OMRON

Cobra 350 Robot

User's Guide

I591-E-05

Copyright Notice

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Revision History

Revision code	Date	Revised Content
01	June, 2016	Original release
02	January, 2017	• Presented SmartController EX as an option, not required. • Added or modified system cable drawings accordingly. • Converted to OAT.css. • Added dwg showing required cooling space for eMB-40R mounting. • Changed diamond mounting alignment pin hole to 4 mm from 6. • Added part number for solenoid cable. • Updated graphics to OAT. • Added notes to stopping distance graph section.
03	July, 2017	• Removed 's' from all "s350" instances. • Replaced two Adept logos photos with Omron | adept logos. • Added photos clarifying insertion of Arm Power/Signal cable between robot and eMB-40/60R. • Noted difference for Cleanroom Arm Power/Signal connector. • Added mm to dimension drawings for camera bracket. • Changed axis to joint, axes to joints.
04	April, 2018	• Updated safety chapter and alert levels throughout manual. • Updated recommended power supply part numbers. • Update T20 and XMCP jumper cable part numbers. • Error reporting and Line E-Stop clarification. • Update ACE software disk to ACE software media.
05	March, 2019	• Updated safety chapter with current safety related information. • Revised encoder battery replacement procedure; added replacement procedure for PC boards with 3 connectors. • Added WEEE disposal information. • Updated copyright for 2019. • Updated all www.adept.com references to www.ia.omron.com. • Removed references to obsolete sDIO unit. • Added Status Fault Codes information. • Updated illustrations with call-outs and tables for translation compatibility. Other minor illustration improvements applied. • Replaced contact support@adept.com with "your local Omron support" in Chapter 9: Technical Specifications. • Added new figures to illustrate all encoder cable configurations and pinouts in Chapter 5: System Cable Installation. • Added a note about typical IO Blox configurations in Chapter 4: MotionBlox-40R. • Dual-Robot Configuration Guide renamed to Single and Multiple Robot Configuration Guide.

Chapter 1: Introduction

1.1 Product Description

Cobra 350 Robots

The Cobra 350 robot is a high-performance, four-joint SCARA robot (Selective Compliance Assembly Robot Arm). Joints 1, 2, and 4 are rotational; Joint 3 is translational. See Robot Joint Motions on page 10 for a description of the robot joint locations.

> **NOTE:** The robot motors are powered by an eMB-40R servo-controller/amplifier. The robot can be controlled by the eMB-40R, running eV+, or an optional SmartController EX motion controller, which also runs eV+.

Mechanical specifications for the Cobra 350 robots are provided in Technical Specifications on page 119.

A cleanroom model is also available, the Cobra 350 CR/ESD. See Cleanroom Robots on page 129 for information.

Figure 1-1. Cobra 350 Robot

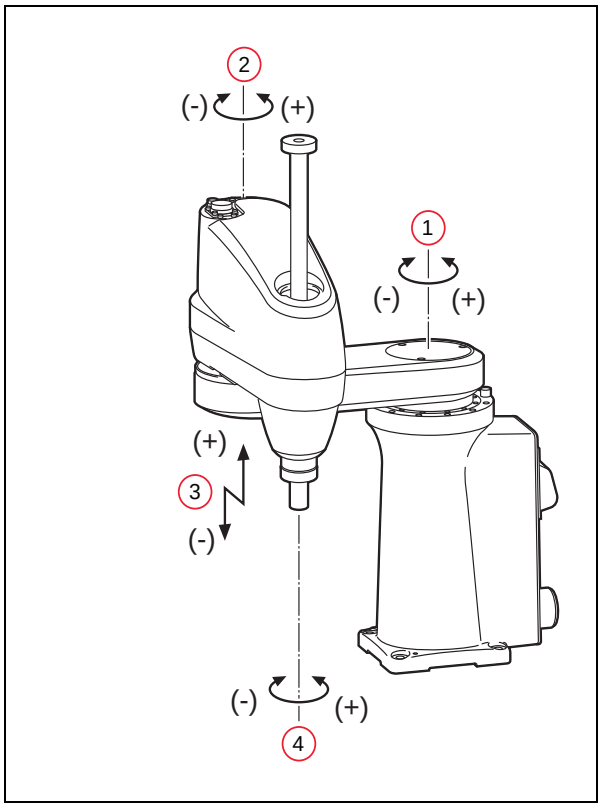


Figure 1-2. Robot Joint Motions

Table 1-1. Robot Joint Motion Description

Item	Description	Item	Description
1	1st Joint (J1)	2	2nd Joint (J2)
3	3rd Joint (J3)	4	4th Joint (J4)

SmartController EX (Option)

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

- Cobra 350 robots
- eCobra robots
- Quattro robots
- Viper robots

The SmartController EX supports a conveyor tracking option, as well as other options. The SmartController EX uses the eV+ Operating System (as does the eMB-40R). It offers scalability and support for IEEE 1394-based digital I/O and general motion expansion modules. The IEEE

1394 interface is the backbone of SmartServo, the distributed controls architecture supporting our products. The SmartController EX also includes Fast Ethernet and DeviceNet.

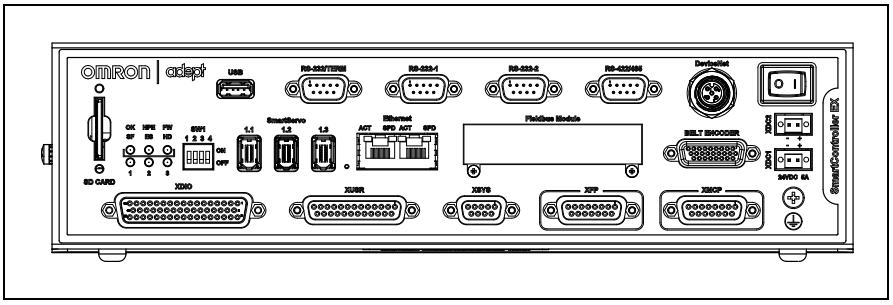


Figure 1-3. SmartController EX Motion Controller

MotionBlox-40R

The MotionBlox-40R (eMB-40R) Distributed Servo Controller controls the amplifiers to power the high-power motors of the Cobra 350 robot, and runs the eV+ operating system for motion control of the 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

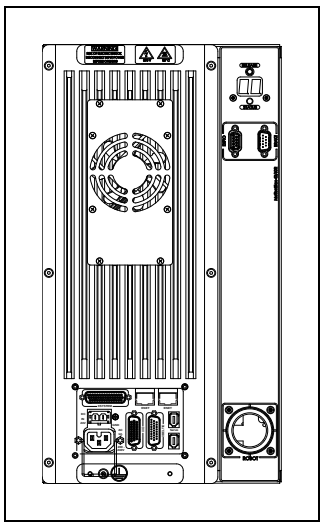


Figure 1-4. MotionBlox-40R

1.2 How Can I Get Help?

You can access information sources on our corporate web site:

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.
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.
Single and Multiple Robot Configuration Guide	Contains cable diagrams and configuration procedures for a single and multi-robot system.

Chapter 2: Safety

2.1 Dangers, Warnings, and Cautions

Alert Levels

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

DANGER: Identifies an imminently hazardous situation which, if not avoided, is likely to result in serious injury, and might result in fatality or severe property damage.

WARNING: Identifies a potentially hazardous situation which, if not avoided, will result in minor or moderate injury, and might result in serious injury, fatality, or significant property damage.

CAUTION: Identifies a potentially hazardous situation which, if not avoided, might result in minor injury, moderate injury, or property damage.

Alert Icons

The icon that starts each alert can be used to indicate the type of hazard. These will be used with the appropriate signal word - Danger, Warning, or Caution - to indicate the severity of the hazard. The text following the signal word will specify what the risk is, and how to avoid it.

Icon	Meaning	Icon	Meaning
	This is a generic alert icon. Any specifics on the risk will be in the text following the signal word.		This identifies a hazardous electrical situation.

Falling Hazards

WARNING: PERSONAL INJURY OR PROPERTY DAMAGE RISK
If mounted incorrectly, the robot can fall over and cause serious injury to personnel or damage to itself or other equipment.

Safety Barriers

To protect personnel from coming in contact with robot unintentionally or objects entering robot's operation zone, install user-supplied safety barriers in the workcell.

Special Information

There are several types of notation used to call out special information.

IMPORTANT: Information to ensure safe use of the product.

NOTE: Information for more effective use of the product.

Additional Information: Offers helpful tips, recommendations, and best practices.

Version Information: Information on differences in specifications for different versions of hardware or software.

2.2 Safety Precautions

WARNING: PERSONAL INJURY OR PROPERTY DAMAGE RISK
A Cobra 350 robot can cause serious injury or death, or damage to itself and other equipment, if safety precautions are not observed.

WARNING: ELECTROCUTION RISK
During maintenance, disconnect AC power from the robot, and install a lock-out tag-out to prevent anyone from reconnecting power.

User's Responsibilities

Safe use of Cobra 350 robots is your responsibility. To ensure compliance with safety rules and regulations:

- 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.
- 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.

Figure 2-1. Read Manual and Impact Warning Labels

- The robot system must not be used for purposes other than described in Intended Use of the Robot on page 17. Contact your local Omron support if you are not sure of the suitability for your application.
- The environment must be suitable for safe operation of the robot.
- 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.
- The Cobra 350 must be well maintained, so that their control and safety functions continue to work properly.

General Hazards

IMPORTANT: The following situations could result in injury or damage to the equipment.

- Do not place objects on the robot.
- Do not exceed the maximum payload capacity.
- Do not exceed the maximum recommended limits given in the technical specifications. See Technical Specifications on page 119
- Do not drop the robot, put weights on it or otherwise operate it irresponsibly.
- Do not use unauthorized parts.

Qualification of Personnel

It is the end-user's responsibility to ensure that all personnel who will work with or around robots have attended an appropriate Omron training course and have a working knowledge of the system. The user must provide the necessary additional training for all personnel who will be working with the system.

As noted in this and the Robot Safety Guide, certain procedures should be performed only by skilled or instructed persons. For a description of the level of qualification, we use the standard terms:

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

All personnel must observe industry-prescribed safety practices during the installation, operation, and testing of all electrically-powered equipment.

IMPORTANT: Before working with the robot, every entrusted person must confirm that they:

- Have the necessary qualifications
- Have received the guides (both this user's guide, and the Robot Safety Guide)
- Have read the guides
- Understand the guides
- Will work in the manner specified by the guides

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.

Releasing the Brakes

In case of an emergency or abnormal situation, the inner and outer robot arms can be manually moved without high power. However, only qualified personnel who have read and understood this User's Guide and *Robot Safety Guide* should manually move the robot into a safe state. Joints 3 and 4 are held by brakes, which can only be released with the Brake Release button. This requires 24 V power to the robot.

WARNING: PERSONAL INJURY RISK
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.

Releasing an E-Stop

CAUTION: PERSONAL INJURY OR PROPERTY DAMAGE RISK
If the robot's E-Stop is triggered, ensure that the cause of the E-Stop is resolved, and all surrounding areas are clear before releasing the E-Stop.

After the E-Stop button has been manually released, the robot will wait until the motors are manually enabled.

There are two ways to enable the motors:

- Enable power through ACE software installed on your PC
- Press the ROBOT POWER button on the Pendant

Once the motors are enabled, the robot will wait two seconds and then resume commanded motion, if there is adequate space to maneuver.

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 and Non-intended Use

Intended Use of the Robot

WARNING: PERSONAL INJURY RISK
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 Cobra 350 robot 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 5.0 kg. See Technical Specifications on page 119 for complete specifications. Refer to the *Robot Safety Guide* for details on the intended use of our robots.

Guidelines for safe use:

- Clean, dry mounting surfaces — surfaces that are routinely kept free of debris and liquids.

- Temperature — 5 to 40°C (41 to 104°F), with a recommended humidity range of 5% to 90%, non-condensing.

Non-Intended Use

The Cobra 350 is not intended for use in any of the following situations:

- 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
- Where the equipment will be subject to extremes of heat or humidity

Non-intended use of robots can:

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

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

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.

T20 Manual Control Pendant (Option)

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.

Disposal

Dispose of in accordance with applicable regulations.

Customers can contribute to resource conservation and protecting the environment by the proper disposal of WEEE (Waste Electronics and Electrical Equipment). All electrical and electronic products should be disposed of separately from the municipal waste system via designation collection facilities. For information about disposal of your old equipment, contact your local Omron support.

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%, 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 robot must always be stored and shipped in an upright position in a clean, dry area that is free from condensation. Do not lay the crate on its side or any other 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 your local Omron support as soon as possible.

If the items received do not match your order, please contact your local Omron support immediately.

Inspect each item for external damage as it is removed from its container. If any damage is evident, contact your local Omron support (see How Can I Get Help? on page 12).

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 1000 m
Pollution degree	2
Robot protection class	IP20 (NEMA Type 1)
NOTE: See Dimension Drawings on page 119 for robot dimensions.	

3.5 Mounting the Robot

At least two people should transport and store the packaged equipment. See the following figure.

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

Figure 3-1. Transporting Robot

Table 3-2. Transporting Robot Description

Item	Description
1	Person 1
2	Person 2

CAUTION: PERSONAL INJURY OR PROPERTY DAMAGE RISK
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 inch) thick steel plate mounted to a rigid tube frame. Excessive vibration or mounting flexure will degrade robot performance. The following figure 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. These are shown in the following figure. 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.

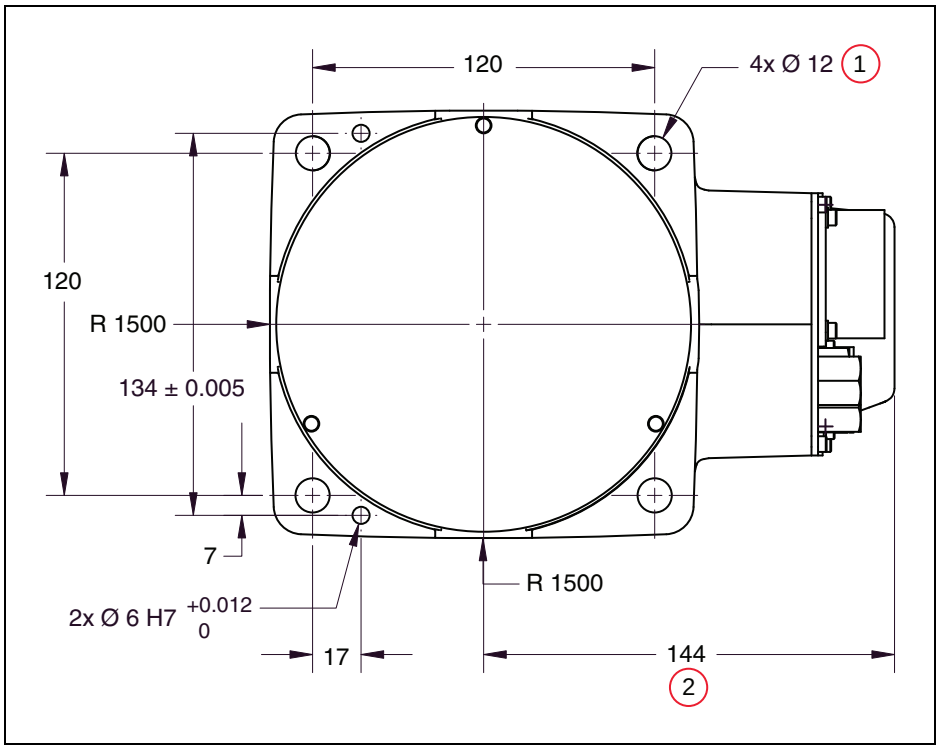


Figure 3-2. Robot Base Mounting Hole Pattern (Units in mm)

Table 3-3. Robot Base Mounting Hold Pattern Description

Item	Description
1	Through Holes
2	Allow 291 mm for cabling

Robot Mounting Procedure

1. See the preceding figure for the dimensions of the mounting holes in the robot base.
   - Drill four bolt holes, M10 x 30 mm (or 3/8-16 UNC) for machine bolts (user-supplied).

     These either need to be tapped for the bolts, or you can drill thru-holes, and use nuts on the other side of the mounting surface.
   - Drill a dowel pin hole Ø4 mm, H7 for the diamond-shaped pin, 10 mm deep or more.

     NOTE: The diamond-shaped pin has a Ø6 mm diamond-shaped section, but the shank is only Ø4 mm. The hole in the base of the Cobra 350 is Ø6, but you need to drill a Ø4 hole in your mounting surface for the shank of that pin.

- Drill a dowel pin hole Ø6 mm, H7 for the internally threaded positioning pin, 10 to 15 mm deep.

WARNING:
PERSONAL INJURY OR PROPERTY DAMAGE RISK
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 the diamond-shaped pin into one of the 6H7 diameter holes in the robot base.
3. Install an internally-threaded positioning pin into the other 6H7 hole in the robot base.
4. Turn joint 2 until the arm comes into contact with the mechanical hardstop to keep the robot in a safe position.

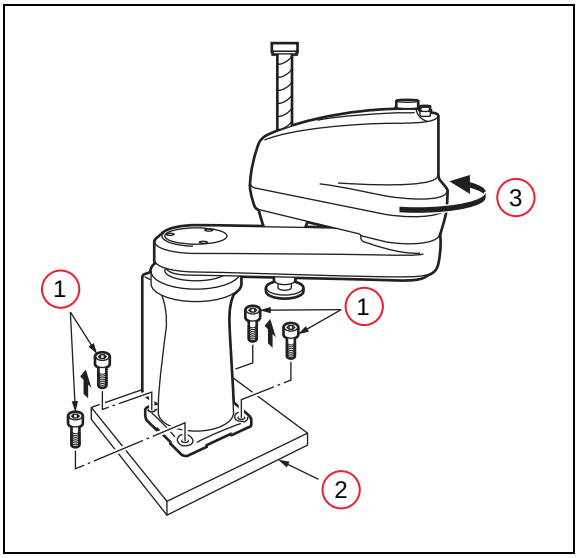


Figure 3-3. Rotate J2 to Safe Position

Table 3-4. J2 Rotation Details

Item	Description
1	Bolts
2	Pallet
3	Turn until it comes into contact with the mechanical end.

5. Remove the four bolts securing the robot base to the pallet. One person should support the J1 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.

8. Install the user-supplied mounting bolts and washers. Tighten bolts to the torque specified in the following table.

   Verify that the robot is mounted squarely (will not rock back and forth) before tightening the mounting bolts.

WARNING: PERSONAL INJURY OR PROPERTY DAMAGE RISK
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 103 for periodic maintenance.

Table 3-5. 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: MotionBlox-40R

4.1 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

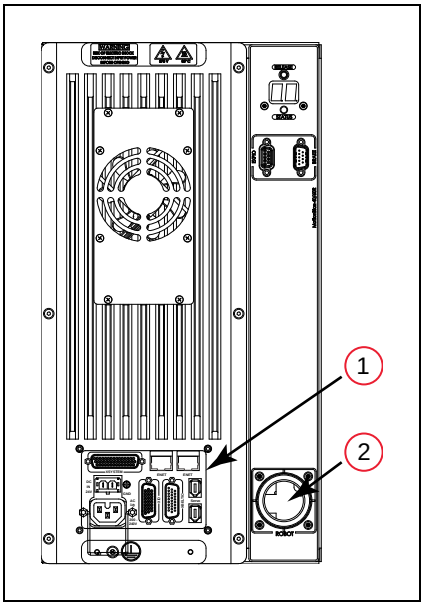


Figure 4-1. eMB-40R Front View

Table 4-1. eMB-40R Front View Description

Item	Description
1	eMB-40R Interface Panel
2	Robot Connector (for Arm Power / Signal Cable from Robot)

4.2 Connectors on eMB-40R Interface Panel

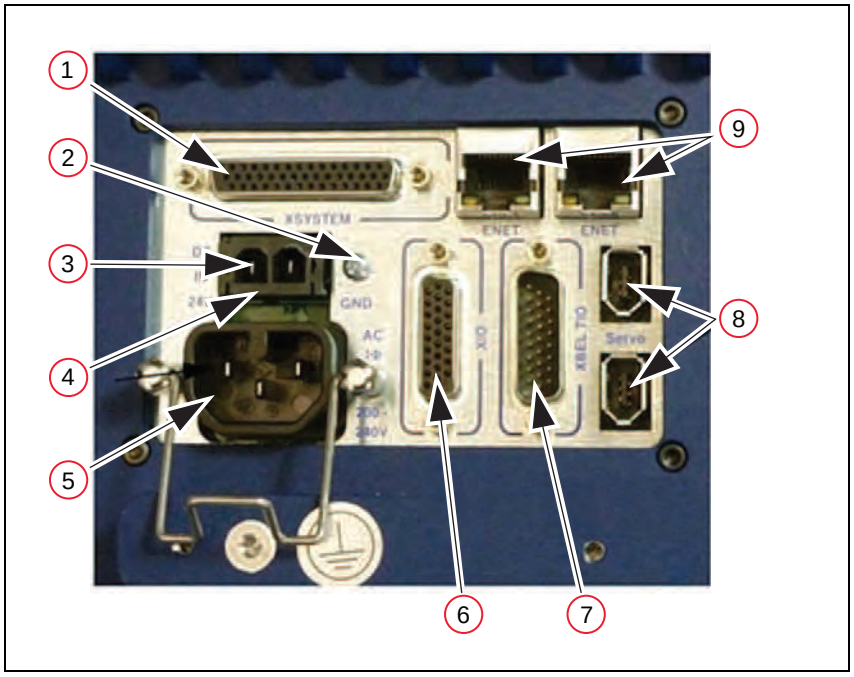


Figure 4-2. eMB-40R Interface Panel

Table 4-2. Connectors on the eMB-40R Interface Panel

Item	Name	Description
1	XSYSTEM	Connects to the controller XSYS connector. Requires an eAIB XSLV Adapter cable to connect to the XSYS cable, or an eAIB XSYS cable (HDB44-to-DB9, male). Replaces the XPANEL and XSLV on the legacy MB-40R.
2	Ground Point	Used for cable shield from user-supplied 24 VDC cable.
3	+24 V Pin	+24V connection point.
4	24 VDC Input	Used for user-supplied 24 VDC power. The mating connector is provided.
5	200 - 240 VAC Input	Used for 200-240 VAC, single-phase, input power. The mating connector is provided.
6	XIO	Used for user I/O signals for peripheral devices (DB-26, high density, female). Provides 8 outputs and 12 inputs. See Connecting Digital I/O to the System on page 38 for more information.
7	XBELTIO	Adds two belt encoders, EXPIO at the back of the robot, and an RS-232 interface, which is reserved for future use.
8	SmartServo Ports	Used for the IEEE 1394 cable from the controller.
9	Ethernet Ports	Reserved for future use.

4.3 eMB-40R Operation

Status LED

The Status LED indicator is located near 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.

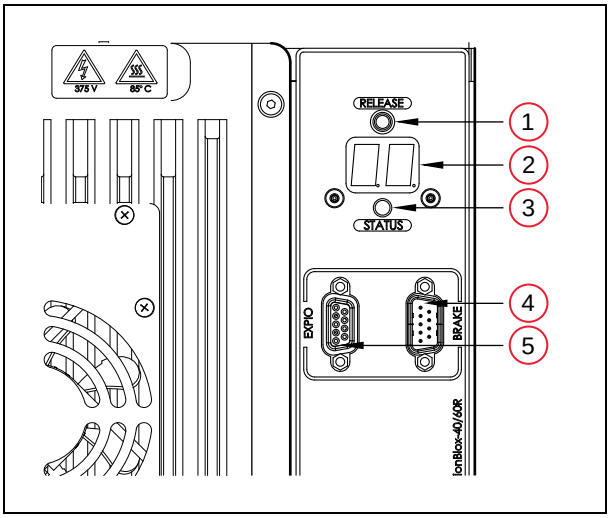


Figure 4-3. Controls and Indicators on eMB-40R

Table 4-3. eMB-40R Control and Indicator Description

Item	Description
1	Brake Release Button
2	Status Panel Display
3	Status LED Indicator
4	Brake Connector
5	EXPIO Connector

Table 4-4. 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 Controls and Indicators on eMB-40R on page 29, 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.

In the Status Panel Codes table, the '#' in the LED column represents a single digit. The digits will be displayed as one of the following:

0	1	2	3	4	5	6	7	8	9
0	1	2	3	4	5	6	7	8	9

Table 4-5. Status Panel Codes

LED	Status Code	V+ Error Message	V+ Error Code	Explanation	User Action
OK	OK	None	N/A	STATUS message-High Power OFF.	None
ON	ON	None	N/A	STATUS message-High Power ON.	None
MA	MA	None	N/A	STATUS message-Robot is in Manual Mode.	None
24	24	*RSC power failure*	-670	The 24 VDC input voltage is out of bounds (too high or low).	Check connections and voltage level from the user-supplied 24 VDC power supply.
A#	A#	*Motor Amplifier Fault*	-1018	A power amplifier fault is indicated on axis #.	Check user motor power connections for shorts or opens. Turn high power back on and restart the program. If the error persists, contact your local Omron support.
AC	AC	*RSC Power Failure*	-670	A loss of AC power was detected	Check user AC power connections for shorts or opens. Turn high power back on and restart the program. If the error persists, contact your local Omron support.
B#	B#	None	N/A	IO-Blox communications error with IO-Blox (#).	Check user IOBlox connections for shorts or opens. Check IOBlox address switches for proper configuration. Cycle power to the control system. If the error persists, contact your local Omron support.
BA	BA	None	N/A	The encoder backup battery is low.	Replace the encoder backup battery.

