

Adept Viper s650/s850 Robot User's Guide



adept®

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1.1 Product Description

Adept Viper s650/s850 Robots

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

NOTE: The descriptions and instructions in this manual apply to both the Adept Viper s650 and the Adept Viper 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.

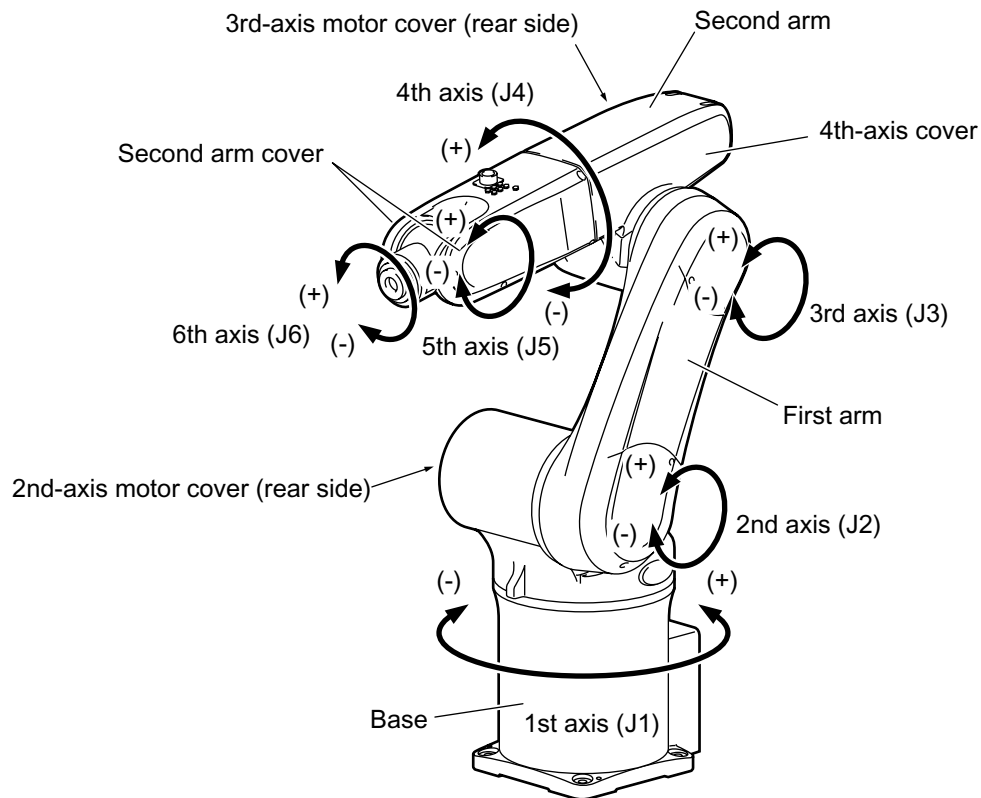


Figure 1-1. Robot Axis Identification

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 Python Modules, the Adept Viper 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.

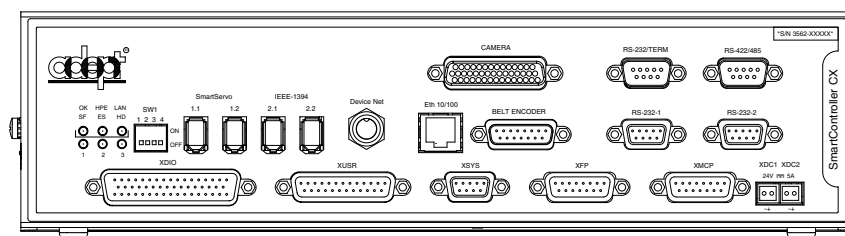


Figure 1-2. Adept SmartController CX

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 Adept Viper robot systems.

The J amplifiers in the Adept Viper 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 43](#).

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 32 .
2. Install the SmartController, Front Panel, and AdeptWindows software.	See Section 4.2 on page 44 .
3. Install the PA-4 power chassis.	See Section 4.3 on page 44 .
4. Install the Arm Power/Signal cable between the PA-4 and the robot.	See Section 4.3 on page 44 .
5. Install the IEEE 1394 and XSYS cables between the PA-4 and SmartController.	See Section 4.3 on page 44 .
6. Connect AC power to PA-4 power chassis.	See Section 4.4 on page 46 .
7. Start AdeptWindows, connect to the controller, and turn on power to the system.	See Section 5.1 on page 53 .

1.3 Manufacturer's Declaration

The Manufacturer's Declaration of Incorporation and Conformity for Adept Viper 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 Viper s650/s850 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
<i>Adept SmartController User's Guide</i>	Contains complete information on the installation and operation of the Adept SmartController and the optional sDIO product.
<i>Adept PA-4 Power Chassis User's Guide</i>	Contains complete information on the installation and operation of the PA-4 Power Chassis.
<i>AdeptWindows Installation Guide</i>	Describes installation of AdeptWindows software.
<i>Instructions for Adept Utility Programs</i>	Describes the utility programs used for advanced system configurations, system upgrades, file copying, and other system configuration procedures.
<i>V+ Operating System User's Guide</i>	Describes the V+ operating system, including disk file operations, monitor commands, and monitor command programs.
<i>V+ Language User's Guide</i>	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 23](#)).

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 7-1 on page 72](#). 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 18](#) 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 Adept Viper 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 24](#)), who must wear safety equipment (see [“Safety Equipment for Operators” on page 24](#)) 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-trying 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 23](#)).

The Adept Viper robots are intended for use in parts assembly and material handling for payloads less than 5 kg. See [Chapter 3](#) 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 Adept Viper 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 Adept Viper 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 24](#)) 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 17**).

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 CO₂ 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 14](#)).

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: <ul style="list-style-type: none"> • 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.	<ul style="list-style-type: none"> • 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 33 .

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 11](#).



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.

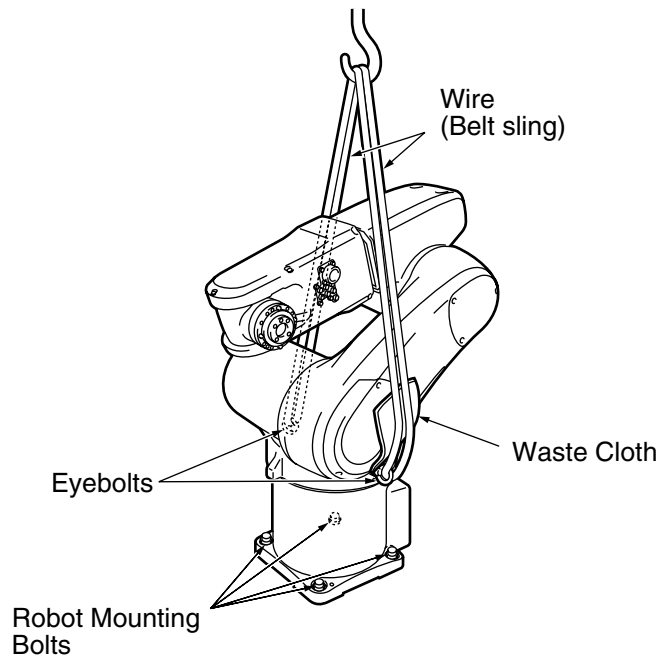
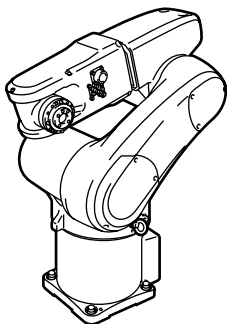
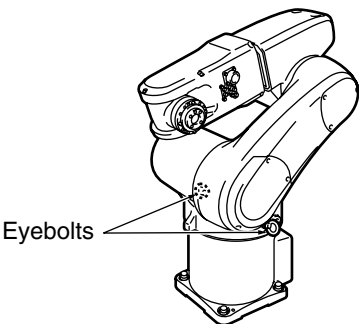
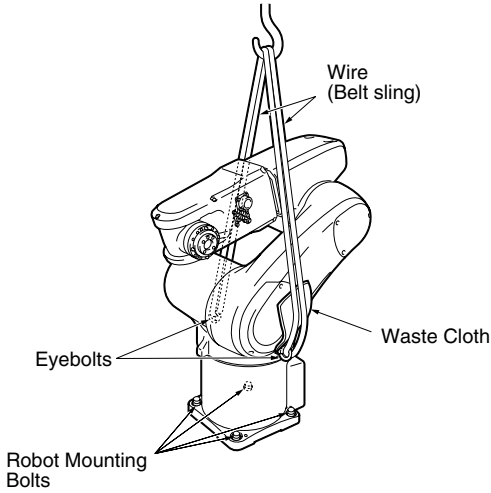


Figure 3-1. Robot in Hoisting Sling

Transport Procedure

Step	Procedure	Drawing	
1	<p>Before transportation, set the robot in a transport position as shown at right by manually moving the second, third and fourth axes.</p> <p>When unpacked first, the robot is in the transport position, so this job is not required.</p>		
		Transport Position	
		Axis	Angle
		First axis (J1)	0°
		Second axis (J2)	-145°
		Third axis (J3)	+243°
		Fourth axis (J4)	-90°
Fifth axis (J5)	-90°		
2	<p>Disconnect the robot control cable, air piping and user signal cables from the robot unit.</p> <p>When the robot unit is first unpacked, this job is not required.</p>		
3	<p>As shown at right, mount the eyebolts.</p> <p>When delivered, the robot unit is packed with eyebolts attached, so this job is not required</p>		

Step	Procedure	Drawing
4	<p>As shown at right, place a waste cloth on the second arm and pass the wire through the two eyebolts.</p> <p>Note: Before transporting the robot, check that the path to the target position is free of obstacles.</p>	 <p>The diagram illustrates the robot unit being prepared for transport. A wire, labeled 'Wire (Belt sling)', is shown passing through two 'Eyebolts' located on the upper part of the robot unit. A 'Waste Cloth' is positioned on the second arm of the robot. The 'Robot Mounting Bolts' are also indicated at the base of the unit.</p>
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	<p>Worker B: Put the robot unit down in the target position.</p> <p>Worker A: Temporarily secure the robot unit with four bolts.</p>	
8	Secure the robot unit according to the instructions in Section 3.4 on page 32 .	
9	Remove the eyebolts from the robot unit.	<p>Caution: Before running the robot unit, be sure to remove the eyebolts. Otherwise, the robot arm will strike against those eyebolts.</p>

3.4 Mounting the Robot

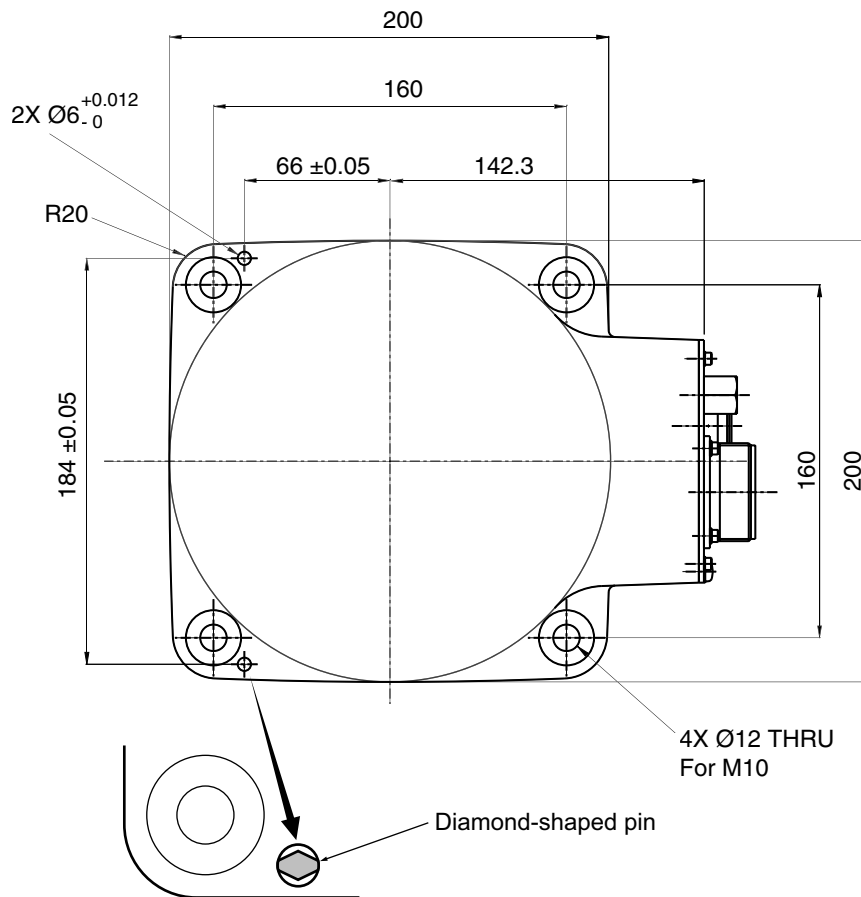


Figure 3-2. Mounting Hole Pattern for Robot

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 29](#).
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.

