

Omron Adept Quattro

User's Guide

**covers the Omron Adept Quattro s650H, s650HS,
s800H, and s800HS Robots**



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Chapter 1: Introduction

1.1 Adept Quattro™ Robots, Product Description

The Adept Quattro robot is a four-axis parallel robot. The four identical axis motors control movement of the robot tool in X, Y, and Z directions, as well as Theta rotation.

The Adept Quattro robot requires an Adept SmartController™ motion controller for operation. The robot is user-programmed and controlled using the SmartController motion controller. The robot servo code runs on an Adept SmartServo distributed-motion control platform embedded in the robot base as part of the power amplifiers.

There are two sizes of Adept Quattro robots, each available with anodized and electroless nickel (EN) aluminum platforms and outer arm spoons:

- Adept Quattro s650H (Standard) and Adept Quattro s650HS (EN)
and
- Adept Quattro s800H (Standard) and Adept Quattro s800HS (EN)

The Adept Quattro s650H and s650HS are also available with stainless steel (SS) platforms and outer arm spoons. The inner arm ends, AIB/eAIB, and cable box are electroless nickel.

The electroless nickel and stainless steel versions of the Quattro s650HS robot are USDA Accepted.

In most aspects, the robots are similar enough that they will be covered together. In areas where there are significant differences, the Quattro H and Quattro HS robots will be presented in two chapters, using titles such as Robot Installation - H for the s650H and s800H robots, and Robot Installation—HS for the s650HS and s800HS robots.

Major Differences between Quattro H and HS Robots

Note that any of the available aluminum platforms can be used on the Quattro s650H and s800H robots.

The Quattro s650HS and s800HS have electroless nickel plating on all aluminum parts. The s650HS is also available with stainless steel in place of aluminum for platforms and outer arm ends.

Table 1-1. Quattro H/HS Differences

	Standard (s650H/s800H)	HS (s650HS/s800HS)
USDA Accepted (Meat and Poultry)	No	s650HS - Yes/s800HS - No
IP- rating	IP-65, Option	IP-66, Standard
P30 Platform, no	Hard-anodized, EN, or	Electroless Nickel (EN) or Stainless

	Standard (s650H/s800H)	HS (s650HS/s800HS)
rotation	SS	Steel (SS on s650HS only)
P31 Platform, 46.25°	Hard-anodized, EN, or SS	EN or SS (SS on s650HS only)
P32 Platform, 92.5°	Hard-anodized, EN, or SS	EN or SS (SS on s650HS only)
P34 Platform, 185°	Hard-anodized, EN, or SS	EN or SS (SS on s650HS only)
Inner Arm Hubs and Ends	Hard-Anodized	Electroless Nickel
Outer Arm Spoons	Hard-Anodized	EN or SS (SS on s650HS only)
Base Mounting Pad Holes	M16-2.0, through-hole	M16-2.0, blind, 40 mm bolt
Base Coating material	White polyurethane powder	White ETFE (Teflon), USDA approved
Adept AIB/eAIB	Black Anodized, Single-bolt installation	EN, 6-bolt installation
Cable Inlet box	Hard-Anodized, Option	EN, Standard
Cable tray	Not required	Required (for USDA)
Status Display	Half-height	Full-height, to shield labels
Protective Earth Ground	On base-mounting pad	In cable inlet box
Motor covers	White with blue Adept label	Solid white, no label
Exposed bolts and screws all gasketed	No	Yes

Similarities Between the Quattro Robots

- All models use the same motors
- All models share the same base casting, although the H and HS have some machining and coating differences.
 - The mounting hole pattern for the bases is the same.
- All share the same inner arm design. Platform coatings/materials differ for HS robots, but dimensions do not.
- All can have either an AIB or an eAIB.



Figure 1-1. Adept Quattro Robots (s650H, s650HS shown)

Note the difference between the Status Display Panels, as shown in these two photos.

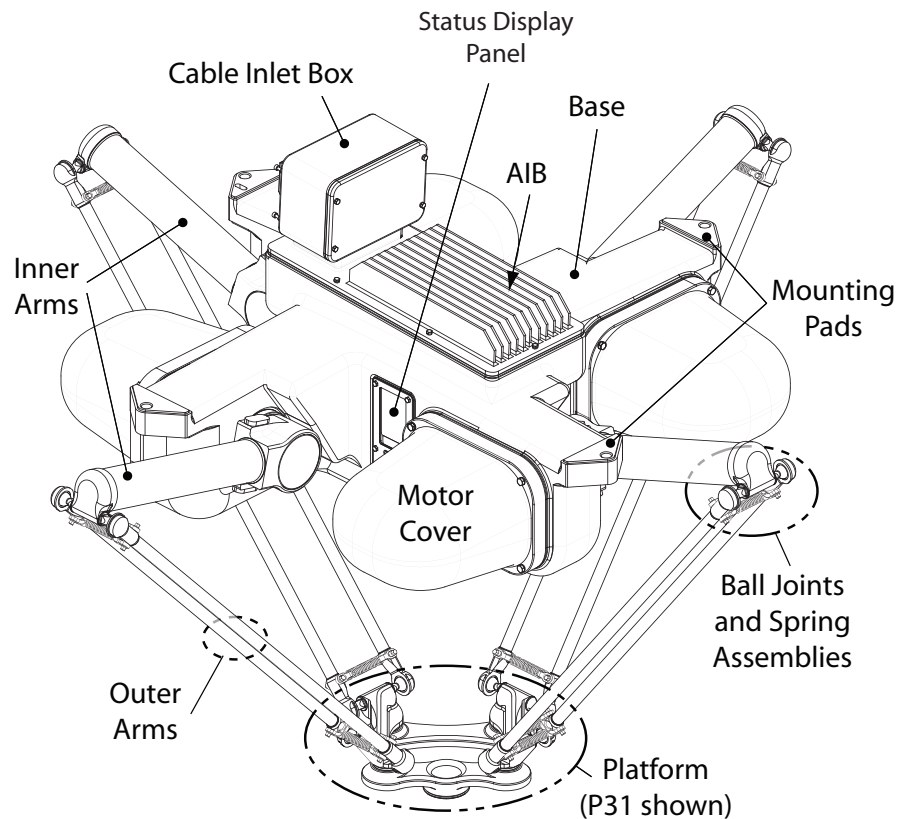


Figure 1-2. Major Robot Components, Isometric View (s650HS shown)

Adept AIB™, eAIB™

The power amplifiers for the Adept Quattro robot are embedded in the base of the robot. This amplifier section is known as the Amplifiers in Base (AIB or eAIB) distributed motion control platform, and provides closed-loop servo control of the robot amplifiers, as well as robot I/O.

There are two versions offered: the AIB and the eAIB. Both provide the power amplifiers and full servo control. Both are available in either anodized or electroless nickel finishes.

The Adept AIB and eAIB feature:

- 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

Adept eAIB only:

- Hardware-based E-Stop and Teach Restrict controls

These are for improved safety relative to European standards implemented in 2012.

The two anodized amplifiers (H) look very similar, and are interchangeable.

The two electroless nickel amplifiers (HS) look very similar, and are interchangeable.

NOTE: The H and HS amplifiers and their cable inlet boxes are not interchangeable.

Quattro Robot Base

The Adept Quattro robot base is an aluminum casting that houses the four drive motors, and supports the power amplifiers. It provides four mounting pads for attaching the base to a rigid support frame. The Status Display Panel is mounted on the side of the robot base.



Figure 1-3. Adept AIBs (Quattro H AIB on left)

Inner Arms

The four robot motors attach directly to the inner arms through a high-performance gear reducer. Other than optional, user-supplied hardware mounted on the platform, these are the only drive motors in the Quattro robot. The following figures show the precision carbon fiber assembly of the inner arms on a Quattro H robot and Quattro HS robot. The ends of the inner arms on the Quattro HS robots are plated with electroless nickel, rather than hard-anodized. The RIA-compliant hard stops limit the inner arm motion to -52° and $+124^{\circ}$.



Figure 1-4. Quattro H Robot Inner Arm, Status Panel



Figure 1-5. Quattro HS Robot Inner Arm, Status Panel

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 $\pm 60^\circ$ of relative motion. No ball joint lubrication is required.

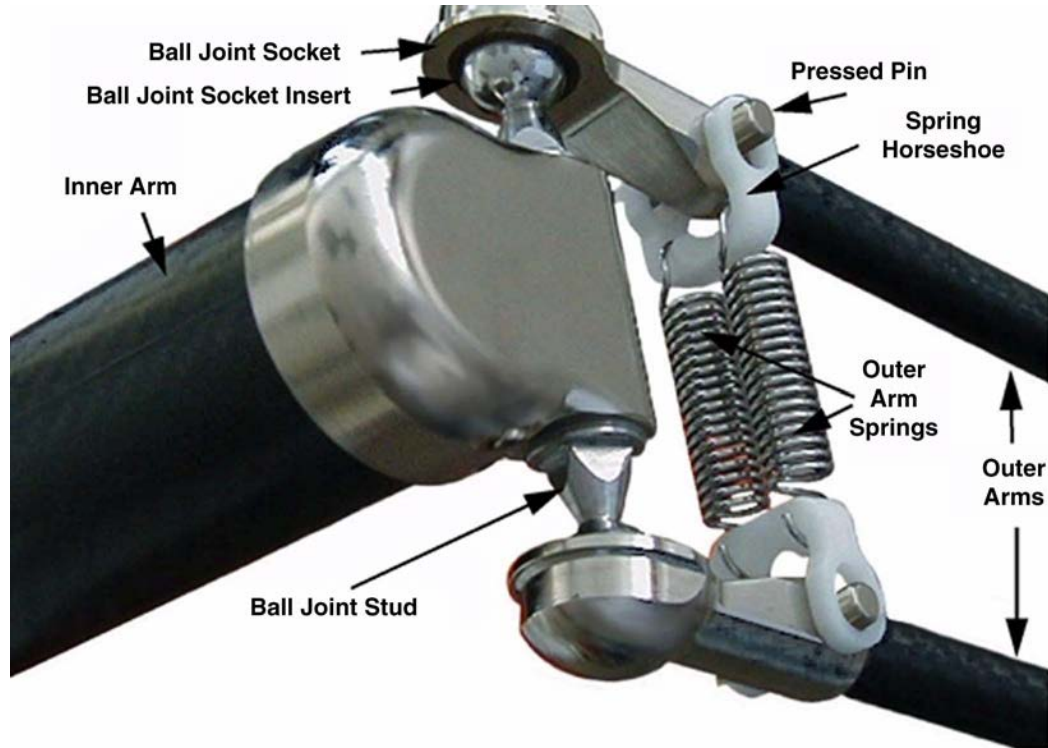


Figure 1-6. Quattro Ball Joint Assembly, Quattro HS Robot shown

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 four Quattro motors into Cartesian motion and, for all but the fixed platform, Theta rotation of the robot tool.

The Adept Quattro robot currently supports four models of platforms, depending on the amount of Theta rotation and inertia needed.

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

The suffix on the part numbers that follow indicates the finish or material of the platform. Refer to Materials and Finishes on page 19.

P31 Platform (P/N 09503-xxx)

The P31 platform has a rotation range of $\pm 46.25^\circ$. The tool flange is machined into one of the pivot links. It does not rotate in relation to the pivot link, so there are no gears or belts involved. See Figure 1-7.

P30 Platform (P/N 09730-xxx)

The P30 platform is a fixed platform that provides no Theta rotation. The tool flange is machined into the one-piece platform. See Figure 1-8.

P32 Platform (P/N 09732-xxx)

The P32 platform has a rotation range of $\pm 92.5^\circ$. The tool flange is mounted on one of the pivot links. See Figure 1-9.

P34 Platform (P/N 09734-xxx)

The P34 platform has a rotation range of $\pm 185^\circ$. The tool flange is mounted on one of the pivot links. See Figure 1-9.

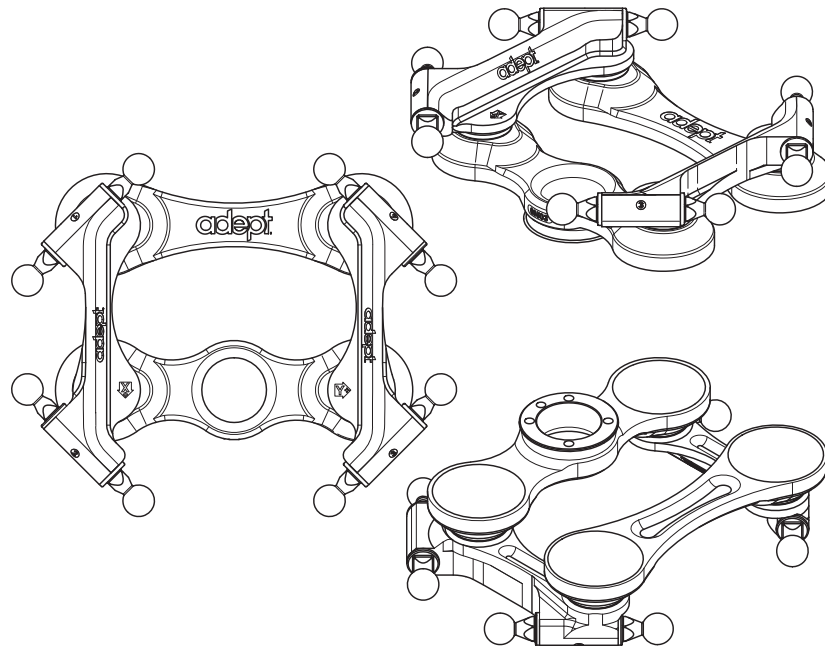


Figure 1-7. P31 Platform, Hard-Anodized Version

NOTE: Adept logo, joint numbers, and axes will not be etched on the electroless nickel platforms.

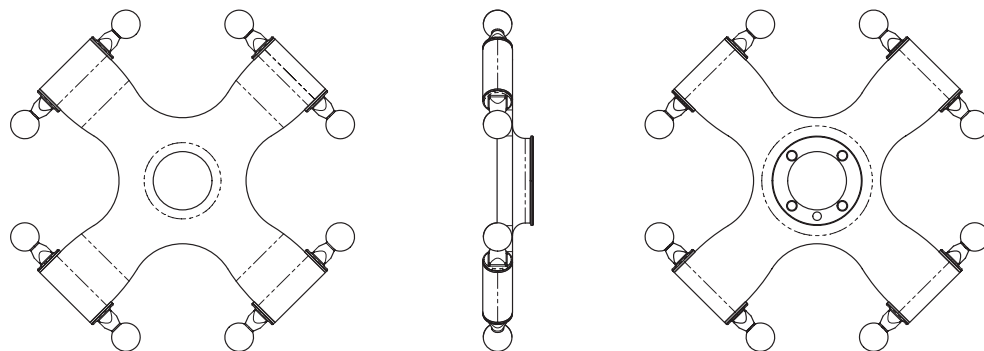


Figure 1-8. P30 Platform, Electroless Nickel and Stainless Steel Versions

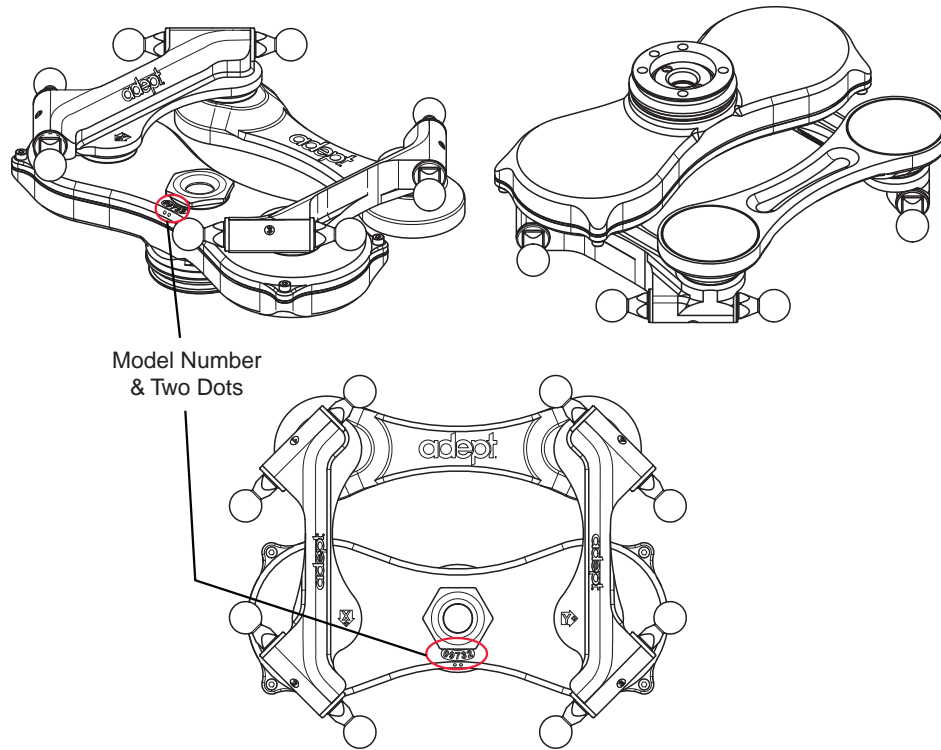


Figure 1-9. P32 Platform, Hard-Anodized Version

NOTE: The only visible difference between the P32 and P34 platforms is the model number, and the two or four dots immediately below that number. Two dots designate a P32 platform.

Materials and Finishes

Platforms are available in:

- Aluminum with hard-anodized finish
- Aluminum with electroless nickel finish
- Stainless steel

The following table shows which materials and finishes are compatible with which robots:

	s650H	s650HS	s800H	Part Number
Hard Anodized	Yes	No	Yes	XXXXX-000
Electroless Nickel	Yes	Yes	Yes	XXXXX-100
Stainless Steel	Yes	Yes	No	XXXXX-200

Platform Clocking

Rotational platforms are constructed such that the clocking, or rotational alignment, of the platform relative to the robot base is critical. This is detailed in *Clocking the Platform to the Base* on page 37.

Platform Shipping

- The platform and outer arms are removed.
- The platform is shipped pre-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.

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

Adept SmartController™

The SmartController motion controller is the foundation of Adept's family of high-performance, distributed motion controllers. The SmartController is designed for use with:

- Adept Quattro robots
- Adept Cobra™ s600/s800 robots
- Adept Viper™ robots
- Adept Python™ linear modules
- Adept MotionBlox-10™ servo-controller and amplifier
- Adept sMI6™ (SmartMotion) interface modules

The controller supports a conveyor tracking option, as well as other options. There are two models available: the SmartController CX, which uses the V+ operating system, and the SmartController EX, which uses the eV+ operating system. Both models offer scalability and support for IEEE 1394-based digital I/O and general motion expansion modules. The IEEE 1394 interface is the backbone of Adept SmartServo, Adept's distributed controls architecture supporting Adept products. The SmartControllers also include Fast Ethernet and DeviceNet.

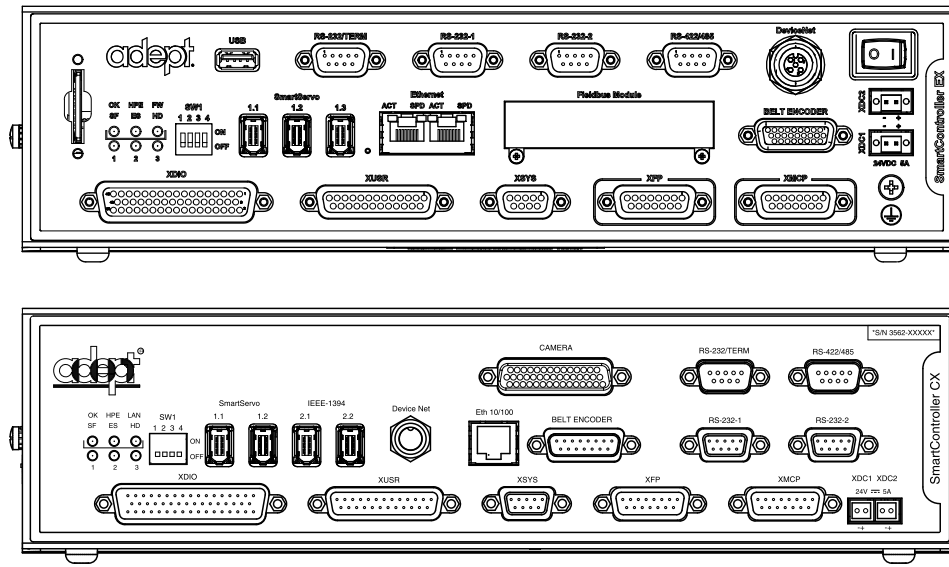


Figure 1-10. Adept SmartController EX and CX

Refer to the [Adept SmartController User's Guide](#) for SmartController specifications.

1.2 Warnings, Cautions, and Notes in Manual

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



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



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



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



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



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

NOTE: Notes provide supplementary information, emphasize a point or procedure, or give a tip for easier operation.

1.3 Safety Precautions



DANGER: An Adept Quattro s650/s800 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 [Adept Robot Safety Guide](#), and complete a training course for their responsibilities in regard to the robot.
- All personnel who design the robot system must read this guide, read the [Adept Robot Safety Guide](#), and must comply with all local and national safety regulations for the location in which the robot is installed.
- The robot system must not be used for purposes other than described in Intended Use of the Robots on page 23. Contact Adept 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.

1.4 What to Do in an Emergency

Press any E-Stop button (a red push-button on a yellow background/field) and then follow the internal procedures of your company or organization for an emergency situation. If a fire occurs, use CO₂ to extinguish the fire.

1.5 Additional Safety Information

Adept provides other sources for more safety information.

The Manufacturer's Declaration of Conformity (MDOC) lists all standards with which each robot complies. See Manufacturer's Declaration on page 24.

The [Adept Robot Safety Guide](#) provides detailed information on safety for Adept robots. It also gives resources for more information on relevant standards. It ships with each robot manual, and is also available from the Adept Document Library. For details, see Adept Document Library on page 25.

1.6 Intended Use of the Robots

The Adept Quattro s650 robot is intended for use in parts assembly and material handling for payloads up to 6.0 kg (13.2 lb) for anodized and electroless nickel platforms, and payloads up to 3 kg (6.6 lb) for stainless steel platforms.

The Adept Quattro s800 robot is intended for use in parts assembly and material handling for payloads up to 4.0 kg (8.8 lb).

See Robot Specifications on page 120 for complete information on the robot specifications. Refer to the [Adept Robot Safety Guide](#) for details on the intended use of Adept robots.

1.7 Installation Overview

The system installation process is summarized in the following table. Also, refer to System Cable Diagram on page 71.

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

Table 1-2. Installation Overview

Task to be Performed	Reference Location
Mount the cable box (Quattro HS robot or Quattro H robot with IP-65 option).	Cable Inlet Box on page 48 and Installing Cable Seal Kit on page 184.
Mount the robot to a level, stable mounting frame.	Mounting the Robot Base on page 32.
Attach the robot outer arms and platform.	Attaching the Outer Arms and Platform on page 37.
Install the SmartController, Front Panel, Pendant (if purchased), and Adept ACE software.	Installing the SmartController Motion Controller on page 72.
Install the IEEE 1394 and XSYS cables between the robot and SmartController.	Cable Connections from Robot to SmartController on page 75.
Create a 24 VDC cable and connect it between the SmartController and the user-supplied 24 VDC power supply.	Installing the SmartController Motion Controller on page 72.
Create a 24 VDC cable and connect it between the robot and the user-supplied 24 VDC power supply.	Connecting 24 VDC Power to Robot on page 76.
Create a 200-240 VAC cable and connect it between	Connecting 200-240 VAC Power to

Task to be Performed	Reference Location
the robot and the facility AC power source.	Robot on page 79.
Install user-supplied safety barriers in the workcell.	Installing User-Supplied Safety Equipment on page 84.
Connect digital I/O through the robot XIO connector.	Using Digital I/O on Robot XIO Connector on page 89.
Start the system, including system start-up and testing operation.	Starting the System for the First Time on page 96.
Install optional equipment, including end-effectors, user air and electrical lines, external equipment, etc.	End-Effectors on page 105.

1.8 Manufacturer's Declaration

The Manufacturer's Declaration of Incorporation and Conformity for Adept robot systems can be found on the Adept website, in the Download Center of the Support section.

<http://www.adept.com/support/downloads/file-search>

NOTE: The Download Center requires that you are logged in for access. If you are not logged in, you will be redirected to the Adept website Login page, and then automatically returned to the Download Center when you have completed the login process.

1. From the Download Types drop-down list, select Manufacturer Declarations.
2. From the Product drop-down list, select Adept Quattro Robots category.
3. Click Begin Search. The list of available documents is shown in the Search Results area, which opens at the bottom of the page. You may need to scroll down to see it.
4. Use the Description column to locate the document for the language you want, and then click the corresponding Download ID number to access the Download Details page.
5. On the Download Details page, click Download to open or save the file.

1.9 How Can I Get Help?

Refer to the How to Get Help Resource Guide (Adept P/N 00961-00700) for details on getting assistance with your Adept software and hardware. Additionally, you can access information sources on Adept's corporate website:

<http://www.adept.com>

Related Manuals

This manual covers the installation, operation, and maintenance of an Adept Quattro robot system. There are additional manuals that cover programming the system, reconfiguring installed components, and adding optional components. See the following table. These manuals are available on the Adept software CD-ROM shipped with each system.

Table 1-3. Related Manuals

Manual Title	Description
Adept Robot Safety Guide	Contains safety information for Adept robots.
Adept SmartController User's Guide	Contains complete information on the installation and operation of the Adept SmartController and the optional sDIO product.
Adept ACE User's Guide	Describes the installation and use of Adept ACE.
Adept Dual-Robot Configuration Procedure	Contains cable diagrams and configuration procedures for a dual-robot system.
Adept T20 Pendant User's Guide Adept T2 Pendant User's Guide	Describes the use of the optional Adept manual control pendant.

Adept Document Library

The Adept Document Library (ADL) contains documentation for Adept products. You can access the ADL from the Adept website. Select:

Support > Document Library

from the Adept home page. To go directly to the Adept Document Library, type the following URL into your browser:

http://www.adept.com/Main/KE/DATA/adept_search.htm

To locate information on a specific topic, use the Document Library search engine on the ADL main page, or select one of the available menu options. To view a list of available product documentation, use the menu links located above the search field.

Chapter 2: Robot Installation - H

2.1 Transport and Storage

This equipment must be shipped and stored in a temperature-controlled environment, within the range -25 to $+55^{\circ}\text{C}$ (-13 to 131°F). The recommended humidity range is 5 to 90 percent, non-condensing. It should be shipped and stored in the Adept-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 and store the packaged equipment.

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

The Adept Quattro robot weighs 118 to 123 kg (260 to 271 lb) with no options installed.

2.2 Unpacking and Inspecting the Adept Equipment

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.

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 Adept as soon as possible (see How Can I Get Help? on page 25).
- If the items received do not match your order, please contact Adept 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 Adept Quattro robot is shipped in a crate that holds the robot base, outer arms, platform, controller, miscellaneous hardware, and any accessories ordered. The crate will be combined wood and cardboard.

The top of the crate should be removed first.

1. Remove the bands holding the top to the rest of the crate. Refer to the following figure.

The outer arms will be above the robot base. These should be removed from the crate, followed by the cardboard and foam that support them.

NOTE: Outer arms for the Quattro s800 robot are packaged differently from the Quattro s650. Refer to Figure 2-2.

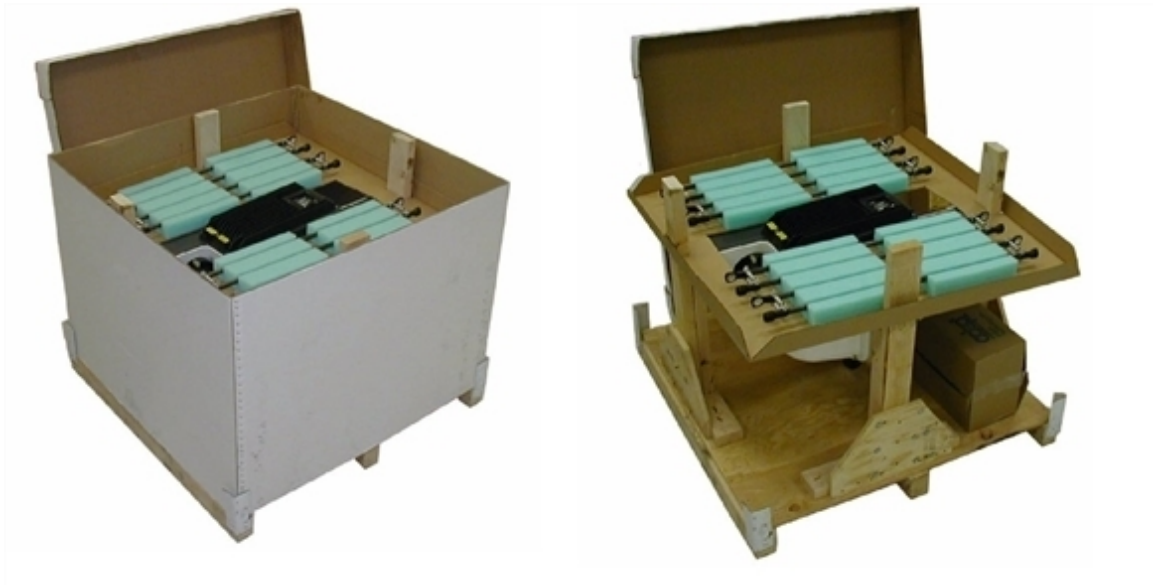


Figure 2-1. Shipping Crate (s650H shown)

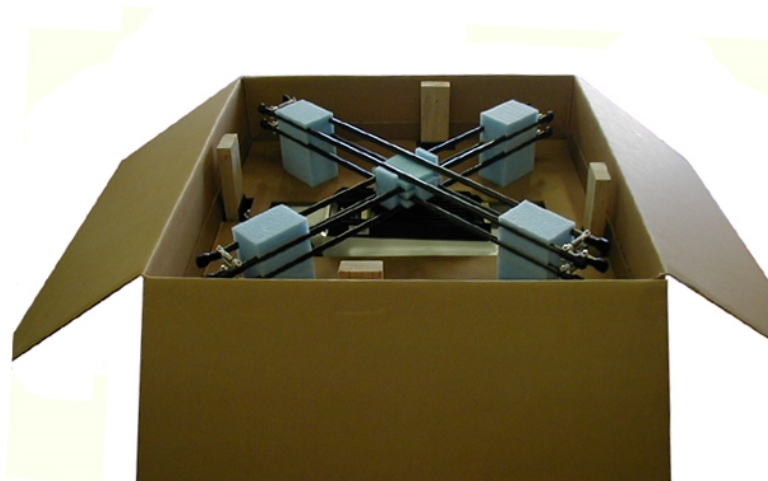


Figure 2-2. Outer Arms for the Quattro s800 (s800H shown)

The robot base is shipped with the inner arms attached. The outer arms are shipped separate from the robot base, assembled in pairs. The platform is shipped fully assembled, but separate from the robot base and outer arms.

Under the robot base, the ancillary items will be attached to the crate bottom.

2. Lift off the cardboard sides.
3. Remove the lag bolts holding the robot base to the crate sides.

2.3 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.

2.4 Environmental and Facility Requirements

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

Table 2-1. 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)
Pollution degree	2
Protection class: robot base	IP-65 (with optional cable sealing kit)
Protection class: arms, platform	IP-67
Note: For robot dimensions, see Technical Specifications on page 111.	
Note: For power requirements, see Connecting 24 VDC Power to Robot on page 76 and Connecting 200-240 VAC Power to Robot on page 79.	
Note: The Adept SmartController must be installed inside a NEMA-1 rated enclosure. The controller must not come into contact with liquids.	

2.5 Mounting Frame

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

While Adept does not offer robot frames for purchase, and the frame design is the responsibility of the user, we provide here some general guidelines as a service to our users. Adept makes no representation or warranty with respect to these guidelines, or the rigidity and longevity of the structure designed and built by the user or for the user by a third party using these guidelines. In addition, when the robot is mounted on the structure based on these guidelines, Adept does not guarantee that the robot will perform to the specifications given in this product documentation, due to user's frame or user's production environmental factors.

As an example, a sample frame design is presented and discussed. For generalized application performance, frames built to the specifications of this sample should experience no

degradation in robot performance due to frame motions. Applications requiring higher than 6 kg * 10 g forces across the belt and/or 6 kg * 3 g along the belt may require a stiffer frame design.