LED	Status Code	V+ Error Message	V+ Error Code	Explanation	User Action
D#	D#	*Duty-cycle exceeded* Mtr #	-1021	The indicated motor (#) has been driven hard for too long a period of time. The servo system has disabled power to protect the robot hardware.	Turn high power back on; reduce the speed and/or acceleration for the motion that was in progress or for motions that preceded that motion. Repeat the motion that failed.
E#	E#	*Encoder Fault*	-1025	The servo system has detected an encoder fault.	User actions vary by product. Please reference individual robot manuals for appropriate actions.
ES	ES	*E-STOP detected by robot*	-643	An E-STOP condition has been detected by the robot.	This is a normal response to many E-STOP conditions. Remove the source of the ESTOP and re-enable high power.
F 1	F1	*E-STOP detected by robot*	-643	The End-Of-Arm Breakaway Sensor has tripped (open circuit). Reporting of this error can be enabled / disabled via ACE.	Re-close the breakaway circuit and re-enable high power.
FM	FM	None	N/A	Firmware version mismatch.	Contact your local Omron support.
FW	FW	*1394 communications timeout*	-927	The IEEE 1394 communications system has failed to initialize or has lost communications with the SmartController EX.	This will occur normally if the SmartController EX is powered down separately from the robot systems. If it occurs unexpectedly, check the connections and integrity of the 1394 cabling.
h#	h#	*Robot overheated*	-606	The temperature sensor on the embedded processor board has reached its temperature limit. It may be neces-	Check for excessive ambient temperature, inadequate ventilation, and proper function

LED	Status Code	V+ Error Message	V+ Error Code	Explanation	User Action
				sary to slow the motion or insert pauses to reduce overall heating.	of any cooling fans.
H#	H#	*Motor over-heating* Mtr #	-1016	The motor encoder temperature sensor indicates an overtemperature.	Reduce the speed, acceleration and/or deceleration of the robot motions, or introduce delays in the application cycle to give the motor an opportunity to cool.
HV	hV	*RSC power failure*	-670	The high-voltage DC bus for the amplifiers is out of bounds (too high or low).	This may occur when AC power is unexpectedly removed. Check AC connections and re-enable high power. If the error persists, contact your local Omron support.
I#	I#	None	N/A	Servo initialization stages. These steps normally sequence (I0, I1, ...) on the display during normal system boot.	None, unless an initialization code persists longer than 30 seconds. This may indicate servo initialization has failed. Contact your local Omron support.
M#	M#	*Motor stalled* Mtr #	-1007	A motor stall occurs when the maximum allowed torque for a given motor was applied for longer than the defined timeout period. This typically occurs when an obstacle is encountered.	Check for obstacles and free movement of all joints. Turn high power back on and repeat the motion that failed.
P0	P0	*Power system failure* Code 0	-1115	The dual-channel brake circuit has reported a cyclic check error.	Contact your local Omron support.
P 1	P1	*Power system failure* Code 1	-1115	The power system has unexpectedly turned off power.	On PA-4 chassis, further information may be indicated on the PA-4 status lights. Refer to Adept

LED	Status Code	V+ Error Message	V+ Error Code	Explanation	User Action
					PA-4 Power Chassis User's Guide for details. Contact your local Omron support if the error persists.
P2	P2	*Power system failure* Code 2	-1115	The high-voltage DC bus to the regenerative energy dump circuit has experienced an over-voltage.	Contact your local Omron support.
P3	P3	*Power system failure* Code 3	-1115	The regenerative energy dump circuit has exceeded its max short-term dump rating.	Contact your local Omron support.
P4	P4	*Power system failure* Code 4	-1115	The high-voltage DC bus did not discharge its voltage when expected. (Note: This error is only relevant to legacy Cobra AIB systems.)	Contact your local Omron support.
P5	P5	*Power system failure* Code 5	-1115	An inrush error was detected by the power sequencer. This means the high-voltage DC bus failed to rise at the expected rate when power was enabled.	This can occur if AC power is abruptly removed during the high-power enable sequence. If it occurs unexpectedly, contact your local Omron support.
PR	PR	None	N/A	A servo task has overrun its allotted execution window.	If the problem persists, contact your local Omron support.
RC	RC	*RSC communications failure*	-651	There is a failure to communicate with the Robot Signature Card.	Contact your local Omron support.
S0	S0	*Safety System Fault* Code 0	-1109*	The robot hardware did not detect that the front-panel high-power button was pressed prior to the servo system attempting to enable power.	Contact your local Omron support.
S1	S1	*Safety System Fault* Code 1	-1109*	The SmartController EX has signaled a power off	Check for other messages on the

LED	Status Code	V+ Error Message	V+ Error Code	Explanation	User Action
				condition to the robot via the HIPWR_DIS line on the XSYS interface. This fault indication typically accompanies other fault conditions that cause "fatal error" on the SmartController EX error (such as a loss in IEEE-1394 communication).	SmartController EX that may indicate a fatal error. If the error source can be eliminated, re-enable power.
S2	S2	*Safety System Fault* Code 2	-1109*	The safety system experienced a failure on channel 1 during the cyclic check of dual-channel power system. This may indicate a welded relay contact or other hardware failure.	If the problem persists, contact your local Omron support.
S3	S3	*Safety System Fault* Code 3	-1109*	The safety system experienced a failure on channel 2 during the cyclic check of dual-channel power system. This may indicate a welded relay contact or other hardware failure.	If the problem persists, contact your local Omron support.
S4	S4	*Safety System Fault* Code 4	-1109*	The internal E-STOP delay timer timed out and power has been turned off. Under normal circumstances, software sequences the shutdown prior to the timeout, averting this message.	If the problem persists, contact your local Omron support.
S5	S5	*Safety System Fault* Code 5	-1109*	The power system was not properly unlocked by software during a power sequence while in manual mode.	Contact your local Omron support.
S6	S6	*Safety System Fault* Code 6	-1109*	The CAT-3 hardware safety system detected an encoder OVERSPEED and power has been turned off. This circuitry is active in manual mode	This fault is triggered on purpose during specific commissioning tests for the CAT-3 system. If the fault occurs dur-

LED	Status Code	V+ Error Message	V+ Error Code	Explanation	User Action
				only, on select robots which have the CAT-3 teach mode option installed.	ing normal operation, contact your local Omron support.
S9	S9	*Safety System Fault* Code 9	-1109*	A watchdog circuit that cross-checks the clocks for the dual-channel safety system is reporting an error.	Contact your local Omron support.
SE	SE	*Safety System Not Commissioned*	-648	The E-Stop Delay has not been commissioned and verified.	Commission and verify the E-Stop Delay.
SW	SW	None	N/A	Software watchdog timer timeout. On some products it is normal for this to occur momentarily during a servo reset.	If the problem persists, contact your local Omron support.
T0	T0	*Safety System Fault* Code 10	-1109	An error was detected during a software self test of a secondary safety and monitoring circuit (SRV_DIRECT / SRV_STAT).	Contact your local Omron support.
TR	TR	*Safety System Not Commissioned*	-648	The Teach Restrict feature has not been commissioned and verified.	Commission and verify the Teach Restrict feature.
V#	V#	*Hard envelope error* Mtr #	-1027	The indicated motor was not tracking the commanded position with sufficient accuracy as set by ACE.	Turn on high power and try to perform the motion at a slower speed. Make sure that nothing is obstructing the robot's motion. If the error recurs, contact your local Omron support.

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

The Brake Release button is located at the top right of the eMB-40R, as shown in Controls and Indicators on eMB-40R on page 29. 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 brakes, which allows movement of Joints 3 and 4. An additional Brake Release button is provided on the robot. For details, see System Operation on page 87.

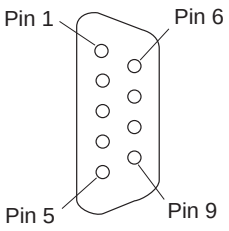
> **NOTE:** If this button is pressed while high power is on, high power will automatically shut down.

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 XIO Input Specifications on page 41 for details.

Table 4-6. 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		

4.4 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.

NOTE: A typical IO Blox configuration is shown in Figure 4-4. Other configurations may be possible. Contact your local Omron support for more information.

Table 4-7. 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 39
XDIO on optional SmartController EX	12 inputs 8 outputs	*SmartController EX User's Guide*
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*

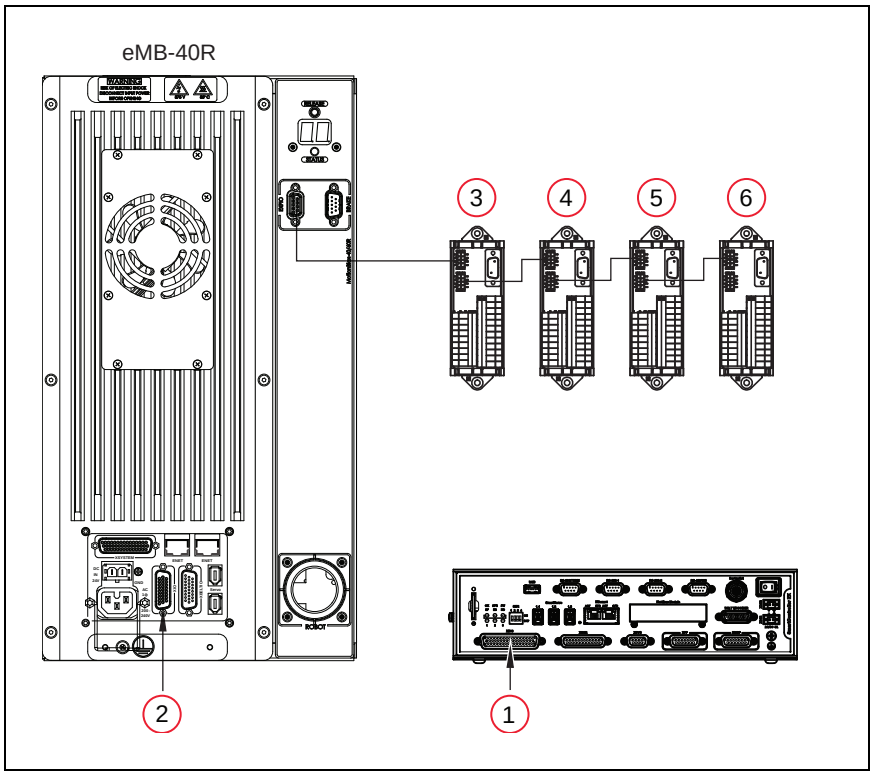


Figure 4-4. Connecting Digital I/O to the System

Table 4-8. Default Digital I/O Signal Configuration, Single Robot System

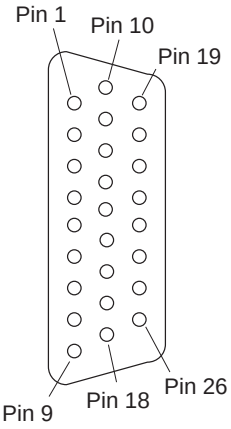
Item	Location	Type	Signal Range
1	Optional SmartController EX, XDIO connector	12 Inputs	1001 - 1012
		8 Outputs	0001 - 0008
2	eMB-40R, 1 XIO connector	12 Inputs	1097 - 1108
		8 Outputs	0097 - 0104
3	Optional IO Blox 1	8 Inputs	1113 - 1120
		8 Outputs	0105 - 0112
4	Optional IO Blox 2	8 Inputs	1121 - 1128
		8 Outputs	0113 - 0120
5	Optional IO Blox 3	8 Inputs	1129 - 1136
		8 Outputs	0121 - 0128
6	Optional IO Blox 4	8 Inputs	1137 - 1144
		8 Outputs	0129 - 0136

4.5 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 4-9. 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 m, with flying leads on user's end (see XIO Breakout Cable on page 46). 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 4-10. 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	Vin = 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 (Vin/Iin)	3.9 KW minimum
Current at Vin = +24 VDC	Iin£ 6 mA
Turn on response time (hardware) Software scan rate/response time	5 µsec maximum 16 ms scan cycle/ 32 ms max response time
Turn off response time (hardware) Software scan rate/response time	5 µsec maximum 16 ms scan cycle/ 32 ms max response time

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

Typical Input Wiring Example

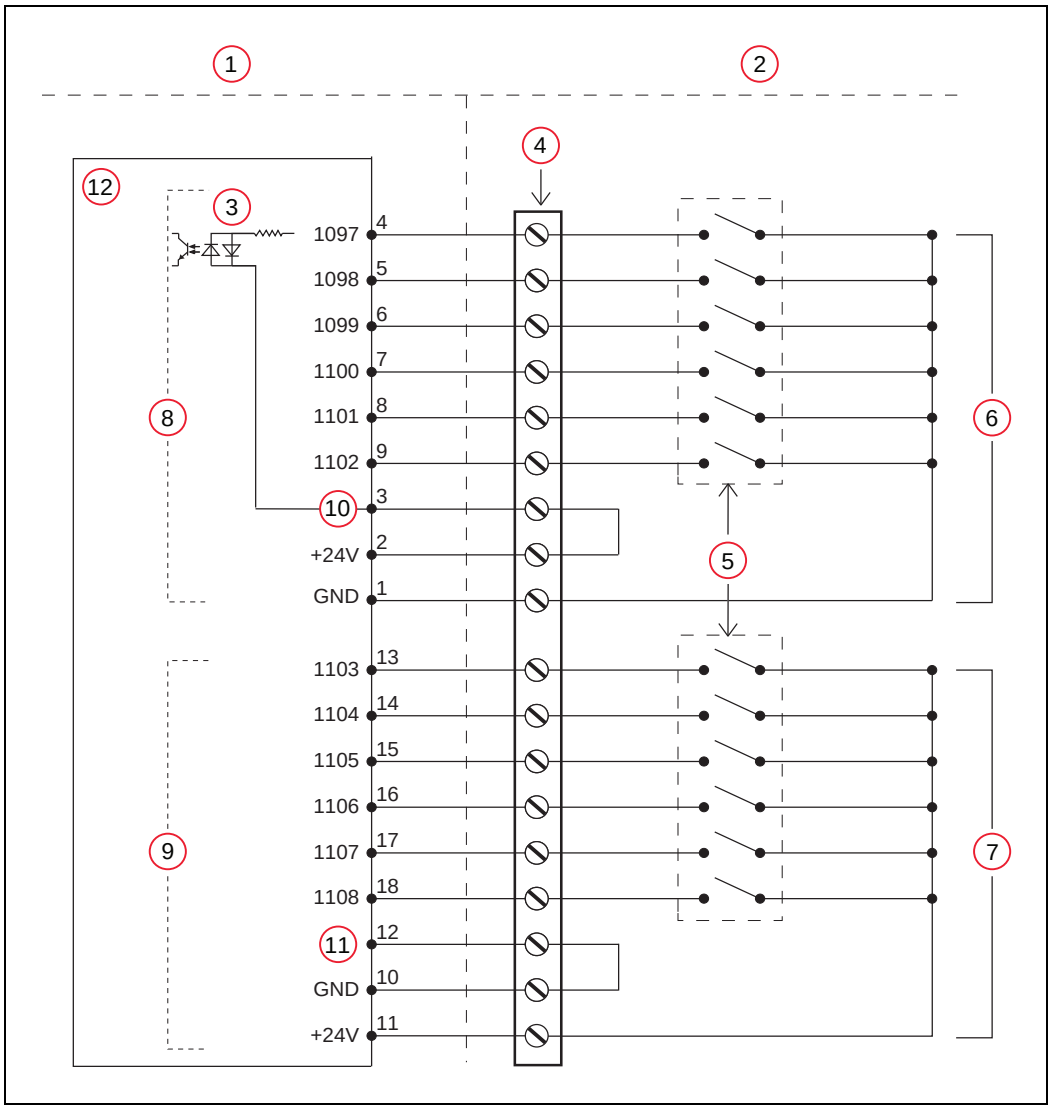


Figure 4-5. Typical User Wiring for XIO Input Signals

NOTE: All input signals can be used for either sinking or sourcing configurations.

Table 4-11. Typical User Wiring for XIO Input Signal Description

Item	Description
1	Supplied Equipment
2	User-supplied Equipment
3	Equivalent Circuit
4	Wiring Terminal Block
5	Typical User Input Signals (part present sensor, feeder empty sensor, part jammed sensor, sealant ready sensor, etc.)
6	Bank 1 configured for Sinking (NPN) inputs
7	Bank 2 configured for Sourcing (PNP) inputs
8	Input Bank 1
9	Input Bank 2
10	Bank 1 Common
11	Bank 2 Common

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 XIO Signal Designations on page 40), or through the optional XIO Termination Block. See the documentation supplied with the Termination Block for details.

XIO Output Specifications

Table 4-12. XIO Output Circuit Specifications

Parameter	Value
Power supply voltage range	See Specifications for 24 VDC User-Supplied Power Supply on page 67.
Operational current range, per channel	$I_{out} \leq$ 700 mA
Total Current Limitation, all channels on.	$I_{total} \leq$ 1.0 A @ 50°C ambient $I_{total} \leq$ 1.5 A @ 25°C ambient
On-state resistance (I_{out} = 0.5 A)	$R_{on} \leq$ 0.32 Ω @ 85°C
Output leakage current	$I_{out} \leq$ 25 µA
Turn-on response time	125 µsec max., 80 µsec typical (hardware only)
Turn-off response time	60 µsec. max., 28 µsec typical (hardware only)
Output voltage at inductive load turnoff (I_{out} = 0.5 A, Load = 1 mH)	(+V - 65) $\leq V_{demag} \leq$ (+V - 45)
DC short circuit current limit	0.7 A $\leq I_{LIM} \leq$ 2.5 A
Peak short circuit current	$I_{ovpk} \leq$ 4 A

Typical Output Wiring Example

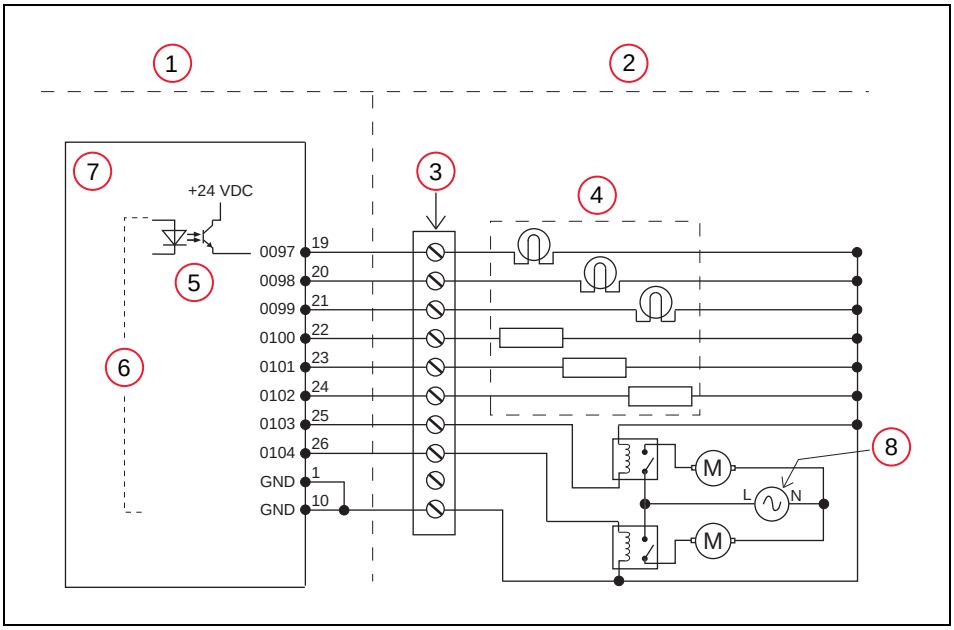


Figure 4-6. Typical User Wiring for XIO Output Signals

Table 4-13. Typical User Wiring for XIO Output Signal Description

Item	Description
1	Supplied Equipment
2	User-supplied Equipment
3	Wiring Terminal Block
4	Typical User Loads
5	Equivalent Circuit
6	Outputs 1 - 8
7	XIO Connector (26-Pin Female D-Sub)
8	Customer AC Power Supply

XIO Breakout Cable

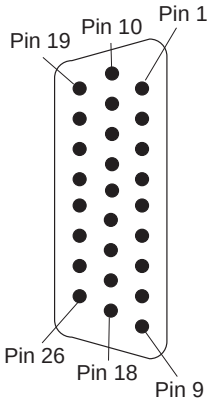
The XIO Breakout cable is available as an option—see the following figure. This cable connects to the XIO connector on the eMB-40R, and provides flying leads on the user's end, for connecting input and output signals in the workcell. The cable length is 5 m (16.4 ft).

See the following table for the cable wire chart.

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

Figure 4-7. Optional XIO Breakout Cable

Table 4-14. 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	

4.6 Mounting the eMB-40R

Dimensions and Mounting Holes

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

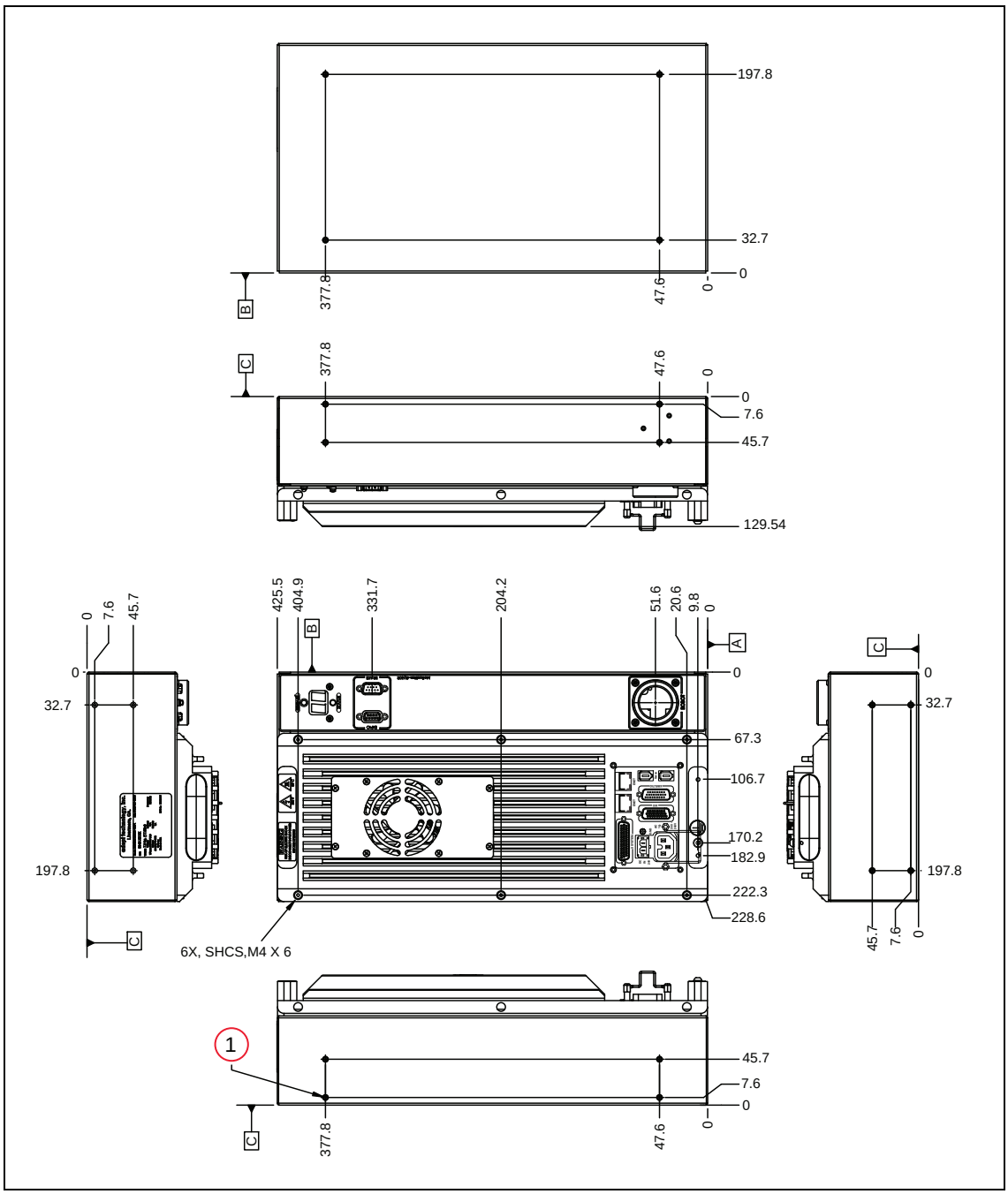


Figure 4-8. eMB-40R Mounting Dimensions. (1) M4 X 7 mm DP blind studs spaced as shown, 20X (Units in mm).

