OMRON

Cobra 350 Robot

User's Guide

I591-E-01

Copyright Notice

Table of Contents

Chapter 1: Introduction

1.1 Product Description

Cobra 350 Robots

The Cobra 350 robot is a high-performance, four-axis SCARA robot (Selective Compliance Assembly Robot Arm). Joints 1, 2, and 4 are rotational; Joint 3 is translational. See See "Robot Joint Motions" for a description of the robot joint locations.

The Cobra 350 robots require an MotionBlox-40R (eMB-40R) and a SmartController EX motion controller. The robots are programmed and controlled using the SmartController, running on the SmartServo distributed motion control platform. Mechanical specifications for the Cobra 350 robots are provided in Technical Specifications on page 97.

A cleanroom model is also available, the Cobra 350 CR/ESD. See Cleanroom Robots on page 105 for information.

Figure 1-1. Cobra 350 Robot

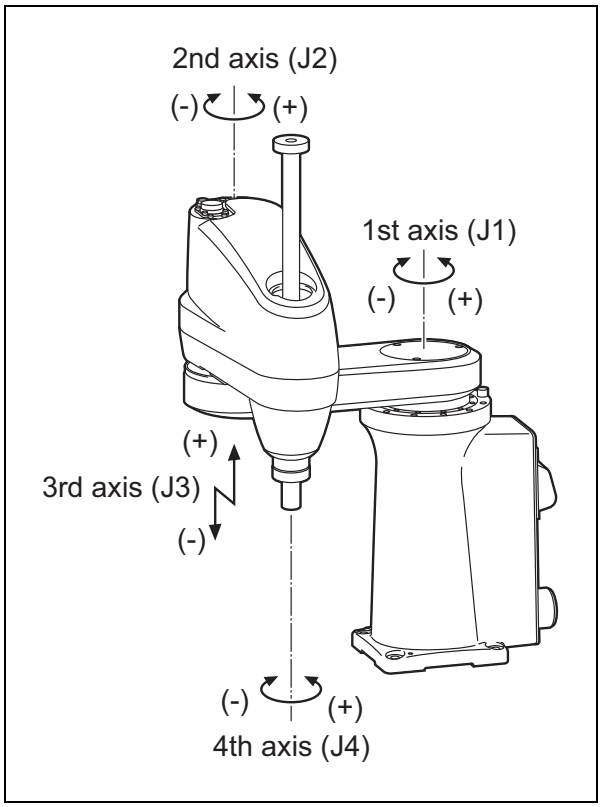


Figure 1-2. Robot Joint Motions

SmartController EX

The SmartController EX is the foundation of our family of high-performance distributed motion controllers. The SmartController EX is designed for use with:

- eCobra robots
- Quattro robots
- Viper series robots

The SmartController EX supports a conveyor tracking option, as well as other options. It uses the eV+ Operating System, and offers scalability and support for IEEE 1394-based digital I/O and general motion expansion modules. The IEEE 1394 interface is the backbone of SmartServo, our distributed controls architecture supporting our products. The SmartController EX also includes Fast Ethernet and DeviceNet.

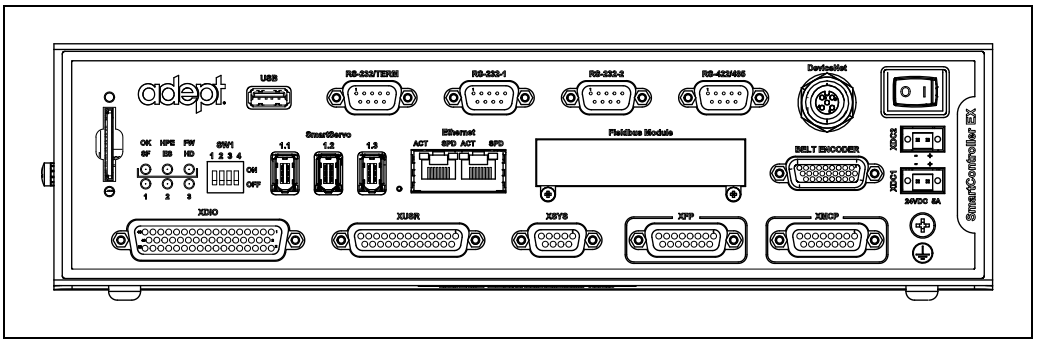


Figure 1-3. SmartController EX Motion Controller

MotionBlox-40R

The MotionBlox-40R (eMB-40R) Distributed Servo Controller controls the behavior of the feedback loop between the digital absolute encoders and the high-power motors of the Cobra 350 robot.

The eMB-40R features:

- Four AC servo motor amplifiers
- Emergency stop circuitry
- High servo rate, to deliver low positional errors and superior path-following
- Sine wave commutation delivers low cogging torque and improved path-following
- Digital feed-forward design maximizes efficiency, torque, and velocity
- Integral temperature sensors and status monitoring for maximum reliability
- Two-digit diagnostics display for easy troubleshooting

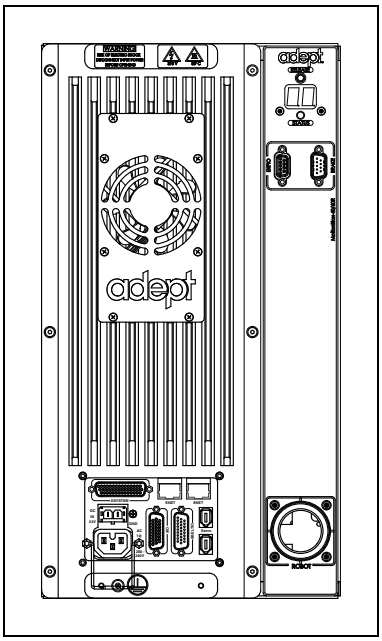


Figure 1-4. MotionBlox-40R

1.2 Installation Overview

The system installation process is summarized in the following table. Refer also to the system cable diagram in See "System Cable Diagram for Cobra 350 Robots".

Table 1-1. Installation Overview

Task to be Performed	Reference Location
Mount the robot on a flat, secure mounting surface.	Mounting the Robot on page 18.
Install the SmartController, Front Panel, optional pendant (if present), and ACE software.	Installing the SmartController on page 24.
Install the IEEE 1394 and XSYS cables between the eMB-40R and SmartController.	Cable Connections from eMB-40R to SmartController on page 25.
Install the Arm Power/Signal cable between the eMB-40R and the robot.	Cable Connections from eMB-40R to Robot on page 26.
Create a 24 VDC cable and connect it between the eMB-40R and the user-supplied 24 VDC power supply.	Connecting 24 VDC Power to eMB-40R Servo Controller on page 26.
Create a 24 VDC cable and connect it between the SmartController and the user-supplied 24 VDC power supply.	Connecting 24 VDC Power to eMB-40R Servo Controller on page 26.
Create a 200-240 VAC cable and connect it between	Connecting 200-240 VAC

Task to be Performed	Reference Location
the eMB-40R and the facility AC power source.	Power to eMB-40R on page 29.
Install user-supplied safety barriers in the workcell.	Installing User-Supplied Safety Equipment on page 34.
Learn about connecting digital I/O through the XIO connector on the eMB-40R.	Connecting Digital I/O to the System on page 50.
Read See "System Operation" to learn about system start-up and testing operation.	System Operation on page 63.
Read Optional Equipment Installation on page 71 if you need to install optional equipment, such as end-effectors, user air and electrical lines, and external equipment.	Optional Equipment Installation on page 71.

1.3 How Can I Get Help?

Refer to the corporate website:

http://www.ia.omron.com

Related Manuals

This manual covers the installation, operation, and maintenance of an Cobra 350 robot system. There are additional manuals that cover programming the system, reconfiguring installed components, and adding other optional components. See the following table.

Table 1-2. Related Manuals

Manual Title	Description
Robot Safety Guide	Contains safety information for our robots.
SmartController EX User's Guide	Contains information on the installation and operation of the SmartController EX and the optional sDIO product.
T20 Pendant User's Guide	Describes the T20 pendant.
ACE User's Guide	Instruction for the use of the ACE software.
IO Blox User's Guide	Describes the IO Blox product.
Dual-Robot Configuration Procedure	Contains cable diagrams and configuration procedures for a dual-robot system.

Chapter 2: Safety

2.1 Dangers, Warnings, Cautions, and Precautions

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

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

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

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

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

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

Precautions for Safe Use: This indicates precautions on what to do and what not to do to ensure using the product safely.

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

2.2 Safety Precautions

DANGER: A Cobra 350 robot can cause serious injury or death, or damage to itself and other equipment, if the following safety precautions are not observed:

- All personnel who install, operate, teach, program, or maintain the system must read this guide, read the *Robot Safety Guide*, and complete a training course for their responsibilities in regard to the robot.

Figure 2-1. Read Manual and Impact Warning Labels

- All personnel who design the robot system must read this guide, read the *Robot Safety Guide*, and must comply with all local and national safety regulations for the location in which the robot is installed.
- The robot system must not be used for purposes other than described in Intended Use of the Robot on page 15. Contact Omron Adept Technologies, Inc. if you are not sure of the suitability for your application.
- The user is responsible for providing safety barriers around the robot to prevent anyone from accidentally coming into contact with the robot when it is in motion.
- Power to the robot and its power supply must be locked out and tagged out before any maintenance is performed.

2.3 What to Do in an Emergency or Abnormal Situation

Press any E-Stop button (a red push-button on a yellow background) and then follow the internal procedures of your company or organization for an emergency or abnormal situation. If a fire occurs, use CO_2 to extinguish the fire.

In case of an emergency or abnormal situation, the inner and outer robot arms can be manually moved without electric power. However, only qualified personnel who have read and understood the *eCobra User's Guide* and *Robot Safety Guide* should manually move the robot into a safe state. Joint 3 is held by a brake, which can only be released with the Brake Release button. This requires 24 V power to the robot.

2.4 Robot Behavior

Hardstops

If the Cobra 350 runs into one of its hardstops, the robot's motion will stop completely, an envelope error will be generated, and power will be cut to the robot motors.

The robot cannot continue to move after hitting a hardstop until the error has been cleared.

The Cobra 350's hardstops are capable of stopping the robot at any speed, load, and maximum or minimum extension.

Limiting Devices

There are no dynamic or electro-mechanical limiting devices provided by Omron Adept Technologies, Inc. The robot does not have safety-rated soft axis or space limiting.

However, the user can install their own safety rated (category 0 or 1) dynamic limiting devices if needed, that comply with ISO 10218-1, Clause 5.12.2.

Singularities

No singularities exist that cause a hazardous situation with a Cobra 350 robot.

2.5 Intended Use of the Robot

DANGER: Cobra 350 robots are not collaborative robots. They require a dedicated work area that will prevent personnel from coming into contact with them during operation.

The normal and intended use of these robots does not create hazards.

The Cobra 350 robots have been designed and constructed in accordance with the relevant requirements of IEC 60204-1.

The Cobra 350 robot is intended for use in parts assembly and material handling for payloads up to 2.0 kg. See Technical Specifications on page 97 for complete specifications. Refer to the *Robot Safety Guide* for details on the intended use of our robots.

The Cobra 350 is not intended for:

- Use in the presence of ionizing or non-ionizing radiation
- Use in potentially explosive atmospheres
- Use in medical or life saving applications
- Use in a residential setting. They are for industrial use only.
- Use before performing a risk assessment

2.6 Additional Safety Information

We provide other sources for more safety information:

Manufacturer's Declaration of Incorporation

This lists all standards with which the robot complies. The Manufacturer's Declarations for the Cobra 350 robot and other products are in the *Manufacturer's Declarations Guide*.

Robot Safety Guide

The *Robot Safety Guide* provides detailed information on safety for our robots. It also gives resources for more information on relevant standards. It ships with each robot.

Manual Control Pendant

The protective stop category for the pendant enable switch is category 1, which complies with the requirements of ISO 10218-1.

The pendant is designed in accordance with the requirements of IEC 60204-1 and ISO 13849. The E-Stop button is ISO 13850 compliant.

> **NOTE**: Omron Adept Technologies, Inc. does not offer a cableless (wireless) pendant.

The manual control pendant can only move one robot at a time, even if multiple robots are connected to a SmartController EX, and the pendant is connected to the SmartController EX.

Chapter 3: Robot Installation

3.1 Transport and Storage

This equipment must be shipped and stored in a temperature-controlled environment, within the range –25 to +60° C (-13 to 140° F). The recommended humidity range is 5 to 90 percent, non-condensing. It should be shipped and stored in the supplied packaging, which is designed to prevent damage from normal shock and vibration. You should protect the package from excessive shock and vibration.

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.

3.2 Unpacking and Inspecting the Equipment

Before Unpacking

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

Upon Unpacking

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 Omron Adept Technologies, Inc. as soon as possible.

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

Inspect each item for external damage as it is removed from its container. If any damage is evident, contact Omron Adept Technologies, Inc. (see See "How Can I Get Help?").

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. Reuse all original packing containers and materials and follow all safety notes used for installation. Improper packaging for shipment will void your warranty. Before unbolting the robot 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. Specify this to the carrier if the robot is to be shipped.

3.4 Environmental and Facility Requirements

The robot system installation must meet the operating environment requirements shown in the following table.

Table 3-1. Robot System Operating Environment Requirements

Ambient temperature	5 to 40° C (41 to 104° F)
Humidity	5 to 90%, noncondensing
Altitude	up to 2000 m (6500 ft.)
Pollution degree	2
Robot protection class	IP20 (NEMA Type 1)
NOTE: See Dimension Drawings on page 97 for robot dimensions.	

3.5 Mounting the Robot

At least two people should transport and store the packaged equipment (see See "Transporting Robot").

The robot weighs 20 kg (45 lb) with no options installed.

Figure 3-1. Transporting Robot

CAUTION: Do not hold the robot by parts other than those shown above.

Mounting Surface

The Cobra 350 robot is designed to be mounted on a smooth, flat, level surface. The mounting surface must be rigid enough to prevent vibration and flexing during robot operation. We recommend a 25 mm (1 in.) thick steel plate mounted to a rigid tube frame. Excessive vibration or mounting flexure will degrade robot performance. See "Mounting Hole Pattern for Robot" shows the mounting hole pattern for the Cobra 350 robot.

> **NOTE:** On the under-side of the base there are two holes that can be used as locating points for user-installed dowel pins in the mounting surface. See See "Mounting Hole Pattern for Robot" for the hole dimension and location. Using locating pins can improve the ability to remove and reinstall the robot in the same position.

The Cobra 350 robot can be mounted on a moving platform with proper attention paid to adequately supporting the robot cabling. The motor/encoder cable connecting the robot to the eMB-40R is not designed to withstand repeated bending operations and has a minimum recommended bend radius of 200 mm. The connectors on this cable are not designed to support any dynamic forces and we always advise users to support the weight of the cable with external supports and tie-downs. Any additional user cabling should be installed with user-designed cabling supports that do not use these motor/encoder connectors as attachment points for auxiliary cabling.

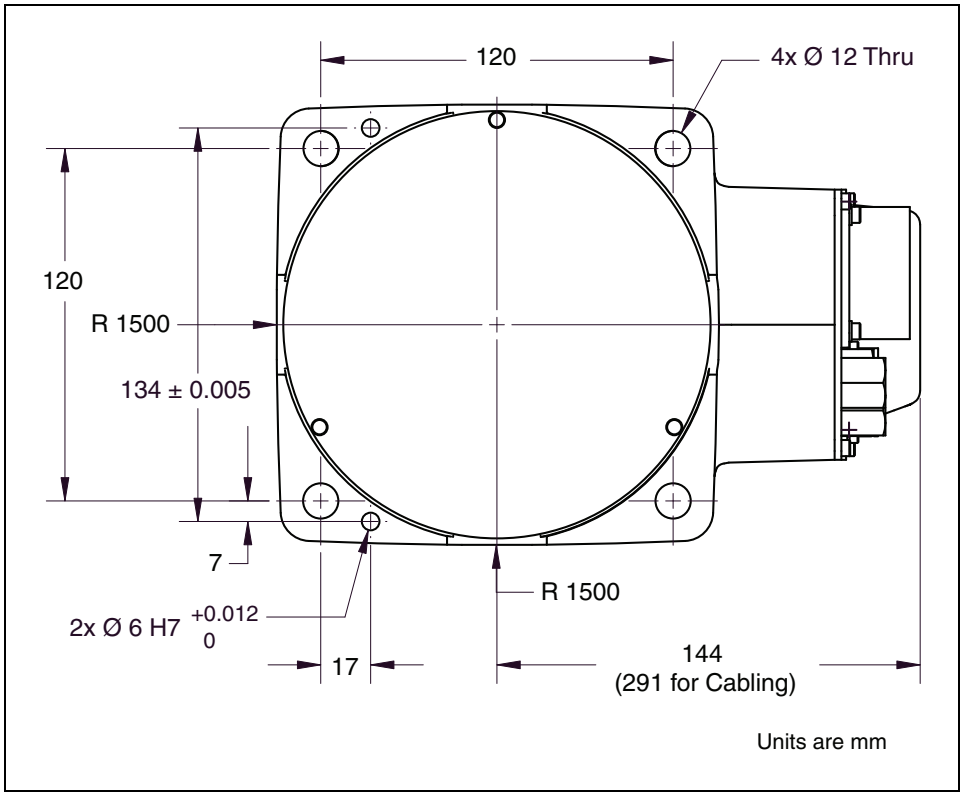


Figure 3-2. Mounting Hole Pattern for Robot

Robot Mounting Procedure

1. Using the dimensions shown in See "Mounting Hole Pattern for Robot", drill and tap the mounting surface for four M10 x 30 mm (or 3/8-16 UNC) machine bolts (user-supplied). Also drill two 6H7 diameter holes for a diamond-shaped dowel pin and an internally-threaded positioning pin. See See "Mounting Bolt Torque Specifications" for bolt and torque specifications.

WARNING: 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.

2. Install a diamond-shaped pin into one of the 6H7 diameter holes.
3. Install an internally-threaded positioning pin into the other 6H7 hole.
4. Turn the J2 axis until it comes into contact with the mechanical hardstop to keep the robot in a safe position.

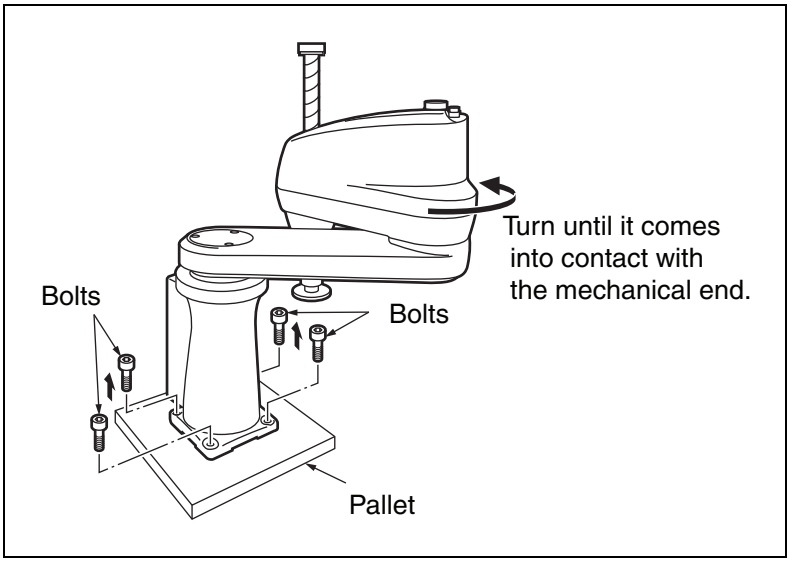


Figure 3-3. Rotate J2 Axis to Safe Position

5. Remove the four bolts securing the robot base to the pallet. One person should support the J1 axis arm while another person removes the bolts. Retain these bolts for possible later relocation of the equipment.
6. Lift the robot and position it directly over the mounting surface.
7. 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.

8. Install the user-supplied mounting bolts and washers. Tighten bolts to the torque specified in See "Mounting Bolt Torque Specifications".

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 Periodic Maintenance Schedule on page 81 for periodic maintenance.

Table 3-2. Mounting Bolt Torque Specifications

Standard	Size	Specification	Torque
Metric	M10 x 30 mm	ISO Property Class 8.8	70 N·m
SAE	3/8-16 UNC	SAE J429 Grade 5 or ASTM A449	52 ft-lbf

Chapter 4: System Cable Installation

4.1 System Cable Diagram

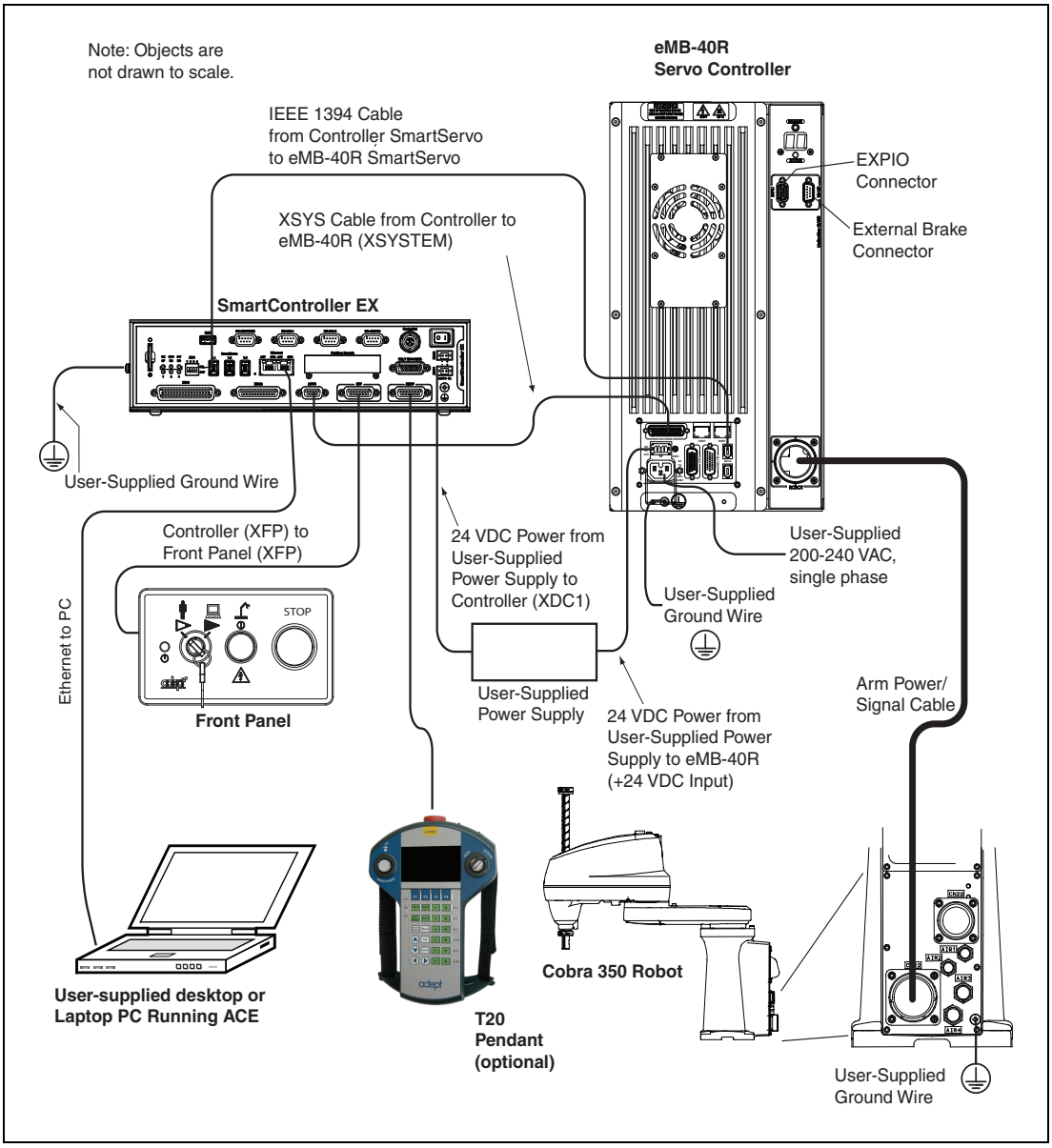


Figure 4-1. System Cable Diagram for Cobra 350 Robots

4.2 Cable List

Table 4-1. Cables and Parts List

Cable Description	Notes
IEEE 1394 Cable, 4.5 M	Standard cable—supplied with system
eAIB XSYS Cable, 4.5 M (for eMB-40R)	Standard cable - supplied with eMB-40R
eAIB XSLV Adapter Cable, 250 mm (for eMB-40R with old XSYS cable)	Standard for MB-40R to eMB-40R upgrade.
Front Panel Cable	Supplied with Front Panel
T20 Pendant Adapter Cable	Supplied with optional T20 pendant
Power Cable Kit - contains 24 VDC and AC power cables	Available as option
XIO Breakout Cable, 12 inputs/ 8 outputs, 5 meters	Available as option—see XIO Breakout Cable on page 57.
Y Cable, for XSYS cable connections to dual robot (for SmartController)	Available as option

4.3 Installing the SmartController

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

1. Mount the SmartController.
2. Install the Front Panel. The Front Panel must be outside of the work area, but near the work area.
3. Connect the Front Panel to the SmartController.
4. Connect the optional pendant (if included) to the SmartController.
5. Connect user-supplied 24 VDC power to the controller. Instructions for creating the cable, and power specifications, are covered in the *SmartController EX User's Guide*.
6. Install a user-supplied ground wire between the SmartController and ground.
7. Install the ACE PC software on the user-supplied PC (see the following section).

