OMRON

Viper 650/850 Robot with EtherCAT

User's Manual

I654-E-02

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Table of Contents

Revision History

Revision code	Date	Revised Content
01	September, 2020	Original release
02	December, 2020	Correct eCS-ECAT dimensional drawing

Chapter 1: Introduction

This manual contains information that is necessary to install and use Viper 650 and 850 Robot with EtherCAT. Read this manual and make sure you understand the functionality, installation, and performance of the robot before attempting to use it.

Related Manuals

Use the following related manuals for reference.

Table 1-1. Related Manuals

Manual	Description
Robot Safety Guide (Cat. No. I590)	Contains safety information for OMRON industrial robots.
Sysmac Studio Robot Integrated System Building Function with Robot Integrated CPU Unit Operation Manual (Cat. No. W595)	Describes the operating procedures of the Sysmac Studio.
Sysmac Studio Robot Integrated System Building Function with IPC Application Controller Operation Manual (Cat. No. W621)	Describes the operating procedures of the IPC Application Controller.
eV+3 User's Manual (Cat. No. I651)	Provides a description of the eV+ programming language and functionality.
eV+3 Keyword Reference Manual (Cat. No. I652)	Provides reference to eV+ Keyword use and functionality.
Automation Control Environment (ACE) Version 4 User's Manual (Cat. No. I633)	Describes the installation and use of the ACE software.
NJ-series Robot Integrated CPU Unit User's Manual (Cat. No. O037)	Provides information that is necessary to use the robot control function of the NJ-series CPU Unit.
IPC Application Controller User's Manual (Cat. No. I632)	Provides information that is necessary to use the robot control function of the IPC Application Controller.
T20 Pendant User's Manual (Cat. No. I601)	Describes the use of the optional T20 manual control pendant.
IO Blox User's Guide (04638-000)	Describes the IO Blox product, its connections, and input/output signals.

1.1 Intended Audience

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

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

1.2 Robot Overview

The Viper 650 and Viper 850 robots are high-performance, six-axis articulated robots designed specifically for assembly applications. The speed and precision of the Viper robots also make them ideal for material handling, packaging, machine tending, and many other operations requiring fast and precise automation.

EtherCAT communications allow the robots to operate together with EtherCAT nodes, other Sysmac products, and the Sysmac Studio Automation Software to achieve optimum functionality and ease of operation.

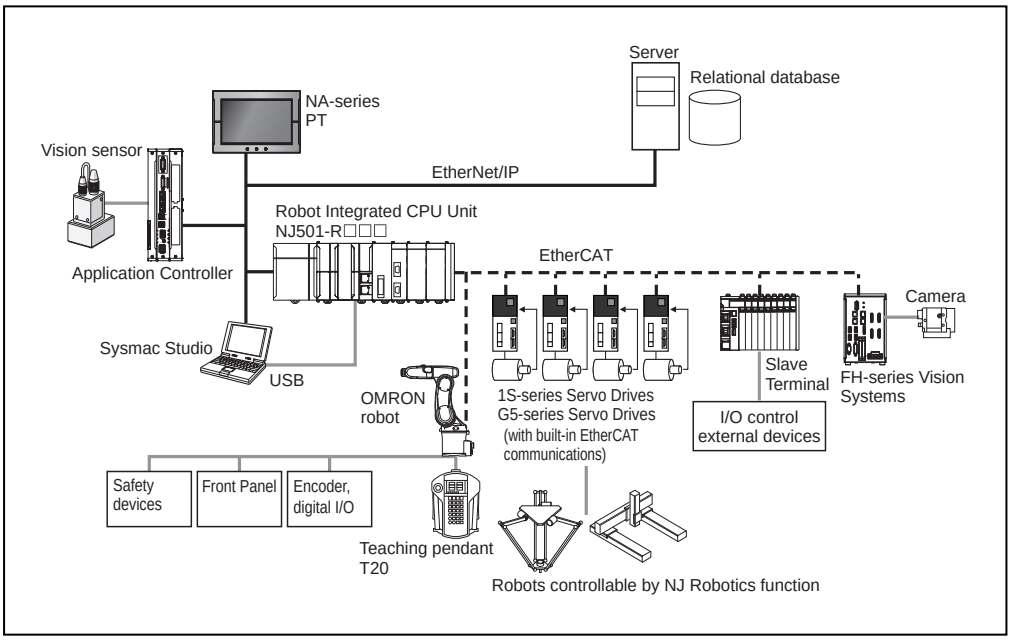


Figure 1-1. System Topology

These robots are offered with two different arm reaches to provide different working envelopes. The Viper 650 has a 650 mm radial reach and the Viper 850 has an 850 mm radial reach, measured from Joint 1 to Joint 5. Refer to Robot Physical Dimension Drawings on page 113

> **NOTE:** The descriptions and instructions in this manual apply to all Viper 650 and 850 Robot with EtherCAT. If there are differences based on type or options, this manual will provide details in the associated sections.

Robot Amplifier and Controller

The robot's amplifier and controller are contained in the External Control System, or eCS-ECAT.

The eCS-ECAT is a distributed servo controller and amplifier. It is designed with a dedicated digital signal processor to communicate, coordinate, and execute servo commands. The eV+ operating system runs on both the eCS-ECAT and the NJ-series Robot Integrated CPU Unit.

The eCS-ECAT contains power amplifiers, safety circuitry, and I/O as well as full trajectory, kinematic, and servo robot control hardware. The robot motors are powered by the eCS-ECAT amplifiers.

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

Figure 1-2. Viper 650 Robot

External Control System (eCS-ECAT)

This section is about the eCS-ECAT, which is a distributed servo controller and amplifier used with Viper robots. The eCS-ECAT has a dedicated microprocessor to communicate, coordinate, and execute servo commands. The eCS-ECAT unit receives eV+ commands from the NJ-series Robot Integrated CPU Unit and processes these commands to execute robots motions and other functions.

The eCS-ECAT contains the 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 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 eCS-ECAT Interface Panel on page 20 for more information.

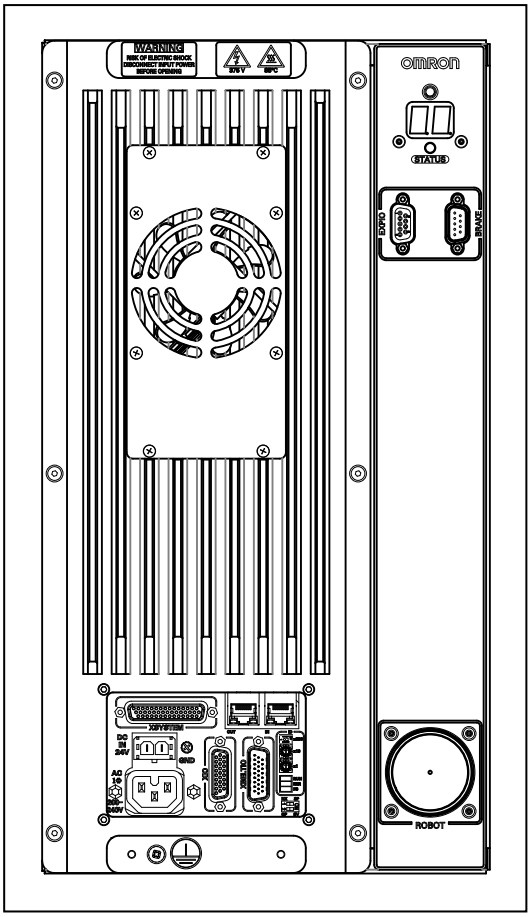


Figure 1-3. eCS-ECAT

eCS-ECAT Features

The eCS-ECAT unit has the following general features.

- EtherCAT communications, for distributed control by an NJ-series Robot Integrated CPU Unit.
- 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.
- 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.
- Power controller that uses single-phase AC power, 200-240 Volts.
- 2-digit alpha-numeric status panel to show operating status and fault codes.
- Expansion Input/Output (EXPIO) port

- BRAKE release port
- STATUS light

Connectors on eCS-ECAT Interface Panel

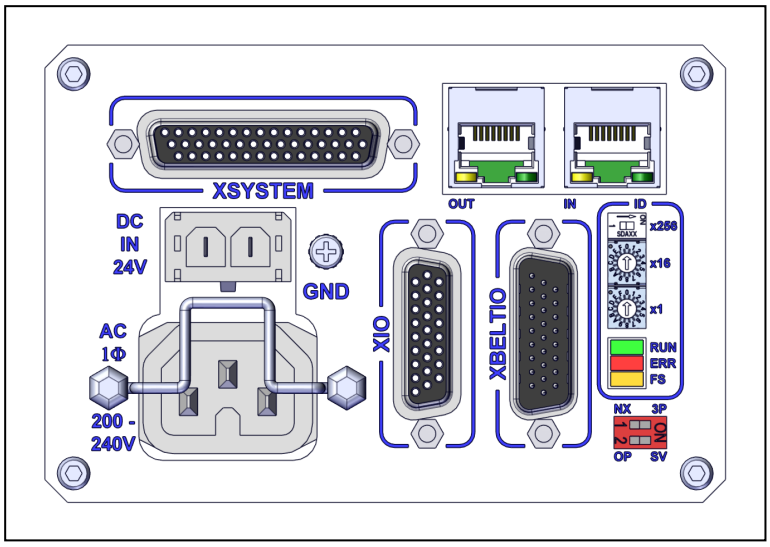


Figure 1-4. eCS-ECAT Interface Panel

Name	Meaning
XSYSTEM	Connects to the eAIB XSYSTEM cable. The mating connector is provided.
DC IN 24V	For user-supplied 24 VDC power. The mating connector is provided.
GND	Ground point for user-supplied 24 VDC cable.
AC 1Ø 200 - 240V	For 200-240 VAC, single-phase, input power. The mating connector is provided.
OUT and IN	EtherCAT Ports for connection to the EtherCAT network.
XIO	For user I/O signals for peripheral devices. Provides 8 outputs and 12 inputs. Refer to Connecting Digital I/O to the System on page 66 for connector pin allocations for inputs and outputs. That section also contains details on how to access these I/O signals. (DB-26, high density, female)
XBELTIO	Adds two belt encoders, EXPIO, and an RS-232 interface.
ID (x256, x16, x1)	Used to set the eCS-ECAT node ID. Refer to Setting the EtherCAT Node ID on page 54
ID (RUN, ERR, FS)	LEDs indicate the status of the EtherCAT connection. Refer to EtherCAT Communications Description on page 92.
NX/3P, OP/SV	Switches used to adjust the operating mode of the robot. Refer to Setting the EtherCAT Node ID on page 54 for more information.

Name	Meaning
	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.

IP54/65 and Cleanroom Versions

Viper robots are also available with options for IP54/65 or Class 10 Cleanroom ratings. These options provide additional protection from dust and fluid.

The following images show the IP54/65 version and the Cleanroom version.

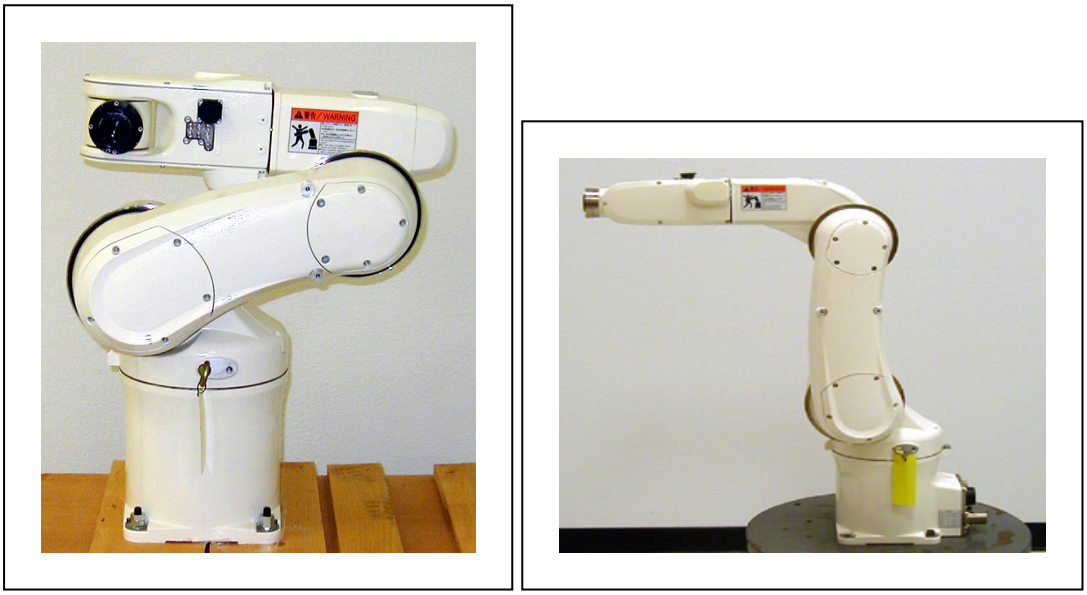


Figure 1-5. IP54/65 Version (left), Cleanroom Version (right)

Robot Features

The following table lists the various features and functionalities that are available.

Feature	Available
Vision Support	Yes
Local I/O (max. input / output, XIO + IO Blox)	76/72
XIO (max. input / output)	12/8
IO Blox (max. input / output, using 8 IO Blox)	64/64 total per robot[1]
Conveyor tracking encoder	Yes (2 max.)[2]
T20 Pendant option	Yes
IP54/65 option	Yes
Cleanroom option	Yes
Pass-through, J1 to J4	7 air lines, 10 user electrical contacts

Feature	Available
[1] Requires XBELTIO Cable for 2nd group of 4 units. [2] Requires XBELTIO Cable.	

Robot Links and Joints

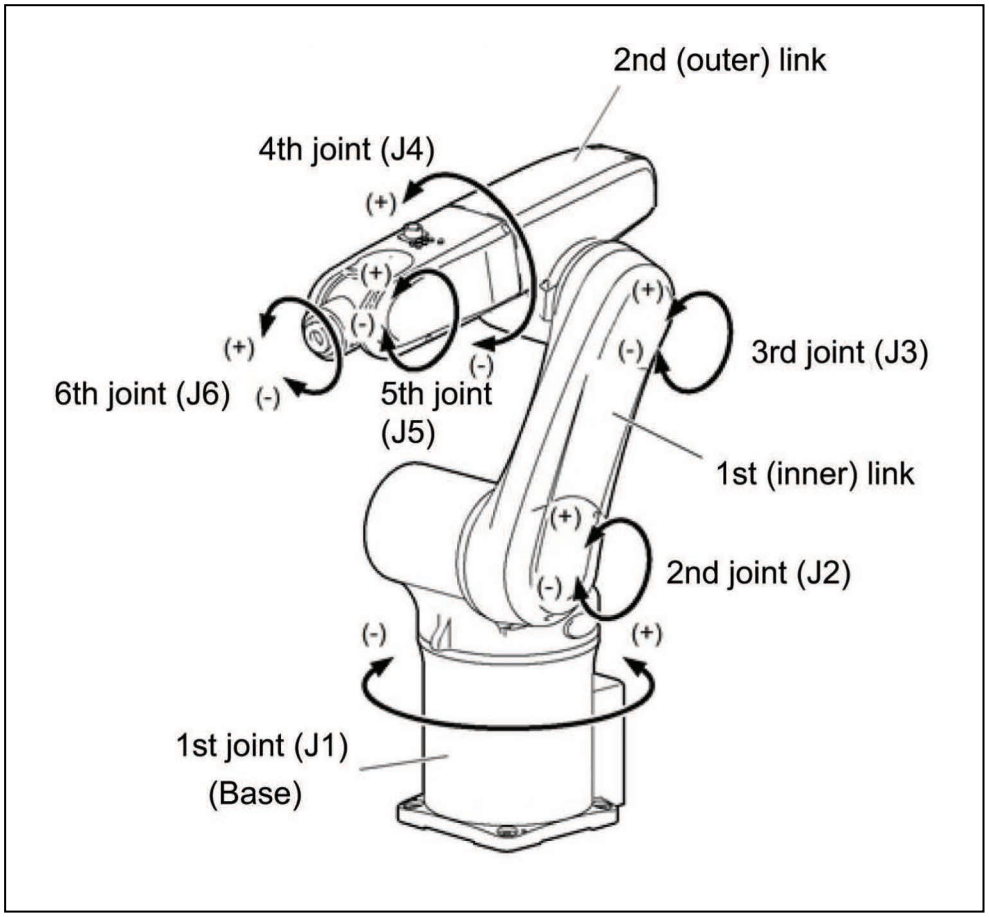


Figure 1-6. Robot Joints and Links

Robot Connections

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

> **NOTE:** Some connections may differ on robots with the IP54/65 or Cleanroom options. Refer to IP54/65 Option Considerations on page 135 and Cleanroom Option Considerations on page 137 for more information.

The external connections include:

- Pneumatic pass-through ports
- Electrical pass-through connections

Pneumatic Pass-through Ports

The pneumatic pass-through ports on the back of the robot connector panel are typically used for end-effector control. Internal air lines are routed through the robot to another set of matching connectors on the top of the outer link (link 2) as shown below.

Additional Information: Refer to Technical Specifications on page 113 for more information.

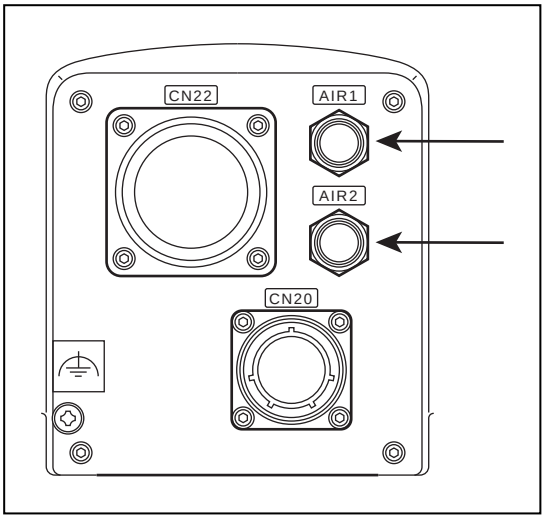


Figure 1-7. Robot Air Connections (arrows)

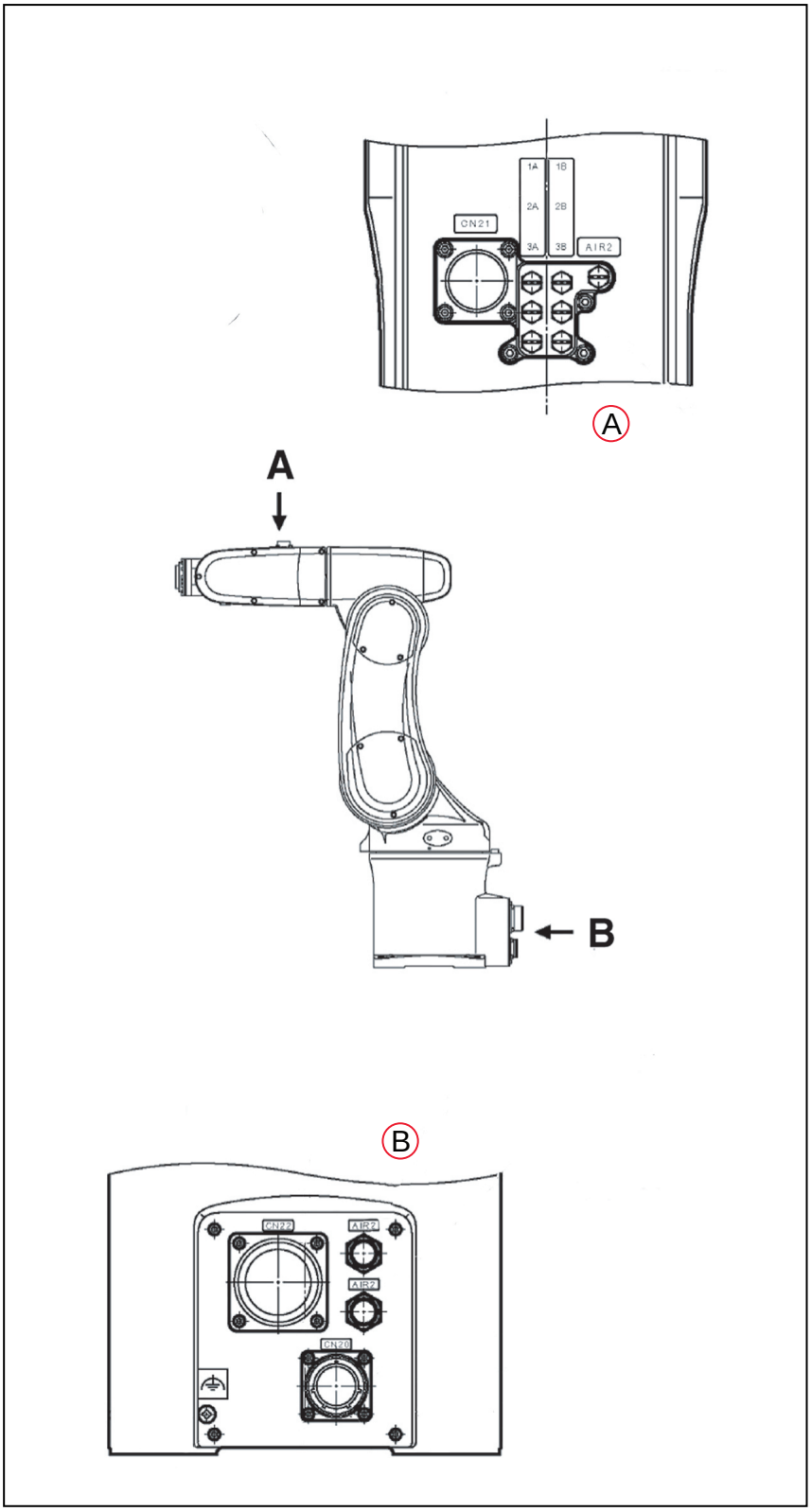


Figure 1-8. Pneumatic Pass-through Ports from (B) Base to (A) Outer Link

Electrical Pass-through Connections

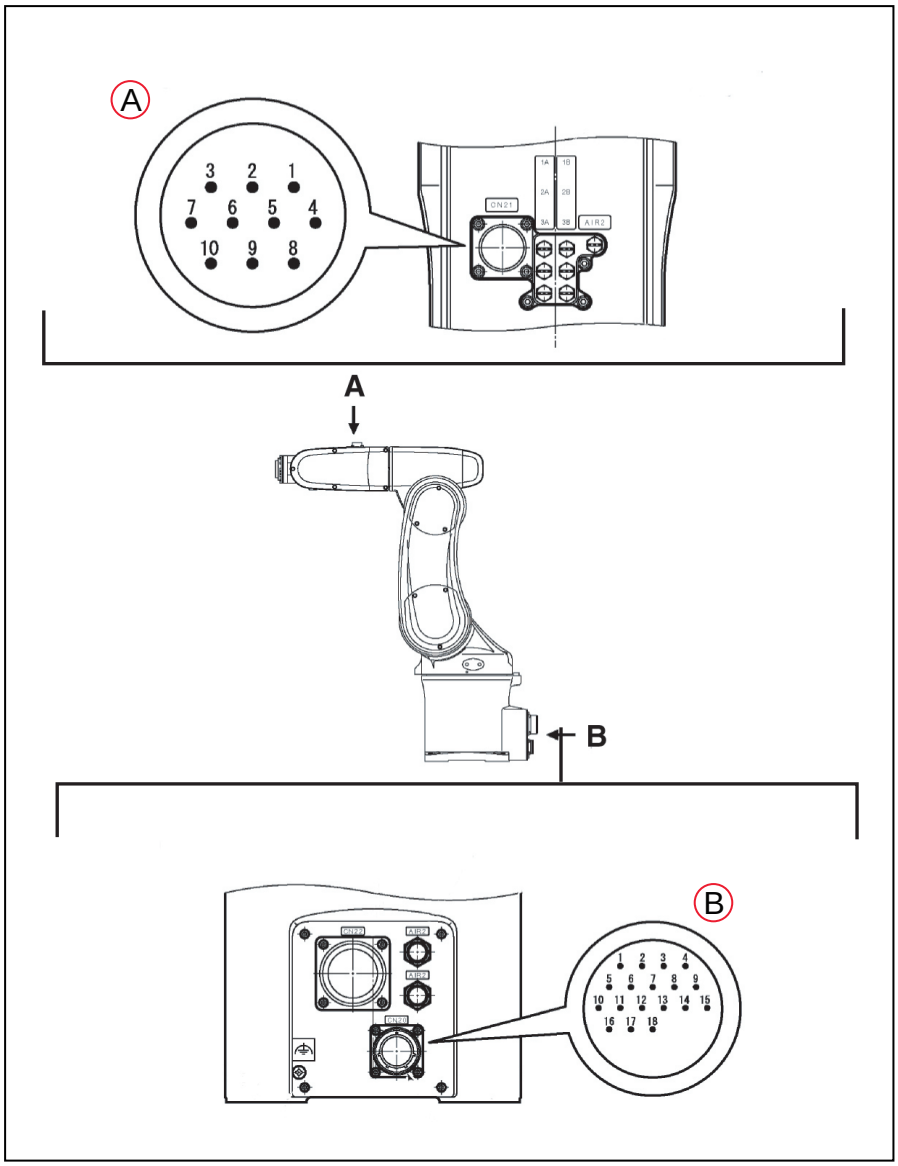


Figure 1-9. Signal Wiring from (B) Robot Base to (A) Outer Link

eCS-ECAT Interface Panel

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

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

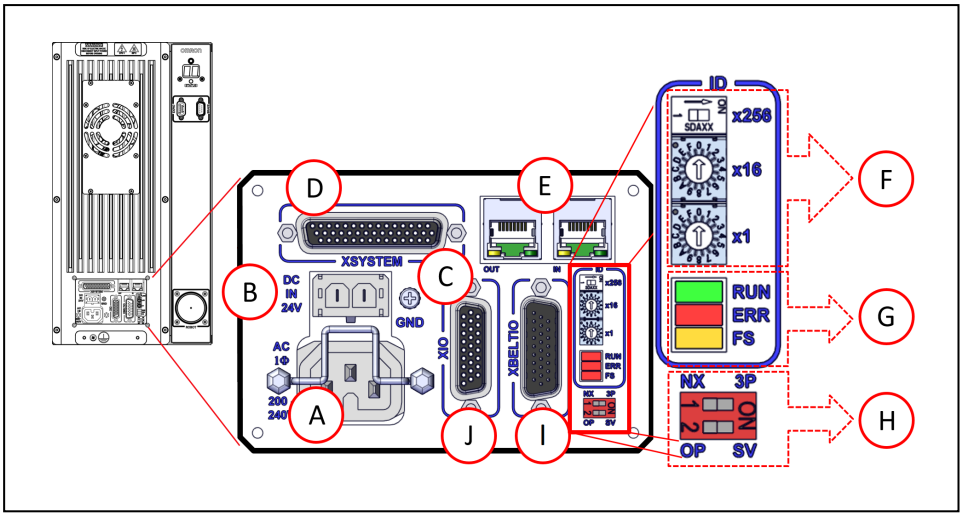


Figure 1-10. eCS-ECAT Interface Panel

Item	Meaning
A	AC Power Supply Connection Used for connecting 200-240 VAC, single-phase input power to the eCS-ECAT. A connector is provided with the robot. Refer to Connecting 200-240 VAC Power Cable on page 80
B	DC Power Supply Connection Used for connecting the user-supplied 24 VDC power to the eCS-ECAT. A connector is provided with the robot. Refer to Connecting the 24 VDC Cable to the eCS-ECAT on page 77 for more information.
C	Ground Terminal
D	XSYSTEM Connection Refer to System Cable Installation on page 59
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 54
G	LEDs Indicates the status of the EtherCAT connection. Refer to EtherCAT Communications Description on page 92 for more information.
H	Two 2-Position Mode Switches Used to adjust the operating mode of the robot.

Item	Meaning
	Refer to Robot Control Modes on page 95 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 Connection Used to connect up to two external belt encoders and IO Blox external I/O module. This requires the XBELTIO Adapter cable. Refer to Basic System Cable Layout on page 59 for more information.
J	XIO Connection Used for user I/O signals for peripheral devices. Refer to Basic System Cable Layout on page 59 for more information.

1.3 Robot Options

This section describes the various options available for a Viper robot.

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

IO Blox

The eCS-ECAT provides an interface to add IO Blox expansion I/O modules to a robot.

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

> **NOTE:** Refer to Connecting Digital I/O to the System on page 66 and the *IO Blox User's Guide (04638-000)* for more information.

You can add up to 8 IO Blox units.

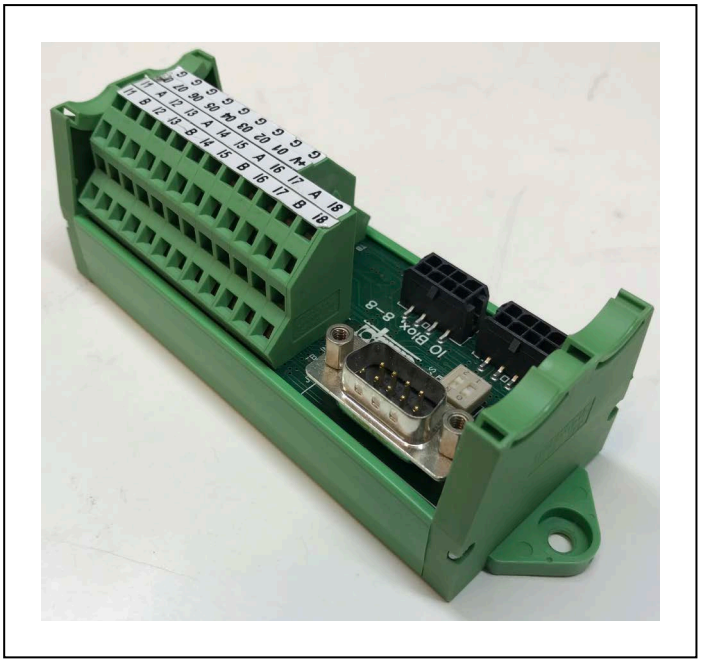


Figure 1-11. IO Blox

T20 Pendant

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

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

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

Figure 1-12. T20 Pendant

IPC Application Controller

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

Refer to the following manuals for more information.

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

Figure 1-13. 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 95 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 97 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 indicator 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 front panel. 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).

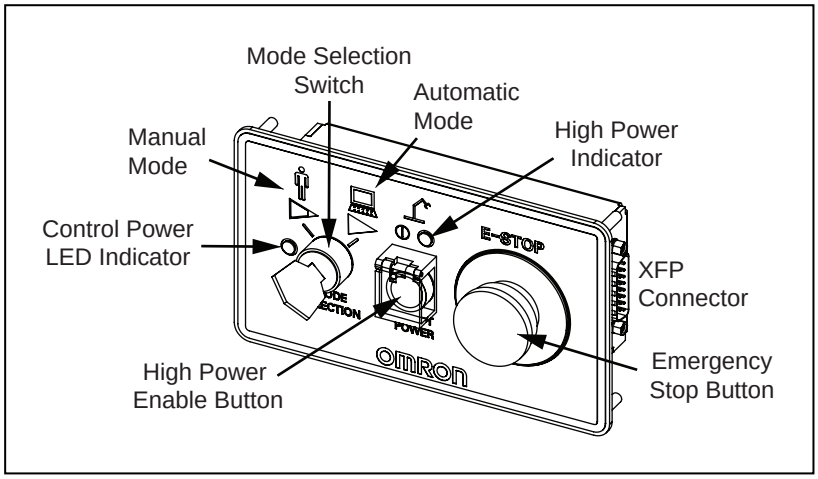


Figure 1-14. Front Panel

- XFP connector

  Connects to the XFP connector on the XSYSTEM Adapter Cable.

- Control Power LED Indicator

  Indicates whether the robot is receiving power.

- Manual Mode

  The system limits robot speed and torque so that an operator can safely work near the robot. Manual mode initiates hardware and software limits to robot speed at no more than 250 mm/s.

  There is no high speed motion available in Manual mode.

  WARNING: PERSONAL INJURY RISK
  If an operator is going to be in the work cell with the switch in Manual mode, the operator must carry an enabling device such as the T20 pendant.

  WARNING: PERSONAL INJURY RISK
  Whenever possible, perform manual mode operations with all personnel outside the workspace.

- Automatic mode

Software programs control the robot allowing operation at full speed.

DANGER: PERSONAL INJURY RISK
In Automatic mode, the robot can move unexpectedly. Ensure all personnel remain clear of the cell when Automatic mode is enabled.

- High Power Enable Button

  Controls high power, which is the flow of current to the robot motors. You can enable high power by pressing and releasing the High Power button twice: After one press, the High Power ON/OFF lamp will start blinking. The second press and release of the button enables high power.

WARNING: PERSONAL INJURY RISK
Disabling the High Power button violates IEC 60204-1. Do not alter its use.

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

- High Power Indicator

  This lamp is on when high power is enabled.

