AdeptThree Robot

User's Guide

. . .

PRELIMINARY VERSION

Printed in the United States of America

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CHAPTER 1

GENERAL INFORMATION

1.1 This Manual and Related Publications

This manual provides general, installation, and maintenance information for the AdeptThree robot, also referred to as a Selective Compliance Assembly Robot Arm, or SCARA.

The following Adept publications are referenced in this manual:

- *V and V+ Reference Guide*
- *Instructions for Adept Utility Programs*
- *Adept MC Controller User's Guide*
- *Adept CC Controller User's Guide*
- User's Guides for options purchased with the robot.

Throughout this manual you will find references to the V or V+ operating system and control language. V+ is Adept's advanced operating system and control language, which offers additional capabilities over the V system.

1.2 Notes, Cautions, and Warnings

There are three levels of special notation used in this equipment manual. In descending order of importance, they are:

WARNING

If the actions indicated in a "WARNING" are not complied with, injury or major equipment damage could result. A Warning statement will typically describe the potential hazard, its possible effect, and the measures that must be taken to reduce the hazard.

CAUTION

If the action specified in the “CAUTION” is not complied with, damaged to your equipment could result.

NOTE

A “NOTE” provides supplementary information, emphasizes a point or procedure, or to gives a tip for easier operation.

Orientation

Throughout this text descriptive words such as "right," "left," "top," and "bottom" will be used to locate items. Whenever these terms appear they are oriented from the standard operator's position as though facing the front of the unit, for example, "right" is that portion of the system to the operator's right, etc.

Controller HIGH POWER Indicator

On the Adept CC controller front panel there is an amber indicator light labeled HIGH POWER; on the Adept MC controller the same indicator is labeled ARM POWER. Any reference in this manual to HIGH POWER also refers to ARM POWER.

1.3 Customer Service Assistance

Service Calls

Adept Technology maintains a fully staffed Customer Service Center at its headquarters in San Jose, CA. Two dedicated phone lines are available for **service calls only**:

(800) 232-3378 from outside California

(800) 232-3379 from within California

When calling Customer Service, please have the unit's serial number available. The serial number is located on the label on the base of the robot (refer to Figure 2-9).

Training Information

For information regarding Adept Training Courses, please call (408) 434-5024.

Application Information

There is also a dedicated phone line for assistance with applications. For Applications assistance call (408) 434-5033.

International Customer Assistance

For information on training, service, or applications, Adept also has a Customer Service Center in Dortmund, West Germany. The phone number is: 0231-129081.

1.4 Safety

The AdeptThree robot may move at high speed and exert considerable force. Like all mechanical systems and most industrial equipment, it must be treated with respect by both the User and the Operator.

NOTE

This manual follows Robotic Industries Association (RIA) definitions of "User" as the responsible person or company and "Operator" as a person who starts, stops, or monitors robot or workcell operation.

This User's Guide should be read by ALL personnel who operate or maintain AdeptThree systems, or who work within, or near, the workcell.

We also recommend you read the American National Standard for Industrial Robot Systems-Safety Requirements, published by the RIA, in conjunction with the American National Standards Institute (ANSI). The publication, ANSI/RIA R15.06-1986, contains guidelines for robot system installation, safeguards, maintenance, testing, start-up, and operator training. The document is available from:

American National Standards Institute
1430 Broadway
New York, NY 10018

This Guide assumes that the User has successfully completed an Adept Training Course and has a basic working knowledge of the Adept system. The User should provide the necessary additional training for ALL personnel working within or around the workcell.

System Safeguards

Safeguards should be an integral part of robot workcell design, installation, Operator training, and operating procedures. Adept systems are computer controlled, and may activate remote devices under program control at times or along paths not anticipated by personnel. It is critical

that safeguards be in place to prevent personnel from entering the workcell whenever equipment power is present.

> **WARNING**
>
> Entering the workcell when the Adept controller HIGH POWER or PROGRAM RUNNING lights are **ON** could result in severe injury.

Adept Technology highly recommends the use of workcell safety features such as light curtains, safety gates, or safety floor mats to prevent access to the workcell while power is present. Adept Controller systems have various control features which may aid the user in constructing system safeguards, including:

- Emergency stop circuitry
- Binary input and output lines

The emergency power-off circuitry in the controller is capable of switching external power systems, as well as detecting intrusion signals from safety barriers.

Equipment Safety

All personnel must observe sound safety practices during the operation and testing of all electrically powered equipment. To avoid injury or damage to equipment, always remove power by disconnecting the AC power cord from the source BEFORE attempting ANY repair or upgrade activity.

> **WARNING**
>
> **DO NOT** remove or replace any assemblies, subassemblies, Printed Circuit Assemblies (PCAs), or components with primary power present. To avoid possible personnel injury or equipment damage, always remove power **BEFORE** attempting repair or upgrade procedures.

1.5 Robot Modifications

It is often necessary to make modifications to Adept robots to successfully integrate them into a workcell. Unfortunately, many seemingly simple modifications can either cause a robot failure, or reduce the robot's performance, reliability, or lifetime. In general, the following robot modifications will not cause any problems, but may affect robot performance:

- Attaching tooling, utility boxes, solenoid packs, vacuum pumps, screwdrivers, cameras, lighting, etc. to the inner link, outer link, or column. The total weight of such items on any robot should not exceed 10 pounds.
- Attaching hoses, pneumatic lines, or cables to the robot. These should be designed so they do not restrict joint motion or cause robot motion errors.
- Modifying robot access covers as long as adequate protection is provided after the modification. Covers for the quill, inner and outer links, Joint 2, and the robot signature card may be modified.

If not done properly, the modifications listed below will damage the robot, reduce system reliability, or shorten the life of the robot. For this reason, these modifications will void the warranty of any components that Adept determines were damaged due to the modification. Please contact Adept Customer Service before attempting any of the following modifications to determine if the change can be made without causing problems.

CAUTION

Making any of the modifications outlined below will void the warranty of any components that Adept determines were damaged due to the modification. Please contact Adept Customer Service before attempting any of the following modifications.

- Modifying any robot harnesses.
- Modifying any drive system components.
- Modifying, including drilling or cutting, any robot casting.
- Modifying any robot electrical component or PC board other than those explicitly stated in the robot user's guide.
- Routing additional hoses, air lines, or wires through the robot.

NOTES

CHAPTER 2

OVERVIEW

2.1 Description

General

The AdeptThree is a four-axis SCARA robot. Joints 1, 2, and 4 are rotational and Joint 3 is translational. Refer to Figure 2-1 for an overview of the robot joint locations. Refer to Figure 2-11 for the operating envelope and Table 2-2 for specifications.

The AdeptThree is designed to interface with either the Adept MC or the Adept CC controller. All control and operation of the AdeptThree is programmed and performed through the selected controller.

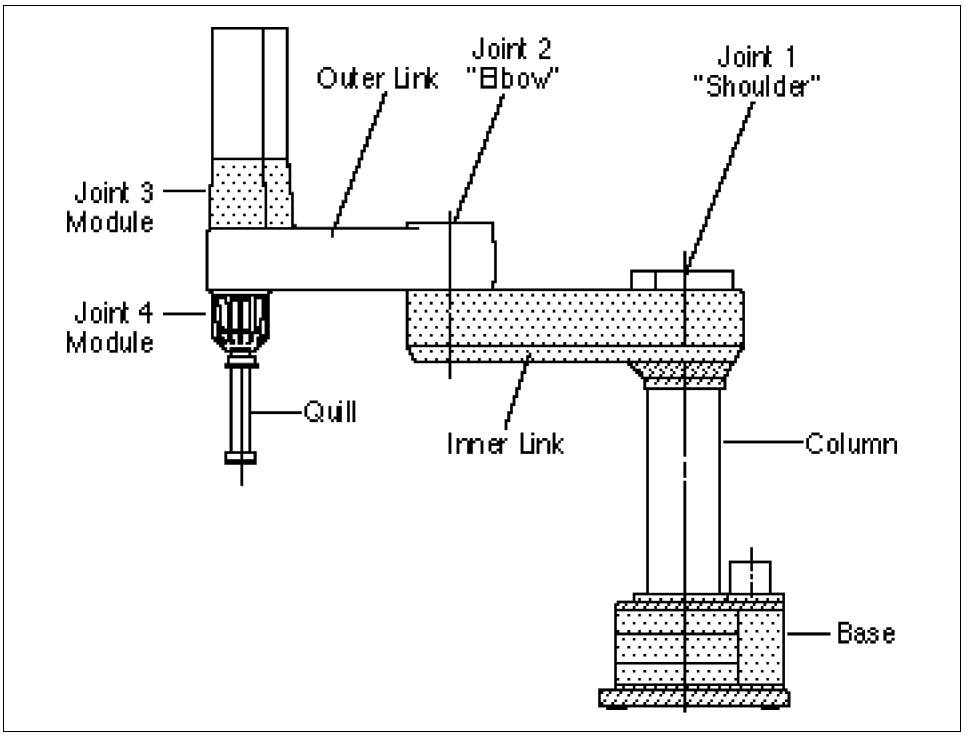

Figure 2-1. AdeptThree Robot Joint Locations

Refer to the User's Guide for your particular controller for explicit controller operating instructions. Refer to the *V and V+ Reference Guide* for programming instructions. The optional Manual Control Pendant (MCP) is required for manually teaching robot locations. Additionally, it can serve as the sole operator interface to the system.

All physical connections between the AdeptThree robot, its controller, and the facility are located at the rear of the robot base, as shown in Figure 2-9.

Joint Motions

Joint 1

Joint 1, also referred to as the "shoulder", provides the rotational movement of the inner link and the column. Travel of the inner link is restricted to 300°. (Refer to Figure 2-2.)

Figure 2-2. Joint 1 Motion

Joint 2

Joint 2, also referred to as the "elbow", is the pivot point between the inner link and the outer link. Outer link travel is limited by hardstops located on top of the inner link. Like Joint 1, travel is restricted to a total of 300°. This motion can be likened to an elbow capable of acting in either a left- or right-hand configuration. (Refer to Figure 2-3.)

The AdeptThree is capable of attaining a given location utilizing either a right-hand ("Righty") or left-hand ("Lefty") configuration. However, when V or V+ moves the arm to a location, it must sometimes make assumptions about which configuration to use. While this generally produces the result desired by the Programmer, sometimes the system assumption may differ from the Programmer's expectations. In those cases, the Programmer must specify (within the program) "Righty" or "Lefty" operation.

NOTE

For further information concerning right- and left-hand configuration, refer to the chapter entitled, "Robot Locations" in your *V and V+ Reference Guide.*

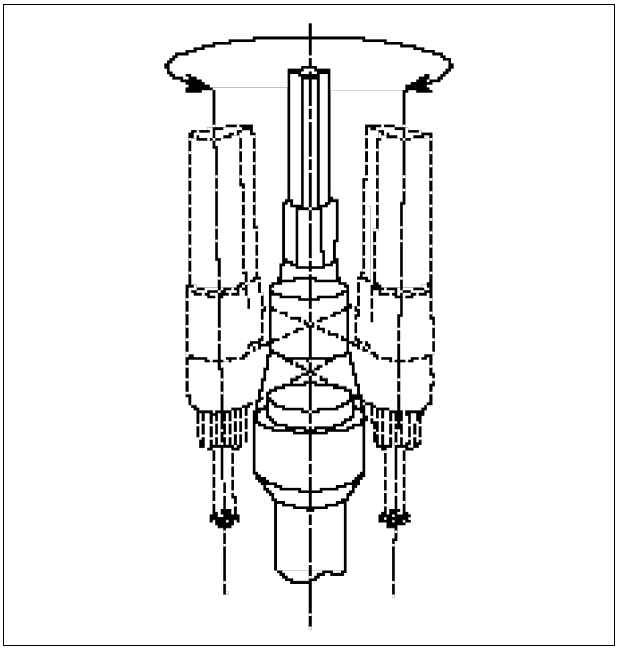

Figure 2-3. Joint 2 Motion

Joint 3

Joint 3 provides vertical movement of the quill at the end of the outer link, with a maximum stroke of 12.0 inches (30.5 cm). (Refer to Figure 2-4.)

Joint 4

Joint 4, also referred to as the "wrist", provides rotation of the quill over a range of 540°. This motion is similar to that of the human hand involved in tightening a bolt or unscrewing a bottle cap. (Refer to Figure 2-4.)

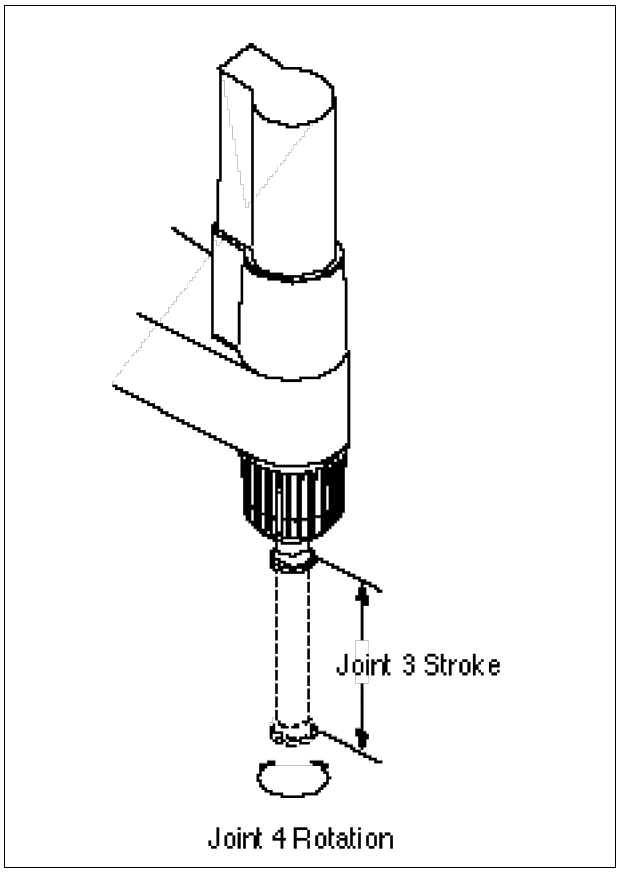

Figure 2-4. Joint 3 and Joint 4 Motion

Limiting Joint Travel

The joint motion or travel is limited by both software and hardware. The programmable software limits are known as softstops; the fixed hardware limits are called hardstops. (See Figures 2-5 to 2-8 and Table 2-1.)

