Adept Cobra s600/s800 Robot

User's Guide

adept®

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User's Guide

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1 Introduction

1.1 Product Description

Adept Cobra s600/s800 Robots

The Adept Cobra s600 and s800 robots are four-axis SCARA robots (Selective Compliance Assembly Robot Arm). See **Figure 1-1**. Joints 1, 2, and 4 are rotational; Joint 3 is translational. See **Figure 1-2 on page 16** for a description of the robot joint locations.

The Adept Cobra s-series robots require an Adept SmartController. The robots are programmed and controlled using the SmartController, running on the Adept SmartServo distributed motion control platform. Mechanical specifications for the Adept Cobra s-series robots are provided in **Chapter 8**.

> **NOTE:** The descriptions and instructions in this manual apply to both the Cobra s600 and the Cobra s800, 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 s800 Robot

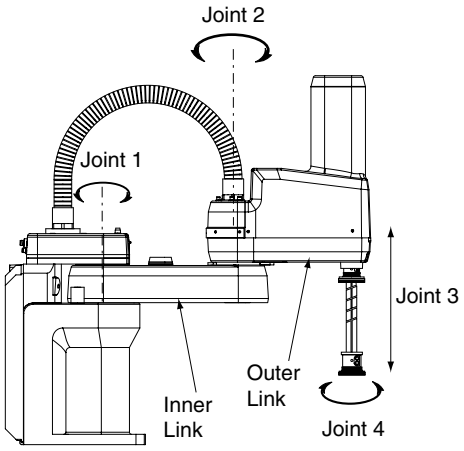


Figure 1-2. Robot Joint Motions

Adept SmartAmp AIB

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

Adept SmartAmp 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 on all amplifiers and motors for maximum reliability and easy troubleshooting

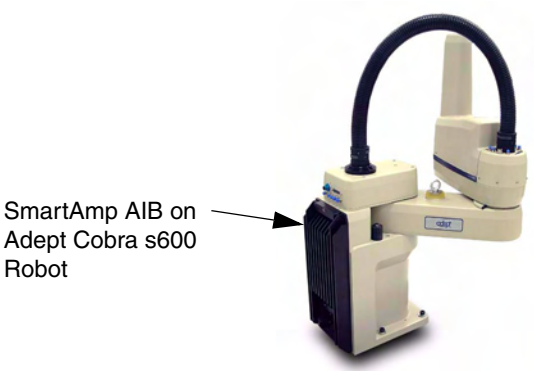


Figure 1-3. Adept SmartAmp AIB

Adept SmartController

The SmartController is the foundation of Adept's family of high-performance distributed motion and vision controllers. The SmartController is designed for use with:

- Adept Cobra s-series robots
- Adept Viper s-series robots
- Adept Python linear modules
- Adept MotionBlox-10
- Adept sMI6 (SmartMotion)

The SmartController CX supports an integrated vision option and a conveyor tracking option, as well as other options. It offers scalability and support for IEEE 1394-based digital I/O and general motion expansion modules. The IEEE 1394 interface is the backbone of Adept SmartServo, Adept's distributed controls architecture supporting Adept products. The controller also includes Fast Ethernet and DeviceNet.

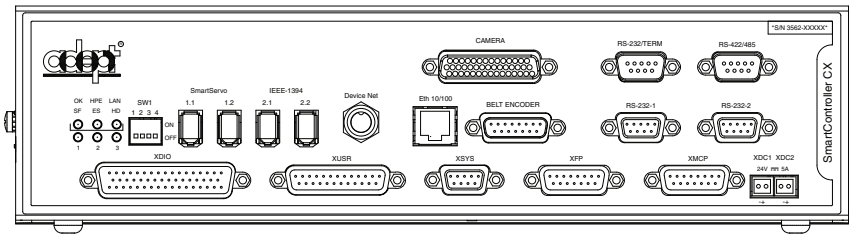


Figure 1-4. Adept SmartController CX

Adept SmartController CX

The Adept SmartController CX is a high performance motion and vision controller. It has the same capability as the SmartController CS, plus additional support for an integrated vision option, a conveyor tracking option, a more powerful processor, an additional pair of serial ports, and a second pair of IEEE 1394 network ports.

sDIO Module

The sDIO module provides 32 optical isolated digital inputs and 32 optical isolated outputs and also includes an IEEE 1394 interface.

1.2 Installation Overview

The system installation process is summarized in the following table. Refer also to the system cable diagram in **Figure 4-1 on page 41**.

Table 1-1. Installation Overview

Task to be Performed	Reference Location
1. Mount the robot on a flat, secure mounting surface.	See Section 3.5 on page 37.
2. Install the SmartController, Front Panel, pendant, and AdeptWindows user interface.	See Section 4.3 on page 42.
3. Install the IEEE 1394 and XSYS cables between the robot and SmartController.	See Section 4.4 on page 43.
4. Create a 24VDC cable and connect it between the robot and the user-supplied 24VDC power supply.	See Section 4.5 on page 43.
5. Create a 200-240 VAC cable and connect it between the robot and the facility AC power source.	See Section 4.6 on page 46.
6. Install user-supplied safety barriers in the workcell.	See Section 4.8 on page 51.
7. Read Chapter 5 to learn about connecting digital I/O through the XIO connector on the robot.	See Section 5.5 on page 59.
8. Read Chapter 5 to learn about commissioning the system, including system start-up and testing operation.	See Section 5.6 on page 65.
9. 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 69.

1.3 Manufacturer's Declaration

The Manufacturer's Declaration of Incorporation and Conformity for Adept robot systems can be found on the Adept web site, under the Support section. The URL for the folder is:

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, which you can open or save.

1.4 How Can I Get Help?

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

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

- For Product Support information:
  http://www.adept.com/support/service-and-support/main
- For further information about Adept Technology, Inc.:
  http://www.adept.com

Related Manuals

This manual covers the installation, operation, and maintenance of an Adept Cobra s600/s800 robot system. There are additional manuals that cover programming the system, reconfiguring installed components, and adding other optional components; see **Table 1-2**.

Table 1-2. Related Manuals

Manual Title	Description
Adept SmartController User's Guide	Contains complete information on the installation and operation of the Adept SmartController and the optional sDIO product.
AdeptWindows Installation Guide and AdeptWindows Online Help	Describes complex network installations, installation and use of NFS server software, the AdeptWindows Offline Editor, and the AdeptWindows DDE software.
Instructions for Adept Utility Programs	Describes the utility programs used for advanced system configurations, system upgrades, file copying, and other system configuration procedures.
V+ Operating System User's Guide	Describes the V+ operating system, including disk file operations, monitor commands, and monitor command programs.
V+ Language User's Guide	Describes the V+ language and programming of an Adept control system.

Adept Document Library

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

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

Safety 2

2.1 Dangers, Warnings, Cautions, and Notes in Manual

There are six levels of special alert notation used in this manual. 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: This provides supplementary information, emphasizes a point or procedure, or gives a tip for easier operation.

2.2 Warning Labels on the Robot

Figure 2-1 and Figure 2-2 show the warning labels on the Adept Cobra s-series robots.

Figure 2-1. Electrical and Thermal Warning Labels on AIB Chassis

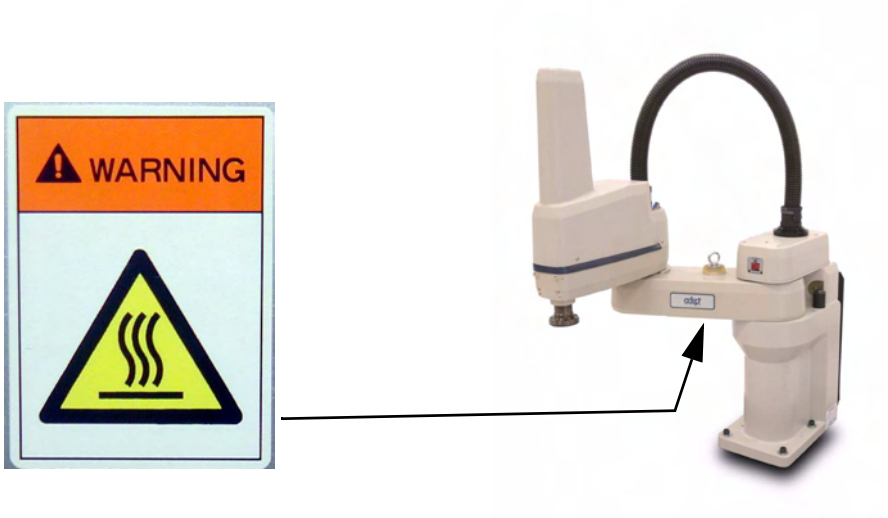


Figure 2-2. Thermal Warning Label on Underside of Inner Link

Figure 2-3. Warning Label on Encoder Cables

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.

2.3 Precautions and Required Safeguards

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

WARNING: Adept Technology strictly prohibits installation, commissioning, or operation of an Adept robot without adequate safeguards according to applicable local and national standards. Installations in EU and EEA countries must comply with EN 775/ISO 10218, especially sections 5,6; EN 292-2; and EN 60204-1, especially section 13.

The table below shows the standards that the robot system has been evaluated to meet.

Table 2-1. Standards Met by Robot

Standard
UL 1740
ANSI/RIA R15.06
NFPA 79
CSA/CAN Z434

Safety Barriers

Safety barriers must be an integral part of robot workcell design. Adept systems are computer-controlled and may activate remote devices under program control at times or along paths not anticipated by personnel. It is critical that safeguards be in place to prevent personnel from entering the workcell whenever equipment power is present.

The robot system integrator, or end user, must ensure that adequate safeguards, safety barriers, light curtains, safety gates, safety floor mats, etc., will be installed. The robot workcell must be designed according to the applicable local and national standards (see **Section 2.8 on page 31**).

The safe distance to the robot depends on the height of the safety fence. The height and the distance of the safety fence from the robot must ensure that personnel cannot reach the danger zone of the robot.

The Adept control system has features that aid the user in constructing system safeguards, including customer emergency stop circuitry and digital input and output lines. The emergency power-off circuitry is capable of switching external power systems, and can be interfaced to the appropriate user-supplied safeguards.

Impact and Trapping Points

Adept robots are capable of moving at high speeds. If a person is struck by a robot (impacted) or trapped (pinched), death or serious injury could occur. Robot configuration, joint speed, joint orientation, and attached payload all contribute to the total amount of energy available to cause injury.

DANGER: The robot system must be installed to avoid interference with buildings, structures, utilities, other machines and equipment that may create a trapping hazard or pinch points.

Instructions for Emergency Movement without Drive Power

In an emergency, when power is removed from the system, the arm can be moved manually. The Joint 3 Brake Release button must be pressed to enable Joint 3 movement.

Emergency Recovery Procedures

In an emergency, follow your internal procedures for emergency recovery of systems.

Additional Safety Information

The standards and regulations listed in this handbook contain additional guidelines for robot system installation, safeguarding, maintenance, testing, startup, and operator training. Table 2-2 lists some sources for the various standards.

Table 2-2. Sources for International Standards and Directives

SEMI International Standards 3081 Zanker Road San Jose, CA 95134 USA Phone: 1.408.943.6900 Fax: 1.408.428.9600 http://www.semi.org	American National Standards Institute (ANSI) 11 West 42nd Street, 13th Floor New York, NY 10036 USA Phone 212-642-4900 Fax 212-398-0023 http://www.ansi.org
Underwriters Laboratories Inc. 333 Pfingsten Road Northbrook, IL 60062-2096 USA Phone: +1-847-272-8800 Fax: +1-847-272-8129 http://www.ul.com/info/standard.htm	BSI Group (British Standards) 389 Chiswick High Road London W4 4AL United Kingdom Phone +44 (0)20 8996 9000 Fax +44 (0)20 8996 7400 http://www.bsi-global.com

Table 2-2. Sources for International Standards and Directives (Continued)

Global Engineering Documents 15 Inverness Way East Englewood, CO 80112 USA Phone 800-854-7179 Fax 303-397-2740 http://global.ihs.com		Document Center, Inc. 1504 Industrial Way, Unit 9 Belmont, CA 94002 USA Phone 415-591-7600 Fax 415-591-7617 http://www.document-center.com
IEC, International Electrotechnical Commission Rue de Varembe 3 PO Box 131 CH-1211 Geneva 20 Switzerland Phone 41 22 919-0211 Fax 41 22 919-0300 http://www.iec.ch		Robotic Industries Association (RIA) 900 Victors Way PO Box 3724 Ann Arbor, MI 48106 USA Phone 313-994-6088 Fax 313-994-3338 http://www.robotics.org
DIN, Deutsches Institut für Normung e.V. German Institute for Standardization Burggrafenstrasse 6 10787 Berlin Germany Phone.: +49 30 2601-0 Fax: +49 30 2601-1231 http://www.din.de http://www2.beuth.de/ (publishing)		

2.4 Risk Assessment

Without special safeguards in its control system, the Adept robot could inflict serious injury on an operator working within its work envelope. Safety standards in several countries require appropriate safety equipment to be installed as part of the system. **Table 2-3** lists some of the safety standards that affect industrial robots. It is *not* a complete list. Safeguards must comply with *all* applicable local and national standards for the location where the robot is installed.

Table 2-3. Partial List of Robot and Machinery Safety Standards

International	USA	Canada	Europe	Title of Standard
ISO 10218			EN 775	Manipulating Industrial Robots - Safety
	ANSI/RIA R15.06	CAN/CSA-Z434-94		Industrial Robots and Robot Systems - Safety Requirements
			EN 292-2	Safety of Machinery - Basic Concepts, General Principles for Design
			EN 954-1	Safety Related Parts of Control Systems - General Principles for Design
			EN 1050	Safety of Machinery - Risk Assessment

Adept has performed a Risk Assessment for this product, based on the intended applications of the robot. The conclusions are summarized below.

Exposure

When Arm Power is on, all personnel must be kept out of the robot work envelope by interlocked perimeter barriers. The only permitted exception is for teaching the robot in Manual Mode by a skilled programmer (see **"Qualification of Personnel" on page 33**), who must wear safety equipment (see **"Safety Equipment for Operators" on page 33**) and carry the pendant (T1/T2 or MCP). Therefore, exposure of personnel to hazards related to the robot is limited (seldom and/or short exposure time).

Severity of Injury

Provided that skilled personnel who enter the robot work envelope are wearing protective headgear, eyeglasses, and safety shoes, it is likely that any injuries caused by the robot would be slight (normally reversible).

Avoidance

A programmer must always carry the pendant when inside the work envelope, as the pendant provides both E-Stop and Enabling switch functions.

For *normal* operation (AUTO mode), user-supplied interlocked guarding must be installed to prevent any person entering the workcell while Arm Power is on.

DANGER: The Adept-supplied system components provide a Category 3 E-Stop control system as defined by EN 954. The robot system must be installed with user-supplied interlock barriers. The interlocked barrier must open the E-Stop circuit in the event of personnel attempting to enter the workcell when Arm Power is enabled, except for teaching in Manual mode. Failure to install suitable guarding or interlocks could result in injury or death.

The E-stop circuit is Dual Channel (Redundant, Diverse, and Control Reliable). The stop function is classified as NFPA Category 1.

See **Figure 8-9 on page 113** for an E-stop internal circuit diagram.

Slow Speed Control Function and Testing

Adept robots can also be controlled manually when the operating mode key switch is in the MANUAL position and the HIGH POWER light on the Front Panel is illuminated. When Manual mode is selected, motion can only be initiated from the pendant (Manual Control Pendant (MCP or T1/T2). Per EN 775/ISO 10218, the maximum speed of the robot is limited to 250 mm per second (10 ips) in Manual mode. It is important to remember that the robot speed is *not* limited when the robot is in Automatic (AUTO) mode.

The Risk Assessment for *teaching* this product depends on the application. In many applications, the programmer will need to enter the robot workcell while Arm Power is enabled to teach the robot. Other applications can be designed so that the programmer does not have to enter the work envelope while Arm Power is on. Examples of alternative methods of programming include:

1. Programming from outside the safety barrier.
2. Programming with Arm Power off.
3. Copying a program from another (master) robot.
4. Off-line or CAD programming.

Control System Behavior Category

The following paragraphs relate to the requirements of European (EU/EEA) directives for Machinery, Electric Safety, and Electromagnetic Compatibility (EMC).

In situations with low exposure consideration factors, European Standard EN 1050 specifies use of a Category 1 Control System per EN 954. EN 954 defines a Category 1 Control System as one that employs Category B components designed to withstand environmental influences, such as voltage, current, temperature, EMI, and well-tried safety principles. The standard control system described in this guide employs hardware components in its safety system that meet or exceed the requirements of the *EU Machinery Directive* and *Low Voltage Directive*.

The standard control system is fully hardened to all EMI influences per the EU EMC *Directive* and meets all functional requirements of ISO 10218 (EN 775) *Manipulating Robots Safety*. In addition, a software-based reduced speed mode has been incorporated to limit speed and impact forces on the Operator and production tooling when the robot is operated in Manual Mode.

The standard control system meets or exceeds the requirements imposed by the EN 954 specified Category 1 level of safety.

2.5 Intended Use of the Robots

The installation and use of Adept products must comply with all safety instructions and warnings in this manual. Installation and use must also comply with all applicable local and national requirements and safety standards (see **Section 2.8 on page 31**).

The Adept Cobra s600 and s800 robots are intended for use in parts assembly and material handling for payloads less than 5.5 kg (12.1 lb).

WARNING: For safety reasons, it is prohibited to make certain modifications to Adept robots (see **Section 2.6**).

The Adept Cobra s-series robots and the Adept SmartController are component subassemblies of a complete industrial automation system. The controller must be installed inside a suitable enclosure. The controller must not come into contact with liquids. Additionally, a standard Adept Cobra s-series robot must not come into contact with liquids.

The Adept equipment is not intended for use in any of the following situations:

- In hazardous (explosive) atmospheres
- In mobile, portable, marine, or aircraft systems
- In life-support systems
- In residential installations

- In situations where the Adept equipment will be subject to extremes of heat or humidity. See **Table 3-1 on page 37** for allowable temperature and humidity ranges.

WARNING: The instructions for installation, operation, and maintenance given in this User's Guide must be strictly observed.

Non-intended use of an Adept Cobra s-series robot can:

- Cause injury to personnel
- Damage the robot or other equipment
- Reduce system reliability and performance

All persons that install, commission, operate, or maintain the robot must:

- Have the necessary qualifications
- Read and follow exactly the instructions in this User's Guide

If there is any doubt concerning the application, ask Adept to determine if it is an intended use or not.

2.6 Robot Modifications

It is sometimes necessary to modify the robot in order to successfully integrate it into a workcell. Unfortunately, many seemingly simple modifications can either cause a robot failure or reduce the robot's performance, reliability, or lifetime. The following information is provided as a guideline to modifications.

Acceptable Modifications

In general, the following robot modifications will not cause problems, but may affect robot performance:

- Attaching tooling, utility boxes, solenoid packs, vacuum pumps, screwdrivers, cameras, lighting, etc., to the inner link, outer link, or J1 harness support.
- Attaching hoses, pneumatic lines, or cables to the robot. These should be designed so they do not restrict joint motion or cause robot motion errors.

Unacceptable Modifications

The modifications listed below may damage the robot, reduce system safety and reliability, or shorten the life of the robot.

CAUTION: Making any of the modifications outlined below will void the warranty of any components that Adept determines were damaged due to the modification. You must contact Adept Customer Service if you are considering any of the following modifications.

- Modifying any of the robot harnesses or robot-to-controller cables.
- Modifying any robot access covers or drive system components.
- Modifying, including drilling or cutting, any robot casting.
- Modifying any robot electrical component or printed-circuit board.
- Routing additional hoses, air lines, or wires through the robot.
- Modifications that compromise EMC performance, including shielding.

2.7 Transport

Always use adequate equipment to transport and lift Adept products. See **Chapter 3** for more information on transporting, lifting, and installing.

WARNING: Do not remain under the robot while it is transported.

2.8 Safety Requirements for Additional Equipment

Additional equipment used with the Adept Cobra s-series robot (grippers, conveyor belts, etc.) must not reduce the workcell safeguards.

All emergency stop switches must always be accessible.

If the robot is to be used in an EU or EEA member country, all components in the robot workcell must comply with the safety requirements in the European Machine Directive 89/392/EEC (and subsequent amendments) and related harmonized European, international, and national standards. For robot systems, these include: EN 775/ISO 10218, sections 5,6; EN 292-2; and EN 60204. For safety fences, see EN 294.

In other countries, Adept strongly recommends, in addition to complying with the applicable local and national regulations, that a similar level of safety be obtained.

In the USA, applicable standards include ANSI/RIA R15.06 and ANSI/UL 1740.

In Canada, applicable standards include CAN/CSA Z434.

2.9 Sound Emissions

The sound emission level of the Adept Cobra s-series robot depends on the speed and payload. The maximum value is 90dB. (This is at maximum AUTO-mode speed.)

WARNING: Acoustic emission from this robot may be up to 90dB (A) under worst-case conditions. Typical values will be lower, depending on payload, speed, acceleration, and mounting. Appropriate safety measures should be taken, such as ear protection and display of a warning sign.

2.10 Thermal Hazard

WARNING: You can burn yourself. Do not touch the robot base or outer link shortly after the robot has been running at high ambient temperatures (40-50°C) (104-122°F) or at fast cycle times (over 60 cycles per minute). The robot skin/surface temperature can exceed 85°C (185°F).

2.11 Working Areas

Adept robots have a Manual and an Automatic (AUTO) operating mode. While in Automatic Mode, personnel are not allowed in the workcell.

In Manual Mode, operators with additional safety equipment (see **Section 2.13 on page 33**) are allowed to work in the robot workcell. For safety reasons the operator should, whenever possible, stay outside of the robot work envelope to prevent injury. The maximum speed and power of the robot is reduced but it could still cause injury to the operator.

Before performing maintenance in the working envelope of the robot, High Power must be switched off and the power supply of the robot must be disconnected. After these precautions, a skilled person is allowed to maintain the robot. See **Section 2.12** for the specifications.

WARNING: Never remove any safeguarding and never make changes in the system that will decommission a safeguard.

2.12 Qualification of Personnel

This manual assumes that all personnel have attended an Adept training course and have a working knowledge of the system. The user must provide the necessary additional training for all personnel who will be working with the system.

As noted in this user's guide, certain procedures should be performed only by **skilled** or **instructed** persons. For a description of the level of qualification, Adept uses the standard terms:

- **Skilled persons** have technical knowledge or sufficient experience to enable them to avoid the dangers, electrical and/or mechanical.
- **Instructed persons** are adequately advised or supervised by skilled persons to enable them to avoid the dangers, electrical and/or mechanical.

All personnel must observe sound safety practices during the installation, operation, and testing of all electrically powered equipment. To avoid injury or damage to equipment, always remove power by disconnecting the AC power from the source before attempting any repair or upgrade activity. Use appropriate lockout procedures to reduce the risk of power being restored by another person while you are working on the system.

DANGER: Any person who programs, teaches, operates, maintains or repairs the robot system must be trained and demonstrate the competence to safely perform the assigned task.

The user must get confirmation from every entrusted person before they start working with the robot that the person:

1. Has received the user's guide.
2. Has read the user's guide.
3. Understands the user's guide and
4. Will work in the manner specified by the user's guide.

2.13 Safety Equipment for Operators

Adept advises operators to wear extra safety equipment in the workcell. For safety reasons operators must wear the following when they are in the robot workcell.

- Safety glasses
- Protective headgear (hard hats)
- Safety shoes

Install warning signs around the workcell to ensure that anyone working around the robot system knows they must wear safety equipment.

2.14 Protection Against Unauthorized Operation

The system must be protected against unauthorized use. Restrict access to the keyboard and the pendant by locking them in a cabinet or use another adequate method to prevent access to them.

2.15 Safety Aspects While Performing Maintenance

Only skilled persons with the necessary knowledge about the safety and operating equipment are allowed to maintain the robot and controller.

DANGER: During maintenance and repair, the power to the robot and controller must be turned off. Unauthorized third parties must be prevented from turning on power through the use of lockout measures.

2.16 Risks Due to Incorrect Installation or Operation

- Purposely defeating any aspect of the safety E-Stop system
- Improper installation or programming of the robot system
- Unauthorized use of cables other than those supplied or use of modified components in the system
- Defeating interlock so that operator can enter workcell with High Power ON

Take precautions to ensure that these situations do not occur.

2.17 What to Do in an Emergency

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.

3 Robot Installation

3.1 Transport and Storage

This equipment must be shipped and stored in a temperature-controlled environment, within the range –25°C to +55°C. 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 3-1**).

The robots 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 position: this could damage the robot.

The s600 robot weighs 41 kg (90 lb) and the s800 weighs 43 kg (95 lb) with no options installed.

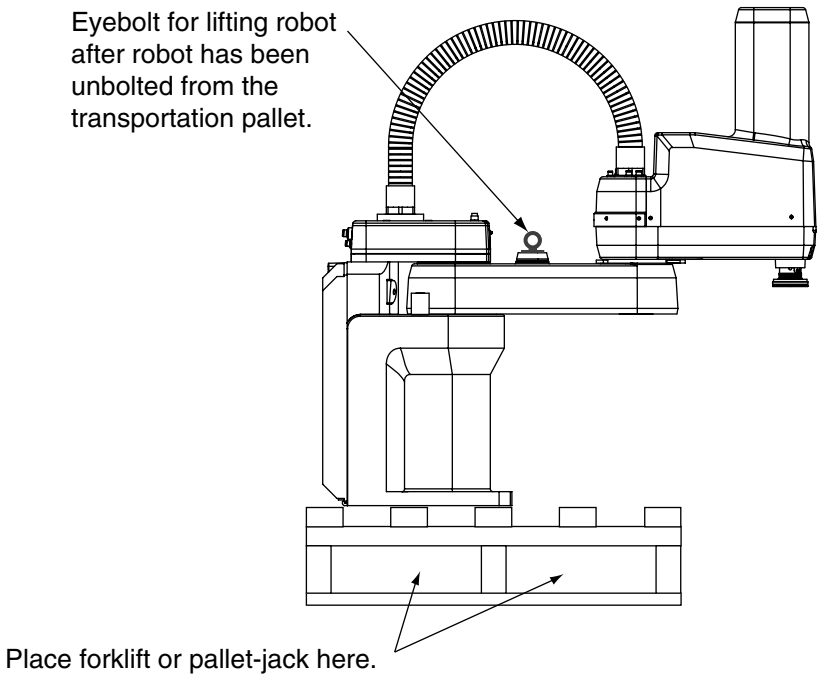


Figure 3-1. Cobra s600/s800 Robot on a Transportation Pallet

3.2 Unpacking and Inspecting the Adept Equipment

Before Unpacking

Carefully inspect all shipping crates for evidence of damage during transit. Pay special attention to 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 1.4 on page 18**).

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

3.3 Repacking for Relocation

If the robot or other equipment needs to be relocated, reverse the steps in the installation procedures that follow this chapter. Reuse all original packing containers and materials and follow all safety notes used for installation. Improper packaging for shipment will void your warranty. Specify this to the carrier if the robot is to be shipped.

CAUTION: Before unbolting the robot from the mounting surface, 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.

3.4 Environmental and Facility Requirements

The Adept robot system installation must meet the operating environment requirements shown in **Table 3-1**.

Table 3-1. Robot System Operating Environment Requirements

Ambient temperature	5°C to 40°C (41°F to 104°F)
Humidity	5 to 90%, noncondensing
Altitude	up to 2000 m (6500 ft.)
Pollution degree	2 (IEC 1131-2/EN 61131-2)
Robot protection class	IP20 (NEMA Type 1)
Note: See **Section 8.1 on page 105** for robot dimensions.	

3.5 Mounting the Robot

Mounting Surface

The Adept Cobra s-series robot is designed to be mounted on a smooth, flat, level tabletop. 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 tube frame. Excessive vibration or mounting flexure will degrade robot performance. **Figure 3-2** shows the mounting hole pattern for the Adept Cobra s-series robots.

> **NOTE:** On the under side 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 3-2**. Using locating pins could improve the ability to remove and reinstall the robot in the same position.