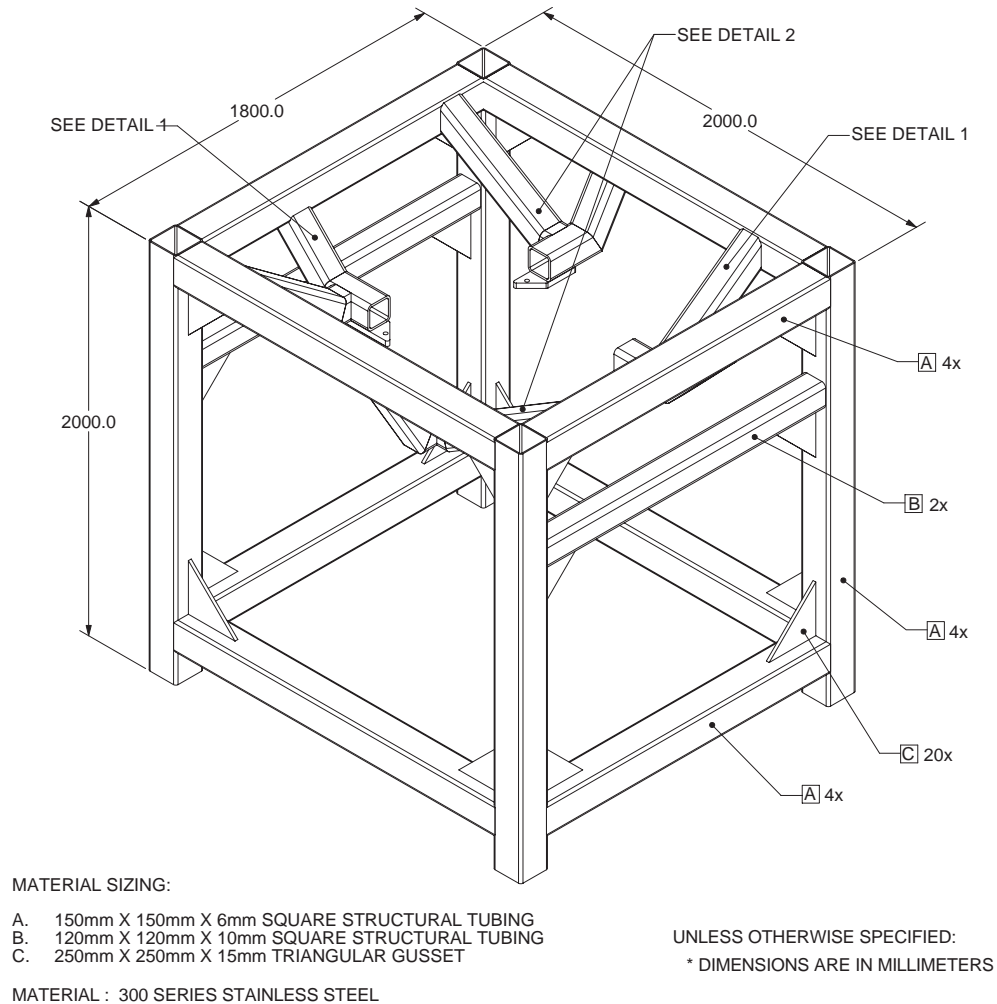


Figure 2-3. Sample Quattro Mounting Frame

NOTE: More specifications for the sample frame are provided in Robot Mounting Frame, Quattro s650H Robot on page 124.

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.

Frame Orientation

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

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

Frame Construction

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

Robot-to-Frame Considerations

The Quattro 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 (s650 shown) on page 118 shows the inner arm travel and how it may encroach on the robot mounting points. As a starting point, for a frame that is 2 meters in each direction, (allowing use of the full range of the Quattro s650 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

The robot mounts in four locations, as detailed in the drawings. The holes are tapped for an M16 x 2.0 bolt. The Adept Quattro robot may be mounted from the top or bottom of the frame. A crane or forklift should be used to position the robot. If lifted from above, the robot must be lifted by user-supplied eyebolts and slings.

Figure 7-2 shows the mounting hole pattern for the Adept Quattro robot. 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. If the frame does not meet this flatness specification, use shims to achieve it.

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

Gussets

The triangular gussets are an integral part of the frame stiffness. The vibrational strength of a structural assembly is strongly governed by controlling the shear forces between members. The 250 mm gussets, shown in Figure 2-3, are nominally sufficient for transferring the load from the vertical members into the horizontal cross pieces. Preferably, gussets should be placed at the edges of the frame members to transfer the loading into the walls of the members, instead of the faces, and enable easier cleaning. Some frame designs may benefit from extending these gussets to 500 mm in the vertical direction, as the design intent of the gussets is mainly to secure the long vertical members from rotating out of position. For this reason, the gussets to the across-the-belt horizontal member should be at the bottom of the member, as shown in Figure 2-3, and as close to the vertical midplane of the frame as feasible (15 mm thickness is adequate for most situations).

2.6 Mounting the Robot Base

NOTE: All mounting hardware is user-supplied.



CAUTION: Remove all ancillary components (controller, outer arms, platform, etc.) from the shipping crate before lifting the robot base.

Robot Orientation

Adept recommends mounting the Adept Quattro robot 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, status LED, and Brake-Release button. It also balances the arm loading for aggressive moves across the belt.

This orientation places the robot World Y-axis along the conveyor belt, and the X-axis across the belt.

Mounting Surfaces

Mounting surfaces for the robot mounting flanges must be within 0.75 mm of a flat plane. If the surfaces do not meet this tolerance, use shims to attain it.



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

Mounting Options

Using the mounting frame design provided by Adept, there are several options for mounting the Adept Quattro robot:

- Lower the robot into the frame from above, or
Lift the robot into the frame from below.
- Place the robot mounting pads on top of the frame mounting pads, or
Place the robot mounting pads under the frame mounting pads.
- Mounting hardware can be bolts threaded directly into the robot base mounting pads, or bolts that go through the robot base mounting pads into nuts.



CAUTION: Do not attempt to lift the robot from any points other than with eyebolts or slings as described here, or with a padded board, as described here.

Mounting Procedure from Above the Frame

The Adept Quattro robot has four mounting pads. Each pad has one M16 x 2.0 threaded through-hole. The robot can be mounted either on top of the frame pads, using the bottom surface of the robot base mounting pads, or to the bottom of the frame pads, using the top surface of the robot base mounting pads.

Mounting to Top of Frame Pads

This procedure uses two user-supplied M16 x 2.0 eyebolts and jam nuts.

1. Remove all lag bolts from the robot base mounting pads.
2. Screw the M16 eyebolts into opposing robot mounting pads, so that the robot will be balanced when lifted.
3. Lock each eyebolt with a jam nut.
4. Connect slings to the M16 eyebolts and take up any slack in the slings.



CAUTION: Do not attempt to lift the robot from any points other than the eyebolts. Failure to comply could result in the robot falling and causing either personnel injury or equipment damage.

5. Lift the robot and position it directly over the mounting frame.
6. Slowly lower the robot while aligning the M16 holes in the robot mounting pads with the holes in the frame mounting pads.
7. When the mounting pad surfaces are touching, start a bolt in each of the two unused mounting holes. Refer to Install Mounting Hardware on page 35.
8. Remove the slings and M16 eyebolts.
9. Follow the instructions in Install Mounting Hardware on page 35.

Mounting to Bottom of Frame Pads

NOTE: Since eyebolts would be in the way of this mounting method, you will have to use slings or other means to lift the robot base. Nylon slings can be wrapped across the center of the robot base, away from the inner arms. See the following figure.

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

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

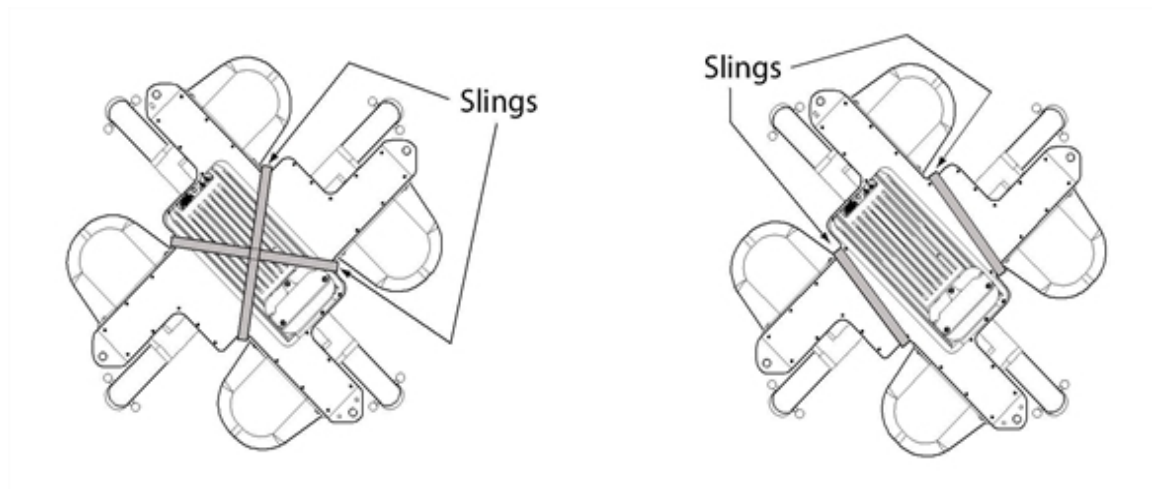


Figure 2-4. Location of Slings for Lifting Robot Base

3. Lift the robot and position it directly over the mounting frame.
4. Slowly lower the robot while rotating it slightly, so that the four mounting pads are lowered past the frame mounting pads without touching.
5. When the robot base mounting pads are below the lower surface of the frame mounting pads, rotate the robot base so that the M16 threaded holes in the robot base mounting pads align with the holes in the frame mounting pads.
6. 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 surface of the frame mounting pads.
7. Follow the instructions in Install Mounting Hardware on page 35.

Mounting Procedure from Below the Frame

The Adept Quattro robot has four mounting pads. Each pad has one M16 x 2.0 threaded hole. The robot can be mounted either on top of the frame pads, using the bottom surface of the

robot base pads, or to the bottom of the frame pads, using the top surface of the robot base pads.

The Adept Quattro robot can be mounted from beneath the mounting frame using a forklift. Use a padded board as a support under the robot base. The robot base can be rotated by hand, once mounted on the lifting pad on a forklift, when needed for clearing obstacles.

Mounting to Bottom of Frame Pads

1. Remove all lag bolts from the mounting pads before lifting the robot base.
2. Lift the robot and position the robot directly under the mounting frame.
3. Slowly lift the robot and align the M16 holes in the robot mounting pads with the holes in the frame mounting pads.
4. Lift the robot until the top of the robot base mounting pads are touching the bottom of the frame mounting pads.
5. Follow the instructions in Install Mounting Hardware on page 35.

Mounting to Top of Frame Pads

1. Remove all lag bolts from the mounting pads before lifting the robot base.
2. Lift the robot so the mounting pads are directly under the mounting pads of the frame.
3. Slowly lift the robot while rotating it slightly, so that the four mounting pads are raised past the frame mounting pads without touching.
4. When the robot base mounting pads are above the top surface of the frame mounting pads, rotate the robot base back, so that the M16 threaded holes in the robot base mounting pads align with the holes in the frame mounting pads.
5. Slowly lower the robot base while aligning the M16 holes in the robot mounting pads with the holes in the frame mounting pads.
6. Continue lowering the robot base until the bottom surface of the robot base mounting pads are touching the top surface of the frame mounting pads.
7. Follow the instructions in Install Mounting Hardware on page 35.

Install Mounting Hardware

NOTE: When mounting the robot, note the following:

- The base casting of the robot is aluminum and can be dented if bumped against a harder surface.
 - Verify that the robot is mounted squarely before tightening the mounting bolts.
 - All mounting hardware is user-supplied.
1. Place split lock, then flat washers on the bolts.
Bolts are M16 x 2.0 if threaded into the robot base mounting tabs.
Bolts are M12 or ½ in. if going through the robot base mounting tabs into nuts.

NOTE: When M16 x 2.0 bolts are used, the bolt must engage at least 24 mm into the threads of the base mounting pad.

2. Insert the bolts through the holes in the frame mounting pads and into the threaded holes in the robot base mounting pads.

If using through-bolts, insert the bolts through the holes in both the mounting pads and through the threaded holes in the robot base mounting pads into nuts.

3. Tighten the mounting hardware to the specifications listed in the following table.

NOTE: Check the tightness of the mounting bolts one week after initial installation, and then recheck every 6 months. For periodic maintenance, see Periodic Maintenance Schedule on page 131.

Table 2-2. Mounting Bolt Torque Specifications

Standard	Size	Minimum Specification	Torque
Threaded into base (aluminum):			
Metric	M16 x 2.0	ISO Property Class 5.8	98 N·m (74 ft-lb)
Using base mounting pad hole as through-hole:			
Metric	M12	ISO Property Class 9.8	100 N·m (75 ft-lb)
SAE	½ in.		100 N·m (75 ft-lb)

2.7 Attaching the Outer Arms and Platform

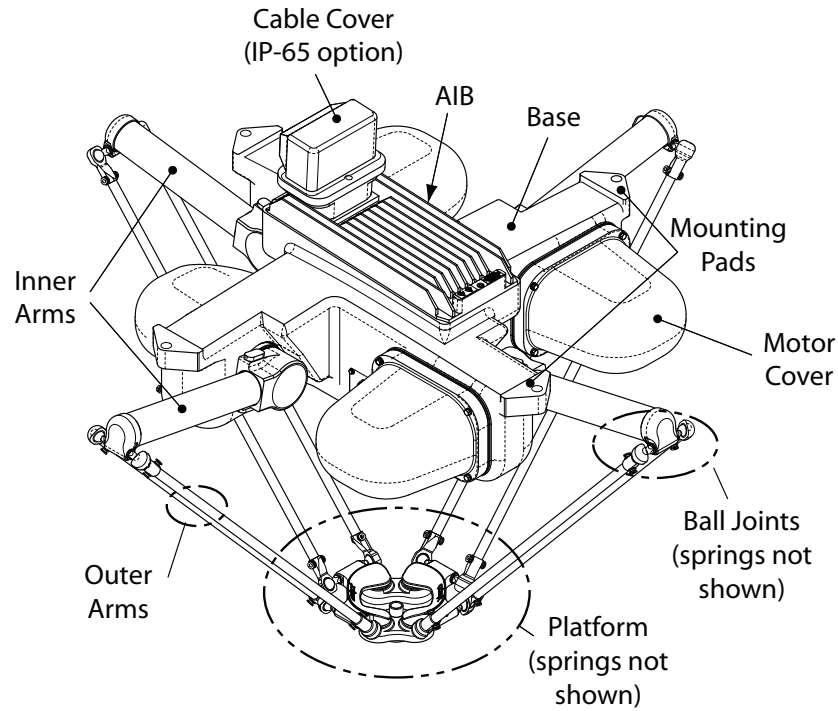


Figure 2-5. Major Robot Components, Top View

The Adept Quattro robot platform is attached to the inner arms by the outer arms.

NOTE: Except for attaching the outer arms and end-effector tooling, the platform is shipped fully assembled.

Clocking the Platform to the Base

The rotational alignment (clocking) of the platform to the base is critical to the correct operation of the Adept Quattro robot.



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

- On the hard-anodized and stainless steel platforms, the ends of the platform cross-pieces (between each pair of ball studs) are labeled with numbers (1–4).

In addition, +X and +Y World Coordinates are labeled on the platform near the flange. See Figure 2-6.

- Electroless nickel platforms are not labeled. Refer to Figure 2-7.
- When installing the platform, the numbers on the platform must match the numbers on the underside of the robot base.



Figure 2-6. Platform Orientation Labeling (P34 shown)

NOTE: The labeling on all anodized platforms is the same except for the part number.

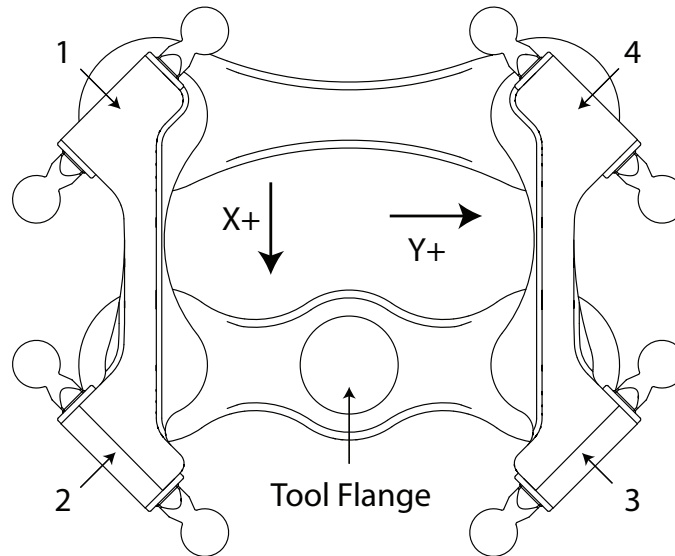


Figure 2-7. Platform Orientation, P31 Platform

Attaching the Outer Arms

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

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



Figure 2-8. 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.

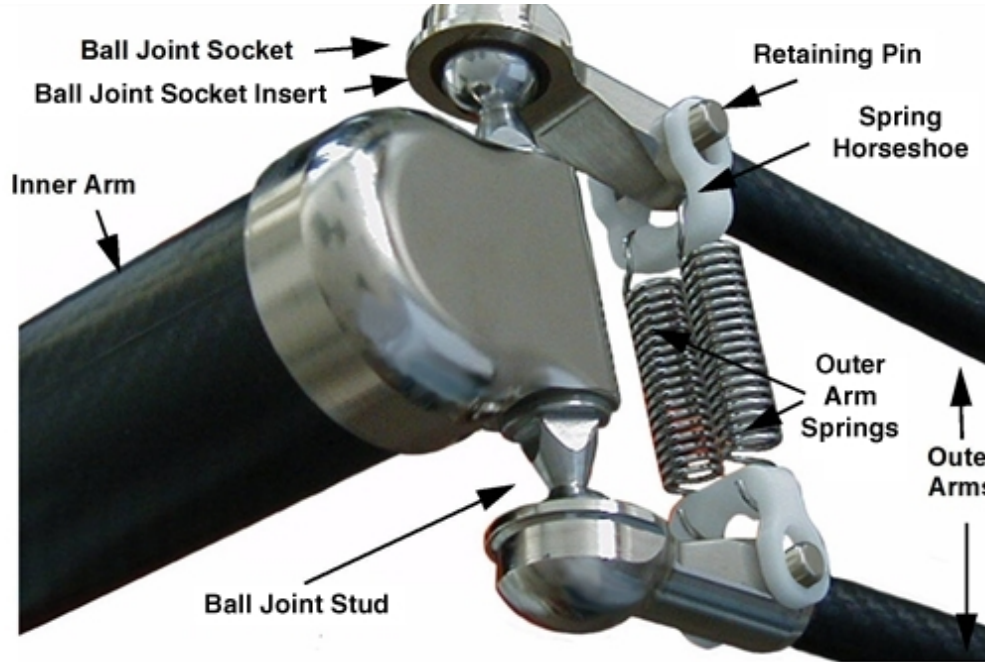


Figure 2-9. Ball Joint Assembly (Quattro HS shown)



CAUTION: Ensure that the bearing insert is in place in the end of each outer arm. If an insert has fallen out of the arm, press it back into place, ensuring that the insert is centered and bottomed-out in the ball joint socket.

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 all platforms.

1. Attach one pair of outer arms to each inner arm.
 - a. As illustrated in the following figure, this 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 2-10. Installing Outer Arms

2. Attach one pair of outer arms to each of the four pairs of ball studs on the platform.

NOTE: Ensure that the numbers on the platform match the numbers on the underside of the robot base. This will place the platform tool flange closest to the Status Display Panel. See Clocking the Platform to the Base on page 37. The platform is installed flange-down.

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

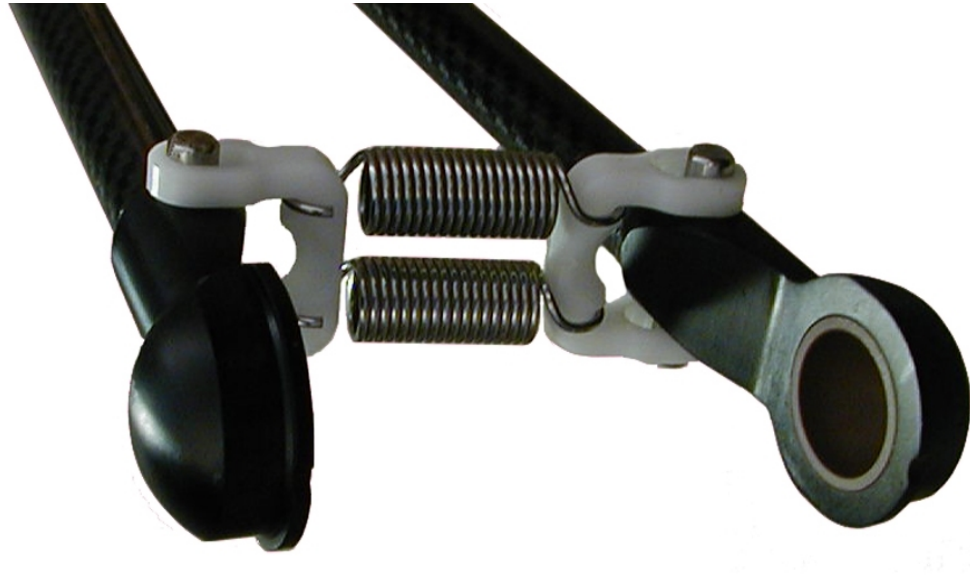


Figure 2-11. Horseshoe and Spring Assembly

Chapter 3: Robot Installation - HS

3.1 Transport and Storage

This equipment must be shipped and stored in a temperature-controlled environment, within the range -25 to $+55^{\circ}\text{C}$ (-13 to 131°F). The recommended humidity range is 5 to 90 percent, non-condensing. It should be shipped and stored in the Adept-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 and store the packaged equipment.

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

The Adept Quattro robot weighs 118 to 123 kg (260 to 271 lb) with no options installed.

3.2 Unpacking and Inspecting the Adept Equipment

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 Adept as soon as possible (see How Can I Get Help? on page 25).
- If the items received do not match your order, please contact Adept 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 Quattro HS robot is shipped in a crate that holds the robot base, outer arms, platform, controller, miscellaneous hardware, and any accessories ordered. The crate will be combined wood and cardboard.

The top of the crate should be removed first.

1. Remove the bands holding the top to the rest of the crate. Refer to the following figure.

The outer arms will be above the robot base. These should be removed from the crate, followed by the cardboard and foam that support them.

NOTE: Outer arms for the Quattro s800HS robot are packaged differently from these illustrations. See Figure 3-2.

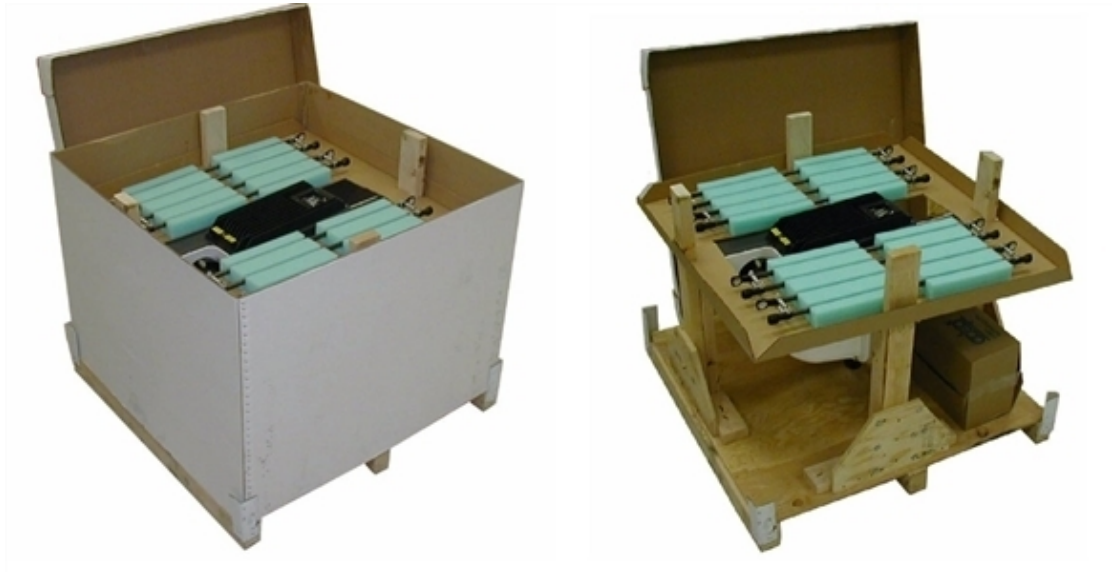


Figure 3-1. Quattro Shipping Crate (Quattro s650H shown)

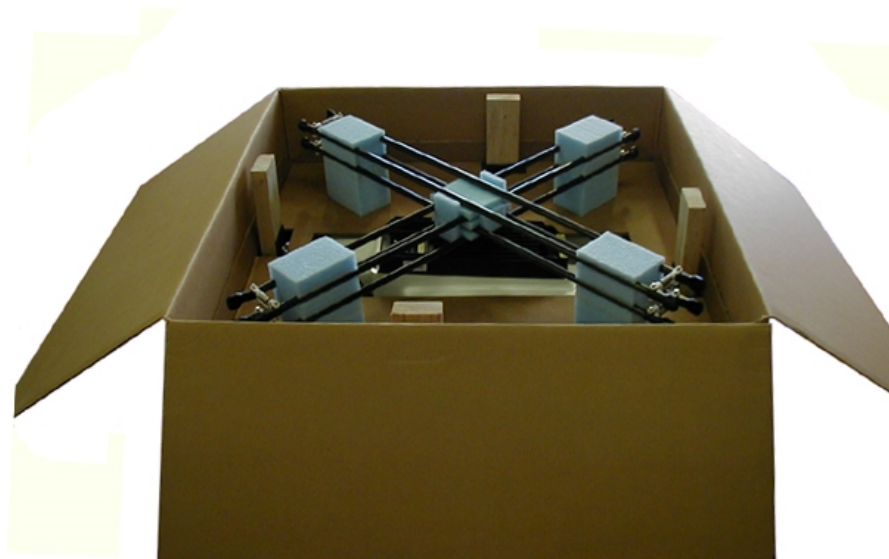


Figure 3-2. View of crate with s800 Outer Arms (s800H shown)

The robot base is shipped with the inner arms attached. The outer arms are shipped assembled in pairs; the platform is shipped fully assembled, but separate from the robot base and outer arms.

Under the robot base, the ancillary items will be attached to the crate bottom.

2. Lift off the cardboard sides.

Under the robot base, the ancillary items will be attached to the crate bottom. Refer to the preceding figure.



Figure 3-3. L-Bracket Securing Robot to Shipping Crate

The robot base is held in place in the crate with L-brackets and machine bolts.

1. Place a protective pad over the AIB/eAIB to protect it from damage from tools during the removal of the L-brackets.
2. Remove the three hex-head wood screws (0.25 in.) from each bracket.
Retain the wood screws and washers for possible future relocation.
3. Remove the M16 bolt and lock and flat washers from each bracket.
Retain the M16 bolts and lock and flat washers for possible future relocation.

NOTE: These are not the M16 bolts used for mounting the robot.

3.3 Repacking for Relocation

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



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

3.4 Environmental and Facility Requirements

The Quattro HS robot 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)
Pollution degree	2
Protection class: robot base	IP-66
Protection class: platform, arms	IP-67
NOTE: For robot dimensions, see Top Dimensions, s650 and s800 Robots on page 111.	
NOTE: For power requirements, see Connecting 24 VDC Power to Robot on page 76 and Connecting 200-240 VAC Power to Robot on page 79.	
NOTE: The Adept SmartController must be installed inside a NEMA-1 rated enclosure. The controller must not come into contact with liquids.	
NOTE: For chemical cleaning information, refer to Chemical Compatibility on page 154.	

3.5 Mounting Frame

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

- The sample given for the s650H robot, while stiff enough for use with the Quattro HS robots, was not designed for USDA applications.
- The thickness of the frame mounting tabs is critical, as is the flatness of those tabs. See Frame Mounting Tabs (following) and Mounting Surfaces on page 55.
- The frame must be stiff enough to prevent excessive vibration.
- You may want to design the frame so that the robot can be installed by lowering it from the top.

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

While Adept does 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.

Frame Mounting Tabs

To achieve the correct compression of the sealing gaskets, the mounting tabs on the frame must be 12.7 mm, +1.3, -0.7 mm thick (0.5 in., +0.05, -0.028 in.).

Because the junction of the robot base mounting pad and the frame mounting pad is sealed with a gasket, the frame mounting pads must be at least as big as the robot base mounting pads. If the frame pad does not cover the entire robot pad, the gasket will not seal properly.

The design of the Quattro HS robot mounting bolts and seals requires fairly tight tolerances for the robot mounting holes in the frame. These should be 17.25 ± 0.75 mm (0.68 ± 0.03 in.) in diameter.

Robot-to-Frame Considerations

The Quattro robot 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 (s650 shown) on page 118 shows the inner arm travel and how it may encroach on the robot mounting points. As a starting point, for a frame that is 2 meters in each direction, (allowing use of the full range of the Quattro s650 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

Mounting Hole Dimensions, Quattro HS Robots on page 113 shows the mounting hole pattern for the Quattro HS robot. 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: Adept suggests welding the robot mounting tabs as a last step in the frame fabrication, using a flat surface as a datum surface during the tack welding operation.

Gussets

The triangular gussets are an integral part of the frame stiffness. The vibrational strength of a structural assembly is strongly governed by controlling the shear forces between members. The 250 mm gussets, shown in Figure 2-3, are nominally sufficient for transferring the load from the vertical members into the horizontal cross pieces. Preferably, gussets should be placed at the edges of the frame members to transfer the loading into the walls of the members, instead of the faces, and enable easier cleaning. Some frame designs may benefit from extending these gussets to 500 mm in the vertical direction, as the design intent of the gussets is mainly to secure the long vertical members from rotating out of position. For this reason, the gussets to the across-the-belt horizontal member should be at the bottom of the member, as shown in Figure 2-3, and as close to the vertical midplane of the frame as feasible (15 mm thickness is adequate for most situations).

3.6 Cable Inlet Box

The cable inlet box (P/N 09564-000) must be mounted on the top of the robot during the robot installation process. This is best done before the robot is mounted on the frame.

Assembling Cable Inlet Box

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

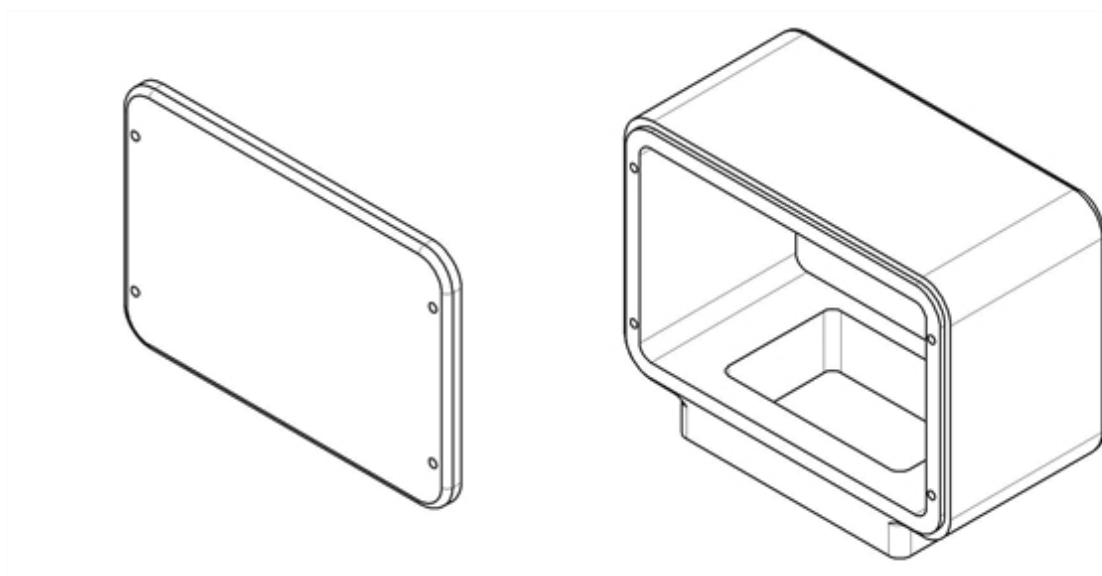


Figure 3-4. Cable Inlet Box and Cover

Components

- Cable Inlet box
- Cable Inlet box cover
- Cable Inlet box-cover gasket
- Cable Inlet box-AIB/eAIB gasket
- Compression Block kit - Roxtec CF 8-8
 - Roxtec CF 8 frame
 - 4 x 2-hole Roxtec modules

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

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

NOTE: The Roxtec CF 8 consists of a frame and integrated compression unit (a wedge and bolt that compress the modules once they are assembled inside the CF frame). See Figure 3-10.

- 4 x Screws, M4 x 40 (cable box-AIB/eAIB; one is used for the ground)
- 1 x Washer, ETL, SS M4 (for ground screw)
- 4 x Screws, M4 x 16 mm (for the back cover)
- 4 x Washer seals (for the back cover screws)
- 4 x Screws, M4 x 12 mm (for attaching the cable tray)

The following may be included as spares:

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

Tasks

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

Procedure

1. Measure and mark all AIB/eAIB cables at 10 - 12 in. from the cable ends.
This amount of slack is needed to make the cable connections to the AIB/eAIB before the cable inlet box is installed. See Figure 3-10.

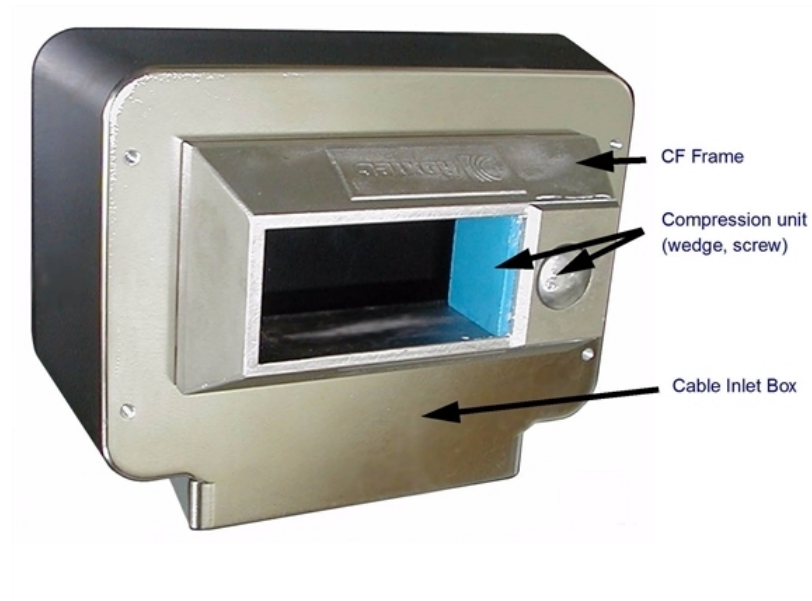


Figure 3-5. Quattro HS Cable Inlet Box with Roxtec Frame

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

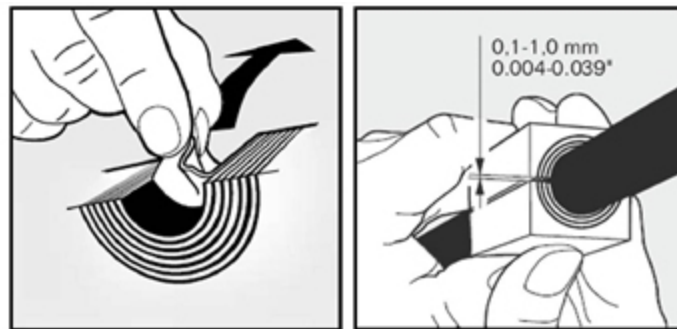


Figure 3-6. Adapting a Module to the Cable Size, Checking the Gap

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

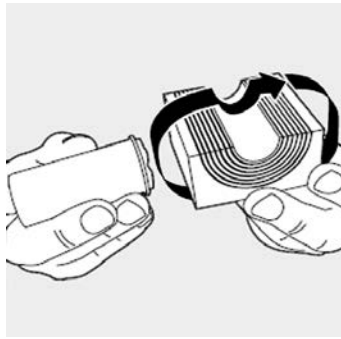


Figure 3-7. Greasing a Roxtec Module

4. Grease the inside of the CF frame, where the modules will touch, using Roxtec grease.
5. Install each AIB/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 3-10.

