OMRON

Viper 650/850 Robot with eMB-60R

User's Guide

Chapter 1: Introduction

1.1 Product Description

The Viper 650 robot and Viper 850 robots are high-performance, six-axis 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.

NOTE: The descriptions and instructions in this manual apply to both the Viper 650 and the Viper 850 robots, except for instances where there is a difference, as in dimension and work envelope drawings. In those cases, the information is presented for both robots. The robot motors are powered by an eMB-60R servo-controller/amplifier. Either robot can be controlled by the eMB-60R, running eV+, or an optional SmartController EX motion controller.

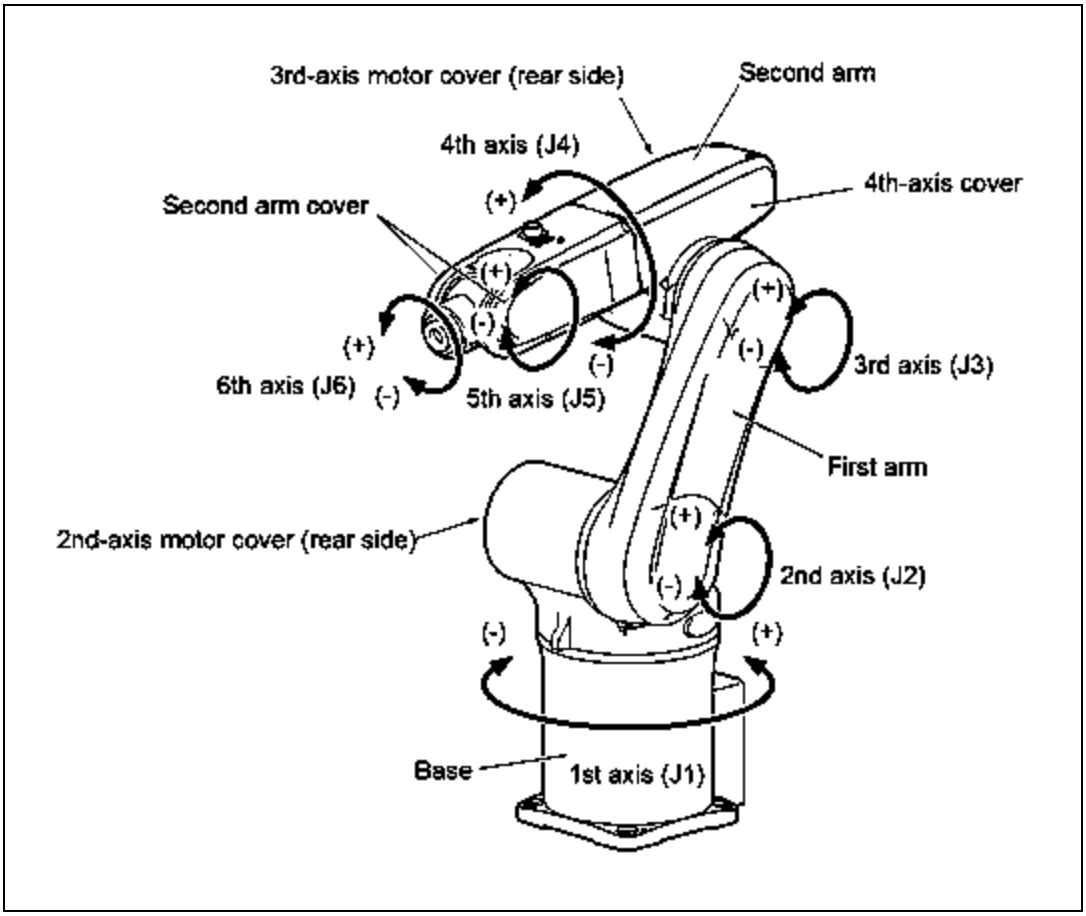


Figure 1-1. Robot Axis Identification

SmartController EX (Option)

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

- eCobra robots
- Quattro robots
- Viper robots

The SmartController EX supports a conveyor tracking option, as well as other options. The SmartController EX uses the eV+ Operating System (as does the eMB-60R). It offers scalability and support for IEEE 1394-based digital I/O and general motion expansion modules. The IEEE 1394 interface is the backbone of SmartServo, the distributed controls architecture supporting our products. The SmartController also includes Fast Ethernet and DeviceNet.

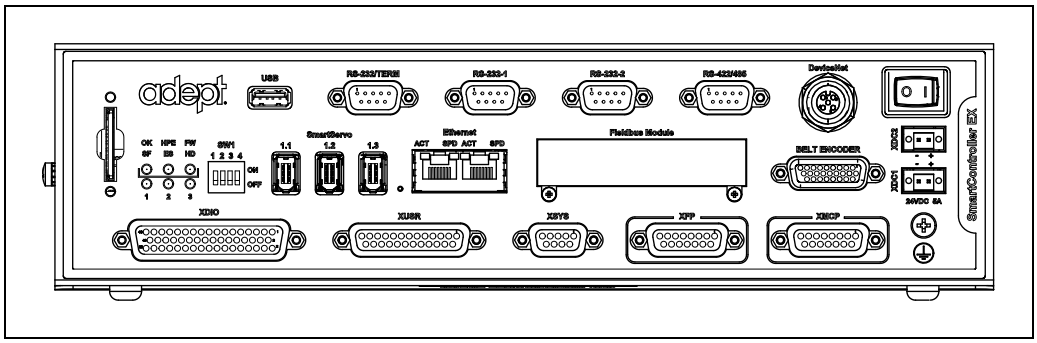


Figure 1-2. SmartController EX Motion Controller

MotionBlox-60R

The MotionBlox-60R (eMB-60R) distributed servo controller contains the amplifiers to power the high-power motors of the Viper 650/850 robots, and runs the eV+ operating system for motion control.

The eMB-60R features:

- Six AC servo motor amplifiers
- Emergency stop circuitry
- High servo rate, to deliver low positional errors and superior path following
- Sine wave commutation, for low cogging torque and improved path following
- Digital feed-forward design, to maximizes efficiency, torque, and velocity
- Integral temperature sensors and status monitoring for maximum reliability
- Dual-digit diagnostics display for easy troubleshooting

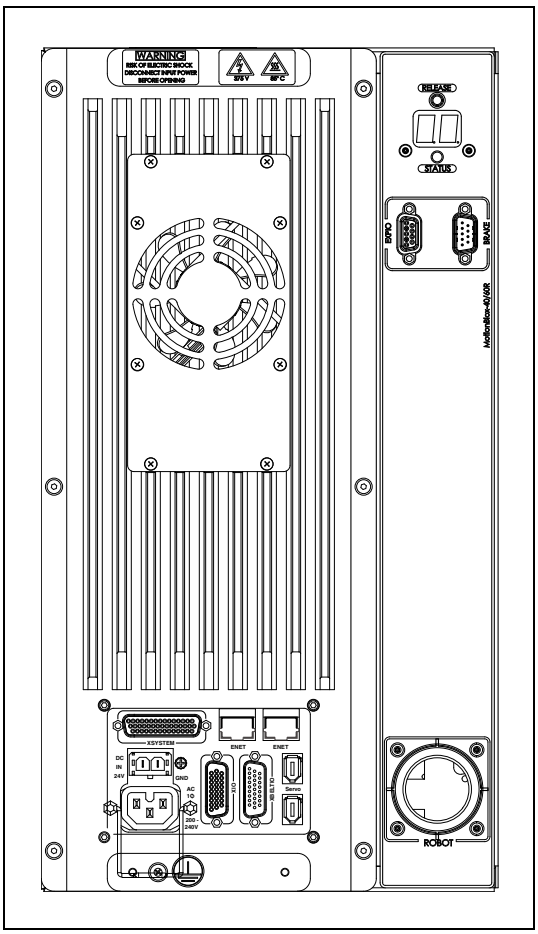


Figure 1-3. MotionBlox-60R (eMB-60R)

1.2 How Can I Get Help?

Corporate Web Site

You can access information sources on our corporate web site:

http://www.ia.omron.com

http://www.adept.com

Related Manuals

This manual covers the installation, operation, and maintenance of a Viper 650/850 robot system. There are additional manuals that cover programming the system, reconfiguring installed components, and adding other optional components. See the following table.

Table 1-1. Related Manuals

Manual Title	Description
Robot Safety Guide	Contains general safety information for all of our robots. A printed copy of this guide ships with each robot.
SmartController User's Guide	Contains complete information on the installation and operation of the optional SmartController EX and the optional sDIO product.
T20 Pendant User's Guide	Describes the T20 pendant.
IO Blox User's Guide	Describes the IO Blox product.
ACE User's Guide	Describes the installation and use of the ACE software.
Dual Robot Configuration Procedure	Contains cable diagrams and configuration procedures for a dual-robot system.

Chapter 2: Safety

2.1 Dangers, Warnings, Cautions, and Precautions

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

DANGER: This indicates an imminently hazardous electrical situation which, if not avoided, will result in death or serious injury.

DANGER: This indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

WARNING: This indicates a potentially hazardous electrical situation which, if not avoided, could result in serious injury or major damage to the equipment.

WARNING: This indicates a potentially hazardous situation which, if not avoided, could result in serious injury or major damage to the equipment.

CAUTION: This indicates a situation which, if not avoided, could result in minor injury or damage to the equipment.

Precautions for Safe Use: This indicates precautions on what to do and what not to do to ensure using the product safely.

2.2 Safety Precautions

DANGER: A Viper robot can cause serious injury or death, or damage to itself and other equipment, if the following safety precautions are not observed.

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

Figure 2-1. Read Manual and Impact Warning Labels

- The Viper system must not be used for purposes other than described in Intended Use of the Robots on page 13. Contact Omron Adept Technologies, Inc. if you are not sure of the suitability for your application.
- The user is responsible for providing safety barriers around the robot to prevent anyone from accidentally coming into contact with the robot when it is in motion.
- Power to the robot and its power supply must be locked out and tagged out before any maintenance is performed.

2.3 What to Do in an Emergency or Abnormal Situation

Press any E-Stop button (a red push-button on a yellow background) and then follow the internal procedures of your company or organization for an emergency or abnormal situation. If a fire occurs, use CO_2 to extinguish the fire.

In case of an emergency or abnormal situation, the joints of the robot can be manually moved without electric power. However, only qualified personnel who have read and understood the robot user's guide and *Robot Safety Guide* should manually move the robot into a safe state. All joints are held in place by brakes, which can be released with the Brake Release button. This requires 24 V power to the robot.

2.4 Robot Behavior

Hardstops

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

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

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

Limiting Devices

There are no dynamic or electro-mechanical limiting devices provided by Omron Adept Technologies, Inc. The robot does not have safety-rated soft axis or space limiting.

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

Singularities

There are no singularities with a Viper robot that cause a hazard.

2.5 Intended Use of the Robots

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

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

The Viper robots have been designed and constructed in accordance with the relevant requirements of IEC 60204-1.

The Viper robots are intended for use in parts assembly and material handling for payloads less than 5 kg (11 lb). See Specifications on page 105 for complete information on the robot specifications. Refer to the *Robot Safety Guide* for details on the intended use of Viper robots.

Viper robots are for not intended for:

- Use in the presence of ionizing or non-ionizing radiation
- Use in potentially explosive atmospheres
- Use in medical or life saving applications
- Use in a residential setting. They are for industrial use only.
- Use before performing a risk assessment

2.6 Additional Safety Information

We provide other sources for more safety information:

Manufacturer's Declaration of Incorporation

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

Robot Safety Guide

The *Robot Safety Guide* provides detailed information on safety for robots. It ships with each robot.

Manual Control Pendant

The E-Stop provided in the T20 Pendant complies with ISO 10218-1 (per clause 5.5.2), with stop category 1 (per IEC 60204). The E-stop button complies with ISO 13850. The E-Stop meets the requirements of PL-d per ISO 13849.

> **NOTE**: Omron Adept Technologies, Inc. does not offer a cableless (wireless) pendant.

The manual control pendant can only move one robot at a time, even if multiple robots are connected to a SmartController, and the pendant is connected to the SmartController.

Chapter 3: Robot Installation

3.1 Unpacking and Inspecting the Equipment

Carefully inspect all shipping crates for evidence of damage during transit. If any damage is apparent, request that the carrier's agent be present at the time the container is unpacked.

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

If the items received do not match the packing slip, or are damaged, do **not** sign the receipt. Contact Omron Adept Technologies, Inc. as soon as possible.

If the items received do not match your order, please contact Omron Adept Technologies, Inc. immediately.

Inspect each item for external damage as it is removed from its container. If any damage is evident, contact Omron Adept Technologies, Inc..

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

3.2 Repacking for Relocation

If the robot or other equipment needs to be relocated, reverse the steps in the installation procedures that follow in this chapter. Reuse all original packing containers and materials and follow all safety notes used for installation. Improper packaging for shipment will void your warranty. Specify this to the carrier if the robot is to be shipped.

CAUTION: Before transportation, set the robot in a transport position by manually moving the second, third, and fourth axes. See the following figure.

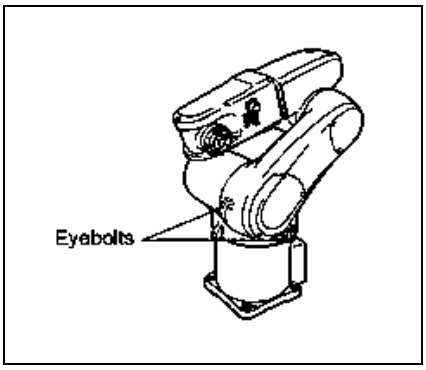


Figure 3-1. Robot in Transport Position

3.3 Environmental and Facility Requirements

The robot system installation must meet the operating environment requirements shown in the following table.

Table 3-1. Robot System Operating Environment Requirements

Item	Condition
Flatness of the mounting surface	0.1 mm/500 mm
Installation type	Floor-mount or Overhead-mount
Ambient temperature	During operation: 0 to 40° C During storage and transportation: -25 to 60° C
Humidity	During operation: 90% or less (Non-condensing) During storage and transportation: 75% or less (Non-condensing)
Altitude	up to 2000 m (6500 ft)
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
Safe Installation Environment	The robot should not be installed in an environment where: • There are flammable gases or liquids • There are any acidic, alkaline, or other corrosive gases • There is sulfuric or other types of cutting or grinding oil mist • There are any large-sized inverters, high output/high frequency transmitters, large contactors, welders, or other sources of electrical noise • There are any shavings from metal processing or other conductive material flying about • It may be directly exposed to water, oil, or cutting chips
Working space, etc.	• Sufficient service space must be available for inspection and disassembly. • Keep wiring space (230 mm or more) behind the robot, and fasten the wiring to the mounting face or beam so that the weight of the cables will not be directly applied to the connectors.
Protective Earth Ground	Grounding resistance: 10 Ohms or less See Robot Installation on page 15.

3.4 Transporting the Robot

Precautions when Transporting Robot

- The robot weighs almost 30 kg (66 lb). 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 arm, elbow, either side of the 2nd arm, 2nd-axis cover, or 3rd-axis cover, or apply force to any of them. See Robot Axis Identification on page 7.

WARNING: 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.

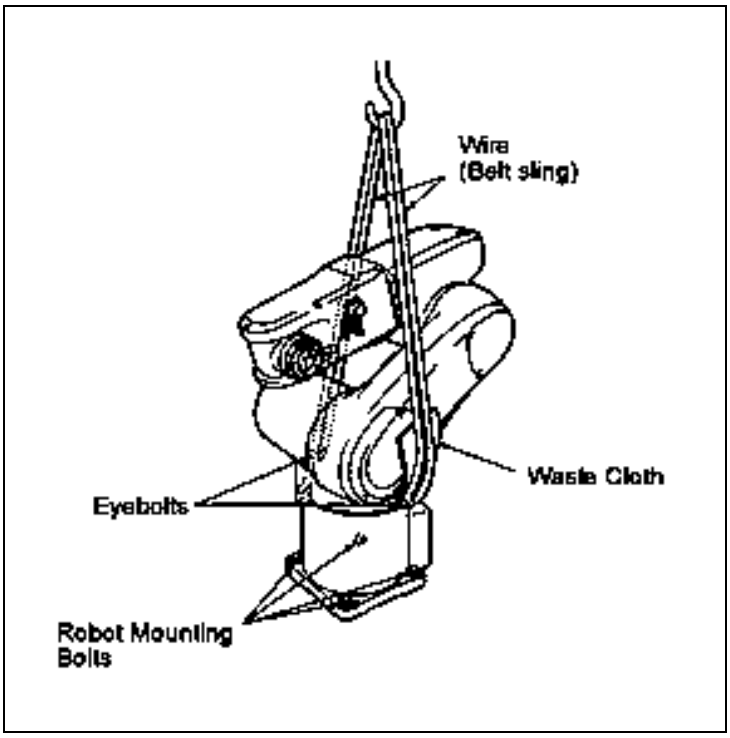
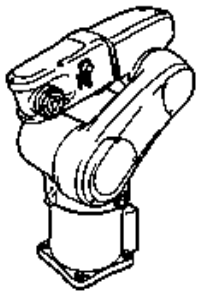
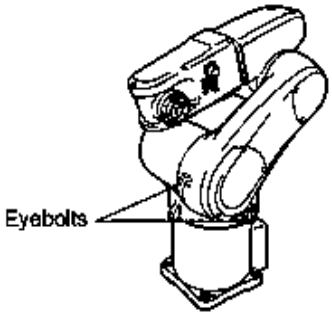
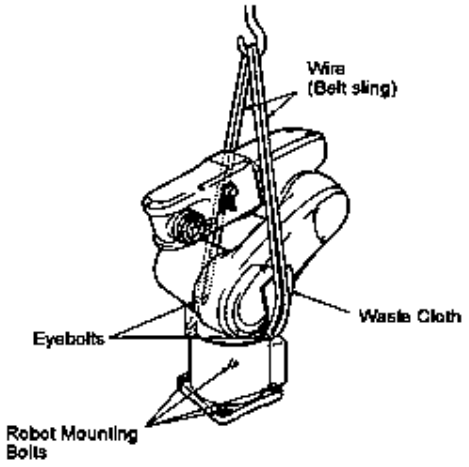


Figure 3-2. Robot in Hoisting Sling

Transport Procedure

<table>
<tr><th>Step</th><th>Procedure</th><th>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 axes.
When initially unpacked, the robot is in the transport position, so this step is not required.</td><td>  </td></tr>
<tr><td>Transport Position</td></tr>
<tr><td>Axis</td><td>Angle</td></tr>
<tr><td>First axis (J1)</td><td>0°</td></tr>
<tr><td>Second axis (J2)</td><td>-145°</td></tr>
<tr><td>Third axis (J3)</td><td>+243°</td></tr>
<tr><td>Fourth axis (J4)</td><td>-90°</td></tr>
<tr><td>Fifth axis (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></td></tr>
<tr><td>3</td><td>As shown at right, mount the eye-bolts.
When delivered, the robot is packed with eyebolts attached, so this step is not required</td><td> 
</td></tr>
<tr><td>4</td><td>As shown at right, place a waste cloth on the second axis and pass the wire through the two eyebolts.

Note: Before transporting the robot, check that the path to the mounting</td><td></td></tr>
</table>

Step	Procedure	Drawing
	location is free of obstacles.	
5	Worker A: Remove the four bolts while supporting the robot to prevent it from tipping over.	
6	Worker B: Operate the crane and move the robot to the mounting location.	
7	Worker B: Put the robot down in the mounting location. Worker A: Temporarily secure the robot base with four bolts.	
8	Secure the robot according to the instructions in Mounting the Robot on page 20.	
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.

3.5 Mounting the Robot

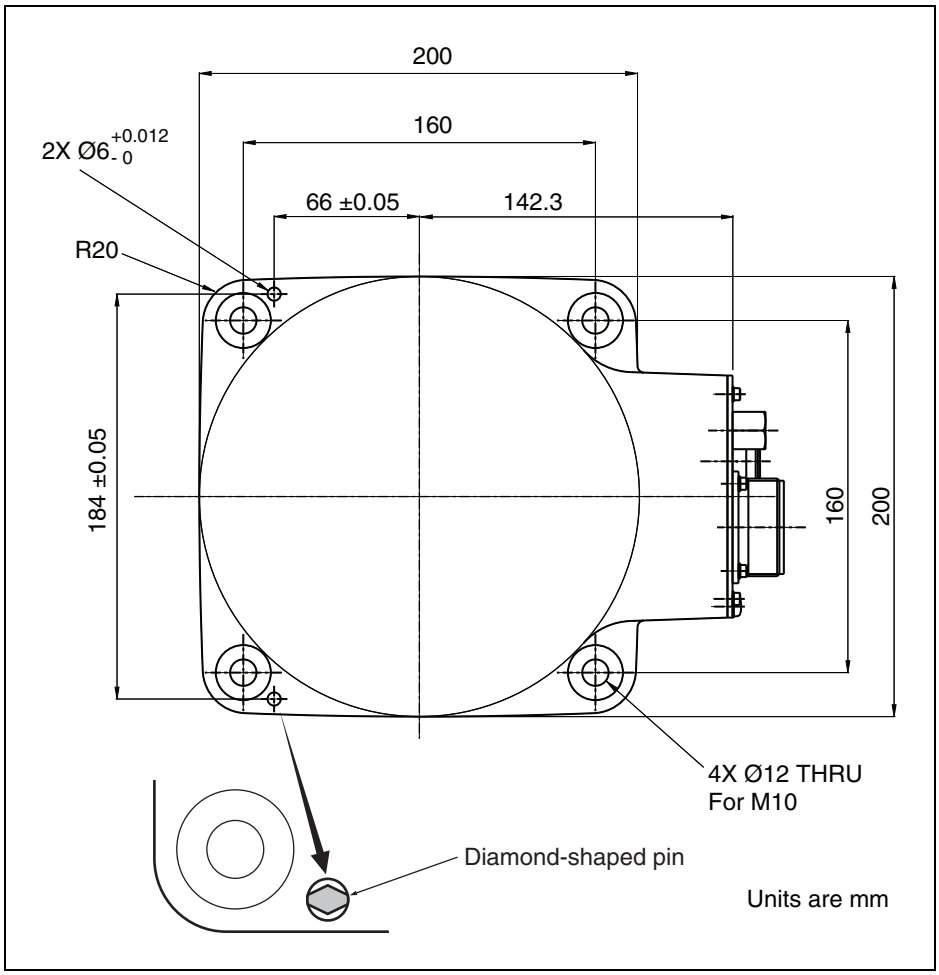


Figure 3-3. Mounting Hole Pattern for Robot

1. See the preceding figure for the dimensions of the mounting holes in the robot mounting position where the robot is to be secured.
    - Drill four bolt holes (M10), 20 mm deep or more.
    - Drill a dowel pin hole Ø6, H7 for the diamond shaped pin, 10 mm deep or more.
    - Drill a dowel pin hole Ø6, H7 for the internally threaded positioning pin, 10 mm deep or more.
2. Locate two alignment pins, one round and one diamond-shaped, supplied in the accessory kit.
3. Drive the diamond-shaped pin into one Ø6, H7 hole so that it is oriented as shown in the preceding figure.
4. Drive the internally threaded alignment pin into the other Ø6, H7 hole.

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.

5. Set the robot into place on the robot mount. When transporting the robot, follow the instructions given in Transporting the Robot on page 16.
6. Secure the robot to the mount with four bolts and plain washers.
   - Bolt: M10 x 30 mm (strength class: 12.9)
   - Tightening torque: 70 ± 14 N·m (52 ± 10 ft-lbf)

3.6 Grounding the Robot

Ground the grounding terminal of the robot with a wire of 12 AWG or larger. Ground resistance must be less than 10 Ohms. See Grounding the Robot System on page 64.

3.7 Mounting the Front Panel

The Front Panel must be installed outside of the workspace.

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

3.8 Description of Connectors on Robot Interface Panel

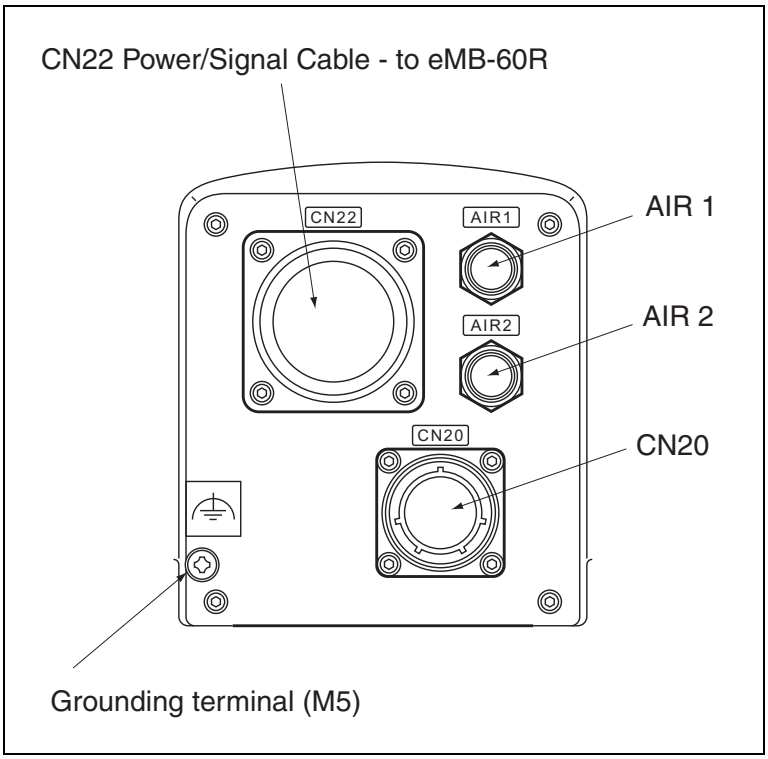


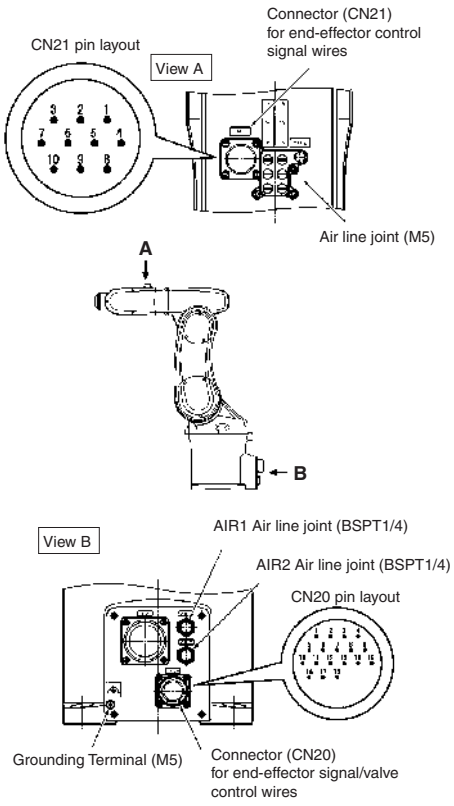
Figure 3-4. Robot Interface Panel

Table 3-2. Robot Interface Connections

CN22	The Arm Power/Signal cable from the eMB-60R 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. See Air Lines and Signal Wiring on page 22.
AIR 1	Air line connector (BSPT1/4) for three solenoids in robot. Air Lines and Signal Wiring on page 22.
AIR 2	Air line connector (BSPT1/4), connects directly to AIR 2 on the second (upper) arm.
Grounding Terminal	Protective earth ground point on the robot. See Grounding the Robot on page 21.

3.9 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 figures 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 Cleanroom Option on page 117 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
AIR2					

CN20 Pin Assignments

NPN type (source IN, sink OUT)

CN20 pin No.	Used for:
12	+24 V
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)

PNP type (sink IN, source OUT)

CN20 pin No.	Used for:
12	0 V
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)

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.	
	for CN21	JMLP1610M (L type plug connector) DDK Electronics, Inc.	

Optional Solenoid Cable

An optional 4 meter solenoid cable is available that connects between the XDIO connector on the SmartController and the CN20 connector on the robot. The part number is 05739-040.

> **NOTE**: The optional solenoid cable does not work with the IP54/65 or the Cleanroom robots.