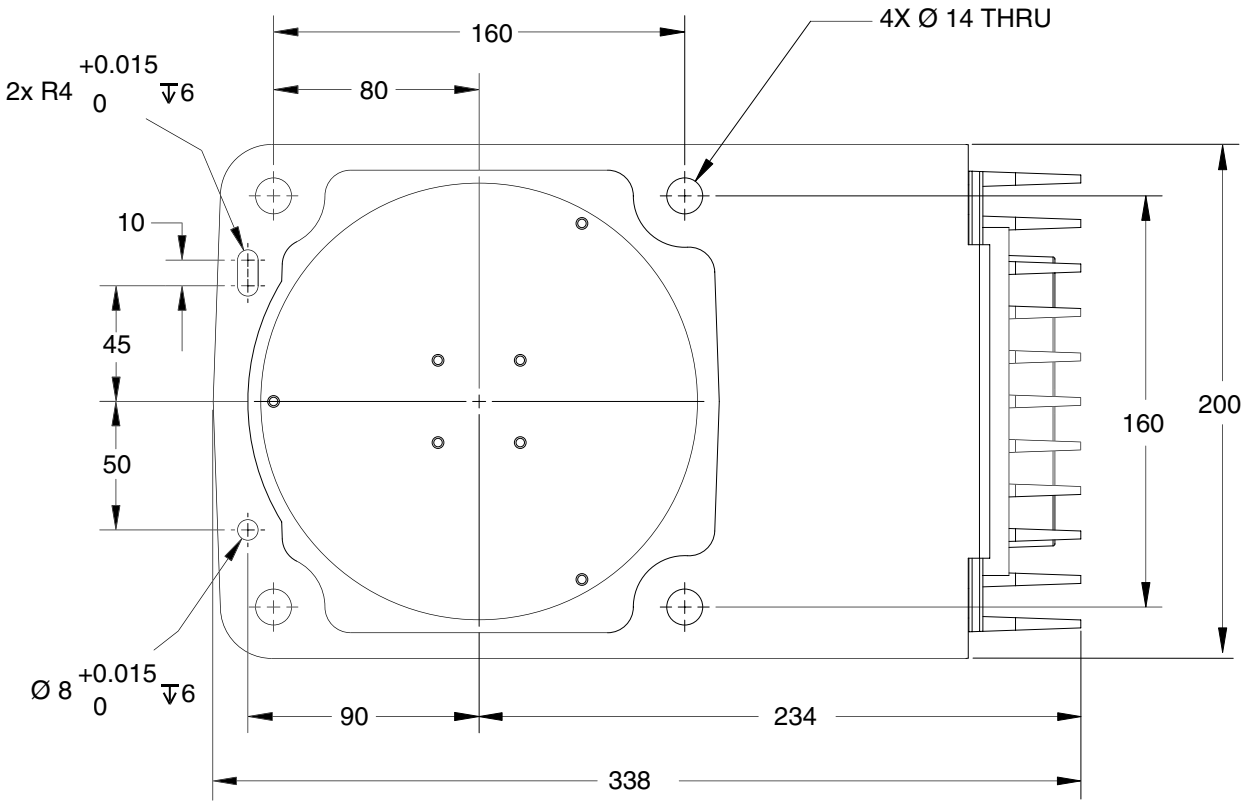


Figure 3-2. Mounting Hole Pattern for Robot

Robot Mounting Procedure

1. Using the dimensions shown in **Figure 3-2**, 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 3-2** 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 3-1 on page 35**). 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 inner or outer links 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 customer-supplied mounting bolts and washers. Tighten bolts to torque specified in **Table 3-2**.

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 7** for periodic maintenance.

Table 3-2. 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	65 ft-lb

3.6 Description of Connectors on Robot Interface Panel

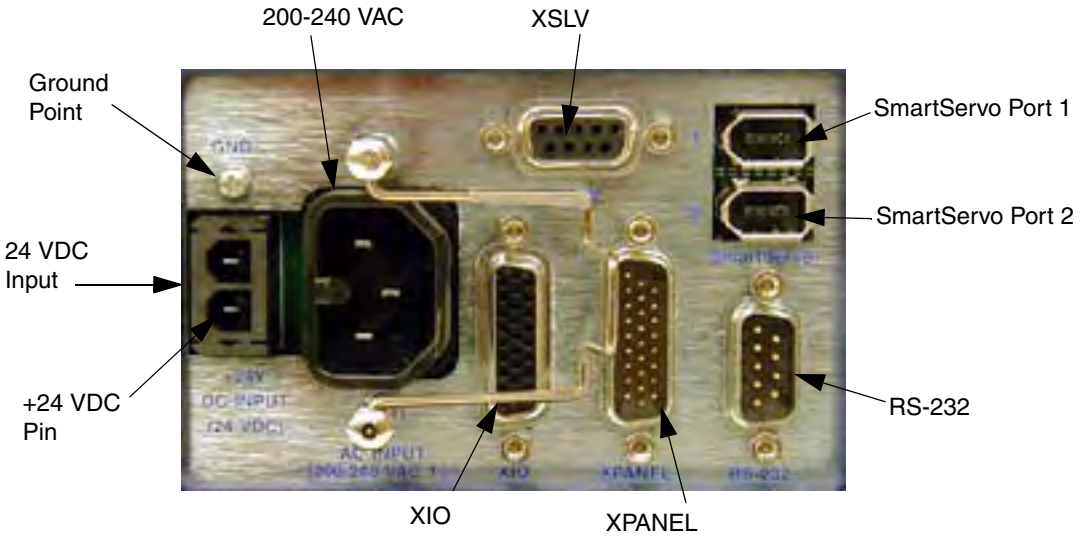


Figure 3-3. Robot Interface Panel

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

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

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

XSLV - for connecting the supplied XSYS cable from the controller XSYS connector. (DB-9, female)

SmartServo 1/2 - for connecting the IEEE 1394 cable from the controller (SmartServo 1.1) to the robot upper connector (SmartServo 1). The robot lower connector (SmartServo 2) can be used to connect to a second robot or another 1394-based motion axis.

RS-232 - used only with Cobra i-series robots, for connecting a system terminal. (DB-9, male)

XPANEL - used only with Cobra i-series robots, for connecting the front panel and MCP. (DB26, high density, male)

XIO - for user I/O signals for peripheral devices. This connector provides 8 outputs and 12 inputs. See **Section 5.5 on page 59** for connector pin allocations for inputs and outputs. That section also contains details on how to access these I/O signals via V+. (DB26, high density, female)

4 System Installation

4.1 System Cable Diagram

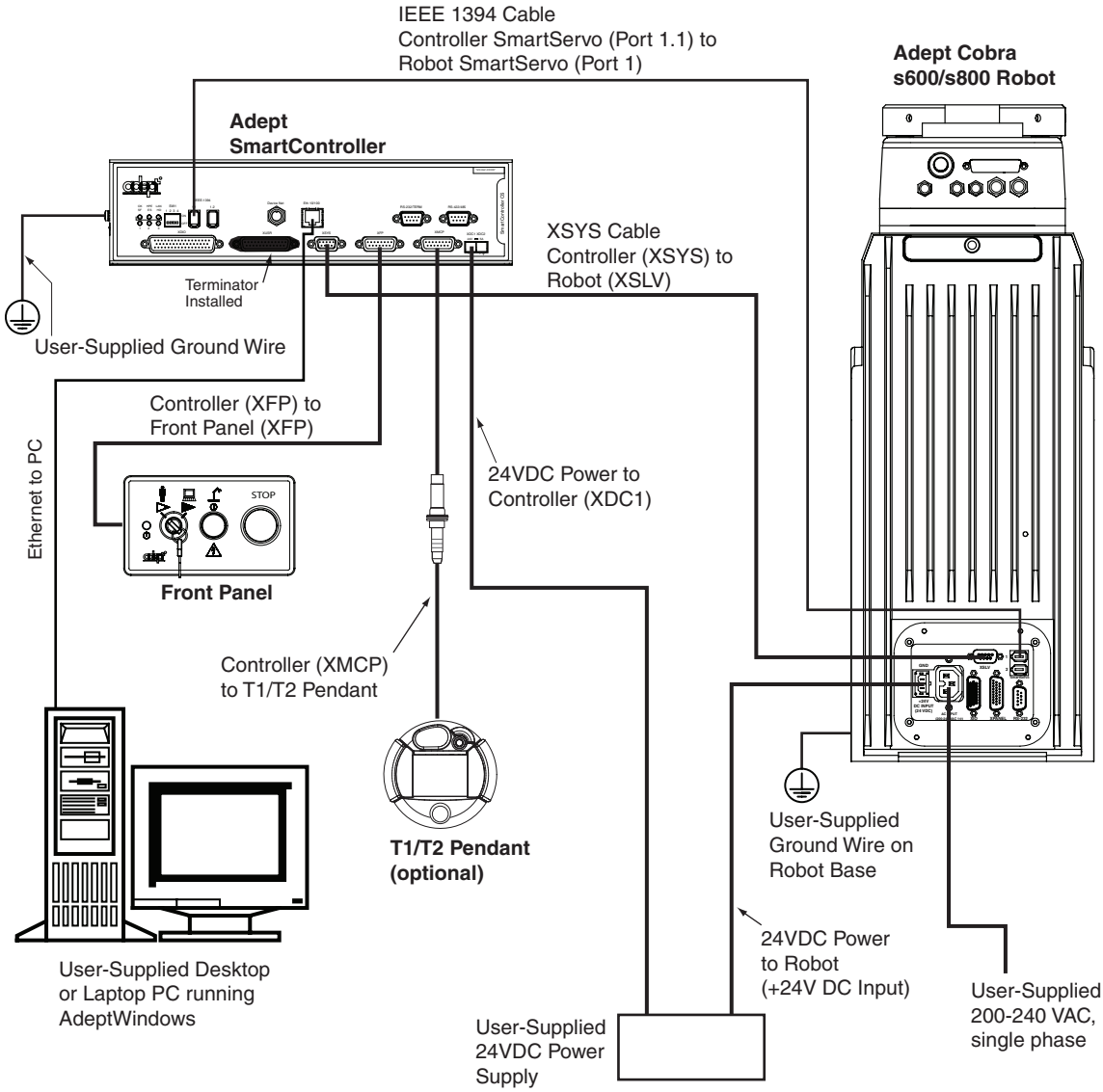


Figure 4-1. System Cable Diagram for Adept Cobra s600/s800 Robots

NOTE: See **"Installing 24VDC Robot Cable" on page 45** for additional system grounding information.

4.2 Cable and Parts List

Table 4-1. Cable and Parts List

Part Description	Part Number	Notes
IEEE 1394 Cable, 4.5M	10410-00545	Standard cable - supplied with system
XSYS Cable, 4.5 M	02928-000	Standard cable - supplied with system
Front Panel Cable	10356-10500	Supplied with Front Panel
MCP Pendant Adapter Cable	10356-10400	Supplied with optional MCP
T1/T2 Pendant Adapter Cable	05002-002	Supplied with optional T1/T2 pendant
Power Cable Kit - contains 24VDC and AC power cables	04972-000	Available as option
XIO Breakout Cable, 12 inputs/ 8 outputs, 5 meter	04465-000	Available as option - see page 63.

4.3 Installing the SmartController

Refer to the *Adept SmartController User's Guide* for complete information on installing the Adept SmartController. This list summarizes the main steps.

1. Mount the SmartController and Front Panel.
2. Connect the Front Panel to the SmartController.
3. Connect the pendant to the SmartController.
4. Connect user-supplied 24 VDC power to the controller.
5. Install a user-supplied ground wire between the SmartController and ground.
6. Install the AdeptWindows PC user interface. Refer to the *AdeptWindows Installation Guide*.

4.4 Cable Connections from Robot to SmartController

1. Locate the IEEE 1394 cable (length 4.5M) and the XSYS cable (length 4.5M). They are typically shipped in the cable/accessories box.
2. Install one end of the IEEE 1394 cable into the SmartServo port 1.1 connector on the SmartController, and install the other end into the SmartServo port 1 connector on the robot interface panel. See **Figure 4-1 on page 41**.
3. Install the XSYS cable between the robot interface panel XSLV safety interlock connector and XSYS connector on the SmartController, and tighten the latching screws.

4.5 Connecting 24 VDC Power to Robot

Specifications for 24 VDC Power

Table 4-2. Specifications for 24VDC User-Supplied Power Supply

Customer-Supplied Power Supply	24VDC (± 10%), 150W (6A) (21.6 V< V_{in} < 26.4 V)
Circuit Protection[a]	output must be less than 300W peak **or** 8 Amp in-line fuse
Power Cabling	1.5 – 1.85mm² (16-14 AWG)
Shield Termination	Braided shield connected to "-" terminal at both ends of cable. See Figure 4-2 on page 45.

[a] User-supplied 24V power supply must incorporate overload protection to limit peak power to less than 300W, **or** 8A in-line fuse protection must be added to the 24V power source. (In case of multiple robots on a common 24V 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 24V, 6A 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 3A for each additional robot.

CAUTION: Make sure you select a 24 VDC power supply that meets the specifications in **Table 4-2**. Using an under rated supply can cause system problems and prevent your equipment from operating correctly. See **Table 4-3** for recommended power supplies.

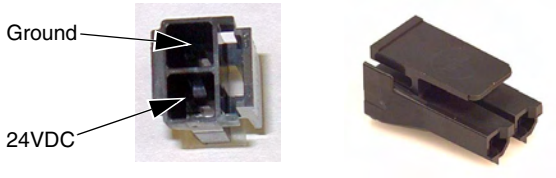
Table 4-3. Recommended 24VDC Power Supplies

Vendor Name	Model	Ratings
XP Power	JPM160PS24	24VDC, 6.7 A, 160 W
Astrodyne	SP-150-24	24VDC, 6.3 A, 150 W
Mean Well	SP-150-24	24VDC, 6.3 A, 150 W

Details for 24 VDC Mating Connector

The 24VDC mating connector and two pins are supplied with each system. They are typically shipped in the cable/accessories box.

Table 4-4. 24VDC Mating Connector Specs

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

NOTE: The 24 VDC cable is not supplied with the system, but is available in the optional Power Cable kit, see **Table 4-1 on page 42**.

Procedure for Creating 24 VDC Cable

1. Locate the connector and pins from **Table 4-4**.
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.

   NOTE: You also must create a separate 24 VDC cable for the SmartController. That cable uses a different style of connector. See the *Adept SmartController User's Guide*.

3. Crimp the pins onto the wires using the crimping tool.

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 24VDC power supply.

Installing 24VDC Robot Cable

1. Connect one end of the shielded 24 VDC cable to your user-supplied 24 VDC power supply. See **Figure 4-2**. The cable shield should be connected to frame ground on the power supply. Do not turn on the 24VDC power until instructed to do so in **Chapter 5**.
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.

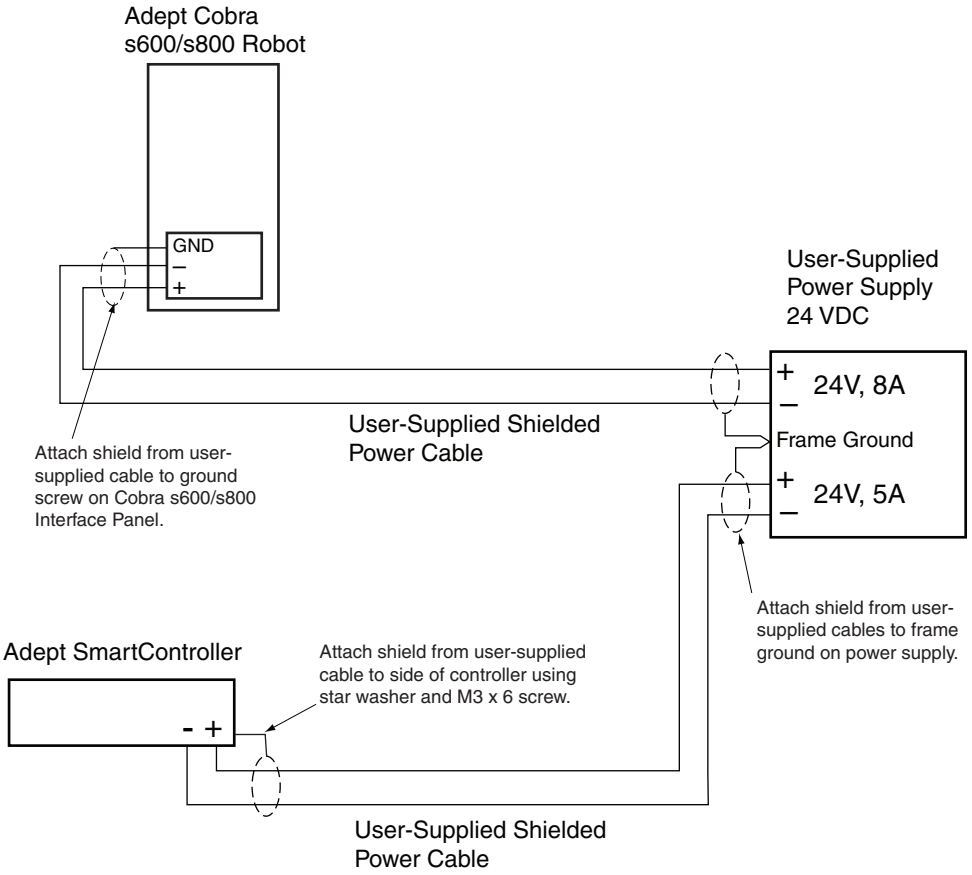


Figure 4-2. User-Supplied 24VDC Cable

NOTE: In order to maintain compliance with EN standards, Adept recommends that DC power be delivered over a shielded cable, with the shield connected to the return conductors at both ends of the cable.

4.6 Connecting 200-240 VAC Power to Robot

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

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

Specifications for AC Power

Table 4-5. Specifications for 200/240VAC User-Supplied Power Supply

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

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

Table 4-6. Typical Robot Power Consumption

Cobra Robot	Move	Average Power (W)	RMS Current (A)	Peak Power (W)[a]
s600/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
s800/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 8-2 on page 115 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.

NOTE: Adept products are designed for connection to symmetrically-earthed, three-phase AC mains systems (with grounded neutral). Connections called out as single-phase can be wired Line-to-Neutral or Line-to-Line.

WARNING: Adept systems require an isolating transformer for connection to mains systems that are asymmetrical or use an isolated (impedant) neutral. Many parts of Europe use an impedant neutral.

DANGER: AC power installation must be performed by a skilled and instructed person - see **Section 2.12 on page 33**. 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, nonperiodic 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

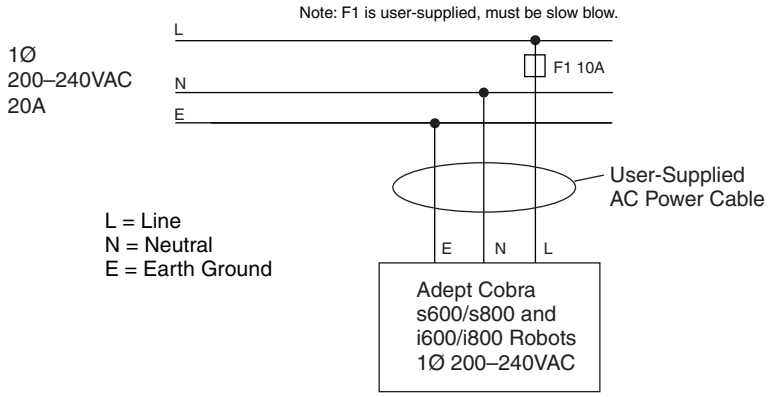


Figure 4-3. Typical AC Power Installation with Single-Phase Supply

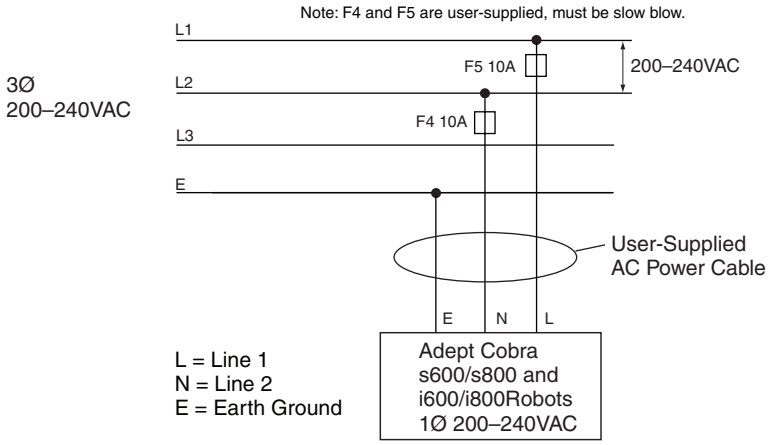
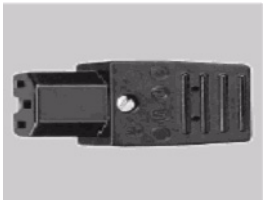


Figure 4-4. Single-Phase AC Power Installation from a Three-Phase AC Supply

Details for AC Mating Connector

The AC mating connector is supplied with each system. It is typically shipped in the cable/accessories box. The supplied plug is internally labeled for the AC power connections (L, E, N).

Table 4-7. 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

NOTE: The AC power cable is not supplied with the system, but is available in the optional Power Cable kit, see Table 4-1 on page 42.

Procedure for Creating 200-240 VAC Cable

1. Locate the AC mating connector shown in Table 4-7.
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 4-5 on page 49.
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 approximately 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. Replace 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.

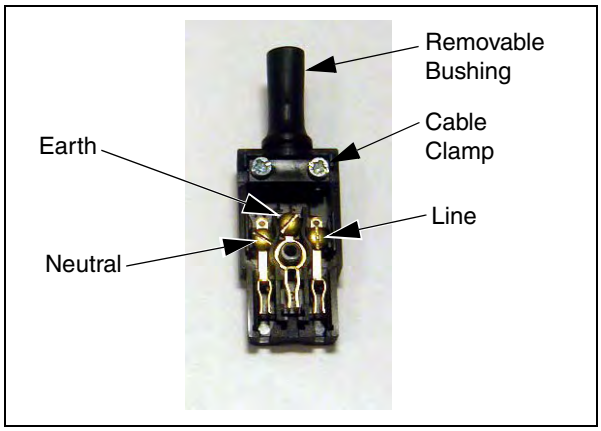


Figure 4-5. AC Power Mating Connector

Installing AC Power Cable to Robot

1. Connect the unterminated end of the AC power cable to your facility AC power source. See Figure 4-3 and Figure 4-4 on page 48. 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.

4.7 Grounding the Adept Robot System

Proper grounding is essential 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 ground wire at the robot base to ground the robot. See **Figure 4-6**. 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 earth ground.

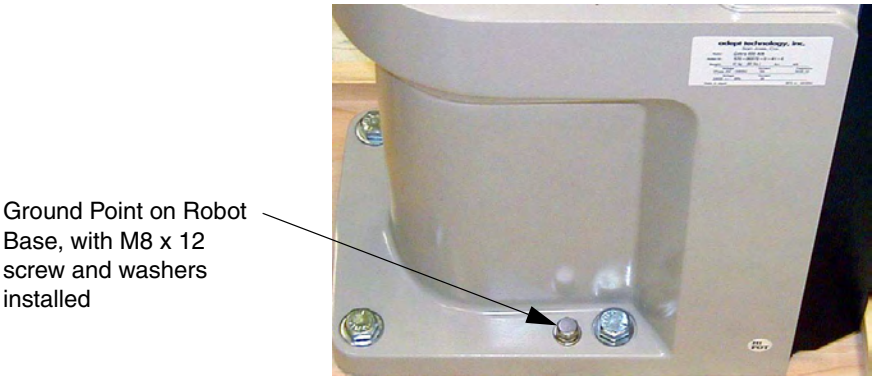


Figure 4-6. Ground Point on Robot Base

Robot-Mounted Equipment Grounding

The following parts of an Adept Cobra s600/s800 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 8-4 on page 108** 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.

4.8 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 **Chapter 2** in this manual for a discussion of safety issues.

Refer to the ***Adept SmartController User's Guide*** for information on connecting safety equipment into the system through the XUSR connector on the SmartController. There is a detailed section on Emergency Stop Circuits and diagrams on recommended E-Stop configurations.

5 System Operation

5.1 Robot Status LED Description

The robot Status LED Indicator is located on the top of the robot. The color and blinking pattern indicates the status of the robot.

The current robot models support the UL standard. The LED on these robots has an amber LED. See **Figure 5-1** for the status information displayed by this LED.

Legacy models have a bi-color, red and green LED. See **Table 5-2** for the status information displayed by this LED.

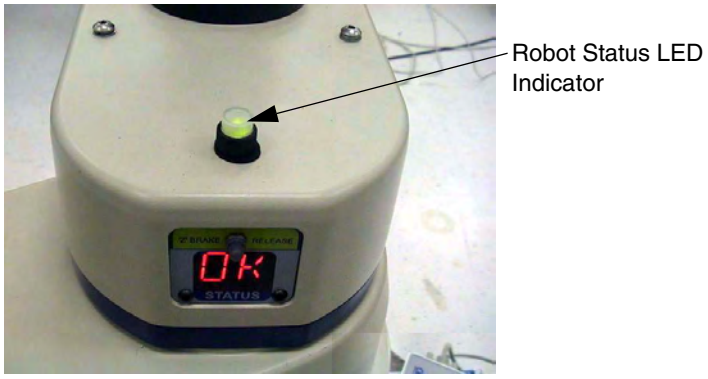


Figure 5-1. Robot Status LED Indicator Location

Table 5-1. Status LED Definitions on UL-Certified Robots

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, Slow Blink	N/A	Selected Configuration Node
Amber, Fast Blink	Fault Code(s)	Fault, see Section 5.2 on page 54
Amber, Solid	Fault Code(s)	Fault, see Section 5.2 on page 54

Table 5-2. Legacy Robot Status LED Definition

LED Status	Description
Off	24 VDC not present
Green, Slow Blink	High Power Disabled
Green, Fast Blink	High Power Enabled
Green/Red Blink	Selected Configuration Node
Red, Fast Blink	Fault, see Section 5.2
Solid Green or Red	Initialization or Robot Fault, see Section 5.2

5.2 Status Panel Fault Codes

The status panel, shown in Figure 5-2, displays alpha-numeric codes that indicate the operating status of the robot, including detailed fault codes. Table 5-3 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 5-2. Status Panel

Table 5-3. Status Panel 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	24V 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* document.

5.3 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. Instructions on configuring the Programmable E-Stop delay can be found within the SPEC section of the ***Instructions for Adept Utility Programs*** manual. The default setting is correct for most applications.

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 5-2 on page 54**). 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.

WARNING: Due to the effect of gravity, pressing the Brake Release button may cause the arm to fall.

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 while releasing the brake and verify that the end-effector or other installed tooling is clear of all obstructions.

5.4 Connecting Digital I/O to the System

You can connect digital I/O to the system in several different ways. See **Table 5-4** and **Figure 5-3**.

Table 5-4. Digital I/O Connection Options

Product	I/O Capacity	For more details
XIO Connector on Robot	12 inputs 8 outputs	see **Section 5.5 on page 59**
XDIO Connector on SmartController	12 inputs 8 outputs	see *Adept SmartController User's Guide*
Optional IO Blox Device, connects to robot	8 inputs, 8 outputs per device; up to four IO Blox devices per robot	see *Adept IO Blox User's Guide*
Optional sDIO Module, connects to controller	32 inputs, 32 outputs per module; up to four sDIO per system	see *Adept SmartController User's Guide*

NOTE: With the release of V+ 16.1 F6 in January 2005, the default signal configuration for digital I/O was changed to the values shown in **Figure 5-3** and **Table 5-5 on page 58**.

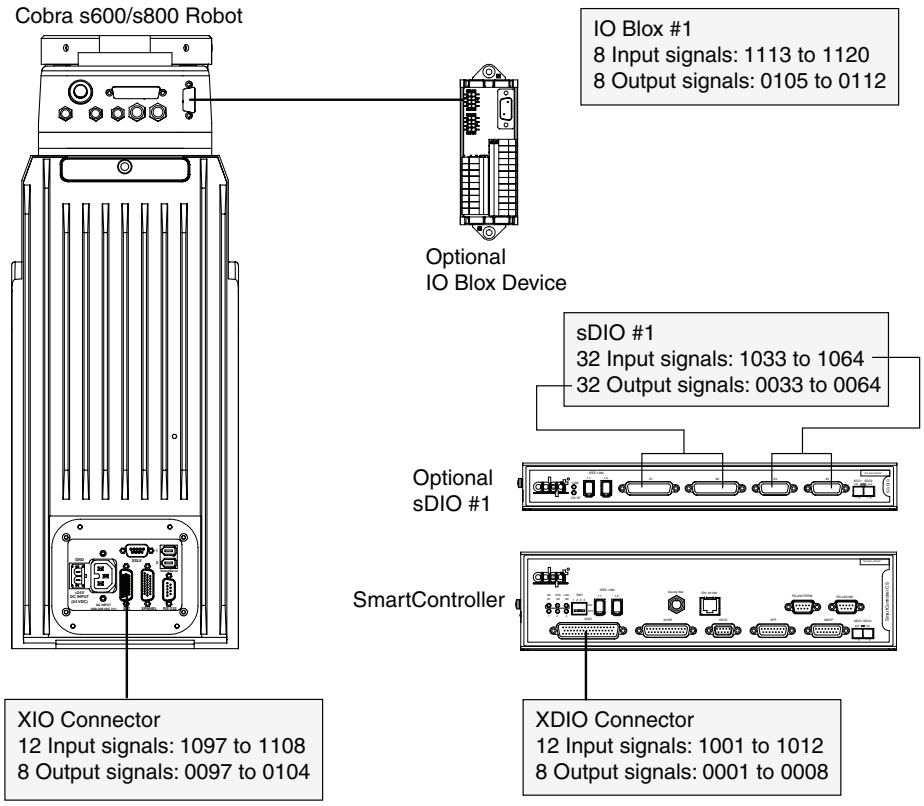


Figure 5-3. Connecting Digital I/O to the System

Table 5-5. Default Digital I/O Signal Configuration, Single Robot System

Location	Type	Signal Range
Controller XDIO connector	Inputs	1001 - 1012
	Outputs	0001 - 0008
sDIO Module 1	Inputs	1033 - 1064
	Outputs	0033 - 0064
sDIO Module 2	Inputs	1065 - 1096
	Outputs	0065 - 0096
sDIO Module 3 (recommended [a])	Inputs	1201 - 1232
	Outputs	0201 - 0232
sDIO Module 4 (recommended [a])	Inputs	1233 - 1264
	Outputs	0233 - 0264
Robot 1 XIO connector[b]	Inputs	1097 - 1108
	Outputs	0097 - 0104
IO Blox 1	Inputs	1113 - 1120
	Outputs	0105 - 0112
IO Blox 2	Inputs	1121 - 1128
	Outputs	0113 - 0120
IO Blox 3	Inputs	1129 - 1136
	Outputs	0121 - 0128
IO Blox 4	Inputs	1137 - 1144
	Outputs	0129 - 0136

[a] For sDIO modules 3 and 4, you must configure the signals using CONFIG_C, to have the system support those modules. See the ***Adept SmartController User's Guide*** for additional information on that process.