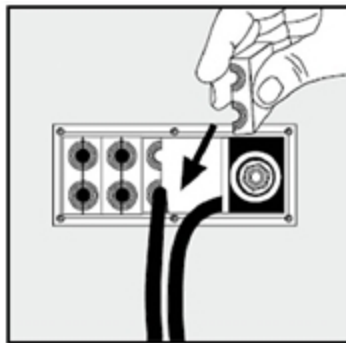


Figure 3-8. Installing Roxtec Modules into the Frame

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.

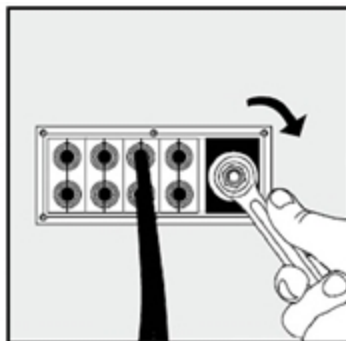


Figure 3-9. Tightening the Compression Unit



Figure 3-10. Cable Inlet Box with Cables

In the preceding figure, note the four holes around the Rextec box. These are for attaching a cable tray. See Attaching the Cable Tray on page 64.

Connecting the Cables

1. Place the cable inlet box-AIB/eAIB gasket around the AIB/eAIB connection panel.
2. Attach the ground lug to the AIB/eAIB. The ground lug is for the cable shield of the user-supplied 24 VDC cable. See the following figure.

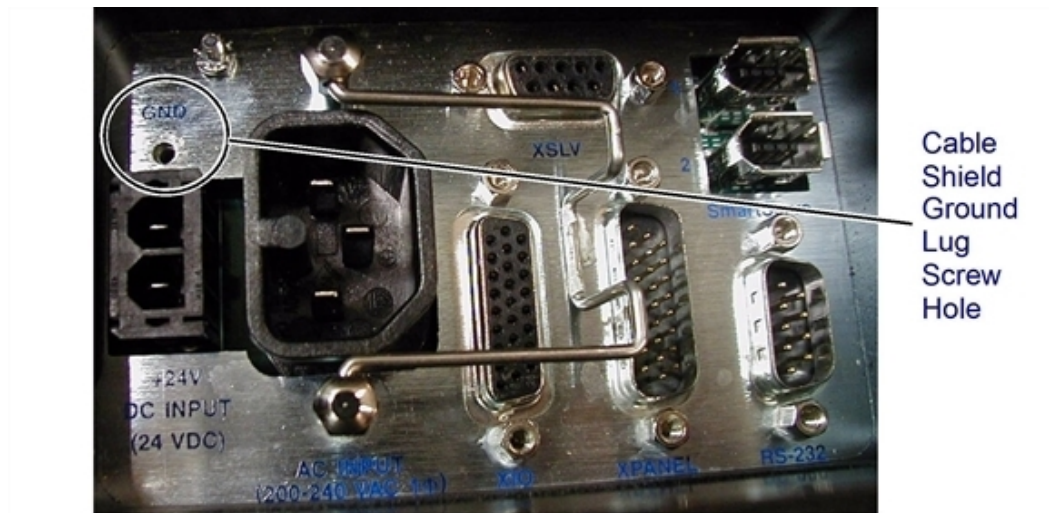


Figure 3-11. Cable Shield Ground Lug Attachment, AIB Shown

3. Hand-tighten all cables to the AIB/eAIB.

NOTE: All cables must be screwed into the AIB/eAIB.

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

Installing the Cable Inlet Box

1. Install the cable inlet box on the top of the AIB/eAIB using three M4 x 40 bolts.
 - Ensure that the gasket is seated between the AIB/eAIB surface and the cable inlet box.
 - Do not yet use the hole labeled as a ground.
 - Apply Loctite 222 in these bolt holes, not on the bolts themselves.
 - Torque the bolts to 1.1 N·m (10 in-lb).

NOTE: The cable inlet box should be installed with the cables exiting away from the AIB/eAIB. The cable tray attachment was designed assuming the cables would exit away from the AIB/eAIB.

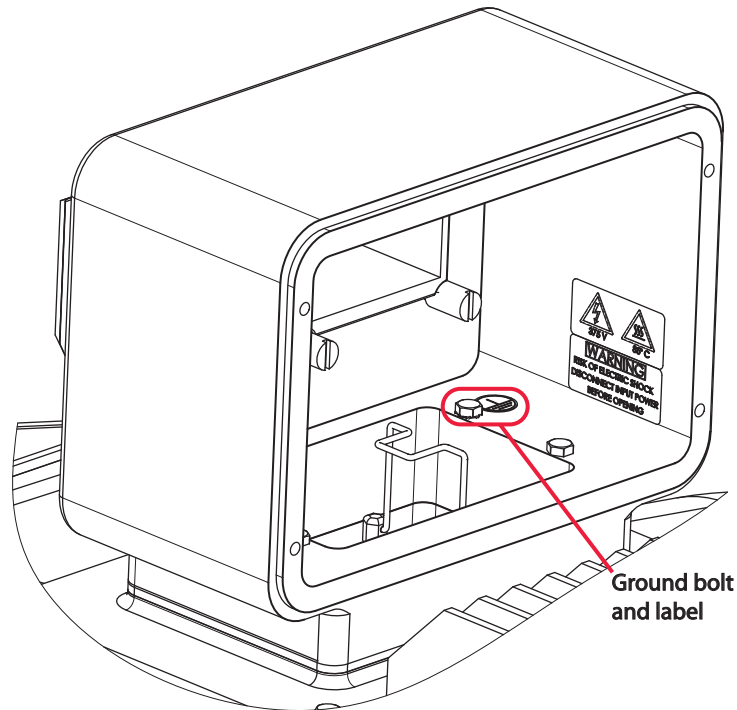


Figure 3-12. Cable Inlet Box, showing Ground Label

2. Install the M4 protective earth ground bolt, with toothed washer, through the cable inlet box into the AIB/eAIB. See the preceding figure.
 - Ensure that the protective earth ground wire lug is under the toothed washer.
 - This bolt does not need Loctite.
 - Torque the bolt to 1.1 N·m (10 in-lb).
3. Attach the cable inlet box back cover with four M4 x 16 bolts.
 - Ensure that the gasket is seated between the cover and the cable inlet box.
 - Put one washer seal under each bolt head.
 - Use Loctite 222 in these bolt holes, not on the bolts themselves.
 - Torque bolts to 1.1 N·m (10 in-lb).

3.7 Mounting the Robot Base



CAUTION: Remove all ancillary components (controller, outer arms, platform, etc.) from the shipping crate before lifting the robot base.

Robot Orientation

Adept recommends mounting the Quattro HS robot 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, status LED, and Brake-Release button. It also balances 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.

Because USDA requirements do not allow external sticker labels, the motor numbers of the electroless nickel platforms are not labeled on the platforms.

Mounting Surfaces

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



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

Because the junction of the robot base mounting pad and the frame mounting pad is sealed with a gasket, the frame mounting pads must be at least as big as the robot base mounting pads.

NOTE: If the frame pad does not cover the entire robot pad, the gasket will not seal properly.

Mounting Options

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

NOTE: Because of USDA requirements, the mounting holes in the robot base mounting tabs are not through-holes. This eliminates the possibility of mounting the robot with the robot tabs on top of the frame tabs. This is different than the Quattro H robots.

Depending on the mounting frame design used, there may be two options for mounting the Quattro HS robot:

- Lower the robot into the frame from above
- or
- Lift the robot into the frame from below



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

The Quattro HS robot has four mounting pads. Each pad has one M16x2.0 threaded hole. The robot must be mounted to the bottom of the frame pads, using the top surface of the robot base mounting pads.

Mounting Procedure from Above the Frame

NOTE: Nylon slings can be wrapped across the center of the robot base, away from the inner arms. See the following figure.

1. Remove all wood screws, machine bolts, and brackets securing the robot to the crate before lifting the robot base.

Retain the removed hardware for future packing of the robot for relocation.

2. Wrap slings around the robot base. See the following figure for two methods.

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

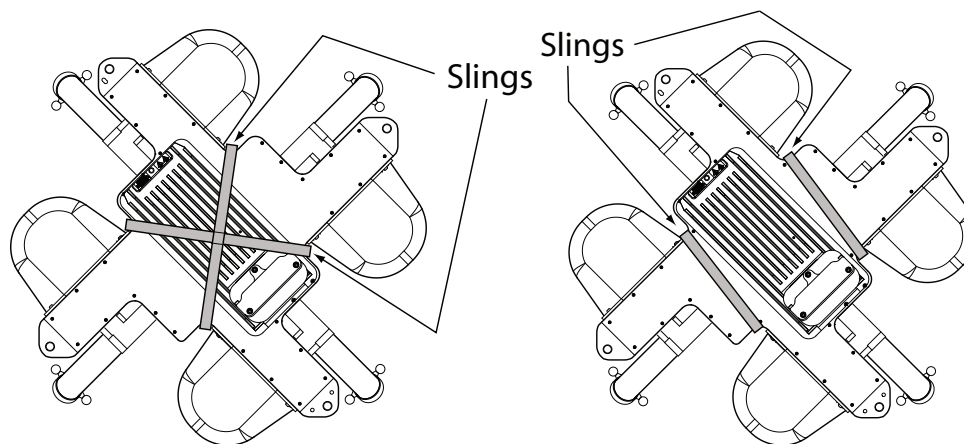


Figure 3-13. Location of Slings for Lifting Robot Base

3. Insert a base-pad sealing-gasket into the groove machined in each robot base mounting pad. The gasket and its positioning are shown in the following figure.

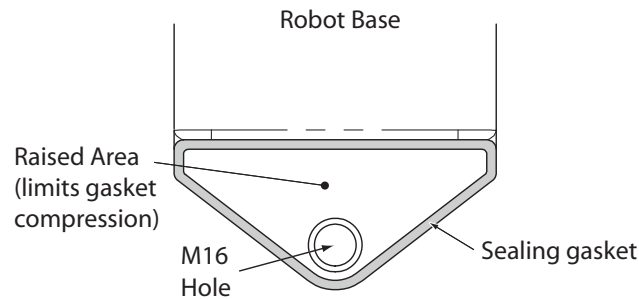


Figure 3-14. Robot Base Pad Sealing Gasket, Top View

The area of the mounting pad surrounded by the groove serves as a spacer, to ensure that the sealing gasket is properly compressed.

4. Lift the robot and position it directly over the mounting frame.
5. Slowly lower the robot while rotating it slightly, so that the four mounting pads are lowered past the frame mounting pads without touching.
6. When the robot base mounting pads are below the lower surface of the frame mounting pads, rotate the robot base so that the M16 threaded holes in the robot base mounting pads align with the holes in the frame mounting pads.
7. Lift the robot base up, keeping the holes in the robot base pads and the frame pads aligned, until the sealing gaskets are touching the bottom surfaces of the frame mounting pads.
8. Follow the instructions in Install Mounting Hardware on page 58.

Mounting Procedure from Below the Frame

The Quattro HS robot can be mounted from beneath the mounting frame using a forklift. Use a padded board as a support under the robot base. The robot base can be rotated by hand, once supported by the lifting pad on a forklift, when needed for clearing obstacles.

1. Remove all wood screws, machine bolts, and brackets securing the robot to the crate before lifting the robot base.
Retain the removed hardware for future packing of the robot for relocation.
2. Insert a base-pad sealing-gasket into the groove machined in each robot base mounting pad. The gasket and its positioning are shown in Figure 3-14.
3. Lift the robot and position it directly under the mounting frame.
4. Slowly lift the robot and align the M16 holes in the robot mounting pads with the holes in the frame mounting pads.
5. Lift the robot base up, keeping the holes in the robot base pads and the frame pads

aligned, until the gaskets on the top surfaces of the robot base pads are touching the bottom surfaces of the frame mounting pads.

6. Follow the instructions in Install Mounting Hardware on page 58.

Install Mounting Hardware

To achieve the correct compression of the sealing gaskets, the mounting tabs on the frame must be 12.7 mm, +1.3, -0.7 mm (0.5 in., +0.05, -0.028 in.) thick.

If you choose to use a different frame pad thickness and provide your own mounting bolts, the bolts need to be M16-2.0, 316 stainless steel flange bolt (DIN 6921 standard). The threads must engage at least 24 mm (0.94 in.) of the robot base threads (HeliCoil), for sufficient support. The bolts must not bottom out, or the washer seals and gaskets will not be compressed enough to form a good seal.

When mounting the robot, note the following:

- Verify that the robot is mounted squarely before tightening the mounting bolts.
- Verify that the gaskets between the robot pads and the mounting frame are in their grooves in the pads, and completely covered by the mounting frame pads.
- USDA requires that all exposed screws be sealed with a gasket, which must be compressed to specific standards. To achieve this, the Quattro HS robot mounting bolts use a spacer that fits inside a compressible sealing gasket. See the following figure.

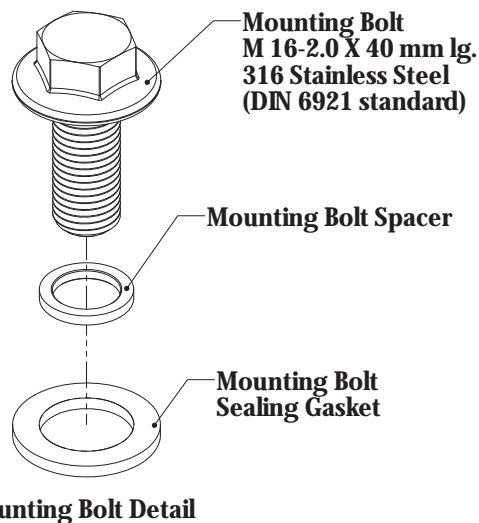


Figure 3-15. Robot Mounting Bolt, Seal, and Gasket

- Place a spacer, then a sealing gasket, on each bolt.
- Insert the bolts through the holes in the frame mounting pads and into the threaded holes in the robot base mounting pads. See the following table for mounting bolt torque specifications.
- Check the position of the gaskets between the robot base pads and the mounting frame.

The frame pads should completely cover the gaskets.

- Tighten the bolts to 98 N·m (74 ft-lb).

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

NOTE: Check the tightness of the mounting bolts one week after initial installation, and then recheck every 3 months. See Periodic Maintenance on page 154.

Table 3-2. Mounting Bolt Torque Specifications

Standard	Size	Minimum Specification	Torque
Metric	M16-2.0 x 40 mm	ISO Property Class 5.8	98 N·m (74 ft-lb)

3.8 Attaching the Outer Arms and Platform

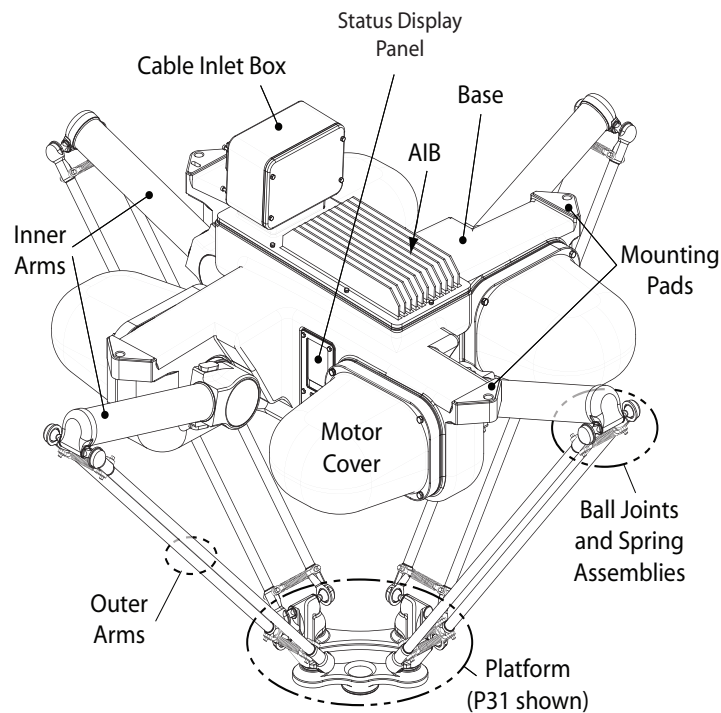


Figure 3-16. Major Robot Components, Top View

The Adept Quattro robot platform is attached to the inner arms by the outer arms.

NOTE: Except for attaching the outer arms and end-effector tooling, the platform is shipped fully assembled.

Clocking the Platform to the Base

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



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

NOTE: There is no marking on the electroless nickel-plated platforms to indicate which pair of ball studs should be connected to which inner arm. Stainless steel platforms are labeled.

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

NOTE: The tool flange face on the P30 platform is centered, so that platform can be installed in any orientation.

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

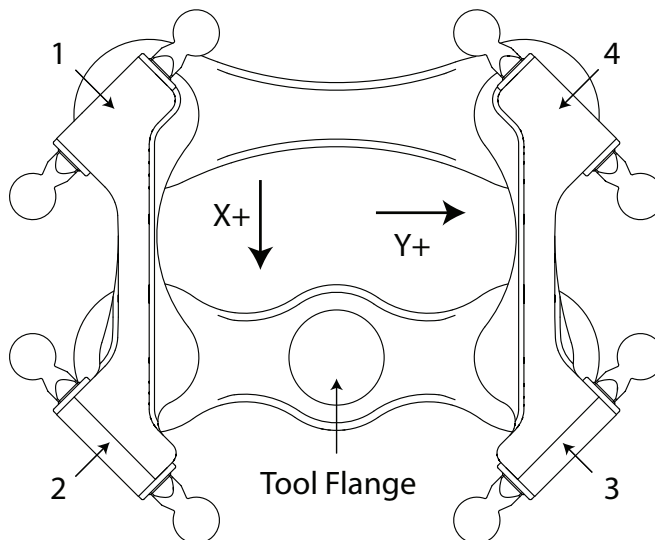


Figure 3-17. Platform Orientation (P31 shown), Top View

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 3-18. 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.

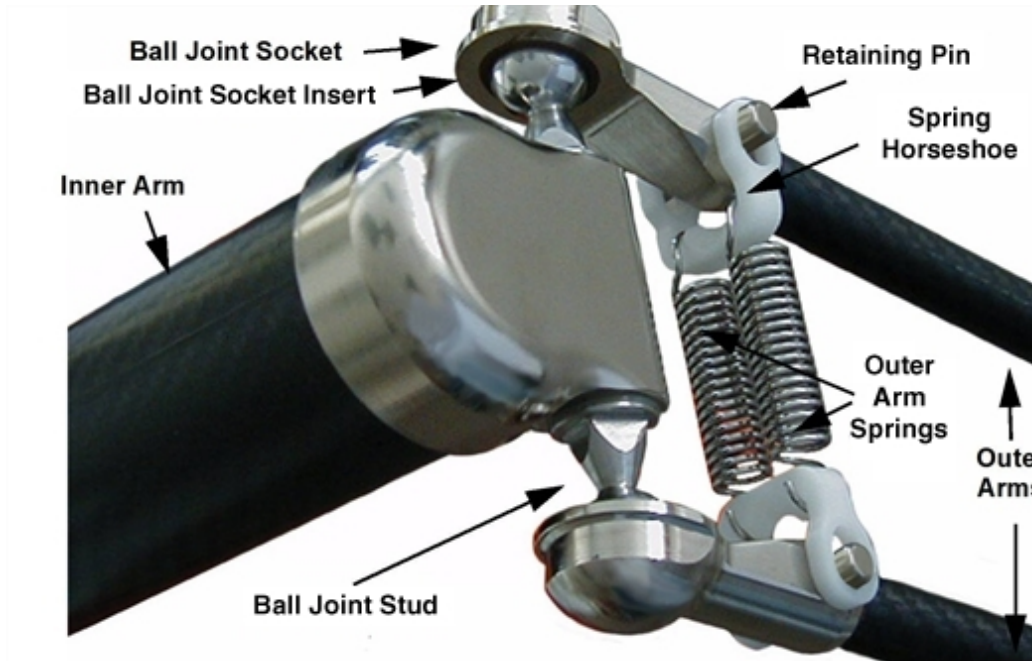


Figure 3-19. Ball Joint Assembly



CAUTION: Ensure that the bearing insert is in place in the end of each outer arm. If an insert has fallen out of the arm, refer to Replacing a Ball Joint Insert on page 175 for instructions on re-inserting it.

NOTE: This is a different procedure than for the Quattro H robots.

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 all platforms.

1. Attach one pair of outer arms to each inner arm.
 - a. As illustrated in Figure 3-20, 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 3-20. Installing Ball Joints (Quattro H shown)

2. Attach one pair of outer arms to each of the four pairs of ball studs on the platform.

NOTE: Ensure that the platform is rotated so that the tool flange is closest to the Status Display Panel. See Clocking the Platform to the Base on page 60. The platform is installed flange-down.

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

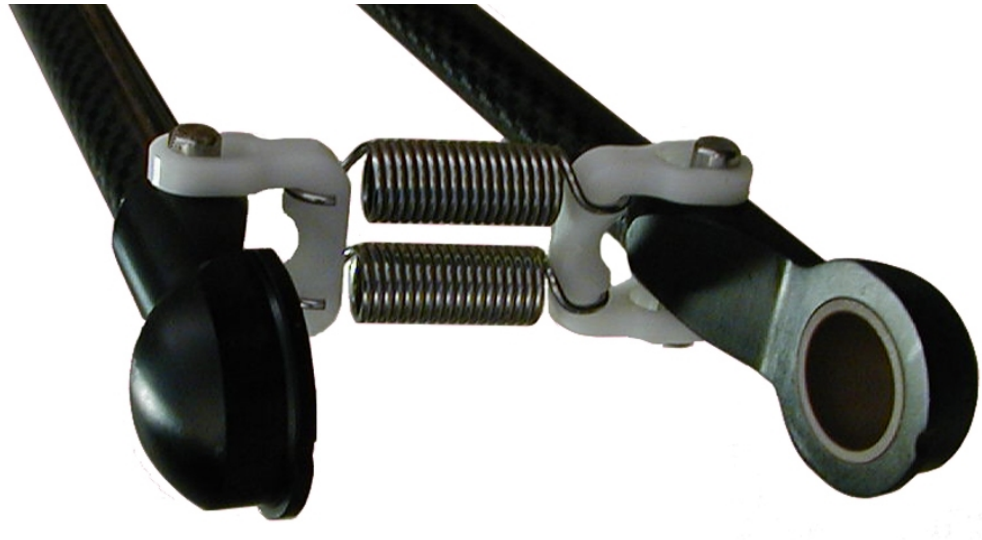


Figure 3-21. Horseshoe and Spring Assembly (Quattro H shown)

3.9 Attaching the Cable Tray

NOTE: The cable inlet box must be installed on the AIB/eAIB before the cable tray can be attached. Refer to Cable Inlet Box on page 48.

NOTE: Adept does not provide a cable tray or a cable-tray gasket.

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

The tray should match the holes in the cable inlet box, and be wide enough at the box to avoid touching the Rextec assembly, and leave room for the cabling exiting the Rextec assembly. See Figure 3-24.

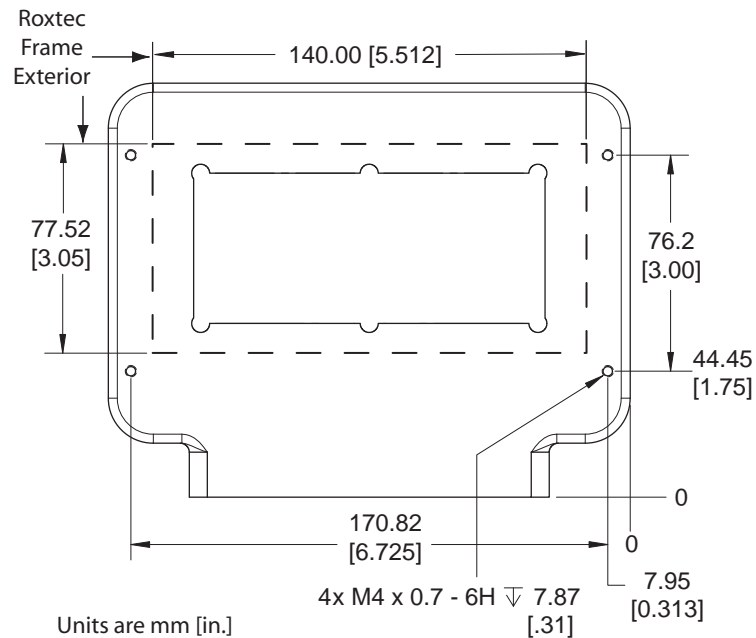


Figure 3-22. Dimensions of Cable Tray Attachment to Cable Inlet Box

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

- Use M4 x 12 bolts with toothed washers.

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

These bolts do not need Loctite.

- Torque the bolts to 1.1 N·m (10 in-lb).

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

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

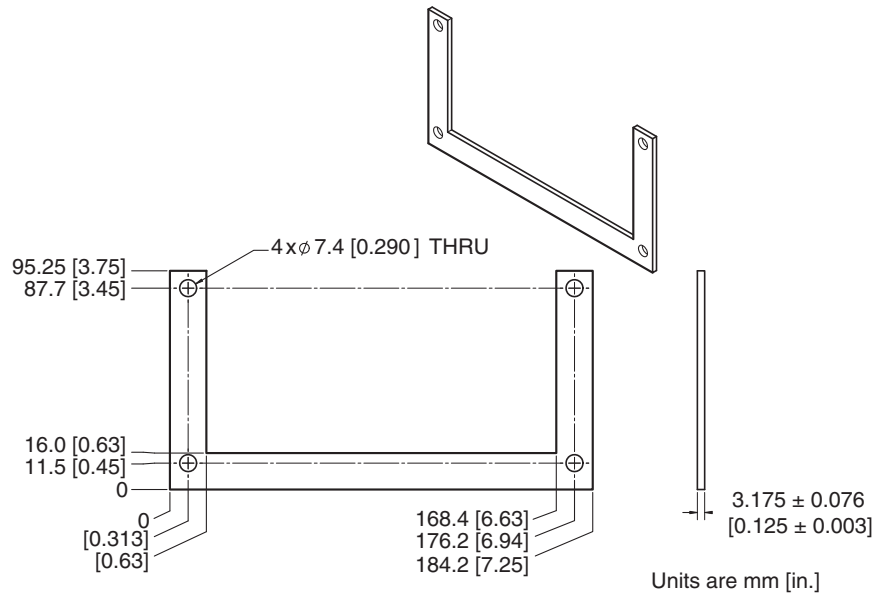


Figure 3-23. Example Cable Tray Gasket

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

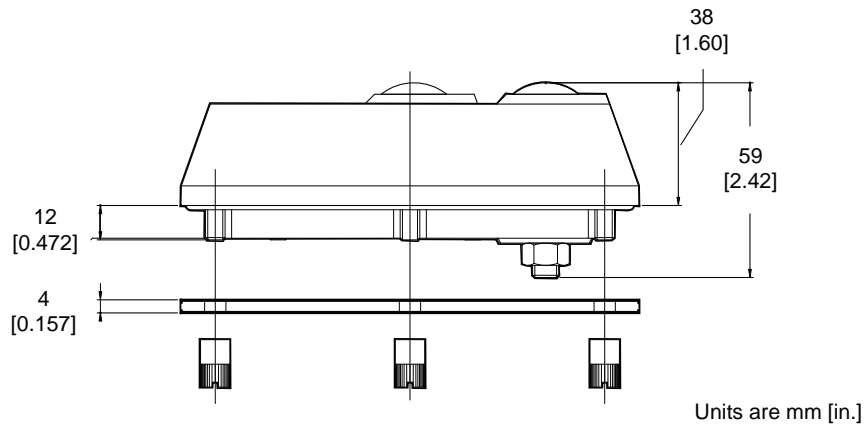


Figure 3-24. Side View of Roxtec Cable Seal Frame

The following apply to the example cable tray.

Material	Item 1	Aluminum 5052-H32	
	Item 2	Aluminum 6061-T6	
		Clean part thoroughly using the following process:	
			Soak part in strong alkaline bath followed by light chemical clean
Finish	Electroless nickel plate per MIL-C-2607E, Class 4, Grade A		
	0.025 -0.038 mm [0.001 - 0.0015 in.] thick, high phosphorus (10-13% by wt.)		
	RoHS-compliant process		

While Adept does not supply a cable tray, the following sample design is provided:

