Adept Cobra i600/i800 Robot

User's Guide

adept®

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User's Guide

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1 Introduction

1.1 Product Description

Adept Cobra i600/i800™ Robots

The Adept Cobra i600 and i800 robots are four-axis SCARA robots (Selective Compliance Assembly Robot Arm). See the following figure. Joints 1, 2, and 4 are rotational; Joint 3 is translational. See **Figure 1-2** for a description of the robot joint locations.

The Adept Cobra i-series robots are programmed and controlled using Adept ACE™ software, running on a user-supplied PC. Mechanical specifications for the Adept Cobra i-series robots are provided in **Chapter 7**.

> **NOTE:** The descriptions and instructions in this manual apply to both the Cobra i600 and the Cobra i800, except for instances where there is a difference, as in dimension and work envelope drawings. In those cases the information is presented for both robots.

Figure 1-1. Adept Cobra i800 Robot

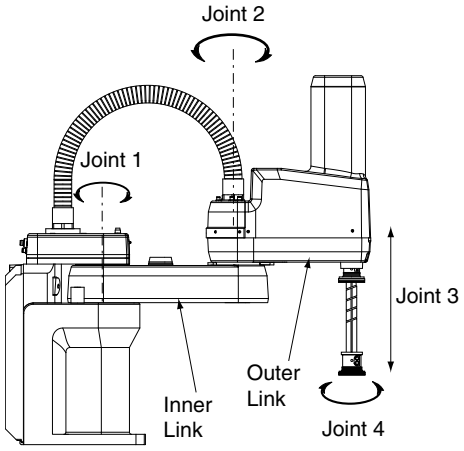


Figure 1-2. Robot Joint Motions

Adept Amps-in-Base (AIB™)

The amplifiers for the Adept Cobra i-series robots are embedded in the base of the robot. This amplifier section is known as the AIB (amp-in-base). It provides power amplifiers and full servo control.

Adept AIB features:

- On-board digital I/O
- Low EMI for use with noise-sensitive equipment
- No external fan for quiet robot operation
- 8 kHz servo rate delivers low positional errors and superior path following
- Sine wave commutation lowers cogging torque and improves path following
- Digital feed-forward design maximizes efficiency, torque, and velocity
- Temperature sensors for all amplifiers and motors for maximum reliability and easy troubleshooting

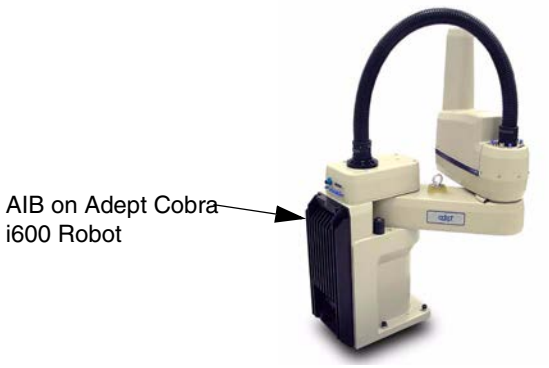


Figure 1-3. Adept AIB

1.2 Dangers, Warnings, Cautions, and Notes

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

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 injury or major damage to the equipment.

WARNING: This indicates a potentially hazardous situation which, if not avoided, could result in 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: An Adept Cobra i600/i800 robot can cause serious injury or death, or damage to itself 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 respo nsibilities in regard to the robot.
- 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 robot is installed.

- The robot system must not be used for purposes other than described in **Section 1.6**. 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.
- 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 CO_2 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 15.**

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" on page 16.**

1.6 Intended Use of the Robots

The Adept Cobra i600 and i800 robots are intended for use in parts assembly and material handling for payloads less than 5.5 kg (12.1 lb).

1.7 Installation Overview

The system installation process is summarized in the following table. Refer also to the system cable diagram in **Figure 3-1 on page 24**.

> **NOTE:** The *Adept Cobra i600/i800 Robot Quick Setup Guide* provides abbreviated instructions on installing your robot system.

Table 1-1. Installation Overview

Task to be Performed	Reference Location
1. Mount the robot on a flat, secure mounting surface.	See Section 2.5 on page 19.
2. Install the system cables and options.	See Section 3.3 on page 25.
3. Connect the PC to the robot.	See Section 3.4 on page 25.
4. Install Adept ACE software on the PC.	See the *Adept Cobra i600/i800 Robot Quick Setup Guide*.
5. Create a 24 VDC cable and connect it between the robot and the 24 VDC power supply.	See Section 3.6 on page 29.
6. Create a 200-240 VAC cable and connect it between the robot and the facility AC power source.	See Section 3.7 on page 31.
7. Install user-supplied safety barriers in the workcell.	See Section 3.9 on page 35.
8. Read Chapter 4 to learn about connecting digital I/O through the XIO connector on the robot.	See Section 4.5 on page 41.
9. Read Chapter 4 to learn about turning on the system and testing operation.	See Section 4.8 on page 55.
10. Read Chapter 6 if you need to install optional equipment, including end-effectors, user air and electrical lines, external equipment, solenoids, etc.	See Section 6.1 on page 71.

1.8 Manufacturer's Declaration

The Manufacturer's Declaration of Incorporation and Conformity lists all standards with which the Adept robot system complies. It can be found on the Adept Web site, in the Download Center of the Support section.

ftp://ftp1.adept.com/Download-Library/Manufacturer-Declarations/

Each Manufacturer's Declaration is supplied in PDF format and stored on the website in a ZIP archive. To access the PDF document:

1. Click on the appropriate .zip file. You are prompted to Open or Save the file.
2. Click Open to open the file and display the archive contents.
3. Double-click on a .pdf file to open it.

1.9 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. Additionally, you can access information sources on Adept's corporate web site:

http://www.adept.com

- 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/

Related Manuals

This manual covers the installation, operation, and maintenance of an Adept Cobra i600/i800 robot system. There are additional manuals that cover programming the system, reconfiguring installed components, and adding other optional components; see **Table 1-2**. These manuals are available on the Adept Document Library CD-ROM shipped with each system.

Table 1-2. Related Manuals

Manual Title	Description
Adept Robot Safety Guide	Contains safety information for Adept robots.
Adept Cobra i600/i800 Robot Quick Setup Guide	Describes the installation and start-up of your Adept Cobra i600/i800 robot. Includes Adept ACE installation on your PC.
Adept ACE User Guide	Describes the Adept ACE environment and configuration of an Adept control system.
MicroV+ User Guide	Describes the MicroV+™ operating system, including terminal setup, monitor commands, example programs, and error codes.

Adept Document Library

The Adept Document Library (ADL) contains documentation for Adept products. You can access the ADL from:

- the Adept Software CD shipped with your system

  or

- the Adept Web site. Select **Support > Document Library** from the Adept home page. To go directly to the Adept Document Library, type the following URL into your browser:

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

To locate information on a specific topic, use the Document Library search engine on the ADL main page. To view a list of available product documentation, select the Active Documents option.

2 Robot Installation

2.1 Transport and Storage

This equipment must be shipped and stored in a temperature-controlled environment, within the range –25° to +55° C (-13° to +131° F). The recommended humidity range is 5 to 90 percent, non-condensing. 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 excessive shock and vibration.

Use a forklift, pallet jack, or similar device to transport and store the packaged equipment (see **Figure 2-1**).

The robot must always be stored and shipped in an upright position in a clean, dry area that is free from condensation. Do not lay the crate on its side or any other non-upright position: this could damage the robot.

The i600 robot weighs 41 kg (90 lb) and the i800 weighs 43 kg (95 lb) with no options installed.

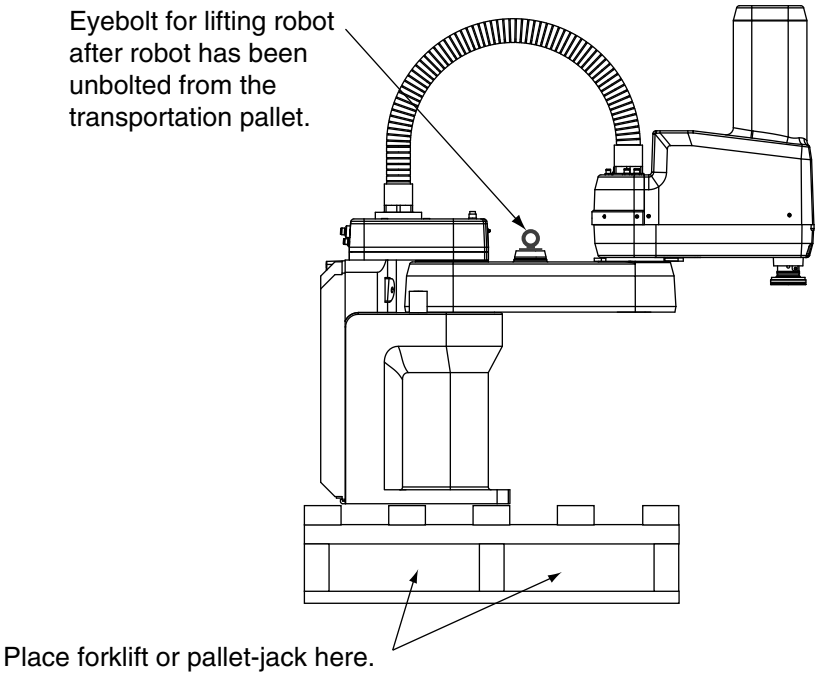


Figure 2-1. Cobra Robot on a Transportation Pallet

2.2 Unpacking and Inspecting the Adept Equipment

Before Unpacking

Carefully inspect all shipping crates for evidence of damage during transit. Pay special attention to any tilt and shock indication labels on the exteriors of the containers. If any damage is indicated, request that the carrier's agent be present at the time the container is unpacked.

Upon Unpacking

Before signing the carrier's delivery sheet, please 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 and free of visible damage.

If the items received do not match the packing slip, or are damaged, do **not** sign the receipt. Contact Adept as soon as possible.

If the items received do not match your order, please contact Adept immediately.

Inspect each item for external damage as it is removed from its container. If any damage is evident, contact Adept (see **Section 1.9 on page 16**).

Retain all containers and packaging materials. These items may be necessary to settle claims or, at a later date, to relocate equipment.

2.3 Repacking for Relocation

If the robot or other equipment needs to be relocated, reverse the steps in the installation procedures that follow. Reuse all original packing containers and materials and follow all safety notes used for installation. Improper packaging for shipment will void your warranty. Before unbolting the robot, fold the outer arm against the Joint 2 hardstops to help centralize the center of gravity. The robot must always be shipped in an upright orientation. Specify this to the carrier if the robot is to be shipped.

CAUTION: Before unbolting the robot from the shipping pallet, fold the outer arm against the Joint 2 hardstops to help centralize the center of gravity. The robot must always be shipped in an upright orientation.

2.4 Environmental and Facility Requirements

The Adept robot system installation must meet the operating environment requirements shown in Table 2-1.

Table 2-1. Robot System Operating Environment Requirements

Ambient temperature	5° to 40° C (41° to 104° F)
Humidity	5 to 90%, non-condensing
Altitude	up to 2000 m (6500 ft)
Pollution degree	2
Robot protection class	IP-20 (NEMA Type 1)
NOTE: See Section 7.1 on page 91 for robot dimensions.	

2.5 Mounting the Robot

Mounting Surface

The Adept Cobra i600 and i800 robots are designed to be mounted on a smooth, flat, level surface. The mounting structure must be rigid enough to prevent vibration and flexing during robot operation. Adept recommends a 25 mm (1 in.) thick steel plate mounted to a rigid steel tube frame. Excessive vibration or mounting flexure will degrade robot performance. Figure 2-2 shows the mounting hole pattern for the Adept Cobra i-series robots.

> **NOTE:** On the underside of the base there is a hole and a slot that can be used as locating points for user-installed dowel pins in the mounting surface; see Figure 2-2. Using locating pins can improve the ability to remove and reinstall the robot in the same position.

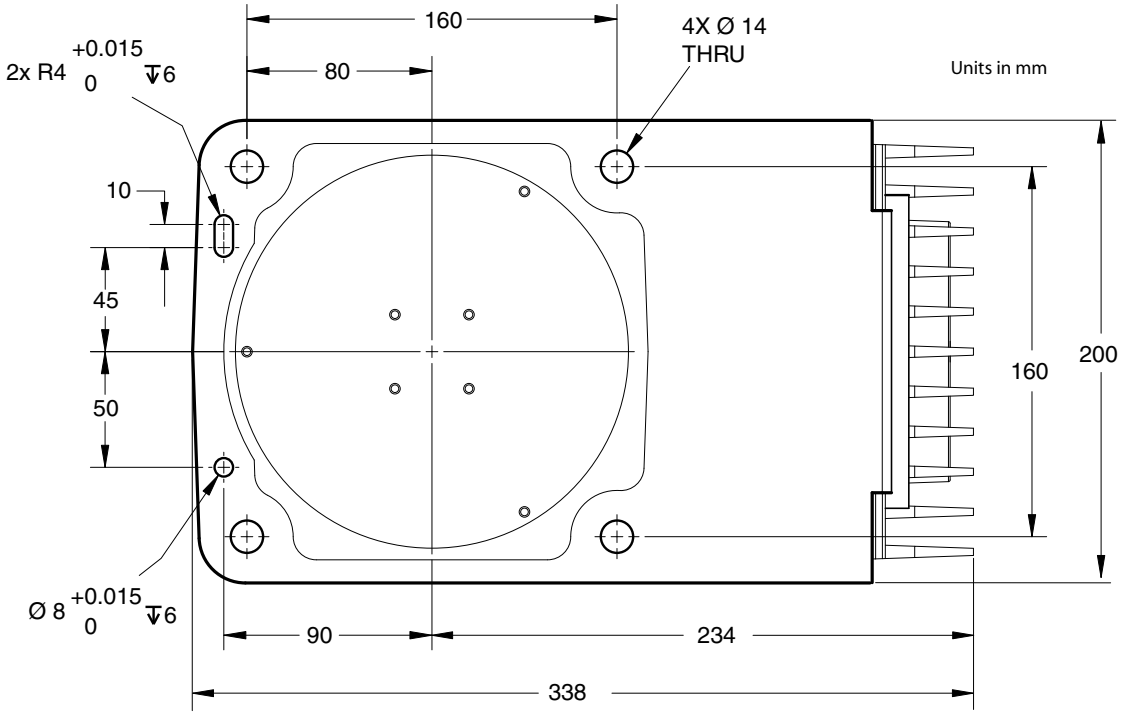


Figure 2-2. Mounting Hole Pattern for Robot

Robot Mounting Procedure

1. Using the dimensions shown in **Figure 2-2**, drill and tap the mounting surface for four M12 - 1.75 x 36 mm (or 7/16 - 14 UNC x 1.50 in.) machine bolts (bolts not provided). See **Table 2-2** for bolt and torque specifications.
2. While the robot is still bolted to the transportation pallet, connect the hydraulic lift to the eyebolt at the top of the inner link (see **Figure 2-1 on page 17**). Take up any slack, but do not lift the robot at this time.

WARNING: Do not attempt to lift the robot at any points other than the eyebolt provided. Do not attempt to extend the outer link of the robot until the robot has been secured in position. Failure to comply could result in the robot falling and causing either personnel injury or equipment damage.

3. Remove the four bolts securing the robot base to the pallet. Retain these bolts for possible later relocation of the equipment.
4. Lift the robot and position it directly over the mounting surface.
5. Slowly lower the robot while aligning the base and the tapped mounting holes in the mounting surface.

NOTE: The base casting of the robot is aluminum and can easily be dented if bumped against a harder surface. Verify that the robot is mounted squarely (will not rock back and forth) before tightening the mounting bolts.

6. Install the user-supplied mounting bolts and washers. Tighten the bolts to the torque specified in **Table 2-2**.

WARNING: The center of mass of the robot may cause the robot to fall over if the robot is not secured with the mounting bolts.

NOTE: Check the tightness of the mounting bolts one week after initial installation, and then recheck every 6 months. See **Chapter 5** for periodic maintenance.

Table 2-2. Mounting Bolt Torque Specifications

Standard	Size	Specification	Torque
Metric	M12 x P1.75	ISO Property Class 8.8	85 N·m
SAE	7/16-14 UNC	SAE Grade 5	63 lbf·ft

2.6 Connectors on the Robot Interface Panel

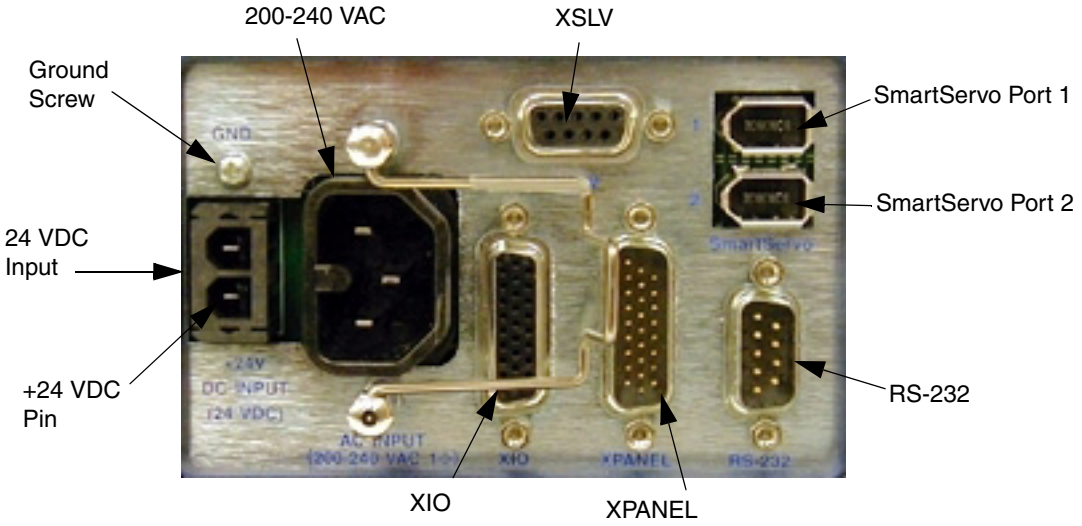


Figure 2-3. Robot Interface Panel

24 VDC - for connecting user-supplied 24 VDC power to the robot. The mating connector is provided.

Ground Screw - for connecting cable shield from user-supplied 24 VDC cable.

200/240 VAC - for connecting 200-240 VAC, single-phase, input power to the robot. The mating connector is provided.

XSLV - not used in a Cobra i600/i800 robot system.

SmartServo 1/2 - not used in a Cobra i600/i800 robot system.

RS-232 - for connecting a user-supplied computer, running Adept ACE software. (DB-9, male).

XPANEL - for connecting the AIB XPANEL cable. The AIB XPANEL cable has connectors for the Front Panel (XFP), T2 pendant (XMCP), and user IO (XUSR). (DB26, high density, male).

XIO - for user I/O signals for peripheral devices. This connector provides 8 outputs and 12 inputs. See **Section 4.6 on page 43** for connector pin allocations for inputs and outputs. That section also contains details on how to access these I/O signals via MicroV+. (DB26, high density, female). The optional XIO Termination Block connects here. This device provides a termination block for I/O connections, plus status LEDs and switches to test I/O signals.

3 System Installation

3.1 Cable and Parts List

Part	Cable and Parts List	Part #	Part of:	Notes
A	AIB XPANEL Cable - for connecting XUSR, Front Panel, and optional T2 pendant to the robot	04715-000	04081-000	Standard, iCobra
B	XUSR Jumper Plug	04736-000	04081-000	Standard, iCobra
C	Front Panel	30356-10358	90356-10358	Standard, iCobra
D	Front Panel Cable	10356-10500	90356-10358	Standard, iCobra
E	XMCP Jumper Plug	04737-000	04081-000	Standard, iCobra
F	T1/T2 Bypass Plug	05004-000	04965-203/ 04965-210	T2 option - 3 m/10 m
G	T1/T2 Adapter Cable	05002-000		
H	T2 (optional)	05215-103/ 05215-110		
J	AC Power Cable - to supply AC power to robot			User-supplied
K	24 VDC Power Cable - to supply 24 VDC to robot			User-supplied
L	24 VDC, 6 A Power Supply			User-supplied
	AC Power Cable - to supply AC power to 24 VDC Power Supply			User-supplied
M	RS-232 Null Modem Serial Cable, 5 meter, for connecting user-supplied PC to robot	04116-001	90565-000	Standard, iCobra

3.2 System Cable Diagram

Installation Procedure		
Step	**Step Description**	**Part(s)**
1	Connect AIB XPANEL cable to XPANEL on Interface Panel.	A
2	Verify XUSR jumper plug is installed on XUSR connector.	B
3	Connect Front Panel cable to Front Panel and XFP connector.	C, D
4	If no T2, install XMCP jumper or T1/T2 bypass plug. Skip to 5.	E, F
4a	If you have T2, connect T1/T2 adapter cable to XMCP connector.	G, H
5	Connect user-supplied ground. See Section 3.8 on page 34 for locations.	-
6	Connect 200-240 VAC to AC Input on Interface Panel, secure with clamp.	J
7	Connect 24 VDC to DC Input on Interface Panel. (May need AC cable.)	K, L
8	Connect null modem serial cable to Interface Panel and serial port on PC.	M

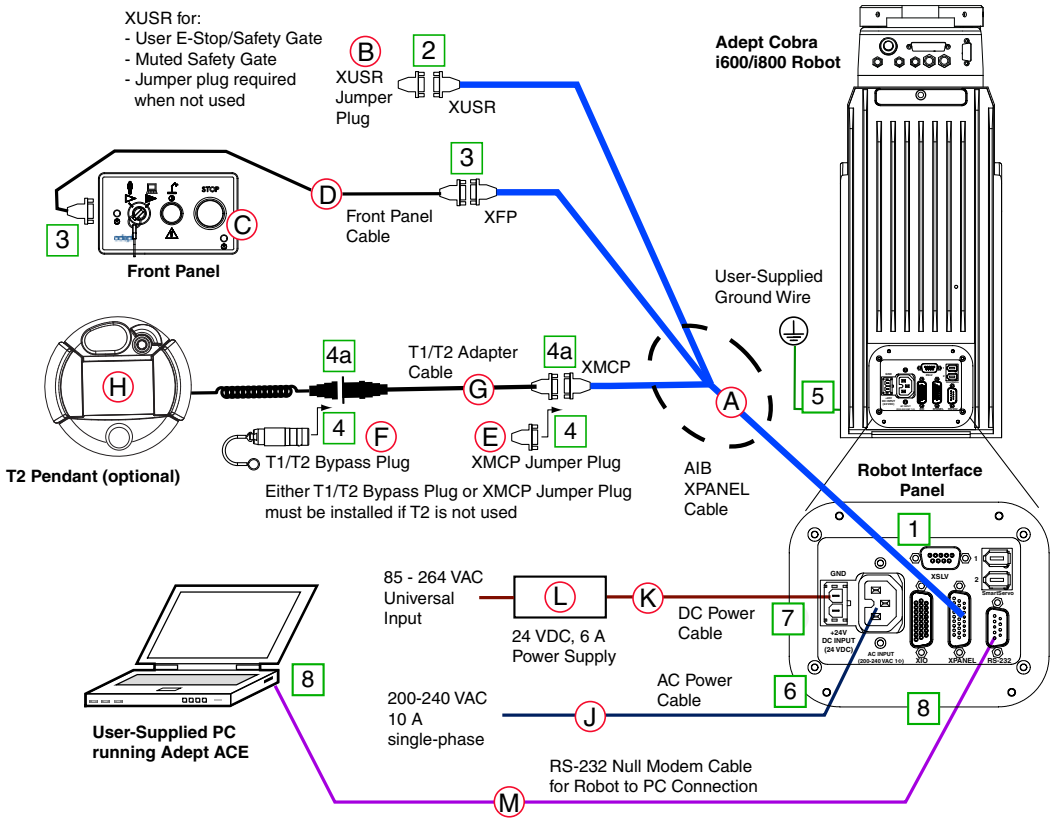


Figure 3-1. iCobra System Cable Diagram

3.3 Cable Connections to the Robot

Installing AIB XPANEL Cable

1. Locate the AIB XPANEL cable. It is shipped in the Accessory Kit.
2. Plug the single end of the AIB XPANEL cable into the XPANEL connector on the robot interface panel. See **Figure 3-1 on page 24**. The AIB XPANEL cable has these connectors on the opposite ends: XUSR, XFP, and XMCP.

   NOTE: The plastic molding on each connector is labeled for identification.

Installing Peripherals and Options

See **Figure 3-1 on page 24** when installing these items.

