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Adept Manipulator System

USER GUIDE

For The

CC CONTROLLER

June 1988

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00315-10100 Rev B

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User Guide for the Adept CC Controller

June 1988

NOTICE TO CUSTOMER

Please insert the accompanying text into your Adept Controller binder. This User Guide and the latest appropriate Adept Manipulator User Guide together supercede all versions of Adept Installation manuals and Adept Basic Operation manuals.

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CHAPTER 1

GENERAL INFORMATION

1.1 THIS MANUAL AND RELATED PUBLICATIONS

This manual provides information concerning the installation and basic operation of the Adept CC Controller.

Adept Technology provides a complete package of technical publications in support of its products. Those referenced in this manual are:

- V+ Reference Guide or V Reference Guide
- Instructions for Adept Utility Programs
- Appropriate Adept Manipulator User Guide
- User Guides for options purchased at time of equipment order.

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

1.2 SPECIAL NOTATIONS AND GLOSSARY OF TERMS

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

WARNING

Used to signify that if the statement is not complied with, injury to personnel or major damage to equipment could result. A Warning statement will typically describe the potential hazard, its possible effect, and the measures which must be taken to reduce the hazard.

CAUTION

- Used to signify that when the statement is not complied with, damage to equipment could result.

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NOTE

Used to provide supplementary information, or to emphasize a point or procedure, or to give a tip for easier operation.

The following terms are used throughout this manual:

Term	Description
ASCII	American Standard Code for Information Interchange
BIO	Binary I/O Board (in the controller chassis)
CPU	Central Processor Unit
JIB	Joint Interface Board (in the controller chassis)
MCP	Manual Control Pendant (optional)
MSC	Mass Storage Controller (in the controller chassis)
OLC	Outer Link Card (in outer link assembly)
PCA	Printed Circuit Assembly
PSS	Power Sequencer/Status Card (in the controller chassis)
RSC	Robot Signature Card (Inside robot base)
SCARA	Selective Compliance Assembly Robot Arm
TWR	Tower Card Assembly (inside quill cover)
V	Adept's Robot Control System and Programming Language
V+	Adept's Advanced Control System and Programming Language
XIB	External Interface Board (in the controller chassis).

1.3 CUSTOMER SERVICE ASSISTANCE

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

(800) 232-3378 from outside California

(800) 232-3379 from within California

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When calling Customer Service, please have available the serial numbers of the robot and controller, and hours of operation of the controller.

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

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

1.4 SYSTEM OVERVIEW

Figure 1-1 illustrates an Adept manipulator system. The appearance of your manipulator may differ from that shown depending upon model purchased. Major components of the system are:

- The CC Controller consisting of a Controller Chassis and an Amplifier Chassis.
- An Adept four-axis (fifth axis optional) SCARA Manipulator
- The V robot control system and programming language, or Adept's V+ advanced control system and programming language
- Accessory kits containing necessary hardware, interconnects, and manuals.
- An optional manual control pendant
- An optional programmer's terminal

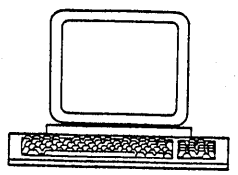
1.4.1 The Controller

The CC controller amplifier chassis houses the system power supply and power distribution subsystem, and the manipulator servo and control electronics. The controller chassis houses the Multibus compatible backplane, microprocessor and memory electronics, disk drives, binary I/O, and serial I/O ports.

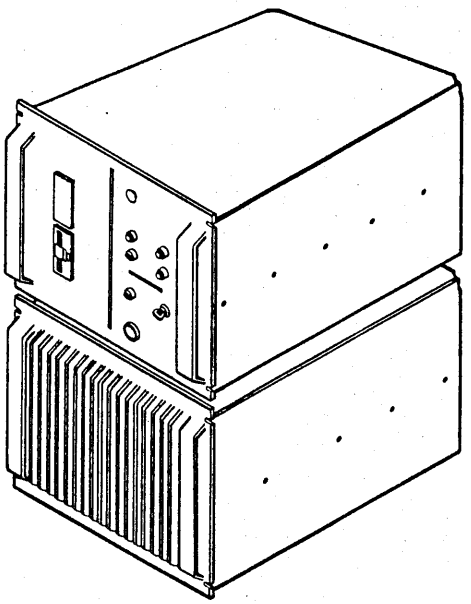
Operator communication with the system is via the Adept control system and programming language (either V or V+) and requires either the optional Manual Control Pendant or the optional Programmer's Terminal during normal operation of the system.

In most cases, the operator will not require access to the inside of the controller cabinet as the disk drives and all necessary controls are externally accessible.

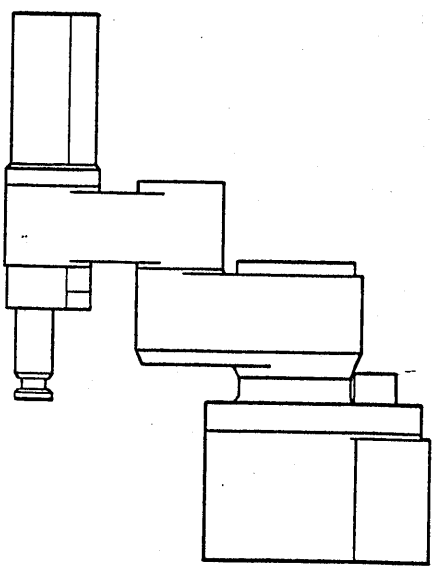
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Programmer's Terminal
(Optional)



Controller



Manipulator

TP0145-10/87

Figure 1-1. Typical System Configuration

1.4.2 The Manipulator

Adept Manipulators are four-axis (fifth axis optional) robots designed primarily for applications in light material handling. The manipulator is connected to the controller by signal and power cables.

Figure 1-I shows one of the manipulators currently being shipped by Adept. All Adept manipulators are similar in design, differing primarily in the size of the working envelope. As shown, joint 1

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rotates about the vertical column and joint 2 rotates in the middle of the horizontal arm. Joints 1 and 2 acting together provide for horizontal positioning of the end-effector. Joint 3 is a linear joint that extends and retracts vertically at the end of the arm. In typical operations, joint 3 is the axis that lifts objects and places them back down. Joint 4 rotates at the hand (or end-effector) mounting flange. It is the axis used to radially orient parts during operations such as lining up a square block into a square hole.

Other characteristics of the manipulator that can be controlled include the manipulator speed, its path profile (movement between positions), and the delay (dwell) at taught positions.

1.4.3 Manual Control Pendant

The Adept Manual Control Pendant (MCP) is optional with all controllers, and functions as a remote operator's control panel. It can be used to teach robot positions that can be stored for later playback, to change robot parameters (for example, motion speed), and to select, prime, and execute pre-written application programs.

The pendant can be operated in either one of two modes. "Manual mode" is used to move the robot to desired locations and to record the locations for later use during program execution. "Computer mode" is used to select, prime and execute application programs. Because of its feedback messages and menu prompts, the MCP is the only control device the operator will need in many cases.

1.4.4 Programmer's Terminal

The programmer's terminal, also a system option, is another device that can be used to control the manipulator. Although the pendant and terminal are both used as inputs to the controller, each has a distinct function. As explained above the pendant is primarily used to manually control the manipulator and to ready for execution the pre-written application programs.

The terminal can be used to control the execution of existing application programs. However, the primary use is for the creation of new programs by a system programmer. The terminal is the interface to V or V+, Adept's robot control systems and programming languages. Utilizing the terminal, the system programmer can write, edit, test, and store application programs for execution at a later time.

1.4.5 Adept Control Systems and Programming Languages

Both V and V+ have many features designed to provide flexibility in programming and controlling manipulator systems. Perhaps the most useful feature is the execution of pre-written application programs.

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Such a program is a set of instructions that guide the performance of an operation, or set of operations, by the manipulator.

Application programs can be written for general operations that may not need to be rewritten for each specific installation. Pre-written application programs are easily executed, and do not require extensive knowledge of the programming language.

From the operator's point of view, V or V+ functions as the system monitor. The monitor accepts commands from the pendant or terminal and processes them to perform program writing, editing, storing, loading, debugging, and execution. For the operator who is executing application programs, the V or V+ system is used for the editing and monitoring of programs and robot control parameters.

Adept's programming languages have been designed to expand the capabilities of the manipulator and other devices found in robot environments. Some of the features of the V and V+ languages are:

- System constants and real-valued functions
- Expressions and arithmetic operators
- Location-valued functions
- Compound transformations
- Assignment statements
- Terminal input and output
- Control structures
- Process synchronization
- Exception handling
- Manipulator trajectory generation

In addition, both the V and V+ languages enable programming of the system for concurrent process control. That is, programs for controlling other machines can be run concurrently with the main robot control program.

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CHAPTER 2

SAFETY

2.1 READING AND TRAINING FOR USERS AND OPERATORS

Adept Manipulator Systems are computer controlled mechanisms, capable of moving at high speeds and exerting considerable force. Like all robot systems and most industrial equipment, they must be treated with respect by the user and the operator.

NOTE

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

This manual should be read by all personnel who operate or maintain Adept Manipulator Systems, or who work within or near the robot work cell.

We also recommend you read the American National Standard for Industrial Robot Systems - Safety Requirements, published by the Robotic Industries Association, in conjunction with the American National Standards Institute. The publication, ANSI/RIA R15.06 - 1986, contains guidelines for robot system installation, safeguarding, maintenance, testing, start-up, and operator training. The document is available from the American National Standards Institute, 1430 Broadway, New York, NY 10018.

This manual assumes that the user has attended an Adept Training Course and has a basic working knowledge of the Manipulator System. The user should provide the necessary additional training for all personnel who will be working with the system.

2.2 SYSTEM SAFEGUARDS

Safeguards should be an integral part of robot work cell design, installation, operator training, and operating procedures.

Adept Manipulator Systems have various communication features which may aid the user in constructing system safeguards. These include remote emergency stop circuitry, binary input and output lines, and spare

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system-controlled user lines. These features are fully described in the "Installation" and "Controller Configuration" chapters of this manual.

Because Adept Manipulators are computer controlled, they move 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 robot work area whenever arm power is on. When the amber Arm Power light on the front of the controller is lit, arm power is on, and current is being supplied to the drive motors. The Lamp Test button allows this light to be periodically checked.

> **WARNING**
>
> Do not remove or replace any assemblies, subassemblies, printed circuit cards, or components with the primary power turned on. To avoid possible injury or equipment damage, always remove power prior to attempting repair procedures.

In addition, these systems have the capability to be programmed to control equipment or devices other than the robot. As with the robot, these devices may also operate at unexpected times under program control. It is critical that safeguards be in place to prevent personnel from entering the work cell when a program is running. The blue Program Running Light on the front of the controller indicates the program is running. The Lamp Test button allows this light to be periodically checked.

> **WARNING**
>
> Entering the robot work cell when either the Arm Power or the Program Running light is on can result in severe injury.

Adept Technology highly recommends the use of additional safety features such as light curtains, safety gates, or safety floor mats to prevent entry to the work cell while Arm Power is enabled. These devices may be connected using the robot's remote emergency stop circuitry. This feature is fully described in the "Installation" chapter of this manual.

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CHAPTER 3

INSTALLATION

3.1 FACILITY REQUIREMENTS

Your CC Controller has certain physical and environmental requirements that must be met to ensure reliable operation. Before installing the controller please verify that the following requirements are satisfied.

3.1.1 Location

Controller location with respect to the manipulator should be determined by several factors:

1. The controller must be outside the manipulator working envelope.

2. There should be easy access to a source of the required AC input voltage.

3. There must be a minimum of six inches of open area at the rear of both chassis of the CC Controller for service access.

NOTE

All cable entry for both controller chassis is via rear panel connectors. If the equipment is to be rack mounted inside an enclosure, be certain to leave the required six inches of open area at the rear of both chassis for cable connections and service access.

4. Length of the arm power and signal cables; these cables are available in 15' standard or 25' optional lengths.

Figure 3-1 shows the physical dimensions of the Adept CC Controller with recommended clearances.