Softstops

The robot controller uses softstops to determine the range of motion it will allow the robot to move under program control, or to be moved by an operator using the manual control pendant. If a robot joint travels beyond a softstop, the controller will automatically shut off arm power (high power), thereby activating the brakes. Furthermore, the controller will not allow the robot power to be turned on while any joint is beyond its softstop. If this situation occurs, use the brake release button (see the section on Brakes later in this chapter) and manually move the arm back within the softstop limits.

Under operator control (using the manual control pendant to move the robot) the robot will stop very abruptly when it encounters a softstop. This abruptness is due to the high-torque motors, there is no hardstop at these locations.

Occasions may arise when it becomes mandatory to limit the travel of one or more of the joints within the normal working envelope. This can be easily accomplished by adjusting softstops using the **CONFIG_R** utility program, which is supplied with the system.

NOTE

For further information concerning joint travel limitation, refer to the *Instructions for Adept Utility Programs* manual furnished with your system.

Hardstops

In most cases the softstop will prevent joint travel from contacting a hardstop; however, contact is possible during high-speed operation. The hardstops are designed to withstand large forces without damaging the robot.

The hardstops for Joints 1, 2, and 3 are fixed mechanical stops. The hardstop for Joint 4 is designed to slip slightly if impacted sufficiently. If the Joint 4 hardstop slips, it should be reset. Refer to the procedure in Chapter 4 on how to diagnose a slipped Joint 4 hardstop.

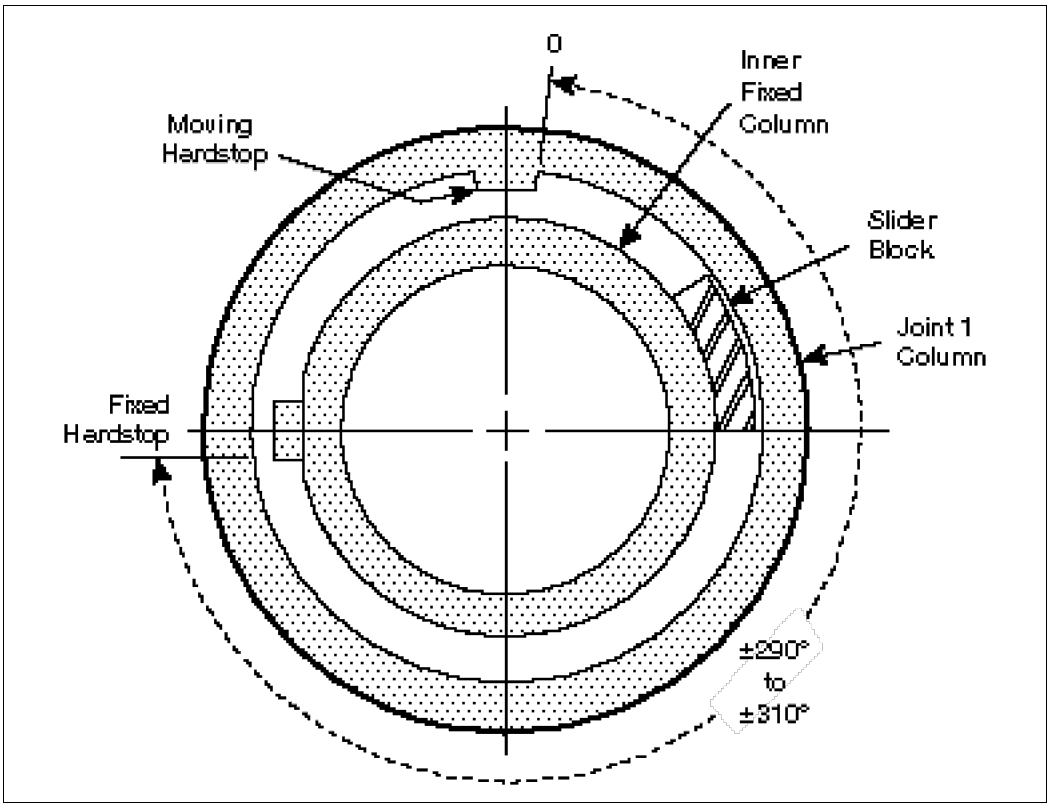

Figure 2-5. Joint 1 Hardstop (Internal to Joint 1 column)

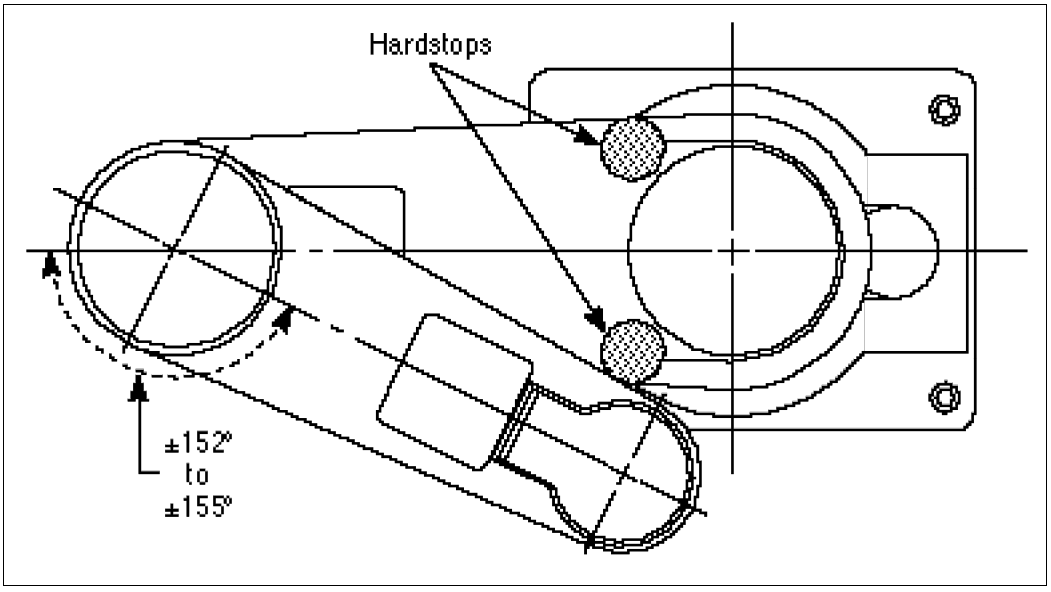

Figure 2-6. Joint 2 Hardstop

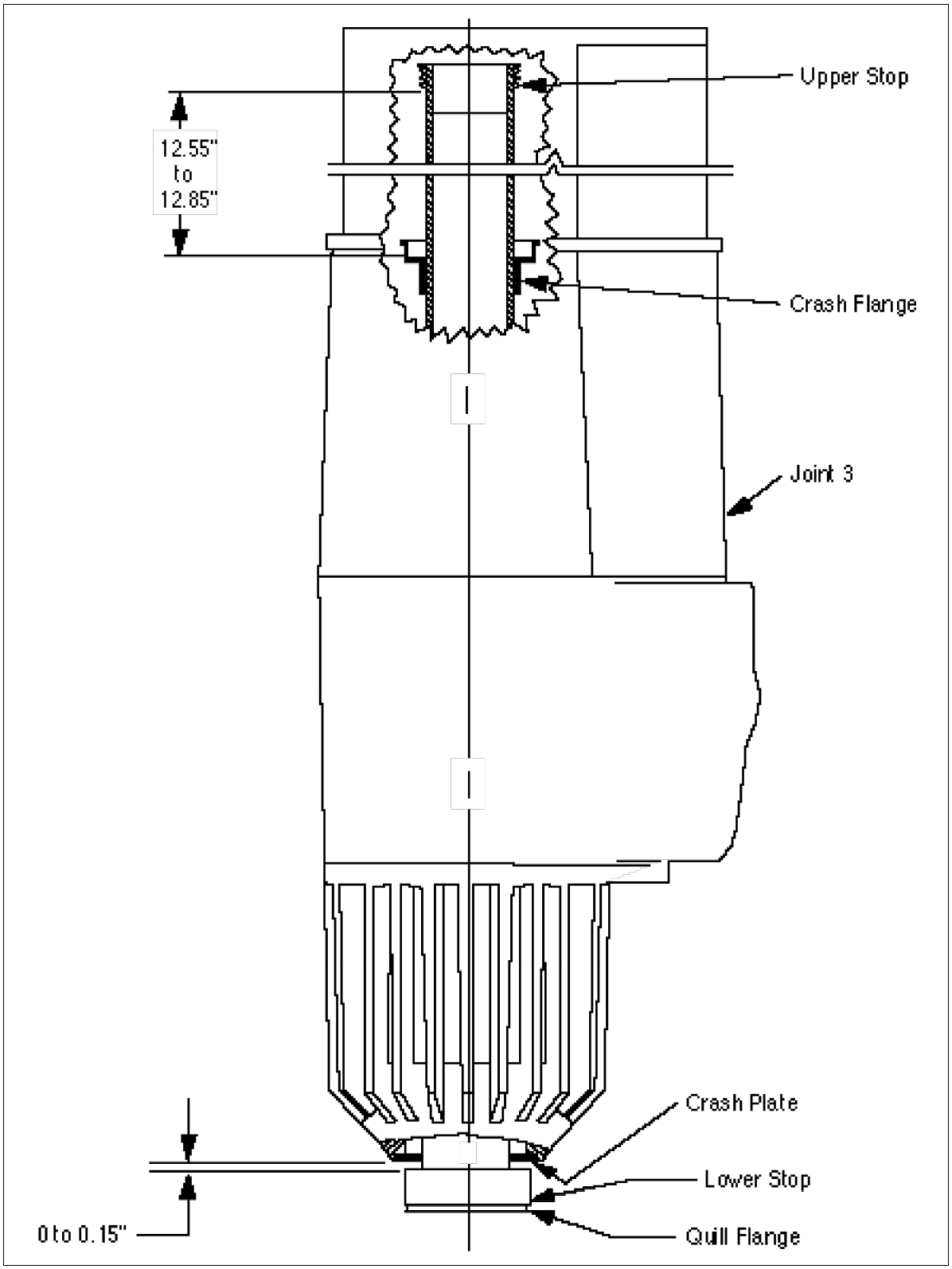

Figure 2-7. Joint 3 Hardstop

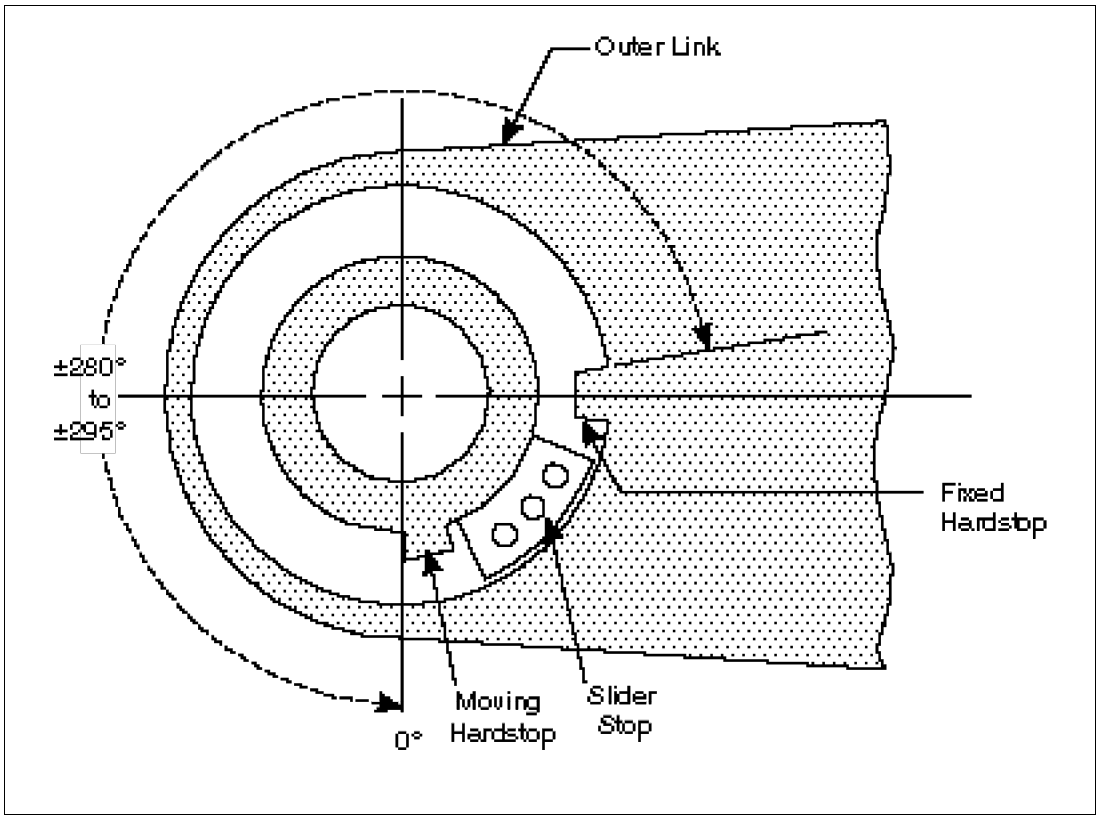

Figure 2-8. Joint 4 Hardstop (Internal to Outer Link)

Table 2-1. Softstop and Hardstop Specifications

	Softstop	Hardstop (approximate)	Comments
Joint 1	±150°	+290° (+20°, –0°) –290° (–20°, +0°)	See also Figure 2-11
Joint 2	±150°	+152° (+3°, –0°) –152° (–3°, +0°)	See also Figure 2-11
Joint 3	0 to 12"	+12.55" to +12.85" –0.15" to 0"	See also Figure 2-7
Joint 4	±270°	+280° (+15°, –0°) –280° (–15°, +0°)	See also Figure 2-11

Brakes

The AdeptThree has "fail-safe" air release brakes on all joints. These brakes are on whenever HIGH POWER (ARM POWER) is off. The brakes are intended primarily to restrict arm movement when high power is off, but they also assist in stopping robot motion when the Emergency Stop circuitry is activated or when there is a robot motion error. These brakes are not designed to be used as a routine method of stopping robot motion.

Under some circumstances it may become desirable to manually position the arm without turning on HIGH POWER. For such instances, a "brake-release" button is located on the rear of the base (see Figure 2-9). When system power is on, pressing the button releases the brakes, which allows movement of the arm. If this button is pressed while HIGH POWER is on, HIGH POWER will automatically shut down.

CAUTION

When the brake release button is pressed, the quill (Joint 3) may drop to the bottom of its travel. To prevent possible damage to the equipment, make sure that the quill is supported while releasing the brake and verify that the end effector or other installed tooling is clear of all obstructions.

