OMRON

Hornet 565 Robot

User's Guide

I596-E-01

Copyright Notice

Created in the United States of America

Table of Contents

Chapter 1: Introduction

1.1 Hornet 565, Product Description

The Hornet 565 is a three-axis parallel robot. The three identical axis motors control movement of the robot tool in X, Y, and Z directions. On the four-motor model, a fourth motor on the robot base turns a telescoping drive shaft, which provides theta rotation of the tool flange through a geared platform.

The Hornet 565 is available in two models. One has a J4 platform, a theta motor and theta drive shaft. This provides ±360° of rotation at the tool flange. The other model has a fixed platform with no tool flange rotation.

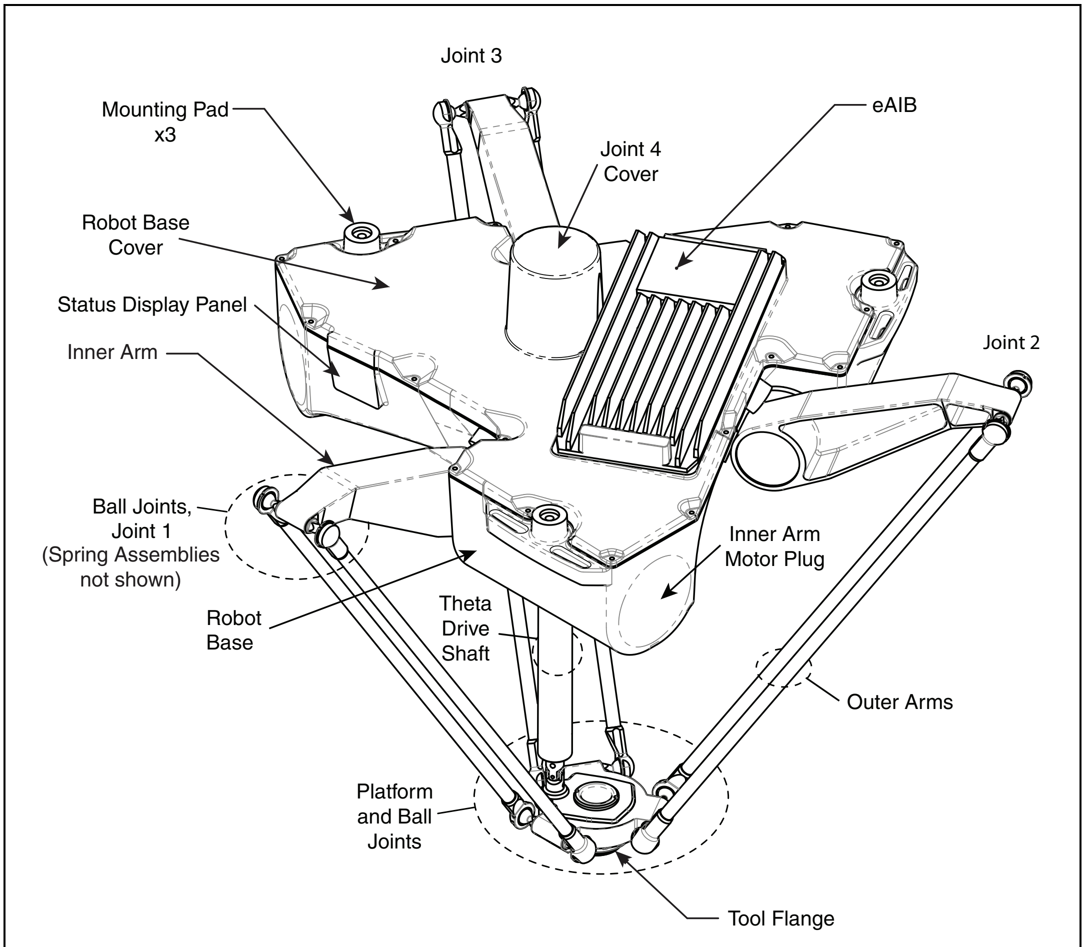


Figure 1-1. Major Robot Components

eAIB Amplifier

The Hornet 565 uses an eAIB amplifier. The robot is powered and controlled using the eAIB. The amplifiers and full servo control for the Hornet 565 are contained in the eAIB, which is embedded in the base of the robot. The eAIB also provides the platform for running the eV+ OS and language.

The eAIB features:

- On-board digital I/O: 12 inputs, 8 outputs
- Low EMI for use with noise-sensitive equipment
- No external fan for quiet operation
- 8 kHz servo rate to deliver low positional errors and superior path following
- Sine-wave commutation to lower cogging torque and improve path following
- Digital feed-forward design to maximize efficiency, torque, and velocity
- Temperature sensors on all amplifiers and motors for maximum reliability and easy troubleshooting
- Hardware-based E-Stop and Teach Restrict controls

  For improved safety relative to European standards implemented in 2012.

Figure 1-2. eAIB

Hornet 565 Base

The Hornet 565 base is an aluminum casting that houses the four or three drive motors, and supports the eAIB. It provides three mounting pads for attaching the base to a rigid support frame. The Status Display panel is mounted on the side of the robot base.

Inner Arms

Three robot motors attach directly to the inner arms through high-performance gear reducers. If the robot has a theta rotation motor, it is mounted at the top of the robot base. The following figure shows an inner arm from a Hornet 565. RIA-compliant hard stops limit the inner arm motion to -53° and +114.6°.

Ball Joints, Outer Arms

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

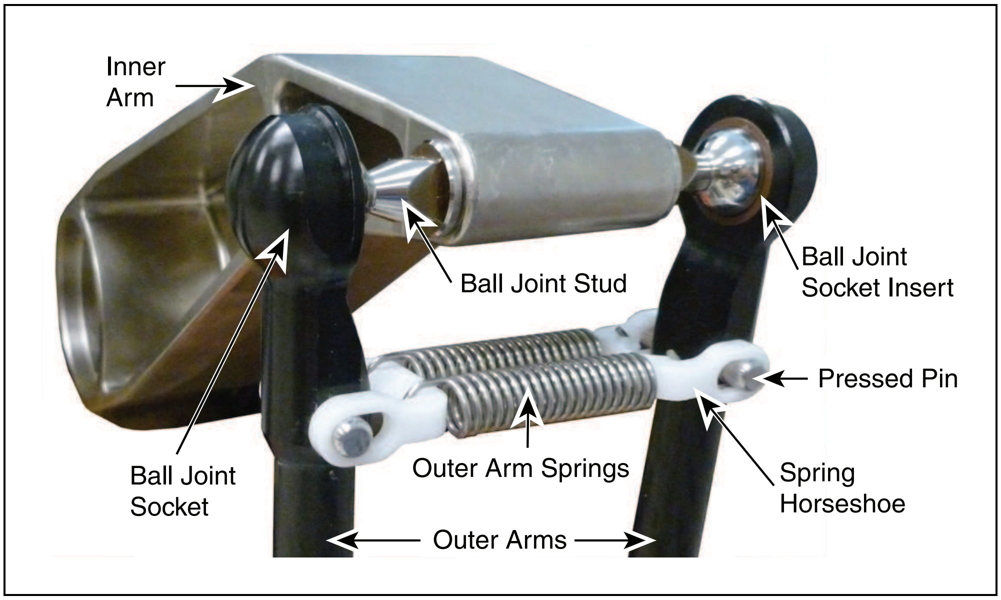


Figure 1-3. Ball Joint Assembly

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

Platforms

The platform converts the motion of the Hornet 565 motors into Cartesian motion, and, for the four-motor version, theta rotation of the robot tool flange.

The fixed platform, with no theta rotation, is stainless steel.

The J4 platform has a fourth motor, theta drive shaft, and geared J4 platform that can rotate its tool flange ±360°. The platform is electroless-nickel-plated aluminum.

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

For the J4 version of the Hornet 565, a stainless steel theta drive shaft attaches to a U-joint at both the platform and the J4 motor on the robot.

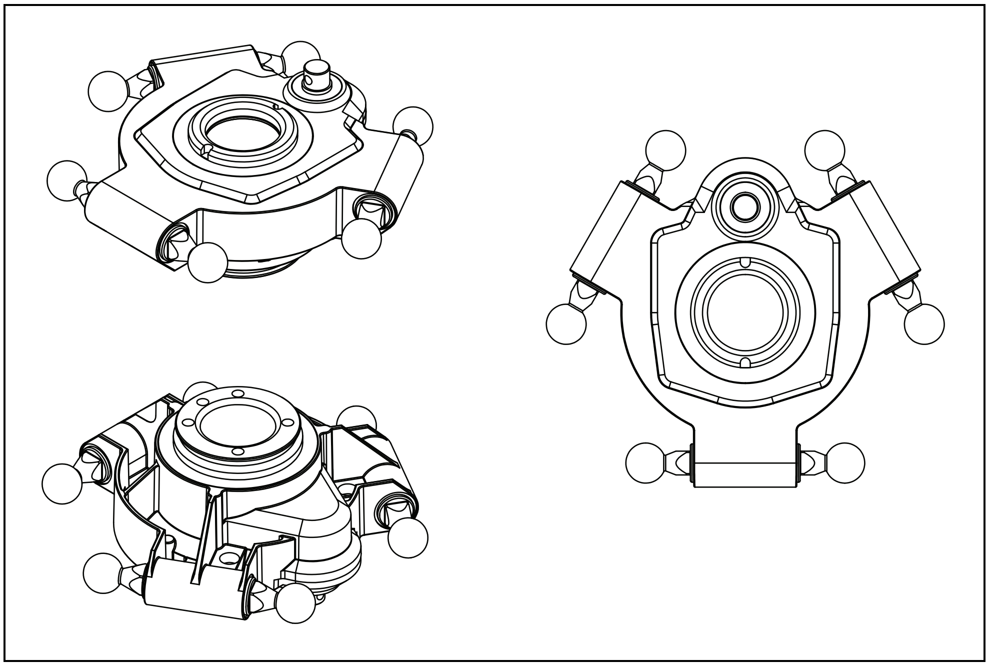


Figure 1-4. J4 Platform (Electroless Nickel-plated Aluminum)

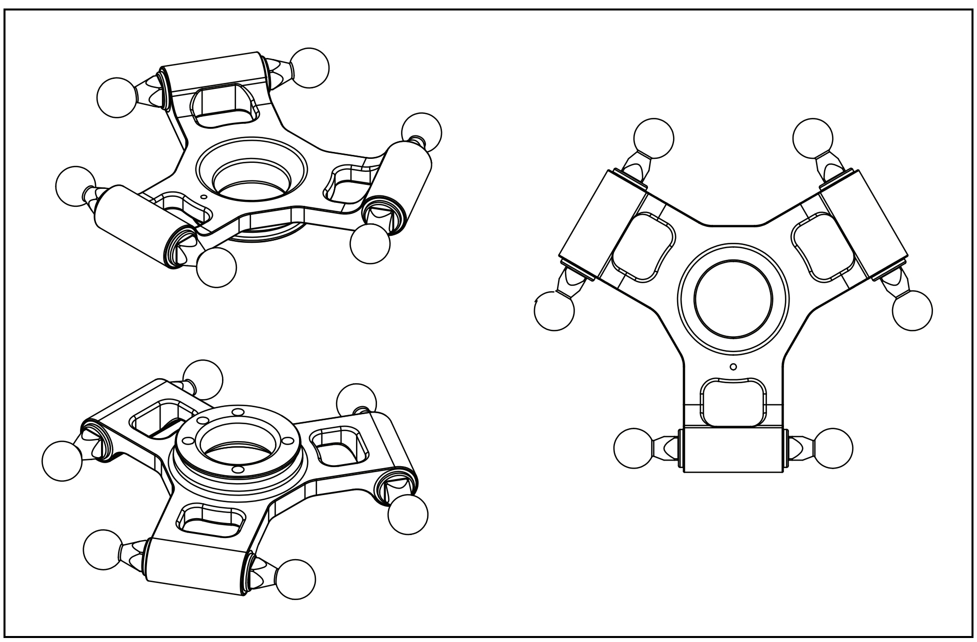


Figure 1-5. Fixed Platform (Stainless Steel)

Platform Clocking

The J4 platform, which is rotational, is constructed such that the clocking, or rotational alignment, of the platform relative to the robot base is critical. This is detailed in Aligning the Platform with the Base on page 27.

Platform Shipping

- The platform, outer arms, and theta drive shaft are removed.
- The platform is shipped assembled as a unit.
  You will need to connect the outer arms between the inner arms and the platform to reassemble the robot. The outer-arm assemblies are interchangeable.

  For the Hornet 565 with the J4 platform, you will also have to connect the telescoping drive shaft that connects the platform to the fourth motor on the robot base.

Any end-effectors and their air lines and wiring are user-supplied.

SmartController EX

The optional SmartController EX motion controller supports tracking more conveyors, as well as other options. Like the eAIB, the SmartController EX uses the eV+ operating system. It offers scalability and support for IEEE 1394-based digital I/O and general motion expansion modules. The SmartController EX also includes Fast Ethernet and DeviceNet.

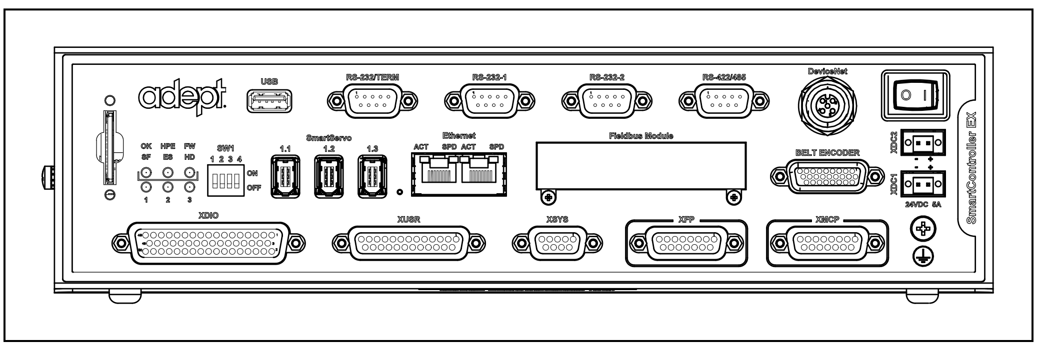


Figure 1-6. SmartController EX

Refer to the *SmartController EX User's Guide* for SmartController specifications.

1.2 Installation Overview

The system installation process is summarized in the following table. Also, refer to System Installation on page 35.

NOTE: For dual-robot installations, see the Dual-Robot Configuration Procedure, which is available in the Document Library.

Table 1-1. Installation Overview

Task to be Performed	Reference Location
If purchased, mount the optional cable box.	Options on page 85.
Mount the robot to a level, stable mounting frame.	Mounting on page 24.
Attach the robot outer arms and platform.	Attaching the Outer Arms on page 28.
Attach the theta drive shaft, for the J4 platform.	Attaching the Theta Drive Shaft on page 31.
Install the Front Panel and Pendant, if purchased, and ACE software.	System Cables, eAIB Only (no SmartController EX) on page 35 and ACE Software on page 45.
Create a 24 VDC cable and connect it between the robot and the user-supplied 24 VDC power supply.	Procedure for Creating 24 VDC Cable on page 48.
Create a 200-240 VAC cable and connect it between the robot and the facility AC power source.	Connecting 200-240 VAC Power to Robot on page 49.
Install user-supplied safety barriers in the workcell.	Installing User-Supplied Safety Equipment on page 55.
Connect digital I/O through the robot XIO connector.	Using Digital I/O on eAIB XIO Connector on page 72.
Start the system, including system operation testing.	Starting the System for the First Time on page 80.
Install optional equipment, including end-effectors, user air and electrical lines, external equipment, etc.	Options on page 85.

1.3 How Can I Get Help?

Refer to the corporate website:

http://www.ia.omron.com

Corporate Addresses

Omron Adept Technologies, Inc.

4550 Norris Canyon Road, Suite 150

San Ramon, CA 94583

USA

925 245-3400

Omron Corporate Headquarters

Shiokoji Horikawa, Shimogyo-ku, Kyoto 600-8530 Japan

TEL: 81-75-344-7000 FAX: 81-75-344-7001

Related Manuals

This manual covers the installation, operation, and maintenance of a Hornet 565 system. There are additional manuals that cover programming the system and adding optional components. See the following table. These manuals are available on the software media shipped with each system.

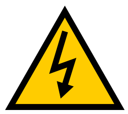
Table 1-2. Related Manuals

Manual Title	Description
Robot Safety Guide	Contains safety information for our robots. A printed copy of this guide ships with each robot.
ACE User's Guide	Describes the installation and use of ACE.
T20 Pendant User's Guide	Describes the use of the optional T20 manual control pendant.
SmartController EX User's Guide	Contains complete information on the installation and operation of the optional SmartController EX and sDIO products.
SmartVision MX User's Guide	Instructions for use of the optional SmartVision MX industrial PC.
ePLC Connect 3 User's Guide	Describes the installation and use of the ePLC Connect 3 software, for using a user-supplied PLC as controller.
IO Blox User's Guide	Describes the IO Blox product.
Dual-Robot Configuration Procedure	Contains cable diagrams and configuration procedures for a dual-robot system.

Chapter 2: Safety

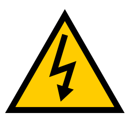
2.1 Warnings, Cautions, and Precautions

There are six levels of special 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.

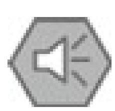
DANGER: This indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.



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

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

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



Precautions for Safe Use: This gives precautions on what to do and what not to do to ensure safe product use.

2.2 Safety Precautions

DANGER: A Hornet 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 the system must read this guide, read the *Robot Safety Guide*, and complete a training course for their responsibilities in regard to the robot.

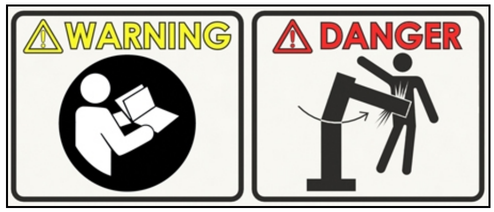


Figure 2-1. Read Manual and Impact Warning Labels

- All personnel who design the robot system must read this guide, read the *Robot Safety Guide*, and must comply with all local and national safety regulations for the location in which the robot is installed.
- The Hornet 565 must not be used for purposes other than described in Intended Use of the Robots on page 19. Contact Customer Support 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/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 situation. If a fire occurs, use CO_2 to extinguish the fire.

In case of an emergency or abnormal situation, the platform can be manually moved without electric power. However, only qualified personnel who have read and understood this manual and the *Robot Safety Guide* should manually move the platform to a safe state. Axes 1 through 3 are held by brakes, which can only be released with the brake release button. This requires 24 V power to the robot.

2.4 Robot Behavior

Hardstops

If the Hornet 565 runs into one of its hardstops, the robot's motion will stop completely, an envelope error will be generated, and power to the robot motors will be cut off.

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

The Hornet 565'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

No singularities exist that cause a hazardous situation with a Hornet 565 robot.

2.5 Intended Use of the Robots

DANGER: Hornet 565s 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 Hornet 565 has been designed and constructed in accordance with the relevant requirements of IEC 60204-1.

The Hornet 565 is intended for use in parts assembly and material handling for payloads up to 3 kg (6.6 lb), or 8 kg (17.6 lb) with the fixed platform. See Robot Specifications on page 134 for complete information on the robot specifications. Refer to the *Robot Safety Guide* for details on the intended use of our robots.

Hornet 565 robots are not intended for:

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

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 Hornet 565 robot and other products are in the *Manufacturer's Declarations Guide*.

Robot Safety Guide

The *Robot Safety Guide* provides detailed information on safety for our robots. It also gives resources for more information on relevant standards. It ships with each robot.

Emergency Stop Circuit and Buttons

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

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

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

Manual Control Pendant

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

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

> **NOTE**: Omron 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 EX, and the pendant is connected to the SmartController EX.

Chapter 3: Robot Installation

3.1 Transport and Storage

This equipment must be shipped and stored within the range –25 to +60° C (-13 to 140° F). Humidity should be less than 75%, non-condensing. The robot should be shipped and stored in the supplied crate, which is designed to prevent damage from normal shock and vibration. You should protect the crate from excessive shock and vibration.

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

The robot must always be stored and shipped in an upright position. Do not lay the crate on its side or any other non-upright position. This could damage the robot.

The Hornet 565 J4 model weighs 52 kg (115 lb) with no options installed.

The fixed model weighs 48.6 kg (107 lb) with no options installed.

The crate weighs 68 kg (150 lb).

3.2 Unpacking and Inspecting the Hornet 565

Before Unpacking

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

Upon Unpacking

Before signing the carrier's delivery sheet, compare the actual items received (not just the packing slip) with your equipment purchase order. 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 (see How Can I Get Help? on page 15).
- If the items received do not match your order, please contact Omron Adept Technologies, Inc. immediately.

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

Unpacking

The Hornet 565 is shipped in a crate that holds the robot base, outer arms, platform, theta drive shaft, and any accessories ordered. The crate is made of wood.

The top of the crate should be removed first.

1. Remove the Klimp® fasteners holding the top to the rest of the crate. See the following figure.

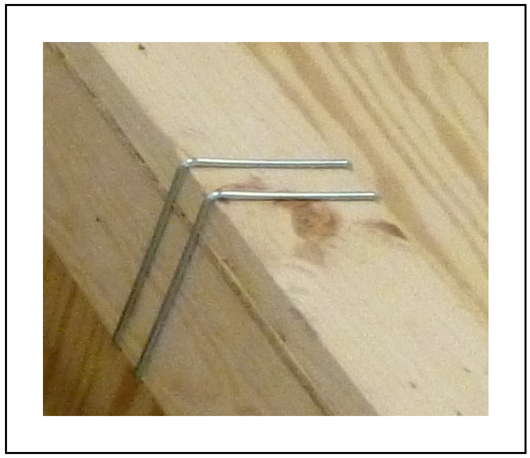


Figure 3-1. Klimp Fastener on Crate

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

2. Lift the top off of the crate sides, and set it aside.

Figure 3-2. Crate, with Top Removed

3. Remove all cardboard boxes from inside the crate. These will include the outer arms, theta drive shaft, and platform.

4. Remove all fasteners (Klimp and lag) holding the crate sides to the base, and lift off the crate sides.

   The four sides will come off as a single piece, so this requires two people lifting from opposite sides of the crate.

   You will be left with the robot base, with eAIB and inner arms, attached to the pallet.

   The robot base is held to the pallet with tie-downs.

5. Remove the tie-downs.

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

3.3 Repacking for Relocation

If the robot or other equipment needs to be relocated, reverse the steps in the installation procedures 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.

CAUTION: The robot must always be shipped in an upright orientation.

3.4 Environmental and Facility Requirements

The Hornet 565 system installation must meet the operating environment requirements shown in the following table.

Table 3-1. Robot System Operating Environment Requirements

Ambient temperature	1 to 40° C (34 to 104° F)
Humidity	5 to 90%, non-condensing
Altitude	up to 2000 m (6500 ft)
NOTE: See also Dimension Drawings on page 131	

3.5 Mounting Frame

The design of the robot mounting frame is the user's responsibility.

- The flatness of the frame mounting tabs is critical. See Robot-to-Frame Considerations (following) and Mounting Surfaces on page 25.
- The frame must be stiff enough to prevent excessive vibration.
- The eAIB must be removable from the robot without removing the robot from the frame. This is needed for maintenance and inspection of the robot.

The Hornet 565 is designed to be mounted above the work area suspended on a user-supplied frame. The frame must be adequately stiff to hold the robot rigidly in place while the robot platform moves within the workspace.

While we do not offer robot frames for purchase, and the frame design is the responsibility of the user, we provide some general guidelines as a service to our users.

Any robot's ability to settle to a fixed point in space is governed by the forces, masses, and accelerations of the robot. Since "every action has an equal and opposite reaction", these forces are transmitted to the robot frame and cause the frame and base of the robot to move and possibly vibrate in space. As the robot system works to position the tool flange relative to the base of the robot, any frame or base motion will be "unobservable" to the robot system, and will be transmitted to the tool flange. This transmitted base motion will result in inertial movement of the tool flange mass, and will cause disturbance forces to be introduced into the robot control system. These disturbance forces cause "work" to be done by the robot servo control system which may result in longer settling times for robot operations.

It is important to note that, even after the system reports the robot to be fully settled, the tool flange will still be moving by any amount of motion that the suspended base of the robot may be experiencing.

Robot-to-Frame Considerations

The Hornet 565 has a moderately-complex mounting requirement due to the nature of the parallel-arm kinematics and the need to minimize the robot size and mass. Arm Travel Volume on page 133 shows the inner arm travel and how it may encroach on the robot mounting points. As a starting point, for a frame that is 1440 mm in the X and Y directions, (allowing use of the full range of the robots), you should attempt to attain a frame frequency of 25 Hz.

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

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

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

Mounting

Dimension Drawings on page 131 shows the mounting hole pattern for the Hornet 565. Note the hole location and mounting pad tolerances for position and flatness.

Deviation from this flatness specification will, over time, cause a possible loss of robot calibration.

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

3.6 Mounting the Robot Base

Robot Orientation

We recommend mounting the Hornet 565 so that the Status Display Panel faces away from the conveyor belt. Although the work envelope of the robot is symmetrical, this orientation gives better access to the status display. It also orients the arm loading for aggressive moves across the belt.

This orientation places the robot World Y-axis along the conveyor belt, and the X-axis across the belt. See Mounting Dimensions on page 131.

Mounting Surfaces

Mounting surfaces for the robot mounting tabs must be within 0.75 mm of a flat plane.

CAUTION: Failure to mount the Hornet 565 within 0.75 mm of a flat plane will result in inconsistent robot locations.

NOTE: The base casting of the robot is aluminum and can be dented if bumped against a harder surface.

CAUTION: Do not attempt to lift the robot from any points other than with slings as described here.

Mounting Procedure

The Hornet 565 has three mounting pads. Each pad has one hole with an M12 x 1.75 spring-lock Heli-Coil®.

1. Position the robot directly under the mounting frame.

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

2. Put nylon straps through the six slots near the three mounting pads.

   The following figure shows two of these slots.

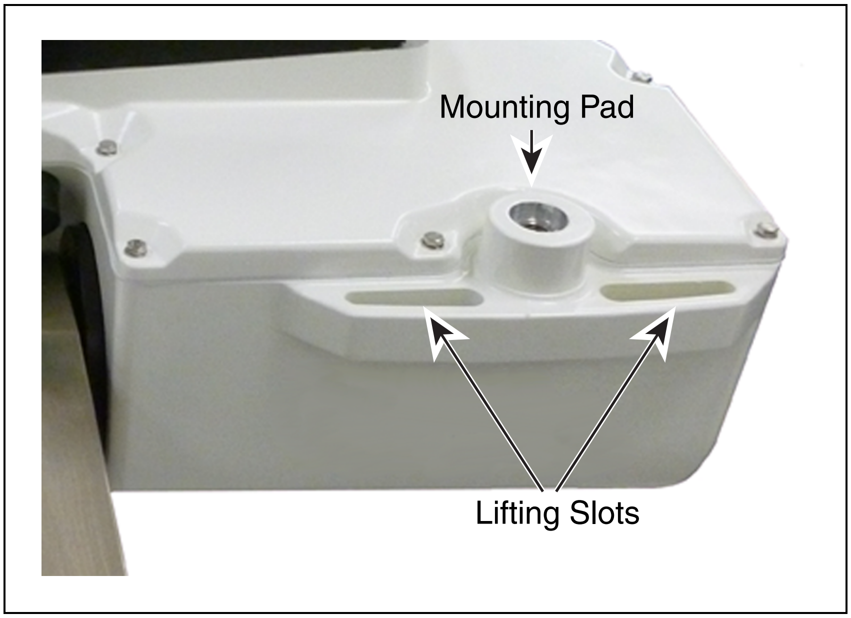


Figure 3-3. Two of Six Lifting Slots

3. Take up any slack in the straps.

   The mechanism you use for lifting the straps will be dependent on the frame design, so it is not specified here.

4. Slowly lift the robot base up, keeping the holes in the robot base pads and the frame pads aligned, until the top surfaces of the robot base pads are touching the bottom surfaces of the frame mounting pads.

5. Follow the instructions in Install Mounting Hardware that follow.

Install Mounting Hardware

Because of the possible variability of the mounting frames, mounting hardware is user-supplied. The bolts need to be M12-1.75, either stainless steel or zinc-plated steel. The threads must engage 24 mm (0.94 in.) of the robot base threads (Heli-Coil), for sufficient support.

When mounting the robot, note the following:

- Verify that the robot is mounted squarely before tightening the mounting bolts.
- Insert the bolts through the holes in the frame and into the threaded holes in the robot base mounting pads.
- Ground the robot base to the mounting frame.

  Refer to Grounding Robot Base to Frame on page 54.
- Tighten the bolts to 61 N·m (45 ft-lb).

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

NOTE: Check the tightness of the mounting bolts one week after initial installation, and then recheck every 3 months. See Checking Robot Mounting Bolts on page 104.

3.7 Attaching the Outer Arms, Platform, and Theta Drive Shaft

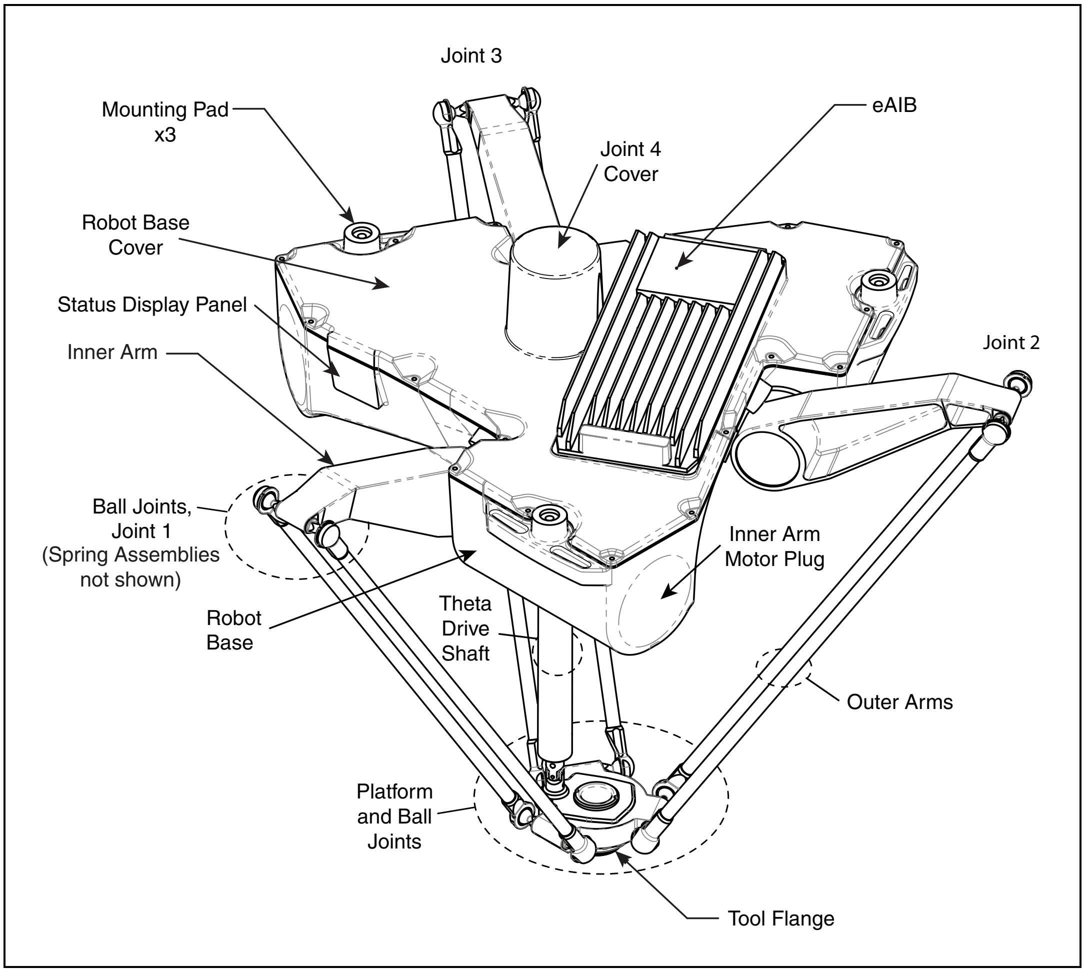


Figure 3-4. Major Robot Components

The Hornet 565 platform is attached to the inner arms by the outer arms.

NOTE: Except for attaching the outer arms and theta drive shaft, the platform is shipped fully-assembled.

Aligning the Platform with the Base

NOTE: The fixed platform is symmetrical, and can be mounted in any rotational position. The tool flange must be down, away from the robot body.

This section only applies to the J4 platform.

