OMRON

iX4 650 H/HS and 800 H/HS Robot with EtherCAT

User's Manual

I656-E-01

Copyright Notice

Created in the United States of America.

Table of Contents

Chapter 1: Introduction

This manual contains information that is necessary to install and use an iX4 robot. Please read this manual and make sure you understand the functionality, installation, and performance of the robot before attempting to use it.

1.1 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 V+ programming language and functionality.
eV+3 User's Manual (Cat. No. I651)	Provides reference to V+ 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 use of the NJ-series Robot Integrated CPU Unit.
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.

1.2 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.

1.3 Robot Overview

The iX4 is a four-arm parallel robot. Servo motors in the robot base control movement of the robot platform through mechanical links and arms. 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 in 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.

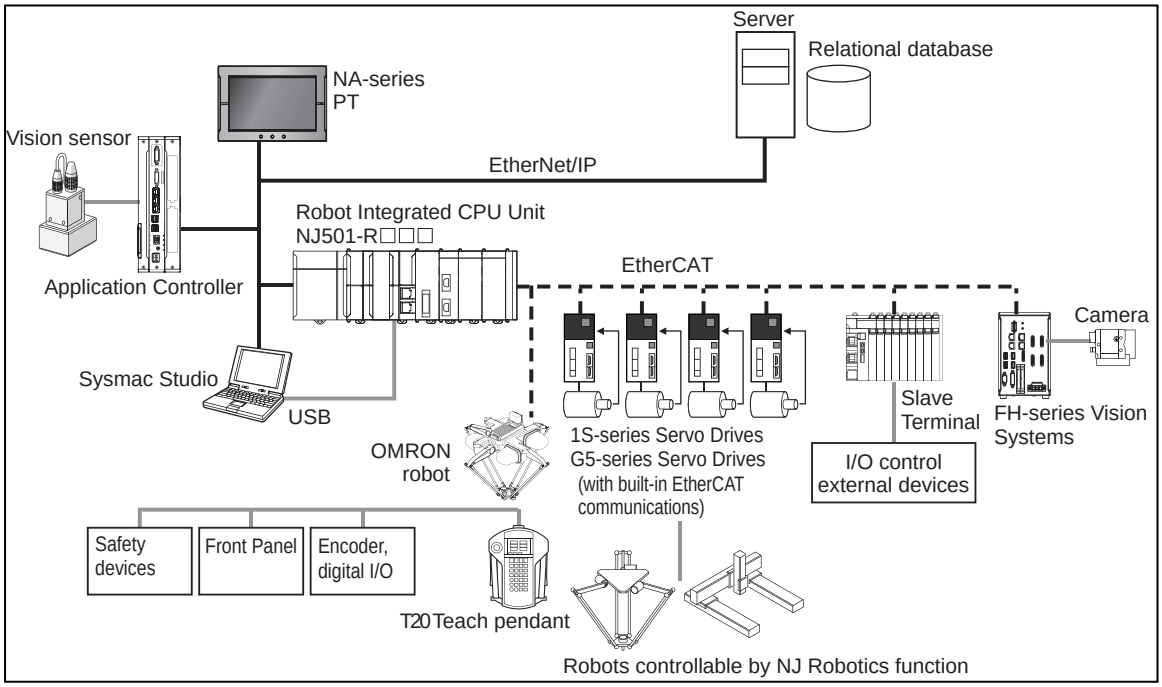


Figure 1-1. EtherCAT System Topology

Four models of the iX4 are available:

- iX4-650H

  This is a standard iX4 robot with a 650 mm radius work envelope.

- iX4-650HS

  This is a USDA-accepted iX4 robot with a 650 mm radius work envelope.

- iX4-800H

  This is a standard iX4 robot with an 800 mm radius work envelope.

- iX4-800HS

  This is a USDA-accepted iX4 robot with an 800 mm radius work envelope

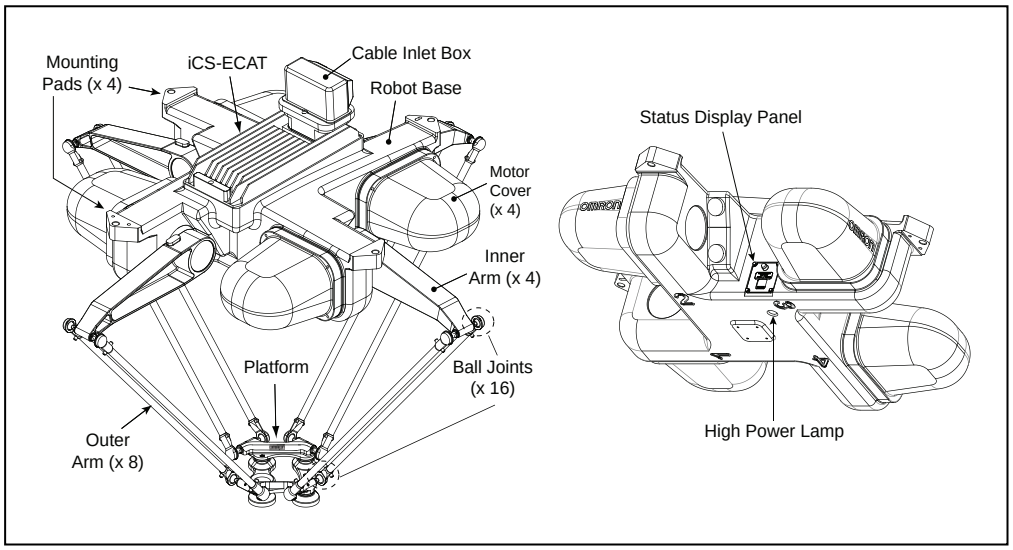


Figure 1-2. iX4 Robot with EtherCAT

Major Differences Between iX4-650H/800H and iX4-650HS/800HS Robots

In most aspects, the robots are similar enough that they will be covered together. In areas where there are significant differences, the iX4-650H/800H and iX4-650HS/800HS robots will be presented separately.

Note that either anodized aluminum or stainless steel platforms can be used on the iX4-650H and iX4-800H robots.

The iX4-650HS and iX4-800HS are only available with stainless steel platforms.

Table 1-2. iX4-650H/800H and iX4-650HS/800HS Robot Differences

	iX4-650H/800H	iX4-650HS/800HS
USDA Accepted (Meat and Poultry)	No	Yes
IP rating	IP65, Option	IP66, Standard
P30 Platform, no rotation	Hard-anodized or Stainless Steel	Stainless Steel
P31 Platform, 46.25°	Hard-anodized or Stainless Steel	Stainless Steel
P32 Platform, 92.5°	Hard-anodized or Stainless Steel	Stainless Steel
P34 Platform, 185°	Hard-anodized or Stainless Steel	Stainless Steel
Outer Arm Ball Joint Sockets	Hard-Anodized	Stainless Steel
Base Mounting Pad Holes	M16-2.0, through-hole	M16-2.0, blind, 40 mm bolt
Base Coating material	polyurethane powder	ETFE, USDA approved
iCS-ECAT	Black Anodized, Single-bolt installation	Electroless Nickel, 6-bolt installation
Cable Inlet box	Hard-Anodized, Option	Electroless Nickel, Standard
Cable Tray	Not required	Required (for USDA)
Labels	On exterior of robot	All labels protected
Protective Earth Ground	On base-mounting pad	In cable inlet box
Motor covers	OMRON label	No label
Exposed bolts and screws all gasketed	No	Yes

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 LEDs to indicate operating status.

> **Additional Information**: Refer to iCS-ECAT Robot Interface Panel on page 13 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.

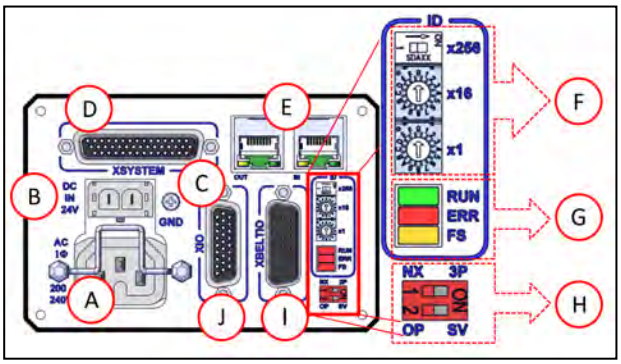


Figure 1-3. iCS-ECAT Robot Interface Panel

Table 1-3. iCS-ECAT Robot Interface Panel Descriptions

Item	Description
A	AC Power Supply Connector

Item	Description
	Used for connecting 200 to 240 VAC, single-phase input power to the robot. A connector is provided with the robot. Refer to Connecting 200 to 240 VAC Power Cable on page 82
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 79 for more information.
C	Ground Terminal
D	XSYSTEM Connector Refer to Basic System Cable Layout on page 63
E	EtherCAT Ports Used for inbound and outbound EtherCAT communications.
F	Node ID Switches Used to set the robot's EtherCAT node ID. Refer to Setting the EtherCAT Node ID on page 58
G	LEDs Indicates the status of the EtherCAT connection. Refer to EtherCAT Communications Description on page 106 for more information.
H	4-Position Mode Switches Used to adjust the operating mode of the robot. Refer to Robot Control Modes on page 109 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 63 for more information. XBELTIO
J	XIO Connector Used for user I/O signals for peripheral devices. Refer to Basic System Cable Layout on page 63 for more information.

Robot Base

The robot base is an aluminum casting that houses the four drive motors and supports the iCS-ECAT. It provides four 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.

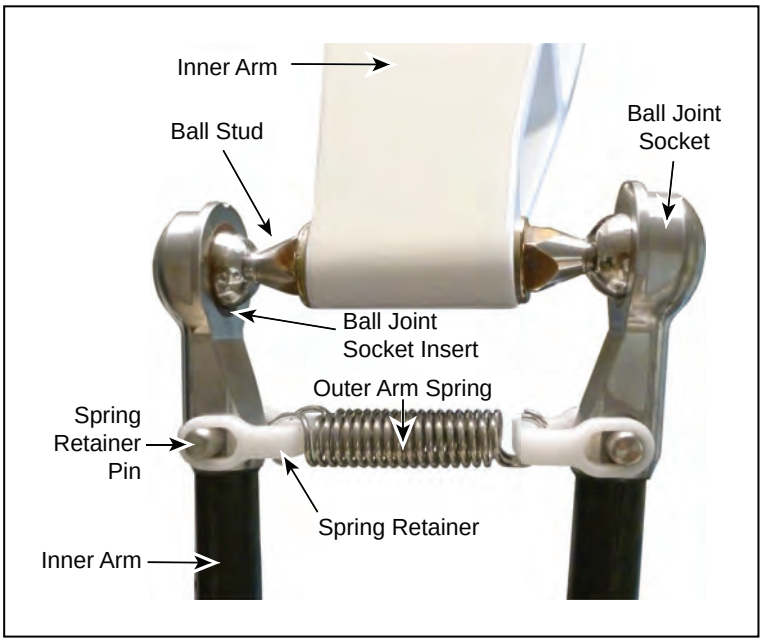


Figure 1-4. Ball Joint Assembly

Table 1-4. Ball Joint Assembly Descriptions

Key	Desctription	Key	Description
A	Inner Arm	E	Outer Arms
B	Ball Joint Socket	F	Ball Joint Socket Insert
C	Ball Joint Stud	G	Pressed Pin
D	Outer Arm Springs	H	Spring Holder

Inner Arms

Four robot motors attach directly to the inner arms through high-performance gear reducers. RIA-compliant hard stops limit the inner arm motion to -52° and +124°.

Platforms

The platform converts the motion of the robot motors into Cartesian motion and, for all but the fixed platform, theta rotation of the tool flange.

The iX4 robot supports four models of platforms, depending on the amount of Theta rotation and inertia needed. Each model is available in either Anodized Aluminum or Stainless Steel.

NOTE: The four models of platforms require different robot parameters.

Part Number	Platform	Rotation	Material
These platforms can be used with iX4-650H/800H robots.			
09730-000	P30	0°	Anodized Aluminum
09503-000	P31	±46.25°	Anodized Aluminum
09732-000	P32	±92.5°	Anodized Aluminum
09734-000	P34	±185°	Anodized Aluminum
These platforms can be used with any iX4 robots.			
09730-200	P30	0°	Stainless Steel
09503-200	P31	±46.25°	Stainless Steel
09732-200	P32	±92.5°	Stainless Steel
09734-200	P34	±185°	Stainless Steel

P30 Platform

The P30 platform is a fixed platform that provides no Theta rotation. The tool flange is machined into the one-piece platform.

Figure 1-5. P30 Platform

P31 Platform

The P31 platform has a rotation range of ±46.25°. The tool flange is machined into one of the pivot links. It does not rotate in relation to the pivot link, so there are no gears or belts involved.

Figure 1-6. P31 Platform

P32 Platform

The P32 platform has a rotation range of ±92.5°. The tool flange is mounted on one of the pivot links.

Figure 1-7. P32 Platform

P34 Platform

P34 platform has a rotation range of ±185°. The tool flange is mounted on one of the pivot links.

Figure 1-8. P34 Platform

NOTE: The only visible difference between the P32 and P34 platforms is the model number, and the dots immediately below that number. Two dots designate a P32 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 cone-like shape 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.

1.4 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.

I/O Options

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

- XIO Breakout Cable (p/n 04465-000)

  Refer to Optional Cables on page 21 for more information.

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

- XIO Termination Block (p/n 90356-40100)

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

- IO Blox (p/n 30410-220)

  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 70 and the *IO Blox User's Guide (04638-000)* for more information.

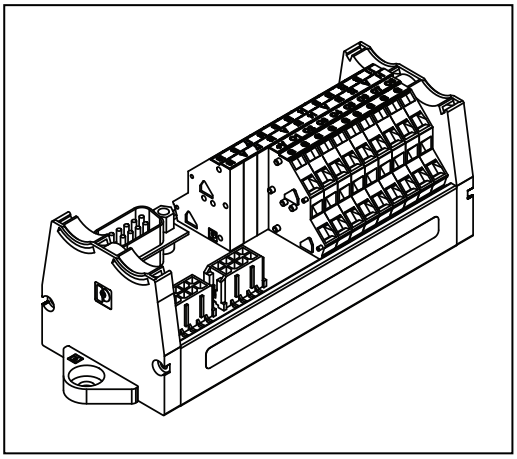


Figure 1-9. IO Blox

T20 Pendant

The T20 pendant is an optional hand held device that allows you to move the robot and teach locations. 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.

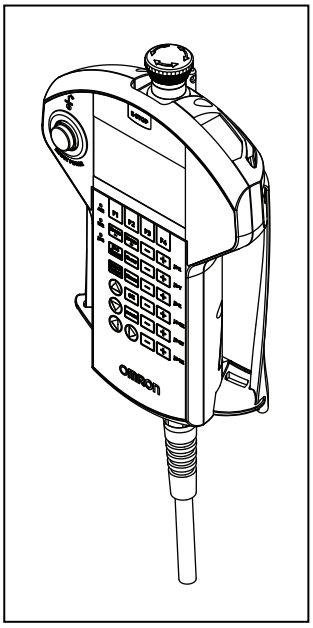


Figure 1-10. T20 Pendant

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)*

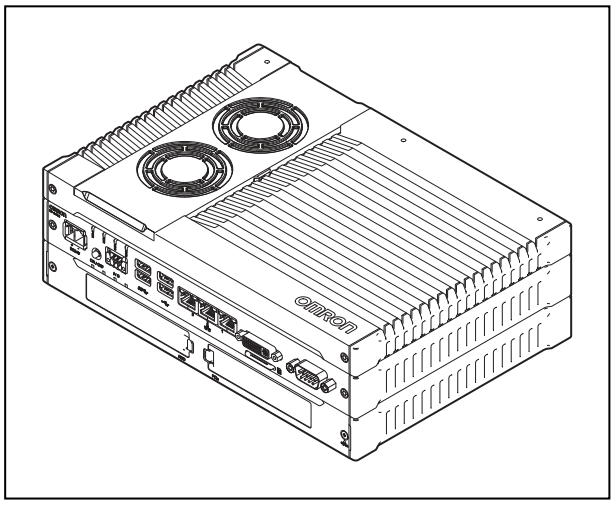


Figure 1-11. IPC Application Controller

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 109 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 110 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).

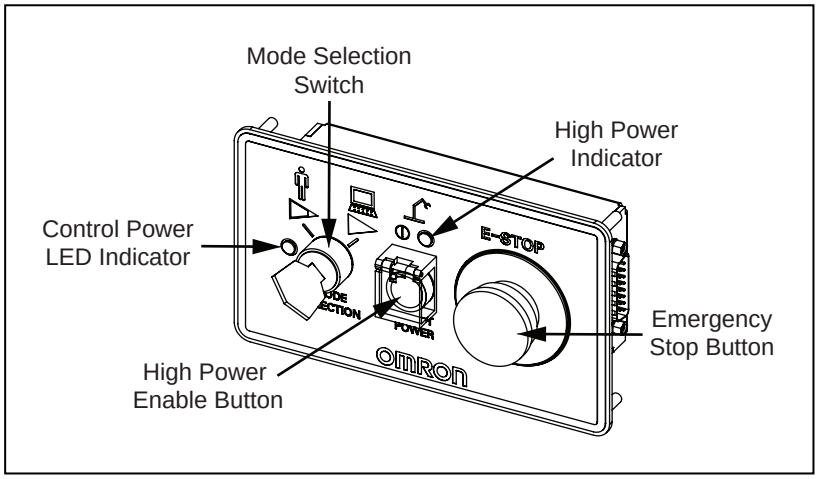
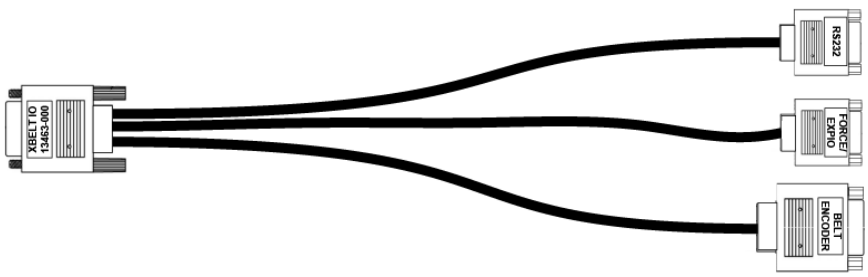


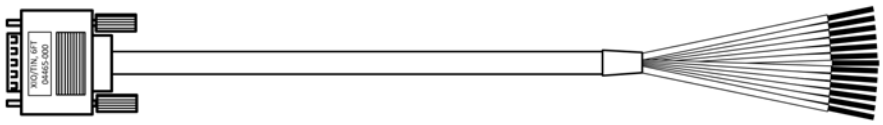
Figure 1-12. Front Panel

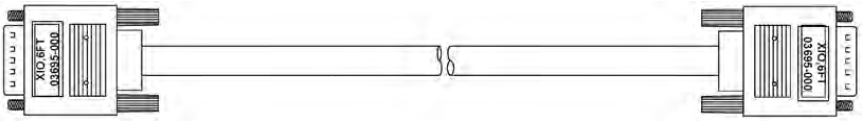
Optional Cables

The following table provides details about optional cables.

Table 1-5. 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. 

P/N	Description
	NOTE: For pinouts for this cable, refer to Pinouts for XBELT IO Adapter on page 68.
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.  **NOTE:** For details on using this cable, refer to XBELT IO Belt Encoder Y Adapter Cable on page 67.
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 70.
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 23 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 addtional details, refer to XIO Termination Block on page 71.

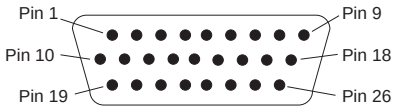
P/N	Description
	

XIO Breakout Cable Pinout

Table 1-6. 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

Pin No.	Signal Designation	Wire Color
25	Output 7	White/Red
26	Output 8	White/Blue
Shell		Shield



Cable Inlet Box

The optional cable inlet box can be used to increase the iX4-650H/800H robot's IP rating to IP65.

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

> **NOTE:** The optional cable inlet box (for the iX4-650H/800H) 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 for iX4-650H/800H Robots on page 88 for more information.

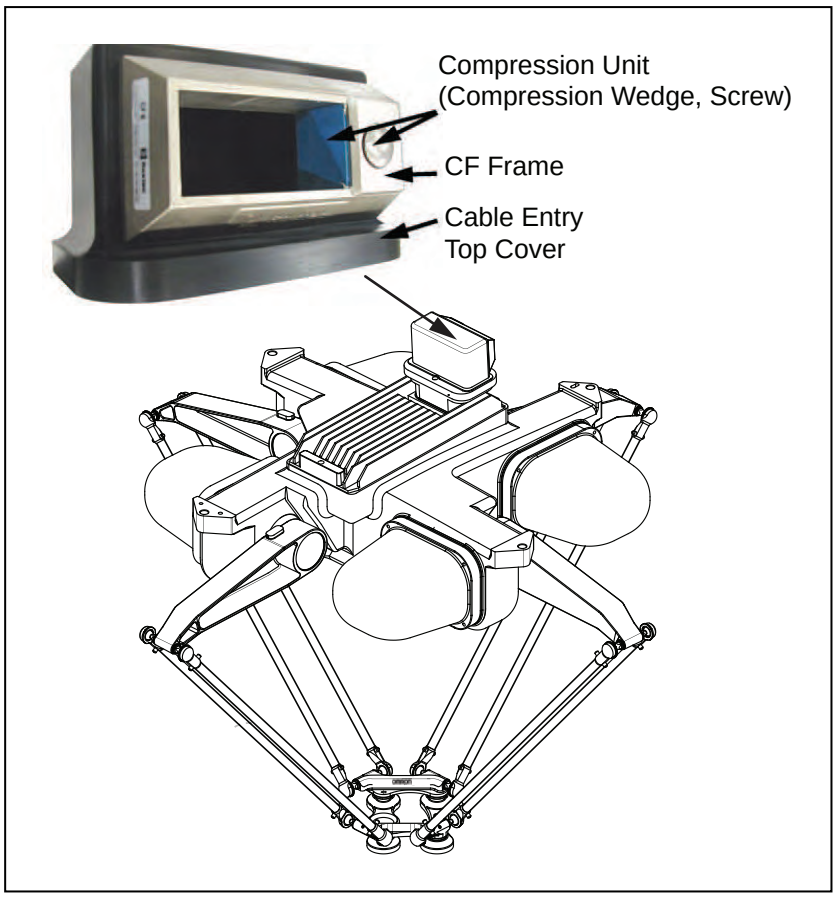


Figure 1-13. Cable Inlet Box

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 61 for more information.

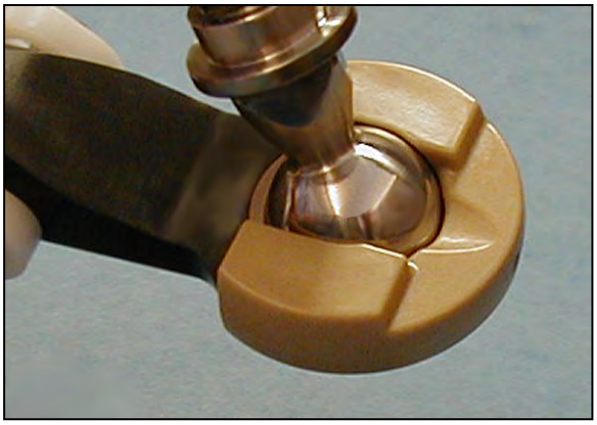


Figure 1-14. Ball Stud Locks

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
Hornet 565s 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
A Hornet 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.

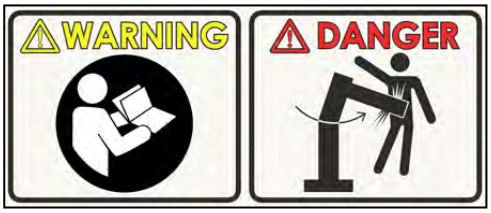


Figure 2-1. Read Manual and Impact Warning Labels

- The robot must not be used for purposes other than described in Intended Use of the Robots on page 31. 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. Refer to Payload Specifications on page 156.
- 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 exist within the work envelope 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 6.0 kg, for anodized platforms, and payloads up to 3 kg for stainless steel platforms. Refer to Payload Specifications on page 156 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 iX4-650H/800H Robots on page 118 and Cleaning iX4-650HS/800HS Robots on page 120 for more information. The robot`s platform and outer arms are IP67 rated. The base of the iX4-650H/800H robots is IP65 rated, and for the iX4-650HS/800HS robots, the rating is IP66.

  IMPORTANT: For iX4-650H/800H 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

iX4 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 iX4 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 187 for more information.

Basic Installation Steps

Use the following steps to understand the basic installation procedure.

Step	Task	Reference
1	Mount the robot.	Mounting the Robot Base on page 39
2	Align the platform.	Align the Platform with the Robot Base on page 42
3	Attach outer arms and install the platform.	Attach the Outer Arms on page 43
4	Install ball stud locks if applicable.	Installing or Removing Ball Stud Locks on page 61.
5	Installing the Front Panel.	Installing the Front Panel on page 47.
6	Install user-supplied safety equipment.	Installing User-Supplied Safety Equipment on page 49
7	Set the EtherCAT Node Address.	Setting the EtherCAT Node ID on page 58.
8	Make robot system cable connections.	System Cable Installation on page 63.
9	Verify the installation.	Verifying Installation on page 103.

3.2 Mounting Frame

The robot is designed to be mounted above the work area suspended on a user-supplied frame.

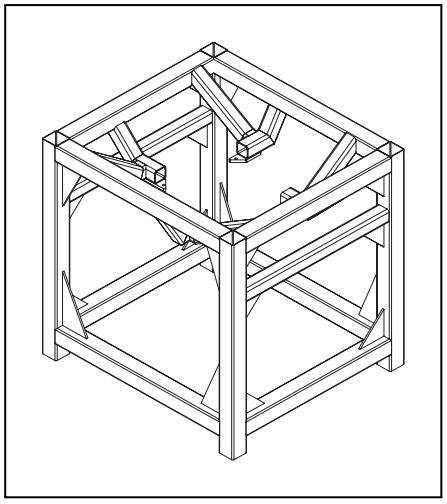


Figure 3-1. Sample iX4 Mounting Frame

The frame design is the responsibility of the user. We make no representation or warranty with respect to these guidelines, or the rigidity and longevity of the structure designed and built by the user or for the user by a third party using these guidelines. In addition, when the robot is mounted on the structure based on these guidelines, we do not guarantee that the robot will perform to the specifications given in this product documentation, due to user's frame or user's production environmental factors.

As an example, a sample frame design is provided in this document. For generalized application performance, frames built to the specifications of this sample should experience no degradation in robot performance due to frame motions. Applications requiring higher than 6 kg * 10 g forces across the belt and/or 6 kg * 3 g along the belt may require a stiffer frame design.

> **Additional Information**:
>
> Refer to Robot Physical Dimension Drawings on page 145 for more information about mounting hole patterns.
>
> Refer to Mounting Frame Specifications on page 170 for more information about mounting frame dimensions and design.

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 38 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 149 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. 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 for iX4-650H/800H Robots on page 88 for more information.
- Applications requiring higher than 6 kg * 10 g forces across the belt and/or 6 kg * 3 g along the belt may require a stiffer frame design.

Frame Orientation

The sample robot frame design is stiffer in one direction than the other. This is to accommodate conveyor belt applications where the robot is moving with much more acceleration across a conveyor belt than along it. The conveyor should generally be aligned so that the belt travel is along the robot World Y-axis, and the mid-height frame members cross the belt at a 90° angle. The across-the-belt dimension of the frame should be minimized to get the best performance of the robot in that direction. While this frame design assumes a 1.8 m across-the-belt frame dimension, a 1.5 m dimension would offer increased stiffness and possibly increased robot performance at high accelerations and payloads. The mid-height horizontal members are important to the frame stiffness, and should be located as close to the belt as possible.

For applications requiring high accelerations along the direction of belt travel, consideration should be given to strengthening the frame in that direction.

Frame Construction

Typically, the frame is constructed of welded steel members. Hygiene-sensitive applications may call for stainless steel fabrication, with care taken to seal up all possible voids and grind smooth all weld joints. For other applications, it may be suitable to manufacture the frame of carbon steel and paint the resulting assembly. The frame design presented here is based on a stainless steel construction using 10 mm thick members. It may be reasonable to use a reduced thickness for carbon steel assemblies. Some customers may choose to use tubular members, or turn horizontal members at 45° angles to facilitate water runoff from the flat frame surfaces.

- The sample shown in Mounting Frame on page 35 is for an iX4-650H/800H robot. While stiff enough for use with the iX4-650HS/800HS robots, it was not designed for USDA applications. Detailed drawings are given in Mounting Frame Specifications on page 170
- The thickness of the frame mounting tabs is critical, as is the flatness of those tabs. See Frame Mounting Tabs (following) and Mounting Surfaces on page 38.
- The frame must be stiff enough to prevent excessive vibration.
- You may want to design the frame so that the robot can be installed by lowering it from the top.

Frame Mounting Tabs

For the iX4-650HS/800HS robots, to achieve the correct compression of the sealing gaskets, the mounting tabs on the frame must be 12.7 mm, +1.3, -0.7 mm thick. Because the junction of the robot base mounting pad and the frame mounting pad is sealed with a gasket, the frame mounting pads must be at least as big as the robot base mounting pads. If the frame pad does not cover the entire robot pad, the gasket will not seal properly. The design of the iX4-

650HS/800HS robot mounting bolts and seals requires tight tolerances for the robot mounting holes in the frame. These should be 17.25 ± 0.75 mm in diameter.

Robot-to-Frame Considerations

The iX4 robots have a moderately-complex mounting requirement due to the nature of the parallel arm kinematics and the need to minimize the robot size and mass. Arm Travel Volumes on page 149 shows the inner arm travel and how it may encroach on the robot mounting points. As a starting point, for a frame that is 2 meters in each direction, (allowing use of the full range of the iX4 robots), you should attempt to attain a frame frequency of 25 Hz.

For specialized applications, such as heavy payloads and/or aggressive moves, you may want to attain a frame frequency of 40 Hz.

In general, a smaller frame will yield a higher frequency. If you aren't going to use the entire work envelope, you can increase the frequency simply by using a smaller frame.

A lower frequency frame, more aggressive robot moves, and heavier payloads will all contribute to longer settling times.

Mounting Surfaces

The mounting frame should have four 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 four 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 Mounting Hole Dimensions, iX4-650H/800H Robots on page 146 for more information.

> **NOTE:** The robot base-mounting pads have spring-lock Heli-Coils in the M16 holes, so lock washers are not needed on the M16 mounting bolts.

The robot mounts in four locations, as detailed in the drawings.

For an iX4-650H/800H robot, the holes are tapped for an M16 x 2.0 bolt. The robot may be mounted from the top or bottom of the frame. A crane or forklift should be used to position the robot. If lifted from above, the robot must be lifted by user-supplied eyebolts and slings. Mounting Hole Dimensions, iX4-650H/800H Robots on page 146 shows the mounting hole pattern for the iX4 robot. Note the hole location and mounting pad tolerances for position and flatness. If the frame does not meet this flatness specification, use shims to achieve it.

For an iX4-650HS/800HS robot, Mounting Hole Dimensions, iX4-650HS/800HS Robots on page 147 shows the mounting hole pattern. Note the hole location and mounting pad tolerances for position and flatness.

Deviation from these flatness specifications will, over time, cause a possible loss of robot calibration.

NOTE: We suggest welding the robot mounting tabs as a last step in the frame fabrication, using a flat surface as a datum surface during the tack welding operation.

Gussets

The triangular gussets are an integral part of the frame stiffness. The vibrational strength of a structural assembly is strongly governed by controlling the shear forces between members. The 250 mm gussets, shown in Mounting Frame Specifications on page 170, are nominally sufficient for transferring the load from the vertical members into the horizontal cross pieces. Preferably, gussets should be placed at the edges of the frame members to transfer the loading into the walls of the members, instead of the faces, and enable easier cleaning. Some frame designs may benefit from extending these gussets to 500 mm in the vertical direction, as the design intent of the gussets is mainly to secure the long vertical members from rotating out of position. For this reason, the gussets to the across-the-belt horizontal member should be at the bottom of the member, as shown in Mounting Frame Specifications on page 170, and as close to the vertical midplane of the frame as feasible (15 mm thickness is adequate for most situations).

3.3 Mounting the Robot Base

This section describes mounting details for the iX4 robot base.

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

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 Procedure

Make the following considerations before attempting to mount the robot:

- The base casting of the robot is aluminum and can be dented if bumped against a harder surface.
- Verify that the robot is aligned with all mounting holes before inserting or tightening the mounting bolts.

Use the following procedures to mount the robot to the mounting frame.

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. Remove all lag bolts from the mounting pads before lifting the robot base.
2. Wrap slings around the robot base. See the following figure for two methods.

NOTE: Make sure the slings do not touch the status panel or inner arms.