3.1.2 AC Power

The CC Controller is configured at the factory to operate with an AC input voltage of either 208, 220, or 240 VAC $\pm$10%, single phase, at a line frequency of 47 to 63 Hz. A procedure for strapping transformer T1

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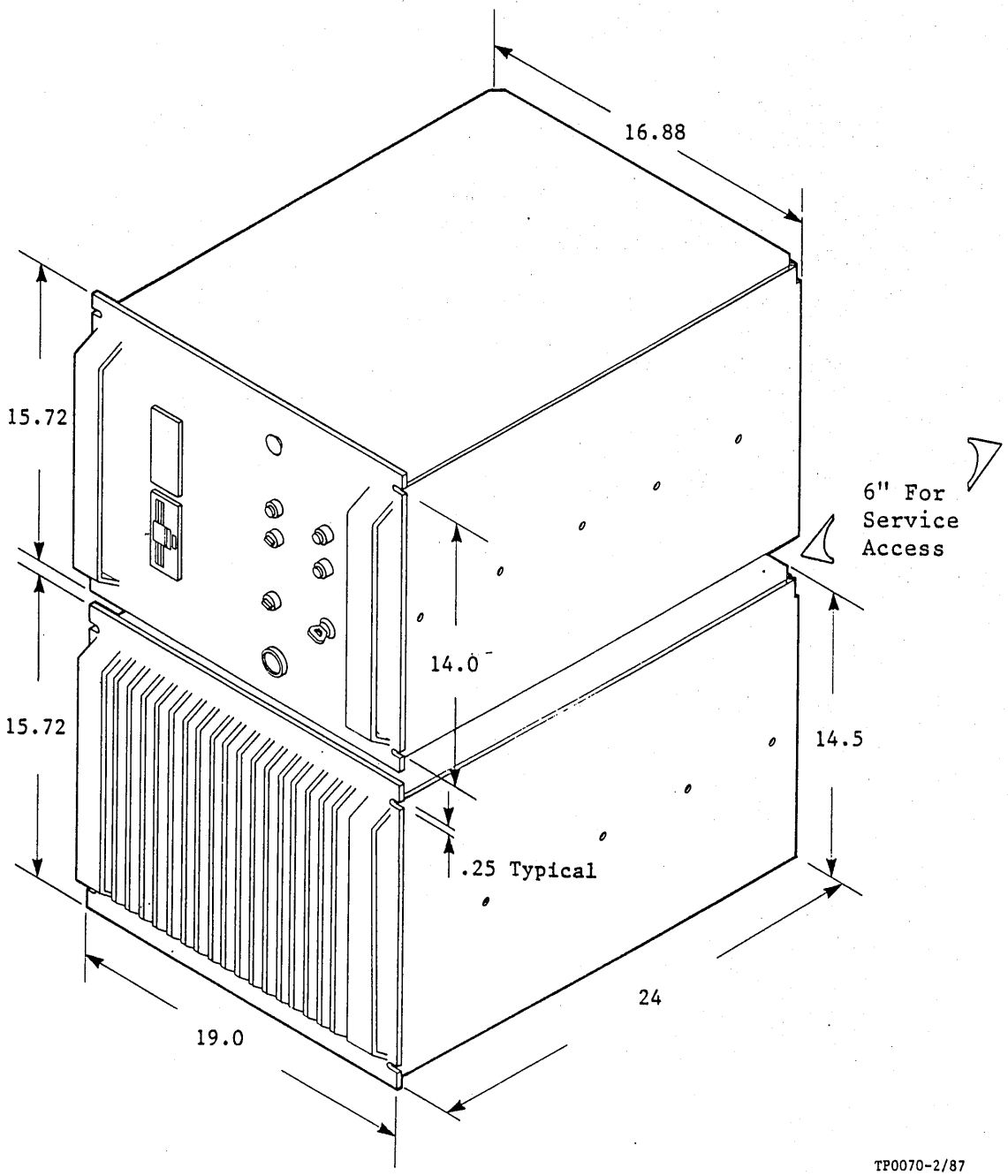


Figure 3-1. CC Controller Physical Dimensions

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for the correct AC input voltage range is presented later in this chapter.

Proper operation of the equipment requires that the source AC voltage remain within ±10% of the selected input voltage under all load conditions. During normal operation, when arm power is turned on, there will be short-term surges to 20 amperes on the line. The user's primary power source must be able to handle these surges without a significant (10%) drop in input voltage.

Primary input power to the amplifier chassis is controlled by a 20 ampere circuit breaker. All AC circuitry is contained in the amplifier chassis, with an AC output cable to the DC power supply in the controller chassis which is controlled by a 10 Ampere circuit breaker.

3.1.3 Environmental Requirements

Environmental requirements of the CC Controller are:

Temperature: The controller chassis must have access to air at 40 degrees Centigrade maximum, and a volume surrounding the fan inlet to allow an air flow of 60 cfm.

The amplifier chassis must have air at 40 degrees Centigrade maximum in the volume around its air inlet and across the heat sink.

Humidity: 0 to 90% relative humidity, non-condensing.

3.2 PHYSICAL DESCRIPTION

The CC Controller is packaged in two chassis: 1) An amplifier chassis, and 2) A controller chassis. This design allows side-by-side table top installation, or an over-under installation in a standard 19-inch rack. Each chassis consists of:

1. A standard 19-inch rack front panel with a standard 24-inch chassis depth. The chassis is 14.5 inches high, and the front panel is 15.75 inches high to permit air flow between the chassis in a rack mount environment.

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2. Hardware, captive nuts with M-4 x 10mm screws, is provided for slide mounting each chassis in standard equipment racks. The slides are to be provided by the user, and the mounting hole patterns fit slides made by Grant Hardware Company, located at:

   7 Hoover Avenue, Haverstraw, NY 10927-1092

   or

   1175 So. Jellick Avenue, City of Industry, CA 91748

   The Grant part number for the controller chassis slide assembly is SS-333-NT-24, and for the amplifier chassis the Grant part number is 3335-26.

   NOTE

   The M-4 x 10mm screws provided in the accessory kit are intended to replace any screws furnished by Grant Hardware with their slide assemblies.

3. Desk top feet are installed on each chassis. These are removable for rack mounting.

4. The standard configuration will have one 3-1/2 inch microfloppy disk drive installed on the front panel of the controller chassis. There is provision for a second, optional, 3-1/2" disk drive, or an optional 3-1/2" Winchester drive.

5. The operator control and indicator panel is also on the front of the controller chassis. The controls and indicators will be described later in this chapter.

6. Each chassis has a detachable top cover for easy access to sub-assemblies.

7. Except for the cable connection for the optional manual control pendant (MCP), all standard and option cable connectors are located on the rear panels of the two chassis (see Figure 3-2). These include:

   Arm power cable
   Arm signal cable
   Optional programmer's terminal connector
   Binary I/O connectors
   Serial I/O RS-232C connectors
   Remote E-Stop connector
   Interconnect cables between the controller and amplifier chassis.

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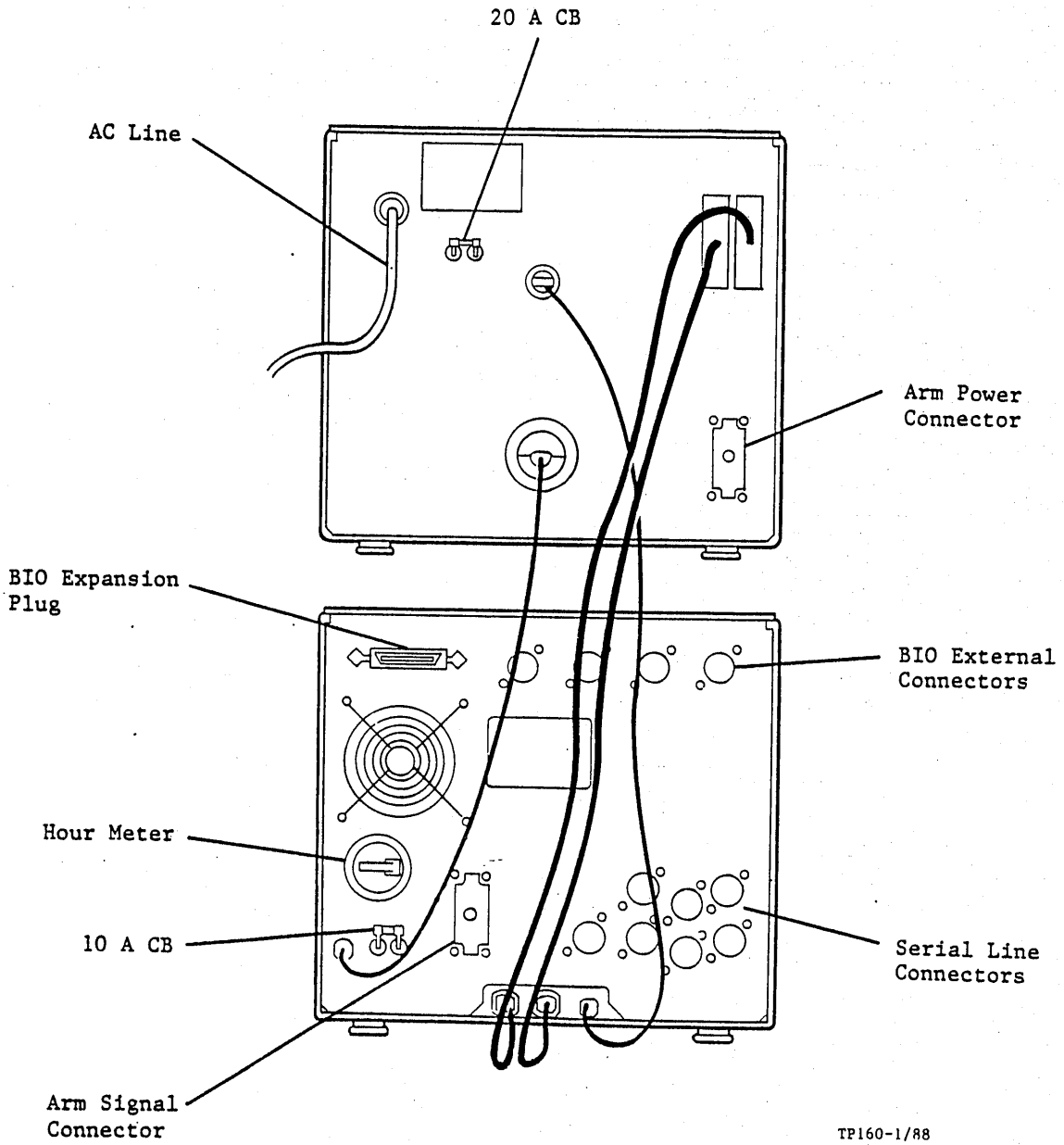


Figure 3-2. Rear Panel Connectors

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3.3 LIFTING PRECAUTIONS

Approximate chassis weights for the CC Controller are:

Amplifier chassis:	125 lbs.	56.8 kgs.
Controller chassis:	75 lbs.	34.1 kgs.

The actual chassis weight may vary slightly because of installed optional equipment.

WARNING

Use two persons to lift either chassis during installation. Because of the physical dimensions of both chassis, their weight, and the attached cables, normal safety precautions require two persons to lift the equipment. This precaution is especially important during rack mount installation.

3.4 UNPACKING AND INSPECTION

Carefully inspect the shipping containers for evidence of mishandling during transit. If any container is damaged, request the carrier's agent be present when the package is opened. Compare the packing list with the equipment purchase order to verify the shipment is correct.

Unpack the shipping containers and inspect each item for external damage. If any damage is evident, notify Adept's Customer Service Center immediately. Telephone hotlines are listed in Chapter 1 of this manual.

NOTE

Retain the shipping containers and all packing materials for examination in the settlement of claims, or for future use should relocation of the equipment become necessary. Shipment with improper packaging will void your warranty.

3.5 PREPARATION

It is recommended that the user verify the AC source voltage and the input wiring to the primary AC transformer (T1) inside the amplifier chassis. Figure 3-3 shows the primary AC voltage input configuration, and indicates the wire numbers and terminals for the different input voltage taps.

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Note also that the flexible, Type SO, 3-wire power cable has no plug attached for mating to the source voltage socket. The user must provide the proper type plug for his installation.

Perform the steps in the following procedure before applying AC power to your Adept CC Controller.

1. Using a phillips screwdriver, remove the screws from the top cover of the amplifier chassis.

> **WARNING**
>
> AC line voltages can cause severe injury or death. These procedures may require work with primary AC wiring and should be performed only by qualified personnel, with the power disconnected.

2. Locate the main transformer T1 and referring to the strapping diagram (Figure 3-3) verify that your controller is strapped for your actual facility AC line voltage.

> **NOTE**
>
> The line voltage specification must be met under all load conditions. Peak load current reaches 20 amperes in the CC Controller. Your facility line voltage should be measured at the controller feed point by a qualified electrician using an appropriate dummy load.

3. If the transformer strapping is not correct for your actual line voltage, refer to Figure 3-3 and determine the proper voltage range. Remove the transformer safety cover and relocate the black wire labeled "401/429/430" to the proper tap as indicated in Figure 3-3.