1. Verify that the XUSR jumper plug is installed on the XUSR connector, or that user-supplied E-Stop devices are installed. See **Section 4.7 on page 49** for information on connecting user-supplied E-Stop devices and safety circuits to the XUSR connector.
2. Connect the Front Panel cable to the XFP connector on the AIB XPANEL cable.
3. Connect the other end of the Front Panel cable to the Front Panel.
4. If you are not using the optional T2 pendant, verify that:
   - The XMCP Jumper Plug is installed in the XMCP connector of the AIB XPANEL cable

     or

   - The T1/T2 Bypass Plug is plugged into the S1 end of the T1/T2 Adapter Cable, and the Adapter Cable is plugged into the AIB XPANEL cable.
5. If your system uses the optional T2 pendant, follow these steps.
   a. Remove the XMCP jumper plug from the XMCP connector on the AIB XPANEL cable.
   b. Plug the T1/T2 Adapter Cable into the XMCP connector of the AIB XPANEL cable.
   c. Connect the T1/T2 Adapter Cable to the matching connector on the T2.

3.4 Connecting User-Supplied PC to Robot

The Adept Cobra i600/i800 robots must be connected to a user-supplied PC for setup, control, and programming. The user loads the Adept ACE software onto the PC and connects it to the robot via an RS-232 serial cable.

PC Requirements

To run and use Adept ACE software, the following hardware and software are required.

> **NOTE:** The specifications are also listed in the ACE PackXpert Datasheet, available on the Adept corporate web site.

Hardware

- **Processor**: Core2Duo 2.0 GHz or better
- **Disk Space**: 500 MB recommended minimum
- **RAM**: 2 GB or more
- **Monitor**: SVGA, minimum resolution 800 x 600
- **Ethernet**: (if using vision) IEEE 1394 or Gigabit-Ethernet support

  Adept recommends using the Adept SmartVision™ EX vision processor
- **Serial cable**: A standard, null modem, shielded, RS-232 data transfer serial cable, DB-9 female connectors on both ends (supplied by Adept)

Software

- **Operating System**: Microsoft Vista (32-bit), Microsoft Windows® XP with Service Pack 2, Microsoft Windows® Server™ 2003 with Service Pack 1, or Microsoft Windows® 2000 with Service Pack 4
- Microsoft .NET Framework 2.0 or later (included in the installation of the Adept ACE installer)
- Microsoft Internet Explorer version 5.01 or later (necessary for viewing Online help)

Installing Serial Cable

1. Locate the RS-232 null modem serial cable that is included in the Accessory Kit.
2. Connect one end of the serial cable to the RS-232 connector on the robot interface panel. See **Figure 3-1 on page 24**.
3. Connect the other end of the cable to a serial port on the PC.
   Serial ports are also referred to as COM ports.

3.5 Installing Adept ACE Software

You install Adept ACE 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 it is not already installed.

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 **Figure 3-2**. 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**.

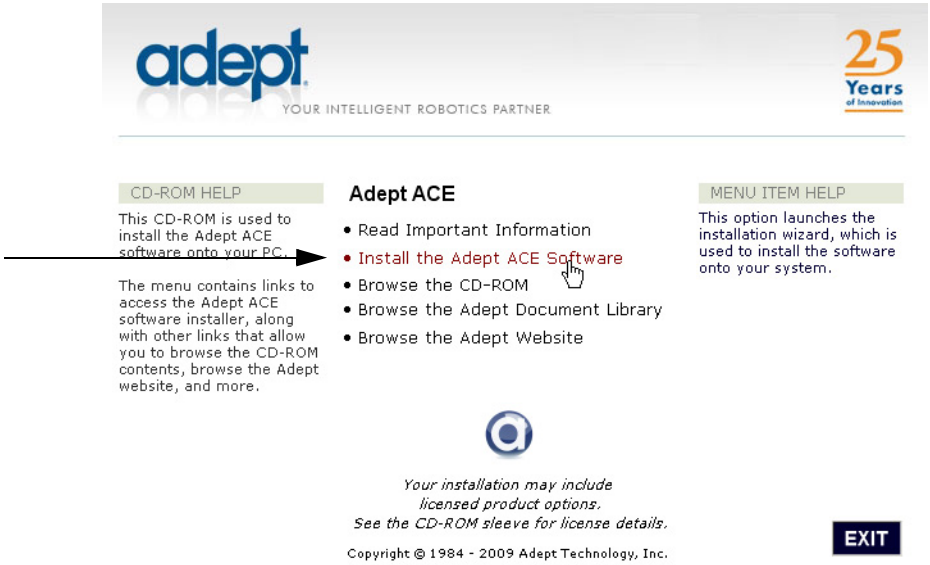


Figure 3-2. Adept ACE CD-ROM Startup Menu

3. The Adept ACE Setup wizard opens - see **Figure 3-4** and **Figure 3-5**. Follow the instructions as you step through the installation process.

Figure 3-3. Setup Welcome Screen

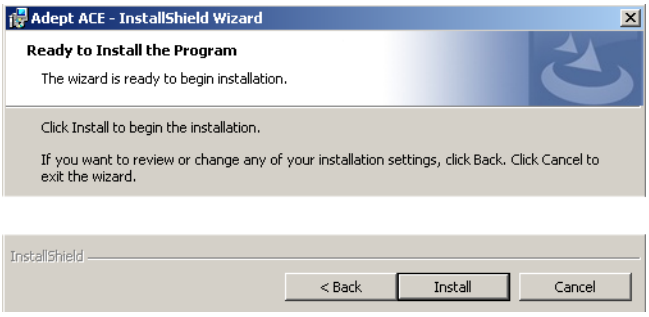


Figure 3-4. Ready-to-Install Screen

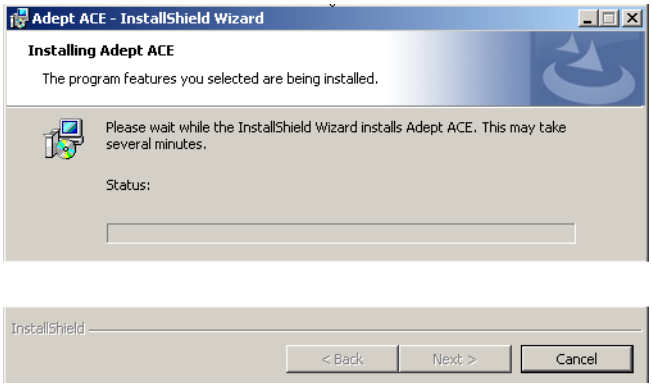


Figure 3-5. Install Screen

4. When the install is complete, click **Finish**.

Figure 3-6. Installation Completed

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 Adept ACE.

3.6 Connecting 24 VDC Power to Robot

Specifications for 24 VDC Power

Table 3-1. Specifications for 24 VDC User-Supplied Power Supply

Customer-Supplied Power Supply	24 VDC (± 10%), 150 W (6 A) (21.6 V< V_{in} < 26.4 V)
Circuit Protection[a]	Output must be less than 300 W peak **or** 8 Amp in-line fuse
Power Cabling	1.5 – 1.85 mm² (16-14 AWG)
Shield Termination	Braided shield connects to ground terminal at both ends of cable. See **Figure 3-7 on page 31** and **Figure 2-3 on page 22**.

[a] User-supplied 24 V power supply must incorporate overload protection to limit peak power to less than 300 W, **or** 8 A in-line fuse protection must be added to the 24 V power source. (In case of multiple robots on a common 24 V supply, each robot must be fused individually.)

NOTE: Fuse information is located on the AIB electronics

The power requirements for the user-supplied power supply will vary depending on the configuration of the robot and connected devices. Adept recommends a 24 V, 6 A power supply to allow for startup current draw and load from connected user devices, such as solenoids and digital I/O loads. If multiple robots are to be sourced from a common 24 V power supply, increase the supply capacity by 3 A for each additional robot.

CAUTION: Make sure you select a 24 VDC power supply that meets the specifications in **Table 3-1**. Using an under-rated supply can cause system problems and prevent your equipment from operating correctly. See **Table 3-2** for recommended power supplies.

Table 3-2. Recommended 24 VDC Power Supplies

Vendor Name	Model	Ratings
XP Power	JMP160PS24	24 VDC, 6.7 A, 160 W
AstroDyne	SP-150-24	24 VDC, 6.3 A, 150 W
Mean Well	SP-150-24	24 VDC, 6.3 A, 150 W

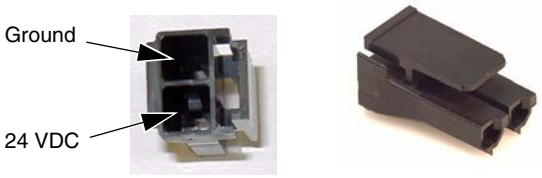
Connecting 24 VDC

This section covers the cable that connects the 24 VDC power supply to the robot.

24 VDC Mating Connector

The 24 VDC mating connector and two pins are supplied with each system. They are shipped in the Accessory Kit.

Table 3-3. 24 VDC Mating Connector Specs

Connector Details 	Connector receptacle, 2 position, type: Molex Sabre, 18 A, 2-Pin
	Molex P/N 44441-2002
	Digi-Key P/N WM18463-ND
	Adept P/N 02708-000
Pin Details 	Molex connector crimp terminal, female, 14-18 AWG
	Molex P/N 43375-0001
	Digi-Key P/N WM18493-ND
	Adept P/N 02709-000
Recommended crimping tool: Molex Hand Crimper	Molex P/N 63811-0400
	Digi-Key P/N WM9907-ND

Creating 24 VDC Cable

1. Locate the connector and pins from the preceding table.
2. Use 14-16 AWG wire to create the 24 VDC cable. Select the wire length to safely reach from the user-supplied 24 VDC power supply to the robot base.
3. Crimp the pins onto the wires using the crimping tool recommended in the preceding table.
4. Insert the pins into the connector. Confirm that the 24 V and ground wires are in the correct terminals in the plug.
5. Prepare the opposite end of the cable for connection to your user-supplied 24 VDC power supply.

Installing 24 VDC Robot Cable

1. Connect one end of the shielded 24 VDC cable to your user-supplied 24 VDC power supply. See **Figure 3-7**. The cable shield should be connected to frame ground on the power supply. Do not turn on the 24 VDC power until instructed to do so in **Chapter 4**.
2. Plug the mating connector end of the 24 VDC cable into the 24 VDC connector on the interface panel on the back of the robot. The cable shield should be connected to the ground point on the interface panel.

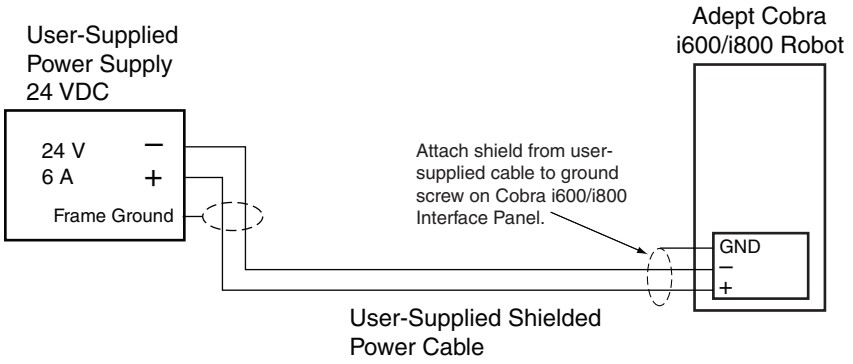


Figure 3-7. User-Supplied 24 VDC Cable

NOTE: Adept recommends that DC power be delivered over a shielded cable, with the shield connected to grounds at both ends of the cable.

Creating AC Cable to 24 VDC Power Supply

If the power supply does not come with an AC power cable, you will have to build one. The cable should be at least 18 AWG, 3 wire, rated for 300 V.

Refer to the 24 VDC power supply you are using for AC input requirements.

3.7 Connecting 200-240 VAC Power to Robot

WARNING: Ensure compliance with all local and national safety and electrical code for the installation and operation of the robot system.

WARNING: Appropriately-sized Branch Circuit Protection and Lockout / Tagout Capability must be provided in accordance with the National Electrical Code and any local codes

Specifications for AC Power

Table 3-4. Specifications for 200/240 VAC User-Supplied Power Supply

Auto-Ranging Nominal Voltage Range	Minimum Operating Voltage[a]	Maximum Operating Voltage	Frequency/ Phasing	Recommended External Circuit Breaker, User-Supplied
200 to 240 V	180 V	264 V	50/60 Hz/ 1-phase	10 Amps

[a] Specifications are established at nominal line voltage. Low line voltage can affect robot performance.

Table 3-5. Typical Robot Power Consumption

Cobra Robot	Move	Average Power (W)	RMS Current (A)	Peak Power (W)[a]
i600	No load - Adept cycle[b]	344	1.56	1559
	5.5 kg - Adept cycle[b]	494	2.25	2061
	5.5 kg - all joints move	880	4.00	2667
i800	No load - Adept cycle[b]	531	2.41	1955
	5.5 kg - Adept cycle[b]	377	1.71	1406
	5.5 kg - all joints move	794	3.61	2110

[a] For short durations (100 ms)
[b] See Table 7-1 on page 99 for details on Adept cycle.

NOTE: The Adept robot system is intended to be installed as a piece of equipment in a permanently-installed system.

DANGER: AC power installation must be performed by a skilled and instructed person. During installation, unauthorized third parties must be prevented from turning on power through the use of fail-safe lockout measures.

Facility Overvoltage Protection

The user must protect the robot from excessive overvoltages and voltage spikes. If the country of installation requires a CE-certified installation, or compliance with IEC 1131-2, the following information may be helpful: IEC 1131-2 requires that the installation must ensure that Category II overvoltages (i.e., line spikes not directly due to lightning strikes) are not exceeded. Transient overvoltages at the point of connection to the power source shall be controlled not to exceed overvoltage Category II, i.e., not higher than the impulse voltage corresponding to the rated voltage for the basic insulation. The user-supplied equipment or transient suppressor shall be capable of absorbing the energy in the transient.

In the industrial environment, non-periodic overvoltage peaks may appear on mains power supply lines as a result of power interruptions to high-energy equipment (such as a blown fuse on one branch in a 3-phase system). This will cause high current pulses at relatively low voltage levels. The user shall take the necessary steps to prevent damage to the robot system (such as by interposing a transformer). See IEC 1131-4 for additional information.

AC Power Diagrams

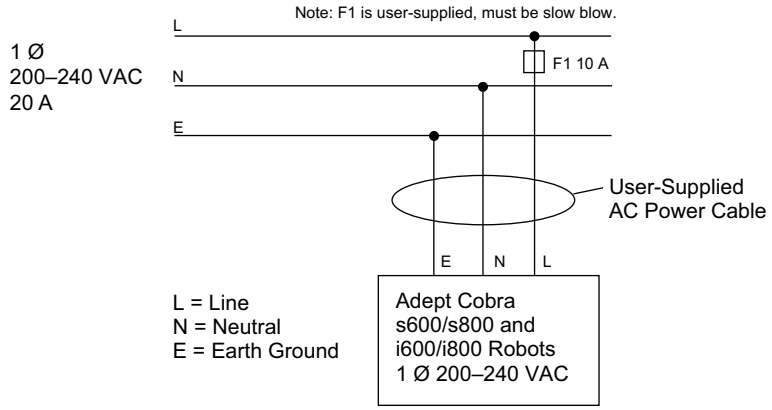


Figure 3-8. Typical AC Power Installation with Single-Phase Supply

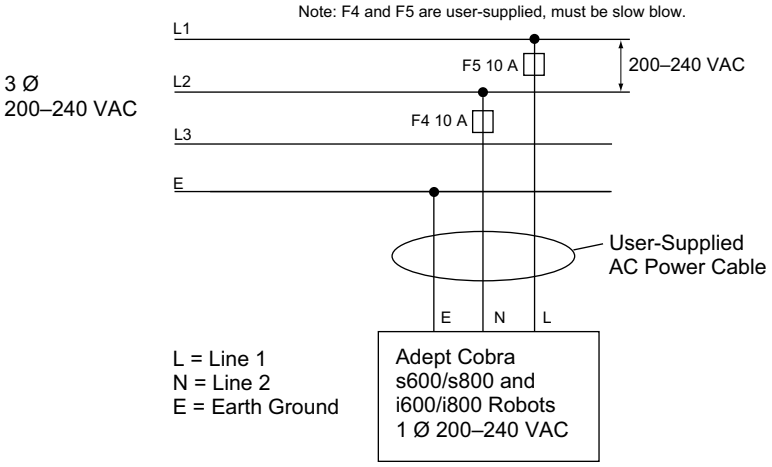
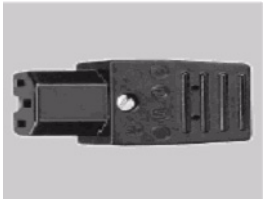


Figure 3-9. Single-Phase Load across L1 and L2 of a Three-Phase AC Supply

Details for AC Mating Connector

The AC mating connector is supplied with each system. It is shipped in the Accessory Kit. The supplied plug is internally labeled for the AC power connections (L, E, N).

Table 3-6. AC Mating Connector Details

AC Connector details 	AC in-line power plug, straight, female, screw terminal, 10 A, 250 VAC
	Qualtek P/N 709-00/00
	Digi-Key P/N Q217-ND
	Adept P/N 02710-000

Procedure for Creating 200-240 VAC Cable

1. Locate the AC mating connector shown in **Table 3-6**.
2. Open the connector by unscrewing the screw on the shell and removing the cover.
3. Loosen the two screws on the cable clamp. See **Figure 3-10**.
4. Use 18 AWG wire to create the AC power cable. Select the wire length to safely reach from the user-supplied AC power source to the robot base.
5. Strip 18 to 24 mm insulation from each of the three wires.
6. Insert the wires into the connector through the removable bushing.
7. Connect each wire to the correct terminal screw, and tighten the screw firmly.
8. Tighten the screws on the cable clamp.
9. Reinstall the cover and tighten the screw to seal the connector.
10. Prepare the opposite end of the cable for connection to the facility AC power source.

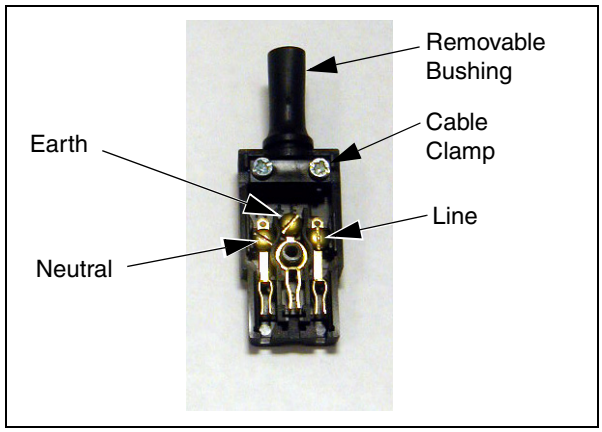


Figure 3-10. AC Power Mating Connector

Installing AC Power Cable to Robot

1. Connect the unterminated end of the AC power cable to your facility AC power source. See **Figure 3-8** and **Figure 3-9 on page 33**. Do not turn on AC power at this time.
2. Plug the AC connector into the AC power connector on the interface panel on the robot.
3. Secure the AC connector with the locking latch.

3.8 Grounding the Adept Robot System

Proper grounding is good practice for safe and reliable robot operation. Follow these recommendations to properly ground your robot system.

Ground Point on Robot Base

The user can install a protective earth ground wire at the robot base to ground the robot. See **Figure 3-11**. The robot ships with an M8 x 12 stainless steel, hex-head screw, and M8 split and flat washers installed in the grounding hole. The user is responsible for supplying the ground wire to connect to protective earth ground.

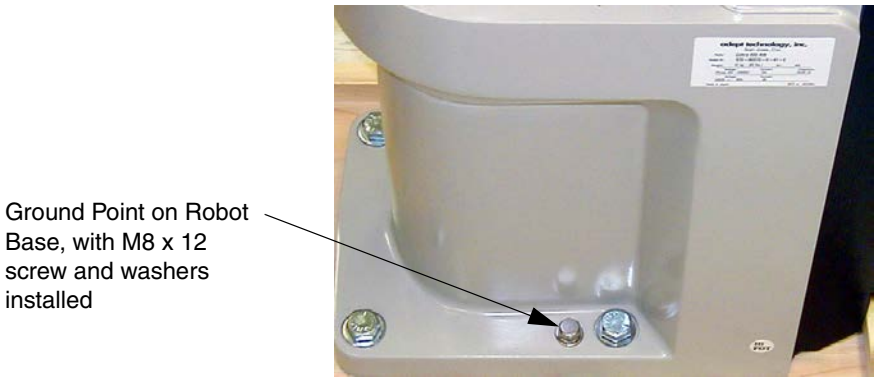


Figure 3-11. Ground Point on Robot Base

Robot-Mounted Equipment Grounding

The following parts of an Adept Cobra i600/i800 robot are not grounded to protective earth: the Joint 3 quill and the tool flange. If hazardous voltages are present at any user-supplied robot-mounted equipment or tooling, you must install a ground connection from that equipment/tooling to the ground point on the robot base. Hazardous voltages can be considered anything in excess of 30 VAC (42.4 VAC peak) or 60 VDC.

See also **Figure 7-4 on page 94** for the grounding point on the tool flange.

DANGER: Failing to ground robot-mounted equipment or tooling that uses hazardous voltages could lead to injury or death of a person touching the end-effector when an electrical fault condition exists.

3.9 Installing User-Supplied Safety Equipment

The user is responsible for installing safety barriers to protect personnel from coming in contact with the robot unintentionally. Depending on the design of the workcell, safety gates, light curtains, and emergency stop devices can be used to create a safe environment. Read the ***Adept Robot Safety Guide*** for a discussion of safety issues.

Refer to **Section 4.7 on page 49** for information on connecting safety equipment to the system through the XUSR connector on the AIB XPANEL cable. There is a detailed section on Emergency Stop Circuits and diagrams on recommended E-Stop configurations.

4 System Operation

4.1 Robot Status LED

The robot Status LED Indicator is located on the top of the robot. See Figure 4-1.

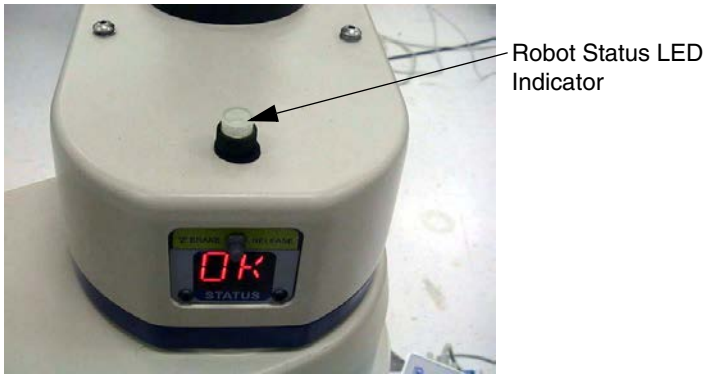


Figure 4-1 Robot Status LED Indicator Location

Table 4-1. Robot Status LED Definition

LED Status	2-Digit Status Panel Display	Description
Off	Off	24 VDC not present
Off	OK	High Power Disabled
Amber, Solid	ON	High Power Enabled
Amber, Fast Blink	Fault Code(s)	Fault, see Status Display
Amber, Solid	Fault Code(s)	Fault, see Status Display

4.2 Status Panel Fault Codes

The status panel, shown in Figure 4-2, displays alphanumeric codes that indicate the operating status of the robot, including detailed fault codes. Table 4-2 gives definitions of the fault codes. These codes provide details for quickly isolating problems during troubleshooting.

The displayed fault code will continue to be displayed even after the fault is corrected or additional faults are recorded. All displayed faults will be cleared from the display, and reset to a no-fault condition, upon successfully enabling high power to the robot, or power cycling the 24 V supply to the robot.

Figure 4-2 Status Panel

Table 4-2. Status Panel Fault Codes

LED	Status Code	LED	Status Code
OK	No Fault	h#	High Temp Amp (Joint #)
ON	High Power ON Status	H#	High Temp Encoder (Joint #)
MA	Manual Mode	hV	High Voltage Bus Fault
24	24 V Supply Fault	I#	Initialization Stage (Step #)
A#	Amp Fault (Joint #)	M#	Motor Stalled (Joint #)
B#	IO Blox Fault (Address #)	NV	Non-Volatile Memory
AC	AC Power Fault	P#	Power System Fault (Code #)
D#	Duty Cycle Exceeded (Joint #)	PR	Processor Overloaded
E#	Encoder Fault (Joint #)	RC	RSC Fault
ES	E-Stop	SW	Watchdog Timeout
F#	External Sensor Stop	S#	Safety System Fault (Code #)
FM	Firmware Mismatch	T#	Safety System Fault (Code 10 + #)
FW	1394 Fault	V#	Hard Envelope Error (Joint #)

For more information on status codes, go to the Adept Document Library on the Adept website, and in the Procedures, FAQs, and Troubleshooting section, look for the *Adept Status Code Summary for Embedded Prodcts* document.

