

OMRON

eCobra 600 and 800 Robot with EtherCAT

User's Manual



I653-E-02

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Revision History

Revision Code	Release Date	Details
A	July, 2020	Original release
B	August, 2020	Minor corrections and updates

Chapter 1: Introduction

This manual contains information that is necessary to install and use eCobra 600 and 800 Robots with EtherCAT. Please read this manual and make sure you understand the functionality, installation, and performance of the robot before attempting to use it.

Related Manuals

Use the following related manuals for reference.

Table 1-1. Related Manuals

Manual	Description
Robot Safety Guide (Cat. No. I590)	Contains safety information for OMRON industrial robots.
Sysmac Studio Robot Integrated System Building Function with Robot Integrated CPU Unit Operation Manual (Cat. No. W595)	Describes the operating procedures of the Sysmac Studio.
Sysmac Studio Robot Integrated System Building Function with IPC Application Controller Operation Manual (Cat. No. W621)	Describes the operating procedures of the IPC Application Controller.
eV+3 User's Manual (Cat. No. I651)	Provides a description of the eV+ programming language and functionality.
eV+3 Keyword Reference Manual (Cat. No. I652)	Provides reference to eV+ Keyword use and functionality.
NJ-series Robot Integrated CPU Unit User's Manual (Cat. No. O037)	Provides information that is necessary to use the robot control function of the NJ-series CPU Unit.
IPC Application Controller User's Manual (Cat. No. I632)	Provides information that is necessary to use the robot control function of the IPC Application Controller.
[[[Undefined variable Primary.T20 User's Guide]]]	Describes the use of the optional T20 manual control pendant.
IO Blox User's Guide (04638-000)	Describes the IO Blox product, its connections, and input/output signals.

1.1 Intended Audience

This manual is intended for the following personnel, who must also have knowledge of common programming practices and robotic control methods.

- Personnel in charge of introducing FA systems.
- Personnel in charge of designing FA systems.
- Personnel in charge of installing and maintaining FA systems.
- Personnel in charge of managing FA systems and facilities.

1.2 Robot Overview

The robots detailed in this manual are four-joint Selective Compliance Assembly Robot Arm (SCARA) industrial robots. These next-generation robots are designed for a variety of automated applications where high speed and precision is required.

Built-in EtherCAT communications allow this robot to operate together with EtherCAT slaves, other Sysmac products, and the Sysmac Studio Automation Software to achieve optimum functionality and ease of operation.

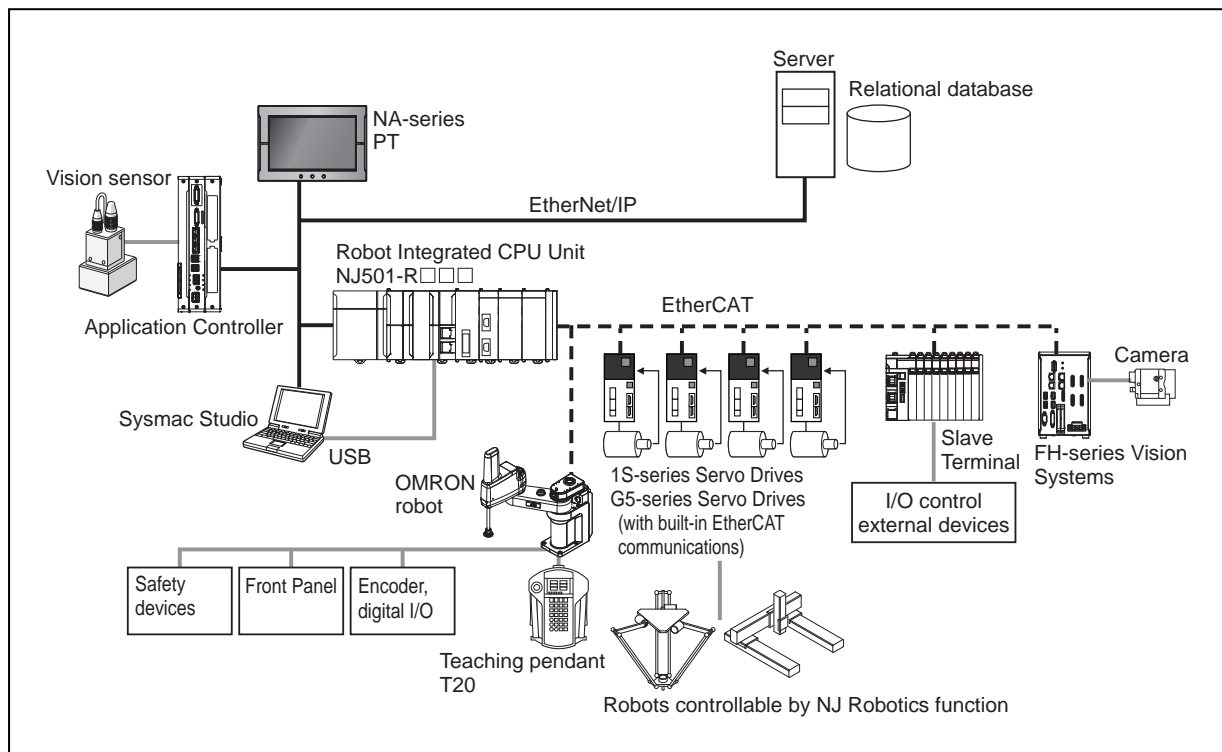


Figure 1-1. EtherCAT System Topology

These robots are offered with two different arm reaches to provide different working envelopes. The eCobra 600 Robot has a 600 mm radial reach and the eCobra 800 Robot has an 800 mm radial reach, measured from Joint 1 to Joint 4. Refer to Robot Physical Dimension Drawings on page 131

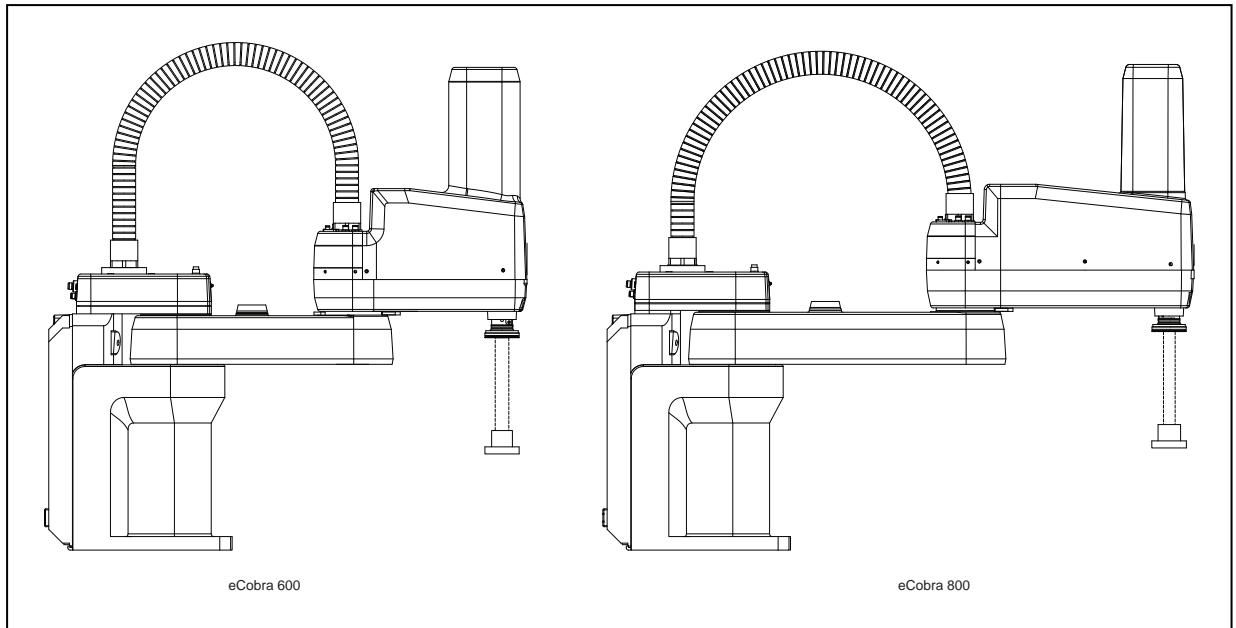


Figure 1-2. eCobra 600 and 800 Models

There are two tiers of eCobra robots; the eCobra Pro and the eCobra Standard. The Pro and Standard tiers are physically identical. The Pro models offer faster performance and more features and connectivity than the Standard models. Refer to Robot Features on page 16 for more information.

NOTE: The descriptions and instructions in this manual apply to all eCobra 600 and 800 Robots with EtherCAT. If there are differences based on type or options, this manual will provide details in the associated sections.

Robot Amplifier and Controller

The robot's amplifier and controller is integrated in the robot's base and referred to as the Internal Control System, or iCS-ECAT.

The iCS-ECAT unit contains power amplifiers, safety circuitry, and I/O as well as full trajectory, kinematic, and servo robot control hardware.

This robot is intended to operate within an EtherCAT network. It receives commands and control signals from the NJ-series Robot Integrated CPU Unit over an EtherCAT network.



Figure 1-3. eCobra Robot with iCS-ECAT Highlighted

Internal Control System

The iCS-ECAT has a dedicated microprocessor to communicate, coordinate, and execute servo commands. The iCS-ECAT unit receives eV+ commands from the NJ-series Robot Integrated CPU Unit and processes these commands to execute robots motions and other functions.

The iCS-ECAT contains the robot interface panel which provides connections for power supply, peripheral devices such as the front panel, pendant, and user-supplied safety equipment, and EtherCAT network cables. The robot interface panel also has switches for setting an explicit EtherCAT Node address and operating mode as well as LED's to indicate operating status.

Additional Information: Refer to iCS-ECAT Robot Interface Panel on page 24 for more information.

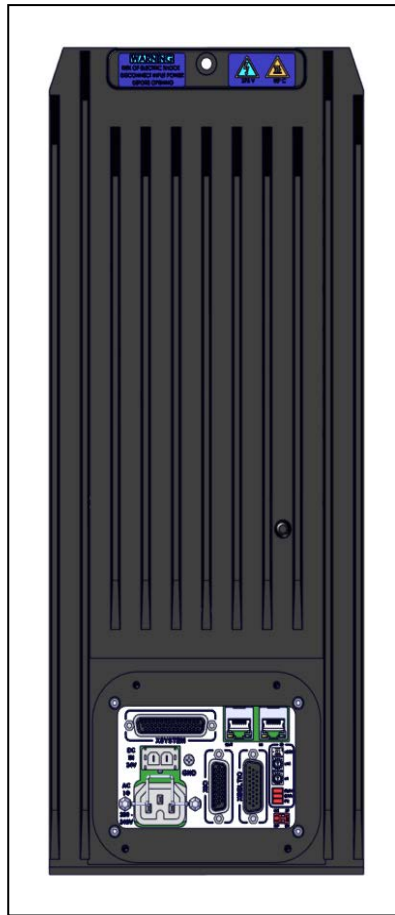


Figure 1-4. iCS-ECAT

iCS-ECAT Features

The iCS-ECAT unit has the following general features.

- Integrated EtherCAT communications for distributed robot control.
- Integrated digital I/O.
- Dual 1 GHz Cortex A9 ARM Processors, 1 GB SDRAM.
- 8 GB MicroSD card.
- Low EMI for use with noise sensitive equipment.
- No external fan.
- 8 kHz servo rate to deliver low positional errors and high-performance path following.
- Digital feed-forward control to maximize efficiency, torque, and positioning.
- Internal temperature sensors for hardware protection and troubleshooting.

IP65 and Cleanroom Versions

eCobra robots are also available with options for IP65 or Class 10 Cleanroom ratings. These options provide additional protection from dust and fluid, and are supplied with a bellows device on the z-axis quill.

The following images show the IP65 version and the Cleanroom version.



Figure 1-5. IP65 Version (left), Cleanroom Version (right)

Robot Features

The following table lists the varying features and functionality that are available with different system configurations.

Feature	eCobra Standard	eCobra Pro
Vision Support	Yes	Yes
Robot position latching	No	Yes
Local I/O (max. input / output)	44/40	76/72
XIO (max. input / output)	12/8	12/8
IO Blox (max. input / output)	32/32, max. 4 units per robot	64/64, max. units 8 per robot ¹
Conveyor tracking	No	Yes (2 max.) ²
T20 Pendant option	Yes	Yes
IP65 option	Yes (only for eCobra 800)	Yes
Cleanroom option	Yes	Yes
Pass-through, J1 to J2	5 air lines 24 user electrical contacts 1 DeviceNet pass-through	
¹ Requires XBELTIO Cable for 2nd group of 4 units.		
² Requires XBELTIO Cable.		

Robot Links and Joints

The robot links and joints are described below.

Joints 1, 2, and 4 are rotational. Joint 3 is translational.

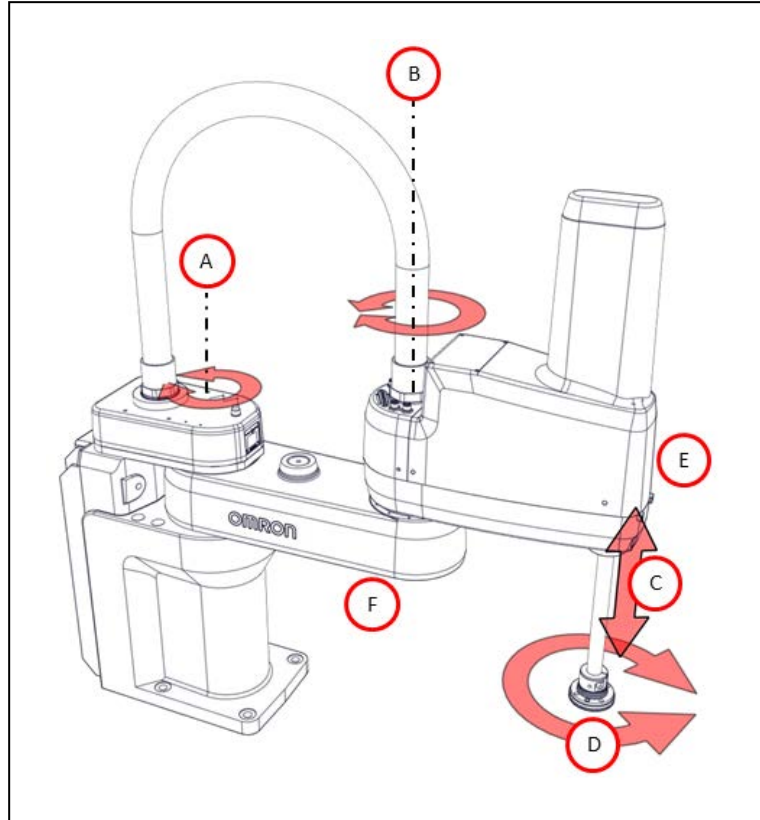


Figure 1-6. Robot Joint Motions - eCobra 600 Robot Shown

Key	Meaning	Key	Meaning
A	Joint 1 (Shoulder)	D	Joint 4 (Wrist)
B	Joint 2 (Elbow)	E	Outer link
C	Joint 3 (Z)	F	Inner link

Robot Connections

This section describes the various external and internal ports and connectors that are available on the standard eCobra robot.

NOTE: Some connections may differ on robots with the IP65 or Cleanroom options. Refer to IP65 Option Considerations on page 153 and Cleanroom Option Considerations on page 167 for more information.

The external connections include:

- iCS-ECAT robot interface panel connections
- Pneumatic pass-through ports

- Electrical pass-through connections
- IO Blox connector

The internal connections include:

- Solenoid connector for the optional Solenoid Valve Kit
- Connector for a second set of optional robot hand valve solenoids (OP3/4)
- End-of-arm power connector (EOAPWR)
- End of Arm Break-away Sensor Connector

Pneumatic Pass-through Ports

The pneumatic pass-through ports on the back of Joint 1 are typically used for end-effector control. Internal air lines are routed internally through the robot to another set of matching connectors on the top of the outer link as shown below.

Additional Information: Refer to Technical Specifications on page 131 for more information.

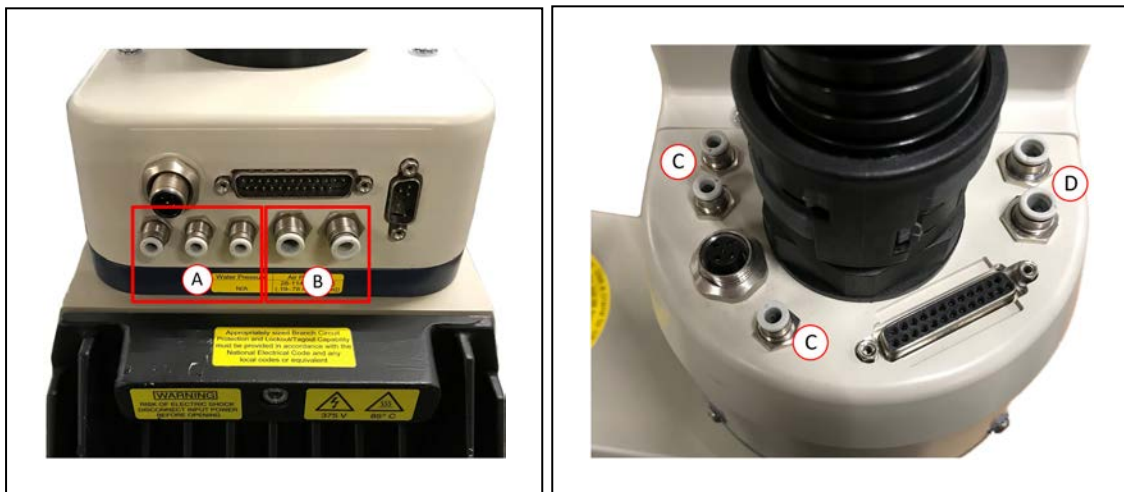


Figure 1-7. Pneumatic Pass-through ports on the back of Joint 1 (left) and Joint 2 (right)

Table 1-2. Pneumatic Pass-Through Port Descriptions

Item	Description
A / C	4 mm ports
B / D	6 mm ports

Electrical Pass-through Connections

The electrical pass-through connectors on the back of Joint 1 are typically used for end-effector sensing and control. Internal harnesses are routed through the robot to another set of mating connectors on the top of the outer link as shown below.

Additional Information: Refer to Technical Specifications on page 131 for more information.

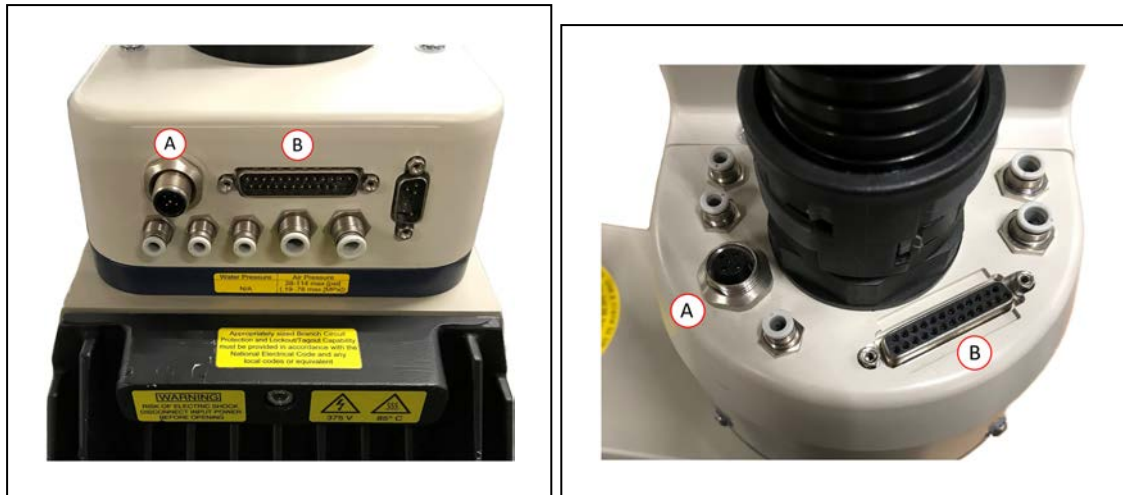


Figure 1-8. User Electrical Connectors on Joint 1 (left) and Joint 2 (right)

Item	Description
A	DeviceNet pass-through
B	General purpose electrical pass-through.

IO Blox Connector

The IO Blox connector on Joint 1 provides an interface to add IO Blox expansion I/O modules to a robot.

NOTE: Refer to Connecting Digital I/O to the System on page 67 and the *IO Blox User's Guide (04638-000)* for more information.



Figure 1-9. IO Blox Connector

Solenoid Connector

The robot has been pre-wired to accommodate a bank of two 24 VDC solenoid valves. Power for the internally mounted solenoid valves is accessible with a connector mounted inside the outer link cover. This 4-pin connector provides the output signals for internally mounted solenoid valves. The solenoid connector location and pin details are provided below.

Additional Information: An optional Solenoid Valve Kit (part number 02853-000) is available for use with the internal solenoid connector. Refer to Robot Options on page 25 and Technical Specifications on page 131 for more information.

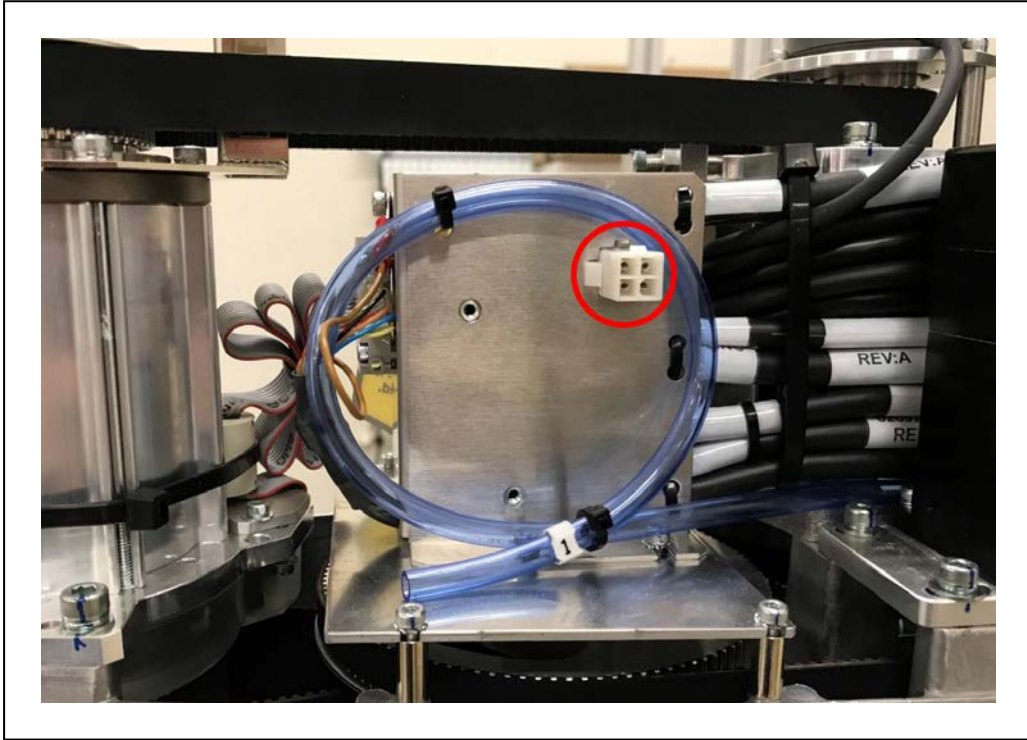


Figure 1-10. Solenoid Connector Location

Table 1-3. Solenoid Connector Pinout

Pin #	Description	Pin Location
1	Output 3001 (+24 VDC)	
2	0 VDC	
3	Output 3002 (+24 VDC)	
4	0 VDC	

OP3/4 Connector

This 4-pin connector provides the output signals for a second set of optional robot hand valve solenoids or other user-supplied devices. The OP3/4 connector location and pin details are provided below.



WARNING: Do not remove the J3-ENC or J4-ENC encoder cable connectors that are located near the OP3/4 connector. If they are removed, the calibration data will be lost and the robot must be factory recalibrated which requires special software and tools.

Additional Information: Technical Specifications on page 131 for more information.



Figure 1-11. OP3/4 Connector Location

Table 1-4. OP3/4 Connector Pinout

Pin #	Description	Pin Location
1	Output 3003 (+24 VDC)	
2	0 VDC	
3	Output 3004 (+24 VDC)	
4	0 VDC	

End of Arm Break-away Sensor Connector

The end of arm break-away sensor shutdown function provides a high power shutdown from the outer link area. For example, if you want a break-away gripper to shut down robot high power, this allows you disable high power through a user relay circuit inside the robot.



WARNING: Do not remove the J3-ENC or J4-ENC encoder cable connectors that are located near the end of arm break-away sensor connector. If they are removed, the calibration data will be lost and the robot must be factory recalibrated which requires special software and tools.

This is typically used with a break-away sensor at the end of arm tooling to immediately turn OFF high power when the circuit becomes open. The end of arm break-away sensor connector location and pin details are provided below.

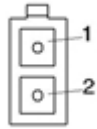
Additional Information: Refer to End of Arm Break-away Sensor on page 26 and Technical Specifications on page 131 for more information.

IMPORTANT: When connecting a cable to the End of Arm Break-away Sensor Connector, be careful to not dislodge or remove the encoder connectors nearby.



Figure 1-12. End of Arm Break-away Sensor Connector Location

Table 1-5. End-effector Break-away Connector Pin Details

Pin #	Description	Pin Location
1	Input	
2	+24 VDC Supply	

EOAPWR Connector

The end of arm power (EOAPWR) connector is a 4-pin connector that provides 24 VDC power and ground for end-of-arm tooling. The location of the EOAPWR connector and pin details are provided below.



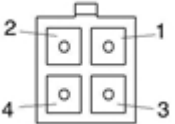
WARNING: Do not remove the J3-ENC or J4-ENC encoder cable connectors that are located near the EOAPWR connector. If they are removed, the calibration data will be lost and the robot must be factory recalibrated which requires special software and tools.



Figure 1-13. EOAPWR Connector Location

See the following table for the pinouts and the following section for the output specifications.

Table 1-6. EOAPWR Connector Pinout

Pin #	Description	Pin Location
1	24 VDC	 <p>EOAPWR Connector as viewed on robot</p>
2	Ground	
3	24 VDC	
4	Ground	

Pin #	Description	Pin Location
Mating Connector:		
Housing: AMP/Tyco #172167-1, 4-pin Mini-Universal Mate-N-Lok		
Pins: AMP/Tyco #770985-1, Pin Contact, Mini-Univ. Mate-N-Lok		

iCS-ECAT Robot Interface Panel

The iCS-ECAT includes the robot interface panel. It has connections for power (240 VAC, 24 VDC), communications, and other peripheral devices such as a pendant, IO Blox, or a Front Panel..

Use the information below to understand all connection points for the iCS-ECAT robot interface panel.

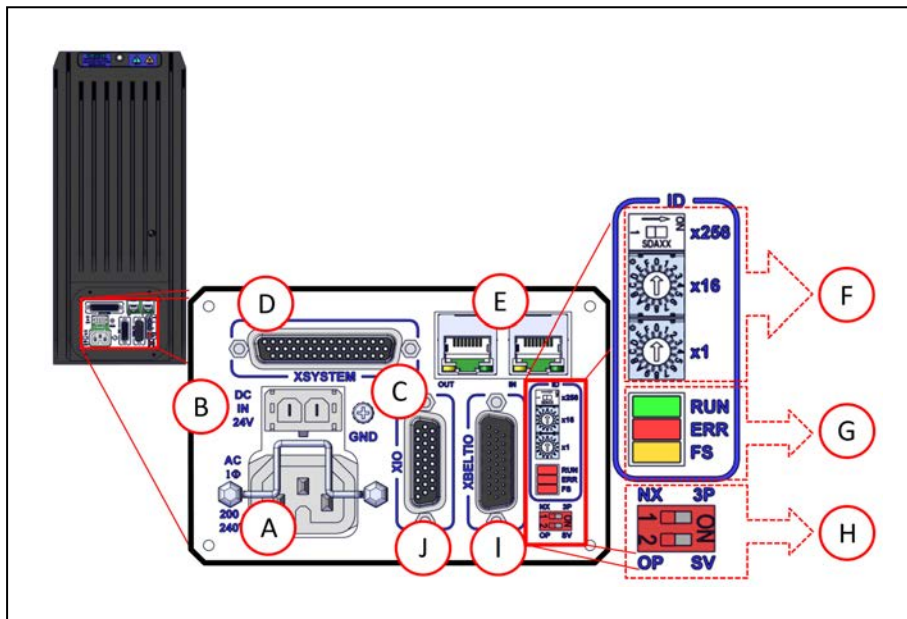


Figure 1-14. iCS-ECAT Robot Interface Panel

Item	Meaning
A	AC Power Supply Connector Used for connecting 200-240 VAC, single-phase input power to the robot. A connector is provided with the robot. Refer to Connecting 200-240 VAC Power Cable on page 81
B	DC Power Supply Connector Used for connecting the user-supplied 24 VDC power to the robot. A connector is provided with the robot. Refer to Connecting the 24 VDC Cable to the Robot on page 78 for more information.
C	Ground Terminal
D	XSYSTEM Connector

Item	Meaning
	Refer to System Cable Installation on page 61
E	EtherCAT Ports Used for inbound and outbound EtherCAT communications.
F	Node ID Switches Used to set the robot's EtherCAT node ID. Refer to Setting the EtherCAT Node ID on page 58
G	LEDs Indicates the status of the EtherCAT connection. Refer to EtherCAT Communications Description on page 102 for more information.
H	4-Position Mode Switches Used to adjust the operating mode of the robot. Refer to Robot Control Modes on page 104 for more information. Additional Information: Switch 1 should remain in the NX / left position. Functionality associated with switch 1 in the 3P / right position is reserved for future use.
I	XBELTIO Connector Used to connect up to two external belt encoders (eCobra Pro only) and IO Blox external I/O. This requires the XBELTIO Adapter cable. Refer to Basic System Cable Layout on page 61 for more information. XBELTIO
J	XIO Connector Used for user I/O signals for peripheral devices. Refer to Basic System Cable Layout on page 61 for more information.

1.3 Robot Options

This section describes the various options available for your eCobra robot.



WARNING: Ensure all optional equipment is installed properly and securely fastened to the robot before operation. Failure to do so may result in personal injury or equipment damage.

Solenoid Valve Kit

The Solenoid Valve Assembly (part number 02853-000) consists of two independent valves-mounted to a common manifold. Each valve has two output ports: A and B. The output ports are arranged so that when Port A is pressurized, Port B is not pressurized. Conversely, when Port B is pressurized, Port A is not pressurized.

The signals actuating the valves are directly switchable from the iCS-ECAT using software signals 3001 and 3002.

NOTE: Refer to the *eV+3 Keyword Reference Manual (Cat. No. I652)*, *eV+3 User's Manual (Cat. No. I651)*, and *Sysmac Studio Robot Integrated System Building Function with Robot Integrated CPU Unit Operation Manual (Cat. No. W595)* for more information about robot signal control.

The supplied solenoids each require a nominal 75 mA at 24 VDC.

The air lines from Port A on each valve have factory-installed plugs at the solenoid assembly so you can use the assembly as 3-way valves. If you need 4-way valves, remove the plugs.

The following image shows an installed Solenoid Valve Kit.

Additional Information: Refer to Solenoid Valve Kit Installation Procedure on page 90 for more information.

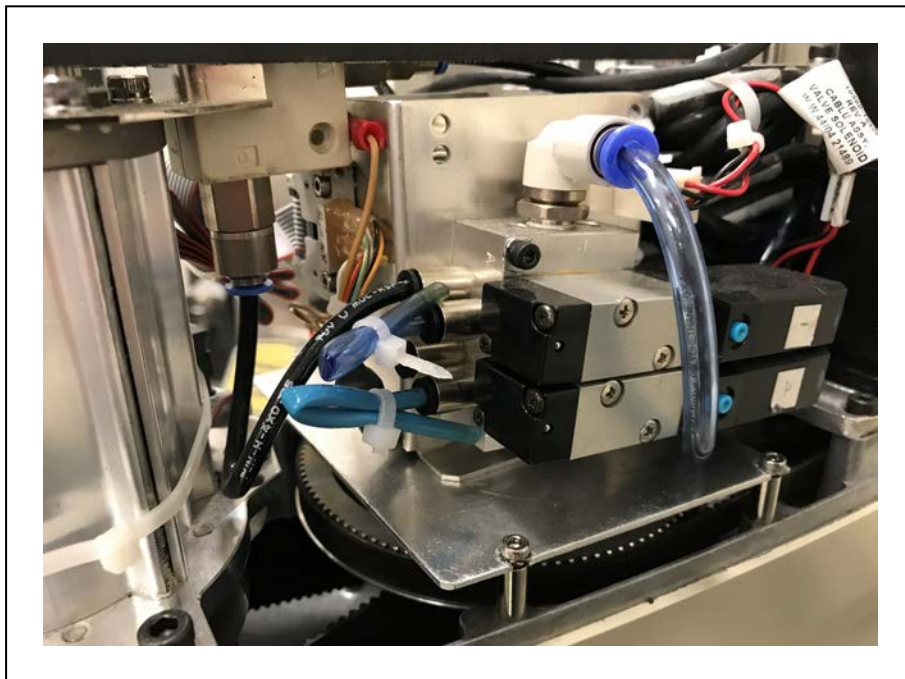


Figure 1-15. Solenoid Valve Kit Installed

End of Arm Break-away Sensor

The internal 2-pin end-of-arm break-away sensor connector provides a pair of contacts that can be used for a user-supplied, break-away sensor at the end of the robot arm. The function is disabled by default and you must enable it using the Sysmac Studio.

The break-away sensor requires a normally-closed circuit wired to Pins 1 and 2 of the connector. When the circuit is opened, the system will stop with a status code F1 (refer to Status Codes Table on page 171 for more information).

Additional Information: Refer to End of Arm Break-away Sensor Connector on page 21 for more information about the connector location.

IMPORTANT: When connecting a cable to the end of arm break-away sensor connector, be careful to not dislodge or remove the encoder connectors nearby.

The following figure shows a typical end-of-arm break-away sensor circuit.

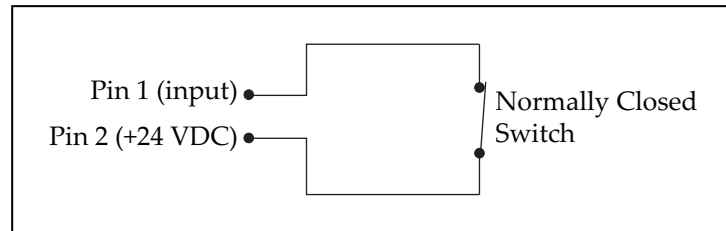


Figure 1-16. End-of-arm break-away sensor Circuit

IO Blox

IO Blox units extend the robot's capabilities by providing expandable I/O capacity..

You can add up to 4 IO Blox units to the eCobra Standard model and up to 4 additional IO Blox units (for a total of 8 units) to the eCobra Pro.

Additional Information: Refer to IO Blox Connections on page 68 and the *IO Blox User's Guide (04638-000)* for more information.



Figure 1-17. IO Blox

Optional I/O Items

The following optional items are available for use with digital I/O.

- XIO Breakout Cable (part number 04465-000)

Refer to Optional Cables on page 33 for more information.

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

- XIO Termination Block (part number 90356-40100)

Includes terminals for user wiring and I/O status LEDs. Connects to the XIO connector with 2m cable.

T20 Pendant

The T20 pendant is an optional hand held device that allows you to move the robot, teach locations, and debug programs without a PC. The pendant can also be used to move the robot before calibration has occurred.

Additional Information: Refer to the *T20 Pendant User's Manual (Cat. No. I601)* for more information about operating a robot with the T20 pendant.

IMPORTANT: The T20 pendant can only communicate with the robot it is directly connected to.



Figure 1-18. T20 Pendant

IPC Application Controller

The IPC Application Controller can be added to your system to execute PackManager and Robot Vision Manager applications.

Refer to the following manuals for more information.

- *Automation Control Environment (ACE) Version 4 User's Manual (Cat. No. I633)*
- *NJ-series Robot Integrated CPU Unit User's Manual (Cat. No. O037)*
- *IPC Application Controller User's Manual (Cat. No. I632)*



Figure 1-19. IPC Application Controller

Front Panel

The Front Panel is an optional device that provides the following functions.

- Setting the robot mode to manual or automatic. Refer to Robot Control Modes on page 104 for more information.
- Indicating the robot high power and system power state.
- Robot high power indicator burnout detection (see note below).
- Enabling robot high power. Refer to Enabling Robot High Power on page 106 for more information.
- Emergency stop / disable robot high power.

Additional Information: Design of the factory-supplied Front Panel E-Stop is in accordance with the requirements of IEC 60204-1 and ISO 13849.

IMPORTANT: If the Front Panel high power ON / OFF lamp (part number 27400-29006) fails, you might incorrectly assume that High Power is OFF and the robot is safe. To prevent this, a failed lamp causes an error (-924) *Front panel HIGH POWER lamp failure* and locks out the High Power enabling until you replace the lamp. Refer to the *eV+3 User's Manual (Cat. No. I651)* for more information about error handling. Refer to Change Front Panel High-Power ON Lamp on page 126 for more information about lamp replacement.







WARNING: PERSONAL INJURY RISK

If you supply your own Front Panel, its design must comply with the requirements of IEC 60204-1 and ISO 13849. The E-Stop's push button must comply with ISO 13850 (Clause 5.5.2).



Figure 1-20. Front Panel

Item	Description
A	XFP connector Connects to the XFP connector on the XSYSTEM Adapter Cable. (on the side of the Front Panel)
B	System 5 VDC Power-On LED Indicates whether the robot is receiving power.
C	Manual mode The system limits robot speed and torque so an operator can safely work near the robot. Manual mode initiates hardware and software limits to robot speed at no more than 250 mm/sec. There is no high speed motion available in Manual mode.  WARNING: PERSONAL INJURY RISK If an operator is going to be in the work cell with the switch in Manual mode, the operator must carry an enabling device such as the T20 pendant.  WARNING: PERSONAL INJURY RISK Whenever possible, perform manual mode operations with all personnel outside the workspace.
D	Automatic mode Software programs control the robot allowing operation at full speed.

Item	Description
	 <p>DANGER: PERSONAL INJURY RISK In Automatic mode, the robot can move unexpectedly. Ensure all personnel remain clear of the cell when Automatic mode is enabled.</p>
E	<p>High Power ON/OFF Switch and Lamp</p> <p>Controls high power, which is the flow of current to the robot motors. You can enable high power by pressing and releasing the High Power switch twice. Once the High Power ON/OFF lamp is blinking, you must press and release the button to enable high power.</p>  <p>WARNING: PERSONAL INJURY RISK Disabling the High Power button violates IEC 60204-1. Do not alter its use.</p> <p>NOTE: If enabled, you must press the Front Panel button while it is blinking (default time-out is 10 seconds). If the button stops blinking, you must enable power again.</p>
F	<p>Emergency Stop Switch</p> <p>A dual-channel, passive E-Stop that supports Category 3 CE safety requirements. Pressing this button turns OFF high power to the robot motors.</p> <p>NOTE: The Front Panel is required to enable power to the robot. To operate without a Front Panel, you must supply the equivalent circuits.</p>
G	<p>Manual/Automatic Mode Switch</p> <p>Switches between Manual and Automatic mode (figure shown in Automatic Mode).</p>

Camera Bracket Kit

The eCobra Robot Camera Bracket Kit (P/N 95000-00100) provides a convenient way of mounting cameras to the outer link of the robot.

