION: Use suitable measures for eliminating electrostatic discharge during removal and installation of the SD card. This includes, but is not limited to, the use of a grounded wrist strap.

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CAUTION: Do not remove the SD card when power is connected to the controller.

Removing an SD Card

To remove an SD card from a Adept SmartController EX motion controller:

1. Make sure that the controller is disconnected from its power source.
2. Locate the SD compartment (see the following figure).

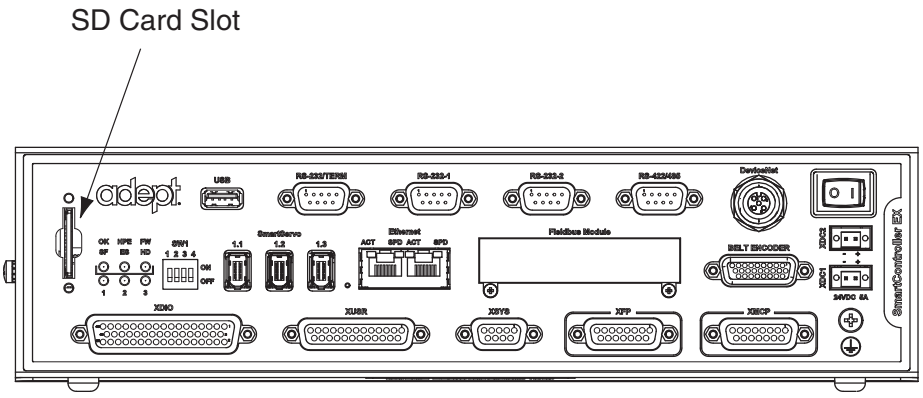


Figure 2-5. SD Memory Card Compartment

NOTE: If you are replacing an existing SD, the original must be sent to Adept for replacement.

3. Press the SD card in, and release. The card will pop out.

   Remove the card and return it to Adept. Contact Adept Customer Service.

Installing an SD Card

To install an SD card into a Adept SmartController EX motion controller:

1. Make sure that the controller is powered off.
2. Locate the SD card compartment (see the preceding figure).
3. Carefully remove the SD card from the READ ME FIRST box or shipping container.

   Position the card so its contacts are facing towards the controller and to the left. The label will be facing to the right.
4. Insert the SD card into the controller.

Once installed, Adept recommends that you do not repeatedly remove and insert the SD card.

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Connecting Power

The Adept SmartController EX motion controller and sDIO module require filtered 24 VDC power.

NOTE: *Users must provide their own power supply.* Make sure the power cables and power supply conform to the specifications that follow.

24 VDC Power Specifications

Table 2-2. Specifications for 24 VDC User-Supplied Power Supply

User-Supplied Power Supply	24 VDC (-10%, +5%), 120 W (5 A)
Circuit Protection	Not more than 8 A (below the amperage rating of the cable used)
Power Cabling	1.5 - 1.85 mm^2 (16-14 AWG), full-cover, braided shield cable, maximum length 10 meters
Shield Termination	Braided shield connected to the marked frame ground screw on the right side of the controller (near the XDC connector). On the other end of the cable, the shield should be connected to the power supply chassis.

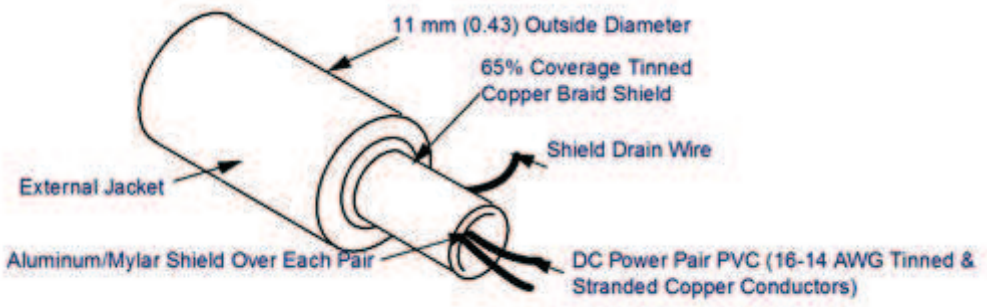


Figure 2-6. User-Supplied 24 VDC Cable

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NOTE: The power requirements for the user-supplied power supply will vary depending on the configuration of the Adept SmartController EX motion controller and connected devices. A minimum configuration of the controller, front panel, and pendant will require 2 A at 24 VDC. However, a 24 V, 5 A power supply is recommended to allow for additional current draw from connected devices, such as external IEEE 1394 devices and digital I/O loads.

24 VDC Power Cabling

In order to maintain compliance with many standards, DC power must be delivered over a shielded cable, with the shield connected to the frame ground at both ends of the cable, as shown in the following figure. Conductors should be 1.5 mm^2- 1.85 mm^2 (16 to 14 AWG) in size. The maximum length for the 24 VDC cable is 10 meters.

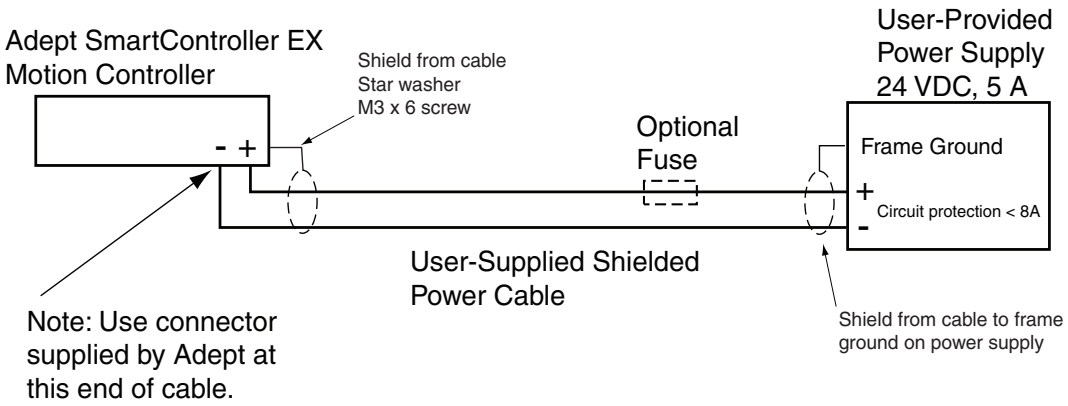


Figure 2-7. User-Supplied Power Cable

Daisy-Chaining Power

The Adept SmartController EX motion controller is equipped with two DC power connectors. These connectors allow the daisy-chaining of power from one controller to another or to an sDIO module. When daisy-chaining power, the power supply circuit must be limited to the lesser of 8 Amps or the ampacity of the cabling. This can be done with a circuit breaker or a fuse. The DC power can be applied to either the XDC1 or XDC2 connector.