4. Replace the transformer safety shield and the top cover.

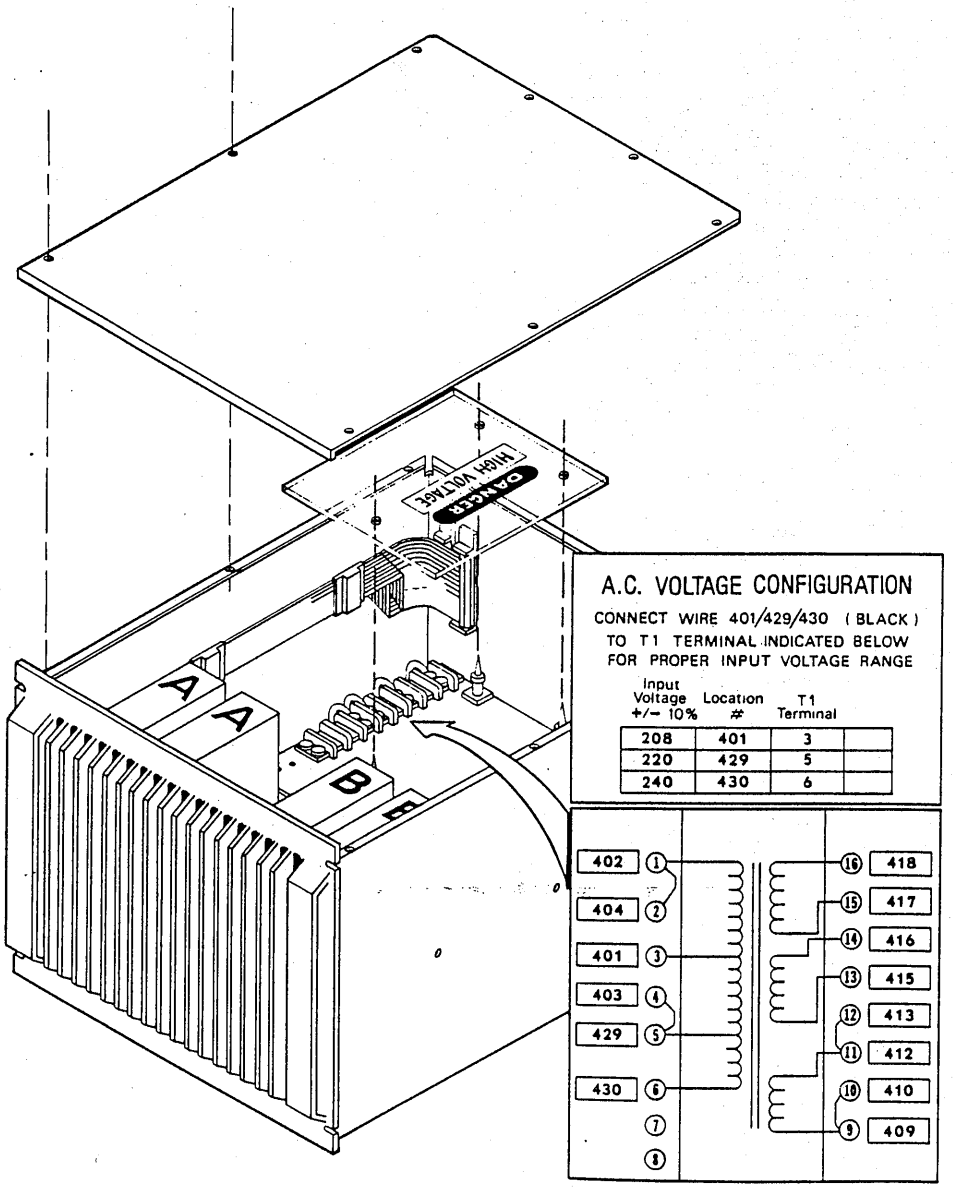
If the controller chassis are to be rack mounted, it is recommended that the chassis slides be installed at this time. Proceed as follows:

1. Remove the factory installed desk top feet from the controller chassis. Install the 175 pound capacity chassis slides; Grant Part No. SS-300-NT-24, using the M4 x 10mm screws provided.

2. Remove the desk top feet from the amplifier chassis. Install the 250 pound capacity chassis slides; Grant Part No. 3335-26, using the M4 x 10mm screws provided.

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NOMINAL VOLTAGE	INPUT VOLTAGE RANGE Minimum	Maximum
208	188	228
220	198	242
240	216	264



TP0072-2/87

Figure 3-3. AC Input Voltage Configuration

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NOTE

Chassis slide assemblies must be used to support the equipment in a rack mount environment. The slide assemblies must be provided by the user.

3.6 CONTROLLER INSTALLATION

The steps below detail the installation of the CC Controller and completion of interconnects between the controller and manipulator. The controller with all necessary tools and equipment should be readily at hand and the steps should be followed in sequence.

Proceed as follows:

1. Position the arm power and signal cables. The female connector on each of the cables mates with a male connector at the base of the robot.

2. The arm signal cable connector is adjacent to the air inlet filter, on your left as you face the robot base. Mate the arm signal cable connectors and secure the connection by tightening the lock screw hand tight. Mate and secure the arm power cable connectors located on the right side of the robot base.

3. At the controller end, the arm signal cable is connected at the rear of the controller chassis. Mate the two signal cable connectors and tighten the lock screw.

4. The arm power cable is connected at the rear of the amplifier chassis. Mate the two power cable connectors and tighten the lock screw.

5. There are four cables coming from the rear of the controller chassis that require mating with jacks located on the rear panel of the amplifier chassis. Verify that system power is off and make the following connections:

   - There are two motor control cables with large connectors labeled P-18 and P-19. Mate P-18 to J-18 on the amplifier chassis, and P-19 to J-19. Secure both connectors.

   - There is a power relay cable with a circular CPC connector attached that is labeled P-20. Mate P-20 to J-20 on the amplifier chassis and tighten the lock ring.

   - The last cable is the controller power cable which has an AC plug attached and is labeled P-21. Plug the connector into J-21 on the rear panel of the amplifier chassis.

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Figure 3-5 shows the location of the remote E-STOP connector (J7) on the controller chassis rear panel. Figure 3-4 illustrates the suggested wiring of remote emergency stop switches or devices, and a remote arm power indicator. The figure shows the factory installed wiring to the connector. All external components and wiring are to be supplied by the user.

WARNING

Adept provides, in the accessories kit, a jumpered connector for J7. The jumpered connector bypasses the normal safety function of this connector and is for system test by qualified service personnel only. If the connector is used for system test, it must be replaced with safeguards for protection of personnel prior to normal system operation.

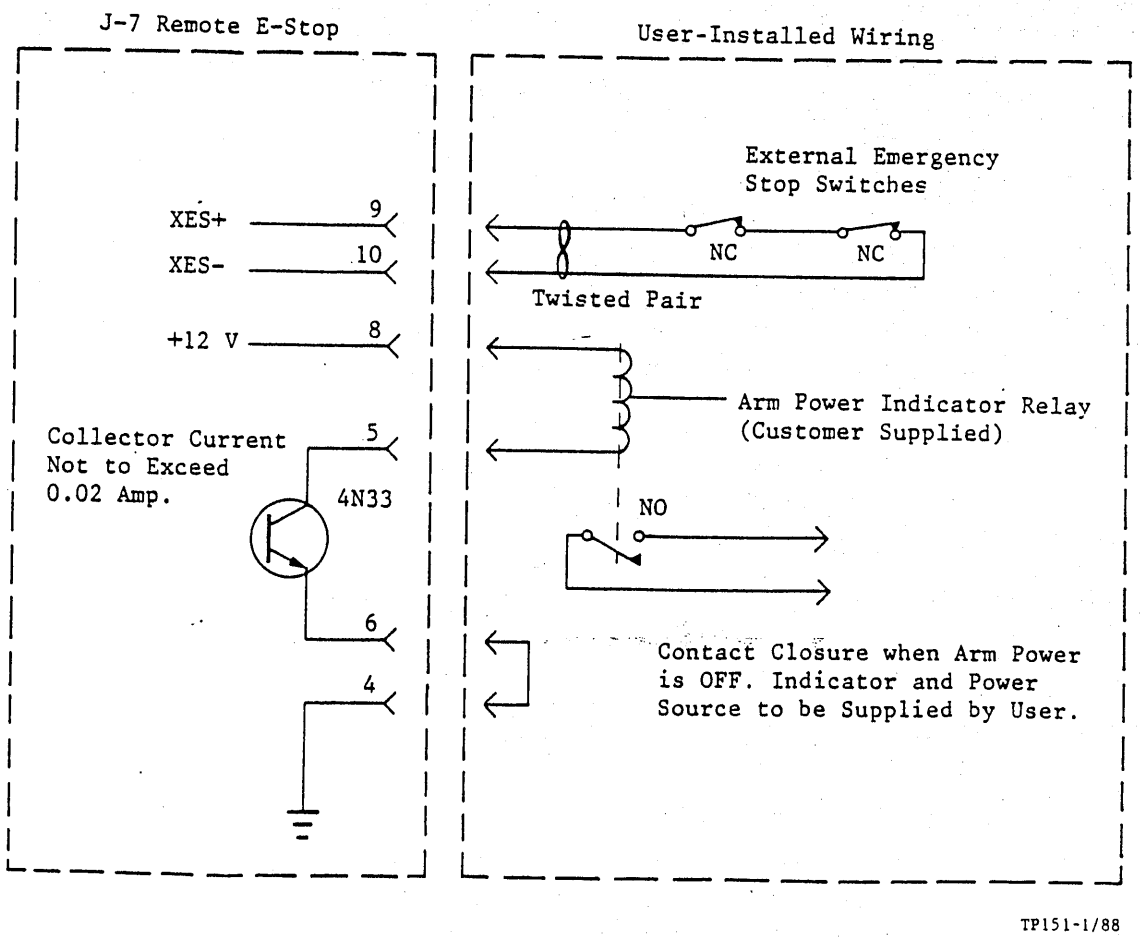


Figure 3-4. Suggested Wiring of J-7

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3.7 CONTROLS AND INDICATORS

Figure 3-5 shows the locations of all front panel controls and indicators. A brief description of each follows:

1. EMERGENCY STOP SWITCH (RED): This push-pull emergency stop switch removes arm power and brings the manipulator to an immediate stop when depressed.

2. ARM POWER LAMP (AMBER): This lamp signals the presence of arm power at the robot. If the amber lamp is on, there is arm power present at the arm.

3. PROGRAM RUNNING LAMP (BLUE): When lit, this blue lamp indicates that a robot control or process control program is running. It is a warning that the arm and other mechanisms in the work cell are under computer control and may move at any time.

4. SYSTEM POWER SWITCH AND LAMP (GREEN): This rotary on/off switch controls the main AC power relay. The green lamp should be lit when main AC power is on.

5. PROGRAM START SWITCH AND LAMP (GREEN): This push button switch is used to execute command programs initiated from the pendant. Pressing the "AUTO", "CALIB", "CMD1" or "CMD2" command buttons on the MCP, will cause the Program Start lamp to flash and require that the Key Switch (description follows) be placed in the "TERMINAL" position and the Program Start Switch be pressed to begin execution.

NOTE

Refer to your V+ Reference Guide or V Reference Guide for information concerning the WAIT.START monitor command and RETRY system switch associated with the Program Start Switch function.

6. LAMP TEST/PENDANT REMOVE SWITCH: This switch has two functions. First, when pressed all the above indicator lamps are tested. A fault condition exists if any lamp does not illuminate when this switch is pressed.

   Second, when pressed it allows the pendant to be disconnected from the front panel and the pendant jumper plug to be put in its place without the loss of arm power and subsequent halting of any program in progress.

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7. KEY SWITCH: The key switch is a 3-position rotary switch marked "PENDANT", "TERMINAL", AND "NETWORK". The "PENDANT" position permits single point control from the MCP when locked in this position. The "TERMINAL" position permits control of the robot system from the optional programmer's terminal, and the Key Switch must be in this position in order to execute programs with the Program Start Switch. The "NETWORK" position of the Key Switch is reserved for future use.

8. PENDANT: 14-pin serial data connector for attaching the optional Manual Control Pendant (MCP) to the front panel. Either the MCP or the supplied pendant jumper plug must be installed at this connector.

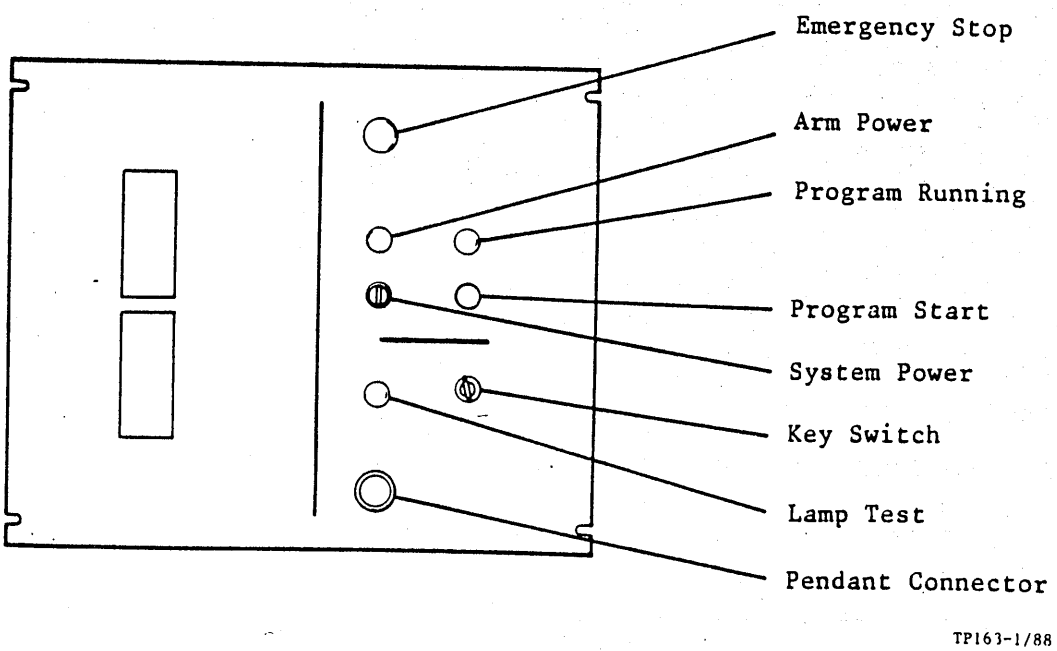


Figure 3-5. Front Panel Controls and Indicators

Located on the rear panel of the controller chassis is an elapsed-time indicator. This indicator shows the power-on time of the CC Controller, in hours.