- Emergency Stop Button

  A dual-channel, passive E-Stop that supports Category 3 CE safety requirements. Pressing this button turns OFF high power to the robot motors.

NOTE: The Front Panel is required to enable power to the robot. To operate without a Front Panel, you must supply the equivalent circuits.

- Mode Selection Switch

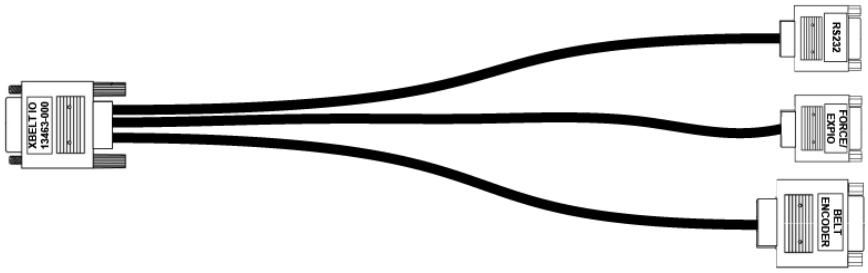
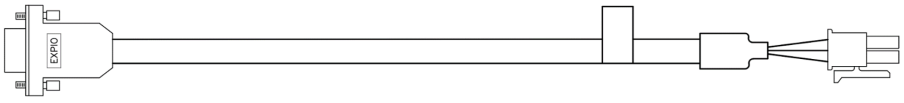
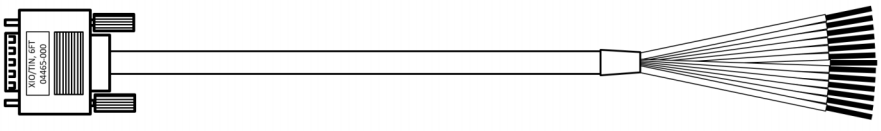
  Switches between Manual and Automatic mode (figure shown in Manual Mode).

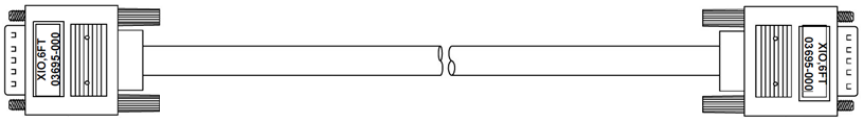
Optional Cables

The following table provides details about optional cables.

Table 1-2. Optional Cables

P/N	Description
13463-000	XBELT I/O Adapter Cable (0.6 m) The optional XBELT IO Adapter cable splits the XBELTIO port on the interface panel into a belt encoder branch, an IO Blox branch, and an RS-232 branch.

P/N	Description
	 **NOTE:** You can use the FORCE / EXPIO connector on this cable to connect a 2nd group of up to 4 IO Blox devices. For details on the pinouts for this cable, refer to Pinouts for XBELT IO Adapter on page 64.
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 63.
04677-000	EXPIO-to-IOBlox Cable (3 m) This optional cable is used to connect IO Blox devices to either eCS-ECAT EXPIO connector. This applies to the DB9 connection on the chassis EXPIO near the BRAKE connector, and to the FORCE/EXPIO connector branch on the XBELTIO cable.  **NOTE:** For details on connecting IO Blox units to your system, refer to IO Blox Connections on page 66.
04465-000	XIO/TIN (Breakout) Cable (5 m) This optional cable connects to the XIO connector on the eCS-ECAT 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 Ter-

P/N	Description
	mination Block. **Additional Information**: Refer to XIO Breakout Cable Pinout on page 28 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 eCS-ECAT interface panel. For addtional details, refer to XIO Termination Block on page 67. 

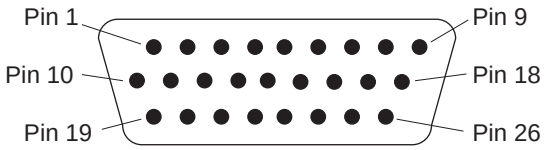
XIO Breakout Cable Pinout

The XIO Breakout cable pinouts are provided below.

Table 1-3. 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

Pin No.	Signal Designation	Wire Color
19	Output 1	Pink
20	Output 2	Pink/Black
21	Output 3	Light Blue
22	Output 4	Light Blue/Black
23	Output 5	Light Green
24	Output 6	Light Green/Black
25	Output 7	White/Red
26	Output 8	White/Blue
Shell		Shield



Chapter 2: Safety

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

2.1 Dangers, Warnings, and Cautions

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

Alert Levels

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

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

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

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

Alert Icons

Each alert consists of a standard warning triangle icon, a signal word, and a description of the risk. In increasing severity, the signals words are: Caution, Warning, and Danger. The alert text provides a description of the hazard and explains how you can prevent or avoid it.

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

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

Special Information

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

IMPORTANT: Information to ensure safe use of the product.

NOTE: Information for more effective use of the product.

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

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

2.2 Safety Precautions

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

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

- If you install, operate, teach, program, or maintain the system, you must read this guide, read the *Robot Safety Guide (Cat. No. I590)*, and complete a training course for your responsibilities in regard to the robot.

Figure 2-1. Read Manual and Impact Warning Labels

- All personnel who design the robot system must read this guide, read the *Robot Safety Guide*, and must comply with all local and national safety regulations for the location in which the robot is installed.
- Never use the robot system for purposes other than described in Intended Use of the Robot on page 34. Contact your local OMRON support if you are not sure of the suitability for your application.

- You are responsible for providing safety barriers around the robot to prevent anyone from accidentally coming into contact with the robot when it is in motion.
- You must lock out and tag out power to the robot and its power supply before performing any maintenance.

2.3 What To Do In An Emergency

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

Stopping the Robot

Press any E-Stop button (a red push-button on a yellow background) and then follow the internal procedures of your company or organization for an emergency situation.

Fire Response

If a fire occurs, use CO_2 fire extinguisher to extinguish the fire.

Entrapment and Brake Release Box

In case of entrapment of a person by the robot, or any other emergency or abnormal situation, an optional Brake Release box, which plugs into the eCS-ECAT just below the Robot Status Display, allows you to manually position the robot arms without enabling high power. When 24 VDC system power is ON, this box allows the user to select and release the brake on one joint. This allows movement of the robot at that joint, and therefore all of the robot from that joint outward.

There is no brake on Joint 1.

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

2.4 Robot Behavior

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

Hardstops

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

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

The robot's hardstops can stop the robot at any speed, load, and maximum or minimum extension.

Limiting Devices

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

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

Singularities

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

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

NOTE: There are no singularities for joint-interpolated move commands. This means that a joint-interpolated move command can be used to get out of a singularity encountered in another type of command.

2.5 Intended Use of the Robot

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

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

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

These robots are for use in parts assembly and material handling for payloads up to 5 kg. See Technical Specifications on page 113 for complete specifications. Refer to the *Robot Safety Guide (Cat. No. I590)* for details on the intended use of OMRON robots.

Never use these robots in the following situations.

- In the presence of ionizing or non-ionizing radiation
- In hazardous environments with explosive gas or oil mist
- In medical or life-saving applications
- In residential applications
- Where there are any acidic, alkaline, or other corrosive gases
- Where there is sulfuric or other types of cutting or grinding oil
- Where there are any large-sized inverters, high output/high frequency transmitters, large contractors, welders, or other sources of electrical noise
- Where there are shavings from metal processing, or other conductive material, being produced
- Where it may be directly exposed to water, oil, or cutting chips
- Without performing a risk assessment

NOTE: Any machining oil used around the robot must be compatible with NBR (nitrile) and a polyurethane resin paint.

2.6 Additional Safety Information

OMRON provides other sources for more safety information:

Manufacturer's Declarations

This lists all standards with which the robot complies. The Manufacturer's Declarations for your robot and other products are in the *Manufacturer's Declarations Guide (part number 18305-000)*.

Robot Safety Guide

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

T20 Pendant (Option)

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

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

NOTE: OMRON does not offer a wireless pendant.

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

2.7 Disposal

Dispose of in accordance with applicable regulations.

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

2.8 How Can I Get Help?

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

http://www.ia.omron.com

Chapter 3: Robot Installation

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

3.1 Robot Installation Overview

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

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

IMPORTANT: Prior to installing the robot, unpack and inspect the equipment. Refer to Unpacking and Inspecting the Equipment on page 151 for more information.

Refer to Appendix on page 151 for details on transporting the robot.

Basic Installation Steps

Step	Task	Reference
1	Mount the robot.	Mounting a Viper Robot on page 37
2	Install the Front Panel.	Installing the Front Panel on page 41
3	Install user-supplied safety equipment.	Installing User-Supplied Safety Equipment on page 45
4	Set the EtherCAT Node Address.	Setting the EtherCAT Node ID on page 54
5	Make robot system cable connections.	System Cable Installation on page 59
6	Install any robot optional hardware.	Optional Equipment Installation on page 87
7	Verify the installation.	Verifying Installation on page 89

3.2 Mounting a Viper Robot

This section describes the mounting procedure for the Viper robot.

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

Mounting Surface

Mount the Viper robot on a smooth, flat surface that is rigid enough to prevent vibration and flexing during robot operation. OMRON recommends a 25 mm thick steel plate mounted to a

rigid tube frame. The Viper robot can be mounted upright (table or floor) or upside-down from the ceiling.

The following figure shows the mounting hole pattern. The underside of the base has a slot and hole for locating points for the pins in the mounting surface. Using locating pins allows you to remove and reinstall the robot in the same position.

IMPORTANT: Excessive vibration or mounting flexure degrades robot performance.

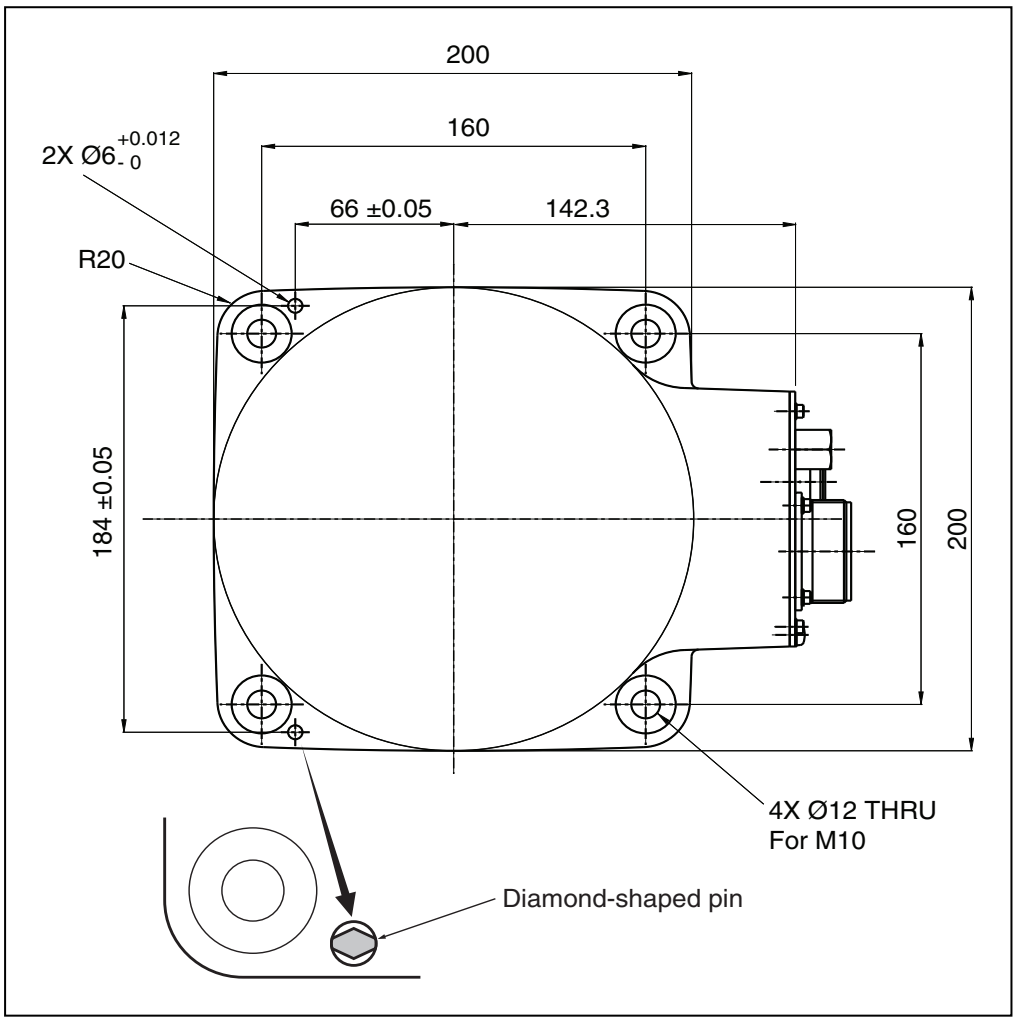


Figure 3-1. Mounting Hole Pattern for Viper Robot (units in mm)

Mounting Surface Preparation

Use the following procedure to prepare the robot mounting surface.

1. Using the dimensions in the previous figure, drill the mounting surface for four user-supplied machine bolts
    - These can either be tapped for M10, at least 20 mm deep, or you can drill 12 mm thru-holes, and use nuts on the other side of the mounting surface.

- Drill a dowel pin hole Ø4 mm, H7 for the diamond-shaped pin, 10 mm deep or more.

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

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

2. Locate two alignment pins, one round and one diamond-shaped, supplied as part of the robot bundle.
3. Drive the diamond-shaped pin into one Ø6, H7 hole in the robot base so that it is oriented as shown in the preceding figure.
4. Drive the internally threaded alignment pin into the other Ø6, H7 hole in the robot base.

   NOTE: Be sure to use the alignment pins. It can minimize positional deviations that may be caused by the removal/installation of the robot for maintenance and reduce vibration during operation.

Mounting Procedure for Upright Viper

Use the following procedure to mount the robot.

1. While the robot is still bolted to the transportation pallet, connect a crane or hydraulic lift to the eyebolts at the top of the base. Refer to the following figure.

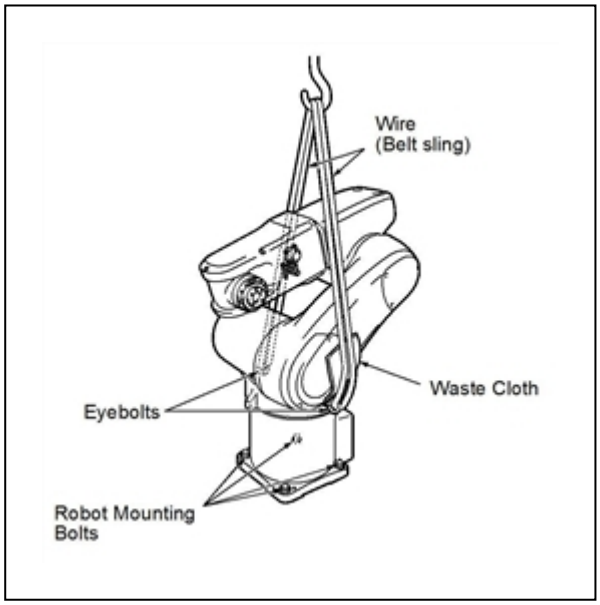


Figure 3-2. Robot in Hoisting Sling

PERSONAL INJURY OR PROPERTY DAMAGE RISK
Do not attempt to lift the robot at any points other than the eyebolts provided. Do not attempt to extend the robot's links until the robot has been secured in position. Failure to comply could result in the robot falling and causing either personnel injury or equipment damage.

2. Remove the four bolts securing the robot base to the pallet.

   Retain these bolts for possible later relocation of the equipment.

3. Lift the robot and position it directly over the mounting surface.

WARNING: PERSONAL INJURY OR EQUIPMENT DAMAGE RISK
Always use at least two people when lifting the robot. Do not attempt to extend robot arm until you have firmly secured the robot in position. Failure to comply could result in the robot falling and causing either personnel injury or equipment damage.

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

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

5. To eliminate the risk of toppling, screw in one bolt, finger-tight.
6. Verify that the robot's base is squarely mounted (cannot rock back and forth) before inserting and tightening the remaining mounting bolts.
7. Install the user-supplied mounting bolts and washers. Tighten bolts to the torque specified in Robot Mounting Torque on page 41.

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

Mounting Procedure for Ceiling Mount

- Mounting should be handled by at least two people, while wearing safety shoes, gloves, safety goggles, a helmet, etc., for ensuring safety.
- Ensure a sufficient work space around the mounting place.
- When hoisting the robot unit, use a lift or crane with sufficient capacity.
- Make a jig designed to turn the robot upside-down safely.
- Check places where there is a potential danger of getting hands or body caught between the robot unit and the surroundings if you hoist the robot unit or turn it to the mounting position, then remove the danger beforehand.
- Do not stay under a hoisted robot.

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

1. Screw in bolts, finger-tight.
2. Verify that the robot's base is squarely mounted (cannot rock back and forth) before tightening the mounting bolts.
3. Install the user-supplied mounting bolts and washers. Tighten bolts to the torque specified in Robot Mounting Torque on page 41.

Robot Mounting Torque

Table 3-1. Torque Specifications for Mounting Bolts

Standard	Size	Specification	Torque
Metric	M10	ISO Property Class 12.9	85 N·m

For threaded M10 holes, use plain washers and 30 mm M10 bolts.

For 12 mm thru holes, use plain and lock washers on both sides.

NOTE: Check the mounting bolts one week after initial installation, and then recheck every 6 months. See Maintenance on page 101 for periodic maintenance.

3.3 Mounting the eCS-ECAT

Dimensions and mounting holes for the eCS-ECAT are presented in Figure 8-6. Clearances needed for cooling are presented in Robot Physical Dimension Drawings on page 113

NOTE: 112 mm clearance is required in front of the unit to remove the amplifier from the eCS-ECAT enclosure.

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

Surface	Air Gap
Top and Sides	50 mm
Back	0 mm
The following two dimensions are from the front of the heat sink.	
Front, when wall-mounted	112 mm
Front, when flat-mounted	200 mm

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

3.4 Installing the Front Panel

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

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

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

Additional Information: Refer to Front Panel Dimensions on page 132 for more information.

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.

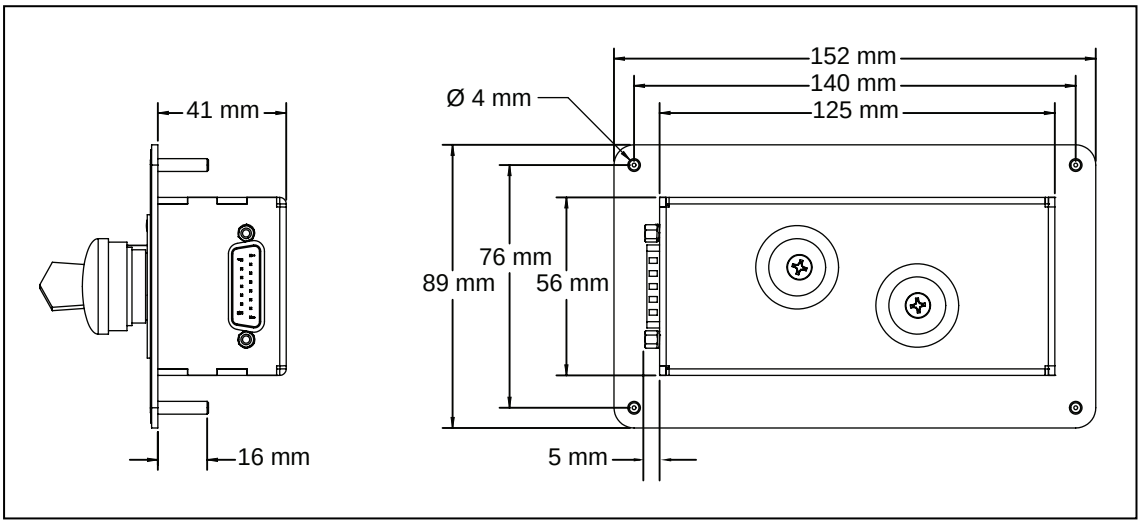


Figure 3-3. Front Panel Dimensions

Connecting the Front Panel

You connect the Front Panel to the Front Panel cable.

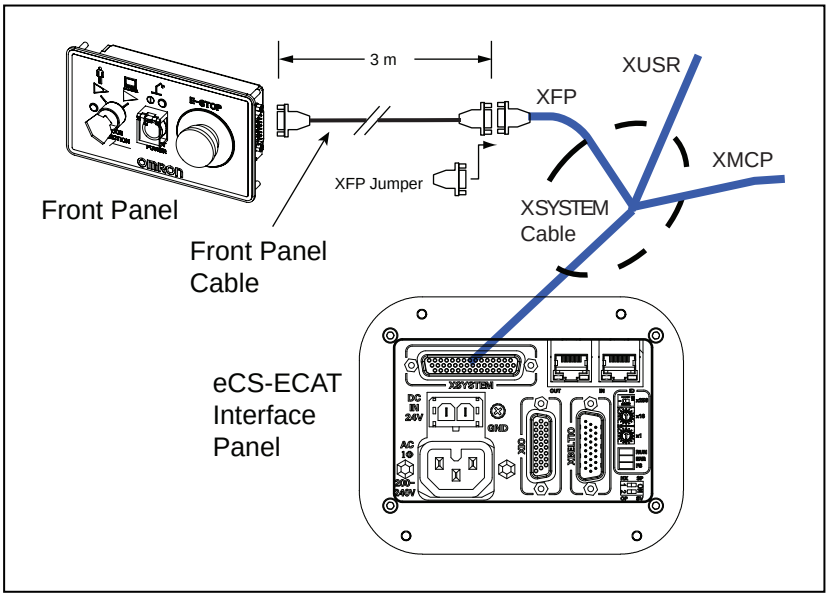


Figure 3-4. Front Panel Connection

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.

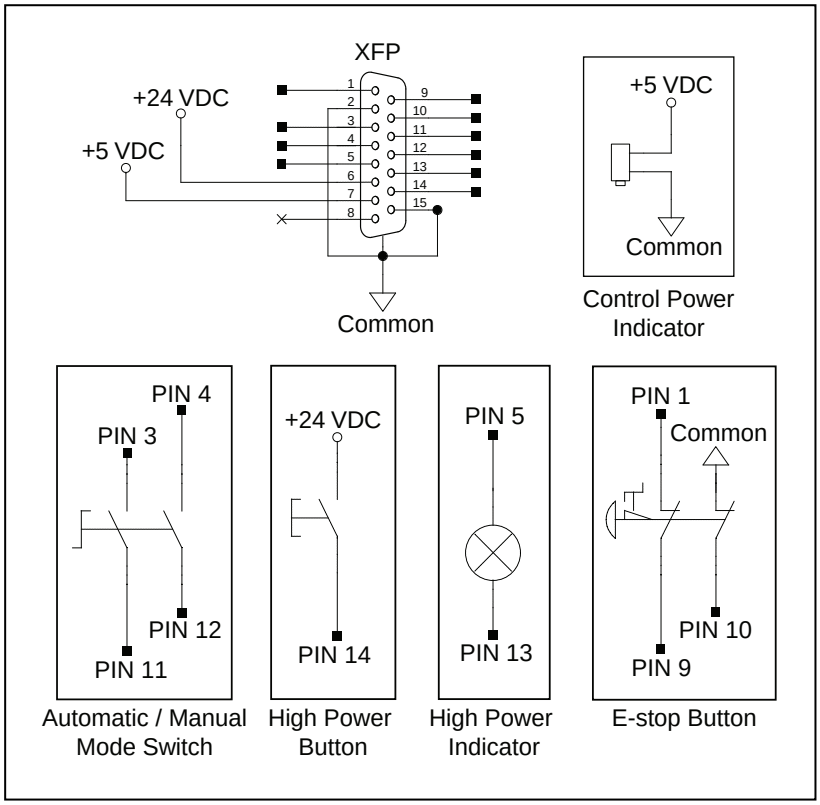
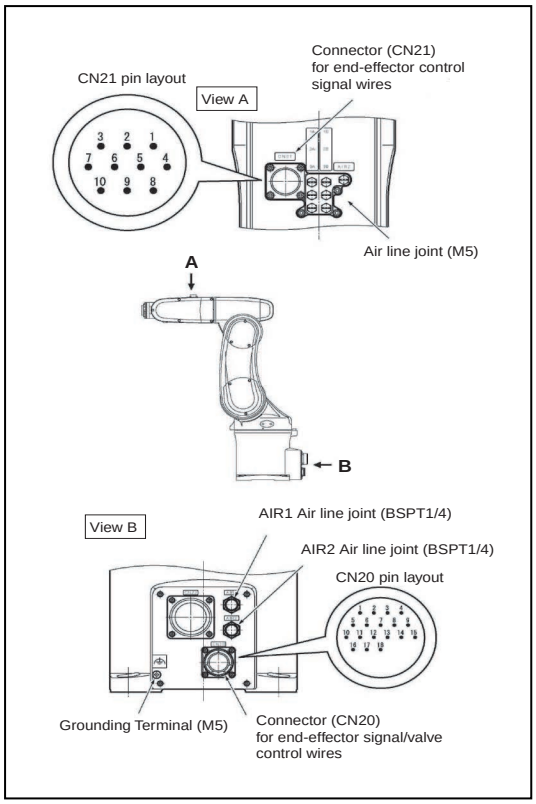


Figure 3-5. Front Panel Schematic

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

3.5 Air Lines and Signal Wiring

The robot is equipped with seven air lines. Six lines, from AIR1 input, are controlled by the three internal solenoid valves. One line, from AIR2 input, is connected directly to AIR2 on the second arm. There are ten user electric lines. See the following figure and tables.



Note 1: Pins #1 to #10 on CN21 and those on CN20 are connected with each other. The allowable current per line is 1 A.

Note 2: Use the supplied mating connector sets for CN20 and CN21. See the following tables for information about the mating connectors on Cleanroom and IP54/65 robots.

Air Intake/Exhaust States.

Air tubing joint			Valve Signal		
AIR1	Air intake	Exhaust	Solenoid valve	Solenoid	
				A	B
	1A	1B	1	ON	OFF
	1B	1A	1	OFF	ON
	2A	2B	2	ON	OFF
	2B	2A	2	OFF	ON
	3A	3B	3	ON	OFF
	3B	3A	3	OFF	ON

CN20 Pin Assignments
PNP/NPN

CN20 pin No.	Used for:
12	Common
13	Solenoid 1A (solenoid valve 1)
14	Solenoid 1B (solenoid valve 1)
15	Solenoid 2A (solenoid valve 2)
16	Solenoid 2B (solenoid valve 2)
17	Solenoid 3A (solenoid valve 3)
18	Solenoid 3B (solenoid valve 3)

CN22	The Arm Power/Signal cable from the eCS-ECAT is installed at this connector.
CN20	Pins 1 to 10 are wired directly to corresponding pins 1 to 10 on CN21 on the upper arm. Pins 12 to 18 are for solenoid control.
AIR 1	Air line connector (BSPT¼) for three solenoids in robot.
AIR 2	Air line connector (BSPT¼), connects directly to AIR 2 on the second (upper) arm.
Grounding Terminal	Protective earth ground point on the robot. See Grounding the Robot System on page 83.

Connectors for using the CN20 and CN21 plugs:

Connector set part No.	Connector No.	Model and part name	Appearance
05019-000	for CN20	SRCN6A25-24S (round type connector) Japan Aviation Electronics Industry Ltd.	

Connector set part No.	Connector No.	Model and part name	Appearance
	for CN21	JMLP1610M (L type plug connector) DDK Electronics, Inc.	

3.6 Installing User-Supplied Safety Equipment

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

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

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

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

Contacts on XUSR Connector

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

Table 3-2. XUSR Connector Signals

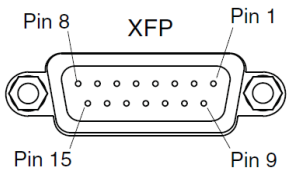
Pin Pairs	Description	Comments
Voltage-Free Contacts Provided by Customer		
1, 14	User E-Stop CH 1 (mushroom push-button, safety gates, etc.)	N/C (Normally Closed) contacts, Shorted if NOT Used
2, 15	User E-Stop CH 2 (same as pins 1, 14)	N/C contacts, Shorted if NOT Used
3, 16	Line E-Stop (used for other robot or assembly line E-Stop interconnection. 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

Pin Pairs	Description	Comments
6, 19	Muted Safety Gate CH 2 (same as pins 5, 18)	N/C contacts, Shorted if NOT Used
Voltage-Free Contacts provided		
7, 20	E-Stop indication CH 1	Contacts are closed when Front Panel, pendant, and user E-Stops are NOT tripped
8, 21	E-Stop indication CH 2 (same as pins 7, 20)	Contacts are closed when Front Panel, pendant, and user E-Stops are NOT tripped
9, 22	Manual or Automatic indication CH 1	Contacts are closed in Automatic mode
10, 23	Manual or Automatic indication CH 2	Contacts are closed in Automatic mode
11, 12, 13, 24, 25	No connection	

Contacts on XFP Connector

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

Table 3-3. XFP Connector Signals

Pins	Description	Additional Information
1, 9	Front Panel E-Stop button channel 1 input	Typically connected to normally-closed contacts on the E-Stop button used with the Front Panel.
2, 10	Front Panel E-Stop button channel 2 input	
3, 11	Automatic / Manual mode selection channel 1 input	Typically connected to the selector switch used with the front panel. An open circuit selects Manual mode. A closed circuit selects Automatic mode.
4, 12	Automatic / Manual mode selection channel 2 input	
5, 13	System-supplied 5 VDC output (pin 5) and common (pin 13) for High Power indicator lamp	If lamp is user-supplied, it must draw between 10 mA to 500 mA to satisfy the internal High Power lamp monitoring function.*1
6, 14	High Power ON / OFF	Typically connected to a momentary push-button that enables High Power when all safety circuits are satisfied.
7, 15*2	System-supplied 5 VDC output (pin 7) and common (pin 15) for Control Power indicator.	If indicator is user-supplied, the recommended load is between 20 to 500 mA.
8	Reserved for future use	
		

Pins	Description	Additional Information
See Front Panel Schematic on page 43 for a schematic diagram of the Front Panel.		
*1Lamps that illuminate with a low current (10 mA to 25 mA) may appear dim when the High Power is OFF due to leakage current. If this occurs, add additional resistance to ensure the lamp is OFF when High Power is not enabled.		
*2Do not inadvertently connect 24 VDC signals to these pins as that will damage the electronics.		

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

Remote Pendant Signals on the XMCP Connector

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

Table 3-4. Remote Pendant Connections on the XMCP Connector

Pin XMCP (15-Pin D-Sub)	Description
1, 9	Pendant E-Stop Push-button CH 1
2, 10	Pendant E-Stop Push-button CH 2
3, 11	Pendant Enable CH 1 (Hold-to-run)
4, 12	Pendant Enable CH 2 (Hold-to-run)
13	Serial GND/Logic GND
7	Pendant TXD: “eV+ to Pendant TXD”
8	Pendant RXD: “eV+ to Pendant RXD”
14	No connection
15	No connection
Shield	Shield GND
6	24 VDC
5	No connection

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

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

E-Stop Circuits on XUSR and XFP Connectors

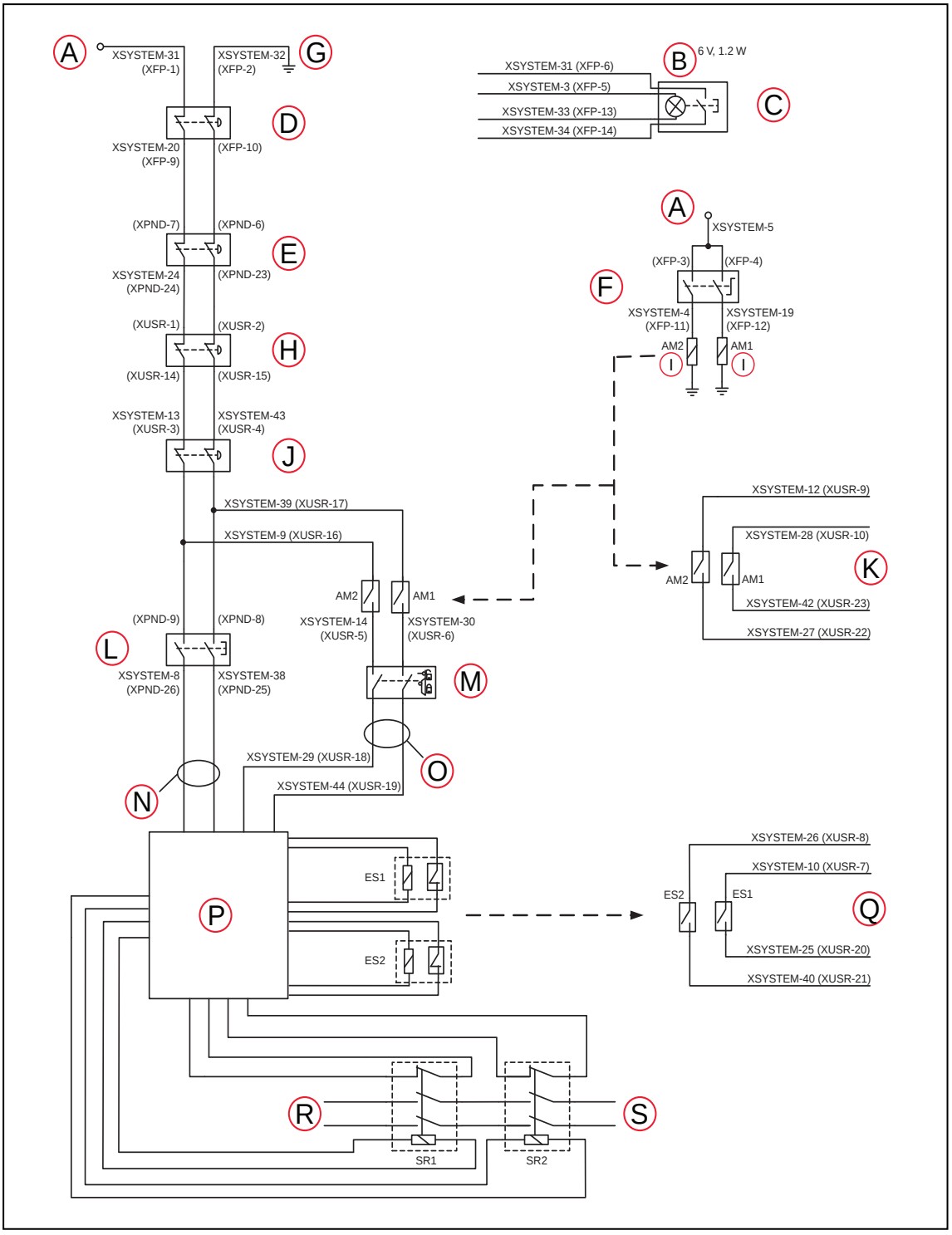


Figure 3-6. E-Stop Circuit on XUSR and XFP Connectors

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

Emergency Stop Circuits

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

> **NOTE:** All pin numbers in this section correspond to the wiring diagram shown in Figure 3-6.