4.4 Installing the ACE Software

The ACE software is installed from the ACE software disk.

1. Insert the disk into the disk drive of your PC.

   If Autoplay is enabled, the software disk menu is displayed. If Autoplay is disabled, you will need to manually start the disk.

2. Especially if you are upgrading your ACE software installation: from the ACE software disk menu, click Read Important Information.
3. From the ACE software disk menu, select:

   Install the ACE Software

   The ACE Setup wizard opens.
4. Follow the online instructions as you step through the installation process.
5. When the installation is complete, click Finish.
6. After closing the ACE Setup wizard, click Exit on the disk menu to close the menu.

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

4.5 Connecting the PC to the SmartController

The SmartController motion controller must be connected to a user-supplied PC or the SmartVision MX vision processor for setup, control, and programming.

- Connect an Ethernet crossover cable between the PC and the SmartController motion controller

  or

- Use two standard Ethernet cables with a network hub or switch in place of the Ethernet crossover cable.

NOTE: Do not use an Ethernet crossover cable with a network hub or switch.

For more details, refer to the *ACE User's Guide*.

4.6 Cable Connections from eMB-40R to SmartController

1. Locate the IEEE 1394 cable (length 4.5 M) and the XSYS or eAIB XSYS cable (length 4.5 M). They are shipped in the cable/accessories box.
2. Install one end of the IEEE 1394 cable into the SmartServo connector on the SmartController, and install the other end into a SmartServo connector on the eMB-40R interface panel, as shown in See "System Cable Diagram for Cobra 350 Robots".
3. Install the eAIB XSYS cable between the XSYS connector on the SmartController and the eMB-40R XSYSTEM connector, and tighten the latching screws.

   If you are upgrading from an MB-40R to an eMB-40R, you can use an eAIB XSLV adapter cable between your existing XSYS cable and the XSYSTEM connector on the new eMB-40R.

NOTE: The IEEE 1394 and XSYS/eAIB XSYS cables should be routed away from AC power and robot interconnect cables.

4.7 Cable Connections from eMB-40R to Robot

Installing the Arm Power/Signal Cable

The cable between the robot and the eMB-40R is called the Arm Power/Signal cable, as shown in See "System Cable Diagram for Cobra 350 Robots".

1. Connect one end of the Arm Power/Signal cable to the CN22 connector on the back plate of the robot. Tighten the thumb-screw securely.
2. Connect the other end of the cable to the large, circular connector on the eMB-40R. Tighten the screws securely.

WARNING: Verify that all connectors are fully inserted and screwed down. Failure to do this could cause unexpected robot motion. Also, a connector could get pulled out or dislodged unexpectedly.

4.8 Connecting 24 VDC Power to eMB-40R Servo Controller

Specifications for 24 VDC Power

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

Customer-Supplied Power Supply	24 VDC (± 10%), 150 W (6 A) (21.6 V < V_{in} < 26.4 V)
Circuit Protection[1]	Output must be less than 300 W peak **or** 8 Amp in-line fuse
Power Cabling	1.5 – 1.85 mm² (16-14 AWG)
Shield Termination	Cable shield connected to frame ground on power supply and ground point on eMB-40R, as shown in See "User-Supplied 24 VDC Cable ".
[1]User-supplied 24 VDC power supply must incorporate overload protection to limit peak power to less than 300 W, or 8 A in-line fuse protection must be added to the 24 V power source.	

The power requirements for the user-supplied power supply will vary depending on the configuration of the robot and connected devices. We recommend a 24 V, 6 A power supply to allow for startup current draw and load from connected user devices, such as digital I/O loads.

CAUTION: Make sure you select a 24 VDC power supply that meets the specifications in See "Specifications for 24 VDC User-Supplied Power Supply". Using an underrated supply can cause system problems and prevent your equipment from operating correctly. See the following table for a recommended power supply.

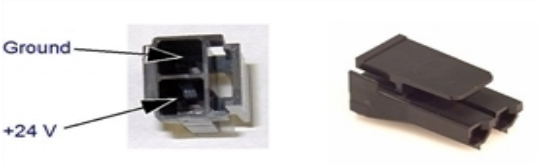
Table 4-3. Recommended 24 VDC Power Supply

Vendor Name	Model	Ratings	Mount
OMRON	S8JX-G15024C	24 VDC, 6.5 A, 150 W	Front Mount
OMRON	S8JX-G15024CD	24 VDC, 6.5 A, 150 W	DIN-Rail Mount

Details for 24 VDC Mating Connector

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

Table 4-4. 24 VDC Mating Connector Specs

Connector Details 	Connector receptacle, 2-position, type: Molex Saber, 18 A, 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 Crimper	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 See "Cables and Parts List".

Procedure for Creating 24 VDC Cable

1. Locate the connector and pins from See "24 VDC Mating Connector Specs".
2. Use shielded two-conductor cable with 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 eMB-40R base.

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

3. Crimp the pins onto the wires using the crimping tool recommended in See "24 VDC Mating Connector Specs".
4. Insert the pins into the connector. Confirm that the +24 V and Ground wires are in the correct terminals in the plug.
5. Install a user-supplied ring lug (for an M3 screw) on the shield at the eMB-40R end of the cable.
6. Prepare the opposite end of the cable for connection to the user-supplied 24 VDC power supply, including a terminal to attach the cable shield to frame ground.

Installing the 24 VDC Cable

Do not turn on the 24 VDC power until instructed to do so in the next chapter.

1. Connect one end of the shielded 24 VDC cable to your user-supplied 24 VDC power supply. See See "User-Supplied 24 VDC Cable ". The cable shield should be connected to frame ground on the power supply. Do not turn on the 24 VDC power until instructed to do so in System Operation on page 63.
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 eMB-40R. The cable shield should be connected to the ground point on the interface panel.

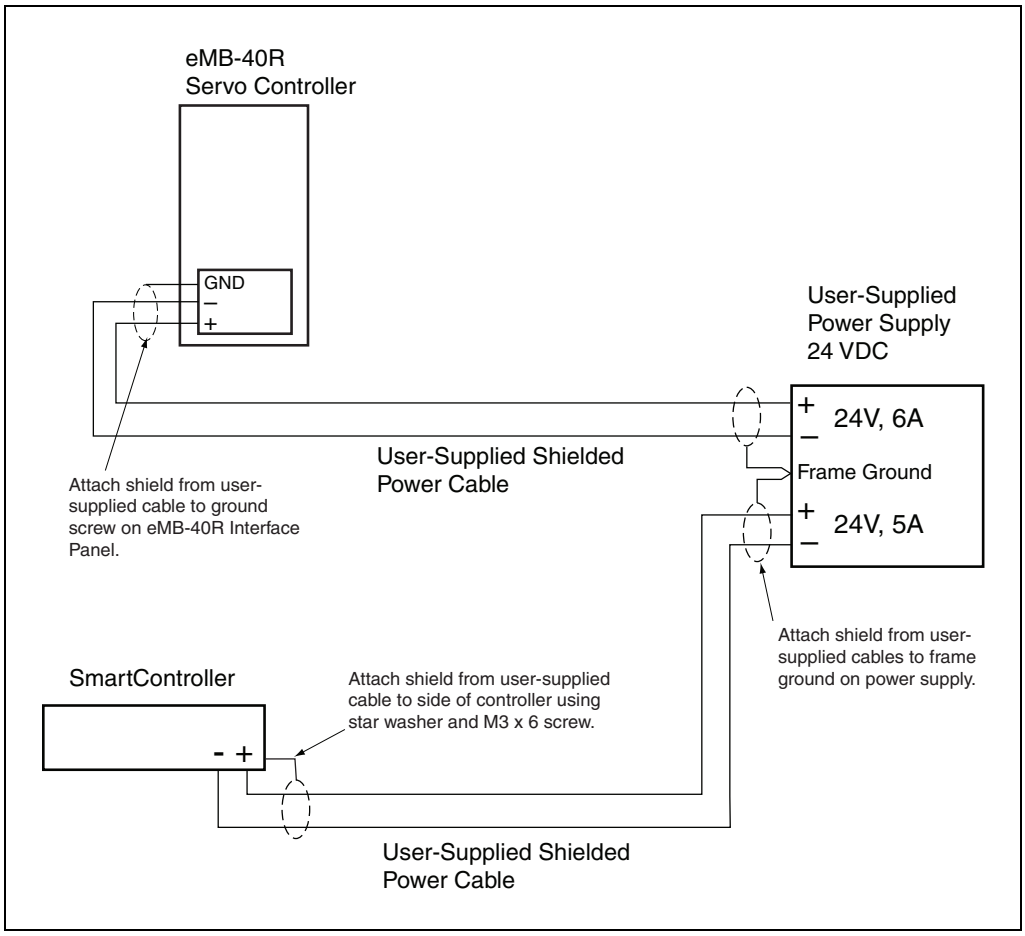


Figure 4-2. User-Supplied 24 VDC Cable

NOTE: We recommend that DC power be delivered over shielded cables, with the shield connected to frame ground at the power supply, and to the ground points shown in the diagram above for the eMB-40R and SmartController EX. The length of the wire from the cable shield to the ground points should be less than 50 mm.

4.9 Connecting 200-240 VAC Power to eMB-40R

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

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

Specifications for AC Power

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

Auto-Ranging Nominal Voltage Ranges	Minimum Operating Voltage[1]	Maximum Operating Voltage	Frequency/ Phasing	Recommended External Circuit Breaker, User-Supplied
200 V to 240 V	180 V	264 V	50/60 Hz, 1-phase	10 Amps
[1]Specifications are established at nominal line voltage. Low line voltage can affect robot performance.				

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

WARNING: Cobra 350 robot 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 the *Robot Safety Guide*. During installation, unauthorized third parties must be prevented from turning on power through the use of fail-safe lockout measures.

Failure to use appropriate power (less than or more than the rated voltage range of 200 - 240 VAC) can lead to malfunction or failures of the robot or hazardous situations.

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 over-voltage 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

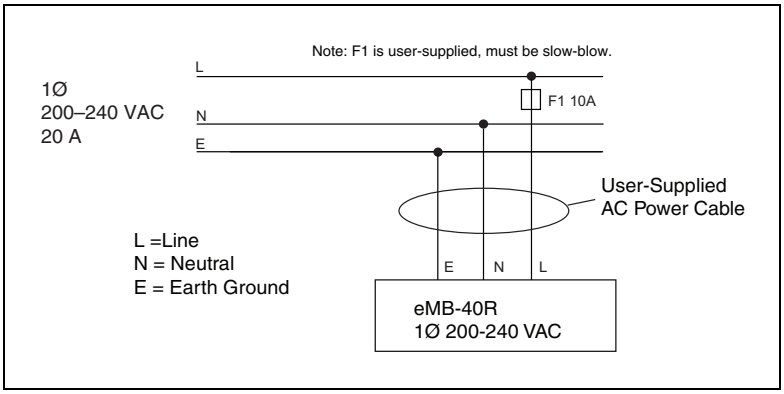


Figure 4-3. Typical AC Power Installation with Single-Phase Supply

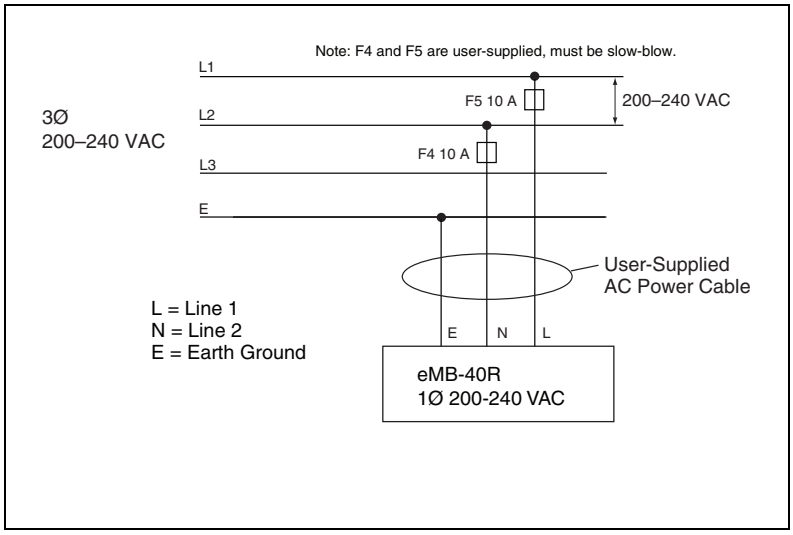


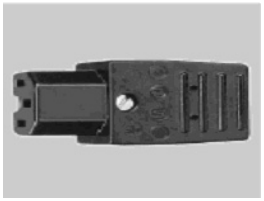
Figure 4-4. Single-Phase Load across L1 and L2 of a Three-Phase Supply

Details for AC Mating Connector

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

Table 4-6. AC Mating Connector Details

AC Connector details	AC in-line power plug, straight, female, screw terminal, 10 A, 250 VAC

	
	Qualtek P/N 709-00/00
	Digi-Key P/N Q217-ND

NOTE: The AC power cable is not supplied with the system, but is available in the optional Power Cable kit. See See "Cables and Parts List".

Procedure for Creating 200-240 VAC Cable

1. Locate the AC mating connector shown in See "AC Mating Connector Details".
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 See "AC Power Mating Connector" for details.
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 eMB-40R base.
5. Strip 18 to 24 mm of 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.

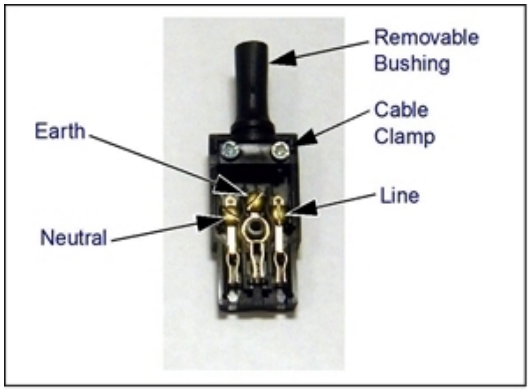


Figure 4-5. AC Power Mating Connector

Installing AC Power Cable to eMB-40R

1. Connect the unterminated end of the AC power cable to your facility AC power source. See See "Typical AC Power Installation with Single-Phase Supply" and See "Single-Phase Load across L1 and L2 of a Three-Phase Supply" for details. 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 eMB-40R.
3. Secure the AC connector with the locking latch.

4.10 Grounding the Robot System

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

NOTE: The resistance of the ground conductor must be ≤ 10 Ω.

Ground Point on Robot Base

The user can install a ground wire at the robot base to ground the robot. The ground point is shown in See "Ground Point on Robot Base". The user is responsible for supplying the ground wire to connect to earth ground.

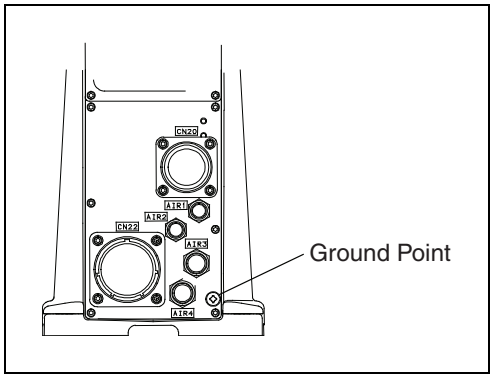


Figure 4-6. Ground Point on Robot Base

Ground Point on MotionBlox-40R

The user can install a ground wire at the eMB-40R chassis. Use the hole below the eMB-40R interface panel - see the following figure. The user should provide a ground wire and use the provided M3 screw and external tooth lock washer to connect to earth ground. Make sure to tighten the screw on the ground wire to create a proper ground connection. Two tapped holes are provided to attach optional user-supplied strain relief.

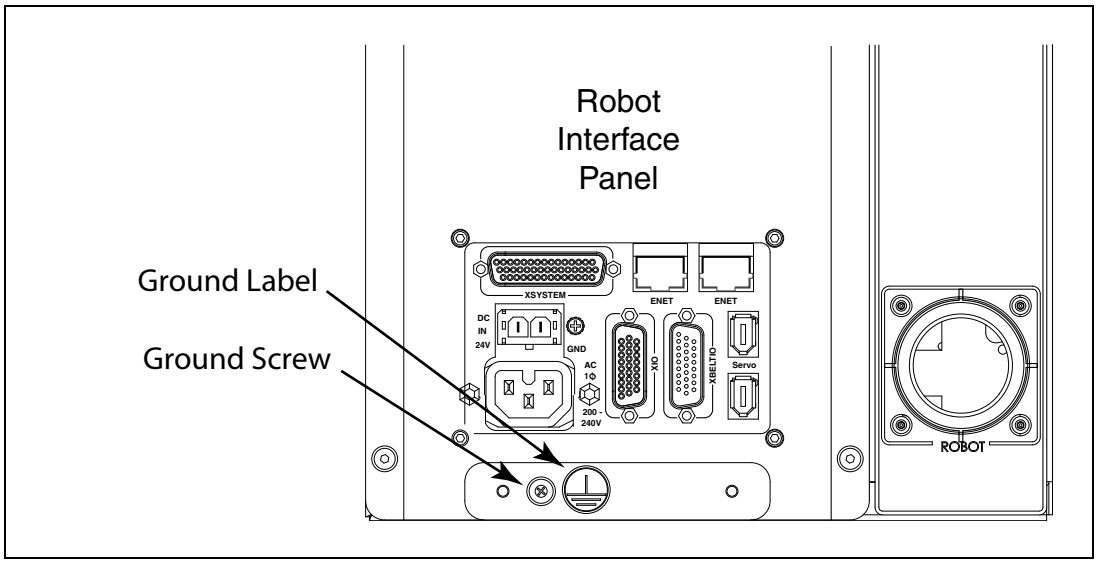


Figure 4-7. Earth Ground Location, MB-40R shown

Robot-Mounted Equipment Grounding

The Cobra 350 Joint 3 quill and tool flange are not reliably grounded to the robot base. 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.

Also, see See "Tool Flange Dimensions for Cobra 350 Robots" 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.

4.11 Installing User-Supplied Safety Equipment

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

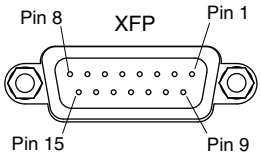
The user-supplied safety and power-control equipment connects to the system through the XUSR and XFP connectors on the eMB-40R XSYSTEM cable. The XUSR connector (25-pin) and XFP (15-pin) connector are both female D-sub connectors. Refer to the following table for the XUSR pin-out descriptions. See "Contacts Provided by the XFP Connector" for the XFP pin-out descriptions. See the figure System Cable Installation on page 23 for the XUSR wiring diagram.

Table 4-7. Contacts Provided by the XUSR Connector

Pin Pairs	Description	Comments
Voltage-Free Contacts Provided by Customer		
1, 14	User E-Stop CH 1 (mushroom push-button, safety gates, etc.)	N/C contacts, Shorted if NOT Used
2, 15	User E-Stop CH 2 (same as pins 1, 14)	N/C contacts, Shorted if NOT Used
3, 16	Line E-Stop (used for other robot or assembly line E-Stop inter-connection. Does not affect E-Stop indication (pins 7, 20))	N/C contacts, Shorted if NOT Used
4, 17	Line E-Stop (same as pins 3, 16)	N/C contacts, Shorted if NOT Used
5, 18	Muted safety gate CH 1 (causes E-Stop in Automatic mode only)	N/C contacts, Shorted if NOT Used
6, 19	Muted Safety Gate CH 2 (same as pins 5, 18)	N/C contacts, Shorted if NOT Used
Voltage-Free Contacts provided by Cobra 350		
7, 20	E-Stop indication CH 1	Contacts are closed when Front Panel, pendant, and customer E-Stops are *not* tripped
8, 21	E-Stop indication CH 2 (same as pins 7, 20)	Contacts are closed when Front Panel, pendant, and customer E-Stops are *not* tripped
9, 22	Manual/Automatic indication CH 1	Contacts are closed in Automatic mode
10, 23	Manual/Automatic indication CH 2	Contacts are closed in Automatic mode
11, 12, 13, 24, 25	No connection	

Table 4-8. Contacts Provided by the XFP Connector

Pin Pairs	Description	Requirements for User-Supplied Front Panel
Voltage-Free Contacts Provided by Customer		
1, 9	Front Panel E-Stop CH 1	User must supply N/C contacts
2, 10	Front Panel E-Stop CH 2	User must supply N/C contacts
3, 11	Remote Manual/Automatic switch CH 1.	Optional - jumper closed for

Pin Pairs	Description	Requirements for User-Supplied Front Panel
	Manual = Open Automatic = Closed	Auto Mode-only operation
4, 12	Remote Manual/Automatic switch CH 2. Manual = Open Automatic = Closed	Optional - jumper closed for Auto Mode-only operation
6, 14	Remote High Power on/off momentary push-button	User must supply momentary push-button to enable High Power to system
Non-voltage-Free Contacts		
5, 13	System-Supplied 5 VDC and GND for High Power On/Off Switch Lamp	User must supply lamp, or use 1 W, 47 ohm resistor - system will not operate if not present
7, 15[a]	Controller system 5 V power on LED, 5 V, 20 mA	Optional - indicator only
8	No connection	
		
See the figure System Cable Installation on page 23 for a schematic diagram of the Front Panel.		
[a]Users must exercise caution to avoid inadvertently connecting 24 V signals to these pins, because this will damage the electronics.		

NOTE: The system was evaluated by Underwriters Laboratory with a Front Panel. Using a substitute front panel could void UL compliance.

Table 4-9. Remote Pendant Connections on the XMCP Connector

Pin XMCP (15-Pin D-Sub)	Description
1, 9	Pendant E-Stop Push-button CH 1
2, 10	Pendant E-Stop Push-button CH 2
3, 11	Pendant Enable CH 1 (Hold-to-run)
4, 12	Pendant Enable CH 2 (Hold-to-run)
13	Serial GND/Logic GND
7	Pendant TXD: “eV+ to Pendant TXD”
8	Pendant RXD: “eV+ to Pendant RXD”

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

The following figure shows an E-Stop diagram for the system. See System Cable Installation on page 23 for a description of the functionality of this circuit.