The main AC circuit breaker (20 A) is located on the rear panel of the amplifier chassis. There is a another 10 A circuit breaker, controlling the AC input from the amplifier chassis, at the rear of the controller chassis. This is used to drive the DC power supply and cooling fan.

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3.8 OPERATIONAL CHECKS

The following procedures are intended to check the basic robot system in a simple and straightforward way. The user may wish to exercise the system further, in which case the information contained in later chapters on system operation will be of use.

3.8.1 Pre-Power on Checks

With the AC power cord disconnected, remove the top covers of both chassis and perform the following:

1. Check that all boards in the card cage are fully seated
2. Visually check for loose connections
3. Check that transformer T1 is jumpered for the correct AC input voltage
4. Replace top covers of both chassis and connect AC power cord
5. Check that the jumper plug, or user supplied external E-STOP circuit connector, is mated to the "REMOTE E-STOP" connector (J7) on the rear panel of the controller chassis.
6. If the optional programmer's terminal is used, check that the data cable for the terminal is connected to serial port J10 on the controller chassis rear panel. Refer to Chapter 10 for information on configuring the system for use with other types of terminals.
7. If the optional MCP is used, check that the pendant cable is connected at the front panel of the controller chassis.
8. Check that the compressed air source is connected to the input filter on the base of the robot, and that the air supply is turned on
9. Remove the cardboard shipping disks that were installed in the disk drives to prevent damage during shipment.

3.8.2 System Start-Up

1. Place the circuit breakers on the rear of both chassis to ON.
2. Insert a system diskette into drive A, the lower 3-1/2" drive. This step is not necessary if the optional Winchester is installed.

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3. Turn the system power switch on. This initializes the controller but does not turn on arm power.

   When system power is turned on, several actions will take place. The system power lamp (green) should illuminate, and the other indicator lamps may flash momentarily. The internal cooling fans will switch on and this will be audible. In addition, the drive activity lights on the installed disk drives will blink on briefly

4. Verify that no mechanical damage has occurred to the robot during shipment. This may be done by depressing the brake release switch and manually moving all joints through their full range of motion, checking for significant binding or roughness. This is most easily accomplished by two people. See your Manipulator User Guide for a complete description of the brake release switch and its use. After verifying that all joints move freely, move all the joints to roughly the middle of their range to ensure enough joint travel for calibration.

CAUTION

The quill (joint 3) will drop to its lowest position when the brake release switch is pushed in. Hold the quill up when the button is pressed to ensure that no component or end-effector damage will result. The quill can then be lowered to its lowest position.

3.8.3 System Checkout Using the MCP

When system power was applied, the operating system started to load from the system diskette. With the MCP connected at the controller front panel and the Key Switch in the "PENDANT" position you may notice a continuous flashing of the pendant LEDs during the loading sequence, and when the boot procedure is completed the following message will appear on the pendant display:

NO PROGRAM PRIMED

Press the "CMD" button on the MCP. This will not result in any robot motion, but will display the command function options and light the LED on the "CMD" button.

During the following sequence we will be turning on arm power and calibrating the manipulator. Joints 1 and 2 will move about fifteen degrees, and joints 3 and 4 will go to their limits of travel.

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NOTE

Never enter the working envelope of the manipulator when arm power is on (amber lamp on controller front panel illuminated). Ensure that the entire working envelope is free of obstructions that could result in collisions.

Proceed as follows:

1. Ensure that the Emergency Stop Switch (RED button on controller front panel) is pulled out.

2. Press the "CALIB" button (second from left in the MCP top row). This will initiate the calibration sequence and cause the Program Start lamp on the controller front panel to begin flashing.

3. Rotate the Key Switch on the controller front panel to the "TERMINAL" position and press the flashing Program Start Switch to start the calibration process.

4. The Program Start lamp will extinguish and the Program Running lamp should light indicating a program in progress. Return the Key Switch to the "PENDANT" position.

5. The system will first turn on arm power and display the message

   ENABLE POWER

   followed by the message

   CALIBRATE

6. When calibration is completed, the MCP display returns to the command function display. Press the "REC/DONE" button to put the pendant in the background mode.

This completes the operational check procedure for verifying your installation of the system with the MCP.

3.8.4 System Checkout Using Programmer's Terminal

This procedure assumes the use of the Adept programmer's terminal. If you are using another type of terminal, refer to Chapter 10 of this manual for information on configuring the system parameters for proper operation with your terminal.

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When system power was applied, the operating system started to load from the system diskette. When the boot procedure is completed, the following message will be displayed on the screen:

```
Version [ ] - [ ] ...
```

This version line will indicate the system serial number and specific configuration information. See the description of the "ID" command in the V+ Reference Guide or V Reference Guide for information on this display. Once the operating system is loaded the diskette may be removed from drive A.

During the following sequence we will be turning on arm power and calibrating the manipulator. Joints 1 and 2 will move about fifteen degrees, and joints 3 and 4 will go to their limits of travel.

> **WARNING**
>
> Never enter the work envelope of the manipulator when arm power is on (amber lamp illuminated). Ensure that the entire working envelope is free of obstructions that could result in collisions.

Proceed as follows:

1. Ensure that the Emergency Stop Switch is pulled out
2. Rotate the Key Switch to the "TERMINAL" position
3. Turn on arm power by entering "ENABLE POWER" command followed by a carriage return (indicated as (Rtn):

   ```
   .En Pow  (Rtn)
   ```

4. Then issue the command:

   ```
   .Cal (Rtn)
   ```

5. Respond with "Y (Rtn)" to the question:

   ```
   Are You Sure (Y/N)?
   ```

The manipulator will then calibrate itself. Calibration need only be performed when system power has been turned off. If arm power was turned off, but system power remained on, the manipulator does not have to be recalibrated. However, issuing the command again does no harm to the system.

This completes the system checkout using the optional programmer's terminal.

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CHAPTER 4

CONTROLLER CONFIGURATION

4.1 BINARY I/O CONFIGURATION

Adept's robot control systems and programming languages are able to interface with up to 512 binary I/O lines. The binary I/O printed circuit boards enable V or V+ to monitor input lines and control output lines via modules that optically isolate external user lines from internal circuits. These isolation modules make it possible to control or sense lines with voltages from low-voltage DC to high- voltage AC.

The Adept CC Controller has one internally mounted binary I/O (BIO) board. Each of the Adept binary I/O (BIO) boards provides for 32 I/O lines. The modules on the BIO boards are quad modules, with I/O lines connected in groups of four lines per module. There can be a maximum of eight modules per board. These modules, input or output and voltage type, can be purchased by the customer. Refer to the module data tables at the end of this chapter. Figure 4-7 presents hardware configuration information for the BIO board.

NOTE

There is a utility program named "CONFIG_C.V2" provided with each system. A portion of that program deals with configuration of the binary I/O. Customer installation of I/O modules, or changes made in I/O configuration will necessitate the loading and execution of the program to correct and store the new configuration. See the "Instructions for Adept Utility Programs" manual for more information.

Each board contains sockets for eight quad modules, and any of the available modules may be placed in any socket. The I/O signal lines are routed in parallel from each socket to 14-pin CPC connectors that protrude through the chassis rear wall, and to screw-type terminals on the BIO board terminal block.

4.1.1 Binary I/O Expansion Unit

This Adept option is a standalone 64-line I/O expansion unit. It provides I/O expansion either for a chassis unit or another expansion unit, via a 50-conductor cable. It contains its own power supply and cooling fan, and requires primary power input of 220 VAC, ±10%, single phase, at a line frequency of 50 to 60 Hz.

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4.1.2 External Cable Connections

The BIO board in the CC Controller provides four CPC connectors for user I/O line connections. These are installed so that these connectors protrude through the rear panel of the controller chassis for easy access.

Each of the female connectors on the rear panel of the chassis has a keying plug installed to minimize incorrect cable connections. The keying scheme utilizes the center four pins of each connector (pins 5, 6, 9, and 10) with the keying plug inserted into one of these positions. The other three pins are connected to frame ground. If the user desires to take advantage of the keying capability, he may fabricate mating connectors with the corresponding contact missing.

The keying scheme is not error proof as the keying pattern is repeated for each group of four connectors. For example, it is possible to mate the J1 male connector with either the J1 or J5 female connectors. The user should apply labels to each cable or connector to provide identification.

Each CPC connector provides for eight I/O lines, two commons, three frame grounds, and one keying plug. Two isolation modules interface to each connector and each module has one common connection for its four signal lines. Table 4-1 shows the CPC pin arrangement and defines the pinouts for J1; other connectors will have similar pinouts but to different modules.

Figure 4-1 is a diagram of a portion of the BIO board showing the interconnects between two isolation modules, the respective CPC connector, and the signal line terminal block.

Because of the probability of introducing EMI into the controller, use of the terminal blocks on BIO boards installed inside the chassis should be restricted to connecting the Usr1 through Usr5 signal lines coming from the robot (see next section). Any other connections to the BIO should be made through the CPC connectors described above.

4.2 INTERNAL USER LINE CONNECTIONS

The controller provides termination for five (5) signal line pairs to the tool end of the manipulator. These five twisted pairs are called Usr1 through Usr5 and provide the user with a convenient set of wires that go from the end-of-arm to the controller. The line pairs Usr1 through Usr5 can be used to connect limit switches or similar digital devices to the binary I/O interface in the system controller. They are terminated on the controller side at the ARM I/O connector (TB1) on the XIB board. Refer to the appropriate Manipulator User Guide for the location of these terminations within the robot.

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CPC Connector Pin Arrangement:

```
3  2  1
7  6  5  4
11 10  9  8
14 13 12
```

Pin	Connection
J1- 1	Signal 5
J1- 2	Common (for signals 5,6,7,8 - Module 2)
J1- 3	Signal 6
J1- 4	Signal 7
J1- 5	Key Plug (see note)
J1- 6	Frame Ground (see note)
J1- 7	Signal 8
J1- 8	Signal 3
J1- 9	Frame Ground (see note)
J1-10	Frame Ground (see note)
J1-11	Signal 4
J1-12	Signal 1
J1-13	Common (for signals 1,2,3,4 - Module 1)
J1-14	Signal 2

NOTE -- Keying scheme and frame grounds for an 4-connector product (32 I/O).

J1- 5 =	Key Plug	J1-6,9,10 =	Frame Ground
J2- 6 =	"	J2-5,9,10 =	"
J3-10 =	"	J3-5,6,9 =	"
J4- 9 =	"	J4-5,6,10 =	"

Table 4-1. CPC Connector (J1) Pinouts

Figure 4-2 shows the location of the XIB board. In addition to Usr1 through Usr5, 12 VDC signal/voltage lines from the manipulator, and 5 VDC are also available at TB1. If the 5 VDC is to be used at the tool end of the manipulator, one of the signal lines (Usr1 through Usr5) must be used to carry the voltage out to the connector on the arm.

