

Start Up

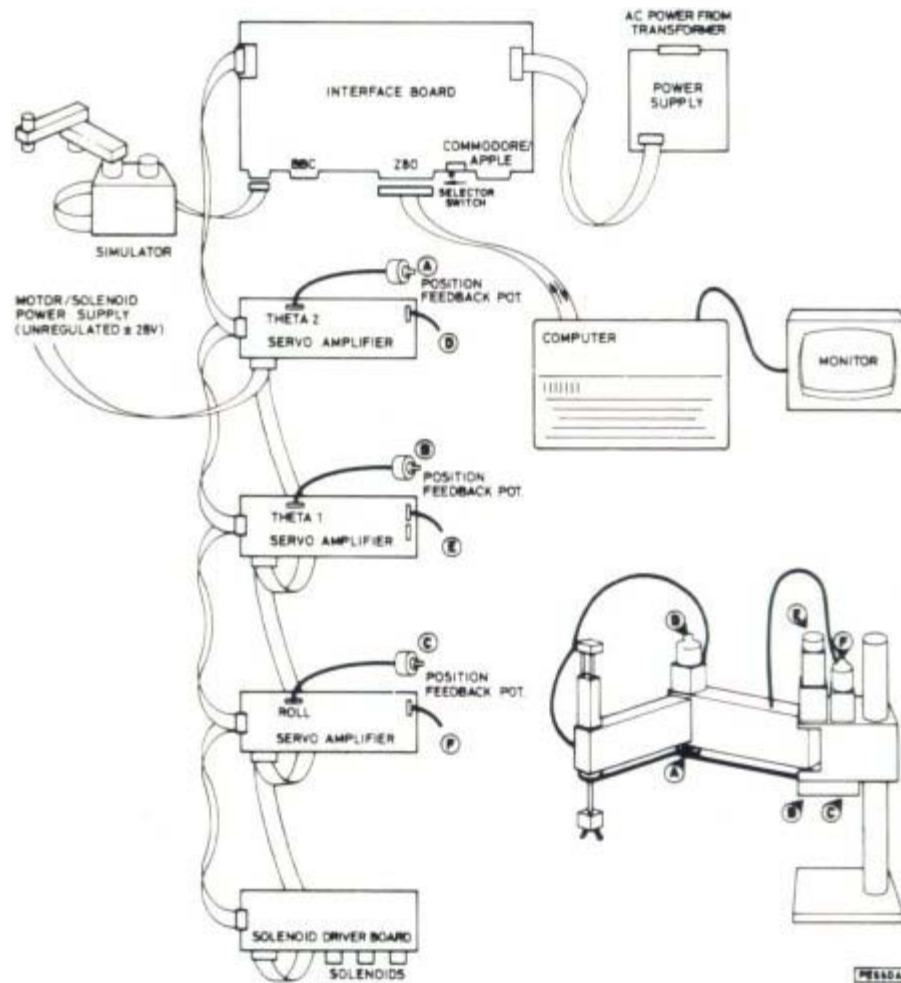


Figure 1: Overall Configuration

of the Robot

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

1. Verify that the PNEUMATICS and MOTOR switches on the Serpent controller are both OFF (down).
 1. The axes may now be moved manually by pressing the Nose Lead buttons on the sides of the axes. Pressing the axis 1 or 2 buttons lightly will move the axes slowly. Applying more pressure will assist the motor and the axes will move faster.
 2. Do not operate the wrist at this stage!
2. Verify that the hose for shop air is connected to the robot controller and the valve at the wall is turned on.
3. Start the computer connected to the Serpent controller. After booting is complete, it will display the DOS prompt. Enter the red commands in response to the ">" prompt. Terminate each line by pressing the ENTER key:


```
C:>d:
D:>cd\robot\scara
D:\ROBOT\SCARA>menu
```

This will start the controller program for the Serpent on the PC and display the top level menu:

- 0 - SYSTEM - Exit to DOS
- 3 - CHARMER - Serpent control program
- 6 - WALLI - Workcell control language
- C - CONFIGURE - Set device addresses