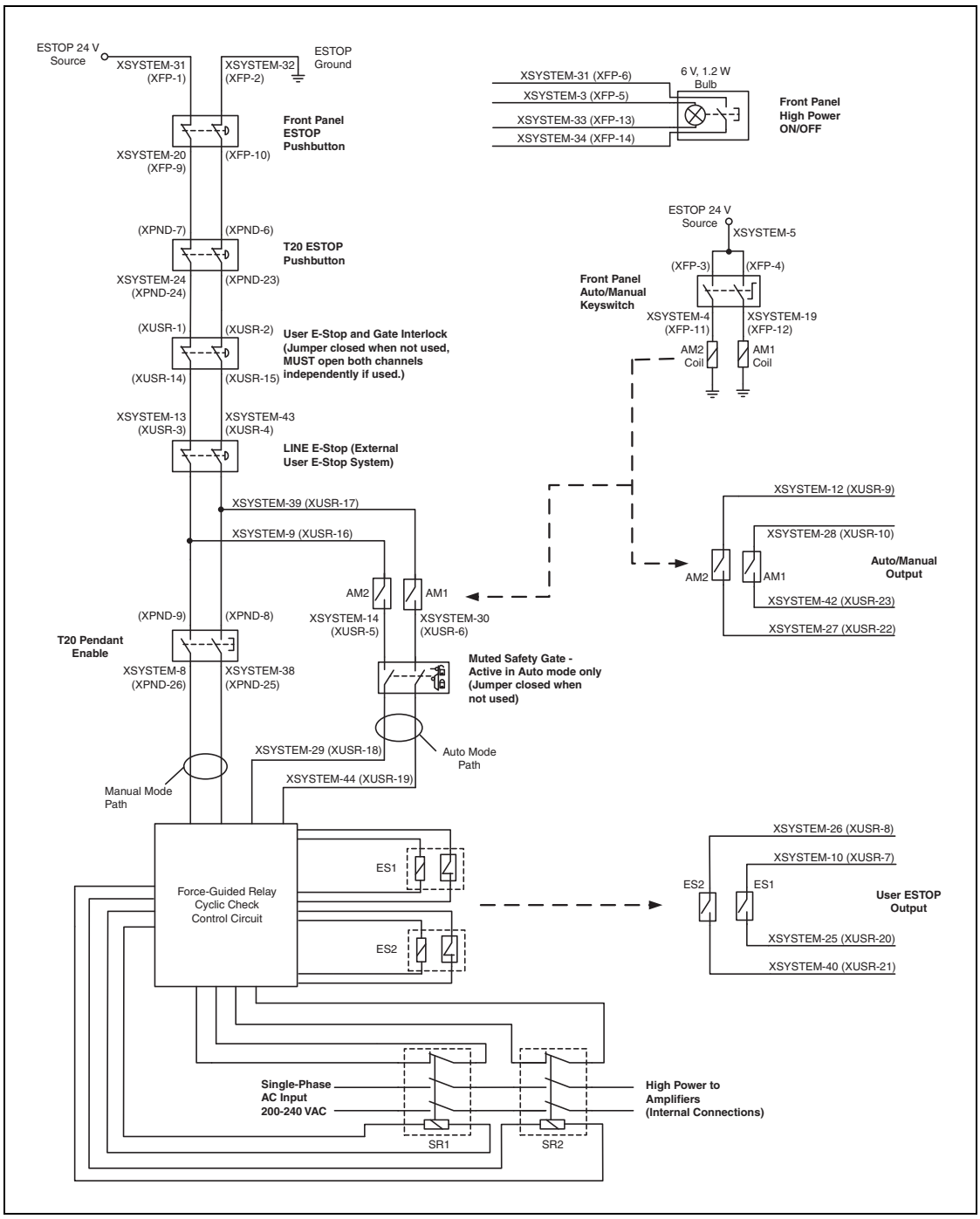


Figure 4-8. E-Stop Circuit on XUSR and XFP Connectors

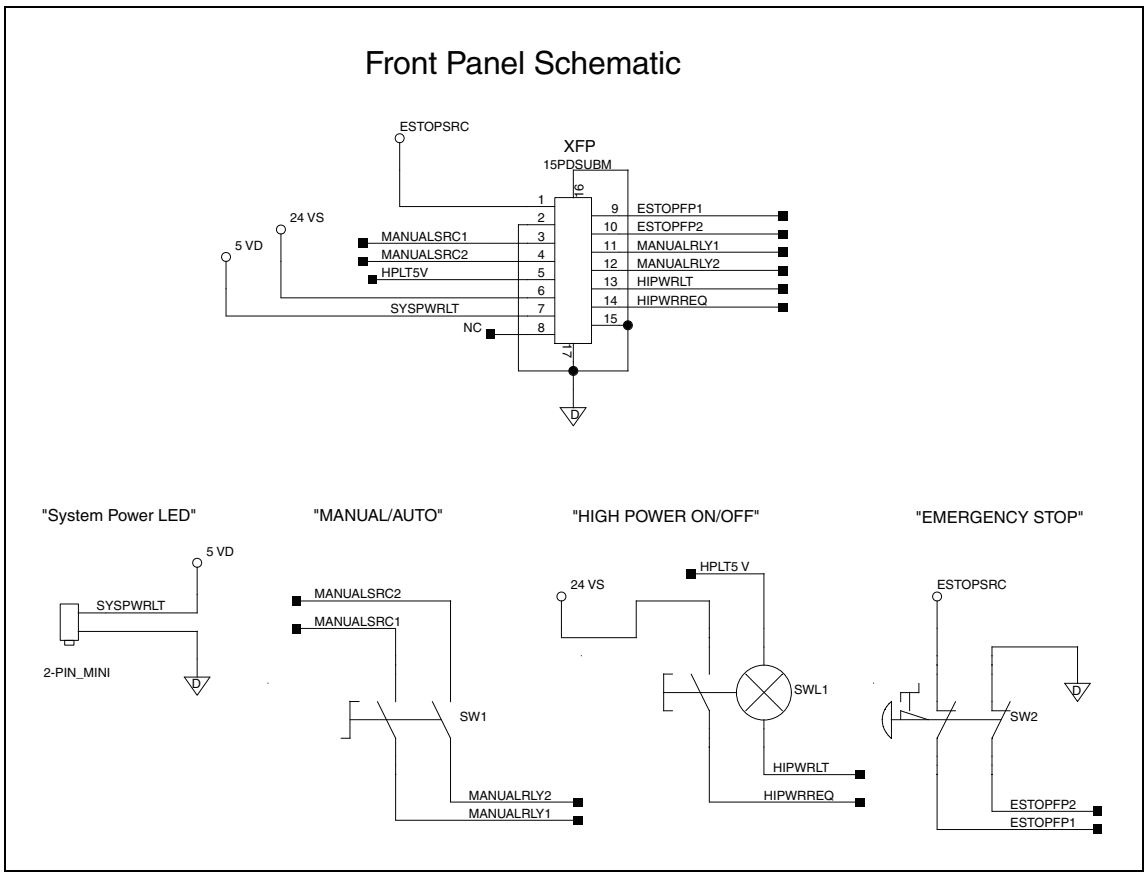


Figure 4-9. Front Panel Schematic

Emergency Stop Circuits

The eMB-40R XSYSTEM cable provides connections for Emergency Stop (E-Stop) circuits on the XUSR and XFP connectors. This gives the controller system the ability to duplicate E-Stop functionality from a remote location using voltage-free contacts. See Figure 4-8.

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

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

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

These contacts provide a method to indicate the status of the ESTOP chain, inclusive of the Front Panel Emergency Stop push-button, the pendant Emergency Stop push-button, and the User Emergency Stop Contacts.

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

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

These voltage-free contacts are provided by a redundant, cyclically-checked, positive-drive, safety relay circuit for Category 3 PL-d per ISO 13849 operation (see Table 4-7. and the table Contacts Provided by the XFP Connector on page 35 for the customer E-Stop circuitry).

Line E-Stop Input

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

The Line E-Stop input comes into the circuit at a point where it cannot affect the customer E-Stop indication relays and will not cause such a lock-up situation. For any situation where two systems should be cross-coupled, for example, the customer E-Stop indication of one controller is to be connected to the input of another controller, the Line E-Stop input is the point to bring in the other controller's output contacts. See the figure E-Stop Circuit on XUSR and XFP Connectors on page 38 for more information.

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

Muted Safety Gate E-Stop Circuitry

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

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

WARNING: Whenever possible, manual mode operations should be performed with all personnel outside the workspace.

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

Remote Manual Mode

The Front Panel provides for a Manual Mode circuit. See Remote High Power On/Off Control on page 41 for further details about the customer Remote Manual Mode circuitry.

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

If the user needs to control the Manual/Automatic mode selection from other control equipment, then a custom splitter cable or complete replacement of the Front Panel may be required. See Front Panel Schematic on page 39. In this situation, a pair of contacts should be wired *in series* with the Front Panel Manual/Automatic mode contacts. Thus, both the Front Panel and the customer contacts need to be closed to allow Automatic mode.

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

User Manual/Auto Indication

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

WARNING: Any safeguards that were suspended shall be returned to full functionality prior to selecting Automatic Mode.

User High Power On Indication

In the optional SmartController EX, eV+ controls a normally-open relay contact on the XDIO connector (pins 45, 46, see the table System Cable Installation on page 23), that will close when high power has been enabled. The user can use this feature to power an indicator lamp or other device, that signals High Power is On. The limit on these contacts is 1 A at 30 VDC or 30 VAC.

Remote High Power On/Off Control

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

However, if the user needs to control high power on/off from other control equipment or from a location other than the Front Panel, then a custom splitter cable will be required. See the Front Panel schematic (Front Panel Schematic on page 39) for details of the Front Panel's wiring. In this situation, a second momentary contact for high power on/off would be placed *in parallel with* the Front Panel push-button contact. This second contact should be suppressed when in Manual mode (see the note on "Single Point of Control" below).

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

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

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

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

High Power On/Off Lamp

The Front Panel High Power On/Off Lamp (p/n: 27400-29006) will cause an error, from eeV+, if the lamp burns out. This error prevents High Power from being turned on. This safety feature prevents a user from not realizing that High Power is enabled because the High Power indicator is burned out. See Changing the Lamp in the Front Panel High-Power Indicator on page 94 for information on changing this lamp.

Remote Front Panel or User-Supplied Control Panel Usage

Users can mount the Front Panel remotely by using an extension cable or by wiring a user-supplied Front Panel (control panel) to the controller using the 15-pin XFP connector. The Front Panel contains no active components, only switches and lights. Customers should be able to adapt the Front Panel's functionality into their own Front Panel design. To automatically control the Front Panel's signals, use relay contacts instead of switches. See the figure Front Panel Schematic on page 39 for a schematic drawing of the Front Panel, and see the table Contacts Provided by the XFP Connector on page 35 for a summary of connections and pin numbers.

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

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

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

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

Remote Pendant Usage

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

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

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

Chapter 5: MotionBlox-40R

5.1 Introduction

The MotionBlox-40R (eMB-40R) is a distributed servo controller and amplifier. It has a dedicated digital signal processor to communicate, coordinate, and execute servo commands.

The eMB-40R consists of:

- a distributed servo amplifier
- a RISC processor for servo loop control
- a node on the IEEE 1394 network
- a power controller that uses single-phase AC power, 200-240 Volts
- a status panel with a 2-digit alpha-numeric display to indicate operating status and fault codes

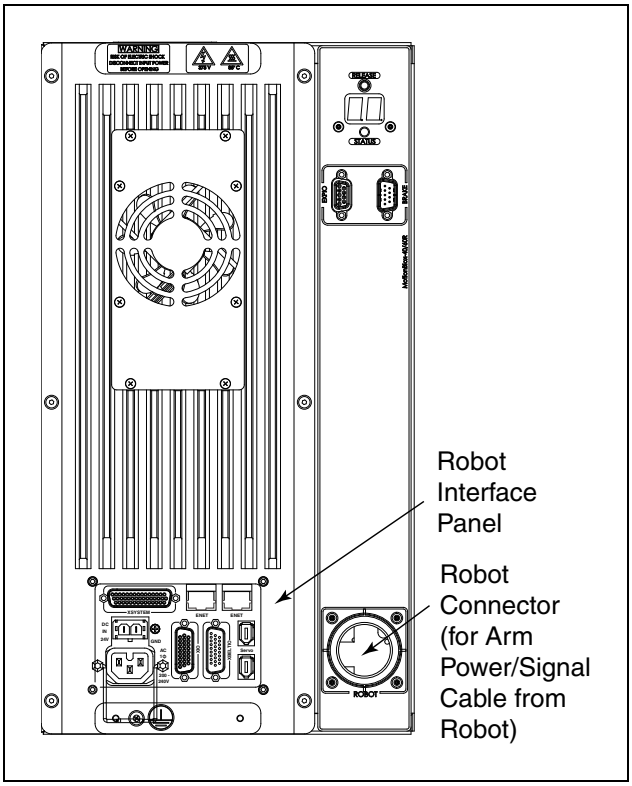


Figure 5-1. eMB-40R Front View

5.2 Description of Connectors on eMB-40R Interface Panel

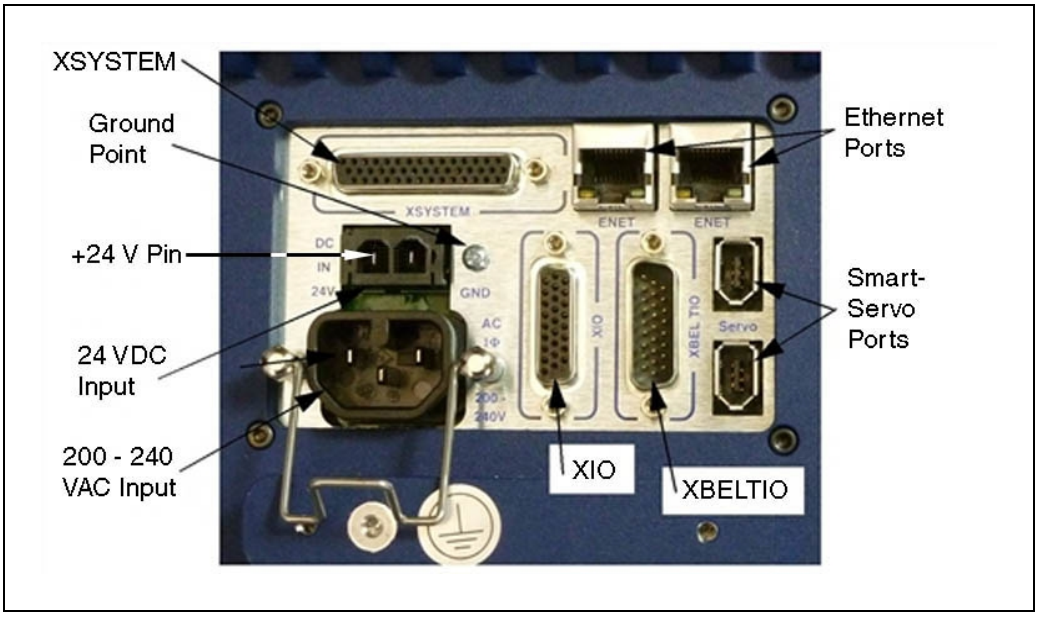


Figure 5-2. eMB-40R Interface Panel

See the following table for descriptions of the connectors shown in the previous figures.

Table 5-1. Connectors on the eMB-40R Interface Panels

24 VDC	For connecting user-supplied 24 VDC power. The mating connector is provided.
Ground Point	For connecting cable shield from user-supplied 24 VDC cable.
200/240 VAC	For connecting 200-240 VAC, single-phase, input power. The mating connector is provided.
SmartServo	For connecting the IEEE 1394 cable from the controller to a SmartServo/Servo on the eMB-40R.
XIO	For user I/O signals for peripheral devices. This connector provides 8 outputs and 12 inputs. See Connecting Digital I/O to the System on page 50 for connector pin allocations for inputs and outputs. That section also contains details on how to access these I/O signals. (DB-26, high density, female)
XSYSTEM	Includes the functions of the XPANEL and XSLV on the legacy MB-60R. Connects to the controller XSYS connector. This requires either an eAIB XSLV Adapter cable to connect to the XSYS cable, or an eAIB XSYS cable (HDB44-to-DB9, male), which replaces the XSYS cable.
ENET	Reserved for future use.
XBELTIO	Adds two belt encoders, EXPIO at the back of the robot, and an RS-232 interface, which is reserved for future use.

5.3 eMB-40R Operation

Status LED on eMB-40R

The Status LED indicator is located on the top of the eMB-40R. See the following figure. This is a bi-color, red and green LED. The color and blinking pattern indicates the status of the robot. See the following table.

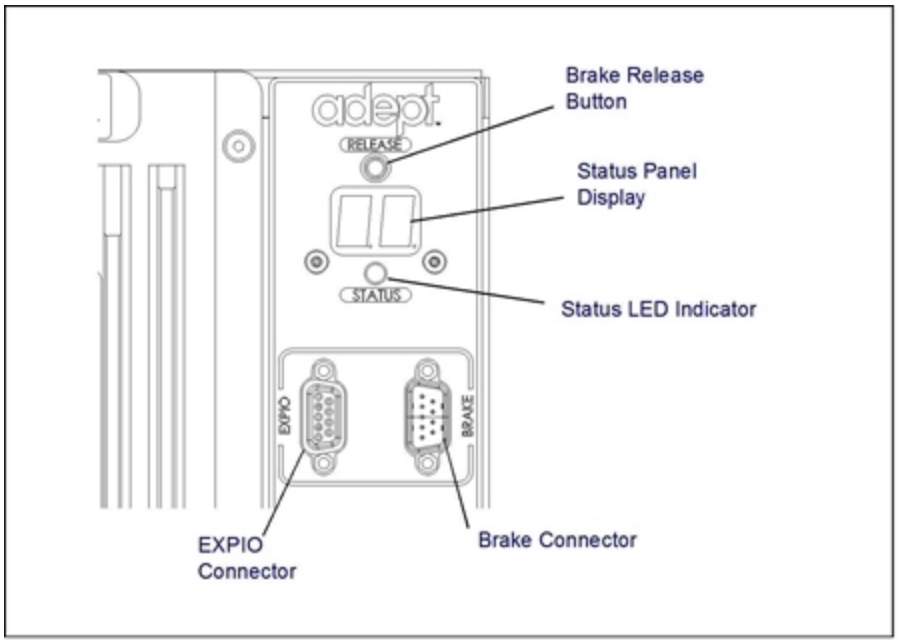


Figure 5-3. Controls and Indicators on eMB-40R

Table 5-2. 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 Status Panel Display
Solid Green or Red	Initialization or Robot Fault

Status Panel

The status panel, shown in See "Controls and Indicators on eMB-40R ", displays alpha-numeric codes that indicate the operating status of the eMB-40R. The following table gives definitions of the fault codes. These codes provide details for quickly isolating problems during troubleshooting.

Table 5-3. Status Panel Codes

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

NOTE: Due to the nature of the Cobra 350 bus line encoder wiring, a single encoder wiring error may result in multiple channels of displayed encoder errors. Reference the lowest encoder number displayed.

Brake Release Button on eMB-40R

The Brake Release button is located at the top right of the eMB-40R, as shown in See "Controls and Indicators on eMB-40R ". Under some circumstances you may want to manually position Joints 3 and 4 without turning on high power. You can use the Brake Release button for this purpose.

When 24 V power is enabled, pressing this button releases the brake, which allows movement of Joints 3 and 4. An additional Brake Release button is provided on the robot. For details, see Brake Release Button on page 63.

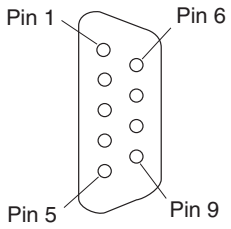
NOTE: If this button is pressed while high power is on, high power will automatically shut down.

Brake Release Connector

The 9-pin Brake Release connector provides low-active input signals to manually release the brakes on Joint 3 and Joint 4. This can be used as an alternative to the Brake Release button.

The digital inputs on this connector meet the same input level requirements as the XIO inputs. See See "XIO Input Specifications" for details.

Table 5-4. Brake Release Connector Pinouts

Pin #	Description	Pin Location
1	Not connected	 DB-9 Female Brake Connector
2	Not connected	
3	Release3_N	
4	Not connected	
5	Not connected	
6	Not connected	
7	GND	
8	Not connected	
9	24V	
Mating Connector: D-Subminiature 9-Pin Male		

5.4 Connecting Digital I/O to the System

You can connect digital I/O to the system in several different ways. See the following table and figure.

Table 5-5. Digital I/O Connection Options

Product	I/O Capacity	For more details
XIO Connector on eMB-40R	12 inputs 8 outputs	Using Digital I/O on eMB-40R XIO Connector on page 52
XDIO Connector on SmartController	12 inputs 8 outputs	*SmartController EX User's Guide*
Optional sDIO Module, connects to controller	32 inputs, 32 outputs per module; up to four sDIO devices per system	
Optional IO Blox Devices, connect to EXPIO connector on the eMB-40R	8 inputs, 8 outputs per device; up to four IO Blox devices per system	*IO Blox User's Guide*

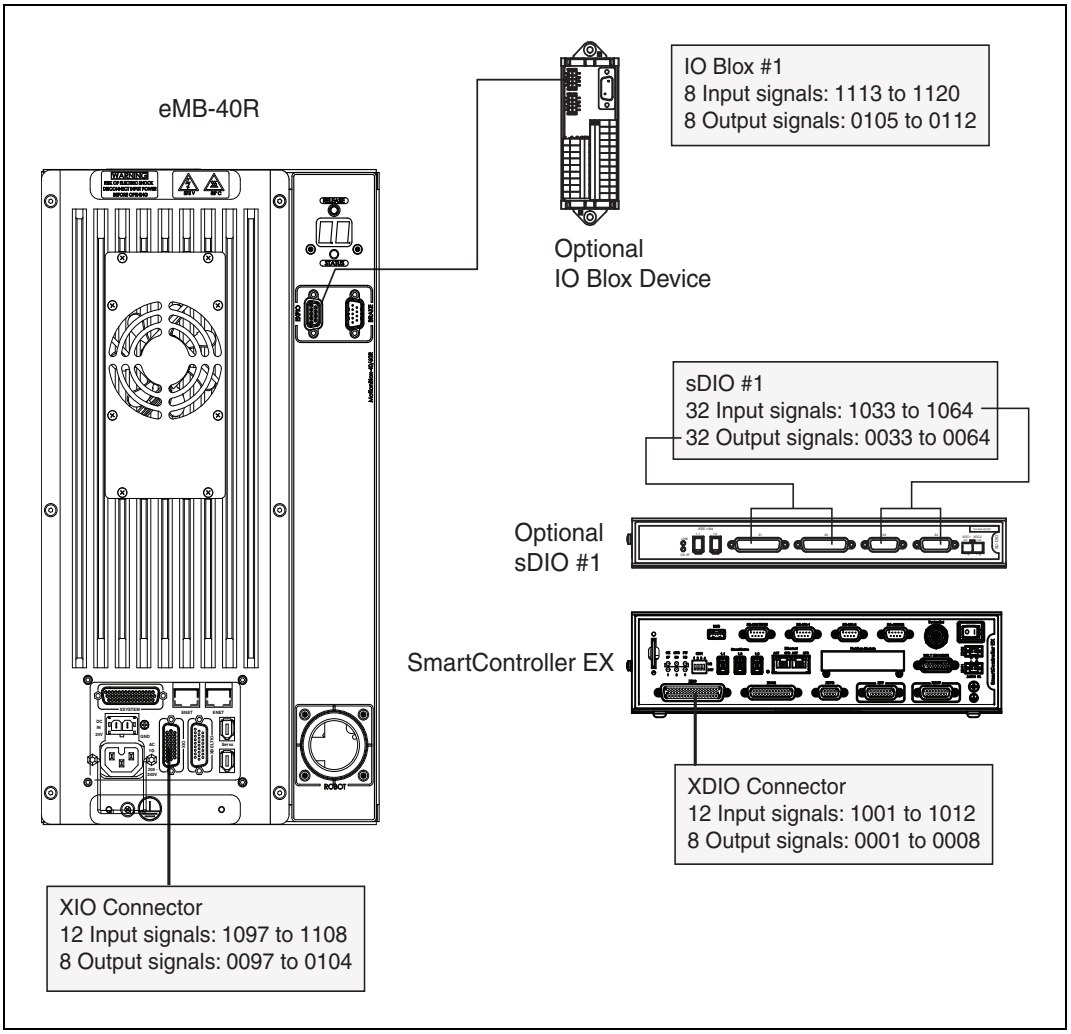


Figure 5-4. Connecting Digital I/O to the System

Table 5-6. Default Digital I/O Signal Configuration, Single Robot System

Location	Type	Signal Range
SmartController 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

Location	Type	Signal Range
eMB-40R 1 XIO connector	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

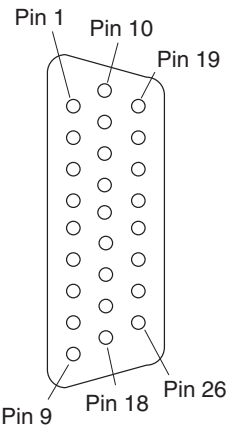
5.5 Using Digital I/O on eMB-40R XIO Connector

The XIO connector on the eMB-40R interface panel offers access to digital I/O, 12 inputs and 8 outputs. These signals can be used by eV+ to perform various functions in the workcell. See the following table for the XIO signal designations.

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

Table 5-7. XIO Signal Designations

Pin No.	Designation	Signal Bank	eV+ Signal Number	Pin Locations
1	GND			
2	24 VDC			
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	24 VDC			
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 eMB-40R 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 XIO Breakout Cable on page 57). It 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 *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 eMB-40R 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 the following table), 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. Refer to the eV+ user guides.

