Seiko RT 3200

- Extremely fast cycle time assures you higher throughout and increased productivity.
- Most powerful control system, insures quick system implementation and modular design and proven reliability make this robot very flexible and easy to service.

Degrees of Freedom	4
Repeatability	±0.025 mm (±0.001")
Payload (at max. speed)	5 kg (11 lbs., *30 lbs. at reduced speeds*)
Vertical Insertion Force	31 lbs. (14.1 kg)
Moment of Inertia o Payload (at max. speed)	105 gf·cm·sec^2 (103 kg·cm^2)
Pneumatics	3 lines
Power Supplies for Sensors or Valve Solenoids	4
Standard Language	DARL II Version 4
I/OAccessible through DARL II	16 / 16 (External) 8 / 8 (Gripper)
Manipulator	Weight: 130 kg
Controller	Weight: 35 kg
Teach Terminal	Weight: 2.5 kg

	Z Axis Vert. Stroke	T Axis Waist Rotation	R Axis Horiz. Stroke	A Axis Wrist Rotation	Combined*
Max. Speed	513 mm / sec. (20" / sec.)	200 deg. / sec.	1000 mm / sec. (40" / sec.)	420 deg. / sec.	106" / sec.
Acceleration	0.52 G's	32 rad / sec.^{2}	1 G	73 rad / sec.^{2}	2.5 G's
Resolution	0.0032 mm (0.00013")	0.0013 deg.	0.0063 mm (0.00025")	0.0023 deg.	0.015 mm (0.0006")
Range	120 mm (4.72")	300 deg.	305 mm (12")	±999 deg.	900 mm^3 (3 cubic ft.)

Power Requirement	AC200, 220 240V ±10% (single phase)
Power Frequency	50 / 60 Hz
Power Consumption	2.5 KVA (7.5 KVA at POWER ON)
Operating Temperature	0 to 40 deg. C
Operating Humidity	20 to 90% R.H. (non-condensing)
Operating Atmosphere	Non-corrosive gas

*Reflect worst case situations: Full Payload, Full Repeatability, through total product life.

INDEX OF USED ROBOTS			
Manufacturer	**Model**	**Payload**	**Number of Axes**
Intelligent Actuator	IS Series	9 kg	3
Seiko	D-TRAN XY 3000	1 kg	4
Seiko	RT 3200	5 kg	4
Seiko	TT 8030	5 lbs.	4
Seiko	XM Series	7.3 kg	4

Seiko D-TRAN XY 3000

- **High speed, 4 axes, DC Servo, with simultaneous control. User-friendly DARL™ programming language.**

Configuration		**4 Axes**
Payload (At maximum speed)		**1 kg (2.2 lbs)**
Arm Range	**A: Grip Rotation**	**±900 deg.**
	X: Horizontal Reach	**300 mm (11.81 in.)**
	Y: Horizontal Traverse	**200 mm (7.87 in.)**
	Z: Vertical Stroke	**100 mm (3.94 in.)**
Speed	**A: Grip Rotation**	**7.5 rps (J = 2.0 gfcms^2)**
	X: Horizontal Reach	**1000 mm (40 in.) / sec**
	Y: Horizontal Traverse	**1000 mm (40 in.) / sec**
	Z: Vertical Stroke	**500 mm (20 in.) / sec**
	Combined Maximum	**1500 mm (59 in.) / sec**
Accuracy (XY-plane)		**0.030 mm (0.0012 in.)**
Repeatability		**±0.008 mm (0.0003 in.)**
Resolution	**A: Grip Rotation**	**0.056 deg.**
	X: Horizontal Reach	**0.010 mm (0.0004) in.**
	Y: Horizontal Traverse	**0.010 mm (0.0004) in.**
	Z: Vertical Stroke	**0.010 mm (0.0004) in.**
Weight		**105 kg (231 lbs)**

- **Degrees of Freedom** 4
- **Repeatability** ±0.025 mm (±0.001")
- **Payload (at max. speed)** 5 kg (11 lbs., *30 lbs. at reduced speeds*)
- **Vertical Insertion Force** 31 lbs. (14.1 kg)
- **Moment of Inertia o Payload (at max. speed)** 105 gf·cm·sec^2 (103 kg·cm^2)
- **Pneumatics** 3 lines
- **Power Supplies for Sensors or Valve Solenoids** 4
- **Standard Language** DARL II Version 4
- **I/O Accessible through DARL II** 16 / 16 (External) 8 / 8 (Gripper)
- **Manipulator** Weight: 130 kg
- **Controller** Weight: 35 kg
- **Teach Terminal** Weight: 2.5 kg

	Z Axis Vert. Stroke	T Axis Waist Rotation	R Axis Horiz. Stroke	A Axis Wrist Rotation	Combined*
Max. Speed	513 mm / sec. (20" / sec.)	200 deg. / sec.	1000 mm / sec. (40" / sec.)	420 deg. / sec.	106" / sec.
Acceleration	0.52 G's	32 rad / sec.^{2}	1 G	73 rad / sec.^{2}	2.5 G's
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Operating Atmosphere	Non-corrosive gas

*Reflect worst case situations: Full Payload, Full Repeatability, through total product life.

XYZ actuator

Special..... $9650 each				
		X	Y	Z
Stroke	mm	500	500	200
Rated Power	W	100	100	100
Rated Speed	mm / sec.	500		
Rated Thrust	N (kgf)	169.5 (17.3)		
Repeatability	mm	+/-0.02		
Unit Weight	kg	10.8	9.6	6.9
Motor		AC Servo Motor		
Encoder		Attached to Motor		
Ballscrew		Lead 10 mm Rolled Thread C10, Backlash 0.0 5mm or Less		
Guide		Unique to IS Integrated into Base		
Motor/Ballscrew Connection		Motor/Ballscrew Shaft Integrated		
Base		Extruded Aluminum (A6NO1S-T5) White Alumite Treatment		
Maximum Thrust (Note 1)	N (kgf)	339.0 (34.7)		
Payload (Note 2, 3)	kgw	Horizontal Use : 40 Vertical Use : 9		

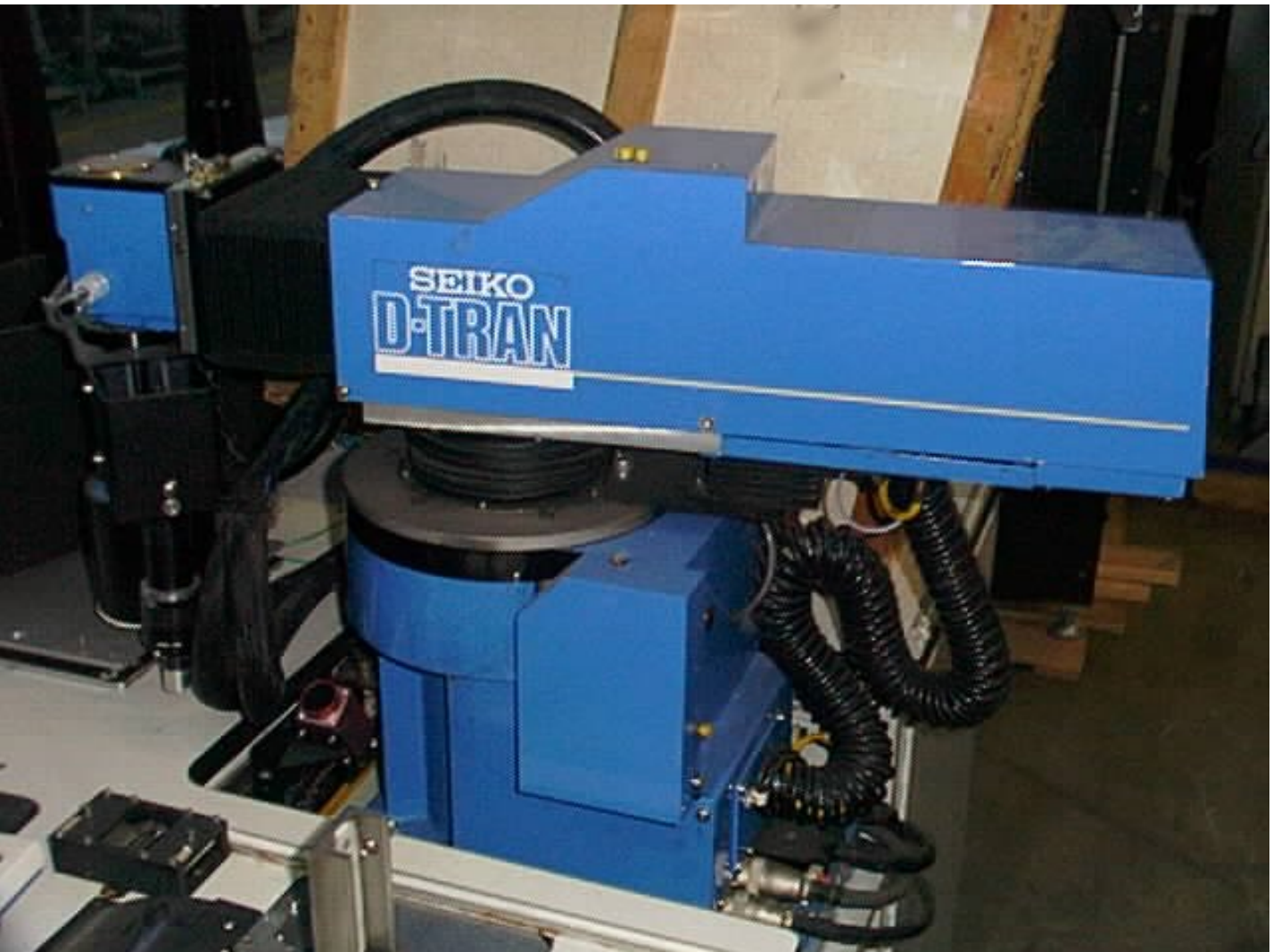
Note 1) At a speed of 10mm/sec for 5 seconds.

Note 2) Load uniformly distributed on the slide. Base affixated to a flat, strong frame.

Note 3) At an acceleration of 0.15 [0.3] <0.3> G, and 250 [500] <1000> mm/sec speed.

Seiko Pendant

Seiko D-Tran



Cylindrical R

- Fast Cycle Time & High R
- 3rd Generation Design
- RT3200 Upgrades to RT3300
- Powerful Controls

- Product Brochures
- CAD Drawings

- Cylindrical Coordinate robots are a unique geometric design that has been highly refined by SEIKO.
- The RT3300 is hybrid mix which incorporates the rotary motion of the SCARA and the linear motion of a CARTESIAN.
- The Z axis is located inside the base, resulting in a compact end-of-arm design that allows the robot to "reach" into tight work envelopes without sacrificing speed or repeatability.
    - **Fast Cycle Time & High Repeatability**
- The RT3300 has a standard cycle time of 0.8 seconds The R axis itself is comprised of a high quality rack and pinion gear design and is repeatable to +0.015mm.
    - **3rd Generation Design**
  - The RT3300 is based on the proven design of the highly successful RT3200 robot. Using the same robust mechanics, this unit now incorporates **AC Servo motors** for reduced maintenance as well as the **powerful SRC310A robot/workcell controller**. All cables and pneumatic lines are neatly routed through the inside of the R axis , reducing wear and making for clean end of arm designs.

