Teach Pendant

UMI-R3-141

CRS *It's all about time*

Teach Pendant

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Introduction

The Teach Pendant is a hand-held robot control terminal that provides a convenient means to move the robot, teach locations, and run robot programs. It features a four-line 20-character LCD display, a 45-key keypad, a live-man switch, and an emergency stop (e-stop) button.

The teach pendant is a useful tool, allowing you to move away from the host computer terminal and control the robot locally. Typically a robot application is programmed with teachable variables using the RAPL programming language. Once the application is setup, it is convenient to use the teach pendant to teach the locations for the application.

A Quick Start tutorial is included in this manual, which is intended to get you started using the teach pendant. By working through the tutorial, you become acquainted with basic pendant operation before moving on to the details of teach pendant operation.
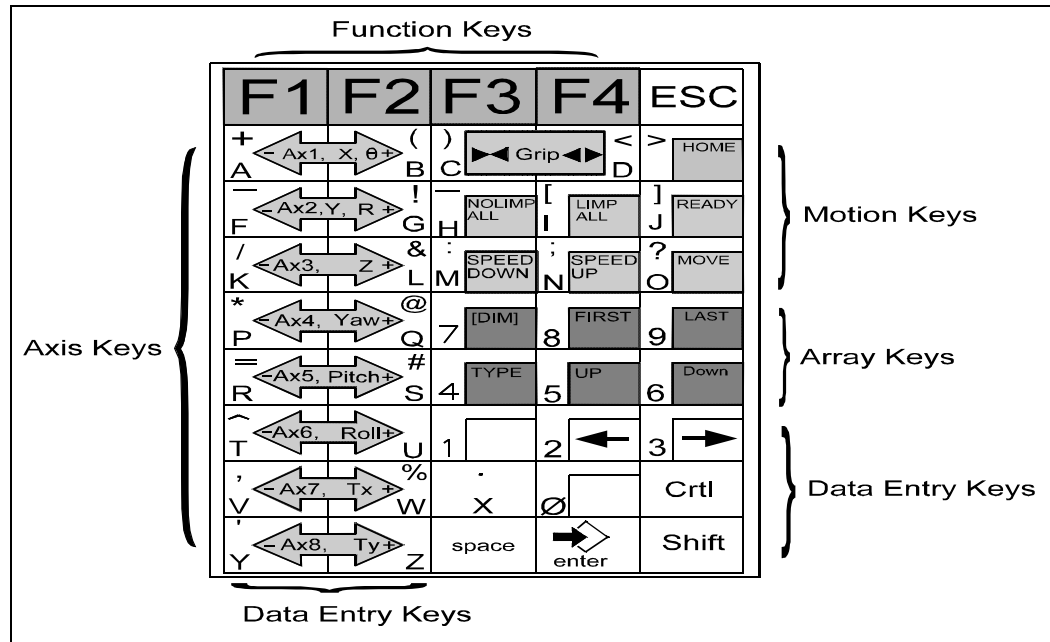
CHAPTER 2

Teach Pendant Features

This section introduces the physical features of the teach pendant:

- Keypad
- Live-Man Switch
- E-Stop
- Screen
- Pendant Sounds

Keypad

The figure below shows the teach pendant layout.

Many of the pendant keys are multi-purpose, invoking their labeled functions only from certain screens. When the key's labeled function is not activated, the alphanumeric value of the key is assumed. For example, the axis keys are active from the Manual Menu screen where they are used to move the robot. From any other screen, the alphanumeric value of the key is assumed.

Function Keys

At each screen, the function keys are assigned a corresponding function. The bottom line of each screen lists the options available from that screen. The list of functions corresponds to the function keys. For example, from the Main Menu screen shown on page 6, the F1 key selects the app (application) option.

Axis Keys

Use the axis keys to move the robot. The axis key's specific functions are available only from the Manual Menu screen, asmanual robot motion can be initiated from only the teach pendant Manual Motion screen.

The response to the axis keys depends on the robot motion settings. Refer to the Moving the Robot chapter of this user guide for details.

Motion Keys

The motion keys perform their specific function only from the Manual Menu screen. They have the following functions:

Key	Function
GRIP	Used to open and close the gripper.
HOME	Moves each axis of the robot to a known reference point.
READY	Moves the robot to the ready position.
LIMP ALL NOLIMP ALL	LIMP ALL limps the robot axes so you can move the robot freely by hand. **WARNING: This may cause the robot to fall and possibly cause equipment damage or personal injury!** NOLIMP ALL unlimps all the robot axes so that the robot maintains its position without support.
MOVE	Moves the robot to the selected location variable if that location has been taught. The MOVE key is available if a location variable has been selected. Refer to the Selecting Variables section.
SPEED UP SPEED DOWN	Used to increase or decrease the robot's speed.

Array Keys

Use the array keys to select elements in variable arrays.

Key	Function
First	Select the first element of the array.
Last	Select the last element of the array.
Type	not used.
Up	Increment the current array index and select that array element.
Down	Decrement the current array index and select that array element.

Data Entry Keys

Each of the Axis keys, Motion keys, and Array keys also have letters or numbers specified.

These represent the Data Entry Keys:

Key	Function
Alpha keys	Use the alphabetical keys to type in new variable or application names, and to quickly find existing variables or applications with the Quick Find utility.
Numeric Keys	When in Select Element screen, the numeric keys can be used to select a particular array element. Or, when creating an array of variables, the Numeric keys can be used to specify the array size.
Shift	Used primarily to display the error log — press Shift and F1.

Live-Man Switch

The teach pendant has a three position live-man switch on the right side of the pendant chassis. When gently depressed, the live-man switch is in the Motion Enabled position. However, if released, or depressed too forcefully, the switch will move into one of the two Motion Disabled positions.

Note: The live-man must be in the Motion Enabled position for teach pendant initiated robot motion to occur. Attempting to move the robot without the live-man switch in the motion enabled position causes arm power to disengage, abruptly stopping the robot.

E-stop Button

The teach pendant e-stop button (the large red knob at the top right of the pendant) is a safety feature which disables the arm power, immediately stopping the robot. The teach pendant e-stop button behaves exactly as the e-stop button on the controller front panel.

Once activated, the e-stop switch must be reset before the arm power can be turned on. The pendant e-stop switch is reset by turning it clockwise until the knob clicks and pops up. After the e-stop switch is reset, the arm power can be turned on at the controller front panel.