XIO Input Specifications

Table 5-8. XIO Input Specifications

Parameter	Value
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 6 mA
Typical threshold current	2.0 mA
Impedance (V_{in}/I_{in})	3.9 K Ω minimum
Current at V_{in} = +24 VDC	$I_{in} \leq$ 6 mA
Turn on response time (hardware) Software scan rate/response time	5 µsec maximum 16 ms scan cycle/ 32 ms max response time
Turn off response time (hardware) Software scan rate/response time	5 µsec maximum 16 ms scan cycle/ 32 ms max response time

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

Typical Input Wiring Example

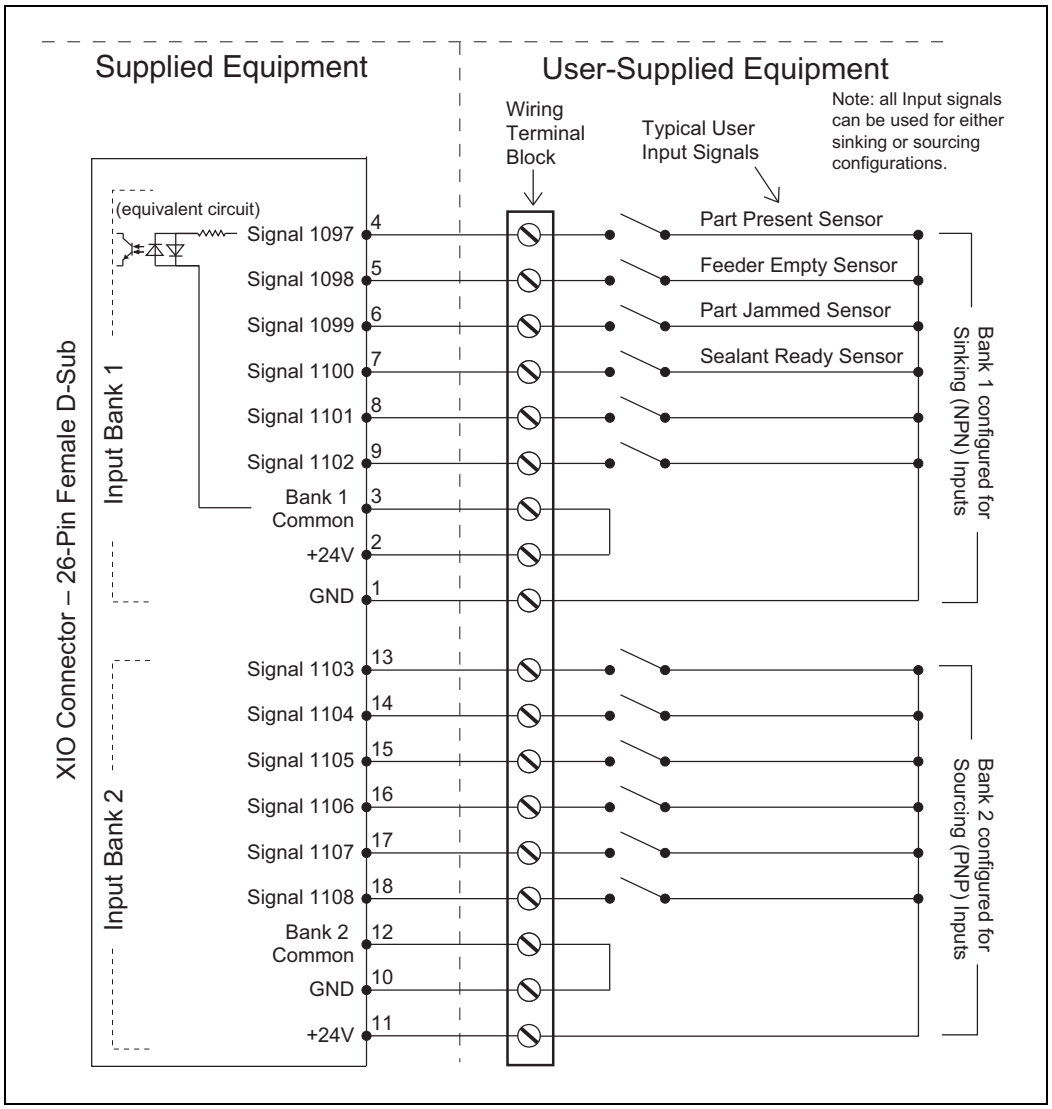


Figure 5-5. Typical User Wiring for XIO Input Signals

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

XIO Output Signals

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

The outputs are accessed through direct connection to the XIO connector (see See "XIO Signal Designations"), or through the optional XIO Termination Block. See the documentation supplied with the Termination Block for details.

XIO Output Specifications

Table 5-9. XIO Output Circuit Specifications

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

Typical Output Wiring Example

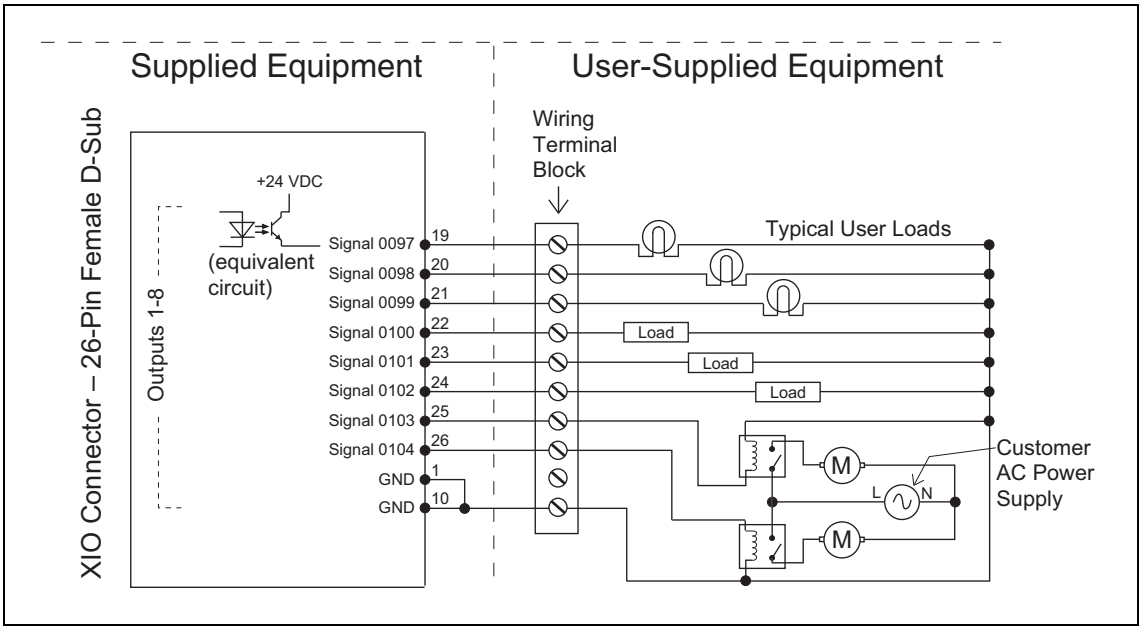


Figure 5-6. Typical User Wiring for XIO Output Signals

XIO Breakout Cable

The XIO Breakout cable is available as an option—see the following figure. This cable connects to the XIO connector on the eMB-40R, and provides flying leads on the user's end, for connecting input and output signals in the workcell. The cable length is 5 M (16.4 ft).

See the following table for the cable wire chart.

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

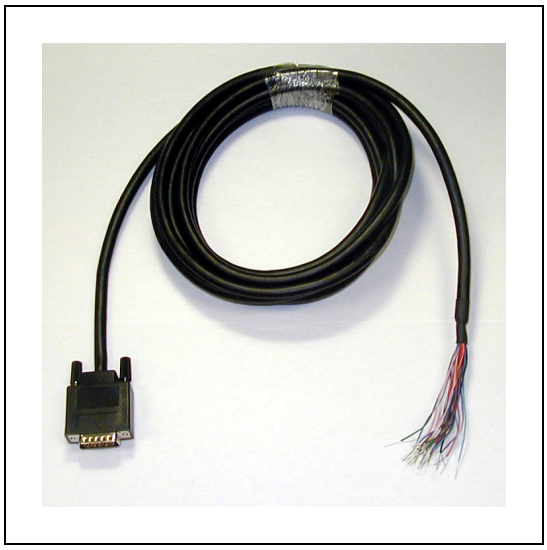
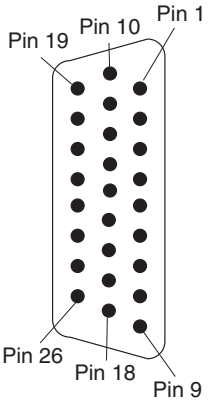


Figure 5-7. Optional XIO Breakout Cable

Table 5-10. XIO Breakout Cable Wire Chart

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

5.6 eMB-40R Dimensions

See the following figure for dimensions of eMB-40R chassis and mounting holes.

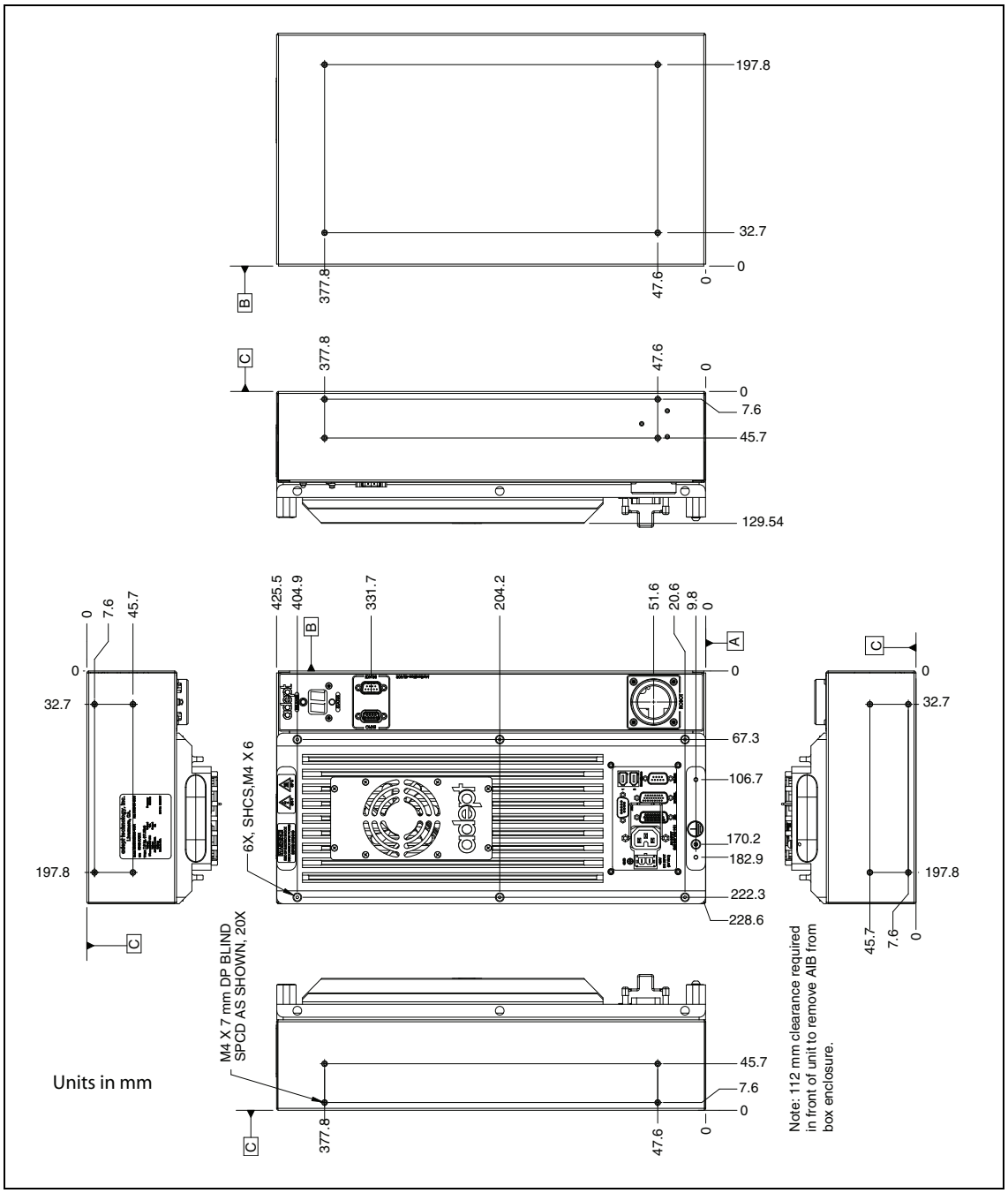


Figure 5-8. eMB-40R Mounting Dimensions

5.7 Mounting the eMB-40R

The eMB-40R can be panel-mounted.

NOTE: The mounting of the eMB-40R and all terminations at the eMB-40R must be performed in accordance with all local and national standards.

Panel-Mounting the eMB-40R

To panel-mount the eMB-40R, install two brackets on each side at the rear of the unit (see the following figure for the bracket dimensions). Use the screws from the accessories kit.

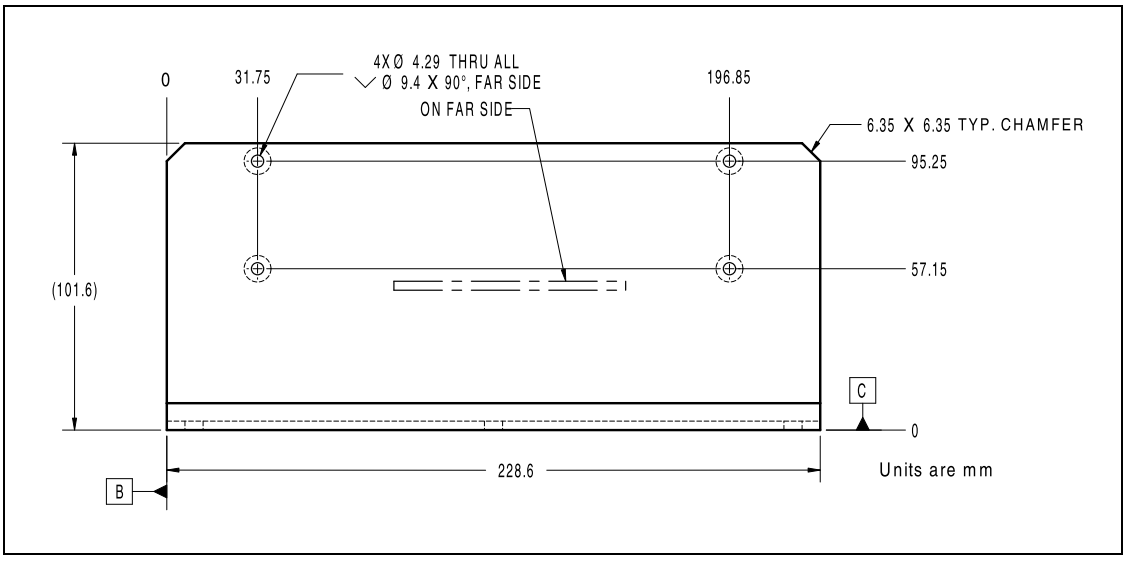


Figure 5-9. Panel-Mounting the eMB-40R

Chapter 6: System Operation

6.1 Status Panel Codes

The status panel display on the eMB-40R displays alpha-numeric codes that indicate the operating status of the robot, including detailed fault codes. The chapter on MotionBlox-40R gives definitions of the fault codes. These codes provide details for quickly isolating problems during troubleshooting. For more details, see MotionBlox-40R on page 45.

6.2 Brakes

The robot has a braking system that decelerates the robot in an emergency condition, such as when the emergency stop circuit is open or a robot joint passes its softstop.

The braking system will not prevent you from moving the robot manually once the robot has stopped (and High Power has been removed).

In addition, Joints 3 and 4 have electromechanical brakes. The brakes are released when high power is enabled. When High Power is turned off, the brakes engage and hold the positions of Joints 3 and 4. There is a Brake Release button for Joints 3 and 4 on the eMB-40R and a Brake Release button on the robot itself. See Brake Release Button on eMB-40R on page 49 for information on the Brake Release button on the eMB-40R.

Brake Release Button

Under some circumstances you may want to manually position Joint 3 or Joint 4. For such instances, a Brake Release button is provided. When system power is on, pressing this button releases the brake, which allows movement of Joint 3 and Joint 4.

> **NOTE:** 24 Volt robot power must be ON to release the brakes.

If this button is pressed while high power is on, high power will automatically shut down.

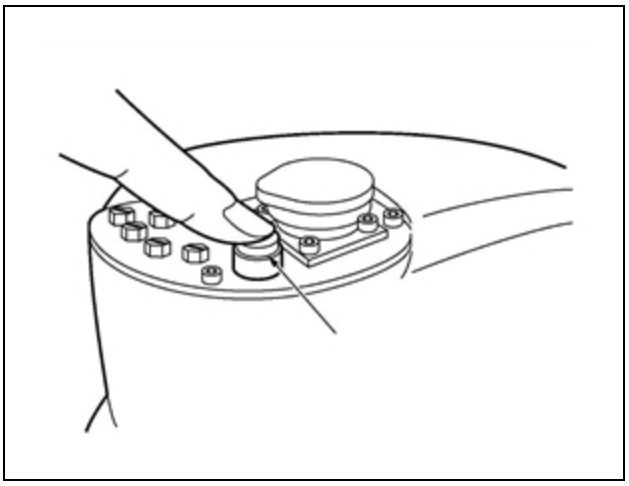


Figure 6-1. Brake Release Button for Third and Fourth Axes

CAUTION: 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.

6.3 Front Panel

NOTE: The factory-supplied Front Panel E-Stop is designed in accordance with the requirements of IEC 60204-1 and ISO 13849.

WARNING: Any user-supplied front panel E-Stop must be designed in accordance with the requirements of IEC 60204-1 and ISO 13849. The push button of the E-Stop must comply with ISO 13850 (Clause 5.5.2).

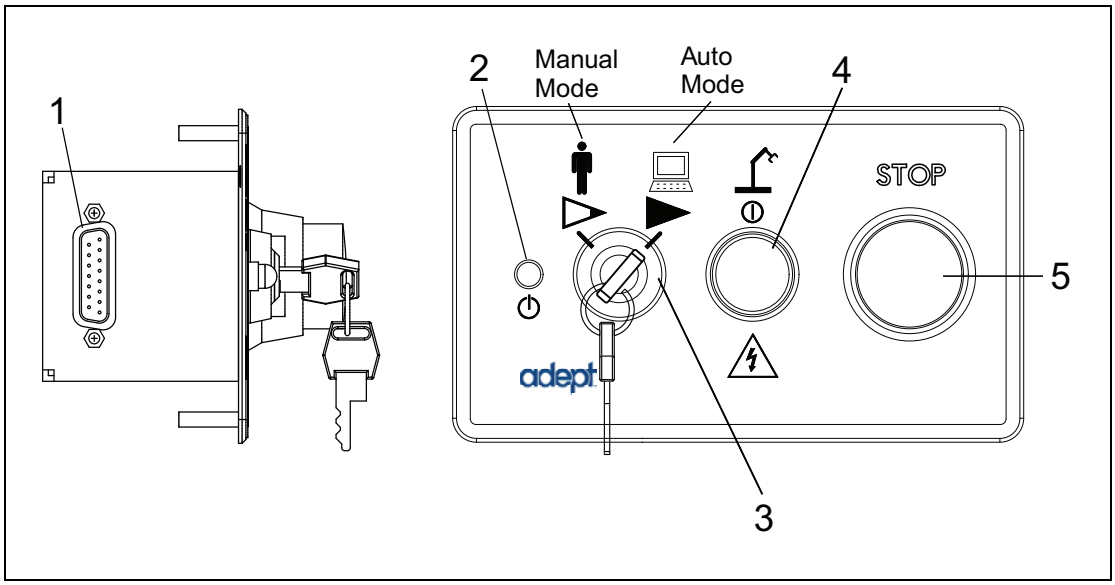


Figure 6-2. Front Panel

1. **XFP connector**
   Connects to the XFP connector on the eAIB XSYSTEM cable (or the optional SmartController EX, if one is being used).

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

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

   There is no high speed mode in manual mode.

   WARNING: If an operator is going to be in the work cell in manual mode, it is strongly recommended that the operator carry an enabling device. The Enable button on the manual control pendant is such a device.

4. **High Power On/Off Switch and Lamp**
   Controls high power, which is the flow of current to the robot motors. Enabling high power is a two-step process. An "Enable Power" request must be sent from the user-supplied PC, an executing program, or the optional pendant. Once this request has been made and the High Power On/Off lamp/button is blinking, the operator must press and release this button, and high power will be enabled.

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

WARNING: Disabling the High Power button violates IEC 60204-1. It is strongly recommended that you not alter the use of the High Power button.

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

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

NOTE: The Front Panel must be installed to be able to Enable Power to the robot. To operate without a Front Panel, the user must supply the equivalent circuits.

6.4 Initial Power-up of the System

The first time you power-up the system, you must follow the steps in this section to safely bring up your robot system. The tasks include:

- Verifying installation, to confirm all tasks have been performed correctly
- Starting up the system by turning on power for the first time
- Verifying all E-Stops in the system function correctly
- Moving each axis of the robot (with the pendant or ACE software Jog Control) to confirm each 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 tightened
- Verify that any end-of-arm tooling is properly installed
- Verify that all other peripheral equipment is properly installed, such that it is safe to turn on power to the robot system

System Cable Checks

Verify the following connections:

- Front Panel to the SmartController
- Optional pendant to the SmartController
- User-supplied 24 VDC power to the controller
- User-supplied ground wire between the SmartController and ground
- IEEE 1394 cable between the SmartServo connector on the SmartController and the SmartServo connector on the eMB-40R.
- eAIB XSYS cable between the XSYS connector on the SmartController and the eMB-40R XSYSTEM safety interlock connector, and latching screws are tight.

  or

  XSYS cable into an eAIB XSLV Adapter, into the eMB-40R XSYSTEM connector.
- User-supplied 24 VDC power to the eMB-40R 24 VDC connector
- User-supplied 200/240 VAC power to the eMB-40R 200/240 VAC connector

User-Supplied Safety Equipment Checks

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

System Start-up Procedure

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

1. Switch on AC power to the eMB-40R.

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

2. Switch on the 24 VDC power to the eMB-40R.
3. Switch on the 24 VDC power to the controller.

   The Status Panel displays OK. The Status LED will be off.
4. Verify the Auto/Manual switch on the Front Panel is set to Auto Mode.
5. Follow the instructions, beginning with Starting the ACE Software, in the following section.

Running the ACE Software

Starting the ACE Software

The robot should be on, and the status panel should display OK before proceeding.

1. Turn on the user-supplied PC and start ACE.
   - Double-click the ACE icon on your Windows desktop,

   or

- From the Windows Start menu bar, select:

  Start > Programs > Omron > ACE x.y.

  where x is the ACE major version, and y is the ACE minor version. For example, for ACE 3.6, it would be:

  Start > Programs > Omron > ACE 3.6

2. On the ACE Getting Started screen, do one of the following:
   - Select New SmartController Workspace.
   - Select Create New Workspace for Selected Controller to make the connection to the controller.
   - Select the IP address of the controller you wish to connect to, or manually type in the IP address.
3. Click OK. You will see the message “Working, please wait”.

Enabling High Power

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

Using ACE to Enable High Power

1. From the ACE main menu, click the Enable High Power icon  .
2. Press and release the blinking High Power button on the Front Panel within 10 seconds.

   The Front Panel is shown in See "Front Panel". (If the button stops blinking, you must Enable Power again.)

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

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

- The eMB-40R Status LED displays a fast green blink.
- The code on the eMB-40R displays ON (see Controls and Indicators on eMB-40R on page 48).

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 for each.

Verify Robot Motions

Use the pendant (if purchased) to verify that the robot moves correctly. Refer to the *T20 Pendant User's Guide* for complete instructions on using the pendant.

If the optional pendant is not installed in the system, you can move the robot using the Robot Jog Control in the ACE software. For details, see the *ACE User's Guide*.

6.5 Learning to Program the Cobra 350 Robot

To learn how to use and program the robot, see the *ACE User's Guide*, which provides information on robot configuration, control and programming through the ACE software "point and click" user interface.

For eV+ programming information, refer to the eV+ user and reference guides.

Chapter 7: Optional Equipment Installation

7.1 Installing End-Effectors

The user is responsible for providing and installing any end-effector or other end-of-arm tooling. End-effectors can be attached to the tool flange using four M6 screws. See See "Tool Flange Dimensions for Cobra 350 Robots" for a detailed dimension drawing of the tool flange.

A 6 mm diameter x 12 mm dowel pin (user-supplied) fits in the through-hole in the tool flange and can be used as a keying or anti-rotation device in a user-designed end-effector.

If hazardous voltages are present at the end-effector, you must install a ground connection from the base of the robot or the outer link to the end-effector. See Grounding the Robot System on page 33.

> **NOTE:** A threaded hole is provided on the tool flange. The user may attach a ground wire through the quill, connecting the outer link and the tool flange.

7.2 Removing and Reinstalling the Tool Flange

The tool 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. The setscrew contacts a flat section of the quill 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 hex driver to loosen the setscrew (see See "Tool Flange Removal Details").
4. Loosen the two M4 socket-head cap screws.
5. Slide the flange down slowly until it is off the shaft.

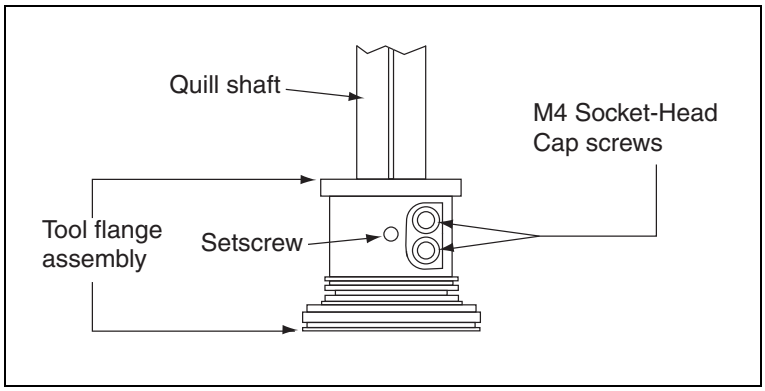


Figure 7-1. Tool Flange Removal Details

Reinstalling the Flange

1. Slide the flange up on the quill shaft as far as it will go, and rotate it until the setscrew is lined up with the flat section on the quill shaft.