- **Upgrade Your RT3200 Robot to an RT3300**
  - With an install base of several thousand units worldwide, the RT3200 has proven to be one of the world's most popular and durable robots.
  - At SEIKO, we regularly rebuild older RT3200's for our customers and re-warranty them as new units.
  - Now, with the introduction of the RT3300, our RT3200 users may upgrade their robots and benefit from both reduced maintenance and more powerful controls.
  - Contact our Customer Service group at service@seikorobots.com for more details.

    - **Powerful Control**

Powerful Controls

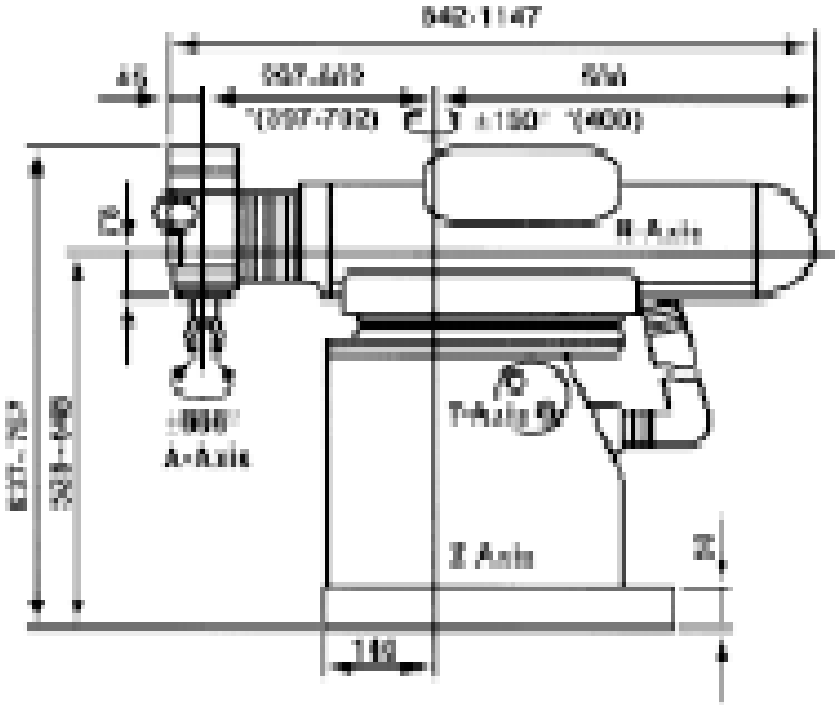
- With our SRC-310A Controller and SPEL for Windows graphical user interface for development, Seiko has redefined the term easy to use.
- Many of our customers have experienced significant reductions in development time due to the ease with which our robots can be programmed.

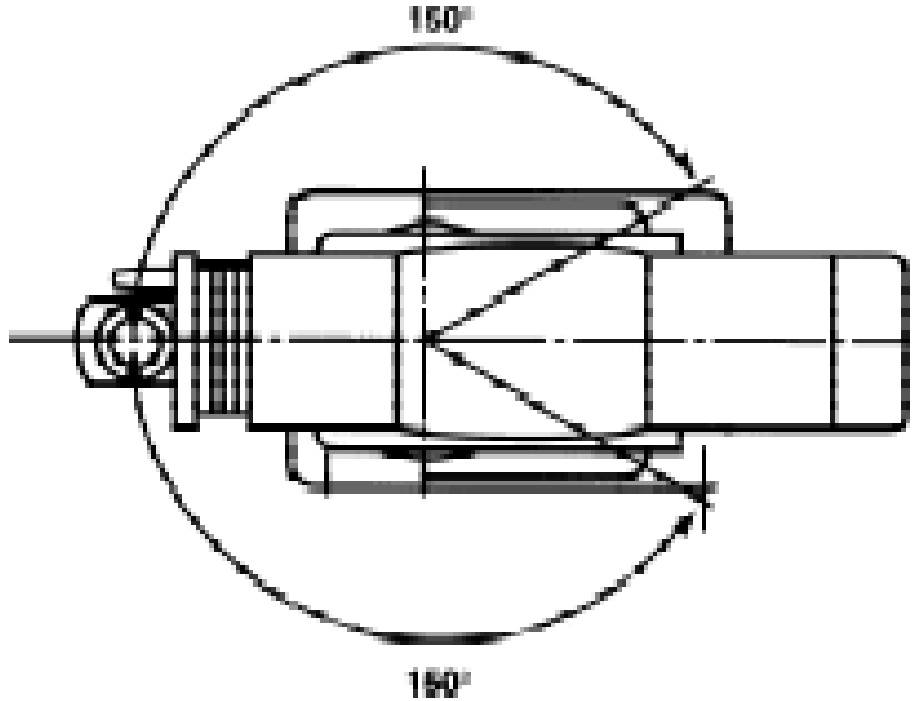
RT3300
Cylindrical Robot

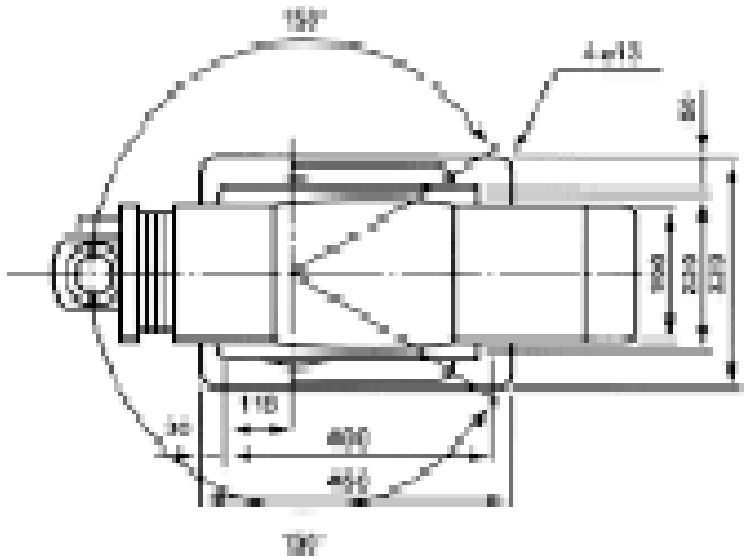
± 0.025 mm Repeatability
±0.015 mm R axis Repeatability
0.76 sec. Cycle Time
Brushless AC Servo Motors

Manipulator Dimensions

Work Envelope


842~1147
B-Axis
A-Axis
T-Axis
Z Axis
140


150°
150°


150°
4-ø13
110
400
450
180°

Specifications

RT3300 Cylindrical Robot

Standard Model Specifications

Model		RT3300
Part number	Standard	RA002241-1
	Clean	Check with Seiko
Payload	rated/max.	Standard model: 5 kg/12 kg
		100 mm Shift model: 2.5 kg/12 kg
U Axis allowable moment of inertia	rated/max.	100 kg·cm²/ 500 kg·cm²[34 lb·in² / 171 lb·in²]
Max. Stroke	T Axis	±150°
	R Axis	305 mm [12.01 in]
	Z Axis	120 mm [4.72 in]
	U Axis	±999°
Weight		138 kg [303.60 lbs]
Max. operating Speed	T Axis	200 °/sec
	R Axis	1000 mm/sec [39.37 in/sec]
	Z Axis	513 mm/sec [20.20]
	U Axis	420 °/sec
Repeatability	T & R Axis	±0.025 mm [0.0009845 in]
	Z Axis	±0.025 mm [0.0009845 in]
	U Axis	±0.03 °
Resolution	X Axis	0.00036621 °/p
	Y Axis	0.00238068 mm/p [0.000093728 in/p]
	Z Axis	0.00112680 mm/p [0.000044362 in/p]
	U Axis	0.00087890 °/p
Motor power consumption	T Axis	400 W
	R Axis	400 W
	Z Axis	400 W
	U Axis	50 W
Z Axis down force		140 N (14.2 kgf)

Motor power consumption	T Axis	400 W
	R Axis	400 W
	Z Axis	400 W
	U Axis	50 W
Z Axis down force		140 N (14.2 kgf)
Installed wire for customer use		15 wires (15 pin D-sub connector)
Installed pneumatic tube for customer use		dia. 6 mm (2 pneumatic tubes)
		Allowable pressure 0.59 MPa, 6 kgf / cm
Environmental requirements		Temperature 5 to 40 °C (no drastic change is allowed)
		Humidity 10 to 80 % (no drastic change is allowed)
Applicable controller		SRC-310CE (CE marked)

PRODUCT SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE - PLEASE CHECK WITH SEIKO FOR CURRENT SPECIFICATIONS

The Seiko RT-3000 Work Cell

DARL Programming Manual

- **OBJECTIVE:**
  - 1. Safety Considerations
  - 2. Operation of the robot control
  - 3. Startup and Shutdown Procedures
  - 4. How to enter and edit a DARL program
  - 5. How to teach the Translation Points in a DARL program
  - 6. How to use the robot Input/Output signals for user defined purposes.

SAFETY NOTE:

- The robot can move very quickly and is capable of causing severe injury. When working around the robot keep in mind that the robot may move at unexpected times. Keep out of the robot work space if at all possible when the robot power is ON. NEVER-NEVER put your head into the robot work space. THINK ABOUT NO. 1 FIRST, namely yourself.
- The conveyor can cause injury also. Keep clear of the conveyor when it is operating. Don't get your clothing caught in the conveyor. Pneumatic actuators and grippers can exert considerable force. Keep your fingers out of grippers, lift stations, and other air operated devices.
- Do not probe the interior of the electrical equipment control enclosures when the power is ON. Some of these have high voltage signals which can cause injury.

INTRODUCTION:

- CAUTION:
- In the procedures to follow PLEASE PLEASE do not use the CALIB command.
- If not done properly this can cause considerable trouble and it will only delay your progress.
- Portions of the Seiko Robot Instruction Manual have been provided to each student.
  - This will be referenced in portions of the experiment procedure.
- Review the pages from Chapter 1 of this manual.
  - This will provide a general description and specifications of the robot.
- Note that the FAU robot installations include additional equipment not described in the Seiko manual.

INTRODUCTION:

- The purpose of this equipment is to provide the Input/Output (I/O) interface between the robot and the conveyor.
- It consists of:
  - a: A Power Distribution Enclosure
  - b. A System Interface Enclosure
  - c. A Pneumatics Enclosure
  - d. A Manual INPUT/OUTPUT Demonstration Box (I/ODB)

STARTUP PROCEDURE:

- Incorporating these Interface devices into the system requires some modification of the standard STARTUP procedure.
- This will introduce you to the operation of the Teach-Terminal and basic operations of the robot.
- Proceed as follows:
    - 1. Turn on the Power Distribution Enclosure
    - 2. Push the POWER ON button at the top of the door to the System Interface Enclosure
    - 3. Push the SERVO ON button at the top of the door to the System Interface Enclosure.
    - 4. Perform the operations provided in Chapter 3 of the Seiko Manual.