CAUTION: Use only one 24 VDC power supply per circuit. Failure to do this could result in damage to the equipment.



CAUTION: The SmartVision EX vision controller has a higher current demand and should be wired independently. Do not daisy-chain its power from a Adept SmartController EX motion controller.

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NOTE: The power switch on the Adept SmartController EX motion controller will shut down both the controller and the second 24 V port. If you want a secondary device to maintain power after the controller is shut down, you will have to provide a separate power line to it.

Chassis Grounding

The Adept SmartController EX motion controller is equipped with a grounding point, as shown in the following figure. Adept recommends connecting a ground wire from the ground point on the controller to earth ground and that all other interconnected Adept components share the same electrical ground potential. The ground wire must meet all local regulations. Additional grounding information for other Adept products is provided in the documentation for those products.

NOTE: The maximum length for the ground wire for the controller is 3 meters.

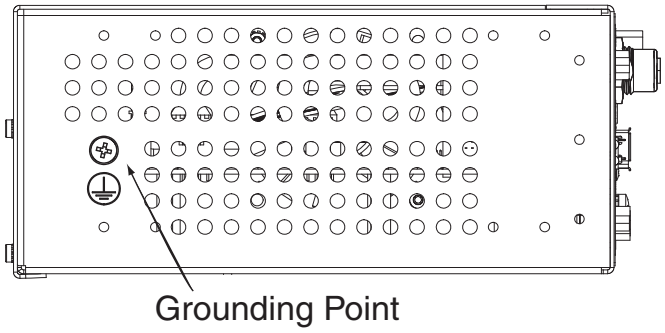


Figure 2-8. Chassis Grounding Point

The mounting of the controller and all terminations must be performed in accordance with local and national regulations.

Installing 24 VDC Connectors

Use the Adept-supplied connector to connect the user-supplied 24 VDC power supply to the Adept SmartController EX motion controller.

1. Locate the 24 VDC connector that is shipped with the controller. See the following figure.
2. Use 14 or 16 gauge wire to connect the 24 VDC power supply to the controller.
3. Strip 7 mm of insulation from the end of the wire that connects to the positive output of the 24 VDC supply.
4. Insert the stripped end of the wire into the opening on the right side of the connector.
5. Using a small, flat-blade screwdriver (2.5 mm), tighten the screw clamp on the connector.
6. Visually inspect the connection to ensure that the clamp has closed on the wire, not on the insulation.

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7. Gently pull on the wire to confirm that it is securely attached to the connector.
8. Repeat this process to connect the wire from the negative side of the power supply to the left side of the connector.
9. Connect the braided shield to the ground screw on the front of the controller.

   A ring lug can be used, as shown in the following figure. The ground screw is an M3.

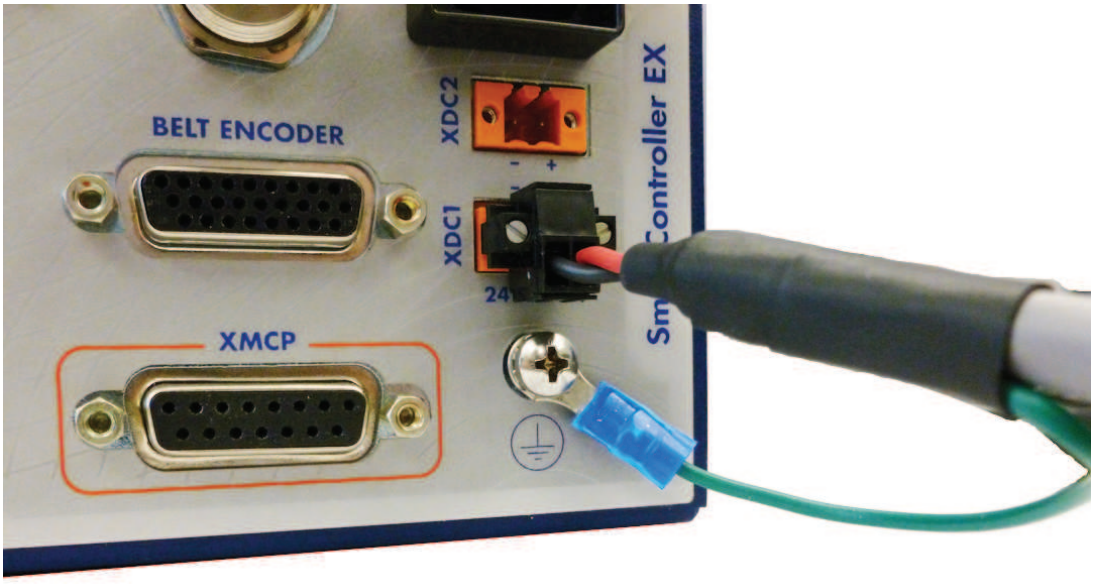


Figure 2-9. 24 V Connector

NOTE: Although no damage will occur, the Adept SmartController EX motion controller will not turn on if the DC polarities on the XDC connectors are reversed.

IEEE 1394 Cable Specifications

Adept supplies the IEEE 1394 cables to connect the Adept SmartController EX motion controller to other Adept devices in the system. If you need a cable of a different length than those supplied by Adept, then you must purchase a cable from one of the Adept-approved vendors listed below:

- CEI: www.componentsexpress.com
- Molex, Inc.: www.molex.com

These purchased cables must meet all specifications of the IEEE 1394 standard. Note that Adept uses 6-pin to 6-pin cables. The maximum length for a 1394 cable is 10 meters. The 1394 Trade Association provides detailed specifications for 1394 cables and other related information. See www.1394ta.org.

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WARNING: You must use cables from vendors approved by Adept that meet all specifications of the IEEE 1394 standard. Using a non-approved or inferior quality IEEE 1394 cable can cause unpredictable system performance.

2.2 System Cable Installation

The Adept SmartController EX motion controller is used in many Adept systems, including Adept Python Linear Modules, Adept Cobra s-series robots, the Adept Viper line of six-axis robots, Adept Quattro robots, and the Adept sMI6 Module for the SmartMotion product.

See your specific product manual for complete details on system cabling for your Adept SmartController system.