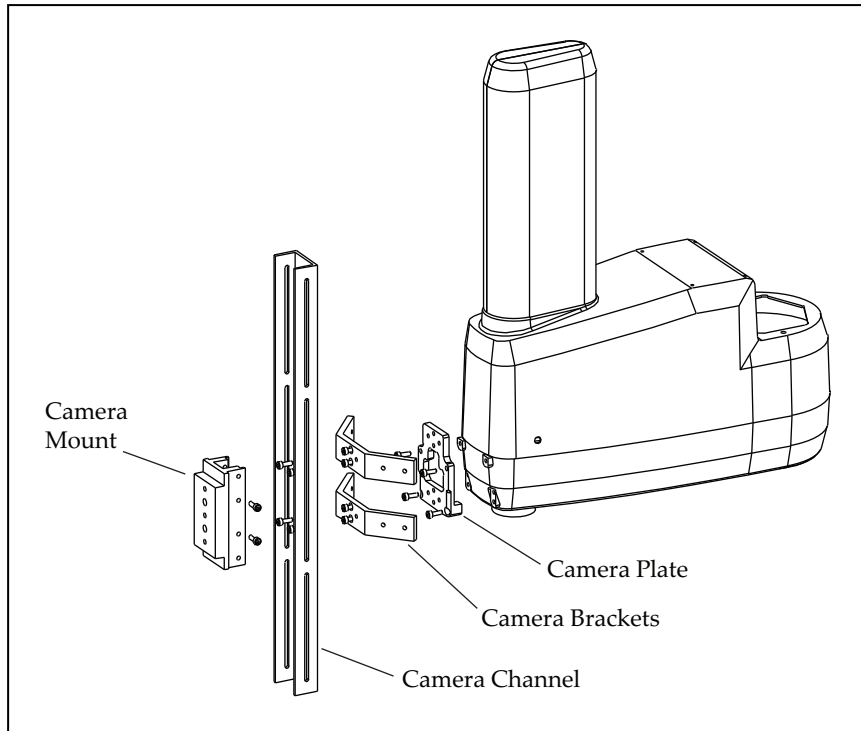


Figure 1-21. Camera Bracket Kit

The kit consists of the following items.

- One camera plate
- Two camera brackets
- One camera mount
- One camera channel
- M4 x 12 mm screws
- M4 flat washers
- M5 x 12 mm screws

Additional Information: Refer to Installing the Camera Bracket Kit on page 93 for more information.

Adjustable Hardstops

Optional adjustable hardstops are available to modify the robot's work envelope by installing physical stops for Joint 1 and Joint 2.

The part number for the adjustable hardstop kit is 02592-000.

Additional Information: Refer to Installing Adjustable Hardstops on page 95 for more information.

Table 1-7. Joint 1 Ranges for Adjustable Hardstops

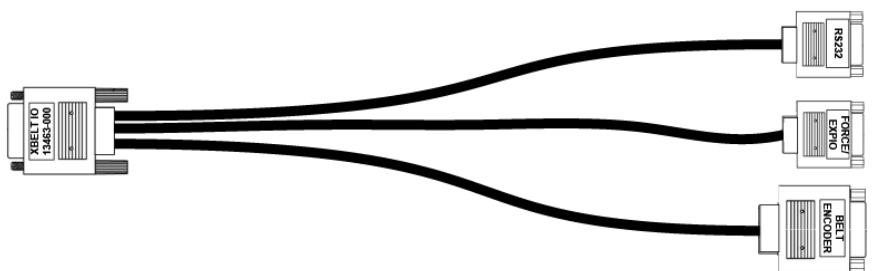

Joint and Installation Position	Hardstop Value	Recommended Software Limit Settings
Joint 1, Position 1	$\pm 50^\circ$	Lower limit: $- 49^\circ$

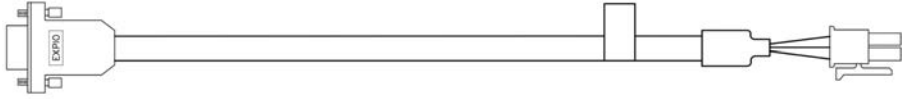
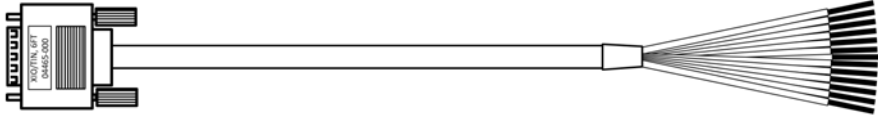
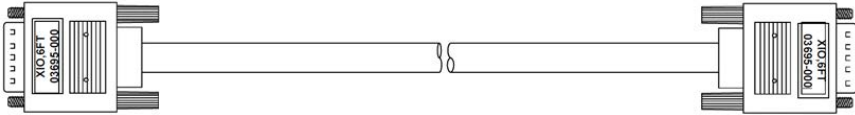
Joint and Installation Position	Hardstop Value	Recommended Software Limit Settings
		Upper limit: + 49°
Joint 1, Position 2	±88°	Lower limit: - 87° Upper limit: + 87°
Joint 2, Position 1	± 81°	Lower limit: - 80° Upper limit: + 80°
Joint 2, Position 2	± 51°	Lower limit: - 50° Upper limit: + 50°
Joint 2, Position 3	± 21°	Lower limit: - 20° Upper limit: + 20°

Optional Cables

The following table provides details about optional cables.

Table 1-8. Optional Cables

P/N	Description
13463-000	<p>XBELT I/O Adapter Cable (600 mm)</p> <p>The optional XBELT IO Adapter cable splits the XBELTIO port on the robot interface panel into a belt encoder branch and an IO Blox branch, and an RS-232 branch.</p>  <p>NOTE: You can use the FORCE / EXPIO connector on this cable to connect a 2nd group of up to 4 IO Blox devices (eCobra Pro only). For details on the pinouts for this cable, refer to Pinouts for XBELT IO Adapter on page 66.</p>
09443-000	<p>Belt Encoder to M12 Y Adapter Cable (3 m)</p> <p>This optional adapter cable splits the belt encoder connection on the XBELTIO cable into two belt encoder branches.</p>  <p>NOTE: For details on using this cable, refer to XBELT IO Belt Encoder Y Adapter Cable on page 65.</p>

P/N	Description
04677-000	<p>EXPIO-to-IOBlox Cable (3 m)</p> <p>This optional cable is used to connect IO Blox devices to the robot's EXPIO connector.</p>  <p>NOTE: For details on connecting IO Blox units to your system, refer to IO Blox Connections on page 68.</p>
04465-000	<p>XIO/TIN Cable (5 m)</p> <p>This optional cable connects to the XIO connector on the robot interface panel to add multiple I/O devices to the system without using an IO Blox unit.</p>  <p>IMPORTANT: This cable is not compatible with the XIO Termination Block.</p> <p>Additional Information: Refer to XIO Breakout Cable Pinout on page 34 for more information.</p>
03695-000	<p>XIO Cable (2 m)</p> <p>The optional XIO cable is for connecting an XIO Termination Block to the XIO port on the iCS-ECAT robot interface panel. For additional details, refer to XIO Termination Block on page 69.</p> 

XIO Breakout Cable Pinout

The XIO Breakout cable pinouts are provided below.

Table 1-9. XIO Breakout Cable Wire Chart

Pin No.	Signal Designation	Wire Color
1	GND	White
2	24 VDC	White/Black
3	Common 1	Red
4	Input 1.1	Red/Black

Pin No.	Signal Designation	Wire Color
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
<p>Diagram illustrating the pin layout of the connector. The pins are arranged in three rows:</p> <ul style="list-style-type: none"> Top row: Pin 1, Pin 9, Pin 18 Middle row: Pin 10, Pin 19 Bottom row: Pin 19, Pin 26 		

This chapter describes the various alert icons used in this manual and their meaning, provides important safety precautions for using OMRON industrial robots and their intended uses, and gives guidance on proper disposal.

2.1 Dangers, Warnings, and Cautions

This section describes the various alert levels and icons which identify potentially hazardous actions or situations

Alert Levels

There are three levels of safety warnings 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

Each alert consists of a standard warning triangle icon, a signal word, and a description of the risk. In increasing severity, the signals words are: Caution, Warning, and Danger. The alert text provides a description of the hazard and explains how you can prevent or 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 potential topple injury hazard.
	This identifies a hazardous electrical situation.		This identifies a fire risk.

Icon	Meaning	Icon	Meaning
	This identifies a hazardous burn-related situation.		This identifies a potential robot impact risk.

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

This section provides important information about the safety precautions you must take to ensure the safe operation of your robot system.



WARNING: PERSONAL INJURY/PROPERTY DAMAGE

These robots can cause serious injury or fatality, or damage to itself and other equipment, if the following safety precautions are not observed:

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



Figure 2-1. Read Manual and Impact Warning Labels

- All personnel who design the robot system must read this guide, read the *Robot Safety Guide*, and must comply with all local and national safety regulations for the location in which the robot is installed.
- Never use the robot system for purposes other than described in Intended Use of the Robot on page 40. Contact your local OMRON support if you are not sure of the suitability for your application.
- You are responsible for providing safety barriers around the robot to prevent anyone from accidentally coming into contact with the robot when it is in motion.

- You must lock out and tag out power to the robot and its power supply before performing any maintenance.

2.3 What To Do In An Emergency

The following is important safety information for actions to take in an emergency.

Stopping the Robot

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 situation.

Fire Response

If a fire occurs, use CO₂ fire extinguisher to extinguish the fire.

Entrapment and Brake Release Button

In case of entrapment of a person by the robot, or any other emergency or abnormal situation, a Brake Release button (above the Robot Status Display) allows you to manually position the robot arms without enabling high power. When 24 VDC system power is ON, pressing this button releases the brakes, which allows movement of the arms.



DANGER: PERSONAL INJURY RISK

This robot is not a collaborative robot. It requires a dedicated work area that prevents personnel from coming into contact with the robot during operation.

2.4 Robot Behavior

This section provides important information about the devices used to limit robot movements.

Hardstops

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

The robot cannot continue to move after hitting a hardstop until you clear the error.

The robot's hardstops can stop 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 Robotics and Safety Technologies, Inc. The robot does not have safety-rated soft axis or space limiting.

However, users 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

A singularity is a condition caused by the collinear alignment of two or more robot axes, resulting in unpredictable robot motion and velocities.

In the eCobra robot, any straight-line (MOVES) command sent to a fully-outstretched arm Cartesian workspace boundary location is a singularity.

IMPORTANT: For safety reasons, you should always avoid all robot workspace boundary locations.

2.5 Intended Use of the Robot

This section lists the intended uses, and prohibitions for use of OMRON industrial robots.



DANGER: PERSONAL INJURY RISK

This robot is not a collaborative robot. It requires a dedicated work area that prevents personnel from coming into contact with the robot during operation.

The normal and intended use of these robots does not create hazards. The design and construction of eCobra robots was per the relevant requirements of IEC 60204-1.

These robots are for use in parts assembly and material handling for payloads up to 5.5 kg. See Technical Specifications on page 131 for complete specifications. Refer to the *Robot Safety Guide* for details on the intended use of OMRON robots.

Never use these robots in the following situations.

- In the presence of ionizing or non-ionizing radiation
- In hazardous environments with explosive gas or oil mist
- In medical or life saving applications
- In residential applications
- Without performing a risk assessment

2.6 Additional Safety Information

OMRON provides other sources for more safety information:

Manufacturer's Declarations

This lists all standards with which the robot complies. The Manufacturer's Declarations for your robot and other products are in the *Manufacturer's Declarations Guide (Cat. No 18305-000)*.

Robot Safety Guide

The *Robot Safety Guide*, which ships with every robot system, provides detailed information on safety for OMRON robots. It also gives resources for more information on relevant standards.

T20 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's design is in accordance with the requirements of IEC 60204-1 and ISO 13849. The E-Stop button complies with ISO 13850.

NOTE: OMRON does not offer a wireless pendant.

The manual control pendant can only move one robot at a time, even if your network contains multiple robots.

2.7 Disposal



Dispose of in accordance with applicable regulations.

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

2.8 How Can I Get Help?

Contact your local OMRON Support, or refer to the corporate website:

<http://www.ia.omron.com>

Chapter 3: Robot Installation

This chapter provides information about installing the robot and other necessary equipment.

3.1 Robot Installation Overview

This section provides an overview of the basic tasks that are required to install the robot.



WARNING: Robot installation must be completed before optional equipment can be installed.

IMPORTANT: Prior to installing the robot, unpack and inspect the equipment. Refer to Unpacking and Inspecting the Equipment on page 177 for more information.

Basic Installation Steps

Step	Task	Reference
1	Mount the robot.	Mounting an eCobra Robot on page 43
2	Install the tool flange.	Install the Tool Flange on page 46
3	Installing the Front Panel.	Installing the Front Panel on page 47
4	Install user-supplied safety equipment.	Installing User-Supplied Safety Equipment on page 49
5	Set the EtherCAT Node Address.	Setting the EtherCAT Node ID on page 58
6	Make robot system cable connections.	System Cable Installation on page 61
7	Install any robot optional hardware.	Optional Equipment Installation on page 87
8	Verify the installation.	Verifying Installation on page 99

Table 3-1. Installation Overview

3.2 Mounting an eCobra Robot

This section describes the mounting procedure for the eCobra robot.



WARNING: PERSONAL INJURY OR PROPERTY DAMAGE RISK
Only allow qualified service personnel to install or service the robot.

3. While the robot is still bolted to the transportation pallet, connect a crane or hydraulic lift to the eye bolt at the top of the inner link. Refer to the following figure.



Figure 3-2. Lifting Eye Bolt



WARNING: PERSONAL INJURY OR PROPERTY DAMAGE RISK

Do not lift the robot at any point other than the eye bolt, or extend the robot's inner or outer links until the robot is secured in position. Failure to comply could result in the robot falling and causing either personnel injury or equipment damage.

4. Remove the four bolts securing the robot base to the pallet.
Retain these bolts for possible later relocation of the equipment.
5. Lift the robot and position it directly over the mounting surface.



WARNING: Always use at least two people when lifting the robot. Do not attempt to extend robot inner or outer links until you have firmly secured the robot in position. Failure to comply could result in the robot falling and causing either personnel injury or equipment damage.

6. Slowly lower the robot, align the base with the tapped holes in the mounting surface and dowel pins, if used.

NOTE: The robot's base is aluminum and can dent easily if bumped against a harder surface.

7. To eliminate the risk of toppling, screw in one bolt, finger-tight.
8. Verify that the robot's base is squarely mounted (cannot rock back and forth) before inserting and tightening the remaining mounting bolts.
9. Install the user-supplied mounting bolts and washers. Tighten bolts to the torque

specified in the following table.

Table 3-2. Torque Specifications for Mounting Bolts

Standard	Size	Specification	Torque
Metric	M12 x 1.75	ISO Property Class 8.8	85 N·m
SAE	7/16-14 UNC	SAE J429 Grade 5 or ASTM A449	65 ft-lb



WARNING: TOPPLE INJURY HAZARD

The robot's center of mass can cause the robot to fall over if the robot is not secured with the mounting bolts.

NOTE: Check the mounting bolts one week after initial installation, and then recheck every 6 months. See Maintenance on page 111 for periodic maintenance.

3.3 Install the Tool Flange

This section provides information to install the tool flange.

The tool flange, which you mount on the robot's quill, is the attachment point for all external tooling and end-effectors that allow the robot to perform work.

To ensure proper tool flange alignment with the grooves on the quill, there is a setscrew on the flange that holds the rotational position of the flange on the quill shaft (refer to the following figure). A steel ball behind the setscrew contacts the shaft in one of the quill's vertical-spline grooves to keep the flange aligned.

Additional Information: For flange dimensions, hole pattern, and location of flange ground point, refer to Tool Flange Dimensions on page 149.

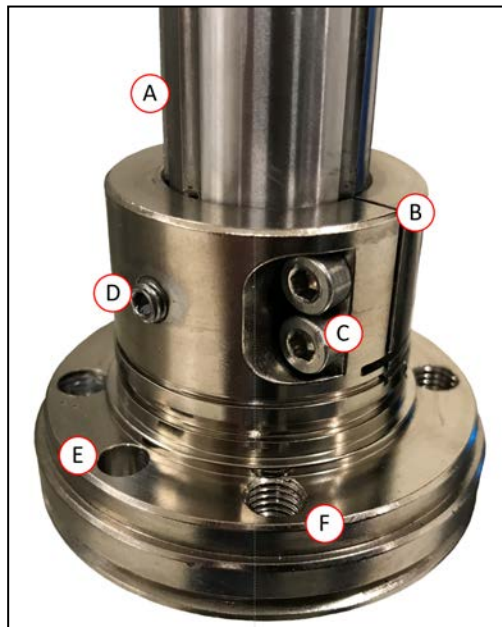


Figure 3-3. Tool Flange

Figure 3-4. Tool Flange Details

Callout	Meaning	Callout	Meaning
A	Quill shaft	D	Setscrew
B	Tool flange assembly	E	Dowel pin hole
C	M4 Socket-head cap screws	F	M6 X 1-6H Thru (x4)

Tool Flange Installation Procedure

Use the following procedure to install the tool flange.

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

3.4 Installing the Front Panel

Use the information provided in this section to install the Front Panel.

When mounting the Front Panel, you must select an installation location outside the robot's workcell where it can immediately be reached in an emergency.

Possible mounting locations include immediately next to the workcell gate, on a nearby desk, or other readily accessible location.

Additional Information: Refer to Front Panel Dimensions on page 150 for more information.



DANGER: A remote High Power push-button must be installed outside of the robot's workspace.

Connecting the Front Panel

You can connect the Front Panel either directly to the XFP connector on the XSYSTEM cable (A), or to the Front Panel cable (B).

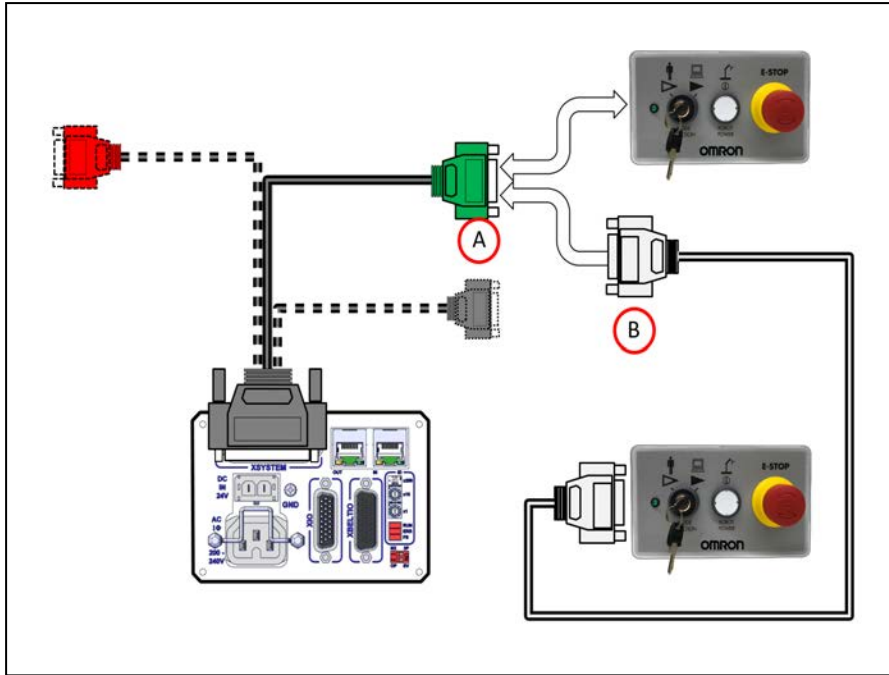


Figure 3-5. Front Panel Connections

Front Panel Schematic

Use the following diagram to understand all Front Panel electrical connections.



DANGER: PERSONAL INJURY RISK

If you supply your own Front Panel E-Stop, its design must comply with the requirements of IEC 60204-1 and ISO 13849. The E-Stop's push button must comply with ISO 13850.

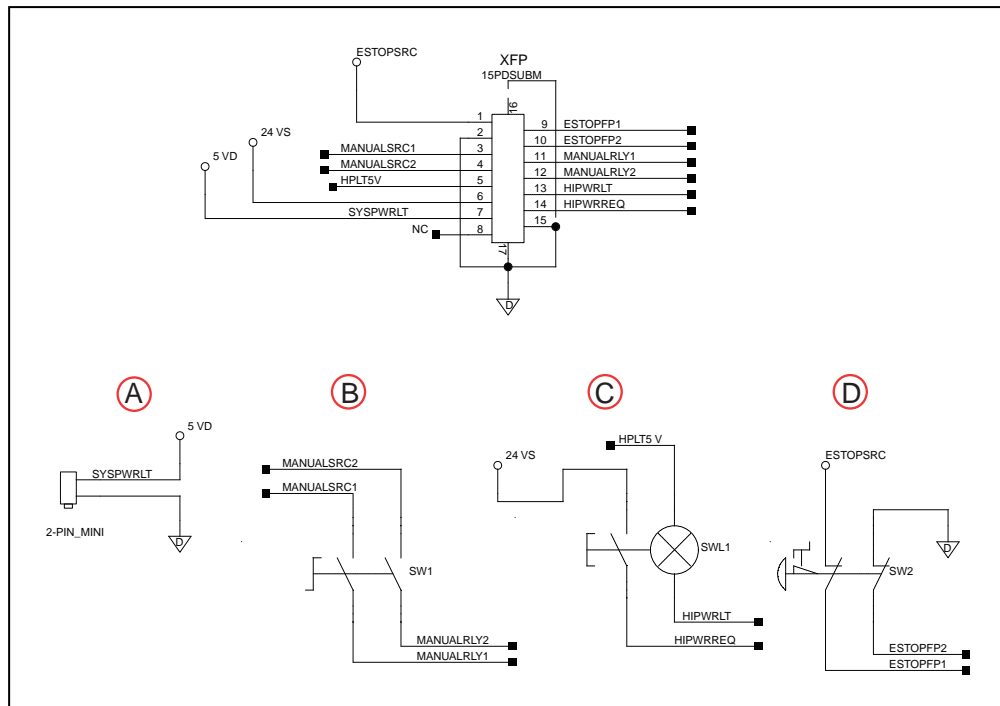


Figure 3-6. Front Panel Schematic showing the System Power LED (A), Manual/Auto Switch (B), High Power On/Off (C), and Emergency Stop (D) circuits

IMPORTANT: Disabling the High Power button violates IEC 60204-1. We strongly recommend that you not alter the use of the High Power button.

3.5 Installing User-Supplied Safety Equipment

You are responsible for properly installing safety equipment to protect personnel from unintentionally coming in contact with the robot. Depending on the design of the workcell, you can use safety gates, light curtains, emergency stop devices, and other safety equipment to create a safe environment.



WARNING: Installing, commissioning, or operation of any robot without adequate safety equipment is strictly prohibited. This equipment must be compliant with all applicable and local standards. Failure to install suitable safety equipment could result in injury or death.

Additional Information: Refer to the *Robot Safety Guide (Cat. No. I590)* for more information.

The user-supplied safety and power-control equipment connects to the system through the XUSR and XFP connectors on the XSYSTEM cable. The XUSR connector (25-pin) and XFP (15-pin) connector are both female D-sub connectors. Refer to the following sections for safety equipment connection details.

Contacts on XUSR Connector

Use the information in the following table to understand the signals provided on the XUSR connector.

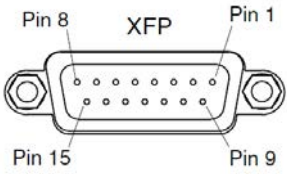
Table 3-3. XUSR Connector Signals

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 (Normally Closed) 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 eCobra		
7, 20	E-Stop indication CH 1	Contacts are closed when Front Panel, pendant, and userE-Stops are <i>not</i> tripped
8, 21	E-Stop indication CH 2 (same as pins 7, 20)	Contacts are closed when Front Panel, pendant, and userE-Stops are <i>not</i> tripped
9, 22	Manual or Automatic indication CH 1	Contacts are closed in Automatic mode
10, 23	Manual or Automatic indication CH 2	Contacts are closed in Automatic mode
11, 12, 13, 24, 25	No connection	

Contacts on XFP Connector

Use the information in the following table to understand the signals provided on the XFP connector.

Table 3-4. XFP Connector Signals

Pin Pairs	Description	Requirements for User-Supplied Front Panel
Voltage-Free Contacts Provided by Customer		
1, 9	Front Panel E-Stop CH 1	User supplies N/C contacts
2, 10	Front Panel E-Stop CH 2	User supplies 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 supplies 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 supplies 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 Figure 3-6. for a schematic diagram of the Front Panel.		
^a Do not inadvertently connect 24 VDC signals to these pins as that will damage the electronics.		

NOTE: Underwriters Laboratory evaluated the system with an OMRON Front Panel. Using a substitute front panel could void UL compliance.

Remote Pendant Signals on the XMCP Connector

Use the information in the following table to understand the remote pendant signals provided on the XMCP connector.

Table 3-5. 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 VDC
5	No connection

The preceding table gives descriptions of this circuit's functionality.

The following figure shows an E-Stop diagram for the system.

E-Stop Circuits on XUSR and XFP Connectors

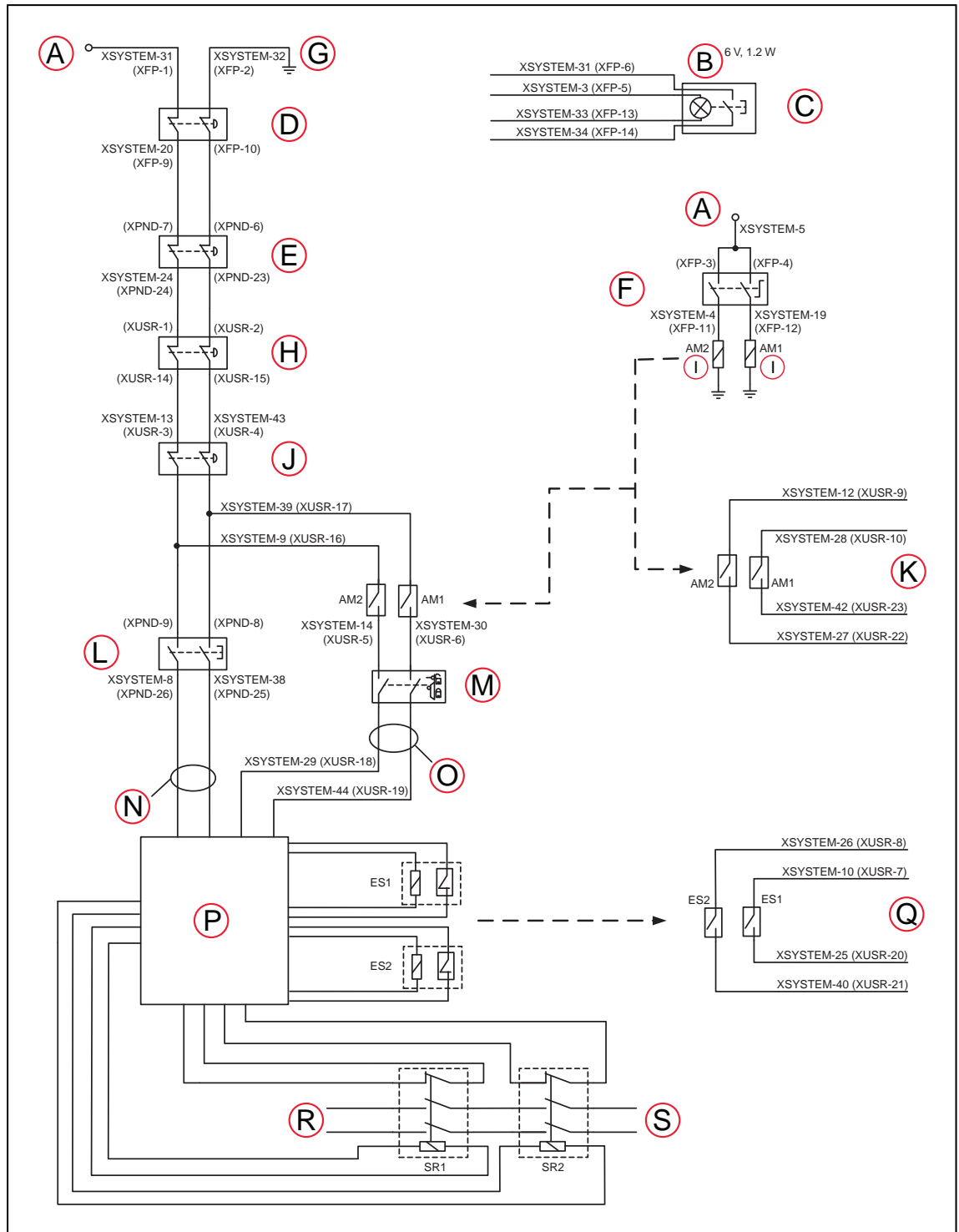


Figure 3-7. E-Stop Circuit on XUSR and XFP Connectors

Key	Meaning	Key	Meaning
A	ESTOP 24 VDC Source	K	Auto/Manual Output
B	Bulb, 6 V, 1.2 W	L	T20 Pendant Enable
C	Front Panel High Power ON/OFF	M	Muted Safety Gate - Active in Auto mode only (Jumper closed when not used)
D	Front Panel E-Stop Pushbutton	N	Manual Mode Path
E	T20 ESTOP Pushbutton	O	Auto Mode Path
F	Front Panel Auto/Manual Key-switch	P	Force-Guided Relay Cycle Check Control Circuit
G	E-Stop Ground	Q	User E-Stop Output
H	User E-Stop and Gate Interlock NOTE: Jumper closed when not used; MUST open both channels independently if used.		
I	Coil	R	Single-Phase AC Input, 200-240 VAC
J	LINE E-Stop (External User E-Stop System)	S	High Power to Amplifiers (Internal Connections)

Emergency Stop Circuits

The information in this section describes emergency stop circuits used with the robot system.

NOTE: All pin numbers in this section correspond to the wiring diagram shown in Figure 3-7.

The XSYSTEM cable provides connections for Emergency Stop (E-Stop) circuits on the XUSR and XFP connectors. This means the controller system can duplicate E-Stop functionality from a remote location using voltage-free contacts. Refer to Figure 3-7. .

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: Short these pins if not used. If used, both channels must open independently. Although an Emergency Stop will occur, the controller will flag an error state if one channel is jumpered closed and the other channel is opened. It will also flag an error state if the channels are shorted together.

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

These contacts provide a method to indicate the status of the ESTOP chain, including the Front Panel Emergency Stop push-button, the pendant Emergency Stop push-button, and the User Emergency Stop Contacts. Refer to items D, E, H, J, and Q in Figure 3-7.

NOTE: These contacts do not indicate the status of any connections below the User E-Stop contacts, so they will not indicate the status of the Line E-Stop, MCP ENABLE, or the Muted Safety gate. If you have a specific need for this function, 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, Figure 3-7.) provide voltage-free contacts, one for each channel, to indicate whether the E-Stop chain on that channel, as described above, is closed. In normal operation (no E-Stop), both switches are closed on each redundant circuit. You can use these contacts to generate an E-Stop for other equipment in the workcell. The load on the contacts must not exceed 40 VDC or 30 VAC at a maximum of 1 A.

NOTE: Per ISO 13849 operation, a redundant, cyclically-checked, positive-drive safety relay circuit for Category 3 PL-d provides these voltage-free circuits (refer to Figure 3-7. and Figure 3-6. for the user E-Stop circuitry).

Line E-Stop Input (KEY: J)

The XUSR connector on the controller contains a two-channel Line E-Stop input for workcell, production line, or other equipment emergency-stop inputs. Refer to item J in Figure 3-7.

Generally, the user E-Stop Indication contact outputs are used to generate an emergency stop in such external equipment. A lock-up could occur if you were to wire the same equipment's outputs into the user E-Stop input (that is, in series with the local robot's E-Stop push-buttons). The Line E-Stop input comes into the circuit at a point where it cannot affect the user 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 user 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 connect the other controller's output contacts. See Figure 3-7. for more information.

IMPORTANT: Do not use the Line E-Stop for devices such as local E-Stop push-buttons. 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 provide connections for a safety gate, allowing access to the workspace of the robot in Manual mode only. Refer to items M and L in Figure 3-7. .

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.

IMPORTANT: It is up to the user to determine if teaching the robot in Manual Mode by qualified personnel, wearing safety equipment, and carrying a pendant, is allowable under local regulations. The E-Stop functionality can be muted in Manual mode and careful consideration should be taken accordingly. Refer to the *Robot Safety Guide (Cat. No. I590)* for more information.



CAUTION: 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.

Additional Information: Refer to Remote High Power ON / OFF Control on page 56 for further details about the user Remote Manual Mode circuitry.

You must incorporate either the Front Panel, or a user-supplied panel into the robot workcell circuitry to provide a single point of control (the pendant) when the controller is placed in Manual mode.

You may need to turn OFF certain workcell devices, such as PLCs or conveyors, when the operating mode switch is set to Manual mode. This is to ensure that the robot controller does not receive commands from devices other than from the pendant (the single point of control in this case).

Controlling the Manual / Automatic mode selection from other control equipment might require a custom splitter cable or complete replacement of the Front Panel. Refer to the Front Panel Schematic on page 48. In this situation, connect a pair of contacts in series with the Front Panel Manual / Automatic mode contacts. Both the Front Panel and the user contacts need to be closed to allow Automatic mode.



WARNING: PERSONAL INJURY RISK

Do not connect 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 provide a voltage-free contact to indicate whether the Front Panel and/or remote Manual / Automatic switches are closed. Refer to item K in Figure 3-7. You can use these contacts to control other mechanisms (for example, conveyor, linear modules, etc.) when Manual mode is selected.

IMPORTANT: The load on the contacts should not exceed 40 VDC or 30 VAC at a maximum of 1 A.



WARNING: PERSONAL INJURY HAZARD

If you suspended any safeguards, you must return them to full functionality before selecting Automatic Mode.

Remote High Power ON / OFF Control

There are two methods to provide high power ON / OFF control in a remote location as described below.



DANGER: A High Power push-button must be installed outside of the robot's workspace.

Extend the Front Panel Connection Cable

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. This method allows you to relocate the Front Panel high power ON / OFF switch to a more convenient location. Implementation of this method must conform to EN standard recommendations.

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

You 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 26 AWG (0.13 mm²) or larger.
- Connectors: must be 15-pin, standard D-sub male and female.
- Maximum cable length is 10 meters.

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

Control High Power from Other Equipment

Controlling high power ON / OFF from other control equipment or from a location other than the Front Panel requires a custom splitter cable. In this situation, place a second momentary contact for high power ON / OFF in parallel with the Front Panel push-button contact. This second contact should be suppressed when in Manual mode.

Additional Information: Refer to Front Panel Schematic on page 48 for more information.



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.

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. Refer to items B and C in Figure 3-7.

Using a User-Supplied Control Panel

You can create a user-supplied control panel that performs the same functions as the optional Front Panel. The optional Front Panel contains only switches and lights (no active components).

Additional Information: Refer to Front Panel Schematic on page 48 for internal wiring information.

IMPORTANT: Underwriters Laboratory evaluated the system with an OMRON Front Panel. If you provide a substitute, the system may no longer be UL compliant.

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

Remote Pendant Usage

You 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 26 AWG (0.13 mm²) or larger.
- Connectors: must be 15-pin, standard D-sub male and female.
- Maximum cable length is 10 meters.



CAUTION: EQUIPMENT DAMAGE HAZARD

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

3.6 Setting the EtherCAT Node ID

The EtherCAT Node ID (address) can be set with two methods.

Use Hardware Switches on the Robot

Use the hardware switches on the robot interface panel to set an explicit EtherCAT node ID for the robot. Refer to Setting the EtherCAT Node ID Using Hardware Switches on page 59 for more information.

Use Sysmac Studio Software

When the EtherCAT node ID is set with Sysmac Studio, it is retained in non-volatile memory and will persist after subsequent power cycles.

Additional Information: Refer to the *Sysmac Studio Version 1 Operation Manual* (Cat. No. W504) for more information about setting the EtherCAT node ID with software.

IMPORTANT: When using Sysmac Studio to set the EtherCAT node ID, ensure the switches are set to the default 0 positions as shown in the figure below. If the switches are set to a non-zero value, the switch positions will dictate the EtherCAT node ID and software adjustment of this value is not possible.

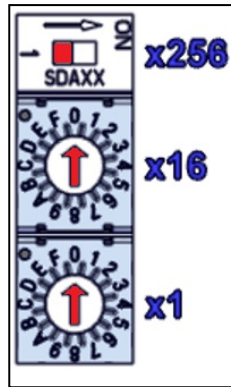


Figure 3-8. EtherCAT Node ID 0 Switch Setting

Setting the EtherCAT Node ID Using Hardware Switches

The robot interface panel has three physical switches that can be used for setting the EtherCAT node ID (address) as described in the figure below.

The switch settings are checked when robot 24 VDC power is applied.

IMPORTANT: Turn OFF AC and DC power before changing EtherCAT node ID switches.

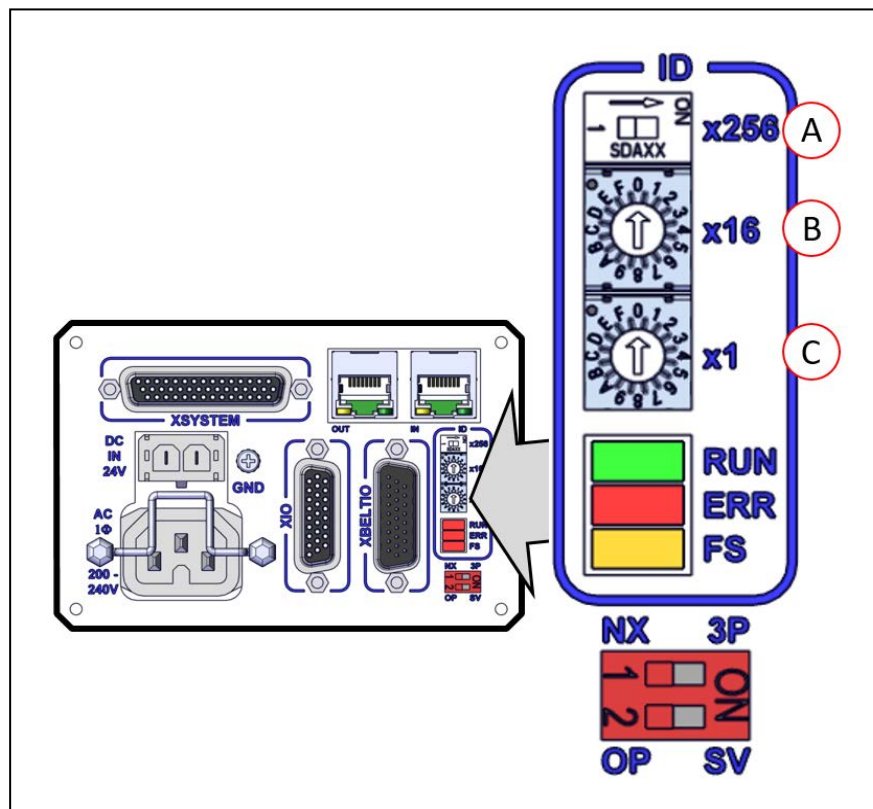


Figure 3-9. Robot Interface Panel EtherCAT ID Switches

Item	Switch	Description
A	2-Position Dip Switch x256	Sets the 8th (most significant bit) of the 9-bit EtherCAT node ID. Moving the switch to the right turns ON the 8th bit for the node ID. The default position is OFF (left).
B	16-Position Rotary Switch x16	Sets bits 7 to 4 of the EtherCAT node ID. The default setting for this switch is 0.
C	16-Position Rotary Switch x1	Sets bits 3 to 0 of the EtherCAT node ID. The default setting for this switch is 0.

EtherCAT Node ID Address Example

Use the following example to understand how to set the EtherCAT node ID. An EtherCAT node ID of 196 is used in this example.

1. Convert the node ID of 196 into hexadecimal format (0x0C4).
2. Set the x256 dip switch to OFF.
3. Set the x16 rotary switch to C.
4. Set the x1 rotary switch to 4.

NOTE: Use Sysmac Studio to verify the EtherCAT node ID setting. Refer to *Sysmac Studio Version 1 Operation Manual (Cat. No. W504)* for more information.

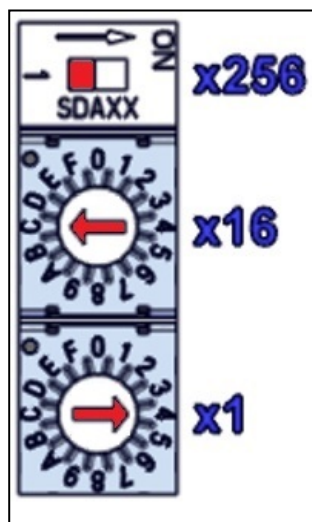


Figure 3-10. EtherCAT Node ID Set to 196

Chapter 4: System Cable Installation

This chapter provides details about system cable installation.