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

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

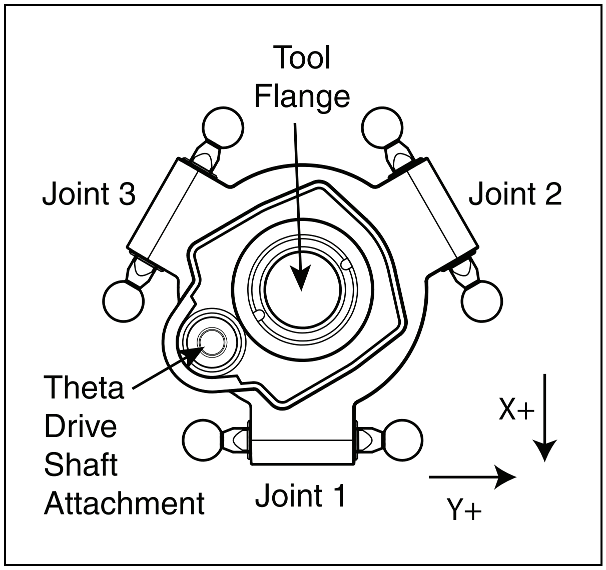


Figure 3-5. J4 Platform Orientation, Top View

Both the theta drive shaft attachment on the robot base and on the platform are offset by about 2 in. from the centers of the robot base and tool flange. The platform should be attached so that the shaft aligns with the J4 motor, between Joint 1 and Joint 3 on the robot base. Joint 1 in the preceding figure should connect to motor 1, which is immediately to the right of the Status Display panel on the robot base.

Attaching the Outer Arms

One pair of outer arms attaches between each inner arm and the platform. No tools are needed.

- Each outer arm has a ball joint socket at each end.
- The inner arms and the platform have corresponding pairs of ball studs.

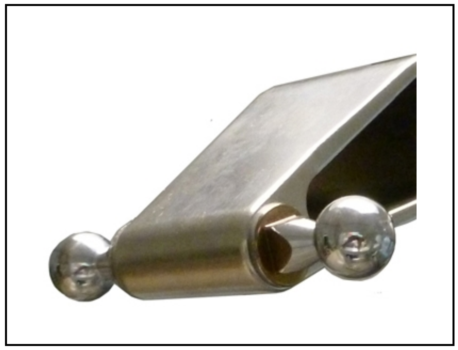


Figure 3-6. Inner Arm Ball Studs

WARNING: Pinch hazard. Ball joints are spring-loaded. Be careful not to pinch your fingers.

- Outer arm pairs are shipped assembled. Each pair has two springs and two horseshoes at each end. See the following figure.

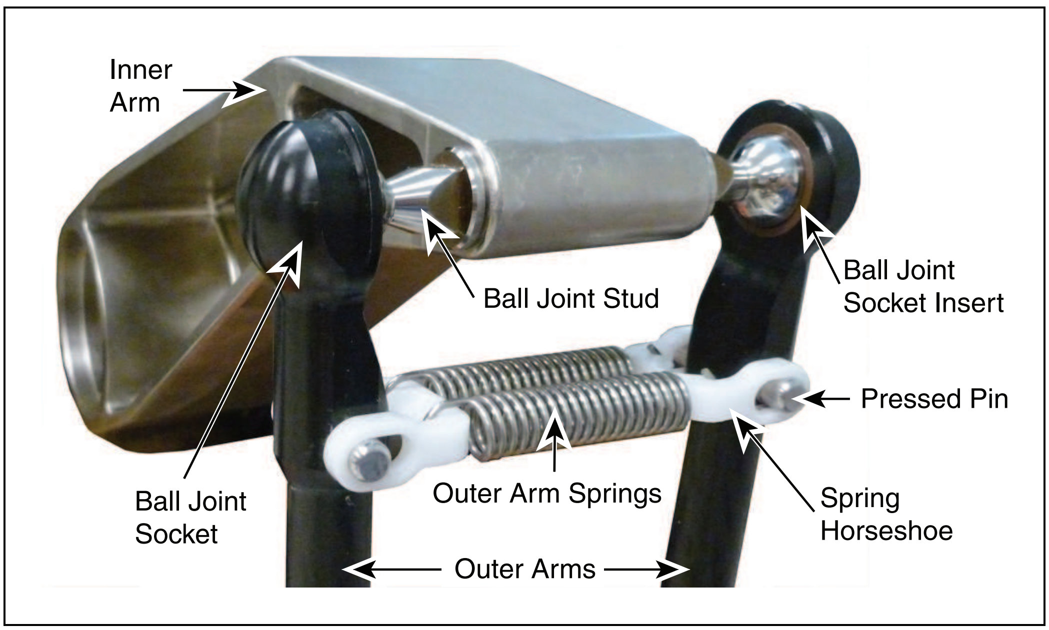


Figure 3-7. Ball Joint Assembly

CAUTION: Ensure that the bearing insert is in place in the end of each outer arm.

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

NOTE: The procedure for attaching outer arms is the same for both platforms.

1. Attach one pair of outer arms to each inner arm.
    a. As illustrated in the following figure, the outer arm assembly is most easily achieved by pivoting the two arms away from each other lengthwise. This requires the least stretching of the spring to attach the ball joints.
    b. Slip one ball joint socket over the corresponding ball stud.
    c. Swing the bottom end of the outer arm pair sideways as you slip the other ball joint socket over the corresponding ball stud.

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

Figure 3-8. Installing Ball Joints

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

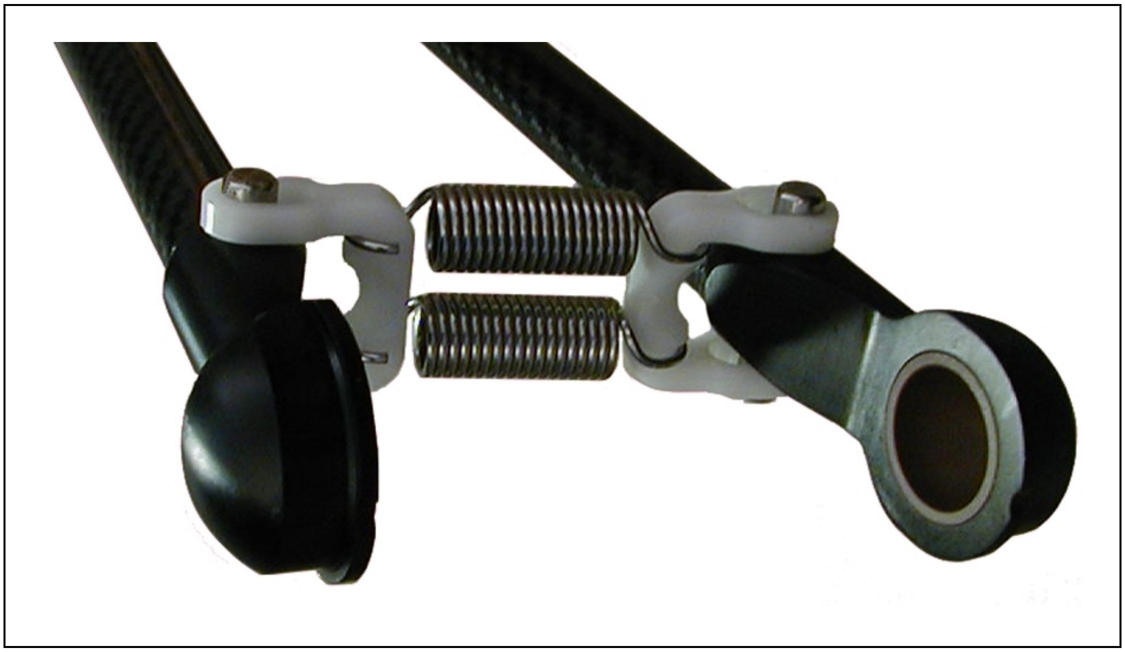
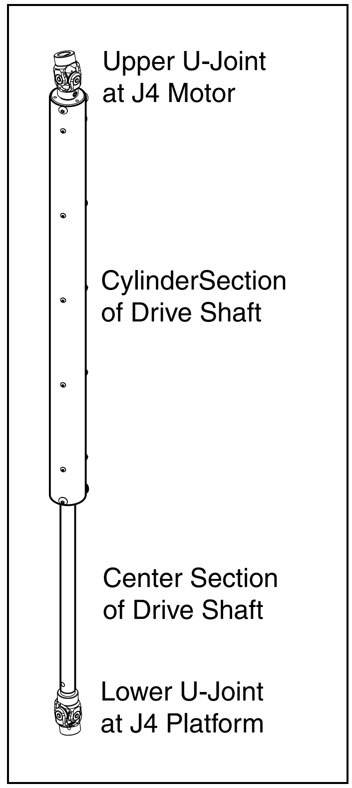


Figure 3-9. Horseshoe and Spring Assembly

Attaching the Theta Drive Shaft

NOTE: The fixed platform does not use a theta drive shaft, so this section does not apply to systems with a fixed platform.

Each U-joint has two identical ends. When the theta drive shaft is shipped, it will have one end of a U-joint attached to each end. One connects to the J4 motor drive, the other connects to a shaft on the top of the J4 platform.



- Connect the upper U-joint to the drive shaft of the J4 motor. This will be the wider cylinder section.

  The upper (J4 motor) end of the drive shaft is labeled with a temporary label, indicating Top. Remove the label before use.

- Connect the lower U-joint to the shaft on top of the J4 platform.

  NOTE: The drive shaft is not symmetrical. There is a top and a bottom. Installing the drive shaft upside-down will degrade system performance. Note the orientation label on the drive shaft. Look for a "Top" label on the drive shaft.

To attach the free end of the U-joints:

1. Slide the U-joint over the shaft (platform or J4 motor).

   The fit will be fairly tight.

   The hole in the side of the U-joint needs to line up with the hole in the shaft.

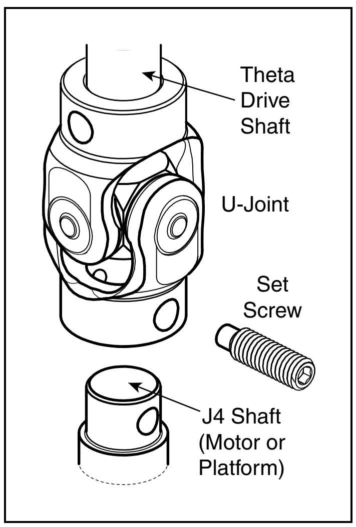


Figure 3-10. U-Joint

2. Screw an M6 x 20 dog point set screw (included) through the shaft, going through the hole in the side of the U-joint, and into the blind hole on the opposite side of the U-joint. The U-joint is not threaded.

   - Use Loctite 242.
   - Tighten to 5 N-m (3.7 ft-lbf) of torque. The head of the set screw should be flush with the outer surface of the U-joint.

   For the top U-joint, use a 3 mm hex key, with a 10 - 15 mm short leg. There is not enough room at the J4 motor shaft to use a standard hex key.

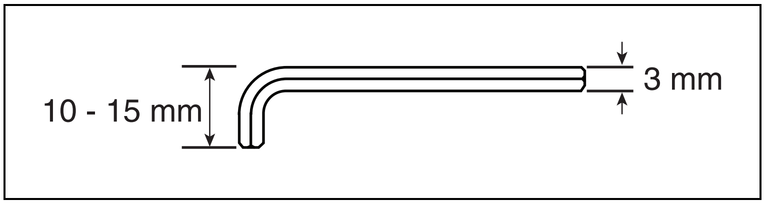


Figure 3-11. Short 3 mm Hex Key

NOTE: The platform and the J4 motor will have to be aligned after the ACE software is installed and the robot is powered-on. See Aligning the Platform and J4 Motor on page 82.

3.8 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.

3.9 End-Effectors

You are responsible for providing and installing any end-effector or other tooling, as well as vacuum lines and wiring to the end-effector.

See the drawing Tool Flange Dimensions, Both Platforms on page 132 for dimensions of the tool flange.

Attaching an End-Effector

You can attach end-effectors to the tool flange using either four M6 x 1.0 screws, or a ring clamp. Hardware for both methods is supplied in the accessories kit.

NOTE: The combined weight of the end-effector and the payload must not exceed the maximum rated payload.

Aligning an End-Effector

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

Grounding

If hazardous voltages are present at the end-effector, you must install a ground connection to the end-effector. See Grounding Robot-Mounted Equipment on page 53.

Accessing Vacuum

The hole through the center of the tool flange has been made as large as possible to allow vacuum and/or electric lines to pass through.

WARNING: Do not drill or tap the tool flange, as this would weaken it.

Routing End-effector Lines

End-effector lines (either vacuum/air lines or electrical wires) can be routed to the platform by:

- Attaching them to the inner and outer arms, and then to the platform.
- Routing them from the robot support frame to the outer arms.
- Routing them from the robot base directly to the platform.

If end-effector lines are attached to the outer arms to reach the end-effector, either directly from the frame, or along the inner arms:

- Make every attempt to keep the load on the outer arms as evenly-balanced as possible. The added weight should be attached symmetrically about the platform center.
- Verify that the arms can be fully-extended without interference from the lines. Ensure that there is enough line to reach the end-effector at all platform locations.
- Verify that the platform can be fully-rotated at all positions without affecting or being affected by the lines.
- Verify that any service loop or excess line does not hang down below the end-effector at any platform position.
- Verify that excess line cannot become tangled in the outer arms or platform.

If end-effector lines are attached directly to the bottom of the robot base to reach the end-effector:

- Lines attached to the robot base need some form of retraction mechanism or service loop to take up the slack when the platform is near the robot base.
- Ensure that the lines (and retraction mechanism) do not apply significant force, in any direction, to the platform.
- Ensure that lines going to the robot base do not block your view of the status LED.
- Ensure that lines going to the robot base do not interfere with the inner arm movement.

User-added end-effector lines:

- Should be checked for the entire work envelope being utilized. They must reach without being pulled, and without impeding arm or platform movement.
- Cannot pull against the platform with significant force. Robot performance will be affected.
- Must be considered as part of the payload, if they add weight to the platform or outer arms.
- Are the user's responsibility for maintenance. They are not covered in the Maintenance section of this manual.

Chapter 4: System Installation

4.1 System Cables, eAIB Only (no SmartController EX)

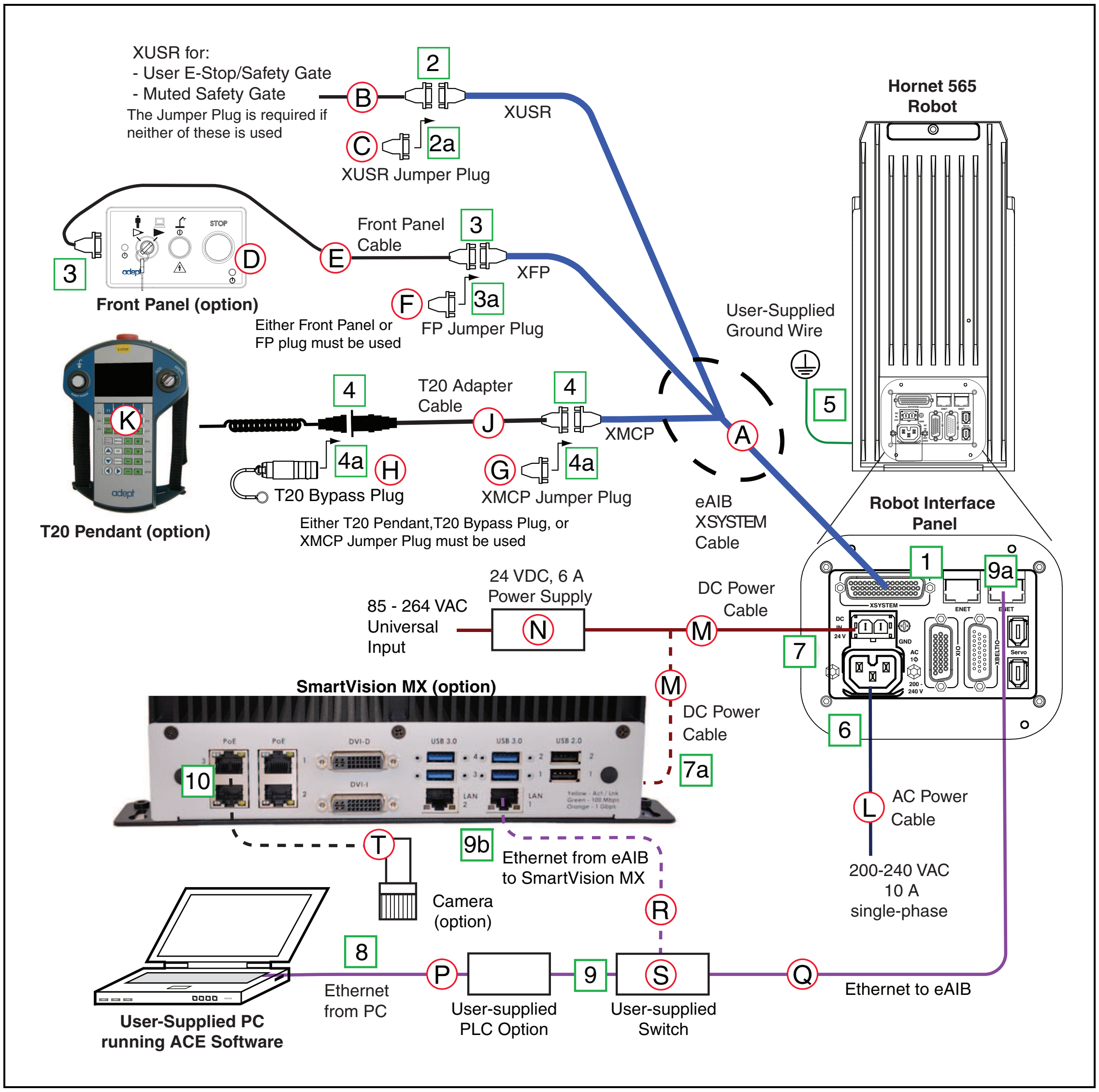


Figure 4-1. System Cable Diagram, eAIB Only

See System Installation on page 35 for additional information on system grounding.

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		standard, eAIB
B	User E-Stop, Safety Gate	n/a	n/a	user-supplied
C	XUSR Jumper Plug	04736-000	13323-000	standard, eAIB
D	Front Panel (option)	90356-10358		or user-supplied
E	Front Panel Cable	10356-10500	90356-10358	or user-supplied
F	Front Panel Jumper Plug	10053-000	13323-000	standard, eAIB
G	XMCP Jumper Plug	04737-000	13323-000	standard, eAIB
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 -> eAIB	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 a Hornet 565 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 Hornet 565 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 optional Front Panel and eAIB XSYSTEM cable XFP connector or	D, E
3a	if using user-supplied Front Panel, connect Front Panel to eAIB XSYSTEM cable XFP. See warning after table.	A, E
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 Grounding the Hornet 565 on page 53.	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 can be purchased with each Hornet 565 system, but you can choose to replace its functionality with equivalent circuits. That is beyond the scope of this guide.

WARNING: A front panel must be installed to provide an E-Stop button and to enable power to the robot. To operate without the standard Front Panel, the user must supply equivalent circuits.

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 78.

Cables for adding belt encoders are covered in System Cables for Systems with Belt Encoders on page 42.

4.2 System Cables, with SmartController EX

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

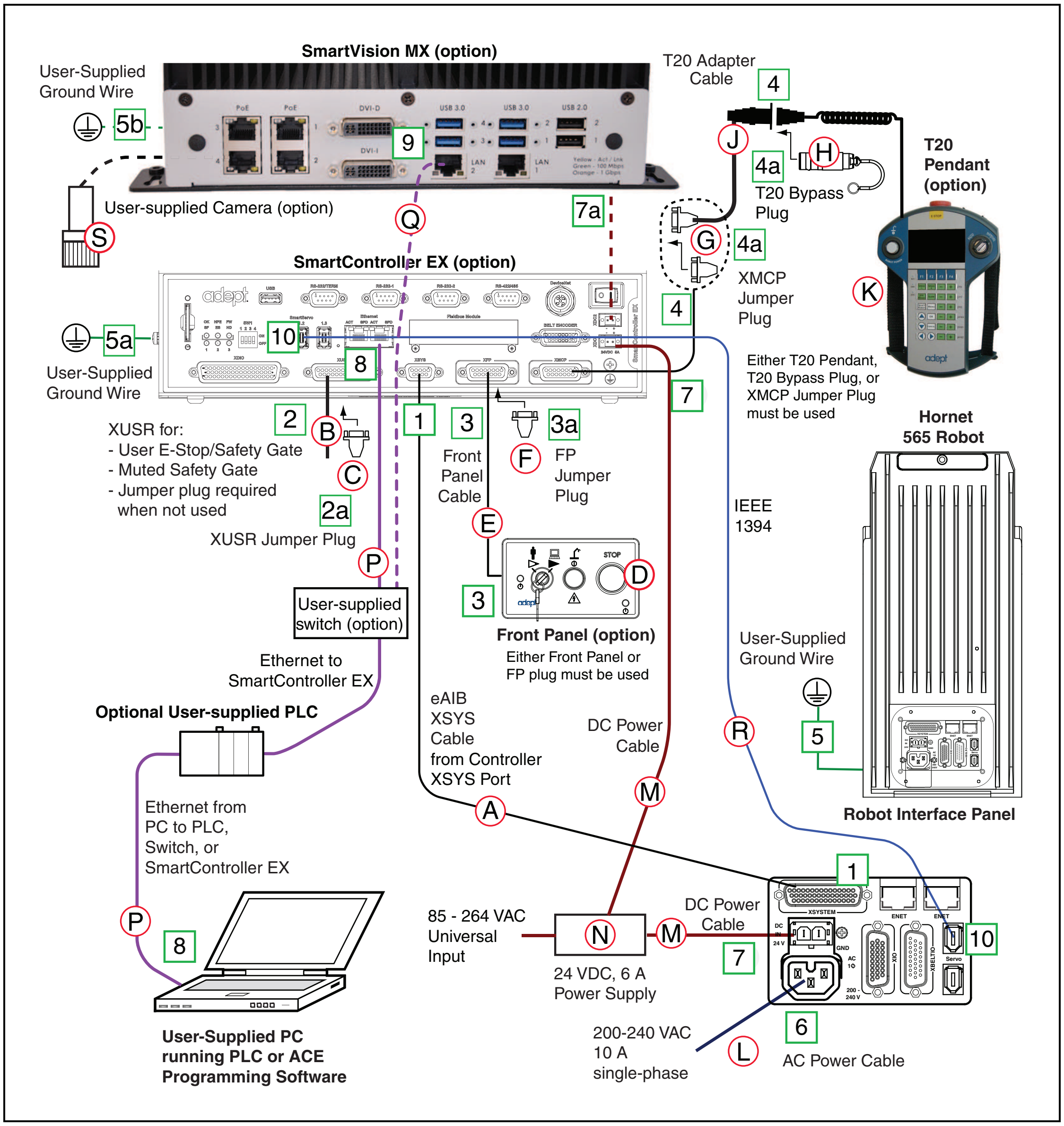


Figure 4-2. System Cable Diagram with SmartController EX

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 optional front panel.
2. Connect the optional front panel to the SmartController EX.

3. Connect the optional pendant to the SmartController EX.
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 (option)	or user-supplied
E	Front Panel Cable	or user-supplied
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, P/N 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 a Hornet 565 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 eAIB	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 optional Front Panel and XFP connector or	D, E
3a	if using user-supplied Front Panel, connect Front Panel to eAIB XSYSTEM cable XFP. See warning after table.	A, E
4	Connect Pendant adapter cable to XMCP connector or	J, K
4a	if no Pendant, install XMCP jumper or bypass plug.	G,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
9	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

WARNING: A front panel must be installed to provide an E-Stop button and to enable power to the robot. To operate without the standard Front Panel, the user must supply equivalent circuits.

Less Common 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 78.

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*.

4.3 System Cables for Systems with Belt Encoders

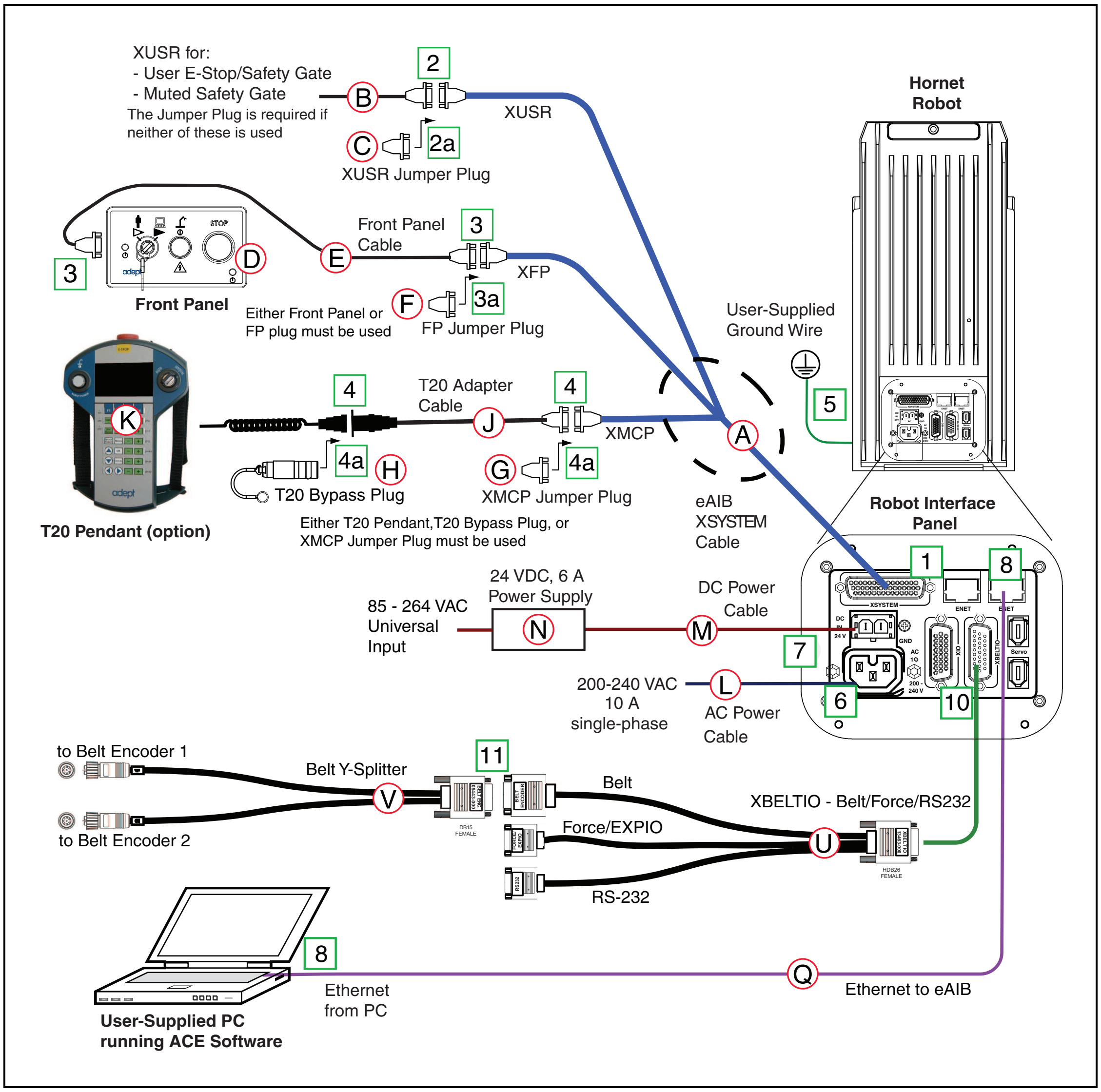


Figure 4-3. System Cable Diagram with Belt Encoder Cables

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.

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.

Part	Cable and Parts List	Part #	Part of:	Notes
A	eAIB XSYSTEM Cable Assembly	13323-000		standard, eAIB
B	User E-Stop, Safety Gate	n/a	n/a	user-supplied
C	XUSR Jumper Plug	04736-000	13323-000	standard, eAIB
D	Front Panel (option)	90356-10358		or user-supplied
E	Front Panel Cable	10356-10500	90356-10358	or user-supplied
F	Front Panel Jumper Plug	10053-000	13323-000	standard, eAIB
G	XMCP Jumper Plug	04737-000	13323-000	standard, eAIB
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
Q	Ethernet Cable -> eAIB	n/a	n/a	user-supplied
U	eAIB XBELTIO cable	13463-000		option
V	Y-adapter cable	09443-000		option

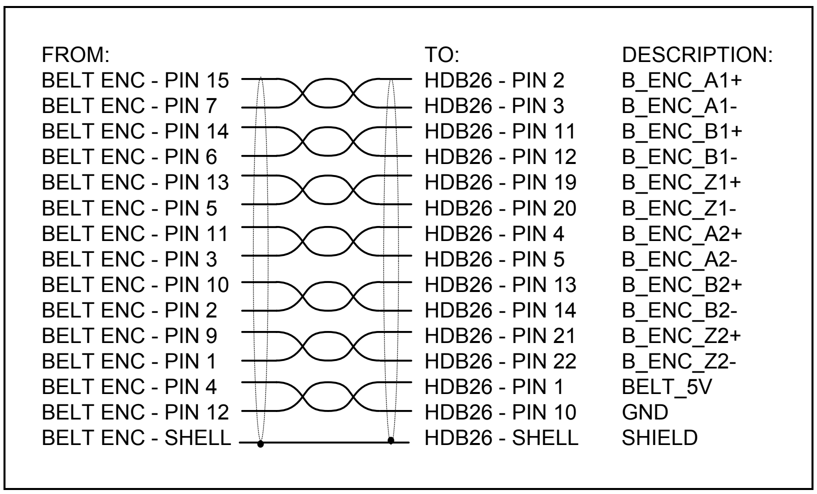
Cable Installation Overview

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 optional Front Panel and eAIB XSYSTEM cable XFP connector or	D, E
3a	if using user-supplied Front Panel, connect Front Panel to eAIB XSYSTEM cable XFP. See warning after table.	A, E
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 Grounding the Hornet 565 on page 53.	n/a

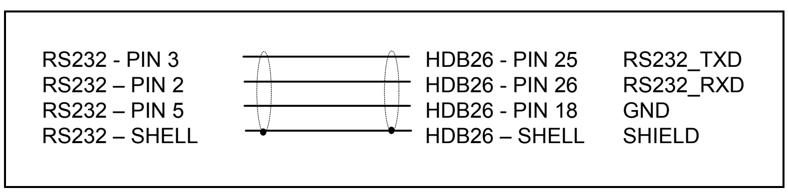
Step	Connection	Part
6	Connect 200-240 VAC to AC Input on eAIB Interface Panel; secure with clamp.	L
7	Connect 24 VDC to DC Input on Interface Panel.	N, M
8	Connect Ethernet cable from PC to eAIB.	P
10	Connect optional eAIB XBELTIO cable to the XBELTIO port on eAIB.	U
11	Connect the Y-adapter cable to the eAIB XBELTIO cable, Belt branch	V

Pinouts for eAIB XBELT IO Adapter

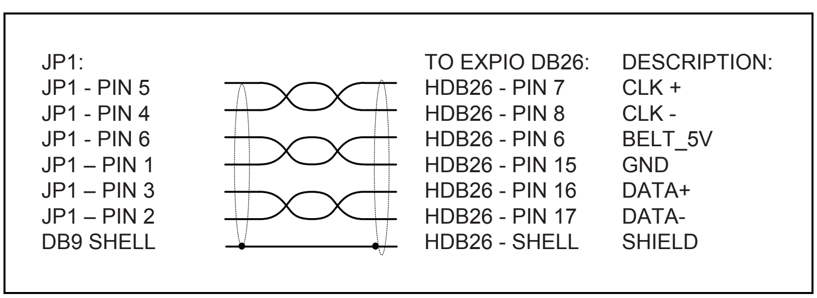
Belt Encoder



RS232



FORCE/EXPIO



4.4 ACE Software

User-supplied PC

The user loads the ACE software onto the PC and connects it to the eAIB 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 disk will display a ReadMe file when inserted in your PC. This contains hardware and software requirements for running ACE software.

You install ACE from the Software disk. ACE needs Microsoft .NET Framework. The ACE Setup Wizard scans your PC for .NET, and installs it automatically if it is not already installed.

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

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

   NOTE: The online document that describes the installation process opens in the background when you select one of software installation steps below.

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.