EDITING AND RUNNING A ROBOT DARL PROGRAM:

- The DARL language is very much like BASIC.
- It is easy to use and understand. It in fact includes some BASIC commands as well as robot commands like MOVE.
- Use the Teach-Terminal to enter the simple introduction program that follows.
  - This program causes the robot to move to point 1 where it waits for a manual input signal to proceed. It then moves to point 2.
- At point 2 it turns on the vacuum gripper. It then moves to point 3 where it turns off the gripper, prints a message to the operator, waits for a second input and then repeats the process.
  - This program has the basic elements of a PICK AND PLACE operation. It includes the DARL commands:
- Declarations of the coordinates of a TRANSLATION point.
- SPEED
  MOVE
  PRINT
  INPUT (From the Terminal)
  DELAY
  IF/THEN
  GOTO
  OUTPUT
  STOP
  END
  Comments

- An explanation of these commands follows: (Refer to the program listing as you read this)
- In line 10 SPEED 20 sets the speed at which the robot moves. The syntax is SPEED <n>. n is a number from 1 to 300. The default value is 100, 1 is slow,300 is very fast. Use a slow speed when first checking out a new program.
- Locations of points where the robot is to move are called TRANSTATIONS. They are designated by T<n> where n is a number.
  - TRANSLATIONS are defined near the start of a program. Lines 20,30, and 40 declare the three robot positions used in this program.
  - The four numbers refer to the X Y Z and A coordinates of the point.
  - Refer to page 9-16 in the Seiko Manual for details on entering and teaching TRANSLATION points.

- Lines 10,20 etc include comments. Comments are for people not robots. Comments make the program more readable and easier to understand. The robot ignores the comments. Comments are introduced by an apostrophe. Note that lines 90 and 130 have no robot commands, only comments.
- Lines 50,110, and 150 are the move instructions. These cause the robot to move to the designated TRANSLATION points.
- Line 60 prints a message to the operator. This provides a method to program information to the operator. If used with the INPUT statement as in lines 70 and 200 it enables a method for any required operator interaction.
- For the INPUT command DARL interprets the ASCI value of the first letter of the INPUT response.
- In lines 70 and 200 if the input is Y the robot interprets the response as 89, the ASCI value for the letter Y.

- Lines 80,100, and 210 include the GOTO command. It causes execution to continue at the indicated line number.
- In line 60 the output is intended for the operator. Line 120 is another form of robot output. It turns on the gripper.

- The robot has provisions to control 16 separate devices such as the gripper. It can also receive signals from external devices such as sensors. External INPUT/OUTPUT (I/O) commands will be discussed in a subsequent section.
- The DELAY command is used in lines 140 and 170. The syntax is DELAY <n>. n is the time delay in milliseconds. The robot delays execution of the next command for the specified time.
- When the gripper is turned on in line 120 notice the time delay before moving to point T3.
- Line 240 causes the program to STOP. If the START button on the Teach-Terminal is subsequently pushed execution will continue at the next statement. PRINT in line 260 will verify START after STOP.
- END in line 280 stops execution and returns the Controller to MONITOR mode.

- Line 120 turns ON the vacuum gripper while line 160 turns it OFF.
- This is a special I/O format for Model RT3000 and Model TT3000 robots due to a unique arrangement of the gripper control valve.

EXAMPLE PICK AND PLACE PROGRAM

- 10 SPEED 20 'Set the speed to a slow value for checkout
  20 T1 400 -70 -25 50 'Define the first point T1= 400 -70 -25 50
  30 T2 290 -275 -50 90 'Define the second point T2= =290 -275 -50 90
  40 T3 -13 400 -17 -45 'Define the third point T3= -13 400 -17 -45
  50 MOVE T1 'Move to point T1
  60 PRINT "LINE 60"
  70 INPUT "ENTER Y TO CONTINUE" S
  80 IF S = 89 THEN GOTO 110
  90 '89 is the ASCI value for Y
  100 GOTO 60 'Try again if S <> Y
  110 MOVE T2 'move to point T2
  120 OUTPUT +OG0 250
  130 'This turns on the vacuum gripper
  140 DELAY 2000 'Delay 2 seconds
  150 MOVE T3 'Move to the third TRANSLATION POINT
  160 OUTPUT +OG1 250 'Turn off the gripper
  170 DELAY 200 'Wait for the gripper to operate
  180 PRINT "DID I DO OK?"
  190 'Another message for the operator
  200 INPUT "ENTER Y OR N" S 'Provide an operator response
  210 IF S = 89 THEN GOTO 50 'Test the INPUT response
  220 PRINT "I NEED TO REST"
  240 STOP 'Push START to demonstrate
  250 'START after STOP
  260 PRINT "GOT TO LINE 260"
  270 PRINT "THE END IS NEAR" 'No operator response required
  280 END

- Refer to the pages from Chapter 9 of the Seiko Manual and enter EDIT mode. TYPE NEW and then type in the example program. Try using the edit commands DELETE, NUMBER, RENUM, NUMBER L#,1, LIST and other editor commands described in Chapter 9.
- Return to MONITOR mode and then enter DISP. Refer to Chapter 9 for a description of the DISPLAY mode.
- Return to MONITOR mode and HOME the ROBOT.Now enter STEP. This is a debug mode for checking out new programs.
- Refer to Chapter 9 for details. Push START to execute each line of the example program. Use the editor to correct any program bugs.

- Return to MONITOR mode and push START. THE robot will enter INTERPETER mode and execute the program. Enter responses as required. Demonstrate START after STOP and demonstrate entering N instead of Y when a response is requested.
- STOP the program and use the JOG keys and the HERE T<n> command to teach new points for the three TRANSLATIONS in the program. Refer to Chap. 9 for details.
- Use the editor to change the SPEED to 100 and execute the program again. Note the increase in speed.

INPUT/OUTPUT SIGNALS

- The Seiko robots include provisions for accepting input signals from external devices.
- The input signals take the form of switch closures.
- Typically they are generated by sensors such as mechanical switches, IR sensors, pressure switches, reflective sensors, etc.
- DARL programs can test these input signals and modify the robot operation according to the state of the signals.
- For example you might use a pressure switch to monitor the compressed air supply used to operate the gripper.

INPUT/OUTPUT SIGNALS

- If the air pressure were too low the gripper might not operate.
- In that case you would want the program to stop and wait until the air pressure was adequate.
- This is easily programmed if the input signal is provided.
- You might also use a sensor and input signal to determine if the part feeder was empty.

- In a similar manner the robot can provide OUTPUT signals to control external devices such as grippers, conveyor lift stations, part feeders etc. The output signals also take the form of switch closures. The operation of the OUTPUT signals is controlled by the robot program.

- The robot has a capability for accepting 16 INPUT signals through the EXTERNAL I/O connector.
- It can also accept 8 INPUT signals through the GRIPPER CABLE. It can generate 16 OUTPUT signals through the EXTERNAL I/O connector and 8 more through the GRIPPER CABLE.
- The GRIPPER CABLE is routed directly to the robot end of arm hence I/O signals routed through the GRIPPER CABLE are intended for operation of devices attached in this area.
- The signals routed through the EXTERNAL I/O connector are intended for devices not attached to the robot such as part feeders, air control valves, conveyor systems and similar.

- Chapter 5 of the Seiko Manual provides a detailed description of the I/O signals and the DARL statements associated with them.
  - Review that material before proceeding.
- The robots which you will be using have three OUTPUT signals connected to operate the conveyor system.
  - The gripper OUTPUT signal controls an air valve which routes compressed air to a vacuum generator used to provide suction at the gripper.

- The conveyor OUTPUT signals are as follows:
  - One signal controls an air cylinder which lifts the pallet off the conveyor and locks the pallet in a fixed position so the robot can place a part on the pallet.
    - This device is called a lift station.
  - A second signal operates a STOP device at the lift station.
  - The STOP is used to stop or release a pallet over the lift station.
  - The third OUTPUT signal controls a similar STOP upstream from the lift station.
  - This is called the QUE STOP. It is used to control flow of pallets to the lift station.
  - All of these signals are permanently connected to the robot controller through the System Interface Enclosure.

- It is possible to connect other devices into the System Interface.
- A small I/O Demonstration Box (I/ODB) is provided to demonstrate how I/O signals are connected and programmed.
- The I/ODB has 4 red LED which responds to robot OUTPUT signals.
- It has 4 manually operated switches which can be connected as an input devices. The circuit diagram for the I/ODB is shown in the Figure 1.

- Turn Off the power at the Power Distribution Enclosure.
- Connect four wires to terminals in the System Interface Enclosure.
- The red wire is to be connected to a +24V DC terminal.
- The black wire is to be connected to GND.
- The system Interface Enclosure terminals and LED display are illustrated on the attached drawings.
- Your instructor will assist you with the details.
- Have your instructor inspect the connections before turning ON the power.

- Figure 1: I/O Demonstration Box.

- Turn On the robot using the startup procedure.
- In Monitor mode:
  - 1. Type DO OUTPUT +OE0. This should turn on the red LED in the I/ODB. Also note that the terminal panel in the back of the System I/O Interface Enclosure has LED indicators at each I/O terminal. The LED at the panel terminal OE0 should also be ON.
  - 2. Now type DO OUTPUT -OE0. This should turn off the both LEDs.
  - 3. Turn off the switch on the I/ODB.
  - 4. Type DO A = INPUT IE0.
  - 5. Then type DO PRINT "A=";A. The Terminal should display A = 0.

- Enter DISP mode and note the state of all I/O channels as described in Chapter 9.
- Also note the LED at the I/O Interface Panel IE0.

- Now turn on the switch on the I/ODB. Note the LED on the Interface Panel Terminal IE0.
- Again use DISP mode to determine the state of all I/O channels.
- Use the editor to type the small program below.
- 10 B = 0
  20 OUTPUT -OE0
  30 A = INPUT IE0
  40 IF B = A THEN GOTO 30
  50 B = A
  60 IF B = 1 THEN GOTO 80
  70 GOTO 20
  80 OUTPUT +OE0
  90 GOTO 30

- Execute the program. Turn the switch on the I/ODB off and on several times. Does the program perform as you expect? This little program demonstrates the ability of a DARL program to respond to and control I/O signals.
- In Monitor mode:
    - 1. Type DO OUTPUT +OE5. Expect the lift station to operate.
      2. Type DO OUTPUT -OE5. The lift station should retract.
      3. Type DO OUTPUT +OE4. This should operate the lift station STOP.
      4. Type DO OUTPUT -OE4. The lift station STOP should reset.
      5. Type DO OUTPUT +OE3 and then DO OUTPUT -OE3. This should operate the QUE STOP.

- Place pallets over the sensor for the lift station, the QUE sensor, and the down stream sensor.
- Observe the LEDs on the System Interface Enclosure panel.
- The LEDs associated with IE1, IE2,and IE3 should all be OFF.
- Use the DISP mode to determine the state of all I/O channels.
- Remove the pallets from the sensors and repeat the observations.

Figure 1: Box connections.