Installing this cable allows you to control the three internal robot solenoids directly from the either the ACE software, using the digital outputs, or programmatically, with eV+. Refer to the following screen shots:

Figure 3-5. ACE Digital I/O Icon

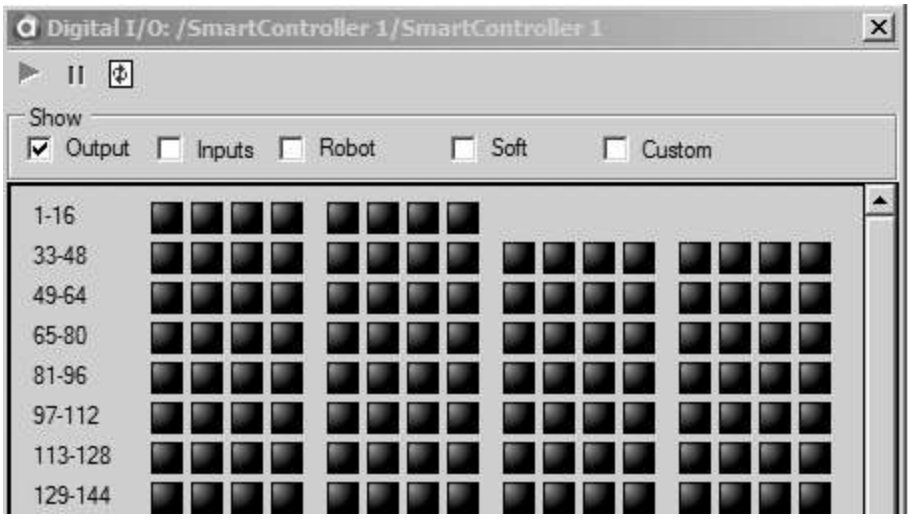


Figure 3-6. ACE Digital I/O Box (Output Shown)

See the following section for the details on activating the individual ports on each solenoid.

Table 3-3. Viper Solenoid Control

	Active Output Port	Signal States[1]	
Solenoid 1	A	0001	–0002
	B	–0001	0002
Solenoid 2	A	0003	–0004
	B	–0003	0004
Solenoid 3	A	0005	–0006
	B	–0005	0006
1 The two-position, double solenoids require both signal states to be activated. Invalid states will result in indeterminate outputs.			

In addition to controlling the internal robot solenoids, the Solenoid cable brings a portion of the other XDIO signals out to the CN21 connector at the top of the robot. See the following table for details of which signals are available at CN21. See the *SmartController User's Guide* for the electrical specifications for the signals from the XDIO connector.

Table 3-4. CN21 Signal List When Using Solenoid Cable

CN21 Pin #	Signal from XDIO on SmartController	CN21 Pin #	Signal from XDIO on SmartController
1	Input 1001[a]	6	Not connected
2	Input 1002[a]	7	Output 0007[b]
3	Input 1003[a]	8	Output 0008[b]
4	Input 1004[a]	9	24 V Output[c]
5	Input 1005[a]	10	Ground
[a]Inputs 1001 to 1005 are preconfigured as low-active (sinking) inputs. [b]Outputs 0007 and 0008 are preconfigured as high-side (sourcing) outputs. [c]Limited to a combined total of 1A of current.			

Solenoid Valve Specifications

Table 3-5. 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 (14 to 101 psi)[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 (14 - 56.6 psi, 71.1 Max). This upper limit is lower than the solenoid's upper limit.		

External Mounting Locations on Robot

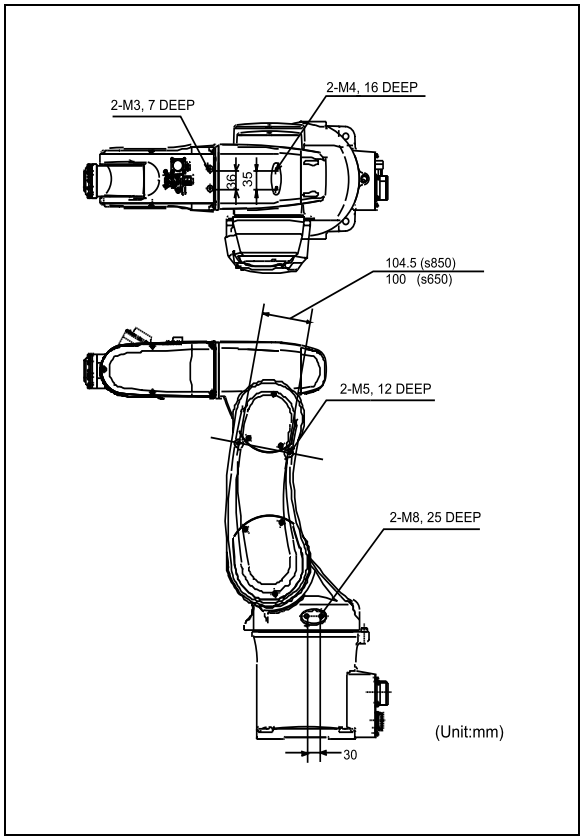


Figure 3-7. External Mounting Holes on Robot

3.10 Designing End-Effectors

Design an end-effector such that it is in compliance with items described in this section.

CAUTION: If the end-effector design precautions are not observed, the clamped parts of the robot may become loose, rattle, or be out of position. The mechanical parts of the robot and robot controller may become damaged.

Continuous Turn on J6

As an option, the Viper 650/850 can be ordered so that Joint 6 (J6) is programmed for continuous turn. Note that if J6 is programmed for continuous turn, it may lose its calibration. However, the other robot joints (J1 - J5) will not be affected.

Mass of End-Effector

Design the end-effector so that the total mass of the end-effector (including workpiece) will be lighter than the maximum payload capacity of the robot (5 kg). The total mass includes the wiring, tubing, etc.

Center of Gravity Position of End-Effector

Design an end-effector so that the center of gravity of the end-effector (including workpiece) is within the range shown in the following figure.

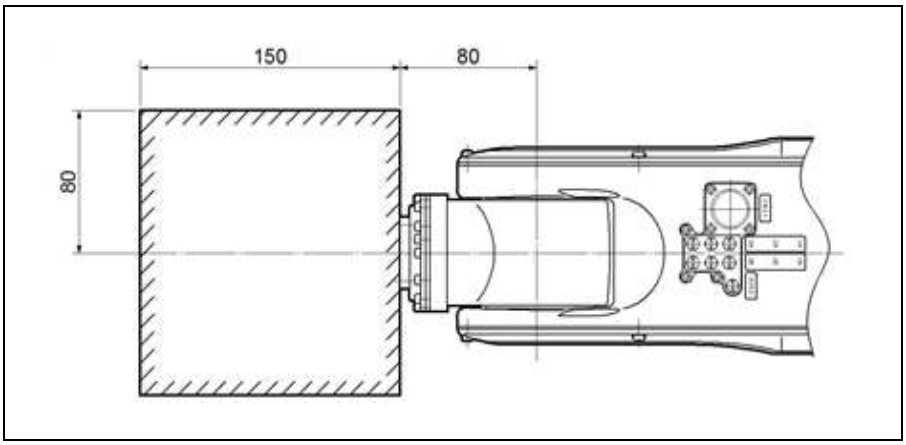


Figure 3-8. Allowable Range of Center of Gravity of End-effector

Moment of Inertia Around J4, J5, and J6

Design an end-effector so that its moments of inertia around J4, J5, and J6 (including mass of workpiece) do not exceed the maximum allowable moments of inertia of the robot.

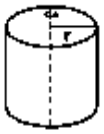
- Maximum allowable moment of inertia around J4 and J5: 0.295 kgm^2
- Maximum allowable moment of inertia around J6: 0.045 kgm^2

When calculating the moment of inertia around J4, J5, and J6 of the end-effector, use the formulas given in the following table. See Moment of Inertia Calculation Examples on page 30.

Table 3-6. Moment of Inertia Formulas

1. Cylinder (1)

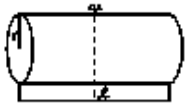
(Axis of rotation = Center axis)



$$I = \frac{mr^2}{2}$$

2. Cylinder (2)

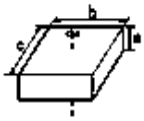
(The axis of rotation passes through the center of gravity.)



$$I = \frac{m}{4}\left(r^2 + \frac{\ell^2}{3}\right)$$

3. Rectangular parallelepiped

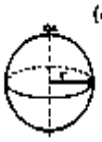
(The axis of rotation passes through the center of gravity.)



$$I = \frac{m}{12}(b^2+c^2)$$

4. Sphere

(Axis of rotation = Center axis)



$$I = \frac{2mr^2}{5}$$

5. Center of gravity not on the axis of rotation

I_g : Inertia moment around center of gravity [kgm²]

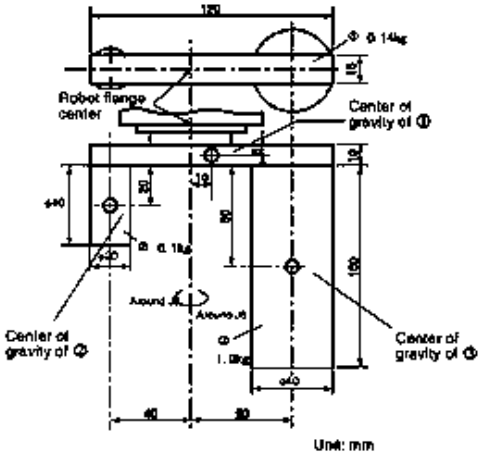
$$I = I_g + m\ell^2$$

I:	Moment of Inertia	[kgm²]
m:	Mass	[kg]
r:	Radius	[m]
b, c, ℓ:	Length	[m]

Calculation example : When calculating the moment of inertia of a complicated shape, divide it into simple parts as much as possible for easier calculations.

As shown in the figure below, divide the end-effector into three parts (①, ②, ③).

(1) Moment of inertia around J6



Moment of inertia around J6 of ①: I_1 (from 3 and 5 in previous table)

$$I_1=\frac{0.14}{12}(0.12^2+0.015^2)+0.14\times0.01^2$$
$$=1.85\times10^{-4}\ [kgm^2]$$

Moment of inertia around J6 of ②: I_2 (from 1 and 5 in previous table)

$$I_2=\frac{0.1\times0.01^2}{2}+0.1\times0.04^2$$
$$=1.65\times10^{-4}\ [kgm^2]$$

Moment of inertia around J6 of ③: I_3 (from 1 and 5 in previous table)

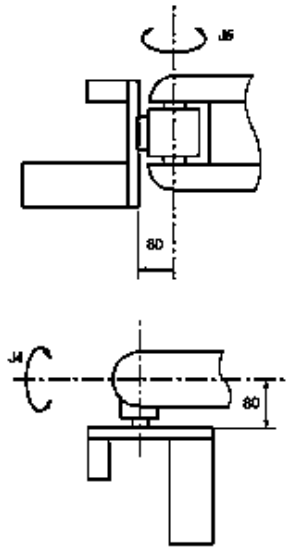
$$I_3=\frac{1.0\times0.02^2}{2}+1.0\times0.05^2$$
$$=2.7\times10^{-3}\ [kgm^2]$$

Moment of inertia around J6 of entire end-effector: I_{J6}

$$I_{J6}=I_1+I_2+I_3=0.003\ [kgm^2]$$

(2) Moment of inertia around J4 and J5

For the end-effector shown below, the moment of inertia around J4 and J5 can be calculated according to the same formula.



Moment of inertia around J4 and J5 of ①: I_1 (from 3 and 5 in prevous table)

$$I_1=\frac{0.14}{12}(0.015^2+0.01^2)+0.14\times\{(0.08+0.005)^2+0.01\}$$
$$=1.03\times10^{-3}\ [kgm^2]$$

Moment of inertia around J4 and J5 of ②: I_2 (from 2 and 5 in previous table)

$$I_2=\frac{0.1}{4}\left(0.01^2+\frac{0.04^2}{3}\right)+0.1\times\{(0.08+0.01+0.02)^2+0.04^2\}$$
$$=1.39\times10^{-3}\ [kgm^2]$$

Moment of inertia around J4 and J5 of ③: I_3 (from 2 and 5 in previous table)

$$I_3=\frac{1.0}{4}\left(0.02^2+\frac{0.1^2}{3}\right)+1.0\times\{(0.08+0.01+0.05)^2+0.05^2\}$$
$$=2.30\times10^{-3}\ [kgm^2]$$

Moment of inertia around J4 and J5 of entire end-effector: I_{J4}, I_{J5}

$$I_{J4}=I_{J5}=I_1+I_2+I_3=2.54\times10^{-2}\ [kgm^2]$$

Figure 3-9. Moment of Inertia Calculation Examples

Chapter 4: MotionBlox-60R

4.1 Introduction

The MotionBlox-60R (eMB-60R) is a distributed servo controller and amplifier. It is designed with a dedicated digital signal processor to communicate, coordinate, and execute servo commands. It is the platform on which the eV+ operating system runs.

The eMB-60R consists of:

- a distributed servo amplifier
- a RISC processor for servo loop control
- a node on the IEEE 1394 network
- a power controller that uses single-phase AC power, 200-240 Volts
- a status panel with 2-digit alpha-numeric display to indicate operating status and fault codes

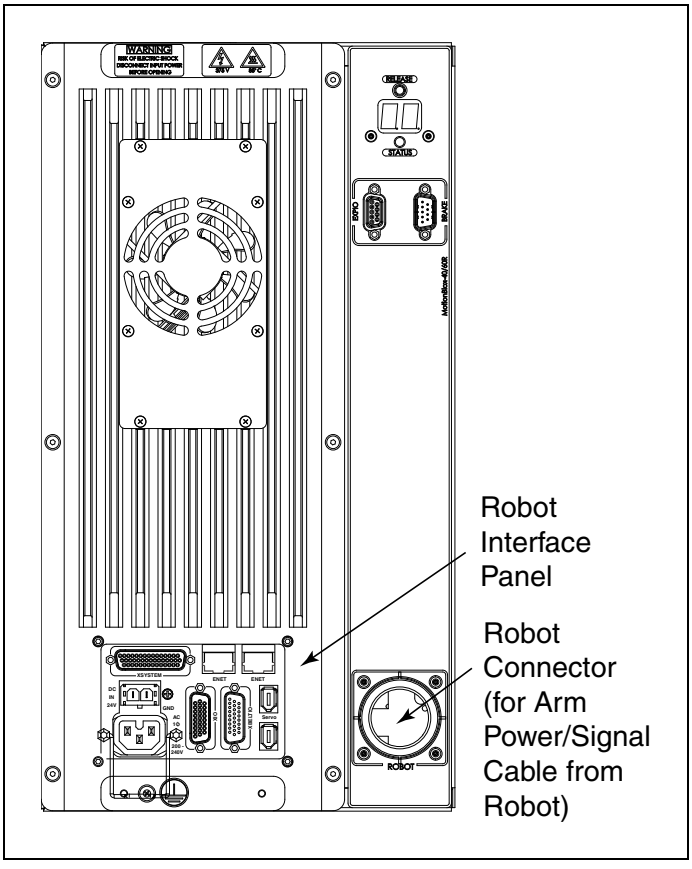


Figure 4-1. eMB-60R

4.2 Description of Connectors on eMB-60R Interface Panel

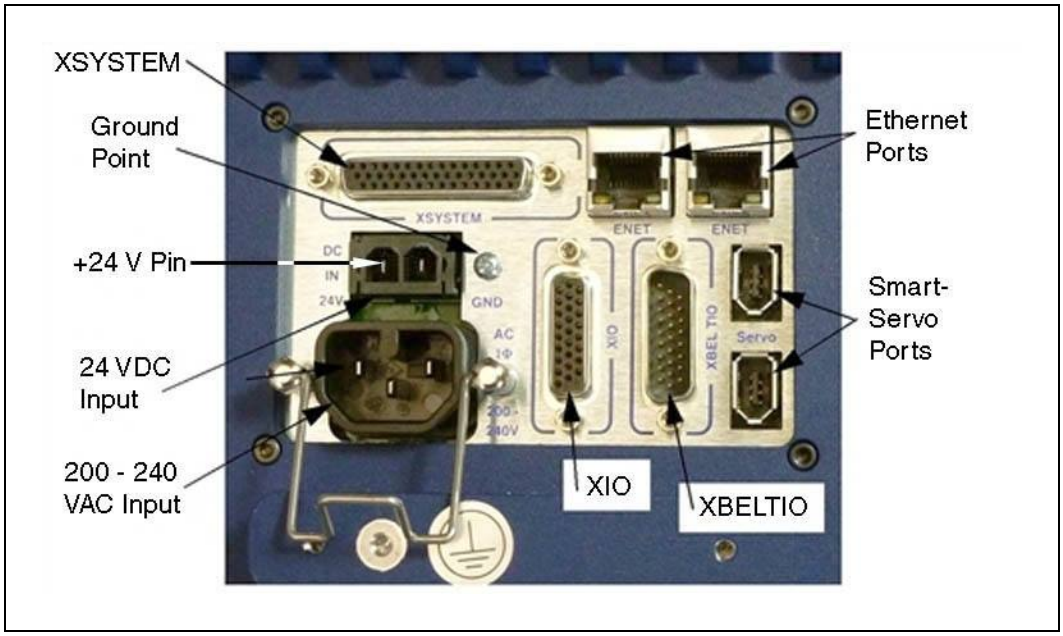


Figure 4-2. eMB-60R Interface Panel

Table 4-1. Connectors on the eMB-60R Interface Panels

24 VDC	For connecting user-supplied 24 VDC power. The mating connector is provided.
Ground Point	For connecting cable shield from user-supplied 24 VDC cable.
200/240 VAC	For connecting 200-240 VAC, single-phase, input power. The mating connector is provided.
SmartServo	For connecting the IEEE 1394 cable from the controller SmartServo to a SmartServo on the eMB-60R.
XIO	For user I/O signals for peripheral devices. This connector provides 8 outputs and 12 inputs. See Connecting Digital I/O to the System on page 35 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)
XSYSTEM	Includes the functions of the XPANEL and XSLV on the legacy MB-60R. Connects to the controller XSYS connector. This requires either an eAIB XSLV Adapter cable to connect to the XSYS cable, or an eAIB XSYS cable (HDB44-to-DB9, male), which replaces the XSYS cable.
ENET	Reserved for future use.
XBELTIO	Adds two belt encoders, EXPIO, and an RS-232 interface (which is reserved for future use).

4.3 eMB-60R Operation

Status LED on eMB-60R

The Status LED Indicator is located near the top of the eMB-60R. See the following figure. This is a bi-color, red and green LED. The color and blinking pattern indicates the status of the robot. See the following table.

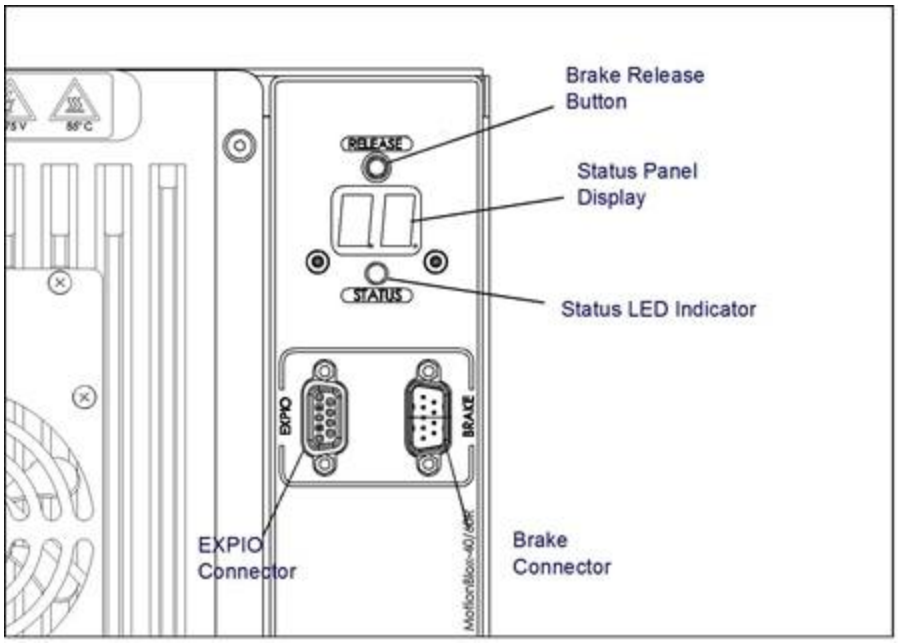


Figure 4-3. Controls and Indicators on eMB-60R

Table 4-2. Status LED Definition

LED Status	Description
Off	24 VDC not present
Green, Slow Blink	High Power Disabled
Green, Fast Blink	High Power Enabled
Green/Red Blink	Selected Configuration Node
Red, Fast Blink	Fault - refer to the following table
Solid Green or Red	Initialization or Robot Fault

Status Panel

The status panel, shown in the preceding figure, displays alpha-numeric codes that indicate the operating status of the eMB-60R, including detailed fault codes. The following table gives

definitions of the fault codes. These codes provide details for quickly isolating problems during troubleshooting.

Table 4-3. Status Panel Codes

LED	Status Code	LED	Status Code
OK	No Fault	H#	High Temp Encoder (Joint #)
ON	High Power ON Status	hV	High Voltage Bus Fault
MA	Manual Mode	I#	Initialization Stage (Step #)
24	24 V Supply Fault	M#	Motor Stalled (Joint #)
A#	Amp Fault (Joint #)	NV	Non-Volatile Memory
B#	IO Blox Fault (Address #)	P#	Power System Fault (Code #)
BA	Backup Battery Low Voltage	PR	Processor Overloaded
AC	AC Power Fault	RC	RSC Fault
D#	Duty Cycle Exceeded (Joint #)	S#	Safety System Fault (Code #)
E#	Encoder Fault (Joint #)	SE	E-Stop Delay Fault
ES	E-Stop	SW	Watchdog Timeout
F#	External Sensor Stop	T#	Safety System Fault (Code 10 + #)
FM	Firmware Mismatch	TR	Teach Restrict Fault
FW	IEEE 1394 Fault	V#	Hard Envelope Error (Joint #)
h#	h# High Temp Amp (Joint #)		

For more information on status codes, refer to the *Status Codes for Embedded Products* document.

> **NOTE**: Due to the nature of the Viper 650/850 robot's bus line encoder wiring, a single encoder wiring error may result in multiple channels of displayed encoder errors. Reference the lowest encoder number displayed.

Brake Release Button on eMB-60R

A Brake Release button is located at the top right of the eMB-60R. See Controls and Indicators on eMB-60R on page 33. When pressed, the button will disable High Power and display "BK" on the eMB-60R, but no brakes will be released. Because of the nature of a Viper robot, you have to specify one joint to release with a brake release, so this button is only used with the Cobra 350 robot.

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

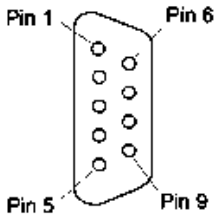
For manual release of the brakes on the Viper 650/850 robot, a Brake Release connector is provided on the eMB-60R for connecting a manual brake release box. See the following section

for more details. Also, an integrated brake release switch is provided on UL robots. See Brakes on page 77.

Brake Release Connector

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

Table 4-4. Brake Release Connector Pinouts

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

4.4 Connecting Digital I/O to the System

You can connect digital I/O to the system in several different ways. See the following table and figure.

Table 4-5. Digital I/O Connection Options

Product	I/O Capacity	For more details
XIO Connector on eMB-60R	12 inputs 8 outputs	see Using Digital I/O on eMB-60R XIO Connector on page 37
XDIO Connector on optional SmartController	12 inputs 8 outputs	see *SmartController User's Guide*
Optional IO Blox Devices, connect to EXPIO connector on the eMB-60R	8 inputs, 8 outputs per device; up to four IO Blox devices per system	see *IO Blox User's Guide*
Optional sDIO Module, connects to controller	32 inputs, 32 outputs per module; up to four sDIO devices per system	see *SmartController User's Guide*

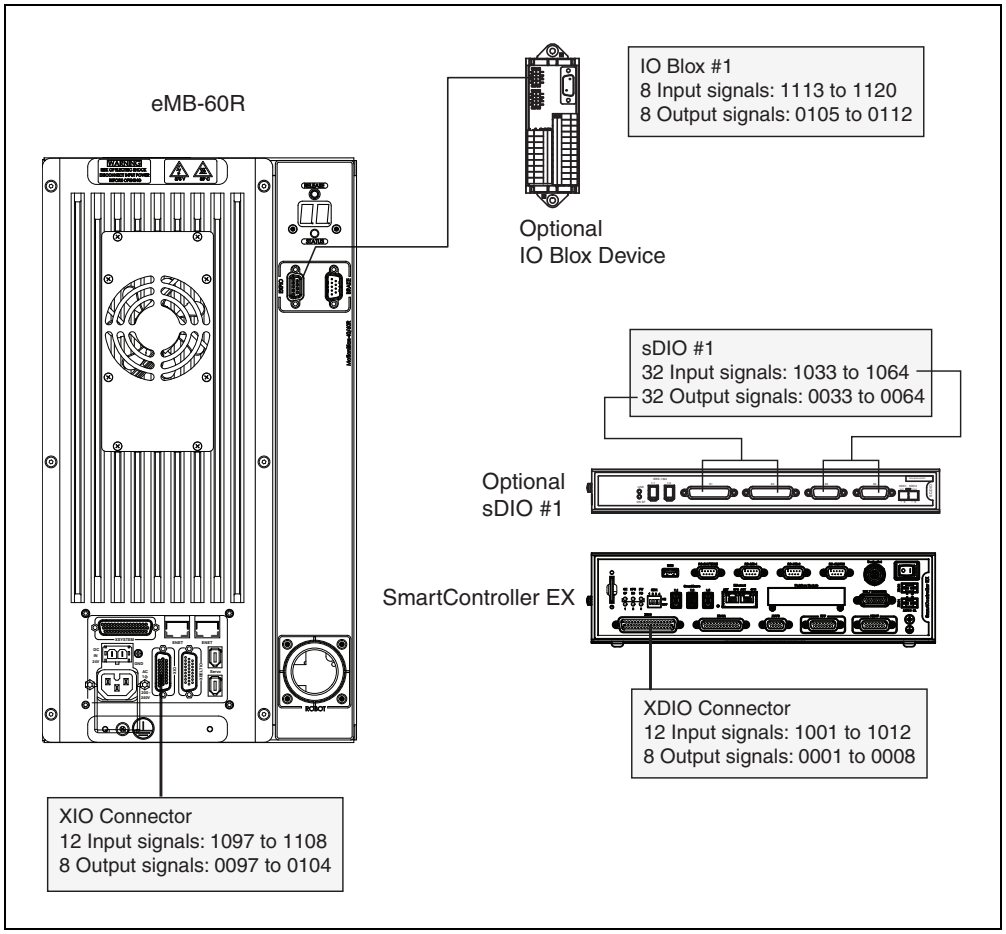


Figure 4-4. Connecting Digital I/O to the System

Table 4-6. Digital I/O Signal Ranges

	Type	**Signal Range**
SmartController XDIO connector	Inputs	1001 - 1012
	Outputs	0001 - 0008
sDIO Module 1	Inputs	1033 - 1064
	Outputs	0033 - 0064
sDIO Module 2	Inputs	1065 - 1096
	Outputs	0065 - 0096

	Type	Signal Range
eMB-60R XIO connector	Inputs	1097 - 1108
	Outputs	0097 - 0104
IO Blox 1	Inputs	1113 - 1120
	Outputs	0105 - 0112
IO Blox 2	Inputs	1121 - 1128
	Outputs	0113 - 0120
IO Blox 3	Inputs	1129 - 1136
	Outputs	0121 - 0128
IO Blox 4	Inputs	1137 - 1144
	Outputs	0129 - 0136

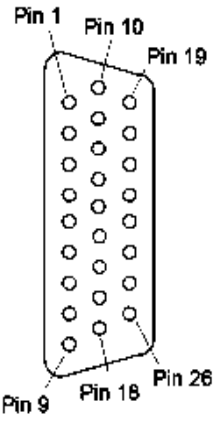
4.5 Using Digital I/O on eMB-60R XIO Connector

The XIO connector on the eMB-60R interface panel offers access to digital I/O, 12 inputs and 8 outputs. These signals can be used by eV+ to perform various functions in the workcell. See the following table for the XIO signal designations.

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

Table 4-7. XIO Signal Designations

Pin No.	Designation	Signal Bank	eV+ Signal Number	Pin Locations
1	GND			
2	24 VDC			
3	Common 1	1		
4	Input 1.1	1	1097	
5	Input 2.1	1	1098	
6	Input 3.1	1	1099	
7	Input 4.1	1	1100	
8	Input 5.1	1	1101	
9	Input 6.1	1	1102	
10	GND			
11	24 VDC			
12	Common 2	2		
13	Input 1.2	2	1103	
14	Input 2.2	2	1104	
15	Input 3.2	2	1105	
16	Input 4.2	2	1106	
17	Input 5.2	2	1107	
18	Input 6.2	2	1108	
19	Output 1		0097	
20	Output 2		0098	
21	Output 3		0099	
22	Output 4		0100	
23	Output 5		0101	
24	Output 6		0102	
25	Output 7		0103	
26	Output 8		0104	



XIO 26-pin female connector on eMB-60R Interface Panel

Optional I/O Products

These optional products are also available for use with digital I/O:

- **XIO Breakout Cable**, 5 meters long, with flying leads on user's end. See XIO Breakout Cable on page 42 for information. This cable is not compatible with the XIO Termination Block mentioned below.
- **XIO Termination Block**, with terminals for user wiring, plus input and output status LEDs. Connects to the XIO connector with 6-foot cable. See the *XIO Termination Block Installation Guide* for details.