[b] For Dual Robot systems, see **Table 11-1 on page 136**.

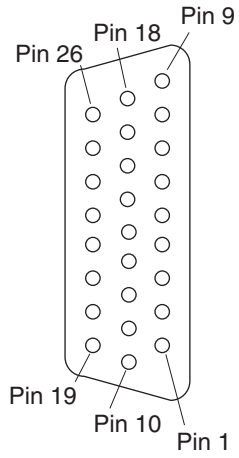
5.5 Using Digital I/O on Robot XIO Connector

The XIO connector on the robot interface panel offers access to digital I/O, 12 inputs and 8 outputs. These signals can be used by V+ to perform various functions in the workcell. See Table 5-6 for the XIO signal designations.

- 12 Inputs, signals 1097 to 1108
- 8 Outputs, signals 0097 to 0104

Table 5-6. XIO Signal Designations

Pin No.	Designation	Signal Bank	V+ Signal Number	Pin Locations
1	GND			
2	24VDC			
3	Common 1	1		
4	Input 1.1	1	1097	
5	Input 2.1	1	1098	
6	Input 3.1	1	1099	
7	Input 4.1	1	1100	
8	Input 5.1	1	1101	
9	Input 6.1	1	1102	
10	GND			
11	24VDC			
12	Common 2	2		
13	Input 1.2	2	1103	
14	Input 2.2	2	1104	
15	Input 3.2	2	1105	
16	Input 4.2	2	1106	
17	Input 5.2	2	1107	
18	Input 6.2	2	1108	
19	Output 1		0097	
20	Output 2		0098	
21	Output 3		0099	
22	Output 4		0100	
23	Output 5		0101	
24	Output 6		0102	
25	Output 7		0103	
26	Output 8		0104	



XIO 26-pin female connector on Robot Interface Panel

Optional I/O Products

These optional products are also available for use with digital I/O:

- **XIO Breakout Cable**, 5 meters long, with flying leads on user's end. See page 63 for information. This cable is not compatible with the XIO Termination Block mentioned below.
- **XIO Termination Block**, with terminals for user wiring, plus input and output status LEDs. Connects to the XIO connector with 6 foot cable. See the *Adept XIO Termination Block Installation Guide* for details.

XIO Input Signals

The 12 input channels are arranged in two banks of six. Each bank is electrically isolated from the other bank and is 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 5-6 on page 59), 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. See the *V+ Language User's Guide* for information on digital I/O programming.

XIO Input Specifications

Table 5-7. 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 K Ω minimum
Current at V_{in} = +24VDC	$I_{in} \leq$ 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

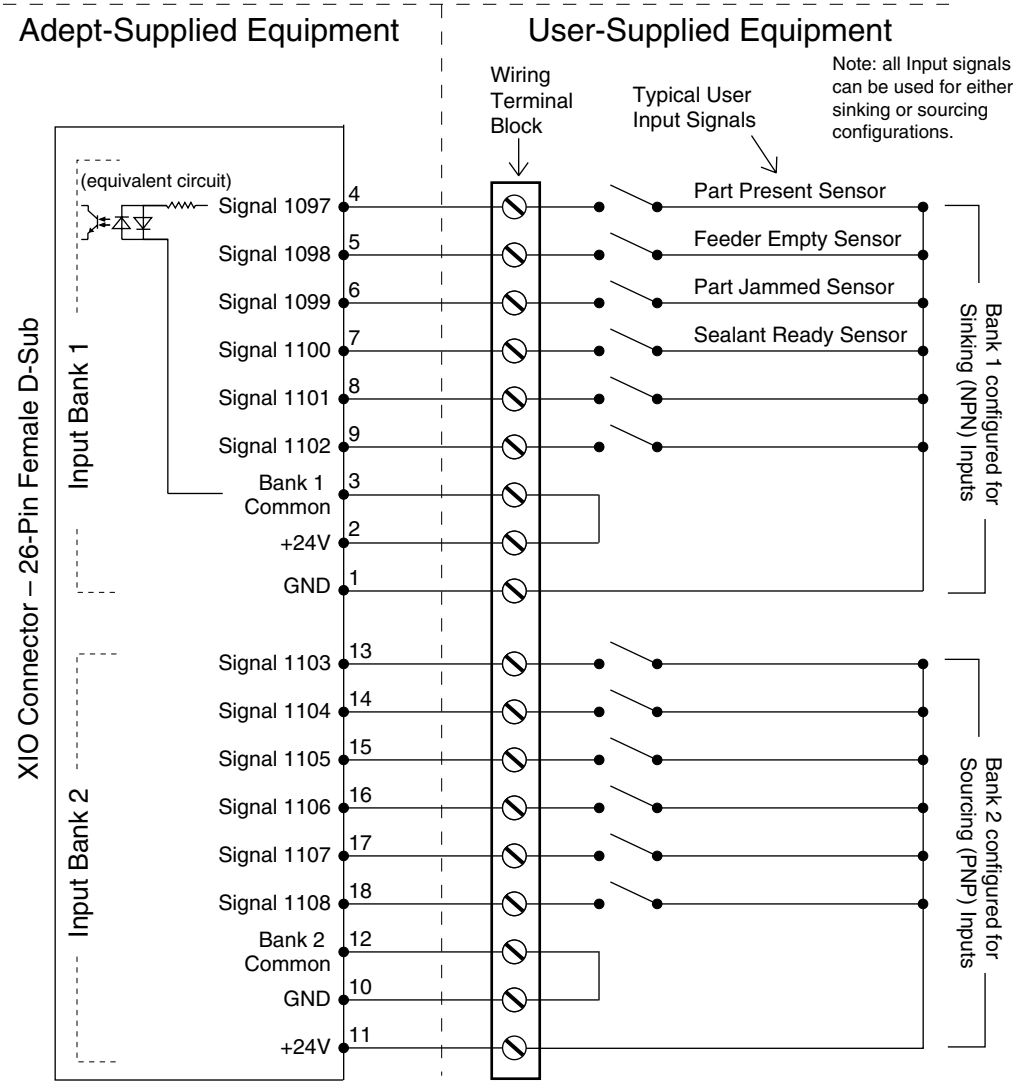


Figure 5-4. Typical User Wiring for XIO Input Signals

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 0.7A 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 24VDC input to the robot through a self-resetting polyfuse.

The outputs are accessed through direct connection to the XIO connector (see **Table 5-6 on page 59**), or through the optional XIO Termination Block. See the documentation supplied with the Termination Block for details.

XIO Output Specifications

Table 5-8. XIO Output Circuit Specifications

Parameter	Value
Power supply voltage range	See **Table 4-2 on page 43**.
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 $I_{total} \leq$ 1.5A @ 25°C ambient
On state resistance (I_{out} = 0.5A)	$R_{on} \leq$ 0.32Ω @ 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} = 0.5A, Load = 1 mH)	(+V - 65) $\leq V_{demag} \leq$ (+V - 45)
DC short circuit current limit	0.7A $\leq I_{LIM} \leq$ 2.5 A
Peak short circuit current	$I_{ovpk} \leq$ 4A

Typical Output Wiring Example

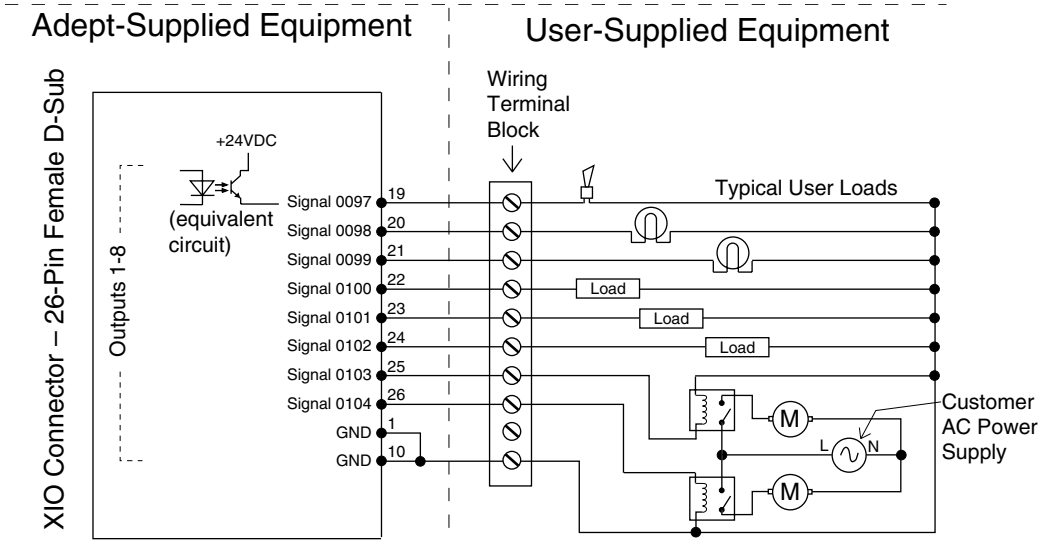


Figure 5-5. Typical User Wiring for XIO Output Signals

XIO Breakout Cable

The XIO Breakout cable is available as an option - see **Figure 5-6**. 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 5-9 on page 64** for the wire chart on the cable.

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

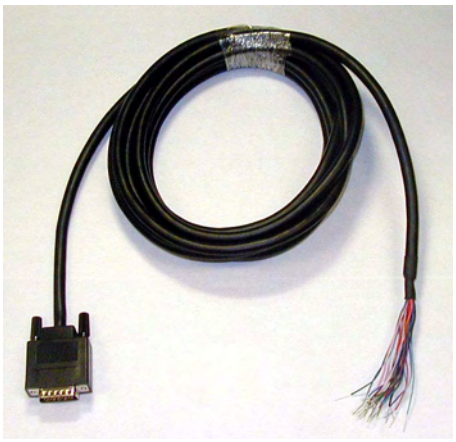
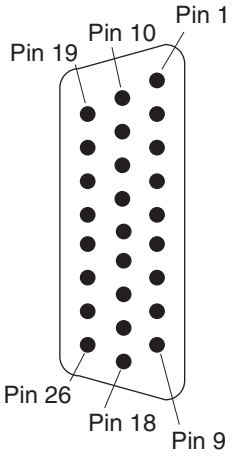


Figure 5-6. Optional XIO Breakout Cable

Table 5-9. XIO Breakout Cable Wire Chart

Pin No.	Signal Designation	Wire Color	Pin Locations
1	GND	White	
2	24VDC	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	24VDC	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	**26-pin male connector on XIO Breakout Cable**
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	

5.6 Commissioning 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.
- Move each axis of the robot with the pendant 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 and controller have 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 where it is safe to turn on power to the robot system.

System Cable Checks

Verify the following connections:

- Connect the Front Panel to the SmartController.
- Connect the pendant to the SmartController, via the pendant adapter cable.
- Connect user-supplied 24 VDC power to the controller.
- Install a user-supplied ground wire between the SmartController and ground.
- Install one end of the IEEE 1394 cable into the SmartServo port 1.1 connector on the SmartController, and install the other end into the SmartServo port 1 connector on the robot interface panel.
- Install the XSYS cable between the robot interface panel XSLV safety interlock connector and XSYS connector on the SmartController, and tighten the latching screws.

- Connect user-supplied 24 VDC power to the robot 24VDC connector.
- Connect user-supplied 200/240 VAC power to the robot 200/240VAC connector.

User-Supplied Safety Equipment Checks

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

System Start-up Procedure

Once the system installation has been verified, you are ready to start up the system.

1. Switch on the 200/240VAC power.
2. Switch on the 24VDC power to the robot.
3. Switch on the 24VDC power to the controller.
4. Connect to the controller via AdeptWindows, and boot the system from the "D" default drive.
5. Wait for the system to complete the boot cycle. Once completed the system will return with a "dot" prompt, and the following window should be displayed.

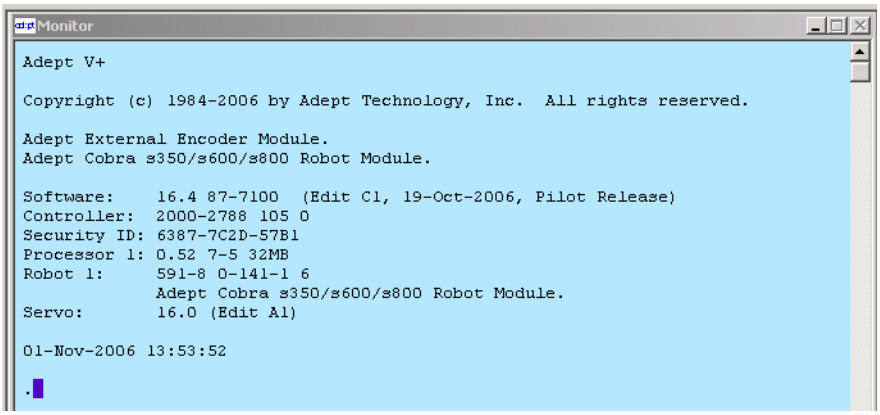


Figure 5-7. Typical Startup Screen

6. There should be no errors, if the boot sequence completed successfully.
7. Disengage any E-Stops.
8. Manually move the arm away from the shipping position. Joints 1, 2, and 4 can be moved by pushing the joint. To move Joint 3, use the brake release button, located above the status panel. Make sure that you hold Joint 3, prior to pressing the brake release button.
9. Type enable power.

   ```
   ENA POW <enter>
   ```

   Press the High Power button on the Front Panel while it is blinking.
10. Type calibrate.

    ```
    CAL <enter>
    ```

NOTE: The system will move slightly, with less than a 1.5 degree rotation of J4, and you might hear an audible click from the J3 brake releasing when calibration is executed. The robot is now servoing all motors to remain in position at all times.

11. System will return with a "dot" (.) prompt, if everything was successful, then high power will be enabled, and the status panel display will read "OK."
12. System is ready for operation.

Verifying E-Stop Functions

Verify that all E-Stop devices are functional (pendant, 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 should go out.

Verify Robot Motions

Use the pendant to test the motion of each axis on the robot to confirm it moves in the proper directions. Refer to the *Adept SmartController User's Guide*, the *T1 Pendant User's Guide* or the *T2 Pendant User's Guide* for complete instructions on using the pendant.

5.7 Learning to Program the Adept Cobra S-Series Robot

To learn how to use and program the robot, go to the *V+ Operating System User's Guide* to find information on basic operation of the V+ Operating System. Also refer to the *Instructions for Adept Utility Programs* for information on using the Adept utility programs.

For programming information you need to refer to the following list of optional manuals:

- *V+ Language User's Guide*
- *V+ Language Reference Guide*
- *V+ Operating System Reference Guide*

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 user flange using four M6 screws. See **Figure 8-4 on page 108** for a detailed dimension drawing of the user flange.

A 6 mm diameter x 12 mm dowel pin (user-supplied) fits in the through hole in the user flange and can be used as a keying or antirotation 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 50**.

> **NOTE:** A threaded hole is provided on the user flange (see **Figure 8-4 on page 108**). The user may attach a ground wire through the quill connecting the outer link and the user flange.

6.2 Removing and Installing the User Flange

The user flange can be removed and reinstalled. 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. Follow the procedures below to remove and replace the flange assembly.

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 70**). Note the vertical-spline groove that is in line with the setscrew. You must replace 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 inside the flange behind the setscrew.

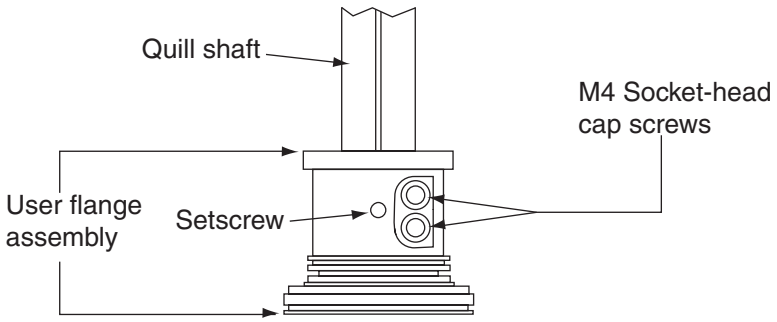


Figure 6-1. User Flange Removal Details

Installing the Flange

1. Make sure the ball bearing is in the setscrew hole inside the flange. 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 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.

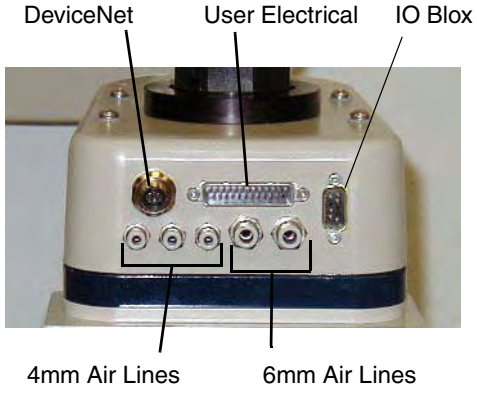


Figure 6-2. User Connectors on Joint 1

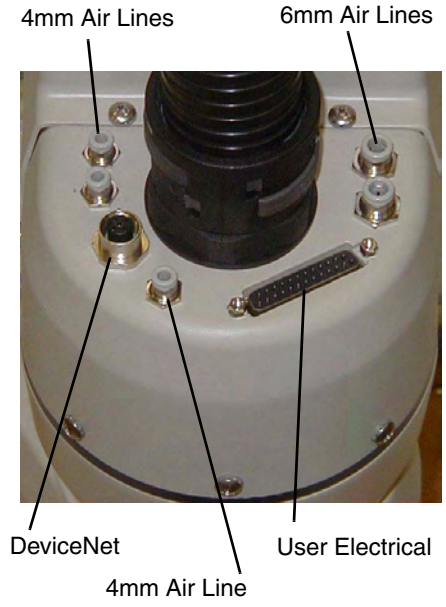


Figure 6-3. User Connectors on Joint 2

NOTE: See **page 57** 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.

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 of the bulkhead area - see **Figure 6-5**.

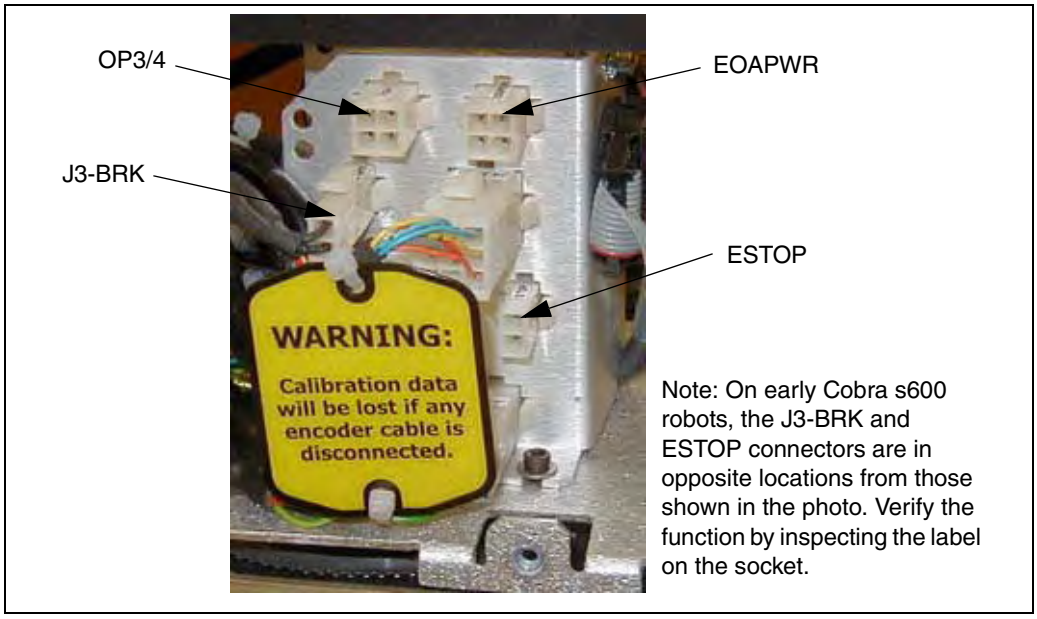


Figure 6-4. Internal User Connectors - OP3/4, EOAPWR, ESTOP

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.

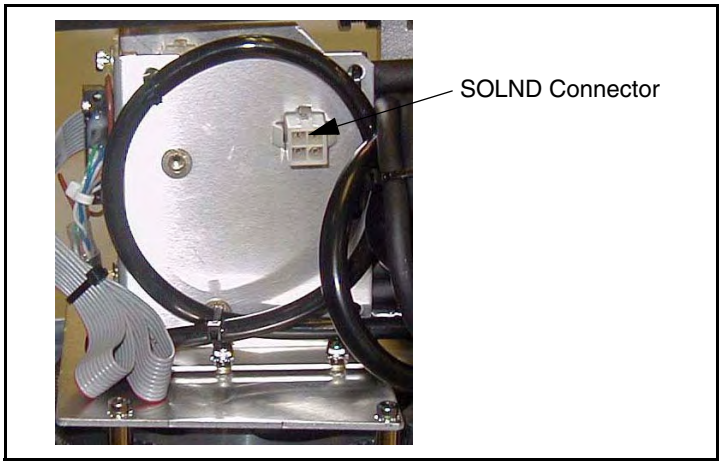
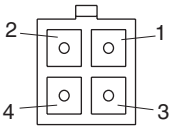


Figure 6-5. SOLND Connector

SOLND Connector

This 4-pin connector provides the output signals for the optional Robot Solenoid Kit. See Table 6-1 and Figure 6-5 on page 72. See Section 6.6 on page 78 for installation details.

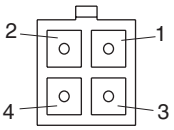
Table 6-1. SOLND Connector Pinout

Pin #	Description	Pin Location
1	Output 3001 (signal 9 in Cobra i600/i800 robots)	 SOLND Connector as viewed on robot
2	Ground	
3	Output 3002 (signal 10 in Cobra i600/i800 robots)	
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 72) provides the output signals for a second set of optional robot hand valve solenoids, or other user-supplied devices. See Table 6-2 and Figure 6-6 on page 74.

Table 6-2. OP3/4 Connector Pinout

Pin #	Description	Pin Location
1	Output 3003 (signal 11 in Cobra i600/i800 robots)	 OP3/4 Connector as viewed on robot
2	Ground	
3	Output 3004 (signal 12 in Cobra i600/i800 robots)	
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		

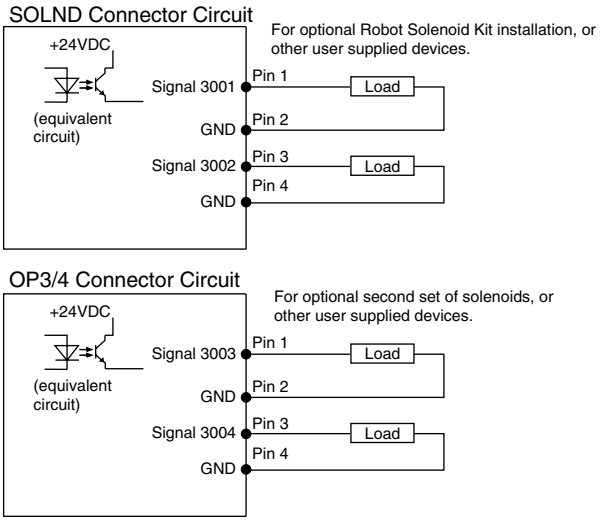
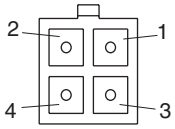


Figure 6-6. OP3/4 and SOLND Circuits

EOAPWR Connector

This 4-pin connector (see Figure 6-4 on page 72) provides 24 VDC power and ground for user applications. See Table 6-3 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 Table 6-4 apply to the EOAPWR, OP3/4, and SOLND internal user connectors.

Table 6-4. Internal User Connector Output Circuit Specifications

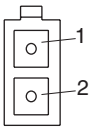
Parameter	Value
Power supply voltage range	See Table 4-2 on page 43.
Operational current range, per channel	$I_{out} \leq$ 700 mA
Total Current Limitation, all channels on.[a]	$I_{total} \leq$ 1.0 A @ 50°C ambient $I_{total} \leq$ 1.5A @ 25°C ambient
On state resistance (I_{out} = 0.5A)	$R_{on} \leq$ 0.32Ω @ 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} = 0.5A, Load = 1 mH)	(+V - 65) $\leq V_{demag} \leq$ (+V - 45)
DC short circuit current limit	0.7A $\leq I_{LIM} \leq$ 2.5 A
Peak short circuit current	$I_{ovpk} \leq$ 4A

[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 SPEC program (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	24V	
Mating Connector: AMP/Tyco #172165-1, 2-pin Mini-Universal Mate-N-Lock AMP/Tyco #770985-1, Pin Contact, Mini-Univ. Mate-N-Lok		

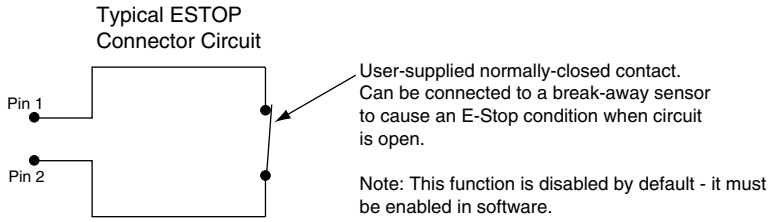


Figure 6-7. Internal E-Stop Connector Circuit

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

Procedure to Enable Breakaway E-Stop Function

To enable the Breakaway E-stop function, you have to use the SPEC utility to change the default configuration.

1. At the V+ prompt, type: load \util\spec.
2. In the opening window, select “Edit robot specifications.”
3. In the next window, select “Edit robot initialization specs.”
4. In the next window, select “Edit servo option word.”
5. In the next window, enter Y to the prompt, “Do you wish to modify servo options?”
6. In the next window, enter Y to the prompt, “Bit 1 clear. Change it (Y/N)?”

7. In the next window, you should see this line:

   Edit Servo Option Word 1

   This confirms that you have enabled the Breakaway E-Stop function.
8. Select “Exit to robot menu”
9. Select “Exit to main menu” on the next displayed menu.
10. Select “Save all specifications to system disk”
11. Finally, answer yes to write the data to the boot disk.

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 tapped holes. See **Figure 8-5 on page 109** and **Figure 8-6 on page 110** 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.

Also see **Section 6.7 on page 82** for information on mounting cameras on the robot.

6.6 Installing Robot Solenoid Kit

Introduction

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

The robot has been prewired 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 6-8 on page 79**). The signals actuating the valves are directly switchable from V^+ utilizing software signals 3001 and 3002. Refer to the SIGNAL command in the ***V+ Language Reference Guide*** for additional information. The Adept supplied solenoids each draw a nominal 75 mA from 24 VDC.

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 (0.19 MPa) minimum to 114 psi (0.786 MPa) maximum). 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 s-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 s-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	.19 - .786

Tools Required

- Assorted Allen drivers
- Tie-wraps
- Pair of 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 s600 (three screws on s800) on each side of the outer link cover. Remove two screws on top and remove 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.

