AdeptViper
s650/s850 Robot
User's Guide

adept®

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s650/s850 Robot
User's Guide

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Introduction 1

1.1 Product Description

AdeptViper s650/s850 Robots

The AdeptViper s650 and AdeptViper s850 are high-performance, six-axis robots designed specifically for assembly applications. The speed and precision of the AdeptViper robots also make them ideal for material handling, packaging, machine tending, and many other operations requiring fast and precise automation.

> **NOTE:** The descriptions and instructions in this manual apply to both the AdeptViper s650 and the AdeptViper s850, except for instances where there is a difference, as in dimension and work envelope drawings. In those cases the information is presented for both robots.
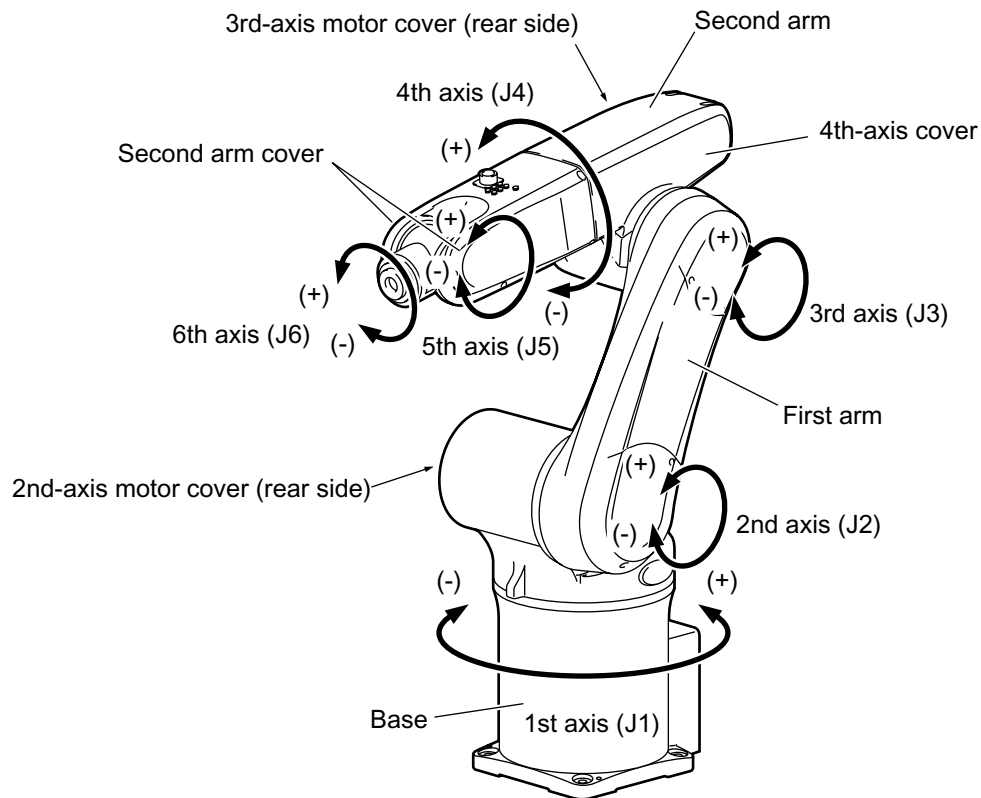
Figure 1-1. Robot Axis Identification

Adept SmartController CX

The SmartController CX is the foundation of Adept's family of high-performance distributed motion and vision controllers. The SmartController CX is designed for use with Adept Cobra s600 and s800 robots, Adept SmartModules, the AdeptViper robot, and the Adept sMI6 Module for the SmartMotion product.

The SmartController CX supports an integrated vision option and a conveyor tracking option. It offers scalability and support for IEEE 1394-based digital I/O and general motion expansion modules. The IEEE 1394 interface is the backbone of Adept SmartServo, Adept's distributed controls architecture supporting Adept products. The controller also includes Fast Ethernet and DeviceNet.
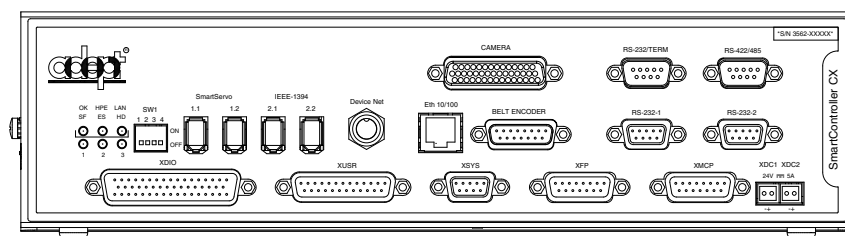
Figure 1-2. Adept SmartController CX

Adept PA-4 CAT-3 Power Chassis

The PA-4 CAT-3 includes AC-DC power conversion electronics that supports a range of Adept power amplifiers and robot control modules. In addition, the PA-4 CAT-3 includes dual (redundant) high-power AC contactors that, in combination with the sDAI, meet the Category-3 E-Stop requirements per EN-954. The PA-4 is configured with J Amplifier modules to support the AdeptViper robot systems.

The J amplifiers in the AdeptViper robot system are controlled by the sDAI distributed control module. The sDAI module resides in the PA-4 chassis and contains a RISC microprocessor and interface circuitry that close the servo loops for high- performance robot motion. The sDAI is connected to a host Adept SmartController via the SmartServo interface (based on IEEE 1394).

1.2   Installation Overview

The system installation process is summarized in the following table. Refer also to the system cable diagram in **Figure 4-1 on page 39**.

Table 1-1. Installation Overview

Task to be Performed	Reference Location
1. Mount the robot on a flat, secure mounting surface.	See Section 3.4 on page 30.
2. Install the SmartController, Front Panel, and AdeptWindows software.	See Section 4.2 on page 40.
3. Install the PA-4 power chassis.	See Section 4.3 on page 40.
4. Install the Arm Power/Signal cable between the PA-4 and the robot.	See Section 4.3 on page 40.
5. Install the IEEE 1394 and XSYS cables between the PA-4 and SmartController.	See Section 4.3 on page 40.
6. Connect AC power to PA-4 power chassis.	See Section 4.4 on page 42.
7. Start AdeptWindows, connect to the controller, and turn on power to the system.	See Section 5.1 on page 49.

1.3   Manufacturer's Declaration

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

http://www.adept.com/support/downloads_disclaimer.asp

In the Download Types search box, select Regulatory Certificates to find the document, which you can then download.

1.4   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 web site:

http://www.adept.com

Related Manuals

This manual covers the installation, operation, and maintenance of an Adept Cobra s600/s800 robot system. There are additional manuals that cover programming the system, reconfiguring installed components, and adding other optional components; see Table 1-2. These manuals are available on the Adept Document Library CD-ROM shipped with each system.

Table 1-2. Related Manuals

Manual Title	Description
Adept SmartController User's Guide	Contains complete information on the installation and operation of the Adept SmartController and the optional sDIO product.
Adept PA-4 Power Chassis User's Guide	Contains complete information on the installation and operation of the PA-4 Power Chassis.
AdeptWindows Installation Guide	Describes installation of AdeptWindows software.
Instructions for Adept Utility Programs	Describes the utility programs used for advanced system configurations, system upgrades, file copying, and other system configuration procedures.
V+ Operating System User's Guide	Describes the V$^+$ operating system, including disk file operations, monitor commands, and monitor command programs.
V+ Language User's Guide	Describes the V$^+$ language and programming of an Adept control system.

Adept Document Library

The Adept Document Library (ADL) contains documentation for Adept products. You can access a local copy of the ADL from the Adept Software CD shipped with your system, or from the separate ADL CD. Additionally, an Internet version of the ADL can be accessed by going to the Adept Web site and selecting Document Library from the 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. To view a list of available product documentation, select the Document Titles option.

Safety **2**

2.1 Dangers, Warnings, Cautions, and Notes

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

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

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

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

NOTE: This provides supplementary information, emphasizes a point or procedure, or gives a tip for easier operation.

2.2   Precautions and Required Safeguards

This manual must be read by all personnel who install, operate, or maintain Adept systems, or who work within or near the workcell.

CAUTION: Adept Technology strictly prohibits installation, commissioning, or operation of an Adept robot without adequate safeguards. These must be compliant with applicable local and national standards. Installations in EU and EEA countries must comply with EN 775/ISO 10218, especially sections 5,6; EN 292-2; and EN 60204-1, especially section 13.

Definition of a Manipulating Industrial Robot

The definition of a manipulating robot according to (ISO 10218:1992(E)) is as follows:

"A manipulating robot is an automatically controlled, reprogrammable, multipurpose, manipulative machine with several degrees of freedom, which may be either fixed in place or mobile for use in industrial automation applications."

Safety Barriers

Safety barriers must be provided that prevent personnel from entering the workcell whenever power is applied to the equipment. 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 power to the equipment is present.

The robot system integrator (user or operator) must ensure that adequate safeguards, safety barriers, light curtains, safety gates, safety floor mats, etc., are installed. The robot workcell must comply with applicable local and national standards (see **Section 2.7 on page 21**).

The height and the distance of the safety fence from the robot must ensure that personnel cannot reach the danger zone of the robot.

The Adept control system has features that aid the user in constructing system safeguards, including customer emergency stop circuitry and digital input and output lines. The emergency power-off circuitry is capable of switching external power systems and can be interfaced to the appropriate user-supplied safeguards. See the *Adept SmartController User's Guide* for additional information.

Impact and Trapping Points

Adept robots are capable of moving at high speeds. If a person is struck by a robot (impacted) or trapped (pinched) serious injury could occur. Robot configuration, joint speed, joint orientation, and attached payload all contribute to the total amount of energy available to cause injury.

Hazards From Expelling a Part or Attached Tooling

The maximum joint tip speeds that can be achieved by the robot are listed in **Table 9-1 on page 83**. Any tooling, fixtures, end-effectors, etc., mounted to the user flange, or one of the other axes of the robot must be attached by sufficient means to resist being expelled from the robot. Additionally, any payload must be held by the end-effector in a manner that prevents the payload from being expelled accidentally.

The safety fence or barrier constructed around the robot must be designed to withstand the impact of any item expelled accidentally from the robot. Projectile energy can be calculated using the formula $E = \frac{1}{2}mv^2$.

> **NOTE:** In the Projectile energy formula above:
>
> - E = Energy
>
> - M = Mass
>
> - V = Velocity

Additional Safety Information

The standards and regulations listed in this handbook contain additional guidelines for robot system installation, safeguarding, maintenance, testing, start-up, and operator training. **Table 2-1 on page 16** lists some sources for the various standards.

Table 2-1. Sources for International Standards and Directives

SEMI International Standards 3081 Zanker Road San Jose, CA 95134 USA Phone: 1.408.943.6900 Fax: 1.408.428.9600 **http://wps2a.semi.org/wps/portal/_pagr/118/_pa.118/200**	American National Standards Institute (ANSI) 11 West 42nd Street, 13th Floor New York, NY 10036 USA Phone 212-642-4900 Fax 212-398-0023 **http://www.ansi.org**
BSI Group (British Standards) 389 Chiswick High Road London W4 4AL United Kingdom Phone +44 (0)20 8996 9000 Fax +44 (0)20 8996 7400 **http://www.bsi-global.com**	Document Center, Inc. 1504 Industrial Way, Unit 9 Belmont, CA 94002 USA Phone 415-591-7600 Fax 415-591-7617 **http://www.document-center.com**
DIN, Deutsches Institut für Normung e.V. German Institute for Standardization Burggrafenstrasse 6 10787 Berlin Germany Phone.: +49 30 2601-0 Fax: +49 30 2601-1231 **http://www.din.de** **http://www2.beuth.de/ (publishing)**	Global Engineering Documents 15 Inverness Way East Englewood, CO 80112 USA Phone 800-854-7179 Fax 303-397-2740 **http://global.ihs.com**
IEC, International Electrotechnical Commission Rue de Varembe 3 PO Box 131 CH-1211 Geneva 20 Switzerland Phone 41 22 919-0211 Fax 41 22 919-0300 **http://www.iec.ch**	Robotic Industries Association (RIA) 900 Victors Way PO Box 3724 Ann Arbor, MI 48106 USA Phone 313-994-6088 Fax 313-994-3338 **http://www.robotics.org**

2.3　Risk Assessment

Without special safeguards in its control system, the AdeptViper robot could inflict serious injury on an operator working within its work envelope. Safety standards in several countries require appropriate safety equipment to be installed as part of the system. Table 2-2 lists some of the safety standards that affect industrial robots. It is *not* a complete list. Safeguards must comply with *all* applicable local and national standards for the location where the robot is installed.

Table 2-2. Partial List of Robot and Machinery Safety Standards

International	USA	Canada	Europe	Title of Standard
ISO 10218			EN 775	Manipulating Industrial Robots - Safety
	ANSI/RIA R15.06	CAN/CSA-Z434-94		Industrial Robots and Robot Systems - Safety Requirements
			EN 292-2	Safety of Machinery - Basic Concepts, General Principles for Design
			EN 954-1	Safety Related Parts of Control Systems - General Principles for Design
			EN 1050	Safety of Machinery - Risk Assessment

Adept has performed a Risk Assessment for this product, based on the intended applications of the robot. The conclusions are summarized below.

