Start Up

Figure 1: Overall Configuration of the Robot

This chapter applies to students who will be working with the robot in the lab. When you want to access the robot via the WEB, somebody must do the start-up (steps 1, 2, and 3) for you and enable remote operation. When you enter the interactive control module of this tutorial you will receive a warning if the robot is not currently ready to operate in remote mode.

To start the robot in the lab do the following steps in order

1. Plug the Teach Box (Pendent) for the robot into the drive unit, if not already plugged in.
2. Start the computer connected to the CRS controller. It is currently configured to run Windows 98.
3. Double-click on the shortcut labeled "Serpent 2" shown on the desktop.

4. Turn on the power to the robot controller from the main switch on the front panel of the controller. You will get the following start-up message:
   RAPL-II ROBOT AND AUTOMATION PROGRAMMING LANGUAGE
   COPYRIGHT CRS PLUS
   VERSION 1.02 FEB 20, 1990
   M1A ROBOT
   M1A CONTROLLER
   >>
5. Respond to the prompt by typing W1 and move the robot arm by hand to check that all joint sensors are responding. All coordinate values should update. Press <CR> to proceed.
   >>W1<cr>
   ACTUAL POSITION (MOTOR PULSES):
   -0000512 -0000133 +0002130 -0000083 +0000266<cr>
   >>
6. Turn on servopower with the toggle switch underneath the main power switch. Be sure the fan in the controller has started before proceeding.
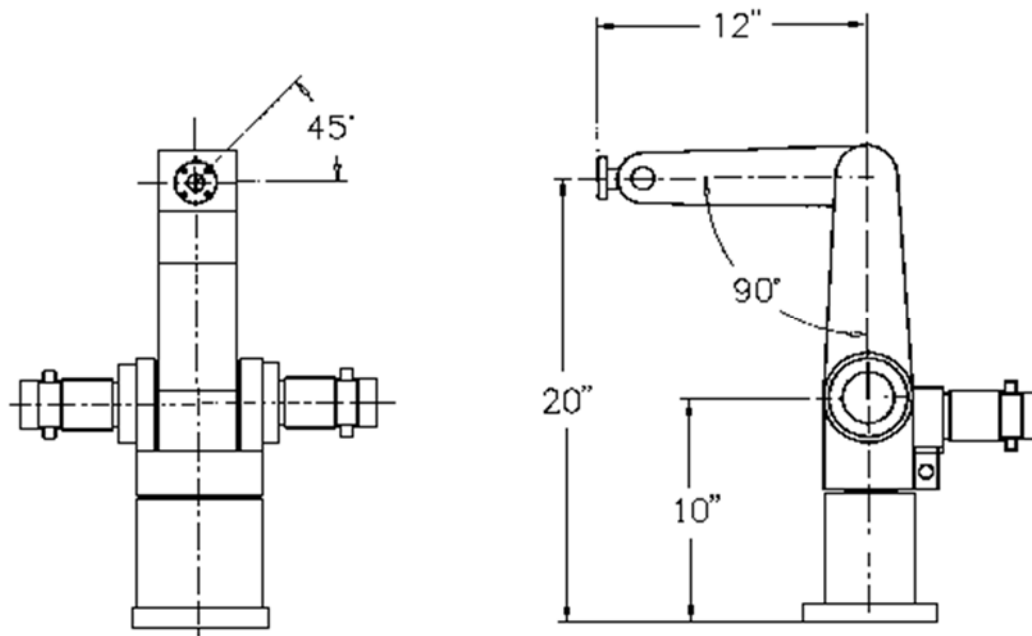7. Use these steps to home the robot arm.

Figure 2: READY position for CRS Plus robot arm

On the terminal carry out the following dialog. Type only the red characters, the controller will complete each command. This may take some getting used to and cause you to type extra characters that need to be deleted. If this is too confusing to you, you can turn off this HELP feature by issuing the NOHELP command:

>>NOHELP<cr> Issue the HELP command to turn this feature back on:

>>HELP<cr>

>>MANUAL<cr>

J>

From the Teach Pendant, set the SPEED dial to less than "10" and move the arm to its READY position as indicated by the small markers on the arm and shown in Figure 2.

J>NOMANUAL<cr>

>>HOME LOCATED IN ITS HOME BOUNDS? Y<cr>

Each axis in turn will slowly move to its HOME position as indicated on the screen:

WAITING FOR HOME ON AXIS #001 *** TEST PASSED

WAITING FOR HOME ON AXIS #002 *** TEST PASSED

WAITING FOR HOME ON AXIS #003 *** TEST PASSED

WAITING FOR HOME ON AXIS #004 *** TEST PASSED

WAITING FOR HOME ON AXIS #005 *** TEST PASSED

>>READY<cr>

>>

At this point the arm should move to its READY position. If not, repeat this sequence of steps and reposition the arm manually very carefully.