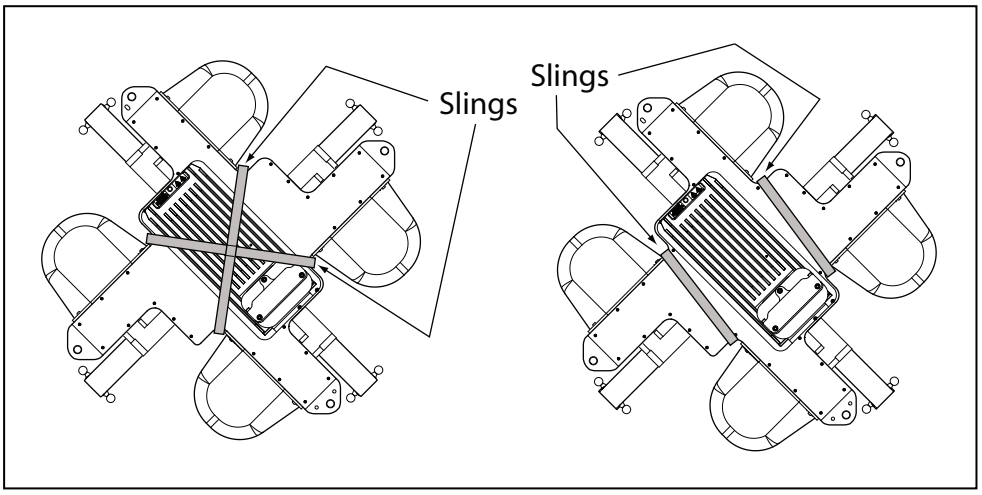


Figure 3-2. Lifting Slots

3. 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. Refer to Installing iX4-650H/800H Mounting Hardware on page 40 or Installing iX4-650HS/800HS Mounting Hardware on page 41 to proceed with the mounting procedure.

Installing iX4-650H/800H Mounting Hardware

Fastening the iX4-650H/800H to the mounting frame can be achieved by either threading bolts into the robot base or inserting bolts through the base and securing with nuts. All mounting bolt types require split lock and flat washers.

The following bolt specifications are required for the iX4-650H/800H.

Fastening Type	Bolt Type	Nut Type	Torque
Threaded into base[1]	M16 x 2, ISO Property Class 5.8	N/A	98 N·m
Through-base	M12 or 1/2 inch, ISO Property Class 9.8		100 N·m
NOTE: When M16 x 2.0 bolts are used, the bolt must engage at least 24 mm into the threads of the base mounting pad.			

Use the following procedure to fasten the iX4-650H/800H robot to the mounting frame.

1. Place split lock, then flat washers on the bolts.
2. Insert the bolts through the holes in the frame mounting pads and into the threaded holes in the robot base mounting pads.

   If using through-bolts, insert the bolts through the holes in both the mounting pads and through the threaded holes in the robot base mounting pads into nuts.
3. Tighten the mounting hardware to the specifications listed in the table above to complete this procedure.

> **IMPORTANT:** Check the tightness of the mounting bolts one week after initial installation, and then recheck every 6 months. For periodic maintenance, refer to Periodic Maintenance Schedule on page 115.

Installing iX4-650HS/800HS Mounting Hardware

iX4-650HS/800HS robots require special considerations for USDA compliance. USDA requires that all exposed screws be sealed with a gasket, which must be compressed to specific standards. To achieve this, the iX4-650HS/800HS robot mounting bolts use a spacer that fits inside a compressible sealing gasket.

The robot base-mounting tabs have spring-lock HeliCoils in the M16 holes, so a lock washer is not needed on the M16 mounting bolts.

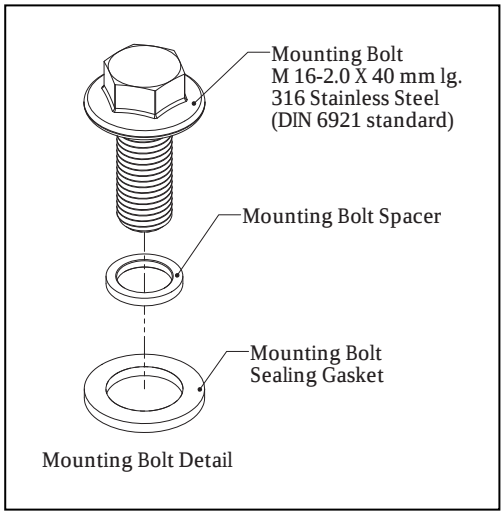


Figure 3-3. Robot Mounting Bolt, Spacer, and Gasket

To achieve the correct compression of the sealing gaskets, the mounting tabs on the frame must be 12.7 mm, +1.3, -0.7 mm thick.

> **Additional Information**: If you choose to use a different frame pad thickness and provide your own mounting bolts, the bolts need to be M16-2.0, 316 stainless steel flange bolt (DIN 6921 standard). The threads must engage at least 24 mm of the robot base threads (HeliCoil), for sufficient support. The bolts must not bottom out, or the washer seals and gaskets will not be compressed enough to form a good seal.

The following bolt specifications are required for the iX4-650HS/800HS.

Type	Minimum Specification	Torque
M16-2.0 x 40 mm	ISO Property Class 5.8	98 N·m

Use the following procedure to fasten the iX4-650HS/800HS robot to the mounting frame.

1. Verify that the gaskets between the robot pads and the mounting frame are in their grooves in the pads, and completely covered by the mounting frame pads.
2. Place a spacer, then a sealing gasket, on each bolt.
3. Insert the bolts through the holes in the frame mounting pads and into the threaded holes in the robot base mounting pads.
4. Check the position of the gaskets between the robot base pads and the mounting frame. The frame pads should completely cover the gaskets.
5. Tighten the bolts to 98 N·m to complete this procedure.

IMPORTANT: Check the tightness of the mounting bolts one week after initial installation, and then recheck every 3 months. Refer to Periodic Maintenance Schedule on page 115.

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 with the robot base.
2. Attach the outer arms to the inner arms.
3. Attach the platform to the outer arms.

Align the Platform with the Robot Base

The rotational alignment of the platform to the base is critical to the correct operation of the robot.

IMPORTANT: Incorrect alignment of the platform will result in incorrect robot performance.

NOTE: Stainless steel platforms are labeled to indicate which pair of ball studs should be connected to which inner arm.

When the platform is installed correctly, the tool flange will be closest to the status display on the robot base.

The bottom of the robot base has embossed numbers, 1 through 4, indicating the motor numbers. The corresponding numbers for the platform, as viewed from the top, are indicated in the following figure, where each number represents a pair of ball studs. When the platform numbers match the robot base numbers, the platform will be correctly aligned.

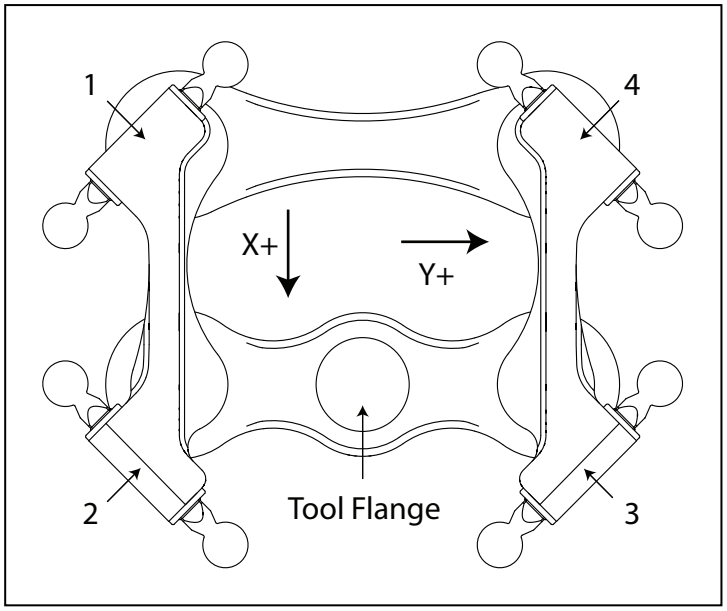


Figure 3-4. Platform Alignment (Top View of P31)

Attach the Outer Arms

Four 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 spring retainers at each end.

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

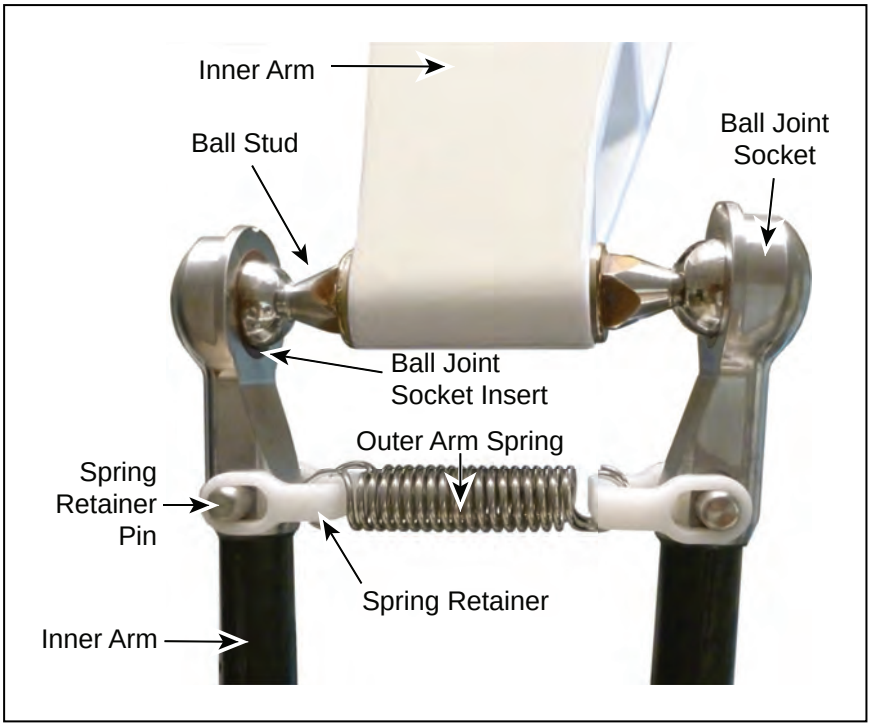


Figure 3-5. Outer Arm Attachment Hardware

Outer Arm Attachment Procedure

Use the following procedure to attach the outer arms. The procedure is the same for all 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.

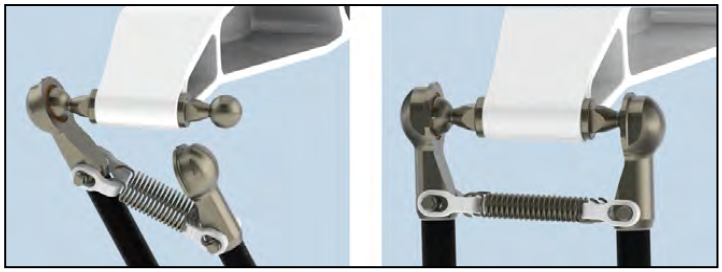


Figure 3-6. Pivot to Install Outer Arms

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 four pairs of ball studs on the platform.

   NOTE: Ensure that the numbers on the platform match the numbers on the underside of the robot base. This will place the platform tool flange closest to the Status Display Panel. Refer to Align the Platform with the Robot Base on page 42. The platform is installed flange-down.

   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.

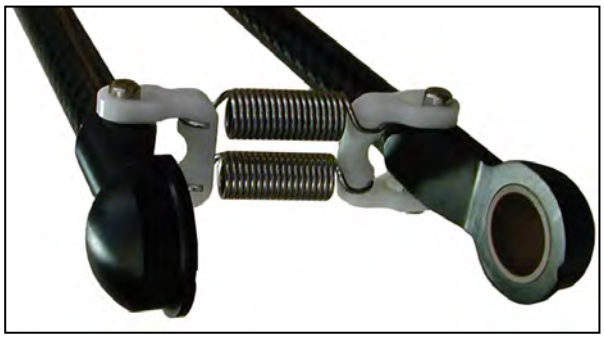


Figure 3-7. Springs Seated Properly

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

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.

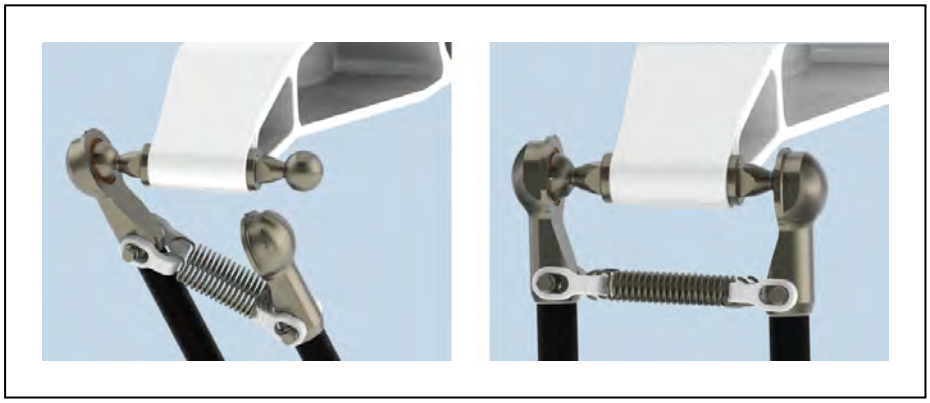


Figure 3-8. Pivot to Install Outer Arms

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 four 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.

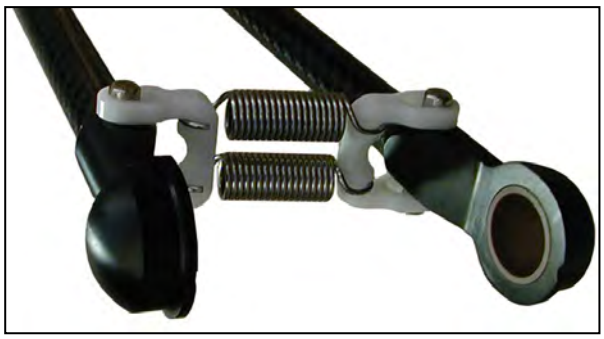


Figure 3-9. Springs Seated Properly

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.

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

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.

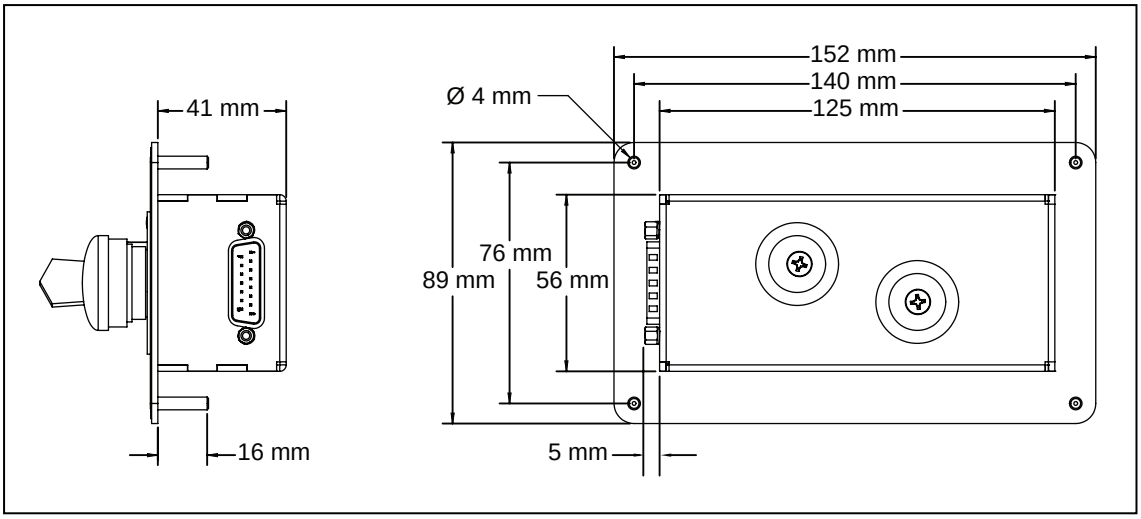


Figure 3-10. Front Panel Dimensions

Connecting the Front Panel

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

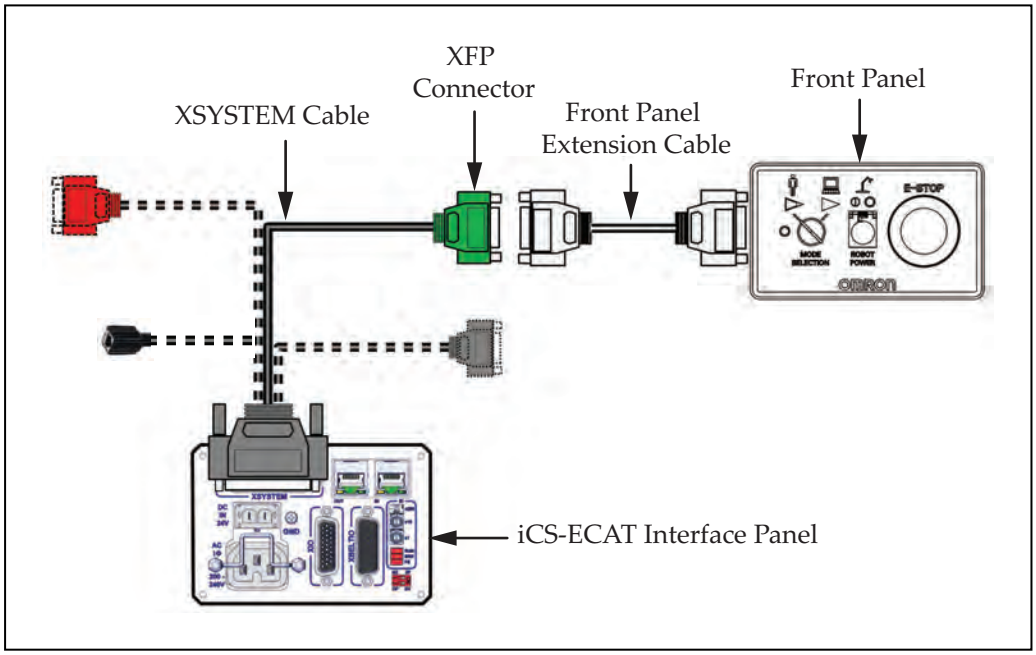


Figure 3-11. Front Panel Connections

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.

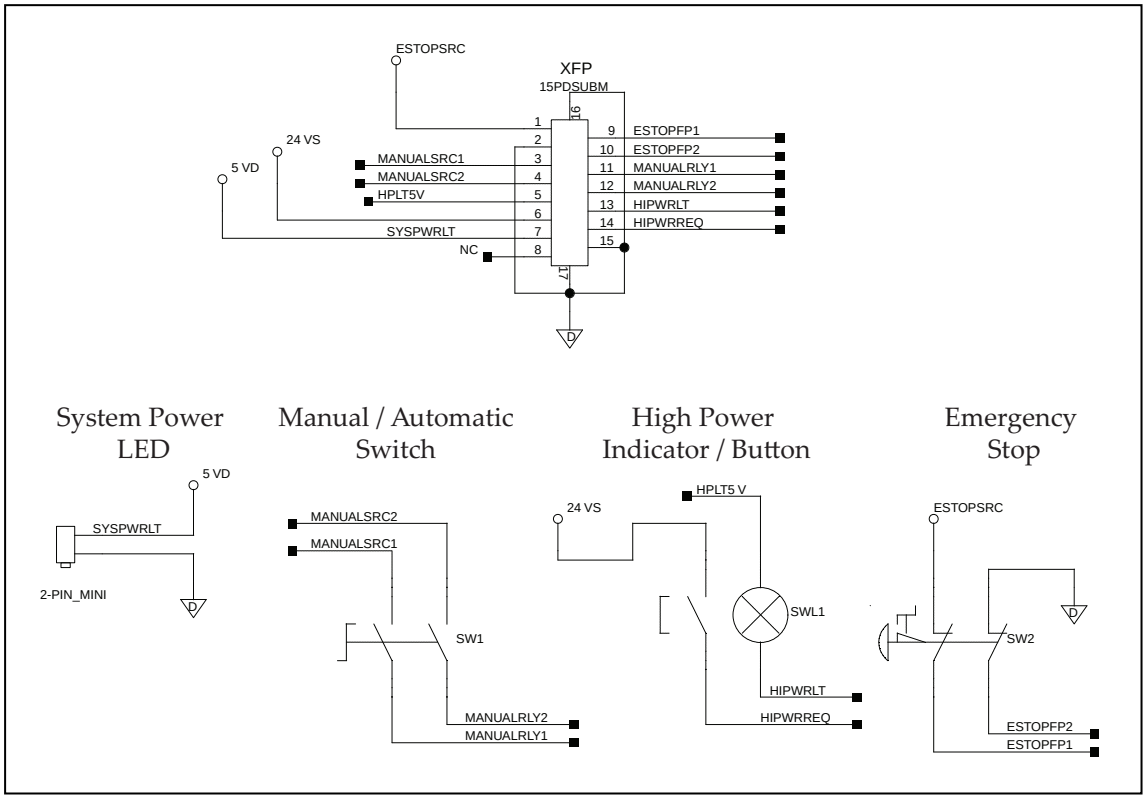


Figure 3-12. Front Panel Schematic

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.

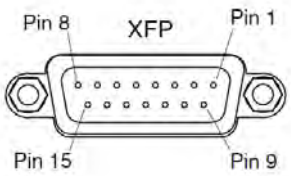
Table 3-1. XUSR Connector Signals

Pin Pairs	Description	Comments
Voltage-Free Contacts Provided by Customer		
1, 14	User E-Stop CH 1 (mushroom push-button, safety gates, etc.)	N/C (Normally Closed) contacts, Shorted if NOT Used
2, 15	User E-Stop CH 2 (same as pins 1, 14)	N/C contacts, Shorted if NOT Used
3, 16	Line E-Stop (used for other robot or assembly line E-Stop inter-connection. Does not affect E-Stop indication (pins 7, 20))	N/C contacts, Shorted if NOT Used
4, 17	Line E-Stop (same as pins 3, 16)	N/C contacts, Shorted if NOT Used
5, 18	Muted safety gate CH 1 (causes E-Stop in Automatic mode only)	N/C contacts, Shorted if NOT Used
6, 19	Muted Safety Gate CH 2 (same as pins 5, 18)	N/C contacts, Shorted if NOT Used
Voltage-Free Contacts Provided by Robot		
7, 20	E-Stop indication CH 1	Contacts are closed when Front Panel, pendant, and userE-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 3-2. 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 3-12. 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 3-3. 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: “V+ to Pendant TXD”
8	Pendant RXD: “V+ 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.

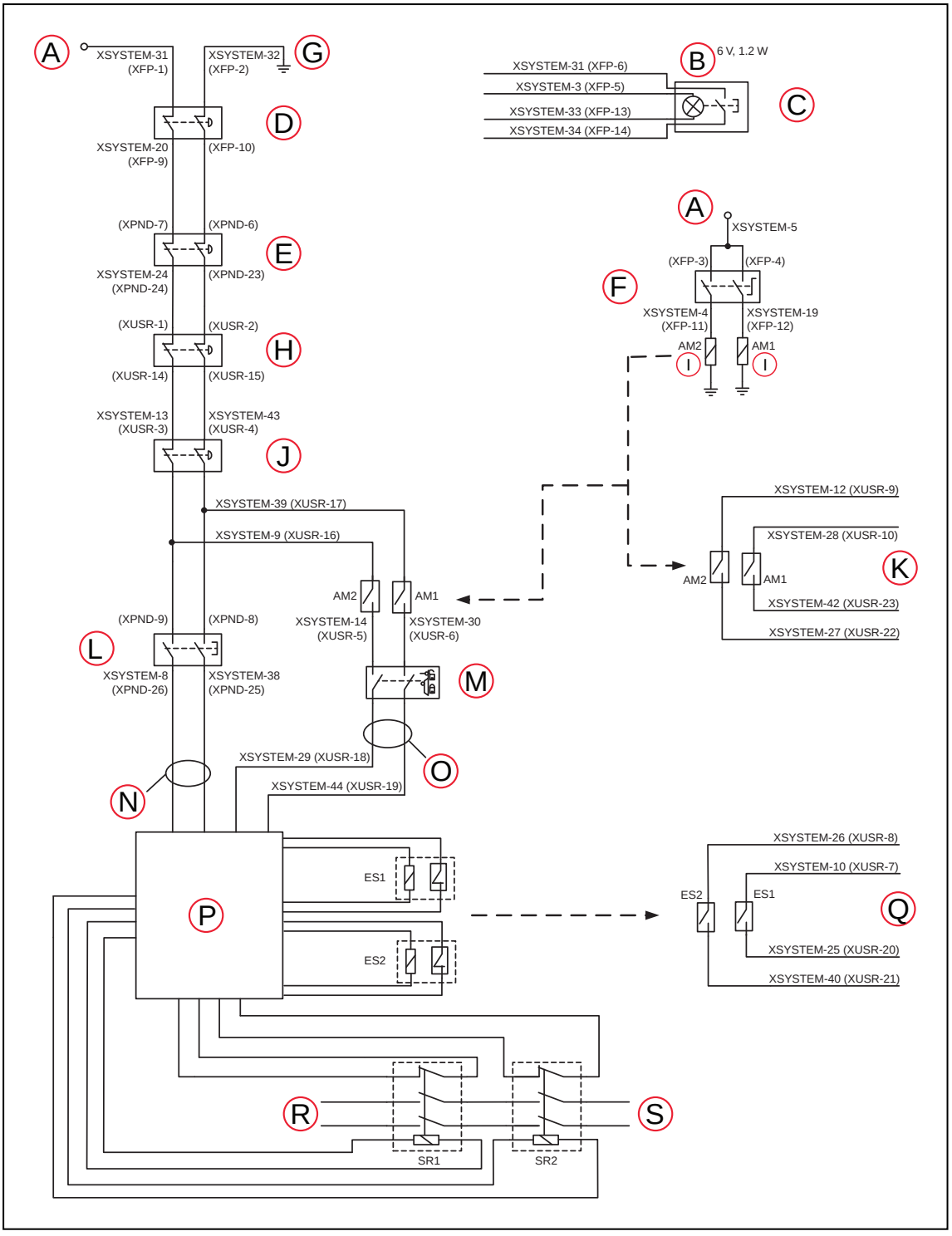


Figure 3-13. E-Stop Circuit on XUSR and XFP Connectors

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 3-13.

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 3-13. .

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 3-13.

> **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 3-13.) 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 3-13. and Figure 3-12. 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 3-13.

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 3-13. 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 3-13.

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 57 for further details about the user Remote Manual Mode circuitry.

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

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

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

WARNING: PERSONAL INJURY RISK
Do not connect user-supplied Manual / Automatic contacts in parallel with the Front Panel switch contact. This would violate the single point of control principle and might allow Automatic (high-speed) mode to be selected while an operator is in the cell.

User Manual/Auto Indication

Two pairs of pins on the XUSR connector provide a voltage-free contact to indicate whether the Front Panel and/or remote Manual / Automatic switches are closed. Refer to item K in Figure 3-13. 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 48 for more information.

WARNING: PERSONAL INJURY RISK
To fulfill the "Single Point of Control" requirement, do not place the Manual/Automatic and High Power On controls in multiple locations. After putting the robot into Manual mode, the operator should remove the key for safety purposes.

Pins 6, 14 and 5, 13 of the XFP connector provide this remote capability. Pins 5, 13 provide power for the lamp, +5 VDC and ground, respectively. Pins 6, 14 are inputs for voltage-free

normally-open contacts from a user-supplied momentary push-button switch. Refer to items B and C in Figure 3-13.

Using a User-Supplied Control Panel

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

> **Additional Information**: Refer to Front Panel Schematic on page 48 for internal wiring information.
>
> **IMPORTANT:** Underwriters Laboratory evaluated the system with an OMRON Front Panel. If you provide a substitute, the system may no longer be UL compliant.
>
> **IMPORTANT:** Though the XMCP and XFP connectors can be interchanged without electrical damage, neither the Front Panel nor the pendant will work properly unless they are plugged into the correct connector.

Remote Pendant Usage

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

- Wire Size: must be 26 AWG (0.13 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 settings are made. Refer to Installing a Cable Inlet Box for iX4-650H/800H Robots on page 88 or Installing a Cable Inlet Box for iX4-650HS/800HS Robots on page 91 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 59 for more information.

Use Sysmac Studio Software

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

Additional Information: Refer to the Sysmac Studio 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.

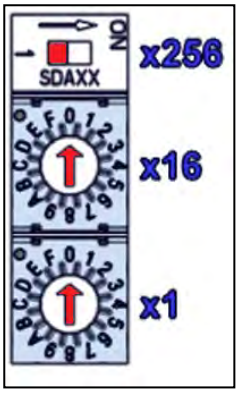


Figure 3-14. EtherCAT Node ID 0 Switch Setting

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.

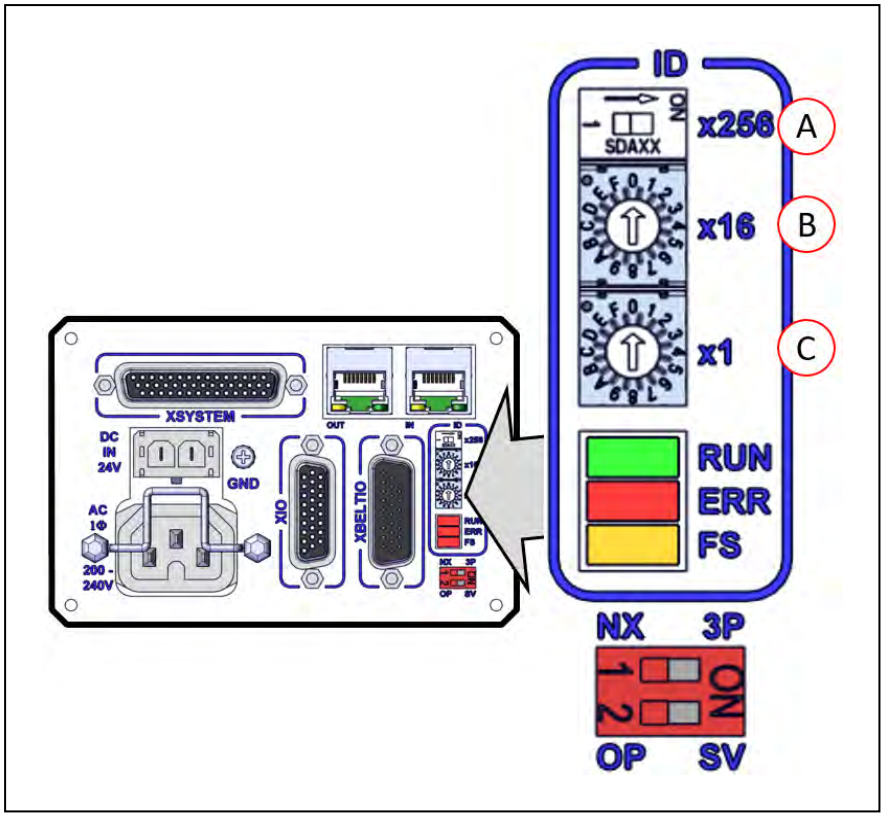


Figure 3-15. Robot Interface Panel EtherCAT ID Switches

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.

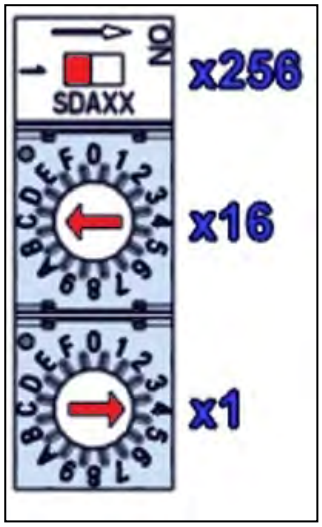


Figure 3-16. EtherCAT Node ID Set to 196

3.8 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 3-17. 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.

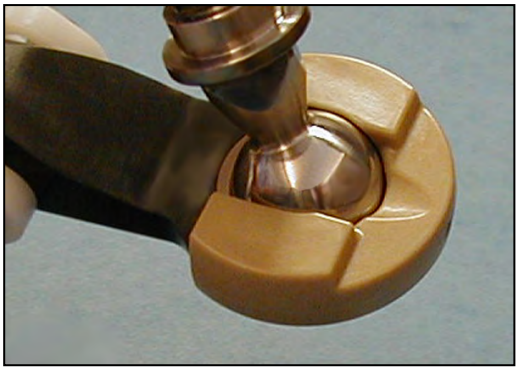


Figure 3-18. Ball Stud Lock in Correct Position

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.

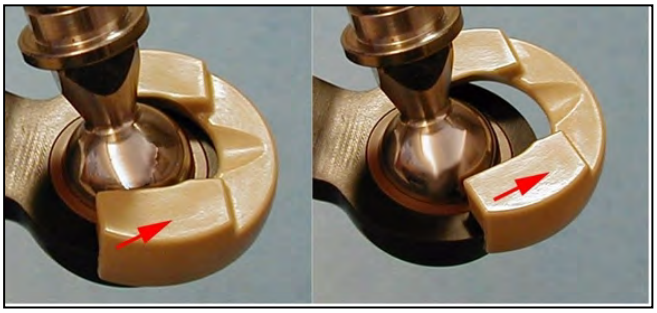


Figure 3-19. Removing a Ball Stud Lock

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
iX4 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 65

The numbers in the following figure correspond to the Cable Installation Steps on page 66.

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.