This chapter assumes that you have already installed the robot and mounted a Front Panel.



WARNING: ELECTROCUTION RISK.

Dangerous voltages are present during cable installation, and you must take appropriate lockout / tagout measures to prevent powering up the robot during installation.



WARNING: ELECTROCUTION RISK

National Electrical Code (and/or local codes) require that you provide an appropriately sized Branch Circuit Protection and lockout / tagout capability. Ensure that you comply with all local and national safety and electrical codes for the installation and operation of the robot system.



WARNING: ELECTROCUTION RISK

eCobra robot systems require an isolating transformer for connection to asymmetrical mains systems or those using an isolated (impedant) neutral. Many parts of Europe use an impedant neutral.



DANGER: ELECTROCUTION RISK

Only a skilled and instructed person must install AC power. Clause 5.2.4 of the ISO 10218-1 requires that the person installing the system must use fail-safe lockout measures to prevent unauthorized third parties from turning on power. Refer to the *Robot Safety Guide (Cat. No. I590)* for more information.



CAUTION: Ensure that all cables are installed with strain-relief to ensure they are not damaged or accidentally removed during operation.

4.1 Basic System Cable Layout

The following diagram illustrates typical cable connections for a robot system.

The letters in the following figure correspond to the letters in the List of Cables and Parts on page 62..

The numbers in the following figure correspond to the Cable Installation Steps on page 64.

NOTE: The figure below includes the optional and user-supplied equipment that may not be present in your system.

Additional Information: Ethernet / EtherCAT network connections may differ for your application. Contact your local OMRON support for more information.

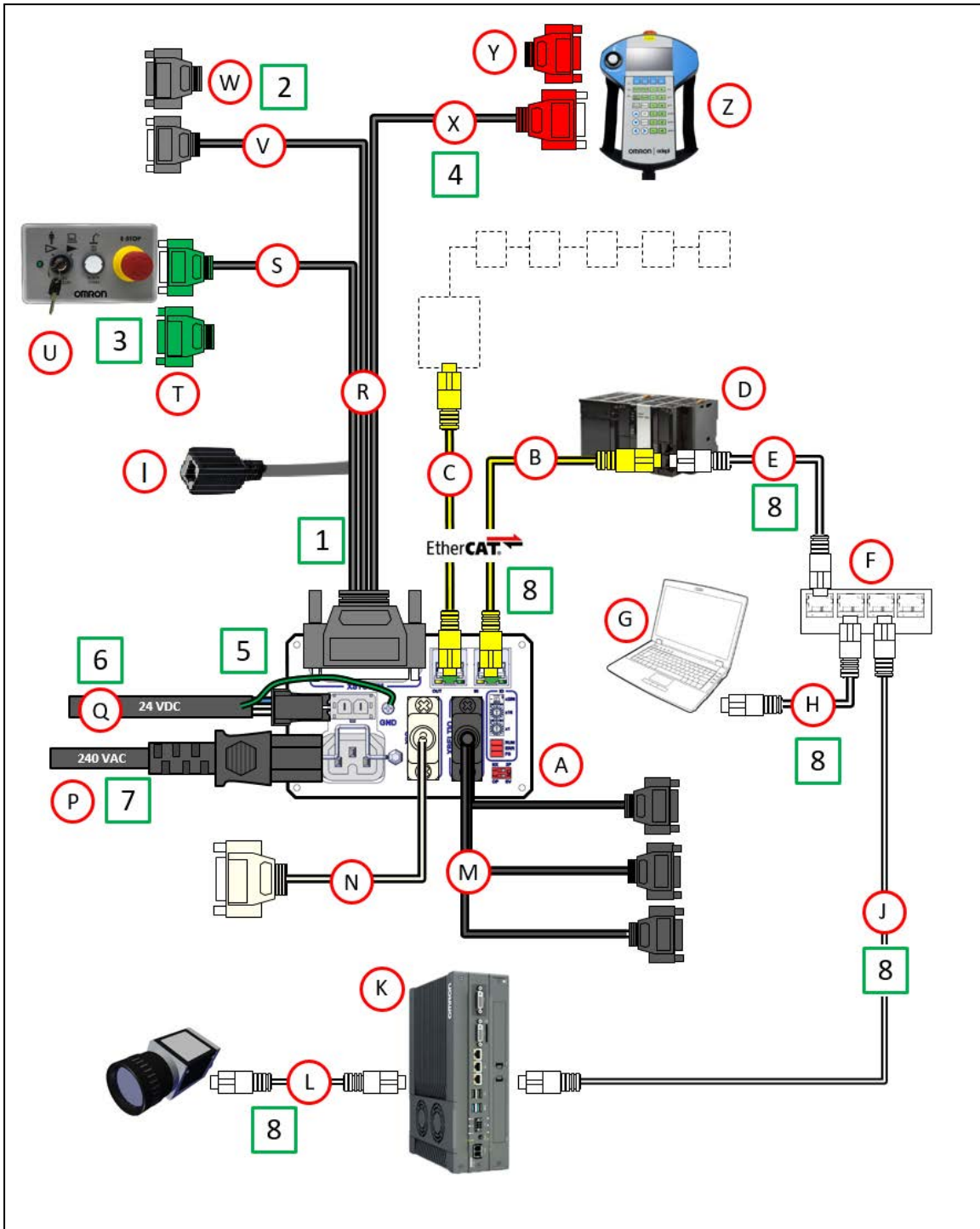


Figure 4-1. Typical System Cable Connections

List of Cables and Parts

The following table identifies and provides details about cables and parts illustrated in Basic System Cable Layout on page 61.

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



WARNING: PERSONAL INJURY RISK

Never run a robot system, in automatic mode, with all three jumpers installed. This would leave the system with no E-Stops.

Part	Cable and Parts List	Part #	Standard	Option	User Supplied
A	iCS-ECAT Robot Interface Panel		X		
B	EtherCAT cable				X
C	EtherCAT cable connection to other EtherCAT peripherals (servos, vision systems, etc.)				X
D	NJ-series Robot Integrated CPU	NJ501-RXXX			X
E	Ethernet/IP cable				X
F	Network switch				X
G	User-supplied PC				X
H	Ethernet/IP cable ¹				X
I	Ethernet RJ45 Port		X		
J	Ethernet/IP cable to IPC Application Controller				X
K	IPC Application Controller			X	
L	Power over Ethernet (PoE) cable to Camera				X
M	XBELTIO Cable	13463-000		X	
N	XIO Breakout Cable	03695-000		X	
P	200-240 VAC AC Power Cable	04118-000		X	X
Q	24 VDC Power Cable	04120-000		X	X
R	Cable Assembly, XSYSTEM Adapter with Jumpers ²	13322-100	X		
S	XFP Connector on XSYSTEM cable		X		
T	XFP Jumper Plug ³	10052-000	X		
U	Front Panel ⁴	90356-10358	X		

Part	Cable and Parts List	Part #	Standard	Option	User Supplied
V	XUSR Connector on XSYSTEM cable		X		
W	XUSR Jumper Plug ⁵	04736-000	X		
X	XMCP Connector on XSYSTEM cable		X		
Y	XMCP Jumper Plug ⁶	10052-000	X		
Z	T20 Pendant	10054-010		X	
<p>NOTES:</p> <p>1 A USB cable can be used as a direct connection between the PC and the NJ-series Robot Integrated CPU Unit.</p> <p>2 This assembly also includes the XFP Jumper Plug, XMCP Jumper Plug, and the XUSR Jumper Plug.</p> <p>3 Required if not using a Front Panel.</p> <p>4 Requires Front Panel Cable (part number 10356-10500).</p> <p>5 Required if not using user-supplied E-Stop circuitry.</p> <p>6 Required if not using a pendant.</p>					

Cable Installation Steps

Use the following procedure to install all necessary system cables. Refer to Basic System Cable Layout on page 61 for references to item letters.

Additional Information: Refer to iCS-ECAT Robot Interface Panel on page 24 for robot interface panel connector details.

Step	Connection	Item
1	Connect the XSYSTEM cable to the XSYSTEM connector on the robot interface panel.	R, A
2	Connect a user E-Stop or Muted Safety Gate to the XSYSTEM cable XUSR connector or verify XUSR jumper plug is installed in XSYSTEM cable XUSR connector.	W, V
3	Connect the Front Panel cable to Front Panel and XSYSTEM cable XFP connector. If no Front Panel is present in the system, install FP jumper on XSYSTEM cable XFP connector.	S, U T
4	Connect T20 adapter cable (not shown) to XSYSTEM cable XMCP connector. If no T20 is present in the system, install XMCP jumper, or T20 Adapter Cable with bypass plug.	X Y

Step	Connection	Item
5	Connect a 24 VDC cable to the DC power supply connector on the robot interface panel.	Q
6	Connect user-supplied ground to the robot. Refer to See Grounding the Robot System on page 84 for more information. NOTE: The ground may be part of the 24 VDC cable.	
7	Connect a 200-240 VAC cable to the AC power supply connector on Robot Interface Panel and secure with clamp.	P
8	Connect user-supplied communication / network cables to their respective devices. Additional Information: Ethernet / EtherCAT network connections may differ. Contact your local OMRON support for more information.	B, C, D, E, F, G, H, J, K, L

XBELT IO Belt Encoder Y Adapter Cable

The XBELT IO Encoder Y Adapter Cable adds two additional encoder outputs (for ENC1 and ENC2, to the Belt Branch.

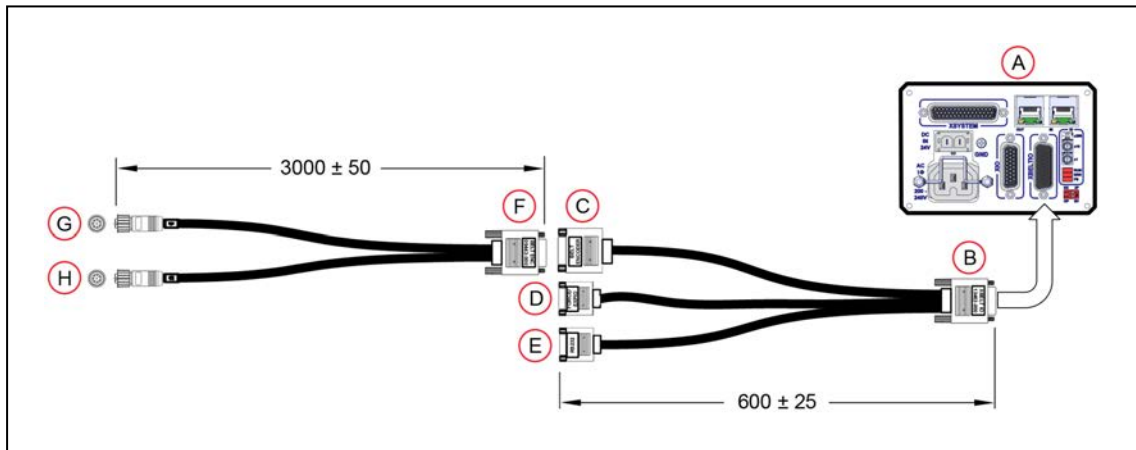


Figure 4-2. System Cable Diagram with Belt Encoders (Units in mm)

Table 4-1. Belt Encoder Cables Description

Item	Description	Part #	Standard	Option	User-supplied	Notes
A	Robot Interface Panel		X			
B	XBELT IO Adapter Cable Connector	13463-000		X	X	HDB26 Female
C	Belt Branch Connector					DB15 Male

Item	Description	Part #	Standard	Option	User-supplied	Notes
D	EXPIO Branch Connector	09443-000		X	X	DB9 Male
E	RS-232 Branch Connector					DB9 Male
F	Belt Y Splitter Cable Connector					DB15 Female
G	Belt Encoder 1 Connector					M12 Female, 8 pin
H	Belt Encoder 2 Connector					M12 Female, 8-pin

Pinouts for XBELT IO Adapter

NOTE: In the following figures, the callout letters (circled in red) correspond to the Item letters in XBELT IO Belt Encoder Y Adapter Cable on page 65.

Belt Encoder

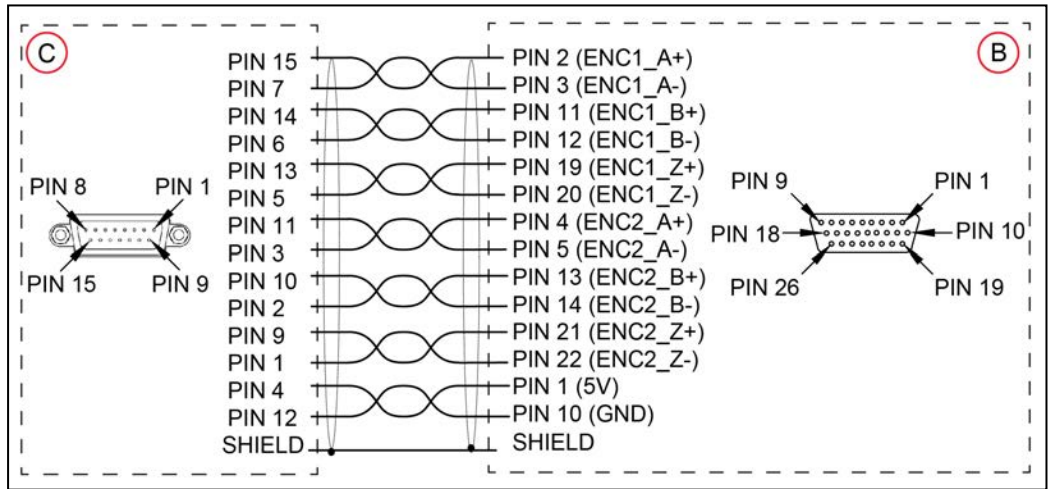


Figure 4-3. XBELT I/O Adapter Cable Pinout - Encoder 1 and 2 Connections

RS-232

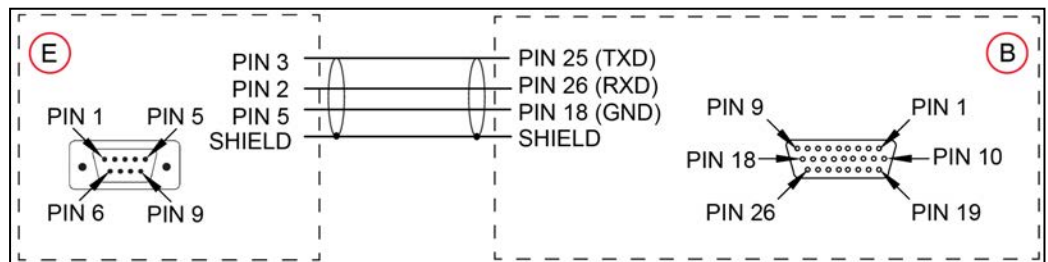


Figure 4-4. XBELT I/O Adapter Cable Pinout - RS-232 Connections

FORCE / EXPIO

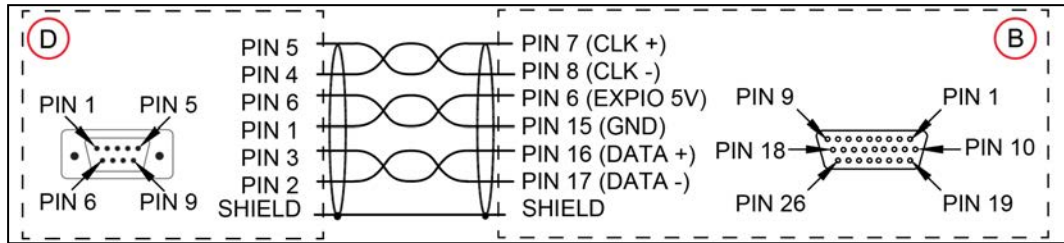


Figure 4-5. XBELT I/O Adapter Cable Pinout - EXPIO Connections

Splitter Cable

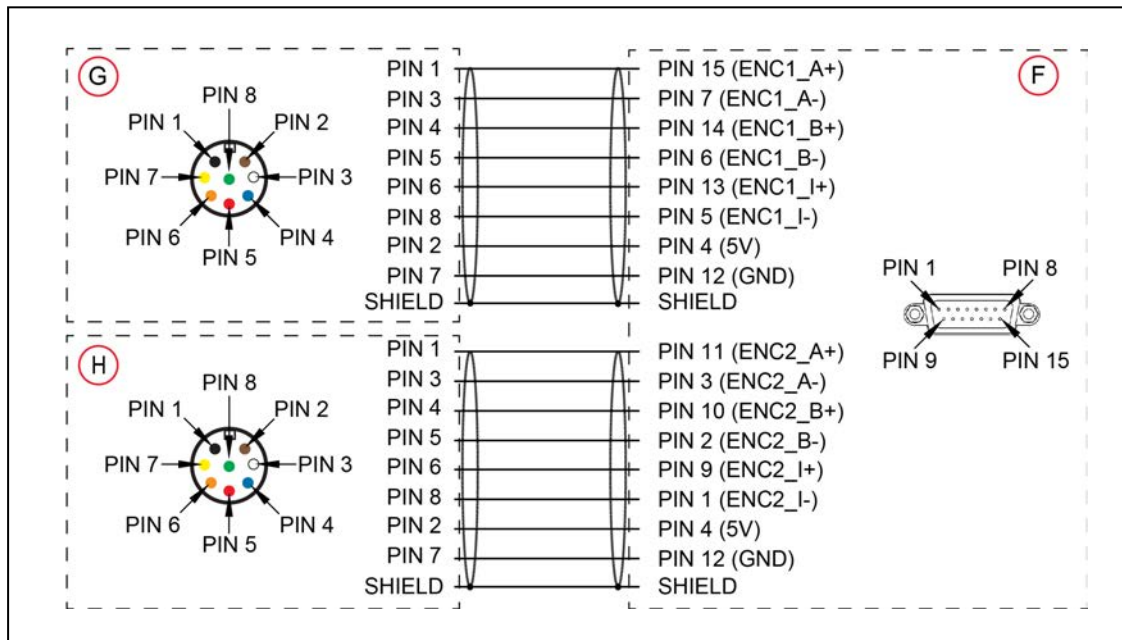


Figure 4-6. Belt Y Splitter Cable Pinout - 2 Encoder Connections

4.2 Connecting Digital I/O to the System

Use the table below to understand the different digital I/O connection methods.

Table 4-2. Digital I/O Connection Options

Connection	I/O Capacity	Additional Information
XIO Connector on the robot interface panel	12 inputs 8 outputs	Refer to XIO Connector Signals on page 76
Optional IO Blox Device, connects to the RS232 connector on the back of	8 inputs, 8 outputs per device; up to 4 IO Blox devices for the Standard eCobra, up to 8 IO Blox	Refer to <i>the IO Blox User's Guide (04638-000)</i>

Connection	I/O Capacity	Additional Information
the robot's Joint 1. 2nd group of IO Blox connect to FORCE/EXPIO branch of the XBELTIO cable.	devices for the eCobra Pro	
Optional XIO Termination Block, connects to iCS-ECAT robot interface panel	12 inputs 8 outputs	Refer to Digital I/O Signal Configuration on page 68

Digital I/O Signal Configuration

This section provides information about digital I/O signal configuration..

NOTE: The eCobra Standard can only support a maximum of 4 daisy-chained IO Blox devices.

IO Blox Connections

When installing more than one IO Blox unit in a system, you must connect the units with the supplied cable(s) and set the address select switch correctly for each additional unit.

NOTE: Each IO Blox unit (up to 4 for Standard, 8 for Pro) must have a unique address. IO Blox units with duplicate addresses will conflict. Refer to the *IO Blox User's Guide (04638-000)* for more information.

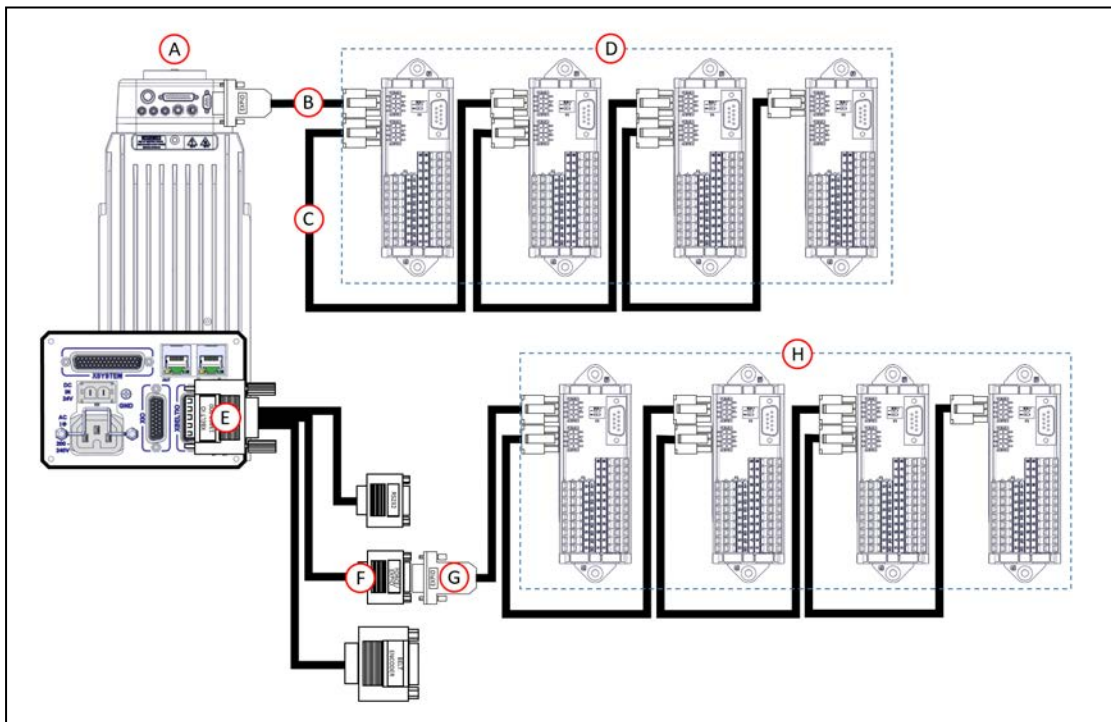


Figure 4-7. Connecting IO Blox to the system (maximum of 4 for Standard, 8 for Pro)

Item	Description
A	eCobra Robot user connections on the back of Joint 1 (viewed from the rear)
B	IO Blox-to-Robot cable (3 m) P/N 04677-030
C	IO Blox-to-IO Blox Cable (3 m) P/N 04679-03
D	IO Blox Group 1 (eCobra Standard and Pro), maximum 4 IO Blox units
The following cables and connections apply to the eCobra Pro only.	
E	XBELT IO Cable P/N 13463-000 connected to XBELTIO connector on the robot interface panel
F	FORCE/EXPIO Connector on XBELTIO cable
G	IO Blox-to-Robot cable (3 m), part number 04677-030
H	IO Blox Group 2 (eCobra Pro only), maximum 4 IO Blox units

XIO Termination Block

You can also expand digital I/O by connecting an XIO Termination Block to the XIO connector on the robot interface panel. The XIO Termination Block provides 12 inputs and 8 outputs (refer to the following figure). This offers the same signal capacity as the XIO connector on the robot interface panel.

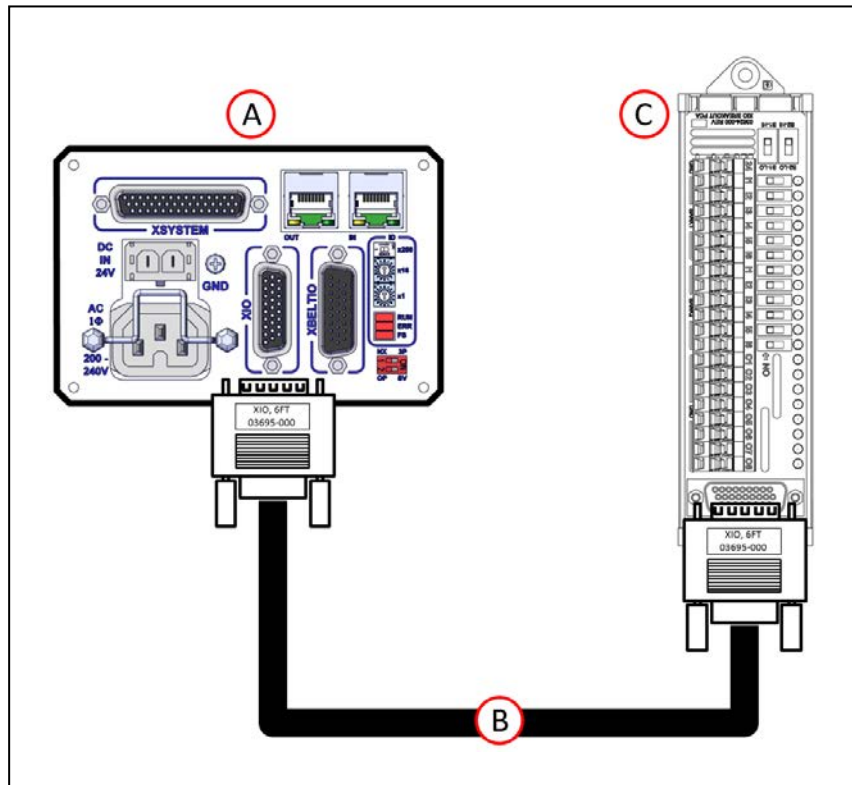


Figure 4-8. Connecting XIO Termination Block

Callout	Function
A	Robot Interface Panel
B	XIO Termination Cable, part number 03695-000
C	XIO Termination Block, part number 90356-40100

NOTE: The supplied XIO Termination cable is 2m long and made using shielded 26 AWG wire(wired 1:1). You can construct your own extended length cables using similar cable stock. Give careful attention to voltage drops on the I/O outputs when using extended length cables and high current loads.

Default Signal Allocations

The digital I/O for the eV+ programming language uses numeric signal numbers, with possible outputs, inputs, software signals, robot signals and external signals in the ranges below.

NOTE: Each IOBlox group has a maximum of 4 IOBlox units, daisy-chained for a range of 32 signals (4 units x 8 inputs/outputs).

Default Input Signal Allocations

Use the table below to understand default input allocations.

Table 4-3. Default Input Signal Allocations

Robot	Connector	Channel	Switch Position (1, 2)	Type	Signal Number	
1	XIO	XIO	N/A	Inputs on the iCS-ECAT	1001 to 1012	
	EXPIO	IOBlox Group 1	OFF, OFF	Inputs on IOBlox 1	1033 to 1040	
			ON, OFF	Inputs on IOBlox 2	1041 to 1048	
			OFF, ON	Inputs on IOBlox 3	1049 to 1056	
			ON, ON	Inputs on IOBlox 4	1057 to 1064	
	XBELTIO	IOBlox Group 2	OFF, OFF	Inputs on IOBlox 5	1065 to 1072	
			ON, OFF	Inputs on IOBlox 6	1073 to 1080	
			OFF, ON	Inputs on IOBlox 7	1081 to 1088	
			ON, ON	Inputs on IOBlox 8	1089 to 1096	
	2	XIO	XIO	N/A	Inputs on the iCS-ECAT	1097 to 1108

Robot	Connector	Channel	Switch Position (1, 2)	Type	Signal Number
	EXPIO	IOBlox Group 1	OFF, OFF	Inputs on IOBlox 1	1129 to 1136
			ON, OFF	Inputs on IOBlox 2	1137 to 1144
			OFF, ON	Inputs on IOBlox 3	1145 to 1152
			ON, ON	Inputs on IOBlox 4	1153 to 1160
	XBELTIO	IOBlox Group 2	OFF, OFF	Inputs on IOBlox 5	1161 to 1168
			ON, OFF	Inputs on IOBlox 6	1169 to 1176
			OFF, ON	Inputs on IOBlox 7	1177 to 1184
			ON, ON	Inputs on IOBlox 8	1185 to 1192
3	XIO	XIO	N/A	Inputs on the iCS-ECAT	1193 to 1204
	EXPIO	IOBlox Group 1	OFF, OFF	Inputs on IOBlox 1	1225 to 1232
			ON, OFF	Inputs on IOBlox 2	1233 to 1240
			OFF, ON	Inputs on IOBlox 3	1241 to 1248
			ON, ON	Inputs on IOBlox 4	1249 to 1256
	XBELTIO	IOBlox Group 2	OFF, OFF	Inputs on IOBlox 5	1257 to 1264
			ON, OFF	Inputs on IOBlox 6	1265 to 1272
			OFF, ON	Inputs on IOBlox 7	1273 to 1280
ON, ON			Inputs on IOBlox 8	1281 to 1288	
4	XIO	XIO	N/A	Inputs on the iCS-ECAT	1289 to 1300
	EXPIO	IOBlox Group 1	OFF, OFF	Inputs on IOBlox 1	1321 to 1328
			ON, OFF	Inputs on IOBlox 2	1329 to 1336

Robot	Connector	Channel	Switch Position (1, 2)	Type	Signal Number
			OFF, ON	Inputs on IOBlox 3	1337 to 1344
			ON, ON	Inputs on IOBlox 4	1345 to 1352
	XBELTIO	IOBlox Group 2	OFF, OFF	Inputs on IOBlox 5	1353 to 1360
			ON, OFF	Inputs on IOBlox 6	1361 to 1368
			OFF, ON	Inputs on IOBlox 7	1369 to 1376
			ON, ON	Inputs on IOBlox 8	1377 to 1384
5	XIO	XIO	N/A	Inputs on the iCS-ECAT	1385 to 1396
	EXPIO	IOBlox Group 1	OFF, OFF	Inputs on IOBlox 1	1417 to 1424
			ON, OFF	Inputs on IOBlox 2	1425 to 1432
			OFF, ON	Inputs on IOBlox 3	1433 to 1440
			ON, ON	Inputs on IOBlox 4	1441 to 1448
	XBELTIO	IOBlox Group 2	OFF, OFF	Inputs on IOBlox 5	1449 to 1456
			ON, OFF	Inputs on IOBlox 6	1457 to 1464
			OFF, ON	Inputs on IOBlox 7	1465 to 1472
			ON, ON	Inputs on IOBlox 8	1473 to 1480
	6	XIO	XIO	N/A	Inputs on the iCS-ECAT
EXPIO		IOBlox Group 1	OFF, OFF	Inputs on IOBlox 1	1513 to 1520
			ON, OFF	Inputs on IOBlox 2	1521 to 1528
			OFF, ON	Inputs on IOBlox 3	1529 to 1536
			ON, ON	Inputs on IOBlox 4	1537 to 1544

Robot	Connector	Channel	Switch Position (1, 2)	Type	Signal Number	
	XBELTIO	IOBlox Group 2	OFF, OFF	Inputs on IOBlox 5	1545 to 1552	
			ON, OFF	Inputs on IOBlox 6	1553 to 1560	
			OFF, ON	Inputs on IOBlox 7	1561 to 1568	
			ON, ON	Inputs on IOBlox 8	1569 to 1576	
7	XIO	XIO	N/A	Inputs on the iCS-ECAT	1577 to 1588	
	EXPIO	IOBlox Group 1	OFF, OFF	Inputs on IOBlox 1	1609 to 1616	
			ON, OFF	Inputs on IOBlox 2	1617 to 1624	
			OFF, ON	Inputs on IOBlox 3	1625 to 1632	
			ON, ON	Inputs on IOBlox 4	1633 to 1640	
	XBELTIO	IOBlox Group 2	OFF, OFF	Inputs on IOBlox 5	1641 to 1648	
			ON, OFF	Inputs on IOBlox 6	1649 to 1656	
			OFF, ON	Inputs on IOBlox 7	1657 to 1664	
			ON, ON	Inputs on IOBlox 8	1665 to 1672	
	8	XIO	XIO	N/A	Inputs on the iCS-ECAT	1673 to 1684
		EXPIO	IOBlox Group 1	OFF, OFF	Inputs on IOBlox 1	1705 to 1712
				ON, OFF	Inputs on IOBlox 2	1713 to 1720
OFF, ON				Inputs on IOBlox 3	1721 to 1728	
ON, ON				Inputs on IOBlox 4	1729 to 1736	
XBELTIO		IOBlox Group 2	OFF, OFF	Inputs on IOBlox 5	1737 to 1744	
			ON, OFF	Inputs on IOBlox 6	1745 to 1752	

Robot	Connector	Channel	Switch Position (1, 2)	Type	Signal Number
			OFF, ON	Inputs on IOBlox 7	1753 to 1760
			ON, ON	Inputs on IOBlox 8	1761 to 1768

Default Output Signal Allocations

Use the table below to understand default output allocations.

Table 4-4. Default Output Signal Allocations

Robot	Connector	Channel	Switch Position (1, 2)	Type	Signal Number	
1	XIO	XIO	N/A	Outputs on the iCS-ECAT	1 to 8	
	EXPIO	IOBlox Group 1	OFF, OFF	Outputs on IOBlox 1	33 to 40	
			ON, OFF	Outputs on IOBlox 2	41 to 48	
			OFF, ON	Outputs on IOBlox 3	49 to 56	
			ON, ON	Outputs on IOBlox 4	57 to 64	
	XBELTIO	IOBlox Group 2	OFF, OFF	Outputs on IOBlox 5	65 to 72	
			ON, OFF	Outputs on IOBlox 6	73 to 80	
			OFF, ON	Outputs on IOBlox 7	81 to 88	
			ON, ON	Outputs on IOBlox 8	89 to 96	
	2	XIO	XIO	N/A	Outputs on the iCS-ECAT	97 to 104
		EXPIO	IOBlox Group 1	OFF, OFF	Outputs on IOBlox 1	129 to 136
				ON, OFF	Outputs on IOBlox 2	137 to 144
OFF, ON				Outputs on IOBlox 3	145 to 152	
ON, ON				Outputs on IOBlox 4	153 to 160	
XBELTIO		IOBlox Group 2	OFF, OFF	Outputs on IOBlox 5	161 to 168	
			ON, OFF	Outputs on IOBlox 6	169 to 176	
			OFF, ON	Outputs on IOBlox 7	177 to 184	
			ON, ON	Outputs on IOBlox 8	185 to 192	
3		XIO	XIO	N/A	Outputs on the iCS-ECAT	193 to 200

Robot	Connector	Channel	Switch Position (1, 2)	Type	Signal Number	
	EXPIO	IOBlox Group 1	OFF, OFF	Outputs on IOBlox 1	225 to 232	
			ON, OFF	Outputs on IOBlox 2	233 to 240	
			OFF, ON	Outputs on IOBlox 3	241 to 248	
			ON, ON	Outputs on IOBlox 4	249 to 256	
	XBELTIO	IOBlox Group 2	OFF, OFF	Outputs on IOBlox 5	257 to 264	
			ON, OFF	Outputs on IOBlox 6	265 to 272	
			OFF, ON	Outputs on IOBlox 7	273 to 280	
			ON, ON	Outputs on IOBlox 8	281 to 288	
4	XIO	XIO	N/A	Outputs on the iCS-ECAT	289 to 296	
	EXPIO	IOBlox Group 1	OFF, OFF	Outputs on IOBlox 1	321 to 328	
			ON, OFF	Outputs on IOBlox 2	329 to 336	
			OFF, ON	Outputs on IOBlox 3	337 to 344	
			ON, ON	Outputs on IOBlox 4	345 to 352	
	XBELTIO	IOBlox Group 2	OFF, OFF	Outputs on IOBlox 5	353 to 360	
			ON, OFF	Outputs on IOBlox 6	361 to 368	
			OFF, ON	Outputs on IOBlox 7	369 to 376	
			ON, ON	Outputs on IOBlox 8	377 to 384	
	5	XIO	XIO	N/A	Outputs on the iCS-ECAT	385 to 392
		EXPIO	IOBlox Group 1	OFF, OFF	Outputs on IOBlox 1	417 to 424
				ON, OFF	Outputs on IOBlox 2	425 to 432
OFF, ON				Outputs on IOBlox 3	433 to 440	
ON, ON				Outputs on IOBlox 4	441 to 448	
XBELTIO		IOBlox Group 2	OFF, OFF	Outputs on IOBlox 5	449 to 456	
			ON, OFF	Outputs on IOBlox 6	457 to 464	
			OFF, ON	Outputs on IOBlox 7	465 to 472	
			ON, ON	Outputs on IOBlox 8	473 to 480	
6		XIO	XIO	N/A	Outputs on the iCS-ECAT	481 to 488

Robot	Connector	Channel	Switch Position (1, 2)	Type	Signal Number	
	EXPIO	IOBlox Group 1	OFF, OFF	Outputs on IOBlox 1	513 to 520	
			ON, OFF	Outputs on IOBlox 2	521 to 528	
			OFF, ON	Outputs on IOBlox 3	529 to 536	
			ON, ON	Outputs on IOBlox 4	537 to 544	
	XBELTIO	IOBlox Group 2	OFF, OFF	Outputs on IOBlox 5	545 to 552	
			ON, OFF	Outputs on IOBlox 6	553 to 560	
			OFF, ON	Outputs on IOBlox 7	561 to 568	
			ON, ON	Outputs on IOBlox 8	569 to 576	
7	XIO	XIO	N/A	Outputs on the iCS-ECAT	577 to 584	
	EXPIO	IOBlox Group 1	OFF, OFF	Outputs on IOBlox 1	609 to 616	
			ON, OFF	Outputs on IOBlox 2	617 to 624	
			OFF, ON	Outputs on IOBlox 3	625 to 632	
			ON, ON	Outputs on IOBlox 4	633 to 640	
	XBELTIO	IOBlox Group 2	OFF, OFF	Outputs on IOBlox 5	641 to 648	
			ON, OFF	Outputs on IOBlox 6	649 to 656	
			OFF, ON	Outputs on IOBlox 7	657 to 664	
			ON, ON	Outputs on IOBlox 8	665 to 672	
	8	XIO	XIO	N/A	Outputs on the iCS-ECAT	673 to 680
		EXPIO	IOBlox Group 1	OFF, OFF	Outputs on IOBlox 1	705 to 712
				ON, OFF	Outputs on IOBlox 2	713 to 720
OFF, ON				Outputs on IOBlox 3	721 to 728	
ON, ON				Outputs on IOBlox 4	729 to 736	
XBELTIO		IOBlox Group 2	OFF, OFF	Outputs on IOBlox 5	737 to 744	
			ON, OFF	Outputs on IOBlox 6	745 to 752	
			OFF, ON	Outputs on IOBlox 7	753 to 760	
			ON, ON	Outputs on IOBlox 8	761 to 768	

XIO Connector Signals

The XIO connector on the robot interface panel offers access to digital I/O (12 inputs and 8 outputs). Refer to the following table for the XIO signal designations.

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

Table 4-5. XIO Signal Designations

Pin No.	Designation	Signal Bank	eV+ Signal Number
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 Input Signals

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

The inputs are accessed through direct connection to the XIO connector (see the previous table), or through the optional XIO Termination Block. See the documentation supplied with the termination block for details.

XIO Output Signals

The eight digital outputs share a common, high side (sourcing) driver integrated circuit. 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 switching up to 0.7 A of current. This driver has overtemperature protection, shorted load protection, and is current limiting. If there is an output short or other overcurrent situation, the affected output of the driver integrated circuit turns OFF and back ON automatically to reduce the internal temperature. 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. Optionally, use the XIO Termination Block. See the documentation supplied with the termination block for details.

High Power Indicator Output Assignment

Output 8 can be assigned to indicate the robot's high power state. When high power is enabled, this output will turn ON. When high power is not enabled, this output will be OFF. Use Sysmac Studio to make this configuration if needed.

4.3 Connecting the 24 VDC Cable to the Robot

Power requirements for the user-supplied power supply vary depending on the configuration of the robot and connected devices. OMRON recommends a 24 VDC, 6 A power supply to allow for startup current draw from connected user devices, such as solenoids and digital I/O loads.

Additional Information: Refer to External Connection Specifications on page 145 for more information about 24 VDC power requirements.

24 VDC Power Supply Connector

The cable and accessory box that came with your system contains the 24 VDC power supply connector and two pins. Use the following figure to determine the pin arrangement.

Additional Information: Refer to Connector Specifications on page 148 for more information.