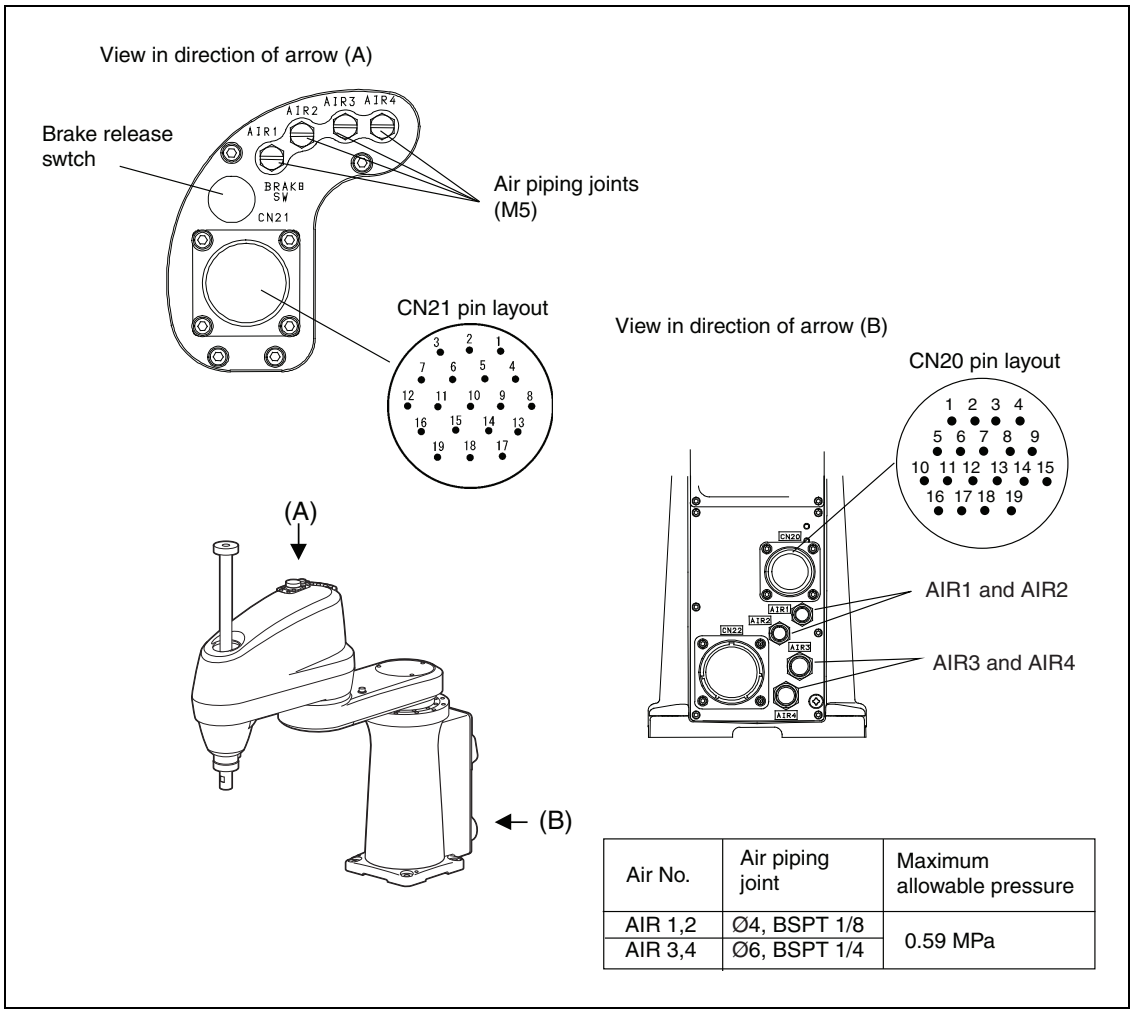
CAUTION: The setscrew must align with the flat section of the shaft or damage to the quill will result.

2. Support the flange while using a 2.5 mm hex driver to tighten the setscrew to finger tightness. Do not over-tighten the setscrew because this will cause the flange to be off-center from the quill shaft.
3. Tighten one of the M4 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 when they are tight. The torque specification for each screw is 8 N·m (70 in-lb).

7.3 User Connections on Robot

User Air Lines

There are four user air line connectors on the robot user panel on the back of the robot (see See "User Air and Electrical Connectors on Robot"). The four air lines run through the robot up to another set of four matching connectors on the top of the outer link. The maximum pressure for the air source is 0.59 MPa (86 psi). The Cobra 350 is *not* equipped with solenoid valves.



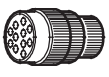
Air No.	Air piping joint	Maximum allowable pressure
AIR 1,2	Ø4, BSPT 1/8	0.59 MPa
AIR 3,4	Ø6, BSPT 1/4	

Figure 7-2. User Air and Electrical Connectors on Robot

User Electrical Lines

There are 19 user electrical lines that run from CN20 at the back of the robot, up to CN21 on the top of Joint 2, as shown in the previous figure. Maximum current per line is 1 Amp. Use the supplied mating connector sets, shown in the following table, for CN20 and CN21.

Table 7-1. Mating Connectors for CN20 and CN21

Connector No.	Model and part name	Appearance
for CN20	SRCN6A25-24S (round type connector) Japan Aviation Electronics Industry Ltd.	
for CN21	JMLP2119M (L type plug connector) DDK Electronics, Inc.	

Optional Solenoid Cable

An optional 4-meter solenoid cable is available that connects between the XDIO connector on the SmartController and the CN20 connector on the robot. Note: this solenoid cable does not work with the Cobra 350CR/ESD robots.

The solenoid cable brings a portion of the XDIO signals out to the CN21 connector at the top of the robot. See the following table for the details on the signals available at CN21. See the *SmartController EX User's Guide* for the electrical specifications for the signals from the XDIO connector.

Table 7-2. CN21 Signal List When Using Solenoid Cable

CN21 Pin #	Signal from XDIO on SmartController	CN21 Pin #	Signal from XDIO on SmartController
1	Input 1001[1]	11	Not connected
2	Input 1002[1]	12	Ground
3	Input 1003[1]	13	Output 0001
4	Input 1004[1]	14	Output 0002
5	Input 1005[1]	15	Output 0003
6	Not connected	16	Output 0004
7	Output 0007[2]	17	Output 0005
8	Output 0008[2]	18	Output 0006
9	24 V Output[3]	19	Not connected
10	Ground		

[1]Inputs 1001 to 1005 are preconfigured as low-active (sinking) inputs.
[2]Outputs 0007 and 0008 are preconfigured as high-side (sourcing) outputs.
[3]Limited to a combined total of 1 A of current.

Mounting Options for User Connections

User air and electrical lines can be routed either through the hollow space in the Z-axis shaft or by attaching them to the robot's exterior by mounting stays on the robot.

CAUTION: Do not remove the mechanical end bolts on the 1st and 2nd axes or the mechanical stoppers on the 3rd axis (see the following figure). Also, do not use these bolts and stoppers to secure a stay to support user air or electrical lines. If you remove these components, the initial calibration position and softstops may become invalid, the robot arm may fail to run as programmed, and the robot arm may interfere with peripheral devices.

NOTE: Do not use the following for user connections:

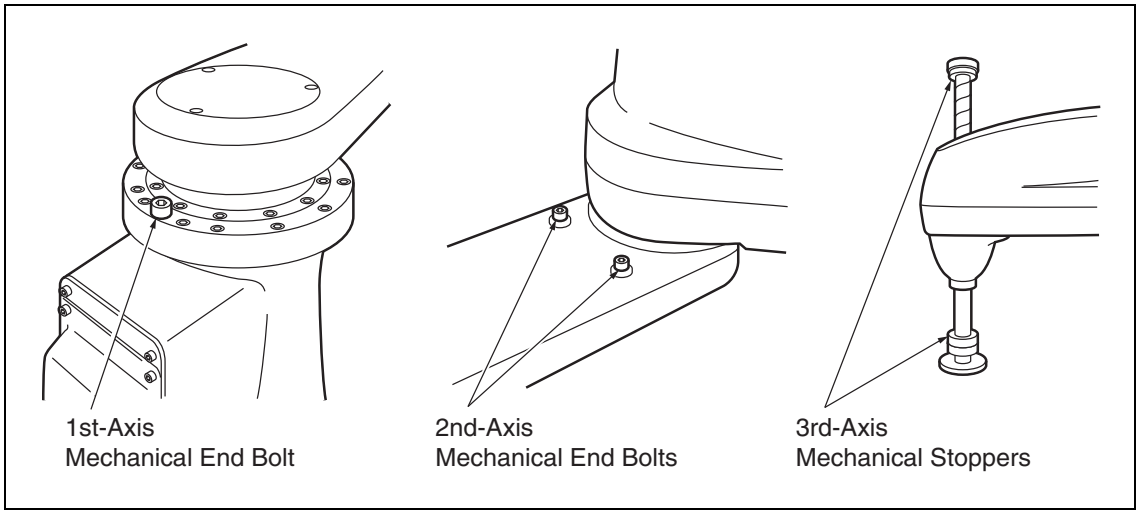


Figure 7-3. Mechanical End Bolts and Stoppers on Robot

Routing User Connections Through the Z-Axis Shaft

You can route air and electrical lines from the CN21 connector or the air line joints on the top of the outer arm (Joint 2) through a hollow space (Ø14 mm) in the Z-axis shaft.

CAUTION: If routing lines in this manner, make sure that, when the robot is in motion, including when the Z-axis is moving, the air and electrical lines do not become taut or interfere with other parts of the robot.

Attaching Stays to Support User Connections

You can attach a user-supplied stay on the exterior of the robot to support air and electrical lines—see See "Stay Attached to Robot's Exterior". See See "Dimensions for Fabricating User-Supplied Stay " for the dimensions to fabricate the stay. To install the stay, attach four M3 bolts to the four threaded holes on the bottom of the outer arm to mount the stay. The mounting holes are the same as those used for the camera bracket, see See "Camera Mounting Details ".

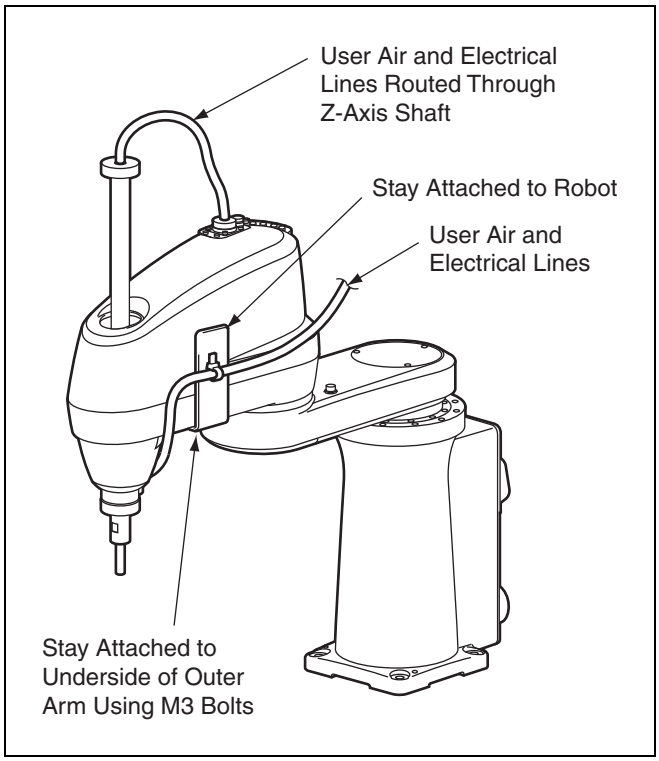


Figure 7-4. Stay Attached to Robot's Exterior

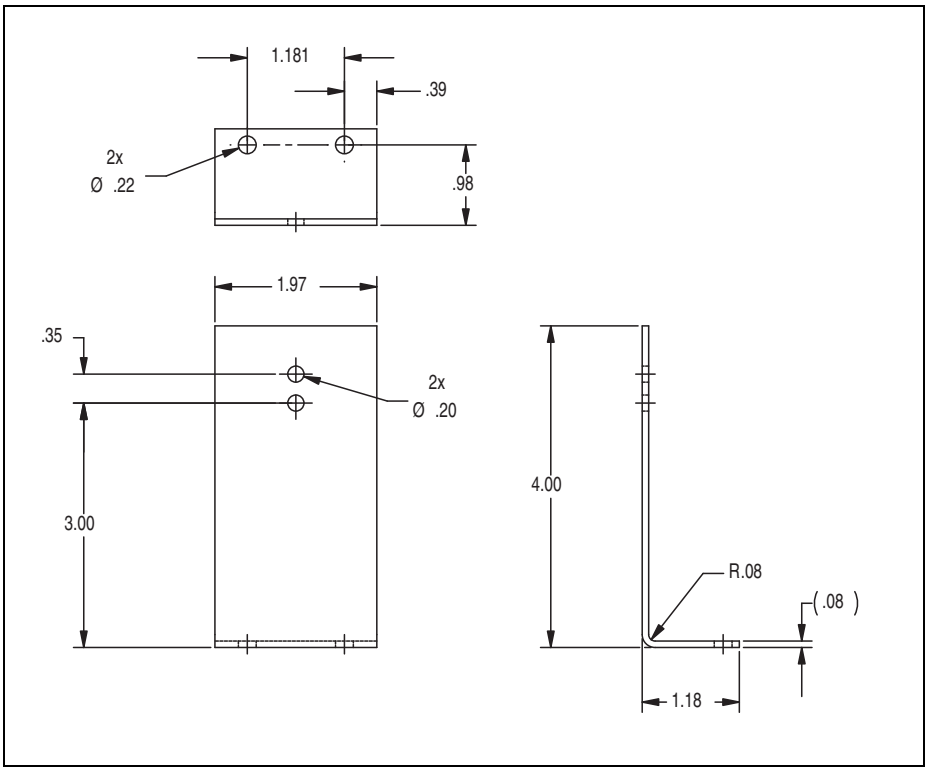


Figure 7-5. Dimensions for Fabricating User-Supplied Stay

7.4 Camera Mounting

A camera can be mounted on the Cobra 350 by installing a user-supplied camera bracket. The bracket is installed on the underside of the robot—see the following figure for the location and dimensions of the mounting holes. See See "Camera Bracket Drawing, Page 1 of 2" and See "Camera Bracket Drawing, Page 2 of 2" for drawings of the brackets. The user must fabricate this bracket.

An optional camera channel (40861-00830) and camera mounting block (40861-00660) are available. These can be attached to the user-supplied camera bracket. See the following figure.

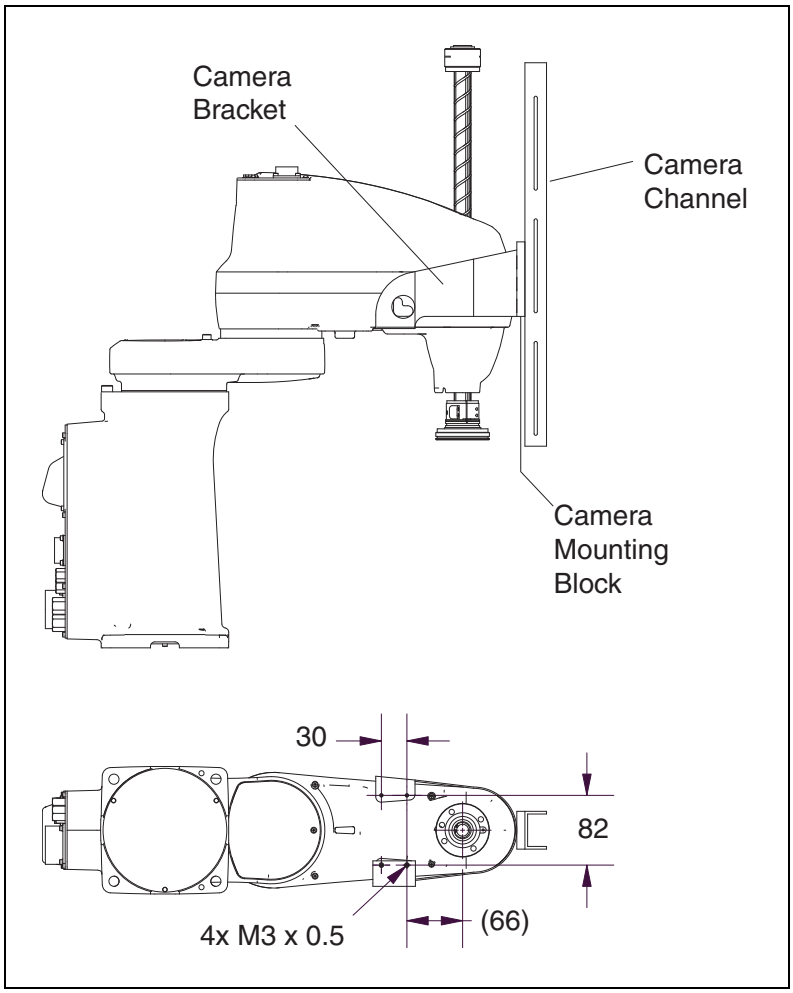


Figure 7-6. Camera Mounting Details

Camera Bracket Drawings

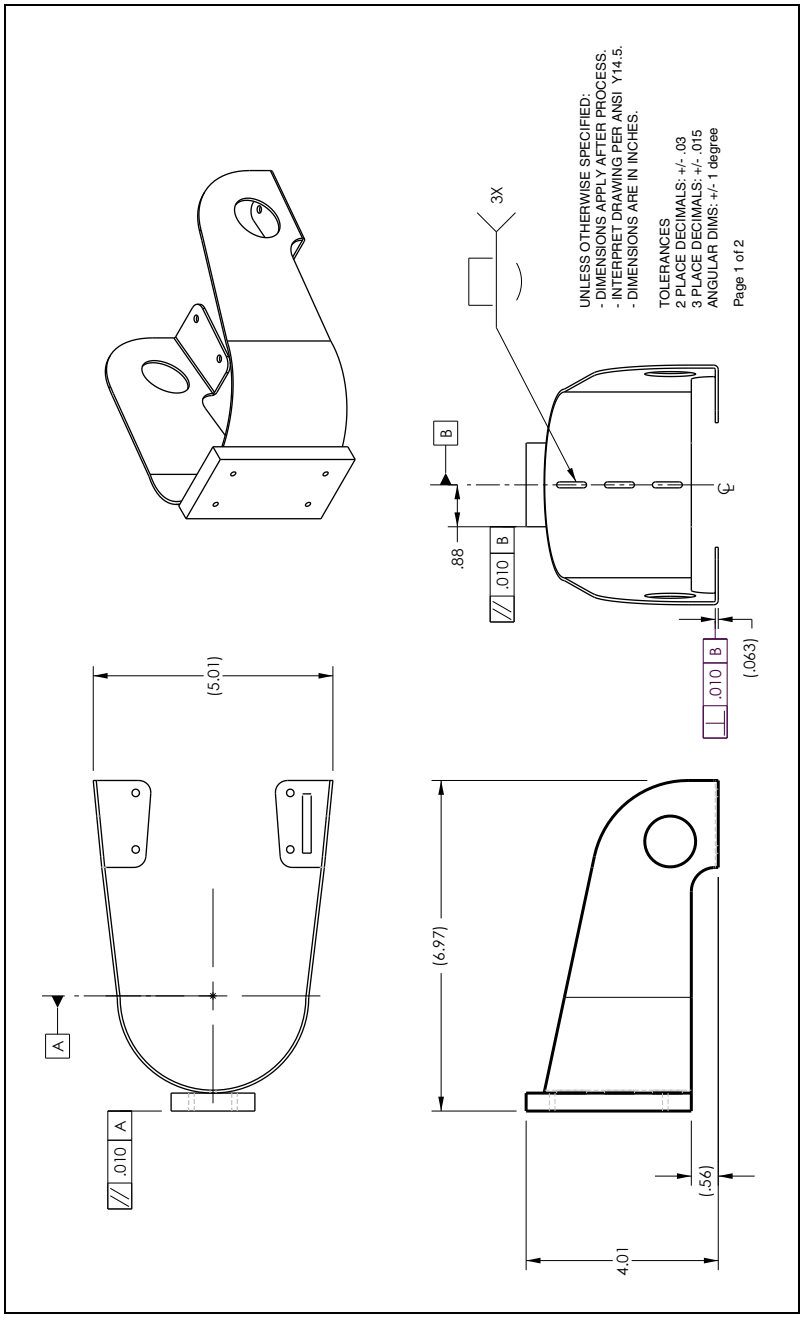


Figure 7-7. Camera Bracket Drawing, Page 1 of 2

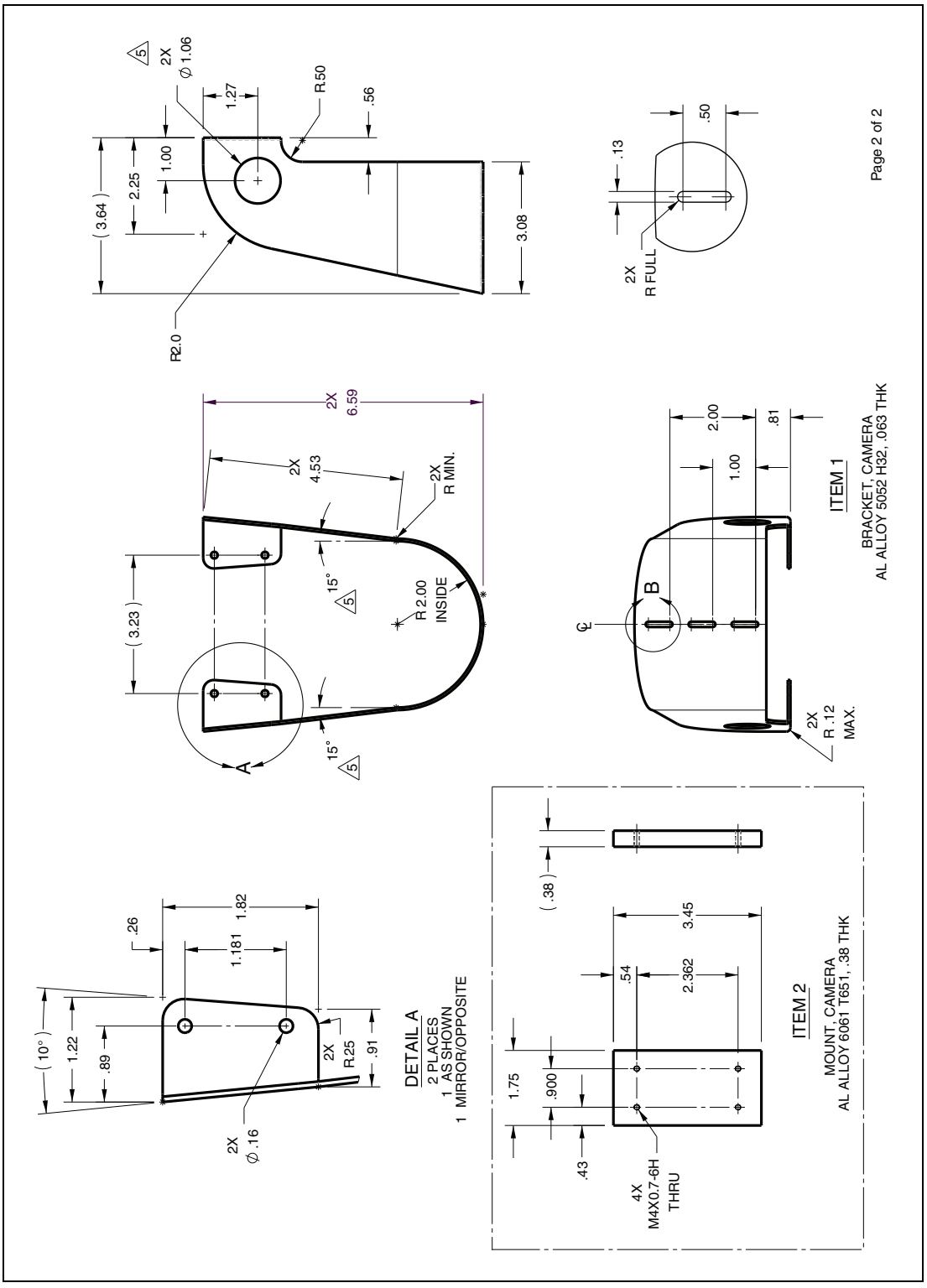


Figure 7-8. Camera Bracket Drawing, Page 2 of 2

Chapter 8: Maintenance

8.1 Periodic Maintenance Schedule

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

Table 8-1. Inspection and Maintenance

Item	Period	Reference
Safety Labels	1 week	
Check E-Stop, enable and key switches, and barrier interlocks	3 months	See "Checking Safety Systems "
Check robot mounting bolts	3 months	See "Checking Robot Mounting Bolts"
Lubricate Joint 3 (Z-axis) ball screw	6 months	See "Lubricate Joint 3 Ball Screw"
Replace Encoder battery	2 - 4 years	See "Replacing Encoder Battery "
Inspect timing belts on 3rd and 4th axes	12 months	See "Inspecting Timing Belts"

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

WARNING: During maintenance, user-supplied fail-safe lock-out measures must be used to prevent unauthorized third parties from turning on power.