XIO Input Signals

The 12 input channels are arranged in two banks of six. Each bank is electrically isolated from the other bank and is optically isolated from the eMB-60R ground. The six inputs within each bank share a common source/sink line.

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

The XIO inputs cannot be used for REACTI programming, high-speed interrupts, or vision triggers. Refer to the eV+ user guides on the corporate website.

XIO Input Specifications

Table 4-8. 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) Software scan rate/response time	5 µsec maximum 16 ms scan cycle/ 32 ms max response time
Turn off response time (hardware) Software scan rate/response time	5 µsec maximum 16 ms scan cycle/ 32 ms max response time

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

Typical Input Wiring Example

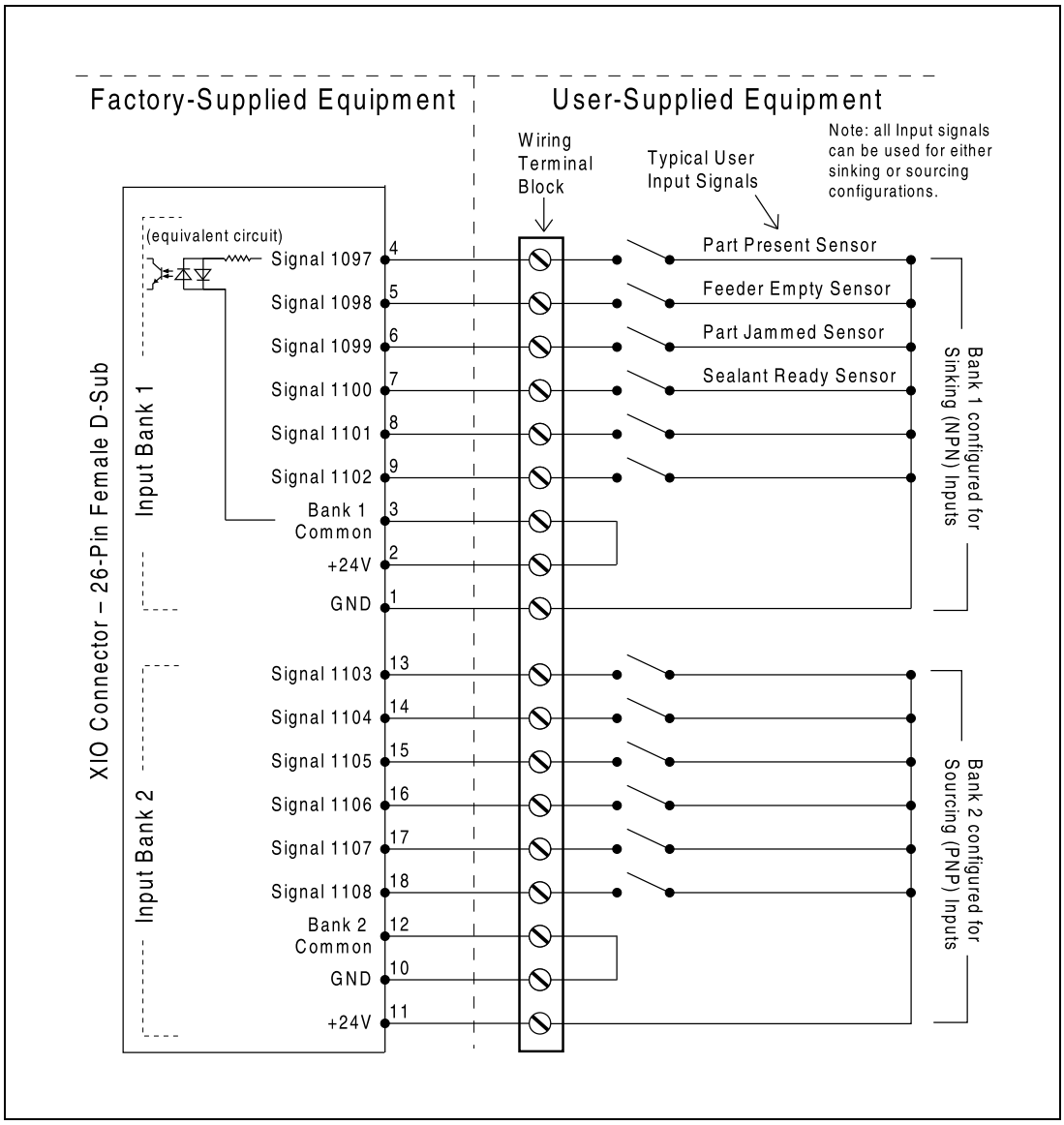


Figure 4-5. Typical User Wiring for XIO Input Signals

NOTE: The off-state current range exceeds the leakage current of XIO outputs. This guarantees that the inputs will not be turned on by the leakage current from the outputs. This is useful in situations where the outputs are looped-back to the inputs for monitoring purposes.

XIO Output Signals

The eight digital outputs share a common, high-side (sourcing) Driver IC. The driver is designed to supply any kind of load with one side connected to ground. It is designed for a range of user-provided voltages from 10 to 24 VDC and each channel is capable of up to 0.7 A of current. This driver has overtemperature protection, current limiting, and shorted load protection. In the event of an output short or other overcurrent situation, the affected output of the Driver IC turns off and back on automatically to reduce the temperature of the IC. The Driver draws power from the primary 24 VDC input to the robot through a self-resetting polyfuse.

The outputs are accessed through direct connection to the XIO connector (see See "XIO Signal Designations"), or through the optional XIO Termination Block. See the documentation supplied with the Termination Block for details.

XIO Output Specifications

Table 4-9. XIO Output Circuit Specifications

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

Typical Output Wiring Example

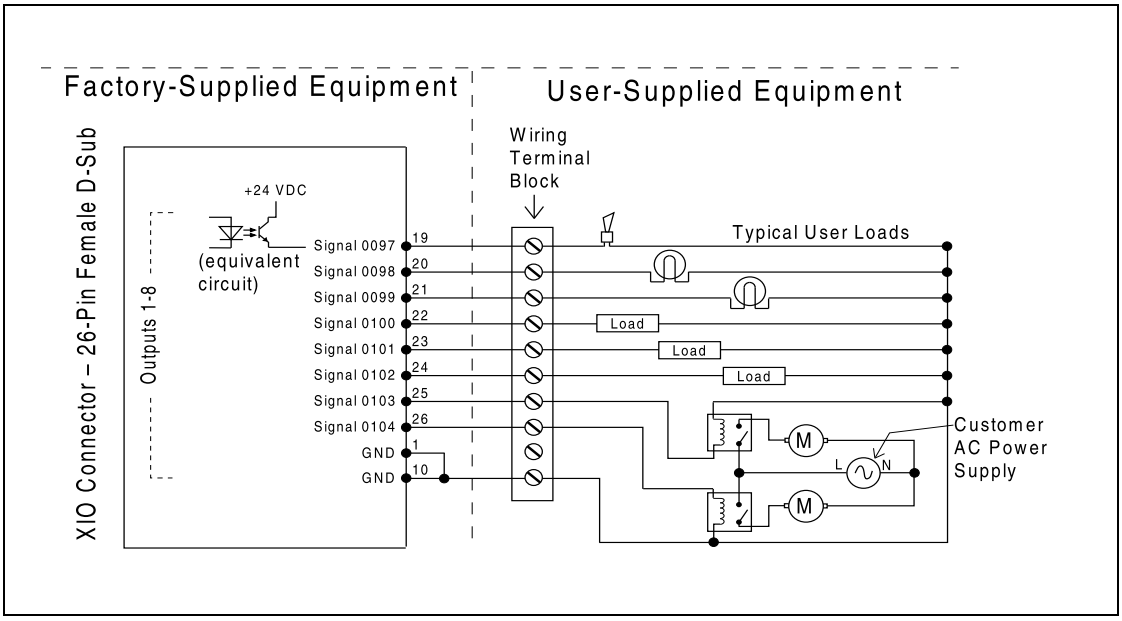


Figure 4-6. Typical User Wiring for XIO Output Signals

XIO Breakout Cable

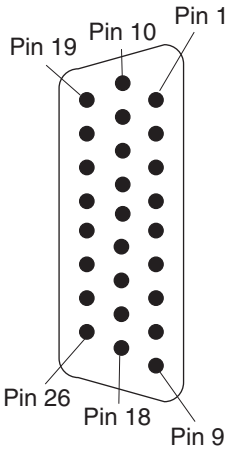
The XIO Breakout cable is available as an option - see the following figure. This cable connects to the XIO connector on the eMB-60R, and provides flying leads on the user's end, for connecting input and output signals in the workcell. The part number for the cable is 04465-000, and the length is 5 M (16.4 ft).

See the following table for the wire chart on the cable.

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

Figure 4-7. Optional XIO Breakout Cable

Table 4-10. XIO Breakout Cable Wire Chart

Pin No.	Signal Designation	Wire Color	Pin Locations
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	26-pin male connector on XIO Breakout Cable
15	Input 3.2	Gray	
16	Input 4.2	Gray/Black	
17	Input 5.2	Violet	
18	Input 6.2	Violet/White	
19	Output 1	Pink	
20	Output 2	Pink/Black	
21	Output 3	Light Blue	
22	Output 4	Light Blue/Black	
23	Output 5	Light Green	
24	Output 6	Light Green/Black	
25	Output 7	White/Red	
26	Output 8	White/Blue	
Shell		Shield	

4.6 eMB-60R Dimensions

The following figure shows dimensions of eMB-60R chassis and mounting holes.

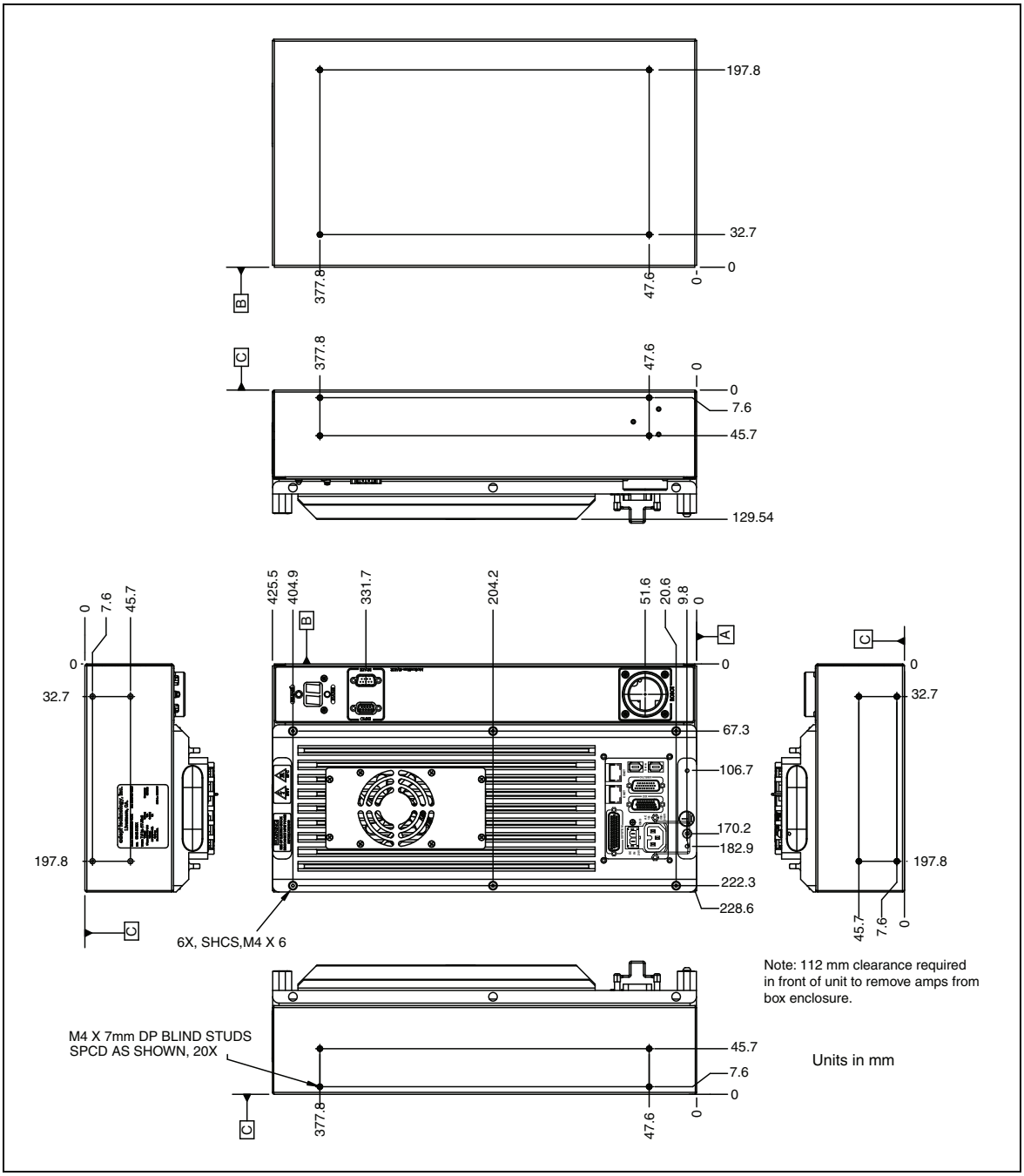


Figure 4-8. eMB-60R Mounting Dimensions

4.7 Mounting the eMB-60R

The eMB-60R can be panel-mounted.

> **NOTE**: The mounting of the eMB-60R and all terminations at the eMB-60R must be performed in accordance with all local and national standards.

To panel-mount the eMB-60R, install two brackets on each side at the rear of the unit (see the following figure for the bracket dimensions). Use the screws from the accessories kit.

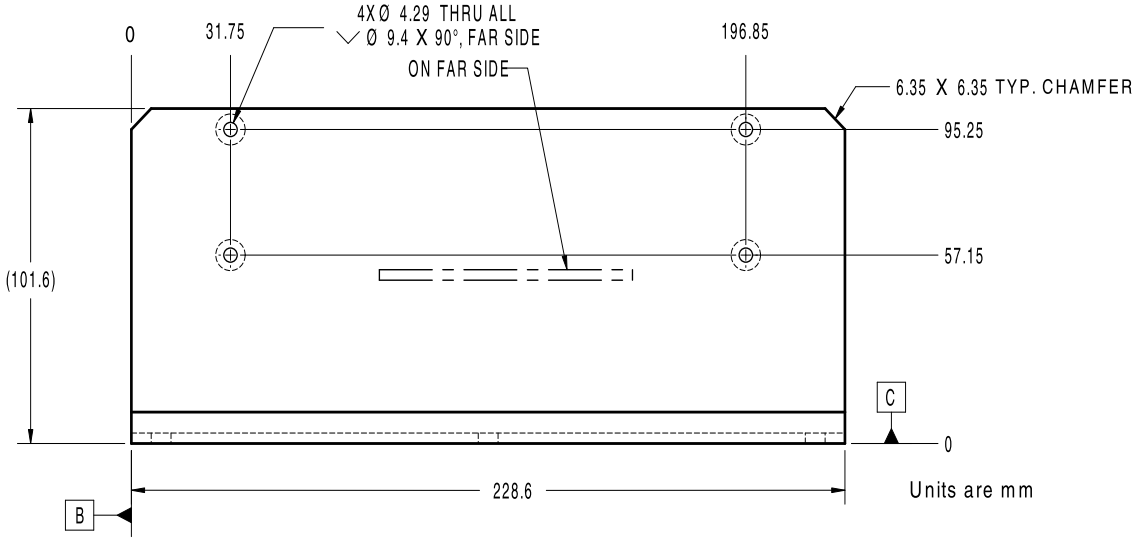


Figure 4-9. Panel-Mounting the eMB-60R

Chapter 5: System Installation

5.1 System Cables, without SmartController EX

The letters in the following figure correspond to the letters in the table of cables and parts. The numbers correspond to the steps in the cable installation overview table. The tables are on the pages following the figure.

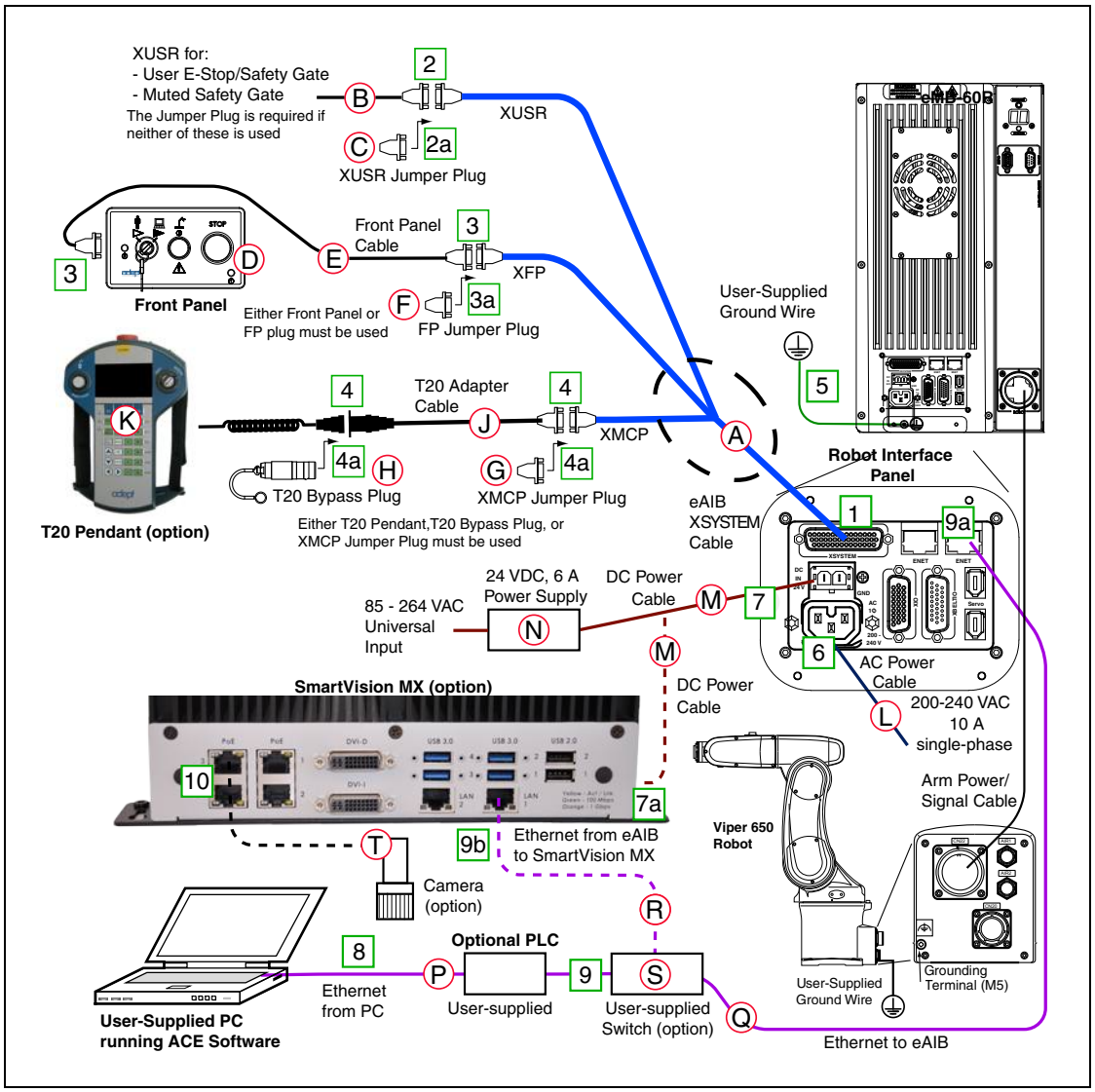


Figure 5-1. System Cable Diagram for Viper 650/850 Robots with eMB-60R, Pendant, and Vision

The pendant is an option, and may not be present in your system. The figure includes the optional T20 pendant and optional SmartVision MX industrial PC.

NOTE: See Installing the 24 VDC Cable on page 60 for additional system grounding information.

List of Cables and Parts

Open the Accessory box and locate the eAIB XSYSTEM cable. Connect the cables and peripherals as shown in the preceding figure. Parts and steps are covered in the following two tables.

Part	Cable and Parts List	Part #	Part of:	Notes
A	eAIB XSYSTEM Cable Assembly	13323-000		std, eMB-60R
B	User E-Stop, Safety Gate	n/a	n/a	user-supplied
C	XUSR Jumper Plug	04736-000	13323-000	std, eMB-60R
D	Front Panel	90356-10358		standard
E	Front Panel Cable	10356-10500	90356-10358	standard
F	Front Panel Jumper Plug	10053-000	13323-000	std, eMB-60R
G	XMCP Jumper Plug	04737-000	13323-000	std, eMB-60R
H	T20 Bypass Plug	10048-000	10055-000	standard, T20
J	T20 Adapter Cable	10051-003	10055-000	standard, T20
K	T20 Pendant (option)	10055-000		option
L	AC Power Cable (option)	04118-000	90565-010	or user-supplied
M	24 VDC Power Cable (option)	04120-000	90565-010	or user-supplied
N	24 VDC, 6 A Power Supply (option)	04536-000	90565-010	or user-supplied
P	Ethernet Cable - PC -> PLC (Only while programming PLC)	n/a	n/a	user-supplied
Q	Ethernet Cable - switch -> eMB-60R	n/a	n/a	user-supplied
R	Ethernet Cable - switch -> SmartVision MX	n/a	n/a	user-supplied
S	Ethernet switch, cable for SmartVision MX.	n/a	n/a	option, user-supplied
T	Camera and cable	n/a	n/a	option

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

WARNING: Under no circumstances should you run an eCobra system, in production mode, with all three jumpers installed. This would leave the system with no E-Stops.

Cable Installation Overview

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

Step	Connection	Part
1	Connect eAIB XSYSTEM cable to XSYSTEM on eAIB.	A
2	Connect a user E-Stop or Muted Safety Gate to the eAIB XSYSTEM cable XUSR connector or	B
2a	verify XUSR jumper plug is installed in eAIB XSYSTEM cable XUSR connector.	C
3	Connect Front Panel cable to Front Panel and eAIB XSYSTEM cable XFP connector or	D, E
3a	if no Front Panel, install FP jumper on eAIB XSYSTEM cable XFP connector. See NOTE after table.	F
4	Connect T20 adapter cable to eAIB XSYSTEM cable XMCP connector or	J, K
4a	if no T20, install XMCP jumper or T20 Adapter Cable with T20 bypass plug.	G or H
5	Connect user-supplied ground to robot. See System Installation on page 47.	n/a
6	Connect 200-240 VAC to AC Input on eAIB Interface Panel; secure with clamp.	L
7	Connect 24 VDC to DC Input on Interface Panel.	N, M
7a	Connect 24 VDC and shield ground to SmartVision MX, if used. See SmartVision MX user's guide for location.	N, M
8	Connect Ethernet cable from PC to PLC, if a PLC is used.	P
9	Connect Ethernet cable from PLC to switch, if a PLC is used.	S
9a	Connect Ethernet cable from switch to eAIB.	Q, S
9b	Connect Ethernet cable from SmartVision MX, if used, to switch.	R, S
10	Connect optional camera and cable to SmartVision MX, if used.	T

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

Optional Cables

NOTE: The following cables are not covered in the steps in the preceding table.

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

The XIO Breakout cable is for using the I/O on the eAIB. See XIO Breakout Cable on page 42.

The optional eAIB XBELT IO Adapter cable splits the eAIB XBELTIO port into a belt encoder lead, an Intelligent Force Sensor or IO Blox lead, and an RS-232 lead.

5.2 System Cables, with SmartController EX

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

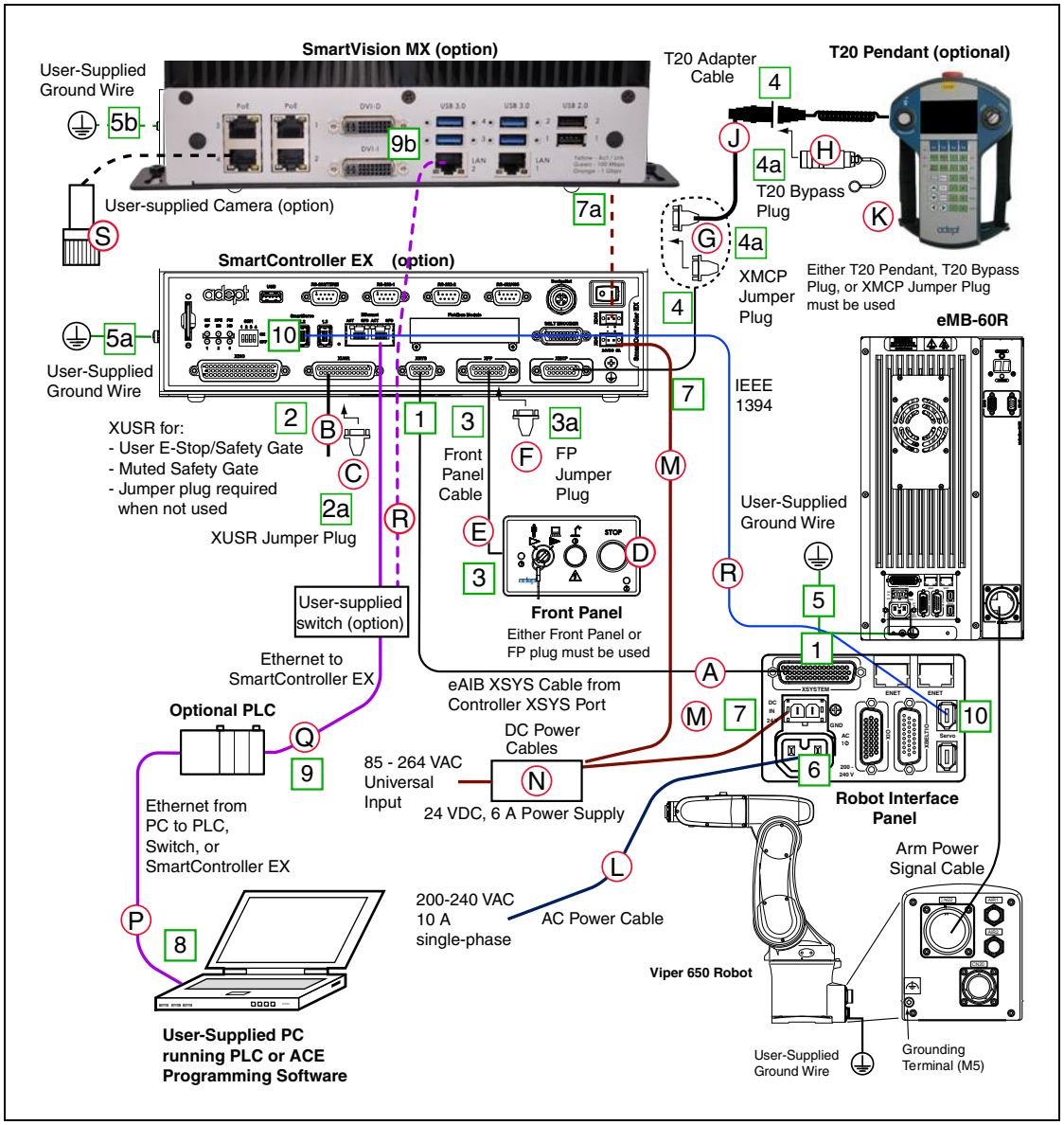


Figure 5-2. System Cable Diagram with SmartController EX

Installing a SmartController EX Motion Controller

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

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

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

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

List of Cables and Parts

Part	Cable and Parts List	Notes
A	eAIB XSYS Cable	standard, eAIB
B	User E-Stop, Safety Gate	user-supplied
C	XUSR Jumper Plug	standard, SmartController EX
D	Front Panel	standard
E	Front Panel Cable	standard
F	Front Panel Jumper Plug	standard, SmartController EX
G	XMCP Jumper Plug	standard, SmartController EX
H	T20 Bypass Plug	standard, T20
J	T20 Adapter Cable	standard, T20
K	T20 Pendant (option)	option
The following three items are available, as an option, in the power supply/cable kit 90565-010		
L	AC Power Cable	user-supplied/option
M	24 VDC Power Cable	user-supplied/option
N	24 VDC, 6 A Power Supply	user-supplied/option
P	Ethernet Cable, PC - SmartController	user-supplied
Q	Ethernet Cable, PC - SmartVision MX	user-supplied, option
R	IEEE 1394 cable	standard
S	Camera and cable	user-supplied, option

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

WARNING: Under no circumstances should you run an eCobra system, in production mode, with all three jumpers installed. This would leave the system with no E-Stops.