Now you can move the robot arm from the Teach Pendant, teach new points, or execute a program contained in the controller's RAM.
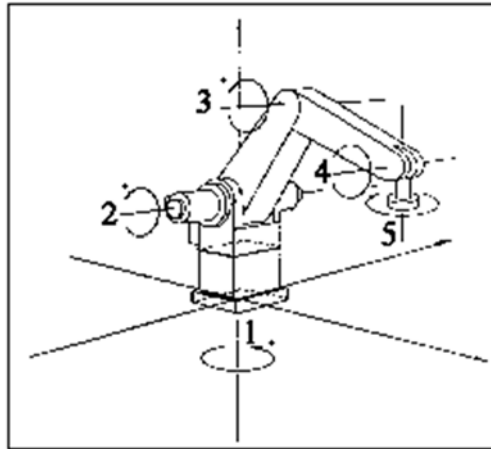
Movements

Robot Arm Articulation

Figure 3: Arm Configuration

The CRS Plus-M1 is a jointed arm with five (5) degrees of freedom. That means the arm has five joints connecting the rigid links of the arm. Starting from the base, the joints are:

1. Waist - connecting base and body. This is a rotary joint allowing 350° rotation in the horizontal plane.
2. Shoulder - connecting body and upper arm. This is a rotary joint with a range of 110° in the vertical plane.
3. Elbow - connecting upper and fore arms. This is a rotary joint with a range of 130° in the vertical plane.
4. Wrist Pitch - connecting fore arm and wrist. This is a rotary joint in the vertical plane allowing rotation of 200°.
5. Wrist Roll - connecting the wrist to the tool adapter. This is a twisting joint allowing ±180° of rotation.

The arm is powered with electric motors giving it a maximum pay load capacity of 1 kg (2.2 lb). Its repeatability is +/- 0.005 in. The maximum reach of the arm defines its work space. This is shown in Figures 4 (side view) and 5 (top view).
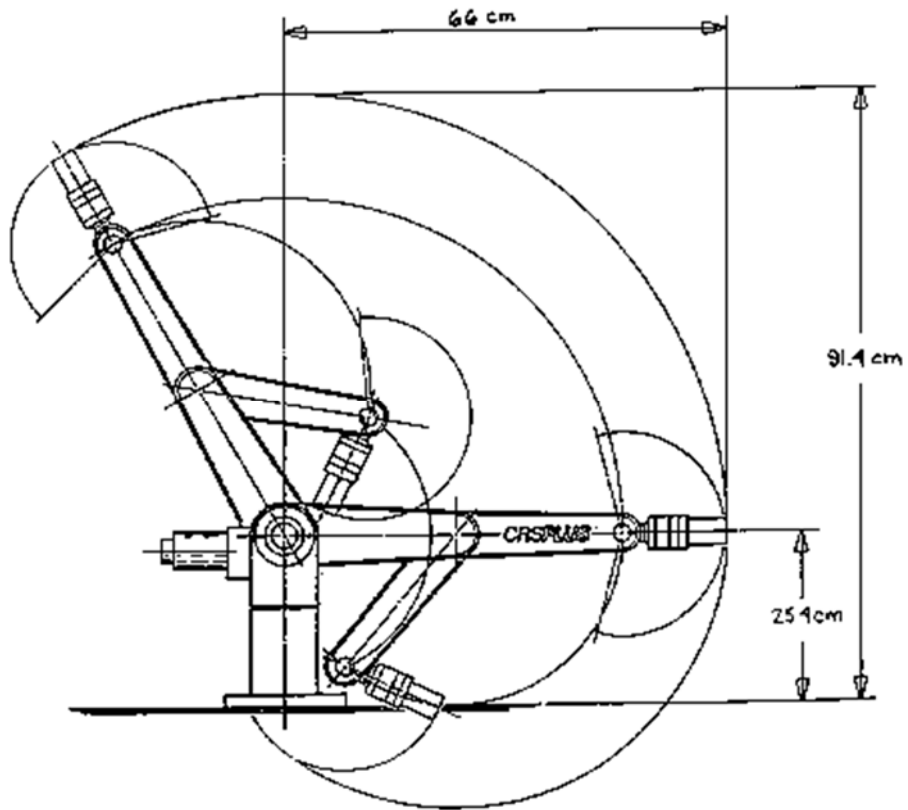
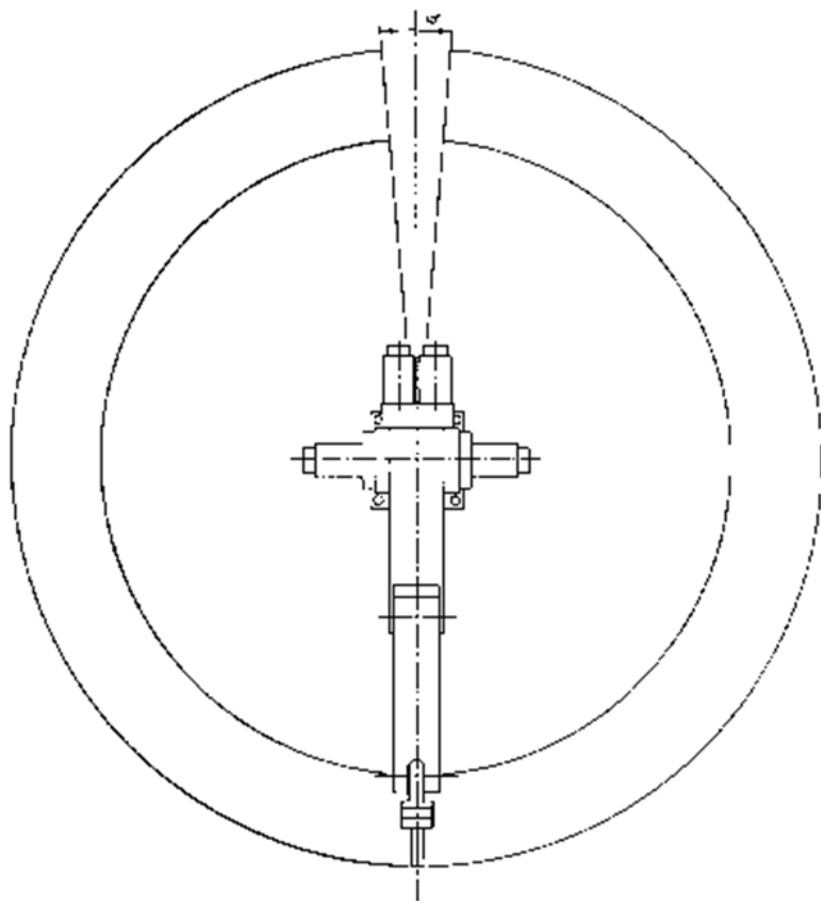Figure 4: Workspace elevation (side view)