NOTE: 112 mm clearance required in front of unit to remove amplifiers from box enclosure.

Mounting Clearances

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.

The following space must be left around the eMB-40R for proper cooling:

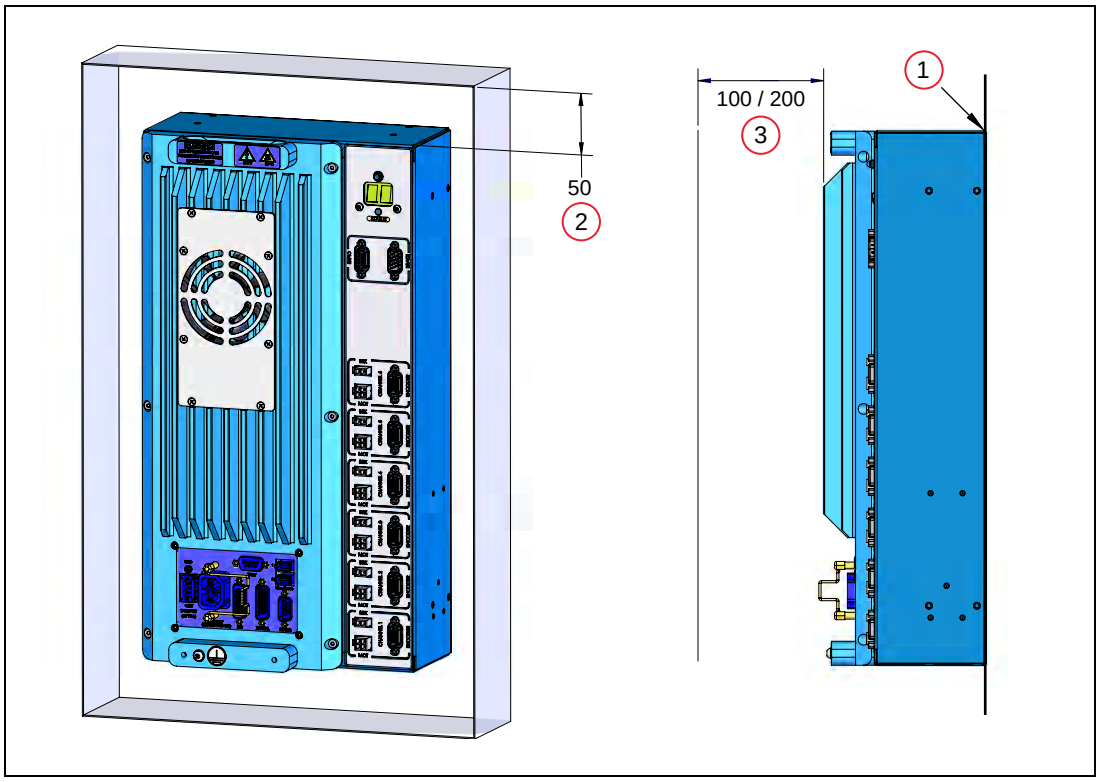


Figure 4-9. Clearance for the eMB-40R (Units in mm)

Table 4-15. eMB-40R Clearance Description

Item	Surface	Air Gap
1	Back	0 mm
2	Sides	50 mm
3	Front, when wall-mounted	100 mm
	Front, when flat-mounted	200 mm

NOTE: These dimensions assume the eMB-40R has exposure to outside air, rather than being in a sealed container. Any sealed container would need to provide sufficient cooling for the eMB-40R's internal fan to be effective.

Chapter 5: System Cable Installation

5.1 System Cables, without SmartController EX

The letters in the following figure correspond to the letters in Table 5-1. Cables and Parts Description (without SmartController EX). The numbers in the following figure correspond to the numbers in Table 5-2. Connections Installation Steps

The figure includes the optional T20 pendant and optional SmartVision MX industrial PC. These items may not be present in your system.

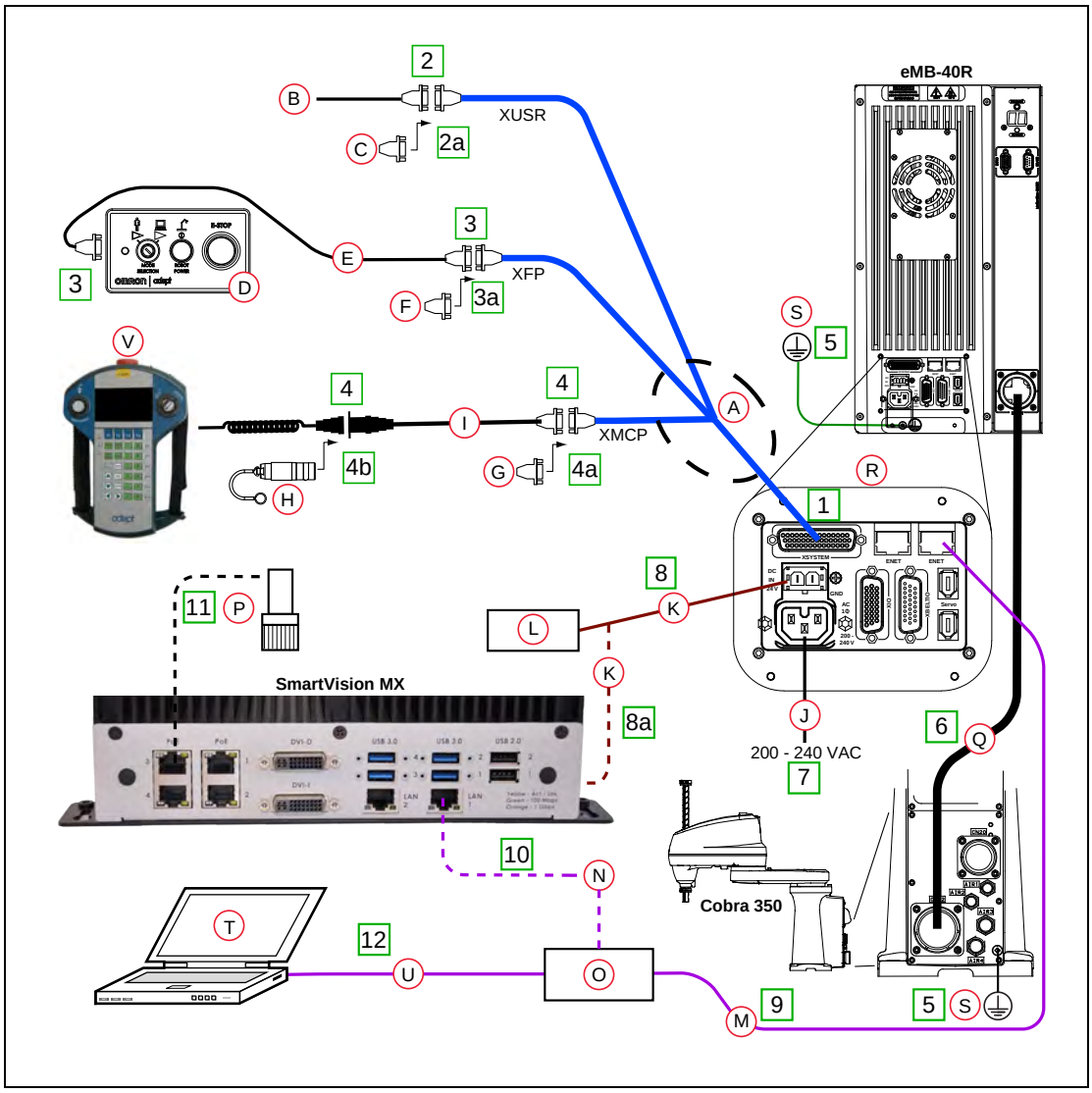


Figure 5-1. System Cable Diagram for Cobra 350 Robot with eMB-40R, Pendant, and Vision

NOTE: See System Cable Installation on page 51 for additional system grounding information.

List of Cables and Parts

Open the Accessory box and locate the eAIB XSYSTEM cable. Cable and peripheral connections are shown in the preceding figure. Installation steps are covered in Connection Installation Overview on page 54.

Table 5-1. Cables and Parts Description (without SmartController EX)

Item	Description	Part #	Standard	Option	User-supplied	Notes
A	eAIB XSYSTEM Cable Assembly	13323-000	X			
B	User E-Stop, Safety Gate	n/a			X	
C	XUSR Jumper Plug	04736-000	X			Required if no E-stop, safety gate or muted safety gate used.
D	Front Panel	90356-10358	X		X	Front Panel (D) or Front Panel Jumper Plug (F) must be used.
E	Front Panel Cable	10356-10500	X		X	
F	Front Panel Jumper Plug	10053-000	X			Front Panel (D) or Front Panel Jumper Plug (F) must be used.
G	XMCP Jumper Plug	10052-000	X			XMCP Jumper Plug (G), T20 Bypass Plug (H), or T20 Pendant must be used.
H	T20 Pendant Bypass Plug	10048-000		X		XMCP Jumper Plug (G), T20 Bypass Plug (H), or T20 Pendant must be used.
I	T20 Pendant Adapter Cable	10051-003		X		

Item	Description	Part #	Standard	Option	User-supplied	Notes
The following three items are available, as an option, in the power supply/cable kit 90565-010						
J	VAC Power Cable	04118-000		X	X	200-240 VAC, single phase
K	24 VDC Power Cable	04120-000		X	X	
L	24 VDC, 6 A Power Supply	04536-000		X	X	85-264 VAC universal input
M	Ethernet Cable - switch -> eMB-40R	n/a			X	
N	Ethernet Cable - switch -> SmartVision MX	n/a			X	
O	Ethernet switch	n/a			X	
P	Camera and cable	n/a		X	X	
Q	Arm Power / Signal Cable	05020-000	X			
R	Robot Interface Panel	n/a	X			
S	User-supplied ground wire	n/a			X	
T	PC running ACE Software	n/a			X	
U	Ethernet Cable - PC-> ethernet switch	n/a			X	
V	T20 Pendant Assembly	10054-010		X		Optional T20 Pendant Kit (10046-010) includes items V, H, and I

The XUSR, XMCP, and XFP jumpers intentionally bypass safety connections so you can test the system functionality during setup.

WARNING: PERSONAL INJURY RISK
Under no circumstances should you run a Cobra 350 system, in production mode, with all three jumpers installed. This would leave the system with no E-Stops.

Connection Installation Overview

The numbers in Figure 5-1. System Cable Diagram for Cobra 350 Robot with eMB-40R, Pendant, and Vision correspond to the steps in the cable installation overview description table. Refer to System Cables, without SmartController EX on page 51 for more information about cables and parts.

Power requirements for the SmartVision MX industrial PC are covered in that user guide. For 24 VDC, both the Cobra 350 robot and a SmartVision MX can usually be powered by the same power supply.

Table 5-2. Connections Installation Steps

Step	Connection Description	Item
1	Connect eAIB XSYSTEM cable to XSYSTEM on eMB-40R.	A, R
2	Connect a user E-Stop or Muted Safety Gate to the eAIB XSYSTEM cable XUSR connector or verify XUSR jumper plug (2a) is installed in eAIB XSYSTEM cable XUSR connector. Refer to Installing User-Supplied Safety Equipment on page 76 for more information.	B, C
3	Connect Front Panel cable to Front Panel and eAIB XSYSTEM cable XFP connector. If no Front Panel is used, install FP jumper (3a) on eAIB XSYSTEM cable XFP connector. See NOTE after table.	D, E, F
4	Connect T20 adapter cable and the T20 Pendant to eAIB XSYSTEM cable XMCP connector. If no T20 Pendant, install XMCP jumper (4a) or T20 Adapter Cable with T20 bypass plug (4b).	G or H, I, T20 Pendant
5	Connect user-supplied ground. Refer to Grounding the Robot System on page 75 for more information.	S
6	Connect the Arm Power / Signal cable to the eMB-40R and the Cobra 350 Robot. Refer to Cable Connection from eMB-40R to Robot on page 66 for more information.	Q
7	Connect 200-240 VAC to VAC Input on eMB-40R Interface Panel; secure with clamp. Refer to Connecting 200-240 VAC Power on page 70 for more information.	J, R
8	Connect 24 VDC to DC Input on Interface Panel. Connect 24 VDC and shield ground to SmartVision MX, if used (8a). See SmartVision MX user's guide for location. Refer to Connecting 24 VDC Power to eMB-40R on page 67 for more information.	K, L, R

Step	Connection Description	Item
9	Connect Ethernet cable from switch to eMB-40R. Refer to Connecting the PC to the SmartController EX on page 65 for more information.	M, O, R
10	Connect Ethernet cable from switch to SmartVision MX, if used. Refer to Connecting the PC to the SmartController EX on page 65 for more information.	N, O
11	Connect optional camera and cable to SmartVision MX, if used.	P
12	Connect Ethernet cable from PC to switch if used. Refer to Connecting the PC to the SmartController EX on page 65 for more information.	T, U

NOTE: A front panel ships with each Cobra 350 robot system, but you can choose not to use it if you replace its functionality with equivalent circuits. That is beyond the scope of this guide.

Other Cables

NOTE: The following cables are not covered in the steps in the preceding table. Refer to Optional Cables on page 60 for more information.

Part Description	Notes
XIO Breakout Cable, 12 inputs/ 8 outputs, 5 m	Available as option
eAIB XBELT IO Adapter Cable	Available as option

5.2 System Cables, with Optional SmartController EX, SmartVision MX

The letters in the following figure correspond to the letters in Table 5-3. Cables and Parts Description (with SmartController EX) on page 57.

When the optional SmartController EX is included in the system, the Pendant, Front Panel, and XUSR connections must connect to the SmartController EX.

The figure includes the optional T20 Pendant, SmartVision MX, and SmartController EX. These items may not be present in your system.

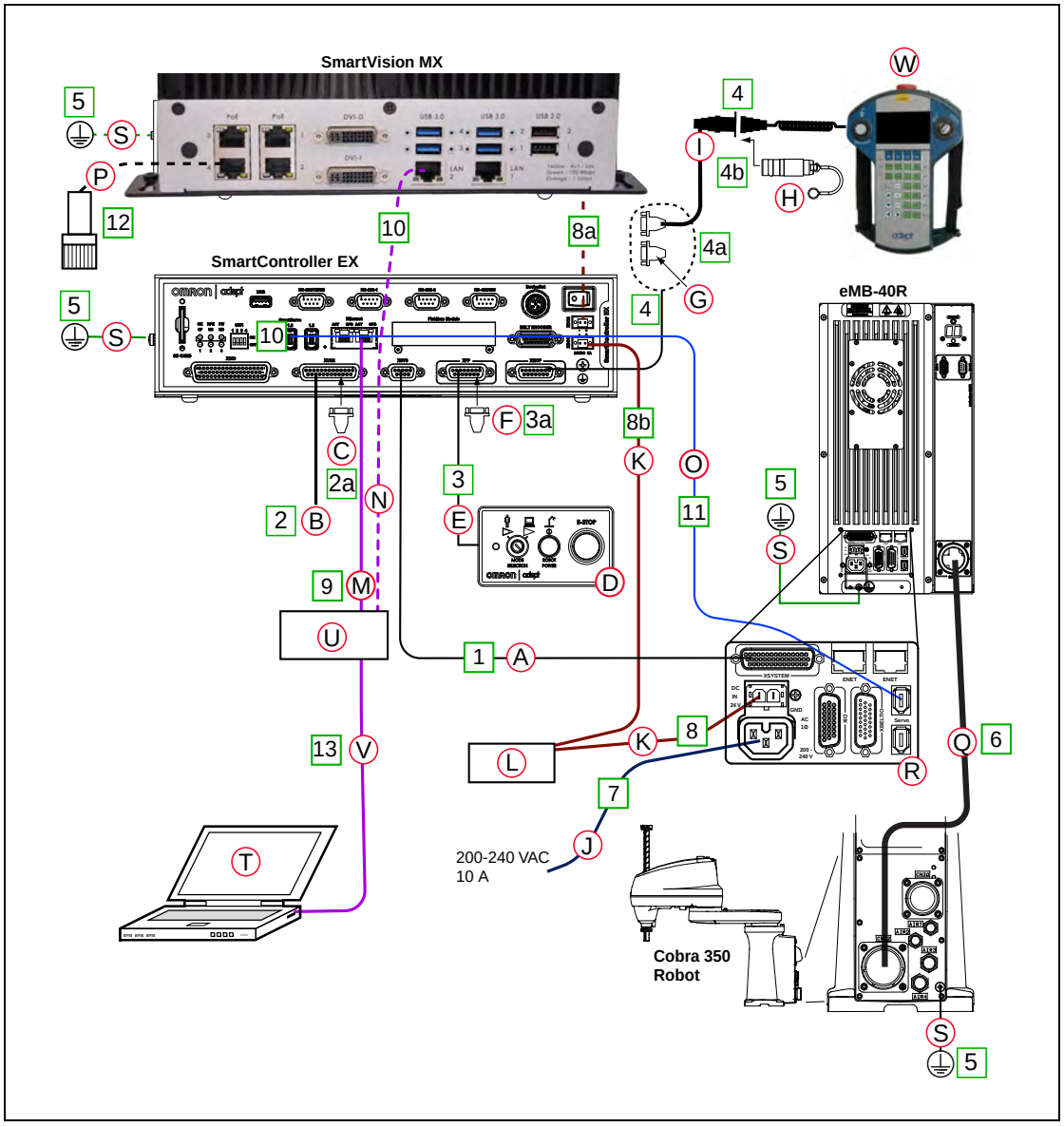


Figure 5-2. System Cable Diagram with SmartController EX

Installing a SmartController EX Motion Controller

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

1. Mount the SmartController EX and Front Panel.
2. Connect the Front Panel to the SmartController EX.
3. Connect the pendant (if purchased) to the SmartController EX.

   Connect a jumper plug, if no pendant is being used.
4. Connect user-supplied 24 VDC power to the controller.

   Instructions for creating the 24 VDC cable, and power specification, are covered in the *SmartController EX User's Guide*.
5. Install a user-supplied ground wire between the SmartController EX and ground.

List of Cables and Parts

Table 5-3. Cables and Parts Description (with SmartController EX)

Part	Cable and Parts List	Part #	Standard	Option	User-supplied	Notes
A	eAIB XSYS Cable	13323-000	X			
B	User E-Stop, Safety Gate	n/a			X	
C	XUSR Jumper Plug	04736-000	X			Required if no E-stop, safety gate or muted safety gate used.
D	Front Panel	90356-10358	X		X	Front Panel (D) or Front Panel Jumper Plug (F) must be used.
E	Front Panel Cable	10356-10500	X		X	
F	Front Panel Jumper Plug	10053-000	X			Front Panel (D) or Front Panel Jumper Plug (F) must be used.
G	XMCP Jumper Plug	10052-000	X			XMCP Jumper Plug (G), T20 Bypass Plug (H), or T20 Pendant must be used.

Part	Cable and Parts List	Part #	Standard	Option	User-supplied	Notes
H	T20 Pendant Bypass Plug	10048-000		X		XMCP Jumper Plug (G), T20 Bypass Plug (H), or T20 Pendant must be used.
I	T20 Pendant Adapter Cable	10051-003		X		
The following three items are available, as an option, in the power supply/cable kit 90565-010						
J	VAC Power Cable	04118-000		X	X	200-240 VAC, single phase
K	24 VDC Power Cable	04120-000		X	X	
L	24 VDC, 6 A Power Supply	04536-000		X	X	85 - 264 VAC universal input
M	Ethernet Cable, Switch (if used) -> SmartController EX	n/a			X	
N	Ethernet Cable, Switch (if used) -> SmartVision MX, if used	n/a			X	
O	IEEE 1394 cable	13632-045	X			
P	Camera and cable	n/a		X	X	
Q	Arm Power / Signal Cable	05020-000	X			
R	Robot Interface Panel	n/a	X			
S	User-supplied ground wire	n/a			X	
T	PC running ACE Soft-ware	n/a			X	
U	Ethernet Switch	n/a			X	
V	Ethernet Cable - PC -> ethernet switch	n/a			X	
W	T20 Pendant Assembly	10054-010		X		Optional T20 Pend-ant Kit (10046-010) includes items W, H, and I

The XUSR, XMCP, and XFP jumpers intentionally bypass safety connections so you can test the system functionality during setup.

WARNING: PERSONAL INJURY RISK
Under no circumstances should you run a Cobra 350 system, in production mode, with all three jumpers installed. This would leave the system with no E-Stops.

Cable Installation Overview

Table 5-4. Connections Installation Steps

Step	Connection	Part
1	Connect eAIB XSYS cable to XSYSTEM on eMB-40R. Refer to Cable Connections from eMB-40R to SmartController EX on page 65 for more information.	A
2	Connect a user E-Stop or Muted Safety Gate to the XUSR connector or verify XUSR jumper plug is installed in XUSR connector (2a). Refer to Installing User-Supplied Safety Equipment on page 76 for more information.	B, C
3	Connect Front Panel cable to Front Panel and XFP connector or if no Front Panel, install FP jumper on XFP connector (3a).	D, E, F
4	Connect Pendant adapter cable to XMCP connector and T20 Pendant. If no Pendant, install XMCP jumper (4a) or bypass plug (4b).	H, I, G, T20 Pendant
5	Connect user-supplied ground to robot, SmartController EX, and SmartVision MX. See user's guides for locations. Refer to Grounding the Robot System on page 75 for more information.	S
6	Connect the Arm Power / Signal cable to the eMB-40R and the Cobra 350 Robot. Refer to Cable Connection from eMB-40R to Robot on page 66 for more information.	Q
7	Connect 200-240 VAC to VAC Input on eMB-40R Interface Panel; secure with clamp. Refer to Connecting 200-240 VAC Power on page 70 for more information.	J, R
8	Connect 24 VDC to DC Input on Interface Panel. Connect 24 VDC and shield ground to SmartVision MX, if used (8a). See SmartVision MX user's guide for location. Connect 24 VDC to SmartController EX, if used (8b). Refer to Connecting 24 VDC Power to eMB-40R on page 67 for more information.	R, K, L

Step	Connection	Part
9	Connect Ethernet cable to SmartController EX, if used.	M,U
10	Connect Ethernet cable to SmartVision MX, if used.	N, U
11	Connect IEEE 1394 cable between SmartController EX and eMB-40R SmartServo. Refer to Cable Connections from eMB-40R to SmartController EX on page 65 for more information.	O, R
12	Connect optional camera and cable to SmartVision MX, if used.	P
13	Connect Ethernet cable from PC to switch if used. Refer to Connecting the PC to the SmartController EX on page 65 for more information.	T, U, V

5.3 Optional Cables

XIO Breakout Cable

The XIO Breakout cable is for using the I/O on the eAIB. This cable provides access to 12 inputs and 8 outputs (5 m). Refer to XIO Breakout Cable on page 46 for more information.

DB9 Splitter Cable

An optional Y cable attaches at the SmartController EX XSYS connector and splits it into two XSYS connectors. This is part number 00411-000. See the *Single and Multiple Robot Configuration Guide*.

eAIB XBELT IO Adapter Cable

The optional eAIB XBELT IO Adapter cable split the eAIB XBELTIO port into a belt encoder lead, an Intelligent Force Sensor or IO Blox lead, and an RS-232 lead. If the system has a SmartController EX, this is only needed for Intelligent Force Sensing.

Find the pin connection diagrams in the figures below.

SmartController EX Belt Encoder Y-Adapter Cable

The optional SmartController EX Belt Encoder Y-Adapter cable split the SmartController EX BELT ENCODER port into two belt encoder leads for encoders 1 and 2 and encoders 3 and 4.

Find the pin connection diagrams in the figures below.