4.3 Using the Brake Release Button

Brakes

The robot has a braking system which decelerates the robot in an emergency condition, such as when the emergency stop circuit is open or a robot joint passes its softstop. The braking system will not prevent you from moving the robot manually once the robot has stopped (and High Power has been removed).

In addition, Joint 3 has an electromechanical brake. The brake is released when High Power is enabled. When High Power is turned off, the brake engages and holds the position of Joint 3.

Brake Release Button

Under some circumstances you may want to manually position Joint 3 on the Z-Axis without turning on High Power. For such instances, a 'Z' Brake Release button is located above the robot status panel (see **Figure 4-2 on page 38**). When system power is on, pressing this button releases the brake, which allows movement of Joint 3.

If this button is pressed while High Power is on, High Power will automatically shut down.

DANGER: When the Brake Release button is pressed, Joint 3 may drop to the bottom of its travel. To prevent possible damage to the equipment, make sure that Joint 3 is supported when releasing the brake and verify that the end-effector and other installed tooling is clear of all obstructions.

4.4 Front Panel

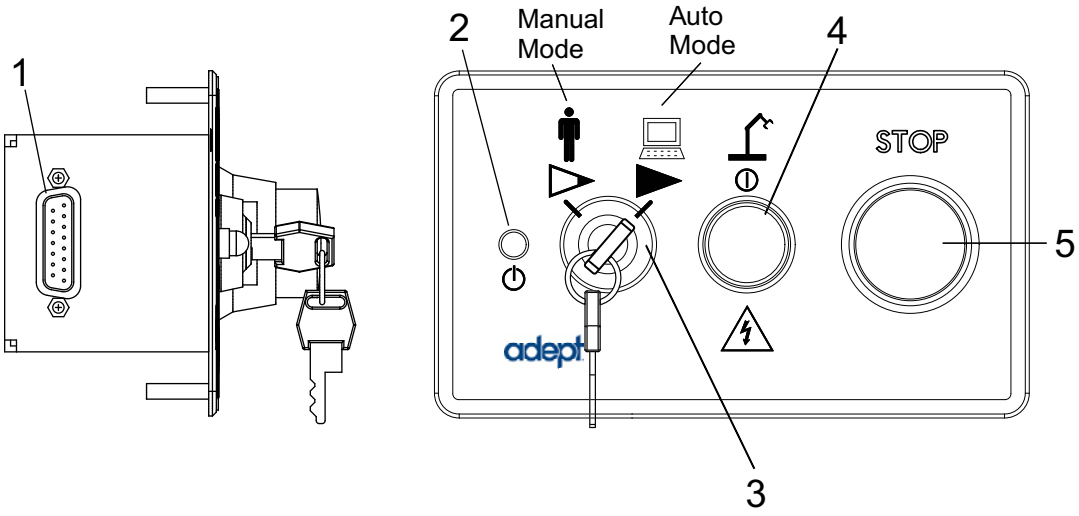


Figure 4-3 Front Panel

1. **XFP connector**
   Connects to the XFP connector on the AIB XPANEL cable on an i600/i800 robot.

2. **System 5 V Power-On LED**
   Indicates whether or not power is connected to the robot.

3. **Manual/Automatic Mode Switch**
   Switches between Manual and Automatic mode. In Automatic mode, executing programs control the robot, and the robot can run at full speed. In Manual mode, the system limits robot speed and torque so that an operator can safely work in the cell. Manual mode initiates software restrictions on robot speed, commanding no more than 250 mm/sec.

4. **High Power On/Off Switch and 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-supplied PC, an executing program, or the T2 pendant. Once this request has been made and the High Power On/Off lamp/button is blinking, the operator must press and release this button, and high power will be enabled.

   NOTE: The use of the blinking High Power button can be configured (or eliminated) in software. Your system may not require this step.

   NOTE: If enabled, the Front Panel button must be pressed while blinking (default time-out is 10 seconds). If the button stops blinking, you must enable power again.

5. **Emergency Stop Switch**
   The E-Stop is a dual-channel, passive E-Stop that supports Category 3 CE safety requirements. Pressing this button turns off high power to the robot motors.

NOTE: The Front Panel must be installed to be able to Enable Power to the robot. To operate without a Front Panel, the user must supply the equivalent circuits. See **"Remote Front Panel or User-Supplied Replacement" on page 55** for a summary of connections required to replace the Front Panel.

4.5 Connecting Digital I/O to the System

You can connect digital I/O to the system in several different ways. See the following table and **Figure 4-4**.

Table 4-3. Digital I/O Connection Options

Product	I/O Capacity	For more details
XIO Connector on Robot	12 inputs 8 outputs	See **Section 4.6 on page 43**
XIO Breakout cable with flying leads on user's end from optional I/O products	12 inputs 8 outputs	See **page 47** for information.
XIO Termination Block with terminals for user wiring, plus input and output status LEDs. Connects to the XIO connector with 6 foot cable.	12 inputs 8 outputs	See the *Adept XIO Termination Block Installation Guide* for details.
IO Blox Device, adds digital I/O capacity, connects to robot.	8 inputs, 8 outputs per device. You can combine up to four IO Blox devices to increase capacity by 32 inputs and 32 outputs.	See *Adept IO Blox User's Guide*

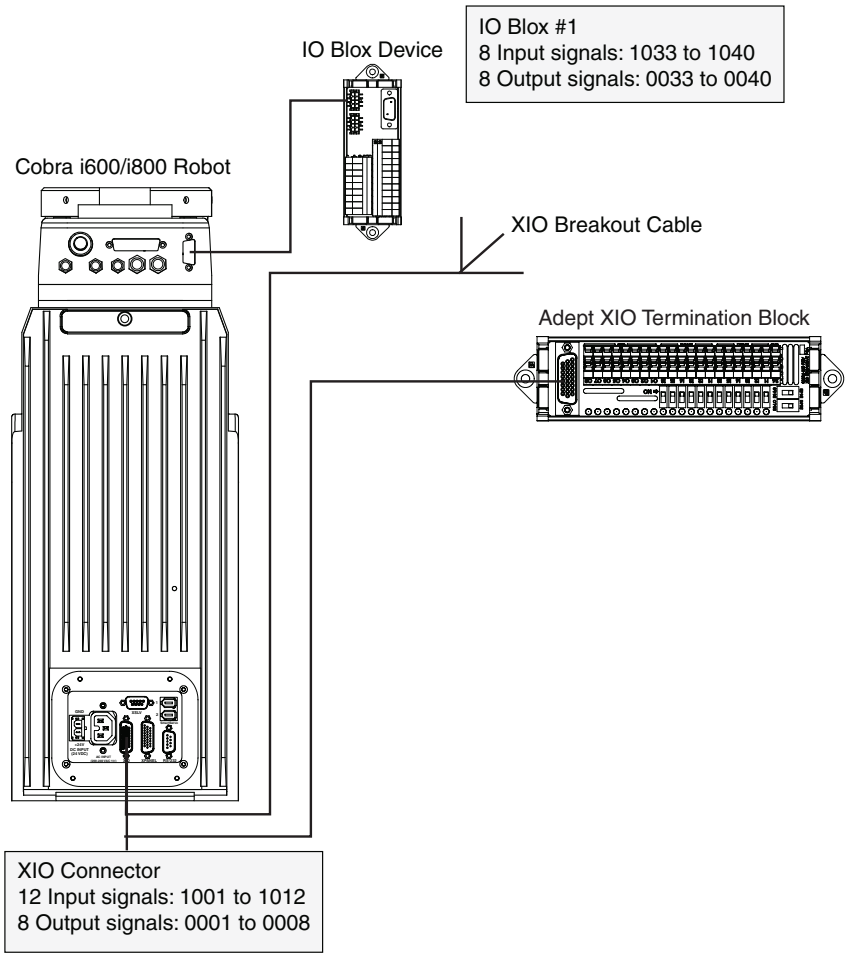


Figure 4-4 Connecting Digital I/O to the System

Table 4-4. Default Digital I/O Signal Configuration, Single Robot System

Location	Type	Signal Range
Robot 1 XIO connector	Inputs	1001 - 1012
	Outputs	0001 - 0008
IO Blox 1	Inputs	1033 - 1044
	Outputs	0033 - 0040
IO Blox 2	Inputs	1041 - 1048
	Outputs	0041 - 0048
IO Blox 3	Inputs	1049 - 1056
	Outputs	0049 - 0056
IO Blox 4	Inputs	1057 - 1064
	Outputs	0057 - 0064

4.6 Using Digital I/O on Robot XIO Connector

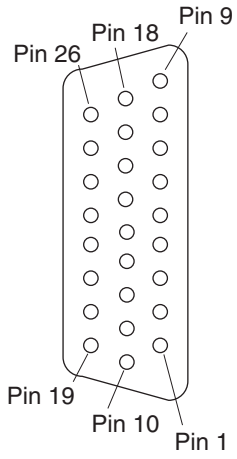
The XIO connector on the robot interface panel supports 20 digital I/O signals - 12 inputs and 8 outputs. These signals can be used by MicroV+ to perform various functions in the workcell. See **Table 4-5** for the XIO signal designations.

- 12 Inputs, signals 1001 to 1012
- 8 Outputs, signals 0001 to 0008

XIO Connector

Table 4-5. XIO Signal Designations

Pin No.	Designation	Signal Bank	MicroV+ Signal Number	Pin Locations
1	GND			
2	24 VDC			
3	Common 1	1		
4	Input 1.1	1	1001	
5	Input 2.1	1	1002	
6	Input 3.1	1	1003	
7	Input 4.1	1	1004	
8	Input 5.1	1	1005	
9	Input 6.1	1	1006	
10	GND			
11	24 VDC			
12	Common 2	2		
13	Input 1.2	2	1007	
14	Input 2.2	2	1008	
15	Input 3.2	2	1009	
16	Input 4.2	2	1010	
17	Input 5.2	2	1011	
18	Input 6.2	2	1012	
19	Output 1		0001	
20	Output 2		0002	
21	Output 3		0003	
22	Output 4		0004	
23	Output 5		0005	
24	Output 6		0006	
25	Output 7		0007	
26	Output 8		0008	



XIO 26-pin female connector on Robot Interface Panel

XIO Input Signals

The 12 input channels are arranged in two banks of six. Each bank is electrically isolated from the other bank and optically isolated from the robot's ground. The six inputs within each bank share a common source/sink line.

The inputs are accessed through direct connection to the XIO connector (see **Table 4-5 on page 43**), or through the optional XIO Termination Block. See the documentation supplied with the Termination Block for details.

The XIO inputs cannot be used for REACTI programming, high-speed interrupts, or vision triggers.

XIO Input Specifications

Table 4-6. XIO Input Specifications

Operational voltage range	0 to 30 VDC
"Off" state voltage range	0 to 3 VDC
"On" state voltage range	10 to 30 VDC
Typical threshold voltage	V_{in} = 8 VDC
Operational current range	0 to 7.5 mA
"Off" state current range	0 to 0.5 mA
"On" state current range	2.5 to 7.5 mA
Typical threshold current	2.0 mA
Impedance (V_{in}/I_{in})	3.9 KΩ minimum
Current at V_{in} = +24 VDC	$I_{in} \leq$ 6 mA
Turn on response time (hardware) Software scan rate/response time	5 µsec maximum 16 ms scan cycle/32 ms max response time
Turn off response time (hardware) Software scan rate/response time	5 µsec maximum 16 ms scan cycle/32 ms max response time

NOTE: The input current specifications are provided for reference. Voltage sources are typically used to drive the inputs.

Typical Input Wiring Example

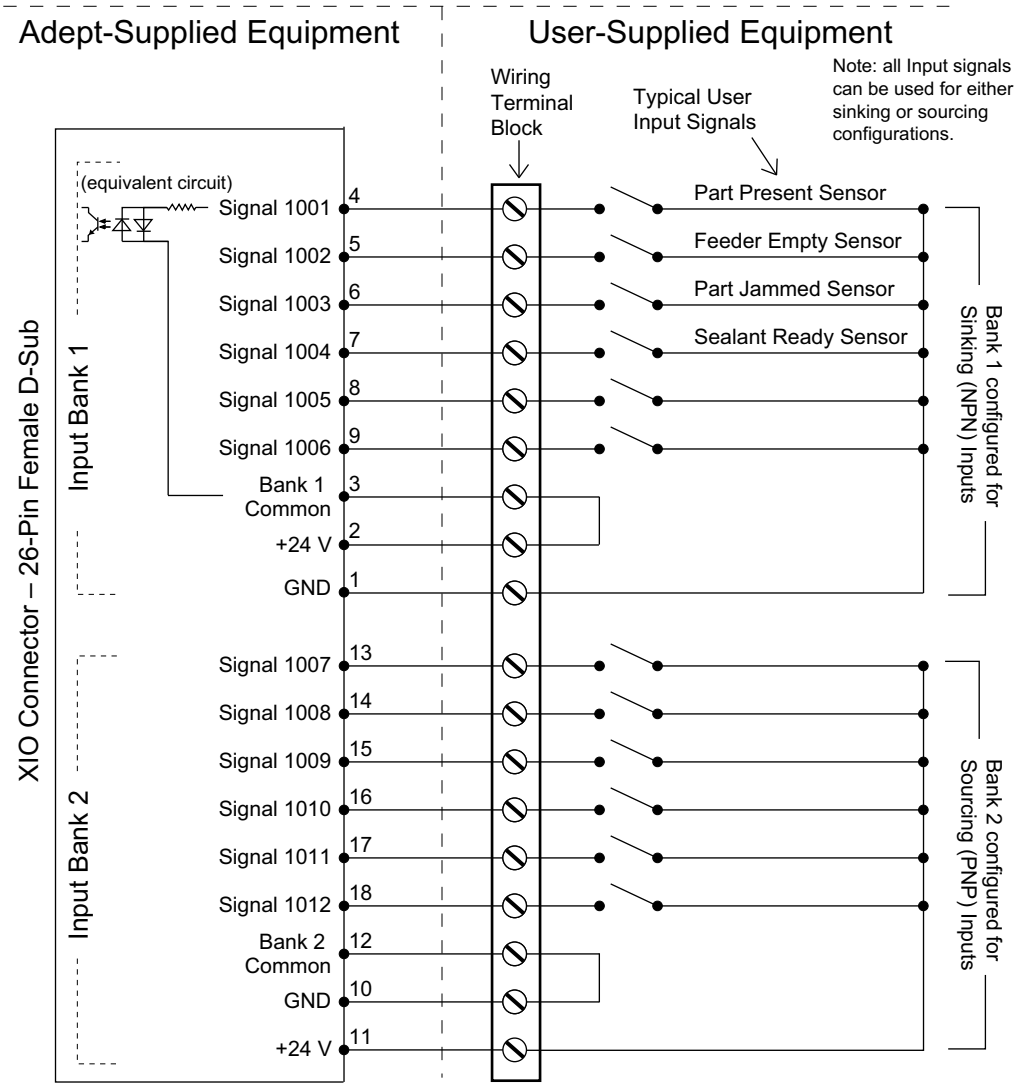


Figure 4-5 Typical User Wiring for XIO Input Signals

NOTE: The off state current range exceeds the leakage current of XIO outputs. This guarantees that the inputs will not be turned on by the leakage current from the outputs. This is useful in situations where the outputs are looped-back to the inputs for monitoring purposes.

XIO Output Signals

The eight digital outputs share a common, high side (sourcing) Driver IC. The Driver is designed to supply any kind of load with one side connected to ground. It is designed for a range of user-provided voltages from 10 to 24 VDC and each channel is capable of up to 0.7 A of current. This Driver has overtemperature protection, current limiting, and shorted-load protection. In the event of an output short or other overcurrent situation, the affected output of the Driver IC turns off and back on automatically to reduce the temperature of the IC. The Driver draws power from the primary 24 VDC input to the robot through a self-resetting polyfuse.

The outputs are accessed through direct connection to the XIO connector (see **Table 4-5 on page 43**), or through the optional XIO Termination Block. See the documentation supplied with the XIO Termination Block for details.

XIO Output Specifications

Table 4-7. XIO Output Circuit Specifications

Parameter	Value
Power supply voltage range	See **Table 3-1 on page 29**.
Operational current range, per channel	$I_{out} \leq$ 700 mA
Total Current Limitation, all channels on.	$I_{total} \leq$ 1.0 A @ 50° C ambient $I_{total} \leq$ 1.5 A @ 25° C ambient
On state resistance (I_{out} = 0.5 A)	$R_{on} \leq$ 0.32 Ω @ 85× C
Output leakage current	$I_{out} \leq$ 25 µA
Turn-on response time	125 µsec. max., 80 µsec typical (hardware only)
Turn-off response time	60 µsec. max., 28 µsec typical (hardware only)
Output voltage at inductive load turnoff (I_{out} = 0.5 A, Load = 1 mH)	(+V - 65) $\leq V_{demag} \leq$ (+V - 45)
DC short circuit current limit	0.7 A $\leq I_{LIM} \leq$ 2.5 A
Peak short circuit current	$I_{ovpk} \leq$ 4 A

Typical Output Wiring Example

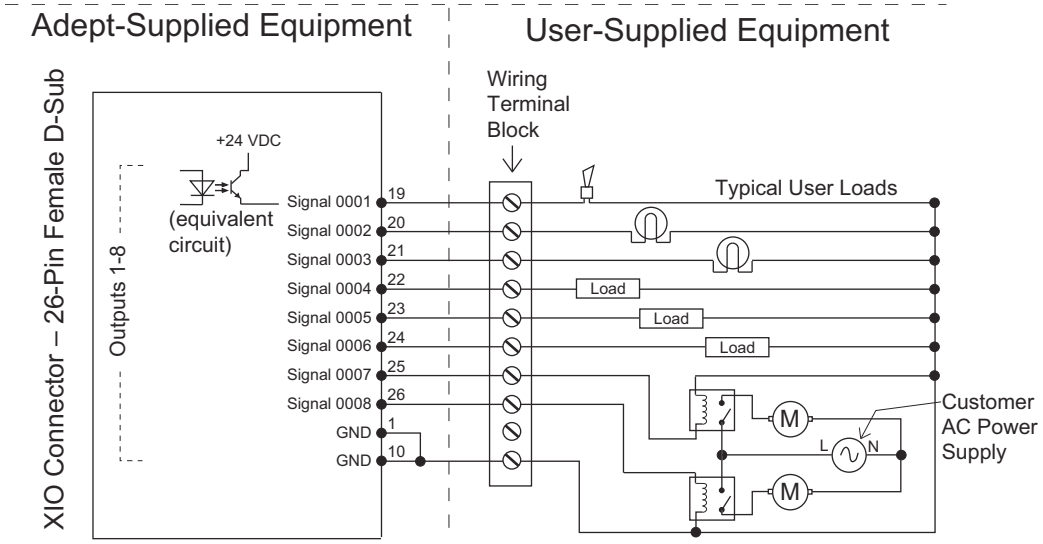


Figure 4-6 Typical User Wiring for XIO Output Signals

XIO Breakout Cable

The XIO Breakout cable is available as an option - see **Figure 4-7**. This cable connects to the XIO connector on the robot, and provides flying leads on the user's end, for connecting input and output signals in the workcell. The part number for the cable is 04465-000, and the length is 5 M (16.4 ft).

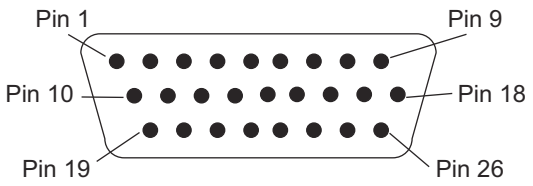
See **Table 4-8 on page 48** for the wire chart on the cable.

NOTE: This cable is not compatible with the XIO Termination Block.

Figure 4-7 Optional XIO Breakout Cable

Table 4-8. XIO Breakout Cable Wire Chart

Pin No.	Signal Designation	Wire Color
1	GND	White
2	24 VDC	White/Black
3	Common 1	Red
4	Input 1.1	Red/Black
5	Input 2.1	Yellow
6	Input 3.1	Yellow/Black
7	Input 4.1	Green
8	Input 5.1	Green/Black
9	Input 6.1	Blue
10	GND	Blue/White
11	24 VDC	Brown
12	Common 2	Brown/White
13	Input 1.2	Orange
14	Input 2.2	Orange/Black
15	Input 3.2	Gray
16	Input 4.2	Gray/Black
17	Input 5.2	Violet
18	Input 6.2	Violet/White
19	Output 1	Pink
20	Output 2	Pink/Black
21	Output 3	Light Blue
22	Output 4	Light Blue/Black
23	Output 5	Light Green
24	Output 6	Light Green/Black
25	Output 7	White/Red
26	Output 8	White/Blue
Shell		Shield



4.7 Connecting Customer-Supplied Safety and Power Control Equipment

Connecting Equipment to the System

The connection of the customer-supplied safety and power control equipment to the system is done through the XUSR and XFP connectors on the AIB XPANEL cable. Refer to **Table 4-9** for the XUSR pin-out explanations. Refer to **Table 4-10 on page 50** for the XFP pin-out explanations. See **Figure 4-8 on page 52** for the E-Stop wiring diagram.

Table 4-9. Contacts Provided by the XUSR Connector

Pin Pairs	Description	Comments	Shorted if NOT Used
Voltage-Free Contacts Provided by Customer			
1, 14	User E-Stop CH 1 (mushroom PB, safety gates, etc.).	N/C contacts	Yes
2,15	User E-Stop CH 2 (same as pins 1 and 14).	N/C contacts	Yes
3,16	Not supported on Cobra i-series robot		
4,17	Not supported on Cobra i-series robot		
5,18	Muted Safety Gate CH 1 (causes E-Stop in AUTOMATIC mode only).	N/C contacts	Yes
6,19	Muted Safety Gate CH 2 (same as pins 5 and 18).	N/C contacts	Yes
Voltage-Free Contacts provided by Adept			
7,20	Not supported on Cobra i-series robot		
8,21	Not supported on Cobra i-series robot		
9,22	Not supported on Cobra i-series robot		
10,23	Not supported on Cobra i-series robot		
11,12, 13, 24, 25	No connection		

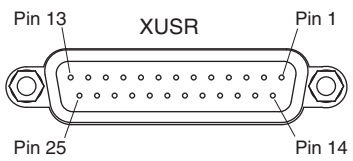
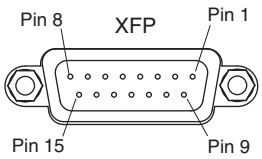


Table 4-10. Contacts Provided by the XFP Connector

Pin Pairs	Description	Requirements for User-Supplied Front Panel
Voltage-Free Contacts Provided by Customer		
1,9	Front Panel E-Stop CH 1 (N/C contacts)	User must supply N/C contacts.
2,10	Front Panel E-Stop CH 2 (N/C contacts)	User must supply N/C contacts.
3,11	Remote MANUAL/AUTOMATIC switch CH 1. MANUAL = Open AUTOMATIC = Closed	Optional - jumper closed for Auto Mode only operation.
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 PB	User must supply momentary push button to enable High Power to system.
Nonvoltage-Free Contacts		
5,13[a]	Adept Supplied 5 VDC and GND for High Power On/Off Switch Lamp	User must supply lamp, or use 1/4 W, 220 Ohm resistor. System will not operate if not present.
7,15[a]	System 5 V power ON LED, 5 V, 20 mA	Optional - indicator only
8	No connection	
		
See Figure 4-9 on page 53 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.