Exposure

When arm power is on, all personnel must be kept out of the robot work envelope by interlocked perimeter barriers. The only permitted exception is for teaching the robot in Manual Mode by a skilled programmer (see "Qualification of Personnel" on page 22), who must wear safety equipment (see "Safety Equipment for Operators" on page 22) and carry the pendant (T1 or MCP). Therefore, exposure of personnel to hazards related to the robot is limited (seldom and/or short exposure time).

Severity of Injury

Provided that skilled personnel who enter the robot work envelope are wearing protective headgear, eyeglasses, and safety shoes, it is likely that any injuries caused by the robot would be slight (normally reversible).

Avoidance

Due to its light payload capacity, it is likely that such personnel could avoid being hit by the robot even in a high-acceleration, runaway, failure condition. However, the programmer must always carry the pendant when inside the work envelope, as the pendant provides both E-Stop and Enabling switch functions.

For *normal* operation (AUTO mode), user-supplied interlocked guarding must be installed to prevent any person entering the workcell while Arm Power is on.

> **DANGER:** The Adept-supplied system components provide a Category 1 control system as defined by EN 954. The robot system must be installed with user-supplied interlock barriers. The interlocked barrier should interrupt the DC and AC supplies to the control system in the event of personnel attempting to enter the workcell when Arm Power is enabled, except for teaching in Manual Mode. Failure to install suitable guarding could result in injury or death.

The Risk Assessment for *teaching* this product depends on the application. In many applications, the programmer will need to enter the robot workcell while Arm Power is enabled to teach the robot. Other applications can be designed so that the programmer does not have to enter the work envelope while Arm Power is on. Examples of alternative methods of programming include:

1. Programming from outside the safety barrier.

2. Programming with Arm Power off.

3. Copying program from another (master) robot.

4. Off-line or CAD programming.

Control System Behavior Category

The following paragraphs relate to the requirements of European (EU/EEA) directives for Machinery, Electric Safety, and Electromagnetic Compatibility (EMC).

In situations with low exposure consideration factors, European Standard EN 1050 specifies use of a Category 1 Control System per EN 954. EN 954 defines a Category 1 Control System as one that employs Category B components designed to withstand environmental influences, such as voltage, current, temperature, EMI, and well-tried safety principles. The standard control system described in this handbook employs hardware components in its safety system that meet or exceed the requirements of the *EU Machinery Directive* and *Low Voltage Directive*.

The standard control system is fully hardened to all EMI influences per the EU EMC *Directive* and meets all functional requirements of ISO 10218 (EN 775) *Manipulating Robots Safety*. In addition, a software-based reduced speed mode has been incorporated to limit speed and impact forces on the Operator and production tooling when the robot is operated in Manual Mode.

The standard control system meets or exceeds the requirements imposed by the EN 954 specified Category 1 level of safety.

2.4   Intended Use of the Robots

The installation and use of Adept products must comply with all safety instructions and warnings in this manual. Installation and use must also comply with all applicable local and national requirements and safety standards (see **Section 2.7 on page 21**).

The AdeptViper robots are intended for use in parts assembly and material handling for payloads less than 5 kg. See **Chapter 5** for complete information tooling and payloads.

> ⚠ **CAUTION:** For safety reasons, it is prohibited to make certain modifications to Adept robots (see **Section 2.5**).

The Adept controller is a component subassembly of a complete industrial automation system. The controller subassembly must be installed inside a suitable enclosure. The controller subassembly must not come into contact with liquids. Additionally, the robot must not come into contact with liquids.

The Adept equipment is not intended for use in any of the following situations:

- In hazardous (explosive) atmospheres

- In mobile, portable, marine, or aircraft systems

- In life-support systems

- In residential installations

- In situations where the Adept equipment will be subject to extremes of heat or humidity.

> ⚠ **CAUTION:** The instructions for operation, installation, and maintenance given in this manual must be strictly observed.

Non-intended use of an AdeptViper robot can:

- Cause injury to personnel

- Damage the robot or other equipment

- Reduce system reliability and performance

All persons that install, commission, operate, or maintain the robot must:

- Have the necessary qualifications

- Read and follow the instructions in this Instruction Handbook exactly

If there is any doubt concerning the application, ask Adept to determine if it is an intended use or not.

2.5   Robot Modifications

It is sometimes necessary to modify the robot in order to successfully integrate it into a workcell. Unfortunately, many seemingly simple modifications can either cause a robot failure or reduce the robot's performance, reliability, or lifetime. The following information is provided as a guideline to modifications.

Acceptable Modifications

In general, the following robot modifications do not cause problems, but may affect robot performance:

- Attaching tooling, utility boxes, solenoid packs, vacuum pumps, cameras, lighting, etc., to the robot tool mount flange.

- 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.

Unacceptable Modifications

The modifications listed below may damage the robot, reduce system safety and reliability, or shorten the life of the robot. The warranty of the entire robot or certain parts may be voided.

CAUTION: Making any of the modifications outlined below voids the warranty of any components that Adept determines were damaged due to the modification. You must contact Adept Customer Service if you are considering any of the following modifications:

- Modifying any of the robot harnesses or robot-to-controller cables.

- Modifying any robot access covers or drive system components.

- Modifying, including drilling or cutting, any robot surface.

- Modifying any robot electrical component or printed-circuit board.

- Routing additional hoses, air lines, or wires through the inside of the robot.

- Modifications that compromise EMC performance, including shielding.

2.6   Transport

Always use adequate equipment to transport and lift Adept products. See **Chapter 3** for more information on transporting, lifting, and installing.

2.7   Safety Requirements for Additional Equipment

Additional equipment used with the AdeptViper robots (grippers, conveyor belts, etc.) must not reduce the workcell safeguards.

Emergency stop switches must be accessible at all times.

If the robot is to be used in an EU or EEA member country, all components in the robot workcell must comply with the safety requirements in the European Machine Directive 89/392/EEC (and subsequent amendments) and related harmonized European, international, and national standards. For robot systems, these include: EN 775/ISO 10218, sections 5,6; EN 292-2; and EN 60204. For safety fences, see EN 294.

In other countries, Adept strongly recommends, that a similar level of safety be obtained as well as complying with the applicable local and national regulations, including SEMI-S2.

In the USA, applicable standards include ANSI/RIA R15.06 and ANSI/UL 1740.

In Canada, applicable standards include CAN/CSA Z434.

2.8   Working Areas

Adept robots have a Manual and an Automatic (AUTO) operating mode. While in Automatic Mode, personnel are not allowed in the workcell.

In Manual Mode, operators with additional safety equipment (see **Section 2.10 on page 22**) are allowed to work in the robot workcell. For safety reasons the operator should, whenever possible, stay outside of the robot work envelope to prevent injury. The maximum speed and power of the robot is reduced, but it could still cause injury to the operator.

Before performing maintenance in the working envelope of the robot, High Power must be switched off and the power supply of the robot must be disconnected. After these precautions, a skilled person is allowed to perform maintenance on the robot. See **Section 2.9** for the specifications.

CAUTION: Never remove any safeguarding and never make changes in the system that will decommission a physical safeguard.

2.9   Qualification of Personnel

This manual assumes that all personnel have attended an Adept training course and have a working knowledge of the system. The user must provide the necessary additional training for all personnel who will be working with the system.

As noted in this handbook, certain procedures should be performed only by **skilled** or **instructed** persons. For a description of the level of qualification, Adept uses the standard terms:

- **Skilled persons** have technical knowledge or sufficient experience to enable them to avoid the dangers, electrical and/or mechanical.

- **Instructed persons** are adequately advised or supervised by skilled persons to enable them to avoid the dangers, electrical and/or mechanical.

All personnel must observe industry-prescribed safety practices during the installation, operation, and testing of all electrically powered equipment. To avoid injury or damage to equipment, always remove power by disconnecting the AC power from the source before attempting any repair or upgrade activity. Use appropriate lockout procedures to reduce the risk of power being restored by another person while you are working on the system.

WARNING: The user must get confirmation from every entrusted person before they start working with the robot that the person:

1. Has received the manual

2. Has read the manual

3. Understands the manual

4. Will work in the manner specified by the manual.

2.10 Safety Equipment for Operators

Operators must wear safety equipment in the workcell. For safety reasons, operators must wear the following when they are in the robot workcell.

- Safety glasses

- Protective headgear (hard hats)

- Safety shoes

Warning signs should be posted around the workcell to ensure that anyone working around the robot system knows they must wear safety equipment.

2.11 Protection Against Unauthorized Operation

The system must be protected against unauthorized use. The user or operator must restrict access to the keyboard and the pendant by locking them in a cabinet or use another adequate method to prevent access to them.

2.12 Safety Aspects While Performing Maintenance

Only skilled persons with the necessary knowledge about the safety and operating the equipment are allowed to maintain the robot, controller, and power chassis.

CAUTION: During maintenance and repair, the power of the Adept controller must be turned off. Lockout measures must be used to prevent unauthorized personnel from turning on power.

2.13 Risks That Cannot Be Avoided

The Adept control system includes devices that disable High Power if a system failure occurs. However, certain residual risks or improper situations could cause hazards. The following situations may result in risks that cannot be avoided:

- Failure of software or electronics that may cause high-speed robot motion in Manual Mode

- Failure of hardware associated with enabling device or E-Stop system

2.14 Risks Due to Incorrect Installation or Operation

Take precautions to ensure that the following situations do not occur:

- Purposely defeating any aspect of the safety E-Stop system

- Improper installation or programming of the robot system

- Unauthorized use of cables other than those supplied or use of modified components in the system

- Defeating interlock so that operator can enter workcell with High Power ON

- Ejection of work piece (see **"Hazards From Expelling a Part or Attached Tooling" on page 15**).

2.15 What to Do in an Emergency Situation

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 CO_2 to extinguish the fire.

Robot Installation 3

3.1 Unpacking and Inspecting the Adept Equipment

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

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

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

Inspect each item for external damage as it is removed from its container. If any damage is evident, contact Adept (see **Section 1.4 on page 12**).

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

3.2 Environmental and Facility Requirements

The Adept robot system installation must meet the operating environment requirements shown in **Table 3-1**.

Table 3-1. Robot System Operating Environment Requirements

Item	Condition
Flatness of the mounting surface	0.1/500 mm
Installation type	Floor-mount or Overhead-mount
Ambient temperature	During operation: 0 to 40°C During storage and transportation: -10 to 60°C
Humidity	During operation: 90% or less (No dew condensation allowed.) During storage and transportation: 75% or less (No dew condensation allowed.)
Vibration	During operation: 4.9 m/s^2 (0.5G) or less During storage and transportation: 29.4 m/s^2 (3G) or less
Safe Installation Environment	The robot should not be installed in an environment where: • there are flammable gases or liquids, • there are any acidic, alkaline or other corrosive gases, • there is sulfuric or other types of cutting or grinding oil mist, or • there are any large-sized inverters, high output/high frequency transmitters, large contactors, welders, or other sources of electrical noise. • there are any shavings from metal processing or other conductive material flying about, • it may be directly exposed to water, oil, or cutting chips.
Working space, etc.	• Sufficient service space must be available for inspection and disassembly. • Keep wiring space (230 mm or more) behind the robot, and fasten the wiring to the mounting face or beam so that the weight of the cables will not be directly applied to the connectors.
Installation conditions	Grounding resistance: 100 milliohms or less See **Figure 3-3 on page 31**.

3.3 Transporting the Robot

Precautions in Transporting Robot

- The robot weighs approximately 30 kg. Use a crane suitable for the robot weight.

- Have at least two workers handle this job.

- Workers should wear helmets, safety shoes, and gloves during transport.

- Do not hold the first arm, elbow, either side of the 2nd arm, 2nd-axis cover, or 3rd-axis cover, or apply force to any of them. See **Figure 1-1 on page 9**.

CAUTION: Pass the hoisting wires through the specified eyebolts as illustrated below. Passing them through other sections may drop the robot unit, resulting in injuries to personnel or damage to the robot.