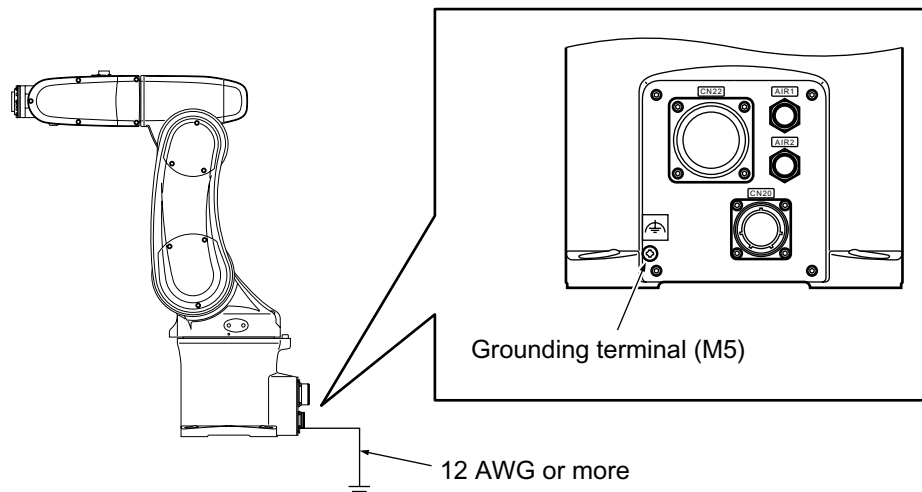


Figure 3-3. Ground Point on Robot

3.6 Description of Connectors on Robot Interface Panel

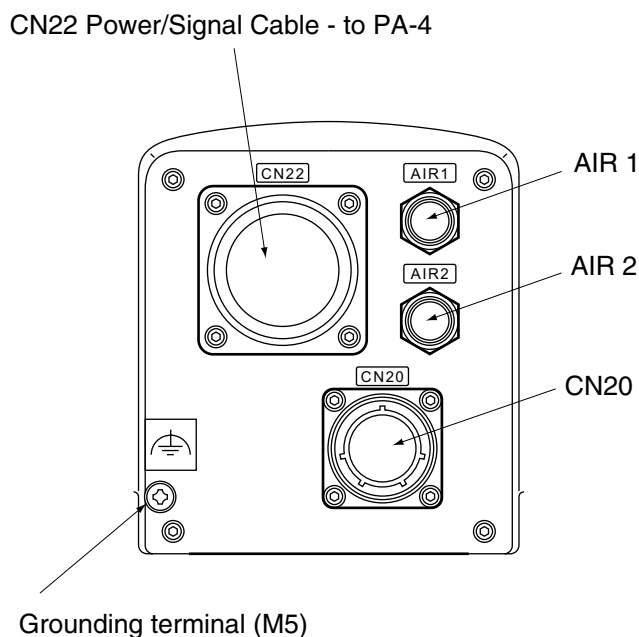


Figure 3-4. Robot Interface Panel

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 35](#).

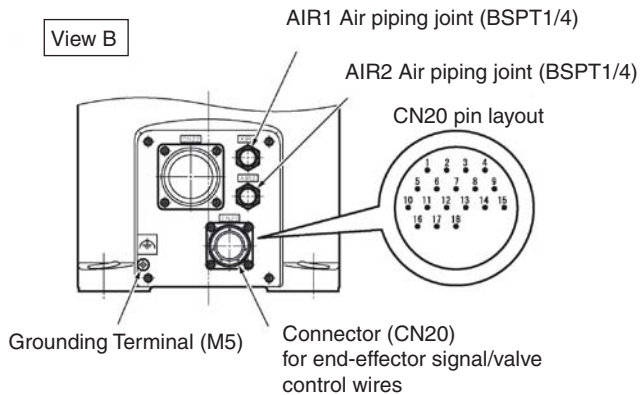
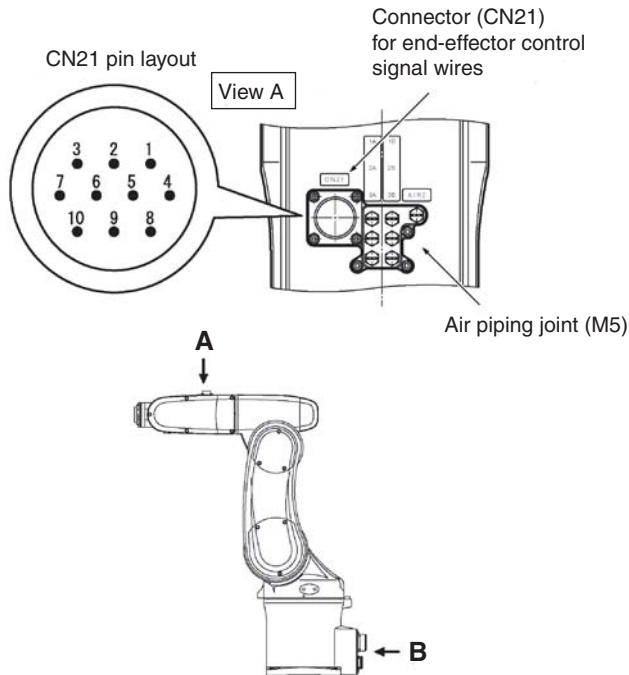
AIR 1 - air piping connector (PT1/4) for three solenoids in robot. See [Section 3.7 on page 35](#).

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 33](#).

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		
AIR1	Air intake	Exhaust	Solenoid valve	Solenoid
	1A	1B	1	A B
	1B	1A	1	ON OFF
	2A	2B	2	ON OFF
	2B	2A	2	OFF ON
	3A	3B	3	ON OFF
	3B	3A	3	OFF ON
AIR2				

CN20 Pin Assignments

NPN type (source IN, sink OUT)

CN20 pin No.	Used for:
12	+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)

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 supplied mating connector sets for CN20 and CN21.

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

Optional Solenoid Cable

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

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

Installing this cable allows you to control the three internal robot solenoids directly from V+. See [Table 3-2](#) for the details on activating the individual ports on each solenoid.

Table 3-2. Viper Solenoid Control from V+

	Active Output Port	V+ Signal States ^a	
Solenoid 1	A	0001	–0002
	B	–0001	0002
Solenoid 2	A	0003	–0004
	B	–0003	0004
Solenoid 3	A	0005	–0006
	B	–0005	0006

^a The two-position, double solenoids require both V+ signal states to be activated. Invalid states will result in indeterminate outputs.

In addition to controlling the internal robot solenoids, the Solenoid cable brings a portion of the other XDIO signals out to the CN21 connector at the top of the robot. See [Table 3-3](#) for the details of which signals are available at CN21. See the [Adept SmartController User's Guide](#) for the electrical specifications for the signals from the XDIO connector.

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

CN21 Pin #	Signal from XDIO on SmartController	CN21 Pin #	Signal from XDIO on SmartController
1	Input 1001 ^a	6	Not connected
2	Input 1002 ^a	7	Output 0007 ^b
3	Input 1003 ^a	8	Output 0008 ^b
4	Input 1004 ^a	9	24V Output ^c
5	Input 1005 ^a	10	Ground

^a Inputs 1001 to 1005 are preconfigured as low-active (sinking) inputs.

^b Outputs 0007 and 0008 are preconfigured as high-side (sourcing) outputs.

^c Limited to a combined total of 1A of current.

Solenoid Valve Specifications

Table 3-4. 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 degrees C (No dew condensation allowed. When dry air is used)
Solenoid	Operating voltage	24 V \pm 10%
	Power consumption (current)	0.5 W (21 mA)
	Surge voltage protection circuit	Zener diode

External Mounting Locations on Robot

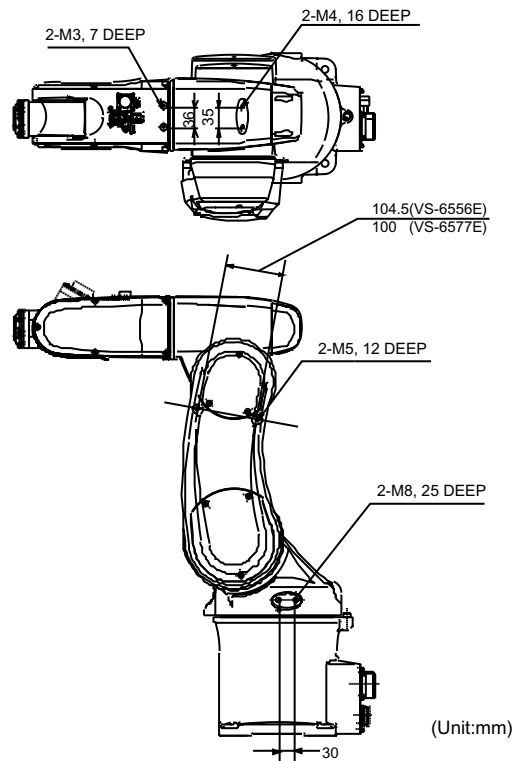


Figure 3-5. External Mounting Holes on Robot

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](#).

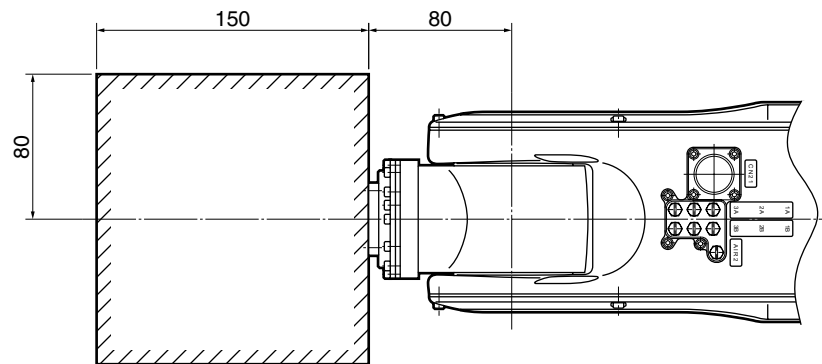


Figure 3-6. Allowable Range of Center of Gravity Position of End-effector

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.

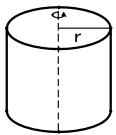
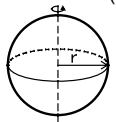
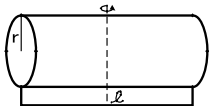
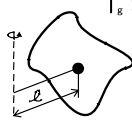
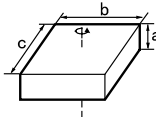
Moment of inertia around J4, J5, and J6 of end-effector (including mass of workpiece) must be less than or equal to the maximum allowable moment of inertia

Maximum allowable moment of inertia around J4 and J5: 0.295 kgm²

Maximum allowable moment of inertia around J6: 0.045 kgm²

When calculating the moment of inertia around J4, J5, and J6 of the end-effector, use the formulas given in [Table 3-5](#), and see examples in [Figure 3-7 on page 41](#).