Table 4-11. Remote T2 Pendant Connections on the XMCP Connector

Pin XMCP (15-Pin D-Sub)	Pin T2 (16-Pin CPC)	Description
1,9	6,7	T2 E-Stop PB CH 1
2,10	11,12	T2 E-Stop PB CH 2
3,11	14,16	T2 Enable CH 1 (Hold-to-run)
4,12	13,15	T2 Enable CH 2 (Hold-to-run)
13	1,4	Serial GND/Logic GND
7	2	T2 TXD: “Micro V^+ to MCP TXD”
8	3	T2 RXD: “Micro V^+ to MCP RXD”
14	5	No connection
15	8	No connection
Shield	9	Shield GND
6		24 V (used by T2 Power Adapter)
5	10	No connection

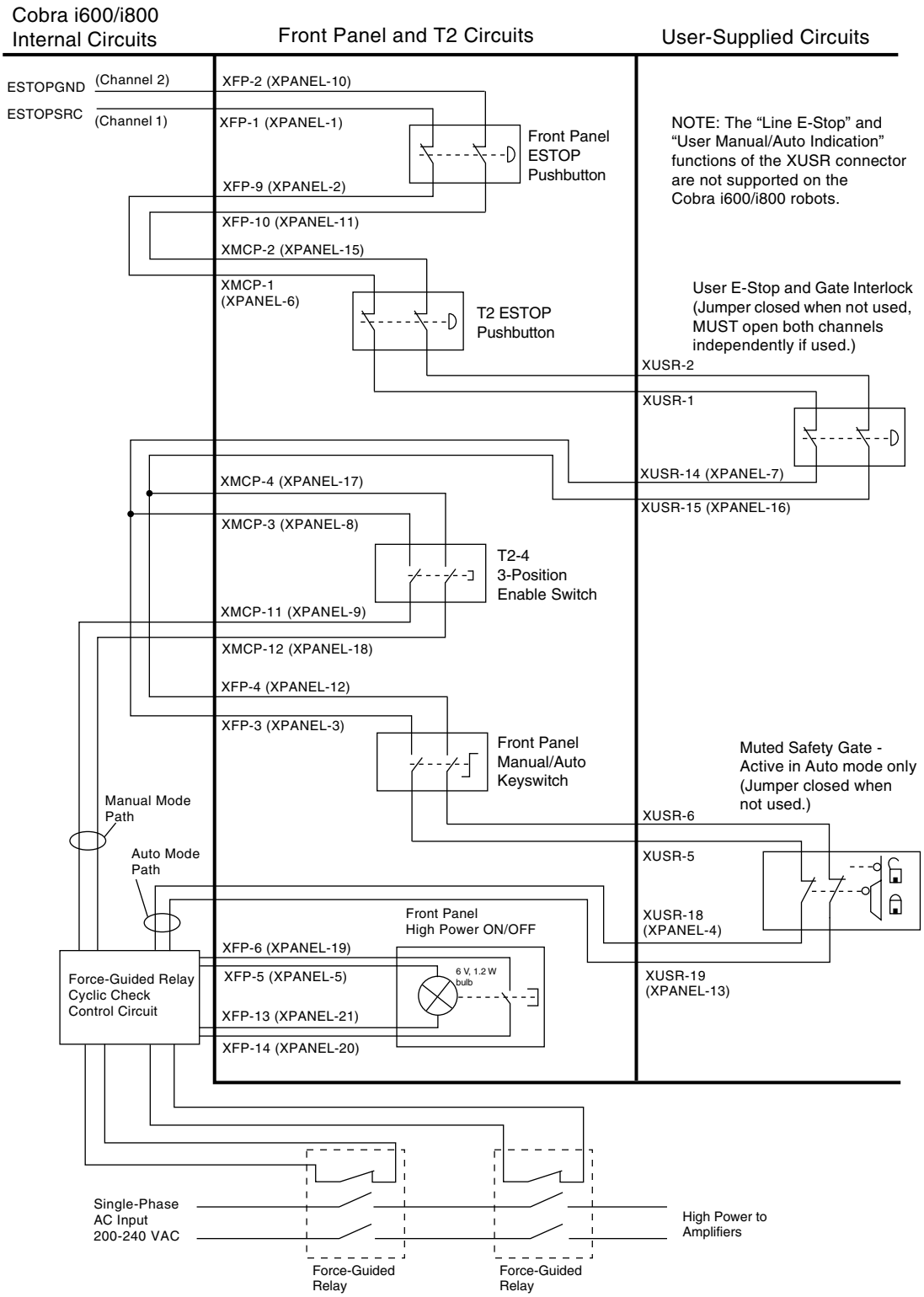


Figure 4-8 Cobra i600/i800 E-Stop Circuit Connections

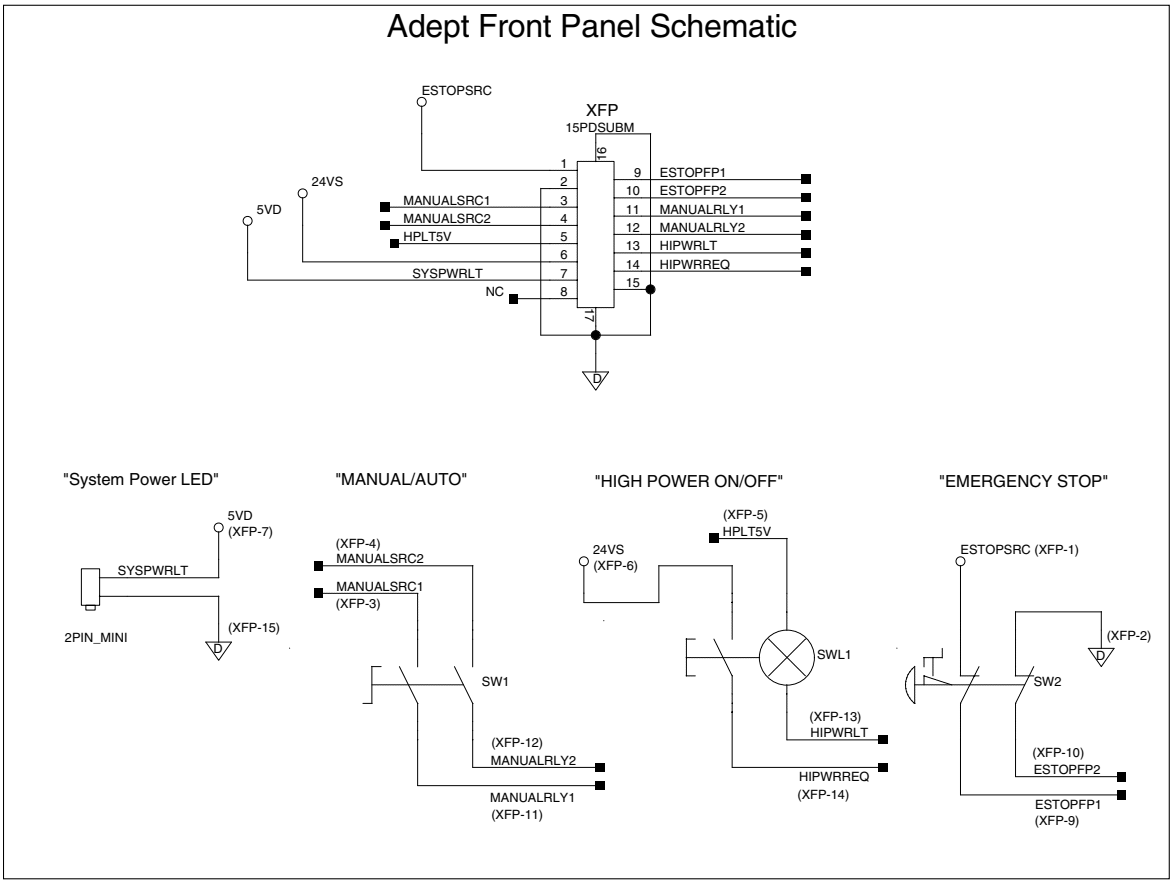


Figure 4-9 Front Panel Schematic

Emergency Stop Circuits

The Cobra i600/i800 robot provides connections for Emergency Stop (E-Stop) circuits on the XUSR and XFP connectors. This gives the robot system the ability to slave E-Stop functionality from a remote location using voltage-free contacts. See **Figure 4-8 on page 52**.

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

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

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 (see **Figure 4-8 on page 52, Table 4-9 on page 49**, **Table 4-10 on page 50**, and **Table 4-11 on page 51** for the customer E-Stop circuitry).

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.

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

Remote Manual Mode

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 **Figure 4-9 on page 53** for the Front Panel schematic. 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 customer-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.

Remote High Power On/Off Control

The easiest and most effective way to provide 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 or complete replacement of the Adept Front Panel will be required. See the Front Panel schematic (**Figure 4-9 on page 53**) for details of the Front Panel's 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 local and national standards.

It is important 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 N/O contacts from a customer-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. To put 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 a MicroV+ error 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 the Maintenance chapter in the *Adept SmartController User's Guide* for information on changing this lamp.

Remote Front Panel or User-Supplied Replacement

Users can mount the Front Panel remotely by using an extension cable or by wiring a user-supplied Front Panel (control panel) to the robot using the 15-pin XFP connector. The Front Panel contains no active components, only switches and lights. Users 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 **Figure 4-9 on page 53** for a schematic drawing of the Front Panel and **Table 4-10 on page 50** for a summary of connections and pin numbers.

4.8 Turning On the System

Turning on the robot system for the first time is known as "commissioning the system." You must follow the steps in this section to safely bring up your robot system. The steps include:

- Verifying installation, to confirm all tasks have been performed correctly
- Starting up the system by turning on power for the first time
- Verifying all E-Stops in the system function correctly
- Moving each axis of the robot to confirm it moves in the proper directions

Verifying Installation

Verifying that the system is correctly installed and that all safety equipment is working correctly is an important process. Before using the robot, make the following checks to ensure that the robot system has been properly installed.

DANGER: After installing the robot, you must test it before you use it for the first time. Failure to do this could cause death or serious injury or equipment damage.

Mechanical Checks

- Verify that the robot is mounted level and that all fasteners are properly installed and tightened.
- Verify that any end-of-arm tooling is properly installed.
- Verify that all other peripheral equipment is properly installed and in a state such that it is safe to turn on power to the robot system.

System Installation Checks

Verify that the installation procedures in **Section 3.3** through **Section 3.8** have been completed.

User-Supplied Safety Equipment Checks

Verify that all user-supplied safety equipment and E-Stop circuits are installed correctly.

Turning on Power and Starting Adept ACE

After the system installation has been verified, you are ready to turn on AC and DC power to the system and start up Adept ACE.

1. Manually move the robot joints away from the folded shipping position, such as is shown in **Figure 2-1 on page 17**.
2. Turn on the 200/240 VAC power. See **Section 3.7 on page 31**.

DANGER: Make sure personnel are skilled and instructed - refer to the ***Adept Robot Safety Guide***.

3. Turn on the 24 VDC power to the robot. See **Section 3.6 on page 29**. The Status Panel displays OK. On newer iCobras, the Robot Status LED will be off. On older iCobras, the Robot Status LED blinks green slowly.
4. Verify the Auto/Manual switch on the Front Panel is set to Auto Mode.
5. Turn on the user-supplied PC and start Adept ACE. Double-click the Adept ACE icon on your Windows desktop, or, from the Windows Start menu bar, select **Start > Programs > Adept Technology > Adept ACE > Adept ACE**.
6. Connect a serial cable from the PC to the robot.
7. On the Adept ACE Startup menu
   - Check Create New Workspace for iCobra at: to make the connection to the iCobra.
   - Select the COM port to match the COM port being used on your PC.

See the following figure.

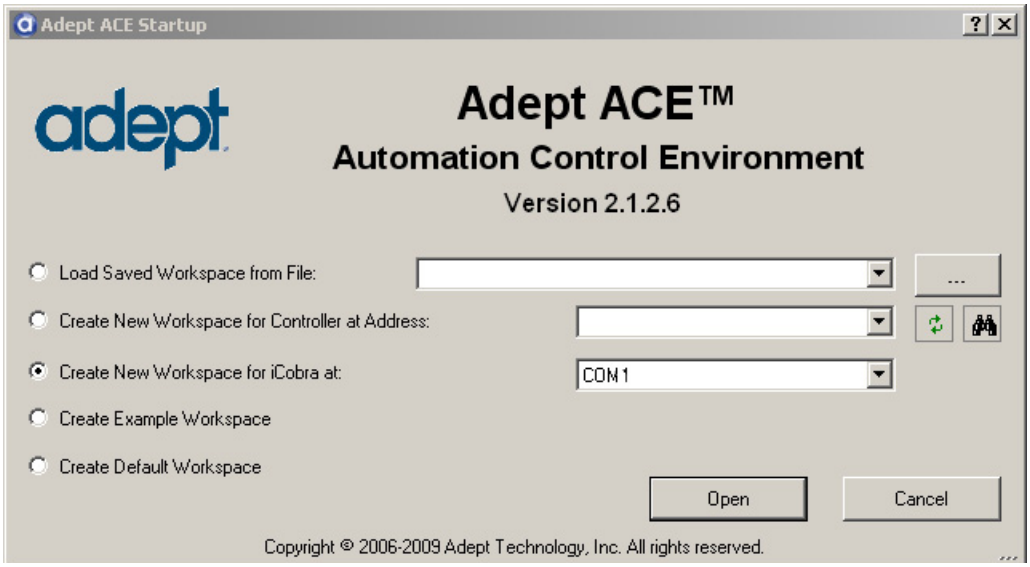


Figure 4-10 Adept ACE Startup Menu

8. Click Open.
   You will see the message "Working, please wait".

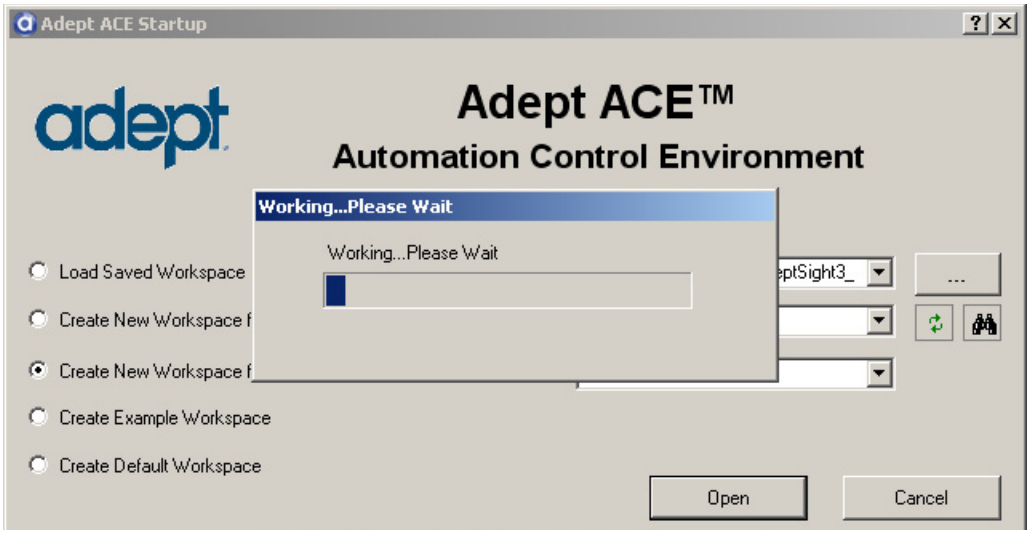


Figure 4-11 Connecting to the iCobra

Enabling High Power

After you have started Adept ACE and connected to the internal controller, enable high power to the robot motors.

Using Adept ACE to Enable High Power

1. From the Adept ACE main menu, click the Enable High Power icon. See the following figure.

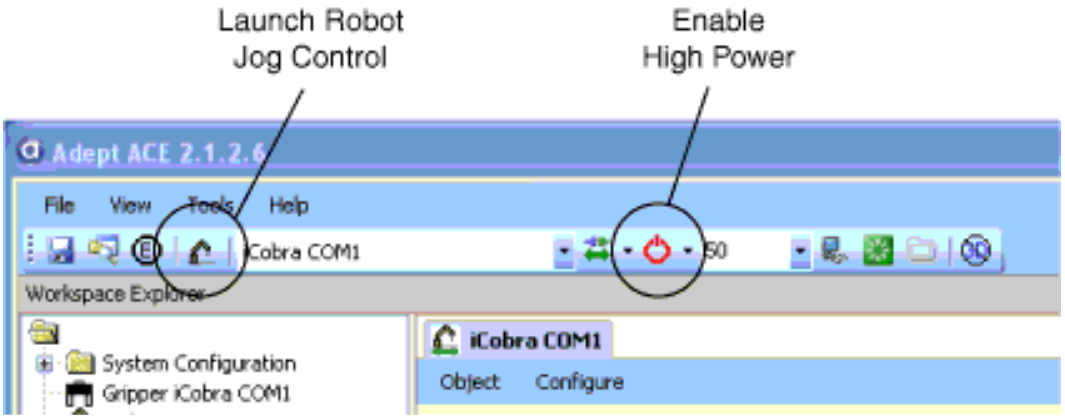


Figure 4-12 High Power and Launch Robot Jog Control Icons

2. Press and release the blinking High Power button on the Front Panel within 10 seconds. The Front Panel is shown in **Figure 4-3 on page 40**. (If the button stops blinking, you must Enable Power again.)

   NOTE: The use of the blinking High Power button can be configured (or eliminated) in software. Your system may not require this step.

   This step turns on high power to the robot motors and calibrates the robot.

   - The Robot Status LED glows amber, or, on older iCobras, blinks green rapidly.
   - The code on the Robot Diagnostic Panel displays ON (see **Figure 4-2 on page 38**).

3. Use the Robot Jog Control (see the following figure) to verify that each robot joint moves correctly in both directions.

   a. To access the Robot Jog Control, on the Adept ACE toolbar, click the Launch Robot Jog Control icon. See **Figure 4-12**.

The Robot Jog Control opens. See the following figure.

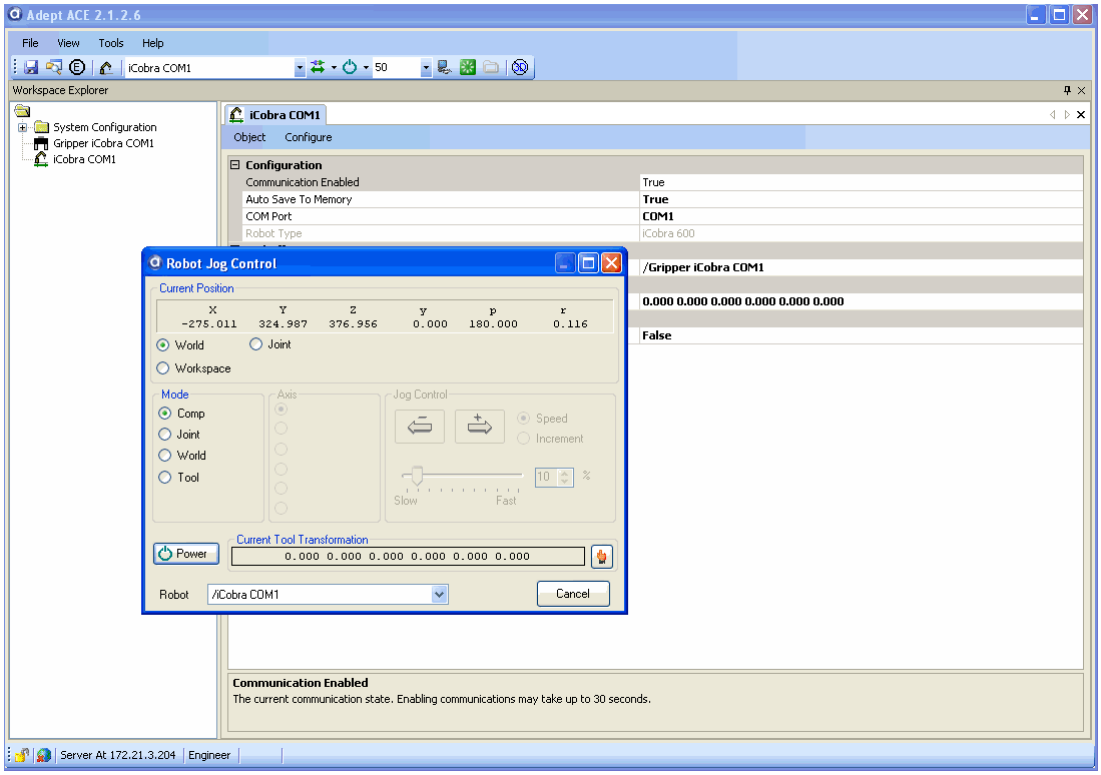


Figure 4-13 Robot Jog Control Window

b. In the Mode section, click Joint. By default, Comp will be selected.

c. Use the Robot Jog Control arrows to move Joint 1 a short distance in both directions. Repeat for Joints 2, 3, and 4. See the following figure.

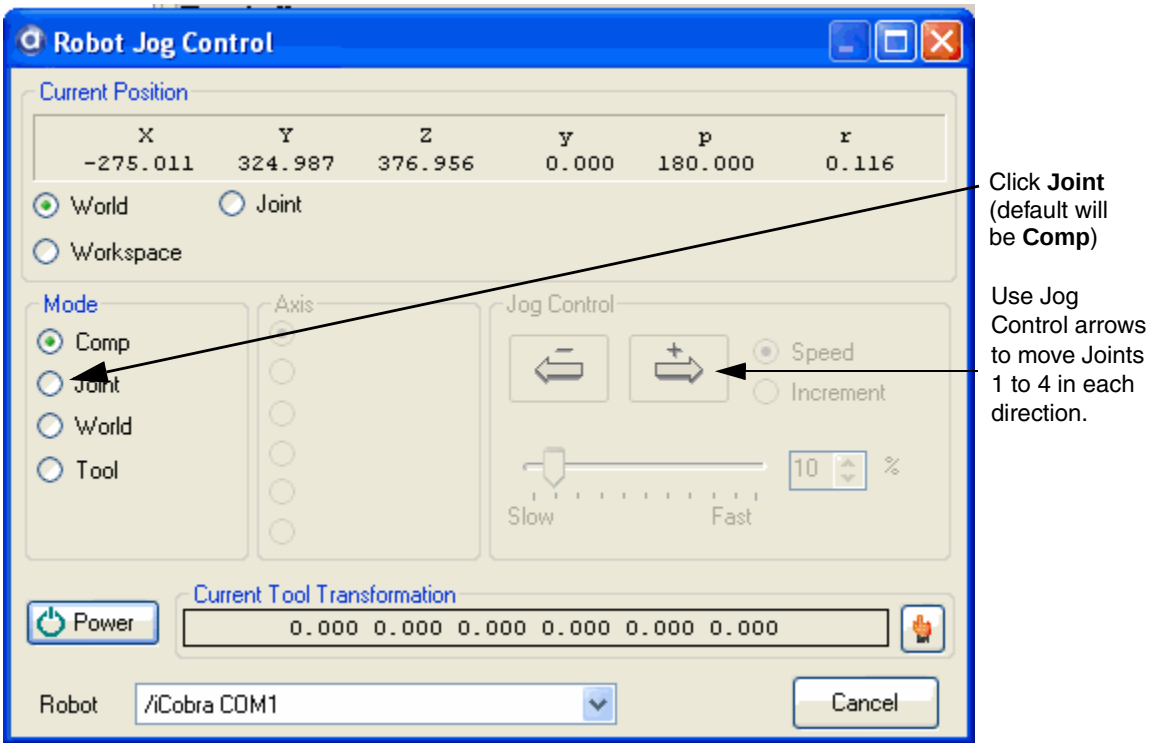


Figure 4-14 Jog Pendant Menu

4. The robot is now ready to use. Go to the next section to verify E-Stops and to **Chapter 6** for details on installing optional equipment.

Verifying E-Stop Functions

Verify that all E-Stop devices are functional (T2, Front Panel, and user-supplied). Test each mushroom button, safety gate, light curtain, etc., by enabling High Power and then opening the safety device. The High Power push-button/light on the Front Panel must go out for each E-Stop. See **Section 4.7 on page 49**.

4.9 Learning to Program the Adept Cobra i-Series Robot

To learn how to use and program the robot, go to the Adept ACE and MicroV+ online documentation in the Adept Document Library, to find information on basic operation and programming.

5 Maintenance

5.1 Field-replaceable Parts

The following two parts are the only field-replaceable parts:

Table 5-1. Field-replaceable Parts

Part	Adept Part Number
Encoder battery	09977-000 (3.6 V, 6.8 Ah) (This has replaced part number 02704-000)
AIB (Amp-In-Base)	04900-000

These parts must only be replaced with the Adept Part Numbers identified in the preceding table.

5.2 Periodic Maintenance Schedule

The following table gives a summary of the preventive maintenance procedures and guidelines on frequency.

Table 5-2. Inspection and Maintenance

Item	Period	Reference
Check E-Stop, enable and key switches, and barrier interlocks	6 months	See Section 5.3.
Check robot mounting bolt torque	6 months	See Section 5.4.
Check for signs of oil around harmonic drive.	3 months	See Section 5.5.
Lubricate Joint 3 (Z-axis) ball screw/spline	3 months	See Section 5.6.
Replace Encoder battery	5 to 10 years	See Section 5.8

NOTE: The frequency of these procedures will depend on the particular system, its operating environment, and amount of usage. Use the times in Table 5-2 as guidelines and modify the schedule as needed.

NOTE: Special maintenance for the Cleanroom version of iCobra robots is covered in Section 8.5 on page 103.

WARNING: Lockout and tagout power before servicing.

WARNING: The procedures and replacement of parts mentioned in this section should be performed only by skilled or instructed persons, as defined in the *Adept Robot Safety Guide*. The access covers on the robot are not interlocked – turn off and disconnect power if covers have to be removed.

5.3 Checking Safety Systems

It is recommended that tests be done every six months.

1. Test operation of:
   - E-Stop button on Front Panel
   - E-Stop button on T2
   - Enabling switch on T2
   - Auto/Manual switch on Front Panel

   NOTE: Operating **any** of the above switches should disable High Power.
2. Test operation of all external (user-supplied) E-Stop buttons.
3. Test operation of barrier interlocks, etc.

5.4 Checking Robot Mounting Bolt Torque

Check the tightness of the base mounting bolts every 6 months. Tighten to 85 N·m (63 ft·lb). Also check the tightness of all cover plate screws.

