The Micro-Grasp robot arm

Part 2

This part covers construction of the interface electronics board, which completes the project.

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ALL THAT REMAINS to complete the Micro-Grasp project is the assembly of the interface board, wiring it to the mechanical assembly and arranging the interface connections.

ELECTRONIC ASSEMBLY

Many of the components on the interface board are closely spaced and you'll find assembly easiest if you follow the order detailed here.

Sockets are used for all the dual-in-line (DIL) ICs. These should be soldered in place first. Identify which is required for each IC position and solder them in place one by one taking care to orientate them correctly.

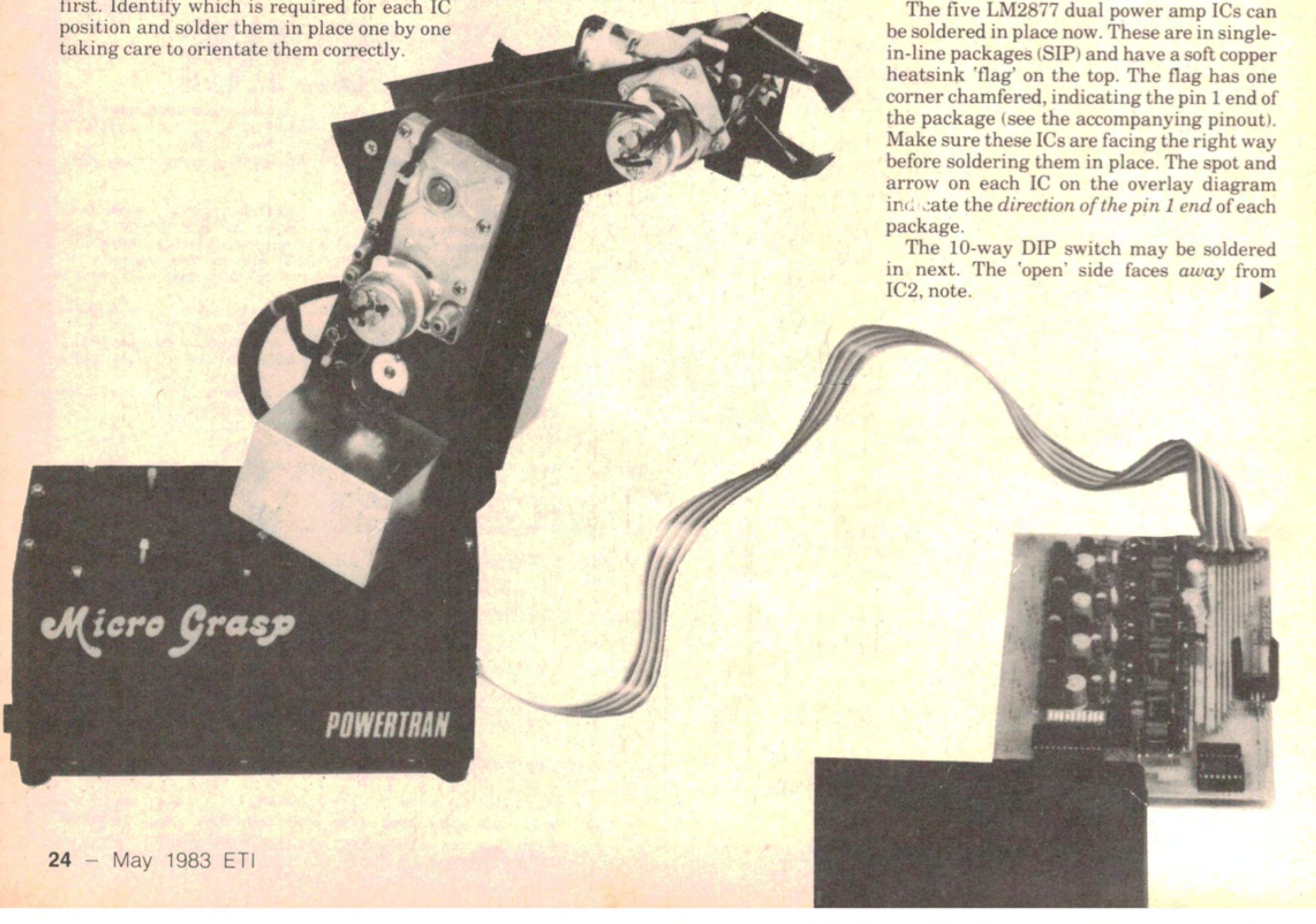
The single-in-line resistor pack, R3-R10, should be soldered in place next, making sure you place the end marked with a spot towards the outer edge of the board, as indicated on the component overlay.