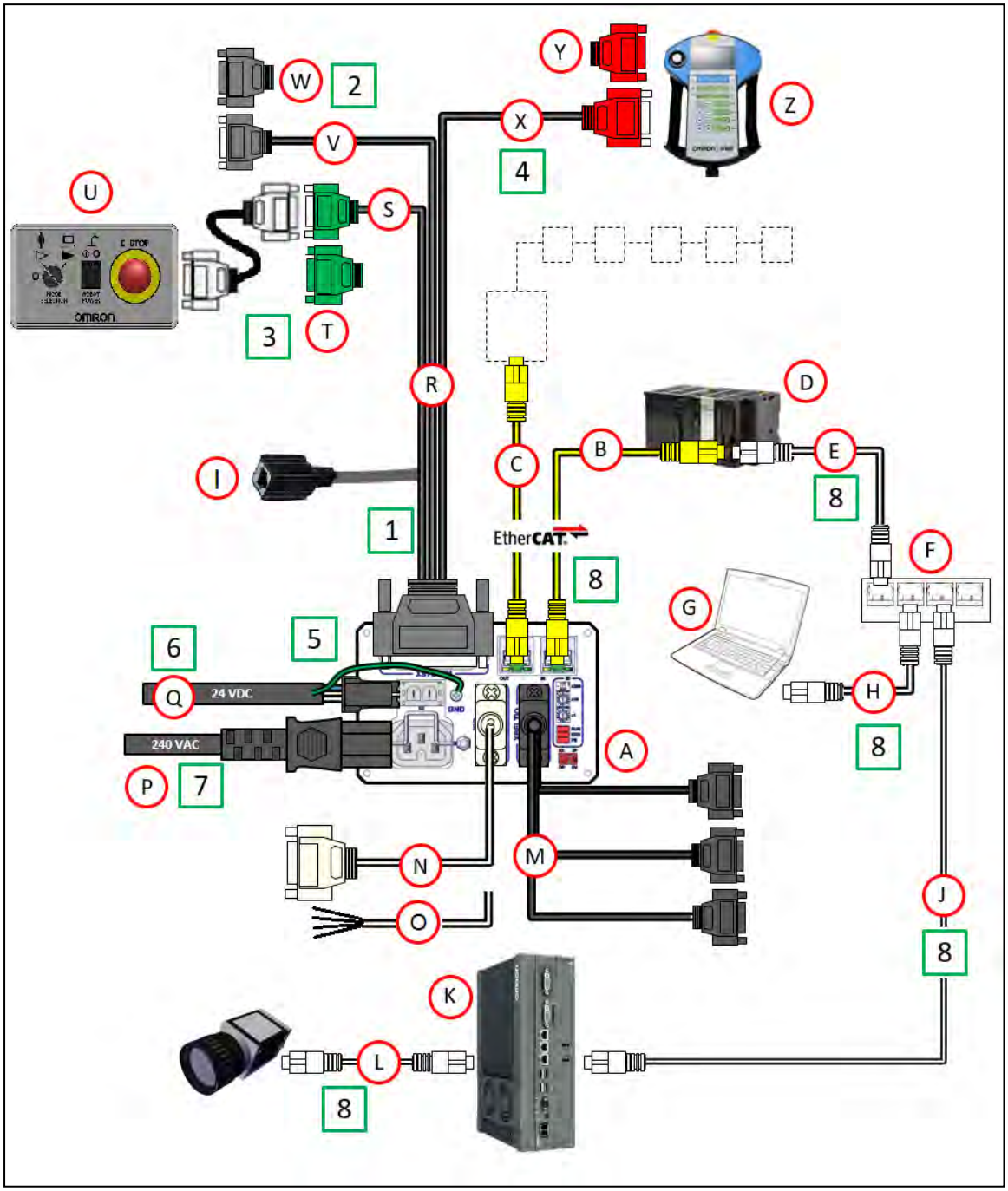


Figure 4-1. Typical System Cable Connections

List of Cables and Parts

The following table identifies and provides details about cables and parts illustrated in Basic System Cable Layout on page 63.

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 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, XFP Adapter 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 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 63 for references to item letters.

Additional Information: Refer to iCS-ECAT Robot Interface Panel on page 13 for robot interface panel connector details.

Considerations for the cable inlet box should be made before connecting cables to the interface panel. Refer to Installing a Cable Inlet Box for iX4-650H/800H Robots on page 88 and Installing a Cable Inlet Box for iX4-650HS/800HS Robots on page 91 for more information.

Step	Connection	Item
1	Connect the XSYSTEM cable to the XSYSTEM connector on the robot interface panel.	R, A

Step	Connection	Item
2	Connect a user E-Stop or Muted Safety Gate to the XSYSTEM cable XUSR connector. The XUSR jumper plug may be used on the XSYSTEM cable XUSR connector for diagnostic purposes only.	W, V
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 86 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.

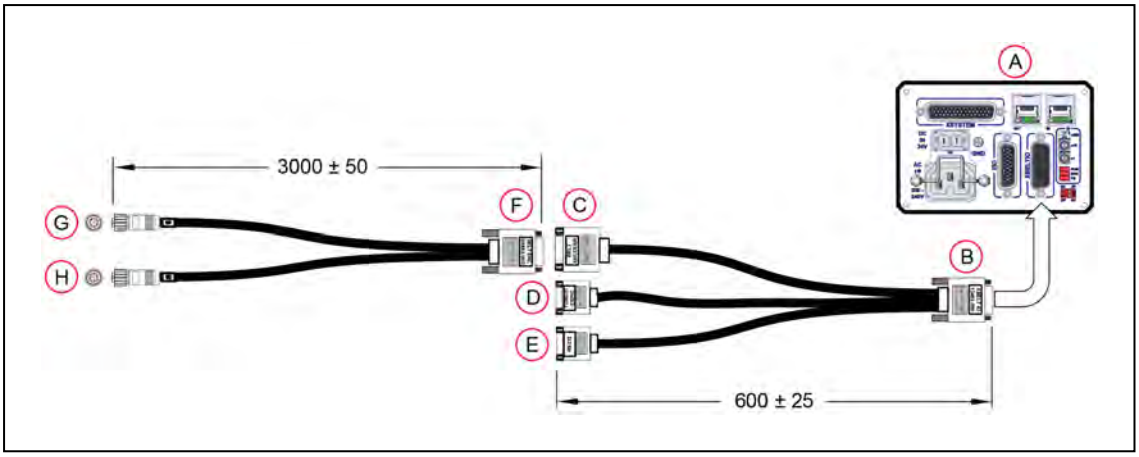


Figure 4-2. System Cable Diagram with Belt Encoders (Units in mm)

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 67.

Belt Encoder

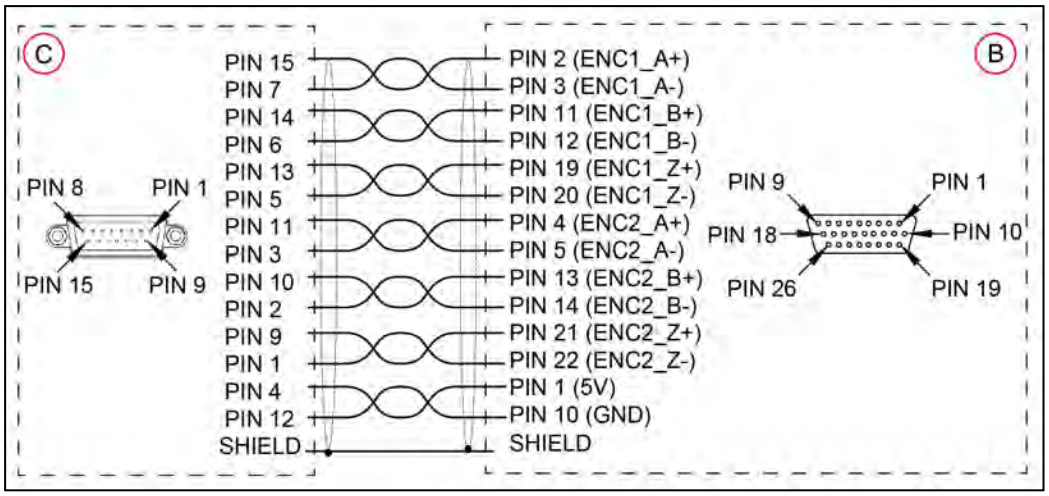


Figure 4-3. XBELT I/O Adapter Cable Pinout - Encoder 1 and 2 Connections

RS-232

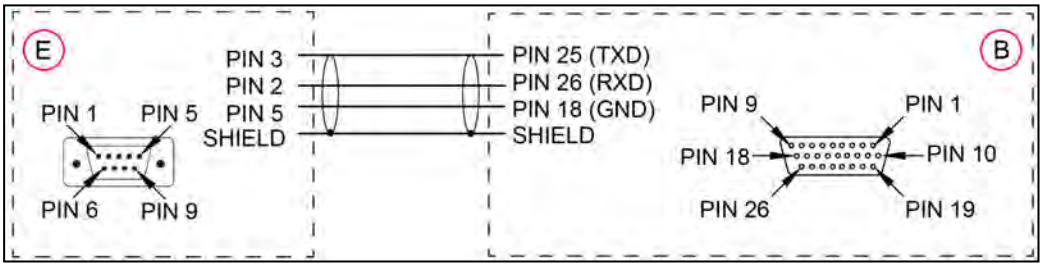


Figure 4-4. XBELT I/O Adapter Cable Pinout - RS-232 Connections

FORCE / EXPIO

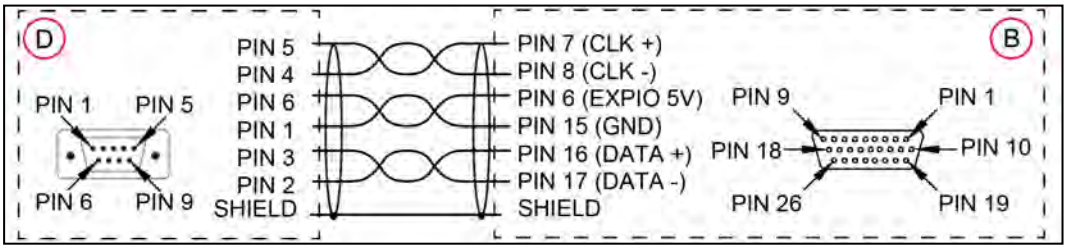


Figure 4-5. XBELT I/O Adapter Cable Pinout - EXPIO Connections

Splitter Cable

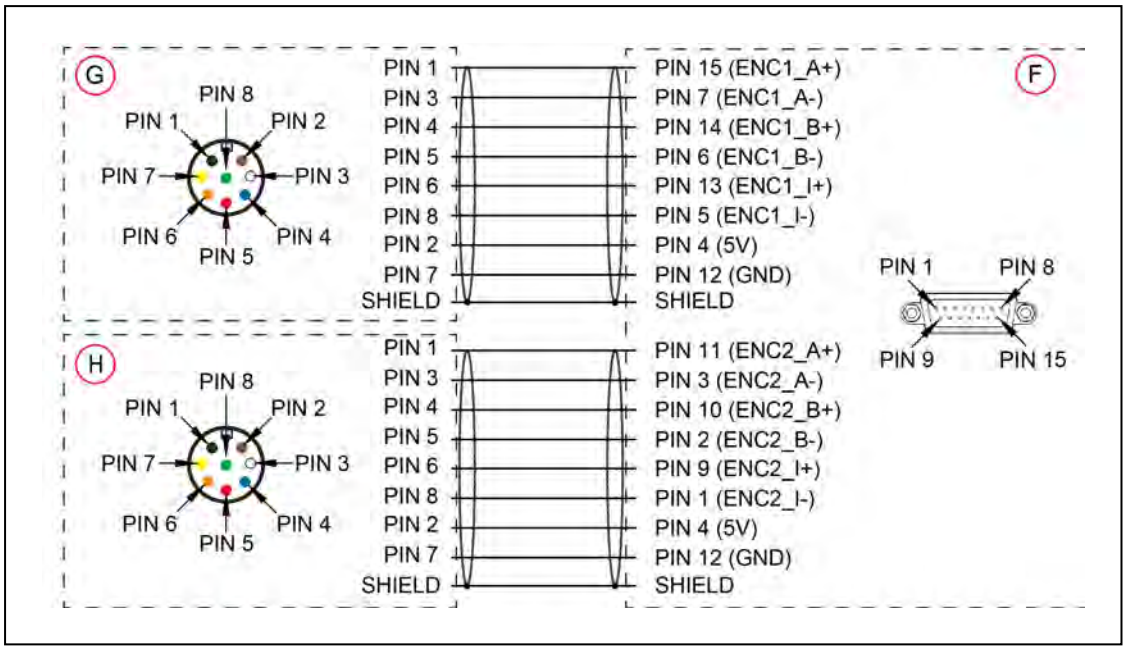


Figure 4-6. Belt Y Splitter Cable Pinout - 2 Encoder Connections

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 77
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 70

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) 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.

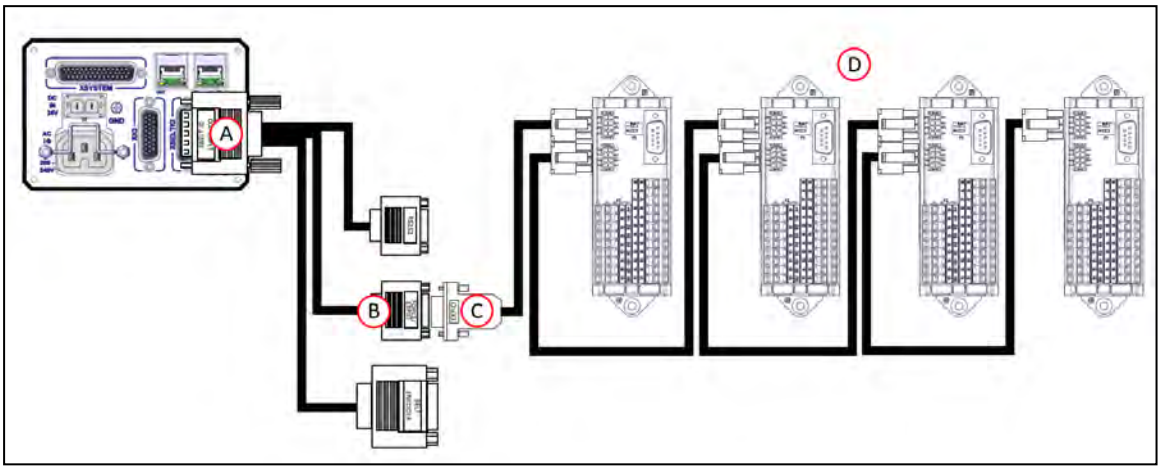


Figure 4-7. Connecting IO Blox to the system (maximum of 4)

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.

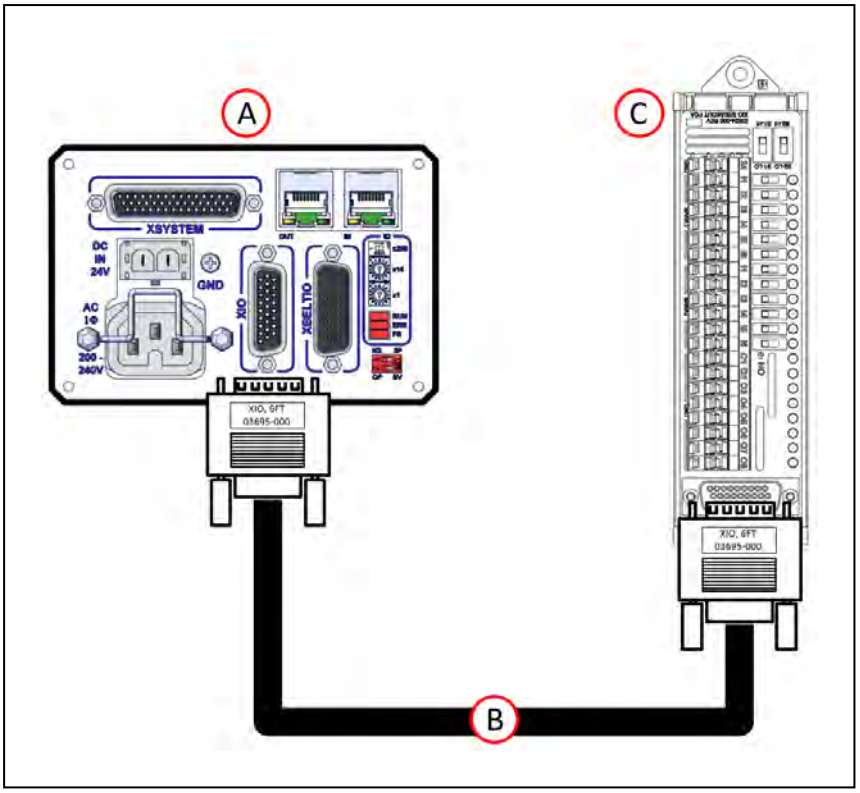


Figure 4-8. Connecting XIO Termination Block

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

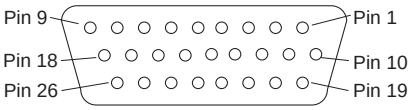
The XIO connector on the robot interface panel offers access to digital I/O (12 inputs and 8 outputs). Refer to the following table for the XIO signal designations.

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

Table 4-5. XIO Signal Designations

Pin No.	Designation	Signal Bank	V+ 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	V+ 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.

The requirements for the user-supplied power supply will vary depending on the configuration of the robot and connected devices. We recommend a 24 VDC, 6 A power supply to allow for startup current draw and load from connected user devices, such as solenoids and digital I/O loads. If multiple robots are to be sourced from a common 24 VDC power supply, increase the supply capacity by 3 A for each additional robot.

> **Additional Information**: Refer to External Connection Specifications on page 166 for more information about 24 VDC power requirements.

> **NOTE:** Fuse information is located on the iCS-ECAT electronics.

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 178 for more information.

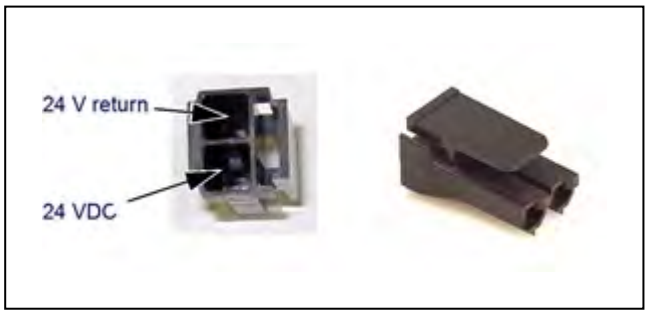


Figure 4-9. 24 VDC Mating Connector Pin Arrangement

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 63 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 166 for more information.

Considerations for the cable inlet box should be made before connecting the 24 VDC cable. Refer to Installing a Cable Inlet Box for iX4-650H/800H Robots on page 88 and Installing a Cable Inlet Box for iX4-650HS/800HS Robots on page 91 for more information.

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

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

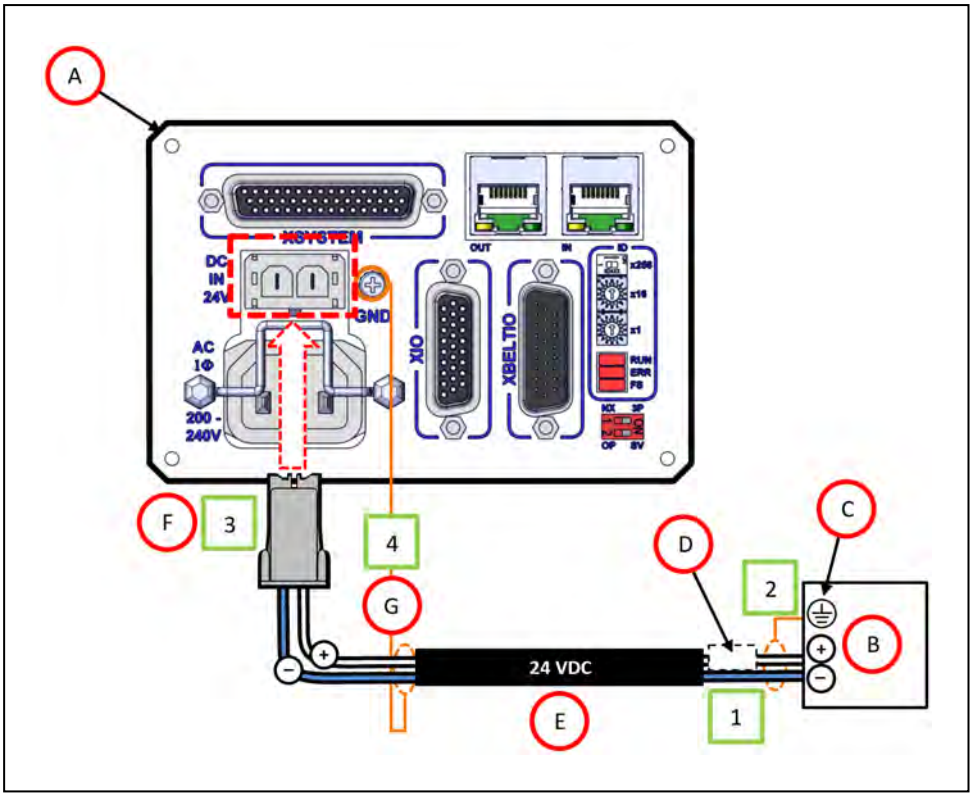


Figure 4-10. User-Supplied 24 VDC Cable, Power Supply

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

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

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

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

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

4.4 Connecting 200 to 240 VAC 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 166 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
iX4 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.

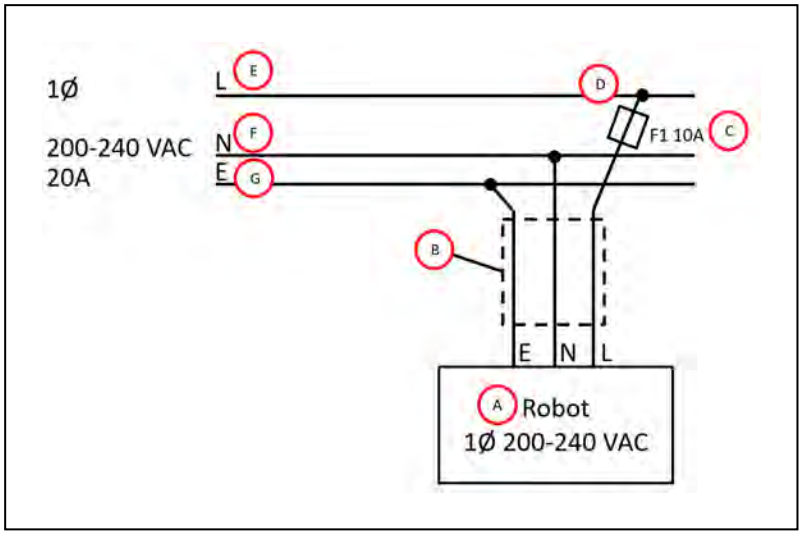


Figure 4-11. Typical AC Power Installation with Single-Phase Supply

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

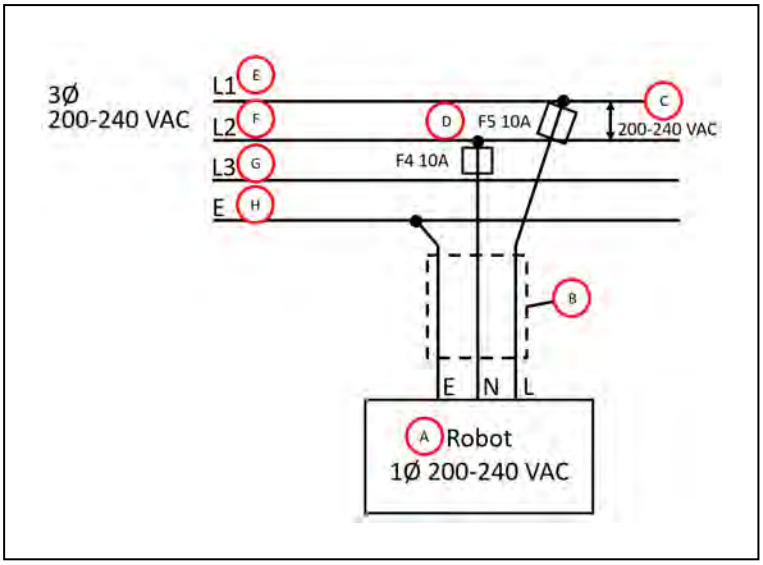


Figure 4-12. Single-Phase Load across L1 and L2 of a Three-Phase Supply

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 178 for more information.

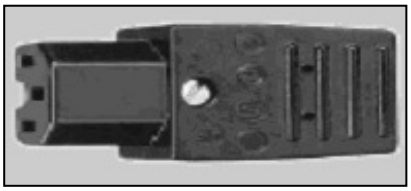


Figure 4-13. AC Power Supply Connector

Making the 200 to 240 VAC 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.

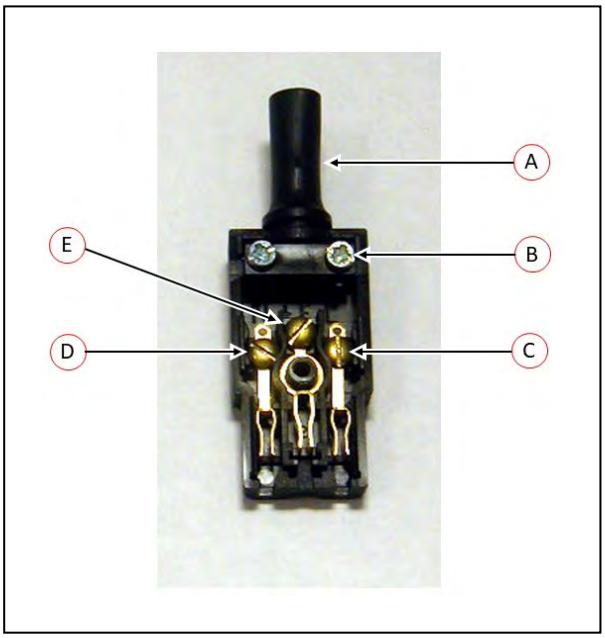


Figure 4-14. AC Power Mating Connector

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 166 for more information.

Considerations for the cable inlet box should be made before connecting the AC power supply cable. Refer to Installing a Cable Inlet Box for iX4-650H/800H Robots on page 88 and Installing a Cable Inlet Box for iX4-650HS/800HS Robots on page 91 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 while considering routing to prevent entanglement.

  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.

Grounding the iX4-650H/800H Robot Base

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

NOTE: You must ground the robot to the frame for all installations

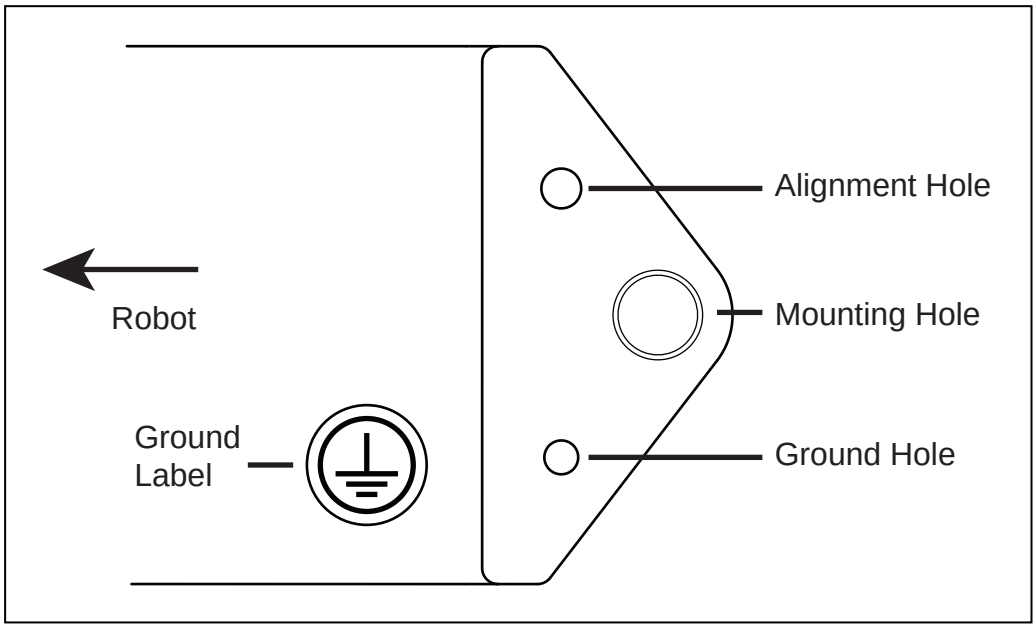


Figure 4-15. Grounding Details

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

- One of the base mounting pads has two small holes (in addition to the M16 mounting hole).
- One of these is an M8 hole, provided as a protective earth ground.
- The mounting pad has the following ground label.

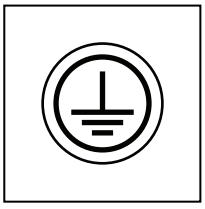


Figure 4-16. Ground Connection Label

- 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.

Grounding the iX4-650HS/800HS Robot Base

Because of the need to seal the junction between the robot base and the frame, the protective earth ground connection for the iX4-650HS/800HS robots has been moved from the base mounting pad to inside the iCS-ECAT cable inlet box, which is electrically connected to the robot base.

The ground screw is marked inside the cable inlet box with a label. Refer to Cable Inlet Box, showing Ground Label on page 97.

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

Grounding Robot-Mounted Equipment

WARNING: ELECTROCUTION RISK Failing to ground robot-mounted equipment or tooling that uses hazardous voltages could lead to injury or fatality of a person touching the end-effector 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:

iX4-650H/800H Robots

- Connect the robot base protective earth ground.
- 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.

iX4-650HS/800HS Robots

- Connect the robot cable inlet box to protective earth ground.
- Ground the end-effector to the robot cable inlet box ground screw.

NOTE: A ground strap from the end-effector to the robot cable inlet box ground must include a service loop that allows full rotation and movement of the tool flange.

4.6 Installing a Cable Inlet Box for iX4-650H/800H Robots

Use the following procedure to install an optional cable inlet box to increase the IP rating of the robot to IP65.

Consider the extra height required to accommodate this unit.

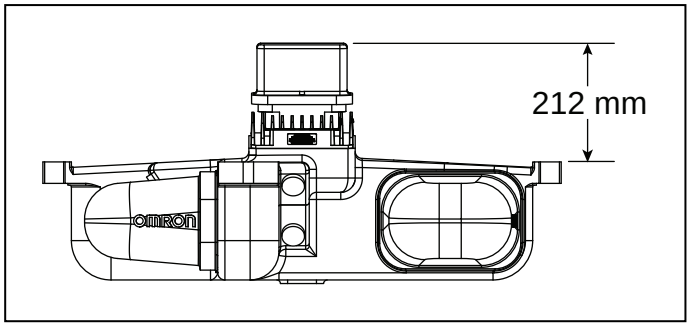


Figure 4-17. Cable Box Height

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 4-18. 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.

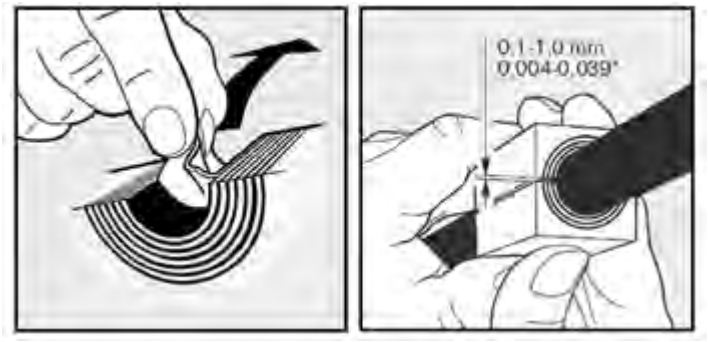


Figure 4-19. Adapting a Module to the Cable Size, Checking the Gap

4. Grease the Roxtec modules using the supplied grease.

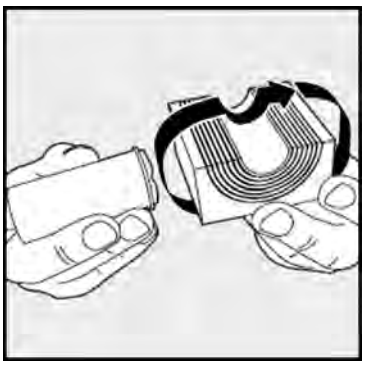


Figure 4-20. Greasing a Roxtec Module

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.

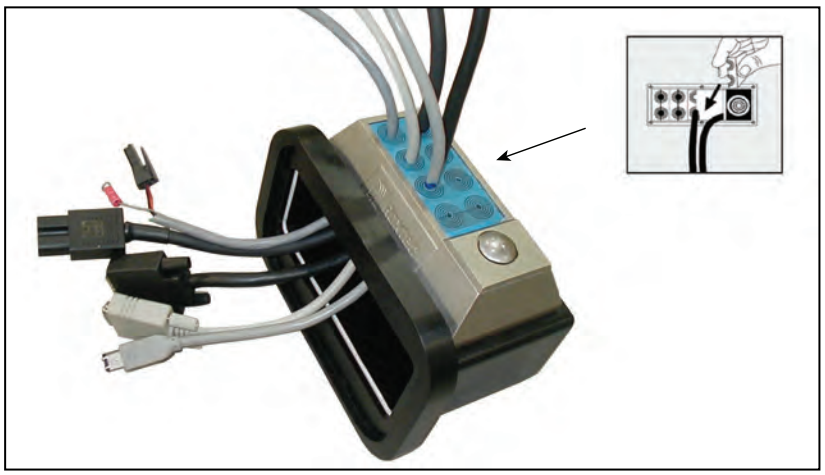


Figure 4-21. Installing Cables

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.

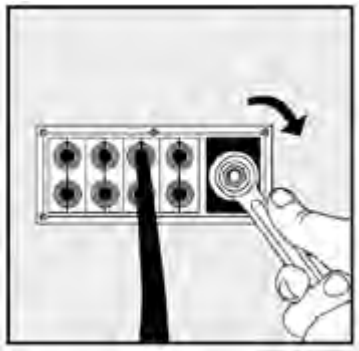


Figure 4-22. Tightening the Compression Unit

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 4-23. Installing Cable Entry Top Cover Assembly

4.7 Installing a Cable Inlet Box for iX4-650HS/800HS Robots

The cable inlet box must be mounted on the top of the robot during the robot installation process.