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 E-Stop Circuits on XUSR and XFP Connectors on page 49.

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 3-6.

> **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 3-6.) 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 3-6. and Figure 3-5. for the user E-Stop circuitry).

Line E-Stop Input (KEY: J)

The XUSR connector on the controller contains a two-channel Line E-Stop input for workcell, production line, or other equipment emergency-stop inputs. Refer to item J in Figure 3-6.

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 3-6. 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 3-6.

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 52 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 43. 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 3-6. You can use these contacts to control other mechanisms (for example, conveyor, linear modules, etc.) when Manual mode is selected.

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

WARNING: PERSONAL INJURY HAZARD
If you suspended any safeguards, you must return them to full functionality before selecting Automatic Mode.

Remote High Power ON / OFF Control

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

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

Extend the Front Panel Connection Cable

The easiest and most effective way to provide the high power ON / OFF control in a remote location is to mount the Front Panel in the desired location with an extension cable. This method allows you to relocate the Front Panel high power ON / OFF switch to a more convenient location. Implementation of this method must conform to EN standard recommendations.

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

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

- Wire Size: must be 26 AWG (0.13 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 43 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.

High Power On/Off Lamp

The Front Panel High Power On/Off Lamp (p/n: 27400-29006) will cause an error, from eV+, if the lamp burns out. This error prevents High Power from being turned on. This safety feature prevents a user from not realizing that High Power is enabled because the High Power indicator is burned out.

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 3-6.

Using a User-Supplied Control Panel

You can create a user-supplied control panel that performs the same functions as the optional Front Panel.

Additional Information: Refer to Front Panel Schematic on page 43 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.

Use Hardware Switches on the eCS-ECAT

Use the hardware switches on the eCS-ECAT interface panel to set an explicit EtherCAT node ID for the robot. Refer to Setting the EtherCAT Node ID Using Hardware Switches on page 55 for more information.

Use Sysmac Studio Software

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

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

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

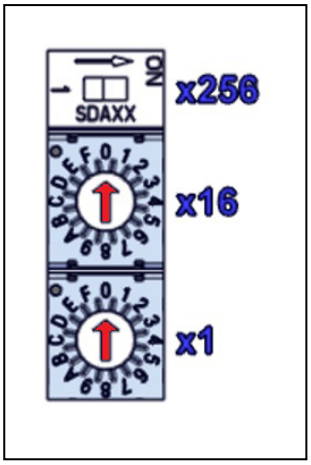


Figure 3-7. EtherCAT Node ID 0 Switch Setting

Setting the EtherCAT Node ID Using Hardware Switches

The eCS-ECAT 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 24 VDC power is applied to the eCS-ECAT.

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

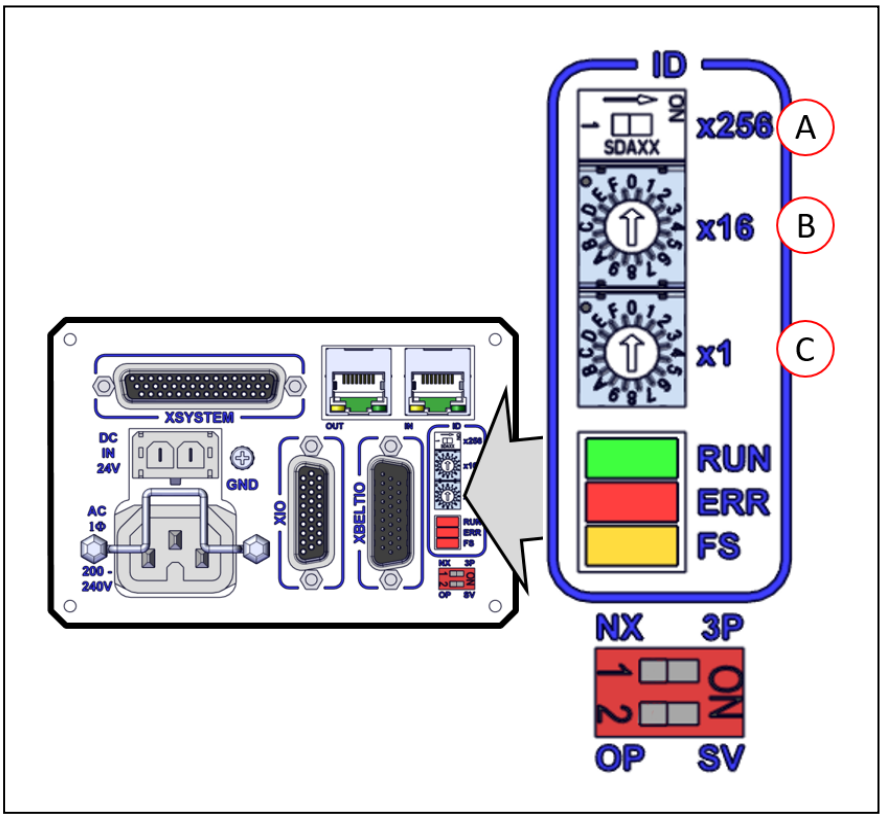


Figure 3-8. eCS-ECAT Interface Panel EtherCAT ID Switches

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

EtherCAT Node ID Address Example

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

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

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

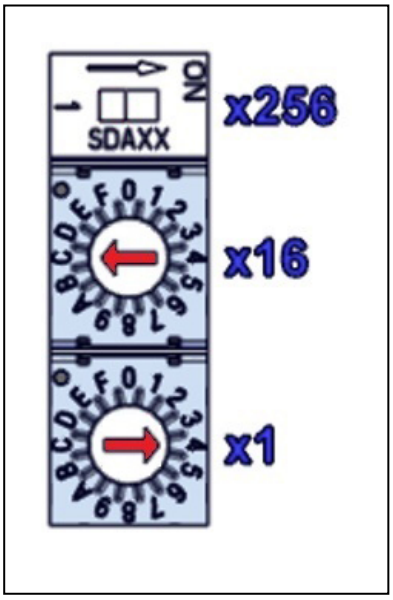


Figure 3-9. EtherCAT Node ID Set to 196

3.8 Installing Joint Labels

The system includes a set of joint directional labels that can be installed on the robot. See the following figure. Also refer to Robot Links and Joints on page 17 for a drawing of the joint identification. The yellow X-Y label can be used to indicate the X and Y axes in the World coordinate system in your workcell.

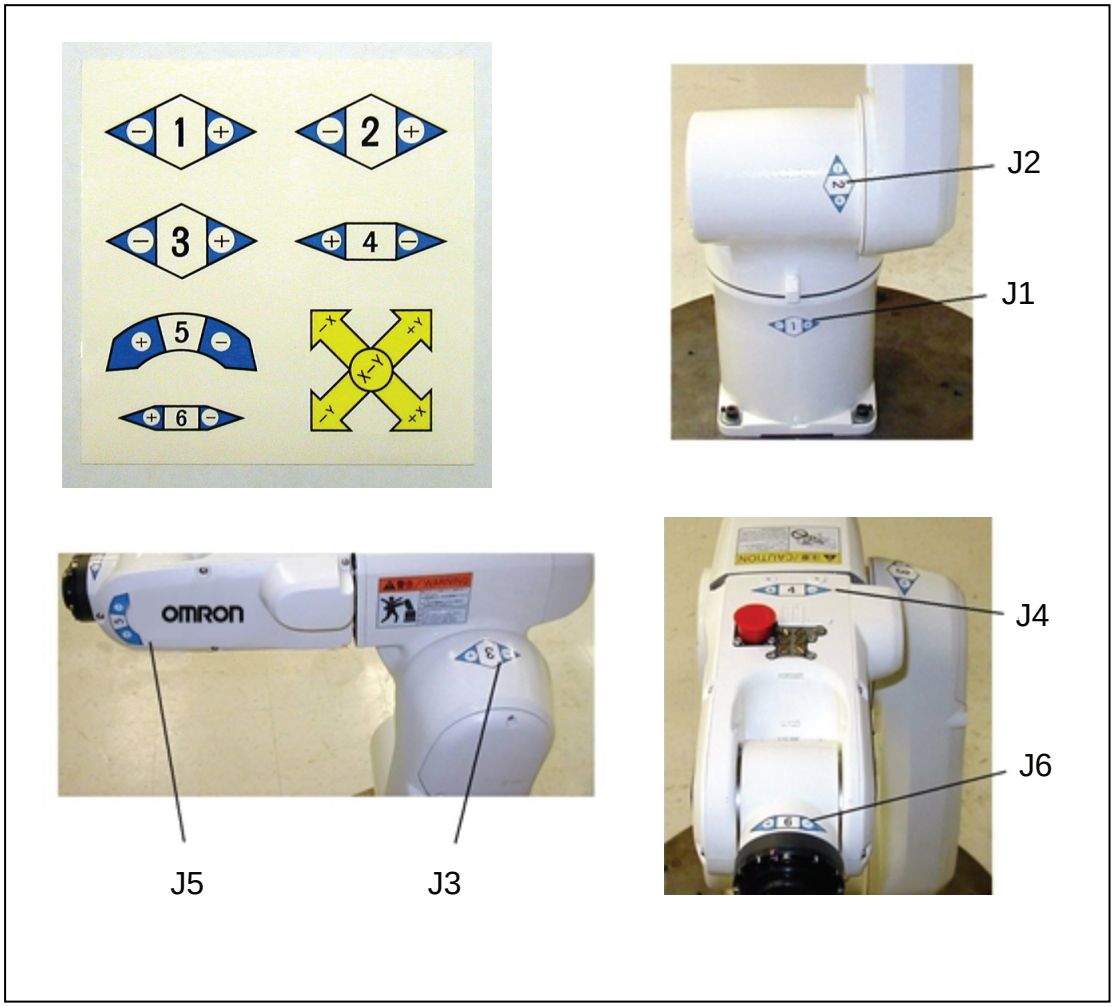


Figure 3-10. Joint and Axes Directional Labels

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

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

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

4.1 Basic System Cable Layout

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

The letters in the following figure correspond to the letters in the List of Cables and Parts on page 60.

The numbers in the following figure correspond to the Cable Installation Steps on page 62.

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

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

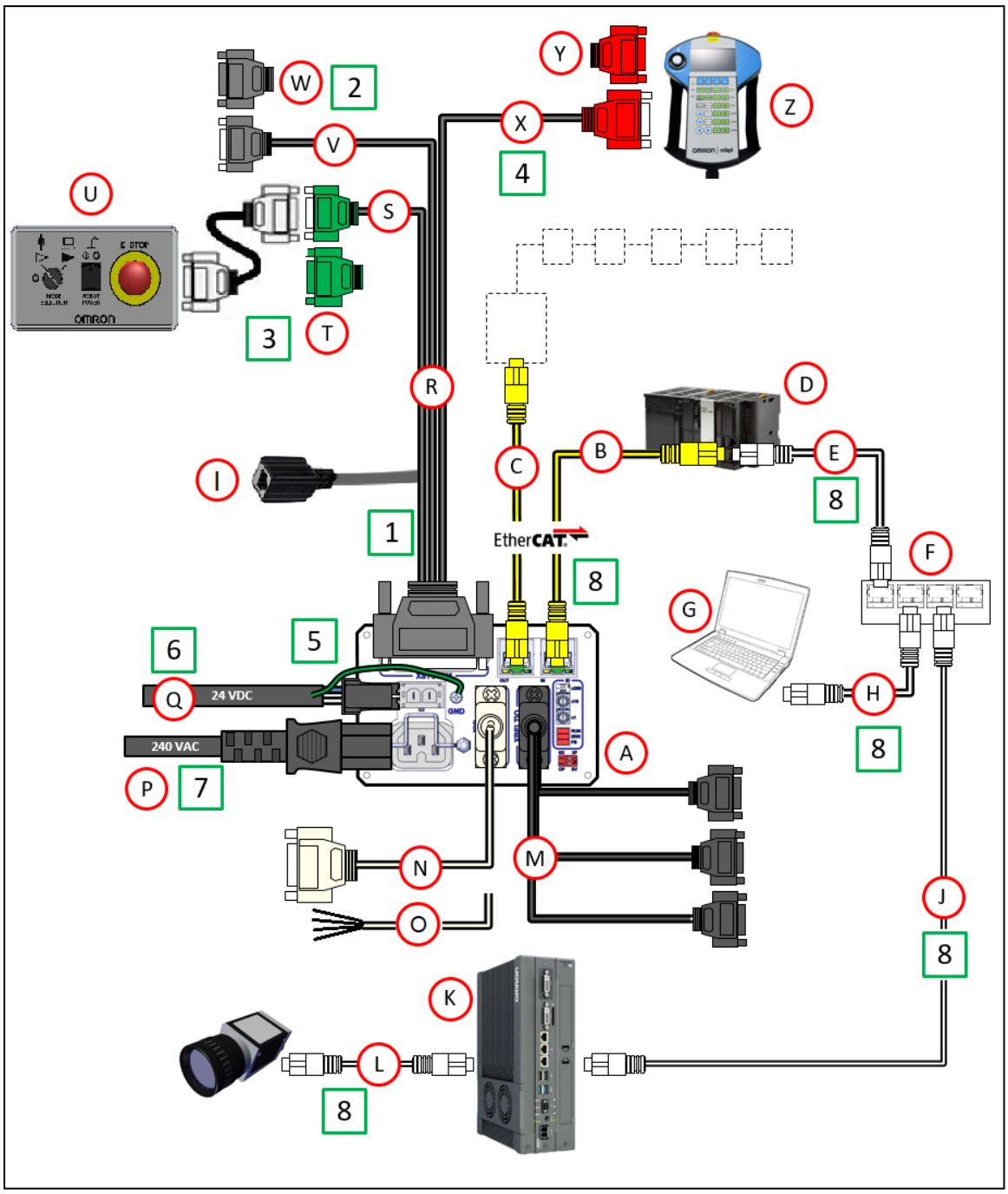


Figure 4-1. Typical System Cable Connections

List of Cables and Parts

The following table identifies and provides details about cables and parts illustrated in Basic System Cable Layout on page 59.

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	eCS-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 (on XSYSTEM cable)		X		
J	Ethernet/IP cable to IPC Application Controller				X
K	IPC Application Controller	20152-000		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	200-240 VAC AC Power Cable	04118-000		X	X
Q	24 VDC Power Cable	04120-000		X	X
R	Cable Assembly, XSYSTEM Adapter with Jumpers[2]	13322-100	X		
S	XFP Connector on XSYSTEM cable		X		
T	XFP Jumper Plug[3]	10052-000	X		
U	Front Panel[4]	90356-10358	X		

Part	Cable and Parts List	Part #	Standard	Option	User Supplied
V	XUSR Connector on XSYSTEM cable		X		
W	XUSR Jumper Plug [5]	04736-000	X		
X	XMCP Connector on XSYSTEM cable		X		
Y	XMCP Jumper Plug[6]	10052-000	X		
Z	T20 Pendant	10054-010		X	

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 59 for references to item letters.

Additional Information: Refer to eCS-ECAT Interface Panel on page 20 for interface panel connector details.

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

Step	Connection	Item
5	Connect a 24 VDC cable to the DC power supply connector on the eCS-ECAT interface panel.	Q
6	Connect user-supplied ground to the eCS-ECAT. Refer to Grounding the Robot System on page 83 for more information. **NOTE:** The ground may be part of the 24 VDC cable.	
7	Connect a 200-240 VAC cable to the AC power supply connector on eCS-ECAT interface panel and secure with clamp.	P
8	Connect user-supplied communication / network cables to their respective devices. **Additional Information**: Ethernet / EtherCAT network connections may differ. Contact your local OMRON support for more information.	B, C, D, E, F, G, H, J, K, L
9	Connect downstream EtherCAT device(s).	

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.

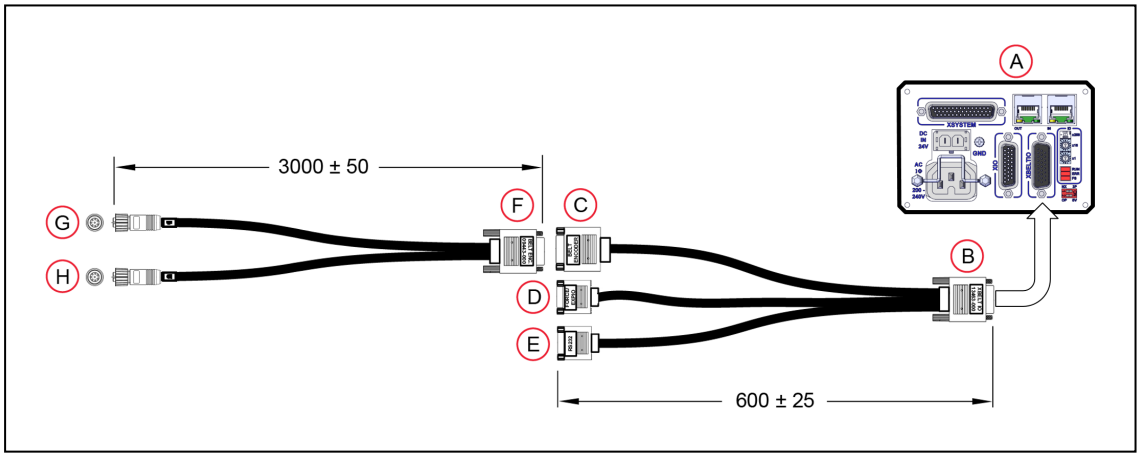


Figure 4-2. System Cable Diagram with Belt Encoders (Units in mm)

Table 4-1. Belt Encoder Cables Description

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

Item	Description	Part #	Standard	Option	User-supplied	Notes
	nector					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 63.

Belt Encoder

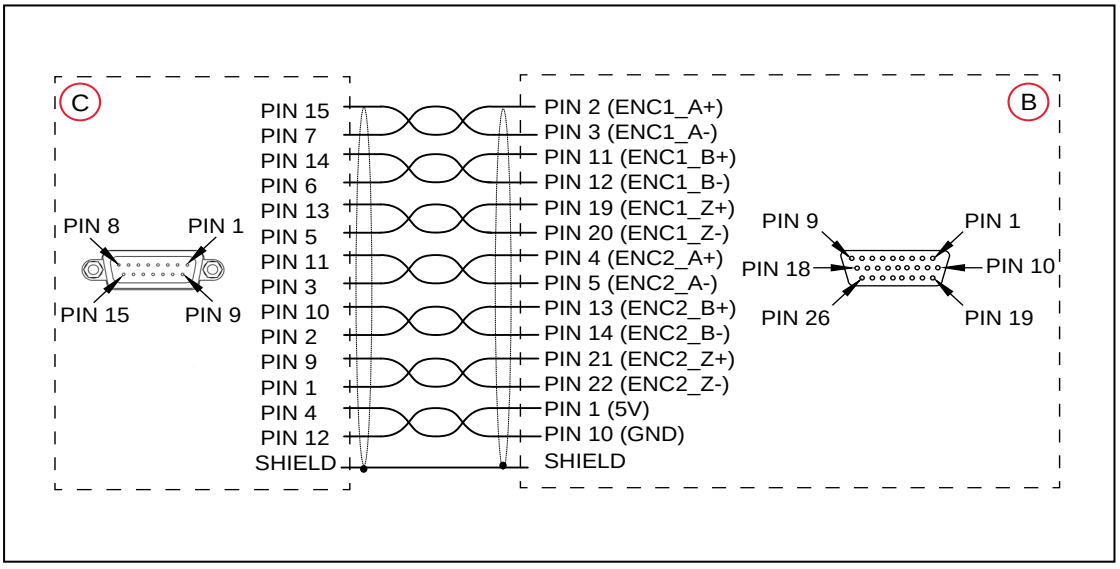


Figure 4-3. XBELT I/O Adapter Cable Pinout - Encoder 1 and 2 Connections

RS232

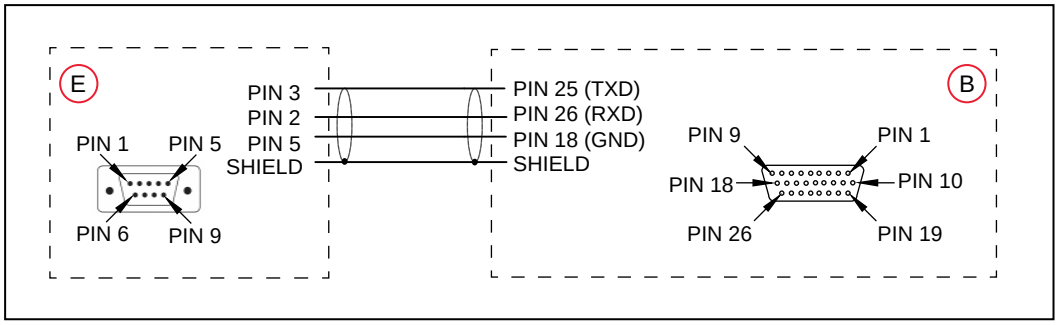


Figure 4-4. XBELT I/O Adapter Cable Pinout - RS232 Connections

FORCE / EXPIO

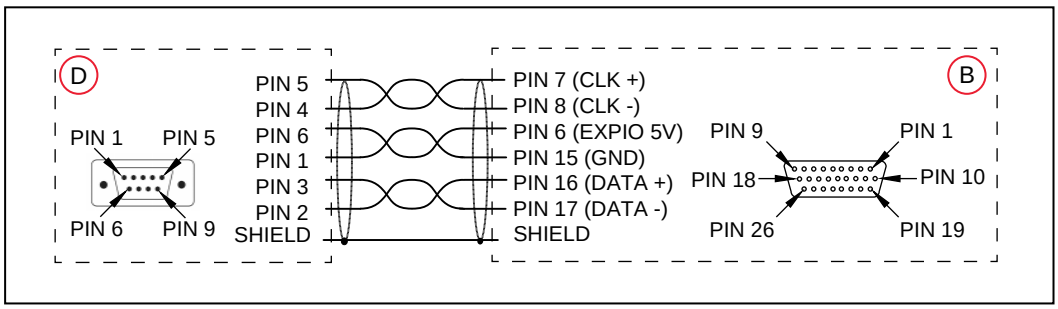


Figure 4-5. XBELT I/O Adapter Cable Pinout - EXPIO Connections

Splitter Cable

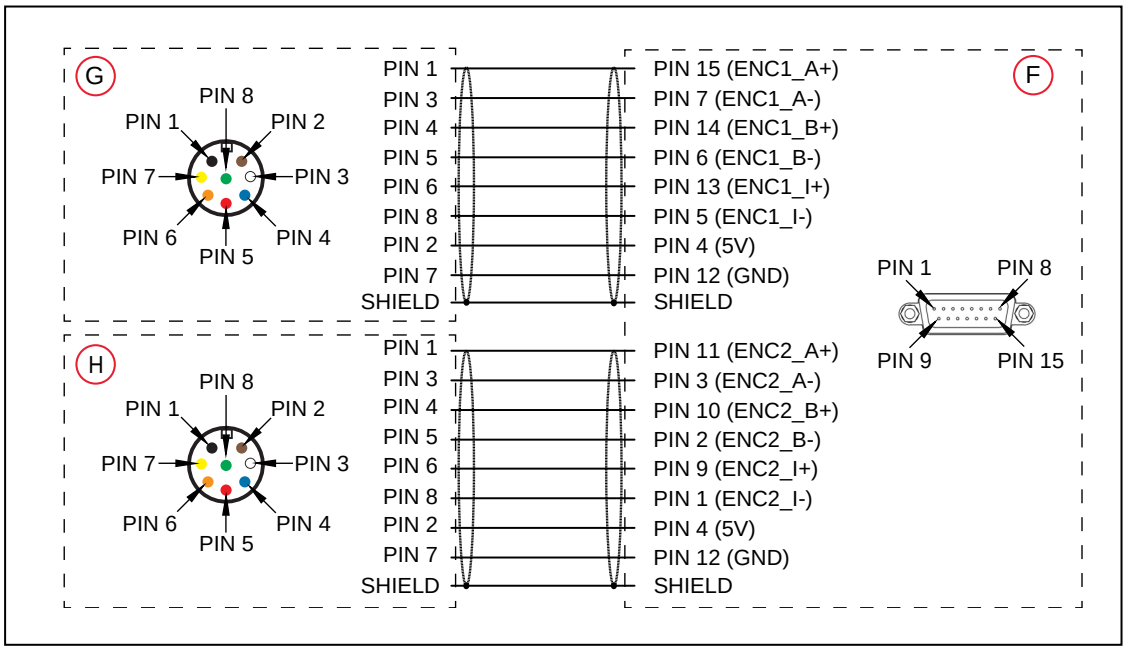


Figure 4-6. Belt Y Splitter Cable Pinout - 2 Encoder Connections

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 eCS-ECAT interface panel The optional XIO Termination Block is a connection option for XIO, and connects to eCS-ECAT interface panel	12 inputs 8 outputs	Refer to XIO Connector Signals on page 74 Refer to Digital I/O Signal Configuration on page 66
Optional IO Blox Device, connects to the RS232 connector on the eCS-ECAT. 2nd group of IO Blox connect to FORCE/EXPIO branch of the XBELTIO cable.	8 inputs, 8 outputs per device; up to 8 IO Blox devices (4 per group) for the Viper	Refer to *the IO Blox User's Guide (04638-000)*

Optional I/O Products

This optional product is also available for use with digital I/O.

- XIO Termination Block (part number 90356-40100)

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

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 8) 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.

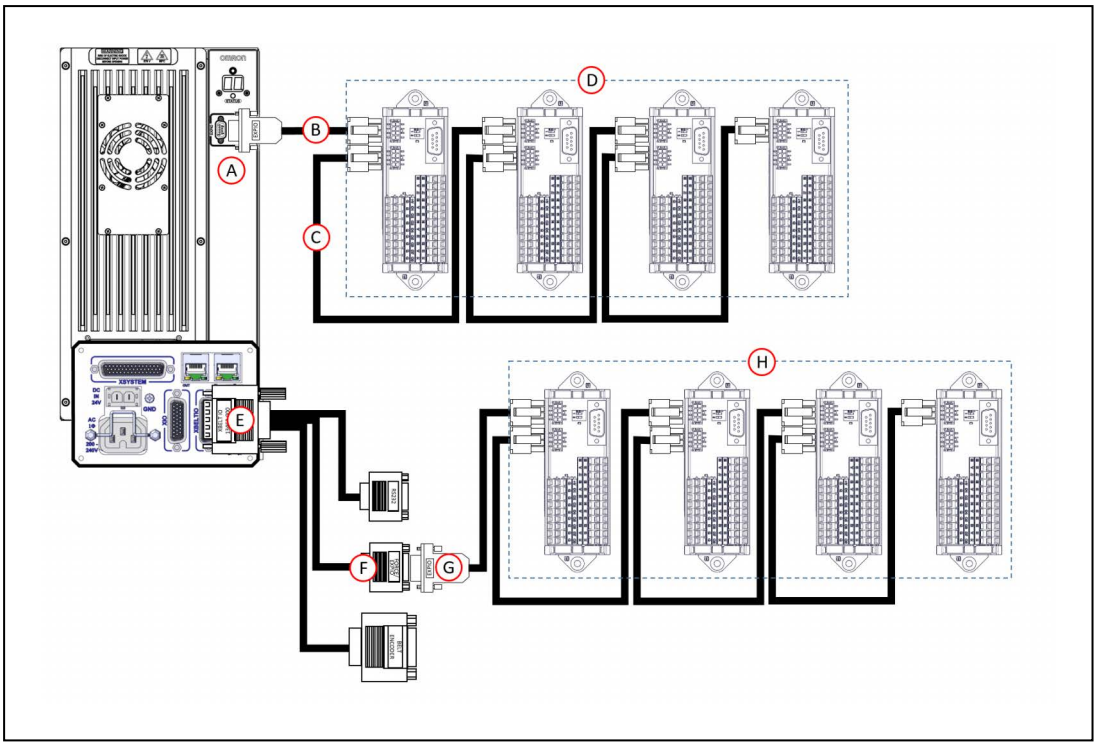


Figure 4-7. Connecting IO Blox to the System (maximum of 8)

Item	Description
A	Viper Robot user connections near the top of eCS-ECAT
B, G	EXPIO to IO Blox cable (3 m) P/N 04677-030
C	IO Blox-to-IO Blox cable (3 m) P/N 04679-03
D	IO Blox Group 1, maximum 4 IO Blox units (in this group)
E	XBELT IO Cable P/N 13463-000 (600 mm) connected to XBELTIO connector on the eCS-ECAT interface panel
F	FORCE/EXPIO connector on XBELTIO cable
H	IO Blox Group 2, maximum 4 IO Blox units (in this group)

XIO Termination Block

You can also expand digital I/O by connecting an XIO Termination Block to the XIO connector on the eCS-ECAT 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 eCS-ECAT interface panel.

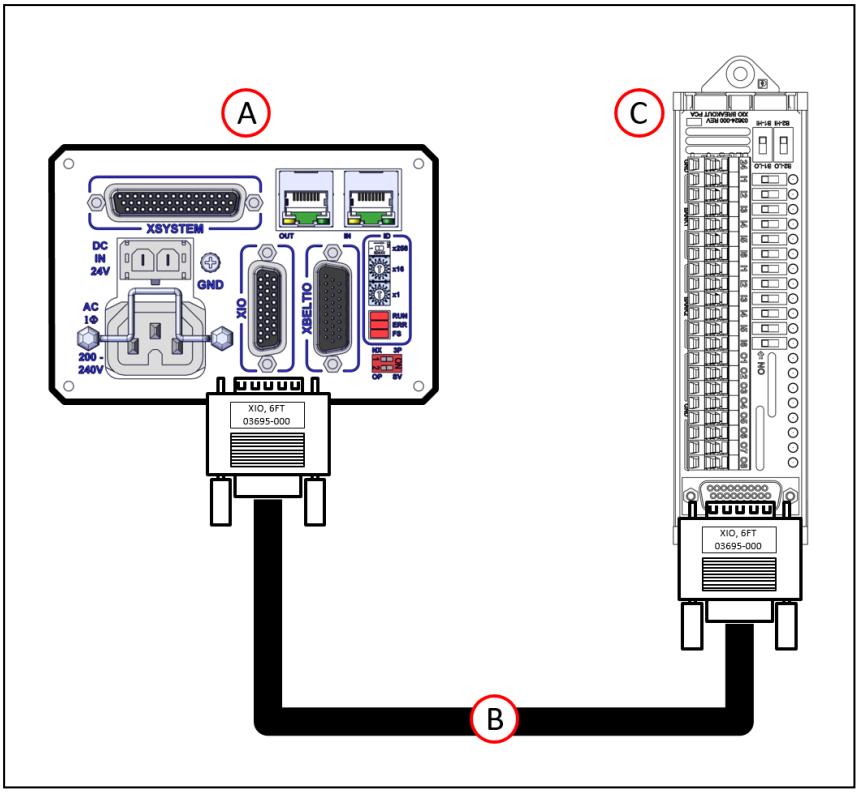


Figure 4-8. Connecting XIO Termination Block

Callout	Function
A	eCS-ECAT 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 twisted-pair (STP) wires. You can construct your own extended length cables using similar cable stock. Give careful attention to voltage drops on the I/O outputs when using extended length cables and high current loads.