5.5 Checking Robot for Oil Around Harmonic Drive

The Cobra i-series robots use oil in the harmonic drive components for lubrication. It is recommended that you periodically inspect the robot for any signs of oil in areas outside of the harmonic drive. Check these locations:

NOTE: Remove all power to the robot before opening the AIB chassis.

- The area around Joint 1
- The area around Joint 2
- Inside the base of the robot, by opening the AIB chassis and inspecting internally

Contact Adept if you find any signs of oil in these areas.

5.6 Lubricating Joint 3 Ball Screw/Spline

Required Grease for the Robot

Ball Screw/Spline Assembly Grease
LG-2 Lubricating Grease Lithium Soap, Synthetic Hydrocarbon
Adept part number: 85139-00002

CAUTION: Using improper lubrication products on the Adept Cobra i600 or i800 robot may cause damage to the robot.

Lubrication Procedure

1. Turn off main power to the robot.
2. Remove the outer link cover by removing six screws located on the sides and top of the cover. Carefully remove the cover.

WARNING: When the outer link cover is removed, you see the label shown in **Figure 6-4 on page 74**. Do not remove the J3-ENC or J4-ENC encoder cable connectors from their sockets. If they are removed, the calibration data will be lost and the robot must be run through a factory recalibration process, which requires special software and tools.

3. Switch on 24 VDC power to the robot
4. Press the Brake Release button and move Joint 3 to the top of its travel. Remove any existing grease with a soft, clean, lint-free cloth.
5. Using a syringe, apply a small bead of grease to the Joint 3 ball screw grooves (see **Figure 5-1 on page 64**).
6. Move Joint 3 to the bottom of its travel. Remove any existing grease with a soft, clean, lint-free cloth.
7. Apply a thin film of grease to any grooves of the ball screw that you did not reach in **Step 5**.
8. Move Joint 3 up and down several times to spread the grease evenly.

9. Remove 24 VDC power from the robot.
10. Reinstall the outer link cover.

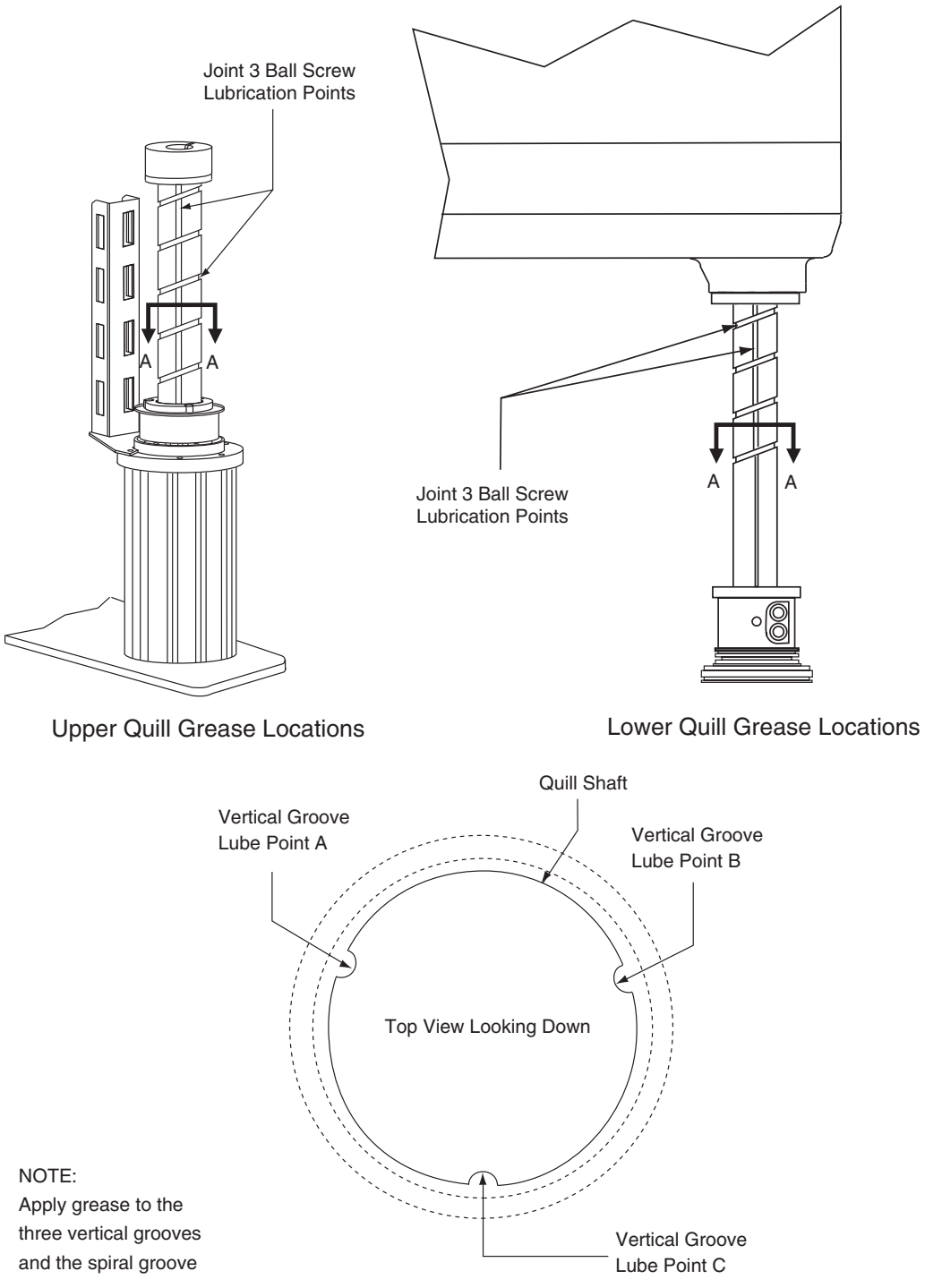


Figure 5-1. Lubrication of Joint 3 Quill

5.7 Replacing the AIB Chassis

This procedure provides details on how to replace the AIB chassis on a Cobra i-series robot.

CAUTION: Follow appropriate ESD procedures during the removal/replacement phases.

CAUTION: All application and robot configuration data are stored on the AIB chassis. Make sure you have backed up this data to the PC before removing the AIB chassis.

After installation of the new AIB chassis, all backed-up data must be written to the new AIB chassis.

Removing the AIB Chassis

1. Switch off the 24 VDC input supply to the chassis.
2. Switch off the 200/240 VAC input supply to the chassis.
3. Disconnect the 24 VDC supply cable from the chassis +24 VDC input connector. See **Figure 2-3 on page 22** for locations of connectors.
4. Disconnect the 200/240 VAC supply cable from the chassis AC Input connector.
5. Disconnect the AIB XPANEL cable from the XPANEL connector.
6. Disconnect any other cables, which may be connected to the chassis, such as XIO, RS-232, or any others.
7. Using a 5 mm Allen key, carefully unscrew the chassis securing screw. See the following figure.

   NOTE: The screw does not need to be completely removed in order to remove the chassis, as this screw is captured on the chassis heat sink.

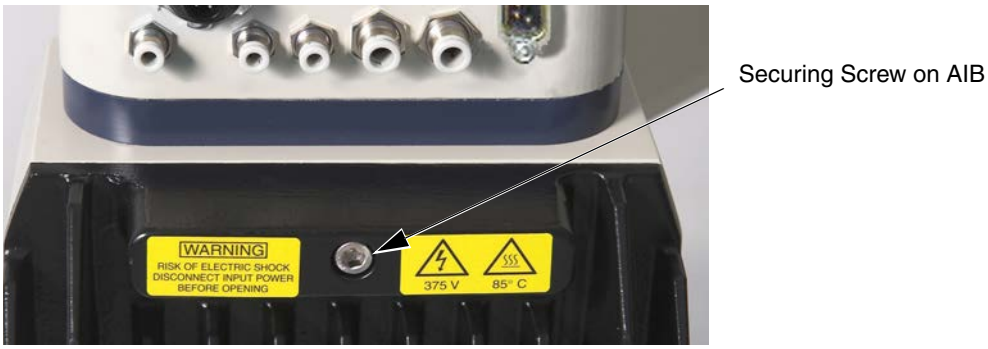


Figure 5-2. Securing Screw on AIB Chassis

8. While holding the chassis heat sink, carefully and slowly lower the chassis down (see **Figure 5-3 on page 66**), so that enough access is available to remove the internal cables. The chassis can be laid flat or placed to the right side of the robot for better access.

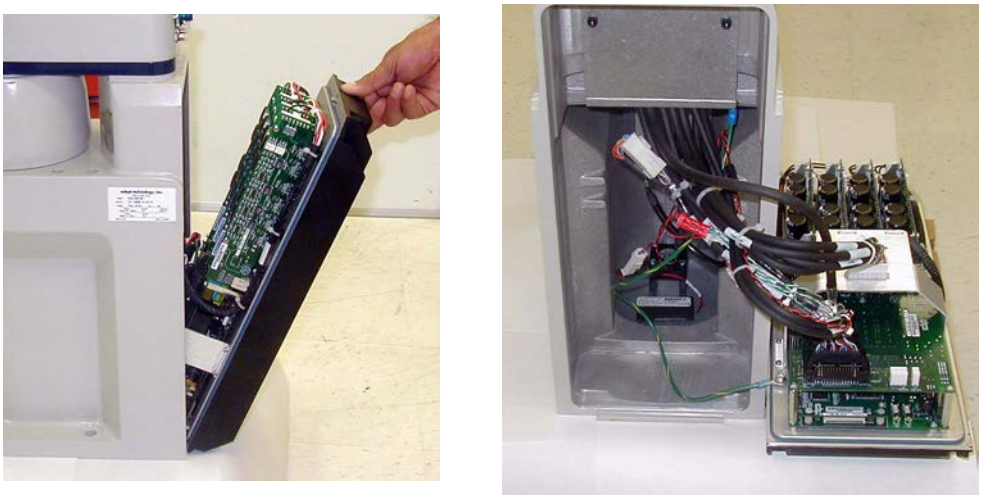


Figure 5-3. Opening and Removing AIB Chassis

9. Disconnect the "white" amplifier cable from the amplifier connector located on the chassis bracket. See **Figure 5-4**.

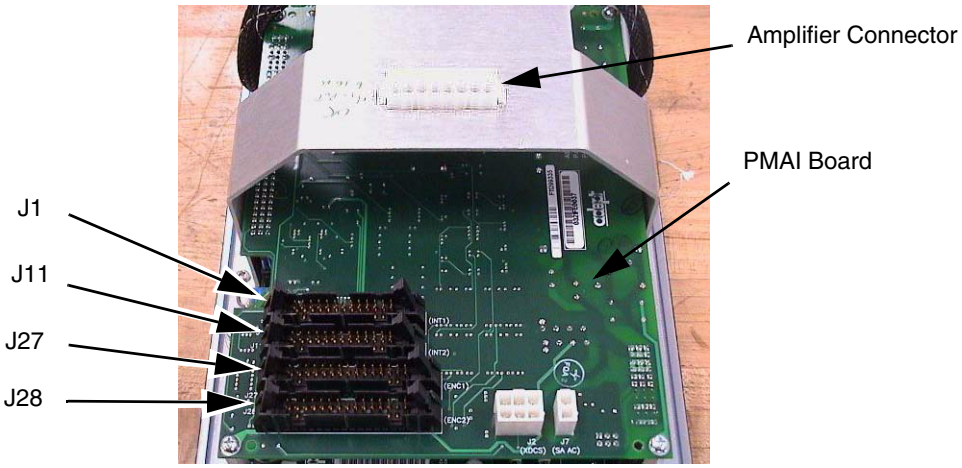


Figure 5-4. Connectors on AIB Chassis

10. Carefully disconnect the J1 cable from the J1 connector on the PMAI, by disengaging the securing latches.
11. Carefully disconnect the J11 cable from the J11 connector on the PMAI, by disengaging the securing latches.
12. Carefully disconnect the J27 cable from the J27 connector on the PMAI, by disengaging the securing latches.
13. Carefully disconnect the J28 cable from the J28 connector on the PMAI, by disengaging the securing latches.

14. Using a 5 mm Allen key, disconnect and remove the ground wire from the chassis. Keep the screw for reassembly later. See the following figure.

Figure 5-5. Ground Screw on AIB Chassis

15. Carefully remove the chassis from the robot, and place it aside. Tag it with the appropriate fault diagnosis faults/errors and robot serial number information.

Installing a New AIB Chassis

1. Carefully remove the new chassis from its packaging, check it for any signs for damage. Remove any foreign packing materials or debris from inside the chassis.
2. Carefully place the chassis next to the robot.
3. Using a 5 mm Allen key, carefully connect the ground wire to the chassis.
4. Carefully connect the J28 cable to the J28 connector on the PMAI, and engage the securing latches.
5. Carefully connect the J27 cable to the J27 connector on the PMAI, and engage the securing latches.
6. Carefully connect the J11 cable to the J11 connector on the PMAI, and engage the securing latches.
7. Carefully connect the J1 cable to the J1 connector on the PMAI, and engage the securing latches.
8. Carefully connect the white amplifier cable to the amplifier connector located on the chassis bracket.

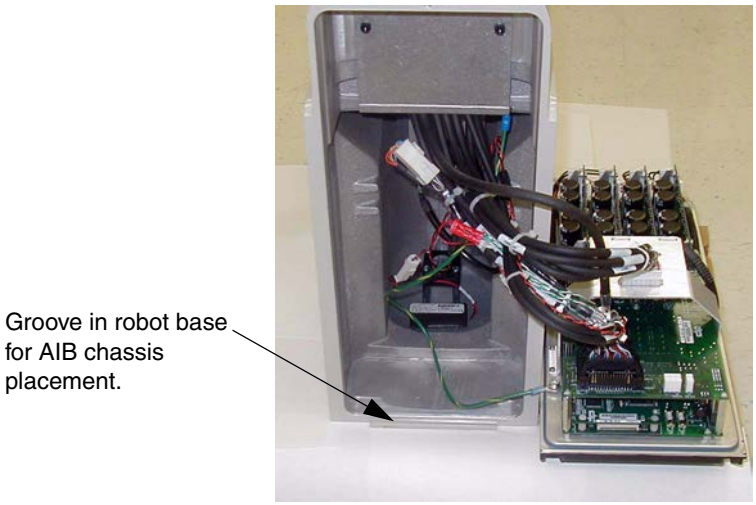


Figure 5-6. Installing AIB Chassis in Robot Base

9. Carefully insert the chassis into the robot base in the groove at the bottom of the base - see **Figure 5-6**. Tilt the chassis up and into place against the robot, making sure that none of the cables get trapped or pinched and that the chassis O-ring is not damaged during installation.
10. Once the chassis is in place, use a 5 mm Allen key to tighten the chassis securing screw. See **Figure 5-2 on page 65** for details.
11. Connect the 200/240 VAC supply cable to the chassis AC Input connector.
12. Connect the AIB XPANEL cable to the XPANEL connector.
13. Connect any other cables that were removed from the chassis, such as XIO, RS-232, or any others.
14. Connect the 24 VDC supply cable to the chassis +24 VDC input connector.
15. Switch on the 200/240 VAC input supply to the chassis.
16. Switch on the 24 VDC input supply to the chassis.
17. Install MicroV+ on the AIB chassis.
18. Install the application and robot configuration data on the AIB chassis.
19. Once the system has completed booting, test the system for proper operation.

5.8 Replacing Encoder Battery

The data stored by the encoders is protected by a 3.6 V lithium backup battery located in the base of the robot.

CAUTION: Replace the battery pack only with a 3.6 V, 6.8 Ah lithium battery pack, Adept P/N 09977-000. Battery information is located in the base of the robot.

NOTE: The previous battery, P/N 02704-000, has been superceded by this battery pack. The battery replacement interval and procedure have not changed.

Battery Replacement Time Periods

If the robot is kept in storage and not in production, or the robot is turned off (no 24 VDC supply) most of the time, then the battery should be replaced every 5 years.

If the robot is turned on with 24 VDC supplied to the robot more than half the time, then you can increase the replacement interval to a maximum of 10 years.

NOTE: Dispose of the battery according to all local and national environmental regulations regarding electronic components.

Battery Replacement Procedure

1. Obtain the replacement battery pack.
2. Switch off the 24 VDC input supply to the robot.
3. Switch off the 200/240 VAC input supply to the robot.
4. Disconnect the 24 VDC supply cable from the robot +24 VDC input connector. See **Figure 2-3 on page 22** for locations of connectors.
5. Disconnect the 200/240 VAC supply cable from the robot AC Input connector.
6. Using a 5 mm Allen key, carefully unscrew the chassis securing screw. See **Figure 5-2 on page 65**. Note that the screw does not need to be completely removed in order to remove the chassis, as this screw is captured on the chassis heat sink.
7. While holding the chassis heat sink, carefully and slowly lower the chassis down (see **Figure 5-3 on page 66**), so there is access to the battery. See **Figure 5-7**.

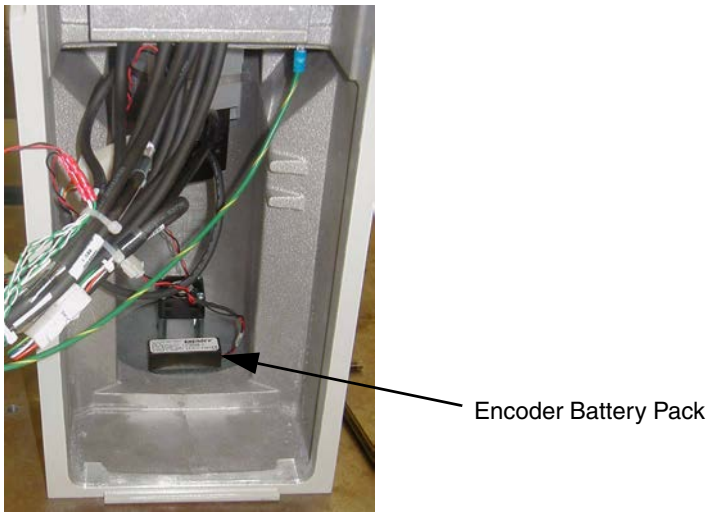


Figure 5-7. Location of Encoder Battery Pack

8. The battery cable assembly has two sets of connectors. Locate the unused battery cable in the wire bundle in the base area.
9. Place the new battery pack next to the original one, but do not disconnect the original one.
10. Connect the new battery pack to the connectors on the unused battery cable. Make sure to verify the positive and negative connections are correct.
11. Once the new battery pack is connected, disconnect and remove the original battery pack.
12. Place the new battery pack in the original location on the base of the robot.
13. Close the robot by reversing the steps in the beginning of this procedure.
14. Reconnect the 200/240 VAC supply cable to the robot AC input connector.
15. Reconnect the 24 VDC supply cable to the robot +24 VDC input connector. See **Figure 2-3 on page 22** for locations of connectors.

Optional Equipment Installation 6

6.1 Installing End-Effectors

The user is responsible for providing and installing any end-effector or other end-of-arm tooling. End-effectors can be attached to the tool flange using four M6 screws. See **Figure 7-4 on page 94** for a dimension drawing of the tool flange.

A 6 mm diameter x 12 mm dowel pin (not supplied) fits in the through-hole in the tool flange and can be used as a keying or anti-rotation device in a user-designed end-effector.

If hazardous voltages are present at the end-effector, you must install a ground connection from the base of the robot or the outer link to the end-effector. See **"Robot-Mounted Equipment Grounding" on page 35**.

> **NOTE:** A threaded hole is provided on the tool flange (see **Figure 7-4 on page 94**). The user may attach a ground wire through the quill connecting the outer link and the tool flange.

6.2 Removing and Installing the Tool Flange

The tool flange can be removed and reinstalled if required. If the flange is removed, it must be reinstalled in exactly the same position to avoid losing the calibration for the system.

There is a setscrew on the flange that holds the rotational position of the flange on the quill shaft. A ball bearing behind the setscrew contacts the shaft in one of the vertical-spline grooves in the shaft. The following procedures cover removal and reinstallation of the flange.

Removing the Flange

1. Turn off High Power and system power to the robot.
2. Remove any attached end-effectors or other tooling from the flange.
3. Use a 2.5 mm Allen driver to loosen the setscrew (see **Figure 6-1 on page 72**). Note the vertical-spline groove that is in line with the setscrew. You must reinstall the flange in the same position.
4. Use a socket driver to loosen the two M4 socket-head screws.
5. Slide the flange down slowly until it is off the shaft. *Be careful* not to lose the ball bearing (3.5 mm) that is between the flange and shaft, behind the setscrew.

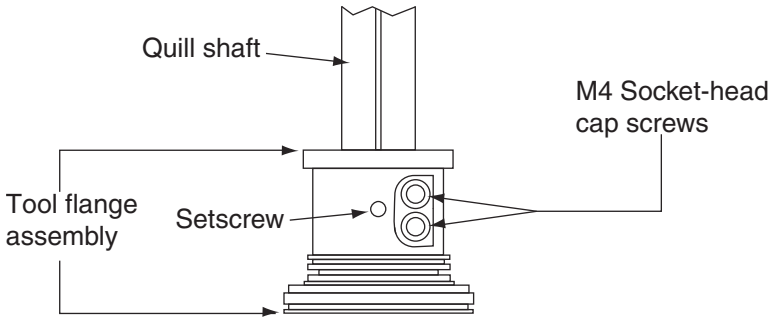


Figure 6-1. Tool Flange Removal Details

Installing the Flange

1. Make sure the ball bearing is in the setscrew hole between the flange and the shaft. Hold it in place with your finger as you get ready to install the flange.
2. Slide the flange up on the quill shaft as far as it will go, and rotate until the setscrew is lined up with the original vertical groove.
3. Support the flange while using a 2.5 mm Allen driver to tighten the setscrew to finger tight. Do not over-tighten the setscrew because this will cause the flange to be off-center from the quill shaft.
4. Use a socket driver to tighten one of the socket-head screws part of the way, then tighten the other one the same amount. Alternate between the two screws so there is even pressure on both once they are tight. The torque specification for each screw is 8 N·m (70 in·lb).

6.3 User Connections on the Robot

User Air Lines

There are five user air line connectors on the robot user panel on the back of Joint 1 (see **Figure 6-2**). The five air lines run through the robot up to another set of five matching connectors on the top of the outer link (see **Figure 6-3**).

- The two larger connectors are 6 mm diameter.
- The three smaller connectors are 4 mm diameter.

NOTE: The DeviceNet feature is not operational in the Cobra i-series robot. The connectors for DeviceNet are wired through the robot, and can be used if the user is supplying the control software for DeviceNet.

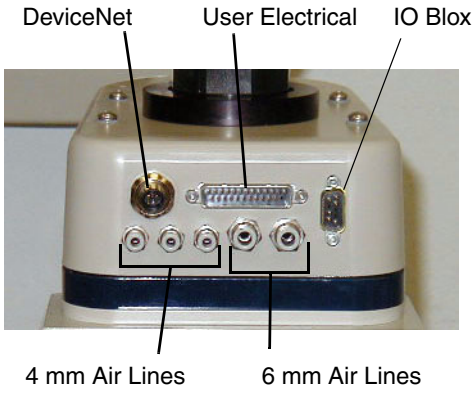


Figure 6-2. User Connectors on Joint 1

NOTE: See page 41 for information on the IO Blox connector. Also refer to the *Adept IO Blox User's Guide* for details.

User Electrical Lines

There is a 25-pin male connector (24 conductor) on the robot user panel on the back of Joint 1 for user electrical lines (see **Figure 6-2**). This connector is wired directly to a 25-pin female connector on the top of the outer link (see **Figure 6-3**). These connectors can be used to run user electrical signals from the user panel, through the robot, and up to the outer link.

Wire Specifications: Wire size: 0.1 mm^2, Pin Numbers 1-24, 12 pairs, twisted in pairs as 1&2, 3&4, 5&6, ..., 23&24. Maximum current per line: 1 Amp.