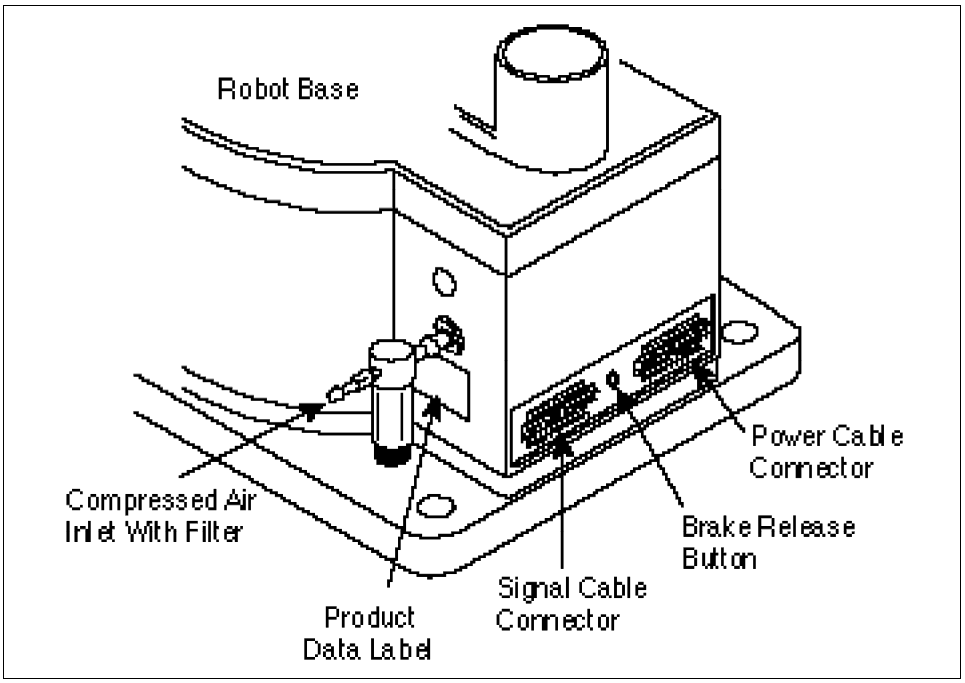

Figure 2-9. Robot base showing brake release button

2.2 Dimensions

Overall dimensions for the AdeptThree are shown in Figure 2-10 and the robot envelope is shown in Figure 2-11.

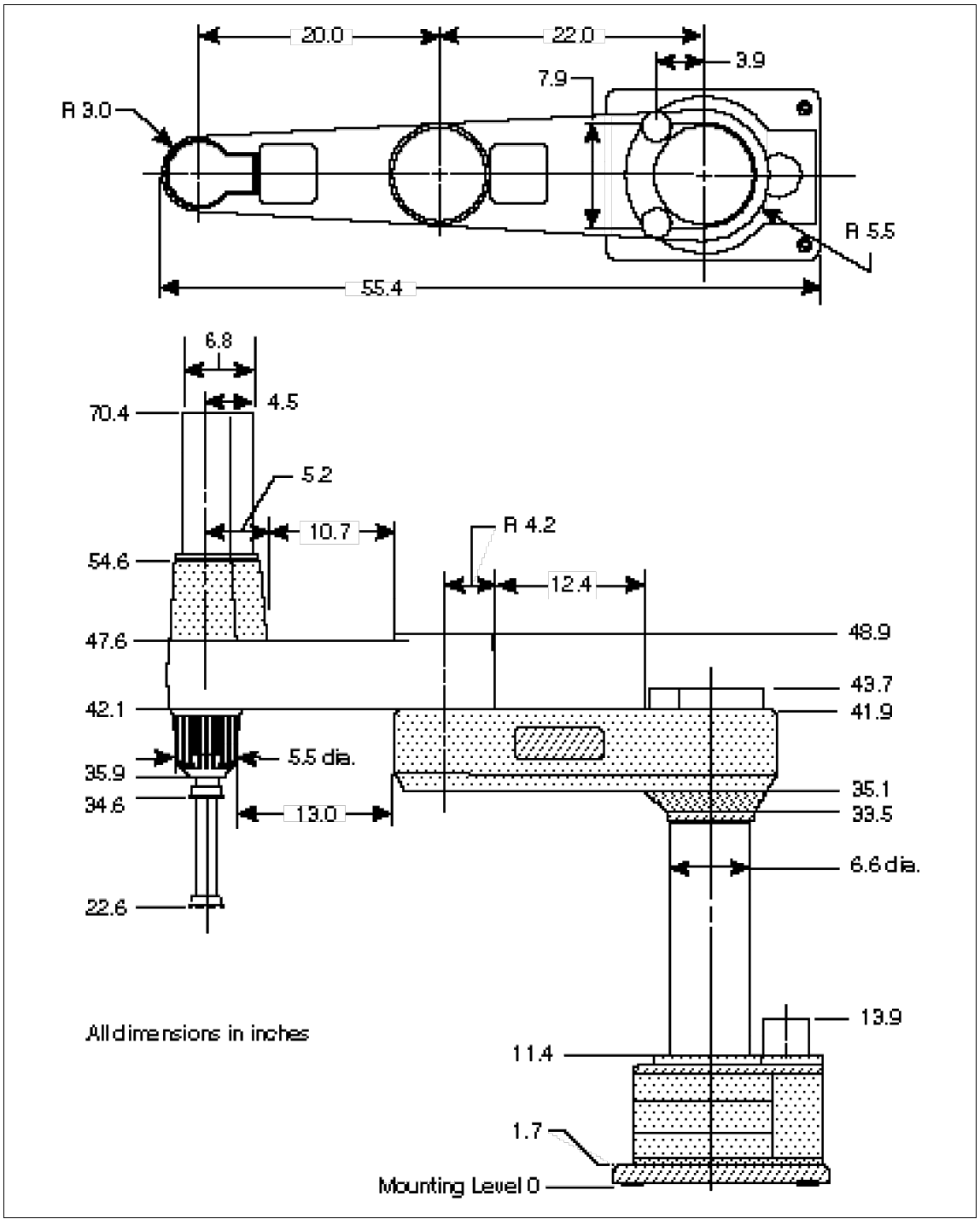

Figure 2-10. Dimensional Overview

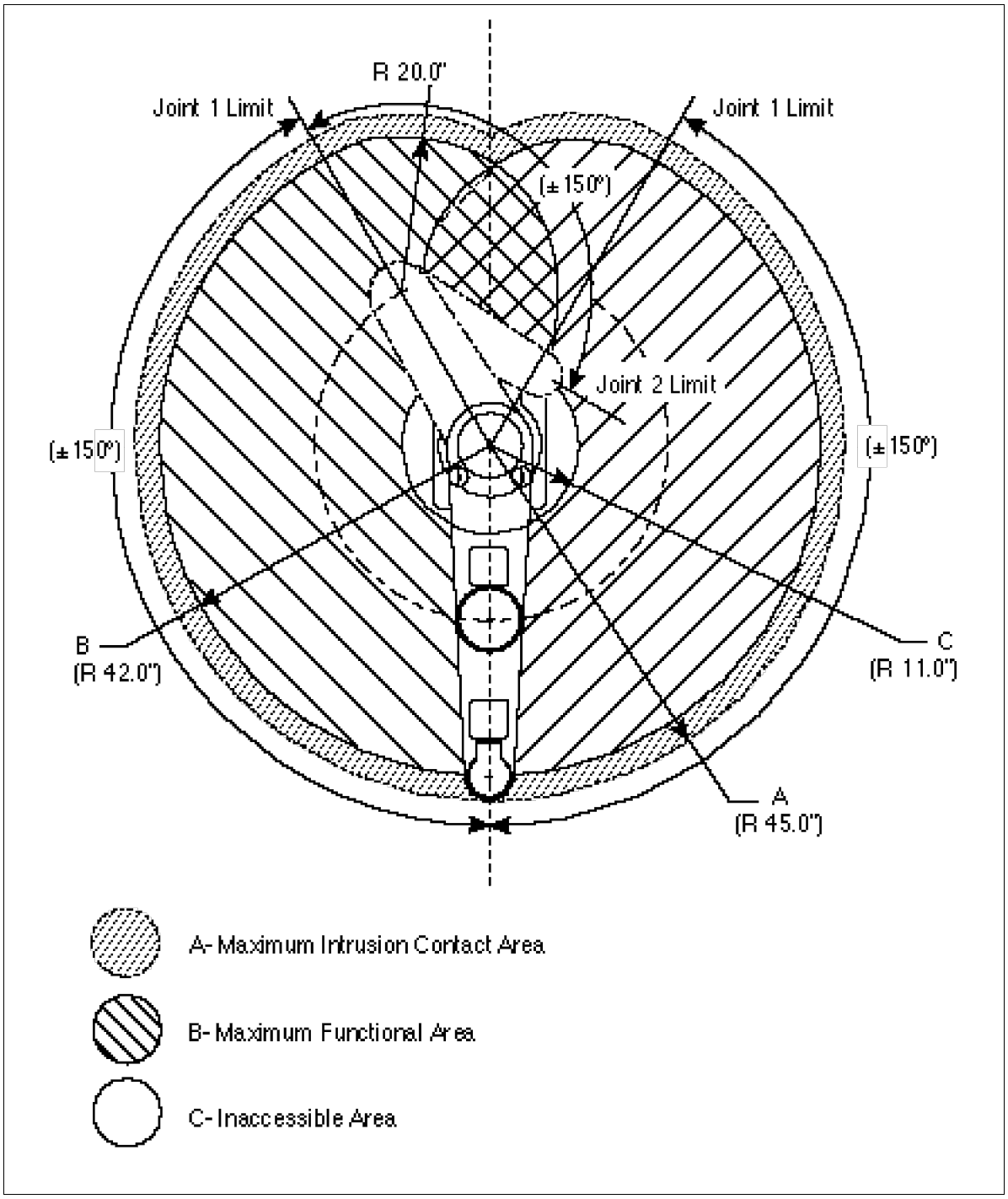

Figure 2-11. AdeptThree Robot Working Envelope

2.3 Specifications

Table 2-2. Specifications[1]

Reach (Refer to Figures 2-10 and 2-11)		
Maximum radial	42.0 in. (1067 mm)	
Minimum radial	11.0 in. (279 mm)	
Vertical clearance (bottom of base to end-effector flange) - with maximum Joint 3 retraction - with maximum Joint 3 extension	 34.6 in. (879 mm) 22.6 in. (547 mm)	
Vertical Stroke (Refer to Figure 2-4)		
Joint 3 (Z direction)	12.0 in. (305 mm)	
Joint Rotation (Refer to Figures 2-2, 2-3, and 2-4)		
Joint 1	±150°	
Joint 2	±150°	
Joint 4	±270°	
Payload (Including End Effector)		
During operation	55 lb (25 kg)	
During calibration	30 lb (13.6 kg)	
Inertia Load (Maximum)		
About Joint 4 axis	2500 lb-in^2 (7300 kg-cm^2)	
About horizontal axis at tool flange face	4500 lb-in^2 (13,000 kg-cm^2)	
Force		
Joint 3 downward force without payload	80 lb (36 kg)	
Torque		
Joint 4 torque	80 lb-in (0.92 kg-m)	
Cycle Time[2]	**12 in. (305 mm)**	**36 in. (915 mm)**
1 lb (0.45 kg)	1.1 sec	1.8 sec
13 lb (5.9 kg)	1.2 sec	2.2 sec
20 lb (9.1 kg)	1.4 sec	2.5 sec
40 lb (13.6 kg)	1.6 sec	2.8 sec
55 lb (24.9 kg)	1.8 sec	3.0 sec

1. Specifications subject to change without notice.
2. The robot tool performs a continuous path motion consisting of all straight-line segments; 1 in. (25 mm) up, either 12 in. (305 mm) or 36 in. (915 mm) over, 1 in. (25 mm) down, and returning along the same path.

Table 2-2. Specifications[1](continued)

Resolution	
Joint 1	0.00078°
Joint 2	0.0016°
Joint 3 (vertical Z)	0.00026 in. (.00066 mm)
Joint 4 (tool rotation)	0.047°
Repeatability (at constant temperature)	
X,Y plane	±0.001 in. (±0.025 mm)
Joint 3 (vertical Z)	±0.002 in. (±0.050 mm)
Joint 4 (rotational)	±0.047°
Joint Speed	
Joint 1	250° / sec
Joint 2	275° / sec
Joint 3	19.7 in. / sec (500 mm / sec)
Joint 4	1600° / sec
Weight	
Robot without options	480 lb (218 kg)
Design Life	42,000 hours

1. Specifications subject to change without notice.

2.4 Options

The AdeptThree is compatible with the following Adept options:

- AdeptVision Systems
- Robot-mounted Camera Hardware
- Variable Compliance Wrist
- Fifth Axis (Joint 5)
- Force Sensing Module

All Adept options interface through the controller. For information on the Fifth Axis, see Appendix A in this manual. Operating instructions and programs for the remaining options listed above are included in the User's Guides supplied with each option.

NOTES

CHAPTER 3

INSTALLATION

3.1 Environmental and Facility Requirements

Facility Ambient Air Quality

Temperature: 41° to 122° F (5° to 50° C)

Relative Humidity: 5 to 95% non-condensing

Although Adept robots are designed to withstand a wide range of environmental conditions, they require additional sealing when used in harsh environments. Examples of environments that require additional robot sealing include those with oil mist, coolant mist, or abrasive dust in the air. When a robot is used in such an environment, take the following steps to protect the robot:

- Seal the quill and outer link assembly with a quill bellows.
- Install gaskets on all access covers.
- Pressurize the robot slightly with clean, dry air.

Contact Adept Customer Service if you have questions concerning robot protection in such environments.

Compressed Air

The AdeptThree requires clean, dry, compressed air at 80-120 pounds per square inch (psi) with a flow rate of 1 Standard Cubic Foot per Minute (SCFM) to release its brakes. Additional air flow may be required for actuation of end effectors.

NOTE

Insufficient air pressure or flow will allow the brakes to engage and will disable HIGH POWER.

The AdeptThree has an air filter and moisture trap on its inlet air fitting. The moisture trap should be emptied periodically; see Chapter 4 for cleaning instructions. If clean, dry air is not available, additional user-supplied filtering is required. The AdeptThree air connection inlet is a 1/4-inch Industrial Interchange nipple located at the air filter at the base of the robot.