The part number for the iX4-650HS/800HS cable inlet box is 09564-000.

Assembling the Cable Inlet Box

The cables entering the cable inlet box are sealed with a Roxtec compression block kit.

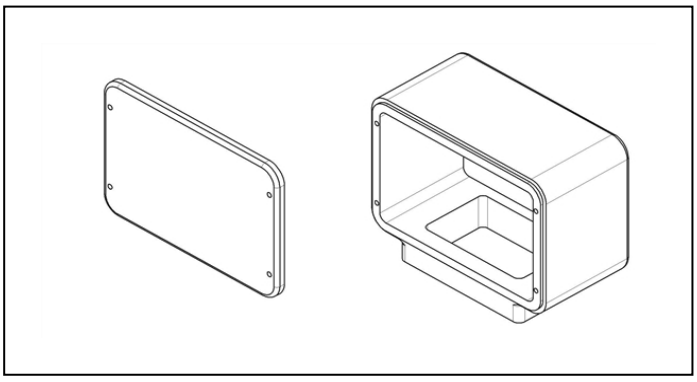


Figure 4-24. Cable Inlet Box and Cover

Components

- Cable Inlet box
- Cable Inlet box cover
- Cable Inlet box-cover gasket
- Cable Inlet box-iCS-ECAT gasket
- Compression Block kit - Roxtec CF 8-8
    - 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. The installation procedure follows.
    - Roxtec grease, used to assemble and seal the modules.

  NOTE: The Roxtec CF 8 consists of a frame and integrated compression unit (a wedge and bolt that compress the modules once they are assembled inside the CF frame).
- 4 x Screws, M4 x 40 (cable box-iCS-ECAT; one is used for the ground)
- 1 x Washer, ETL, Stainless Steel M4 (for ground screw)
- 4 x Screws, M4 x 16 mm (for the back cover)
- 4 x Washer seals (for the back cover screws)
- 4 x Screws, M4 x 12 mm (for attaching the cable tray)

The following may be included as spares:

- 4 x Screws, M4 x 16 mm (for the cable tray)
- 4 x Washer seals (for the cable tray screws)
- 4 x Washers, ETL, Stainless Steel M4 (for the cable tray)

Tasks

1. Measure and mark cables to establish service length
2. Adapt Roxtec modules to fit cables
3. Install cables through cable inlet box (via Roxtec modules)
4. Attach cables to iCS-ECAT
5. Install iCS-ECAT cable inlet box
6. Attach cable inlet box back cover

Procedure

1. Measure and mark all iCS-ECAT cables at 10 - 12 in. from the cable ends.
   This amount of slack is needed to make the cable connections to the iCS-ECAT before the cable inlet box is installed.

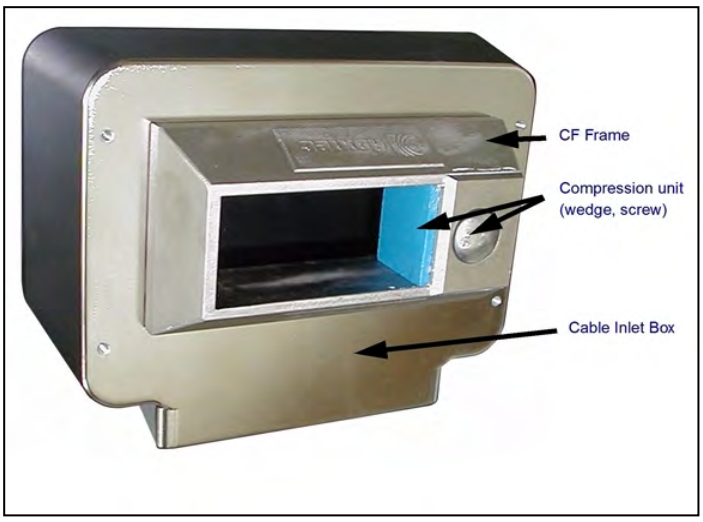


Figure 4-25. iX4-650HS/800HS Cable Inlet Box with Roxtec Frame

2. Adapt Roxtec modules to fit the cables that will be used. There should be a 0.1 to 1.0 mm gap between the halves of the modules for a proper seal. See the following figure.

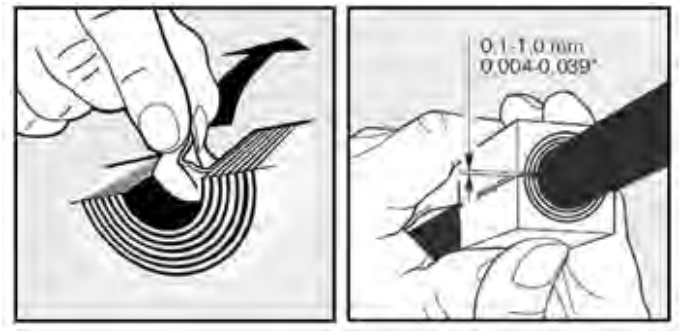


Figure 4-26. Adapting a Module to the Cable Size, Checking the Gap

3. Grease the Roxtec modules, using Roxtec grease. See the following figure.

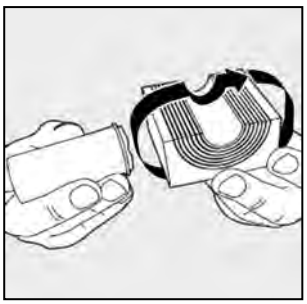


Figure 4-27. Greasing a Roxtec Module

4. Grease the inside of the CF frame, where the modules will touch, using Roxtec grease.
5. Install each iCS-ECAT cable through its corresponding module, and insert the modules into the frame. See the following figure. Ensure that the terminated cable ends have 10 - 12 in. of slack.

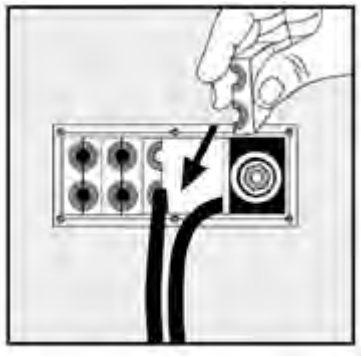


Figure 4-28. Installing Roxtec Modules into the Frame

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

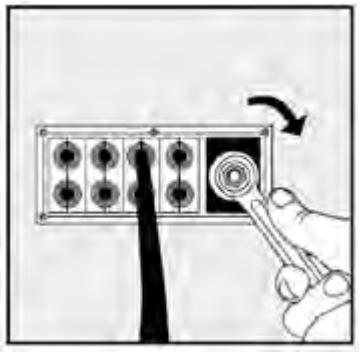


Figure 4-29. Tightening the Compression Unit

Figure 4-30. Cable Inlet Box with Cables

In the preceding figure, note the four holes around the Roxtec box. These are for attaching a cable tray. See Attaching the Cable Tray on page 98.

Connecting the Cables

1. Place the cable inlet box-iCS-ECAT gasket around the iCS-ECAT connection panel.
2. Attach the ground lug to the iCS-ECAT. The ground lug is for the cable shield of the user-supplied 24 VDC cable. This is circled in the following figure.

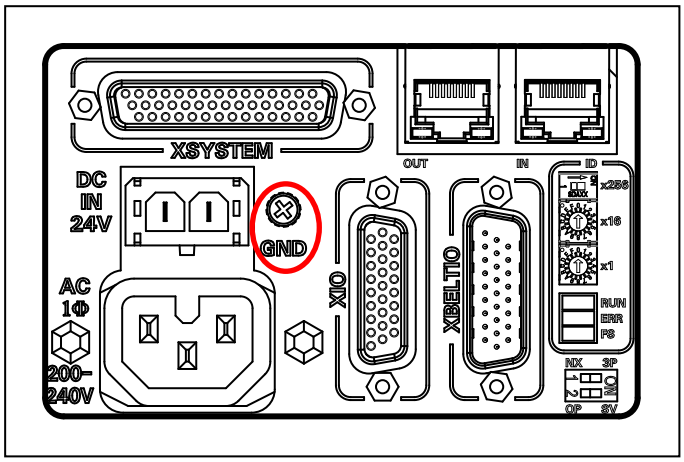


Figure 4-31. Cable Shield Ground Lug on iCS-ECAT Panel

3. Hand-tighten all cables to the iCS-ECAT.

NOTE: All cables must be screwed into the iCS-ECAT.

The protective earth ground will be installed in the following section.

Installing the Cable Inlet Box

1. Install the cable inlet box on the top of the iCS-ECAT using three M4 x 40 bolts.
   - Ensure that the gasket is seated between the iCS-ECAT surface and the cable inlet box.
   - Do not yet use the hole labeled as a ground.
   - Apply Loctite 222 in these bolt holes, not on the bolts themselves.
   - Torque the bolts to 1.1 N·m.

NOTE: The cable inlet box should be installed with the cables exiting away from the iCS-ECAT. The cable tray attachment was designed assuming the cables would exit away from the iCS-ECAT.

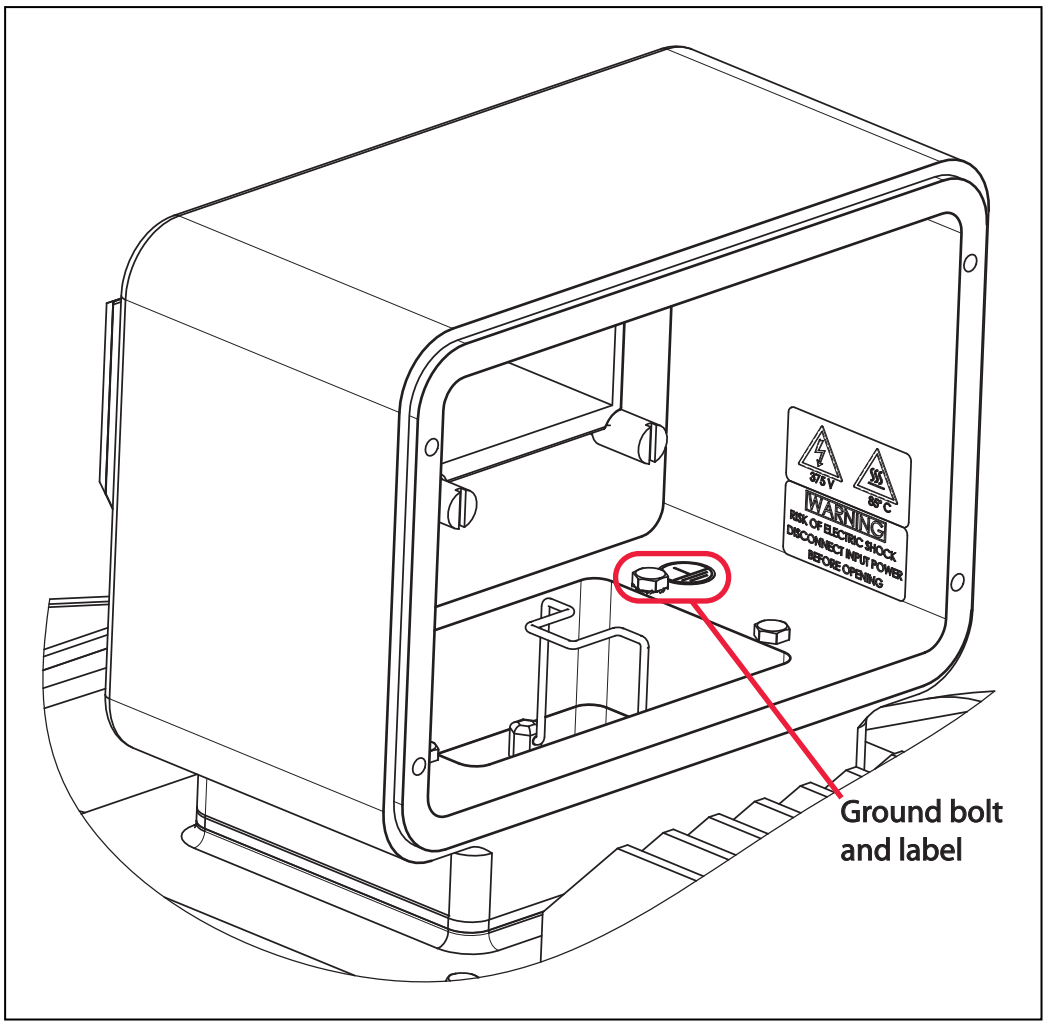


Figure 4-32. Cable Inlet Box, showing Ground Label

2. Install the M4 protective earth ground bolt, with toothed washer, through the cable inlet box into the iCS-ECAT. See the preceding figure.
    - Ensure that the protective earth ground wire lug is under the toothed washer.
    - This bolt does not need Loctite.
    - Torque the bolt to 1.1 N·m.
3. Attach the cable inlet box back cover with four M4 x 16 bolts.
    - Ensure that the gasket is seated between the cover and the cable inlet box.
    - Put one washer seal under each bolt head.
    - Use Loctite 222 in these bolt holes, not on the bolts themselves.
    - Torque bolts to 1.1 N·m.

4.8 Attaching the Cable Tray

> **NOTE:** The cable inlet box must be installed on the iCS-ECAT before the cable tray can be attached. Refer to Installing a Cable Inlet Box for iX4-650HS/800HS Robots on page 91

To comply with USDA regulations, the cables from the cable inlet box must be contained in a tray until they are no longer over the robot work area. The cable inlet box provides four M4-threaded holes for attaching a cable tray. Four M4 x 12 screws and toothed washers are provided, for attaching the user-provided cable tray.

The tray should match the holes in the cable inlet box, and be wide enough at the box to avoid touching the Roxtec assembly, and leave room for the cabling exiting the Roxtec assembly. See Side View of Roxtec Cable Seal Frame (units are mm [inches]) on page 99.

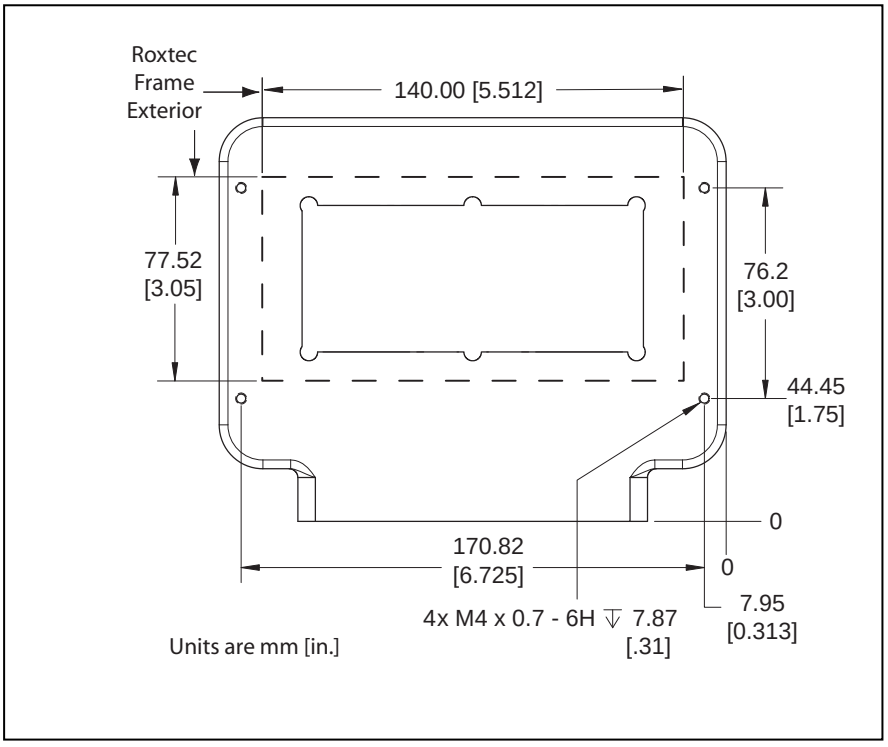


Figure 4-33. Dimensions of Cable Tray Attachment to Cable Inlet Box

Attach the cable tray to the cable inlet box, with a gasket between the two.

- Use M4 x 12 bolts with toothed washers.

  These bolt heads do not have to be sealed, as they are contained by the cable tray.

  These bolts do not need Loctite.

- Torque the bolts to 1.1 N·m.

Ensure that the cable tray is adequately supported at the end where the cables exit it.

An example of a three-sided gasket, which seals between the cable tray and the cable inlet box, is shown in the following figure:

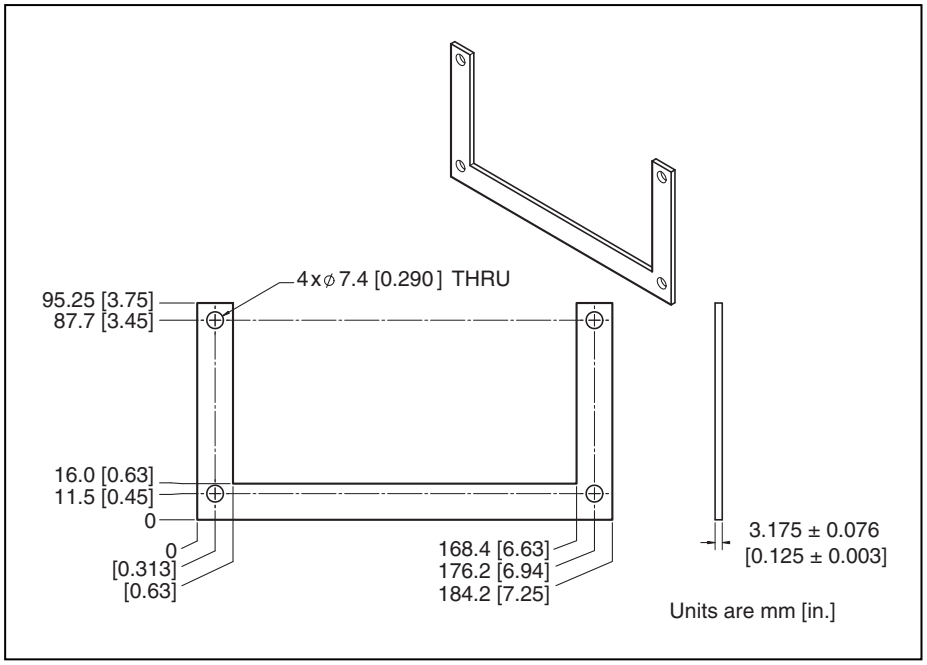


Figure 4-34. Example Cable Tray Gasket (units are mm [inches])

NOTE: This cable-tray gasket is available as an option as part number 09751-000.

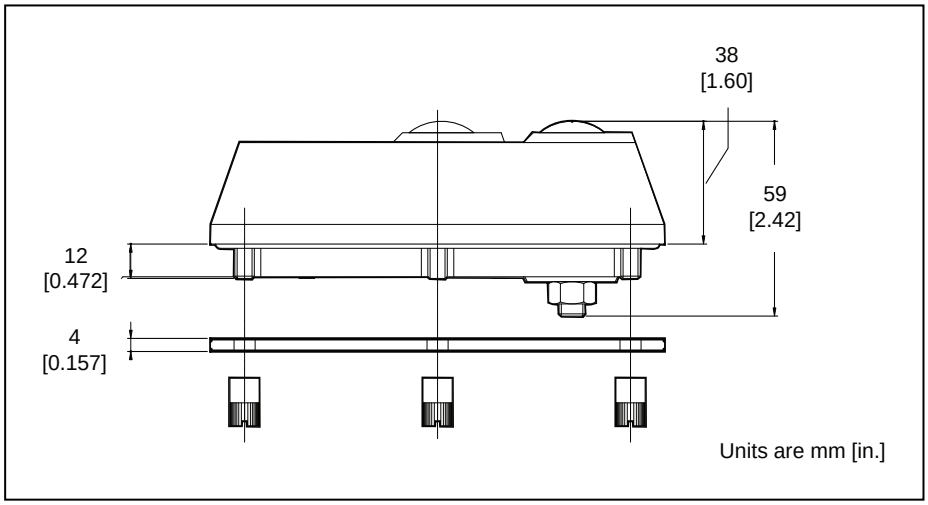


Figure 4-35. Side View of Roxtec Cable Seal Frame (units are mm [inches])

The following apply to the example cable tray.

Material	Item 1	Aluminum 5052-H32
	Item 2	Aluminum 6061-T6
		Clean part thoroughly using the following process:

			Soak part in strong alkaline bath followed by light chemical clean
Finish	Electroless nickel plate per MIL-C-2607E, Class 4, Grade A		
	0.025 to 0.038 mm thick, high phosphorus (10-13% by wt.)		
	RoHS-compliant process		

While we do not supply a cable tray, the following sample design is provided:

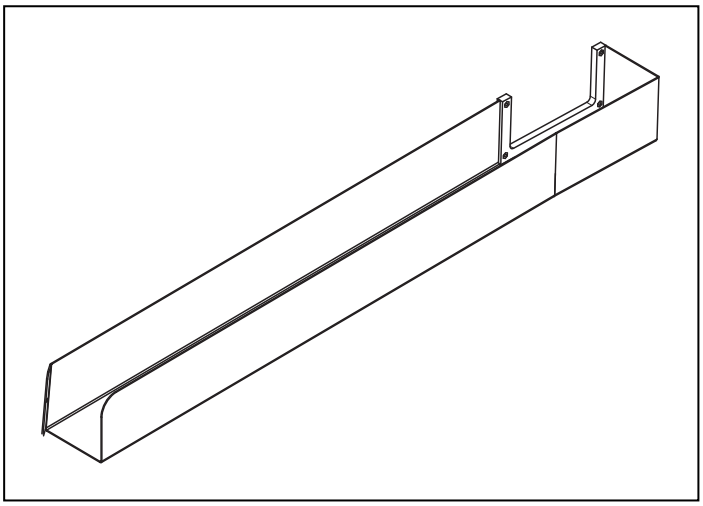


Figure 4-36. Sample Cable Tray, Isometric View

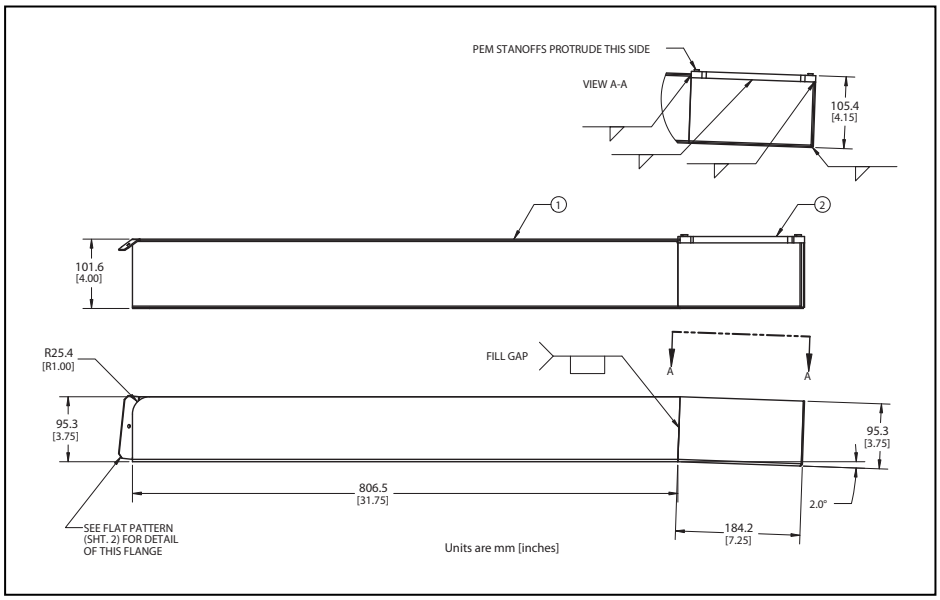


Figure 4-37. Sample Cable Tray, Dimension Drawing 1 (units are mm [inches])

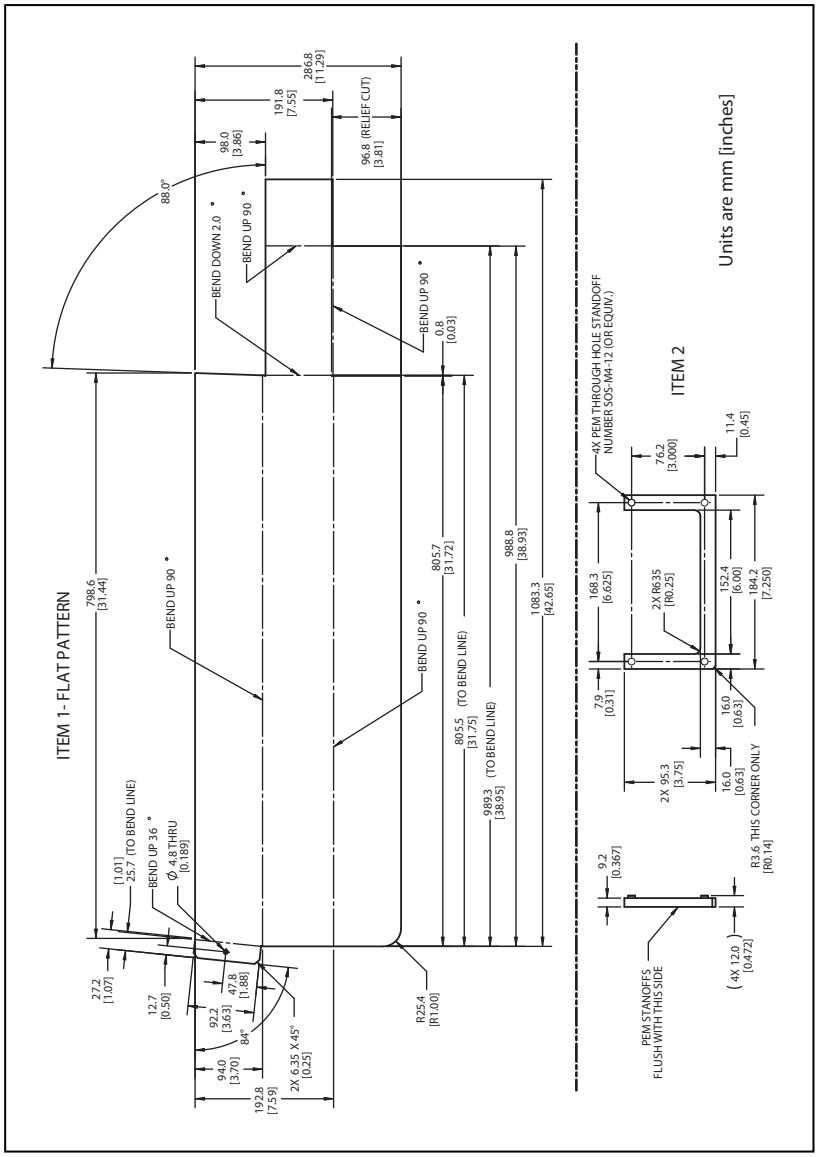


Figure 4-38. Sample Cable Tray, Dimension Drawing 2 (units are mm [inches])

Callout	Description	Callout	Description
A	Item 1-Flat Pattern	F	R3.6 This Corner Only [R0.14]
B	To Bend Line	G	Item 2
C	Bend up 36 Degrees	H	4X PEM Through Hole Standoff Number SOS-M4-12 (OR EQUIV.)
D	Bend up 90 Degrees	J	(RELIEF CUT)
E	PEM Standoffs Flush with this side	K	Bend down 2.0 Degrees

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 63

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.

Safety Equipment Checks

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

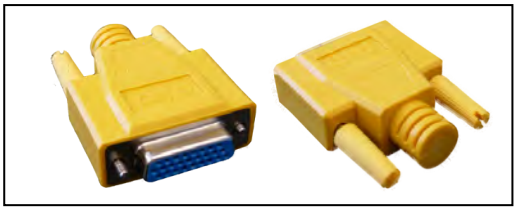


Figure 5-1. Safety Equipment Check Jumper Plug

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.

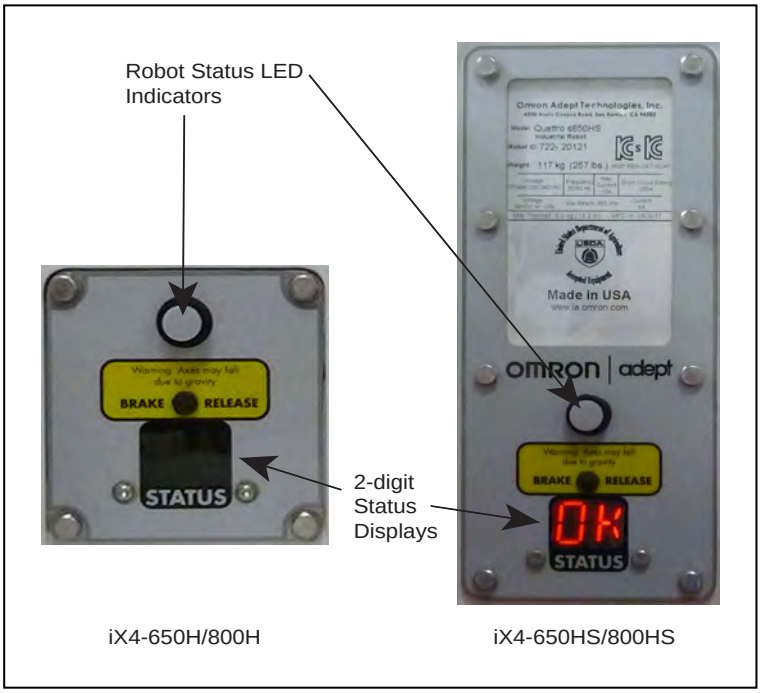


Figure 5-2. Robot Status LED and Display Panel

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 179 for more information.
ON Flashing (5 Hz)	Status Code(s)	System fault is present. Refer to Status Codes on page 179 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.

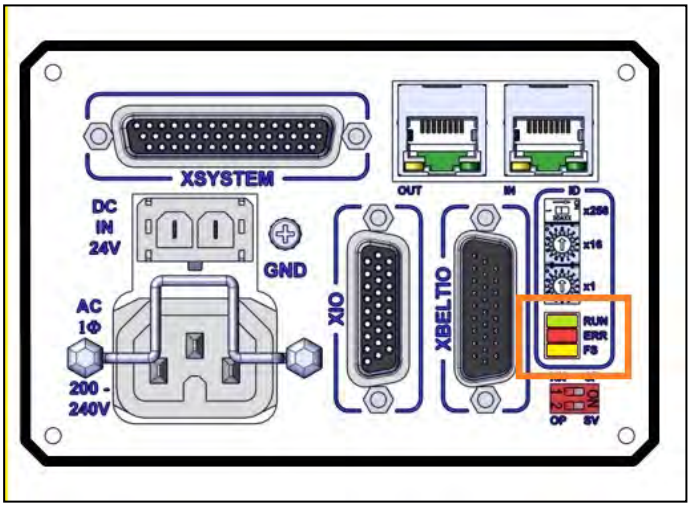


Figure 5-3. EtherCAT LED Location

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 in the Status Display panel.

Figure 5-4. Brake Release Button Locations (iX4-650H/800H on left, and iX4-650HS/800HS on right)

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 Unito 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.

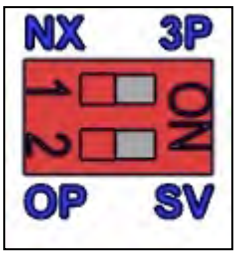


Figure 5-5. Operation Mode Selected

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 48 for more information.

High Power and Faults

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

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

High Power Request Methods

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

Request High Power with the Front Panel

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

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

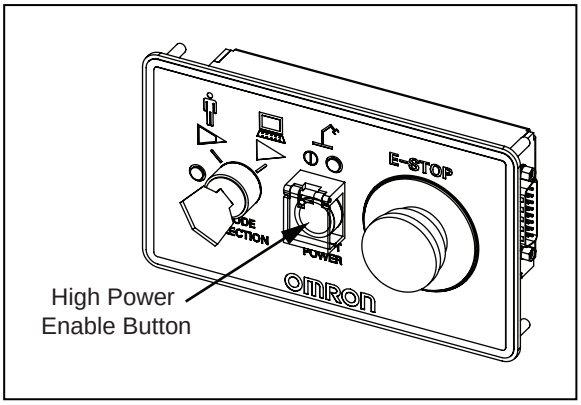


Figure 5-6. High Power Enable Button on Front Panel

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 Seletion 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.

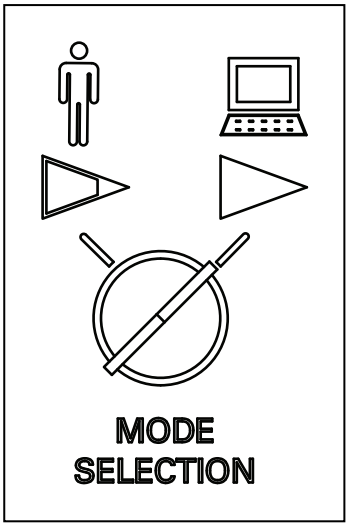


Figure 5-7. Front Panel Keyswitch in Automatic Mode

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 111 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.

NOTE: The Maintenance procedures are often different for the iX4-650H/800H robots than they are for the iX4-650HS/800HS robots. This chapter will present maintenance for the iX4-650H/800H robot, with indications when the iX4-650HS/800HS is different, and references to instructions that pertain to the iX4-650HS/800HS.