Cable Installation Overview

Step	Connection	Part
1	Connect eAIB XSYS cable to XSYSTEM on eMB-60R	A
2	Connect a user E-Stop or Muted Safety Gate to the XUSR connector or	B
2a	verify XUSR jumper plug is installed in XUSR connector.	C
3	Connect Front Panel cable to Front Panel and XFP connector or	D, E
3a	if no Front Panel, install FP jumper on XFP connector.	F
4	Connect Pendant adapter cable to XMCP connector or	J, K
4a	if no Pendant, install XMCP jumper or bypass plug.	G or H
5	Connect user-supplied ground to robot. See robot user's guide for location.	n/a
5a	Connect user-supplied ground to SmartController EX. See SmartController EX user's guide for location.	n/a
5b	Connect user-supplied ground to SmartVision MX, if used. See SmartVision MX user's guide for location.	n/a
6	Connect 200-240 VAC to AC Input on eAIB; secure with clamp.	L
7	Connect 24 VDC to DC Input on eAIB and SmartController EX.	N,M
7a	Connect 24 VDC to SmartVision MX, if used.	N,M
8	Connect Ethernet cable from PC to SmartController EX.	P
9a	Connect Ethernet cable to SmartVision MX, if used.	Q
10	Connnect IEEE 1394 cable between SmartController EX and eAIB SmartServo	R
11	Connect optional camera and cable to SmartVision MX, if used.	S

Optional Cables

NOTE: The following cables are not covered in the steps in the preceding table.

Part Description	Notes
XIO Breakout Cable, 12 inputs/ 8 outputs, 5 M	Available as option
Y Cable, for XSYS cable connections to dual robots	Available as option with SmartController EX
eAIB XBELT IO Adapter Cable	Available as option

The XIO Breakout cable is for using the I/O on the eAIB. See XIO Breakout Cable on page 42.

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

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

5.3 System Cables, with Two Conveyor Encoders

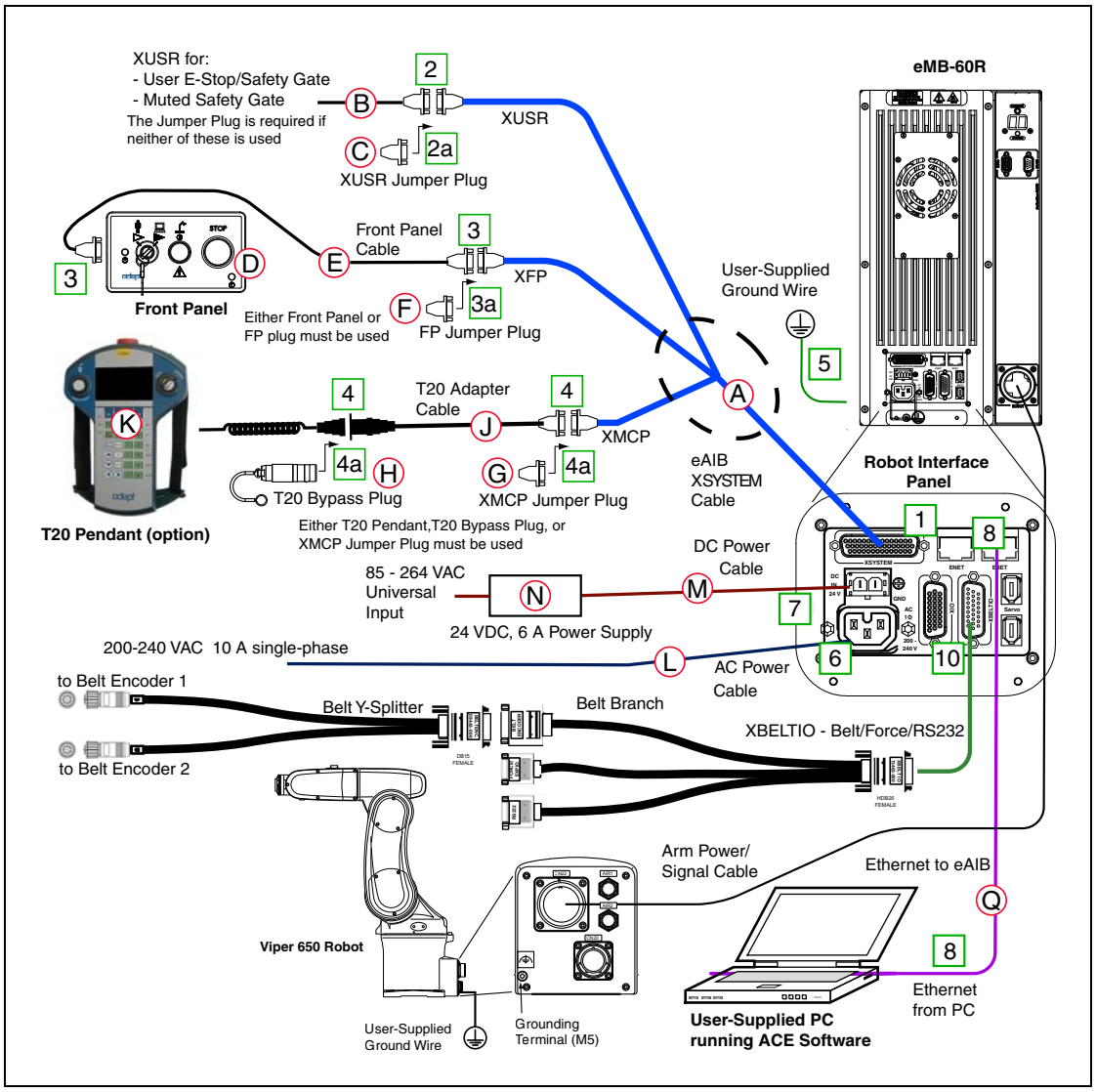
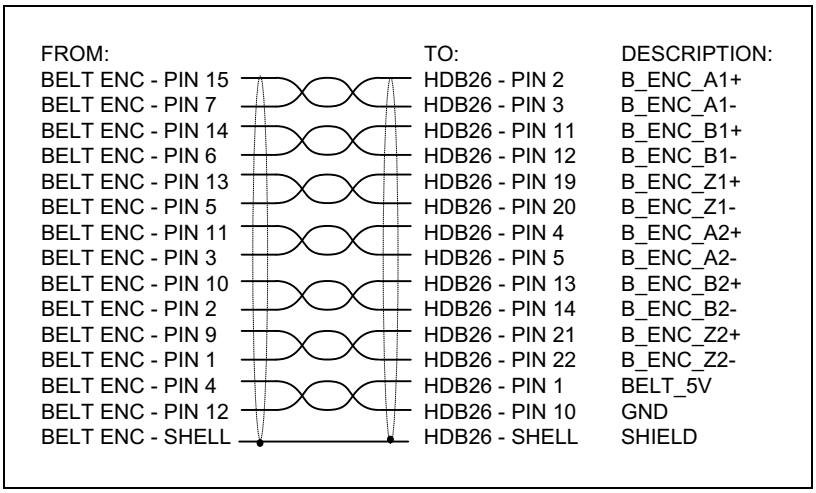


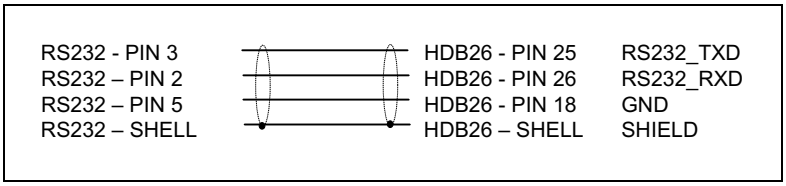
Figure 5-3. System Cable Diagram with Belt Encoders

Pinouts for eAIB XBELT IO Adapter

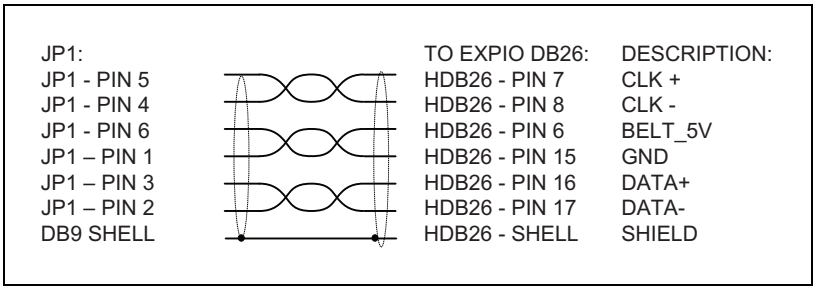
Belt Encoder



RS232



FORCE/EXPIO



5.4 ACE Software

User-supplied PC

The user loads the ACE software onto the PC and connects it to the eMB-60R via an Ethernet cable. Depending on the other equipment in the system, there may be an Ethernet switch between the two.

Installing ACE Software

The ACE software is installed from the ACE software disk.

1. Insert the disk into the disk drive of your PC.

   If Autoplay is enabled, the ACE software menu is displayed. If Autoplay is disabled, you will need to manually start the disk.

2. Especially if you are upgrading your ACE software installation: from the ACE software disk menu, click Read Important Information.

3. From the ACE software disk menu, select:

   Install the ACE Software

   The ACE Setup wizard opens.

4. Follow the online instructions as you step through the installation process.

5. When the installation is complete, click Finish.

6. After closing the ACE Setup wizard, click Exit on the disk menu to close the menu.

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

5.5 Connecting Cables from the eMB-60R to the Robot

The cable between the robot and the eMB-60R is called the Arm Power/Signal cable.

1. Connect one end of the Arm Power/Signal cable to the CN22 connector on the back plate of the robot. Tighten the thumb-screw securely.

2. Connect the other end of the cable to the large, circular connector on the eMB-60R. See System Cable Diagram for Viper 650/850 Robots with eMB-60R, Pendant, and Vision on page 47.

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.

5.6 Connecting 24 VDC Power to eMB-60R Servo Controller

Specifications for 24 VDC Power

Table 5-1. Specifications for 24 VDC User-Supplied Power Supply

Customer-Supplied Power Supply	24 VDC (± 10%), 150 W (6 A) (21.6 V< V_{in} < 26.4 V)
Circuit Protection[1]	Output must be less than 300 W peak or 8 Amp in-line fuse
Power Cabling	1.5 – 1.85 mm² (16-14 AWG)
Shield Termination	Cable shield connected to frame ground on power supply and ground point on eMB-60R. See User-Supplied 24 VDC Cable on page 60.
[1]User-supplied 24 VDC power supply must incorporate overload protection to limit peak power to less than 300 W, or 8 A in-line fuse protection must be added to the 24 V power source.	

NOTE: Fuse information is located on the eMB-60R electronics.

The power requirements for the user-supplied power supply will vary depending on the configuration of the robot and connected devices. We recommend a 24 V, 6 A power supply to allow for startup current draw and load from connected user devices, such as digital I/O loads.

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

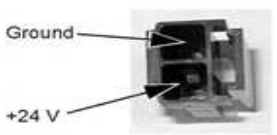
Table 5-2. Recommended 24 VDC Power Supply

Vendor Name	Model	Ratings	Mount
OMRON	S8JX-G15024C	24 VDC, 6.5 A, 150 W	Front Mount
OMRON	S8JX-G15024CD	24 VDC, 6.5 A, 150 W	DIN-Rail Mount

Details for 24 VDC Mating Connector

The 24 VDC mating connector and two pins are supplied with each system. They are shipped in the cable/accessories box.

Table 5-3. 24 VDC Mating Connector Specs

Connector Details  	Connector receptacle, 2 position, type: Molex Saber, 18 A, 2-Pin
	Molex P/N 44441-2002
	Digi-Key P/N WM18463-ND
Pin Details 	Molex connector crimp terminal, female, 14-18 AWG
	Molex P/N 43375-0001
	Digi-Key P/N WM18493-ND
Recommended crimping tool, Molex Hand Crimper	Molex P/N 63811-0400
	Digi-Key P/N WM9907-ND

NOTE: The 24 VDC cable is not supplied with the system, but is available in the optional Power Cable kit. See List of Cables and Parts on page 48.

Procedure for Creating 24 VDC Cable

1. Locate the connector and pins from the preceding table.
2. Use shielded two-conductor cable with 14-16 AWG wire to create the 24 VDC cable. Select the wire length to safely reach from the user-supplied 24 VDC power supply to the eMB-60R base.

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

3. Crimp the pins onto the wires using the recommended crimping tool.
4. Insert the pins into the connector. Confirm that the +24 V and ground wires are in the correct terminals in the plug.
5. Install a user-supplied ring lug (for an M3 screw) on the shield at the eMB-60R end of the cable.

6. Prepare the opposite end of the cable for connection to the user-supplied 24 VDC power supply, including a terminal to attach the cable shield to frame ground.

Installing the 24 VDC Cable

Do not turn on the 24 VDC power until instructed to do so in the next chapter.

1. Connect one end of the shielded 24 VDC cable to your user-supplied 24 VDC power supply. See User-Supplied 24 VDC Cable on page 60. The cable shield should be connected to frame ground on the power supply.
2. Plug the mating connector end of the 24 VDC cable into the 24 VDC connector on the interface panel on the back of the eMB-60R. The cable shield should be connected to the ground point on the interface panel.

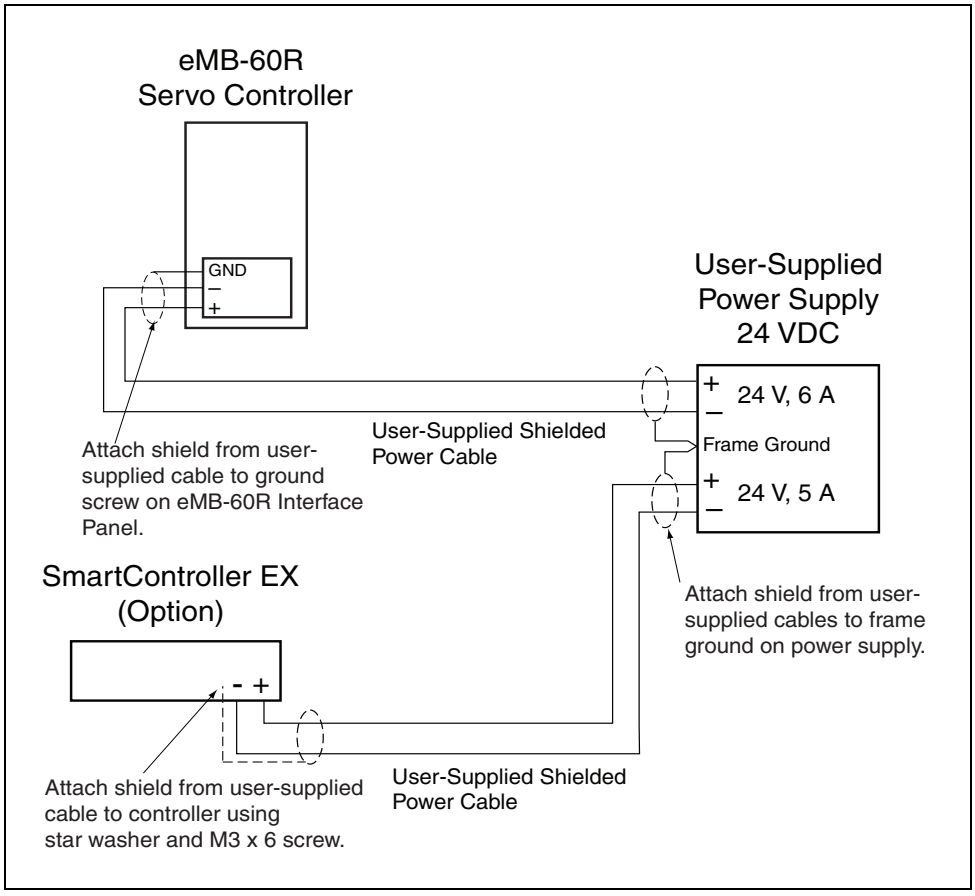


Figure 5-4. User-Supplied 24 VDC Cable

NOTE: We recommend that DC power be delivered over shielded cables, with the shield connected to frame ground at the power supply, and to the ground points shown in the diagram above for the eMB-60R and SmartController. The length of the wire from the cable shield to the ground points should be less than 50 mm.

5.7 Connecting 200-240 VAC Power to eMB-60R

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

WARNING: Appropriately-sized Branch Circuit Protection and Lockout / Tagout Capability must be provided in accordance with the National Electrical Code and any local codes.

Specifications for AC Power

Table 5-4. Specifications for 200/240 VAC User-Supplied Power Supply

Auto-Ranging Nominal Voltage Ranges	Minimum Operating Voltage[1]	Maximum Operating Voltage	Frequency/ Phasing	Recommended External Circuit Breaker, User-Supplied
200 to 240 V	180 V	264 V	50/60 Hz 1-phase	10 Amps
[1]Specifications are established at nominal line voltage. Low line voltage can affect robot performance.				

The robot system is intended to be installed as a piece of equipment in a permanently-installed system.

Table 5-5. Typical Robot Power Consumption[1]

Robot	Move	Average Power	Peak Power[2]
Viper 650	No load - Adept cycle[3]	371 W	947 W
	5.0 kg - Adept cycle[3]	477 W	1526 W
	5.0 kg - all joints move	834 W	2088 W
Viper 850	No load - Adept cycle[3]	358 W	1237 W
	5.0 kg - Adept cycle[3]	407 W	1202 W
	5.0 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 (1 in.) up, 305 mm (12 in.) over, 25 mm (1 in.) 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.			

DANGER: AC power installation must be performed by a skilled and instructed person - refer to the *Robot Safety Guide*. During installation, unauthorized third parties must be prevented from turning on power through the use of fail-safe lockout measures, as mandated by ISO 10218-1, Clause 5.2.4.

Failure to use appropriate power (less than or more than the rated voltage range of 200-240 VAC) can lead to malfunction or failures of the robot or hazardous situations.

Facility Overvoltage Protection

The user must protect the robot from excessive overvoltages and voltage spikes. If the country of installation requires a CE-certified installation, or compliance with IEC 1131-2, the following information may be helpful: IEC 1131-2 requires that the installation must ensure that Category II overvoltages (i.e., line spikes not directly due to lightning strikes) are not exceeded. Transient overvoltages at the point of connection to the power source shall be controlled not to exceed overvoltage Category II, i.e., not higher than the impulse voltage corresponding to the rated voltage for the basic insulation. The user-supplied equipment or transient suppressor shall be capable of absorbing the energy in the transient.

In the industrial environment, nonperiodic over-voltage peaks may appear on mains power supply lines as a result of power interruptions to high-energy equipment (such as a blown fuse on one branch in a 3-phase system). This will cause high-current pulses at relatively low voltage levels. The user shall take the necessary steps to prevent damage to the robot system (such as by interposing a transformer). See IEC 1131-4 for additional information.

AC Power Diagrams

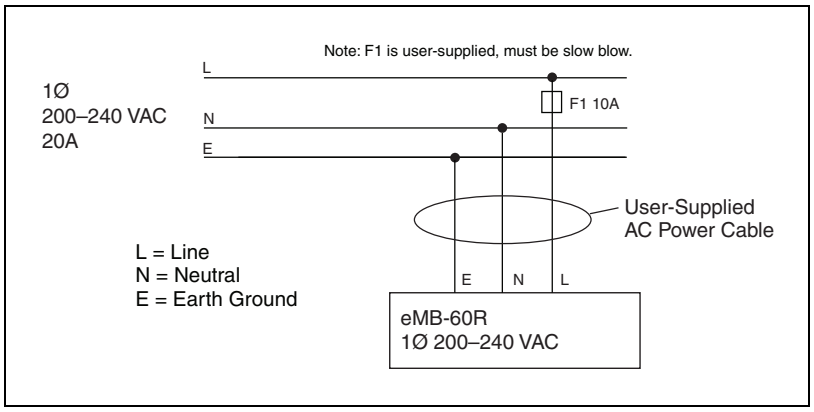


Figure 5-5. Typical AC Power Installation with Single-Phase Supply

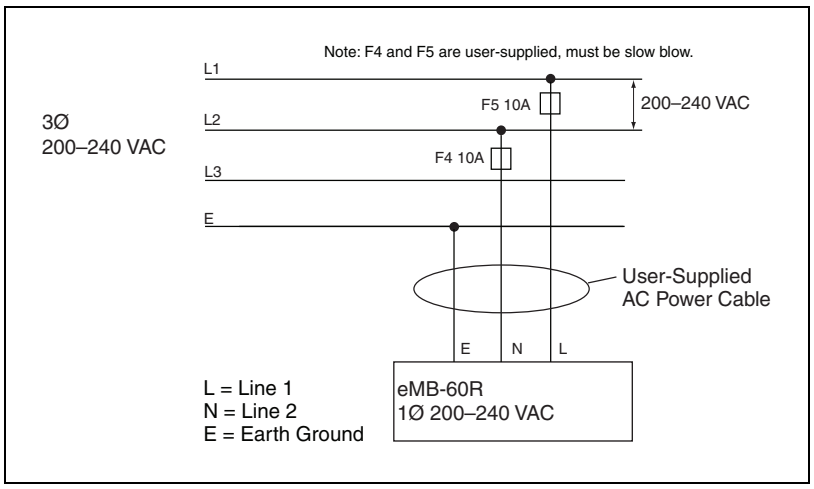
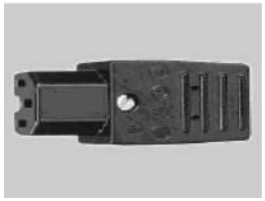


Figure 5-6. Single-Phase Load across L1 and L2 of a Three-Phase Supply

Details for AC Mating Connector

The AC mating connector is supplied with each system. It is shipped in the cable/accessories box. The supplied plug is internally labeled for the AC power connections (L, E, N).

Table 5-6. AC Mating Connector Details

AC Connector details 	AC in-line power plug, straight, female, screw terminal, 10 A, 250 VAC
	Qualtek P/N 709-00/00
	Digi-Key P/N Q217-ND

NOTE: The AC power cable is not supplied with the system, but is available in the optional Power Cable kit.

Procedure for Creating 200-240 VAC Cable

1. Locate the AC mating connector shown in the preceding table.
2. Open the connector by unscrewing the screw on the shell and removing the cover.
3. Loosen the two screws on the cable clamp. See AC Power Mating Connector on page 64.
4. Use 18 AWG wire to create the AC power cable. Select the wire length to safely reach from the user-supplied AC power source to the eMB-60R base.
5. Strip approximately 18 to 24 mm of insulation from each of the three wires.

6. Insert the wires into the connector through the removable bushing.
7. Connect each wire to the correct terminal screw, and tighten the screw firmly.
8. Tighten the screws on the cable clamp.
9. Replace the cover and tighten the screw to seal the connector.
10. Prepare the opposite end of the cable for connection to the facility AC power source.

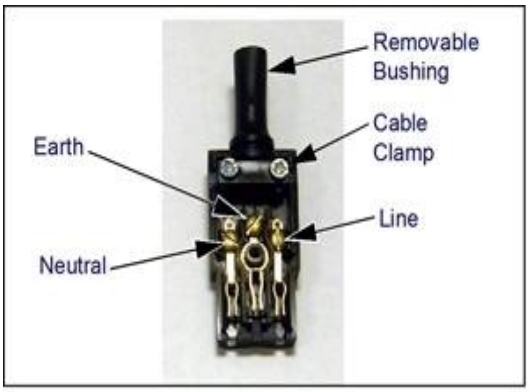


Figure 5-7. AC Power Mating Connector

Installing AC Power Cable to eMB-60R

1. Connect the unterminated end of the AC power cable to your facility AC power source. See Figure 5-5. and Figure 5-6.

   Do not turn on AC power at this time.
2. Plug the AC connector into the AC power connector on the interface panel on the eMB-60R.
3. Secure the AC connector with the locking latch.

5.8 Grounding the Robot System

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

WARNING: Wiring must be performed by authorized or certified personnel. Failure to observe this precaution may result in fire or electric shock.

NOTE: Ground the grounding terminal of the robot with a wire of 12 AWG or larger. Ground resistance must be ≤ 10 Ω.

NOTE: Use a dedicated grounding wire and grounding electrode. Do not share them with any other electric power or power equipment, such as a welder.

Ground Point on Robot Base

The user can install a protective earth ground wire at the robot base to ground the robot. See the following figure. The user is responsible for supplying the ground wire to connect to protective earth ground.

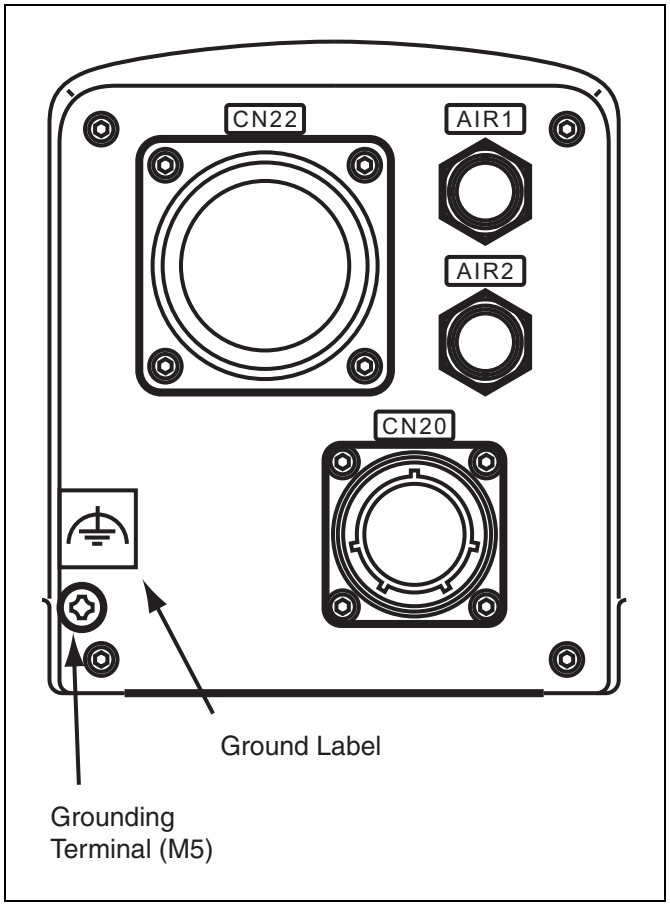


Figure 5-8. Ground Point on Robot Base

Ground Point on MotionBlox-60R

The user can install a ground wire at the eMB-60R chassis. Use the hole below the eMB-60R 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. Optionally, two tapped holes are provided to attach user-supplied strain relief.

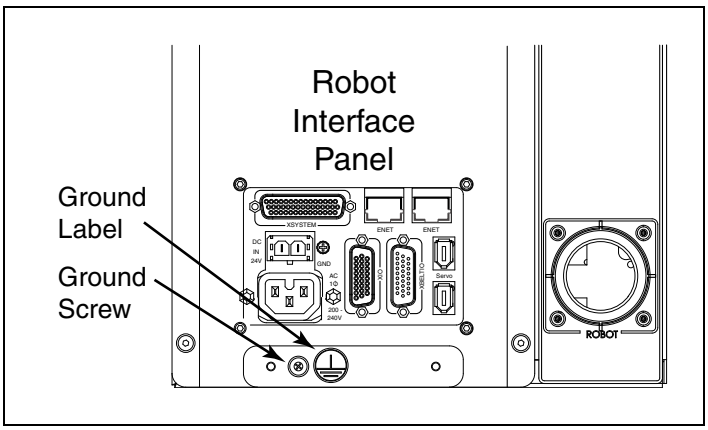


Figure 5-9. User Ground Location

Robot-Mounted Equipment Grounding

The robot tool flange is not reliably grounded to the robot base. If hazardous voltages are present at any user-supplied robot-mounted equipment or tooling, you must install a ground connection from that equipment/tooling to the ground point on the robot base. Hazardous voltages can be considered anything in excess of 30 VAC (42.4 VAC peak) or 60 VDC.