Electrical

The facility electrical supply must conform with specifications for the particular system controller, Adept MC or Adept CC. Refer to the appropriate controller User's Guide for those specifications.

Robot Workcell Free Space

Adequate space must be provided in the design of the working area (workcell) to allow for freedom of movement of the AdeptThree within the area specified in Figure 2-11. Additional allowances are required to accommodate any installed end-of-arm tooling and the calibration fixture.

Each robot is calibrated at the factory and the calibration data is stored on the Robot Signature Card (RSC) in the base of the robot. Under certain conditions the robot may need to be recalibrated, such as the replacement of the Joint 3 or Joint 4 modules. Recalibration requires that the calibration fixture be installed on the base of the robot, see Figure 3-1. If adequate space is not provided in the workcell, the robot will have to be removed if recalibration is required.

Floor

The floor at the intended installation site must be concrete to a minimum of 4.0 inches (102 mm) and must comply with all local codes. The floor should also be level to avoid having to add shims to attain the correct installation position for the robot.

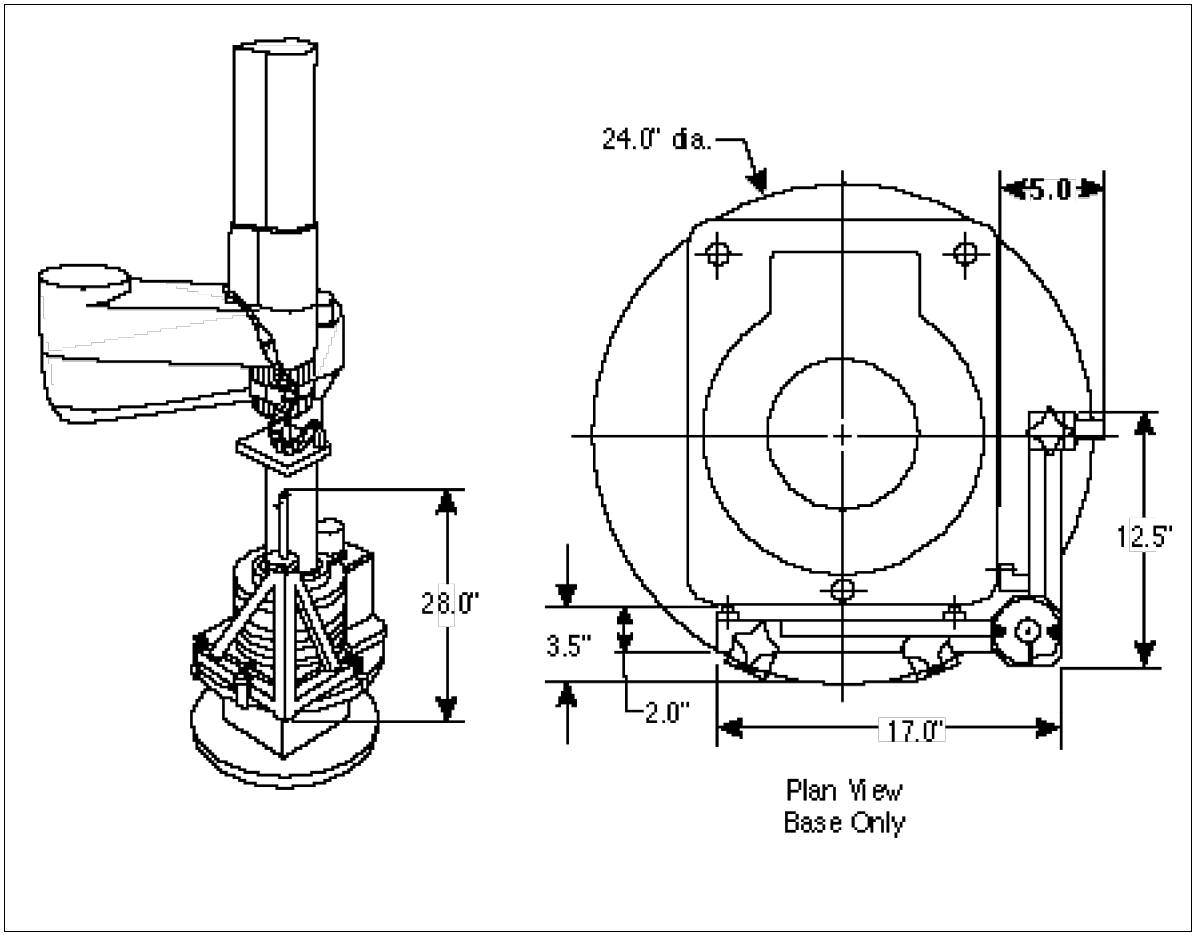

Figure 3-1. AdeptThree with Calibration Fixture

Mounting Surface

Due to the very high torque transmitted by the AdeptThree, the robot MUST be mounted to an extremely rigid structure. Any mounting structure vibration or flexing will seriously degrade robot performance. Adept recommends using either a mounting plate or a mounting spool. Both have proven reliable over extended periods of use, details are given below. If another type of mounting structure is used, it must adequately resist vibration and flexure. Whichever method is selected, it must be supplied by the User.

NOTE

Mounting the base on any surface other than the recommended steel plate (or spool) may cause extreme difficulty if robot recalibration is required.

The User may further facilitate recalibration by designing a workcell that allows for mounting of the calibration fixture without extensive dismantling of the workcell.

Plate

The first method of mounting requires a flat steel plate and is mandatory if the robot is to be mounted directly to the facility floor. The mounting plate should conform to the following recommended specifications:

- Material: steel
- Diameter: 24.0 inches (610 mm)
- Thickness: 1.0 inch (25 mm)
- Mounting surface flatness: within 0.01 inch (0.25 mm)
- Mounting hole pattern: as shown in Figures 3-2 and 3-3

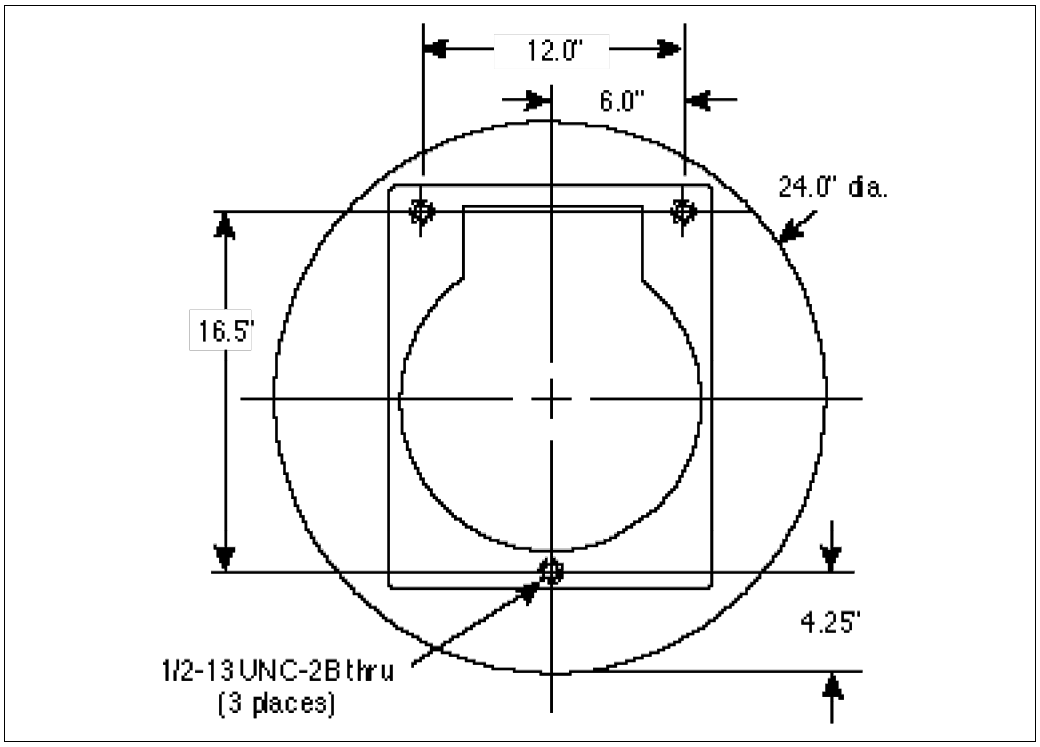

Figure 3-2. Mounting Hole Pattern (Robot-to-Plate/Spool)

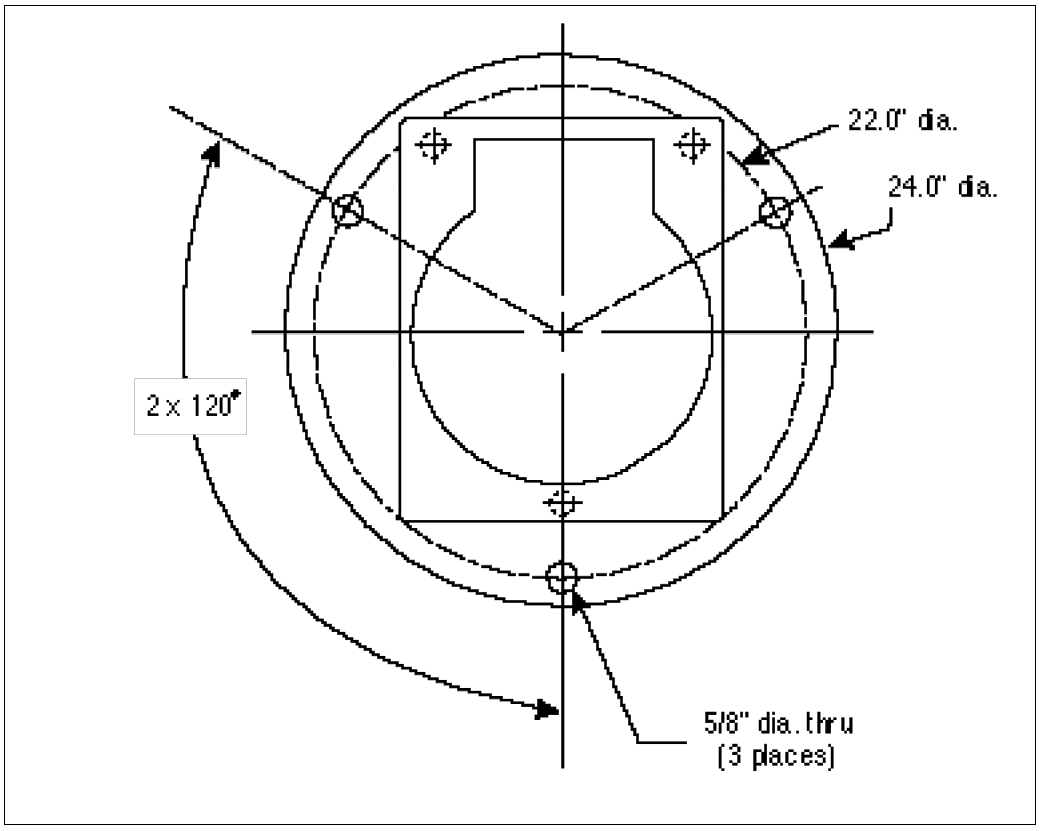

Figure 3-3. Mounting Hole Pattern (Plate/Spool-to-Floor)

Spool

The second method of mounting uses a spool. The spool may be either procured or manufactured. Refer to Figure 3-1 for an overview of an AdeptThree robot mounted on a spool. One recommended source for a prefabricated spool is:

INTERLAKE BASES
17480 Malyn Boulevard
Fraser, MI 48026
(313) 294-8120

The recommended design for a manufactured spool is a welded assembly consisting of three steel parts: top and bottom plates welded to a center column, as detailed in Figure 3-4.

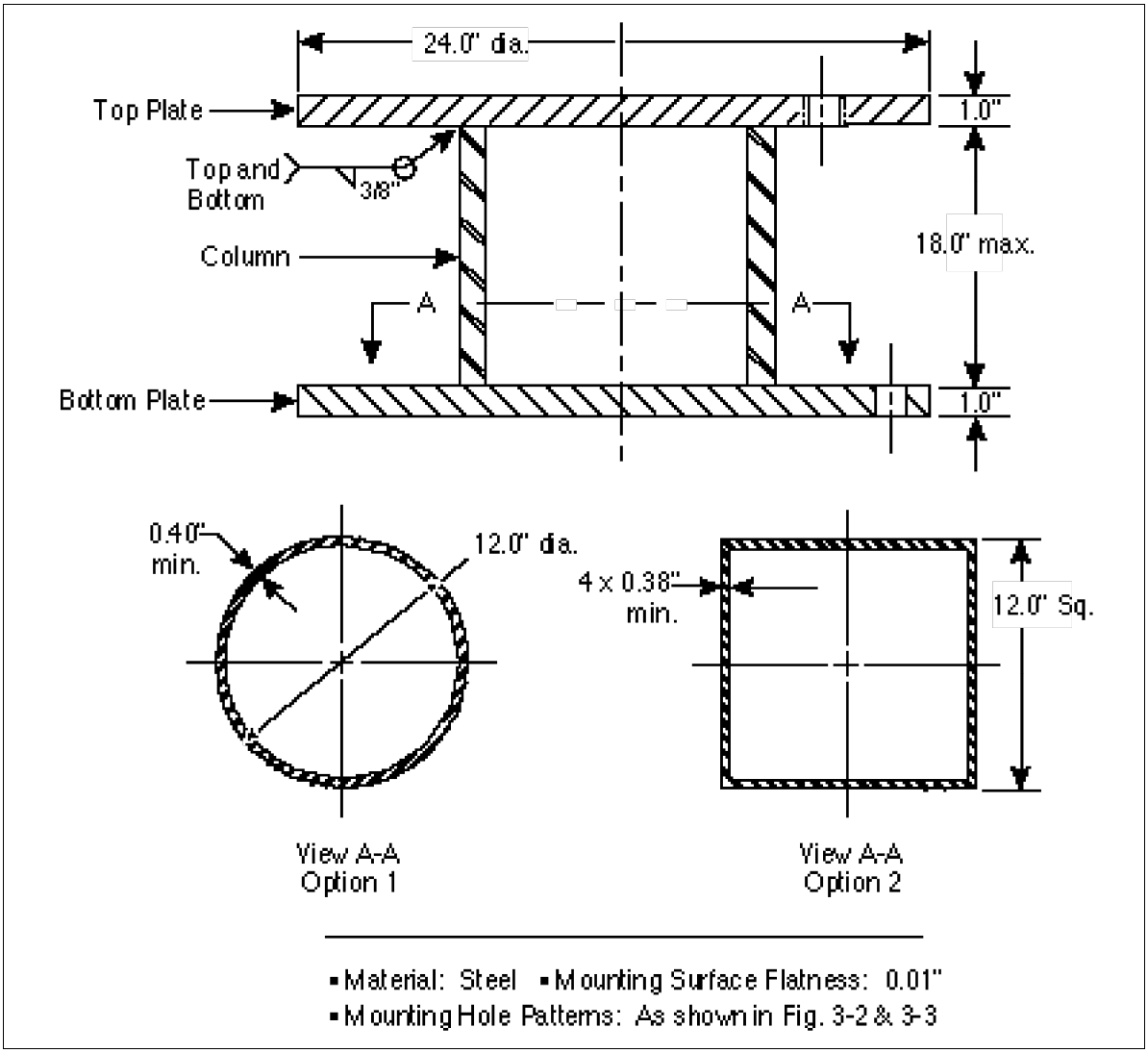

Figure 3-4. Recommended Mounting Spool Specifications

3.2 Tool and Equipment Requirements

Common hand tools, supplemented by the following items, are required for installation of the AdeptThree and any options or end effectors:

- Drill motor, 1/2 inch drive
- Masonry bit, 7/8 inch
- Ratchet handle, 1/2 inch drive
- Socket, 3/4 inch x 1/2 inch drive
- Spirit level
- Torque wrench, 1/2 inch drive, 100 foot-pound capacity
- Vacuum cleaner
- Pallet jack (or forklift)
- Hydraulic lift with dual-leg sling (both rated for 700 pounds [320 kg] minimum)
- Mounting plate (or spool)

3.3 Unpacking and Inspection

Before Unpacking

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

Upon Unpacking

Compare the actual items received (not just the packing slip) with your equipment purchase order and verify that all items are present and that the shipment is correct.