Wire
(Belt sling)

Waste Cloth

Eyebolts

Robot Mounting
Bolts
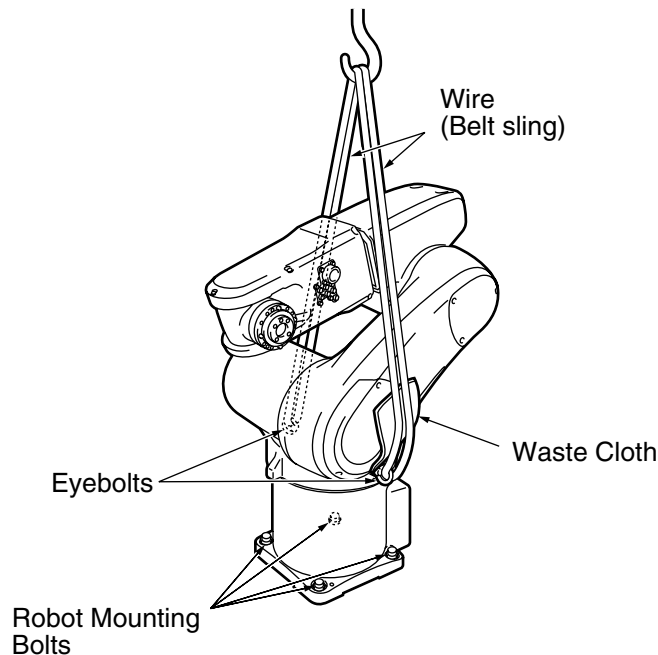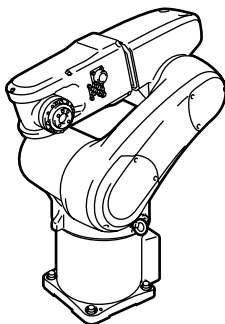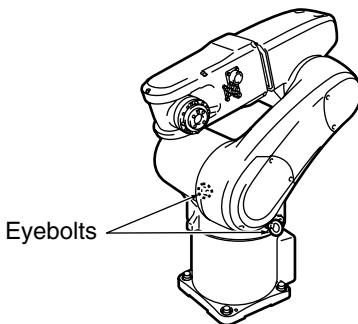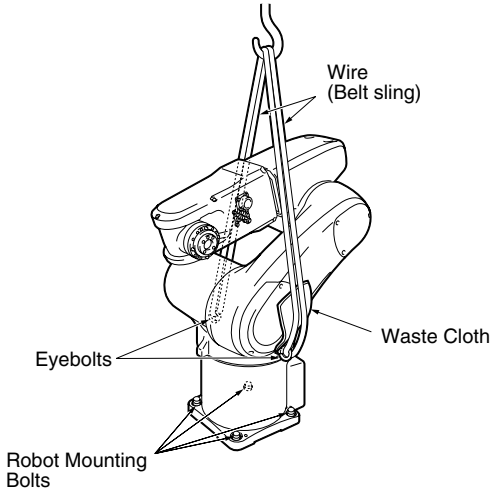
Figure 3-1. Robot in Hoisting Sling

Transport Procedure

Step	Procedure	Drawing
1	Before transportation, set the robot in a transport position as shown at right by manually moving the second, third and fourth axes. When unpacked first, the robot is in the transport position, so this job is not required.	

Transport Position	
Axis	**Angle**
First axis (J1)	0°
Second axis (J2)	-145°
Third axis (J3)	+243°
Fourth axis (J4)	-90°
Fifth axis (J5)	-90°

Step	Procedure	Drawing
2	Disconnect the robot control cable, air piping and user signal cables from the robot unit. When the robot unit is first unpacked, this job is not required.	
3	As shown at right, mount the eyebolts. When delivered, the robot unit is packed with eyebolts attached, so this job is not required	Eyebolts

Step	Procedure	Drawing
4	As shown at right, place a waste cloth on the second arm and pass the wire through the two eyebolts. **Note**: Before transporting the robot, check that the path to the target position is free of obstacles.	Wire (Belt sling) Waste Cloth Eyebolts Robot Mounting Bolts
5	Worker A: Remove the four bolts while supporting the robot unit to prevent it from getting overturned.	
6	Worker B: Operate the crane and move the robot unit to the target site.	
7	Worker B: Put the robot unit down in the target position. Worker A: Temporarily secure the robot unit with four bolts.	
8	Secure the robot unit according to the instructions in **Section 3.4 on page 30**.	
9	Remove the eyebolts from the robot unit.	**Caution:** Before running the robot unit, be sure to remove the eyebolts. Otherwise, the robot arm will strike against those eyebolts.

3.4   Mounting the Robot
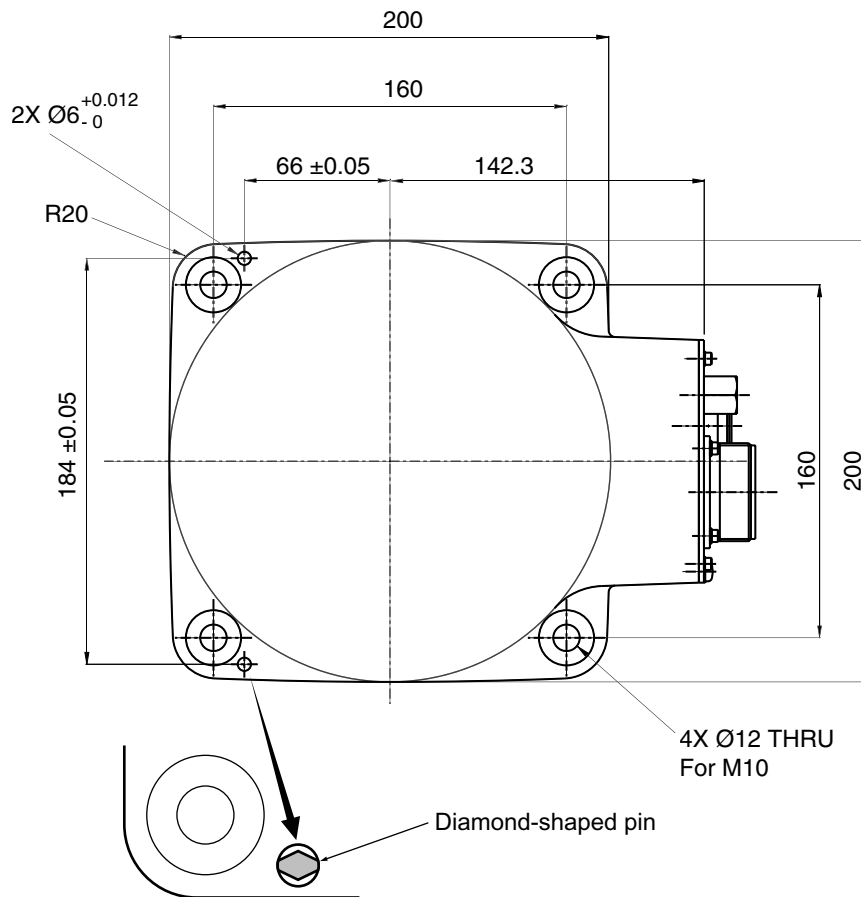
Figure 3-2. Mounting Hole Pattern for Robot

1. See **Figure 3-2** for the dimensions of the mounting holes in the robot mounting position where the robot unit is to be secured.

   - Drill four bolt holes (M10), 20 mm deep or more

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

   - Drill a dowel pin hole Ø6, H7 for internally threaded positioning pin, 10-mm deep or more

2. Locate two alignment pins, one round and one diamond-shaped, supplied in the accessory kit.

3. Drive the diamond-shaped pin into the Ø4, H7 hole so that it orients as shown in **Figure 3-2**.

4. Drive the internally threaded alignment pin into the Ø6, H7 hole.

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

5. Set the robot unit into place on the robot mount. When transporting the robot unit, follow the instructions given in **Section 3.3 on page 27**.

6. Secure the robot unit to the mount with four bolts and plain washers.

   • Bolt: M10 x 30 mm (strength class: 12.9)

   • Tightening torque: 70 +/- 14 Nm

3.5   Grounding the Robot

Ground the grounding terminal of the robot unit with a wire of 12 AWG or more. Ground resistance must be less than 100 milliohms.

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

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

Grounding terminal (M5)

12 AWG or more
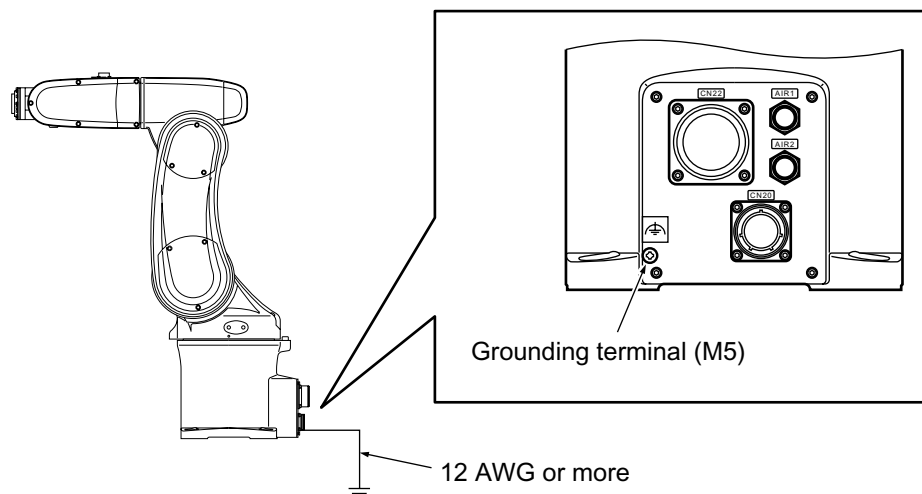
Figure 3-3. Ground Point on Robot

3.6   Description of Connectors on Robot Interface Panel

CN22 Power/Signal Cable - to PA-4

Grounding terminal (M5)
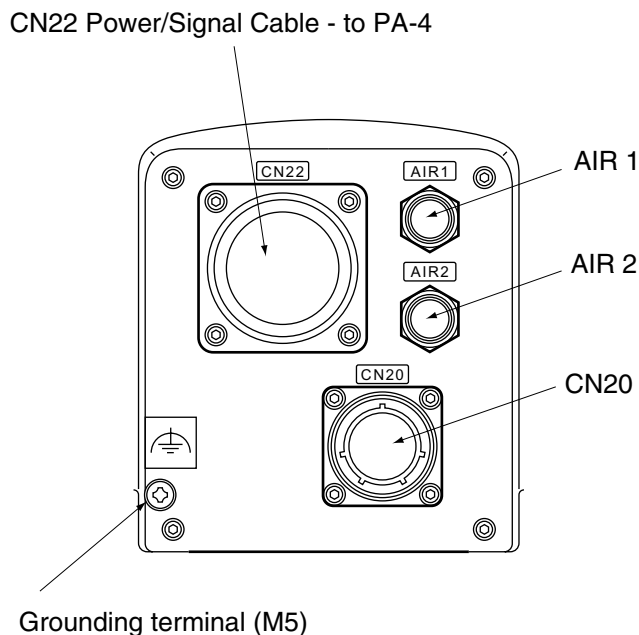
Figure 3-4. Robot Interface Panel

CN22 - the Arm Power/Signal cable from the PA-4 is installed at this connector.

CN20 - Pins 1 to 10 are wired directly to corresponding pins 1 to 10 on CN21 on the upper arm. Pins 12 to 18 are for solenoid control. See **Section 3.7 on page 33**.

AIR 1 - air piping connector (PT1/4) for three solenoids in robot. See **Section 3.7 on page 33**.

AIR 2 - air piping connector (PT1/4), connects directly to AIR 2 on the second (upper) arm.

Grounding Terminal - ground point on robot, see **Section 3.5 on page 31**.

3.7   Air Lines and Signal Wiring

The robot is equipped with 7 air pipes, or lines. Six lines, from AIR1 input, are controlled by the 3 internal solenoid valves. One line, from AIR2 input, is connected directly to AIR2 on the second arm. There are 10 user electric lines. The air lines and signal wiring are shown below.
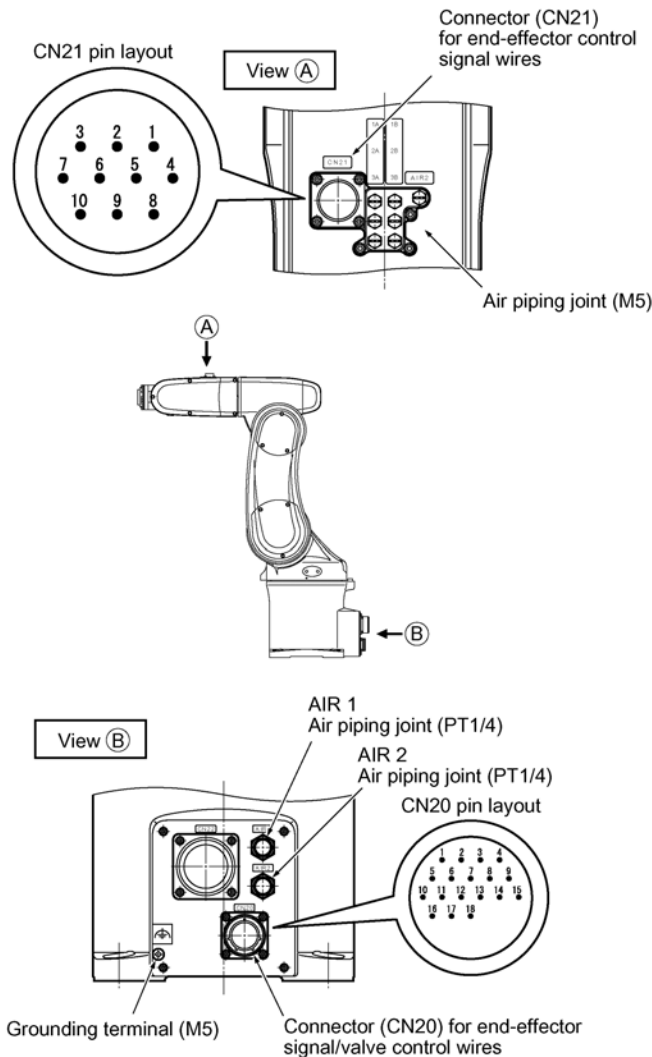
Valve Symbols and Air Intake/Exhaust States
(1A and 1B are piping joint symbols.)