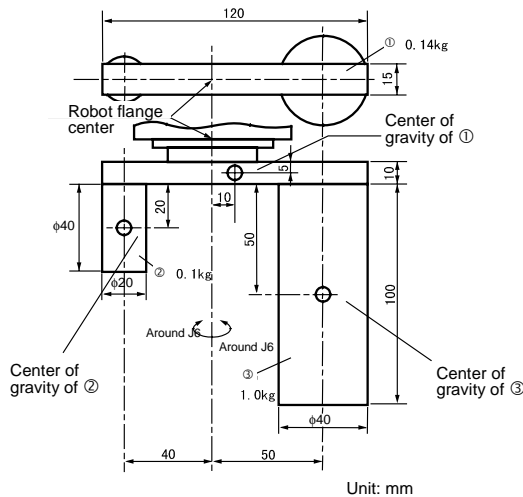
Table 3-5. Moment of Inertia Formulas

<p>1. Cylinder (1) (Axis of rotation = Center axis)</p>  $I = \frac{mr^2}{2}$	<p>4. Sphere (Axis of rotation = Center axis)</p>  $I = \frac{2mr^2}{5}$
<p>2. Cylinder (2) (The axis of rotation passes through the center of gravity.)</p>  $I = \frac{m}{4} \left(r^2 + \frac{l^2}{3} \right)$	<p>5. Center of gravity not on the axis of rotation</p>  <p>I_g: Inertia moment around center of gravity [kgm²]</p> $I = I_g + m.l^2$
<p>3. Rectangular parallelepiped (The axis of rotation passes through the center of gravity.)</p>  $I = \frac{m}{12} (b^2 + c^2)$	<p> I: Moment of inertia (kgm²) m: Mass (kg) r: Radius (m) b, c, l: Length (m) </p>

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

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

(1) Moment of inertia around J6



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

$$I_1 = \frac{0.14}{12} (0.12^2 + 0.015^2) + 0.14 \times 0.01^2$$

$$= 1.85 \times 10^{-4} \text{ [kgm}^2\text{]}$$

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

$$I_2 = \frac{0.1 \times 0.01^2}{2} + 0.1 \times 0.04^2$$

$$= 1.65 \times 10^{-4} \text{ [kgm}^2\text{]}$$

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

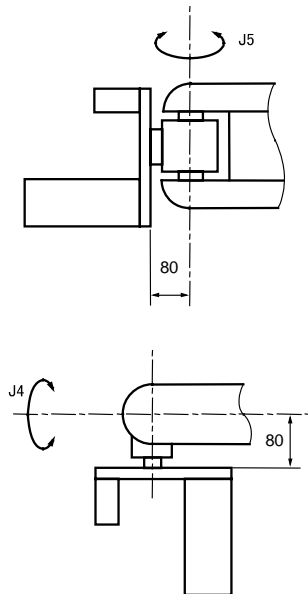
$$I_3 = \frac{1.0 \times 0.02^2}{2} + 1.0 \times 0.05^2$$

$$= 2.7 \times 10^{-3} \text{ [kgm}^2\text{]}$$

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

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

(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)

$$I_1 = \frac{0.14}{12} (0.015^2 + 0.01^2) + 0.14 \times ((0.08 + 0.005)^2 + 0.01^2)$$

$$= 1.03 \times 10^{-3} \text{ [kgm}^2\text{]}$$

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

$$I_2 = \frac{0.1}{4} \left(0.01^2 + \frac{0.04^2}{3} \right) + 0.1 \times ((0.08 + 0.01 + 0.02)^2 + 0.04^2)$$

$$= 1.39 \times 10^{-3} \text{ [kgm}^2\text{]}$$

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

$$I_3 = \frac{1.0}{4} \left(0.02^2 + \frac{0.1^2}{3} \right) + 1.0 \times ((0.08 + 0.01 + 0.05)^2 + 0.05^2)$$

$$= 2.30 \times 10^{-3} \text{ [kgm}^2\text{]}$$

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

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

Figure 3-7. Moment of Inertia Calculation Examples

System Installation

4

4.1 System Cable Diagram

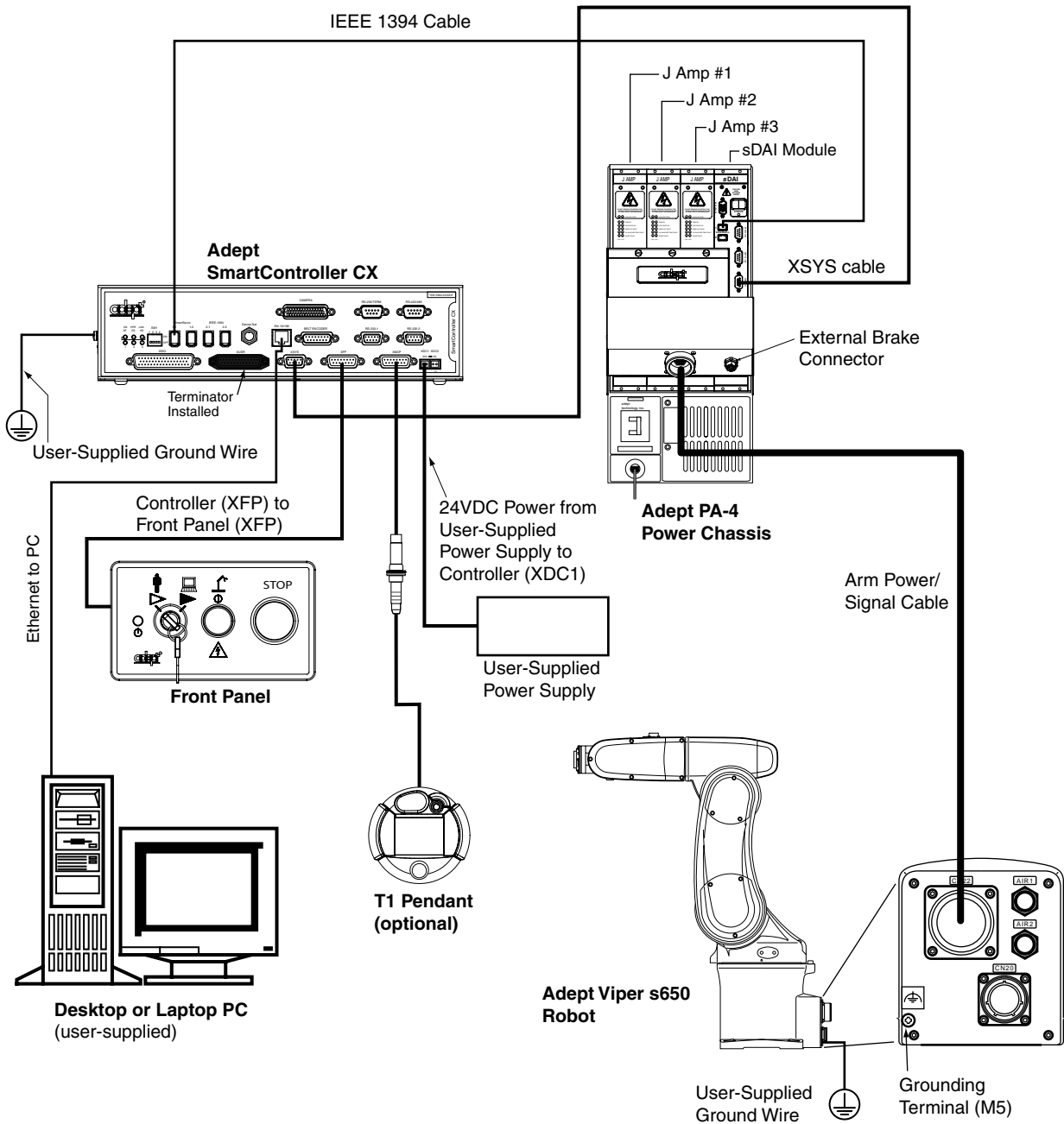


Figure 4-1. System Cable Diagram for Adept Viper s650 Robot

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 SmartController.

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 Adept Viper 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 43** and **Figure 4-2 on page 45**.
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.

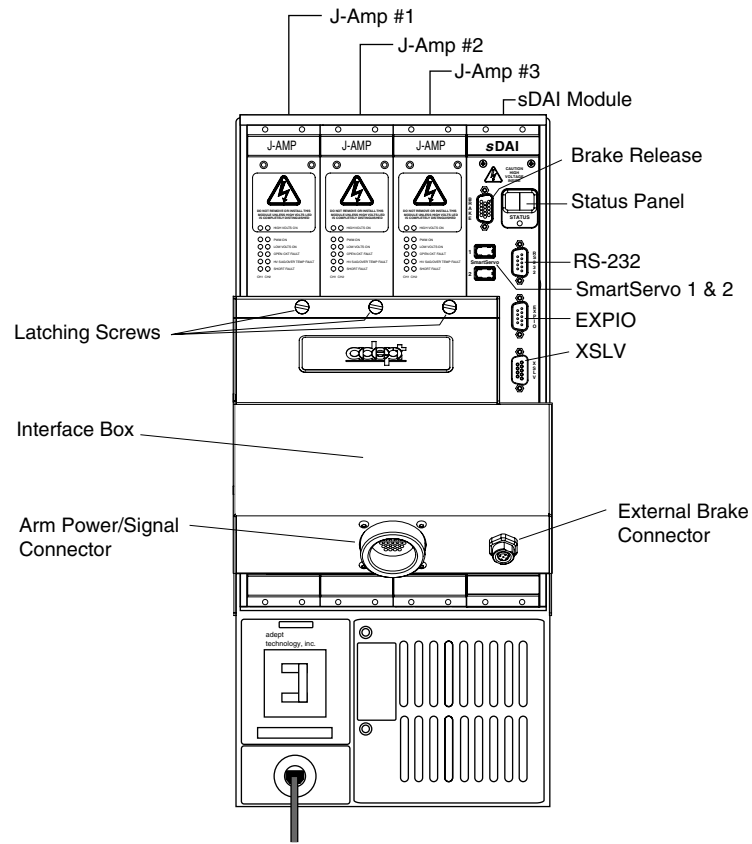


Figure 4-2. Adept PA-4 Power Chassis with sDAI Module

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
Adept Viper s650	No load - Adept cycle ^c	371	947
	5.0 kg - Adept cycle ^c	477	1526
	5.0 kg - all joints move	834	2088
Adept Viper s850	No load - Adept cycle ^c	358	1237
	5.0 kg - Adept cycle ^c	407	1202
	5.0 kg - all joints move	704	2090

^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 49](#).

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 line 2 line 3 no connection ground	black black (or gray) ^a brown blue (must be insulated) green/yellow
Color code: 380 - 415 VAC line 1 line 2 line 3 neutral ground	black black (or gray) ^a brown blue 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

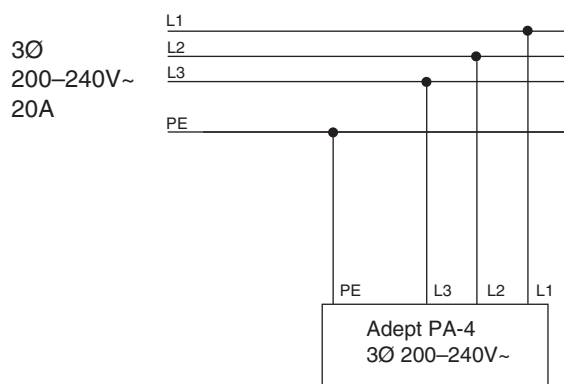


Figure 4-3. Typical 3-Phase 200-240 VAC Connection for PA-4 System

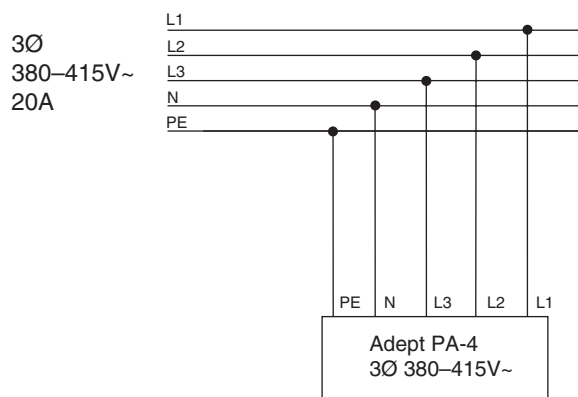


Figure 4-4. Typical 3-Phase 380-415 VAC Connection for PA-4 System

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 46](#).

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 51](#) 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 \pm 0.1 m (9 ft. 10 in. \pm 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.

