Adept Viper s1300 Robot

User's Guide

adept®

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User's Guide

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Table of Contents

List of Figures

Introduction 1

1.1 Product Description

Adept Viper s1300™ Robots

The Adept Viper s1300 is a high-performance, six-axis robot 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.

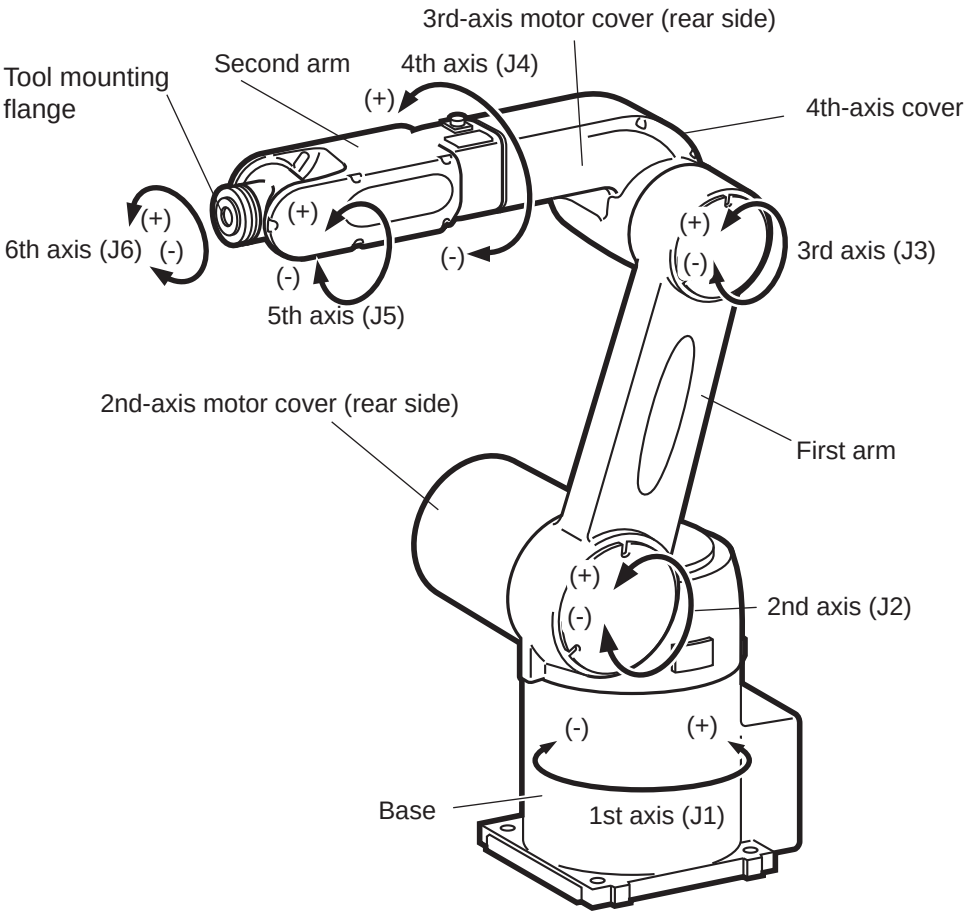


Figure 1-1. Robot Axis Identification

Adept SmartController CX™

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

The SmartController CX supports 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.

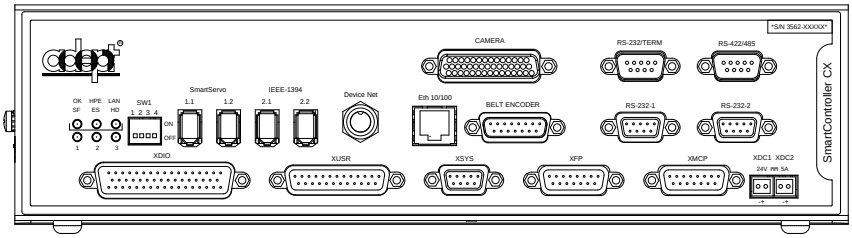


Figure 1-2. Adept SmartController CX

Adept PA-4™ CAT-3 Power Chassis

The PA-4 CAT-3 includes AC-DC power conversion electronics that support a range of Adept power amplifiers and robot control modules. In addition, the PA-4 CAT-3 includes dual (redundant) high-power AC contactors. The PA-4 is configured with J Amplifier modules to support the Adept Viper s1300 robot systems.

The J and K amplifiers in the Adept Viper s1300 robot system are controlled by the sDAI (100 W) 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 Dangers, Warnings, Cautions, and Notes

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

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

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

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

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

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

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

1.3 Safety Precautions

DANGER: The Adept Viper s1300 robot can cause serious injury or death, or damage to itself and other equipment, if the following safety precautions are not observed:

- All personnel who install, operate, teach, program, or maintain the system must read this guide, read the ***Adept Robot Safety Guide***, and complete a training course for their responsibilities in regard to the robot.
- All personnel who design the robot system must read this guide, read the ***Adept Robot Safety Guide***, and must comply with all local and national safety regulations for the location in which the robot is installed.
- The robot system must not be used for purposes other than described in **Section 1.6**. Contact Adept if you are not sure of the suitability for your application.
- The user is responsible for providing safety barriers around the robot to prevent anyone from accidentally coming into contact with the robot when it is in motion.
- Power to the robot and its power supply must be locked out and tagged out before any maintenance is performed.

1.4 What to Do in an Emergency 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.

1.5 Additional Safety Information

Adept provides other sources for more safety information:

Manufacturer's Declaration of Compliance (MDOC)

This lists all standards with which each robot complies. **See "Manufacturer's Declaration" on page 13.**

Adept Robot Safety Guide

The ***Adept Robot Safety Guide*** provides detailed information on safety for Adept robots. It also gives resources for more information on relevant standards.

It ships with each robot manual, and is also available from the Adept Document Library. **See "Adept Document Library" on page 15.**

1.6 Intended Use of the Robots

The Adept Viper robots are intended for use in parts assembly and material handling for payloads less than 10 kg. See **Chapter 2** for complete information on tooling and payloads.

1.7 Installation Overview

The system installation process is summarized in the following table. Refer also to the system cable diagram in **Figure 3-1 on page 33**.

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

Table 1-1. Installation Overview

Task to be Performed	Reference Location
1. Mount the robot on a flat, secure mounting surface.	See Section 2.4 on page 22.
2. Install the SmartController, Front Panel, and Adept ACE™ software.	See Section 3.2 on page 34.
3. Install the PA-4 power chassis.	See Section 3.5 on page 35.
4. Install the Arm Power/Signal cable between the PA-4 and the robot.	See Section 3.5 on page 35.
5. Install the IEEE 1394 and XSYS cables between the PA-4 and SmartController.	See Section 3.5 on page 35.
6. Connect AC power to PA-4 power chassis.	See Section 3.6 on page 37.
7. Start the Adept ACE software, connect to the controller, and turn on power to the system.	See Section 4.1 on page 41.

1.8 Manufacturer's Declaration

The Manufacturer's Declaration of Incorporation and Conformity lists all standards for which the Adept Viper robot system complies. It can be found on the Adept Web site, in the Download Center of the Support section.

ftp://ftp1.adept.com/Download-Library/Manufacturer-Declarations/

Each Manufacturer's Declaration is supplied in PDF format and stored on the website in a ZIP archive. To access the PDF document:

1. Click on the appropriate .zip file. You are prompted to Open or Save the file.
2. Click Open to open the file and display the archive contents.
3. Double-click on a .pdf file to open it.

1.9 How Can I Get Help?

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

http://www.adept.com

- For Contact information:
  http://www.adept.com/contact/americas
  http://www.adept.com/contact/asiapacific-rim
  http://www.adept.com/contact/europe
- For Product Support information:
  http://www.adept.com/support/service-and-support/main
- For user discussions, support, and programming examples:
  http://www.adept.com/forum/
- WEEE/RoHS, Policy:
  ftp://ftp1.adept.com/Download-Library/Regulatory/
- WEEE Drop-off Sites:
  http://www.adept.com/contact/americas
  http://www.adept.com/contact/asiapacific-rim
  http://www.adept.com/contact/europe

  The Download Center (ID # 500080) provides Adept WEEE/RoHS Policy. The Contact area of the web site gives locations of WEEE drop-off sites.

Related Manuals

This manual covers the installation, operation, and maintenance of an Adept Viper s1300 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 Robot Safety Guide	Contains general safety information for all Adept robots.
Adept SmartController User's Guide	Contains complete information on the installation and operation of the Adept SmartController and the optional sDIO product.
Adept PA-4 Power Chassis User's Guide	Contains complete information on the installation and operation of the PA-4 Power Chassis.
Adept ACE User's Guide	Describes installation of Adept ACE software.
Adept Viper Dual Robot Configuration Procedure	Contains cable diagrams and configuration procedures for a dual-robot system.
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 the ADL from:

- the Adept Software CD shipped with your system
- the Adept Web site. Select Document Library from the Adept home page. To go directly to the Adept Document Library, type the following URL into your browser:

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

To locate information on a specific topic, use the Document Library search engine on the ADL main page. To view a list of available product documentation, select the Document Titles option.

2 Robot Installation

2.1 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 1.9 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.

2.2 Environmental and Facility Requirements

The Adept robot system installation must meet the operating environment requirements shown in **Table 2-1**.