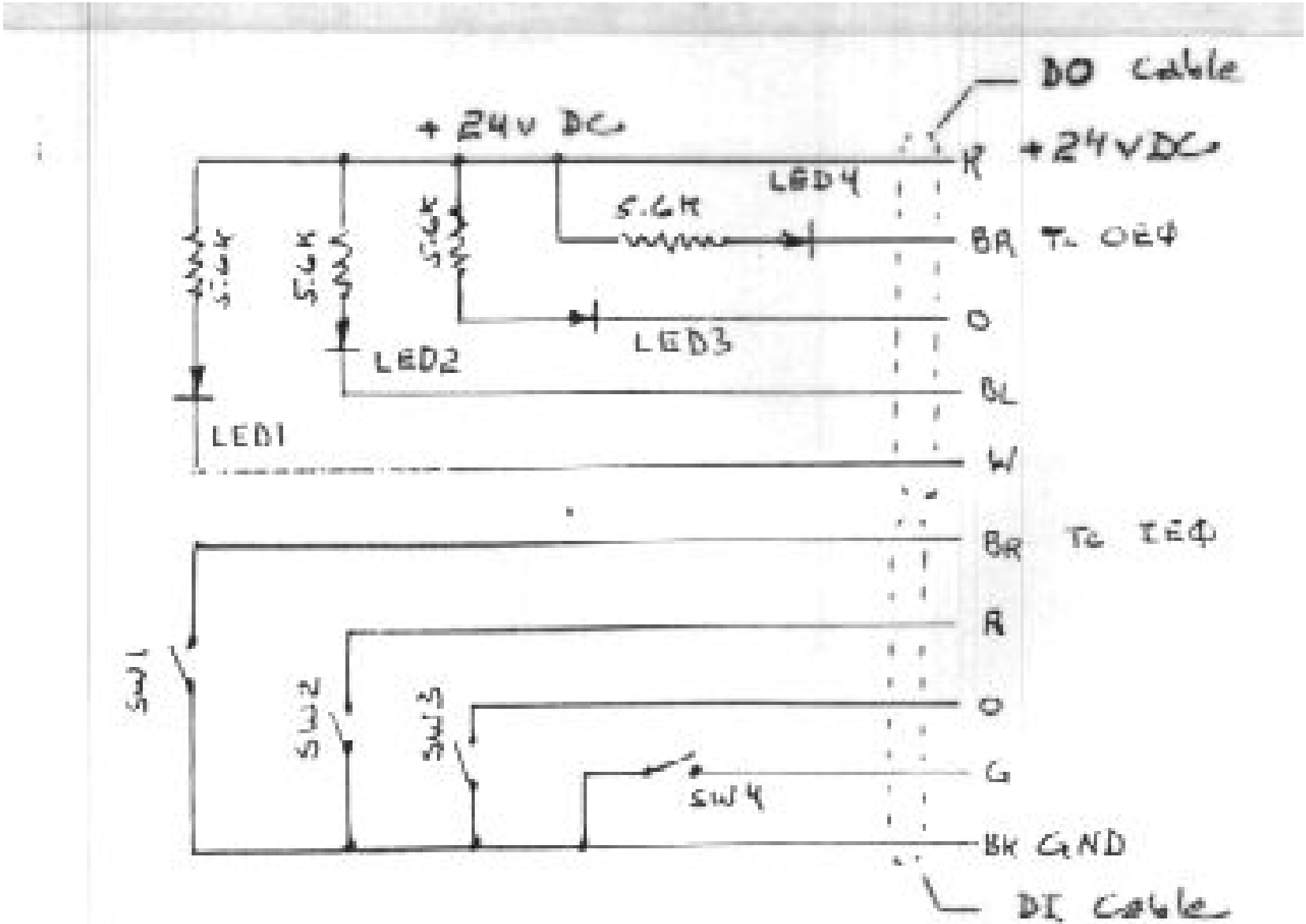
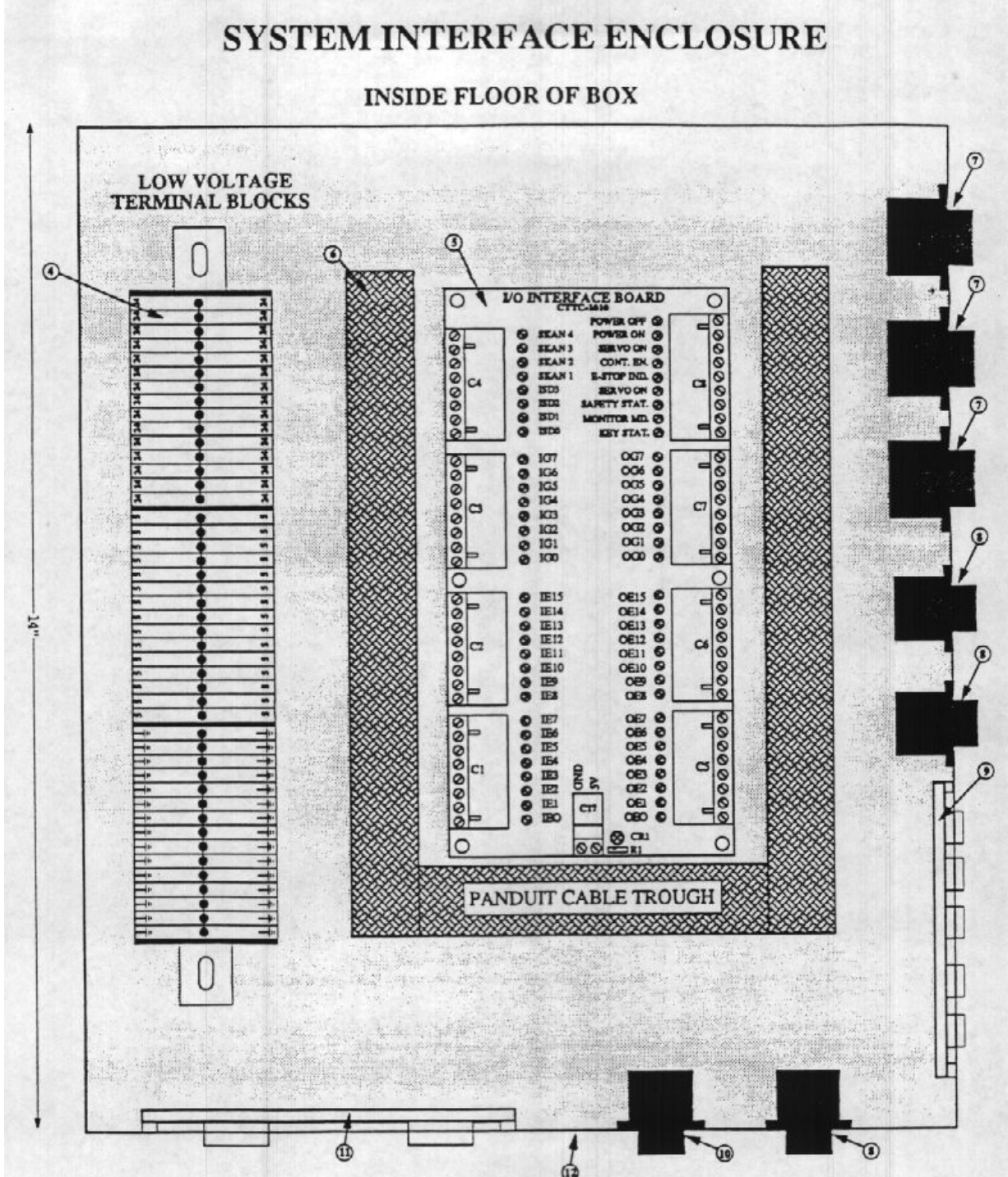


Figure 2: Interface box.



SYSTEM INTERFACE ENCLOSURE

INSIDE FLOOR OF BOX

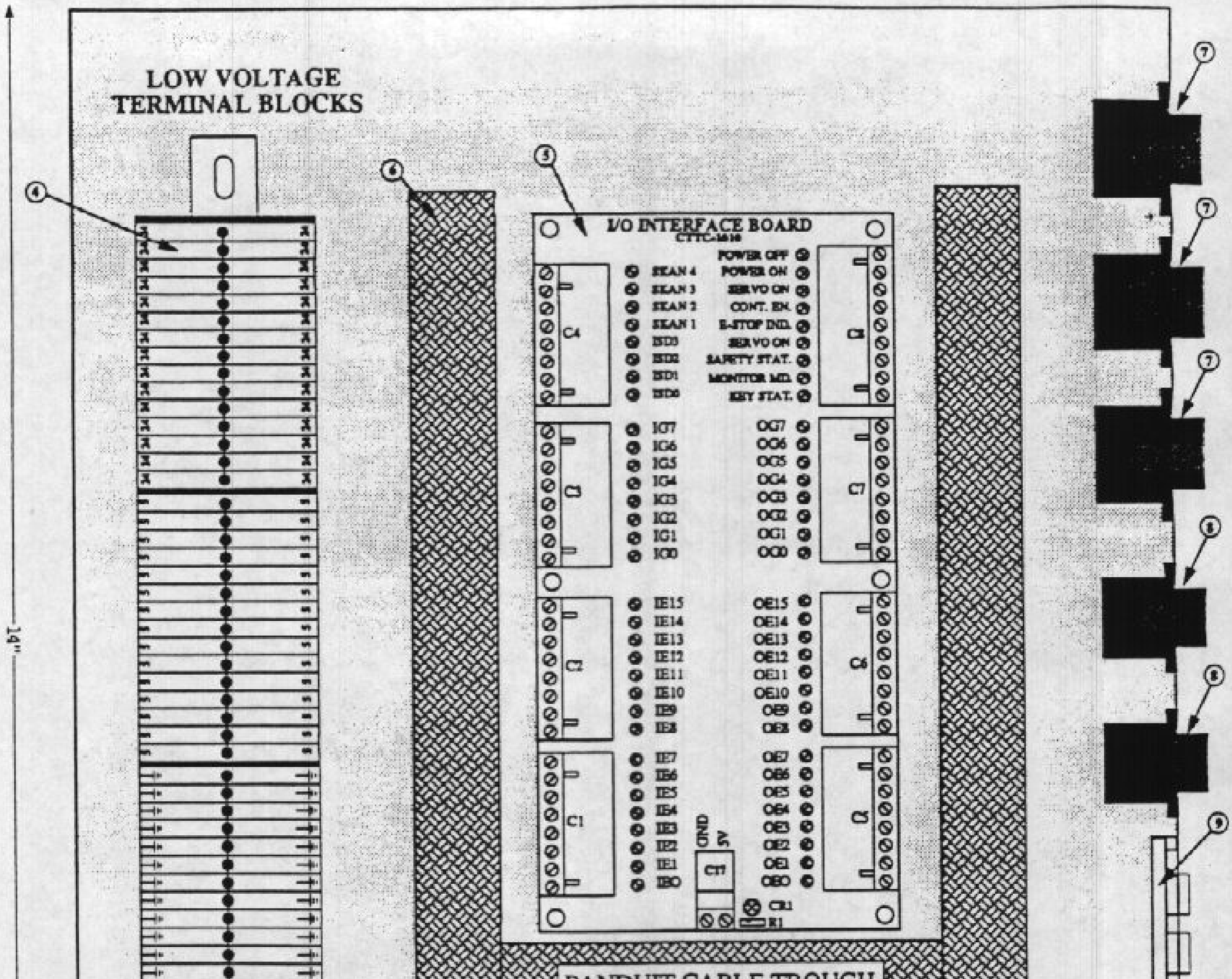


Figure 3: Interface box.