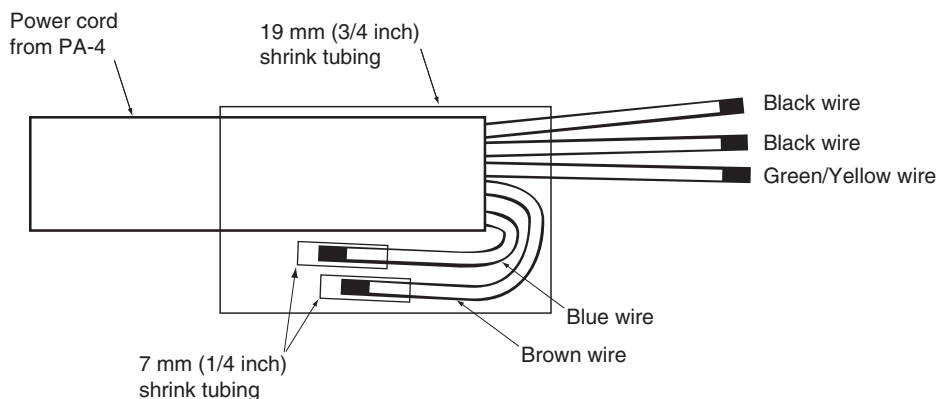


Figure 4-5. 1-Phase AC Cable Wiring

Typical Single Phase, 220 VAC Power Installation Diagrams

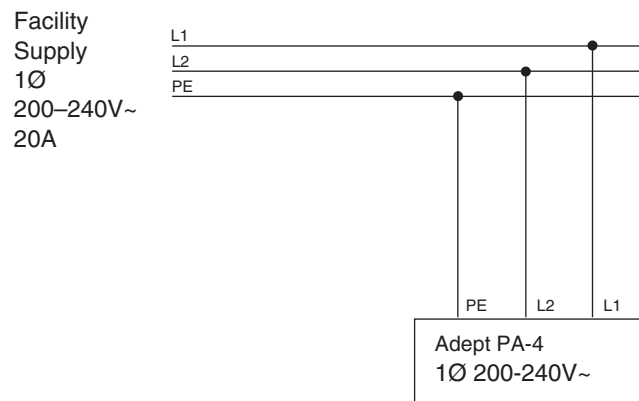


Figure 4-6. Typical 1-Phase 200-240 VAC Connection

System Operation 5

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.

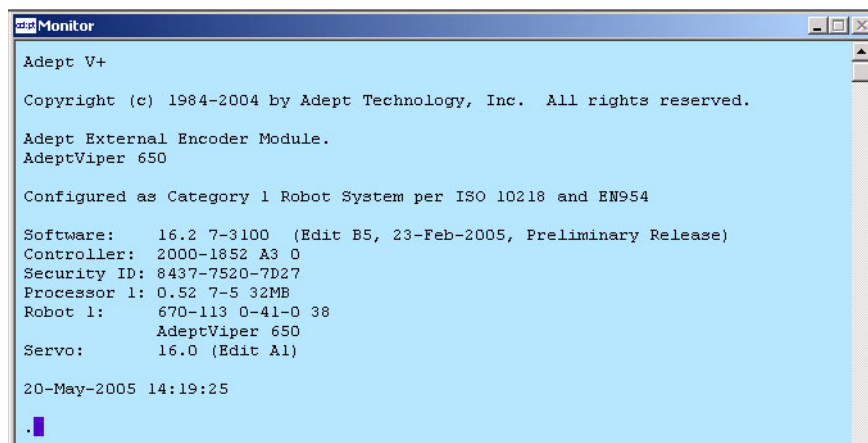


Figure 5-1. Typical Start-up Screen

5. Disengage any E-Stops.
6. Make sure the Front Panel is set to Auto mode.
7. Type enable power.

EN PO <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*

NOTE: When using a pendant, either the Adept T1 Pendant or the MCP4, with an Adept Viper robot, the Free Mode is disabled for safety reasons.

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](#). Also refer to [page 36](#) for information on the optional Solenoid cable.

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

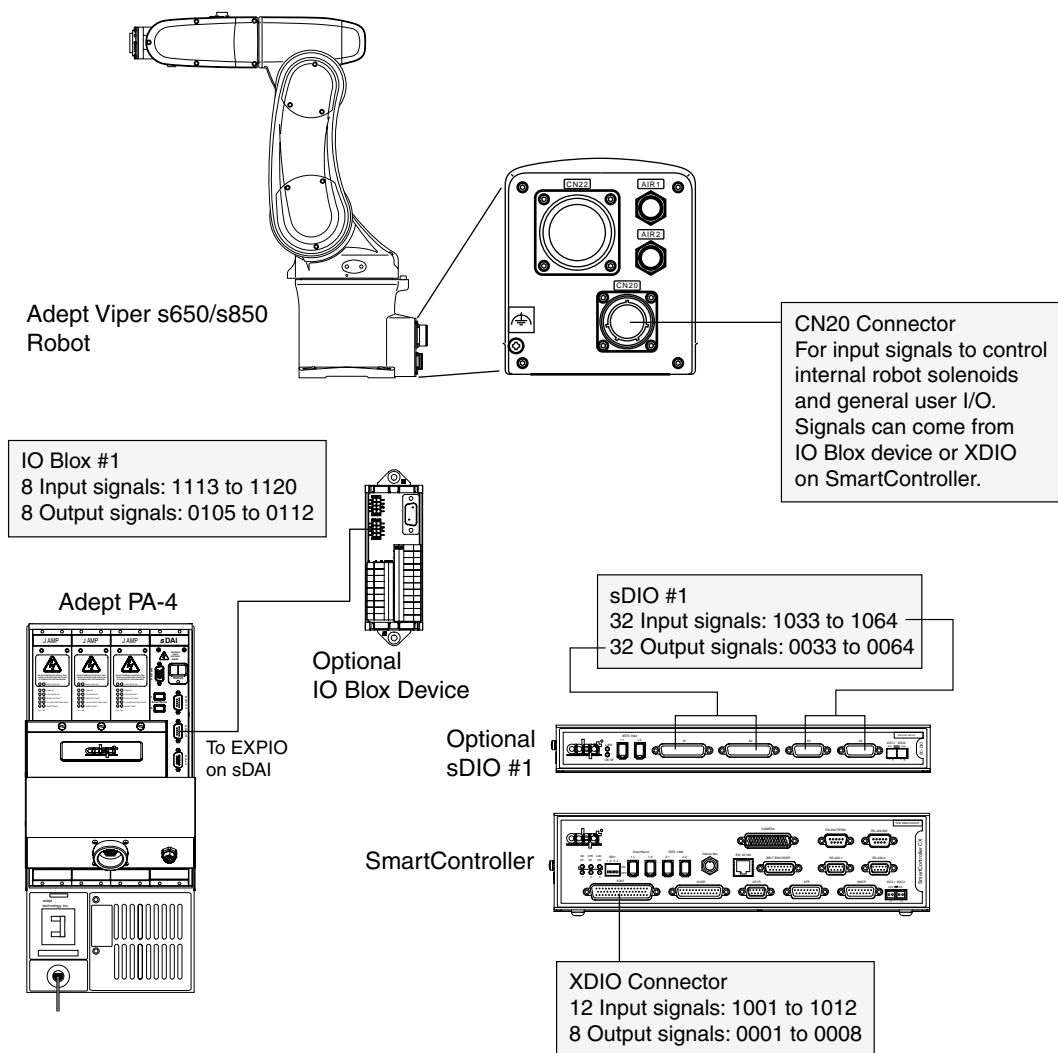


Figure 5-2. Connecting Digital I/O to the System

Table 5-2. Default Digital I/O Signal Configuration, Single Robot System

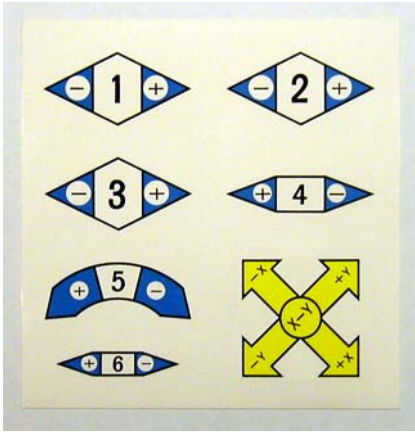



Location	Type	Signal Range
Controller XDIO connector	Inputs	1001 - 1012
	Outputs	0001 - 0008
sDIO Module 1	Inputs	1033 - 1064
	Outputs	0033 - 0064
sDIO Module 2	Inputs	1065 - 1096
	Outputs	0065 - 0096
sDIO Module 3 (recommended ^a)	Inputs	1201 - 1232
	Outputs	0201 - 0232
sDIO Module 4 (recommended ^a)	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 11](#) 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 $\pm 190^\circ$. 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 Adept Viper 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 Amp (Joint #)
ON	High Power ON Status	H#	High Temp Encoder (Joint #)
MA	Manual Mode	hV	High Voltage Bus Fault
24	24V Supply Fault	I#	Initialization Stage (Step #)
A#	Amp Fault (Joint #)	M#	Motor Stalled (Joint #)
B#	IO Blox Fault (Address #)	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	SW	Watchdog Timeout
F#	External Sensor Stop	S#	Safety System Fault (Code #)
FM	Firmware Mismatch	T#	Safety System Fault (Code 10 + #)
FW	1394 Fault	V#	Hard Envelope Error (Joint #)

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

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 62](#).



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.

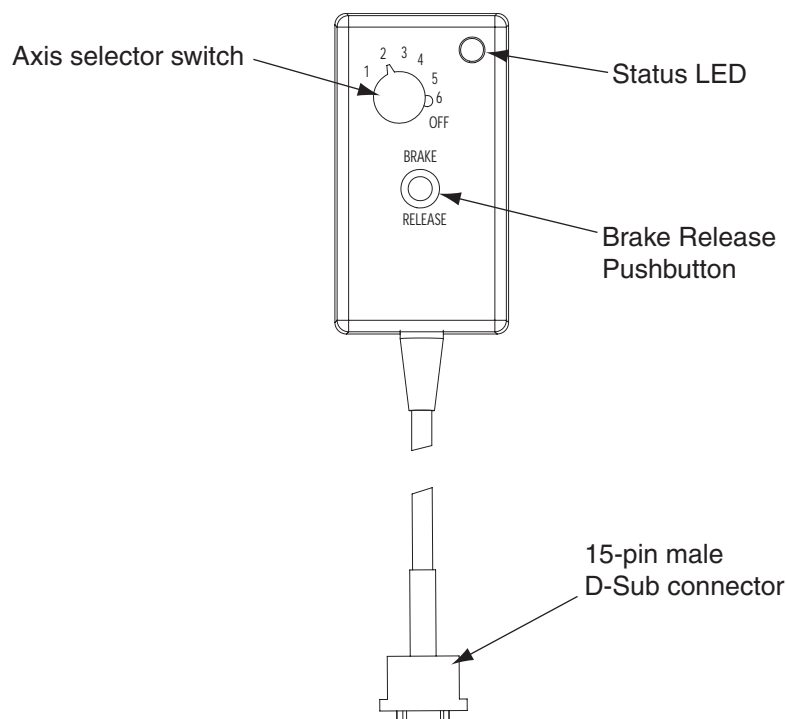


Figure 6-1. Manual Brake Release Box

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. See [Figure 6-2](#).

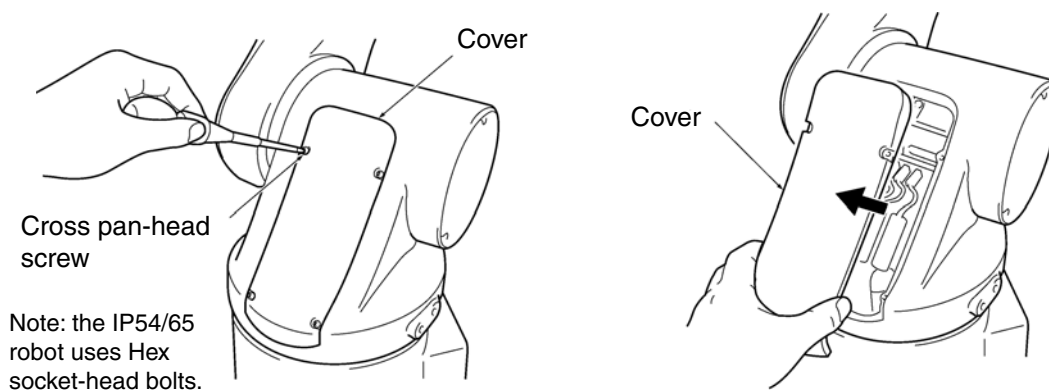


Figure 6-2. Removing Cover to Replace Encoder Batteries

4. Remove the dummy connector cap from the battery board. See [Figure 6-3](#).

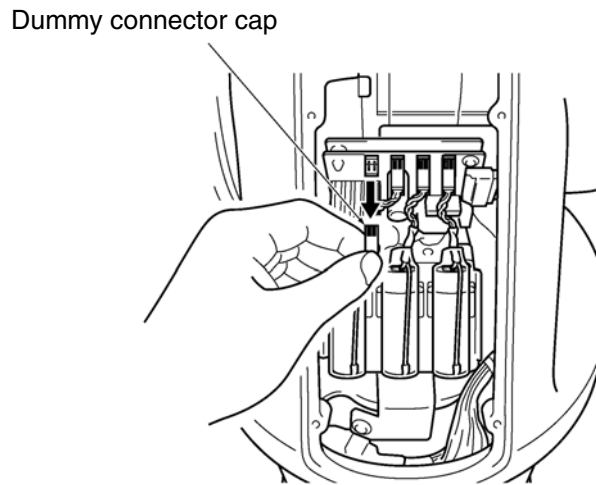


Figure 6-3. Removing Dummy Connector Cap

5. Connect a new battery (1st one) to the pin from which you have disconnected the dummy connector cap in Step 4. See [Figure 6-4](#).