Table 2-1. 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 2-3 on page 23**.

2.3 Transporting the Robot

Precautions in Transporting Robot

- The robot weighs approximately 78 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.

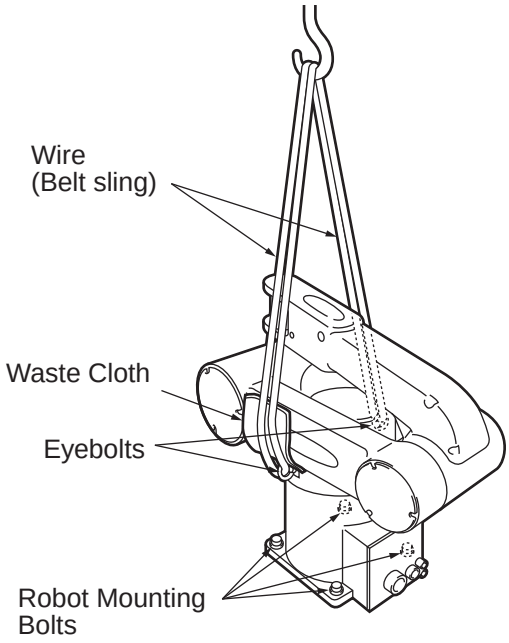
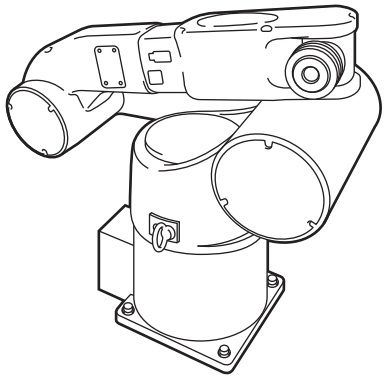


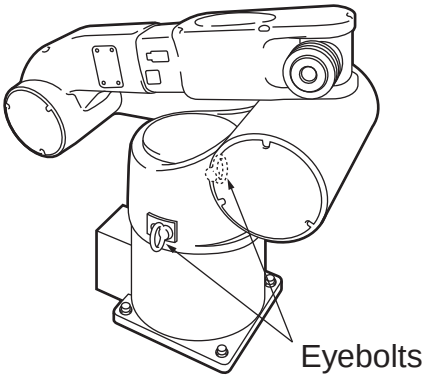
Figure 2-1. Robot in Hoisting Sling

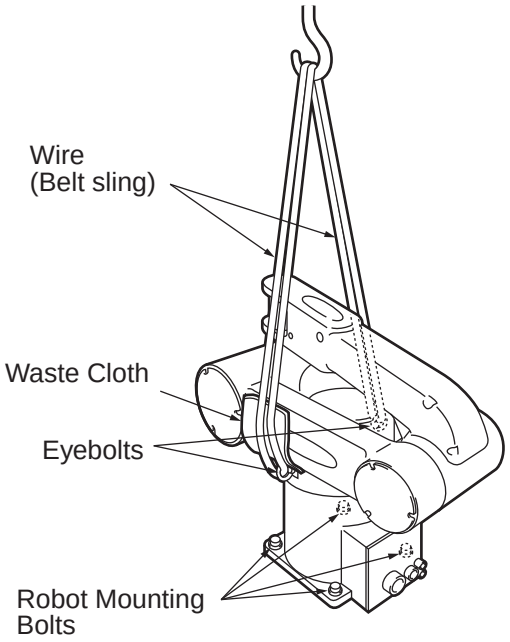
Transport Procedure

<table>
<tr><th>Step</th><th>Procedure</th><th>Drawing</th></tr>
<tr><td>1</td><td>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.</td><td> 
Transport Position<table><tr><th>Axis</th><th>Angle</th></tr><tr><td>First axis (J1)</td><td>+90°</td></tr><tr><td>Second axis (J2)</td><td>-175°</td></tr><tr><td>Third axis (J3)</td><td>+255°</td></tr><tr><td>Fourth axis (J4)</td><td>-90°</td></tr><tr><td>Fifth axis (J5)</td><td>-90°</td></tr></table></td></tr>
<tr><td>2</td><td>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.</td><td></td></tr>
<tr><td>3</td><td>As shown at right, mount the eyebolts.

When delivered, the robot unit is packed with eyebolts attached, so this job is not required</td><td>  </td></tr>
</table>

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.	
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 2.4 on page 22**.	
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.

2.4 Mounting the Robot

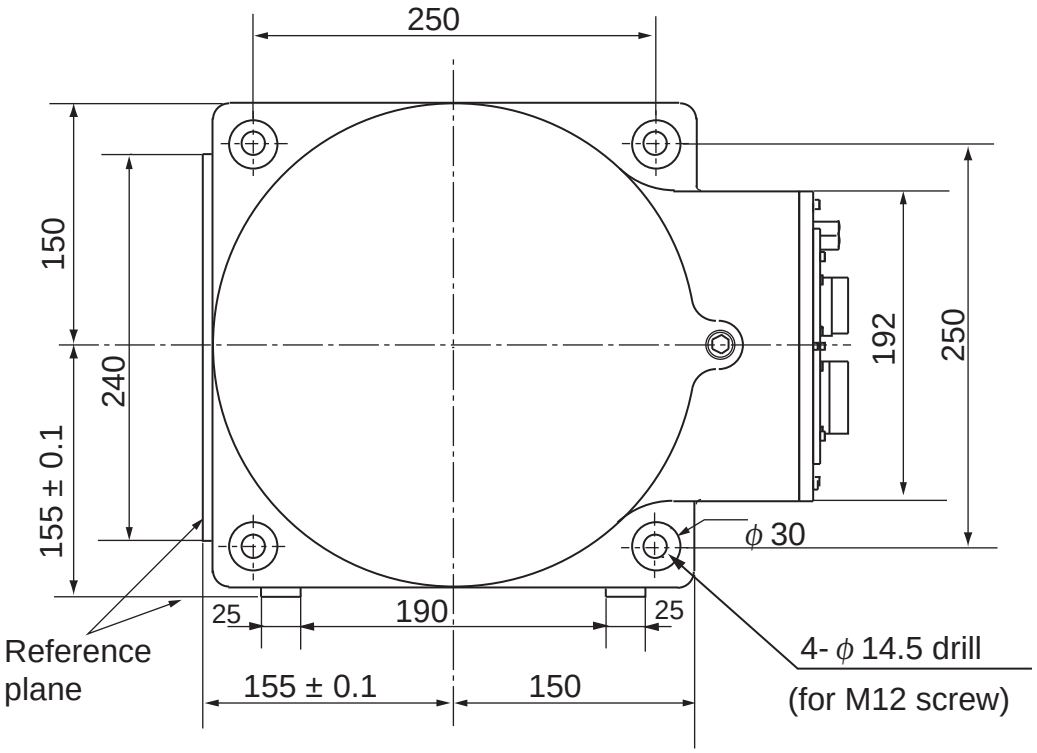


Figure 2-2. Mounting Hole Pattern for Robot

1. See **Figure 2-2** for the dimensions of the mounting holes in the robot mounting position where the robot unit is to be secured.
2. Drill four bolt holes (M12), 15 mm deep or more.
3. Secure keys or pins to the reference planes.

   NOTE: Be sure to secure keys or pins. They can minimize positional deviations that may be caused by the removal and installation of the robot unit for maintenance.

4. Set the robot unit into place on the robot mount. When transporting the robot unit, follow the instructions given in **Section 2.3 on page 19**.
5. Secure the robot unit to the mount with four bolts and plain washers.
   - Bolt: M12 x 40 mm (strength class: 12.9)
   - Tightening torque: 110 +/- 22 Nm
   - Plain washer: JIS B 1256 (polished round)

2.5 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.