Inspect each item for external damage as it is removed from its container. If any damage is evident, contact Adept at the numbers listed in Chapter 1.

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

Repacking For Relocation

Should relocation of the robot become necessary, reverse the steps employed in the installation procedures that follow this section. Re-use all original packing containers and materials and follow all safety notes used for installation. Improper packaging for shipment will void your warranty. Before unbolting the robot from the plate or spool, fold the outer arm against the Joint 2 hardstops to help centralize the center of gravity.

3.4 Preparation For Installation

The following sequence details the preparation of materials required before actually beginning the installation procedure.

1. Locate and set aside the "Robot-to-Plate/Spool" and "Plate/Spool-to-Floor" hardware kits. This hardware is typically packaged together and placed in the "Accessories" container.

2. Separate the following items from the "Robot-to-Plate/Spool" hardware kit:

   - Bolts, hex-head, 1/2-13 UNC x 2 inch (3 each)
   - Washers, flat, 1/2 inch (3 each)
   - Washers, lock, 1/2 inch (3 each)

3. Separate the following items from the "Plate/Spool-to-Floor" hardware kit:

   - Bolts, hex-head, 1/2-13 UNC x 4 inch (3 each)
   - Washers, flat, 1/2 inch (3 each)
   - Washers, lock, 1/2 inch (3 each)
   - Anchors, expansion bolt (3 each)

3.5 Installing a Mounting Plate

The following sequence details the installation of the robot-mounting plate to the floor. (See Figure 3.5)

1. Drill and tap three (3) 1/2-13 UNC-2B mounting holes, as shown in Figure 3-2, for robot-to-plate attachment.

2. Drill three (3) 5/8 inch (16 mm) diameter through holes, as shown in Figure 3-3, for plate-to-floor anchoring.

3. Place the plate at the installation site exactly where the robot is to be installed. Ensure that the plate is positioned such that the "footprint" for the robot is properly oriented relative to the workcell. Using the plate as a template, transfer the locations of the three plate-to-floor mounting holes directly to the floor.

4. Set the plate aside and drill three holes, 7/8 inch (22 mm) in diameter by 3.5 inches (89 mm) deep, in the floor at the locations identified in step 3.

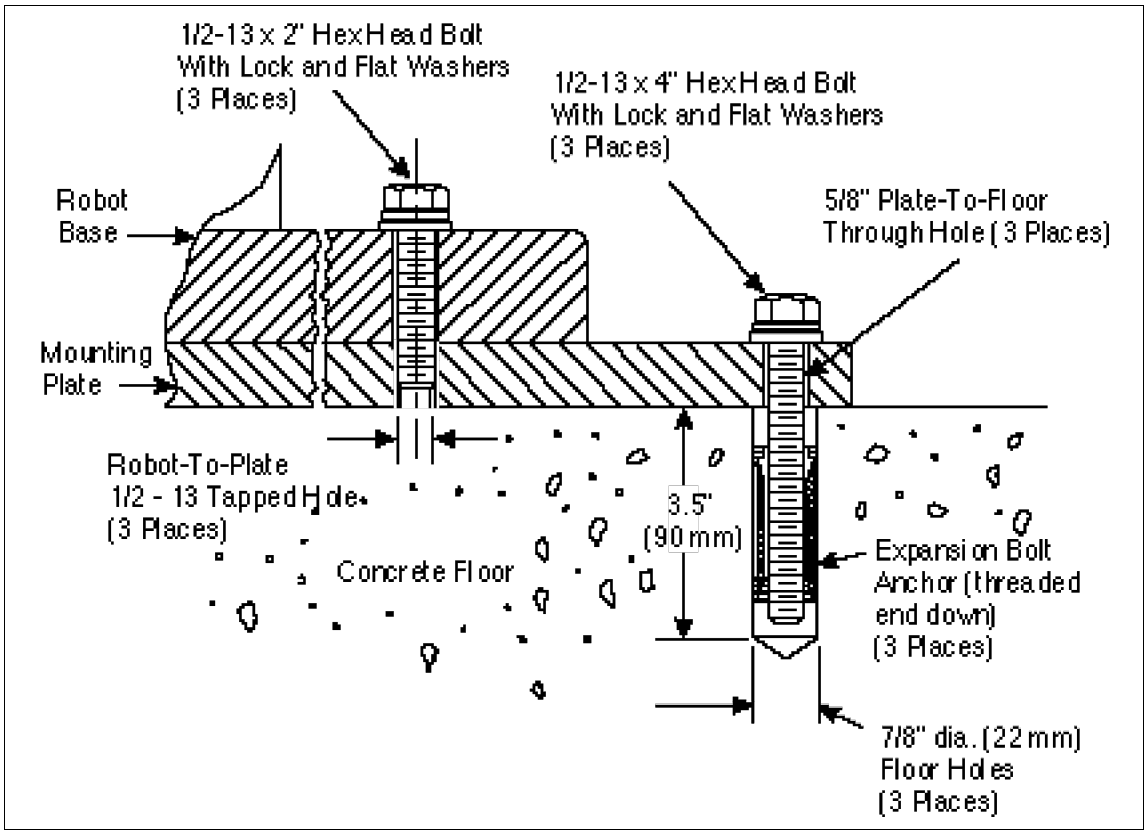

Figure 3-5. Mounting Plate-to-Floor Installation Detail

5. Using a vacuum cleaner, remove all chips and debris from the holes (and surrounding area) drilled in step 4.

6. Insert an expansion bolt anchor into each of the three holes in the floor. Ensure that the threaded end of each bolt anchor is toward the bottom of each hole, as shown in Figure 3-5.

7. Reposition the plate over the anchor holes in the floor using care to align the three plate-to-floor holes with the anchor holes. Also, ensure that the plate is positioned such that the "footprint" for the robot is properly oriented relative to the workcell.

8. Using a spirit level, verify that the top (mounting) surface of the plate is level. The surface must be horizontal within ±3 degrees. If the plate is not level, insert shims between the plate and the floor to bring the plate within specifications. The shims should be at least three inches (75 mm) in diameter and have cutouts provided to fit around the anchor bolts.

9. Insert a 1/2-13 x 4 inch bolt, fitted with a lock washer and a flat washer, through the holes in the plate into each of the three plate-to-floor anchor holes. Tighten the bolts to a recommended torque of 40 foot-pounds.

10. Re-check the robot mounting surface of the plate using the spirit level and re-shim as required to bring the mounting surface horizontal within ±3 degrees.

3.6 Installing a Mounting Spool

The following sequence details the installation of the robot-mounting spool to the floor. (See Figure 3-6.)

1. Drill and tap three (3) 1/2-13 UNC-2B mounting holes (through), as shown in Figure 3-2, for robot-to-spool attachment.

2. Prepare the opposite flange of the mounting spool by drilling three (3) 5/8-inch (16 mm) diameter through holes, as shown in Figure 3-3, for spool-to-floor anchoring.

3. Place the spool at the installation site exactly where the robot is to be installed. Ensure that the spool is positioned such that the "footprint" for the robot is properly oriented relative to the workcell. Transfer the locations of the three spool-to-floor mounting holes directly to the floor.

4. Set the spool aside and drill three holes, 7/8 inch (22 mm) in diameter by 3.5 inches (90 mm) deep, in the floor at the locations identified in step 3.

5. Using a vacuum cleaner, remove all chips and debris from the holes (and surrounding area) drilled in step 4.

6. Insert an expansion bolt anchor into each of the three holes in the floor. Ensure that the threaded end of each bolt anchor is toward the bottom of each hole, as shown in Figure 3-6.

7. Reposition the spool over the anchor holes in the floor taking care to align the three spool-to-floor holes with the anchor holes. Also, ensure that the spool is positioned such that the "footprint" for the robot is properly oriented relative to the workcell.

8. Using a spirit level, verify that the top (mounting) surface of the spool is level. The surface must be horizontal within ±3 degrees. If the spool is not level, insert shims between the spool and the floor to bring the spool within specifications. The shims should be at least three inches (75 mm) in diameter and have cutouts provided to fit around the anchor bolts.

9. Insert a 1/2-13 x 4 inch bolt, fitted with a lock washer and a flat washer, through the holes in the spool into each of the three spool-to-floor anchor holes. Tighten the bolts to a recommended torque of 40 foot-pounds.

10. Re-check the robot-mounting surface of the spool using the spirit level and re-shim as required to bring the mounting surface horizontal within ±3 degrees.

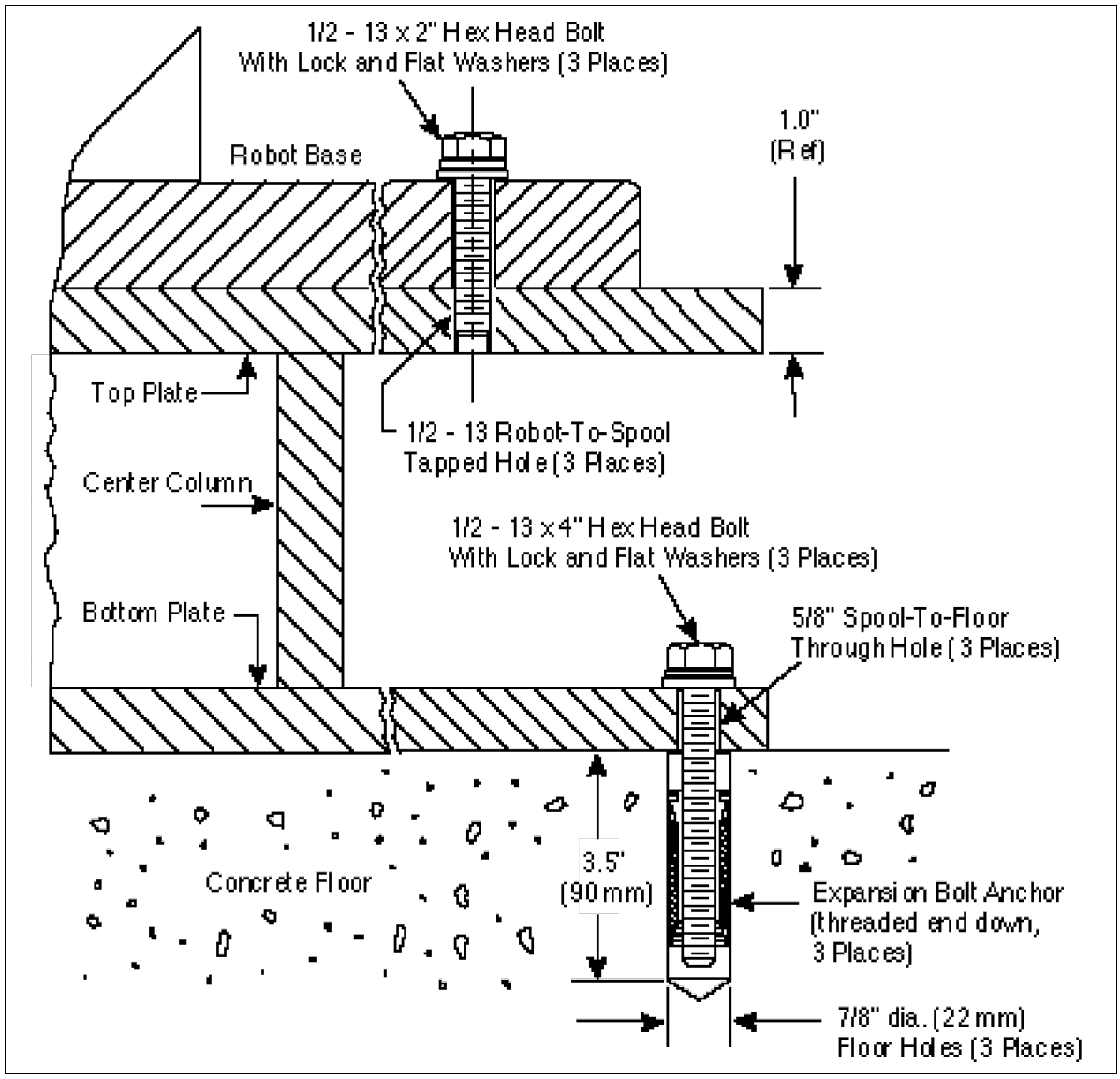

Figure 3-6. Mounting Spool-to-Floor Installation Detail

3.7 Robot Installation

The following sequence details the installation of the robot to the mounting plate or spool.

1. Connect the hydraulic lift to the eyebolts at the top of the robot (Figure 3-7) by means of the dual-leg sling. Take up any slack but DO NOT lift the robot at this time.

> **WARNING**
>
> Do not attempt to lift the robot at any points other than the eyebolts provided.
>
> Do not attempt to extend the inner or outer links of the robot until the robot has been secured in position. Failure to comply could result in the robot falling and causing either personnel injury or equipment damage.