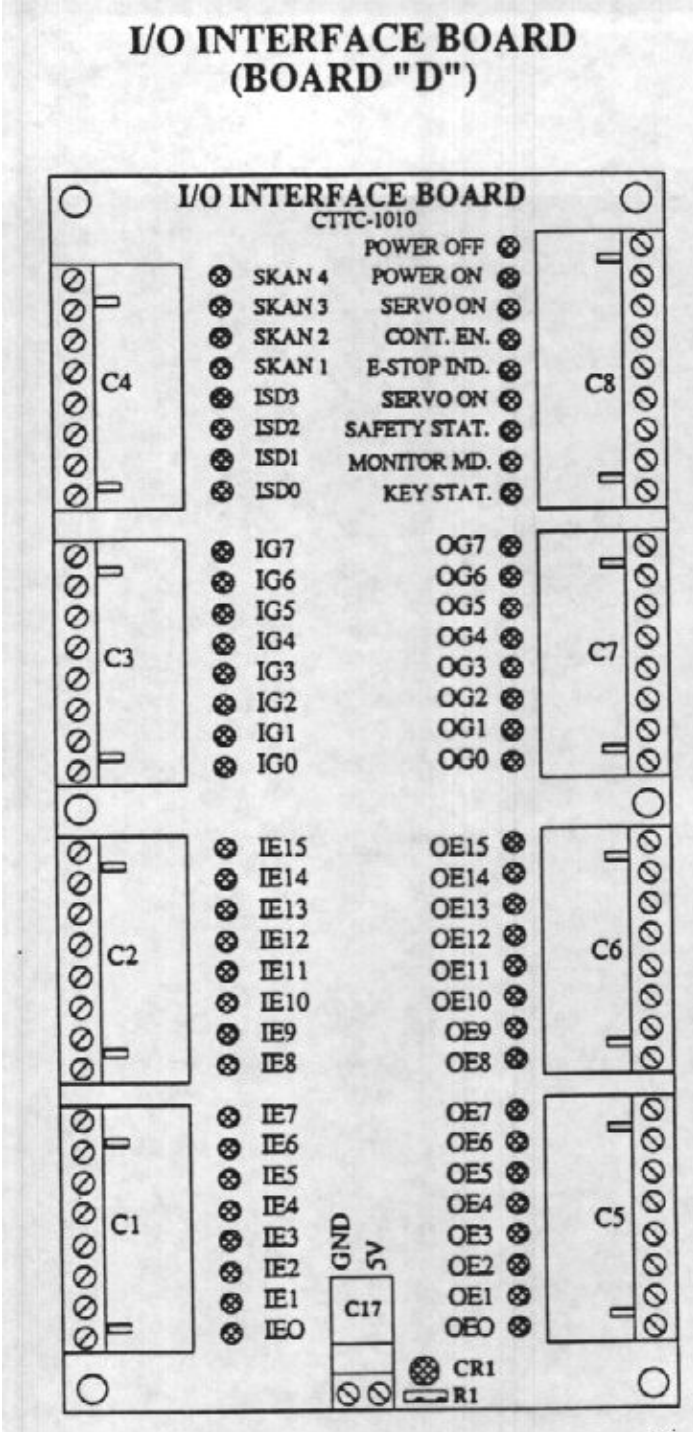
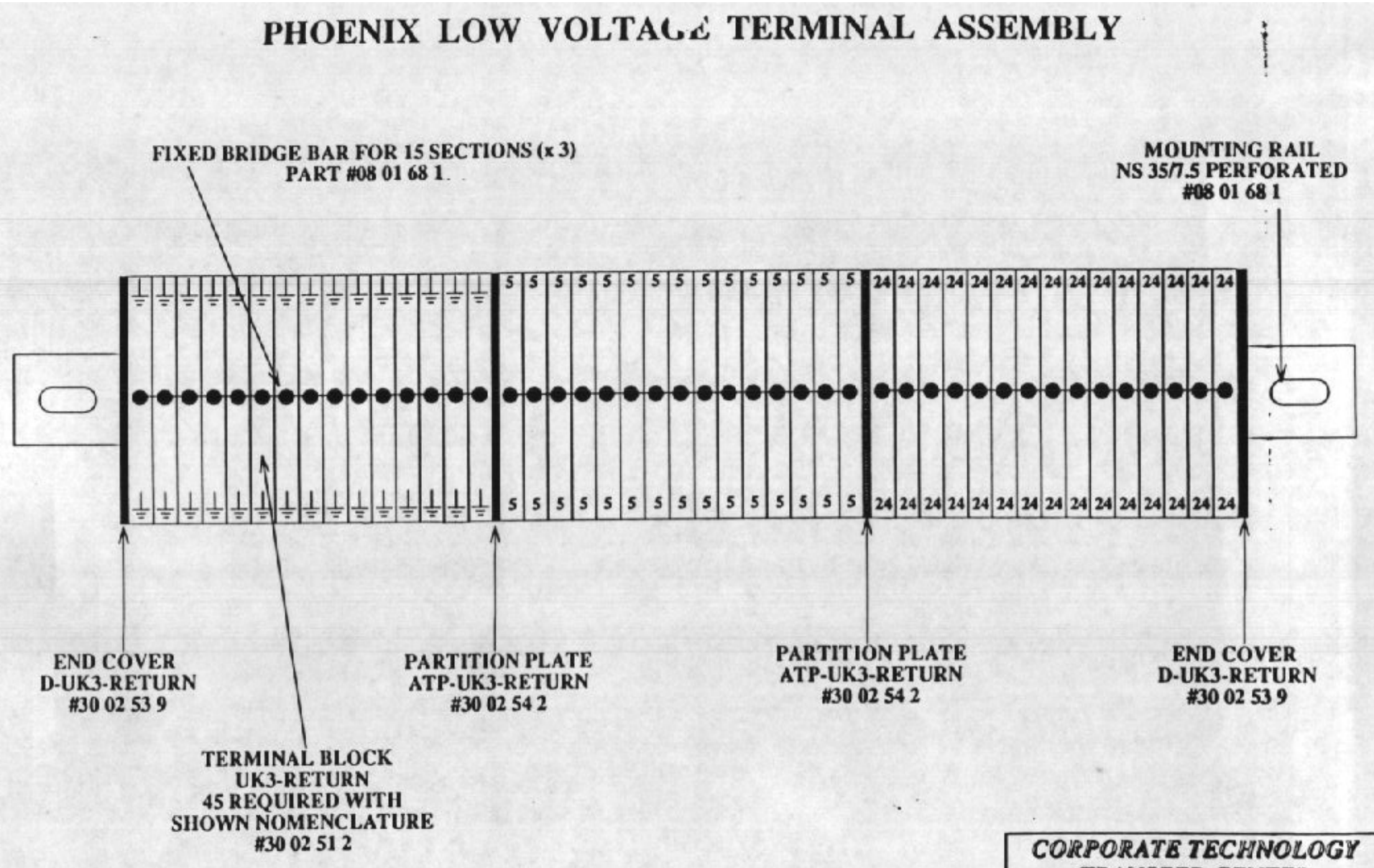


Figure 4: Power supply connections

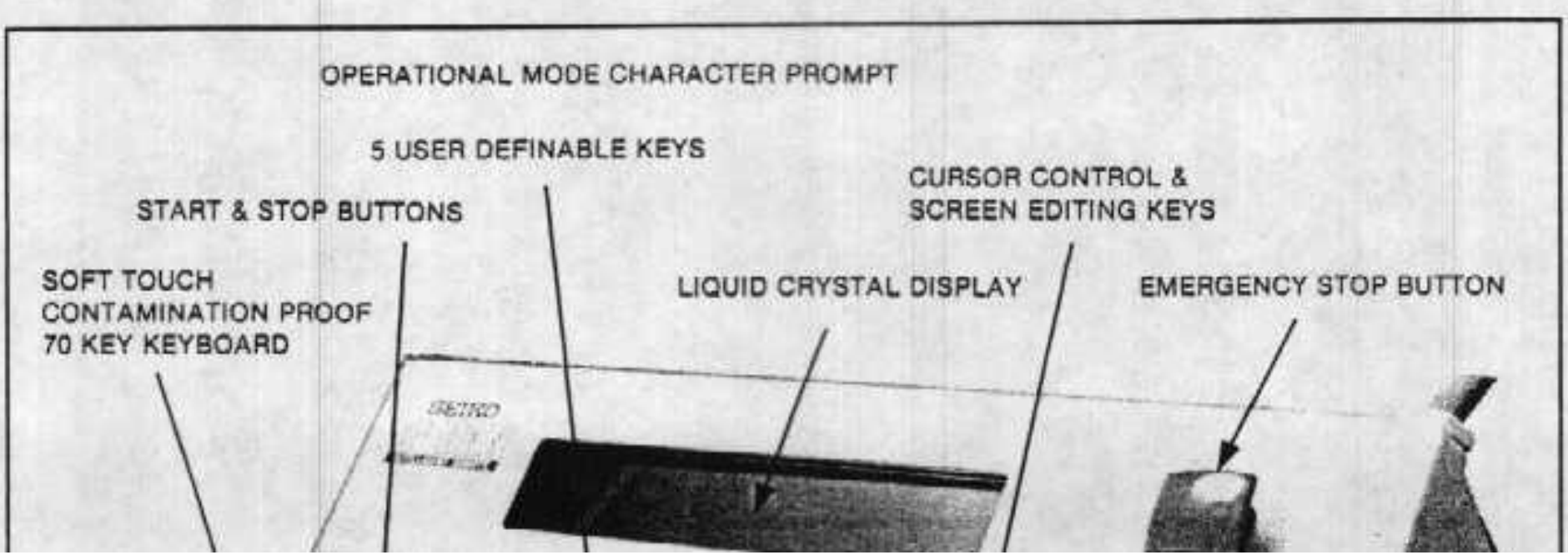


1.4 THE SEIKO D-TRAN TEACH-TERMINAL

OVERVIEW

The Teach-Terminal was designed for mobility and easy operator interaction. It contains the keyboard and Liquid Crystal Display (LCD) that allow for programming and robot operation. The same Teach-Terminal can be used to program and operate all models of the SEIKO D-TRAN Servo Robots. The Teach-Terminal is convenient if a program must be changed in an industrial environment. It can also be disengaged using a built-in key switch so that programs are not accidentally modified. The Teach-Terminal is further discussed in Sections 3 and 5, and some of its uses are described in Section 9.

As described in Section 8, peripheral terminals and host computers can also be used to program the robot; however, the Teach-Terminal is an integral part of the basic RT 3000 package. It should always be available for use with the robot, because it is very useful for trouble-shooting and maintenance.