This is mandated by Clause 5.2.4 of ISO 10218-1.

8.2 Warning Labels

NOTE: Labels giving instructions for lifting or installing are not considered warning labels. They may be removed by the user, and do not need to be checked.

All warning labels on the Cobra 350 should be checked on a weekly basis for being present and legible. If any of the labels are missing or illegible, they should be replaced. The labels, with part numbers, are:

- Read User's Guide, Impact Warning Label, 18241-000

  These labels instruct the user to read the user's guide before using the robot, and to be aware of the potential of impact by the robot.

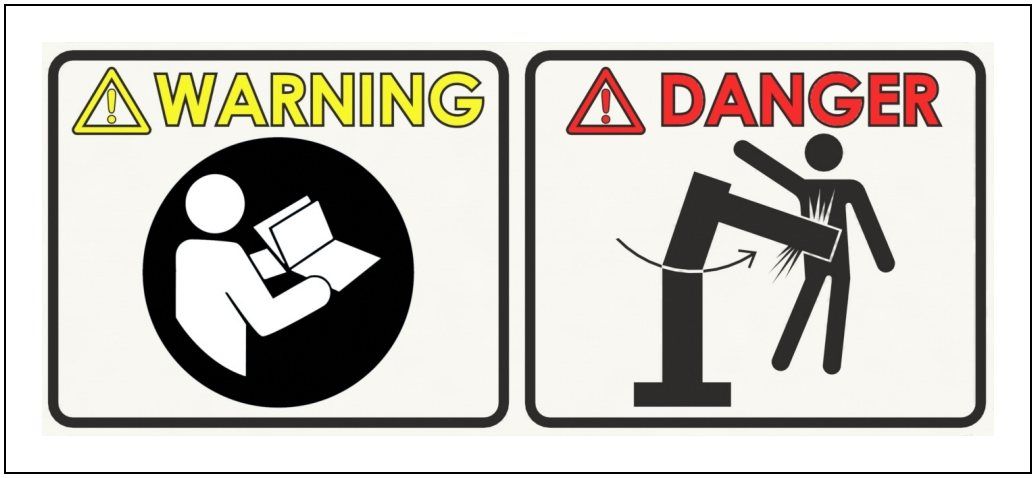


Figure 8-1. Read Manual and Impact Warning Label

  This is placed on the side of the upper cover of the robot.

- Gravity/Brake Release Label, 18272-000

  This label warns about the possibility of a robot axis dropping suddenly when the brake release is pressed because of gravity. In the case of the eCobra, this applies to the quill and tool flange.

Figure 8-2. Brake Release/Gravity Label

Figure 8-3. Location of Brake Release/Gravity Warning Label

8.3 Checking 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.

8.4 Checking Robot Mounting Bolts

Check the tightness of the base mounting bolts after one week, and then every 6 months. Tighten to 70 N-m (52 ft-lbf). Also check the tightness of all cover plate screws.

8.5 Lubricate Joint 3 Ball Screw

Required Grease for the Robot

Table 8-2. Robot Lubrication

Lubrication Point	Lubrication Type	Lubrication Amount	Remarks
Joint 3 quill shaft	Epinoc AP1	2 to 3 cc	Apply grease to entire shaft.

CAUTION: Using improper lubrication products on the Cobra 350 robot may cause damage to the robot.

Lubrication Procedure

1. Turn off main power to the controller and robot.

   Lock out and tag out power.

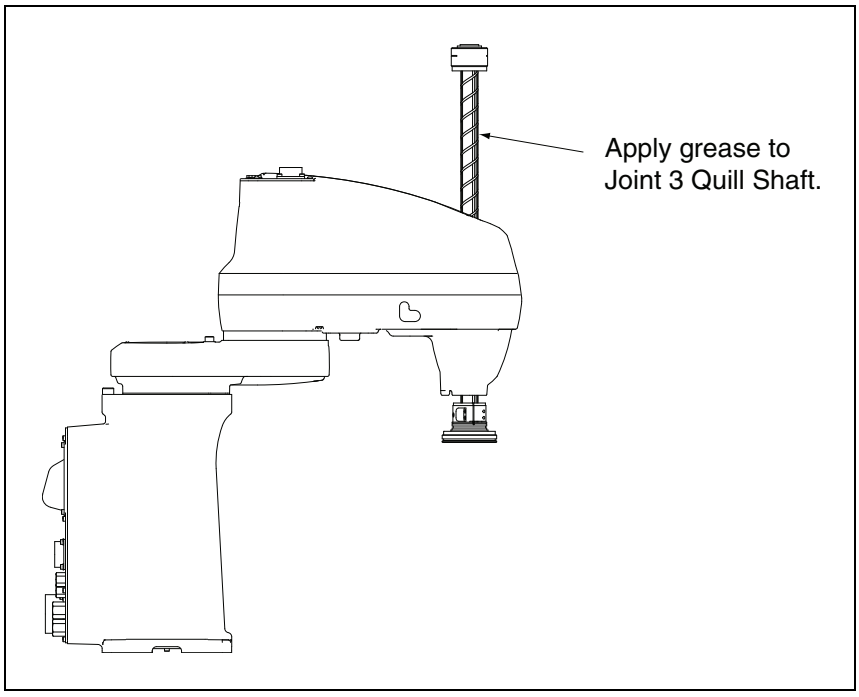


Figure 8-4. Lubrication of Joint 3 Quill

2. Raise the Joint 3 quill shaft to the upper position.

3. Apply grease to the entire shaft. See See "Robot Lubrication" for details.
4. Move the Joint 3 shaft up and down to distribute the grease. Wipe off any excess grease.

8.6 Replacing Encoder Battery

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

CAUTION: Replace the batteries only with 3.6 V, 2.7 Ah lithium batteries, part number: 06126-000. Battery information is located in the base of the robot.

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

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 2 years.

If the robot is turned on with 24 VDC supplied to the robot more than half the time, then you can increase the replacement interval to a maximum of 4 years.

NOTE: In the following steps, the top and bottom batteries are referred to assuming a table-mount for the robot, and the orientation is as shown in the figures.

1. Obtain a replacement battery pack, part number 06126-000.

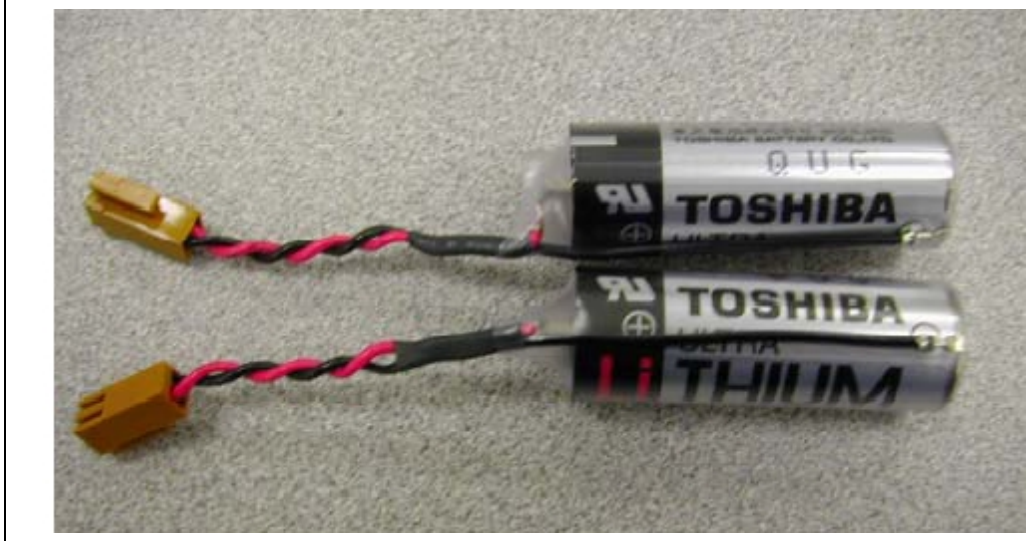


Figure 8-5. Replacement Battery Pack

2. Switch off the SmartController.
3. Switch off the 24 VDC input supply to the eMB-40R.
4. Switch off the 200/240 VAC input supply to the eMB-40R.
5. Disconnect the 24 VDC supply cable from the eMB-40R +24 VDC input connector. See See "eMB-40R Interface Panel" for locations of connectors.
6. Disconnect the 200/240 VAC supply cable from the eMB-40R AC input connector.

   Lock out and tag out power.
7. Remove the battery cover from the robot, by removing 4 hex socket-head bolts (M3 x 8), as shown in the following figure.

NOTE: On the cleanroom robot, the cover has a packing for sealing. Take care not to lose or pinch it.

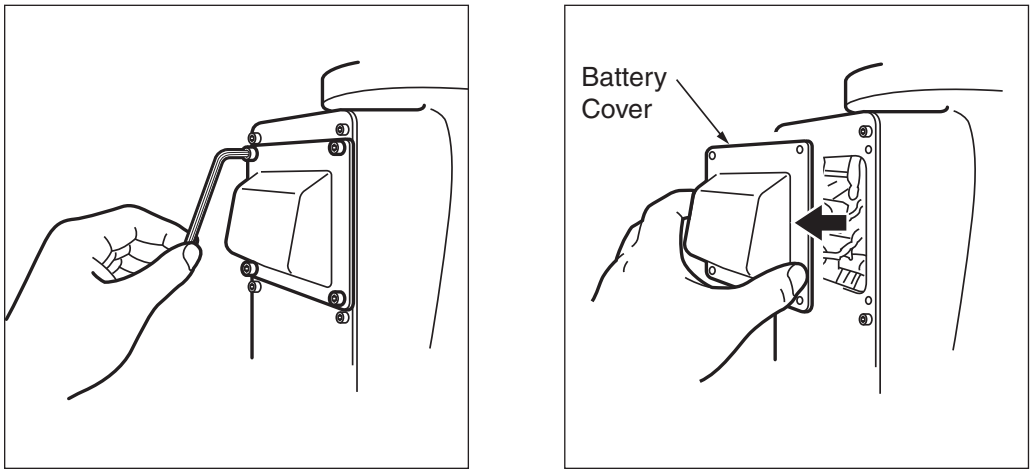


Figure 8-6. Removing Battery Cover

8. Attach the two new backup batteries to unused connectors on the battery board. See the following figure for details.

NOTE: Always leave at least two batteries connected at all times. Failure to do so may lose the encoder positional data, requiring factory recalibration.

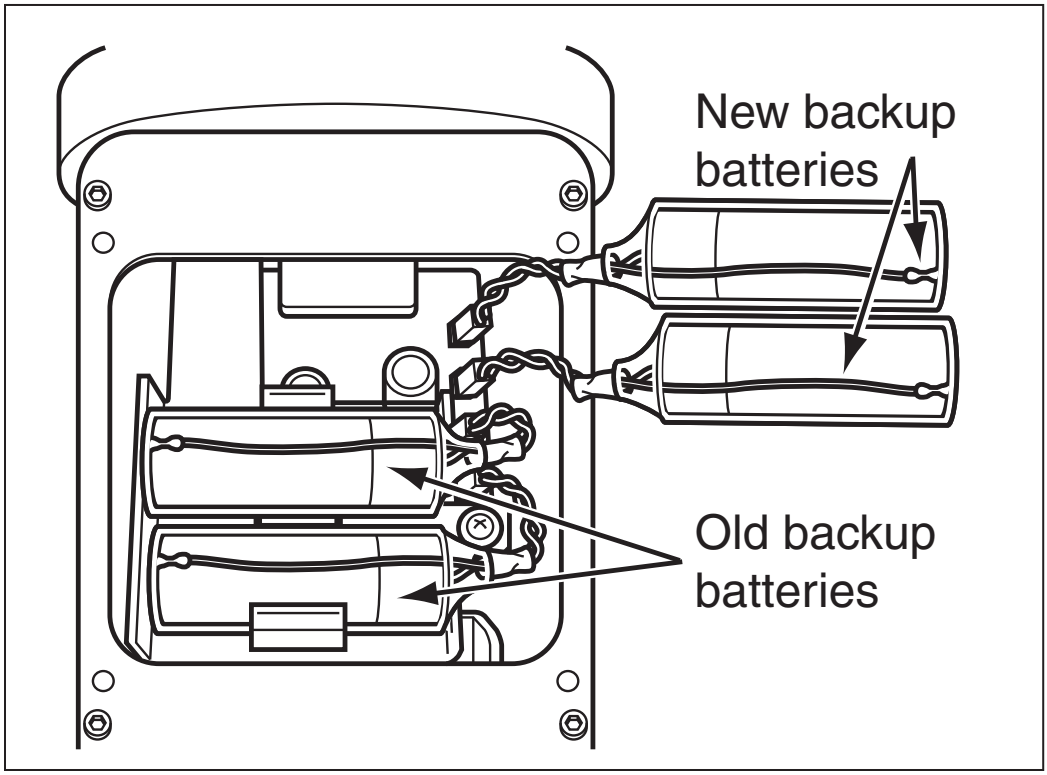


Figure 8-7. Attaching New Batteries

9. Disconnect the two old batteries from the battery board and then remove them from the holders.
10. Put the new batteries into the battery holders, as shown in the following figure.

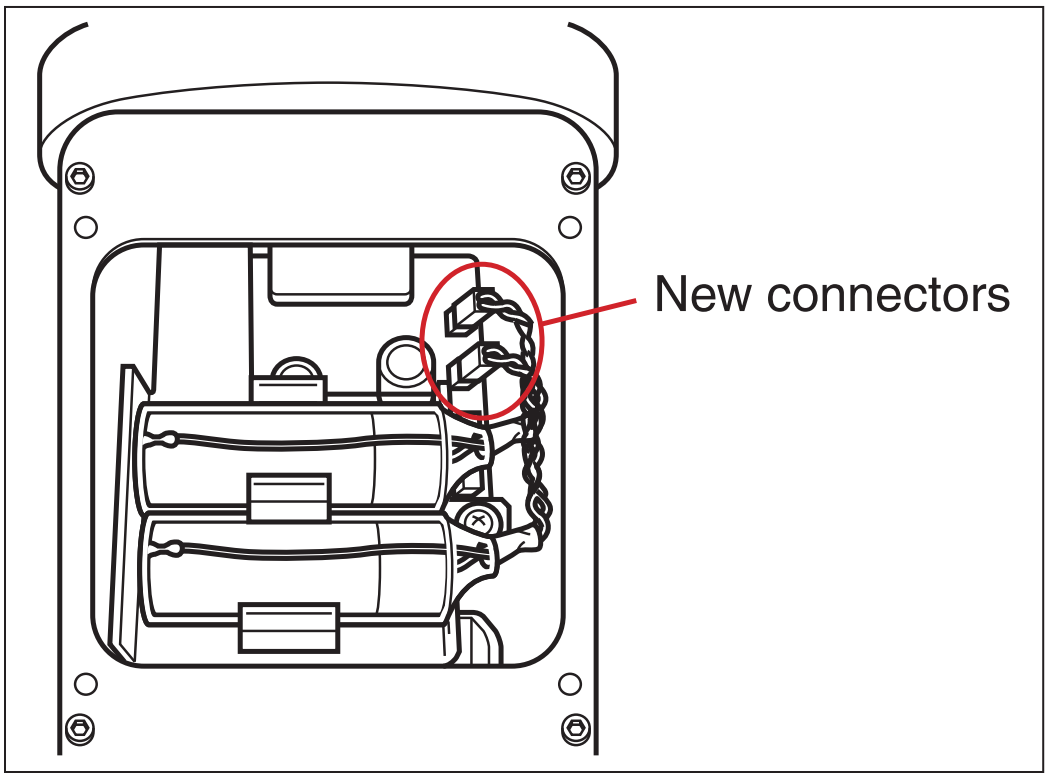


Figure 8-8. New Batteries in Holders

11. Reinstall the battery cover on the robot.

    Tightening toque: Hex socket-head bolt (M3 x 8): 1.6 ± 0.3 N·m (1.2 ± 0.2 ft-lbf)

NOTE: On the cleanroom robot, reinstall the packing under the cover. Take care not to pinch it.

8.7 Inspecting Timing Belts

This inspection should be done every 12 months.

1. Turn off power to the SmartController and eMB-40R.
2. Visually inspect the timing belts for Joint 3 and Joint 4 for excessive wear or missing teeth.
3. If you discover any problems, contact Omron Adept Technologies, Inc..

8.8 Replacing the eMB-40R Amplifier

Remove the eMB-40R Amplifier

1. Switch off the SmartController.
2. Switch off the 24 VDC input supply to the eMB-40R.
3. Switch off the 200/240 VAC input supply to the eMB-40R.

Lock out and tag out power.

4. Disconnect the 24 VDC supply cable from the eMB-40R +24 VDC input connector.

   See Description of Connectors on eMB-40R Interface Panel on page 46 for locations of connectors.

5. Disconnect the 200/240 VAC supply cable from the eMB-40R AC Input connector.

6. Disconnect the eAIB XSYS cable from the eMB-40R XSYSTEM connector.

   If the system was upgraded from an MB-40R to an eMB-40R, you may need to disconnect the XSYS cable and eAIB XSLV Adapter from the XSYSTEM connector.

7. Disconnect the IEEE 1394 cable from the eMB-40R SmartServo connector.

8. Disconnect any other cables, which may be connected to the eMB-40R, such as XIO, RS-232, or any others.

Installing a New eMB-40R

1. Carefully remove the new eMB-40R from its packaging, check it for any signs of damage, and remove any foreign packing materials or debris.

2. Carefully place the eMB-40R next to the robot.

3. Connect the 200/240 VAC supply cable to the eMB-40R AC input connector.

4. Connect the XSYS cable to the eMB-40R XSLV connector, or

   Connect the eAIB XSYS cable to the eMB-40R XSYSTEM connector.

   If you are upgrading from an MB-40R to an eMB-40R, connect the existing XSYS cable to the eAIB XSLV Adapter, which connects to the eMB-40R XSYSTEM connector.

5. Connect the IEEE 1394 cable to the eMB-40R SmartServo/Servo connector.

6. Connect any other cables, which were connected to the eMB-40R, such as XIO, RS-232, or any others.

7. Connect the 24 VDC supply cable to the eMB-40R +24 VDC input connector.

8. Switch on the 200/240 VAC input supply to the eMB-40R.

9. Switch on the 24 VDC input supply to the eMB-40R.

10. Switch on the SmartController.

11. Once the system has completed booting, test it for proper operation.

8.9 Commissioning a System with an eMB-40R

Commissioning a system involves synchronizing the robot with the eMB-40R.

> **NOTE**: This section only applies to robots that have an eMB-40R amplifier. A robot with an MB-40R amplifier does not need the ACE commissioning.

For a new system with an eMB-40R, the robot and the eMB-40R will have been commissioned at the factory and should not need commissioning.

If you are replacing an MB-40R with an eMB-40R, you will need to commission the system.

In rare cases with a new robot with an eMB-40R, you may need to commission the system.

- If the system will not power up, and the robot status display shows SE, you need to commission the system.
- If the system will not power up in Manual mode, and the robot status display shows TR, you need to commission the system.

Safety Commissioning Utilities

The eMB-40R adds two functions that implement safety in hardware:

- E-Stop

  This serves as a backup to the standard software E-Stop process. The system will always try to stop the robot using the software E-Stop first. The hardware E-Stop will take over in the event of a failure of the software E-Stop.

- Teach Restrict

  This limits the maximum speed of the robot when it is operated in Manual mode. As with the E-Stop, this is a hardware backup to software limits on robot speed. If the software fails to limit the robot speed during manual operation, the hardware Teach Restrict will disable power to the system.

These two functions are only in the eMB-40R amplifiers. They were not implemented in hardware in the MB-40R amplifiers, so these utilities do not apply to those amplifiers.

These two functions are supported by four wizards:

- E-Stop Configuration

  This sets the E-Stop hardware delay to factory specifications.

- E-Stop Verification

  This verifies that the hardware E-Stop is functioning correctly.

- Teach Restrict Configuration

  This sets the hardware Teach Restrict maximum speed to factory specifications.

- Teach Restrict Verification

  This verifies that the hardware Teach Restrict is functioning correctly.

The initial utility screen will tell you which functions are commissioned. If a function is not commissioned, its verification wizard will not be displayed. Any displayed verification wizard can be run at any time, to ensure that its function is working properly.

Prerequisites

- The robot must be set up and functional.
- The robot must use eMB-40R amplifiers.

  The MB-40R amplifiers do not support these hardware functions, and these wizards will not run.

- ACE software must be installed.

- The Front Panel keyswitch must be in Auto mode.

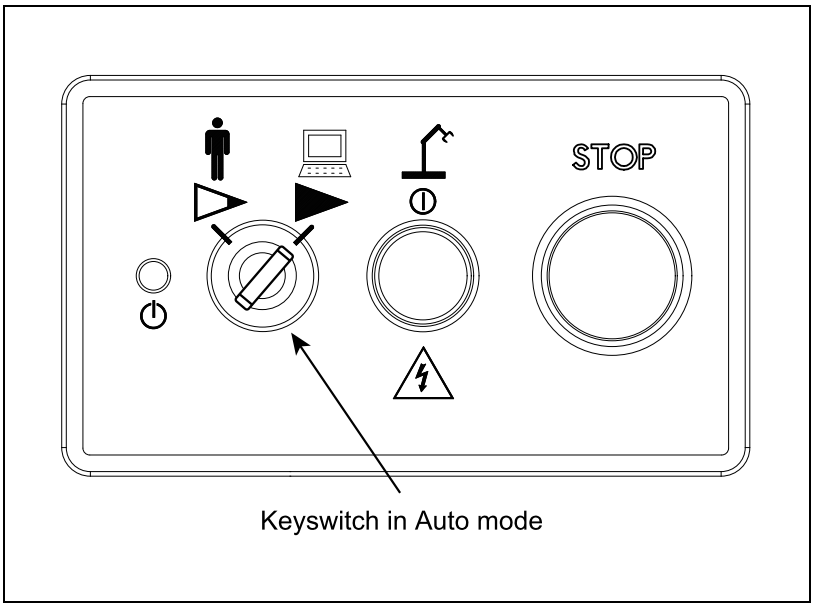


Figure 8-9. Front Panel

- No E-Stops can be activated.
- For Configuration (E-Stop and Teach Restrict), the eAIB Commissioning Jumper must be plugged into the XBELTIO jack on the eMB-40R.

  NOTE: This is the only time that this jumper will be used. It is part number 11901-000, and must be removed for Verification and normal operation.

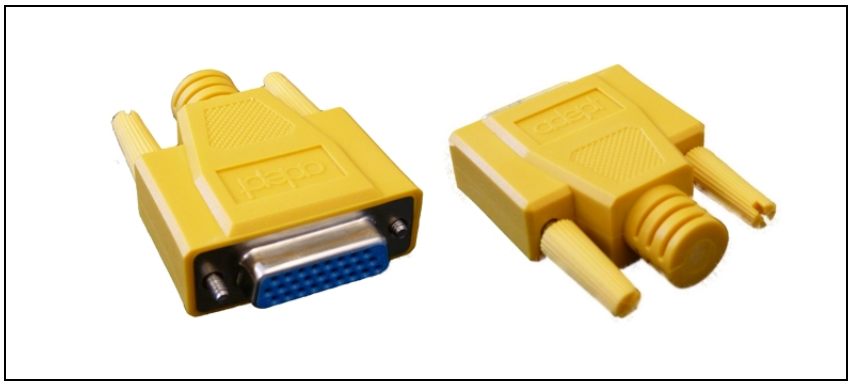


Figure 8-10. eAIB Commissioning Jumper

- A pendant is required for the Teach Restrict verification.

E-Stop Configuration Utility

This utility sets the E-Stop hardware delay to factory specifications.

NOTE: Ensure that the commissioning jumper is plugged into the XBELTIO jack on the eMB-40R before you start this procedure.

Procedure

From within the ACE software:

1. Open the robot object editor.
2. Select **Configure > Safety Settings > Configure ESTOP Hardware Delay**, then click Next.

   This procedure will configure Channel A and then Channel B.
   It will then report the delay that it set for each.
3. Reboot the SmartController.

   On some systems, the SmartController will reboot automatically.
4. Reboot the eMB-40R.

E-Stop Verification Utility

This utility verifies that the hardware E-Stop parameters are set correctly and that the hardware E-Stop is working.

The hardware E-Stop must have already been configured for this wizard to run.

NOTE: If the commissioning jumper is plugged into the XBELTIO jack on the eMB-40R, remove it before you start this procedure.

Procedure

From within the ACE software:

1. Open the robot object editor.
2. Select **Configure > Safety Settings > Verify ESTOP Hardware Delay**, then click Next.
3. Enable high power, if not already enabled, then click Next.
4. Press an E-Stop button (on the Front Panel), then click Next.

   The utility will confirm that the hardware delay has been verified for this robot, and display the delay times for channels A and B.
5. Reboot the SmartController.

   On some systems, the SmartController will reboot automatically.

Teach Restrict Configuration Utility

This utility sets the hardware Teach Restrict maximum speed parameter to factory specifications.