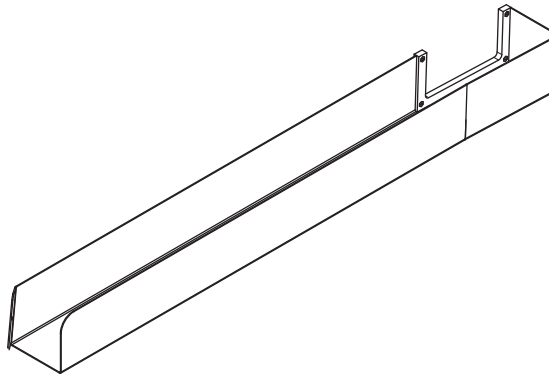


Figure 3-25. Sample Cable Tray, Isometric View

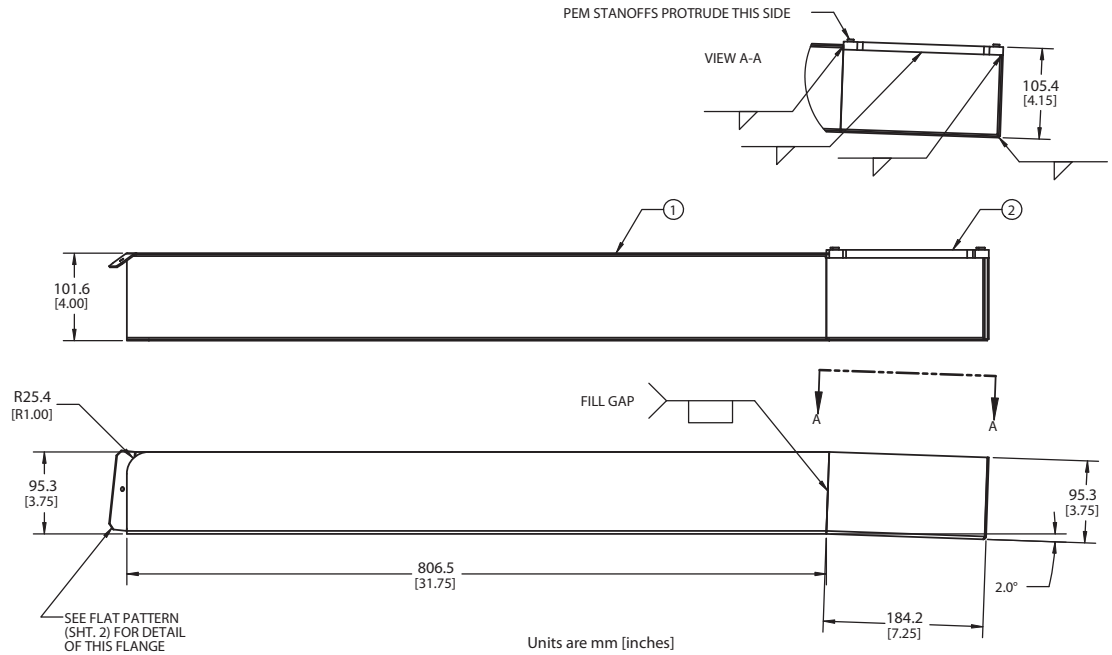


Figure 3-26. Sample Cable Tray, Dimension Drawing 1

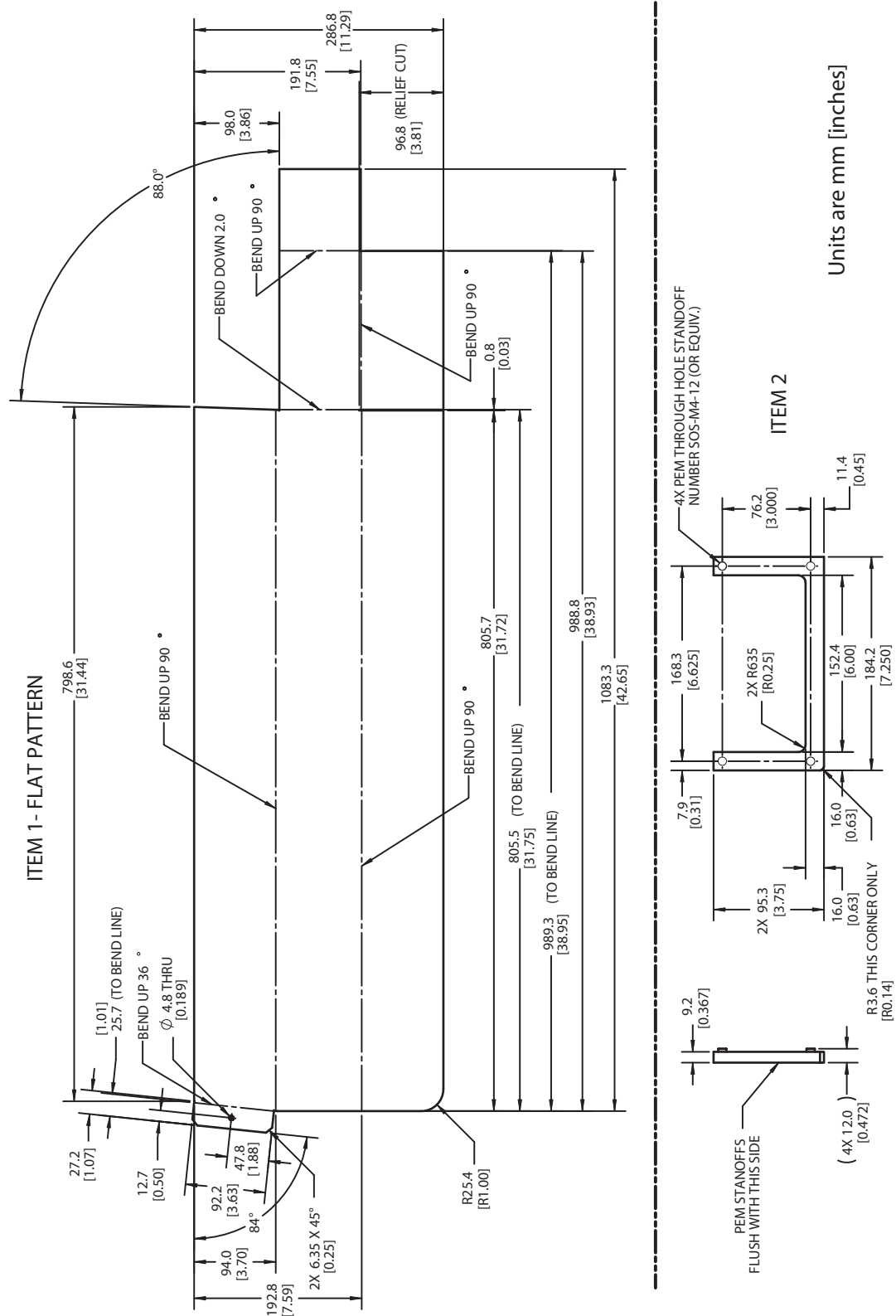


Figure 3-27. Sample Cable Tray, Dimension Drawing 2

Chapter 4: System Installation

4.1 System Cable Diagram

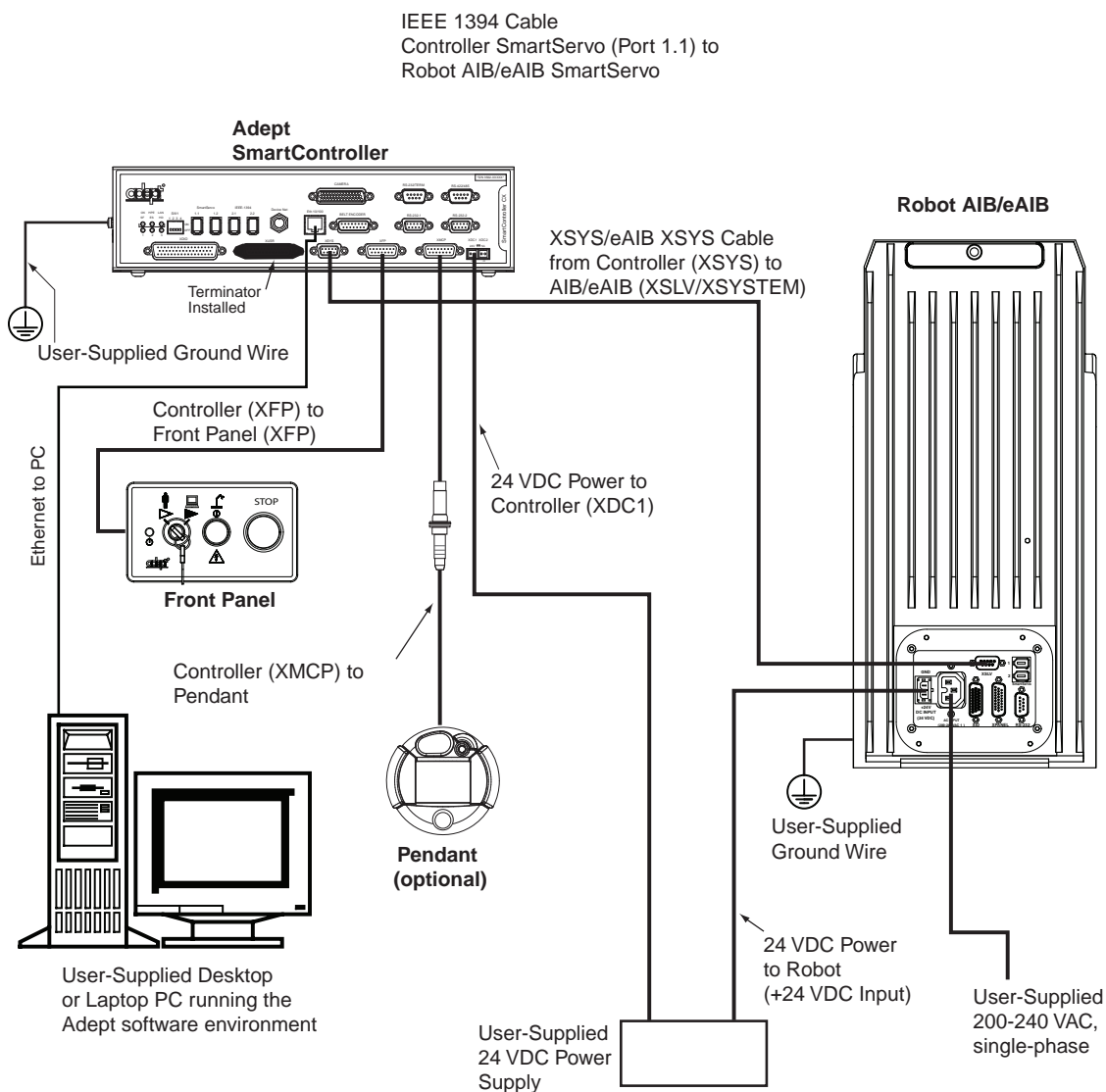


Figure 4-1. System Cable Diagram

See Installing 24 VDC Robot Cable on page 78 for additional information on system grounding.

4.2 Cable Parts List

Table 4-1. Cable Parts List

Part Description	Part of
IEEE 1394 Cable, 4.5 M	All systems
XSYS Cable (AIB), 4.5 M	AIB
eAIB XSYS Cable (eAIB), 4.5 M	eAIB
eAIB XSLV Adapter Cable (eAIB), 250 mm	AIB to eAIB upgrade
Front Panel Cable	Front panel
T1/T2 Pendant Adapter Cable	Optional T2 pendant
T20 Pendant Adapter Cable	Optional T20 pendant
Power Cable Kit - contains 24 VDC and AC power cables	Available as option
XIO Breakout Cable, 12 inputs/ 8 outputs, 5 meter	Available as option – see XIO Breakout Cable on page 94
Y Cable, for XSYS cable connections to dual robots - attaches at the controller for an eAIB system	Available as option -- see the Dual Robot Configuration Guide .

4.3 Installing the SmartController Motion Controller

Refer to the [Adept SmartController User's Guide](#) for complete information on installing the Adept SmartController. This list summarizes the main steps.

1. Mount the SmartController and front panel.
2. Connect the front panel to the SmartController.
3. Connect the pendant (if purchased) to the SmartController.
4. Connect user-supplied 24 VDC power to the controller.

Instructions for creating the 24 VDC cable, and power specification, are covered in the [Adept SmartController User's Guide](#).

5. Install a user-supplied ground wire between the SmartController and ground.

4.4 Connecting User-Supplied PC to Robot

The Adept Quattro robots must be connected to a user-supplied PC for setup, control, and programming. The user loads the Adept ACE software onto the PC and connects it to the robot via an Ethernet cable.

PC Requirements

The Adept ACE CD-ROM will display a ReadMe file when inserted in your PC. This contains hardware and software requirements for running Adept ACE software.

NOTE: The specifications are also listed in the ACE PackXpert Datasheet, available on the Adept corporate website.

4.5 Installing Adept ACE Software

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

1. Insert the CD-ROM into the CD-ROM drive of your PC. If Autoplay is enabled, the Adept Software CD-ROM menu is displayed. If Autoplay is disabled, you will need to manually start the CD-ROM.

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 Adept ACE software installation: from the Adept ACE software CD-ROM menu, click Read Important Information.
3. From the Adept Software CD-ROM menu, click Install the Adept ACE Software.
4. The Adept ACE Setup wizard opens. Follow the instructions as you step through the installation process.
5. When the install is complete, click Finish.
6. After closing the Adept ACE Setup wizard, click Exit on the CD-ROM menu and proceed to the Start-up Procedure.

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

4.6 Description of Connectors on Robot Interface Panel

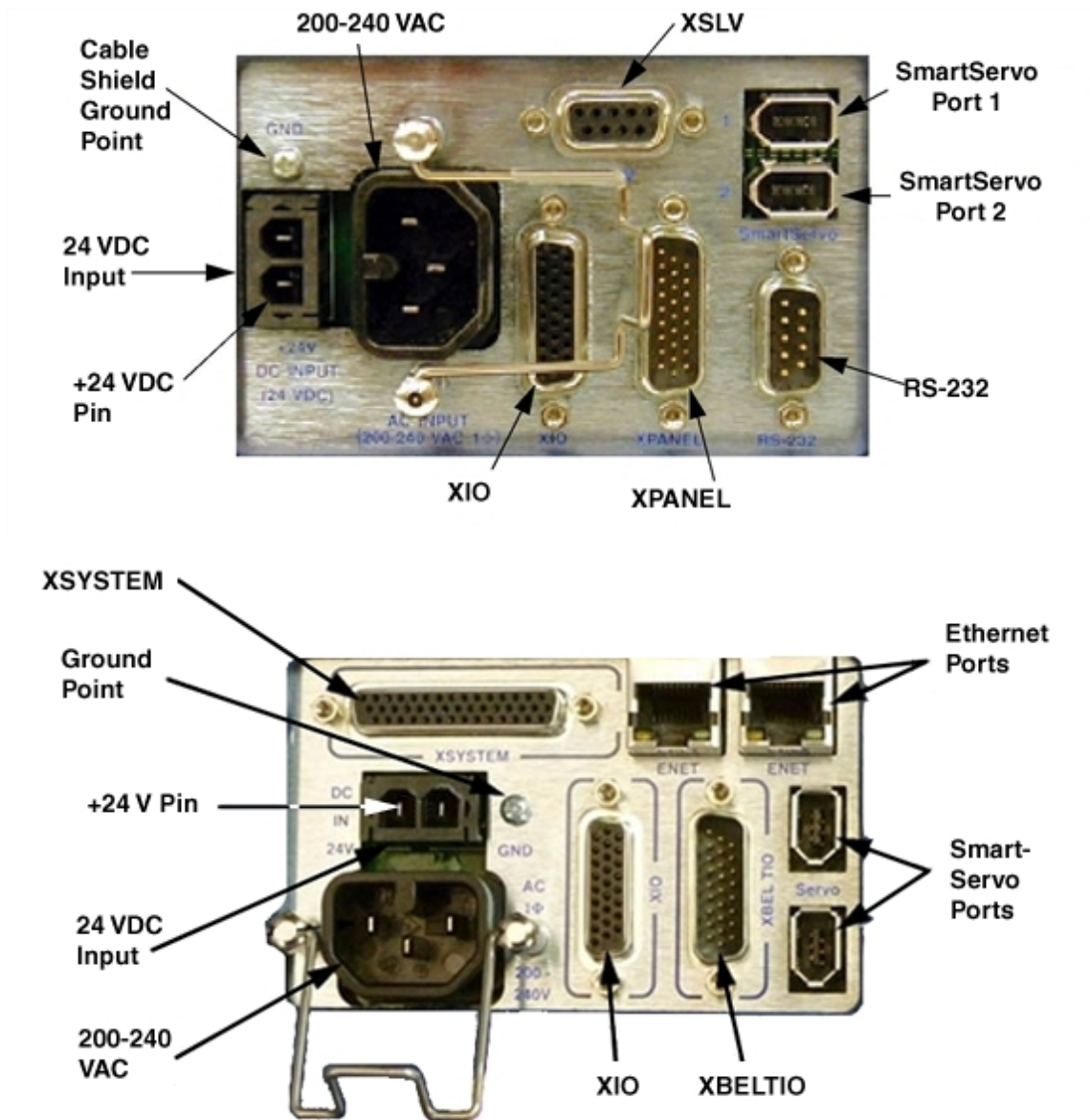


Figure 4-2. Robot Interface Panel, AIB and eAIB

The following connections are the same for both the AIB and the eAIB:

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.

SmartServo x2 (IEEE 1394) — for connecting the IEEE 1394 cable from the controller (SmartServo 1.1) to the robot. The other robot connector can be used to connect to a second robot or another 1394-based motion axis.

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 Robot XIO Connector on page 43. That section also contains details on how to access these I/O signals via V+/eV+.

The following connections are different on the AIB and the eAIB:

XSYSTEM (eAIB only) — includes the functions of the XPANEL and XSLV on the AIB. This requires either the eAIB XSLV Adapter cable, to connect to the XSYS cable, or an eAIB XSYS cable, which replaces the XSYS cable. See Cable Connections from Robot to SmartController in the following section.

XPANEL (DB26, high density, male; AIB only) — used only with Cobra i-series robots, for connecting the front panel and MCP circuit.

XSLV (DB-9, female; AIB only) — for connecting the supplied XSYS cable from the controller XSYS connector.

XBELTIO (eAIB only) — adds two belt encoders, EXPIO at the back of the robot (which is not available on an AIB), and an RS-232 interface.

RS-232 (DB-9, male; AIB only) — used only with Cobra i-series robots, for connecting a system terminal.

Ethernet x2 (eAIB only) — these are not used with the SmartController CX, and are not currently used with the SmartController EX.

4.7 Cable Connections from Robot to SmartController

The following cables are shipped in the cable/accessories box.

- Locate the IEEE 1394 cable (length 4.5 M)
- For an AIB system, locate the XSYS cable (length 4.5 M).

For an eAIB system, locate the eAIB XSYS cable or eAIB XSLV Adapter cable, which can be used with an existing XSYS cable.

Install one end of the IEEE 1394 cable into the SmartServo port 1.1 connector on the SmartController, and the other end into a SmartServo connector on the AIB or eAIB interface panel. See Figure 3-1.

NOTE: The IEEE 1394 cable **MUST** be in either the 1.1 or 1.2 SmartServo port of the SmartController. Do **NOT** use the 2.1 or 2.2 ports.

AIB only:

- Install the XSYS cable between the robot interface panel XSLV safety interlock connector and XSYS connector on the SmartController, and tighten the latching screws.

eAIB only:

- For a new SmartController system with an eAIB, the system will be supplied with a 15 ft (4.5 m) cable with connectors for XSYS (DB9) on one end and XSYSTEM (DB44) on

the other. Connect the XSYSTEM end to the eAIB, and the XSYS end to the SmartController.

- For a field upgrade from an old AIB, if you already have the old XSYS (DB9-DB9) cable routed and all you want to do is adapt your new eAIB to plug into the old cable, use the eAIB XSLV Adapter cable. This is a 1 ft (250 mm) long adapter that essentially turns the XSYSTEM into the old XSLV connector. Connect the XSYSTEM end to the eAIB, and the XSLV end to the old XSYS cable.

Quattro HS Cables

Note that, for a USDA-Accepted robot, you must install a tray under the cables, starting at the AIB/eAIB on the robot, and continuing beyond the area in which food is processed. Any washdown dripping from the cables must be contained by this tray, to a location beyond the food-processing area.

4.8 Connecting 24 VDC Power to Robot

Specifications for 24 VDC Robot and Controller Power

Table 4-2. VDC User-Supplied Power Supply

User-Supplied Power Supply	24 VDC ($\pm 10\%$), 150 W (6 A) ($21.6\text{ V} < V_{in} < 26.4\text{ V}$)
Circuit Protection ^a	Output must be $< 300\text{ W}$ peak, or 8 Amp in-line fuse
Power Cabling	1.5 – 1.85 mm ² (16-14 AWG)
Shield Termination	Braided shield connected to ‘-’ terminal at both ends of cable. See Figure 4-3.
^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 protection 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 AIB/eAIB electronics.

The requirements for the user-supplied power supply will vary depending on the configuration of the robot and connected devices. Adept recommends 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 Table 4-2. Using an underrated supply can cause system problems and prevent your equipment from operating correctly. See the following table for recommended power supplies.



Table 4-3. Recommended 24 VDC Power Supplies

Vendor Name	Model	Ratings
XP Power	JPM160PS24	24 VDC, 6.7 A, 160 W
Mean Well	SP-150-24	24 VDC, 6.3 A, 150 W
Astrodyne	ASM150-24	24 VDC, 6.66 A, 150 W

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 4-4. 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 63811-0400
	Digi-Key P/N WM9907-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 Table 4-1.

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: A separate 24 VDC cable is required for the SmartController. That cable uses a different style of connector. See the [Adept SmartController 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 opposite end of the cable for connection to your user-supplied 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 Figure 4-3.
 - The cable shield should be connected to frame ground on the power supply.
 - Do not turn on the 24 VDC power until instructed to do so in System Operation on page 85.
2. Plug the mating connector end of the 24 VDC cable into the 24 VDC connector on the interface panel on the top of the robot.
3. Connect the cable shield to the ground point on the interface panel.

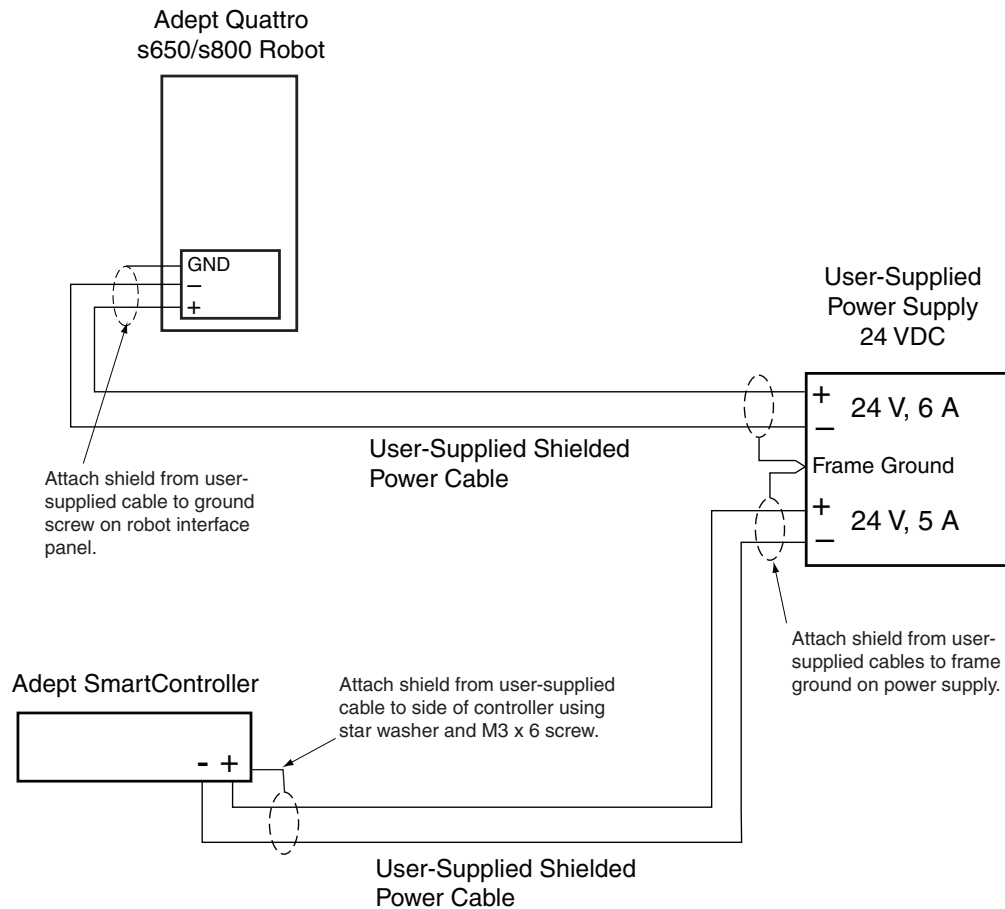


Figure 4-3. User-Supplied 24 VDC Cable

NOTE: Adept recommends that DC power be delivered over a shielded cable, with the shield connected to the return conductors at both ends of the cable.

4.9 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 4-5. Specifications for 200-240 VAC User-Supplied Power Supply

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

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

NOTE: Adept products are designed for connection to symmetrically-earthed, three-phase AC mains systems (with grounded neutral). Connections called out as single-phase can be wired Line-to-Neutral or Line-to-Line.



WARNING: Adept 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 [Adept Robot Safety Guide](#). During installation, unauthorized third parties must be prevented, through the use of fail-safe lockout measures, from turning on power.

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

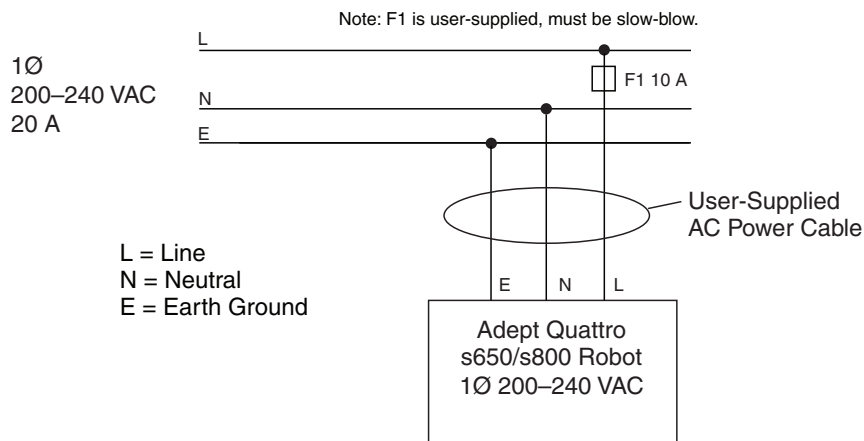


Figure 4-4. Typical AC Power Installation with Single-Phase Supply

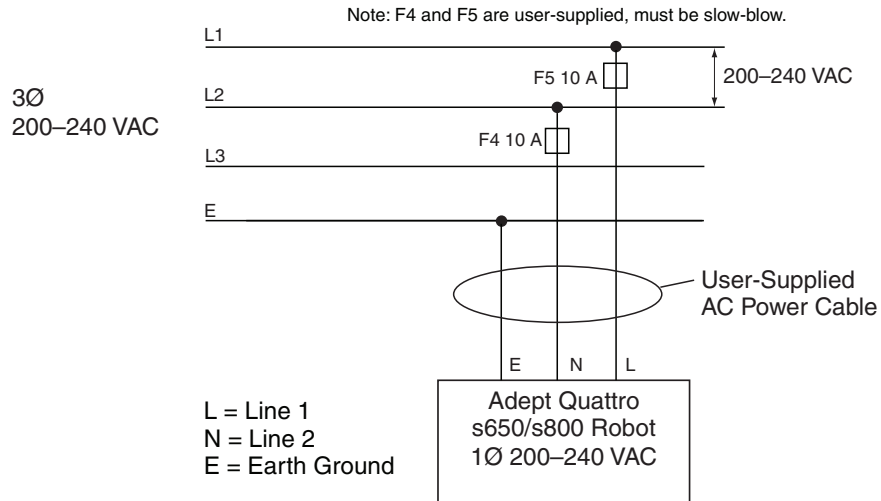



Figure 4-5. Single-Phase Load across L1 and L2 of a Three-Phase Supply

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 4-6. AC Mating Connector Details

<p>AC Connector details</p> 	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 Table 4-1.

Procedure for Creating 200-240 VAC Cable

1. Locate the AC mating connector shown in Table 4-6.
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 Figure 4-6.
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.

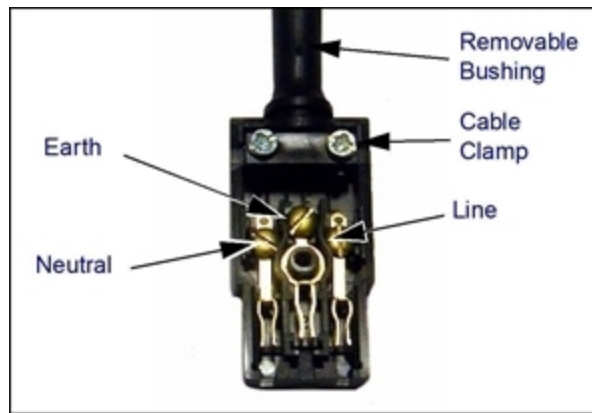


Figure 4-6. AC Power Mating Connector

Installing AC Power Cable to Robot

1. Connect the AC power cable to your facility AC power source. See Figure 4-4 and Figure 4-5. Do not turn on AC power at this time.
2. Plug the AC connector into the AC power connector on the interface panel on the robot.
3. Secure the AC connector with the locking latch.

4.10 Grounding the Adept Quattro Robot System

Proper grounding is essential for safe and reliable robot operation.

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

Adept Quattro Robot Base

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

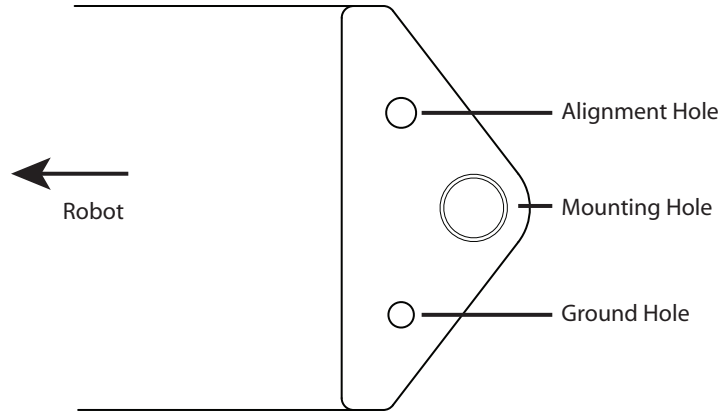


Figure 4-7. Base Mounting Pad with Ground Hole, Top View

Quattro HS Robot Base

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

The ground screw is marked inside the cable inlet box with a label.

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:

Adept Quattro H Robots

- Connect the robot base protective earth ground.
- Ground the end-effector to the robot base.

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

Adept Quattro HS Robots

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

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

4.11 Installing User-Supplied Safety Equipment

You must install safety barriers to protect personnel from unintentional contact with the robot. Depending on the design of the workcell, you can use safety gates, light curtains, and emergency stop devices to create a safe environment. Read the [Adept Robot Safety Guide](#) for a discussion of safety issues.

Refer to the [Adept SmartController User's Guide](#) for information on connecting safety equipment into the system through the XUSR connector on the SmartController. There is a detailed section on Emergency Stop Circuits and diagrams on recommended E-Stop configurations.

Chapter 5: System Operation

5.1 Robot Status Display Panel

The robot Status Display panel is located on the robot base. The Status Display and LED blinking pattern indicate the status of the robot.

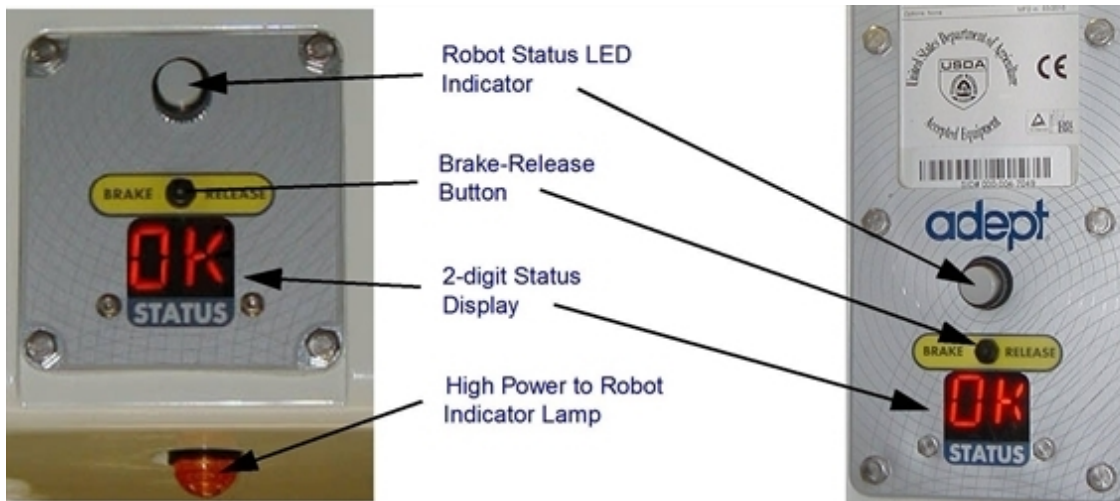


Figure 5-1. Robot Status Display Panels

NOTE: The status codes and LED status indications are the same for both the Quattro H and Quattro HS robots.

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 or Fault Code(s)	Selected Configuration Node ¹
Amber, Fast Blink	Fault Code(s)	Fault, see Status Display ¹
¹ See Status Panel Fault Codes on page 86.		

5.2 Status Panel Fault Codes

The Status Display, shown in Figure 5-1, 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

Code	Meaning	Code	Meaning
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
AC	AC Power Fault	P#	Power System Fault (Code #)
B#	IO Blox Fault (Address #)	PR	Processor Overloaded
D#	Duty Cycle Exceeded (Joint #)	RC	RSC Fault
E#	Encoder Fault (Joint #)	S#	Safety System Fault (Code #)
ES	E-Stop	SE	E-Stop Delay Fault
F#	External Sensor Stop	SW	Watchdog Timeout
FM	Firmware Mismatch	T#	Safety System Fault (Code 10 + #)
FW	1394 Fault	TR	Teach Restrict Fault
h#	High Temp Amp (Joint #)	V#	Hard Envelope Error (Joint #)

NOTE: All joint numbers correspond to the numbers on the under-side of the robot base.

For more information on status codes, go to the Adept Document Library on the Adept website, and in the Procedures, FAQs, and Troubleshooting section, look for the [Adept Status Code Summary](#) document.

5.3 Using the Brake-Release Button

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.

The standard 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 motors have electromechanical brakes. The brakes are released when high power is enabled. When high power is disabled, the brakes engage and hold the position of the robot 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 Status Panel (see Robot Status Display Panel on page 85). When system power is ON, pressing this button releases the brakes, which allows movement of the arms and platform.

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.



CAUTION: When the Brake-Release button is pressed, the end-effector platform 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 brake and verify that the end-effector or other installed tooling is clear of all obstructions.

5.4 Front Panel

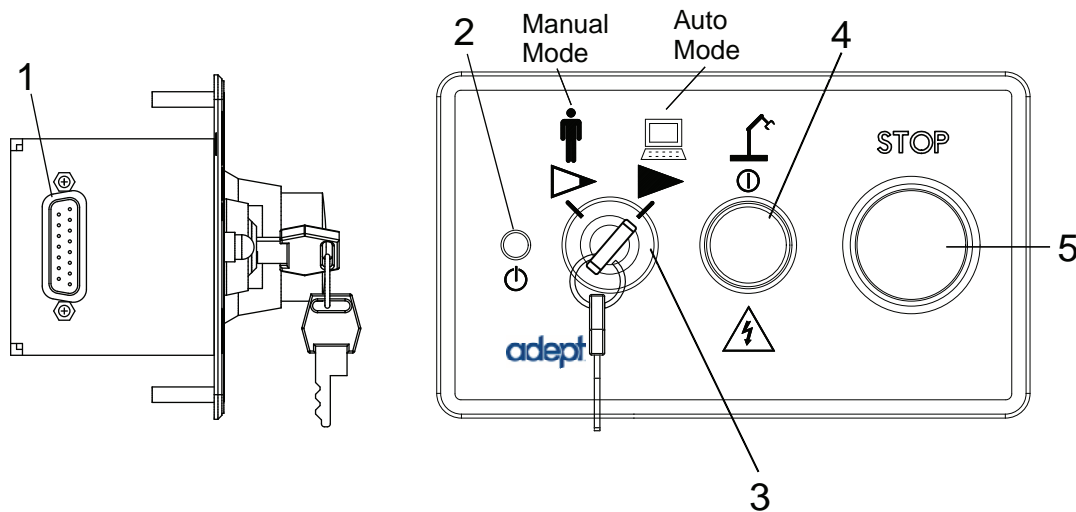


Figure 5-2. Front Panel

1. **XFP cable**
Connects to the XFP connector on the SmartController.
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.

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.

5. **Emergency Stop Switch**

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

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

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.

Table 5-3. Digital I/O Connection Options

Product	I/O Capacity	For more details
XIO Connector on Robot	12 inputs 8 outputs	see Using Digital I/O on Robot XIO Connector on page 89
XDIO Connector on SmartController	12 inputs 8 outputs	see the Adept SmartController User's Guide
Optional sDIO Module, connects to controller	32 inputs, 32 outputs per module; up to four sDIO per system	see the Adept SmartController User's Guide

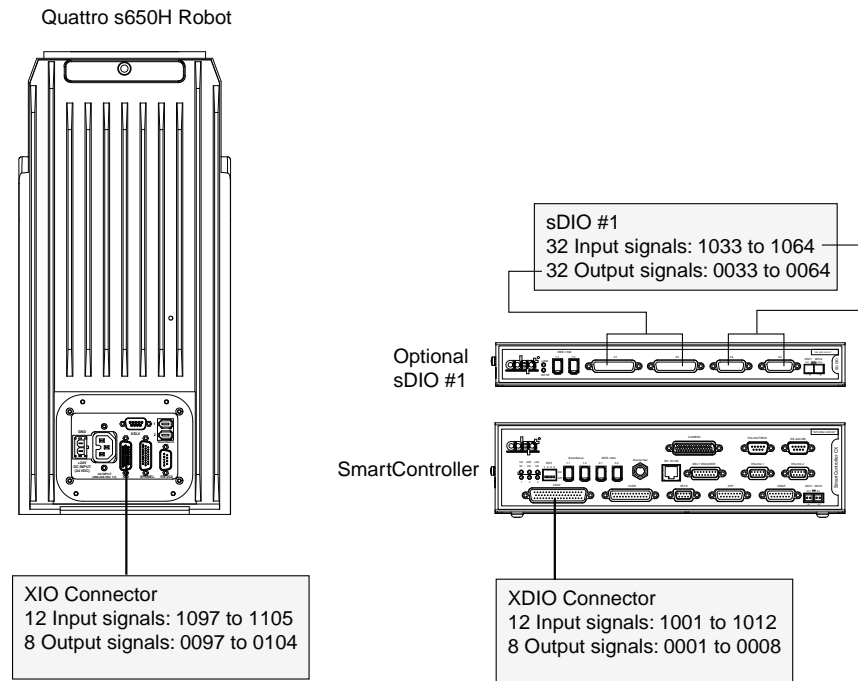


Figure 5-3. Connecting Digital I/O to the System (s650H with AIB shown)

Table 5-4. 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 [Adept Dual-Robot Configuration Procedure](#).