4.5 Robot Interface Panel

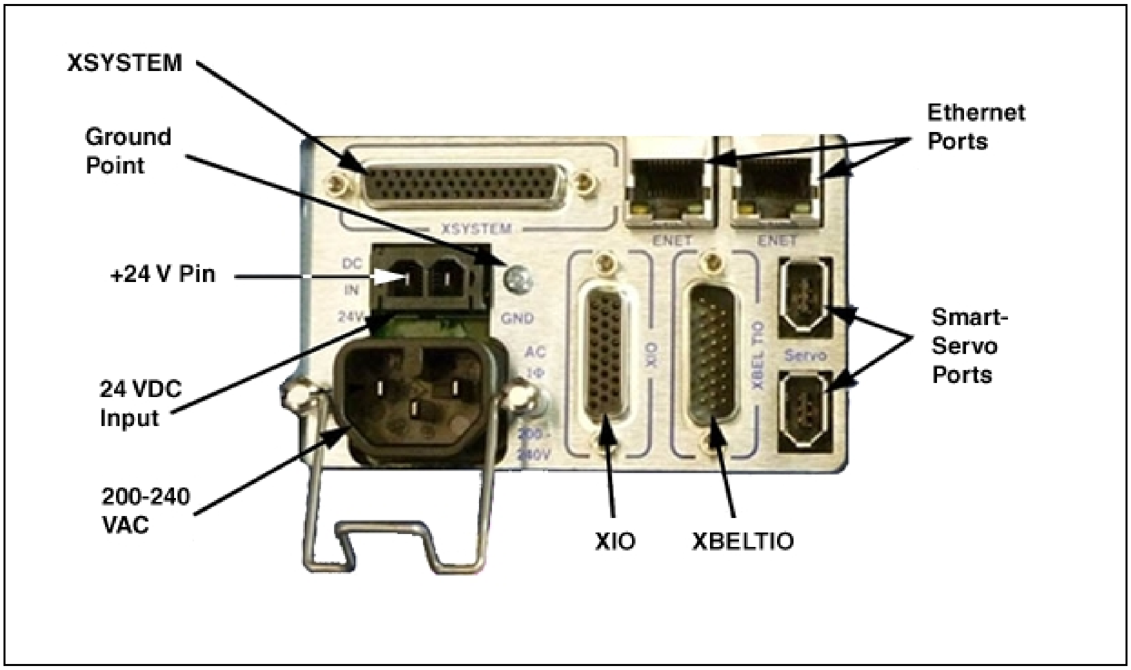


Figure 4-4. Robot Interface Panel

24 VDC—for connecting user-supplied 24 VDC power to the robot. 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 to the robot. The mating connector is provided.

XIO (DB26, high density, female) — for user I/O signals for peripheral devices. This connector provides 8 outputs and 12 inputs. For connector pin allocations for inputs and outputs, see Using Digital I/O on eAIB XIO Connector on page 72. That section also contains details on how to access these I/O signals via eV+.

XBELTIO — adds a belt encoder, EXPIO, (which supports either IO BLOX or an Intelligent Force sensor), and an RS-232 interface. Requires optional eAIB XBELT IO Adapter cable. The belt encoder can be split for two belts with a Y-adapter.

SmartServo x2 (IEEE 1394) — for connecting the IEEE 1394 cable from the robot to a controller. The other robot connector can be used to connect to a second robot or another 1394-based motion axis.

XSYSTEM — This requires either the eAIB XSYSTEM (three-headed) cable (XFP, XMCP, and XUSR), or an eAIB XSYS cable, if connecting to a SmartController EX.

ENET - Two Ethernet ports are available. One will be needed to connect to a PC running ACE software.

4.6 Connecting 24 VDC Power to Robot

Specifications for 24 VDC Robot and Controller Power

Table 4-1. VDC User-Supplied Power Supply

User-Supplied Power Supply	24 VDC (± 10%), 150 W (6 A) (21.6 V< V_{in} < 26.4 V)
Circuit Protection[a]	Output must be < 300 W peak, or 8 Amp in-line fuse
Power Cabling	1.5 – 1.85 mm^2 (16-14 AWG)
Shield Termination	Braided shield connected to ground at both ends of cable. See User-Supplied 24 VDC Cable on page 49.
[a]User-supplied 24 VDC power supply must incorporate overload protection to limit peak power to less than 300 W, or an 8 A in-line fuse must be added to the 24 VDC power source. (In case of multiple robots on a common 24 VDC supply, each robot must be fused individually.)	

NOTE: Fuse information is located on the eAIB electronics.

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

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 recommended power supplies.

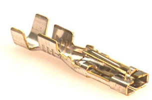
Table 4-2. Recommended 24 VDC Power Supply

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 4-3. 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 tools:	Molex P/N 63811-7200
	Digi-Key P/N WM1618-ND

Procedure for Creating 24 VDC Cable

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 36.

1. Locate the connector and pins shown in the preceding table.
2. Use 14-16 AWG wire to create the 24 VDC cable. Select the wire length to safely reach from the user-supplied 24 VDC power supply to the robot base.

NOTE: Separate 24 VDC cables are required for the optional SmartController EX and SmartVision MX. Those cables use different styles of connectors. See the *SmartController EX User's Guide* and the *SmartVision MX User's Guide*.

3. Crimp the pins onto the wires using the crimping tool.
4. Insert the pins into the connector. Confirm that the 24 VDC and ground wires are in the correct terminals in the plug.
5. Prepare the other end of the cable for connection to your 24 VDC power supply.

Installing 24 VDC Robot Cable

1. Connect one end of the shielded 24 VDC cable to the user-supplied 24 VDC power supply. See the following figure.
   - The cable shield should be connected to frame ground on the power supply.
   - Do not turn on the 24 VDC power yet. See System Operation on page 65.
2. Plug the mating connector end of the 24 VDC cable into the 24 VDC connector on the interface panel of the eAIB, which is on top of the robot.
3. Connect the cable shield to the ground point on the interface panel.

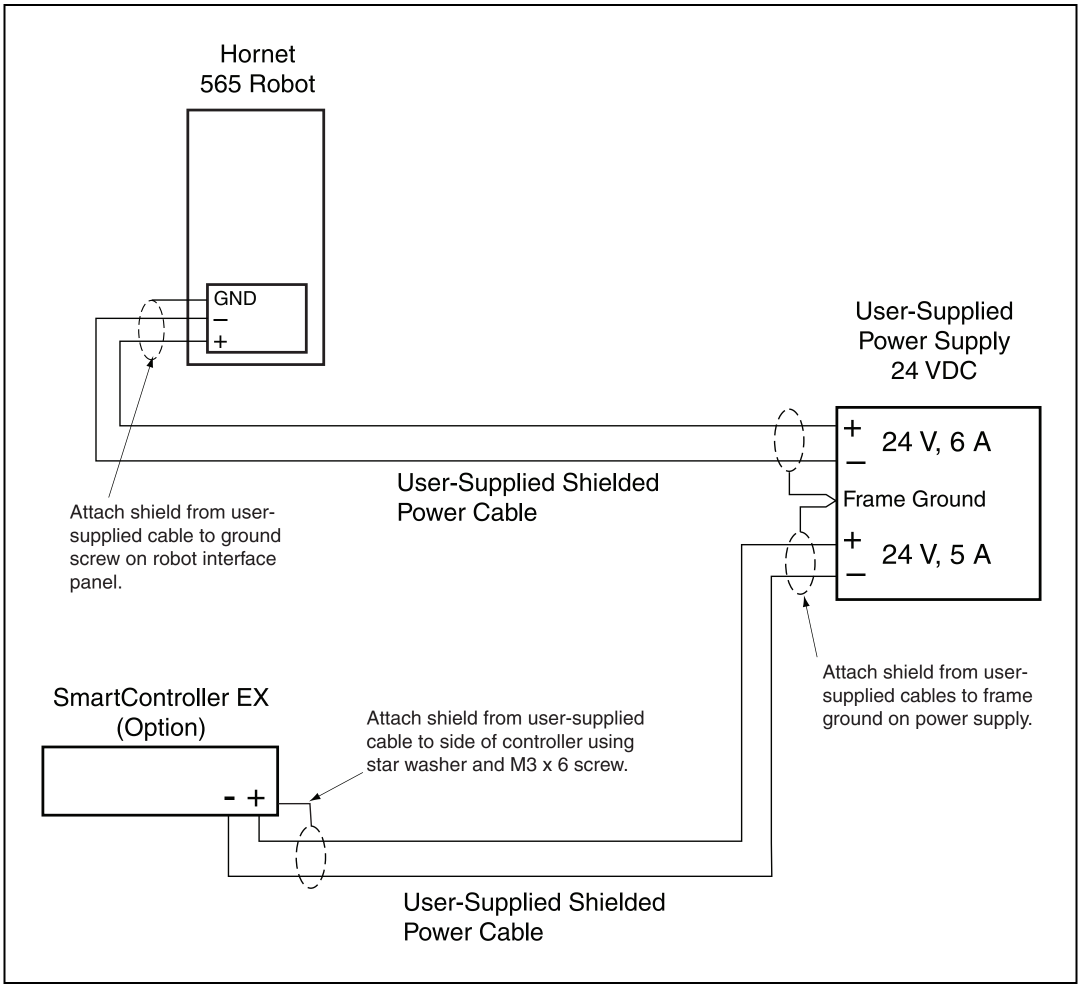
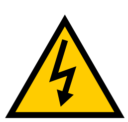


Figure 4-5. User-Supplied 24 VDC Cable

NOTE: We recommend that DC power be delivered over a shielded cable, with the shield connected to ground at both ends of the cable.

4.7 Connecting 200-240 VAC Power to Robot



WARNING: Appropriately-sized branch circuit protection and lockout/tagout capability must be provided in accordance with the National Electrical Code and any local codes.

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

Specifications for AC Power

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

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

NOTE: The Hornet 565 robot is intended to be installed as a piece of equipment in a permanently-installed system.

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

WARNING: Hornet 565 systems require an isolating transformer for connection to mains systems that are asymmetrical or use an isolated (impedant) neutral. Many parts of Europe use an impedant neutral.

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

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 robot must be protected 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, non-periodic overvoltage 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. Take the necessary steps to prevent damage to the robot system (for example, by interposing a transformer). See IEC 1131-4 for additional information.

AC Power Diagrams

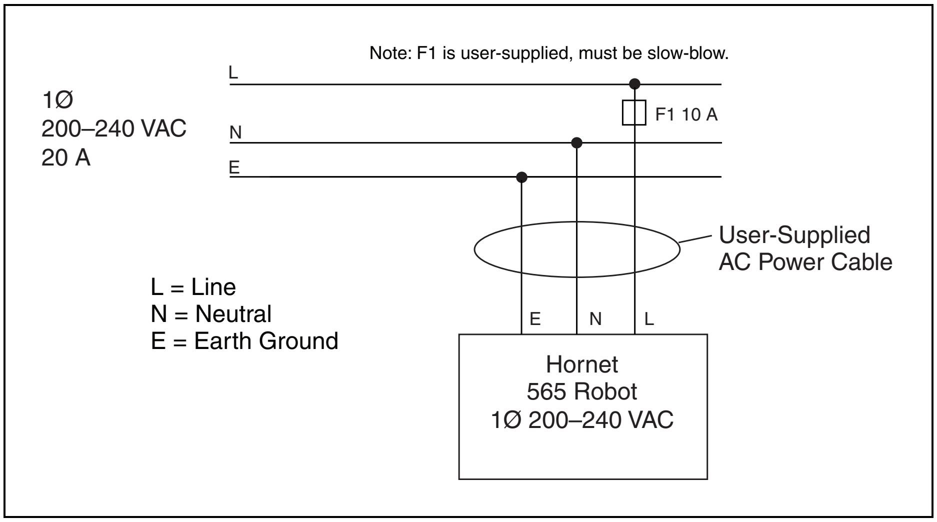


Figure 4-6. Typical AC Power Installation with Single-Phase Supply

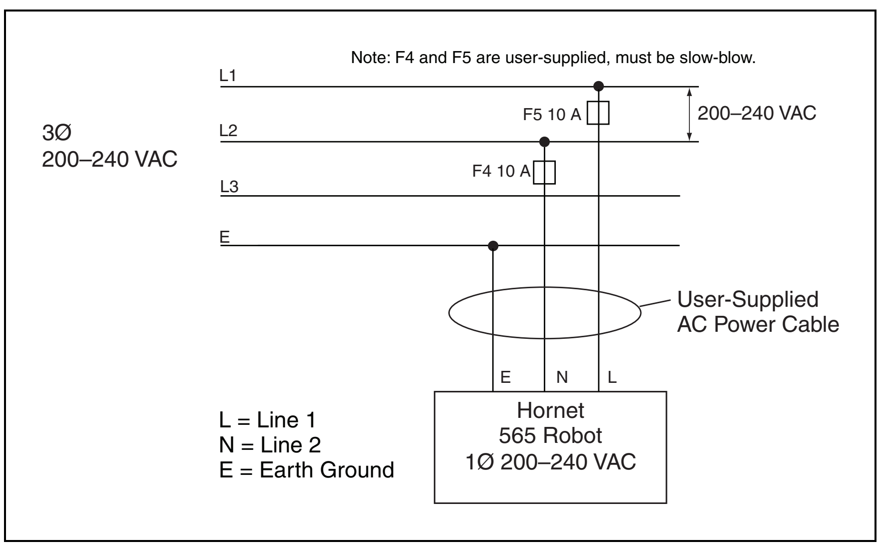
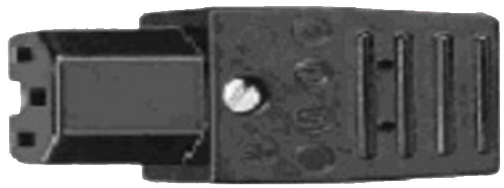


Figure 4-7. Single-Phase Load across L1 and L2 of a Three-Phase Supply

Details for AC Mating Connector

The AC mating connector is supplied with each system. It is shipped in the Robot Accessory Kit. The plug is internally labeled for the AC power connections (L, E, N).

Table 4-5. 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. However, it is available in the optional Power Cable kit. See List of Cables and Parts on page 36.

Procedure for Creating 200-240 VAC Cable

1. Locate the AC mating connector shown in AC Mating Connector Details on page 52.
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 53.
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 robot base.
5. Strip 18 to 24 mm 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. Reinstall the cover and tighten the screw to secure the connector.
10. Prepare the opposite end of the cable for connection to the facility AC power source.

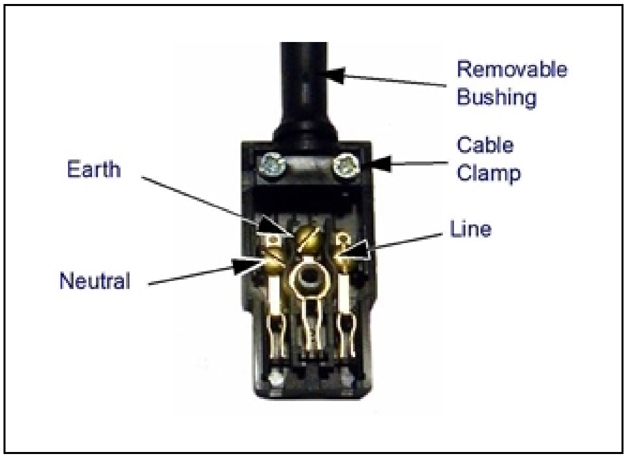


Figure 4-8. AC Power Mating Connector

Installing AC Power Cable to Robot

1. Connect the AC power cable to your facility AC power source.

   Do not turn on AC power at this time.

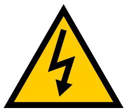
   See Typical AC Power Installation with Single-Phase Supply on page 51 and Single-Phase Load across L1 and L2 of a Three-Phase Supply on page 51.
2. Plug the AC connector into the AC power connector on the interface panel on the robot.
3. Secure the AC connector with the locking latch.

4.8 Grounding the Hornet 565

Proper grounding is essential for safe and reliable robot operation.

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

Grounding Robot-Mounted Equipment



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.

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

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

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

The eAIB is grounded to the robot base through a conductive gasket.

- Ground the end-effector to the robot base.

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

Grounding Robot Base to Frame

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

- Use any of the three M12 mounting screws for this connection.

  Each of the mounting points is labeled as a ground:

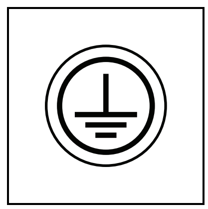


Figure 4-9. Ground Label

  Screws must be stainless or zinc-plated steel.

- Use an external-tooth star washer, touching the mounting screw head.

  Washers must be stainless or zinc-plated steel.

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

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

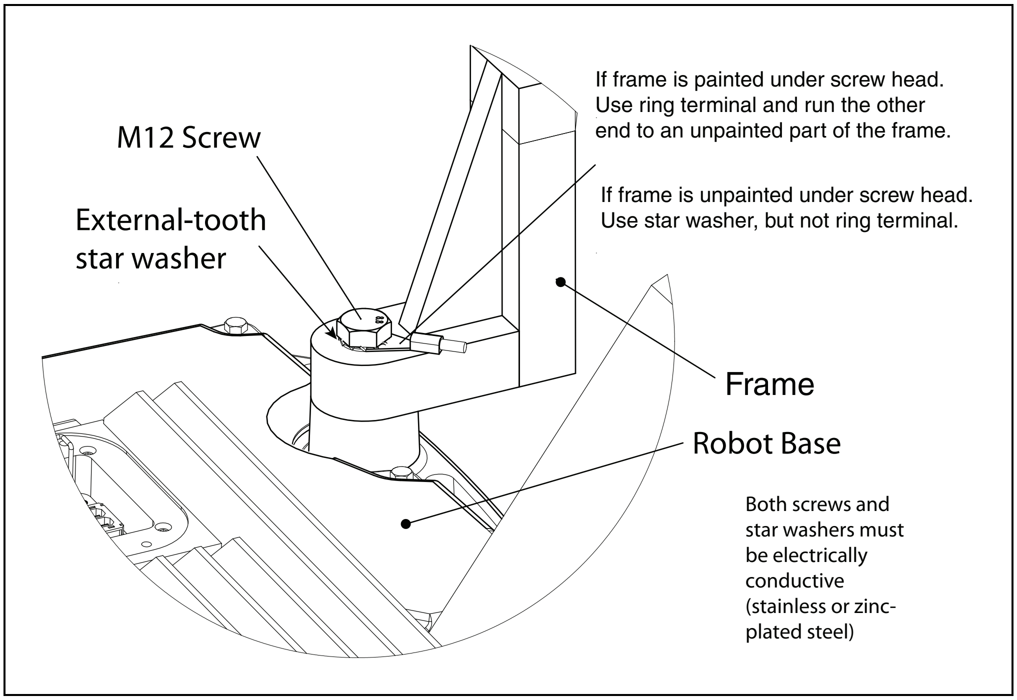


Figure 4-10. Any of the Three M12 Mounting Screws can be used for Grounding.

4.9 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.

Refer to the *SmartController EX User's Guide* for information on connecting safety equipment into the system through the XUSR connector on the optional SmartController, details on Emergency Stop Circuits, and diagrams on recommended E-Stop configurations.

The user-supplied safety and power-control equipment connects to the system through the XUSR and XFP connectors, either on the eAIB XSYSTEM cable or the optional SmartController EX. 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 Table 4-7. for the XFP pin-out descriptions. See the figure E-Stop Circuit on XUSR and XFP Connectors on page 59 for the XUSR wiring diagram.

Table 4-6. Contacts Provided by the XUSR Connector

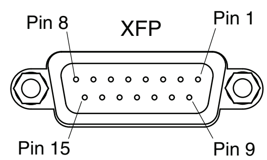
Pin Pairs	Description	Comments
Voltage-Free Contacts Provided by Customer		
1, 14	User E-Stop CH 1 (mushroom push-button, safety gates, etc.)	N/C contacts, Shorted if NOT Used
2, 15	User E-Stop CH 2 (same as pins	N/C contacts, Shorted if NOT Used

Pin Pairs	Description	Comments
	1, 14)	
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 the Hornet 565 System		
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)	
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 4-7. 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	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 oper-

Pin Pairs	Description	Requirements for User-Supplied Front Panel
		ate 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 60 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 factory Front Panel. If you provide a substitute front panel, this could void UL compliance.

Table 4-8. 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 System Installation on page 35 for a description of the functionality of this circuit.

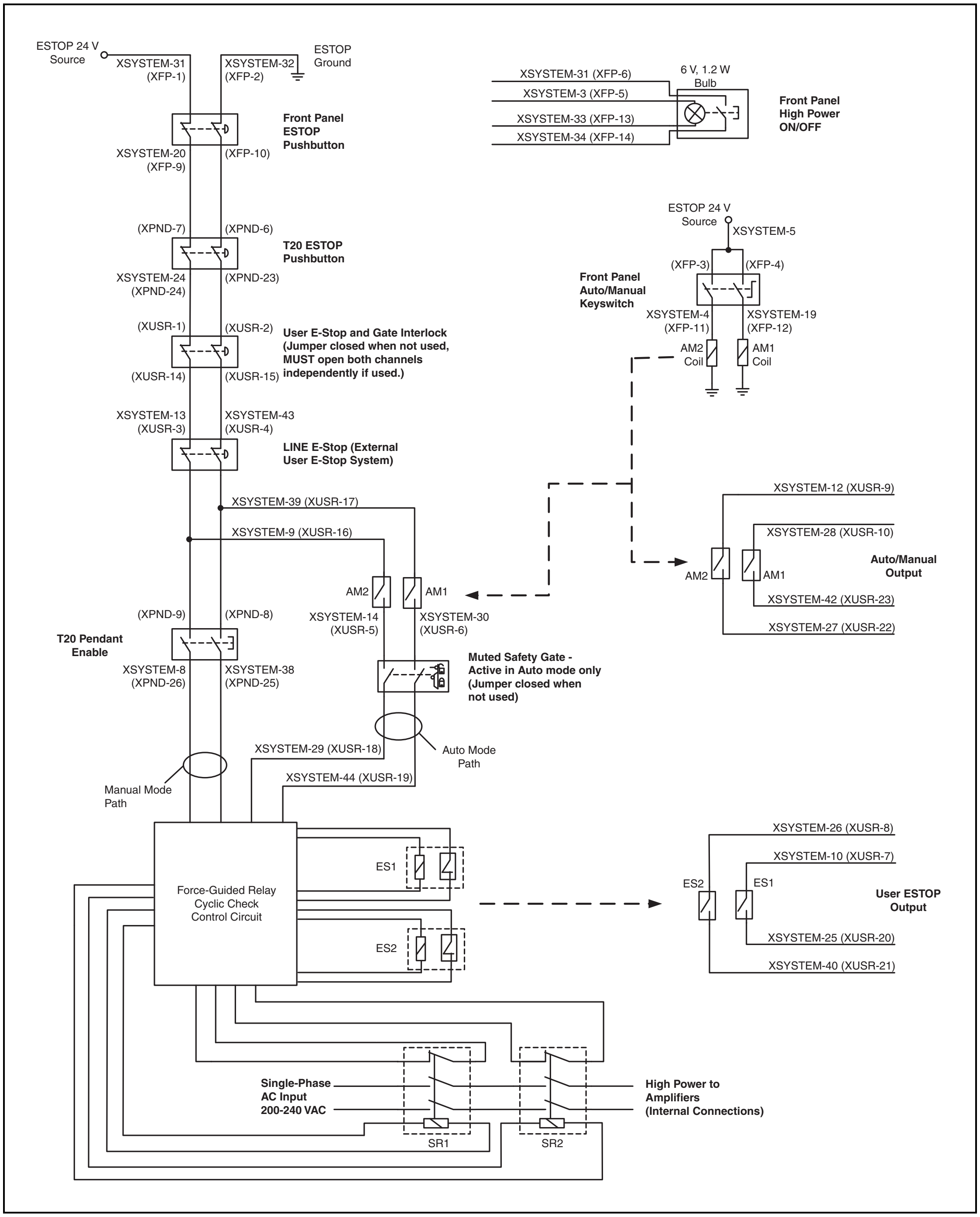


Figure 4-11. E-Stop Circuit on XUSR and XFP Connectors

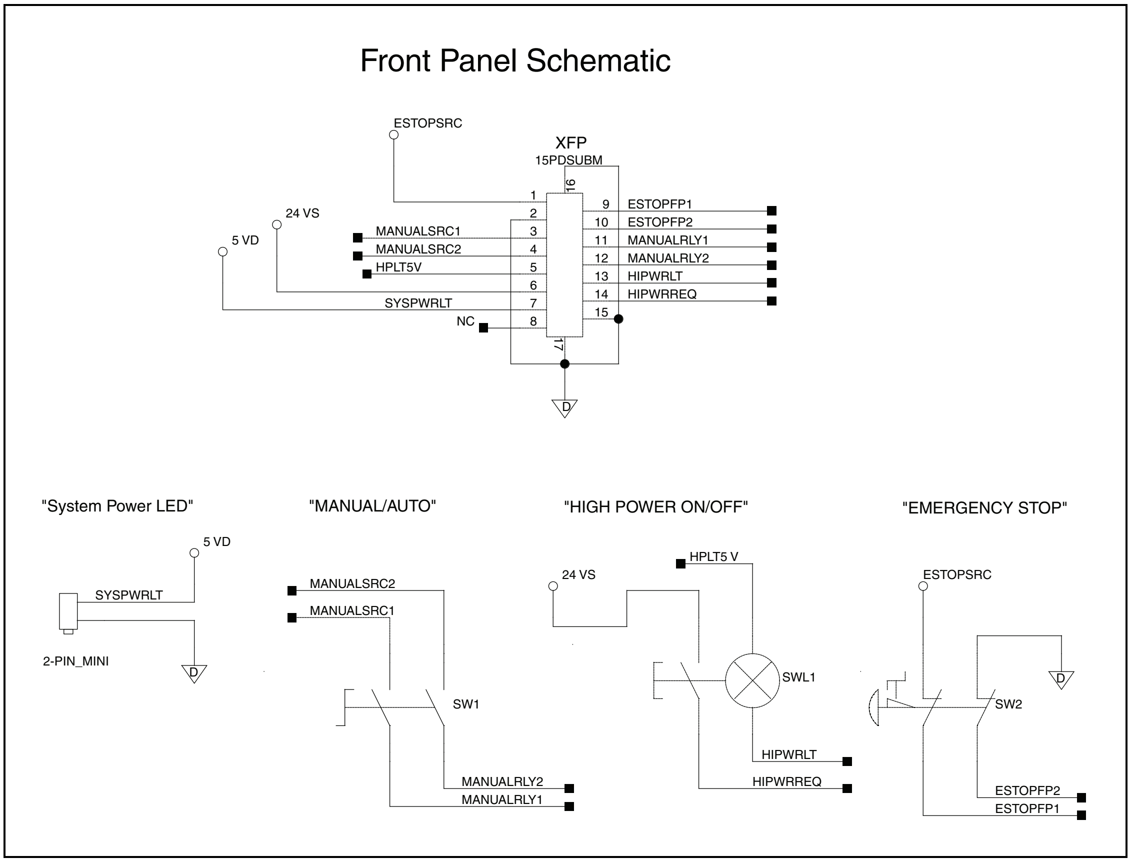


Figure 4-12. Front Panel Schematic

Emergency Stop Circuits

The eAIB 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 4-11.

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 Customer Service 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 EN ISO 13849 operation (see Figure 4-11. and the table System Installation on page 35 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 59 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 the section System Installation on page 35).

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.

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

Remote Manual Mode

The optional Front Panel provides for a Manual Mode circuit. See Remote High Power On/Off Control on page 62 for further details about the customer Remote Manual Mode circuitry.

The Front Panel, or a 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 60. 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, or the user-supplied 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 standard Front Panel, or the user-supplied 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 must 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 System Installation on page 35), 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 an optional 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 60) 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 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 Front Panel High-Power Indicator Lamp on page 115 for information on changing this lamp.

Remote Front Panel or User-Supplied Control Panel Usage

Users can mount the optional 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 60 for a schematic drawing of the Front Panel, and see the table System Installation on page 35 for a summary of connections and pin numbers.

> **NOTE:** The system was evaluated by Underwriters Laboratory with a factory-supplied 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 optional 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 5: System Operation

5.1 Robot Status Display Panel

The robot Status Display panel is located on the side of the robot base.

The combined status LED/high-power lamp and the brake-release button are on the underside of the robot base.

The Status Display and LED blinking pattern indicate the status of the robot.

Figure 5-1. Robot Status Display Panel

Table 5-1. Robot Status LED Definition

LED Status	2-Digit Status Panel Display	Description
Off	No display	24 VDC not present
Off	**OK**	High Power Disabled
Amber, Solid	**ON**	High Power Enabled
Amber, Solid	Fault Code(s)	Fault, see Status Display[1]
Amber, Slow Blink	**OK**	Selected Configuration Node
Amber, Fast Blink	Fault Code(s)	Fault, see Status Display[1]
[1]See Status Panel Fault Codes on page 66.		

5.2 Status Panel Fault Codes

The Status Display, shown in Robot Status Display Panel on page 65, displays alpha-numeric codes that indicate the operating status of the robot, including fault codes. The following table gives definitions of the fault codes. These codes provide details for quickly isolating problems during troubleshooting.

The displayed fault code will continue to be displayed even after the fault is corrected or additional faults are recorded. All displayed faults are cleared from the display, and reset to a no-fault condition, upon successfully enabling high power to the robot, or power cycling the 24 V supply to the robot.

Table 5-2. 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 #)		

See Major Robot Components on page 9 for Joint # locations.

5.3 Using the Brake-Release Button

Robot Brakes

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

This braking system does not prevent you from moving the robot manually, once the robot has stopped (and high power has been disabled).

In addition, the three inner-arm motors have electromechanical brakes, which are released when high power is enabled. When high power is disabled, the brakes engage and hold the position of the platform fixed.

Brake-Release Button

Under some circumstances, you may want to manually position the platform without enabling high power. For such instances, a Brake-Release button is located on the underside of the robot base. When system power is ON, pressing this button releases the brakes, which allows movement of the arms.

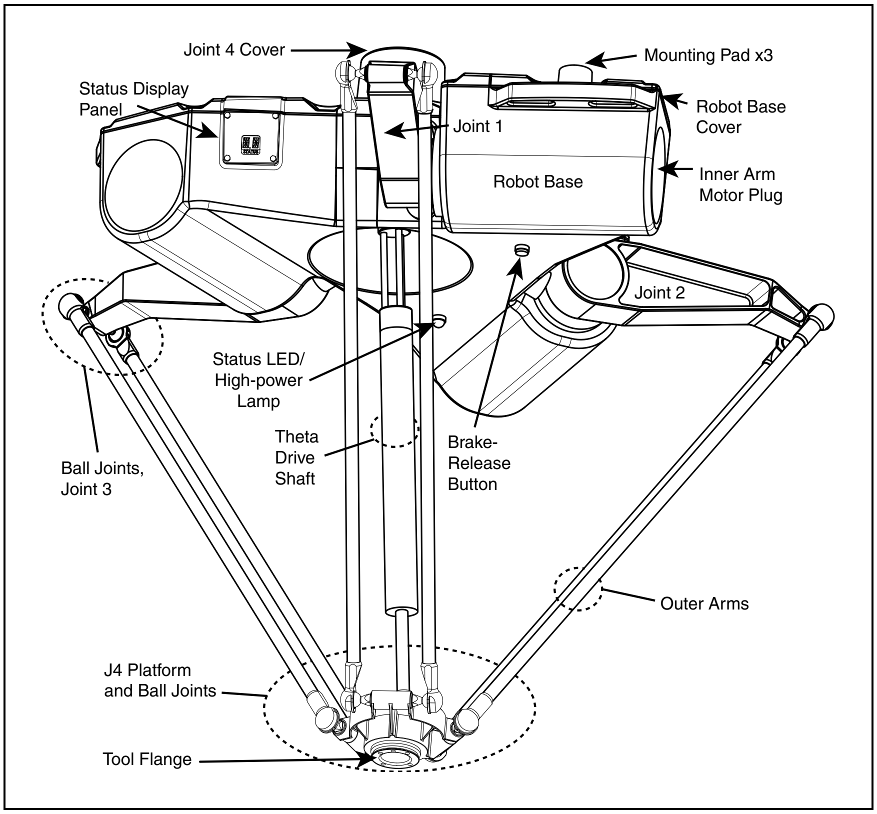


Figure 5-2. Brake Release and LED Light

If this button is pressed while high power is ON, high power automatically shuts down.

NOTE: 24 Volt robot power must be ON to release the brakes.

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

Remote Brake Release Feature

You can also configure the XIO Input 6.2 (pin 18) to act as an alternate hardware brake release input. The setting is available on the Robot page in the ACE software. The parameter is Remote Brake Release Input. When enabled (True), activating XIO Input 6.2 is identical to pressing the physical brake release button on the robot base. The input status will still reflect in the IO register.

If an alternate (user-supplied) brake release button is used, ensure that the brake release button displays a warning similar to the preceding WARNING. This is to comply with ISO 10218-1, Clause 5.13.