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

5.9 Installing User-Supplied Safety Equipment

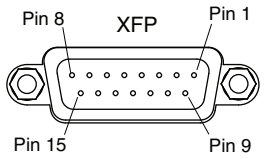
The user is responsible for installing safety barriers to protect personnel from coming in contact with the robot unintentionally. Depending on the design of the workcell, safety gates, light curtains, and emergency stop devices can be used to create a safe environment. Read the *Robot Safety Guide*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

The user-supplied safety and power-control equipment connects to the system through the XUSR and XFP connectors on the eMB-60R XSYSTEM cable. The XUSR connector (25-pin) and XFP (15-pin) connector are both female D-sub connectors. Refer to the following table for the XUSR pin-out descriptions. See "Contacts Provided by the XFP Connector" for the XFP pin-out descriptions. See the figure E-Stop Circuit on XUSR and XFP Connectors on page 70 for the XUSR wiring diagram.

Table 5-7. Contacts Provided by the XUSR Connector

Pin Pairs	Description	Comments
Voltage-Free Contacts Provided by Customer		
1, 14	User E-Stop CH 1 (mushroom push-button, safety gates, etc.)	N/C contacts, Shorted if NOT Used
2, 15	User E-Stop CH 2 (same as pins 1, 14)	N/C contacts, Shorted if NOT Used
3, 16	Line E-Stop (used for other robot or assembly line E-Stop 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
6, 19	Muted Safety Gate CH 2 (same as pins 5, 18)	N/C contacts, Shorted if NOT Used
Voltage-Free Contacts provided by Viper		
7, 20	E-Stop indication CH 1	Contacts are closed when Front Panel, pendant, and customer E-Stops are *not* tripped
8, 21	E-Stop indication CH 2 (same as pins 7, 20)	Contacts are closed when Front Panel, pendant, and customer E-Stops are *not* tripped
9, 22	Manual/Automatic indication CH 1	Contacts are closed in Automatic mode
10, 23	Manual/Automatic indication CH 2	Contacts are closed in Automatic mode
11, 12, 13, 24, 25	No connection	

Table 5-8. Contacts Provided by the XFP Connector

Pin Pairs	Description	Requirements for User-Supplied Front Panel
Voltage-Free Contacts Provided by Customer		
1, 9	Front Panel E-Stop CH 1	User must supply N/C contacts
2, 10	Front Panel E-Stop CH 2	User must supply N/C contacts
3, 11	Remote Manual/Automatic switch CH 1. Manual = Open Automatic = Closed	Optional - jumper closed for Auto Mode-only operation
4, 12	Remote Manual/Automatic switch CH 2. Manual = Open Automatic = Closed	Optional - jumper closed for Auto Mode-only operation
6, 14	Remote High Power on/off momentary push-button	User must supply momentary push-button to enable High Power to system
Non-voltage-Free Contacts		
5, 13	System-Supplied 5 VDC and GND for High Power On/Off Switch Lamp	User must supply lamp, or use 1 W, 47 ohm resistor - system will not operate if not present
7, 15[a]	Controller system 5 V power on LED, 5 V, 20 mA	Optional - indicator only
8	No connection	
		
See the figure Front Panel Schematic on page 71 for a schematic diagram of the Front Panel.		
[a]Users must exercise caution to avoid inadvertently connecting 24 V signals to these pins, because this will damage the electronics.		

NOTE: The system was evaluated by Underwriters Laboratory with a Front Panel. Using a substitute front panel could void UL compliance.

Table 5-9. Remote Pendant Connections on the XMCP Connector

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

The following figure shows an E-Stop diagram for the system. See Emergency Stop Circuits on page 71 for a description of the functionality of this circuit.

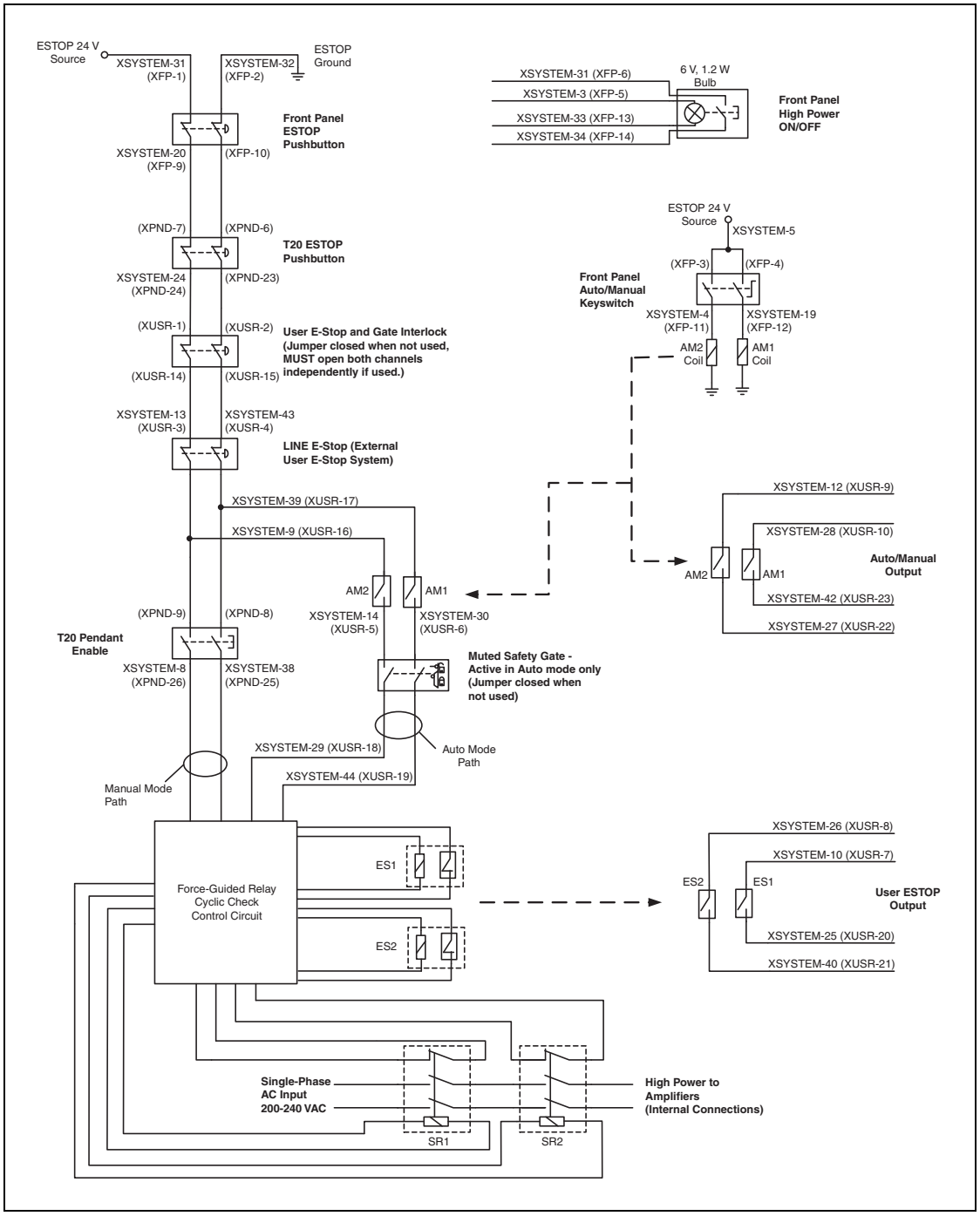


Figure 5-10. E-Stop Circuit on XUSR and XFP Connectors

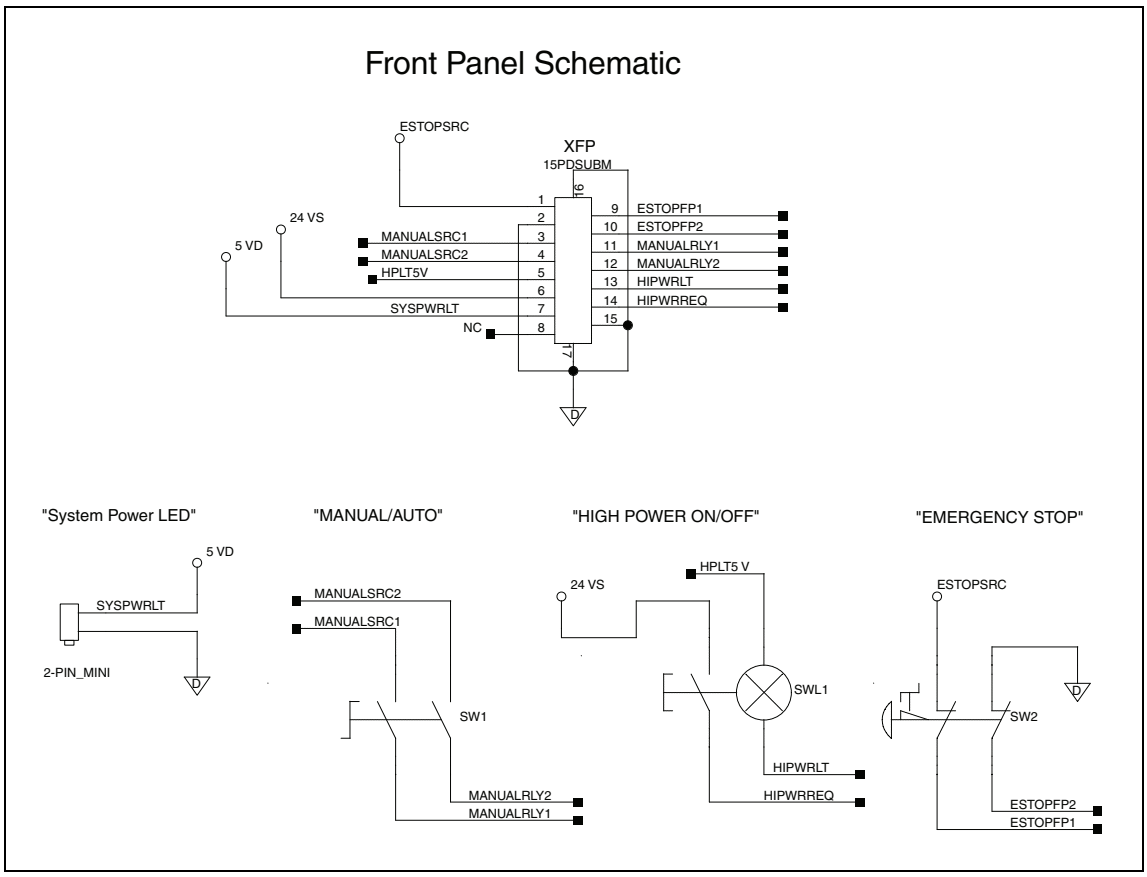


Figure 5-11. Front Panel Schematic

Emergency Stop Circuits

The eMB-60R XSYSTEM cable provides connections for Emergency Stop (E-Stop) circuits on the XUSR and XFP connectors. This gives the controller system the ability to duplicate E-Stop functionality from a remote location using voltage-free contacts. See Figure 5-10.

The XUSR connector provides external two-channel E-Stop input on pin pairs 1, 14 and 2, 15. The XFP connector provides two-channel E-Stop input on pin pairs 1, 9 and 2, 10.

> **NOTE:** These pins must be shorted if not used. Both channels must open independently if used. 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, inclusive of the Front Panel Emergency Stop push-button, the pendant Emergency Stop push-button, and the User Emergency Stop Contacts.

NOTE: These contacts do not indicate the status of any connections below the User E-Stop contacts. Thus, they will NOT indicate the status of the Line E-Stop, MCP ENABLE, or the Muted Safety gate. If you have a specific need in this area, contact Omron Adept Technologies, Inc. for information on alternate indicating modes.

Two pairs of pins on the XUSR connector (pins 7, 20 and 8, 21) provide voltage-free contacts, one for each channel, to indicate whether the E-Stop chain, as described above, on that channel is closed. Both switches are closed on each of the redundant circuits in normal operation (no E-Stop). The user may use these contacts to generate an E-Stop for other equipment in the work-cell. The load on the contacts must not exceed 40 VDC or 30 VAC at a maximum of 1 A.

These voltage-free contacts are provided by a redundant, cyclically-checked, positive-drive, safety relay circuit for Category 3 PL-d per ISO 13849 operation (see Figure 5-10. and the table Contacts Provided by the XFP Connector on page 68 for the customer E-Stop circuitry).

Line E-Stop Input

The XUSR connector on the controller contains a two-channel Line E-Stop input for workcell or other equipment emergency-stop inputs. Generally, the customer E-Stop Indication contact outputs are used to generate an emergency stop in such external equipment. Thus, if one were to wire the same equipment's outputs into the customer E-Stop input (that is, in series with the local robot's E-Stop push-buttons), a lock-up situation could occur.

The Line E-Stop input comes into the circuit at a point where it cannot affect the customer E-Stop indication relays and will not cause such a lock-up situation. For any situation where two systems should be cross-coupled, for example, the customer E-Stop indication of one controller is to be connected to the input of another controller, the Line E-Stop input is the point to bring in the other controller's output contacts. See the figure E-Stop Circuit on XUSR and XFP Connectors on page 70 for more information.

Do not use the Line E-Stop for such devices as local E-Stop push-buttons, since their status should be reported to the outside on the local user E-Stop indication output contact while the Line E-Stop inputs will not.

Muted Safety Gate E-Stop Circuitry

Two pairs of pins on the XUSR connector (pins 5, 18 and 6, 19) provide connections for a safety gate designed to yield an E-Stop allowing access to the workspace of the robot in Manual mode only, not in Automatic mode. It is up to the customer to determine if teaching the robot in Manual Mode, by a skilled programmer (See Qualification of Personnel in the *Robot Safety Guide*), wearing safety equipment and carrying a pendant, is allowable under local regulations. The E-Stop is said to be "muted" in Manual mode (for the customer E-Stop circuitry, see the figures and tables at the beginning of this section).

The muted capability is useful for a situation where a shutdown must occur if the cell gate is opened in Automatic mode, but you need to open the gate in Manual mode. If the mute gate is opened in Automatic mode, the robot defaults to Manual mode operation when power is re-enabled. In muted mode, the gate can be left open for personnel to work in the robot cell. However, safety is maintained because of the speed restriction.

WARNING: Whenever possible, manual mode operations should be performed with all personnel outside the workspace.

CAUTION: If you want the cell gate to always cause a robot shut-down, wire the gate switch contacts in series with the user E-Stop inputs. Do not wire the gate switch into the muted safety gate inputs.

Remote Manual Mode

The Front Panel provides for a Manual Mode circuit. See Remote High Power On/Off Control on page 73 for further details about the customer Remote Manual Mode circuitry.

The Front Panel, or the user-supplied panel, must be incorporated into the robot workcell to provide a "Single Point of Control" (the pendant) when the controller is placed in Manual mode. Certain workcell devices, such as PLCs or conveyors, may need to be turned off when the operating mode switch is set to Manual mode. This is to ensure that the robot controller does not receive commands from devices other than from the pendant, the single point of control.

If the user needs to control the Manual/Automatic mode selection from other control equipment, then a custom splitter cable or complete replacement of the Front Panel may be required. See Front Panel Schematic on page 71. In this situation, a pair of contacts should be wired *in series* with the Front Panel Manual/Automatic mode contacts. Thus, both the Front Panel and the customer contacts need to be closed to allow Automatic mode.

WARNING: Do not wire user-supplied Manual/Automatic contacts in parallel with the Front Panel switch contact. This would violate the "Single Point of Control" principle and might allow Automatic (high-speed) mode to be selected while an operator is in the cell.

User Manual/Auto Indication

Two pairs of pins on the XUSR connector (pins 9, 22 and 10, 23) provide a voltage-free contact to indicate whether the Front Panel and/or remote Manual/Automatic switches are closed. The user may use these contacts to control other mechanisms (for example, conveyor, linear modules, etc.) when Manual mode is selected. The load on the contacts should not exceed 40 VDC or 30 VAC at a maximum of 1 A.

WARNING: Any safeguards that were suspended shall be returned to full functionality prior to selecting Automatic Mode.

User High Power On Indication

In the optional SmartController EX, eV+ controls a normally-open relay contact on the XDIO connector (pins 45, 46, see the table XDIO Digital I/O Connector Pin Assignments in the SmartController EX manual), that will close when high power has been enabled. The user can use this feature to power an indicator lamp or other device, that signals High Power is On. The limit on these contacts is 1 A at 30 VDC or 30 VAC.

Remote High Power On/Off Control

The easiest and most effective way to provide the high power on/off control in a remote location is to mount the Front Panel in the desired location with an extension cable.

However, if the user needs to control high power on/off from other control equipment or from a location other than the Front Panel, then a custom splitter cable will be required. See the Front Panel schematic (Front Panel Schematic on page 71) for details of the Front Panel's wiring. In this situation, a second momentary contact for high power on/off would be placed *in parallel with* the Front Panel push-button contact. This second contact should be suppressed when in Manual mode (see the note on "Single Point of Control" below).

This method allows relocating the push-button switch to a more convenient location. Implementation of this method must conform to EN standard recommendations.

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

Pins 6, 14 and 5, 13 of the XFP connector provide this remote capability. Pins 5, 13 provide power for the lamp, +5 VDC and ground, respectively. Pins 6, 14 are inputs for voltage-free normally-open contacts from a user-supplied momentary push-button switch.

WARNING: To fulfill the "Single Point of Control" requirement, do not place the Manual/Automatic and High Power On controls in multiple locations. After putting the robot into Manual mode, the operator should remove the key for safety purposes. The system should not be wired so that a PLC or another operator can put the system back into Automatic mode.

High Power On/Off Lamp

The Front Panel High Power On/Off Lamp (p/n: 27400-29006) will cause an error, from 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. See Changing the Lamp in the Front Panel High-Power Indicator on page 98 for information on changing this lamp.

Remote Front Panel or User-Supplied Control Panel Usage

Users can mount the Front Panel remotely by using an extension cable or by wiring a user-supplied Front Panel (control panel) to the controller using the 15-pin XFP connector. The Front Panel contains no active components, only switches and lights. Customers should be able to adapt the Front Panel's functionality into their own Front Panel design. To automatically control the Front Panel's signals, use relay contacts instead of switches. See the figure Front Panel Schematic on page 71 for a schematic drawing of the Front Panel, and see the table System Installation on page 47 for a summary of connections and pin numbers.

> **NOTE:** The system was evaluated by Underwriters Laboratory with our Front Panel. If you provide a substitute front panel, the system may no longer be UL compliant.

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

- Wire Size: must be larger than 26 AWG.
- Connectors: must be 15-pin, standard D-sub male and female.
- Maximum cable length is 10 meters.

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

Remote Pendant Usage

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

- Wire Size: must be larger than 26 AWG.
- Connectors: must be 15-pin, standard D-sub male and female.
- Maximum cable length is 10 meters.

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

Chapter 6: System Operation

6.1 Status Panel Codes

The status panel display on the eMB-60R displays alpha-numeric codes that indicate the operating status of the robot, including detailed fault codes. The chapter on MotionBlox-60R gives definitions of the fault codes. These codes provide details for quickly isolating problems during troubleshooting. See Status Panel on page 33.

6.2 Brakes

UL robots have an integrated brake-release switch located on the robot. On non-UL robots, you can install a manual brake-release box. In both cases, you can release the brakes on a specific axis.

WARNING: Pressing the Brake Release button may cause robot arms and the tool flange to fall.

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

Installing and Using the Brake Release Box

This procedure describes how to install and use a manual brake release box on non-UL robots. See the following figure.

1. Make sure that high power is disabled (off).
2. Connect the 9-pin male D-sub connector into the 9-pin female D-sub connector marked Brake on the eMB-60R.
3. Press one of the E-Stops (Pendant, Front Panel, or external).

   NOTE: An E-Stop must be activated in order for the brake release box to work.

4. Using the axis selector switch, select the axis for which you want to release the brake.
5. Depress the Brake Release push button to release the brake.
6. Repeat steps 4 and 5 above for releasing the brake on another axis.

NOTE: When the Status LED (Green) is on, it indicates that the circuit is enabled, when the Brake Release push button is pressed.

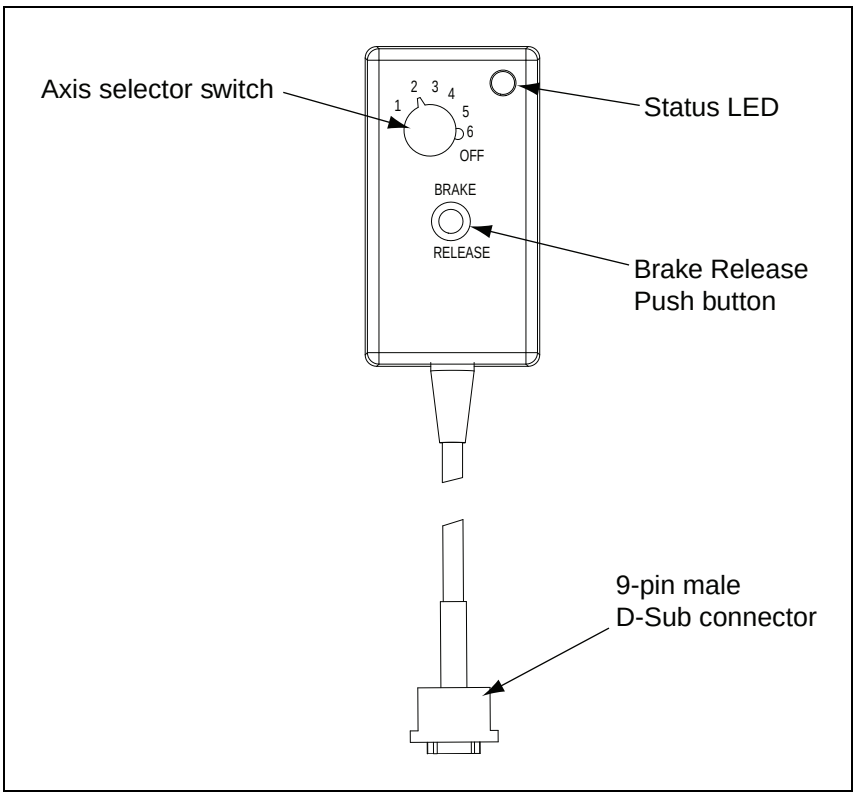


Figure 6-1. Manual Brake-Release Box

Using the Brake Release Switch on UL Robots

This procedure describes how to use the brake release switch on the base of UL robots. See the following figure.

1. Make sure that high power is disabled (off).
2. Press one of the E-Stops (Pendant, Front Panel, or external).

   NOTE: An E-Stop must be activated in order for the brake release to work.

3. Using the axis selector switch, select the axis for which you want to release the brake.
4. Depress the Brake Release push button to release the brake.
5. Repeat steps 3 and 4 above to release the brake on another axis.

   NOTE: When the Status LED (Green) is on, it indicates that the circuit is enabled, when the Brake Release push button is pressed.

Figure 6-2. Brake Release Switch on UL Robots

6.3 Front Panel

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

WARNING: Any user-supplied front panel E-Stop must be designed in accordance with the requirements of IEC 60204-1 and ISO 13849. The push button of the E-Stop must comply with ISO 13850 (Clause 5.5.2).

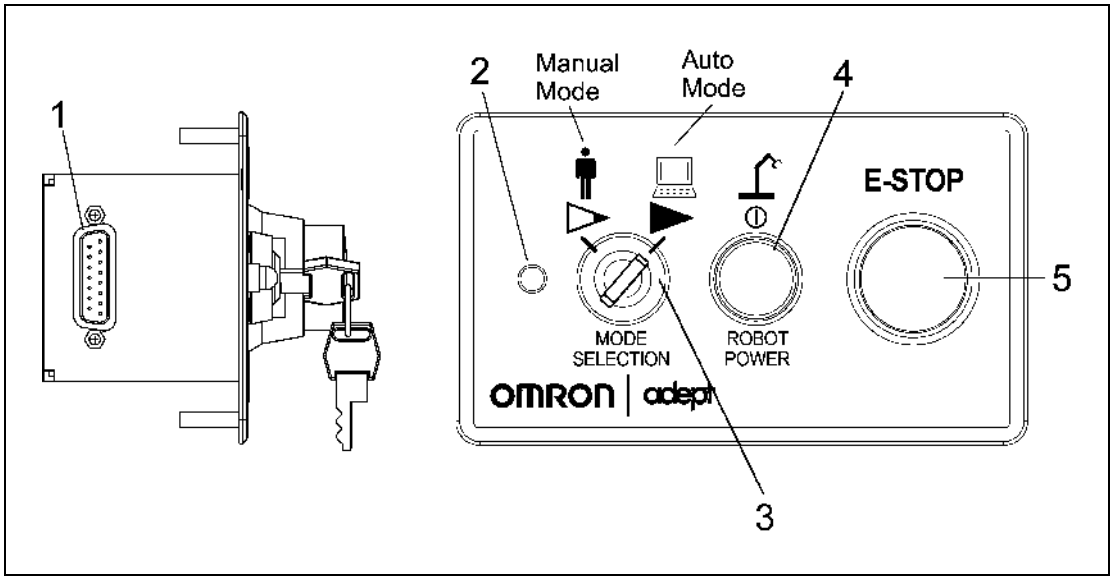


Figure 6-3. Front Panel

1. **XFP connector**
   Connects to the XFP connector on the eAIB XSYSTEM cable (or the optional SmartController EX, if one is being used).

2. **System 5 V Power-On LED**
   Indicates whether or not power is connected to the robot.

3. **Manual/Automatic Mode Switch**
   Switches between Manual and Automatic mode. In Automatic mode, executing programs control the robot, and the robot can run at full speed. In Manual mode, the system limits robot speed and torque so that an operator can safely work in the cell. Manual mode initiates hardware and software restrictions on robot speed, commanding no more than 250 mm/sec.

   There is no high speed mode in manual mode.

WARNING: If an operator is going to be in the work cell in manual mode, it is strongly recommended that the operator carry an enabling device. The Enable button on the manual control pendant is such a device.

WARNING: Whenever possible, manual mode operations should be performed with all personnel outside the workspace.

4. **High Power On/Off Switch and Lamp**
   Controls high power, which is the flow of current to the robot motors. Enabling high power is a two-step process. An "Enable Power" request must be sent from the user-supplied PC, an executing program, or a pendant. Once this request has been made and the High Power On/Off lamp/button is blinking, the operator must press and release this button, and high power will be enabled.

   NOTE: The use of the blinking High Power button can be configured (or eliminated) in software. Your system may not require this step.

WARNING: Disabling the High Power button violates IEC 60204-1. It is strongly recommended that you not alter the use of the High Power button.

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

5. **Emergency Stop Switch**
   The E-Stop is a dual-channel, passive E-Stop that supports Category 3 CE safety requirements. Pressing this button turns off high power to the robot motors.

NOTE: The Front Panel must be installed to be able to Enable Power to the robot. To operate without a Front Panel, the user must supply the equivalent circuits.

6.4 Starting the System for the First Time

The first time you power-up the system, you must follow the steps in this section to safely bring up your robot system. The tasks include:

- Verifying installation, to confirm all tasks have been performed correctly.
- Starting up the system by turning on power for the first time.
- Verifying all E-Stops in the system function correctly.
- Moving each axis of the robot (typically with the pendant) to confirm it moves in the proper directions.

Verifying Installation

Verifying that the system is correctly installed and that all safety equipment is working correctly is an important process. Before using the robot, make the following checks to ensure that the robot and controller have been properly installed.

DANGER: After installing the robot, you must test it before you use it for the first time. Failure to do this could cause death, serious injury or equipment damage.

Mechanical Checks

- Verify that the robot is mounted level and that all fasteners are properly installed and tightened.
- Verify that any end-of-arm tooling is properly installed.
- Verify that all other peripheral equipment is properly installed and in a state where it is safe to turn on power to the robot system.

System Cable Checks

Verify the following connections:

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

- Front Panel to the XSYSTEM on the eMB-60R.
- Pendant to the XSYSTEM on the eMB-60R.
- XUSR to the XSYSTEM on the eMB-60R.
- User-supplied 24 VDC power to the eMB-60R 24 VDC connector.
- User-supplied 200/240 VAC power to the eMB-60R 200/240 VAC connector.

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

- eAIB XSYS cable between the robot interface panel XSYSTEM connector and XSYS connector on the SmartController, and the latching screws tightened.
- Front Panel to the SmartController EX.
- Optional pendant to the SmartController EX.
- User-supplied 24 VDC power to the controller.
- User-supplied ground wire between the SmartController EX and ground.
- One end of the IEEE 1394 cable into a SmartServo port connector on the SmartController EX, and the other end into a SmartServo connector on the eMB-60R.

User-Supplied Safety Equipment Checks

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

System Start-up Procedure

Once the system installation has been verified (see Verifying Installation on page 81), you are ready to start up the system.

1. Switch on AC power to the eMB-60R.
2. Switch on the 24 VDC power to the controller (if used) and the eMB-60R.
3. Follow the instructions, beginning with Starting the ACE Software, in the following section.