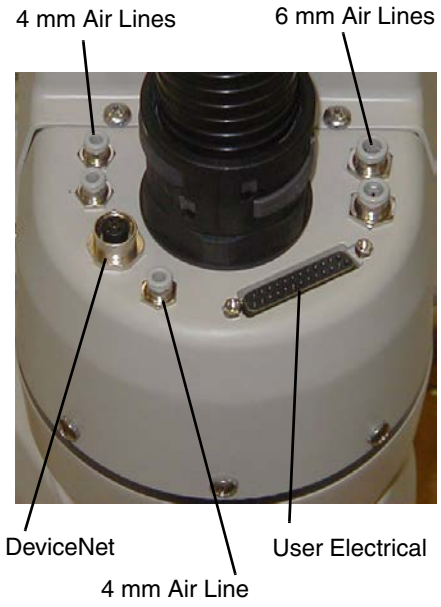
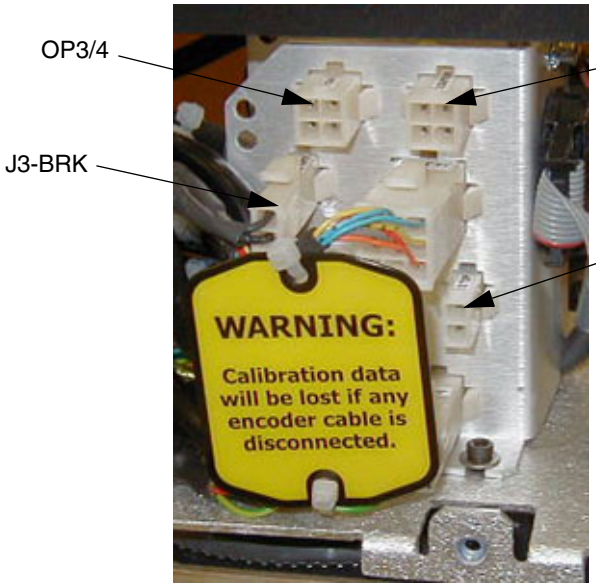


Figure 6-3. User Connectors on Joint 2

6.4 Internal User Connectors

The internal user connectors, OP3/4, EOAPWR, and ESTOP, can be accessed with the outer link cover removed - see **Figure 6-4**. The SOLND connector is located on the opposite side of the bulkhead area - see **Figure 6-5**.



NOTE: On early Cobra i600 robots, the J3-BRK and ESTOP connectors are in opposite locations from those shown in the photo. Verify the function by inspecting the label on the socket.

Figure 6-4. Internal User Connectors - OP3/4, EOAPWR, ESTOP

WARNING: When the outer link cover is removed, you see the label shown above. Do not remove the J3-ENC or J4-ENC encoder cable connectors from their sockets. If they are removed, the calibration data will be lost and the robot must be run through a factory recalibration process, which requires special software and tools.

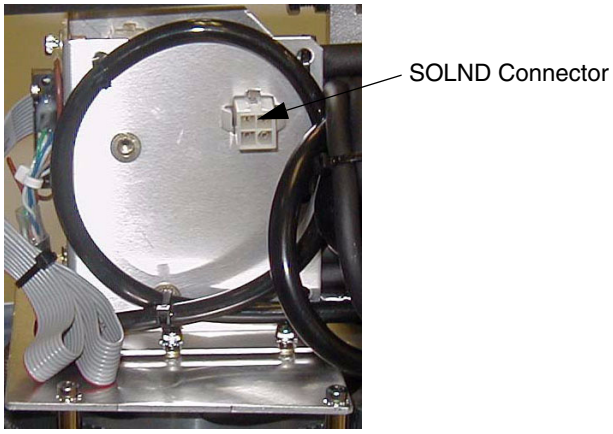
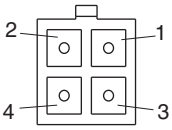


Figure 6-5. SOLND Connector

SOLND Connector

This 4-pin connector provides the output signals for the optional Robot Solenoid Kit. See the following table and Figure 6-5 on page 74. See Section 6.6 on page 79 for installation details.

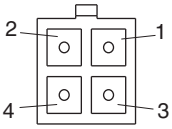
Table 6-1. SOLND Connector Pinout

Pin #	Description	Pin Location
1	Output signal 9	 SOLND Connector as viewed on robot
2	Ground	
3	Output signal 10	
4	Ground	
Mating Connector: AMP/Tyco #172167-1, 4-pin Mini-Universal Mate-N-Lok AMP/Tyco #770985-1, Pin Contact, Mini-Univ. Mate-N-Lok		

OP3/4 Connector

This 4-pin connector (see Figure 6-4 on page 74) provides the output signals for a second set of optional robot hand valve solenoids, or other user-supplied devices. See the following table and Figure 6-6 on page 76.

Table 6-2. OP3/4 Connector Pinout

Pin #	Description	Pin Location
1	Output signal 11	 OP3/4 Connector as viewed on robot
2	Ground	
3	Output signal 12	
4	Ground	
Mating Connector: AMP/Tyco #172167-1, 4-pin Mini-Universal Mate-N-Lok AMP/Tyco #770985-1, Pin Contact, Mini-Univ. Mate-N-Lok		

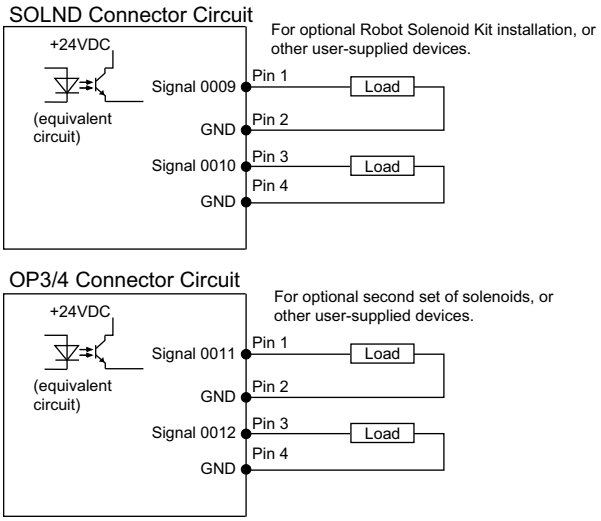
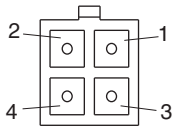


Figure 6-6. OP3/4 and SOLND Circuits

EOAPWR Connector

This 4-pin connector (see **Figure 6-4 on page 74**) provides 24 VDC power and ground for user applications. See the following table for the pinouts and **Table 6-4** for the output specifications.

Table 6-3. EOAPWR Connector Pinout

Pin #	Description	Pin Location
1	24 VDC (see **Table 6-4** for current specs)	 EOAPWR Connector as viewed on robot
2	Ground	
3	24 VDC (see **Table 6-4** for current specs)	
4	Ground	
Mating Connector: AMP/Tyco #172167-1, 4-pin Mini-Universal Mate-N-Lok AMP/Tyco #770985-1, Pin Contact, Mini-Univ. Mate-N-Lok		

Internal User Connector Output Specifications

The output specifications in the following table apply to the EOAPWR, OP3/4, and SOLND internal user connectors.

Table 6-4. Internal User Connector Output Circuit Specifications

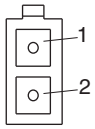
Parameter	Value
Power supply voltage range	24 VDC (± 10%), 150 W (6 A) (21.6 V< V_{in} < 26.4 V)
Operational current range, per channel	$I_{out} \leq$ 700 mA
Total Current Limitation, all channels on.[a]	$I_{total} \leq$ 1.0 A @ 50° C ambient $I_{total} \leq$ 1.5 A @ 25° C ambient
On-state resistance (I_{out} = 0.5 A)	$R_{on} \leq$ 0.32 Ω @ 85° C
Output leakage current	$I_{out} \leq$ 25 µA
Turn-on response time	125 µsec. max., 80 µsec typical (hardware only)
Turn-off response time	60 µsec. max., 28 µsec typical (hardware only)
Output voltage at inductive load turnoff (I_{out} = 0.5 A, Load = 1 mH)	(+V - 65) $\leq V_{demag} \leq$ (+V - 45)
DC short circuit current limit	0.7 A $\leq I_{LIM} \leq$ 2.5 A
Peak short circuit current	$I_{ovpk} \leq$ 4 A

[a] **NOTE**: Total current is the sum of the output current used by output signals 3001-3004 (SOLND and OP3/4) and any user current drawn from EOAPWR.

ESTOP Connector

This 2-pin connector provides a pair of contacts that can be used for a Breakaway E-Stop function at the end of the arm. See **Table 6-5**. The function is disabled by default when the system is shipped. The user must enable this function using the Configuration Manager (see below), and connect a normally-closed circuit to pins 1 and 2. When the circuit is opened, the system will stop in an E-Stop condition. See **Figure 6-7**.

Table 6-5. ESTOP Connector

Pin #	Description	Pin Location
1	ESTOP_INPUT	 ESTOP Connector as viewed on robot
2	24 V	
Mating Connector: AMP/Tyco #172165-1, 2-pin Mini-Universal Mate-N-Lock AMP/Tyco #770985-1, Pin Contact, Mini-Univ. Mate-N-Lok		

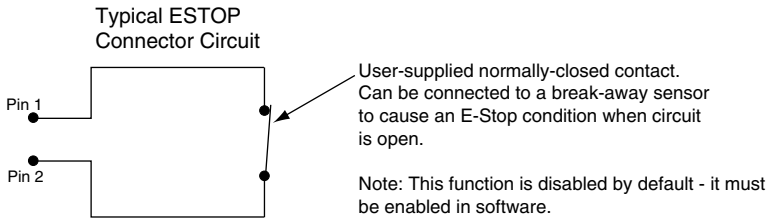


Figure 6-7. Internal E-Stop Connector Circuit

NOTE: This circuit will trigger an emergency stop of the local robot only. It does not to link the E-Stop chain of the host system

Procedure to Enable Breakaway E-Stop Function

To enable the Breakaway E-Stop function, you have to use the Configuration Manager to change the default configuration.

1. Double-click the iCobra object in the Folder pane of the Workspace Explorer.
2. In the object editor, select **Configure > Configuration Manager**. See the following figure.

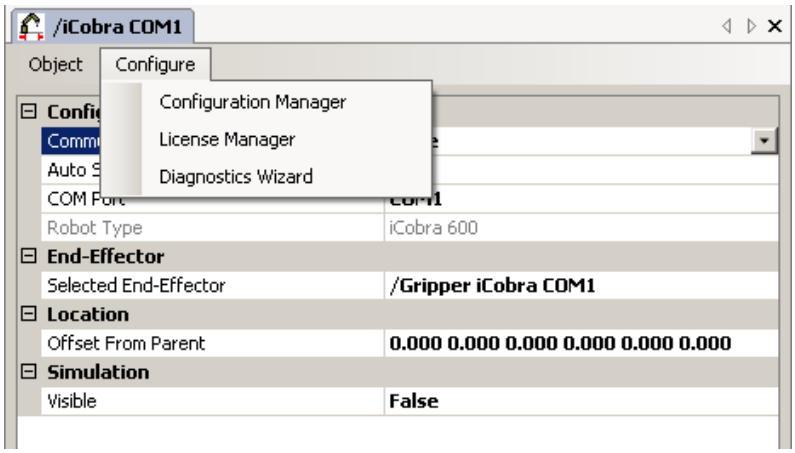
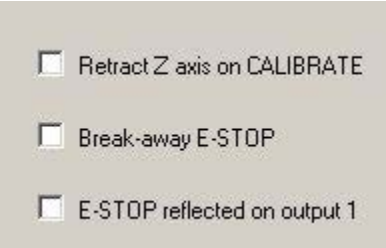


Figure 6-8. Selecting the Configuration Manager

3. Click the Advanced tab.
4. Check the Break-away E-STOP box.



5. Click Apply.

NOTE: When the Break-away E-Stop function has been enabled, you must connect a normally-closed circuit to pins 1 and 2 of the ESTOP connector, as described above. If this is not done, the system will be in an E-Stop condition and you will not be able to enable power.

6.5 Mounting Locations for External Equipment

Three locations are provided for mounting user's external equipment on the robot arm. The first location is on the J1 Harness Support (top side of the inner link), a second is on the top side of the outer link, and a third is on the bottom side of the outer link. Each location has a set of four threaded holes. See **Figure 7-5 on page 95** and **Figure 7-6 on page 96** for the dimensions.

NOTE: The cover on the outer link must be removed for maintenance (lubrication), so keep this in mind when mounting any external equipment to the outer link cover.

6.6 Installing the Robot Solenoid Kit

Introduction

This procedure describes how to mount the 24 V solenoid option kit on an Adept Cobra i-series robot. The solenoid kit is available as Adept P/N 02853-000.

The robot has been pre-wired to accommodate a bank of two 24 VDC solenoid valves. Power for the internal mounting is accessible via a connector mounted inside the outer link cover (see **Figure 6-9 on page 81**). The signals actuating the valves are directly switchable from MicroV$^+$ utilizing software signals 9 and 10. Each driver is designed to handle 24 VDC solenoids at a nominal 75 mA per valve.

The solenoid valve assembly consists of two independent valves (Valve #1 and Valve #2) on a common manifold. The manifold supplies air at the user's line pressure, 28 psi minimum to 114 psi (0.2 MPa to 0.8 MPa). Each valve has two output ports, A and B. The output ports are arranged so that when Port A is pressurized, Port B is not pressurized. Conversely, when Port B is pressurized, Port A is not. In the Adept Cobra i-series robots, the air lines from Port A on each valve are plugged at the factory (at the solenoid assembly).

The Solenoid Kit for the Adept Cobra i-series robot is available through Adept. Contact your Adept Sales Representative for current price and availability.

Table 6-6. Air Pressure

Air Pressure (psi)	Air Pressure (MPa)
28 - 114	0.2 - 0.8

Tools Required

- Assorted Allen drivers
- Cable ties
- Diagonal wire cutters
- Solenoid Valve upgrade Kit (Adept P/N 02853-000)

Procedure

1. Turn off all power to the robot.
2. Remove two screws on the i600 (three screws on the i800) on each side of the outer link cover. Remove two screws on the top and remove the cover.
3. Connect the Internal Solenoid Valve Cable assembly to the Solenoid Manifold assembly, by plugging the SOL 1 connector into Valve 1 and SOL 2 into Valve 2.

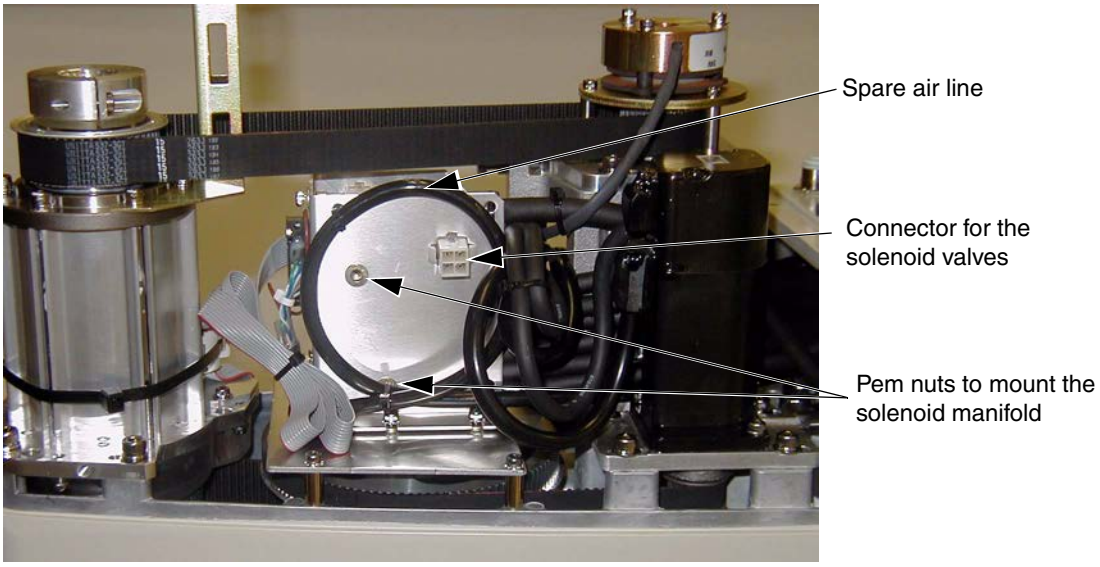


Figure 6-9. Solenoid Mounting Bracket with Connector and Spare Air Line

4. Cut and discard the cable ties holding the spare air line at the top of the mounting bracket. Move the air line away to facilitate the mounting of the solenoid manifold (see **Figure 6-9**).
5. Mount the solenoid manifold onto the bracket using the supplied M3 x 25 mm screws and washers (see **Figure 6-10 on page 82**).
6. Insert the spare air line into the air intake coupling of the solenoid manifold. Make sure the air line is pushed in all the way and secured in place by the intake coupling. Confirm by pulling on the air line.

   NOTE: If you are installing a Solenoid Kit on a Cleanroom robot, the spare air line is used for a different purpose in those robots. You will have to provide a piece of 6 mm tubing to run from one of the 6 mm user air lines at the Joint 2 cover to the air intake coupling mentioned above.

7. Plug the connector plug into the female connector jack (marked SOLND) on the bracket.
8. Use cable ties, as needed, to secure the air line to the bracket.

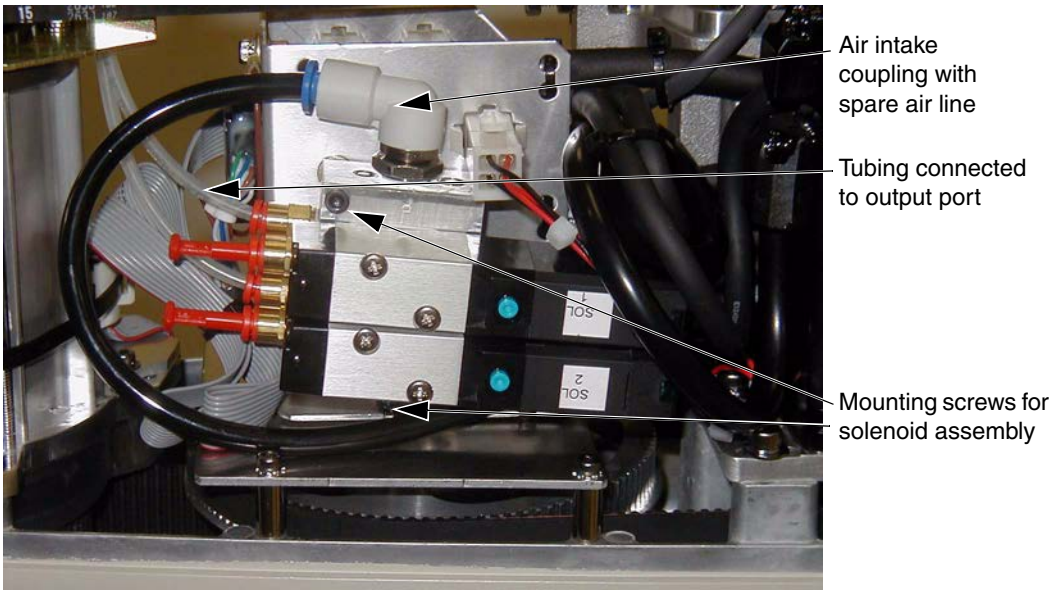


Figure 6-10. Solenoid Placement Using Mounting Hardware

9. Install the appropriate lengths of 4 mm (5/32 in.) plastic tubing (supplied) into the two output ports on the manifold. Route the tubing up along the tower bracket next to the quill and down through the center of the quill. Use cable ties, as needed, to secure the tubing.
10. Loosen the securing screw on the AIB chassis, and lower the chassis down flat. See **Figure 5-2 on page 65** for the location of the securing screw.
11. Remove the cable strap plate by removing two screws and split washers. See **Figure 6-11**. This allows the harness to move when you lift the J1 cover in the next step.

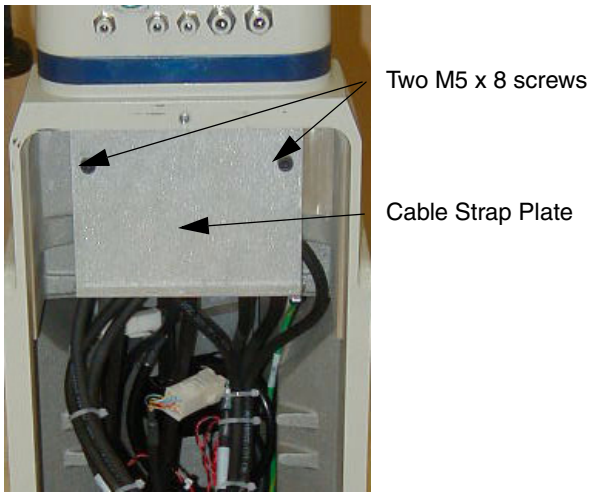


Figure 6-11. Removing the Cable Strap Plate

12. Remove the four screws for the Joint 1 cover and lift the cover up so you have access to the tubing under the cover. See **Figure 6-12**.

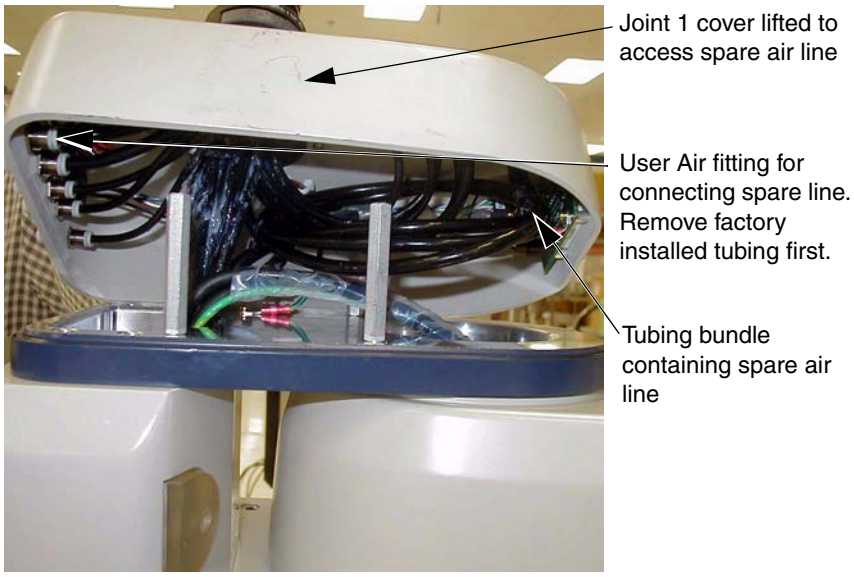


Figure 6-12. Connecting Spare Air Line to User Connector

13. Disconnect the tubing from the 6 mm User Air fitting shown in **Figure 6-12**. Fold the tubing out of the way and restrain using cable ties.
14. Locate the spare air line contained in the tubing bundle inside the front end of the cover. Remove the spare air line from the bundle.
15. Insert the spare air line into the back of the empty 6 mm User Air fitting.

    NOTE: This 6 mm User Air connector and the corresponding 6 mm User Air connector at the top of **Figure 6-2 on page 73** are not functional for other uses after this modification.

16. Reinstall the Joint 1 cover, taking care to ensure that all tubing is inside the cover and nothing gets crimped or pinched when pushing the cover into position. Reinstall the screws to secure the cover. Tighten the screws to 1.6 N·m (14 in·lb).
17. Reinstall the outer link cover and tighten the screws to 1.6 N·m (14 in·lb) of torque.
18. Connect the factory air supply to the modified 6 mm User Air connector.
19. Turn on system power and boot the system. The default values for the gripper signals that activate the solenoids are 9 and 10. Once the system boot has completed, at the MicroV+ dot prompt, type in the following commands to activate the solenoids one at a time.

    .SIGNAL 9
    .SIGNAL 10

WARNING: The robot air pressure should be disconnected until this test has been done to prevent unsecured pneumatic lines from accidentally injuring personnel.

6.7 Installing Adjustable Hardstops

Adept offers an adjustable hardstop kit for Joint 1 and Joint 2 on the Adept Cobra i600/i800 robots. These are user-installed options that can be used to limit the work envelope of the robot. The Adept part number for the kit is 02592-000.

Joint 1 Adjustable Hardstops

The Joint 1 Adjustable Hardstops consist of two black rubber stop cylinders, and the screws to install them. There are two locations for the hardstops on each side of the robot: Position 1 and Position 2. See the following figure.

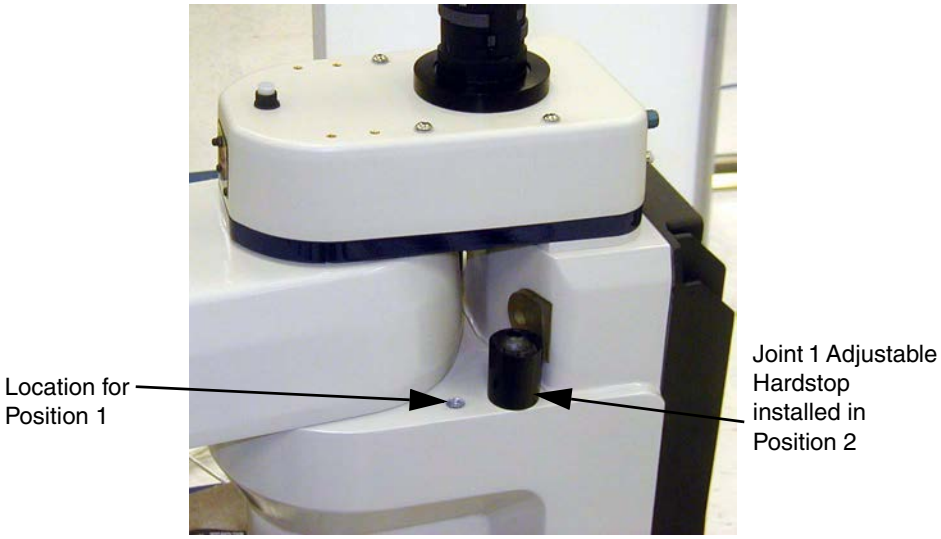


Figure 6-13. Joint 1 Adjustable Hardstops

Installation Procedure

1. Remove the plug from the desired threaded hole, Position 1 or 2, on each side of the robot.
2. Install the adjustable hardstop into the threaded hole using an 8 mm Allen wrench. Tighten to a torque of 5.1 N··m (45 in-lbf).
3. Repeat the process on the other side of the robot.