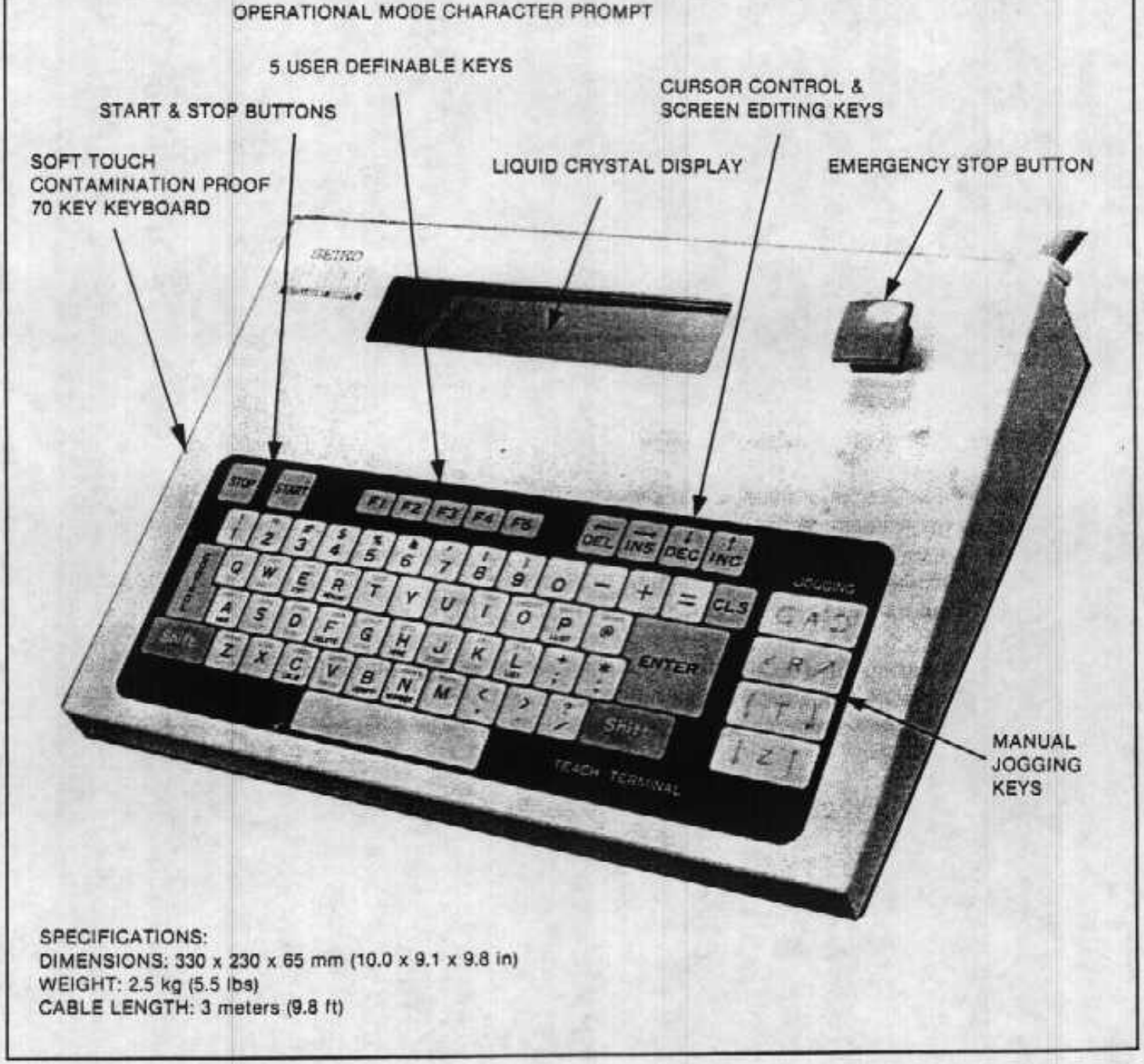
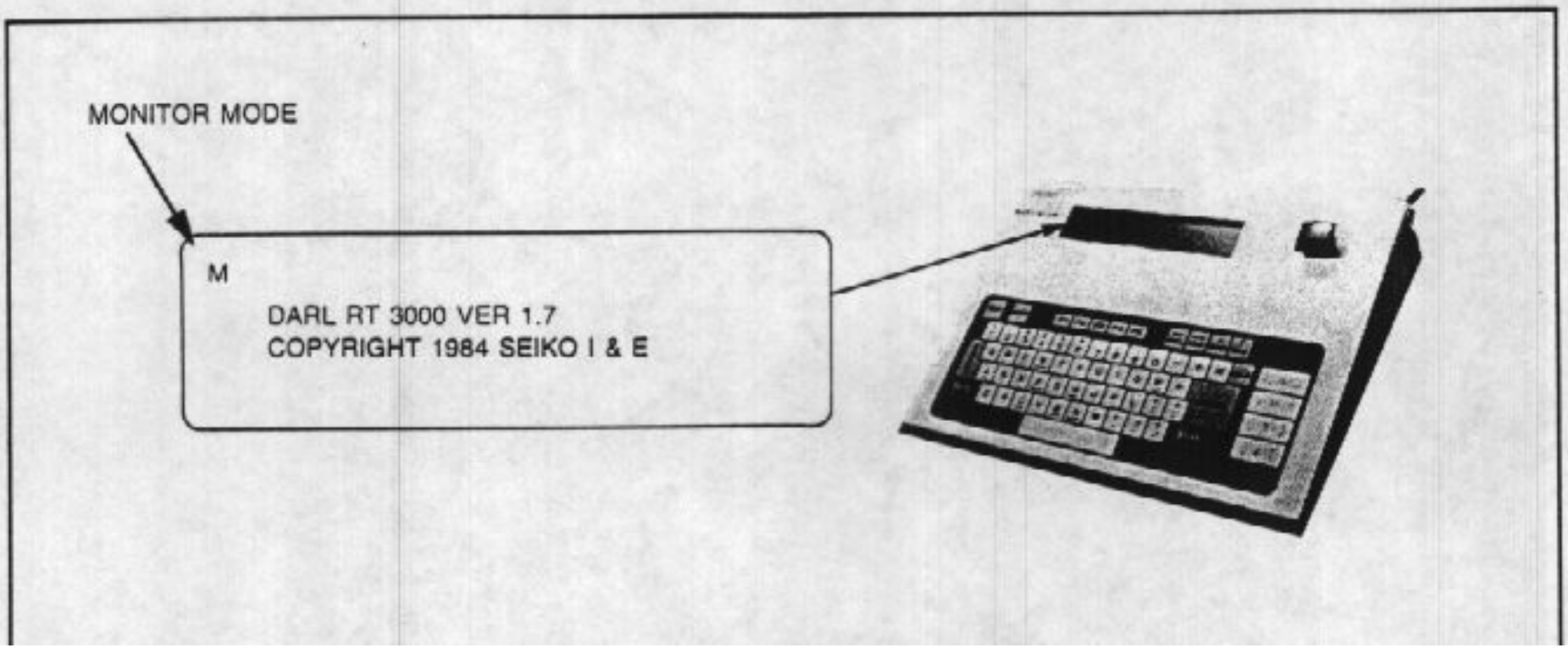


Figure 1.10 The SEIKO D-TRAN Teach-Terminal

THE LIQUID CRYSTAL DISPLAY OF THE TEACH-TERMINAL

The Liquid Crystal Display or LCD is a 4-line 40 character-per-line output device. It is the default output device of the SEIKO D-TRAN Controller. When the robot is powered-up, the Controller uses the LCD to display information. A different output device (i.e. printer, RS-232C Port) can be specified in a program or manually input through the keyboard. The LCD permits the monitoring of activity within the Controller and allows the operator to verify commands or statements being input into the Controller. The upper left-hand corner of the LCD will always display a character prompt representing the current operational mode. The LCD can also be used to determine the robot's coordinates or help in determining where the robot is within a program.



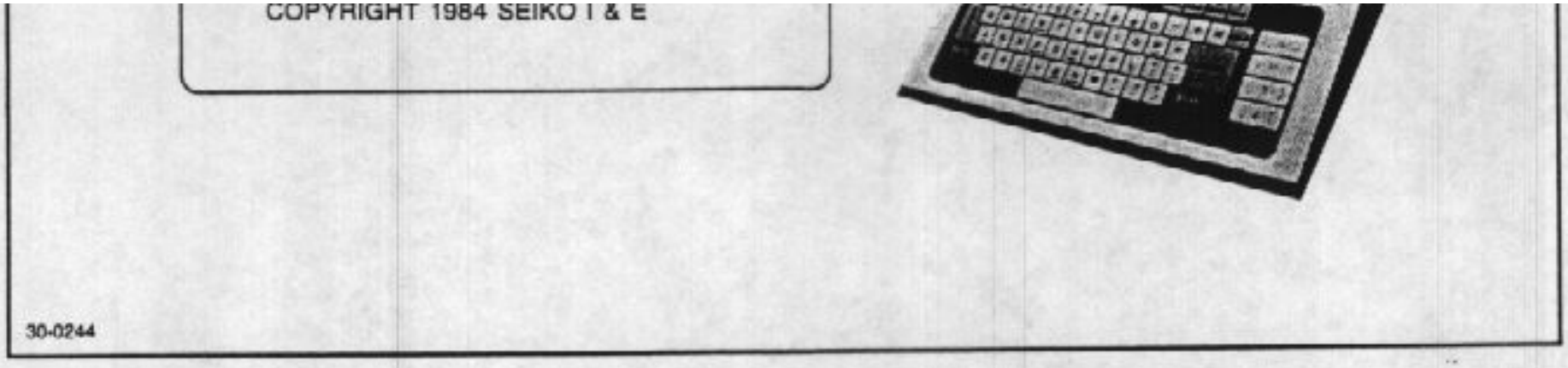


Figure 1.11 The LCD of the Teach-Terminal

THE KEYBOARD OF THE TEACH-TERMINAL

The Keyboard of the Teach-Terminal is the default input device of the SEIKO D-TRAN Controller. Just as the LCD acts as the primary output device, the Keyboard acts as the primary input device when the robot is first powered-up and before any program or manually input command specifies differently. It permits the operator to input commands, program statements or other information. It also allows for quick and easy editing of any program line displayed on the LCD.

Anything to be input using the Keyboard must be followed by the ENTER key (<ENTER >). Upon pressing the ENTER key the Controller reads the line on which the LCD's cursor lies. If the line is not recognized as a command or program statement of proper syntax then an error message will appear. Error messages are listed in Appendix B.

STOPS PROGRAM EXECUTION.

INITIATES OPERATION OF THE PROGRAM RESIDENT IN THE CONTROLLER MEMORY ACTIVATING THE ROBOT SYSTEM. (Program starts at beginning or restarts where last stopped.)

DELETES A CHARACTER/BACKSPACE CURSOR.

INSERT/FORWARD SPACE CURSOR.

DECREMENT PROGRAM LINE ON LCD/CURSOR DOWN.

FIVE USER DEFINABLE KEYS WHICH MAY BE SELECTED TO REPRESENT ANY DARL STATEMENT THROUGH A SINGLE KEYSTROKE.

INCREMENT PROGRAM LINE ON LCD/CURSOR UP.

CLEAR SCREEN.