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Chapter 3: Operation

3.1 Connectors and Indicators

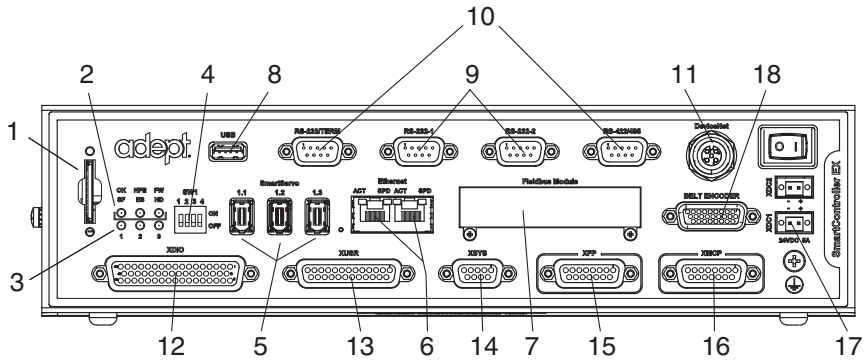


Figure 3-1. SmartController EX Connectors and Indicators

All of the connectors on the Adept SmartController EX motion controller use standard-density spacing, D-subminiature connectors. For customization purposes, the user needs to provide connectors of the appropriate gender and pin count, or use optional Adept cables.

1. **SD Card Slot**

   See Installing an SD Card on page 20.

2. **Top Three Status LEDs**

   The top three two-color LEDs indicate diagnostic test, power control, and communication status.

Table 3-1. Controller LEDs

LED	Green Indicates	Red Indicates
OK/SF	System OK	System Fault
HPE/ES	High Power Enabled	E-Stop Open
FW/HD	SmartServo Connection	Read/Write from SD card

During system bootup, the red OK/SF and HPE/ES LEDs are lit and the red FW/HD LED blinks. After system bootup, the OK/SF LED should show green. If the HPE/ES LED shows red, the E-Stop circuit is open. During SD card reads and

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writes, the FW/HD LED pulses red. When a robot is connected on one of the SmartServo ports, the FW/HD LED shows green

3. **Bottom Three Status LEDs**

   The bottom three LEDs on the front of the Adept SmartController EX motion controller give the following information about the status of the main controller.

   O = Off G = Green R = Red

Table 3-2. LED Status Indicators

LED Display 1 2 3	Error Number	Description
O-O-O	0	No error.
R-O-O	1	System clock is dead or too fast. Clock interrupts are not being received.
O-R-O	2	Hardware configuration error.
O-O-R	4	Memory test failure. Free storage error.
O-R-R	6	Software serial I/O configuration error.
R-R-R	7	Initial display set by hardware before software has started.
G-O-O	9	Transient display set when PCI is configured.
O-O-G	C	Uninitialized trap.
G-O-G	D	Bus error detected.

   If the Adept SmartController EX motion controller displays an error, cycle the power off, then on again. If the problem persists, contact Adept Customer Service.

4. **SW1 DIP switches**

   The definition for DIP switches on the Adept SmartController EX motion controller is as follow:

   Switch 1:

   - OFF: use IP address from configuration on SD card
   - ON: use default factory IP address (printed on the bottom of the controller)

   Switch 2:

   - OFF: normal connection through Ethernet
   - ON: communication through RS-232 on the TERM port

   Switch 3 and 4: reserved for future use; always leave in the OFF position.

   In normal operation, all switches should be OFF.

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5. **SmartServo 1.1, 1.2, and 1.3**

   These ports connect any Adept SmartServo-compatible product to the controller via the IEEE-1394 cable. These ports are interchangeable - any one can be used.



WARNING: Remove power from the controller before plugging in or unplugging any IEEE-1394 cables to or from these connectors. Failure to remove power could result in unpredictable behavior by the system.

6. **Ethernet (Eth 10/100/1000) connectors**

   The shielded RJ-45 receptacles support 10/100/1000 BaseT Ethernet communications. The two ports are interchangeable.

NOTE: The default IP address for the controller is located on a label on the bottom side of the controller chassis.

7. **Fieldbus Module**

   This module is reserved for future use.

8. **USB port**

   This port is reserved for future use.

9. **RS-232-1 and RS-232-2 connectors**

   These are RS-232 serial ports for general use. See Installing the Adept ACE Software on page 32 for more information.

10. **RS-232 and RS-422/485 connectors**

    These ports support RS-232 and RS-422/485 devices, respectively. See Installing the Adept ACE Software on page 32 for pin descriptions and locations.

11. **DeviceNet connector**

    DeviceNet is a field bus for industrial devices. This standard supports a variety of products, including sensors, digital I/O, analog I/O, RS-232, and PLCs. Other DeviceNet product types, such as keypads and displays, can be controlled using the eV+ FCMD program instruction (see the eV+ *Language Reference Guide* for details). See Adept DeviceNet on page 85.

12. **XDIO connector**

    This connector includes 20 signal pairs: 8 digital outputs (100 mA max) and 12 digital inputs, all of which are fast inputs. The digital outputs are short-circuit protected. This connector also supplies 24 VDC power for customer equipment. See Connecting User-Supplied Digital I/O Equipment on page 45 for more information.

13. **XUSR connector**

    Provides switch functions for emergency stop (E-Stop) and Manual/Automatic interfaces to external push-buttons and other equipment. For example, an external E-Stop can be

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connected to the XUSR connector. A line E-Stop from other equipment can be connected. A muted safety gate that causes an E-Stop only in Automatic mode is included. Also included are contacts to report the status of E-Stop push-buttons and the Manual/Automatic switch.

NOTE: The Adept SmartController EX motion controller ships with a terminator plug attached to the XUSR connector. The terminator plug must be installed in the absence of any user-supplied safety equipment used to close the E-Stop circuit. For more information about the XUSR connector, see Connecting User-Supplied Safety and Power-Control Equipment on page 36.

14. **XSYS connector**

    Connects to the XSLV connector on an Adept robot or servo controller.

15. **XFP connector**

    Connects to the optional Front Panel. See Connecting User-Supplied Safety and Power-Control Equipment on page 36 for information.

16. **XMCP connector**

    The optional Adept T20 pendant plugs into this connector, via the T20 adapter cable, which has the mating connector for the XMCP connector. The controller ships with a terminator plug in the XMCP connector. The plug must be installed in the absence of a pendant or the E-Stop circuit will remain open, and you will not be able to start the system.

17. **24 VDC connectors/switch**

    Connect power from a user-supplied 24 VDC power supply to the XDC1 connector (see Connecting Power on page 21). If using an sDIO module or an sMI6 module, connect a separate cable from the unused XDC connector on the controller to the XDC1 connector on the sDIO module or sMI6 module.

    An On/Off switch turns the controller and the second 24 VDC power jack on or off.

    Any daisy-chained devices will be turned on or off with this switch.

    A ground screw is located immediately below the 24 VDC power jacks.

18. **Belt Encoder connector**

    This is a 26-pin D-Sub connector for up to four belt encoders in a conveyor-tracking installation. See Belt Encoder Interface on page 50 for more information.