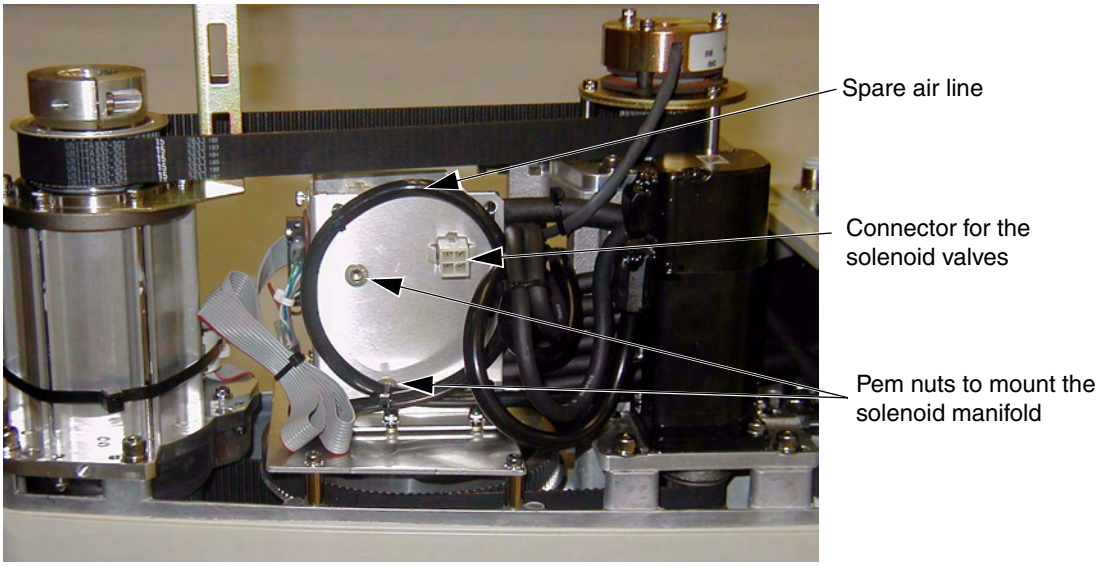


Figure 6-8. Solenoid Mounting Bracket With Connector and Spare Air Line

4. Cut and discard the tie-wraps 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 6-8**).
5. Mount the solenoid manifold onto the bracket using the supplied M3 x 25 mm screws and washers (see **Figure 6-9 on page 80**).
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 the air line.

   NOTE: If you are installing on a Cleanroom or IP65 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 6mm user airlines 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 tie-wraps to secure air line to the bracket as needed.

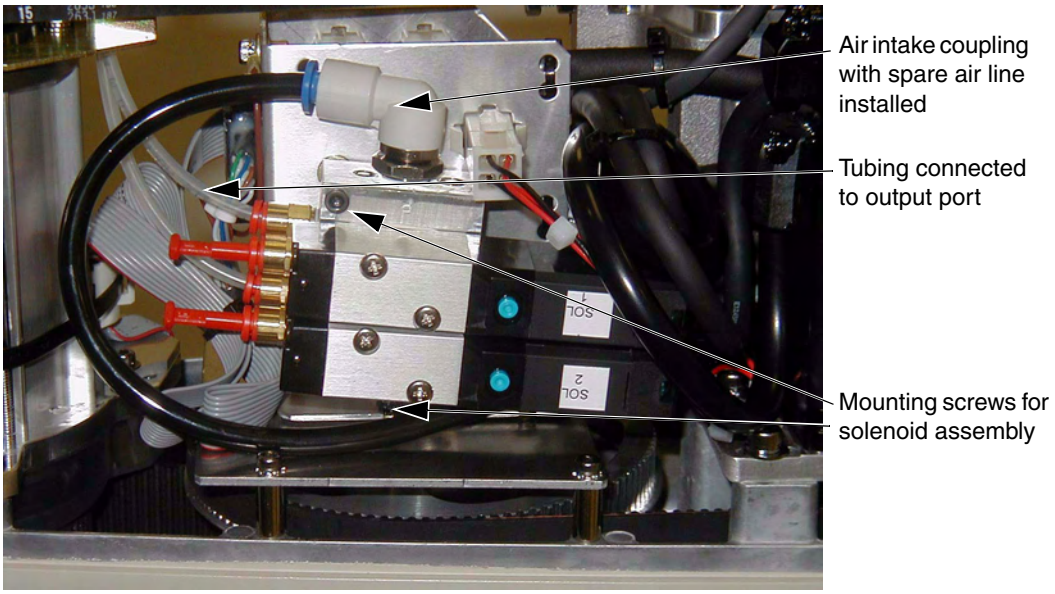


Figure 6-9. Solenoid Placement Using Mounting Hardware

9. Install the appropriate lengths of 5/32 inch 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 tie-wraps as needed to secure the tubing.
10. Loosen the securing screw on the AIB chassis, and lower the chassis down flat. See **Figure 7-2 on page 99** for the location of the securing screw.
11. Remove the cable strap plate by removing two screws and split washers. See **Figure 6-10**. This allows the harness to move when you lift the J1 cover in the next step.

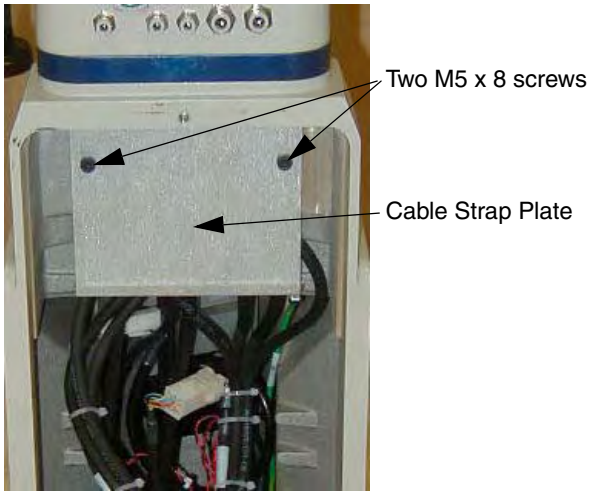


Figure 6-10. Removing the Cable Strap Plate

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 6-11**.

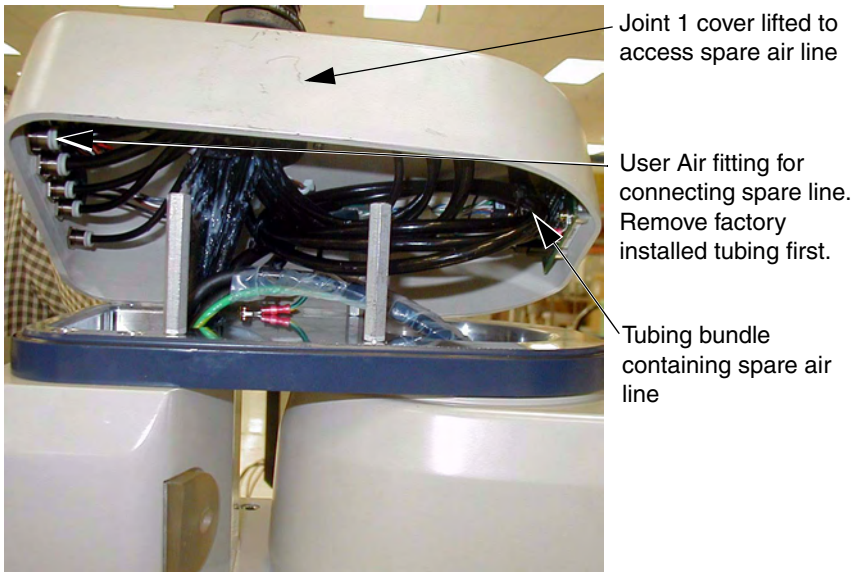


Figure 6-11. Connecting Spare Air Line to User Connector

13. Disconnect the tubing from the 6mm User Air fitting shown in **Figure 6-11**. Fold the tubing out of the way and restrain using tie-wraps.
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 6mm User Air fitting.

    NOTE: This 6mm User Air connector and the 6 mm User Air connector at the top of **Figure 6-2 on page 71** are not functional for other uses after this modification.

16. Replace the Joint 1 cover, taking care to insure that all tubing is inside the cover and nothing gets crimped or pinched while pushing the cover into position. Replace four screws to secure the cover. Tighten the screws to 1.6 N•m (14 in-lb) of torque.
17. Replace the cable strap plate that you removed earlier in the procedure.
18. Raise the AIB chassis to the closed position and tighten the securing screw.
19. Replace the outer link cover and tighten the screws to 1.6 N•m (14 in-lb) of torque.
20. Connect the factory air supply to the modified 6 mm User Air connector.
21. Turn on system power and boot the system. Once the system boot has completed, at the V+ dot prompt, type in the following commands to activate the solenoids one at a time.

    .Signal 3001

    .Signal 3002

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

6.7 Robot Camera Bracket Kit

Introduction

The Adept Cobra Robot Camera Bracket Kit provides a convenient way of mounting cameras to the outer link of the robot. The kit consists of the following:

- One camera plate
- Two camera brackets
- One camera mount slide bracket
- One camera mount channel
- M4 X 12 mm screws
- M4 stainless steel flat washers
- M5 X 12 mm screws

Tools Required

- M4 Allen wrench
- M3 Allen wrench

Procedure

1. Install the camera plate to the outer link with four M5 X 12 mm screws (see **Figure 6-12 on page 83** as you perform this procedure).
2. Install the two camera brackets to the camera plate with two stainless steel washers and two M4 X 12 mm screws for each bracket. (The camera brackets are not required unless you are mounting more than one camera.)
3. Mount the camera channel to the camera brackets or camera plate with M4 x 12 mm screws.
4. Mount the camera to the camera mount.
5. Mount the camera and camera mount to the camera channel using M5 x 12 mm screws.

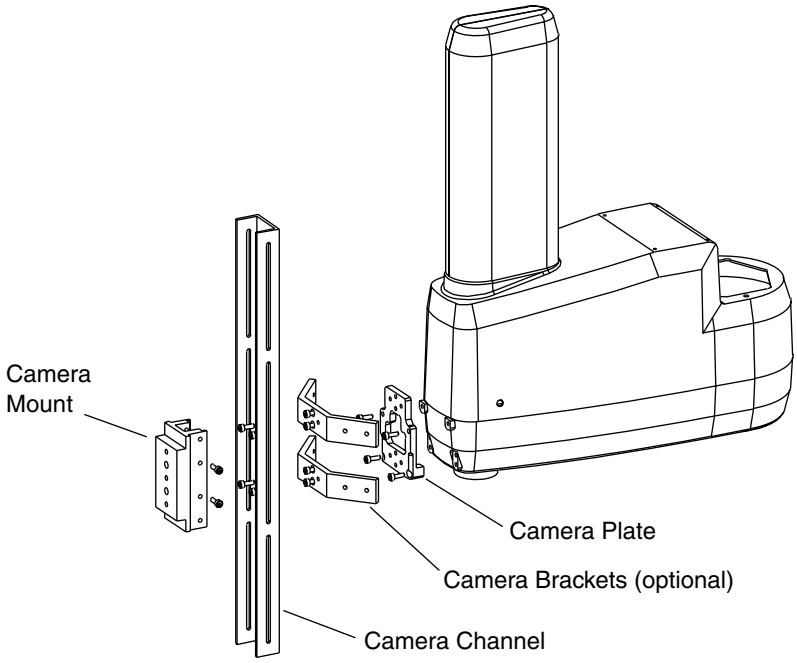


Figure 6-12. Mounting a Camera on the Robot

6.8 DeviceNet Communication Link

DeviceNet is a communications link that connects industrial I/O devices to a message-packeting network. All devices connect to the same backbone cable, eliminating the need for individual wiring for each I/O point.

Adept incorporates the following DeviceNet ready hardware in the Adept Cobra s-series robot:

- Female connector for the robot tower; Micro-style 12 mm thread DIN female connector (see **Figure 6-3 on page 71** and **Figure 6-13 on page 84**)
- Male Micro-style 12 mm thread DIN connector at the robot base (see **Figure 6-2 on page 71**).
- A nonstandard DeviceNet cable consisting of two shielded twisted pairs that connect the above connectors. Adept considers this cabling to be a drop line with a maximum total length of 6 meters and therefore uses the following wire sizes:

Wire	Adept	DeviceNet "thin cable"
Power pairs	24	22
Signal pairs	28	24

This means that total current on the power pairs must be limited to 2A instead of the standard 3A in a DeviceNet trunk line. Because this is intended to be a DeviceNet “drop line” with a maximum of 6 meters (16.5 feet), the full data rate should be achievable. However, Adept has tested the internal cable only at 125k baud.

See the *Adept SmartController User’s Guide* for physical installation. See the *Instructions for Adept Utility Programs* for software setup.

Recommended Vendors for Mating Cables and Connectors

A variety of vendors have molded cable assemblies for the “Micro-style” connector including **Brad Harrison, Crouse Hinds, Lumberg, Turk,** and others. In addition, **Hirshmann, Phoenix Contact,** and **Beckhoff** have mating micro connectors that have screw terminals in the plug to allow the user to make custom cables.

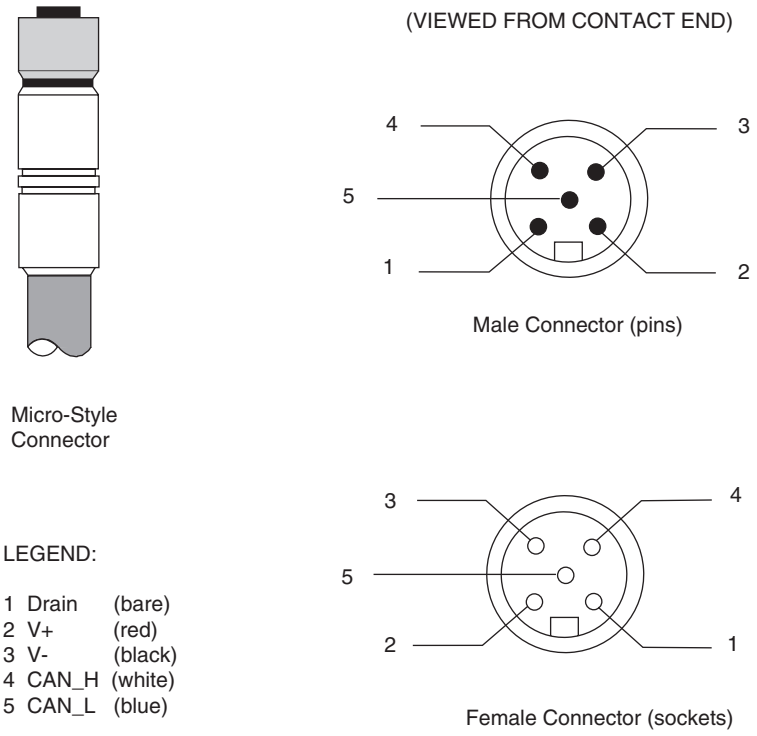


Figure 6-13. Micro-Style Connector Pinouts for DeviceNet

6.9 Installing Adjustable Hardstops

Adept offers an adjustable hardstop kit for Joint 1 and Joint 2 on the Adept Cobra s600/s800 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 required screws to install them. There are two locations for the hardstops on each side of the robot, Position 1 and Position 2. See **Figure 6-14**.

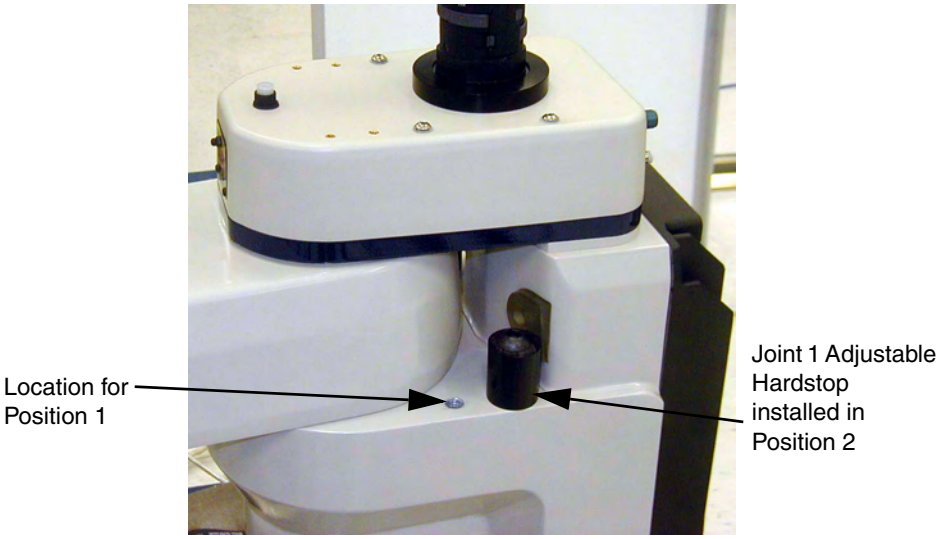


Figure 6-14. Joint 1 Adjustable Hardstops

Installation Procedure

1. Remove the plug from 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-lb).
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 SPEC program. See the ***Instructions for Adept Utility Programs*** for more details on the SPEC program.

1. Load and run the SPEC.V2 program. The main screen appears as shown in **Figure 6-15**.
2. Select option 4 => Edit robot specifications.

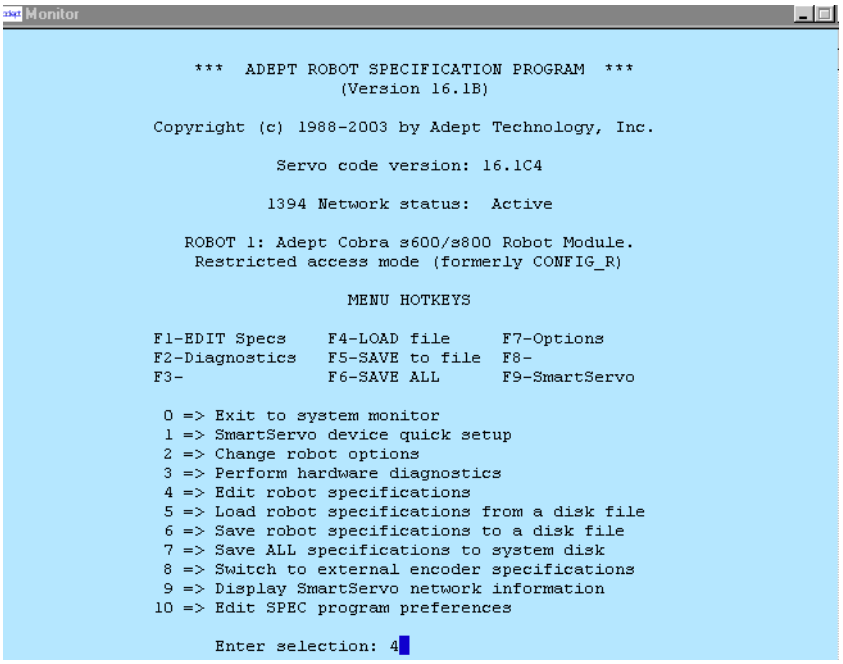


Figure 6-15. SPEC Program Main Menu

3. In the next menu, select option 3 => Edit joint motion specs. See **Figure 6-16**.

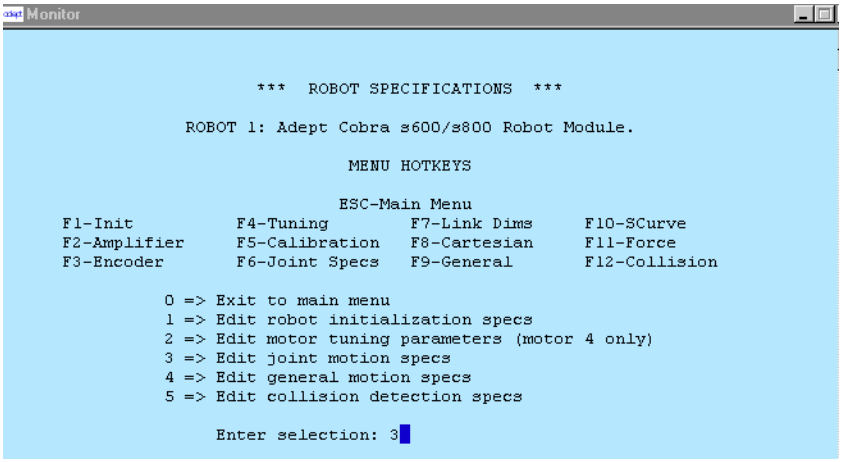


Figure 6-16. Robot Specs Menu

4. The system should go to the menu for Joint 1 - verify this at the top of the screen as shown in **Figure 6-17**. If it is not displaying Joint 1, select option 1 => Change joint number, and enter 1.

5. After confirming you are in the Joint 1 menu, select option 4 => lower joint limit. See **Figure 6-17**.

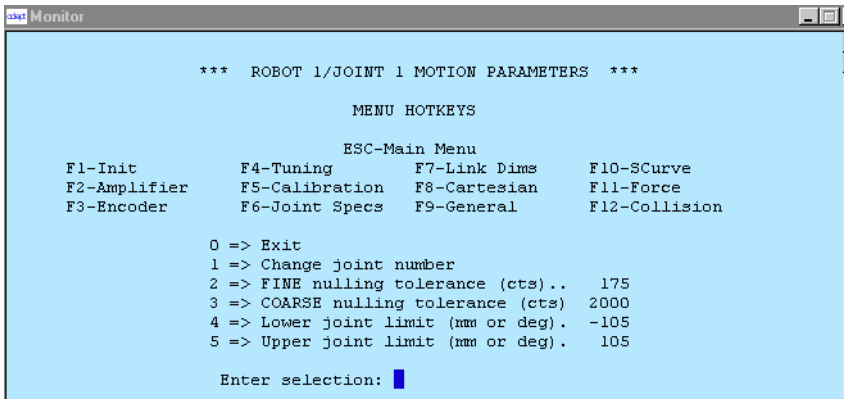


Figure 6-17. Joint 1 Motion Parameters Menu

6. In the next menu, enter the new value for the J1 lower limit softstop. See **Table 6-7** for recommended softstop values for Position 1 or Position 2. Note that this value must be a negative number.

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°

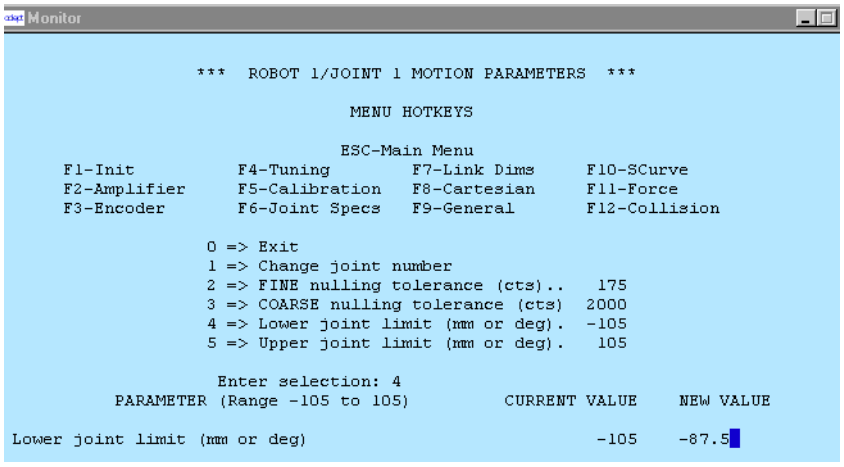


Figure 6-18. Joint 1 Menu - Lower Limits

7. In the next menu, select option 5=> upper joint limit. See **Figure 6-19**.

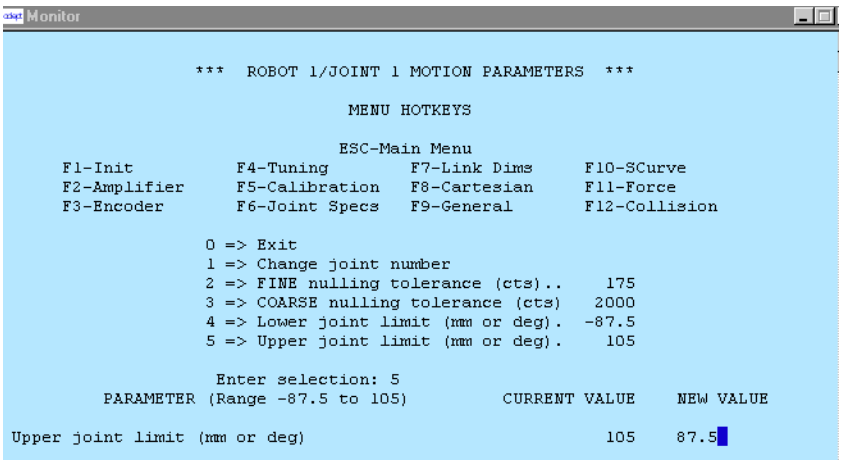


Figure 6-19. Joint 1 Menu - Upper Limits

8. In the next menu, enter the new value for the J1 upper limit softstop. See **Table 6-7**.
9. Once you have modified the upper and lower joint limit softstops, you must save the new values. Select option 0 => Exit, then select option 7 = Save ALL specifications to system disk.
10. Reboot the system by cycling 24VDC power to the SmartController. The new joint limits will be in affect when the system reboot is done.

Joint 2 Adjustable Hardstops

The Joint 2 Adjustable Hardstop kit (Figure 6-20) consists of two curved plates that are the adjustable hardstops, a small, black rectangular device 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.

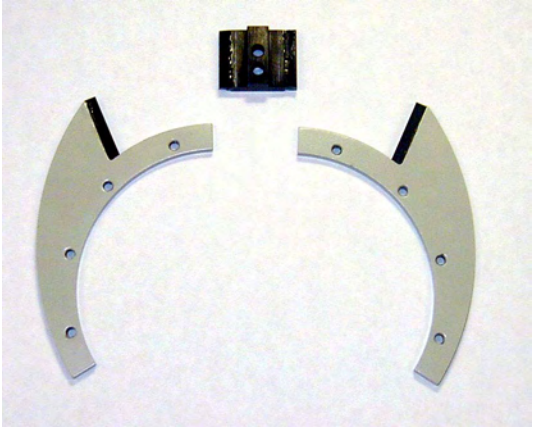
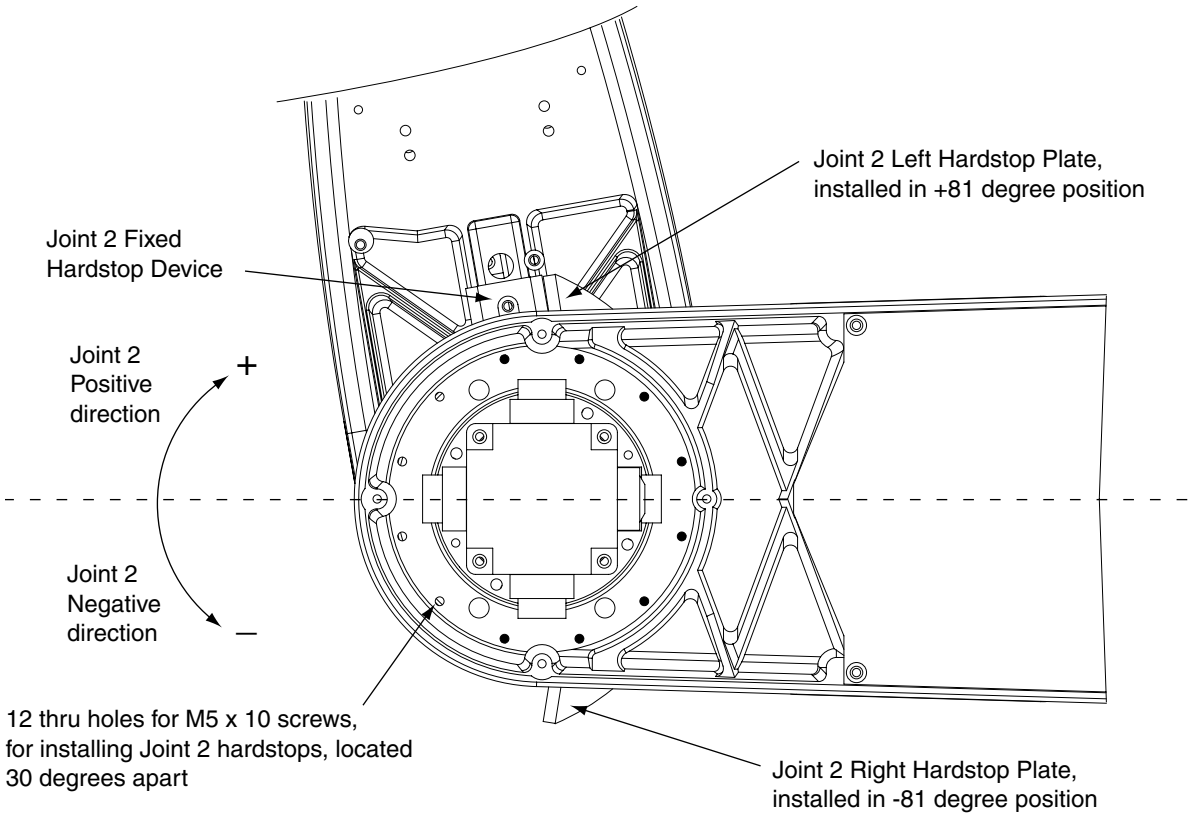


Figure 6-20. Joint 2 Hardstop Kit

Installation Procedure

1. Slide the two adjustable hardstop plates into the space between inner and outer links. See Figure 6-21. Looking up at the inner link from underneath, align the holes in the plates with the holes in the inner link - see Figure 6-22 on page 90.

