OMRON

iX3 Robot with EtherCAT

User's Manual

I655-E-01

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Table of Contents

Chapter 1: Introduction

This manual contains information that is necessary to install and use iX3 565 Robot 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 User's Manual (Cat. No. I651)	Provides reference to eV+ Keyword use and functionality.
eV+3 Keyword Reference Manual (Cat. No. I652)	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.
NJ-series Robot Integrated CPU Unit User's Manual (Cat. No. O037)	Describes the settings and operation of the CPU Unit and programming concepts for OMRON robot control.
T20 Pendant User's Manual (Cat. No. I601)	Describes the use of the optional T20 manual control pendant.

Manual	Description
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 factory automation (FA) systems 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 iX3 565 Robot with EtherCAT is a three-arm parallel robot. Servo motors in the robot base control movement of the robot platform through mechanical links, arms, and an optional drive shaft when platform rotation is needed. A tool flange is provided on the bottom of the platform for mounting end-of-arm tooling.

Servo and other control functions are provided with an integrated controller (iCS-ECAT) that is mounted on the top of the robot base.

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.

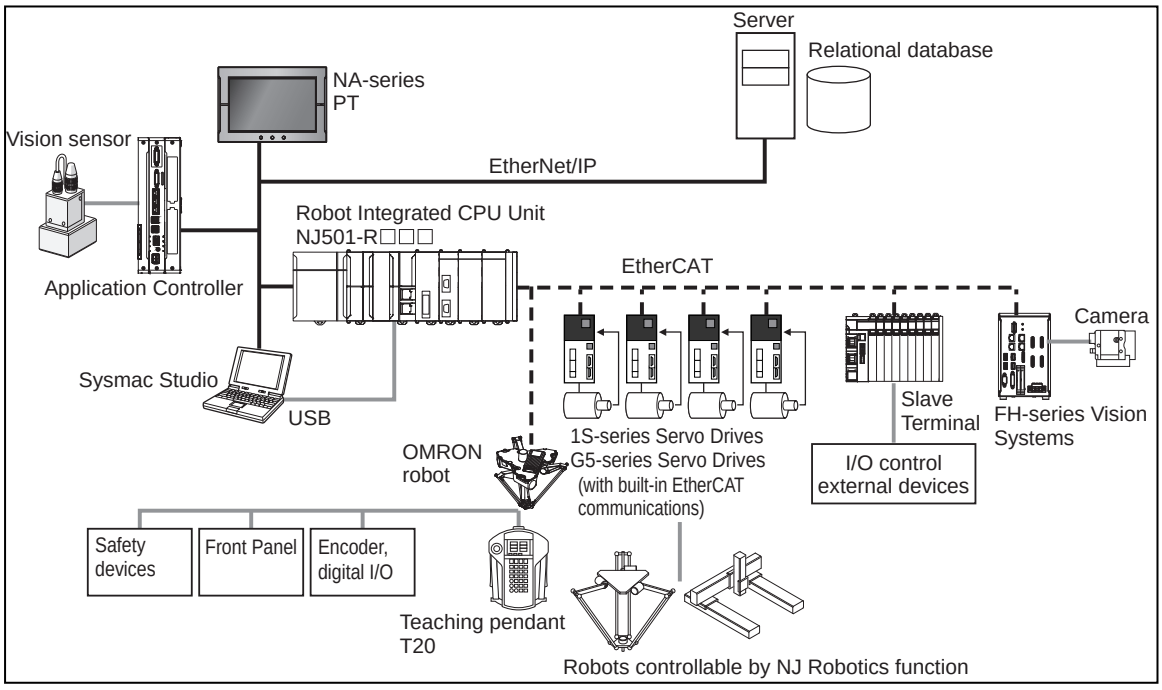


Figure 1-1. EtherCAT System Topology

Two models of the iX3 565 Robot with EtherCAT are available:

- 3 axis unit with a fixed platform and no tool flange rotation.
- 4 axis unit with ±360° of rotation at the tool flange driven by a theta motor and drive shaft.

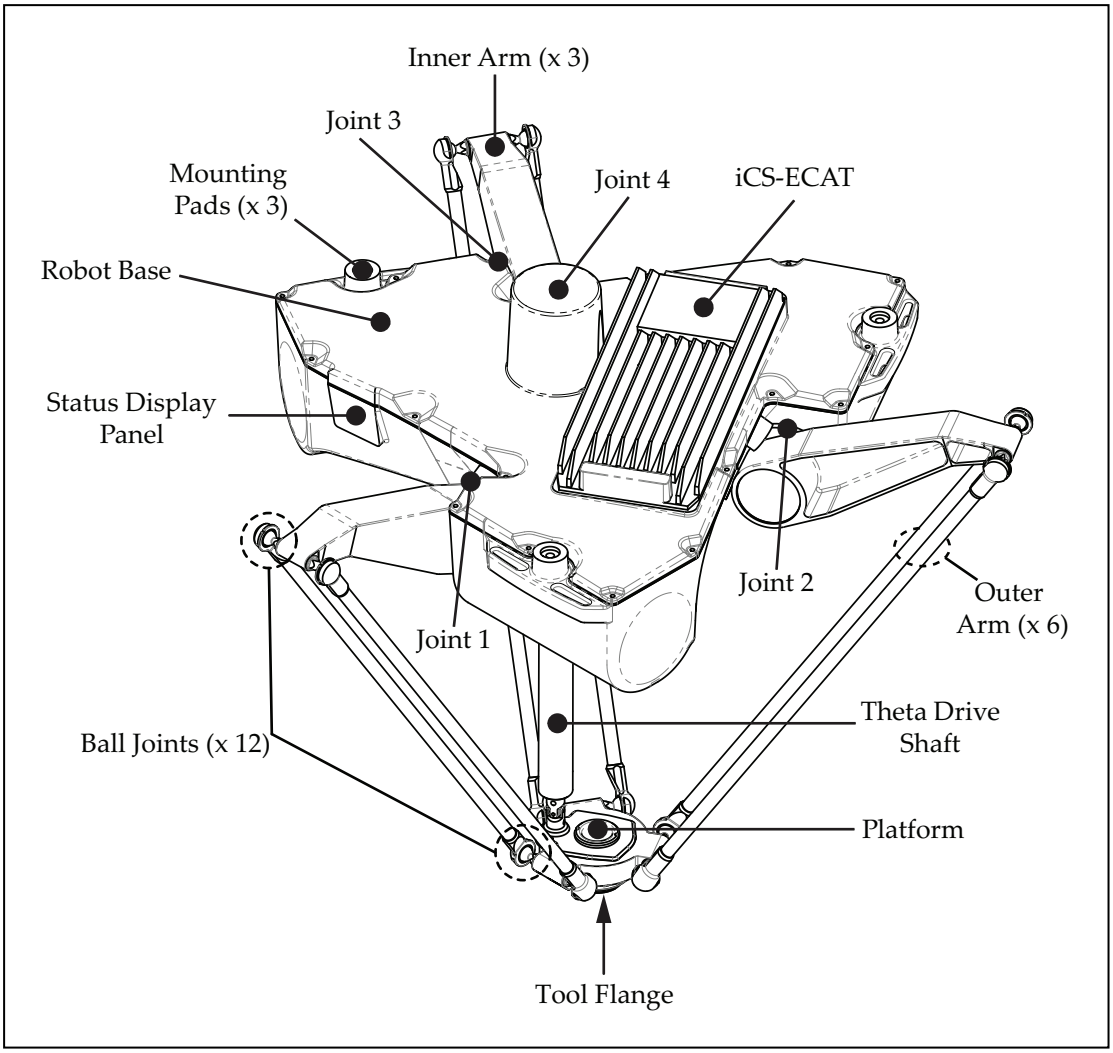


Figure 1-2. iX3 565 Robot with EtherCAT (4 axis model shown)

NOTE: The descriptions and instructions in this manual apply to all iX3 565 Robot with EtherCAT types. If there are differences based on type or options, this manual will provide details in the associated sections.

Robot Amplifier and Controller

The 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.

Internal Control System

The iCS-ECAT has a dedicated microprocessor to communicate, coordinate, and execute servo commands. The iCS-ECAT unit receives V+ 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 12 for more information.

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.

iCS-ECAT Robot Interface Panel

The iCS-ECAT includes the robot interface panel. It has connections for power (200 to 240 VAC, 24 VDC), communications, and other peripheral devices such as a pendant, IO Blox, or a Front Panel.

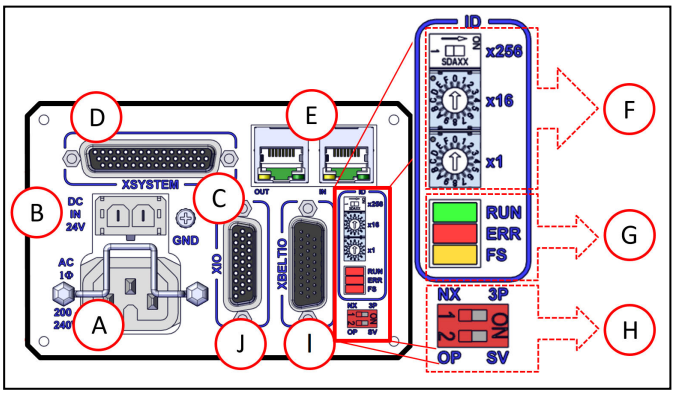


Figure 1-3. iCS-ECAT Robot Interface Panel

Table 1-2. iCS-ECAT Robot Interface Panel Descriptions

Item	Description
A	AC Power Supply Connector Used for connecting 200 to 240 VAC, single-phase input power to the robot. A connector is provided with the robot. Refer to Connecting the 24 VDC Cable to the Robot on page 77
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 77 for more information.
C	Ground Terminal
D	XSYSTEM Connector Refer to Basic System Cable Layout 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 52
G	LEDs Indicates the status of the EtherCAT connection. Refer to EtherCAT Communications Description on page 90 for more information.
H	4-Position Mode Switches Used to adjust the operating mode of the robot. Refer to Robot Control Modes on page 93 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 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

Item	Description
	Used for user I/O signals for peripheral devices. Refer to Basic System Cable Layout on page 61 for more information.

IP65 Versions

This robot is available with an IP65 rating to provide additional protection from dust and fluid ingress. The base of the robot and inner arms are IP65 rated while the platform and outer arms are IP67 rated for this option.

Robot Base

The robot base is an aluminum casting that houses the drive motors and supports the iCS-ECAT. It provides three mounting pads for attaching the base to a rigid support frame. The Status Display panel is mounted on the side of the robot base.

Outer Arms and Ball Joints

The inner arm motion is transmitted to the platform through the outer arms, which are connected between the inner arms and platform with precision ball joints. The outer arms are carbon fiber epoxied assemblies with identical ball joint sockets at each end. A bearing insert in each socket accepts the ball joint studs on the inner arms and platform and allows for approximately ± 60° of relative motion. No ball joint lubrication is required.

Each pair of outer arms is held together with spring assemblies that pre-tension the ball joints which allows the outer arms to be installed and removed without tools.

The ball joint assembly is shown below.

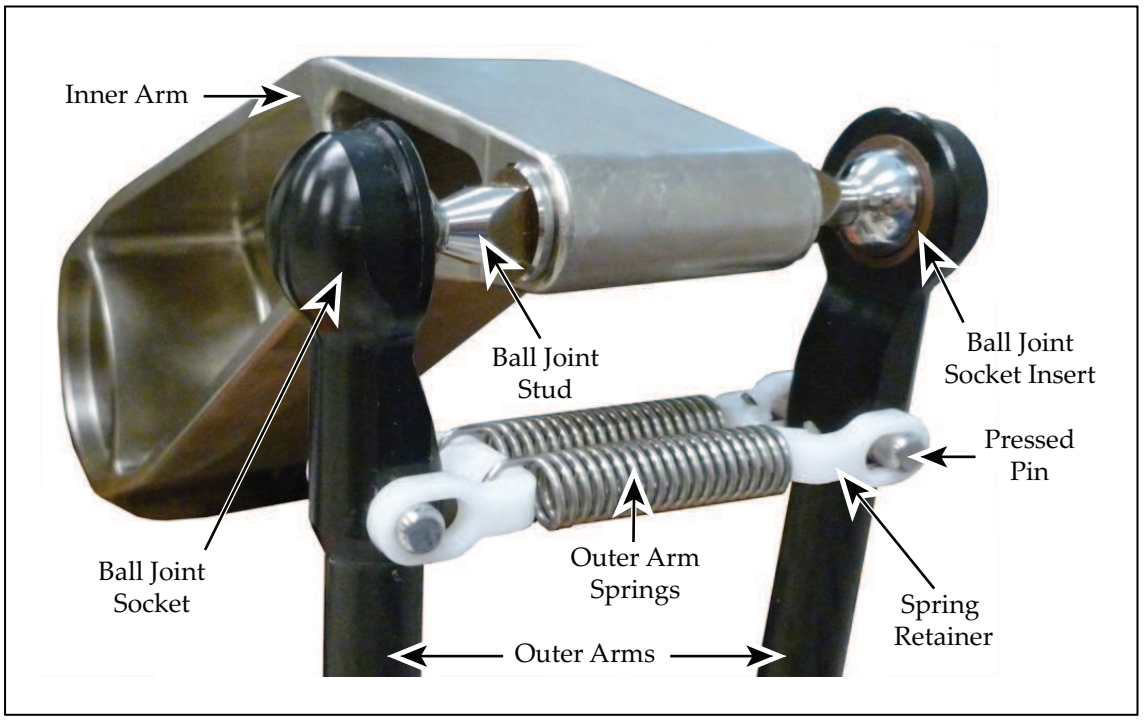


Figure 1-4. Ball Joint Assembly

Inner Arms

Three robot motors attach directly to the inner arms through high-performance gear reducers. If the robot has a theta rotation motor, it is mounted at the top of the robot base. RIA-compliant hard stops limit the inner arm motion to -53° and +114.6°.

Platforms

The platform converts the motion of the robot motors into Cartesian motion. The 4 axis version platform is capable of theta rotation of ±360°.

The 3 axis version's platform is made from stainless steel. The 4 axis version's platform is made from electroless-nickel-plated aluminum and is rotated by a stainless steel drive shaft driven by the 4th axis motor.

Both platforms have a 38 mm hole through their center for routing air lines or electric cables to the tool flange.

Images of the two types of platforms are shown below.

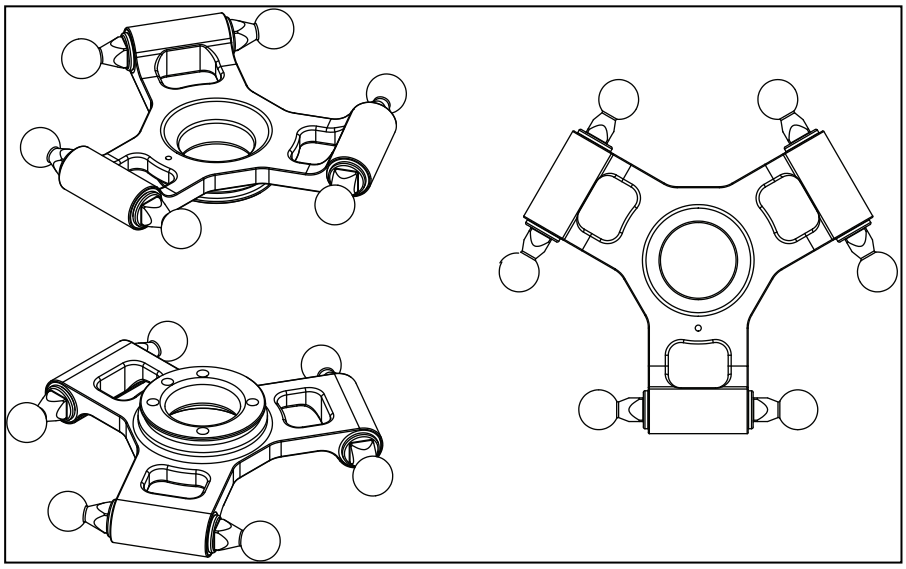


Figure 1-5. 3 Axis Robot Platform

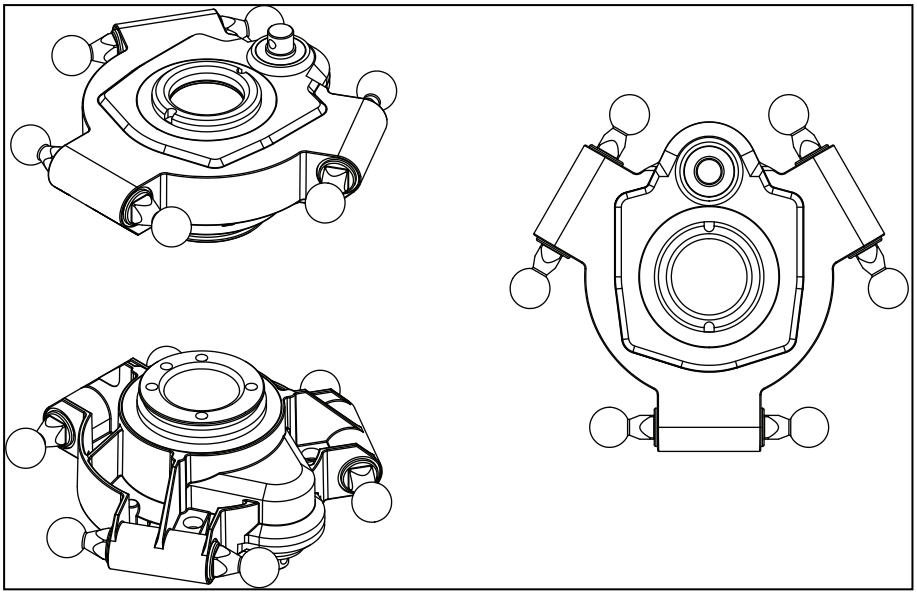


Figure 1-6. 4 Axis Robot Platform

Robot Motions and Obstacles

Considerations for robot motions and obstacles are described below.

Robot Motions

Joint-interpolated motion is not possible with the robot because the positions of all the joints must always be coordinated in order to maintain the connections to the platform. As a result, the control system automatically performs a straight-line motion when a joint-interpolated motion request is encountered.

Containment Obstacle

The work space of the robot is defined by an inclusion obstacle. This is done because, unlike other robots, joint limits are not meaningful in defining the work space. The system defines a cylindrical shape tapered at the bottom as a containment obstacle as the work envelope. Other obstacles can be defined within this area. Refer to the *Sysmac Studio Robot Integrated System Building Function with Robot Integrated CPU Unit Operation Manual (Cat. No. W595)* for more information.

1.3 Robot Options

This section describes the various options available for the 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.

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 system.

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

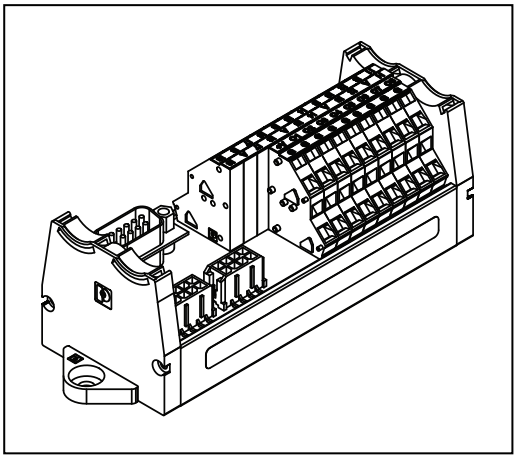


Figure 1-7. IO Blox

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 20 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.

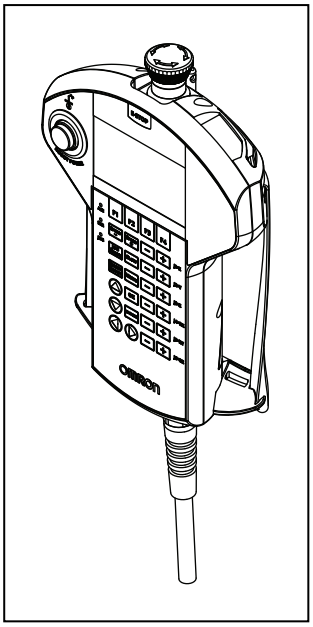


Figure 1-8. T20 Pendant

IPC Application Controller

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

The Pack Manager application controls automated pick-and-place systems with cameras, conveyors, and robots based on the data that you set up in the Sysmac Studio. It is executed on the IPC Application Controller to control the process data and recipe data.

The Robot Vision Manager application processes images captured by cameras based on the data that you set up in the Sysmac Studio. It is executed on the IPC Application Controller.

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)*

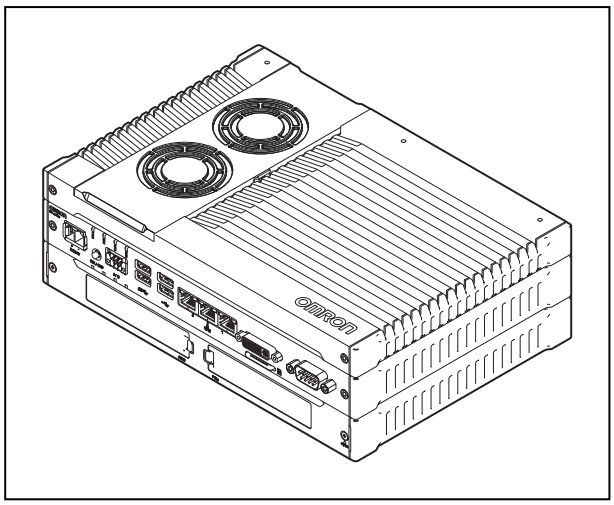


Figure 1-9. IPC Application Controller

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 93 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 94 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.

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).

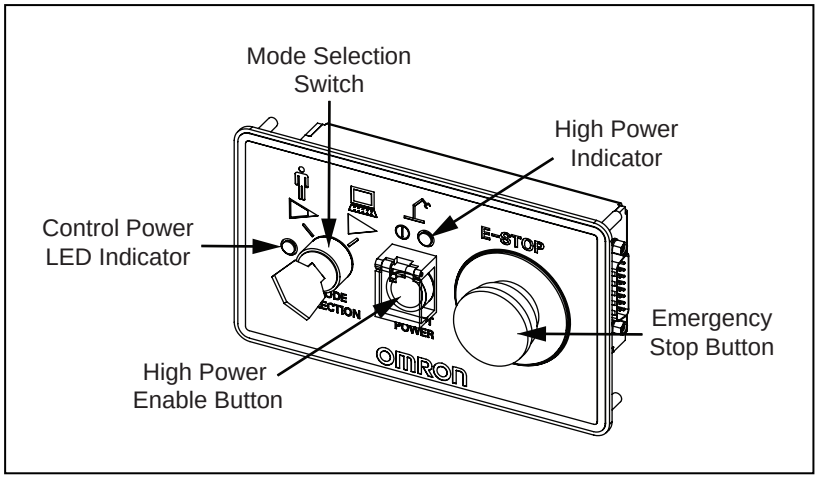
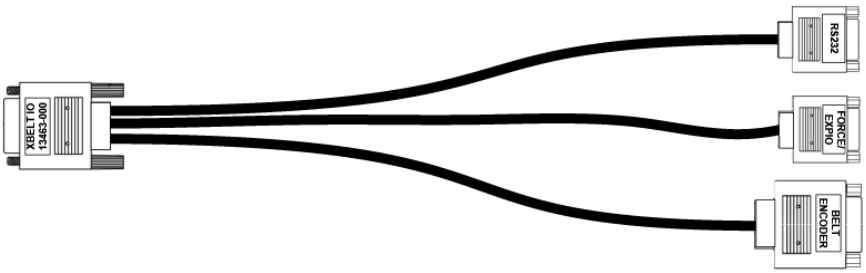


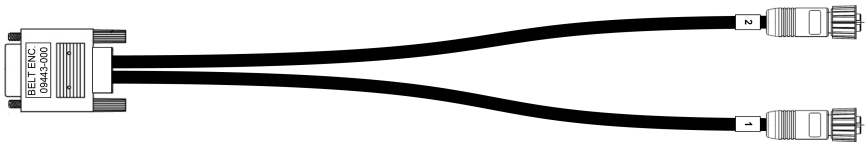
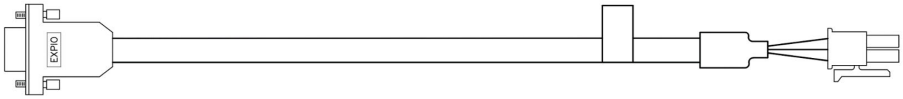
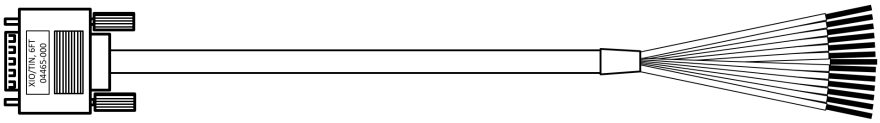
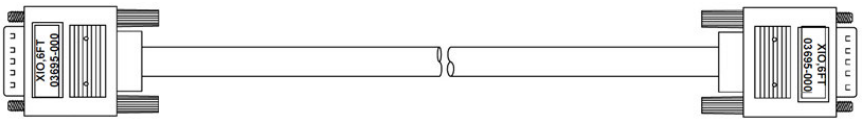
Figure 1-10. Front Panel

Optional Cables

The following table provides details about optional cables.

Table 1-3. Optional Cables

P/N	Description
13463-000	XBELT I/O Adapter Cable (600 mm) 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.  **NOTE:** You can use the FORCE / EXPIO connector on this cable to connect up to 4 IO Blox devices. For details on the pinouts for this cable, refer to Pinouts for XBELT IO Adapter on page 66.
09443-000	Belt Encoder to M12 Y Adapter Cable (3 m) This optional adapter cable splits the belt encoder connection on the XBELTIO cable into two belt encoder branches.

P/N	Description
	 **NOTE:** For details on using this cable, refer to XBELT IO Belt Encoder Y Adapter Cable on page 65.
04677-000	EXPIO-to-IOBlox Cable (3 m) This optional cable is used to connect IO Blox devices to the robot's EXPIO connector.  **NOTE:** For details on connecting IO Blox units to your system, refer to IO Blox Connections on page 68.
04465-000	XIO/TIN Cable (5 m) 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.  **IMPORTANT:** This cable is not compatible with the XIO Termination Block. **Additional Information**: Refer to XIO Breakout Cable Pinout on page 21 for more information.
03695-000	XIO Cable (2 m) 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. 

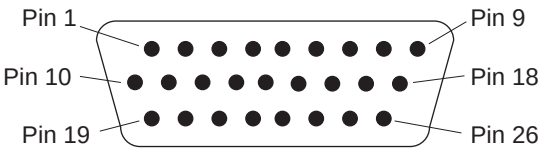
XIO Breakout Cable Pinout

The XIO Breakout cable pinouts are provided below.

Table 1-4. XIO Breakout Cable Wire Chart

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

Pin No.	Signal Designation	Wire Color



Tall Frame Mounting Adapters

The robot can be mounted in a tall frame by installing a set of three frame adapters.

The frame adapters lower the height of the robot by 118 mm.

If used, the lengths of the three mounting bolts will need to be increased by 118 mm.

Cable Inlet Box

The optional cable inlet box can be used to increase the robot's IP rating to IP65.

The part number of the cable inlet box is 08765-000.

> **NOTE:** The cable inlet box is not USDA compliant. Drainage of wash-down from the cable seal assembly does not comply with USDA requirements.

The cable seal assembly must be mounted on the top of the robot during the robot installation process. The cable seal assembly is an extra-cost option, and is shipped separately from the robot. Refer to Installing a Cable Inlet Box on page 55 for more information.

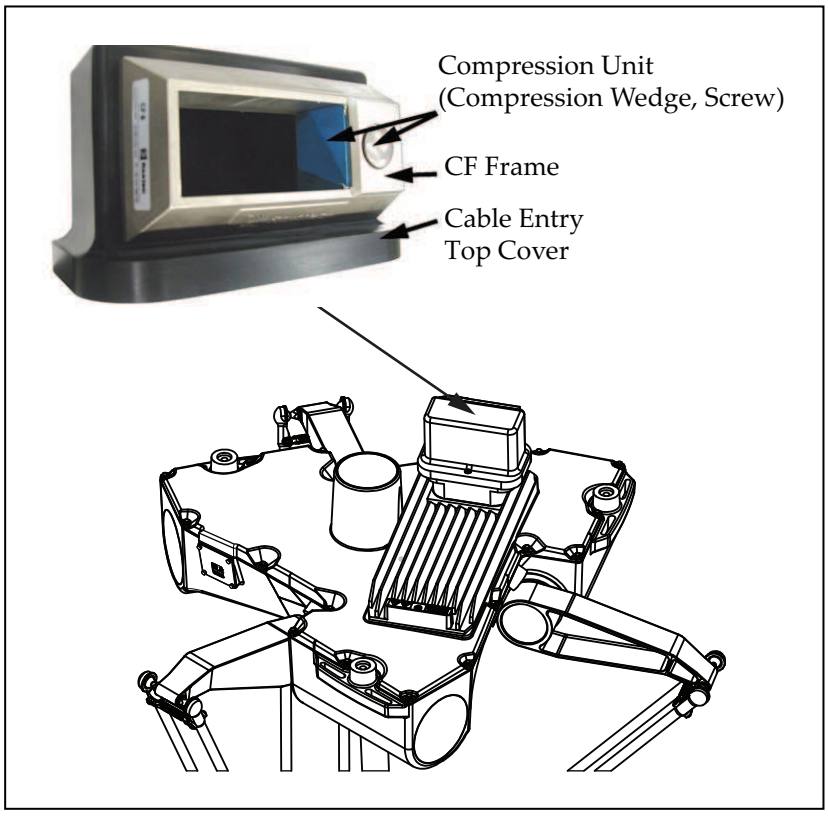


Figure 1-11. Cable Inlet Box

Cable Inlet Box Components

The Cable Inlet Box includes the following components.