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.
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 123 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 spring retainers for wear.	Replace arms if damaged. Replace springs and spring retainers 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 125 and Checking Fan Operation on page 126.	Diagnose non-operational fans. (Not field-replaceable) Replace gear drives.
HS Only: Motor Cover seals	1 year	Check for good seal contact, missing sections, inflexible, broken, seals.	Replace motor cover seals.
HS Only: Motor Cover bolt washer seals	3 Months	Check that washer seals are present and in good condition. Check for cracks or missing sections.	Replace washer seals
Dynamic and Static seals	3 Months	Inspect dynamic seals on inner arms and static seals for sanitizing wash-down environments. Check for good seal contact, 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 123.	Replace Front Panel, or customer E-Stops.
Robot Mounting bolts	3 Months	Check tightness of bolts. Proper torque should be 98 N-m.	Tighten bolts.
HS Only: Robot Mount-	3 Months	Check for good seal contact, missing sections, inflexible, broken,	Replace gaskets.

Item	Frequency	Inspection	Remedy
ing bolt gaskets		seals.	
HS Only: Robot Mounting surface gasket	3 Months	Check for good seal contact, missing sections, inflexible, broken, seals.	Replace gasket.
iCS-ECAT seal	3 Months	Check for good seal contact, inflexible, broken, seal.	Replace seal.
Cable Inlet Box gaskets	3 Months	Check for good gasket contact, inflexible, broken gaskets.	Replace gaskets.
Cable Inlet Box Tray gaskets	3 Months	Check for good seal contact, missing sections, inflexible, broken, seals.	Replace gaskets.
Status Display Panel	3 Months	Check for water inside the display. Check for good seal contact, inflexible, or broken seal.	Replace seal.
Status Display Panel bolt washer seals	3 Months	Check for good seal contact, missing sections, broken, seals.	Replace seals.

Table 6-2. Suggested Part Replacement Schedule

Item	Suggested Interval	Description
Backup Encoder Battery Pack	2 years to 4 years	Refer to Replacing the Encoder Battery Pack on page 126.

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. Refer to Replacing a Platform on page 130 for more information.
Ball Joint Inserts	Inspect plastic bushings / inserts for excessive wear. Refer to Replacing a Ball Joint Socket Insert on page 133 for more information.
Springs and Retainers	Springs and spring retainers can be replaced in case of excessive wear or accidental breakage. Refer to Replacing Outer Arm Spring Assemblies on page 131 for more information.
Outer Arms	Inspect for damage from accidental impacts. Refer to Attach the Outer Arms on page 43.

6.3 Cleaning iX4-650H/800H Robots

The iX4-650H/800H robots are 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.

> **NOTE:** Anodized parts cannot be tank cleaned. If highly caustic cleaning agents are to be used, refer to the iX4-650H/800H robots.

These robots are designed for the following operating conditions:

- IP67 rating for the robot platform and arms.
- IP65 rating for the rest of the robot (with optional cable sealing kit).
- 1 to 40°C ambient temperature.
- Humidity of 5% to 90%, non-condensing.
- Mild alcohol, alkali, and chlorinated caustic agents commonly used in cleaning operations.

> **NOTE:** Do not submerse hard-anodized platforms in a COP tank.

These robots protect the operating environment in the following ways:

- High level of surface coating adhesion prevents erosion of coating during cleaning.
- Lubricants are contained within multiple seals.
- Ball joints and spring assemblies are 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.

Caustic Compatibility

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.

The iX4-650H/800H is designed to be compatible with moderate cleaning agents commonly used in the cleaning of food-processing equipment, at room temperature. 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. For acidic environments, contact your local OMRON representative.

> **NOTE:** Anodized parts cannot be tank cleaned. If highly caustic cleaning agents are to be used, use the iX4-650HS/800HS type.

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.

Design Factors

Environmental and cleaning aspects are addressed by the following features in the iX4-650H/800H robots.

Robot Base and Components

The aluminum robot base and the removable motor covers are coated with a polyurethane powder coating, 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 gearboxes are sealed internally, and sealed externally by a lip seal that is designed to meet IP65 rating.

All base seal materials are designed to be compatible with caustic agents and common industrial cleaning procedures.

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.

The motor cover seals allow for periodic motor and fan inspections.

Inner Arms

The inner arms are painted aluminum. The assemblies are resistant to some caustic cleaning agents at room temperature, as well as to chipping.

The inner arms are sealed at the robot base with a rotary V-ring seal (P/N 09078-101). The inner arms are designed to meet IP65 rating.

Ball Joints

The ball studs are stainless steel, which resist wear, as well as caustic agents. The hemispherical plastic inserts are resistant to caustic agents. Lubrication of the ball joints is not needed.

Outer Arms

The outer arms are a composite assembly of anodized aluminum or stainless steel and carbon fiber. The interior volume of the carbon fiber tube is designed to be sealed with an internal and external continuous epoxy bond. The inserts are press-fit into the aluminum outer-arm ends with a slight interference, which seals the plastic to the aluminum.

The outer arms may be cleaned either with wash-down in place on the robot, or removal and tank cleaning.

Spring Assemblies

The outer arms are attached through the positive pressure of springs that are made of electropolished stainless steel. The springs attach to the arms via plastic retainers that fit over bearing pins on the arms. This open spring-assembly design allows inspection for contamination, as well as wash-down or dunk bath.

Platforms

The iX4-650H/800H robots support four types of platforms, depending on the amount of Theta rotation and inertia needed, and the level of chemical resistance needed. For the iX4-650H/800H robots, these platforms are available in a hard-anodized aluminum or stainless steel.

All platforms are designed to meet the basic criteria of wash-down compatibility and long life. Please contact your local OMRON representative for more information.

6.4 Cleaning iX4-650HS/800HS Robots

The iX4-650HS/800HS robots are designed to be compatible with standard cleaning and operational needs for the handling of raw, unpackaged meat and poultry products, as well as less stringent requirements. 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.

These robots are designed for the following operating conditions:

- IP67 rating for the robot platform and arms.
- IP66 rating for the rest of the robot.
- Removal and submersion of the platform and outer arms (designed for COP tank).
- 1 to 40°C (34 to 104°F) ambient temperature.
- Humidity of 5% to 90%, non-condensing.

- Cleaning agents commonly used in food-processing operations. Refer to Chemical Compatibility on page 121.

These robots protect the operating environment in the following ways:

- High level of surface coating adhesion prevents erosion of coating during cleaning.
- Lubricants are contained within multiple seals.
- Ball joints, springs, and spring retainers are 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.

Chemical Compatibility

This section applies to the iX4-650HS/800HS robots.

CAUTION: PROPERTY DAMAGE RISK Not all materials used on the iX4-650HS/800HS robots are compatible with all cleaning solutions available.

The iX4-650HS/800HS robot was tested to withstand the following cleaning solutions, at the manufacturers recommended concentrations, at 140° F:

Caustic:

- Dura Foam 263
- Chloro Clean 269
- Multiquat 455
- Liquid Fury
- Enrich 299

Acidic:

In general, acidic cleaning solutions are incompatible with the iX4-650HS/800HS robot's materials.

Wash Down

Wash-down cleaning is appropriate for cleaning the iX4-650HS/800HS robots. Surfaces and joints have been designed with smooth internal radii for easy cleaning.

Table 6-4. Typical Cleaning Schedule, Non-raw Food

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.

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

Table 6-5. Typical Cleaning Schedule, Raw Food

Item	Interval	Suggested Cleaning Action
Minimum: Entire robot	Daily	Clean In Place
Optional: Platform	Daily	Clean Out of Place (dunk)

Water Shedding

Surfaces of the iX4-650HS/800HS have been designed to shed water. This increases the likelihood that contaminants or cleaning agents will drain with a hose-down procedure.

Design Factors

Environmental and cleaning aspects are addressed by the following features in the iX4-650HS/800HS robots.

Robot Base and Components

The aluminum robot base and the removable motor covers are coated with a ETFE, USDA-approved coating, 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 gearboxes are sealed internally, and sealed externally by a lip seal that is designed to meet IP66 rating.

All base seal materials are designed to be compatible with caustic agents and common industrial cleaning procedures.

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.

The motor cover seals allow for periodic motor and fan inspections.

Inner Arms

The inner arms are painted aluminum. The assemblies are resistant to some caustic cleaning agents at room temperature, as well as to chipping.

The inner arms are sealed at the robot base with a rotary V-ring seal (P/N 09078-101). The inner arms are designed to meet IP65 rating.

Ball Joints

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.

Acidic Operating Conditions

Refer to Chemical Compatibility on page 121. Contact your local OMRON representative for more information.

Outer Arms

The outer arms are a composite assembly of carbon fiber and stainless steel. The interior volume of the carbon fiber tube is sealed with an internal and external continuous epoxy bond. Spring retainer pins are press-fit into the outer-arm ends with a slight interference to hold the spring-retainer.

The outer arms may be cleaned either with wash-down in place on the robot, or removal and tank cleaning.

Spring Assemblies

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 via plastic retainers that fit over pins on the arms. This open spring-assembly design allows inspection for contamination, as well as wash-down.

Platforms

The iX4-650HS/800HS supports four types of platforms, depending on the amount of Theta rotation and inertia needed. All four platform types are available in stainless steel for either the iX4-650HS or iX4-800HS robot.

All platforms are designed to meet the basic criteria of wash-down compatibility and long life. Please contact your local OMRON representative for more information.

6.5 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.

- 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.

IMPORTANT: The High Power indicator must be operational to satisfy safety requirements. Refer to the following section.

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 Studio 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 Enabling Robot High Power on page 110.
3. Check that the High Power indicator flashes. After the High Power request is made and the indicator is checked, the procedure is complete.

6.6 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.

  This label is not present on the iX4-650HS/800HS robots.

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

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.

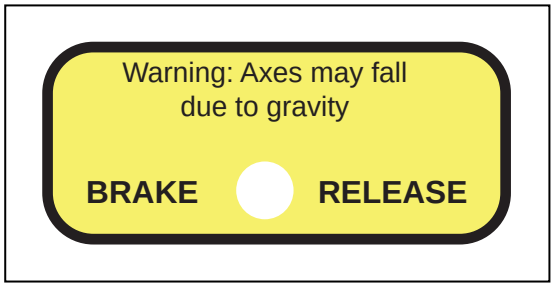


Figure 6-3. Brake Release / Gravity Label

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

6.7 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.

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 for an iX4-650H/800H Robot on page 135 and Replacing the iCS-ECAT Unit for an iX4-650HS/800HS Robot on page 138 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. The references for removing the iCS-ECAT also cover re-installing one.

6.8 Checking Fan Operation

The motor fans are PWM controlled. This check needs to be done with 24 VDC to the robot ON.

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

Verify that all four motor fans operate:

1. Ensure the motors are cool before performing this check.
2. Remove all motor covers.
3. Toggle power to the iCS-ECAT. This will start the fans and they will continue to run for about one minute.
4. Verify that each motor fan is running.
5. Verify that the iCS-ECAT fan is running. The iCS-ECAT fan runs continuously, but its speed will vary.
6. Reinstall all motor covers.

6.9 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.

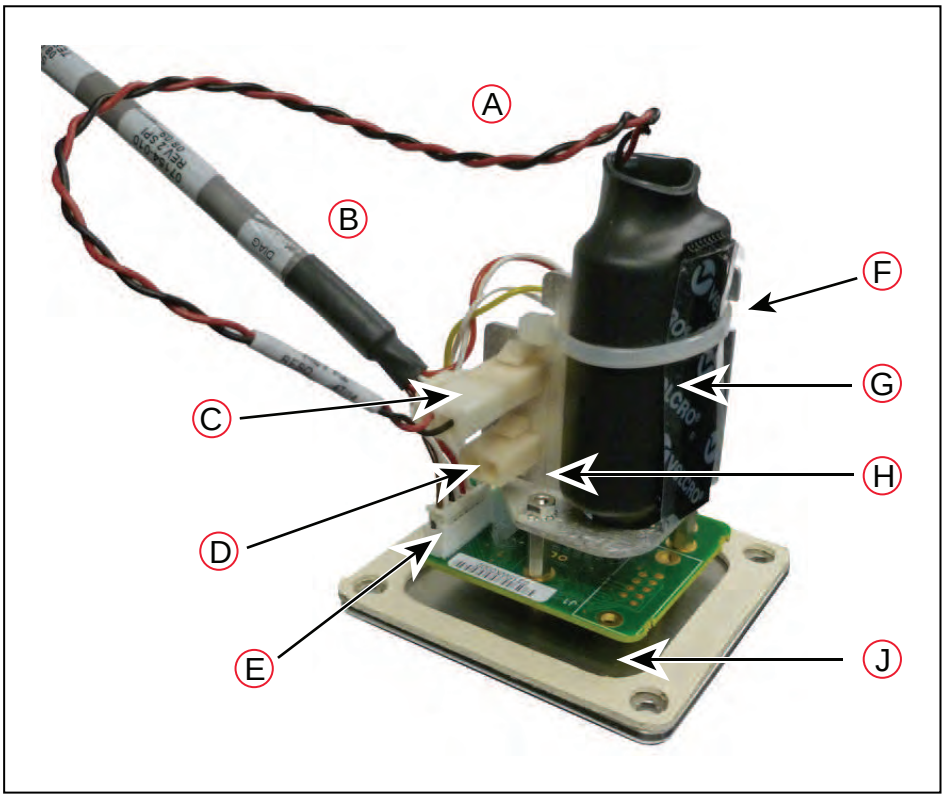


Figure 6-4. Battery Pack Assembly

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. For the iX4-650H/800H robots: Remove the four M4 hex-head bolts that secure the Status Display panel. Retain the bolts for reassembly. See the following figure:

Figure 6-5. iX4-650H/800H Robot Status Panel

For the iX4-650HS/800HS robots: Remove the eight hex-head bolts that secure the Status Display panel. See the following figure:

> **NOTE:** Do not remove the two smaller hex-head bolts on each side of the word "STATUS".

- Retain the bolts and washer seals for re-installation.
- These bolts were installed with Loctite 222.

Figure 6-6. iX4-650HS/800HS Status 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. For the iX4-650HS/800HS robots, retain the Status Display panel cover and gasket for reinstallation.

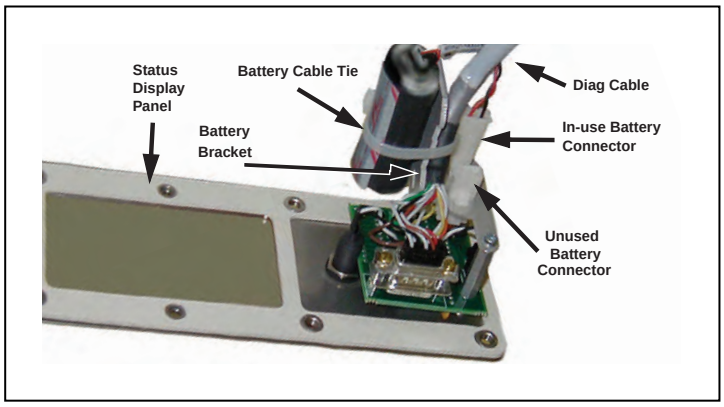


Figure 6-7. Battery Bracket on Status Display Panel

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. For the iX4-650H/800H robots, 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

    For the iX4-650HS/800HS robots,

    - Route the “diag” cable AWAY from the iCS-ECAT fan inside the robot base.
    - Be careful not to hit the top of the amber lamp with the back of the battery assembly.
    - Apply Loctite 222 in each bolt hole, not on the bolts themselves.
    - Ensure that the Status Display panel gasket is in place between the panel and the robot body.
    - Ensure that a washer seal is in place under each bolt.
    - Torque the bolts to 1.1 N·m.

6.10 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.

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.

NOTE: Refer to Attach the Outer Arms on page 43 for details on installing the outer arms. Removal is the reverse of installation.

1. Remove the four pairs of outer arms from the four pairs of ball studs on the installed platform.
2. Attach one pair of outer arms to each of the four pairs of ball studs on the new platform.
    - The platform must be installed with the tool flange facing down.
    - Ensure that the joint numbers on the base match the numbers shown in the following figure. This places the platform tool flange closest to the Status Display.

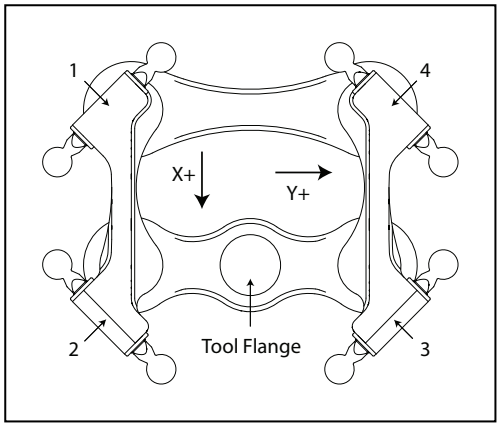


Figure 6-8. Platform Orientation, Top View, Showing P31

- Take care not to trap debris between the ball studs and their sockets.

Configuration

If the replacement platform has the same part number as the old platform, the robot does not need to be reconfigured. If the replacement platform is a different type of platform, contact your local OMRON representative for more information.

NOTE: The P30, P31, P32, and P34 platforms have stainless steel ball studs, and must be used with special brown acetal inserts. Contact your local OMRON representative for details.

6.11 Replacing Outer Arm Spring Assemblies

Use the following procedure to replace outer arm spring assemblies. This includes spring and retainer removal and replacement.

IMPORTANT: Cutting and destroying the old spring retainers is required for this procedure. Do not attempt this procedure unless replacement parts are available.

1. Begin by removing the outer arm pair that needs service.
2. Bend the spring so that the end is 90° from normal.

Figure 6-9. Bending Spring

3. Slip the springs off of the retainers. Removing the first spring is the most difficult, as the other spring will tend to restrict movement. The narrowest part of the retainer is 90° from the groove in which the spring end normally rests. Use this narrow area for easier removal.

Figure 6-10. Spring Removal

4. Repeat steps 1 through 4 for all other spring removal.
5. After all springs are removed, cut the retainer(s) with a diagonal cutter. Take care to prevent damage to any part of the outer arm.
6. Remove the cut spring retainer(s) from the outer arm pins.
7. After all spring retainers are removed, slip one end of the new retainer over one of the outer arm pins.

Figure 6-11. Retainer On One Pin

8. Pull the loose end of the retainer while spreading it slightly and slip the end over the top of the other outer arm pin.

Figure 6-12. Retainer Over Top of Pin

9. Push the retainer the rest of the way until it is over the pin and snaps into position.

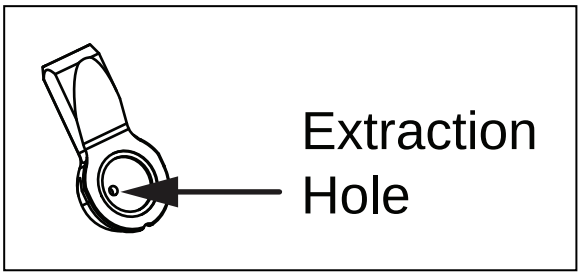
Figure 6-13. Push the retainer Into Position

10. After all spring retainers are replaced, slip the new springs onto the retainers at 90° from their normal position. After all springs are replaced, install all outer arms that were removed to complete this procedure.

6.12 Replacing a Ball Joint Socket Insert

For the iX4-650H/800H robots, 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.

For the iX4-650HS/800HS robots, use the following procedure to replace a ball joint socket insert.

The inserts used in the ball joints for the iX4-650HS/800HS robots must seal very tightly. If simply pushed into the ball joint socket, it forms a pocket of compressed air that pushes the insert back out.

Because of this, the ball joint insert must be cooled sufficiently to make it shrink. It can then be inserted into the ball joint, where it will warm up and expand to form a seal.

WARNING: BURN RISK
Dry ice can cause burns if touched. Wear well-insulated gloves when you handle the dry ice. You may want to wear lighter gloves to handle the cold inserts.

1. Remove the old insert.
   a. If the insert is held tightly, you can facilitate its removal by packing the insert with dry ice. Have dry ice touching as much of the insert surface as possible. Leave it for 15 minutes.
   b. Turn the ball joint socket so the insert faces down, and tap it lightly on something. The insert should fall out.
2. Pack the new insert in dry ice.

   It typically takes 15 minutes packed in dry ice for the insert to shrink enough to fit into and stay in the ball joint.
3. Wearing gloves, put the cooled insert into the ball joint.

This must be done quickly, before the insert warms up, or you will not be able to fit it into the ball joint socket.

4. Ensure that the insert is centered in the ball joint socket, and bottomed-out, so that it will form a seal as it expands.
5. Verify that the insert has warmed up in the correct position in the ball joint socket.

6.13 Replacing the iCS-ECAT Unit for an iX4-650H/800H Robot

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

Record all faults or errors before beginning this procedure.

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

NOTE: This procedure is different for the iX4-650HS/800HS robot. Refer to Replacing the iCS-ECAT Unit for an iX4-650HS/800HS Robot on page 138.

Removing the iCS-ECAT Chassis

1. Remove all power from the robot.
2. Take note of the switch positions on the interface panel. these will be used for a replacement controller.
3. Disconnect the 24 VDC supply cable from the chassis 24 VDC input connector.
4. Disconnect the 200 to 240 VAC supply cable from the chassis AC Input connector.
5. Disconnect the XSYSTEM cable from the chassis XSYSTEM connector.
6. Disconnect any other cables that may be connected to the iCS-ECAT.
7. 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.

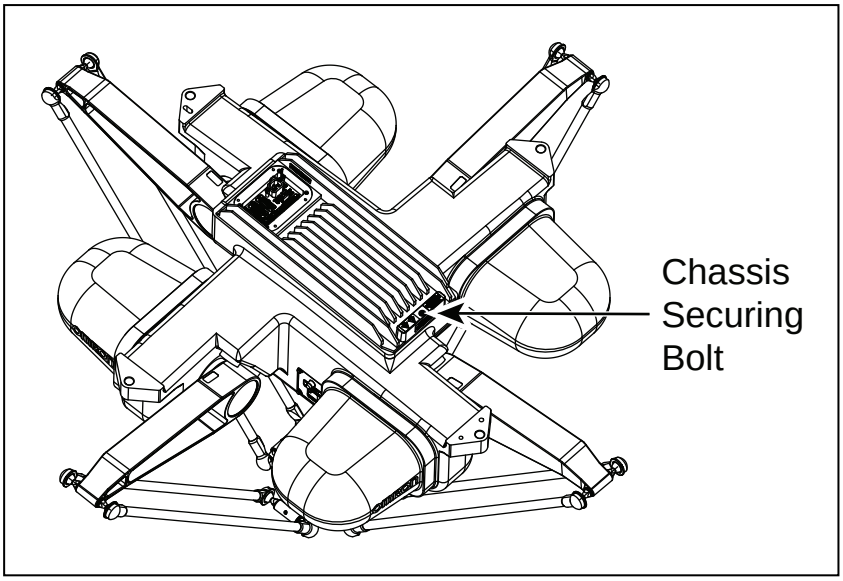


Figure 6-14. Chassis-securing Bolt

8. 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.

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

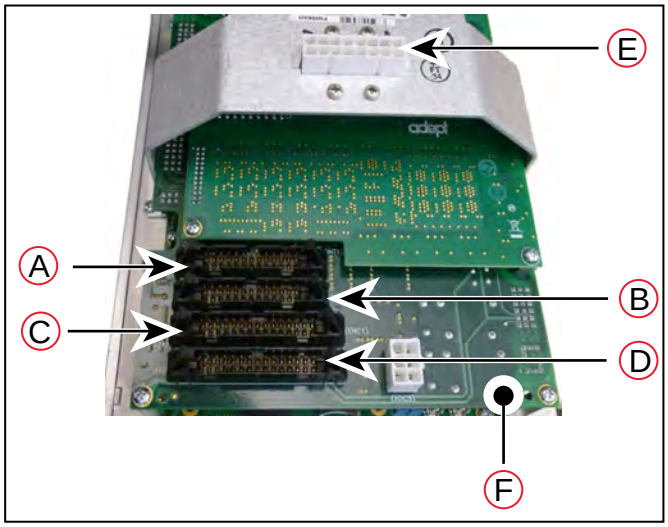


Figure 6-15. Chassis Items

Table 6-6. Chassis Item Descriptions

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

10. 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.
11. Remove and retain the microSD card for insertion into the replacement iCS-ECAT. Refer to Remove and Replace a MicroSD Card on page 142.
12. Using a 5 mm hex wrench, disconnect and remove the ground wire from the chassis.

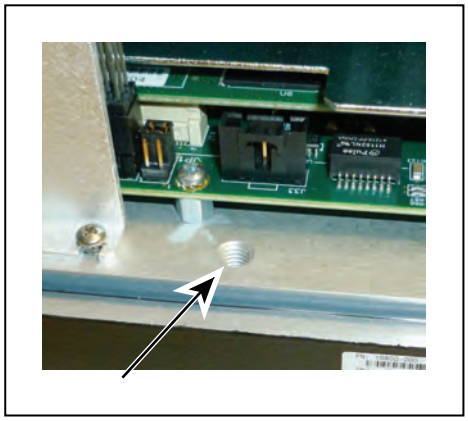


Figure 6-16. Chassis Ground Screw Hole

13. Tag the chassis with appropriate fault diagnosis and robot serial number information.

Installing a New iCS-ECAT Chassis

1. 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.
2. Using a 5 mm hex wrench, connect the ground wire to the chassis.
3. Reconnect the cables you removed from their connectors on the ePMAI board, and engage the securing latches.
4. Connect the white amplifier cable to the amplifier connector located on the chassis bracket.
5. Insert the chassis into its mount, at the top of the base.
6. Lower the chassis into place against the mount, making sure that none of the cables get trapped or pinched and that the chassis O-ring is not damaged during installation.

7. Once the chassis is in place, use a 5 mm hex wrench to tighten the chassis securing screw.
8. Set all switch positions to the removed controller settings.
9. After connecting all previously disconnected cables to their original locations, the procedure is complete.

If you have problems bringing up the robot after iCS-ECAT replacement

- Verify that all system cables are fully seated and installed correctly. Refer to System Cable Installation on page 63.
- Remove power from the iCS-ECAT, then verify that all iCS-ECAT electrical connectors are fully-seated.

  After checking iCS-ECAT cables, restore power to the robot and reboot the controller.
- Check the Status Display fault code. This should be either OK or ON. Refer to Status Codes on page 179 and Robot Status LED and Display Panel on page 105.

6.14 Replacing the iCS-ECAT Unit for an iX4-650HS/800HS Robot

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

Record all faults or errors before beginning this procedure.

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

NOTE: This procedure is different for the iX4-650H/800H robot. Refer to Replacing the iCS-ECAT Unit for an iX4-650H/800H Robot on page 135.

Removing the iCS-ECAT Chassis from an iX4-650HS/800HS Robot

1. Remove all power from the robot.
2. Switch OFF the 24 VDC input supply to the chassis 24 VDC input connector.
3. Switch off the 200 to 240 VAC input supply to the chassis AC Input connector.

4. Unscrew the six M4 chassis-securing bolts, shown in the following figure.

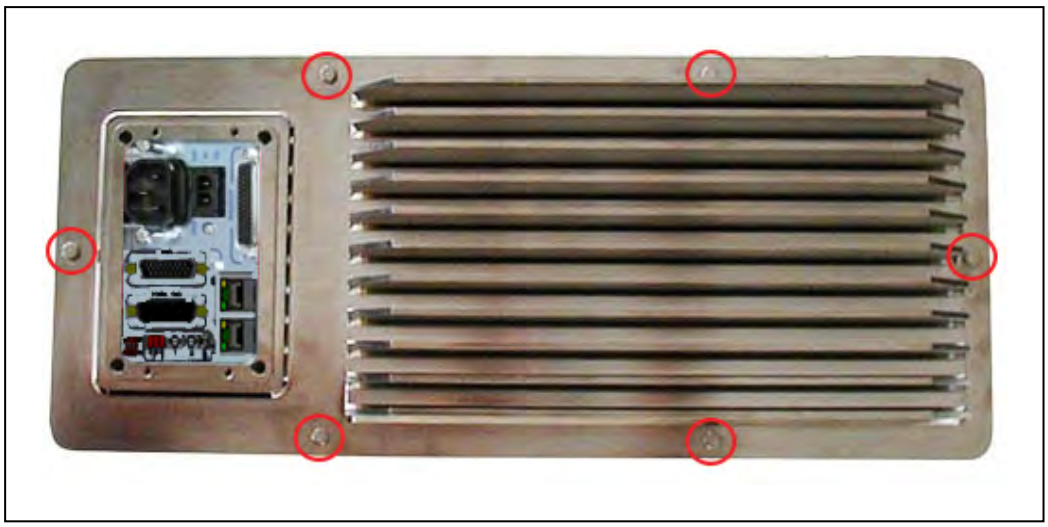


Figure 6-17. iCS-ECAT Chassis-securing Bolts, Circled

- These bolts were installed using Loctite 222.
- Retain the bolts for reinstallation.

NOTE: The iCS-ECAT on the iX4-650HS/800HS robots can be difficult to remove after the cable inlet box has been removed. You should lift the iCS-ECAT slightly, to loosen the seal, before proceeding.

5. Remove the cable inlet box. Refer to Installing a Cable Inlet Box for iX4-650HS/800HS Robots on page 91.
6. Disconnect the 24 VDC supply cable from the chassis 24 VDC input connector.
7. Disconnect the 200 to 240 VAC supply cable from the chassis AC input connector.

   Lock out and tag out AC power.
8. Disconnect the XSYSTEM cable from the chassis XSYSTEM connector.
9. Disconnect any other cables that may be connected to the iCS-ECAT.
10. 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 6-18. Chassis Removal

11. Disconnect the white amplifier cable from the amplifier connector located on the chassis bracket, shown in the following figure.

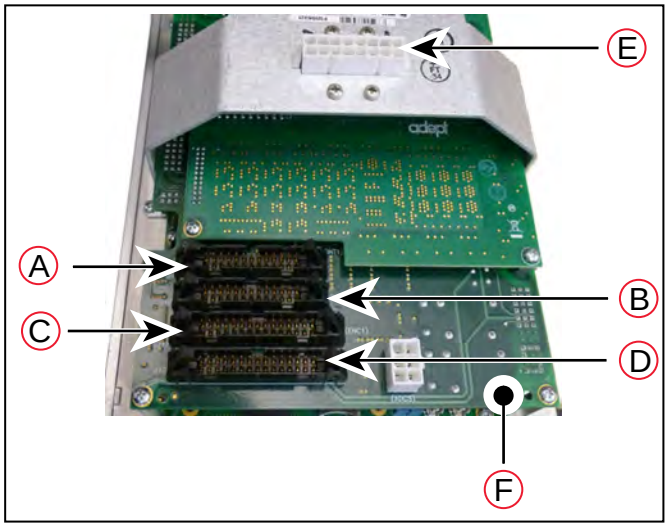


Figure 6-19. Chassis Items

Table 6-7. Chassis Item Descriptions

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

12. Carefully disconnect the INT1, INT2, ENC1, and ENC2 cables from their connectors on the ePMAI board by disengaging the connector securing latches to free the connectors.

13. Remove and retain the microSD card for insertion into the replacement iCS-ECAT. Refer to Remove and Replace a MicroSD Card on page 142.
14. Using a 5 mm hex wrench, disconnect and remove the ground wire from the chassis.

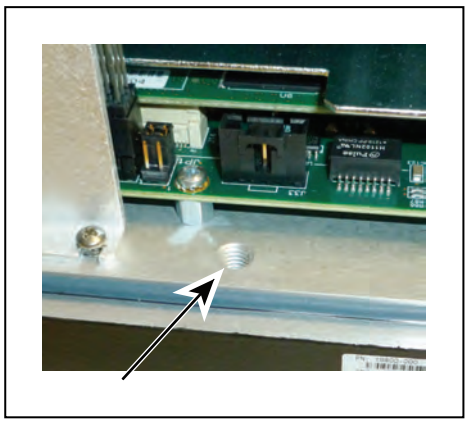


Figure 6-20. Chassis Ground Screw Hole

15. Remove the chassis from the robot, and tag it with appropriate fault diagnosis and robot serial number information.

Installing a new iCS-ECAT Chassis

Harness Connections

1. Carefully remove the new chassis from its packaging, check it for any signs of damage, and remove any packing materials or debris from inside the chassis.
2. Carefully place the chassis, on its heat-sink fins, next to the robot.
3. Using a 5 mm hex wrench, connect the ground wire to the chassis.
4. Reconnect the cables you removed from their connectors on the ePMAI board, and engage the securing latches.
5. Connect the white amplifier cable to the amplifier connector located on the chassis bracket.
6. Insert the chassis into its mount, at the top of the base.
7. Lower the chassis into place against the mount, making sure that none of the cables get trapped or pinched and that the chassis O-ring is not damaged during installation.
8. Once the chassis is in place, tighten the six M4 chassis-securing bolts. Refer iCS-ECAT Chassis-securing Bolts, Circled on page 139.
    - Use Loctite 222 in the bolt holes, not on the bolts themselves.
    - Torque the bolts to 1.1 N·m.

External Connections

1. Connect the 200 to 240 VAC supply cable to the chassis AC input connector.
2. Connect the eXSYS cable to the chassis XSYSTEM connector.

3. Connect any other cables connected to the chassis, such as XIO or RS-232.
4. Connect the 24 VDC supply cable to the chassis 24 VDC input connector.
5. Install the cable inlet box. Refer to Installing a Cable Inlet Box for iX4-650HS/800HS Robots on page 91.
6. Switch ON the 200 to 240 VAC input supply to the chassis.
7. Switch ON the 24 VDC input supply to the chassis.
8. Once the system has completed booting, test the robot for proper operation.