2. Remove the three bolts securing the robot base to the pallet. Retain these bolts for possible later relocation of the equipment.

3. Lift the robot and position it directly over the floor plate or spool.

> **WARNING**
>
> The robot may swing free if not lifted straight up. Stand clear of the robot at all times while it is supported by the lift.

4. Slowly lower the robot while aligning the base and the tapped mounting holes in the plate or spool.

5. Insert a 1/2-13 x 2 inch bolt fitted with both a lock washer and a flat washer through each of the three mounting holes in the robot base into the mounting plate or spool and torque to 65 foot-pounds.

6. Disconnect the sling and remove the eyebolts from the arm. Retain the eyebolts for use during possible future relocation of the equipment.

3.8 Facility Interconnection

All interconnection points to the robot are located at the rear of the base, see Figure 2-9.

Robot to Controller

Electrical power and control signals are supplied to the robot via cables from the controller. Refer to the User's Guide for your specific controller (Adept MC or Adept CC) for instructions on robot-to-controller interconnect cabling, as well as complete instructions on connecting the controller to the facility electrical power.

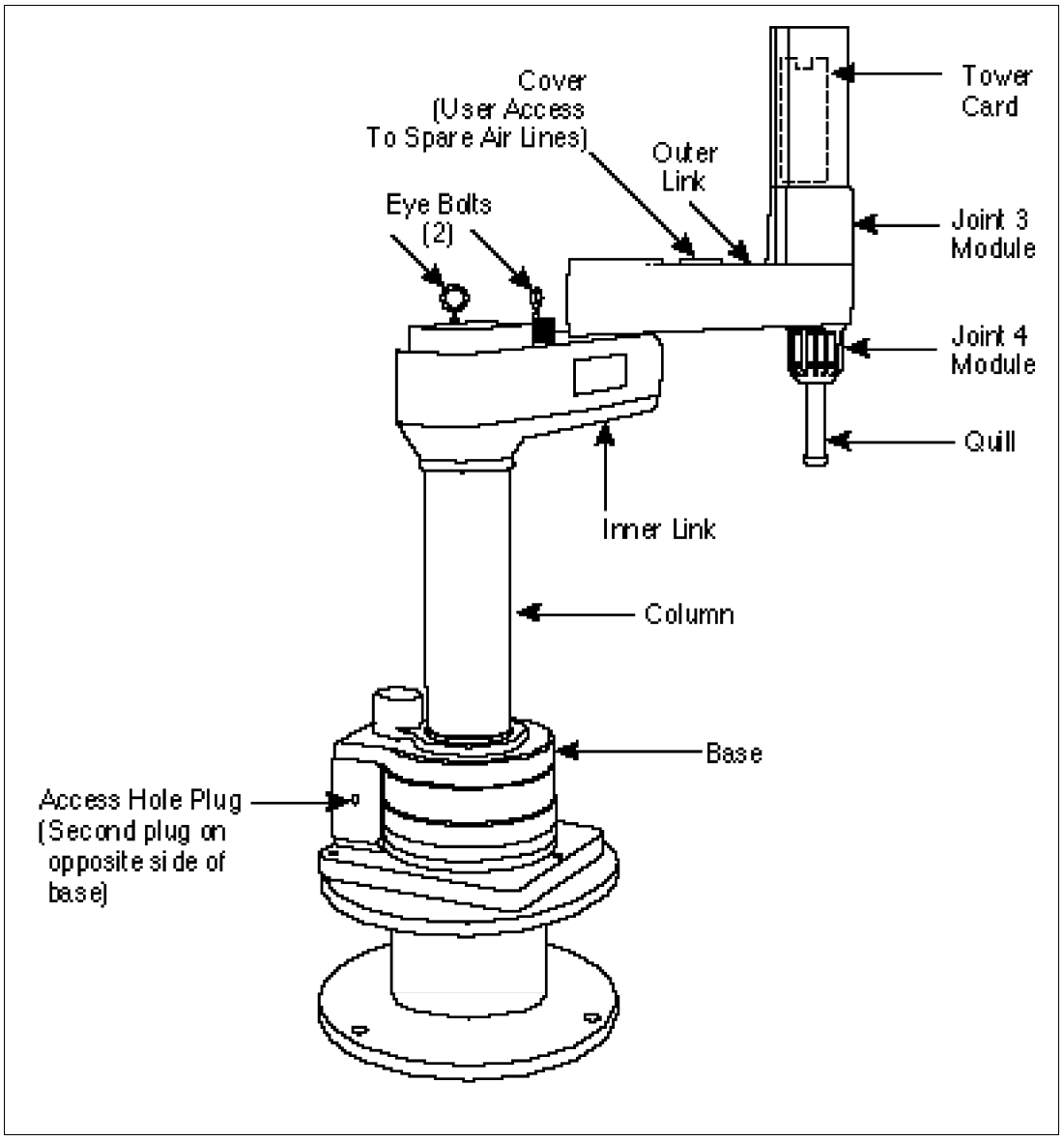

Figure 3-7. User Access to Spare Air Lines and Tower Card Location

Facility Air Supply

It is the responsibility of the User to supply tubing and fittings which may be required to plumb the facility air supply to the robot. The robot is supplied with an air filter with a standard 1/4-inch Industrial Interchange nipple.

Two "spare" air lines, 1/8 inch and 1/4 inch, are incorporated into the robot to allow for User options. These lines run from the base of the robot up to the area near the solenoid valve in the outer link. The lines are not supplied with connection fittings at either end. At the base, the ends of the air lines can be routed through either one of the access holes capped with removeable plastic plugs (Figure 3-7). To gain access to the spare air lines at the base, remove eight cap-head screws that secure the base top cover, then lift and turn the cover out of the way. Be careful not to disturb exposed parts and wiring when top cover is off. At the outer link location, the air lines can be accessed by removing the outer-link cover.

3.9 End Effectors

Provision of an end effector or other end-of-arm tooling is the responsibility of the User. The AdeptThree design allows simple integration with end effectors. There is easy access to the User air lines, spare air lines, and electrical connectors on the Tower printed circuit assembly (PCA).

Installation

Physical attachment of an end effector to the flange may be accomplished either by utilizing a ring clamp (supplied) or four 8-32 screws. For details of the flange mounting surface refer to Figure 3-8.

Clamp-mounted End Effector

The following procedure describes the installation of a typical end effector using the ring clamp. (Refer to Figure 3-9.)

1. Disconnect the air supply to the robot.
2. Remove the plugs from the "OPEN" and "CLOSE" air lines where they protrude from the quill flange.
3. Place the ring clamp over the quill flange.

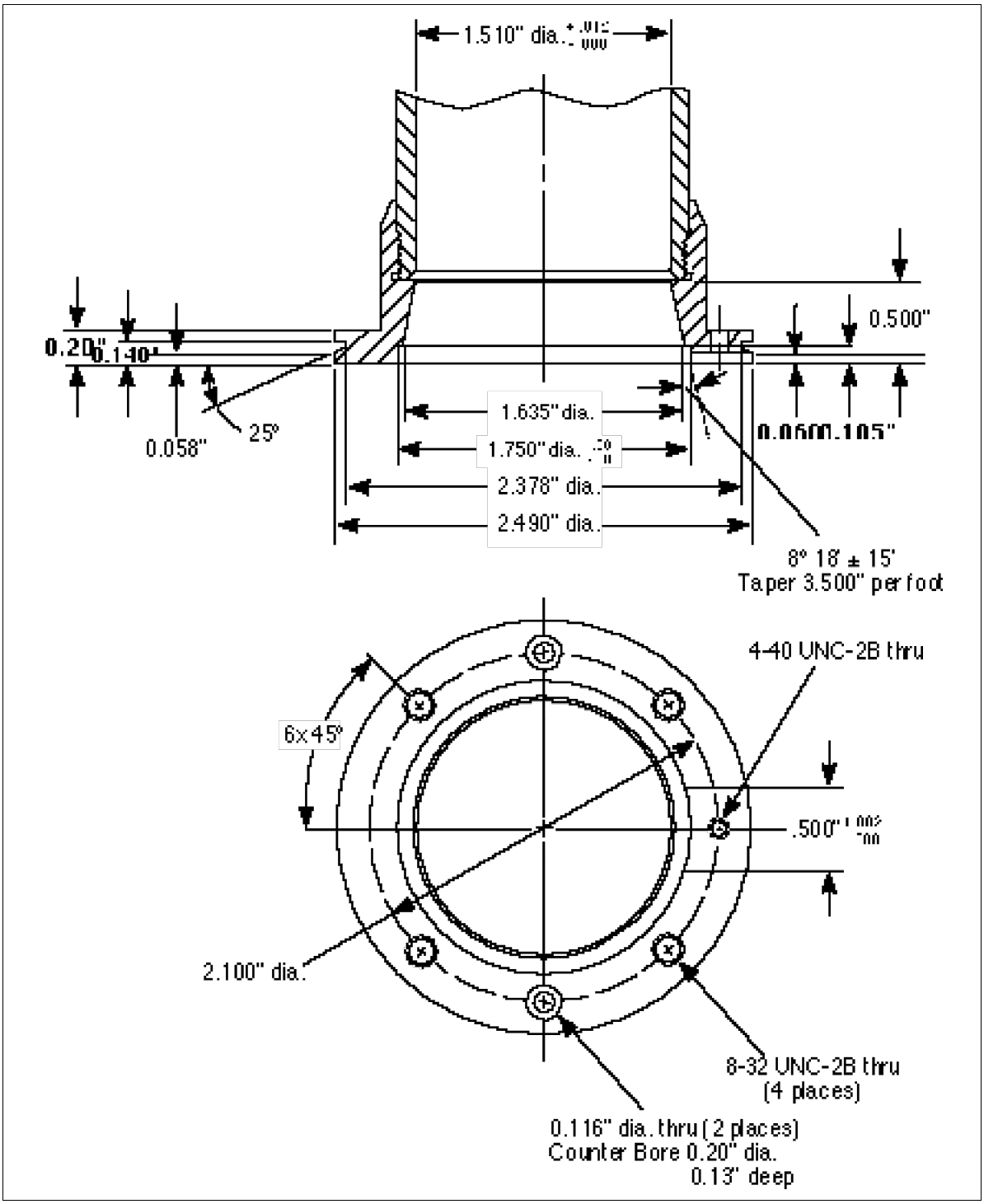

Figure 3-8. Quill Flange Dimensions

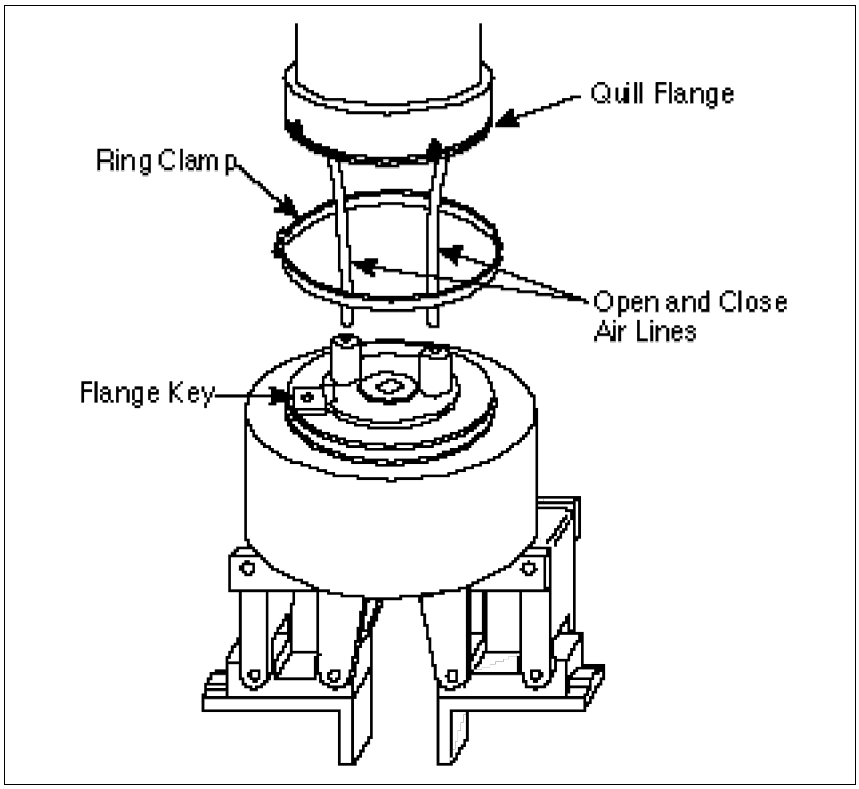

Figure 3-9. Clamp-mounted End Effector Installation

4. Install the "OPEN" and "CLOSE" air lines onto the appropriate fittings on the end effector.

5. Mate the end-effector flange to the quill flange. Rotate the end effector until its key aligns with the keyway in the quill flange, then place the ring clamp over both flanges and tighten the clamp screw.

Screw-mounted End Effector

The following procedure describes installing an end effector using four screws. (See Figure 3-10.)

1. Disconnect the air supply to the robot.

2. Remove the plugs from the "OPEN" and "CLOSE" air lines where they protrude from the quill flange.

3. Install the "OPEN" and "CLOSE" air lines onto the appropriate fittings on the end effector.

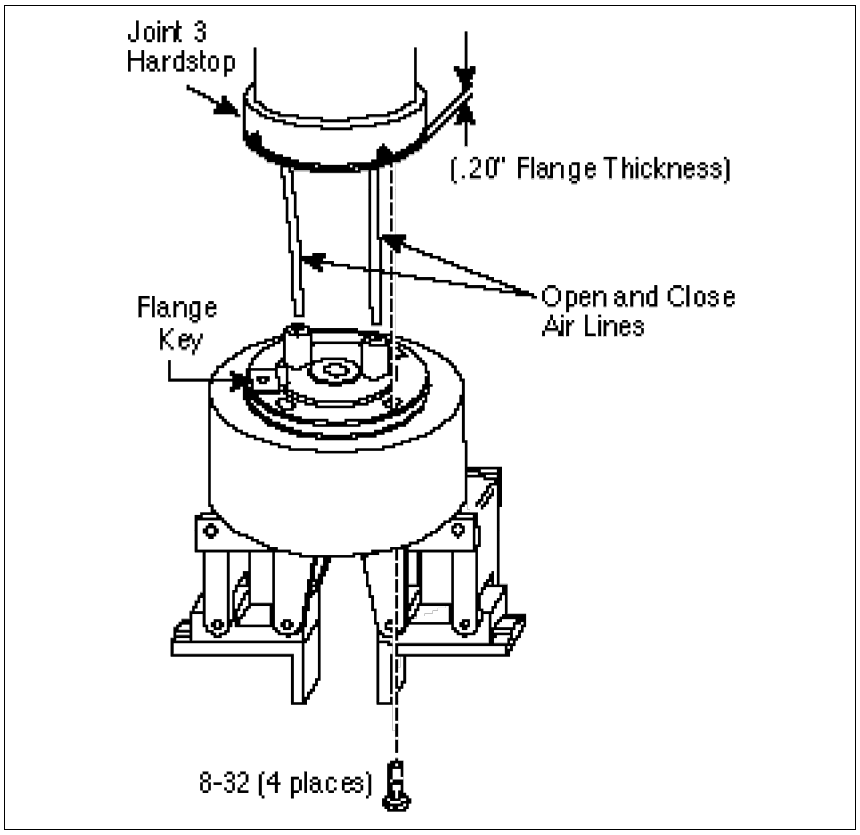

Figure 3-10. Screw-mounted End Effector Installation

4. Mate the end-effector flange to the quill flange. Rotate the end effector until its key aligns with the keyway in the quill flange.