- Cable harness.
- Cable seal housing, 2 gaskets, 4 screws.
- Cable entry top cover assembly including the Roxtec CF 8 frame.
- 4 x 2-hole Roxtec modules.

  These are dense foam blocks surrounding pre-cut half-sleeves that can be peeled away to match the diameter of the cable to be sealed.

- Roxtec grease, used to assemble and seal the modules.

Ball Stud Locks

Under extreme loading conditions using very aggressive moves or in the case of a collision, it is possible for the ball studs to separate from the ball joint sockets. Optional ball stud locks can be used to prevent this from occurring.

A ball stud lock kit (16 locks) is available as part number 09824-000.

> **Additional Information**: Refer to Installing or Removing Ball Stud Locks on page 58 for more information.

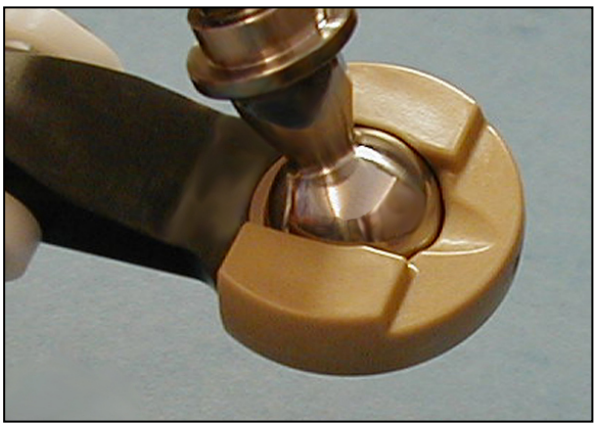


Figure 1-12. Ball Stud Locks

Chapter 2: Safety

2.1 Dangers, Warnings, and Cautions

Alert Levels

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

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

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

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

Alert Icons

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

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

Falling Hazards

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

Safety Barriers

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

Special Information

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

IMPORTANT: Information to ensure safe use of the product.

NOTE: Information for more effective use of the product.

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

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

2.2 What to Do in an Emergency or Abnormal Situation

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 or abnormal situation. If a fire occurs, use CO_2 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, you may want to manually position the platform without enabling high power. For such instances, a Brake-Release button is located on the underside of the robot base. When system power is ON, pressing this button releases the brakes, which allows movement of the arms.

DANGER: PERSONAL INJURY RISK
iX3 robots are not collaborative robots. They require a dedicated work area that will prevent personnel from coming into contact with them during operation.

Releasing an E-Stop

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

After the E-Stop button has been manually released, the robot will wait until the motors are manually enabled. Once the motors are enabled, the robot will wait two seconds and then resume commanded motion.

2.3 Safety Precautions

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

WARNING: PERSONAL INJURY OR PROPERTY DAMAGE RISK
An iX3 robot can cause serious injury or death, or damage to itself and other equipment, if the safety precautions in this manual are not observed.

User's Responsibilities

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

- All personnel who install, operate, teach, program, or maintain the system must read this guide, read the *Robot Safety Guide*, and complete a training course for their responsibilities in regard to the robot.
- All personnel who design the robot system must read this guide, read the *Robot Safety Guide*, and must comply with all local and national safety regulations for the location in which the robot is installed.

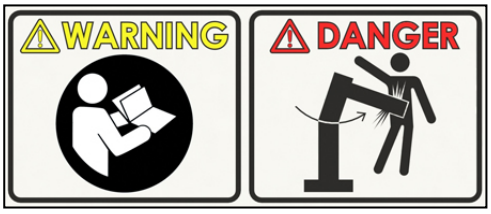


Figure 2-1. Read Manual and Impact Warning Labels

- The robot must not be used for purposes other than described in Intended Use of the Robots on page 29. Contact Customer Support if you are not sure of the suitability for your application.
- The environment must be suitable for safe operation of the robot.
- The user is responsible for providing safety barriers around the robot to prevent anyone from accidentally coming into contact with the robot when it is in motion.
- Power to the robot and its power supply must be locked out and tagged out before any maintenance is performed.
- The robot must be well maintained, so that their control and safety functions continue to work properly.

General Hazards

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

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

Qualification of Personnel

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

As noted in this and the *Robot Safety Guide (Cat. No. I590)*, certain procedures should be performed only by skilled or instructed persons. For a description of the level of qualification, we use the standard terms:

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

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

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

- Have the necessary qualifications
- Have received the guides (both this document, and the *Robot Safety Guide (Cat. No. I590)*)
- Have read the guides
- Understand the guides
- Will work in the manner specified by the guides

2.4 Robot Behavior

Hardstops

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

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

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

Limiting Devices

There are no dynamic or electro-mechanical limiting devices provided by OMRON. The robot does not have safety-rated soft axis or space limiting.

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

Singularities

No singularities within the work envelope exist that cause a hazardous situation with the robot.

2.5 Intended and Non-intended Use

Intended Use of the Robots

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

The robot has been designed and constructed in accordance with the relevant requirements of IEC 60204-1.

The robot is intended for use in parts assembly and material handling for payloads up to 3 kg (4 axis model) or 8 kg (3 axis model). Refer to Technical Specifications on page 119 for complete information on the robot specifications. Refer to the *Robot Safety Guide (Cat. No. I590)* for details on the intended use of our robots.

Guidelines for safe use:

- Exposure to Liquid and Particles — Surfaces of the robot have been designed to shed water. Refer to Cleaning on page 101 for more information. The robot's platform and outer arms are IP67 rated and the base is IP65 rated.

  IMPORTANT: For standard robots, the topside of the base is IP20 rated, and therefore, must not be exposed to liquid.

- Temperature — 1 to 40° C, with a recommended humidity range of 5% to 90%, non-condensing.

Non-Intended Use

Robots are not intended for:

- Use in the presence of ionizing or non-ionizing radiation
- Use in potentially explosive atmospheres
- Use in medical or life saving applications
- Use in a residential setting. They are for industrial use only
- Use before performing a risk assessment
- Where the equipment will be subject to extremes of heat or humidity

Non-intended use of robots can:

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

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

2.6 Additional Safety Information

We provide other sources for more safety information:

Manufacturer's Declaration of Incorporation

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

Robot Safety Guide (Cat. No. I590)

The *Robot Safety Guide (Cat. No. I590)* that is shipped with every robot system provides detailed information on safety for OMRON robots. It also gives resources for information on relevant standards.

Emergency Stop Circuit and Buttons

The E-Stop provided complies with ISO 10218-1 (Clause 5.5.2), with stop category 1 (per IEC 60204). The E-stop button complies with ISO 13850. The E-Stop meets the requirements of PL-d per ISO 13849.

If you design your own front panel, it must meet the requirements of ISO 13849, and be at least PL-d. The E-Stop button must comply with IEC 60204-1 and ISO 13850, Clause 5.5.2.

If you choose to use your own E-Stop buttons, they must meet the requirements of IEC 60204-1 and ISO 13850, Clause 5.5.2.

2.7 How Can I Get Help?

Contact your local OMRON representative or refer to the corporate website below.

http://www.ia.omron.com

T20 Manual Control Pendant (Option)

The protective stop category for the pendant enable switch is category 1, which complies with the requirements of ISO 10218-1. The pendant is designed in accordance with the requirements of IEC 60204-1 and ISO 13849. The E-Stop button is ISO 13850.

NOTE: OMRON does not offer a cableless (wireless) pendant.

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

Disposal

Dispose of in accordance with applicable regulations.

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

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 153 for more information.

Basic Installation Steps

Use the following steps to understand the basic installation procedure.

Table 3-1. Basic Installation Steps

Step	Task	Reference
1	Mount the robot.	Mounting an iX3 Robot on page 34
2	Attach outer arms and drive shaft (if applicable).	Attach the Outer Arms on page 39 Attaching the Theta Drive Shaft on page 36
3	Install the platform.	Installing the Platform on page 1
4	Installing the Front Panel.	Installing the Front Panel on page 41
5	Install user-supplied safety equipment.	Installing User-Supplied Safety Equipment on page 43
6	Set the EtherCAT Node Address.	Setting the EtherCAT Node ID on page 52
7	Install any robot optional hardware.	Installing End-of-Arm Tooling on page 55 Installing a Cable Inlet Box on page 55 Installing or Removing Ball Stud Locks on page 58
8	Make robot system cable connections.	System Cable Installation on page 61
9	Verify the installation.	Verifying Installation on page 87

3.2 Mounting an iX3 Robot

This section describes mounting details for the iX3 robot.

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

Mounting Frame Overview

The robot is designed to be mounted above the work area suspended on a user-supplied frame. Refer to Robot Physical Dimension Drawings on page 119 for more information about mounting hole patterns.

The design of the robot mounting frame is the user's responsibility. The following general considerations should be made when designing a mounting frame.

- The flatness of the frame mounting tabs is critical for accurate positioning. Deviation from this flatness specification can cause loss of robot calibration. Refer to Mounting Surfaces on page 35 for more information.
- The iCS-ECAT unit must be removable from the robot without removing the robot from the frame. This is needed for maintenance and inspection of the robot.
- The frame must be designed to prevent inner arm travel from interfering with the mounting frame. Refer to Arm Travel Volumes on page 120 for more information.
- Frame stiffness and vibration characteristics affect motion settling times. Frames with lower natural frequencies will lead to longer motion settling times because the tool flange of a robot will continue moving by any amount that the suspended robot base is moving, even after servo control considers robot motion to be fully settled. A modal analysis should be performed on the frame design with each robot approximated as a 120 kg rigid plate. The first mode frequency should be at least 25 Hz, and greater than 40 Hz is recommended when using heavy payloads, high accelerations, or multiple robots.
- If an optional cable inlet box is used, account for the increased height needed for this item. Refer to Installing a Cable Inlet Box on page 55 for more information.

Reactive Forces

All robot motions cause reactive forces. These forces are transmitted directly to the robot frame. As the robot system works to position the tool flange relative to the base of the robot, any frame or base motion will be unknown to the robot system and will be transmitted to the tool flange. This transmitted base motion will result in inertial movement of the tool flange mass and will cause disturbance forces to be introduced into the robot control system. These disturbance forces cause additional work to be done by the robot servo control system which may result in longer settling times for robot operations. This can be reduced with high frame stiffness.

> **Additional Information**: After the system reports the robot to be fully settled, the tool flange may still be moving by any amount of motion that the suspended base of the robot may be experiencing.

Robot Orientation

We recommend mounting the robot so that the Status Display Panel faces away from a conveyor belt (when present). Although the work envelope of the robot is symmetrical, this orientation gives better access to the status display. It also orients the arm loading for aggressive moves across the belt. This orientation places the robot World Y-axis along the conveyor belt, and the X-axis across the belt.

Mounting Surfaces

The mounting frame should have 3 mounting tabs that provide a mounting surface for the robot. These mounting tabs will be mated to the robots mounting pads. Use the following considerations when designing the mounting tabs.

- The 3 mounting tabs should be aligned to a flat, horizontal plane with a maximum of 0.75 mm parallelism deviation. Exceeding this allowance will cause inconsistent robot move positioning.
- If welding mounting tabs to the frame, this should be done as a last step in the construction process to ensure parallelism to a flat, horizontal plane.
- Consider using a flat surface as a datum during the construction of mounting tabs.

Refer to Robot Physical Dimension Drawings on page 119 for more information.

NOTE: The robot base-mounting pads have spring-lock Heli-Coils in the M12 holes, so lock washers are not needed on the M12 mounting bolts.

Mounting Procedure

Use the following procedure to mount the iX3 robot.

WARNING: PERSONAL INJURY OR PROPERTY DAMAGE RISK
Do not attempt to lift the robot from any points other than with slings as described in the mounting procedure.

NOTE: The shipping pallet will not fit inside most frames, so the robot will need to be manually moved to the inside of the frame.

1. Position the robot directly under the mounting frame.
2. Put adequately sized straps through the six lifting slots near the three mounting pads. The following figure shows two of these slots.

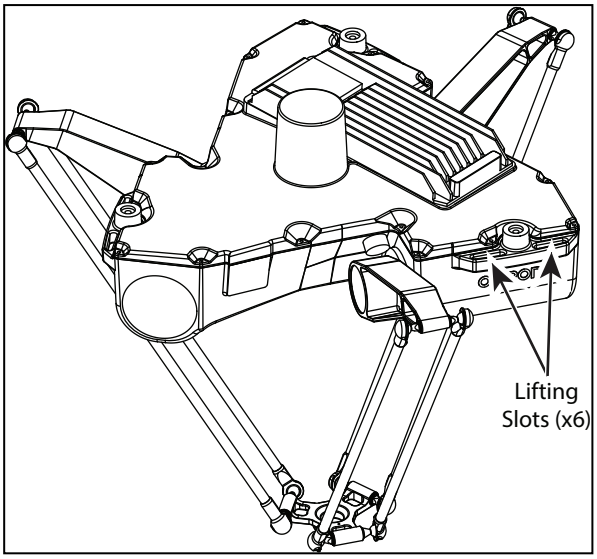


Figure 3-1. Lifting Slots

3. After the straps are secured and tensioned, lift the robot up while aligning the robot mounting tabs with the frame mounting tabs until the two are mated together.
4. Verify that robot mounting tab holes are aligned with the frame mounting tab holes and then insert bolts to fasten the robot to the mounting frame. Use the following user-supplied bolts details and tighten to a torque of 61 N-m.
    - M12 x 1.75
    - Stainless steel or zinc-plated steel
    - Engage with at least 24 mm of the robot base threads

3.3 Attaching the Theta Drive Shaft

The information in this section only applies to robots with a 4 axis option.

The theta drive shaft consists of a sliding cylinder and ball joints at the ends. The upper U-joint connects to the robot base. The lower U-joint connects to the platform.

IMPORTANT: The drive shaft is not symmetrical. There is a top and a bottom. Installing the drive shaft upside-down will degrade system performance. A "Top" label is included on the drive shaft.

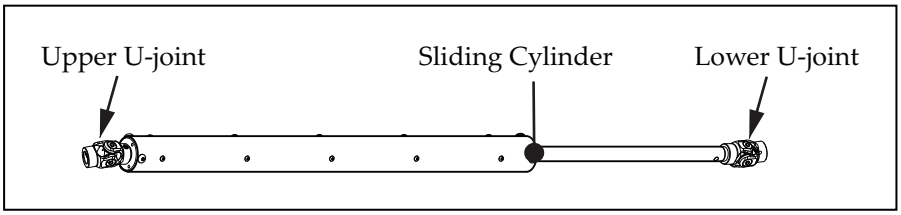


Figure 3-2. Theta Drive Shaft Components

Theta Drive Shaft Attachment Procedure

Use the following procedure to attach the theta drive shaft. The following items are required for this installation.

> **NOTE:** The platform and the joint 4 motor will have to be aligned with 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

- Loctite 243 or equivalent thread locking compound.
- 3 mm hex key with a 10 to 15 mm short leg as shown below.

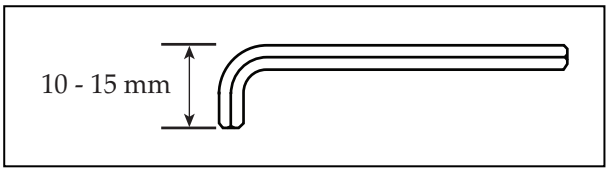


Figure 3-3. Hex Key with Short Leg

1. Slide the upper U-joint over the joint 4 motor output shaft on the robot base.

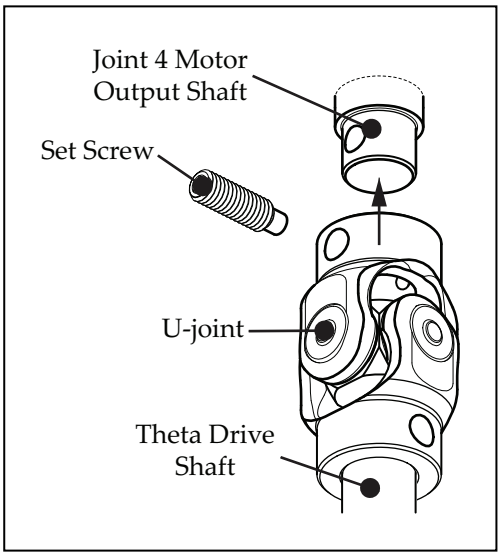


Figure 3-4. Upper U-joint Attachment

2. Align the set screw hole on the U-joint with the set screw hole on the output shaft.
3. Apply Loctite 243 or equivalent thread locking compound to the set screw, insert it into the U-joint screw hole, and tighten to 3.5 N-m.
4. Repeat steps 1 through 3 to attach the lower U-joint to the platform to complete this installation procedure.

3.4 Installing the Platform

After the robot base is attached to the frame, the platform must be installed. The basic platform installation steps are provided below.

1. Align the platform (4 axis version only).
2. Attach the outer arms.
3. Attach the platform.
4. Attach the theta drive shaft (4 axis version only).

Align the Platform with the Robot Base

Robots with the 4 axis option include a platform that must be aligned with the robot base for correct operation. These platforms are asymmetric because of the drive shaft connection point.

Both the theta drive shaft attachment on the robot base and on the platform are offset by about 50 mm from the centers of the robot base and tool flange. The platform should be attached so that the drive shaft aligns with the attachment points on the base and the platform.

IMPORTANT: Robots without the 4 axis option do not need alignment because the platform is symmetrical.

CAUTION: PROPERTY DAMAGE RISK
Incorrect alignment of the platform with the robot base will result in incorrect robot performance and possible damage to the drive shaft.

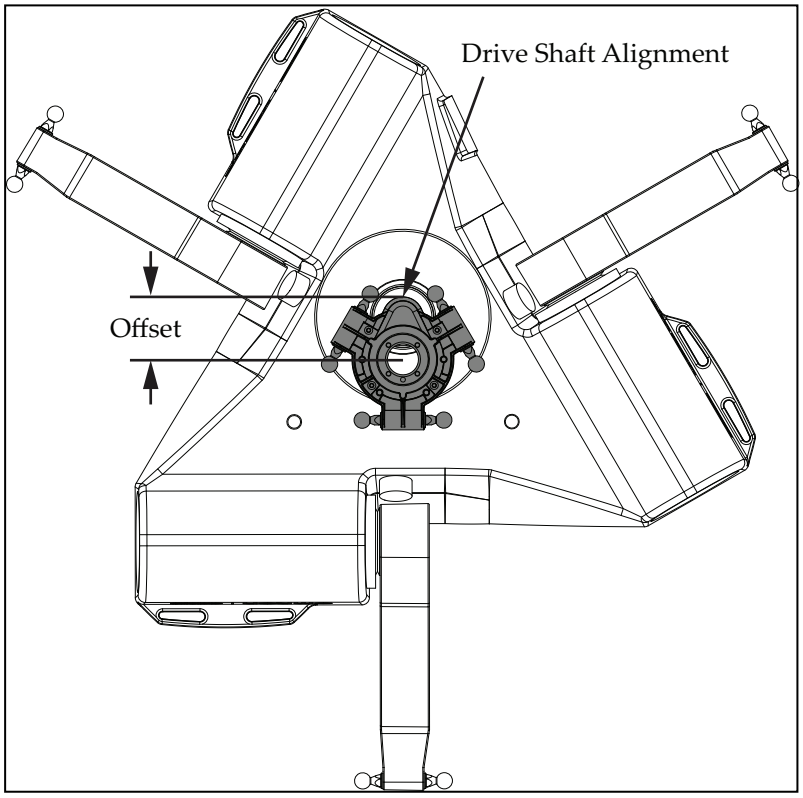


Figure 3-5. Platform Drive Shaft Alignment (Bottom View)

Attach the Outer Arms

Three pairs of outer arms attach between each inner arm and the platform. Outer arms can be attached without the use of any tools. Outer arms are fastened with ball and socket connections. Outer arm pairs are shipped assembled. Each pair has two springs and two horseshoes at each end.

CAUTION: PINCH RISK
Ball joints are spring-loaded. Be careful not to pinch your fingers.

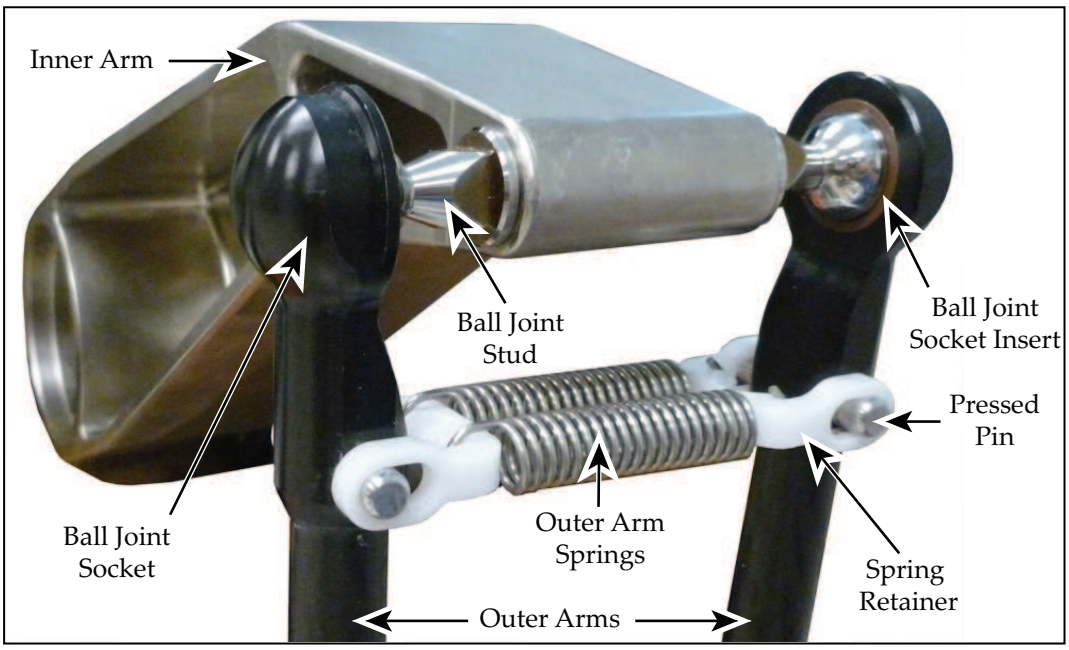


Figure 3-6. Outer Arm Attachment Hardware

Outer Arm Attachment Procedure

Use the following procedure to attach the outer arms. The procedure is the same for both platform types.

NOTE: In the following steps, take care not to trap debris between the ball studs and their sockets.

1. Attach one pair of outer arms to each inner arm.

CAUTION: PROPERTY DAMAGE RISK
Ensure that the ball joint socket inserts are in place in the end of each outer arm.

As illustrated in the following figure, the outer arm assembly is most easily achieved by

pivoting the two arms away from each other lengthwise. This requires the least stretching of the spring to attach the ball joints.

Figure 3-7. Pivot to Install Outer Arms

a. Slip one ball joint socket over the corresponding ball stud.
b. Swing the bottom end of the outer arm pair sideways as you slip the other ball joint socket over the corresponding ball stud.

CAUTION: PROPERTY DAMAGE RISK
Do not overstretch the outer arm springs. Separate the ball joint sockets only enough to fit them over the ball studs.

2. Attach one pair of outer arms to each of the three pairs of ball studs on the platform.
   a. Swing the bottom end of the outer arm pair to the right, as far as possible.
   b. Slip the right ball joint socket over the right ball stud. Move the platform as needed to do this.
   c. Move the platform and outer arm pair to the left as you slip the left ball joint socket over the corresponding ball stud.
3. Ensure that all spring hooks are fully-seated in the grooves of the spring retainers, as shown in the following figure.

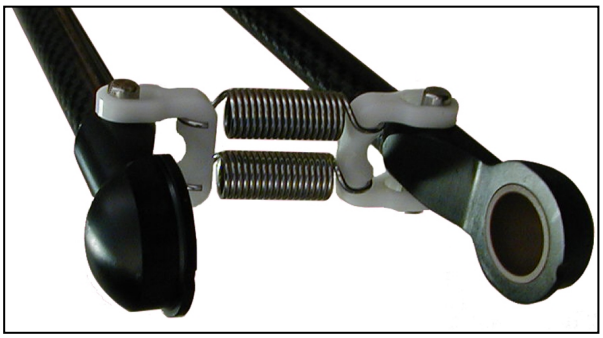


Figure 3-8. Springs Seated Properly

After all outer arms are fastened to both the inner arms and platform, the platform installation procedure is complete.

3.5 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.

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

Mounting the Front Panel

Use dimensions provided in the figure below when mounting the Front Panel.

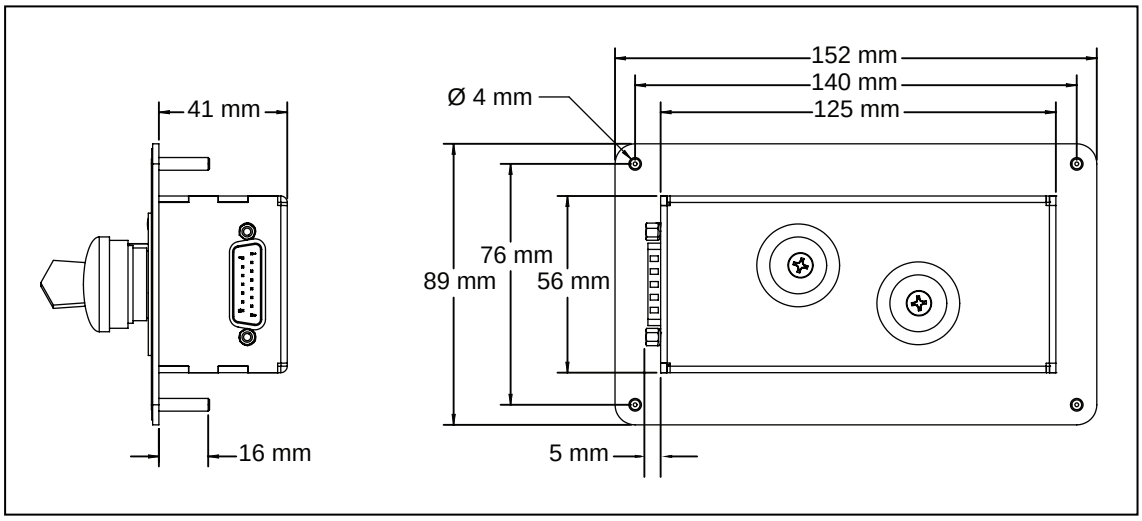


Figure 3-9. Front Panel Dimensions

Connecting the Front Panel

The Front Panel is connected to the XFP connector on the XSYSTEM cable using the supplied Front Panel extension cable.

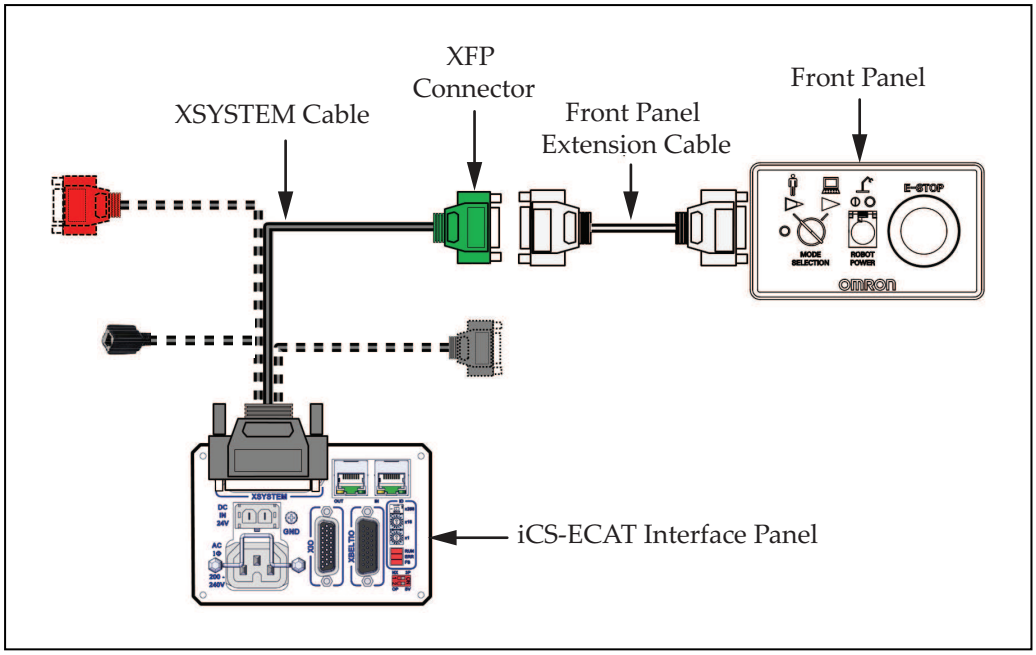


Figure 3-10. Front Panel Connections

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.