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

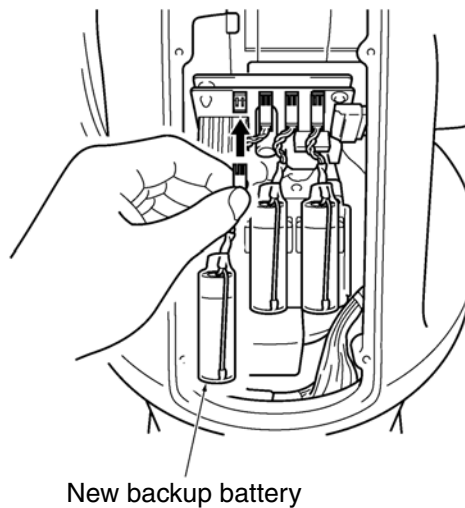


Figure 6-4. Connecting First New Battery

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). See [Figure 6-5 on page 64](#).

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

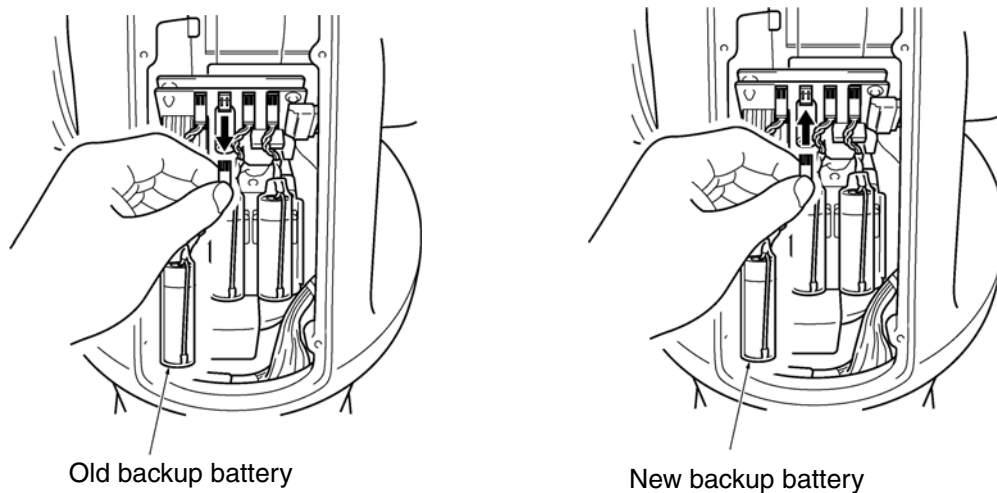


Figure 6-5. Connecting Second New Battery

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). See [Figure 6-6](#).

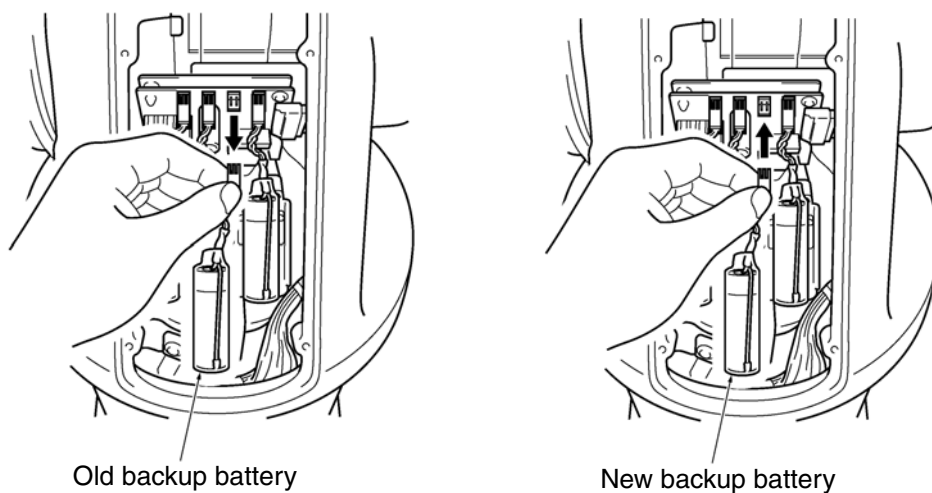


Figure 6-6. Connecting Third New Battery

8. Remove the last old battery and connect the dummy connector cap disconnected in Step 4. See [Figure 6-7](#).

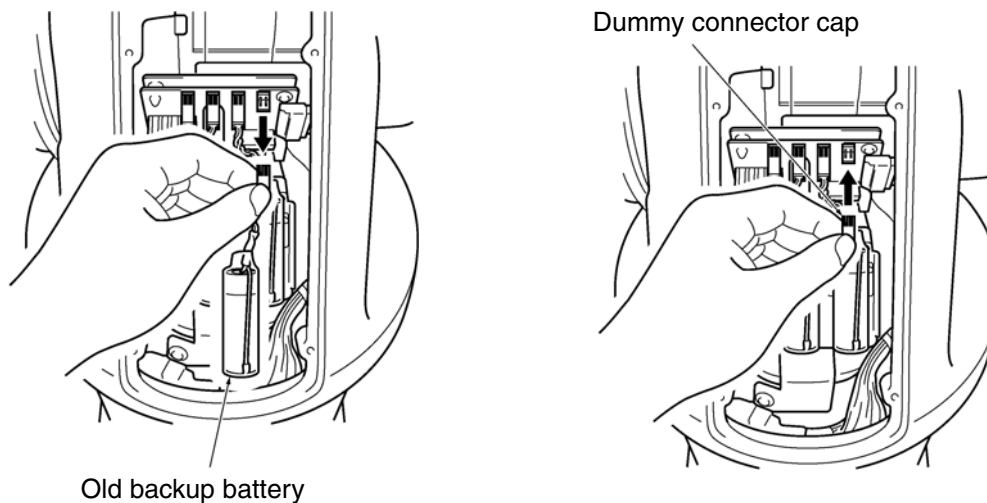


Figure 6-7. Reconnecting Dummy Connector Cap

9. Replace the cover on the robot.

Tightening torque: Standard robot model - cross pan-head screw: 0.59 Nm

Tightening torque: IP54/65 robot model - Hex socket bolt: 2.0 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 Adept Viper 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.