Air piping joint			Valve signal		
	Air intake	Exhaust	Solenoid valve	Solenoid	
				A	B
AIR1	1A	1B	1	ON	OFF
	1B	1A	1	OFF	ON
	2A	2B	2	ON	OFF
	2B	2A	2	OFF	ON
	3A	3B	3	ON	OFF
	3B	3A	3	OFF	ON
AIR2					

CN20 Pin Assignment
For controller I/O unit, NPN type (source IN, sink OUT)

CN20 pin No.	Used for:
12	+24V
13	Solenoid 1A (solenoid valve 1)
14	Solenoid 1B (solenoid valve 1)
15	Solenoid 2A (solenoid valve 2)
16	Solenoid 2B (solenoid valve 2)
17	Solenoid 3A (solenoid valve 3)
18	Solenoid 3B (solenoid valve 3)

For controller I/O unit, PNP type (sink IN, source OUT)

| CN20 pin No.	Used for:
12	0V
13	Solenoid 1A (solenoid valve 1)
14	Solenoid 1B (solenoid valve 1)
15	Solenoid 2A (solenoid valve 2)
16	Solenoid 2B (solenoid valve 2)
17	Solenoid 3A (solenoid valve 3)
18	Solenoid 3B (solenoid valve 3)

Note 1: Pins #1 to #10 on CN21 and those on CN20 are connected with each other. The allowable current per line is 1 A.
Note 2: Use the attached connector sets for CN20 and CN21.

Connector set part No.	Connector #	Model and part name	Appearance
05019-000	For CN20	SRCN6A25-24S (round type connector) Japan Aviation Electronics Industry Ltd.	
	For CN21	JMLP1610M (L type plug connector) DDK Electronics, Inc.	

Table 3-2. Solenoid Valve Specifications

	Item	Specifications
Valve	Switching system	2-position double
	Applicable fluid	Air
	Operating system	Pilot type
	Effective cross section (Cv value)	1.2 mm^2
	Lubrication	Oilless
	Operating pressure range	0.1 to 0.7 Mpa
	Response time	15 ms or less (at 0.5 Mpa)
	Maximum operating frequency	10 Hz
	Ambient temperature	-5 to 50°C (No dew condensation allowed. When dry air is used)
Solenoid	Operating voltage	24 V ±10%
	Power consumption (current)	0.5 W (21 mA)
	Surge voltage protection circuit	Zener diode
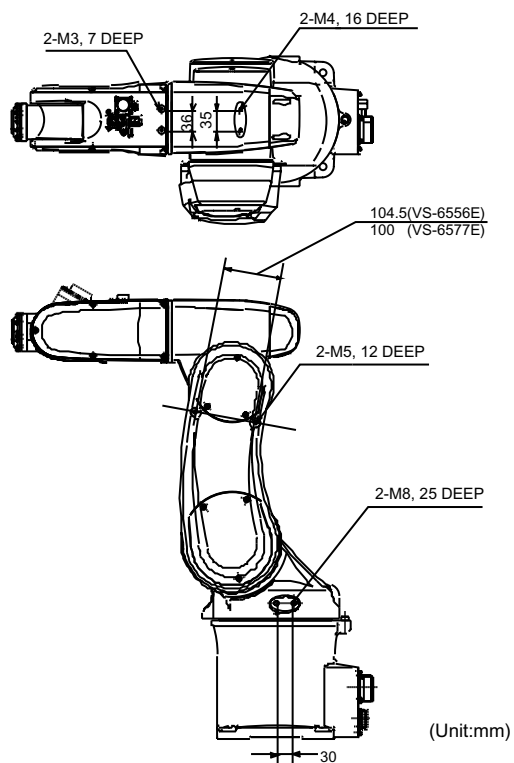
Figure 3-5. External Mounting Holes on Robot

3.8   Designing End-Effectors

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

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

Mass of End-Effector

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

Maximum total mass of end-effector (including workpiece) must be less than or equal to maximum payload capacity (5 kg).

Center of Gravity Position of End-Effector

Design an end-effector so that the center of gravity position of the end-effector (including workpiece) is within the range shown in **Figure 3-6**.

Figure 3-6. Allowable Range of Center of Gravity Position of End-effector

Moment of Inertia Around J4, J5 and J6

Design an end-effector so that its moments of inertia around J4, J5, and J6 (including workpiece) do not exceed the maximum allowable moment of inertia of the robot.
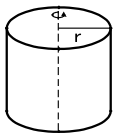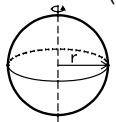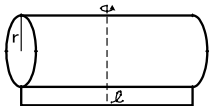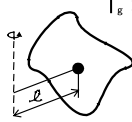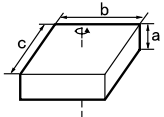
Moment of inertia around J4, J5, and J6 of end-effector (including mass of workpiece) must be less than or equal to the maximum allowable moment of inertia

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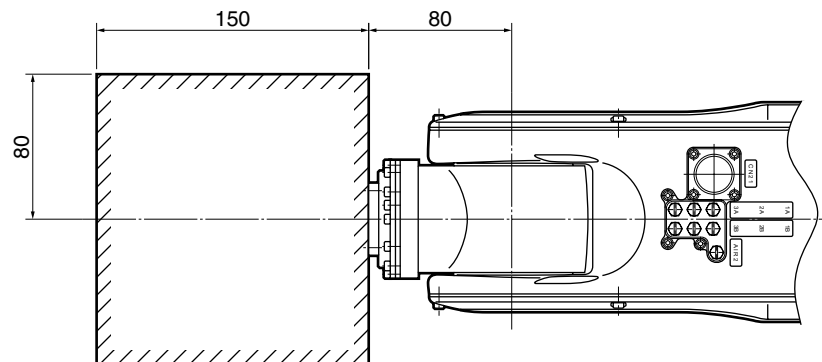
Maximum allowable moment of inertia around J6: 0.045 kgm^2

When calculating the moment of inertia around J4, J5, and J6 of the end-effector, use the formulas given in **Table 3-3**, and see examples in **Figure 3-7 on page 37**.

Table 3-3. Moment of Inertia Formulas

1. Cylinder (1)	4. Sphere

(Axis of rotation = Center axis)
  $$I = \frac{mr^2}{2}$$
	(Axis of rotation = Center axis)
	  $$I = \frac{2mr^2}{5}$$

2. Cylinder (2) (The axis of rotation passes through the center of gravity.) $$I = \frac{m}{4}\left(r^2 + \frac{\ell^2}{3}\right)$$	5. Center of gravity not on the axis of rotation I_g: Inertia moment around center of gravity $[\text{kgm}^2]$ $$I = I_g + m\ell^2$$
3. Rectangular parallelepiped (The axis of rotation passes through the center of gravity.) $$I = \frac{m}{12}(b^2 + c^2)$$	I: Moment of inertia (kgm^2) m: Mass (kg) r: Radius (m) b, c, ℓ: Length (m)

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

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

(1) Moment of inertia around J6

Unit: mm

Moment of inertia around J6 of ①: I_1 (from 3 and 5 in Table 2-3)

$$I_1 = \frac{0.14}{12}\,(0.12^2 + 0.015^2) + 0.14 \times 0.01^2$$
$$= 1.85 \times 10^{-4}\ [\mathrm{kgm^2}]$$

Moment of inertia around J6 of ②: I_2 (from 1 and 5 in Table 2-3)

$$I_2 = \frac{0.1 \times 0.01^2}{2} + 0.1 \times 0.04^2$$
$$= 1.65 \times 10^{-4}\ [\mathrm{kgm^2}]$$

Moment of inertia around J6 of ③: I_3 (from 1 and 5 in Table 2-3)

$$I_3 = \frac{1.0 \times 0.02^2}{2} + 1.0 \times 0.05^2$$
$$= 2.7 \times 10^{-3}\ [\mathrm{kgm^2}]$$

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

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

(2) Moment of inertia around J4 and J5

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

Moment of inertia around J4 and J5 of ①: I_1 (from 3 and 5 in Table 2-3)

$$I_1 = \frac{0.14}{12}\,(0.015^2 + 0.01^2) + 0.14 \times ((0.08 + 0.005)^2 + 0.01)$$
$$= 1.03 \times 10^{-3}\ [\mathrm{kgm^2}]$$

Moment of inertia around J4 and J5 of ②: I_2 (from 2 and 5 in Table 2-3)

$$I_2 = \frac{0.1}{4}\left(0.01^2 + \frac{0.04^2}{3}\right) + 0.1 \times ((0.08 + 0.01 + 0.02)^2 + 0.04^2)$$
$$= 1.39 \times 10^{-3}\ [\mathrm{kgm^2}]$$

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

$$I_3 = \frac{1.0}{4}\left(0.02^2 + \frac{0.1^2}{3}\right) + 1.0 \times ((0.08 + 0.01 + 0.05)^2 + 0.05^2)$$
$$= 2.30 \times 10^{-3}\ [\mathrm{kgm^2}]$$

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

$$I_{J4} = I_{J5} = I_1 + I_2 + I_3 = 2.54 \times 10^{-2}\ [\mathrm{kgm^2}]$$

Figure 3-7. Moment of Inertia Calculation Examples

System Installation 4

4.1 System Cable Diagram

IEEE 1394 Cable

J Amp #1
J Amp #2
J Amp #3
sDAI Module

User-Supplied Ground Wire
Between PA-4 and SmartController

Adept
SmartController CX

XSYS cable

External Brake
Connector

Terminator
Installed

User-Supplied Ground Wire

Controller (XFP) to
Front Panel (XFP)

24VDC Power from
User-Supplied
Power Supply to
Controller (XDC1)

Adept PA-4
Power Chassis

Arm Power/
Signal Cable

Ethernet to PC

STOP

Front Panel

User-Supplied
Power Supply

T1 Pendant
(optional)

AdeptViper s650
Robot

Desktop or Laptop PC
(user-supplied)

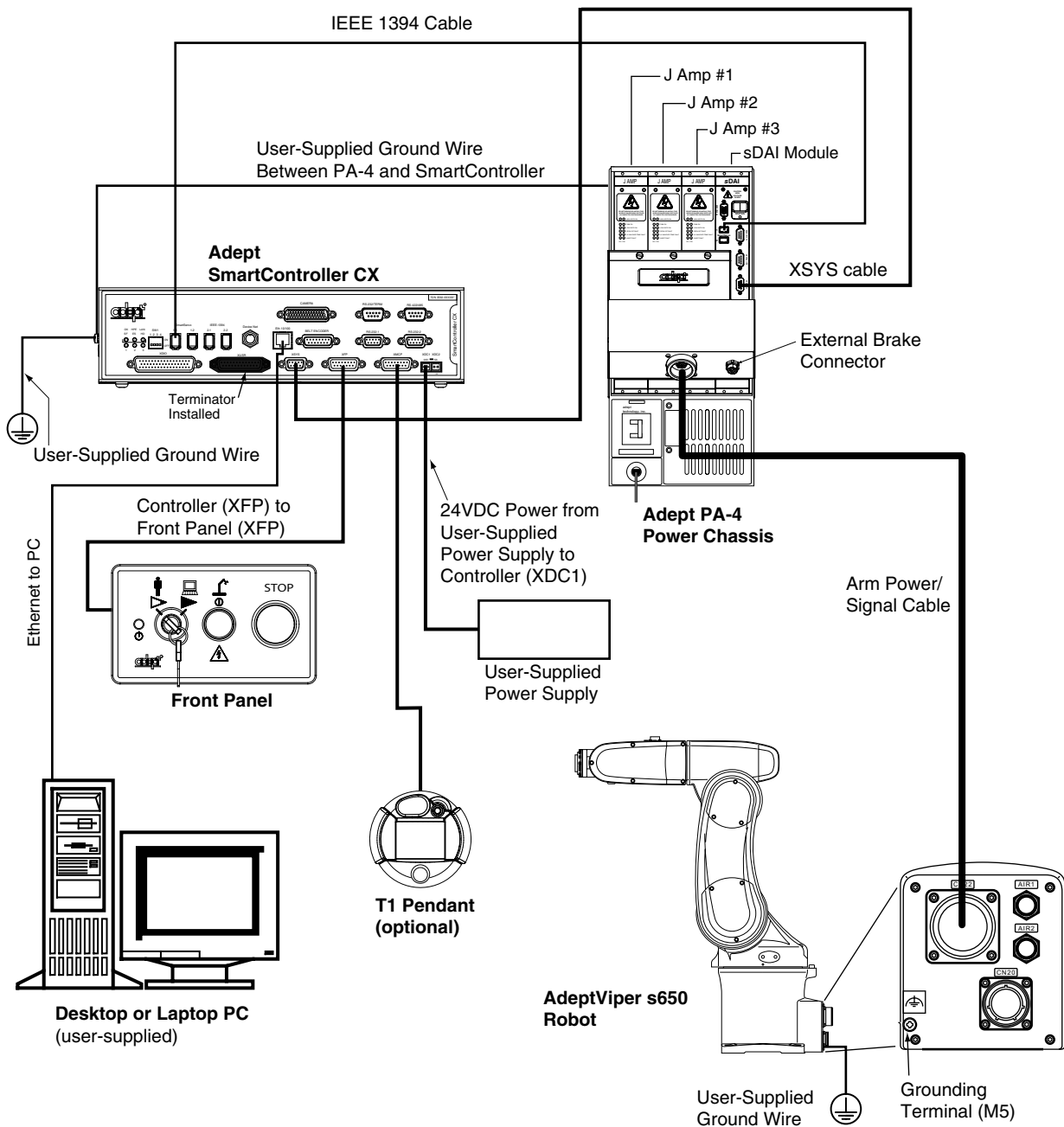User-Supplied
Ground Wire

Grounding
Terminal (M5)

Figure 4-1. System Cable Diagram for AdeptViper s650 Robot

4.2   Installing the SmartController

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 optional pendant to the SmartController, if included.