5.4 Optional 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).

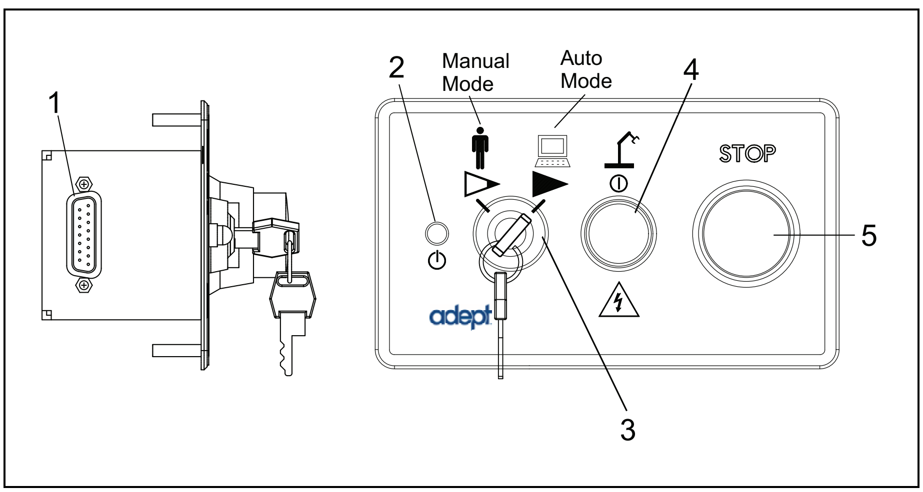


Figure 5-3. Front Panel

1. **XFP cable**
   With a SmartController EX: Connects to the XFP connector on the SmartController.

   Without a SmartController EX, connects to the XFP branch of the eAIB XSYSTEM cable.
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 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 the optional 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.

   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.

   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.

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: A Front Panel or equivalent circuits must be installed to be able to Enable Power to the robot. To operate without the standard Front Panel, the user must supply the equivalent circuits.

5.5 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.

I/O on the eAIB

Table 5-3. Digital I/O Connection Options

Product	**I/O Capacity**	**For more details**
XIO Connector on eAIB	12 inputs 8 outputs	see Using Digital I/O on eAIB XIO Connector on page 72
IO Blox, using optional eAIB XBELT IO Adapter Cable	12 inputs 8 outputs	*IO Blox User's Guide*

I/O with an Optional SmartController EX

Table 5-4. More Digital I/O Connection Options

Product	I/O Capacity	For more details
XDIO Connector on optional SmartController EX	12 inputs 8 outputs	see the *SmartController EX User's Guide*
Optional sDIO Module, connects to SmartController EX	32 inputs, 32 outputs per module; up to four sDIO per system	see the *SmartController EX User's Guide*

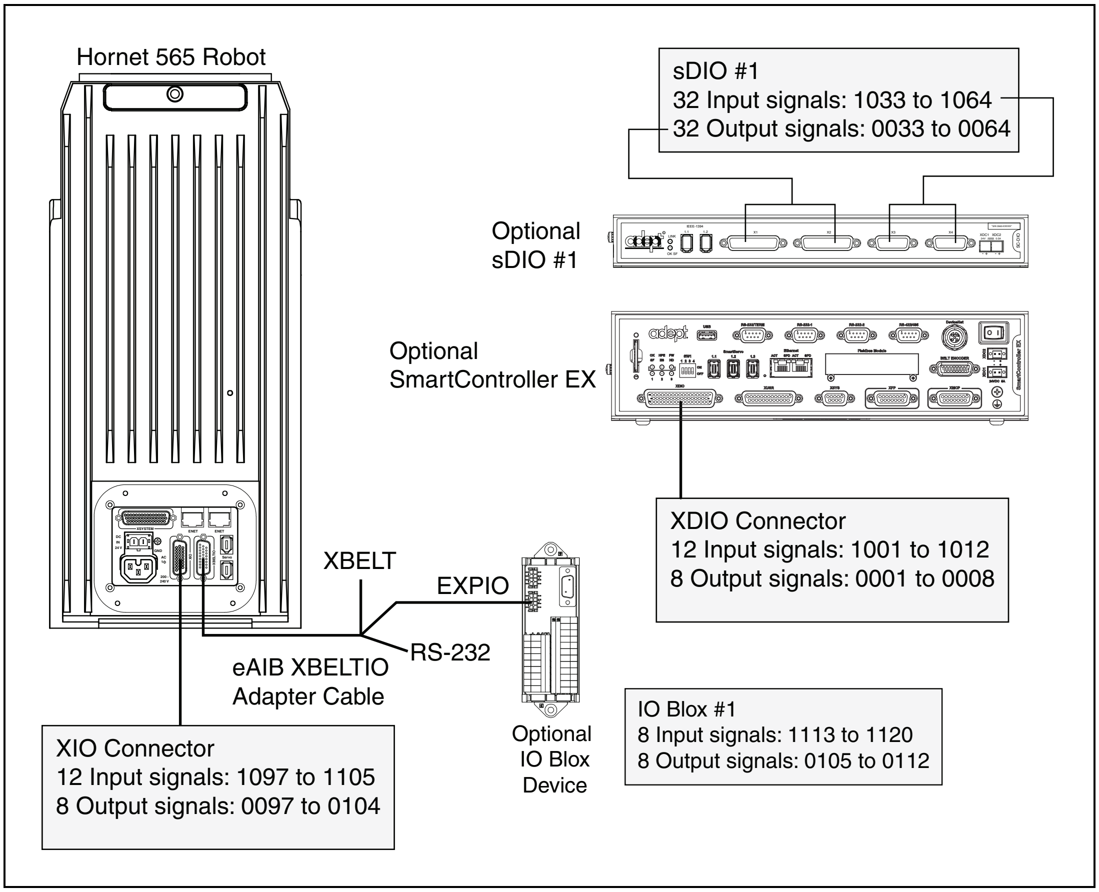


Figure 5-4. Connecting Digital I/O to the System

Table 5-5. Default Digital I/O Signal Configuration, Single Robot System

Location	Type	Signal Range
Controller XDIO connector	Inputs	1001 - 1012
	Outputs	0001 - 0008
sDIO Module	Inputs	1033 - 1064
	Outputs	0033 - 0064
sDIO Module 2	Inputs	1065 - 1096
	Outputs	0065 - 0096
Robot 1 XIO connector	Inputs	1097 - 1108
	Outputs	0097 - 0104

For Dual Robot systems, see the *Dual-Robot Configuration Procedure*.

5.6 Using Digital I/O on eAIB XIO Connector

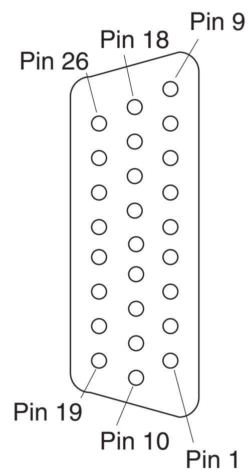
The XIO connector on the robot interface panel offers access to digital I/O, 12 inputs and 8 outputs. These signals can be used by eV+ to perform various functions in the workcell.

See the following table for the XIO signal designations.

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

Brake Release and LED Light

Table 5-6. XIO Signal Designations, Inputs

<table>
<tr><th>Pin No.</th><th>Designation</th><th>Signal Bank</th><th>eV+ Signal Number</th><th>Pin Locations</th></tr>
<tr><td>1</td><td>GND</td><td></td><td></td><td rowspan="18">

XIO 26-pin female connector on Robot Interface Panel</td></tr>
<tr><td>2</td><td>24 VDC</td><td></td><td></td></tr>
<tr><td>3</td><td>Common 1</td><td>1</td><td></td></tr>
<tr><td>4</td><td>Input 1.1</td><td>1</td><td>1097</td></tr>
<tr><td>5</td><td>Input 2.1</td><td>1</td><td>1098</td></tr>
<tr><td>6</td><td>Input 3.1</td><td>1</td><td>1099</td></tr>
<tr><td>7</td><td>Input 4.1</td><td>1</td><td>1100</td></tr>
<tr><td>8</td><td>Input 5.1</td><td>1</td><td>1101</td></tr>
<tr><td>9</td><td>Input 6.1</td><td>1</td><td>1102</td></tr>
<tr><td>10</td><td>GND</td><td></td><td></td></tr>
<tr><td>11</td><td>24 VDC</td><td></td><td></td></tr>
<tr><td>12</td><td>Common 2</td><td>2</td><td></td></tr>
<tr><td>13</td><td>Input 1.2</td><td>2</td><td>1103</td></tr>
<tr><td>14</td><td>Input 2.2</td><td>2</td><td>1104</td></tr>
<tr><td>15</td><td>Input 3.2</td><td>2</td><td>1105</td></tr>
<tr><td>16</td><td>Input 4.2</td><td>2</td><td>1106</td></tr>
<tr><td>17</td><td>Input 5.2</td><td>2</td><td>1107</td></tr>
<tr><td>18</td><td>Input 6.2</td><td>2</td><td>1108</td></tr>
</table>

Table 5-7. XIO Signal Designations, Outputs

Pin No.	Designation	Signal Bank	eV+ Signal Number	Pin Locations
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	

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 78 for information. This cable is not compatible with the XIO Termination Block.
- **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 6. Each bank is electrically isolated from the other bank and is optically isolated from the robot's ground. The 6 inputs within each bank share a common source/sink line.

The inputs are accessed through direct connection to the XIO connector (see Table 5-6.), or through the optional XIO Termination Block. See the documentation supplied with the Termination Block for details.

For REACTI programming, high-speed interrupts, or vision triggers:

- With a SmartController EX, you can only use the EX XDIO inputs.
- With a Hornet robot without a SmartController EX, you can only use the XIO inputs.

See the *eV+ Language User's Guide* for information on digital I/O programming.

XIO Input Specifications

Table 5-8. XIO Input Specifications

Operational voltage range	0 to 30 VDC
OFF state voltage range	0 to 3 VDC
ON state voltage range	10 to 30 VDC
Typical threshold voltage	V_{in} = 8 VDC
Operational current range	0 to 7.5 mA
OFF state current range	0 to 0.5 mA
ON state current range	2.5 to 7.5 mA
Typical threshold current	2.0 mA
Impedance (V_{in}/I_{in})	3.9 KΩ minimum
Current at V_{in} = +24 VDC	$I_{in} \leq$ 6 mA
Turn-on response time (hardware) 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

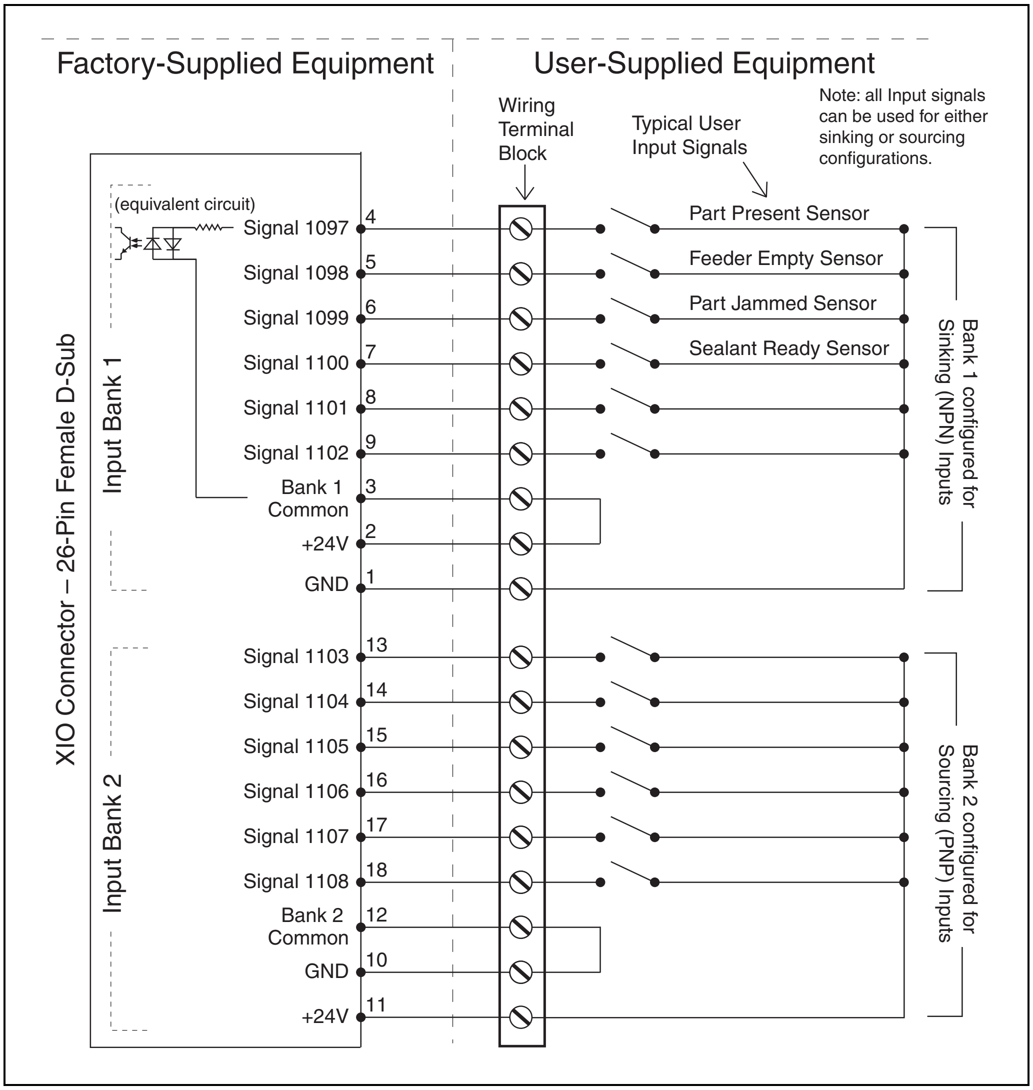


Figure 5-5. Typical User Wiring for XIO Input Signals

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 a direct connection to the XIO connector (see XIO Signal Designations, Inputs on page 73), or through the optional XIO Termination Block. See the documentation supplied with the Termination Block for details.

XIO Output Specifications

Table 5-9. XIO Output Circuit Specifications

Parameter	Value
Power supply voltage range	See System Installation on page 35.
Operational current range, per channel	$I_{out} \leq$ 700 mA
Total Current Limitation, all channels on	$I_{total} \leq$ 1.0 A @ 40° 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

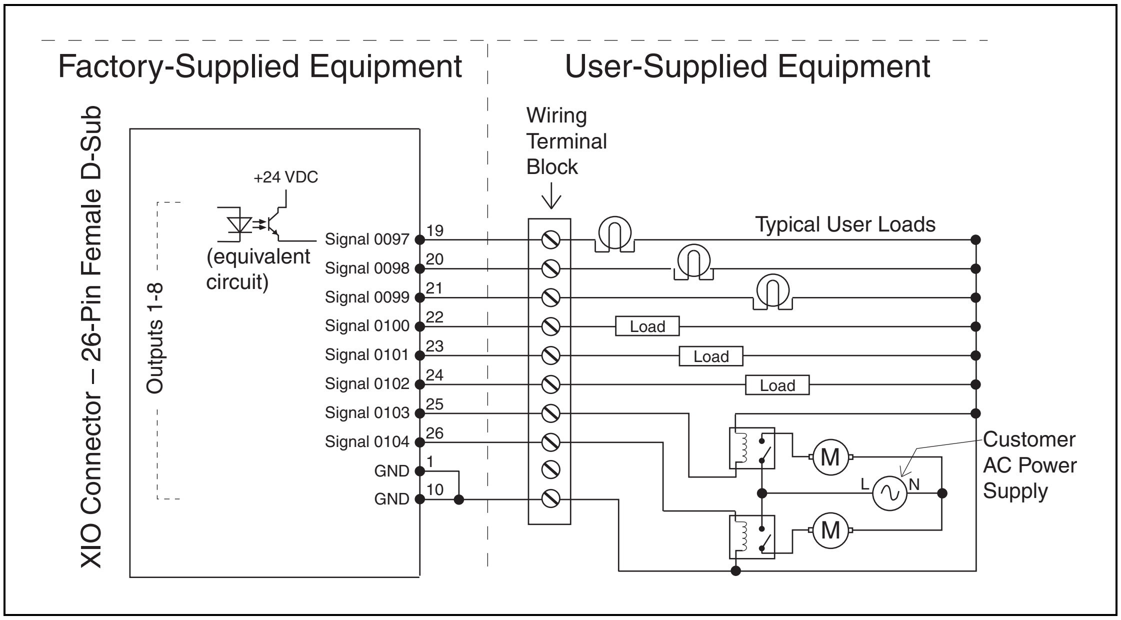


Figure 5-6. Typical User Wiring for XIO Output Signals

XIO Breakout Cable

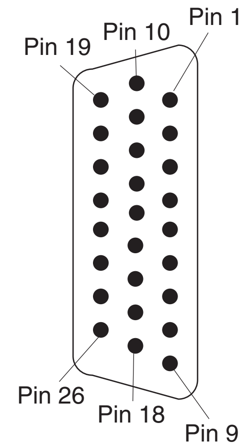
The XIO Breakout cable is available as an option—see the following figure. This cable connects to the XIO connector on the eAIB, and provides flying leads on the user's end, for connecting input and output signals in the workcell. The cable length is 5 M (16.4 ft).

See the following table for the cable wire chart.

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

Figure 5-7. Optional XIO Breakout Cable

Table 5-10. XIO Breakout Cable Wire Chart

Pin No.	Signal Designation	Wire Color	Pin Locations
1	GND	White	 **26-pin male connector on XIO Breakout Cable**
2	24 VDC	White/Black	
3	Common 1	Red	
4	Input 1.1	Red/Black	
5	Input 2.1	Yellow	
6	Input 3.1	Yellow/Black	
7	Input 4.1	Green	
8	Input 5.1	Green/Black	
9	Input 6.1	Blue	
10	GND	Blue/White	
11	24 VDC	Brown	
12	Common 2	Brown/White	
13	Input 1.2	Orange	
14	Input 2.2	Orange/Black	
15	Input 3.2	Grey	
16	Input 4.2	Grey/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	

5.7 Starting the System for the First Time

Follow the steps in this section to safely bring up your robot system. The tasks include:

- Verifying installation, to confirm that all tasks have been performed correctly
- Starting up the system by turning on power for the first time
- Verifying that all E-Stops in the system function correctly
- Moving the robot with the pendant (if purchased), to confirm that it moves correctly

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, perform 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 level and that all fasteners are properly installed and tightened.
- Verify that any platform tooling is properly installed.
- Verify that the platform has been aligned with the J4 motor (J4 version only).
- Verify that all peripheral equipment is properly installed such that 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.

- Front Panel to the XSYSTEM on the eAIB, or

  XFP port on a SmartController EX.
- Pendant to the XSYSTEM on the eAIB, or

  XMCP port on a SmartController EX, or a loop-back dongle installed.
- XUSR to the XSYSTEM on the eAIB, or

  XUSR port on a SmartController EX,

  or XUSR jumper installed.
- User-supplied 200/240 VAC power to the robot 200/240 VAC connector.

- User-supplied 24 VDC power to the robot 24 VDC connector.
- Ethernet cable from PLC (if used) to eAIB or SmartController EX (if used)

If you are using an optional SmartController EX:

- User-supplied 24 VDC power connected to the SmartController.
- User-supplied ground wire installed between the SmartController and ground.
- One end of the IEEE 1394 cable installed into a SmartServo port on the SmartController EX, and the other end installed into a SmartServo port on the robot interface panel.
- eAIB XSYS (eAIB) cable between the robot interface panel XSYSTEM connector and XSYS connector on the SmartController EX, and the latching screws tightened.

  See System Installation on page 35.
- Ethernet cable from PLC (if used) to SmartController EX.

User-Supplied Safety Equipment Checks

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

Turning on Power and Starting ACE

After the system installation has been verified, you are ready to turn on AC and DC power to the system and start up ACE.

1. Turn on the 200-240 VAC power. See System Installation on page 35.

   WARNING: Make sure personnel are skilled and instructed—refer to the *Robot Safety Guide*.

2. Turn on the 24 VDC power to the robot. See System Installation on page 35. The Status Panel displays OK. The Robot Status LED will be off.
3. If you have a standard Front Panel, verify the Auto/Manual switch on the Front Panel is set to Auto Mode.
4. Turn on the user-supplied 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 <major>.<minor>
5. On the ACE Getting Started screen:
   - Select Create New Workspace for Selected Controller to make the connection to the controller.
   - Select the IP address of the controller you wish to connect to, or manually type in the IP address.
6. Click OK. You will see the message “Working, please wait”.

Enabling High Power

NOTE: If you are controlling the robot with a PLC, see Options on page 85.

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.

   The optional Front Panel is shown in Optional Front Panel on page 68. (If the button stops blinking, you must Enable Power again.)

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.

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

- The Robot Status LED glows amber.
- The code on the Robot Diagnostic Panel displays ON (see Robot Status Display Panel on page 65).

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 for each.

Aligning the Platform and J4 Motor

It is possible for either the motor shaft or the platform shaft to be turned, manually, before the theta drive shaft is connected to both. If not detected, the software may assume the robot's tool flange is at a different angle than it really is. To ensure that the software knows the actual rotation of the tool flange with respect to the J4 motor, you need to use the ACE software to establish this alignment.

1. Within the ACE software, open the Hornet565 robot object.
2. In the Configure tab, click Adjust J4 Zero.

   This will launch a utility for aligning the theta drive shaft.
3. Follow the instructions in the utility.

Contact Omron Adept Technologies, Inc. for more information on this procedure.

NOTE: Once the theta drive shaft is installed, the J4 motor and the tool flange will always rotate together, so the software will know the orientation of the tool flange.

Verify Robot Motions

Use the pendant (if purchased) to verify that the robot moves correctly. Refer to the *T20 Pendant User's Guide* for complete instructions on using the pendant.

The Hornet 565 is a parallel-arm robot and, as such, individual joint motions are not allowed. If you attempt to move a joint in Joint mode, you will get an error message:

JOINT <n> OUT OF RANGE

where <n> is the joint that you attempted to move. Joints are identified in Major Robot Components on page 9.

- If one joint must be moved separately, release the brakes (while supporting the platform) and move the joint manually.
- 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*.

Verify that the Teach Restrict speed limitation is working correctly by running the Teach Restrict verification procedure. Refer to the Teach Restrict Verification Utility on page 128.

5.8 Robot Motions

Straight-line Motion

Joint-interpolated motion is not possible with the Hornet 565, because the positions of all the joints must always be coordinated in order to maintain the connections to the moving platform. Therefore, for the Hornet 565, the eV+ system automatically performs a straight-line motion when a joint-interpolated motion instruction is encountered.

Containment Obstacles

The work space of the robot is defined by an inclusion obstacle. This is done because, unlike other robots, joint limits are not meaningful in defining the work space. The eV+ software defines a cone-like shape as a containment obstacle. This is actually the work envelope. See Work Envelope, Side View on page 132 and Technical Specifications on page 131. Other obstacles can be defined within this obstacle.

5.9 Learning to Program the Hornet 565

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.

Chapter 6: Options

This section covers options that are available to enhance the Hornet 565. The options available are:

- Tall Frame Mounting Adapters

  For mounting the Hornet 565 in a taller (competitor's) frame.

- ePLC Connect

  For using a user-supplied PLC to program the robot's motions.

- SmartVision MX industrial PC

  To add vision-processing power and connectivity to the robot.

- SmartController EX motion controller

  To increase connectivity, I/O, conveyor tracking and general processing speed for the Hornet 565.

- sDIO Module

  Add 32 inputs and 32 outputs, up to 4 sDIO modules per system.

- IO Blox I/O Devices

  Add 8 inputs and 8 outputs, up to 4 IO Blox devices per system.

- eAIB XBELT IO Adapter cable

  Splits the EXPIO port into a belt encoder lead, a RS-232 lead, and a lead for either IO Blox or an Intelligent Force Sense System.

- Inlet Cable Box

  To increase the overall robot's IP rating to IP65.

- Intelligent Force Sense System

  Allows quick detection of forces in six dimensions at the gripper.

- Ball Stud Locks

  To ensure that ball joints do not separate under extreme use.

6.1 Tall Frame Adapters

The Hornet 565 can be mounted in a tall frame, previously used for a competitive parallel robot, by installing a set of three frame adapters.

The frame adapters lower the height of the robot by 118 mm (4.65 in.).

The lengths of the three mounting bolts will need to be increased by 118 mm.

6.2 ePLC Connect

The Hornet 565 can use a user-supplied PLC, with the ePLC Connect software, to control the robot motions.

Refer to *ePLC Connect 3 User's Guide*.

Hornet 565s that use a PLC, but do not use a SmartController EX, rely on the user-supplied PLC for all digital I/O.

Configuration

The user-supplied PLC and Hornet 565 are connected either through a shared network or via a user-supplied Ethernet cable.

When the robot is powered on and waiting for a PLC connection, the robot status panel will display its IP address, two digits at a time.

The format will be:

IP xxx-xxx-xxx-xxx OK

> **NOTE**: If you can use the robot's default IP address, then you can skip the ACE software installation completely.

Setting the Robot IP Address

Configure the IP address of the Hornet 565 using ACE software.

1. Connect the PC and the robot, either through a shared network or with an Ethernet cable between them.
2. Start the ACE software. Refer to ACE Software on page 45.
3. Click the Detect and Configure button, circled in red in the following figure.

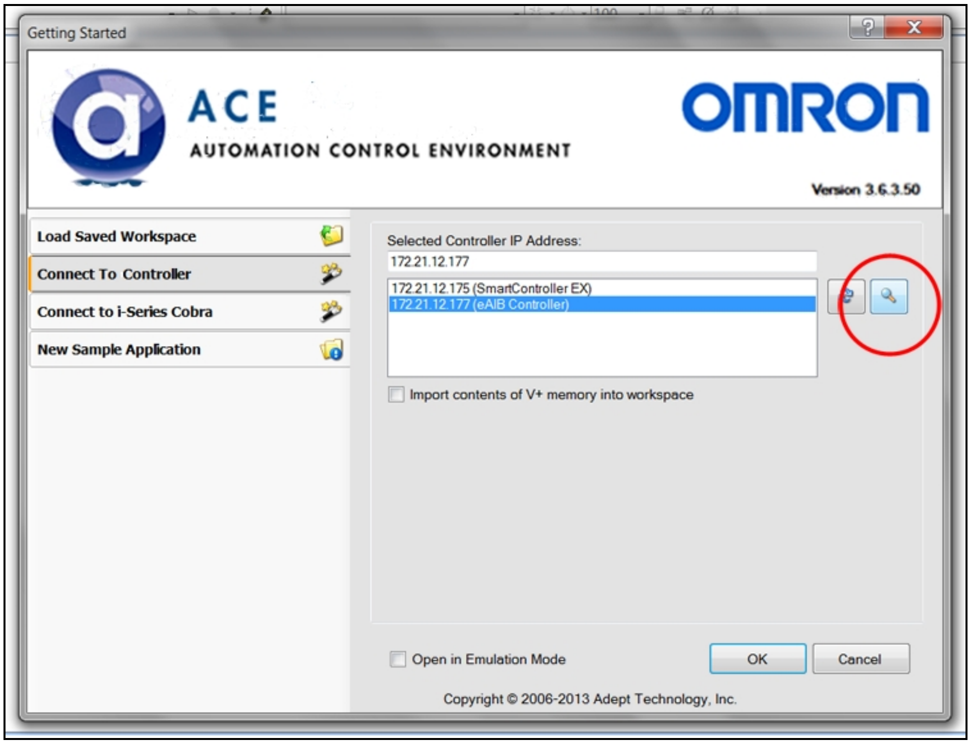


Figure 6-1. Detect and Configure Button

The IP address detection and configuration window will open. The ACE software will show the IP address of any controllers it detects. See the following figure.

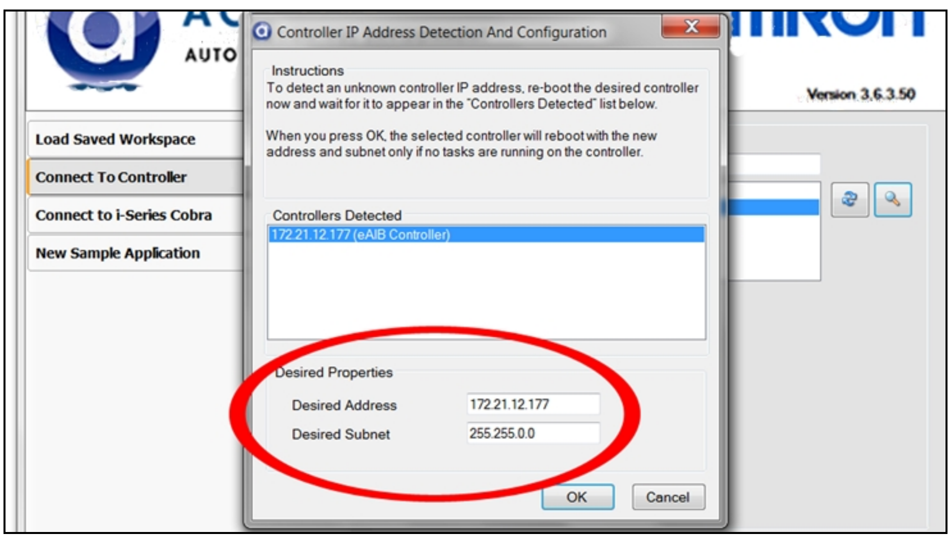


Figure 6-2. IP Addresses Detected

4. You can change the IP address and subnet mask in the Desired Address and Desired Subnet fields, if needed.
5. Click OK. The ACE software will ask you to wait for the controller to reboot.

Configuring the Omron PLC

Refer to the EtherNet/IP Connection Guide (P649-E1-01) for configuring the Omron PLC to work with Omron Adept robots. Refer to Resources on Omron Web Sites on page 3.

Using your PLC software, set the IP address for the PLC to connect to on the robot.

Enabling High Power

The details of enabling high power to the robot are covered in the EtherNet/IP Connection Guide (P649-E1-01).

Once high power is enabled, the Robot Status Panel displays ON, and the amber Robot Status LED is on.

6.3 SmartVision MX Industrial PC

The SmartVision MX is a Windows® 7 Embedded industrial PC designed to run the ACE software. It is compatible with the Hornet 565, with or without the SmartController EX motion controller.

For inspection applications, the SmartVision MX industrial PC is designed to be a "plug-and-play" vision system. Using a USB or GigE camera, along with the ACE Sight PC-based vision software, the unit is a complete industrial vision solution, providing expanded vision processing power for vision-guided robotics or inspection.

Refer to *SmartVision MX User's Guide*.

6.4 SmartController EX Motion Controller

The optional SmartController EX motion controller supports tracking more conveyors than an eAIB alone, as well as other options. Like the eAIB, the SmartController EX uses the eV+ operating system. It offers scalability and support for IEEE 1394-based digital I/O and general motion expansion modules. The SmartController EX also includes Fast Ethernet and DeviceNet.

Refer to *SmartController EX User's Guide*.

6.5 sDIO Module

Adds 32 inputs and 32 outputs to the system. This requires the optional SmartController EX motion controller. Up to 4 sDIO modules can be added to a system.

6.6 IO Blox I/O Device

Adds 8 inputs and 8 outputs per device. Up to 4 devices can be used. Requires the eAIB XBELT IO Adapter cable.

6.7 eAIB XBELT IO Adapter Cable

Splits the EXPIO port into a belt encoder lead, one RS-232 lead, and one lead for either IO Blox or Intelligent Force Sense System.

The belt encoder lead can be split into two belt encoder leads with the belt encoder Y-adapter. See System Cable Diagram with Belt Encoder Cables on page 42.

6.8 Cable Inlet Box

The addition of the cable inlet box raises the entire robot's IP rating to IP65.

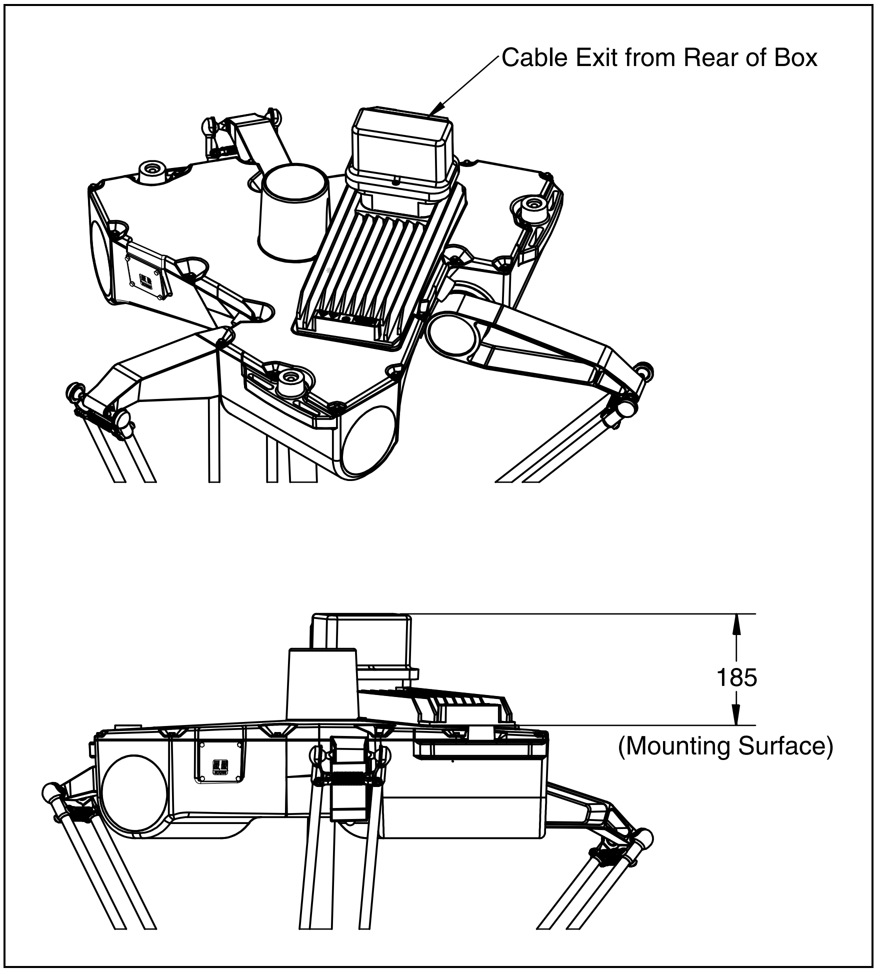


Figure 6-3. Cable Inlet Box Mounted on a Hornet 565

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

Overview

The cable seal assembly must be mounted on the top of the robot during the robot installation process. The cable seal assembly is an extra-cost option, and is shipped separately from the robot.