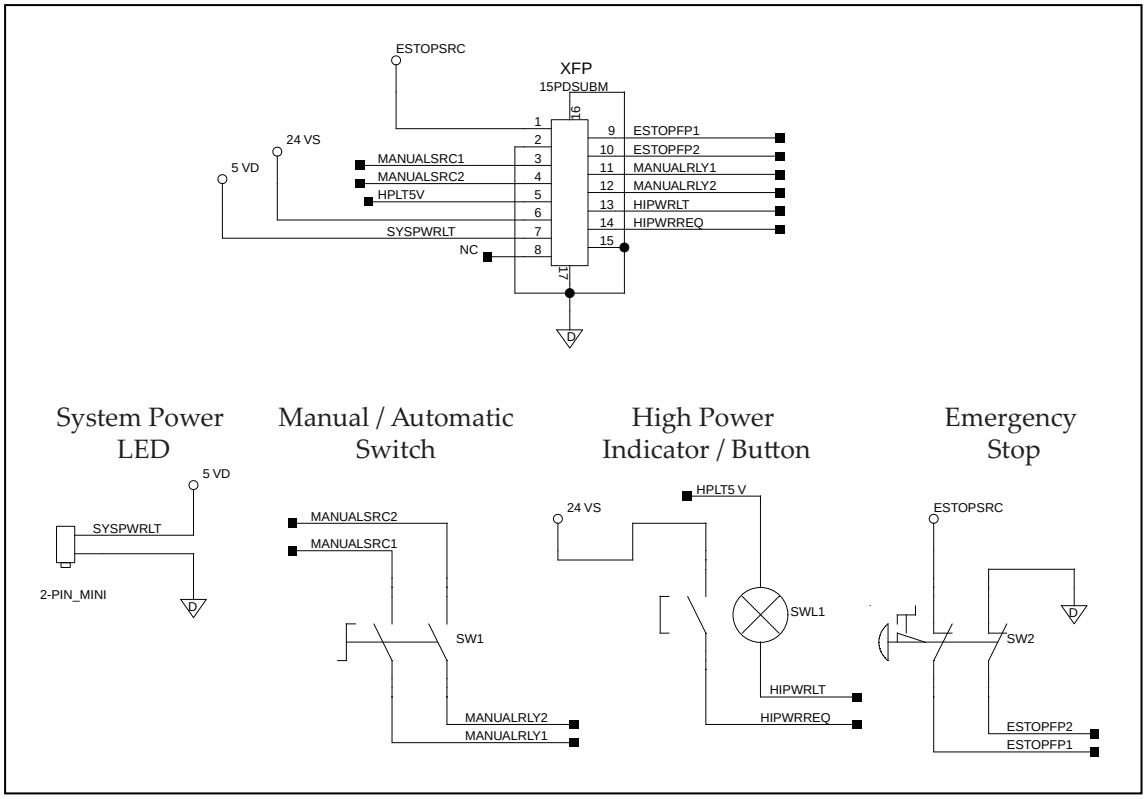


Figure 3-11. Front Panel Schematic

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

3.6 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.

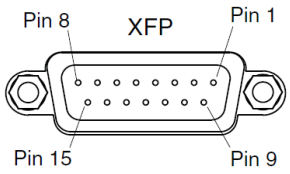
Table 3-2. XUSR Connector Signals

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		
7, 20	E-Stop indication CH 1	Contacts are closed when Front Panel, pendant, and user E-Stops are *not* tripped
8, 21	E-Stop indication CH 2 (same as pins 7, 20)	Contacts are closed when Front Panel, pendant, and userE-Stops are *not* 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 3-3. 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 3-11. 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 3-4. 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

E-Stop Circuits on XUSR and XFP Connectors

The following figure shows E-Stop circuits for the system.

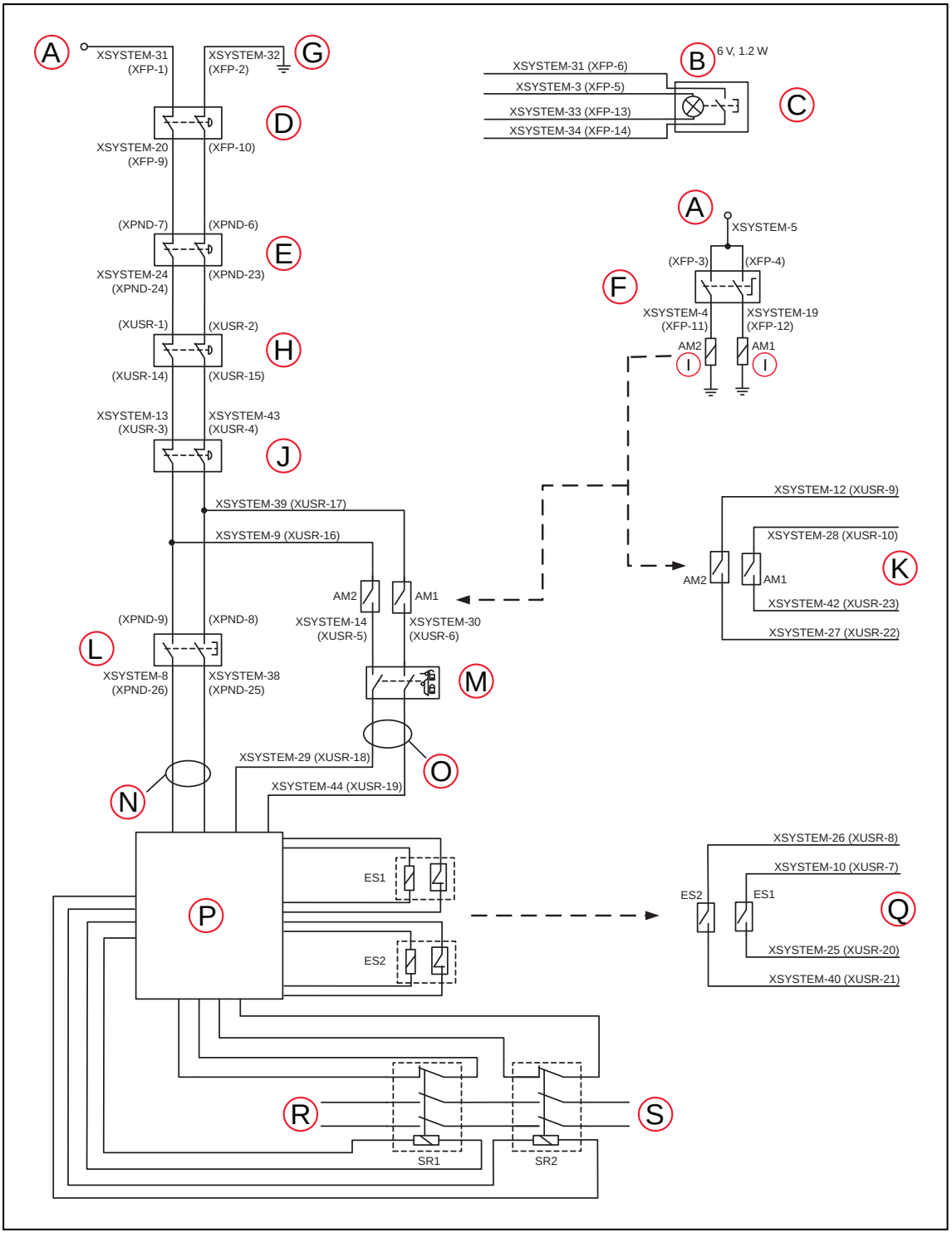


Figure 3-12. E-Stop Circuit on XUSR and XFP Connectors

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 to 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 3-12.

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 3-12. .

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 3-12.

> **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 3-12.) 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 3-12. and Figure 3-11. for the user E-Stop circuitry).

Line E-Stop Input

The XUSR connector on the controller contains a two-channel Line E-Stop input for workcell, production line, or other equipment emergency-stop inputs. Refer to item J in Figure 3-12.

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 3-12. 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 3-12.

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 51 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 42. 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 3-12. 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 0.13 mm^2 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 42 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 3-12.

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 42 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 mm^2) 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.

3.7 Setting the EtherCAT Node ID

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

> **IMPORTANT:** Considerations must be made for the cable inlet box before switch settings are made. Refer to Installing a Cable Inlet Box on page 55 for more information.

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 53 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 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.

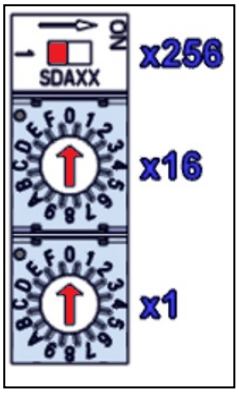


Figure 3-13. EtherCAT Node ID 0 Switch Setting

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.

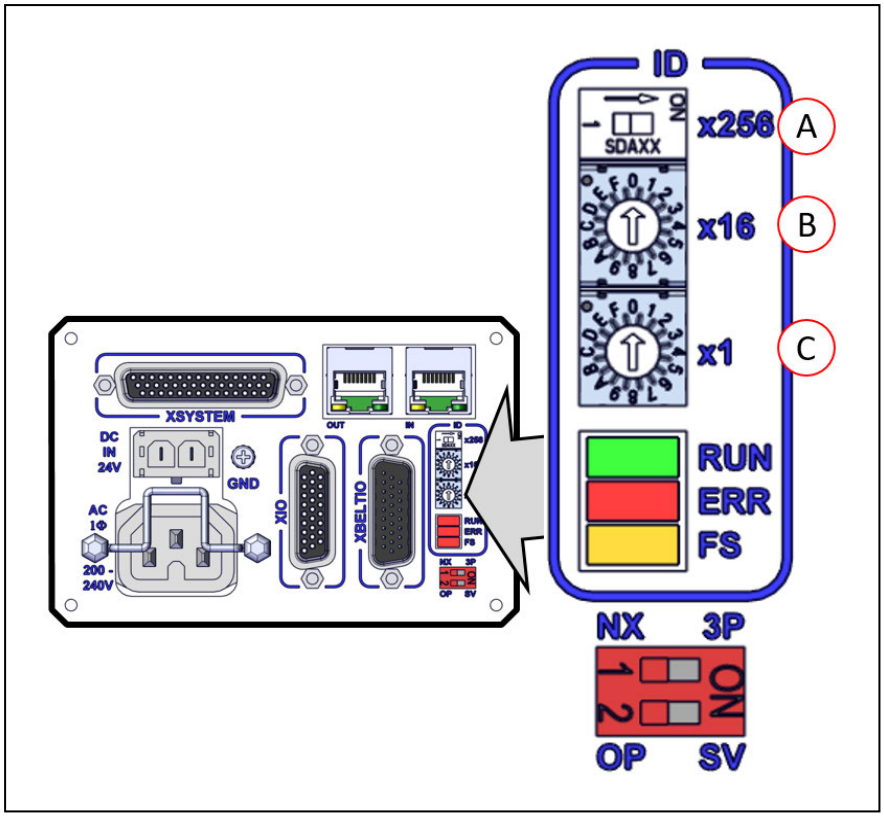


Figure 3-14. Robot Interface Panel EtherCAT ID Switches

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 Robot Integrated System Building Function with Robot Integrated CPU Unit Operation Manual (Cat. No. W595)* for more information.

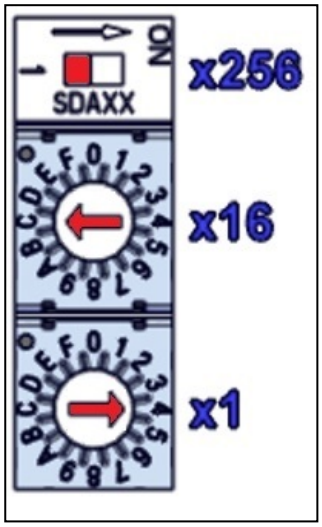


Figure 3-15. EtherCAT Node ID Set to 196

3.8 Installing End-of-Arm Tooling

Robots with 4 axis have a tool flange that rotates within the platform.

When mounting end-of-arm tooling to the tool flange, ensure that the fasteners used engage the threads in the tool flange between 8 mm and 11 mm.

Additional Information: Refer to Tool Flange Dimensions on page 123 for more information.

3.9 Installing a Cable Inlet Box

Use the following procedure to install an optional cable inlet box to increase the IP rating of the robot.

Consider the extra height required to accommodate this unit.

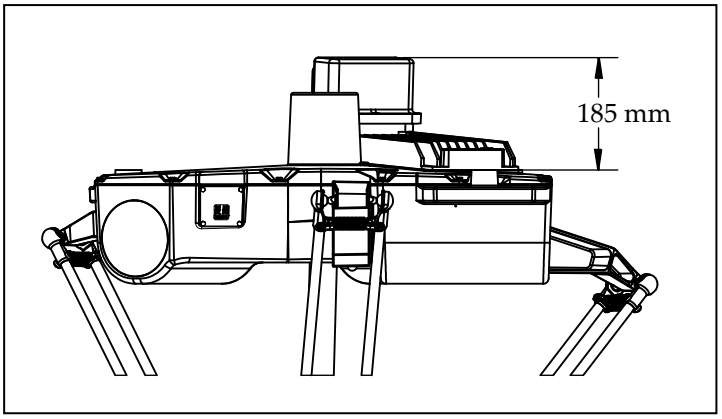


Figure 3-16. Cable Box Height

1. Measure and mark all cables at 250 to 300 mm from the cable ends. This amount of slack is needed to install the seal assembly after the connections are made to the iCS-ECAT.
2. Install the cable seal housing on the top of the iCS-ECAT using four M4 x 50 screws, four M4 lock washers, and four M4 flat washers. Note that the centered M6-threaded hole must be toward the center of the robot base (refer to the figure below). Ensure that the gasket is seated between the iCS-ECAT surface and the cable seal housing.

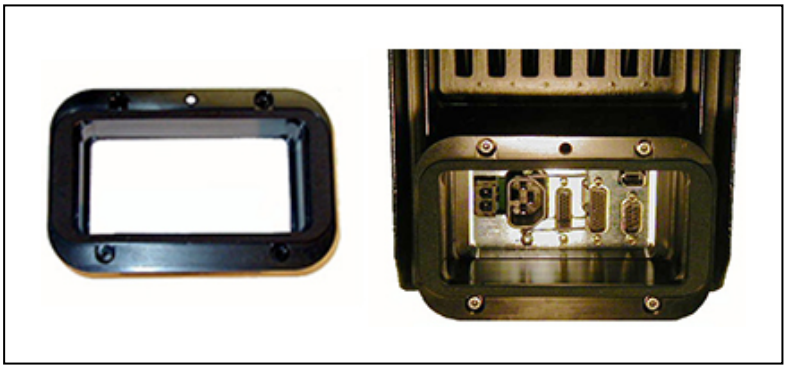


Figure 3-17. Cable Seal Housing (left), Installed (right)

3. Roxtec modules to fit the cables that will be used by peeling out half-circle strips from the modules. There should be a 0.1 to 1.0 mm gap between the halves of the modules for a proper seal as shown in the following figure.

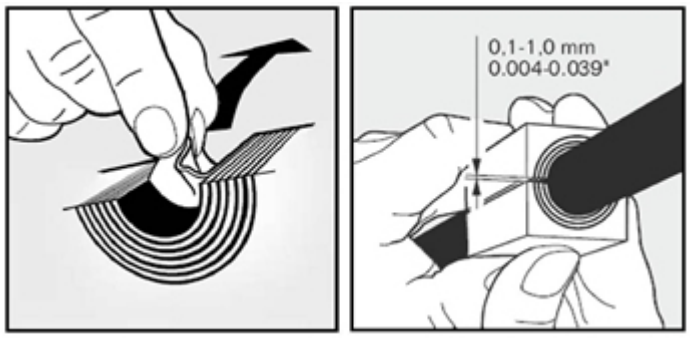


Figure 3-18. Adapting a Module to the Cable Size, Checking the Gap

4. Grease the Roxtec modules using the supplied grease.

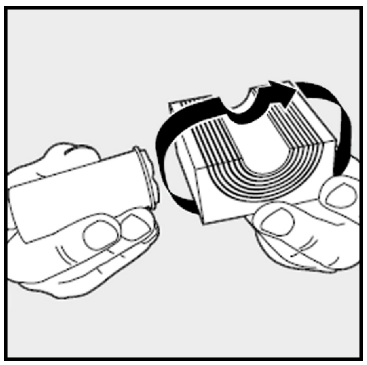


Figure 3-19. Greasing a Roxtec Module

5. Grease the inside of the CF frame where the modules will contact using the supplied grease.
6. Install each cable through its corresponding module and insert the modules into the frame. Ensure that the terminated cable ends have 250 to 300 mm of slack.

IMPORTANT: Cables must be prepared and routed before proceeding with this step. Refer to System Cable Installation on page 61 for more information.

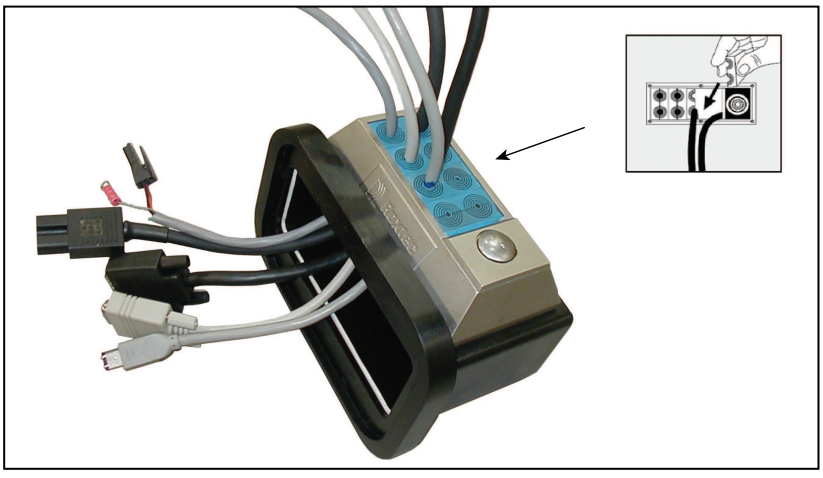


Figure 3-20. Installing Cables

7. When all of the modules are in place, tighten the compression unit to 8 - 12 N-m. There should be no visible gaps between the modules or around the cables.

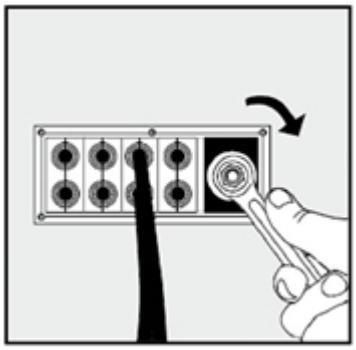


Figure 3-21. Tightening the Compression Unit

8. Attach all cables to the iCS-ECAT.
9. Attach the cable entry top cover with Roxtec frame and modules to the iCS-ECAT cable seal housing. After the top cover is attached, this installation procedure is complete.
    - Slide the top cover over the seal housing lip as shown in the following figure.
    - Ensure that the gasket between the top cover and the cable seal housing is seated, and that all cables are contained within the top cover.
    - Lower the top cover onto the seal housing and secure with one screw.

Figure 3-22. Installing Cable Entry Top Cover Assembly

3.10 Installing or Removing Ball Stud Locks

Use the following procedure to install or remove optional ball stud locks.

Installing Ball Stud Locks

Use the following procedure to install ball stud locks.

1. Align the groove in the ball stud lock with the lip in the ball joint socket and then slide the ball stud lock into position. No tools are required for this step.

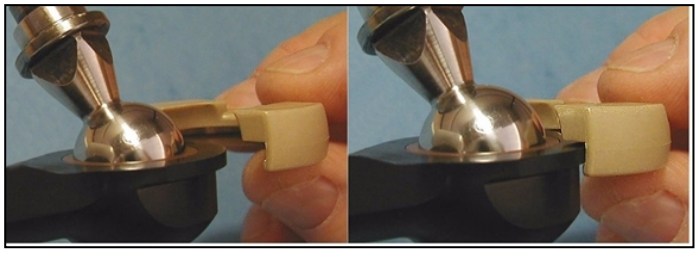


Figure 3-23. Slide the Ball Stud Lock Into Position

2. Twist the ball stud lock back-and-forth slightly to ensure that it is fully seated. A fully seated ball stuck lock is shown below.

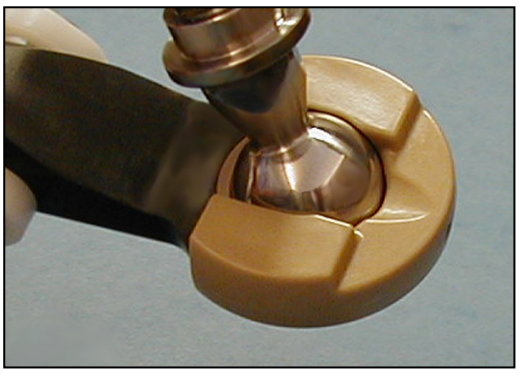


Figure 3-24. Ball Stud Lock in Correct Position

3. Repeat steps 1 and 2 for all ball stud locks to complete this procedure.

Removing Ball Stud Locks

To remove a ball stud lock, pull one end of the lock away from the ball joint socket. The lock will slide off with some resistance. No tools are needed for this removal.

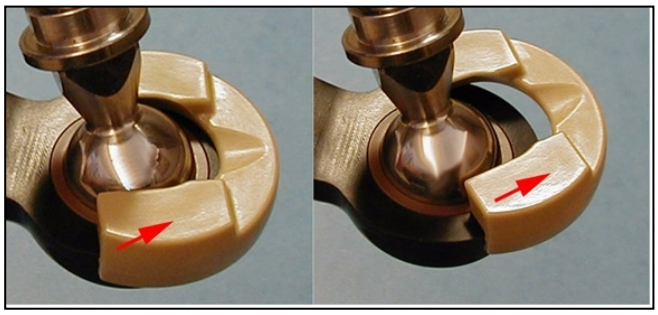


Figure 3-25. Removing a Ball Stud Lock

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
iX3 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.

WARNING: 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 63

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 representative for more information.

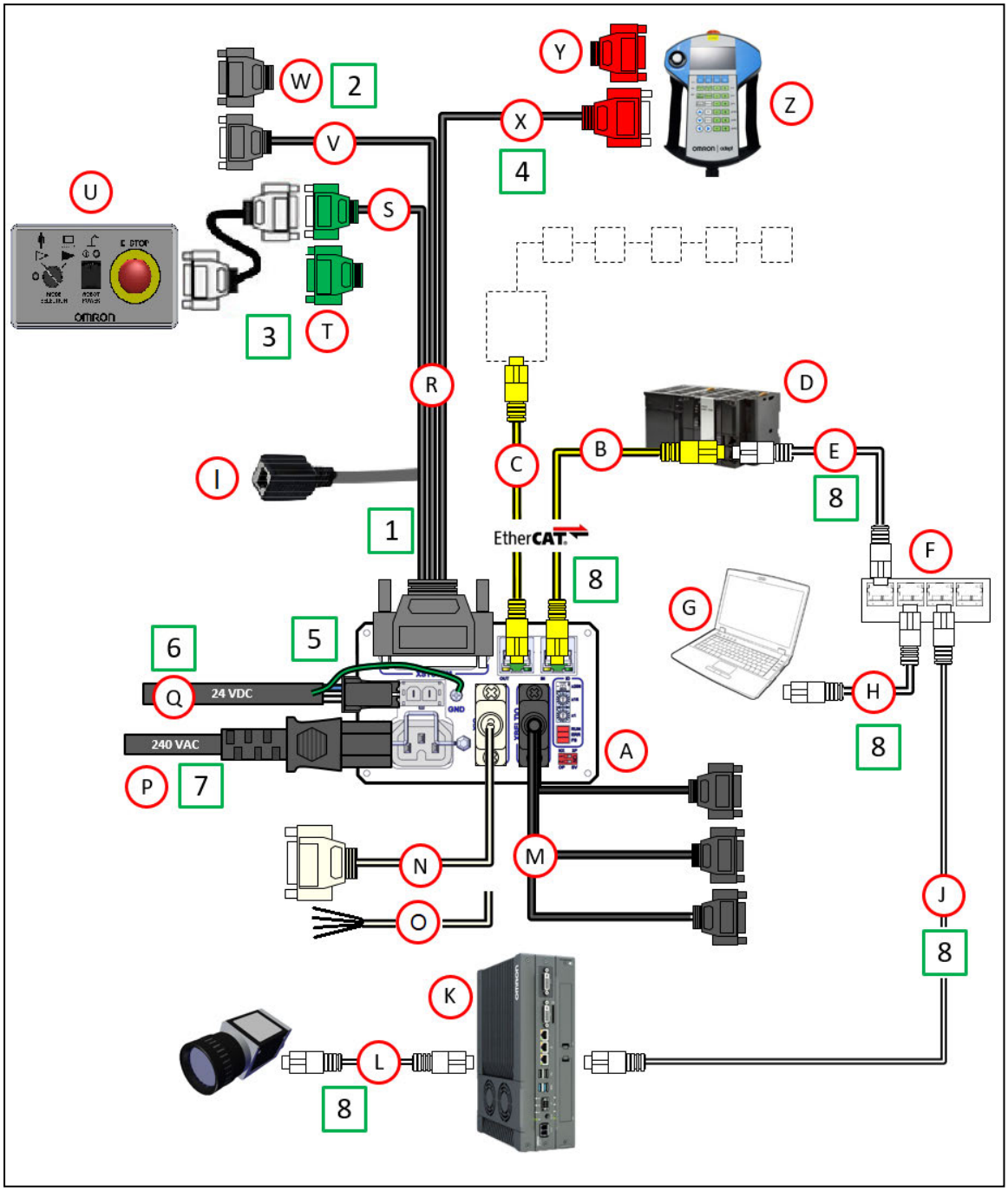


Figure 4-1. Typical System Cable Connections

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	Inbound EtherCAT cable				X
C	Outbound EtherCAT cable				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 Cable	03695-000		X	
O	XIO Breakout Cable	04465-000		X	
P	200 to 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		

Part	Cable and Parts List	Part #	Standard	Option	User Supplied
S	XFP Connector on XSYSTEM cable		X		
T	XFP Jumper Plug[3]	10052-000	X		
U	Front Panel[4]	90356-10358	X		
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	

NOTES:

[1] A USB cable can be used as a direct connection between the PC and the NJ-series Robot Integrated CPU Unit.

[2] This assembly also includes the XFP Jumper Plug, XMCP Jumper Plug, and the XUSR Jumper Plug.

[3] Required if not using a Front Panel.

[4] Includes Front Panel Extension Cable (part number 10356-10500).

[5] Required if not using user-supplied E-Stop circuitry.

[6] Required if not using a pendant.

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.

IMPORTANT: Considerations must be made for the cable inlet box before connections are made. Refer to Installing a Cable Inlet Box on page 55 for more information.

Additional Information: Refer to iCS-ECAT Robot Interface Panel on page 12 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	W, V

Step	Connection	Item
	connector. The XUSR jumper plug may be used on the XSYSTEM cable XUSR connector for diagnostic purposes only.	
3	Connect the Front Panel cable to Front Panel and XSYSTEM cable XFP connector. The Front Panel jumper plug may be used on the XSYSTEM cable XFP connector for diagnostic purposes only.	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
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 to 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 representative 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.