5. Insert four 8-32 screws through the mounting holes and tighten. Recommended torque is 70 in-lb. If the screws protrude slightly through the flange, align the cutouts in the Joint 3 hardstop located just above the quill flange to accommodate the screw tips.

CAUTION

Do not allow the mounting screws to protrude up into the hardstop any farther than the cutouts, because this can prevent proper seating of the flange against the hardstop. Improper seating against the hardstop will prevent the robot from calibrating properly and will cause all of the previously taught robot locations to have the wrong height.

3.10 User Signal and Voltage Lines

User signal and voltage lines are available at connectors located on the Tower printed circuit assembly (PCA). The Tower PCA is mounted to the top of the Joint 3 housing (refer to Figure 3-7). For the location of the connectors on the Tower PCA, including the location of pin 1 for each connector, see Figure 3-11. The pin-out (wire list) for each connector is shown in Table 3-1.

USR1 Through USR5

USR1 through USR5 line pairs provide the User with a convenient wiring run from the robot Tower PCA to the controller. These lines terminate at connector J9 (User) on the Tower PCA and can be used to connect limit switches or similar digital devices to the binary interface of the controller. Refer to Table 3-1 for the pin configuration of J9. Refer to your controller User's Guide for further information on termination of these lines within the controller. Use of these lines should be limited to a maximum of 12 VDC at 2 Amps.

WARNING

USR1 through USR5 lines are routed through the robot harness in close proximity to robot control signals. In order to ensure long life, these lines are constructed from 28 AWG high-strand-count wires and are not designed to carry high current or high voltage. These lines should be limited to a maximum of 12 VDC at 2 Amps. To minimize coupling with the robot control signals in adjacent harnesses, the User should minimize voltage transients and maintain a current balance in each +/- pair. Exceeding these recommendations could couple noise onto the robot control lines and cause robot motion errors.

Solenoid Drivers

Two spare solenoid drivers are provided on the Tower PCA: Sig-2025 and Sig-2026. These are directly switchable from V or V^+ by utilizing software signals 2025 and 2026, respectively. Refer to the SIGNAL command in the *V and V^+ Reference Guide* for additional information.

The actual driver transistors are located on the Robot Signature Card (RSC), at the base of the robot, and interface to the Tower PCA at J7 (USER SOL) via the robot harness. Refer to Table 3-1 for pin assignments and Figure 3-11 for the connector's location.

Each driver is designed to handle 12 VDC solenoids at up to 500 mA, similar to the hand OPEN / CLOSE solenoids. To overcome the customary problem of dirt buildup at the solenoids, special circuitry has been incorporated to provide a momentary 24 V initial pulse to the solenoid to break any stiction, dropping to 12 V for holding.

Some solenoid manufacturers include a transient-suppression diode across the leads of their solenoids. If such a diode is installed on the solenoid you have selected, verify that the polarity is correct. A reverse installation will short the diode across the driver circuitry. The User is cautioned to use solenoids similar in design to the ones used for the hand OPEN / CLOSE lines and to carefully check the wiring polarity before applying power.

CAUTION

The solenoid driver hardware has no current limiting capability and will attempt to drive a solenoid with as much current as the impedance of the solenoid will accept. As a result, if the User accidently shorts the solenoid +/- leads together, the driver circuit will "over-current" and fail. The RSC will then have to be repaired before that User solenoid can be reused.

DC Power

The Tower PCA provides limited DC power (500 mA max.) to drive User end-of-arm hardware such as indicators, small motors, or other analog devices. 12 VDC, -12 VDC, 12RTN, and FRAME ground are available. Each of these is terminated at J12 (POW) on the Tower PCA. Refer to Table 3-1 for pin assignments and Figure 3-11 for the connector's location. These supplies are fused at 0.5 Amp by fuses F1 and F2 on the Tower PCA.

CAUTION

Power lines are similar to User lines in that they are routed in close proximity to the robot harness. In order to ensure their long life, they are constructed of 26 AWG high-strand-count wire and are not designed to carry high current or voltage. To minimize coupling with robot control signals in the harness, the User should minimize power demand transients on these lines.

The ±12 V power supplies are fused by F1 and F2 on the Tower PCA. In the event of unexpected power loss at J12, turn off power to the controller and check F1 and F2 with an Ohm meter; these fuses do not visually indicate an open circuit. If a fuse requires replacement, DO NOT SUBSTITUTE a fuse with a higher rating. Since the 12 Volt supply is common throughout the controller, drawing too much current at the Tower PCA may damage the robot harness or cause controller problems.

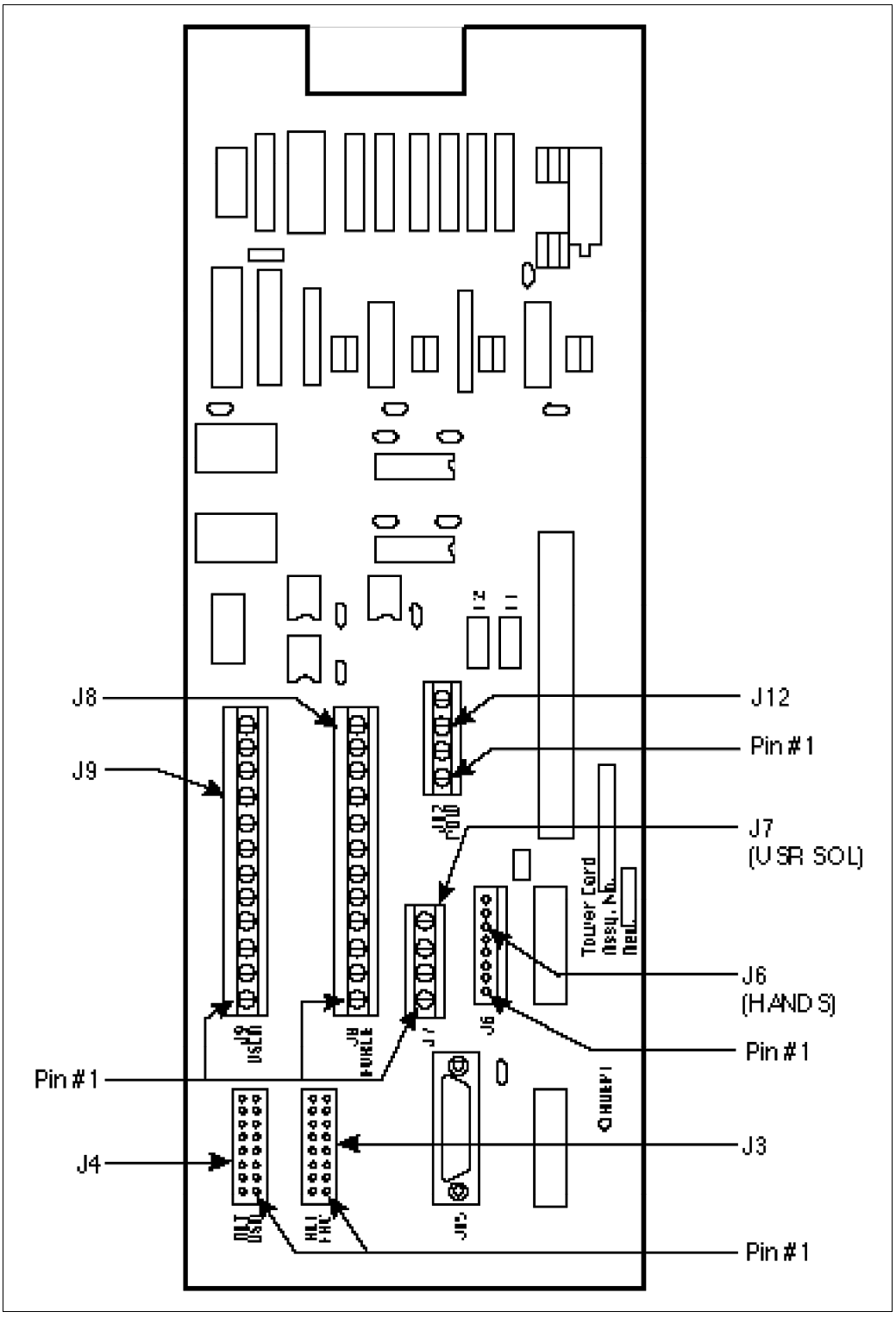

Figure 3-11. Tower Card User Signal and Voltage Lines

Table 3-1. Tower PCA Connector Pinouts

	PIN	SIGNAL	COMMENTS
ALT FRC / J3	Tower card connector: T and B Corp. #500-1627ES User's harness end: AMP #499936-3		
	01	+12BF	Uncommitted supply
	02	FRC1+	User signal
	03	FRC1-	" "
	04	FRC2+	" "
	05	FRC2-	" "
	06	FRC3+	" "
	07	FRC3-	" "
	08	FRC4+	" "
	09	FRC4-	" "
	10	FRC5+	" "
	11	FRC5-	Force balance
	12	12B-RTN	Uncommitted supply
	13	Sig-2026+	Solenoid drive channel
	14	Sig-2026-	" " "
	15	Sig-2025+	" " "
	16	Sig-2025-	" " "
ALT USR / J4	Tower card connector: T and B Corp. #500-1627ES User's harness end: AMP #499936-3		
	01	+12BF	Uncommitted supply
	02	USR1+	User signal
	03	USR1-	" "
	04	USR2+	" "
	05	USR2-	" "
	06	USR3+	" "
	07	USR3-	" "
	08	USR4+	" "
	09	USR4-	" "
	10	USR5+	" "
	11	USR5-	" "
	12	12B-RTN	Uncommitted supply
	13	Sig-2026+	Solenoid drive channel
	14	Sig-2026-	" " "
	15	Sig-2025+	" " "
	16	Sig-2025-	" " "

(Table 3-1 continued on next page)

Table 3-1. Tower PCA Connector Pinouts (continued)

	PIN	SIGNAL	COMMENTS
HANDS / J6	Tower card connector: Panduit Corp. #MLSS100-8 User's harness end: AMP MTA-100 #640441-8		
	01*	Sig-2031+	Hand open solenoid
	02*	Sig-2031-	" " "
	03*	Sig-2030+	Hand close solenoid
	04*	Sig-2030-	" " "
	05**	Sig-2026+	Solenoid drive channel
	06**	Sig-2026-	" " "
	07**	Sig-2025+	" " "
	08**	Sig-2025-	" " "
	* These pins are already used for the Adept harness #10640-12300. ** These pins can be used for two additional solenoid valves.		
USR SOL / J7	Tower card connector: Terminal strip, Phoenix #1715 747 (MKDS 1.5 / 4-5.08) User's harness end: 16 AWG - 30 AWG wires		
	01	Sig-2026+	Solenoid drive channel
	02	Sig-2026-	" " "
	03	Sig-2025+	" " "
	04	Sig-2025-	" " "
FORCE / J8	Tower card connector: Terminal strip, Phoenix #1715 828 (MKDS 1.5 / 12-5.08) User's harness end: 16 AWG - 30 AWG wires		
	01	+12BF	Uncommitted supply
	02	FRC1+	User signal
	03	FRC1-	" "
	04	FRC2+	" "
	05	FRC2-	" "
	06	FRC3+	" "
	07	FRC3-	" "
	08	FRC4+	" "
	09	FRC4-	" "
	10	FRC5+	" "
	11	FRC5-	" "
	12	12B-RTN	Uncommitted supply

Table 3-1. Tower PCA Connector Pinouts (continued)

	PIN	SIGNAL	COMMENTS
User / J9	Tower card connector: Terminal strip, Phoenix #1715 828 (MKDS 1.5/12-5.08) User's harness end: 16 AWG - 30 AWG wires		
	01	+12BF	Uncommitted supply
	02	USR1+	User signal
	03	USR1-	" "
	04	USR2+	" "
	05	USR2-	" "
	06	USR3+	" "
	07	USR3-	" "
	08	USR4+	" "
	09	USR4-	" "
	10	USR5+	" "
	11	USR5-	" "
	12	12B-RTN	Uncommitted supply
J10			
	01	Not used	Brake solenoid auxilliary
	02	" "	" " "
POW / J12	Tower card connector: Terminal strip, Phoenix 1715 747 (MKDS 1.5/4-5.08) User's harness end: 16 AWG - 30 AWG wires		
	01	FRAME	Frame ground
	02	+12BF	Uncommitted supply
	03	12B-RTN	" "
	04	-12BF	" "

NOTES

CHAPTER 4

MAINTENANCE

4.1 Introduction

The AdeptThree robot requires very little maintenance due to its direct-drive design. Joints 1 and 2 need no maintenance at all. This chapter describes the preventive maintenance procedures that are required to keep the robot operating properly.

4.2 Lubrication

The two areas that need lubrication are Joint 3 and Joint 4. The frequency of lubrication depends on the robot operating environment and usage. Initially, check the quill once a week, recording the results with the intent of producing a schedule appropriate to the particular system, its environment, and usage.

To check for adequate lubrication at Joint 3 and 4, run a finger along the quill. A thin film of grease should be present. If the shaft is dry, it needs lubrication. Use only Dow Corning MOLYKOTE BR2 PLUS, a molybdenum disulfide based grease (Dow catalog number 89570-81), for lubricating the robot.

NOTE

Lubrication of the robot requires that the quill be moved while HIGH POWER (ARM POWER) is off. Use the brake release button at the rear of the base to release the brake allowing manual quill movement.