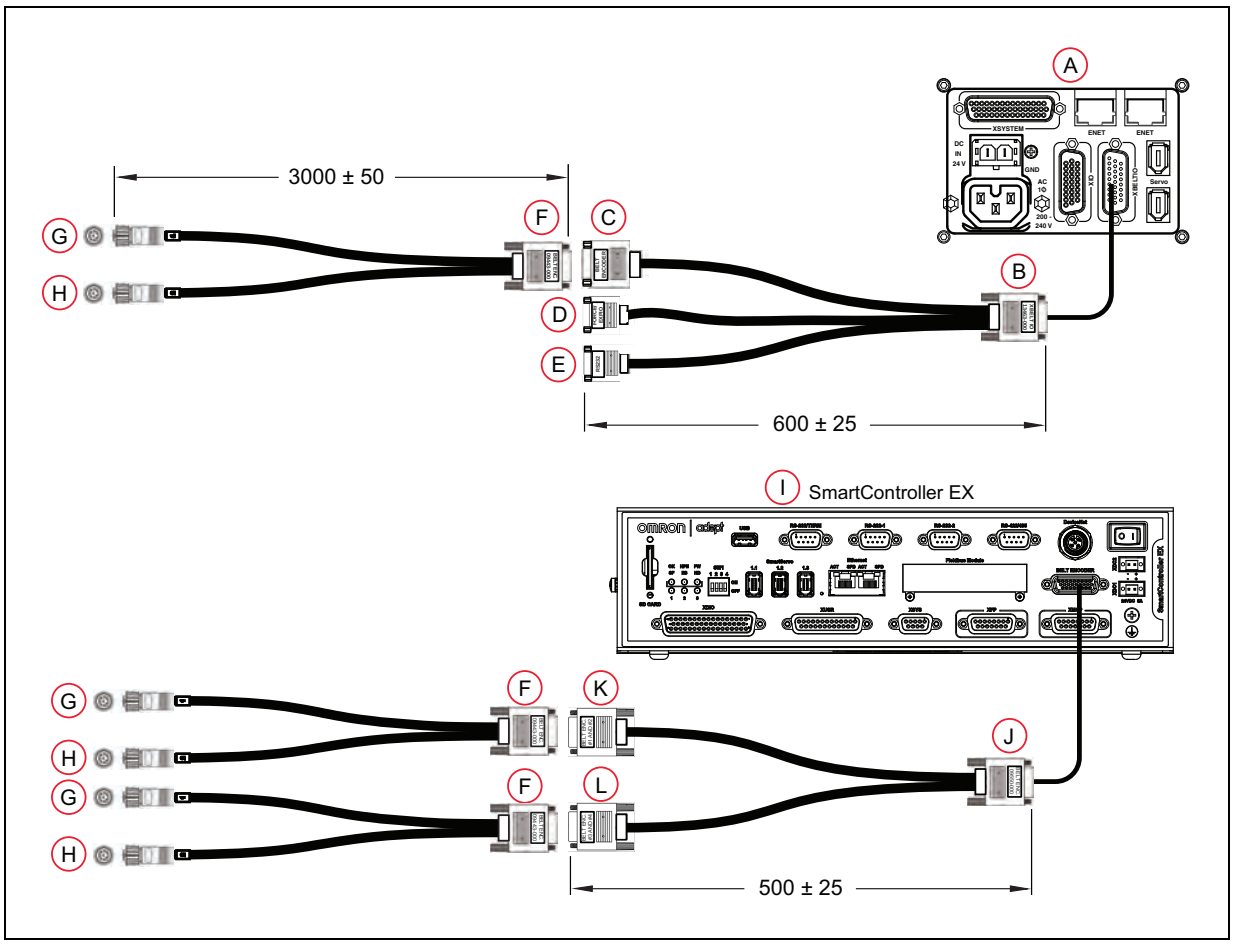


Figure 5-3. System Cable Diagram with Belt Encoders (Units in mm)

Table 5-5. Conveyor Belt Encoder Cables Description

Item	Description	Part #	Standard	Option	User-supplied	Notes
A	Robot Interface Panel	n/a	X			
B	eAIB XBELT IO Adapter Cable Connector	13463-000		X	X	HDB26 Female
C	Belt Branch Connector					DB 15 Male
D	Force / EXPIO Branch Connector					DB9 Male
E	RS232 Branch Connector					DB9 Male
F	Belt Y Splitter Cable Connector	09443-000		X	X	DB15 Female
G	Belt Encoder 1 Connector					M12 Female, 8-pin

Item	Description	Part #	Standard	Option	User-supplied	Notes
H	Belt Encoder 2 Connector					M12 Female, 8-pin
I	SmartController EX (optional)	19300-000		X		
J	SmartController EX Belt Encoder Y Adapter Cable Connector	09550-000		X	X	HDB26 Female
K	Belt Branch Connector, Encoder 1 and 2					DB15 Male
L	Belt Branch Connector, Encoder 3 and 4					DB15 Male

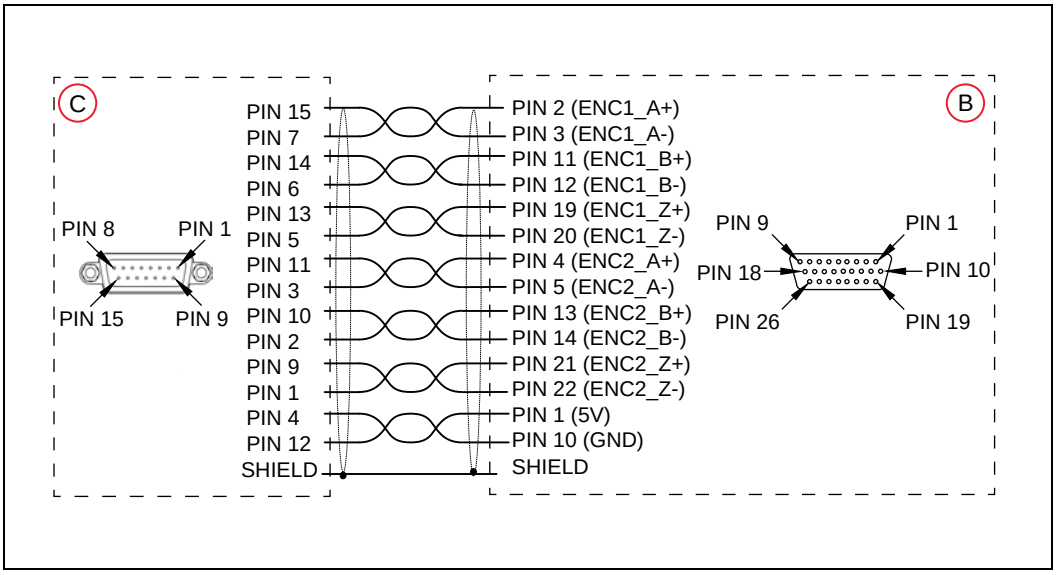


Figure 5-4. eAIB XBELT IO Adapter Cable Pinout - Encoder 1 and 2 Connections

NOTE: Cable shields connected to DSUB shell.

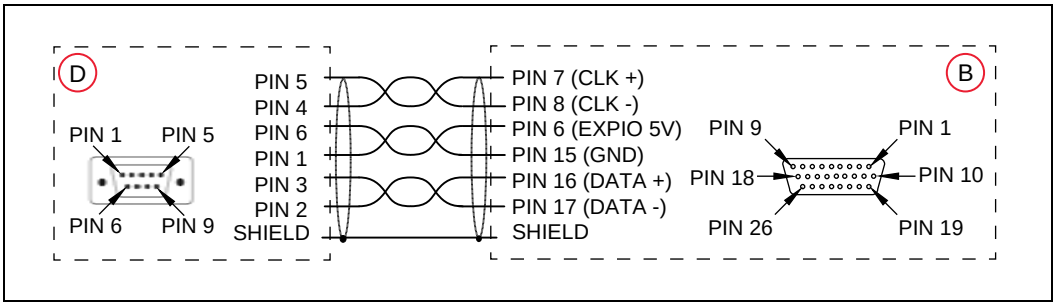


Figure 5-5. eAIB XBELT IO Adapter Cable Pinout - Force / EXPIO Connections

NOTE: Cable shields connected to DSUB shell.

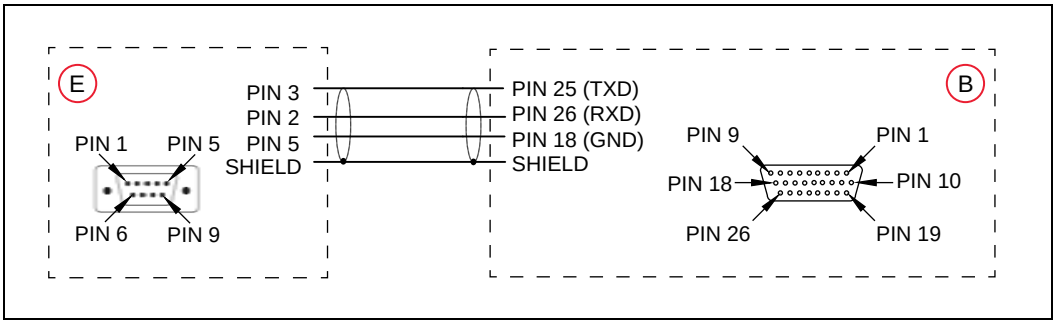


Figure 5-6. eAIB XBELT IO Adapter Cable Pinout - RS232 Connections

NOTE: Cable shields connected to DSUB shell.

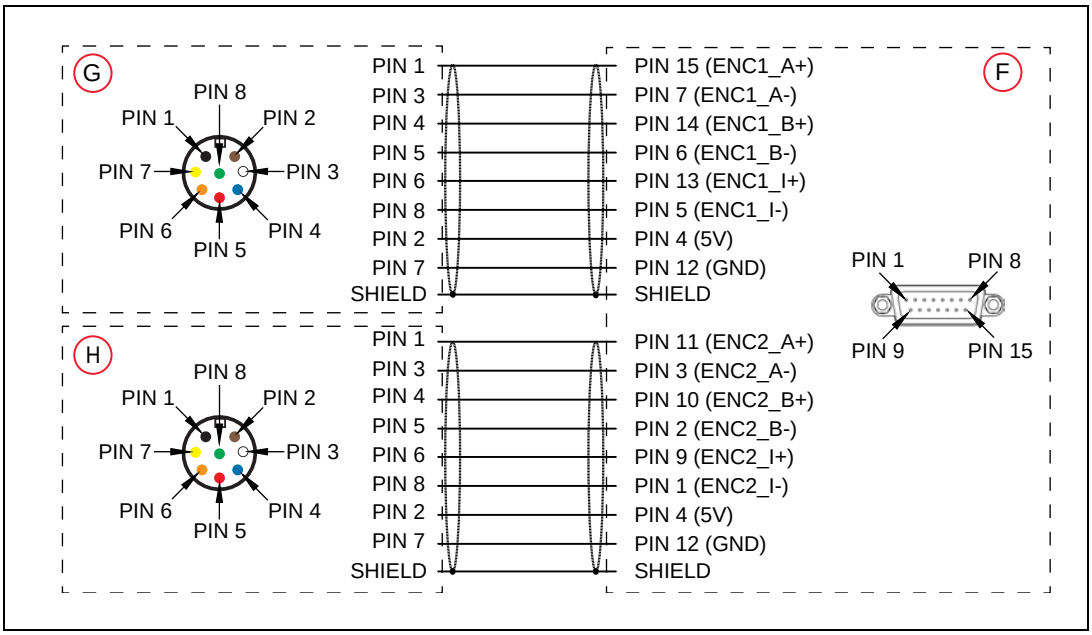


Figure 5-7. Belt Y Splitter Cable Pinout - 2 Encoder Connections

NOTE: Cable shields connected to DSUB shell.

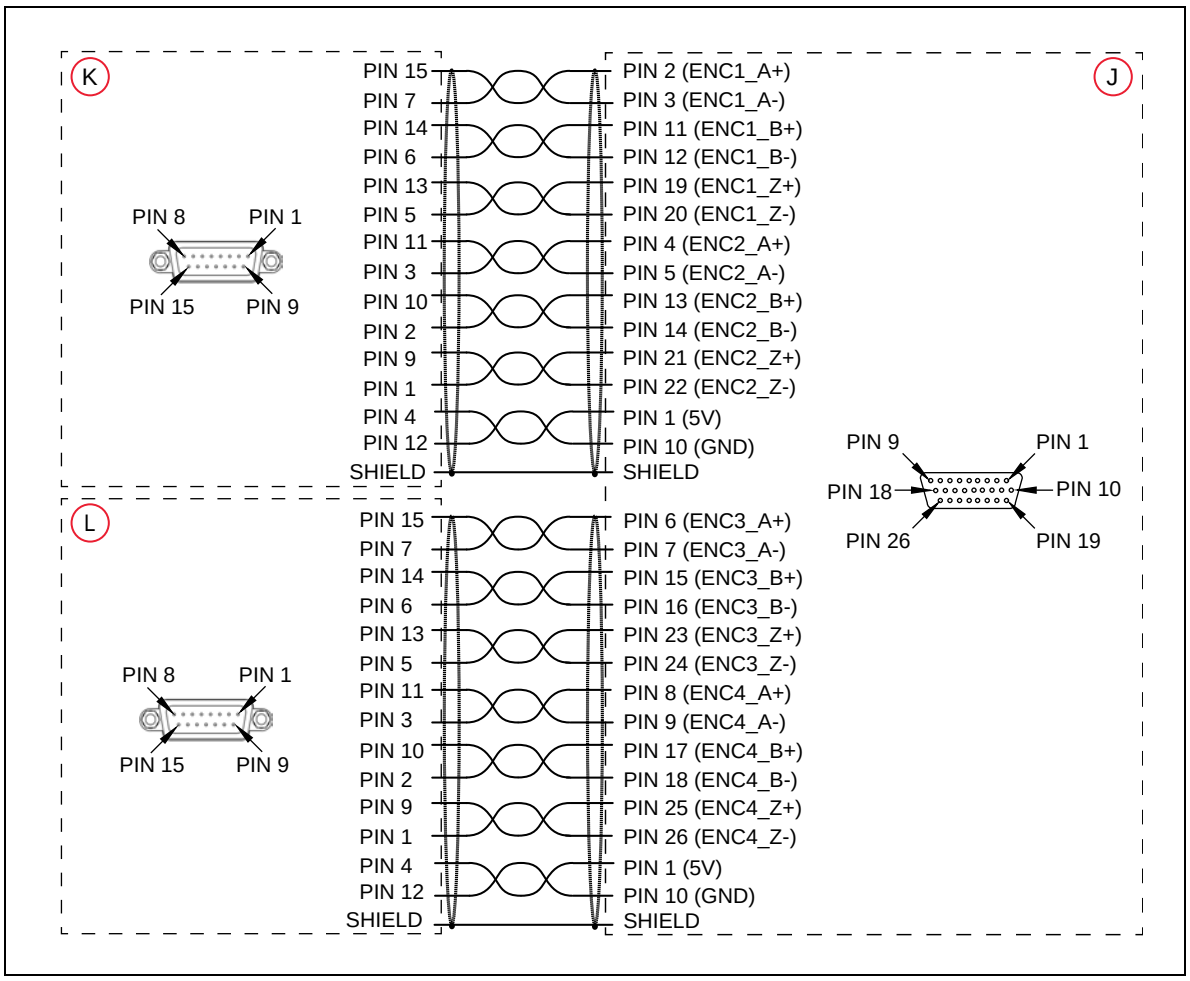


Figure 5-8. SmartController EX Belt Encoder Y Adapter Cable Connections

NOTE: Cable shields connected to DSUB shell.

5.4 Installing the SmartController EX

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

1. Mount the SmartController EX.
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 EX.
4. Connect the optional pendant (if included) to the SmartController EX.
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 EX and ground.
7. Install the ACE software on the user-supplied PC (see the following section).

5.5 Installing the ACE Software

The ACE software is installed from the ACE software media.

1. Insert the media into your PC.

   If Autoplay is enabled, the software menu is displayed. If Autoplay is disabled, you will need to manually access the media content.
2. Especially if you are upgrading your ACE software installation: from the ACE software menu, click Read Important Information.
3. From the ACE software 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 menu to close the menu.

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

5.6 Connecting the PC to the SmartController EX

The SmartController EX 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 EX 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*.

5.7 Cable Connections from eMB-40R to SmartController EX

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 EX, and install the other end into a SmartServo connector on the eMB-40R interface panel, as shown in System Cable Installation on page 51.
3. Install the eAIB XSYS cable between the XSYS connector on the SmartController EX 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.

5.8 Cable Connection from eMB-40R to Robot

The cable between the robot and the eMB-40R is called the Arm Power/Signal cable, as shown in System Cable Installation on page 51.

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.

   For both ends of the cable, line up the groove with the matching key in the connector, apply firm pressure straight in, and thread the lock ring fully onto the connector. There should be no visible threads when connected.

2. Connect the other end of the cable to the large, circular connector on the eMB-40R. Tighten the screws securely.

CAUTION: PROPERTY DAMAGE RISK
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.

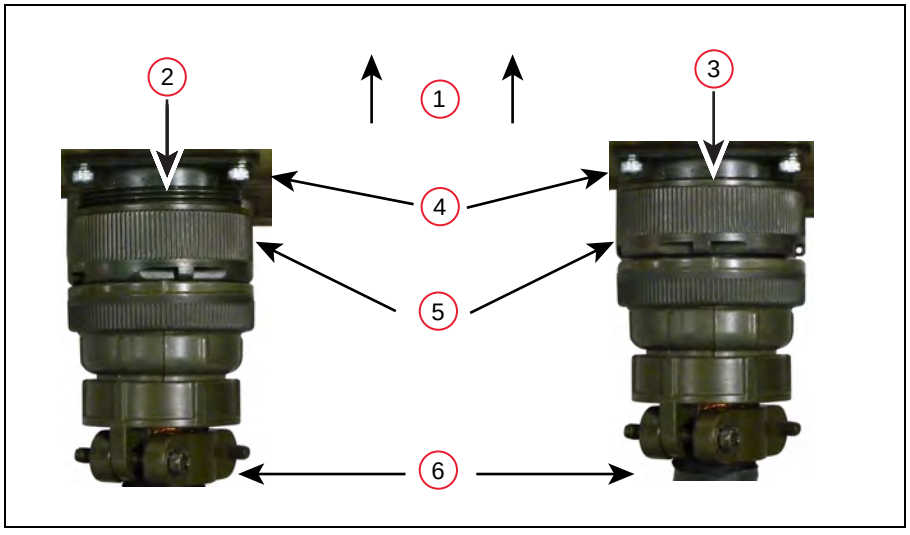


Figure 5-9. Incorrect and Correct Arm Power / Signal Cable Insertion

Table 5-6. Arm Power/Signal Cable Insertion Description

Item	Description
1	Robot bodies
2	Incorrect assembly: no threads should be visible.
3	Correct assembly: no threads are visible.
4	Robot interface panels
5	Lock rings
6	Arm Power / Signal cable

5.9 Connecting 24 VDC Power to eMB-40R

Specifications for 24 VDC Power

Table 5-7. 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 User-Supplied 24 VDC Cable on page 69.
[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.

NOTE: Make sure you select a 24 VDC power supply that meets the specifications in the preceding table. Using an underrated supply can cause system problems and prevent your equipment from operating correctly.

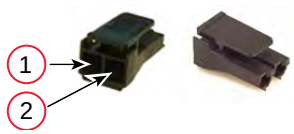
Table 5-8. Recommended 24 VDC Power Supplies

Vendor Name	Model	Ratings	Mount
OMRON	S8FS-G15024C	24 VDC, 6.5 A, 150 W	Front Mount
OMRON	S8FS-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 5-9. 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
	Item 1: Ground Item 2: +24V
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 List of Cables and Parts on page 52.

Procedure for Creating 24 VDC Cable

1. Locate the connector and pins from the preceding table.
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.

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

3. Crimp the pins onto the wires using the tool recommended in the preceding table.
4. Insert the pins into the connector. Confirm that the +24 V and Ground wires are in the correct terminals in the plug.
5. 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 the following figure. 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 87.
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.

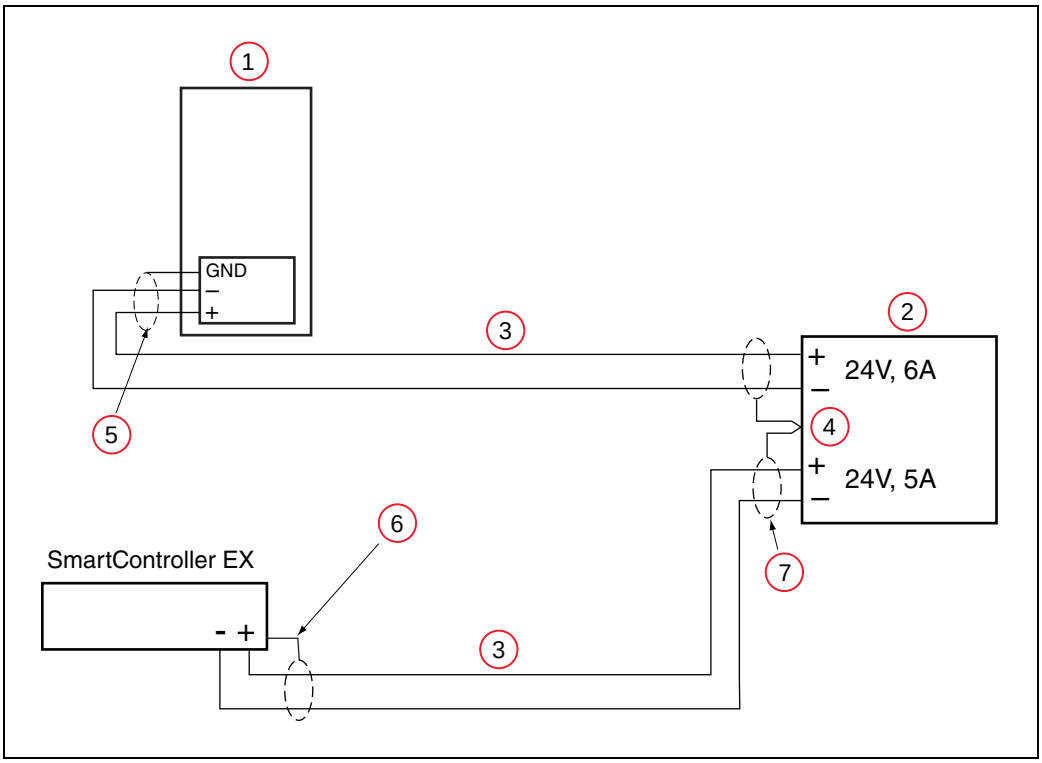


Figure 5-10. User-Supplied 24 VDC Cable

Table 5-10. User-Supplied 24 VDC Cable Description

Item	Description
1	eMB-40R Servo Controller
2	User-supplied Power Supply, 24 VDC
3	User-supplied shielded power cable
4	Frame Ground
5	Attach shield from user-supplied cable to ground screw on eMB-40R Interface Panel
6	Attach shield from user-supplied cable to side of controller using star washer and M3 x 6 screw.
7	Attach shield from user-supplied cables to frame ground on power supply.

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. The length of wire from the cable shield to the grounds should be less than 50 mm.

5.10 Connecting 200-240 VAC Power

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

WARNING: ELECTROCUTION RISK
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 5-11. 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: ELECTROCUTION RISK
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.

WARNING: ELECTROCUTION RISK
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

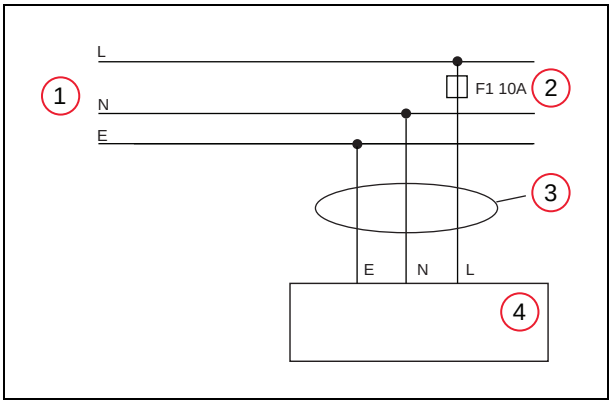


Figure 5-11. Typical AC Power Installation with Single-Phase Supply

Table 5-12. AC Power Installation with Single-Phase Supply Description

Item	Description
1	Single-phase 200-240 VAC, 20 A L = Line N = Neutral E = Earth Ground
2	User-supplied, must be slow-blow.
3	User-supplied AC power cable
4	eMB-40R Single-phase, 200-240 VAC

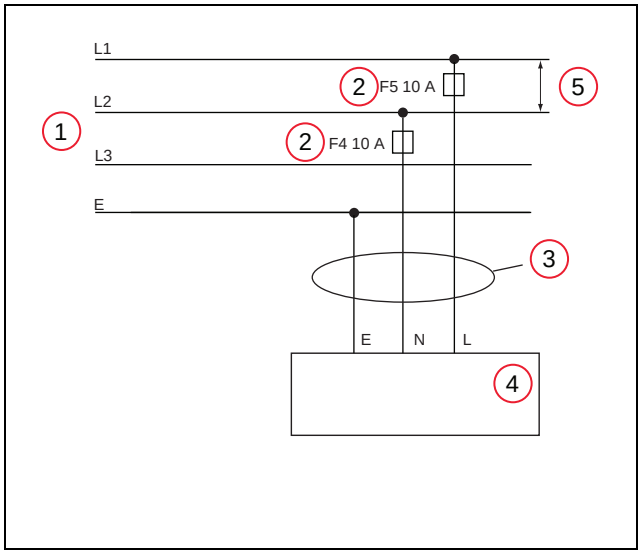


Figure 5-12. Single-Phase Load across L1 and L2 of a Three-Phase Supply

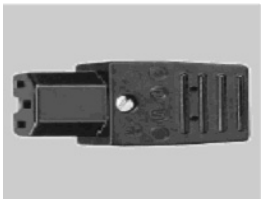
Table 5-13. AC Power Installation with Three-Phase Supply Description

Item	Description
1	Three-phase 200-240 VAC L = Line N = Neutral E = Earth Ground
2	F4 and F5 are user-supplied, must be slow-blow.
3	User-supplied AC power cable
4	eMB-40R single-phase 200-240 VAC
5	200-240 VAC

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 5-14. 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 List of Cables and Parts on page 52.

Procedure for Creating 200-240 VAC Cable

1. Locate the AC mating connector shown in the preceding table.
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 the following figure 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.