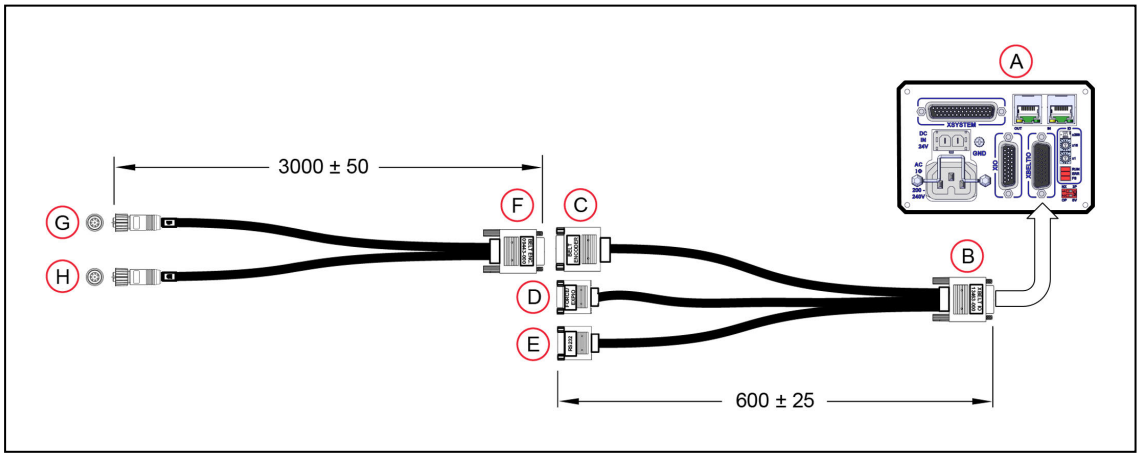


Figure 4-2. System Cable Diagram with Belt Encoders (Units in mm)

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
D	EXPIO Branch Connector					DB9 Male
E	RS-232 Branch Connector					DB9 Male
F	Belt Y Splitter Cable Connector	09443-000		X	X	DB15 Female
G	Belt Encoder 1 Connector					M12 Female, 8 pin
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

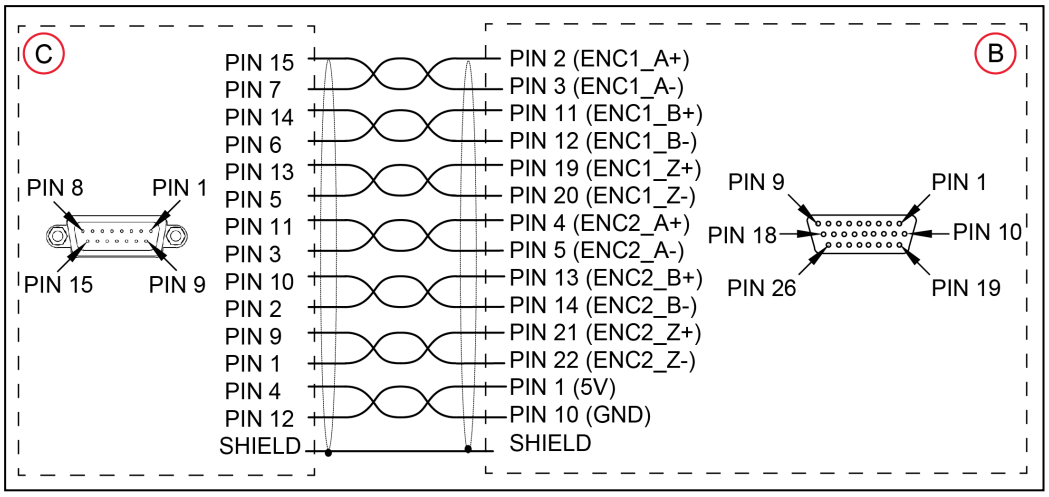


Figure 4-3. XBELT I/O Adapter Cable Pinout - Encoder 1 and 2 Connections

RS-232

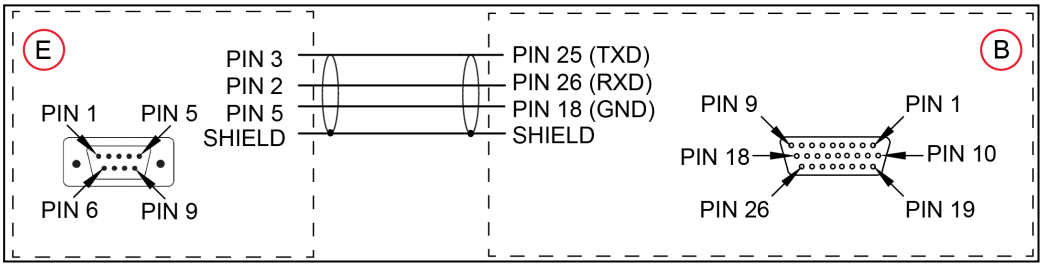


Figure 4-4. XBELT I/O Adapter Cable Pinout - RS-232 Connections

FORCE / EXPIO

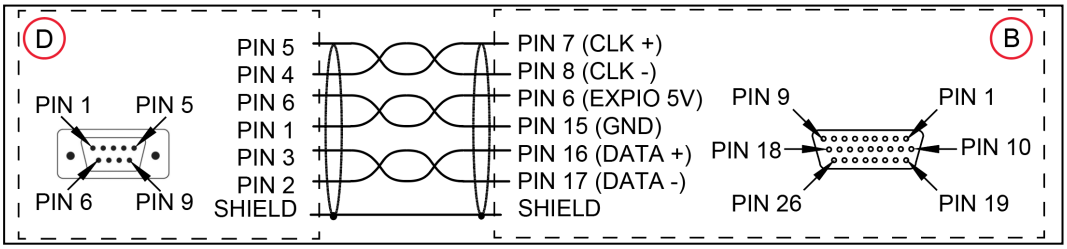


Figure 4-5. XBELT I/O Adapter Cable Pinout - EXPIO Connections

Splitter Cable

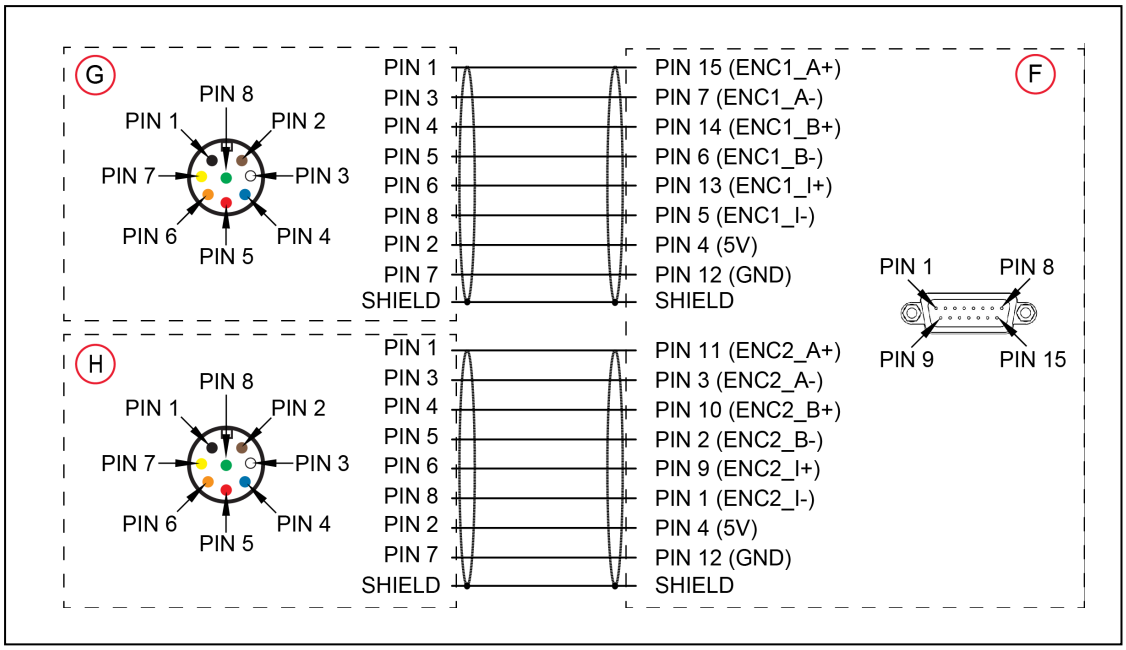


Figure 4-6. Belt Y Splitter Cable Pinout - 2 Encoder Connections

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 75
IO Blox connect to FORCE/EXPIO branch of the XBELTIO cable.	8 inputs, 8 outputs per device, up to 4 IO Blox devices	Refer to *the IO Blox User's Guide (04638-000)*
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.

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.

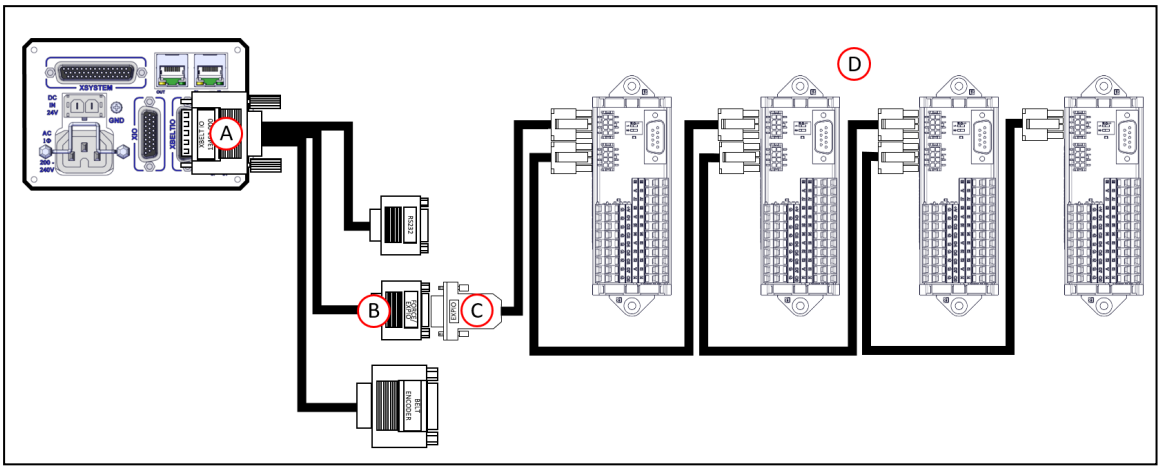


Figure 4-7. Connecting IO Blox to the system (maximum of 4 for Standard, 8 for Pro)

Item	Description
A	XBELT IO Cable (part number 13463-000) connected to XBELTIO connector on the robot interface panel
B	FORCE/EXPIO Connector on XBELTIO cable
C	IO Blox-to-Robot cable (3 m), part number 04677-030
D	IO Blox units, 4 units maximum, part number

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.

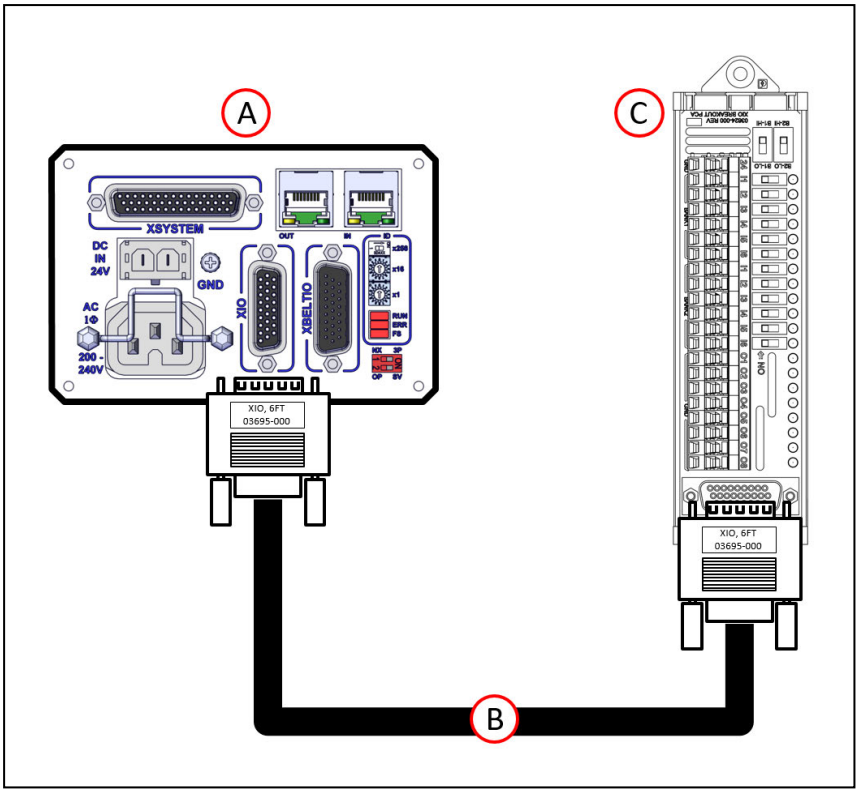


Figure 4-8. Connecting XIO Termination Block

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 2 m 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 V+ programming language uses numeric signal numbers with possible outputs and inputs 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
	XBELTIO	IOBlox	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
2	XIO	XIO	N/A	Inputs on the iCS-ECAT	1101 to 1112
	XBELTIO	IOBlox	OFF, OFF	Inputs on IOBlox 1	1133 to 1140
			ON, OFF	Inputs on IOBlox 2	1141 to 1148
			OFF, ON	Inputs on IOBlox 3	1149 to 1156
			ON, ON	Inputs on IOBlox 4	1157 to 1164
3	XIO	XIO	N/A	Inputs on the iCS-ECAT	1201 to 1212
	XBELTIO	IOBlox	OFF, OFF	Inputs on IOBlox 1	1233 to 1240
			ON, OFF	Inputs on IOBlox 2	1241 to 1248
			OFF, ON	Inputs on IOBlox 3	1249 to 1256
			ON, ON	Inputs on IOBlox 4	1257 to 1264
4	XIO	XIO	N/A	Inputs on the iCS-ECAT	1301 to 1312
	XBELTIO	IOBlox	OFF, OFF	Inputs on IOBlox 1	1333 to 1340
			ON, OFF	Inputs on IOBlox 2	1341 to 1348

Robot	Connector	Channel	Switch Position (1, 2)	Type	Signal Number
			OFF, ON	Inputs on IOBlox 3	1349 to 1356
			ON, ON	Inputs on IOBlox 4	1357 to 1364
5	XIO	XIO	N/A	Inputs on the iCS-ECAT	1401 to 1412
	XBELTIO	IOBlox	OFF, OFF	Inputs on IOBlox 1	1433 to 1440
			ON, OFF	Inputs on IOBlox 2	1441 to 1448
			OFF, ON	Inputs on IOBlox 3	1449 to 1456
			ON, ON	Inputs on IOBlox 4	1457 to 1464
6	XIO	XIO	N/A	Inputs on the iCS-ECAT	1501 to 1512
	XBELTIO	IOBlox	OFF, OFF	Inputs on IOBlox 1	1533 to 1540
			ON, OFF	Inputs on IOBlox 2	1541 to 1548
			OFF, ON	Inputs on IOBlox 3	1549 to 1556
			ON, ON	Inputs on IOBlox 4	1557 to 1564
7	XIO	XIO	N/A	Inputs on the iCS-ECAT	1601 to 1612
	XBELTIO	IOBlox	OFF, OFF	Inputs on IOBlox 1	1633 to 1640
			ON, OFF	Inputs on IOBlox 2	1641 to 1648
			OFF, ON	Inputs on IOBlox 3	1649 to 1656
			ON, ON	Inputs on IOBlox 4	1657 to 1664
8	XIO	XIO	N/A	Inputs on the iCS-ECAT	1701 to 1712
	XBELTIO	IOBlox	OFF, OFF	Inputs on IOBlox 1	1733 to 1740

Robot	Connector	Channel	Switch Position (1, 2)	Type	Signal Number
			ON, OFF	Inputs on IOBlox 2	1741 to 1748
			OFF, ON	Inputs on IOBlox 3	1749 to 1756
			ON, ON	Inputs on IOBlox 4	1757 to 1764

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
	XBELTIO	IOBlox	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
2	XIO	XIO	N/A	Outputs on the iCS-ECAT	101 to 108
	XBELTIO	IOBlox	OFF, OFF	Outputs on IOBlox 1	133 to 140
			ON, OFF	Outputs on IOBlox 2	141 to 148
			OFF, ON	Outputs on IOBlox 3	149 to 156
			ON, ON	Outputs on IOBlox 4	157 to 164
3	XIO	XIO	N/A	Outputs on the iCS-ECAT	201 to 208
	XBELTIO	IOBlox	OFF, OFF	Outputs on IOBlox 1	233 to 240
			ON, OFF	Outputs on IOBlox 2	241 to 248

Robot	Connector	Channel	Switch Position (1, 2)	Type	Signal Number
			OFF, ON	Outputs on IOBlox 3	249 to 256
			ON, ON	Outputs on IOBlox 4	257 to 264
4	XIO	XIO	N/A	Outputs on the iCS-ECAT	301 to 308
	XBELTIO	IOBlox	OFF, OFF	Outputs on IOBlox 1	333 to 340
			ON, OFF	Outputs on IOBlox 2	341 to 348
			OFF, ON	Outputs on IOBlox 3	349 to 356
			ON, ON	Outputs on IOBlox 4	357 to 364
5	XIO	XIO	N/A	Outputs on the iCS-ECAT	401 to 408
	XBELTIO	IOBlox	OFF, OFF	Outputs on IOBlox 1	433 to 440
			ON, OFF	Outputs on IOBlox 2	441 to 448
			OFF, ON	Outputs on IOBlox 3	449 to 456
			ON, ON	Outputs on IOBlox 4	457 to 464
6	XIO	XIO	N/A	Outputs on the iCS-ECAT	501 to 508
	XBELTIO	IOBlox	OFF, OFF	Outputs on IOBlox 1	533 to 540
			ON, OFF	Outputs on IOBlox 2	541 to 548
			OFF, ON	Outputs on IOBlox 3	549 to 556
			ON, ON	Outputs on IOBlox 4	557 to 564
7	XIO	XIO	N/A	Outputs on the iCS-ECAT	601 to 608
	XBELTIO	IOBlox	OFF, OFF	Outputs on IOBlox 1	633 to 640

Robot	Connector	Channel	Switch Position (1, 2)	Type	Signal Number
			ON, OFF	Outputs on IOBlox 2	641 to 648
			OFF, ON	Outputs on IOBlox 3	649 to 656
			ON, ON	Outputs on IOBlox 4	657 to 664
8	XIO	XIO	N/A	Outputs on the iCS-ECAT	701 to 708
	XBELTIO	IOBlox	OFF, OFF	Outputs on IOBlox 1	733 to 740
			ON, OFF	Outputs on IOBlox 2	741 to 748
			OFF, ON	Outputs on IOBlox 3	749 to 756
			ON, ON	Outputs on IOBlox 4	757 to 764

XIO Connector Signals

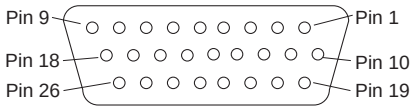
The XIO connector on the robot interface panel offers access to digital I/O (12 inputs and 8 outputs). Refer to the following table for the XIO signal designations.

- 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

Pin No.	Designation	Signal Bank	eV+ Signal Number
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. The driver draws power from the primary 24 VDC input to the robot through a self-resetting polyfuse.

This driver has overtemperature protection, shorted load protection, and is current limiting. If there is an output short or other over-current condition, the affected output of the driver integrated circuit turns OFF until the condition is removed.

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. A 24 VDC, 6 A power supply is recommended 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 132 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 Power Connector Specifications on page 144 for more information.

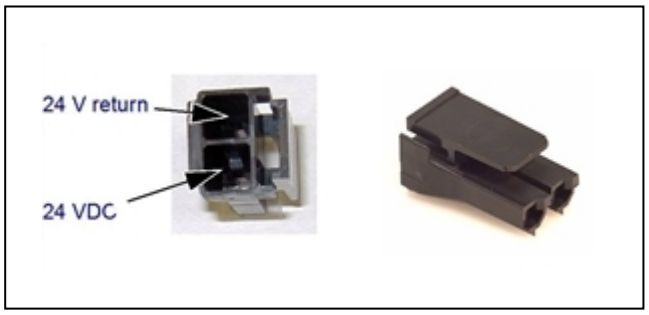


Figure 4-9. 24 VDC Mating Connector Pin Arrangement

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 mm^2 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 132 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.

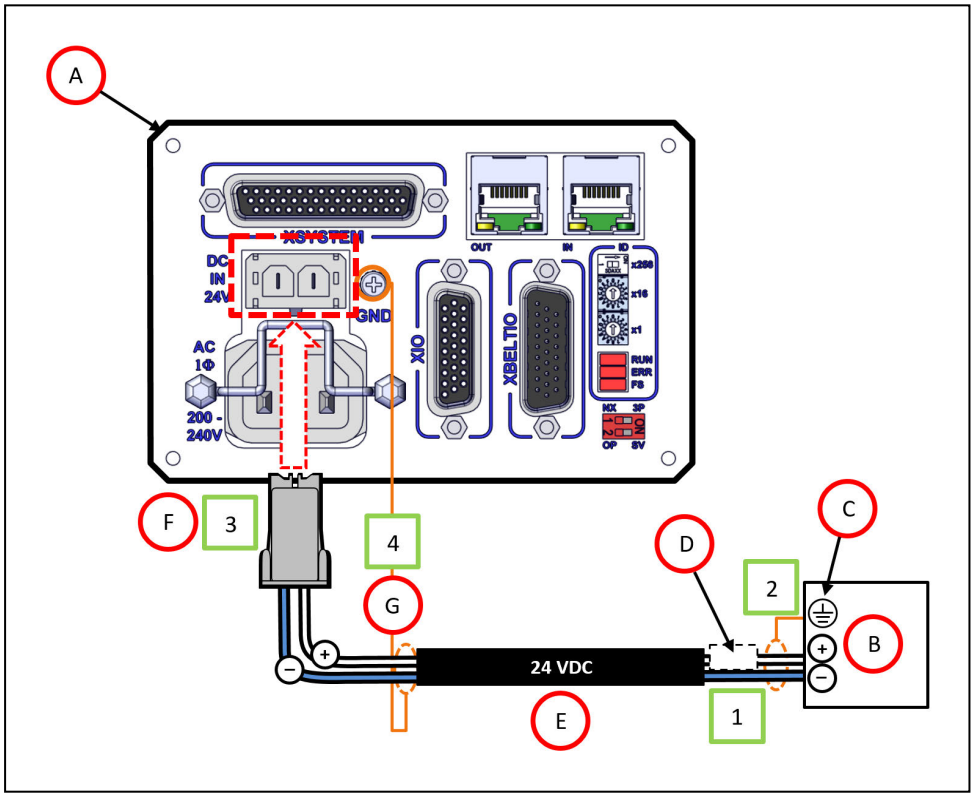


Figure 4-10. User-Supplied 24 VDC Cable, Power Supply

Item	Description
A	Robot interface panel
B	User-supplied 24 VDC power supply

Item	Description
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 AC Power Cable

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

Additional Information: Refer to External Connection Specifications on page 132 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
iX3 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.

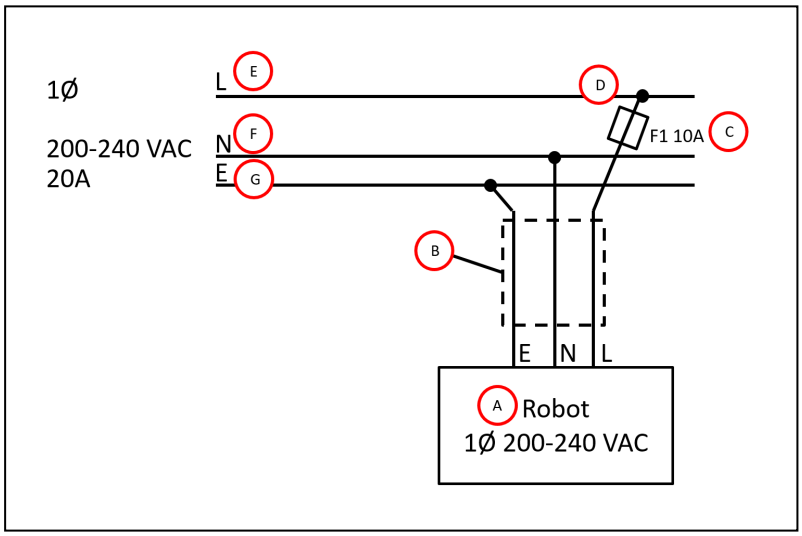


Figure 4-11. Typical AC Power Installation with Single-Phase Supply

Item	Description
A	Robot 1Ø 200 to 240 VAC
B	User-supplied AC power cable
C	F1 - 10A
D	**NOTE:** F1 is user-supplied, and must be slow-blow

Item	Description
E	L=Line
F	N=Neutral
G	E=Earth Ground

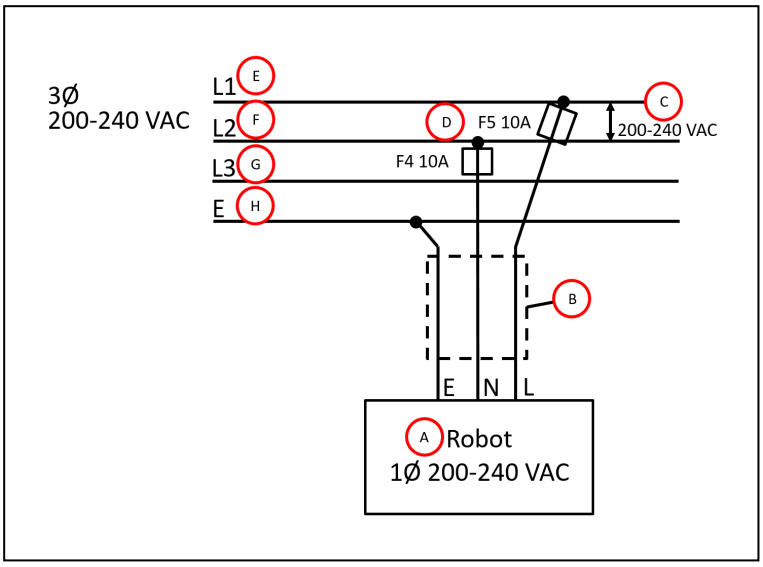


Figure 4-12. Single-Phase Load across L1 and L2 of a Three-Phase Supply

Item	Description
A	Robot 1Ø 200 to 240 VAC
B	User-supplied AC power cable
C	200 to 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 Power Connector Specifications on page 144 for more information.

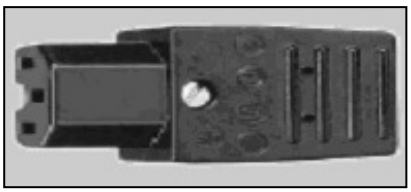


Figure 4-13. AC Power Supply Connector

Making the AC Power Supply Cable

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

Before you begin, you will need 3-wire, 0.8 mm^2 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.

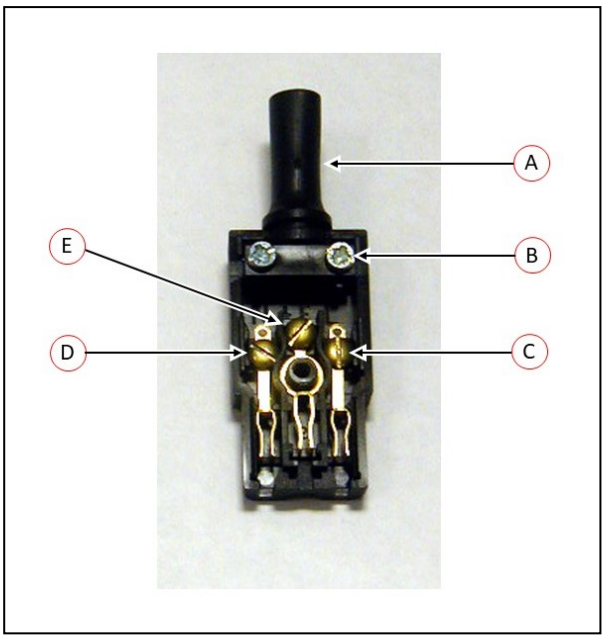


Figure 4-14. AC Power Mating Connector

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

AC Power Supply Cable Connection Procedure

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 132 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.

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

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

If hazardous voltages are present at any user-supplied robot-mounted equipment or tooling, you must install a ground connection for that equipment or tooling. Hazardous voltages can be considered anything in excess of 30 VAC (42.4 VAC peak) or 60 VDC.

If there will be hazardous voltages present at the tool flange or end-effector, you must:

- Connect the mounting frame to protective earth ground.
- Ground the robot base to the mounting frame.

  The iCS-ECAT is grounded to the robot base through a conductive gasket.
- Ground the end-effector to the robot base.

NOTE: A ground strap from the end-effector to the base mounting pad must include a service loop that allows full rotation and movement of the tool flange with 4 axis robots.

Grounding the Robot Base

The robot base must be properly grounded to the mounting frame.

If the frame is painted where the M12 screw makes contact with it, use a ring terminal under the star washer and connect the other end of the wire from the terminal to a suitable grounding surface on the frame.

If the frame is not painted where the M12 screw makes contact with it, you do not need to use a ring terminal. Use an external-tooth star washer under the mounting screw head.

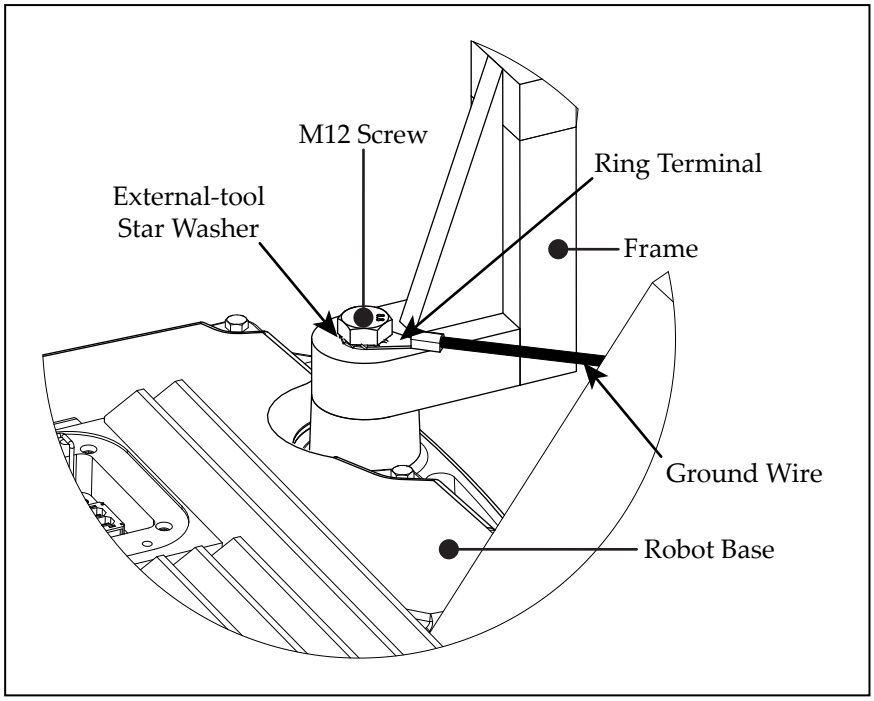


Figure 4-15. Grounding Details

The following considerations must be made when grounding the robot base.

- Use any of the three M12 mounting screws for the ground connection. Each of the mounting points has the following ground label.

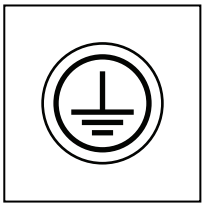


Figure 4-16. Ground Connection Label

- Ground screws must be stainless or zinc-plated steel.
- Use an external-tooth star washer touching the mounting screw head. Washers must be stainless or zinc-plated steel.

Chapter 5: System Operation

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

5.1 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.
- Ensure that all spring hooks are fully-seated in the grooves of the spring retainers.

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 a pendant is present, ensure it is connected to the XMCP connector 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 all safety devices are properly installed and connected to the XUSR connector on the XSYSTEM cable.
- 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 to 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 5-1. 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.

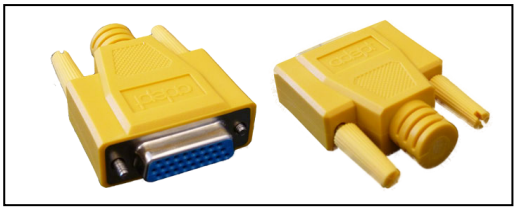


Figure 5-1. Safety Equipment Check Jumper Plug

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.