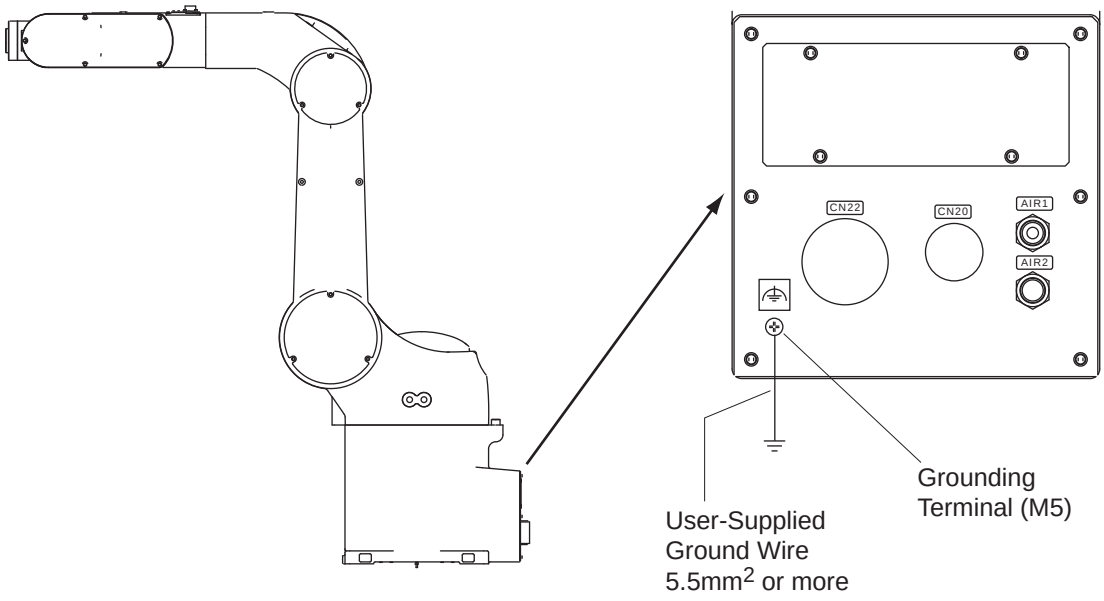


Figure 2-3. Ground Point on Robot

2.6 Description of Connectors on Robot Interface Panel

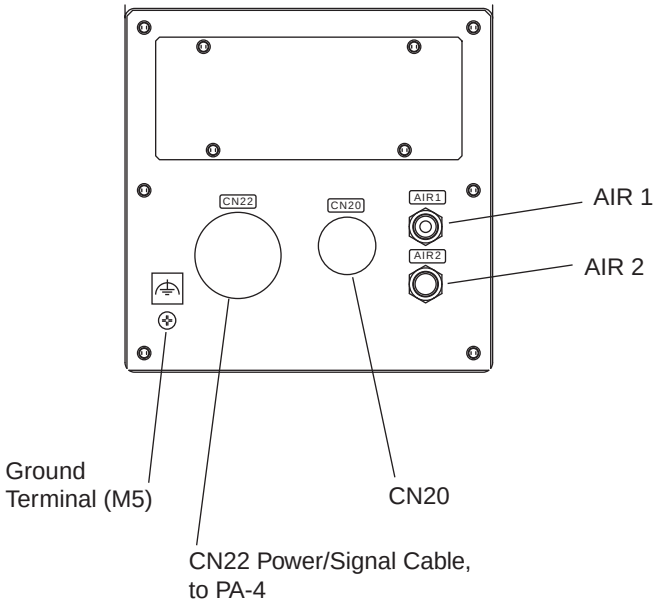


Figure 2-4. Robot Interface Panel

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

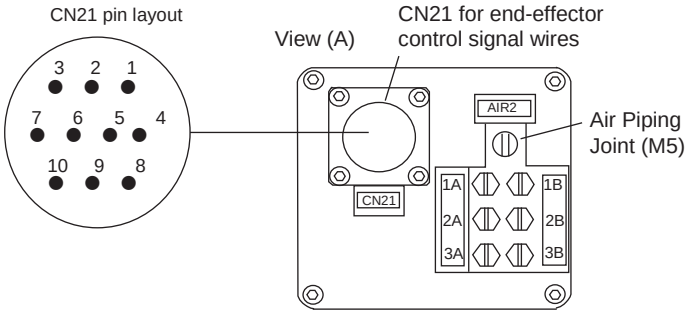
CN20 - Pins 1 to 10 are wired directly to corresponding pins 1 to 10 on CN21 on the upper arm. Pins 12 to 18 are for solenoid control. See **Section 2.7 on page 25**.

AIR 1 - air piping connector (BSPT1/4) for three solenoids in robot. See **Section 2.7 on page 25**.

AIR 2 - air piping connector (BSPT1/4), connects directly to AIR 2 on the second (upper) arm.

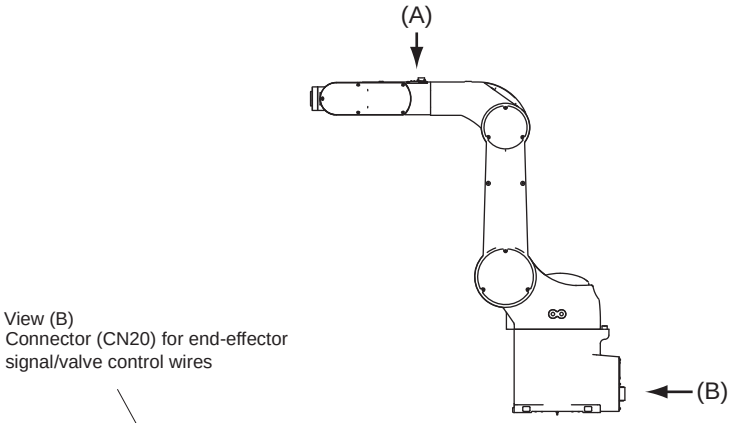
Grounding Terminal - ground point on robot, see **Section 2.5 on page 23**.

2.7 Air Lines and Signal Wiring



Valve Symbols and Air Intake and Exhaust States
(1A and 1B are piping joint symbols.)

Air piping joint			Valve signal		
	Air intake	Exhaust	Solenoid valve	Solenoid A	Solenoid 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					



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: Pin #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 connector sets for CN20 and CN21.

Connector set part 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.

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

Table 2-2. 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 2-3** 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 2-3. 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 2-4. Solenoid Valve Specifications

	Item	Specifications
Valve	Switching system	2-position double
	Applicable fluid	Air
	Operating system	Pilot type
	Effective cross section (Cv value)	0.27 (P-->A/B) 0.3 (A/B-->EA/EB)
	Lubrication	Oilless
	Operating pressure range	0.1 to 0.7 Mpa
	Response time	10 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 ±10%
	Power consumption (current)	0.65 W (27 mA)
	Surge voltage protection circuit	Diode

External Mounting Locations on Robot

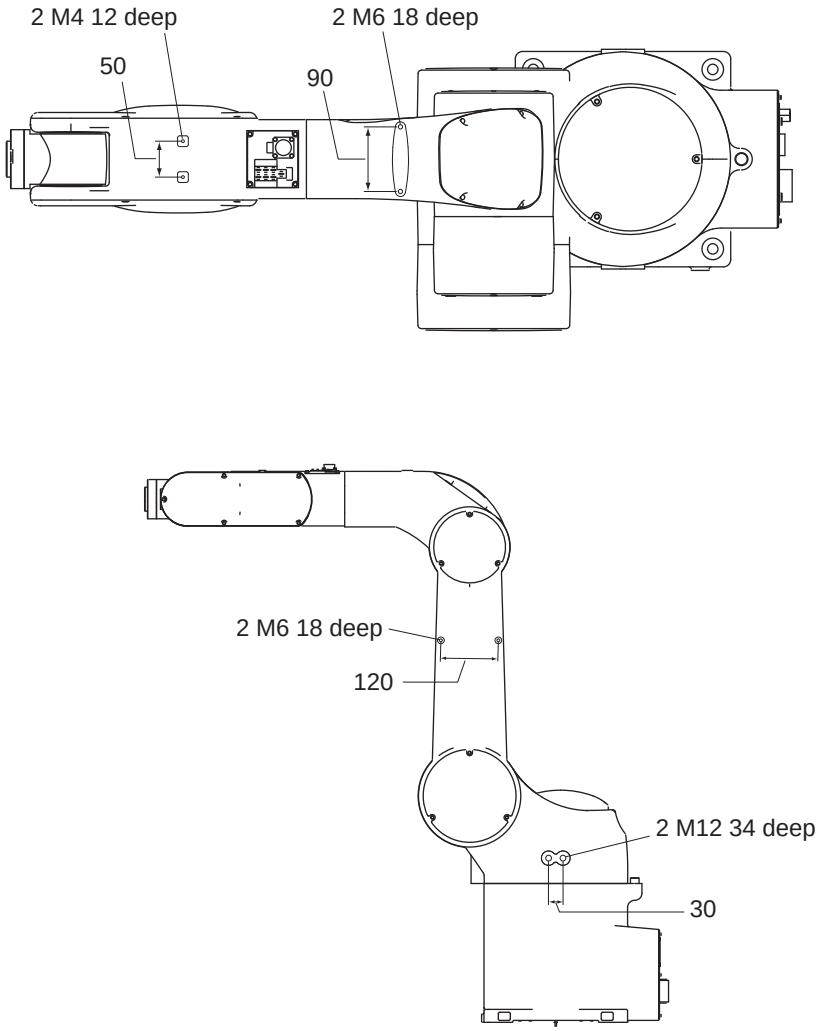


Figure 2-5. External Mounting Holes on Robot

2.8 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 (10 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 2-6**.

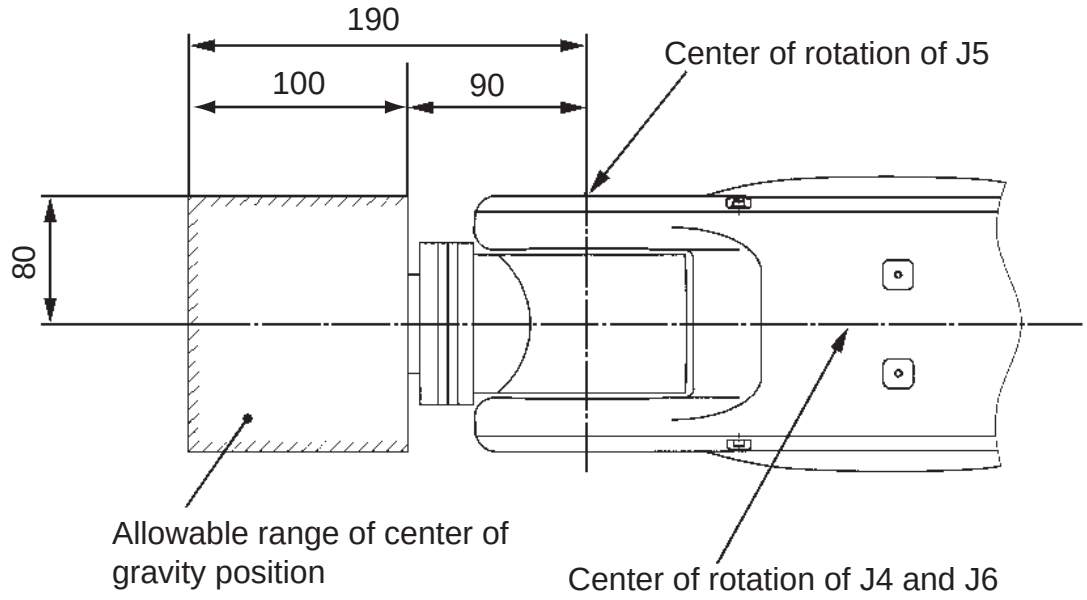


Figure 2-6. Allowable Range of Center of Gravity Position of End-effector

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.