If you have problems bringing up the robot after iCS-ECAT replacement

- Verify that all system cables are fully seated and installed correctly. System Cable Installation on page 63.
- Remove power from the iCS-ECAT, then verify that all iCS-ECAT electrical connectors are fully seated.
- After checking iCS-ECAT cables, restore power to the robot and reboot the controller.
- Check the Status Display fault code. This should be either OK or ON. Refer to Status Codes on page 179 and Robot Status LED and Display Panel on page 105.

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 from the robot 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 chassis.

Additional Information: Refer to Replacing the iCS-ECAT Unit for an iX4-650H/800H Robot on page 135 or Replacing the iCS-ECAT Unit for an iX4-650HS/800HS Robot on page 138 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.

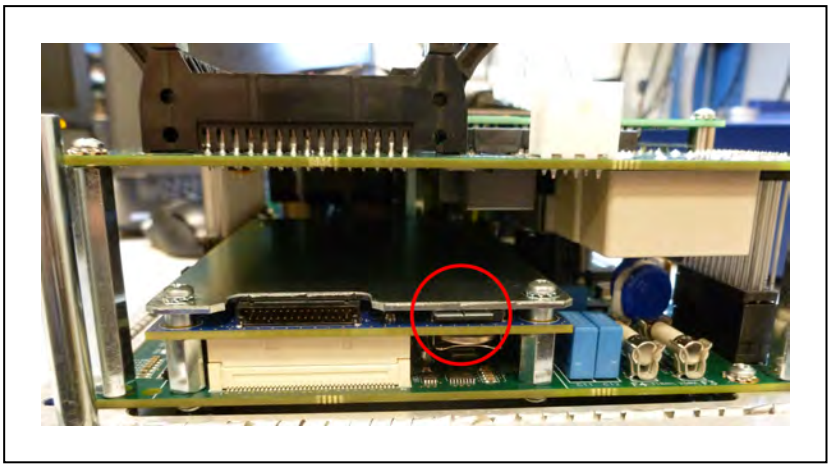


Figure 6-21. MicroSD Card Location (circled)

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 for an iX4-650H/800H Robot on page 135 and Replacing the iCS-ECAT Unit for an iX4-650HS/800HS Robot on page 138 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 (iX4-650H/800H) or six screws (iX4-650HS/800HS) 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.

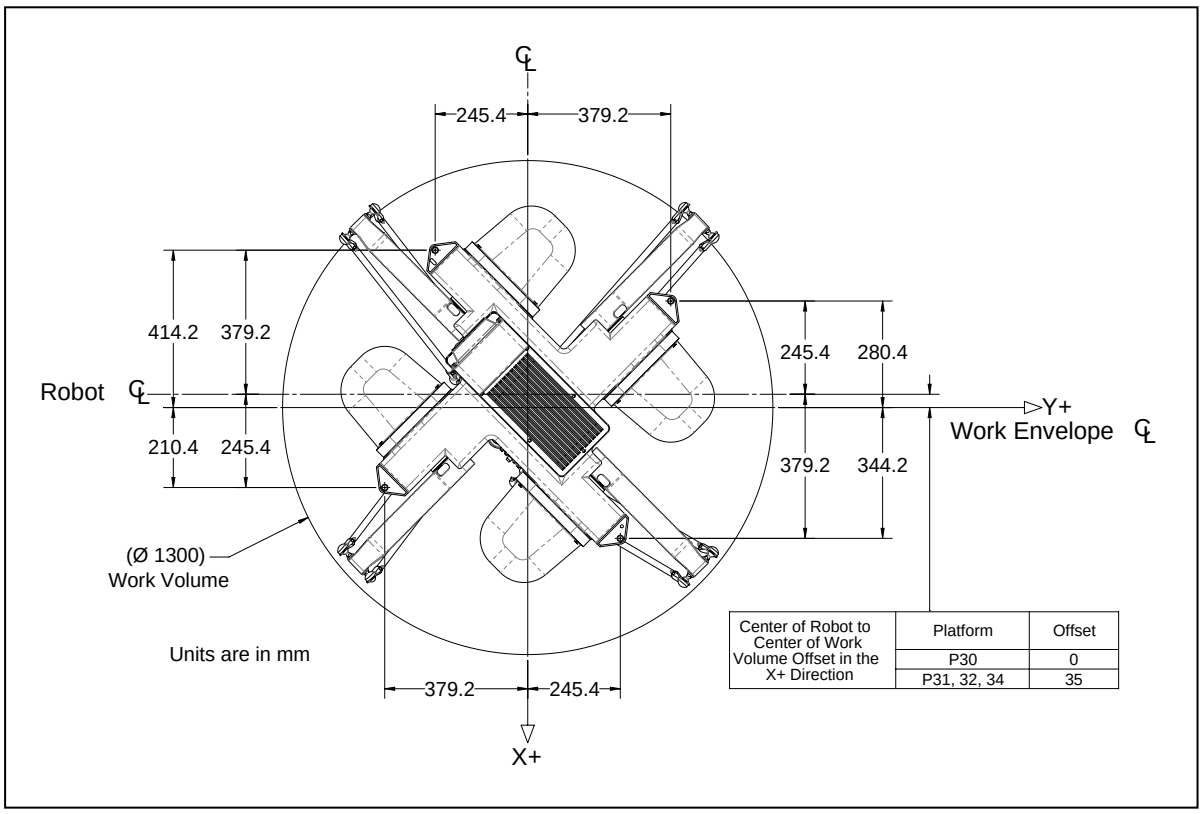


Figure 7-1. Top Dimensions, iX4-650HS Shown

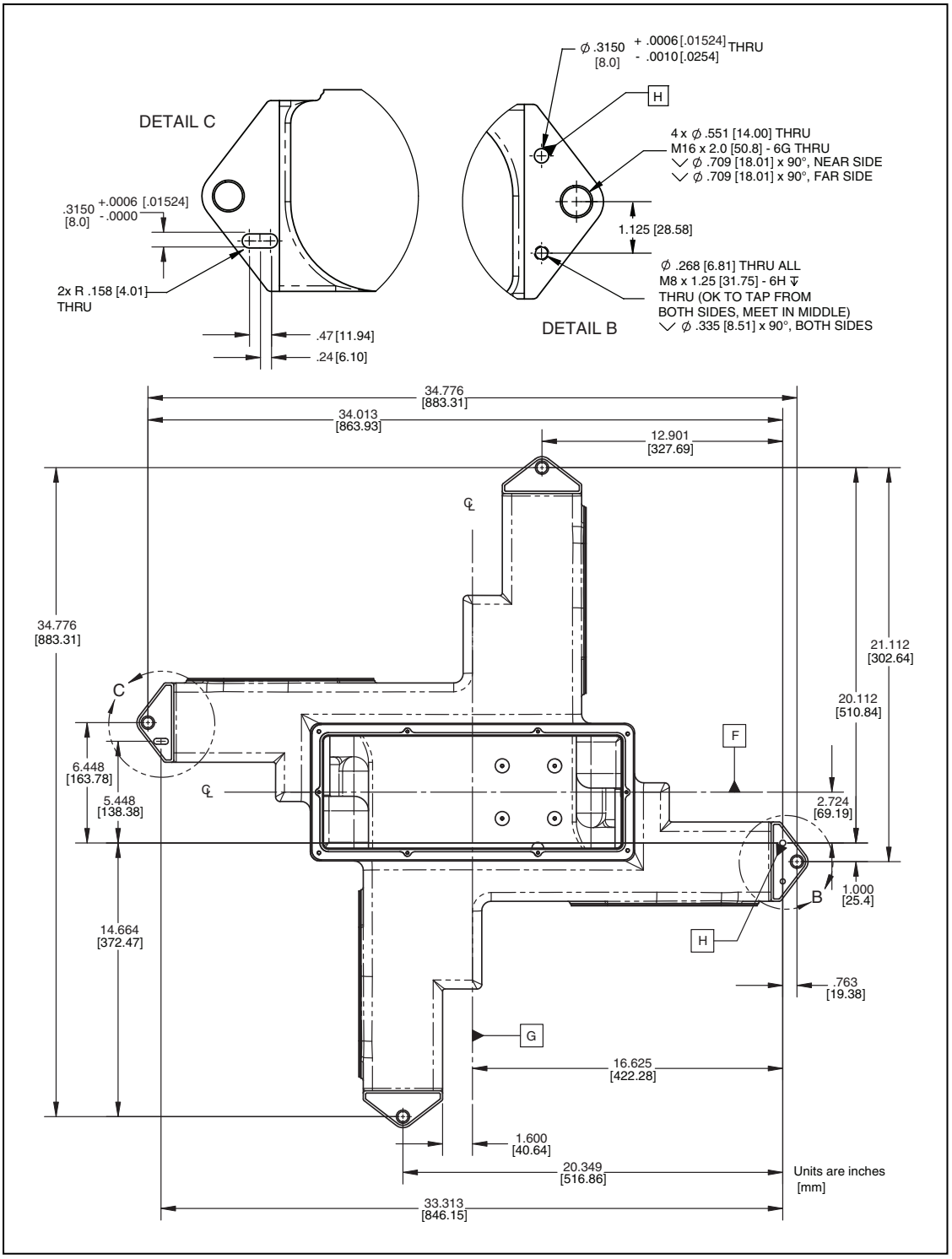


Figure 7-2. Mounting Hole Dimensions, iX4-650H/800H Robots

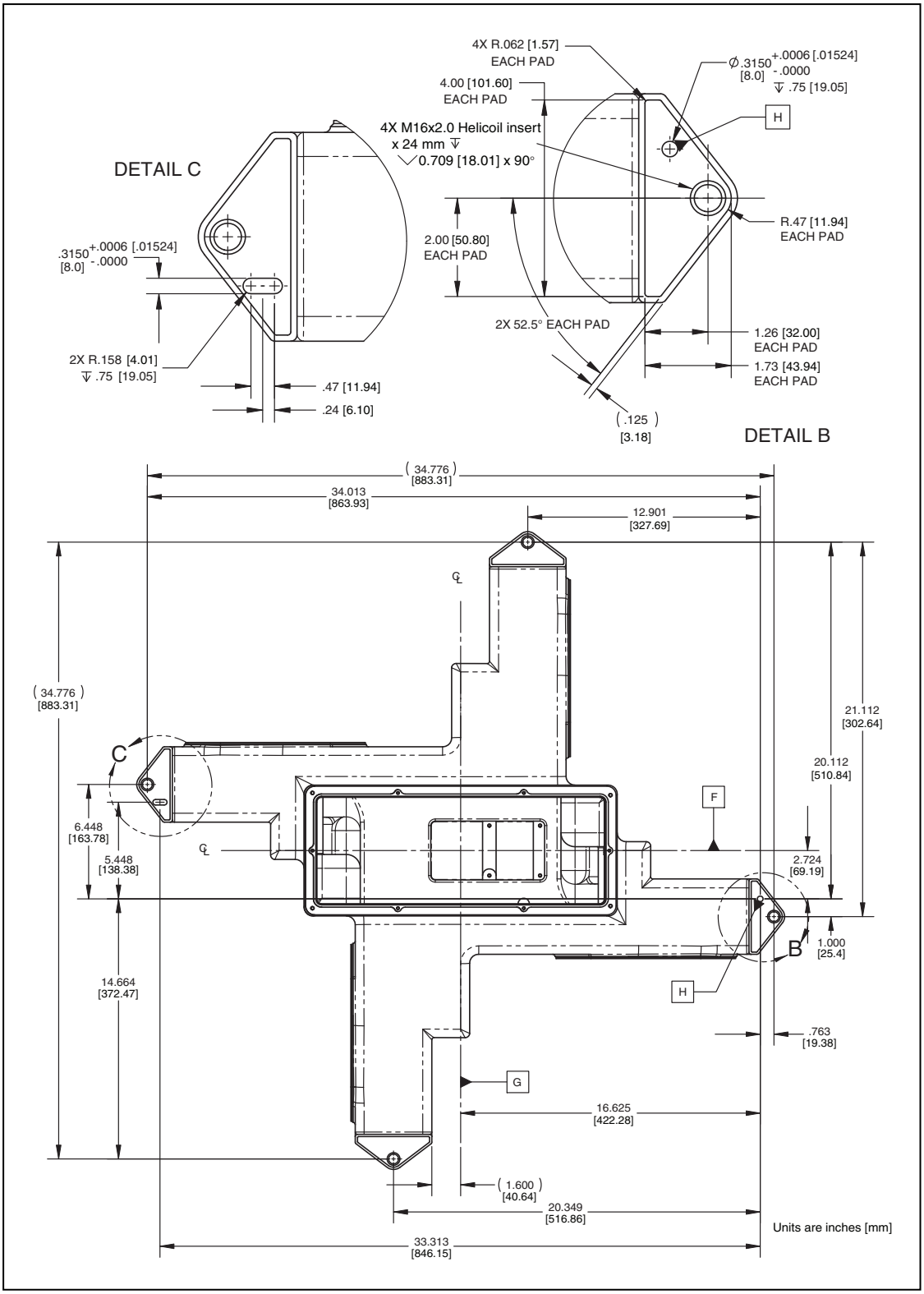


Figure 7-3. Mounting Hole Dimensions, iX4-650HS/800HS Robots

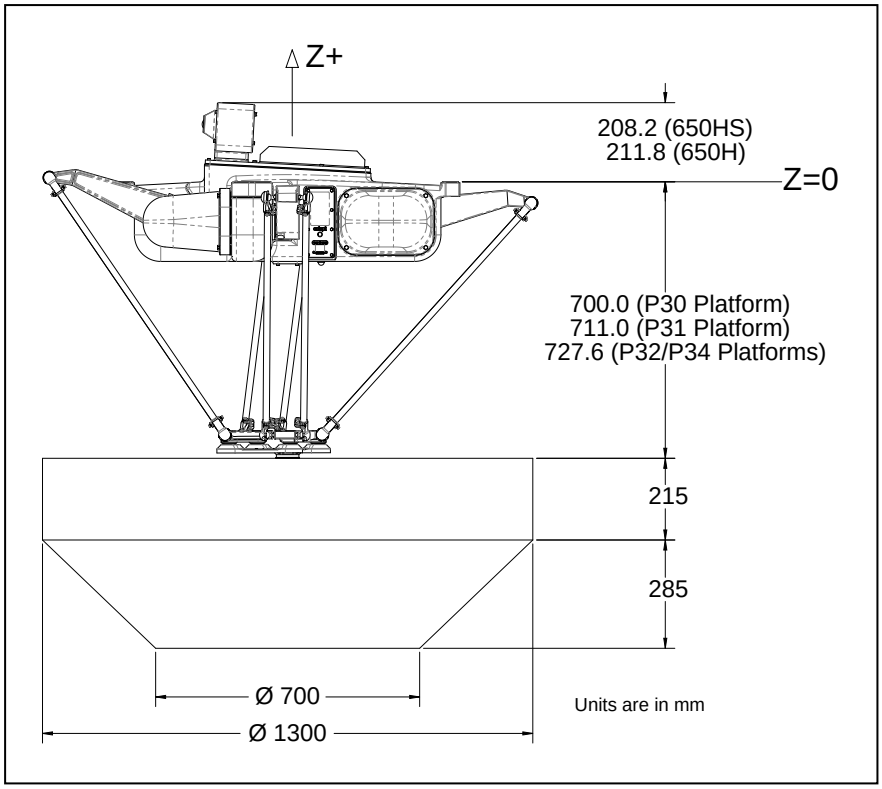


Figure 7-4. Work Envelope Side View, iX4-650H

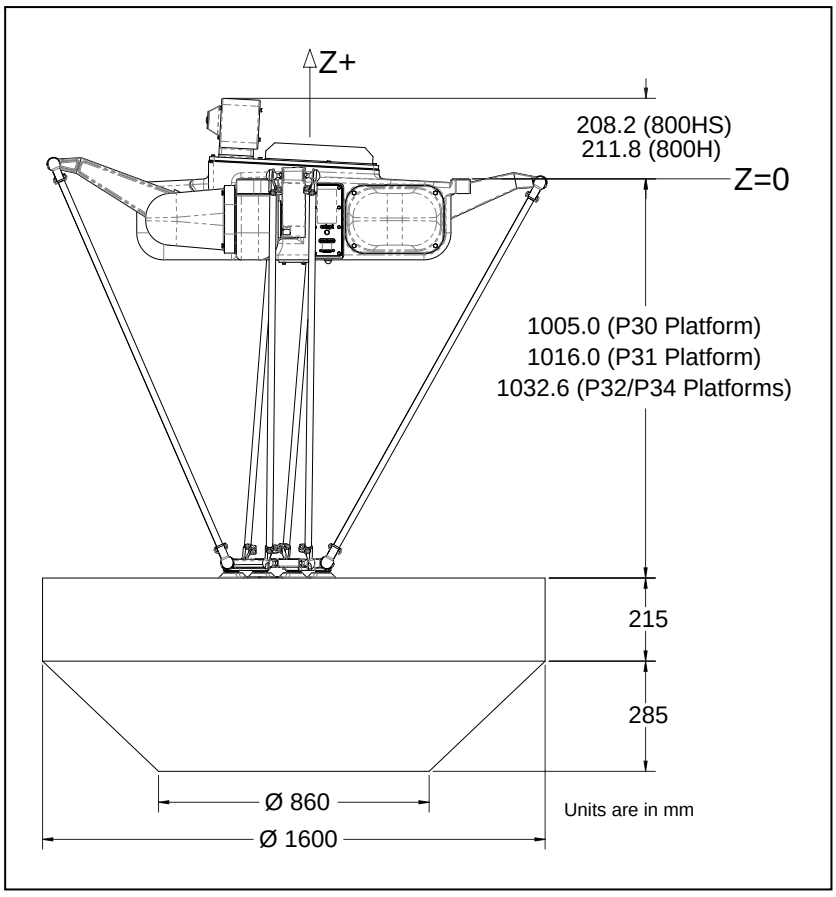


Figure 7-5. Work Envelope Side View, iX4-800H

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.

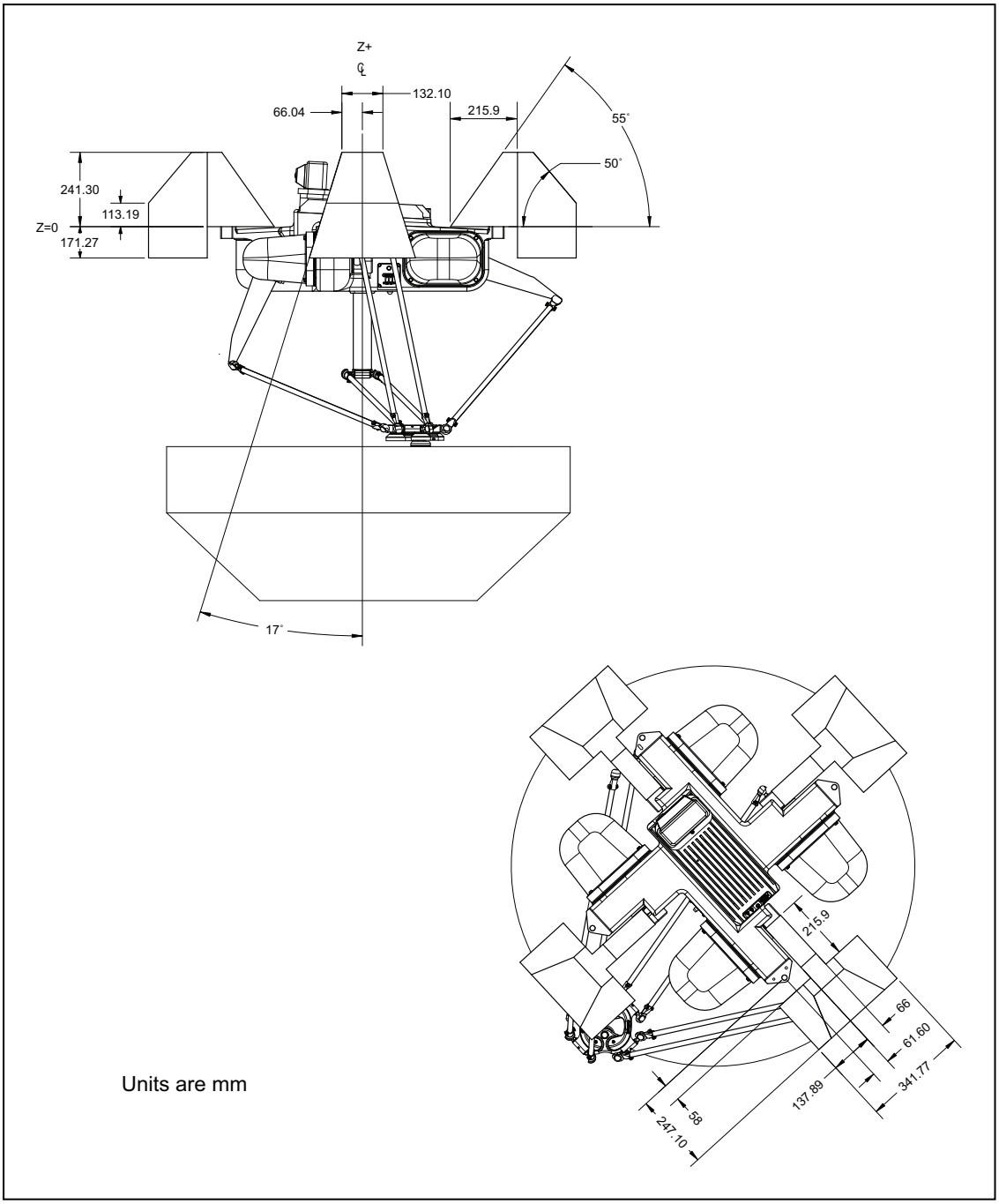


Figure 7-6. Inner Arm Travel Volume (iX4-650H Shown)

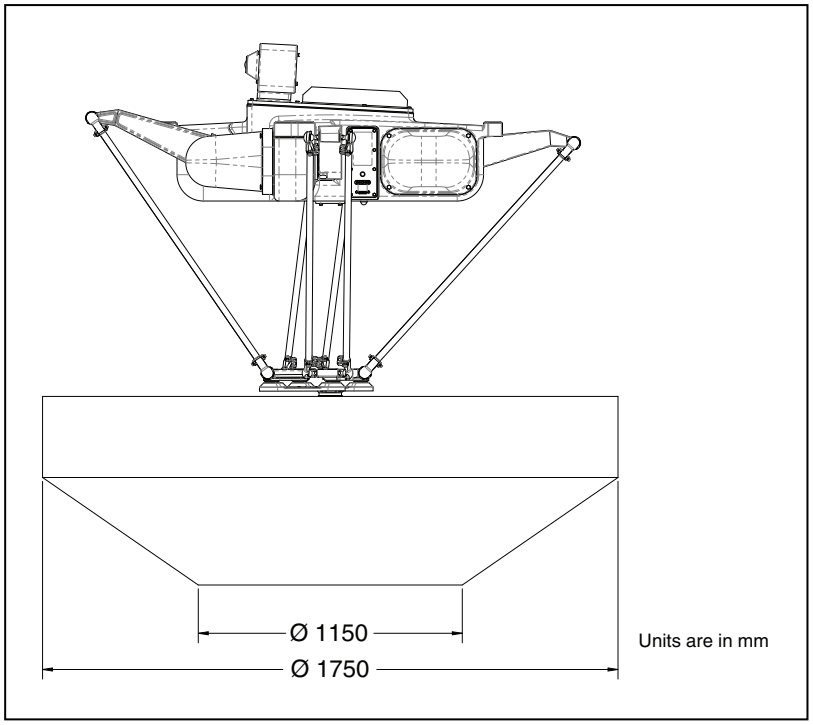


Figure 7-7. iX4-650H/HS Outer Arm Travel Volume (Worst Case)

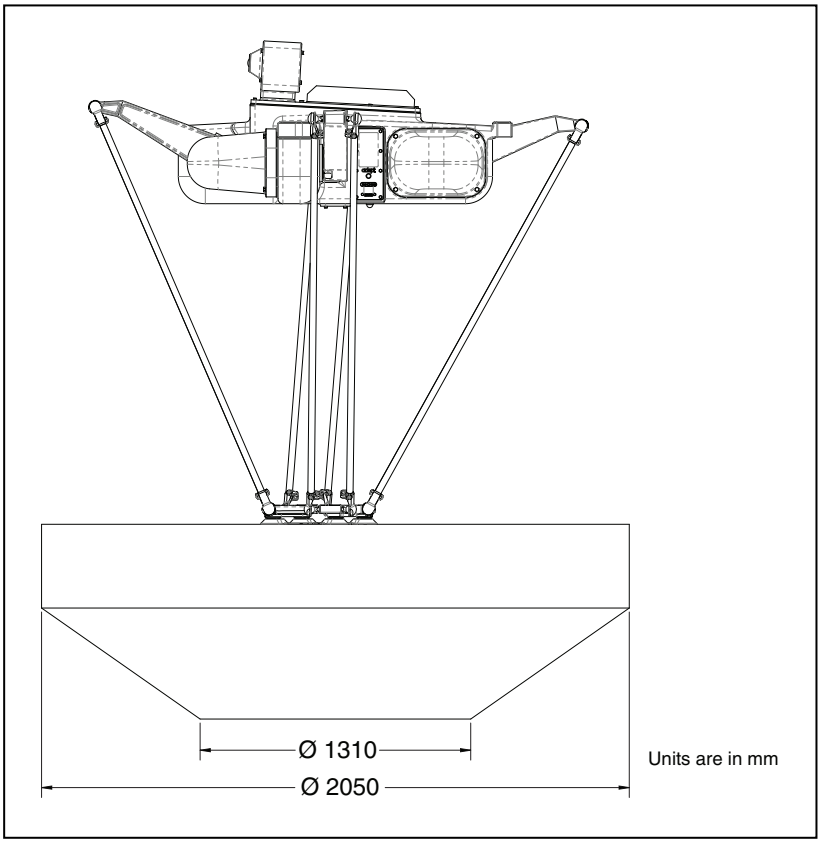


Figure 7-8. iX4-800H/HS Outer Arm Travel Volume (Worst Case)

7.3 Tool Flanges

Both the P31 and P30 platforms have built-in tool flange faces. The tool flange face is machined into the strut or platform.

The P31 tool flange face moves with the strut that it is part of, providing ± 46.25° of rotation.

The P32 and P34 have tool flanges that rotate relative to the platform. Both are belt-driven.

Ensure that the bolts used to attach end-effectors engage the threads in the tool flange sufficiently, as described in the following table:

Table 7-1. Tool Flange Bolt Engagement

Platform	Minimum	Maximum
P30	9 mm	15 mm
P31	8 mm	12 mm
P32, P34	6 mm	8 mm

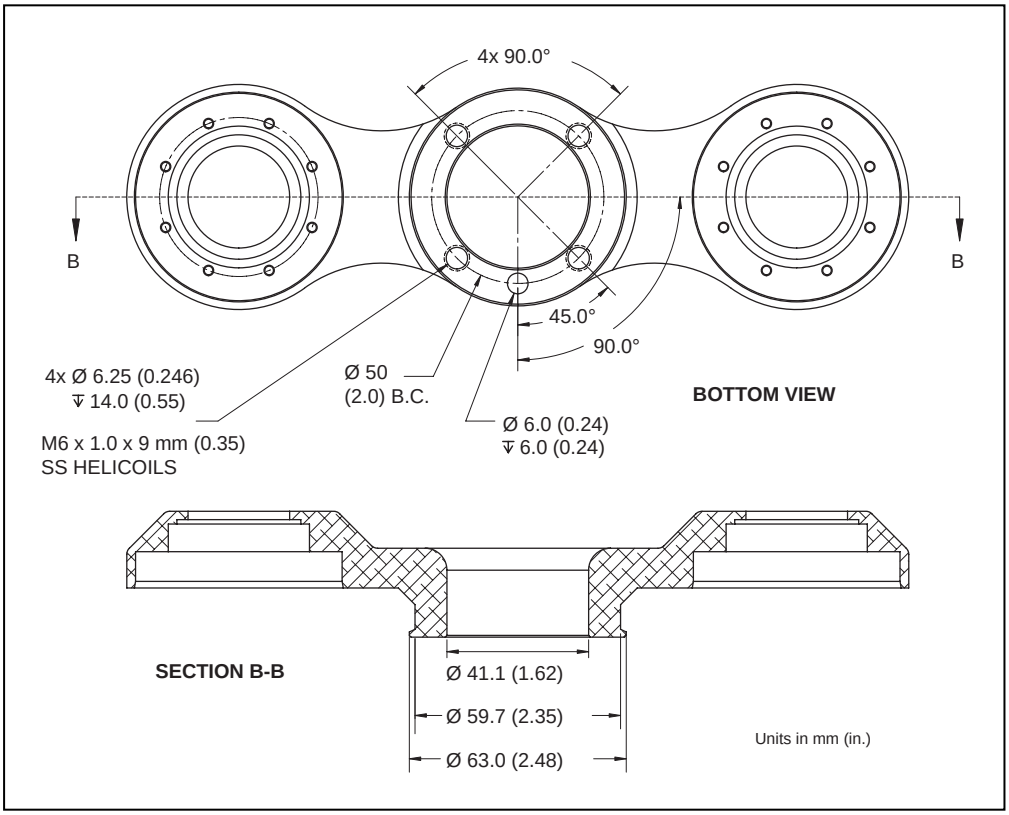


Figure 7-9. Tool Flange Dimensions, P31 Platform

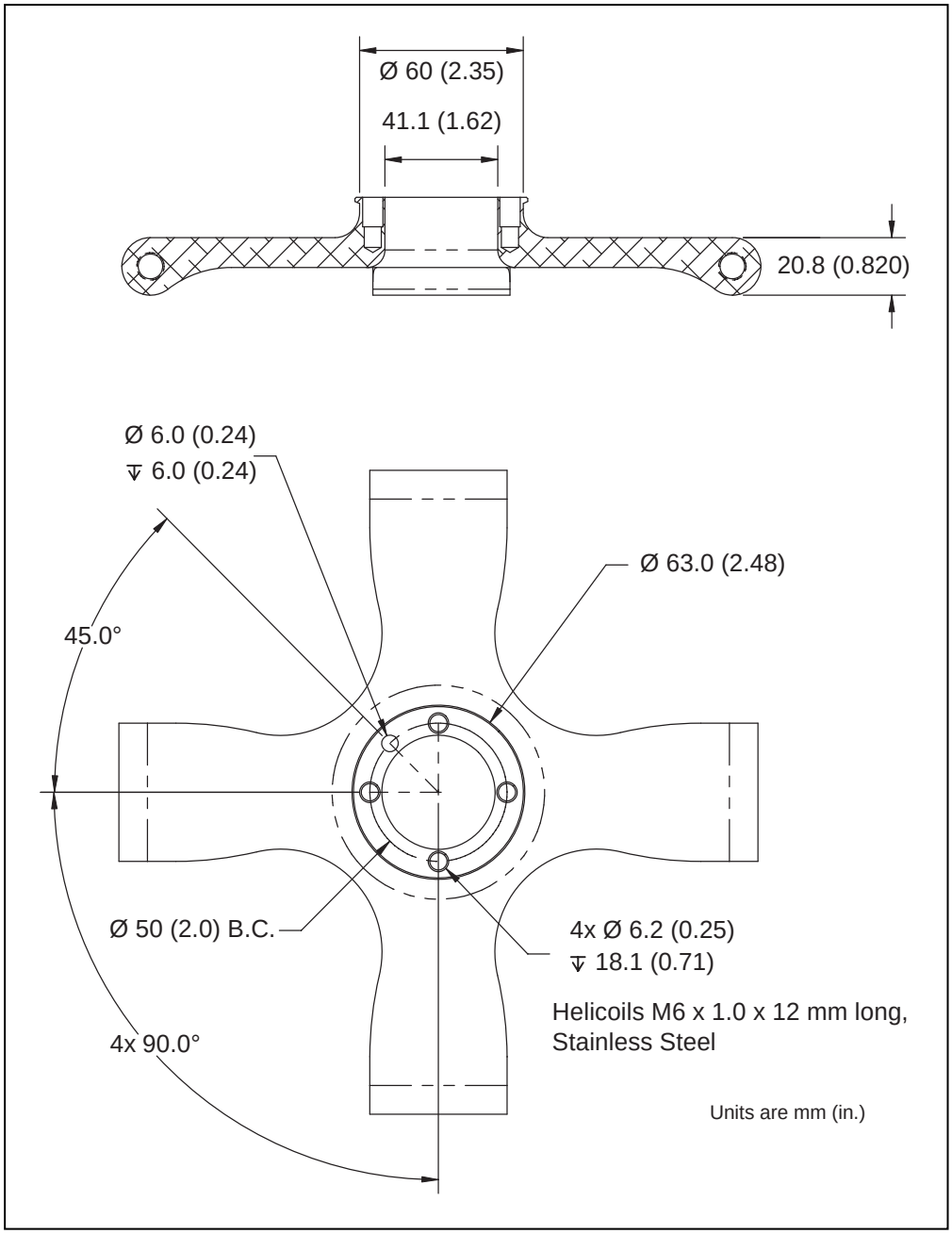


Figure 7-10. Tool Flange Dimensions, P30 Platform

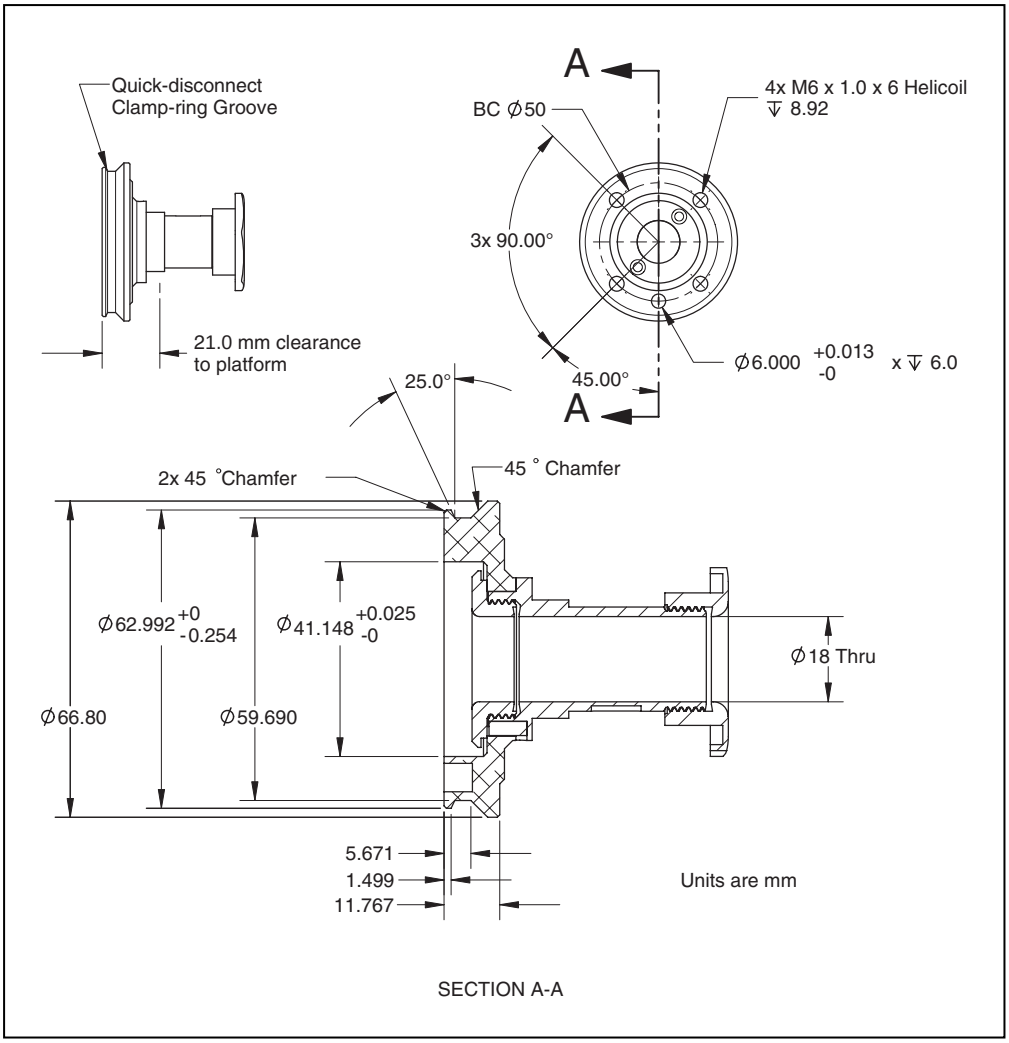


Figure 7-11. Tool Flange Dimensions, P32, P34 Platforms

7.4 General Robot Specifications

The following table provides general robot specifications.