Components

- Cable harness
- eAIB Cable Seal Housing, 2 gaskets, 4 screws (Cable Seal Housing (left), Installed (right) on page 91)
- Cable Entry Top Cover assembly, screw (Cable Entry Top Cover Assembly on page 91)

  This includes the Roxtec CF 8 frame
- 4 x 2-hole Roxtec modules

  These are dense foam blocks surrounding pre-cut half-sleeves that can be peeled away to match the diameter of the cable to be sealed. See Adapting a Module to the Cable Size, Checking the Gap on page 92.
- Roxtec grease, used to assemble and seal the modules (Greasing a Roxtec Module on page 92).

NOTE: The Roxtec CF 8 consists of a frame and integrated compression unit (a wedge and bolt that compress the modules once they are assembled inside the CF frame). See Cable Entry Top Cover Assembly on page 91.

Tasks

Measure and mark cables to establish service length.

1. Install eAIB cable inlet box.
2. Adapt Roxtec modules to fit cables.
3. Install cables through cable entry top cover assembly.
4. Attach cables to eAIB.
5. Attach cable entry top cover to eAIB cable inlet box.

Installation Procedure

1. Measure and mark all eAIB cables at 10 - 12 in. from the cable ends.
   This amount of slack is needed to install the seal assembly after the connections are made to the eAIB. See Cable Entry Assembly with Cables on page 94.
2. Install the cable seal housing on the top of the eAIB using four M4 x 50 screws, four M4 lock washers, and four M4 flat washers. Note that the centered M6-threaded hole must be toward the center of the robot base. See the following figure, right photograph. Ensure that the gasket is seated between the eAIB surface and the cable seal housing.

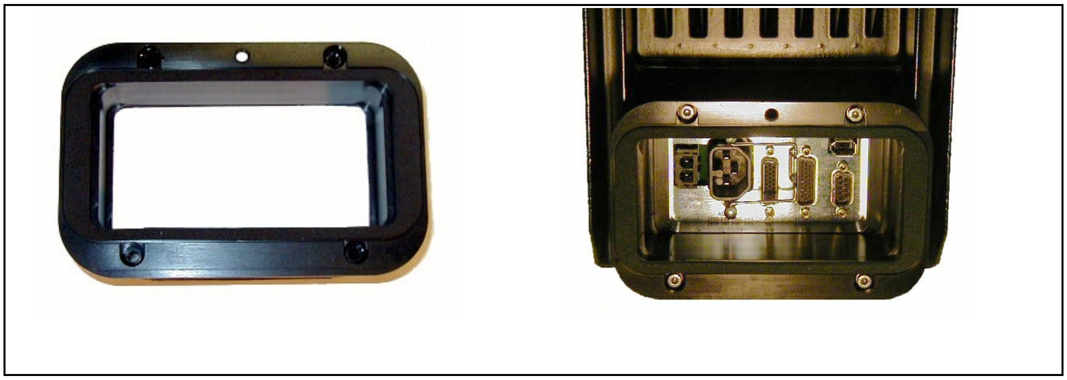


Figure 6-4. Cable Seal Housing (left), Installed (right)

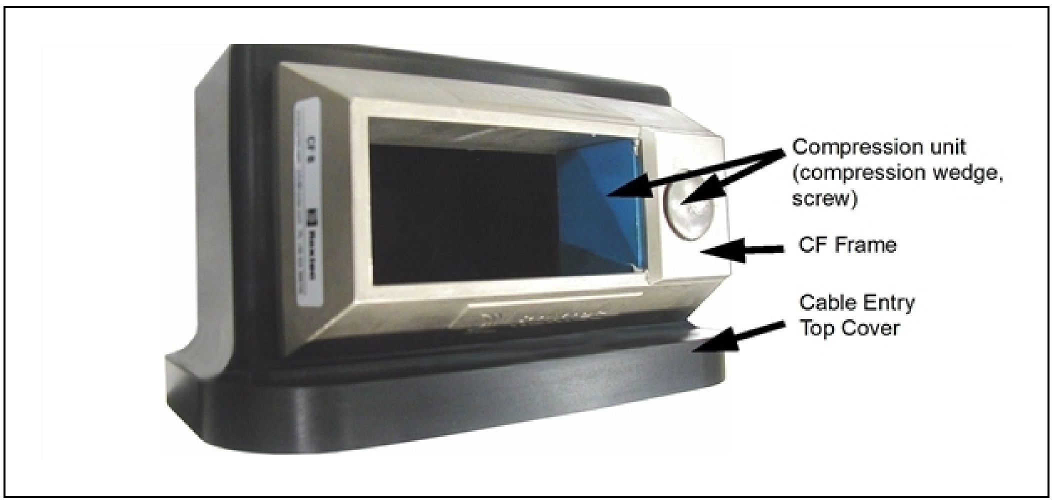


Figure 6-5. Cable Entry Top Cover Assembly

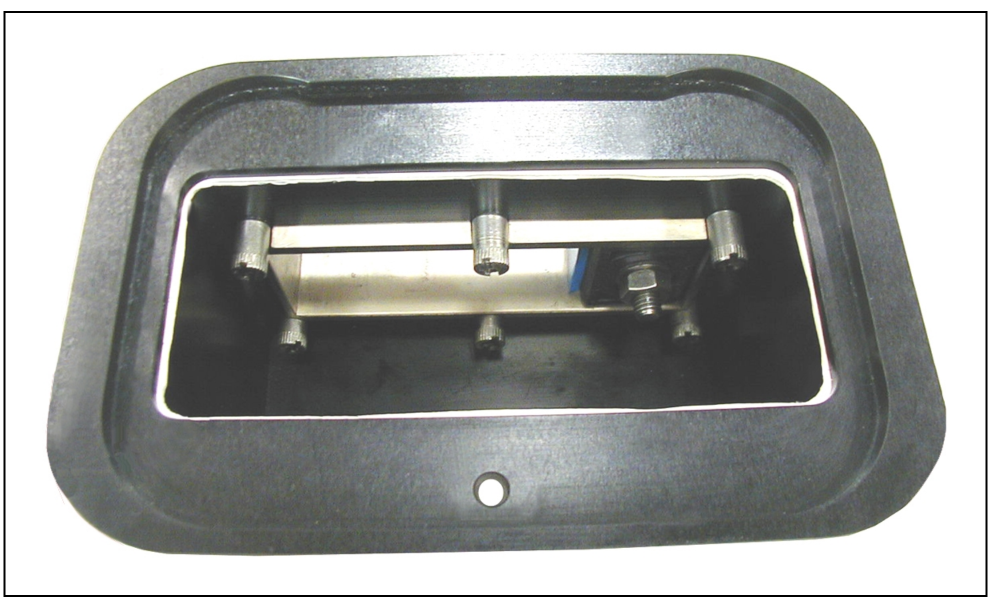


Figure 6-6. Bottom of Cable Entry Top Cover, CF Frame

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

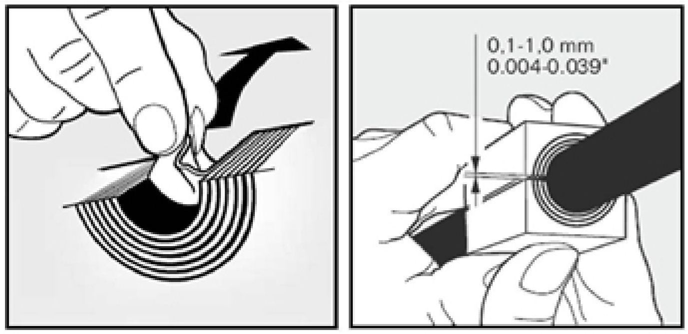


Figure 6-7. Adapting a Module to the Cable Size, Checking the Gap

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

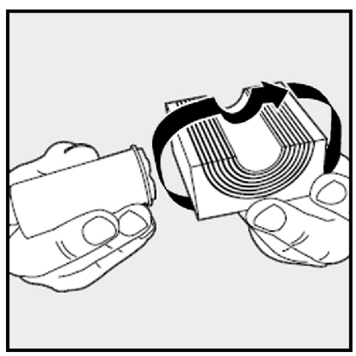


Figure 6-8. Greasing a Roxtec Module

5. Grease the inside of the CF frame, where the modules will touch, using Roxtec grease.
6. Install each eAIB cable through its corresponding module, and insert the modules into the frame. See the following figure.
   Ensure that the terminated cable ends have 10 - 12 in. of slack. See Figure 6-11.

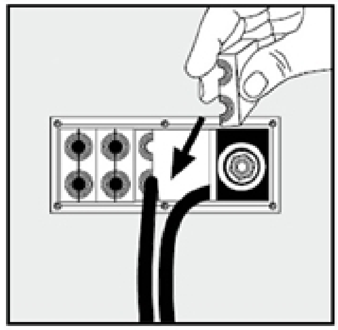


Figure 6-9. Installing Roxtec Modules into the Frame

7. When all of the modules are in place, tighten the compression unit to 8 - 12 N-m (6 - 9 ft-lbf). See the following two figures.
   There should be no visible gaps between the modules or around the cables.

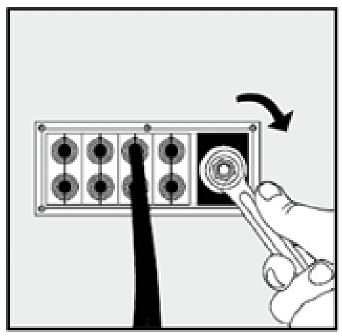


Figure 6-10. Tightening the Compression Unit

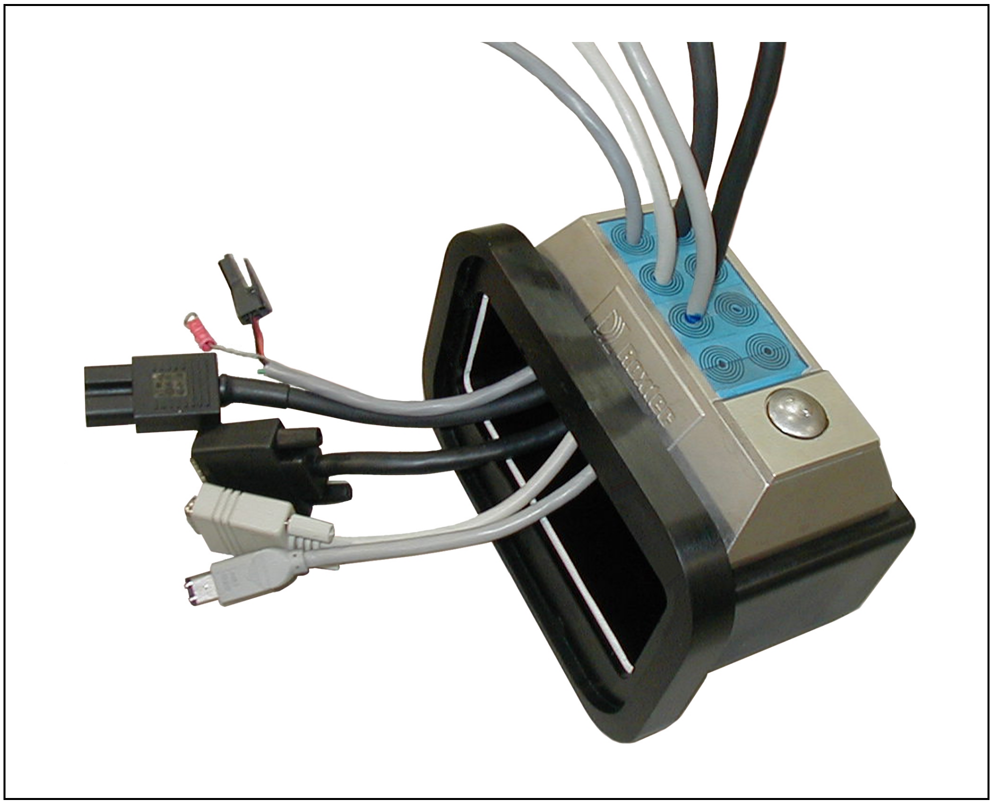


Figure 6-11. Cable Entry Assembly with Cables

8. Attach the ground lug to GND on the eAIB. The ground lug is for the cable shield of the user-supplied 24 VDC cable. See the following figure.

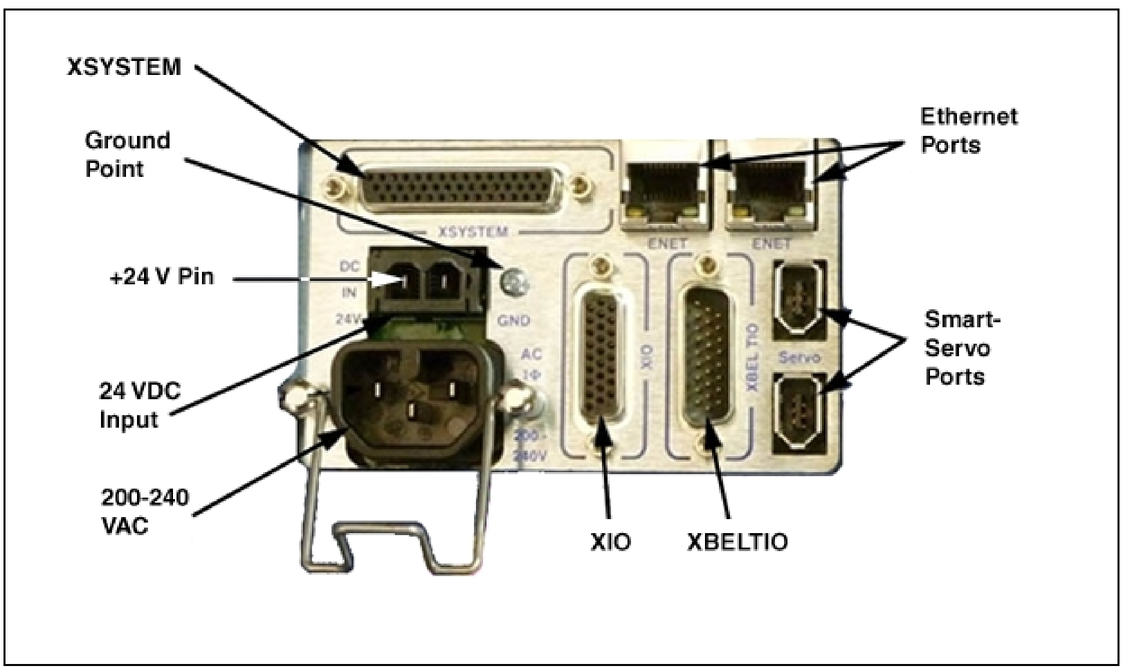


Figure 6-12. Ground Lug Attachment

9. Hand-tighten all cables to the eAIB.

NOTE: All cables must be screwed into the eAIB.

10. Attach the cable entry top cover, with Roxtec frame and modules, to the eAIB cable seal housing.
    - Slide the top cover over the seal housing lip, as shown in the following figure.
    - Ensure that the gasket between the top cover and the cable seal housing is seated, and that all cables are contained within the top cover.
    - Lower the top cover onto the seal housing, and secure with one screw.

Figure 6-13. Installing Cable Entry Top Cover Assembly

6.9 Intelligent Force Sensor

The force sensor allows you to detect forces applied at the gripper, so you can stop the robot's movement when a threshhold is passed. Requires the eAIB XBELT IO Adapter cable.

Refer to *Intelligent Force Sensing System User's Guide*.

6.10 Ball Stud Locks

Under abnormal or extreme loading conditions using very aggressive moves, or in the case of a collision, it is possible for the ball studs to separate from the ball joint sockets.

> **NOTE:** In normal use, this will not happen.

If you are planning on extremely aggressive moves or extreme loading conditions, you may want to install ball stud locks. These attach to the ends of the outer arms, and trap the ball, to prevent the ball studs from separating from their sockets.

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

The ball stud lock consists of slightly more than a half-circle of hard plastic that slides over the end of the ball joint socket. They can be installed and removed without tools. See the following figures.

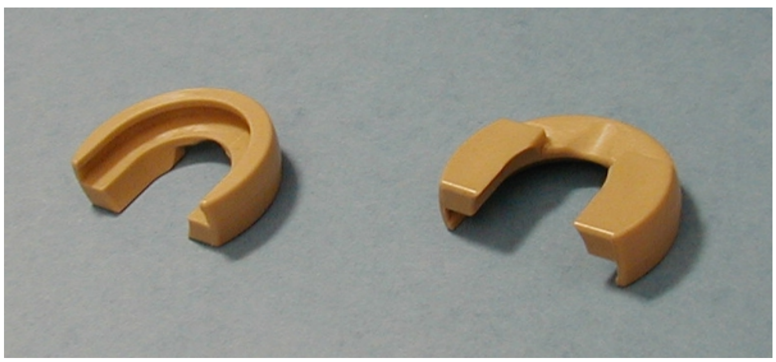


Figure 6-14. Ball Stud Locks

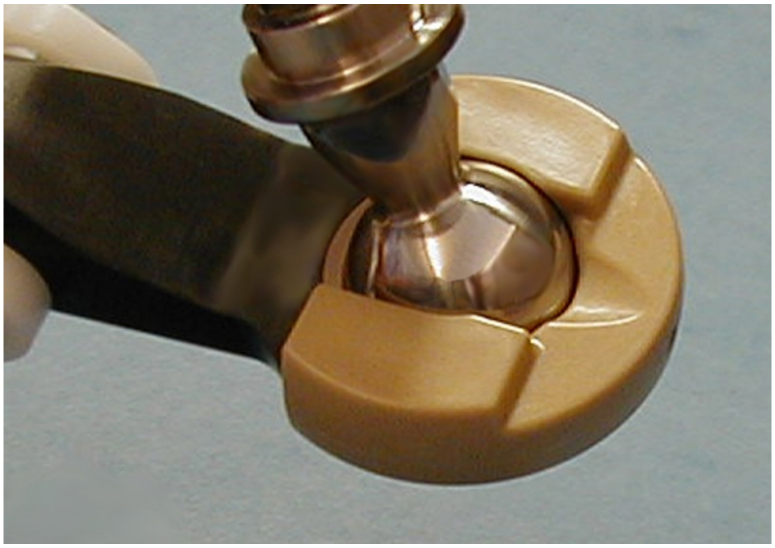


Figure 6-15. Ball Stud Lock on Ball Joint Socket

Installing a Ball Stud Lock

The ball stud lock has a groove that mates with a lip around the end of the ball joint socket.

1. To install a ball stud lock, line up the groove in the ball stud lock with the lip in the ball joint socket, and slide the lock on.

   The lock is designed to be tight enough that it will not come off in use. No tools are needed.

2. Twist the ball stud lock back-and-forth slightly, after installation, to ensure that it is fully seated.

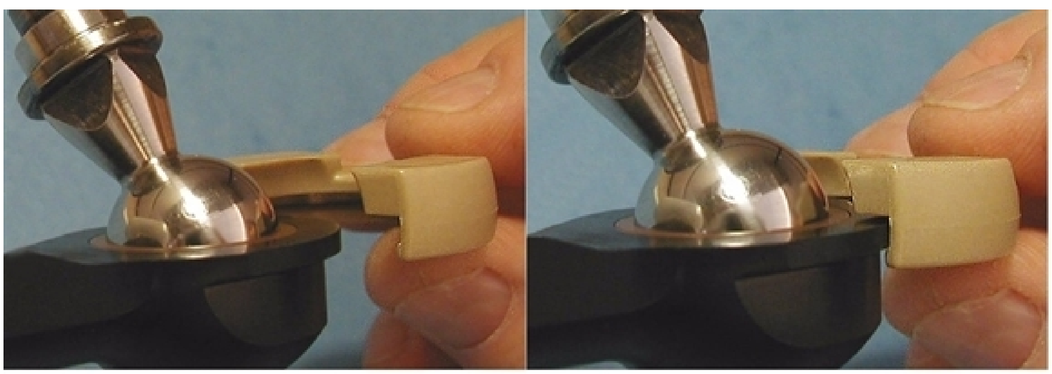


Figure 6-16. Installing a Ball Stud Lock

Removing a Ball Stud Lock

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

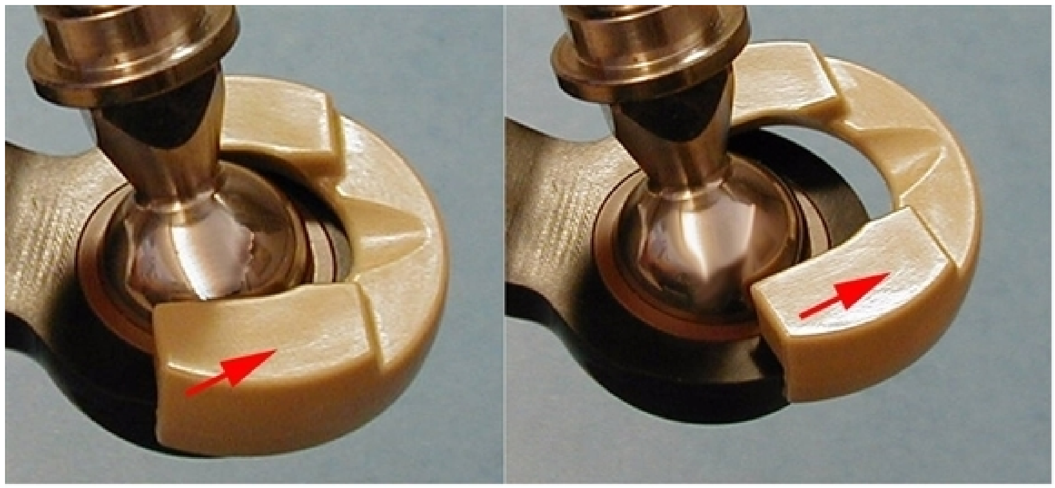


Figure 6-17. Removing a Ball Stud Lock

Chapter 7: Maintenance

WARNING: Only qualified service personnel may install or service the robot system. All maintenance work must be performed by a skilled and instructed personnel - refer to the *Robot Safety Guide*.

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

During any maintenance-related activities, care must be taken involving AC power lockout. It is the user's responsibility to make sure adequate measures are taken to

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

  The cover and the eAIB on the robot are not interlocked—turn off and disconnect power if these have to be removed. Lock out and tag out power before servicing.

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

NOTE: When performing maintenance on the robot, move any sub-assemblies away from any food processing area, to avoid any chance of contamination. Cover or protect the food processing area.

7.1 Cleaning

Water Shedding

Surfaces of the Hornet 565 have been designed to shed water. This increases the likelihood that contaminants or cleaning agents will drain with a wash-down procedure.

Wash-Down

Wash-down cleaning is appropriate for cleaning the Hornet 565. Surfaces and joints have been designed with smooth internal radii for easy cleaning.

Table 7-1. Typical Cleaning Schedule, Non-raw Food

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

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

Table 7-2. Typical Cleaning Schedule, Raw Food

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

Chemical Compatibility

CAUTION: Not all materials used on the Hornet 565 are compatible with all cleaning solutions available.

Caustic

The Hornet 565 is designed to be compatible with moderate cleaning agents commonly used in the cleaning of food-processing equipment, at room temperature. All robot components are designed to handle daily exposure to cleaning agents. Exposure may result in some discoloration of the materials, but no significant material removal.

NOTE: Anodized parts cannot be tank cleaned. Highly caustic cleaning agents are not suitable for the Hornet 565.

Acidic

In general, acidic cleaning solutions are incompatible with the Hornet 565's materials. For acidic environments, contact Omron Adept Technologies, Inc.

7.2 Periodic Maintenance Schedule

Suggested Inspection Schedule on page 101 gives a summary of the inspection and maintenance procedures, and guidelines on frequency.

NOTE: The estimated times listed in the following table are for the inspection, not repairs.

Table 7-3. Suggested Inspection Schedule

Item	Sugg. Freq.	Est. Time (Min)	Inspection	Suggested Remedy
Labels	1 Week	5	Check for presence and legibility of all labels on robot	Replace labels if damaged or missing.
User Cabling	1 Week	15	Inspect for wear around robot joints and possible binding on robot.	Replace if cracked or worn. Adjust position if binding.
Outer Arm Inserts	1 Week	15	Inspect inserts for excessive wear.	Replace worn inserts.
Outer Arms	3 Mon	30	Inspect outer arms for damage caused by possible accidental impact. Inspect springs and horseshoes for wear.	Replace arms if damaged. Replace springs and horse-shoes if worn or damaged.
Platform	3 Mon	10	Inspect platform for damage caused by possible accidental impact.	Replace platform.
Robot Fans and Gear drives	1 Year	60	Partially remove eAIB and Status Display to inspect fans for operation. Look for lubrication leaking from gear drives. See Checking for Gear Drive Oil Leakage on page 105 and Checking Fan Operation on page 106.	Diagnose non-operational fans. (Not field-replaceable) Replace gear drives.
Dynamic and Static seals	3 Mon	10	Inspect dynamic seals on inner arms and static seals for sanitizing wash-down environments. Check for good seal contact, inflexible, broken, seals.	Platforms: replace platform. Inner arms: replace seals.
E-Stops	6 Mon	30	Check functioning of E-Stops. See Checking Safety Systems on page 104.	Replace Front Panel, or customer E-Stops.
Robot Mounting bolts	3 Mon	15	Check tightness of bolts. See Checking Robot Mounting Bolts on page 104.	Tighten bolts.
Cable Inlet Box seals	3 Mon	10	Check for good seal contact, inflexible, broken, seals.	Replace seals.
eAIB seal	3 Mon	10	Check for good seal contact, inflexible, broken, seal.	Replace seal.
Cable Inlet Box gaskets	3 Mon	10	Check for good gasket contact, inflexible, broken gaskets.	Replace gaskets.
Status Display Panel	3 Mon	10	Check for water inside the display. Check for good seal contact, inflexible, broken, seal.	Replace seal.

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

NOTE: These lists are not necessarily complete.

Table 7-4. Suggested Part Replacement Schedule

Item	Suggested Interval	Estimated Time of Maintenance	Description
Theta Drive Bushings	1 Year or 5,000 hours	30 Minutes	Drive shaft bushings are a normal wear item. A bushing replacement kit is available as p/n 15005-000.
Backup Encoder Battery Pack	5 years to 10 years	15 Minutes	Replacement battery pack is inserted from the side of the robot through the Status Display opening. See Maintenance on page 99

7.3 Checking Labels

NOTE: Labels giving instructions for lifting or installing are not covered. They may be removed by the user, and do not need to be checked.

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

Warning Labels

- Read User's Guide, Impact Warning Label, 18241-000

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

Figure 7-1. Read User's Guide, Impact Warning Label

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

Figure 7-2. Location of Read user's Guide, Impact Warning Label

- Brake Release/Gravity Label, 18272-000

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

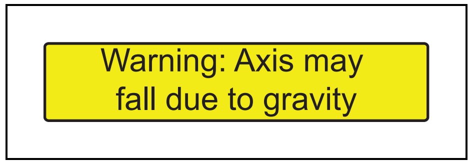


Figure 7-3. Brake Release/Gravity Label

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

Informative Labels

- Brake Release Label, 18265-000

  This label identifies the brake release button on the underside of the Hornet 565.

  It is a ring that surrounds the brake release button.

7.4 Checking Safety Systems

These tests should be performed every six months.

> **NOTE:** Operating **any** of the following switches or buttons must disable high power. If any of the tests fail, repairs must be made before the robot is put back into operation.

1. Test operation of:
   - E-Stop button on front panel
   - Auto/Manual switch on front panel

     If the optional pendant is present:
   - E-Stop button on pendant
   - Enabling switch on pendant (Manual mode only)
2. Test operation of any user-supplied E-Stop buttons.
3. Test operation of barrier interlocks, etc.

7.5 Checking Robot Mounting Bolts

Check the tightness of the base mounting bolts after the first week, and then every 3 months. Refer to the following table for torque specifications.

Table 7-5. Mounting Bolt Torque Specifications

Standard	Size	Torque
Metric	M12-1.75	61 N·m (45 ft-lb)

7.6 Checking for Gear Drive Oil Leakage

NOTE: Gear drive inspection and fan operation inspection require removal of the same robot parts, and have the same schedules. You will probably want to perform these two inspections at the same time.

NOTE: The inner arm motor plugs are not used for this inspection because they cannot be removed without destroying them.

WARNING: Remove all power to the robot before opening the eAIB chassis.

The Hornet 565 uses gear drives, which use oil in their components for lubrication. Periodically inspect the robot for signs of oil on and around the gear drives.

To check the J1 and J2 gear drives:

1. Remove all power to the robot before starting this check.

   Lock out and tag out AC power.

2. Wait for the motors to cool before performing this check.

3. Remove the eAIB.

   See Replacing the eAIB Chassis on page 121.

   You do not need to disconnect the cables to the eAIB.

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

4. Check for oil inside the base of the robot.

   - Look through the venting slots under each motor for oil leakage.
   - Feel the bottom of the motors with your finger through the venting slots.

5. Check the outside of the motors and gear drives for any signs of oil.

6. Contact Omron Adept Technologies, Inc. if you find any signs of oil in these areas.

   If you aren't going to check the operation of the motor fans:

7. Re-install the eAIB.

   See Installing a New eAIB Chassis on page 124.

To check the J3 gear drive:

1. Remove the four M4 hex-head bolts holding the Status Display panel.

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

2. Remove but do not disconnect the Status Display panel.

   Retain the Status Display panel and gasket for re-installation.

3. Check the outside of the motor and gear drive for any sign of oil.

   Contact Omron Adept Technologies, Inc. if you find any sign of oil in these areas.

4. Re-install the Status Display panel with the four M4 bolts previously removed.
   - Apply Loctite 222 in each bolt hole, not on the bolts themselves.
   - Ensure that the Status Display panel gasket is in place between the panel and the robot body.
   - Torque the bolts to 1.1 N·m (10 in-lb).

7.7 Checking Fan Operation

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

> **NOTE**: The fans are not field-replaceable. In the unlikely event that a fan fails, it needs to be replaced at the factory.

Verify that all fans operate:

Fans for J1 and J2 motors:

1. Remove the eAIB.

   See Replacing the eAIB Chassis on page 121.

   You do not need to disconnect the cables to the eAIB.

2. Toggle power to the eAIB.

   Motor fans run for about 1 minute before shutting off. (If the robot is hot, they will continue to run.)

3. Verify that J1 and J2 motor fans are running by looking through the eAIB opening.

4. Re-install the eAIB.

   Installing a New eAIB Chassis on page 124.

Fan for J3 motor: (this cannot be seen through the eAIB opening)

1. Remove the four M4 hex-head bolts holding the Status Display panel.
   - Retain the bolts for re-installation.
   - These bolts were installed with Loctite 222.

2. Remove but do not disconnect the Status Display panel.

   Retain the Status Display panel and gasket for re-installation.

3. Toggle power to the eAIB.

Motor fans run for about 1 minute before shutting off. (If the robot is hot, they will continue to run.)

4. Verify that the J3 motor fan is running by looking through the Status Display opening.
5. Re-install the Status Display panel with the four M4 bolts previously removed.
   - Apply Loctite 222 in each bolt hole, not on the bolts themselves.
   - Ensure that the Status Display panel gasket is in place between the panel and the robot body.
   - Torque the bolts to 1.1 N·m (10 in-lb).

7.8 Theta Drive Shaft

NOTE: The fixed platform Hornet 565 does not use a theta drive shaft, so the following procedures do not apply to those robots.

Replacing the Drive Shaft Bushings

The bushings in the drive shaft are a normal wear item, and need to be replaced yearly or every 5,000 hours of use. A bushing replacement kit is available as p/n 15005-000.

Figure 7-4. Drive Shaft Bushing Replacement Kit

1. Remove power from the Hornet.
2. Disconnect the lower U-joint from the drive shaft.

   Do not disconnect the upper U-joint.