All the resistors should be soldered in place next. Note that four are stood vertically from the board: R26, R27, R29 and R30. Solder the disc ceramic capacitors in place next, then the polyester capacitors (the colour-coded ones). The four 47n capacitors are located between the row of trimpots and the row of IC6s (A, B, C, D). The 100n capacitors are all located between the row of trimpots and the line of LM2877s (ICs 8A-D and 10). Finish off this stage of the construction by soldering the electrolytic and tantalum capacitors in place. Take care they are each orientated correctly.

Now you can mount the eight trimpots. Follow by assembling the 7805 regulator, IC1, and its heatsink to the board, carefully bending the leads to fit into the holes provided. Solder the leads *after* tightening the securing bolt.

The five LM2877 dual power amp ICs can be soldered in place now. These are in single-in-line packages (SIP) and have a soft copper heatsink 'flag' on the top. The flag has one corner chamfered, indicating the pin 1 end of the package (see the accompanying pinout). Make sure these ICs are facing the right way before soldering them in place. The spot and arrow on each IC on the overlay diagram indicate the *direction of the pin 1 end* of each package.

The 10-way DIP switch may be soldered in next. The 'open' side faces *away* from IC2, note. ▶



INTERFACE BOARD

Resistors .... all ½W, 5%

R1, 2, 15A-D, 16A-D, 31, 33	4k7 (12 off)
R3-10	4k7 8-up SIP network
R11	82R
R12	68R
R13A-D, 18A-D, 19A-D, 21A-D, 27, 30	1k (18 off)
R14A-D	3k9 (4 off)
R17A-D	470R (4 off)
R20A-D, 22A-D, 25, 28, 32, 34	100k (12 off)
R23A-D, 24A-D, 35, 36	3R3 (10 off)
R26, R29	10k (2 off)
RV1A-D, RV2A-D	22k trim pots (8 off)

Capacitors

C1, C2	220u/16 V RB electro. (2 off)
C3, C4	1u/16 V tant. (2 off)
C5A-D	47n ceramic (4 off)
C6A-D	100u/10 V RB electro. (4 off)
C7A-D	100p ceramic (4 off)
C8A-D	47u/10 V RB electro. (4 off)
C9A-D	47n polyester (4 off)
C10A-D, 11A-D, 12A-D, 13A-D, 16, 19	100n polyester (20 off)
C14, C15	47u/6V3 tant. (2 off)