Default Signal Allocations

The digital I/O for the eV+ programming language uses numeric signal numbers, with possible outputs 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)	Signal Number
1	XIO	XIO	N/A	1001 to 1012
	EXPIO	IOBlox Group 1	OFF, OFF	1033 to 1040
			ON, OFF	1041 to 1048
			OFF, ON	1049 to 1056
			ON, ON	1057 to 1064
	XBELTIO	IOBlox Group 2	OFF, OFF	1065 to 1072
			ON, OFF	1073 to 1080
			OFF, ON	1081 to 1088
			ON, ON	1089 to 1096
2	XIO	XIO	N/A	1097 to 1108
	EXPIO	IOBlox Group 1	OFF, OFF	1129 to 1136
			ON, OFF	1137 to 1144
			OFF, ON	1145 to 1152
			ON, ON	1153 to 1160
	XBELTIO	IOBlox Group 2	OFF, OFF	1161 to 1168
			ON, OFF	1169 to 1176
			OFF, ON	1177 to 1184
			ON, ON	1185 to 1192
3	XIO	XIO	N/A	1193 to 1204
	EXPIO	IOBlox Group 1	OFF, OFF	1225 to 1232
			ON, OFF	1233 to 1240
			OFF, ON	1241 to 1248
			ON, ON	1249 to 1256
	XBELTIO	IOBlox Group 2	OFF, OFF	1257 to 1264
			ON, OFF	1265 to 1272
			OFF, ON	1273 to 1280
			ON, ON	1281 to 1288

Robot	Connector	Channel	Switch Position (1, 2)	Signal Number
4	XIO	XIO	N/A	1289 to 1300
	EXPIO	IOBlox Group 1	OFF, OFF	1321 to 1328
			ON, OFF	1329 to 1336
			OFF, ON	1337 to 1344
			ON, ON	1345 to 1352
	XBELTIO	IOBlox Group 2	OFF, OFF	1353 to 1360
			ON, OFF	1361 to 1368
			OFF, ON	1369 to 1376
			ON, ON	1377 to 1384
5	XIO	XIO	N/A	1385 to 1396
	EXPIO	IOBlox Group 1	OFF, OFF	1417 to 1424
			ON, OFF	1425 to 1432
			OFF, ON	1433 to 1440
			ON, ON	1441 to 1448
	XBELTIO	IOBlox Group 2	OFF, OFF	1449 to 1456
			ON, OFF	1457 to 1464
			OFF, ON	1465 to 1472
			ON, ON	1473 to 1480
6	XIO	XIO	N/A	1481 to 1492
	EXPIO	IOBlox Group 1	OFF, OFF	1513 to 1520
			ON, OFF	1521 to 1528
			OFF, ON	1529 to 1536
			ON, ON	1537 to 1544
	XBELTIO	IOBlox Group 2	OFF, OFF	1545 to 1552
			ON, OFF	1553 to 1560
			OFF, ON	1561 to 1568
			ON, ON	1569 to 1576

Robot	Connector	Channel	Switch Position (1, 2)	Signal Number
7	XIO	XIO	N/A	1577 to 1588
	EXPIO	IOBlox Group 1	OFF, OFF	1609 to 1616
			ON, OFF	1617 to 1624
			OFF, ON	1625 to 1632
			ON, ON	1633 to 1640
	XBELTIO	IOBlox Group 2	OFF, OFF	1641 to 1648
			ON, OFF	1649 to 1656
			OFF, ON	1657 to 1664
			ON, ON	1665 to 1672
8	XIO	XIO	N/A	1673 to 1684
	EXPIO	IOBlox Group 1	OFF, OFF	1705 to 1712
			ON, OFF	1713 to 1720
			OFF, ON	1721 to 1728
			ON, ON	1729 to 1736
	XBELTIO	IOBlox Group 2	OFF, OFF	1737 to 1744
			ON, OFF	1745 to 1752
			OFF, ON	1753 to 1760
			ON, ON	1761 to 1768

Default Output Signal Allocations

Use the table below to understand default output allocations.

Table 4-4. Default Output Signal Allocations

Robot	Connector	Channel	Switch Position (1, 2)	Signal Number
1	XIO	XIO	N/A	1 to 8
	EXPIO	IOBlox Group 1	OFF, OFF	33 to 40
			ON, OFF	41 to 48
			OFF, ON	49 to 56
			ON, ON	57 to 64
	XBELTIO	IOBlox Group 2	OFF, OFF	65 to 72
			ON, OFF	73 to 80
			OFF, ON	81 to 88
			ON, ON	89 to 96

Robot	Connector	Channel	Switch Position (1, 2)	Signal Number
2	XIO	XIO	N/A	97 to 104
	EXPIO	IOBlox Group 1	OFF, OFF	129 to 136
			ON, OFF	137 to 144
			OFF, ON	145 to 152
			ON, ON	153 to 160
	XBELTIO	IOBlox Group 2	OFF, OFF	161 to 168
			ON, OFF	169 to 176
			OFF, ON	177 to 184
			ON, ON	185 to 192
3	XIO	XIO	N/A	193 to 200
	EXPIO	IOBlox Group 1	OFF, OFF	225 to 232
			ON, OFF	233 to 240
			OFF, ON	241 to 248
			ON, ON	249 to 256
	XBELTIO	IOBlox Group 2	OFF, OFF	257 to 264
			ON, OFF	265 to 272
			OFF, ON	273 to 280
			ON, ON	281 to 288
4	XIO	XIO	N/A	289 to 296
	EXPIO	IOBlox Group 1	OFF, OFF	321 to 328
			ON, OFF	329 to 336
			OFF, ON	337 to 344
			ON, ON	345 to 352
	XBELTIO	IOBlox Group 2	OFF, OFF	353 to 360
			ON, OFF	361 to 368
			OFF, ON	369 to 376
			ON, ON	377 to 384

Robot	Connector	Channel	Switch Position (1, 2)	Signal Number
5	XIO	XIO	N/A	385 to 392
	EXPIO	IOBlox Group 1	OFF, OFF	417 to 424
			ON, OFF	425 to 432
			OFF, ON	433 to 440
			ON, ON	441 to 448
	XBELTIO	IOBlox Group 2	OFF, OFF	449 to 456
			ON, OFF	457 to 464
			OFF, ON	465 to 472
			ON, ON	473 to 480
6	XIO	XIO	N/A	481 to 488
	EXPIO	IOBlox Group 1	OFF, OFF	513 to 520
			ON, OFF	521 to 528
			OFF, ON	529 to 536
			ON, ON	537 to 544
	XBELTIO	IOBlox Group 2	OFF, OFF	545 to 552
			ON, OFF	553 to 560
			OFF, ON	561 to 568
			ON, ON	569 to 576
7	XIO	XIO	N/A	577 to 584
	EXPIO	IOBlox Group 1	OFF, OFF	609 to 616
			ON, OFF	617 to 624
			OFF, ON	625 to 632
			ON, ON	633 to 640
	XBELTIO	IOBlox Group 2	OFF, OFF	641 to 648
			ON, OFF	649 to 656
			OFF, ON	657 to 664
			ON, ON	665 to 672

Robot	Connector	Channel	Switch Position (1, 2)	Signal Number
8	XIO	XIO	N/A	673 to 680
	EXPIO	IOBlox Group 1	OFF, OFF	705 to 712
			ON, OFF	713 to 720
			OFF, ON	721 to 728
			ON, ON	729 to 736
	XBELTIO	IOBlox Group 2	OFF, OFF	737 to 744
			ON, OFF	745 to 752
			OFF, ON	753 to 760
			ON, ON	761 to 768

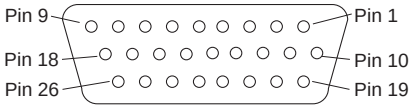
XIO Connector Signals

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

Table 4-5. XIO Signal Designations

Pin No.	Designation	Signal Bank
1	GND	
2	24 VDC	
3	Common 1	1
4	Input 1.1	1
5	Input 2.1	1
6	Input 3.1	1
7	Input 4.1	1
8	Input 5.1	1
9	Input 6.1	1
10	GND	
11	24 VDC	
12	Common 2	2
13	Input 1.2	2
14	Input 2.2	2
15	Input 3.2	2
16	Input 4.2	2
17	Input 5.2	2
18	Input 6.2	2

Pin No.	Designation	Signal Bank
19	Output 1	
20	Output 2	
21	Output 3	
22	Output 4	
23	Output 5	
24	Output 6	
25	Output 7	
26	Output 8	



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 Input Specifications

Table 4-6. XIO Input Specifications

Parameter	Value
Operational voltage range	0 to 30 VDC
OFF state voltage range	0 to 3 VDC
ON state voltage range	10 to 30 VDC
Typical threshold voltage	V_{in} = 8 VDC
Operational current range	0 to 7.5 mA
OFF state current range	0 to 0.5 mA
ON state current range	2.5 to 6 mA
Typical threshold current	2.0 mA
Impedance (V_{in}/I_{in})	3.9 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

Parameter	Value
	32 ms max response time
Turn off response time (hardware)	5 µsec maximum
Software scan rate and response time	16 ms scan cycle 32 ms max response time

XIO Output Signals

The eight digital outputs share a common, high side (sourcing) driver integrated circuit. The driver is designed to supply any kind of load with one side connected to ground. It is designed for a range of user-provided voltages from 10 to 24 VDC and each channel is capable of switching up to 0.7 A of current. This driver has overtemperature protection, shorted load protection, and is current limiting. If there is an output short or other over-current condition, the affected output of the driver integrated circuit turns OFF until the condition is removed. The driver draws power from the primary 24 VDC input to the eCS-ECAT through a self-resetting polyfuse.

The outputs are accessed through direct connection to the XIO connector. Optionally, use the XIO Termination Block. See the documentation supplied with the termination block for details.

High Power Indicator Output Assignment

Output 8 can be assigned to indicate the robot's High Power state. When High Power is enabled, this output will turn ON. When High Power is not enabled, this output will be OFF. This is not a safety-rated means of indicating a High Power state and should only be used for monitoring the robot status. Use Sysmac Studio to make this configuration if needed.

> **NOTE:** Once output 8 is configured for this, it is no longer available as a general-purpose user output.

4.3 Connecting Cable from the eCS-ECAT to the Robot

The cable between the robot and the eCS-ECAT is called the Arm Power/Signal cable.

1. Switch off the 24 VDC and 200-240 VAC input supplies to the eCS-ECAT.
2. Disconnect the 24 VDC supply cable from the eCS-ECAT.
3. Disconnect the 200-240 VAC supply cable from the eCS-ECAT.
4. Connect one end of the Arm Power/Signal cable CN22 connector on the back plate of the robot. Tighten the thumb-screw securely.

   For both ends of the cable, line up the slot with the matching key in the connector, apply firm pressure straight in, and thread the lock ring fully onto the connector. There should be no visible threads when connected.
5. Connect the other end of the cable to the large, circular connector on the eCS-ECAT. Refer to the following figure.

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

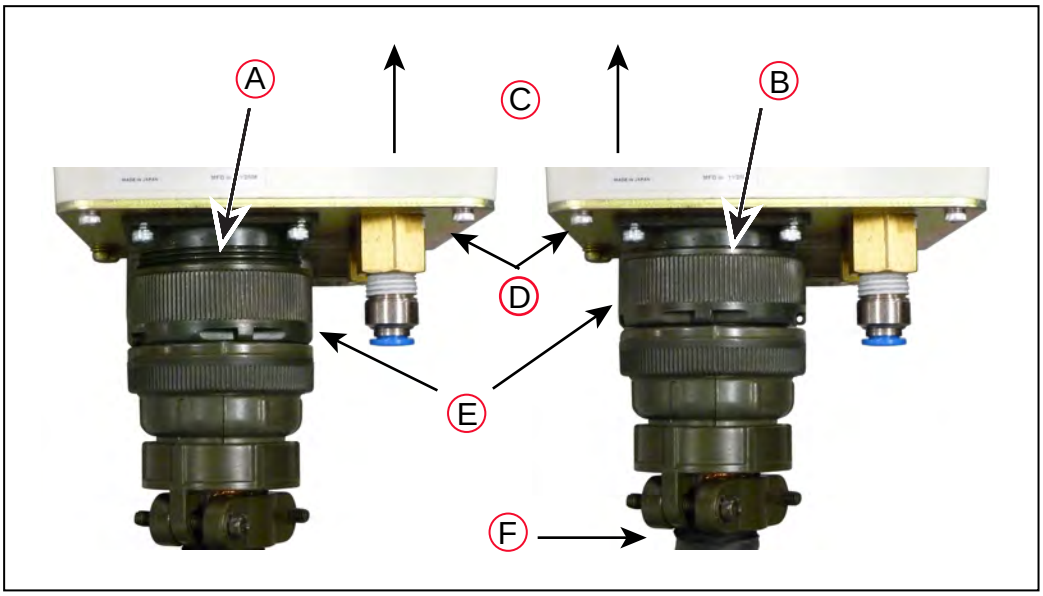


Figure 4-9. Incorrect and Correct Arm Power/Signal Cable Insertion

Key	Meaning	Key	Meaning
A	Incorrect Assembly: Threads are visible	D	Viper Interface Panel
B	Correct Assembly: No threads are visible	E	Lock Ring
C	Viper Base	F	Arm Power/Signal Cable

6. Connect the 24 VDC cable to the eCS-ECAT.
7. Connect the 200-240 VAC cable to the eCS-ECAT.
8. Switch ON the 200-240 VAC input supply to the eCS-ECAT.
9. Switch ON the 24 VDC input supply to the eCS-ECAT.

4.4 Connecting the 24 VDC Cable to the eCS-ECAT

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

> **Additional Information**: Refer to External Connection Specifications on page 127 for more information about 24 VDC power requirements.

24 VDC Power Supply Connector

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

Additional Information: Refer to Connector Specifications on page 130 for more information.

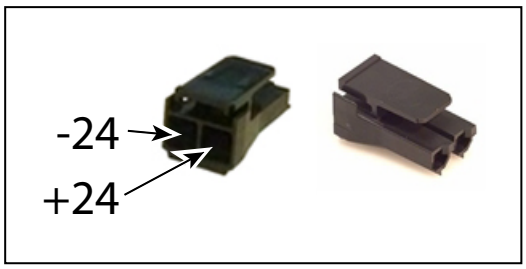


Figure 4-10. 24 VDC Mating Connector Pin Arrangement

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 59 for more information. See Figure 4-12.

1. Locate the connector and pins.
2. Use 2.08-1.31 mm^2 (14-16 AWG) wire to create the 24 VDC cable. Select the wire length to safely reach from the user-supplied 24 VDC power supply to the eCS-ECAT interface panel.
3. Crimp the pins to the wires using a crimping tool.
4. Insert the pins into the connector. Confirm that the positive and negative 24 Volt 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 eCS-ECAT interface panel.

Additional Information: Refer to External Connection Specifications on page 127 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.

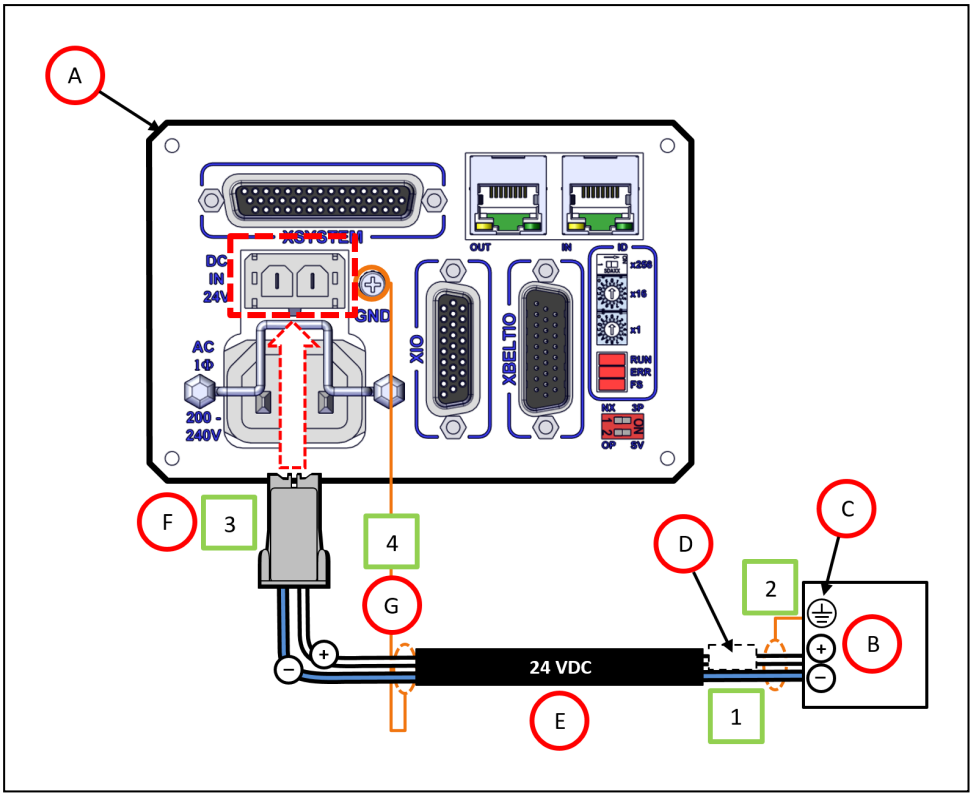


Figure 4-11. User-Supplied 24 VDC Cable, Power Supply

Item	Description
A	eCS-ECAT 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 eCS-ECAT 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 4-11. above.

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

4.5 Connecting 200-240 VAC Power Cable

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

Additional Information: Refer to External Connection Specifications on page 127 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
Viper 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.

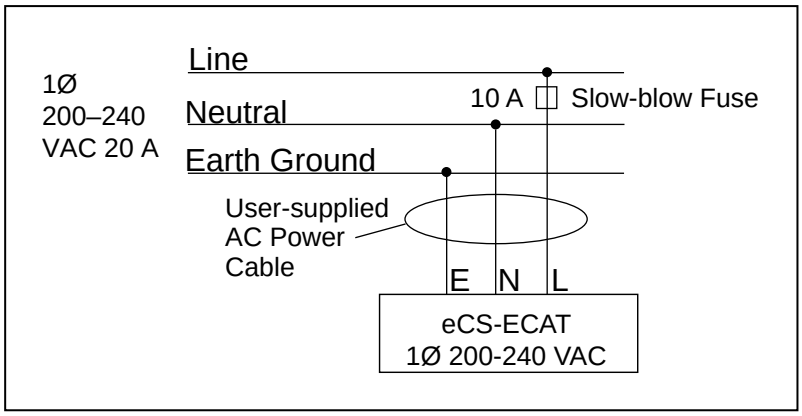


Figure 4-12. Typical AC Power Installation with Single-Phase Supply

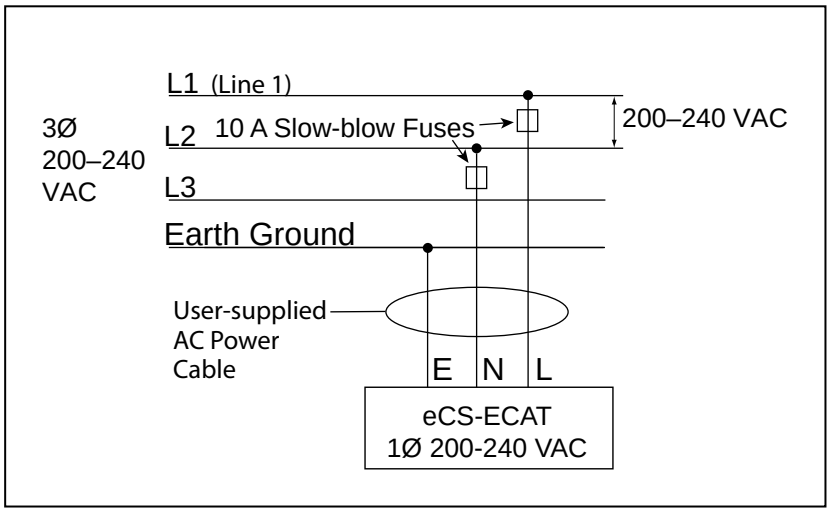


Figure 4-13. Single-Phase Load across L1 and L2 of a Three-Phase Supply

AC Power Supply Connector

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

> **Additional Information**: Refer to Connector Specifications on page 130 for more information.

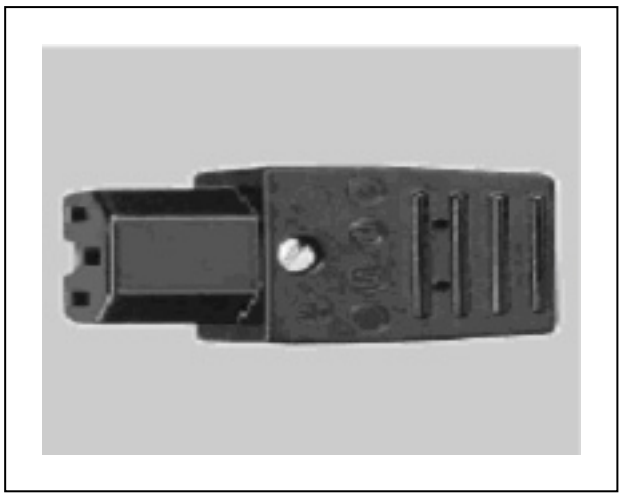


Figure 4-14. AC Power Supply Connector

Making the 200-240 VAC Power Supply Cable

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

Before you begin, you will need 3-wire, 0.8 mm^2 (18 AWG) cable long enough to reach from the AC power source to the eCS-ECAT interface panel.

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 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.

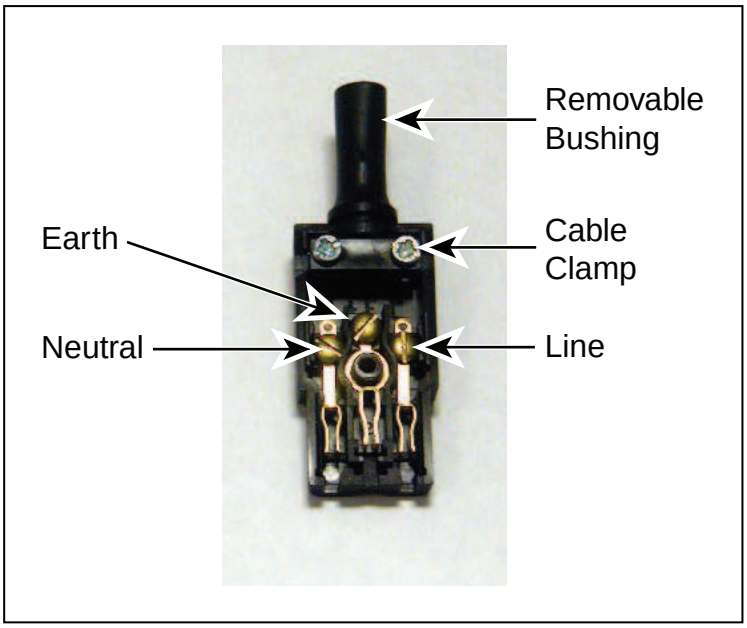


Figure 4-15. AC Power Mating Connector

Connecting the AC Power Supply Cable

Use the following procedure to connect the AC power supply cable from the power source to the eCS-ECAT interface panel.

> **Additional Information**: Refer to External Connection Specifications on page 127 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 eCS-ECAT interface panel.
3. Secure the AC connector with the locking latch.

4.6 Grounding the Robot System

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

Grounding the Robot Base

You can ground the robot base by using a ground wire at the robot base (see the following figure). The robot ships with an M5 screw in the grounding hole. You must supply the ground wire.

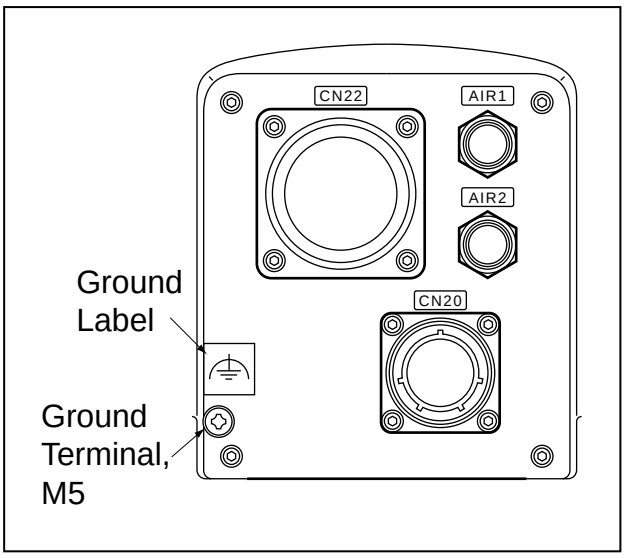


Figure 4-16. Ground Point on Robot Base

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

Ground Point on eCS-ECAT

The user can install a ground wire at the eCS-ECAT chassis. Use the hole below the eCS-ECAT interface panel. See the following figure. The user should provide a ground wire and use the provided M4 screw and external tooth lock washer to connect to earth ground. Make sure to tighten the screw on the ground wire to create a proper ground connection. Two tapped holes are provided to attach optional user-supplied strain relief.

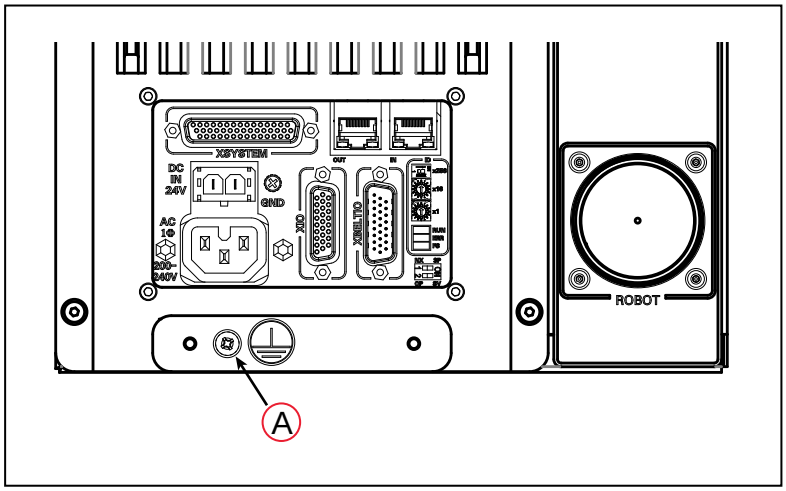


Figure 4-17. (A) eCS-ECAT Ground Location

Grounding Robot-Mounted Equipment

The tool flange is not grounded to protective earth. If hazardous voltages are present at any user-supplied robot-mounted equipment or tooling, you must install a ground connection from

that equipment or tooling to the ground point on the robot base. Hazardous voltages are anything over 30 VAC (42.4 VAC peak) or 60 VDC.

Additional Information: Refer to Tool Flange Dimensions on page 132 for more information about the tool flange grounding point.

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

Chapter 5: Optional Equipment Installation

This chapter describes the process for installing various robot options such as end-effectors.

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

NOTE: Additional optional equipment installation may be necessary for IP54/65 and Cleanroom robot options. Refer to IP54/65 Option Considerations on page 135 and Cleanroom Option Considerations on page 137

5.1 Installing End-Effectors

You must provide, install, and ground (if necessary) any end-effector or other end-of-arm tooling.

You can attach end-effectors to the tool flange using four M5 screws. Refer to Tool Flange Dimensions on page 132 for more information.

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

The tool flange is not grounded to protective earth. If hazardous voltages are present at the end-effector, you must install a ground connection from the base of the robot or the outer link to the end-effector. Refer to Grounding Robot-Mounted Equipment on page 84 for more information.

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

5.2 Mounting Locations for External Equipment

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

Additional Information: Refer to Figure 8-5. for mounting hole dimensional information.

The five locations are shown in the following two figures.

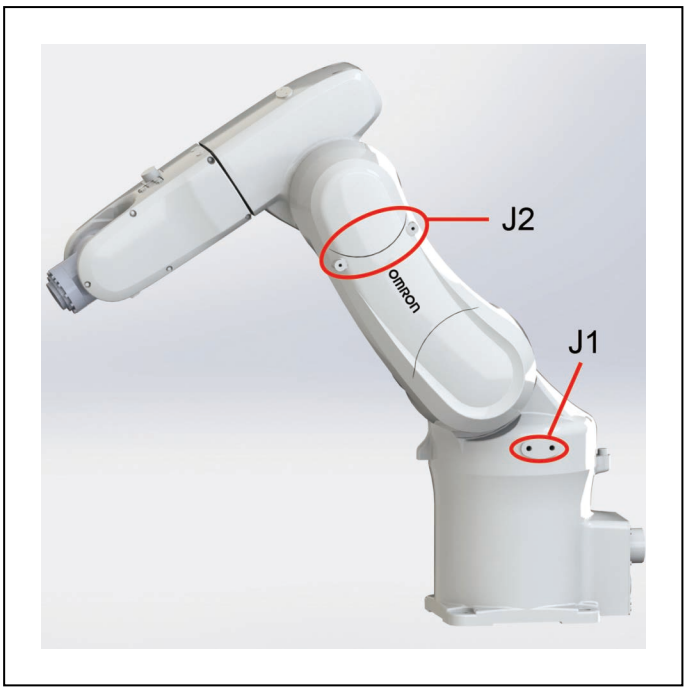


Figure 5-1. External Equipment Mounting Locations for J1 and J2. For J1, there are two holes on each side, so two holes are not visible in this figure.

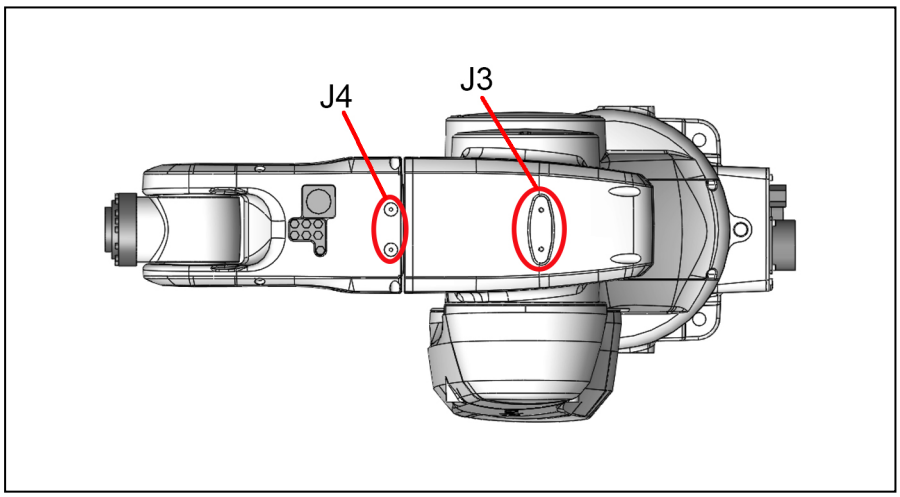


Figure 5-2. External Equipment Mounting Locations for J3 and J4

Chapter 6: System Operation

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

6.1 Verifying Installation

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

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

Mechanical Checks

Perform the following checks to verify proper mechanical installation.

- The robot is mounted in a level manner.

  This can be either floor, table, or ceiling mounted.
- All fasteners are properly installed and tightened to the specified torque.
- Any end-of-arm tooling is properly installed and grounded (if necessary).
- All other peripheral equipment is properly installed and in a state where it is safe to turn ON power to the robot.

System Cable Checks

Make the following checks to verify proper system cable installation.

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

Additional Information: Refer to Basic System Cable Layout on page 59

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

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

User-Supplied Safety Equipment Checks

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

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

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

Table 6-1. Safety Utilities in Sysmac Studio

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

Safety Equipment Check Prerequisites

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

- Sysmac Studio must be installed on a PC 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 XBELTIO connector on the eCS-ECAT interface panel.