5.2 Robot Status LED and Display Panel

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

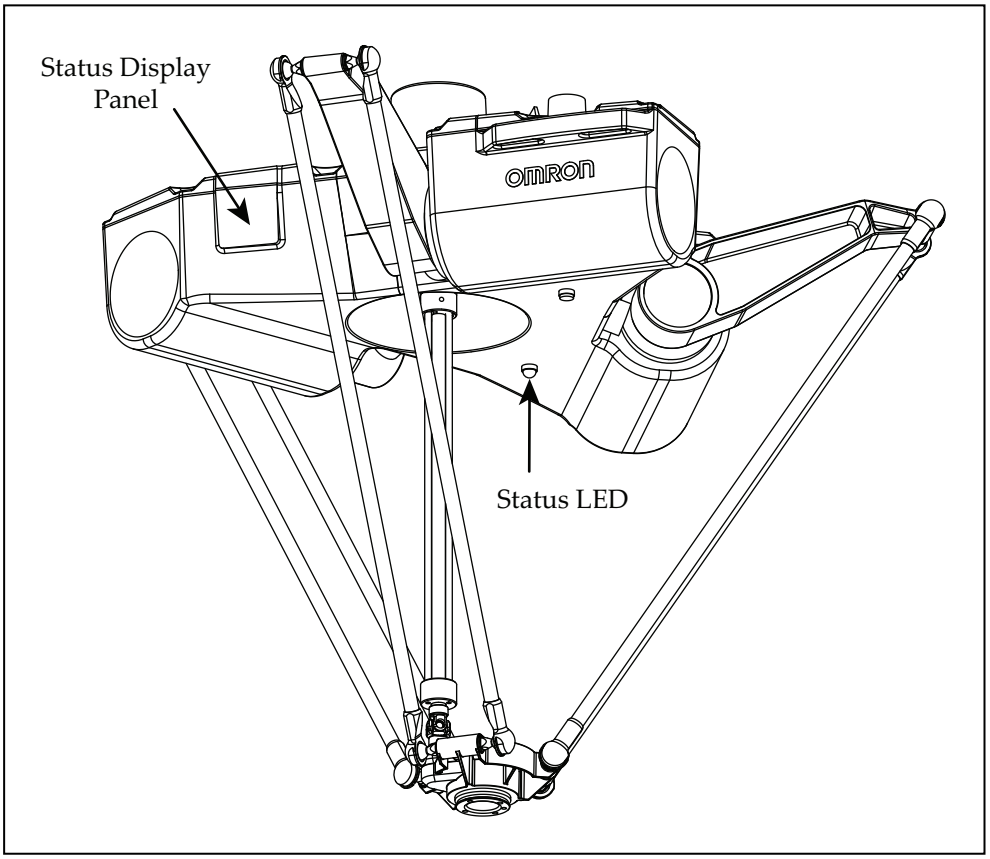


Figure 5-2. Robot Status LED and Display Panel

General Robot States

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

Table 5-2. 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 145 for more information.
ON Flashing (5 Hz)	Status Code(s)	System fault is present. Refer to Status Codes on page 145 for more information.

5.3 EtherCAT Communications Description

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

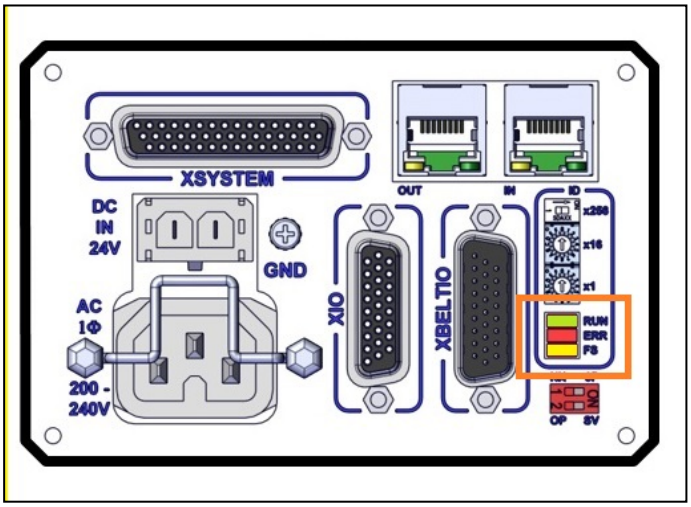


Figure 5-3. EtherCAT LED Location

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: • Only message communications are functioning. • Only message communications and I/O data input operations are functioning.
		Not lit	EtherCAT communications are stopped. • 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 an no network communication is possible, all robots on the network will stop with controlled 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 controlled deceleration and high power being disabled.

5.4 Brakes

An electromechanical brake system is provided to hold the platform in a fixed location when High Power is disabled. This prevents the system from moving due to gravity when power is not present. This brake system is automatically engaged when High Power is disabled. A brake is provided on each inner-arm motor.

The brake system prevents manually moving the robot when High Power is disabled.

> **NOTE:** The robot has a dynamic braking system that decelerates the robot in a controlled manner during an emergency or abnormal situation, such as when the emergency stop circuit is open or a robot joint passes its softstop.

Brake Release Button

Under some circumstances, you may want to manually position the platform without enabling High Power. For such instances, a Brake-Release button is located on the underside of the robot base.

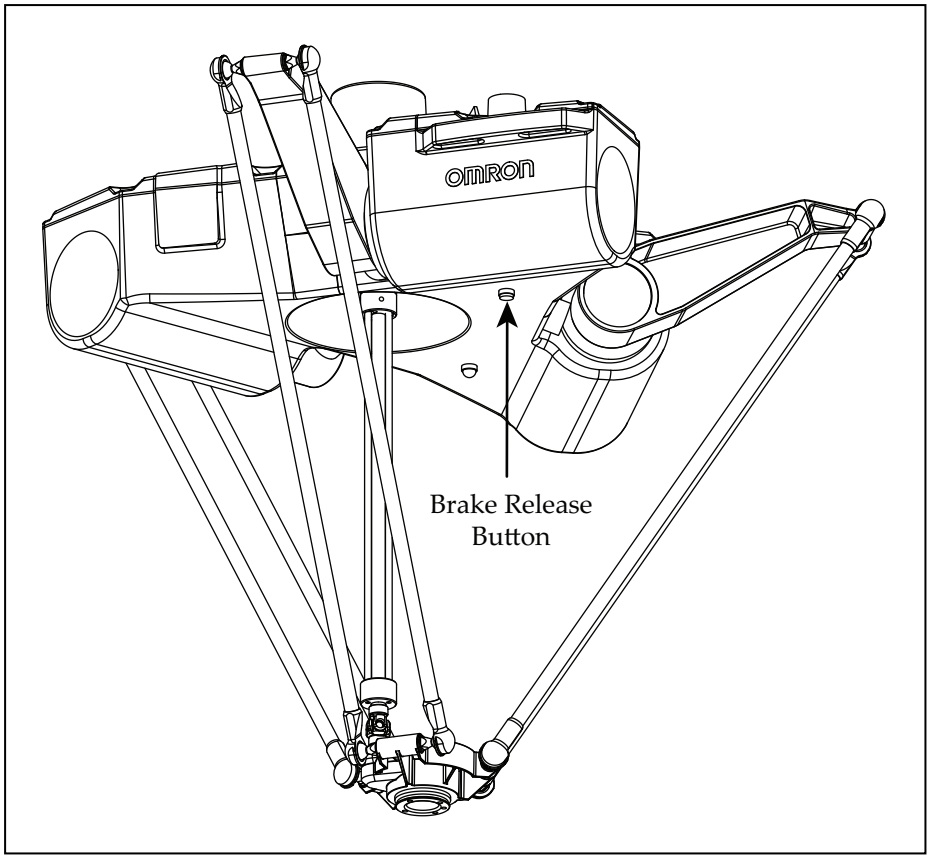


Figure 5-4. Brake Release Button Location

When system power is ON, pressing this button releases the brakes which allows movement of the arms.

CAUTION: PROPERTY DAMAGE RISK
When the Brake-Release button is pressed, the platform and end-effector may drop to the bottom of its travel. To prevent possible damage to the equipment, make sure that the platform is supported when releasing the brakes and verify that the end-effector or other installed tooling is clear of all obstructions.

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 the platform 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.

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 Robot Integrated System Building Function with Robot Integrated CPU Unit Operation Manual (Cat. No. W595)* 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 platform of the robot may fall due to gravity if the brake is released.

5.5 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.

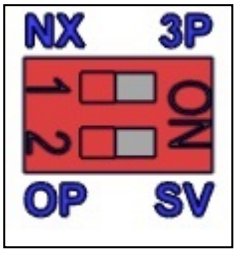


Figure 5-5. Operation Mode Selected

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.

5.6 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.

5.7 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 to 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 42 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 enable power button can be used to request high power to the robot.

Additional Information: Refer to Front Panel Schematic on page 42 for more information about connecting external devices to the high power enable signal on the XFP connector.

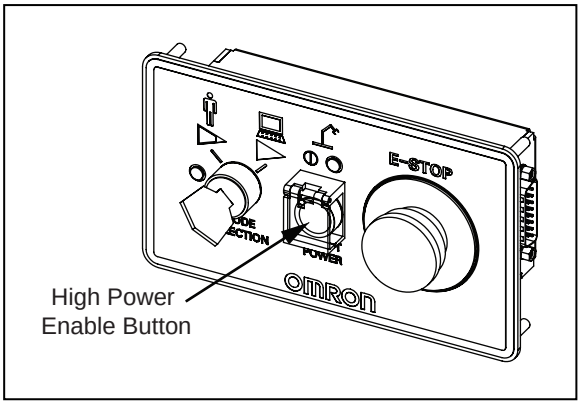


Figure 5-6. High Power Enable Button on Front Panel

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 Robot Integrated System Building Function with Robot Integrated CPU Unit Operation Manual (Cat. No. W595)* 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.
2. On the Front Panel, set the Mode Selection switch to Automatic mode, then press and release the High Power enable 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.

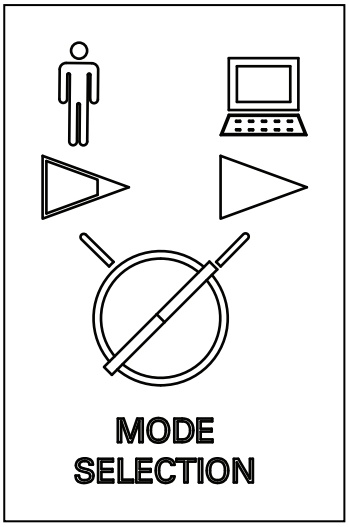


Figure 5-7. Front Panel Keyswitch in Automatic Mode

5.8 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 95 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.

Chapter 6: Maintenance

This chapter provides information about maintaining your robot.

During any maintenance activities, care must be taken involving AC power lockout. The cover and the iCS-ECAT on the robot are not interlocked. Turn OFF and disconnect power if these have to be removed. Lock out and tag out power before servicing.

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)*.

WARNING: ELECTROCUTION RISK
During maintenance, user-supplied fail-safe lockout measures must be used to prevent unauthorized third parties from turning on power. This is mandated by Clause 5.2.4 of the ISO 10218-1.

It is the user's responsibility to make sure adequate measures are taken for 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.

NOTE: Maintenance and cleaning of user-added optional equipment is the user's responsibility. It is not covered in this manual.

6.1 Periodic Maintenance Schedule

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

NOTE: The frequency of these procedures depends on the particular system, its operating environment, and amount of usage. Use the frequencies in the tables as guidelines and modify the schedule as needed.

Table 6-1. Suggested Inspection Schedule

Item	Frequency	Inspection	Remedy
Labels	1 Week	Check for presence and legibility of all labels on robot	Replace labels if damaged or missing.
User Cabling	1 Week	Inspect for wear around robot joints and possible binding on robot.	Replace if cracked or worn. Adjust position if binding.

Item	Frequency	Inspection	Remedy
Outer Arm Inserts	1 Week	Inspect inserts for excessive wear.	Replace worn inserts.
Front Panel High Power Indicator	1 Week	Inspect the operation of the Front Panel High Power indicator. Refer to High Power Indicator Check on page 102 for more information.	Replace the Front Panel if indicator is not operational.
Outer Arms	3 Months	Inspect outer arms for damage caused by possible accidental impact. Inspect springs and horseshoes for wear.	Replace arms if damaged. Replace springs and horse-shoes if worn or damaged.
Platform	3 Months	Inspect platform for damage caused by possible accidental impact.	Replace platform.
Robot Fans and Gear drives	1 Year	Partially remove iCS-ECAT and Status Display to inspect fans for operation. Look for lubrication leaking from gear drives. See Checking for Gear Drive Leaks on page 105 and Checking Fan Operation on page 106.	Diagnose non-operational fans. (Not field-replaceable) Replace gear drives.
Dynamic and Static seals	3 Months	Inspect dynamic seals on inner arms and static seals for sanitizing wash-down environments. Check for good seal con-tact, inflexible, broken, seals.	Platforms: replace platform. Inner arms: replace seals.
E-Stops	6 Months	Check functioning of E-Stops. See Checking Safety Systems on page 102.	Replace Front Panel, or cus-tomer E-Stops.
Robot Mounting bolts	3 Months	Check tightness of bolts. Proper torque should be 61 N-m.	Tighten bolts.
Cable Inlet Box seals	3 Months	Check for good seal contact, inflexible, or broken seals.	Replace seals.
iCS-ECAT seal	3 Months	Check for good seal contact, inflexible, broken, seal.	Replace seal.
Cable Inlet Box gas-kets	3 Month	Check for good gasket contact, inflex-ible, broken gaskets.	Replace gaskets.
Status Display Panel	3 Month	Check for water inside the display. Check for good seal contact, inflexible, or broken seal.	Replace seal.

Table 6-2. Suggested Part Replacement Schedule

Item	Suggested Interval	Description
Theta	1 Year or	Drive shaft bushings are a normal wear item. A bushing replacement kit is

Item	Suggested Interval	Description
Drive Shaft Bushings	5,000 hours	available as P/N 15005-000. Refer to Theta Drive Shaft Bushing Replacement Procedure on page 107. **NOTE:** Not all Theta Drive Shaft models are field serviceable.
Backup Encoder Battery Pack	2 years to 4 years	Refer to Replacing the Encoder Battery Pack on page 110.

6.2 Non-periodic Maintenance Schedule

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

Item	Description
Platform	Excessive wear or damage from accidental impact.
Ball Joint Inserts	Inspect ball joint socket inserts for excessive wear. Refer to Replacing a Ball Joint Socket Insert on page 113 for more information.
Springs and Retainers	Springs and spring retainers can be replaced in case of excessive wear or accidental breakage.
Outer Arms	Inspect for damage from accidental impacts.

6.3 Cleaning

The robot is designed to be compatible with moderate cleaning agents commonly used in the cleaning of food-processing equipment. All robot components are designed to handle daily exposure to cleaning agents. Exposure may result in some discoloration of the materials, but no significant material removal.

The platform and outer arms can either be removed and submerged in a clean-out-of place (COP) washer or cleaned with wash down in place.

CAUTION: PROPERTY DAMAGE RISK
Cleaning agents should be room-temperature when applied to the robot.
In general, acidic cleaning solutions are incompatible with the robot's materials.

Make the following considerations when cleaning the robot.

Wash Down

Wash down cleaning methods are appropriate for cleaning the robot. Surfaces and joints have been designed with smooth internal radii for easy cleaning.

NOTE: The following cleaning actions and intervals are suggestions only. Refer to HACCP guidelines to determine what is required for your installation.

Table 6-3. Typical Cleaning Schedule

Item	Interval	Suggested Cleaning Action
Outer Arms and Ball Studs	1 Week	Clean with wipes or water.
Platform	1 Week	Clean with wipes, air, or water.
Entire robot	1 Week	Clean In Place

Water Shedding

Surfaces of the robot have been designed to shed water. This increases the likelihood that contaminants or cleaning agents will drain with a wash-down procedure.

6.4 Checking Safety Systems

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

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

The High Power indicator must be operational to satisfy safety requirements.

- E-stop button on the Front Panel or connected to the XSYSTEM cable.
- E-stop button and enabling switch on the pendant (if present).
- Any other user-supplied safety devices that have been installed in the robot system.

High Power Indicator Check

The robot monitors current used by the High Power indicator. This is to ensure that a High Power indicator device is connected and functioning properly to satisfy safety requirements.

If the robot does not detect a current between 10 mA to 500 mA when High Power is requested, an error condition (-924) *Front panel HIGH POWER lamp failure* will be present and High Power will not be enabled.

The High Power indicator needs to be periodically checked for correct functionality. The following considerations should be made before beginning the High Power indicator check procedure.

- Control power and High Power needs to be available.
- All connected safety devices must be capable of providing signals for a safe state.
- The robot High Power needs to be disabled and robot motions will not execute during this procedure.
- High Power safety timeout must be enabled to allow the indicator to flash after a High Power request is made. The recommended setting is 10 seconds. Refer to the *Sysmac Stu-*

dio Robot Integrated System Building Function with Robot Integrated CPU Unit Operation Manual (Cat. No. W595) for more information.

High Power Indicator Check Procedure

Use the following procedure to verify that the High Power indicator is working correctly.

1. Apply Control Power to the robot and disable High Power.
2. Make a High Power request using one of the methods described in High Power Request Methods on page 95.
3. Check that the High Power indicator flashes. After the High Power request is made and the indicator is checked, the procedure is complete.

6.5 Checking Labels

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

Warning Labels

The following warning labels are found on the robot.

- Read User's Manual, Impact Warning Label (part number 18241-000)

  This label instructs the user to read the user's manual before using the robot and to be aware of the potential of impact by the robot.

Figure 6-1. Read User's Guide, Impact Warning Label

This label is located near the status display on the iX3 body.

Figure 6-2. Location of Read User's Guide, Impact Warning Label

- Brake Release / Gravity Label (part number 18272-000)

  This label warns of the possibility of the platform dropping suddenly, due to gravity, when the brake release button is pressed.

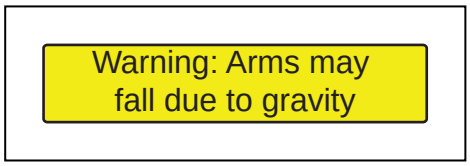


Figure 6-3. Brake Release / Gravity Label

  This label is located next to the brake release button and brake release button label.

Information Labels

The following information labels are found on the robot.

Brake Release Label (part number 18265-000)

This label identifies the brake release button on the underside of the robot and surrounds the brake release button.

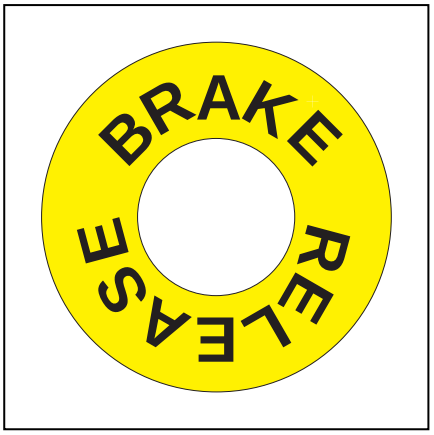


Figure 6-4. Brake Release Label

6.6 Checking for Gear Drive Leaks

The robot uses gear drives that rely on oil for lubrication. Periodically inspect the robot for signs of oil on and around the gear drives.

If signs of oil leaks are found, contact your local OMRON representative for more information.

WARNING: ELECTROCUTION RISK
Lock out and tag out AC power to the robot before opening the iCS-ECAT chassis.

Use the following procedure to check for gear drive leaks on joints 1 and 2.

> **NOTE:** Gear drive leak inspection and fan operation inspection require removal of the same robot parts. It is advised to make these two inspections at the same time.

1. Ensure the motors are cool before performing this check.
2. Remove all power to the robot before starting this check.
3. Remove the iCS-ECAT. Refer to Replacing the iCS-ECAT Unit on page 113 for more information.

   > **IMPORTANT:** Do not remove the encoder cable connectors from their sockets on the motors. If they are removed, the calibration data will be lost requiring factory recalibration.

4. Check for oil inside the base of the robot.
   - Look through the venting slots under each motor for oil leakage.
   - Feel the bottom of the motors with your finger through the venting slots.
5. Check the outside of the motors and gear drives for any signs of oil.
6. Reinstall the iCS-ECAT to complete this procedure. Refer to Replacing the iCS-ECAT Unit on page 113 for more information.

Use the following procedure to check for gear drive leaks on joint 3.

1. Remove the four M4 hex-head bolts holding the Status Display panel.
2. Remove but do not disconnect the Status Display panel.
3. Check the outside of the motor and gear drive for any sign of oil.
4. Re-install the Status Display panel with the four M4 bolts previously removed.
    - Apply Loctite 222 or a thread lock compound equivalent to the M4 bolts before inserting.
    - Ensure that the Status Display panel gasket is in place between the panel and the robot body.
    - Torque the bolts to 1.1 N-m

6.7 Checking Fan Operation

The robot uses fans to cool the motors. The 24 VDC Control Power will need to be applied to the robot during this procedure.

Use the following procedure to check the fan operation on joints 1 and 2.

1. Ensure the motors are cool before performing this check.
2. Remove the iCS-ECAT but do not disconnect any cables. Refer to Replacing the iCS-ECAT Unit on page 113 for more information.

    IMPORTANT: Do not remove the encoder cable connectors from their sockets on the motors. If they are removed, the calibration data will be lost requiring factory recalibration.

3. Turn Control Power ON to the robot. This will start the fans and they will continue to run for about 1 minute. Verify that joint 1 and joint 2 fans are running by looking through the iCS-ECAT opening.
4. After checking the fans, turn Control Power OFF.
5. Reinstall the iCS-ECAT to complete this procedure. Refer to Replacing the iCS-ECAT Unit on page 113 for more information.

Use the following procedure to check the fan operation on joint 3.

1. Remove the four M4 hex-head bolts holding the Status Display panel.
2. Remove but do not disconnect the Status Display panel.
3. Turn Control Power ON to the robot. This will start the fans and they will continue to run for about 1 minute. Verify that the joint 3 fan is running by looking through status display opening.
4. After checking the fan, turn Control Power OFF.
5. Re-install the Status Display panel with the four M4 bolts previously removed.
    - Apply Loctite 222 or an equivalent thread lock compound to the M4 bolts before inserting.
    - Ensure that the Status Display panel gasket is in place between the panel and the robot body.
    - Torque the bolts to 1.1 N-m

6.8 Theta Drive Shaft Bushing Replacement

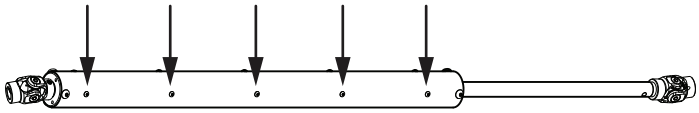
The bushings in the drive shaft are a normal wear item and need to be replaced yearly or every 5,000 hours of use.

A bushing replacement kit is available with a part number of 15005-000.

NOTE: Only the 4 axis robot has a theta drive shaft. Information in this section does not apply to the 3 axis robot.

Figure 6-5. Theta Drive Shaft Bushing Replacement Kit

Version Information: Bushings can only be replaced on certain theta drive shaft models. Inspect the cylindrical outer section of the drive shaft to determine which model is installed on your robot. For theta drive shafts that feature screws on the cylindrical outer section, the bushings can be replaced.



For theta drive shafts that feature a smooth cylindrical outer section without screws, bushings are not serviceable and the theta drive shaft must be replaced. Contact your local OMRON representative for more information

Theta Drive Shaft Bushing Replacement Procedure

Use the following procedure to replace the theta drive shaft bushings.

IMPORTANT: Do not rotate the drive shaft or the lower U-joint during this procedure. If either is rotated, the calibration data for joint 4 will be lost, requiring recalibration. Refer to Aligning the Platform with the Joint 4 Motor on page 110

1. Remove power from the robot.
2. Remove the lower U-joint drive shaft set screw to disconnect the lower U-joint from the theta drive shaft while leaving the U-joint connected to the platform shaft. Do not disconnect the upper U-joint.

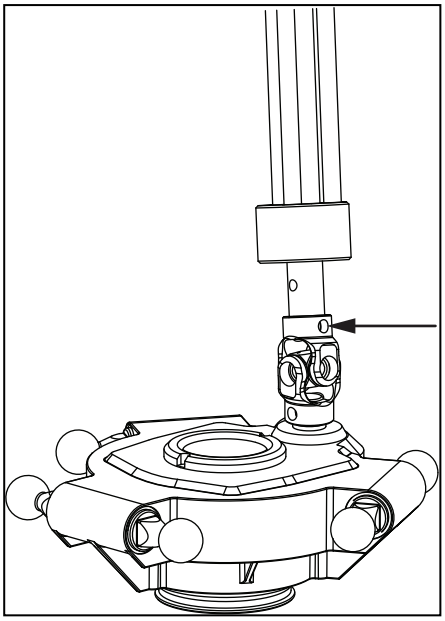


Figure 6-6. Remove Lower U-joint Drive Shaft Set Screw

3. Remove the three screws at the lower end of the drive shaft. These retain the end cap that holds a sleeve bushing through which the center shaft slides.
4. Remove and discard the lower end cap from the drive shaft cylinder. It will slide over the center shaft. A new end cap is included in the bushing replacement kit.
5. Remove the center shaft from the drive shaft cylinder. Retain the center shaft for reassembly.
6. The upper end of the center shaft has a fixture that holds three bushings. These bushings will be replaced, but the center shaft will be reused.

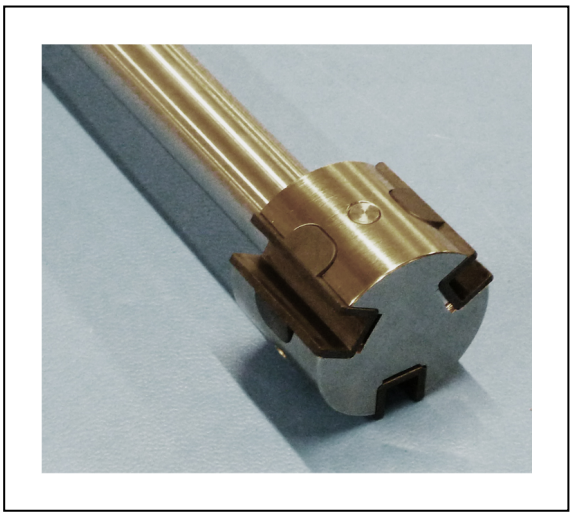


Figure 6-7. Center Shaft Bushing-holding Fixture, with Bushings

7. Remove and discard the three old bushings from the fixture at the end of the center

shaft.

8. Replace the old bushings with the three new bushings from the rebuild kit.
9. Insert the center shaft, fixture end first, into the drive shaft cylinder.
    - The top end cap of the cylinder and the bottom end of the center shaft each have a hole that a U-joint attaches to. Make sure that those two holes are parallel with each other when you insert the center shaft into the cylinder.
    - The three sets of five screws down the length of the drive shaft cylinder hold three guides that the bushings slide over. Confirm that the bushings align with these guides inside the cylinder.
10. Slide the replacement bottom end cap over the end of the center shaft.

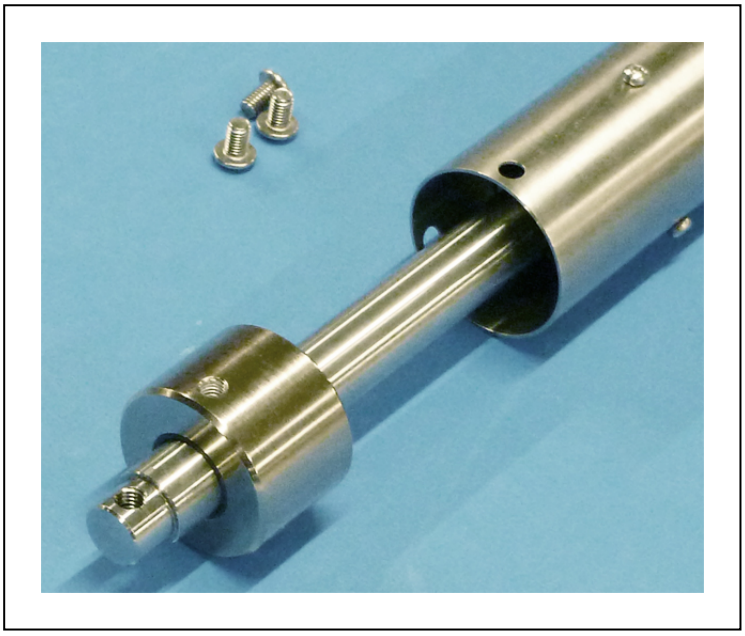


Figure 6-8. End Cap Placed Over Center Shaft

11. Slide the end cap into the end of the drive shaft cylinder so that the three holes in the cylinder align with the holes in the end cap.
12. Screw the three screws previously removed through the cylinder and into the end cap. Use Loctite 243 or an equivalent thread locking compound on the screws before inserting.
13. Reattach the lower U-joint to the drive shaft using the set screw previously removed. Use Loctite 243 or an equivalent thread locking compound on the screws before inserting. This completes the theta drive shaft bushing replacement procedure.

6.9 Theta Drive Shaft Replacement

If the theta drive shaft needs to be replaced, reverse and then execute the procedure described in Attaching the Theta Drive Shaft on page 36.

6.10 Aligning the Platform with the Joint 4 Motor

If the joint 4 motor shaft or platform shaft is inadvertently turned during maintenance procedures, Sysmac Studio must be used to re-establish alignment. If this misalignment is not resolved, the system will not know the actual position of the platform. Refer to the *Sysmac Studio Robot Integrated System Building Function with Robot Integrated CPU Unit Operation Manual (Cat. No. W595)* for more information.

6.11 Replacing the Encoder Battery Pack

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 part number of the replacement battery pack is 09977-000.

> **IMPORTANT:** Only replace items on the robot system with the parts supplied by OMRON.

Encoder Battery Pack Replacement Interval

If the robot is kept in storage and not in production or the 24 VDC supply is ON less than half the time while the encoder backup battery is in the robot, 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.

Encoder Battery Pack Replacement Procedure

Use the following procedure to replace the encoder battery pack.

The encoder battery pack assembly is shown below for reference.