Modifying Joint Limit Softstop Locations for Joint 1

After installing the adjustable hardstops, you must modify the softstop locations using the Configuration Manager utility. See the online help for more details on this utility.

1. Double-click the iCobra object in the Folder pane of the Workspace Explorer.
2. In the object editor, select **Configure > Configuration Manager**.

3. Click Joint 1.

   The following screen opens to allow editing the limits:

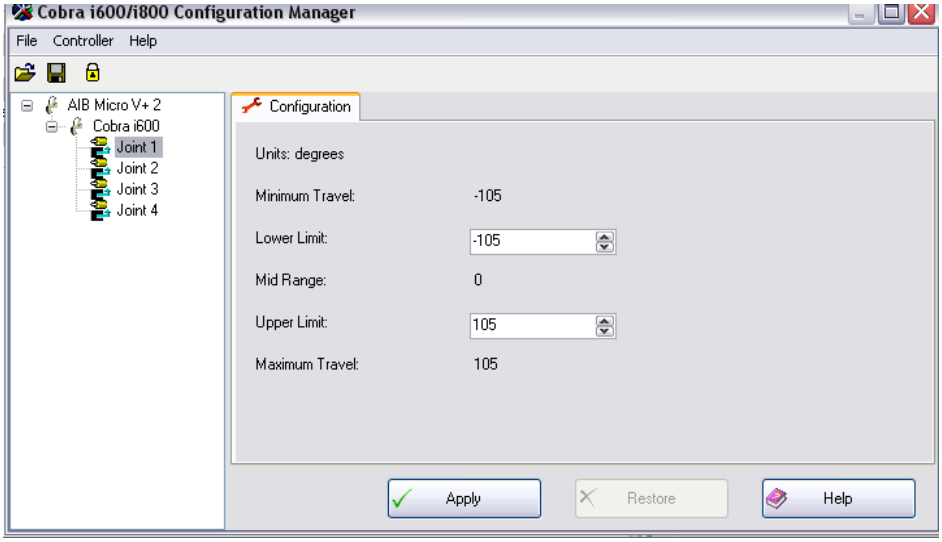


Figure 6-14. Configuration Manager - Modifying Joint 1 Limits

4. In the Lower Limit field, enter the new value for the J1 lower limit softstop. See the following table for recommended softstop values for Position 1 or Position 2.

Table 6-7. Joint 1 Ranges for Adjustable Hardstops

	Hardstop Value	Recommended Joint Limit Softstop
J1 Hardstop Position 1	± 50°	Lower limit: – 49° Upper limit: + 49°
J1 Hardstop Position 2	± 88°	Lower limit: – 87° Upper limit: + 87°

5. In the Upper Limit field, enter the new value for the J1 upper limit softstop. See the preceding table for recommended softstop values for Position 1 or Position 2.
6. Click Apply. The Apply Changes window opens, as illustrated in **Figure 6-15**.
7. Select the required options for saving joint limit values to temporary or permanent memory. For more information on saving changes, click Help
8. Click Write to apply and save the changes.

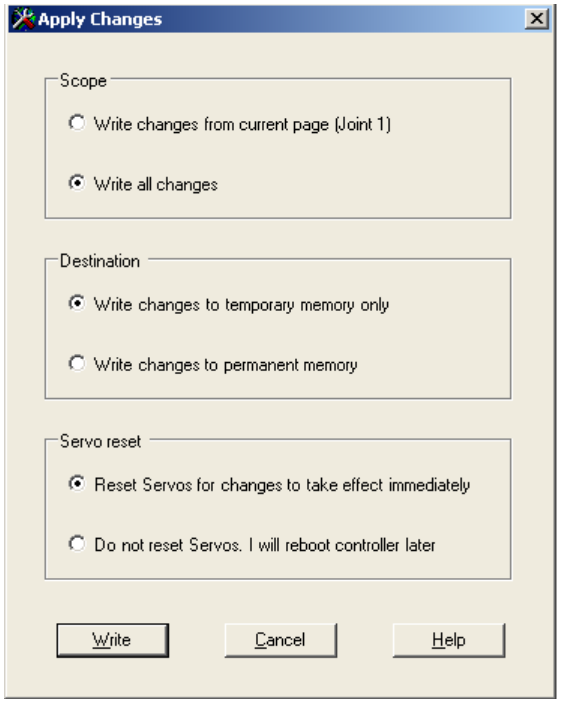


Figure 6-15. Configuration Manager - Apply Changes

Joint 2 Adjustable Hardstops

The Joint 2 Adjustable Hardstop kit (see **Figure 6-16**) consists of two curved plates that are the adjustable hardstops, a small, black rectangular block that is the fixed hardstop, and the required screws to install them. The adjustable hardstop plates can be installed in different locations, depending on how much you need to limit the Joint 2 range of motion.

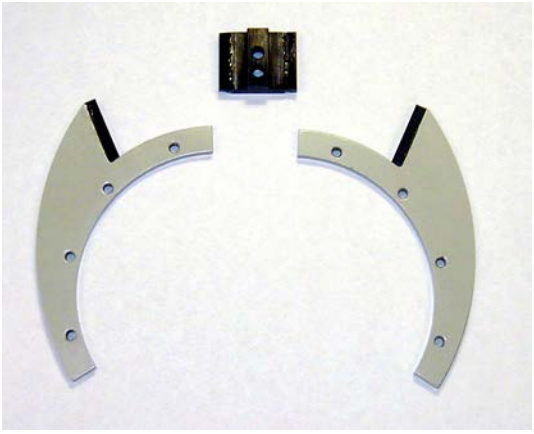


Figure 6-16. Joint 2 Hardstop Kit

Installation Procedure

1. Slide the two adjustable hardstop plates into the space between inner and outer links. See **Figure 6-17**. Looking up at the inner link from underneath, align the holes in the plates with the holes in the inner link - see **Figure 6-19 on page 88**.

Figure 6-17. Joint 2 Adjustable Hardstop Locations

2. Use a 4 mm Allen wrench to install four supplied M5 x 10 screws to secure the plate. Tighten the screws to a torque of 4.5 N·m (40 in·lb). Repeat the process for the second plate. Note that the plates can be installed in different positions, depending on how much you need to limit the range of Joint 2. See **Table 6-8 on page 89**.
3. Slide the fixed hardstop block into the slot on the underside of the outer link. See **Figure 6-18**.

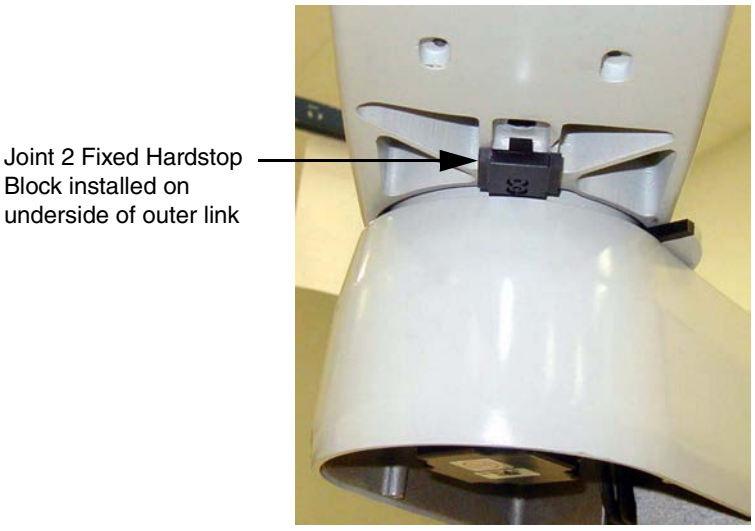


Figure 6-18. Fixed Hardstop Device for Joint 2

4. Use a 3 mm Allen wrench to install two supplied M4 x 10 screws to secure the hardstop block. Tighten the screws to a torque of 2.5 N·m (22 in·lb).

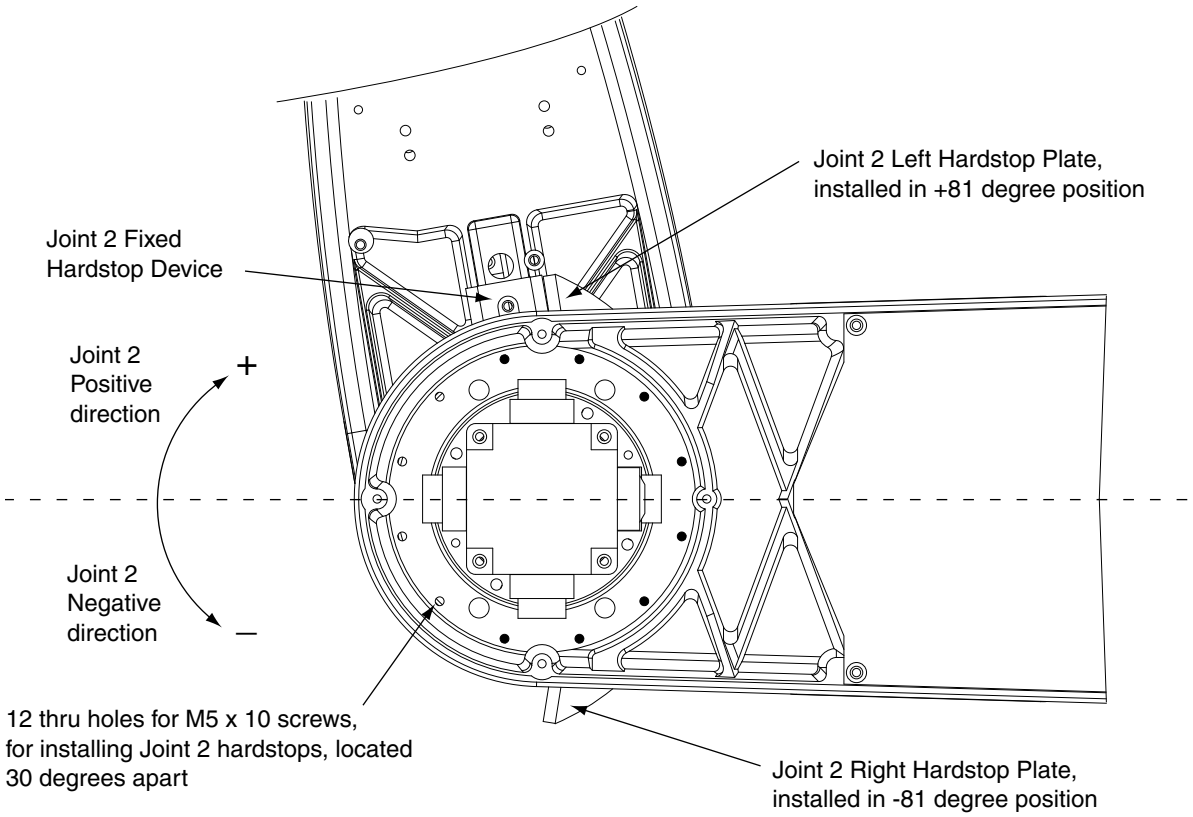


Figure 6-19. Screw Locations for Joint 2 Adjustable Hardstops

Modifying Joint Limit Softstop Locations for Joint 2

After installing the adjustable hardstops, you must modify the softstop locations using the Configuration Manager utility. See the online help for more details on this utility.

1. Double-click the iCobra object in the Folder pane of the Workspace Explorer.
2. In the object editor, select **Configure > Configuration Manager**.

3. Click Joint 2. The following screen opens to allow editing the limits:

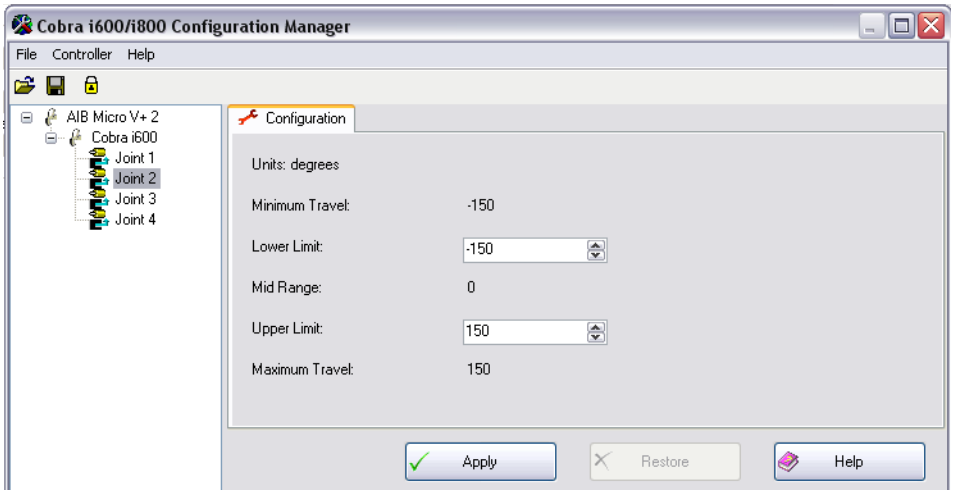


Figure 6-20. Configuration Manager - Modifying Joint 2 Limits

4. In the Lower Limit field, enter the new value for the J2 lower limit softstop. See **Table 6-8** for recommended softstop values.

Table 6-8. Joint 2 Ranges for Adjustable Hardstops

	Hardstop Value	Recommended Joint Limit Softstop
J2 Hardstop Position 1	± 81°	Lower limit: – 80° Upper limit: + 80°
J2 Hardstop Position 2	± 51°	Lower limit: – 50° Upper limit: + 50°
J2 Hardstop Position 3	± 21°	Lower limit: – 20° Upper limit: + 20°
NOTE: J2 Hardstops can be installed in a number of positions, depending on how the robot workcell needs to be configured. The positions are spaced 30° apart.		

5. In the Upper Limit field, enter the new value for the J2 upper limit softstop. See **Table 6-8** for recommended softstop values.
6. Click Apply. The Apply Changes window opens, as illustrated in **Figure 6-15**.
7. Select the required options for saving joint limit values to temporary or permanent memory. For more information on saving changes, click Help
8. Click Write to apply and save the changes.
9. Once the joint limits have been changed and written to memory, the system is ready to use with the new limits in place.

   NOTE: With both adjustable hardstop plates installed, Joint 2 has a maximum range of motion of 160°.