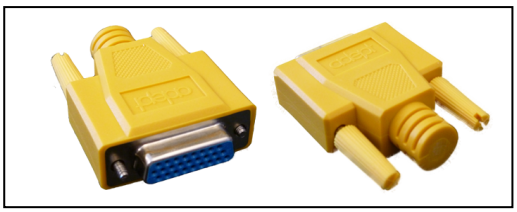


Figure 6-1. Safety Equipment Check Jumper Plug

Switch Position Checks

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

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

6.2 Status LED and Display Panel

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

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

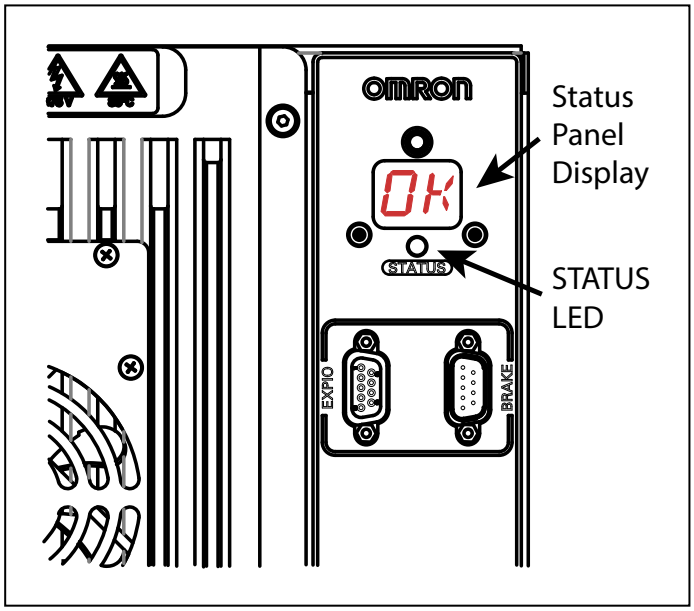


Figure 6-2. eCS-ECAT Status LED and Display Panel

General Robot States

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

Table 6-2. General Robot State Descriptions

Status LED	Display Panel	Description
OFF	Off	24 VDC power not present
OFF	OK	High power disabled
OFF	ON	High power enabled
ON Solid	Status Code(s) E1, 2, 3 . . .	Robot reboot in progress. Refer to Status Codes on Status Codes Table on page 145 for more information.
ON, Fast Flashing (5 Hz)	Status Code(s)	System fault is present. Refer to Status Codes on Status Codes Table on page 145 for more information.

6.3 EtherCAT Communications Description

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

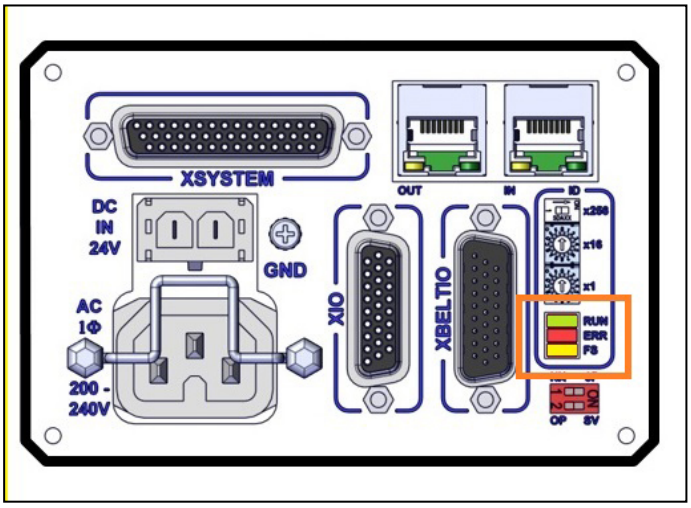


Figure 6-3. EtherCAT LED Location

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

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

Use the table below to understand EtherCAT communication states.

LED	Color	Status	Description
RUN	Green	Lit	EtherCAT communications are in progress.
		Flashing	EtherCAT communications are established and in one of the following states: • 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 and 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.

6.4 Brakes

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

> **NOTE:** The braking system will not prevent you from moving Joint 1 of the robot manually after the robot has stopped and high power has been removed.

Joints J2 through J6 have electromechanical brakes that release when high power is ON. When high power is turned OFF, the brakes engage and hold the joints in position.

WARNING: Secure the robot prior to releasing the brakes on axes 2 or 3, to prevent injury to personnel or equipment damage.

Brake Release Connector

The 9-pin Brake Release connector provides an interface for connecting a manual brake release box.

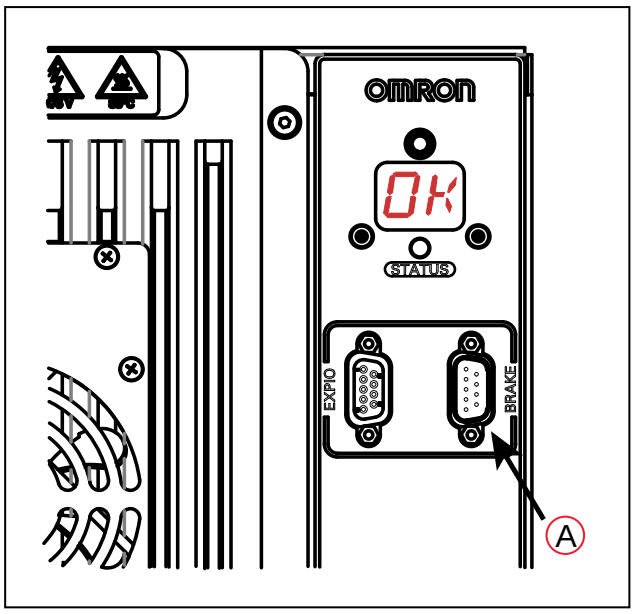
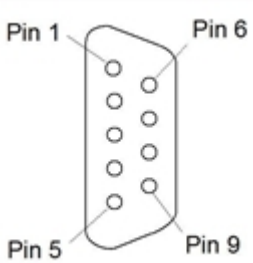


Figure 6-4. eCS-ECAT Showing (A) Brake Release Connector

Table 6-3. Brake Release Connector Pinouts

Pin #	Description	Pin Location
1	Release1_N	
2	Release2_N	
3	Release3_N	
4	Release4_N	
5	Release5_N	
6	Release6_N	
7	GND	
8	Not connected	DB-9 Female Brake Connector
9	24 V	
Mating Connector: D-Subminiature 9-Pin Male		

Installing and Using the Brake Release Box

This procedure describes how to install and use a brake-release box on Viper robots. The brake-release box is an option, which must be purchased.

Refer also to the following figure.

1. Make sure that high power is off.
2. Connect the 9-pin male D-sub connector into the 9-pin female D-sub connector marked BRAKE on the eCS-ECAT.
3. Press one of the E-Stops (Pendant, Front Panel, or external).

NOTE: As a safety precaution, an E-Stop should be activated before releasing an axis using the brake release box.

4. Using the axis selector switch, select the axis on which you want to release the brake.

   Note that axis 1 does not have a brake.

5. Press and hold the Brake Release push button to release the brake.

6. Repeat steps 4 and 5 above for releasing the brakes on another axis.

NOTE: When the Status LED (Green) is on, it indicates that the brake-release box is receiving power (i.e. plugged into a Viper that is turned on).

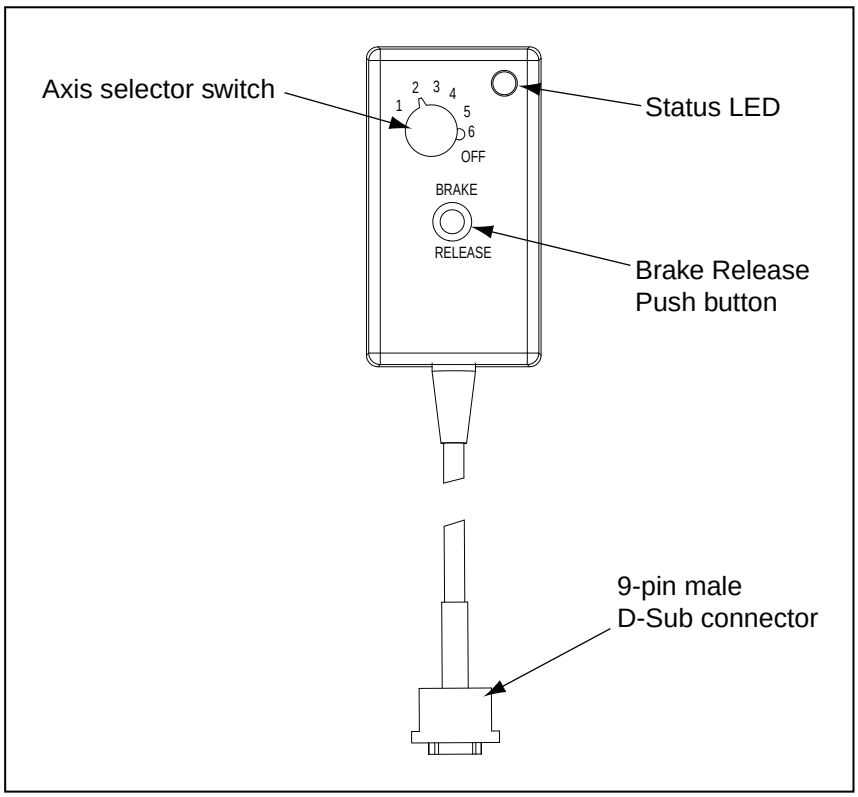


Figure 6-5. Brake-Release Box

NOTE: The cable for the break-release box is 4.6 m long.

6.5 Robot Control Modes

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

Manual Mode

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

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

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

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

Automatic Mode

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

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

DANGER: PERSONAL INJURY RISK
The robot can move unexpectedly in Automatic mode. Ensure that personnel stay clear of the robot work area.

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

Operation Mode

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

To place the robot in operation mode, set the OP/SV two-position dip switch on the eCS-ECAT 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. Remove all robot power before changing the position of this switch.

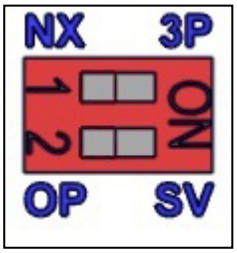


Figure 6-6. Operation Mode Selected

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.
- The robot needs factory recalibration.

6.6 Manually Jogging the Robot

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

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

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

6.7 Enabling Robot High Power

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

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

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

Enabling the robot high power for the first time after system power-up executes a calibrate function that uses the joint calibration offsets to update the current position of the robot. This does not perform a full robot hardware calibration.

NOTE: The calibration offsets are determined during a full robot hardware calibation. Refer to the *eV+3 Keyword Reference Manual (Cat. No. I652)* and the *eV+3 User's Manual (Cat. No. I651)* for information on the CALIBRATE keyword. (This does not cover full hardware calibration, though.)

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 43 for more information.

High Power and Faults

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

This switch defaults to disabled, so high power remains on after the following non-fatal errors, to allow for program automatic recovery from errors without manual intervention:

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

The setting of this switch has no effect during manual mode.

High Power Request Methods

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

Request High Power with the Front Panel

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

> **Additional Information**: Refer to Front Panel Schematic on page 43 for more information about connecting external devices to the high power enable signal on the XFP connector.

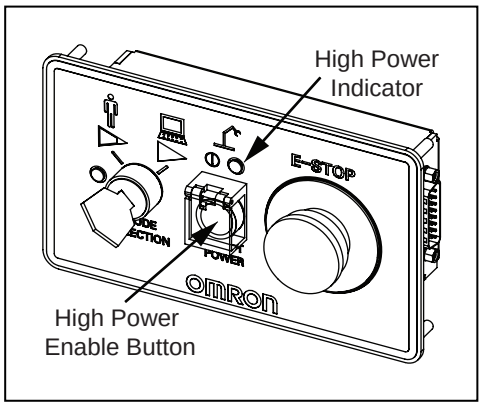


Figure 6-7. High Power Button on Front Panel

Request High Power with a Connected PC

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

Request High Power with a User Program

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

Request High Power with the Pendant

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

1. Verify that the eCS-ECAT 2-digit display reads OK (OK), and the status LED is off. Refer to the following figure.

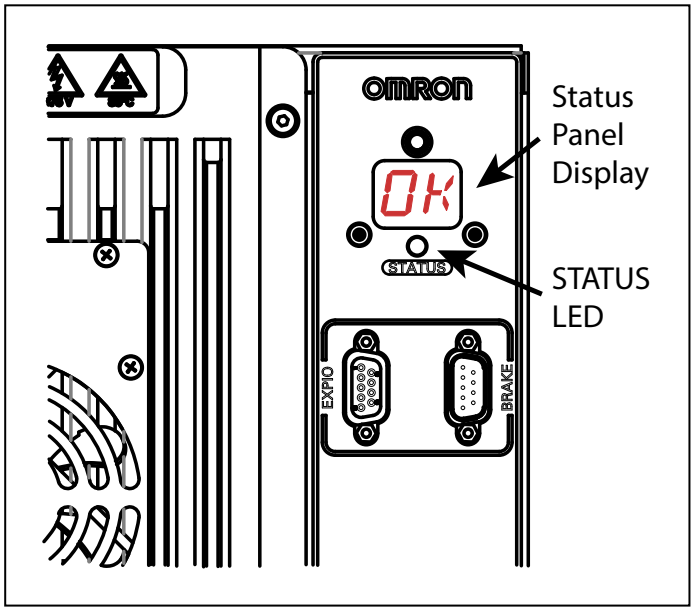


Figure 6-8. eCS-ECAT (A) Status Display and (B) LED

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

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

6.8 Disabling Robot High Power

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

- Robot faults - refer to High Power and Faults on page 98 for more information.
- E-stop open circuit detection.

- User programming of the POWER system switch or an NJ function block.
  Refer to the *eV+3 User's Manual* (Cat. No. I651) or the *Sysmac Studio Version 1 Operation Manual* (Cat. No. W504) for more information.
- External signal state control through the XUSR connector on the XSYSTEM cable.

Chapter 7: Maintenance

This chapter provides information about maintaining the robot.

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

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

7.1 Periodic Maintenance

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

> **NOTE:** Additional maintenance may be necessary for IP54/65 and Cleanroom robot options. Refer to IP54/65 Option Considerations on page 135 and Cleanroom Option Considerations on page 137 for more information.

Periodic Maintenance Schedule

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

Table 7-1. Inspection and Maintenance

Item to Inspect	Period	Reference
Check E-Stop, enable and key switches, and barrier interlocks	6 months	Checking Safety Functions on page 102
Check robot mounting bolts	6 months	Refer to Checking Robot Mounting Bolts and Cover Plates on page 102
Check Safety Labels	1 week	Refer to Checking Safety and Warning Labels on page 103
Check the High Power indicator operation	1 week	Refer to High Power Indicator Check on page 102
Replace encoder battery	2 to 4 years	Replacing the Encoder Batteries on page 103

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

Checking Safety Functions

E-Stops and Enabling Switches

All safety devices in the system should be checked regularly for proper functionality. Operating any of the following safety devices should disable robot High Power.

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

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.

> **IMPORTANT:** The High Power indicator must be operational to satisfy safety requirements.

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 supplies need 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 *Sysmac Studio Version 1 Operation Manual (Cat. No. W504)* for more information.

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

1. Apply Control Power to the robot and disable High Power.
2. Make a High Power request using one of the methods described in High Power Request Methods on page 98.
3. Check that the High Power indicator flashes. After the High Power request is made and the indicator is checked, the procedure is complete.

Checking Robot Mounting Bolts and Cover Plates

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

Checking Safety and Warning Labels

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

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

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

Read User's Manual, Impact Warning Label

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

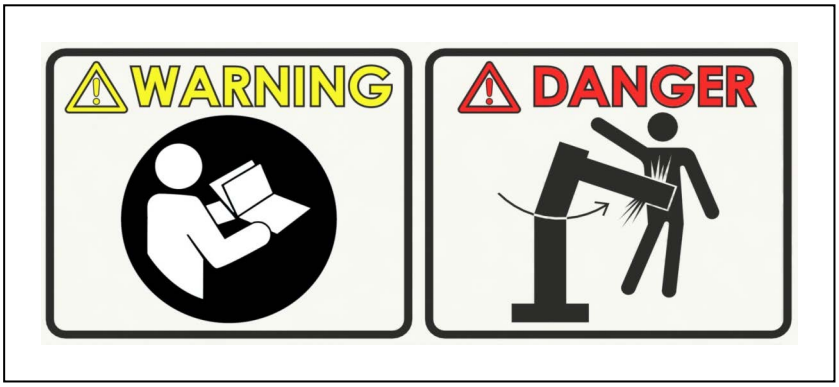


Figure 7-1. Read Manual and Impact Warning Label

This is placed in the following location on the robot:

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

Replacing the Encoder Batteries

Every 2 to 4 years, or if the eCS-ECAT's 2-digit Status Display shows the battery low BA (BA) error, you must replace the batteries to prevent loss of encoder data (which renders the robot inoperative). The data stored by the encoders is protected by 3.6 V lithium backup batteries located under a cover on the link just above the base of the robot.

The replacement battery part number is 05234-000, which includes three individual batteries.

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

Encoder Battery Replacement Time Periods

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

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

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

Battery Replacement Procedure

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

CAUTION: DC power must remain supplied to the eCS-ECAT during this procedure or encoder data could be lost.

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

1. Prepare a new set of three backup batteries for replacement.
2. Turn off AC power to the eCS-ECAT.

   IMPORTANT: Do NOT turn off the 24 VDC to the eCS-ECAT, and do not disconnect the arm/power cable between the eCS-ECAT and the robot.

3. Remove the cover from the robot. See the following figure.

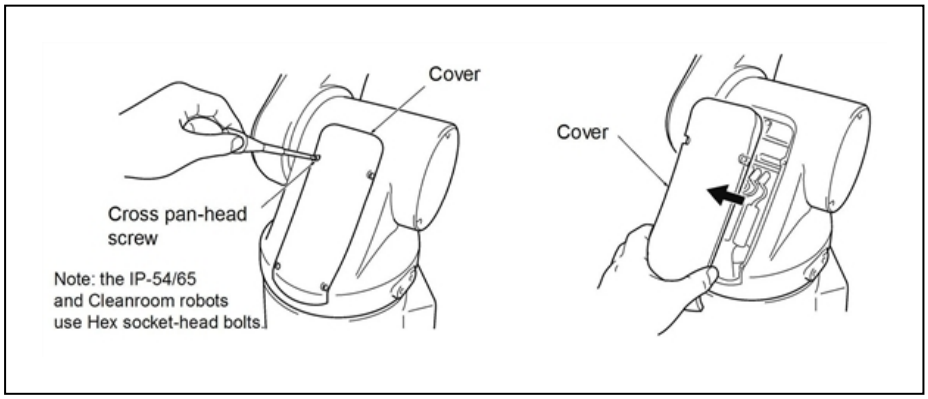


Figure 7-3. Removing Cover to Replace Encoder Batteries

4. Remove the dummy connector cap from the battery board. See the following figure.

   NOTE: Newer robots (which includes those with an eCS-ECAT) have PCAs with only three battery connections, therefore, they do not have dummy connectors. For those robots, remove and replace all three batteries one at a time. This is the reason that 24 VDC must be left on for this procedure.

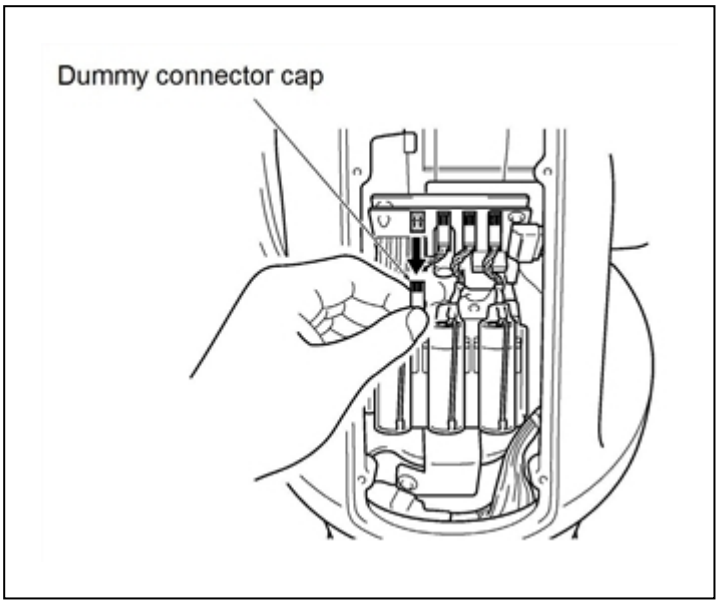


Figure 7-4. Removing Dummy Connector Cap

5. Connect a new battery (1st one) to the pin from which you disconnected the dummy connector cap in the previous step. See the following figure.

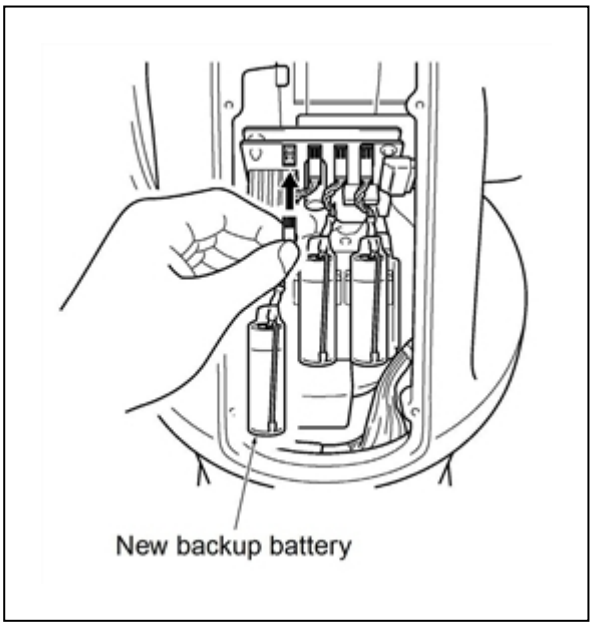


Figure 7-5. Connecting First New Battery

6. Disconnect the old backup battery that is next to the new battery connected in the previous step, and then connect a new battery (2nd one). See the following figure.

   NOTE: Be sure to replace all three old batteries with a new set. Otherwise, the battery service life will be reduced.

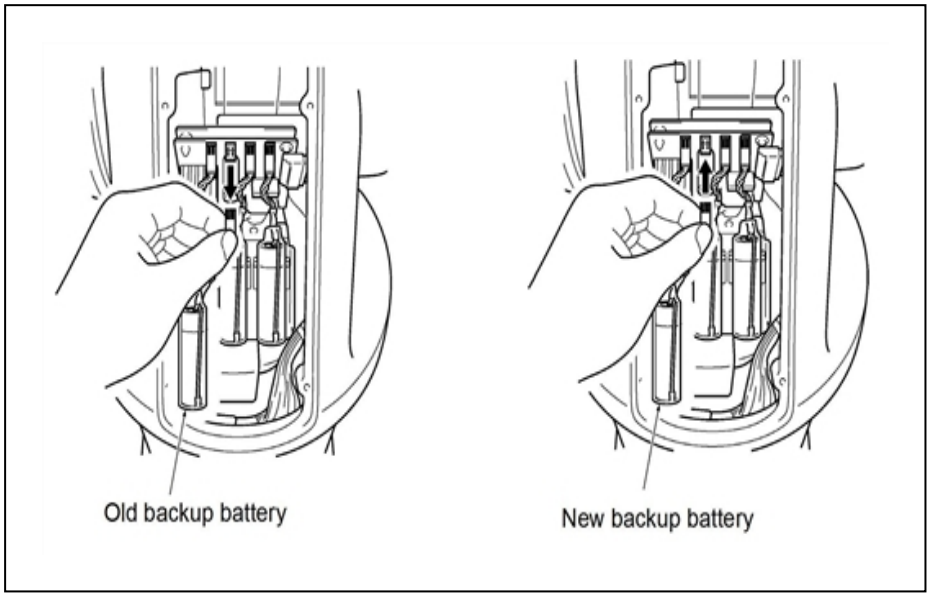


Figure 7-6. Connecting Second New Battery

7. Disconnect the old backup battery that is next to the new battery connected in the previous step, and then connect a new battery (3rd one). See the following figure.

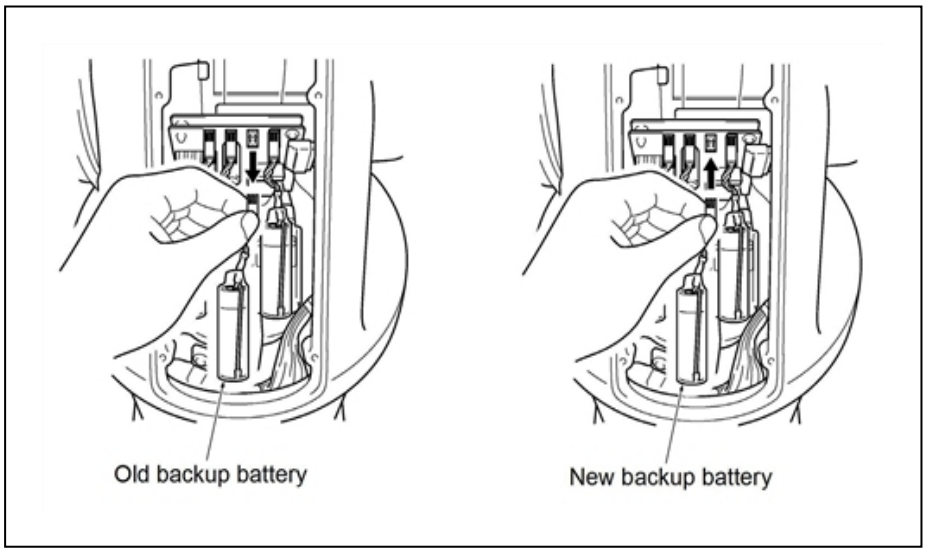


Figure 7-7. Connecting Third New Battery

8. Remove the last old battery and connect the dummy connector cap disconnected in Step 4. See the following figure.

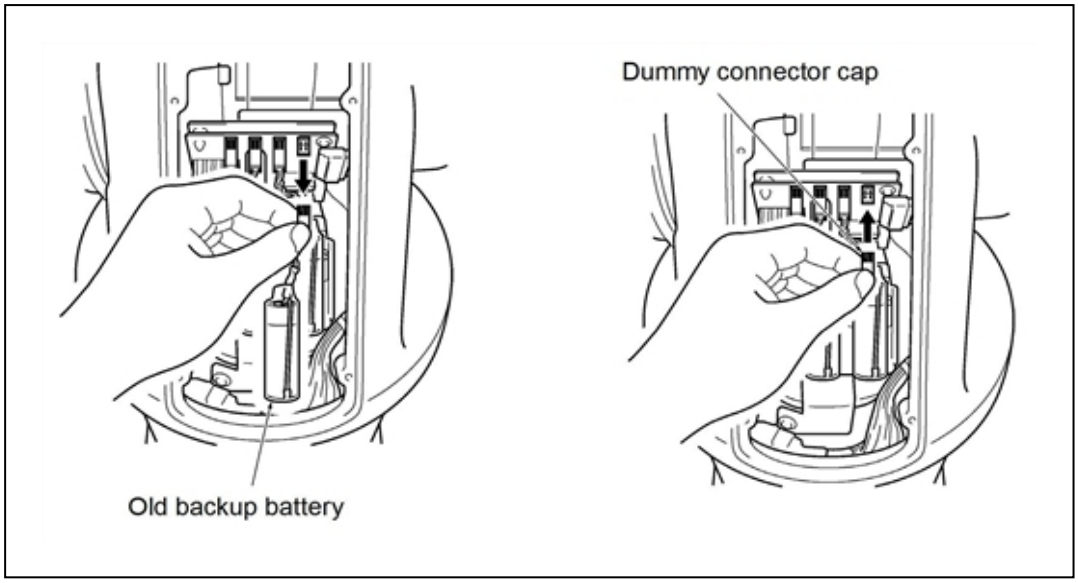


Figure 7-8. Reconnecting Dummy Connector Cap

9. Replace the cover on the robot.
    - Tightening torque: standard models - Phillips-head screw: 0.59 N·m
    - Tightening torque: IP54/65 and cleanroom models - Hex socket bolt: 2.0 N·m

7.2 Non-Periodic Maintenance

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

Field-Replaceable Parts

This section provides details about field-replaceable parts.

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

DANGER: ELECTROCUTION RISK
During maintenance, you must use fail-safe lockout measures to prevent unauthorized third parties from turning on power.

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

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

Table 7-2. Non-periodic Field-replaceable Parts

Item	OMRON Part Number
eCS-ECAT	29600-000F
MicroSD card	Contact your local OMRON support if you need to replace your MicroSD card.

Replacing the eCS-ECAT Amplifier Chassis

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

IMPORTANT: The Teach Restrict and E-Stop hardware delay configurations are lost when replacing an eCS-ECAT unit. These safety settings must be configured after replacing the eCS-ECAT amplifier. Refer to the *Sysmac Studio Version 1 Operation Manual (Cat. No. W504)* for more information.

IMPORTANT: When replacing an eCS-ECAT amplifier chassis, make a note of the Node ID address settings on the old eCS-ECAT. The settings on the new unit will need to be set to match those of the unit being replaced.

CAUTION: PROPERTY DAMAGE RISK
Follow appropriate ESD procedures when removing or replacing the chassis.

Removing the eCS-ECAT from the Robot System

Use the following procedure to remove the eCS-ECAT from the robot system.

1. Switch off the 24 VDC and 200-240 VAC input supplies to the eCS-ECAT.
2. Disconnect the 24 VDC supply cable from the eCS-ECAT.
3. Disconnect the 200-240 VAC supply cable from the eCS-ECAT.
4. Disconnect all other cables from the eCS-ECAT.
5. Remove and retain the microSD card for insertion into the replacement eCS-ECAT. Refer to Remove and Replace a MicroSD Card on page 109.
6. Attach a tag to the eCS-ECAT listing the fault diagnosis, faults or errors, and robot serial number information.

Installing a New eCS-ECAT

Use the following procedure to install a new eCS-ECAT.

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

1. Carefully remove the new eCS-ECAT from its packaging, check it for any signs of damage, and remove any foreign packing materials or debris.
2. If you are replacing an existing eCS-ECAT, insert the microSD card that you removed from the failed unit into the new eCS-ECAT.
3. Carefully place the eCS-ECAT next to the robot.
4. Connect all cables and wires that were removed when removing the old eCS-ECAT.
5. Connect the 24 VDC cable to the VDC plug on the eCS-ECAT.
6. Connect the 200-240 VAC cable to the VAC plug on the eCS-ECAT.
7. Switch ON the 200-240 VAC input supply to the eCS-ECAT.
8. Switch ON the 24 VDC input supply to the eCS-ECAT.
9. After the eCS-ECAT has completed booting:
   - Verify that the new eCS-ECAT passes the safety equipmjent checks. Refer to User-Supplied Safety Equipment Checks on page 90.

     In general, if the eCS-ECAT has passed the safety utilities on one Viper, it can be used on another Viper without running those utilities again. If the Sysmac safety utilities were never run, you will have to run them. Refer to User-Supplied Safety Equipment Checks on page 90.
   - Test the system for proper operation.

Remove and Replace a MicroSD Card

The eCS-ECAT 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 eCS-ECAT will not function and will not indicate that it is receiving power.

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

Removing a MicroSD Card from an eCS-ECAT

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

1. Make sure that the eCS-ECAT is powered OFF.
2. Disconnect all power and other cables from the eCS-ECAT.
3. Lay the eCS-ECAT on its back.
4. Remove the six M4 screws as shown in the following figure. Save the screws for reassembly.

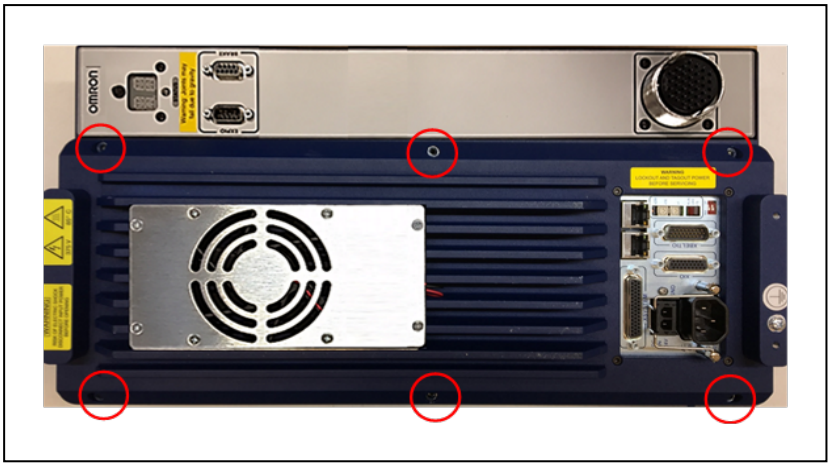


Figure 7-9. eCS-ECAT Bolt Locations (circled)

5. Lift the controller up from the eCS-ECAT frame.

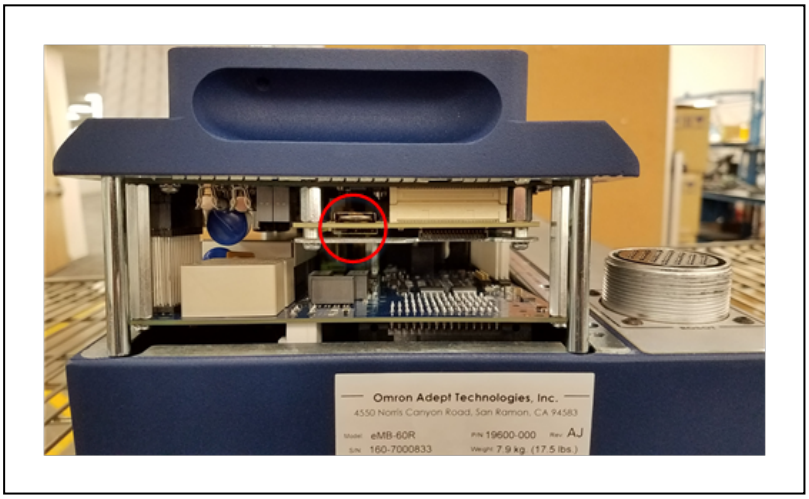


Figure 7-10. eCS-ECAT Lifted with MicroSD Card Circled

NOTE: The circle in the preceding figure includes both the battery, above, and the MicroSD card in the horizontal slot below the battery.