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

Technical Specifications

7

7.1 Robot Dimensions

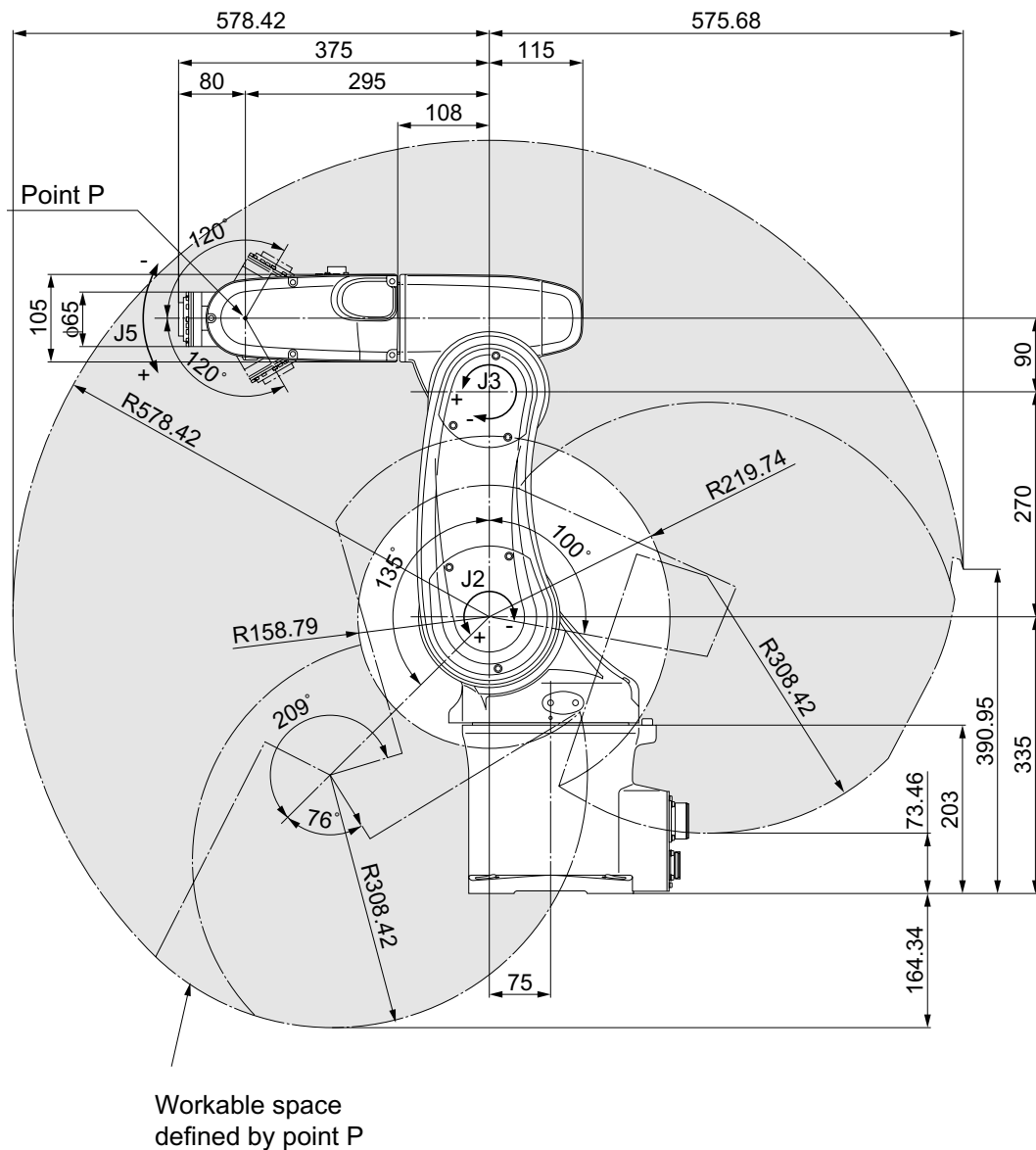


Figure 7-1. Adept Viper s650 Side Dimensions and Work Envelope

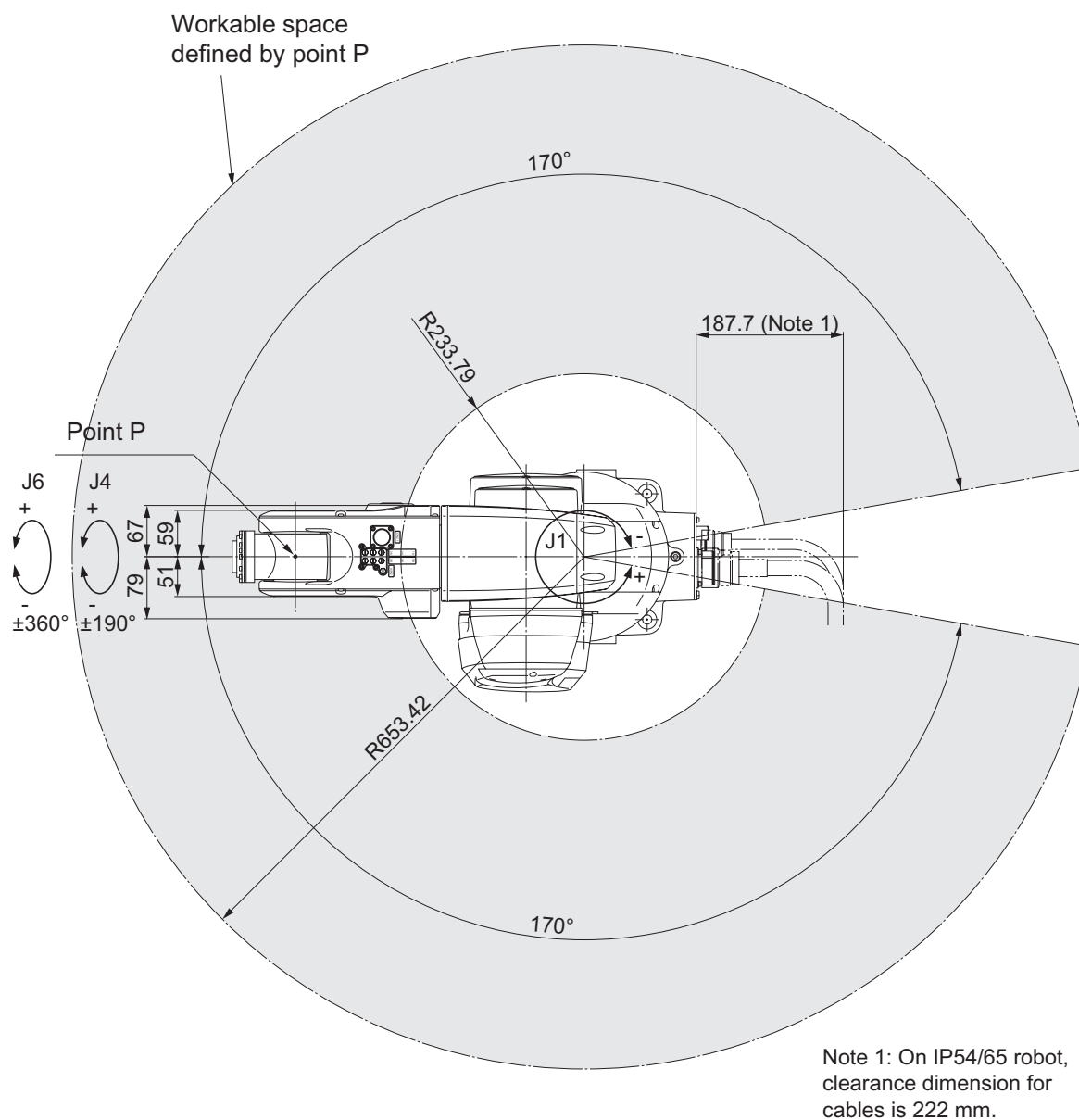


Figure 7-2. Adept Viper s650 Top Dimensions and Work Envelope

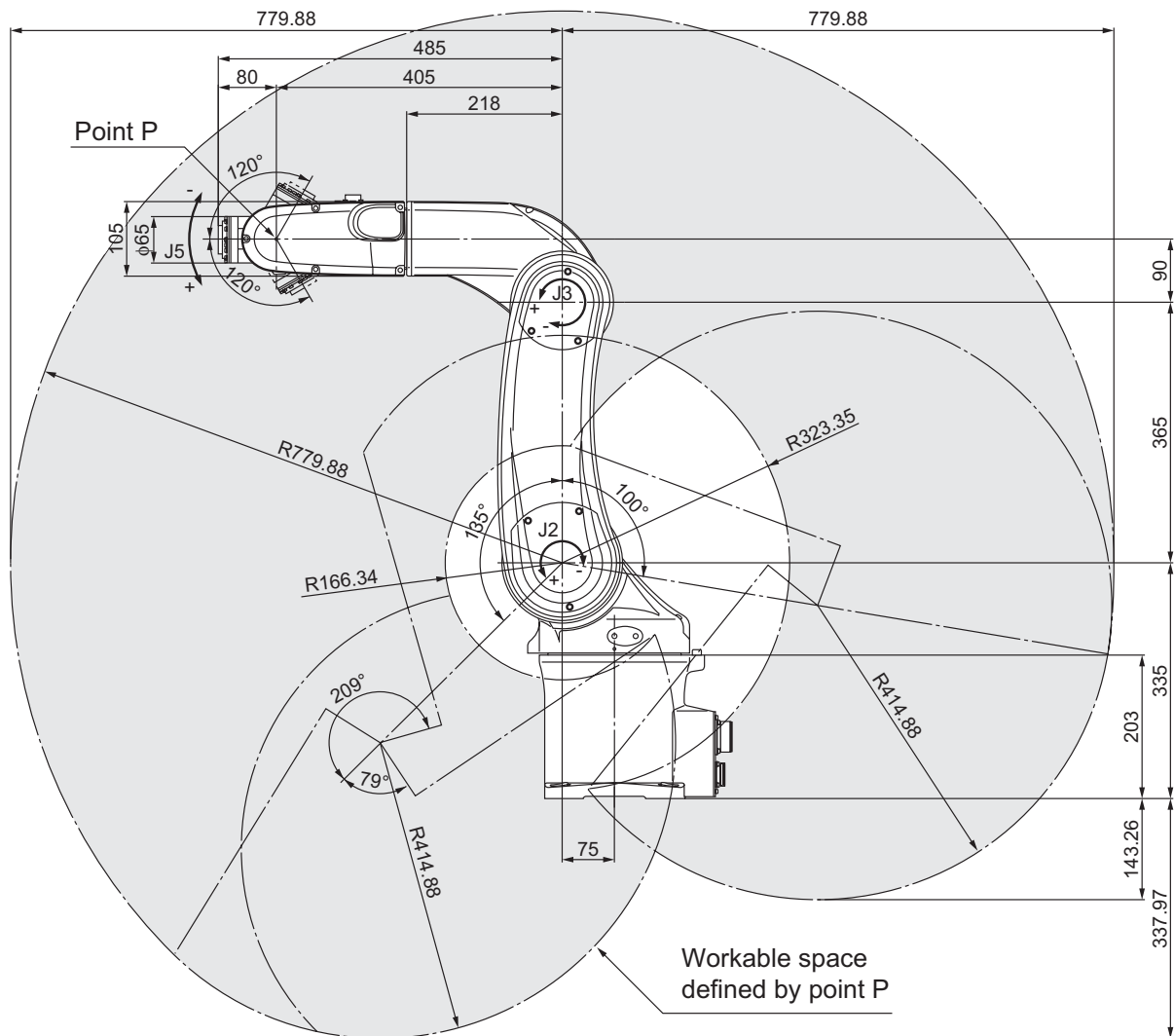


Figure 7-3. Adept Viper s850 Side Dimensions and Work Envelope

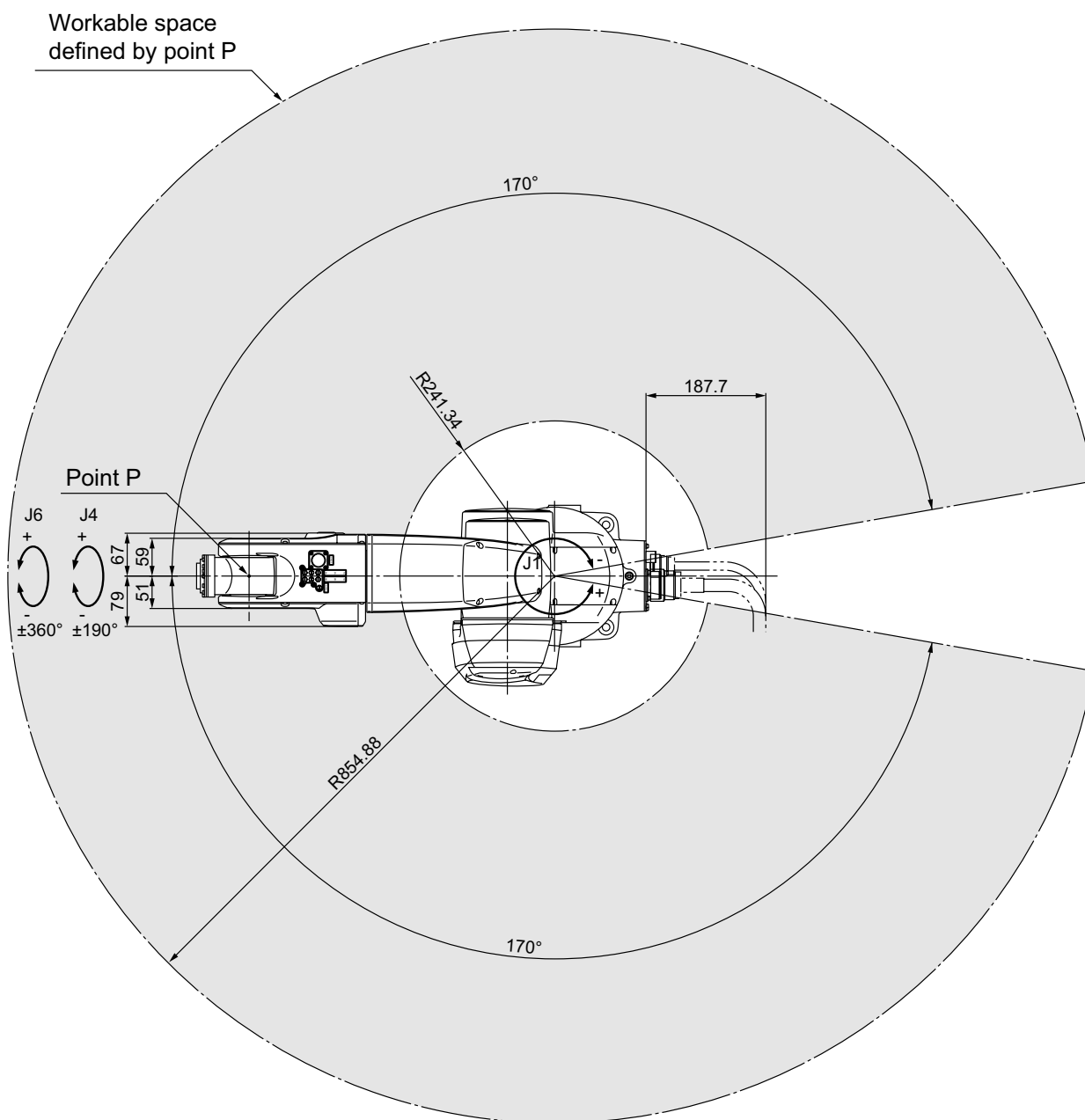


Figure 7-4. Adept Viper s850 Top Dimensions and Work Envelope

7.2 Robot Flange Dimensions

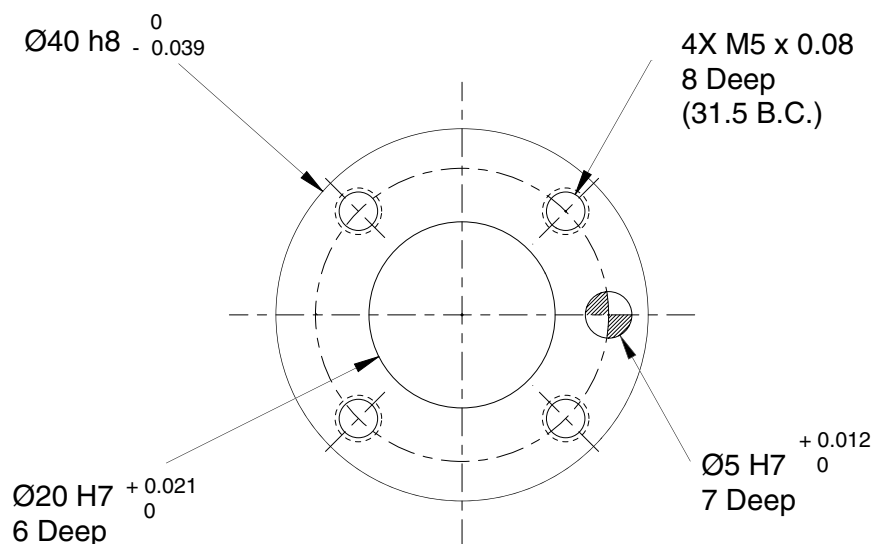


Figure 7-5. Robot Flange Dimensions

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: $\pm 170^\circ$ J2: $-190^\circ, +45^\circ$ J3: $-29^\circ, +256^\circ$ J4: $\pm 190^\circ$ J5: $\pm 120^\circ$ J6: $\pm 360^\circ$	J1: $\pm 170^\circ$ J2: $-190^\circ, +45^\circ$ J3: $-29^\circ, +259^\circ$ J4: $\pm 190^\circ$ J5: $\pm 120^\circ$ J6: $\pm 360^\circ$
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 ($\varnothing 4 \times 6$, $\varnothing 6 \times 1$), 3 solenoid valves (2-position, double solenoid) contained.	7 systems ($\varnothing 4 \times 6$, $\varnothing 6 \times 1$), 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.		