Note: The teach pendant e-stop switch is active even if the teach pendant does not have point of control. So long as the pendant is connected to the controller, the e-stop switch is active and able to kill the arm power.

Screens

All teach pendant functions are accessed from layered levels of screens which list menu items corresponding to the four function keys (F1, F2, F3, F4). The function keys are used not only to access teach pendant functions but also to move through the levels of teach pendant screens. Each screen presents a title, messages, and menu items.

The teach pendant's various screens identify the function, purpose, and menu choices available from that screen. The following is an example of a teach pendant screen. It is the initial screen if the teach pendant is started from the system shell.

```
Main Menu

1app   2rob   3crtl
```
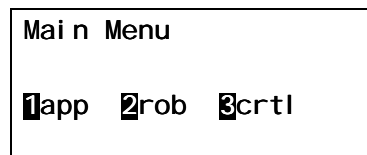
Navigating Through the Screens

The function keys F1, F2, F3, and F4 are used to choose options from the menus displayed on the pendant screens. Often these options allow you to move to new pendant screens. In the case of the Main Menu screen pictured above, F1, F2, and F3 function keys are used to move to the Application, Robot, or Controller Menu screens.

At other times, the function keys can be used to scroll through a list of variables or applications, or to configure robot motion modes.

At any time, the Esc key, located on the upper right corner of the teach pendant, can be used to navigate upwards through menu screens. From any screen:

- Pressing the ESC key once returns you to the previous screen.

- Pressing the ESC key repeatedly brings up the Terminate Pendant screen.

For example, if you press the F1 key from the Main Menu screen, you move to the Application screen, where you can select the application you want to work on. From the Application screen, hit the Esc key to return to the Main Menu screen. Pressing Esc again (from the Main Menu screen) to reach the Terminate Pendant screen, from which you can terminate teach pendant operation. Terminating the teach pendant returns the point of control to the host computer.

The flowchart on the following page shows the flow through the levels of pendant screens.

```
                                ┌──────────────┐      ctrl      ┌──────────────┐
                                │  Main Menu   │───────────────▶│ Not Available│
                                └──────────────┘                └──────────────┘
                                  ╱    │
                               app     │ rob
                                ╱       ▼
                               ╱     ◇ Robot ◇        No      ┌──────────────┐
                              ╱      ◇ Homed ◇ ─────────────▶ │  Robot Menu  │
                             ╱        ◇      ◇                │  NOT HOMED   │
                            ╱            │                    └──────────────┘
                           ╱          Yes │                     │        │
                    ┌──────────────┐   ┌──────────────┐     cfg │        │
                    │ Application  │   │  Robot Menu  │         ▼        │
                    │    Find      │   │   HOMED      │   ┌──────────────┐│ Manual Menu
                    └──────────────┘   └──────────────┘   │Not Available ││ NOT HOMED
                           │ sel           │  cfg                         │
                           ▼         home  │  ⋯⋯▶               home       │
    ┌──────────────┐ run ┌──────────────┐  ▼                             │
    │    Run       │◀────│ Application  │ ┌──────────────┐◀───────────────┘
    │ Application  │     └──────────────┘ │ Manual Menu  │
    └──────────────┘           │          │   HOMED      │
                          edit │          └──────────────┘
                               ▼
                        ┌──────────────┐  motn  ┌──────────────┐
                        │ Application  │───────▶│ Manual Menu  │
                        │    Edit      │        │ No Variable  │
                        └──────────────┘        └──────────────┘
                           │ var
                           ▼
                        ┌──────────────┐
                        │   Var Find   │
                        └──────────────┘
                         ╱          │
                        ╱           │
          ┌──────────────┐   ┌──────────────┐ sel ┌──────────────┐ tch
          │ Non-location │   │   Location   │────▶│ Manual Menu  │────┐
          │  variable    │   │   variable   │     │  Variable    │    │
          └──────────────┘   └──────────────┘     └──────────────┘    │
                 │ Yes                                                 │
                 ▼                                                     ▼
          ┌──────────────┐                                  ┌──────────────┐
          │Teach variable│                                  │Teach Location│
          └──────────────┘                                  └──────────────┘
```

Pendant Sounds

The Teach Pendant is equipped with a small speaker that is capable of producing some simple sounds to signify events. The following describes the sounds and the teach pendant events that they signify:

Sound	Event	Example
short, soft click	A valid pendant key has been pressed.	From the Application screen, press the F1(edit) key.
short, sharp beep	An invalid pendant key has been pressed.	From the Application screen, press the Move key.
three short, sharp beeps	User has initiated an action and is being prompted for confirmation.	From the Manual Menu screen, press the Home key.
long, sharp beep	A pendant error has been encountered.	From the Manual Menu screen, press the Ready key with arm power turned off.

For more information on pendant errors, see the *Teach Pendant Errors* chapter of this user guide.

C H A P T E R 3

Quick Start Tutorial

The Quick Start tutorial allows you to begin with some practical routines. This short tutorial teaches you how to do some useful teach pendant functions. Learn to pass control to the pendant, move the robot through some simple motions, demonstrate basic pendant operation, and then terminate the teach pendant, returning point of control to the computer.

Warning: Ensure that the robot workspace is clear of people and obstacles. Although robot speeds are limited when using the pendant, serious collisions can occur which may cause equipment damage and/or personal injury.

Passing Control to the Teach Pendant

Often the teach pendant is used for teaching and testing locations when developing applications. When using the teach pendant to develop your applications, open the application in the Application Shell (ash) and then pass control to the teach pendant.

Note: If the teach pendant is connected when the controller is started, point of control is automatically given to the teach pendant. You can use the following procedure to pass point of control to the teach pendant when ash has point of control.

To open ash and pass control to the teach pendant:

1. When the C500 controller is first turned on and has completed its startup sequence, press Enter to reach a '**$**' prompt. This is the system shell prompt.

2. To start ash, enter:
    ash "application".
    Note: "application" is the name of the application you wish to work with. (See the *Ash Reference Guide* for more information).

3. At the ash prompt, enter:
    pendant
    to pass control to the teach pendant.

The point of control is transferred from the terminal to the teach pendant. The pendant opens to the Application screen with your specified application displayed in the second line of the pendant display.

Note: You can also pass control to the pendant from the system shell. See the Teach Pendant Applications chapter of this user guide for more information on this option. If you start the teach pendant from the system shell, you must use the teach pendant functions to select or create an application.

Moving the Robot

The following procedure leads you through some basic robot motions using the teach pendant. For more details on robot motion options, refer to the Moving the Robot chapter of this user guide.