Running the ACE Software

Starting the ACE Software

The robot should be on, and the status panel should display OK before proceeding.

1. Turn on the PC and start the ACE software.
   - Double-click the ACE icon on your Windows desktop

     or, from the Windows Start menu bar,
   - Select **Start > Programs > Omron > ACE x.y**

     x.y where x is the ACE major version, and y is the ACE minor version.

     For example, for ACE 3.6, it would be: Start > Programs > Omron > ACE 3.6
2. On the ACE Startup menu, click New SmartController Workspace.
3. Click-select the SmartController you want to use, and click OK.

Enabling High Power

After you have started the ACE software and connected to the controller, enable high power to the robot motors:

1. From the ACE main menu, click the Enable High Power icon: 
2. If the High Power button on the Front Panel is blinking, press and release it.

   NOTE: The use of the blinking High Power button can be configured (or eliminated) in software. Your system may not require this step.

   The Front Panel, which is mounted just outside the workcell safety barrier, is shown in the following figure. If enabled, the High Power button must be pressed while blinking (default time-out is 10 seconds). If the button stops blinking, you must enable power again.

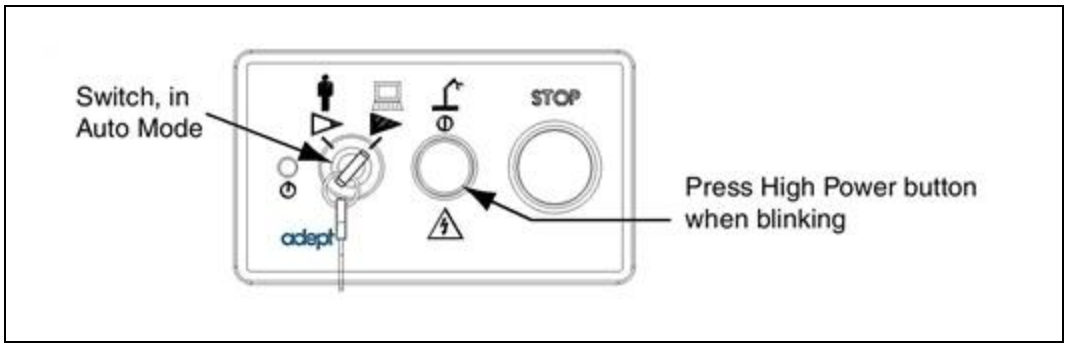


Figure 6-4. High Power Button on Front Panel

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

- The amplifier status LED blinks green rapidly
  (a slow green blink has a different meaning).

  In addition, for IP65 Viper robots, the lamps on the robot glow solid amber.

- The status panel on the robot or amplifier chassis displays ON.

Verifying E-Stop Functions

Verify that all E-Stop devices are functional (pendant, Front Panel, and user-supplied). Test each mushroom button, safety gate, light curtain, etc., by enabling high power and then opening the safety device. The High Power push button/light on the Front Panel should go out.

Verify Robot Motions

Use the pendant (or jog control) to test the motion of each axis on the robot to confirm it moves in the proper directions.

Refer to the *T20 Pendant User's Guide* for instructions on using the pendant.

If the optional pendant is not installed in the system, you can move the robot using the Robot Jog Control in the ACE software. For details, see the *ACE User's Guide*.

NOTE: When using a pendant with a Viper robot, the Free mode is disabled for safety reasons.

6.5 Learning to Program the Robot

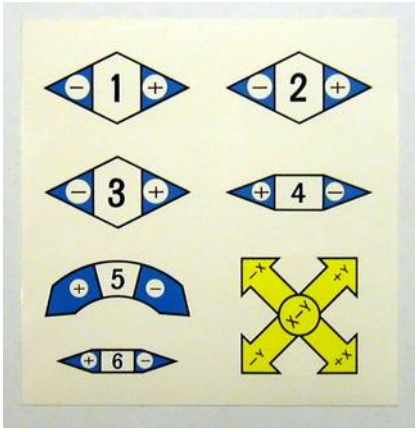
To learn how to use and program the robot, see the *ACE User's Guide*, which provides information on robot configuration, control and programming through the ACE software "point and click" user interface.

For eV+ programming information, refer to the eV+ user and reference guides.

6.6 Installing Axis Labels

The system includes a set of axis directional labels that can be installed on the robot. See the following table. Also refer to Robot Axis Identification on page 7 for a drawing of the axis identification. The yellow X-Y label can be used to indicate the X and Y axes in the World coordinate system in your workcell.

Table 6-1. Axis Directional Labels

<table>
<tr>
<td> 
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6.7 Caution Label on Robot

The Caution label shown in the following figure refers to rotation of Joint 4. When power is turned off, **do not** manually rotate Joint 4 more than the Joint Limits of ±190°. If Joint 4 is rotated beyond these limits, the internal wiring can be damaged.

Figure 6-5. Caution Label on Joint 4 Rotation

NOTE: There is no CALSET operation on the Viper robot, and there is no Installation and Maintenance Guide.

Chapter 7: Maintenance

7.1 Field-replaceable Parts

WARNING: 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. The access covers on the robot are not interlocked - turn off and disconnect power if covers have to be removed.

WARNING: During maintenance, user-supplied fail-safe lock-out measures must be used to prevent unauthorized third parties from turning on power.

This is mandated by Clause 5.2.4 of ISO 10218-1.

The only field-replaceable parts on the Viper 650/850 robots are the encoder battery and the eMB-60R.

The part number for the battery is 05234-000.

7.2 Periodic Maintenance Schedule

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

Also, for cleanroom robots, see Cleanroom Option on page 117. For IP54/65 robots, see IP54/65 Option on page 113.

Item	Period	Reference
Check E-Stop, enable and key switches, and barrier interlocks	6 months	See Checking Safety Systems on page 88
Check robot mounting bolts	6 months	See Checking Robot Mounting Bolts on page 88
Replace encoder battery	2 to 7 years	See Replacing Encoder Backup Batteries on page 88

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

7.3 Checking Safety Systems

These tests should be done every six months.

1. Test operation of:
    - E-Stop button on Front Panel
    - E-Stop button on pendant
    - Enabling switch on pendant
    - Auto/Manual switch on Front Panel

    NOTE: Operating **any** of the above switches should disable high power.

2. Test operation of any external (user-supplied) E-Stop buttons.
3. Test operation of barrier interlocks, etc.

7.4 Checking Robot Mounting Bolts

Check the tightness of the base mounting bolts every 6 months. Tighten to 70 ± 14 N·m (52 ± 10 ft-lbf).

7.5 Replacing Encoder Backup Batteries

CAUTION: Replace the batteries only with 3.6 V, 8.5 Ah lithium batteries, part number: 05234-000. Battery information is located in the base of the robot.

Battery Replacement Intervals

The encoder backup batteries should be replaced according to the intervals that follow.

- 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 batteries should be replaced every two years.
- If the robot is turned on with 24 VDC supplied to the robot half the time, the batteries should be replaced every four years.
- If the robot is turned on with 24 VDC more than half the time, then you can increase the replacement interval to seven years. If, for example, a robot is typically turned off only on weekends, the batteries would need to be replaced every seven years.

Battery Replacement Procedure

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

Replace the batteries according to the following procedure:

1. Prepare a new set of three backup batteries for replacement.
2. Turn off AC power to the eMB-60R and DC power to the controller.
3. Remove the cover from the robot. See the following figure.

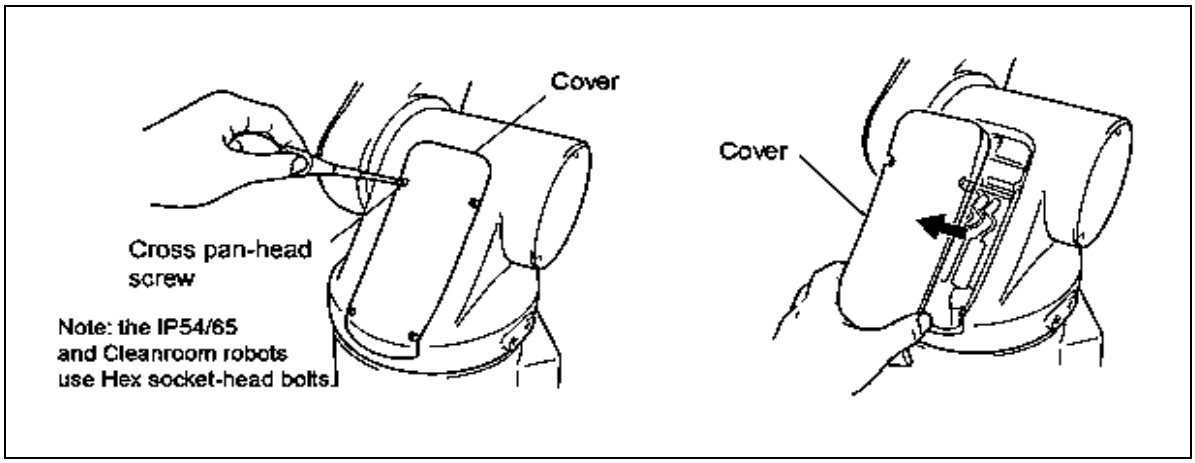

Figure 7-1. Removing Cover to Replace Encoder Batteries

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

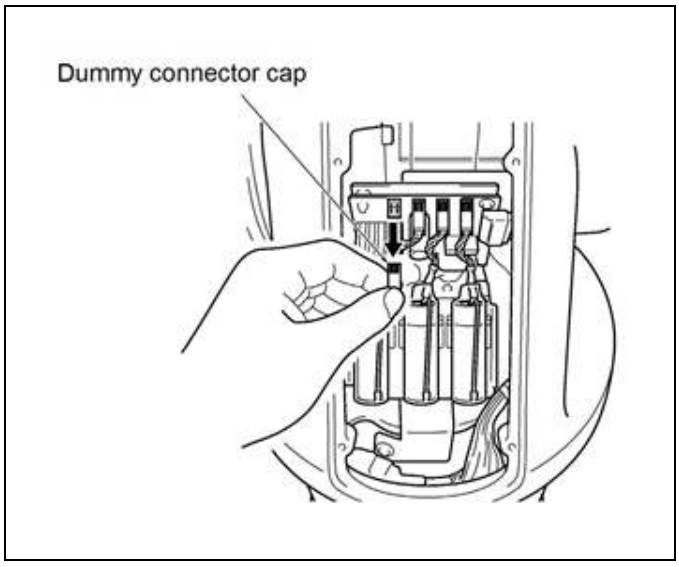

Figure 7-2. Removing Dummy Connector Cap

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.

   NOTE: Do not disconnect the old backup battery before connecting a new one to the pin from which the dummy connector cap is removed. If you do so, the encoder positional data may be lost.

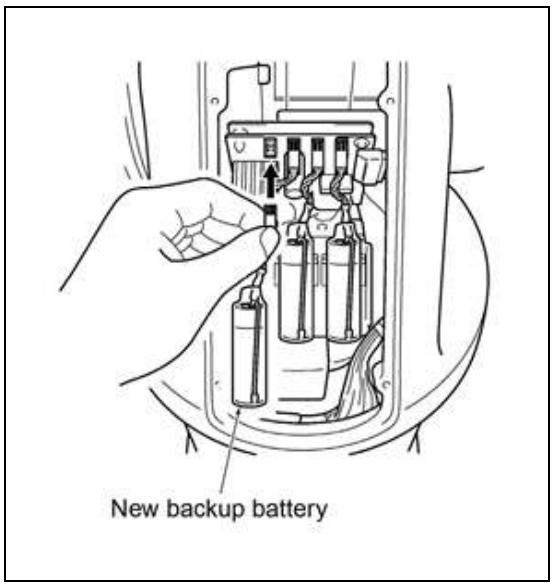

Figure 7-3. Connecting First New Battery

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 of three batteries with new ones at one time. Otherwise, the battery service life will be reduced.

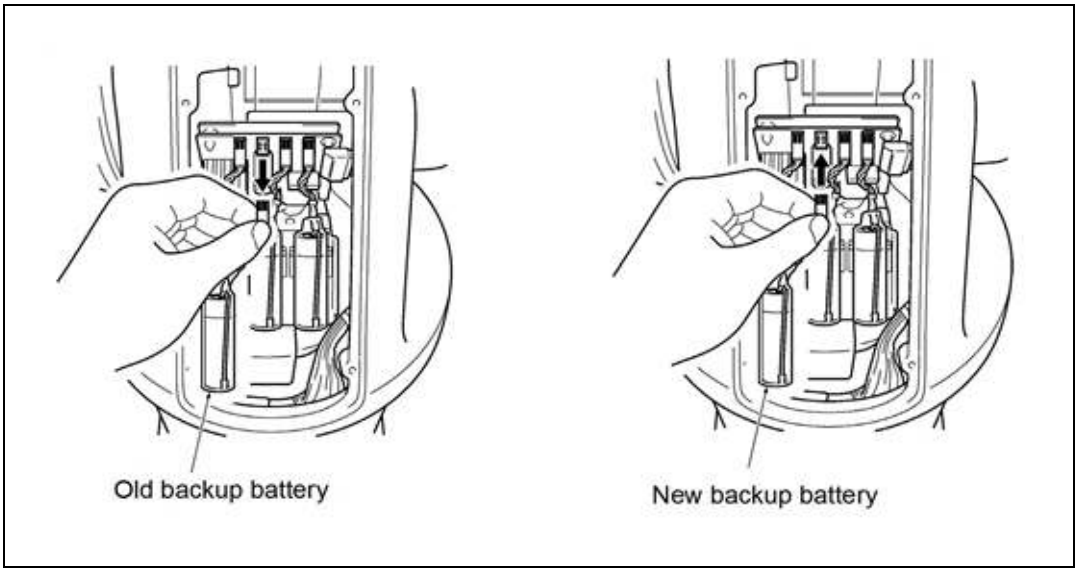

Figure 7-4. Connecting Second New Battery

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

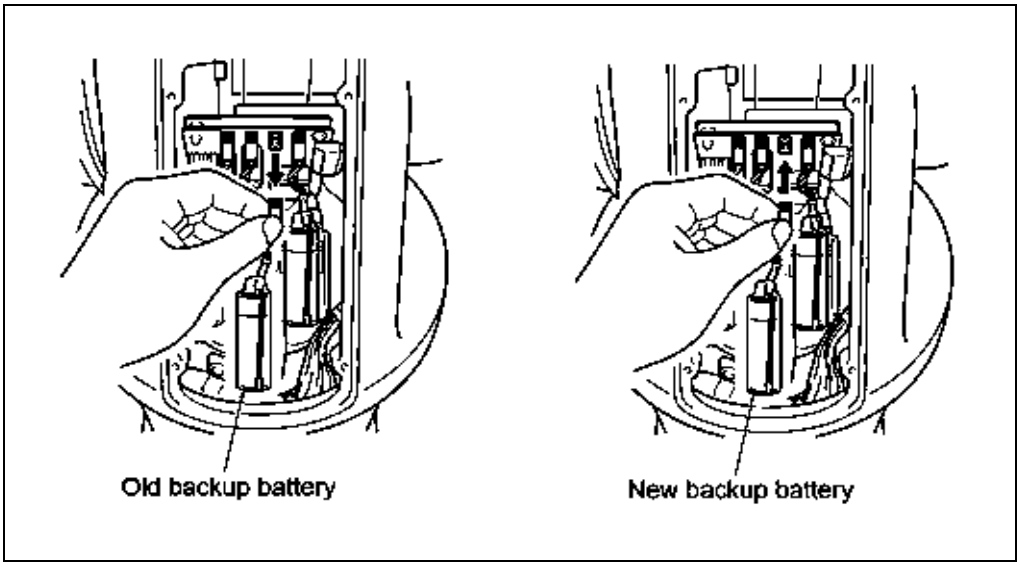

Figure 7-5. Connecting Third New Battery

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

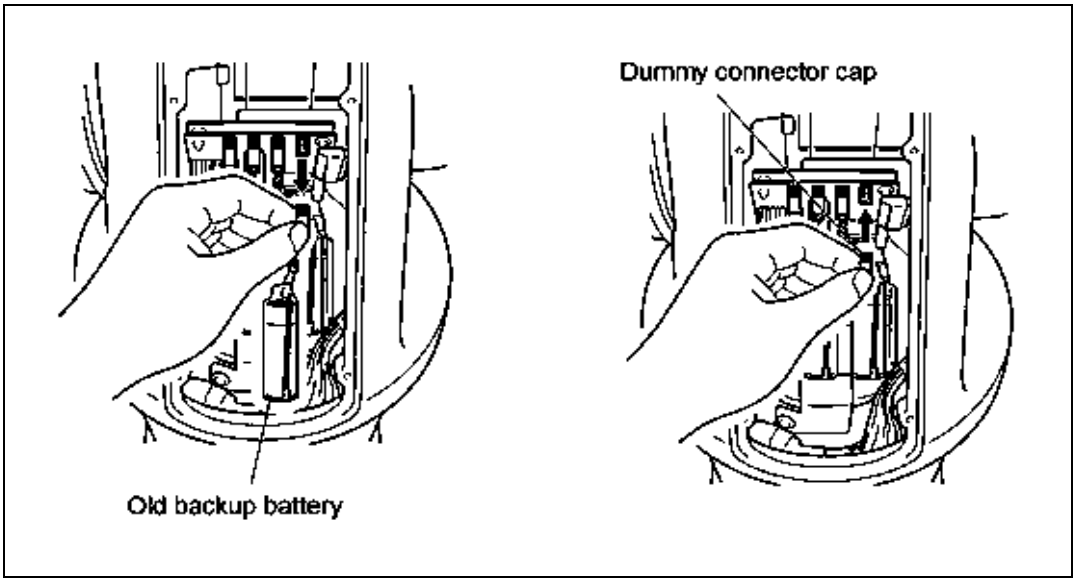

Figure 7-6. Reconnecting Dummy Connector Cap

9. Replace the cover on the robot.
    - Tightening torque: IP54/65 models - Hex socket bolt: 2.0 N·m (1.5 ft-lbf)
    - Tightening torque: Standard models - cross pan-head screw: 0.59 N·m (0.4 ft-lbf)

7.6 Replacing the eMB-60R Amplifier

Remove the eMB-60R Amplifier

1. Switch off the SmartController EX.
2. Switch off the 24 VDC and 200/240 VAC input supplies to the eMB-60R.
3. Disconnect the 24 VDC supply cable from the eMB-60R +24 VDC connector.

   See Description of Connectors on eMB-60R Interface Panel on page 32 for locations of connectors.
4. Disconnect the 200/240 VAC supply cable from the eMB-60R AC connector.
5. Disconnect the eAIB XSYS cable from the eMB-60R XSYSTEM connector.

   If the system was upgraded from an MB-60R to an eMB-60R, you may need to disconnect the XSYS cable and eAIB XSLV Adapter from the XSYSTEM connector.
6. Disconnect the IEEE 1394 cable from the eMB-60R SmartServo connector.
7. Disconnect any other cables, which are connected to the eMB-60R, such as XIO.

Installing a New eMB-60R

1. Carefully remove the new eMB-60R from its packaging, check it for any signs of damage, and remove any foreign packing materials or debris.
2. Carefully place the eMB-60R next to the robot.
3. Connect the 200/240 VAC supply cable to the eMB-60R AC input connector.
4. Connect the eAIB XSYS cable to the eMB-60R XSYSTEM connector.

   If you are upgrading from an MB-60R to an eMB-60R, connect the existing XSYS cable to the eAIB XSLV Adapter, which connects to the eMB-60R XSYSTEM connector.
5. Connect the IEEE 1394 cable to the eMB-60R SmartServo connector.
6. Connect any other cables, which were connected to the eMB-60R, such as XIO.
7. Connect the 24 VDC supply cable to the eMB-60R +24 VDC input connector.
8. Switch on the 200/240 VAC input supply to the eMB-60R.
9. Switch on the 24 VDC input supply to the eMB-60R.
10. Switch on the SmartController EX.
11. Once the system has completed booting:
    - Verify that the new eMB-60R has been commissioned. The initial commissioning utility screen will tell you which functions are commissioned. Refer to Commissioning Status on page 93.
    - Test the system for proper operation.

7.7 Commissioning a System with an eMB-60R

Commissioning a system involves synchronizing the robot with the eMB-60R.

NOTE: This section only applies to robots that have an eMB-60R amplifier. A robot with an MB-60R amplifier does not need the ACE commissioning.

For a new system with an eMB-60R, the robot and the eMB-60R will have been commissioned at the factory and should not need commissioning.

If you are replacing an MB-60R with an eMB-60R, you will need to commission the system.

In rare cases with a new robot with an eMB-60R, you may need to commission the system.

- If the system will not power up, and the robot status display shows SE, you need to commission the system.
- If the system will not power up in Manual mode, and the robot status display shows TR, you need to commission the system.

Safety Commissioning Utilities

The eMB-60R adds two functions that implement safety in hardware:

- **E-Stop** serves as a backup to the standard software E-Stop process. The system will always try to stop the robot using the software E-Stop first. The hardware E-Stop will take over in the event of a failure of the software E-Stop.
- **Teach Restrict** limits the maximum speed of the robot when it is operated in Manual mode. As with the E-Stop, this is a hardware backup to software limits on robot speed. If the software fails to limit the robot speed during manual operation, the hardware Teach Restrict will disable power to the system.

These two functions are only in the eMB-60R amplifiers. They were not implemented in hardware in the MB-60R amplifiers, so these utilities do not apply to those amplifiers.

These two functions are supported by four wizards:

- E-Stop Configuration

  This sets the E-Stop hardware delay to factory specifications.

- E-Stop Verification

  This verifies that the hardware E-Stop is functioning correctly.

- Teach Restrict Configuration

  This sets the hardware Teach Restrict maximum speed to factory specifications.

- Teach Restrict Verification

  This verifies that the hardware Teach Restrict is functioning correctly.

Commissioning Status

The initial utility screen will tell you which functions are commissioned. If a function is not commissioned, its verification wizard will not be displayed. Any displayed verification wizard can be run at any time, to ensure that its function is working properly.

Prerequisites

- The robot must be set up and functional.
- The robot must use eMB-60R amplifiers.

  The MB-60R amplifiers do not support these hardware functions, and these wizards will not run.
- A PC with ACE software version 3.3.2.10 or later must be connected to the eMB-60R.
- The Front Panel keyswitch must be in Auto mode.

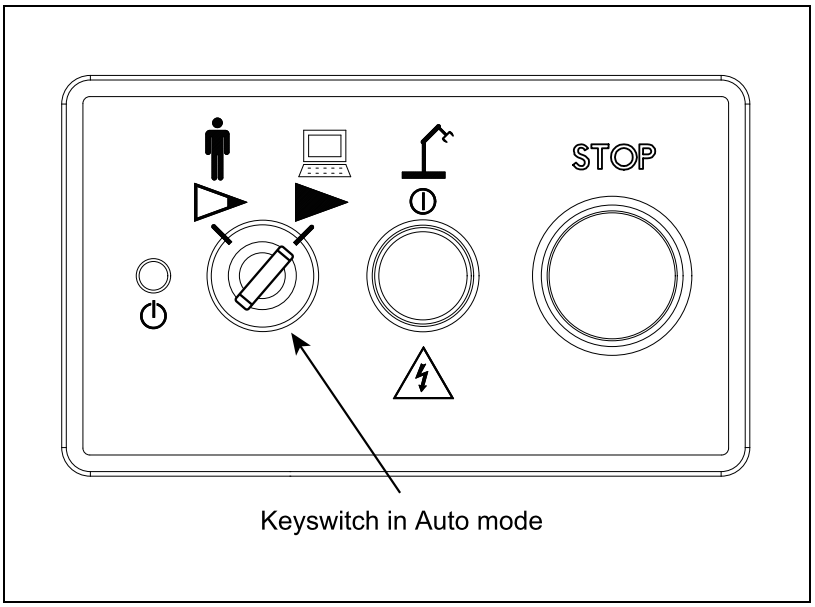

Figure 7-7. Front Panel

- A manual control pendant is required for the Teach Restrict verification.
- No E-Stops can be activated.
- For Configuration (E-Stop and Teach Restrict), the eAIB Commissioning Jumper must be plugged into the XBELTIO jack on the eMB-60R.

  NOTE: This is the only time that this jumper will be used. It is part number 11901-000, and must be removed for Verification and normal operation.

Figure 7-8. eAIB Commissioning Jumper

E-Stop Configuration Utility

This utility sets the E-Stop hardware delay to factory specifications.

> **NOTE**: Ensure that the commissioning jumper is plugged into the XBELTIO jack on the eMB-60R before you start this procedure.

Procedure

From within the ACE software:

1. Open the robot object editor.

   Double-click on the robot object in the tree structure, usually the left pane.

2. Select **Configure > Safety Settings > Configure ESTOP Hardware Delay**, then click Next.

   This procedure will configure Channel A and then Channel B.
   It will then report the delay that it set for each.

3. If the SmartController does not reboot, cycle power on the SmartController.

4. Cycle power on the eMB-60R.

E-Stop Verification Utility

This utility verifies that the hardware E-Stop parameters are set correctly and that the hardware E-Stop is working.

The hardware E-Stop must have already been configured for this wizard to run.

> **NOTE**: If the commissioning jumper is plugged into the XBELTIO jack on the eMB-60R, remove it before you start this procedure.

Procedure

From within the ACE software:

1. Open the robot object editor.

   Double-click on the robot object in the tree structure, usually the left pane.

2. Select **Configure > Safety Settings > Verify ESTOP Hardware Delay**, then click Next.

3. Enable high power, if not already enabled, then click Next.

4. Press an E-Stop button (on the Front Panel), then click Next.

   The utility will confirm that the hardware delay has been verified for this robot, and display the delay times for channels A and B.

5. If the SmartController does not reboot, cycle power on the SmartController.

Teach Restrict Configuration Utility

This utility sets the hardware Teach Restrict maximum speed parameter to factory specifications.

> **NOTE**: Ensure that the commissioning jumper is plugged into the XBELTIO jack on the eMB-60R before you start this procedure.

Procedure

> **NOTE**: This procedure takes 2 or 3 minutes to complete.

From within the ACE software:

1. Open the robot object editor.

   Double-click on the robot object in the tree structure, usually the left pane.

2. Select **Configure > Safety Settings > Configure Teach Restrict**, then click Next.

3. From the Prerequisite screen, click Next.

   The wizard will go through all of the robot's motors, and display messages that it is configuring Channel A and B for each.

   It will then record the configuration, and display the target times that it set.

4. Click Finish.

5. If the SmartController does not reboot, cycle power on the SmartController.

Teach Restrict Verification Utility

This utility verifies that the Teach Restrict parameters are set correctly and that the hardware Teach Restrict maximum speed control is working.

This is a two-part wizard. The first is run in Auto mode. The second is run in Manual mode.

Before running this verification utility, the Teach Restrict must be configured.

> **NOTE**: If the commissioning jumper is plugged into the XBELTIO jack on the eMB-60R, remove it before you start this procedure.

Automatic Mode Procedure

WARNING: The robot will move during this wizard. Ensure that personnel stay clear of the robot work area.

From within the ACE software:

1. Open the robot object editor.

   Double-click on the robot object in the tree structure, usually the left pane.

2. Select **Configure > Safety Settings > Verify Teach Restrict**, then click Next.

3. Teach a Start Position.

   NOTE: This procedure will move the robot approximately ±5 degrees from the starting point of each joint.

   This can be any position that does not conflict with obstacles or the limits of joint movements.

   - If the robot is already in such a position, you can just click Next.
   - Otherwise, move the robot to such a position, then click Next.
   - The screen will display the number of degrees that each joint is expected to move during the verification process.
   - You can click Preview Motions on this screen to view the motions at slow speed. The default speed is 10, but you can change that speed with this screen's speed control.
   - You can click Move to Ready, to move the robot to the Ready position.

     The robot will move each joint, in succession. It will generate an over-speed condition for each, and verify that the hardware detected the over-speed condition.

4. Click Next, to proceed to the Manual Mode Procedure.

   If the Automatic Mode Procedure fails, you will not be allowed to proceed with the Manual Mode.

Manual Mode Procedure

The manual mode of this verification requires the use of a manual control pendant.

For this verification, the Front Panel keyswitch must be in Manual mode.

1. From the Introduction screen, click Next.
   - Set the pendant to Joint mode.
   - Set the pendant manual control speed to 100.
2. Click Next.
3. Using the pendant, jog any of the robot's joints until power is disabled.

This indicates that the Teach Restrict function is working.

4. Click Next.

   The results of the verification will be displayed.