IP 54/65 Option 8

8.1 Introduction

The Adept Viper s650 IP54/65 robot is a dust-proof, splash-proof model that is an IP54-equivalent structure for the main body of the robot, plus the wrist area, Joint 5 and Joint 6, is an IP65-equivalent.

Note that the SmartController and PA-4 are not a dust- or splash-proof structures. Therefore, when using these products in an environment exposed to mist, put them in an optional protective box.



Figure 8-1. Adept Viper s650 Robot - IP54/65 Model

8.2 Differences From Standard Robot Model

The installation, operation, and specifications of the IP54/65 robot are the same as the standard robot, except for issues noted in this section.

Installation Environment

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

1. there are any flammable gases or liquids,
2. there are any acidic, alkaline, or other corrosive gases,

3. there are any large-sized inverters, high output/high frequency transmitters, large contactors, welders, or other sources of electrical noise,
4. it may likely be submerged in fluid,
5. there is sulfuric cutting or grinding oil mist.

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

Robot Connector Panel

For the IP54/65 robot, the robot connector panel is different than the standard robot. The drain-bolt (M3 x 8mm) is screwed onto the robot connector panel as shown in [Figure 8-2](#).

For a floor-mount installation, remove the drain-bolt shown in the figure below, before installing the robot unit. It will become a drain-hole for the liquid.



CAUTION: For an overhead-mount installation, do not remove the drain-bolt when installing the robot unit. If you do so, robot failure may occur.

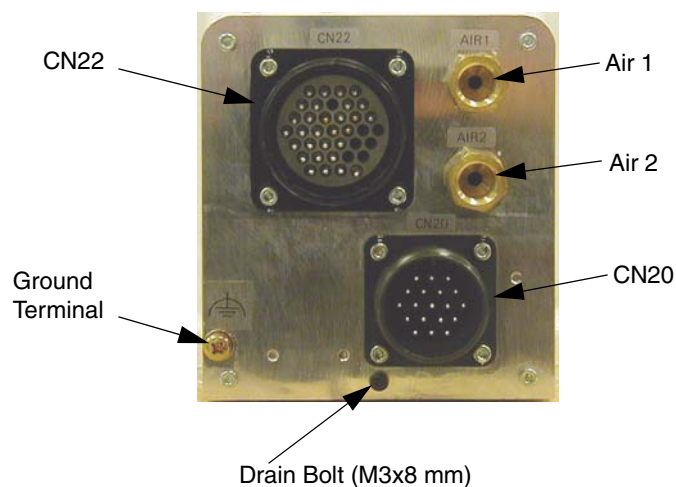


Figure 8-2. IP54/65 Robot Connector Panel

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

Cable Clearance

For the IP54/65 robot, the cable clearance dimension at the back of the robot is 222 mm. See [Figure 7-2 on page 68](#) for the dimension drawing.

Replacing Encoder Backup Battery

For the IP54/65 robot, the procedure to replace the encoder battery is the same as the standard robot, except the cover uses hex socket-head bolts instead of screws. See [Figure 6-2 on page 62](#). Tightening torque: Hex socket bolt: 2.0 Nm.

Cleanroom Option 9

9.1 Introduction

The Adept Viper s850 robot is available in a Cleanroom model.

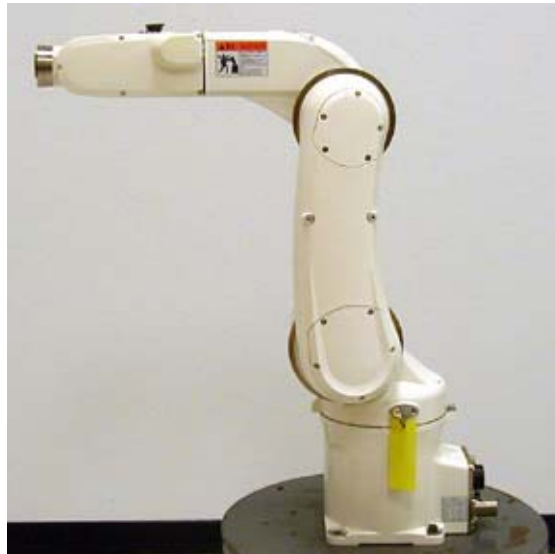


Figure 9-1. Adept Viper s850 Robot - Cleanroom Model

9.2 Differences From Standard Robot Model

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

Technical Specifications

Table 9-1. Cleanroom Robot Specifications

Adept Viper s850	
Clean Class for Cleanroom Robot	Class 10 (0.1 μ)
Recommended vacuum flow rate	130 liters/minute
User air lines	6 systems (Ø4x6), 3 solenoid valves (2-position, double solenoid) contained.

Robot Connector Panel

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

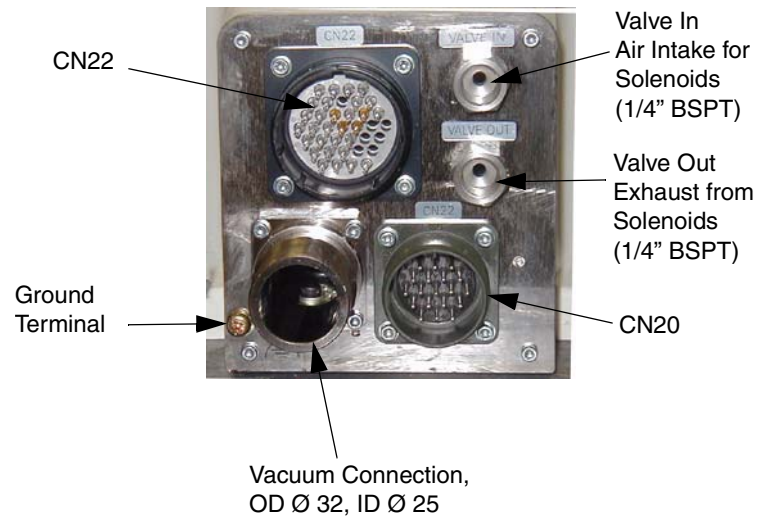


Figure 9-2. Cleanroom Robot Connector Panel

See [Table 9-1 on page 79](#) for the recommended vacuum flow rate.

Air Lines and Signal Wiring

The Cleanroom robot is equipped with 6 air lines. The six lines, from Valve In input, are controlled by the 3 internal solenoid valves. There are 10 user electric lines. The air lines and signal wiring are shown below.

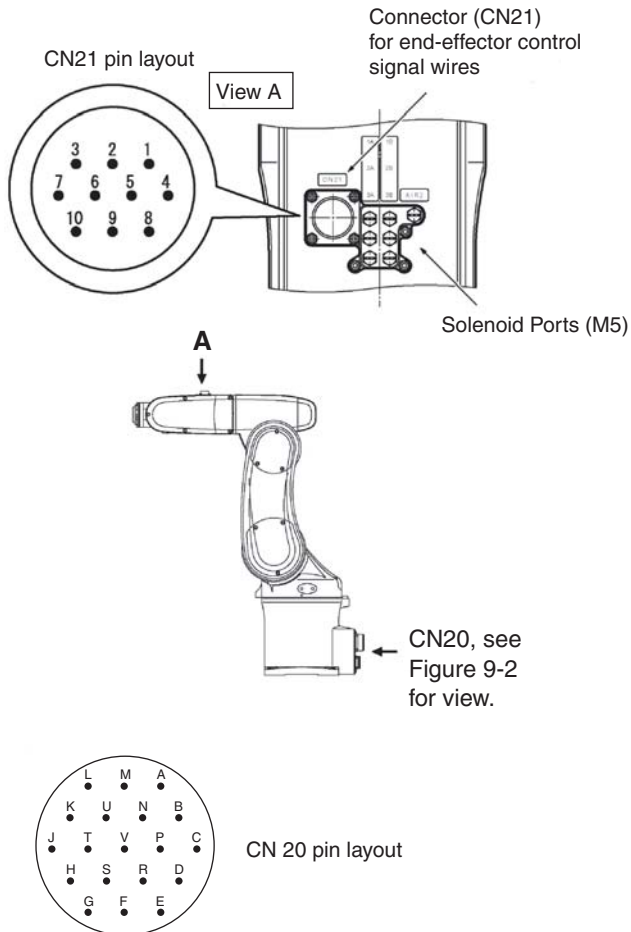


Table 9-2. Air Intake/Exhaust States

Air Connections		Valve Signal		
Air Intake (Valve In)	Exhaust (Valve Out)	Solenoid valve	Solenoid	
			A	B
1A	1B	1	ON	OFF
1B	1A	1	OFF	ON
2A	2B	2	ON	OFF
2B	2A	2	OFF	ON
3A	3B	3	ON	OFF
3B	3A	3	OFF	ON
AIR 2 - Not used on Cleanroom Robot				

Table 9-3. CN 20 Pin Assignments, M to U

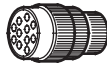
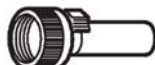

NPN type (source IN, sink OUT)		PNP type (sink IN, source OUT)	
CN20 pin No.	Used for:	CN20 pin No.	Used for:
M	+24V	M	0V
N	Solenoid 1A (solenoid valve 1)	N	Solenoid 1A (solenoid valve 1)
P	Solenoid 1B (solenoid valve 1)	P	Solenoid 1B (solenoid valve 1)
R	Solenoid 2A (solenoid valve 2)	R	Solenoid 2A (solenoid valve 2)
S	Solenoid 2B (solenoid valve 2)	S	Solenoid 2B (solenoid valve 2)
T	Solenoid 3A (solenoid valve 3)	T	Solenoid 3A (solenoid valve 3)
U	Solenoid 3B (solenoid valve 3)	U	Solenoid 3B (solenoid valve 3)

Table 9-4. CN 20 Pin Assignments, A to K

Pins A to K on CN20 and #1 to #10 on CN21 are connected with each other as shown below. The allowable current per line is 1 A.										
CN20	A	B	C	D	E	F	G	H	J	K
CN21	1	2	3	4	5	6	7	8	9	10

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

Table 9-5. CN20 and CN21 Mating Connectors

Connector Set Part No.	Connector No.	Model and Part Name	Appearance	
05584-000	for CN20	H/M3106A22-14S (straight plug) (HIROSE ELECTRIC CO., LTD.)		
	for CN20	H/MS3057-12A (cord clamp) (HIROSE ELECTRIC CO., LTD.)	Applicable wire diameter 11.4 to 15.9	
	for CN20	H/MS3057-12A1 (cord clamp) (HIROSE ELECTRIC CO., LTD.)	Applicable wire diameter 8 to 11.6	
	for CN21	EBLP1610M (L type plug connector) (Dai-ichi Electronic Industry)		

Cleanroom Cover at J6 Flange

The Cleanroom robot has a J6 Cleanroom Cover that is not present on the standard robot - see [Figure 9-3](#). Any user tooling at the flange must allow for clearance - see [Figure 9-4](#).