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3.2 Front Panel

The following figure shows an Adept Front Panel.

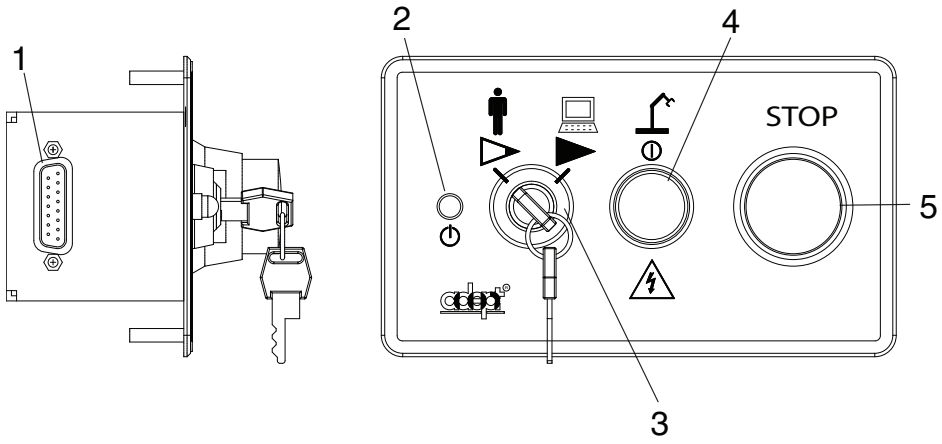


Figure 3-2. Front Panel

Before running programs, either the optional Adept Front Panel or user-supplied switches for High Power On/Off, MAN/AUTO, and E-Stop must be connected to the XFP connector on the Adept SmartController EX motion controller.

> **NOTE:** Safety regulations dictate the sequence of events required for the user to enable high power. For instance, a user may be required to press the High Power On button on the Front Panel after pressing the COMP/PWR button on the pendant or issuing the eV+ "enable power" command. Users cannot jumper this button input and still enable power (see your robot manual for further details).

1. **XFP connector**

   Connects to the XFP connector on the controller.

2. **System 5 V Power-On LED**

   Indicates whether or not power is connected to the controller.

3. **Manual/Automatic Mode Switch**

   Switches between Manual and Automatic mode. In Automatic mode, executing programs control the mechanism, and the mechanism can run at full speed.

   In Manual mode, the system limits mechanism speed and torque, to reduce the risk to an operator working in the cell. It is the user's responsibility to determine if this is allowed under local regulations. Manual mode initiates software restrictions on robot speed, commanding no more than 250 mm/sec as required by RIA and ISO standards. Please refer to your robot manual for further details.

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4. **High Power On/Off Switch & Lamp**

   Controls high power, which is the flow of current to the robot motors. Enabling high power is a two-step process. An "Enable Power" request must be sent from the user terminal, an executing program, or a pendant. Once this request has been made, the button light blinks, and the operator must press the button for high power to be applied. The default timeout for the button is 10 seconds

   NOTE: The default timeout period of 10 seconds is programmable, and can be changed or disabled, in which case the button does not blink, and does not need to be pressed to enable high power.

5. **Emergency Stop Switch**

   The E-Stop is a dual-channel, passive E-Stop that supports Category 3 CE safety requirements. It supports a customer-programmable E-Stop delay that maintains motor power for a programmed time after the E-Stop is activated. This customizable feature allows the motors to decelerate under servo control to a stop. This can aid in eliminating coasting or overshooting on low friction mechanisms. It can also aid in the reduction of wear on highly-geared, high-inertia mechanisms, while maintaining safety compliance per all standards.

Programming the E-Stop Delay

To set the programmable E-Stop delay from the Adept ACE software, go to the object editor for the robot, and enable Expert Access:

Object > Expert Access

NOTE: This requires a password to enable.

Once enabled, you will be able to see and modify the following three parameters (among others):

- Auto Mode E-Stop Shutdown Timeout
- Hold-to-Run E-Stop Shutdown Timeout
- Manual Mode E-Stop Shutdown Timeout

Each of these is the time, in seconds, after that mode E-Stop is asserted, in which eV+ is allowed to decelerate the robot, engage the brakes, and shut down power before the servo nodes automatically shut down power. The value can be set from 0 (immediate power-off) to 0.512 seconds. If the deceleration is too slow, or the brake-on delay too long, the servo will automatically cut power.

3.3 Installing the Adept ACE Software



WARNING: Make sure that all cables are installed correctly and fully inserted and screwed down before applying power to the system. Failure to do this could cause unexpected robot motion. Also, a connector could be pulled out or dislodged unexpectedly.

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You install Adept ACE software from the Adept Software CD-ROM. Adept ACE needs Microsoft .NET Framework. The Adept ACE Setup Wizard scans your PC for .NET, and installs it automatically, if needed.

1. Insert the CD-ROM into the CD-ROM drive of your PC. If Autoplay is enabled, the Adept Software CD-ROM menu is displayed - see Operation on page 27. If Autoplay is disabled, you will need to manually start the CD-ROM.

   NOTE: The online document that describes the installation process opens in the background when you select one of software installation steps below.

2. From the Adept Software CD-ROM menu, click Install the Adept ACE Software.
3. The Adept ACE Setup wizard opens.

   Follow the instructions as you step through the installation process.
4. When the install is complete, click Finish.
5. After closing the Adept ACE Setup wizard, click Exit on the CD-ROM menu and proceed to the Start-up Procedure.

NOTE: You will have to restart the PC after installing the Adept ACE software.

3.4 Configuring the SmartController

Configuring Serial Ports

The Adept SmartController EX motion controller has four serial I/O ports:

- RS-232/Term
- RS-422/485
- RS-232-1
- RS-232-2

See Connectors and Indicators on page 27 for the connector locations.

From the Adept ACE software:

1. Double-click on the controller in the tree structure pane.

   This opens the object editor for the controller.
2. Select **Configure > Configure eV+**.
3. Click Configuration.
4. Select SERIAL
5. Click Add, to create a new entry

   or

   Highlight an entry and click Edit, to modify the existing values.

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6. Set the values as appropriate for your port.
7. Click Accept.
8. Click Done.
9. Click Yes, to write the values to the eV+ system disk.
10. Click Yes to reboot the controller, so the values you just set will take effect.