Figure 6-21. Joint 2 Adjustable Hardstop Locations



View of under side of Inner Link, looking up

Figure 6-22. Screw Locations for Joint 2 Adjustable Hardstops

2. Use a 4 mm Allen wrench to install three 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 multiple different positions, depending on how much you need to limit the range of Joint 2.
3. Slide the fixed hardstop device into the slot on the underside of the outer link. See **Figure 6-23 on page 91**.

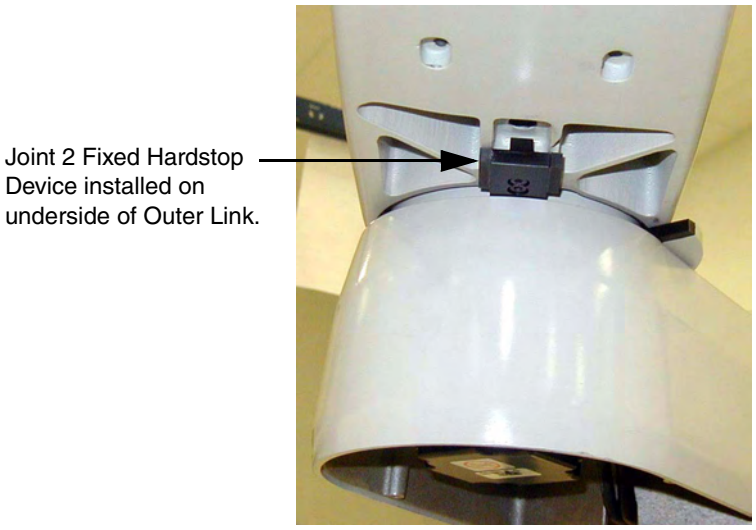


Figure 6-23. Fixed Hardstop Device for Joint 2

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

Modifying Joint Limit Softstop Locations for Joint 2

After installing the adjustable hardstops, you must modify the softstop locations using the SPEC program.

1. Load and run the SPEC.V2 program. The main screen appears as shown in **Figure 6-15 on page 86**.
2. Select option 4 => Edit robot specifications.
3. In the next menu, select option 3 => Edit joint motion specs. See **Figure 6-16 on page 86**.
4. In the next menu, select option 1 => Change joint number, and enter 2. Verify this at the top of the screen as shown in **Figure 6-24**.

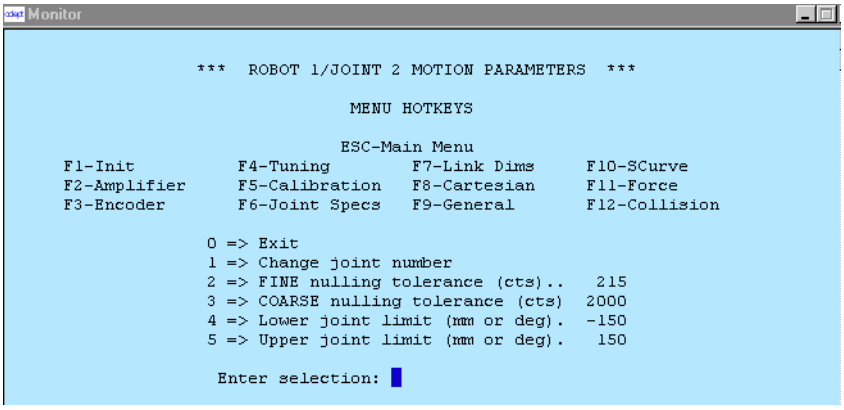


Figure 6-24. Joint 2 Motion Parameters Menu

5. After confirming you are in the Joint 2 menu, select option 4 => lower joint limit.

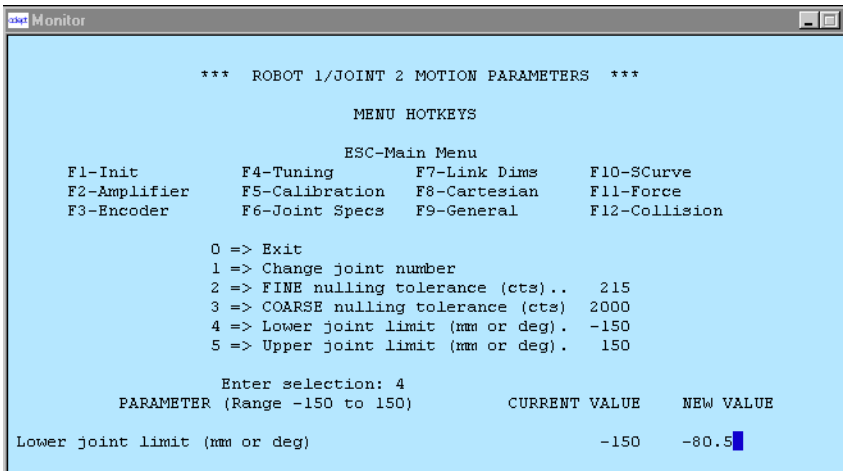


Figure 6-25. Joint 2 Menu - Lower Limits

6. In the next menu (see **Figure 6-25**), enter the new value for the J2 lower limit softstop. See **Table 6-8** for recommended softstop values for Position 1. Note that this value must be a negative number.

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°
Note: J2 Hardstops can be installed in multiple positions, depending on how the robot workcell needs to be configured. Each position is spaced 30° apart.		

7. In the next menu, select option 5=> upper joint limit. See **Figure 6-26**.

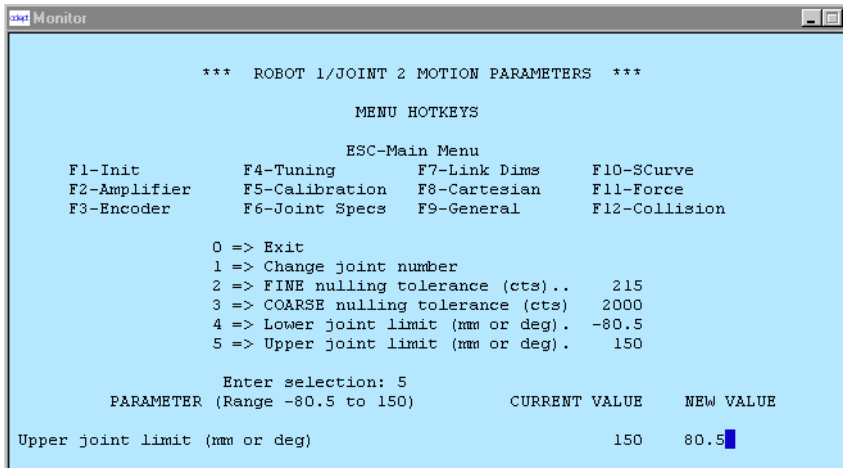


Figure 6-26. Joint 2 Menu - Upper Limits

8. In the next menu, enter the new value for the J2 upper limit softstop. See **Table 6-8 on page 92**.
9. Once you have modified the upper and lower joint limit softstops, you must save the new values. Select option 0 => Exit, then select option 7 = Save ALL specifications to system disk.
10. Reboot the system by cycling 24VDC power to the SmartController. The new joint limits will be in affect when the system reboot is done.

7 Maintenance

7.1 Periodic Maintenance Schedule

Table 7-1 gives a summary of the preventive maintenance procedures and guidelines on frequency.

Table 7-1. Inspection and Maintenance

Item	Period	Reference
Check E-Stop, enable and key switches, and barrier interlocks	6 months	See Section 7.2
Check robot mounting bolts	6 months	See Section 7.3
Check for signs of oil around of harmonic drive area.	3 months	See Section 7.4.
Lubricate Joint 3 (Z-axis) ball screw	3 months	See Section 7.5
Replace Encoder battery	5 to 10 years[a]	See Section 7.7

[a] For robot models with the smaller, rectangular batteries, inspect the battery every 18 months to 3 years.

NOTE: The frequency of these procedures will depend on the particular system, its operating environment, and amount of usage. Use the times in Table 7-1 as guidelines and modify the schedule as needed.

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 Chapter 2. The access covers on the robot are not interlocked – turn off and disconnect power if covers have to be removed.

7.2 Checking of Safety Systems

These tests should be done every six months.

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

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

7.3 Checking Robot Mounting Bolts

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.

7.4 Check Robot for Oil Around Harmonic Drive

The Cobra i-series and s-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:

- the area around Joint 1
- the area around Joint 2
- inside the base of the robot, by opening the AIB chassis and inspecting internally. Be sure to remove all power to the robot before opening the AIB chassis.

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

7.5 Lubricate Joint 3 Ball Screw

Required Grease for the Robot

Ball Screw/Spline Assembly Grease
LG-2 Lubricating Grease Lithium Soap, Synthetic Hydrocarbon
Adept part number: 90401-04029

CAUTION: Using improper lubrication products on the Adept Cobra s600 or s800 robot may cause damage to the robot.

Lubrication Procedure

1. Turn off main power to the controller and 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 2-3 on page 23**. 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. Move Joint 3 to the top of its travel. Remove any existing grease with a soft cloth.
4. Using a syringe, apply a small bead of grease to the Joint 3 ball screw grooves (see **Figure 7-1 on page 98**).
5. Move Joint 3 to the bottom of its travel. Remove any existing grease with a clean, lint-free, soft cloth.
6. Apply a thin film of grease to any grooves of the ball screw that you did not reach in step 4.
7. Move Joint 3 up and down several times to spread the grease evenly.
8. Replace the outer link cover.

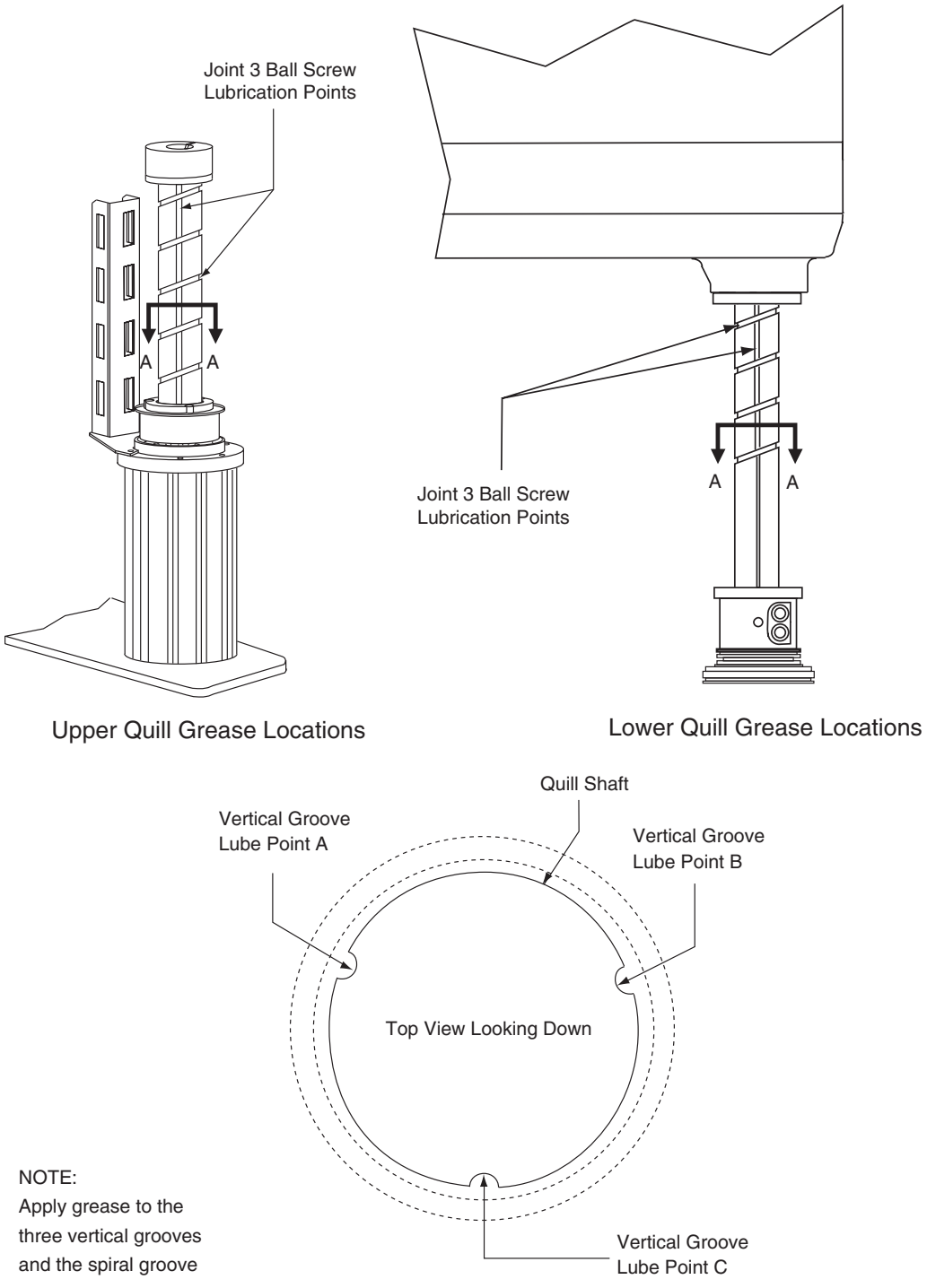


Figure 7-1. Lubrication of Joint 3 Quill

7.6 Replacing the SmartAmp AIB Chassis

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

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

Removing the SmartAmp AIB Chassis

1. Switch off the SmartController.
2. Switch off the 24VDC input supply to the chassis.
3. Switch off the 200/240VAC input supply to the chassis.
4. Disconnect the 24VDC supply cable from the chassis +24VDC input connector. See **Figure 3-3 on page 40** for locations of connectors.
5. Disconnect the 200/240VAC supply cable from the chassis AC Input connector.
6. Disconnect the XSLV cable from the chassis XSLV connector.
7. Disconnect the 1394 cable from the chassis SmartServo connector.
8. Disconnect any other cables, which may be connected to the chassis, such as XIO, RS-232, or any others.
9. Using a 5 mm Allen key, carefully unscrew the chassis securing screw. See **Figure 7-2**. 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.

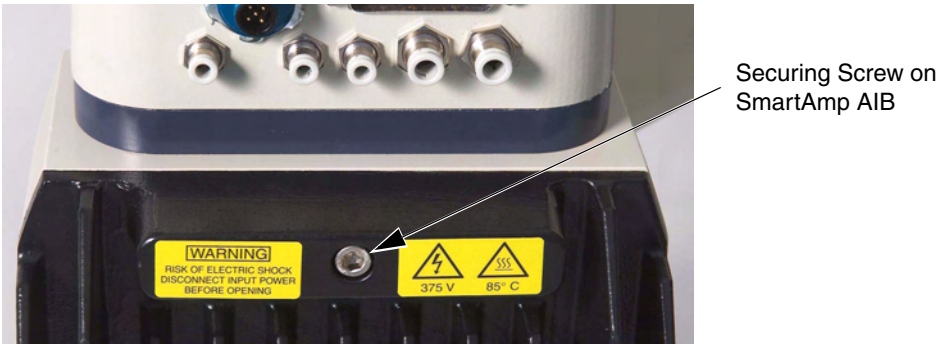


Figure 7-2. Securing Screw on SmartAmp AIB Chassis

10. While holding the chassis heat sink, carefully and slowly lower the chassis down (see **Figure 7-3 on page 100**), 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.

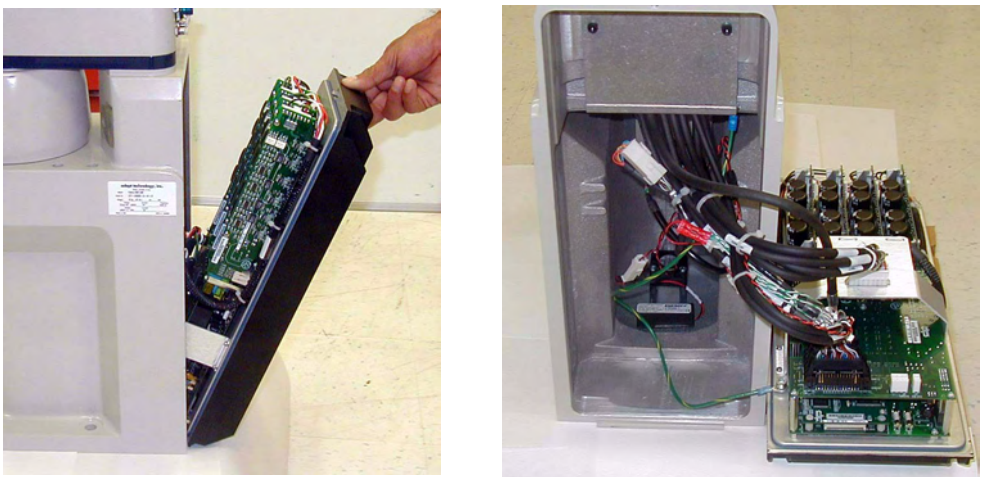


Figure 7-3. Opening and Removing AIB Chassis

11. Disconnect the “white” amplifier cable from the amplifier connector located on the chassis bracket. See **Figure 7-4**.

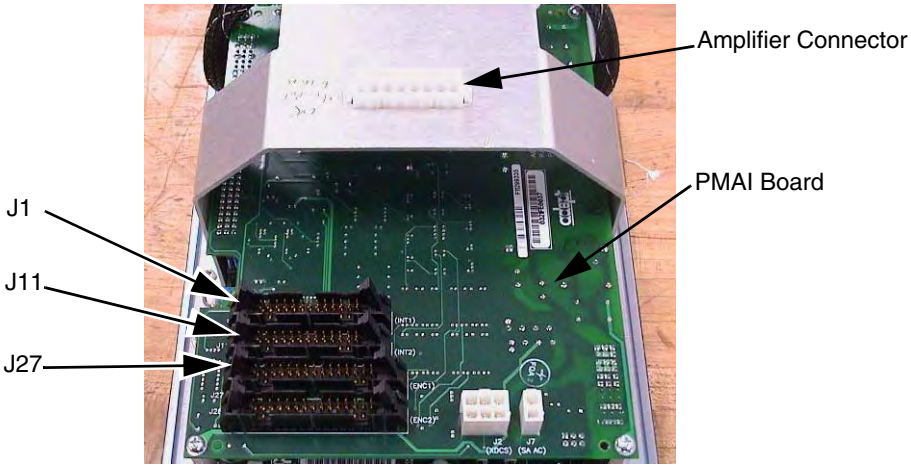


Figure 7-4. Connectors on AIB Chassis

12. Carefully disconnect the J1 cable from the J1 connector on the PMAI, by disengaging the securing latches.
13. Carefully disconnect the J11 cable from the J11 connector on the PMAI, by disengaging the securing latches.
14. Carefully disconnect the J27 cable from the J27 connector on the PMAI, by disengaging the securing latches.
15. Using a 5MM Allen key, disconnect and remove the ground wire from the chassis. Keep the screw for reassembly later. See **Figure 7-5 on page 101**.

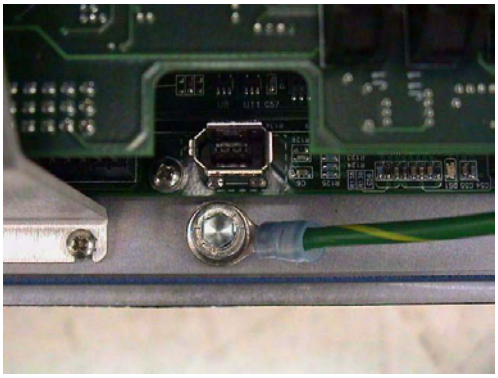


Figure 7-5. Ground Screw on AIB Chassis

16. 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 SmartAmp AIB Chassis

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

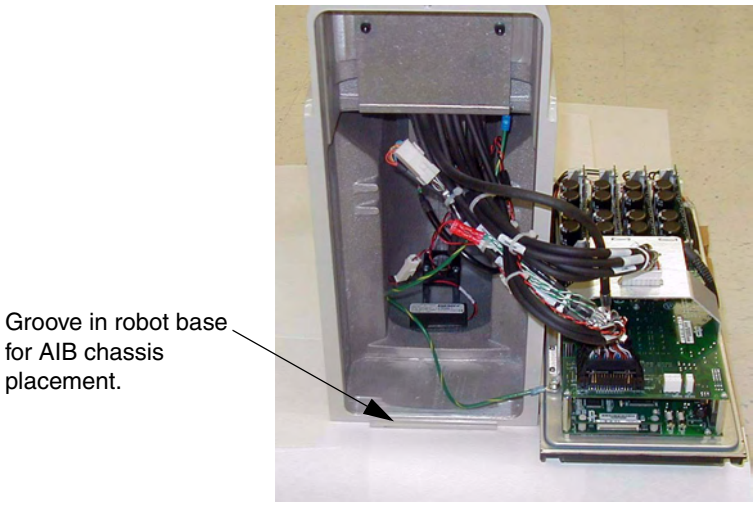


Figure 7-6. Installing AIB Chassis in Robot Base

8. Carefully insert the chassis into the robot base in the groove at the bottom of the base - see **Figure 7-6**. 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.
9. Once the chassis is in place, use a 5 mm Allen key to tighten the chassis securing screw. See **Figure 7-2 on page 99** for details.
10. Connect the 200/240VAC supply cable to the chassis AC Input connector.
11. Connect the XSLV cable to the chassis XSLV connector.
12. Connect the 1394 cable to the chassis SmartServo connector.
13. Connect any other cables, which may be connected to the chassis, such as XIO, RS-232, or any others.
14. Connect the 24VDC supply cable to the chassis +24VDC input connector.
15. Switch on the 200/240VAC input supply to the chassis.
16. Switch on the 24VDC input supply to the chassis.
17. Switch on the SmartController.
18. Once the system has completed booting, test the system for proper operation.

7.7 Replacing the 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 only with 3.6 V, 8.5 Ah lithium battery, Adept part number: 02704-000. Battery information is located in the base of the robot.

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.

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

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.

Battery Replacement Procedure

1. Obtain the replacement battery.
2. Switch off the SmartController.
3. Switch off the 24VDC input supply to the robot.
4. Switch off the 200/240VAC input supply to the robot.
5. Disconnect the 24VDC supply cable from the robot +24VDC input connector. See **Figure 3-3 on page 40** for locations of connectors.
6. Disconnect the 200/240VAC supply cable from the robot AC Input connector.
7. Using a 5mm Allen key, carefully unscrew the AIB chassis securing screw. See **Figure 7-2 on page 99**. 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.
8. While holding the chassis heat sink, carefully and slowly lower the chassis down (see **Figure 7-3 on page 100**), so there is access to the battery. See **Figure 7-7**.

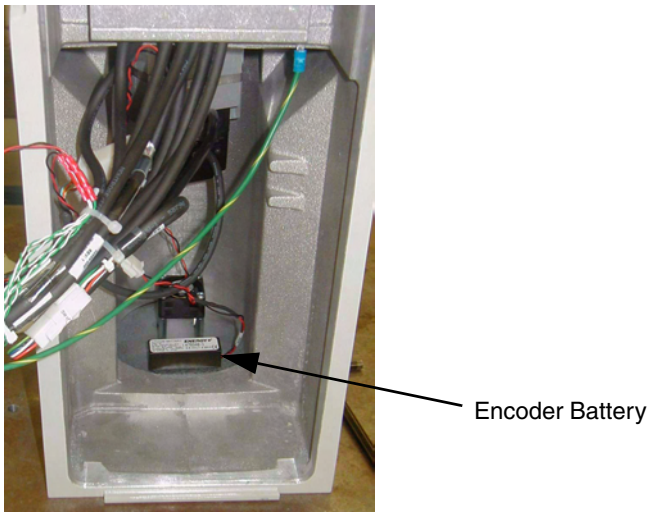


Figure 7-7. Location of Encoder Battery

9. The battery cable assembly has two sets of connectors. Locate the secondary battery cable in the wire bundle in the base area.
10. Place the new battery next to the original one, but do not disconnect the original one.
11. Connect the new battery to the connectors on the secondary battery cable. Make sure to verify the positive and negative connections are correct.
12. Once the new battery is connected, you can disconnect and remove the original battery.
13. Place the new battery in the original location on the base of the robot.
14. Close the robot by reversing the steps in the beginning of this procedure.