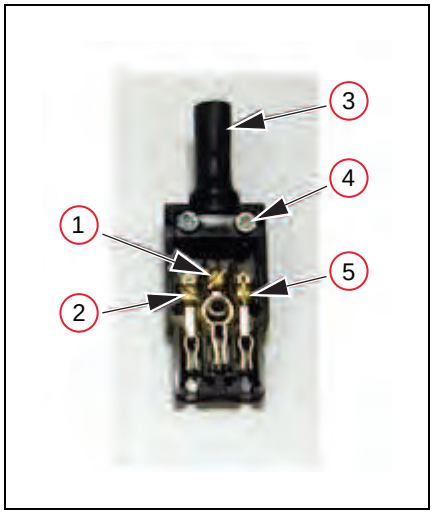


Figure 5-13. AC Power Mating Connector

Table 5-15. AC Power Mating Connector Description

Item	Description
1	Earth
2	Neutral
3	Removable bushing
4	Cable clamp
5	Line

Installing AC Power Cable to eMB-40R

1. Connect the unterminated end of the AC power cable to your facility AC power source. See Figure 5-11. and Figure 5-12. 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.

5.11 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 the following figure. The user is responsible for supplying the ground wire to connect to earth ground.

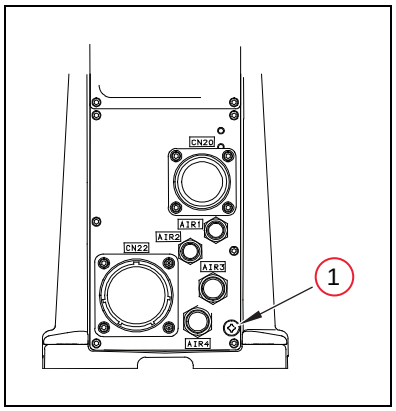


Figure 5-14. (1) Ground Point on Robot Base

Ground Point on eMB-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.

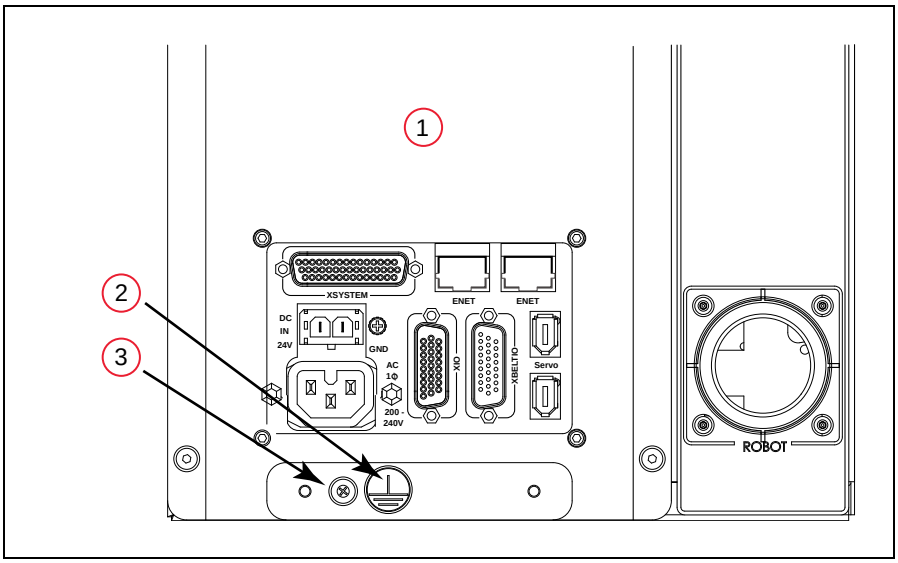


Figure 5-15. Earth Ground Location

Table 5-16. Earth Ground Location Description

Item	Description
1	Robot Interface Panel
2	Ground Label
3	Ground Screw

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 tooling, you must install a ground connection from that 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 Tool Flange Dimensions for Cobra 350 Robots (Units in mm) on page 122 for the grounding point on the tool flange.

WARNING: ELECTROCUTION RISK
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.

5.12 Installing User-Supplied Safety Equipment

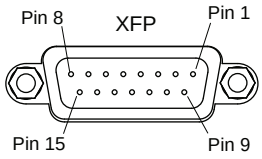
The user is responsible for installing safety barriers to protect personnel from coming in contact with the robot unintentionally. Depending on the design of the workcell, safety gates, light curtains, and emergency stop devices can be used to create a safe environment. Read the *Robot Safety Guide* 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 51 for the XUSR wiring diagram.

Table 5-17. 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 5-18. 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. Manual = Open Automatic = Closed	Optional - jumper closed for Auto Mode-only operation
4, 12	Remote Manual/Automatic switch CH 2. Manual = Open Automatic = Closed	Optional - jumper closed for Auto Mode-only operation
6, 14	Remote High Power on/off momentary 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 51 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 5-19. Remote Pendant Connections on the XMCP Connector

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

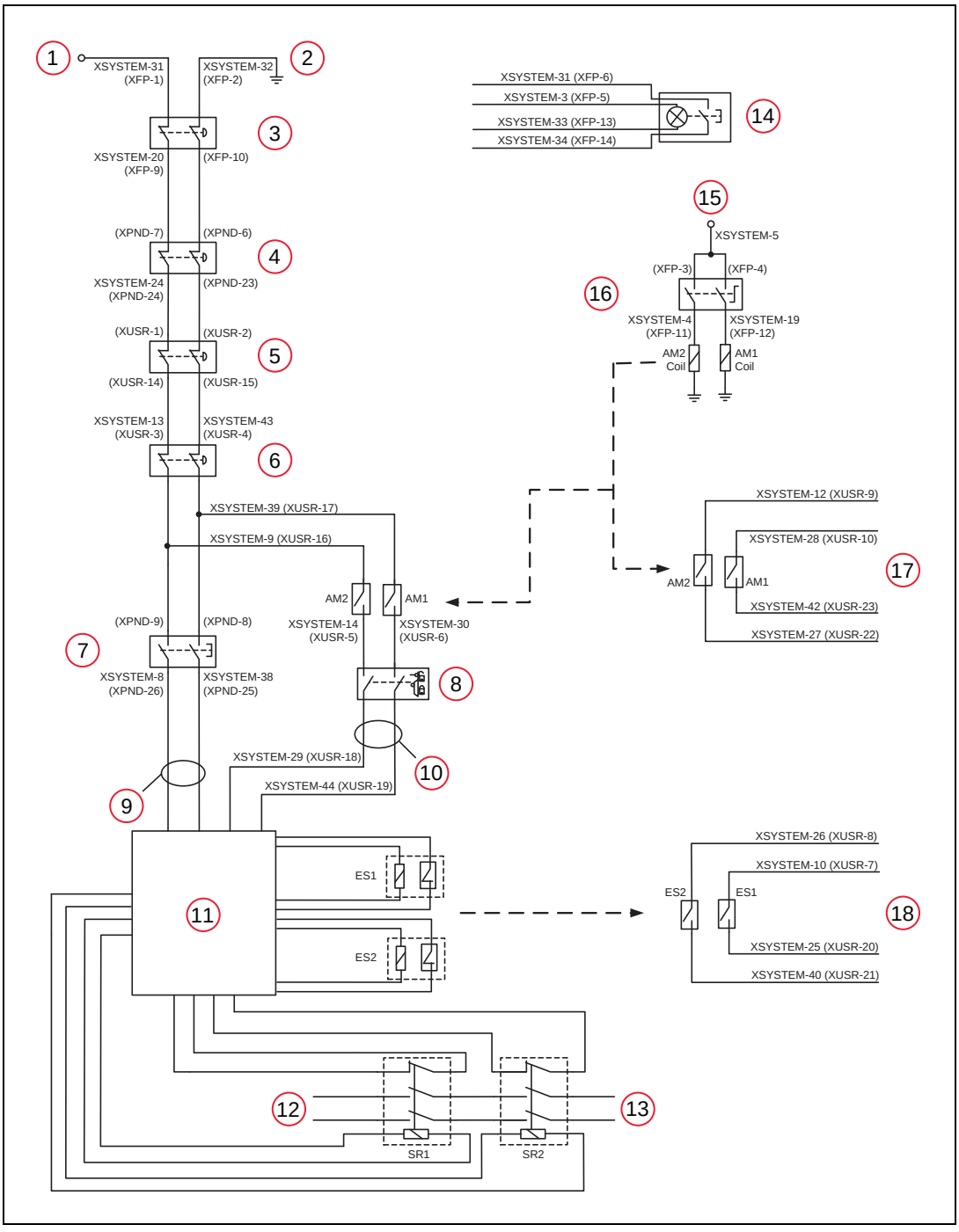


Figure 5-16. E-Stop Circuit on XUSR and XFP Connectors

Table 5-20. E-Stop Circuit on XUSR and XFP Connectors Description

Item	Description
1	ESTOP 24 V Source
2	ESTOP Ground
3	Front Panel ESTOP Pushbutton
4	T20 ESTOP Pushbutton
5	User E-Stop and Gate Interlock (jumper closed when not used, must open both channels independently if used)
6	LINE E-Stop (external user E-Stop system)
7	T20 Pendant Enable
8	Muted Safety Gate - Active in auto mode only (jumper closed when not used)
9	Manual Mode Path
10	Auto Mode Path
11	Force-Guided Relay Cyclic Check Control Circuit
12	Single-Phase AC Input, 200-240 VAC
13	High Power to Amplifiers (internal connections)
14	Front Panel High Power ON / OFF (6 V, 1.2 W bulb)
15	ESTOP 24 V Source
16	Front Panel Auto / Manuals Keyswitch
17	Auto / Manual Output
18	User ESTOP Output

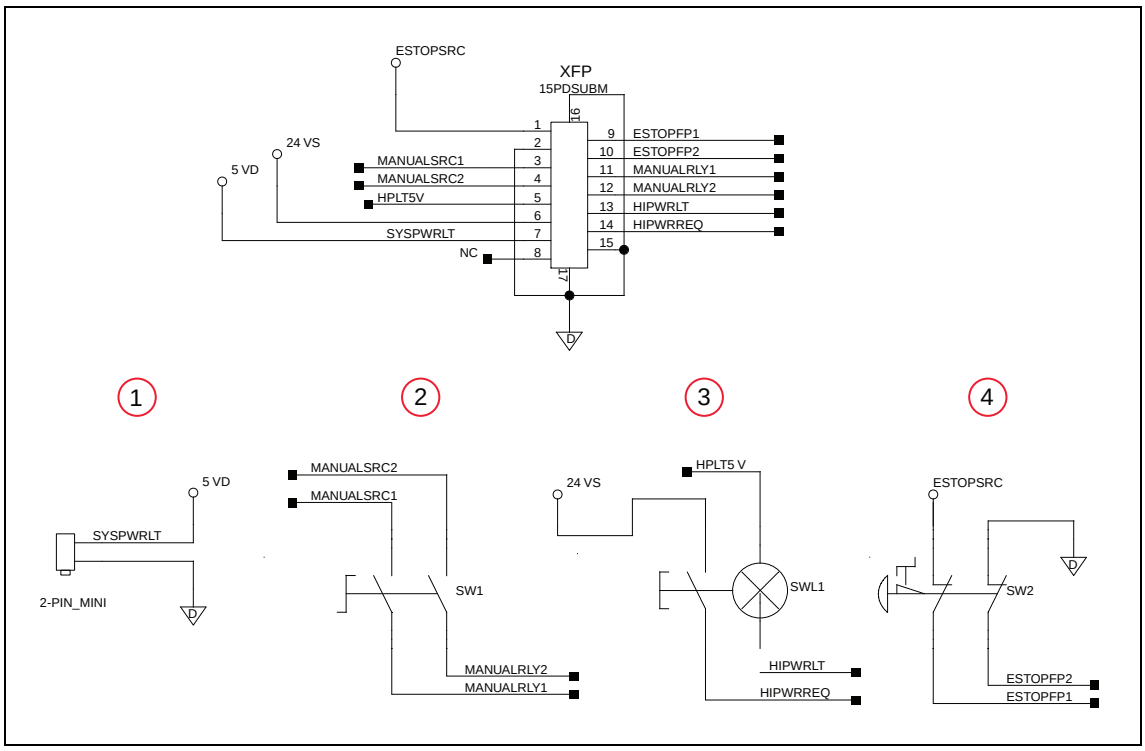


Figure 5-17. Front Panel Schematic

Table 5-21. Front Panel Schematic Description

Item	Description
1	System Power LED
2	Manual / Auto
3	High Power ON / OFF
4	Emergency Stop

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 5-16.

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 pin pairs must be shorted if not used. Both channels must open independently if used. The controller will flag an error state if one channel is jumpered closed and the other channel is opened, although an Emergency Stop will still occur. It will also flag an error state if the independent channels are crossed, meaning one line from each channel is accidentally connected to the other channel.

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 your local Omron support 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 5-17. and the table Contacts Provided by the XFP Connector on page 78 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, production line, 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 80 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: PERSONAL INJURY RISK
Whenever possible, manual mode operations should be performed with all personnel outside the workspace.

WARNING: PERSONAL INJURY RISK
If you want the cell gate to always cause a robot shutdown, wire the gate switch contacts in series with the user E-Stop inputs. Do not wire the gate switch into the Muted Safety Gate inputs.

Remote Manual Mode

The Front Panel provides for a Manual Mode circuit. See Remote High Power On/Off Control on page 85 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 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 82. 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: PERSONAL INJURY RISK
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: PERSONAL INJURY RISK
Return any suspended safeguards 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 51), 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 82) 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: PERSONAL INJURY RISK
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 116 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 82 for a schematic drawing of the Front Panel, and see the table Contacts Provided by the XFP Connector on page 78 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.

Users 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 m.

> **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 m.

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

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 Status Panel on page 30.

6.2 Brake Release Button

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 page 37 for information on the Brake Release button on the eMB-40R.

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.

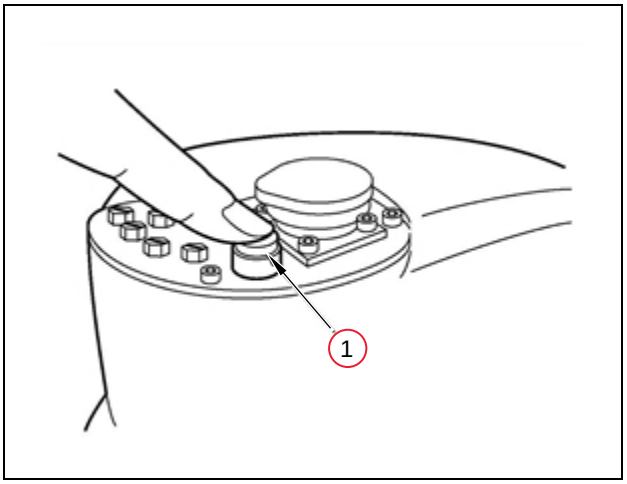


Figure 6-1. (1) Brake Release Button for Third and Fourth Joints

CAUTION: PROPERTY DAMAGE RISK
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.

IMPORTANT: 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).

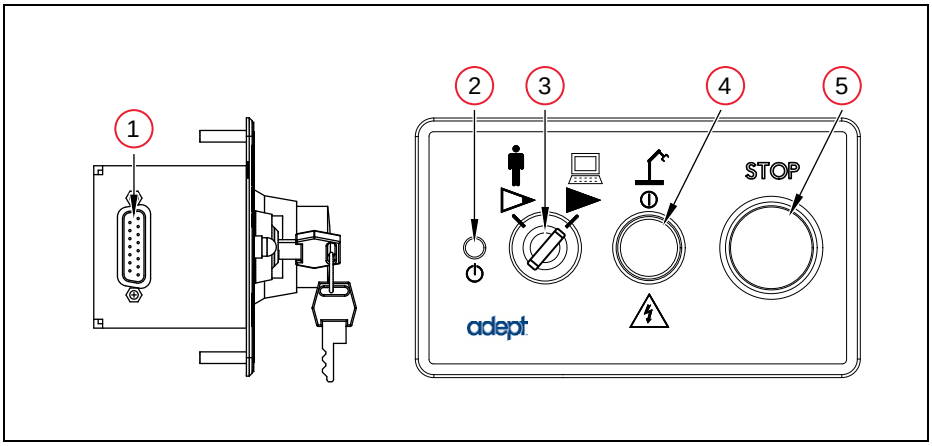


Figure 6-2. Front Panel

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: PERSONAL INJURY RISK
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.

   IMPORTANT: 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 joint of the robot (with the pendant or ACE software Jog Control) to confirm that 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, eMB-40R, and optional SmartController EX have been properly installed.

WARNING: PERSONAL INJURY OR PROPERTY DAMAGE RISK
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:

> **NOTE:** The first three connections are made via the eAIB XSYSTEM cable if you are not using an optional SmartController EX motion controller.

- Front Panel to the XSYSTEM on the eMB-40R.
- Pendant to the XSYSTEM on the eMB-40R.
- XUSR to the XSYSTEM on the eMB-40R.
- User-supplied 200/240 VAC power to the robot 200/240 VAC connector.
- User-supplied 24 VDC power to the robot 24 VDC connector.

If you are using an optional SmartController EX, you should check the following:

- eAIB XSYS cable between the robot interface panel XSYSTEM connector and XSYS connector on the SmartController EX, and the latching screws tightened.
- Front Panel to the SmartController EX.
- Pendant to the SmartController EX, via the pendant adapter cable.
- User-supplied 24 VDC power to the controller.
- User-supplied ground wire between the SmartController EX and ground.
- One end of the IEEE 1394 cable into the SmartServo connector on the SmartController EX, and the other end into a SmartServo connector on the robot interface panel.

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.

WARNING: E-Stop
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 SmartController EX, if present.

   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:
   - Select Connect To Controller.
   - 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 Chapter 6: (If the button stops blinking, you must Enable Power again.)

   > **NOTE:** The use of the blinking High Power button can be configured (or eliminated) in software. Your system may not require this step.
   >
   > **IMPORTANT:** Disabling the High Power button violates IEC 60204-1. It is strongly recommended that you not alter the use of the High Power button.

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

   - The Robot Status LED glows amber.
   - The code on the Robot Status Panel displays ON. See System Operation on page 87.

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 Tool Flange Dimensions for Cobra 350 Robots (Units in mm) on page 122 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 75.

> **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 the following figure.
4. Loosen the two M4 socket-head cap screws.
5. Slide the flange down slowly until it is off the shaft.

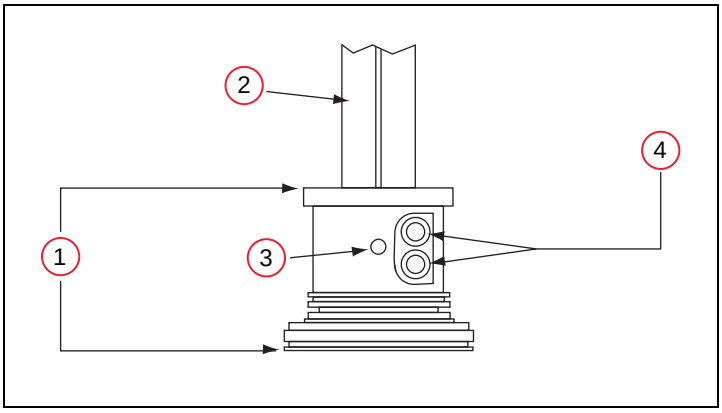


Figure 7-1. Tool Flange Removal

Table 7-1. Tool Flange Removal Description

Item	Description
1	Tool Flange Assembly
2	Quill Shaft
3	Setscrew
4	M4 Socket-head Cap Screws

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: PROPERTY DAMAGE RISK
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 the following figure. 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 as standard equipment.

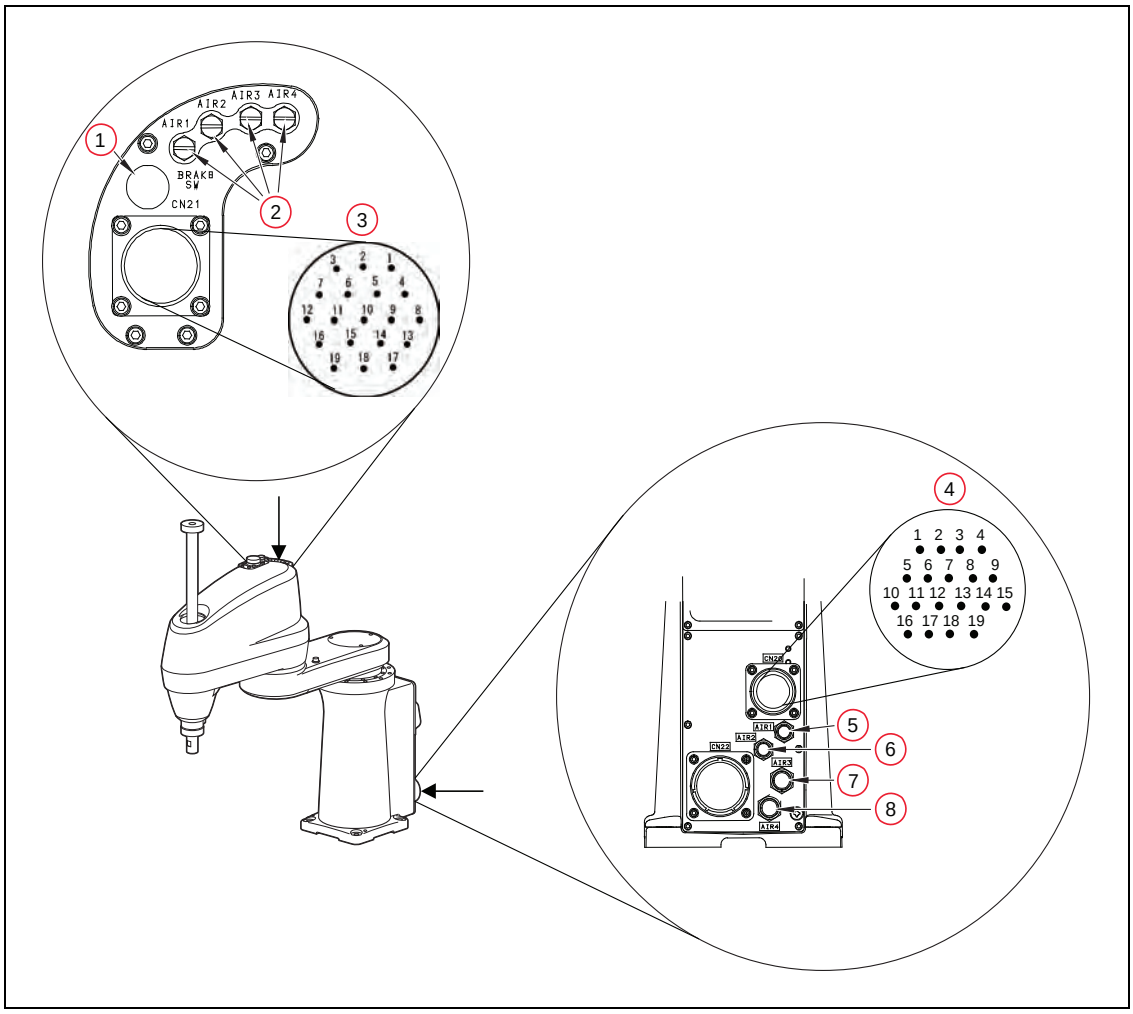


Figure 7-2. User Air and Electrical Connectors on Robot

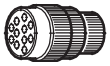
Table 7-2. User Air and Electrical Connectors on Robot Description

Item	Description
1	Brake release switch
2	Air piping joints (M5)
3	CN21 pin layout
4	CN20 pin layout
5	AIR 1 - Ø4, BSPT 1/8
6	AIR 2 - Ø4, BSPT 1/8
7	AIR 3 - Ø6, BSPT 1/4
8	AIR 4 - Ø6, BSPT 1/4

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 7-3. 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 m solenoid cable is available that connects between the XDIO connector on the SmartController EX and the CN20 connector on the robot. Note: this solenoid cable does not work with the Cobra 350CR/ESD robots. The part number is 05739-040.

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 7-4. CN21 Signal List When Using Solenoid Cable

CN21 Pin #	Signal from XDIO on SmartController EX	CN21 Pin #	Signal from XDIO on SmartController EX
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

CN21 Pin #	Signal from XDIO on SmartController EX	CN21 Pin #	Signal from XDIO on SmartController EX
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 center of the quill (J3) or by attaching them to the robot's exterior by mounting stays on the robot.