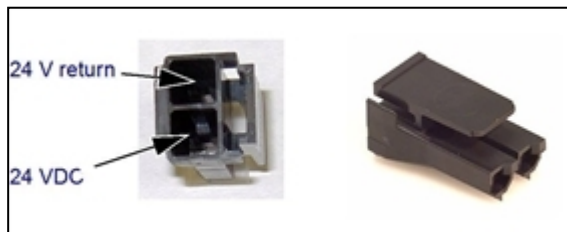


Figure 4-9. 24 VDC Mating Connector Pin Arrangement

Making the 24 VDC Power Supply Cable

Use the following procedure to make a 24 VDC cable.

Additional Information: The 24 VDC cable is not supplied with the system, but is available in the optional Power Cable kit (part number 04120-000) Refer to Basic System Cable Layout on page 61 for more information. See Figure 4-11.

1. Locate the connector and pins.
2. Use 2.08-1.31 mm² (14-16 AWG) wire to create the 24 VDC cable. Select the wire length to safely reach from the user-supplied 24 VDC power supply to the robot interface panel.
3. Crimp the pins to the wires using a crimping tool.
4. Insert the pins into the connector. Confirm that the 24 VDC and 24 VDC return wires are in the correct terminals in the plug.

Connecting the 24 VDC Cable

Use the following procedure to connect the 24 VDC cable from the power supply to the robot interface panel.

Additional Information: Refer to External Connection Specifications on page 145 for more information.

IMPORTANT: Do not apply 24 VDC power until all installation steps are complete and verified and all safety measures are in place.

The following instructions correspond to the numbered steps in green boxes in the following figure. The red circled letters identify specific items.

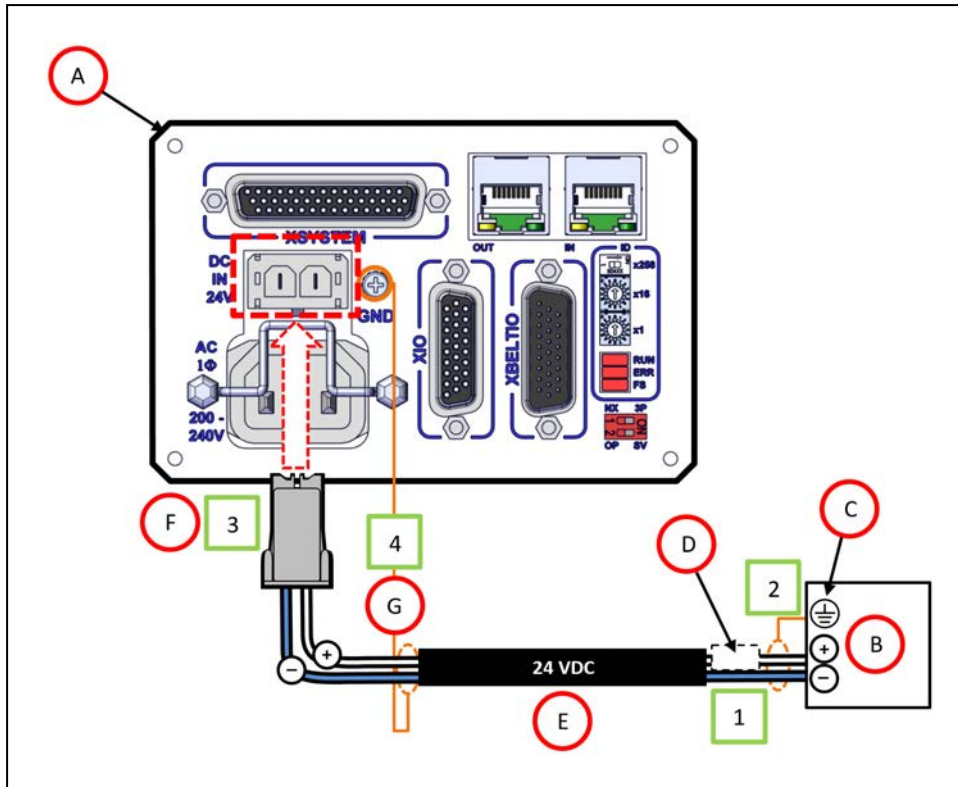


Figure 4-10. User-Supplied 24 VDC Cable, Power Supply

Item	Description
A	Robot interface panel
B	User-supplied 24 VDC power supply
C	Power Supply frame ground
D	8 A (max) in-line circuit protection
E	User-supplied 24 VDC (14-16 AWG) Shielded Cable
F	Molex Saber 18 A, 2-pin Connector
G	Ground screw on robot interface panel

NOTE: To comply with standards, DC power should be supplied over a shielded cable with the shield connected to frame ground at both ends of the cable.

1. Connect one end of the shielded 24 VDC cable (E) to the 24 VDC power supply (B) observing the correct polarity.



CAUTION: PROPERTY DAMAGE RISK

The 24 VDC output must be less than 300 W peak or 8 Amp (max) in-line circuit protection must be provided for each connected robot. Refer to (D) in Figure 4-10. .

2. Connect the cable shield (D) to frame ground on the power supply (C).
3. Plug the mating connector end of the 24 VDC cable (F) into the 24 VDC connector on the robot interface panel(A).
4. Connect the cable shield (G) to the ground point on the robot interface panel (A).

4.4 Connecting 200-240 VAC Power Cable

Use the following procedure to connect the 200-240 VAC cable from the power supply to the robot interface panel.

Additional Information: Refer to External Connection Specifications on page 145 for more information.

IMPORTANT: Do not apply AC power until all installation steps are complete and verified and all safety measures are in place.



WARNING: ELECTROCUTION RISK

National Electrical Code (and/or local codes) require that you provide an appropriately sized branch circuit protection and lockout/tagout capability. Ensure you comply with all local and national safety and electrical codes for the installation and operation of the robot system.



DANGER: ELECTROCUTION RISK

ISO 10218-1, Clause 5.2.4 mandates that, during installation, you must provide a fail-safe lockout to prevent unauthorized third parties from turning on power.



WARNING: ELECTROCUTION RISK

eCobra robot systems require an isolating transformer for connection to asymmetrical mains systems or those using an isolated (impedant) neutral. Many parts of Europe use an impedant neutral.



DANGER: ELECTROCUTION RISK

Only a skilled and instructed person must install AC power. Clause 5.2.4 of the ISO 10218-1 requires that the person installing the system must use fail-safe lockout measures to prevent unauthorized third parties from turning on power. Refer to the *Robot Safety Guide (Cat. No. I590)* for more information.

NOTE: Install the robot system as a piece of equipment in a permanently-installed system.

AC Power Diagrams

If using a three-phase power source, it must be symmetrically-earthed (with grounded neutral). Connections called out as single-phase can be wired Line-to-Neutral or Line-to-Line.

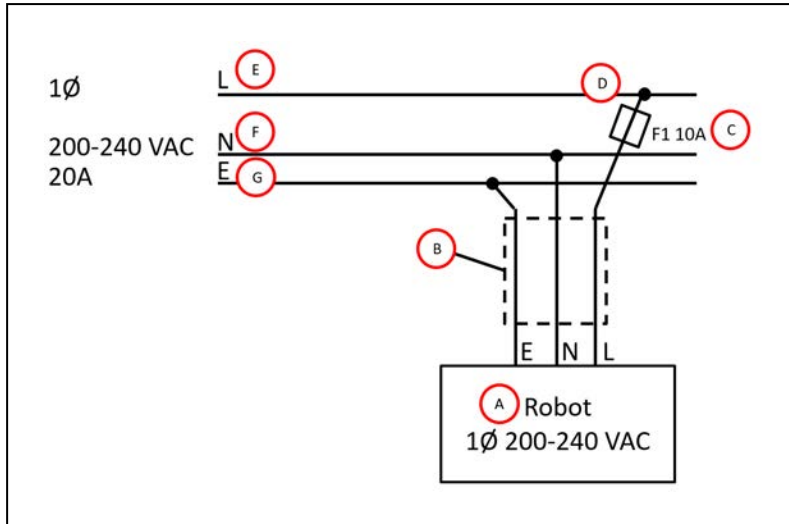


Figure 4-11. Typical AC Power Installation with Single-Phase Supply

Key	Meaning
A	Robot 1Ø 200-240 VAC
B	User-supplied AC power cable
C	F1 - 10A
D	NOTE: F1 is user-supplied, and must be slow-blow
E	L=Line
F	N=Neutral
G	E=Earth Ground

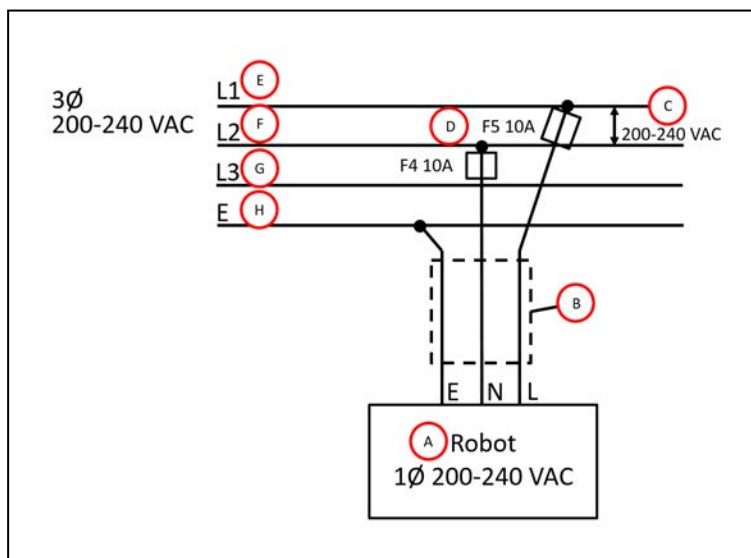


Figure 4-12. Single-Phase Load across L1 and L2 of a Three-Phase Supply

Key	Meaning
A	Robot 1Ø 200-240 VAC
B	User-supplied AC power cable
C	200-240 VAC
D	Fuses F4 and F5 NOTE: These fuses must be slow-blow
E	L=Line 1
F	N=Line 2
G	L3=Line 3 (not used)
H	E= Earth Ground

AC Power Supply Connector

The cable and accessory box that came with your system contains the AC power supply connector. The supplied plug is internally labeled for the AC power connections (L, E, N).

Additional Information: Refer to Connector Specifications on page 148 for more information.

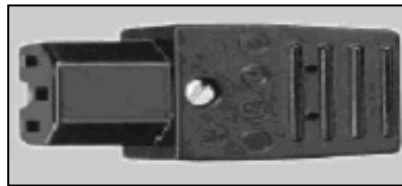


Figure 4-13. AC Power Supply Connector

Making the 200-240 VAC Power Supply Cable

Use the following procedure to make the 200-240 VAC power supply cable.

Before you begin, you will need 3-wire, 0.8 mm² (18 AWG) cable long enough to reach from the AC power source to the robot.

1. Locate the AC power supply connector.
2. Unscrew the shell screw, open the connector, and remove the cover.
3. Loosen the two screws on the cable clamp.
4. Strip approximately 18 to 24 mm of insulation from each of the three wires.
5. Insert the wires into the connector through the removable bushing.
6. Connect each wire to the correct terminal screw and tighten the screw firmly.
7. Tighten the screws on the cable clamp, then reinstall the cover and tighten the screw.
8. Prepare the opposite end of the cable for connection to the facility AC power source.

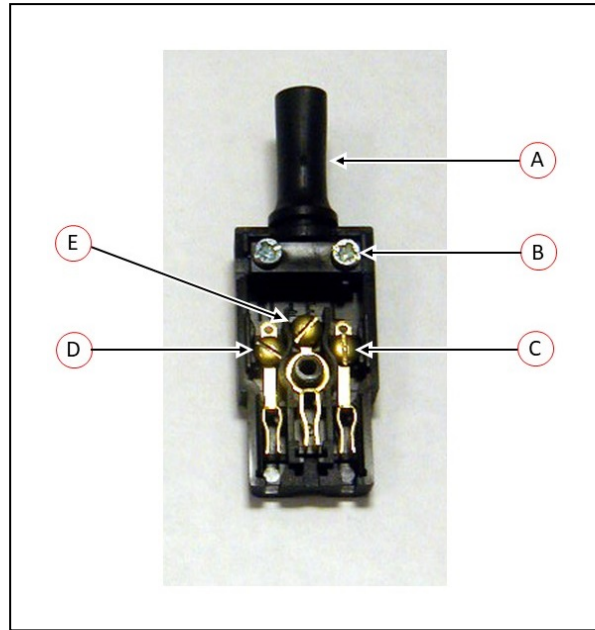


Figure 4-14. AC Power Mating Connector

Key	Meaning	Key	Meaning
A	Removable Bushing	D	Neutral
B	Cable Clamp	E	Earth
C	Line		

Connecting the AC Power Supply Cable

Use the following procedure to connect the AC power supply cable from the power source to the robot interface panel.

Additional Information: Refer to External Connection Specifications on page 145 for more information.

IMPORTANT: Do not apply AC power until all installation steps are complete and verified and all safety measures are in place.

1. With the AC supply OFF, connect the unterminated end of the AC power cable to your facility AC power source.
2. Plug the AC connector into the AC power connector on the robot interface panel on the robot.
3. Secure the AC connector with the locking latch.

4.5 Grounding the Robot System

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

Grounding the Robot Base

You can ground the robot base by using a ground wire at the robot base (see the following figure). The robot ships with an M8 x 12 stainless steel, hex-head screw, and M8 split and flat washers installed in the grounding hole. You must supply the ground wire.

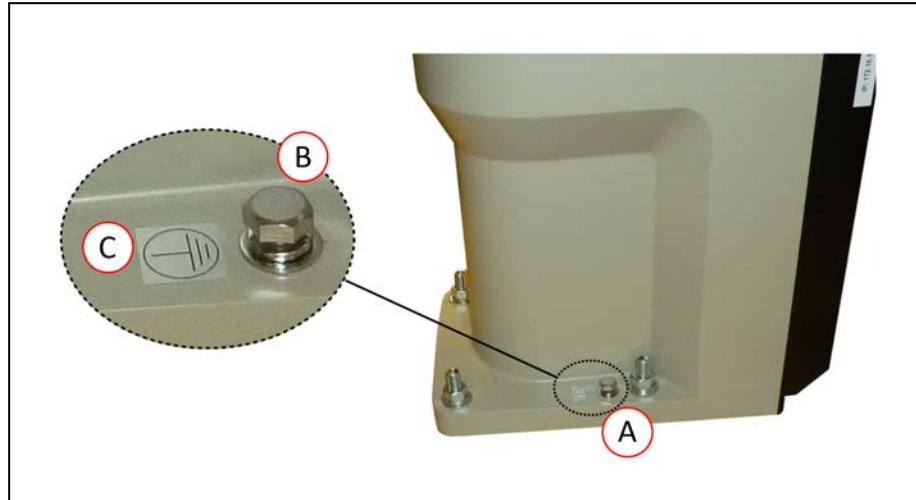


Figure 4-15. Ground Point on Robot Base

IMPORTANT: The earth ground conductor resistance must be $\leq 10 \Omega$.

Callout	Description
A	Ground point location on robot base
B	Ground lug
C	Ground label

Grounding Robot-Mounted Equipment

The Joint 3 quill and the tool flange are not grounded to protective earth. If hazardous voltages are present at any user-supplied robot-mounted equipment or tooling, you must install a ground connection from that equipment or tooling to the ground point on the robot base. Hazardous voltages are anything over 30 VAC (42.4 VAC peak) or 60 VDC.

Additional Information: Refer to Tool Flange Dimensions on page 149 for more information about the tool flange grounding point.



DANGER: ELECTROCUTION HAZARD

Failing to ground robot-mounted equipment or tooling that uses hazardous voltages could lead to injury or fatality of a person touching the end-effector during an electrical fault.

Chapter 5: Optional Equipment Installation

This chapter describes the process for installing various robot options such as end-effectors, solenoids, camera brackets, and adjustable hardstops.



DANGER: Do not make modifications to the robot that are not described in this document. Doing so can result in personal and equipment danger.

NOTE: Additional optional equipment installation may be necessary for IP65 and Cleanroom robot options. Refer to IP65 Option Considerations on page 153 and Cleanroom Option Considerations on page 167.

5.1 Installing End-Effectors

You must provide, install, and ground (if necessary) end-effector or other end-of-arm tooling. An installed end-effector is shown in the figure below as an example.

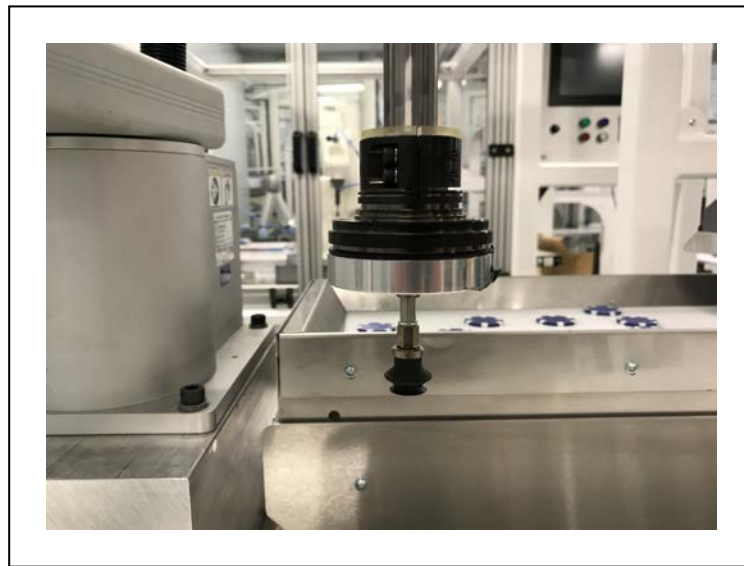


Figure 5-1. Suction Cup End-effector Installed

You can attach end-effectors to the tool flange using four M6 screws. Refer to Tool Flange Dimensions on page 149 for more information.

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

The Joint 3 quill and the tool flange are not grounded to protective earth. 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. Refer to Grounding Robot-Mounted Equipment on page 85 for more information.

If the end-effector requires a pneumatic supply or electrical connections, use the pass-through connections on the robot body. Refer to Robot Connections on page 17 for more information.

5.2 Mounting Locations for External Equipment

The robot arm has three multi-purpose mounting locations for adding external equipment. Each location has a set of four tapped holes.

NOTE: The cover on the outer link must be removed for lubrication maintenance. Consider this when mounting any external equipment to the outer link cover. Refer to Maintenance on page 111 for more information.

Additional Information: Refer to Robot Physical Dimension Drawings on page 131 for mounting hole dimensional information.

The first location is on the J1 harness support as shown in the figure below at the top side of the inner link.



Figure 5-2. External Equipment Mounting location, J1

A second external equipment mounting location is on the top side of the outer link as shown in the figure below.



Figure 5-3. External Tooling Location, Outer Link (top)

A third external equipment mounting location is on the bottom side of the outer link.



Figure 5-4. External Tooling Location, Outer Link (bottom)

5.3 Installing the Solenoid Valve Kit

This procedure describes how to install the Solenoid Valve Kit (part number 02853-000) on a standard robot.

NOTE: If you are installing the Solenoid Valve Kit on a robot with the IP65 option or the Cleanroom option, special considerations must be made. Refer to Robot Solenoid Option Consideration for IP65 Robots on page 163 and Robot Solenoid Option Consideration for Cleanroom Robots on page 168 for more information.

Before beginning this procedure, have the following items available.

- Hex drives
- Cable ties
- Diagonal wire cutters
- Solenoid Valve Kit

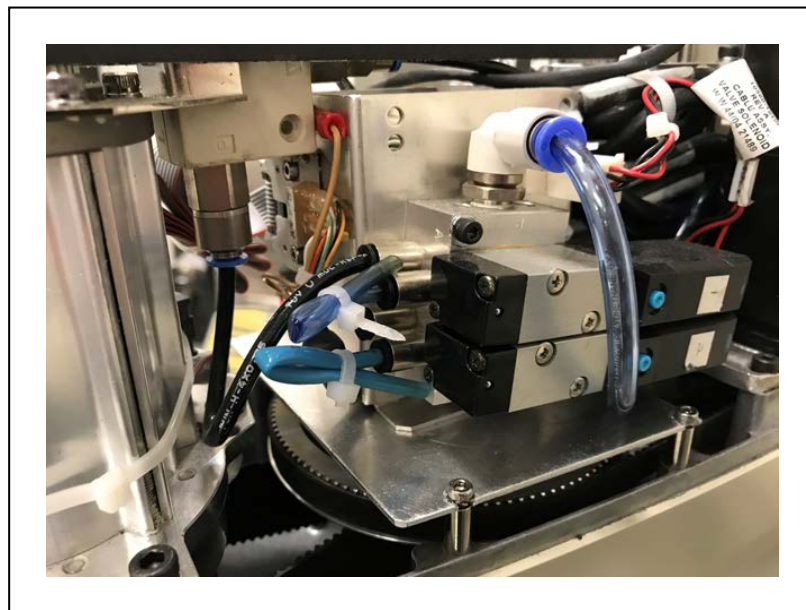


Figure 5-5. Solenoid Valve Kit Assembly Installed

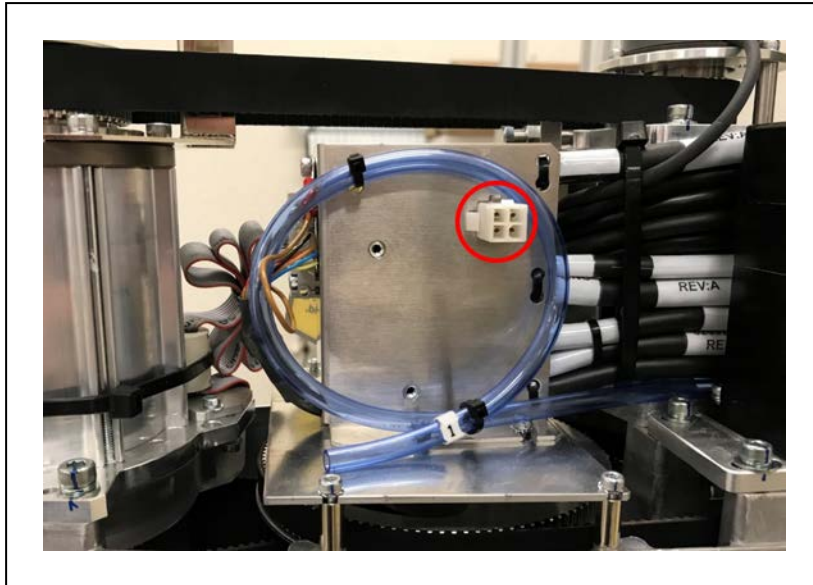


Figure 5-6. Solenoid Connector Location and Spare Air Line (blue, coiled)

Solenoid Valve Kit Installation Procedure

Use the following procedure to install the Solenoid Valve Kit.

1. Turn OFF all power to the robot.
2. Remove the screws from each side of the outer link cover (two screws on an eCobra 600, three screws on an 800). Remove two screws on top and remove the cover. Retain the screws for reassembly.

For IP65 and Cleanroom versions, refer to Outer Link Cover Removal Procedure on page 159 for instructions on removing the link cover. Retain the screws for reassembly.

3. Connect the Internal Solenoid Valve Cable assembly to the Solenoid Manifold assembly, by plugging the SOL 1 connector into Valve 1 and SOL 2 into Valve 2.

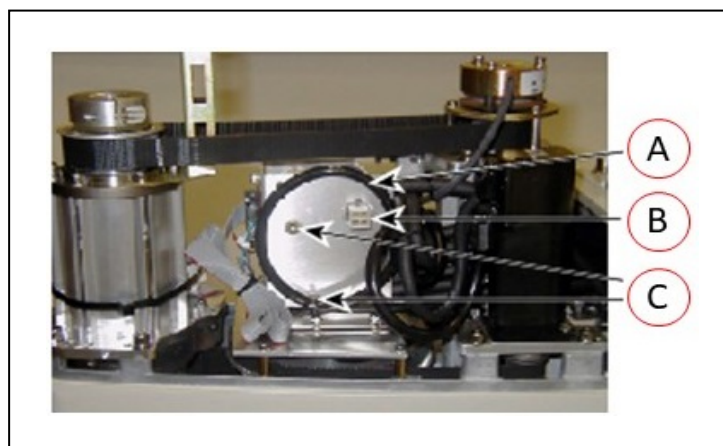


Figure 5-7. Solenoid Mounting Bracket with Connector and Spare Air Line

Key	Meaning
A	Spare air line
B	Connector for solenoid valve (labeled SOLND)
C	Self-clinching nuts to mount the solenoid manifold

- Cut and discard the cable ties holding the spare air line at the top of the mounting bracket. Move the air line out of the way to mount the solenoid manifold. See the preceding figure.
- Mount the solenoid manifold onto the bracket using the supplied M3 x 25 mm screws and washers.

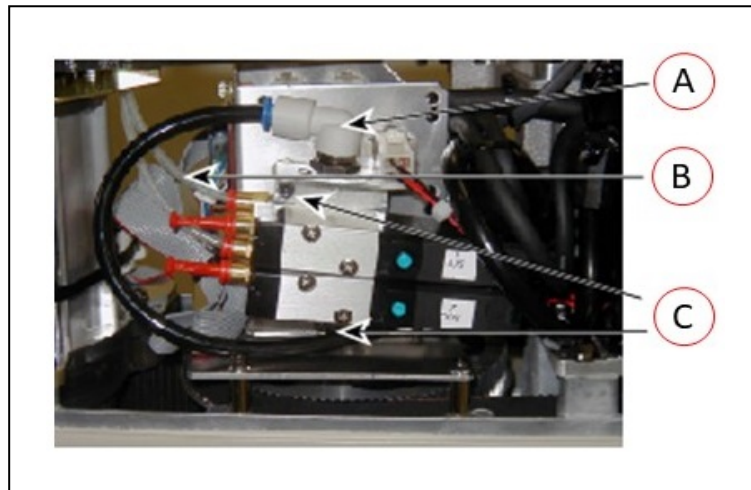


Figure 5-8. Solenoid Placement Using Mounting Hardware

Key	Meaning
A	Air intake coupling with spare air line
B	Tubing connected to output port
C	Mounting screws for solenoid assembly

- Insert the spare air line into the air intake coupling of the solenoid manifold. Make sure to push the air line in all the way and secure it in place by the intake coupling. Confirm by gently pulling the air line.
- NOTE:** If you are installing on a Cleanroom or IP65 robot, the spare air line is used to either evacuate or pressurize the robot. You will have to provide 6 mm tubing to run connect one of the 6 mm user air lines at the Joint 2 cover to the air intake coupling mentioned above.
- Plug the connector plug into the female connector jack (marked SOLND) on the bracket.
 - Use cable ties to secure air line to the bracket as needed.
 - Install the appropriate lengths of approximately 4 inch plastic tubing (supplied) into the two output ports on the manifold.
 - Route the tubing up along the tower bracket next to the quill and down through the

center of the quill. Use cable ties as needed to secure the tubing.

11. Loosen the securing screw on the robot chassis and lower the chassis down flat.
12. Remove the cable strap plate by removing two screws and split washers. See the following figure. This allows the harness to move when you lift the J1 cover in the next step. Retain the screws for re-assembly.

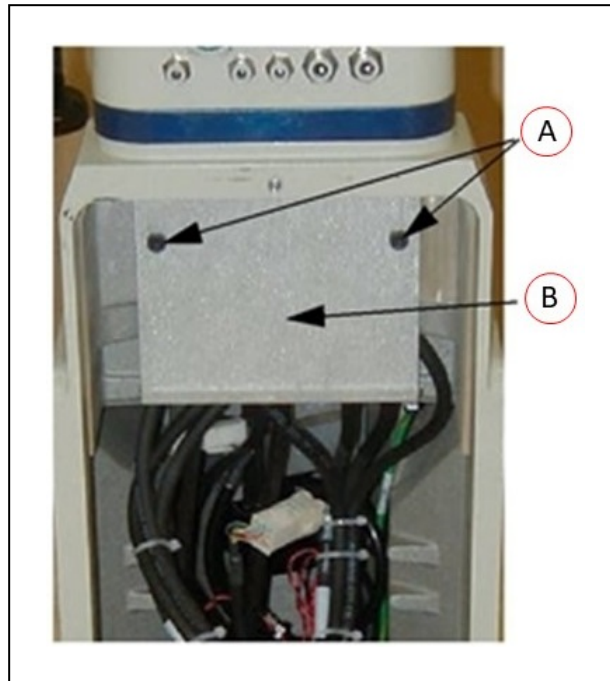


Figure 5-9. Removing the Cable Strap Plate showing two M5x8 screws (A) and the cable strap plate (B)

13. Remove the four screws from the Joint 1 cover. Retain the screws for re-assembly.



Figure 5-10. Joint 1 Cover Screws (circled)

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

NOTE: This 6 mm User Air connector and the 6 mm User Air connector at the top of are not available for other uses after this modification.

17. Reinstall the Joint 1 cover, ensuring that all tubing is inside the cover and nothing gets crimped or pinched while pushing the cover into position. Reinstall four screws to secure the cover. Tighten the screws to 1.6 N·m.
18. Reinstall the cable strap plate removed earlier in the procedure.
19. Raise the robot chassis to the closed position and tighten the securing screw.
20. Reinstall the outer link cover and tighten the screws to 1.6 N·m.

Testing Solenoid Valve Kit Installation

Use the following procedure to test the solenoid valve kit installation.



WARNING: INJURY RISK.

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

1. Connect the low-pressure air supply to the 6 mm User Air connector (for non-IP65 robots, this is the modified air connector).
2. Test each solenoid by turning ON the output signal associated with the valve(s).

5.4 Installing the Camera Bracket Kit

Use the following information to understand the installation procedure for the Camera Bracket Kit.

Tools Required

- M4 hex wrench
- M3 hex wrench

Procedure

Use the following procedure to install the Camera Bracket Kit.

1. Install the camera plate to the outer link with four M5 x 12 mm screws using the mounting holes shown in the figure below.

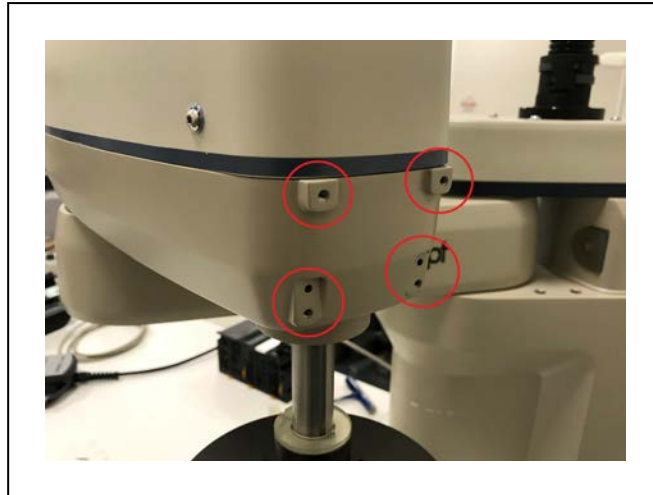


Figure 5-11. External Camera Mounting Holes

2. Install the two camera brackets to the camera plate with two washers and two M4 x 12 mm screws for each bracket. The camera brackets are not required unless you are mounting more than one camera.
3. Mount the camera channel to the camera brackets or camera plate with M4 x 12 mm screws.
4. Mount the camera to the camera mount.
5. Mount the camera and camera mount to the camera channel using M5 x 12 mm screws.

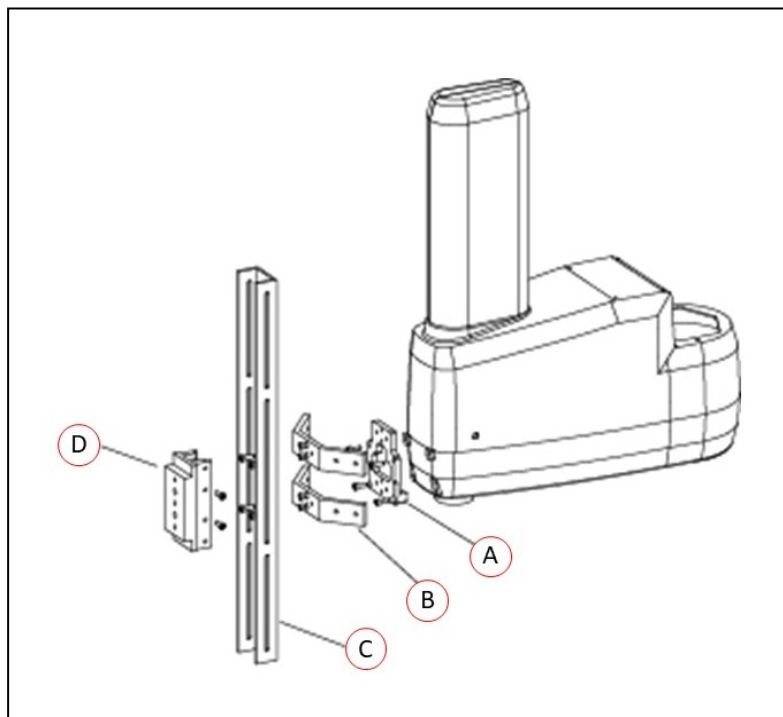


Figure 5-12. Mounting a Camera Plate (A), Camera Brackets (B), Camera Channel (C), and Camera Mount (D) on the Robot.

5.5 Installing Adjustable Hardstops

Use the following information to understand the installation procedure for the adjustable hardstops.

Joint 1 Adjustable Hardstop Installation

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

Tools Required

- Torque wrench
- 8mm hex bit

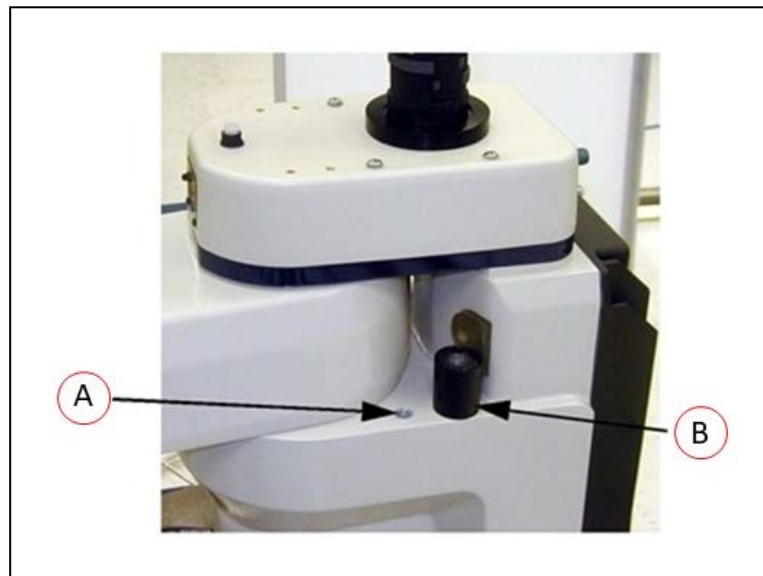


Figure 5-13. Hardstop Mounting Positions - Position 1 (A), Position 2 (B)

Installation Procedure

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

NOTE: The two sides do not have to have a hardstop in the same position. You can use Position 1 on one side and Position 2 (or none) on the other side.

IMPORTANT: After installing any adjustable hardstops, modify the robot joint motion limit(s). Refer to the *Sysmac Studio Version 1 Operation Manual (Cat. No. W504)* for more information. Refer to Adjustable Hardstops on page 32 for information about robot joint range limitations.

Joint 2 Adjustable Hardstop Installation

The Joint 2 Adjustable Hardstops consists of two curved plates for adjustment and a small, black rectangular device that is the fixed hardstop. You can install the adjustable hardstop plates in different locations, depending on how much you need to limit the Joint 2 range of motion. The positions are spaced 30° apart.

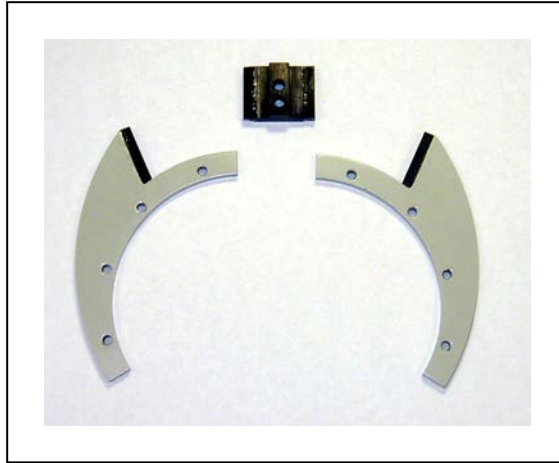


Figure 5-14. Joint 2 Hardstop Kit

Tools Required

- Torque wrench
- 4mm hex bit
- 3mm hex bit

Installation Procedure

1. Slide the two adjustable hardstop plates into the space between inner and outer links (see Figure 5-15. Looking up at the inner link from underneath, align the holes in the plates with the holes in the inner link (see Figure 5-16.

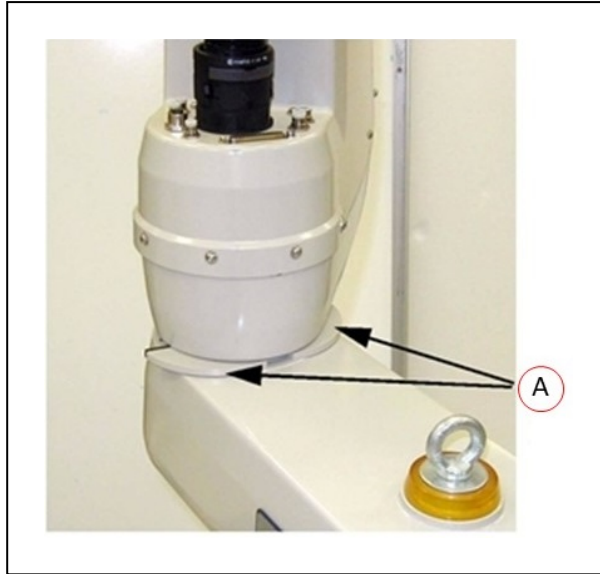


Figure 5-15. Joint 2 Adjustable Hardstop Plates installed in Position 2 (A)

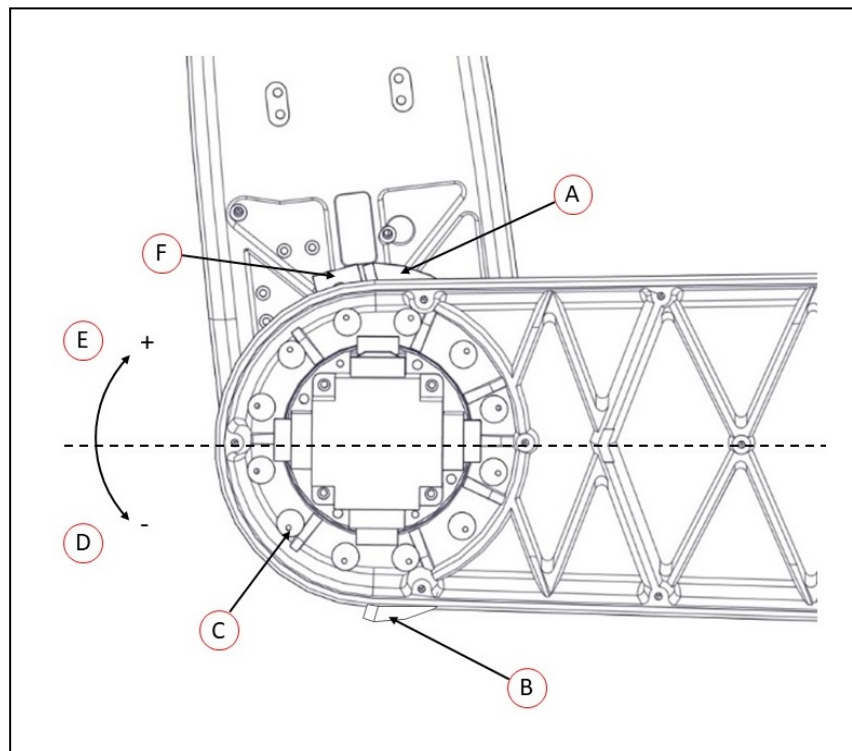


Figure 5-16. Screw Locations for Joint 2 Adjustable Hardstops (as seen from below)

Item	Meaning	Item	Meaning
A	Joint 2 Left Hardstop Plate installed in +81° position	D	Joint 2 Negative direction
B	Joint 2 Right Hardstop	E	Joint 2 Positive direction

Item	Meaning	Item	Meaning
	Plate installed in -81° position		
C	12 thru holes for M5 x 10 screws to install Joint 2 hardstops, located 30° apart	F	Joint 2 Fixed Hardstop device

- Use a 4 mm hex wrench to install three supplied M5 x 10 screws to secure the plate. Tighten the screws to 4.5 N·m. Repeat the process for the second plate. The plates can be installed in a number of different positions, depending on how much you need to limit the range of Joint 2.