CAUTION

The user lines Usr1 through Usr5 go through the Arm Harness of the robot. In order to assure long life, they are #26 AWG high strand count wires and are in close proximity to the robot control signals. As a result, they are NOT designed to carry large currents or voltages. Adept recommends these User lines be limited to a maximum of 24 VDC at two (2) amperes. To minimize coupling to the robot control signals in the Arm

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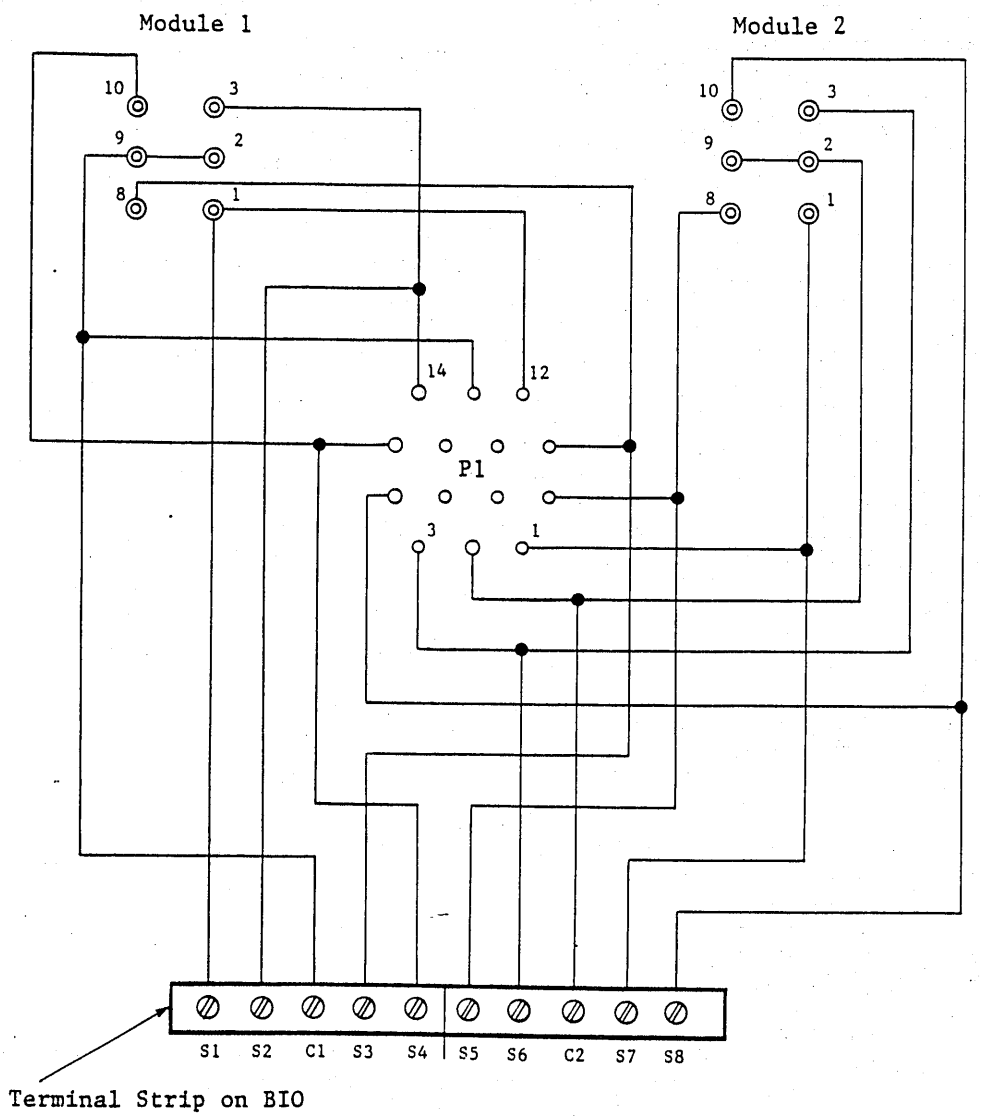


Figure 4-1. I/O Module Interconnect Diagram

Harness, the user should minimize voltage transients and keep the currents in each +/- pair balanced. Exceeding these recommendations will couple noise onto the robot control lines and could cause the robot to behave in an unpredictable manner.

If system binary I/O is used for control and sensing of installed Usr1 through Usr5 signal lines, there must be quad-line isolation modules installed on the BIO board. The modules must be of low-voltage DC type, not exceeding 24 VDC on the line for either input or output.

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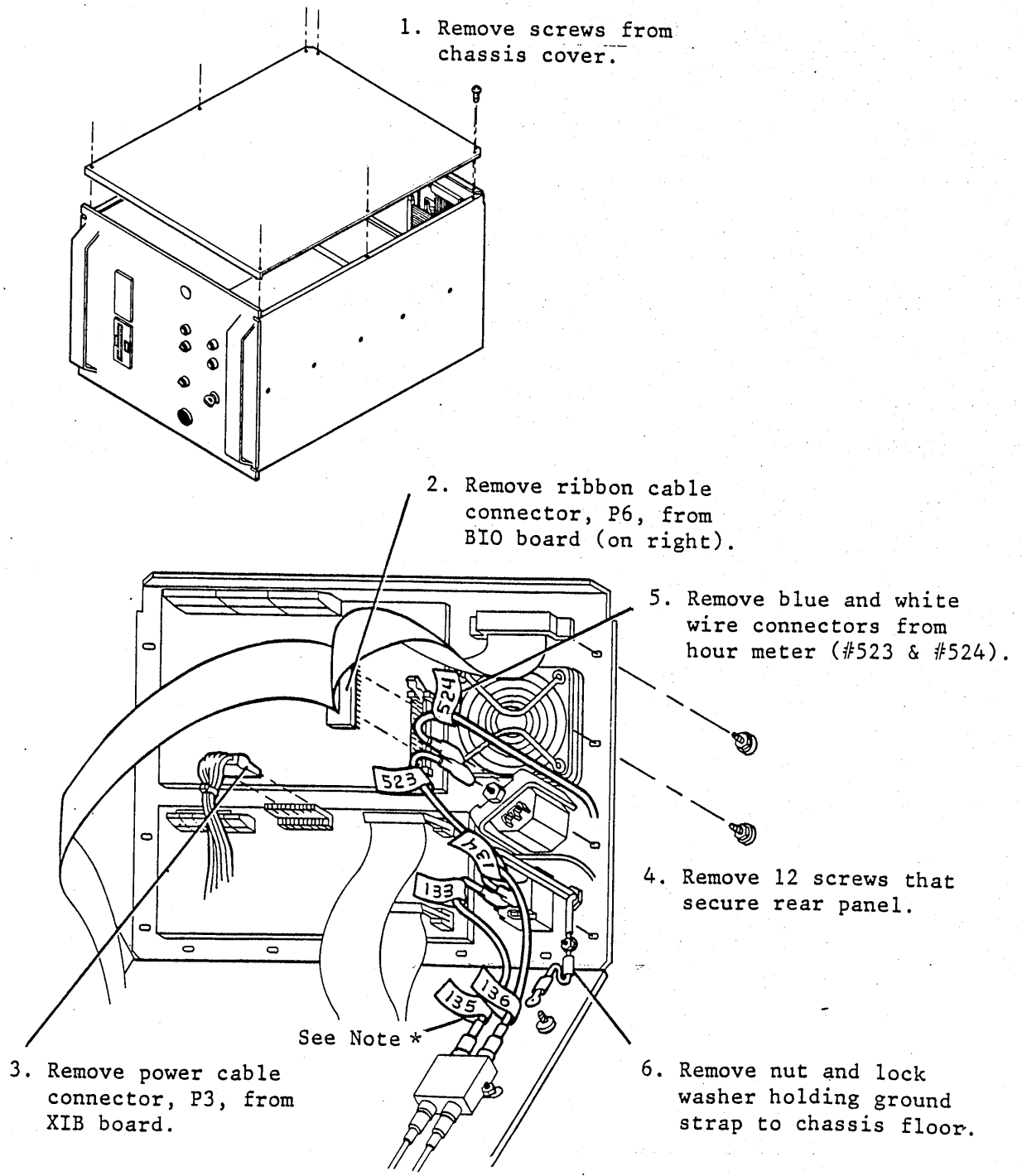


Figure 4-2. Disassembly for Internal Wiring Access

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CAUTION

As stated earlier, there are four signal lines and one common line for each module at the terminal block located on the BIO boards. There is one type of isolation module with which you must observe polarity when connecting the signal and common lines. The module is identified as a DC output module, Model ODC5Q, with a red case.

If installing this module, be sure that the positive sides of each of the lines are tied together and connected to the common terminal of the module. The other sides of the lines are connected individually.

Remember, if you have added I/O modules, or have changed inputs to outputs (or vice versa) it will be necessary for you to load and execute the "CONFIG_C.V2" utility program to reflect these changes in the I/O configuration stored on the V or V+ system disk.

4.2.1 Internal User Wiring Procedures

If the Usr1 through Usr5 signal pairs from the robot are to be connected via isolation modules to the system binary I/O, the user must complete the wiring from the ARM I/O connector block on the XIB board to the appropriate I/O lines of the terminal block on the BIO board. Both boards are located inside the controller chassis and are mounted on the rear panel. Figure 4-2 shows the location of both connectors and should be referred to during the following procedure.

CAUTION

If you have rack mounted the equipment, it is strongly recommended that you remove the controller chassis from the rack prior to attempting the wiring procedure outlined below.

Note that isolation modules for this purpose must be of low voltage DC type, not exceeding 24 VDC @2A on the lines for either input or output.

Some disassembly of the controller chassis is required to gain access to the connectors on the BIO and XIB boards. Disconnect the AC power cord from the source socket and proceed as follows:

1. Remove the screws from the controller chassis top cover and set the cover and hardware aside.

2. Remove the ribbon cable connector, P-6, from the right side of the BIO board.

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3. Remove the power cable connector, P-3, from the XIB board.

4. Remove the 12 screws that secure the rear panel. Set the hardware aside.

5. Remove the blue and white wire connectors (523 and 524) from the hour meter.

6. Remove the nut and lock washer holding the ground strap to the chassis floor. Lift the strap free of the threaded stud and lay back the chassis rear panel far enough to obtain free access to the ARM I/O connector block on the XIB board.

NOTE

The preceding disassembly should allow you access to both the ARM I/O connections on the XIB board and the signal line connectors on the BIO board. If more room is required to make the necessary wire runs, you may also disconnect connectors 135 and 136 from the line side of the AC input filter located adjacent to the ground strap referenced in step 6.

Usr1 through Usr5 signal line pairs are tied to ground at the ARM I/O connector block on the XIB board by means of a ground strap. This is to make sure that these lines are not floating when unused. Remove the ground strap when making connections to these lines.

Complete the required wire connections between the ARM I/O connector block on the XIB board and the terminal strip on the BIO board. If it is necessary to add isolation modules to the BIO board, now is a good time to install them.

To reassemble the unit, refer to Figure 4-2 and proceed as follows:

1. If necessary, replace the terminal connectors 135 and 136 on the AC input filter.

2. Replace the ground strap, lock washer and nut, and secure it.

3. Replace the terminal connectors 523 and 524 on the hour meter.

4. Temporarily replace the top cover and secure with one screw installed on each side at rear of chassis.

NOTE

Because the screws securing the rear panel to the chassis are mounted through slots, it is necessary to

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temporarily replace the top cover to ensure proper alignment of the sides of the chassis prior to securing the rear panel.

5. Replace the 12 screws that secure the rear panel to the chassis. With the rear panel securely in place, the top cover can be removed to accomplish the following steps.

6. Replace the power cable connector, P-3, on the XIB board.

7. Replace the ribbon cable connector, P-6, on the BIO board.

8. Replace the top cover and secure it with the associated hardware.

9. Connect the AC power cord to the AC source outlet.

Again, if you have added I/O modules, or have changed inputs to outputs (or vice versa) it will be necessary to load and execute the "CONFIG_C.V2" utility program to reflect the changes in the I/O configuration stored on the system disk.

4.3 SERIAL PORT CONNECTIONS

There are six serial ports on the XIB, which extend through the rear panel of the controller chassis. One of these ports is reserved for the optional programmer's terminal, the other five are for user installed devices.

Figure 4-3 shows the location of the user serial ports on the XIB board, and a pinout for these connectors.

One serial data cable for the optional Adept programmer's terminal is supplied in the accessories kit. All cables for user installed devices are to be supplied by the user. However, the following parts are included in the accessories kit to assist in fabricating additional cables:

1. Plug, connector, 14 pin (Amp part number 206044-1), 10 each

2. Backshell (Amp part number 206070-1), 10 each

3. Contact, pin (Amp part number 66162-1), 150 each

If the user connects serial devices to the system, it may be necessary to configure the port parameters to match the installed devices. This is done by using the "CONFIG_C.V2" utility program provided with the system. Refer to the Instructions for Adept Utility Programs for more information.