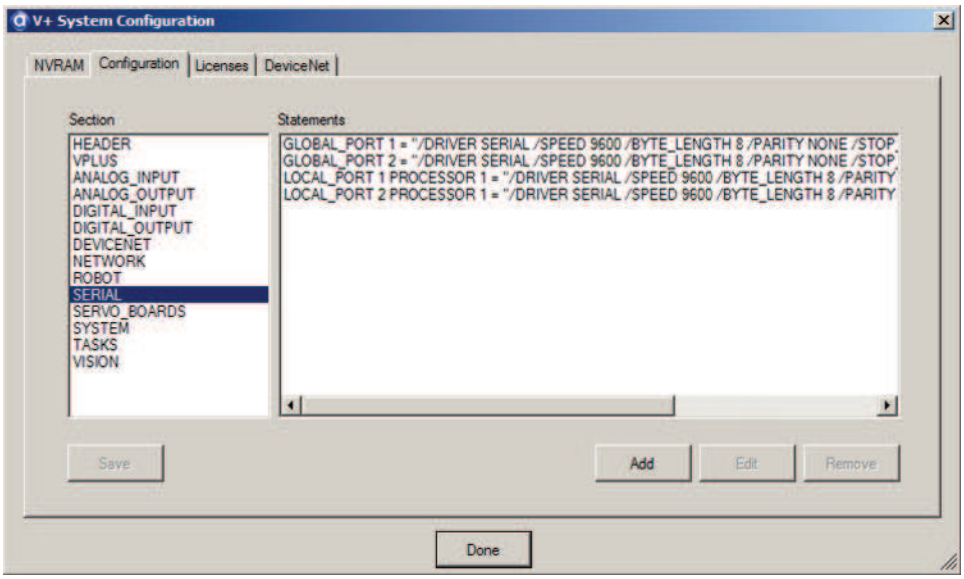


Figure 3-3. Configuring Serial Ports

RS-232 Connectors

All three types of RS-232 connectors are 9-pin DB9 male (standard PC) connectors. The user-supplied cable to connect to the RS-232 connectors should be a DB9, F/F, null-modem data-transfer cable. The pin assignments are the same for all three connectors and are shown in the following table.

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Table 3-3. RS-232 Connector Pin Assignments

Pin	RS-232-1 RS-232-2		RS-232/Term	
	Signal	Type	Signal	Type
1	Reserved	-	NC	-
2	RXD	Input	RXD	Input
3	TXD	Output	TXD	Output
4	Reserved	-	NC	-
5	GND	Ground	GND	Ground
6	Reserved	-	NC	-
7	RTS	Output	RTS	Output
8	CTS	Input	CTS	Input
9	Reserved	-	NC	-

These ports support the RTS, and CTS signals used for hardware handshaking (also known as modem control). By default, these signals are not enabled. To configure hardware handshaking and other communication parameters, use the Adept ACE software. The eV+ designations for these ports, when referenced in the eV+ ATTACH or FSET instructions, are shown in the following table.

NOTE: To configure the port speed and other communications parameters, use Adept ACE software.

Table 3-4. Serial Connectors and eV+ Designations

Connector	eV+ Designation
RS-422/485	LOCAL.SERIAL:1
RS-232/Term	LOCAL.SERIAL:2
RS-232-1	SERIAL:1
RS-232-2	SERIAL:2

RS-422/485 Connector

The RS-422/485 connector is a 9-pin DB9 male connector. The pin assignments are shown in the following table. RS-422 is a point-to-point protocol for connecting to a single destination. This port can also be configured as a multidrop port (RS-485).

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Table 3-5. RS-422/485 Connector Pin Assignments

Pin	Signal	Type
1	NC	
2	RXD+	Input
3	TXD+	Output
4	TXD-	Output
5	GND	Ground
6	RXD–	Input
7	NC	
8	EXPIO_5V	Output
9	GND	Ground

To change the configuration of the RS-422/485 port, see Configuring Serial Ports on page 33. See the previous table for the eV+ designation when referenced in the eV+ ATTACH or FSET instructions.

3.5 Connecting User-Supplied Safety and Power-Control Equipment

The user-supplied safety and power-control equipment connects to the system through the XUSR and XFP connectors on the controller. The XUSR connector (25-pin) and XFP (15-pin) connector are both female D-sub connectors located on the front panel of the controller. Refer to the following table for the XUSR pin-out descriptions. Refer to the table Contacts Provided by the XFP Connector on page 37 for the XFP pin-out descriptions. See the figure CAT-3 E-Stop Circuit on XUSR and XFP Connectors on page 40 for the XUSR wiring diagram.

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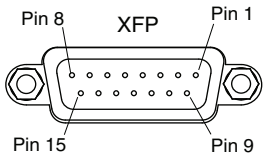
Table 3-6. Contacts Provided by the XUSR Connector

Pin Pairs	Description	Comments
Voltage-Free Contacts Provided by Customer		
1, 14	User E-Stop CH 1 (mushroom push-button, safety gates, etc.)	N/C contacts, Shorted if NOT Used
2, 15	User E-Stop CH 2 (same as pins 1, 14)	N/C contacts, Shorted if NOT Used
3, 16	Line E-Stop (used for other robot or assembly line E-Stop inter-connection. Does not affect E-Stop indication (pins 7, 20))	N/C contacts, Shorted if NOT Used
4, 17	Line E-Stop (same as pins 3, 16)	N/C contacts, Shorted if NOT Used
5, 18	Muted safety gate CH 1 (causes E-Stop in Automatic mode only)	N/C contacts, Shorted if NOT Used
6, 19	Muted Safety Gate CH 2 (same as pins 5, 18)	N/C contacts, Shorted if NOT Used
Voltage-Free Contacts provided by Adept		
7, 20	E-Stop indication CH 1	Contacts are closed when Front Panel, pend-ant, and customer E-Stops are *not* tripped
8, 21	E-Stop indication CH 2 (same as pins 7, 20)	Contacts are closed when Front Panel, pend-ant, and customer E-Stops are *not* tripped
9, 22	Manual/Automatic indication CH 1	Contacts are closed in Automatic mode
10, 23	Manual/Automatic indication CH 2	Contacts are closed in Automatic mode
11, 12, 13, 24, 25	No connection	

Table 3-7. Contacts Provided by the XFP Connector

Pin Pairs	Description	Requirements for User-Supplied Front Panel
Voltage-Free Contacts Provided by Customer		
1, 9	Front Panel E-Stop CH 1	User must supply N/C con-tacts
2, 10	Front Panel E-Stop CH 2	User must supply N/C con-tacts
3, 11	Remote Manual/Automatic switch CH 1. Manual = Open Automatic = Closed	Optional - jumper closed for Auto Mode-only operation

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Pin Pairs	Description	Requirements for User-Supplied Front Panel
4, 12	Remote Manual/Automatic switch CH 2. Manual = Open Automatic = Closed	Optional - jumper closed for Auto Mode-only operation
6, 14	Remote High Power on/off momentary push-button	User must supply momentary push-button to enable High Power to system
Non-voltage-Free Contacts		
5, 13	Adept Supplied 5 VDC and GND for High Power On/Off Switch Lamp	User must supply lamp, or use 1 W, 47 ohm resistor - system will not operate if not present
7, 15[a]	Controller system 5 V power on LED, 5 V, 20 mA	Optional - indicator only
8	No connection	
		
See the figure Front Panel Schematic on page 41 for a schematic diagram of the Adept Front Panel.		
[a]Users must exercise caution to avoid inadvertently connecting 24 V signals to these pins, because this will damage the electronics.		