1. Ensure that the arm power light on the controller is on.

2. From the Application screen, press the F1(edit) key to move to the Application Edit screen.

3. Press the F3(motn) key to move to the Manual Menu screen. The second line on the display reads "**1% VEL JOINT**".

1%	Is the relative speed setting
VEL	Is the motion type
Joint	Is the motion mode

4. Press the Speed Up pendant key twice to increase the robot speed to 10%.

5. Gently depress the live-man switch on the right hand side of the pendant.
    Note: The live-man switch must be held down whenever you move the robot with the teach pendant. Releasing the switch while moving the robot automatically turns off arm power.

6. While holding in the live-man switch, continually press the '+' Ax1 key (directly below the F2 key). This causes joint 1 to move in a counter-clockwise direction. Release the '+' Ax1 key to stop the robot.

7. Press the F4(mode) key twice. This will change the motion from joint mode to world mode.

8. While holding in the live-man switch, press the '+' Ax3 key. This causes the tool tip of the robot to move upward toward the ceiling. Release the '+' Ax3 key to stop the robot.

9. Press the F4(mode) key two times. This will toggle the motion frame of reference from world mode to cylindrical mode. Press the '-' Ax2 key. This causes the tool tip of the robot to move inward, directly toward from the robot base. Release the Ax2 key to stop the robot.

10. Press and hold the READY key on the pendant (two keys below the red ESC key). This moves the robot to the ready position. Release the READY key once the robot reaches the ready position.

Terminating Pendant Control

When the teach pendant is running, it has point of control, which means that the pendant has exclusive control over moving the robot. No other process or user can move the robot until the pendant terminates. On termination, point of control is passed back to the host computer.

To terminate the teach pendant and release control from the Manual Menu:

1. Press the Esc key five times to access the Terminate Pendant screen.

Terminate Pendant Screen

From the Terminate Pendant screen you can use the function keys to do the following:

```
Terminate pendant
and release robot
      control
1yes            4no
```
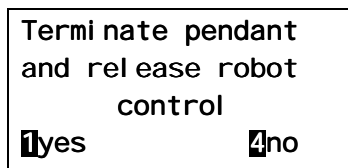
F1 yes   Transfer control from the teach pendant to the host computer.

F4 no   Return to the Application screen.

If the F1 key is pressed, control is passed to the host computer and the Pendant Off screen is displayed.

CHAPTER 4

Moving the Robot

This section describes the different manual motion types and modes available in the teach pendant. Robot motion initiated from the teach pendant is possible only from the Manual Menu screen.

The robot motion initiated from the teach pendant depends on two configurable options: the motion mode, and the motion type. The motion mode corresponds to the coordinate system used to define the motion. There are four choices for motion mode: joint, world, cylindrical and tool.

The other configurable option is the motion type. The motion type describes how the robot moves within the mode selected. There are four motion types: velocity, jog, align and limp. Not all motion types are compatible with all motion modes. For example, you cannot use the jog motion type in the cylindrical mode.

Note: If the robot is not homed, the Not Homed message will appear on the Manual Menu screen. **Until the robot is homed, you can only move the robot using joint motion--all other motion modes are disabled.** See the Homing (A465 and A255) section of this user guide for details on homing the robot.

The following sections define the motion modes followed by the motion types. In each case, the function of the motion keys is defined relative to the configured motion.

Motion Modes (Coordinate Systems)

There are four modes of robot motion available through the teach pendant. Each of these modes corresponds to a unique coordinate system for robot motion. The coordinate systems define how the robot moves in response to the axis keys. The motion modes are Joint, Cylindrical, World, and Tool.

Joint Mode

In Joint mode, each of the axis keys moves the specified robot joint. For example, pressing the Ax1,X,θ + key moves joint 1 in a positive direction, pressing the -Ax2,Y,R key moves joint 2 in a negative direction, etc. Extra axes, if available, can be moved with the appropriate axis keys in joint mode. The following figure shows the motion of each joint and the positive and negative directions of joint motion.
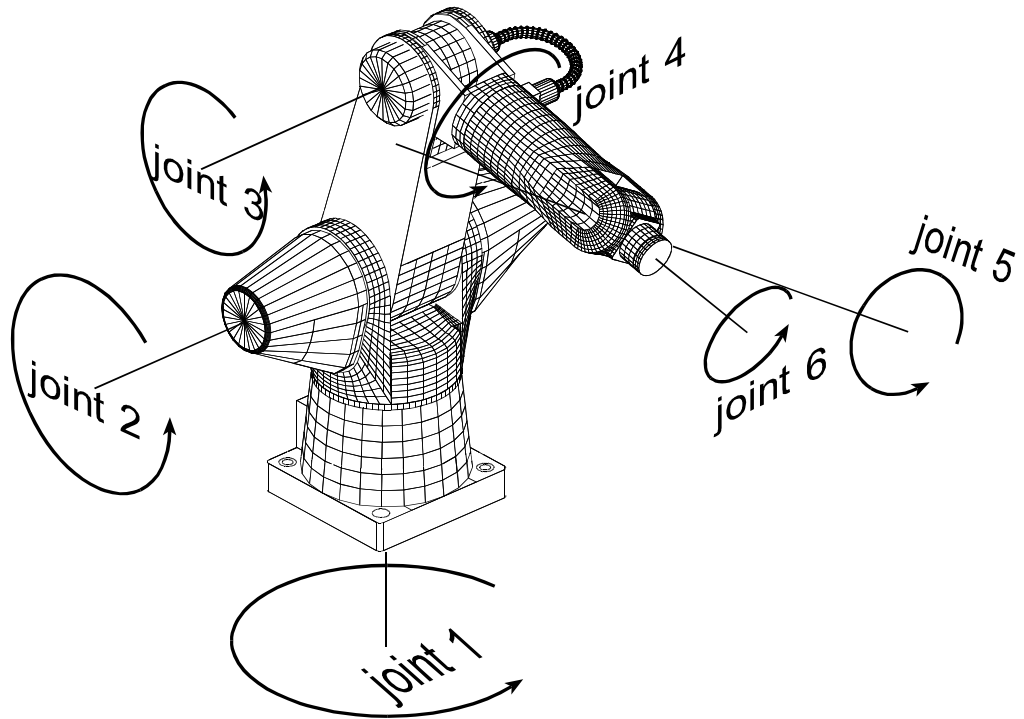
Cylindrical Mode

In Cylindrical mode, the axis keys move the robot in the cylindrical coordinate system. The cylindrical coordinates and the corresponding axis key function are defined in the following table.