5. Click Finish.

6. If the SmartController does not reboot, cycle power on the SmartController.

7. Reset the Front Panel keyswitch to Auto mode.

7.8 Changing the Lamp in the Front Panel High-Power Indicator

The system is equipped with circuitry to detect the potentially dangerous condition of a burned-out High Power indicator on the Front Panel. If this lamp is burned out, you cannot enable high power until the lamp has been replaced. Follow this procedure to replace the High Power indicator lamp. The part number for the lamp is 27400-29006.

WARNING: Lockout and tagout power before servicing.

WARNING: The procedures and replacement of parts mentioned in this section should be performed only by trained, authorized personnel. The access covers on the Front Panel are not interlocked – turn off and disconnect power before removing the cover.

1. Turn off system power to the robot.

2. Turn off power to the optional SmartController EX, if you are using one.

3. Disconnect the cable between the Front Panel and the eAIB (or controller).

4. Remove the Front Panel from its mounting location.

5. Remove the two screws on the back of the Front Panel.

   Save the screws for re-installation.

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

   You will encounter some resistance, as there are three plug-type connectors that you need to disconnect as you pull the front cover away from the body.

   > **NOTE:** Separate the cover from the body slowly to avoid damaging the two wires that go between the LED and the PC board inside the body. Pull the front cover as straight out as possible. You do not have to disconnect the wires from the PC board, although you can if needed.

7. Locate the lamp body in the center of the back side of the front cover. Turn the lamp body approximately 20° in either direction and then pull straight back.

8. The lamp body is now free. You can remove the old lamp and insert a new one.

9. Re-install the lamp body by pushing it straight into the lamp housing receptacle. Make

sure the contacts on the lamp body are properly oriented, as shown in the following figure.

10. Make sure to reconnect the wires from the LED if you disconnected them earlier.
11. Push the front cover into the body, taking care to align all of the plug-type connectors.

    Verify that the wires do not get crimped as you reinstall the cover.
12. Re-install the two screws on the back of the body.
13. Re-install the Front Panel in its mounting.
14. Reconnect the cable between the Front Panel and the eAIB (or controller).

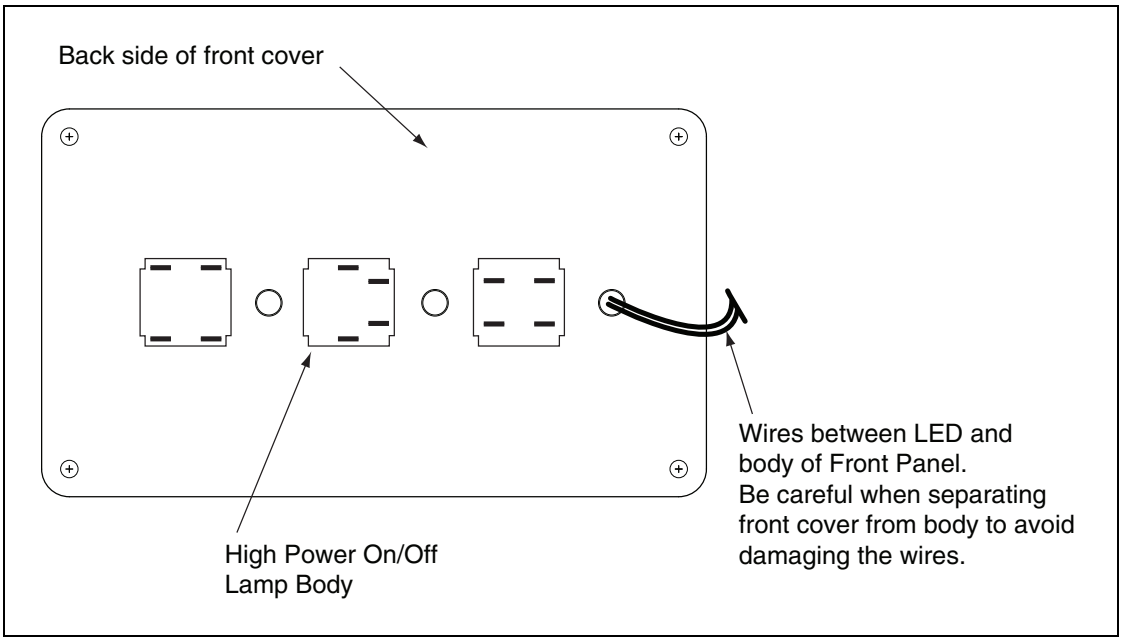

Figure 7-9. Lamp Body Contact Alignment

Chapter 8: Technical Specifications

8.1 Robot Dimensions

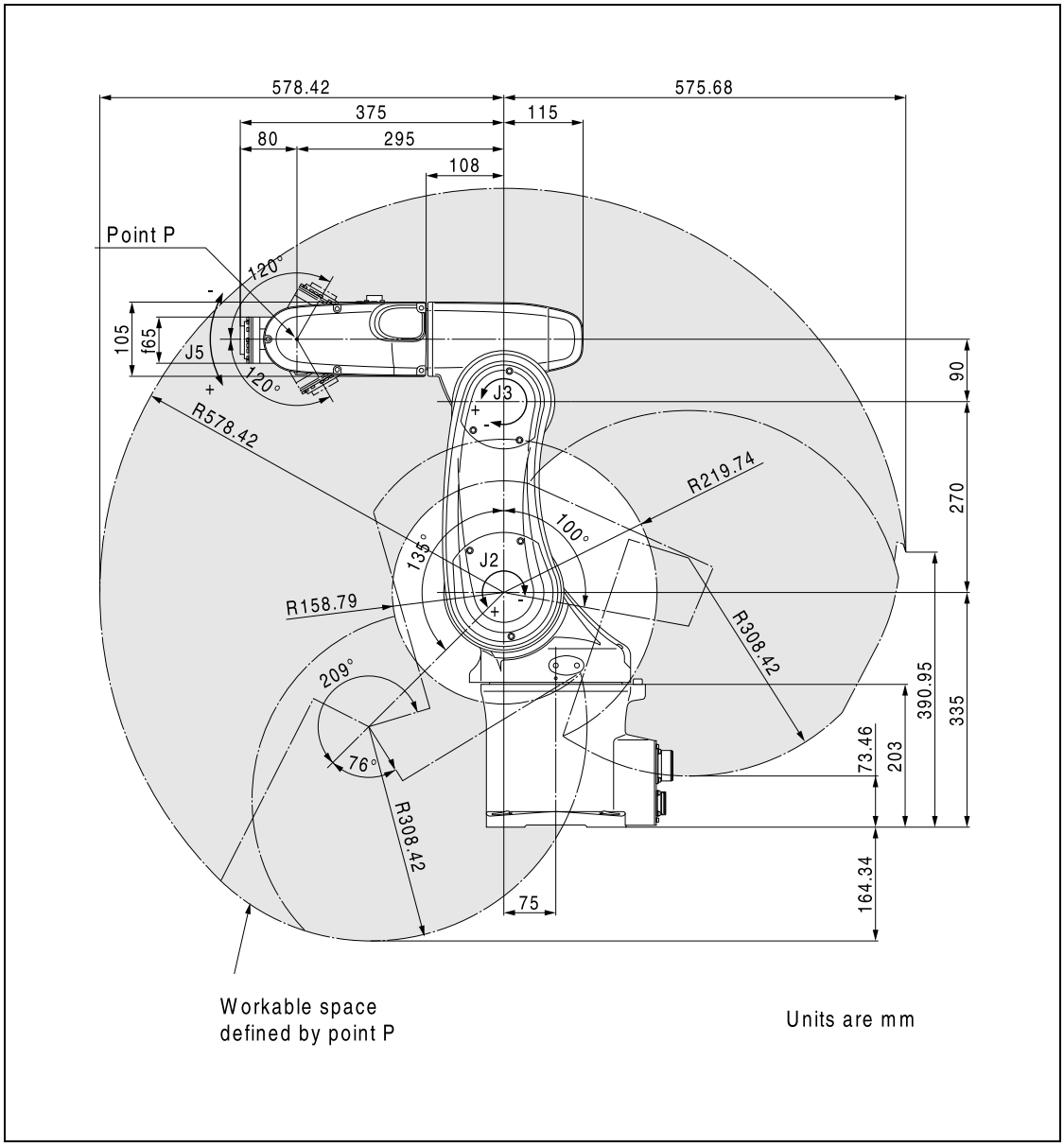

Figure 8-1. Viper 650 Side Dimensions and Work Envelope

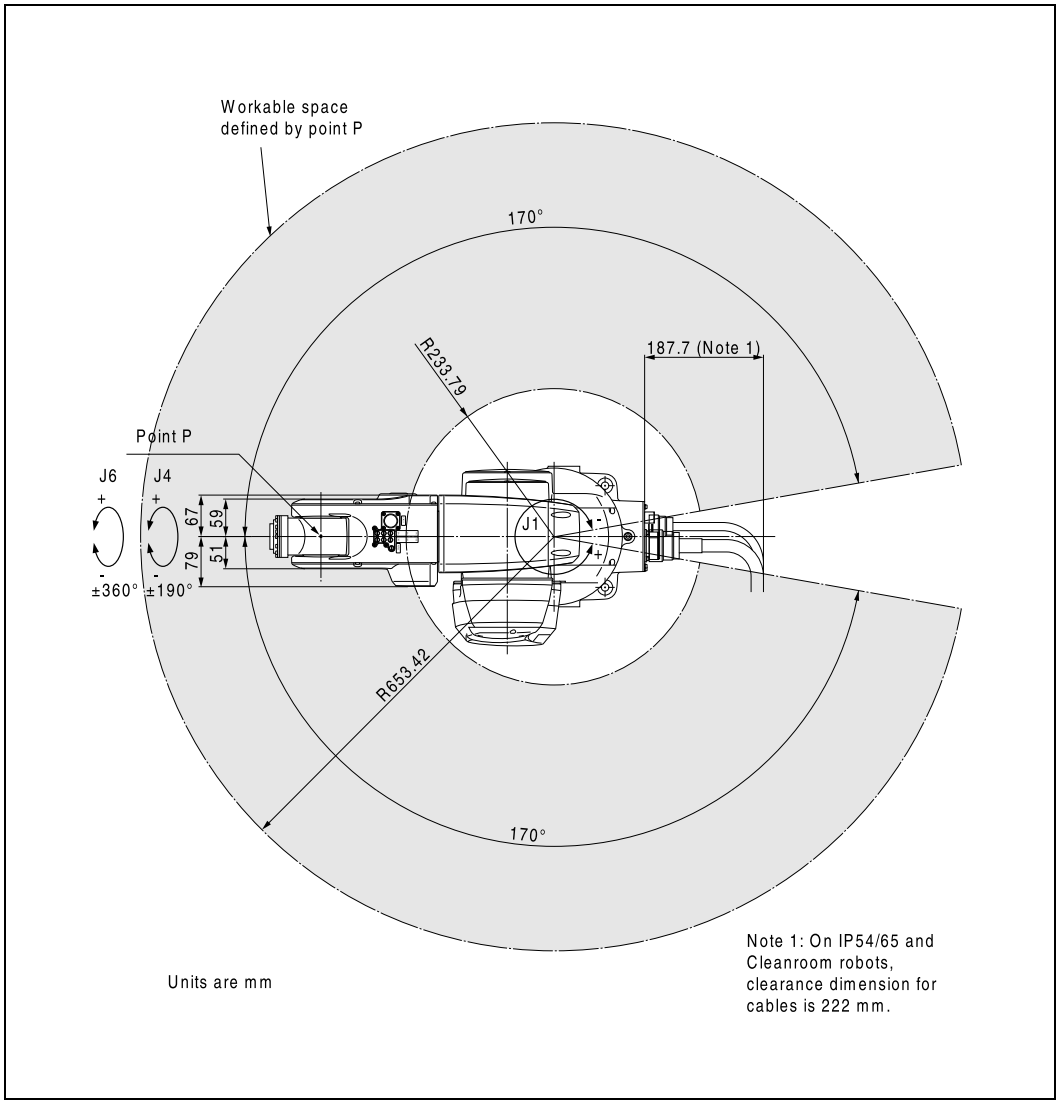

Figure 8-2. Viper 650 Top Dimensions and Work Envelope

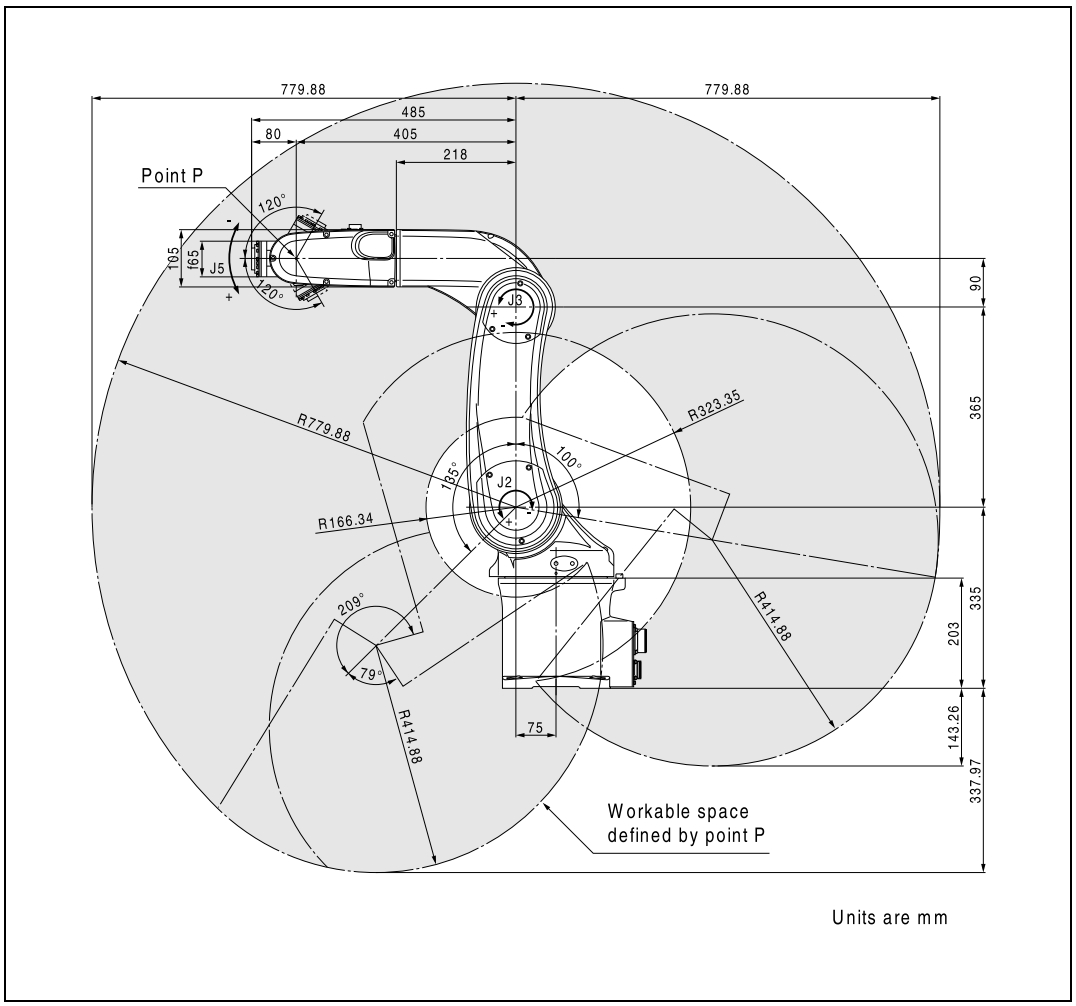

Figure 8-3. Viper 850 Side Dimensions and Work Envelope

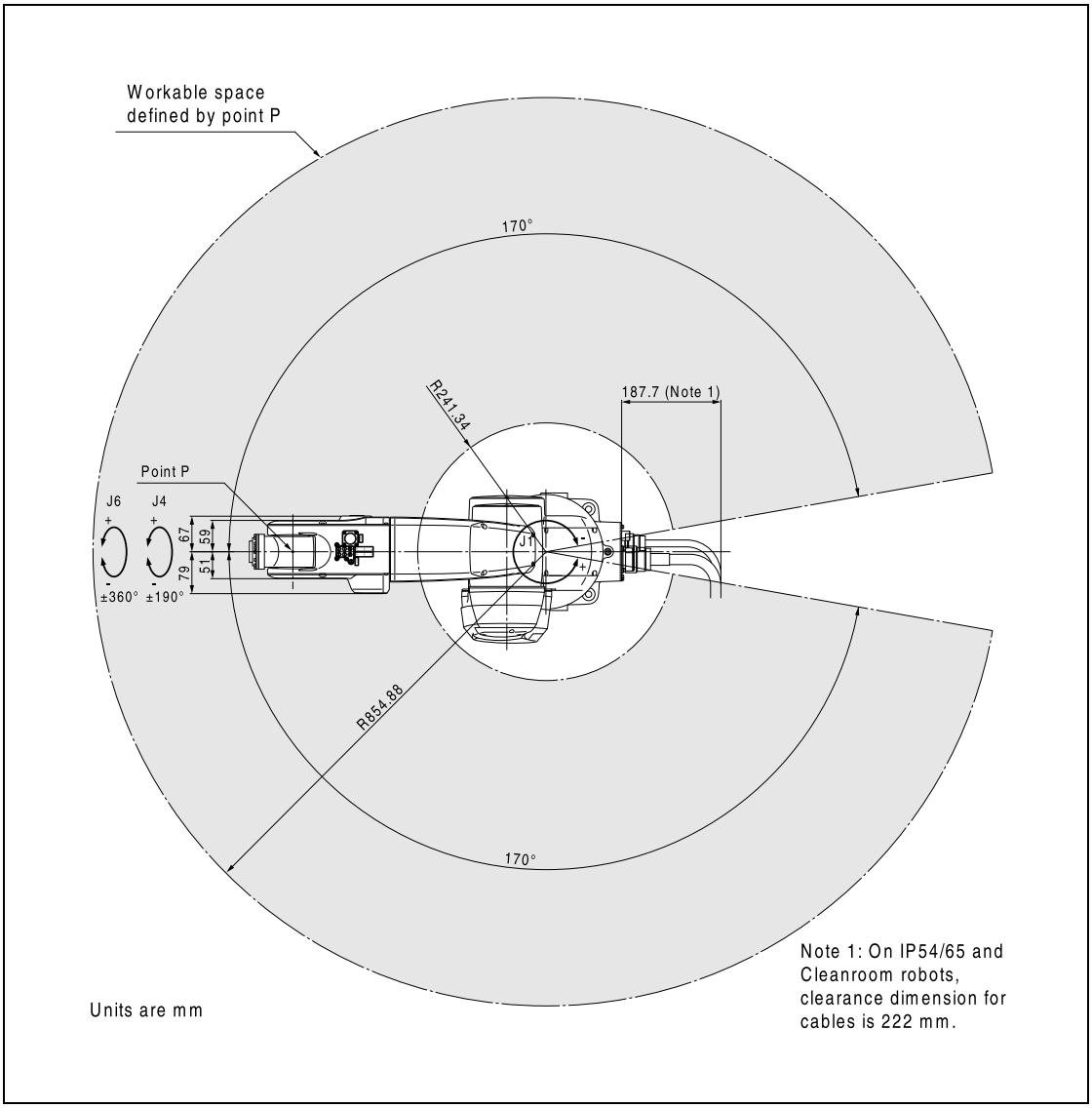

Figure 8-4. Viper 850 Top Dimensions and Work Envelope

8.2 Robot Flange Dimensions

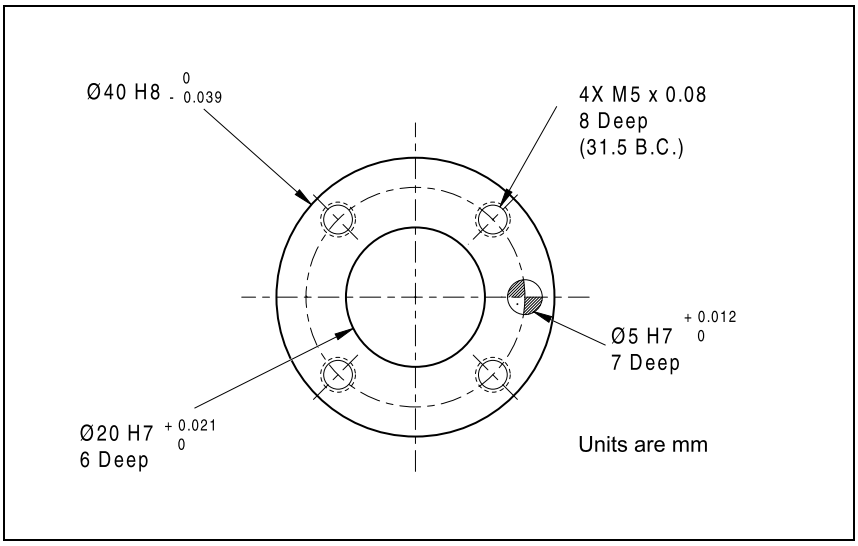

Figure 8-5. Robot Flange Dimensions

8.3 Specifications

Physical

Table 8-1. Robot Specifications

Specification	Viper 650	Viper 850
Overall arm length	270 (first link) + 295 (second link) = 565 mm	365 (first link) + 405 (second link) = 770 mm
Arm offset	J1 (swing): 75 mm, J3 (front link): 90 mm	
Maximum motion area	R = 733 mm (end-effector mounting face) R = 653 mm (Point P: J4, J5, J6 center)	R = 934 mm (end-effector mounting face) R = 854 mm (Point P: J4, J5, J6 center)
Motion range	J1: ±170° J2: -190°, +45° J3: -29°, +256° J4: ±190° J5: ±120° J6: ±360°	
Position detection	Simplified absolute encoder	Simplified absolute encoder
Drive motor and brake	AC servomotors for all joints, Brakes for joints J2 to J6	
User air lines (Note 1)	7 systems (Ø4x6, Ø6x1),	

Specification	Viper 650	Viper 850
	3 solenoid valves (2-position, double solenoid) contained.	
User signal line	10 (for proximity sensor signals, etc.)	
Air source - Operating pressure	0.1 to 3.9 MPa (14.5 to 56.6 psi)	
Air source - Maximum allowable pressure	0.49 MPa (71.1 psi)	
Degree of Protection	IP40 (IP54/65 w/ option)	IP40 (IP54/65 w/ option)
Weight	Approx. 28 kg	Approx. 29 kg
Note 1: Only the Ø4x6 air tubing system may be controlled by built-in solenoid valves.		

Performance

Specification	Viper 650	Viper 850
Maximum joint speed	J1: 328°/sec J2: 300°/sec J3: 375°/sec J4: 375°/sec J5: 375°/sec J6: 600°/sec	J1: 250°/sec J2: 250°/sec J3: 250°/sec J4: 375°/sec J5: 375°/sec J6: 600°/sec
Maximum composite speed (at the center of an end-effector mounting face)	8200 mm/s	7600 mm/s
Maximum payload	5 kg	
Position repeatability (Note 2)	In each of X, Y and Z directions: ±0.02 mm	In each of X, Y and Z directions: ±0.03 mm
Maximum allowable inertia moment	Around J4: 0.295 kgm^2 Around J5: 0.295 kgm^2 Around J6: 0.045 kgm^2	
Note 2: Position repeatability is the value at constant ambient temperature.		