6. Remove the installed MicroSD card (circled in the preceding figure).

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

Replacing a MicroSD Card in an eCS-ECAT

Use the following procedure to replace a MicroSD card.

You must remove the existing MicroSD card before performing these steps.

1. Insert the MicroSD Card until fully seated in its slot, then release.

   Check to see that it remains seated.

2. Reinstall the eCS-ECAT controller back into the eCS-ECAT frame, and secure with the six M4 screws previously removed.
3. Reconnect all cables that were disconnected to access the MicroSD card.
4. Turn on AC and DC power to the eCS-ECAT.
5. Power-on the eCS-ECAT.

Chapter 8: Technical Specifications

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

8.1 Robot Physical Dimension Drawings

This section provides physical dimensions for the Viper 650 and Viper 850 robots and their operating envelopes.

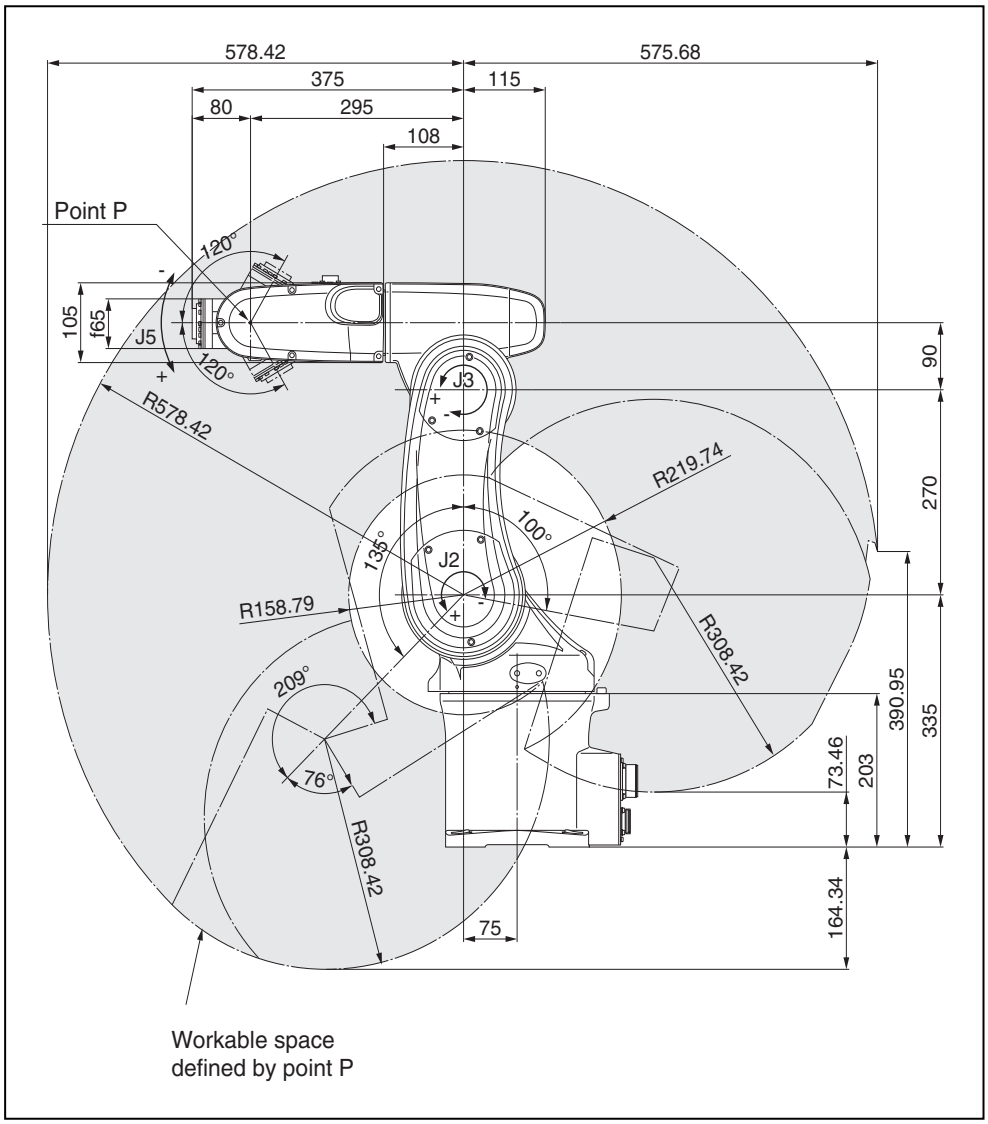


Figure 8-1. Viper 650 Robot Side View Dimensions (units in mm)

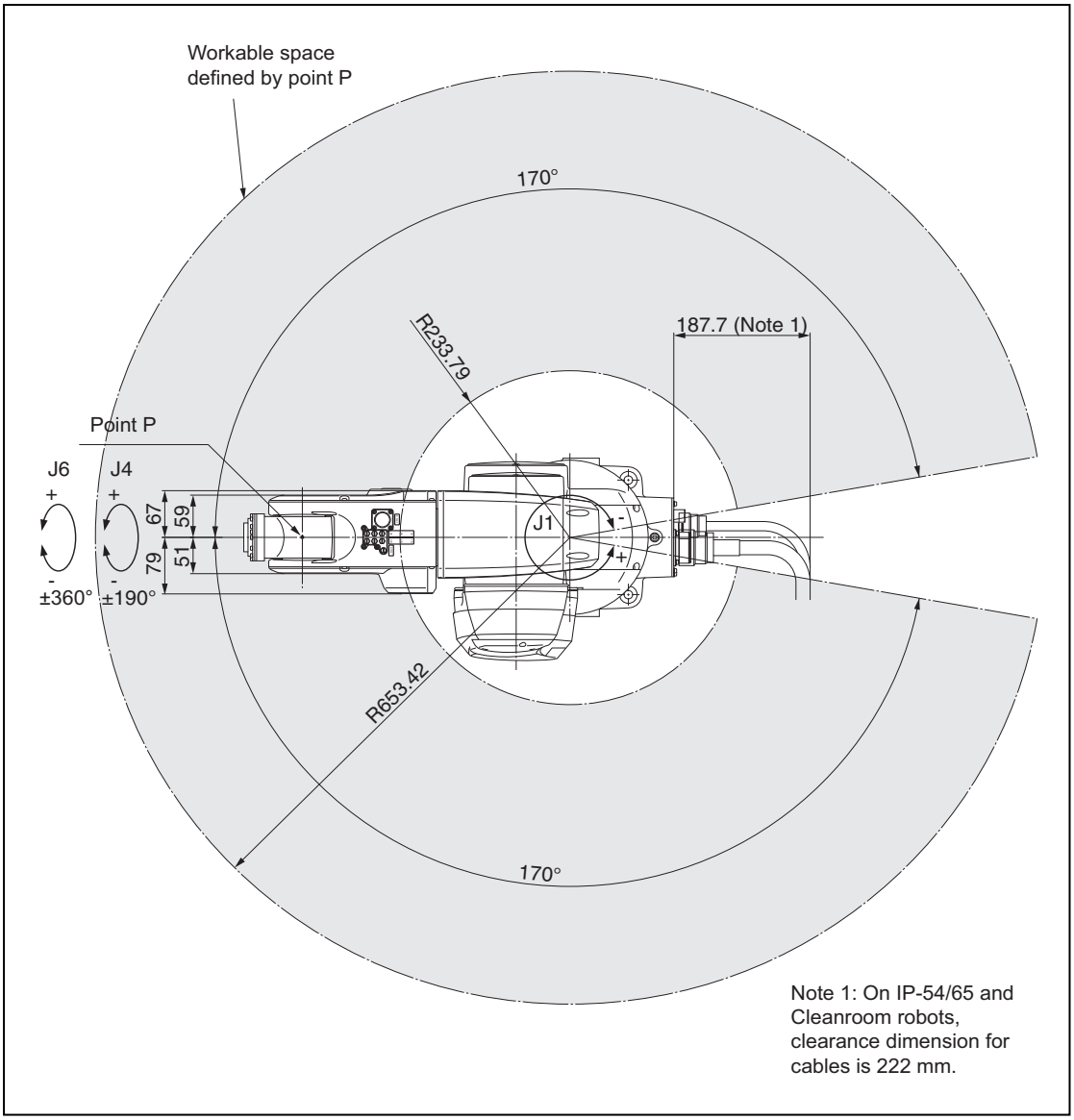


Figure 8-2. Viper 650 Robot Top View Dimensions (units in mm)

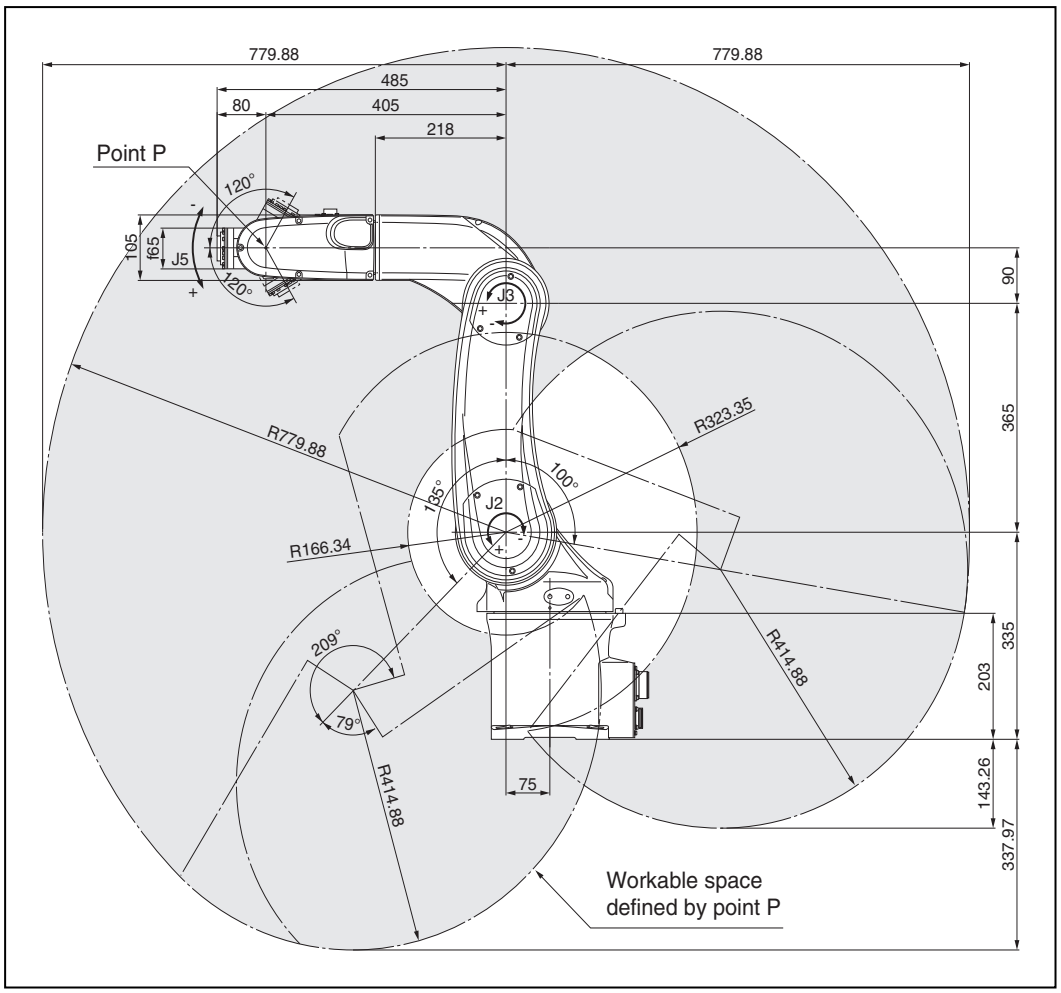


Figure 8-3. Viper 850 Robot Side View Dimensions (units in mm)

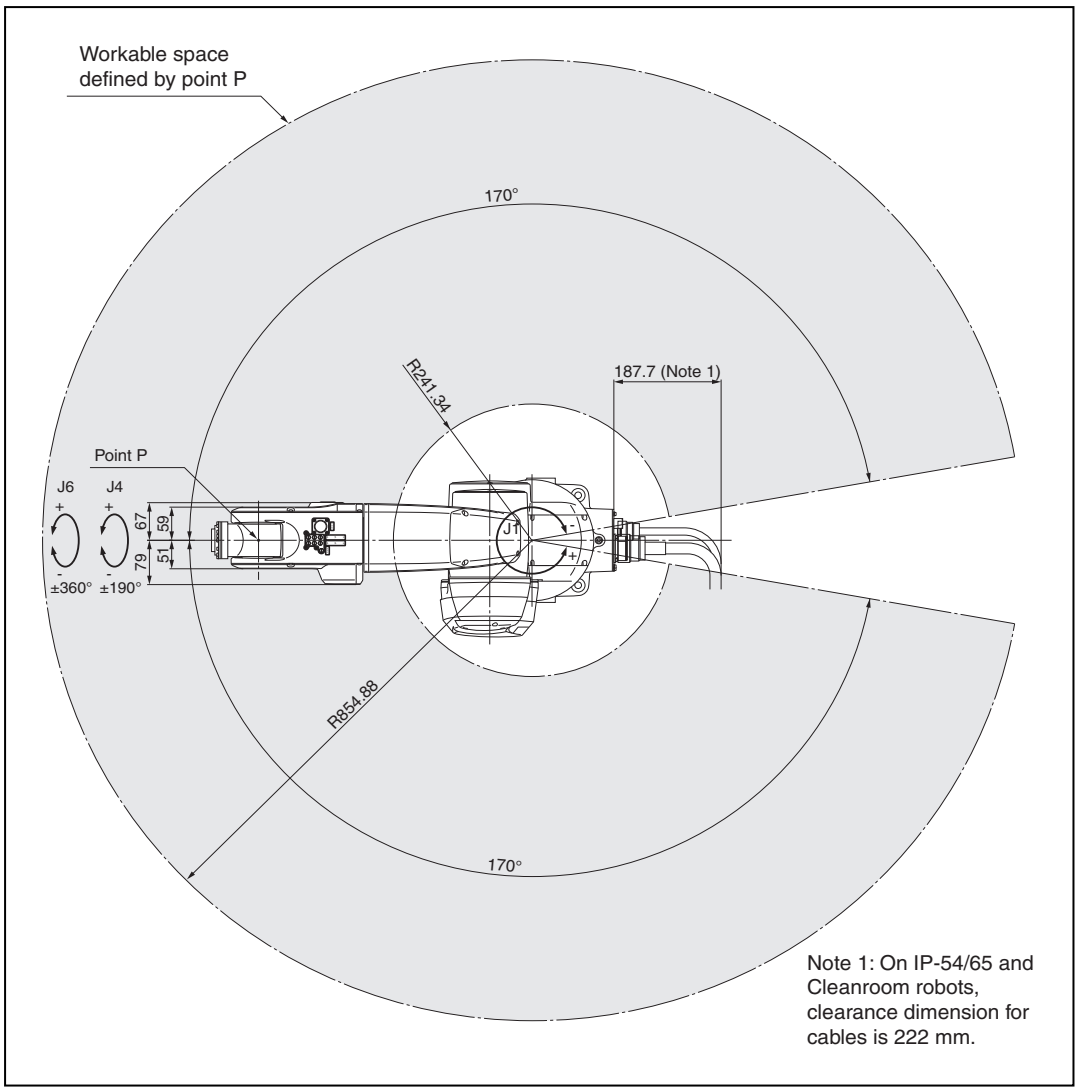


Figure 8-4. Viper 850 Robot Top View Dimensions (units in mm)

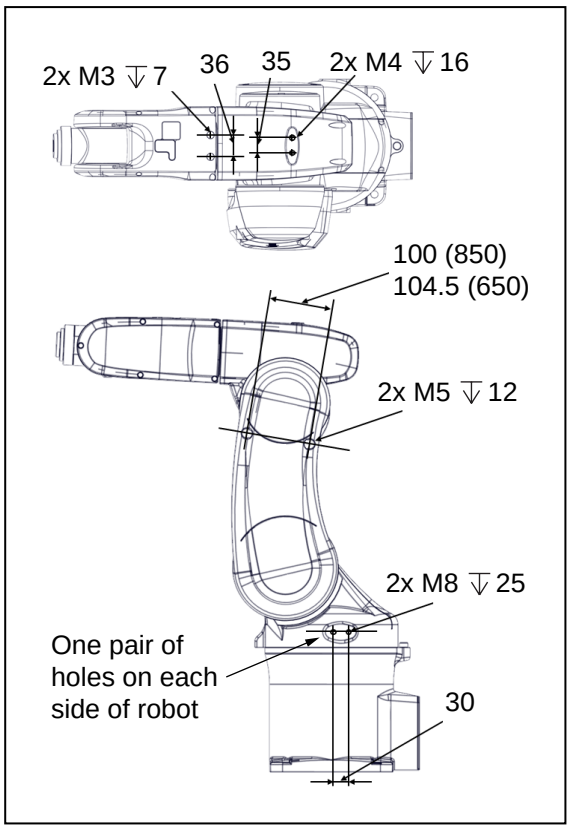


Figure 8-5. External Tooling Mounting Lcations (units in mm)

Refer also to Mounting Locations for External Equipment on page 87.

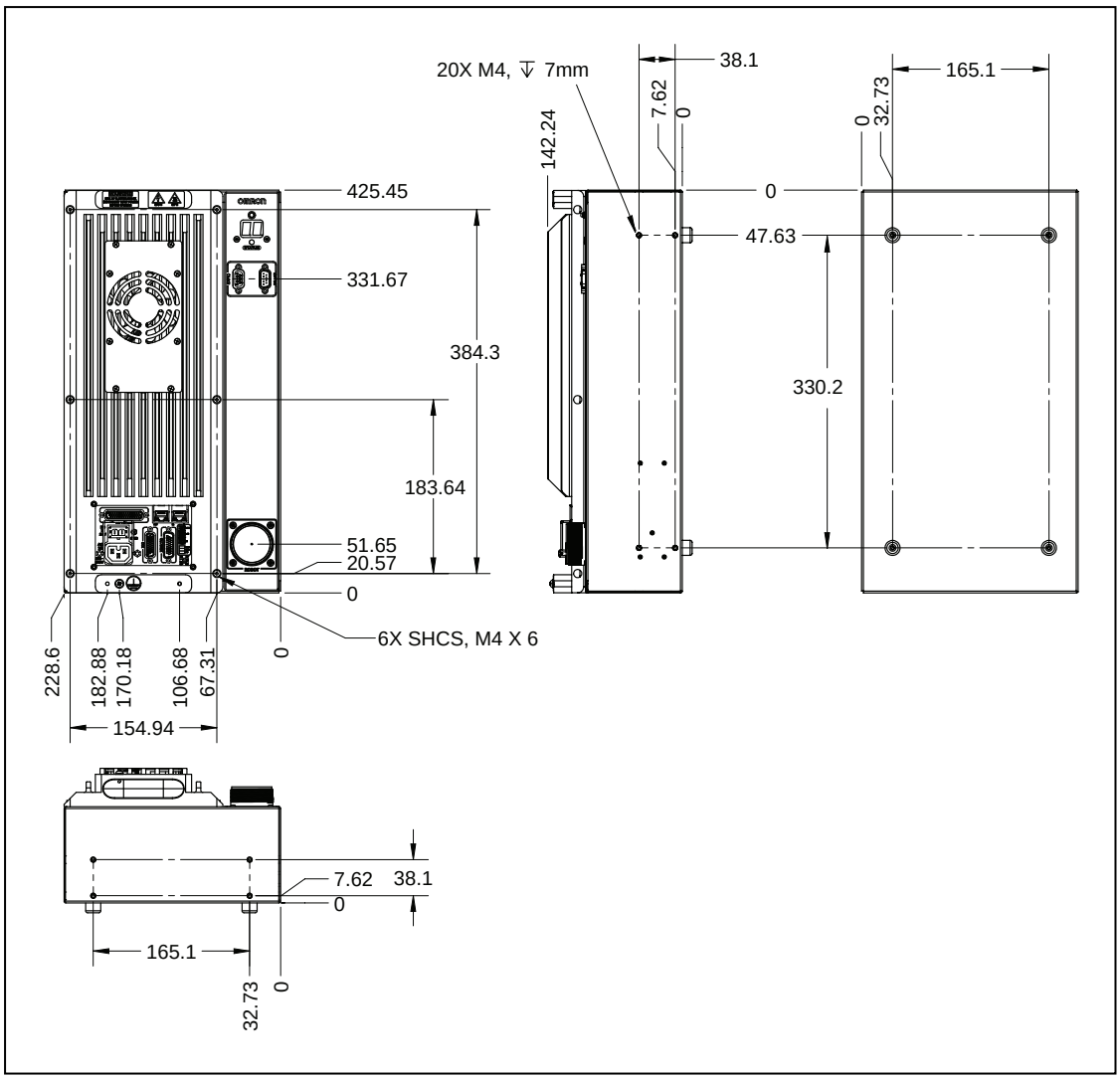


Figure 8-6. eCS-ECAT Dimensions (units in mm)

8.2 General Robot Specifications

The following table provides general robot specifications.

Table 8-1. General Robot Specifications

Item	Viper 650 Robot Specification	Viper 850 Robot Specification
Reach	653 mm	854 mm
Payload—rated	2.5 kg	
Payload—maximum	5 kg	
Encoder types	Absolute	
Drive Motor and Brakes	AC servomotors for all joints, Brakes for joints J2 through J6	

Item	Viper 650 Robot Specification	Viper 850 Robot Specification
Weight (without options)	34 kg	36 kg

8.3 Performance Specifications

This section provides the robot's performance specifications.

General Performance Information

The following table provides general performance information for the robot.

Table 8-2. General Robot Performance Information

Performance Item	Viper 650 and Viper 850 Robots	
Maximum Moment of Inertia	Joint 4 and 5 - 0.295 kg-m^2	
	Joint 6 - 0.045 kg-m^2	
Repeatability	X, Y, Z: ±0.02 mm	X, Y, Z: ±0.03 mm
Joint ranges	Joint 1: ±170°	
	Joint 2: -190°, +45°	
	Joint 3: -29°, +256°	
	Joint 4: ±190°	
	Joint 5: ±120°	
	Joint 6: ±360°	
Maximum Joint speeds	Joint 1: 328°/sec	Joint 1: 250°/sec
	Joint 2: 300°/sec	Joint 2: 250°/sec
	Joint 3: 375°/sec	Joint 3: 250°/sec
	Joint 4: 375°/sec	Joint 4: 375°/sec
	Joint 5: 375°/sec	Joint 5: 375°/sec
	Joint 6: 600°/sec	Joint 6: 600°/sec

Stopping Distances and Times

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

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

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

For stop category 1, the stopping time and distance values depend on the speed, load, and extension of the robot, stated for 33%, 66% and 100% of the maximum payload (5 kg). Data provided is for the three joints of greatest displacement (J1, J2, and J3).

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

Viper 650

In the following charts, the horizontal axis is always speed. The vertical axis will be either time or distance, as noted in the figure caption.

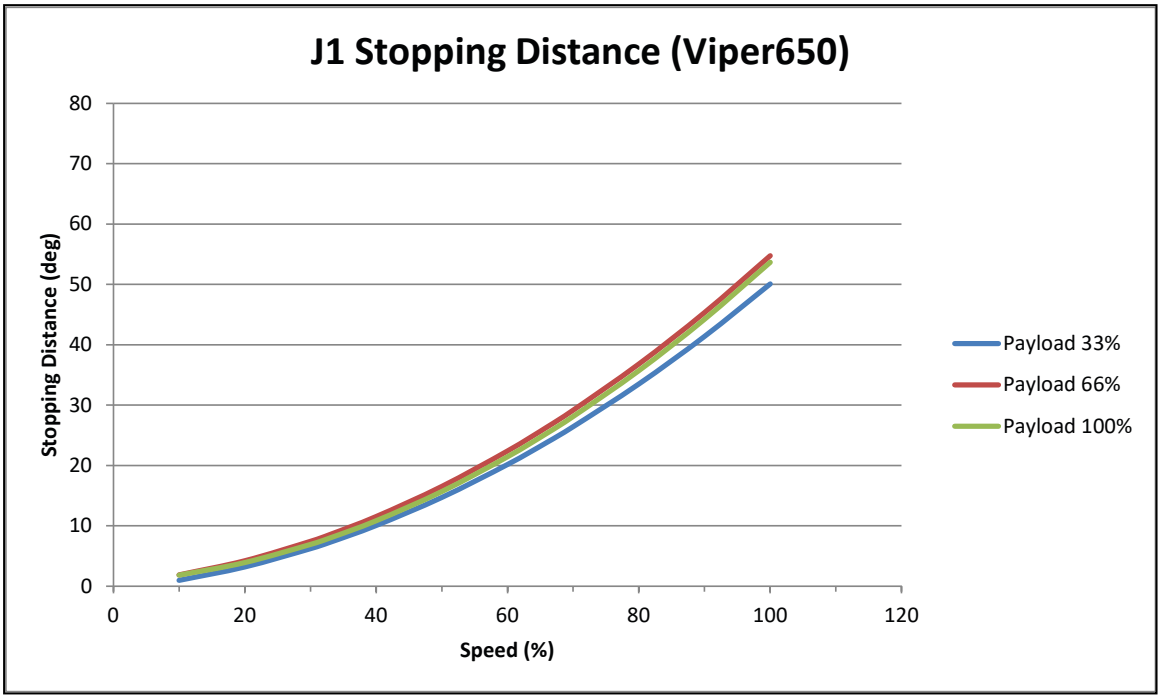


Figure 8-7. Stopping Distance in Degrees versus Speed % for Viper 650 Joint 1

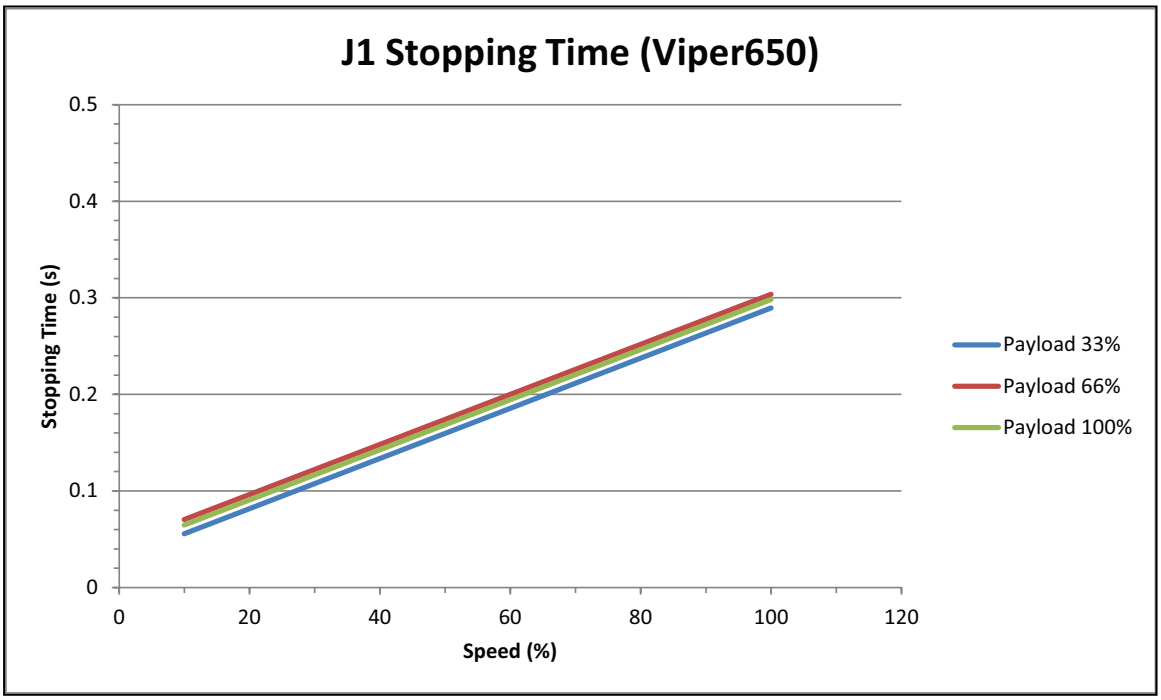


Figure 8-8. Stopping Time in Seconds versus Speed% for Viper 650 Joint 1

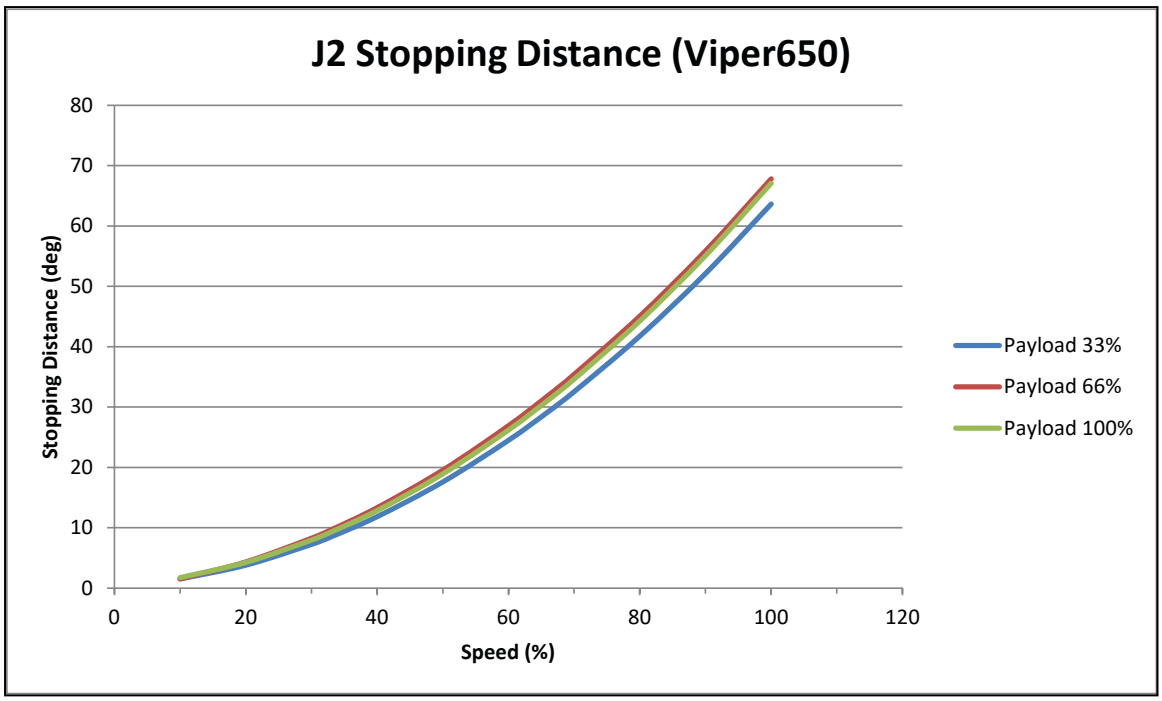


Figure 8-9. Stopping Distance in Degrees versus Speed % for Viper 650 Joint 2

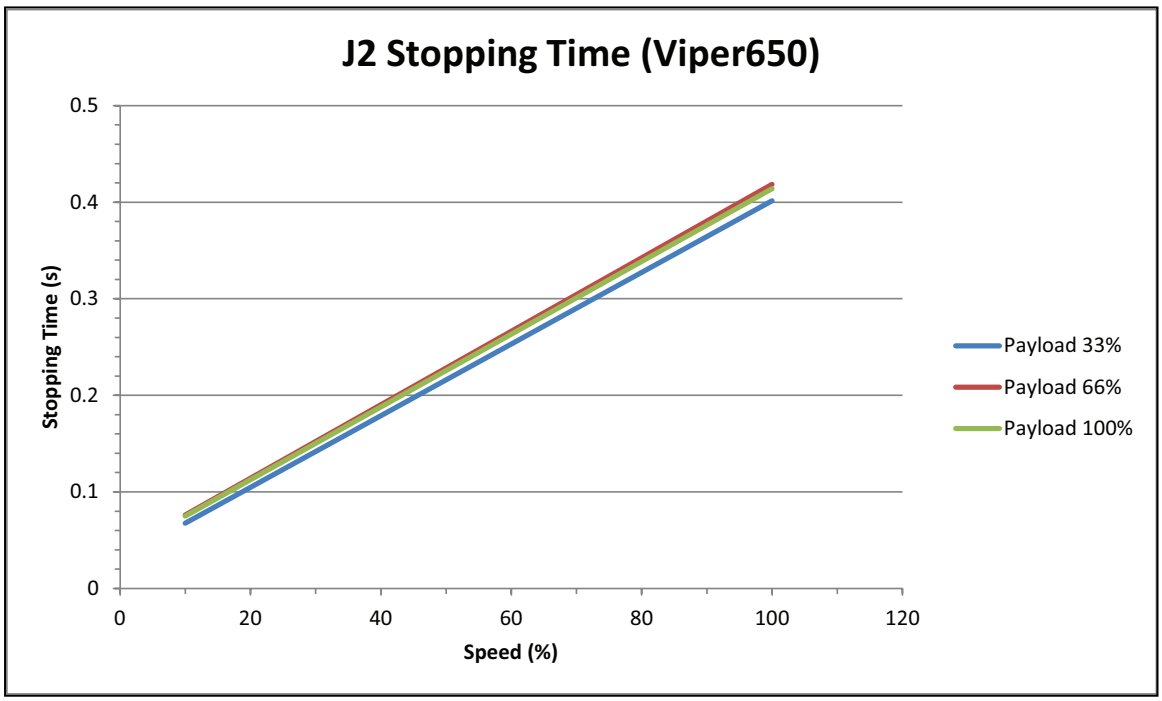


Figure 8-10. Stopping Time in seconds versus Speed % for Viper 650 Joint 2

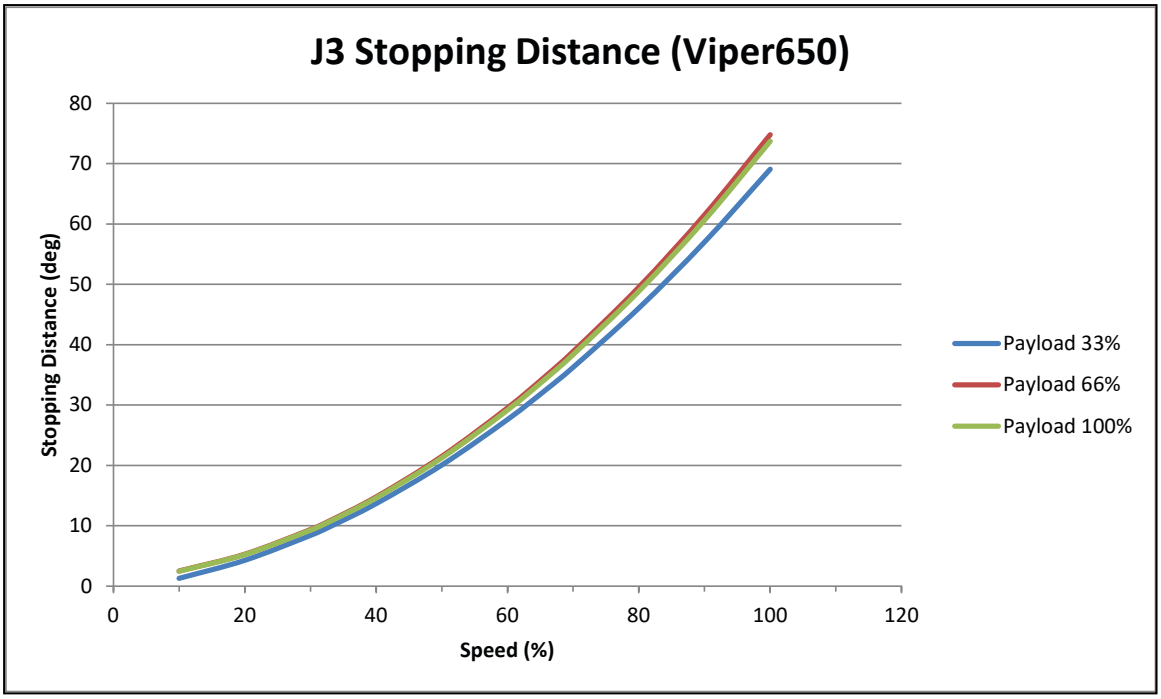


Figure 8-11. Stopping Distance in Degrees versus Speed (%) for Viper 650, Joint 3