Cylindrical Coordinates Motion

Coordinate	Axis Key	Description
Θ (theta)	1	Move the tool tip around the base of the robot, keeping a constant distance.
R (radius)	2	Extend the tool tip horizontally outwards from the robot (+) or draw it inwards (-) along the radius vector.
Z (height)	3	Move the tool tip vertically upwards (+) or vertically downwards (-).
Cyl-Yaw	4	Rotate the tool tip around a vertical axis.
Cyl-Pitch	5	Rotate the tool tip upwards or downwards.
Cyl-Roll	6	Rotate the tool tip around a horizontal line between the tool and the robot.
Extra Axis	7	Move the first extra axis (if connected) in the positive (+) or negative (-) direction.
Extra Axis	8	Move the second extra axis (if connected) in the positive (+) or negative (-) direction.
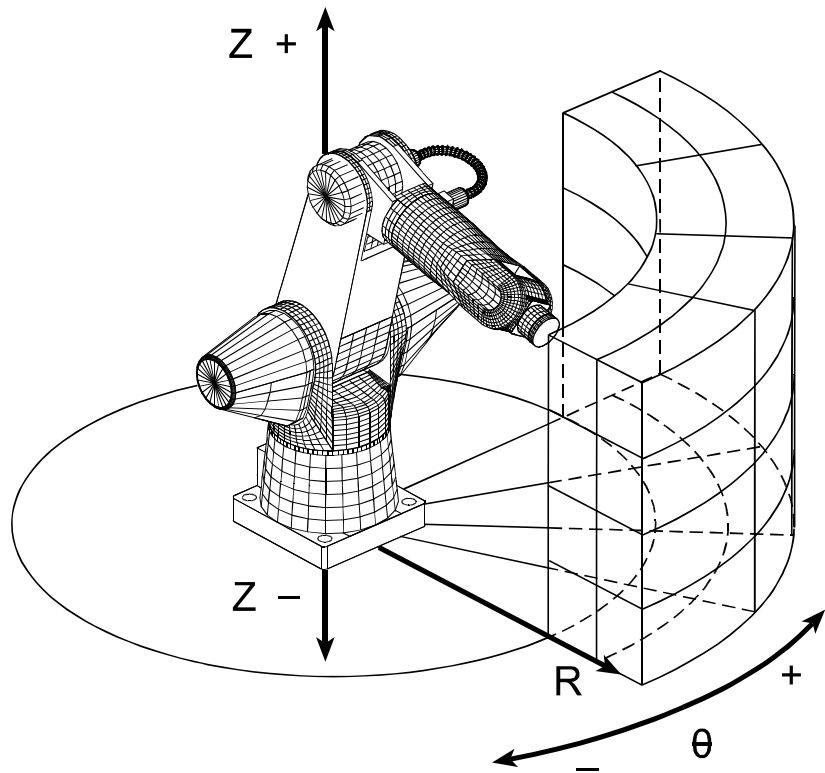
World Mode

The positive and negative directions of the XYZ axis in world mode are shown in the following figure. The origin in the world coordinate system is the center bottom of the robot base. The Z coordinate extends vertically upwards from the robot base, the Y coordinate extends out to the right (when facing the front of the robot) and the X coordinate extends out to the front of the robot.
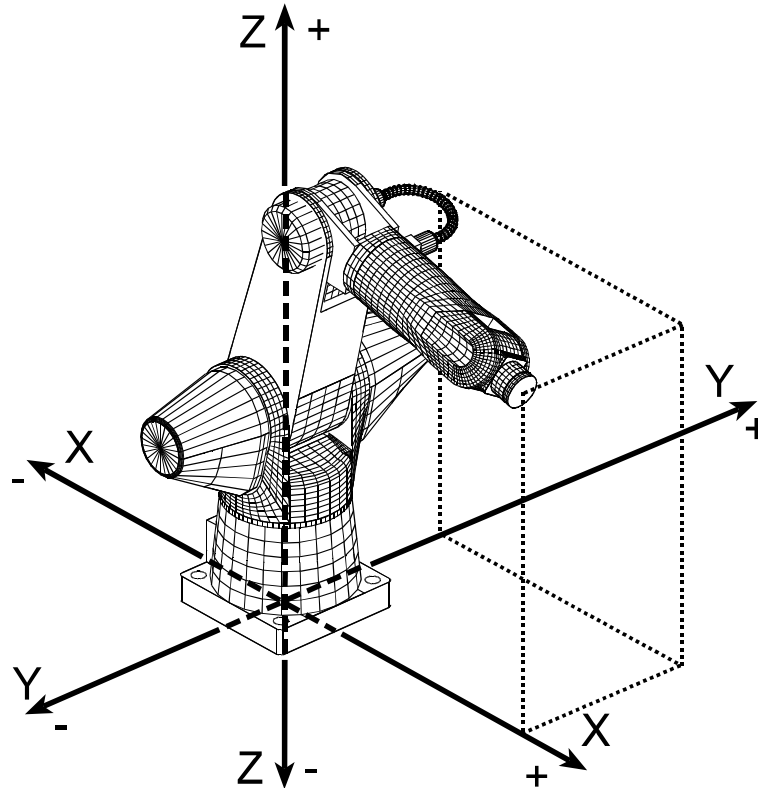
World Coordinates Motion

Coordinate	Axis Key	Description
World X	1	Move the tool tip forward (+) or backward (-) along the world X coordinate.
World Y	2	Move the tool tip in the positive (+) or negative (-) world Y coordinate direction.
World Z	3	Move the tool tip vertically upwards (+) or vertically downwards (-) in the world Z direction.
World Zrot	4	Rotate the tool tip around the world Z axis.
World Yrot	5	Rotate the tool tip around the world Y axis.
World Xrot	6	Rotate the tool tip around the world X axis.
Extra Axis	7	Move the first extra axis (if connected) in the positive (+) or negative (-) direction.
Extra Axis	8	Move the second extra axis (if connected) in the positive (+) or negative (-) direction.

Tool Mode

Tool mode refers to the tool coordinate system which is defined by the position of the tool. When the tool moves, so does its tool coordinate system in reference to a fixed coordinate system, for example, world coordinates. In general, the tool coordinates do not align with the world XYZ coordinates. An exception to this rule (for the A255 and A465) is at the ready position. At the ready position, tool XYZ coordinates align exactly with the world XYZ coordinates.