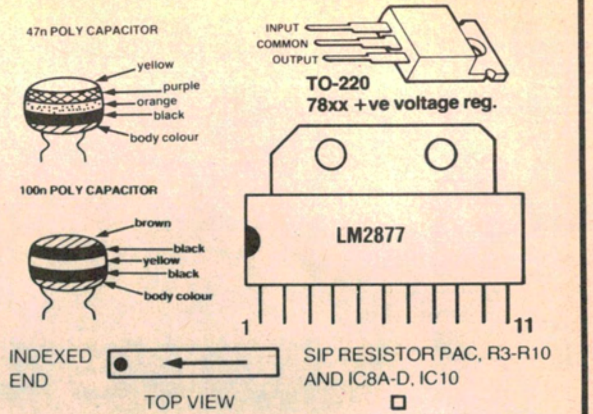
Semiconductors

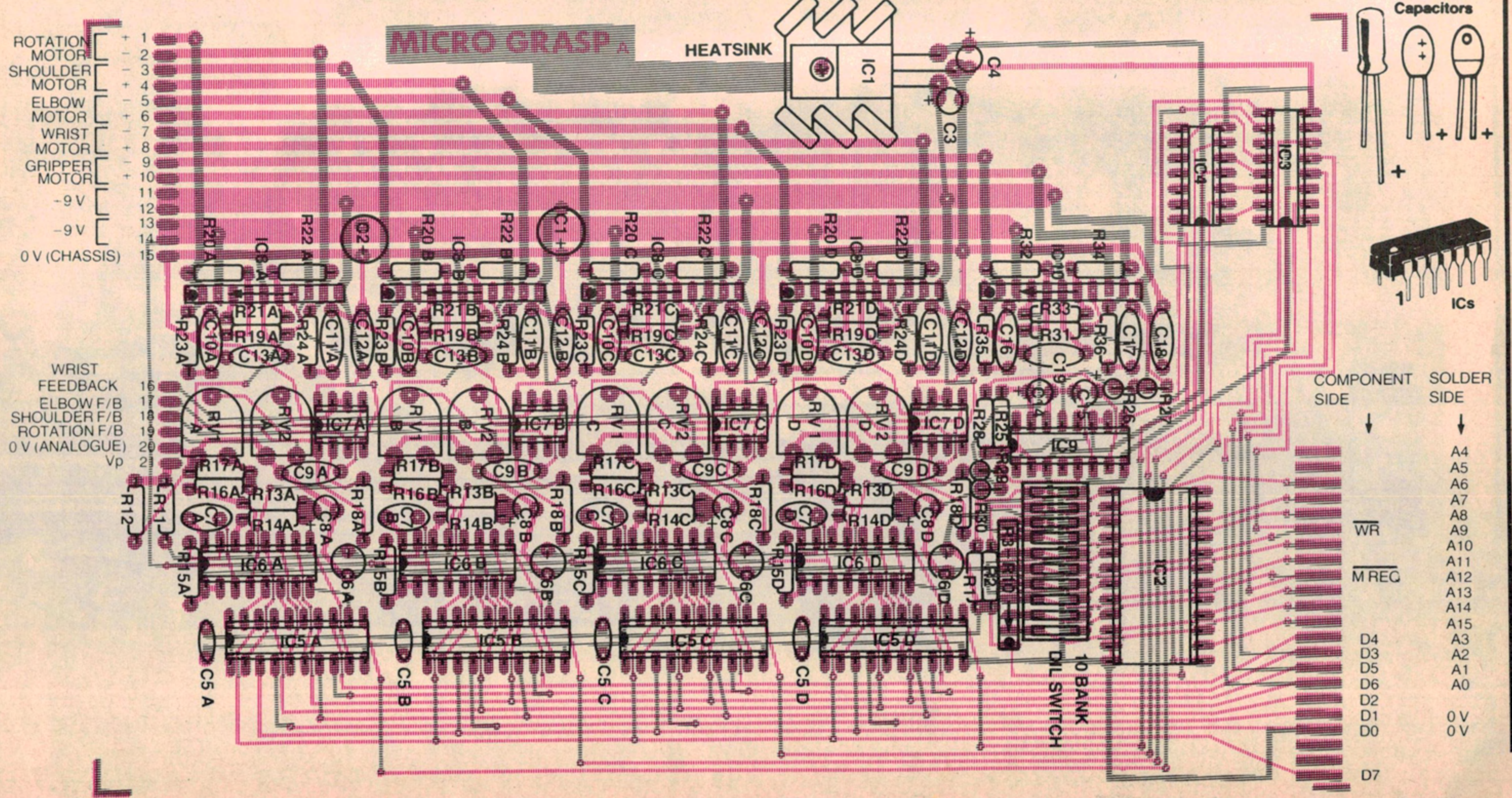
IC1	7805
IC2	DM8130
IC3	74LS138
IC4	74LS04
IC5A-D	74LS373 (4 off)
IC6A-D	DAC0808 (4 off)
IC7A-D	1458 (4 off)
IC8A-D, IC10	LM2877 (5 off)
IC9	74LS123