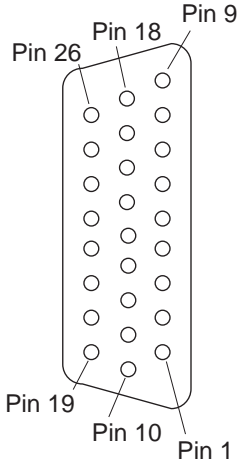
5.6 Using Digital I/O on Robot XIO Connector

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 V+/eV+ to perform various functions in the workcell.

See the following table for the XIO signal designations.

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

Table 5-5. XIO Signal Designations

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

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 94 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 [Adept 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 5-5.), or through the optional XIO Termination Block. See the documentation supplied with the Termination Block for details.

The XIO inputs cannot be used for REACTI programming, high-speed interrupts, or vision triggers. See the [eV+ Language User's Guide](#) for information on digital I/O programming.

XIO Input Specifications

Table 5-6. 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 K Ω minimum
Current at $V_{in} = +24$ VDC	$I_{in} \leq 6$ mA
Turn-on response time (hardware)	5 μ sec maximum
Software scan rate/response time	16 ms scan cycle/ 32 ms max response time
Turn-off response time (hardware)	5 μ sec maximum
Software scan rate/response time	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

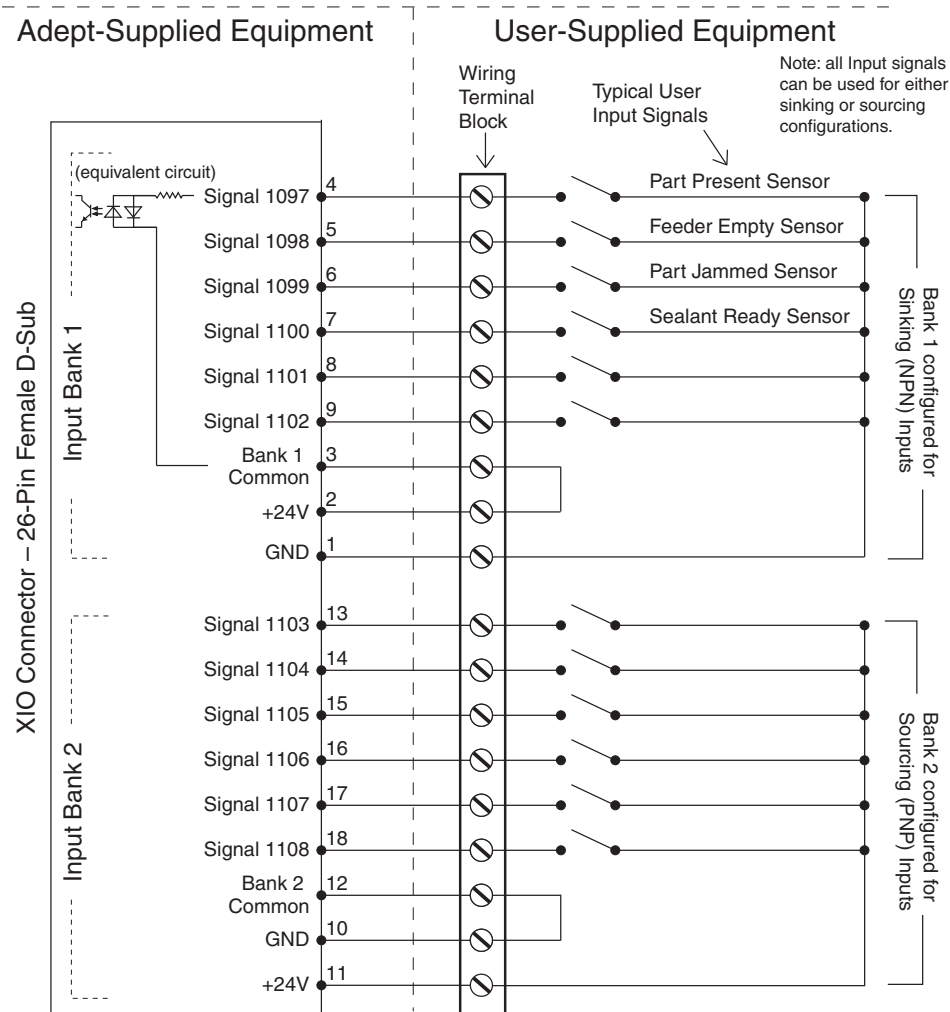


Figure 5-4. Typical User Wiring for XIO Input Signals

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 Table 5-5), or through the optional XIO Termination Block. See the documentation supplied with the Termination Block for details.

XIO Output Specifications

Table 5-7. XIO Output Circuit Specifications

Parameter	Value
Power supply voltage range	See Chapter 4.
Operational current range, per channel	$I_{out} \leq 700 \text{ mA}$
Total Current Limitation, all channels on	$I_{total} \leq 1.0 \text{ A @ } 40^{\circ} \text{ C ambient}$ $I_{total} \leq 1.5 \text{ A @ } 25^{\circ} \text{ C ambient}$
ON-state resistance ($I_{out} = 0.5 \text{ A}$)	$R_{on} \leq 0.32 \text{ } \Omega \text{ @ } 85^{\circ} \text{ C}$
Output leakage current	$I_{out} \leq 25 \text{ } \mu\text{A}$
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 ($I_{out} = 0.5 \text{ A}$, Load = 1 mH)	$(+V - 65) \leq V_{demag} \leq (+V - 45)$
DC short circuit current limit	$0.7 \text{ A} \leq I_{LIM} \leq 2.5 \text{ A}$
Peak short circuit current	$I_{ovpk} \leq 4 \text{ A}$

Typical Output Wiring Example

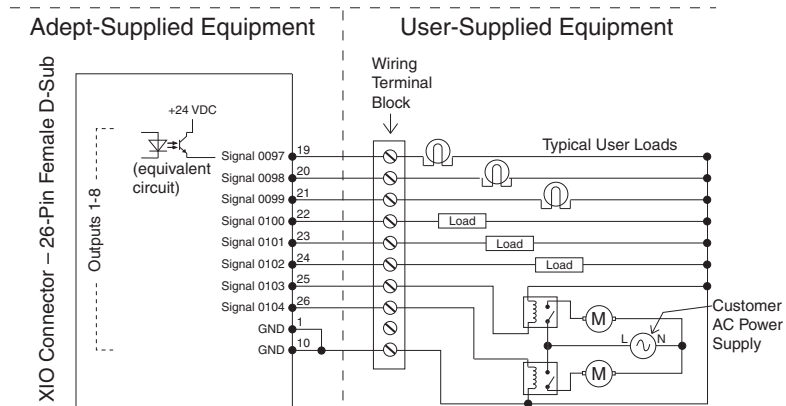


Figure 5-5. Typical User Wiring for XIO Output Signals

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 AIB/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.

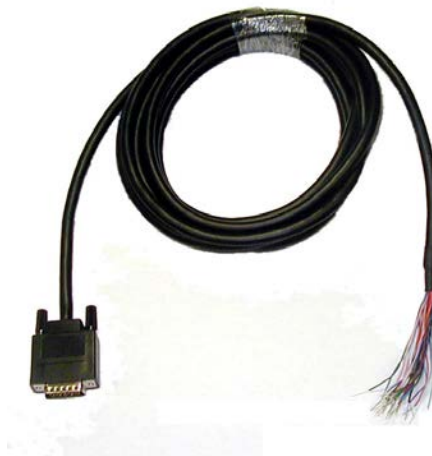
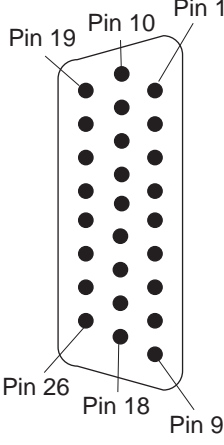


Figure 5-6. Optional XIO Breakout Cable

Table 5-8. XIO Breakout Cable Wire Chart

Pin No.	Signal Designation	Wire Color	Pin Locations
1	GND	White	 <p>26-pin male connector on XIO Breakout Cable</p>
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 each joint 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 mounted level and that all fasteners are properly installed and tightened.
- Verify that any platform tooling is properly installed.
- Verify that the platform is clocked.
- 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:

- Front panel connected to the SmartController
- Optional pendant connected to the SmartController, via the adapter cable, or a loop-back dongle installed
- 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 SmartServo port 1.1 or 1.2 on the SmartController, and the other end installed into a SmartServo port on the robot interface panel
- XSYS cable between the XSYS connector on the SmartController and either the robot interface panel XSLV connector (AIB) or eAIB XSLV Adapter cable and XSYSTEM

connector (eAIB), with the latching screws tightened.

or

eAIB XSYS (eAIB) cable between the robot interface panel XSYSTEM connector and XSYS connector on the SmartController, and the latching screws tightened.

See Cable Connections from Robot to SmartController on page 75

- User-supplied 24 VDC power connected to the robot 24 VDC connector
- User-supplied 200-240 VAC power connected to the robot 200-240 VAC connector

User-Supplied Safety Equipment Checks

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

Turning on Power and Starting Adept ACE

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

1. Turn on the 200-240 VAC power. See Connecting 200-240 VAC Power to Robot on page 79.




WARNING: Make sure personnel are skilled and instructed—refer to the [Adept Robot Safety Guide](#).

2. Turn on the 24 VDC power to the robot. See Connecting 24 VDC Power to Robot on page 76. The Status Panel displays OK. The Robot Status LED will be off.
3. Verify the Auto/Manual switch on the Front Panel is set to Auto Mode.
4. Turn on the user-supplied PC and start Adept ACE.
 - Double-click the Adept ACE icon on your Windows desktop,
 - or
 - From the Windows Start menu bar, select:
Start > Programs > Adept Technology > Adept ACE > Adept ACE.
5. On the Adept ACE Getting Started screen:
 - Select New SmartController Workspace.
 - 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

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

1. From the Adept 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 Front Panel is shown in Figure 5.4. (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.

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 Figure 5-1).

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.

Verify Robot Motions


Use the pendant (if purchased) to verify that the robot moves correctly. Refer to the [Adept T2 Pendant User's Guide](#) or [Adept T20 Pendant User's Guide](#) for complete instructions on using the pendant.

The Adept Quattro robot 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.

NOTE: All joint numbers correspond to the number embossed on the bottom of the base.

- 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 Adept ACE software. For details, see the Adept ACE User's Guide.

5.8 Quattro Motions

Straight-line Motion

Joint-interpolated motion is not possible with the Adept Quattro robot, because the positions of all the joints must always be coordinated in order to maintain the connections to the moving platform. Therefore, for the Adept Quattro robot, the V+/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 V+/eV+ software defines a cone-like shape as a containment obstacle. This is actually the work envelope. See Figure 7-4 and Figure 7-5. Other obstacles can be defined within this obstacle.

Tool Flange Rotation Extremes

Single and Multiple Program Instructions

The program instructions SINGLE and MULTIPLE have been enabled for the Adept Quattro robot with V+ version 17.1 edit C (and later) and eV+. In addition to these instructions, the OVERLAP and NOOVERLAP instructions have also been enabled, and are discussed in this section.

These instructions apply with:

- Adept Quattro robots
- P34 platform (PN 09068-x00)
- V+ system version 17.1 edit C (and later)
- eV+ (all)

The diagrams that follow represent an overhead view of the tool flange on the P34 platform (i.e., as seen from the robot base casting). The shaded area is the overlap zone of roll values.

The example V+ code that follows includes BREAK instructions only to cause the motions to go all the way to the destinations, that is, to eliminate any subtleties that might occur during continuous-path motions.

The V+/eV+ real-valued function ROBOT.OPR (2,1) returns the maximum tool-flange rotation angle available with the current platform (e.g., 185 in the case of the P34 platform).

SINGLE Program Instruction

In Figure 5-7, the arrow indicates the counter-clockwise rotation that the tool flange will take as the robot moves from location A to location B with the V+/eV+ program instruction SINGLE asserted. That is, when the following code is executed:

```
MOVE A
BREAK
SINGLE
MOVE B
```

The roll value of location A is -90 degrees and the roll value for location B is 2 degrees. One way to think of this motion is that the tool flange will not “cross over” the zero-roll position as the robot moves from location A to location B when SINGLE is asserted. This type of motion can prevent the end-effector air lines from being stretched, and ensures that a part is always accessed from the same direction. This motion can also be used to position the tool flange in preparation for the next motion.

NOTE: When SINGLE is asserted, the tool flange will always rotate in the direction that does not cross the zero-roll position, even if that means a very large rotation.

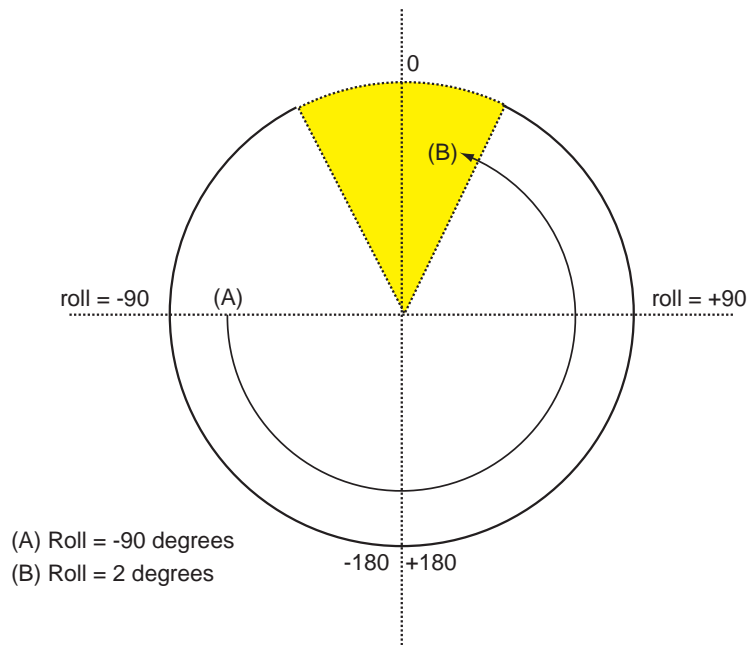


Figure 5-7. Motion with SINGLE Asserted

MULTIPLE Program Instruction

In Figure 5-8, the arrow indicates the clockwise rotation that the tool flange will take as the robot moves from location A to location B with the program instruction MULTIPLE asserted. That is, when the following code is executed:

```
MOVE A
BREAK
MULTIPLE
MOVE B
```

As in Figure 5-7, the roll value of location A is -90 degrees and the roll value for location B is 2 degrees. With MULTIPLE asserted, however, the tool flange will “cross over” the zero-roll position as the robot moves from location A to location B.

NOTE: MULTIPLE always is automatically asserted every time program execution is initiated with an EXECUTE command or instruction.

NOTE: When MULTIPLE is asserted, the tool flange will always rotate the smallest angle when the robot moves from one location to the next.

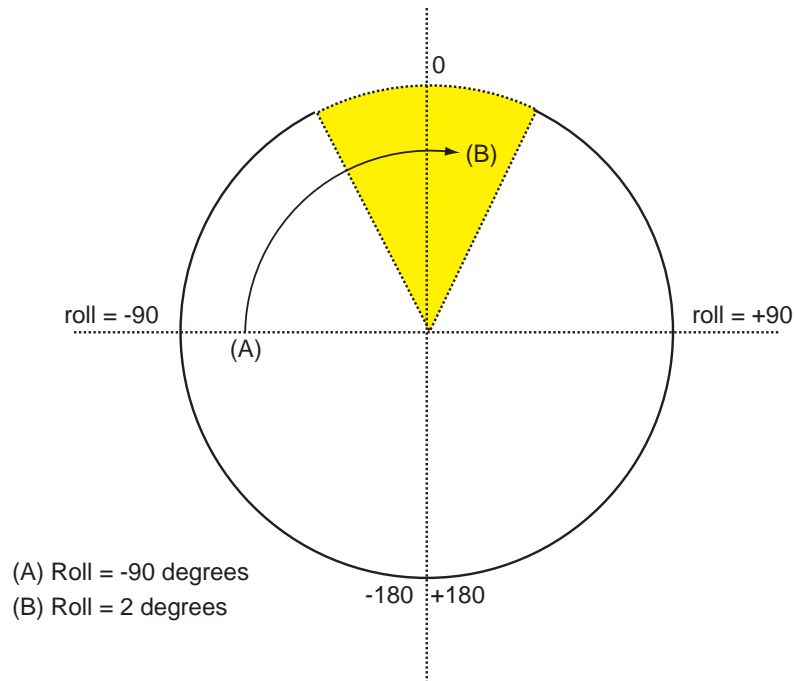


Figure 5-8. Motion with MULTIPLE Asserted

Side Effects

There are some interesting side effects when using the SINGLE and MULTIPLE instructions. One of them is shown in the following figure, which shows the robot motions for the following code:

```
MOVE A
MULTIPLE
MOVE B
BREAK
SINGLE
MOVE C
```

In this scenario, MULTIPLE is asserted and the robot is commanded to move into the positive half of the overlap zone (moving from location A [roll=-90] to location B [roll=2]). Next, SINGLE is asserted and the robot is asked to move to location C (roll = 4). Even though the zero-roll position has already been crossed, the robot will move in a counter-clockwise direction to location C, instead of taking the shortest path. That happens because SINGLE forces the tool-flange rotation angle to remain within $\pm 180^\circ$ - that is, the rotation is not permitted to use the full 185-degree range of motion.

The lesson here is to be aware of the mode that the robot was in when it was commanded to move into the overlap zone. In other words this weird rotation could have been avoided if the robot moved into the overlap zone with SINGLE asserted. (But then, of course, a large rotation would have been done during the motion to location B.)

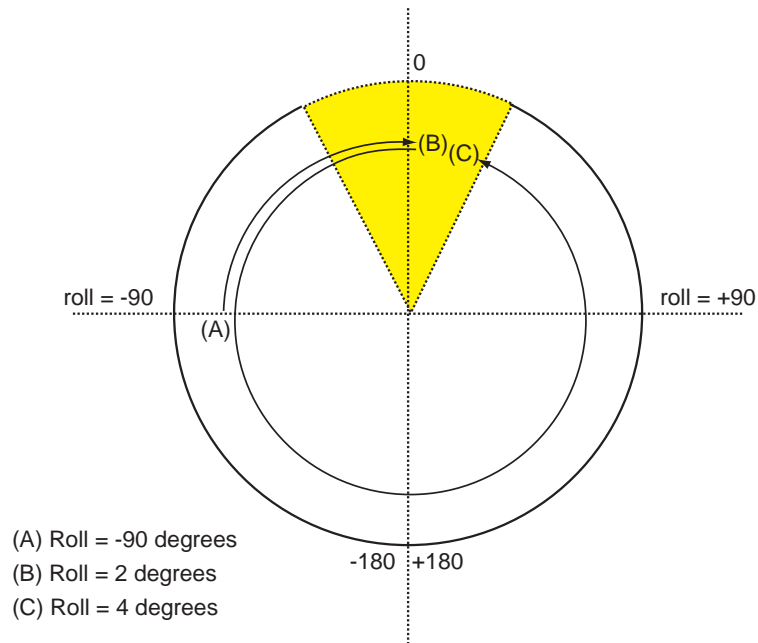


Figure 5-9. Motions with *MULTIPLE* and *SINGLE* Asserted

OVERLAP Program Instruction

The OVERLAP and NOOVERLAP program instructions determine the system response when a motion requires more than 180 degrees of tool-flange rotation. When OVERLAP is set and a robot motion requires a rotation greater than 180 degrees (in either direction), the motion is executed without generating a program error.

With OVERLAP set, the settings of SINGLE and MULTIPLE do affect the robot motion as described above.

NOTE: OVERLAP ALWAYS is automatically asserted every time program execution is initiated with an EXECUTE command or instruction.

NOOVERLAP Program Instruction

When NOOVERLAP is set and a robot motion requires a rotation greater than 180 degrees (in either direction), in order to avoid a limit stop, the motion is not executed. Instead, the program error “*Orientation out of range*” (error code -935) is reported.

NOTE: The error can be “captured” by a REACTE routine, providing a way to respond to the situation.

When NOOVERLAP is set, the setting of SINGLE and MULTIPLE modes has no effect on the robot motion.

5.9 Learning to Program the Adept Quattro Robot

To learn how to use and program the robot, see the [Adept ACE User's Guide](#), which provides information on robot configuration, control and programming through the Adept ACE software “point and click” user interface.

For V+/eV+ programming information, refer to the V+/eV+ user and reference guides in the Adept Document Library (ADL) on the Adept website. For more details on the ADL, see Adept Document Library on page 25.

Chapter 6: Optional Equipment Installation

6.1 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.

NOTE: For the Adept Quattro s650HS robots, any end-effectors, tooling, and vacuum or electric lines must conform to USDA regulations to maintain the robot's USDA Acceptance.

Attaching

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. See the drawings starting with Figure 7-6 for dimensions of the tool flanges.

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

Aligning

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. See the drawings starting with Figure 7-6 for dimensions of the tool flanges.

Grounding

If hazardous voltages are present at the end-effector, you must install a ground connection to the end-effector. See Robot-Mounted Equipment on page 83.

Accessing Vacuum

The tool flange has been made as large as possible to allow vacuum lines to pass through.



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

See the drawings starting with Tool Flange Dimensions, P31 Platform on page 115.

6.2 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.

The holes on the bottom of the robot base are sealed with bolts and washer seals on the Quattro HS robots. If you choose to use these holes for mounting lines, it is your responsibility to ensure that the mounting seals meet USDA regulations.

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 or vacuum fitting of the flange 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:

- For Quattro s650HS robots, bolts must be sealed, to meet USDA regulations.
- 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.
- Are not considered in the robot's IP rating or USDA Acceptance.

6.3 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 from Adept as part number 09824-000.

NOTE: Ball stud locks, while made of FDA-approved material, are NOT USDA Accepted.

The Quattro s650HS was USDA Accepted without ball stud locks.

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.

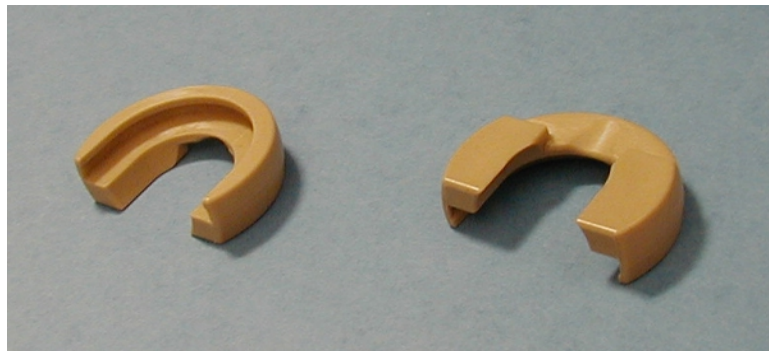


Figure 6-1. Ball Stud Locks

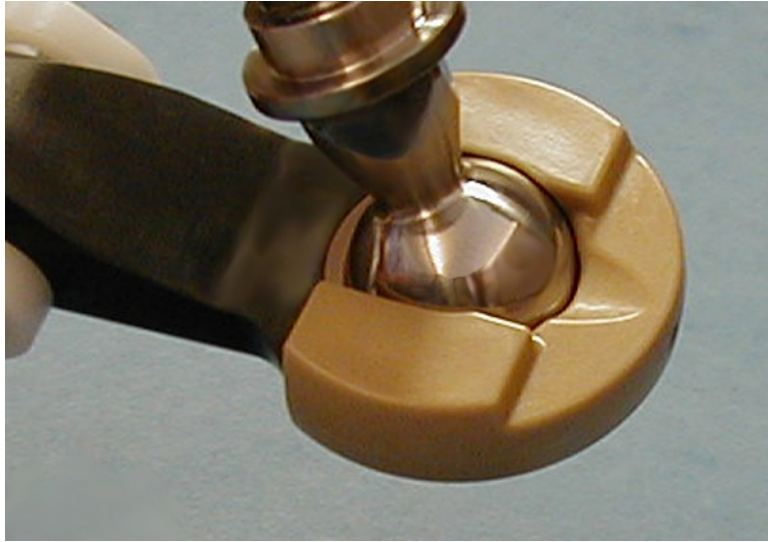


Figure 6-2. Ball Stud Lock on Ball Joint Socket

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.

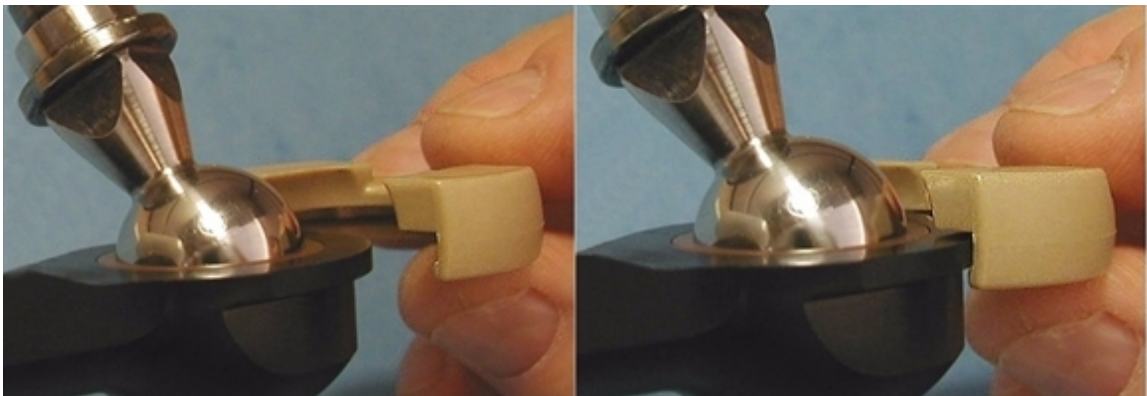


Figure 6-3. Installing a Ball Stud Lock

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.