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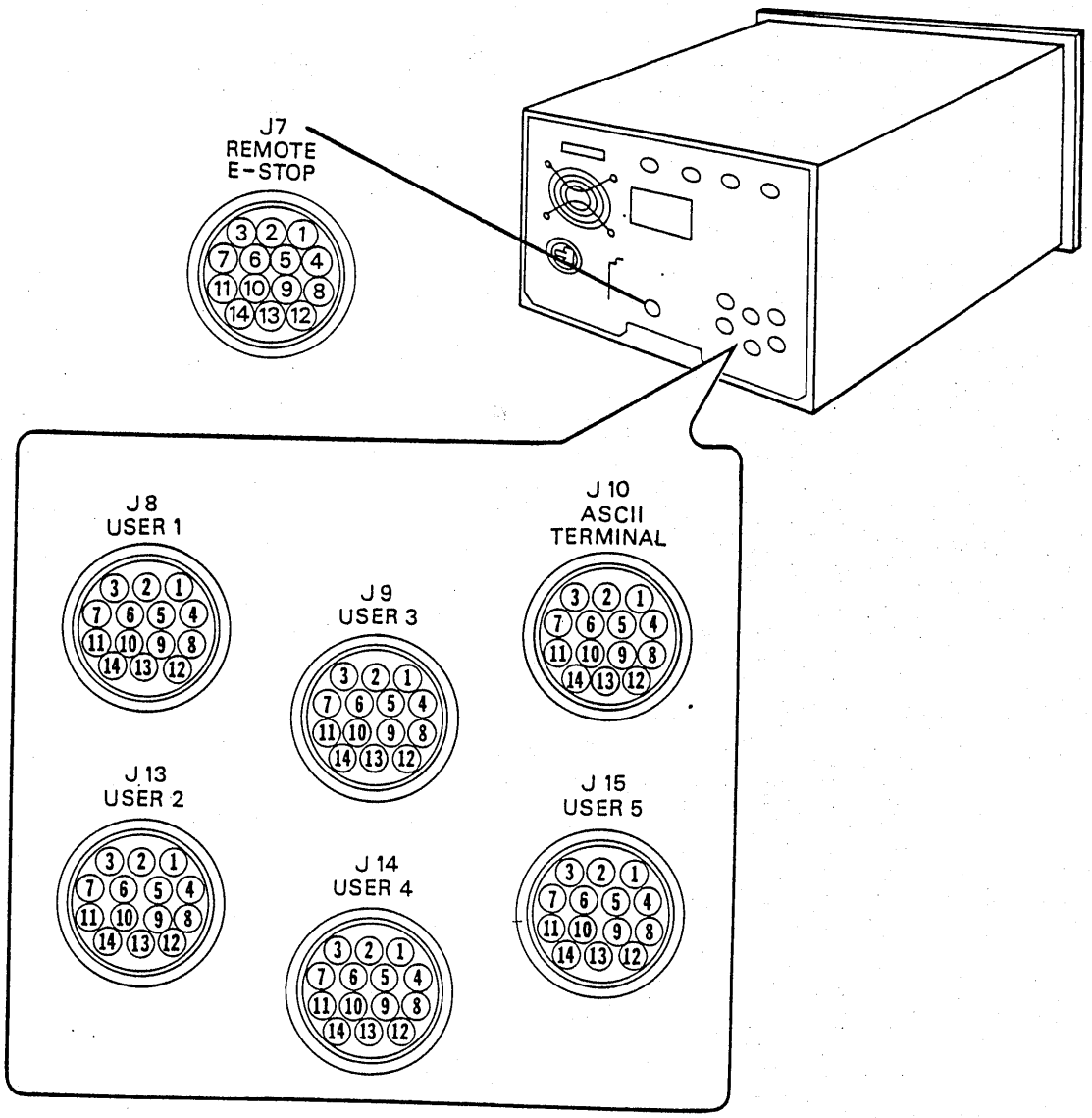


Figure 4-3. XIB Serial Ports

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4.4 MODULE DATA TABLES

There are six types of 4-channel isolation modules available from Adept. Some of the input modules can support either AC or DC voltages. Refer to the following tables for details.

Adept Part No. 15400-00009

FAST SWITCHING DC INPUT - WHITE CASE
4 to 16 volt

Model	IDC5BQ
Input Voltage Range	4 to 16 VDC
Input Current at Max. Line	45 mA (14 mA at 5 V)
Input Allowed for No Output	0.7 mA (1 V)
Isolation Input-to-Output	4000 Vrms
Input Resistance	300 ohms
Turn-on Time	50 microsec max.
Turn-off Time	100 microsec max.

Adept Part No. 15400-00010

DC INPUT - WHITE CASE
10 to 32 volt DC or AC

Model	IDC5Q
Input Line Voltage-Maximum	32 VDC/AC
Input Voltage Range	10 to 32 VDC 15 to 32 VAC
Input Current at Max. Line	25 mA
Input Allowed for No Output	1 mA (3 V)
Isolation Input-to-Output	4000 Vrms
Input Resistance	1K ohms
Turn-on Time	5 millisec max.
Turn-off Time	5 millisec max.

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Adept Part No. 15400-00011

AC INPUT - YELLOW CASE
120 volt AC or DC

Model	IAC5Q
Input Line Voltage-Nominal	120 VAC/DC
Input Voltage Range	90 to 140 VAC/DC
Input Current at Max. Line	11 mA
Input Allowed for No Output	1 mA (16 V)
Isolation Input-to-Output	4000 Vrms
Input Resistance	14K ohms
Turn-on Time	20 millisec max.
Turn-off Time	20 millisec max.

Adept Part No. 15400-00012

AC INPUT - YELLOW CASE
240 volt AC or DC

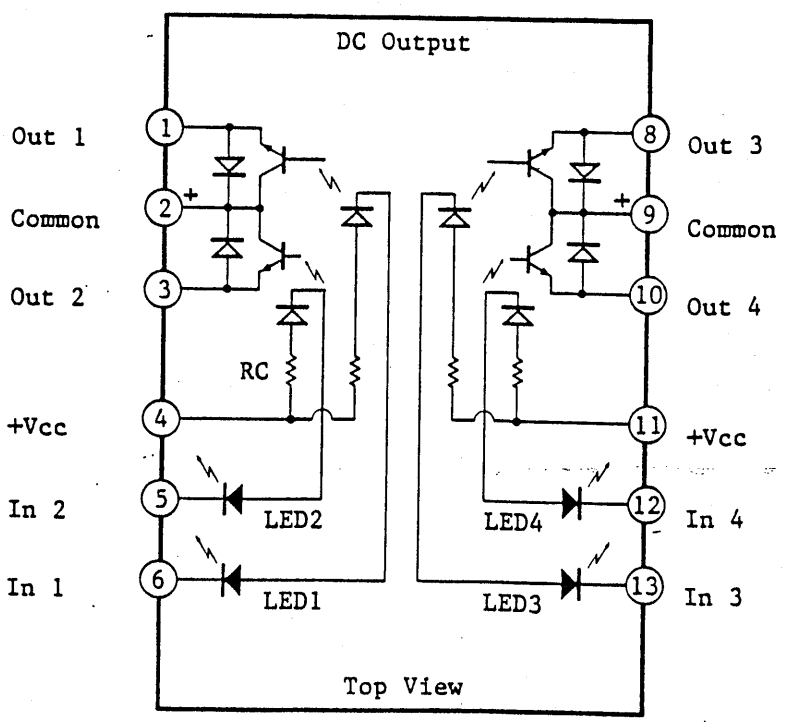
Model	IAC5AQ
Input Line Voltage-Nominal	240 VAC/DC
Input Voltage Range	180 to 280 VAC/DC
Input Current at Max. Line	7 mA
Input Allowed for No Output	0.5 mA (22 V)
Isolation Input-to-Output	4000 Vrms
Input Resistance	43K ohms
Turn-on Time	20 millisec max.
Turn-off Time	20 millisec max.

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Adept Part No. 15400-00013

DC OUTPUT - RED CASE
60 volt

Model	ODC5Q
Line Voltage-Maximum	60 VDC
Operating Voltage Range	5 to 60 VDC
Current Rating Per Channel-	
at 20 degrees C Ambient	3 A
at 45 degrees C Ambient	2 A
1 Second Surge	5 A
Output Voltage Drop	1.6 V max.
Off-state Leakage @ Max. Voltage	1 mA
Isolation Input-to-Output	4000 Vrms
Turn-on Time	100 microsec
Turn-off Time	750 microsec



Observe polarity shown on pins 2 and 9.

TP0113-5/87

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Adept Part No. 15400-00014

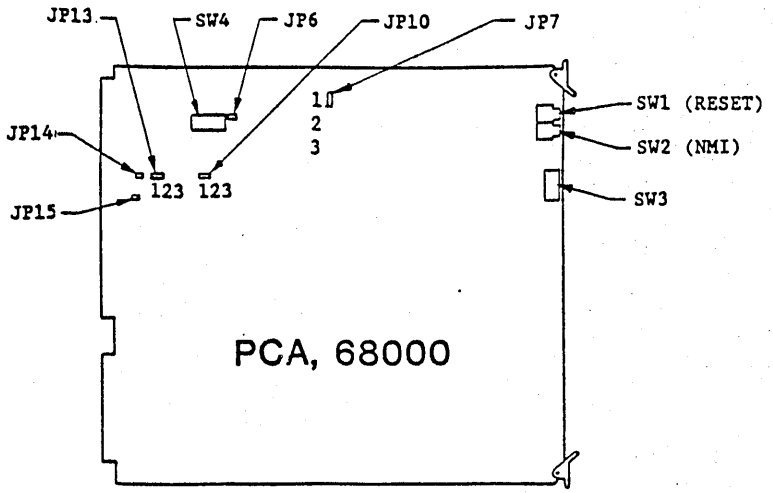
AC OUTPUT - BLACK CASE
120/240 volt

Model	OAC5Q
Line Voltage-Nominal	120/240 VAC
Operating Voltage Range	12 to 280 VAC
Peak Repetitive Voltage	500 V
Current Rating-	
at 20 degrees C Ambient	3 A
at 45 degrees C Ambient	2 A
1 Cycle Surge	80 A Peak
Minimum Load Current	20 mA
Output Voltage Drop-Max Peak	1.6 V.
Off-state Leakage-60 Hz 120 V	3 mA rms
60 Hz 240 V	5 mA rms
Isolation Input-to-Output	4000 Vrms
Turn-on Time	1/2 cycle max. - zero voltage
Turn-off Time	1/2 cycle max. - zero voltage

4.5 PCA CONFIGURATION

The following diagrams detail the correct configuration of some common Adept printed circuit assemblies (PCA's). The PCA's in your controller are correctly configured at the factory.

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PCA Switch Number

PCA Location	SW3	SW4
SYSTEM PROCESSOR	2-5: NC USER SELECT 1:NC for No Autoload 1:NO for Autoload 6:NC for 1200 7:NO baud at boot 6:NO for 2400 7:NC baud at boot 6:NC for 9600 7:NC baud at boot 6:NO for 19200 7:NO baud at boot 8:NC Boot Drive A (Floppy) 8:NO Boot Drive C (Winchester)	1-3,6-8: NC 4,5 : NO
VISION PROCESSOR	1-8: NC	1,2,6-8: NC 3-5 : NO

SW3 and SW4 Switch Settings

PCA Jumper Number (NOTE 1)

PCA Location	JP6	JP7	JP10	JP13	JP14	JP15
SYSTEM PROCESSOR	Pin 1 to 2	OPEN	Pin 1 to 2	Pin 1 to 2	Pin 1 to 2	Pin 1 to 2
VISION PROCESSOR	OPEN	OPEN	Pin 1 to 2	OPEN	OPEN	OPEN

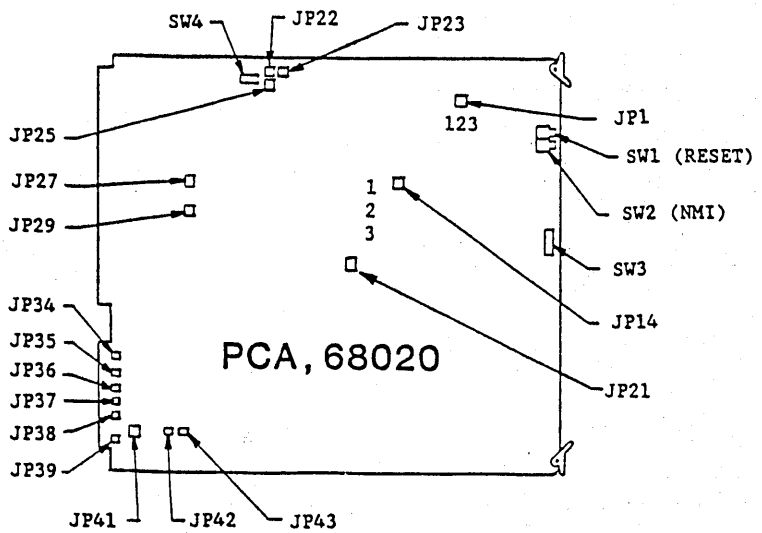
Jumper Configuration Shorting Table

NOTE 1: Use Jumper Shorting Block (27200-00014).

68000 PCA Configuration,
for use on Adept Part Number 10300-16600

Figure 4-4

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PCA Part number	PCA Switch Number SW3	SW4
10310-61100	1-8: NC	1,2: NC 3,4: NO
10310-61200	1-8: NC	1-4: NC

SW3 and SW4 Switch Settings

PCA Part Number Number	PCA Jumper Number (NOTE 1) JP1	JP14	JP21 JP34-39 JP41-43 NOTE 3	JP22	JP23	JP25	JP27 NOTE 2	JP29 NOTE 3
10310-61100	Pin 2 to 3	Pin 1 to 2	Pin 1 to 2	Pin 1 to 2	OPEN	OPEN	Pin 1 to 2	OPEN
10310-61200	OPEN	Pin 1 to 2	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN

Jumper Configuration Shorting Table

NOTE 1: Use Jumper Shorting Block (27200-00014).

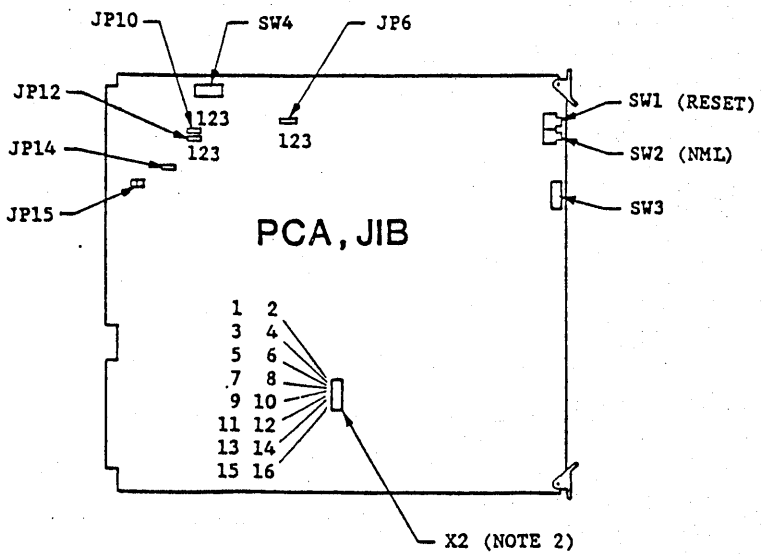
NOTE 2: PCA revision A only.