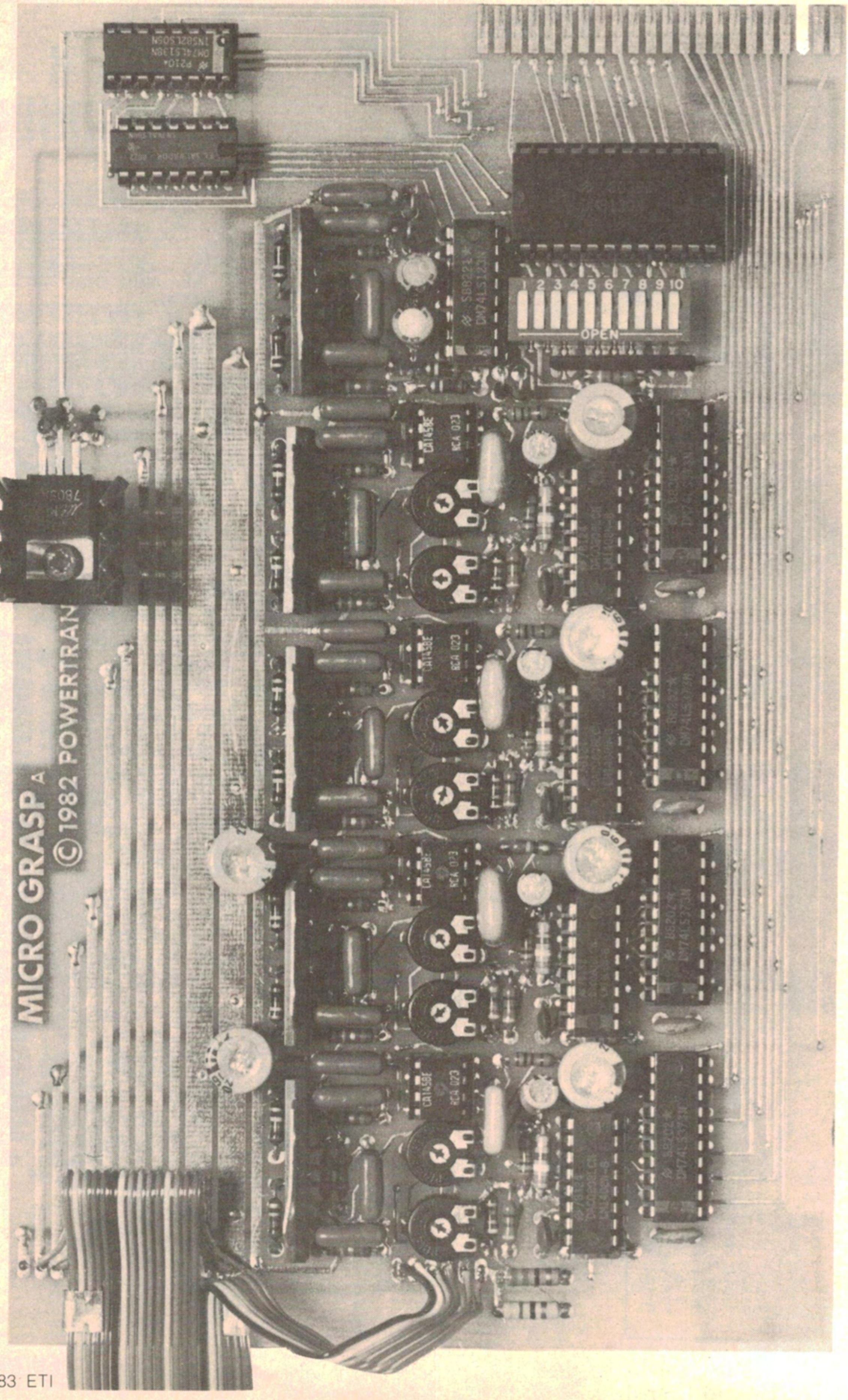
Miscellaneous

S1-S10 .... SPST 10-band DIL switch

Printed circuit board; flatpack heatsink; 4 x 8-pin IC sockets; 1 x 14-pin IC socket; 6 x 16-pin IC sockets; 4x20-pin IC sockets; 1x24-pin IC sockets.