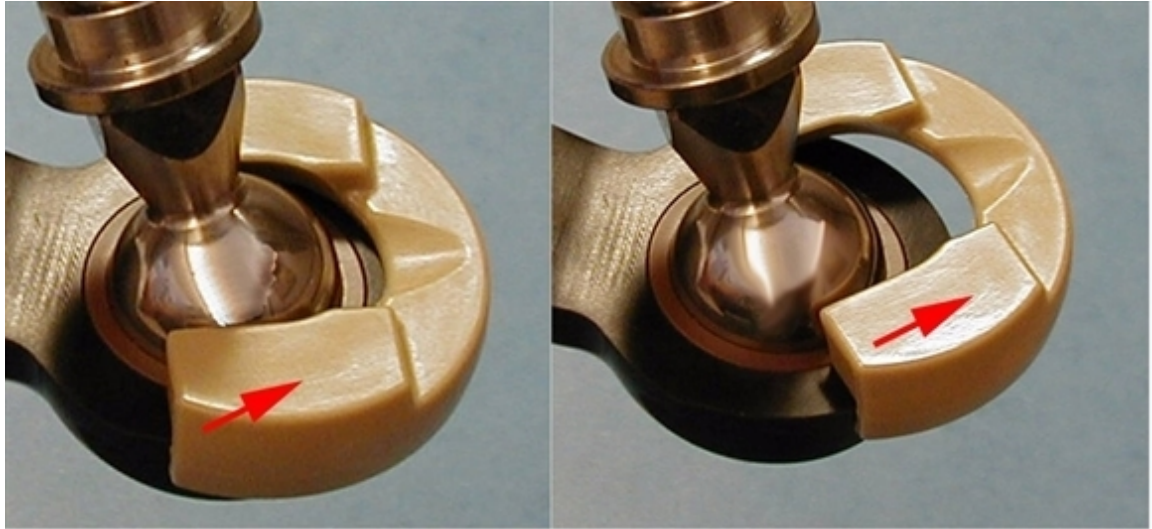


Figure 6-4. Removing a Ball Stud Lock

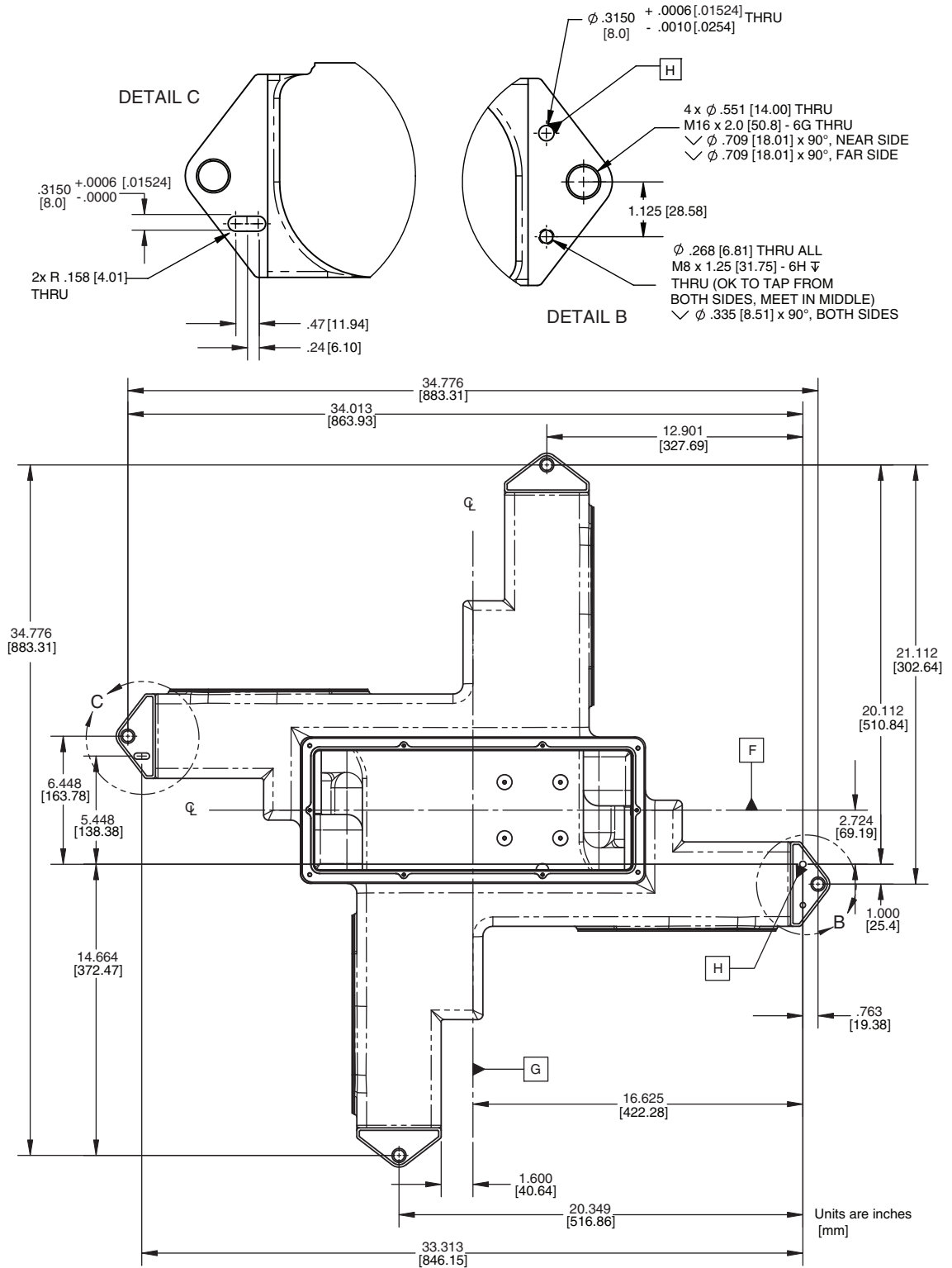


Figure 7-2. Mounting Hole Dimensions, Quattro H Robots

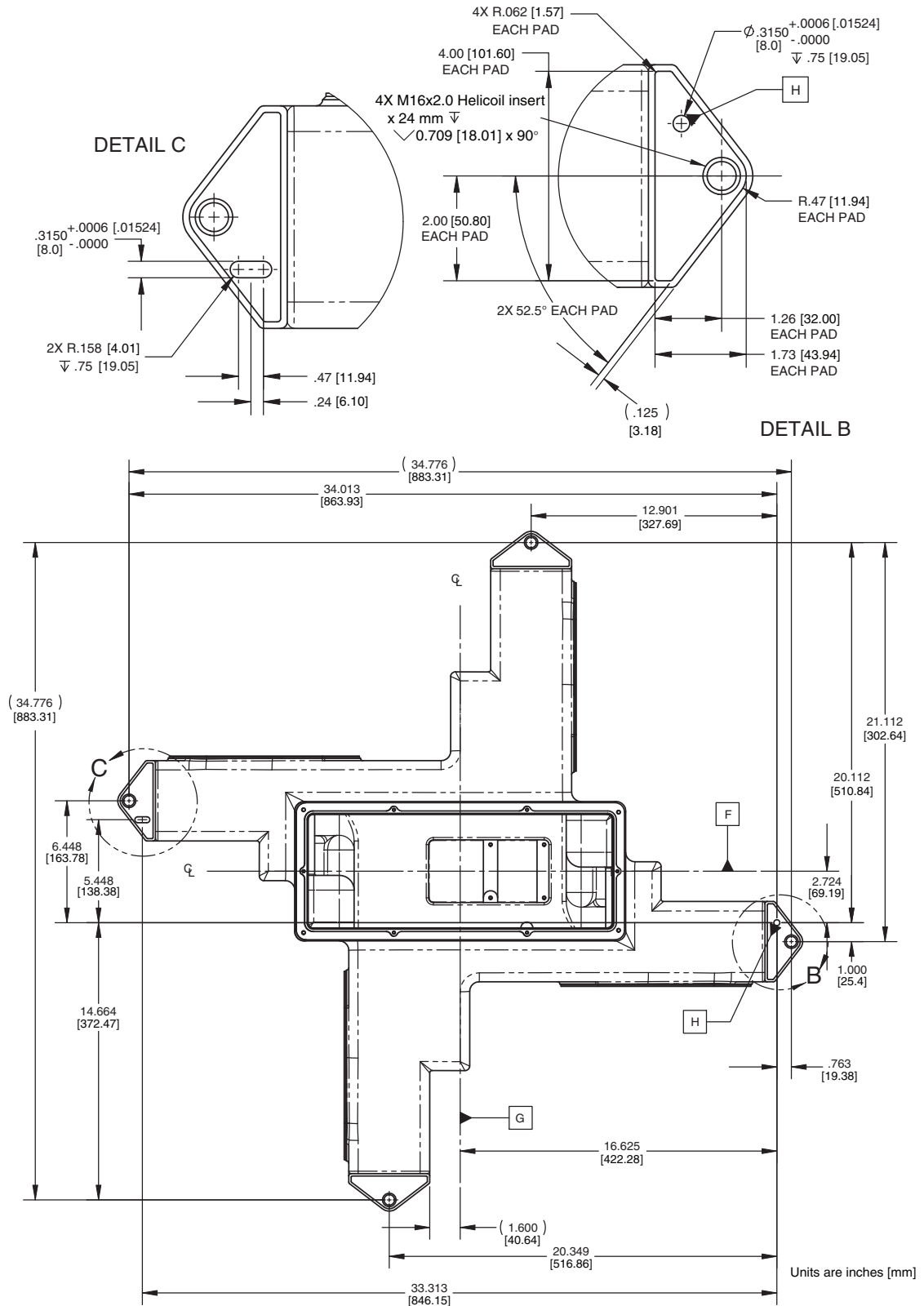


Figure 7-3. Mounting Hole Dimensions, Quattro HS Robots

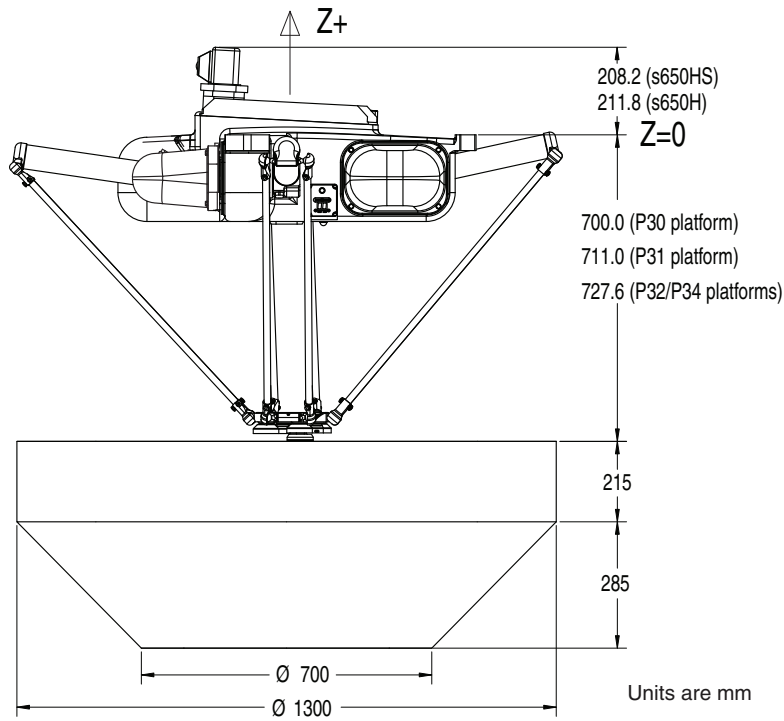


Figure 7-4. Work Envelope, Side View, Quattro s650 Robot

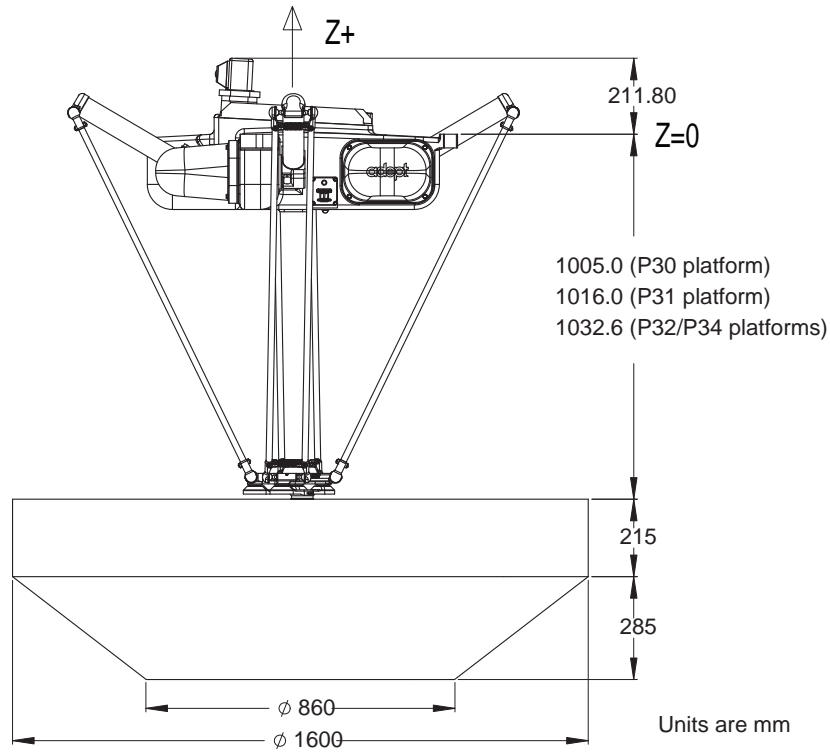


Figure 7-5. Work Envelope, Side View, Quattro s800 Robot

Tool Flanges

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

The P31 tool flange face moves with the strut that it is part of, providing $\pm 46.25^\circ$ of rotation.

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

Ensure that the bolts used to attach end-effectors engage the threads in the tool flange sufficiently:

Table 7-1. Tool Flange Bolt Engagement

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

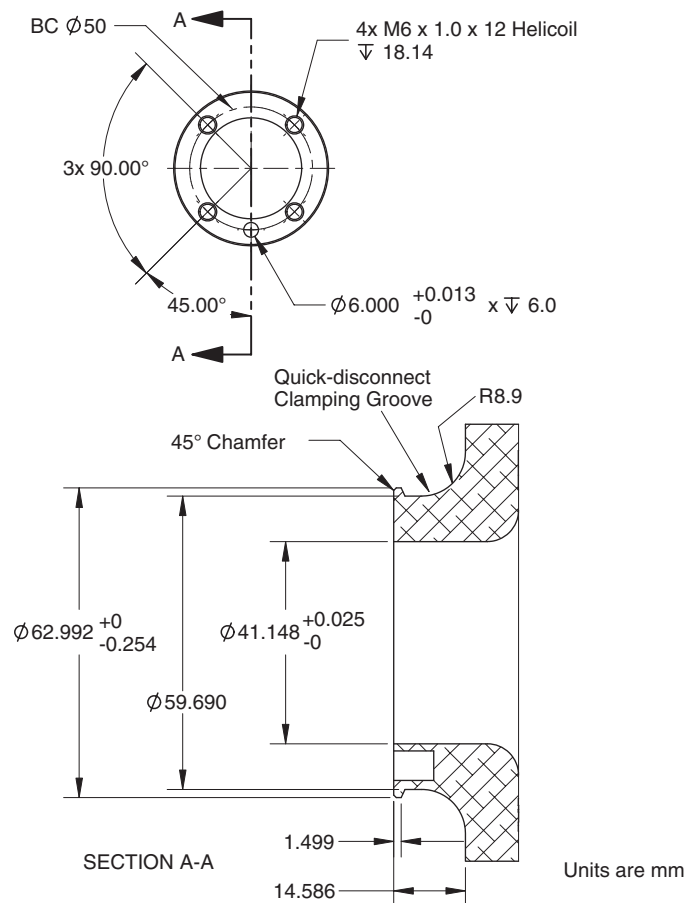


Figure 7-6. Tool Flange Dimensions, P31 Platform

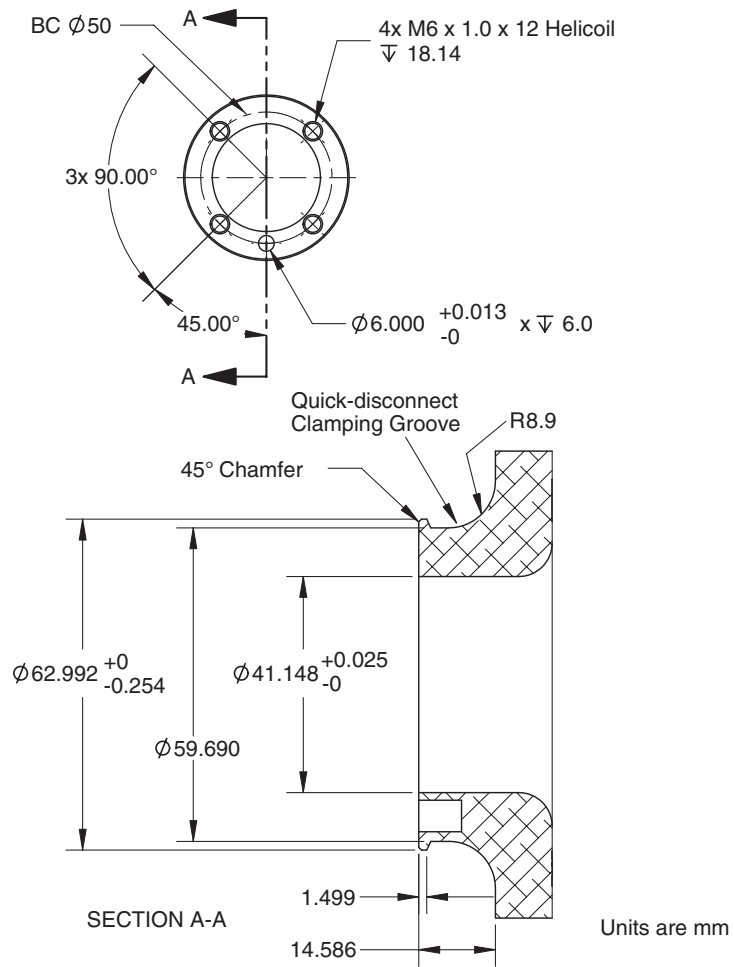
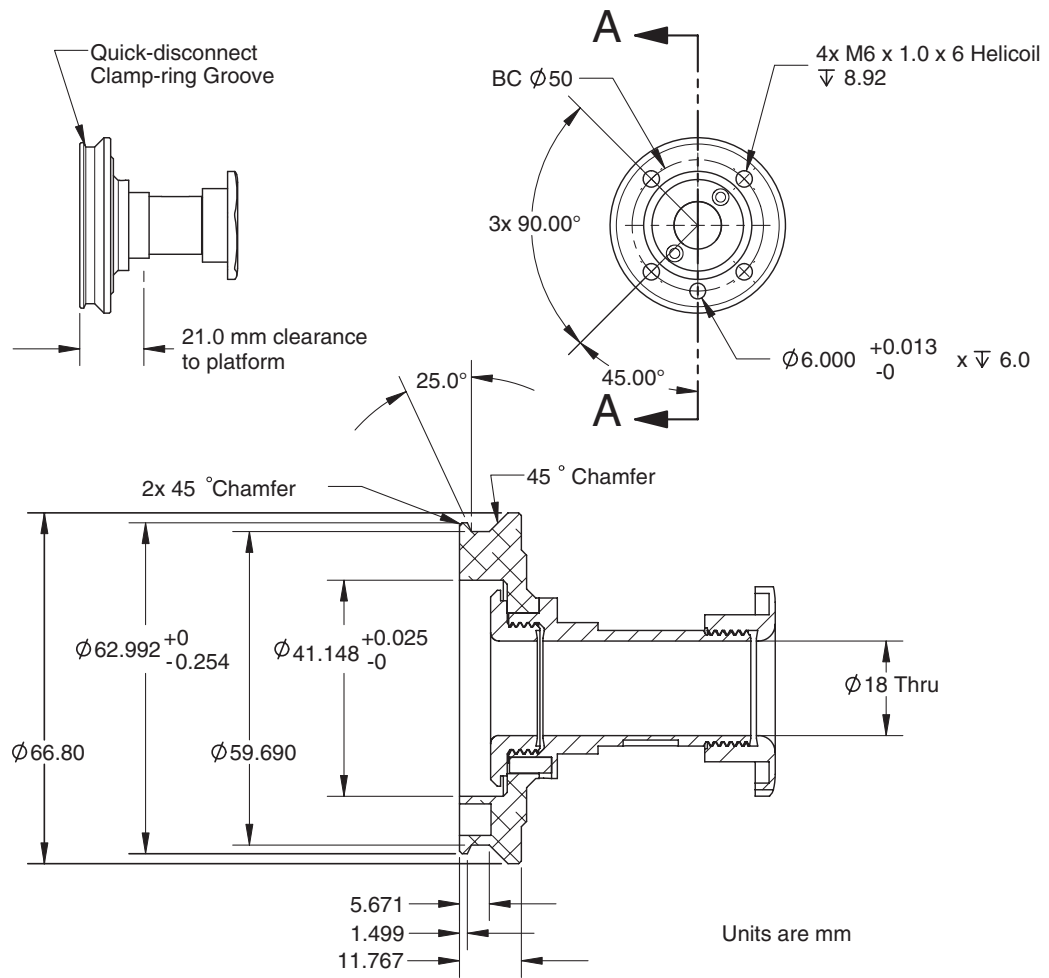
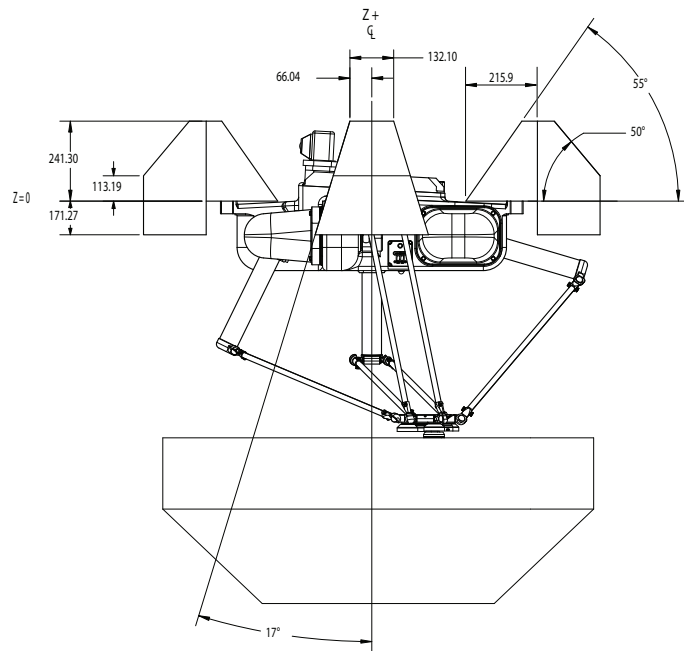


Figure 7-7. Tool Flange Dimensions, P30 Platform



SECTION A-A

Figure 7-8. Tool Flange Dimensions, P32, P34 Platforms



Typical Inner Arm Travel Volume

Units are mm

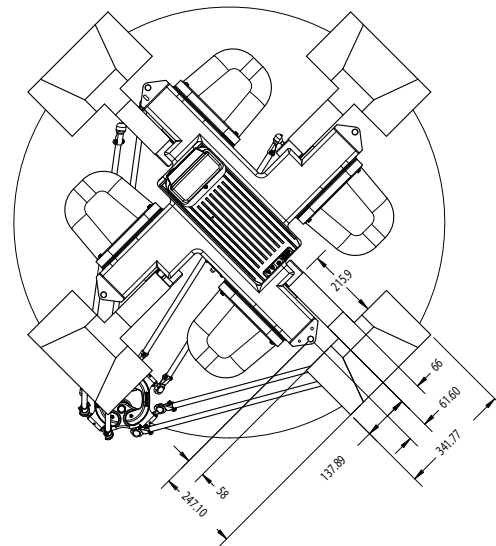


Figure 7-9. Arm Travel Volume (s650 shown)

7.2 Adept Quattro Internal Connections

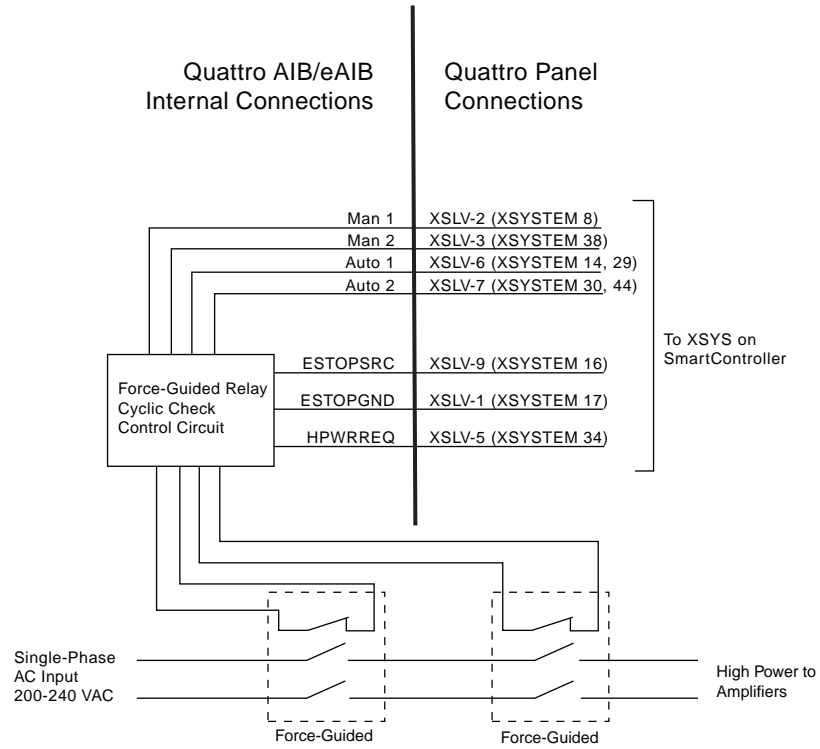


Figure 7-10. Robot Internal Connections Diagram

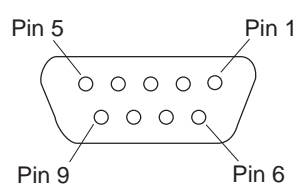
7.3 XSYS/XSYSTEM Connector

Table 7-2. XSYS to XSYSTEM Connector Pinouts (eAIB only)

XSYS Pin #	XSYSTEM Pin #	Description	Comment	Pin Location
1	17	ESTOP_GND	E-Stop system Ground	
2	8	ENABLE_SW_1-		
3	38	ENABLE_SW_2-		
4	15	HPWR_DIS	High Power Disable	
5	34	HPWR_REQ		
6	14 & 29	MUTE_GATE_1-		
7	30 & 44	MUTE_GATE_2-		
8	N/C			
9	16	ESTOP_SRC	E-Stop System +24 V	
Shell	Shell	SHIELD		

7.4 XSLV Connector

Table 7-3. XSLV Connector Pinout (AIB only)

Pin #	Description	Comment	Pin Location
1	ESTOPGND	ESTOP System Ground	 <p>XSLV1/2 Connector</p>
2	MAN1	ESTOP Manual Input Ch 1	
3	MAN2	ESTOP Manual Input Ch 2	
4	HIPWRDIS	High Power Disable	
5	ESTOP_RESET	Normally-Closed Check Contacts	
6	AUTO1	ESTOP Auto Input Ch 1	
7	AUTO2	ESTOP Auto Input Ch 2	
8	N/C		
9	ESTOP_SRC	ESTOP System +24 V	
Mating Connector:			
AMP/Tyco #747904-2, 9-pin D-Sub			
AMP/Tyco #748676-1, D-Sub Cable Clamp			

7.5 Robot Specifications

Specifications subject to change without notice.

Table 7-4. Robot Specifications

Description	Specification		
	Quattro s650 AL and EN	Quattro s650 SS	Quattro s800 SS
Reach (cylinder radius)	650 mm (25.6 in.)		800 mm (31.5 in.)
Payload - rated	2.0 kg (4.4 lb)	1.0 kg (2.2 lb)	2.0 kg (4.4 lb)
Payload - maximum	6.0 kg (13.2 lb)	3.0 kg (6.6 lb)	4.0 kg (8.8 lb)
Adept Cycle ^a - seconds	25-305-25 mm		
0.1 kg	0.3	0.39	0.33
1 kg	0.36	0.41	0.38
2 kg	0.37	0.42	0.40
3 kg	0.39	0.43	
4 kg	0.41	n/a	0.45
6 kg	0.43	n/a	n/a
Packaging Cycle ^a -	25-700-25 mm		

Description	Specification		
	Quattro s650 AL and EN	Quattro s650 SS	Quattro s800
seconds			
0.1 kg	0.46	0.55	0.48
1 kg	0.47	0.58	0.50
2 kg	0.52	0.59	0.55
3 kg	0.55	0.61	
4 kg	0.58	n/a	0.62
6 kg	0.61	n/a	n/a
Joint Range	+124° to -52°		
Soft Stops	+121° to -49°		
Encoder type	Absolute		
Robot Brakes	24 VDC		
Digital I/O Channels	12 inputs, 8 outputs		
Weight (no options)	118 - 123 kg (260 - 271 lb)		
Weight (in crate)	155 - 160 kg (342 - 352 lb)		
Footprint	883 x 883 mm (34.8 x 34.8 in.)		
aThe 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.			

Table 7-5. Adept Quattro (all) Robot Power Consumption

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

7.6 Payload Specifications

Torque and Rotation Limits

Table 7-6. Tool Flange Torque and Rotation Limits of Platforms

Platform	60 deg.	185 deg.	P31	P32	P34
Maximum Torque (N·m)	8	2.7	10	4.6	3.8
Maximum Rotation	± 60°	± 185°	± 46.25°	± 92.5°	± 185°
Hard Stop Limit	± 65°	± 195°	± 52.4°	± 104.3°	± 208.6°

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

Payload Mass vs. Acceleration

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

Table 7-7. Payload Mass vs. Acceleration - s650 Quattro, Aluminum Platforms

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

^a% is the V+ Accel/Decel setting, which, for the Quattro, can be set as high as 1000%.

Table 7-8. Payload Mass vs. Acceleration - s650 Quattro, Stainless Steel Platforms

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

^a% is the V+ Accel/Decel setting, which, for the Quattro, can be set as high as 1000%.

Table 7-9. Payload Mass vs. Acceleration - s800 Quattro

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

^a% is the V+ Accel/Decel setting, which, for the Quattro, can be set as high as 1000%.

Payload Inertia vs. Acceleration

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

Table 7-10. Payload Inertia vs. Acceleration

	Platform				
	60 deg.	185 deg.	P31	P32	P34
Acceleration Value	Allowable Tool Inertia (kg-cm ²)				
100	672	75	750	188	47
250	269	30	300	75	19
500	134	15	150	37	9
750	90	10	100	25	6

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

7.7 Robot Mounting Frame, Quattro s650H Robot

NOTE: The example frame provided here was not designed to meet USDA standards. While most mechanical specifications are the same, you will have to

make adjustments to comply with USDA requirements.

NOTE: The design of the Quattro HS robot mounting bolts and seals requires fairly tight tolerances for the robot mounting holes in the frame. These should be 17.25 ± 0.75 mm (0.68 ± 0.03 in.) in diameter.

The Adept Quattro robot is designed to be mounted above the work area, suspended on a user-supplied frame. The frame must be adequately stiff to hold the robot rigidly in place while the robot platform moves around the workspace. You can either use the design provided or design a custom support frame. See Mounting Frame on page 29. The drawings for the sample frame are provided here, starting with Figure 7-11.

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 of a flat plane.

For Quattro H robots only: If the flanges are not within this tolerance, they should be shimmed.



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



CAUTION: Shimming the frame for a Quattro s650HS robot will result in failure of the robot to comply with USDA requirements.

The AIB/eAIB must be removable from the top of the frame, and the inner and outer arm travel envelopes must be considered. See Figure 7-9.

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

NOTE: This frame is designed to have the robot mounted to the underside of the frame mounting tabs.

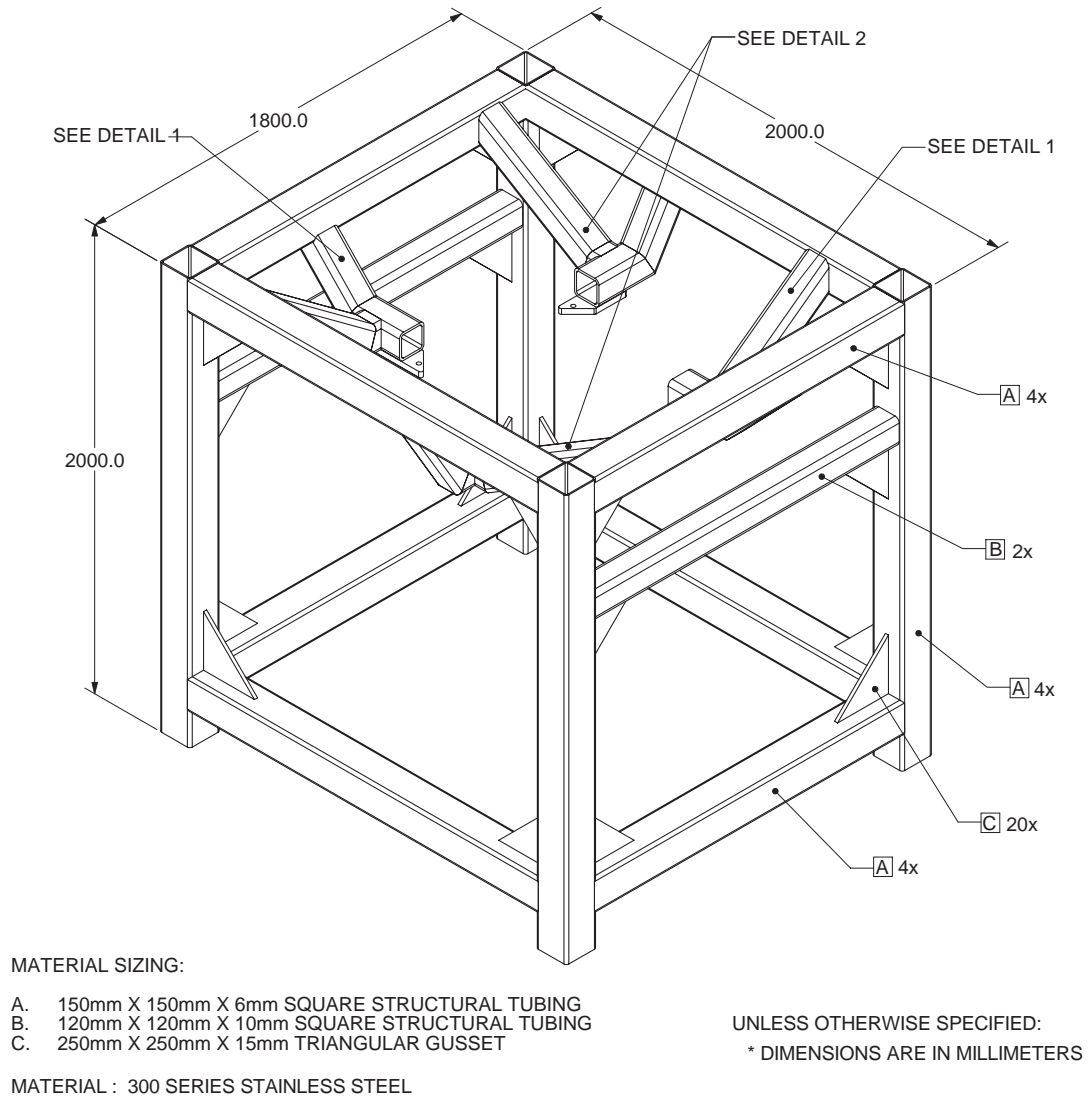


Figure 7-11. Mounting Frame, Orthogonal View

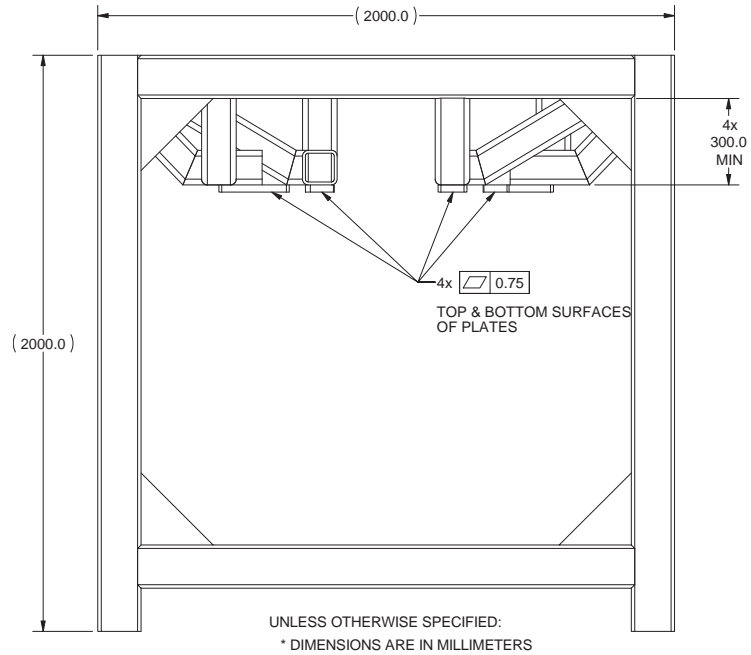


Figure 7-12. Mounting Frame, Side View 1

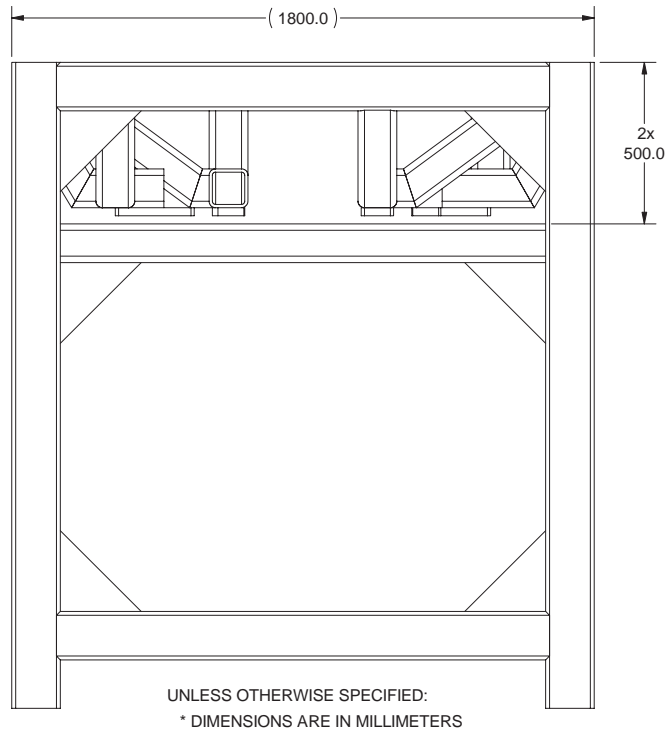


Figure 7-13. Mounting Frame, Side View 2

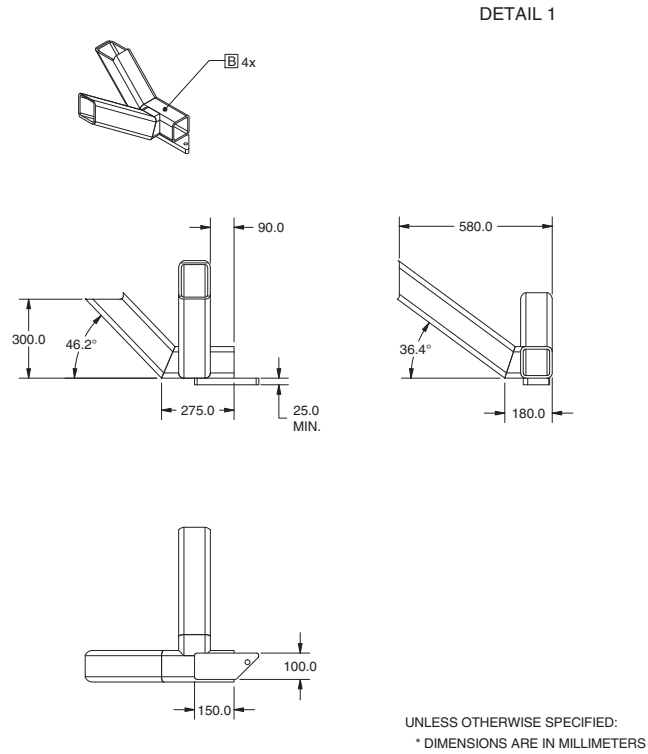


Figure 7-14. Mounting Frame, Detail 1

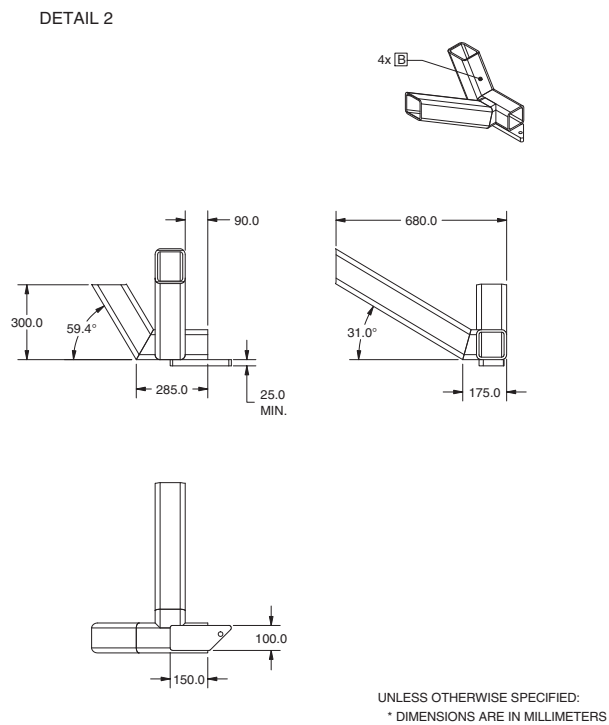


Figure 7-15. Mounting Frame, Detail 2

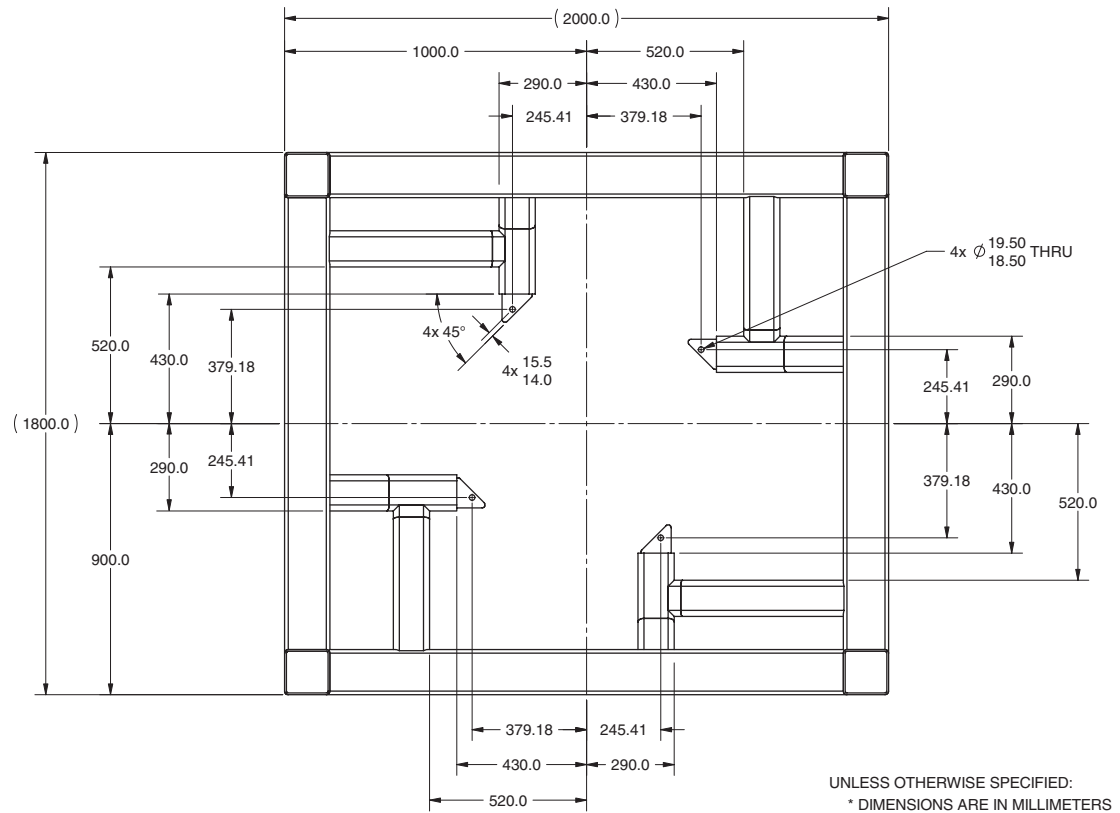


Figure 7-16. Mounting Frame, Top View

Chapter 8: Maintenance - H

NOTE: This chapter applies to the Adept Quattro H robots (non-USDA) only.