4. Connect user-supplied 24 VDC power to the controller.

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

6. Install the AdeptWindows PC software on the user-supplied PC. Refer to the *AdeptWindows Installation Guide*. This includes connecting the supplied Ethernet crossover cable between the user-supplied PC and the Ethernet port on the SmartContoller.

4.3   Installing the PA-4 Power Chassis

Refer to the *Adept PA-4 Power Chassis User's Guide* for complete information on the PA-4 chassis. This list summarizes the main steps.

1. Mount the PA-4 chassis.

   NOTE: For the PA-4 in an AdeptViper system, only the panel-mounting option is available.

2. Locate these cables, typically shipped in the cable/accessories box.

   - IEEE 1394 cable (length 4.5M)

   - XSYS cable (length 4.5M)

   - Arm Power/Signal cable (length 4 M)

3. Install one end of the IEEE 1394 cable into the SmartServo port 1.1 connector on the SmartController, and install the other end into the SmartServo port 1 connector on the sDAI module in the PA-4. See **Figure 4-1 on page 39** and **Figure 4-2 on page 41**.

4. Install the XSYS cable between the XSYS connector on the SmartController, and the XSLV connector on the sDAI module, and tighten the latching screws.

5. Install the Arm Power/Signal cable between the CN22 connector on the robot and the Arm Power/Signal connector on the PA-4.

6. Install a ground wire between the PA-4 and the SmartController.
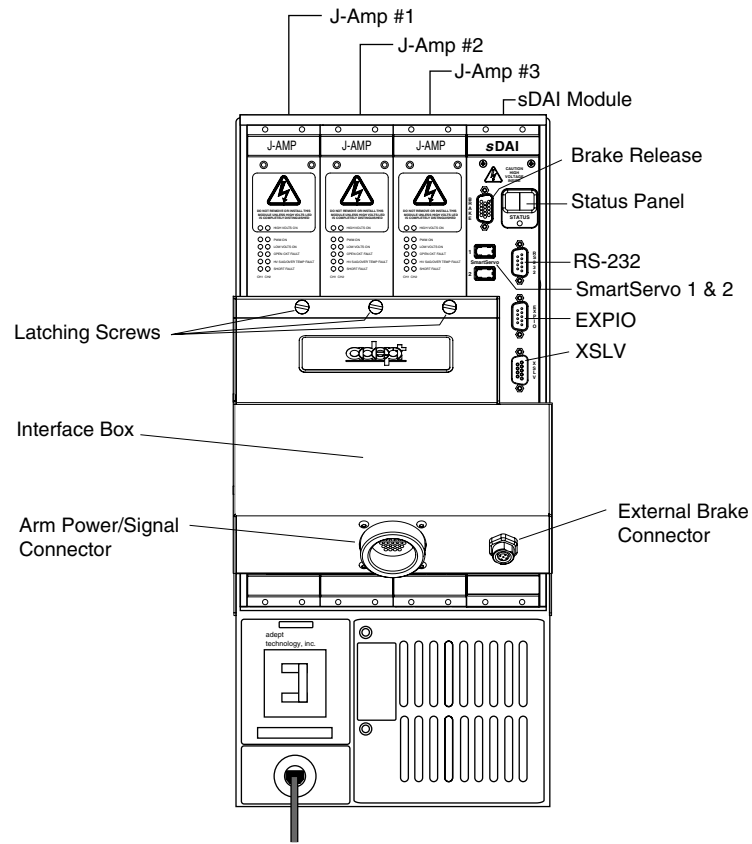
Figure 4-2. Adept PA-4 Power Chassis with sDAI Module

4.4   Connecting 3-Phase AC Power to PA-4

PA-4 3-Phase Power Requirements

Table 4-1. Adept PA-4 Power Chassis 3-Phase Power Requirements

Nominal Voltage Range	Frequency/ Phasing	Minimum Operating Voltage	Maximum Operating Voltage	Recommended External Circuit Breaker (user-supplied)
200 to 240 VAC	50-60Hz, 3-phase	180 VAC	245 VAC	20 amps
380 to 415 VAC	50-60Hz, 3-phase with neutral	342 VAC	424 VAC	20 amps

Table 4-2. Typical Robot Power Consumption[a]

Robot	Move	Average Power (W)	Peak Power (W)[b]
AdeptViper s650	No load - Adept cycle[c]	371	947
	5.0 kg - Adept cycle[c]	477	1526
	5.0 kg - all joints move	834	2088

[a] Typical power data is with 220VAC, 60Hz, 3-phase nominal input.

[b] For short durations (100 ms)

[c] Adept cycle: the robot tool performs continuous path, straight-line motions 25 mm up, 305 mm over, 25 mm down, and back along the same path. COARSE is enabled and BREAKs are used at each end location. Not achievable over all paths.

The Adept PA-4 power chassis can be shipped from the factory configured for either 3-phase 200-240 VAC or 380-415 VAC operation, depending on your sales order. For 1-phase AC, see **Section 4.5 on page 45**.

A voltage setting label is located on the front of the chassis below the circuit breaker. The voltage setting is also shown on the ID label on the side of the chassis. Verify that the setting matches your facility power before installation.

If you need to change the AC voltage setting from 200-240 VAC to 380-415 VAC, or vice versa, see the *Adept PA-4 Power Chassis User's Guide*.

WARNING: Verify the voltage settings are correct before turning on power. Operating the Adept PA-4 power chassis with incorrect voltage settings can cause damage or injury.

Connecting the PA-4 3-Phase AC Power Cord to AC Supply

The user end of the cord is unterminated. Connect each conductor of the power cord securely to your AC power source, using the color code shown in **Table 4-3**. The installation must meet all applicable European, international, and national standards and regulations.

Table 4-3. 3-Phase AC Power Cord Specifications for PA-4

Cord length	3 meters ±0.1 m (9 ft 10 in ±4 in)
Cord rating	25 amps
Number and size of conductor size	5 x 2.5 mm^2
Color code: 200 - 240 VAC	
line 1	black
line 2	black (or gray)[a]
line 3	brown
no connection	**blue** (must be insulated)
ground	green/yellow
Color code: 380 - 415 VAC	
line 1	black
line 2	black (or gray)[a]
line 3	brown
neutral	blue
ground	green/yellow

[a] Note: The two black wires can also be one black and one gray wire, but the functionality is the same for either case.

DANGER: Electrical hazard!
The installation of the power cord must be done by a skilled person. The power supply can injure or kill the person who installs the cord. An incorrect installation can injure or kill anyone that touches the equipment in the robot workcell.

The protective ground conductor (colored green/yellow) of the Adept PA-4 power chassis is internally connected to the accessible metal parts of the power chassis. To ensure electrical-shock protection, the ground conductor must be connected to a properly grounded power source.

WARNING: Ensure that a proper protective ground connection exists before turning on the power.
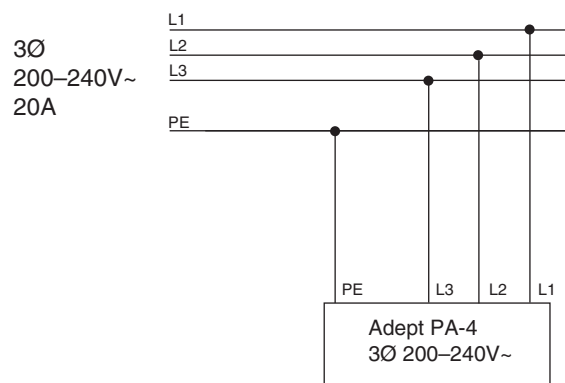
Typical 3-Phase AC Power Installation Diagrams

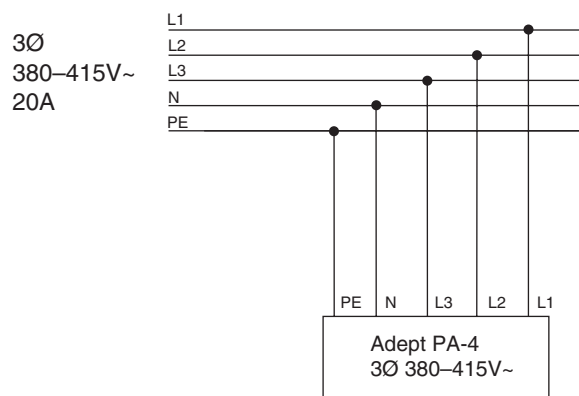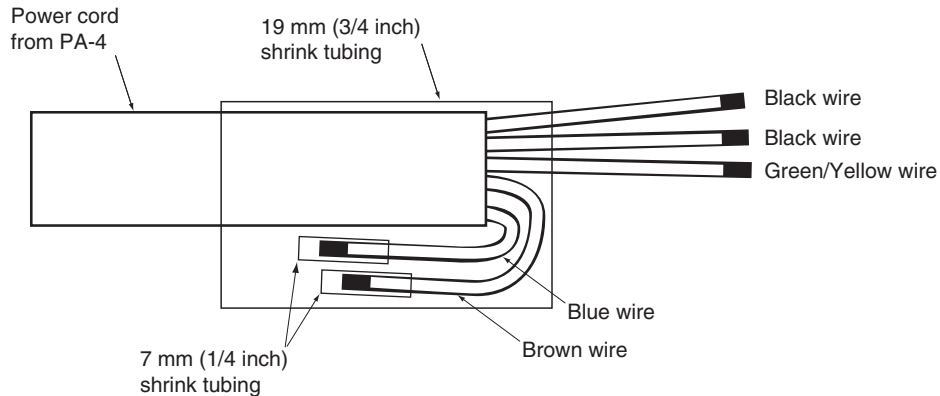**Figure 4-3. Typical 3-Phase 200-240 VAC Connection for PA-4 System**

Figure 4-4. Typical 3-Phase 380-415 VAC Connection for PA-4 System

4.5   Connecting 1-Phase AC Power to PA-4

PA-4 1-Phase AC Power Requirements

The PA-4 can be shipped from the factory configured for 200-240 VAC single phase operation. A voltage setting label is located on the front of the chassis below the circuit breaker. The voltage setting is also shown on the ID label on the side of the chassis. Verify that the setting matches your facility power before installation.

> **NOTE:** For 3-Phase AC power wiring information, see **Section 4.4 on page 42**.

Table 4-4. Adept PA-4 Power Chassis 1-Phase Power Requirements

Nominal Voltage Range	Frequency/ Phasing	Minimum Operating Voltage	Maximum Operating Voltage	Recommended External Circuit Breaker (user-supplied)
200 to 240 VAC	50-60Hz, 1-phase	180 VAC	245 VAC	20 amps

Connecting the PA-4 1-Phase AC Power Cord to AC Supply

The user end of the cord is unterminated. Connect each conductor of the power cord securely to your AC power source, using the color code shown in **Table 4-5**. See **Figure 4-6 on page 47** for a typical power installation diagram. The installation must meet all applicable European, international, and national standards and regulations.

Table 4-5. 1-Phase AC Power Cord Specifications for PA-4

Cord length	3 meters ±0.1 m (9 ft. 10 in. ±4 in.)
Cord rating	25 amps
Number and size of conductor size	3 x 2.5 mm^2

Color code: 200 - 240 VAC
 	
    line 1
    line 2
    ground
	
	black
	black[a]
	green/yellow

[a] Note: The two black wires can also be one black and one gray wire, but the functionality is the same for either case.

DANGER: The installation of the power cord must be done by a skilled person. The power supply can injure or kill the person who installs the cord. An incorrect installation can injure or kill anyone that touches the equipment in the robot workcell.

The protective ground conductor (colored green/yellow) of the chassis is internally connected to the accessible metal parts of the power chassis. To ensure electrical-shock protection, this must be connected to a properly grounded power source.

DANGER: Ensure that a proper protective ground connection exists before turning on the power.

Figure 4-5. 1-Phase AC Cable Wiring

Typical Single Phase, 220 VAC Power Installation Diagrams

Facility
Supply
1Ø
200–240V~
20A

L1
L2
PE

PE   L2   L1

Adept PA-4
1Ø 200-240V~
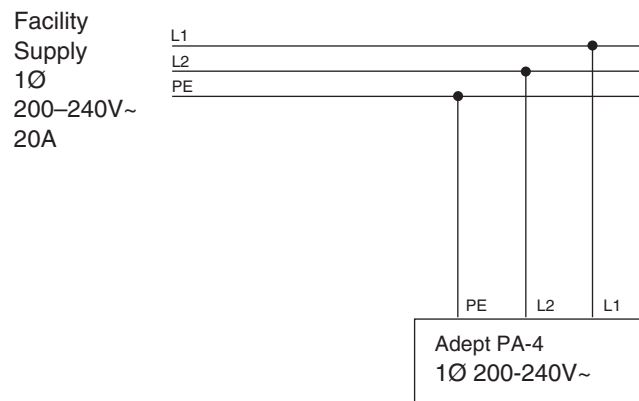
Figure 4-6. Typical 1-Phase 200-240 VAC Connection

5 System Operation

5.1 System Start-up Procedure

Verify that the robot is securely mounted, the system is correctly installed, and that all safety equipment is working before going through the system start-up process. Once the system installation has been verified, you are ready to start up the system.