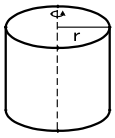
Moment of inertia around J4, J5, and J6 of end-effector (including mass of workpiece) must be less than or equal to the maximum allowable moment of inertia

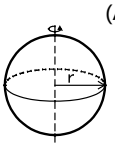
Maximum allowable moment of inertia around J4 and J5: 0.36 kgm^2

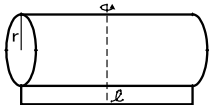
Maximum allowable moment of inertia around J6: 0.064 kgm^2

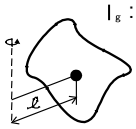
When calculating the moment of inertia around J4, J5, and J6 of the end-effector, use the formulas given in **Table 2-5**, and see examples in **Figure 2-7 on page 31**.

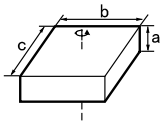
Table 2-5. Moment of Inertia Formulas

<table>
<tr>
<td>1. Cylinder (1)
(Axis of rotation = Center axis)
 

$I = \frac{mr^2}{2}$</td>
<td>4. Sphere
(Axis of rotation = Center axis)
 

$I = \frac{2mr^2}{5}$</td>
</tr>
<tr>
<td>2. Cylinder (2)
(The axis of rotation passes through the center of gravity.)
 

$I = \frac{m}{4}\left(r^2 + \frac{\ell^2}{3}\right)$</td>
<td>5. Center of gravity not on the axis of rotation
 

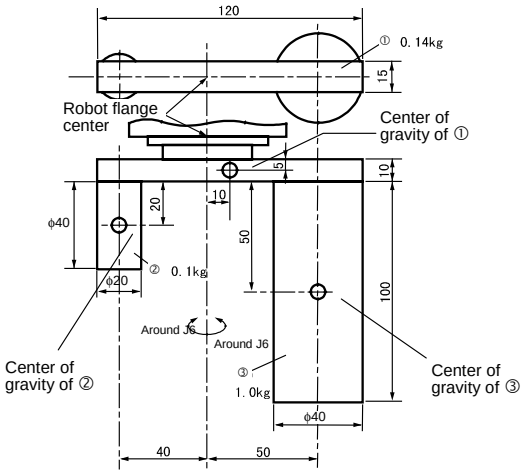
I_g : Inertia moment around center of gravity [kgm^2]
$I = I_g + m\ell^2$</td>
</tr>
<tr>
<td>3. Rectangular parallelepiped
(The axis of rotation passes through the center of gravity.)
 

$I = \frac{m}{12}(b^2 + c^2)$</td>
<td>I: Moment of inertia (kgm^2)
m: Mass (kg)
r: Radius (m)
b, c, ℓ: Length (m)</td>
</tr>
</table>

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 3-5)

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

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

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

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

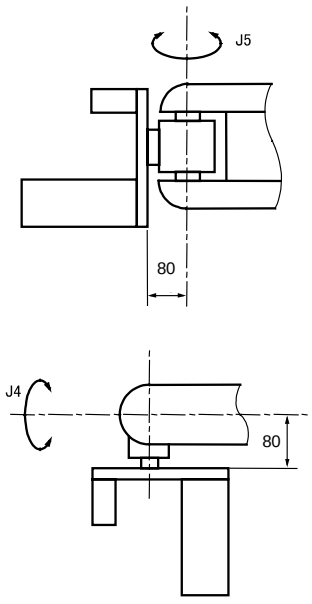
$$I_3 = \frac{1.0 \times 0.02^2}{2} + 1.0 \times 0.05^2$$
$$= 2.7 \times 10^{-3} \ [\mathrm{kgm^2}]$$

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 3-5)

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

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

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

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

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

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 2-7. Moment of Inertia Calculation Examples

3 System Installation

3.1 System Cable Diagram

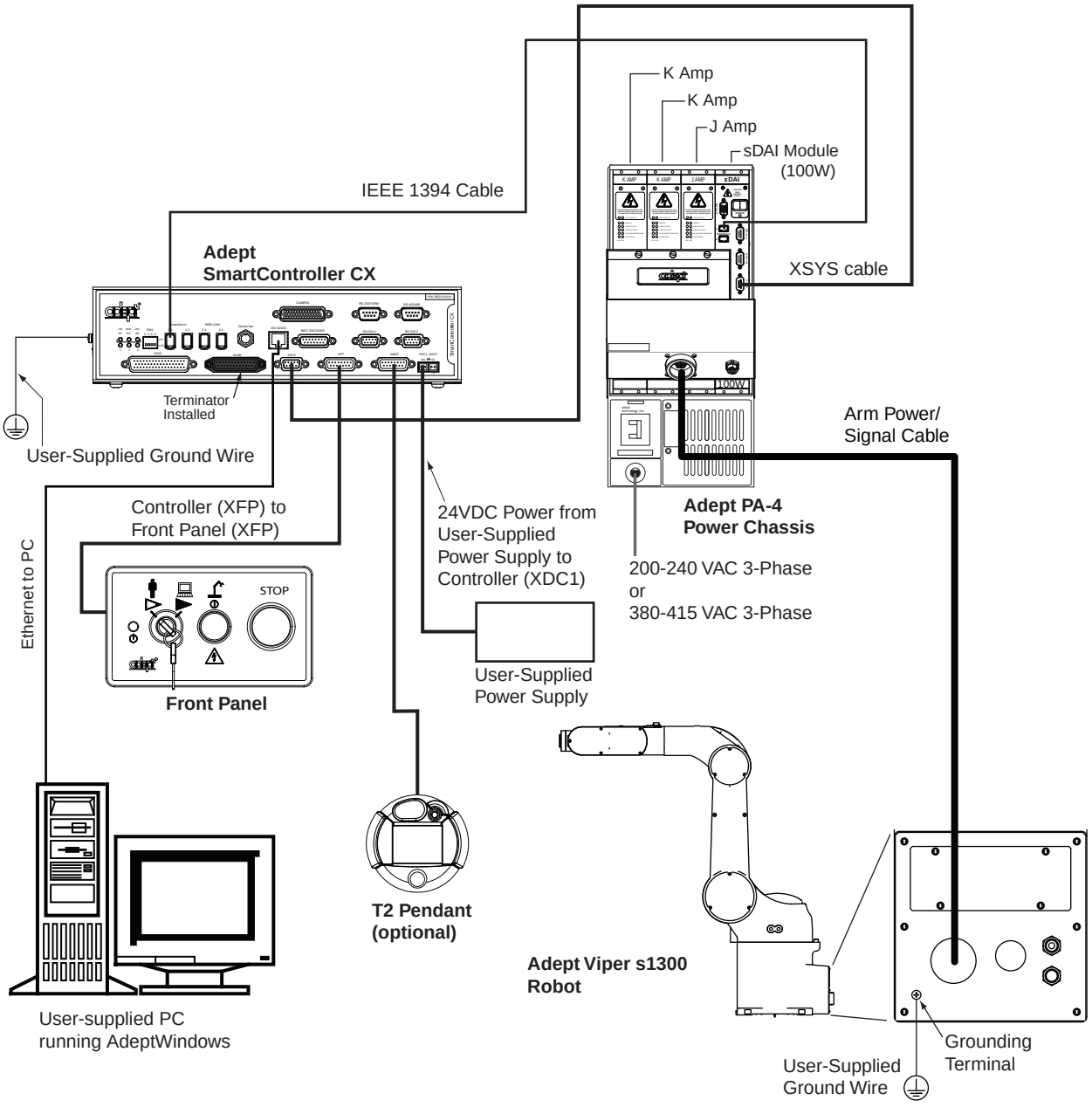


Figure 3-1. System Cable Diagram for Adept Viper s1300 Robot

3.2 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 Adept ACE PC software on the user-supplied PC. This includes connecting the supplied Ethernet crossover cable between the user-supplied PC and the Ethernet port on the SmartContoller.

3.3 Installing the Adept ACE Software

The Adept ACE software is installed from the Adept ACE software CD-ROM.

1. Insert the CD-ROM into the CD-ROM drive of your PC.

   If Autoplay is enabled, the Adept software CD-ROM menu is displayed. If Autoplay is disabled, you will need to manually start the CD-ROM.
2. Especially if you are upgrading your Adept ACE software installation: from the Adept ACE software CD-ROM menu, click Read Important Information.
3. From the Adept ACE software CD-ROM menu, select:

   Install the Adept ACE Software

   The Adept ACE Setup wizard opens.
4. Follow the online instructions as you step through the installation process.
5. When the installation is complete, click Finish.
6. After closing the Adept ACE Setup wizard, click Exit on the CD-ROM menu to close the menu.