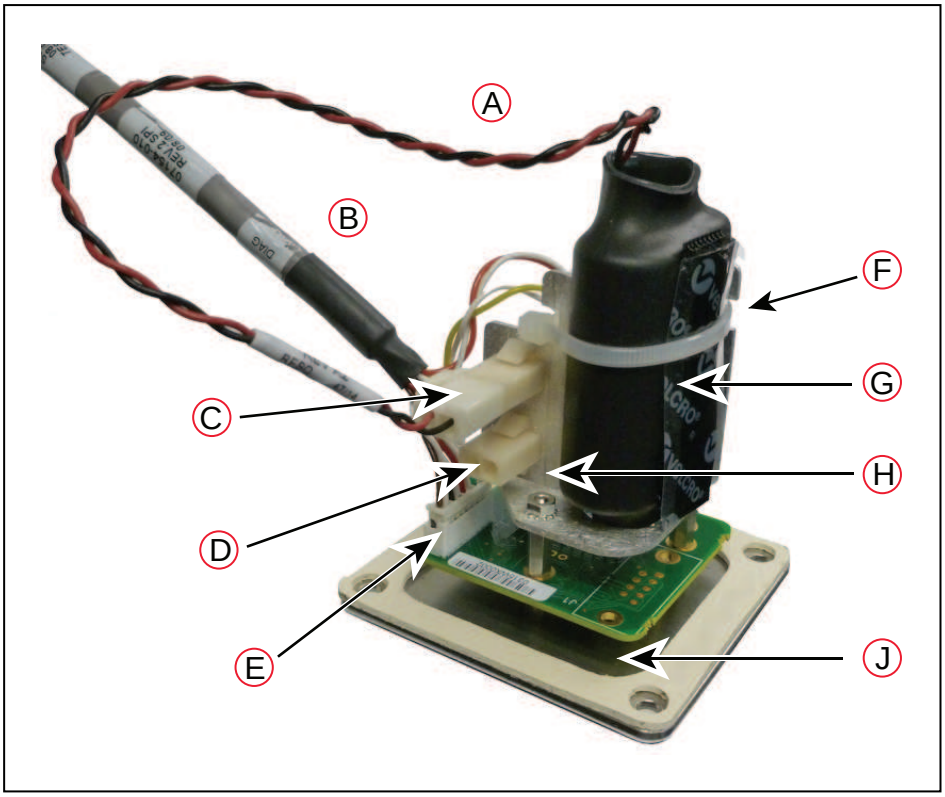


Figure 6-9. Battery Pack Assembly

Item	Description	Item	Description	Item	Description
A	Battery Cable	D	Unused Battery Connector	G	Battery Pack
B	Diagnostic Cable	E	Diagnostic Cable Connector	H	Battery Bracket
C	In-use Battery Connector	F	Cable Tie	J	Status Display Panel

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 to 240 VAC supply cable from the robot AC input connector.
4. Switch OFF and disconnect any other power supplies connected to the robot.
5. Remove the four M4 hex-head bolts that secure the Status Display panel.
6. Remove, but do not disconnect the Status Display Panel. The battery pack is supported in a bracket that is attached to the back side of the Status Display panel with stand-offs. The battery pack is exposed when the Status Display panel is removed.
7. The battery bracket assembly has two battery connectors. Locate the unused battery connector on the battery bracket.

IMPORTANT: Do not disconnect the old battery before the new battery is connected. If battery power is removed from the robot, factory calibration data may be lost requiring robot recalibration by OMRON support.

8. Connect the new battery pack to the unused connector on the battery bracket. Do not disconnect the old battery pack.
9. Once the new battery pack is connected, you can disconnect and remove the old one. You will need to cut the cable tie holding the battery pack in the bracket.

   IMPORTANT: 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 battery bracket and secure it and the diagnostic cable using a cable tie.
    - Fold any excess wiring under the battery pack so that it lies between the battery pack and the channel in the battery bracket.
    - The diagnostic cable must be fastened to the bracket and battery pack with a cable tie to relieve strain on the Status Display connector.
11. Re-install the Status Display panel with the four M4 bolts previously removed.
    - Apply Loctite 222 or an equivalent thread lock compound to the M4 bolts before inserting.
    - Ensure that the Status Display panel gasket is in place between the panel and the robot body.
    - Torque the bolts to 1.1 N-m

6.12 Replacing a Platform

Use the following procedure to replace a platform.

CAUTION: PROPERTY DAMAGE RISK
Incorrect alignment of the platform with the robot base will result in incorrect robot performance and possible damage to the drive shaft.

CAUTION: PROPERTY DAMAGE RISK
Do not overstretch the outer-arm springs. Separate the ball joint sockets only enough to fit them over the ball studs.

IMPORTANT: Installation of a new platform for 4 axis robots requires factory calibration by OMRON.

NOTE: Refer to Attach the Outer Arms on page 39 for details on installing the outer arms. Removal is the reverse of installation.

1. Remove the three pairs of outer arms from the three pairs of ball studs on the installed platform.
2. For a 4 axis robot, disconnect the theta drive shaft from the platform shaft. Refer to Theta Drive Shaft Bushing Replacement Procedure on page 107 for details. Do not

remove the top U-joint, which is attached to the J4 motor shaft.

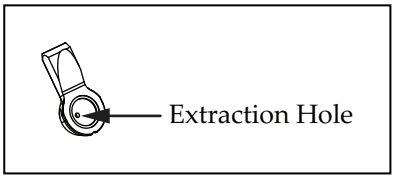
3. Attach one pair of outer arms to each of the three pairs of ball studs on the new platform.
   - The platform must be installed with the tool flange in the downward orientation.
   - Take care not to trap debris between the ball studs and their sockets.
4. For a 4 axis robot, attach the theta drive shaft to the platform drive shaft.

   Refer to Installing the Platform on page 37 for details.

6.13 Replacing a Ball Joint Socket Insert

Use the following procedure to replace a ball joint socket insert.

1. Remove the outer arm from the ball joint. This does not require any tool and can be accomplished by hand.
2. The inserts have a threaded hole to facilitate removal. To extract the old insert, use an M4 bolt to thread into the insert and then pull it out.



3. To install the new insert, press it into place by hand ensuring that it is centered and fully seated.
4. After the insert is in place, install the outer arm on the ball joint.
5. Repeat steps 1 through 4 for all ball joint socket inserts that need to be replaced to complete this procedure.

6.14 Replacing the iCS-ECAT Unit

Use the following procedure to replace the iCS-ECAT unit.

Record all faults or errors and switch positions before beginning this procedure.

CAUTION: PROPERTY DAMAGE RISK
Follow appropriate ESD procedures during the removal and replacement phases.

1. Remove all power from the robot.
2. Disconnect the 24 VDC supply cable from the chassis +24 VDC input connector.
3. Disconnect the 200 to 240 VAC supply cable from the chassis AC Input connector.
4. Disconnect the XSYSTEM cable from the chassis XSYSTEM connector.
5. Disconnect any other cables that may be connected to the iCS-ECAT.

6. 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.

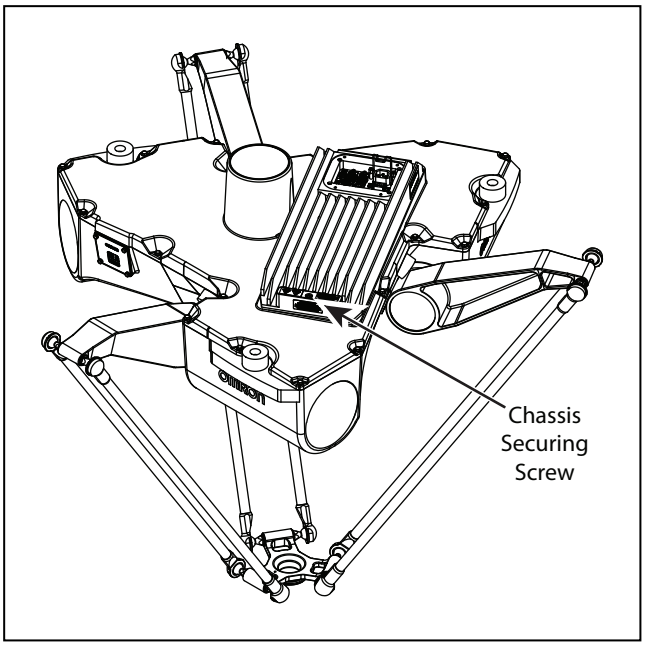


Figure 6-10. Chassis-securing Screw

7. Carefully and slowly lift up the chassis so that enough access is available to remove the internal cables. The chassis can be laid flat on its cooling fins.

CAUTION: PROPERTY DAMAGE RISK
Lifting the chassis can damage the O-ring that seals it if you are not careful. Ensure that nothing scrapes against the O-ring.

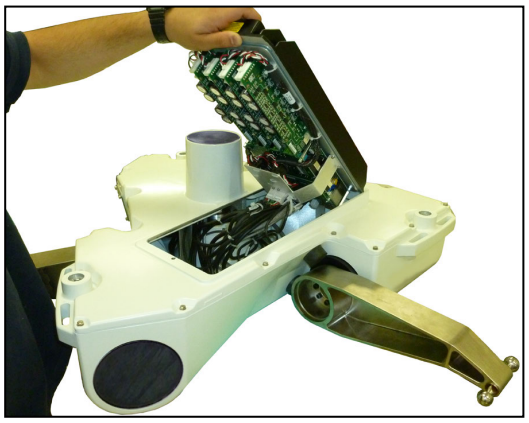


Figure 6-11. Chassis Removal

8. Disconnect the white amplifier cable from the amplifier connector located on the chassis bracket as identified in the figure below.

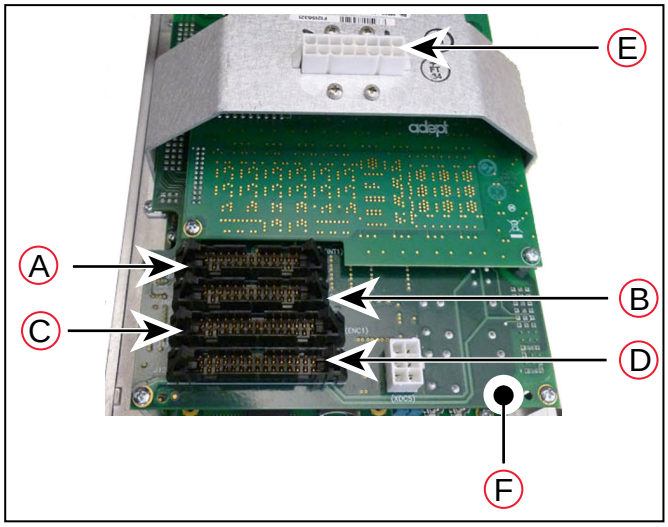


Figure 6-12. Chassis Items

Table 6-4. Chassis Item Descriptions

Item	Description	Item	Description
A	INT1	D	ENC2
B	INT2	E	Amplifier Connector
C	ENC1	F	ePMAI Board

9. Carefully disconnect the INT1, INT2, ENC1, and ENC2 cables from their connectors on the ePMAI board. Use the connector securing latches to free the connectors.
10. Remove and retain the microSD card for insertion into the replacement iCS-ECAT. Refer to Remove and Replace a MicroSD Card on page 116.
11. Using a 5 mm hex wrench, disconnect and remove the ground wire from the chassis.

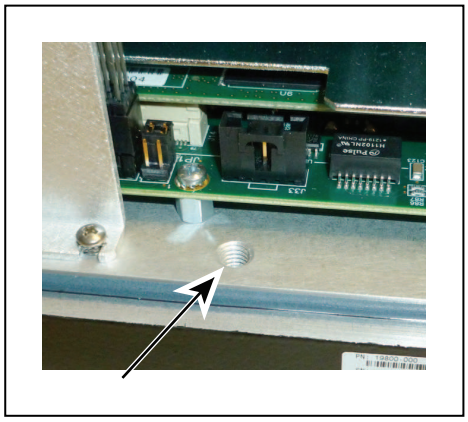


Figure 6-13. Chassis Ground Screw

12. Tag the chassis with appropriate fault diagnosis and robot serial number information.
13. 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.
14. Using a 5 mm hex wrench, connect the ground wire to the chassis.
15. Reconnect the cables you removed from their connectors on the ePMAI board, and engage the securing latches.
16. Connect the white amplifier cable to the amplifier connector located on the chassis bracket.
17. 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.
18. Once the chassis is in place, use a 5 mm hex wrench to tighten the chassis securing screw.
19. Restore all switch positions from the previously removed iCS-ECAT unit.
20. After connecting all previously disconnected cables to their original locations, the procedure is complete.

6.15 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.

Additional Information: Refer to Replacing the iCS-ECAT Unit on page 113 for more information.

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

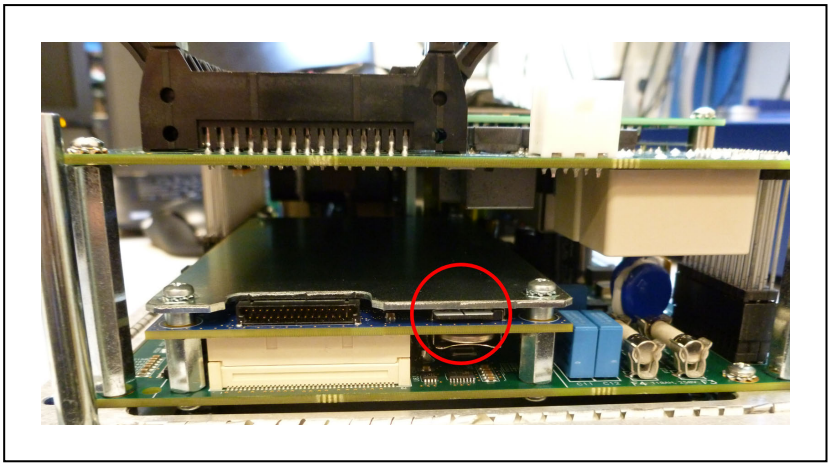


Figure 6-14. MicroSD Card Location (circled)

4. Remove the installed MicroSD card to complete this procedure.

   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.

> **Additional Information**: Refer to Replacing the iCS-ECAT Unit on page 113 for more information.

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 to complete this procedure.

Chapter 7: Technical Specifications

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

NOTE: Unless otherwise specified, all dimensions are in mm.

7.1 Robot Physical Dimension Drawings

This section provides physical dimensions for the robot and its operating envelope.

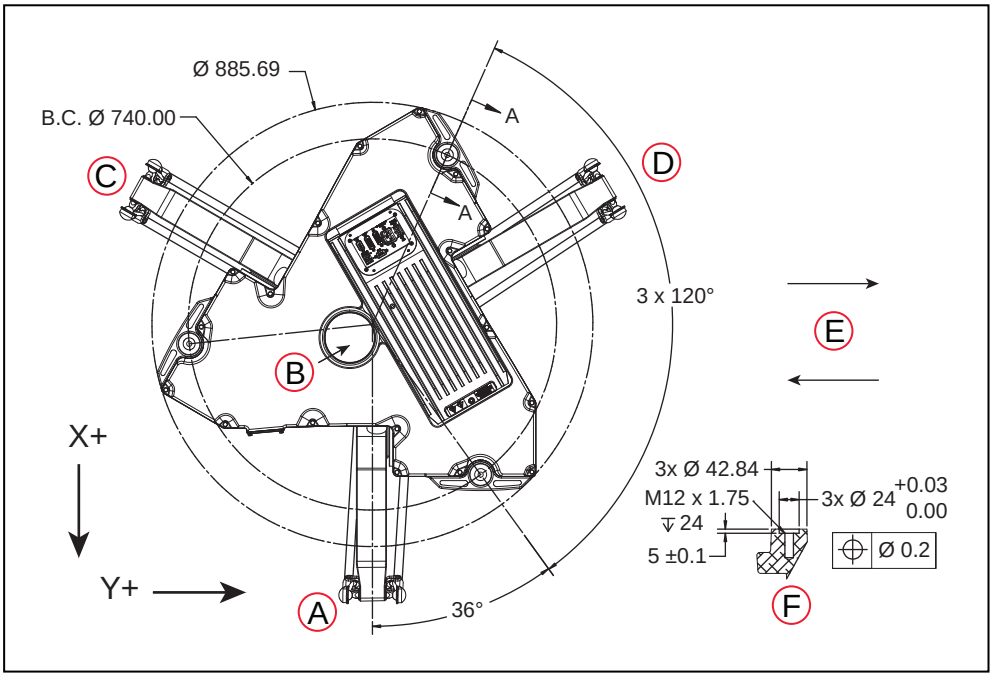


Figure 7-1. Mounting Dimensions

Table 7-1. Mounting Dimension Descriptions

Item	Description	Item	Description
A	Joint 1	D	Joint 2
B	Joint 4	E	Conveyor Direction
C	Joint 3	F	Section A-A

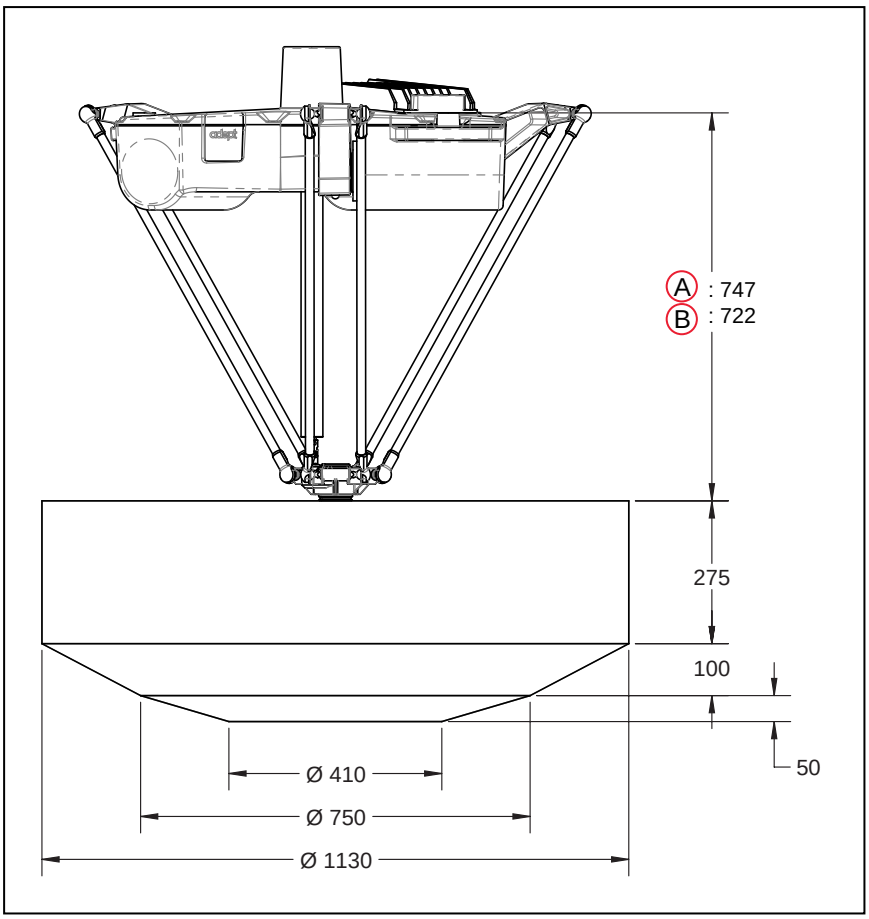


Figure 7-2. Work Envelop (Side View)

Table 7-2. Work Envelope Descriptions

Item	Description	Item	Description
A	Joint 4 Platform	B	Fixed Platform

7.2 Arm Travel Volumes

Arm travel volumes represent the space required for all arm movements. This should be considered when designing a mounting frame. Required clearances for a flat plate are also provided.

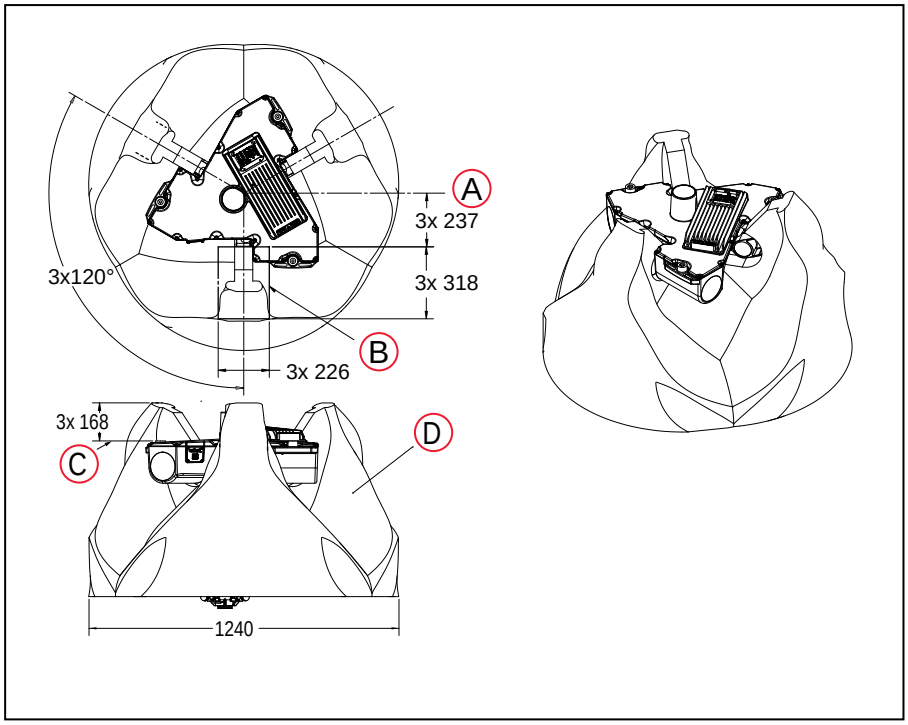


Figure 7-3. Arm Travel Volume

Table 7-3. Arm Travel Volume Descriptions

Item	Description
A	Center of Robot
B	Cutout needed in plate at robot mount surface height
C	Robot Mount Surface
D	Arm travel volume

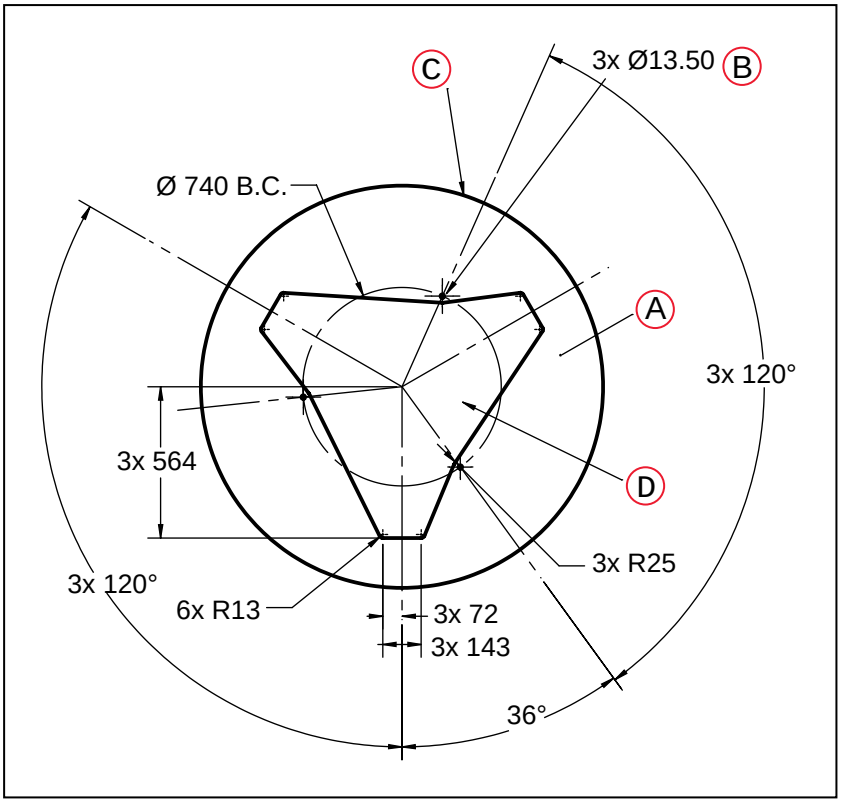


Figure 7-4. Flat Plate Dimensions

Table 7-4. Flat Plate Dimension Descriptions

Item	Description
A	Flat Plate
B	Through (Mounting holes for robot)
C	Outside dimensions of plate are determined by frame
D	Cut-out

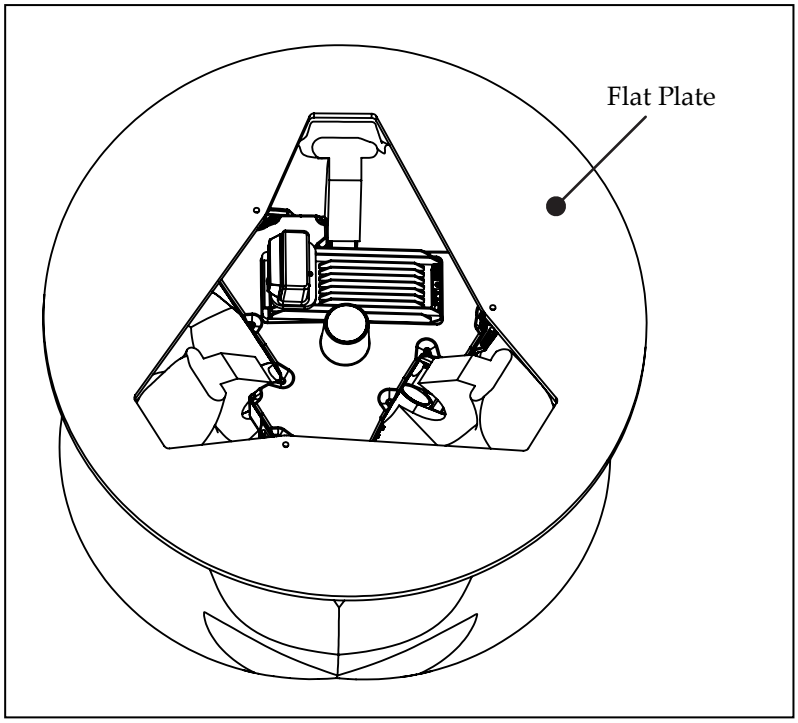


Figure 7-5. Flat Plate (Isometric View)

7.3 Tool Flange Dimensions

This section provides physical dimensions for the tool flange.

NOTE: This details the tool flange for both 3 and 4 axis robots.

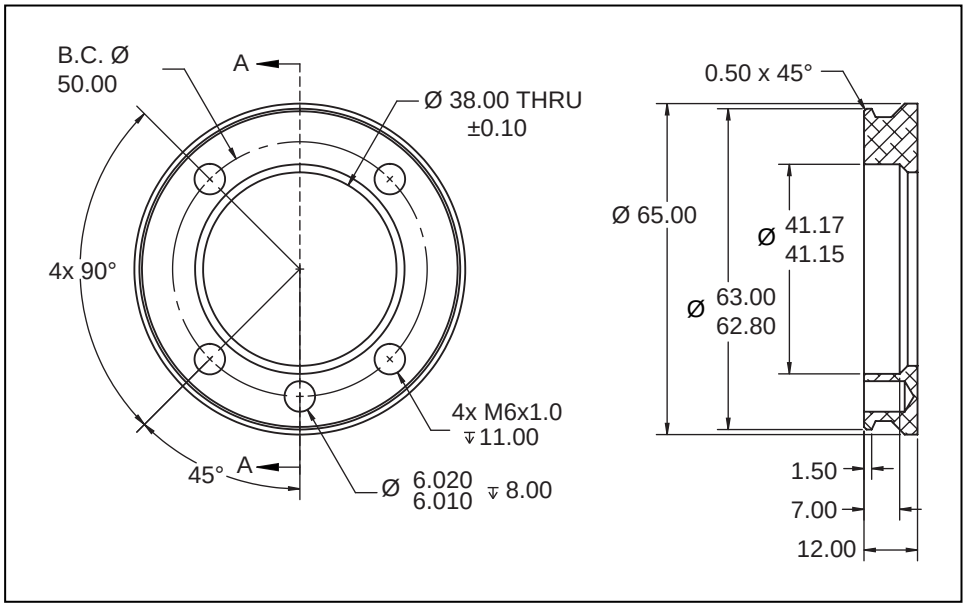


Figure 7-6. Tool Flange Dimensions

7.4 General Robot Specifications

The following table provides general robot specifications.

Table 7-5. Robot Specifications

Item	Specification	
	4 Axis Model	3 Axis Model
Payload	1.0 kg rated 3.0 kg maximum	1.0 kg rated 8.0 kg maximum
Repeatability	X, Y, Z directions: 0.1 mm Theta directions: 0.2°	
Joint 4 Torque	33 N-m	Not applicable
Joint 4 Range	±360°	
Joint Range	113° to -47°	
Soft Stops	113° to -47°	
Hard Stops	115° to -53°	
Theta Range	±360°	n/a
Encoder type	Absolute	
Robot Brakes	24 VDC	
Weight (no options)	52 kg	49 kg
Weight (in crate)	120 kg	117 kg
Digital I/O Channels	12 inputs, 8 outputs	

7.5 Performance Specifications

This section provides the robot's performance specifications.

Payload Inertia and Acceleration Specifications

The following table provides a general guideline based on typical high-performance use. The practical inertia for any application will vary depending on the performance requirements.

> **Additional Information**: Payloads for the 4 axis robot should be designed with their center of mass in line with the center axis of the tool flange. This will minimize induced torque during X-Y-Z motions.

The values in the table below only apply to 4 axis robots.

Acceleration Value	Allowable Tool Inertia (kg-cm^2)
100	600
250	240
500	120
750	80

Cycle Time and Acceleration Specifications

The table below provides cycle time and acceleration specifications.

Additional Information: Use the acceleration information in the table below to avoid excessive vibrations.