NOTE: The system was evaluated by Underwriters Laboratory with an Adept Front Panel. If you provide a substitute Front Panel, this could void UL compliance.

Table 3-8. Remote Pendant Connections on the XMCP Connector

Pin XMCP (15-Pin D-Sub)	Description
1, 9	Pendant E-Stop Push-button CH 1
2, 10	Pendant E-Stop Push-button CH 2
3, 11	Pendant Enable CH 1 (Hold-to-run)
4, 12	Pendant Enable CH 2 (Hold-to-run)
13	Serial GND/Logic GND
7	Pendant TXD: “eV+ to Pendant TXD”
8	Pendant RXD: “eV+ to Pendant RXD”
14	No connection

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Pin XMCP (15-Pin D-Sub)	Description
15	No connection
Shield	Shield GND
6	24 V
5	No connection

Table 3-9. XSYS Connector Pin Assignments

Pin	Signal	Description
1	ESTOPGND	GND Return
2	MANUAL1	Manual Mode ESTOP Ckt. CH 1
3	MANUAL2	Manual Mode ESTOP Ckt. CH 2
4	HIPWRDIS	High Power Disable
5	HIPWRREQ	High Power Request
6	AUTO1	Auto Mode ESTOP Ckt. CH 1
7	AUTO2	Auto Mode ESTOP Ckt. CH 2
8	N/C	No Connection
9	ESTOPSRC	24 V Output to Slave ESTOP

NOTE: The XSYS connector is used to link the E-Stop system to Adept robots. It is not intended for customer connections.

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The following figure shows an E-Stop diagram for the Adept SmartController EX motion controller. See Introduction on page 9 for a description of the functionality of this circuit.