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

3.4 Connecting the PC to the SmartController

The Adept SmartController motion controller must be connected to a user-supplied PC or the Adept SmartVision EX processor for setup, control, and programming.

- Connect an Ethernet crossover cable between the PC and the SmartController motion controller

  or

- Use two standard Ethernet cables with a network hub or switch in place of the Ethernet crossover cable.

  NOTE: Do not use an Ethernet crossover cable with a network hub or switch.

For more details, refer to the Adept ACE User's Guide.

3.5 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, 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 3-1 on page 33** and **Figure 3-2 on page 36**.
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.

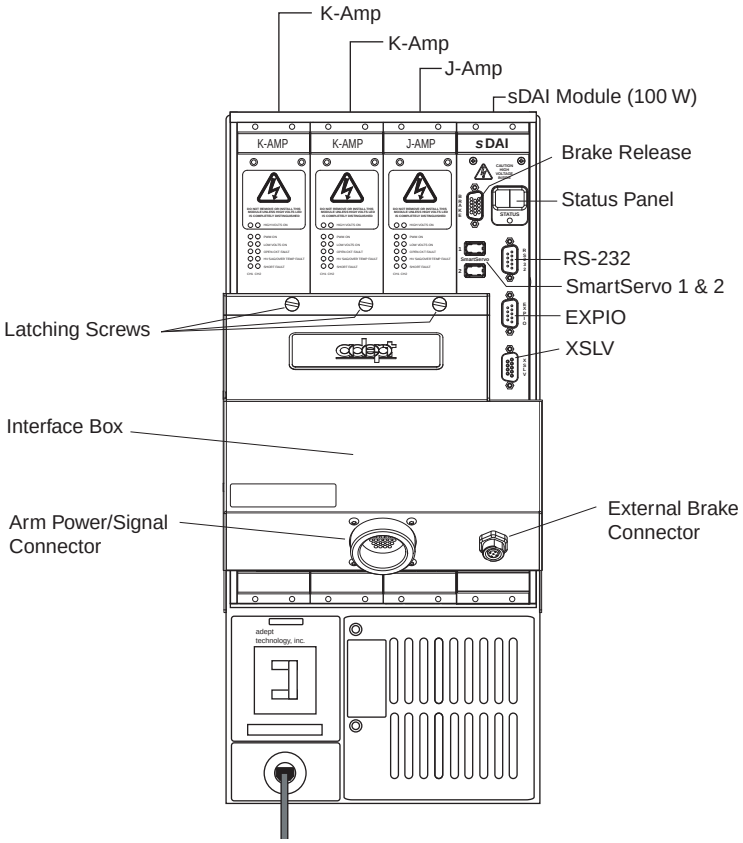


Figure 3-2. Adept PA-4 Power Chassis with sDAI Module

NOTE: In Adept Viper s1300 systems, the sDAI module must be a 100 W version. A standard sDAI will not work.

3.6 Connecting 3-Phase AC Power to PA-4

PA-4 3-Phase Power Requirements

Table 3-1. 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	50-60 Hz, 3-phase	180 VAC	245 VAC	20 amps
380 to 415 VAC	50-60 Hz, 3-phase with neutral	342 VAC	424 VAC	20 amps

Table 3-2. Typical Robot Power Consumption[a]

Robot	Move	Average Power (W)	Peak Power (W)[b]
Adept Viper s1300	No load - Adept cycle[c]	385	1871
	10.0 kg - Adept cycle[c]	319	1382
	10.0 kg - all joints move	912	3674

[a] Typical power data is with 220 VAC, 60 Hz, 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.

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 3-3**. The installation must meet all applicable European, international, and national standards and regulations.

Table 3-3. 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

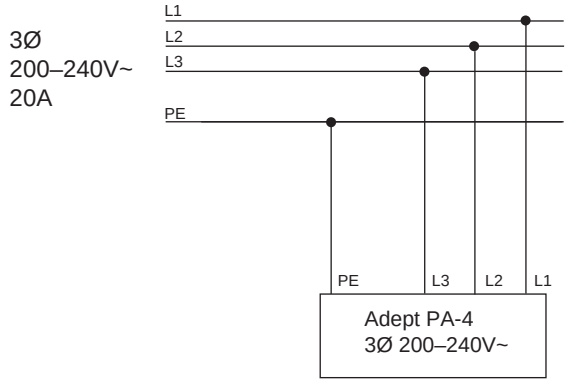


Figure 3-3. Typical 3-Phase 200-240 VAC Connection for PA-4 System

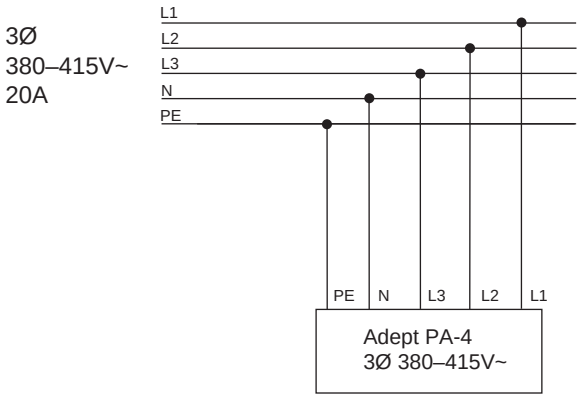


Figure 3-4. Typical 3-Phase 380-415 VAC Connection for PA-4 System

4 System Operation

4.1 Commissioning the System

Turning on the robot system for the first time is known as "commissioning the system." Follow the steps in this section to safely bring up your robot system. The steps include:

- Verifying installation, to confirm all tasks have been performed correctly
- Starting up the system by turning on power for the first time
- Verifying all E-Stops in the system function correctly
- Moving each axis of the robot to confirm it moves in the proper directions

Verifying Installation

Verifying that the system is correctly installed and that all safety equipment is working correctly is an important process. Before using the robot, make the following checks to ensure that the robot and controller have been properly installed.

DANGER: After installing the robot, you must test it before you use it for the first time. Failure to do this could cause death, serious injury, or equipment damage.

Mechanical Checks

- Verify that the robot is mounted level and all fasteners are installed and tightened.
- Verify that any end-of-arm tooling is properly installed.
- Verify that all other peripheral equipment is properly installed and in a state where it is safe to turn on power to the robot system.

System Cable Checks

Verify the following connections:

- Front Panel to the SmartController.
- Pendant to the SmartController, via the pendant adapter cable.
- User-supplied 24 VDC power to the controller.
- User-supplied 200/240 VAC power to the PA-4.
- User-supplied ground wire between the SmartController and ground.
- XSYS cable between the robot interface panel XSLV safety interlock connector and XSYS connector on the SmartController, and the latching screws tightened.

- One end of the IEEE 1394 cable into the SmartServo port 1.1 connector on the SmartController, and the other end into the SmartServo port 1 connector on the robot interface panel.
- XSYS cable between the robot interface panel XSLV safety interlock connector and XSYS connector on the SmartController, and the latching screws tightened.

User-Supplied Safety Equipment Checks

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

System Start-up Procedure

Once the system installation has been verified (see **"Verifying Installation" on page 41**), you are ready to start up the system.

1. Switch on AC power to the PA-4.
2. Switch on the 24 VDC power to the SmartController.
3. Turn on power to the robot.
4. Follow the instructions, beginning with Starting the Adept ACE Software, in the following section.

Running the Adept ACE Software

Starting the Adept ACE Software

The robot should be on, and the status panel should display OK before proceeding.

1. Turn on the PC and start the Adept ACE software.
   - Double-click the Adept ACE icon on your Windows desktop

     or, from the Windows Start menu bar,
   - Select **Start > Programs > Adept Technology > Adept ACE > Adept ACE**.
2. On the Adept ACE Startup menu, click New SmartController Workspace.
3. Click-select the SmartController you want to use, and click OK.

Enabling High Power

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

1. From the Adept ACE main menu, click the Enable High Power icon: 
2. If the High Power button on the Front Panel is blinking, press and release it.

   NOTE: The use of the blinking High Power button can be configured (or eliminated) in software. Your system may not require this step.

   The Front Panel, which is mounted just outside the workcell safety barrier, is shown in the following figure. If enabled, the High Power button must be pressed while blinking (default time-out is 10 seconds). If the button stops blinking, you must enable power again.

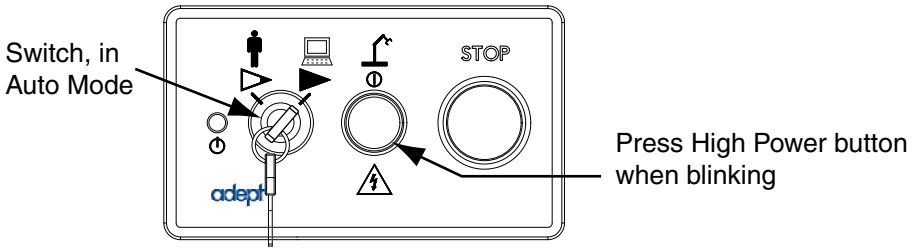


Figure 4-1. High Power Button on Front Panel

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

- The amplifier status LED blinks green rapidly (a slow green blink has a different meaning).