8 Technical Specifications

8.1 Dimension Drawings

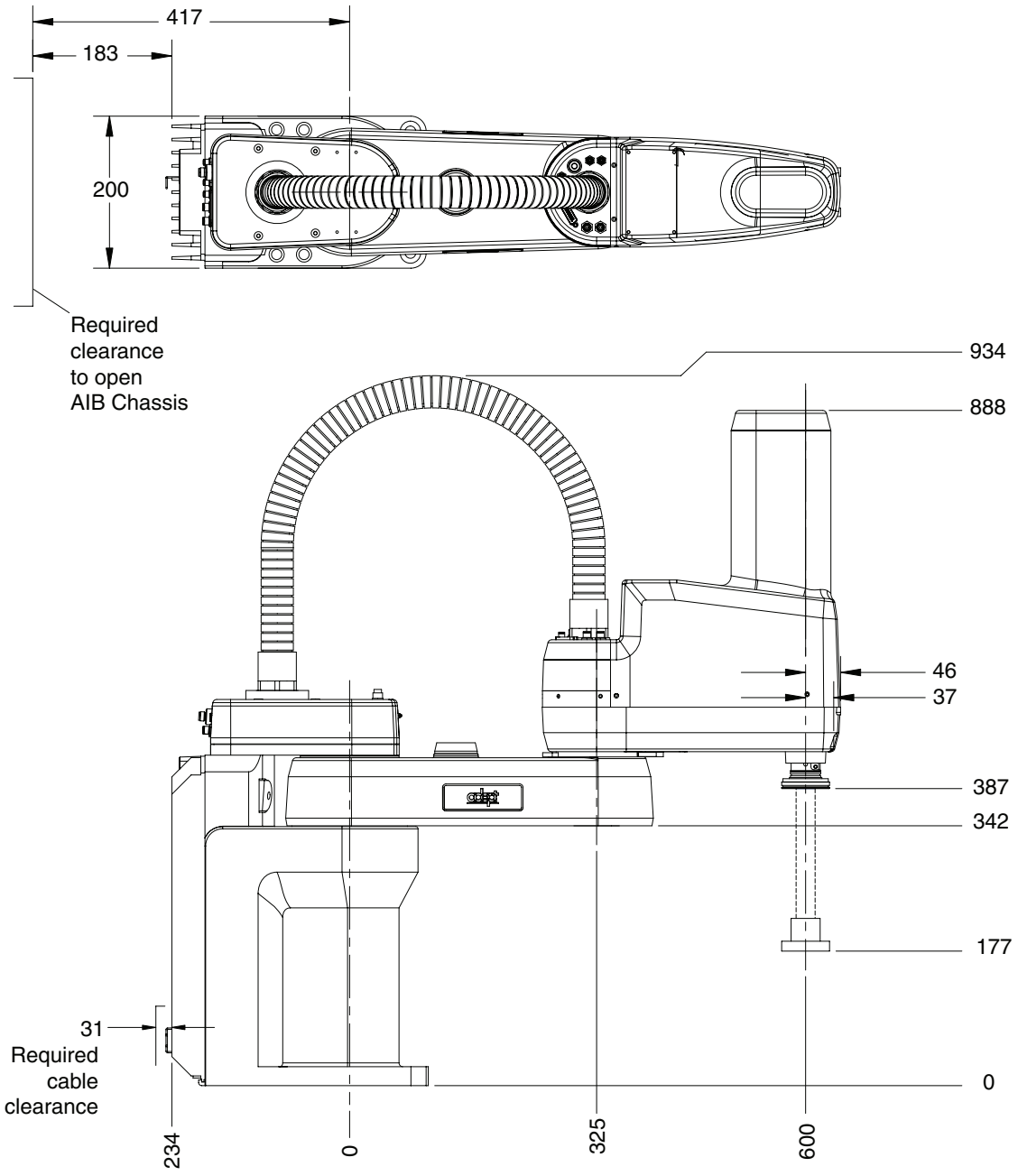


Figure 8-1. Adept Cobra s600 Robot Top and Side Dimensions

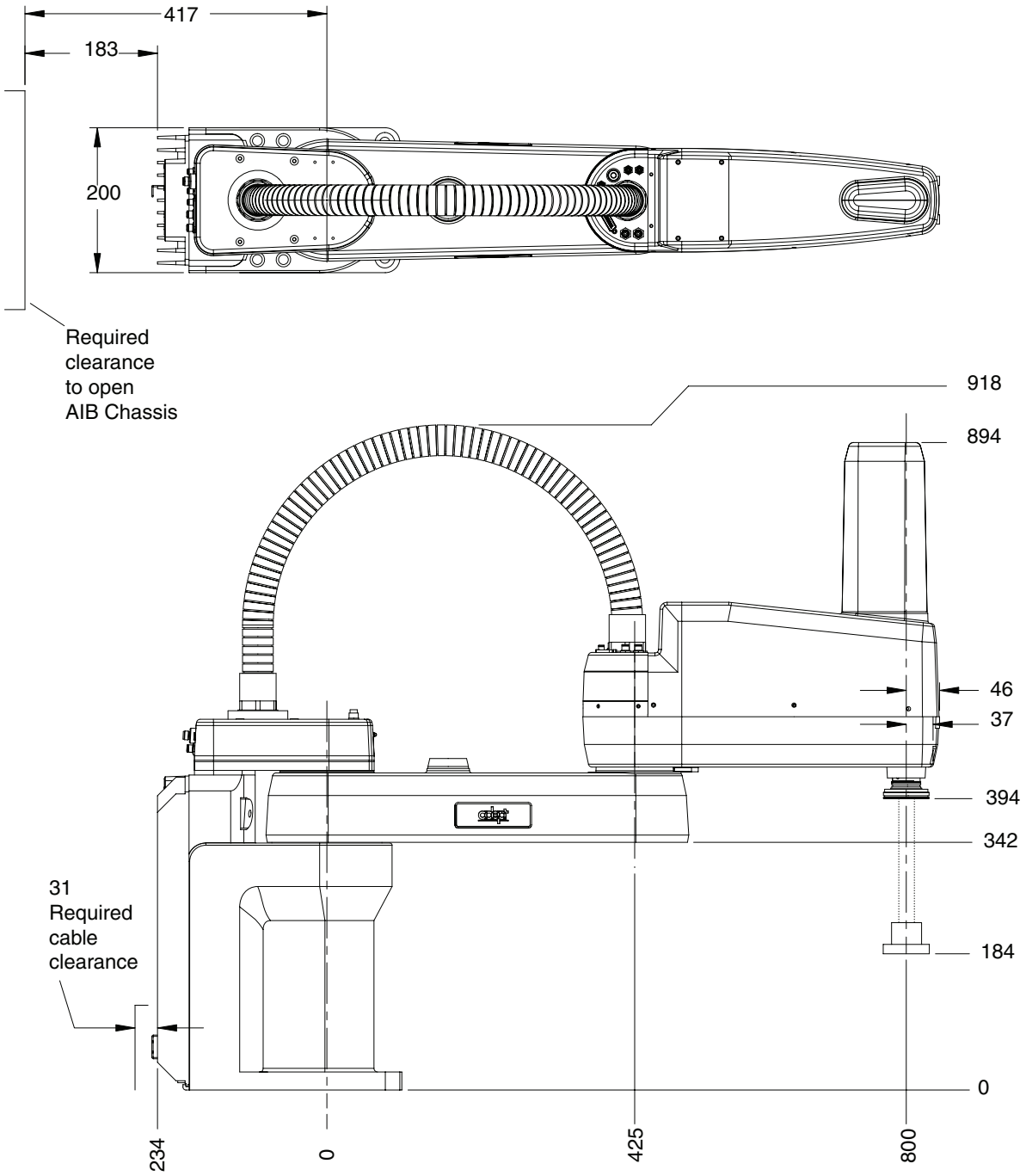


Figure 8-2. Adept Cobra s800 Robot Top and Side Dimensions

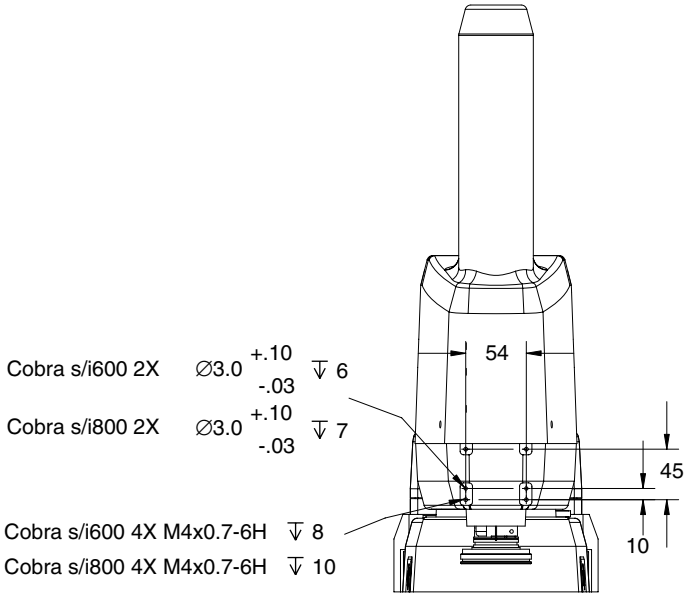


Figure 8-3. Dimensions of the Camera Bracket Mounting Pattern

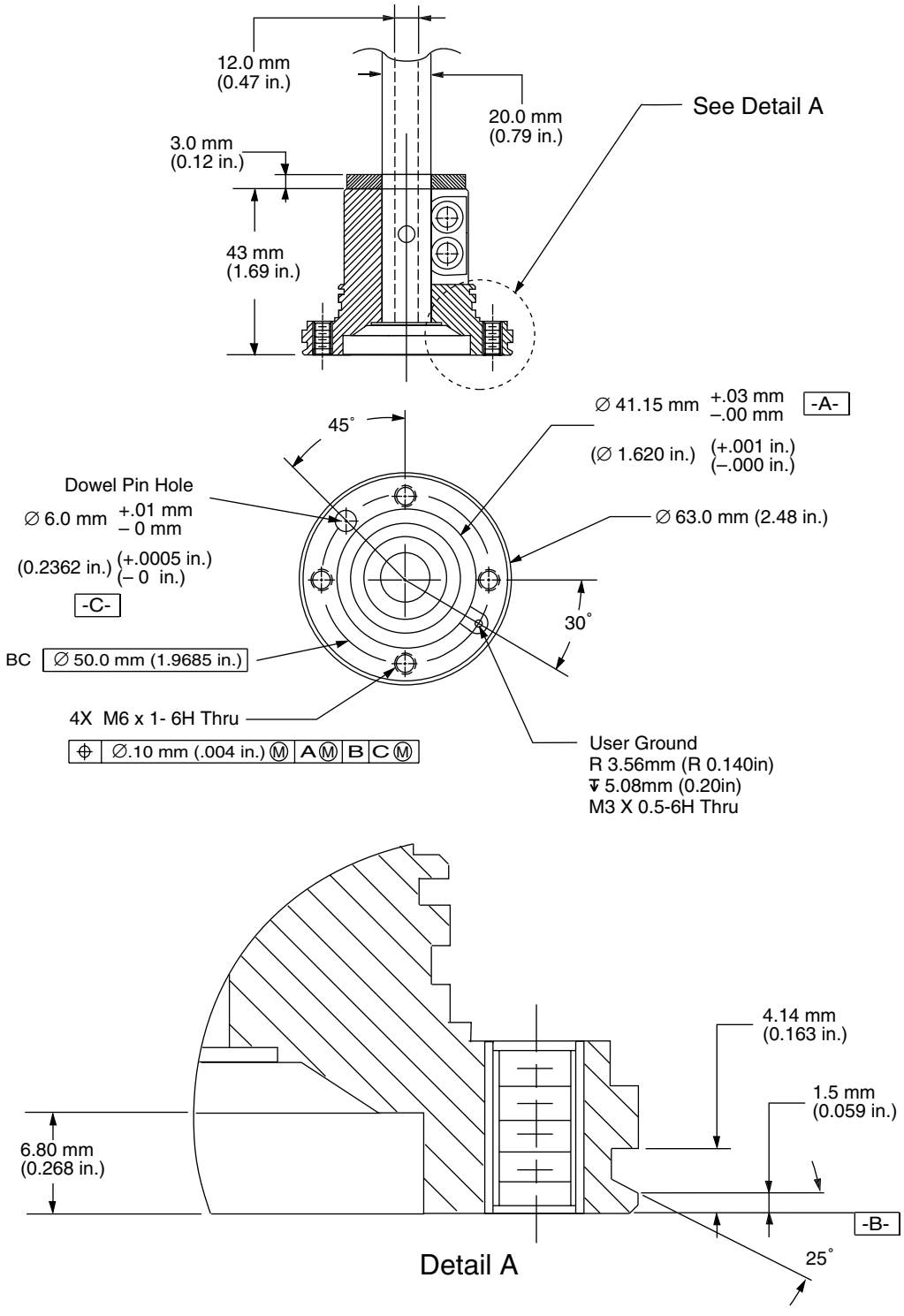


Figure 8-4. Tool Flange Dimensions for Adept Cobra Robots

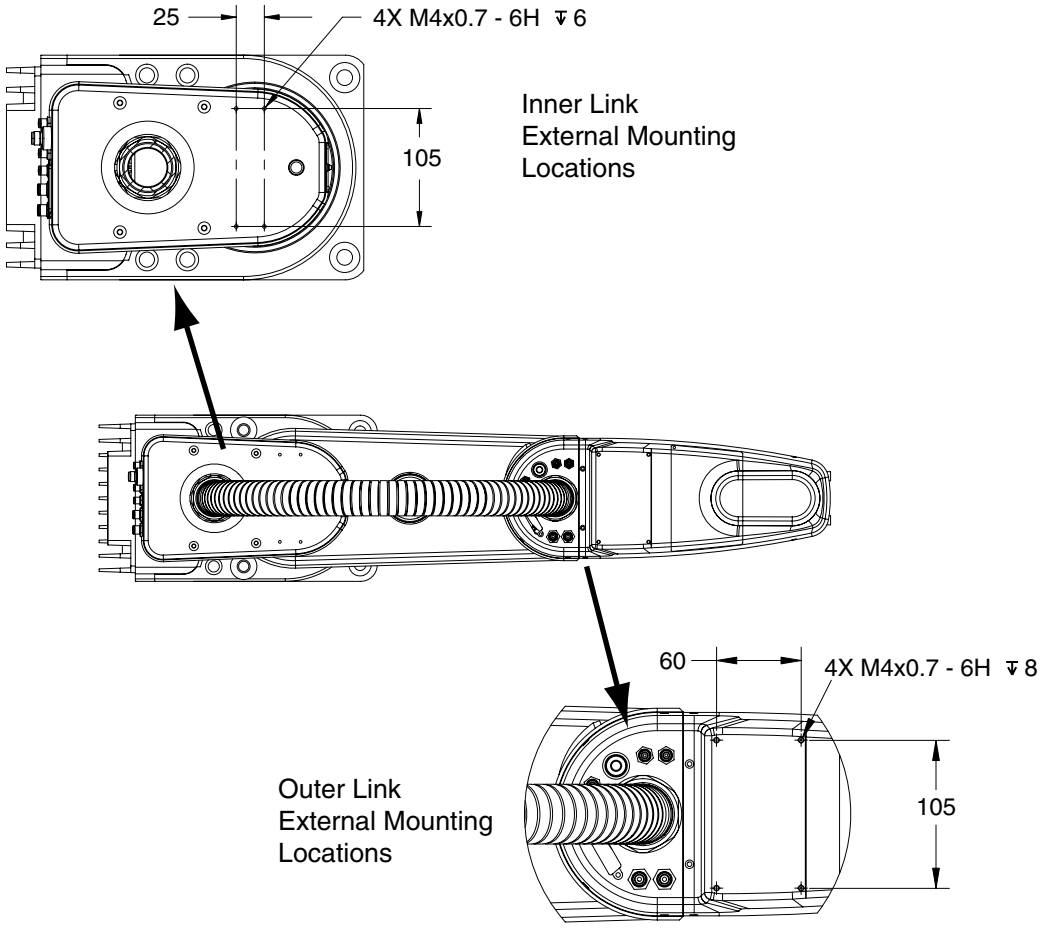


Figure 8-5. External Tooling on Top of Robot Arm

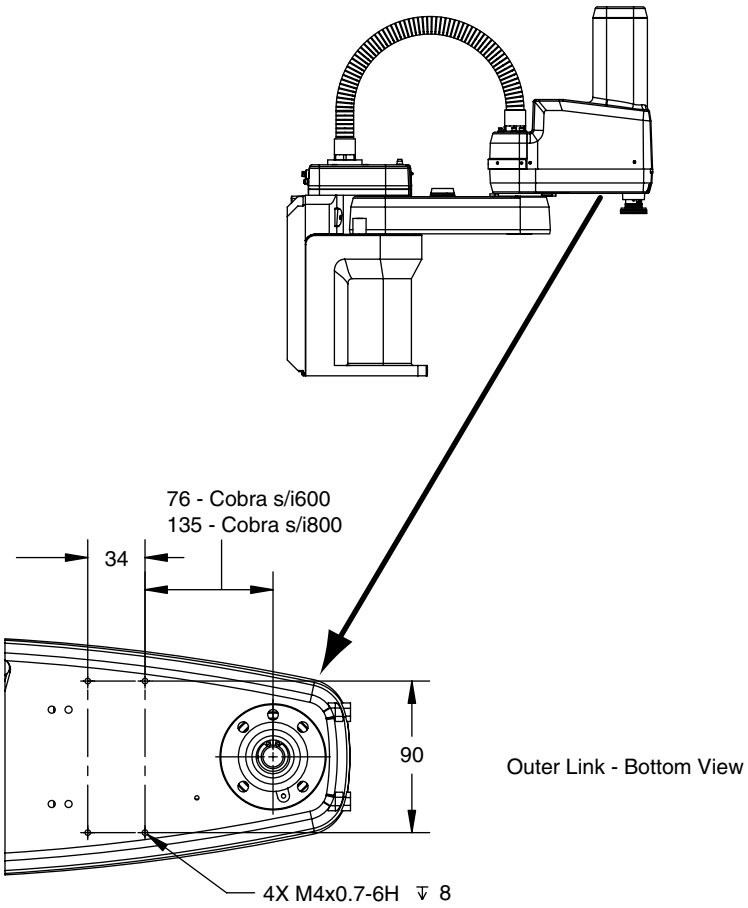


Figure 8-6. External Tooling on Underside of Outer Link

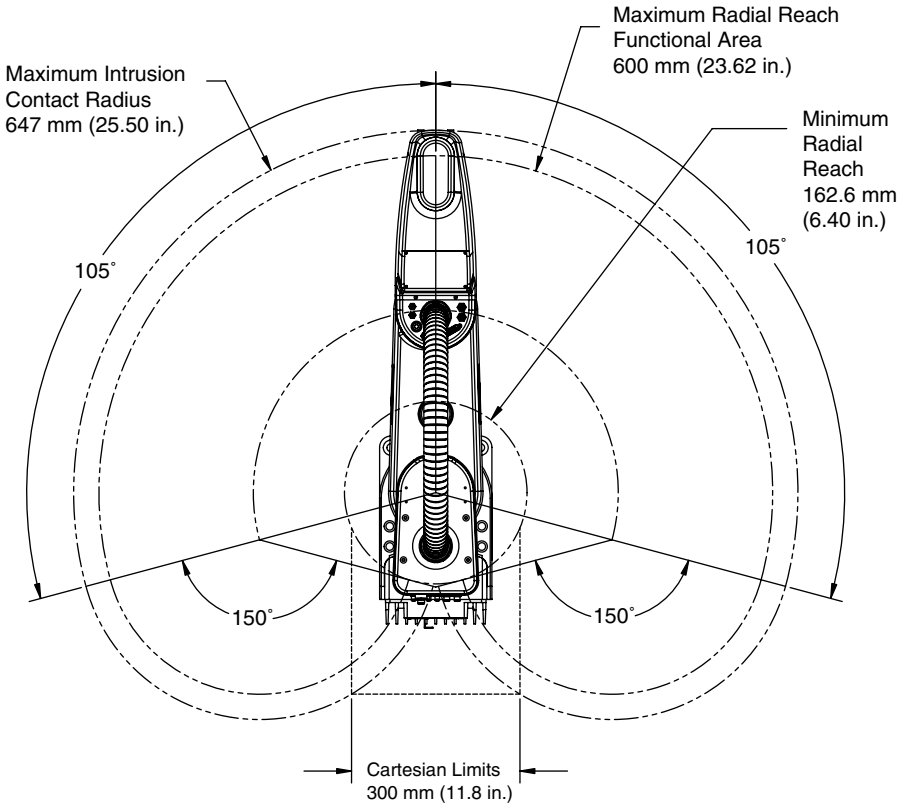


Figure 8-7. Adept Cobra s600 Robot Working Envelope

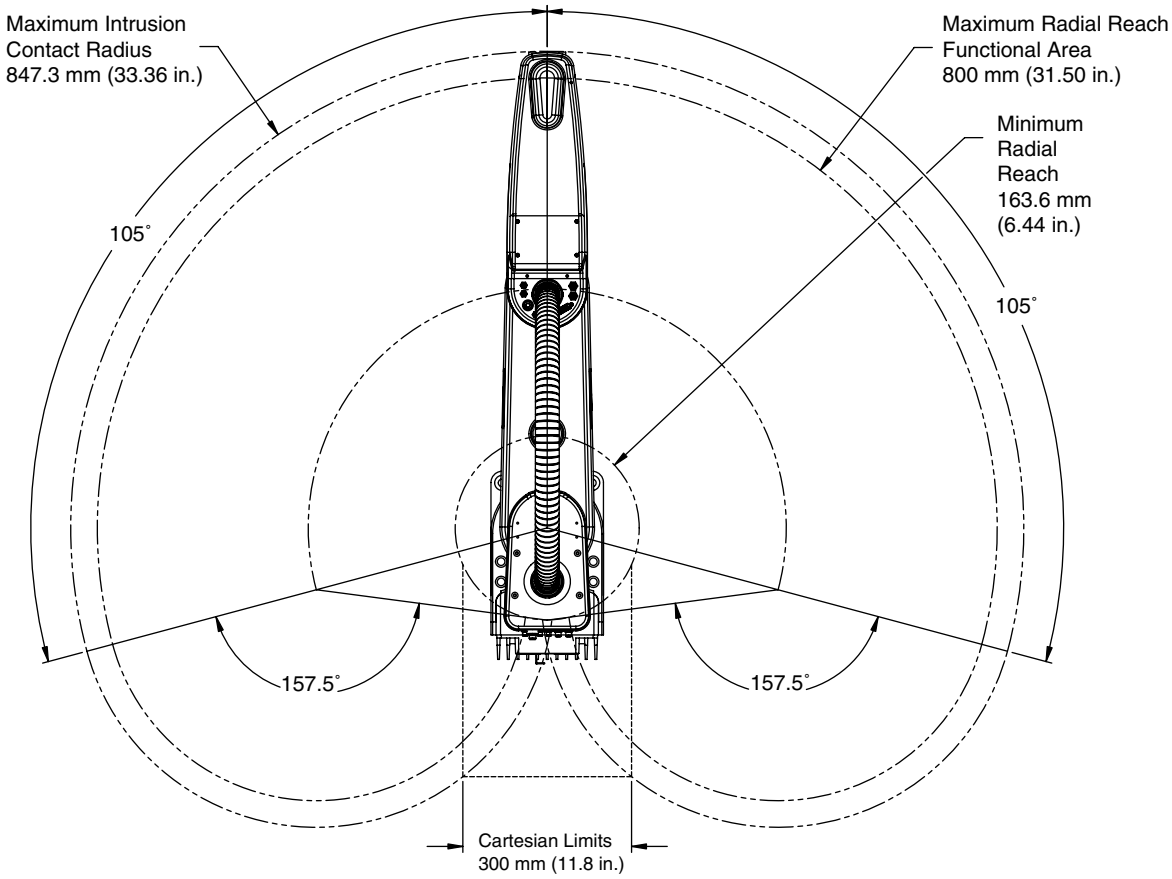


Figure 8-8. Adept Cobra s800 Robot Working Envelope

8.2 Cobra s600/s800 Internal Connections

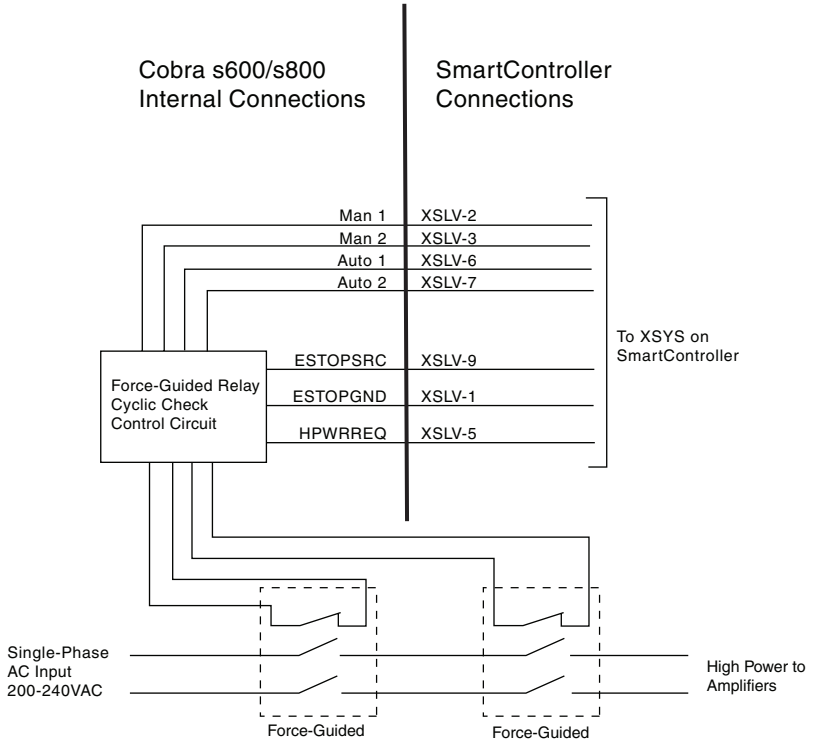
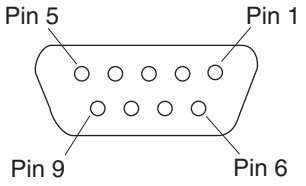


Figure 8-9. Adept Cobra s600/s800 Internal Connections Diagram

8.3 XSLV Connector

Table 8-1. XSLV Connector Pinout

Pin #	Description	Comment	Pin Location
1	ESTOPGND	ESTOP System Ground	 XSLV1/2 Connector as viewed on Cobra
2	MAN1	ESTOP Manual Input Ch 1	
3	MAN2	ESTOP Manual Input Ch 2	
4	HIPWRDIS	High Power Disable	
5	ESTOP_RESET	Normally Closed Check Contacts	
6	AUTO1	ESTOP Auto Input Ch 1	
7	AUTO2	ESTOP Auto Input Ch 2	
8	N/C		
9	ESTOP_SRC	ESTOP System +24 V	
Mating Connector: AMP/Tyco #747904-2, 9-pin D-Sub AMP/Tyco #748676-1, D-Sub Cable Clamp			

8.4 Robot Specifications

Table 8-2. Adept Cobra s600/s800 Robot Specifications[a]

Description	s600 Robot	s800 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
2 kg	0.42 sec	0.54
5.5 kg	0.53 sec	0.64
Adept Cycle - Burst (180° J4 rotation)		
0 kg	0.42 sec	0.48
2 kg	0.42 sec	0.54
5.5 kg	0.59 sec	0.76
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")	±0.017 mm (±0.00067")
z	±0.003 mm (±0.00012")	±0.003 mm (±0.00012")
Theta	±0.019°	±0.019°

Table 8-2. Adept Cobra s600/s800 Robot Specifications[a] (Continued)

Description	s600 Robot	s800 Robot
Joint Range		
Joint 1	±105°	±105°
Joint 2	±150°	±157.5°
Joint 3	210 mm (8.3")	210 mm (8.3")
Joint 4	±360°	±360°
Joint Speed (maximum)		
Joint 1	386°/sec	386°/sec
Joint 2	720°/sec	720°/sec
Joint 3	1,100mm/sec (43 in/sec)	1,100mm/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 8-3. Softstop and Hardstop Specifications

Joint	Cobra s600		Cobra s800	
	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

9 Cleanroom Robots

9.1 Cobra s600/s800 Cleanroom Option

Introduction

The Adept Cobra s600/s800 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.

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 9-1. Adept Cobra s600 Cleanroom Robot

Specifications

Table 9-1. Adept Cobra Cleanroom Robot Specifications

Robot Performance Specification	See Table 8-2 on page 115.
Ambient Temperature Specification	5 - 35 degrees C (41 - 95 degrees F)

9.2 Connections

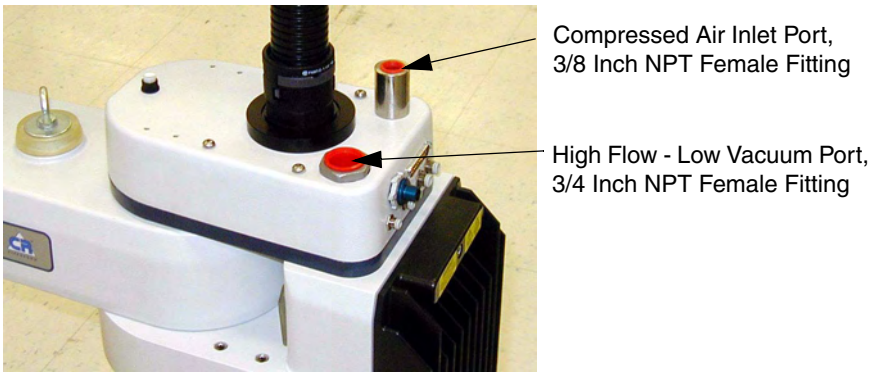


Figure 9-2. Cleanroom Connections

9.3 Requirements

Table 9-2. Cleanroom Robot Requirements

Vacuum source	0.80 m^3/min (28 ft^3/min) minimum volumetric flow rate
	6 mm of water (0.2 inches of water) differential pressure measured between the robot and the vacuum source
	3/4 inch 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 (.04 m^3/min.) flow rate
	3/8 inch 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.

9.4 Exclusions and Incompatibilities

Table 9-3. 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.

9.5 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 9-3**.
2. Remove the user tool flange. Refer to **Section 6.2 on page 69** for the user 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.

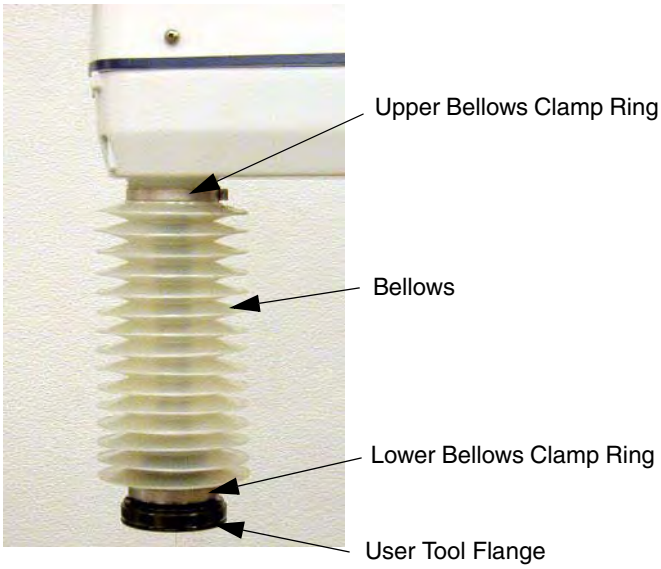


Figure 9-3. Cleanroom Bellows Replacement

Lubrication

The upper and lower quill requires lubrication in the same manner as the standard Cobra s600/s800 robot. See **Section 7.5 on page 97**.

10 IP 65 Option

10.1 Cobra s800 IP 65 Classification

The factory installed IP 65 option kit provides an improved level of dust and water protection. IP 65 means “dust-tight and protection against water jetting.”

- Dust Resistance - protection of the equipment inside the robot shell against ingress of solid foreign objects
- Specifically for IP 65 Dust Protection - “No ingress of dust is allowed.”
- Water Resistance - protection of the equipment inside the robot shell against harmful effects due to the ingress of water
- Specifically for IP 65 Water Protection - “Water projected in jets against the robot enclosure from any direction shall have no harmful effects”

NOTE: The IP 65 Option is available only for the Cobra s800 robot.