When positioned at ready, the tool coordinates can be describes as follows:

Tool Coordinates Motion

Coordinate	Axis Key	Description
Tool X	1	Move the tool tip forward (+) or backward (-) along the tool X axis.
Tool Y	2	Move the tool tip in the positive (+) or negative (-) tool Y coordinate direction.
Tool Z	3	Move the tool tip vertically upwards (+) or vertically downwards (-) along the tool Z axis.
Yaw	4	A-Series: Rotate the tool tip around the tool Z axis. F3: Rotate the tool tip around the negative X axis.
Pitch	5	All Robots: Rotate the tool tip around the tool Y axis.
Roll	6	A-Series: Rotate the tool tip around the tool X axis. F3: Rotate the tool tip around the tool Z axis.
Extra Axis	7	Move the first extra axis (if connected) in the positive (+) or negative (-) direction.
Extra Axis	8	Move the second extra axis (if connected) in the positive (+) or negative (-) direction.
Note: There are differences between the F3 and the A-series robots.		

Motion Types

There are four motion types: Velocity, Jog, Limp, and Align.

Velocity Motion

Use the velocity motion type to move the robot at a constant speed along a particular axis as determined by the motion mode. You can use the velocity motion type with any one of the four coordinate systems: Joint, World, Tool, and Cylindrical.

The robot relative speed is displayed on the third line of the Manual Menu teach pendant screen (1%, 5%, 10%, 20%, or 50%).

Jog Motion

Use jog motion to step the robot a prescribed distance in a particular direction. In jog motion the speed is fixed, but the jog distance can be varied. The distance to be moved is displayed on the Manual Menu screen, and can be increased or decreased with the Speed Up, Speed Down pendant keys. The direction of motion depends on the motion mode chosen and the axis key pressed. Each time an axis key is pressed, the robot moves the displayed

distance in the direction determined by the motion mode (i.e. the coordinate system selected).

You can use the jog motion type with the Joint, World, or Tool coordinate systems, but not with Cylindrical coordinates.

Limp Motion

Using the Limp motion type and the axis keys, individual robot joints can be limped or unlimped. Also, all the joints at the same time can be limped or unlimped. Limping a joint disengages the servo motors, essentially releasing control of the joint. If the robot is in a position in which limping a joint causes the robot to fall under gravity, damage to the robot or other equipment may result.

Warning! Limping the robot may result in robot collisions causing personal injury and/or robot and equipment damage. Read this entire section before using the limp motion type. You may need to have another person assist you when limping the arm.

Limping an Individual Joint

To limp a joint, ensure the Motion Type is set to limp, and press the + Ax1,X,θ key to limp joint 1. Similarly to limp another joint, press the axis key associated with that joint. For example, to limp axis 4, press the +Ax4,Yaw key.

Nolimping an Individual Joint

To nolimp a joint, ensure the Motion Type is set to limp, and press the - side of the axis key you wish to limp. For example, to nolimp axis 4, press the - Ax4, Yaw key.

Limping All Joints

The Limp motion type does not need to be chosen to limp or nolimp all robot axes. The pendant motion keys Limp All and NoLimp All can be pressed any time the Manual Menu screen is displayed on the pendant.

Align Motion

Use the Align motion type to align the robot tool's depart axis with one of the world coordinate axes.

The depart axis is defined as the axis the robot moves along when a depart command is executed. On A-Series robots, this corresponds to the tool X axis, while on the F3 arm this corresponds to the tool Z axis.

It is possible to align the tool's depart axis with the positive or negative world X, Y or Z axes by choosing the Align motion type and pressing the appropriate axis key. For example, to align the tool with the positive X axis, press the Ax1, X, ,θ + key. To align the tool with the negative Z axis, press the - Ax3,Z key.

Tip: A practical usage is to align the tool with the negative world Z-axis so the tool points exactly downwards. This is useful for inserting or removing parts or samples.

Allowable Motion Combinations

Not all motion types are compatible with all motion modes. The chart below shows the allowable combination of manual motion:

Motion Types (F3 key)	Modes (Coordinate Systems) (F4 key)			
	Joint	Cylindrical	World	Tool
Velocity	✓	✓	✓	✓
Jog	✓	x	✓	✓
Limp	✓	x	x	x
Align	x	x	✓	x

(✓) indicates an allowed combination.

(x) indicates an illegal combination.

Manual Menu Screen

The Manual Menu screen is the only teach pendant screen from which you can manually initiate robot motion with the teach pendant. You can access the screen from both the application or variable screens. The available options are different depending how you access the Manual Menu screen. The differences arise because in one case you have selected a variable, and in the other you have not.

When you access the Manual Menu screen by selecting a location variable, you can teach the variable. If you access the Manual Menu screen directly from the Application Edit screen, you have not selected a variable, and as a result the teach option is not available. The robot motion options are the same for both screens. It is only the absence of a location variable that differentiates the screens.

The following screen shows the Manual Menu accessed directly from the Application Edit menu:

```
Manual  Menu SL  OFF
        1%  VEL  JOINT


        3motn 4mode
```

When accessed by selecting a location variable, the Manual Menu screen appears as shown below. The location variable in this case [a two dimensional array of locations (lowloc)]is displayed in the third line of the screen. Two additional option choices are listed: the F1(tch) teach command and the F2 (rows) option for selecting the array element.

```
Manual Menu
         1%  VEL  JOINT
lowloc[0,1]
1tch 2rows3motn 4mode
```

Below is a description of the information displayed on the Manual Menu screens:

SL: Straight line mode is enabled. If this symbol does not appear, straight line mode is disabled. Toggle straight line motion on and off using the Shift-F4 key.

OFF: Arm power is disengaged. If arm power is turned on, this symbol will change to **ON**.

1%:   Current robot speed as controlled by the pendant. The speed can be increased or decreased using the Speed Up and Speed Down keys.

VEL: Current motion type. There are 4 motion types: VEL, JOG, LIMP and ALIGN. These are described in detail in the Moving the Robot chapter of this user guide. Toggle between them using the pendant F3 key (motn).

JOINT: Current motion mode. There are several motion modes available through the VEL and JOG motion types. These are described in more detail in the Motion Modes (Coordinate Systems) section. Toggle between them using the pendant F4 key (mode).