NOTE: Do not remove the mechanical end bolts on the 1st and 2nd joints or the mechanical stoppers on the quill (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:

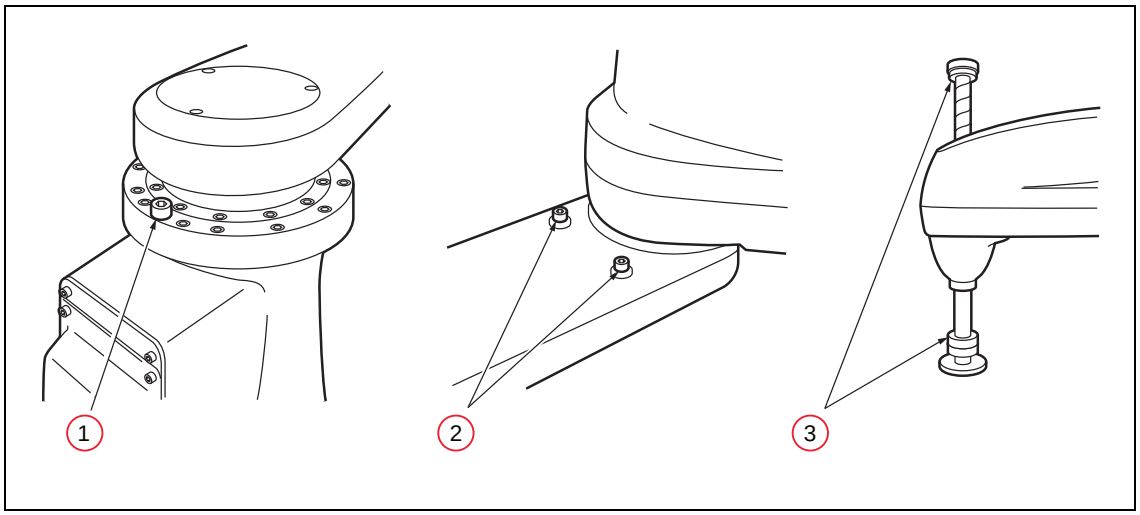


Figure 7-3. Mechanical End Bolts and Stoppers on Robot

Table 7-5. Mechanical End Bolts and Stoppers Description

Item	Description
1	Joint 1: Mechanical End Bolt
2	Joint 2: Mechanical End Bolts
3	Joint 3: Mechanical Stoppers

Routing User Connections Through the Quill (J3)

You can route air and electrical lines from the CN21 connector or the air line ports on the top of the outer arm (Joint 2) through the hollow center (Ø14 mm) of the quill.

CAUTION: PROPERTY DAMAGE RISK
If routing lines in this manner, make sure that, when the robot is in motion, including when the quill 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 the following figure. See Dimensions for Fabricating User-Supplied Stay (Units in mm) on page 99. 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 Camera Mounting Details (Units in mm) on page 100.

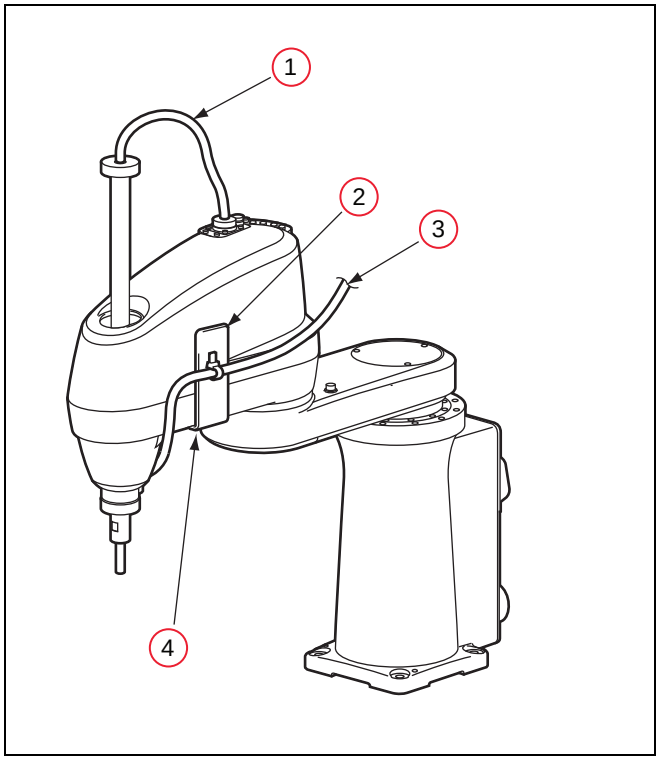


Figure 7-4. Stay Attached to Robot's Exterior

Table 7-6. Stay Attachment Description

Item	Description
1	User Air and Electrical Lines Routed Through Quill (J3)
2	Stay Attached to Robot

Item	Description
3	User Air and Electrical Lines
4	Stay Attached to Underside of Outer Arm Using M3 Bolts

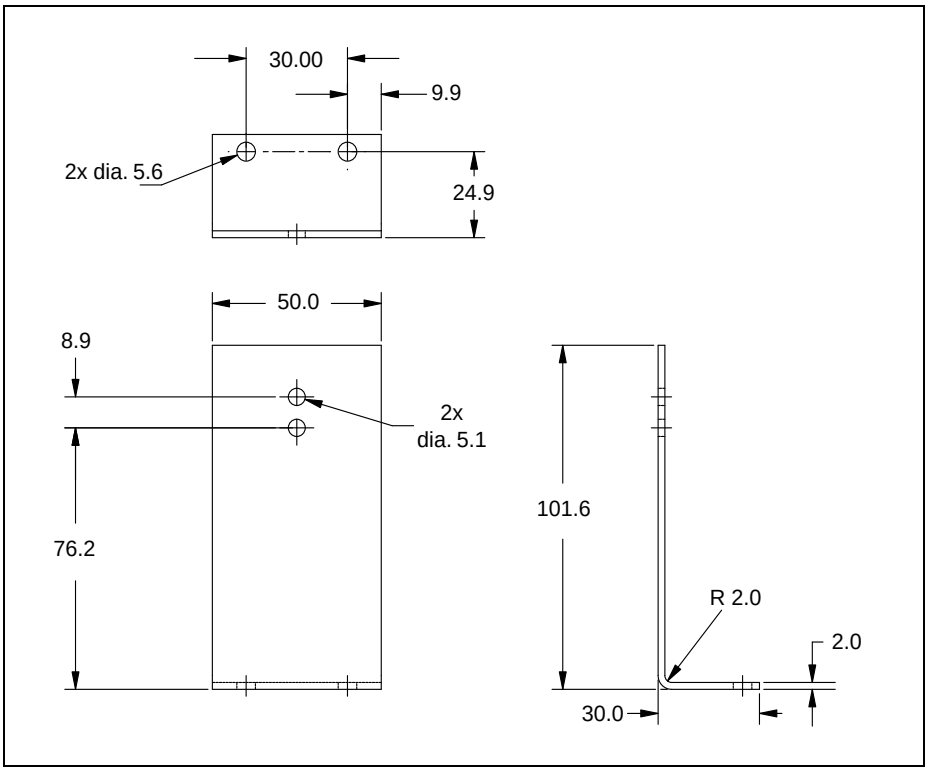


Figure 7-5. Dimensions for Fabricating User-Supplied Stay (Units in mm)

7.4 Camera Mounting

Camera Channel

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.

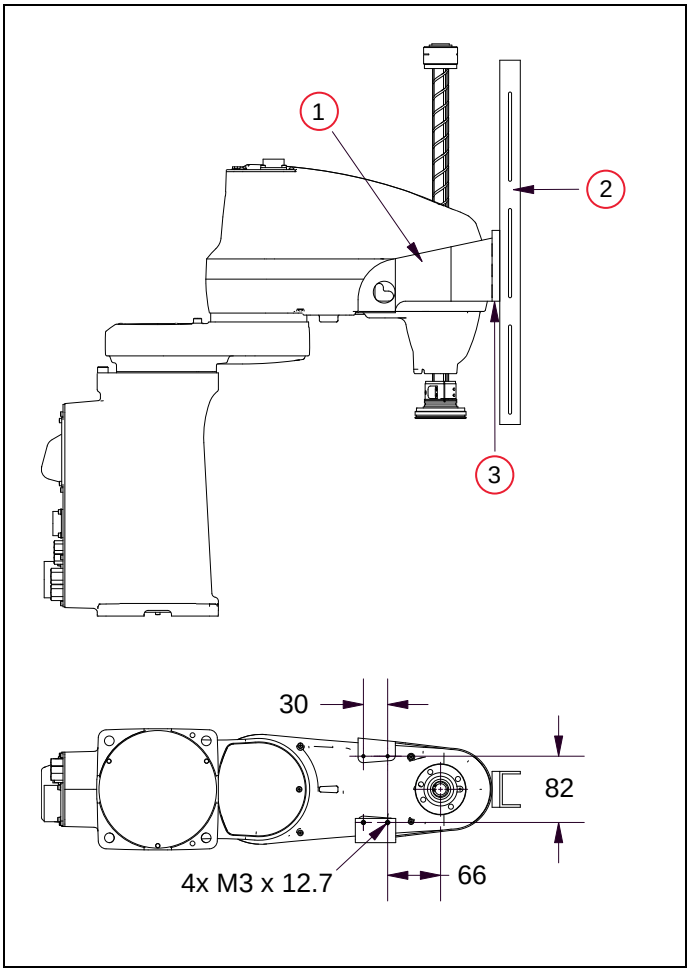


Figure 7-6. Camera Mounting Details (Units in mm)

Table 7-7. Camera Mounting Description

Item	Description
1	Camera Bracket
2	Camera Channel
3	Camera Mounting Block

Camera Bracket

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 Camera Bracket Drawing, 1 of 2 (Units in mm) on page 101. The user must fabricate this bracket.

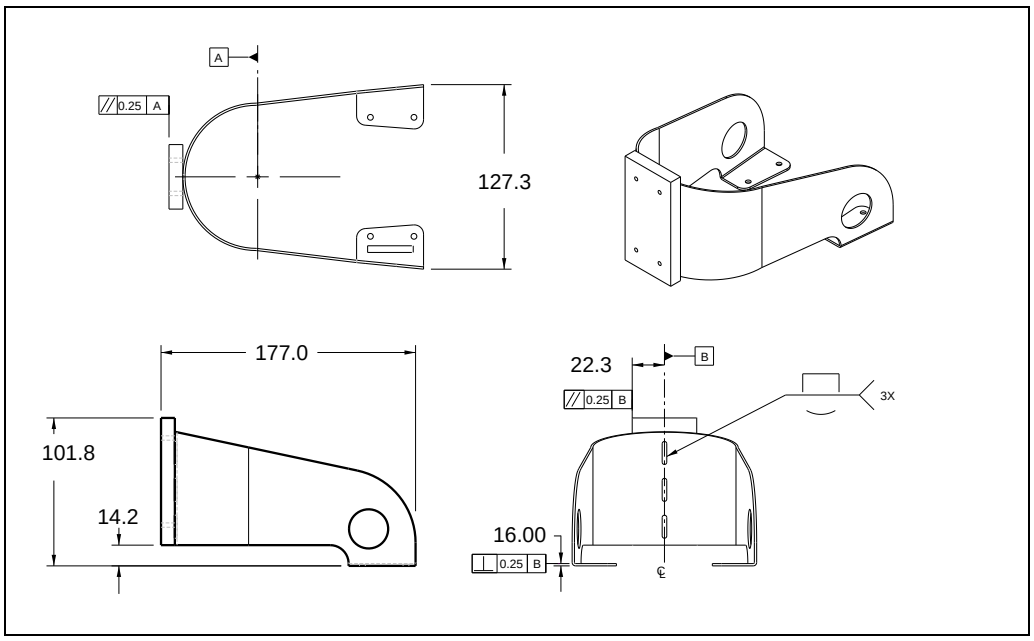


Figure 7-7. Camera Bracket Drawing, 1 of 2 (Units in mm)

Unless otherwise specified:

- Dimensions apply after process.
- Interpret drawing per ANSI Y14.5
- Tolerances:
    - 2 place decimals: +/- 0.8 mm
    - 2 place decimals: +/- 0.38
    - Angular dimensions: +/- 1 degree

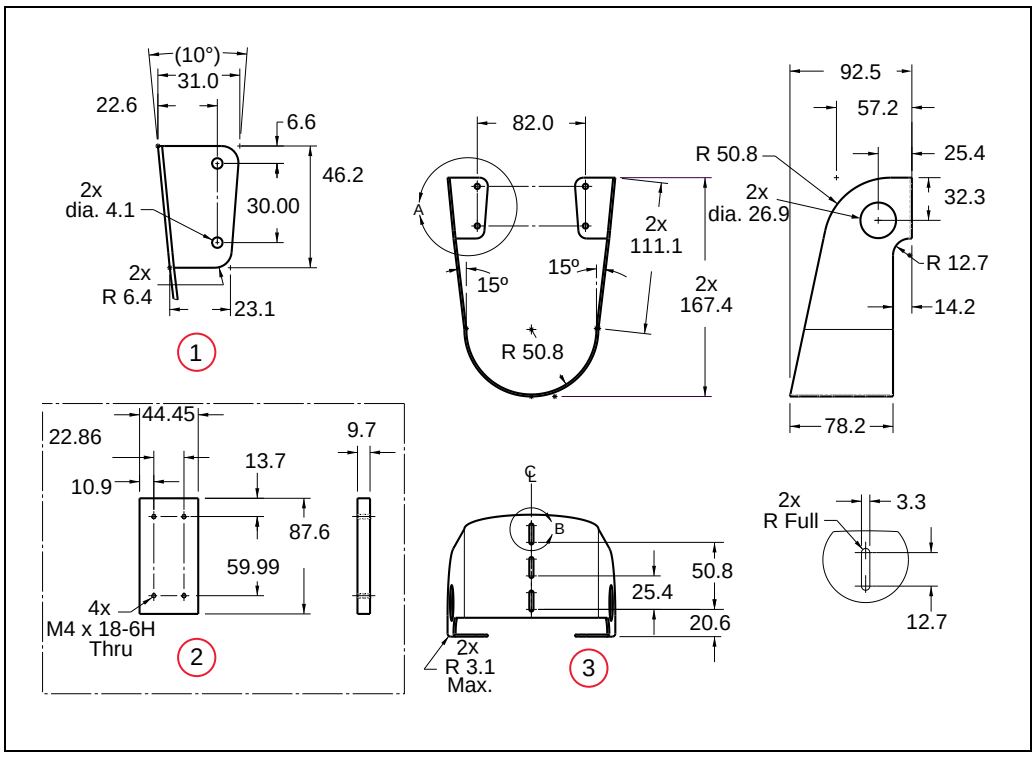


Figure 7-8. Camera Bracket Drawing, 2 of 2 (Units in mm)

Table 7-8. Camera Bracket Drawing 2 Description

Item	Description
1	Detail A: 2 places, 1 as shown, 1 mirror/opposite
2	Item 2: Mount, Camera, AL alloy 6061 T651, 9.7 mm thick
3	Item 1: Bracket, Camera, AL alloy 5052 H32, 1.60 mm thick

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	Checking Safety Systems on page 105
Check robot mounting bolts	3 months	Checking Robot Mounting Bolts on page 105
Lubricate Joint 3 (Quill) ball screw	6 months	Lubricate Joint 3 Ball Screw on page 105
Replace Encoder battery	2 - 4 years	Replacing Encoder Battery on page 106
Inspect timing belts on 3rd and 4th joints	12 months	Inspecting Timing Belts on page 110

WARNING: ELECTROCUTION RISK
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 lock-out/tagout power if covers have to be removed.

WARNING: ELECTROCUTION RISK
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 joint dropping suddenly when the brake release is pressed because of gravity. In the case of the Cobra 350, this applies to the quill and tool flange.

Figure 8-2. 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. See Figure 8-3.	Epinoc AP1	2 to 3 cc	Apply grease to entire shaft.

CAUTION: PROPERTY DAMAGE RISK
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.

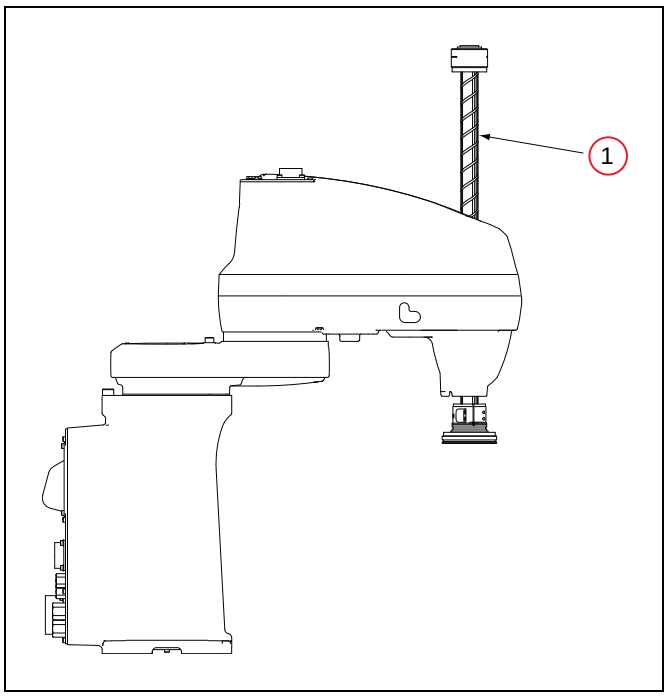


Figure 8-3. (1) Lubrication of Joint 3 Quill Shaft

2. Raise the Joint 3 quill shaft to the upper position.
3. Apply grease to the entire shaft. See the preceding table 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.

IMPORTANT: Replace the batteries only with 3.6 V, 2.7 Ah lithium batteries, P/N 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.

Replacement Procedure

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.

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

1. Obtain a replacement battery pack, P/N 06126-000.

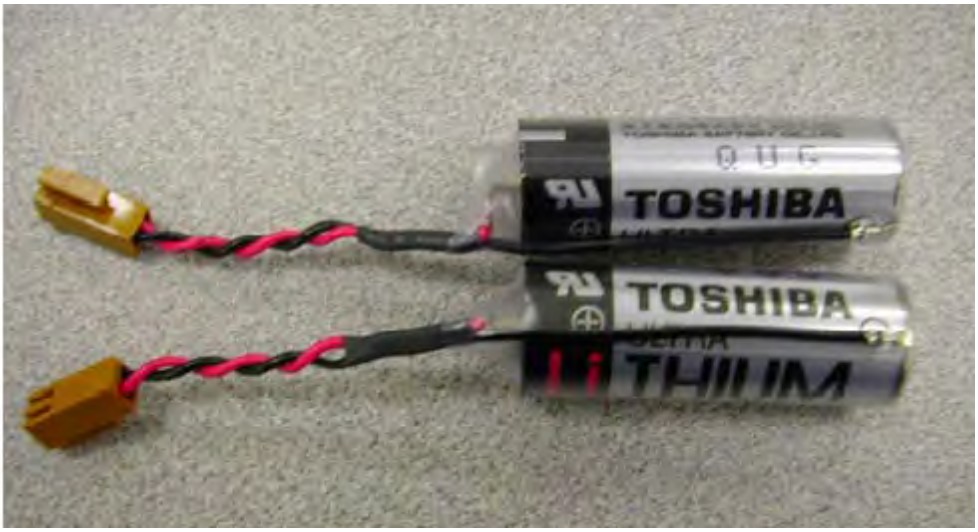


Figure 8-4. Replacement Battery Pack

2. Switch off the SmartController EX, if present.
3. Leave the 24 VDC input supply to the eMB-40R on.
4. Switch off the 200/240 VAC input supply to the eMB-40R.
5. Leave the 24 VDC supply cable from the eMB-40R +24 VDC input connector on. See Connectors on eMB-40R Interface Panel on page 28 for locations of connectors.

   IMPORTANT: DC power must be supplied to eMB-40R, otherwise encoder data could be lost.

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.

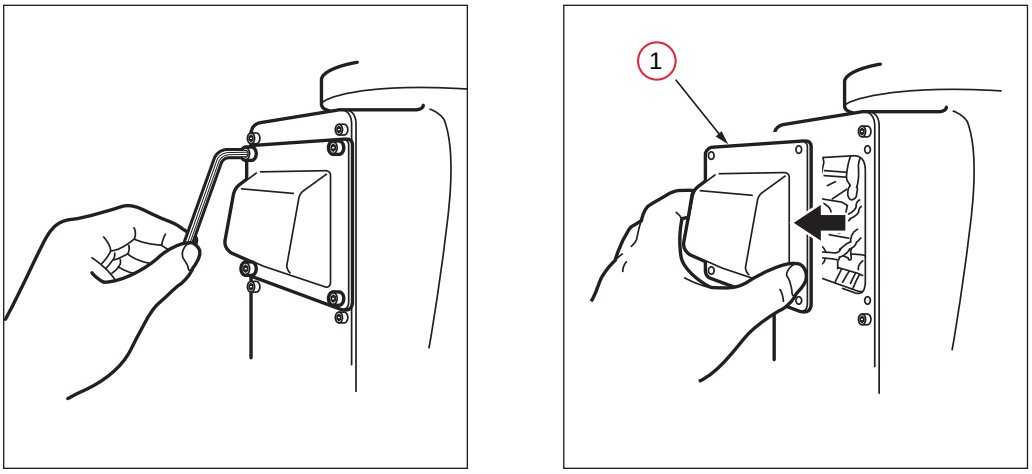


Figure 8-5. Removing (1) Battery Cover

8. Attach the first new backup battery to the unused connector on the battery board. See the following figures 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.

   NOTE: Some robots have PCAs with four battery connections. On those robots, connect the two new batteries to spare connectors at the same time while the old batteries remain connected. Once the new batteries are connected, disconnect the old batteries and remove them from the battery board.

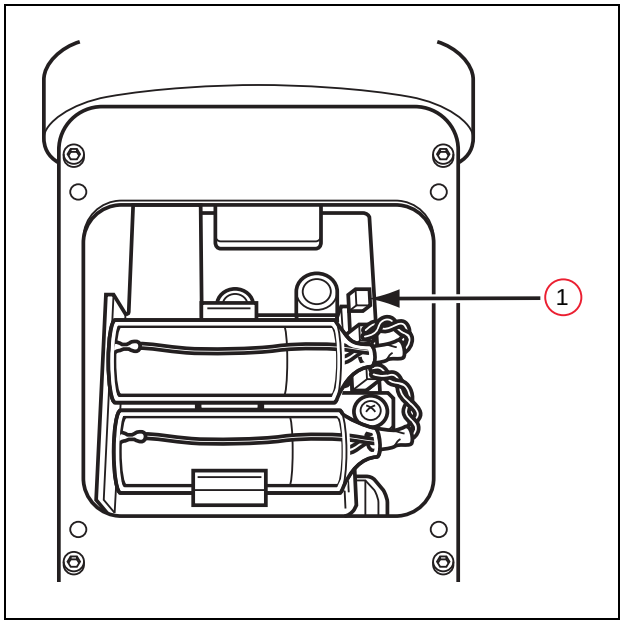


Figure 8-6. (1) Unused Backup Battery Connector

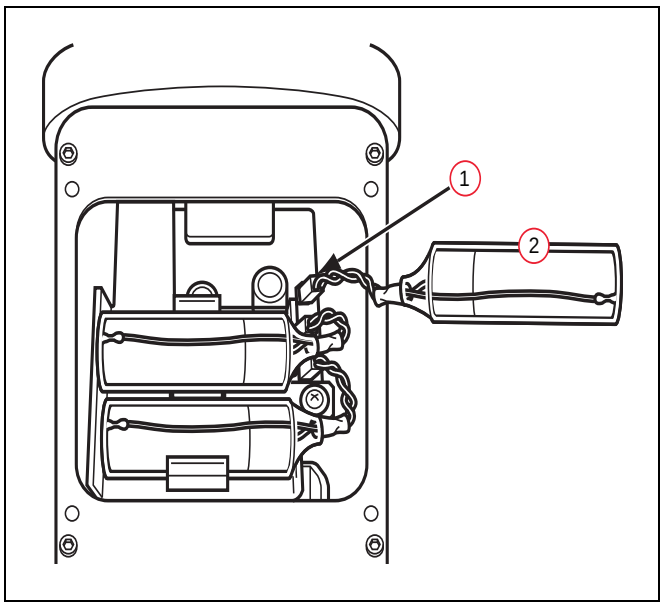


Figure 8-7. Attaching New Backup Battery, (1) Unused Connector (2) New Battery

9. Disconnect the top old battery from the battery board, and then remove it from the holder.

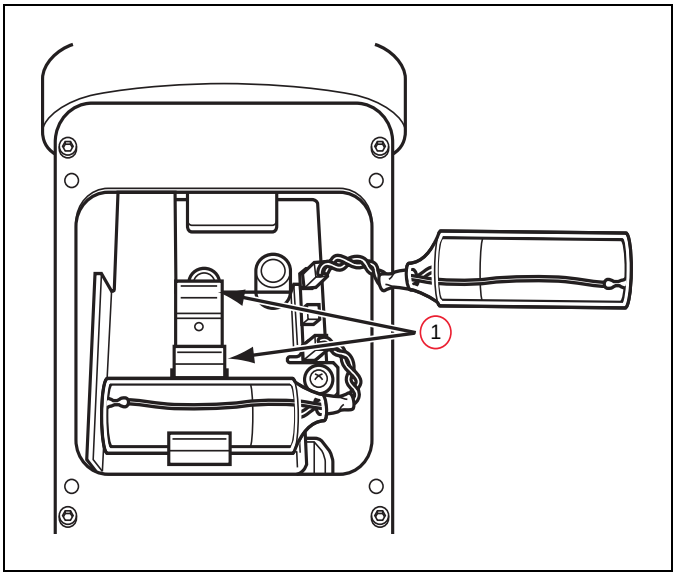


Figure 8-8. Top Old Backup Battery Removed from (1) Holder

10. Attach the second new backup battery to the connector that the old battery was disconnected from in the previous step.
11. Remove the bottom old battery from the connector and the holder and place both new batteries in the holders as shown in the figure below.