CAUTION

When the brake release button is pressed, the quill could drop to the bottom of its travel. To prevent possible damage to the equipment, make sure that the quill is supported while releasing the brake and verify that installed tooling is clear of all obstructions.

Lubrication of Joint 3

1. Turn HIGH POWER (ARM POWER) off.
2. Remove the quill cover and move the quill to its fully-raised position.
3. Apply a thin coating of grease to the ballscrew threads and move the ballscrew up and down several times to ensure an even spread of grease. Do not use an excessive amount of grease because it could cause problems with the Joint 3 encoder disk.
4. Replace the quill cover.

Lubrication of Joint 4

1. Turn HIGH POWER (ARM POWER) off.
2. Move the quill to its fully-raised position.

CAUTION

The quill MUST be in the fully-raised position before lubricating. Improper quill positioning could result in excessive lubricant getting on the Joint 4 brake, which could cause its failure.

3. Using a 5/16-inch Allen wrench, remove the grease fitting access plug from the side of the Joint 4 housing. See Figure 4-1.
4. While looking through the access plug hole, rotate the quill until the zerk fitting is accessible.
5. Insert the tip of a grease gun and apply grease until excess grease squeezes out from the quill seal.
6. Remove the grease gun.
7. Reposition the quill to the bottom of its travel and wipe excess grease from the quill.
8. Replace the access plug.

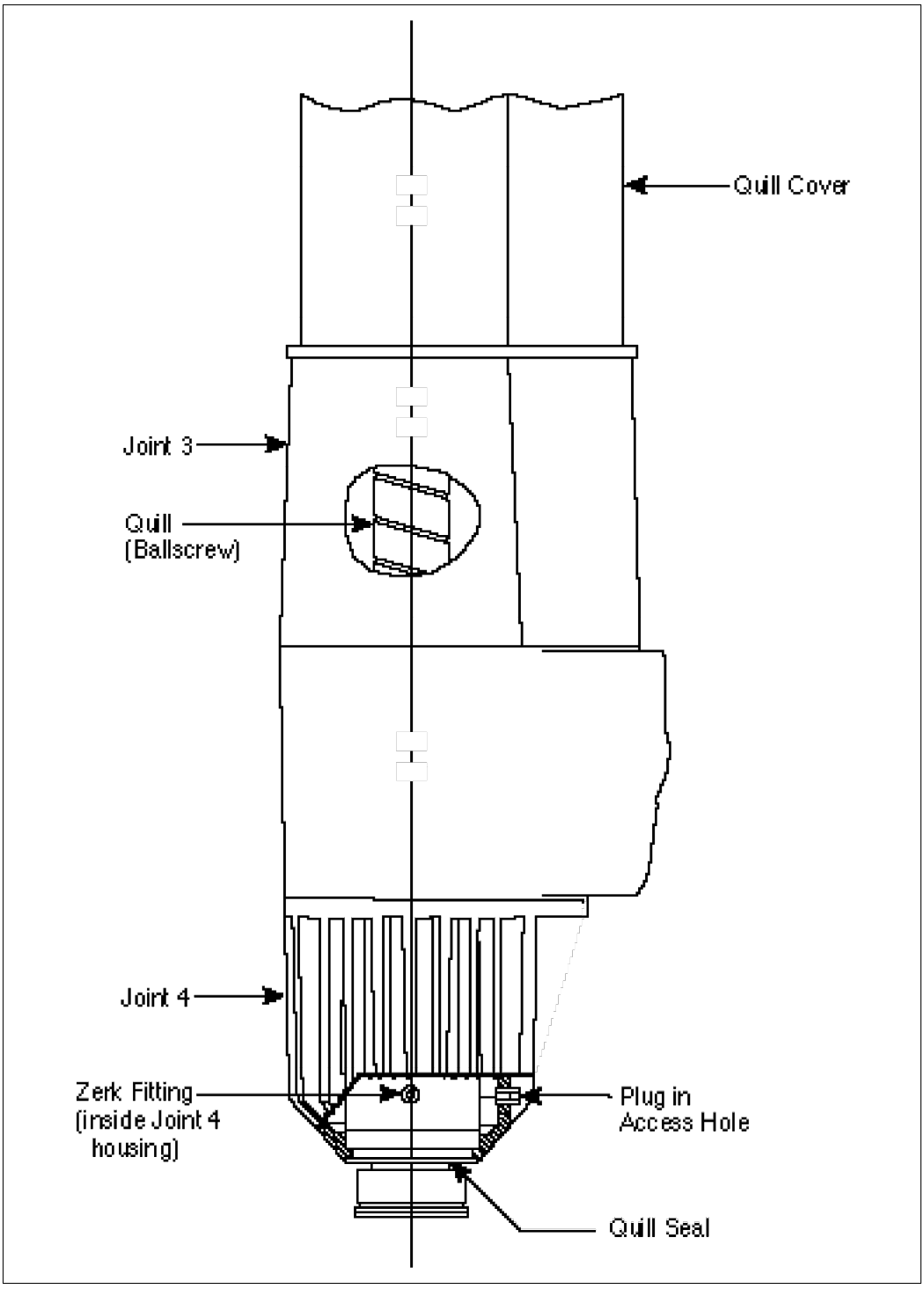

Figure 4-1. Joint 3 and Joint 4 Lubrication

4.3 Draining Moisture from the Air Filter

The air filter on the compressed air inlet at the robot base has a moisture trap that should be emptied periodically, depending on the quality of the air supply and the frequency of usage. The procedure to empty the trap is done with the air supply connected. To empty the trap, use a rag to push up on the bottom of the air filter.

4.4 Joint 4 Overtravel

Softstop and hardstop limits are discussed in Chapter 2. The hardstops for Joints 1, 2, and 3 do not require maintenance. With Joint 4, however, it is possible, under conditions involving high speed, for the robot to contact a hardstop. The Joint 4 hardstop is designed to withstand large forces without damage and even to slip slightly if impacted sufficiently. In such cases the robot is unharmed, but may not be able to attain previously programmed locations.

Diagnostic Procedure

A robot with a slipped Joint 4 hardstop will display one of two symptoms: 1) If the robot has been recalibrated using the CALIBRATE command, the Joint 4 rotation at all locations may have an offset; 2) If the robot has not been calibrated since the hardstop encounter, the robot will produce a Joint 4 *Envelope error* or *Time-out nulling errors*. In either case it is likely that the Joint 4 hardstop has slipped and needs to be reset.

Use the following procedure to diagnose hardstop slippage:

1. Verify that the robot controller is on and the robot is calibrated.

2. Turn HIGH POWER (ARM POWER) off.

3. Place the manual control pendant (MCP) into the Joint Angle Display mode by pressing the DISP button, followed by pressing the JOINT VALUES button. Four joint values should be visible on the MCP display (five if you have the optional fifth axis package installed).

   If there is no MCP on the system, the operator would type “WHERE 1” at the system terminal to start a continuous display of position information. Typing ^C terminates the display.

4. While supporting the quill, press the brake release button at the back of the robot base**.**

CAUTION

When the brake release button is pressed, the quill could drop to the bottom of its travel. To prevent possible damage to the equipment, make sure that the quill is supported while releasing the brake and verify that installed tooling is clear of all obstructions.

5. Move the quill so that it is not near either the upper or lower Joint 3 hardstop, then rotate the quill to one of the Joint 4 hardstops.

6. Check the angle of Joint 4 on the MCP display. The Joint 4 hardstop should be within a few degrees of either +285° or -285°. (The plus or minus value depends on which hardstop is encountered.) If the value is not close to the proper settings, the hardstop has slipped.

7. Rotate the quill away from the hardstop about 90°, then release the brake release button.

8. If you determine that the Joint 4 hardstop has slipped, contact Adept Customer Service at the number listed in Chapter 1. Customer Service can provide you with instructions on how to reset the hardstop. The procedure takes only a few minutes.

NOTES

APPENDIX A

FIFTH AXIS OPTION

A.1 Introduction

The fifth axis, also known as Joint 5, is a servo pitch option for Adept robots. The fifth axis allows the robot to position end-of-arm tooling between +90° and -90° from vertical. The fifth axis is fully integrated into the robot system. The servo mechanism is contained within the robot quill, and the control hardware is located in the robot controller. Movement of the fifth axis is controlled by the standard Adept system software, either V or V^+.

A.2 Specifications

Table A-1. Fifth Axis Specifications

Maximum Travel	±91° (0° reference - vertically downward)
Maximum Speed	180° in 0.3 seconds
Maximum Payload	7 lb (3.18 kg)
Resolution	±0.0057° (0.0002" [±0.005 mm] at the fifth-axis flange)
Repeatability	±0.086° (±0.003" [±0.076 mm] at the fifth-axis flange)
Static Torque	45 lb-in. (0.52 kg-m)
Mounting Flange	Standard Adept tool flange without center hole
Axis center-to-flange offset	2" (50 mm)

A.3 Installation

The fifth axis can be installed either at the factory or by an Adept Customer Service Engineer at the user's site. Call Customer Service for information on installing the fifth axis.

A.4 Operation

Installing End Effectors

The fifth-axis end-effector tool flange will accept any "flat-back" end effector compatible with the standard Adept flange (see Figure A-1). The end effector can either be bolted on or secured with the standard Adept ring clamp. A 1.749" diameter by 0.100" high alignment pad on the end effector is accommodated, but any utilities must be side ported.

The fifth axis includes two air line fittings and a user electrical receptacle for interfacing to end-of-arm tooling, see Figure A-1.

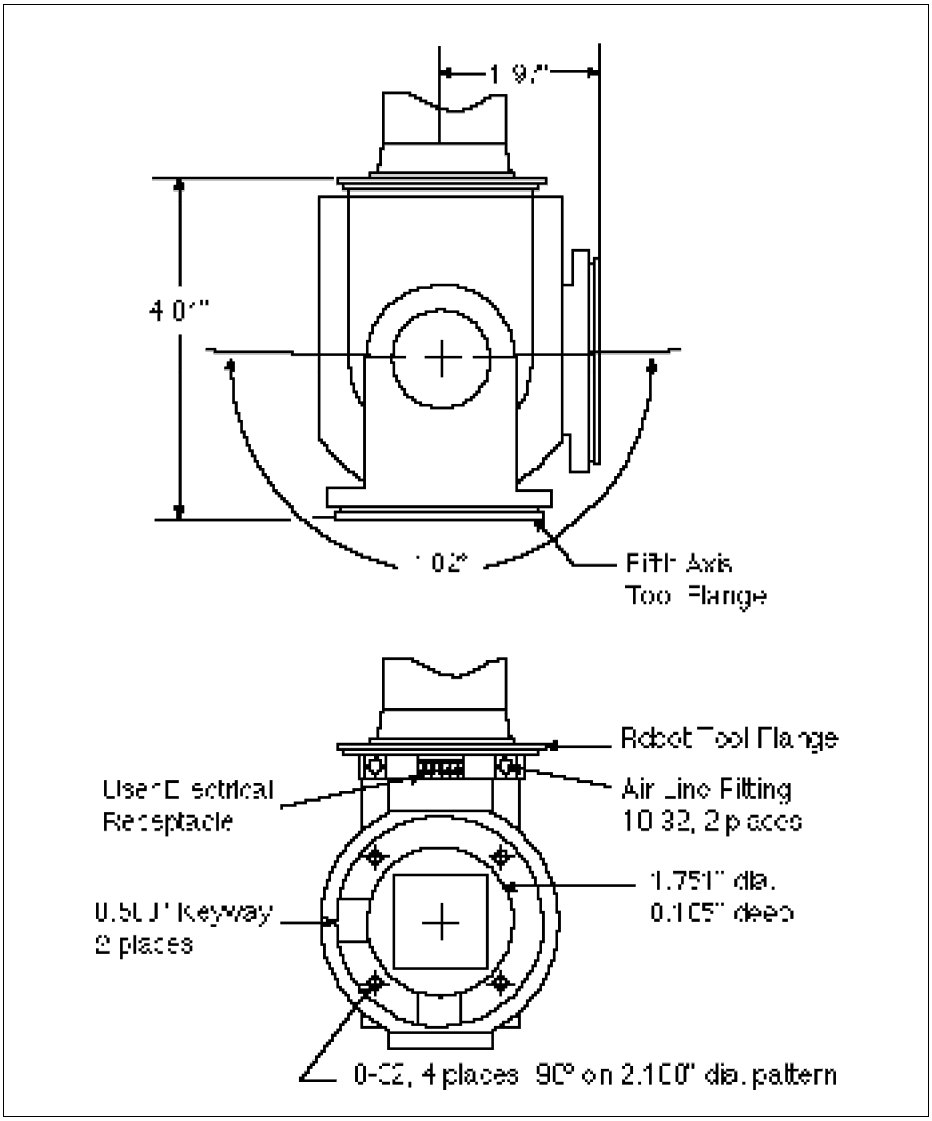

Figure A-1. Fifth-Axis End Effector Mounting Details

User Electrical Connector

A cable with a six-pin connector on one end (Adept part number 10845-24950) is supplied with the fifth axis. This cable is designed to mate with the user electrical receptacle located between the two air fittings (see Figure A-1). The table below shows the connector pin identification and the corresponding pin number at the Tower PCA. Pin cavities 1, 5, 9, and 10 are not used. The connector is polarized and will not mate if incorrectly aligned.

Table A-2. Fifth-Axis User Connector Pin Identification

User Connector Pin #	User Connector Wire Color	Signal	Pin # at J3 on Tower PCA
2	black	FRC1+	2
3	red	FRC1-	3
4	orange	FRC2+	4
6	green	FRC2-	5
7	blue	FRC3+	6
8	white	FRC3-	7

Programming Information

The fifth axis is a fully integrated robot joint and treated the same as the other joints. Like Joints 1 through 4, the fifth axis can be controlled by either the manual control pendant (MCP) or by program instructions from the controller. Refer to the controller User's Guide for information on the MCP and the *V and V+ Reference Guide* for robot programming instructions.

A.5 Maintenance and Troubleshooting

The fifth axis requires no regular maintenance or lubrication.

Checking Flange Position

The fifth-axis flange surface should be at 90° to the side of the gear box when the Joint 5 value is zero. A substantial fifth-axis crash could cause the flange position to slip. Use a machinist square to check for possible slippage when the Joint 5 value is zero. If the flange is not at 90°, contact Customer Service at the number listed in Chapter 1. Do not attempt to force the joint back to its proper position.

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ADEPT USER'S MANUAL

COMMENT FORM

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