The following pendant function keys are used:

Key	Function
F1(tch)	Press the F1(tch) button to teach the present robot location to the selected variable.
F2(rows)	Use the F2 key to select the location array element.
F3(motn)	Use the F3(motn) key to change the motion type. You can toggle between velocity, jog, limp, and align motion types.
F4(mode)	Use the F4(mode) key to change the motion mode. You can toggle between joint, world, tool, and cylindrical.

To move the robot, choose the motion type, speed, and mode. Ensure the live-man switch is in the Motion Enabled position and the arm power is engaged. Make certain that the robot workspace is clear and then press one of the teach pendant axis keys to initiate motion.

CHAPTER 5

Teach Pendant Applications

You can open and run or edit an existing application with the teach pendant, or you can create a new application and new variables. These features allow you to choose one of two ways of creating robot applications.

- First you can create an application using the RAPL language with teachable variables. After the application has been created, you can use the teach pendant to open the application, select and teach the variables and run the application.

- The process can also be done in reverse. You can create the application and create and teach the location variables from the teach pendant. With the application and variables set, you can then write the program code to complete the application.

In either case, once an application is created, you can reach it from the teach pendant and from the application shell on the host computer.

Selecting an Existing Application

There are two routes for selecting existing applications. You can select the application at the host computer using the application shell, and then pass control to the pendant. Or, you can start the pendant from the system shell and then select an application using the teach pendant functions.

From Ash

When the teach pendant is started from an ash shell, it opens to the Application Screen. The application that is displayed in Line 2 of the teach pendant screen is the ash application from which the pendant command was issued. For example, if the pendant command was issued from the ash application "dryrun", the pendant opens to the Application screen with "dryrun" selected.

```
Application
dryrun


1edit 2run
```

At the Application screen, you can choose to:

F1 (edit)   Move to the Application Edit screen from which you can edit, create, or teach variables and locations, and move or home the robot.

F2 (run)   Run the application.

Note: If the location variables are taught and the non-location variables are initialized, the application runs. The robot will move independent of the live-man switch. In this instance, the point of control is passed from the pendant to the controller. When the application is completed, the control is returned to the pendant.

Using the Teach Pendant

It is possible to start up the pendant directly from the system shell by typing pendant directly at the system shell $ prompt before an application has been specified. The teach pendant opens to the Main Menu screen.
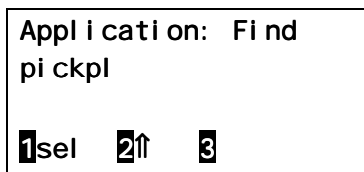
```
Main Menu



1app 2rob 3ctrl
```

The three options in the Main Menu are:

F1   app   press F1 to access the Application Find screen.

F2   rob   Robot Menu, either homed if the robot is homed or unhomed if the robot is not homed.

F3   cfg   Not available

To select an existing application:

1. Press the F1(app) key to open the Application Find screen.

```
Application: Find
pickpl


1sel    2⇑     3
```

The Application Find screen displays an application (the first in alphabetical order of the available applications) in the second line of the display screen. You can scroll through the list of applications using the F2 and F3 keys. When the application you wish to open is displayed, press the F1(sel) key to select the application.
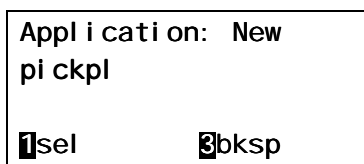
You can also type in the first few characters of the name of the application you wish to open and use the Quick-Find utility to locate it. The Quick Find utility is described in Quick-Find Utility section, page 29. Once you locate the application you want to work with, press the F1(sel) key to open the Application screen.

At the Application screen, you can choose to run the application or edit the application. If you choose to edit the application, open the Application Edit Screen.

Creating a New Application

You can create a new application from the teach pendant when you pass control to the pendant from the system shell. To create a new application:

1. At the system shell prompt '$' enter:
    pendant

2. From the teach pendant Main Menu, press the F1(app) key.

3. At the Application Find screen, type in the name of the application you wish to create. If no existing application exists with the name you typed, the Application New screen opens.

```
Application: New
pickpl


1sel        3bksp
```

4. After you have completed typing the name for the application, press the F1(sel) key.

    Note: Use the F3(bksp) key to edit the name if necessary.

5. Confirm your intention to create the application by pressing the F2 key.

The application is created, and you can access it with both the teach pendant or the Application Shell at the host computer. After creating the application, the teach pendant opens the Application screen. To work with the application, select the F1(edit) key.

Editing an Application

From the Application Edit screen, there are two options you can choose:

F1   (var)   Select or create, teach, or modify variables. This option will bring up the Var Find screen.

F2   (motn)   Move the robot in one of several motion modes. Manipulate the gripper, limp axes, etc. This option will bring you to the Manual Menu screen.

   Note: Selecting the F2(motn) command from the Application Edit screen opens the Manual menu screen with no variable selected. With no variable selected you cannot teach locations.

C H A P T E R 6

Teaching Variables

Once an application has been selected or created, you can work with the application variables. This section describes how to:

- Select variables from a variable file

- Edit the contents of a non-location variable

- Create and manipulate an array of variables

When teaching robot locations, move the robot to the desired location and enter the teach command. The location variable is packed with the robot's current location. Once a location is taught, move to that location using the variable name.

Selecting Variables

Variables are selected or created from the Var Find screen. In the Var Find screen shown below, the variable displayed is an array of 6 clocs (cartesian locations) named tubetray. The (undef) displayed at the top right of the screen indicates that the variable has not been taught.

```
Var Find:     (undef)
cloc[6]
tubetray
1sel  2del  3⇑   4
```
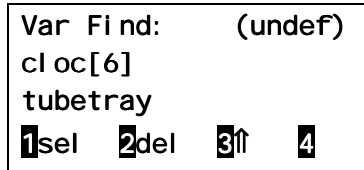
From the Var Find screen you can:

F1 (sel) Select the specified variable. Depending on the type of variable selected, the appropriate screen for editing variables opens. Refer to the Editing Variables section. If, as in this example, the variable is an array, the Select Element screen opens.

F2 (del) Deletes the specified variable.

F3 Scroll upwards through the variable list to locate a variable.

F4 Scroll down through the variable list to locate a variable.

Type the name of the variable using the data keys. This will invoke the Quick Find Utility. Refer to the Quick-Find Utility section of this user guide for details.

To select a variable:

1. Select the application which has the variable you wish to select.

2. From the Application Edit screen press F1(var) to access the Var Find screen.

3. You can scroll through the list of variables until the variable you want to select is displayed in the pendant screen. If you know the name of the variable you want, type it using the pendant alphanumeric keys. Typing the variable name opens the Quick Find utility.