MICRO GRASP A
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OPEN

TABLE 2.

PC BOARD CONNECTION POINT	TERMINAL BLOCK	DESTINATION
1	1	rotation motor +ve
2	2	rotation motor −ve
3	3	shoulder motor −ve
4	4	shoulder motor +ve
5	5	elbow motor −ve
6	6	elbow motor +ve
7	7	wrist motor −ve
8	8	wrist motor +ve
9	9	gripper motor −ve
10	10	gripper motor +ve
11, 12	11	+9 V
13, 14	12	−9 V
15	tag	0 V (solder tag on chassis)
16	13	wrist feedback (RV101D, tag B)
17	14	elbow feedback (RV101C, tag B)
18	15	shoulder feedback (RV101B, tag B)
19	16	rotation feedback (RV101A, tag B)
20	17	0 V, analogue
21	18	Vp

That completes the component assembly. A careful check at this stage may obviate problems later on.

The 21-wire flat ribbon cable can now be prepared for connecting between the interface board and the arm assembly. Separate the wires at one end and strip and tin the wires. A group of six on one side is pared back from the rest to go to connection points 16-21 (see the overlay and photograph).

The other end of the ribbon cable connects to the terminal blocks on the end plate of the arm assembly according to Table 2 (which is related to Table 1). Temporarily leave off the wires to terminals 2, 4, 6, 8 and 10.

Check everything, once again.

Don't plug in the remaining ICs yet.

All that remains now is to arrange the interface connections according to your computer's expansion socket pinout.

The edge connector at the right hand end of the board plugs into a 44-way keyed socket. This is British-made, UECL part CS 1692F 1585 8237, and suits the Sinclair ZX81 expansion connector. To interface the board to your computer, you'll need one of these sockets, a short length of 28-way ribbon cable and a plug or socket to suit your computer's expansion connector.

Testing and calibration

Power up the robot and interface board without the computer connected and with all the ICs unplugged and check the power rails for ±9 V approximately and ±5 V from the regulator. Assuming all is well, switch off and plug in the ICs. Check again and switch off.

Connect the computer, switch on the robot followed by the computer and check the computer's operation is unaffected by the interface board. If it is, then there is probably a short across the address or data lines on the board.

Set all the DIL switches to open, rotate RV1 A-B-C-D fully anticlockwise and enter POKE 65472,0. Each output of IC5a will now be low and IC7a pin 1 will be close to 0 V. Enter POKE 65472,255 and each output will change to high and IC7a pin 1 will change to close to +1 V. Enter POKE 65472,128 and IC7a pin 1 will change to 0.5 V.

Similar results will be obtained on servo circuits B, C, D using addresses 65473, 65474, 65475 respectively.

Address the monostables with POKE 65477,0 and POKE 65478,0 and IC9 pins 13 and 5 respectively will go high for about two seconds and then return to low.

Connect the rotation motor (terminal block 2) whilst the robot is switched off, turn each preset to its midway position and switch on. The arm will move to some extent and come to rest peaceably i.e: without being held back by its cables.

Turning RV1A will result in the arm changing its position.

Return RV1A to its midway position, successively enter data of 0 and 255 (i.e: minimum) and maximum codes and adjust RV1A-RV2A for 180° of movement symmetrical about the forward facing position.

Repeat this procedure one axis at a time for the other three servo-controlled axes, adjusting for the shoulder to move between almost touching the end stop and about 10 below horizontal and for the elbow and wrist joints to have 180° movement.

Finally, connect and check the gripper motor circuit and after fitting the end panels the robot is ready for use.

We hope to follow up this project description with some general software details plus interfacing to some popular micros and a few programs. ●