Table 7-2. Robot Specifications

Item	Specification			
	iX4 650		iX4 800	
	Aluminum Platform	Stainless Steel Platform	Aluminum Platform	Stainless Steel Platform
Reach (cylinder radius)	650 mm		800 mm	
Payload - rated	2.0 kg	1.0 kg	2.0 kg	

Item	Specification			
	iX4 650		iX4 800	
	Aluminum Platform	Stainless Steel Platform	Aluminum Platform	Stainless Steel Platform
Payload - maximum	6.0 kg	3.0 kg	4.0 kg	1.0 kg
Adept Cycle[1] - seconds	25-305-25 mm			
0.1 kg	0.3	0.39	0.33	
1 kg	0.36	0.41	0.38	0.45
2 kg	0.37	0.42	0.40	
3 kg	0.39	0.43		
4 kg	0.41	n/a	0.45	
6 kg	0.43	n/a	n/a	
Packaging Cycle[1] - seconds	25-700-25 mm			
0.1 kg	0.46	0.55	0.48	
1 kg	0.47	0.58	0.50	0.62
2 kg	0.52	0.59	0.55	
3 kg	0.55	0.61		
4 kg	0.58	n/a	0.62	
6 kg	0.61	n/a	n/a	
Joint Range	+124° to -52°			
Soft Stops	+121° to -49°			
Encoder type	Absolute			
Robot Brakes	24 VDC			
Digital I/O Channels	12 inputs, 8 outputs			
Weight (no options)	118 - 123 kg			
Weight (in crate)	155 - 160 kg			
Footprint	883 x 883 mm			
[1]The robot tool performs continuous path, straight-line motions 25 mm up, 305 or 700 mm over, 25 mm down, and back along the same path, at 20° C ambient. Not achievable over all paths.				

7.5 Performance Specifications

This section provides the robot's performance specifications.

Payload Specifications

This section provides the payload specifications.

Torque and Rotation Limits

Table 7-3. Tool Flange Torque and Rotation Limits of Platforms

Platform	P31	P32	P34
Maximum Torque (N·m)	10	4.6	3.8
Maximum Rotation	± 46.25°	± 92.5°	± 185°
Hard Stop Limit	± 52.4°	± 104.3°	± 208.6°

NOTE: The P30 platform is not listed in the this table because this platform does not rotate.

IMPORTANT: Do not exceed the tool flange torque limits. Excessive torque can cause permanent misalignment of the tool flange.

Payload Mass vs. Acceleration

To avoid excited vibrations, the following acceleration values are recommended for given tool payloads.

Table 7-4. Payload Mass vs. Acceleration - iX4 650, Aluminum Platforms

Platform	Payload	Maximum Acceleration			Preferred Acceleration		
Type	kg	%[1]	m/s^2	g	%[1]	m/s^2	g
P30	15.0	75	15	1.5	40	8	0.8
P30	12.0	100	20	2.0	50	10	1.0
P30	10.0	120	23	2.4	60	12	1.2
P30	8.0	150	29	3.0	75	15	1.5
ALL	6.0	250	49	5.0	100	20	2.0
ALL	4.0	375	73	7.5	150	29	3.0
ALL	2.0	700	137	14.0	300	59	6.0
ALL	1.5	725	142	14.5	400	78	8.0
ALL	1.0	750	147	15.0	400	78	8.0
ALL	0.1	765	150	15.3	400	78	8.0

Table 7-5. Payload Mass vs. Acceleration - iX4 650, Stainless Steel Platforms

Platform	Payload	Maximum Acceleration			Preferred Acceleration		
Type	kg	%[1]	m/s^2	g	%[1]	m/s^2	g
P30	12.0	75	15	1.5	40	8	0.80
P30	10.0	87	17	1.7	46	9	0.92
P30	8.0	100	20	2.0	55	11	1.09
P30	6.0	125	25	2.5	67	13	1.33
P30	4.0	160	32	3.2	86	17	1.71
ALL	3.0	188	37	3.8	100	20	2.0
ALL	2.0	225	44	4.5	120	24	2.4
ALL	1.0	281	55	5.6	150	29	3.0
ALL	0.1	375	74	7.5	200	39	4.0

Table 7-6. Payload Mass vs. Acceleration - iX4 800

Platform	Payload	Maximum Acceleration			Preferred Acceleration		
Type	kg	%	m/s^2	g	%[1]	m/s^2	g
P30	10.0	90	17.6	1.8	45	8.8	0.9
P30	8.0	120	23.5	2.4	60	11.8	1.2
P30	6.0	200	39.2	4.0	80	15.7	1.6
ALL	4.0	300	58.8	6.0	120	23.5	2.4
ALL	2.0	560	109.8	11.2	240	47.0	4.8
ALL	1.5	580	113.7	11.6	320	62.7	6.4
ALL	1.0	600	117.6	12.0	320	62.7	6.4
ALL	0.1	612	120.0	12.2	320	62.7	6.4

Payload Inertia vs. Acceleration

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.

Table 7-7. Payload Inertia vs. Acceleration

	Platform		
	P31	P32	P34
Acceleration Value	**Allowable Tool Inertia (kg-cm^2)**		

	Platform		
100	750	188	47
250	300	75	19
500	150	37	9
750	100	25	6

NOTE: The P30 platform is not listed in this table because this platform does not rotate. Payloads for the P30 platform should be designed with their center-of-mass in line with the center axis of the tool flange. This will minimize induced torque during XYZ motions.

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.

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

Table 7-8. Maximum Allowable Center of Gravity

Acceleration	Maximum Allowable Center of Gravity		
	Payload		
	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.