4. When the variable you want to work with is displayed, press the F1(sel) key. If the variable is a:

location variable The Manual Menu screen opens.

non-location variable The appropriate teach variable screen opens. Teach integer, Teach float, or Teach string screen opens.

variable array The Select Element screen opens, requiring that you select the element you wish to work with. From the Select Element screen, scroll up or down the element list, or directly type in the element number you want. When you have selected the element, press F1(sel). If it is a location variable, the Manual

> Menu opens, and if it is a non-location variable, the appropriate teach variable window opens.

Quick-Find Utility

The quick find utility allows you to find and then select variables and applications by typing in the variable or application name. For selecting between many applications, or for finding variables when an application has a large variable table, the Quick Find utility can save time. It eliminates the need to scroll through the list to find the specific instance you are looking for.

Finding Variables

At the Var Find screen, type the name of a variable using the alphanumeric data keys. The Var Qfind screen opens.

This screen displays a variable from the variable table whose name starts with the same characters that you typed. If, for example, you type 'c', and there are two application variables 'counter' and 'custom', Quick-Find displays the variable 'counter' as shown in the following Var Qfind screen.

```
Var Qfind:
int
counter
1sel  2del  3qfnd  4bksp
```

The displayed variable is always the first variable listed beginning with the letter that you typed.

If you type the letter "u" after the "c", the variable 'custom' is displayed.

From the Var Qfind screen you have the following options:

F1	(sel)	Selects the displayed variable.
F2	(del)	Deletes the displayed variable.
F3	(qfind)	Moves the cursor to the end of the variable name.
F4	(bksp)	Moves back a space in the variable name.
Note: If there is no existing variable in the table that corresponds to the name that is typed into the pendant, the Var Create screen is displayed so that you can create the variable.		

Finding Applications

Similarly from the Application Find screen, you can type in an application name and access the Quick Find Utility for finding an existing application. If the application you type does not exist, the Application New screen is opened for creating new applications.

Creating a Variable

The starting point for creating a variable is the Var Find screen. To create a new variable, type the name of the variable you want to create. If the variable does not exist, the Var Create screen opens allowing you to create a new variable.

```
Var Create:
cloc
safel
1make2type 3dim
4bksp
```
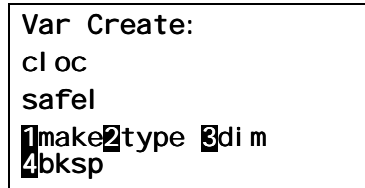
From the Var Create screen you can create a new variable of any type or an array of variables. Note that with the teach pendant you are limited to two dimensional arrays.

To create a new variable from the Var Find screen:

1. Type the name of the variable using the alphanumeric keys on the teach pendant. If you make a mistake typing, use the F4(bksp) key to make the correction. The Var Create screen opens.

2. Press the F2 type key to toggle through the list of variable types. Stop when the variable type you want is displayed.

3. If you want to make an array of variables, press the F3(dim) key to open the Input Dimension 1 screen.

4. In the first of two Input Dimension screens, enter the size of the first array dimension using either the pendant number keys or the scroll keys F2, F3. Press the F1(sel) key to register the selection.

5. In Input Dimension 2 screen, enter the size of the second dimension. If no second dimension is desired, enter a value of 0. Press the F1 key. You are returned to the Var Create screen.

6. Press the F1(make) key to create the new variable and enter it into the variable table.

Note: When a variable has been newly created, although it exists in the variable table, it has not yet been taught, and is considered not initialized. If this variable is a location variable (cloc, ploc), it is not possible to move the robot to that location until it has been taught.

C H A P T E R 7

Application Examples

This section provides the user with step by step instructions on how to accomplish a number of common teach pendant tasks.

These tasks include:

- Creating and teaching a new location
- Setting the value of a variable
- Moving through an array of locations
- Running an application

Creating and Teaching a new Location

One of the more common tasks performed with the Teach Pendant is to teach location variables. Teaching locations involves moving the robot to a specific location. When at the location, enter the teach command. The teach command results in the present location being written to the location variable.

To create and teach a new variable location:

1. At the host computer, open the ash shell to the application for which you require the new variable.

2. Start the teach pendant by entering the command pendant. This gives the teach pendant point of control. The teach pendant opens to the Application screen.

3. Press the F1(edit) pendant key to edit the application.

4. There are only two options at the Application Edit screen. You can choose a variable to work with, or choose to move the robot. To work with a variable, press the F1(var) key.

5. If there are variables residing in the variable table (.v3 file) corresponding to your application, the first variable (alphabetically) is displayed in the Var Find screen.

6. Using the alphanumeric data keys on the pendant, type in the name of the location variable you wish to create.

7. The Var Create screen opens with the variable name you entered displayed. The default variable type is cloc (cartesian location). If you wish to create a ploc (precision location), press the F2(type) key to toggle the variable type to ploc.

8. Press the F1(make) pendant key to create the new location variable.

9. You are returned to the Var Find screen, with the variable just created displayed. Notice that the upper right corner of the screen displays (undef). This signifies that the variable has not been taught.

10. Press the F1(sel) key to select the new variable. The Manual Menu screen opens with the variable name displayed.

11. Use the axis keys in the Manual Menu to move the robot to the position you would like the variable to represent. Refer to the section *Moving the Robot* for a description of the motion modes and types.

12. When satisfied with the robot location, press the F1(tch) pendant key to record this position in the variable table.

The created variable is now taught and can be used in the application.

Setting the Value of a Variable

You can also initialize a non-location variable using the teach pendant.

To set a non-location variable using the teach pendant:

1. At the host computer, open the ash shell to the application you wish to work with. Refer to the RAPL User Guide if necessary.

2. Start the teach pendant by entering the command pendant . This gives the teach pendant point of control. The teach pendant opens to the Application screen with application displayed.

3. Press the F1(edit) key to edit the application.

4. There are only two options at the Application Edit screen. You can choose a variable to work with, or move the robot. To work with a variable, press the F1(var) key.

5. If there are variables residing in the variable table (.v3 file) for the application, the first variable (alphabetically) is displayed in the Var Find screen.

6. Locate the variable you want to initialize and press the F1(sel) key to select it.

7. There are three non-location variable types: float, int, and string[20]. Depending on which type your variable is, the next screen will either be the Teach float, Teach int, or Teach string screen. Each of these screens operates in the same way. Simply type in the value you want to set the variable to.