Figure 5: Workspace plan (top view)

Teach Pendent

Using the Teach Pendant:

- From the teach pendant you can control the robot arm for setup and teaching of locations.
- With the pendant you can move the arm in any direction, you can open and close the hand, and change its speed.
- You will not be able to create programs with the pendant nor will you be able to execute an existing program.
- In this tutorial all the switches on the pendant will be explained. Click on any switch and its function will be described in this window.

Keys

Speed of Operation-Set operation speed

Waist-Rotates the waist (1st axis)

Shoulder-Rotates the shoulder (2nd axis)

Elbow-Rotates the elbow (3rd axis)

Wrist Bending-Bends the wrist (4th axis)

Wrist rotation-Twists the wrist (5th axis)

Auxiliary Axis-Rotates the auxiliary axis (6th axis)

Align robot arm-Press button to align arm.

Engage/disengage servo power-Manual positioning of the arm

Activate gripper

Teach button-Press button to teach current location.

About current move-Press button to abort current move.

Instruction Set

The instruction set for the CRS-M1 robot can be divided into several subsets depending on the general function an instruction executes. In the following table only those instructions are listed which are deemed necessary for the student to successfully understand this tutorial.

Many commands can be issued from the keyboard (immediate mode) or used within a program (Program mode). During immediate mode, only the beginning of most commands needs to be entered, the system will do the rest. This can be confusing at first and cause you to enter extra characters that need to be deleted!

The following system prompts are used to distinguish the different modes of the system

Prompt

>*

>*

J>

C>

Explanation

Edit Mode

Immediate Mode

Joint Manual Mode

Cylindrical Manual Mode

1) **System Commands** (generally used in immediate mode):

Help

>>HELP<cr>

Turns on HELP mode including command completion and listing of parameters. This is the default mode on system start-up.

noHelp
>>NOHELP<cr>

Turns off HELP mode.