NOTE: The two hardstop sides do not have to be in the same position, so the workspace does not have to be symmetrical.

- Slide the fixed hardstop device into the slot on the underside of the outer link. See Figure 5-17.

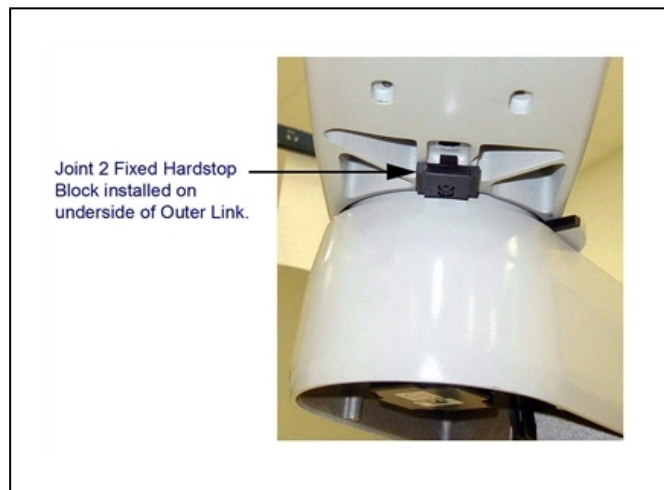


Figure 5-17. Fixed Hardstop Block for Joint 2 installed on underside of Outer Link

- Use a 3 mm hex wrench to install two supplied M4 x 10 screws to secure the hardstop device. Tighten the screws to a torque of 2.5 N·m.

IMPORTANT: After installing any adjustable hardstops, modify the robot joint motion limit(s). Refer to the *Sysmac Studio Version 1 Operation Manual (Cat. No. W504)* for more information. Refer to Adjustable Hardstops on page 32 for information about robot joint range limitations.

This chapter provides information necessary to operate the robot. Read and understand this information before attempting to use the robot.

6.1 Verifying Installation

Before using the robot after installation or other modifications, you must verify that the system is correctly installed and that all safety equipment is working.



DANGER: PERSONAL INJURY/FATALITY HAZARD

After installing the robot, you must test it before using it for the first time. Failure to do this could result in fatality, or serious injury, or equipment damage.

Mechanical Checks

Make the following checks to verify proper mechanical installation.

- The robot is mounted in a level manner.
- All fasteners are properly installed and tightened to the specified torque.
- Any end-of-arm tooling is properly installed and grounded (if necessary).
- All other peripheral equipment is properly installed and in a state where it is safe to turn ON power to the robot.

System Cable Checks

Make the following checks to verify proper system cable installation.

IMPORTANT: Inspect all cables and connectors to ensure they are securely fastened and free of damage.

Additional Information: Refer to Basic System Cable Layout on page 61

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



WARNING: PERSONAL INJURY RISK

Never run a robot system, in automatic mode, with all three jumpers installed. This would leave the system with no E-Stops.

- If a Front Panel is present, ensure it is connected to the XFP connector on the XSYSTEM cable. If not using a Front Panel, ensure the appropriate jumper is installed.
- If a pendant is present, ensure it is connected to the XMCP on the XSYSTEM cable. If not using a pendant, ensure the appropriate jumper is installed.
- Ensure the XSYSTEM cable is connected to the XSYSTEM connector on the robot interface panel.

- Ensure the 24 VDC supply cable and ground wire are connected to the robot interface panel. If required, ensure the tool flange is properly grounded.
- Ensure the 200-240 VAC supply cable is connected to the robot interface panel.
- Ensure all optional cabling is properly connected.

User-Supplied Safety Equipment Checks

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

Use Sysmac Studio utilities to check the safety settings of the robot as described in the table below. Refer to the *Sysmac Studio Robot Integrated System Building Function with Robot Integrated CPU Unit Operation Manual (Cat. No. W595)* for more information.

Additional Information: If the robot will not enter the high power state and displays **SE** or **TR** *Safety System not Commissioned* on the Robot Status LED panel, use the utilities below to troubleshoot the system.

Table 6-1. Safety Utilities in Sysmac Studio

Utility	Description
E-Stop Configuration Utility	This utility sets the E-Stop hardware delay to factory specification.
E-Stop Verification Utility	This utility verifies that the hardware E-Stop is functioning correctly.
Teach Restrict Configuration Utility	This utility sets the hardware Teach Restrict maximum speed to factory specifications.
Teach Restrict Verification Utility	This utility verifies that the hardware Teach Restrict is functioning correctly.

Safety Equipment Check Prerequisites

When checking safety equipment with the utilities described above, the following prerequisites are necessary.

- Sysmac Studio must be installed and available.
- If Teach Restrict verification is necessary, a Teach Pendant must be available.
- The Front Panel mode selection must be in Auto.
- All E-Stops must be deactivated.
- If E-Stop or Teach Restrict configuration is necessary, the supplied jumper plug (11901-000) must be installed on the XBELLTIO connector on the robot interface panel.

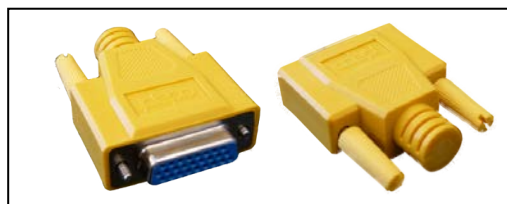


Figure 6-1. Safety Equipment Check Jumper Plug

Switch Position Checks

Verify that the following switch positions are set correctly on the robot interface panel.

- Ensure the EtherCAT node ID switches are set to the proper values.
- Ensure that the operating mode switches are set to the proper positions.

6.2 Robot Status LED and Display Panel

The status LED and display panel are used to visually indicate the general state of the robot.

NOTE: The status LED on the robot is amber to meet UL standards.



Figure 6-2. Robot Status LED and Display Panel

General Robot States

The table below provides general information about the robot state when observing the status LED and display panel.

Table 6-2. General Robot State Descriptions

Status LED	Display Panel	Description
OFF	OFF	24 VDC power not present.
OFF	OK	High power disabled.
OFF	ON	High power enabled.
ON	Status Code(s) E1, 2, 3, ...	Robot boot in progress. Refer to Status Codes on page 171 for more information.
ON Flashing (5 Hz)	Status Code(s)	System fault is present. Refer to Status Codes on page 171 for more information.

6.3 EtherCAT Communications Description

The EtherCAT LEDs located on the robot interface panel are used to indicate the current state of EtherCAT communications.

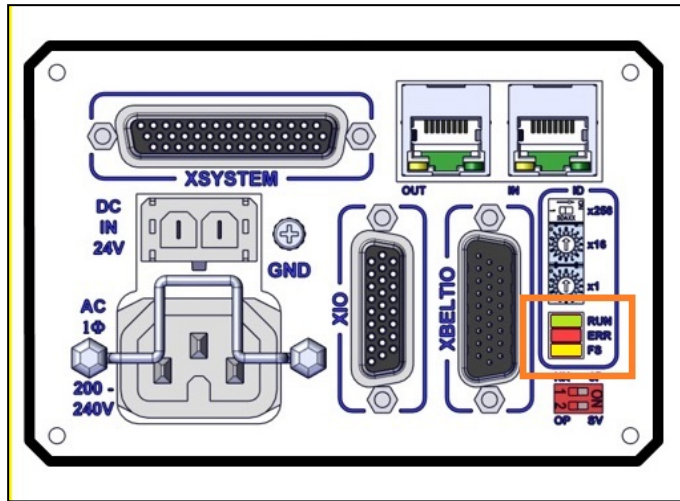


Figure 6-3. EtherCAT LED Location

The LED indicators will be in the following states during normal EtherCAT communications.

- RUN: Lit green
- ERR: Not lit
- FS: Not lit

Use the table below to understand EtherCAT communication states.

LED	Color	Status	Description
RUN	Green	Lit	EtherCAT communications are in progress.
		Flashing	EtherCAT communications are established and in one of the following states: <ul style="list-style-type: none"> • Only message communications are functioning. • Only message communications and I/O data input operations are functioning.
		Not lit	EtherCAT communications are stopped. <ul style="list-style-type: none"> • Robot power is OFF or the controller is being reset. • There is a communications error.
ERR	Red	Lit	There is an unrecoverable error, such as a hardware error or an exception.
		Flashing	There is a recoverable error.
		Not lit	There is no error.
FS	Yellow	Not Lit	Reserved for Future Use

System Behavior with EtherCAT Communication Errors

If an EtherCAT communication error is present and no network communication is possible, all robots on the network will stop with maximum deceleration and high power will be disabled.

If an EtherCAT communication error is present for a specific robot node(s), only that robot is affected by stopping with maximum deceleration and high power being disabled.

6.4 Brakes

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

NOTE: The braking system will not prevent you from moving the robot manually after the robot has stopped and high power has been removed.

Joint 3 has an electromechanical brake that releases when high power is ON. When high power is turned OFF, the brake engages and holds Joint 3 in position.

Brake Release Button

If you want to manually position Joint 3 on the Z-Axis without turning ON high power, use the Z Brake Release button located above the robot display panel, as shown in the following figure. When system power is ON, pressing this button releases the brake so you can move Joint 3 manually.



CAUTION: PROPERTY DAMAGE RISK

Pressing the Brake Release button may cause the quill (and tool flange) to fall to the bottom of its travel.

NOTE: 24 VDC robot system power must be ON to release the brake. To prevent possible damage to the equipment, remove any payload from the end-effector, 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.

IMPORTANT: Pressing the brake release button while high power is ON automatically turns high power OFF.



Figure 6-4. Brake Release Button

Remote Brake Release Feature

You can also configure the XIO Input 6.2 (pin 18) to act as an alternate hardware brake release input. Refer to the *Sysmac Studio Version 1 Operation Manual (Cat. No. W504)* for more information.

When this setting is enabled, activating XIO Input 6.2 is the same as pressing the brake button on the status display.

NOTE: To comply with ISO 10218-1 when using a remote brake release button, ensure the brake release button displays a warning label to indicate that the Z-axis of the robot may fall due to gravity if the brake is released.

6.5 Robot Control Modes

The robot can operate in several different control modes. The selection and function of these modes are described in this section.

Manual Mode

Manual mode is typically used during functions of commissioning, position teaching, and other setup operations.

When the robot is placed in Manual mode, robot motion speed is limited to 250 mm/sec and servo torque is limited so an operator can safely work inside the cell. Manual mode programs can execute from the pendant in STEP mode. Refer to the *T20 Pendant User's Manual (Cat. No. I601)* for more information.

To place the robot in Manual mode, use the Front Panel keyswitch and rotate it to the left position (▶). In this mode, the robot will respond to the control signals coming from the pendant.

NOTE: Controlling the robot from a single location satisfies the single point of control requirement from ISO-10218-1.

Automatic Mode

Automatic mode is used when the robot is operating under normal conditions.

When the robot is placed in Automatic mode, program execution will control the robot up to the robot's maximum speed.



DANGER: PERSONAL INJURY RISK

The robot can move unexpectedly in Automatic mode. Ensure that personnel stay clear of the robot work area.

To place the robot in Automatic mode, use the Front Panel keyswitch and rotate it to the right position (▶).

Operation Mode

Operation mode should be used when the robot is operating under normal conditions and is being controlled by the NJ-series Robot Integrated CPU Unit with EtherCAT communications.

To place the robot in operation mode, set the OP/SV two-position dip switch on the robot interface panel to the OP position (left) as shown in the figure below.

IMPORTANT: The position of the dip switch is checked during power-up only. Changing this switch position while 24 VDC power is supplied will not change the mode of the robot until power is cycled. It is recommended to remove all robot power before changing the position of this switch.

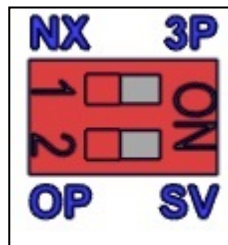


Figure 6-5. Operation Mode Selected

Service Mode

Service mode is used for special conditions when the robot must be accessed with methods other than EtherCAT communications.

NOTE: If the robot is placed in service mode, it will not communicate with an NJ-series Robot Integrated CPU Unit.

IMPORTANT: The operating mode switch state is checked only during robot startup after power is applied.

If the following conditions are present on your system, contact your local OMRON representative for support.

- The license mode of the robot needs to be changed.
- EtherCAT communications cannot be achieved.
- The robot has an unrecoverable hardware fault or error.
- Factory recalibration.

6.6 Manually Jogging the Robot

Manually jogging the robot typically occurs during setup or other system configuration procedures. You can manually jog the robot with a connected pendant or with software.

Refer to the *T20 Pendant User's Manual (Cat. No. I601)* for complete instructions on using the pendant to jog the robot.

If the optional pendant is not present in the system, you can move the robot using the Sysmac Studio. Refer to the *Sysmac Studio Robot Integrated System Building Function with Robot Integrated CPU Unit Operation Manual (Cat. No. W595)* for more information.

6.7 Enabling Robot High Power

When the robot high power is enabled, all robot servo motors are energized and the robot enters a state where it is prepared for motion. The 200-240 VAC power source is used to facilitate this state.



DANGER: ELECTROCUTION HAZARD

When personnel are working with a robot where high power is enabled, make sure they are properly skilled and instructed. Refer to the *Robot Safety Guide (Cat. No. I590)* for more information.

IMPORTANT: High power can only be enabled when safety circuits are satisfied.

Enabling the robot high power for the first time after system power up executes a calibrate function to load joint calibration offsets into memory. This does not perform a full robot hardware calibration.

NOTE: Enabling high power also executes a robot calibration procedure using the CALIBRATE keyword. Refer to the *eV+3 Keyword Reference Manual (Cat. No. I652)* and the *eV+3 User's Manual (Cat. No. I651)* for more information.

High Power Safety Timeout

If the safety timeout function is enabled in the robot configuration, the high power lamp on the Front Panel will flash for a specified amount of time after a high power request is made. If the high power button is not pressed within the specified amount of time, a safety timeout occurs and high power is not applied.

The safety timeout function is enabled by default and has a duration set for 10 seconds. The safety timeout function configuration settings are accessed with Sysmac Studio. Refer to the software user documentation for more information.

Additional Information: If a Front Panel is not present, the high power lamp and high power button signals can be accessed with the XFP system cable connector. Refer to Front Panel Schematic on page 48 for more information.

High Power and Faults

The AUTO.POWER.OFF system switch controls if the robot prevents or disables high power for the following errors. Refer to the *eV+3 User's Manual (Cat. No. I651)* for more information.

- (-624) Force protect limit exceeded
- (-1003) Time-out nulling errors Mtr
- (-1006) Soft envelope error Mtr

High Power Request Methods

There are several methods to request robot high power as described below.

Request High Power with the Front Panel

When a Front Panel is present in the system, the high power button can be used to request high power to the robot.

Additional Information: Refer to Front Panel Schematic on page 48 for more information about connecting external devices to the high power enable signal on the XFP connector.



Figure 6-6. High Power Button on Front Panel

Request High Power with a Connected PC

High power can be requested with Sysmac Studio software. Refer to the software user documentation for more information.

Request High Power with a User Program

High power can be requested with a user program through the use of the POWER system switch or an NJ function block. Refer to the *eV+3 User's Manual (Cat. No. I651)* or the *Sysmac Studio Version 1 Operation Manual (Cat. No. W504)* for more information.

Request High Power with the Pendant

The handheld pendant can be used to request high power to the robot. Refer to the *T20 Pendant User's Manual (Cat. No. I601)* for more information.

1. Verify that the robot 2-digit display reads OK (**OK**), and the status LED is off (refer to the following figure).



Figure 6-7. Robot Status Display and LED

2. On the Front Panel, set the Auto/Manual switch to Auto (see the following figure), then press and release the blinking Robot Power button to enable high power to the robot.

NOTE: The factory default high power timeout is 10 seconds, after which the high power transition is terminated. If this happens, you must re-initiate the high power sequence.



Figure 6-8. Front Panel Keyswitch in Auto

6.8 Disabling Robot High Power

The conditions described below can disable or prevent the robot high power state.

- Robot faults - refer to High Power and Faults on page 107 for more information.
- E-stop open circuit detection.

- User programming with the POWER system switch keyword.
- External signal state control through the XUSR connector on the XSYSTEM cable.

This chapter provides information about maintaining your robot.

7.1 Periodic Maintenance

This section lists when to perform periodic maintenance on your robots and the steps for checking each item to inspect.

NOTE: Additional maintenance may be necessary for IP65 and Cleanroom robot options. Refer to IP65 Option Considerations on page 153 Cleanroom Option Considerations on page 167

Periodic Maintenance Schedule

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

Table 7-1. Inspection and Maintenance

Item to Inspect	Period	Reference
Check E-Stop, enable and key switches, and barrier interlocks	6 months	Checking Safety Systems on page 111
Check robot mounting bolts	6 months	Refer to Checking Robot Mounting Bolts and Cover Plates on page 112
Check Safety Labels	1 week	Refer to Checking Safety and Warning Labels on page 112
Check for signs of oil around gearbox area.	3 months	Refer to Checking for Oil Leaks on page 114
Lubricate Joint 3 ball screw	3 months	Lubricating Joint 3 on page 115
Replace encoder battery	2 to 4 years	Replacing the Encoder Battery Pack on page 117

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

Checking Safety Systems

Use the following steps to check all robot safety devices that may be present in the system. These tests should be done every six months.

IMPORTANT: Operating any of the following safety devices should disable robot high power.

- E-stop button on the Front Panel
- E-stop button on the pendant
- Enabling switch on the pendant
- Any other user-supplied safety devices that have been installed in the robot system.

Checking Robot Mounting Bolts and Cover Plates

Check the tightness of the base mounting bolts after one week and then every 6 months thereafter during robot operation. The torque of the base mounting bolts should be tightened to 85 N·m.

Check the tightness of all cover plate screws. The torque of the fasteners should be 1.6 N·m.

Checking Safety and Warning Labels

This section lists the various safety and warning labels and their placement on the robot. Use this information to perform periodic checks.

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

On a weekly basis, you should check all safety labels on the robot for being present and legible. Replace any missing or illegible labels. The labels part numbers are provided below.

Read User's Guide, Impact Warning Label

This label instructs personnel to read the user's guide before using the robot and to be aware of the potential of impact by the robot. The part number of this label is 18241-000.



Figure 7-1. Read Manual and Impact Warning Label

This is placed in the following location on the robot.



Figure 7-2. Location of Read Manual and Impact Warning Label

Gravity/Brake Release Label

This label warns about the possibility of a robot joint dropping suddenly because of gravity when the brake release is pressed. This applies to the quill and tool flange. The part number for this label is 18272-000.

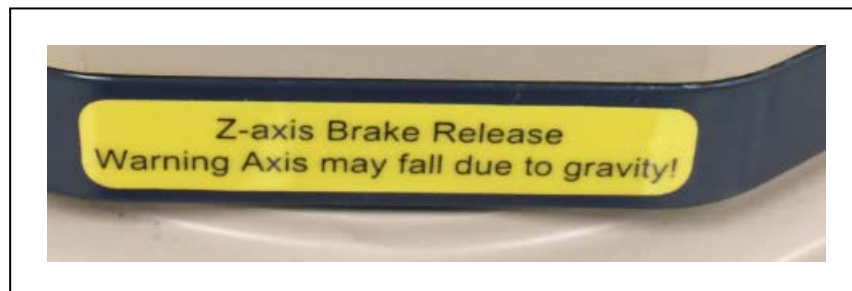


Figure 7-3. Brake Release/Gravity Label

Lifting Point Label

This label is partially around the eyebolt, marking that as a point to lift from. The part number is 08613-000.




Figure 7-4. Lifting Eyebolt Label

Checking for Oil Leaks

The eCobra robots use oil in the gearboxes for lubrication. Periodically inspect the robot for any signs of oil in areas immediately outside of the gearboxes. Check the locations identified in the following image.



Figure 7-5. eCobra Oil Leak Inspection Areas

Item	Description
A	Area around Joint 1 (both sides)
B	Area around Joint 2 (both sides)
C	Bottom of the robot base interior (accessed by opening the iCS-ECAT chassis and inspecting internally)  WARNING: ELECTROCUTION RISK Remove all power robot power before opening the iCS-ECAT chassis.

Lubricating Joint 3

This section provides important safety information and instructions for lubricating Joint 3.

Use the following grease type:

- LG-2 Grease (Lithium Soap/Synthetic Hydrocarbon)
- Part number: 90401-04029



CAUTION: PROPERTY DAMAGE RISK

Using improper lubrication on the robot may cause damage.

Lubrication Procedure

1. Remove all power from the robot.
2. Carefully remove the outer link cover by removing screws located on the sides and top of the cover.



WARNING: After removing the outer cover, you will see the label shown in OP3/4 Connector on page 20. Do not remove the J3-ENC or J4-ENC encoder cables from their sockets, or all calibration data will be lost and the robot must go through a factory recalibration process.

For the IP65 version, refer to Remove and Reinstall Outer Link Cover on page 159 for instructions on removing the link cover, and IP65 Bellows Replacement on page 164 for instructions on removing the bellows.

For the Cleanroom version, refer to Cleanroom Option Considerations on page 167 for instructions on removing the bellows. The outer link cover is standard.

3. Turn ON 24 VDC power to the robot.
4. Press the 'Z' BRAKE RELEASE button (above the 2-digit Robot Status Display) and move Joint 3 to the top of its travel.

Remove any existing grease with a clean, lint-free, soft cloth.

5. Use a syringe to apply a small bead of grease to the three Joint 3 ball screw grooves and the spiral groove. Refer to Figure 7-6.
6. Press the brake button and move Joint 3 to the bottom of its travel.
Remove any existing grease with a clean, lint-free, soft cloth.
7. Apply a small bead of grease to any grooves of the ball screw that are now exposed.
8. Move Joint 3 up and down several times to spread the grease evenly.
9. Remove 24 VDC power from the robot.
10. Reinstall the outer link cover.

IMPORTANT: For Cleanroom and IP65 versions, reinstall or replace the bellows.

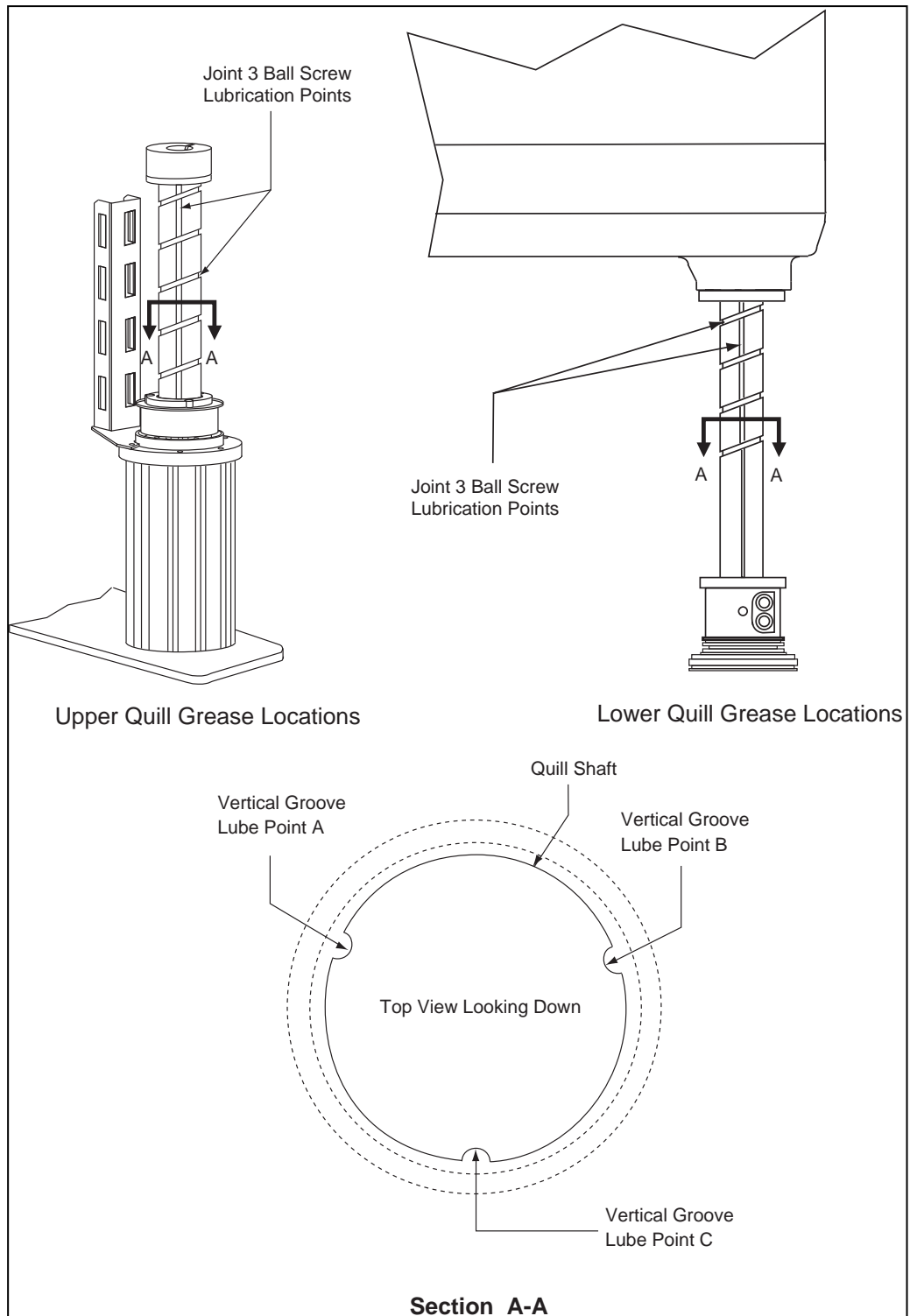


Figure 7-6. Lubricating Joint 3 Quill

Replacing the Encoder Battery Pack

Every 2 to 4 years, or if the robot's 2-digit Status Display shows the battery low BA (**BA**) error, you must replace the battery pack to keep from losing encoder data (which renders the robot

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

The replacement battery pack part number is 09977-000.

IMPORTANT: It is not recommended to use substitute batteries supplied by other manufacturers.

NOTE: The previous battery (part number 02704-000, has been superseded by this battery pack. The battery replacement interval and procedure have not changed.

Encoder Battery Replacement Time Periods

If the robot is kept in storage and not in production, or the robot is turned OFF (no 24 VDC supply) most of the time, then the battery should be replaced every 2 years.

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

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

Battery Replacement Procedure

Use the following procedure to replace the battery after you have procured a replacement battery.



CAUTION: Failure to follow these instructions exactly can result in lost encoder data, and unpredictable robot behavior.

1. Remove all power from the robot.
2. Disconnect the 24 VDC supply cable from the robot +24 VDC input connector.
3. Disconnect the 200/240 VAC supply cable from the robot AC input connector.
4. Using a 5 mm hex wrench, carefully unscrew the robot chassis captive screw.

NOTE: You do not need to completely remove the screw, as it is captured on the heat sink.

5. While holding the chassis heat sink, carefully and slowly lower the chassis down. This provides access to the battery pack, as shown in the following figure.

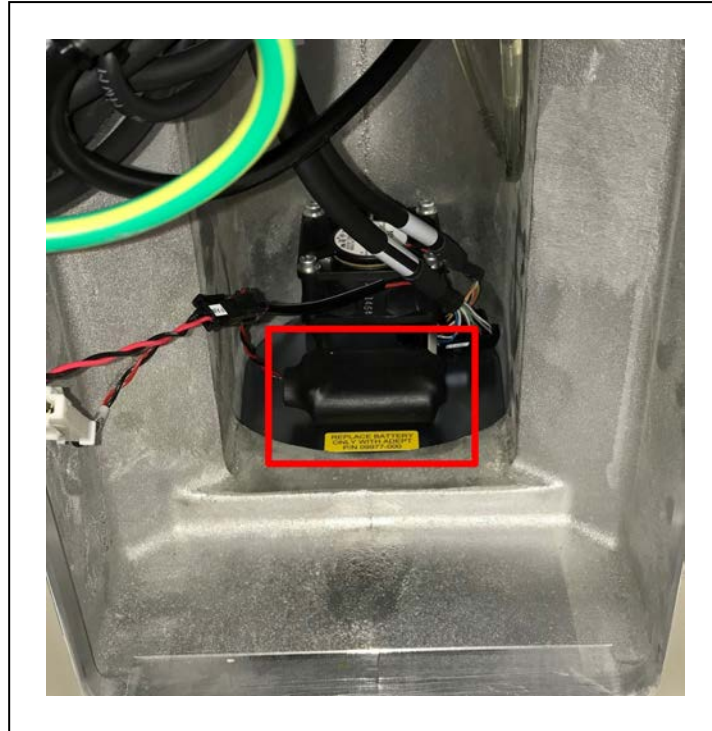


Figure 7-7. Location of Encoder Battery Pack in the robot base interior

6. The battery cable assembly has two sets of connectors. Locate the secondary (unused) battery cable in the wire bundle in the base area.

IMPORTANT: Do not disconnect the original battery pack until after you connect the new battery pack.

7. Place the new battery pack next to the original one, but do not disconnect the original one.
8. Connect the new battery pack to the connectors on the secondary battery cable. Make sure to verify the positive and negative connections are correct.
9. After the new battery pack is connected, disconnect and remove the original battery pack.

NOTE: Dispose of the battery pack in accordance with all local and national environmental regulations regarding electronic components.

10. Place the new battery pack in the original location on the base of the robot.
11. Close the robot by reversing the steps in the beginning of this procedure.
12. Reconnect the 200/240 VAC supply cable to the robot AC input connector.
13. Reconnect the 24 VDC supply cable to the robot +24 VDC input connector.

7.2 Non-Periodic Maintenance

This section provides information and instructions for performing maintenance that does not occur at regular intervals.

Field-Replaceable Parts

This section provides details about field-replaceable parts.



WARNING: ELECTROCUTION RISK

Only qualified service personnel may install or service the robot system. All maintenance work must be performed by skilled and instructed personnel. Refer to the *Robot Safety Guide (Cat. No. I590)* for more information.



DANGER: ELECTROCUTION RISK

During maintenance, you must use fail-safe lockout measures to prevent unauthorized third parties from turning on power. This is mandated by Clause 5.2.4 of ISO 10218-1.

During any maintenance-related activities, care must be taken involving AC power lockout. It is your responsibility to make sure that you observe the following:

- Lockout/ tagout power to the robot and related equipment
- Make sure that the robot cannot be energized during maintenance, as mandated by Clause 5.2.4 of ISO 10218-1.

The parts listed in the following table are the only field-replaceable items available.

IMPORTANT: Only replace items on the robot system with the parts listed in the following table.

Table 7-2. Field-replaceable Parts

Item	OMRON Part Number
Encoder battery	09977-000 (3.6 V, 6.8 Ah) This has replaced part number 02704-000.
iCS-ECAT	29800-000F
MicroSD card	21909-000L
Front Panel high power ON/OFF lamp	27400-29006

Remove the Tool Flange

If you remove the flange, you must reinstall it in exactly the same position to avoid losing the calibration for the robot.

The setscrew on the flange holds the rotational position of the flange on the quill shaft (refer to the following figure).



Figure 7-8. Tool Flange Setscrew

A steel ball behind the setscrew contacts the shaft in one of the vertical-spline grooves in the shaft.

Procedure for Removing the Tool Flange

Use the following procedure to remove the tool flange.

Be careful to not misplace the steel ball (3.5 mm) that is inside the flange, behind the setscrew.

1. Remove all power from the robot.
2. Remove any attached end-effectors or other tooling from the flange.
3. Use a 2.5 mm hex wrench to loosen the setscrew.

Note the vertical-spline groove that is in line with the setscrew. You must reinstall the flange in the same position.

4. Use a socket driver to loosen the two M4 socket-head screws.
5. Slide the flange down slowly until it is removed from the shaft.

Replacing the iCS-ECAT Amplifier Chassis

This section describes the process of removing and replacing the iCS-ECAT amplifier.

IMPORTANT: The Teach Restrict and E-stop hardware delay configurations are lost when replacing an iCS-ECAT unit. These safety settings must be configured

after replacing the iCS-ECAT amplifier. Refer to the *Sysmac Studio Version 1 Operation Manual (Cat. No. W504)* for more information.



CAUTION: PROPERTY DAMAGE RISK

Follow appropriate ESD procedures when removing or replacing the chassis.

Removing the iCS-ECAT Amplifier Chassis

Use the following procedure to remove the iCS-ECAT amplifier chassis.

1. Remove all power from the robot.

NOTE: Take note of any switch settings on the interface panel. These will need to be restored if replacing the iCS-ECAT Amplifier Chassis with a new unit.

2. Disconnect all cables and wires from the robot interface panel.
3. Using a 5 mm hex wrench, carefully unscrew the chassis securing screw, which is shown in the following figure. Note that the screw does not need to be completely removed in order to remove the chassis, as this screw is captured on the chassis heat sink.



Figure 7-9. Securing Screw on iCS-ECAT Chassis

4. While holding the chassis heat sink, carefully and slowly lower the chassis down (see the following figure), so that enough access is available to remove the internal cables. The chassis can be laid flat or placed to the right side of the robot for better access.

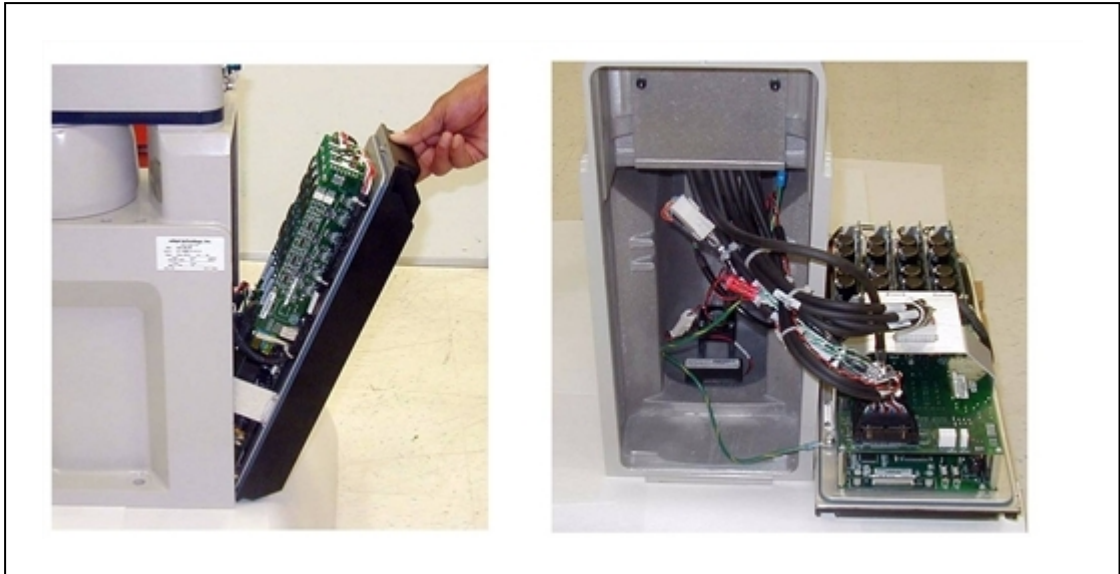


Figure 7-10. Opening and Removing Chassis

5. Remove the MicroSD card. Refer to Removing a MicroSD Card from an iCS-ECAT on page 125 for more information.
6. Disconnect the amplifier cable from the white amplifier connector located on the chassis bracket (callout (A) in the following figure).

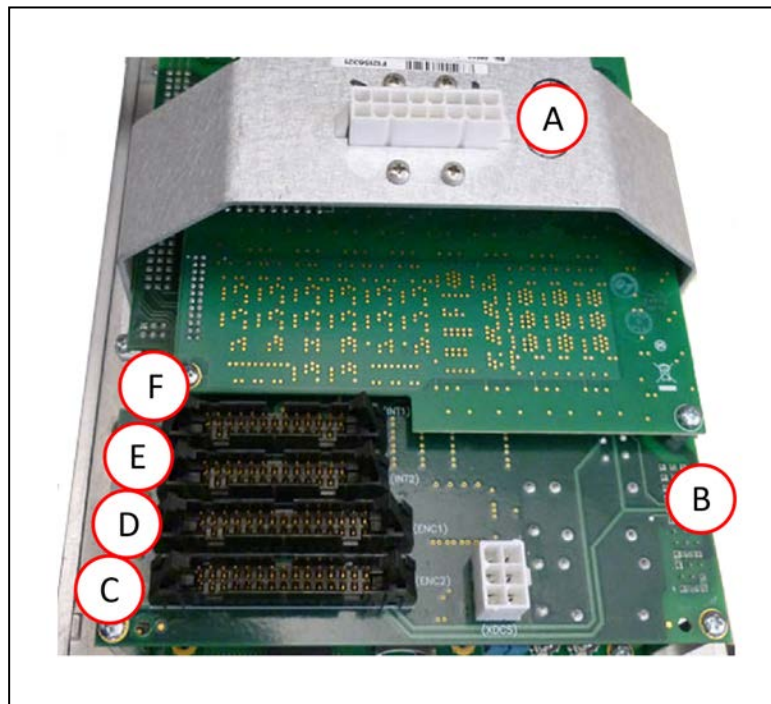


Figure 7-11. Connectors on Chassis and ePMAI Board

Item	Description	Item	Description
A	Amplifier Connection	D	ENC 1
B	ePMAI Board	E	INT2
C	ENC 2	F	INT1

- Carefully disconnect the INT1, INT2, ENC1, and ENC2 cables from their connectors on the ePMAI board, by disengaging the securing latches.
- Using a 5 mm hex wrench, disconnect and remove the ground wire from the chassis. Keep the screw for reassembly later.



Figure 7-12. Removing Ground Screw Wire on iCS-ECAT Amplifier Chassis with 5 mm Hex Wrench

- Tag the chassis with the any fault diagnosis, faults or errors, and robot serial number information.

Installing a New iCS-ECAT Chassis

Use the following procedure to install a new iCS-ECAT chassis.



CAUTION: PROPERTY DAMAGE RISK
Follow appropriate ESD procedures during the replacement phase.

- Carefully remove the new chassis from its packaging, check it for any signs of damage, and remove any foreign packing materials or debris from inside the chassis.
- Carefully place the chassis next to the robot.

3. Using a 5 mm hex wrench, connect the ground wire to the chassis.
4. Reconnect the cables you removed from their connectors on the ePMAI board during the removal procedure (following their respective labels), and engage the securing latches.
5. Connect the amplifier cable to the white amplifier connector located on the chassis bracket.
6. Carefully insert the chassis into the robot base in the groove at the bottom of the base. Tilt the chassis up and into place against the robot, making sure that none of the cables get trapped or pinched and that the chassis O-ring is not damaged during installation.
7. After the chassis is in place, use a 5 mm hex wrench to tighten the chassis securing screw.
8. Connect all required cables and wires to the robot interface panel.
9. Restore all switch settings to their appropriate positions.
10. Switch ON the 200/240 VAC input supply to the chassis.
11. Switch ON the 24 VDC input supply to the chassis.
12. After the robot has completed booting, check the robot for proper operation.

Remove and Replace a MicroSD Card

The robot requires a MicroSD card to operate. The following procedures provide important precautions and instructions for removing and replacing the MicroSD card.



CAUTION: PROPERTY DAMAGE RISK

Follow appropriate ESD procedures when removing or replacing the MicroSD card.

NOTE: Without a functioning MicroSD card, the iCS-ECAT will not function and will not indicate that it is receiving power.

Additional Information: These instructions assume the iCS-ECAT is removed and ready to receive the new MicroSD card.