SEND CURRENT ENTRY FROM LCD

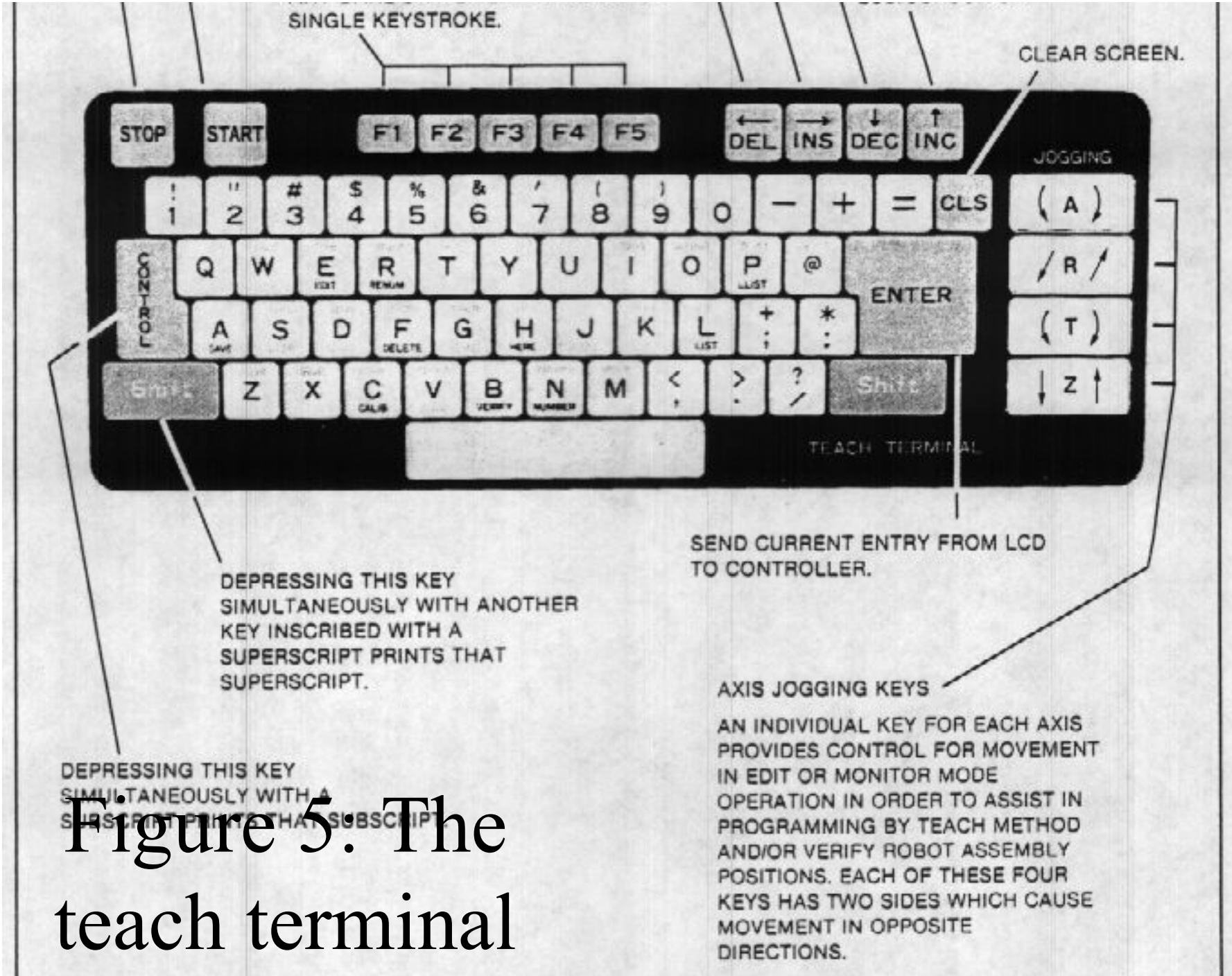


Figure 5. The teach terminal

3.7 BASIC OPERATIONS OF THE RT 3000 ROBOT

INITIAL START-UP & OPERATION OF THE UNIT

The remainder of this section describes the steps necessary to power up and operate the unit. Some easy introductory programs are given, but only to satisfy the natural curiosity of the operator. Please be sure to read the entire section on DARL very carefully before operating the unit!

The assumption is made that the unit has been unpacked and properly set-up as described previously in this section.

The power supply must have been measured and the voltage tap on the transformer must be properly set. Be sure to review Section 3.4 (3-Phase) or 3.5 (Single Phase) before attempting to power up the unit.

Information regarding day-to-day operation can be found at the end of this section.

The following subsections lay out a step-by-step procedure to power-up the robot unit and begin operation. These steps should be reviewed whenever there are difficulties in powering up the unit. Some subsections request a specific action and detail the expected system response. If these procedures are not successful, please contact your local distributor or SEIKO INSTRUMENTS U.S.A., Inc.

A. CHECK ALL CABLE CONNECTIONS: Check all connections between the robot unit and the controller. Also, check between the controller and all peripheral equipment.

B. PLUG IN THE CONTROLLER

NOTE: All connections within the controller should have been checked as previously described in this section.

C. EXAMINE THE STATUS OF EMERGENCY STOP & STOP: There are several ways to activate EMERGENCY STOP. If EMERGENCY STOP is activated, the unit will not power up!

Make sure that the EMERGENCY STOP buttons on the controller and teach-terminal are not being tripped by anything holding them open.

The teach-terminal must be properly connected to the controller. If the teach-terminal is not connected, EMERGENCY STOP is activated. See the Section 8.2 on Peripheral Equipment for operation without the teach-terminal.

Check the status of any EMERGENCY STOP or STOP devices connected to the External I/O cable. If there are no such devices, make sure that the by-pass connector is connected to the External I/O cable. This connector has the necessary jumpers to prevent EMERGENCY STOP or STOP from being activated from the External I/O cable.

D. CHECK THE TERMINAL/AUTO SWITCH POSITION: The differences between "Terminal Operation" and "Auto Operation" are discussed in detail in Section 3.8. For now it is only important

Check the status of any EMERGENCY STOP or STOP devices connected to the External I/O cable. If there are no such devices, make sure that the by-pass connector is connected to the External I/O cable. This connector has the necessary jumpers to prevent EMERGENCY STOP or STOP from being activated from the External I/O cable.

D. CHECK THE TERMINAL/AUTO SWITCH POSITION: The differences between "Terminal Operation" and "Auto Operation" are discussed in detail in Section 3.8. For now it is only important to know that "Auto Operation" is for use only after the unit has been programmed and fully debugged for an application. The LCD will display an "A" for "Auto Operation" and an "M" for MONITOR Mode when the key is in "Terminal Position".

ACTION: Insert the key (shipped in the tool box) into the TERMINAL/AUTO SWITCH, turn the TERMINAL/AUTO SWITCH to the "TERMINAL" position.

PROCEDURE TO POWER-UP THE ROBOT

A. TURN ON THE MAIN POWER

ACTION: Switch the main power breaker to the "ON" position.

RESULT: The Power Indicator Lamp lights, and a fan in the controller will turn on. The LCD will display robot type and the version of the software as shown in Figure 3.16.

Figure 6:Basic operations

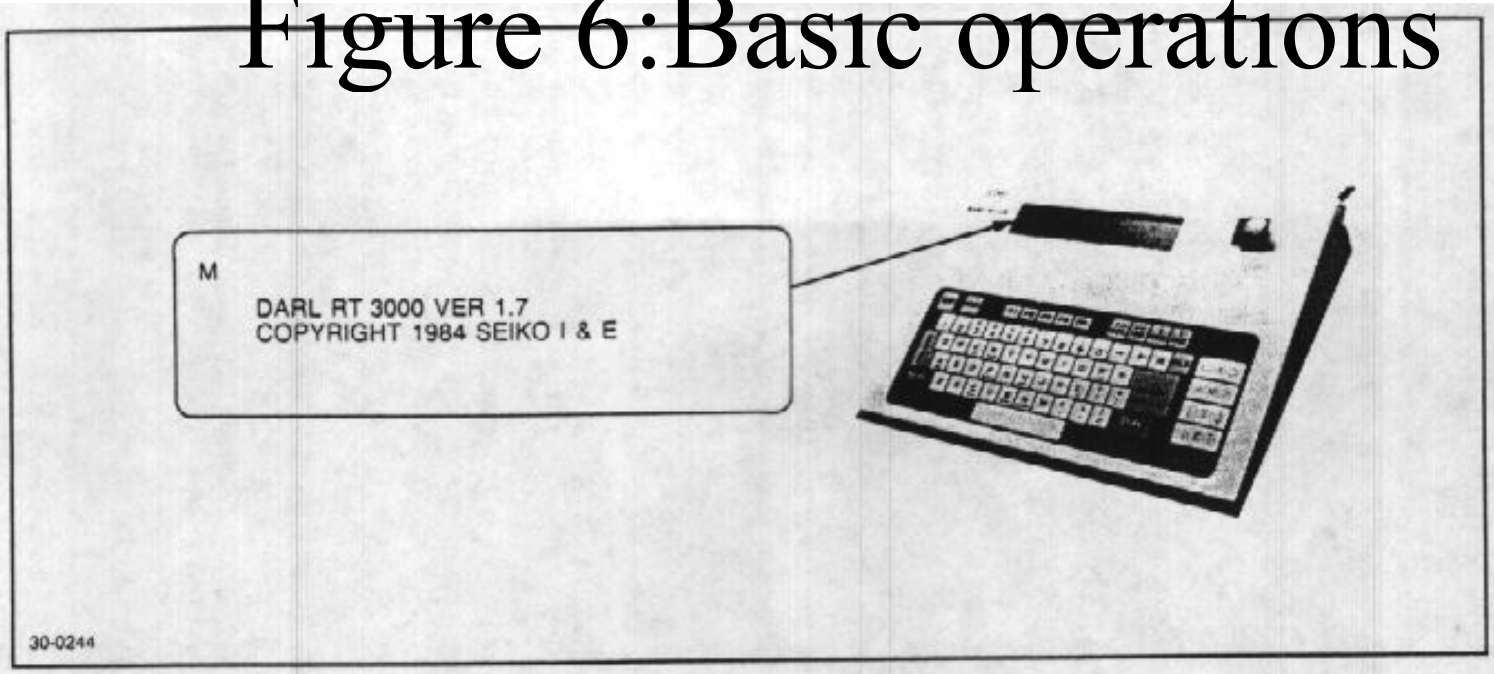


***Figure 3.16** Teach-Terminal LCD Message at Power "ON"*

B. TURN "ON" THE POWER TO THE SERVO MOTORS

ACTION: Press and release the green servo power "ON" button.

RESULT: The servo indicator lamp lights. Also a second fan within the controller will activate.

NOTE: Some servo feedback is in the audible range, including fan sounds. These sounds indicate that the system has successfully powered up.

If the unit does not power up, check EMERGENCY STOP, the power supply and all connections. DO NOT HOLD IN THE SERVO "ON" BUTTON. Also check all of the fuses and connections within the controller. Refer to Appendix A for troubleshooting procedures. See Section 5 for information regarding remote start-up.

PROCEDURE TO POWER-DOWN THE ROBOT

A. Before turning off the power make sure that the Controller is in the Monitor Mode.

RESULT: The servo indicator lamp lights. Also a second fan within the controller will start.

NOTE: Some servo feedback is in the audible range, including fan sounds. These sounds indicate that the system has successfully powered up.

If the unit does not power up, check EMERGENCY STOP, the power supply and all connections. DO NOT HOLD IN THE SERVO "ON" BUTTON. Also check all of the fuses and connections within the controller. Refer to Appendix A for troubleshooting procedures. See Section 5 for information regarding remote start-up.

PROCEDURE TO POWER-DOWN THE ROBOT

A. Before turning off the power make sure that the Controller is in the Monitor Mode.

B. Push the Red Servo Power Button or the Red Emergency Stop Button.

C. Wait a few seconds after shutting off the Servo Power and then switch off the Main Power switch.

TAKING ADVANTAGE OF TEACH-TERMINAL KEYBOARD FEATURES

The operator should be familiar with the Teach-Terminal Keyboard. It is the input device to the robot. It allows the operator to diagnose, program, and operate any SEIKO D-TRAN Robot.

An overview of the layout of the Teach-Terminal is provided in Section 1. More detailed information on programming is provided in Section 9.

TEACH-TERMINAL KEYBOARD FEATURES (DETAIL)

Halts program execution or stops robot action.