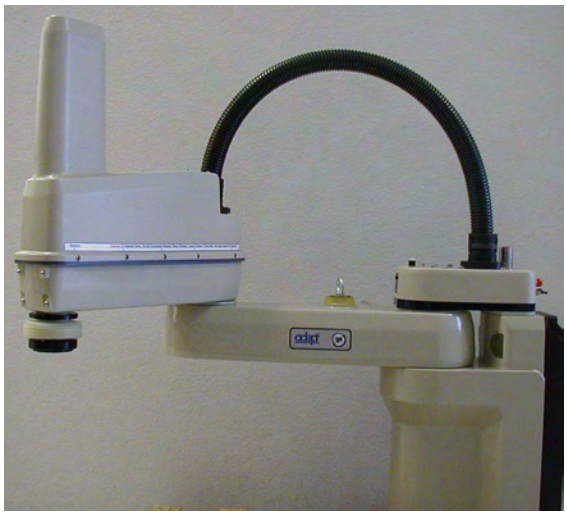


Figure 10-1. Adept Cobra s800 Robot - IP 65 Version

10.2 Installing Cable Seal Assembly

Cable Seal Identification

The cable seal assembly (04813-000) must be mounted on the back of the robot during the robot installation process. The cable seal assembly is shipped separately from the robot. See Figure 10-2 to identify the cable seal parts.

Figure 10-2. Cable Seal Parts

Cable Seal Housing

Cable Seal Flange - Upper

Cable Seal Flange - Lower

Splash Guard

Installation Procedure

1. Disassemble the cable seal assembly into separate pieces by removing all screws.
2. Install the cable seal housing on the back of the robot using four M4x50 screws, four M4 lock washers, and four M4 flat washers. Note that the centered M6 threaded hole must be at the top. See Figure 10-3.

Figure 10-3. Cable Seal Housing Installed

3. Attach all system cables to the robot. See Figure 4-1 on page 41.
4. Install the lower cable seal flange onto the housing. The lower flange fits into the groove at the bottom of the housing.
   a. Tilt the flange away from the robot as you install it - see Figure 10-4.

b. Then pull up on the flange and push it toward the robot.

c. Finally push down on the flange to secure it against the housing. See **Figure 10-5** for the lower flange in the installed position.

Figure 10-4. Installing Lower Flange

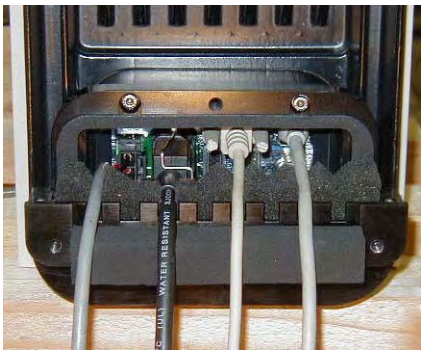


Figure 10-5. Lower Flange in Position

5. Seat all of the cables by pushing down into the foam on the lower flange.
6. Attach the upper flange to the lower flange using two M6x20 screws, two M6 lock washers, and two M6 flat washers. Make sure none of the cable are pinched or crimped when installing the upper flange.
7. Attach the flange assembly using one M6x20 screw, one M6 lock washer, and one M6 flat washer. See **Figure 10-6**.

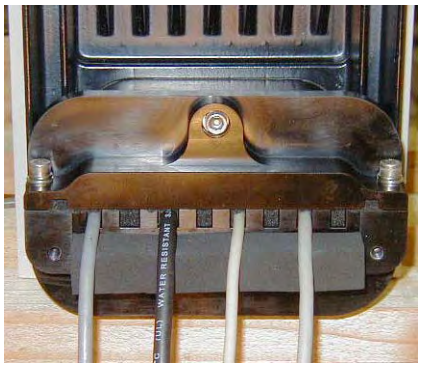


Figure 10-6. Upper Flange Installed

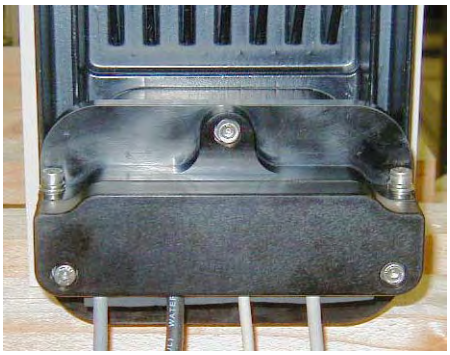


Figure 10-7. Splash Guard Installed

8. Install the splash guard using two M6x20 screws, two M6 lock washers, and two M6 flat washers. See **Figure 10-7**.

10.3 Robot Outer Link Cover Removal and Replacement

The robot outer link cover has special sealing hardware to insure nothing can enter the inside of the robot. If you need to remove the outer link cover from the robot for any reason, please follow the procedures below.

Cover Removal Procedure

1. Turn off main power to the controller and power chassis.
2. Turn off the air supply to the robot. Clean the exterior of the outer link thoroughly to remove any dust or particles that might fall inside the robot when the cover is removed.
3. Unscrew the collar nut on the top of the outer link. See **Figure 10-8**.
4. Remove 2 screws and nylon washers on the top of the outer link.
5. Remove 2 screws (one on each side) at the front of the outer link. Make sure the o-ring on each screw stays in place and is not lost.
6. For the 8 screws along the side of the cover (4 on each side; see **Figure 10-8**), loosen only 1 to 2 turns, just enough to loosen the inside clamp nuts. You do not want to completely remove the screws. See the label on the side of the outer link cover.

CAUTION: Do not loosen these screws any more than 2 turns, because the special clamp nut on the inside of the cover might come loose and fall inside of the robot.

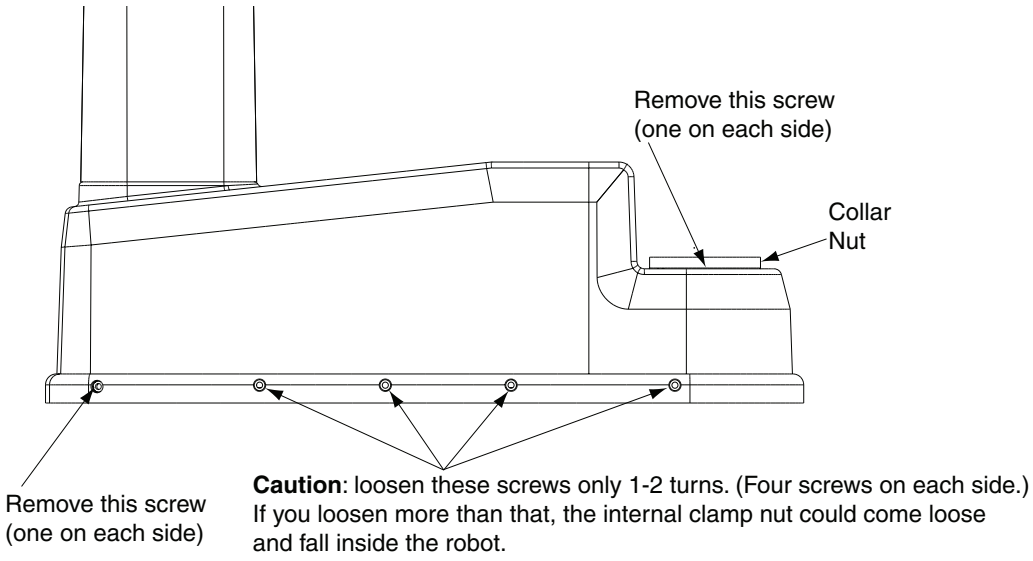


Figure 10-8. Cover Removal Instructions

7. When all 8 screws are loose (but not removed), lift the cover up and slide it back along the cable track and out of the way. Protect the cover with a soft cloth or other padding material so the cover does not get scratched. See **Figure 10-9**.

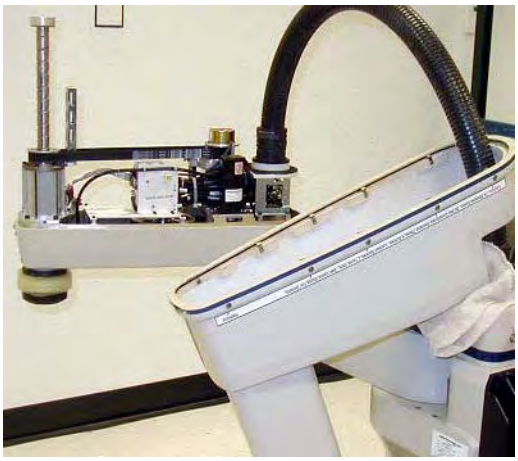


Figure 10-9. IP 65 Robot with Outer Link Cover Removed

Cover Replacement Procedure

1. Check the cover o-ring around the inner groove of the cover to make sure it is in place and not crimped when installing cover.
2. Hold the cover over the outer link and check to see that the clamp nuts attached to the 8 side screws are positioned so they will slip into place when the cover is lowered down onto the outer link.
3. Slowly lower the cover down onto the outer link, making sure the o-ring does not fall out or get pinched as the cover presses down to make the seal.

   NOTE: As you lower the cover down onto the outer link, make sure the 8 side screws are pushed all the way in, so the clamp nuts will slide into the correct position.

4. Replace the 2 screws and nylon washers at the top of the outer link and tighten to 5 in-lb (0.56 N-m).
5. Replace the 2 screws (check for o-ring on screw) near the front of the outer link and tighten to 10 in-lb (1.1 N-m).
6. Tighten the 8 side screws to 10 in-lb (1.1 N-m). Be careful to not over-tighten. Begin with the two screws (one on each side) at the back of the outer link, then move forward to the next two, and so on, until all eight are tightened. This pattern is recommended to achieve a balanced secure fit around the cover.
7. Replace the collar nut and tighten until secure.
8. Remember to turn on the compressed air supply to the system before restarting the robot.

10.4 Customer Requirements

The IP 65 robot provides most of the hardware needed to achieve an IP 65 protection level, but customers must provide a way of sealing the tool flange and pressurizing the robot through the compressed air attachment fitting (located at the top of the robot). These two requirements, sealing the tool flange and pressurizing the robot, are critical to achieving the IP 65 level of protection.

In addition, the robot must be inspected periodically to make sure these requirements are being met, as part of a periodic maintenance program.

Sealing the Tool Flange

The tool flange must be sealed so that the robot shell can be positively pressurized. The positive pressure reinforces the sealing properties of the gaskets and seals provided in the IP 65 robot.

The tool flange for the IP 65 robot has an additional protective shield on the outer edge that is not present on the standard robot tool flange. See **Figure 10-10** for the side view dimensions. The bottom face of the flange (mounting surface) is the same as the standard flange, so the dimensions in **Figure 8-4 on page 108** are correct.

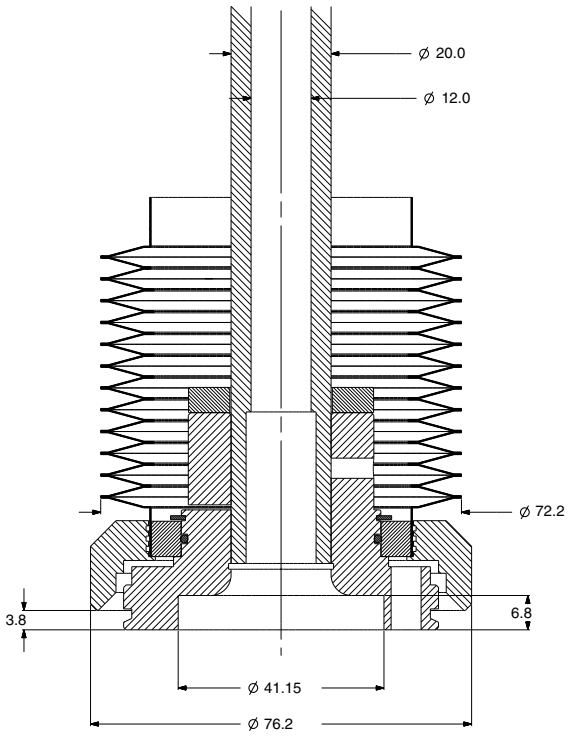


Figure 10-10. Cobra IP 65 Tool Flange

Pressurizing the Robot

The user must supply compressed air to keep a positive airflow pressure in the robot cavity.

1. Remove the red shipping plug from the compressed air fitting on the top of the robot. See **Figure 10-11**.

Figure 10-11. Compressed Air Fitting on Robot

2. Connect a compressed air source to the air fitting. The specification for the regulated air supply is shown in **Table 10-1**.

Table 10-1. Compressed Air Specifications

Required Air Pressure	Required Air Flow, Minimum
3 bar, ± 10% (44 PSI, ± 10%)	57 liters per minute (2 cubic feet per minute)

CAUTION: The compressed air supply must be **clean** and **dry** and it must be turned on continuously to maintain a positive air pressure inside the robot. Failure to do this could result in moisture or particle buildup inside the robot and lead to reduced performance or damage to the robot. This will also void your warranty.

10.5 User Connectors

User Electrical and DeviceNet

On the back of the Joint 1 cover, the user electrical, IO Blox, and DeviceNet connectors are filled with removable plugs at the factory. See **Figure 10-12**. If you use any of these connectors, you must provide a seal (see note below) at the connection to prevent moisture from entering the robot.

> **NOTE:** The user electrical connector (DB-25) and the IO Blox connector (DB-9) on the back of the Joint 1 cover require a gel seal gasket to maintain an adequate seal. The gaskets are supplied in the accessory kit.

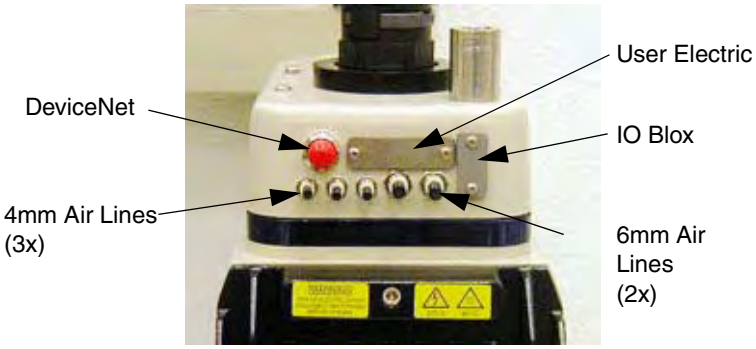


Figure 10-12. User Connectors on Joint 1 Cover

The user electrical and DeviceNet connectors on the outer link are accessible with the cover removed. See **Figure 10-13** for locations of the internal connectors.

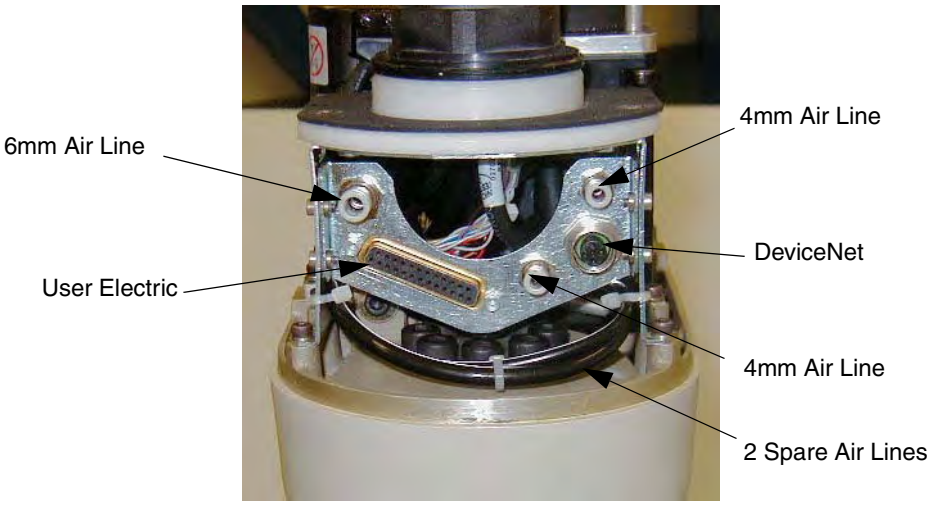


Figure 10-13. IP 65 Internal Connectors with Outer Link Cover Removed

User Air Lines

On the back of the Joint 1 cover, the user air line connectors are fitted with removable plugs at the factory - see Figure 10-12 on page 128.

The user air line connectors on the outer link are accessible with the cover removed. See Figure 10-13 on page 128 for locations of the internal connectors.

When routing air lines outside of the robot, any fittings you use must maintain an adequate seal in the cover to prevent moisture from entering the outer link. See the nest section for bulkhead fittings that can be used for this purpose.

CAUTION: Failure to prevent water intrusion through improperly sealed external fittings could void your warranty.

Robot Solenoid Option

In an IP-65 robot, if you are installing the internally mounted solenoid hand valves (Adept Option Kit P/N 02853-000), you must use a different air line than described in Section 6.6 on page 78.

The internal air line normally used to supply the solenoid manifold is instead used to provide positive airflow pressure to the bellows/outer link. You can use one of the passive 6 mm user air lines shown in Figure 10-12 and Figure 10-13 on page 128.

10.6 Maintenance

IP 65 Bellows Replacement

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

1. Remove the lower bellows clamp by removing two M3 screws and pulling the clamp apart. See Figure 10-14.
2. Remove the user tool flange. Refer to Section 6.2 on page 69 for the user flange removal procedure.
3. Remove the upper bellows clamp by removing two M3 screws and pulling the clamp apart.
4. Slide the old bellows down off of the quill.
5. Install a new bellows by sliding it up onto the quill.
6. Re-install the upper bellows clamp. You must align mating surface of the clamp half-rings with the bellows seam - see Figure 10-15. Tighten the screw to secure the bellows.

7. Re-install the user tool flange.
8. Place new gaskets in the lower bellows clamp - extra gaskets are shipped in the accessory kit. Then install the clamp over the bottom of the bellows, on the bearing ring just above the user flange. Align the mating surfaces of the clamp half-rings with the bellows seam - see **Figure 10-15**. Tighten the screw to secure the clamp.

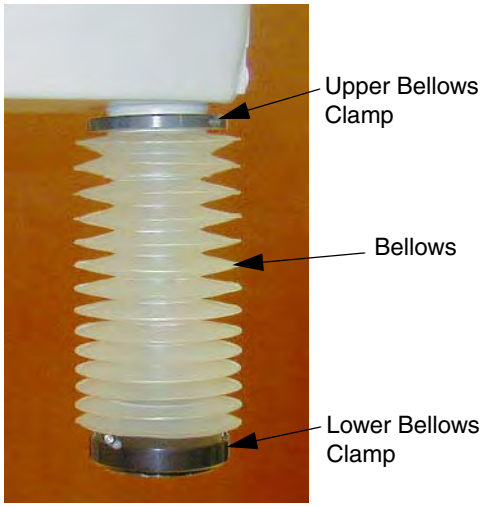


Figure 10-14. Bellows Replacement

Note: align the bellows clamps with the bellows seam, on both upper and lower clamps.

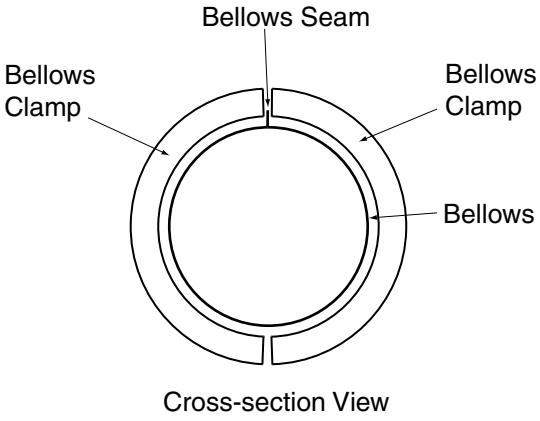


Figure 10-15. Bellows Clamp Alignment

10.7 Dimension Drawing for Cable Seal Assembly

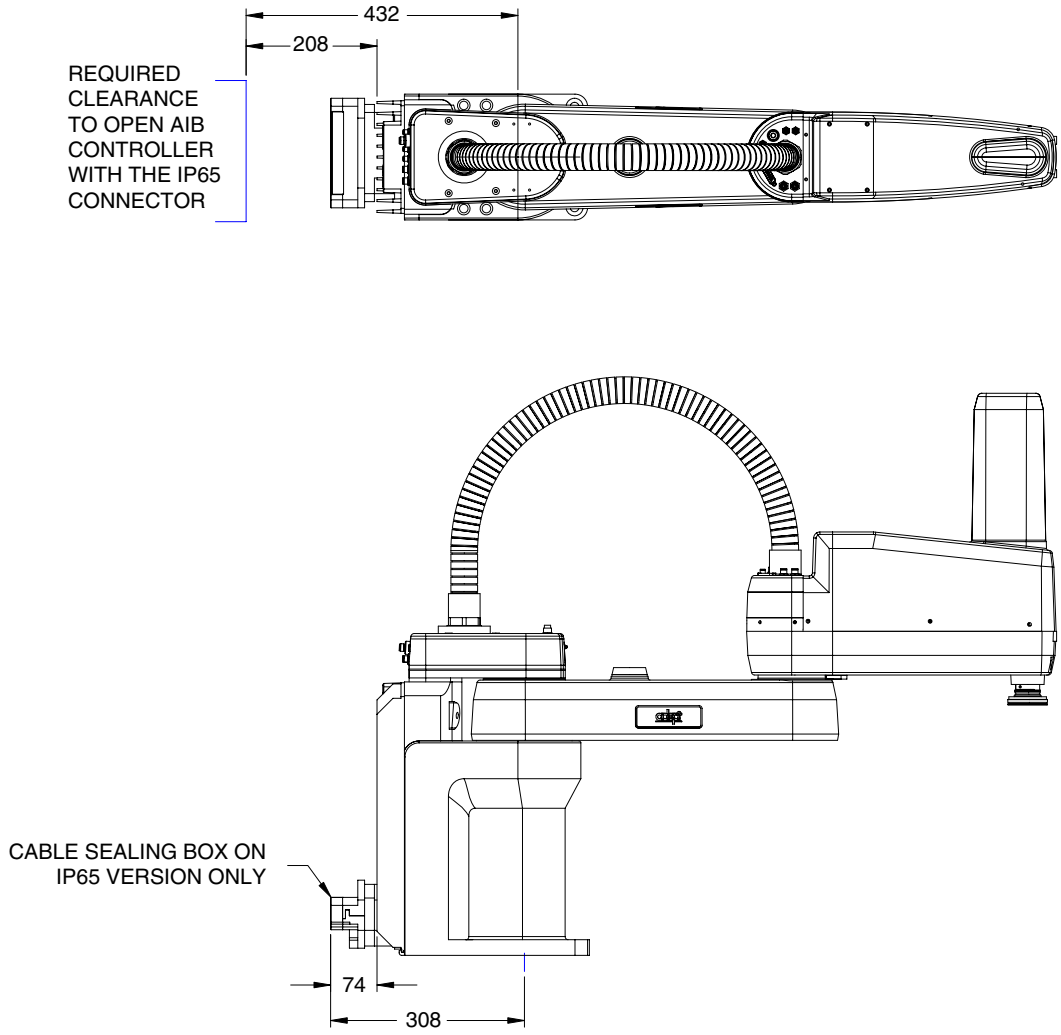


Figure 10-16. Cable Seal Assembly Dimensions

11 Dual Robot Systems

11.1 System Installation

Mount the robots according to the instructions in Chapter 3. Install the system cables as shown in Figure 11-1. Refer to Chapter 4 for details on 24 VDC power, AC power, and grounding.

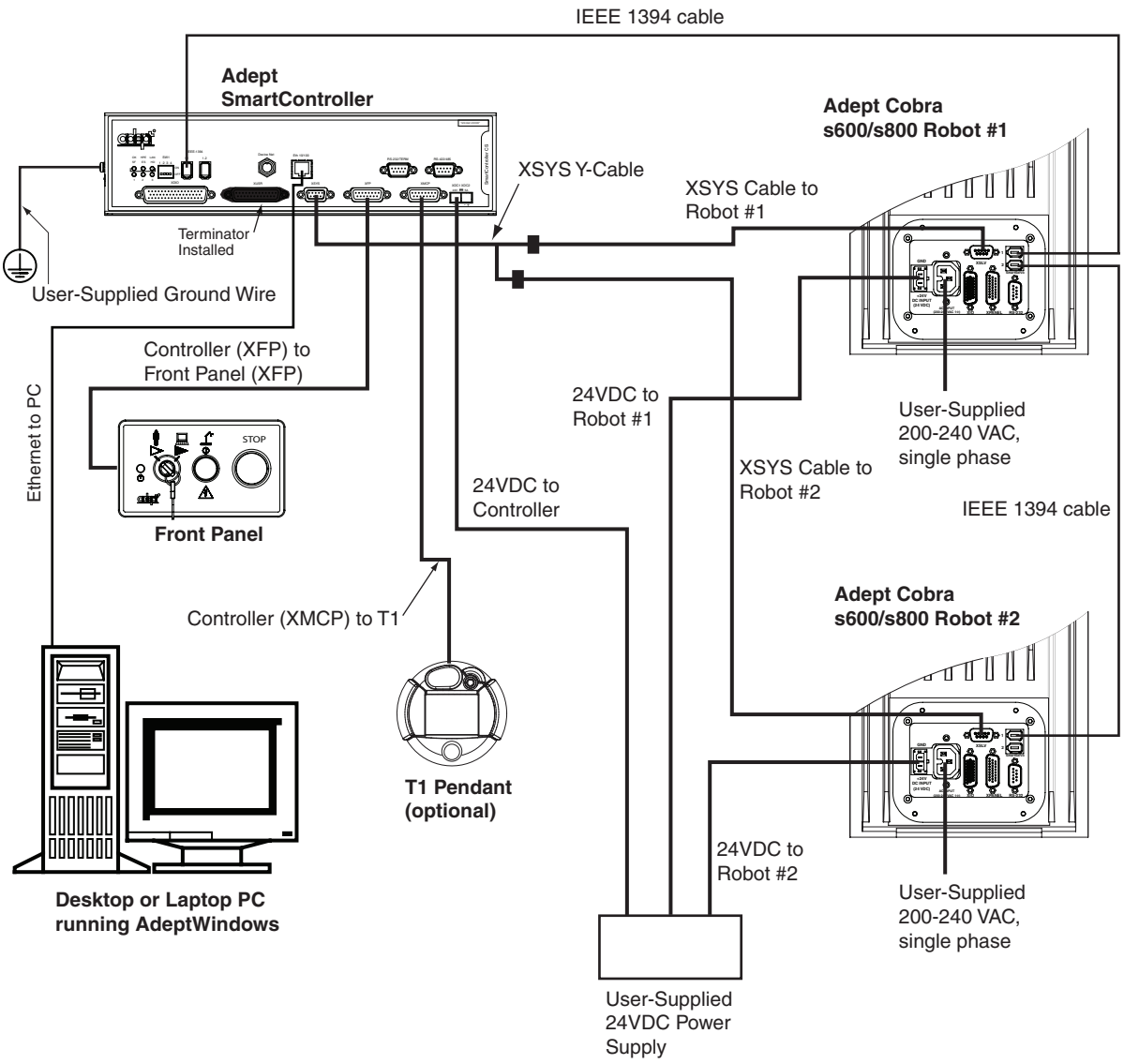


Figure 11-1. Dual Robot System Cable Diagram

A Dual Adept Cobra robot system consists of the following components:

- Two standard Adept Cobra s600 or s800 robots
- Adept SmartController CS or CX
- Multiple Adept robots License
- V+ Extensions License

11.2 System Configuration

If you purchased both robots at the same time as part of a Dual Robot system, then the two robots will be configured at the factory for the correct software setup.

If you are setting up a system that was not configured at the factory, then you will need to do this process. Go to the Procedures section of the Adept Document Library, and open the ***Dual Cobra S-Series Robot Configuration Procedure***.

The main steps in the configuration procedure are:

1. Install the robots and controller as per the diagram in **Figure 11-1 on page 133**.

   NOTE: The procedure below is only required if your system was not configured for dual robots at the factory.

2. Use the CONFIG_C utility to determine if the Cobra s600/s800 device modules are already installed in the V+ system. If not, use the CONFIG_C utility to load the "ASN" device-module file, and to select the device modules for the two robots.
3. If changes to the configuration were made, save the data and reboot the system.
4. Use the DC_SETUP utility to configure each robot as a unique node on the SmartServo network.
5. Use the DC_SETUP utility to assign the correct digital "logical" IO blocks to each robot. Robot 1 uses block 1 and block 3; robot 2 uses block 2 and block 4. See **Figure 11-3 on page 138** and **Figure 11-8 on page 142**.
6. If you are adding digital IO to the system, go to the next section for details on that process.

11.3 Connecting Digital I/O to a Dual Robot System

You can connect digital I/O to a dual robot system as shown in **Figure 11-2**. The default signal configuration, or mapping, is shown in **Table 11-1 on page 136**. This configuration is usually sufficient for most installations. If you need to add more I/O, or change the mapping, see **Section 11.4** and **Section 11.5**.

> **NOTE:** With the release of V+ 16.1 F6 in January 2005, the default signal configuration for digital I/O was changed to the values shown in **Figure 11-2** and **Table 11-1 on page 136**.