1. Switch on AC power to the PA-4.

2. Switch on the 24VDC power to the controller.

3. Connect to the controller via AdeptWindows, and boot the system from the "D" default drive. Refer to the *AdeptWindows Installation Guide* for complete details on working with AdeptWindows.

4. Wait for the system to complete the boot cycle. Once completed the system will return with a "dot" prompt, and the following window should be displayed.


```
Monitor                                                        _ □ ×

Adept V+

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Adept External Encoder Module.
AdeptViper 650

Configured as Category 1 Robot System per ISO 10218 and EN954

Software:    16.2 7-3100  (Edit B5, 23-Feb-2005, Preliminary Release)
Controller:  2000-1852 A3 0
Security ID: 8437-7520-7D27
Processor 1: 0.52 7-5 32MB
Robot 1:     670-113 0-41-0 38
             AdeptViper 650
Servo:       16.0 (Edit A1)

20-May-2005 14:19:25

.
```

Figure 5-1. Typical Start-up Screen

5. Disengage any E-Stops.

6. Make sure the Front Panel is set to Auto mode.

7. Type enable power.

   ENA POW <enter>

   Press the High Power button on the Front Panel while it is blinking. The system will return to the dot prompt once high power is enabled.

8. Type calibrate.

   CAL <enter>

9. Once the calibration is complete, the system will return with a "dot" (.) prompt, and the status panel display on the sDAI module will read "OK."

10. System is ready for operation.

5.2 Learning to Program the Robot

To learn how to use and program the robot, go to the *V+ Operating System User's Guide* to find information on basic operation of the V$^+$ Operating System. Also refer to the *Instructions for Adept Utility Programs* for information on using the Adept utility programs.

For programming information you need to refer to the following list of optional manuals:

- *V+ Language User's Guide*
- *V+ Language Reference Guide*
- *V+ Operating System Reference Guide*

5.3   Connecting Digital I/O to the System

You can connect digital I/O to the system in several different ways. See **Table 5-1** and **Figure 5-2**.

Table 5-1. Digital I/O Connection Options

Product	I/O Capacity	For more details
XDIO Connector on SmartController	12 inputs 8 outputs	see *Adept SmartController User's Guide*
Optional IO Blox Device, connects to sDAI in PA-4	8 inputs, 8 outputs per device; up to four IO Blox devices per robot	see *Adept IO Blox User's Guide*
Optional sDIO Module, connects to controller	32 inputs, 32 outputs per module; up to four sDIO per system	see *Adept SmartController User's Guide*

AdeptViper s650/s850 Robot

CN20 Connector
For input signals to control internal robot solenoids and general user I/O. Signals can come from IO Blox device or XDIO on SmartController.

IO Blox #1
8 Input signals: 1113 to 1120
8 Output signals: 0105 to 0112

Adept PA-4

To EXPIO on sDAI

Optional IO Blox Device

sDIO #1
32 Input signals: 1033 to 1064
32 Output signals: 0033 to 0064

Optional sDIO #1

SmartController

XDIO Connector
12 Input signals: 1001 to 1012
8 Output signals: 0001 to 0008

Figure 5-2. Connecting Digital I/O to the System

Table 5-2. Default Digital I/O Signal Configuration, Single Robot System
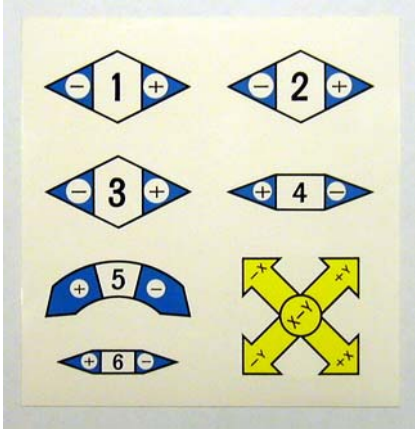
Location	Type	Signal Range
Controller XDIO connector	Inputs	1001 - 1012
	Outputs	0001 - 0008
sDIO Module 1	Inputs	1033 - 1064
	Outputs	0033 - 0064
sDIO Module 2	Inputs	1065 - 1096
	Outputs	0065 - 0096
sDIO Module 3 (recommended [a])	Inputs	1201 - 1232
	Outputs	0201 - 0232
sDIO Module 4 (recommended [a])	Inputs	1233 - 1264
	Outputs	0233 - 0264
IO Blox 1	Inputs	1113 - 1120
	Outputs	0105 - 0112
IO Blox 2	Inputs	1121 - 1128
	Outputs	0113 - 0120
IO Blox 3	Inputs	1129 - 1136
	Outputs	0121 - 0128
IO Blox 4	Inputs	1137 - 1144
	Outputs	0129 - 0136

[a] For sDIO modules 3 and 4, you must configure the signals using CONFIG_C, to have the system support those modules. See the *Adept SmartController User's Guide* for additional information on that process.

5.4   Installing Axis Labels

The system includes a set of axis directional labels that can be installed on the robot. See **Table 5-3**. Also refer to **Figure 1-1 on page 9** for a drawing of the axis identification. The yellow X-Y label can be used to indicate the X and Y axes in the World coordinate system in your workcell.

Table 5-3. Axis Directional Labels

5.5   Caution Label on Robot

The Caution label shown in **Figure 5-3** refers to rotation of Joint 4. When power is turned off, **do not** manually rotate Joint 4 more than the Joint Limits of ±190°. If Joint 4 is rotated beyond these limits, the internal wiring can be damaged.

Figure 5-3. Caution Label on Joint 4 Rotation

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

5.6   Status Panel Codes on sDAI Module

The status panel display on the sDAI module in the PA-4 displays alpha-numeric codes that indicate the operating status of the robot, including detailed fault codes. See **Table 5-4** for definitions of the status codes. These codes provide details for quickly isolating problems during troubleshooting. See the *Adept PA-4 Power Chassis User's Guide* for additional information on the sDAI module.

Table 5-4. Status Panel Codes

LED	Status Code	LED	Status Code
OK	No Fault	H#	High Temp Encoder (Joint #)
ON	High Power ON Status	hV	High Voltage Bus Fault
MA	Manual Mode	I#	Initialization Stage (Step #)
24	24V Supply Fault	IO	24V I/O Fault
A#	Amp Fault (Joint #)	LV	Low Voltage (24V)
B#	IO Blox Fault (Address #)	M#	Motor Stalled (Joint #)
bF	Base Board Fault	NV	Non-Volatile Memory
AC	AC Power Fault	P#	Power System Fault (Code #)
D#	Duty Cycle Exceeded (Joint #)	PR	Processor Overloaded
E#	Encoder Fault (Joint #)	RC	RSC Fault
ES	E-Stop	S#	Safety System Fault (Code #)
FM	Firmware Mismatch	SW	Watchdog Timeout
FW	1394 Fault	V#	Hard Envelope Error (Joint #)
h#	High Temp Amp (Joint #)		

Maintenance 6

6.1 Installing and Using Brake Release Box

The manual brake release box can be used to release the brakes on a specific axis of the robot. This procedure describes how to install and use this device. See **Figure 6-1 on page 58**.

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

1. Make sure that high power is disabled (off).

2. Connect the 15-pin male D-sub connector into the 15-pin female D-sub connector marked Brake on the sDAI board.

3. Press one of the E-Stops (Pendant, Front Panel, or external).

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

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

5. Depress the brake release pushbutton, to release the brake.

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

   NOTE: When the Status LED (Green) is on, it indicates that the circuit is enabled, when the brake release pushbutton is pressed.
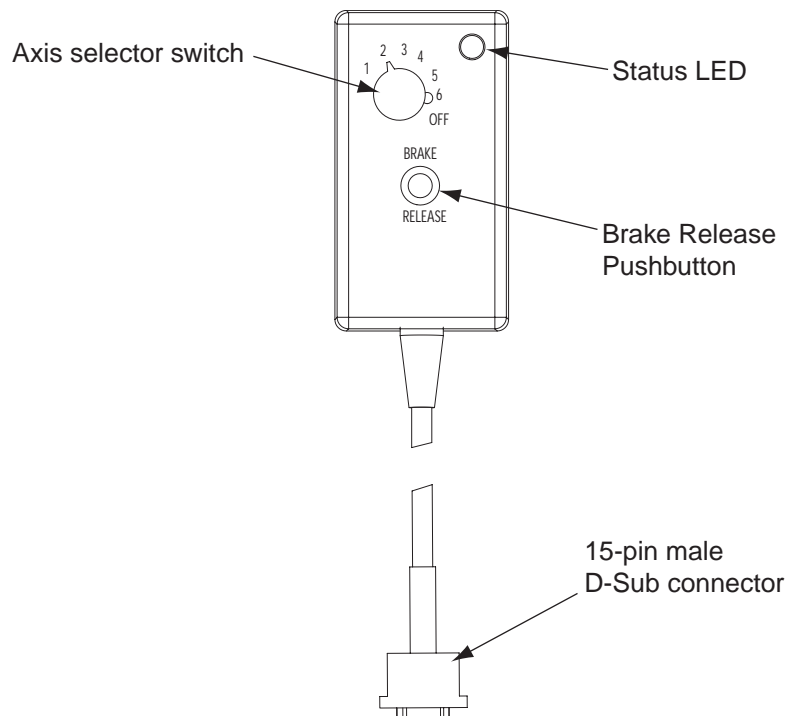
Figure 6-1. Manual Brake Release Box

6.2   Replacing Encoder Backup Battery

The encoder backup batteries should be replaced every two years. Replace the batteries according to the procedure below.

1. Prepare a new set of 3 backup batteries for replacement.

2. Turn off AC power to the PA-4 and DC power to the controller.

3. Remove the cover from the robot unit.
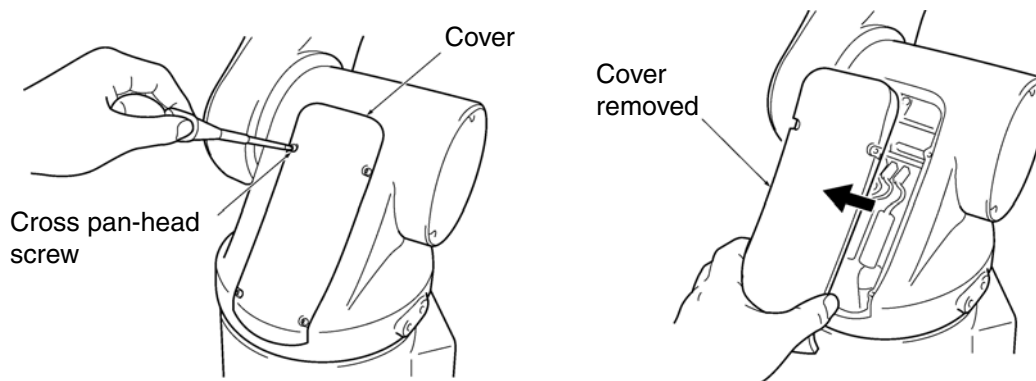
Figure 6-2.

4. Remove the dummy connector cap from the battery board.

Dummy connector cap
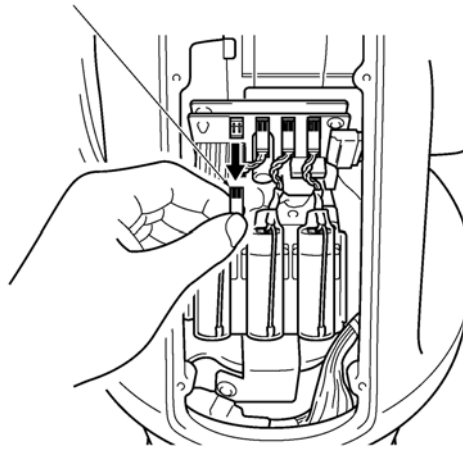
Figure 6-3.

5. Connect a new battery (1st one) to the pin from which you have disconnected the dummy connector cap in Step 4.

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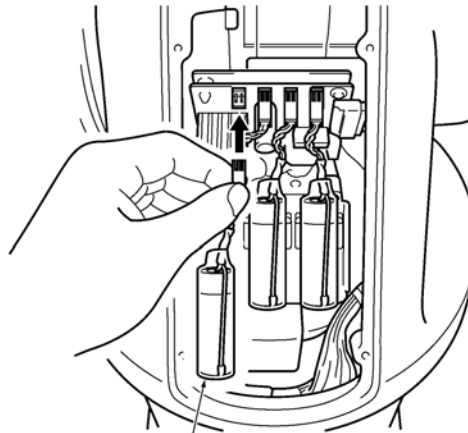
New backup battery

Figure 6-4.

6. Disconnect the old backup battery that is right next to the new battery connected in Step 5, and then connect a new battery (2nd one).

   NOTE: Be sure to replace all of three batteries with new ones at one time. Otherwise, the battery service life will be reduced.