Executes a program from the beginning. However, when the START key is pushed after program execution is halted by the STOP key, the program is restarted from where the program was halted.

PROGRAMMABLE FUNCTION KEYS

These five keys are user programmable and will type to the output device the programmed keystrokes (up to 78 characters) See KEY Section 9.

A. "DEL" KEY

(1) When pressing the DEL key alone: Deletes the character at the position immediately to the left of the cursor, and shifts the following character string to the left.

(2) When pressing the DEL key simultaneously with the SHIFT key: The cursor moves left.

B. "INS" KEY

(1) When pressing the INS key alone: Inserts a space at the cursor position and moves the following character string to the right.

(2) When pushing the INS key simultaneously with the SHIFT key: The cursor moves right.

C. "DEC" KEY

(1) When pressing the DEC key alone:

(a) When in the EDIT mode: Shifts a displayed program upward and displays the program lines in a decreasing order.

(b) When in the DISP mode: Displays the page preceding the current page.

(2) When pressing the DEC key simultaneously with the SHIFT key: The cursor moves downward.

D. "INC" KEY

(2) When pressing the DEC key simultaneously with the SHIFT key: This cursor moves downward.

D. "INC" KEY

(1) When pressing the INC key alone:

(a) When in the EDIT mode: Shifts a displayed program downward and displays the program lines in an increasing order.

(b) When in the DISP mode: Displays the page after the current page.

(2) When pressing the INC key simultaneously with the SHIFT key: The cursor moves upward.

Clears the screen of all the characters except the operational mode character prompt and moves the cursor behind the mode display.

When the SHIFT key and a character key are pressed at the same time, a superscript represented above the character on the key will be displayed.

When the CONTROL key and a character key are pressed at the same time, a subscript represented below the character on the key will be displayed.

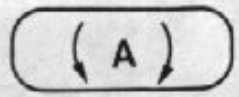
When the CONTROL key and the character key Z are pressed at the same time, all the characters following the position at which the cursor lies are deleted.

When the CONTROL key and the character key X are pressed at the same time, all characters on the line where the cursor lies (one or two lines) are deleted.

Inputs the line where the cursor lies.

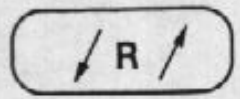
A-Axis rotates clockwise (as viewed from above)

A-Axis rotates counterclockwise (as viewed from above)



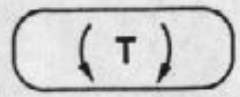
R-Axis extends away from the robot

R-Axis retracts toward the robot



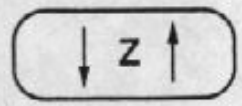
T-Axis rotates clockwise (as viewed from above)

T-Axis rotates counterclockwise (as viewed from above)

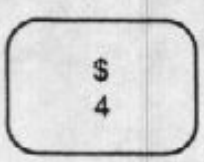


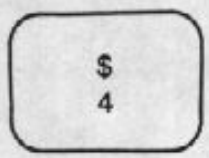
Z-Axis jogs toward its upper limit

Z-Axis jogs toward its lower limit



The Keyboard does not offer upper and lower case characters, but some keys do offer two symbols or digits as commonly found on many keyboards. These can be found on Figure 1.12 and are used as shown in the following examples:

pushing 

types "4" on LCD and pushing Shift + 

types "$" on LCD

For added convenience for the operator, many of the commands and statements are written as superscripts or subscripts on most character keys as shown in Figure 1.12. Using the SHIFT or CONTROL key in conjunction with a character key will cause the appropriate statement or command to appear on the LCD. The command or statement will appear just as though it were typed.

Example of how to obtain a *subscript:*

following examples:

pushing [$ / 4] types "4" on LCD and pushing Shift + [$ / 4] types "$" on LCD

For added convenience for the operator, many of the commands and statements are written as superscripts or subscripts on most character keys as shown in Figure 1.12. Using the SHIFT or CONTROL key in conjunction with a character key will cause the appropriate statement or command to appear on the LCD. The command or statement will appear just as though it were typed.

Example of how to obtain a *subscript:*

Pushing CONTROL + [delay / D / DISP] Types "DISP" on the LCD

Example of how to obtain a *superscript:*

Pushing Shift + [return / R / RENUM] types "RETURN" on the LCD

NOTE: In general, commands are listed in upper case on the keyboard, and statements are in lower case

Figure 7:Programmable function keys.

Figure 8: Jogging the robot.

Figure 9:Homing the robot.

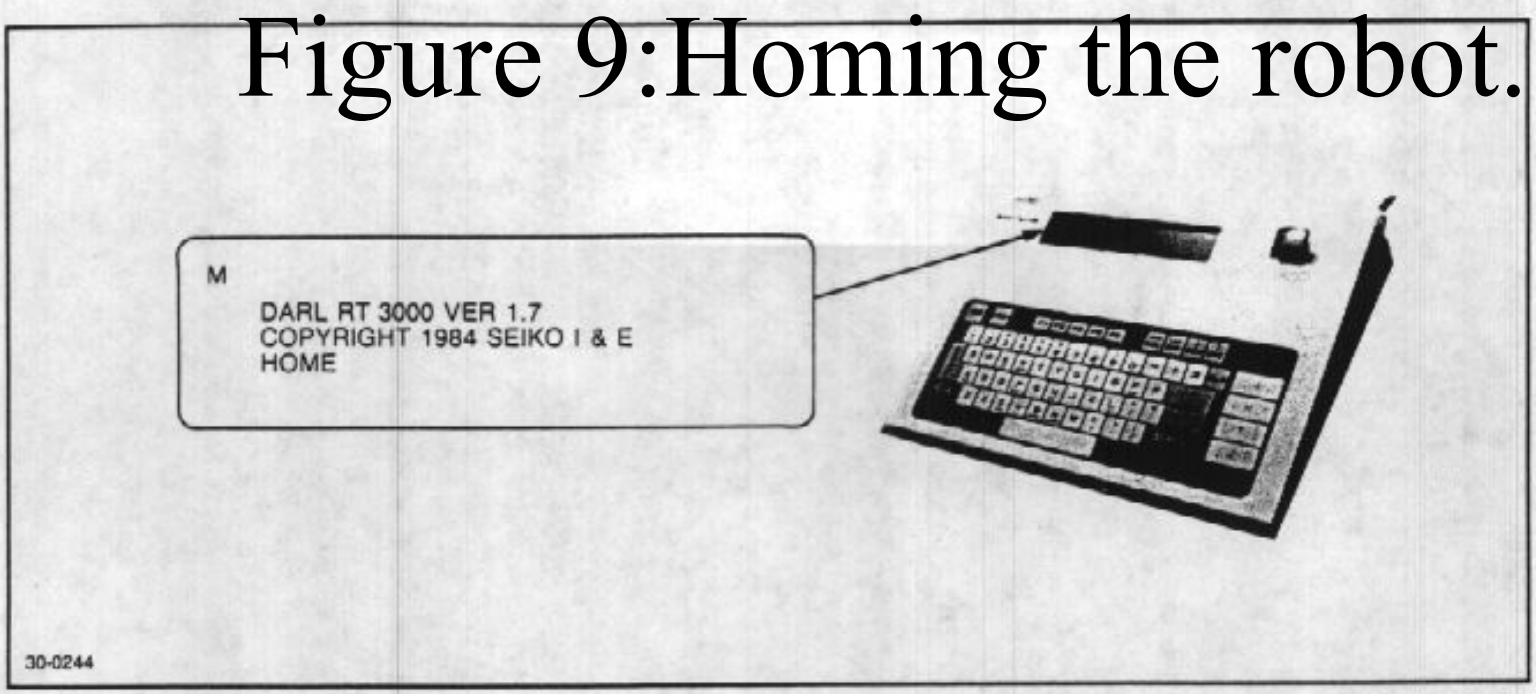


***Figure 3.18** LCD Message While HOME is Being Executed*

THE HOMING SEQUENCE FOR THE RT 3000 ROBOT:

A. The Z-Axis moves up until it reaches full vertical height.

B. The A-Axis rotates to its CCW (Counter-Clockwise) limit switch and then rotates in the opposite direction to its 0 degree (HOME) position.

C. The R-Axis moves to its retracted position.

D. The T-Axis rotates towards its center position. (The T-Axis can rotate ± 145 degrees from this position.)

If an error message appears, refer to the DARL ERROR MESSAGES (Appendix B). An ERROR message indicates that the execution of HOME was not successful. Please repeat the above procedure if an error message is displayed.

THE EDIT MODE COMMANDS:

The following are the valid commands for the EDIT Mode:

EDIT COMMANDS	DESCRIPTION
COPY <0-6> [L#,[L#]]	Copies the program or specified program lines in the specified bank to the current memory bank.
DELETE <L#,[L#]>	Causes the line or range, including those specified, to be erased from the program memory.
LIST [L#]	Causes the next line, when no line number (L#) is specified, or the specified line, to appear on the LCD. The "INC" and "DEC" keys on the Teach-Terminal can be used to scroll the program lines on the LCD.
LLIST (alone)	Prints the entire program to an optional printer.
LLIST L#	Prints the program lines from specified L# through the end of the program to an optional printer.
LLIST L#,[L#]	Prints from L# to [L#] only to an optional printer.
LOAD ["Y" or "N"]	Loads a specified program and translations from a cassette into the controller's memory (see Section 8.1).
MEM	Displays the remaining amount of memory in the current bank (DARL II only).
NEW	Erases all program lines in memory. The RAM is reset and prepared for a new program. Note translations remain unchanged by the NEW command (See MONITOR Mode Command "DO CLEAR").
NUMBER (alone)	Causes the controller to automatically number program lines starting at line 100 in increments of 10.

	program. Note translations remain unchanged by the NEW command (See MONITOR Mode Command "DO CLEAR").
NUMBER (alone)	Causes the controller to automatically number program lines starting at line 100 in increments of 10.
NUMBER L#	Causes the controller to automatically number program lines starting at line L# in increments of 10.
NUMBER L#,I	Causes the controller to automatically number program lines starting at line L# in increments of "I".

NOTE: (For NUMBER [L#,[I]]) If the automatically numbered line duplications are already in memory, an asterisk (*) will appear adjacent to the duplicated line number.

RCV [#1 or #2]	Receives a program from the assigned RS-232C port. RCV terminates with an END Command.
RENUM	Causes the controller to automatically renumber the current program from the beginning line in increments of 10. All GOTO and GOSUB line numbers are also changed automatically.
RENUM L#@	Causes the controller to automatically renumber the current program from the specified line #@ in increments of 10. All GOTO and GOSUB line numbers are also changed automatically.

Figure 10: Edit mode commands.

RENUM L#@,I	Causes the controller to automatically renumber the current program from the specified line #@ in increments of "I". ALL GOTO and GOSUB line numbers are also changed automatically.
SAVE	Saves the resident program(s), <Program Name>, and translations under a specified program name onto a cassette (see Section 8.4).
SEND [#1 or #2]	Sends entire program and translation points that have been assigned to the specified RS-232C Port (either 1 or 2).
TLLIST (alone)	Prints all translations in memory to an optional printer.
TLLIST T#	Prints the specified T# through end of translations within memory to an optional printer.
TLLIST T#,[T#]	Prints from T# to [T#] only to optional printer.
VERIFY ["Y" or "N"]	Verifies that a specified program and its translations were properly saved onto a cassette (see Section 8.1).