Leave the lower U-joint connected to the platform shaft.

WARNING: Do not rotate the drive shaft or the lower U-joint. If either is rotated, the calibration data for J4 will be lost, requiring factory recalibration.

Retain the dog point set screw for reassembly. It was installed using Loctite 242.

3. Unscrew the three screws at the lower end of the drive shaft.

   Retain the screws for reassembly.

   These hold the end cap that holds a sleeve bushing through which the center shaft slides.

4. Remove and discard the lower end cap from the drive shaft cylinder. It will slide over the center shaft.

   A new end cap is included in the bushing replacement kit.

5. Remove the center shaft from the drive shaft cylinder.

   Retain the center shaft for reassembly.

6. The upper end of the center shaft has a fixture that holds three bushings. These bushings will be replaced, but the center shaft will be reused.

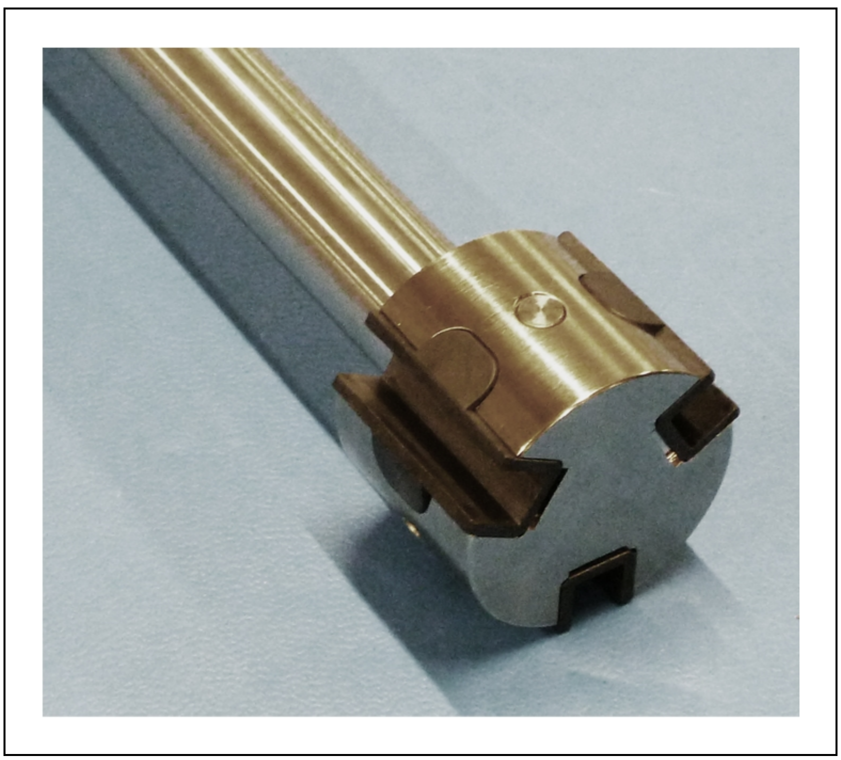


Figure 7-5. Center Shaft Bushing-holding Fixture, with Bushings

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

shaft.

8. Replace the old bushings with the three new bushings from the rebuild kit.

9. Insert the center shaft, fixture end first, into the drive shaft cylinder.

   - The top end cap of the cylinder and the bottom end of the center shaft each have a hole that a U-joint attaches to. Make sure that those two holes are parallel with each other when you insert the center shaft into the cylinder.

   - The three sets of five screws down the length of the drive shaft cylinder hold three guides that the bushings slide over. You will need to "feel" for the bushings lining up with their guides inside the cylinder.

10. Slide the replacement bottom end cap over the end of the center shaft.

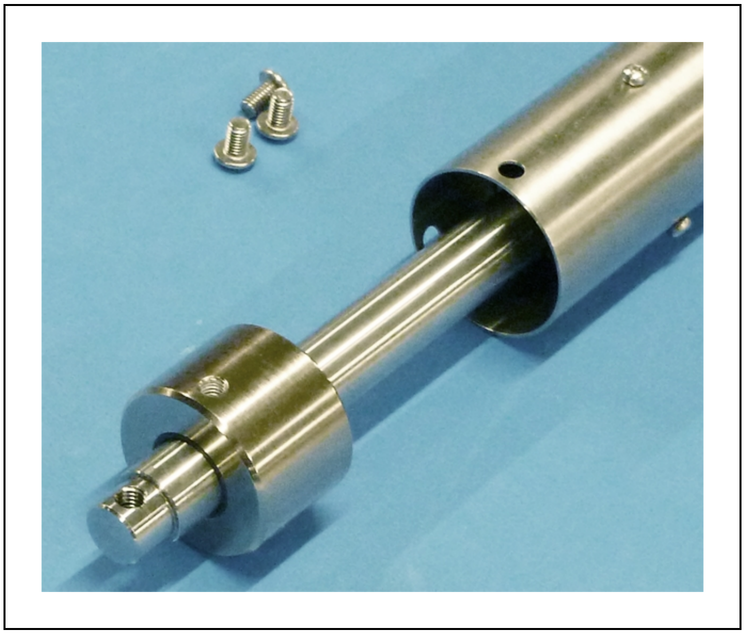


Figure 7-6. End Cap Placed Over Center Shaft

11. Slide the end cap into the end of the drive shaft cylinder, so that the three holes in the cylinder align with the holes in the end cap.

12. Screw the three screws previously removed through the cylinder and into the end cap. Use Loctite 242 on the screws.

13. Reattach the lower U-joint to the platform, using the dog point set screw previously removed. Use Loctite 242 on the set screw.

Removing the Drive Shaft

The theta drive shaft has a U-joint on each of its ends. One connects to the J4 motor drive, the other connects to a shaft on the top of the J4 platform.

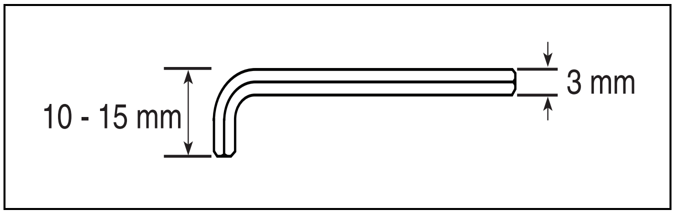
- Disconnect the bottom U-joint from the shaft on top of the J4 platform.

- Disconnect the top U-joint from the drive shaft of the J4 motor.

To remove a U-joint from a J4 motor or platform shaft:

1. Unscrew the M6 x 20 dog point set screw that goes through the U-joint and shaft.

   For the top U-joint, use a 3 mm hex key, with a 10 - 15 mm short leg. There is not enough room at the J4 motor shaft to use a standard hex key.



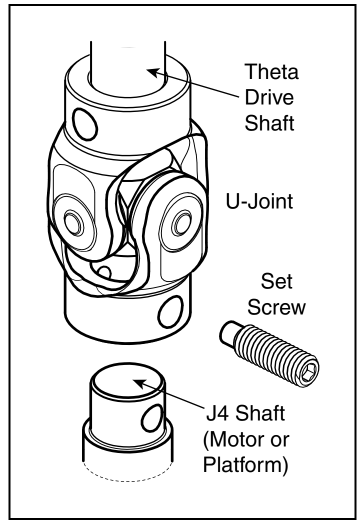


Figure 7-7. Short 3 mm Hex Key (Above), U-Joint (Right)

   The set screw was put in with Loctite 242.

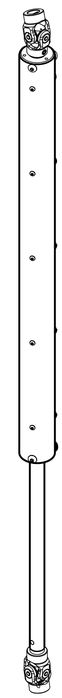
   Save the set screw for installing the replacement drive shaft.

2. Slide the end of the U-joint off of the J4 motor or platform shaft.

   The fit will be fairly tight.

Installing a Drive Shaft

When the theta drive shaft is shipped, it will have one end of a U-joint attached to each end.



NOTE: The drive shaft has a top and bottom. Installing it upside-down will degrade system performance. Look for a "Top" label on the drive shaft.

The larger cylinder section goes at the top.

- Attach the top U-joint to the drive shaft of the J4 motor.

  The top (J4 motor) end of the drive shaft is labeled with a temporary label, indicating Top. Remove the label before use. See figure at right.

- Attach the bottom U-joint to the shaft on top of the J4 platform.

To attach the free end of a U-joint:

1. Slide the free end of the U-joint over the J4 motor or platform shaft.

   The fit will be fairly tight.

   The hole in the side of the U-joint needs to line up with the hole in the shaft.

2. Insert one of the M6 x 20 dog point set screws previously removed through the hole in the side of the U-joint, screw it through the shaft, and into the blind hole on the opposite side of the U-joint. The shafts are threaded, the U-joints are not.

   - Use Loctite 242.
   - Tighten to 5 N-m (3.7 ft-lbf) of torque. The head of the set screw should be flush with the outer surface of the U-joint.

Aligning the Platform and J4 Motor

It is possible for either the motor shaft or the platform shaft to be turned, manually, before the theta drive shaft is connected to both. If not detected, the software may assume the robot's tool flange is at a different angle than it really is. To ensure that the software knows the actual rotation of the tool flange with respect to the J4 motor, you need to use the ACE software to establish this alignment.

1. Within the ACE software, open the Hornet565 robot object.
2. In the Configure tab, click Adjust J4 Zero.

   This will launch a utility for aligning the theta drive shaft.
3. Follow the instructions in the utility.

Contact Omron Adept Technologies, Inc. for more information on this procedure.

NOTE: Once the theta drive shaft is installed, the J4 motor and the tool flange will always rotate together, so the software will know the orientation of the tool flange.

7.9 Replacing the Encoder Battery Pack

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

CAUTION: Replace the battery pack only with a 3.6 V, 6.8 Ah lithium battery pack, P/N 09977-000.

Battery Replacement Interval

If the robot is kept in storage and not in use, or if the robot is turned off (no 24 VDC supply) most of the time, then the battery pack should be replaced every 5 years.

If the robot is turned on, with 24 VDC supplied to the robot more than half the time, then you can increase the replacement interval to 10 years. If, for example, a robot is typically turned off only on weekends, the battery pack would need to be replaced every 10 years.

Battery Replacement Procedure

1. Obtain the replacement battery pack.
2. Switch off the optional SmartController EX, if one is being used.
3. Switch off the 24 VDC input supply to the robot.
4. Switch off the 200-240 VAC input supply to the robot.
5. Disconnect the 24 VDC supply cable from the robot +24 VDC input connector. See Robot Interface Panel on page 46 for locations of connectors.
6. Disconnect the 200-240 VAC supply cable from the robot AC input connector.
7. Switch off and disconnect any other power supplies connected to the robot.
8. Remove the four M4 hex-head bolts holding the Status Display panel.
    - Retain the bolts for re-installation.
    - These bolts were installed with Loctite 222.

Figure 7-8. Status Display Panel Face

9. Remove but do not disconnect the Status Display panel.

   Retain the Status Display panel and gasket for re-installation.

NOTE: The battery pack is supported in a bracket that is attached to the back side of the Status Display panel with stand-offs. The battery pack is exposed when the Status Display panel is removed.

10. The battery bracket assembly has two battery connectors. Locate the unused battery connector on the battery bracket. See the following figure.

    CAUTION: If battery power is removed from the robot, factory calibration data may be lost, requiring robot recalibration by Omron Adept Technologies, Inc. personnel.

11. Connect the new battery pack to the unused connector on the battery bracket, but do not disconnect the old battery pack yet. There is only one way to plug in the connector.

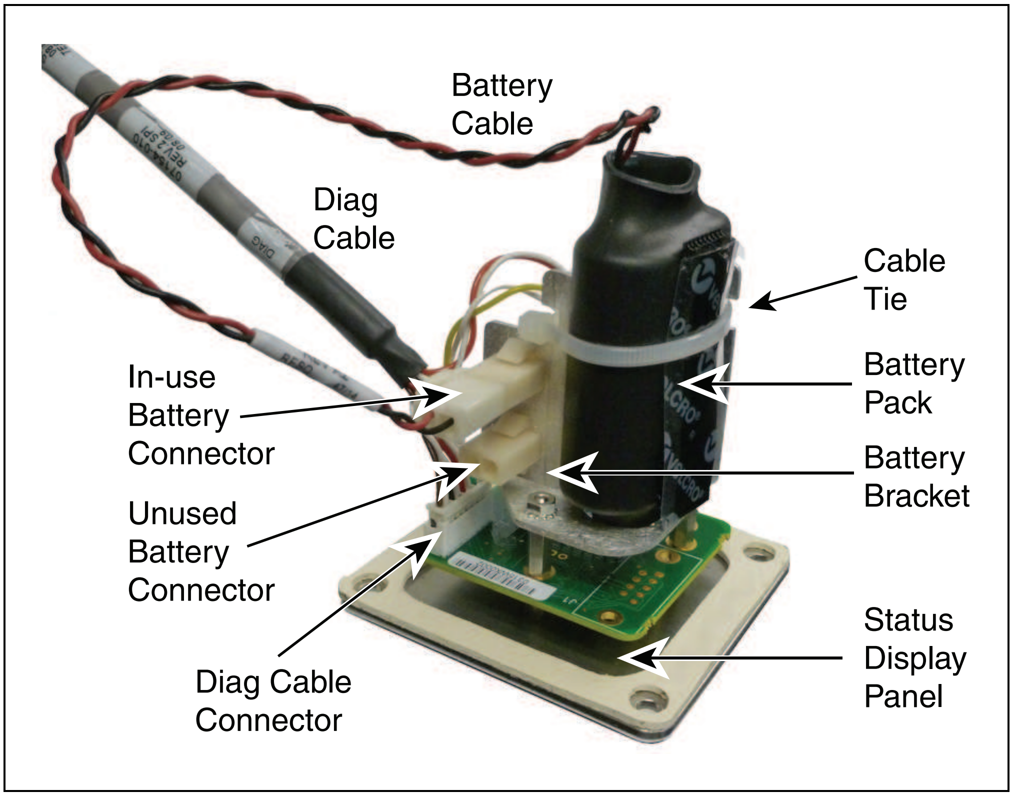


Figure 7-9. Battery Bracket on Status Display Panel

12. Once the new battery pack is connected, you can disconnect and remove the old one. You will need to cut the cable tie holding the battery pack in the bracket.

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

13. Place the new battery pack in the battery bracket, and secure it and the “diag” cable, using a cable tie.
    - Fold any excess wiring (red and black) under the battery pack, so that it lies between the battery pack and the ‘V’ in the battery bracket.
    - The “diag” cable must be cable-tied to the bracket (and battery pack) to relieve strain on the Status Display connector.

    NOTE: In the preceding figure, the diag cable has not yet been attached to the battery bracket.
14. Re-install the Status Display panel with the four M4 bolts previously removed.
    - Apply Loctite 222 in each bolt hole, not on the bolts themselves.
    - Ensure that the Status Display panel gasket is in place between the panel and the robot body.
    - Torque the bolts to 1.1 N·m (10 in-lb).

7.10 Non-Periodic Maintenance

Item	Estimated Time of Maintenance	Description
Front Panel Lamp	30 Minutes	Lamp can burn out over time.
Platform	30 Minutes	Excessive wear, gritty environment, damage from accidental impact.
Ball Joint Inserts	45 Minutes	Plastic inserts can be replaced in case of excessive wear. Preferred solution is to stock and swap extra outer arms.
Springs and Horseshoes	15 Minutes	Springs and horseshoes can be replaced in case of excessive wear or accidental breakage. Preferred solution is to stock and swap outer arms.
Outer Arms	15 Minutes	Broken by accidental impact. Sold in pairs with springs, horseshoes, and inserts.
eAIB	1 Hour	Accumulated wear on electronics by excessive operations or poor line voltage.

7.11 Changing the Front Panel High-Power Indicator Lamp

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.

   Save the mounting hardware for re-installation.
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 will be disconnected 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).

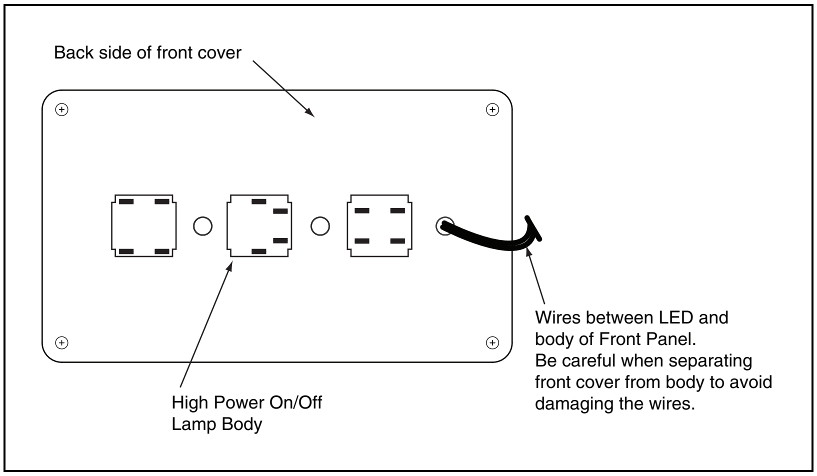


Figure 7-10. Lamp Body Contact Alignment

7.12 Replacing a Platform

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

NOTE: Refer to Robot Installation on page 21 for details on installing the outer arms. Removal is the reverse of installation.

1. Remove the three pairs of outer arms from the three pairs of ball studs on the installed platform.
2. For a J4 platform, disconnect the theta drive shaft from the platform drive shaft.

   See Theta Drive Shaft on page 107 for details. Do not remove the top U-joint, which is attached to the J4 motor shaft.
3. Attach one pair of outer arms to each of the three pairs of ball studs on the new platform.
   - The platform is installed flange-down.
   - Take care not to trap debris between the ball studs and their sockets.
4. For a J4 platform, attach the theta drive shaft to the platform drive shaft.

   See Installing a Drive Shaft on page 110 for details.

7.13 Replacing a Ball Joint Insert

1. Remove the old insert.

   The inserts have a threaded hole in the bottom to facilitate removal. Use an M4 bolt to thread into the insert, and pull it out.
2. Install the new insert.

   Ensure that the insert is centered in the ball joint socket, and bottomed-out.

7.14 Replacing Outer Arm Spring Assemblies

NOTE: It is unlikely that you will ever need to remove the components of the outer arm spring assemblies.

Removing Outer Arm Springs

1. Bend the spring so that the end is 90° from normal. See the following figure.

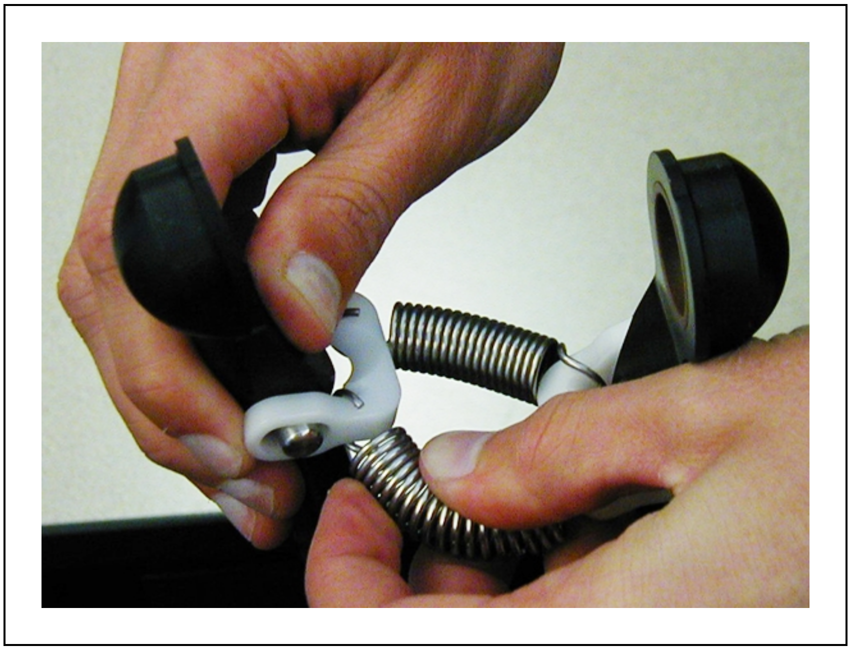


Figure 7-11. Removing an Outer Arm Spring

Removing the first spring is the most difficult, as the other spring will tend to restrict movement of the spring.

2. Slip the springs off of the horseshoes. See the following figure.

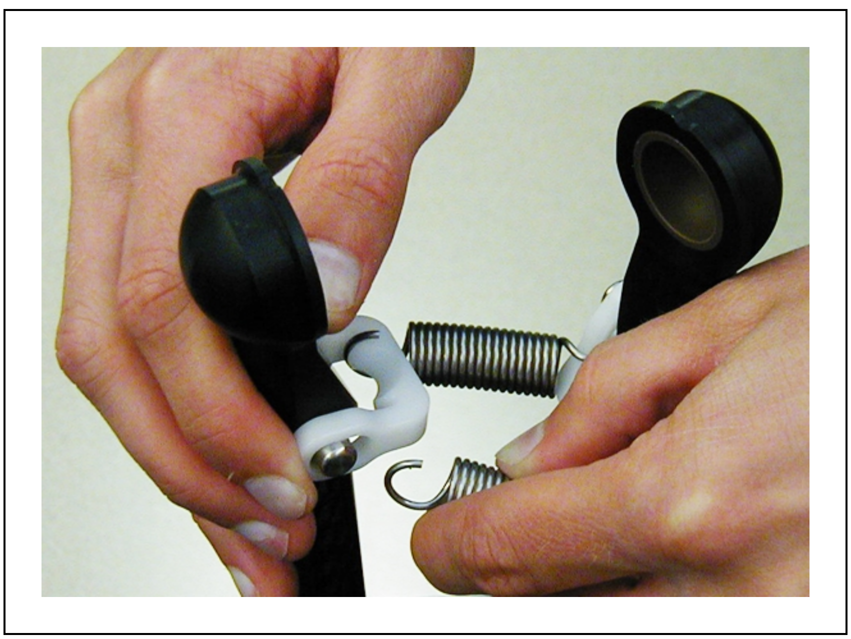


Figure 7-12. Spring, with End Removed from Horseshoe

The narrowest part of the horseshoe is 90° from the groove in which the spring end normally rests.

3. Repeat these steps for the remaining spring.

Removing Outer Arm Spring Horseshoes

NOTE: The only reason for removing an outer arm horseshoe is to replace one that has been damaged.

1. Remove the outer arm springs from the horseshoe. See the previous section, Removing Outer Arm Springs on page 117.
2. Cut the horseshoe with diagonal cutters.

   Take care not to damage any part of the outer arm end.
3. Remove the cut horseshoe from the outer arm pins.

Installing Horseshoes

1. Slip one end of the horseshoe over one of the outer arm pins. See the following figure.

Figure 7-13. Horseshoe over One Pin

2. Pull the loose end of the horseshoe (spreading it slightly), and slip the end on top of the other outer arm pin.

   The horseshoes are very stiff, and do not bend easily. See the following figure.

Figure 7-14. End of Horseshoe on Pin

3. Squeeze the horseshoe the rest of the way, until it is over the pin. See the following figure. The horseshoe will snap into place.

Figure 7-15. Squeezing the Horseshoe into Position

Installing Springs on a Horseshoe

1. Slip the spring onto the horseshoe at 90° from its normal position. Refer to the figures in Removing Outer Arm Springs on page 117.

   The narrowest part of the horseshoe is 90° from the groove in which the spring end normally rests.

2. Repeat for the remaining spring.

   Installing the last spring is the most difficult, as the other spring will tend to keep the spring from moving.

7.15 Replacing the eAIB Chassis

Removing the eAIB Chassis

CAUTION: Follow appropriate ESD procedures during the removal/replacement phases.

1. Switch off the 24 VDC input supply to the chassis.
2. Switch off the 200/240 VAC input supply to the chassis.
3. Switch off the optional SmartController EX, if you are using one.
4. Disconnect the 24 VDC supply cable from the chassis +24 VDC input connector. For the connector location, see Robot Interface Panel on page 46.
5. Disconnect the 200/240 VAC supply cable from the chassis AC Input connector.
6. Disconnect the eAIB XSYSTEM cable from the chassis XSYSTEM connector.
7. Disconnect any other cables, which may be connected to the chassis, such as XIO, RS-232, 1394, or any others.

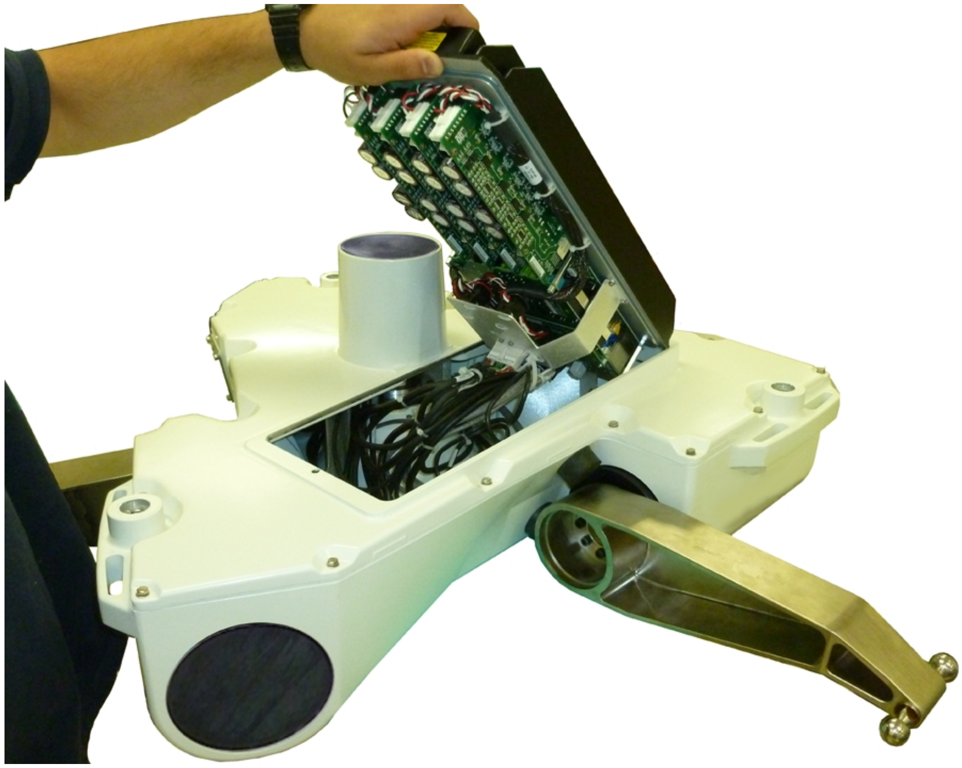
Figure 7-16. eAIB on Hornet 565 Base

8. Using a 5 mm hex wrench, carefully unscrew the chassis securing screw, which is shown in the following figure. Note that the screw does not need to be completely removed in order to remove the chassis, as this screw is captured on the chassis heat sink.

Figure 7-17. Securing Screw on eAIB Chassis

9. Carefully and slowly lift up the chassis (see the following figure), so that enough access is available to remove the internal cables. The chassis can be laid flat on its cooling fins.

CAUTION: The eAIB can damage the O-ring that seals it if you are not careful. Ensure that nothing scrapes against the O-ring.



10. Disconnect the “white” amplifier cable from the amplifier connector located on the chassis bracket. See the following figure.

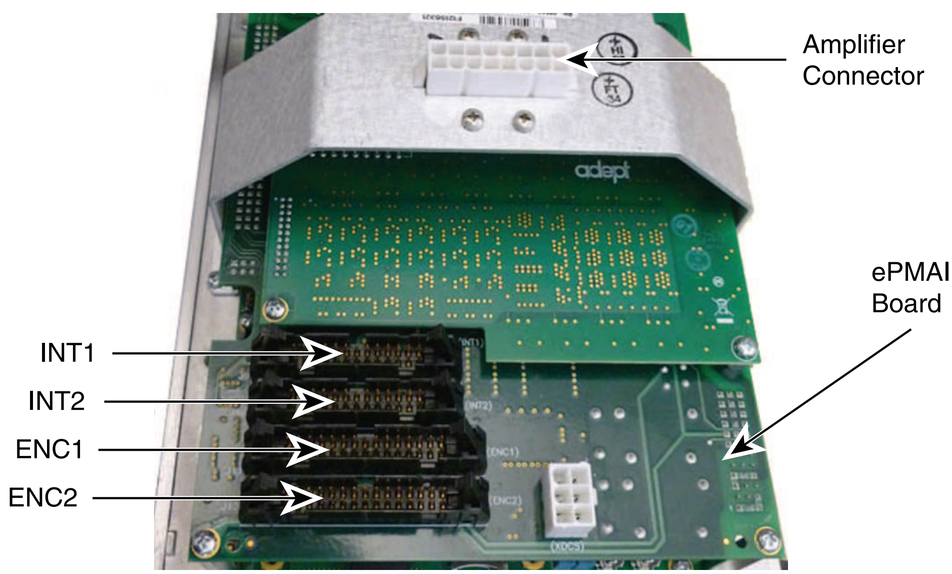


Figure 7-18. Connectors on Chassis and ePMAI Board

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

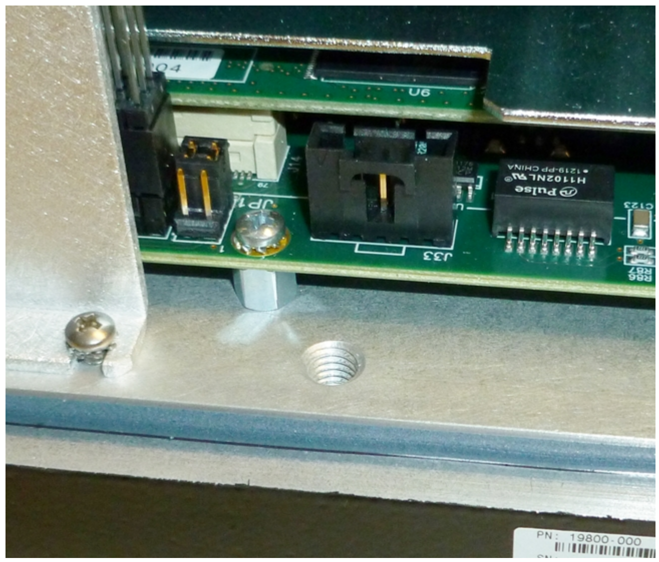


Figure 7-19. Ground Screw Hole on eAIB Chassis

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

Installing a New eAIB Chassis

1. Carefully remove the new chassis from its packaging, check it for any signs of damage, and remove any foreign packing materials or debris from inside the chassis.
2. Carefully place the chassis next to the robot.
3. Using a 5 mm hex wrench, connect the ground wire to the chassis.
4. Reconnect the cables you removed from their connectors on the ePMAI board, and engage the securing latches.
5. Connect the “white” amplifier cable to the amplifier connector located on the chassis bracket.
6. Carefully insert the chassis into the robot base in the groove at the bottom of the base. Tilt the chassis up and into place against the robot, making sure that none of the cables get trapped or pinched and that the chassis O-ring is not damaged during installation.
7. Once the chassis is in place, use a 5 mm hex wrench to tighten the chassis securing screw. See Figure 7-17.
8. Connect the 200/240 VAC supply cable to the chassis AC input connector.

9. Connect the eAIB XSYSTEM cable to the chassis XSYSTEM connector, or,
if you are using an optional SmartController EX, connect the eAIB XSYS cable to the chassis XSYSTEM connector.
10. Connect any other cables that were connected to the chassis, such as XIO, RS-232, 1394, or any others.

    If you are using an optional SmartController EX, connect the XSYS end of the eAIB XSYS cable to the XSYS port on the controller.
11. Connect the 24 VDC supply cable to the chassis +24 VDC input connector.
12. Switch on the 200/240 VAC input supply to the chassis.
13. Switch on the 24 VDC input supply to the chassis.
14. Switch on the optional SmartController EX, if you are using one.
15. Once the system has completed booting, test the system for proper operation.

7.16 Commissioning a System with an eAIB

Commissioning a system involves synchronizing the robot with the eAIB.

For a new system, the robot and the eAIB will have been commissioned at the factory and should not need commissioning.

In rare cases with a new robot with an eAIB, 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 eAIB adds two functions from previous amplifiers that implement safety in hardware:

- E-Stop

  This 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

  This 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 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.

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.
- ACE software must be installed.
- If using a factory-supplied Front Panel, the keyswitch must be in Auto mode.