New
>>NEW<cr>
Are you sure? Y<cr>

Clear user memory. All programs, locations, and variables will be erased

Free
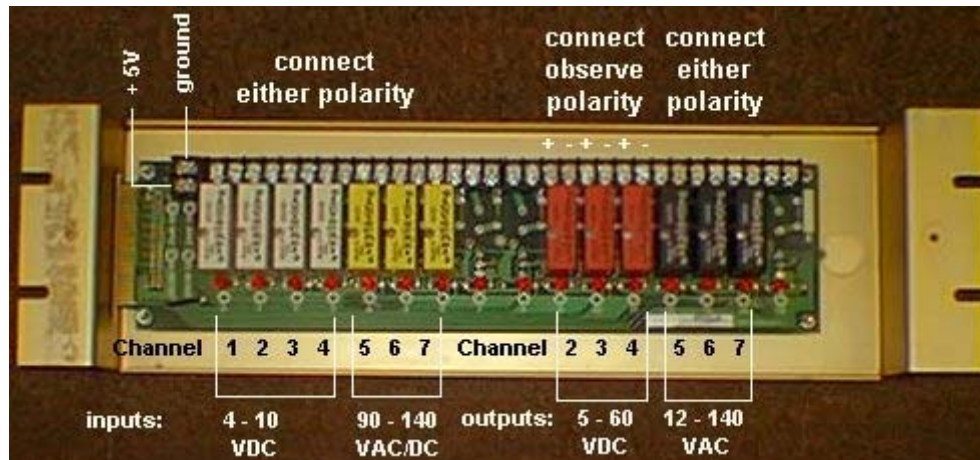**>>FREE<cr>**

Displays user memory status.

Status
>>Status<cr>

Displays the operating status of the robot.

Binary I/O

Connection to Digital I/O Circuits

All digital input and output signals to and from the CRS Plus Robot are connected through a terminal strip in the DB16/R interface box. The interface can handle up to 8 input and 8 output signals.


Each signal is buffered through a signal conditioning module which isolates the "outside" world from the robot controller. Different colors of the I/O modules signify different voltage ranges and types.

1. The white DC input modules are CRS part number SRS-DB/IDC5B. The input voltage range is: 4 to 16 VDC. Input impedance is 1 KW.
2. The yellow AC/DC input modules are CRS part number SRS-DB/IAC5. The input voltage range is 90 to 140 VAC/DC. The input impedance is 14 KW.
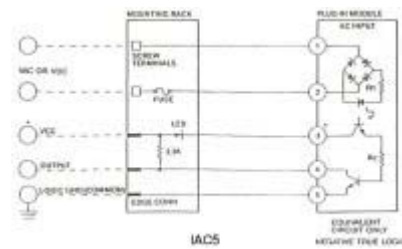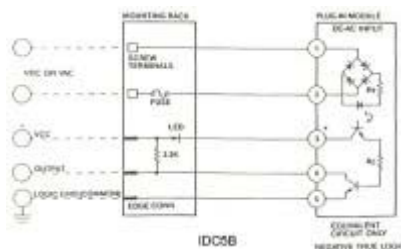
3.
4. The red DC output modules are CRS part number SRS-DB/ODC5. The operating voltage range is 5 to 60 VDC, 3A max.
5. The black AC output modules are CRS part number SRS-DB/OAC5. The operating voltage is 12 to 140 VAC, 3A max.
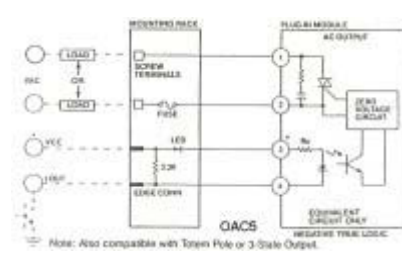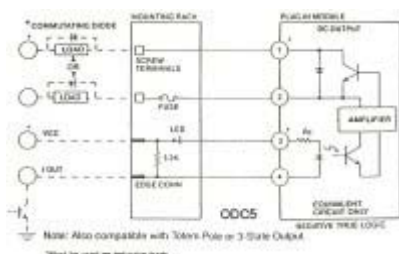
Shut Down

This chapter applies to students who will be working with the robot in the lab. When you have accessed the robot via the WEB the remote control program for the robot will remain active after you terminate your session.

At the end of your lab session the computer and robot system must be shut down properly to avoid damage to the equipment.

1. Turn off power to the servo motors on the control box. Have somebody support the arm and lower it gently to the ground as it will drop without motor power.
2. When the arm reaches that position, turn off the controller;
3. Terminate which the terminal emulation program on the computer:
        type ALT/X
        followed by Y or press the ENTER key to exit ProComm.
4. Shut down Windows following established procedure.
5. Turn off power to the computer on the power strip.