Removing a MicroSD Card from an iCS-ECAT

Use the following procedure to remove a MicroSD card from an iCS-ECAT amplifier unit.

1. Make sure that the iCS-ECAT is powered OFF.
2. Remove the iCS-ECAT from the robot.
Refer to Removing the iCS-ECAT Amplifier Chassis on page 122.
3. Lay the chassis on its back next to the robot so you can access the connector end of the iCS-ECAT.

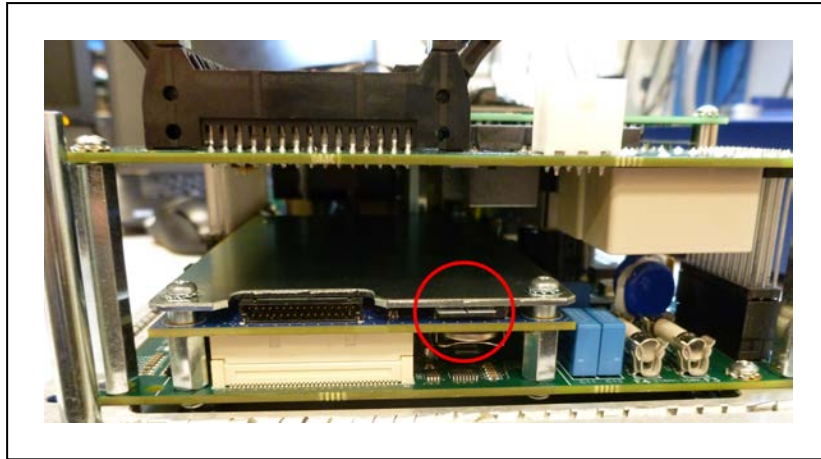


Figure 7-13. MicroSD Card Location (circled)

4. Remove the installed MicroSD card.

Remove the card by pressing it all the way in, and then releasing. The card will pop out slightly, and can be pulled out.

Replacing a MicroSD Card in an iCS-ECAT

Use the following procedure to replace a MicroSD card.

1. Insert the MicroSD Card until fully seated in its slot, then release.
Check to see that it remains seated.
2. Reinstall the iCS-ECAT back into the robot base, and tighten the captive screw.
Refer to Installing a New iCS-ECAT Chassis on page 124 for more information.

Change Front Panel High-Power ON Lamp

The system's circuitry detects the potentially dangerous condition of a faulty high power indicator lamp on the Front Panel. If this lamp is burned out, you cannot enable high power until the lamp has been replaced.

Use the following procedure to replace the high power indicator lamp (part number 27400-29006).



WARNING: ELECTROCUTION RISK.
Lockout and tagout power before servicing.



WARNING: ELECTROCUTION/EQUIPMENT DAMAGE RISK.
Only trained, authorized personnel should perform the procedures and replace parts mentioned in this section. The access covers on the Front Panel are not interlocked – turn off and disconnect power before removing the cover.

1. Remove all power from the robot.
2. Disconnect the cable between the Front Panel and the iCS-ECAT.

3. Remove the Front Panel from its mounting location.
4. Loosen the two screws on the back of the Front Panel.

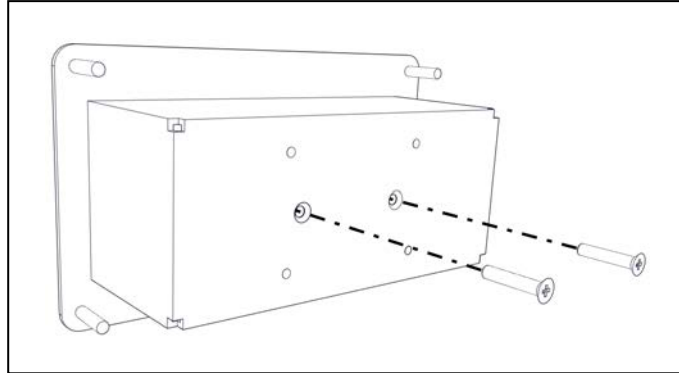


Figure 7-14. Front Panel Rear Screws

5. Carefully pull the front cover away from the body of the Front Panel.



Figure 7-15. Front Panel Backside (note connected LED wires, left)

The three plug-type connectors will offer some resistance. Disconnect them 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 out as straight as possible. You do not have to disconnect the wires from the PC board, although you can if needed.

6. 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.

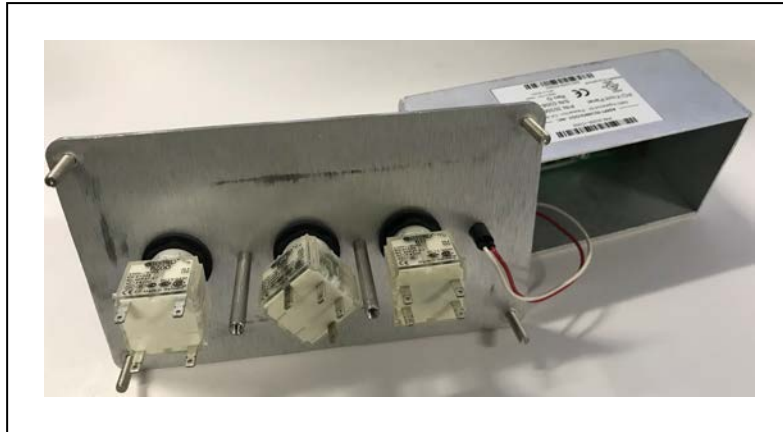


Figure 7-16. Removing Robot Power Lamp (twisted center lamp)

The lamp body is now free, and you can remove the old lamp.

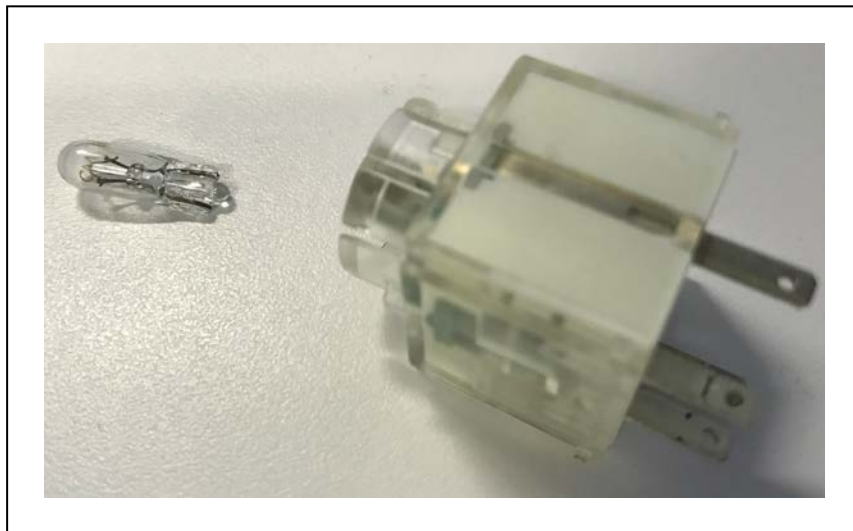


Figure 7-17. High Power Lamp Removed

7. Re-install the lamp body by pushing it straight into the lamp housing receptacle. Ensure the proper orientation of lamp body contacts.

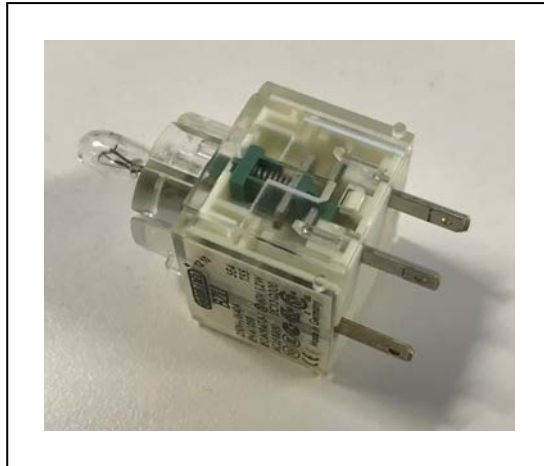


Figure 7-18. Bulb Properly Seated

8. Make sure to reconnect the wires from the LED if you disconnected them earlier.
9. Push the front cover into the body, taking care to align all of the plug-type connectors. Verify that the LED light wires do not get crimped as you reinstall the cover.



CAUTION: PROPERTY DAMAGE RISK.

Make sure the connector lugs are properly aligned with the receptacle before attempting to seat the connector.

1. Re-install the two screws on the back of the body.
2. Re-install the Front Panel in its mounting.
3. Reconnect the cable between the Front Panel and the iCS-ECAT.

Chapter 8: Technical Specifications

This chapter provides technical specifications for the robot's hardware, performance, electrical connections, installation environment, and other aspects of the system.

8.1 Robot Physical Dimension Drawings

This section provides physical dimensions for the eCobra 600 and 800 robots and their operating envelope.

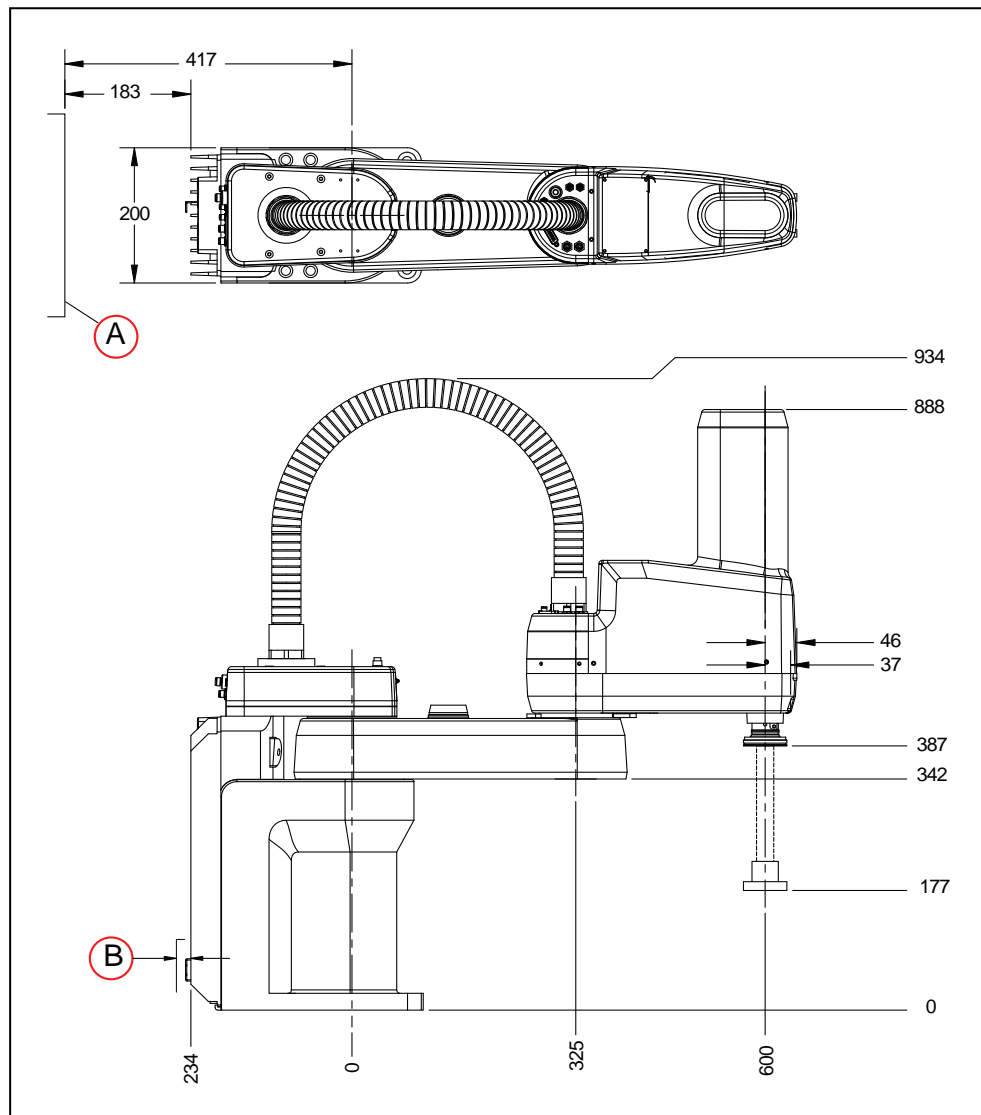


Figure 8-1. eCobra 600 robot Top and Side Dimensions (units in mm) where (A) is the (required clearance to open iCS-ECAT chassis, and (B) is the required cable clearance of 31 mm

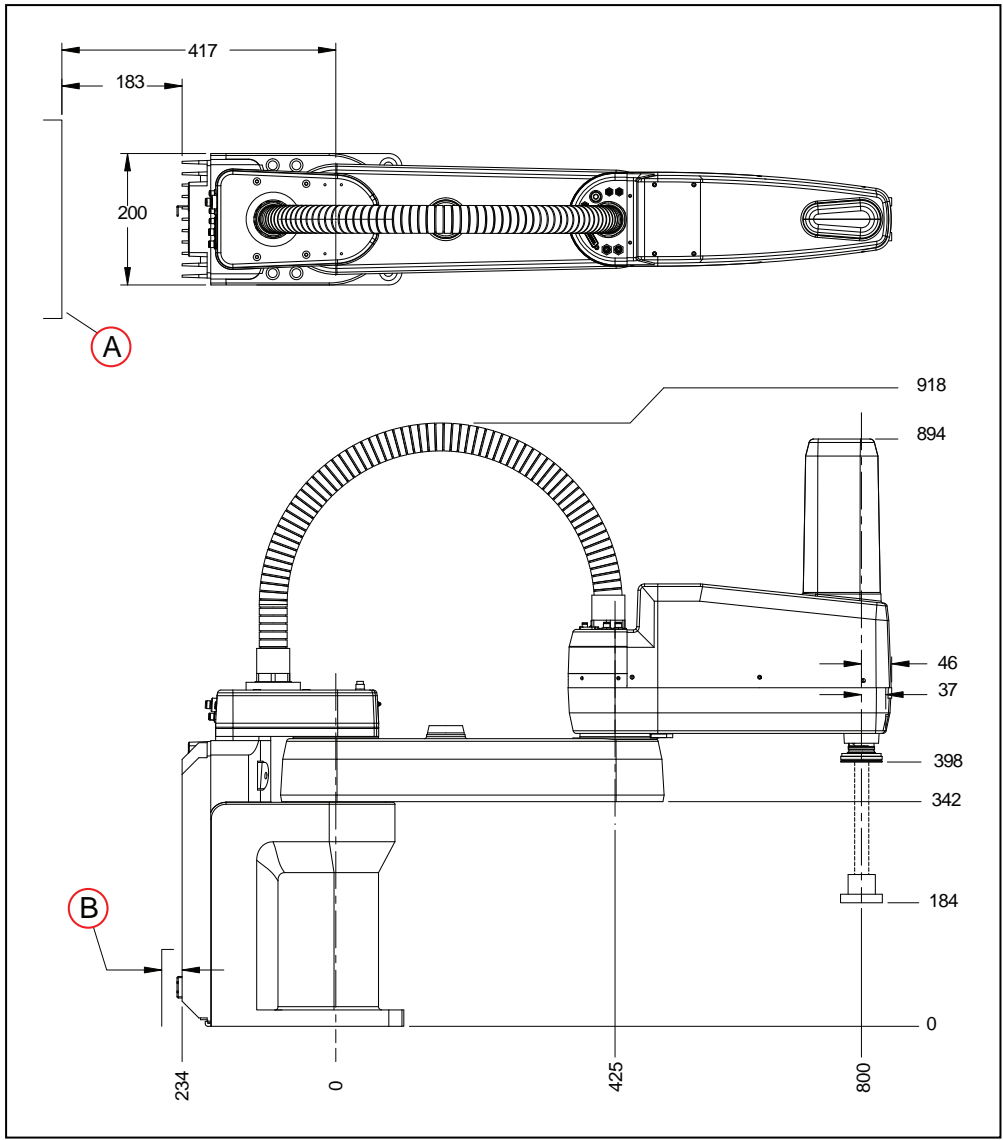


Figure 8-2. eCobra 800 robot Top and Side Dimensions (units in mm) where (A) is the (required clearance to open iCS-ECAT chassis, and (B) is the required cable clearance of 31 mm

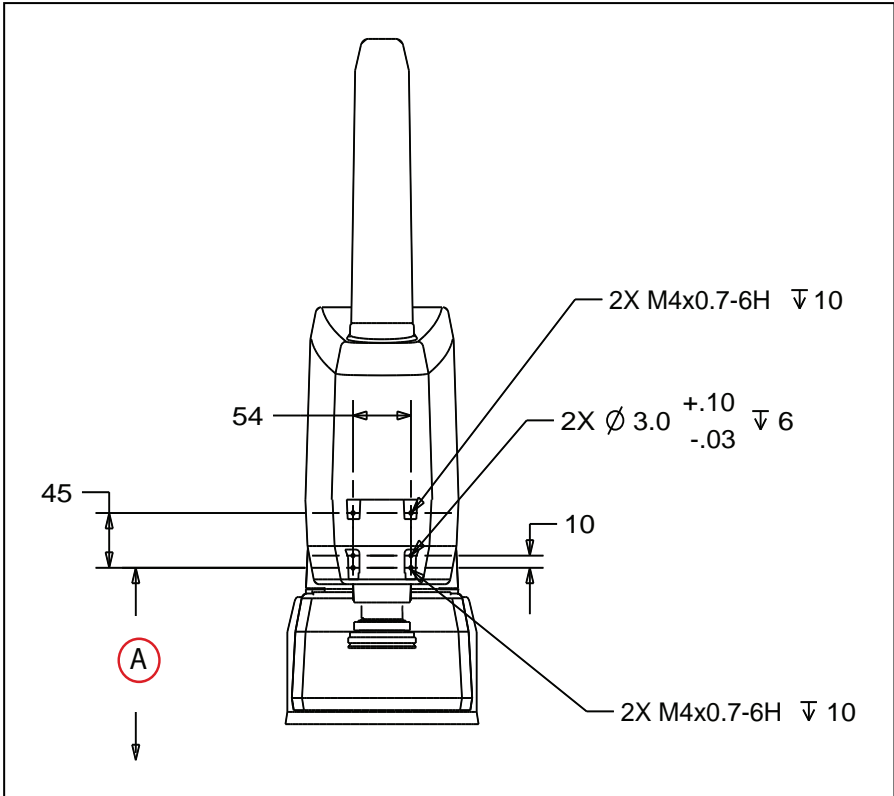


Figure 8-3. (A) Dimensions of the Camera Bracket Mounting Pattern (units in mm) (457 mm to base) for eCobra 600 and 800

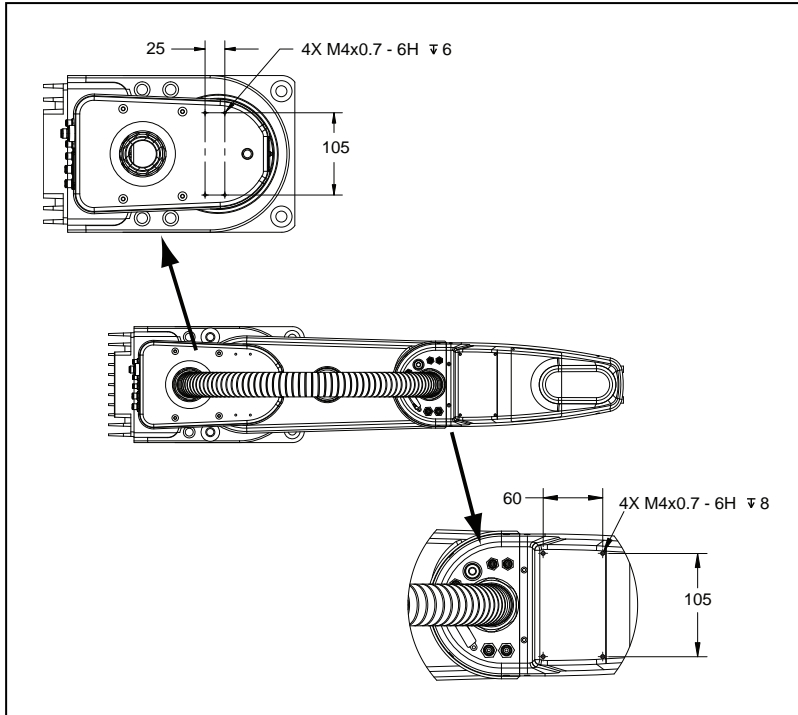


Figure 8-4. External Tooling on Top of Robot Arm, Inner link (top), outer link (bottom), eCobra (units in mm)

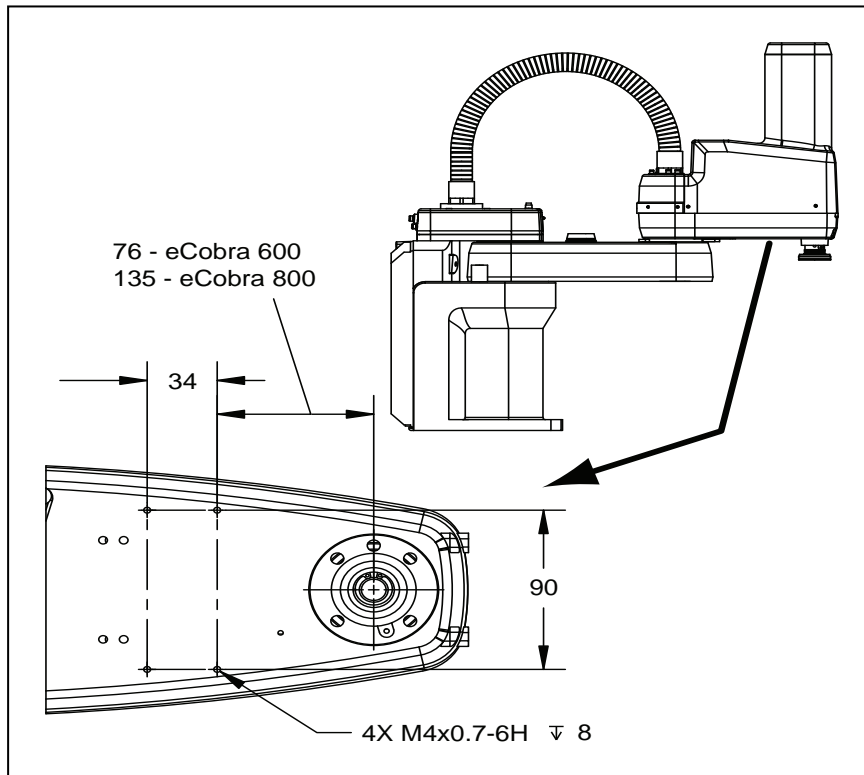


Figure 8-5. External Tooling on Underside of Outer Link (bottom) (units in mm)

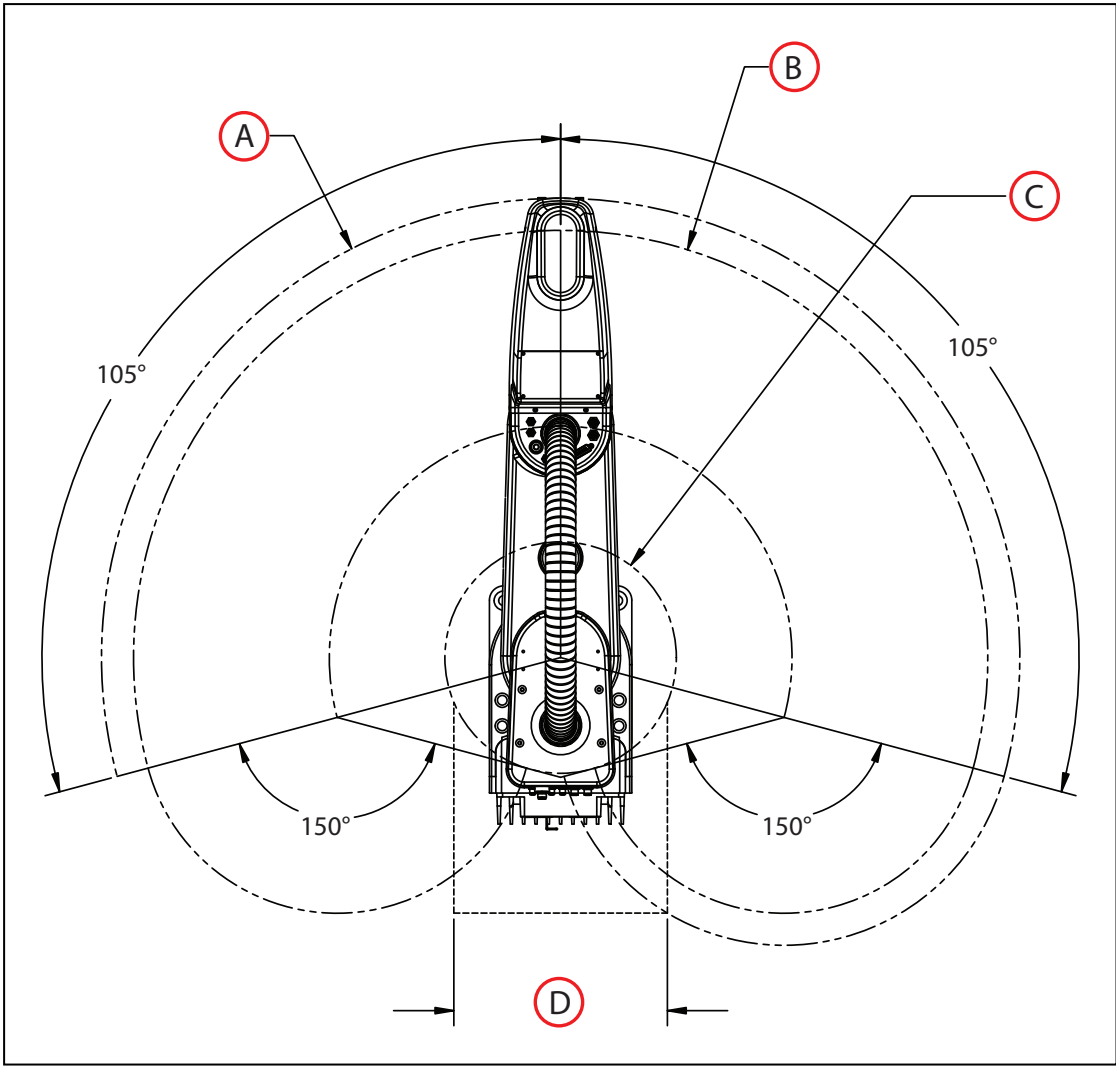


Figure 8-6. eCobra 600 Robot Working Envelope

Key	Meaning	Key	Meaning
A	Maximum intrusion contact radius 647mm	C	Minimum radial reach 162.6mm
B	Maximum radial reach functional area 600mm	D	Cartesian limits 300mm

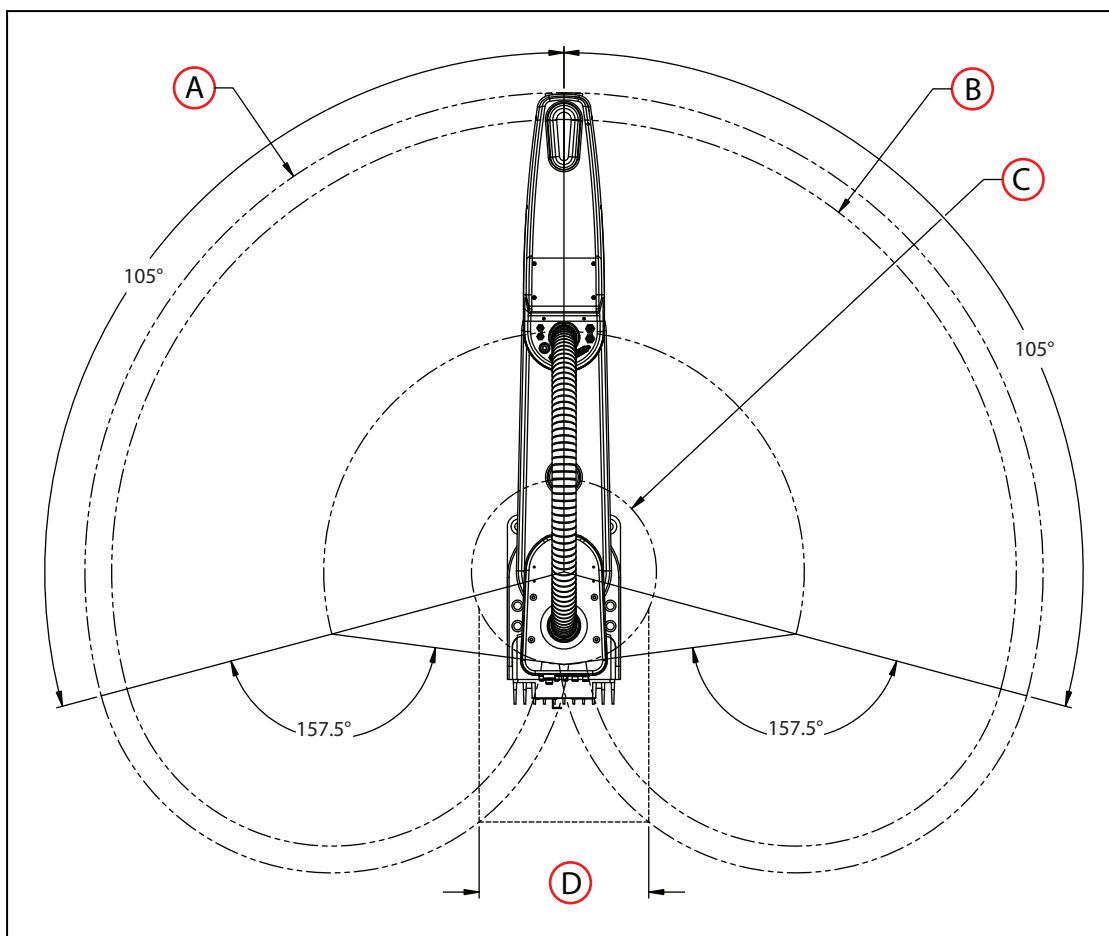


Figure 8-7. eCobra 800 Robot Working Envelope

Key	Meaning	Key	Meaning
A	Maximum intrusion contact radius 847.3mm	C	Minimum radial reach 163.6mm
B	Maximum radial reach functional area 800mm	D	Cartesian limits 300mm

8.2 General Robot Specifications

The following table provides general robot specifications.

Table 8-1. General Robot Specifications

Item	eCobra 600 Robot Specification	eCobra 800 Robot Specification
Reach	600 mm	800 mm
Payload—rated	2.0 kg	2.0 kg

Item	eCobra 600 Robot Specification	eCobra 800 Robot Specification
Payload—maximum	5.5 kg	5.5 kg
Encoder types	Absolute	
Robot Brakes	Joints 1, 2, and 4: Dynamic Joint 3: Electric	
Weight (without options)	41 kg	43 kg

8.3 Performance Specifications

This section provides the robot's performance specifications.

General Performance Information

The following table provides general performance information for the robot.

Table 8-2. General Robot Performance Information

Performance Item	eCobra 600 Robot	eCobra 800 Robots
Moment of Inertia	Joint 4 - 450 kg-cm ² maximum	Joint 4 - 450 kg-cm ² maximum
Downward Push Force—Burst, (no load)	343 N maximum	298 N maximum
Lateral / Side Push Force—Burst	178 N maximum	133 N maximum
Adept Cycle ¹ Time (sustained)	0.55 seconds (standard)	0.62 seconds (standard)
No Joint 4 rotation	0.45 seconds (pro)	0.54 seconds (pro)
2 kg payload		
Repeatability	X, Y: ±0.017 mm Z: ±0.003 mm Theta: ±0.019°	
Joint ranges	Joint 1: ±105°	
	Joint 2: ±150°	Joint 2: ±157.5°
	Joint 3: 210 mm	
	Joint 4: ±360°	
Joint speeds	Joint 1: 386°/sec	
	Joint 2: 720°/sec	
	Joint 3: 1,100 mm/sec	
	Joint 4: 1200°/sec	
¹ The Adept Cycle is defined as a continuous path with straight-line motion cycle in which the robot tool moves up 25 mm, over 305 mm, down 25 mm, and then back along the same		

Performance Item	eCobra 600 Robot	eCobra 800 Robots
path (not achievable over all paths in the robot working envelope).		

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.



WARNING: The stopping time and distance, or angle, of a robot joint from initiation of a stop signal is not negligible and must be taken into account when designing and applying 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 (5.5 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.