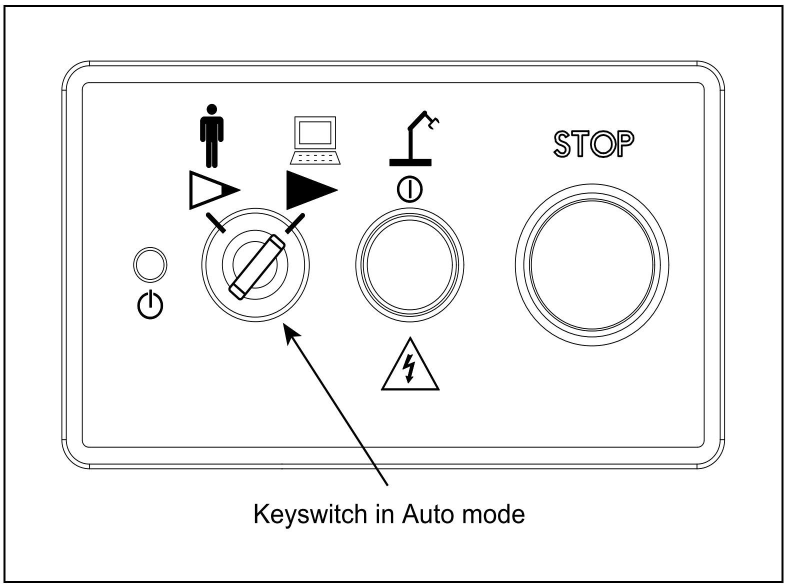


Figure 7-20. Front Panel

- 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 eAIB.

  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.

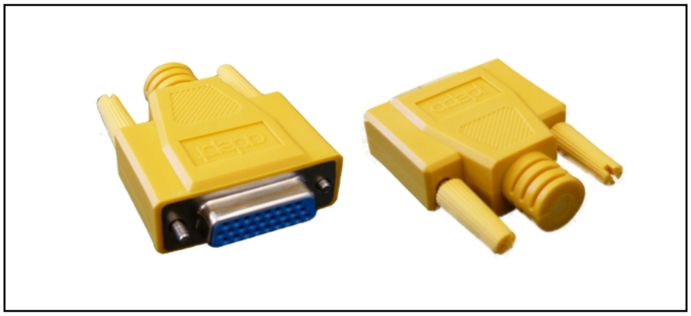


Figure 7-21. eAIB Commissioning Jumper

- A pendant is required for the Teach Restrict verification.

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 eAIB before you start this procedure.

Procedure

From within the ACE software:

1. Open the robot object editor.
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. Reboot the eAIB.
4. If you are using an optional SmartController EX, reboot it.

   On some systems, the SmartController EX will reboot automatically.

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 eAIB, remove it before you start this procedure.

Procedure

From within the ACE software:

1. Open the robot object editor.
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.

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 eAIB 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.
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. Reboot the eAIB.
6. If you are using an optional SmartController EX, reboot it.

   On some systems, the SmartController EX will reboot automatically.

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 eAIB, 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.
2. Select **Configure > Safety Settings > Verify Teach Restrict**, then click Next.
3. Teach a Start Position.

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

   - Move the robot to such a position, if necessary, 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 to 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 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. Reset the Front Panel keyswitch to Auto mode.

Chapter 8: Technical Specifications

8.1 Dimension Drawings

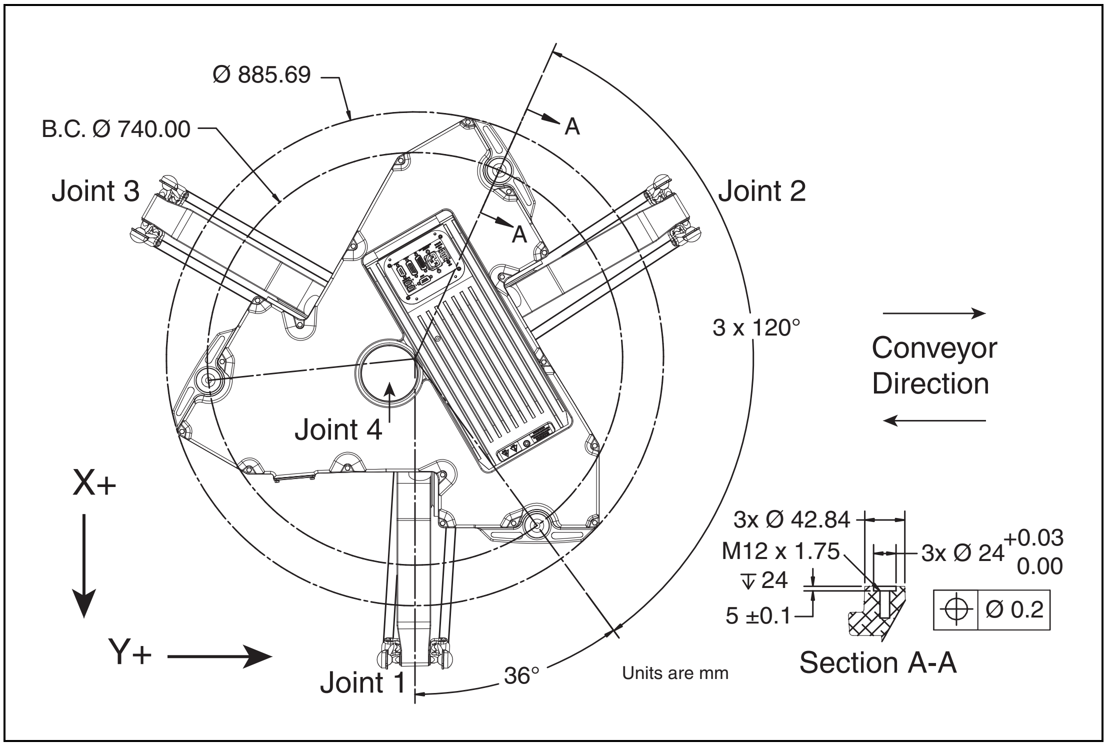


Figure 8-1. Mounting Dimensions

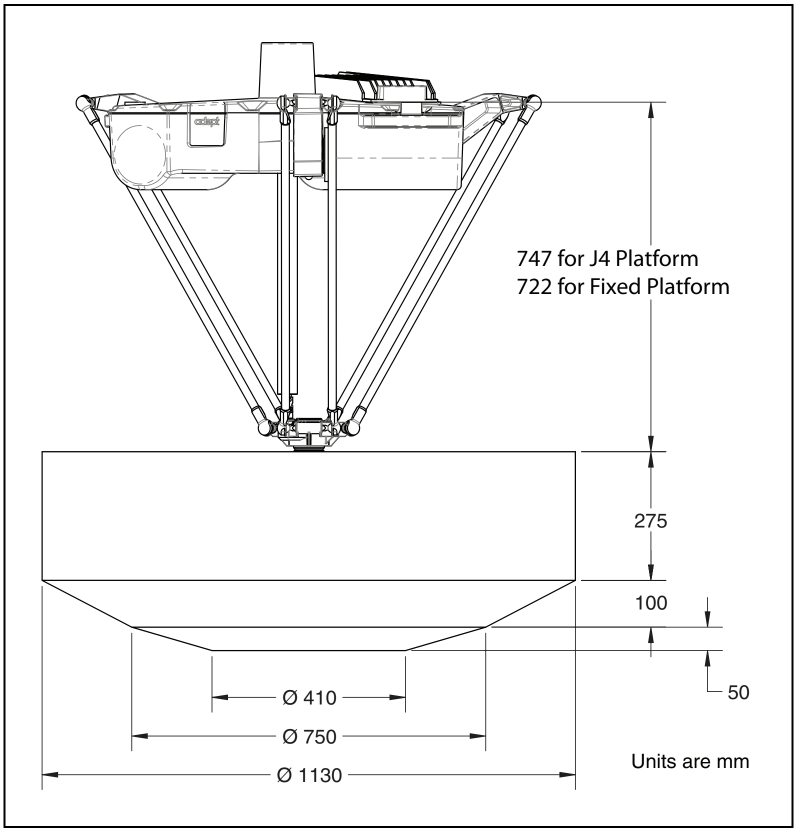


Figure 8-2. Work Envelope, Side View

Tool Flange

The J4 platform has a tool flange that rotates relative to the platform. It is gear-driven, attached to the theta drive shaft.

Ensure that the bolts used to attach end-effectors engage the threads in the tool flange sufficiently. The engagement needs to be between 8 and 11 mm (0.3 and 0.4 in.).

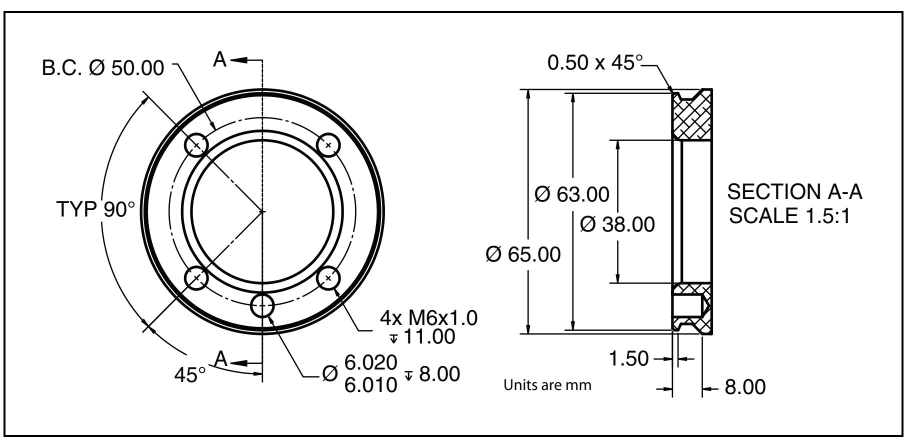


Figure 8-3. Tool Flange Dimensions, Both Platforms

Arm Travel Volume

This represents the space where any part of the arm could go. This is needed for designing a supporting frame. Required clearances for a flat plate are also given.

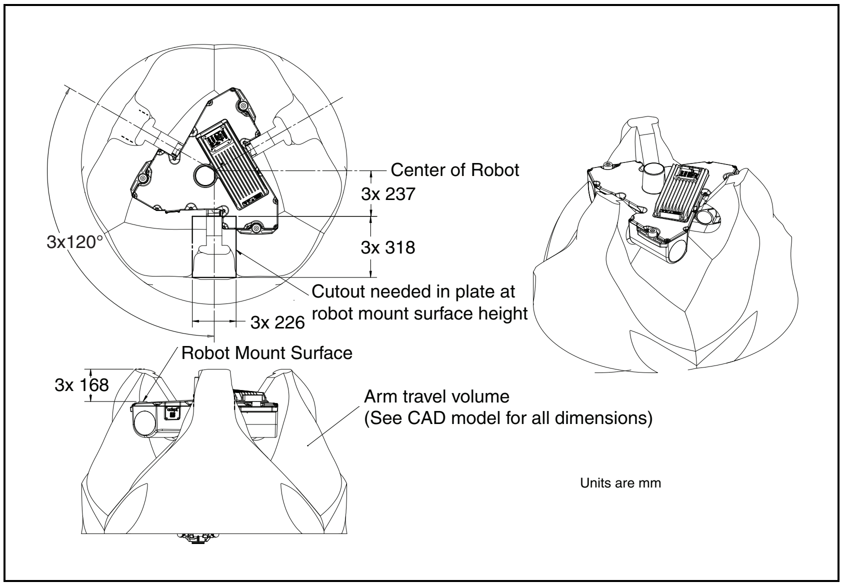


Figure 8-4. Arm Travel Volume

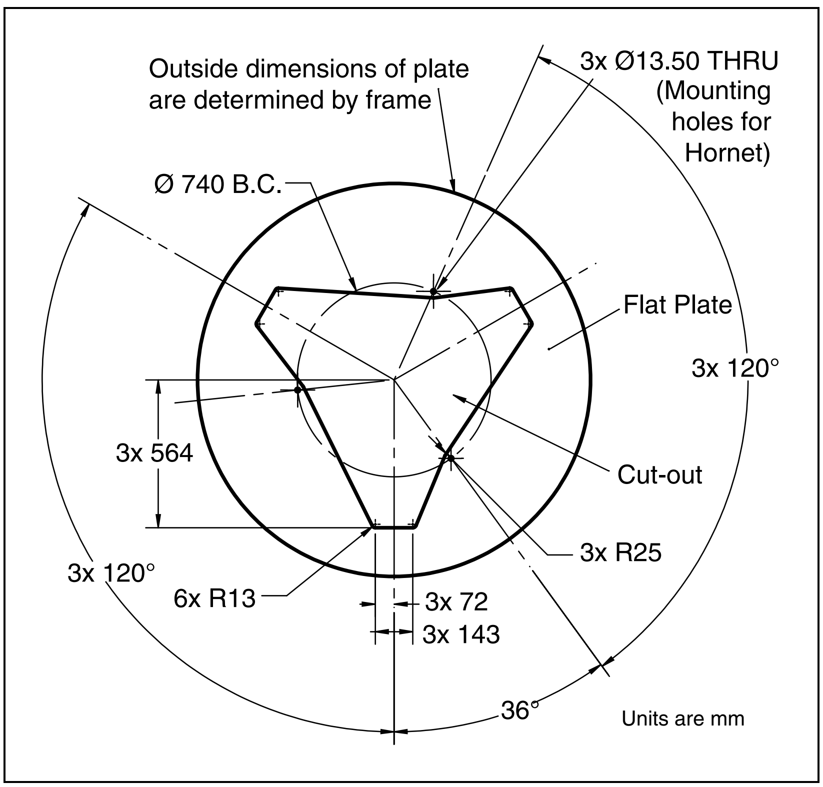


Figure 8-5. Flat Plate Dimensions

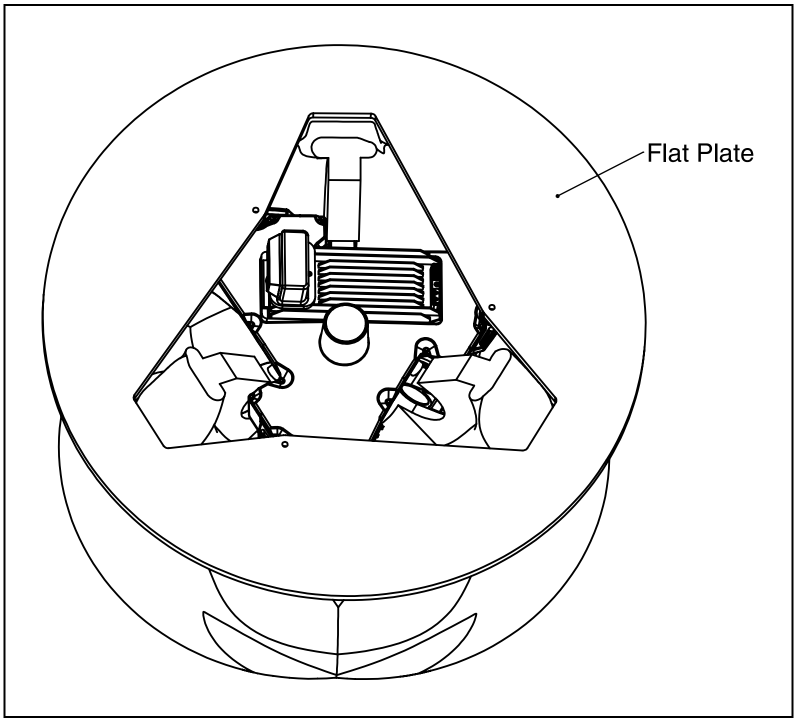


Figure 8-6. Flat Plate Iso View

8.2 Robot Specifications

Specifications subject to change without notice.

Table 8-1. Robot Specifications

Description	Specification	
	J4	Fixed
Work envelope	Ø 1130 mm x Z 275 mm, tapers to Ø 750 mm at Z 375 mm tapers to Ø 410 mm at Z 425 mm	
Joint Range	113° to -47°	
Soft Stops	113° to -47°	
Hard Stops	114.6° to -53°	
Theta Range	±360°	n/a
Encoder type	Absolute	
Robot Brakes	24 VDC	
Weight (no options)	52 kg (115 lb)	48.6 kg (107 lb)
Weight (in crate)	120 kg (265 lb)	116.6 (257)
Digital I/O Channels	12 inputs, 8 outputs	

8.3 Environmental Specifications

Operating

Temperature

1 to +40° C (34 to 104° F)

Humidity

5 to 90%, non-condensing

Shipping and Storage

Temperature

-25 to 60° C (-13 to 140° F)

Humidity

75% or less, non-condensing

8.4 Payload Specifications

Payload

Platform	J4	Fixed
Rated	1.0 kg (2.2 lb)	1.0 kg (2.2 lb)
Maximum	3.0 kg (6.6 lb)	8.0 kg (17.6 lb)

Torque

Maximum: 33 N·m

Maximum rotation: ±360°, J4 platform

NOTE: The fixed platform does not rotate.

NOTE: Take care not to exceed the tool flange torque limits. Excessive torque can cause permanent misalignment of the tool flange.

8.5 Performance

Cycle Times

Description	Specification	
	J4	Fixed
Adept Cycle[a] - seconds	25-305-25 mm	
0.1 kg	0.35 sec.	0.33 sec.
1 kg	0.37 sec.	0.34 sec.
2 kg	0.40 sec.	0.37 sec.
3 kg	0.42 sec.	0.38 sec.
Packaging Cycle[a] - seconds	25-700-25 mm	
0.1 kg	0.50 sec.	0.47 sec.
1 kg	0.54 sec.	0.50 sec.
2 kg	0.58 sec.	0.54 sec.
3 kg	0.62 sec.	0.58 sec.
[a]The robot tool performs continuous path, straight-line motions 25 mm (1 in.) up, 305 or 700 mm (12/27.6 in.) over, 25 mm (1 in.) down, and back along the same path, at 20° C ambient. Not achievable over all paths.		

Power Consumption

	Averaged Sustained Power (W)	Peak Momentary Power (W)	Sustained RMS Current (A)	Cycle Time
Packaging cycle - 25-700-25 mm, 1 kg, no rotation				
1 kg, no rotation	270	1420	2.1	0.54 sec.
Adept cycle - 25-305-25 mm, 1 kg, no rotation				
1 kg, no rotation	260	1160	2.0	0.37 sec.
Long Vertical Strokes - 410 mm, 3 kg, 90° rotation				
3 kg, 90° rotation	270	1630	2.1	0.41 sec.