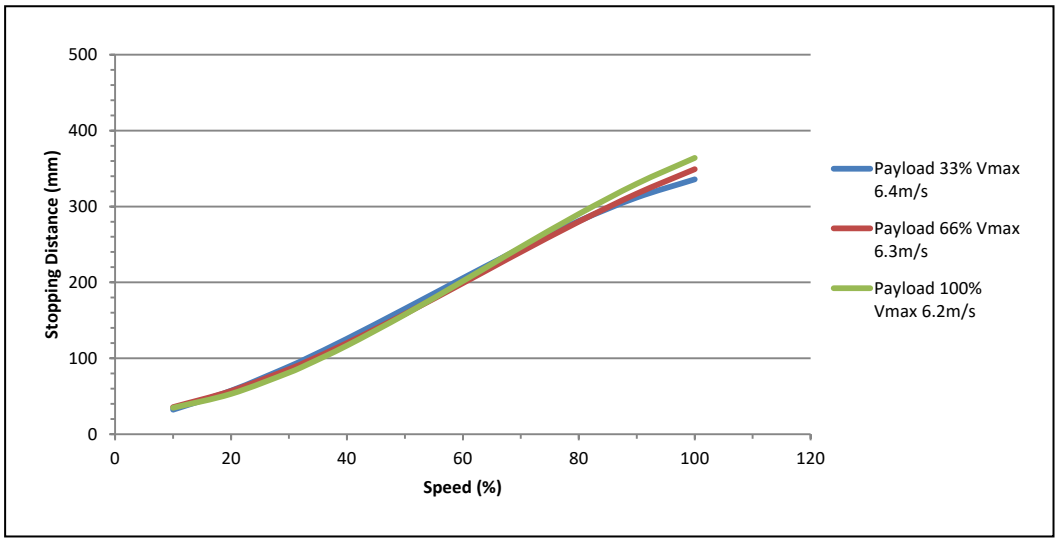


Figure 7-12. iX4-650H/iX4-650HS X Stopping Distance with P34 Platform

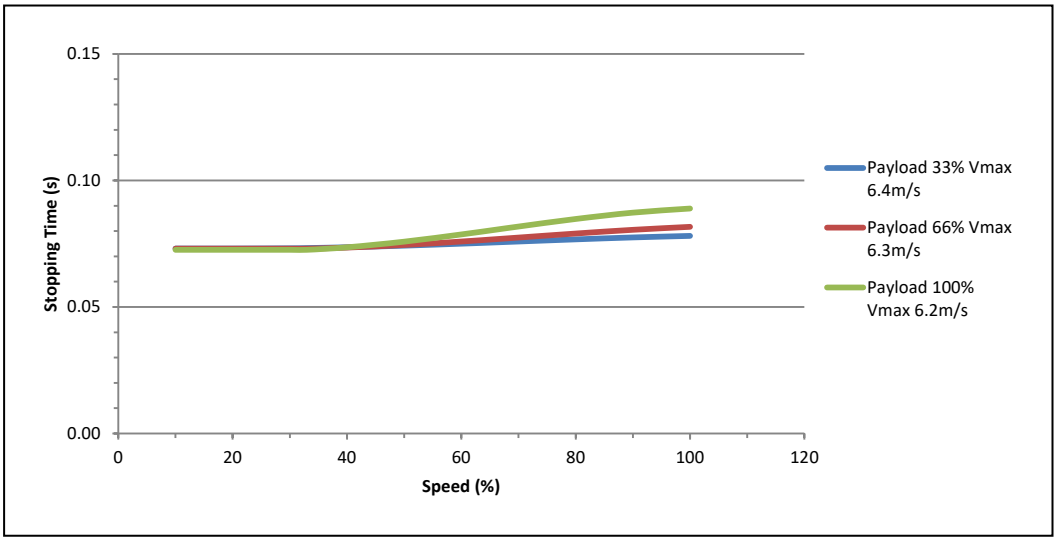


Figure 7-13. iX4-650H/iX4-650HS X Stopping Time with P34 Platform

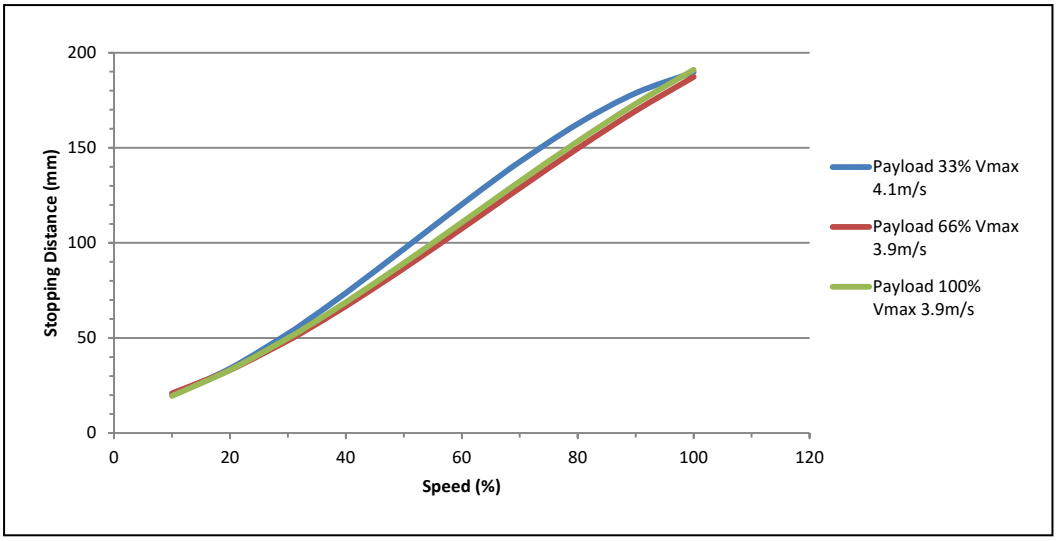


Figure 7-14. iX4-650H/iX4-650HS Z Stopping Distance with P34 Platform

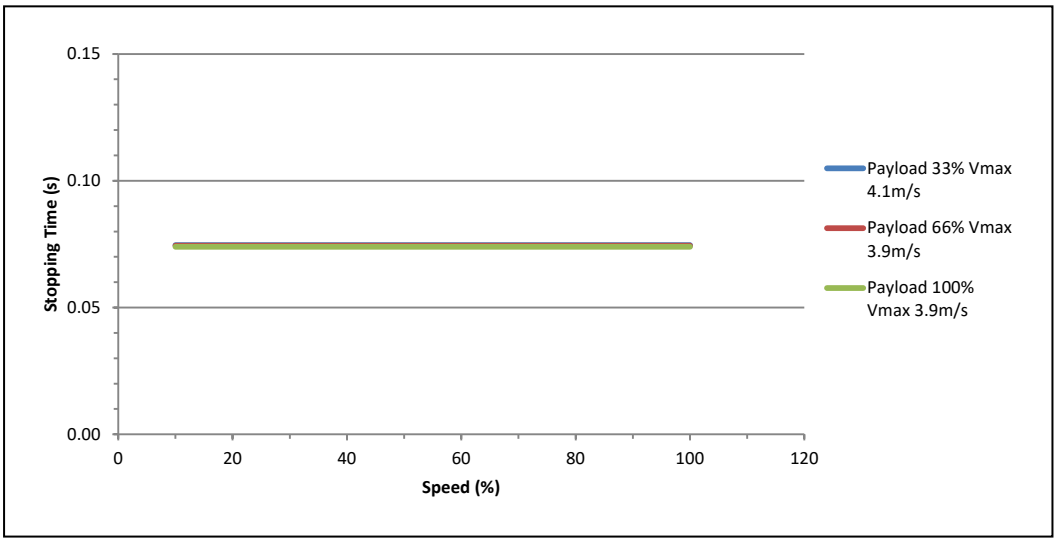


Figure 7-15. iX4-650H/iX4-650HS Z Stopping Time with P34 Platform

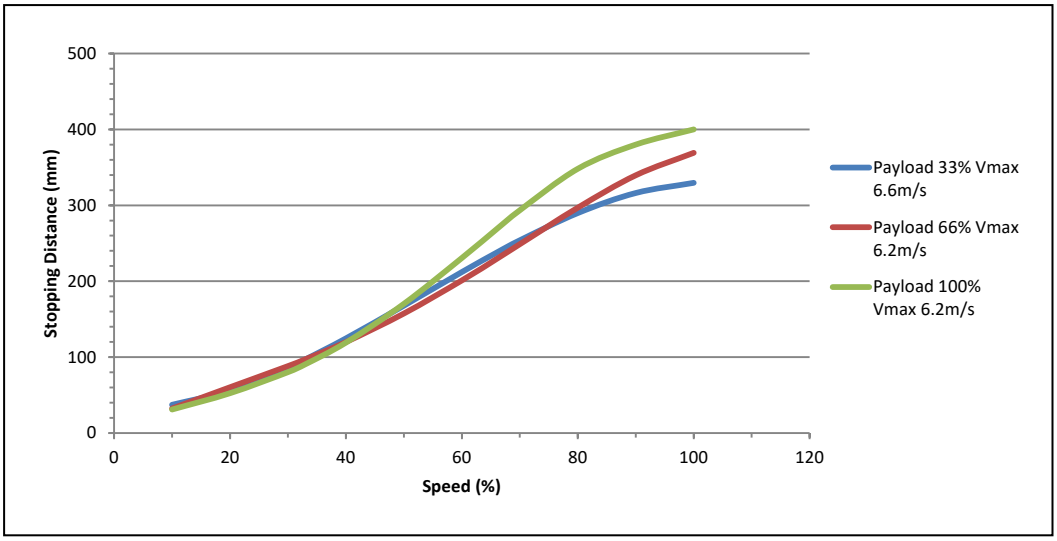


Figure 7-16. iX4-650H/iX4-650HS X Stopping Distance with P30 Platform

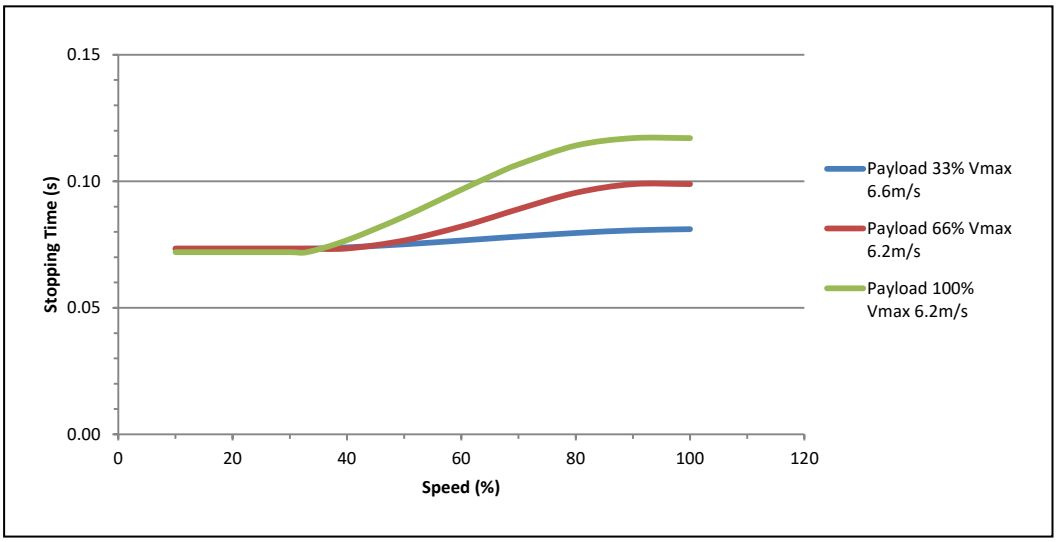


Figure 7-17. iX4-650H/iX4-650HS X Stopping Time with P30 Platform

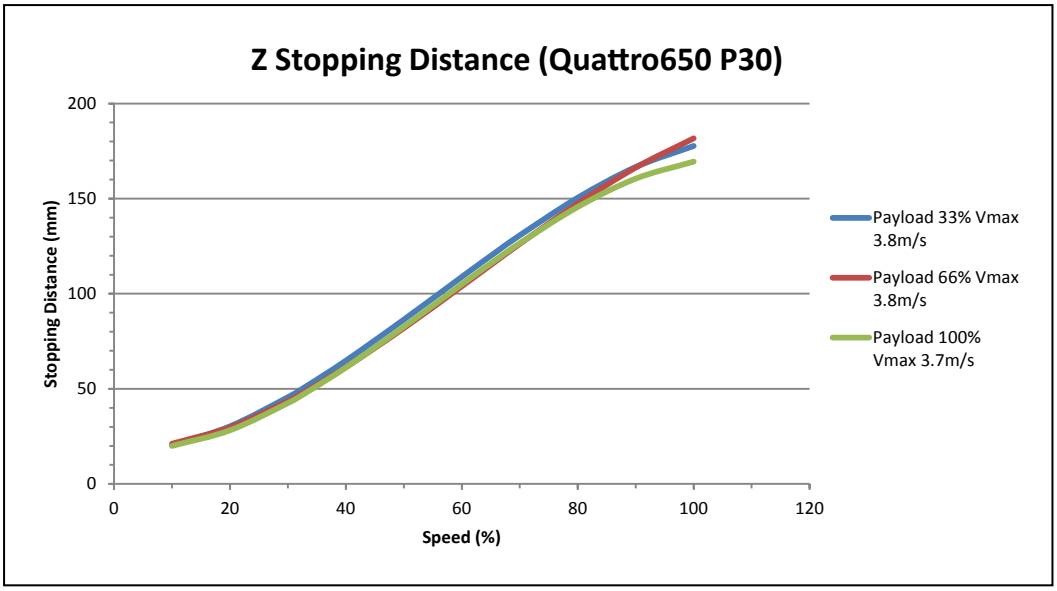


Figure 7-18. iX4-650H/iX4-650HS Z Stopping Distance with P30 Platform

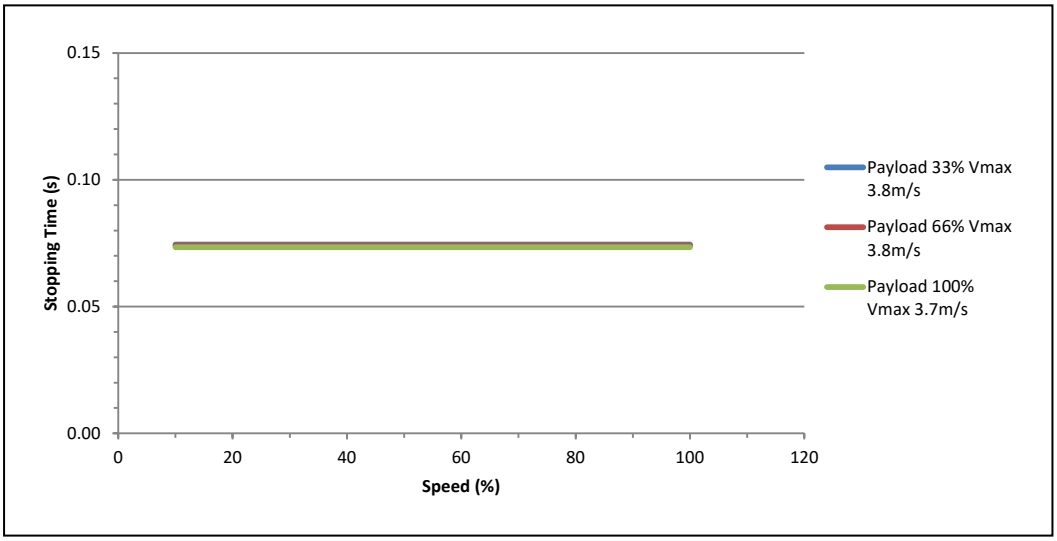


Figure 7-19. iX4-650H/iX4-650HS Z Stopping Time with P30 Platform

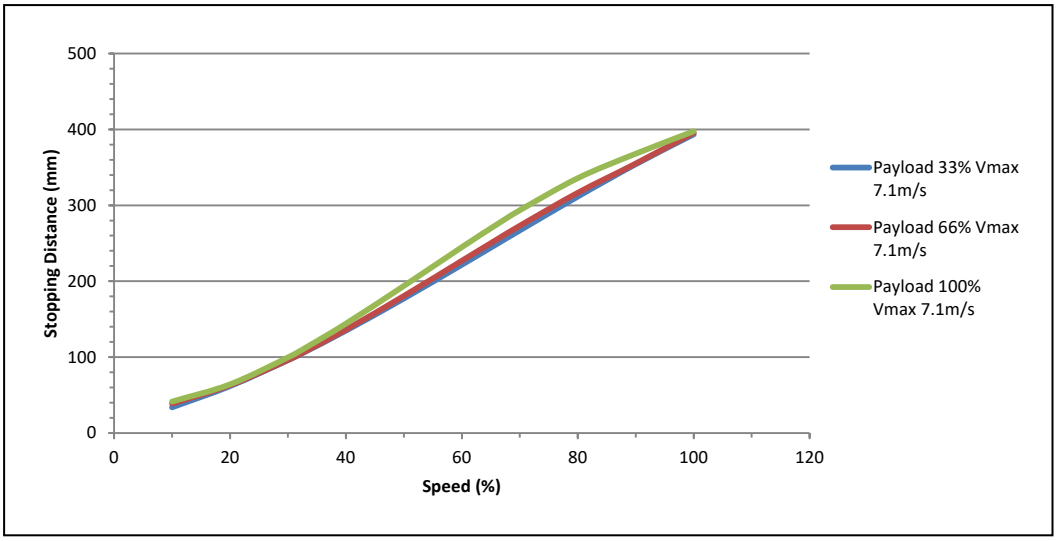


Figure 7-20. iX4-800H/iX4-800HS Stopping Distance with P34 Platform

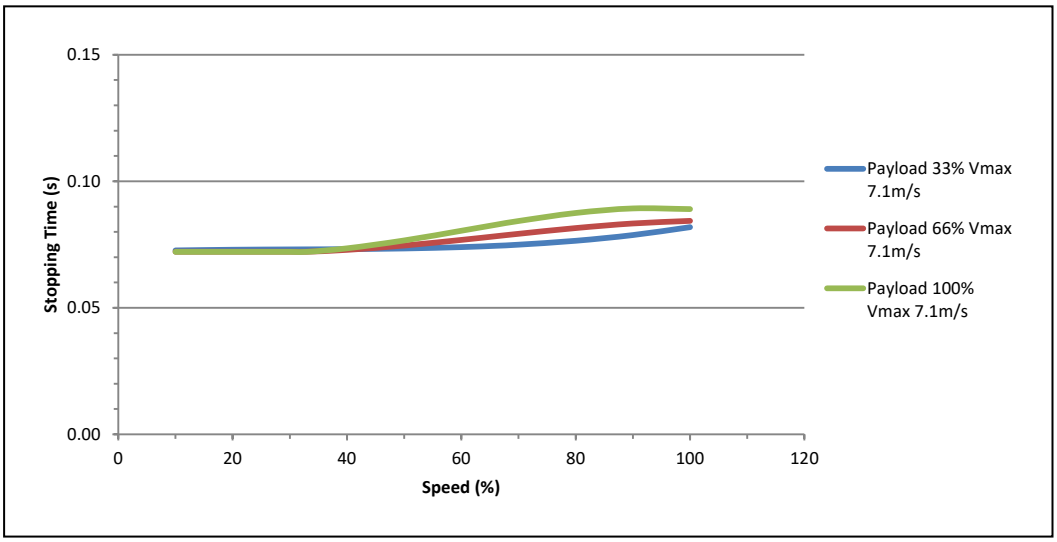


Figure 7-21. iX4-800H/iX4-800HS X Stopping Time with P34 Platform

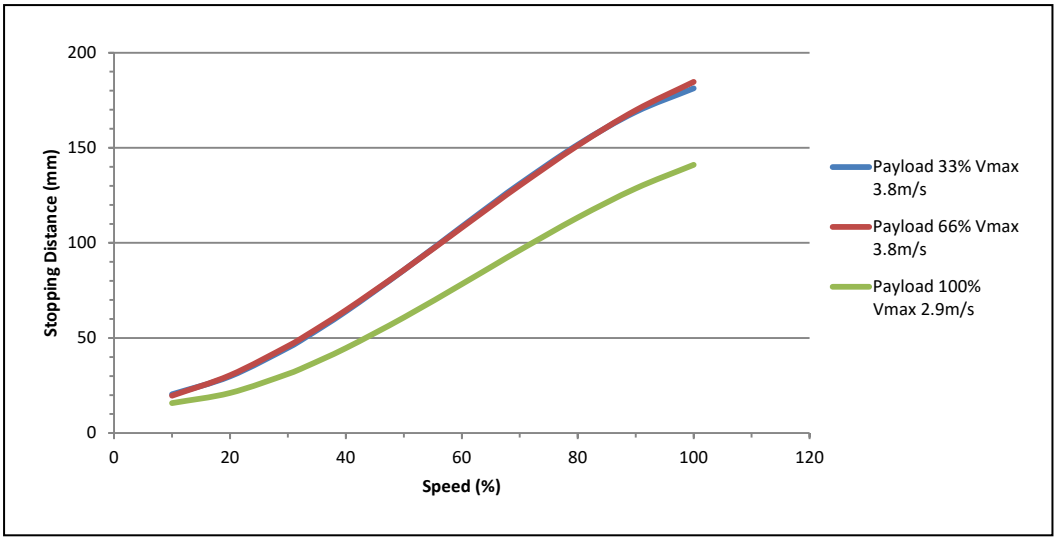


Figure 7-22. iX4-800H/iX4-800HS Z Stopping Distance with P34 Platform

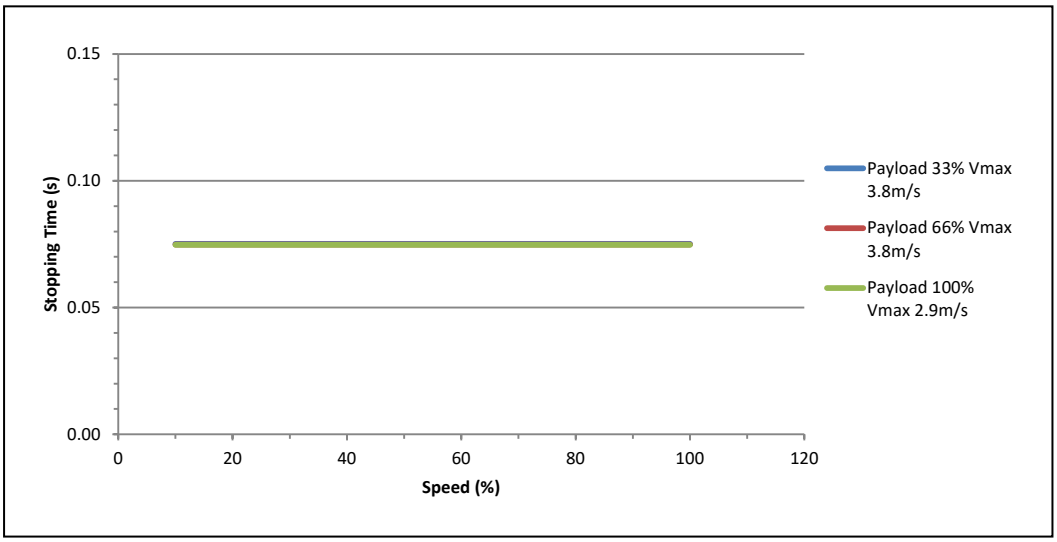


Figure 7-23. iX4-800H/iX4-800HS Z Stopping Time with P34 Platform

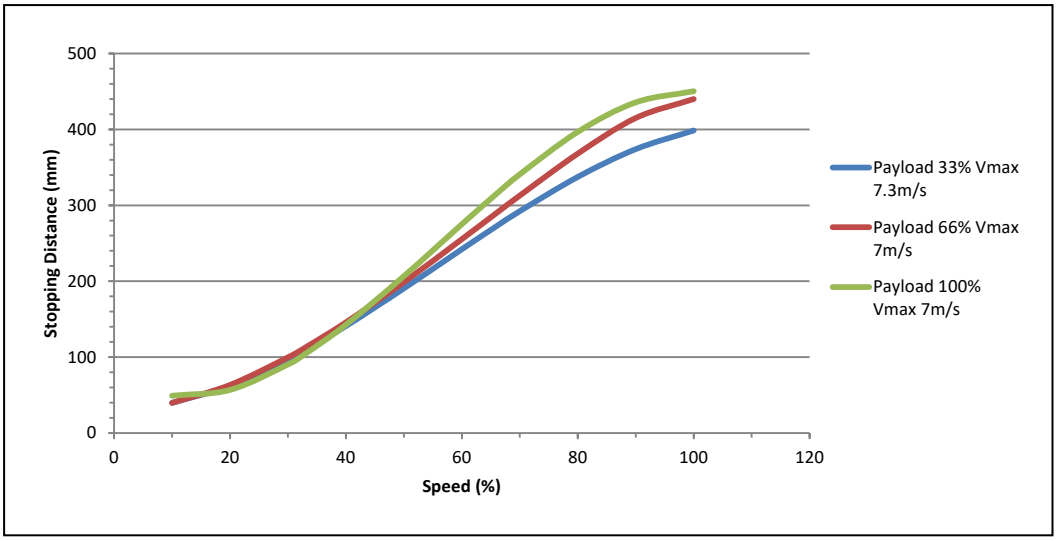


Figure 7-24. iX4-800H/iX4-800HS X Stopping Distance with P30 Platform

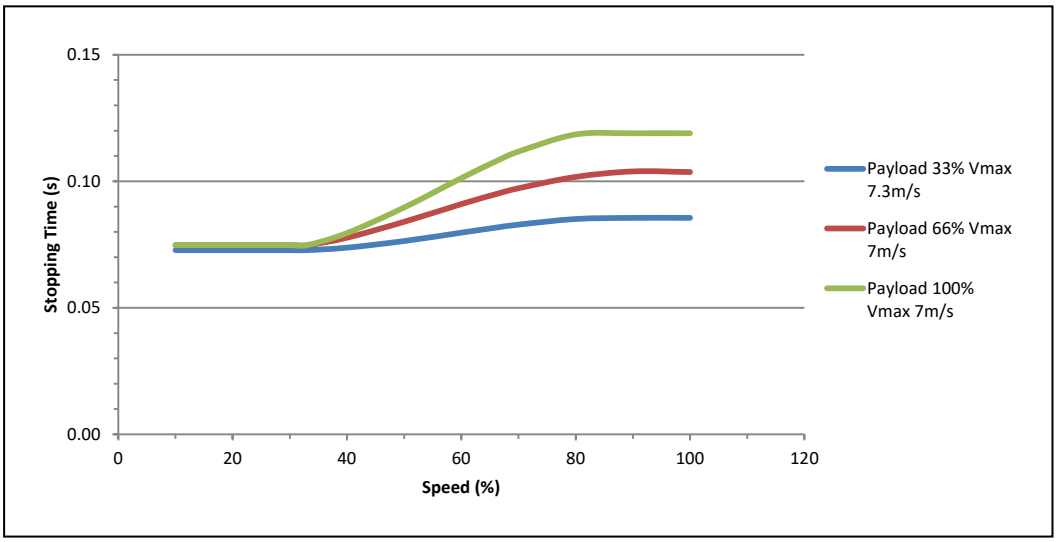


Figure 7-25. iX4-800H/iX4-800HS X Stopping Time with P30 Platform

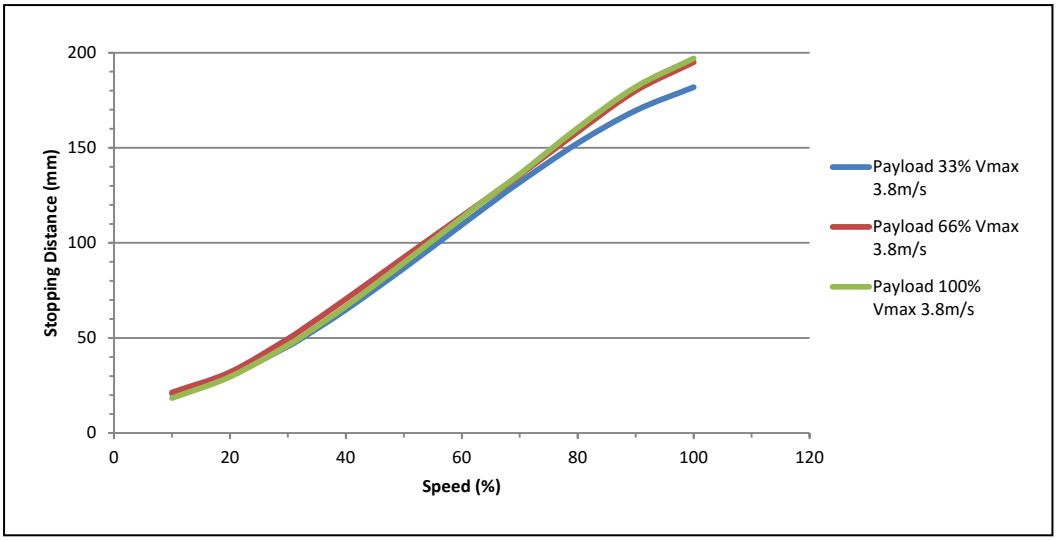


Figure 7-26. iX4-800H/iX4-800HS Z Stopping Distance with P30 Platform

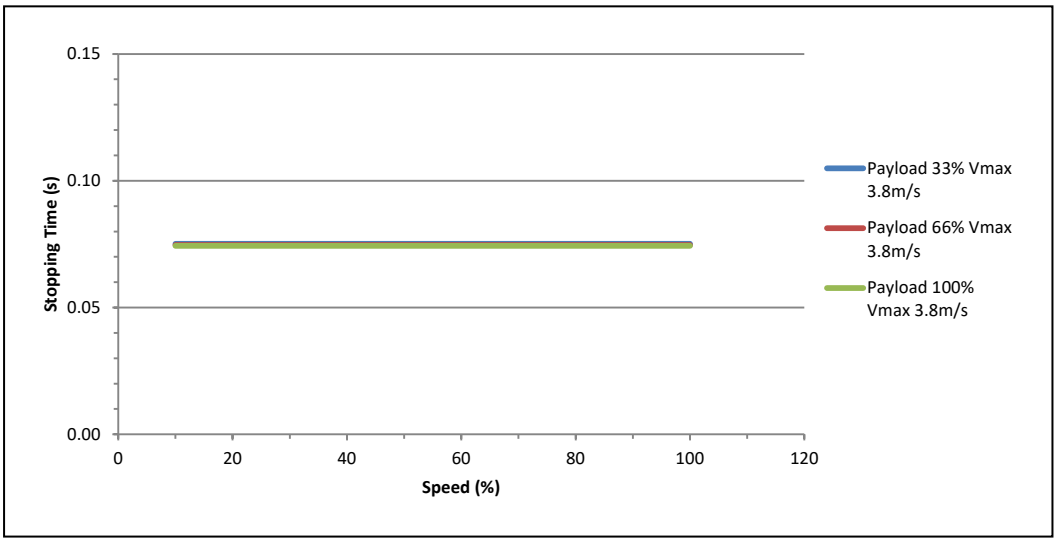


Figure 7-27. iX4-800H/iX4-800HS Z Stopping Time with P30 Platform

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 7-9. External Electrical Connection Specifications

Item	Specification	Details
24 VDC supply[1,3]	Voltage range	24 VDC ± 10%

Item	Specification	Details
		(21.6 VDC < V_{in} < 26.4 VDC)
	Circuit Protection	Output must be less than 300 W peak or provide 8 Amp in-line circuit protection
	Cabling	1.5 – 1.85 mm²
	Shielding	Braided shield connected to frame ground terminal at both ends of cable. Refer to Connecting the 24 VDC Cable to the Robot on page 79 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 83 for more information.
	Average Sustained Power	910 W
	Sustained RMS Current	4.5 A
	Peak Momentary Power	5390 W
General purpose electrical pass-through connections	Wire size	0.1 mm^2
	Maximum current	1 amp

Item	Specification	Details
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 current range, per channel	700 mA
	Maximum total current limit, all channels	1.0 A @ 50°C 1.5 A @ 25°C
	Maximum ON state resistance (I_{out} = 0.5 A)	0.32 Ω @ 85°C
	Maximum output leakage current	25 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	$I_{ovpk} \leq 4$ 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		

Item	Specification	Details
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.		

Table 7-10. Robot Power Consumption During

	Averaged Sustained Power (W)	Sustained RMS Current (A)	Peak Momentary Power (W)
25-700-25 mm cycle	830	4.0	5080
25-305-25 mm cycle	490	2.5	4640
Long Vertical Strokes	910 max.	4.5	5390

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 7-28. EtherCAT Communications Specification Description

Item	Specification
Synchronization	DC (Distributed Clock)
Physical Layer	100BASE-TX

Item	Specification
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 iX4 robot is designed to be mounted above the work area, suspended on 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. The drawings for a sample frame are provided here.

> **NOTE:** The design of the iX4-650HS/800HS robot mounting bolts and seals requires tight tolerances for the robot mounting holes in the frame. These should be 17.25 ±0.75 mm in diameter.
>
> **IMPORTANT:** Shimming the frame for a iX4-650HS/800HS robot will result in failure of the robot to comply with USDA requirements.

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

- 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.

> **NOTE:** 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 149 for more information.

The following are drawings of a frame suitable for supporting the iX4. This frame allows the robot to be either lowered from above or lifted up from underneath the frame for installation.

> **NOTE:** The example frame provided here was not designed to meet USDA standards. While most mechanical specifications are the same, you will have to make adjustments to comply with USDA requirements.
>
> This frame is designed to have the robot mounted to the underside of the frame mounting tabs.

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.
- Remove all burrs and sharp edges.
- Dimensions apply after process.
- Interpret drawings per ANSI Y14.5.
- Dimensional tolerances in the figures below:
    - 1 place decimals: ±2.5 mm
    - 2 place decimals: ±1.5 mm
    - 3 place decimals: ±0.75 mm
    - Angular dimensions: ±0 .5°

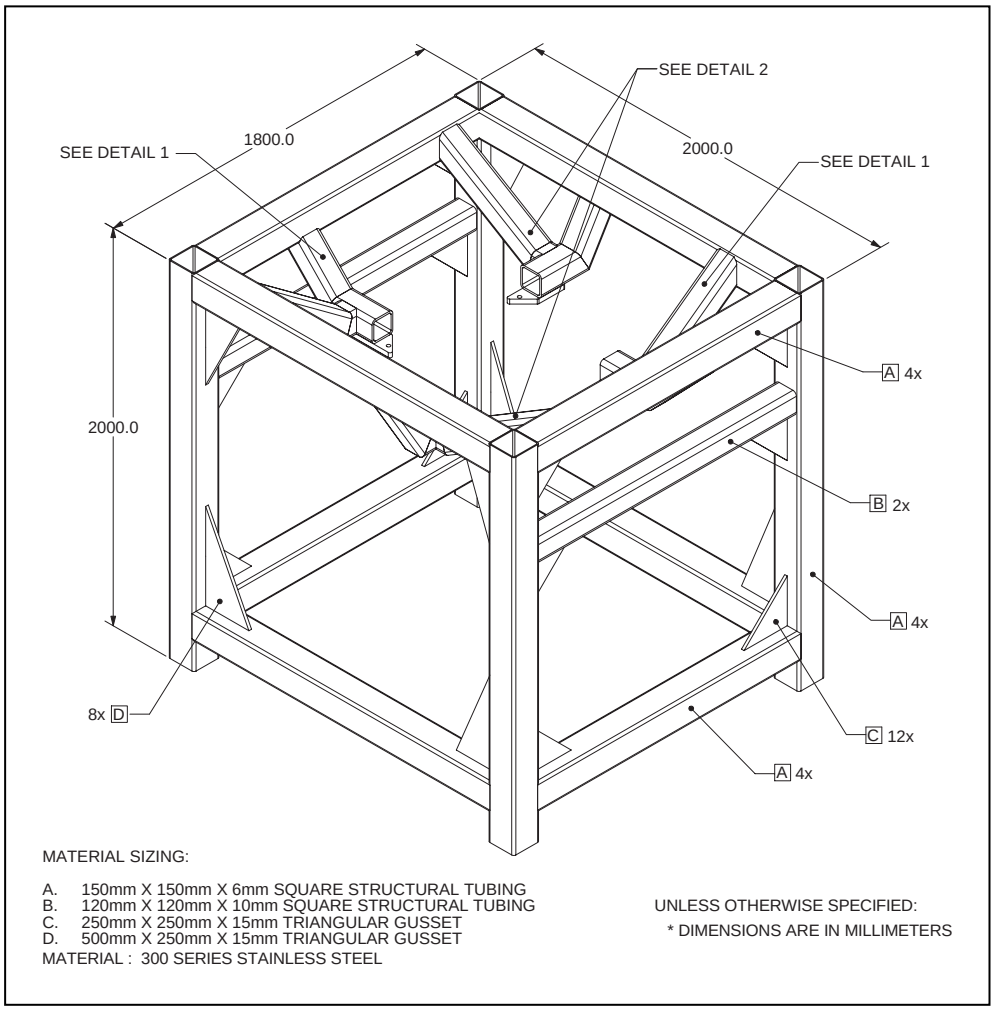


Figure 7-29. Mounting Frame, Orthogonal View

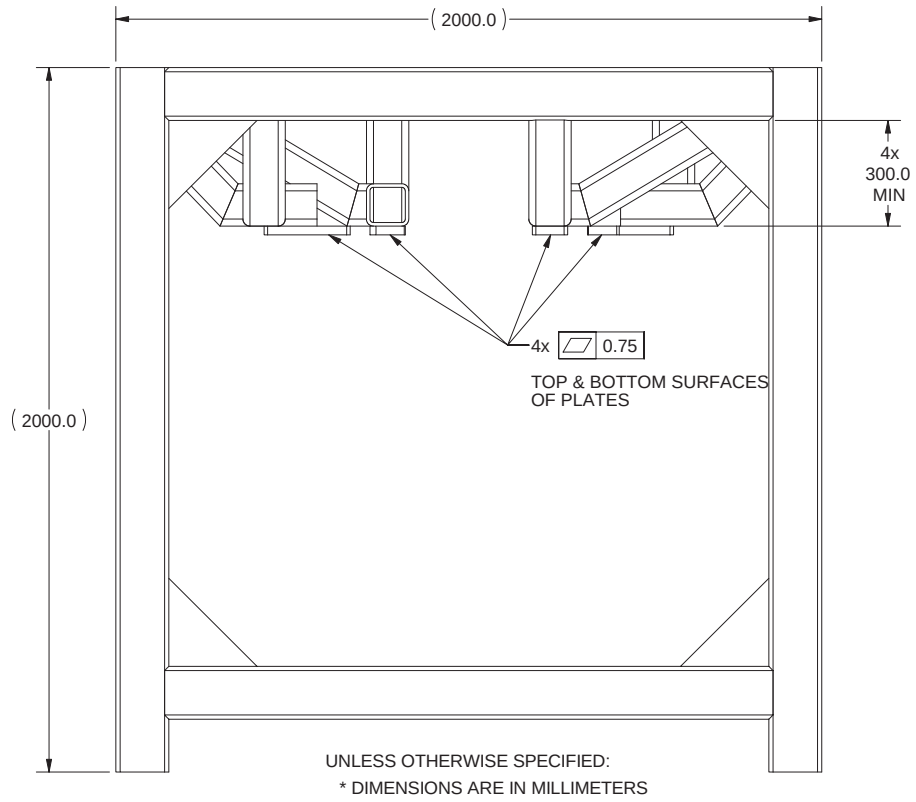


Figure 7-30. Mounting Frame, Side View 1

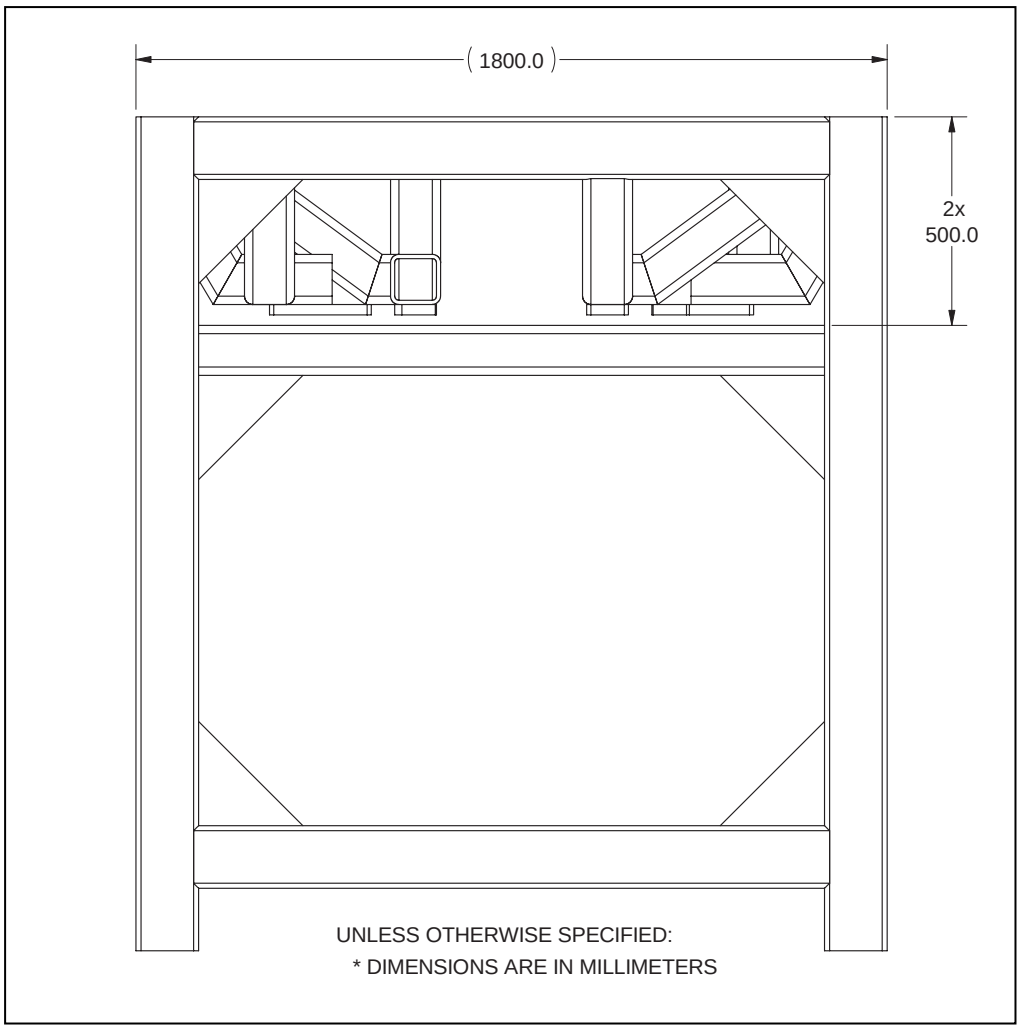


Figure 7-31. Mounting Frame, Side View 2

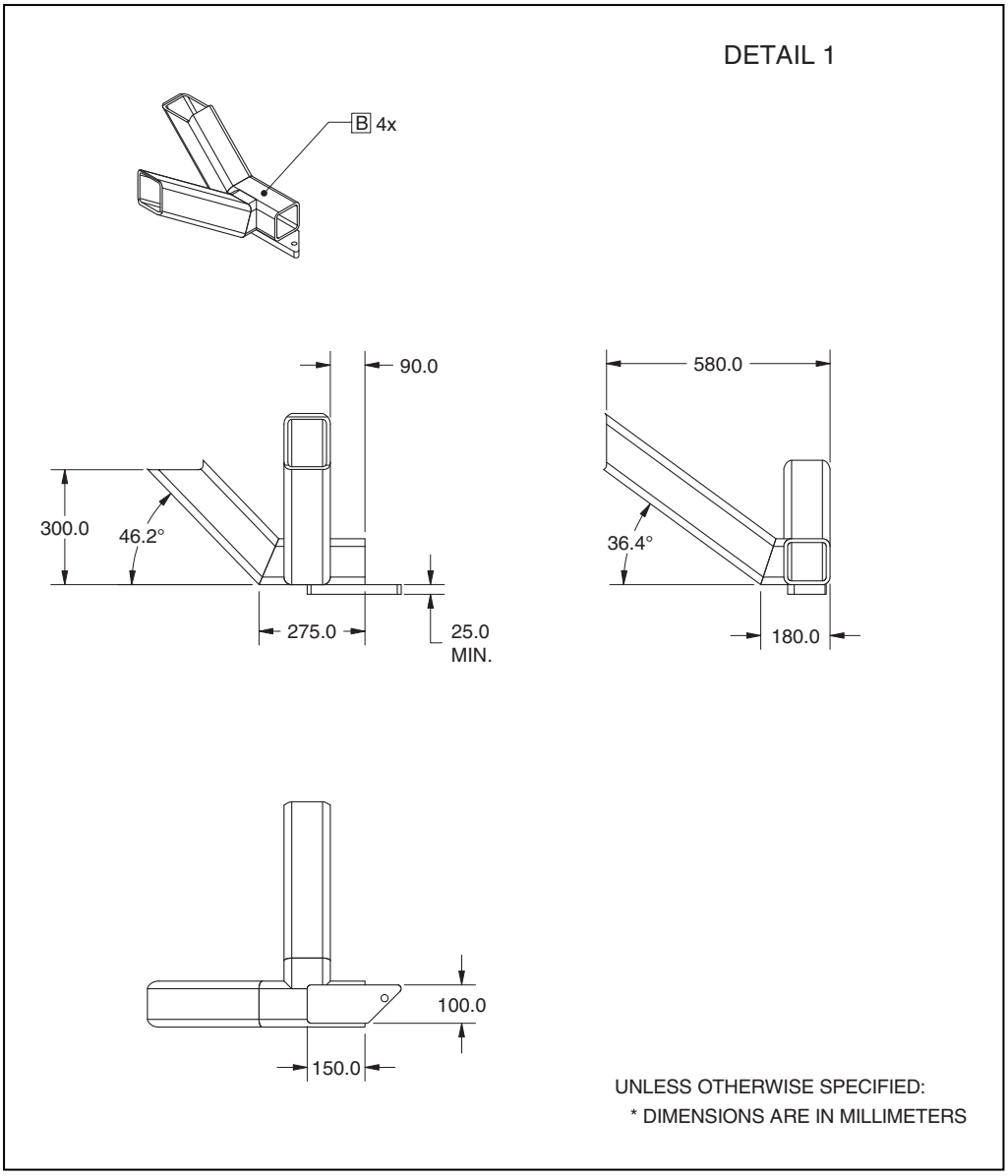


Figure 7-32. Mounting Frame, Detail 1

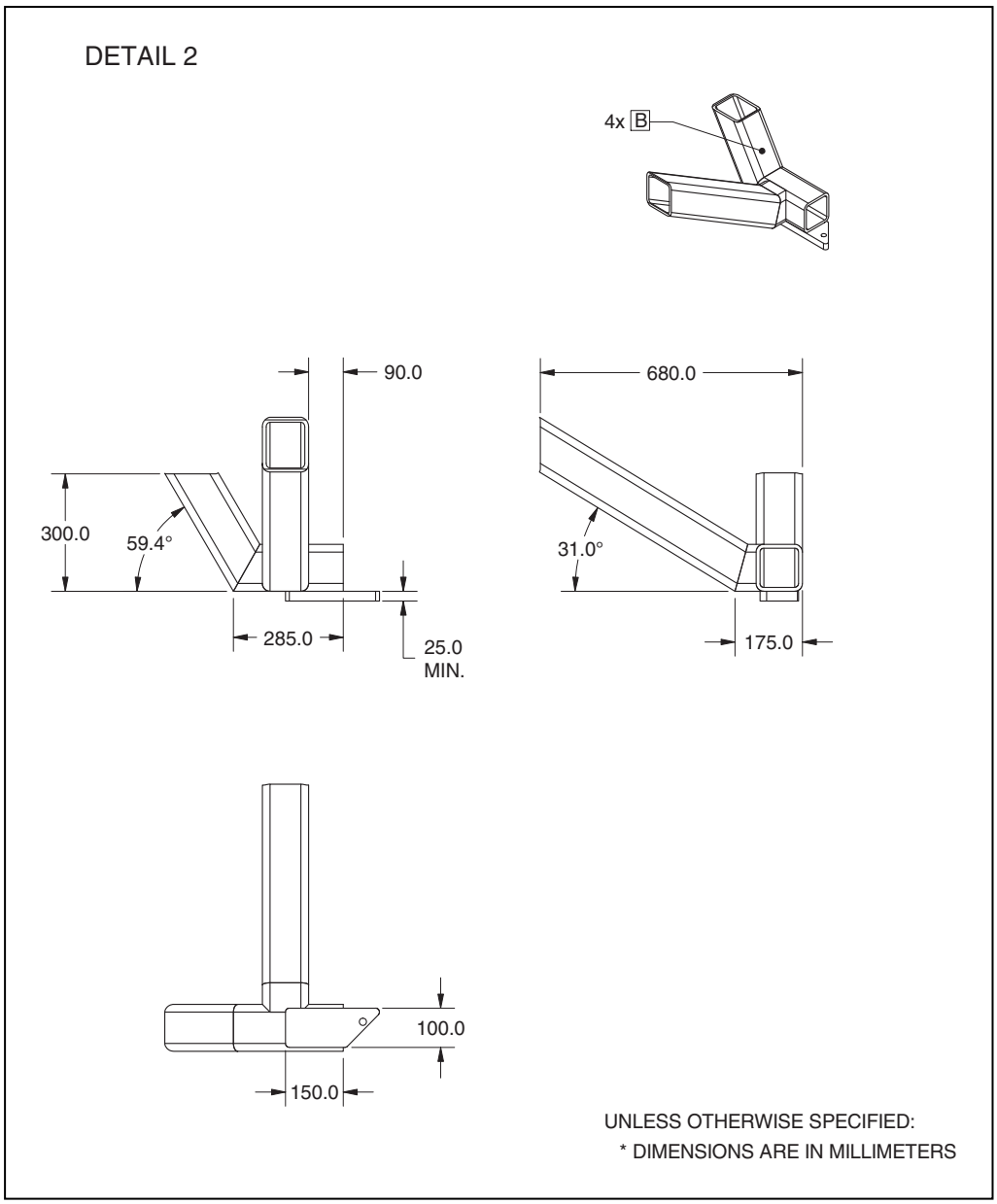


Figure 7-33. Mounting Frame, Detail 2

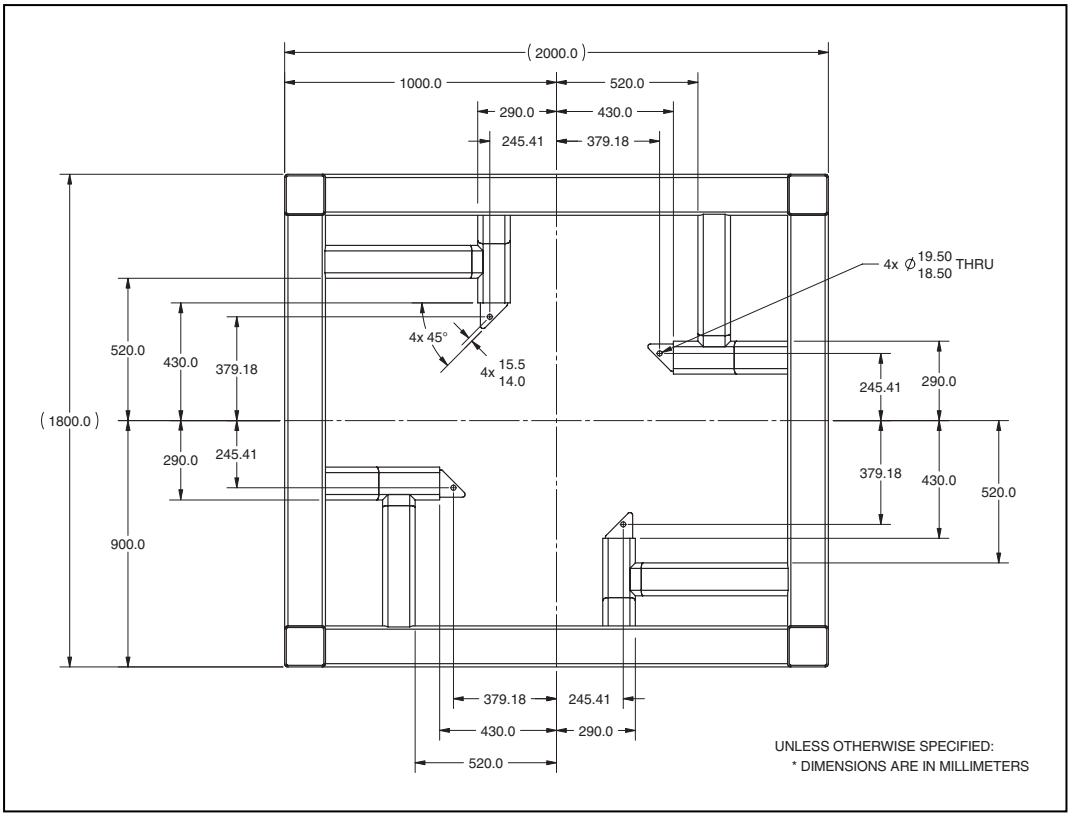


Figure 7-34. Mounting Frame, Top View

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 iX4-650H/800H robot base has an IP65 rating (with the optional cable sealing kit). The iX4-650HS/800HS robot has an IP66 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.

- 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 7-11. Weight Specifications

Item	Weight
Robot with no options installed	118 to 123 kg
Shipping Crate (empty)	75 kg

7.11 Power Connector Specifications

Power connector specifications are provided in the table below.

Table 7-12. 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 status display panel.

8.1 Status Display Panel

The status display panel shows 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.

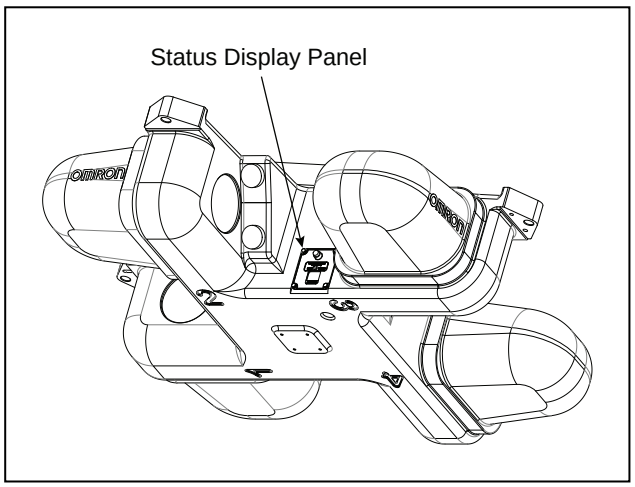


Figure 8-1. Status Display Panel

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

LED	Status Code	V+ Error Message	V+ Error Code	Explanation	User Action
				tery is low.	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 V+ 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.
F1	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 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

LED	Status Code	V+ Error Message	V+ Error Code	Explanation	User Action
					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 failure* Code 1	-1115	The power system has unexpectedly turned off power.	Contact your local OMRON support if the error persists.
P2	P2	*Power system failure* Code 2	-1115	Overvoltage in the high-voltage DC bus to the regenerative energy dump circuit.	Contact your local OMRON support.
P3	P3	*Power system failure* Code 3	-1115	The regenerative energy dump circuit has exceeded its max short-term dump rat-	Contact your local OMRON support.

LED	Status Code	V+ Error Message	V+ Error Code	Explanation	User Action
				ing.	
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.
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.	If the problem persists, contact your local

LED	Status Code	V+ Error Message	V+ Error Code	Explanation	User Action
				Normally, software sequences the shut-down before the time-out.	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 circuit (SRV_DIRECT / SRV_STAT).	Contact your local OMRON support.
TR	TR	*Safety System Not Commissioned*	-648	The Teach Restrict has not been commissioned and verified.	Commission and verify the Teach Restrict.
V'#	V#	*Hard envelope error* Mtr #	-1027	The indicated motor was not tracking the commanded position	Turn on high power and try to perform the motion at a

LED	Status Code	V+ Error Message	V+ Error Code	Explanation	User Action
				with sufficient accuracy as set by Sysmac Studio.	slower speed. Make sure that nothing is obstructing the robot's motion. If the error recurs, contact your local OMRON support.

Appendix

9.1 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 items received do not match the packing slip, or are damaged, do **not** sign the receipt. Contact your local OMRON representative as soon as possible.
- If the items received do not match your order, please contact your local OMRON representative immediately.

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

Unpacking Procedure

The iX4 robot is shipped in a crate that holds the robot base, outer arms, platform, controller, miscellaneous hardware, and any accessories ordered.

The top of the crate should be removed first.

Figure 9-1. Robot Base and Accessories in Crate

The robot base is shipped with the inner arms attached. The outer arms are assembled in pairs, packed in a cardboard box at the bottom of the crate. The platform is shipped fully assembled, but separate from the robot base and outer arms.

1. Remove the ancillary items (controller, outer arms, platform, etc.) that are in cardboard boxes and attached to the crate bottom.

Figure 9-2. Outer Arms

2. The robot base is secured to the crate with four machine bolts, one in each crate post.

Place a protective pad over the iCS-ECAT to protect it from damage from tools during the removal of the bolts.

3. Remove the bolts from each crate post.

Figure 9-3. Removal of Bolt

9.2 Repacking for Relocation

If you need to relocate the robot or other equipment, reverse the installation and unpacking 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.

9.3 Transportation and Storage

This equipment must be shipped and stored within the range –25 to +60° C. Humidity should be less than 75%, non-condensing. The robot should be shipped and stored in the supplied crate that is ASTM D4169-16 DC12 certified, and designed to prevent damage from normal shock and vibration. You should protect the crate from excessive shock and vibration.

Use a forklift, pallet jack, or similar device to transport and store the packaged equipment.

The robot must always be stored and shipped in an upright position in a clean, dry area that is free from condensation. Do not lay the crate on its side or any other non-upright position. This could damage the robot.

The iX4 weighs 85 kg with no options installed.

Base plate and arms weigh 5.9 to 11.6 kg depending upon ordered options.

The empty crate weighs 75 kg.

The crate dimensions are: 1160 x 1160 x 880 mm.

OMRON Corporation **Industrial Automation Company**

Kyoto, JAPAN

Contact: www.ia.omron.com

Regional Headquarters

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

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

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

OMRON 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:

Cat. No. I656-E-01 1220

22793-000 A