NOTE: Ensure that the commissioning jumper is plugged into the XBELTIO jack on the eMB-40R before you start this procedure.

Procedure

NOTE: This procedure takes 2 or 3 minutes to complete.

From within the ACE software:

1. Open the robot object editor.
2. Select **Configure > Safety Settings > Configure Teach Restrict**, then click Next.
3. From the Prerequisite screen, click Next.

   The wizard will go through all of the robot's motors, and display messages that it is configuring Channel A and B for each.

   It will then record the configuration, and display the target times that it set.
4. Click Finish.
5. Reboot the SmartController.

   On some systems, the SmartController will reboot automatically.

Teach Restrict Verification Utility

This utility verifies that the Teach Restrict parameters are set correctly and that the hardware Teach Restrict maximum speed control is working.

This is a two-part wizard. The first is run in Auto mode. The second is run in Manual mode.

Before running this verification utility, the Teach Restrict must be configured.

NOTE: If the commissioning jumper is plugged into the XBELTIO jack on the eMB-40R, remove it before you start this procedure.

Automatic Mode Procedure

WARNING: The robot will move during this wizard. Ensure that personnel stay clear of the robot work area.

From within the ACE software:

1. Open the robot object editor.
2. Select **Configure > Safety Settings > Verify Teach Restrict**, then click Next.
3. Teach a Start Position.

   This can be any position that does not conflict with obstacles or the limits of joint movements.

- If the robot is already in such a position, you can just click Next.
- Otherwise, move the robot to such a position, then click Next.
- The screen will display the number of degrees that each joint is expected to move during the verification process.
- You can click Preview Motions on this screen to view the motions at slow speed. The default speed is 10, but you can change that speed with this screen's speed control.
- You can click Move to Ready, to move the robot to the Ready position.

  The robot will move each joint, in succession. It will generate an over-speed condition for each, and verify that the hardware detected the over-speed condition.

4. Click Next, to proceed to the Manual Mode Procedure.

   If the Automatic Mode Procedure fails, you will not be allowed to proceed with the Manual Mode.

Manual Mode Procedure

The manual mode of this verification requires the use of a pendant.

For this verification, the Front Panel keyswitch must be in Manual mode.

1. From the Introduction screen, click Next.
   - Set the pendant to Joint mode.
   - Set the pendant manual control speed to 100.
2. Click Next.
3. Using the pendant, jog any of the robot's joints until power is disabled.

   This indicates that the Teach Restrict function is working.
4. Click Next.

   The results of the verification will be displayed.
5. Click Finish.
6. Reboot the SmartController.

   On some systems, the SmartController will reboot automatically.
7. Reset the Front Panel keyswitch to Auto mode.

8.10 Changing the Lamp in the Front Panel High-Power Indicator

The system is equipped with circuitry to detect the potentially dangerous condition of a burned-out High Power indicator on the Front Panel. If this lamp is burned out, you cannot enable high power until the lamp has been replaced. Follow this procedure to replace the High Power indicator lamp. The part number for the lamp is 27400-29006.

WARNING: Lockout and tagout power before servicing.

WARNING: The procedures and replacement of parts mentioned in this section should be performed only by trained, authorized personnel. The access covers on the Front Panel are not interlocked – turn off and disconnect power before removing the cover.

1. Turn off system power to the robot.
2. Turn off power to the optional SmartController EX, if you are using one.
3. Disconnect the cable between the Front Panel and the eAIB (or controller).
4. Remove the Front Panel from its mounting location.
5. Remove the two screws on the back of the Front Panel.

   Save the screws for re-installation.
6. Carefully pull the front cover away from the body of the Front Panel.

   You will encounter some resistance, as there are three plug-type connectors that you need to disconnect as you pull the front cover away from the body.

   NOTE: Separate the cover from the body slowly to avoid damaging the two wires that go between the LED and the PC board inside the body. Pull the front cover as straight out as possible. You do not have to disconnect the wires from the PC board, although you can if needed.
7. Locate the lamp body in the center of the back side of the front cover. Turn the lamp body approximately 20° in either direction and then pull straight back.
8. The lamp body is now free. You can remove the old lamp and insert a new one.
9. Re-install the lamp body by pushing it straight into the lamp housing receptacle. Make sure the contacts on the lamp body are properly oriented, as shown in the following figure.
10. Make sure to reconnect the wires from the LED if you disconnected them earlier.
11. Push the front cover into the body, taking care to align all of the plug-type connectors.

    Verify that the wires do not get crimped as you reinstall the cover.
12. Re-install the two screws on the back of the body.
13. Re-install the Front Panel in its mounting.
14. Reconnect the cable between the Front Panel and the eAIB (or controller).

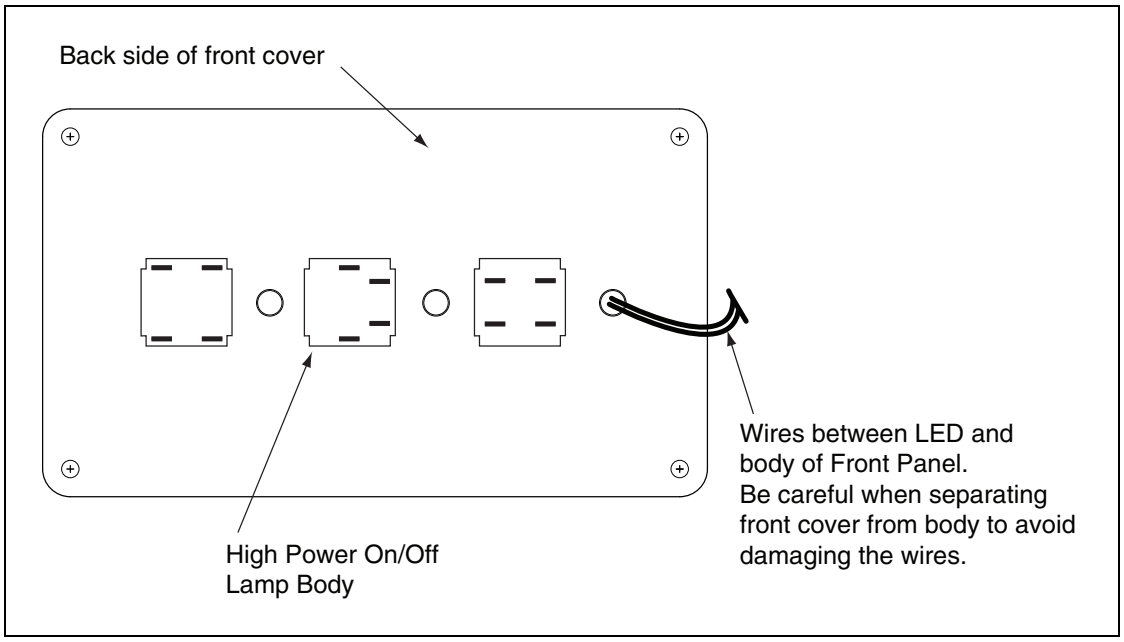


Figure 8-11. Lamp Body Contact Alignment

Chapter 9: Technical Specifications

9.1 Dimension Drawings

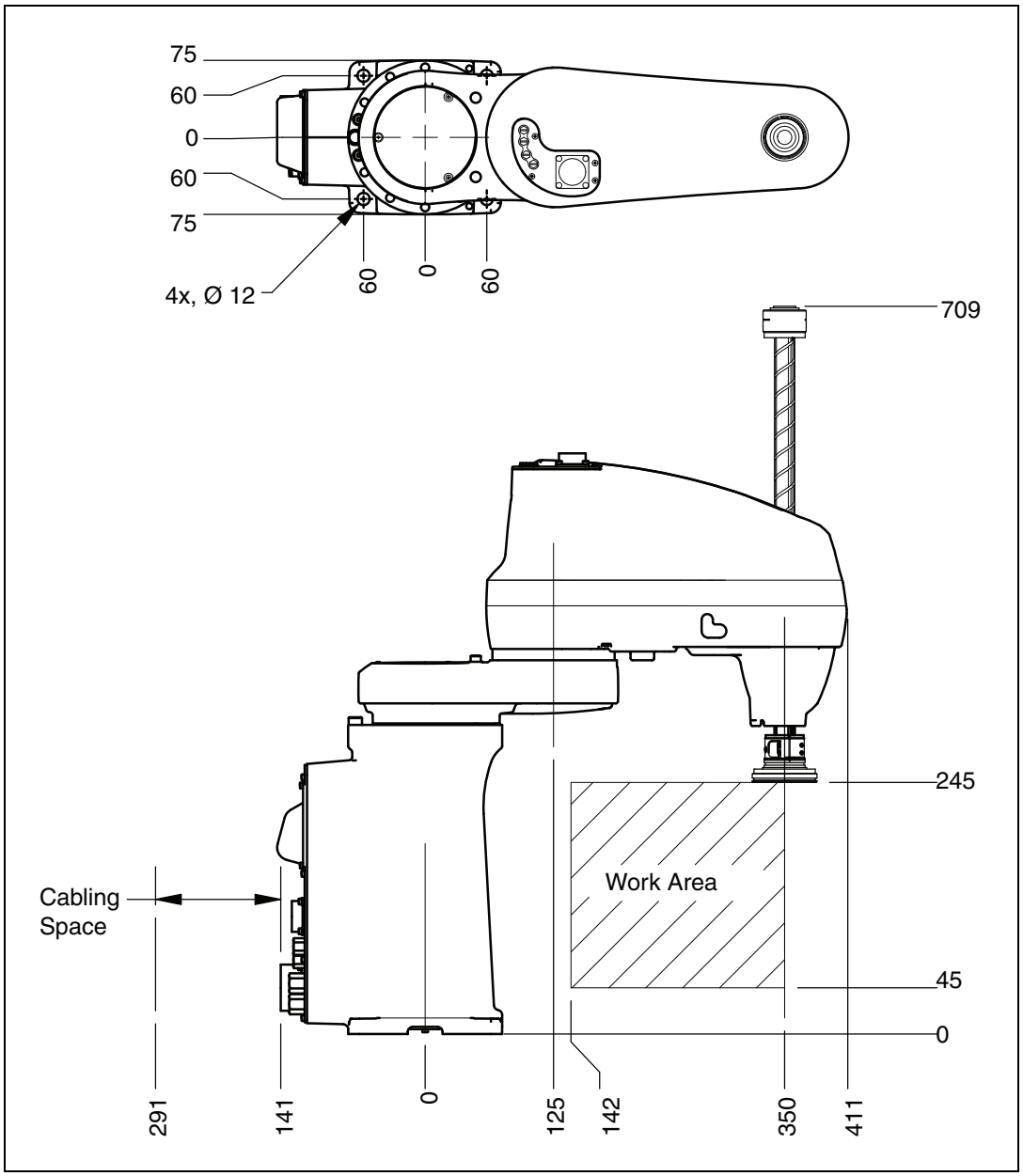


Figure 9-1. Cobra 350 Top and Side Dimensions

NOTE: The supplied tool flange sits 10.0 mm below the bottom of the quill shown in the previous figure.

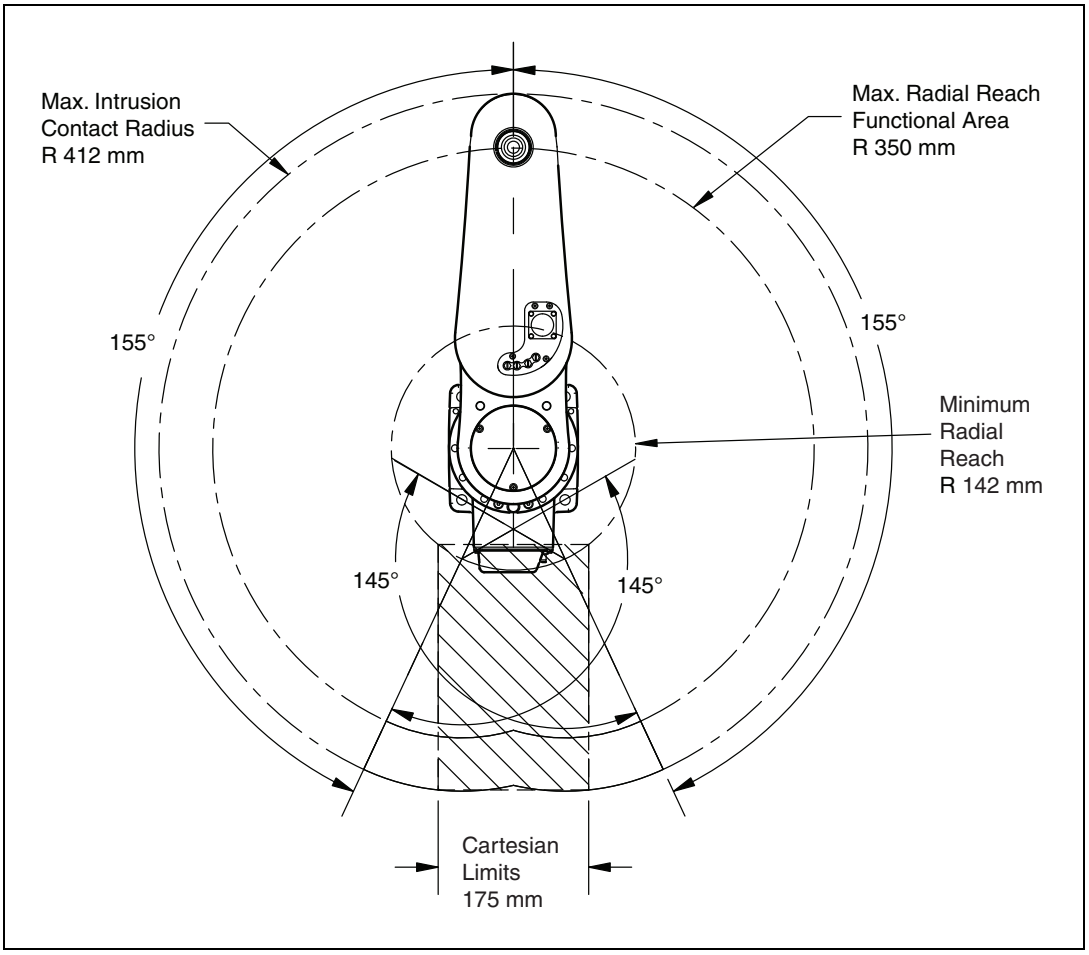


Figure 9-2. Cobra 350 Robot Working Envelope

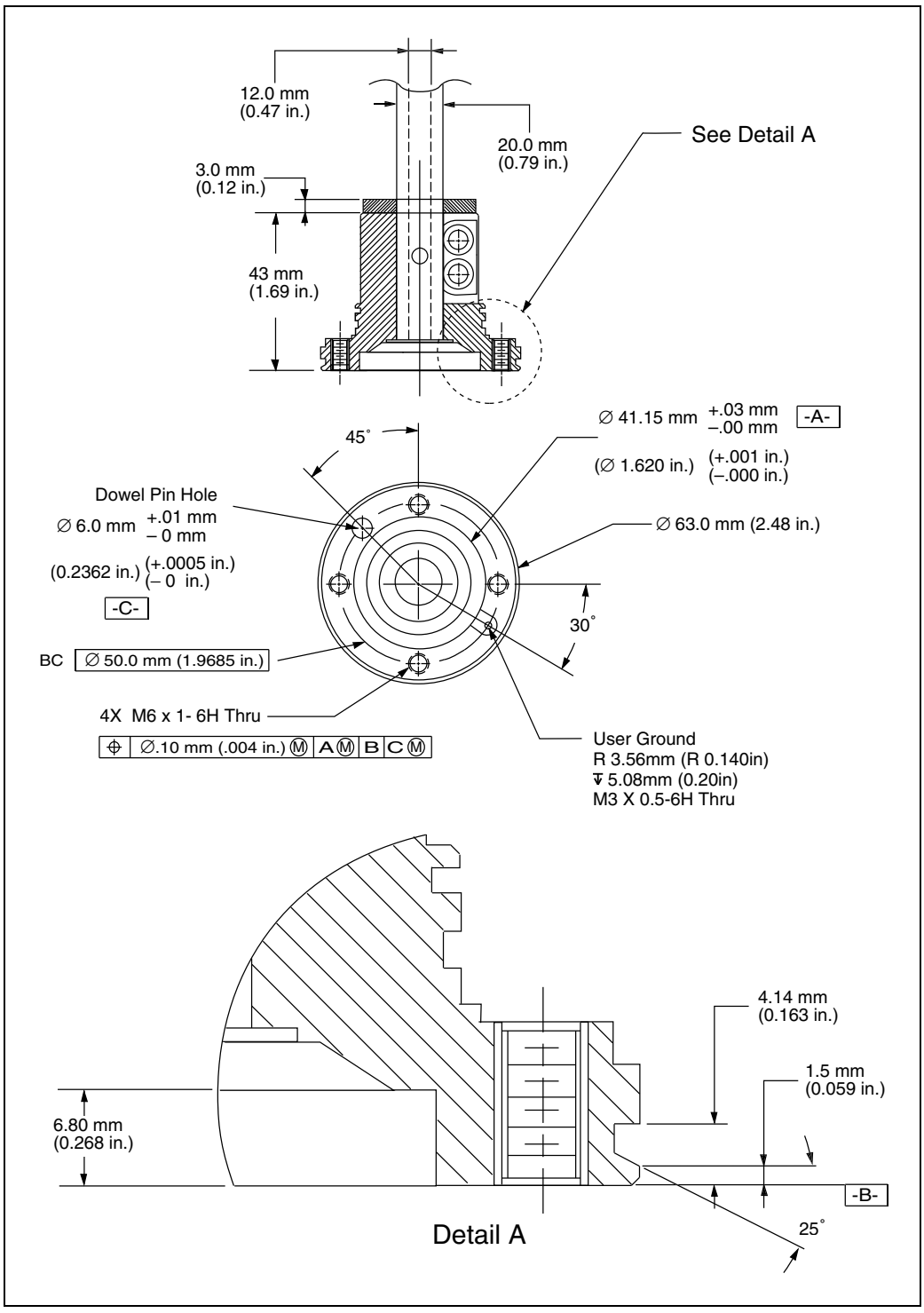


Figure 9-3. Tool Flange Dimensions for Cobra 350 Robots

9.2 Robot Specifications

Physical

Table 9-1. Cobra 350 and 350CR/ESD Physical Robot Specifications[1]

Description	Specification
Reach	350 mm
Payload - rated/maximum	2.0 kg/5.5 kg
Joint Range	
Joint 1	±155°
Joint 2	±145°
Joint 3	200 mm (7.8 in.)
Joint 4	±360°
Encoder type	Absolute
Robot Brakes	Joints 1, 2: Dynamic
	Joint 3, 4: Electric
Airline pass-through (quantity)	6 mm diameter (2) 4 mm diameter (2)
Electrical pass-through	19 conductors
Weight (without options)	20 kg
[1]Specifications subject to change without notice.	

Performance

Table 9-2. Cobra 350 and 350CR/ESD Robot Performance Specifications[1]

Description	Specification
Moment of Inertia	Joint 4 - 450 kg-cm² (150 lb-in²) - max
Downward Push Force - Burst (no load)	98 N - maximum
Repeatability	
x, y	±0.015 mm
z	±0.01 mm
Theta	±0.005°
Joint Speed (maximum)	
Joint 1/Joint 2	720°/sec
Joint 3	2000 mm/sec
Joint 4	2400°/sec
[1]Specifications subject to change without notice.	

Table 9-3. Softstop and Hardstop Specifications

Joint	Softstop	Hardstop – Approx.
Joint 1	± 155	± 158
Joint 2	± 145	± 147
Joint 3	0 to 200 mm	-5 to 205 mm
Joint 4	± 360	not applicable

Stopping Distances and Times

The following graphs present information required by Clause 7.2 n) of ISO 10218-1. This information should be used to calculate the safe distance needed when designing and installing safeguarding devices.

The graphs show the time elapsed and distances traveled between the initiation of a stop signal and the cessation of all robot motion.

For stop category 1, the stopping time and distance values depend on the speed, load, and extension of the robot, stated for 33%, 66% and 100% of the maximum payload (5.5kg). Data provided is for the three axes of greatest displacement (J1, J2 and J3).