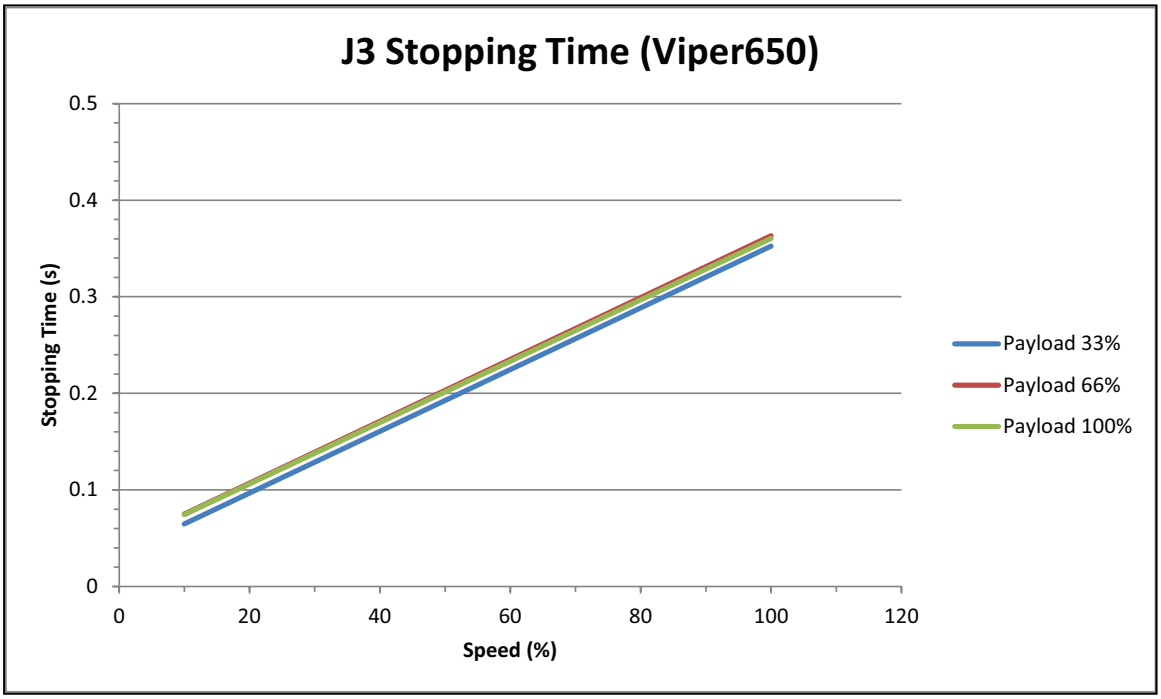


Figure 8-12. Stopping Time in Seconds versus Speed (%) for Viper 650 Joint 3

Viper 850

In the following charts, the horizontal axis is always speed. The vertical axis will be either time or distance, as noted in the figure caption.

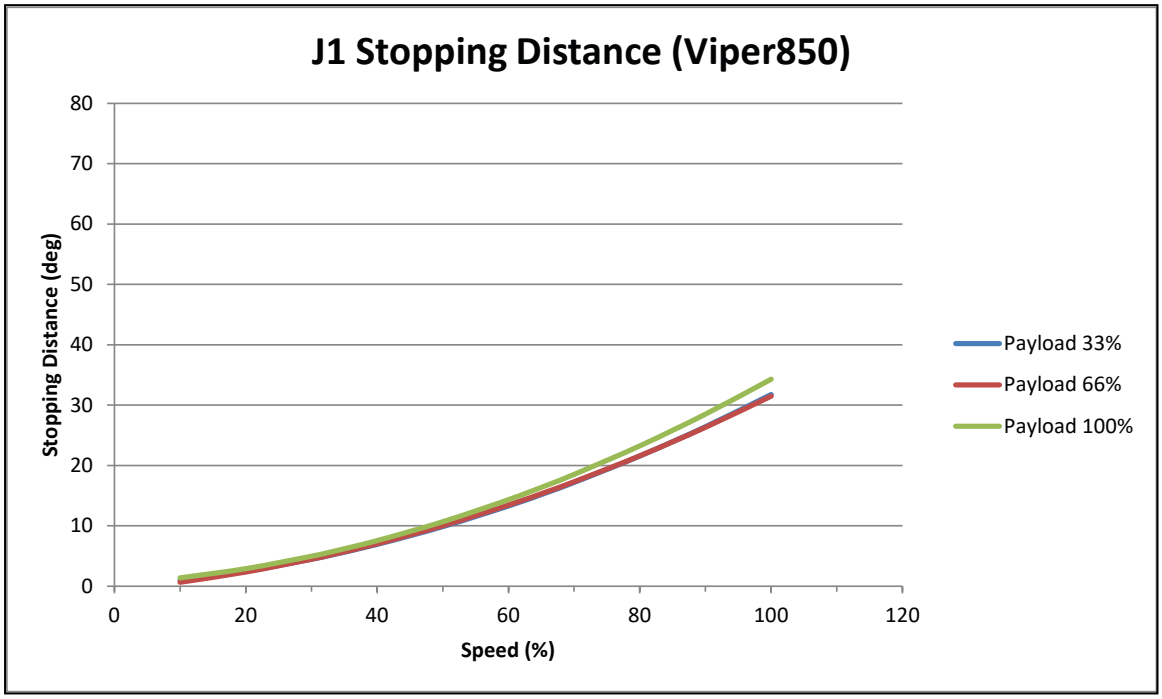


Figure 8-13. Stopping Distance in Degrees versus Speed (%) for Viper 850 Joint 1

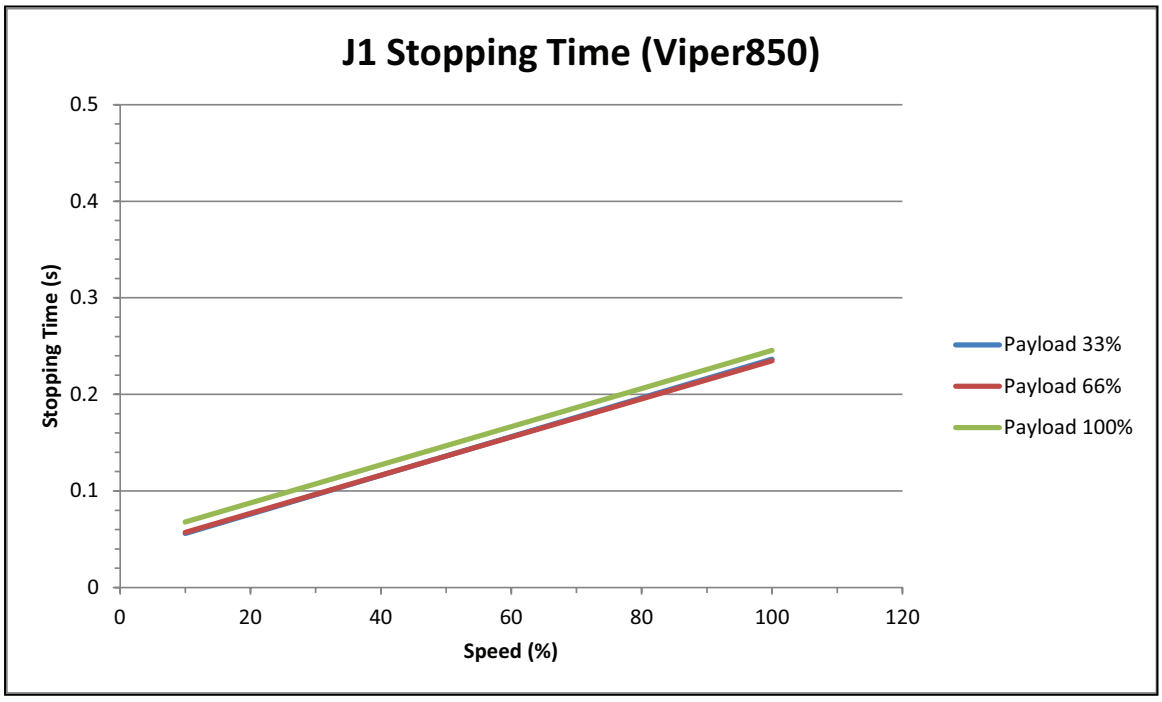


Figure 8-14. Stopping Time in Seconds versus Speed (%) for Viper 850 Joint 1

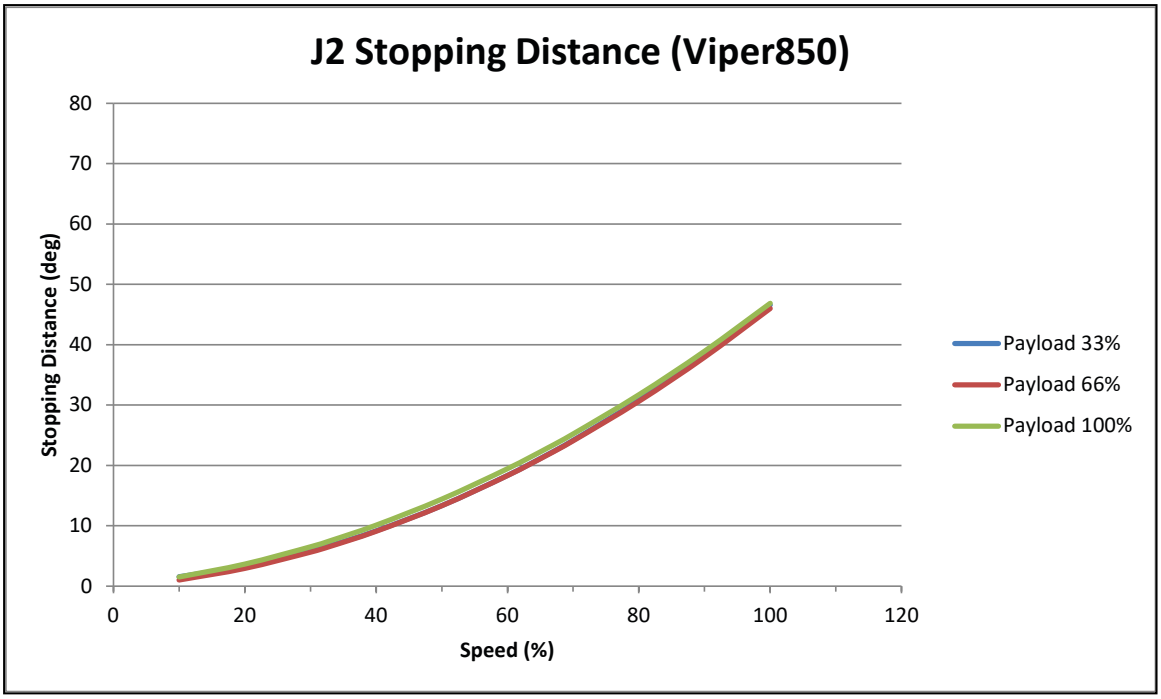


Figure 8-15. Stopping Distance in Degrees versus Speed (%) for Viper 850 Joint 2

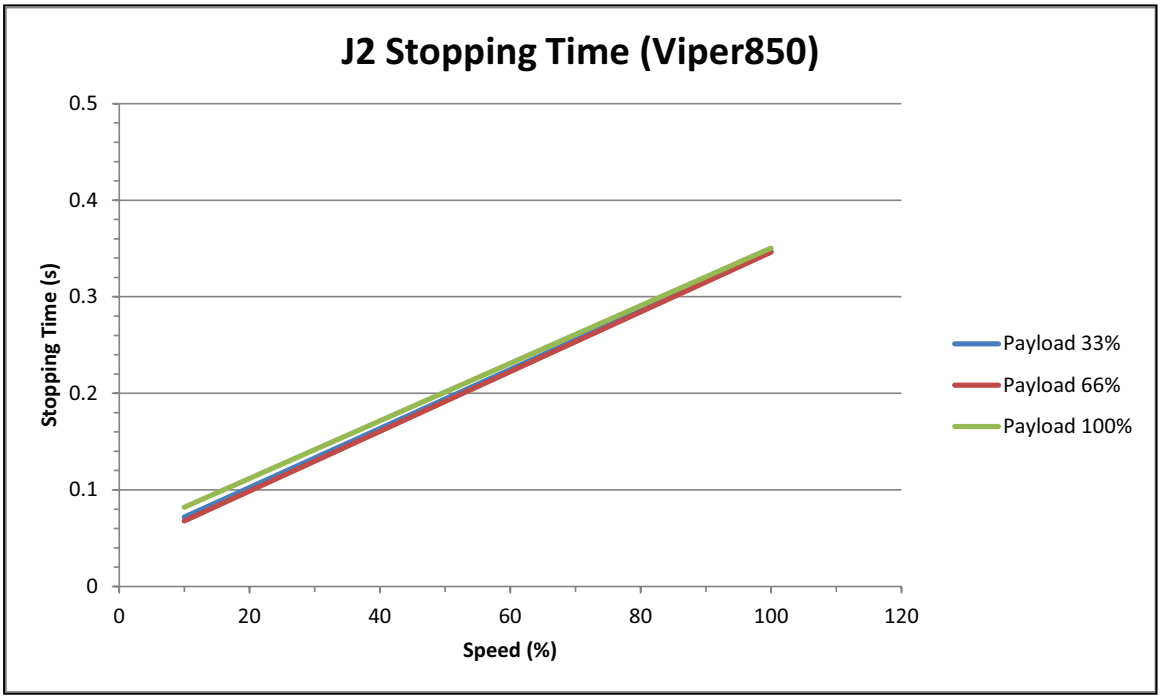


Figure 8-16. Stopping Time in Seconds versus Speed (%) for Viper 850 Joint 2

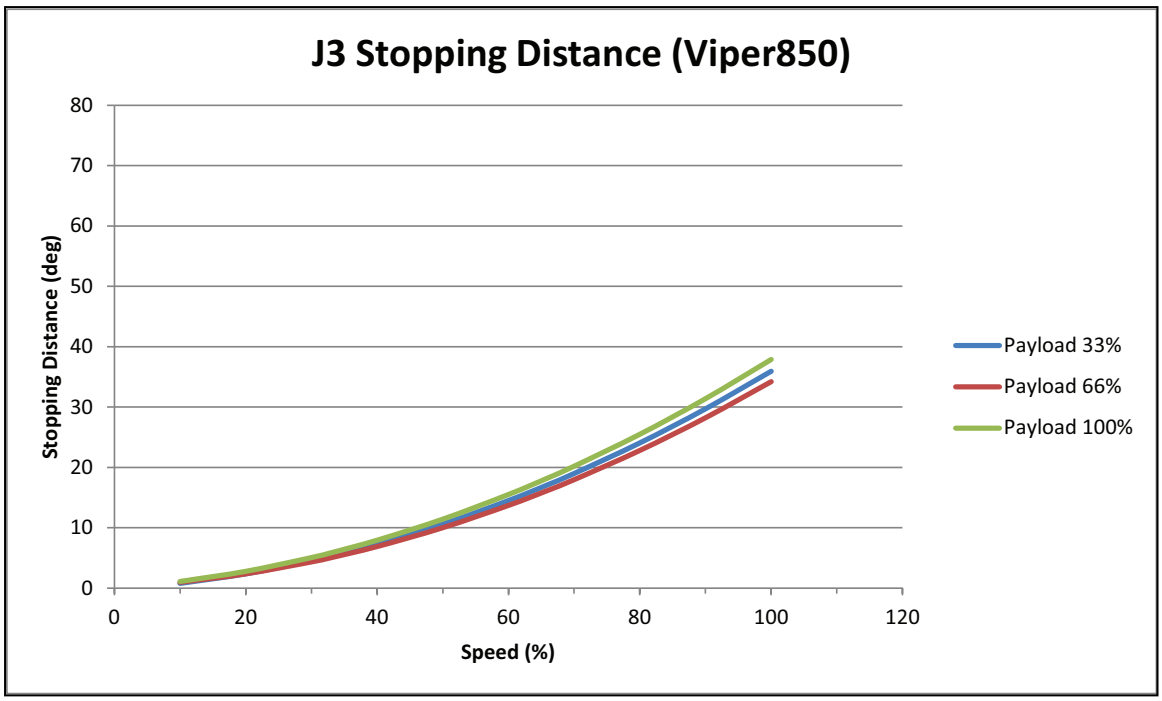


Figure 8-17. Stopping Distance in Degrees versus Speed (%) for Viper 850 Joint 3

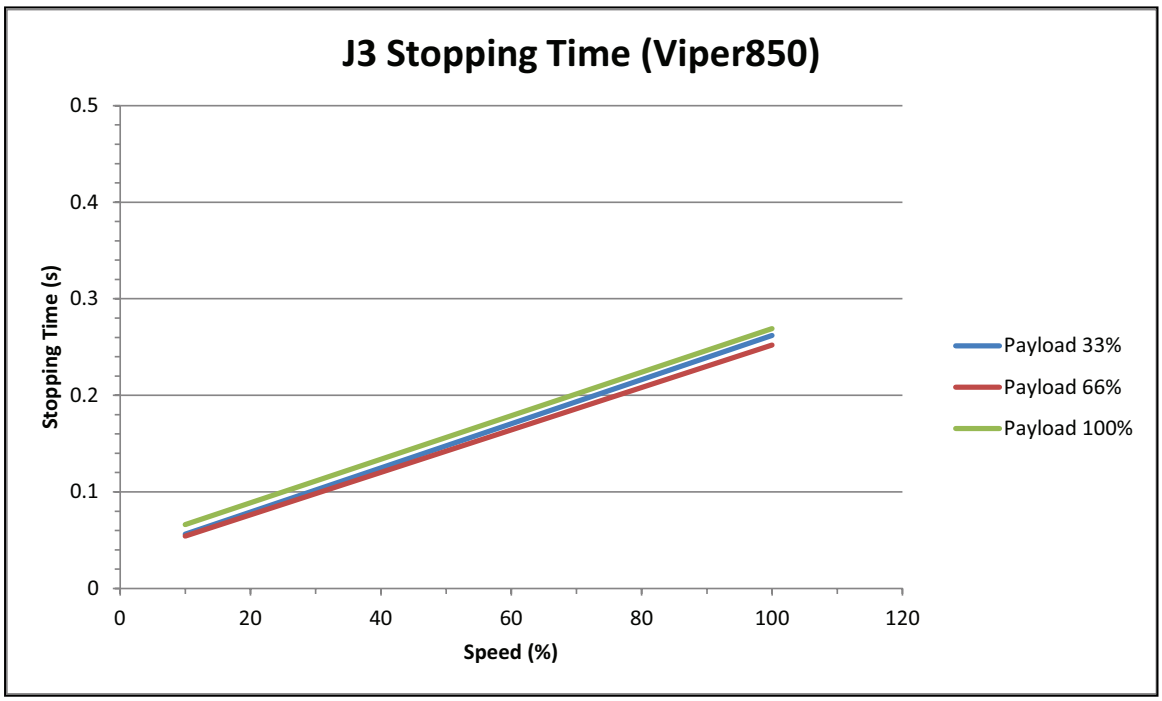


Figure 8-18. Stopping Time in Seconds versus Speed (%) for Viper 850 Joint 3

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

If you want to measure stopping distances and time with your application, contact your local OMRON support.

8.4 Electrical Specifications

The following section provides electrical specifications for the robot system.

Solenoid Valve Specifications

The following table provides specifications for the solenoid valves.

Table 8-3. Solenoid Valve Specifications

	Item	Specifications
Valve	Switching system	2-position double
	Applicable fluid	Air
	Operating system	Pilot type
	Effective cross section (Cv value)	1.2 mm^2
	Lubrication	Oilless
	Operating pressure range	0.1 to 0.7 MPa[a]
	Response time	15 ms or less at 0.5 MPa (72.5 psi)
	Maximum operating frequency	10 Hz
	Ambient temperature	-5 to 50° C (Dry air, non-condensing)
Solenoid	Operating voltage	24 V ±10%
	Power consumption (current)	0.5 W (21 mA)
	Surge voltage protection circuit	Zener diode
[a]Note that the robot is rated at 0.1 to 0.39 MPa, 0.49 Max. This upper limit is lower than the solenoid's upper limit.		

External Connection Specifications

The following table provides external electrical connection specifications.

Table 8-4. External Electrical Connection Specifications

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

Item	Specification	Details
		at both ends of cable.
AC Power	Nominal supply voltage	200 to 240 VAC (auto ranging)
	Minimum operating voltage[2]	180 VAC
	Maximum operating voltage	264 VAC
	Operating frequency	50 / 60 Hz, 1-phase
	Circuit protection	10 A (user-supplied) Refer to AC Power Diagrams on page 80 for more information.
Protective Earth Ground	Grounding resistance: 10 Ω or less	
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	Refer to 24 VDC supply in XIO inputs circuits above for Operational voltage range.	
	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	25 µA

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

Facility Overvoltages Protection

You must protect the robot and eCS-ECAT from excessive overvoltages and voltage spikes. If your country requires a CE-certified installation or compliance with IEC 61131-2, IEC 61131-2 requires that the installation must ensure that Category II overvoltages (i.e., line spikes not directly due to lightning strikes) are not exceeded.

Transient overvoltages at the point of connection to the power source shall be controlled not to exceed overvoltages Category II, i.e., not higher than the impulse voltage corresponding to the rated voltage for the basic insulation. Your equipment or transient suppressor must be capable of absorbing the energy in the transient.

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

8.5 Environment and Facility Specifications

The robot installation must meet the following operating environment specifications.

Table 8-5. Robot System Operating Environment Requirements

Item	Specification
Ambient operating temperature	5 to 40°C 5 to 35°C (cleanroom models)
Temperature during storage and transport	–25 to 60°C
Humidity during operation	5% to 90%, non-condensing
Humidity during storage and transport	75% or less, non-condensing
Altitude	up to 1000 m
Vibration	During operation: 4.9 m/s^2 (0.5 G) or less During storage and transportation: 29.4 m/s^2 (3 G) or less
Pollution degree	2
Protection class	IP40 / NEMA Type 1 (standard version) IP54/65 (IP version)
Installation type	Table-mount, Floor-mount, or Overhead-mount
Flatness of the mounting surface	0.1 mm/500 mm
Cleanroom rating (cleanroom models only)	ISO 4, Fed Reg Class 10

8.6 Other Specifications

Other item specifications are provided in the sections below.

Connector Specifications

Connector specifications are provided in the sections below.

> **NOTE:** Some connection specifications may differ on robots with the IP54/65 or Cleanroom options. Refer to IP54/65 Option Considerations on page 135 and Cleanroom Option Considerations on page 137 for more information.

Table 8-6. Connector Specifications

Item	Specification
Compressed Air Fitting (Cleanroom option only)	6 mm diameter Pressure: 0.3 MPa + 10% Flow: 0.06 m^3/min

Item	Specification
Pneumatic pass-through ports	6 mm diameter (quantity 1) 4 mm diameter (quantity 6)
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

Power Consumption Specifications

Robot power consumption specifications are provided in the table below.

Table 8-7. Typical Robot Power Consumption[1]

Viper Robot	Move	Average Power (W)	Peak Power (W)[2]
650	No load—Adept cycle[3]	371	947
	5 kg—Adept cycle[3]	477	1526
	5 kg—all joints move	834	2088
850	No load—Adept cycle[3]	358	1237
	5 kg—Adept cycle[3]	407	1202
	5 kg—all joints move	704	2090

[1]Typical power data is with 220 VAC, 60 Hz, 1-phase nominal input.

[2]For short durations (100 ms).

[3]Adept cycle: The robot tool performs continuous path, straight-line motions 25 mm up, 305 mm over, 25 mm down, and back along the same path, at 20° C ambient. COARSE is enabled and BREAKs are used at each end location.

Not achievable over all paths.

8.7 Tool Flange Dimensions

The following figure provides dimensions for the tool flange.

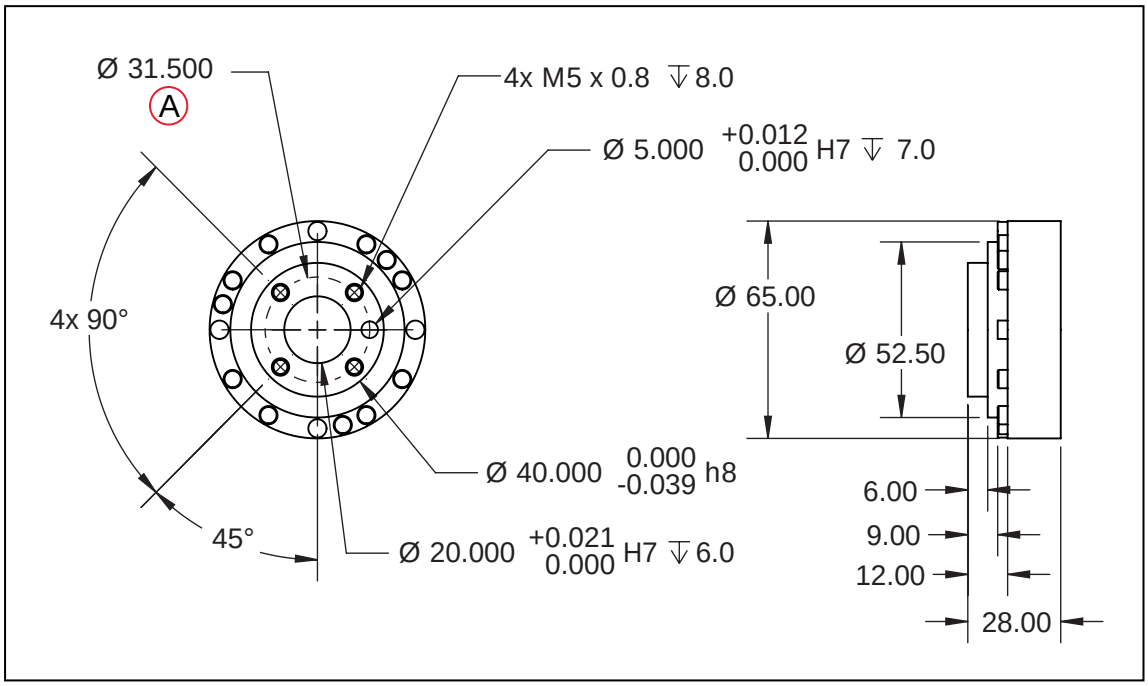


Figure 8-19. Tool Flange Dimensions for Viper Robots - (A) is Bolt Circle. (units in mm)

8.8 Front Panel Dimensions

The following figure provides Front Panel enclosure dimensions.

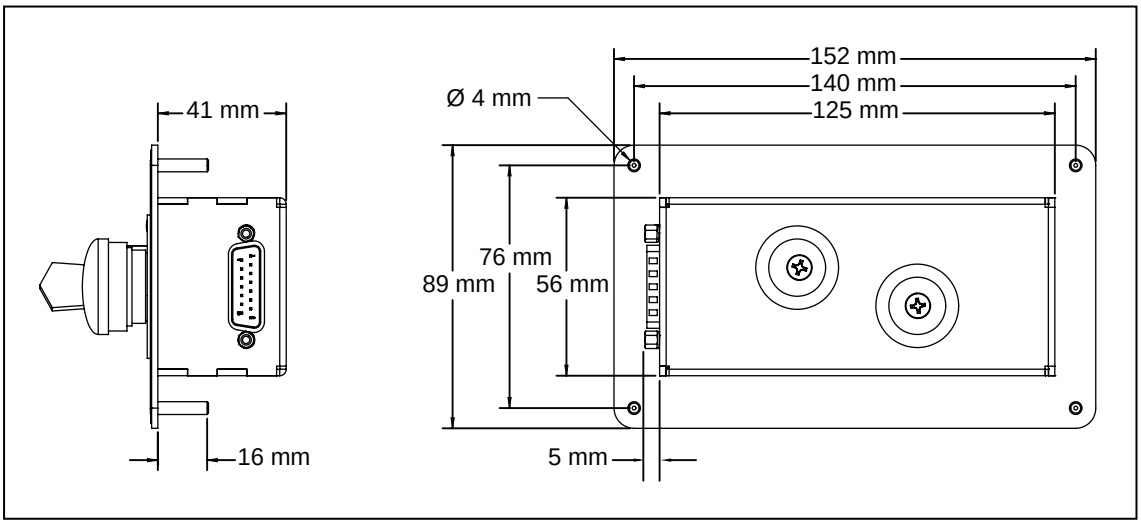


Figure 8-20. Front Panel Dimensions (Rear and Side Views)

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

8.9 EtherCAT Communications Specifications

EtherCAT communications specifications are provided in the table below.

Figure 8-21. EtherCAT Communications Specification Description

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

Chapter 9: IP54/65 Option Considerations

This chapter provides important considerations when using a robot with the IP54/65 option.