Movements

Robot Arm Articulation

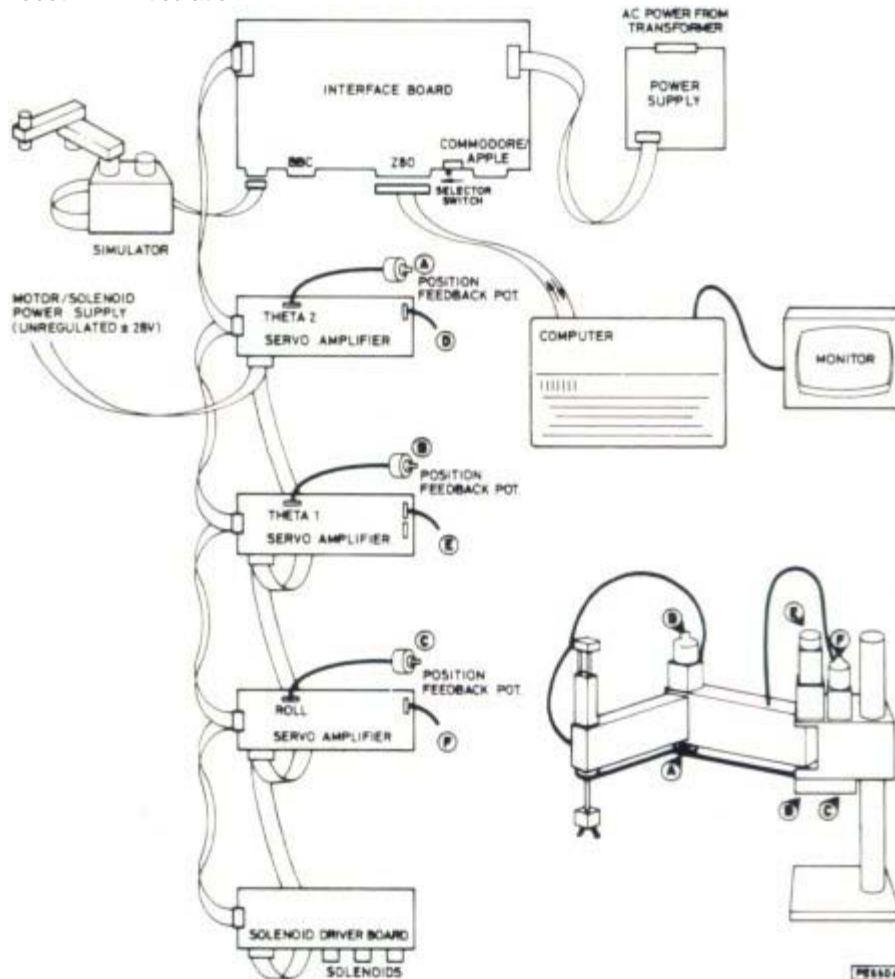


Figure 2: Serpent Configuration

The Serpent 2 robot is a SCARA arm with four (4) degrees of freedom. That means the arm has four joints

connecting the rigid links of the arm. Starting from the base, the joints are:

1. Waist - connecting body and upper arm. This is a rotary joint with a range of 200° in the horizontal plane.
2. Elbow - connecting upper and fore arms. This is a rotary joint with a range of 250° in the horizontal plane.
3. Wrist roll - connecting fore arm and wrist extender. This is a twisting joint in the vertical axis allowing 450° of rotation.
4. Wrist height - connecting the wrist extender to the tool adapter. This is a linear joint allowing a maximum stroke of 75 mm (3 inch).

The arm is powered with electric motors giving it a maximum pay load capacity of 2.0 kg (4.4 lb). The maximum reach of the arm defines its work space. This is shown in Figure 3.