8. Use the alphanumeric data keys on the pendant to type in the value you wish to store in the variable you have selected.

9. Press the F1(sel) key to set the value.

Moving Through an Array of Locations

Suppose you want to use the teach pendant to confirm the locations of an array of locations. This involves moving to each array location and determining if the position is sufficiently accurate for your purposes.

To verify the correct positioning of an array of locations:

1. At the host computer, open the ash shell to the desired application you wish to work with.

2. Start the teach pendant by entering the command pendant . This gives the teach pendant point of control. The teach pendant opens to the Application screen with the name of the application displayed.

3. Press the F1(edit) pendant key to edit the application.

4. Press the F1(var) key to access the Var Find screen. If there are variables residing in the variable table (.v3 file) corresponding to your application, the first variable (alphabetically) is displayed in the Var Find screen.

5. Select the location array variable you wish to check.
   Hint: Type the first few characters of the variable name to invoke the Quick Find utility.

6. The Select Element screen is used to choose the element of the array you want to check first. Type in the desired array element, and press F1(sel) to select it.
   Note: If the array has two dimensions, you must perform this step twice.

7. The Manual Menu screen opens. While holding in the live-man switch on the right side of the pendant, press and hold the pendant Move key. The robot will move to the desired location. The robot stops if the Move key is released before the location is reached.

8. Confirm the location.

9. The pendant Axis keys (the ones in yellow) are used for selecting array elements while in the Manual Menu screen. Press the Up Index pendant key to select the next location array index.

10. While holding in the live-man switch, press and hold the Move Key until the robot reaches the next location.

11. Confirm the location.

12. Repeat step 10, 11, 12 until each location in the array is confirmed.

Running an Application

If you have created an application, and all the location variables have been taught and the non-location variables have been initialized, you can run the application from the teach pendant.

For the following procedure, it is assumed that an application "teachloc" exists and that you pass control to the teach pendant from the application shell with the "teachloc" application active.

1. At the host computer, from the system shell prompt "$", open the ash shell to the teachloc application by entering:

   ash teachloc

2. At the teachloc> prompt, enter:

   pendant

   to pass control to the teach pendant.

3. If the variables are taught, you can run the application by pressing the F2(run) key.

4. You are asked to confirm your intention to run the application. Press F1(yes) to run the application. F2(no) returns you to the Application teachloc screen.

5. It may be necessary for you to press the Pause/Continue button on the controller front panel before the application can run. A message on the teach pendant requests that you press the PAUSE/CONTINUE if required.

Note: When running an application, you do not need to hold the live-man switch. To stop the robot motion while the application is running, hit the teach pendant Esc key or an e-stop button.
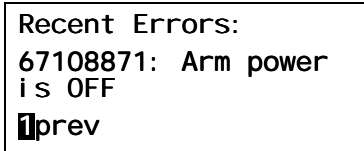
C H A P T E R 8

Teach Pendant Errors

When an error is encountered by the teach pendant, you are notified by the "error beep"—a single solid beep, about half a second in duration. This signifies that an error has occurred; however, it may not be immediately obvious what error was encountered.

Whenever an error occurs while using the teach pendant, the error number and a brief description is placed into an error log. The error log contains the last four errors encountered.

To display the most recently encountered error:

1. Hold down the Shift key (bottom right corner of the keypad)and the F1 key (upper left corner of the keypad) simultaneously.

```
Recent Errors:
67108871: Arm power
is OFF
1prev
```

Each error has both a number and a description. Although the error number is not generally useful, the error description may help you to determine the cause of the error. In the case of the screen pictured above, the "Arm power is OFF" error was returned when a robot move was attempted while the arm power was off.

If more than one error has occurred since the teach pendant was started, you can move through the list using the F1(prev) key and F2(next) key to display the other error items stored in the log.

When finished looking at the error listing, use the ESC key (upper right corner of the keypad) to return to the teach pendant application.

Note: Once an error has been displayed and the the ESC key is used to exit the error log, the error listing is removed from the log. It is not possible to recover an error listing once it has been cleared from the error log.

Troubleshooting

This section lists potential problems and possible solutions that you might encounter when using the teach pendant.

1. When I attempt to move the robot, the controller arm power shuts off.

   Solution: Ensure the live-man switch remains depressed during all robot motions. See the *Live-Man Switch* section in this user guide.

2. Whenever I attempt to move the robot the pendant beeps and nothing happens.

   Solution: There might be some type of robot error such as:

- Robot is not Homed

- Arm Power is off

Press shift and F1 to display the error log.

A P P E N D I X   A

Homing (A465 and A255)

Each time the C500 controller is turned on, the A465 and A255 robots must be homed before you can teach locations or run most robot applications. If the robot has not already been homed, home it using the teach pendant.

This section briefly describes how to home the A465 and A255 robot arms using the teach pendant. For details on the Homing requirements and procedures, refer to your *Robot Arm User Guide*.

Note: The F3 robot arms do not requiring homing. If you have an F3 robot, this section can be ignored.

Homing the Robot

The homing procedure moves each of the robot axes to a fixed reference point that allows them to synchronize their current position with stored calibration data. Simply put, once this procedure is completed, the robot will 'remember' and be able to move to previously taught locations. Once the robot has been homed, it remains homed until the controller is turned off.

Note: Turning the arm power off or on does not affect the homing status.

The Homing Procedure

Until the robot is homed, the only motions possible with the teach pendant are Joint based motion modes (i.e. Cylindrical, World, and Tool modes are disabled). Prior to homing, you may need to move the arm to avoid colliding with obstacles when the homing command is issued. The homing procedure requires robot motion; therefore, it is initiated from the Manual Menu screen.

To home an A465 or A255 robot using the teach pendant, complete the following:

1. Open the Manual Motion screen. From the Application screen, press F1(edit) to move to the Application Edit screen, and press F3(motn) to move to the Manual Menu screen.

2. Depending on your robot type:

    a) If it is an A255, use the Axis keys to line up markers on each joint.

    b) If the robot is an A465, ensure that the arm is in a position such that it will not collide with any obstacles during the homing procedure. Individual joints can be moved using the pendant Axis keys.

3. Press the Home key (directly below the red ESC key) on the pendant.

4. The Homing Confirmation screen is displayed. Press F1(yes) to initiate the homing procedure, or F2(no) to cancel. The live-man switch must be held through the duration of the homing procedure.