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

8.1 Periodic Maintenance Schedule

Table 8-2 and Table 8-3 give a summary of the preventive maintenance procedures and guidelines on frequency.

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



WARNING: The procedures and replacement of parts mentioned in this section should be performed only by skilled or instructed persons, as defined in the [Adept Robot Safety Guide](#).

The motor covers and the AIB/eAIB on the robot are not interlocked—turn off and disconnect power if these have to be removed. Lockout and tagout power before servicing.

Table 8-1. 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.

Table 8-2. Suggested Inspection

Inspect/Check	Sugg. Interval	Est. Insp. Time	Inspection	Suggested Action
User Cabling	1 Week	15 Min	Inspect for wear around robot joints and possible binding on robot.	Replace cabling if cracked or worn. Adjust cable position if binding.

Inspect/ Check	Sugg. Interva- l	Est. Insp. Time	Inspection	Suggested Action
Outer Arm Inserts	1 Week	15 Min	Inspect inserts for excessive wear.	Replace worn inserts.
Outer Arms	3 Mon	30 Min	Inspect outer arms for cracking or damage caused by possible accidental impact of robot. Inspect spring horseshoes for wear.	Replace arms if damaged. Replace springs and horseshoes if worn or damaged.
Platform	3 Mon	10 Min	Inspect platform for damage caused by possible accidental impact of robot.	Replace platform.
Robot Fans, Geardrives, and Motor Cover seals	3 Mon	60 Min	Remove motor covers and inspect cooling fans for operation. Look for lubrication leaking from geardrives. See Checking Robot Gear Drives on page 134 and Checking Fan Operation on page 135. Check for good seal contact, missing sections, inflexible or broken seals.	Diagnose and/or replace non-operational fans. Replace geardrives. Replace motor cover seals.
Dynamic and Static seals	3 Mon	10 Min	Inspect dynamic seals on inner arms as well as static seals for sanitizing wash-down environments. Check for good seal contact, missing sections, inflexible or broken seals.	Platforms: replace platform. Inner arms: replace seals.
Inner Arms	6 Mon	15 Min	Inspect Inner Arms for cracking or damage caused by possible accidental impact of robot.	Replace inner arms.
E-Stop, Enable and Key Switch, Barrier Interlocks	6 Mon	30 Min	Check functioning of E-Stops. See Checking Safety Systems on page 134	Replace Front Panel, or customer E-Stops.
Robot Mount. bolts	3 Mon	15 Min	Check tightness of bolts. See Checking Robot Mounting Bolts on page 134	Tighten bolts.

Table 8-3. Suggested Part Replacement

Item	Suggested Interval	Estimated Time of Maintenance	Description
Motor & Gear Assembly	5 Years	1 Hour + Factory Calibration for each joint	Motor and geardrives are sold as a unit because damage to one often results in damage to both. Replacement interval is rated 5-10 years for most applications.
AIB/eAIB	5 Years	1 Hour	Accumulated wear on electronics by excessive operations or poor line voltage.
Inner Arms	5 Years	1 Hour +	Broken by accidental impact. Requires Factory Calibration.
Outer Arms	5 Years	15 Minutes	Broken by accidental impact.
Platform	3 Years	30 Minutes	Excessive wear, gritty environment, damage from accidental impact.
Cable & AIB/eAIB Seal Kit	2 Years	3 Hours	Foam and rubberized seals may selectively be replaced as needed due to cleaning causing brittle seal failures. Replacement time controlled by seal condition at time of replacement.
Motor Fan	2 Years	30 Minutes	Fan lifetime is strongly affected by robot temperatures. Aggressive moves at high ambient temps will shorten fan lifetimes.
IP-65 Cable Seal Kit	2 Years	30 Minutes	AIB/eAIB cables have IP-65 sealing kit available as an option.
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 Replacing the Encoder Battery Pack on page 144
Motor Cover	Indefinite	15 Minutes	Motor covers may become damaged by accidental impact.
Factory Calibration	Indefinite	1 Hour	Needed for full accuracy after any motor change, inner arm breakage, or accidental battery disconnection. Usually performed by Adept or a trained service representative with a tooling fixture.
Spring Assemblies	Indefinite	15 Minutes	Springs and horseshoes can be replaced in case of excessive wear or unexpected breakage. Preferred solution is to stock and swap outer arms.

8.2 Checking Safety Systems

These tests should be done 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
 - E-Stop button on pendant
 - Auto/Manual switch on front panel
 - Enabling switch on pendant (Manual mode only)
2. Test operation of any external (user-supplied) E-Stop buttons.
3. Test operation of barrier interlocks, etc.

8.3 Checking Robot Mounting Bolts

Check the tightness of the base mounting bolts every 6 months. Refer to Mounting Bolt Torque Specifications on page 36 for torque specifications.

8.4 Checking Robot Gear Drives

Adept Quattro robots use gear drives, which use oil in their components for lubrication. It is recommended that you periodically inspect the robot for signs of oil on and around the gear drives.

NOTE: Check the operation of the fans while the motor covers are off.
See Checking Fan Operation on page 135.

1. Remove all power to the robot before starting this check.
Lock out and tag out power.
2. Wait for the motors to cool before performing this check.



WARNING: Do not remove the encoder cable connectors from their sockets on the motors. If they are removed, the calibration data will be lost and the robot must be recalibrated, which requires special software and tools

3. Check for oil inside the base of the robot after removing the motor covers.
 - Look through the venting slots under each motor for oil leakage.
 - Feel the bottom of the motors with your finger through the venting slots.

4. Check the outside of the motors and gear drives for any signs of oil.
5. Contact Adept if you find any signs of oil in these areas.

8.5 Checking Fan Operation

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

Verify that all four motor fans operate:

1. Remove all motor covers.
2. Toggle power to the AIB/eAIB.

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

3. Verify that each motor fan is running.
4. Verify that the AIB/eAIB fan is running.

NOTE: The AIB/eAIB fan runs continuously, but its speed will vary.

5. Reinstall all motor covers.

8.6 Replacing the AIB or eAIB Chassis

This section gives instructions on how to replace the AIB/eAIB chassis on an Adept Quattro robot.



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

Removing the AIB/eAIB Chassis

1. Switch OFF the SmartController.
2. Switch OFF the 24 VDC input supply to the AIB/eAIB chassis.
3. Switch OFF the 200-240 VAC input supply to the AIB/eAIB chassis.
4. Disconnect the 24 VDC supply cable from the chassis +24 VDC input connector. See Figure 4-2 for locations of connectors.
5. Disconnect the 200-240 VAC supply cable from the chassis AC input connector.

Lock out and tag out power.

6. Disconnect the XSYS cable from the chassis XSLV connector (AIB) or XSYS cable and eAIB XSLV Adapter cable from the chassis XSYSTEM connector (eAIB)

or

Disconnect the eXSYS cable (eAIB) from the chassis XSYSTEM connector.

7. Disconnect the 1394 cable from the chassis SmartServo connector.
8. Disconnect any other cables, which may be connected to the chassis, such as XIO or RS-232.
9. Using a 5 mm hex key, carefully unscrew the chassis securing bolt. See the following figure.

NOTE: The bolt does not need to be completely removed in order to remove the chassis, as this bolt is captured on the chassis heat sink.

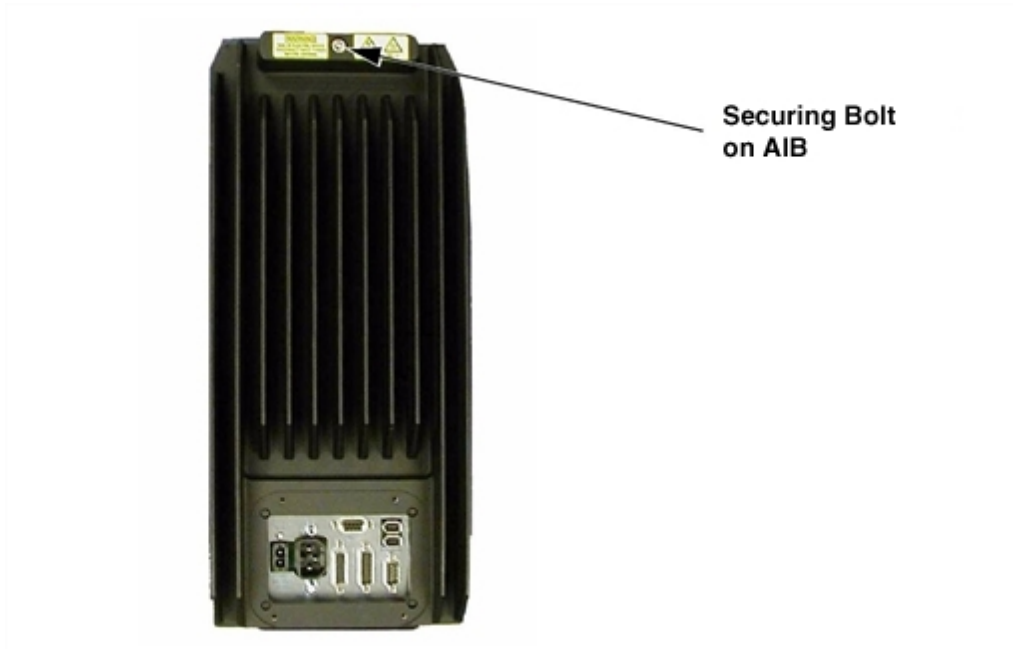


Figure 8-1. Securing Bolt on Chassis, AIB Shown

10. While holding the chassis heat sink, slowly and carefully lift the chassis up (see the following figure), so that enough clearance is available to remove the chassis from the base.
11. Lay the chassis flat (on its heat sink fins) next to the base opening.



Figure 8-2. Opening the Chassis

12. Disconnect the white amplifier cable (motor power) from the amplifier connector located on the chassis bracket. See the following figure.

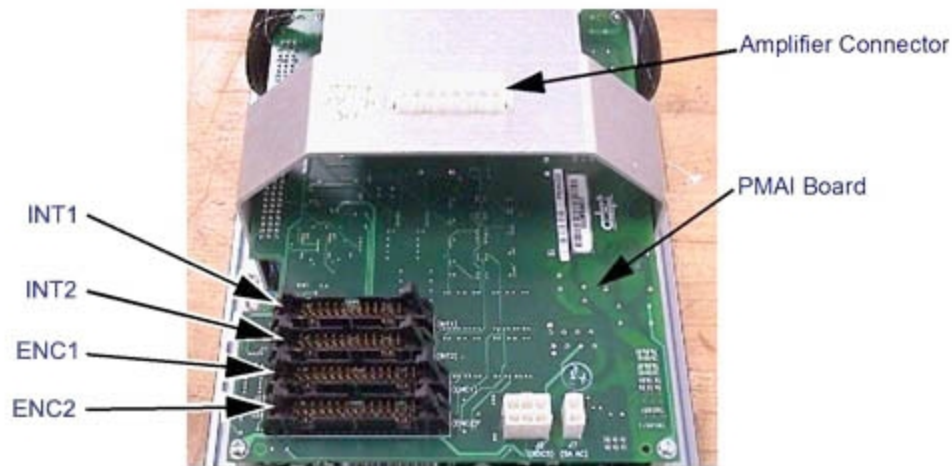


Figure 8-3. Connectors on AIB/eAIB Chassis and PMAI/ePMAI Board (AIB Shown)

13. Disconnect the cables from the INT1, INT2, ENC1, and ENC2 connectors on the PMAI/ePMAI board by disengaging the securing latches.
14. Using a 5 mm hex key, disconnect and remove the cable shield ground wire from the chassis. Keep the bolt for reassembly later. See the following figures.



Figure 8-4. Cable Ground Screw on AIB Chassis



Figure 8-5. Cable Ground Screw Hole on eAIB Chassis

15. Remove the chassis from the robot, and set it aside.
Tag it with the appropriate fault/error diagnosis and robot serial number information.

Installing a New AIB/eAIB Chassis

Harness Connections

1. Carefully remove the new chassis from its packaging, check it for any signs of damage, and remove any packing materials or debris from inside the chassis.
2. Carefully place the chassis, on its heat-sink fins, next to the robot.
3. Using a 5 mm hex key, connect the cable shield ground wire to the chassis. See Figure 8-4.
The chassis is grounded to the robot base through the bare aluminum where they meet.
4. Connect the INT1, INT2, ENC1, and ENC2 cables to the corresponding connectors on the

PMAI/ePMAI board and engage the securing latches.

5. Connect the white amplifier cable (motor power) to the amplifier connector located on the chassis bracket. See Figure 8-3.
6. Insert the chassis into its mount, at the top of the base.
7. Lower the chassis into place against the mount, making sure that none of the cables get trapped or pinched and that the chassis O-ring is not damaged during installation.
8. Once the chassis is in place, use a 5 mm hex key to tighten the chassis securing bolt. See Figure 8-1.
9. If the robot will be used in the presence of chemicals that are caustic to aluminum, follow the instructions at Caustic Compatibility on page 182.

External Connections

1. Connect the 200-240 VAC supply cable to the chassis AC input connector.
2. Connect the XSYS cable to the chassis XSLV connector (AIB) or XSYS cable and eAIB XSLV Adapter cable to the chassis XSYSTEM connector (eAIB)
or
Connect the eAIB XSYS cable to the chassis XSYSTEM connector (eAIB).
3. Connect the 1394 cable to the chassis SmartServo connector.
4. Connect any other cables which may be connected to the chassis, such as XIO or RS-232.
5. Connect the 24 VDC supply cable to the chassis +24 VDC input connector.
6. Switch ON the 200-240 VAC input supply to the chassis.
7. Switch ON the 24 VDC input supply to the chassis.
8. Switch ON the SmartController.
9. Once the system has completed booting, test the robot for proper operation.

If you have problems bringing up the robot after AIB/eAIB replacement

- Verify that all system cables are fully seated and installed correctly. See Figure 4-1.
- Remove power from the AIB/eAIB, then verify that all AIB/eAIB electrical connectors are fully seated.

After checking AIB/eAIB cables, restore power to the robot and reboot the controller.

- Check the Status Display fault code. This should be either OK or ON. See Table 5-1 and Table 5-2.

8.7 Commissioning a System with an eAIB

Commissioning a system involves synchronizing the robot with the eAIB.

NOTE: This section only applies to robots that have an eAIB amplifier. A robot with an AIB amplifier does not need the Adept ACE commissioning.

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

If you are replacing an AIB with an eAIB, you will need to commission the system.

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 Adept eAIB adds two functions 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 only in the eAIB amplifiers. They were not implemented in hardware in the AIB amplifiers, so these utilities do not apply to those amplifiers.

These two functions are supported by four wizards:

- E-Stop Configuration

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

- E-Stop Verification

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

- Teach Restrict Configuration

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

- Teach Restrict Verification

This verifies that the hardware Teach Restrict is functioning correctly.

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

Prerequisites

- The robot must be set up and functional.
- The robot must use eAIB amplifiers.

The AIB amplifiers do not support these hardware functions, and these wizards will not run.

- Adept ACE software must be installed.
- The Front Panel keyswitch must be in Auto mode.

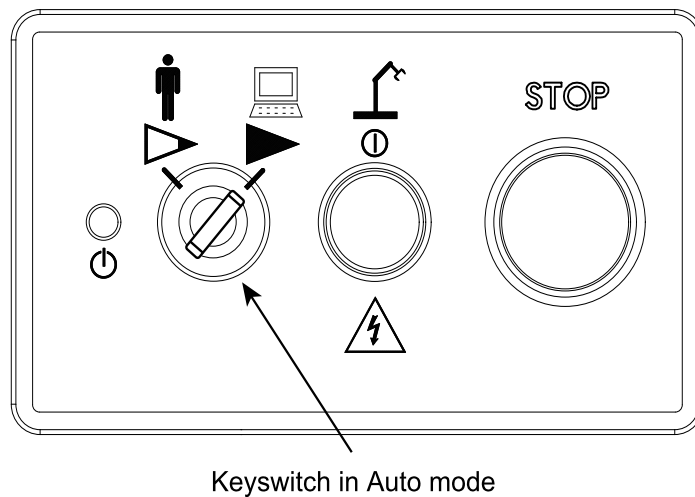


Figure 8-6. Adept Front Panel

- 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 8-7. eAIB Commissioning Jumper

- An Adept 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 Adept 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 SmartController.

On some systems, the SmartController will reboot automatically.

4. Reboot the eAIB.

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 Adept 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.

5. Reboot the SmartController.

On some systems, the SmartController will reboot automatically.

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 Adept 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 SmartController.

On some systems, the SmartController 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 Adept 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.

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

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

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

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

Manual Mode Procedure

The manual mode of this verification requires the use of an Adept 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. Reboot the SmartController.

On some systems, the SmartController will reboot automatically.
7. Reset the Front Panel keyswitch to Auto mode.

8.8 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, Adept P/N 09977-000.

NOTE: The previous battery, P/N 02704-000, has been superceded by this battery pack. The battery replacement interval and procedure have not changed.

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 SmartController.
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 Figure 4-2 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 hex-head bolts holding the Status Display panel.
See the following figure:



Figure 8-8. Status Display Panel, Showing 4 hex-head Bolts

9. Remove the Status Display panel.
The battery pack is supported in a bracket that is attached to the back side of the Status Display panel with stand-offs. The battery pack is exposed when the Status Display panel is removed.
10. The battery bracket assembly has two connectors. Locate the unused battery connector on the battery bracket. See the following figure:

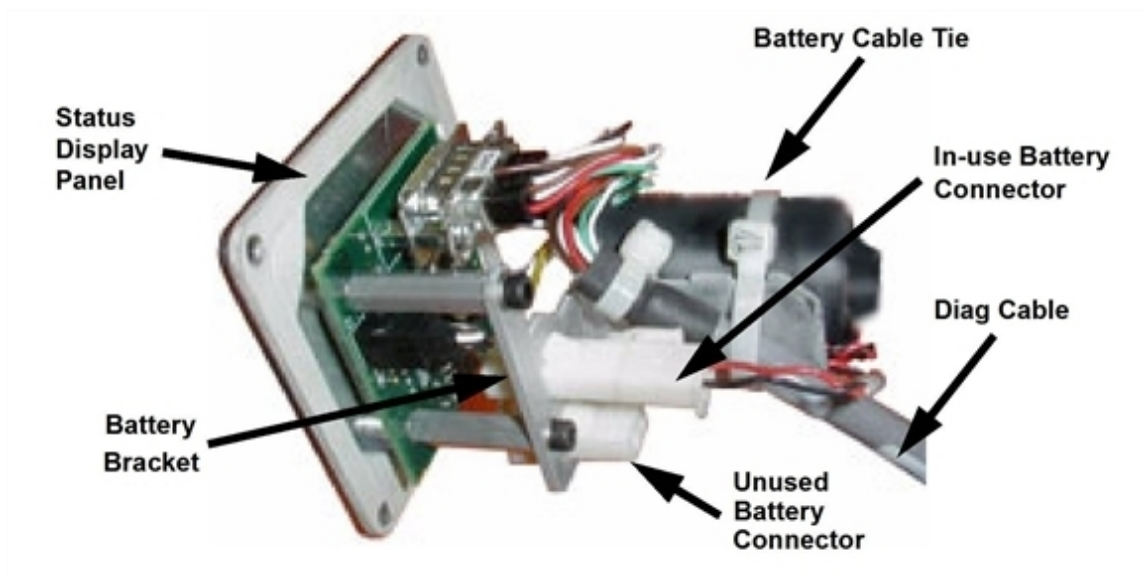


Figure 8-9. Battery Bracket on Status Display Panel



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

11. Connect the new battery pack to the unused connector on the battery bracket, but do not disconnect the old battery pack.

There is only one way to plug in the connector. See Figure 8-9.

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. See Figure 8-9.
14. Reinstall the Status Display panel with four bolts.
 - Take care that the “diag” cable is routed away from the AIB/eAIB fan inside the robot base.
 - Be careful not to hit the top of the amber lamp with the back of the battery assembly.

8.9 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.

Replacement

NOTE: Refer to Attaching the Outer Arms and Platform on page 37 for details on installing the outer arms. Removal is the reverse of installation.

1. Remove the four pairs of outer arms from the four pairs of ball studs on the installed platform.
2. Attach one pair of outer arms to each of the four pairs of ball studs on the new platform.

- The platform is installed flange-down.
- Ensure that the numbers on the platform match the joint numbers on the underside of the robot base. This places the platform tool flange closest to the Status Display. See Clocking the Platform to the Base on page 37.
- Take care not to trap debris between the ball studs and their sockets.

Configuration

If the replacement platform has the same part number as the old platform, the robot does not need to be reconfigured.

If the replacement platform is a different type of platform, for instance, replacing a 185° platform with a P31 platform, the new configuration needs to be loaded using Adept ACE software.

Binary SPEC files are available in the SPECDATA directory on the CompactFlash card of the Adept controller. These files contain configuration data for the available Adept Quattro robot platforms. The robot will not operate correctly if the wrong SPEC file is loaded. (If these files are not on your CompactFlash card, you can copy them from your V+ system CD-ROM.)

Platform Data Files:

Platform	Tool Rotation	SPEC File
P31	±46.25°	QP09503.SPC
P30	0°	QP09730.SPC
P32	±92.5°	QP09732.SPC
P34	±185°	QP09734.SPC

From the Adept ACE software:

1. Open the robot object editor.

You can do this by double-clicking on the robot in the tree structure pane.

2. Click the Configure tab.

3. Select Load Spec File . . .

4. Select Load Platform File.

Click Next.

5. Select the new platform from the list.

Click Next.

The wizard will say Working - Please wait, and then return to the robot object editor.

8.10 Replacing a Ball Joint Insert

1. Remove the old insert.

The Quattro H 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.

8.11 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 Spring Assemblies

Removing Outer Arm Springs

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



Figure 8-10. 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. Refer to the following figure.



Figure 8-11. 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.
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 Outer Arm Spring Assemblies

Installing Horseshoes

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



Figure 8-12. Horseshoe over One Pin

2. While pulling the loose end of the horseshoe to spread the horseshoe slightly, slip the loose end of the horseshoe over the other outer arm pin.

This is easiest if you get the end of the horseshoe to rest on the tip of the outer arm pin. See the following figure.



Figure 8-13. End of Horseshoe on Pin

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



Figure 8-14. 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 149.

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.

Chapter 9: Maintenance - HS

NOTE: This chapter applies to the Adept Quattro HS robots only.

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

NOTE: Some of the parts contained within the Adept Quattro HS robots are not FDA-compliant, but are contained within another assembly that is.

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



CAUTION: Over-torquing any bolts that have washer seals can damage the washer seals. Observe the stated torques.

9.1 Cleaning

Water Shedding

Surfaces of the Adept Quattro HS robots 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 Adept Quattro HS robot. Surfaces and joints have been designed with smooth internal radii for easy cleaning.

Table 9-1. 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 9-2. 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 Adept Quattro robot are compatible with all cleaning solutions available.

The Adept Quattro robot was tested to withstand the following cleaning solutions, at the manufacturers recommended concentrations, at 140° F:

Caustic:

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

Acidic:

In general, acidic cleaning solutions are incompatible with the Quattro robot's materials.

9.2 Periodic Maintenance

Table 9-3 gives a summary of the inspection procedures and guidelines on frequency.

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



WARNING: The procedures and replacement of parts mentioned in this section should be performed only by skilled or instructed persons, as defined in the [Adept Robot Safety Guide](#).

The motor covers and the AIB/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: The estimated times listed in the following table are for the inspection, not the repair.

Table 9-3. Suggested Inspection Schedule

Item	Sugg. Interval	Est. Time (Min)	Inspection	Suggested Action
User Cabling	1 Week	15	Inspect for wear around robot joints and possible binding on robot.	Replace cabling if cracked or worn. Adjust cable 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 cracking or damage caused by possible accidental impact of robot. Inspect springs and horseshoes for excessive wear.	Replace arms if damaged. Replace springs and horseshoes if worn or damaged.
Platform	3 Mon	10	Inspect platform for damage caused by possible accidental impact of robot.	Replace platform.
Robot Fans, Geardrives, and Motor Cover seals	3 Mon	60	Remove motor covers and inspect cooling fans for operation. (Retain the motor cover bolts and washer seals.) Look for lubrication leaking from geardrives. See Checking Robot Gear Drives on page 158 and Checking Fan Operation on page 159. Check for good seal contact, missing sections, inflexible, broken, seals.	Diagnose and/or replace non-operational fans. Replace geardrives. Replace motor cover seals.
Motor Cover bolt washer seals	3 Mon	5	Check that washer seals are present and in good condition. Check for cracks or missing sections.	Replace washer seals.
Dynamic and Static seals	3 Mon	10	Inspect dynamic seals on inner arms as well as static seals for sanitizing wash-down environments. Check for good seal contact, missing sections, inflexible, broken, seals.	Platforms: replace platform. Inner arms: replace seals.

Item	Sugg. Interval	Est. Time (Min)	Inspection	Suggested Action
Inner Arms	6 Mon	15	Inspect Inner Arms for cracking or damage caused by possible accidental impact of robot.	Replace inner arms.
E-Stop, Enable and Key Switches, Barrier Interlocks	6 Mon	30 in	Check functioning of E-Stops. See Checking Safety Systems on page 158	Replace Front Panel, or customer E-Stops.
Robot Mounting bolts	3 Mon	15	Check tightness of bolts. See Checking Robot Mounting Bolts on page 158	Tighten bolts.
Robot Mounting bolt gaskets	3 Mon	5	Check for good seal contact, missing sections, inflexible, broken, seals.	Replace gaskets.
Robot Mounting surface gasket	3 Mon	10	Check for good seal contact, missing sections, inflexible, broken, seals.	Replace seals.
Cable Inlet Box seals	3 Mon	10	Check for good seal contact, missing sections, inflexible, broken, seals.	Replace seals.
AIB/eAIB seal	3 Mon	10	Check for good seal contact, missing sections, inflexible, broken, seal.	Replace seal.
Cable Inlet Box gaskets (including tray)	3 Mon	10	Check for good seal contact, missing sections, inflexible, broken, seals.	Replace gaskets.
Cable Inlet Box cover bolt washer seals	3 Mon	10	Check for good seal contact, missing sections, inflexible, broken, seals.	Replace seals.
Status Display Panel seal	3 Mon	10	Check for water inside the display. Check for good seal contact, missing sections, inflexible, broken, seal.	Replace seal.
Status Display Panel bolt washer seals	3 Mon	5	Check for good seal contact, missing sections, broken, seals.	Replace seals.

NOTE: These lists are not necessarily complete.

Table 9-4. Suggested Part Replacement

Item	Suggested Interval	Estimated Time of Maintenance	Description
Motor and Gear Assembly	5 Years	1 Hour + Factory Calibration for each joint	Motor and geardrives are sold as a unit because damage to one often results in damage to both. Replacement interval is rated 5-10 years for most applications.
AIB/eAIB	5 Years	1 Hour	Accumulated wear on electronics by excessive operations or poor line voltage.
Inner Arms	5 Years	1 Hour + Factory Calibration	Broken by accidental impact.
Outer Arms	5 Years	15 Minutes	Broken by accidental impact. Sold in pairs with springs, horseshoes, and inserts.
Platform	3 Years	30 Minutes	Excessive wear, gritty environment, damage from accidental impact.
Motor Fan	2 Years	30 Minutes	Fan lifetime is strongly affected by robot temperatures. Aggressive moves at high ambient temps will shorten fan lifetimes.
Motor Cover	Indefinite	15 Minutes	Motor covers may become damaged by accidental impact.
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 Replacing the Encoder Battery Pack on page 171
Factory Calibration	Indefinite	1 Hour	Needed for full accuracy after any motor change, inner arm breakage, or accidental battery disconnection. Usually performed by Adept or a trained service representative with a tooling fixture.
Springs and Horseshoes	Indefinite	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.
	Indefinite	15 Minutes	The springs are USDA accepted provided that they are kept clean. Should they become soiled during normal operation, they will need to be replaced
Outer Arm Inserts	Indefinite	45 Minutes	Plastic inserts can be replaced in case of excessive wear. Preferred solution is to stock and swap extra outer arms.

9.3 Checking Safety Systems

These tests should be done 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
 - E-Stop button on pendant
 - Auto/Manual switch on front panel
 - Enabling switch on pendant (Manual mode only)
2. Test operation of any external (user-supplied) E-Stop buttons.
3. Test operation of barrier interlocks, etc.

9.4 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 9-5. Mounting Bolt Torque Specifications

Standard	Size	Minimum Specification	Torque
Metric	M16-2.0 x 40 mm	ISO Property Class 5.8	98 N·m (74 ft-lb)

9.5 Checking Robot Gear Drives

Adept Quattro robots use gear drives, which use oil in their components for lubrication. It is recommended that you periodically inspect the robot for signs of oil on and around the gear drives.

NOTE: Check the operation of the fans while the motor covers are off.
See Checking Fan Operation on page 159.

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.



WARNING: Do not remove the encoder cable connectors from their sockets on the motors. If they are removed, the calibration data will be lost and the robot must be recalibrated, which requires special software and tools

3. Remove the motor covers.
 - The M6 motor cover bolts were installed with Loctite 242.
 - Retain the bolts and washer seals for reinstallation.
 - Retain the motor cover gaskets for reinstallation.
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 Adept if you find any signs of oil in these areas.
If you aren't going to check the operation of the motor fans:
7. Reinstall all motor covers.
 - a. Ensure that the motor cover gaskets are in place.
 - b. Use a washer seal on each bolt.
 - c. Apply Loctite 242 in each bolt hole, not on the bolt itself.
 - d. Torque the motor cover bolts (with seals) to 5 N·m (45 in-lb).



CAUTION: Over-torquing the motor cover bolts can damage the bolt washer seals.

9.6 Checking Fan Operation

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

Verify that all fans operate:

1. Remove the motor covers.
 - The motor cover bolts were installed with Loctite 242.
 - Retain the bolts and washer seals for reinstallation.
 - Retain the motor cover gaskets for reinstallation.

2. Toggle power to the AIB/eAIB.

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

3. Verify that each motor fan is running.
4. Verify that the AIB/eAIB fan is running.

NOTE: The AIB/eAIB fan runs continuously, but its speed will vary.