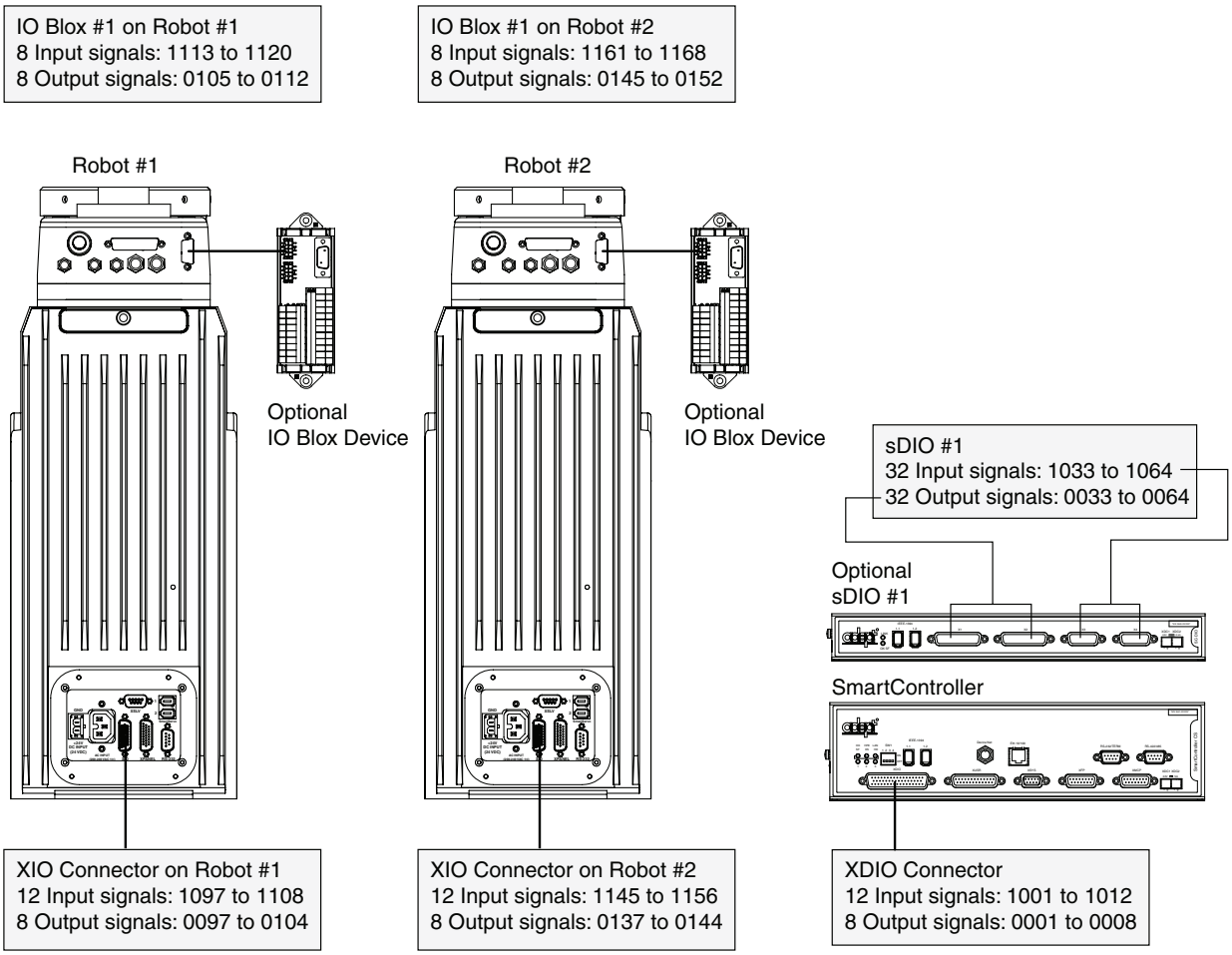


Figure 11-2. Digital I/O Connections to a Dual Robot System

Table 11-1. Default Digital I/O Signal Configuration, Dual Robot System

Location		Type	Signal Range
Controller XDIO connector		Inputs	1001 - 1012
		Outputs	0001 - 0008
sDIO Module 1		Inputs	1033 - 1064
		Outputs	0033 - 0064
sDIO Module 2		Inputs	1065 - 1096
		Outputs	0065 - 0096
sDIO Module 3 (recommended [a])		Inputs	1201 - 1232
		Outputs	0201 - 0232
sDIO Module 4 (recommended [a])		Inputs	1233 - 1264
		Outputs	0233 - 0264
Robot 1 XIO connector		Inputs	1097 - 1108
		Outputs	0097 - 0104
Robot 2 XIO connector		Inputs	1145 - 1156
		Outputs	0137 - 0144
Robot 1	IO Blox 1	Inputs	1113 - 1120
		Outputs	0105 - 0112
	IO Blox 2	Inputs	1121 - 1128
		Outputs	0113 - 0120
	IO Blox 3	Inputs	1129 - 1136
		Outputs	0121 - 0128
	IO Blox 4	Inputs	1137 - 1144
		Outputs	0129 - 0136
Robot 2	IO Blox 1	Inputs	1161 - 1168
		Outputs	0145 - 0152
	IO Blox 2	Inputs	1169 - 1176
		Outputs	0153 - 0160
	IO Blox 3	Inputs	1177 - 1184
		Outputs	0161 - 0168
	IO Blox 4	Inputs	1185 - 1192
		Outputs	0169 - 0176

[a] For sDIO modules 3 and 4, you must configure the signals using CONFIG_C, to have the system support those modules. See the ***Adept SmartController User's Guide*** for additional information on that process.

11.4 Digital I/O Block Configuration

In most system installations you can use the default I/O configurations shown in the previous section, and you will not have to modify the I/O configuration files. If you need to modify the I/O configuration, then you must use the CONFIG_C program, as described in Section 11.5 on page 140.

The information in this section can help during the configuration, or mapping process. The diagram in Figure 11-4 on page 139 shows the output and input blocks for robots 1 and 2 in a dual robot system.

XIO Inputs/Outputs

The XIO connector on the Cobra s-series robot provides 8 outputs and 12 inputs. See also Section 5.5 on page 59 for details on the XIO connector signal designations and electrical specifications.

XIO Outputs

XIO outputs are mapped starting at 0097 for robot 1 and 0137 for robot 2. Because there are only 8 outputs available on the XIO, they only take up the first byte on the first output block.

XIO Inputs

XIO inputs are mapped starting at 1097 for robot 1 and 1145 for robot 2. The first 2 bytes are allocated as follows:

1st Cobra (1097 - 1108) on Block 1, 2nd Cobra (1145 - 1156) on Block 2.

Internal Robot Outputs

The internal outputs are the signals 3001-3004 that can be used to control optional solenoids (hand valves) internal to the robot. These internal outputs take up the 2nd byte on the first output block allocated to each robot.

Signals 3001-3004 are allocated to each robot (robot 1 and robot 2). This means you need to SELECT the robot from your application before attempting to control its outputs (e.g. SELECT ROBOT = 1) This mapping is done using CONFIG_C - Robot option.

IO Blox Inputs/Outputs

Up to four IO Blox devices can be daisy-chained together to give you 32 inputs and 32 outputs. IO Blox occupy the first 4 bytes of the second block allocated to the robot. See Figure 11-3 on page 138. Also see the *Adept IO Blox User's Guide* for more information.

sDIO Inputs/Outputs

Up to four sDIO modules can be added to a system. The first sDIO occupies the first 4 bytes of block 16. See Figure 11-4 on page 139. Also see the *Adept SmartController User's Guide* for more information.

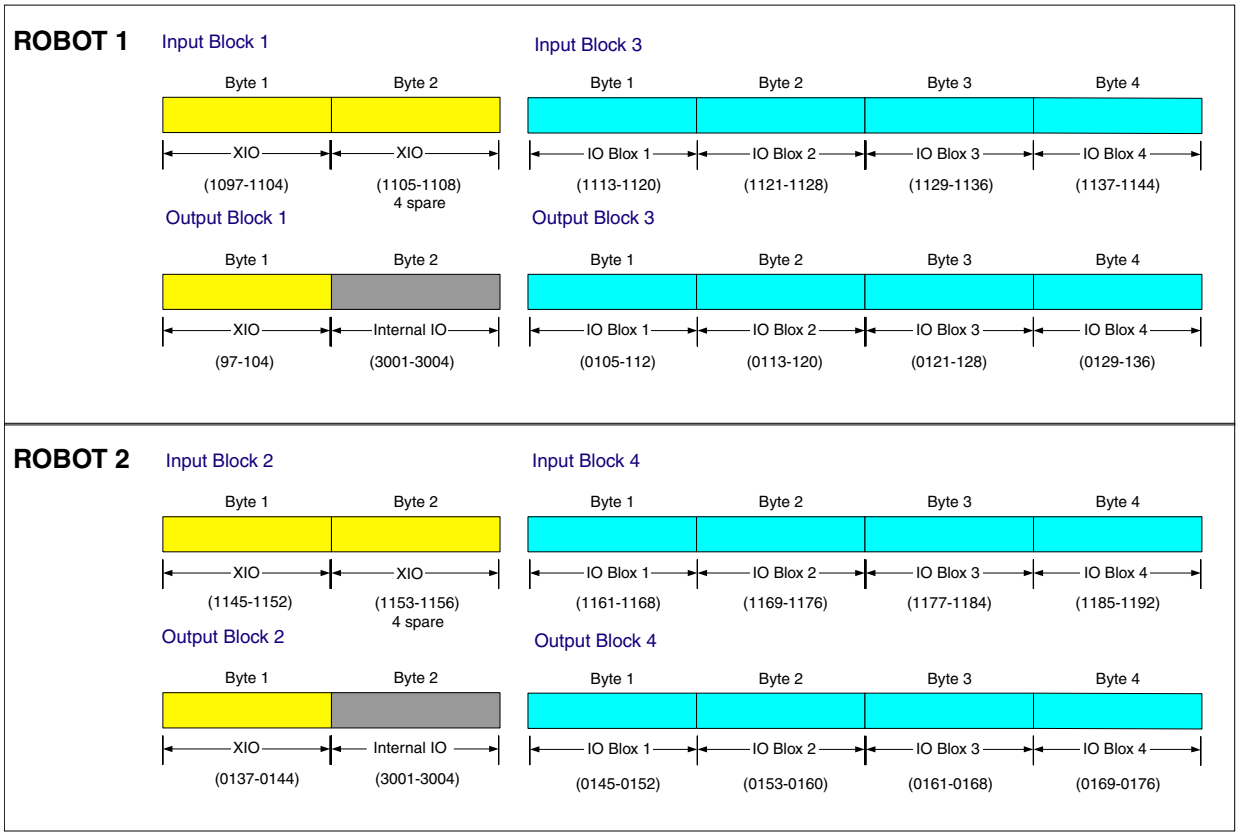


Figure 11-3. Input/Output Block Configuration in Dual Robot Systems

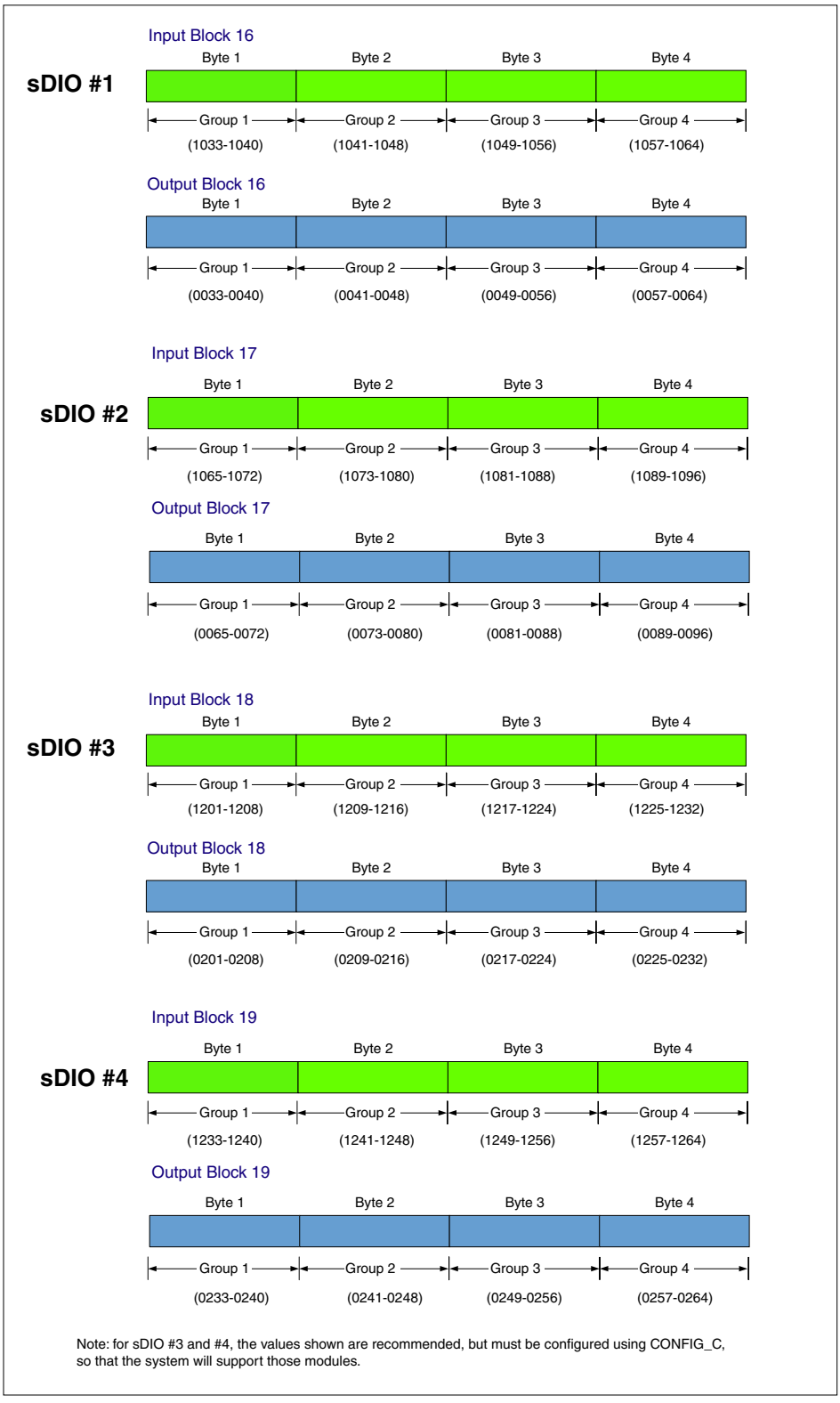


Figure 11-4. Input/Output Block Configuration for Optional sDIO Modules

11.5 Using CONFIG_C to Configure I/O

If you purchased both robots at the same time as part of a Dual Robot system, then the two robots will be set up at the factory for the correct I/O configuration.

If you are setting up a system that was not configured at the factory, or combining two formerly single robots, then you will need to go through the configuration process.

There are two methods for configuring the I/O:

- IO configuration by editing system file
- IO configuration by importing pre-configured file

IO Configuration by Editing System File

This procedure provides details of configuring the I/O to support the XIO and solenoid value option.

1. Load \util\config_c
2. Exe 1 a.config_c

The following will be displayed.

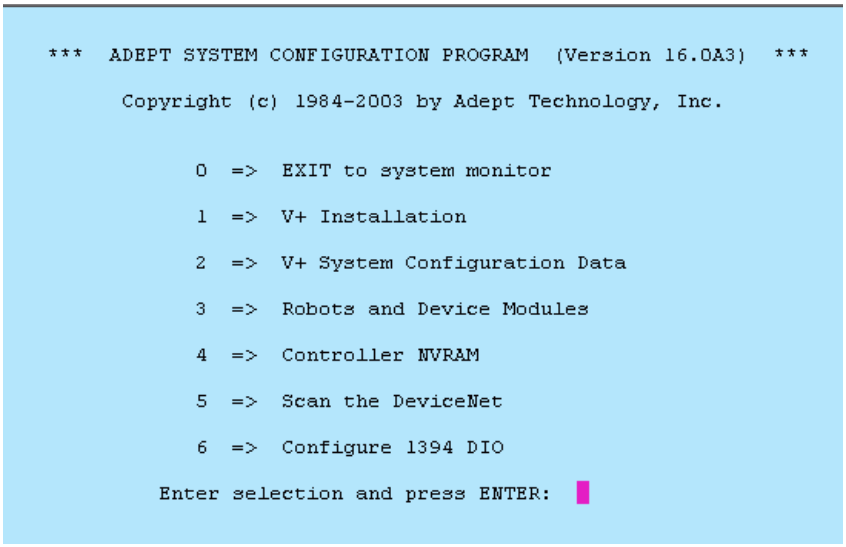


Figure 11-5. CONFIG_C Menu

3. Select option 2 “V+ system configuration data”

The following will be displayed.

```
***  CONTROLLER CONFIGURATION EDITOR  ***

   0  =>  Return to MAIN MENU

   1  =>  DISPLAY system CONFIGURATION

   2  =>  EDIT system CONFIGURATION

   3  =>  EXPORT configuration DATA

   4  =>  IMPORT configuration DATA

Enter selection and press ENTER:
```

Figure 11-6. Controller Configuration Editor Menu

4. Select option 2 “Edit system configuration”

The following will be displayed.

```
V+ SYSTEM CONFIGURATION EDITOR


Accessing disk drive D...

        Reading the configuration file

Ready to edit the configuration data.


         0  =>  Done editing

         1  =>  Change HEADER configuration
         2  =>  Change VPLUS configuration
         3  =>  Change ANALOG_INPUT configuration
         4  =>  Change ANALOG_OUTPUT configuration
         5  =>  Change DIGITAL_INPUT configuration
         6  =>  Change DIGITAL_OUTPUT configuration
         7  =>  Change DEVICENET configuration
         8  =>  Change NETWORK configuration
         9  =>  Change ROBOT configuration
        10  =>  Change SERIAL configuration
        11  =>  Change SERVO_BOARDS configuration
        12  =>  Change SYSTEM configuration
        13  =>  Change TASKS configuration
        14  =>  Change VISION configuration

Enter selection:
```

Figure 11-7. System Configuration Editor Menu

5. Configure the I/O as shown in **Figure 11-8 on page 142** showing an example from a CONFIG_C file - look closely at the highlighted areas. Do not delete any of the default configurations. This file is configured for:
   - XIO connected to both robots.
   - IO Blox connected to both robots.
   - Internal Outputs 3001-3004 for both robots.

```
.DIGITAL_INPUT
      POS_LATCH 1 = "/SIGNAL NONE"
      POS_LATCH 2 = "/SIGNAL NONE"
      SIGNAL 1033 = "/INPUT_BLOCK 16 /INPUT_BYTE 1 /IO_OPTIONAL YES"
      SIGNAL 1041 = "/INPUT_BLOCK 16 /INPUT_BYTE 2 /IO_OPTIONAL YES"
      SIGNAL 1049 = "/INPUT_BLOCK 16 /INPUT_BYTE 3 /IO_OPTIONAL YES"
      SIGNAL 1057 = "/INPUT_BLOCK 16 /INPUT_BYTE 4 /IO_OPTIONAL YES"
      SIGNAL 1065 = "/INPUT_BLOCK 17 /INPUT_BYTE 1 /IO_OPTIONAL YES"
      SIGNAL 1073 = "/INPUT_BLOCK 17 /INPUT_BYTE 2 /IO_OPTIONAL YES"
      SIGNAL 1081 = "/INPUT_BLOCK 17 /INPUT_BYTE 3 /IO_OPTIONAL YES"
      SIGNAL 1089 = "/INPUT_BLOCK 17 /INPUT_BYTE 4 /IO_OPTIONAL YES"
      SIGNAL 1097 = "/INPUT_BLOCK 1 /INPUT_BYTE 1 /IO_OPTIONAL YES"
      SIGNAL 1105 = "/INPUT_BLOCK 1 /INPUT_BYTE 2 /IO_OPTIONAL YES"
      SIGNAL 1113 = "/INPUT_BLOCK 3 /INPUT_BYTE 1 /IO_OPTIONAL YES"
      SIGNAL 1121 = "/INPUT_BLOCK 3 /INPUT_BYTE 2 /IO_OPTIONAL YES"
      SIGNAL 1129 = "/INPUT_BLOCK 3 /INPUT_BYTE 3 /IO_OPTIONAL YES"
      SIGNAL 1137 = "/INPUT_BLOCK 3 /INPUT_BYTE 4 /IO_OPTIONAL YES"
      SIGNAL 1145 = "/INPUT_BLOCK 2 /INPUT_BYTE 1 /IO_OPTIONAL YES"
      SIGNAL 1153 = "/INPUT_BLOCK 2 /INPUT_BYTE 2 /IO_OPTIONAL YES"
      SIGNAL 1161 = "/INPUT_BLOCK 4 /INPUT_BYTE 1 /IO_OPTIONAL YES"
      SIGNAL 1169 = "/INPUT_BLOCK 4 /INPUT_BYTE 2 /IO_OPTIONAL YES"
      SIGNAL 1177 = "/INPUT_BLOCK 4 /INPUT_BYTE 3 /IO_OPTIONAL YES"
      SIGNAL 1185 = "/INPUT_BLOCK 4 /INPUT_BYTE 4 /IO_OPTIONAL YES"
      VIS_TRIGGER 1 = "/SIGNAL NONE"
      VIS_TRIGGER 2 = "/SIGNAL NONE"

.DIGITAL_OUTPUT
      SIGNAL 33 = "/OUTPUT_BLOCK 16 /OUTPUT_BYTE 1 /IO_OPTIONAL YES"
      SIGNAL 41 = "/OUTPUT_BLOCK 16 /OUTPUT_BYTE 2 /IO_OPTIONAL YES"
      SIGNAL 49 = "/OUTPUT_BLOCK 16 /OUTPUT_BYTE 3 /IO_OPTIONAL YES"
      SIGNAL 57 = "/OUTPUT_BLOCK 16 /OUTPUT_BYTE 4 /IO_OPTIONAL YES"
      SIGNAL 65 = "/OUTPUT_BLOCK 17 /OUTPUT_BYTE 1 /IO_OPTIONAL YES"
      SIGNAL 73 = "/OUTPUT_BLOCK 17 /OUTPUT_BYTE 2 /IO_OPTIONAL YES"
      SIGNAL 81 = "/OUTPUT_BLOCK 17 /OUTPUT_BYTE 3 /IO_OPTIONAL YES"
      SIGNAL 89 = "/OUTPUT_BLOCK 17 /OUTPUT_BYTE 4 /IO_OPTIONAL YES"
      SIGNAL 97 = "/OUTPUT_BLOCK 1 /OUTPUT_BYTE 1 /IO_OPTIONAL YES"
      SIGNAL 105 = "/OUTPUT_BLOCK 3 /OUTPUT_BYTE 1 /IO_OPTIONAL YES"
      SIGNAL 113 = "/OUTPUT_BLOCK 3 /OUTPUT_BYTE 2 /IO_OPTIONAL YES"
      SIGNAL 121 = "/OUTPUT_BLOCK 3 /OUTPUT_BYTE 3 /IO_OPTIONAL YES"
      SIGNAL 129 = "/OUTPUT_BLOCK 3 /OUTPUT_BYTE 4 /IO_OPTIONAL YES"
      SIGNAL 137 = "/OUTPUT_BLOCK 2 /OUTPUT_BYTE 1 /IO_OPTIONAL YES"
      SIGNAL 145 = "/OUTPUT_BLOCK 4 /OUTPUT_BYTE 1 /IO_OPTIONAL YES"
      SIGNAL 153 = "/OUTPUT_BLOCK 4 /OUTPUT_BYTE 2 /IO_OPTIONAL YES"
      SIGNAL 161 = "/OUTPUT_BLOCK 4 /OUTPUT_BYTE 3 /IO_OPTIONAL YES"
      SIGNAL 169 = "/OUTPUT_BLOCK 4 /OUTPUT_BYTE 4 /IO_OPTIONAL YES"

.ROBOT
      BELT 1 = "/POS_LATCH 1 /LATCH_BUFFER 3"
      BELT 2 = "/POS_LATCH 2 /LATCH_BUFFER 3"
      ROBOT 1 = "/MODULE -1 /OUTPUT_BLOCK 1 /OUTPUT_BYTE 2 /IO_OPTION
      ROBOT 2 = "/MODULE -1 /OUTPUT_BLOCK 2 /OUTPUT_BYTE 2 /IO_OPTION
```


Figure 11-8. Sample Configuration File for Digital I/O

NOTE: After using CONFIG_C to map I/O signals for dual robots or IO Blox devices, you must run the DC_SETUP utility to assign the correct digital IO blocks. Select Option 1> "Configure DIO input/output blocks."

IO Configuration by Importing Pre-Configured File

You can use a pre-configured file to do the IO configuration process. The file is available in the Adept Download Center on the Adept website.

http://www.adept.com/main/ke/ServicesDB/search.asp

Search for "Cobra s600/s800 IO Configuration" to find the file and download it. Then follow the procedure below.

NOTE: Be aware that importing this file will replace **all** of the configuration information in the system. See the ***Instructions for Adept Utility Programs*** for details on the CONFIG_C utility program.

1. Start the procedure described in the previous section, by loading and executing CONFIG_C, as shown in **Figure 11-5 on page 140**.
2. In **Figure 11-6 on page 141**, select option 4 "Import configuration data."
3. Follow the instructions to import the file that you downloaded from the website.
4. Save the new configuration data.

11.6 System Startup Procedure

Verify that the system has been installed according to **Figure 11-1 on page 133**, and that the system configuration is complete.

1. Turn on the 24 V DC to robot #1.
2. Turn on the 24 V DC to robot #2.
3. Turn on the 24 V DC to the SmartController.
4. Turn on AC power to robot #1.
5. Turn on AC power to robot #2.
6. Turn on the PC running AdeptWindows and connected to the SmartController.
7. At the V+ dot prompt, type enable power.

   ```
   ENA POW <enter>
   ```

   Press the High Power button on the Front Panel while it is blinking. This turns on High Power to both robots.

8. Type calibrate.

   ```
   CAL <enter>
   ```

   NOTE: The robots will move slightly, with less than a 1.5 degree rotation of J4, and you might hear an audible click from the J3 brake releasing when calibration is executed. The robots are now servoing all motors to remain in position at all times.

9. System will return with a “dot” (.) prompt, if everything was successful, then high power will be enabled, and the status panel display will read “OK.”
10. System is ready for operation.

11.7 Operation With the Adept T1/T2 Pendant

The optional Adept T1/T2 pendant can be used to control either robot in a dual robot system. By default, the T1/T2 controls robot 1. To switch to robot 2, press the DEV/F3 button on the pendant. The DEV LED turns on in this condition.

To switch back to robot 1, press the DEV/F3 button again. The DEV LED turns off.

See the ***T1 Pendant User’s Guide*** or the ***T2 Pendant User’s Guide*** for complete information on using the T1 or T2 pendant.

> **NOTE:** When using a pendant, either the Adept T1/T2 Pendant or the MCP4, with an Adept robot, the Free Mode is disabled for safety reasons.

11.8 Programming Information

V+ Language Programming

By default, Task 0 is used to control robot 1. Task 1 is normally recommended for robot 2. Use the SELECT ROBOT=2 and ATTACH instructions in your program to select robot 2. See the ***V+ Language User’s Guide*** and the ***V+ Language Reference Guide*** for more information on these instructions.

V+ Monitor Commands

By default, monitor commands such as HERE and WHERE apply to robot 1. Use the monitor command SELECT ROBOT=2 first when you need to display the location of robot 2.

> **NOTE:** The DISABLE POWER command shuts off high power to both robots in a dual robot system.

The CALIBRATE monitor command will calibrate both robots. Robot 1 will be calibrated first, then robot 2.

You can temporarily disable either robot and continue to use the other, by using the DISABLE ROBOT[ ] command. For example DISABLE ROBOT[2] will cause V+ to ignore robot 2. If you issue this command before you use the CALIBRATE command, then only one robot will be calibrated. Robot 1 can be then used normally. To re-enable robot 2, use the command ENABLE ROBOT[2].

11.9 Emergency Stop Circuit Shuts Off Both Robots

The Adept SmartController has an Emergency Stop circuit that is designed to safely stop both robots simultaneously in the event of a problem. The Adept multi-robot system is designed for multiple robots operating in the same workcell. Therefore, if one robot has a fault, the other robot will also be stopped. A brief message will be displayed, indicating the problem. The message will also state which joint(s) and which robot is affected. The most common system messages are described in the ***V+ Operating System User's Guide***. A full list of system messages with complete explanation and suggested user actions is in the ***V+ Language Reference Guide***.

Examples of faults that can be detected by the Adept control system are *Hard envelope error*, *Soft envelope error*, and *Motor stalled*. Any of these messages may mean that a robot has collided with an unexpected object in the workspace, therefore, both robots will be stopped.

The Emergency Stop signal stops both robots connected to the same controller. It is not possible to use the E-Stop signal to stop only one robot. The Emergency Stop switches on the Front Panel and the pendant shut off high power to both robots when the switch is pressed.

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