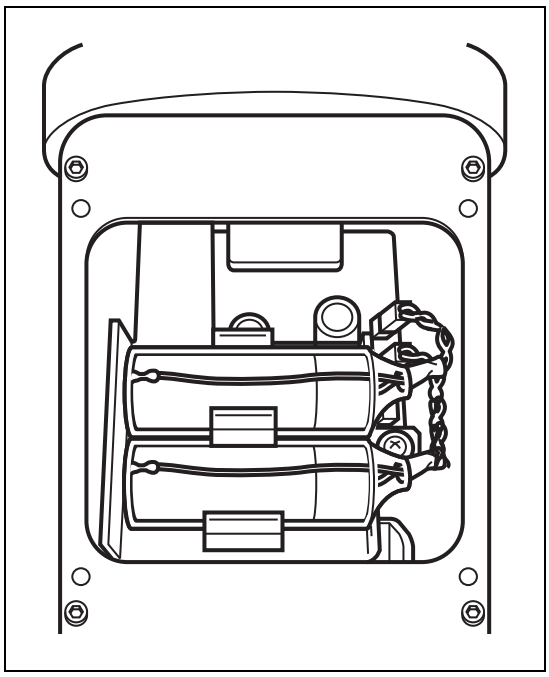


Figure 8-9. New Batteries Installed

12. 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 eMB-40R and SmartController EX, if present.
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 your local Omron support.

8.8 Replacing the eMB-40R Amplifier

Remove the eMB-40R Amplifier

1. Switch off the SmartController EX, if present.
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 MotionBlox-40R on page 27 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 EX, if present.
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.

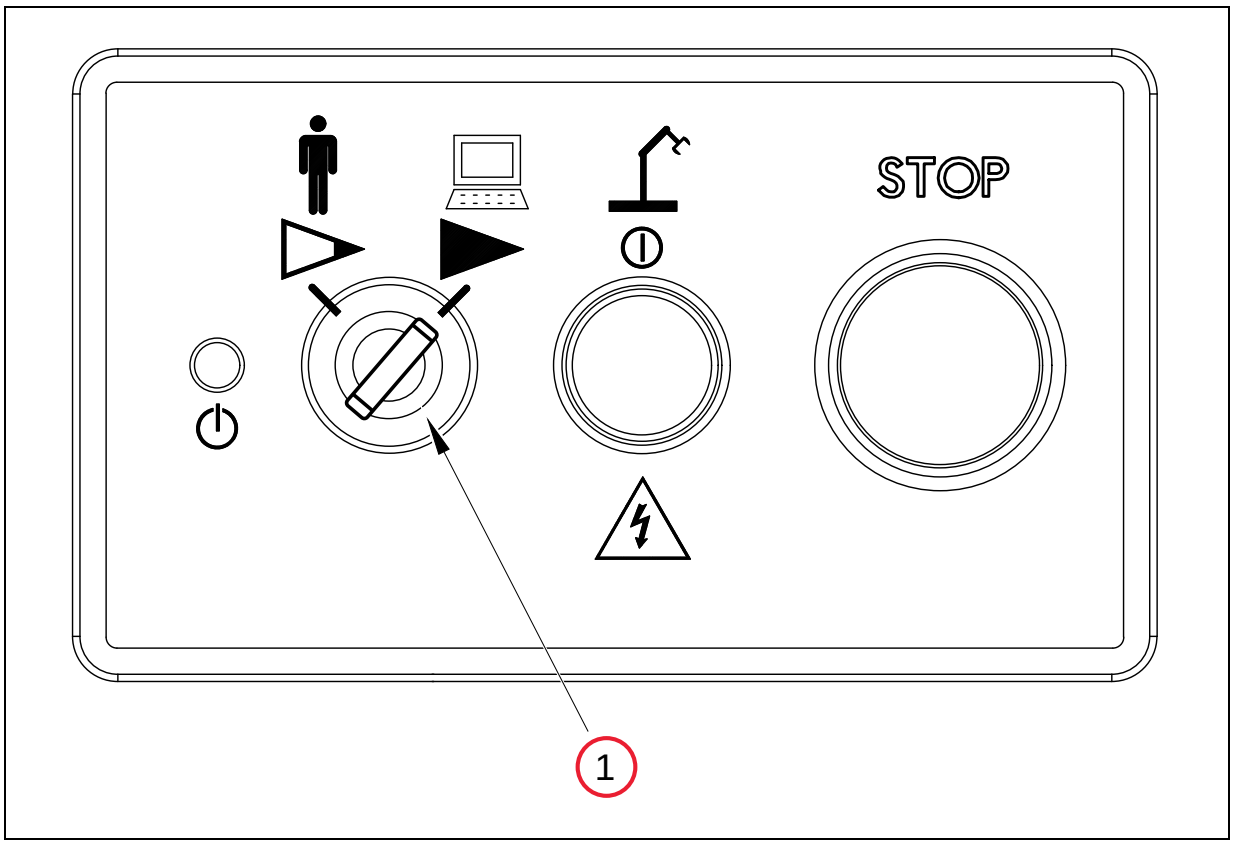


Figure 8-10. (1) Front Panel Key Switch in Auto Mode

- 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.

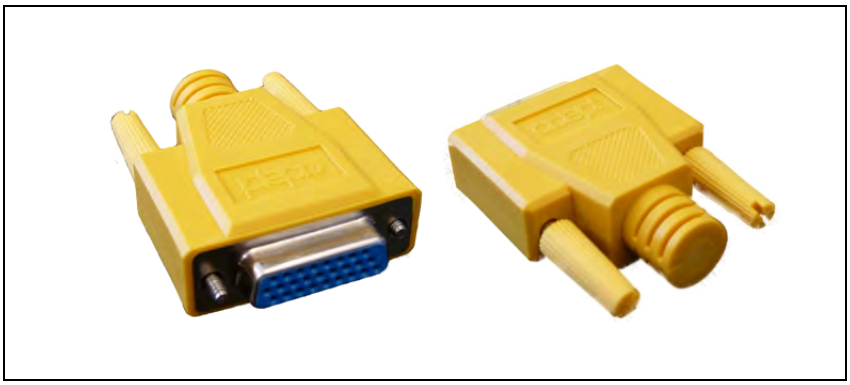


Figure 8-11. eAIB Commissioning Jumper

- 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

> **NOTE:** In this procedure, the word "controller" means the SmartController EX, if there is one in your system, or, if not, the eMB-40R.

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 controller.

   On some systems, the controller 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 controller.

   On some systems, the controller 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 controller.

   On some systems, the controller 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: PERSONAL INJURY RISK
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 controller.

   On some systems, the controller 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: ELECTROCUTION RISK
Lock out and tag out power before servicing.

WARNING: ELECTROCUTION RISK
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 eMB-40R (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 eMB-40R (or controller).

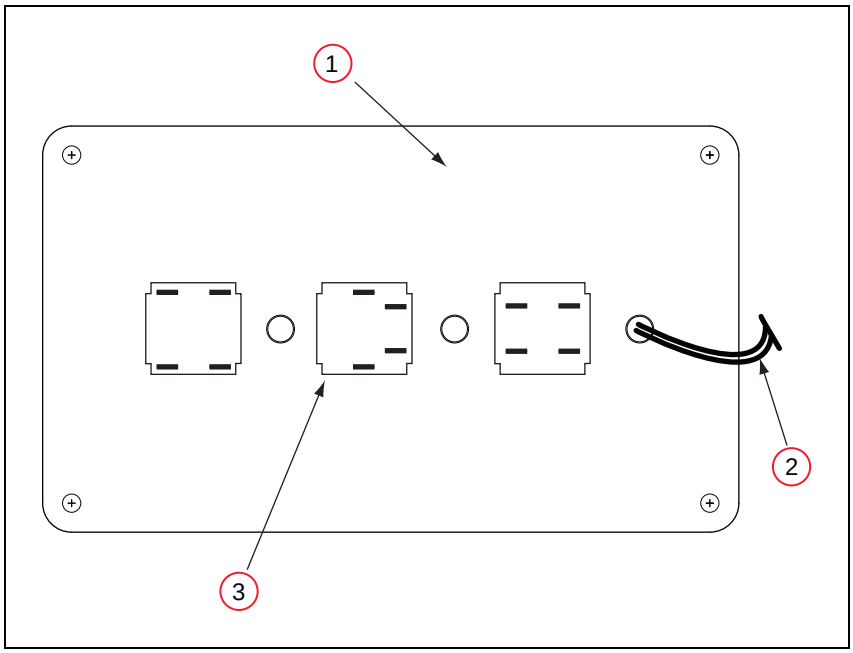


Figure 8-12. Lamp Body Contact Alignment

Table 8-3. Lamp Body Contact Alignment Description

Item	Description
1	Back side of Front Panel
2	Wires between LED and body of Front Panel. Be careful when separating Front Panel from body to avoid damaging the wires.
3	High Power ON / OFF Lamp Body

Chapter 9: Technical Specifications

9.1 Dimension Drawings

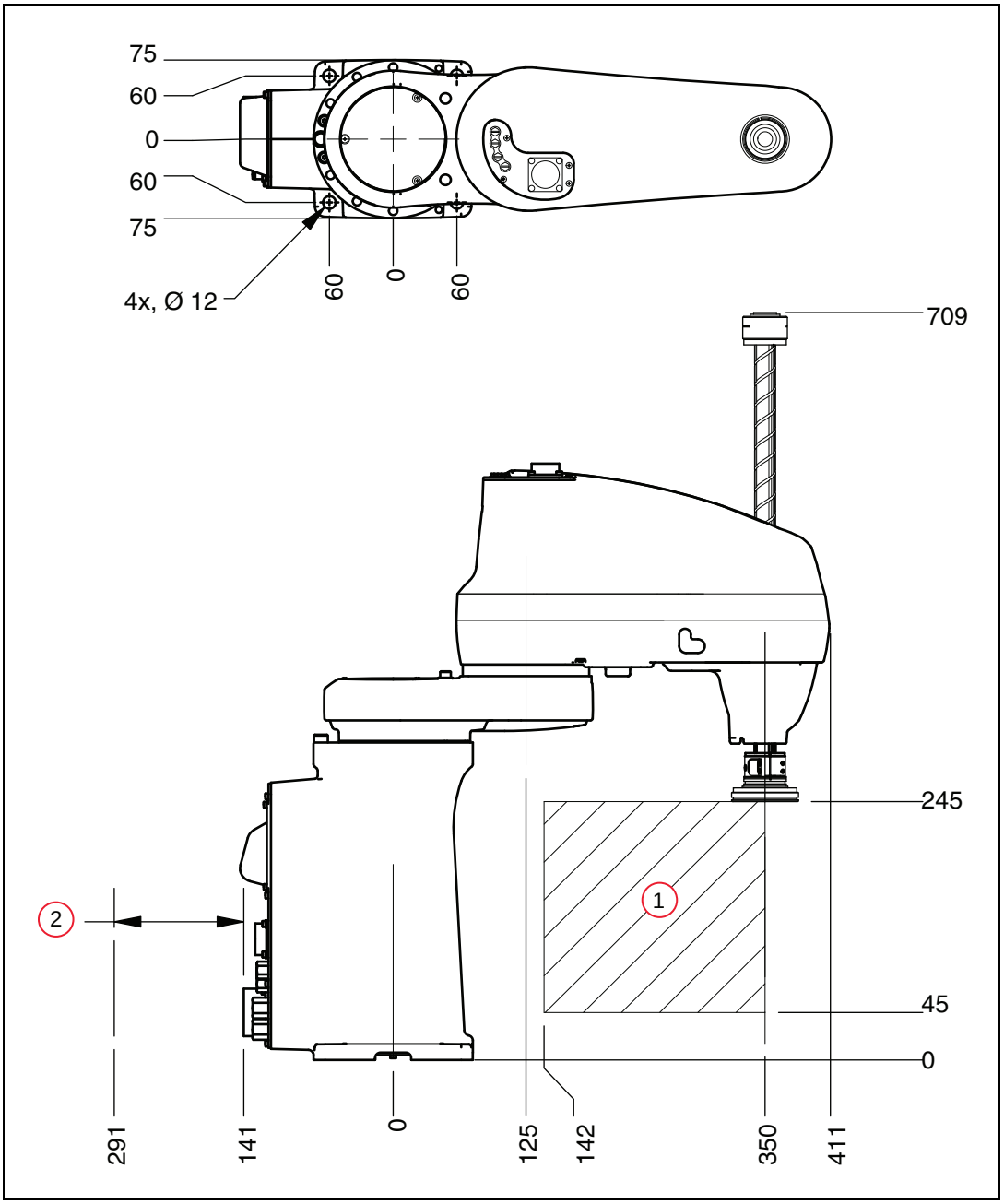


Figure 9-1. Cobra 350 Top and Side Dimensions (Units in mm)

Table 9-1. Cobra 350 Top and Side Dimension Description

Item	Description
1	Work Area
2	Cabling Space

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

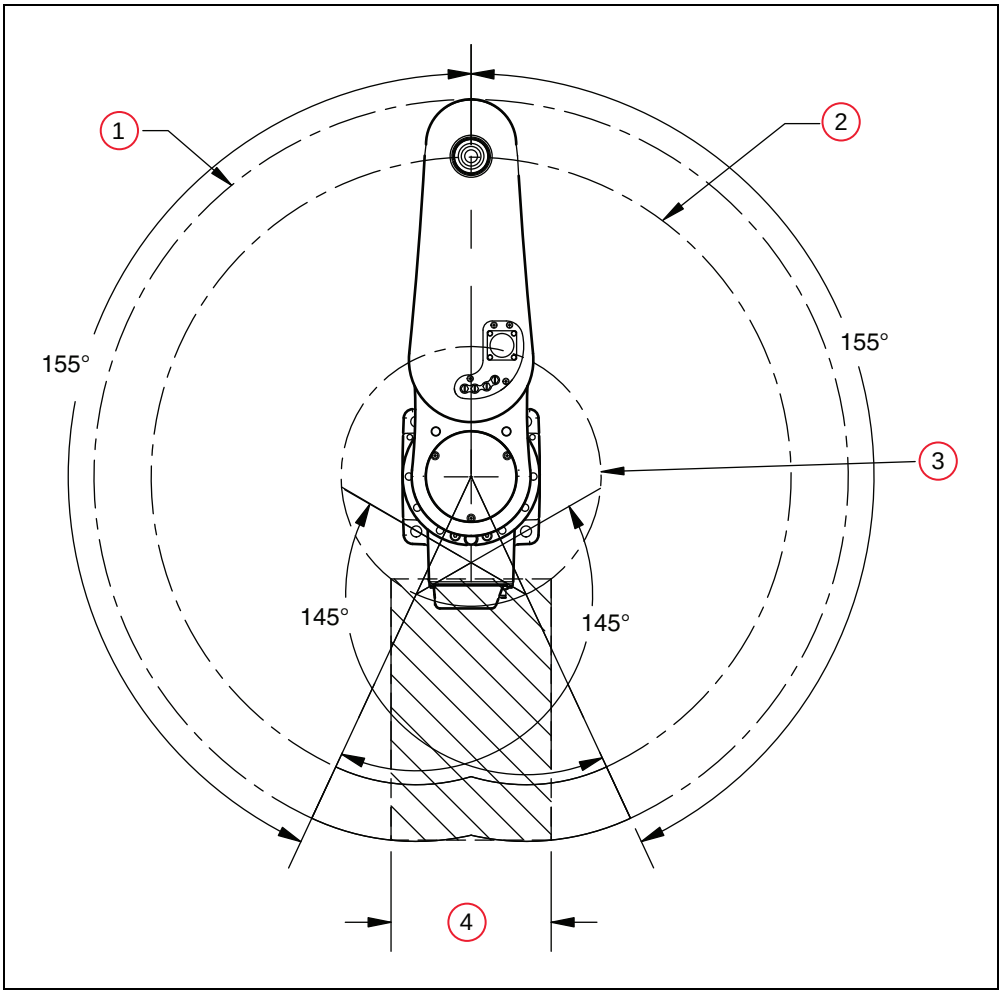


Figure 9-2. Cobra 350 Robot Working Envelope

Table 9-2. Cobra 350 Robot Working Envelope Description

Item	Description
1	Maximum Intrusion Contact Radius (R 412 mm)
2	Maximum Radial Reach Functional Area (R 350 mm)
3	Minimal Radial Reach (R 142 mm)
4	Cartesian Limits (175 mm)

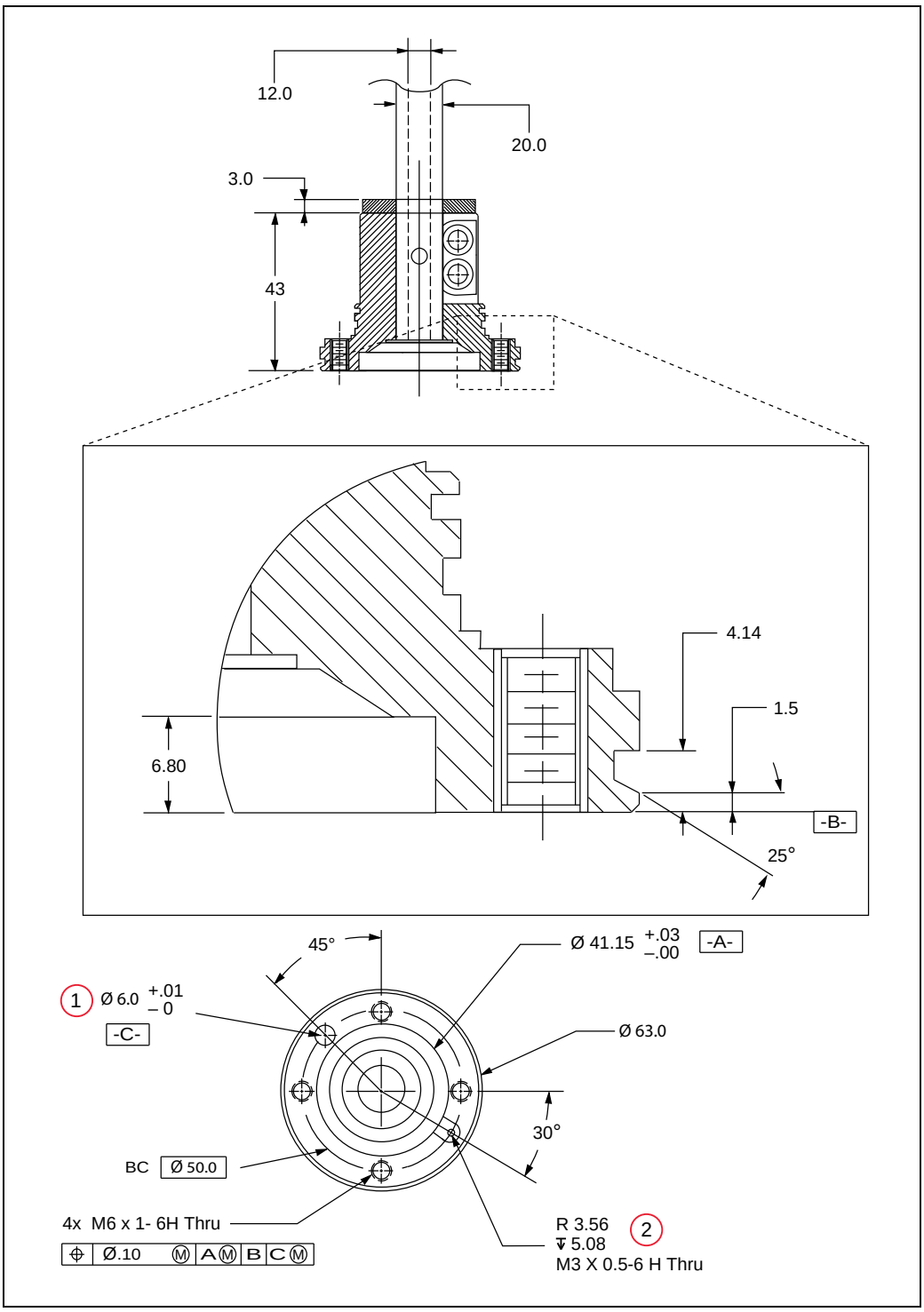


Figure 9-3. Tool Flange Dimensions for Cobra 350 Robots (Units in mm)

Table 9-3. Tool Flange Description

Item	Description
1	Dowel Pin Hole
2	User Ground

NOTE: Dimension drawings for the eMB-40R are shown in eMB-40R Mounting Dimensions. (1) M4 X 7 mm DP blind studs spaced as shown, 20X (Units in mm). on page 48.

9.2 Robot Specifications

Physical

Table 9-4. Cobra 350 and 350CR/ESD Physical Robot Specifications[1]

Description	Specification
Reach	350 mm
Payload - rated/maximum	2.0 kg/5.0 kg
Joint Range	
Joint 1	±155°
Joint 2	±145°
Joint 3	200 mm (7.8 inches)
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 9-5. 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 9-6. 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 (5.0 kg). Data provided is for the three joints of greatest displacement (J1, J2 and J3).

> **NOTE:** Where lines overlap (and may not be visible) differences are not significant.