eCobra 600

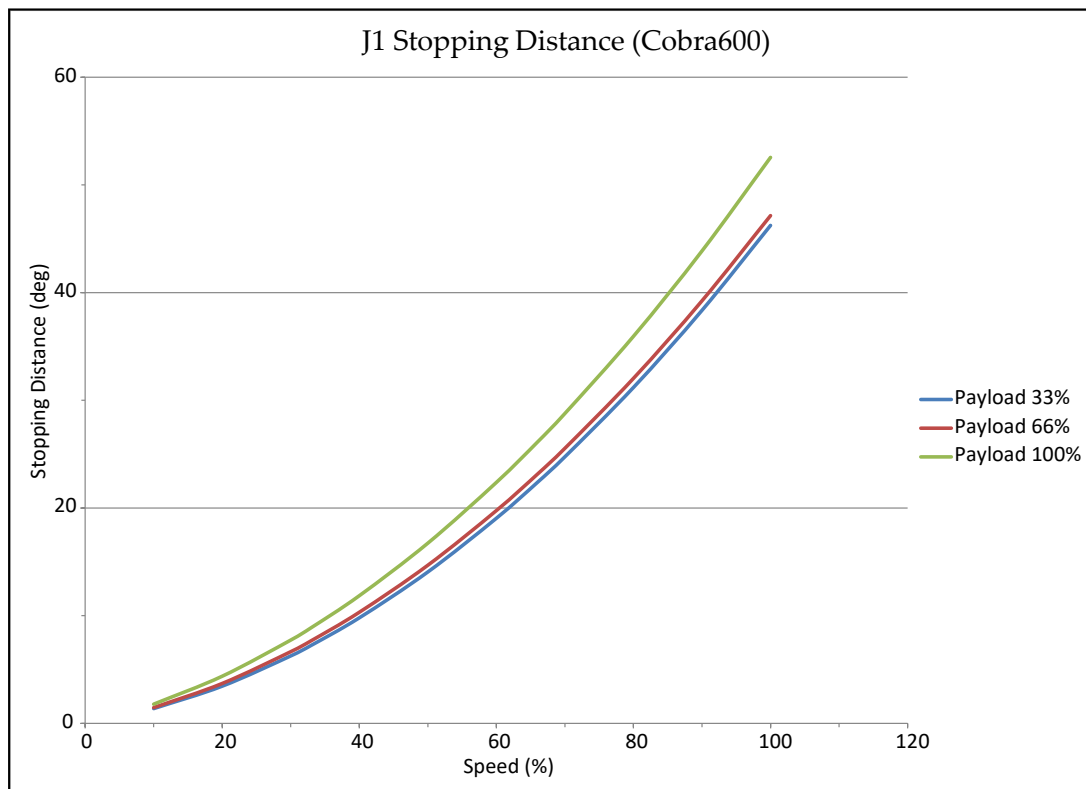


Figure 8-8. Stopping Distance in Degrees versus Speed % for eCobra 600, Joint 1

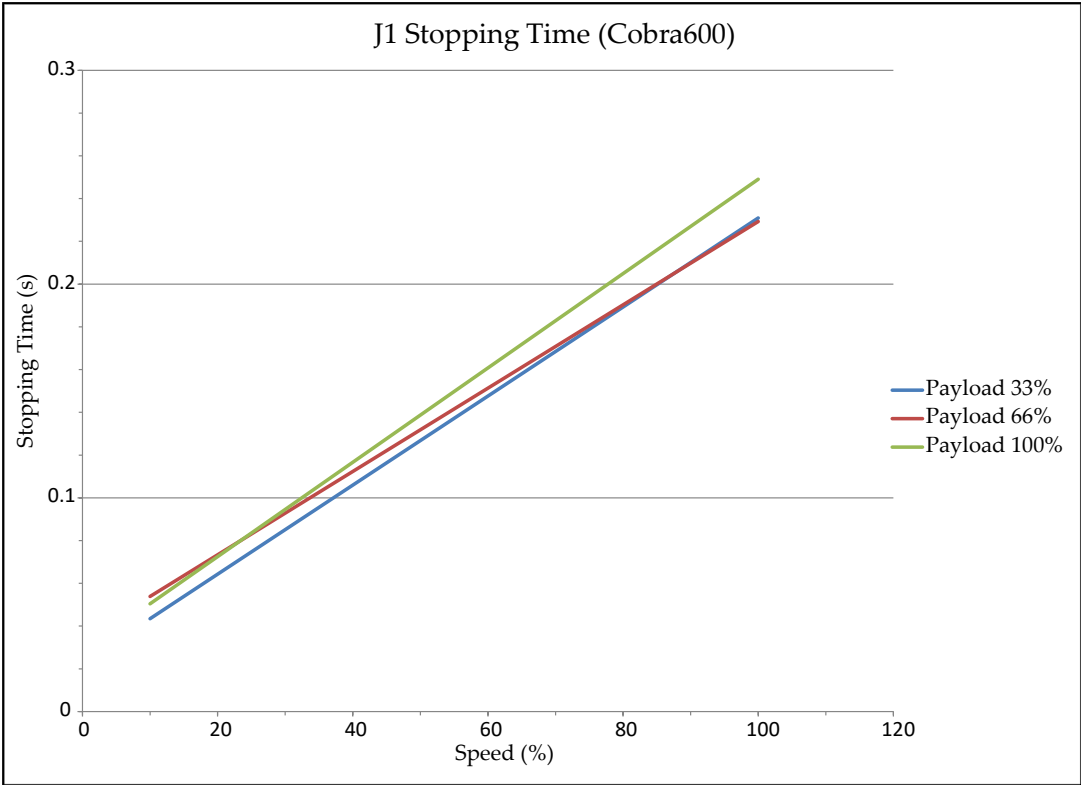


Figure 8-9. Stopping Time in Seconds versus Speed% for eCobra 600, Joint 1

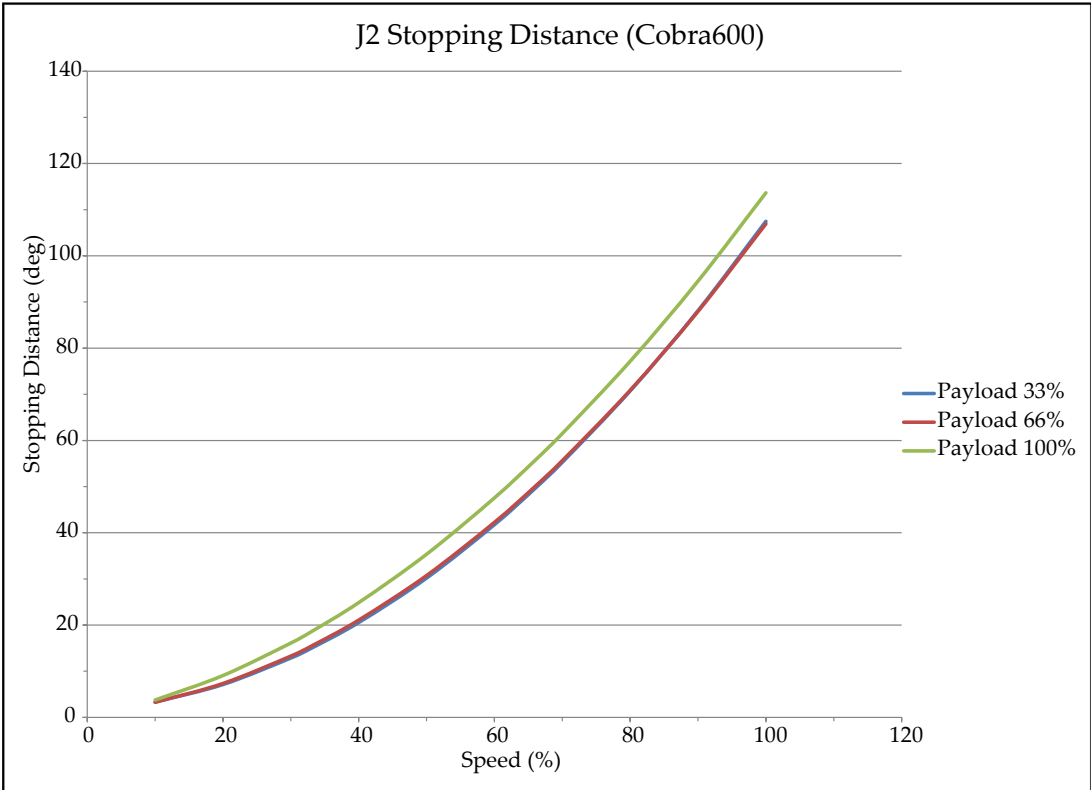


Figure 8-10. Stopping Distance in Degrees versus Speed % for eCobra 600, Joint 2

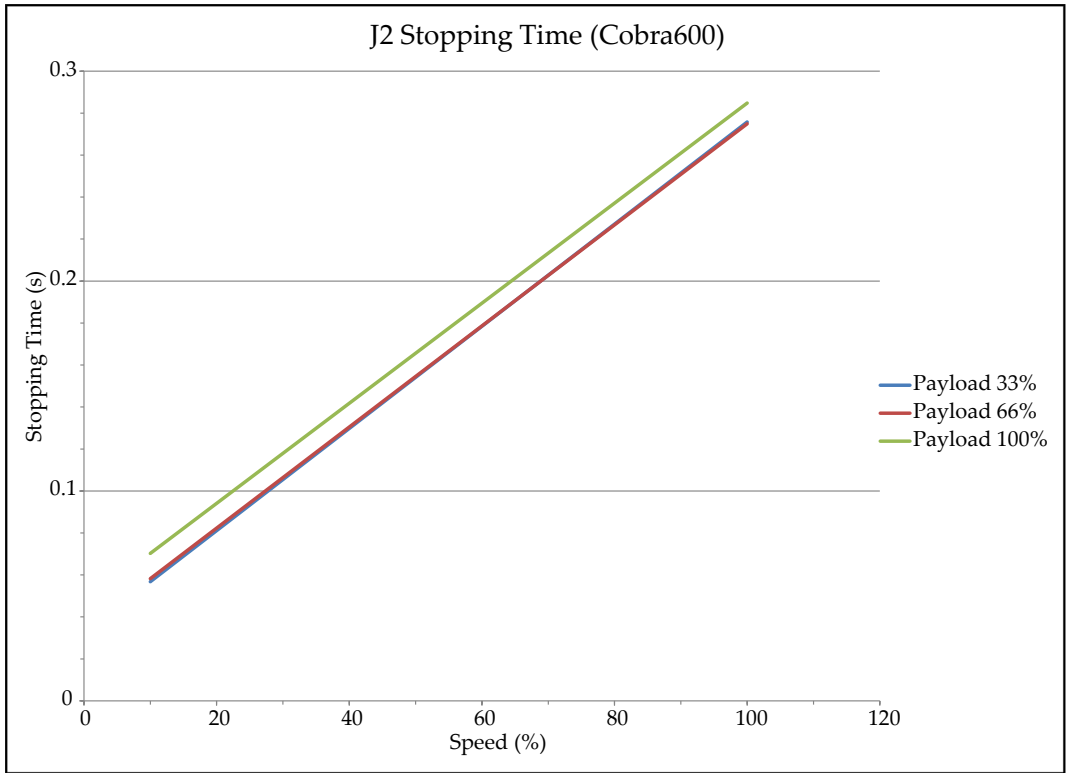


Figure 8-11. Stopping Time in seconds versus Speed % for eCobra 600, Joint 2

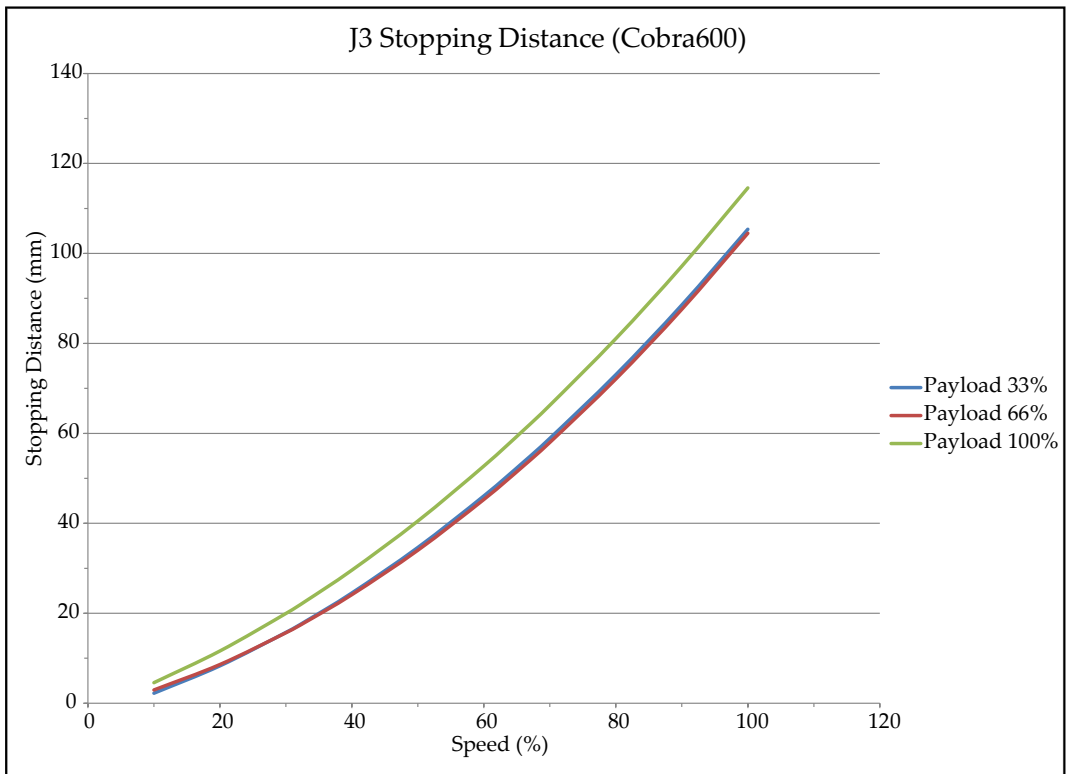


Figure 8-12. Stopping Distance (mm) versus Speed (%) for eCobra 600, Joint 3

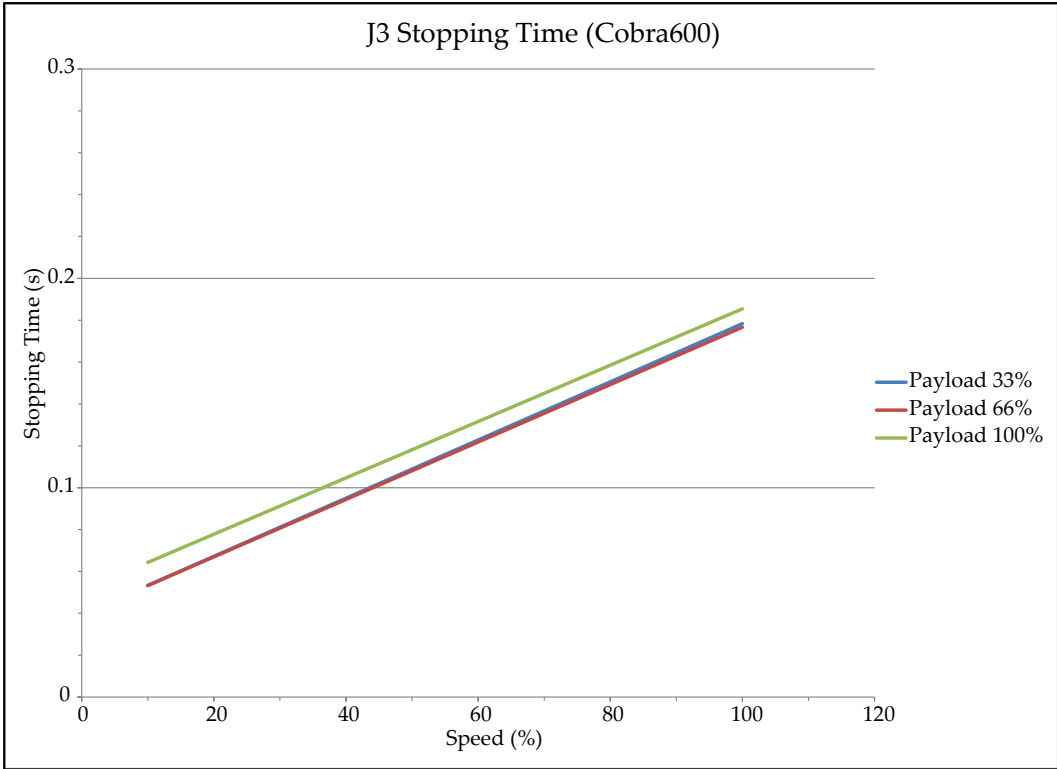


Figure 8-13. Stopping Time in Seconds versus Speed (%) for eCobra 600, Joint 3

eCobra 800

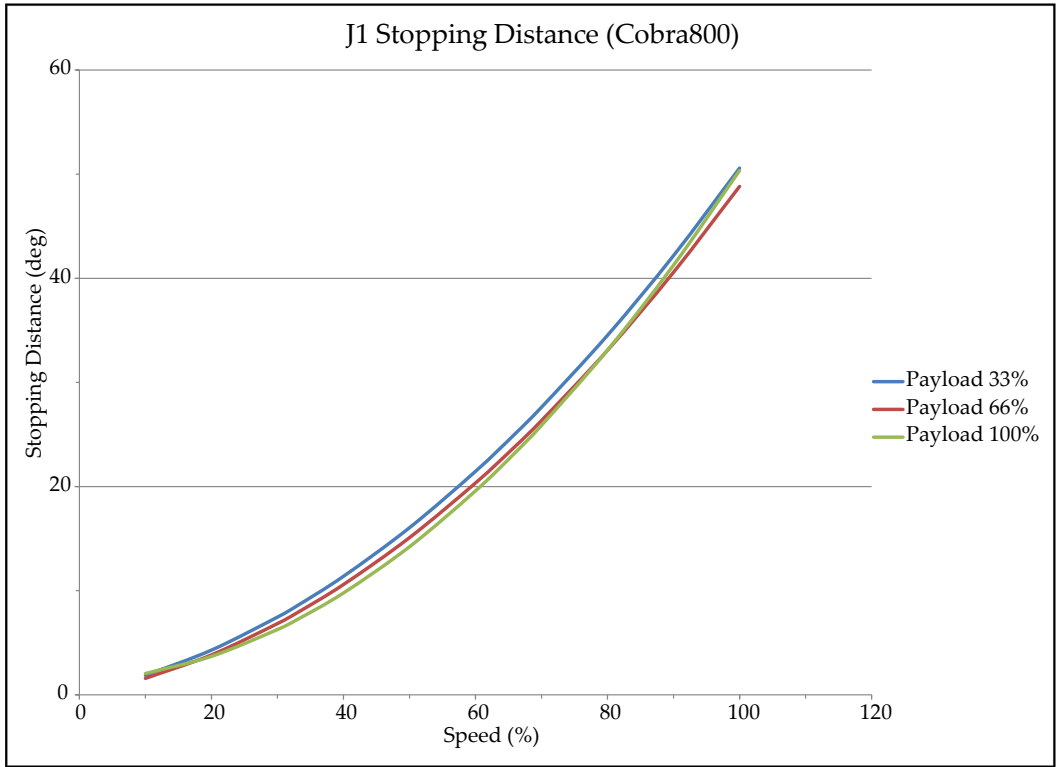


Figure 8-14. Stopping Distance in Degrees versus Speed (%) for eCobra 800, Joint 1

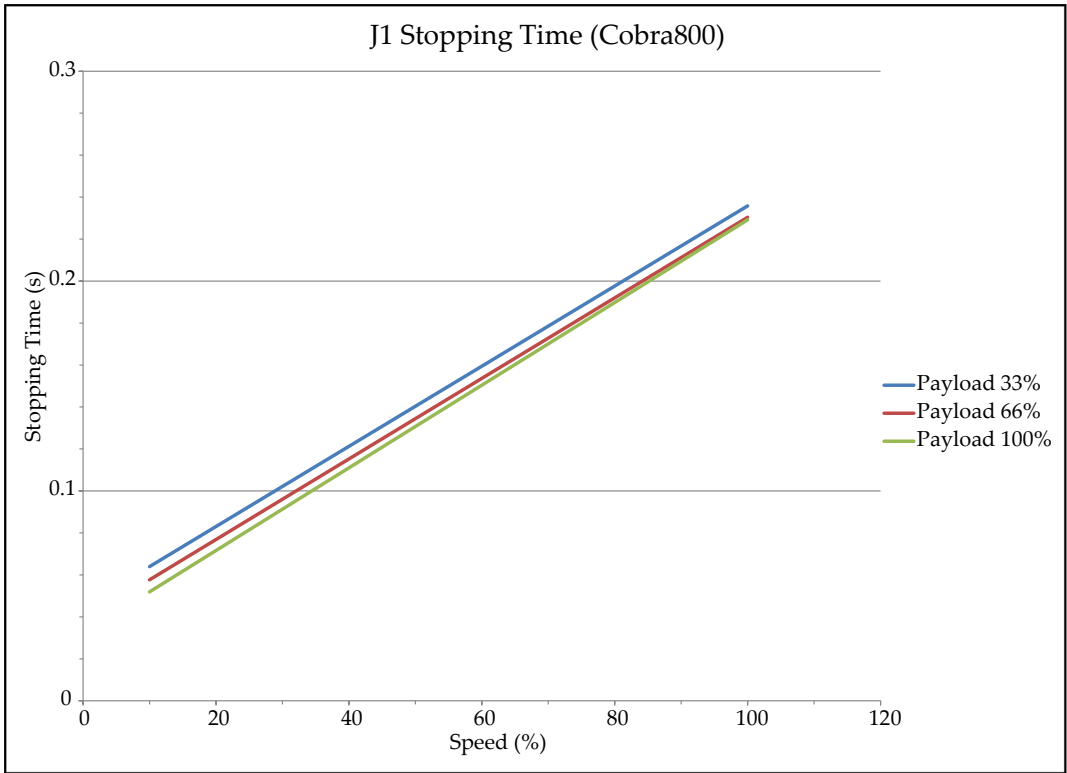


Figure 8-15. Stopping Time in Seconds versus Speed (%) for eCobra 800, Joint 1

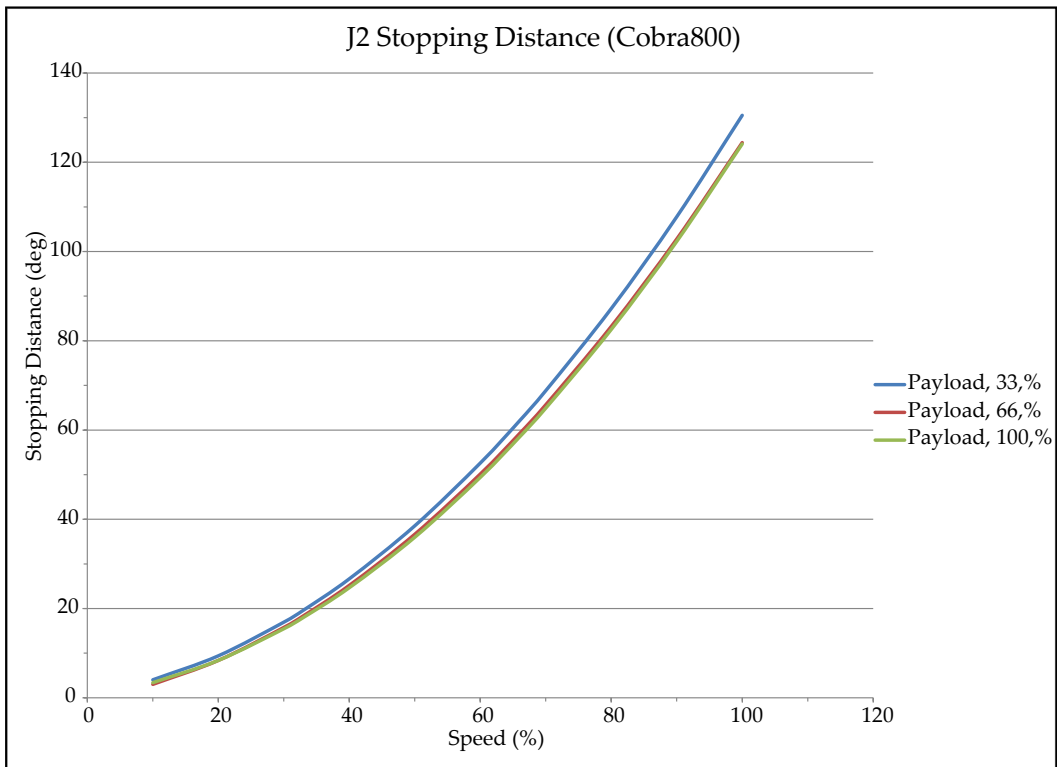


Figure 8-16. Stopping Distance in Degrees versus Speed (%) for eCobra 800, Joint 2

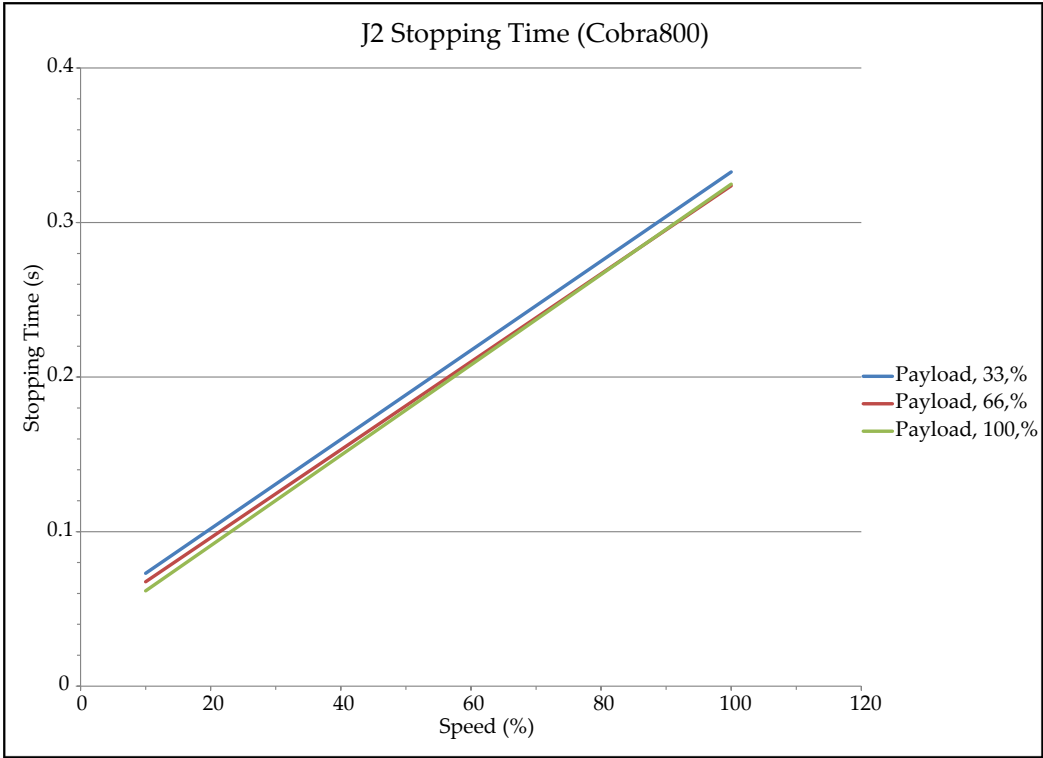


Figure 8-17. Stopping Time in Seconds versus Speed (%) for eCobra 800, Joint 2

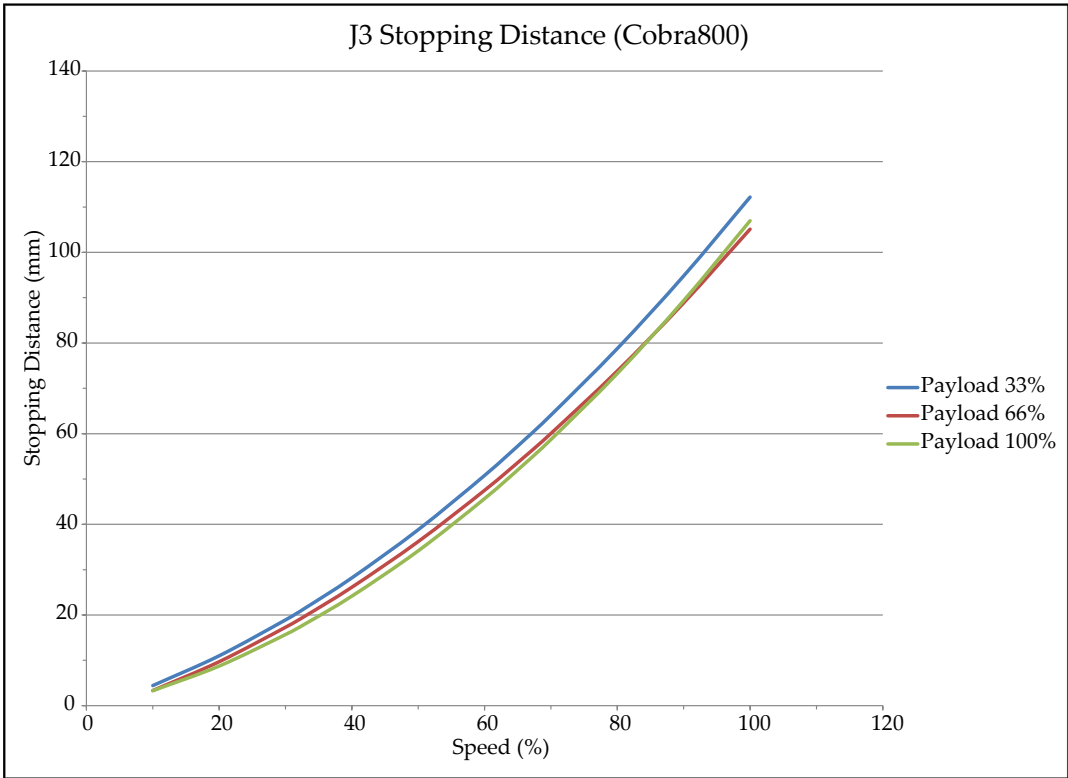


Figure 8-18. Stopping Distance in Millimeters versus Speed (%) for eCobra 800, Joint 3

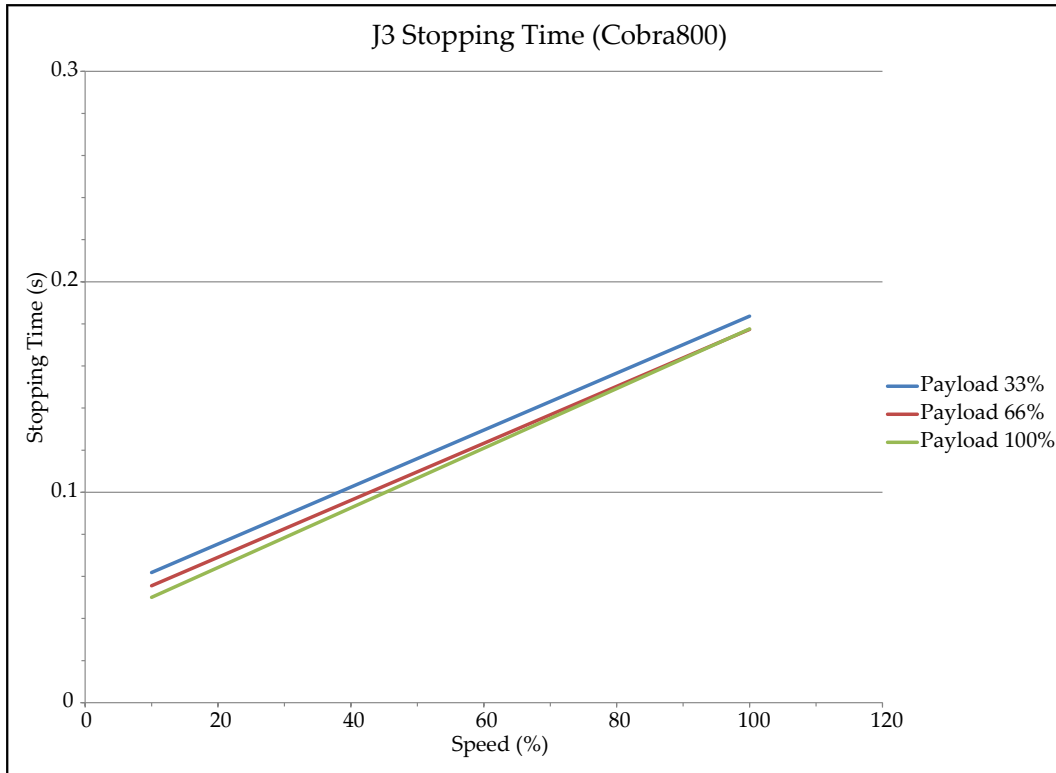


Figure 8-19. Stopping Time in Seconds versus Speed (%) for eCobra 800, Joint 3

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

If you want to measure stopping distances and time in a real cell with a real robot and with real tools and loads, contact your local OMRON support.

Hardstop and Softstop Limits

Use the table below to understand the robot hardstop and softstop limits.

NOTE: The following Joint 1 and Joint 2 hardstop values are only valid without the optional hardstops installed..

Table 8-3. Softstop and Hardstop Specifications

Joint	eCobra 600		eCobra 800	
	Softstop	Hardstop – Approximate	Softstop	Hardstop – Approximate
Joint 1	±105	±108	±105	±108
Joint 2	±150	±151	±157.5	±160
Joint 3	0 to 210 mm	-5 to 215 mm	0 to 210 mm	-5 to 215 mm
Joint 4	±360	not applicable	±360	not applicable

8.4 Electrical Specifications

The following section provides electrical specifications for the robot system.

Internal Connection Specifications

The following table provides internal connector electrical specifications.

Table 8-4. Internal Connections Electrical Specifications

Item	Specification	Details
Internal solenoid connections	Maximum current, per circuit	700 mA
OP3/4 connections	Total maximum current, all circuits	1.0 A @ 50°C
EOAPWR connections		1.5 A @ 25°C
NOTE: Total current is the sum of the output current used by output signals 3001-3004 (Solenoid and OP3/4) and any user current drawn from EOAPWR.	ON state maximum resistance ($I_{out} = 0.5A$)	0.32 W @ 85° C
	Output maximum leakage current	25 μ A
	ON response time	125 μ sec (max.), 80 μ sec typical (typical)
	OFF response time	60 μ sec (max.), 28 μ sec typical (typical)
	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	$0.7A \leq I_{LIM} \leq 2.5 A$
	Peak short circuit current	$I_{ovpk} \leq 4 A$

External Connection Specifications

The following table provides external electrical connection specifications.

Table 8-5. External Electrical Connection Specifications

Item	Specification	Details
24 VDC supply ^{1,3}	Voltage range	24 VDC \pm 10% (21.6 VDC < V_{in} < 26.4 VDC)
	Current / Power	6 A / 150 W
	Circuit Protection	Output must be less than 300 W peak or provide 8 Amp in-line circuit protection
	Cabling	1.31 – 2.08 mm ² (16-14 AWG)
	Shielding	Braided shield connected to frame ground terminal at both ends of cable.

Item	Specification	Details
AC Power	Nominal supply voltage	200 to 240 VAC (auto ranging)
	Minimum operating voltage ²	180 VAC
	Maximum operating voltage	264 VAC
	Operating frequency	50 / 60 Hz, 1-phase
	Circuit protection	10 A (user-supplied) Refer to AC Power Diagrams on page 81 for more information.
General purpose electrical pass-through connections	Wire size	0.1 mm ²
	Maximum current	1 amp
XIO input circuits	Operational voltage range	0 to 30 VDC
	OFF state voltage range	0 to 3 VDC
	ON state voltage range	10 to 30 VDC
	Typical threshold voltage	$V_{in} = 8$ VDC
	Operational current range	0 to 7.5 mA
	OFF state current range	0 to 0.5 mA
	ON state current range	2.5 to 7.5 mA
	Typical threshold current	2.0 mA
	Impedance (V_{in}/I_{in})	3.9 K Ω minimum
	Current at $V_{in} = +24$ VDC	$I_{in} \leq 6$ mA
	Turn on response time (hardware)	5 μ sec maximum
	Software scan rate and response time	16 ms scan cycle 32 ms max response time
	Turn off response time (hardware)	5 μ sec maximum
XIO output circuits	Maximum operational current range, per channel	700 mA
	Maximum total current limit, all channels	1.0 A @ 50°C 1.5 A @ 25°C
	Maximum ON state resistance ($I_{out} = 0.5$ A)	0.32 Ω @ 85°C
	Maximum output leakage current	25 μ A
	ON response time	125 μ sec max., 80 μ sec typical (hardware)

Item	Specification	Details
		only)
	OFF response time	60 μ sec max., 28 μ sec typical (hardware only)
	Output voltage at inductive load turnoff ($I_{out} = 0.5A$, Load = 1 mH)	$(+V - 65) \leq V_{demag} \leq (+V - 45)$
	DC short circuit current limit	$0.7A \leq I_{LIM} \leq 2.5 A$
	Peak short circuit current	$I_{ovpk} \leq 4 A$
<p>NOTE1: User-supplied 24 VDC power supply must incorporate overload protection to limit peak power to less than 300 W or 8 A in-line circuit protection must be added to the 24 VDC power source. For multiple robots on a common 24 VDC supply, protect each unit individually.</p> <p>Make sure you select a 24 VDC power supply that meets the specifications provided. Using an under-rated supply can cause system problems and prevent your equipment from operating correctly.</p> <p>NOTE2: Specifications established at nominal line voltage. Low line voltage can affect robot performance.</p> <p>NOTE3: If multiple robots are sharing a 24 VDC power supply, increase the supply capacity by 3 A for each additional robot.</p>		

Facility Overvoltages Protection

You must protect the robot from excessive overvoltages and voltage spikes. If your country requires a CE-certified installation or compliance with IEC 61131-2, IEC 61131-2 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 overvoltages Category II, i.e., not higher than the impulse voltage corresponding to the rated voltage for the basic insulation. Your equipment or transient suppressor must be capable of absorbing the energy in the transient.

In the industrial environment, nonperiodic overvoltage peaks may appear on mains power supply lines. These can come from power interruptions to high-energy equipment (such as a blown fuse on one branch in a 3-phase system), which will cause high current pulses at relatively low voltage levels. You must take the necessary steps to prevent damage to the robot system (such as by interposing a transformer). See IEC 61131-4 for additional information.

8.5 Environment and Facility Specifications

The robot installation must meet the following operating environment specifications.

Table 8-6. Robot System Operating Environment Requirements

Item	Specification
Ambient operating temperature	5 to 40°C 5 to 35°C (cleanroom models)

Item	Specification
Shipping / storage temperature	-25 to 60°C
Humidity	5 to 90%, non-condensing
Altitude	up to 2000 m
Pollution degree	2
Protection class	IP20 / NEMA Type 1 (standard version) IP65 (IP65 version)
Cleanroom rating (cleanroom models only)	ISO 4, Fed Reg Class 10

8.6 Other Specifications

Other item specifications are provided in the table below.

Solenoid Valve Kit Specifications

The optional solenoid valve kit has the following air pressure specifications.

Operating pressure range: 0.19 to 0.786 MPa

Connector Specifications

Connector specifications are provided in the table below for standard robots.

NOTE: Some connection specifications may differ on robots with the IP65 or Cleanroom options. Refer to IP65 Option Considerations on page 153 and Cleanroom Option Considerations on page 167 for more information.

Table 8-7. Connector Specifications

Item	Specification
Internal solenoid connectors OP3/4 connectors EOAPWR connectors	Housing: AMP/Tyco (part number #172167-1) 4-pin Mini-Universal Mate-N-Lok Pins: AMP/Tyco (part number #770985-1) Pin Contact: Mini-Universal Mate-N-Lok
End-of-Arm Break-away sensor connector	Housing: AMP/Tyco (part number #172165-1) 2-pin Mini-Universal Mate-N-Lock Pins: AMP/Tyco (part number: #770985-1) Pin Contact: Mini-Universal Mate-N-Lok
Compressed Air Fitting (Cleanroom option only)	6 mm diameter Pressure: 0.3 MPa + 10% Flow: 0.06 m ³ /min
Pneumatic pass-through ports	6 mm diameter (quantity 2) 4 mm diameter (quantity 3)

Item	Specification
Electrical pass-through	25-pin Dsub male (Joint 1) 25-pin Dsub female (outer link) 24 conductors, twisted pair>
DeviceNet pass-through	M12 micro, 5-pin Complies with typical DeviceNet communication requirements.
DC supply connector	Housing: Connector receptacle, 2 position, type: Molex Saber, 18 A, 2-Pin <ul style="list-style-type: none"> Molex part number: 44441-2002 Digi-Key part number: WM18463-ND Pins: Molex connector crimp terminal, female, 14-18 AWG <ul style="list-style-type: none"> Molex part number: 43375-0001 Digi-Key part number: WM18493-ND
AC power supply connector	AC in-line power plug, straight, female with screw terminals. Rated at 10 A, 250 VAC Qualtek part number: 709-00/00 Digi-Key part number: Q217-ND

Power Consumption Specifications

Robot power consumption specifications are provided in the table below.

Table 8-8. Typical Robot Power Consumption

eCobra Robot	Move	Average Power (W)	RMS Current (A)	Peak Power (W) ^a
600	No load—Adept cycle ^b	344	1.56	1559
	5.5 kg—Adept cycle ^b	494	2.25	2061
	5.5 kg—all joints move	880	4.00	2667
800	No load—Adept cycle ^b	377	1.71	1406
	5.5 kg—Adept cycle ^b	531	2.41	1955
	5.5 kg—all joints move	794	3.61	2110
^a For short durations (100 ms). ^b For details on Adept cycle, see General Performance Information on page 137.				

8.7 Tool Flange Dimensions

The following figure provides dimensions for the tool flange.

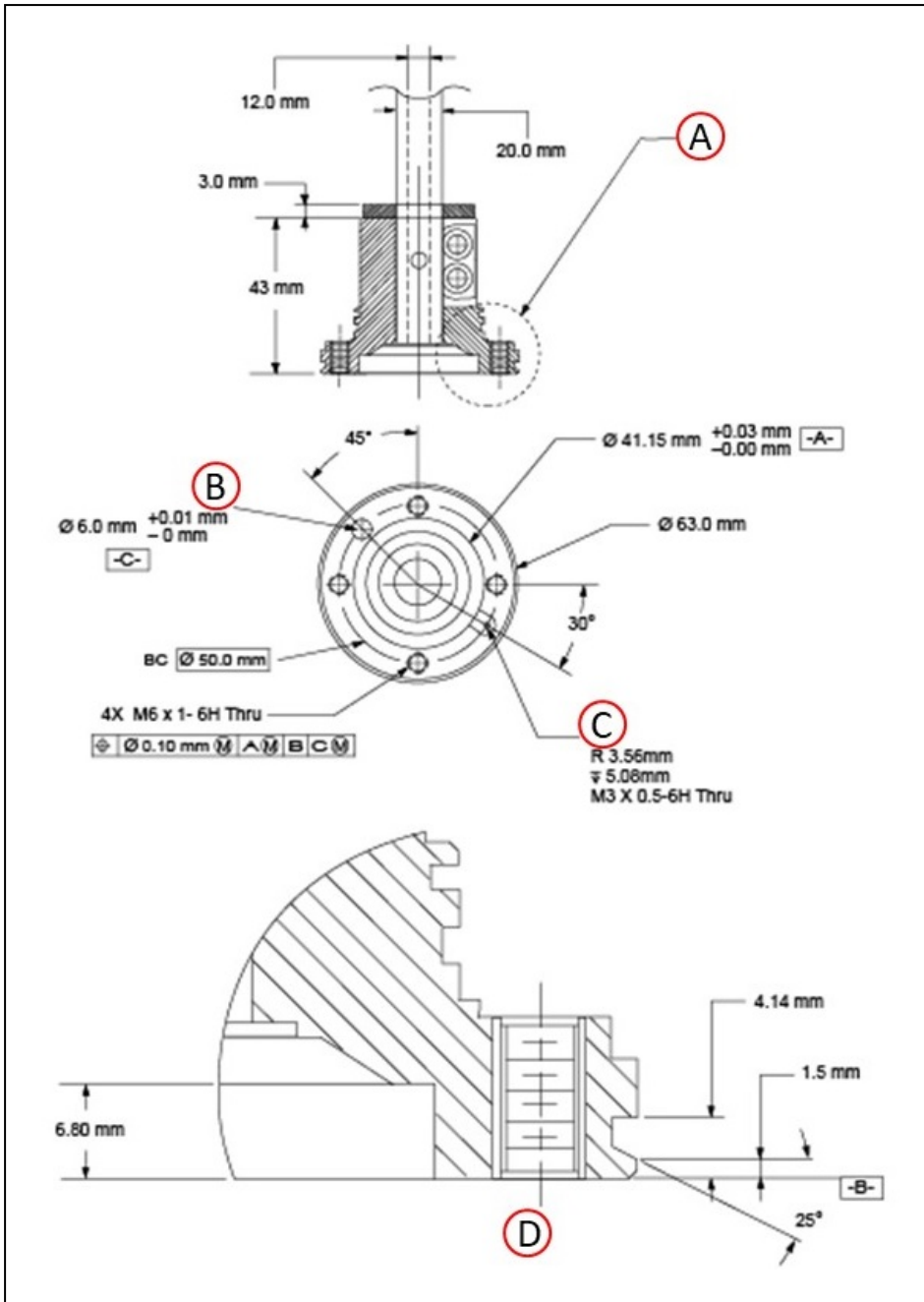


Figure 8-20. Tool Flange Dimensions for eCobra Robots

Key	Meaning	Key	Meaning
A	Flange edge - see callout (D) for profile and dimensions	C	Tool Flange Ground
B	Dowel pin hole	D	Flange rim dimensions from callout (A)

8.8 Front Panel Dimensions

The following figures provide Front Panel enclosure dimensions.