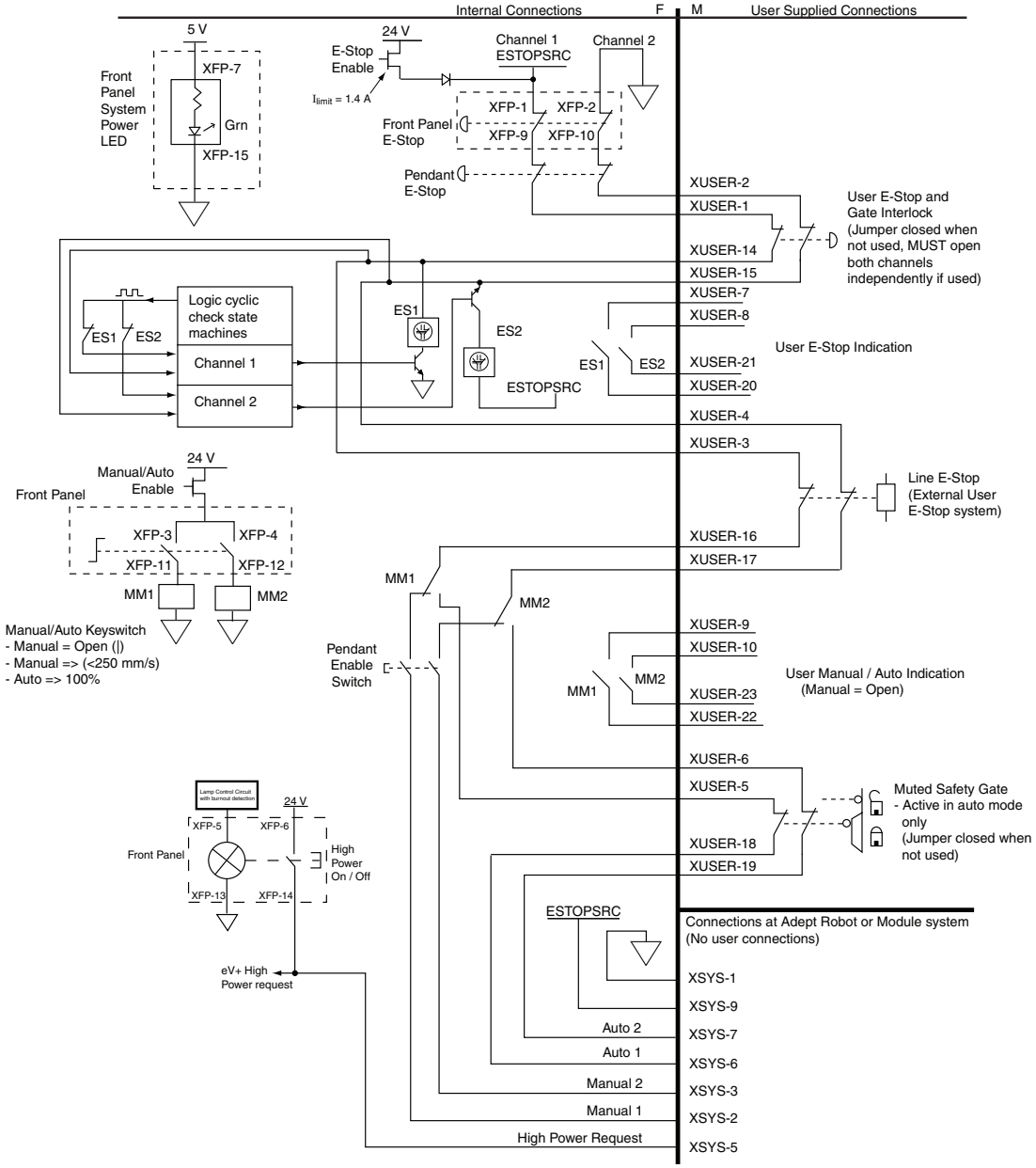


Figure 3-4. CAT-3 E-Stop Circuit on XUSR and XFP Connectors

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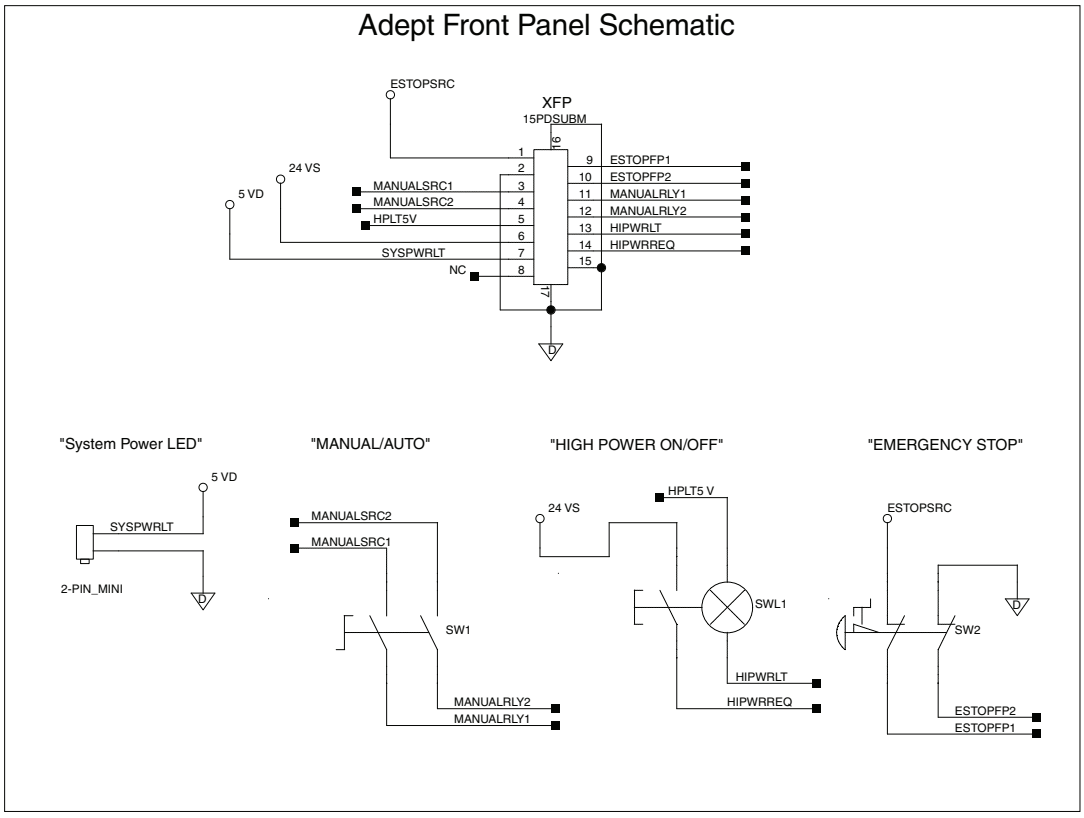


Figure 3-5. Front Panel Schematic

Emergency Stop Circuits

The Adept SmartController EX motion controller provides connections for Emergency Stop (E-Stop) circuits on the XUSR and XFP connectors. This gives the controller system the ability to duplicate E-Stop functionality from a remote location using voltage-free contacts. See the figure CAT-3 E-Stop Circuit on XUSR and XFP Connectors on page 40.

The XUSR connector provides external two-channel E-Stop input on pin pairs 1, 14 and 2, 15. The XFP connector provides two-channel E-Stop input on pin pairs 1, 9 and 2, 10.

> **NOTE:** These pins must be shorted if not used. Both channels must open independently if used. Although an Emergency Stop will occur, the controller will flag an error state if one channel is jumpered closed and the other channel is opened. It will also flag an error state if the channels are shorted together.

User E-Stop Indication - Remote Sensing of E-Stop

A method has been provided to indicate the status of the ESTOP chain, inclusive of the Front Panel Emergency Stop push-button, the pendant Emergency Stop push-button, and the User Emergency Stop Contacts.

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NOTE: These contacts do not indicate the status of any connections below the User E-Stop contacts. Thus, they will NOT indicate the status of the Line E-Stop, MCP ENABLE, or the Muted Safety gate. If you have a specific need in this area, contact Adept Customer Service for information on alternate indicating modes.

Two pairs of pins on the XUSR connector (pins 7, 20 and 8, 21) provide voltage-free contacts, one for each channel, to indicate whether the E-Stop chain, as described above, on that channel is closed. Both switches are closed on each of the redundant circuits in normal operation (no E-Stop). The user may use these contacts to generate an E-Stop for other equipment in the workcell. The load on the contacts must not exceed 40 VDC or 30 VAC at a maximum of 1 A.

These voltage-free contacts are provided by a redundant, cyclically-checked, positive-drive, safety relay circuit for Category 3 operation (see the figure CAT-3 E-Stop Circuit on XUSR and XFP Connectors on page 40 and the table Contacts Provided by the XFP Connector on page 37 for the customer E-Stop circuitry).

Line E-Stop Input

The XUSR connector on the controller contains a two-channel Line E-Stop input for workcell or other equipment emergency-stop inputs. Generally, the customer E-Stop Indication contact outputs are used to generate an emergency stop in such external equipment. Thus, if one were to wire the same equipment's outputs into the customer E-Stop input (that is, in series with the local robot's E-Stop push-buttons), a lock-up situation could occur.

The Line E-Stop input comes into the circuit at a point where it cannot affect the customer E-Stop indication relays and will not cause such a lock-up situation. For any situation where two systems should be "cross-coupled", for example, the customer E-Stop indication of one controller is to be connected to the input of another controller, the Line E-Stop input is the point to bring in the other controller's output contacts. See the figure CAT-3 E-Stop Circuit on XUSR and XFP Connectors on page 40 for more information.

Do not use the Line E-Stop for such devices as local E-Stop push-buttons, since their status should be reported to the outside on the local customer E-Stop indication output contact while the Line E-Stop inputs will not.

Muted Safety Gate E-Stop Circuitry

Two pairs of pins on the XUSR connector (pins 5, 18 and 6, 19) provide connections for a safety gate designed to yield an E-Stop allowing access to the workspace of the robot in Manual mode only, not in Automatic mode. It is up to the customer to determine if teaching the robot in Manual Mode, by a skilled programmer (See "Qualification of Personnel" in the *Adept Robot Safety Guide*), wearing safety equipment and carrying an Adept pendant, is allowable under local regulations. The E-Stop is said to be "muted" in Manual mode (for the customer E-Stop circuitry, see the figures and tables at the beginning of the section Connecting User-Supplied Safety and Power-Control Equipment on page 36).

The muted capability is useful for a situation where a shutdown must occur if the cell gate is opened in Automatic mode, but you need to open the gate in Manual mode. If the mute gate is opened in Automatic mode, the robot defaults to Manual mode operation when power is re-enabled. In muted mode, the gate can be left open for personnel to work in the robot cell. However, safety is maintained because of the speed restriction.

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CAUTION: If you want the cell gate to always cause a robot shutdown, wire the gate switch contacts in series with the user E-Stop inputs. Do not wire the gate switch into the muted safety gate inputs.