Stopping Distances and Times

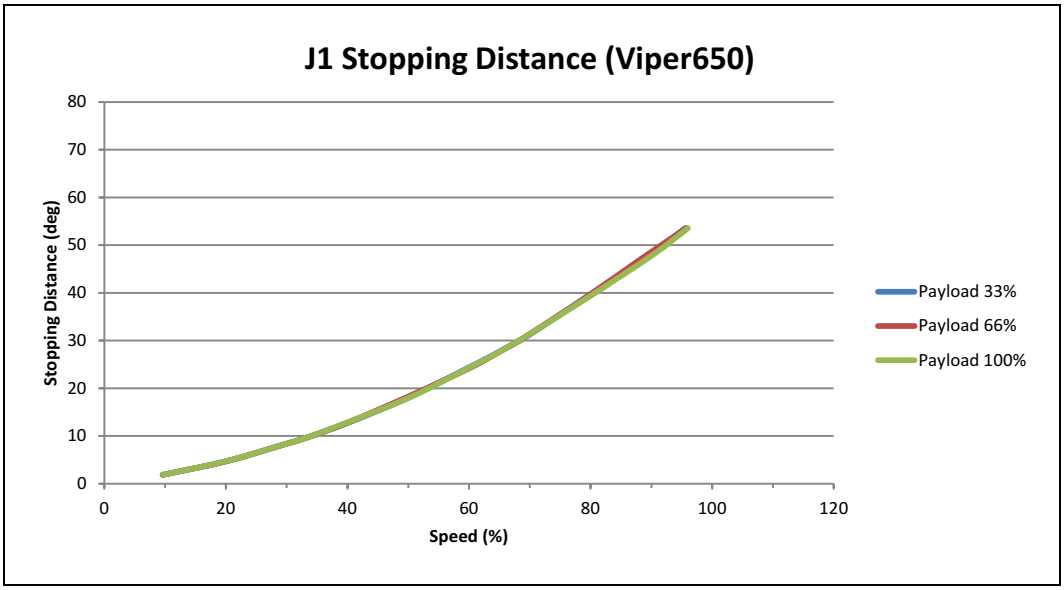

Figure 8-6. Joint 1 Stopping Distance for Viper 650, in Degrees

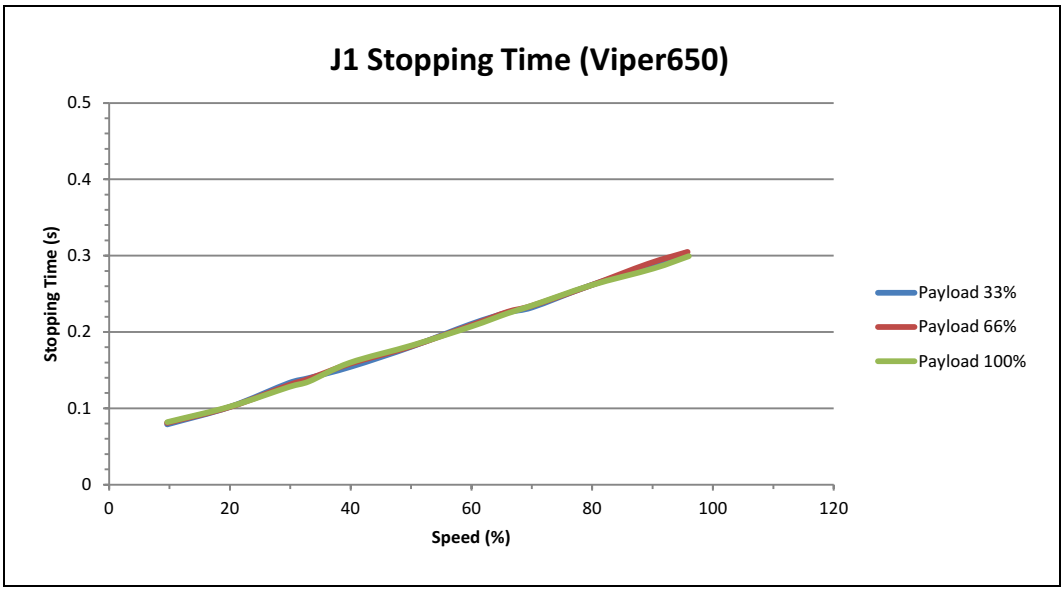

Figure 8-7. Joint 1 Stopping Time for Viper 650, in Seconds

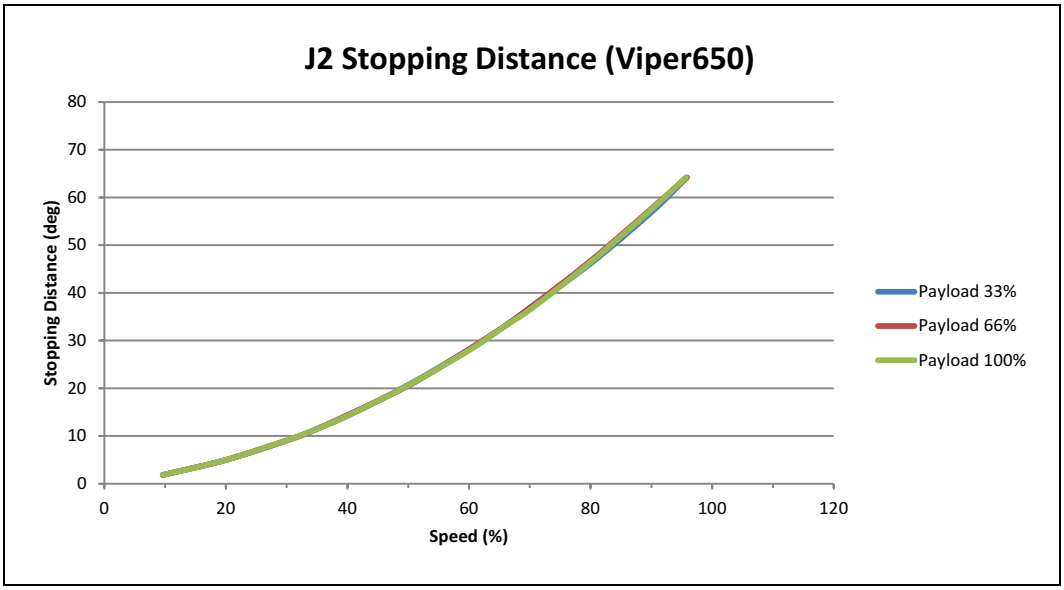

Figure 8-8. Joint 2 Stopping Distance for Viper 650, in Degrees

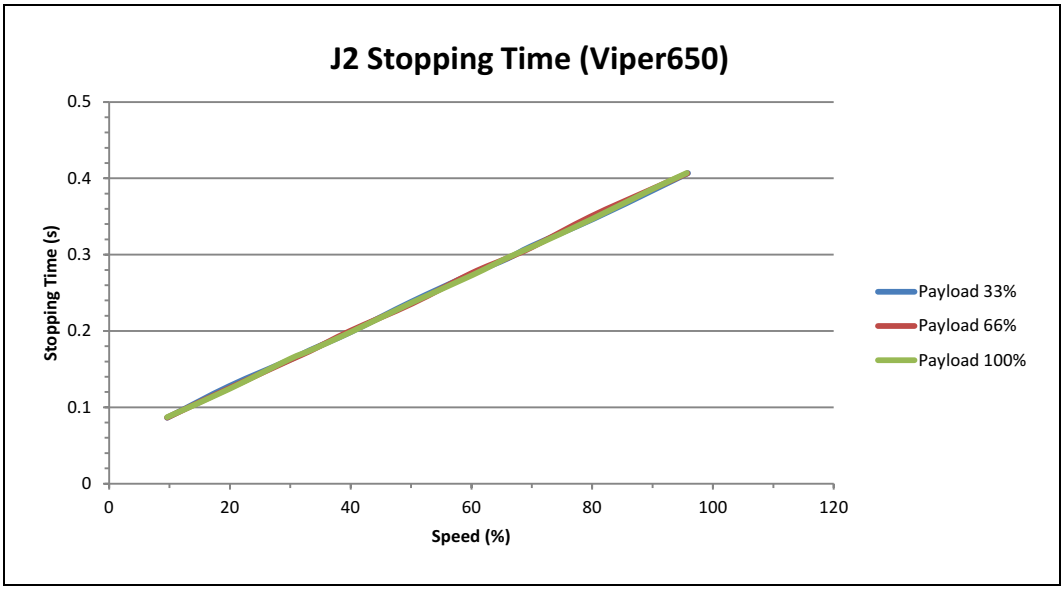

Figure 8-9. Joint 2 Stopping Time for Viper 650, in Seconds

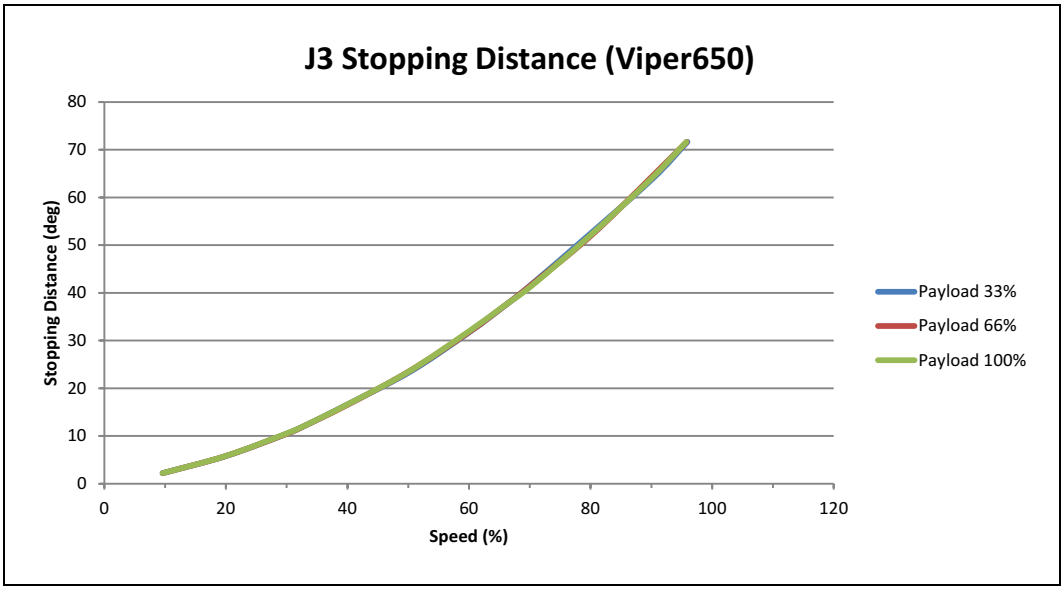

Figure 8-10. Joint 3 Stopping Distance for Viper 650, in Degrees

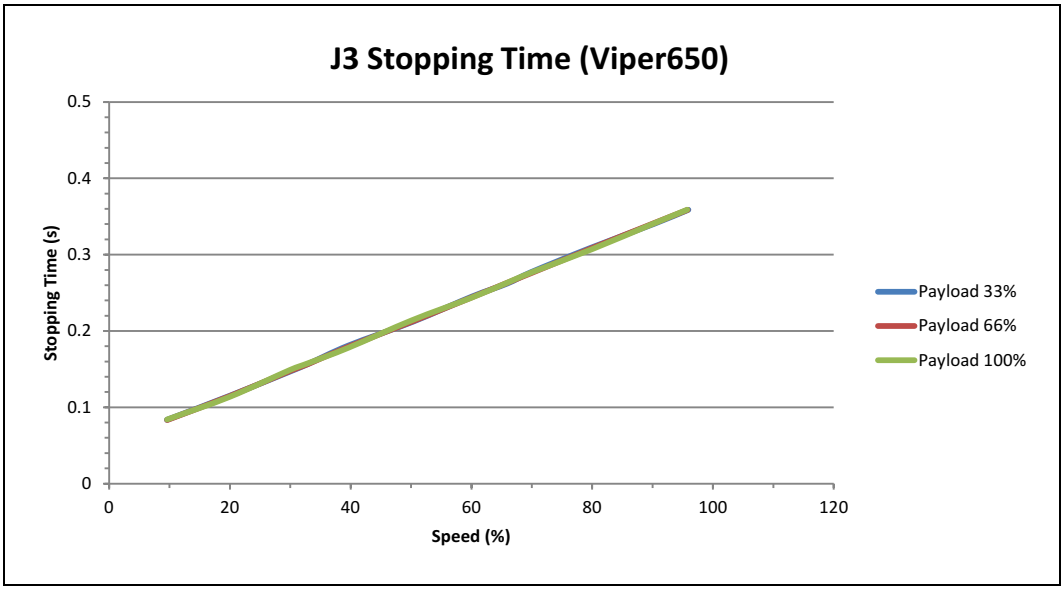

Figure 8-11. Joint 3 Stopping Time for Viper 650, in Seconds

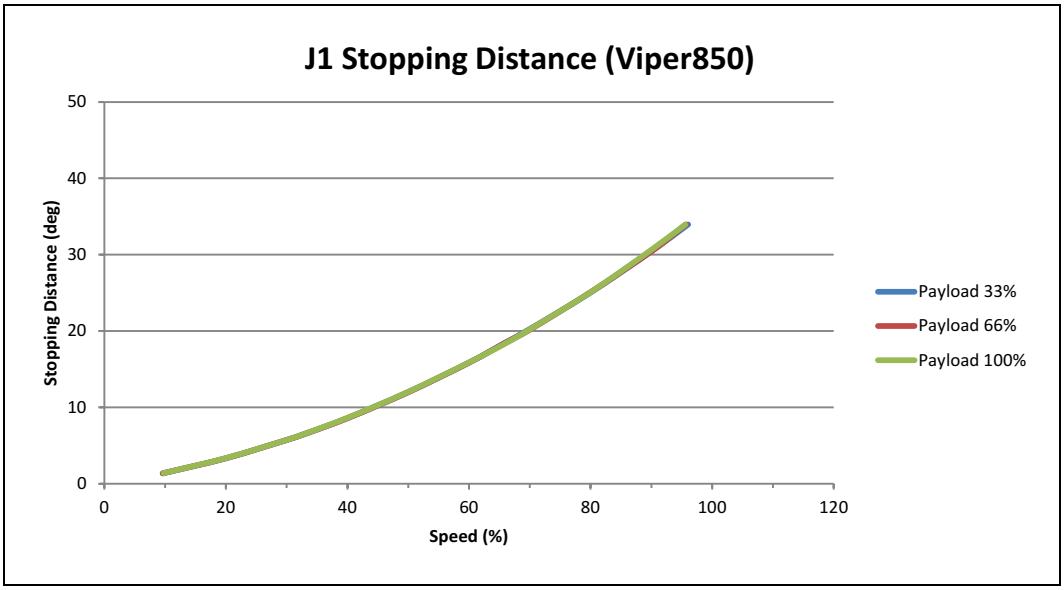

Figure 8-12. Joint 1 Stopping Distance for Viper 850, in Degrees

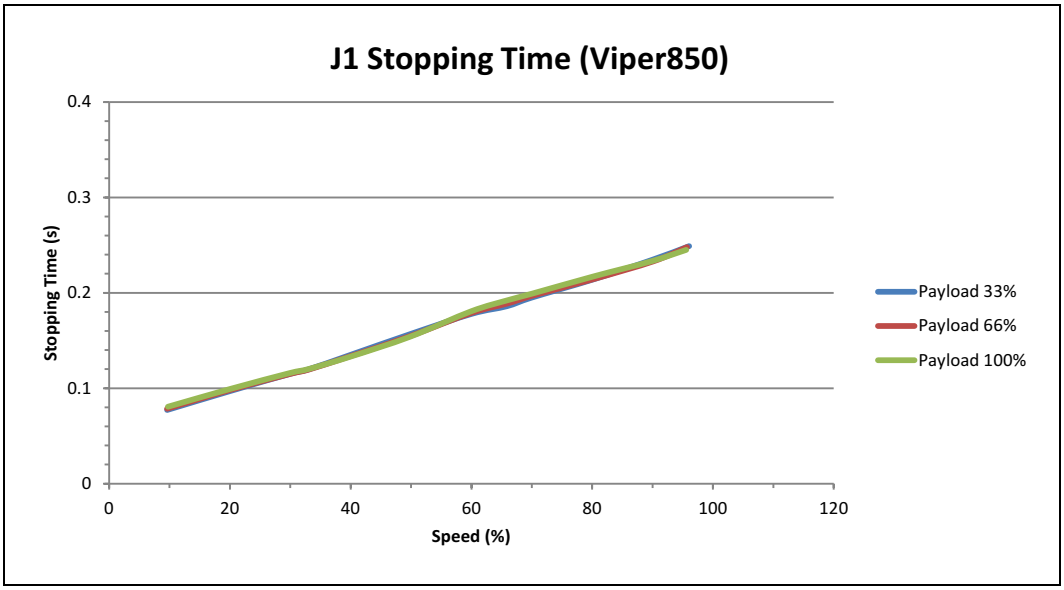

Figure 8-13. Joint 1 Stopping Time for Viper 850, in Seconds

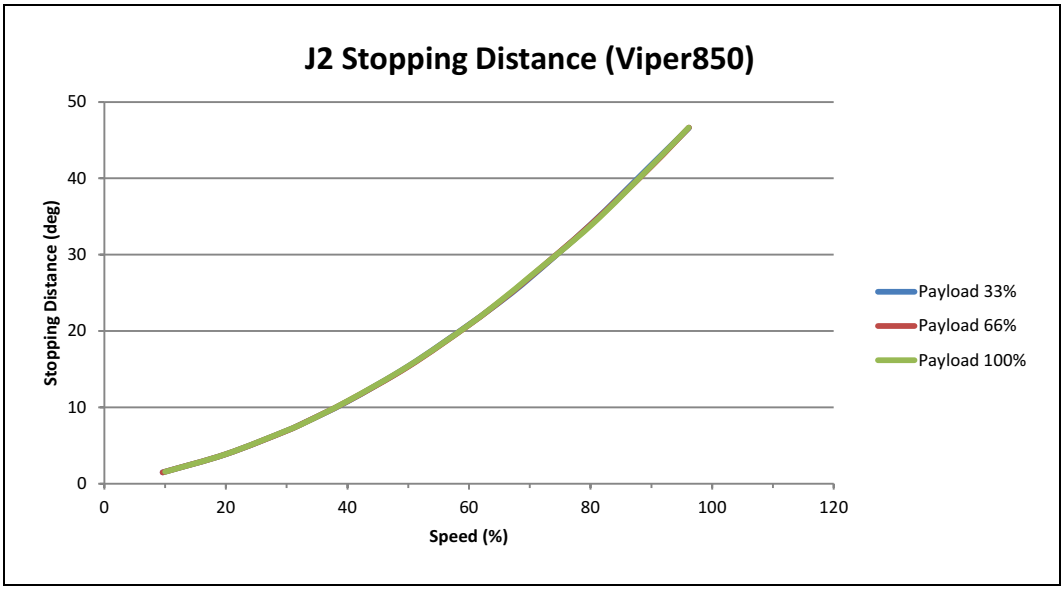

Figure 8-14. Joint 2 Stopping Distance for Viper 850, in Degrees

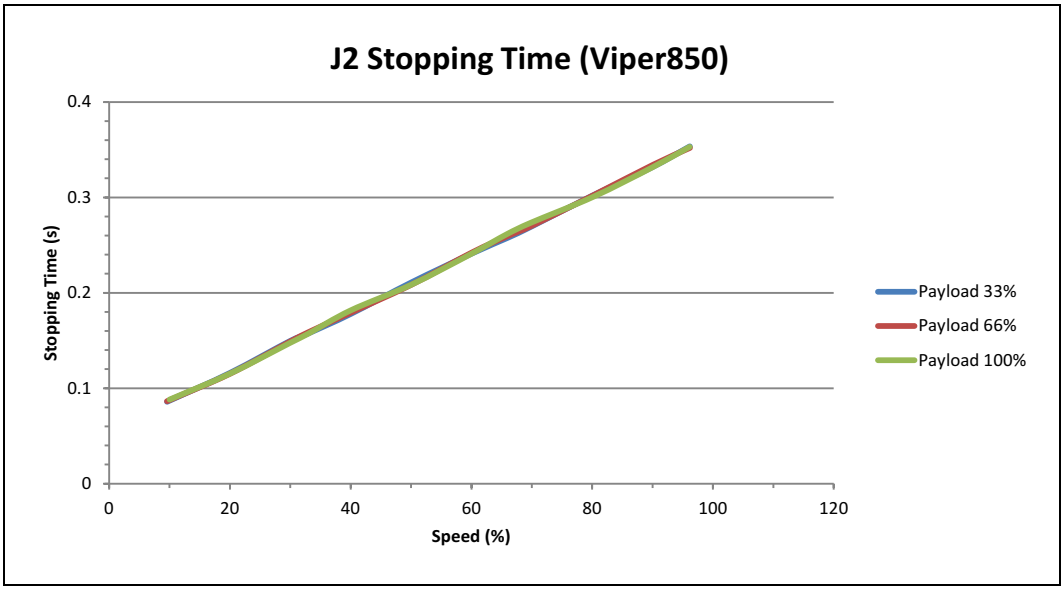

Figure 8-15. Joint 2 Stopping Time for Viper 850, in Seconds

Figure 8-16. Joint 3 Stopping Distance for Viper 850, in Degrees

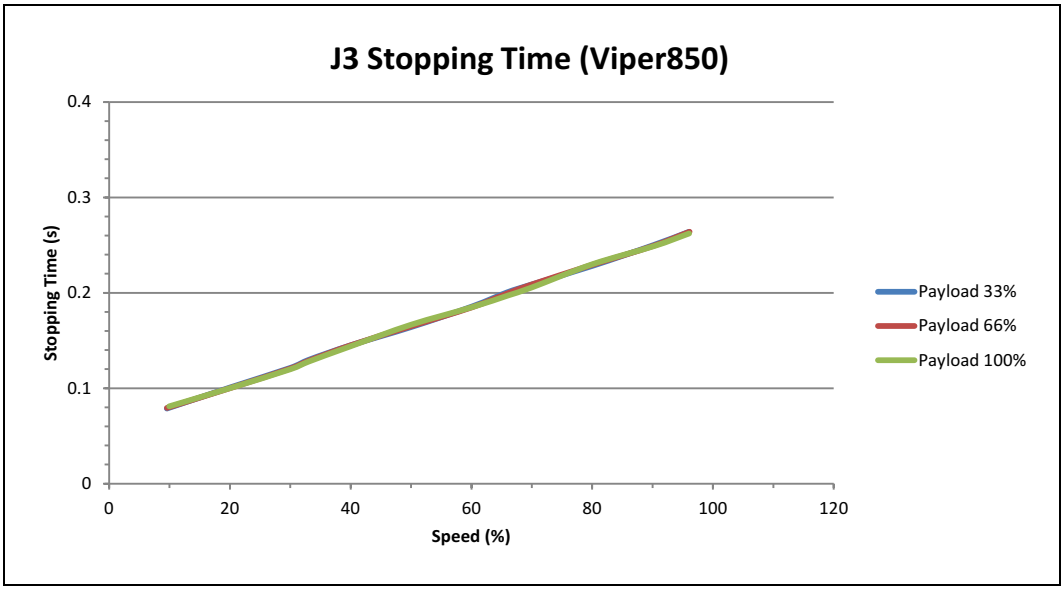

Figure 8-17. Joint 3 Stopping Time for Viper 850, in Seconds

Chapter 9: IP54/65 Option

9.1 Introduction

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.

CAUTION: The SmartController and eMB-60R are not dust- or splash-proof. Therefore, when using these products in an environment exposed to dust or mist, put them in protective enclosures.

Figure 9-1. Viper 650 Robot with IP54/65 Option

9.2 Differences from the 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.

Installation Environment

The IP54/65 robot should not be installed in any environment where:

- there are any flammable gases or liquids,
- there are any acidic, alkaline, or other corrosive gases,
- there are any large-sized inverters, high output/high frequency transmitters, large contactors, welders, or other sources of electrical noise,
- it may likely be submerged in fluid,
- there is sulfuric cutting or grinding oil mist.

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

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.

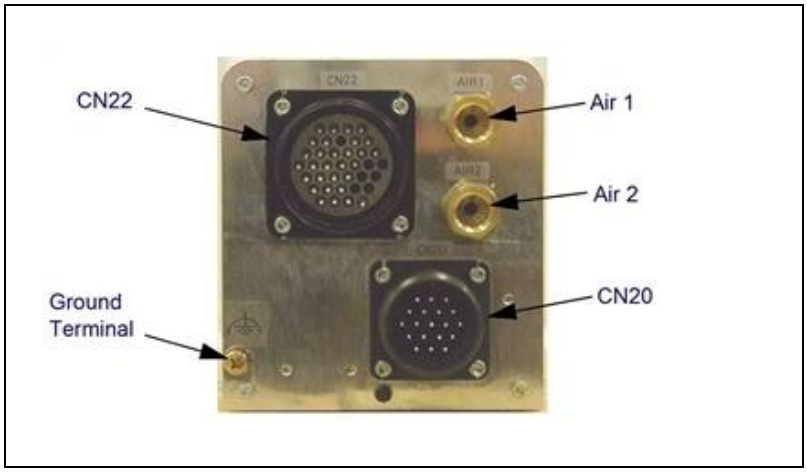

Figure 9-2. IP54/65 Robot Connector Panel

NOTE: On the IP54/65 robot, the CN20 and CN21 connectors are IP65 rated. Also, the robot cable has a splash-proof connector on the robot end.

NOTE: The mating connector sets for CN20 and CN21 are different for IP54/65 and Cleanroom robots. See Cleanroom Option on page 117.

NOTE: For IP54/65 compliance, keep the factory-installed plugs over 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. See Technical Specifications on page 101 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. Removing Cover to Replace Encoder Batteries on page 89. Tightening torque: Hex socket bolt: 2.0 N·m (1.5 ft-lbf).

Chapter 10: Cleanroom Option

10.1 Introduction

The Viper 650 and 850 robots are available in Class 10 Cleanroom models.

Figure 10-1. Viper 850 Robot - Cleanroom Model

10.2 Differences from Standard Robot Model

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

Cleanroom Technical Specifications

Table 10-1. 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.

Robot Connector Panel

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

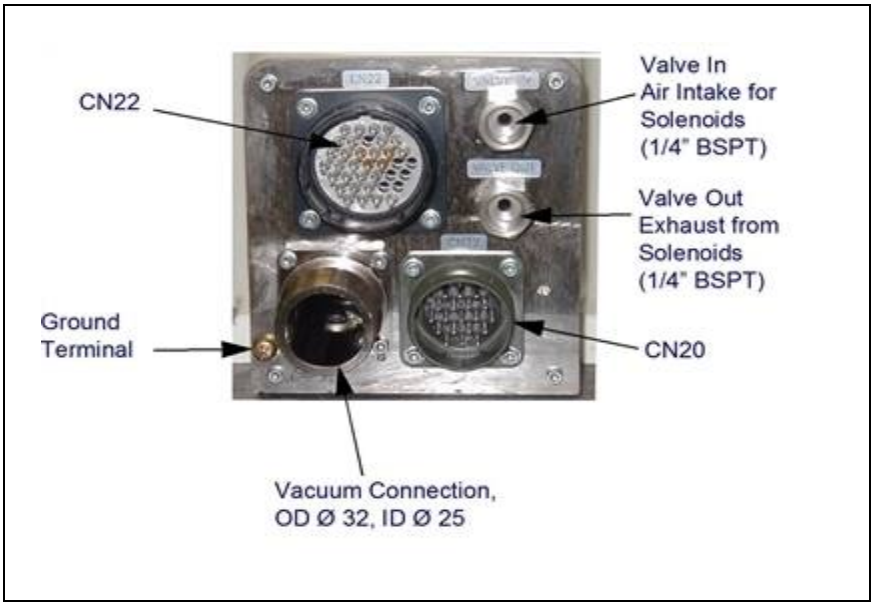

Figure 10-2. Cleanroom Robot Connector Panel

See Cleanroom Technical Specifications on page 118 for the recommended vacuum flow rate.

10.3 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.

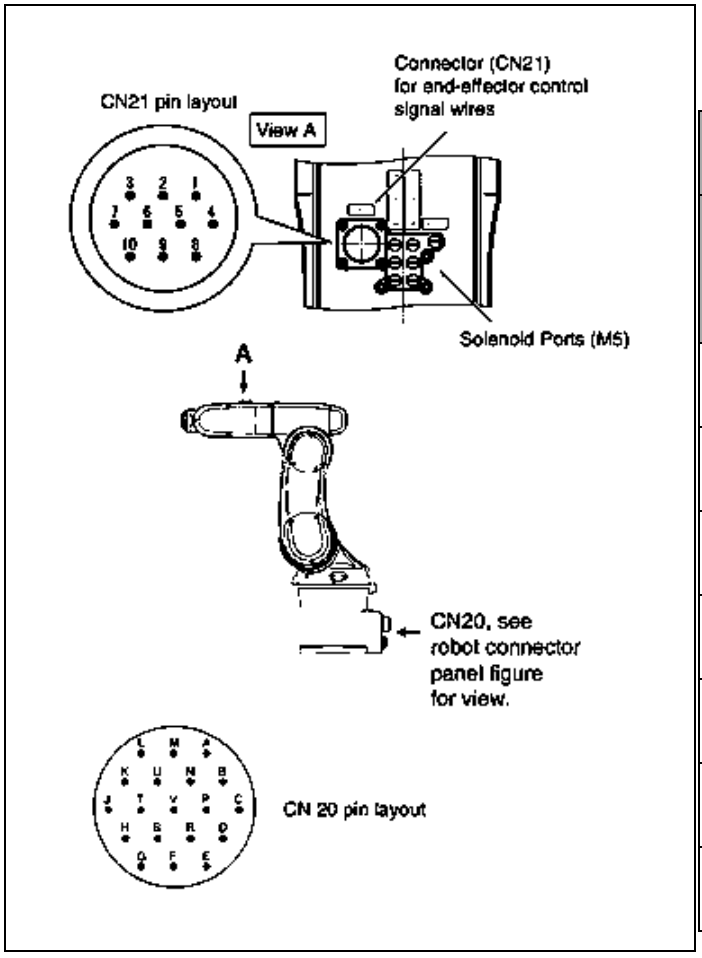

Table 10-2. Air Intake/Exhaust States

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 10-3. CN 20 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)

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

Use the supplied mating connector sets shown in the table below for CN20 and CN21.

CN20 and CN21 Mating Connectors

Table 10-4. CN20 and CN21 Mating Connectors

Connector Set Part No.	Connector No.	Model and Part Name	Appearance	Connector Set Part No.
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.

10.4 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. Any user tooling at the flange must allow for clearance - see See "J6 Cleanroom Cover Dimensions".

Figure 10-3. Viper 850 J6 Cleanroom Cover

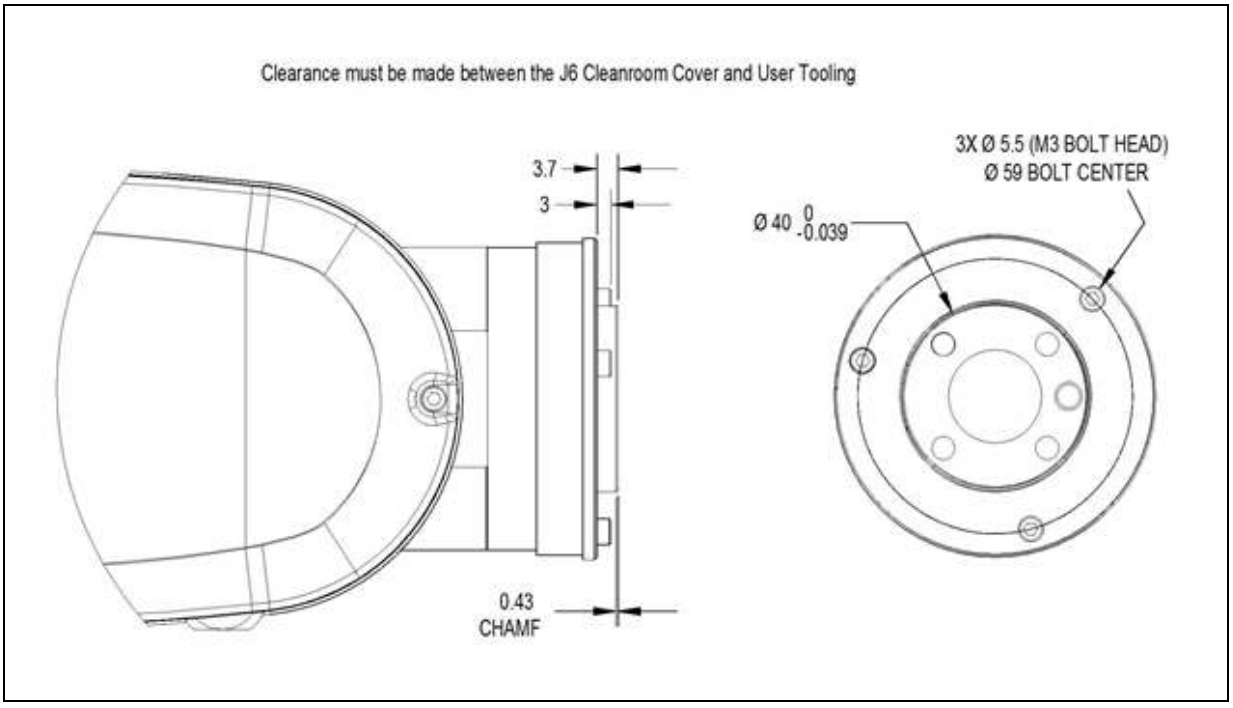

Figure 10-4. J6 Cleanroom Cover Dimensions

10.5 Cable Clearance

For the Cleanroom robot, the cable clearance dimension at the back of the robot is 222 mm. Technical Specifications on page 101 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. See See "Removing Cover to Replace Encoder Batteries". Tightening torque: Hex socket bolt: 2.0 N·m (1.5 ft-lbf).