  In addition, for Adept IP-65 Viper robots, the lamps on the robot glow solid amber.

- The status panel on the robot or amplifier chassis displays ON.

Verifying E-Stop Functions

Verify that all E-Stop devices are functional (pendant, Front Panel, and user-supplied). Test each mushroom button, safety gate, light curtain, etc., by enabling high power and then opening the safety device. The High Power push button/light on the Front Panel should go out.

Verifying Robot Motions

Use the pendant to test the motion of each axis on the robot to confirm it moves in the proper directions. Refer to the *Adept SmartController User's Guide* and the *T2 Pendant User's Guide* for complete instructions on using the pendant.

> **NOTE:** If the optional pendant is not installed in the system, you can move the robot using the Robot Jog Control in the Adept ACE software. For details, see the Adept ACE User's Guide.

4.2 Learning to Program the Robot

To learn how to use and program the robot, see the *Adept ACE User's Guide*, which provides information on robot configuration, control and programming through the Adept ACE software "point and click" user interface.

For V+ programming information, refer to the following optional manuals:

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

> **NOTE:** When using an Adept pendant with an Adept Viper robot, the Free Mode is disabled for safety reasons.

4.3 Connecting Digital I/O to the System

You can connect digital I/O to the system in several different ways. See **Table 4-1** and **Figure 4-2**. Also refer to **page 26** for information on the optional Solenoid cable.

Table 4-1. 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*

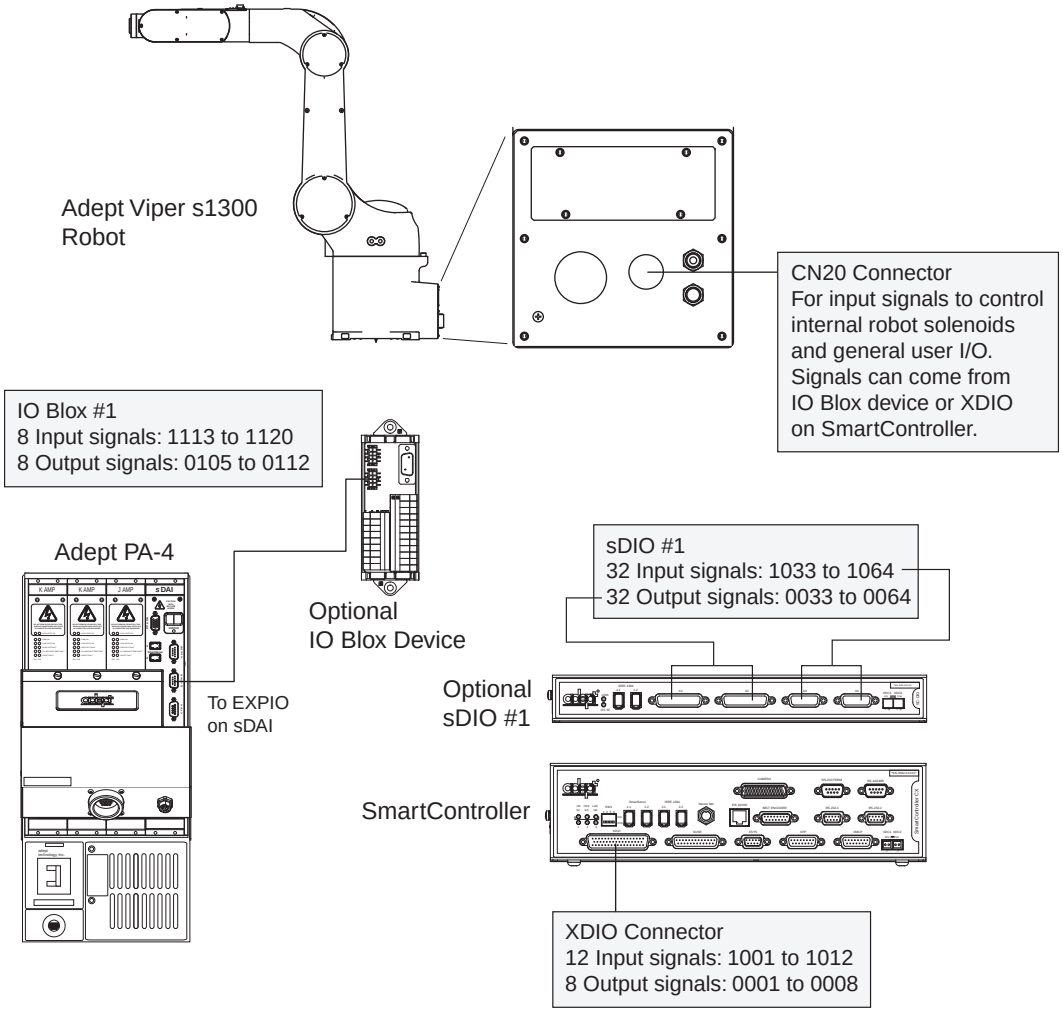


Figure 4-2. Connecting Digital I/O to the System

Table 4-2. 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)	Inputs	1201 - 1232
	Outputs	0201 - 0232
sDIO Module 4 (recommended)	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

4.4 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 4-3** 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 4-3. 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.

4.5 Installing and Using the 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 4-3 on page 47**.

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).
4. Using the axis selector switch, select the axis that you want to release the brake.
5. Depress the brake release push button, 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 push button is pressed.

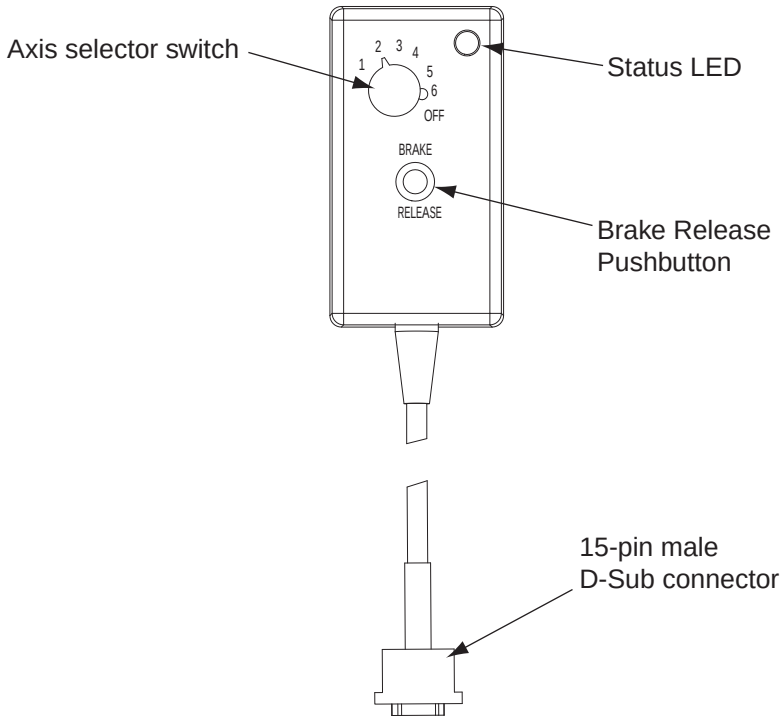


Figure 4-3. Manual Brake Release Box

5 Maintenance

5.1 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 5-1**.