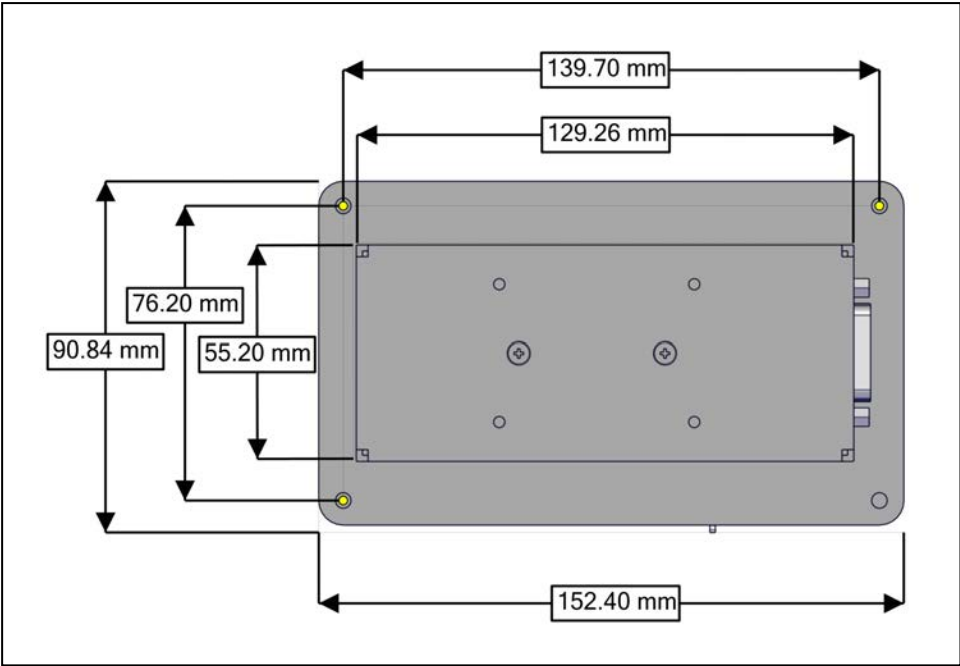


Figure 8-21. Front Panel Dimensions (Rear View)

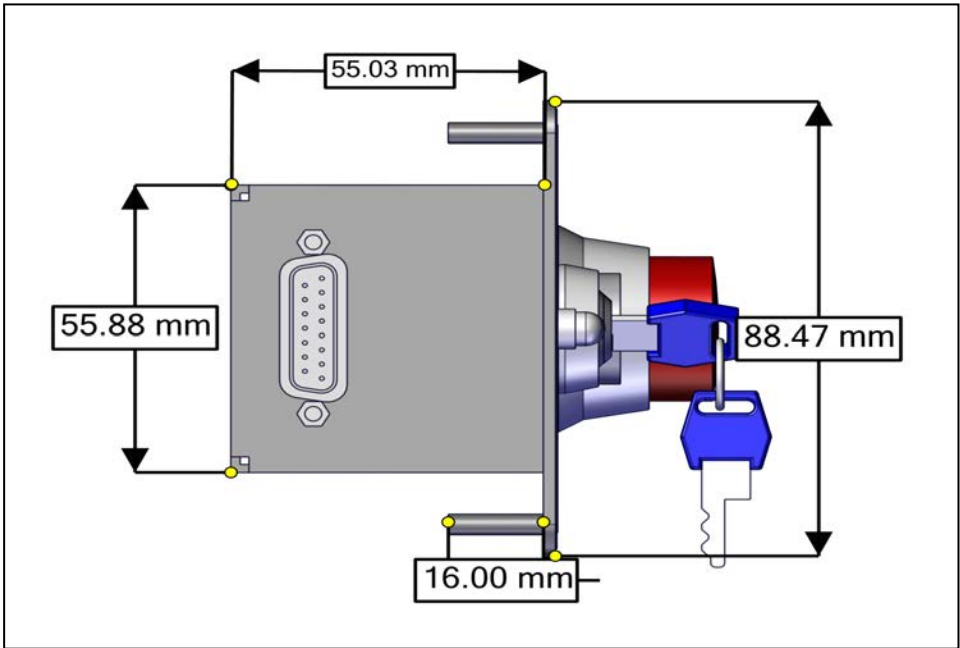


Figure 8-22. Front Panel Dimensions (Side View)

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

8.9 EtherCAT Communications Specifications

EtherCAT communications specifications are provided in the table below.

Figure 8-23. EtherCAT Communications Specification Description

Item	Specification
Synchronization	DC (Distributed Clock)
Physical Layer	100BASE-TX
Modulation	Baseband
Baud rate	100 Mbits/s
Topology ¹	Line, daisy chain, and branching
Transmission media	Twisted-pair cable of category 5 or higher Recommended cable: straight, double-shielded cable with aluminum tape and braiding
Maximum transmission distance between nodes	100 m
Communications cycle	2 ms, 4 ms
¹ Wiring in a ring configuration is not possible.	

Chapter 9: IP65 Option Considerations

This chapter provides important considerations when using a robot with the IP65 option.

NOTE: The IP65 option is available only for the eCobra 800 robot.

9.1 IP65 Option Classification

The following ingress protection measures are included with the IP65 option.

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

The eCobra 800 with the IP65 option is shown in the figure below.



Figure 9-1. eCobra 800 Robot—IP65 Option

9.2 User Requirements to Meet IP65 Rating

The IP65 robot provides the hardware needed to achieve an IP65 protection level, but you must provide a way of sealing the tool flange and pressurizing the robot through the compressed air attachment fitting (located at the top of the robot).

IMPORTANT: These two requirements of sealing the tool flange and pressurizing the robot are critical to achieving the IP65 level of protection.

As part of a your periodic maintenance plan, inspect the robot periodically to make sure these requirements are being met.

Sealing the Tool Flange

The tool flange must be sealed so that the robot shell can be positively pressurized. The positive pressure reinforces the sealing properties of the gaskets and seals provided in the IP65 robot.

The tool flange for the IP65 robot has an additional protective shield on the outer edge that is not present on the standard robot tool flange. Refer to the following figure for the side view dimensions. The bottom face of the flange (mounting surface) is the same as the standard flange, so the dimensions in Robot Physical Dimension Drawings on page 131 are the same.

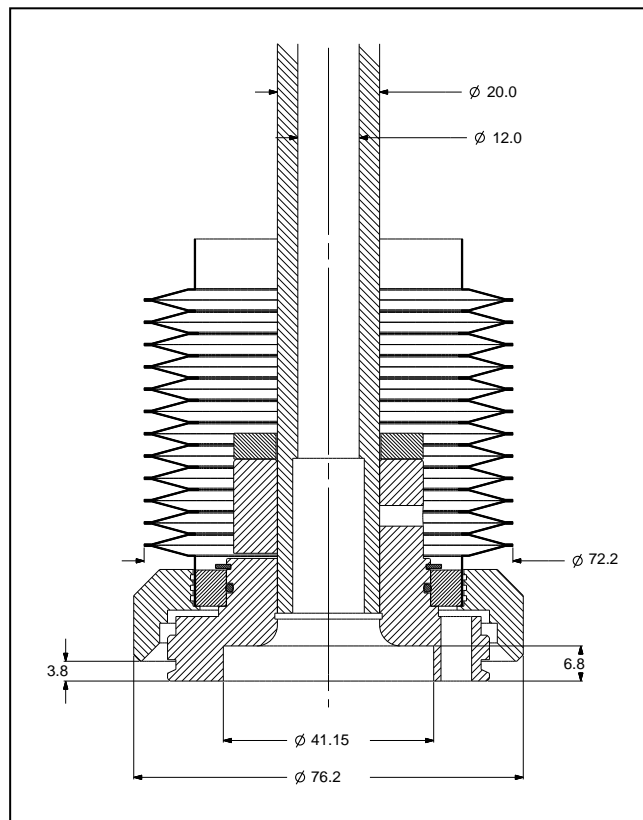


Figure 9-2. eCobra 800 IP65 Tool Flange (units in mm)

Pressurizing the Robot

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

1. Remove the red shipping plug from the compressed air fitting on the top of the robot.

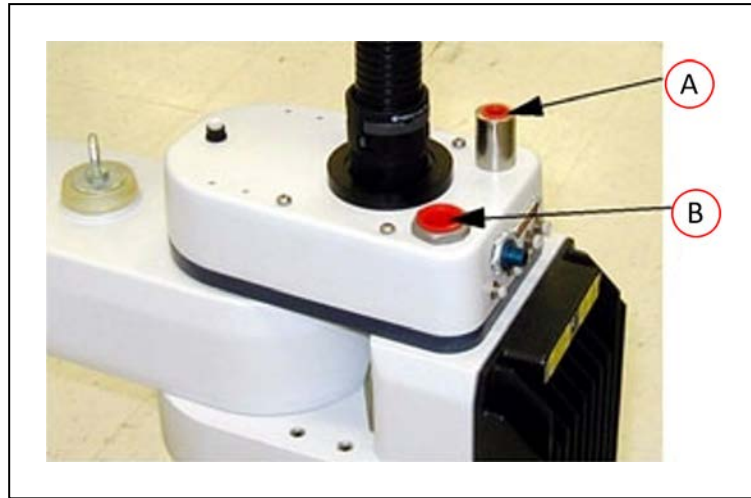


Figure 9-3. Compressed Air Inlet Port - 3/8 inch NPT Female fitting (A) and High Flow-Low Vacuum Port - 3/4 Inch NPT Female Fitting (B)

2. Connect a compressed air source to the air fitting. The specification for the regulated air supply is shown in the following table.

Table 9-1. Compressed Air Specifications

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



CAUTION: PROPERTY DAMAGE RISK

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

9.3 Cable Seal Assembly

This section describes the cable seal assembly that is provided with the IP65 option, and provides instructions for properly installing the seal.

Cable Seal Identification

You must mount the cable seal assembly (part number 04813-000) on the back of the robot during the robot installation process. The cable seal assembly ships separately from the robot. Use the figure below to identify the cable seal assembly parts. Figure 9-4.

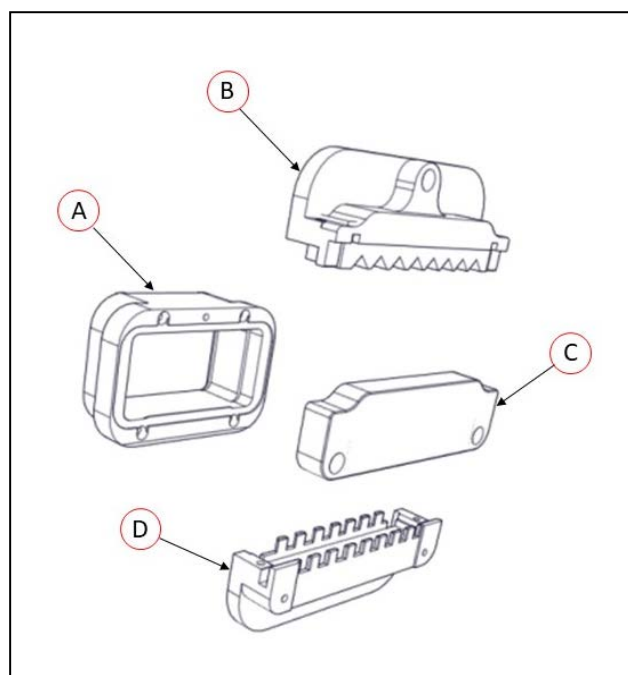


Figure 9-4. Cable Seal Parts Assembly

Item	Description
A	Cable Seal Housing Part number 04814-000
B	Cable Seal Flange (upper) Part number 04816-000
C	Splash Guard Part number 04817-000
D	Cable Seal Flange (lower) Part number 04815-000 NOTE: Shown with Cable Seal (P/N 04818-000) in place.

Installation Procedure

Use the following procedure to install the cable seal assembly.

NOTE: Begin this procedure with all cables disconnected from the robot interface panel.

1. Disassemble the cable seal assembly into separate pieces by removing all screws.
2. Install the cable seal housing on the back of the robot using four M4 x 50 screws, four M4 lock washers, and four M4 flat washers. Note that the centered M6 threaded hole must be at the top.
3. Attach all system cables to the robot interface panel.
4. Install the lower cable seal flange onto the housing. The lower flange fits into the groove at the bottom of the housing.
 - a. Tilt the flange away from the robot as you install it—Figure 9-5.
 - b. Then pull up on the flange and push it toward the robot.
 - c. Finally, push down on the flange to secure it against the housing. See Figure 9-6 for the lower flange in the installed position.

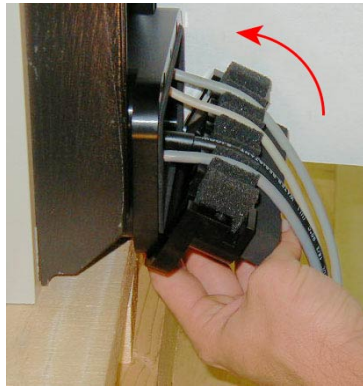


Figure 9-5. Installing Lower Flange

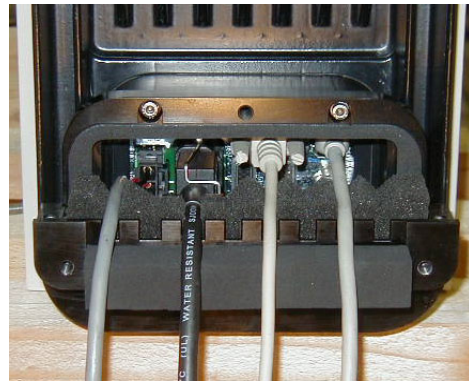
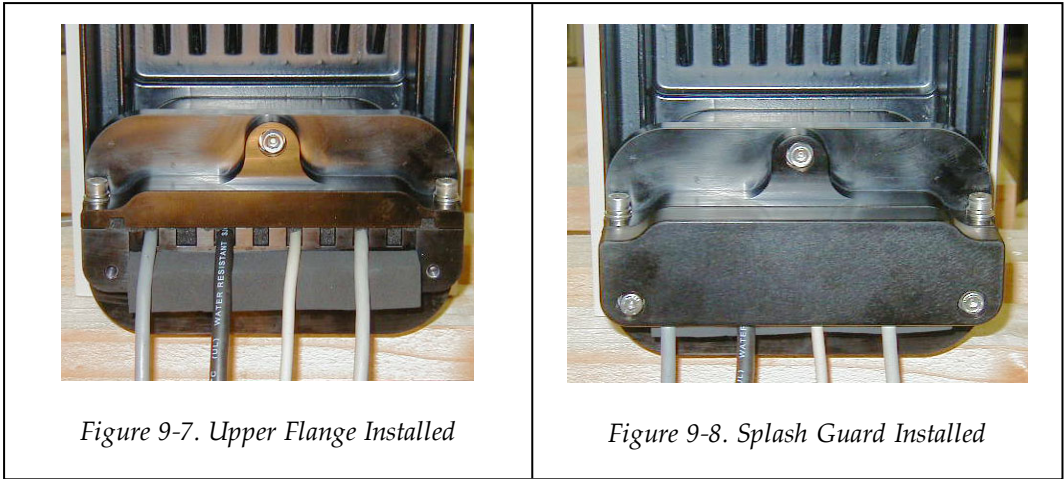


Figure 9-6. Lower Flange in Position

5. Seat all of the cables by pushing down into the foam on the lower flange.
6. Attach the upper flange to the lower flange using two M6 x 20 screws, two M6 lock washers, and two M6 flat washers. Make sure that none of the cable are pinched or crimped when installing the upper flange.
7. Attach the flange assembly using one M6 x 20 screw, one M6 lock washer, and one M6 flat washer. See Figure 9-7.



8. Install the splash guard using two M6 x 20 screws, two M6 lock washers, and two M6 flat washers. See Figure 9-8.

Dimension Drawing for Cable Seal Assembly

The following diagram provides dimensional details of the cable seal assembly.

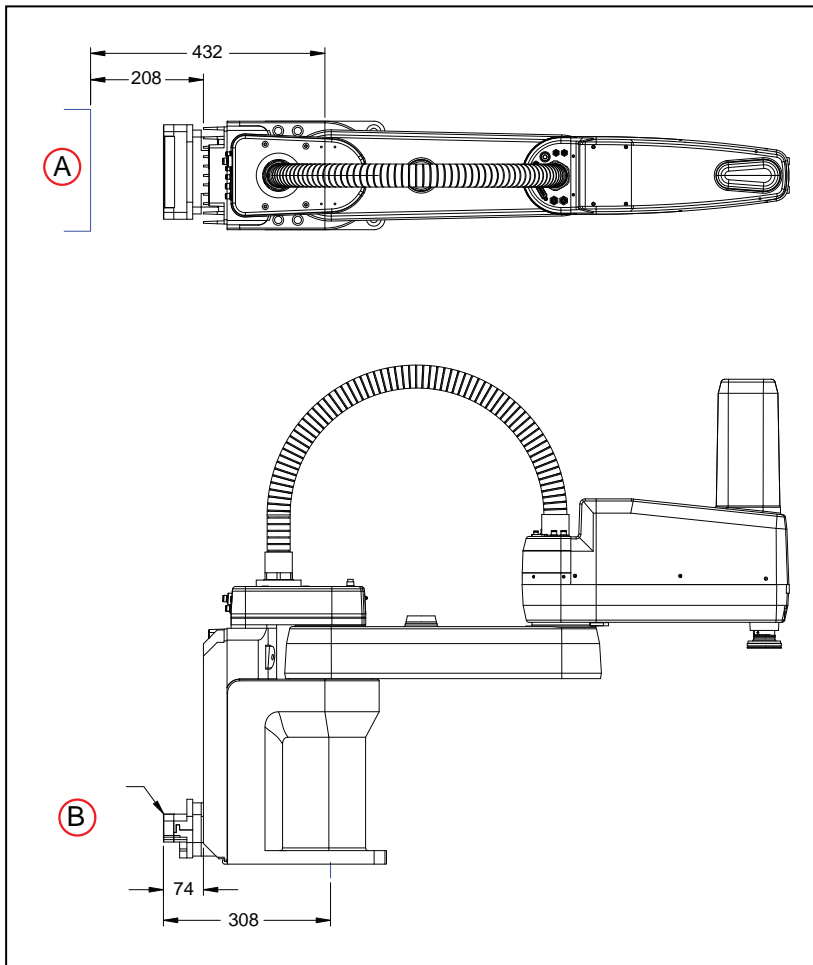


Figure 9-9. Cable Seal Assembly Dimensions showing required clearance to open iCS-ECAT controller with IP65 connector (A), and dimensions of cable sealing box on IP65 version (B) (units in mm)

9.4 Remove and Reinstall Outer Link Cover

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

IMPORTANT: For any maintenance procedures that involve removing and replacing the outer link cover, be very careful to not damage any of the seals that give provide the IP65 rating.

Outer Link Cover Removal Procedure

Use the procedure below to remove the outer link cover.

1. Remove all power and any air supply from the robot.
2. Thoroughly clean the outer link exterior to remove any dust or particles that might fall inside the robot when you remove the cover. Refer to Figure 9-10.
3. Unscrew the collar nut on the top of the outer link (A)
4. Remove two screws and nylon washers on the top of the outer link (B).
5. Remove two screws (one on each side) at the front of the outer link (C).

Make sure the O-ring on each screw stays in place and is not lost.

6. For the 8 screws along the side of the cover (four on each side, see (D)), loosen only one to two turns, just enough to loosen the inside clamp nuts. Do not completely remove the screws. See the label on the side of the outer link cover.



CAUTION: PROPERTY DAMAGE RISK

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

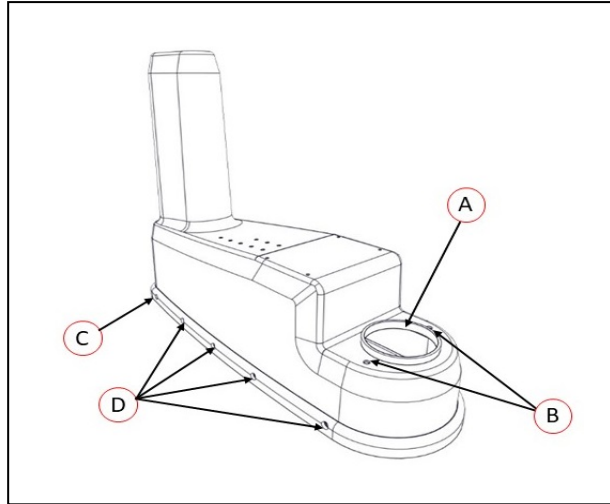


Figure 9-10. Cover Screw Removal

Key	Meaning	Key	Meaning
A	Collar Nut	C	Remove the screws (one on each side)
B	Remove these screws	D	Loosen these screws only 1-2 turns (four screws on each side). If you loosen more than that, the internal clamp nut could come loose)

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

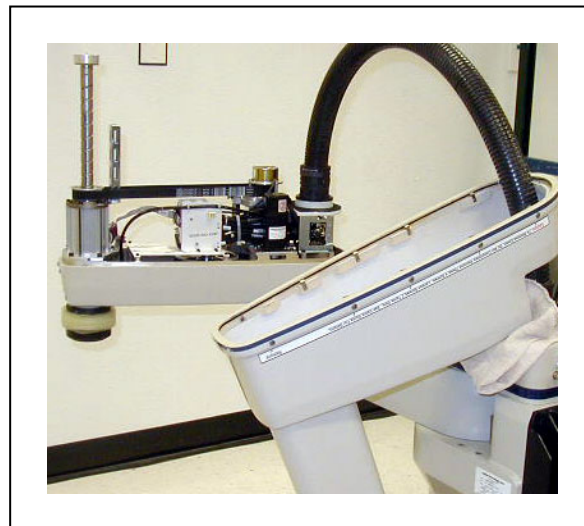


Figure 9-11. IP65 Robot with Outer Link Cover Removed

Outer Link Cover Reinstallation Procedure

Use the following procedure to reinstall the outer link cover.

IMPORTANT: To maintain the robot's IP65 rating, use care when reassembling the robot's cover.

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

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

5. Reinstall the two screws and nylon washers at the top of the outer link and tighten to 0.56 N-m.
6. Reinstall the two screws (check for O-ring on screw) near the front of the outer link and tighten to 1.1 N-m.
7. Tighten the 8 side screws to 1.1 N-m. Be careful to not over-tighten. Begin with the two screws at the back of the outer link (one on each side), then move forward to the next two until you have tightened all eight. We recommend this pattern to achieve a balanced secure fit around the cover.
8. Reinstall the collar nut and tighten until secure.
9. Turn on the compressed air supply to the system before restarting the robot.

9.5 IP65 Robot Connections

This section describes unique information about connection that apply to the IP65 option.

Joint 1 Connections

The user electrical, and IO Blox connectors on the back of the robot's Joint 1 cover are fitted with removable plugs at the factory (see below) If you use any of these connectors, you must provide a seal at the connection to prevent moisture from entering the robot.

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

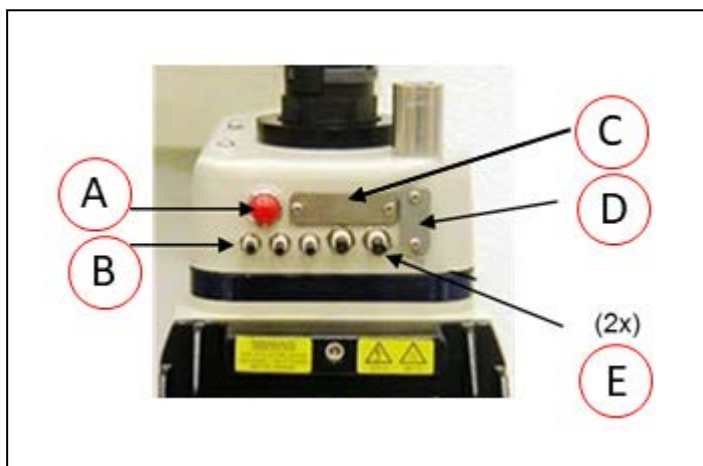


Figure 9-12. User Connectors on eCobra Robot

Key	Meaning
A	DeviceNet connector
B	4 mm Air Lines (3x)
C	User Electric
D	IO Blox
E	6 mm Air Lines (2x)

The user electrical connectors on the outer link are accessible with the cover removed. See the following figure for locations of the internal connectors.

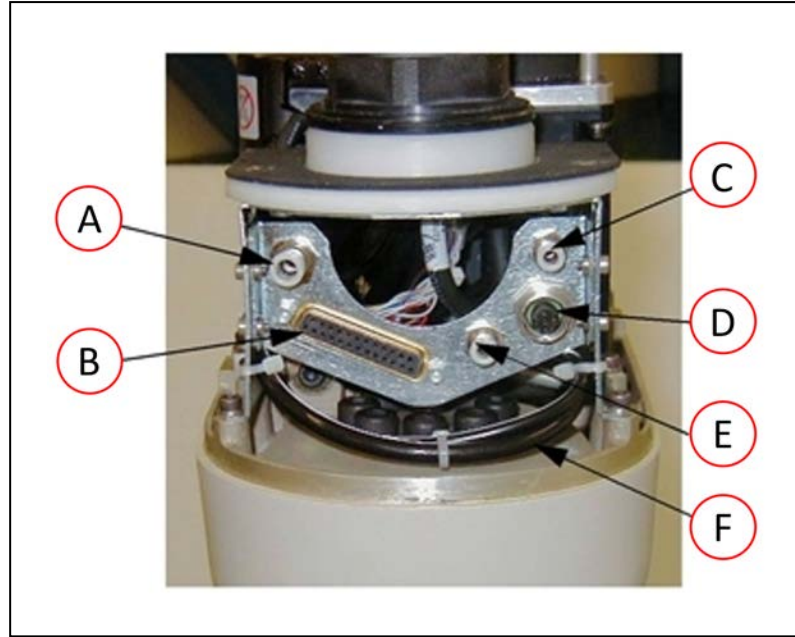


Figure 9-13. IP65 Internal Connectors with Outer Link Cover Removed

Key	Meaning	Key	Meaning
A	6 mm Air Lines	D	DeviceNet
B	User Electric	E	4 mm Air Line
C	4 mm Air Line	F	Two spare Air Lines

Pneumatic Pass-through Connections

The user air line connectors have removable plugs fitted at the factory. Refer to User Connectors on eCobra Robot on page 162.

The pass-through connectors on the outer link are accessible with the cover removed. See Figure 9-13. for locations of the internal connectors.

When routing air lines outside of the robot, any fittings you use must maintain an adequate seal in the cover to prevent moisture from entering the outer link.



CAUTION: PROPERTY DAMAGE RISK

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

Robot Solenoid Option Consideration for IP65 Robots

If you are installing the internally-mounted solenoid valves on a robot with the IP65 option, you must use a different air line than what is described in Installing the Solenoid Valve Kit on page 89.

The internal air line normally used to supply the solenoid manifold is instead used to provide positive airflow pressure to the bellows / outer link. You can use one of the passive 6 mm user air lines shown in Figure 9-12. and Figure 9-13.

9.6 IP65 Option Maintenance

This section provides maintenance instructions for replacing the bellows provided with the IP65 option.

IP65 Bellows Replacement

Use the following procedure to replace the bellows. The part number for the bellows is 04625-000.

IMPORTANT: Check the bellows periodically for cracks, wear, or damage.

1. Remove all power and air supply from the robot.
2. To remove the lower bellows clamp, remove two M3 screws and pull the clamp apart.
3. Remove the tool flange.
For the tool flange removal procedure, see Remove the Tool Flange on page 120.
4. To remove the upper bellows clamp, remove two M3 screws and pull the clamp apart.
5. Slide the old bellows down off of the quill.
6. Install a new bellows by sliding it up onto the quill.
7. Re-install the upper bellows clamp. You must align the mating surface of the clamp half-rings with the bellows seam—see Figure 9-14. Tighten the screw to secure the bellows.
8. Re-install the tool flange.
9. Place new gaskets in the lower bellows clamp—extra gaskets are shipped in the accessory kit. Then install the clamp over the bottom of the bellows, on the bearing ring just above the tool flange. Align the mating surfaces of the clamp half-rings with the bellows seam—see Tighten the screw to secure the clamp.

NOTE: Align the bellows clamps with the bellows seam, on both upper and lower clamps

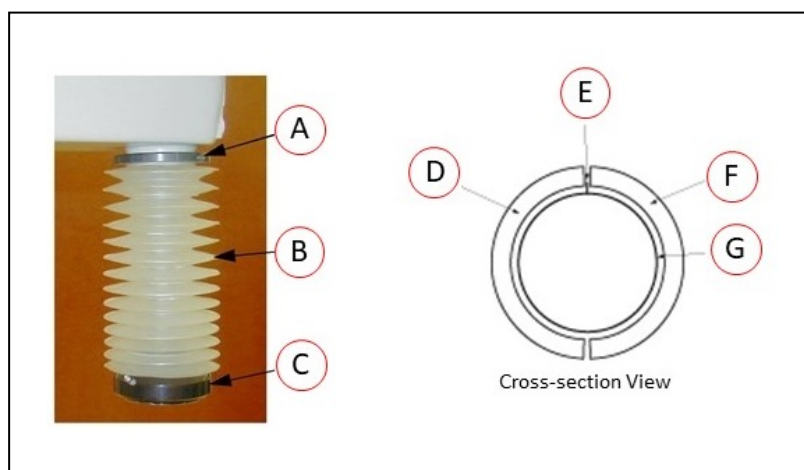


Figure 9-14. Bellows Replacement and Alignment

Key	Meaning	Key	Meaning
A	Upper Bellows Clamp	E	Bellows Seam
B	Bellows	F	Bellows Clamp
C	Lower Bellows Clamp	G	Bellows
D	Bellows Clamp		

Chapter 10: Cleanroom Option Considerations

This chapter provides important considerations when using a robot with the Cleanroom option.

10.1 Cleanroom Option Classification

The eCobra robots are available in Class 10 Cleanroom, and ISO Class 4 models.

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

IMPORTANT: You must use an additional high flow rate vacuum source to evacuate the inner link and base.

An eCobra 600 with the Cleanroom option is shown in the figure below.

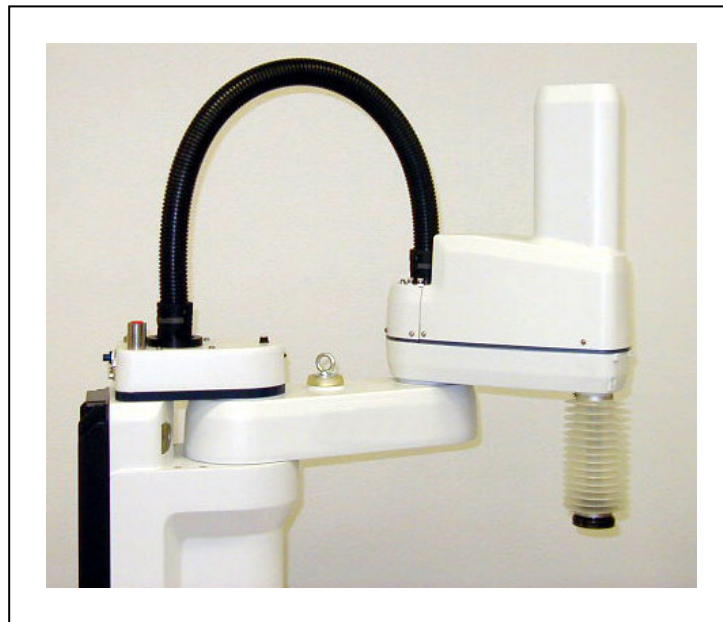


Figure 10-1. eCobra 600 - Cleanroom Option

10.2 User Requirements to Meet Cleanroom Rating

The following table lists the vacuum and compressed air source requirements to meet the Cleanroom rating.

Table 10-1. Cleanroom Option Requirements

Consideration	Recommendation
Vacuum source	0.80 m ³ /min minimum volumetric flow rate
	6 mm of water differential pressure measured between the robot and the vacuum source
	3/4 inch NPT female thread pipe fitting at the back of the robot
Compressed air source	Clean, dry, oil-free compressed air
	0.52 MPa
	.04 m ³ /min flow rate
	3/8 inch NPT female thread pipe fitting at the back of the robot, flow regulator not supplied
Quill inside diameter	Your end-effector must plug the quill's inside diameter to develop sufficient vacuum in the outer link.

10.3 Cleanroom Robot Connections

This section describes unique information about connections that apply to the Cleanroom option.

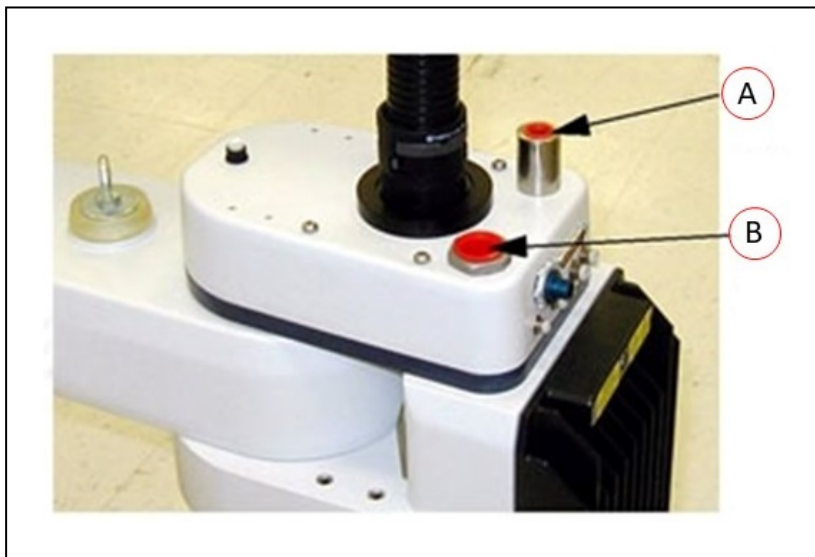


Figure 10-2. Compressed Air Inlet Port - 3/8 inch NPT Female fitting (A), High Flow, Low Vacuum Port - 3/4 inch NPT Female Fitting (B)

Robot Solenoid Option Consideration for Cleanroom Robots

If you are installing the internally mounted solenoid valves on a robot with the Cleanroom option, the following considerations must be made.

Installation Considerations

The internal air line normally used to supply the solenoid manifold is instead used to provide vacuum to the bellows / outer link. You can use one of the passive 6 mm user air lines shown in Figure 9-12. and Figure 9-13.

Performance Considerations

The exhaust from the internally mounted valve may exceed Class 10 particulate limits.

NOTE: To avoid the issues described above, consider mounting pneumatic solenoid valves externally when using a Cleanroom robot.

10.4 Cleanroom Option Maintenance

This section provides special maintenance instructions for replacing the bellows used on the Cleanroom robots.

Cleanroom Bellows Replacement

Use the following procedure to replace the bellows. The part number for the bellows is 04625-000.

IMPORTANT: Check the bellows periodically for cracks, wear, or damage.

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

1. Remove all power and air supply from the robot.
2. Remove the lower bellows clamp ring from the bearing ring by loosening the screw on the clamp.
3. Remove the tool flange.
For the tool flange removal procedure, refer to Remove the Tool Flange on page 120.
4. Remove the upper bellows clamp ring by loosening the screw on the clamp.
5. Slide the old bellows down off of the quill.
6. Install a new bellows, and reverse the steps listed above.

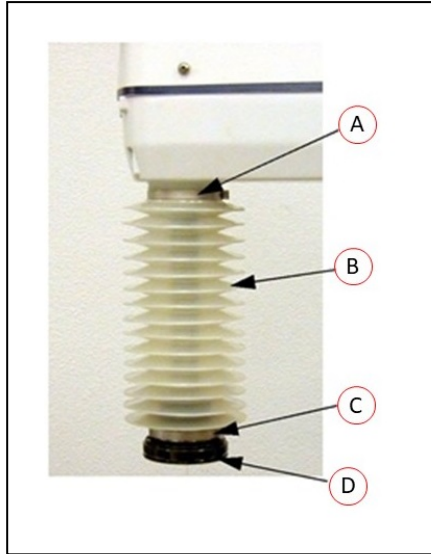


Figure 10-3. Cleanroom Bellows Replacement

Key	Meaning
A	Upper Bellows Clamp Ring
B	Bellows
C	Lower Bellows Clamp Ring
D	User Tool Flange

Chapter 11: Status Codes

This chapter provides information about status codes that may appear on the robot display panel.

11.1 Robot Display Panel

The robot display panel displays alpha-numeric codes that indicate the operating status of the robot. These codes provide details for quickly isolating problems during troubleshooting and determining the operating state of the robot.

In the Display Panel Codes table, the '#' in the LED column represents a single digit. The digits will be displayed as shown below.

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

11.2 Status Codes Table

The following table lists the possible informational, warning, and error messages that eV+ will generate, and display on the robot's 2-digit Status Display.

These messages use the following numbering scheme:

- **Informational Messages:** Numbers 0 to 49, provide information
- **Warning Messages:** Numbers 50 to 299, list warning messages about abnormal system behavior
- **Error Messages:** Negative numbers, list error messages

Table 11-1. Display Panel Codes

LED	Status Code	eV+ Error Message	eV+ 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.

LED	Status Code	eV+ Error Message	eV+ Error Code	Explanation	User Action
					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.
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 electrical or physical condition that resulted in an encoder fault.	Write down the failure message or code, and look it up in the eV+ Help.
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

LED	Status Code	eV+ Error Message	eV+ Error Code	Explanation	User Action
					of the ESTOP and re-enable high power.
F I	F1	*E-STOP detected by robot*	-643	The End-Of-Arm Break-away Sensor has tripped (open circuit). Reporting of this error can be enabled / disabled via Sysmac Studio.	Re-close the break-away circuit and re-enable high power.
FM	FM	None	N/A	Firmware version mismatch.	Contact your local OMRON support.
h#	h#	*Robot over-heated*	-606	The temperature sensor on the embedded processor board is at its temperature limit.	Try slowing the motion or insert pauses. Also, check for excessive ambient temperature, inadequate ventilation, and proper function of any cooling fans.
H#	H#	*Motor over-heating* Mtr #	-1016	The motor encoder temperature sensor indicates an overtemperature.	Reduce robot speed, acceleration and/or deceleration 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).	Can 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. Could indicate servo initialization failure. Contact your local OMRON support.

LED	Status Code	eV+ Error Message	eV+ Error Code	Explanation	User Action
M#	M#	*Motor stalled* Mtr #	-1007	A motor stall occurs when the maximum allowed torque was applied on a given motor for longer than the timeout period. 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.
P1	P1	*Power system failure* Code 1	-1115	The power system has unexpectedly turned off power.	Contact your local OMRON support if the error persists.
P2	P2	*Power system failure* Code 2	-1115	Overvoltage in the high-voltage DC bus to the regenerative energy dump circuit.	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	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*	Robot hardware did not detect pressing the Front Panel high-power button before the servo system attempted to enable power.	Contact your local OMRON support.

LED	Status Code	eV+ Error Message	eV+ Error Code	Explanation	User Action
S1	S1	*Safety System Fault* Code 1	-1109*	Contact your local OMRON support for more information.	
S2	S2	*Safety System Fault* Code 2	-1109*	The safety system failed 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 failed channel 2 during the cyclic check of dual-channel power system. May indicate 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 turned power off. Normally, software sequences the shutdown before the time-out.	If the problem persists, contact your local OMRON support.
S5	S5	*Safety System Fault* Code 5	-1109*	The power system was improperly unlocked by software during a power sequence in manual mode.	Contact your local OMRON support.
S6	S6	*Safety System Fault* Code 6	-1109*	CAT-3 hardware safety system detected an encoder OVERSPEED and turned power off. This circuit is active in manual mode only, on select robots which have the CAT-3 teach mode option.	Intentionally triggered during specific commissioning tests for the CAT-3 system. If during normal operation, contact your local OMRON support.
S9	S9	*Safety System Fault* Code 9	-1109*	Error reported by the watchdog circuit that cross-checks the clocks for the dual-channel safety system.	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 timeout. On some products it is normal for	If the problem persists, contact your local OMRON support.

LED	Status Code	eV+ Error Message	eV+ Error Code	Explanation	User Action
				this to occur momentarily during a servo reset.	port.
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 has not been commissioned and verified.	Commission and verify the Teach Restrict.
V#	V#	*Hard envelope error* Mtr #	-1027	The indicated motor was not tracking the commanded position with sufficient accuracy as set by Sysmac Studio.	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.

A.1 Unpacking and Inspecting the Equipment

This section provides information about unpacking and inspecting a robot..

Before Unpacking

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

After Unpacking

Before accepting delivery of your robot, 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 received items do not match the packing slip, are damaged, or do not match your order, do not sign the receipt, and call your local OMRON support as soon as possible.

Inspecting the Equipment

Inspect each item for external damage as you remove it from its container. If any damage is evident, your local OMRON support.

Retain all containers and packaging materials. These items may be necessary if there is any apparent damage or relocation becomes necessary at a later date..

A.2 Repacking for Relocation

If you need to relocate the robot or other equipment, reverse the installation procedures.. Reuse all original packing containers and materials and follow all safety guidelines for installation. Improper packaging for shipment will void your warranty. Specify this to the carrier if you must ship the robot.



CAUTION: PROPERTY DAMAGE RISK

Always ship the robot upright.

A.3 Transportation and Storage

This section provides details about transporting and storing your robot.

Always ship and store this equipment upright, in its supplied shipping crate, and in a clean, dry temperature-controlled environment as specified below.

- Temperature range: -25 to +60° C
- Humidity range: 5% to 90%, non-condensing

Additional Information: The supplied crate's design prevents damage to the robot from normal vibration and shock.



CAUTION: EQUIPMENT DAMAGE HAZARD

Do not expose the crate to excessive shock and vibration.

Use a forklift or pallet jack to transport the packaged equipment in an upright position. Always keep the ISO double-arrows on the sides of the crate oriented up.



CAUTION: EQUIPMENT DAMAGE HAZARD

Do not lay the crate on its side or any other non-upright position. This could damage the robot.

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 ROBOTICS AND SAFETY TECHNOLOGIES, INC.

4225 Hacienda Drive, Pleasanton, CA 94588 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

Authorized Distributor:

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