7 Technical Specifications

7.1 Dimension Drawings

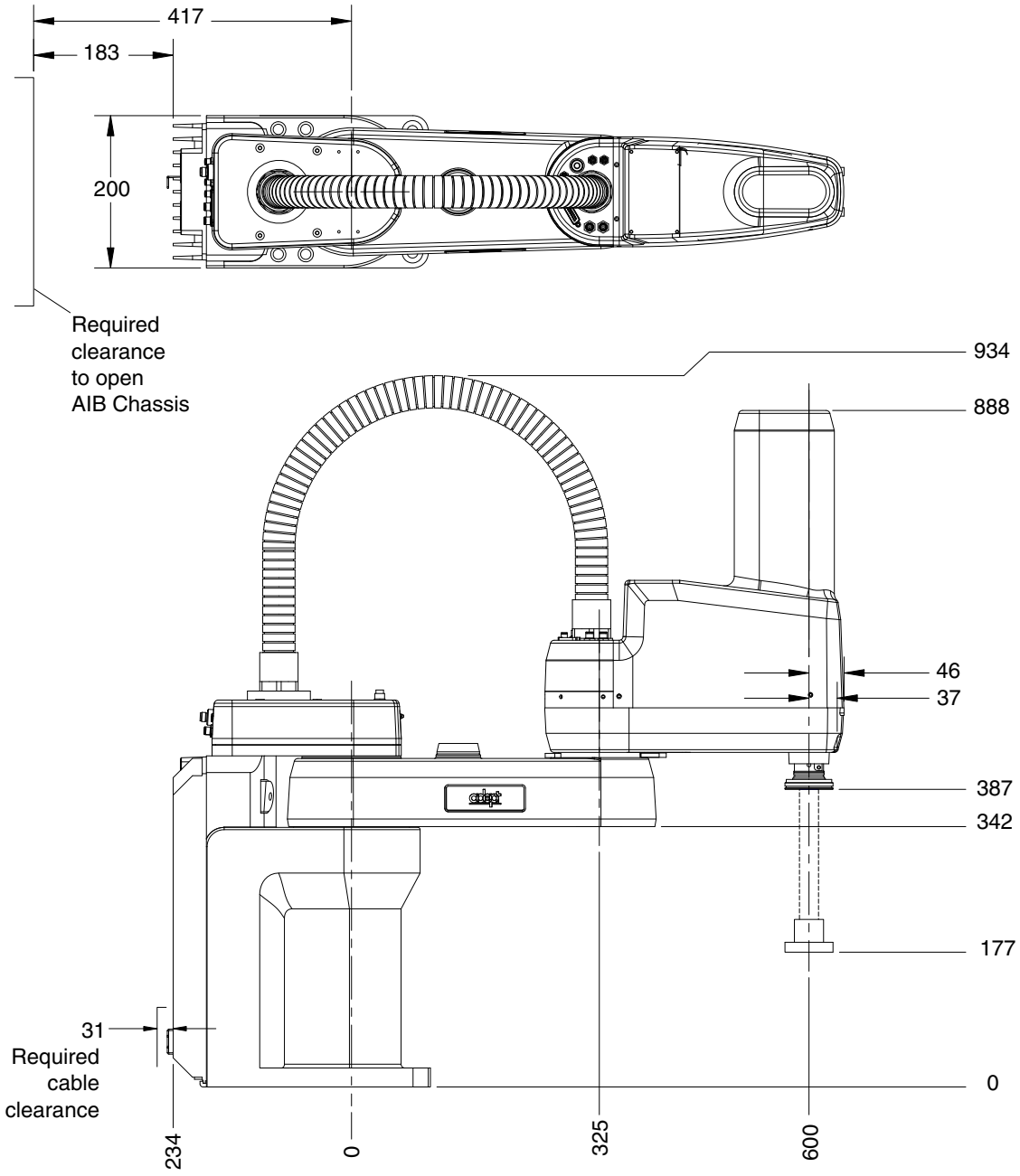


Figure 7-1. Adept Cobra i600/s600 Top and Side Dimensions

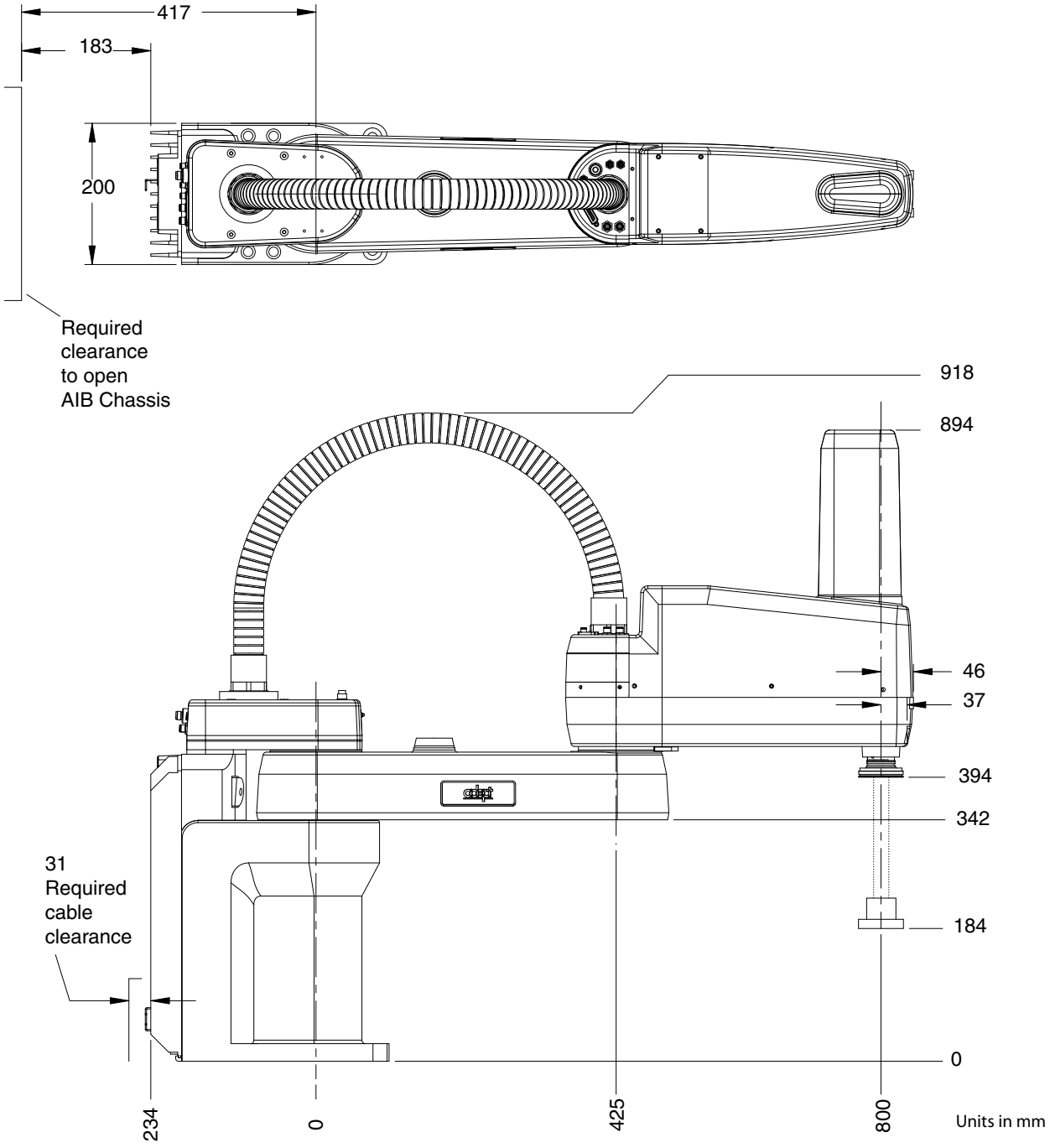


Figure 7-2. Adept Cobra i800/s800 Top and Side Dimensions

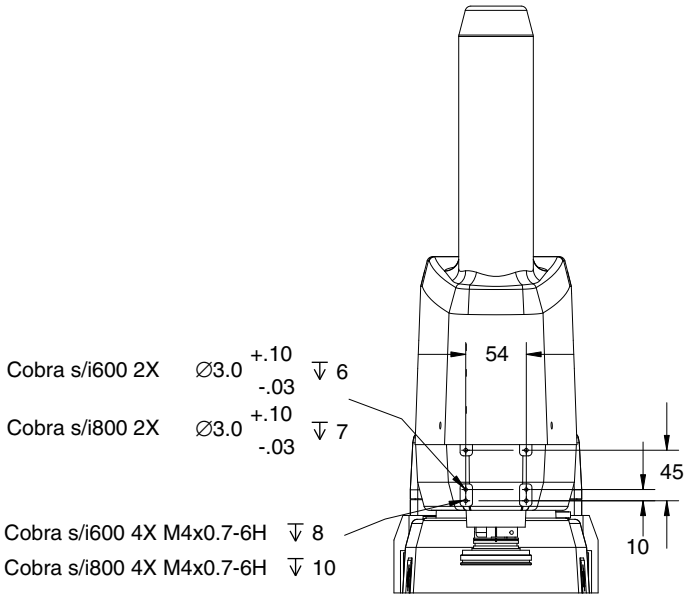


Figure 7-3. Dimensions of the Camera Bracket Mounting Pattern

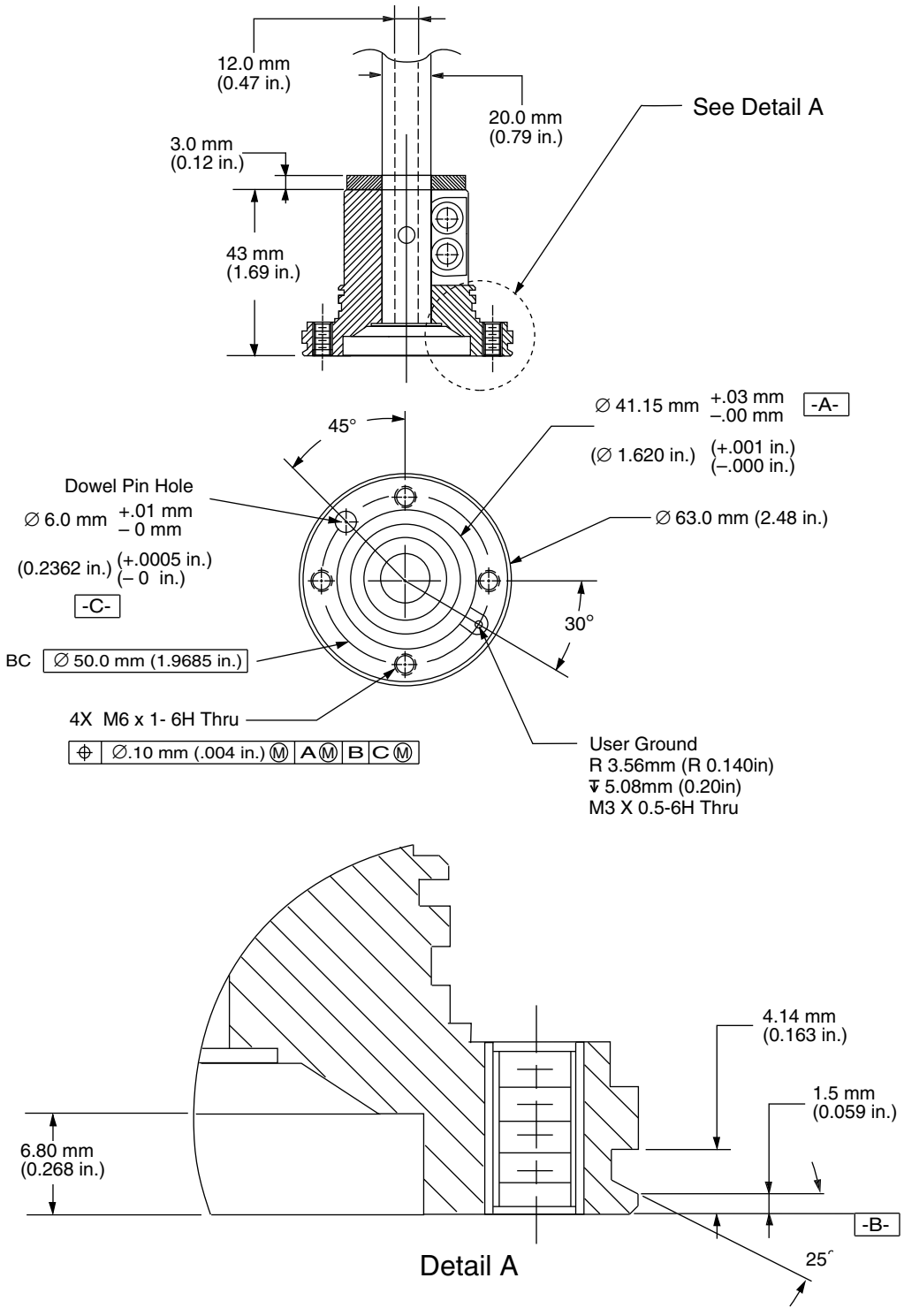


Figure 7-4. Tool Flange Dimensions

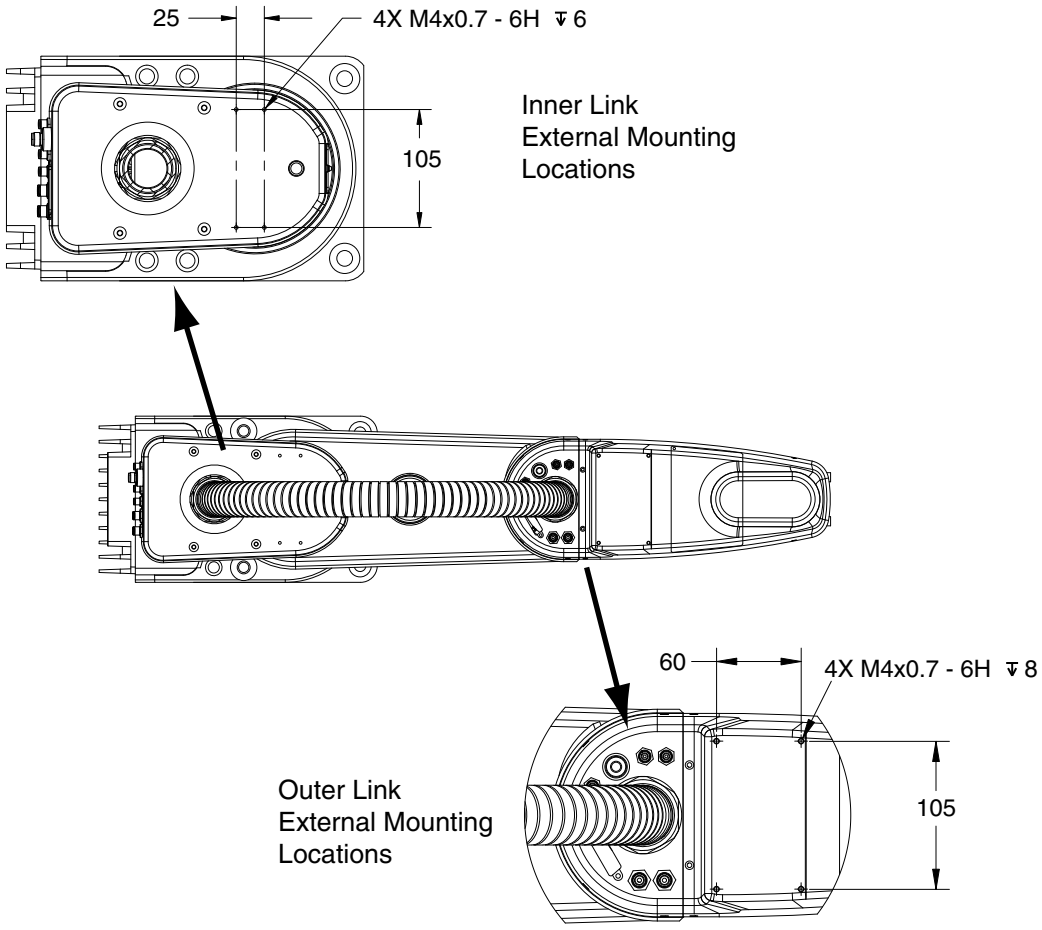


Figure 7-5. External Tooling on Top of Robot Arm

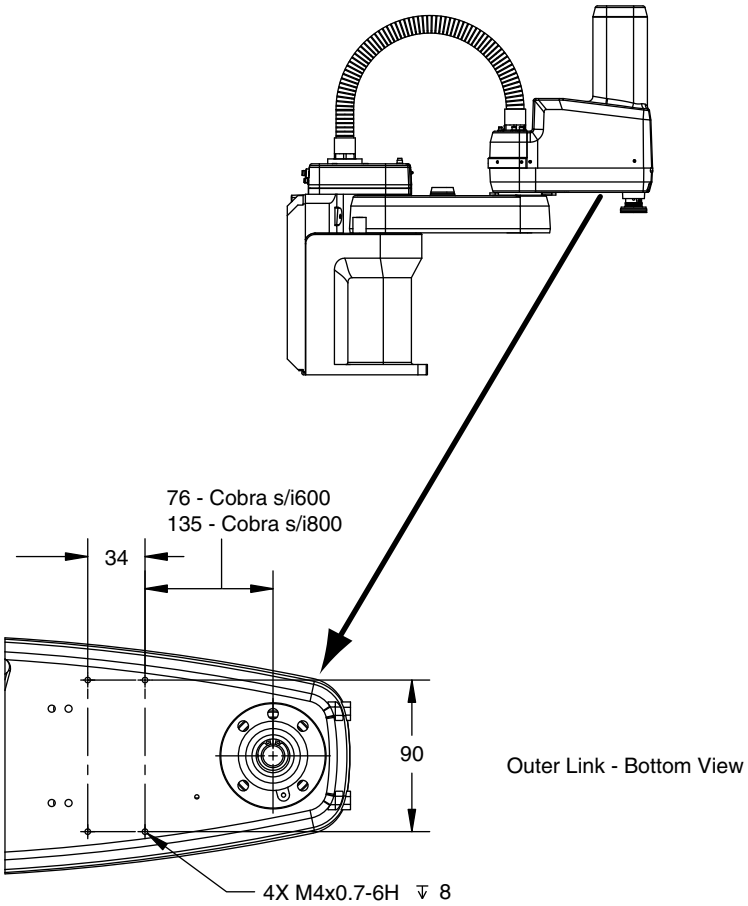


Figure 7-6. External Tooling on Underside of Outer Link

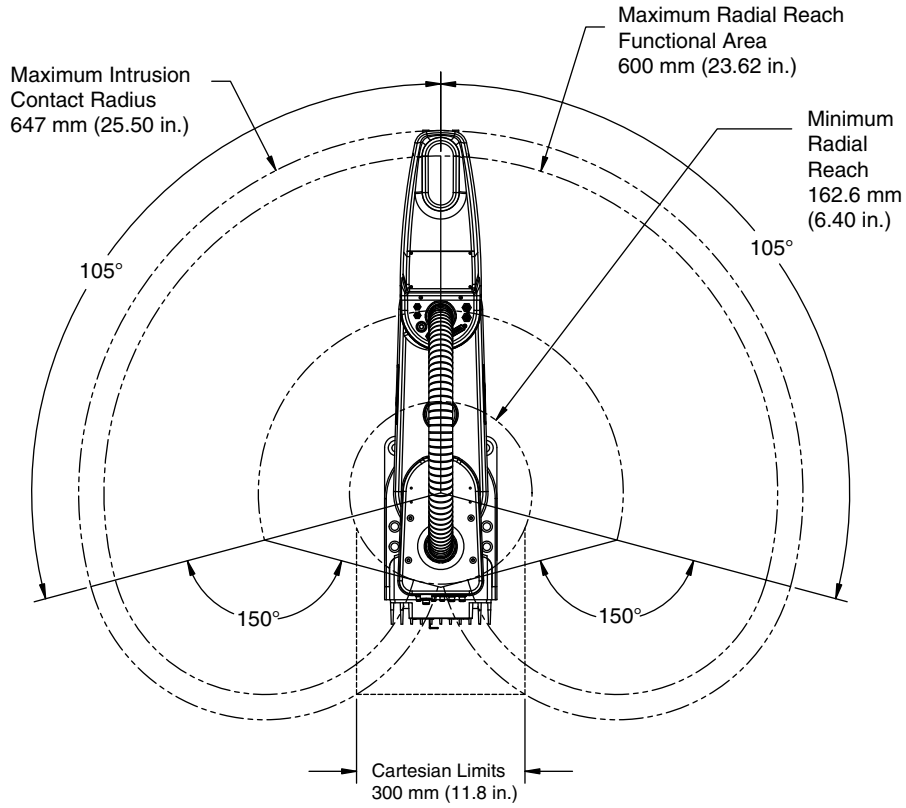


Figure 7-7. Adept Cobra i600/s600 Robot Working Envelope

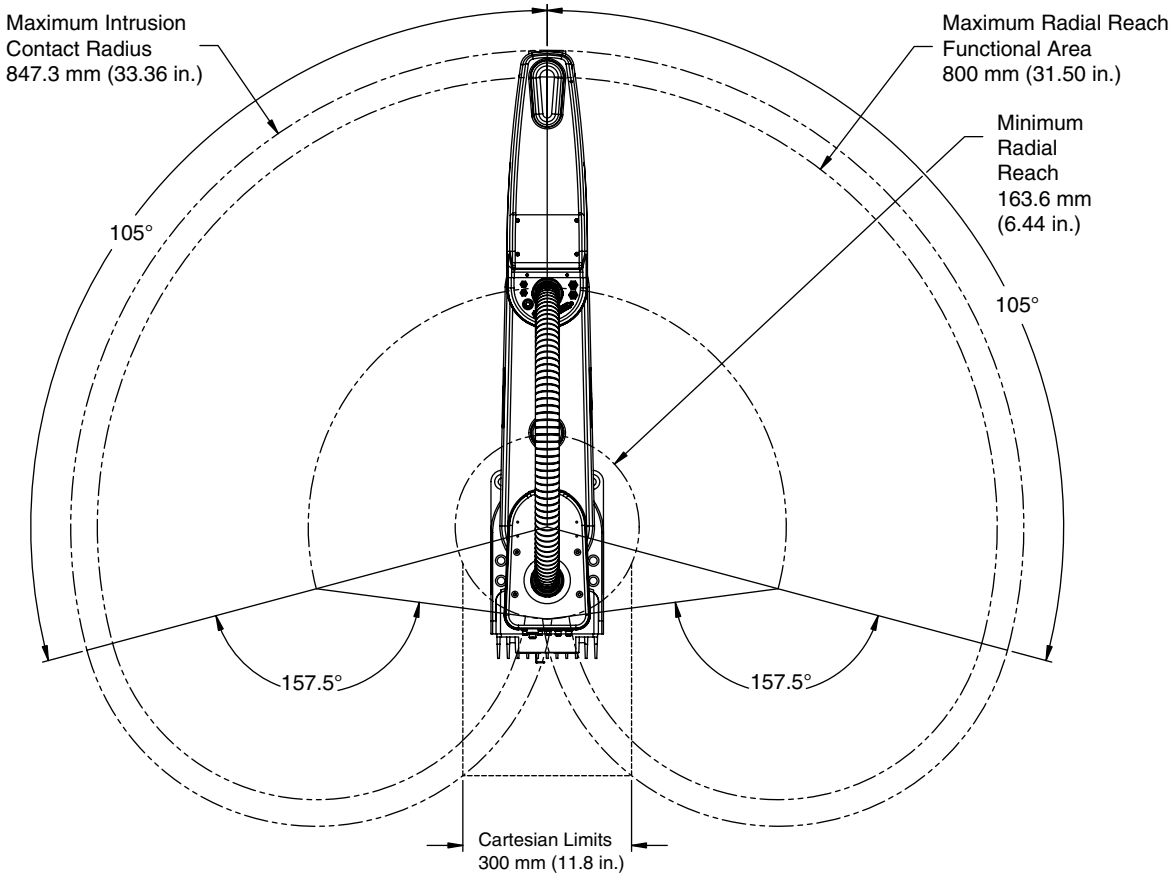


Figure 7-8. Adept Cobra i800/s800 Robot Working Envelope

7.2 Robot Specifications

Table 7-1. Adept Cobra i600/i800 Robot Specifications[a]

Description	i600 Robot	i800 Robot
Reach	600 mm (23.6 in)	800 mm (31.5 in)
Payload - rated	2.0 kg (4.4 lb)	2.0 kg (4.4 lb)
Payload - maximum	5.5 kg (12.1 lb)	5.5 kg (12.1 lb)
Moment of Inertia	Joint 4 - 450 kg-cm² (150 lb-in²) - max	Joint 4 - 450 kg-cm² (150 lb-in²) - max
Downward Push Force - Burst - (no load)	343 N (77 lb) - maximum	298 N (67 lb) - maximum
Lateral/Side Push Force - Burst	178 N (40 lb) - maximum	133 N (30 lb) - maximum
Adept Cycle - Burst (no J4 rotation)[b]		
0 kg	0.42 sec	0.48 sec
2 kg	0.42 sec	0.54 sec
5.5 kg	0.53 sec	0.64 sec
Adept Cycle - Burst (180° J4 rotation)		
0 kg	0.42 sec	0.48 sec
2 kg	0.42 sec	0.54 sec
5.5 kg	0.59 sec	0.76 sec
Adept Cycle - Sustained (no J4 rotation)[b]		
0 kg	0.42 sec at 20° C 0.48 sec at 40° C	0.48 sec at 20° C 0.51 sec at 40° C
2 kg	0.45 sec at 20° C 0.51 sec at 40° C	0.54 sec at 20° C 0.54 sec at 40° C
5.5 kg	0.58 sec at 20° C 0.64 sec at 40° C	0.70 sec at 20° C 0.70 sec at 40° C
Adept Cycle - Sustained (180° J4 rotation)		
0 kg	0.42 sec at 20° C 0.48 sec at 40° C	0.48 sec at 20° C 0.48 sec at 40° C
2 kg	0.45 sec at 20° C 0.51 sec at 40° C	0.54 sec at 20° C 0.61 sec at 40° C
5.5 kg	0.80 sec at 20° C 0.86 sec at 40° C	0.77 sec at 20° C 0.91 sec at 40° C
Repeatability		
x, y	±0.017 mm (±0.00067 in.)	±0.017 mm (±0.00067 in.)
z	±0.003 mm (±0.00012 in.)	±0.003 mm (±0.00012 in.)
Theta	±0.019°	±0.019°

Table 7-1. Adept Cobra i600/i800 Robot Specifications[a] (Continued)

Description	i600 Robot	i800 Robot
Joint Range		
Joint 1	±105°	±105°
Joint 2	±150°	±157.5°
Joint 3	210 mm (8.3 in.)	210 mm (8.3 in.)
Joint 4	±360°	±360°
Joint Speed (maximum)		
Joint 1	386°/sec	386°/sec
Joint 2	720°/sec	720°/sec
Joint 3	1,100 mm/sec (43 in./sec)	1,100 mm/sec (43 in./sec)
Joint 4	1200°/sec	1200°/sec
Encoder type	Absolute	
Robot Brakes	Joints 1, 2, and 4: Dynamic	
	Joint 3: Electric	
Airline pass-through (quantity)	6 mm diameter (2), 4 mm diameter (3)	
Electrical pass-through	24 conductors (12 twisted pair)	
DeviceNet pass-through	One available	
Weight (without options)	41 kg (90 lb)	43 kg (95 lb)

[a] Specifications subject to change without notice.
[b] The robot tool performs continuous path, straight-line motions 25 mm (1 in.) up, 305 mm (12 in.) over, 25 mm (1 in.) down, and back along the same path. COARSE is enabled and BREAKs are used at each end location. Not achievable over all paths.

Table 7-2. Softstop and Hardstop Specifications

Joint	Cobra i600		Cobra i800	
	Softstop	Hardstop – Approximate	Softstop	Hardstop – Approximate
Joint 1	± 105°	± 108°	± 105°	± 108°
Joint 2	± 150°	± 151°	± 157.5°	± 160°
Joint 3	0 to 210 mm	-5 to 215 mm	0 to 210 mm	-5 to 215 mm
Joint 4	± 360°	not applicable	± 360°	not applicable

8 Cleanroom Robots

8.1 Cobra i600/i800 Cleanroom Option

Introduction

The Adept Cobra i600/i800 Cleanroom Option is a modification to the standard robot that certifies the robot to meet the Class 3 Airborne Particulate Cleanliness Limits as defined by ISO Standard 14644 (Class 10 for Federal Standard 209E).

> **NOTE:** Class 1 Limits can be achieved by maintaining the robot speed at Speed 50 or below.
> Contact Adept for details.

This option is a factory-installed configuration. Changes to the robot include the addition of a bellows assembly mounted at the Joint 3 quill, fully-sealed access covers, and a two-stage vacuum system to evacuate the arm. This vacuum system incorporates a compressed air vacuum generator mounted in the base of the robot to provide a high vacuum in the outer link and bellows area. An additional high flow rate vacuum source is required to evacuate in the inner link and base.

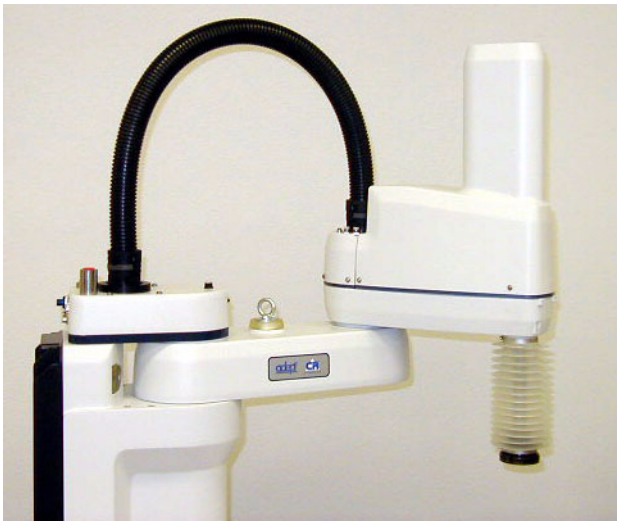


Figure 8-1. Adept Cobra i600 Cleanroom Robot

Specifications

Table 8-1. Adept Cobra Cleanroom Robot Specifications

Robot Performance Specification	See Table 7-1 on page 91.
Ambient Temperature Specification	5 - 35° C (41 - 95° F)

8.2 Connections

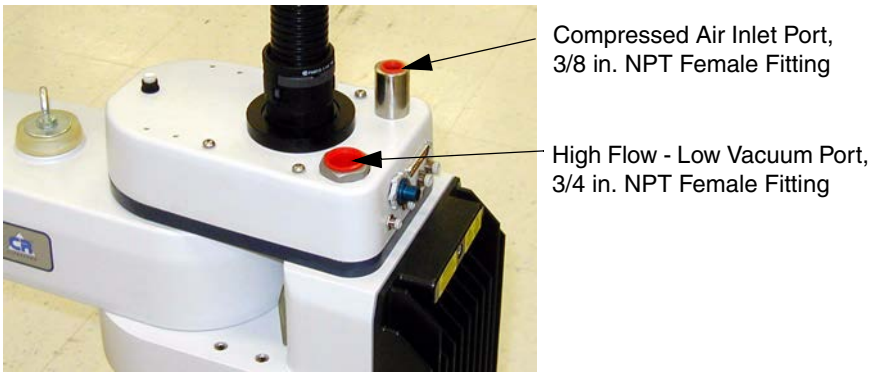


Figure 8-2. Cleanroom Connections

8.3 Requirements

Table 8-2. Cleanroom Robot Requirements

Vacuum source	0.80 m^3/min (28 ft^3/min) minimum volumetric flow rate
	6 mm (0.2 inches) of water differential pressure measured between the robot and the vacuum source
	3/4 in. NPT female thread pipe fitting at the back of the robot
Compressed air source	Clean, dry, oil-free compressed air
	75 psi (0.52 MPA)
	1.4 SCFM flow rate (0.04 m^3/min.)
	3/8 in. NPT female thread pipe fitting at the back of the robot, flow regulator not supplied
Quill inside diameter	The inside diameter of the quill must be plugged by the user's end-effector in order for sufficient vacuum to develop in the outer link.

8.4 Exclusions and Incompatibilities

Table 8-3. Internally-Mounted Hand Valves

Installation considerations	The internal air line normally used to supply the internally-mounted hand valves (Adept Option Kit P/N 02853-000) is instead used to provide vacuum to the bellows/outer link. One of the passive 6 mm user air lines would need to be used instead.
Performance considerations	The air exhausting from the internally-mounted hand valves (Adept Option Kit P/N 02853-000) may be of sufficient quantity/ quality to cause the robot to exceed Class 10 Particulate Limits.
Recommendation	For these reasons, Adept recommends mounting hand valves externally.

8.5 Maintenance

Bellows Replacement

Check the bellows periodically for cracks, wear, or damage. Replace bellows (Adept P/N 04625-000) if necessary, using the procedure below.

1. Remove the lower bellows clamp ring from the bearing ring by loosening the screw on the clamp. See **Figure 8-3**.
2. Remove the tool flange. Refer to **Section 6.2 on page 71** for the tool flange removal procedure.
3. Remove the upper bellows clamp ring by loosening the screw on the clamp.
4. Slide the old bellows down off of the quill.
5. Install a new bellows, and reverse the steps listed above.

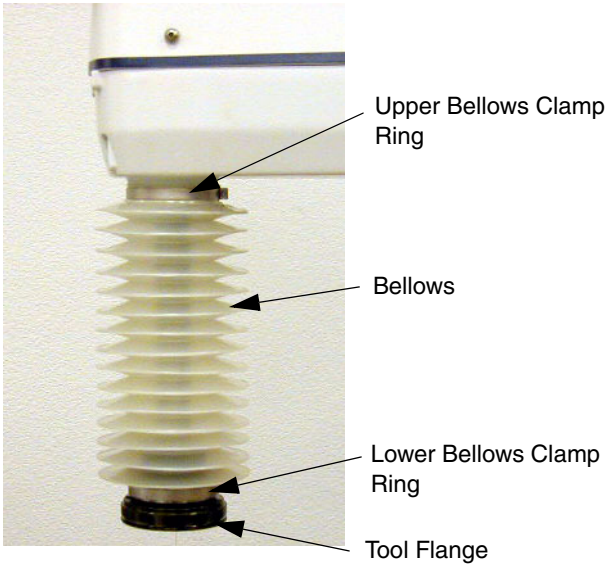


Figure 8-3. Cleanroom Bellows Replacement

Lubrication

The upper and lower quill requires lubrication in the same manner as the standard Cobra i600/i800 robot. See **Section 5.6 on page 63**.

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P/N: 03589-000, Rev G

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