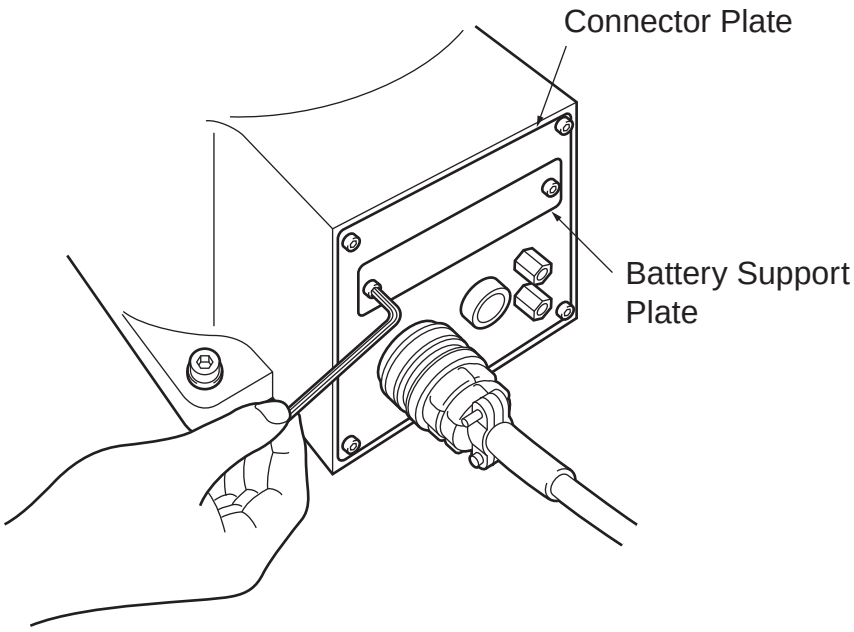


Figure 5-1. Removing Cover to Replace Encoder Batteries

4. Pull out the battery support plate. See **Figure 5-2**.

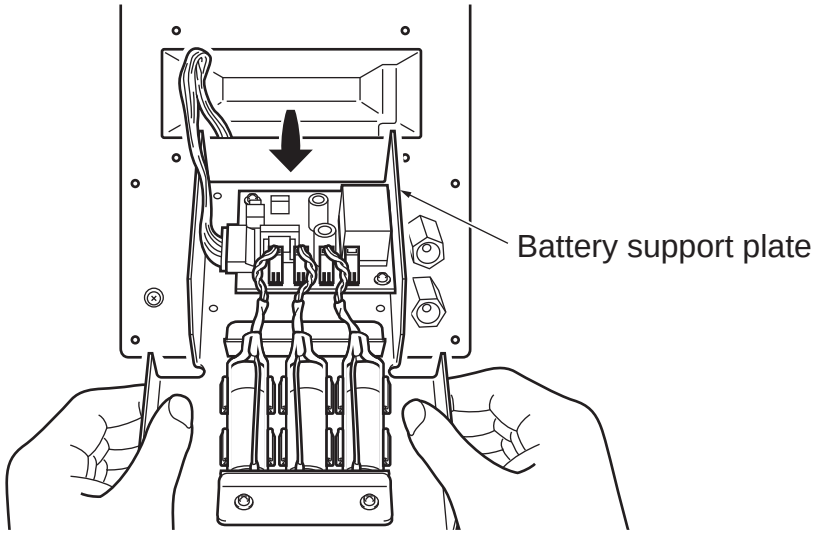


Figure 5-2. Removing Battery Support Plate

5. Remove the dummy connector cap from the battery board. See **Figure 5-3**.

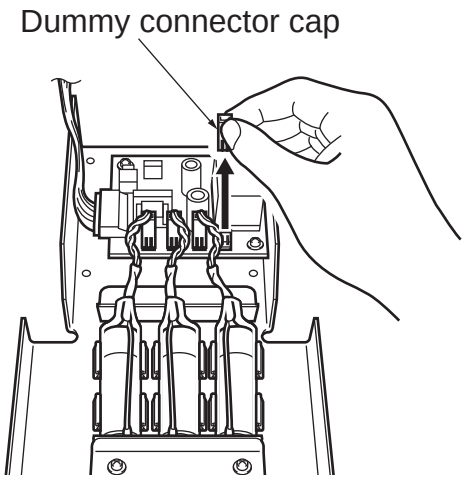


Figure 5-3. Removing Dummy Connector Cap

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

   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.

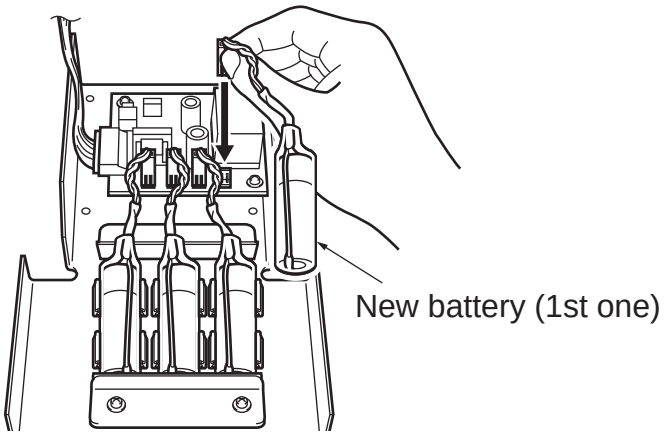


Figure 5-4. Connecting First New Battery

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

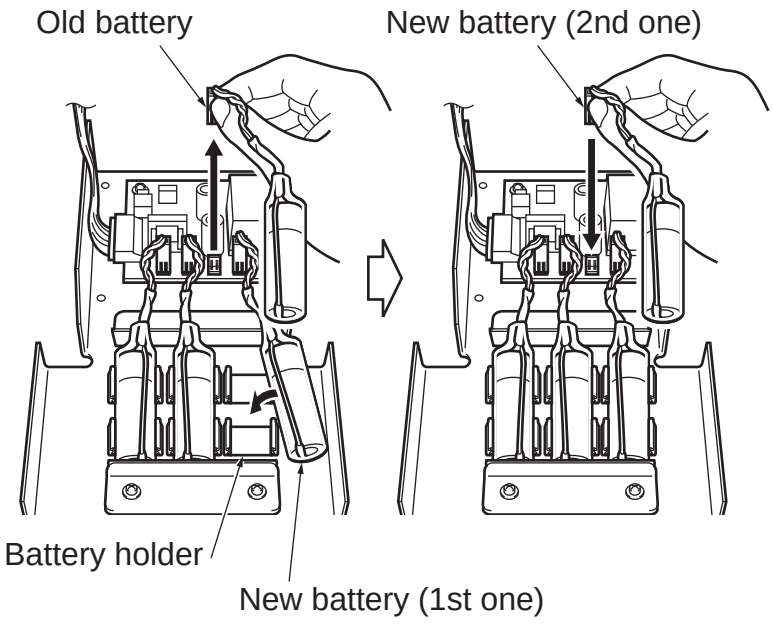


Figure 5-5. Connecting Second New Battery

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

8. Disconnect the old backup battery that is next to the new battery connected in Step 7, and then connect a new battery (3rd one). See **Figure 5-6**.

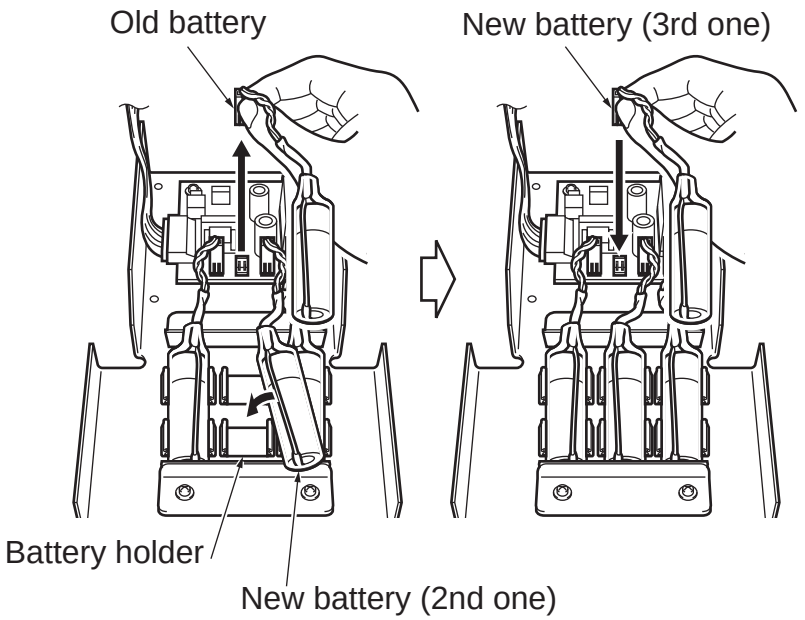


Figure 5-6. Connecting Third New Battery

9. Remove the last old battery and connect the dummy connector cap disconnected in Step 5. See **Figure 5-7**.

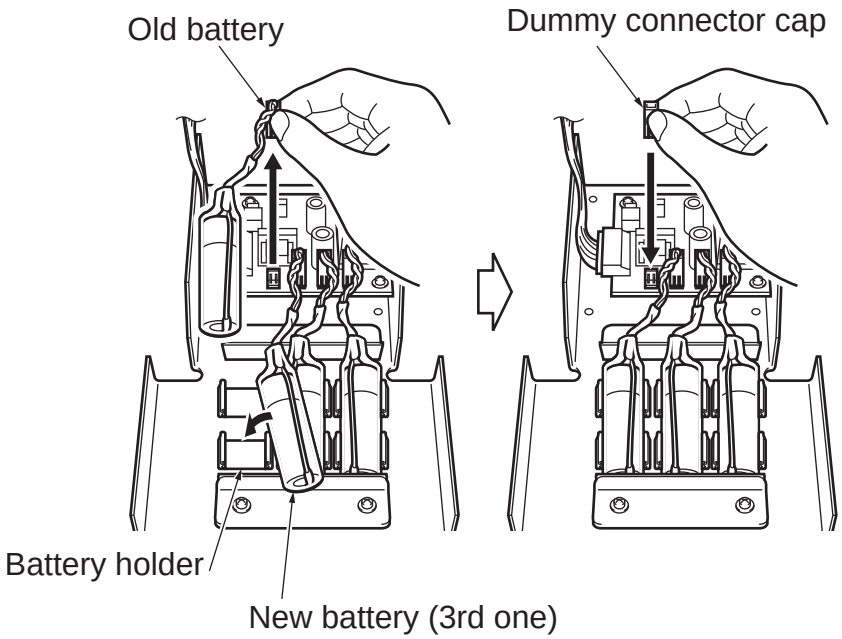


Figure 5-7. Reconnecting Dummy Connector Cap

10. Secure the battery support plate to the connector plate.

    Tightening torque: 1.6 +/- 0.3 Nm

5.2 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.