Remote Manual Mode

The Front Panel provides for a Manual Mode circuit. See Remote High Power On/Off Control and your robot manual for further details about the customer Remote Manual Mode circuitry.

The Adept Front Panel, or the user-supplied panel, must be incorporated into the robot workcell to provide a "Single Point of Control" (the pendant) when the controller is placed in Manual mode. Certain workcell devices, such as PLCs or conveyors, may need to be turned off when the operating mode switch is set to Manual mode. This is to ensure that the robot controller does not receive commands from devices other than from the pendant, the single point of control.

If the user needs to control the Manual/Automatic mode selection from other control equipment, then a custom splitter cable or complete replacement of the Adept Front Panel may be required. See Front Panel Schematic on page 41. In this situation, a pair of contacts should be wired *in series* with the Adept Front Panel Manual/Automatic mode contacts. Thus, both the Adept Front Panel and the customer contacts need to be closed to allow Automatic mode.



WARNING: Do not wire user-supplied Manual/Automatic contacts in parallel with the Adept Front Panel switch contact. This would violate the "Single Point of Control" principle and might allow Automatic (high-speed) mode to be selected while an operator is in the cell.

User Manual/Auto Indication

Two pairs of pins on the XUSR connector (pins 9, 22 and 10, 23) provide a voltage-free contact to indicate whether the Front Panel and/or remote Manual/Automatic switches are closed. The user may use these contacts to control other mechanisms (for example, conveyor, linear modules, etc.) when Manual mode is selected. The load on the contacts should not exceed 40 VDC or 30 VAC at a maximum of 1 A.

User High Power On Indication

In the Adept SmartController EX motion controller, eV+ controls a normally-open relay contact on the XDIO connector (pins 45, 46, see the table XDIO Digital I/O Connector Pin Assignments on page 49), that will close when high power has been enabled. The user can use this feature to power an indicator lamp or other device, that signals High Power is On. The limit on these contacts is 1 A at 30 VDC or 30 VAC.`

Remote High Power On/Off Control

The easiest and most effective way to provide the high power on/off control in a remote location is to mount the Adept Front Panel in the desired location with an extension cable.

However, if the user needs to control high power on/off from other control equipment or from a location other than the Adept Front Panel, then a custom splitter cable will be required. See the Front Panel schematic (Front Panel Schematic on page 41) for details of the Front Panel's

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wiring. In this situation, a second momentary contact for high power on/off would be placed *in parallel with* the Adept Front Panel push-button contact. This second contact should be suppressed when in Manual mode (see the note on "Single Point of Control" below).

This method allows relocating the push-button switch to a more convenient location. Implementation of this method must conform to EN standard recommendations.

> **NOTE**: European standards require that the remote High Power push-button be located outside of the workspace of the robot.

Pins 6, 14 and 5, 13 of the XFP connector provide this remote capability. Pins 5, 13 provide power for the lamp, +5 VDC and ground, respectively. Pins 6, 14 are inputs for voltage-free normally-open contacts from a user-supplied momentary push-button switch.



WARNING: To fulfill the "Single Point of Control" requirement, do not place the Manual/Automatic and High Power On controls in multiple locations. After putting the robot into Manual mode, the operator should remove the key for safety purposes. The system should not be wired so that a PLC or another operator can put the system back into Automatic mode.

High Power On/Off Lamp

The Front Panel High Power On/Off Lamp (P/N: 27400-29006) will cause an error, from eV+, if the lamp burns out. This error prevents High Power from being turned on. This safety feature prevents a user from not realizing that High Power is enabled because the High Power indicator is burned out. See Changing the Lamp in the Front Panel High-Power Indicator on page 55 for information on changing this lamp.

Remote Front Panel or User-Supplied Control Panel Usage

Users can mount the Front Panel remotely by using an extension cable or by wiring a user-supplied Front Panel (control panel) to the controller using the 15-pin XFP connector. The Front Panel contains no active components, only switches and lights. Customers should be able to adapt the Front Panel's functionality into their own Front Panel design. To automatically control the Front Panel's signals, use relay contacts instead of switches. See the figure Front Panel Schematic on page 41 for a schematic drawing of the Front Panel, and see the table Contacts Provided by the XFP Connector on page 37 for a summary of connections and pin numbers.

> **NOTE:** The system was evaluated by Underwriters Laboratory with an Adept Front Panel. If you provide a substitute Front Panel, the system may no longer be UL compliant.

Customers can build an extension cable to place the Front Panel in a remote location. The extension cable must conform to the following specifications:

- Wire Size: must be larger than 26 AWG.
- Connectors: must be 15-pin, standard D-sub male and female.
- Maximum cable length is 10 meters.

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NOTE: The XMCP and XFP connectors on the controller can be interchanged without electrical damage. However, neither the Front Panel nor the pendant will work properly unless they are plugged into the correct connector.

Remote Pendant Usage

Customers can build an extension cable to place the pendant in a remote location. The extension cable must conform to the following specifications:

- Wire Size: must be larger than 26 AWG.
- Connectors: must be 15-pin, standard D-sub male and female.
- Maximum cable length is 10 meters.



CAUTION: Do not modify the cable that is attached to the pendant. This could cause unpredictable behavior from the robot system.

3.6 Connecting User-Supplied Digital I/O Equipment

The controller contains two options for connecting Inputs and Outputs (I/O). I/O can be hard-wired to the XDIO and/or Controller Area Network (CAN) connectors.

DeviceNet Connector

The DeviceNet connector on the controller is used to interface to a CAN using the DeviceNet protocol. See Adept DeviceNet on page 85 for details.

XDIO Connector

The XDIO connector on the Adept SmartController EX motion controller is a 50-pin, standard density D-Sub female connector (see SmartController EX Connectors and Indicators on page 27 for location). There are 12 inputs and 8 outputs, each optically isolated from the circuitry of the controller. The signals are numbered 1001 through 1012 for the inputs and 1 through 8 for the outputs. All the signals have independent source and ground connections. These inputs contain the four high-speed inputs that are used by the system for interrupts and latching. The outputs, although independent, have a lower current rating of 100 mA compared to 700 mA for the extended outputs on the sDIO module (described in sDIO Module on page 61). See the *eV+ Language User's Guide* for information on digital I/O programming.

The connector also provides 24 V pins for powering customer equipment. There are four 24 V pins and four ground pins, which are limited to a total of 1 A of current. The source of the 24 V is the XDC connector on the front of the controller.

Input Signals

The XDIO connector handles input signals 1001 to 1012. Each channel has an input and a corresponding return line. See the following table for input specifications. The connector pin-outs are shown in the table XDIO Digital I/O Connector Pin Assignments on page 49.

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