Table 7-6. General Performance Specifications

Performance Item	Specification	
	4 Axis Model	3 Axis Model
Cycle Time for a move 25 mm up, 305 mm over, and 25 mm down, and then back along the same path[1].	0.1 kg payload: 0.35 s 1.0 kg payload: 0.37 s 2.0 kg payload: 0.40 s 3.0 kg payload: 0.42 s	0.1 kg payload: 0.33 s 1.0 kg payload: 0.34 s 2.0 kg payload: 0.37 s 3.0 kg payload: 0.38 s
Cycle Time for a move 25 mm up, 700 mm over, and 25 mm down, and then back along the same path[1].	0.1 kg payload: 0.50 s 1.0 kg payload: 0.54 s 2.0 kg payload: 0.58 s 3.0 kg payload: 0.62 s	0.1 kg payload: 0.47 s 1.0 kg payload: 0.50 s 2.0 kg payload: 0.54 s 3.0 kg payload: 0.58 s
Acceleration % (maximum)[2]	0.1 kg payload: 550 1.0 kg payload: 500 2.0 kg payload: 450 3.0 kg payload: 400	0.1 kg payload: 550 1.0 kg payload: 500 2.0 kg payload: 450 3.0 kg payload: 400 4.0 kg payload: 270 5.0 kg payload: 220 6.0 kg payload: 170 7.0 kg payload: 130 8.0 kg payload: 110
Acceleration % (recommended)[2]	0.1 kg payload: 275 1.0 kg payload: 250	0.1 kg payload: 275 1.0 kg payload: 250

Performance Item	Specification	
	4 Axis Model	3 Axis Model
	2.0 kg payload: 225 3.0 kg payload: 200	2.0 kg payload: 225 3.0 kg payload: 200 4.0 kg payload: 135 5.0 kg payload: 110 6.0 kg payload: 85 7.0 kg payload: 65 8.0 kg payload: 55
Acceleration m/s^2(maximum)	0.1 kg payload: 108 1.0 kg payload: 98 2.0 kg payload: 88 3.0 kg payload: 78	0.1 kg payload: 108 1.0 kg payload: 98 2.0 kg payload: 88 3.0 kg payload: 78 4.0 kg payload: 53 5.0 kg payload: 43 6.0 kg payload: 33 7.0 kg payload: 25 8.0 kg payload: 22
Acceleration m/s^2(recommended)	0.1 kg payload: 54 1.0 kg payload: 49 2.0 kg payload: 44 3.0 kg payload: 39	0.1 kg payload: 54 1.0 kg payload: 49 2.0 kg payload: 44 3.0 kg payload: 39 4.0 kg payload: 26 5.0 kg payload: 22 6.0 kg payload: 17 7.0 kg payload: 13 8.0 kg payload: 11
Acceleration G (maximum)	0.1 kg payload: 11.0 1.0 kg payload: 10.0 2.0 kg payload: 9.0 3.0 kg payload: 8.0	0.1 kg payload: 11.0 1.0 kg payload: 10.0 2.0 kg payload: 9.0 3.0 kg payload: 8.0 4.0 kg payload: 5.4 5.0 kg payload: 4.4 6.0 kg payload: 3.4

Performance Item	Specification	
	4 Axis Model	3 Axis Model
		7.0 kg payload: 2.6 8.0 kg payload: 2.2
Acceleration G (recommended)	0.1 kg payload: 5.5 1.0 kg payload: 5.0 2.0 kg payload: 4.5 3.0 kg payload: 4.0	0.1 kg payload: 5.5 1.0 kg payload: 5.0 2.0 kg payload: 4.5 3.0 kg payload: 4.0 4.0 kg payload: 2.7 5.0 kg payload: 2.2 6.0 kg payload: 1.7 7.0 kg payload: 1.3 8.0 kg payload: 1.1
[1]The robot tool performs continuous path, straight-line motions at 20° C ambient operating temperatures (not achievable over all paths). [2]% is the eV+ Accel / Decel setting. This can be set as high as 750%.		

Payload Center of Gravity Specifications

Use the information in the table below for maximum allowable center of gravity for the payload.

The distance is measured from the mounting surface of the flange.

NOTE: The values in the table below only apply to 4 axis robots.

Additional Information: The recommended allowable center of gravity values are half the values provided in the table below.

Table 7-7. Maximum Allowable Center of Gravity

Acceleration	Maximum Allowable Center of Gravity		
	3 kg	2 kg	1 kg
100%	25 mm	37 mm	75 mm
80%	31 mm	47 mm	93 mm
60%	41 mm	62 mm	125 mm
40%	62 mm	93 mm	187 mm
20%	125 mm	187 mm	375 mm
Max Allowable Moment: 3 kg * 78 m/s² * 0.025 m = 5.85 N-m.			

Stopping Time and Distance

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 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.

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

If you want to measure stopping distances and times on a system, contact your local OMRON representative for more information.

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

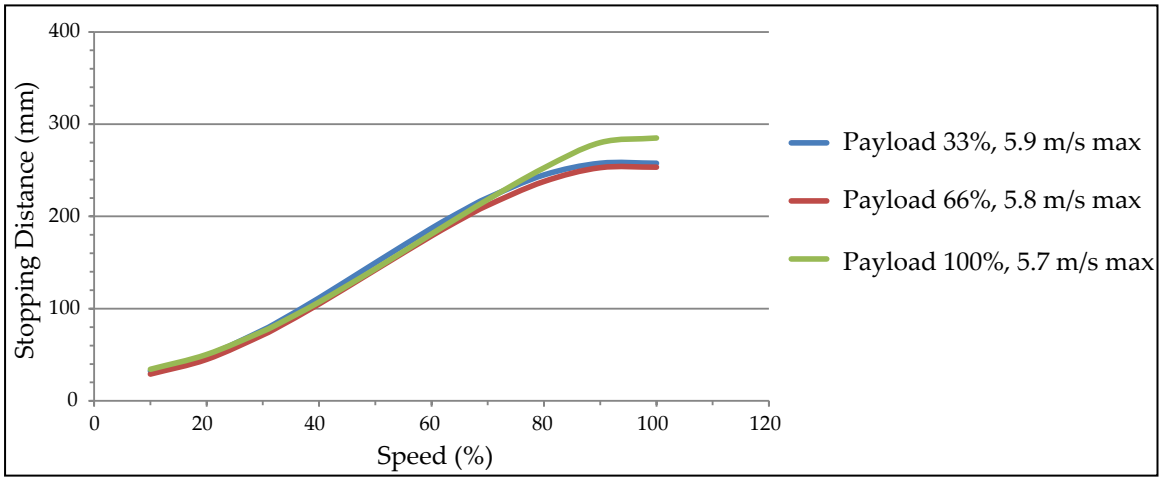


Figure 7-7. Stopping Distance, X Axis Move (4 Axis Robot Type)

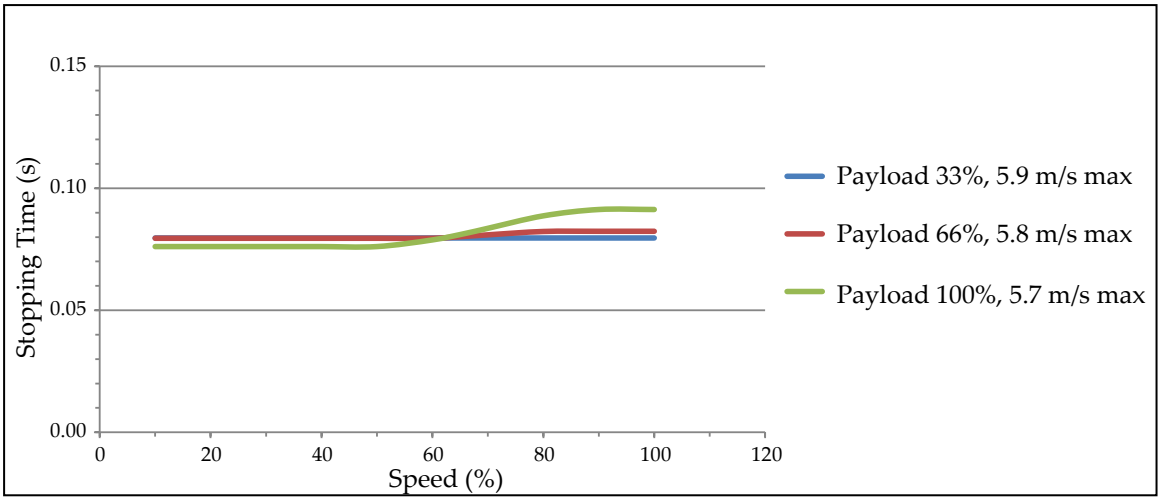


Figure 7-8. Stopping Time, X Axis Move (4 Axis Robot Type)

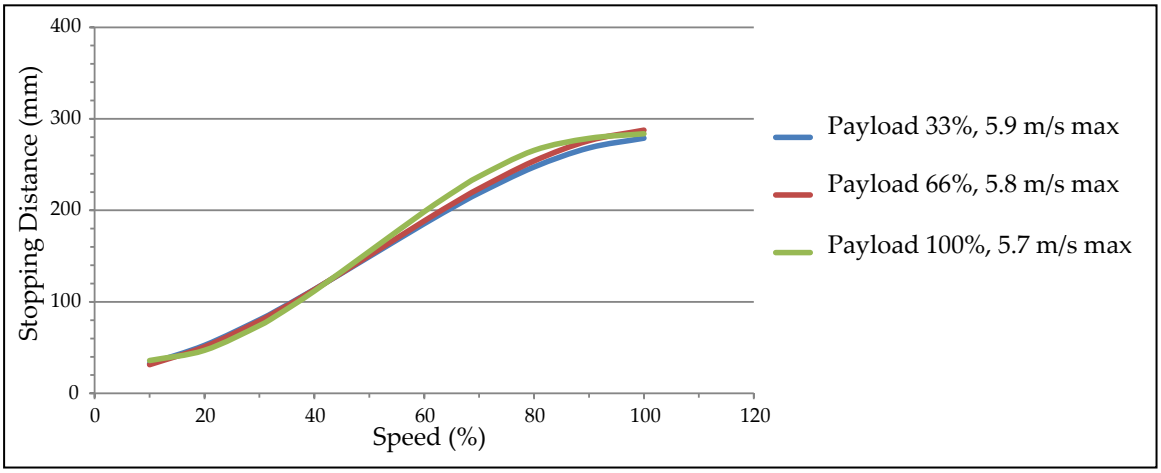


Figure 7-9. Stopping Distance, Y Axis Move (4 Axis Robot Type)

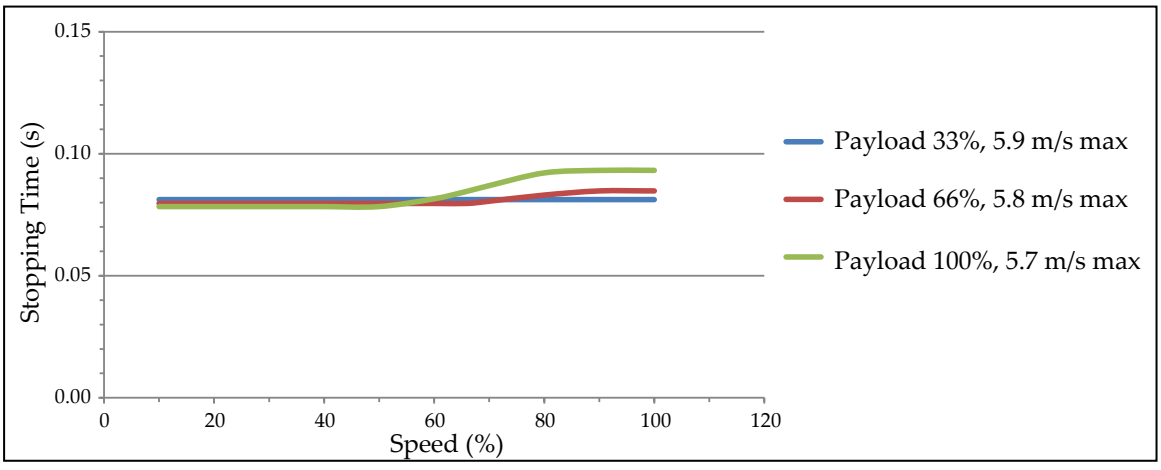


Figure 7-10. Stopping Time, Y Axis Move (4 Axis Robot Type)

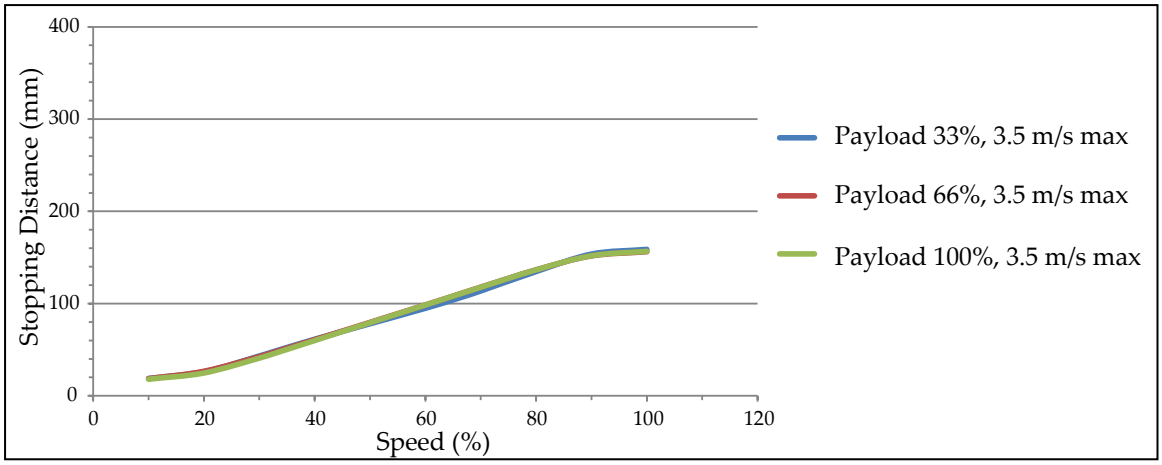


Figure 7-11. Stopping Distance, Z Axis Move (4 Axis Robot Type)

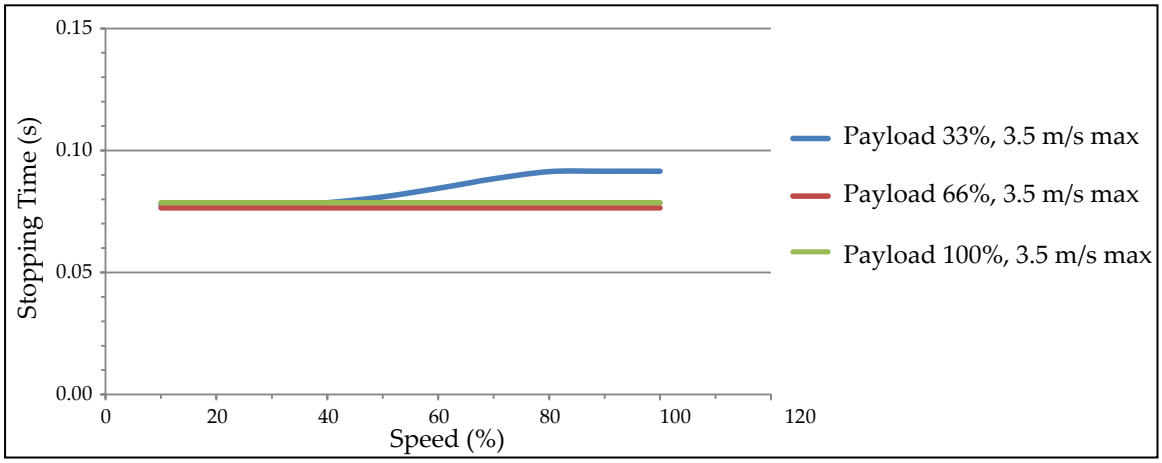


Figure 7-12. Stopping Time, Z Axis Move (4 Axis Robot Type)

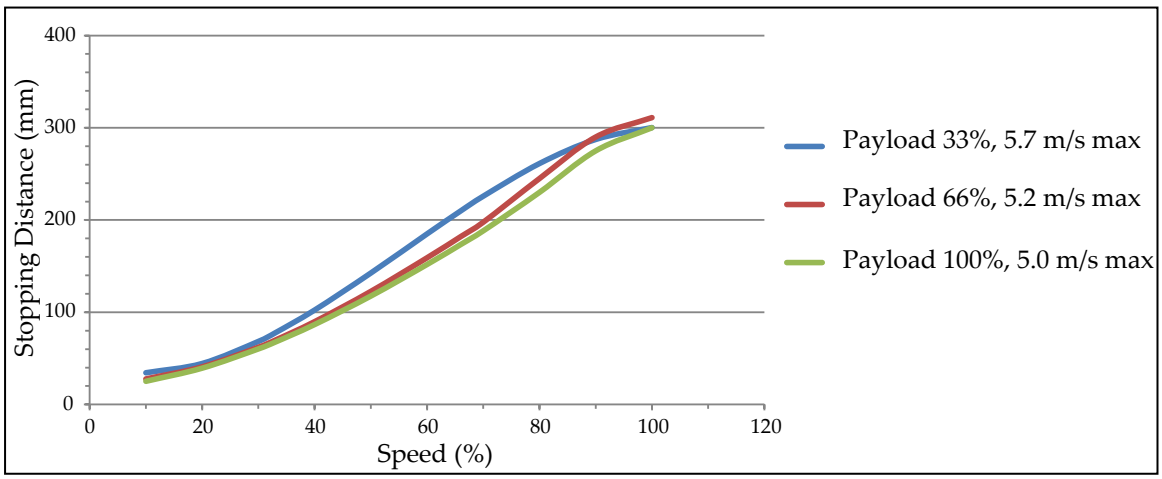


Figure 7-13. Stopping Distance, X Axis Move (3 Axis Robot Type)

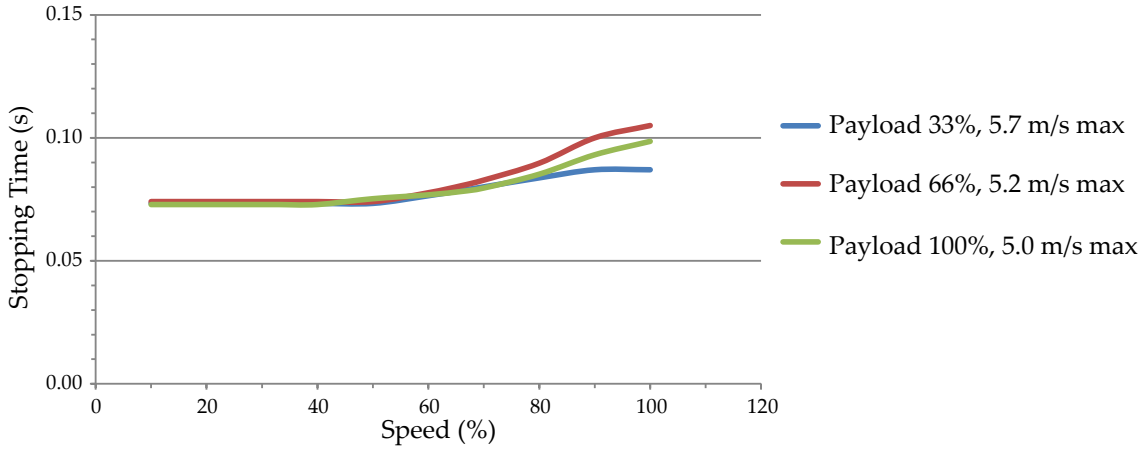


Figure 7-14. Stopping Time, X Axis Move (3 Axis Robot Type)

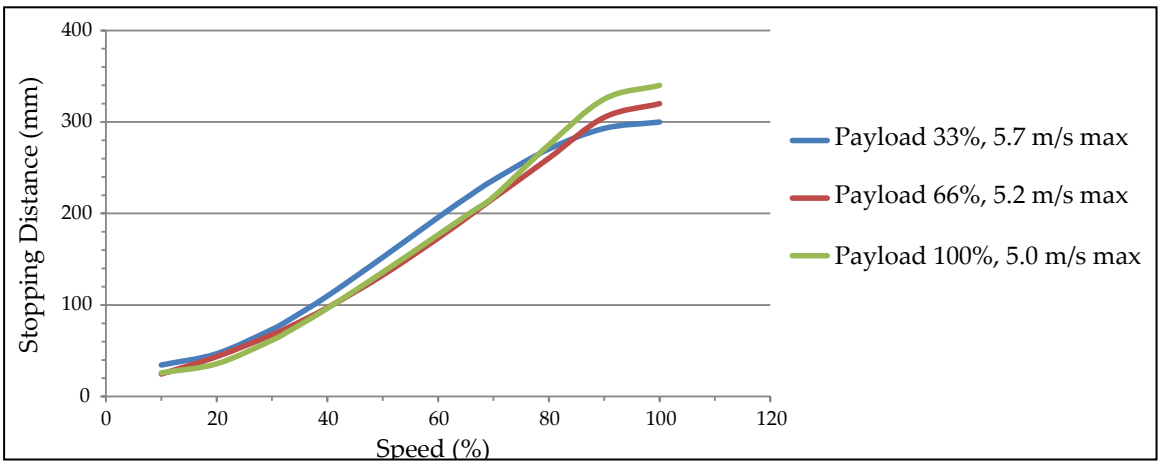


Figure 7-15. Stopping Distance, Y Axis Move (3 Axis Robot Type)

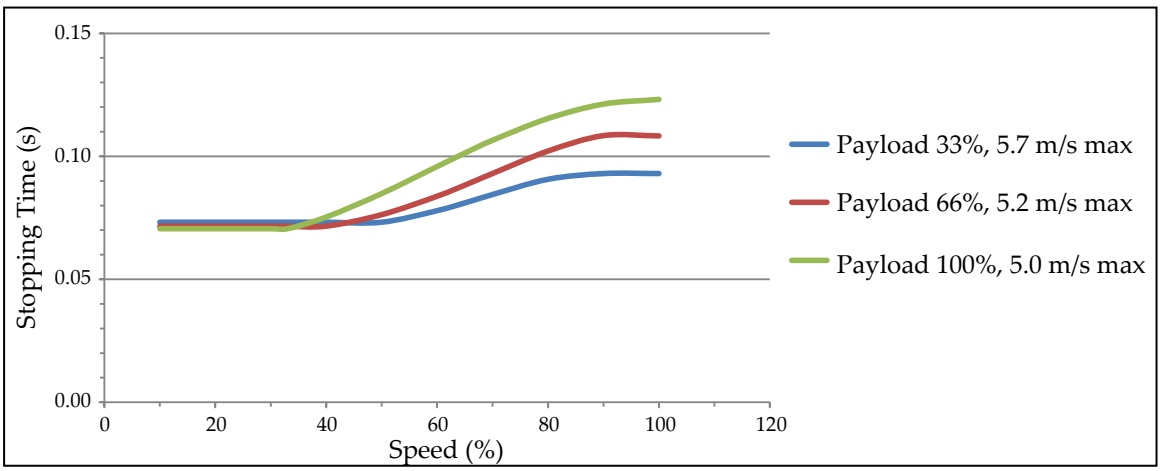


Figure 7-16. Stopping Time, Y Axis Move (3 Axis Robot Type)

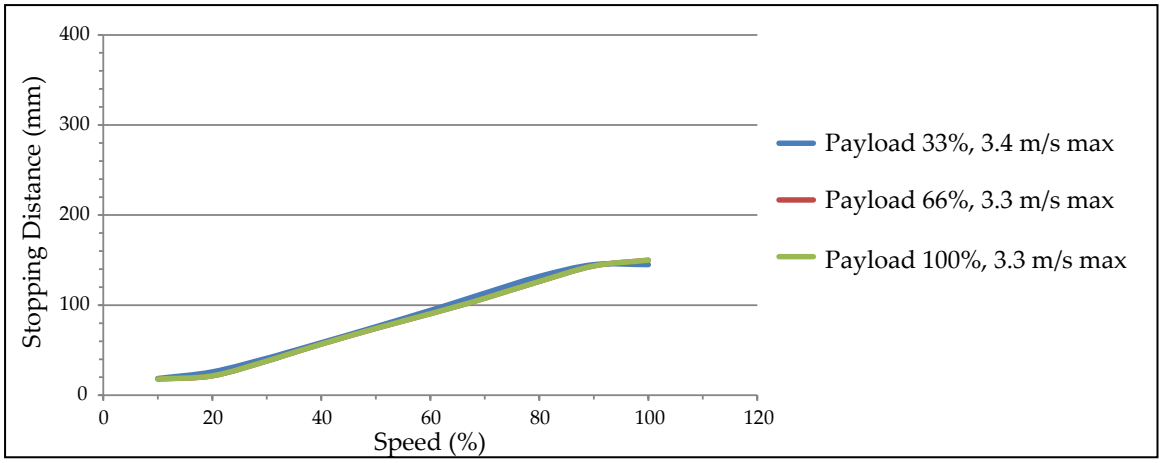


Figure 7-17. Stopping Distance, Z Axis Move (3 Axis Robot Type)

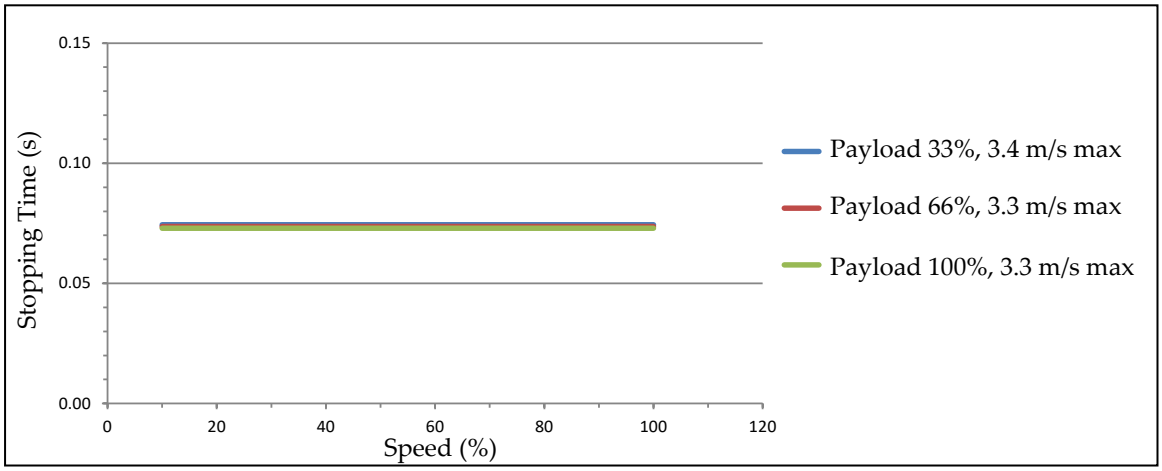


Figure 7-18. Stopping Time, Z Axis Move (3 Axis Robot Type)

7.6 Electrical Specifications

The following section provides electrical specifications for the robot system.

External Connection Specifications

The following table provides external electrical connection specifications.

Table 7-8. External Electrical Connection Specifications

Item	Specification	Details
24 VDC supply[1,3]	Voltage range	24 VDC ± 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

Item	Specification	Details
		provide 8 Amp in-line circuit protection
	Cabling	1.31 – 2.08 mm²
	Shielding	Braided shield connected to frame ground terminal at both ends of cable. Refer to Connecting the 24 VDC Cable on page 78 for more information.
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 80 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 KΩ minimum
	Current at V_{in} = +24 VDC	$I_{in} \leq 6$ mA
	Turn on response time (hardware)	5 µsec maximum
	Software scan rate and response time	16 ms scan cycle 32 ms max response time
	Turn off response time (hardware)	5 µsec maximum
XIO output circuits	Maximum operational cur-	700 mA

Item	Specification	Details
	rent range, per channel	
	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 µA
	ON response time	125 µsec max., 80 µsec typical (hardware only)
	OFF response time	60 µsec max., 28 µsec typical (hardware only)
	Output voltage at inductive load turnoff (I_{out} = 0.5A, Load = 1 mH)	(+V - 65) ≤ V_{demag} ≤ (+V - 45)
	DC short circuit current limit	0.7A ≤ I_{LIM} ≤ 2.5 A
	Peak short circuit current	I_{ovpk} ≤ 4 A
NOTE[1]: User-supplied 24 VDC power supply must incorporate overload protection to limit peak power to less than 300 W or 8 A in-line circuit protection must be added to the 24 VDC power source. For multiple robots on a common 24 VDC supply, protect each unit individually. 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. **NOTE**[2]: Specifications established at nominal line voltage. Low line voltage can affect robot performance. **NOTE**[3]: If multiple robots are sharing a 24 VDC power supply, increase the supply capacity by 3 A for each additional robot.		

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.

7.7 EtherCAT Communications Specifications

EtherCAT communications specifications are provided in the table below.

Figure 7-19. 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.	

7.8 Mounting Frame Specifications

The robot is designed to be mounted above the work area, suspended from a user-supplied frame. The frame must be adequately stiff to hold the robot rigidly in place while the robot platform moves around the workspace. You can either use the design provided or design a custom support frame.

If you choose to design a custom frame, it must meet the following specifications:

Frame natural frequencies for stable robot operations:

- Frequency > 25 Hz (> 40 Hz for aggressive moves or heavy payloads)
- Mounting surfaces for the robot pads must be within 0.75 mm of a flat plane.

If the surfaces are not within this tolerance, they should be shimmed.

> **IMPORTANT:** Failure to mount the robot within 0.75 mm of a flat plane will result in inconsistent robot motions.

The iCS-ECAT must be removable from the top of the frame and the inner and outer arm travel envelopes must be considered. Refer to Arm Travel Volumes on page 120 for more information.

Make the following considerations when constructing a mounting frame with the information in this section.