NOTE 3: May have soldered or PCA trace jumpers.

68020 PCA Configuration,
for use on Adept Part Numbers;
10310-61100 (Vision Processor)
10310-61200 (System Processor)

Figure 4-5

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	PCA Switch	
Manipulator Axis	SW3	SW4
Joint 1,2	1-8: NC	1,3,4,5,7,8: NC 2,6 : NO
Joint 3,4	1-8: NC	1,4,5,7,8 : NC 2,3,6 : NO
Joint 5	1-8: NC	2-5,7,8 : NC 1,6 : NO

SW3 and SW4 Switch Settings (all manipulators)

		PCA Jumper Number (NOTE 1)					
Manipulator and Axis		X2 NOTE 2	JP6	JP10 NOTE 2	JP12	JP14	JP15
AdeptOne	J1,J2 J3,J4 J5	Pin 5 to 6	OPEN	Pin 1 to 2	Pin 1 to 2	OPEN	OPEN
AdeptTwo, AdeptThree	J1,J2 J3,J4	Pin 7 to 8					
	J5	Pin 5 to 6					

Jumper Configuration Shorting Table

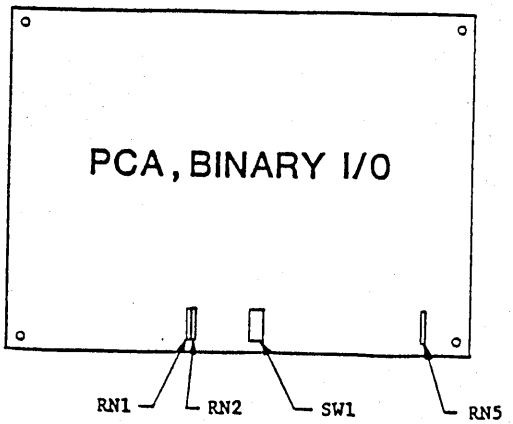
NOTE 1: Use Jumper Shorting Block (27200-00014).

NOTE 2: PCA revisions prior to N may have soldered or PCA trace jumpers.

JIB PCA Configuration,
for use on Adept Part Numbers;
10300-11200 (JIB Joints 1-4)
10845-72000 (JIB Joint 5)

Figure 4-6

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SW1 Switch Setting

I/O Channel number	S6	S5, 7,8	S4	S3	S2	S1
1-32	NC	NO	NO	NO	NO	NO
33-64	NC	NO	NO	NO	NO	NC
65-96	NC	NO	NO	NO	NC	NO
97-128	NC	NO	NO	NO	NC	NC
129-160	NC	NO	NO	NC	NO	NO
161-192	NC	NO	NO	NC	NO	NC
193-224	NC	NO	NO	NC	NC	NO
225-256	NC	NO	NO	NC	NC	NC
257-288	NC	NO	NC	NO	NO	NO
289-320	NC	NO	NC	NO	NO	NC
321-352	NC	NO	NC	NO	NC	NO
353-384	NC	NO	NC	NO	NC	NC
385-416	NC	NO	NC	NC	NO	NO
417-448	NC	NO	NC	NC	NO	NC
449-480	NC	NO	NC	NC	NC	NO
481-512	NC	NO	NC	NC	NC	NC

RN socket

RN1	RN2	RN5
470 ohm	330 ohm	1K ohm

Resistor Network Configuration

NOTE: Resistor Networks are always installed only in one BIO PCA, and always the last PCA of the cable chain from the cardcage.

BIO PCA Configuration,
for use on Adept Part Numbers 10310-58000, 10310-58010

Figure 4-7

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Notes

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CHAPTER 5

PREPARATION FOR SHIPMENT

Should relocation of the equipment become necessary, the following procedure details the disassembly of the controller and preparation for shipment. The procedure assumes that all packing materials used during shipment from the factory have been retained and are available for reuse. Shipment with improper packaging will void your warranty. Proceed as follows:

1. If the system is on, turn off arm power and then rotate the system power switch to the off position.

CAUTION

Ensure that all essential programs have been saved to disk prior to powering down the system. Refer to Chapter 10 of this manual for information on disk file operations.

2. Open the circuit breakers located on the rear panel of each chassis, starting with the 10A breaker on the controller chassis.

3. Disconnect the main AC power by removing the AC power cord plug from the wall socket.

4. Label and disconnect all external cables and wire runs such as binary I/O and remote emergency stop safety devices.

5. Disconnect the arm signal cable, terminal cable, and MCP cable from the controller chassis. Coil and tie these cables.

6. Disconnect the arm power cable from the rear of the amplifier chassis. Coil and tie this cable.

7. If necessary, 1) remove the equipment from the rack, and 2) remove the chassis slides and other user installed items.

8. Install protective packing around each controller chassis and package all accessories for the move.

This completes the instructions for disassembly and preparation for shipment.

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Notes

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CHAPTER 6

CONTROLLER ARCHITECTURE

6.1 INTRODUCTION

The Adept CC Controller provides an environment to run the V robot control language or V+ advanced robot control language on a Multibus-based computer with the following basic configuration:

- Optional manual control pendant and programmer's terminal
- One 3-1/2 inch floppy disk drive with option for a second floppy drive, or a Winchester drive
- 32 line I/O capability with expansion to 512 lines possible
- Six user accessible RS-232C serial ports (one dedicated to the optional programmer's terminal).

The controller chassis contains an 8-slot Multibus-compatible backplane. Three slots are dedicated to the Joint Interface Boards (JIB), and one to the V/V+ CPU board. The four remaining slots are available for Adept options.

6.2 FUNCTIONAL AREAS

The CC controller can be divided into three major functional areas as shown in Figure 6-1. These areas are: 1) the central processor unit, 2) the joint interface system, and 3) the optional AdeptVision system.

The following paragraphs discuss the functional operation of the major parts of the controller.

6.2.1 The CPU Board

Figure 6-1 shows the relationship between the CPU and other functional areas of the controller. The CPU interfaces with the joint and vision systems via the Multibus. Communications with other functions are through several input/output ports and include: The user interfaces (terminal and pendant), disk storage devices, binary I/O (BIO), and the robot signature card (RSC).

Both the manual control pendant and the terminal communicate with the CPU via standard RS-232C serial I/O ports. The BIO ports provide the

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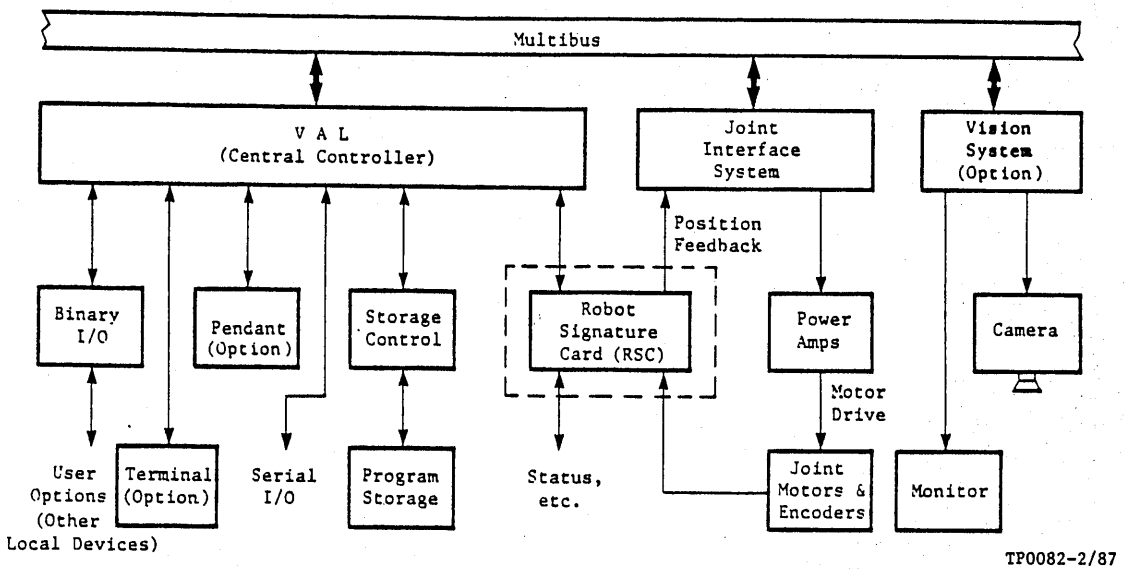


Figure 6-1. CC Controller Block Diagram

controller with a means of interfacing with external devices such as sensors and limit switches. The disk storage interface is used to store and retrieve information such as application programs.

6.2.2 Joint Interface System (JIB)

The JIBs receive commands from the CPU via the Multibus (see Figure 6-1), and in response to those commands generate the signals that cause the power amplifiers to drive the robot joint motors. The encoders located at each joint transmit positional information back to the JIBs. This arrangement constitutes a servo loop. In addition, the JIBs monitor the conveyor encoders used for belt tracking, and generate synch signals for the camera in a line vision system.

Figure 6-2 illustrates the joint interface arrangement in greater detail. The JIB processor and the servo control circuitry are located on the JIB board. The power amplifiers are located on the heat sink on the front of the amplifier chassis.

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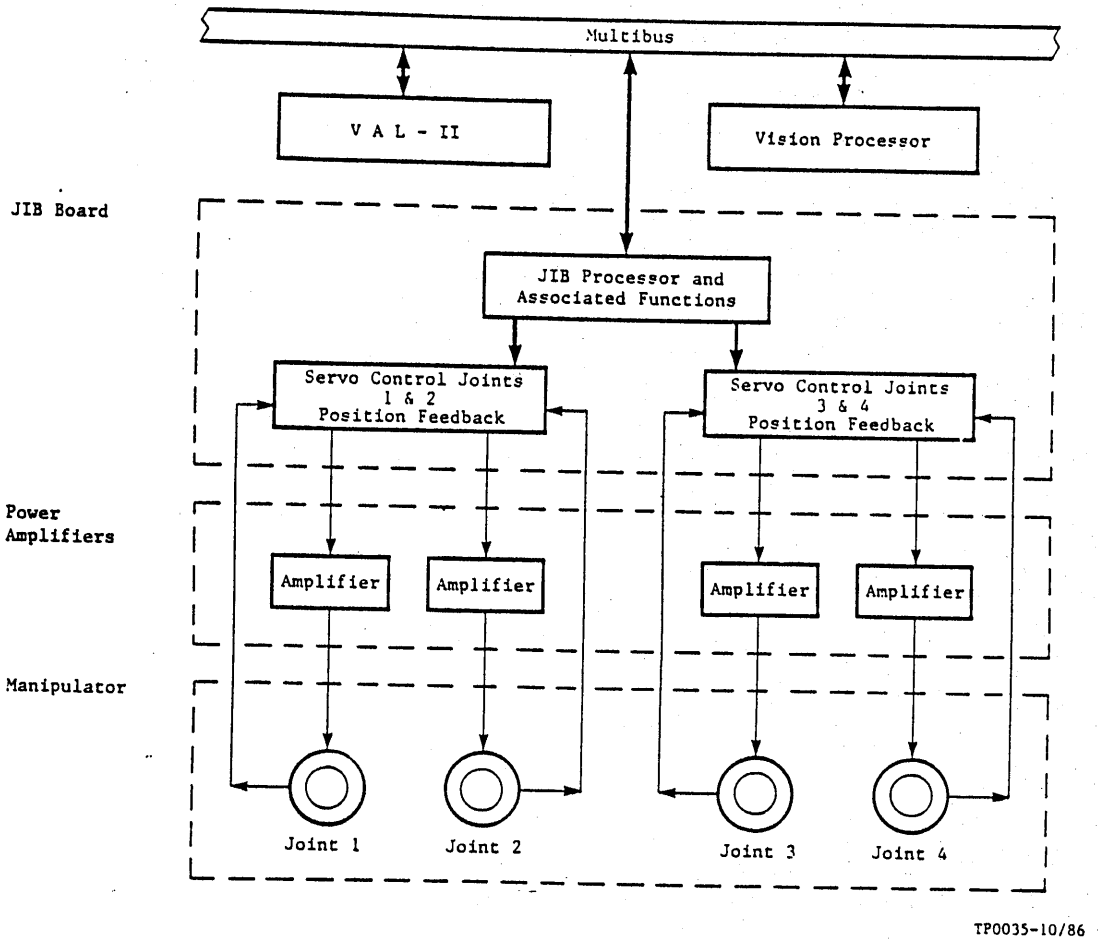


Figure 6-2. Joint Interface System Block Diagram

6.2.3 Optional AdeptVision Systems

The optional AdeptVision systems identify work pieces on which the manipulator acts. The operator uses the system in two basic ways: first to teach the manipulator to recognize a certain item, and second to locate or measure objects.