Stopping Time and Distance

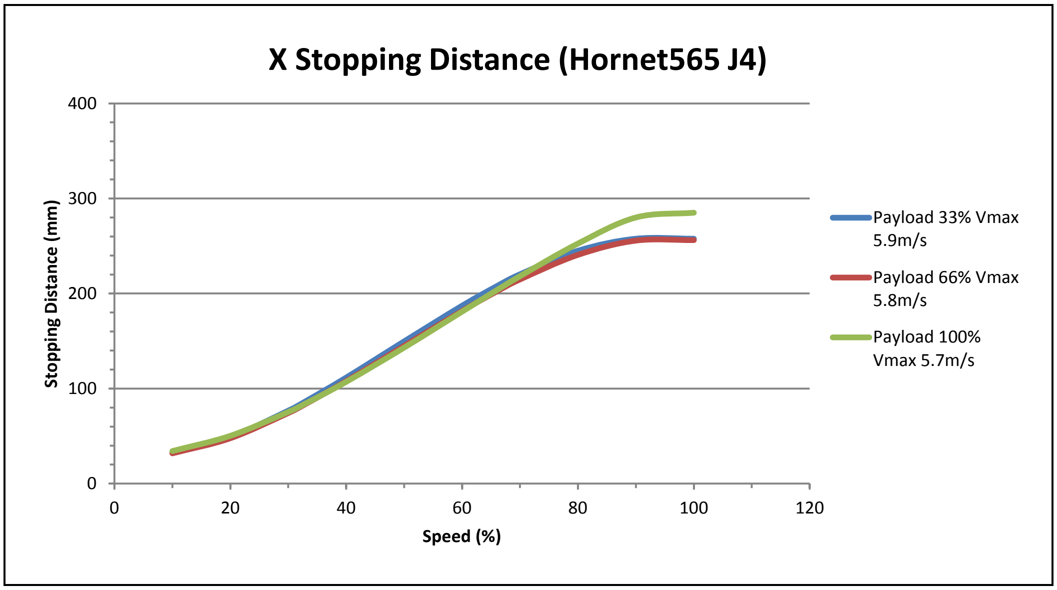


Figure 8-7. Hornet 565 X Stopping Distance with J4 Platform

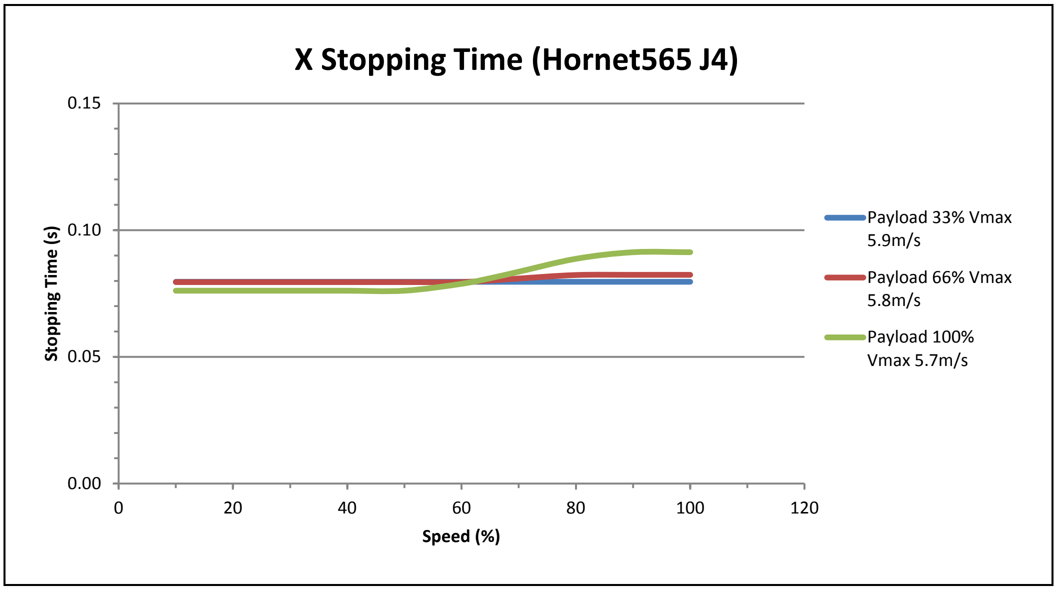


Figure 8-8. Hornet 565 X Stopping Time with J4 Platform

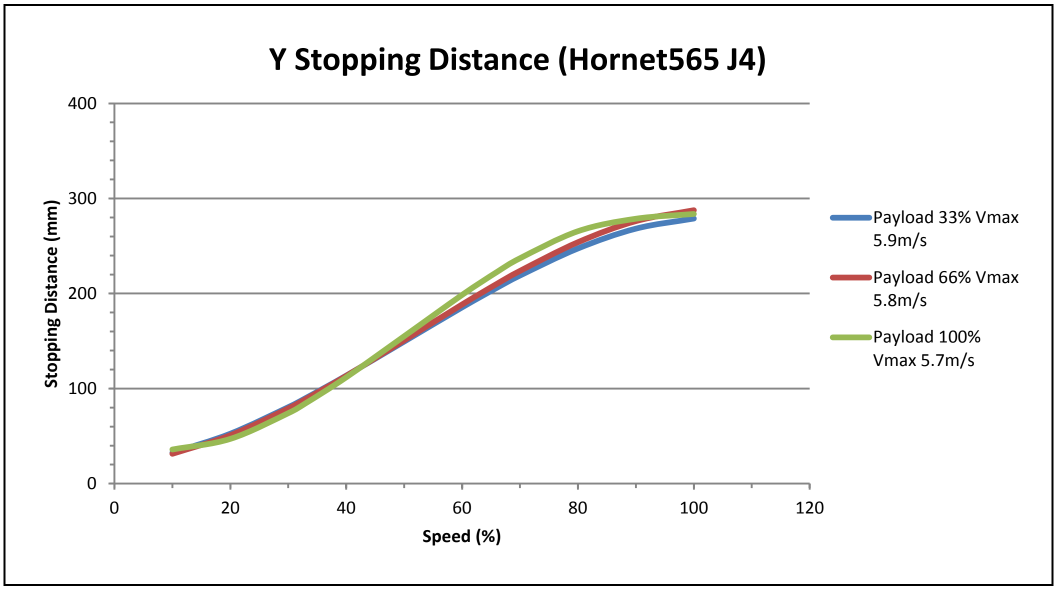


Figure 8-9. Hornet 565 Y Stopping Distance with J4 Platform

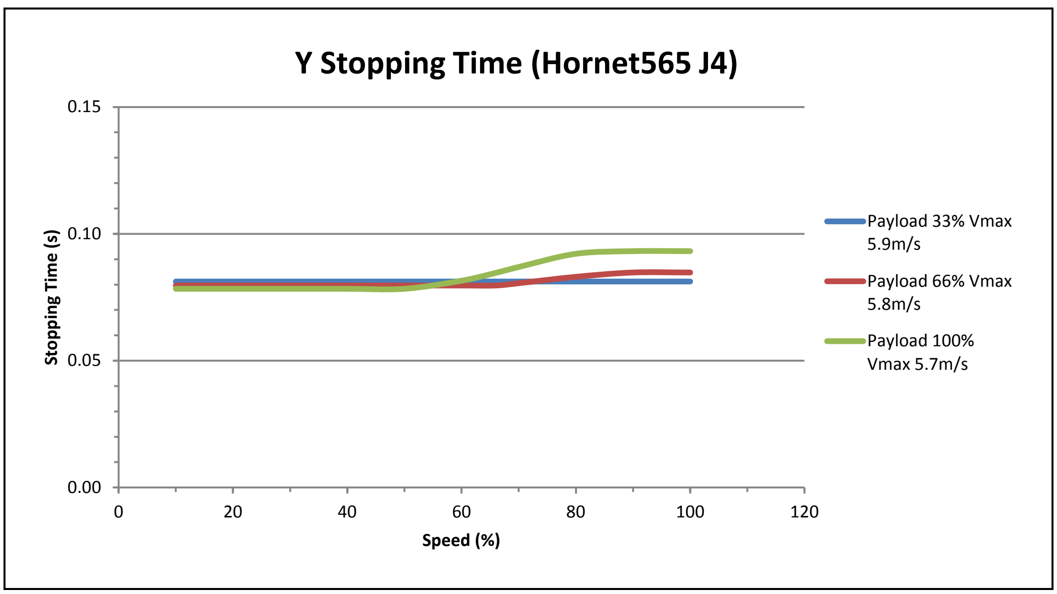


Figure 8-10. Hornet 565 Y Stopping Time with J4 Platform

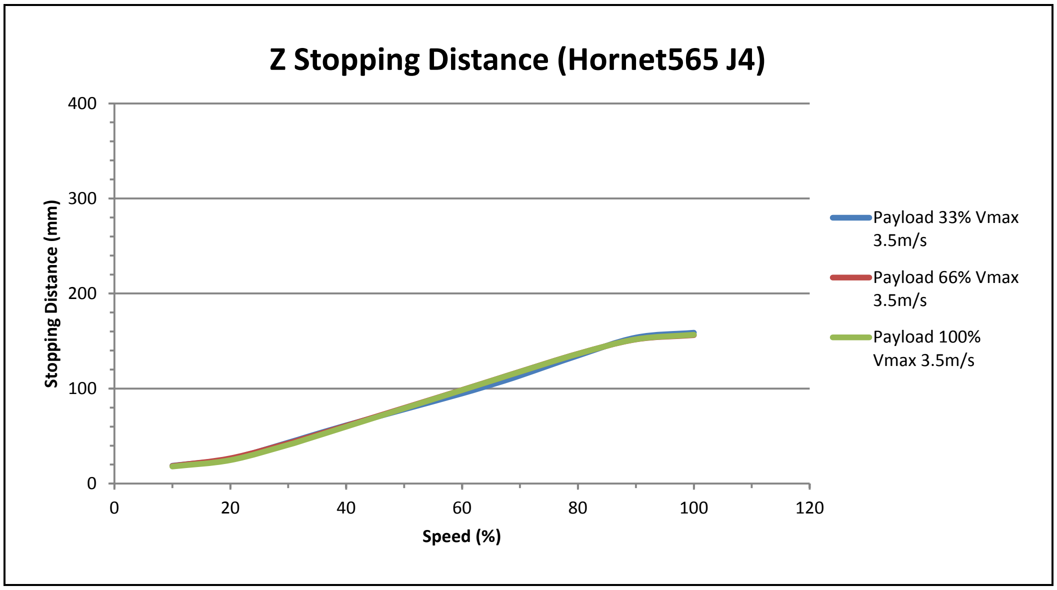


Figure 8-11. Hornet 565 Z Stopping Distance with J4 Platform

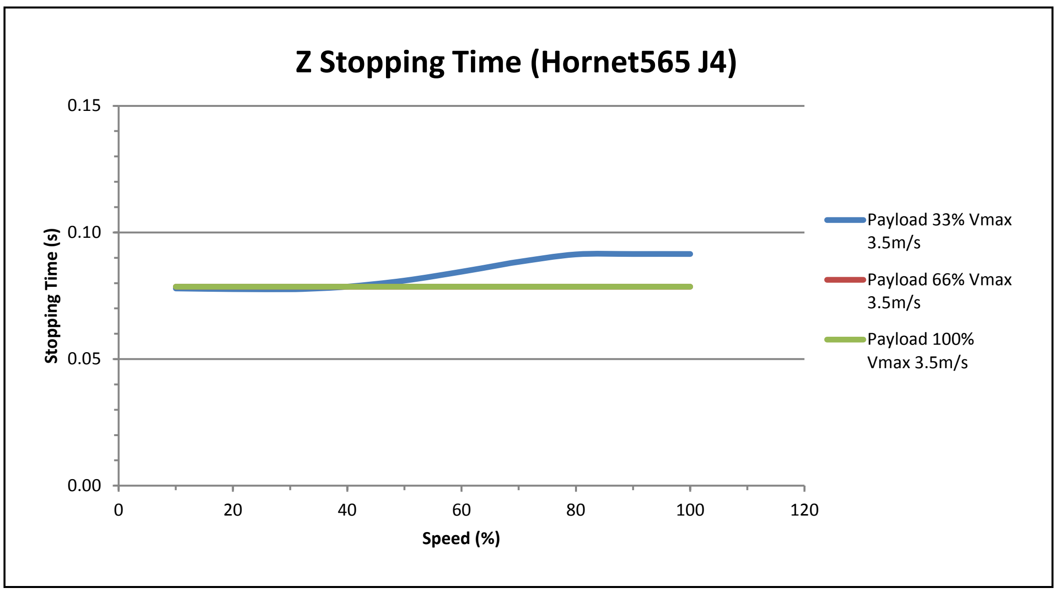


Figure 8-12. Hornet 565 Z Stopping Time with J4 Platform

Figure 8-13. Hornet 565 X Stopping Distance with Fixed Platform

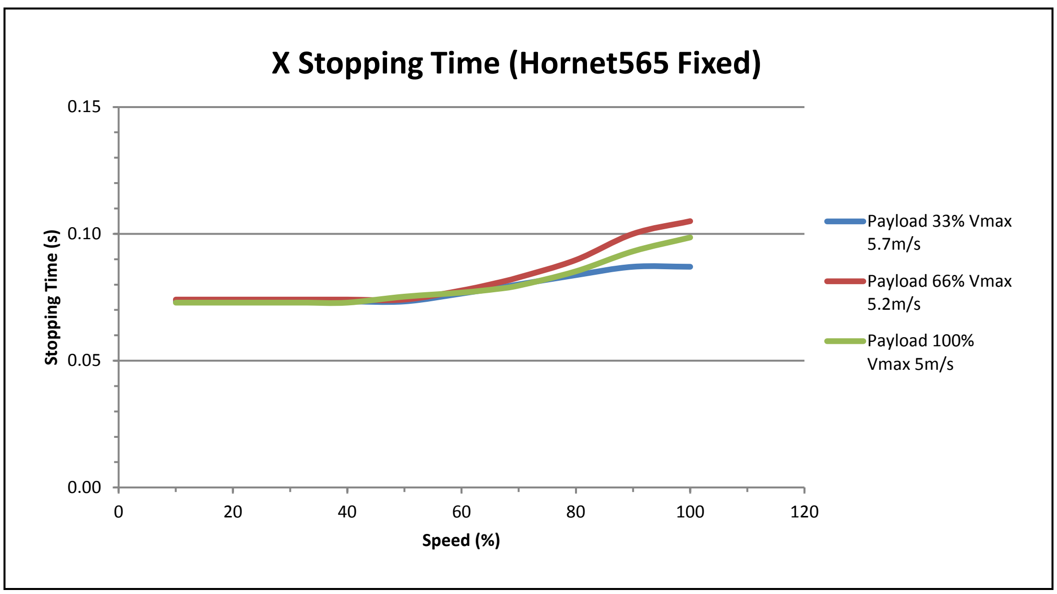


Figure 8-14. Hornet 565 X Stopping Time with Fixed Platform

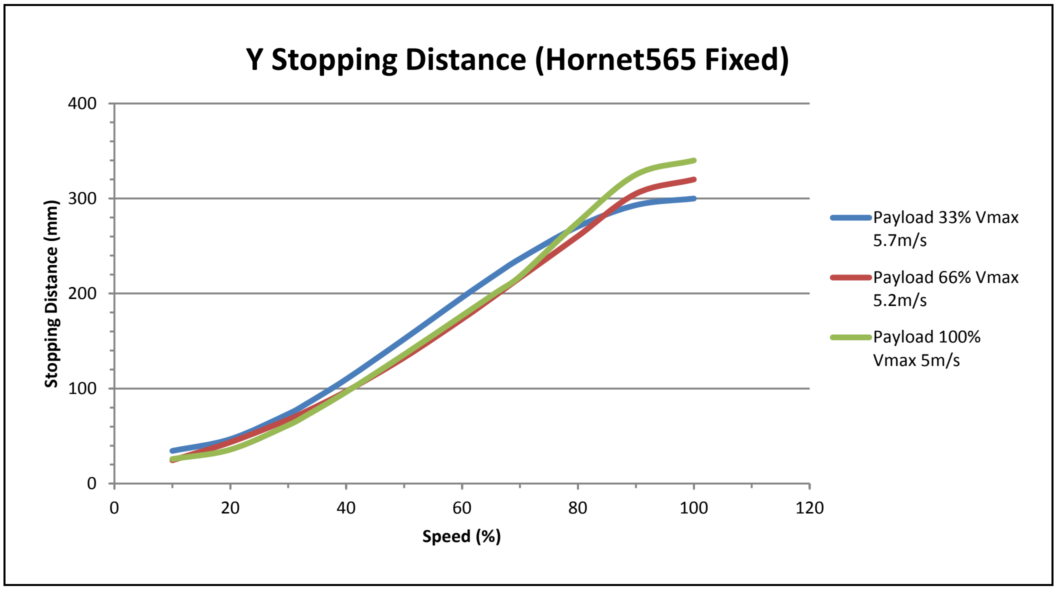


Figure 8-15. Hornet 565 Y Stopping Distance with Fixed Platform

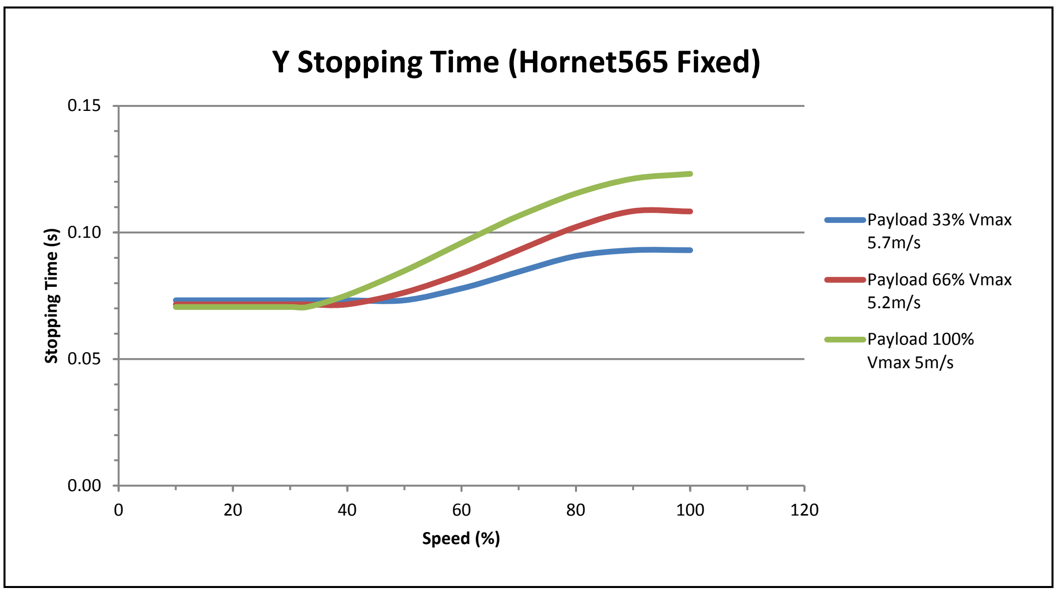


Figure 8-16. Hornet 565 Y Stopping Time with Fixed Platform

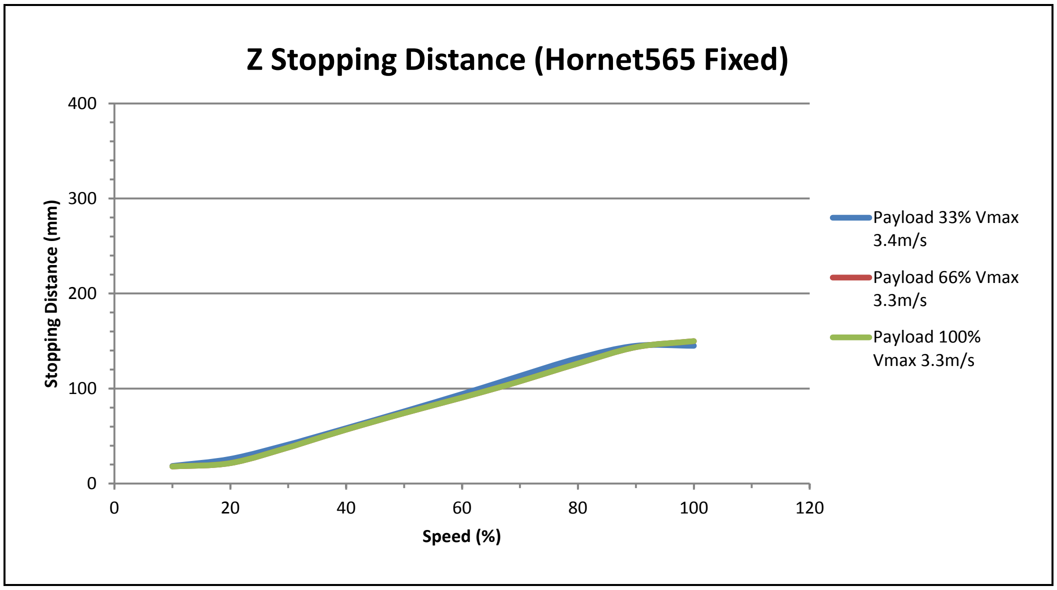


Figure 8-17. Hornet 565 Z Stopping Distance with Fixed Platform

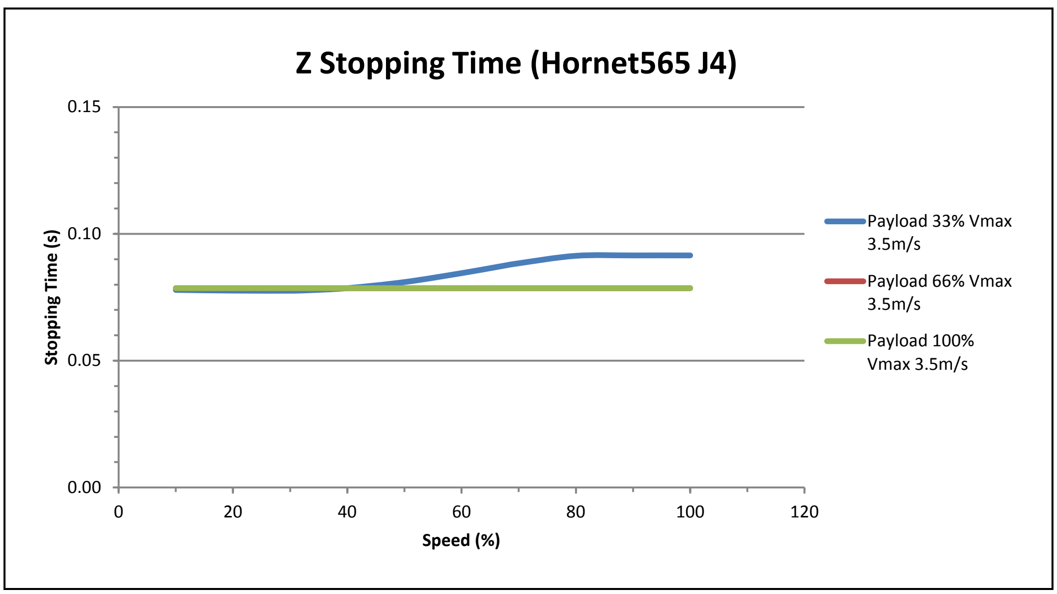


Figure 8-18. Hornet 565 Z Stopping Time with Fixed Platform

Payload Mass vs. Acceleration

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

Table 8-2. Payload Mass vs. Acceleration - Hornet 565, Both Platforms

Platform Type	Payload	Maximum Acceleration			Preferred Acceleration		
	kg	%[a]	m/s^2	g	%[a]	m/s^2	g
Fixed	8.0	110	22	2.2	55	11	1.1
Fixed	7.0	130	25	2.6	65	13	1.3
Fixed	6.0	170	33	3.4	85	17	1.7
Fixed	5.0	220	43	4.4	110	22	2.2
Fixed	4.0	270	53	5.4	135	26	2.7
All	3.0	400	78	8.0	200	39	4.0
All	2.0	450	88	9.0	225	44	4.5
All	1.0	500	98	10.0	250	49	5.0
All	0.1	550	108	11.0	275	54	5.5
	[a]% is the eV+ Accel/Decel setting, which, for the Hornet 565, can be set as high as 750%.						

Payload Inertia vs. Acceleration

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

Table 8-3. Payload Inertia vs. Acceleration

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

NOTE: The fixed platform is not covered in this table because it does not rotate. Payloads for the J4 platform should be designed with their center-of-mass in line with the center axis of the tool flange. This will minimize induced torque during XYZ motions.

8.6 Robot Mounting Frame

The Hornet 565 is designed to be mounted above the work area, suspended from a user-supplied frame. The frame must be adequately stiff to hold the robot rigidly in place while the robot platform moves around the workspace. You can either use the design provided or design a custom support frame. See Mounting Frame on page 23. The drawings for a sample frame are provided here, starting with Mounting Frame, Orthogonal View on page 145.

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

Frame natural frequencies for stable robot operations:

- Frequency > 25 Hz (> 40 Hz for aggressive moves or heavy payloads)
- Mounting surfaces for the robot flanges must be within 0.75 mm (0.029 in.) of a flat plane.

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

CAUTION: Failure to mount the robot within 0.75 mm (0.029 in.) of a flat plane will result in inconsistent robot motions.

The eAIB must be removable from the top of the frame, and the inner and outer arm travel envelopes must be considered. See Arm Travel Volume on page 133.

The following are drawings of a frame suitable for supporting the Hornet 565.

NOTES: (Unless otherwise specified)

- Material: ASTM A500 Carbon Steel, Grade B or Grade C permissible.
- Remove all weld spatter and debris.
- Continuously weld all seams and grind protruding welds to match adjacent surfaces.
- Finish: Powder coat per RAL 9003 - Pure White.
- Remove all burrs and sharp edges.
- Dimensions apply after process.
- Interpret drawings per ANSI Y14.5.
- Dimensions are in mm, [in.]
- Tolerances mm [in.]:
    - 1 place decimals: ±2.5 [0.090]
    - 2 place decimals: ±1.5 [0.060]
    - 3 place decimals: ±0.75 [0.030]
- Angular dimensions: ±0 .5°

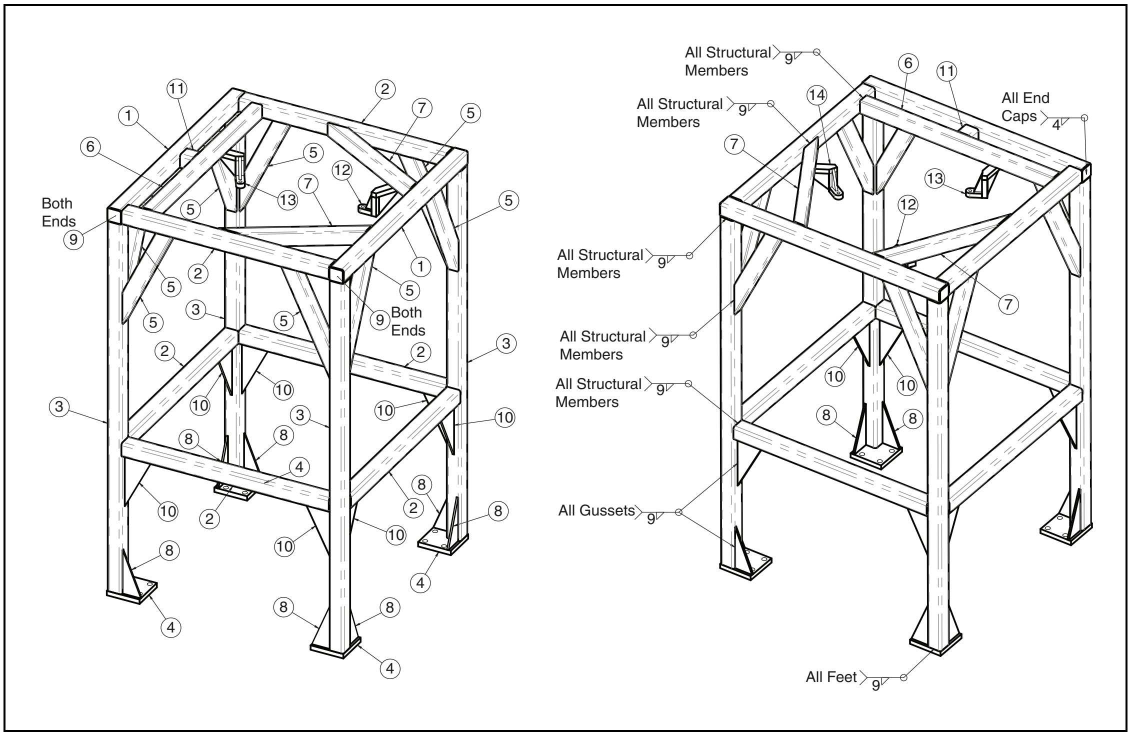


Figure 8-19. Mounting Frame, Orthogonal View

Refer to the following table for item descriptions.

ITEM NO.	QTY.	DESCRIPTION	LENGTH
1	2	Tube, Square, Steel, 80 x 80 x 6.3	1290
2	6	Tube, Square, Steel, 80 x 80 x 6.3	1140
3	4	Tube, Square, Steel, 80 x 80 x 6.3	2130
4	4	Mounting Foot, 25.4 [1.00] Thick	See detail
5	8	Tube, Rectangular, Steel, 80 x 40 x 4.0	(638.95) See detail
6	1	Tube, Rectangular, Steel, 80 x 40 x 4.0	1140
7	2	Tube, Rectangular, Steel, 80 x 40 x 4.0	(749.18) See detail
8	8	Gusset, Mounting Foot, 9.5 [.38] Thick	See detail
9	4	End Cap, 5 [.20] Thick	See detail
10	8	Gusset, 9.5 [.38] Thick	See detail
11	1	Tube, Square, Steel, 80 x 80 x 6.3	70
12	1	Mounting Bracket 1	See detail
13	1	Mounting Bracket 2	See detail
14	1	Mounting Bracket 3	See detail

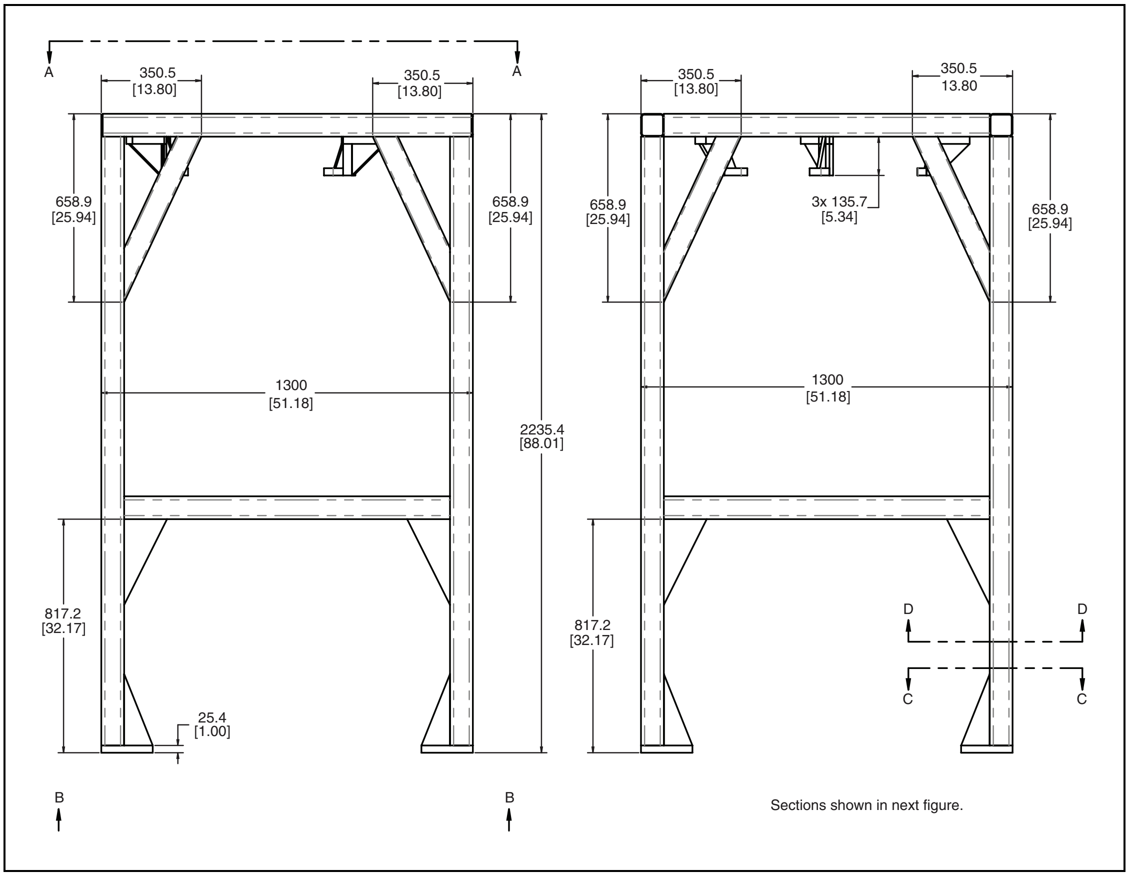


Figure 8-20. Mounting Frame, Side View 1

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

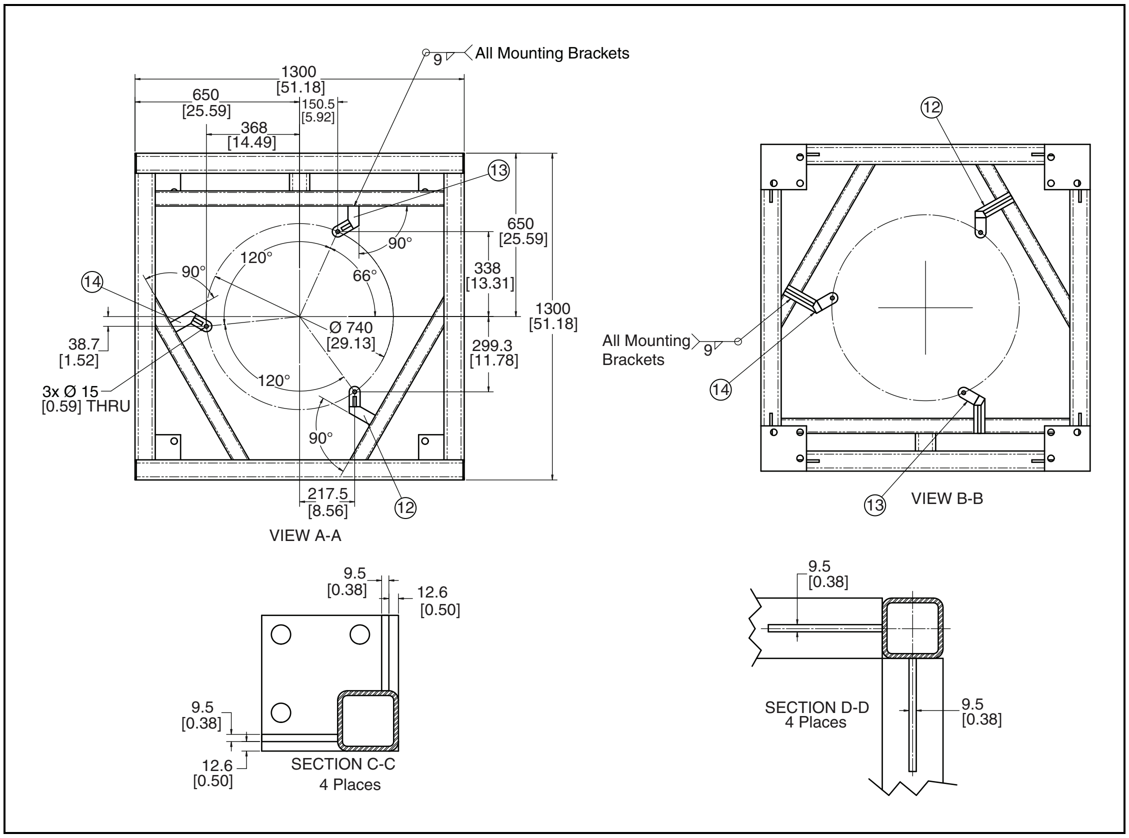


Figure 8-21. Mounting Frame, Top View

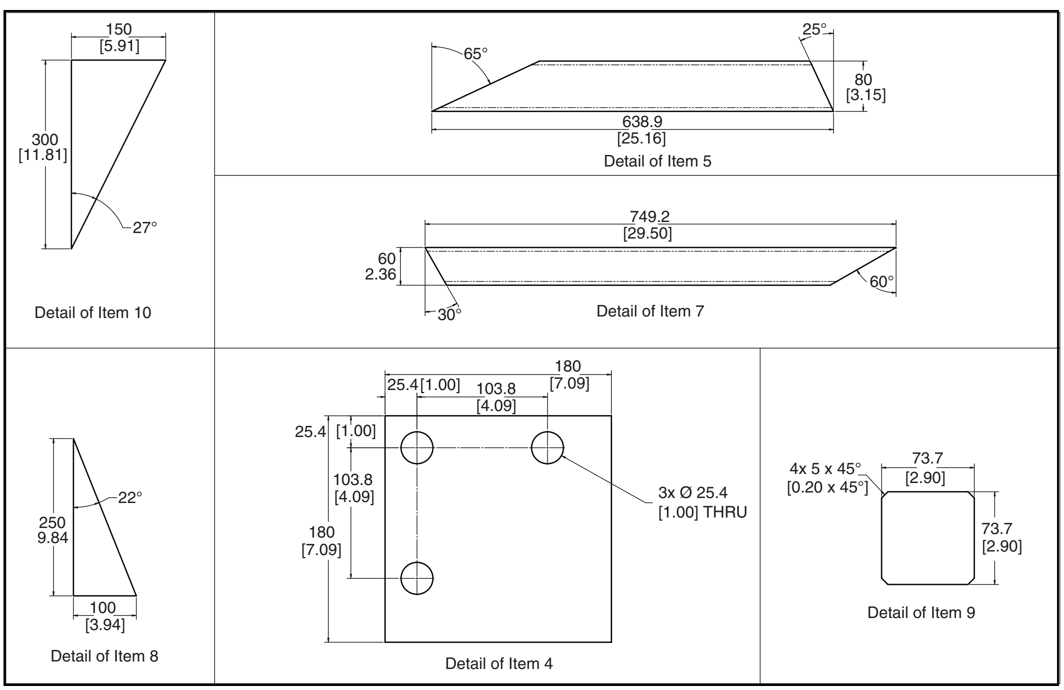


Figure 8-22. Mounting Frame, Details Items 4-5, 7-10

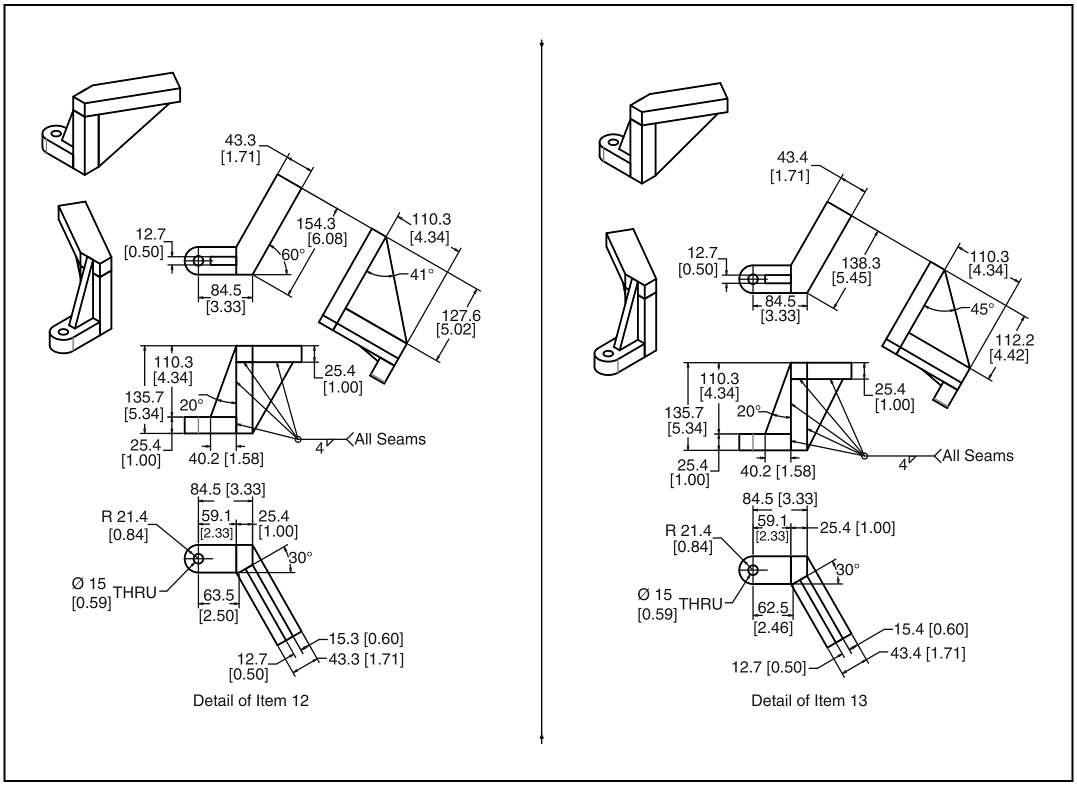


Figure 8-23. Mounting Frame, Detail Items 12 & 13

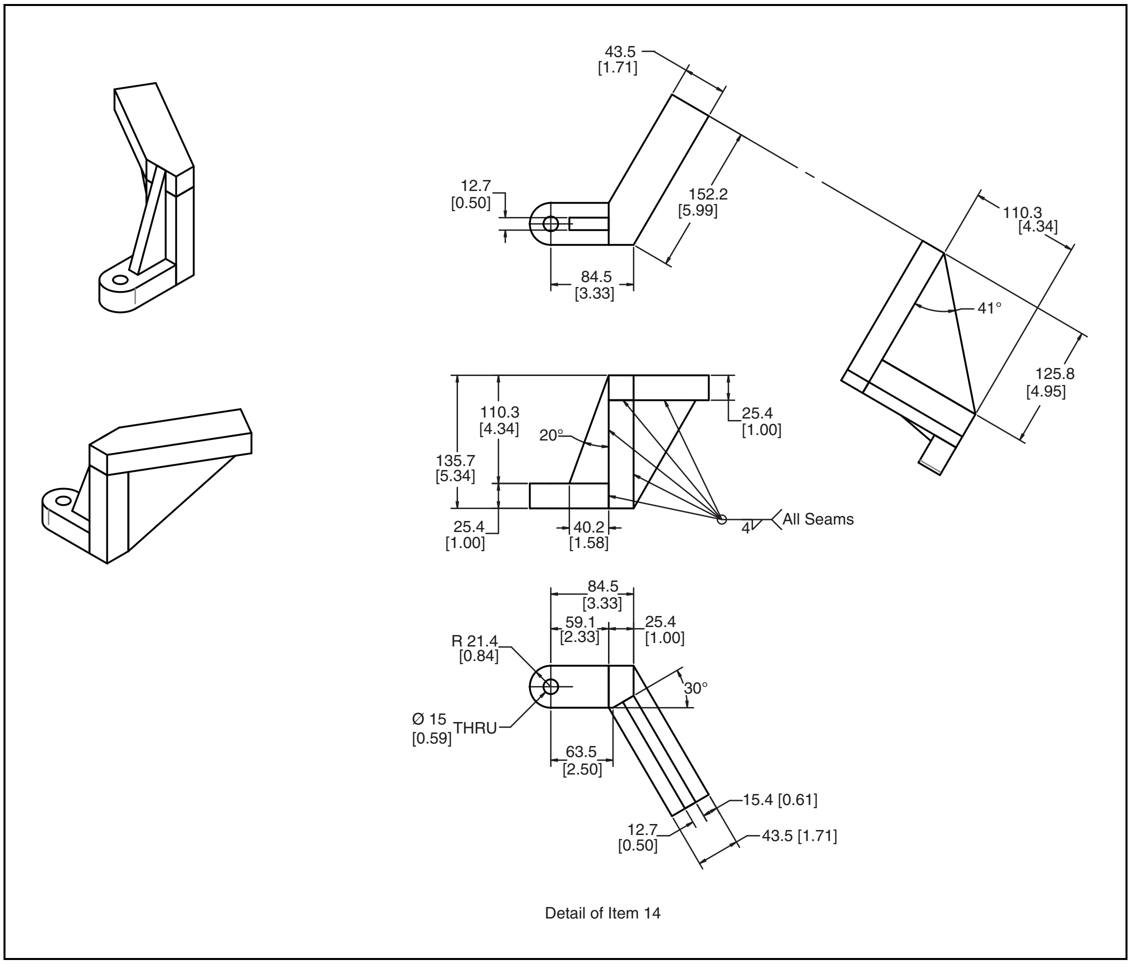


Figure 8-24. Mounting Frame, Detail Item 14

Chapter 9: Environmental Concerns

> **NOTE:** The optional SmartController EX must be installed inside a NEMA-1-rated enclosure.

The rest of this chapter applies to the Hornet 565, not to the SmartController.

The Hornet 565 is designed to be compatible with standard cleaning and operational needs for the handling of food products, as well as less stringent requirements. These design criteria impact how the environment can affect the robot operations, as well as how the robot can affect the cleanliness of its operating environment.

9.1 Ambient Environment

The Hornet 565 is designed for the following operating conditions:

- 1° to 40° C (34° to 104° F) ambient temperature.

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

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

- Humidity of 5% to 90%, non-condensing.

9.2 Cleanroom Classification

The Hornet 565 is rated for cleanroom class 1000.

Please contact Field Support for more information.

9.3 Design Factors

Environmental and cleaning aspects are addressed by the following features in the Hornet 565.

- IP67 rating for the robot platform and outer arms.
- IP65 rating for the underside of the robot.
- Removal and submersion of the platform and outer arms (designed for COP tank).
- Cleaning agents commonly used in food-processing operations. See Chemical Compatibility on page 100.

The Hornet 565 protects the operating environment in the following ways:

- High level of surface coating adhesion prevents erosion during cleaning.
- Lubricants are contained within multiple seals.
- Ball joints and springs/horseshoes are designed for minimal particulate generation.
- The theta drive shaft is designed for minimal particulate generation.
- All moving parts are designed so that small parts are encased within larger assemblies, and are unable to contaminate the work environment.

Robot Base and Components

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

The gearboxes are sealed internally, and sealed externally by a lip seal that is designed to meet IP65 rating.

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

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

Inner Arms

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

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

Ball Joints

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

Refer to Chemical Compatibility on page 100. Contact Omron Adept Technologies, Inc. for more information.

Outer Arms

The outer arms are a composite assembly of carbon fiber and black anodized aluminum. The interior volume of the carbon fiber tube is sealed with an internal and external continuous epoxy bond. The horseshoe-retaining pins are press-fit into the outer-arm ends with a slight interference.

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

Spring Assemblies

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

Platforms

The Hornet 565 supports two types of platforms. The J4 platform is electroless-nickel-plated aluminum. The fixed platform is made of stainless steel.

Both platforms are designed to meet IP67 and the basic criteria of wash-down compatibility and long life. Please contact Omron Adept Technologies, Inc. for more information.

OMRON Corporation **Industrial Automation Company**
Kyoto, JAPAN
Contact: industrial.omron.eu

Regional Headquarters

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

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

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

OMRON ADEPT TECHNOLOGIES, INC.
4550 Norris Canyon Road, Suite 150, San Ramon, CA 94583 U.S.A.
Tel: (1) 925-245-3400/Fax: (1) 925-960-0590

OMRON (CHINA) CO., LTD.
Room 2211, Bank of China Tower, 200 Yin Cheng Zhong Road,
PuDong New Area, Shanghai, 200120, China
Tel: (86) 21-5037-2222/Fax: (86) 21-5037-2200

Authorized Distributor:

Printed in USA
0416
Cat. No. I596-E-01