Coordinate System

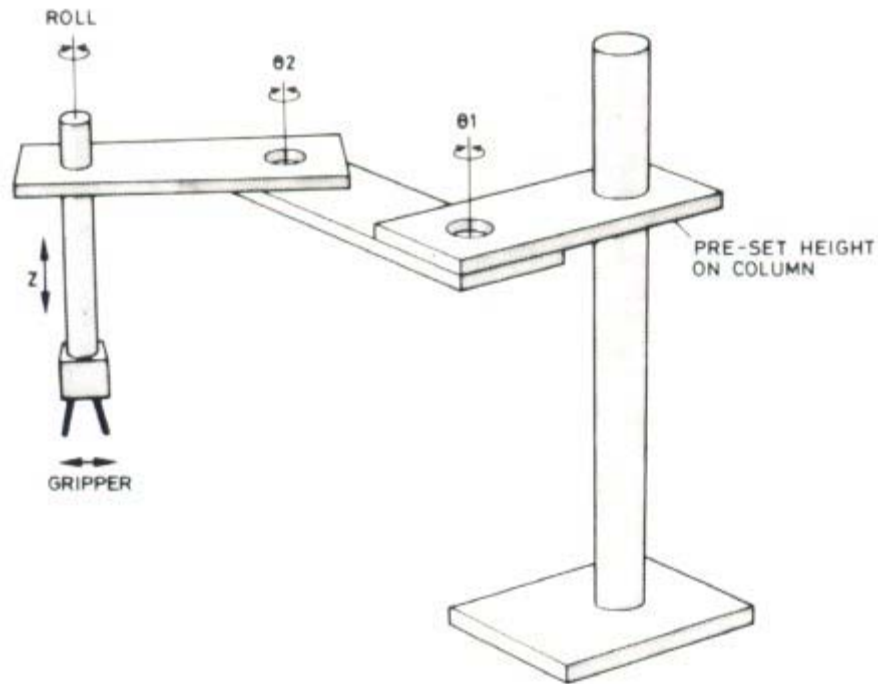


Figure 4: Joint Coordinate System (Articulated Motion)

- In the Joint Coordinate System a position of the robot hand in space is defined by the angles of rotation of three joints and the linear joint of the arm. Because of the design of the arm, positions can be reached through different combinations of these angles.
- Specifying a new coordinate for one of the joints results in motion of only that one joint; the endeffector (hand, tool) moves on an arc. Movement from some point A to another point B using linear interpolation in these joint coordinates does not result in straight line motion but rather follows a complex curve in three space.
- This is the coordinate system used by the servo-loops of the robot controller. It allows for independent control of each joint.

Serpent Control

The Serpent control program is called **Charmer**. It is a computer based control system and provides several modes of operation for the Serpent robot. Selecting **option 3 - CHARMER** from the top level control menu loads and runs this program which will first verify the workcell interface with the following question:

Robot assumed to be selected by ADDRESS LINE A4 as standard

Has robot been modified? Y/N

Answer by entering **N** or pressing the **ENTER key**.

Next the main menu will be displayed on screen:

CHARMER - Serpent Control Program

- O Open loop keyboard control
- C Closed loop keyboard control
- S Simulator control
- N Nose lead control
- R Replay of sequence
- L List sequence
- T Test workcell interface
- Q Quit - return to top level menu

The PNEUMATIC and MOTOR current may be switched ON (switches UP) after selecting a control mode. No significant movement should occur.

DO NOT USE THE NOSE LEAD BUTTONS

with the MOTOR switch in the ON position!

The first four options in the main menu (O, C, S, N) allow the robot arm to be repositioned and those positions to be remembered in sequence (TEACHING).

Analog/Digital Interface

The Serpent workcell interface connectors are at the rear of the controller box. There are 18 sockets with the following signals:

Top Row (left to right)		Bottom Row (left to right)	
Black	Digital ground	Black	Digital ground
Black	Digital ground	Black	Digital ground
Black	Digital ground	Black	Digital ground
Green	Digital output 1	Blue	Digital input 1
Green	Digital output 2	Blue	Digital input 2
Green	Digital output 3	Blue	Digital input 3
Green	Digital output 4	Black	Analog ground
Green	Digital output 5	White	Analog input
Green	Digital output 6	Red	power output: +5V

Signal Specifications:

Digital Outputs:	Single negative going pulse Pulse length - approx. 2 msec Voltage - TTL level (0 to +5 V) Current - 20 mA drive capability
Digital inputs:	Voltage - TTL level (0 to +5 V)
Analog inputs:	Voltage range - 0 to +10 V

Workcell Control

A workcell is a group of handling, modifying, transporting, sensing, and control devices, operating together from a single control system for implementing a manufacturing process automatically.

WALLI is a powerful high level language by which up to eight robots and eight machine tools may be intelligently operated from a single controlling computer. The robots, which may be any combination of range, may be moved individually or conditionally and also in conjunction with the machines.

Branching occurs dependent upon sensor inputs. Peripheral devices are operated as required. Subroutines may be written and additional parallel subroutines are also implemented.

The main control programs enable data and programmed-in delays to be played back step by step or in sequence.

The robot sequence files are used as the directories of positions to which the robots are sent. The order of the positions is defined by the program rather than the order in which they were entered.

WALLI is interactive and menu-driven; the programs may be easily edited, stored on disk, and printed out.

There are six main parts in WALLI:

- * Editor
- * Debugger
- * Interpreter which includes an interrupt routine
- * Workcell control program created by the user
- * Robot position data files created by the user
- * NC program files for the machine tools

Shut Down

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

1. On the PC return to the top level menu and select option "0 - exit to DOS";
2. Turn off the PNEUMATIC and MOTOR switches on the front panel of the controller;
3. Turn off power to the computer.