- Material: ASTM A500 Carbon Steel, Grade B or Grade C permissible.
- Remove all weld spatter and debris.
- Continuously weld all seams and grind protruding welds to match adjacent surfaces.
- Finish: Powder coat per RAL 9003 - Pure White.
- Remove all burrs and sharp edges.
- Dimensions apply after process.
- Interpret drawings per ANSI Y14.5.
- Dimensions are in mm
- - 1 place decimals: ±2.5 mm
  - 2 place decimals: ±1.5 mm
  - 3 place decimals: ±0.75 mm
- Angular dimensions: ±0 .5°

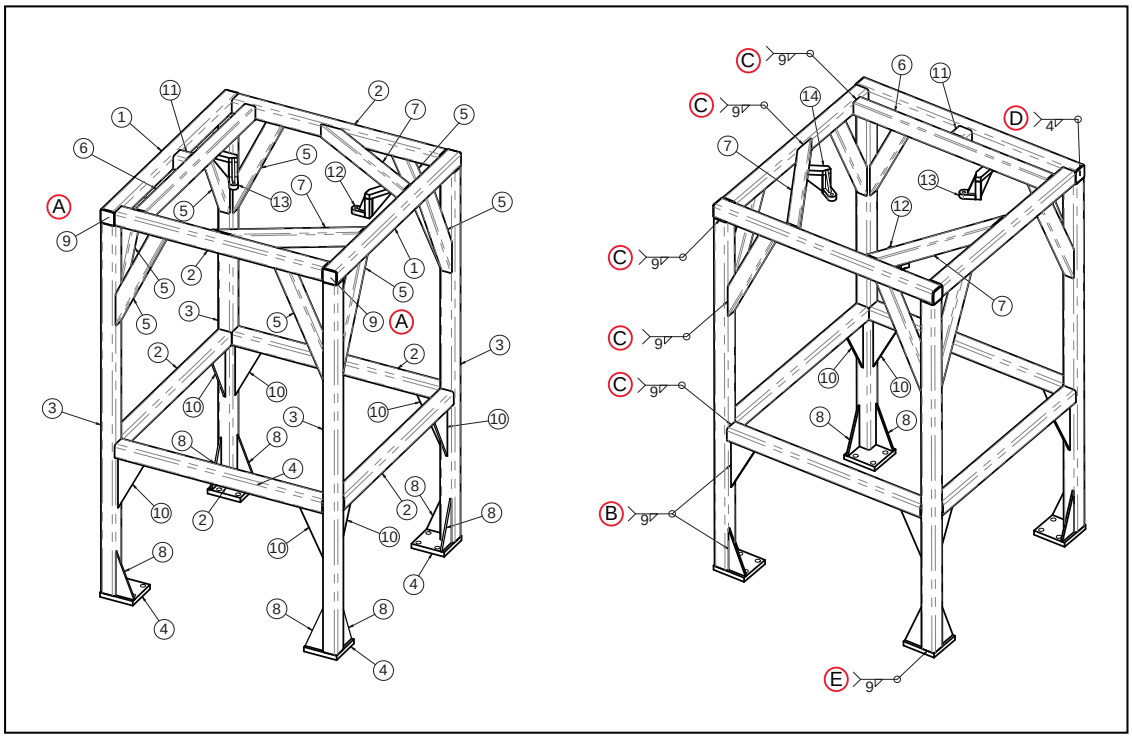


Figure 7-20. Mounting Frame, Orthogonal View

Callout	Description	Callout	Description
A	Both Ends	D	All End Caps

B	All Gussets	E	All Feet
C	All Structural Members		

Refer to the following table for description of the numbered items.

Item	Quantity	Description	Length
1	2	Tube, Square, Steel, 80 x 80 x 6.3	1290
2	6	Tube, Square, Steel, 80 x 80 x 6.3	1140
3	4	Tube, Square, Steel, 80 x 80 x 6.3	2130
4	4	Mounting Foot, 25.4 Thick	See detail
5	8	Tube, Rectangular, Steel, 80 x 40 x 4.0	(638.95) See detail
6	1	Tube, Rectangular, Steel, 80 x 40 x 4.0	1140
7	2	Tube, Rectangular, Steel, 80 x 40 x 4.0	(749.18) See detail
8	8	Gusset, Mounting Foot, 9.5 Thick	See detail
9	4	End Cap, 5 Thick	See detail
10	8	Gusset, 9.5 Thick	See detail
11	1	Tube, Square, Steel, 80 x 80 x 6.3	70
12	1	Mounting Bracket 1	See detail
13	1	Mounting Bracket 2	See detail
14	1	Mounting Bracket 3	See detail

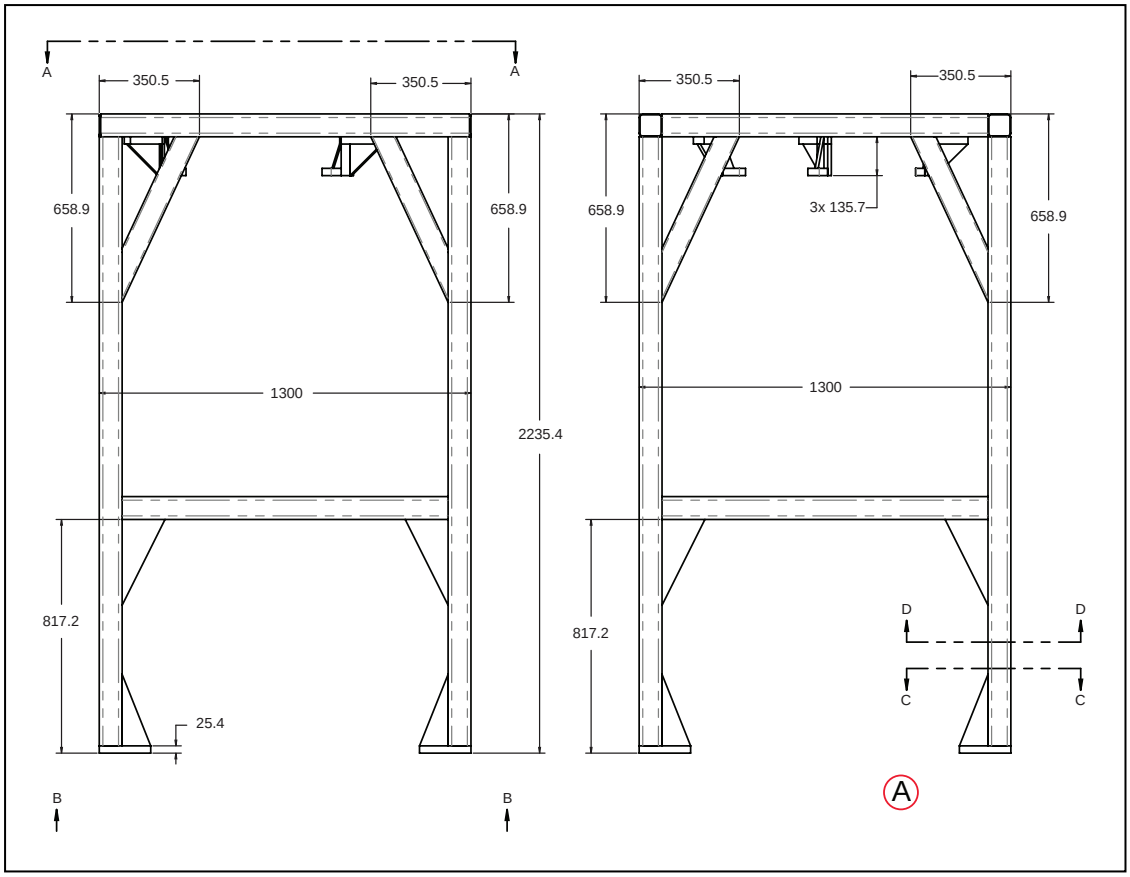


Figure 7-21. Mounting Frame, Side View 1, (A) Sections Shown in the Next Figure

Sections A, B, C, and D are shown in the following figure.

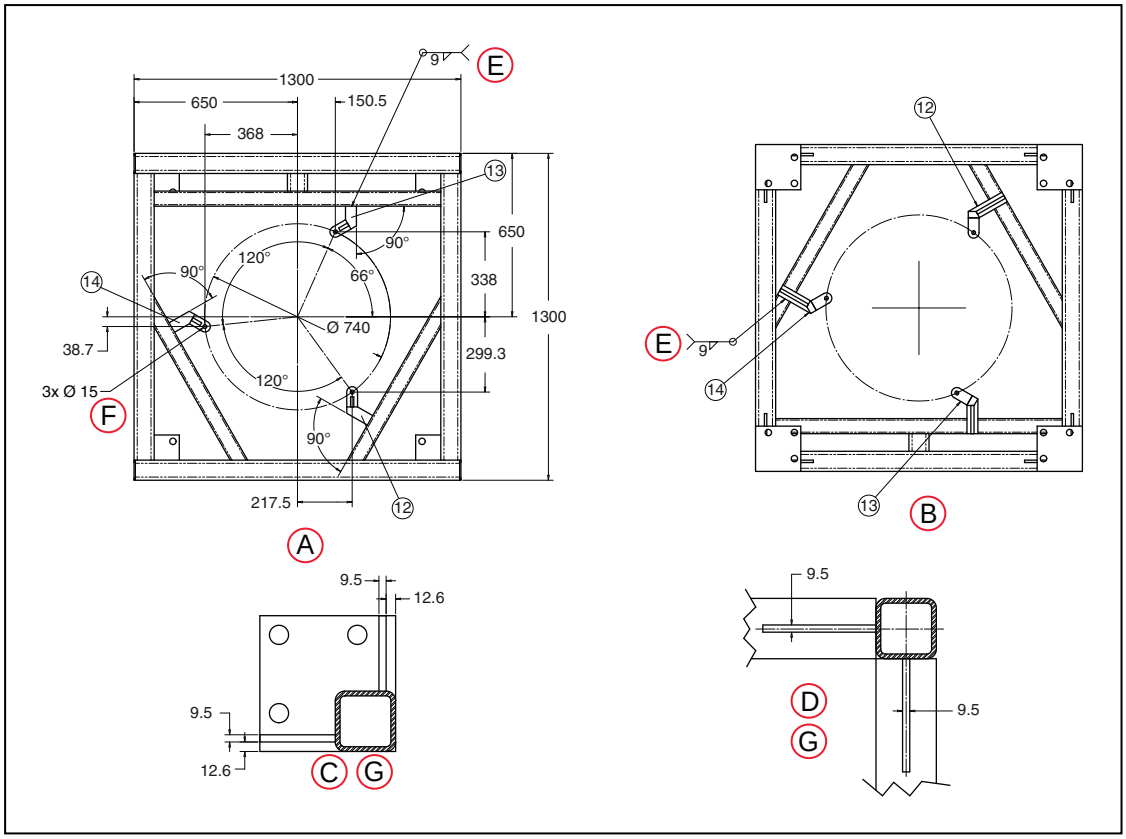


Figure 7-22. Mounting Frame, Top View

Callout	Description	Callout	Description
A	View A-A	E	All Mounting Brackets
B	View B-B	F	Through Hole
C	View C-C	G	4 Places
D	View D-D		

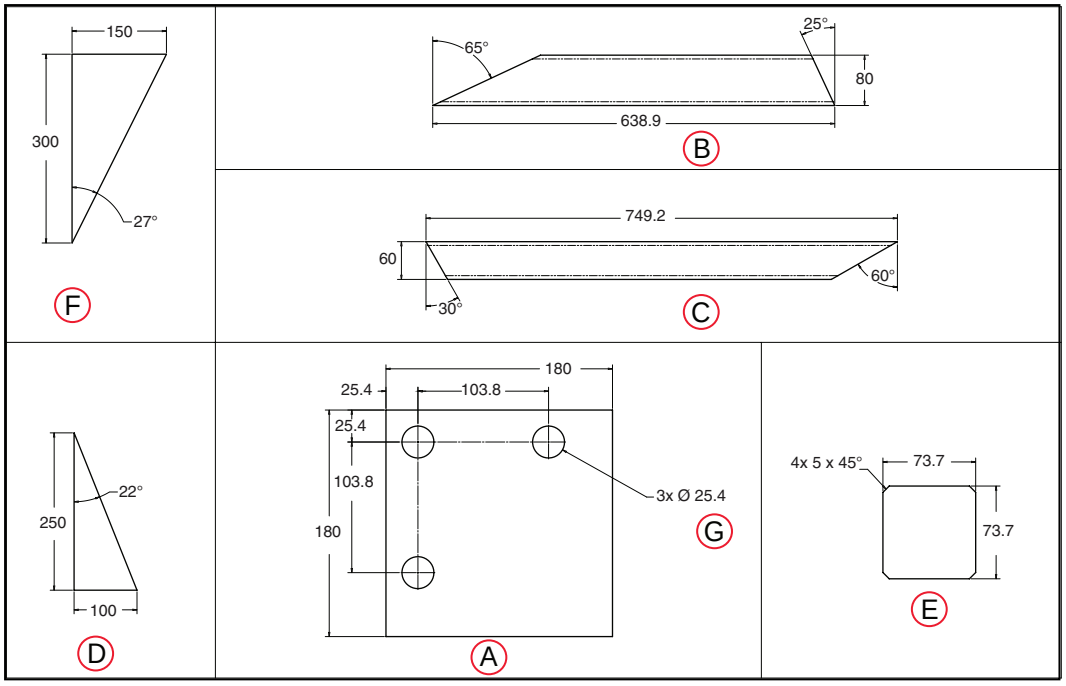


Figure 7-23. Mounting Frame, Details Items 4-5, 7-10

Callout	Description	Callout	Description
A	Detail of Item 4	E	Detail of Item 9
B	Detail of Item 5	F	Detail of Item 10
C	Detail of Item 7	G	Through Hole
D	Detail of Item 8		

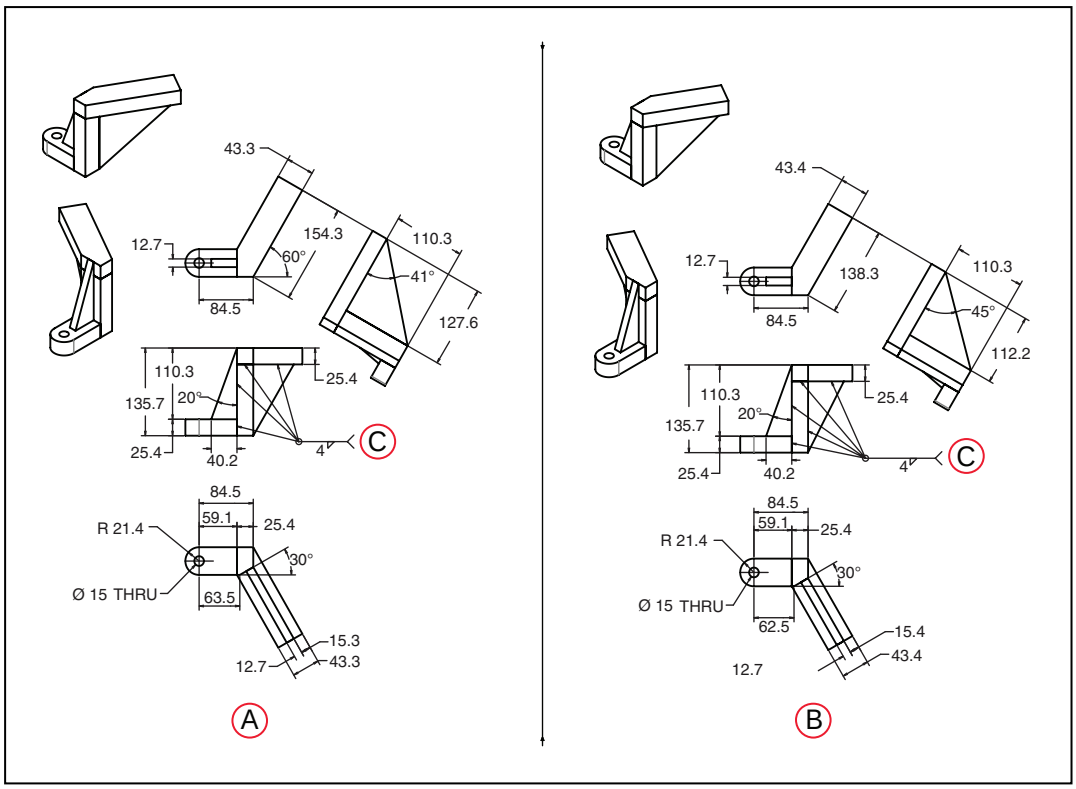


Figure 7-24. Mounting Frame, Detail Items 12 and 13

Callout	Description	Callout	Description
A	Detail of Item 12	C	All Seams
B	Detail of Item 13		

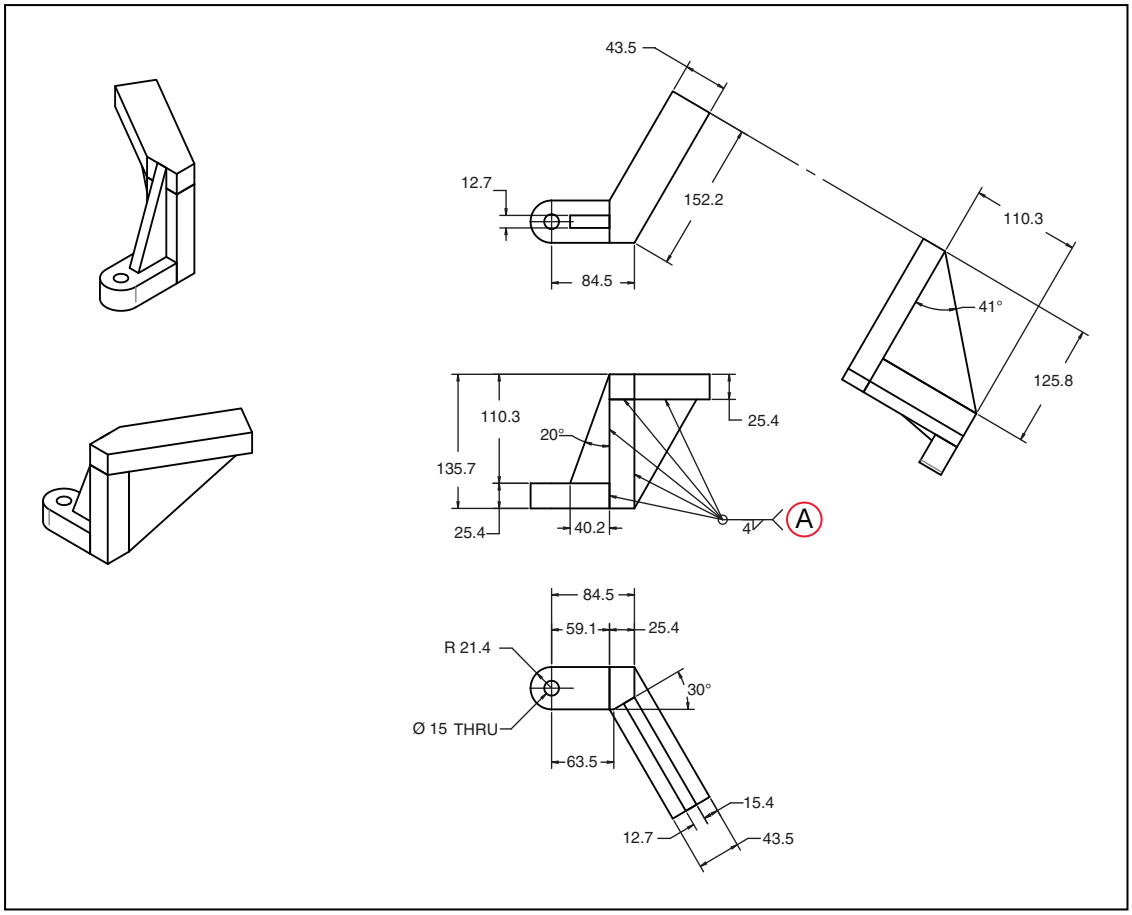


Figure 7-25. Mounting Frame, Detail Item 14, (A) All Seams

7.9 Environmental and Facility Specifications

The robot is designed to be compatible with standard cleaning and operational needs for the handling of food products. These design criteria impact how the environment can affect the robot operations, as well as how the robot can affect the cleanliness of its operating environment.

Environmental Requirements

The robot installation must meet the following operating environment specifications.

- Ambient temperature from 1° to 40° C.

  At near-freezing temperatures, moderate robot motions should be used until the robot mechanical joints warm up. A monitor speed of 10 or less for 10 minutes is recommended.

  The robot system can sustain higher average throughput at lower ambient temperatures, and will exhibit reduced average throughput at higher ambient temperatures.

- Humidity of 5% to 90%, non-condensing.
- Altitude up to 1000 m.

Design Considerations

The following design considerations should be made when selecting an operating environment.

- The robot has a cleanroom class 1000 rating.
- The robot platform and outer arms have an IP67 rating.
- The underside of the robot body has an IP65 rating.
- A high level of surface coating adhesion prevents erosion during cleaning.

  The aluminum robot base and cover are coated with a Ethylene tetrafluoroethylene (ETFE) fluorine-based plastic, which will not flake off with repeated high-pressure washings. This coating is resistant to caustic and chlorinated agents, has strong adherence to the metal base to resist impact, and has a smooth finish that is easy to clean.

  The inner arms will be either electroless nickel-plated aluminum or two-part epoxy painted aluminum. The assemblies are resistant to some caustic cleaning agents at room temperature, as well as to chipping.

- Lubricants are contained within multiple seals.

  The gearboxes are sealed internally and sealed externally by a lip seal that is designed to meet IP65 ratings. All base seal materials are designed to be compatible with caustic agents and common industrial cleaning procedures.

  The inner arms are sealed at the robot base with a rotary V-ring seal. The inner arms are designed to meet IP65 ratings.

  CAUTION: PROPERTY DAMAGE RISK
  Like most seals, it is possible to prematurely destroy these seals by deliberate, direct, excessive spraying of water-based agents into the sealing materials.

- Ball joints and springs and retainers are designed for minimal particulate generation.

  The ball studs are stainless steel.

  The hemispherical plastic inserts are resistant to caustic agents. The inserts generally produce few wear particulates. The material used in the inserts is FDA-compliant. Lubrication of the ball joints is not needed.

- The theta drive shaft is designed for minimal particulate generation.
- All moving parts are designed so that small parts are encased within larger assemblies, and are unable to contaminate the work environment.
- The outer arms are a composite assembly of carbon fiber and black anodized aluminum. The interior volume of the carbon fiber tube is sealed with an internal and external continuous epoxy bond. The spring retainer pins are press-fit into the outer-arm ends with a slight interference.
- The outer arms are attached through the positive pressure of springs that are made of electro-polished stainless steel. The springs attach to the arms with retainers that fit over bearing pins on the arms. This open spring-assembly design allows inspection for contamination as well as wash-down.
- Platforms are designed to meet IP67 and the basic criteria of wash-down compatibility.

7.10 Weights

Weight specifications are provided below.

Table 7-9. Weight Specifications

Item	Weight
3 Axis Robot	49 kg with no options installed
4 Axis Robot	52 kg with no options installed
Base plate and arms	6.5 to 11.5 kg depending upon ordered options.
Shipping Crate (empty)	70 kg

7.11 Power Connector Specifications

Power connector specifications are provided in the table below.

Table 7-10. Other Specifications

Item	Specification
DC supply connector	Housing: Connector receptacle, 2 position, type: Molex Saber, 18 A, 2-Pin • Molex part number: 44441-2002 • Digi-Key part number: WM18463-ND Pins: Molex connector crimp terminal, female, 14-18 AWG • 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

Chapter 8: Status Codes

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

8.1 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.

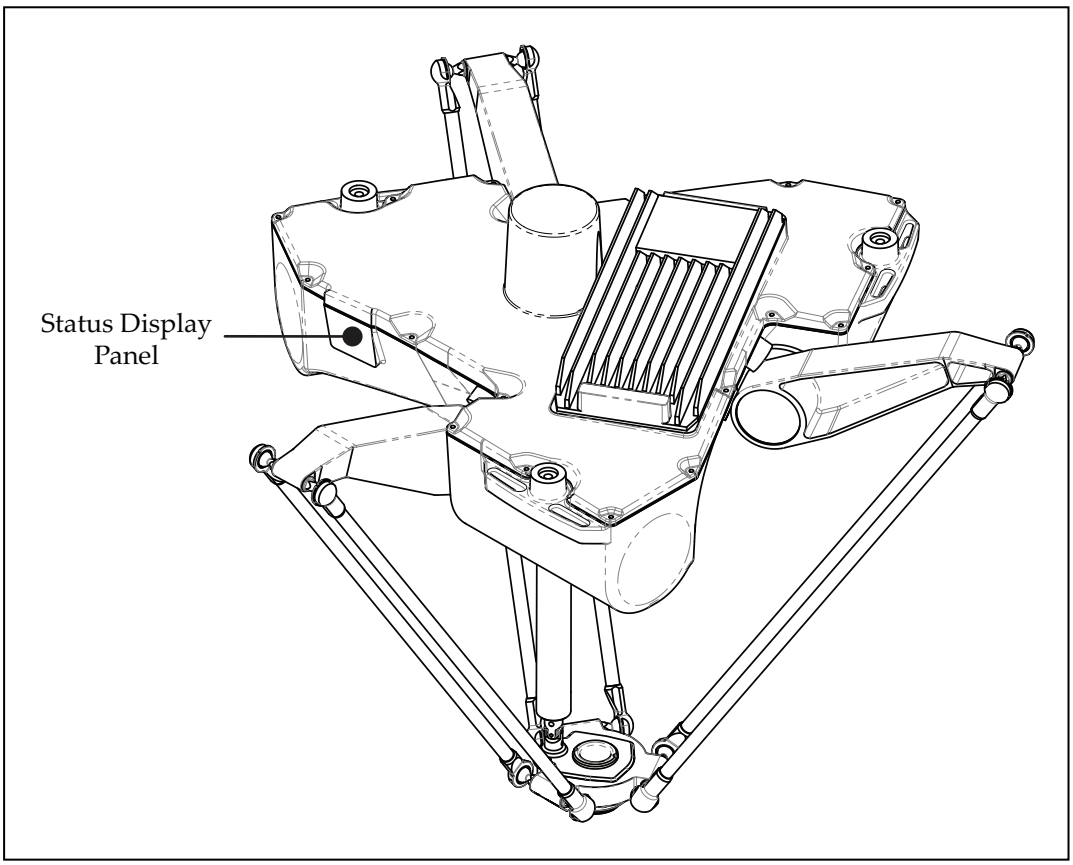


Figure 8-1. Robot Display Panel

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

8.2 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 8-1. 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. 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	IOBlox communications error with IOBlox (#).	Check user IOBlox

LED	Status Code	eV+ Error Message	eV+ Error Code	Explanation	User Action
					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 of the ESTOP and re-enable high power.
F 1	F1	*E-STOP detected by robot*	-643	The End-Of-Arm Breakaway Sensor has tripped (open circuit). Reporting of this error can be enabled / disabled via Sysmac Studio.	Re-close the breakaway circuit and re-enable high power.
FM	FM	None	N/A	Firmware version mismatch.	Contact your local OMRON support.
h#	h#	*Robot overheated*	-606	The temperature sensor on the embedded processor board is at its temperature limit.	Try slowing the motion or insert pauses. Also, check

LED	Status Code	eV+ Error Message	eV+ Error Code	Explanation	User Action
					for excessive ambient temperature, inadequate ventilation, and proper function of any cooling fans.
H#	H#	*Motor overheating* 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.
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	-1115	The power system has	Contact your local

LED	Status Code	eV+ Error Message	eV+ Error Code	Explanation	User Action
		failure* Code 1		unexpectedly turned off power.	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.
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.

LED	Status Code	eV+ Error Message	eV+ Error Code	Explanation	User Action
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 timeout.	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 this to occur momentarily during a servo reset.	If the problem persists, contact your local OMRON support.
T0	T0	*Safety System Fault* Code 10	-1109	An error was detected during a software self test of a secondary safety and monitoring	Contact your local OMRON support.

LED	Status Code	eV+ Error Message	eV+ Error Code	Explanation	User Action
				circuit (SRV_DIRECT / SRV_STAT).	
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.

Appendix

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, contact your local OMRON representative.

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.

Unpacking Procedure

The robot is shipped in a crate that holds the robot base, outer arms, platform, theta drive shaft (if applicable), and any accessories ordered. The shipping crate is made of wood and has overall dimensions of 1150 mm x 1100 mm x 855 mm.

> **NOTE:** The pallet will not fit inside most mounting frames, so the robot will need to be manually moved to the inside of the frame for mounting after unpacking.

Figure A-1. Shipping Crate Contents

The robot base is shipped with the inner arms attached. The outer arms are in a cardboard box, assembled in pairs. The platform is shipped fully assembled, but separate from the robot base and outer arms. The theta drive shaft is shipped with U-joints attached, but separate from the robot and platform.

Use the following procedure to unpack the robot.

1. Remove the top of the shipping crate.
2. Remove all cardboard boxes from inside the crate. These will include the outer arms, theta drive shaft, and platform.
3. Remove all fasteners (screws and lags) holding the crate sides to the base, and lift off the crate sides.

   The four sides will come off as a single piece, so this requires two people lifting from opposite sides of the crate. You will be left with the robot base, with the iCS-ECAT and inner arms attached to the pallet. The robot base is held to the pallet with tie-downs.

4. Remove the robot tie-downs.
5. After the robot tie-downs are removed, the robot and accessories can be relocated to complete this procedure.

A.3 Transportation and Storage

This section provides details about transporting and storing your robot.

The robot should be shipped and stored in the supplied shipping crate that is ASTM D4169-16 DC12 certified and designed to prevent damage from normal shock and vibration. You should protect the shipping crate from excessive shock and vibration.

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: less than 75%, non condensing.

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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