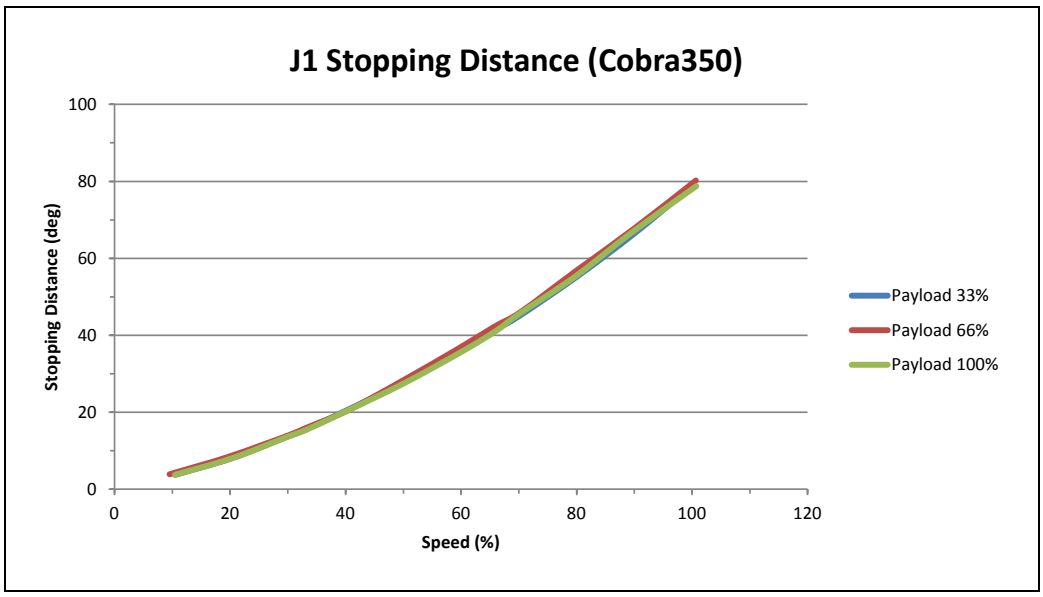


Figure 9-4. Joint 1 Stopping Distance for Cobra 350, in Degrees

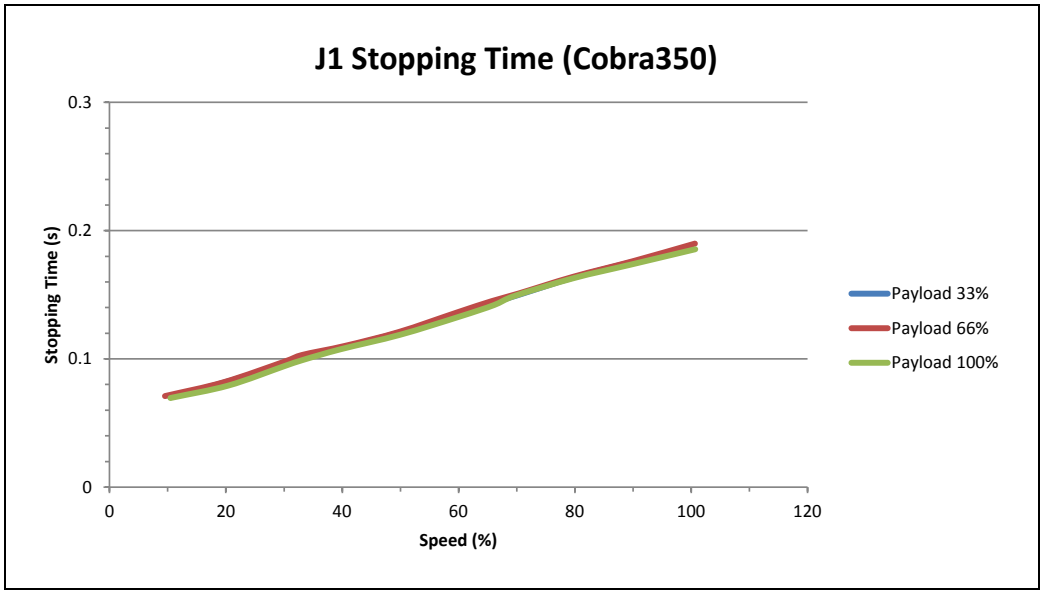


Figure 9-5. Joint 1 Stopping Time for Cobra 350, in Seconds

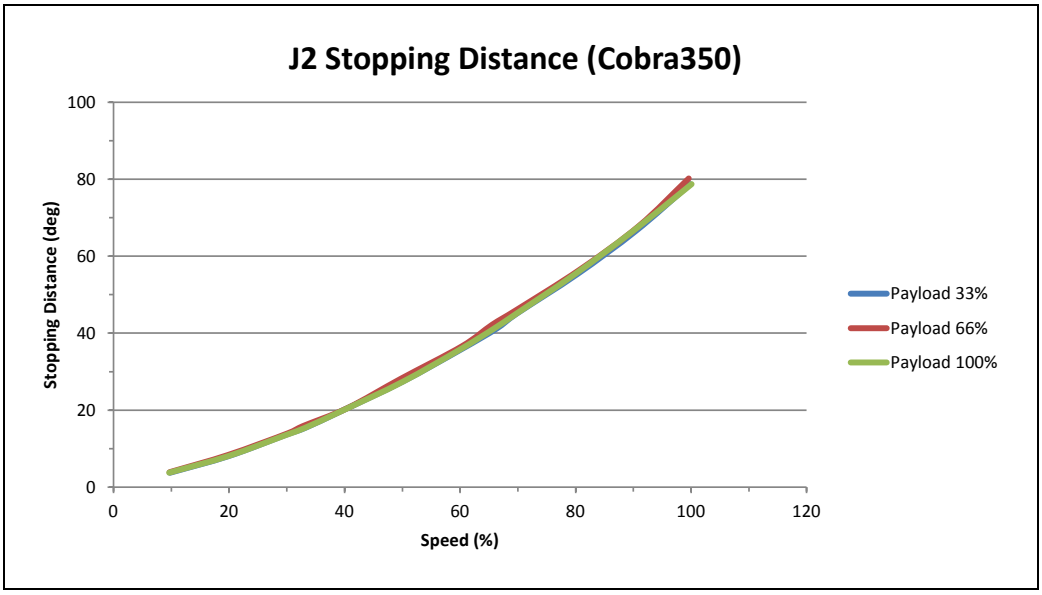


Figure 9-6. Joint 2 Stopping Distance for Cobra 350, in Degrees

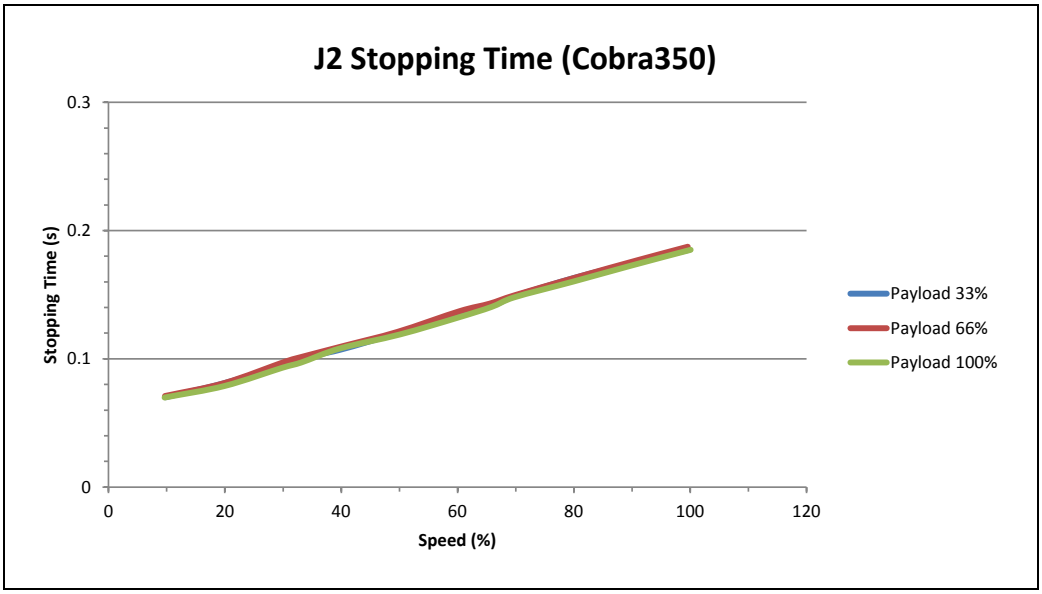


Figure 9-7. Joint 2 Stopping Time for Cobra 350, in Seconds

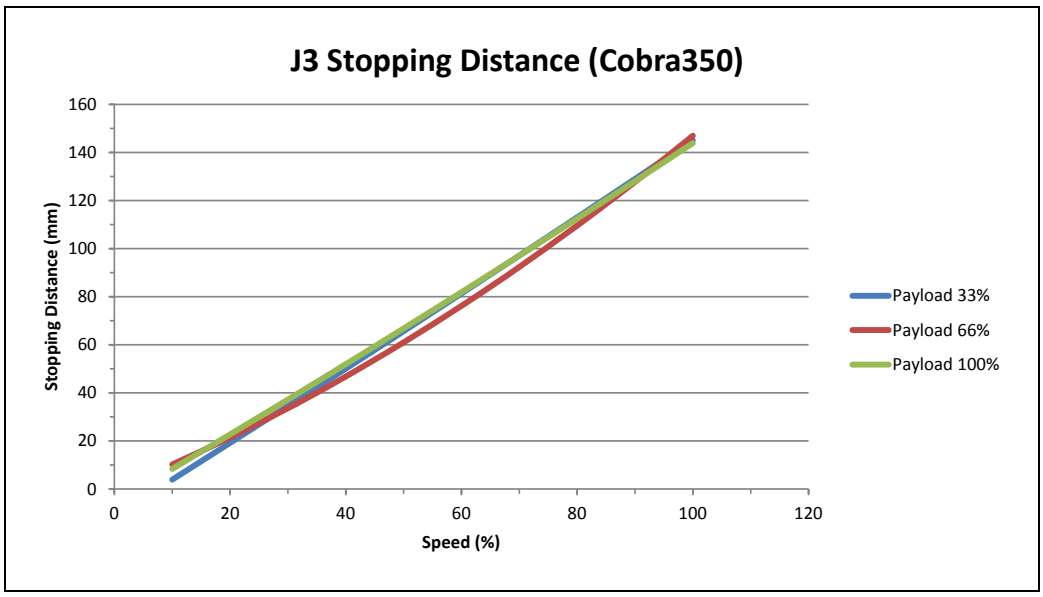


Figure 9-8. Joint 3 Stopping Distance for Cobra 350, in Millimeters

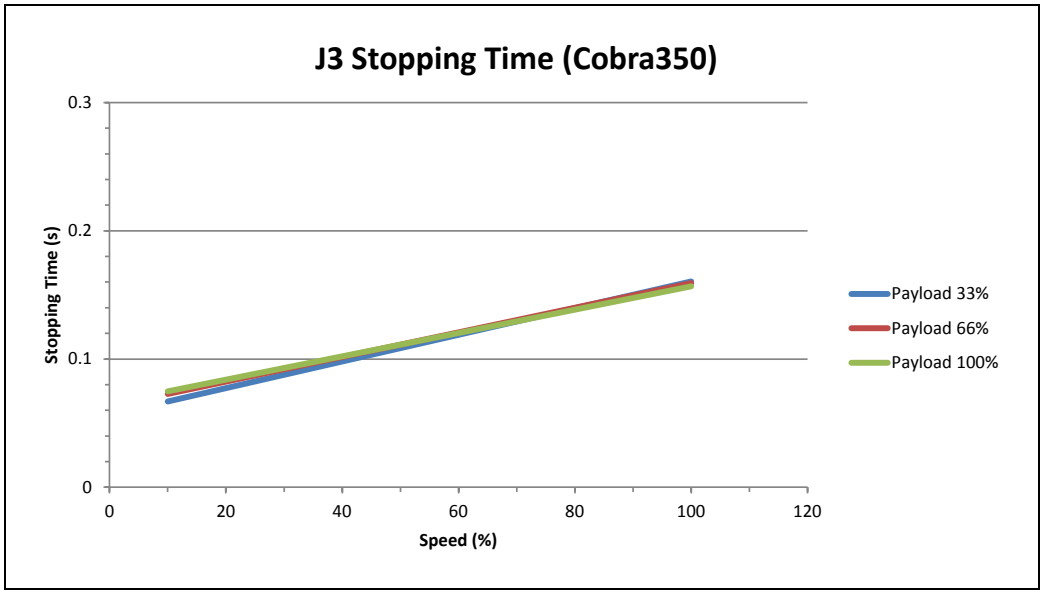


Figure 9-9. Joint 3 Stopping Time for Cobra 350, in Seconds

Chapter 10: Cleanroom Robots

10.1 Cobra 350 CR/ESD Cleanroom Option

Introduction

The Cobra 350 robot is available in a Class 10 Cleanroom model.

This option is a factory-installed configuration. Changes to the robot include the addition of bellows assemblies mounted at the Joint 3 quill, increased sealing at the joints, fully-sealed access covers, and a vacuum system to evacuate the arm.

Figure 10-1. Cobra 350 CR/ESD Cleanroom Robot

Specifications

Table 10-1. Cobra 350 CR/ESD Cleanroom Robot Specifications

Robot Performance Specification	Same as standard robot.
Ambient Temperature Specification	5° - 35° C (41° - 95° F)

10.2 Connections

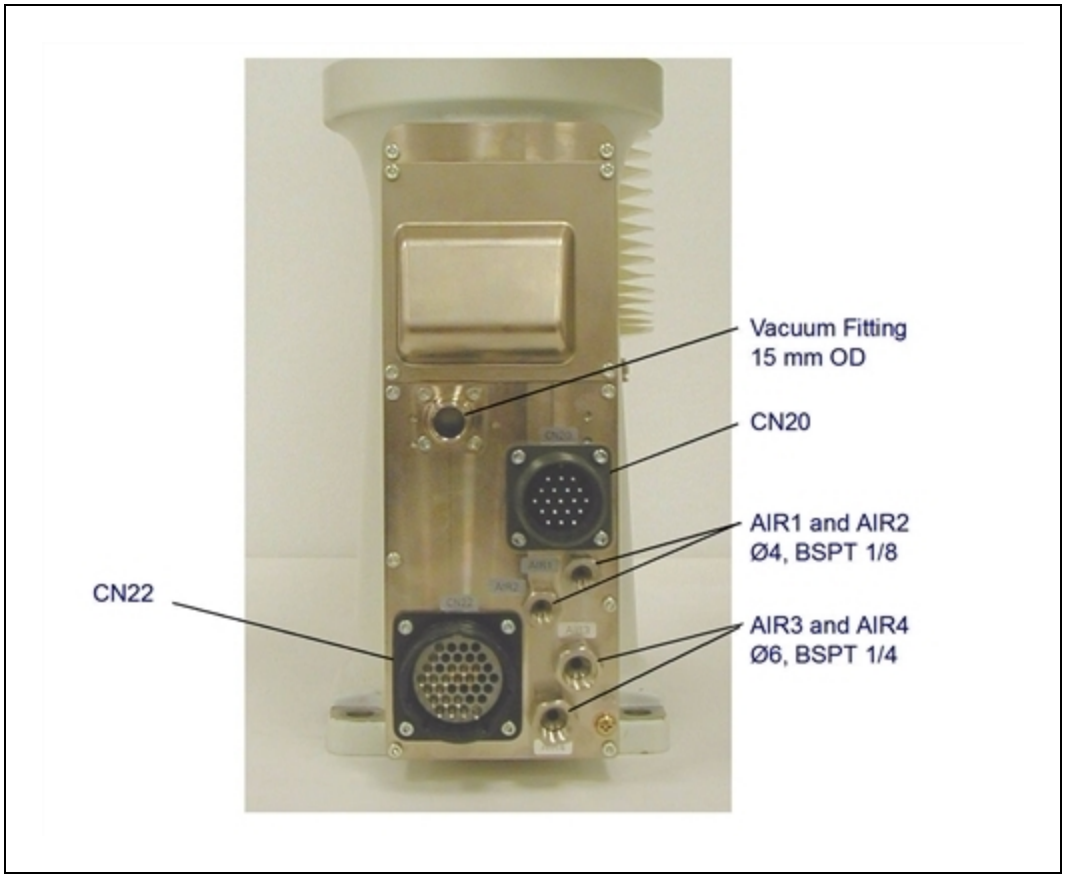


Figure 10-2. Cleanroom Connections

10.3 Requirements

Table 10-2. Cleanroom Robot Requirements

Vacuum source	0.10 m^3/min (3 ft^3/min) minimum volumetric flow rate
	350 mm of water (13.5 inches of water) differential pressure measured between the robot and the vacuum source

	15 mm OD tube fitting at the back of the robot
Quill inside diameter	The inside diameter of the quill must be plugged by the user's end-effector in order to maintain cleanliness at the tool flange.

10.4 ESD Control Features

The 350 CR/ESD robot is compatible with common magnetic semiconductor ESD control measures. The surface of the robot is painted so that it is resistively coupled to the robot ground. The bellows are also made of a resistive material that will conduct electrical charges to the robot ground. This treatment precludes the buildup of any electrical charge (such as tribocharging) on the robot surfaces. In addition, it is formulated to provide a significant resistance to ground so that charged surfaces brought in close proximity to the robot will slowly leak into the robot ground - rather than arc quickly to ground and create a magnetic field event.

Contact Omron Adept Technologies, Inc. for your specific application details.

10.5 Maintenance

Bellows Replacement

Check the bellows periodically for cracks, wear, or damage. Replace the upper and lower bellows if necessary, using the procedures below. Part numbers: 05555-000 (upper) and 05556-000 (lower).

Procedure for Lower Bellows Replacement

1. Remove the lower clamp ring from the bearing ring by loosening the screw on the clamp. See See "Cleanroom Lower Bellows Replacement" for details.
2. Remove the tool flange. Refer to Removing and Reinstalling the Tool Flange on page 71 for the tool flange removal procedure.
3. Remove the upper 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. Take care to correctly seat the tool flange firmly up against its hardstop and rotate the flange so that the setscrew lies in the middle of the machined flat of the quill.

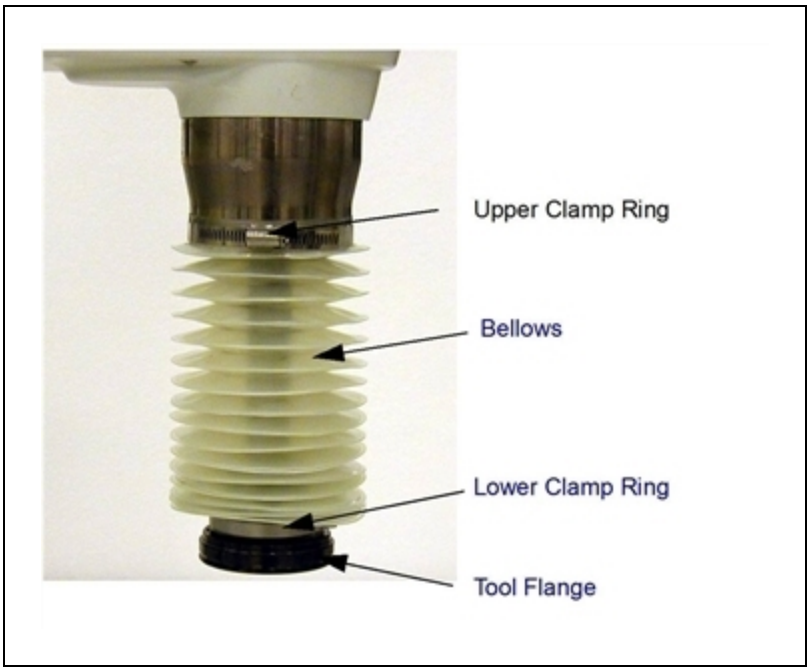


Figure 10-3. Cleanroom Lower Bellows Replacement

Procedure for Upper Bellows Replacement

1. Remove the clamp rings from the top and bottom of the upper bellows.
2. Slide the bellows down and remove the assembly at the top of the quill with a M3 hex wrench. Note the position of the top assembly is such that the split nut lies just at the top of the quill.
3. Replace the bellows.
4. Replace the top assembly to the flange with the vertical position set so that the split of the nut lies level with the top of the quill. (Failure to do so may result in decreased vertical stroke.)

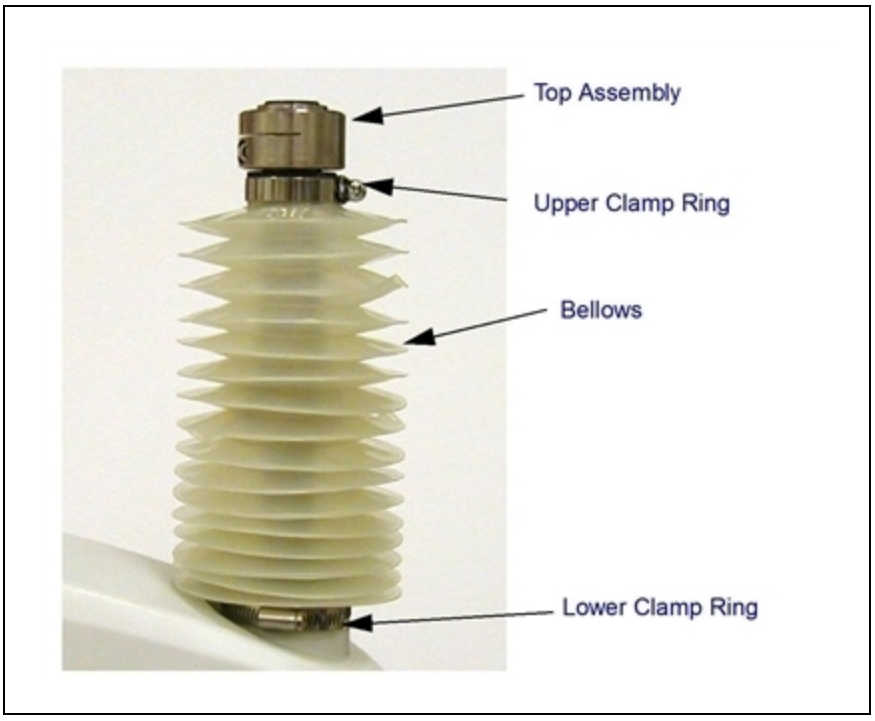


Figure 10-4. Cleanroom Upper Bellows Replacement

Lubrication

The upper and lower ends of the Joint 3 quill shaft require lubrication in the same manner as the standard Cobra 350 robot. See Lubricate Joint 3 Ball Screw on page 84.

10.6 Dimension Drawings

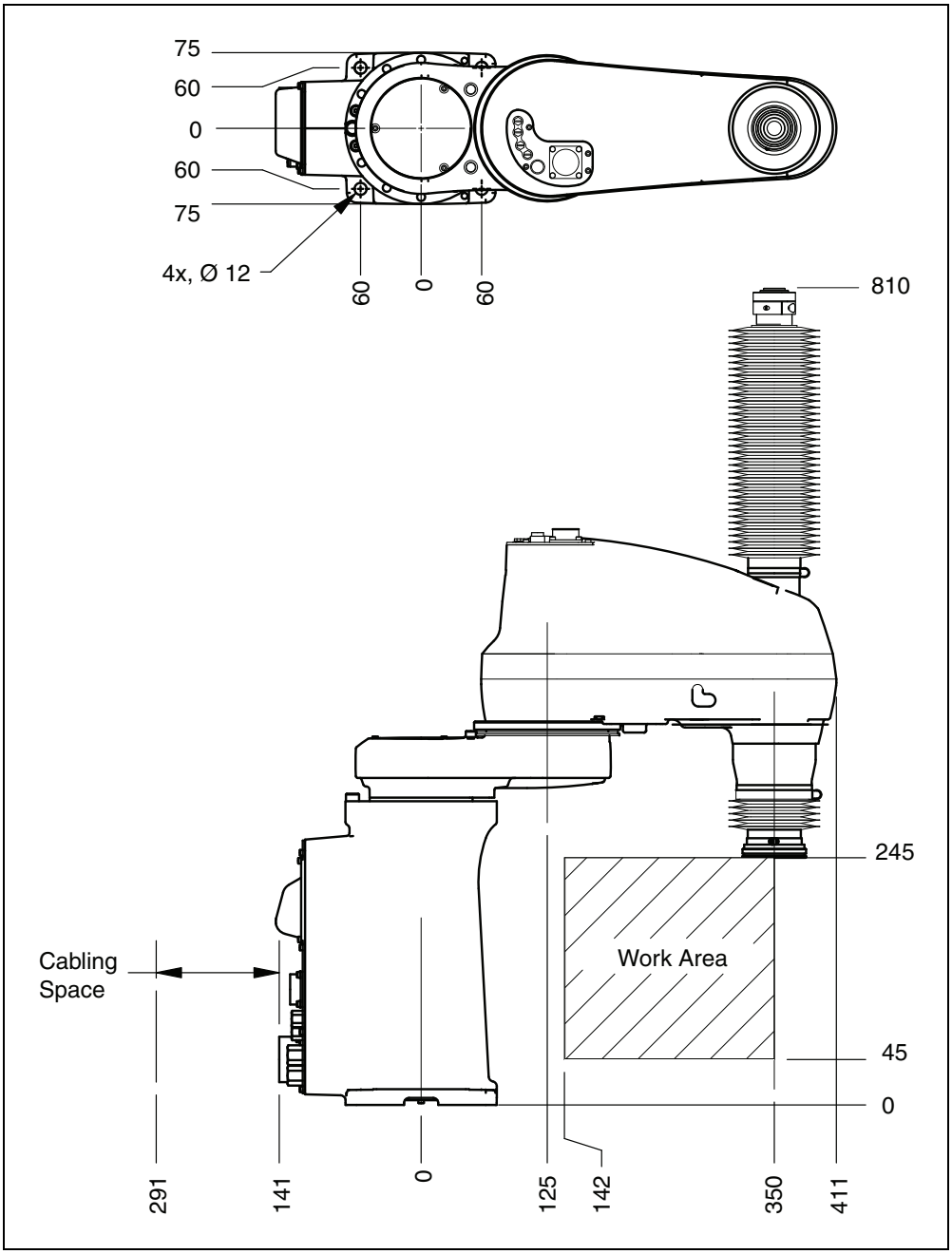


Figure 10-5. Cobra 350 CR/ESD Top and Side Dimensions

NOTE: The total height of the Cobra 350 CR/ESD robot is different than the standard robot. See See "Cobra 350 Top and Side Dimensions" for a comparison.

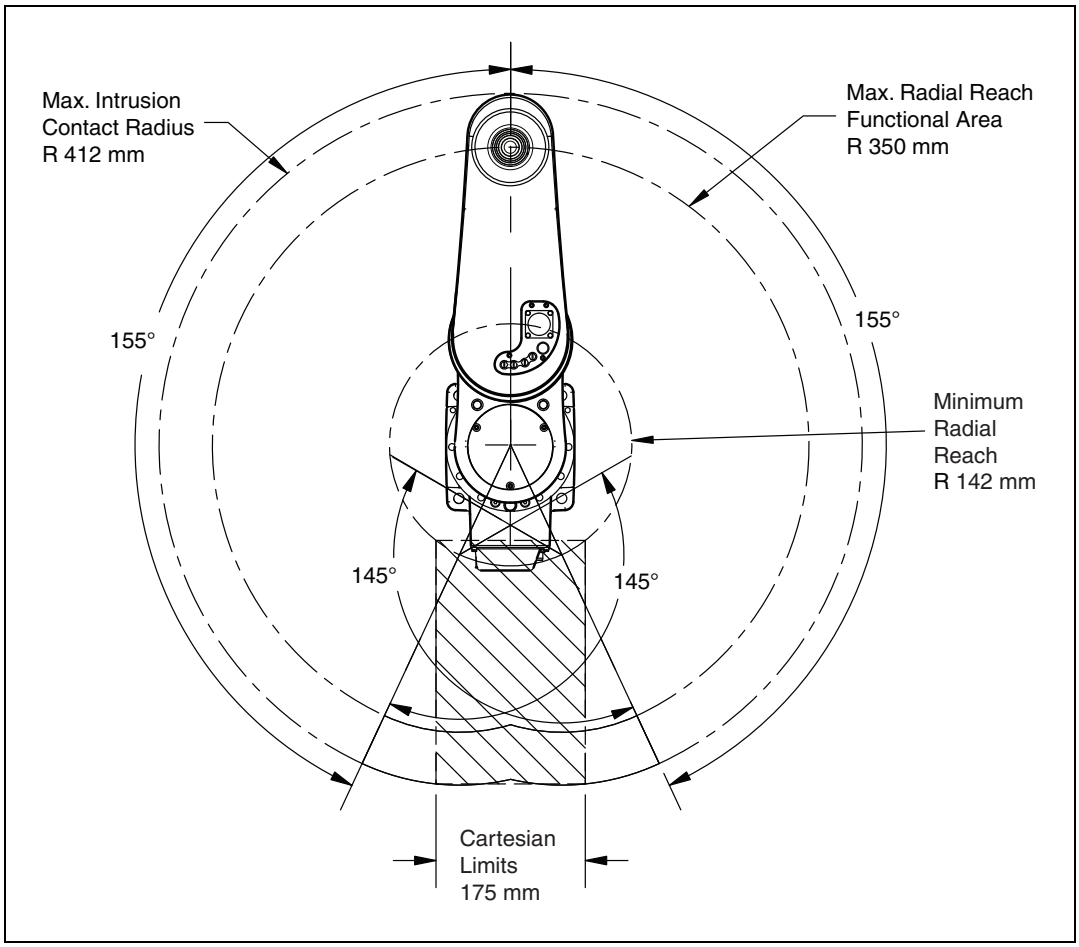


Figure 10-6. Cobra 350 CR/ESD Robot Working Envelope

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