The vision processor controls the vision system, and the V or V+ system controls the vision processor by sending commands via the Multibus.

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6.3 CONTROLS AND INDICATORS

All operator controls and indicators are located on the right side of the front panel of the controller chassis. Figure 6-3 shows the position of the controls and indicators. The function of each of them is listed below.

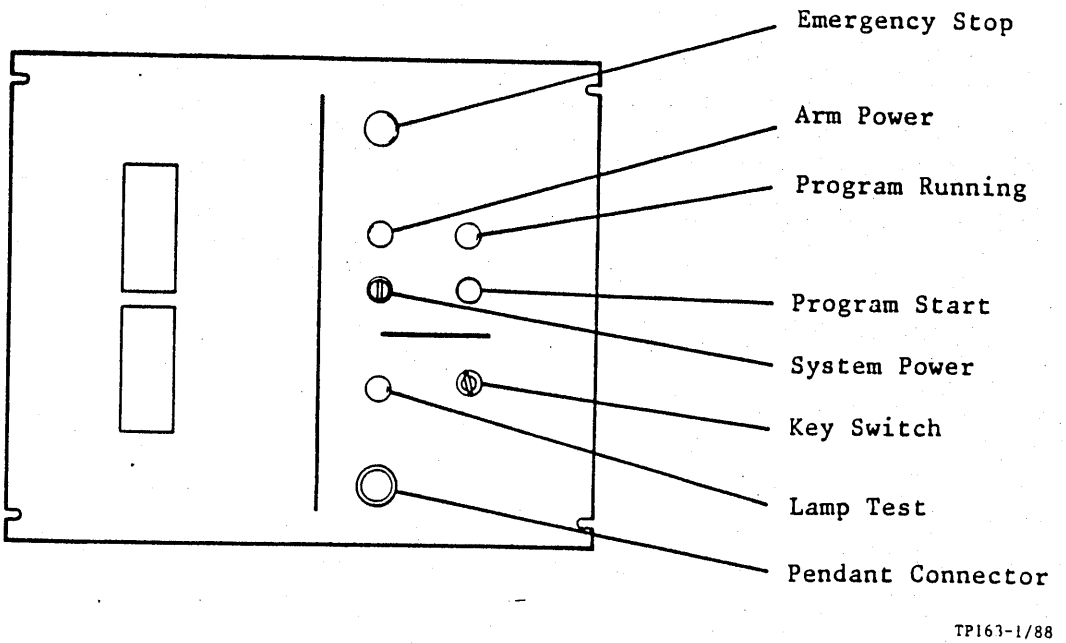


Figure 6-3. Controls and Indicators

1. EMERGENCY STOP SWITCH:

   This push-pull emergency stop switch removes arm power and brings the manipulator to an immediate stop when pushed in.

2. ARM POWER LAMP (AMBER):

   This lamp signals the presence of arm power at the manipulator. If the amber lamp is illuminated, there is arm power present at the manipulator. If the lamp is extinguished, arm power is not on.

   If any emergency stop has been activated, the amber arm power lamp will be off. The operator can also disable power to the arm through software control (monitor command or program instruction).

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3. PROGRAM RUNNING LAMP (BLUE):

When illuminated, this blue lamp indicates that a robot control or process control program is running. This is intended as a warning that the arm and other mechanisms in the work cell are under computer control and may move at any time.

4. SYSTEM POWER SWITCH AND LAMP (GREEN):

The rotary on/off switch controls the main AC power relay. The green lamp is illuminated when main AC power is on.

5. PROGRAM START SWITCH AND LAMP (GREEN):

This momentary push button switch is used to execute command programs initiated from the optional pendant. Pressing the "AUTO", "CALIB", "CMD1" or "CMD2" command buttons on the MCP will cause the Program Start lamp to flash and require that the Key Switch (description follows) be placed in the "TERMINAL" position and the Program Start Switch pressed to start execution.

NOTE

Refer to your V+ Reference Guide or V Reference Guide for information concerning the WAIT.START monitor command and the RETRY system switch associated with the Program Start Switch function.

6. LAMP TEST/PENDANT REMOVE SWITCH:

When pressed this switch tests all of the above indicator lamps. A fault condition exists (probably defective bulb) if any lamp does not illuminate when this switch is pressed.

This switch must be held in while disconnecting the MCP and replacing the MCP jumper plug, otherwise any program in progress will be aborted.

7. KEY SWITCH

The Key Switch is a 3-position rotary switch marked PENDANT, TERMINAL, and NETWORK. THE "PENDANT" position permits single point control from the optional MCP when locked in this position. The "TERMINAL" position provides system control from the optional programmer's terminal. Also, the Key Switch must be in this position to execute pendant initiated command programs with the Program Start Switch. The "NETWORK" position is reserved for future use.

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8. PENDANT CONNECTOR:

Serial port for connection of the optional Manual Control Pendant (MCP). Requires pendant jumper plug when MCP is not connected.

Immediately to the left of the control and indicator area is the standard 3-1/2" microfloppy drive. There is also provision to add an optional drive.

The main AC circuit breaker (20A) is located on the rear panel of the amplifier chassis. Located on the rear of the controller chassis there is a 10A circuit breaker for the AC voltage from the amplifier chassis. This AC voltage is used in the controller chassis for the DC power supply and the cooling fan.

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CHAPTER 7

USING THE DISK DRIVES

7.1 INTRODUCTION

The standard configuration of the CC controller contains one 3-1/2 inch, double-sided microfloppy disk drive. There is provision for adding as options a second 3-1/2" microfloppy drive or an optional 3-1/2" Winchester.

Included with your system are two copies of a V or V+ System Diskette (identified by a yellow mark on the label), two copies of "Utility Disk #1" (blue mark on the label), and two blank (unformatted) diskettes. The system diskette contains the V or V+ software, and the utility diskette contains several calibration and tutorial programs. The second copy of these diskettes is an exact duplicate and provides backup should the primary diskette become damaged.

The V and V+ systems use the disk unit specifiers "A", "B", and "C" for the various drives. The 3-1/2" disk drives are designated as "A" (lower drive) and "B" (upper drive), respectively. The "A" drive is considered by the V or V+ system to be the default drive unless otherwise specified. The optional Winchester is designated drive "C".

NOTE

All procedures described throughout this manual assume that the default drive is drive "A". If you select another drive as the default drive, to avoid confusion it is important that you make the change known to all who operate or maintain the equipment.

All diskettes are either "system diskettes" or "general-use diskettes". The Winchester can be both, but 3-1/2" diskettes must be dedicated for use as one or the other. The FORMAT command determines whether the diskette is a system or general-use diskette. All blank diskettes must be formatted prior to use.

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7.2 MEDIA FORMAT

The format for the 3-1/2" diskettes is eight sectors per track with 512 data bytes per sector. Each standard diskette can have up to 80 tracks per side, for a total of 1280 sectors per diskette.

The Winchester format has 2586 clusters of eight 512 byte sectors, for a total of 20688 sectors.

The FORMAT command is outlined below:

FORMAT disk-unit:/switch/switch

Where "disk-unit" is either "A", "B", or "C". The following switches can be specified:

/F For Winchester only

/D For single-sided, double-density (Default Switch)

/Q For double-sided, double-density (Also referred to as quad density)

/S For single-sided, single-density

/B For designating a system boot disk (use with one of the above).

Examples of the format command:

FORMAT C:/F/B	Formats the Winchester disk as a fixed boot device
FORMAT A:/B/Q	Formats the diskette in drive "A" as a double-sided double-density "system boot diskette"
FORMAT A:/Q	Formats the diskette in drive "A" as a double-sided double-density "general-use diskette"

More information on the FORMAT command, and other disk I/O commands can be found in the "dictionary" section of the V+ Reference Guide or the V Reference Guide.

7.3 MEDIA HANDLING

The standard diskettes furnished with the 3-1/2" drives are hard-jacketed diskettes, and therefore are protected against media damage as a result of handling. However, all diskettes, whether hard or soft jacketed, should be protected from exposure to heat and magnetic influences to help ensure the integrity of stored data.

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Figure 7-1 shows the front and back sides of the standard 3-1/2" hard-jacketed diskette furnished with the system. Looking at the front side, note the presence of a small window in the upper right corner. If this window is open, the disk is write protected. That is, any attempt to write to such a diskette will result in a write-protect error being returned by the system. This provides the user the means to prevent accidental deletion of previously recorded programs or data. To store additional information on a partially filled diskette, turn the diskette over and close the window by sliding the tab to the opposite position. Remember, window open means the diskette is write protected; window closed means the diskette is not write protected.

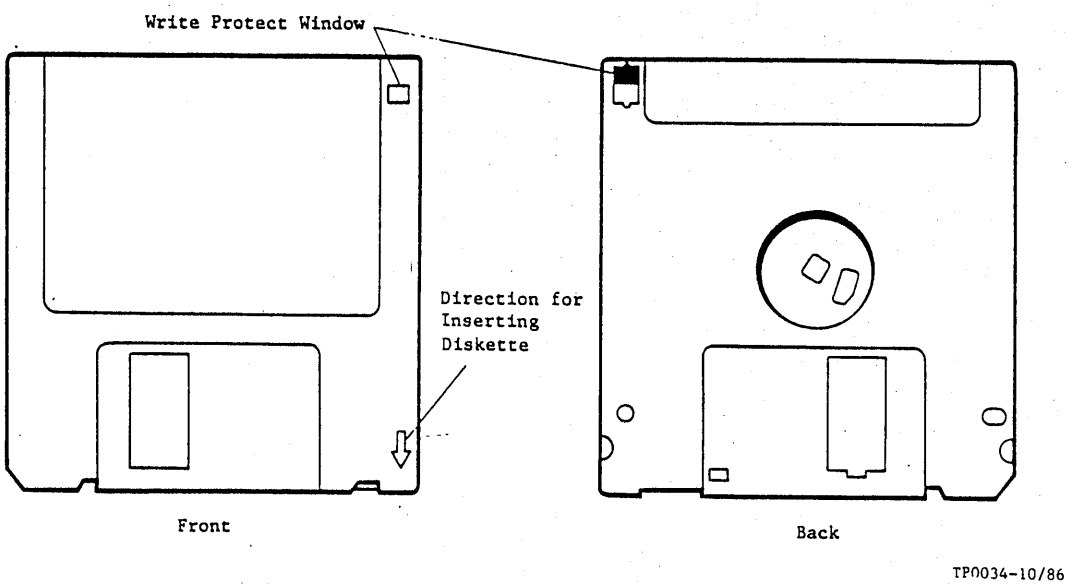


Figure 7-1. Standard 3-1/2 Inch Diskettes

Looking at Figure 7-1 again, note the presence of the arrow embossed into the plastic jacket in the lower right corner of the diskette. The arrow indicates the direction for inserting the diskette into the drive. By orienting the diskette so that the arrow is at the upper left, it is easily inserted into the drive and seated with just slight finger pressure. Press the diskette release button on the drive to remove the diskette. This will eject the diskette from the drive.

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CAUTION

There is a drive activity light located on the front panel of each installed drive. When lit, it indicates that the drive motor is spinning. Do not attempt to remove the diskette when the drive activity light is on.

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CHAPTER 8

SYSTEM STARTUP

8.1 INTRODUCTION

This chapter begins the tutorial portion of this manual--the user will be guided through the process of system startup. At the end of the chapter the system will be turned on, ready for calibration and operation.

8.2 STARTUP PROCEDURE

Follow the listed steps in sequence:

1. Switch on both AC circuit breakers located on the rear panel of each chassis.

2. Insert a 'system diskette' into drive "A", the lower 3-1/2" disk drive. This step is not necessary if the optional Winchester drive is installed.

3. Turn the system power switch to on. The switch is located on the control and indicator panel. This action will initialize the controller, but it does not enable movement of the arm.

NOTE

Several actions should automatically take place when the system power switch is turned on. The system power lamp (green) will illuminate, and the other indicator lamps may flash momentarily. The internal cooling fan will start and should be audible. In addition, the drive activity lights on the installed drives will come on briefly, and then go off.

Boot (loading) time from the 3-1/2" disk drive is approximately 1.5 minutes, and from the Winchester it is about 1 minute. Actual load time will vary considerably with software version and system options. The drive activity light of the appropriate drive should be on while system is loading.

If the optional MCP is connected to the system and the controller Key Switch is in the "PENDANT" position, the LEDs on

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the pendant may flash continuously during the boot process and when the loading sequence is completed, the message "NO PROGRAM PRIMED" will appear on the pendant display.

If the optional programmer's terminal is connected to the system and the controller Key Switch is in the "TERMINAL" position, the following message will be displayed on the screen when the software starts loading.

Adept Technology, Inc. Robot/Vision System

and end with the version line when loading is completed:

Version [ ] - [ ] ...

The version line will indicate the system serial number and specific configuration information. See the description of the "ID" command in the V+ Reference Guide or V Reference Guide

for more information on this display.

4. Once the system is booted, the "system diskette" can be removed from drive "A".

The system is now ready to accept commands.

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