Key to Graphs

Item	Meaning
Blue Line	Payload 33%
Red Line	Payload 66%
Green Line	Payload 100%
1	Stopping Distance (mm)
2	Stopping Distance (degrees)
3	Stopping Time (seconds)
4	Speed (%)

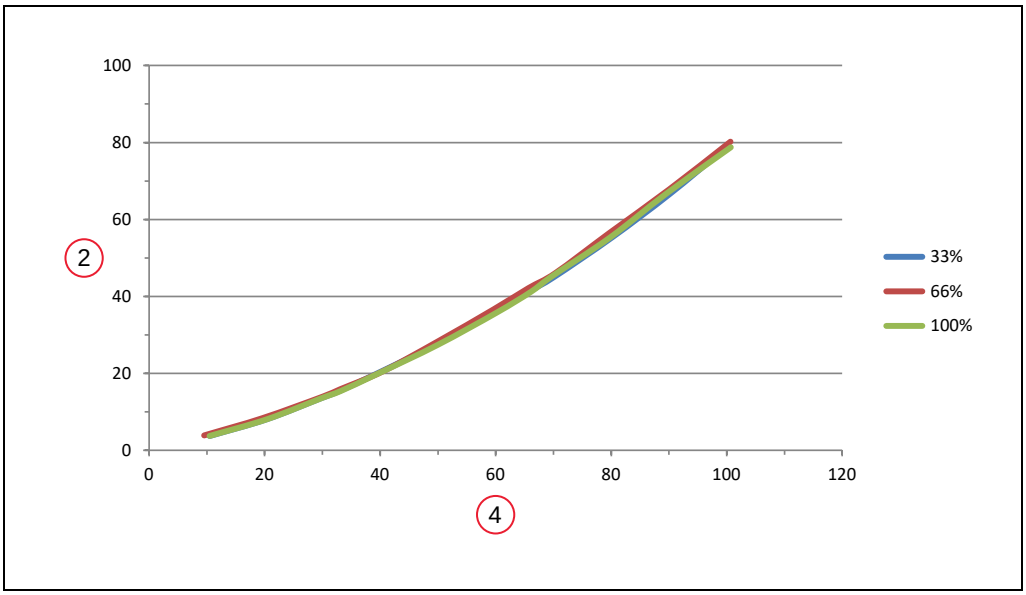


Figure 9-4. Joint 1 Stopping Distance for Cobra 350, in Degrees

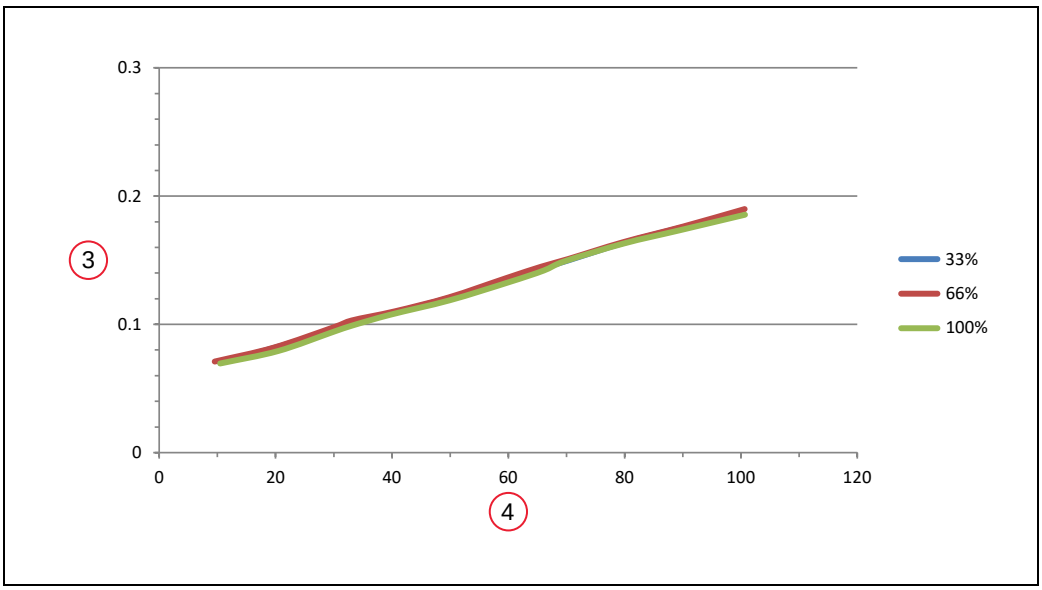


Figure 9-5. Joint 1 Stopping Time for Cobra 350, in Seconds

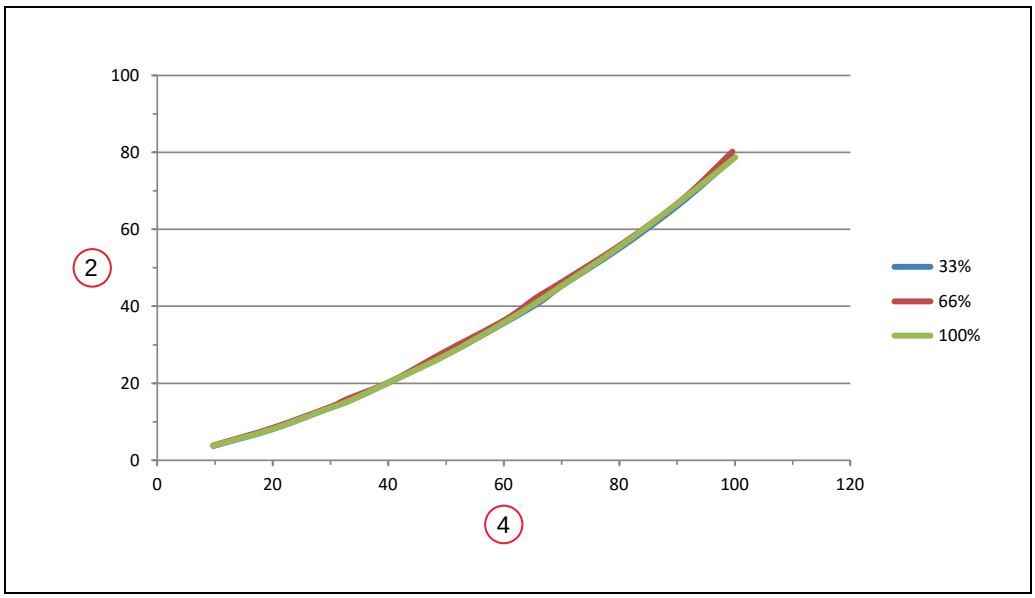


Figure 9-6. Joint 2 Stopping Distance for Cobra 350, in Degrees

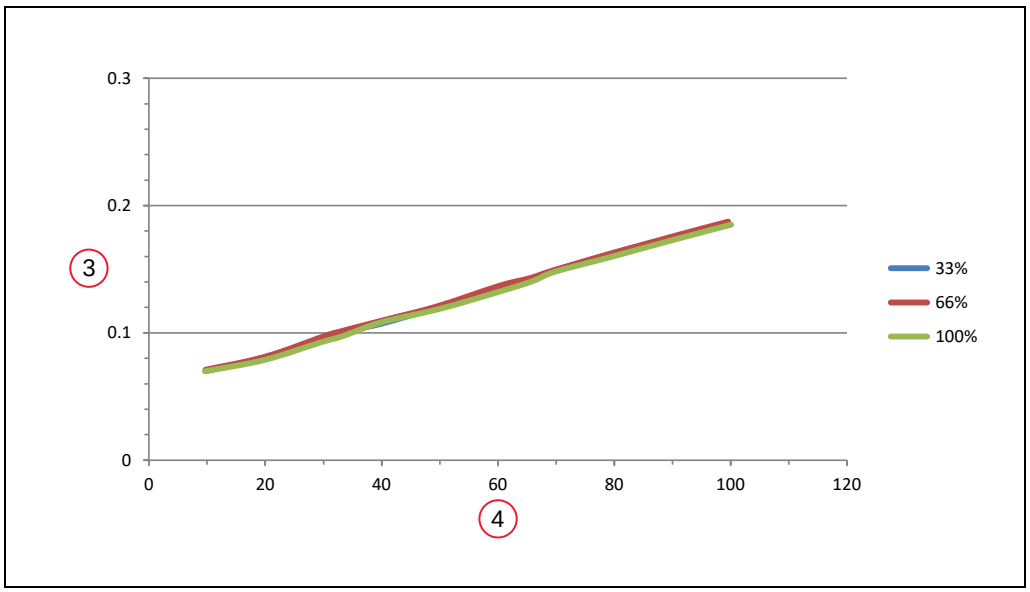


Figure 9-7. Joint 2 Stopping Time for Cobra 350, in Seconds

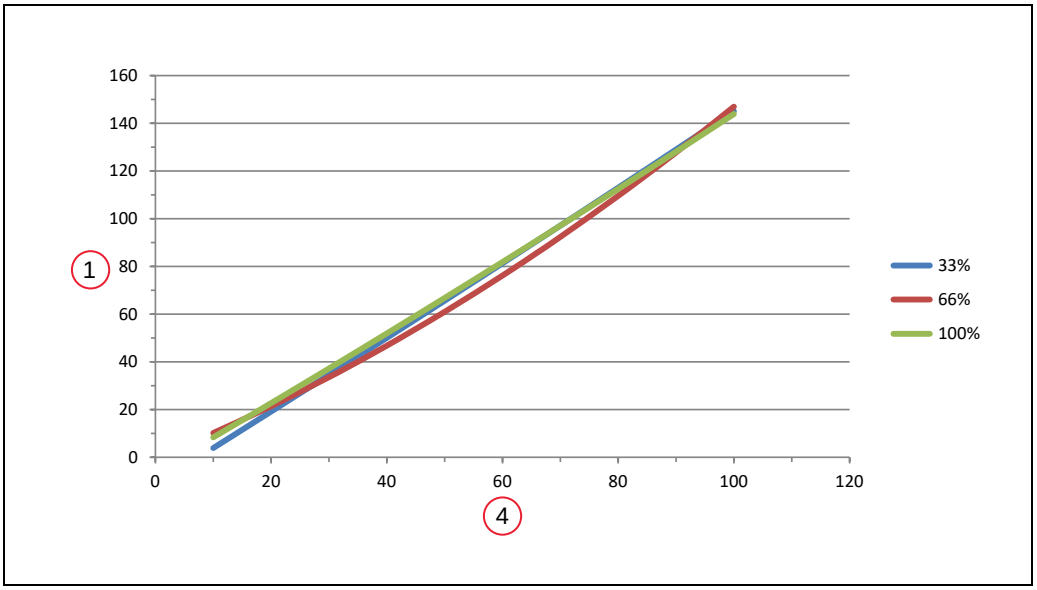


Figure 9-8. Joint 3 Stopping Distance for Cobra 350, in Millimeters

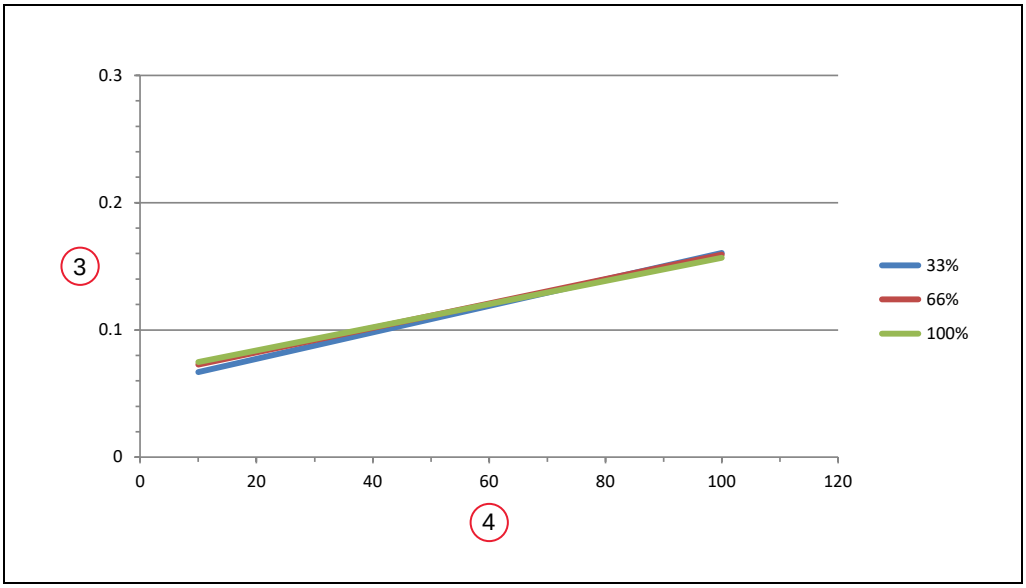


Figure 9-9. Joint 3 Stopping Time for Cobra 350, in Seconds

Stopping distances and times will not degrade as a result of either aging or normal use. Stopping distance will vary only if there is an actuating mechanism failure, which may require replacement of the failed component.

If an integrator wants to perform their own measurement of stopping distances and time in a real cell with a real robot and with real tools and loads, contact your local Omron support.

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 to 35°C (41 to 95°F)

10.2 Connections

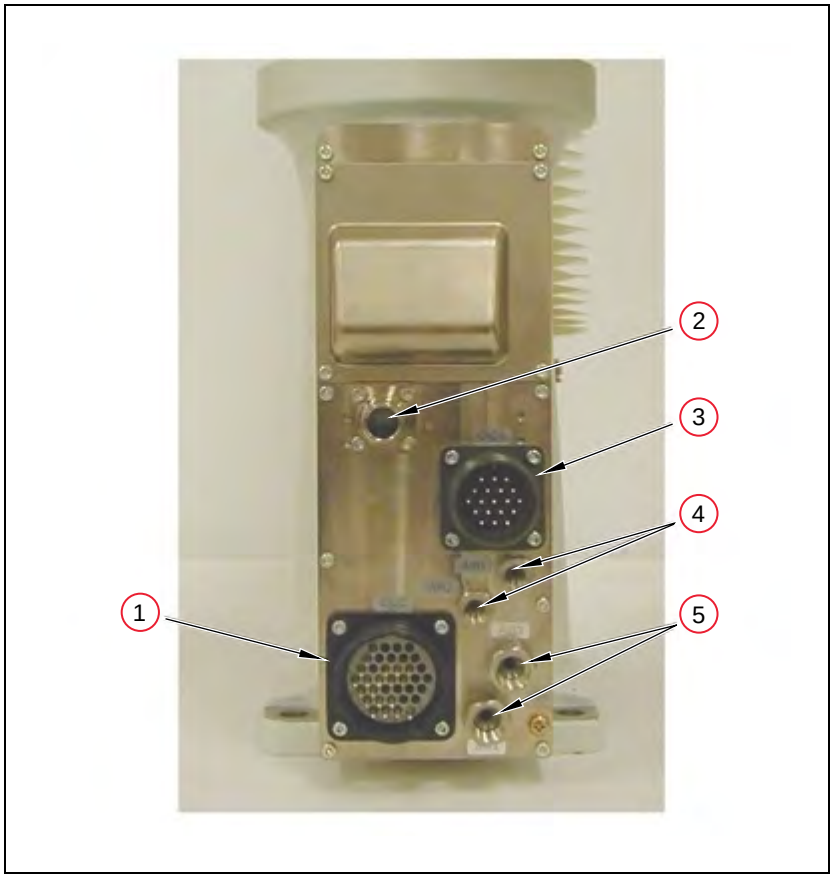


Figure 10-2. Cleanroom Connections

Table 10-2. Cleanroom Connections Description

Item	Description
1	CN22
2	Vacuum Fitting, 15 mm OD
3	CN20
4	AIR1 and AIR2, Ø4, BSPT 1/8
5	AIR3 and AIR4, Ø6, BSPT 1/4

For the eMB-40R end of the cable, line up the slot in the cable end with the matching key in the connector, apply firm pressure straight in, and thread the lock ring fully onto the connector. There should be no visible threads when connected. See Cable Connection from eMB-40R to Robot on page 66.

For the robot end of the cable, line up the keys (1 large, 4 small) on the cable end with the grooves in the connector, apply firm pressure straight in, and twist the locking ring a quarter turn. You should hear and feel a click as it latches into place.

10.3 Requirements

Table 10-3. 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 your local Omron support 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 the following figure for details.
2. Remove the tool flange. Refer to Removing and Reinstalling the Tool Flange on page 93 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.

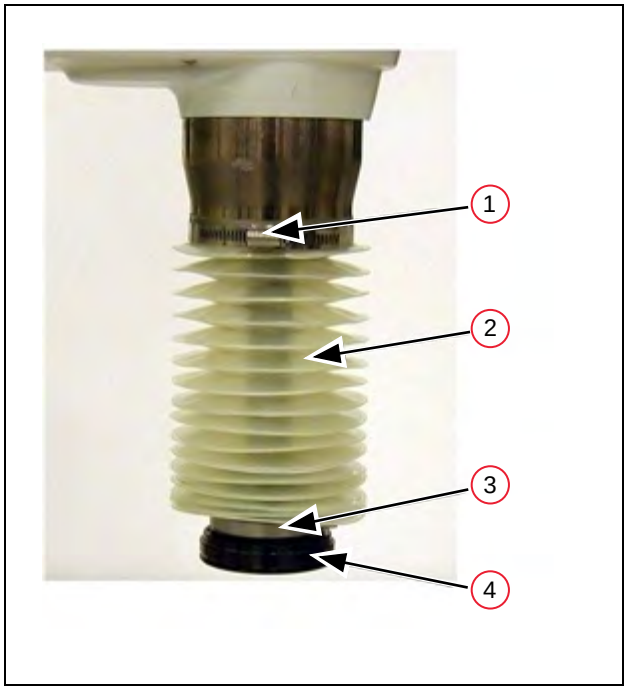


Figure 10-3. Cleanroom Lower Bellows Replacement

Table 10-4. Cleanroom Lower Bellows Description

Item	Description
1	Upper Clamp Ring
2	Bellows
3	Lower Clamp Ring
4	Tool Flange

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.)

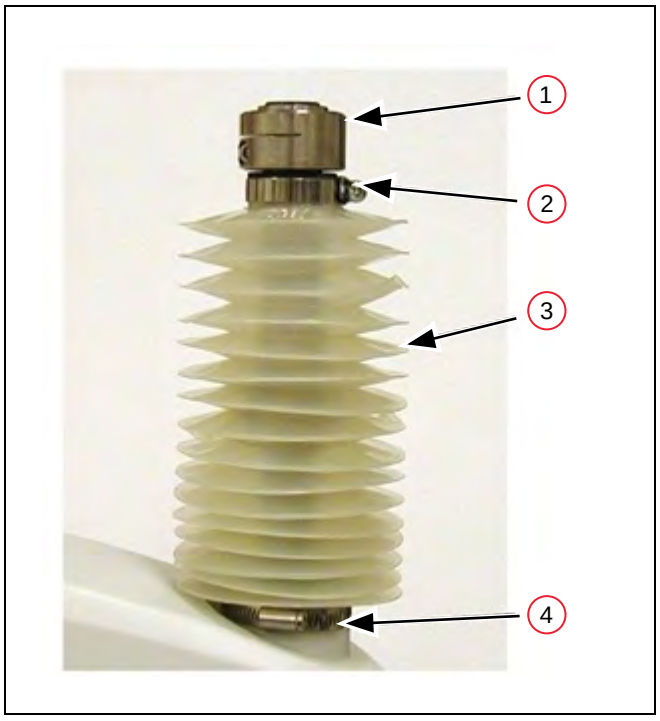


Figure 10-4. Cleanroom Upper Bellows Replacement

Table 10-5. Cleanroom Upper Bellows Description

Item	Description
1	Top Assembly
2	Upper Clamp Ring
3	Bellows
4	Lower Clamp Ring

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 105.

10.6 Dimension Drawings

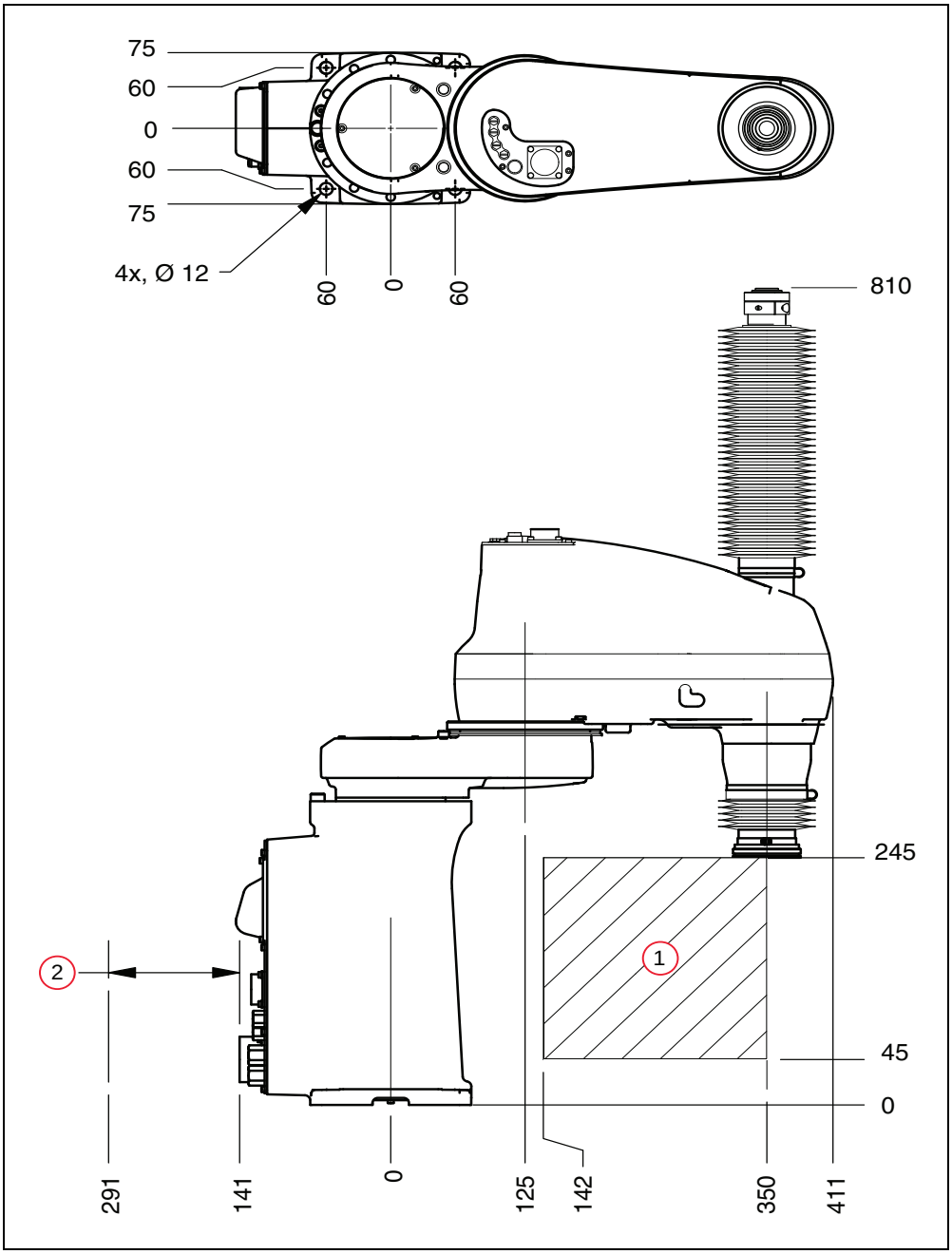


Figure 10-5. Cobra 350 CR / ESD Top and Side Dimensions (Units in mm)

Table 10-6. Cobra 350 CR / ESD Top and Side Dimension Description

Item	Description
1	Work Area
2	Cabling Space

NOTE: The total height of the Cobra 350 CR/ESD robot is different than the standard robot. See Cobra 350 Top and Side Dimensions (Units in mm) on page 119 for a comparison.

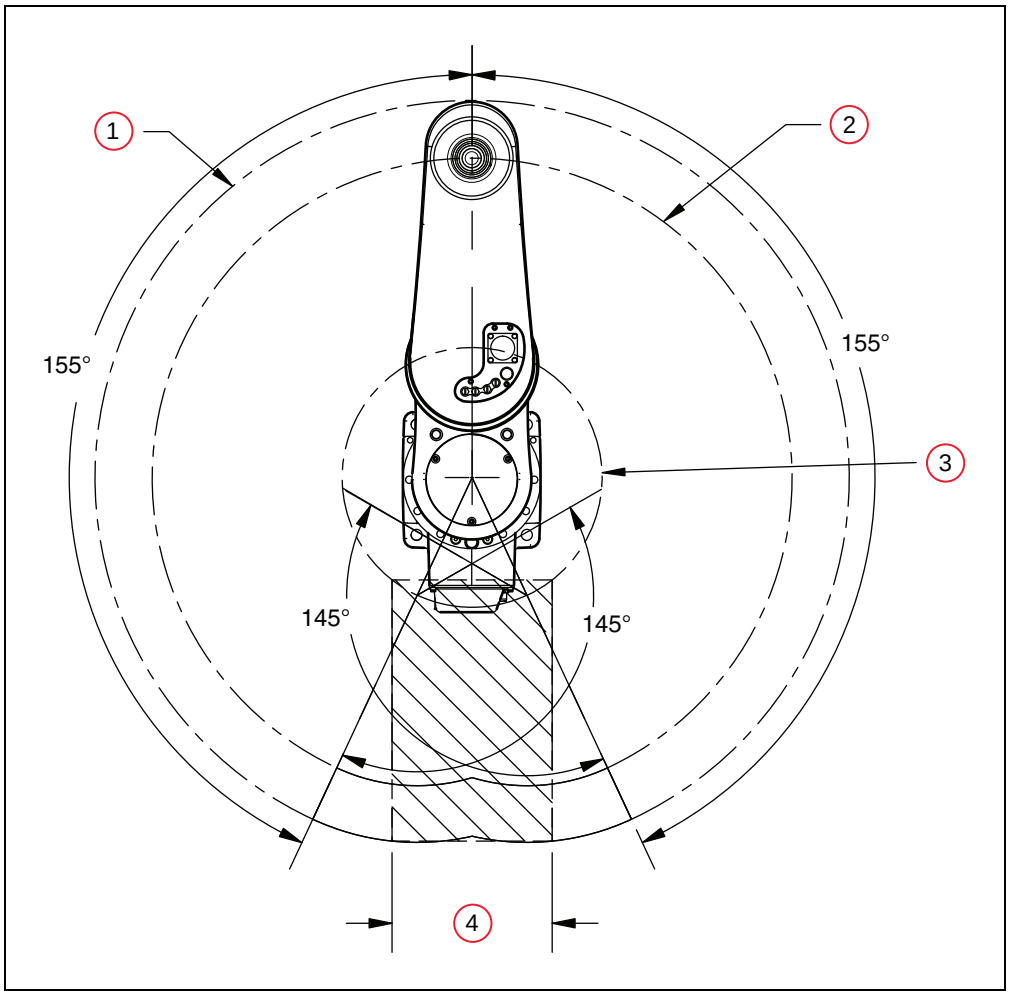


Figure 10-6. Cobra 350 CR / ESD Robot Working Envelope

Table 10-7. Cobra 350 CR / ESD Robot Working Envelope Description

Item	Description
1	Maximum Intrusion Contact Radius (R 412 mm)
2	Maximum Radial Reach Functional Area (R 350 mm)
3	Minimal Radial Reach (R 142 mm)
4	Cartesian Limits (175 mm)

OMRON Corporation **Industrial Automation Company**
Kyoto, JAPAN
Contact: www.ia.omron.com

Regional Headquarters

OMRON EUROPE B.V.
Wegalaan 67-69, 2132 JD Hoofddorp
The Netherlands
Tel: (31)2356-81-300/Fax: (31)2356-81-388

OMRON ASIA PACIFIC PTE. LTD.
No. 438A Alexandra Road # 05-05/08 (Lobby 2),
Alexandra Technopark,
Singapore 119967
Tel: (65) 6835-3011/Fax: (65) 6835-2711

OMRON ELECTRONICS LLC
2895 Greenspoint Parkway, Suite 200 Hoffman Estates,
IL 60169 U.S.A.
Tel: (1) 847-843-7900/Fax: (1) 847-843-7787

OMRON ADEPT TECHNOLOGIES, INC.
4550 Norris Canyon Road, Suite 150, San Ramon, CA 94583 U.S.A.
Tel: (1) 925-245-3400/Fax: (1) 925-960-0590

OMRON (CHINA) CO., LTD.
Room 2211, Bank of China Tower, 200 Yin Cheng Zhong Road,
PuDong New Area, Shanghai, 200120, China
Tel: (86) 21-5037-2222/Fax: (86) 21-5037-2200

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