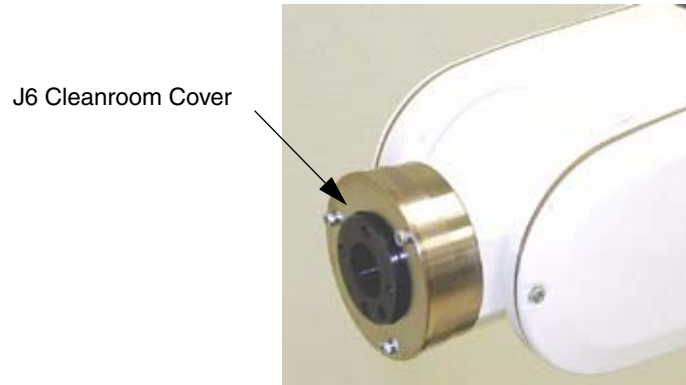


Figure 9-3. Adept Viper s850 J6 Cleanroom Cover

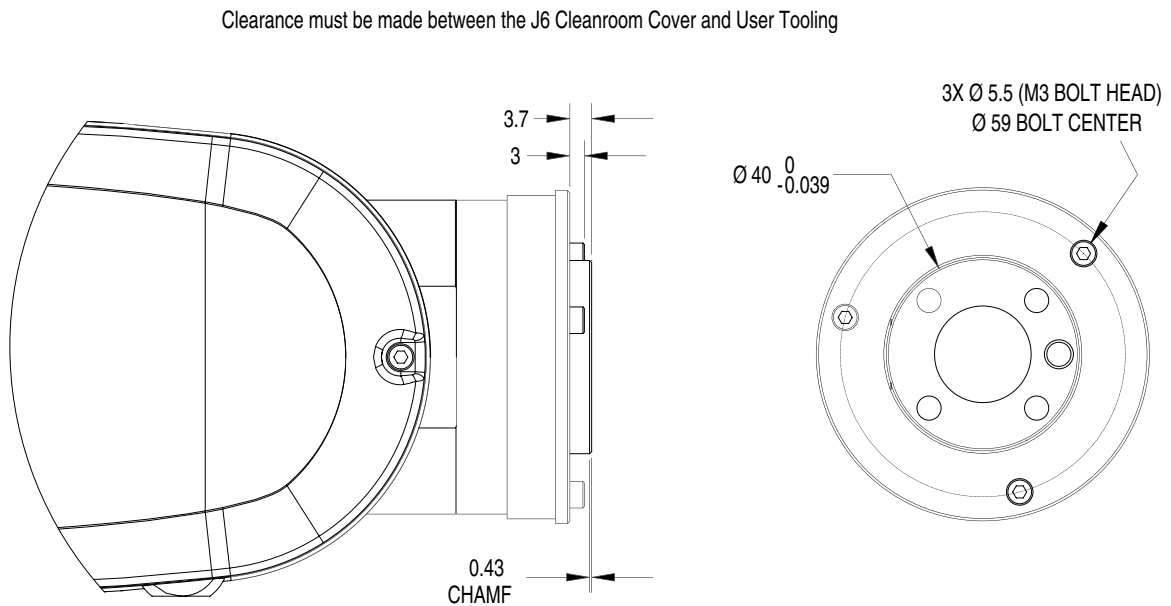


Figure 9-4. J6 Cleanroom Cover Dimensions

Cable Clearance

For the Cleanroom robot, the cable clearance dimension at the back of the robot is 222 mm. See [Figure 7-2 on page 68](#) for the dimension drawing.

Replacing Encoder Backup Battery

For the Cleanroom robot, the procedure to replace the encoder battery is the same as the standard robot, except the cover uses hex socket-head bolts instead of screws. See [Figure 6-2 on page 62](#). Tightening torque: Hex socket bolt: 2.0 Nm.

Dual Robot Systems

10

10.1 System Installation

The major steps in installing a dual Adept Viper robot system are presented in [Table 10-1](#).

Table 10-1. Dual Robot Installation Overview

Task to be Performed	Reference Location
1. Mount each robot on a flat, secure mounting surface. Designate one robot as Robot #1, and the other as Robot #2.	See Section 3.4 on page 32 .
2. Install the SmartController, Front Panel, and AdeptWindows software.	See Section 4.2 on page 44 .
3. Install one PA-4 for use with Robot #1, and the second PA-4 for use with Robot #2.	See Section 4.3 on page 44 .
4. Install the system cables according to the system cable drawing.	See Figure 10-1 on page 86 .
5. Connect AC power to each PA-4 power chassis.	See Section 4.4 on page 46 .
6. Start AdeptWindows, connect to the controller, and turn on power to the system.	See Section 10.3 on page 87 .
7. Connect digital I/O to the system as needed.	See Section 10.4 on page 88 .

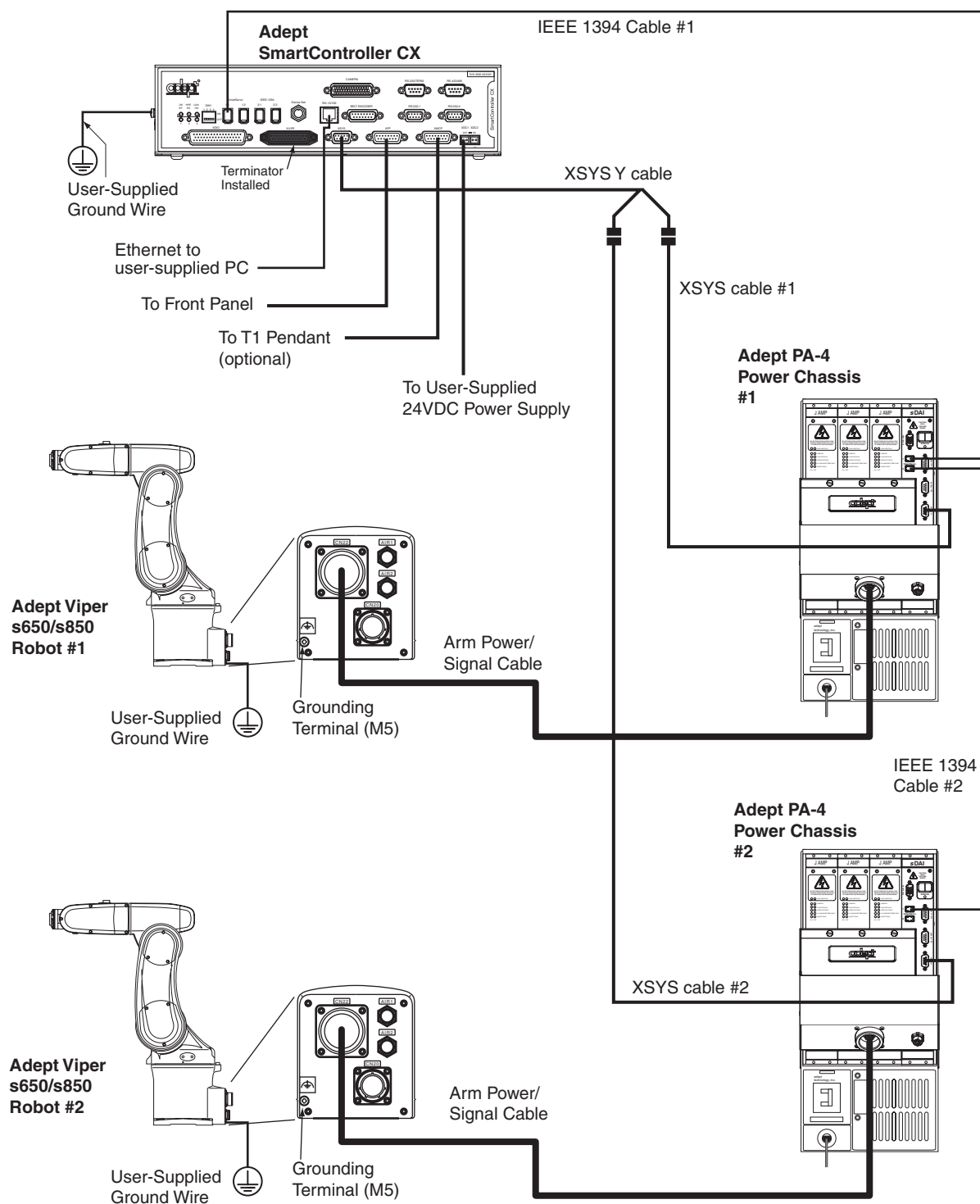


Figure 10-1. System Cable Diagram for Dual Adept Viper Robots

10.2 System Configuration

NOTE: If you purchased both robots at the same time as part of a Dual Robot system, then the two robots will be configured at the factory for the correct software setup. In this case you do not have to perform the steps in this section - you can proceed directly to [Section 10.3](#).

If you are setting up a system that was not configured at the factory, then you will need to go through this process. Go to the Procedures section of the Adept Document Library, and open the *Dual Adept Viper Robot Configuration Procedure*.

The main steps in the configuration procedure are:

1. Install the robots and related equipment as per [Table 10-1 on page 85](#) and the diagram in [Figure 10-1 on page 86](#).
2. Use the CONFIG_C utility to load the "42" device-module file each of the two robots.
3. Save the data and reboot the system.
4. Use the DC_SETUP utility to configure each robot as a unique node on the SmartServo network.
5. Use the DC_SETUP utility to assign the correct digital "logical" IO blocks to each robot. Robot 1 uses block 1 and block 3; robot 2 uses block 2 and block 4.

10.3 System Startup Procedure

Verify that the system has been installed according to [Figure 10-1 on page 86](#), and that the system configuration is complete.

1. Turn on AC power to PA-4 #1.
2. Turn on AC power to PA-4 #2.
3. Turn on the 24 V DC to the SmartController.
4. Turn on the PC running AdeptWindows and verify that it is connected to the SmartController.
5. At the V+ dot prompt, type enable power.

```
ENA POW <enter>
```

Press the High Power button on the Front Panel while it is blinking. This turns on High Power to both robots.

6. Type calibrate.
- ```
CAL <enter>
```
7. System will return with a "dot" (.) prompt, if everything was successful, then high power will be enabled, and the status panel display on each sDAI module will read "OK."
  8. System is ready for operation.

## 10.4 Connecting Digital I/O to a Dual Robot System

You can connect digital I/O to a dual robot system using the same methods as shown on a single robot system in [Figure 5-2 on page 55](#), but the dual system has added I/O capacity due to the additional PA-4 Power Chassis. The default signal configuration, or mapping, is shown in [Table 10-2](#).

**Table 10-2. Default Digital I/O Signal Configuration, Dual 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<br>(recommended <sup>a</sup> ) |           | Inputs  | 1201 - 1232  |
|                                              |           | Outputs | 0201 - 0232  |
| sDIO Module 4<br>(recommended <sup>a</sup> ) |           | Inputs  | 1233 - 1264  |
|                                              |           | Outputs | 0233 - 0264  |
| At sDAI in PA-4 #1                           | 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  |
| At sDAI in PA-4 #2                           | IO Blox 1 | Inputs  | 1161 - 1168  |
|                                              |           | Outputs | 0145 - 0152  |
|                                              | IO Blox 2 | Inputs  | 1169 - 1176  |
|                                              |           | Outputs | 0153 - 0160  |
|                                              | IO Blox 3 | Inputs  | 1177 - 1184  |
|                                              |           | Outputs | 0161 - 0168  |
|                                              | IO Blox 4 | Inputs  | 1185 - 1192  |
|                                              |           | Outputs | 0169 - 0176  |

<sup>a</sup> 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.

## 10.5 Operation With the Adept T1 Pendant

The optional Adept T1 pendant can be used to control either robot in a dual robot system. By default, the T1 controls robot 1. To switch to robot 2, press the DEV/F3 button on the pendant. The DEV LED turns on in this condition.

To switch back to robot 1, press the DEV/F3 button again. The DEV LED turns off.

See the *Adept T1 Pendant User's Guide* for complete information on using the T1 pendant.

**NOTE:** When using a pendant, either the Adept T1 Pendant or the MCP4, with an Adept Viper robot, the Free Mode is disabled for safety reasons.

## 10.6 Programming Information

### V+ Language Programming

By default, Task 0 is used to control robot 1. Task 1 is normally recommended for robot 2. Use the SELECT ROBOT=2 and ATTACH instructions in your program to select robot 2. See the *V+ Language User's Guide* and the *V+ Language Reference Guide* for more information on these instructions.

### V+ Monitor Commands

By default, monitor commands such as HERE and WHERE apply to robot 1. Use the monitor command SELECT ROBOT=2 first when you need to display the location of robot 2.

**NOTE:** The DISABLE POWER command shuts off high power to both robots in a dual robot system.

The CALIBRATE monitor command will calibrate both robots. Robot 1 will be calibrated first, then robot 2.

You can temporarily disable either robot and continue to use the other, by using the DISABLE ROBOT[ ] command. For example DISABLE ROBOT[2] will cause V+ to ignore robot 2. If you issue this command before you use the CALIBRATE command, then only one robot will be calibrated. Robot 1 can be then used normally. To re-enable robot 2, use the command ENABLE ROBOT[2].



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## Revision History

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*Adept Viper s650/s850 Robot User's Guide*, part number 05173-000

First release, Rev A, August 2005

Second release, Rev B, February 2006

Changes from Rev A:

- On [page 36](#), added section on optional Solenoid cable.
- In [Figure 4-1 on page 43](#), removed ground wire between SmartController and PA-4. Also added the adapter cable for the T1 Pendant.
- In [Section 4.3 on page 44](#), deleted step 6 because ground cable is not required.
- In [Table 4-2 on page 46](#), added power consumption specs for s850 robot.
- In [Table 5-4 on page 59](#), updated Status Code information.
- Added [Chapter 8 - starting on page 75](#), with information on the IP54/65 model.
- Added [Chapter 9 - starting on page 79](#), with information on the Cleanroom model.
- Added [Chapter 10 - starting on page 85](#), with information on Dual Robot systems.





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