5. Reinstall all motor covers.
 - a. Ensure that the motor cover gaskets are in place.
 - b. Use a washer seal on each bolt.
 - c. Use Loctite 242 in the bolt holes, not on the bolts themselves.
 - d. Torque the motor cover bolts (with washer seals) to 5 N·m (45 in-lb).



CAUTION: Over-torquing the motor cover bolts can damage the bolt washer seals.

9.7 Removing and Installing the Cable Inlet Box

Removing the Cable Inlet Box

1. Remove the cable tray.
 - Retain all hardware securing the cable tray for reinstallation.
 - Retain the cable tray 3-sided gasket.
2. Remove the four bolts securing the back cover to the cable inlet box.
 - Retain the bolts and washer seals for reinstallation.
 - These bolts were installed with Loctite 222.
 - Retain the back cover and its gasket for reinstallation.
3. Remove the cable inlet box-AIB/eAIB bolt labeled as ground.
 - This bolt is where the protective earth ground is attached.
 - This is one of four bolts that secure the cable inlet box to the AIB/eAIB.
 - Retain the bolt and toothed washer for reinstallation.

NOTE: Because the bolts securing the cable inlet box to the AIB/eAIB are inside the cable inlet box, they do not require washer seals.

4. Remove the three remaining bolts securing the cable inlet box to the AIB/eAIB.
 - Retain the bolts for reinstallation.
 - These bolts were installed with Loctite 222.
5. Remove the cable inlet box from the AIB/eAIB.
 - Retain the gasket between the cable inlet box and the AIB/eAIB for reinstallation.
6. Disconnect the electrical connections to the AIB/eAIB.

Installing the Cable Inlet Box

1. Place the cable inlet box-AIB/eAIB gasket around the AIB/eAIB connection panel.
2. Attach the cable shield ground lug to the AIB/eAIB. The ground lug is for the cable shield of the user-supplied 24 VDC cable. See Figure 3-11.
3. Hand-tighten all cables to the AIB/eAIB.

NOTE: All cables must be screwed into the AIB/eAIB.

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

4. Place the cable inlet box on the AIB/eAIB.
Ensure the gasket between the cable inlet box and the AIB/eAIB is in place.
5. Install three M4 bolts to secure the cable inlet box to the AIB/eAIB.
 - Do not yet install the bolt in the hole labeled as ground.
 - Use Loctite 222 in the bolt holes, not on the bolts themselves.
 - Use the bolts retained from removal.
 - Torque the bolts to 1.1 N·m (10 in-lb).
6. Install the M4 protective earth ground bolt, with toothed washer, through the cable inlet box into the AIB/eAIB.
 - Ensure that the protective earth ground wire lug is under the toothed washer.
 - Use the bolt and toothed washer retained from removal.
 - No Loctite is needed for this bolt.
 - Torque the bolt to 1.1 N·m (10 in-lb).
7. Attach the cable inlet box back cover with four M4 bolts.
 - Use the bolts and washer seals retained from removal.
 - Use Loctite 222 in these bolt holes, not on the bolts themselves.
 - Torque bolts to 1.1 N·m (10 in-lb).
8. Install the cable tray.

Use the hardware and gasket retained during removal for securing the cable tray.

9.8 Replacing the AIB/eAIB Chassis

This section gives instructions on how to replace the AIB/eAIB chassis on an Adept Quattro robot.



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

Removing the AIB/eAIB Chassis

1. Switch OFF the SmartController.
2. Switch OFF the 24 VDC input supply to the AIB/eAIB chassis.
3. Switch OFF the 200-240 VAC input supply to the AIB/eAIB chassis.
4. Unscrew the six M4 chassis securing bolts. See the following figure.

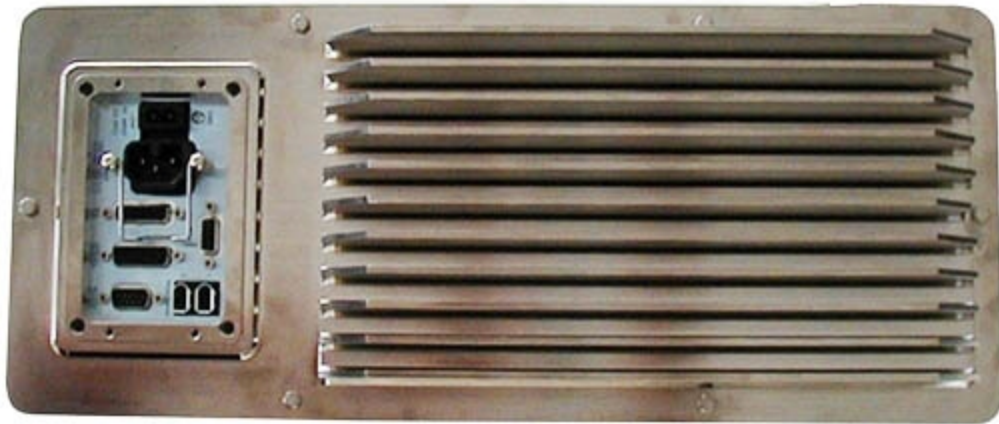


Figure 9-1. Securing Bolts on Chassis, AIB Shown

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

NOTE: The AIB/eAIB on the Quattro HS robots can be difficult to remove after the cable inlet box has been removed. You should lift the AIB/eAIB slightly, to loosen the seal, before proceeding.

5. Remove the cable inlet box. See Removing and Installing the Cable Inlet Box on page 160.
6. Disconnect the 24 VDC supply cable from the chassis +24 VDC input connector. See Figure 4-2 for locations of connectors.
7. Disconnect the 200-240 VAC supply cable from the chassis AC input connector.
Lock out and tag out AC power.
8. Disconnect the XSYS cable from the chassis XSLV connector (AIB) or XSYS cable and eAIB XSLV Adapter cable (eAIB) from the chassis XSYSTEM connector

or

Disconnect the eXSYS cable (eAIB) from the chassis XSYSTEM connector.

9. Disconnect the 1394 cable from the chassis SmartServo connector.
10. Disconnect any other cables, which may be connected to the chassis, such as XIO.
11. While holding the chassis heat sink, slowly and carefully lift the chassis up, so that enough clearance is available to remove the chassis from the base.
Retain the AIB/eAIB gasket for reinstallation.
12. Lay the chassis flat (on its heat sink fins) next to the base opening.
13. Disconnect the white amplifier cable (motor power) from the amplifier connector located on the chassis bracket. See Figure 9-3.
14. Disconnect the INT1, INT2, ENC1, and ENC2 cables from their connectors on the PMAI/ePMAI board by disengaging the securing latches.



Figure 9-2. Connectors on AIB/eAIB Chassis and PMAI/ePMAI Board (AIB Shown)

15. Using a 5 mm hex key, disconnect and remove the ground wire from the chassis. Keep the bolt for reassembly later. See the following figures.



Figure 9-3. Ground Screw on AIB Chassis



Figure 9-4. Ground Screw Hole on eAIB Chassis

16. Remove the chassis from the robot, and set it aside.
Tag it with the appropriate fault/error diagnosis and robot serial number information.

Installing a New AIB/eAIB Chassis

Harness Connections

1. Carefully remove the new chassis from its packaging, check it for any signs of damage, and remove any packing materials or debris from inside the chassis.
2. Carefully place the chassis, on its heat-sink fins, next to the robot.
3. Using a 5 mm hex key, connect the ground wire to the chassis. See Figure 9-3.
4. Connect the INT1, INT2, ENC1, and ENC2 cables to their connector on the PMAI/ePMAI board and engage the securing latches.
5. Connect the white amplifier cable (motor power) to the amplifier connector located on the chassis bracket. See Figure 9-3.
6. Lower the chassis into place, making sure that none of the cables get trapped or pinched and that the chassis gasket is in place and not damaged.
7. Once the chassis is in place, tighten the six M4 chassis-securing bolts. See Figure 9-1.
 - Use Loctite 222 in the bolt holes, not on the bolts themselves.
 - Torque the bolts to 1.1 N·m (10 in-lbf).

External Connections

1. Connect the 200-240 VAC supply cable to the chassis AC input connector.
2. Connect the XSYS cable to the chassis XSLV connector (AIB) or XSYS cable and eAIB XSLV Adapter cable (eAIB) to the chassis XSYSTEM connector
or
Connect the eXSYS cable (eAIB) to the chassis XSYSTEM connector.
3. Connect the 1394 cable to the chassis SmartServo connector.
4. Connect any other cables connected to the chassis, such as XIO or RS-232.
5. Connect the 24 VDC supply cable to the chassis +24 VDC input connector.
6. Install the cable inlet box. Refer to Installing the Cable Inlet Box on page 53.
7. Switch ON the 200-240 VAC input supply to the chassis.
8. Switch ON the 24 VDC input supply to the chassis.
9. Switch ON the SmartController.
10. Once the system has completed booting, test the robot for proper operation.

If you have problems bringing up the robot after AIB/eAIB replacement

- Verify that all system cables are fully seated and installed correctly. See Figure 4-1.
- Remove power from the AIB/eAIB, then verify that all AIB/eAIB electrical connectors are fully seated.

- After checking AIB/eAIB cables, restore power to the robot and reboot the controller.
- Check the Status Display fault code. This should be either OK or ON. See Table 5-1 and Table 5-2.

9.9 Commissioning a System with an eAIB

Commissioning a system involves synchronizing the robot with the eAIB.

NOTE: This section only applies to robots that have an eAIB amplifier. A robot with an AIB amplifier does not need the Adept ACE commissioning.

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

If you are replacing an AIB with an eAIB, you will need to commission the system.

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 Adept eAIB adds two functions 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 only in the eAIB amplifiers. They were not implemented in hardware in the AIB amplifiers, so these utilities do not apply to those amplifiers.

These two functions are supported by four wizards:

- E-Stop Configuration

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

- E-Stop Verification

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

- Teach Restrict Configuration

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

- Teach Restrict Verification

This verifies that the hardware Teach Restrict is functioning correctly.

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

Prerequisites

- The robot must be set up and functional.
- The robot must use eAIB amplifiers.

The AIB amplifiers do not support these hardware functions, and these wizards will not run.

- Adept ACE software must be installed.
- The Front Panel keyswitch must be in Auto mode.

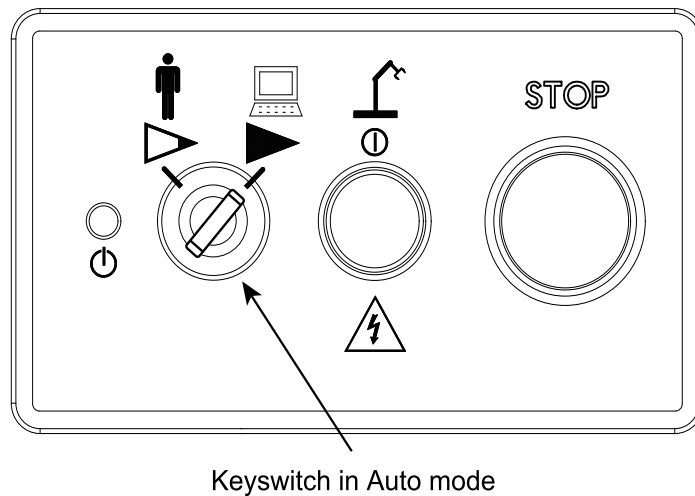


Figure 9-5. Adept Front Panel

- 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 9-6. eAIB Commissioning Jumper

- An Adept 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 Adept 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 SmartController.

On some systems, the SmartController will reboot automatically.

4. Reboot the eAIB.

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 Adept 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.

5. Reboot the SmartController.

On some systems, the SmartController will reboot automatically.

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 Adept 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 SmartController.

On some systems, the SmartController 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 Adept 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.

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

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

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

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

Manual Mode Procedure

The manual mode of this verification requires the use of an Adept 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. Reboot the SmartController.

On some systems, the SmartController will reboot automatically.

7. Reset the Front Panel keyswitch to Auto mode.

9.10 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, Adept P/N 09977-000.

NOTE: The previous battery, P/N 02704-000, has been superseded by this battery pack. The battery replacement interval and procedure have not changed.

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 SmartController.
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 Figure 4-2 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 eight hex-head bolts holding the Status Display panel.

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

- Retain the bolts and washer seals for reinstallation.

- These bolts were installed with Loctite 222.
See the following figure:



Figure 9-7. Status Display Panel, Showing 8 Hex-head Bolts

9. Remove the Status Display panel.

Retain the Status Display panel cover and gasket for reinstallation.

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 Figure 9-8



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

11. Connect the new battery pack to the unused connector on the battery bracket, but do not disconnect the old battery pack.

There is only one way to plug in the connector. See Figure 9-8.

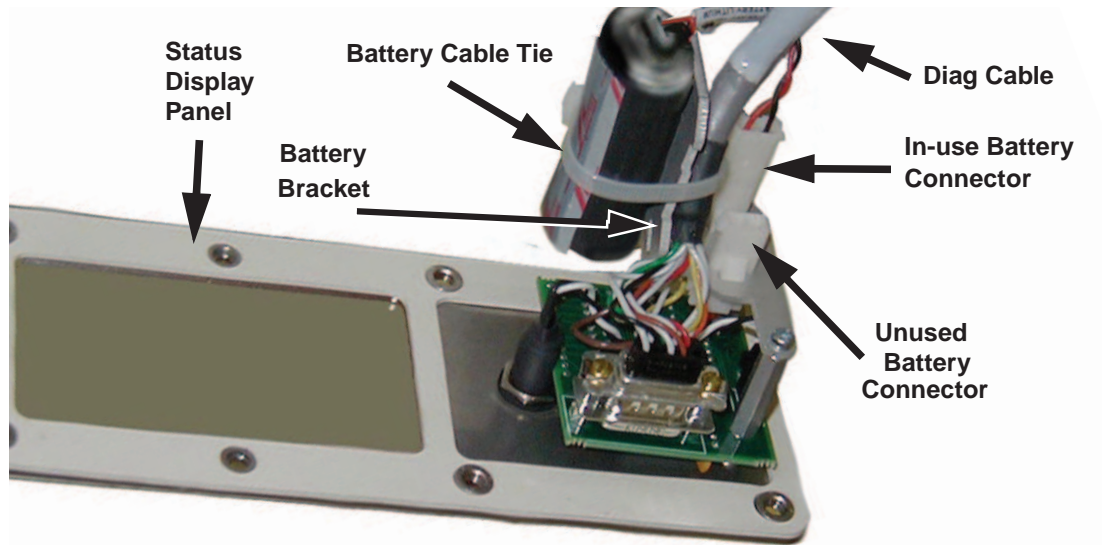


Figure 9-8. Battery Bracket on Status Display Panel

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. See Figure 9-8.
14. Reinstall the Status Display panel with eight M4 bolts.
 - Take care that the “diag” cable is routed away from the AIB/eAIB fan inside the robot base.
 - Be careful not to hit the top of the amber lamp with the back of the battery assembly.
 - Apply Loctite 222 in each bolt hole, not on the bolts themselves.
 - Ensure that the Status Display panel gasket is in place between the panel and the robot body.
 - Ensure that the Status Display panel cover is in place over the panel.

- Ensure that a washer seal is in place under each bolt.
- Torque the bolts to 1.1 N·m (10 in-lb).

9.11 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.

Replacement

NOTE: Refer to Attaching the Outer Arms and Platform on page 37 for details on installing the outer arms. Removal is the reverse of installation.

1. Remove the four pairs of outer arms from the four pairs of ball studs on the installed platform.
2. Attach one pair of outer arms to each of the four pairs of ball studs on the new platform.
 - The platform is installed flange-down.
 - Ensure that the joint numbers on the base match the numbers shown in the following figure. This places the platform tool flange closest to the Status Display. See also Clocking the Platform to the Base on page 37.

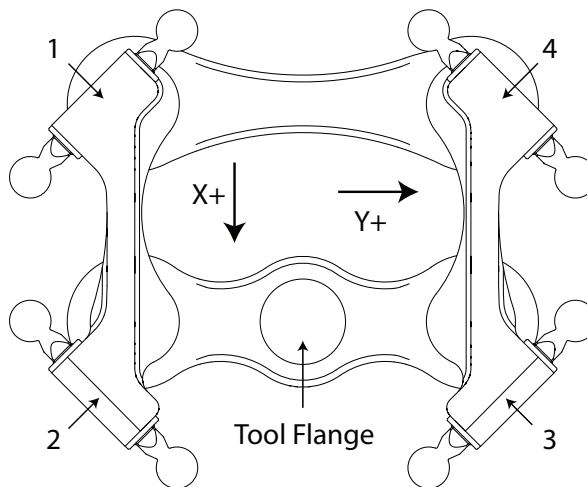


Figure 9-9. Platform Orientation, Top View, Showing P31

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

Configuration

If the replacement platform has the same part number as the old platform, the robot does not need to be reconfigured.

If the replacement platform is a different type of platform, for instance, replacing a 185° platform with a P31 platform, the new configuration needs to be loaded using Adept ACE software.

NOTE: The P30, P31, P32, and P34 platforms have stainless steel ball studs, and must be used with Delrin inserts.

Binary SPEC files are available in the SPECDATA directory on the CompactFlash card of the Adept controller. These files contain configuration data for the available Adept Quattro robot platforms. The robot will not operate correctly if the wrong SPEC file is loaded. (If these files are not on your CompactFlash card, you can copy them from your V+ system CD-ROM.)

Platform Data Files:

Platform	Tool Rotation	SPEC File
P31	$\pm 46.25^\circ$	QP09503.SPC
P30	0°	QP09730.SPC
P32	$\pm 92.5^\circ$	QP09732.SPC
P34	$\pm 185^\circ$	QP09734.SPC

From the Adept ACE software:

1. Open the robot object editor.

You can do this by double-clicking on the robot in the tree structure pane.

2. Click the Configure tab.

3. Select Load Spec File . . .

4. Select Load Platform File.

Click Next.

5. Select the new platform from the list.

Click Next.

The wizard will say Working - Please wait, and then return to the robot object editor.

9.12 Replacing a Ball Joint Insert

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

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



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

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

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

This must be done quickly, before the insert warms up, or you will not be able to fit it into the ball joint socket.
4. Ensure that the insert is centered in the ball joint socket, and bottomed-out, so that it will form a seal as it expands.
5. Verify that the insert has warmed up in the correct position in the ball joint socket.

9.13 Replacing Outer Arm Spring Assemblies

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

NOTE: The figures in this section show outer arms for a Quattro H. The procedures for the Quattro HS are the same.

Removing 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 9-10. 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.

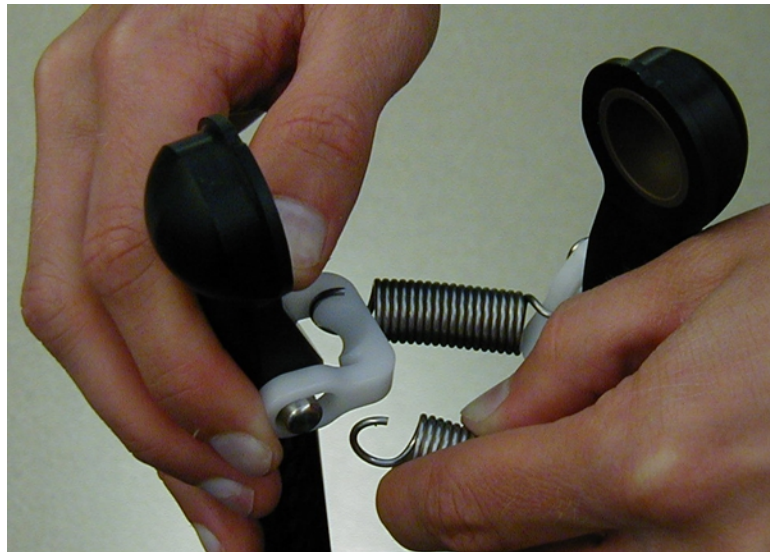


Figure 9-11. Spring, with End Removed from Horseshoe

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, See "Removing Outer Arm Springs".
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 Outer Arm Spring Assemblies

Installing Horseshoes

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



Figure 9-12. 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.

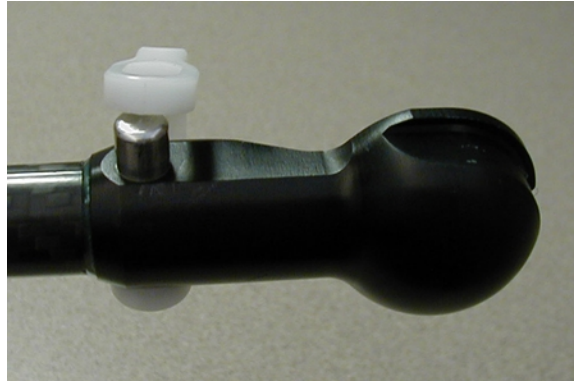


Figure 9-13. End of Horseshoe on Pin

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 9-14. 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 176.

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.

Chapter 10: Robot Cleaning/ Environmental Concerns- H

NOTE: The Adept SmartController must be installed inside a NEMA-1 rated enclosure.

The rest of this chapter applies to the non-USDA Accepted Adept Quattro robot, not to the Adept SmartController.

The Adept Quattro robot is designed to be compatible with standard cleaning and operational needs for secondary food packaging, 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.

The Adept Quattro robot is designed for the following operating conditions:

- IP-67 rating for the robot platform and arms.
- IP-65 rating for the rest of the robot (with optional cable sealing kit).
- Electroless nickel platforms can be removed and submersed in a COP tank. This does NOT apply to hard-anodized platforms.
- 1° to 40° C (34° to 104° F) ambient temperature.
- Humidity of 5% to 90%, non-condensing.
- Mild alcohol, alkali, and chlorinated caustic agents commonly used in cleaning operations.

The Adept Quattro robot protects the operating environment in the following ways:

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

10.1 Ambient Environment

Humidity

The Adept Quattro robot is designed to operate in environments with a relative humidity of 5% to 90%, non-condensing.

Temperature

The Adept Quattro robot is designed to operate from 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. Adept recommends a monitor speed of 10 or less for 10 minutes.

The robot system can sustain higher average throughput at lower ambient temperatures. Throughput will be reduced at higher ambient temperatures.

10.2 Cleaning

Caustic Compatibility

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

NOTE: Anodized parts cannot be tank cleaned. If highly caustic cleaning agents are to be used, refer to the Adept Quattro HS robots.

Water Shedding

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

NOTE: The top of the robot base and the amplifiers have flat areas where it is possible for small amounts of water to pool.

Wipe-Down

Wipe-down cleaning with alcohol-impregnated disposable wipes is appropriate for cleaning the Adept Quattro robot. Most surfaces and joints have been designed with smooth internal radii for easy cleaning.

10.3 Cleanroom Classification

The Adept Quattro robot is rated for cleanroom class 1000.

Please contact your Adept representative for more information.

10.4 Design Factors

Environmental and cleaning aspects are addressed by the following features in the Adept Quattro robot.

Robot Base and Components

The aluminum robot base and the removable motor covers are coated with a White polyurethane powder coating, which will not flake off with repeated high-pressure washings. This coating is resistant to caustic and chlorinated agents, has strong adherence to the metal base to resist impact, and has a smooth finish that is easy to clean.

The gearboxes are sealed internally, and sealed externally by a lip seal that is designed to meet IP-65 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.

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

Inner Arms

The inner arms are an epoxied assembly of carbon fiber tube and hard-anodized aluminum. The assemblies are resistant to some caustic cleaning agents at room temperature, as well as to chipping.

The inner arms are sealed at the robot base with a rotary V-ring seal (P/N 07043-000). The inner arms are designed to meet IP-65 rating.

Ball Joints

The ball studs supplied with the P30, P31, P32, and P34 platforms are stainless steel, which resist wear, as well as caustic agents. The hemi-spherical plastic insert is resistant to caustic agents. Lubrication is not needed.

Acidic Operating Conditions

Contact Adept for more information.

Outer Arms

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

The outer arms may be cleaned with wash-down in place on the robot. They should not be tank cleaned.

Springs

The outer arms are attached through the positive pressure of springs that are made of electro-polished stainless steel. This open spring design allows inspection for contamination, as well as wash-down or dunk bath.

Platforms

The Adept Quattro robot currently supports four platform models, depending on the amount of Theta rotation and inertia needed, and the level of chemical resistance needed. For the Quattro s800H robots, these platforms are available in hard-anodized or electroless nickel finishes. For the Quattro s650H, they are also available in stainless steel.

All platforms are designed to meet the basic criteria of wipe down compatibility and long life. Please contact your Adept representative for more information.

10.5 Installing Cable Seal Kit

NOTE: The Adept Quattro s650H cable seal kit is not USDA compliant. Drainage of wash-down from the cable seal assembly does not comply with USDA requirements. Refer to the Adept Quattro s650HS robot.

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
- AIB/eAIB Cable Seal Housing, 2 gaskets, 4 screws (Figure 10-1)
- Cable Entry Top Cover assembly, screw (Figure 10-2)

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 Figure 10-4.

- Roxtec grease, used to assemble and seal the modules (Figure 10-5).

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 Figure 10-2.

Tasks

Measure and mark cables to establish service length.

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

4. Attach cables to AIB/eAIB.
5. Attach cable entry top cover to AIB/eAIB cable inlet box.

Installation Procedure

1. Measure and mark all AIB/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 AIB/eAIB. See Figure 10-8.
2. Install the cable seal housing on the top of the AIB/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 AIB/eAIB surface and the cable seal housing.

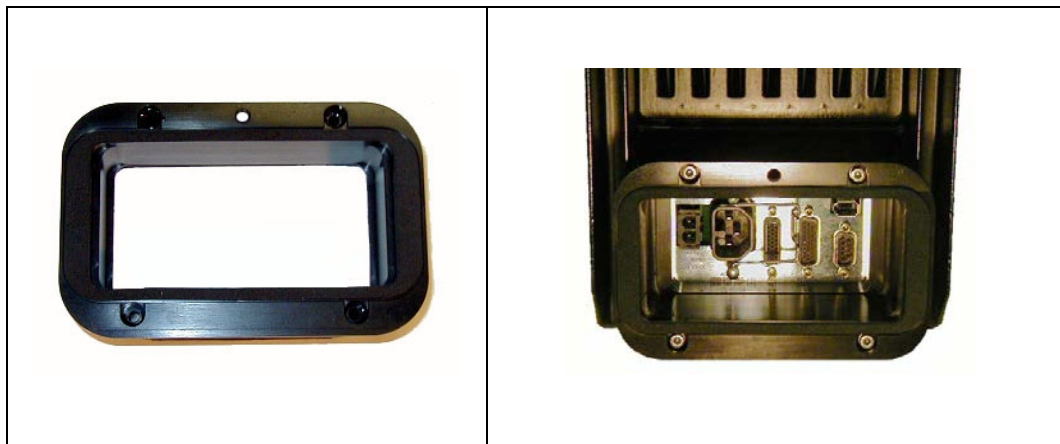


Figure 10-1. Cable Seal Housing (left), Installed (right)



Figure 10-2. Cable Entry Top Cover Assembly



Figure 10-3. Bottom of Cable Entry Top Cover, CF Frame

3. Adapt Rextec 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.

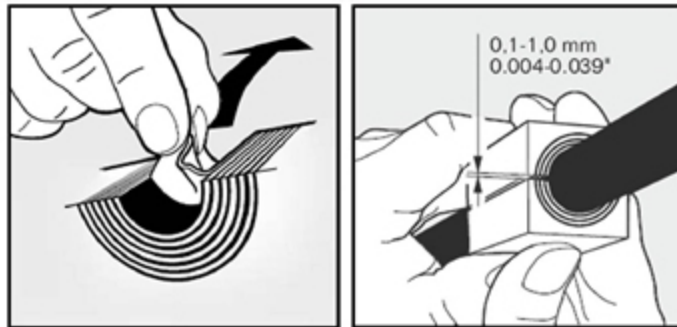


Figure 10-4. Adapting a Module to the Cable Size, Checking the Gap

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

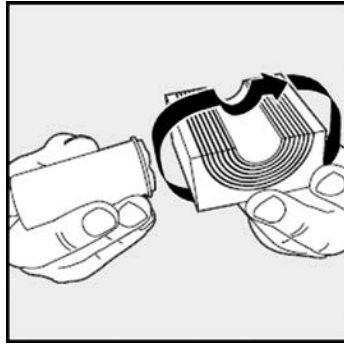


Figure 10-5. Greasing a Roxtec Module

5. Grease the inside of the CF frame, where the modules will touch, using Roxtec grease.
6. Install each AIB/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 10-8. .

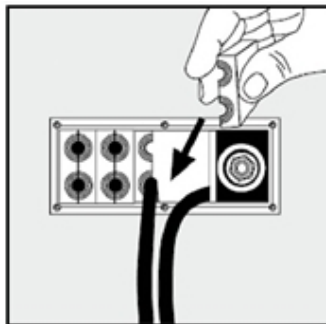


Figure 10-6. Installing Roxtec Modules into the Frame

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.

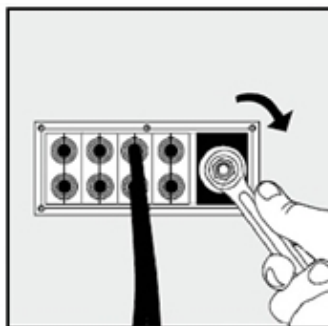


Figure 10-7. Tightening the Compression Unit



Figure 10-8. Cable Entry Assembly with Cables

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

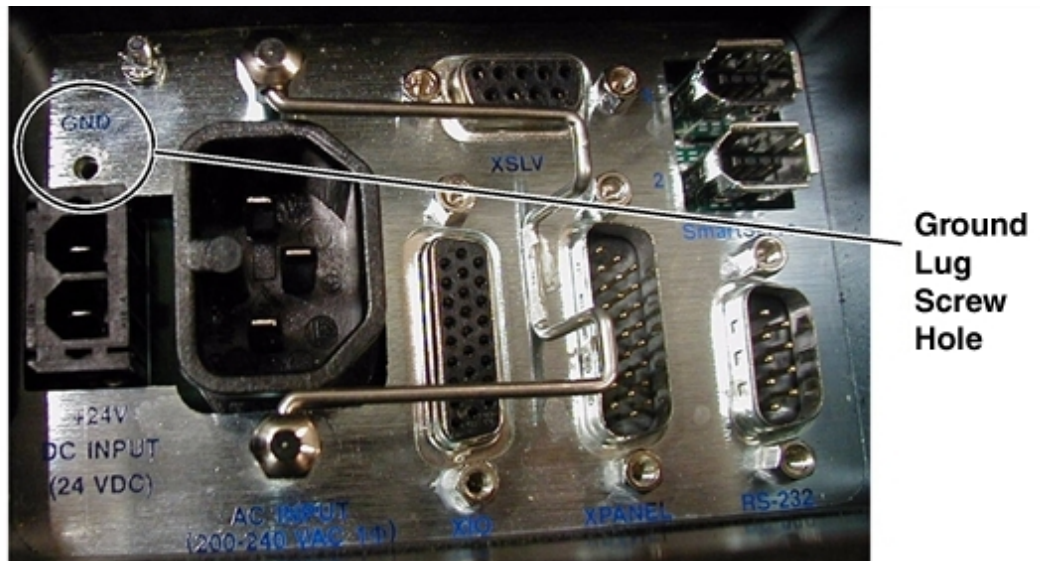


Figure 10-9. Ground Lug Attachment, AIB Shown

9. Hand-tighten all cables to the AIB/eAIB.

NOTE: All cables must be screwed into the AIB/eAIB.

10. Attach the cable entry top cover, with Roxtec frame and modules, to the AIB/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 10-10. Installing Cable Entry Top Cover Assembly

Chapter 11: Environmental Concerns - HS

NOTE: The Adept SmartController CX must be installed inside a NEMA-1 rated enclosure.

The rest of this chapter applies to the Adept Quattro HS robot, not to the Adept SmartController.

The Adept Quattro HS robot is designed to be compatible with standard cleaning and operational needs for the handling of raw, unpackaged meat and poultry products, as well as less stringent requirements. These design criteria impact how the environment can affect the robot operations, as well as how the robot can affect the cleanliness of its operating environment.

The Adept Quattro HS robot is designed for the following operating conditions:

- IP-67 rating for the robot platform and arms.
- IP-66 rating for the rest of the robot.
- Removal and submersion of the platform and outer arms (designed for COP tank).
- 1° to 40° C (34° to 104° F) ambient temperature.
- Humidity of 5% to 90%, non-condensing.
- Cleaning agents commonly used in food-processing operations. See Chemical Compatibility on page 154.

The Adept Quattro HS robot protects the operating environment in the following ways:

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

11.1 Ambient Environment

Humidity

The Adept Quattro HS robot is designed to operate in environments with a relative humidity of 5% to 90%, non-condensing.

Temperature

The Adept Quattro HS robot is designed to operate from 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. Adept recommends 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.

11.2 Cleanroom Classification

The Adept Quattro HS robot is rated for cleanroom class 1000.

Please contact your Adept representative for more information.

11.3 Design Factors

Environmental and cleaning aspects are addressed by the following features in the Adept Quattro HS robot.

Robot Base and Components

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

The gearboxes are sealed internally, and sealed externally by a lip seal that is designed to meet IP-66 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.

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

Inner Arms

The inner arms are an epoxied assembly of carbon fiber tube, and aluminum plated with electroless nickel (EN). The assemblies are resistant to caustic cleaning agents, as well as to chipping.

The inner arms are sealed at the robot base with a rotary V-ring seal (P/N 09078-101). The inner arms are designed to meet IP-66 rating.

Ball Joints

The ball studs are stainless steel. The hemispherical plastic inserts are resistant to caustic agents. The inserts generally produce few wear particulates. The material used in the inserts is

FDA-compliant. Lubrication of the ball joints is not needed.

Acidic Operating Conditions

Refer to Chemical Compatibility on page 154. Contact Adept for more information.

Outer Arms

The outer arms are a composite assembly of carbon fiber and either EN-plated aluminum or stainless steel. 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 Adept Quattro HS robot supports four types of platforms, depending on the amount of Theta rotation and inertia needed. All four platform types are available in electroless-nickel-plated aluminum for either the s650HS or s800HS robot. All four platform types are also available in stainless steel for the s650HS.

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



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