9.1 IP54/65 Option Classification

The Viper 650 and 850 robots can be ordered with an IP54/65 option that is a dust-proof, splash-proof model. With the IP54/65 option, the main body of the robot is rated IP54, and Joints 4, 5, 6 are rated IP65. Without this option, the robots have a rating of IP40.

WARNING: The eCS-ECAT and other peripheral electronics are not dust- or splash-proof. Therefore, when using these products in an environment exposed to dust or mist, put them in protective enclosures.

A Viper robot with the IP54/65 option is shown in the figure below.

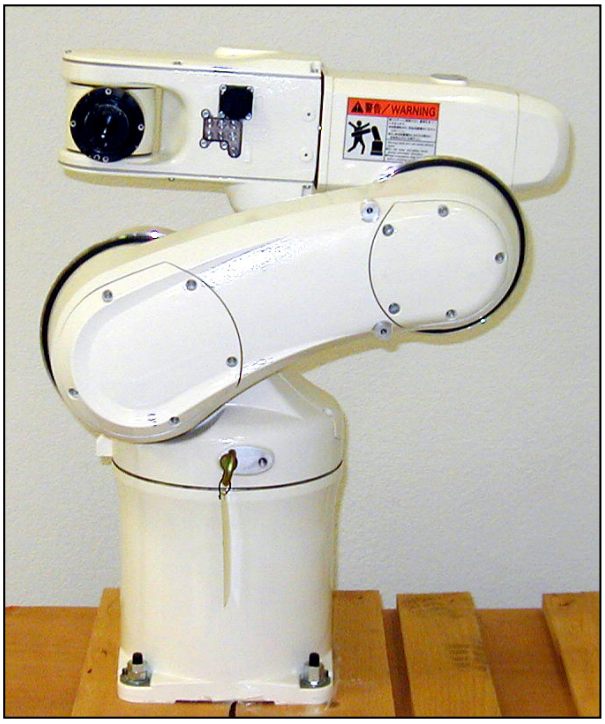


Figure 9-1. Viper Robot—IP54/65 Option

9.2 Differences from Standard Robot Model

The installation, operation, and specifications of the IP54/65 robot are the same as the standard robot, except for issues noted in this section.

Robot Connector Panel

For the IP54/65 robot, the robot connector panel is different than the standard robot. The panel is shown in the following figure.

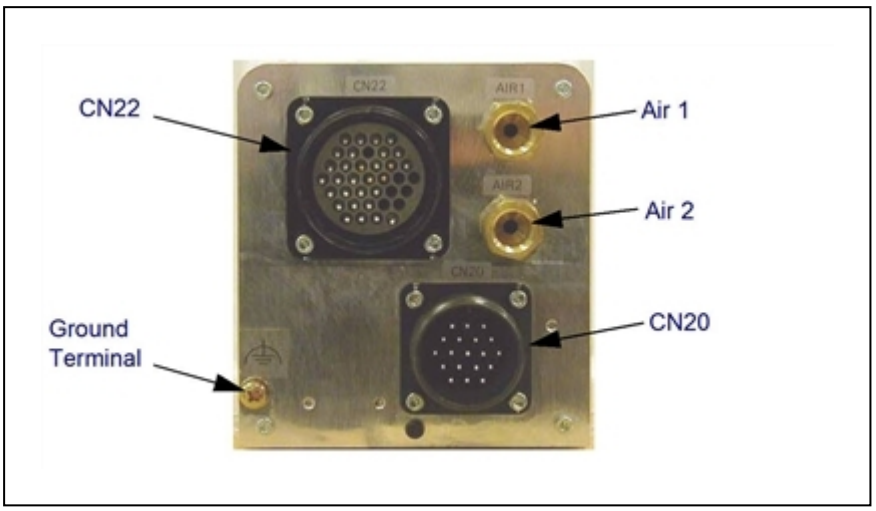


Figure 9-2. IP54/65 Robot Connector Panel

NOTE: On the IP54/65 robot

- the CN20 and CN22 connectors are IP65 rated.
- the robot cable has a splash-proof connector on the robot end.
- the mating connector sets for CN20 and CN22 are different for IP54/65 and Cleanroom robots. Refer to Differences from Standard Robot Model on page 137.
- for IP54/65 compliance, keep the factory-installed plugs over unused I/O connectors in place.

Cable Clearance

For the IP54/65 robot, the cable clearance dimension at the back of the robot is 222 mm. Refer to Robot Physical Dimension Drawings on page 113 for dimension drawings.

Replacing Encoder Backup Battery

For the IP54/65 robot, the procedure to replace the encoder battery is the same as the standard robot, except the cover uses hex socket-head bolts instead of screws. Refer to Replacing the Encoder Batteries on page 103. Tightening torque: Hex socket bolt: 2.0 N·m.

Chapter 10: Cleanroom Option Considerations

This chapter provides important considerations when using a robot with the Cleanroom option. Both the Viper 650 and Viper 850 robots are available in Class 10 Cleanroom models.

10.1 Differences from Standard Robot Model

This option is a factory-installed configuration. The installation, operation, and specifications of the Cleanroom robot are the same as the standard robot, except for issues noted in this section.

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

A Viper robot with the Cleanroom option is shown in the figure below.

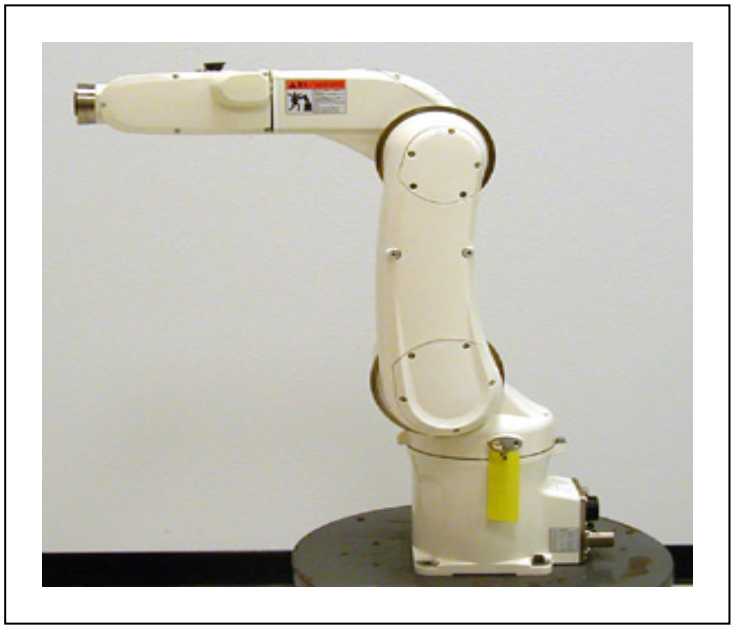


Figure 10-1. Viper Robot - Cleanroom Option

10.2 Cleanroom Robot Connections

This section describes the connections that apply to the Cleanroom option robot.

For the Cleanroom robot, the robot connector panel is different than the standard robot.

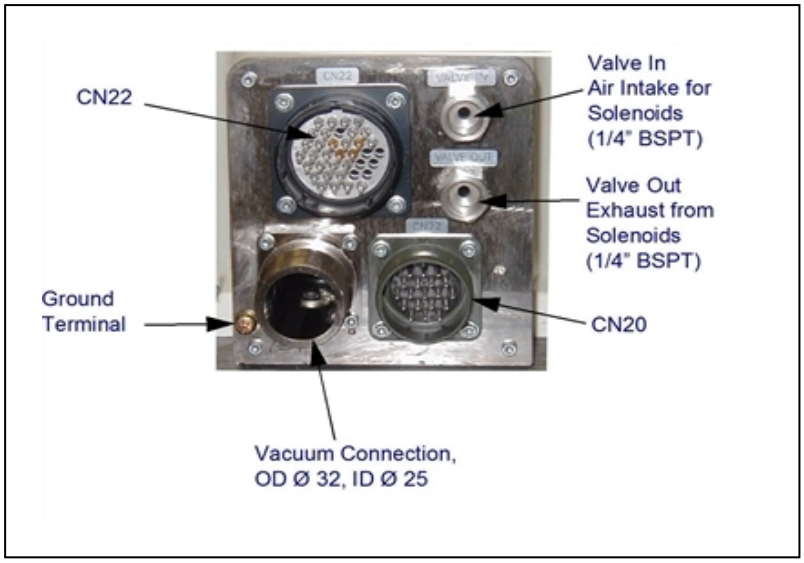


Figure 10-2. Cleanroom Robot Connector Panel

The following two graphics are included to show the vacuum connection from different angles.

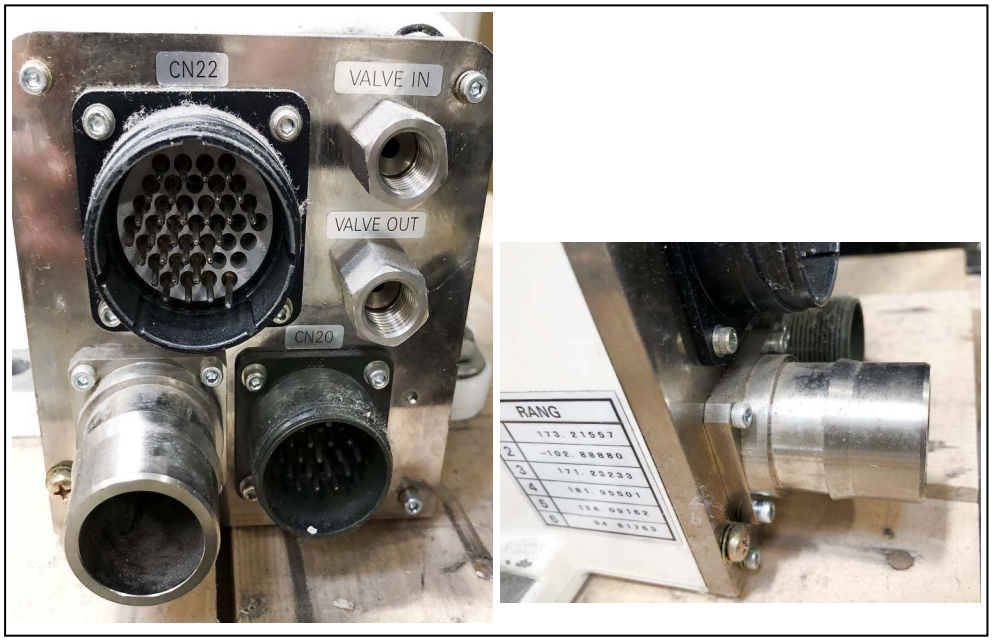


Figure 10-3. Cleanroom Viper Robot Connection Panel, Vacuum Fitting

The vacuum fitting on the Cleanroom Viper Robot Connection Panel, shown in the preceding figures, is a simple push-fit, with an OD of Ø32 mm and an ID of Ø25 mm.

Cleanroom CN22 Cable

For the eCS-ECAT end of the cable, line up the slot in the cable end with the matching key in the eCS-ECATconnector, apply firm pressure straight in, and thread the lock ring fully onto the connector. There should be no visible threads when connected.

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

Refer to Cleanroom Technical Specifications on page 134 for the recommended vacuum flow rate.

Air Lines and Signal Wiring

The Cleanroom robot is equipped with six air lines. The six lines, from Valve In input, are controlled by the three internal solenoid valves. There are ten user electric lines. The air lines and signal wiring are shown in the following figures and tables.

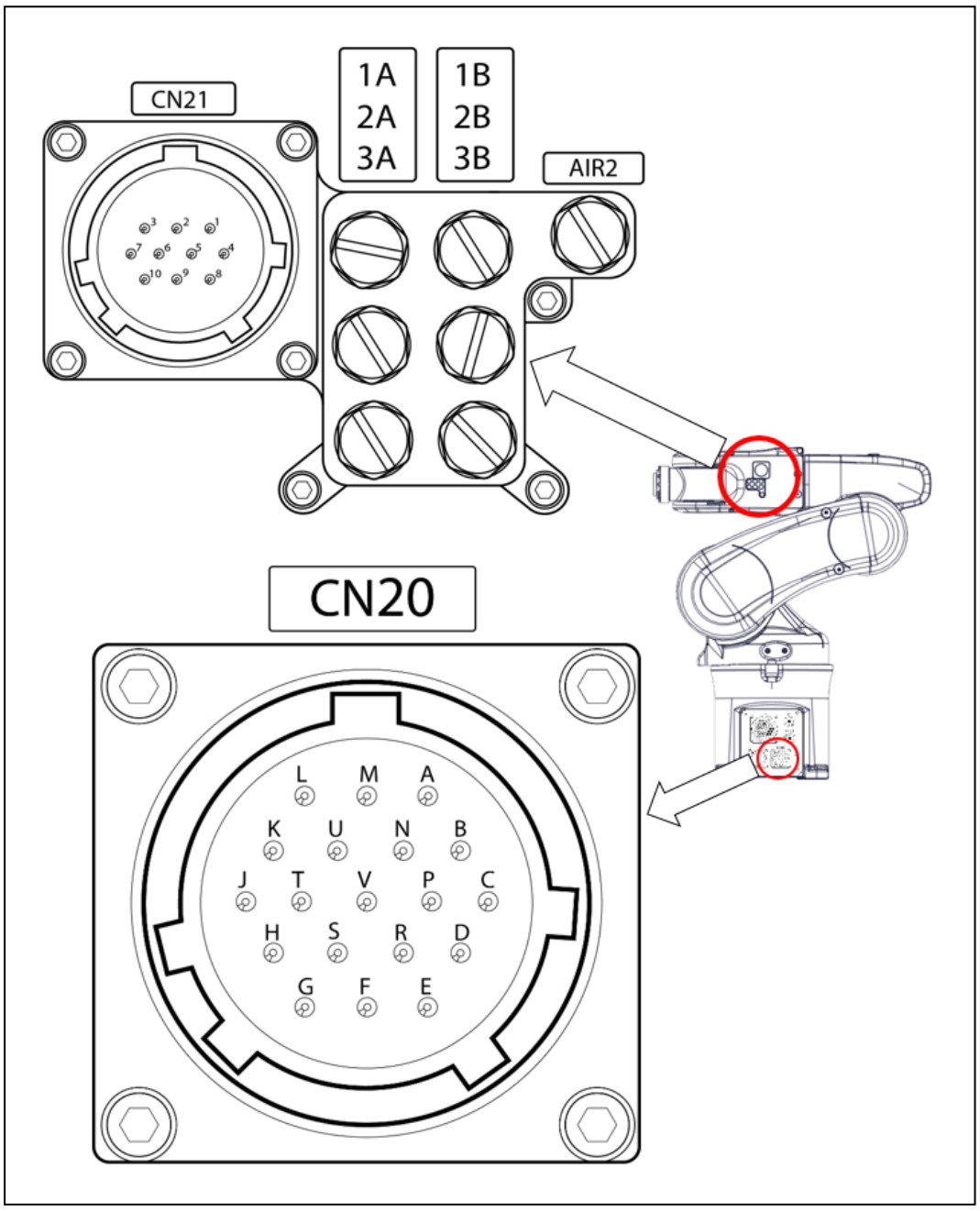


Figure 10-4. Air Intake/Exhaust Connections and Signals

Table 10-1. Air Intake/Exhaust States

Air Connections		Valve Signal		
Intake (Valve in)	Exhaust (Valve out)	Solenoid Valve	Solenoid	
			A	B
1A	1B	1	ON	OFF
1B	1A	1	OFF	ON
2A	2B	2	ON	OFF
2B	2A	2	OFF	ON
3A	3B	3	ON	OFF
3B	3A	3	OFF	ON
AIR 2 - Not used on Cleanroom robot				

Table 10-2. CN20 Pin Assignments, M to U

NPN type (source IN, sink OUT)		PNP type (sink IN, source OUT)	
CN20 pin	Used for:	CN20 pin	Used for:
M	+24 V	M	0 V
N	Solenoid 1A (solenoid valve 1)	N	Solenoid 1A (solenoid valve 1)
P	Solenoid 1B (solenoid valve 1)	P	Solenoid 1B (solenoid valve 1)
R	Solenoid 2A (solenoid valve 2)	R	Solenoid 2A (solenoid valve 2)
S	Solenoid 2B (solenoid valve 2)	S	Solenoid 2B (solenoid valve 2)
T	Solenoid 3A (solenoid valve 3)	T	Solenoid 3A (solenoid valve 3)
U	Solenoid 3B (solenoid valve 3)	U	Solenoid 3B (solenoid valve 3)

Pass-Through Electrical Signal Wires

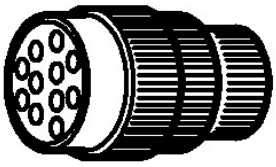
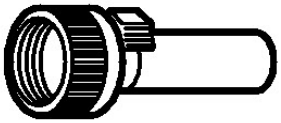
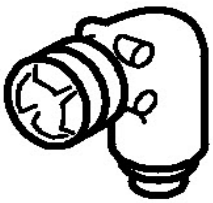
Pins A to K on CN20 and #1 to #10 on CN21 are connected with each other as shown below. The allowable current per line is 1 A.

CN20	A	B	C	D	E	F	G	H	J	K
CN21	1	2	3	4	5	6	7	8	9	10

CN20 and CN21 Mating Connectors

The IP54/65 and Cleanroom versions of the following connectors are different than the CN20 and CN21 connectors for standard Viper robots.

Table 10-3. CN20 and CN21 Mating Connectors

Connector Set Part No.	Connector No.	Model and Part Name	Appearance/Wire Size
05584-000	for CN20	H/M3106A22-14S (straight plug) (HIROSE ELECTRIC CO., LTD.)	
	for CN20	H/MS3057-12A (cord clamp) (HIROSE ELECTRIC CO., LTD.)	Applicable wire diameter 11.4 to 15.9 
	for CN20	H/MS3057-12A1 (cord clamp) (HIROSE ELECTRIC CO., LTD.)	Applicable wire diameter 8 to 11.6
	for CN21	EBLP1610M (L type plug connector) (Dai-ichi Electronic Industry)	

NOTE: The mating connectors are the same for Cleanroom and IP54/65 robots.

10.3 Cleanroom Cover at J6 Flange

The Cleanroom robot has a J6 Cleanroom Cover that is not present on the standard robot. See the following figure.

Figure 10-5. Viper 850 J6 Cleanroom Cover

Any user tooling at the flange must allow for clearance. See the following figure.

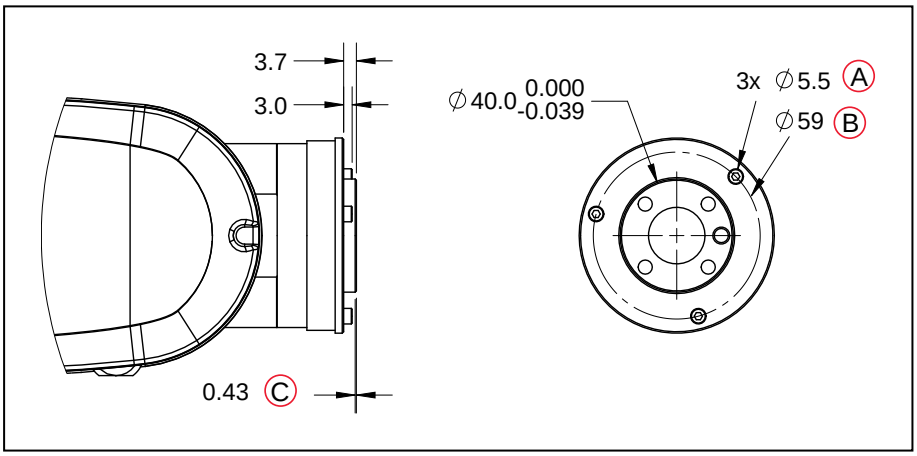


Figure 10-6. J6 Cleanroom Cover Dimensions (units in mm)

Key	Meaning	Key	Meaning
A	M3 Bolt Head	C	Chamfer
B	Bolt Circle (BC)		

NOTE: Clearance must be made between the J6 Cleanroom Cover and user tooling.

10.4 Cleanroom Technical Specifications

Table 10-4. Cleanroom Robot Specifications

Viper 650/850	
Clean Class for Cleanroom Robot	Class 10
Recommended vacuum flow rate	130 liters/minute (4.6 SCFM)
User air lines	6 systems (Ø4x6), 3 solenoid valves (2-position, double solenoid) contained.

10.5 Cable Clearance

For the Cleanroom robot, the cable clearance dimension at the back of the robot is 222 mm. Refer to Figure 8-1. for dimension drawings.

10.6 Replacing Encoder Backup Battery

For the Cleanroom robot, the procedure to replace the encoder battery is the same as the standard robot, except the cover uses hex socket-head bolts instead of screws. Refer to Battery Replacement Procedure on page 104. Tightening torque: Hex socket bolt: 2.0 N·m.

Chapter 11: Status Codes

This chapter provides information about status codes that may appear on the eCS-ECAT display panel.

11.1 eCS-ECAT Display Panel

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

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

0	1	2	3	4	5	6	7	8	9
									

11.2 Status Codes Table

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

These messages use the following numbering scheme:

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

Table 11-1. Display Panel Codes

LED	Status Code	eV+ Error Message	eV+ Error Code	Explanation	User Action
	OK	None	N/A	STATUS message-High Power OFF.	None
	ON	None	N/A	STATUS message-High Power ON.	None
	MA	None	N/A	STATUS message-Robot is in Manual Mode.	None
	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#	*Motor Amplifier Fault*	-1018	A power amplifier fault is indicated on axis #.	Check user motor

LED	Status Code	eV+ Error Message	eV+ Error Code	Explanation	User Action
					power connections for shorts or opens. Turn high power back on and restart the program. If the error persists, contact your local OMRON support.
AC	AC	*RSC Power Failure*	-670	A loss of AC power was detected	Check user AC power connections for shorts or opens. Turn high power back on and restart the program. If the error persists, contact your local OMRON support.
B#	B#	None	N/A	IO-Blox communications error with IO-Blox (#).	Check user IOBlox connections for shorts or opens. Check IOBlox address switches for proper configuration. Cycle power to the control system. If the error persists, contact your local OMRON support
BA	BA	None	N/A	The encoder backup battery is low.	Replace the encoder backup battery.
D#	D#	*Duty-cycle exceeded* Mtr #	-1021	The indicated motor (#) has been driven hard for too long a period of time. The servo system has disabled power to protect the robot hardware.	Turn high power back on; reduce the speed and/or acceleration for the motion that was in progress or for motions that preceded that motion. Repeat the motion that failed.
E#	E#	*Encoder Fault*	-1025	The servo system has detected an electrical or physical condition that resulted in an encoder fault.	Write down the failure message or code, and look it up in the eV+ Help.
ES	ES	*E-STOP detected by robot*	-643	An E-STOP condition has been detected by the	This is a normal response to many

LED	Status Code	eV+ Error Message	eV+ Error Code	Explanation	User Action
				robot.	E-STOP conditions. Remove the source of the ESTOP and re-enable high power.
F 1	F1	*E-STOP detected by robot*	-643	The End-Of-Arm Break-away Sensor has tripped (open circuit). Reporting of this error can be enabled / disabled via Sys-mac Studio.	Re-close the break-away circuit and re-enable high power.
FM	FM	None	N/A	Firmware version mis-match.	Contact your local OMRON support.
h#	h#	*Robot over-heated*	-606	The temperature sensor on the embedded pro-cessor board is at its tem-perature limit.	Try slowing the motion or insert pauses. Also, check for excessive ambi-ent temperature, inadequate vent-ilation, and proper function of any cool-ing fans.
H#	H#	*Motor over-heating* Mtr #	-1016	The motor encoder tem-perature sensor indicates an overtemperature.	Reduce robot speed, acceleration and/or deceleration motions, or intro-duce delays in the application cycle to give the motor an opportunity to cool.
Hv	hV	*RSC power fail-ure*	-670	The high-voltage DC bus for the amplifiers is out of bounds (too high or low).	Can occur when AC power is unex-pectedly removed. Check AC con-nections and re-enable high power. If the error persists, contact your local OMRON support.
I#	I#	None	N/A	Servo initialization stages. These steps nor-mally sequence (I0, I1, ...) on the display during normal system boot.	None, unless an ini-tialization code per-sists longer than 30 seconds. Could indic-ate servo ini-tialization failure. Contact your local OMRON support.

LED	Status Code	eV+ Error Message	eV+ Error Code	Explanation	User Action
M#	M#	*Motor stalled* Mtr #	-1007	A motor stall occurs when the maximum allowed torque was applied on a given motor for longer than the timeout period. Typically occurs when an obstacle is encountered.	Check for obstacles and free movement of all joints. Turn high power back on and repeat the motion that failed.
P0	P0	*Power system failure* Code 0	-1115	The dual-channel brake circuit has reported a cyclic check error.	Contact your local OMRON support.
P1	P1	*Power system failure* Code 1	-1115	The power system has unexpectedly turned off power.	Contact your local OMRON support if the error persists.
P2	P2	*Power system failure* Code 2	-1115	Overvoltage in the high-voltage DC bus to the regenerative energy dump circuit.	Contact your local OMRON support.
P3	P3	*Power system failure* Code 3	-1115	The regenerative energy dump circuit has exceeded its max short-term dump rating.	Contact your local OMRON support.
P4	P4	*Power system failure* Code 4	-1115	Contact your local OMRON support.	
P5	P5	*Power system failure* Code 5	-1115	An inrush error was detected by the power sequencer. This means the high-voltage DC bus failed to rise at the expected rate when power was enabled.	This can occur if AC power is abruptly removed during the high-power enable sequence. If it occurs unexpectedly, contact your local OMRON support.
PR	PR	None	N/A	A servo task has overrun its allotted execution window.	If the problem persists, contact your local OMRON support.
RC	RC	*RSC communications failure*	-651	There is a failure to communicate with the Robot Signature Card.	Contact your local OMRON support.
S0	S0	*Safety System Fault* Code 0	-1109*	Robot hardware did not detect pressing the Front Panel high-power button before the servo system	Contact your local OMRON support.

LED	Status Code	eV+ Error Message	eV+ Error Code	Explanation	User Action
				attempted to enable power.	
S1	S1	*Safety System Fault* Code 1	-1109*	Contact your local OMRON support for more information.	
S2	S2	*Safety System Fault* Code 2	-1109*	The safety system failed on channel 1 during the cyclic check of dual-channel power system. This may indicate a welded relay contact or other hardware failure.	If the problem persists, contact your local OMRON support.
S3	S3	*Safety System Fault* Code 3	-1109*	The safety system failed channel 2 during the cyclic check of dual-channel power system. May indicate hardware failure.	If the problem persists, contact your local OMRON support.
S4	S4	*Safety System Fault* Code 4	-1109*	The internal E-STOP delay timer timed out and turned power off. Normally, software sequences the shutdown before the time-out.	If the problem persists, contact your local OMRON support.
S5	S5	*Safety System Fault* Code 5	-1109*	The power system was improperly unlocked by software during a power sequence in manual mode.	Contact your local OMRON support.
S6	S6	*Safety System Fault* Code 6	-1109*	CAT-3 hardware safety system detected an encoder OVERSPEED and turned power off. This circuit is active in manual mode only, on select robots which have the CAT-3 teach mode option.	Intentionally triggered during specific commissioning tests for the CAT-3 system. If during normal operation, contact your local OMRON support.
S9	S9	*Safety System Fault* Code 9	-1109*	Error reported by the watchdog circuit that cross-checks the clocks for the dual-channel safety system.	Contact your local OMRON support.
SE	SE	*Safety System Not Commissioned*	-648	The E-Stop Delay has not been commissioned and verified.	Commission and verify the E-Stop Delay.

LED	Status Code	eV+ Error Message	eV+ Error Code	Explanation	User Action
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 with sufficient accuracy as set by Sysmac Studio.	Turn on high power and try to perform the motion at a slower speed. Make sure that nothing is obstructing the robot's motion. If the error recurs, contact your local OMRON support.

Appendix

A.1 Unpacking and Inspecting the Equipment

This section provides information about unpacking and inspecting a robot.

Before Unpacking

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

After Unpacking

Before accepting delivery of your robot, please compare the actual items received (not just the packing slip) with your equipment purchase order and verify that all items are present and that the shipment is correct and free of visible damage.

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

Inspecting the Equipment

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

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

A.2 Repacking for Relocation

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

CAUTION: PROPERTY DAMAGE RISK
Always ship the robot upright.

A.3 Transportation and Storage of Robot

This section provides details about transporting and storing your robot.

Transportation and Storage Environment

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

- Temperature range: –25 to +60° C
- Humidity range: Maximum 75%, non-condensing

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

CAUTION: EQUIPMENT DAMAGE HAZARD
Do not expose the crate to excessive shock and vibration.

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

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

Precautions when Transporting Robot

- The robots weigh 34 and 36 kg. Use a crane suitable for the robot weight.
- Have at least two workers handle this job.
- Workers should wear hardhats, safety shoes, and gloves during transport.
- Do not hold the first link, elbow, either side of the 2nd link, 2nd-joint cover, or 3rd-joint cover, or apply force to any of them. Refer to Robot Links and Joints on page 17.

WARNING: PERSONNEL OR EQUIPMENT DAMAGE HAZARD
Do not attempt to lift the robot at any points other than the eyebolts provided. Do not attempt to move any robot links until the robot has been secured in position. Failure to comply could result in the robot falling and causing either personnel injury or equipment damage.

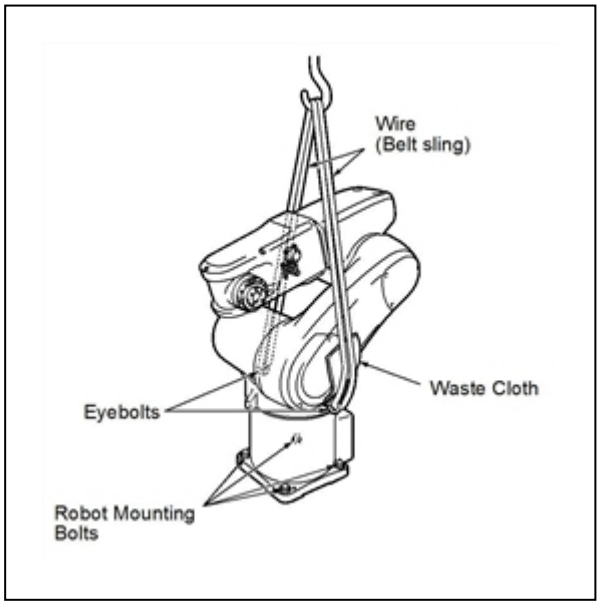


Figure A-1. Robot in Hoisting Sling

Transport Procedure

<table>
<tr><th>Step</th><th>Procedure</th><th colspan="2">Drawing</th></tr>
<tr><td rowspan="8">1</td><td rowspan="8">Before transportation, set the robot in a transport position as shown at right by manually moving the second, third, and fourth joints.
When initially unpacked, the robot is in the transport position, so this step is not required.</td><td colspan="2"></td></tr>
<tr><td colspan="2">Transport Position</td></tr>
<tr><td>Joint</td><td>Angle</td></tr>
<tr><td>First joint (J1)</td><td>90°</td></tr>
<tr><td>Second joint (J2)</td><td>-155°</td></tr>
<tr><td>Third joint (J3)</td><td>+245°</td></tr>
<tr><td>Fourth joint (J4)</td><td>-90°</td></tr>
<tr><td>Fifth joint (J5)</td><td>-90°</td></tr>
<tr><td>2</td><td>Disconnect the robot control cable, air hoses, and user signal cables from the robot.
When the robot is first unpacked, this step is not required.</td><td colspan="2"></td></tr>
<tr><td>3</td><td>As shown at right, mount the eyebolts.
When delivered, the robot is packed with eyebolts attached, so this step is not required.
(A) is one of two eyebolts.</td><td colspan="2"></td></tr>
<tr><td>4</td><td>As shown at right, place a waste cloth on the second joint and pass the wire through the two eyebolts.

Note: Before transporting the robot, check that the path to the mounting location is free of obstacles.
Callouts are defined following
(A) is the sling, (B) is a waste cloth for padding, (C) is one of two eyebolts.</td><td colspan="2"></td></tr>
<tr><td>5</td><td>Worker A: Remove the four bolts while supporting the robot to prevent it from tipping over.</td><td colspan="2"></td></tr>
<tr><td>6</td><td>Worker B: Operate the crane and move the robot to the mounting location.</td><td colspan="2"></td></tr>
<tr><td>7</td><td>Worker B: Put the robot down in the mounting location.
Worker A: Temporarily secure the robot base with four bolts.</td><td colspan="2"></td></tr>
<tr><td>8</td><td>Secure the robot according to the instructions in Transport Procedure on page 153.</td><td colspan="2"></td></tr>
</table>

Step	Procedure	Drawing
9	Remove the eyebolts from the robot.	 **WARNING:** Before running the robot, be sure to remove the eyebolts. Otherwise, the robot arm will strike these eyebolts.

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