Old backup battery   New backup battery
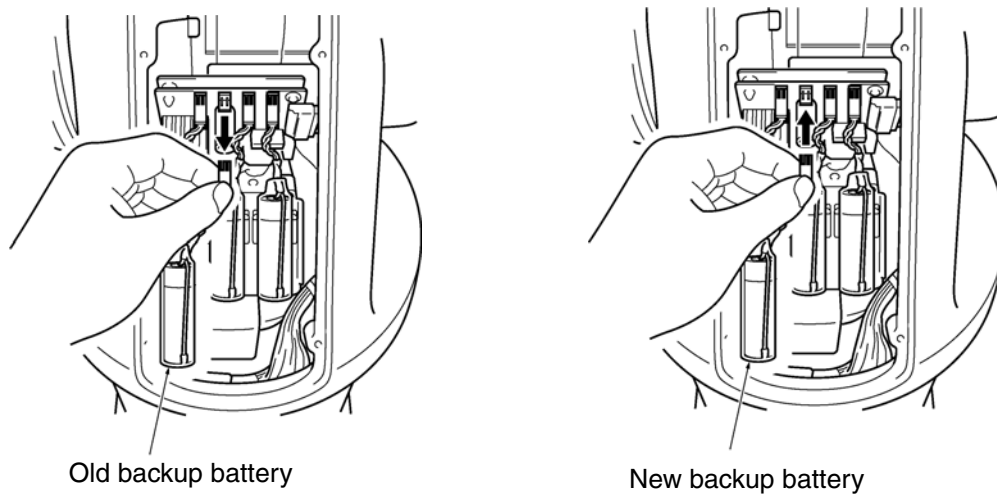
Figure 6-5.

7. Disconnect the old backup battery that is right next to the new battery connected in Step 6, and then connect a new battery (3rd one).

Old backup battery   New backup battery
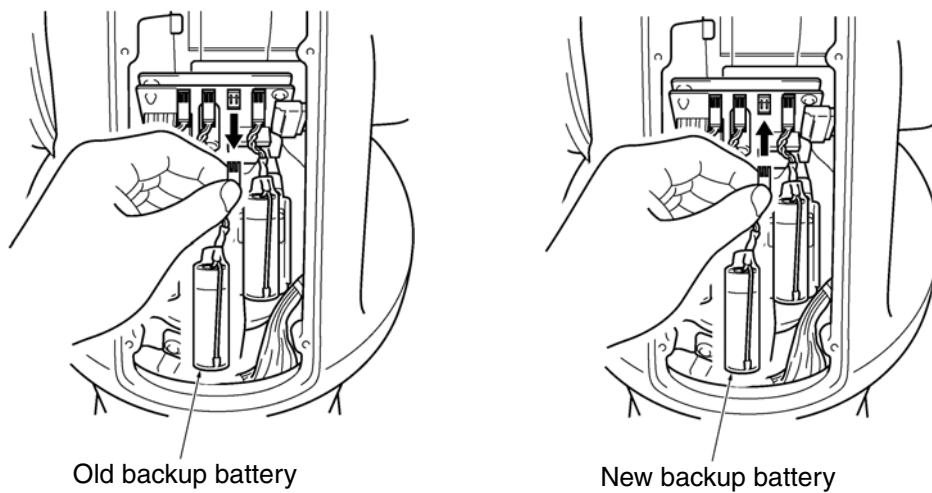
Figure 6-6.

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

Dummy connector cap

Old backup battery
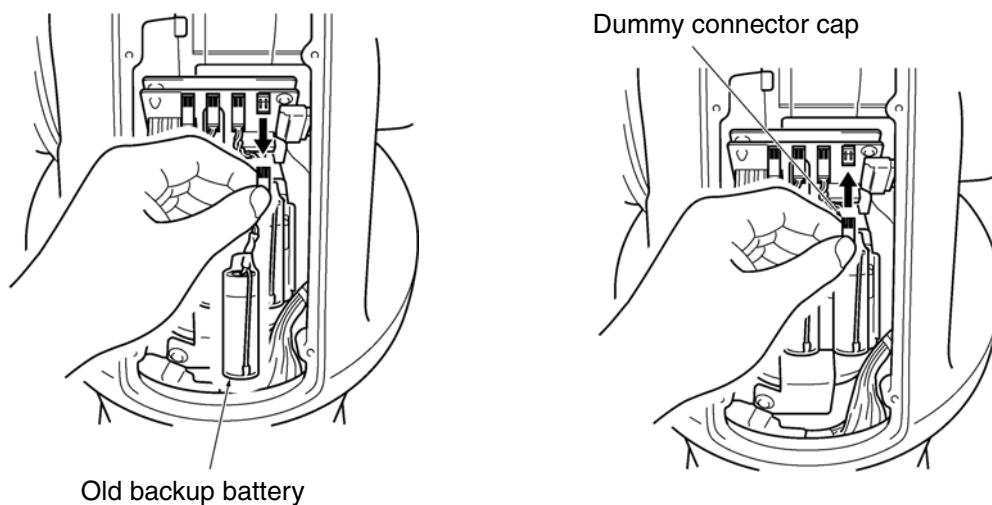
Figure 6-7.

9. Replace the cover on the robot.

    Tightening torque: Cross pan-head screw: 0.59 Nm

6.3   Installing User-Supplied Hardstops

For the purpose of limiting the robot working envelope, the hardstops, or mechanical ends, for Joints 1, 2, and 3 on the AdeptViper robots can be changed by installing user-supplied hardstop devices. In addition, the default softstops, or software limits, must be modified after the hardstops have been installed.

If you need information on modifying hardstops, please contact Adept Customer Service and request the document that describes this process.

CAUTION: Failures caused by user-supplied hardstops are not covered by the warranty, even if the robot is under warranty.

7 Technical Specifications

7.1 Robot Dimensions
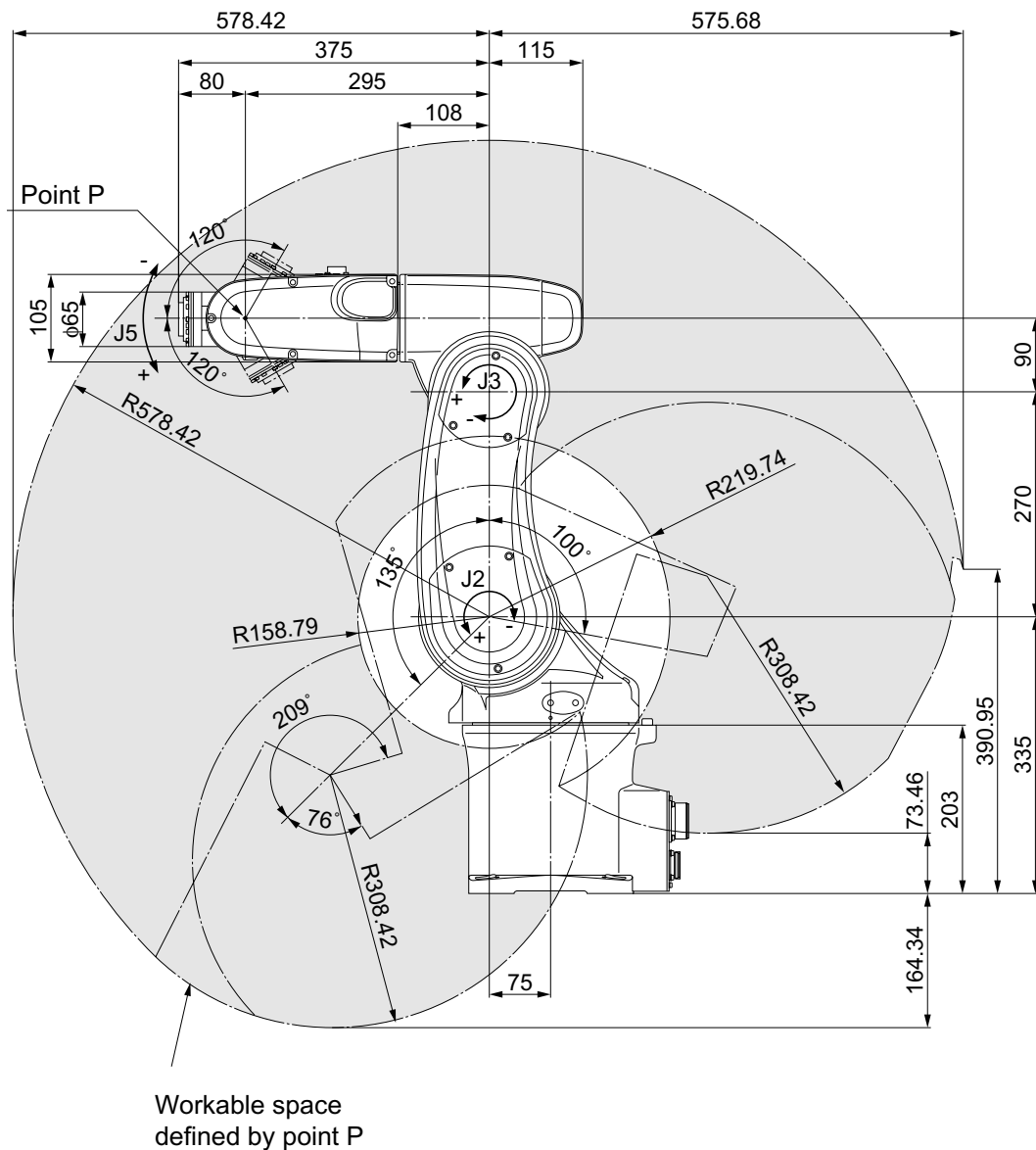
Figure 7-1. AdeptViper s650 Side Dimensions and Work Envelope