6 Technical Specifications

6.1 Robot Dimensions

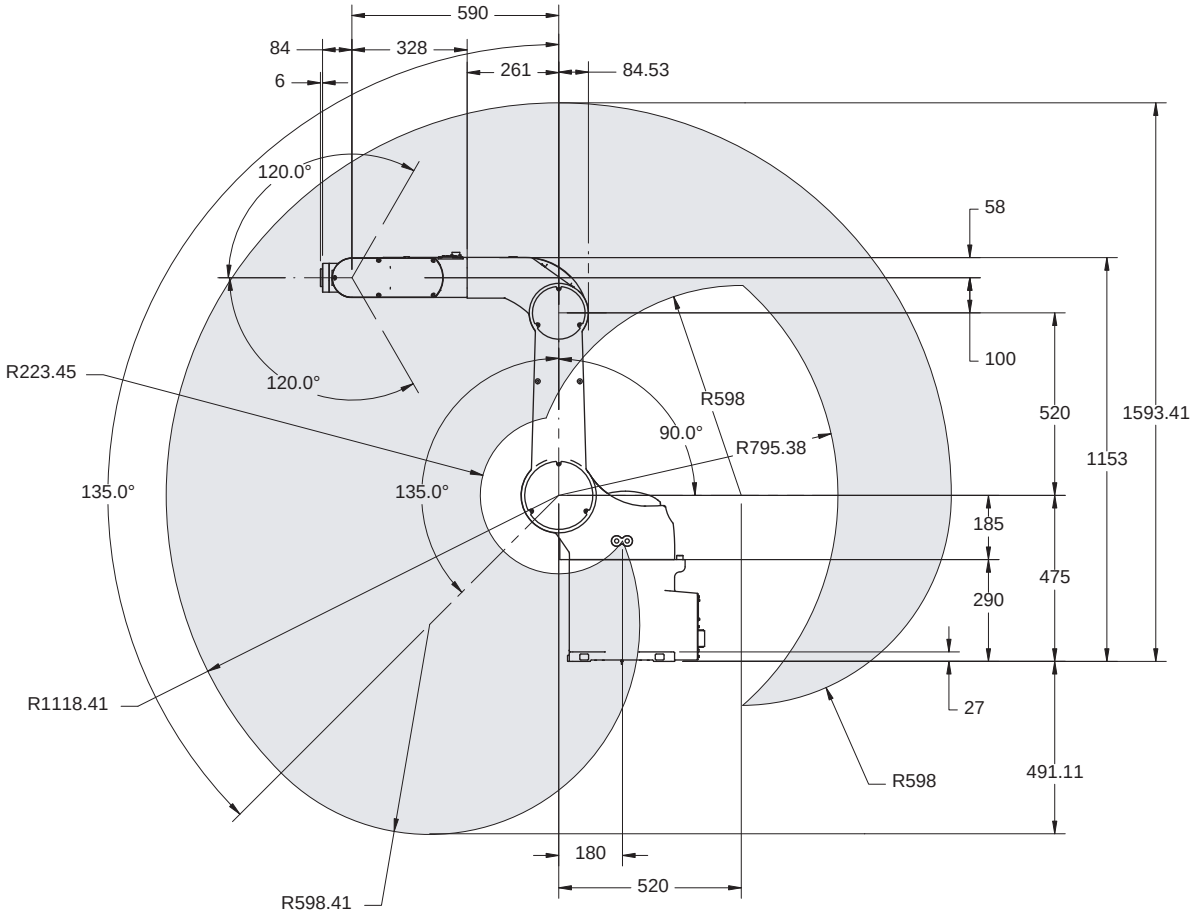


Figure 6-1. Adept Viper s1300 Side Dimensions and Work Envelope

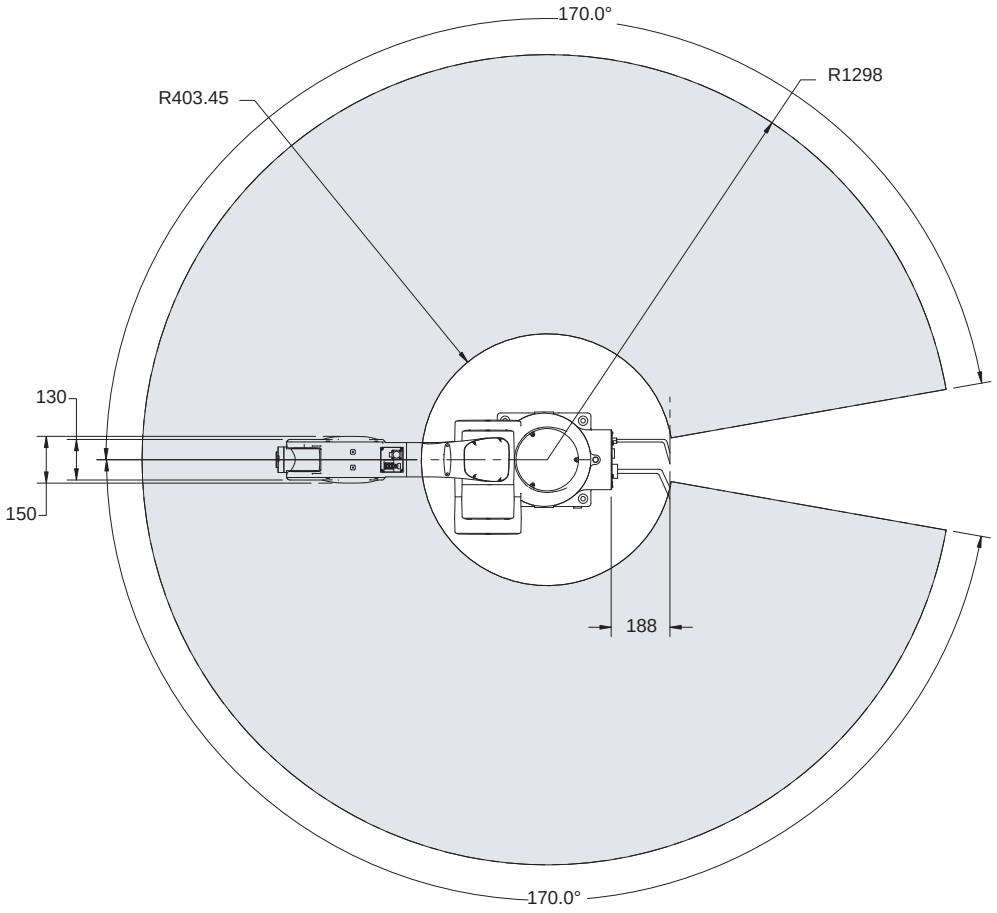


Figure 6-2. Adept Viper s1300 Top Dimensions and Work Envelope

6.2 Robot Flange Dimensions

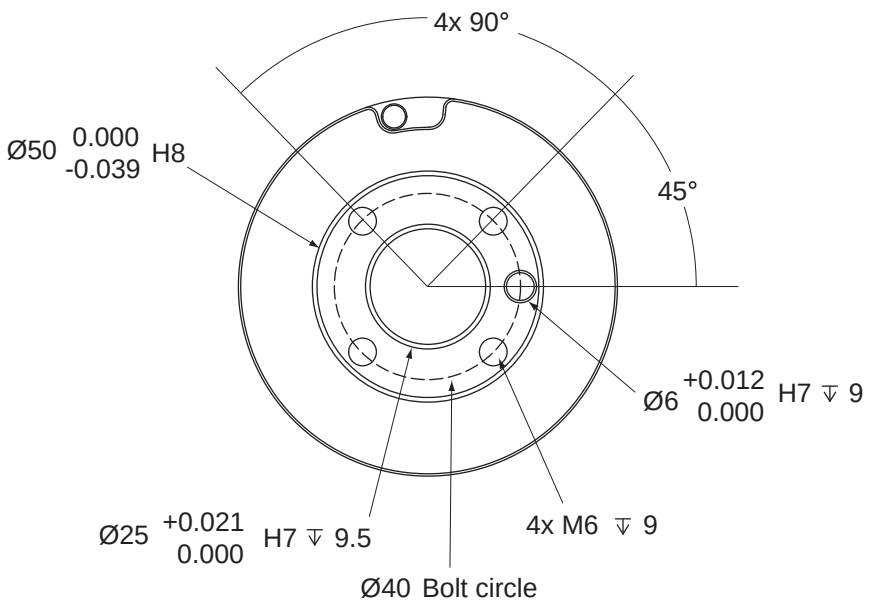


Figure 6-3. Robot Flange Dimensions

6.3 Specifications

Table 6-1. Robot Specifications

Specification	s1300
Overall arm length	520 (first arm) + 590 (second arm) = 1100 mm
Arm offset	J1 (swing): 180 mm, J3 (front arm): 100 mm
Maximum motion area	R = 1388 mm (end-effector mounting face) R = 1298 mm (Point P: J4, J5, J6 center)
Motion range	J1: ±170° J2: -180°, +45° J3: +10°, +255° J4: ±185° J5: ±120° J6: ±360°
Maximum composite speed (at the center of an end-effector mounting face)	8300 mm/s
Maximum payload	10 kg
Position repeatability (Note 1)	In each of X, Y and Z directions: ±0.07 mm (at the center of an end-effector mounting face)
Maximum allowable inertia moment	Around J4: 0.36 kgm^2 Around J5: 0.36 kgm^2 Around J6: 0.064 kgm^2
Position detection	Absolute encoder
Drive motor and brake	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.
User signal line	10 (for proximity sensor signals, etc.)
Air source - Operating pressure	1.0×10^5 Pa to 3.9×10^5 Pa
Air source - Maximum allowable pressure	4.9×10^5 Pa
Degree of Protection	IP-40
Weight	Approx. 78 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.	

Index

P/N: 06561-000, Rev B

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