Workable space
defined by point P

170°

R233.79

187.7

Point P

J6
+
J4
+

67 59
79 51

J1

−
+

−
±360°
−
±190°

R653.42

170°
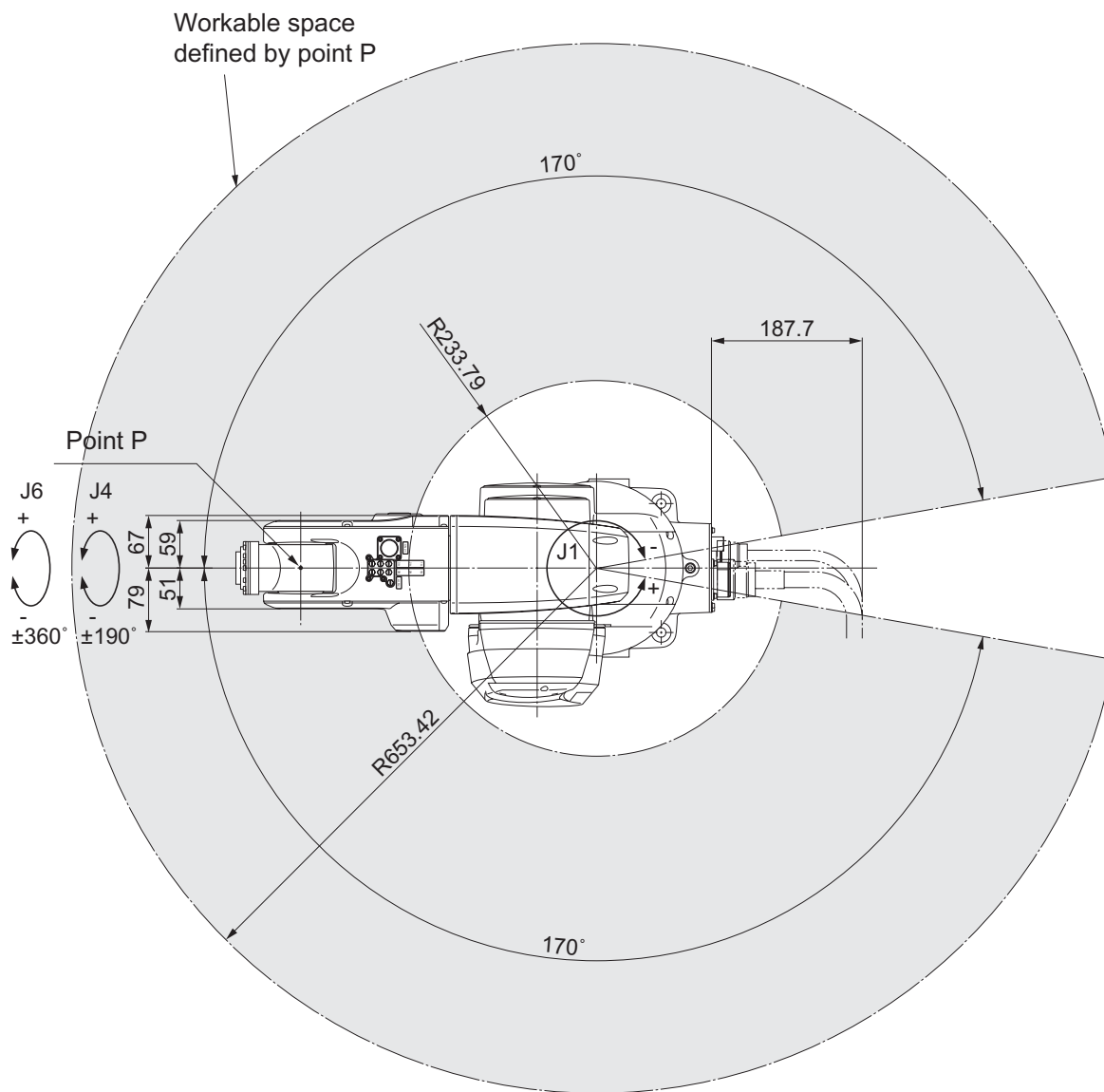
Figure 7-2. AdeptViper s650 Top Dimensions and Work Envelope
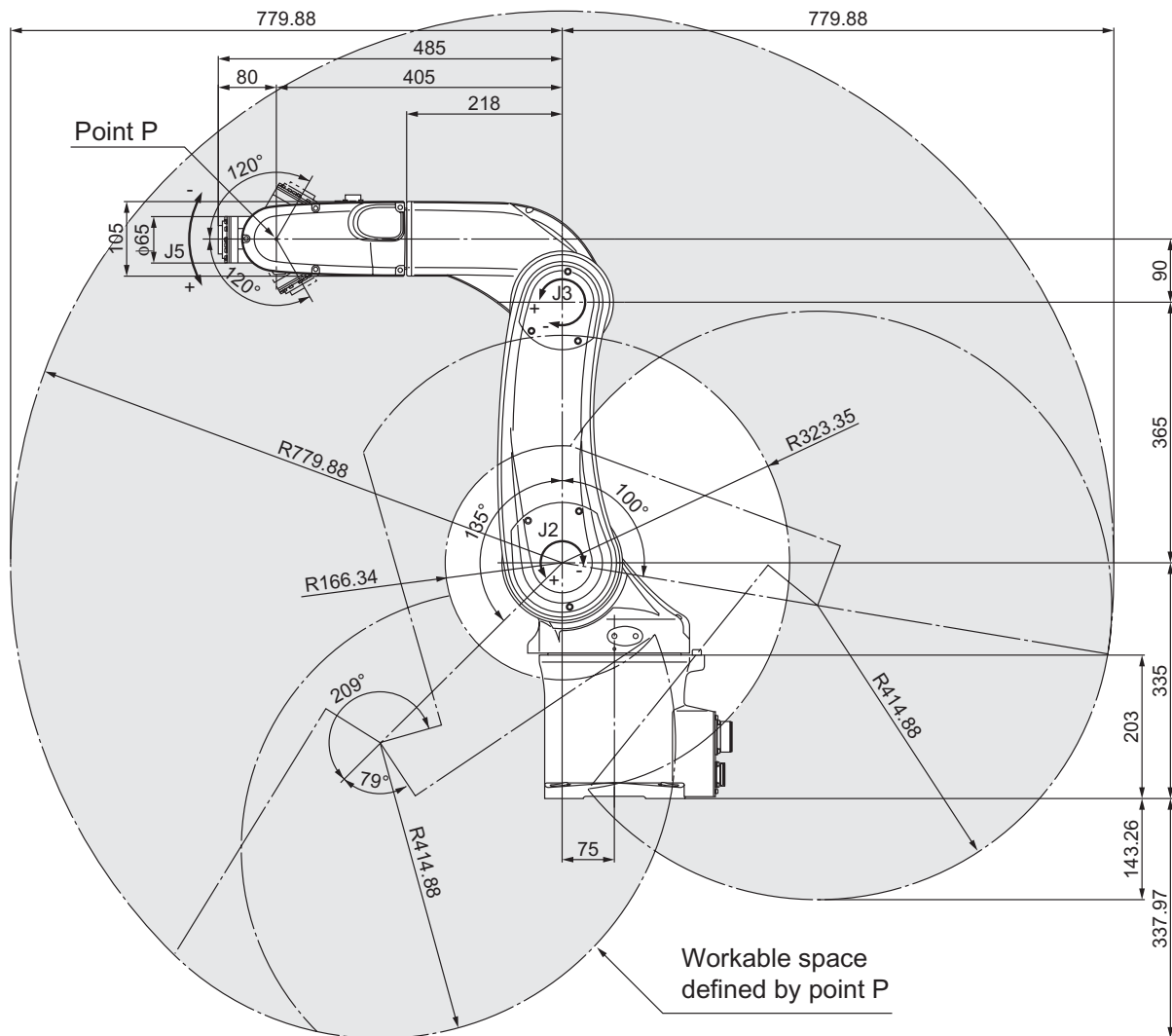
Figure 7-3. AdeptViper s850 Side Dimensions and Work Envelope

Workable space
defined by point P

170°

R241.34

187.7

Point P

J6   J4

+   +

67
59
51
79

J1

-     -

±360° ±190°

R854.88

170°
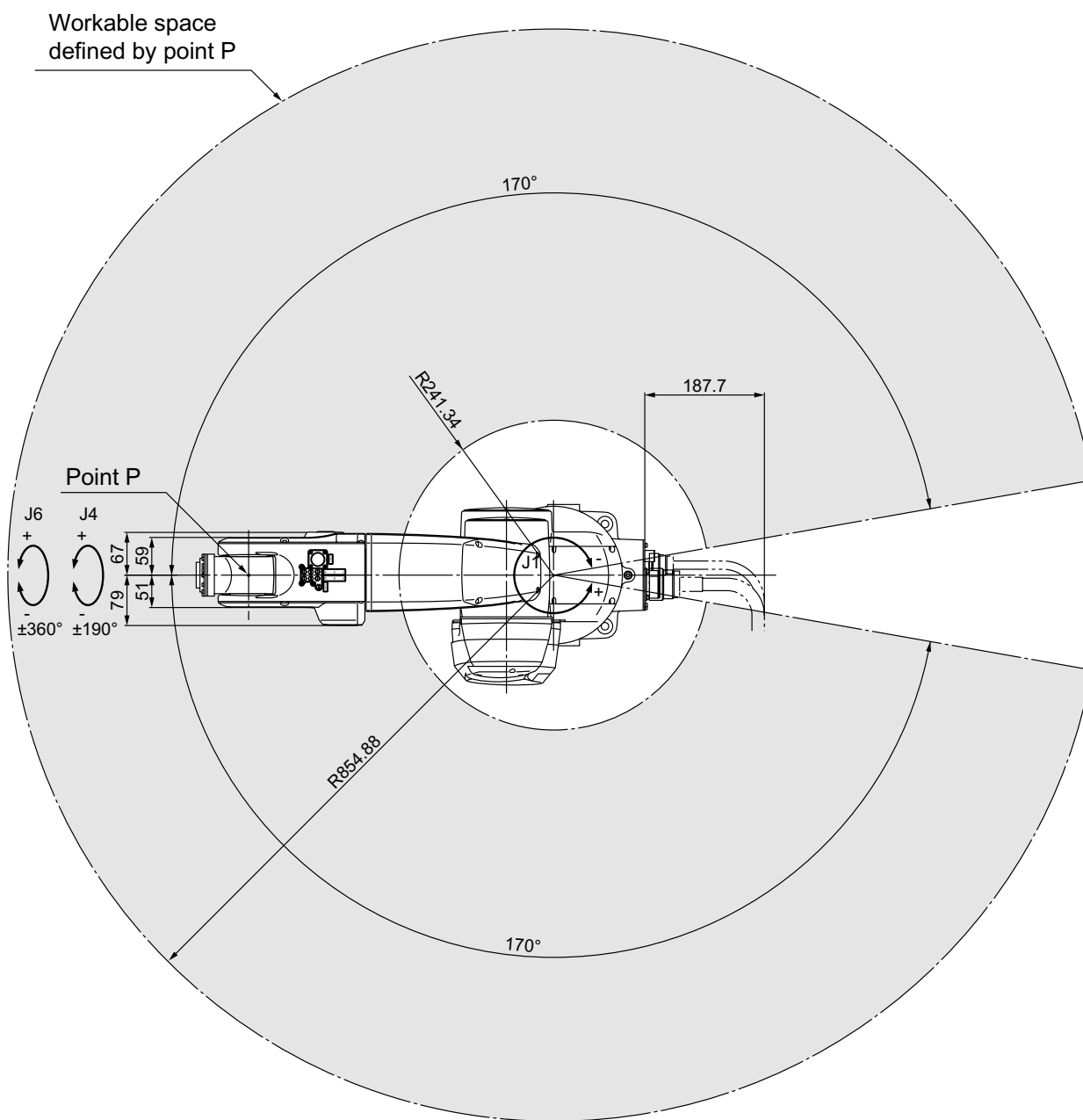
Figure 7-4. AdeptViper s850 Top Dimensions and Work Envelope

7.2   Robot Flange Dimensions

Ø40 h8 $-^{0}_{0.039}$

4X M5 x 0.08
8 Deep
(31.5 B.C.)

Ø5 H7 $^{+\,0.012}_{0}$
7 Deep

Ø20 H7 $^{+\,0.021}_{0}$
6 Deep
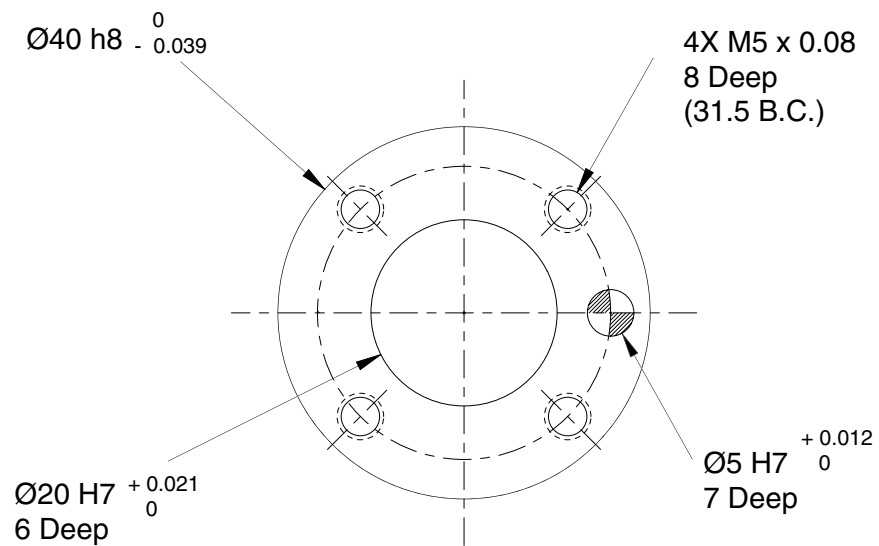
Figure 7-5. Robot Flange Dimensions

7.3   Specifications

Table 7-1. Robot Specifications

Specification	s650	s850
Overall arm length	270 (first arm) + 295 (second arm) = 565 mm	365 (first arm) + 405 (second arm) = 770 mm
Arm offset	J1 (swing): 75 mm, J3 (front arm): 90 mm	J1 (swing): 75 mm, J3 (front arm): 90 mm
Maximum motion area	R = 733 mm (end-effector mounting face) R = 653 mm (Point P: J4, J5, J6 center)	R = 934 mm (end-effector mounting face) R = 854 mm (Point P: J4, J5, J6 center)
Motion range	J1: ±170° J2: -190°, +45° J3: -29°, +256° J4: ±190° J5: ±120° J6: ±360°	J1: ±170° J2: -190°, +45° J3: -29°, +259° J4: ±190° J5: ±120° J6: ±360°
Maximum joint speed	J1: 328°/sec J2: 300°/sec J3: 375°/sec J4: 375°/sec J5: 375°/sec J6: 600°/sec	J1: 250°/sec J2: 250°/sec J3: 250°/sec J4: 375°/sec J5: 375°/sec J6: 600°/sec
Maximum composite speed (at the center of an end-effector mounting face)	8200 mm/s	7600 mm/s
Maximum payload	5 kg	5 kg
Position repeatability (Note 1)	In each of X, Y and Z directions: ±0.02 mm	In each of X, Y and Z directions: ±0.03 mm
Maximum allowable inertia moment	Around J4: 0.295 kgm^2 Around J5: 0.295 kgm^2 Around J6: 0.045 kgm^2	Around J4: 0.295 kgm^2 Around J5: 0.295 kgm^2 Around J6: 0.045 kgm^2
Position detection	Simplified absolute encoder	Simplified absolute encoder
Drive motor and brake	AC servomotors for all joints, Brakes for joints J2 to J6	AC servomotors for all joints, Brakes for joints J2 to J6
User air piping (Note 2)	7 systems (Ø4x6, Ø6x1), 3 solenoid valves (2-position, double solenoid) contained.	7 systems (Ø4x6, Ø6x1), 3 solenoid valves (2-position, double solenoid) contained.
User signal line	10 (for proximity sensor signals, etc.)	10 (for proximity sensor signals, etc.)
Air source - Operating pressure	1.0×10^5 Pa to 3.9×10^5 Pa	1.0×10^5 Pa to 3.9×10^5 Pa

Table 7-1. Robot Specifications (Continued)

Specification	s650	s850
Air source - Maximum allowable pressure	4.9×10^5 Pa	4.9×10^5 Pa
Degree of Protection	IP-40	IP-40
Weight	Approx. 28 kg	Approx. 29 kg
Note 1: Position repeatability is the value at constant ambient temperature. Note 2: Only the Ø4x6 air piping system may be controlled by built-in solenoid valves.		

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